GCAS®

Manual Guide

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Revision: 26

Last updated: 11 July 2018

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Revision Log

Revision : 26
Finalised on : 11 July 2018
Based on : GCAS version 1.18.0.18191

- Updated chapter 30 (Batch report)

Revision : 25
Finalised on : 7 May 2018
Based on : GCAS version 1.17.1.18122

- Updated chapter 17 (Dashboard)
- Updated chapter 28 (Data provision)
- Updated screenshots

Revision : 24
Finalised on : 27 February 2018
Based on : GCAS version 1.17.0.18057

- Update on chapter 27.1.2 (Bit length and byte ordering)

Revision : 23
Finalised on : 8 January 2018
Based on : GCAS version 1.16.1.18007

- Minor update on chapter 13 (Uncertainty trend)
- Minor update on chapter 15 (Component uncertainty trend)
- Updated chapter 17.4.2 (Dashboard alarm alert)
- Updated chapter 27.5.2 (AlertMe by email)
- Updated screenshots

Revision : 22
Finalised on : 21 December 2017
Based on : GCAS version 1.16.0.17355

- Inserted chapter 13.3.3 (Change axes scale)
- Inserted chapter 13.6 (Uncertainty Trend form to Component Uncertainty Trend form linkage)
- Inserted chapter 15 (Component uncertainty trend)

- Reserved chapter 30 (Batch report) for a future version
- Updated screenshots

Revision : 21
Finalised on : 15 November 2017
Based on : GCAS version 1.15.3.17318

- Updated chapter 16.1 (Dashboard settings)
- Updated chapter 16.1.3 (Uncertainty calculation settings)
- Updated screenshots

Revision : 20
Finalised on : 6 November 2017
Based on : GCAS version 1.15.2.17309

- Inserted chapter 16.1.5 (Dashboard settings, alarm alert)
- Inserted chapter 16.3 (Dashboard printing)
- Inserted chapter 16.4 (Alarms)
- Updated screenshots

Revision : 19
Finalised on : 11 October 2017
Based on : GCAS version 1.15.0.17283

- We renamed the software to just "GCAS", no longer "GCAS Desktop". Most references to "GCAS Desktop" in this document have been replaced by "GCAS", leaving only those which need emphasis on the distinction between GCAS web version and GCAS desktop version.
- Updated chapter 26.5 (AlertMe)
- Updated screenshots

Revision : 18
Finalised : 27 September 2017
Based on : GCAS version 1.14.2.17270

- Updated chapter 25 (Device management)
- Updated chapter 27 (Data provision)
- Updated screenshots

Revision : 17E
Finalised : 8 June 2017
Based on : GCAS version 1.12.4.17158

- Updated chapter 14 (Uncertainty trend comparison)
- Updated screenshots

Revision : 17D
Finalised : 7 June 2017
Based on : GCAS version 1.12.3.17157

- Updated chapter 1.4.8 (Deactivation)
- Inserted chapter 1.4.9 (Licence migration)
- Updated chapter 30 (Export data)
- Updated screenshots

Revision : 17C
Finalised on : 16 May 2017
Based on : GCAS version 1.12.2.17136

- Updated chapter 16 (Dashboard)
- Updated chapter 28 (Report)
- Updated screenshots

Revision : 17B
Finalised on : 4 May 2017
Based on : GCAS version 1.12.1.17122

- Updated chapter 13 (Uncertainty trend)
- Updated screenshots

Revision : 17A
Finalised on : 25 April 2017
Based on : GCAS version 1.12.0.17114

- Updated chapter 1.4 (GCAS licence and activation)
- Updated chapter 11 (Uncertainty calculation)
- Updated screenshots

Revision : 17
Finalised on : 7 April 2017
Based on : GCAS version 1.11.4.17096

- Updated chapter 8.10 (Send to ISO 6976/GPA 2172 calculator)
- Updated chapter 9.9 (Send to ISO 6976/GPA2172 calculator)
- Updated chapter 10.2.2 (Chart types)
- Inserted chapter 13.5 (Printing)
- Updated chapter 14 (Uncertainty trend comparison)
- Inserted chapter 20 (GPA 2172 calculator)
- Renamed and updated chapter 21 (ISO 6976/GPA 2172 trend)
- Renamed and updated chapter 22 (ISO 6976/GPA 2172 trend comparison)
- Updated chapter 24 (Lag time)
- Added chapter 26.5 (AlertMe)
- Updated chapter 28 (Report)
- Updated screenshots

Revision : 16
Finalised on : 4 January 2017
Based on : GCAS version 1.11.0.17003

- Updated chapter 1.2 (System requirements)
- Updated chapter 1.4 (GCAS licence and activations) – new GCAS features (Simple Report)
- Updated chapter 2.2 (Supported DBMS)
- Updated chapter 7.4 (Import new footprint/calibration data)
- Inserted chapter 7.13 (Exponential RF)
- Updated chapter 8.3 (Import new composition data)
- Inserted chapter 8.12 (Exponential composition)
- Inserted chapter 25.1.6 (Data capture, Configure register mappings, For ABB devices)
- Inserted chapter 25.2.10 (Data capture, Capture data, For ABB devices)
- Updated chapter 26 (Data provision)
- Updated chapter 26.7 (Data provision log)
- Updated chapter 27 (Report)
- Updated chapter 32 (GCAS startup parameters)
- Updated screenshots

Revision : 15
Finalised on : 15 June 2016
Based on : GCAS version 1.9.0.0

- Updated chapter 1.2 (System requirements)
- Updated chapter 1.3 (Supported GC brands)
- Updated chapter 1.4 (GCAS licence and activations)

- Updated chapter 6 (C-number glossary)
- Inserted chapter 7.6 (Bulk set status for Footprint & Calibration Data)
- Chapter 8.3 was split to 8.3.1 and 8.3.2 to accommodate mole composition text import
- Inserted chapter 8.7 (Change stream number)
- Inserted chapter 9.7 (Copy certificate)
- Updated chapter 24 (Device management)
- Inserted chapter 26 (Data provision)
- Updated chapter 32 (GCAS startup parameters)
- Updated various screenshots
- Minor updates on chapter 17 (Mole composition comparison), 21 (ISO 6976 trend comparison), and 28 (Administrator menu)

Revision : 14
Finalised on : 12 October 2015
Based on : GCAS version 1.8.1.0

- Updated chapter 21 (ISO 6976 trend comparison)
- Inserted chapter 17.3.7 (Send to ISO 6976 trend comparison)
- Updated screenshots for few other chapters

Revision : 13
Finalised on : 17 September 2015
Based on : GCAS version 1.8.0.0

- Updated chapter 20 (ISO 6976 trend)
- Updated chapter 15 (Comments)

Revision : 12
Finalised on : 26 August 2015
Based on : GCAS version 1.7.4.0

- Updated screenshots
- Renumbered chapter 27 to 31 (GCAS startup parameters)
- Renumbered chapter 26 to 30 (Diagnostics and maintenance)
- Renumbered chapter 25 to 29 (Working offline)
- Renumbered chapter 24 to 28 (Export data)
- Renumbered chapter 23 to 27 (Administrator menu)
- Renumbered chapter 22 to 25 (Data capture)
- Renumbered chapter 21 to 24 (Device management)
- Renumbered chapter 17 to 18 (Correlation calculator)
- Renumbered chapter 16 to 17 (Mole composition comparison)

- Renumbered chapter 15 to 16 (Dashboard)
- Renumbered chapter 14 to 15 (Comments)
- Updated chapter 1-13 in regard to ISO 10723 support
- Chapter 14 (Uncertainty trend comparison) was reserved for future updates
- Updated chapter 19 (ISO 6976 calculator)
- Chapter 20 (ISO 6976 trend) and 21 (ISO 6976 trend comparison) were reserved for future updates
- Inserted chapter 22 (ISO 10723)
- Updated chapter 23 (Lag time)
- Chapter 26 (Report) is reserved for future updates
- Removed chapter 30.2 (Bug report wizard)

Revision : 11
Finalised on : 22 December 2014
Based on : GCAS version 1.4.5.0

- Updated screenshots
- Inserted chapter 13 (Uncertainty trend)
- Complete rewrite on chapter 16 (Mole composition comparison)
- Updated chapter 11 (Uncertainty calculation)
- Updated chapter 27 (GCAS startup parameters)
- Minor update on chapter 1.4

Revision : 10
Finalised on : 5 November 2014
Based on : GCAS version 1.3.4.0

- Updated screenshots
- Updated chapter 12 (Uncertainty coefficients)
- Updated chapter 23 (Export data)
- Updated chapter 24 (Work offline, minor changes)

Revision : 9
Finalised on : 30 October 2014
Based on : GCAS version 1.3.3.0

- Inserted subchapter 8.8
- Inserted subchapter 9.7
- Updated chapter 14 (Dashboard)
- Updated chapter 17 (ISO 6976 calculator)
- Minor updates on chapter 1.4

Revision : 8
Finalised on : 13 October 2014
Based on : GCAS version 1.3.1.0

- Updated chapter 11 (Uncertainty calculation)
- Updated screenshots

Revision : 7
Finalised on : 6 October 2014
Based on : GCAS version 1.3.0.0

- Major changes in chapter 8 (inserted subchapter 8.5)
- Updated chapter 12 (Uncertainty coefficients)
- Major changes in chapter 20 (*Agreements and Devices* becomes *Device Management*)
- Major changes in chapter 21 (Data capture)
- Updated screenshots

Revision : 6
Finalised on : 20 August 2014
Based on : GCAS version 1.2.0.0

- Inserted chapter 11 (Uncertainty calculation), Mole composition comparison becomes chapter 15.
- Reserved chapter 12 (Uncertainty coefficients) for future release
- 'Comments' was moved to chapter 13
- Inserted chapter 14 (Dashboard)
- Updated chapter 'Correlation calculator', formerly chapter 13, now moved to chapter 16
- Reserved chapter 17 (ISO 6976 calculator) for future release
- Reserved chapter 18 (Lag time calculator) for future release
- Reserved chapter 19 for future release, possibly for AGA-8 calculator
- 'Agreements and devices' is moved to chapter 20, and all previous chapters afterwards are moved to chapter 21 onwards.

Revision : 5
Finalised on : 30 June 2014
Based on : GCAS version 1.1.0.1

- Updated GCAS system requirements
- Added chapter 1.4.4 (Instant trial)
- Updated chapter 7.4.3 (Manual entry)

- Inserted chapter 11 (Mole composition comparison)
- Reserved chapter 13 (Correlation calculator)
- Updated chapter 15.1.5 (What if my GC device...)
- Updated chapter 18.9 (Conflict resolution)
- Minor updates for contents here and there
- Updated screenshots

Revision : 4
Finalised on : 6 June 2014
Based on : GCAS version 1.0.4.114

- Skipped revision 3 because revision 3 is only available in the HTML version of manual guide;
- Included support for Daniel C9+ and C10+ GCs.
- Updated chapter 4, 6, 7, 8, 10, 11, 12, 13, and 18
- Updated screenshots.

Revision : 2
Finalised on : 29 April 2014
Based on : GCAS version 1.0.2.37

- Added chapter 1.3 (Supported GC brands),
- Added chapter 8 (Mole composition),
- Included support for ABB GCs,
- Updated chapter 10, 12, and 18,
- Reserved chapter 9 (Lag time calculator),
- Corrections on chapter 14.3 (Manage groups),
- Expanded chapter 17 into 17.1 (Diagnostic mode) and 17.2 (Bug report wizard),
- Updated screenshots,
- Corrections on grammar and spelling errors.

Revision : 1
Finalised on : 20 February 2014
Based on : GCAS version 1.0.0.1

- First release.

1 Welcome

Thank you for choosing GCAS® as a companion for your gas chromatograph devices. These help files provide guides about GCAS operation.

1.1 What GCAS is

GCAS® (Gas Chromatography Analysis Software) is a software tool specifically designed for GC (Gas chromatograph) conditional-based monitoring. The main purposes of the monitoring method embedded in the software are:

1. To analyse instantaneous GC data to see if it is working properly,
2. To provide and analyse historical data in order to identify changes and predict failures,
3. To support extended reproducibility tests so that the GC uncertainty may be determined.

GCAS comes in two versions, GCAS Web and GCAS Desktop. GCAS Web is available for customers using i-Vigilant central database. Both share the same database, so that you can log in to either version and see the same data. GCAS Web is being phased out, therefore i-Vigilant Technologies encourages all customers to move onto GCAS Desktop.

1.2 System Requirements

GCAS® requires:

1) **Multi-core CPU.**
   Even low-power processors like Intel® Atom Z3000 series—found on many tablets and on Intel® Compute Stick—would suffice; but running GCAS inside a virtualised environment with single-core processor (such as inside Microsoft Azure virtual machine A1 basic tier) will impact the performance.
2) **2 GB of RAM**.
   Normal GCAS operation consumes around 60-150 MB RAM, so we need to make sure there is enough memory for the entire OS.
3) **Microsoft® Windows® Vista, Windows 7, Windows 8, Windows 8.1, or Windows 10.**
   Although many customers still use Windows XP (in 2017), it is no longer supported. GCAS cannot function correctly on XP.
4) **Microsoft .NET Framework 4.5.2**
   This is available from https://www.microsoft.com/en-us/download/details.aspx?id=42642.
   Windows 8.1 and 10 have included .NET Framework 4.5 therefore no need to install .NET Framework unless the setup package tells you.
5) **Microsoft SQL Server Compact Edition (CE) version 4.0**.
   This is available from http://www.microsoft.com/en-us/download/details.aspx?id=17876.
6) **Microsoft Visual C++ 2010 Runtime redistributable x86**.
   This is available from http://www.microsoft.com/en-us/download/details.aspx?id=5555.

7) To use data capture and/or data provision feature, your PC should have either **serial port (RS-232)**, **Ethernet port**, or **Wi-Fi**.
8) Internet connection, preferred.
9) **1280 x 720 screen resolution**.
10) If you need to work with Microsoft Access databases or to export data to Microsoft Access database: You would need a separate licence of Microsoft Office or Microsoft Access 2010/2013/2016, or either the **free** Microsoft Access Database Engine 2010, Microsoft Access Runtime 2013, or Microsoft Access Runtime 2016.
    a) Get Microsoft Access Database Engine 2010 from http://www.microsoft.com/en-us/download/details.aspx?id=13255.
    b) Get Microsoft Access Runtime 2013 from http://www.microsoft.com/en-us/download/details.aspx?id=39358.
    c) Get Microsoft Access Runtime 2016 from https://www.microsoft.com/en-us/download/details.aspx?id=50040.

1.3 Supported GC Brands

GCAS is compatible with any gas chromatograph device using **thermoconductivity detector** (TCD) and **peak area** formula to calculate response factor.

GCAS supports these gas chromatographs:

1. Brand-specific:
    a. Daniel (Emerson)
    b. ABB
    c. Siemens
    d. Elster (Honeywell)
2. Non brand-specific:
    a. LNG chromatographs (Liquid Natural Gas, up to pentane)
    b. BTEX analysers (aromatic hydrocarbons)
    c. Single gas analysers

If your GC device is not in this list, consult our support team to find a workaround. Worst case is GCAS can only trend your historical data without the ability to provide additional useful information such as correlation (R^2) and uncertainty values.

1.4 GCAS Licence and Activation

GCAS requires a valid *GCAS licence* to run. GCAS licence carries the information required such as what features are available to you, how many number of GC devices you can use, and the expiry date.

Current version of GCAS operates GCAS licence version 3. GCAS licence version 1 was used for development purposes and is now obsolete. GCAS licence version 2 was used by beta (test) version of

GCAS. Although current GCAS can read GCAS licence version 2, some features will be unavailable and we strongly recommend users of licence version 2 to upgrade their licences into version 3.

Customers can select which *GCAS features* to include in order to suit their need. The features are listed here:

- Modules
  - **Basic features** (always included) – Analysis parameter, Footprint, Calibration data, and Comments.
  - **Data Analysis**
  - **Live Data Analysis**
  - **Data Comparison**
  - **Calibration Gas Certificate**
  - **Uncertainty Calculation** (automatically unlocks calibration gas certificate module)
  - **Uncertainty Trend** (automatically unlocks calibration gas certificate module too)
  - **ISO 6976 Calculator**
  - **ISO 6976 Trend**
  - **GPA 2172 Calculator**
  - **GPA 2172 Trend**
  - **ISO 10723**
  - **Lag Time Calculator**
- Device communication
  - **Modbus® Client over Serial**
  - **Modbus® Client over TCP**
  - **Modbus® Server over Serial**
  - **Modbus® Server over TCP**
- Data import
  - **Text Import** (for Daniel, ABB, and Siemens GCs)
  - **CSV Import**
  - **Manual Data Entry** (always included)
- Data export
  - **Export to CSV**
  - **Export to Microsoft SQL Server Compact Edition**
  - **Export to Microsoft Office**
- Report
  - **Simple Report**
- Databases
  - **i-Vigilant Central Database**
  - **Local Corporate Database**
  - **Local Offline Database** (always included)
  - **Work-offline Capability**

Our website offers two packages of GCAS namely *Advance* and *Comprehensive*. GCAS *Basic* package has been discontinued and is now superseded by GCAS *Demo* package (free with read-only access). Features included in each package are listed in this table.

Features	GCAS Advance	GCAS Comprehensive
Modules		
Basic features	✓	✓
Data Analysis	✓	✓
Live Data Analysis	✓	✓
Data Comparison		✓
Calibration Gas Certificate	✓	✓
Uncertainty Calculation	✓	✓
Uncertainty Trend	✓	✓
ISO 6976 Calculator	✓	✓
ISO 6976 Trend		✓
GPA 2172 Calculator	✓	✓
GPA 2172 Trend		✓
ISO 10723	✓	✓
Lag Time Calculator	✓	✓
Communication		
Modbus® Client over Serial		✓
Modbus® Client over TCP		✓
Modbus® Server over Serial		✓
Modbus® Server over TCP		✓
AlertMe		✓
Data import		
Text import	✓	✓
CSV import	✓	✓
Manual Data Entry	✓	✓
Data export		
Export to CSV	✓	✓
Export to Microsoft SQL Server CE	✓	✓
Export to Microsoft Office	✓	✓
Report		
Simple Report	✓	✓
Databases		
i-Vigilant Central Database	✓	✓
Local Corporate Database	✓	✓
Local Offline Database	✓	✓
Work-Offline Capability	✓	✓

Users buying GCAS Advance package have options to purchase add-on features *à la carte* which are appended to their licences. Visit our website for pricing information of each feature. Users buying GCAS Comprehensive package have no more add-ons available as they already get access to all GCAS features.

1.4.1 Types of Licence

There are two types of GCAS licence: Lifetime and Subscription.

Lifetime licences or perpetual licences are GCAS licences that never expire. Lifetime licences are intended for customers who purchased retail copies of GCAS, i.e. one-off purchases.

On the contrary, **subscription licences** are licences that renew periodically. They are intended for customers with subscription plan. Depending on customer preference, renewal period can be monthly, quarterly, semester, annual, or biannual. Customer with subscription licence should check for licence update periodically or leave the automatic licence update on, in order to ensure continuous access to GCAS.

Trial licence is a subtype of subscription-based licence for new and prospective customers. Depending on customer request, i-Vigilant Technologies Limited issues trial licences which typically last between one to three months. Usually, trial licences carry *all* GCAS features with a limited maximum number of GC devices. Within their trial period, customers can upgrade their licences to standard subscription licence with select GCAS features and enough number of GCs to suit their needs.

Instant trial licence is more specific type of trial licence. This licence is issued only once per computer and only valid for 4-day trial. An instant trial licence is upgradable to a regular trial licence (see the previous paragraph) which later on, still upgradable again to a full licence. Read more about instant trial.

1.4.2 How Many PCs?

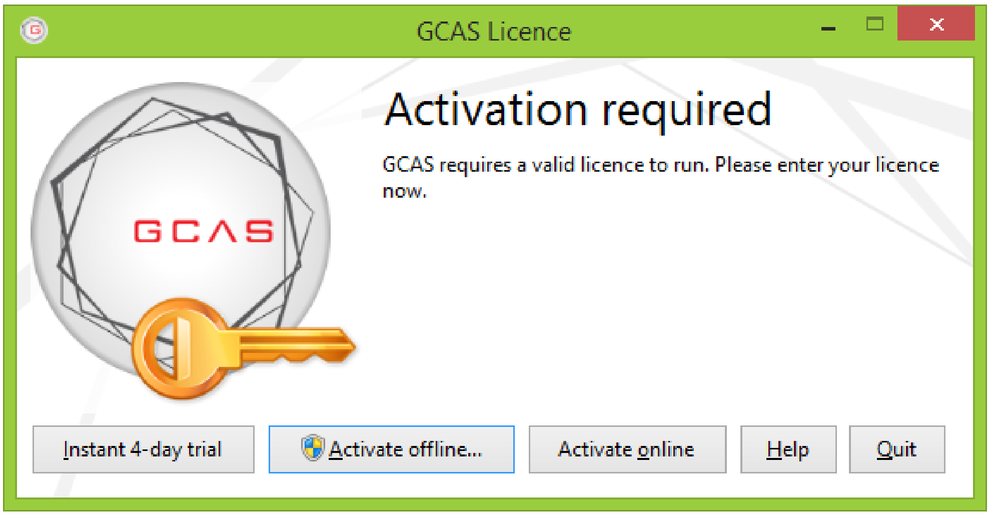
When you purchase GCAS from i-Vigilant website, the website asks for information such as the package you want, any feature add-on packs, how many GCs and how many PCs. We generate your licence based on this information thus your licence is ready when you go through online activation process.

Currently our website offers 1, 3, or 5 computers. Contact us if you need more than 5 computers so we can arrange a discount for you. This number of PC becomes the **activation count**. One successful online activation will reduce this number by one. If you don't have internet access and request offline activation by sending your computer code, we will send your licence via email then we will also decrease your activation count by one. When this activation count reaches zero, you have used up all your available licences and cannot activate GCAS on other PCs.

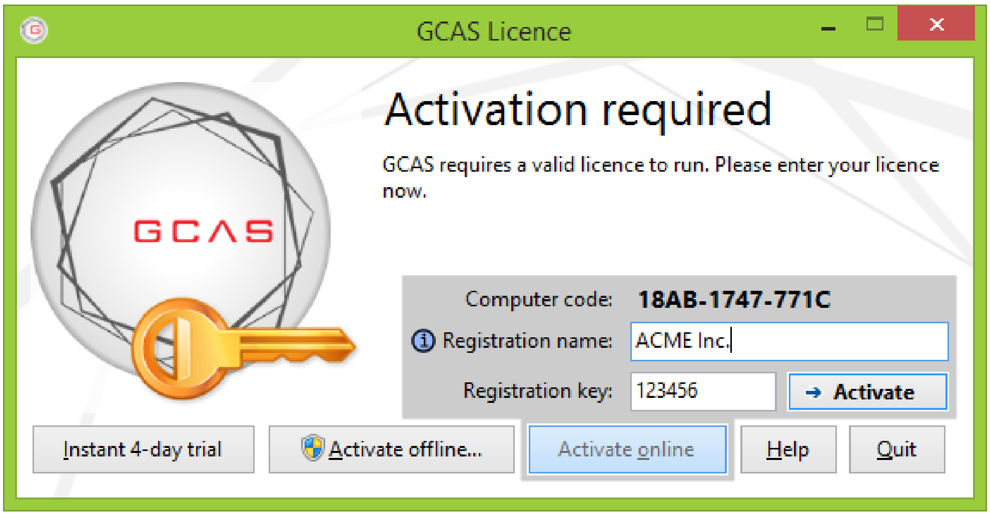
1.4.3 Online Activation

If your computer has a working internet connection, we advise to activate your GCAS online. During online activation, GCAS contacts GCAS Activation Server maintained by i-Vigilant Technologies to retrieve your licence.

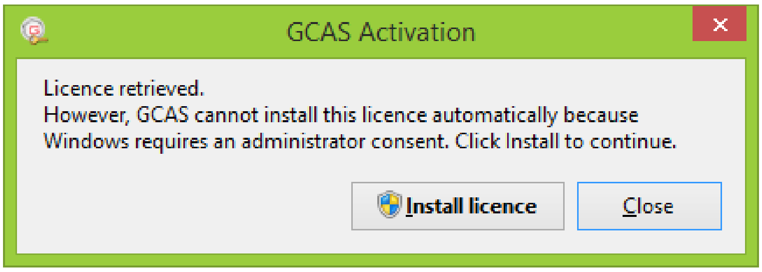
1. The first time GCAS is run, it requests for activation. The following window pops up.



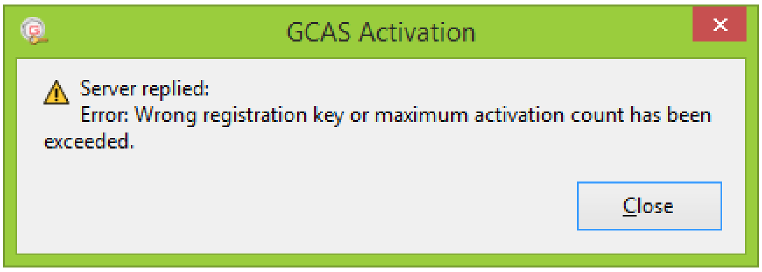
2. Online activation requires internet connection.
3. Click **Activate online** button and you shall see this window:



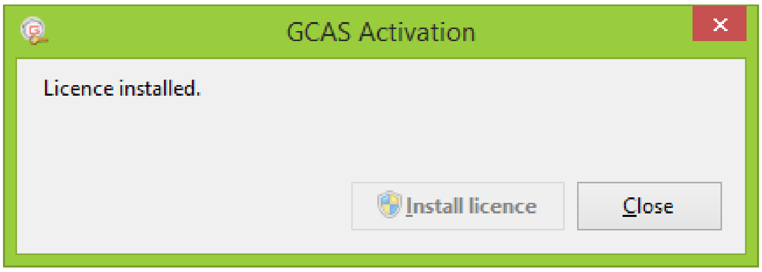
4. **Registration name** is your customer identifier name as you have entered during checkout process on our website. For offline purchase, we will send your registration name. This name is case sensitive, requires exact spelling.
5. **Registration key** is six numeric digits and doesn't start with zero. This key is available on the confirmation page and my account page (for online purchase) or in our confirmation email (for offline purchase).
6. *If you purchased GCAS through an offline channel such as PO or direct meeting:*
   Tell us your **computer code** either by email, fax, or phone. Our email address is support@i-Vigilant.com. Wait for our confirmation that we have successfully generated your licence.
7. *If you purchased GCAS through our website:*
   You don't have to tell your computer code because your licence is generated automatically at the time of first activation. As long as you entered correct registration name and key (case sensitive) and you haven't exceeded your activation count, licence generation should work without problems.
8. Type your registration name and registration key, then click ➔ **Activate**. Provided that all data were correct, this window will show.



Otherwise you see an error message similar to this one.



9. Click **Install licence**. If UAC is enabled on your computer, and it is usually enabled by default, a UAC prompt will appear. If you are the computer administrator, click **Yes** to continue. Otherwise ask your computer administrator to type in the admin password.
10. The following window confirms that your licence and registration key have been installed on your computer.

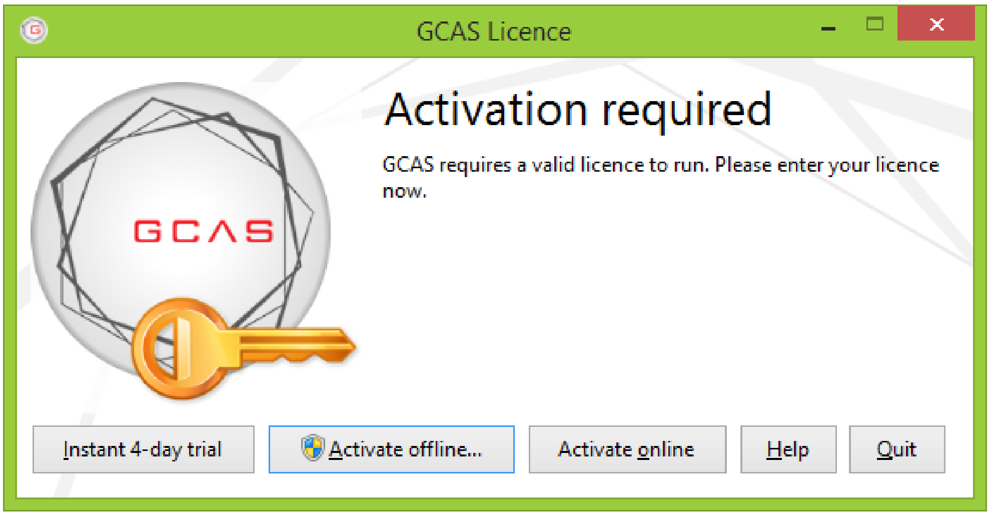


11. Click **Close** and now GCAS is activated, ready to use.
12. In rare cases where UAC is disabled possibly by your system administrator, the licence would be installed automatically without UAC prompt. This implies you wouldn't see the screen as depicted in step 8 and 10.

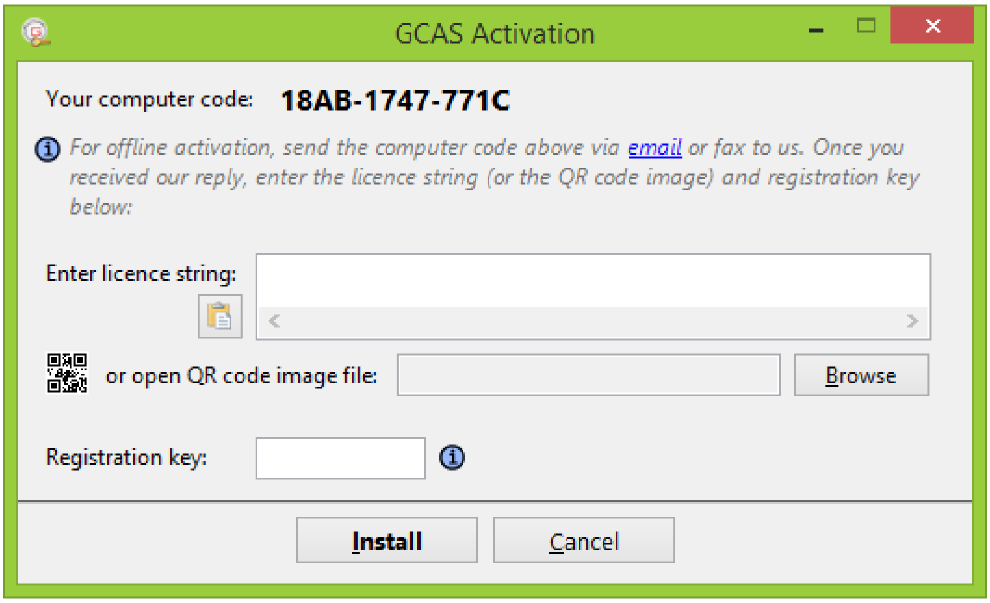
1.4.4 Offline Activation

For computers without internet connection e.g. on off-shore location or remote site, you can activate GCAS offline. You need your *licence string* (or QR code image file) together with your registration key stored offline such as in your corporate email or in a USB flash drive.

1. The first time GCAS is run, it requests for activation. The following window pops up.



2. Offline activation does not require internet connection.
3. Click **Activate offline**. UAC prompt may appear.
4. *GCAS Activator* window is displayed.

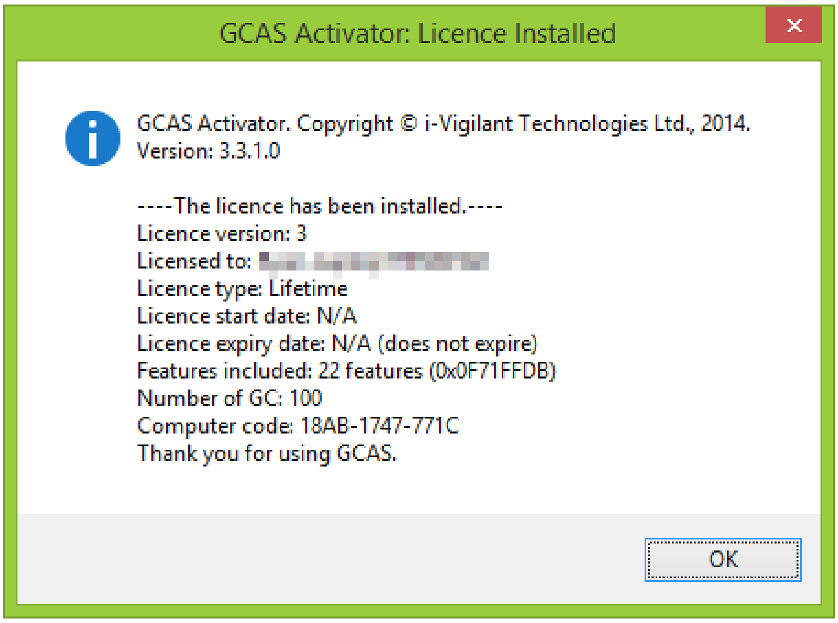


5. Tell us your **computer code** via email to support@i-vigilant.com or via fax. We need this code to generate your licence. After we generate your *licence string*, we will reduce your activation count by one (1) accordingly.
6. Once you have received our reply, either enter the licence string or load the QR code image. Then enter the registration key as well.
7. *Licence string* is a long, encoded text which looks similar to this.

zZPgHRyhHRqMsZijmaukdJaW-
laqhpZuIp4SuroCR76Oum6KXoqiZmJ3mkaC1eZq2qpidn6eOp4WYl4GYrYukuHmnl6KutqqupKqKq
ZyU3e/brLWklouss5qgspajqoGTkRSE-
qea6ie6GqqqRnL92obiIqamkvaKsoLSsjaCegaKnrKigpaV7uA==

8. QR code image file looks like the following.

   This is a standard QR code image that contains the licence string itself. You can use your smartphone or any QR code scanner to verify its content.
9. Click **Install** on GCAS Activator form.
10. The following message box confirms that your licence and registration key have been successfully installed. On some Windows versions, this message is displayed in a command prompt window instead of a message box.

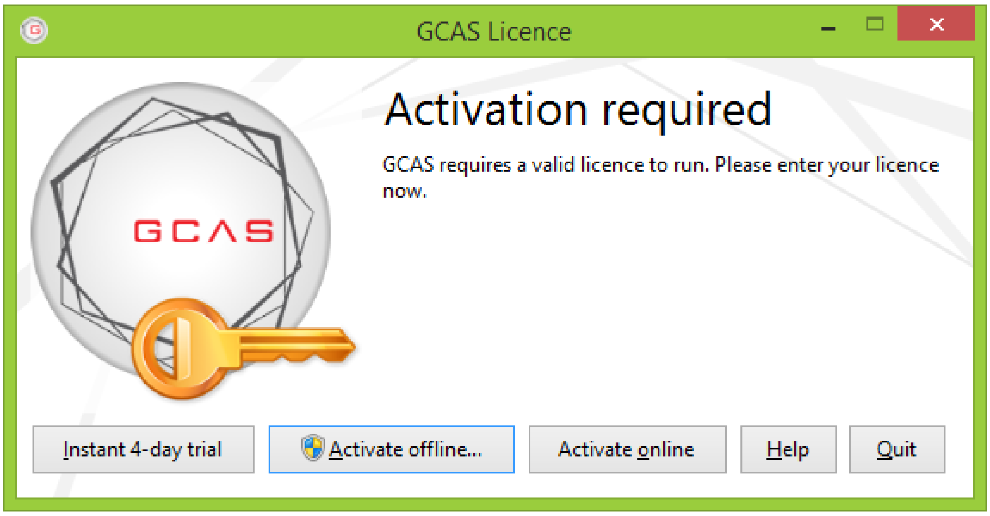


11. Click **OK** and GCAS is activated, ready to use.
12. In case GCAS Activator displayed a message about your computer being locked, that is because the licence string or the QR code image had been previously installed on this computer but somebody deactivated GCAS at some point. You need *GCAS Licence Unlock Tool* to undo this lock, which we will provide upon request.

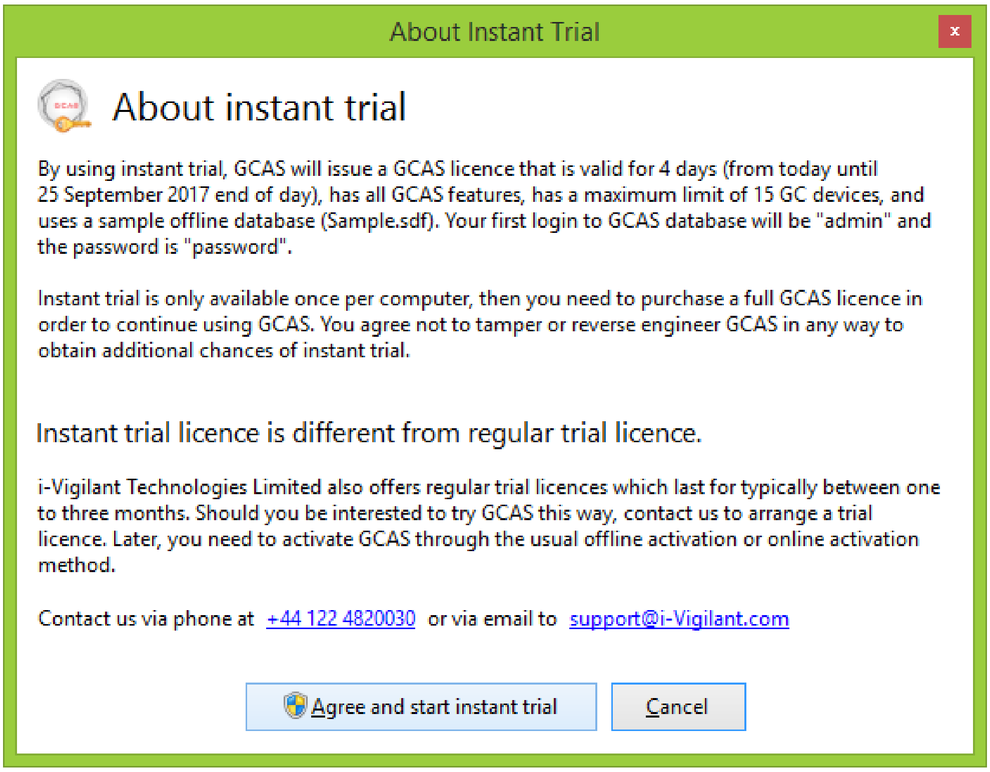
1.4.5 Instant Trial

Instant trial is offered to new and prospective customers to try GCAS quickly without the hassle of sending your computer code and waiting for your licence in our reply and for us to set up a database for you. Unlike "regular" trial licences, instant trial licence is only valid for **4 (four) days**, including the day you started the instant trial. After your trial period expires, GCAS will stop working. You can then request for an extended trial or purchase a full licence altogether. Contact us to get an arrangement.

To try GCAS using instant trial, click **Instant 4-day trial** on this window.



Read the information presented in the oncoming window. If you agree, click **Agree and start instant trial**.



Instant trial information window.

A UAC prompt may appear. If you are the computer administrator, click **Yes** to continue. Otherwise, ask an administrator to enter the required password.

If you cannot find the button, instant trial may not be available for you because probably you already used it before. Instant trial is only offered once per computer. For example, if a user tries to uninstall GCAS after his trial period is over and then reinstalls the software again, he will not see the **Instant 4-day trial** button a second time.

1.4.6 Automatic Licence Update

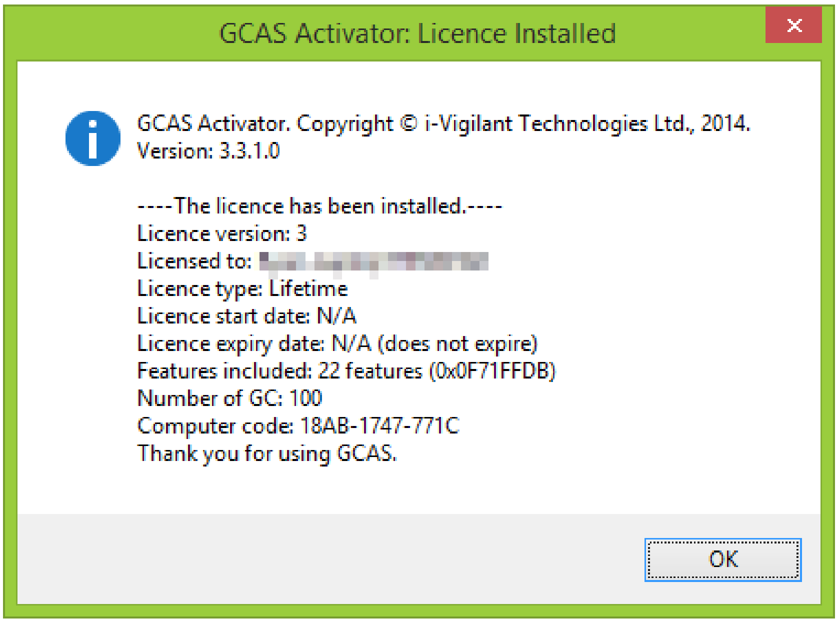
Licence update is an update for your licence. For example, a customer has subscription plan and they just extended their subscription for another month, the expiry date on their licence is then updated to the latest subscription end date. Another example, a customer decided to add more features to their licence. Their licence is updated to reflect this change.

By default, GCAS checks for licence update in GCAS Activation Server once during launch, and once every 24 hours. Automatic licence update works only if your computer has a working internet connection.

1. If there is any update for the licence in GCAS Activation Server, a window similar to this one shall appear. The text on this notification window may vary depending on what kind of update is available for you (e.g. extension of expiry date, feature update, or limit upgrade on number of GC).

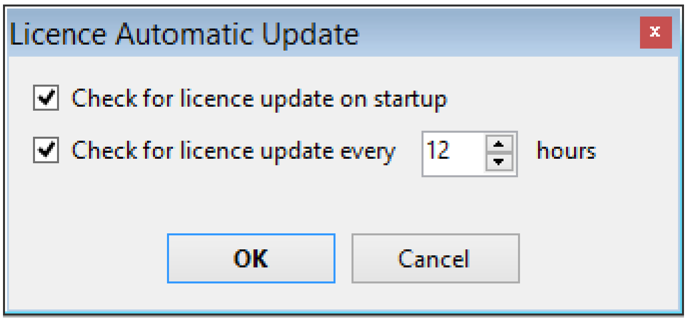
2. Click **Install**. It may trigger a UAC prompt. Click **Yes** on the UAC prompt or ask your computer administrator to type the required password. GCAS will update the licence and the window similar to

this one shall appear.



3. In rare cases where UAC is disabled by your system administrator, or if GCAS is running in elevated mode (run as administrator), the notification window will appear green instead of yellow. The licence is updated automatically and you don't have to click the Install button.

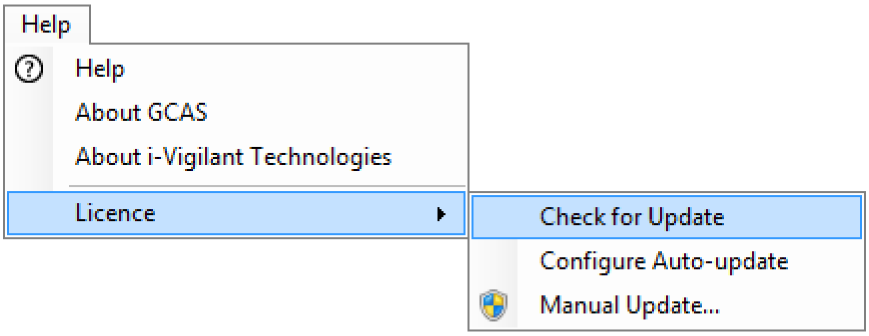
To configure how GCAS should check licence update automatically, log in to GCAS and go to the Help menu > Licence > **Configure Auto-update**.



1.4.7 Manual Licence Update

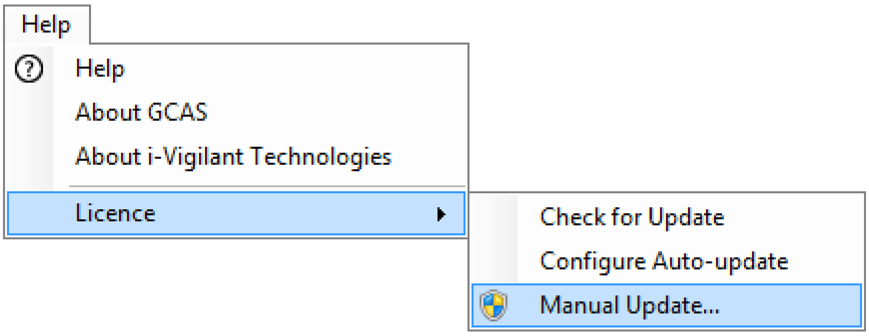
1.4.7.1 If you are online

You can force GCAS to check for licence update now. To do so, go to the Help menu > Licence > **Check for update**.

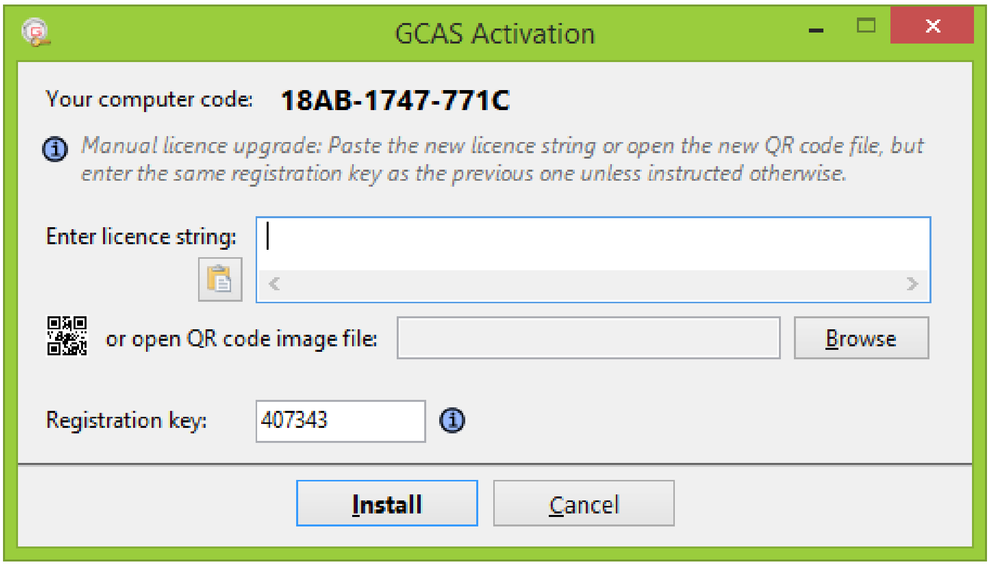


1.4.7.2 If you are offline

Should the computer have difficulties connecting to the internet e.g. on remote areas or off-shore sites, we will send you a new licence string and/or QR code. To install this new licence, go to the Help menu > Licence > **Manual Update**.



UAC prompt may appear. Afterwards, either enter the new licence string or open the new QR code, but re-enter the same registration key as the previous one. (The software automatically does this for you.) Click **Install** and GCAS Activator will replace the installed licence string with the new one.

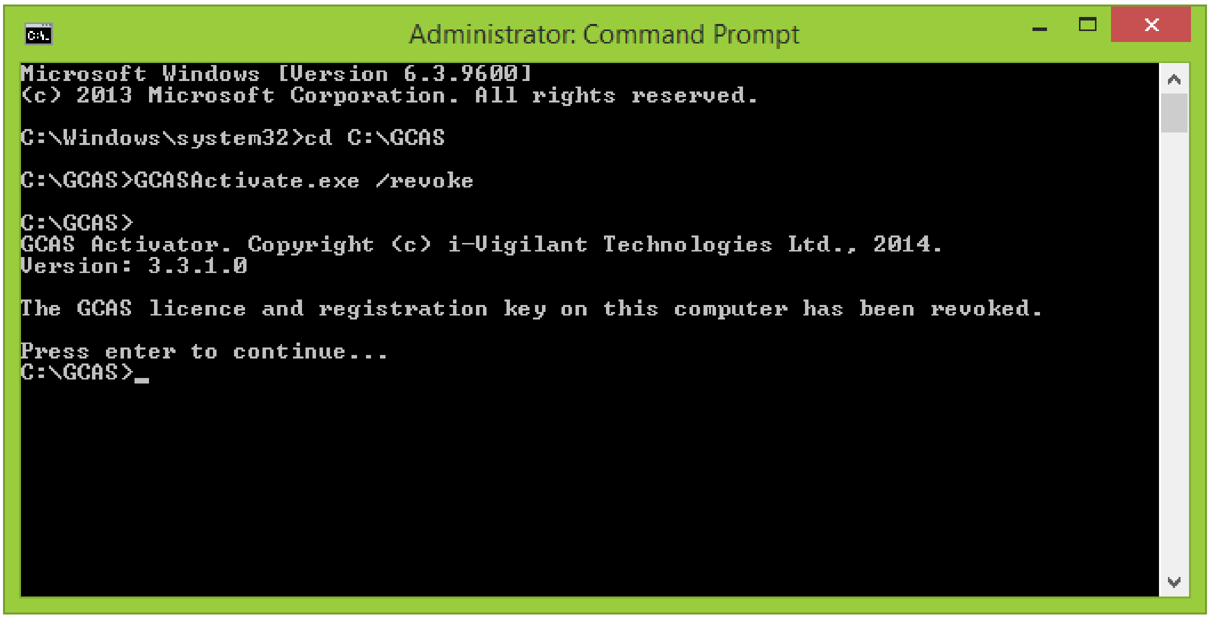


1.4.8 Deactivation

To uninstall your licence and registration key, start an elevated command prompt (run as administrator) and then execute this command on GCAS installation directory:

`GCASActivate /revoke`

You need an internet connection to perform deactivation.



Deactivation automatically increases your activation count, unless a problem occurred during the process such as connection problem to GCAS activation server. If your activation count is not increased, please contact us so we can raise your activation count manually. *Please attach a screenshot of your command prompt window in your email.*

The deactivation will also "lock" your computer so that the licence string or QR code you have previously used on this computer cannot be reused. Therefore, we advise not to perform deactivation unless necessary. If you are decommissioning or recycling your old computer, it is better to transfer your GCAS licence to the new computer using licence migration tool.

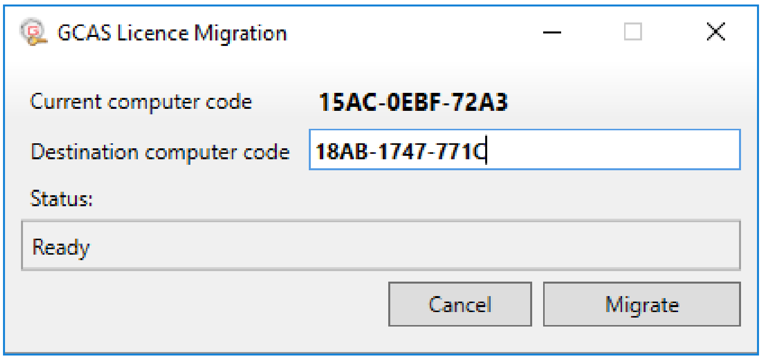
Instant trial users, do not deactivate your instant trial licence because instant trial licence is only offered once per computer—unless you have a full licence or extended trial licence available, or unless you decided not to use GCAS.

1.4.9 Licence Migration

A GCAS licence can be transferred to another computer using *GCAS Licence Migration Tool*. This tool should be accessible from Start Menu > All Programs > i-Vigilant Technologies > **GCAS Licence Migration**. Licence migration is useful when you need to replace your workstation computer with a new hardware.

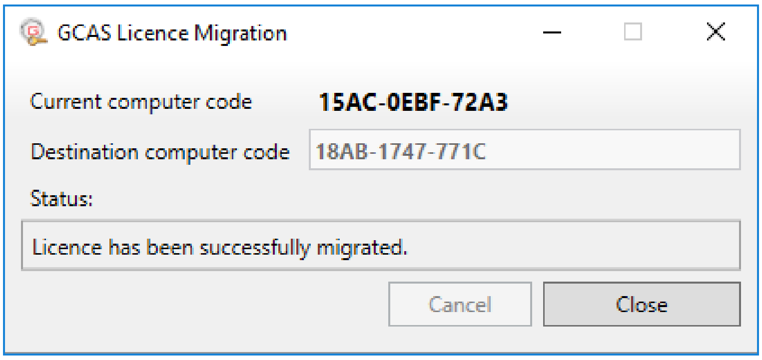
Licence migration requires internet connection on the old computer which the licence will be transferred from. Here are the steps.

1. First, get the computer code of the new computer to which the licence will be transferred. You can do this by running *GCAS Activator* on the new computer (as if you were to do online activation, or running GCAS Activator with **/compcode** command line switch). The computer code is twelve digits, with hyphen separating every 4 digits.
2. On old computer with existing GCAS licence, run *GCAS Licence Migration Tool*. A UAC prompt may appear. If you are the computer administrator, click **Yes** to continue. Otherwise, ask an administrator to enter the required password.
3. Type the computer code of the new computer in the input box.



4. Click **Migrate**. This tool will connect to GCAS license server and requests a migration.

5. The status box in *GCAS Licence Migration Tool* should notify you when the migration process has finished.



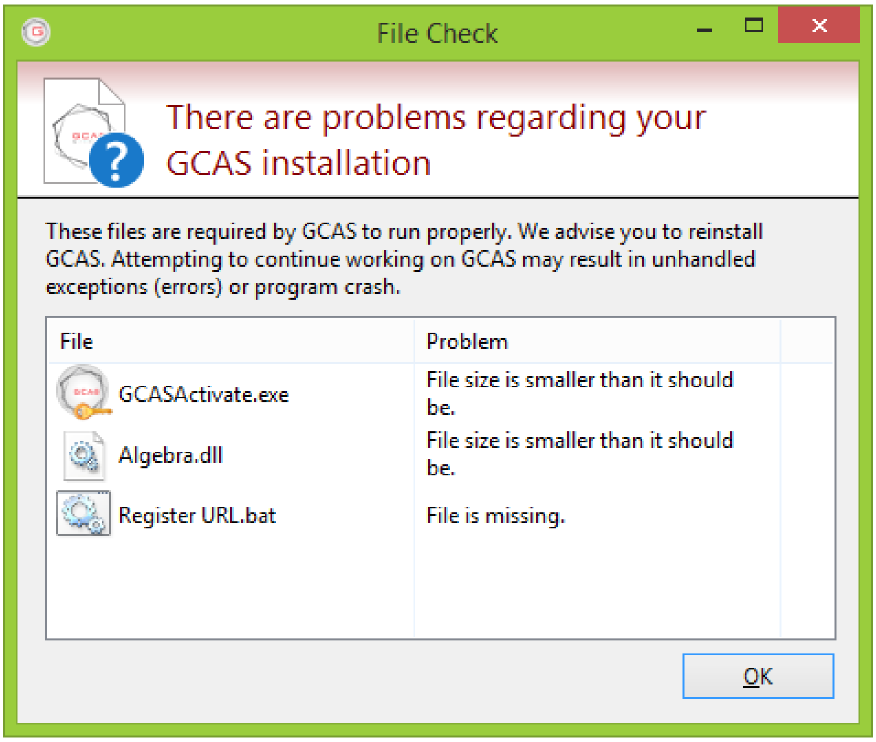
6. Go to your new computer and carry out the usual online activation using your registered customer name and 6-digit registration key. During migration, this key remained the same. Only the computer code embedded in your licence changed.

Note

Licence migration deactivates GCAS on your old computer *effective immediately*. In case of GCAS licence server could not be reached during migration process (e.g. your computer was offline), the deactivation still occurs. Contact us so we can finish the licence migration for you. *Please attach a screenshot of GCAS Licence Migration Tool window in your email as we need both computer codes.*

1.5 Integrity Check

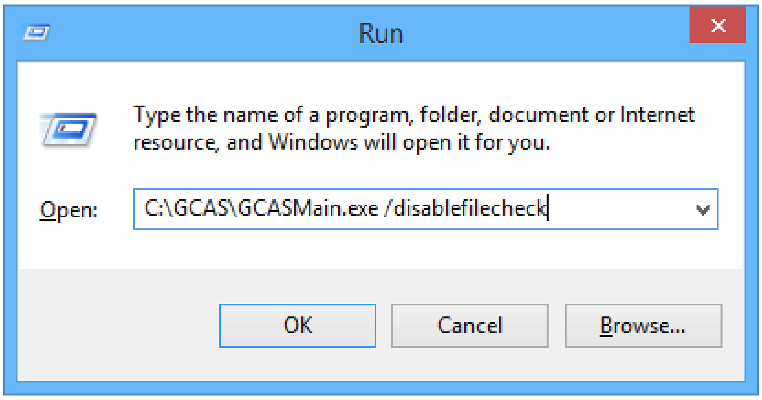
GCAS performs a check on the installation directory during start up in order to ensure that all required files are present and unmodified. When GCAS detects a file is missing or has unauthorised changes, it presents a warning similar to this.



This notification does not prevent you from using GCAS; you could still dismiss the notification through **OK** button and log in to GCAS as usual. However, there is a higher risk of GCAS crashing at some point later. Especially when there is a .dll file missing, this will raise `Dll Not Found Exception` or `File Not Found Exception` error message later on.

If you see this warning every time you start GCAS, the first step to try is to reinstall GCAS. Have your registration key and your licence string or QR code ready in case you need to reactivate GCAS again.

Should the reinstall action provides no remedy to the problem, you can disable this feature by running GCAS with an additional **/disablefilecheck** parameter. You might want to modify the shortcut to GCAS to include this additional switch.



2 Database

GCAS Web and GCAS Desktop reads and stores data into *GCAS database*. This chapter explains further about GCAS database.

2.1 Where Your Data is Stored

There are three different choices of data storage:

1. **i-Vigilant central database**
   Data is stored in database server(s) maintained by i-Vigilant Technologies. Using this server requires internet connection.
2. **Corporate database server**
   Also known as "local corporate database", your data is stored in a database server within your company local area network (LAN).
3. **Local offline database**
   Data is stored in a file on your computer. This database is permanently offline, isolated from the outside world.

Each choice is a distinct GCAS feature in your GCAS licence. For instance, customer with GCAS licence that only includes *i-Vigilant Central Database* and *Local Corporate Database* cannot use local offline database.

2.2 Supported DBMS

GCAS database is a relational database managed by a *Database Management Server* (DBMS). GCAS does not develop its own DBMS, but instead uses one of the following commercial DBMSes.

1. Local corporate database
   a. MySQL version 5 or later,
   b. Microsoft SQL Server 2008 (untested), 2012, or 2014.
2. Local offline database
   a. Microsoft SQL Server Compact Edition v4.0,
   b. Microsoft Access 2010/2013/2016.

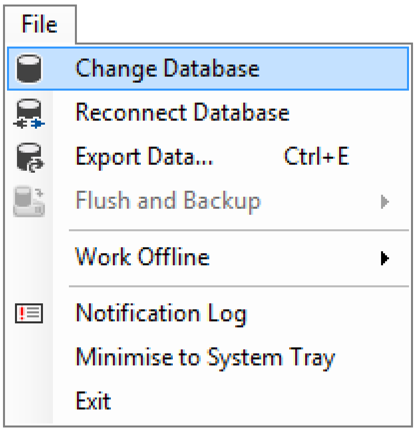
*Especially for Microsoft SQL Server 2014, you need to install updates for Microsoft .NET Framework 4 from Windows Update. Microsoft SQL Server 2016 and 2017 are already released at the time this document is written, but we haven't had opportunity to test it out.

Should you have interest in setting up a local corporate GCAS database within your company network or using a local offline database for your company, contact our support team to arrange a deployment for you.

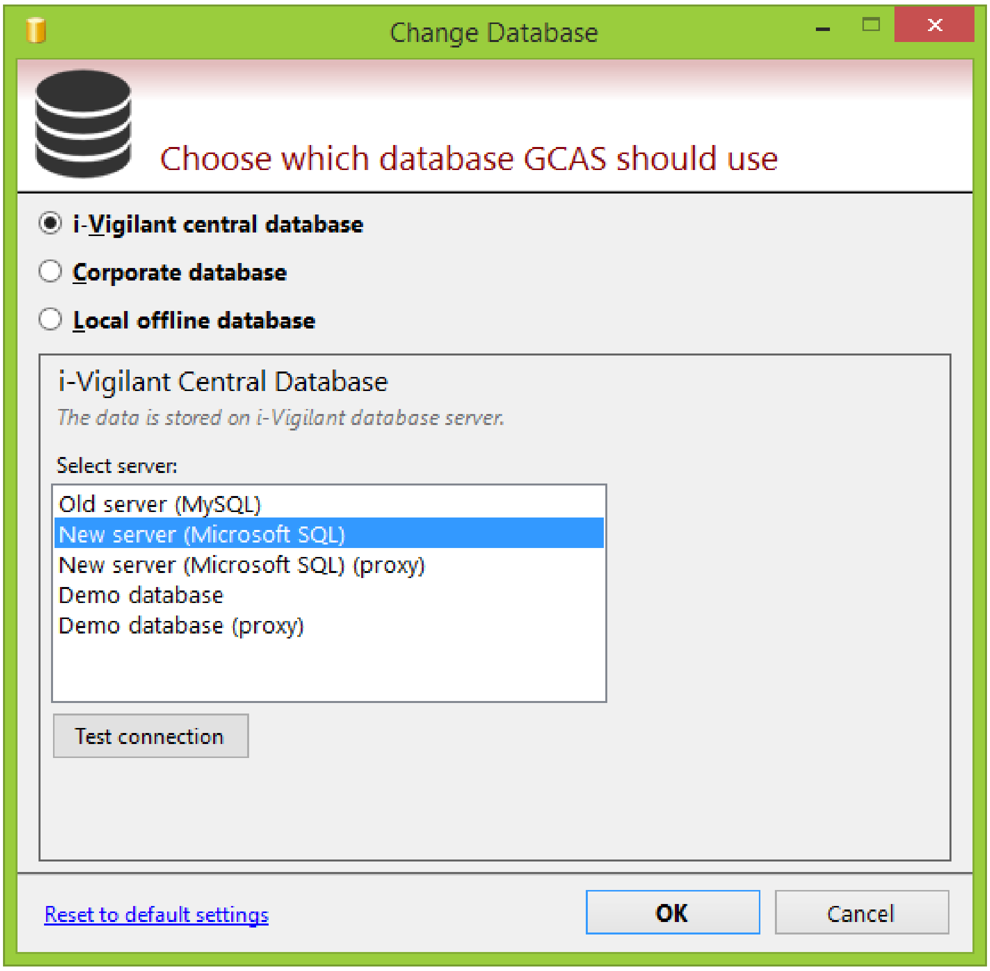
2.3 Change Database

Most users do not have to worry about changing database. But if your data is stored in two or more databases, tell GCAS which database it should connect to.

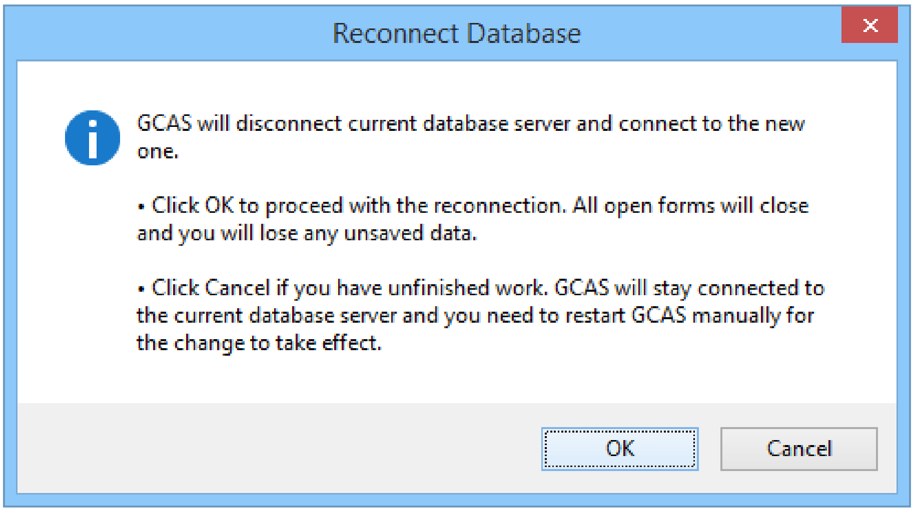
To switch database, make sure that no forms open on your work area and you are not working offline. Next, go to File menu > **Change Database**.



This menu will bring up the *Change Database* dialogue. Choose which database you would like to use whether i-Vigilant central database, your own corporate database, or an offline database file.



Enter the required parameters, e.g. IP address or server host name, DBMS username, and DBMS password. You can test whether the parameters are correct through **Test connection** button. Make sure you have your GCAS username and password registered in the desired GCAS database so you can log in to GCAS later. When you click **OK**, GCAS asks you whether to switch it now or later.

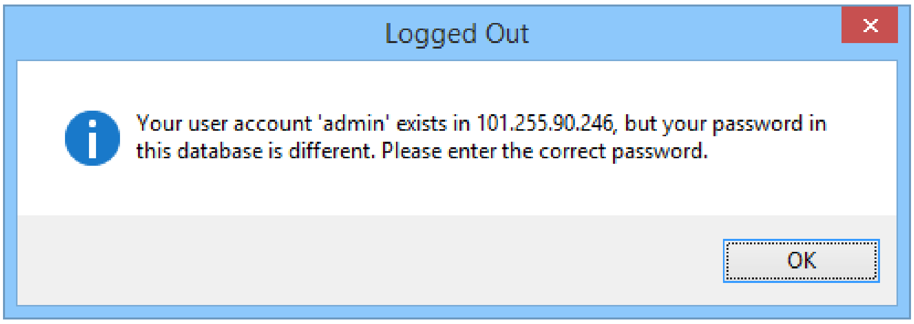


If you click **OK**, GCAS will:

1. Unload all workspaces and devices from current database,
2. Disconnect from current database,
3. Connect to the new database, and finally
4. Load workspaces and devices from new database.

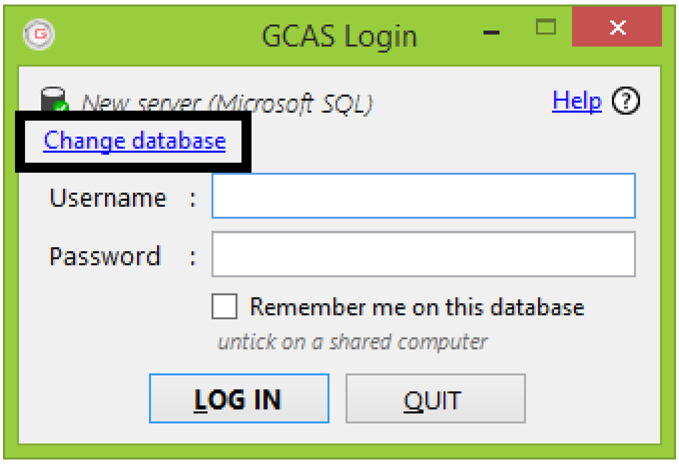
Otherwise if you click **Cancel**, GCAS keeps connection to current database until you exit the software.

You can resume working afterwards if your credential (username and password) is exactly the same in both databases. Otherwise, GCAS will log you out and you are prompted to log in again using the correct credential.

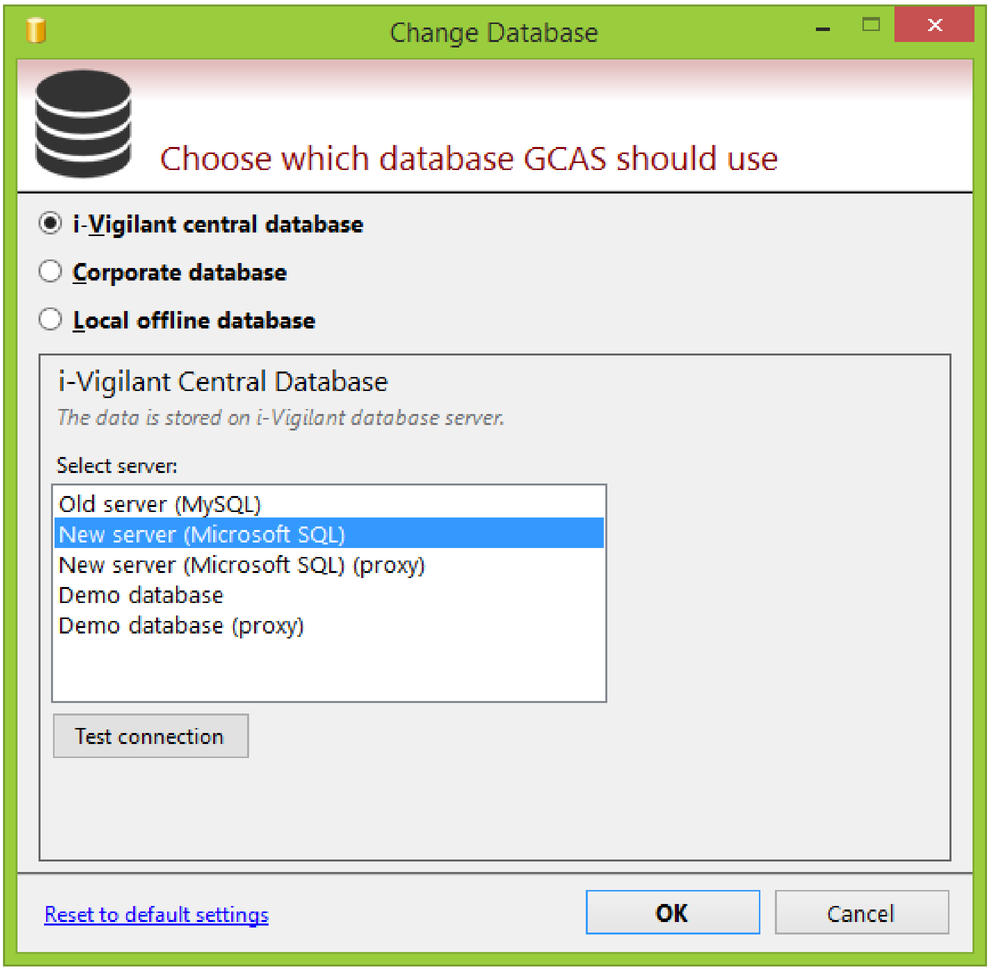


2.4 Change Database before Login

Starting from GCAS 1.7.3.0, login window displays a link to change database. Find the link near the top left corner under the database name.

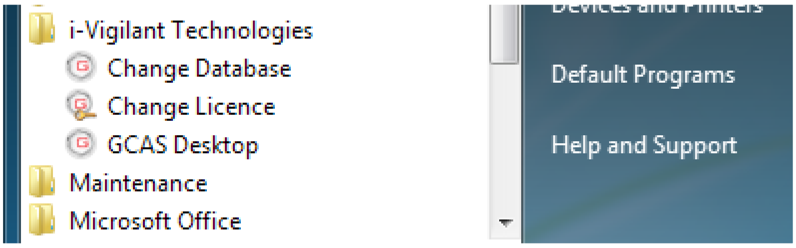


This link brings you to the same *Change Database* dialogue. Enter the required parameters e.g. the IP address or server host name, DBMS username, and DBMS password. Click **OK** and GCAS will restart. After restart, you see the new database displayed on the top of login form.



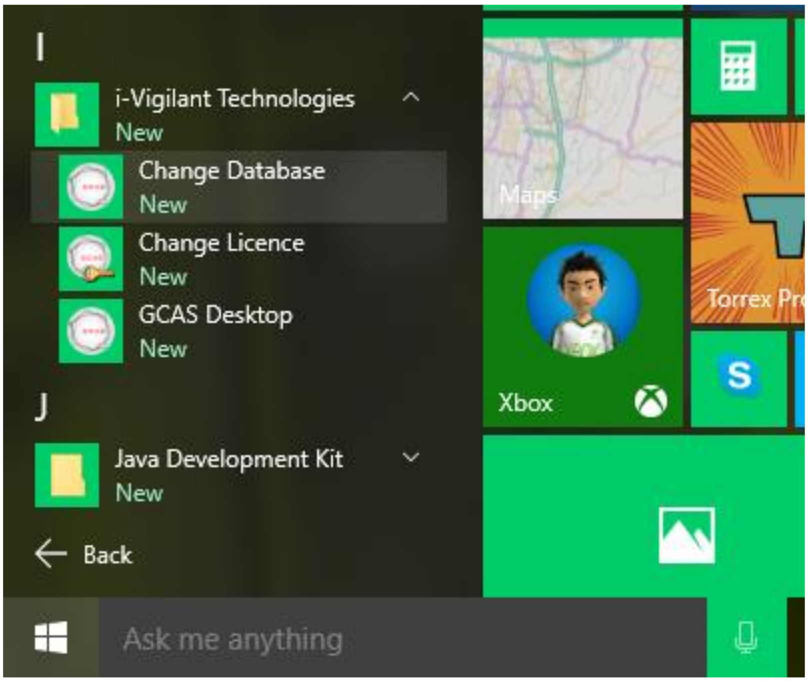
2.5 Change Database without Running GCAS

1. On Windows Vista or 7, open the Start menu then go to All Programs. Within *i-Vigilant Technologies*, click on the shortcut **Change Database**.

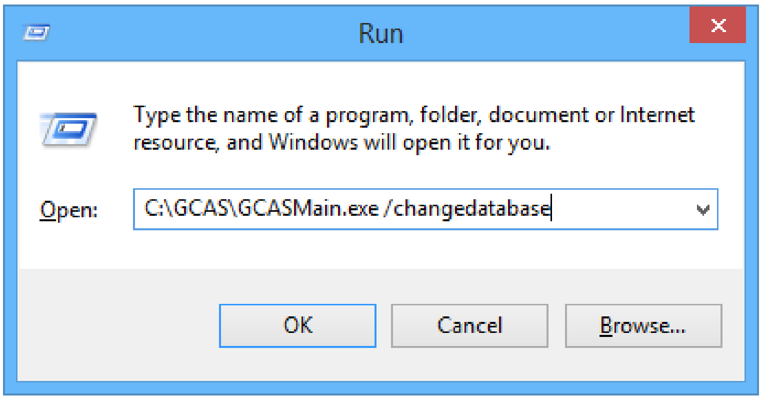


2. On Windows 8 or 8.1, open the Start screen. Change the view to All Apps view. Scroll to the right, find *i-Vigilant Technologies* and the same shortcut should be there.

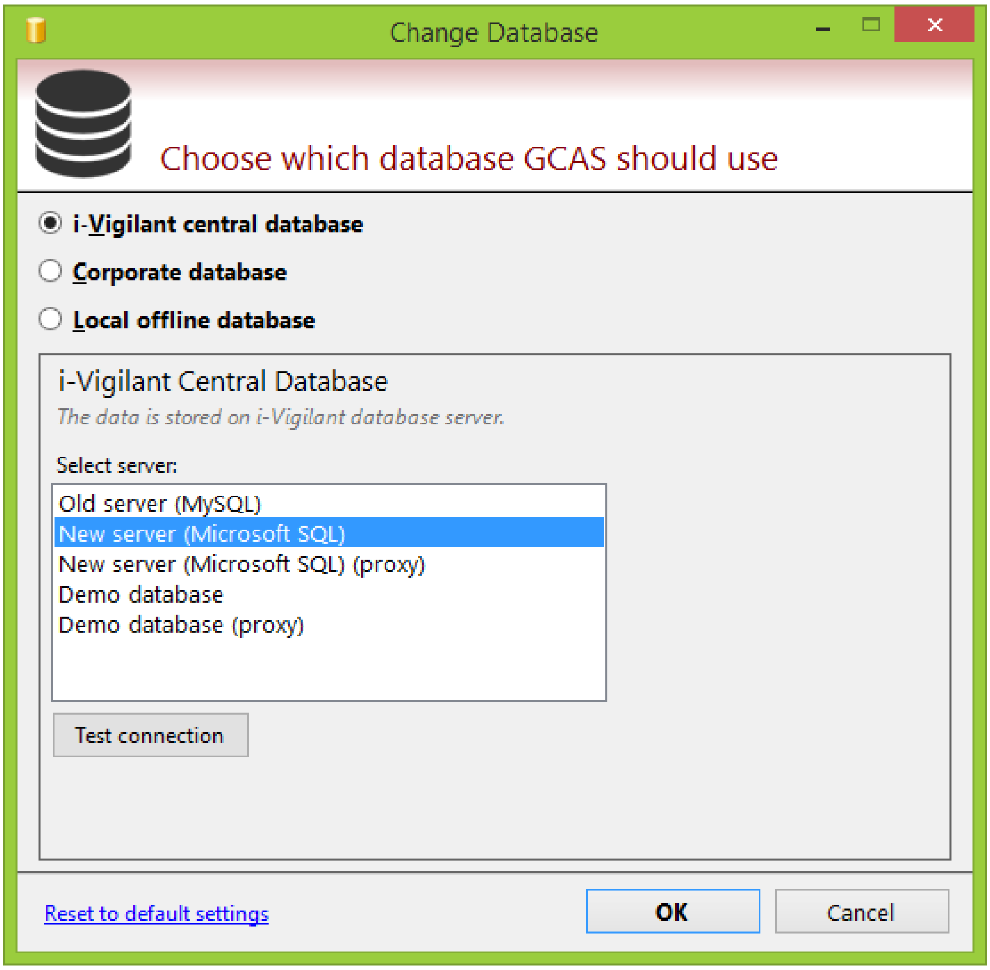
3. On Windows 10, open the Start menu (or Start screen if you are on tablet mode). For Windows 10 systems before the [Anniversary Update](), you also need to click **All Apps**. Jump to the letter I then find *i-Vigilant Technologies*. Inside the folder you will find the **Change Database** shortcut.



4. Alternatively, run GCAS with additional **/changedatabase** parameter.



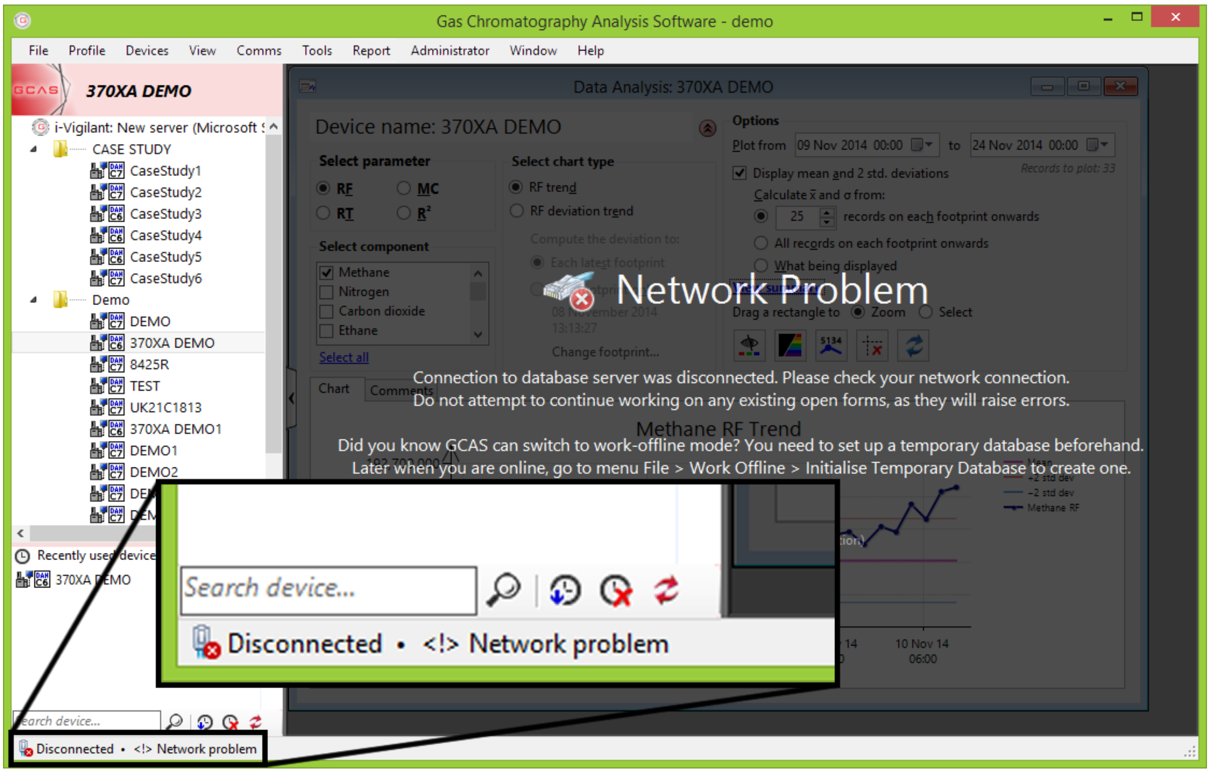
Any of the actions above would bypass the login screen straight to the *Change Database* dialogue. On this dialogue box, select the desired database server.



Click **OK** and start GCAS again.

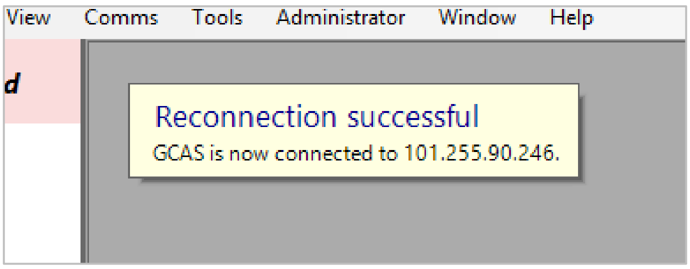
2.6 Reconnect on Network Problem

If you were disconnected from GCAS database server because of network problem*, GCAS displays an overlay notification and the status bar reads `Network Problem`. Click anywhere on the overlay to dismiss the notification.



(*because of network problem and you do not have *Work-offline Capability* included in your licence; or you *do* have one but you've never set up a temporary database before)

Wait for network connectivity to recover and then go to the File menu > **Reconnect Database** in order to reconnect. If the reconnection attempt is successful, GCAS displays a tooltip notification while all workspaces and devices are reloaded. Please close and reopen all windows and dialogues that were opened before network disconnection.



2.7 Temporary Database

Temporary database is a subset of whole GCAS database. This kind of database is used by work-offline feature, on which GCAS operates if it is in offline mode. Temporary databases use Microsoft SQL Server Compact Edition as the DBMS.

Unlike the complete database that stores all data for all GCAS users, temporary database stores only data relevant to you. This means temporary database contains data for groups you have been assigned to, devices in these groups, and data for these devices only. Each user would have their own temporary database. You would find these databases in `[installation directory]\DB-WorkOffline\` directory.

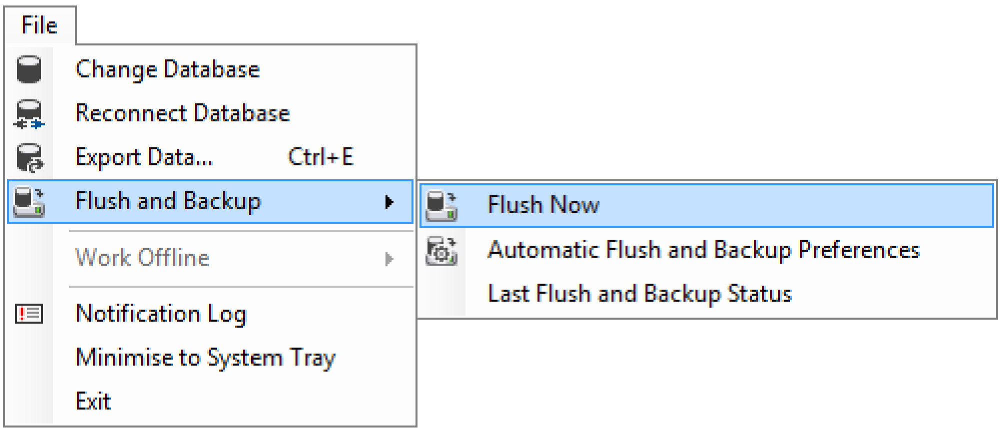
By default, GCAS synchronises data from the database server to temporary database for one latest month. That is, today minus one month. You can change this range from one month up to two years. To set up your temporary database and change how much data to synchronise, go to chapter 33 Work offline and 33.1 Set up temporary database.

2.8 Flush and Backup

Flush and backup is applicable for users with *local offline* databases—that is, Microsoft SQL Server Compact Edition or Microsoft Access. Users of local corporate databases or i-Vigilant central database may skip chapter 2.8 and 2.9.

Flushing a file means writing any pending changes to the file currently existing in computer memory into a permanent storage device—in this case, your hard disk drive. If for some unfortunate reason GCAS crashed, or a power cut happened, your database in computer memory/cache is lost. If GCAS doesn't flush the file at all, you will lose all data since the time GCAS was started. With a periodic flush, you lose only data since the last flush, not all the way back to GCAS start time. Nonetheless, GCAS cannot protect your hard disk from physical damages, especially during a power cut event.

To flush your database manually, go to the File menu on main user interface. Select **Flush and Backup**, then **Flush Now**.

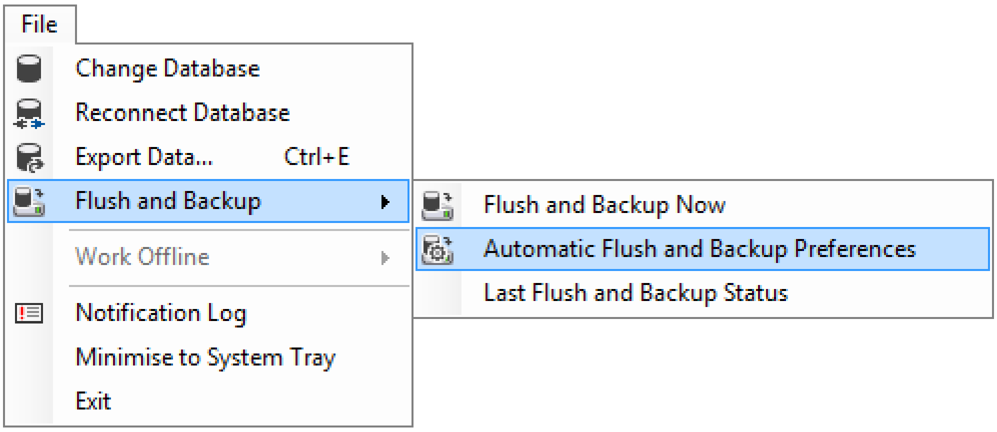


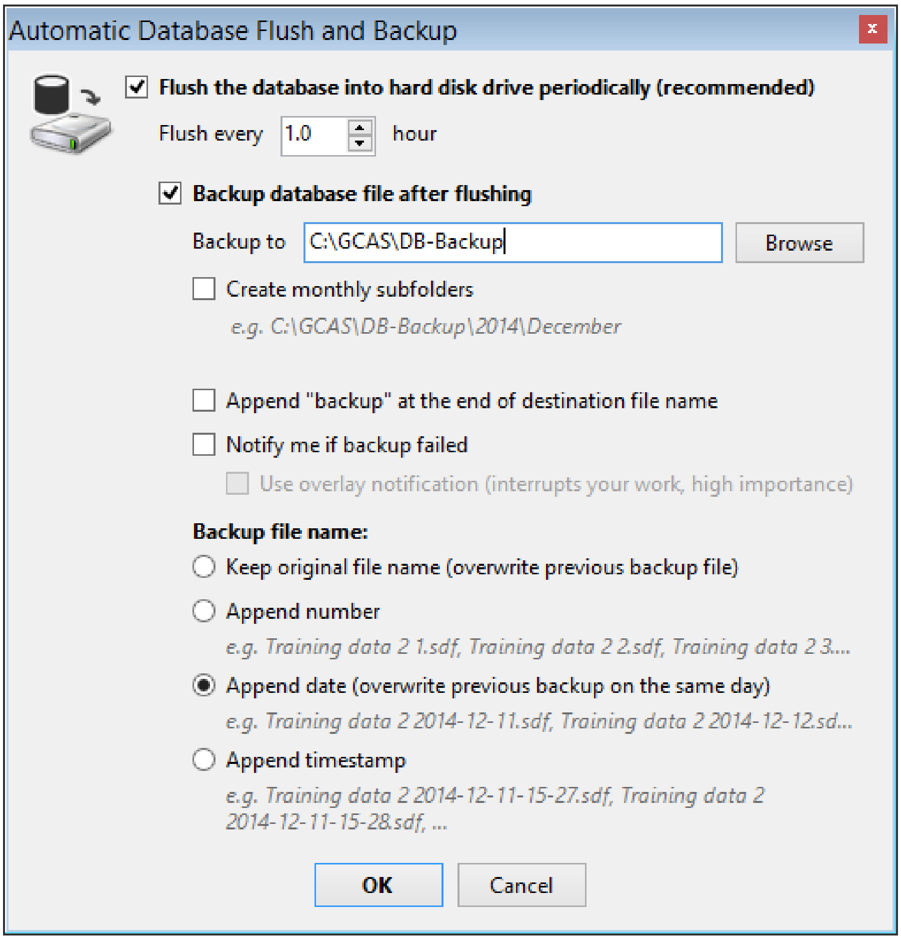
GCAS can also backup your database file after a flush. This feature is not yet turned on as you need to set up the backup destination directory beforehand.

By default, GCAS flushes your database file once every hour. You can configure the automatic flush settings at chapter 2.9 Automatic flush and backup.

2.9 Automatic Flush and Backup

On main user interface, go to the File menu, select **Flush and Backup**, and finally **Automatic Flush and Backup Preferences**. This menu shows the *Automatic Database Flush and Backup* dialogue.





To turn off automatic flush, uncheck **Flush the database into hard disk drive periodically**. All other options will be turned off.

Set the desired flush interval at **Flush every** field. You can choose between 0.5 hours (every 30 minutes) and 168 hours (one week). The default is one hour.

To turn on automatic backup, check **Backup database file after flushing** and set the desired backup directory. The backup directory can be on an internal hard disk of the same PC, an external hard disk, a USB thumb drive, or at a network location. Be sure that external drives are plugged or network path is accessible when GCAS finished flushing. For network locations, GCAS supports UNC notation such as \\server\shared directory\ or mapped network drives. Currently there is no support for FTP, SSH/SFTP, or WebDAV access.

Create monthly subfolders: If this is ticked, GCAS creates additional folders having the format of year\month. The database backup files go to the directory\year\month.

Append "backup" at the end of destination file name: Tick this to add "backup" to the file name. For example if your local offline database is Contoso.sdf, the backup file will be Contoso backup.sdf (or Contoso backup 1.sdf, Contoso backup 2014-12-11.sdf, depending on what selected at the file name options). Tick this option if you back up your database to the same directory as the local offline database file itself.

Notify me if backup failed: This option causes GCAS to display a tooltip notification if backup operation failed. Cause of failure can be an unplugged external drive, insufficient free space on the hard disk, your external drive has a write-protect switch, invalid or inaccessible network locations, a firewall that prevented GCAS from reaching the network location, or the target network server is down.

Use overlay notification: If this option is checked, GCAS prompts an overlay notification instead of a tooltip notification. Overlay notification is that black transparent overlay which covers entire working area — therefore it will interrupt your work, signifying backup is a high-priority task. Tooltip notification disappears after few seconds, but overlay notification remains until you click it to dismiss. Additionally, upon dismissing the overlay notification, GCAS will open Windows Explorer or File Explorer and point it to the location of your local offline database, so you can do the backup manually.

There are four options that determine how the backup file shall be named.

1. **Keep original file name**: The backup file has the same name as the original database file (with additional word "backup" if you opt to append "backup" at the end of filename). GCAS overwrites the previous backup file because it has the same name.
2. **Append number**: GCAS appends a sequential number at the end of file name. This option prevents overwriting.
3. **Append date**: GCAS appends today's date to the backup file with the format of yyyy-mm-dd. This overwrites previous backup files on the same day, hence only one backup file can exist per day.
4. **Append timestamp**: GCAS appends today's date and current hour and minute with the format of yyyy-mm-dd-hh-nn. This option prevents overwriting.

3 Users, Groups, and Workspaces

GCAS *users* are users who are authorised to access data in GCAS database. GCAS requires users to enter their valid credential before presenting the main interface. Each user has their own user type and role, which control what kinds of data in the database are accessible to the user and what permissions the user has over the data.

When a GCAS user is assigned into a *group*, this implies the user is authorised to access, read, and write data to a portion of GCAS database which is allocated for this particular group. A user may be assigned to multiple groups.

3.1 User Types and Roles (Concept)

User types and *user roles* constitute the access control list (ACL). If you use i-Vigilant central database, this ACL is shared between GCAS Web and GCAS Desktop.

User types control which *menus* are available to the user. Default installation of GCAS would set up three user types: Administrator, super user, and general user. Administrator has access to all areas of GCAS modules and menus, while general user has access to essential features only.

You can create custom user types and assign custom menu permissions to each of them if you are the GCAS administrator. To do so, read chapter 31.2 Define new user types and roles and 31.5 Menu permissions.

User roles control which *actions* are available to the user. An *action* is a specific command available in some modules such as Footprint, Calibration Data, Mole Composition, and Device management. Those commands are accessible through the **Action** menu on the menu bar. Default installation of GCAS would set up six user roles:

- System administrator
- Engineer 1
- Engineer 2
- Partner
- Read-only
- Custom

Similar to user types, system administrator has access to all actions in both GCAS Web and GCAS Desktop. On the other side, read-only role has the least access.

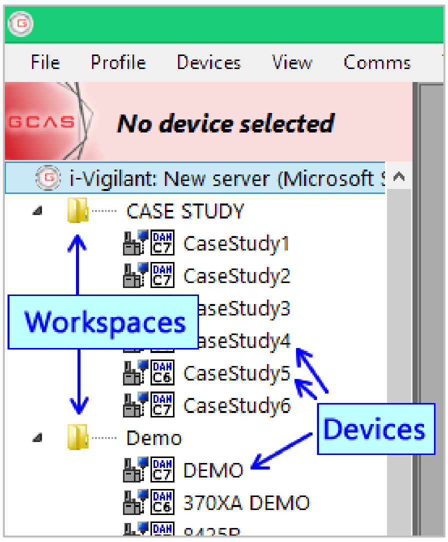
You can also define your own user roles and assign action permissions to them if you are the GCAS administrator. Jump to chapter 31.2 Define new user types and roles and 31.6 Action permissions to read more.

3.2 Groups and Workspaces (Concept)

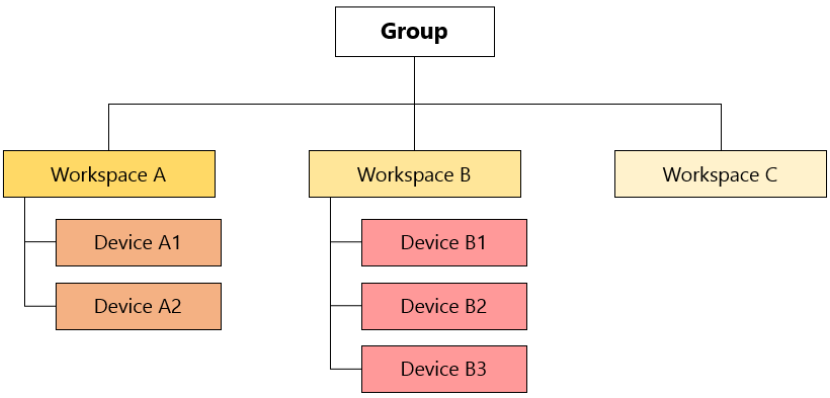
Group is the highest hierarchy of all GCs. Each GC device has to be a part of a group. A GCAS database should have at least one group. For example, a company called ACME Ltd. has three different platforms. These three platforms are all part of "*Platforms*" group.

Workspace is a way to separate GC devices which belong to the same group. Each group may have several workspaces. For instance, group *Platforms* has three different platforms thus each platform has its own separate workspace: *Platform A*, *Platform B*, and *Platform C*.

You should see workspaces of the groups assigned to you on the *device panel* in the main user interface once you have logged in. Underneath these workspaces are GC devices. If you don't see anything on this panel, your GCAS administrator could have not assigned your user account to any groups yet.



One group may have several workspaces, and one workspace contains many GC devices. One GC device cannot be assigned to multiple workspaces. Chapter 26 Device management explains more about creating, moving, and deleting devices (requires user type "super user"). Chapter 31.3 Manage groups explains about managing groups and workspaces within groups (requires user type "administrator").



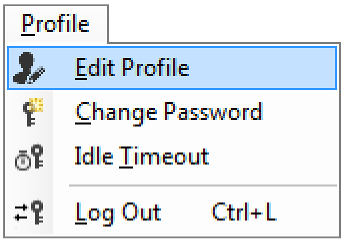
3.3 Edit Your Profile and Change Your Password

Each user has their associated user profile and credential. *User profile* is a set of personal information such as real name, email address, postal address, and phone number. *Credential* is the username and password required to log in to GCAS database.

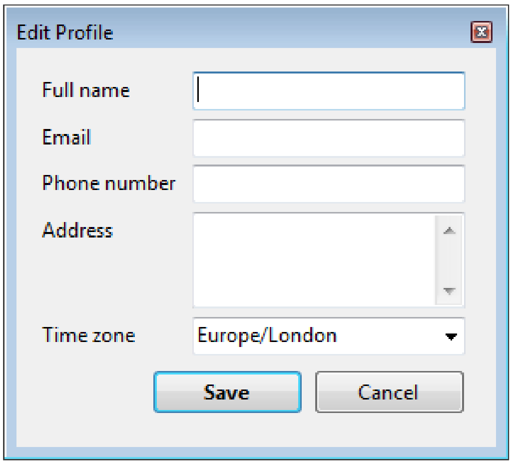
3.3.1 Edit Your Profile

To edit your user profile, follow the steps below.

1. Go to the Profile menu > **Edit profile**. If you do not see this menu, your user type may not have the menu permission for it. Contact your GCAS administrator.



2. This menu brings forth the *Edit Profile* dialogue.



3. Enter the information then click Save.

Regarding time zone

If you use i-Vigilant central database, all user comments (e.g. in the Footprint or Calibration Data) have their timestamps converted to server time zone. GCAS uses this time zone information in your user profile to display timestamps of user comments in the correct time, including times when you are travelling. If you enter a time zone other than the actual time zone you are living in, GCAS may display user comments with wrong time and wrong order.

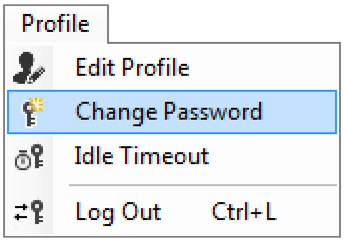
If you use local corporate database or local offline database, GCAS assumes the server time zone is the same as your time zone. No time zone conversion is performed.

Empty time zone information is replaced by the default **Europe/London** (UTC+0 standard time, UTC+1 daylight saving time).

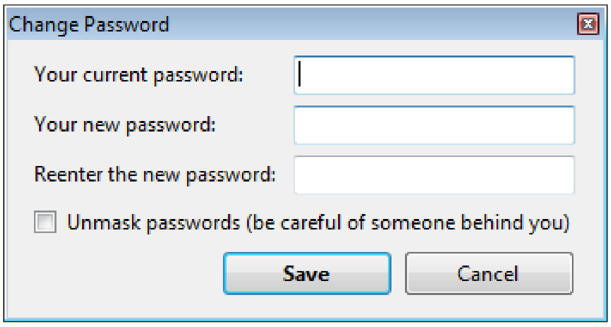
3.3.2 Change Your Password

Once your GCAS administrator finished creating your user account, it has usually a default password of "**password**" (all lowercase). Otherwise, your administrator should have informed you about your initial password. To change your password, follow these steps.

1. Go to the Profile menu > **Change Password**. If you don't see this menu on the menu bar, your user type may not have the menu permission for it (i.e. your GCAS administrator prohibits you from changing password).



2. The *Change Password* dialogue will appear.



3. Type your current password once and your desired password twice. Then click **Save** to commit the change.
4. Use the new password for the next time you log in to GCAS.

3.4 Forgot Your Password?

If you forgot your password and you use i-Vigilant central database, send a request for password reset quoting your GCAS username to support@i-vigilant.com then we will reset your password.

If you use local corporate database or local offline database, contact your GCAS administrator to reset your password. To GCAS administrators, follow chapter 31.1 Manage users to reset a user's password.

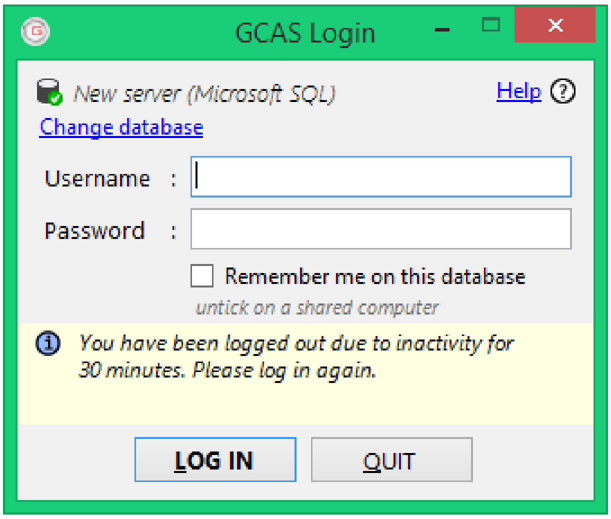
3.5 Logging Out

Go to the Profile menu > **Log Out** or press `Ctrl+L` shortcut key to log out. The next user can now log in.

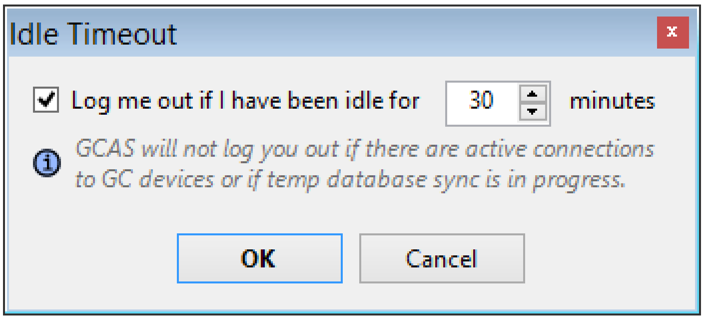
Be informed that if GCAS is in offline mode, only users who have set up their temporary databases can log in to GCAS.

3.6 Automatic Logout on Inactivity

To protect your data, GCAS can trigger automatic logout if it has been idle for certain period of time. The login form will look like this if you leave GCAS without any activity for some amount of time.



By default, GCAS *does not* log you out automatically. To turn on this feature and to configure the idle timeout threshold, go to the Profile menu > **Idle timeout**.



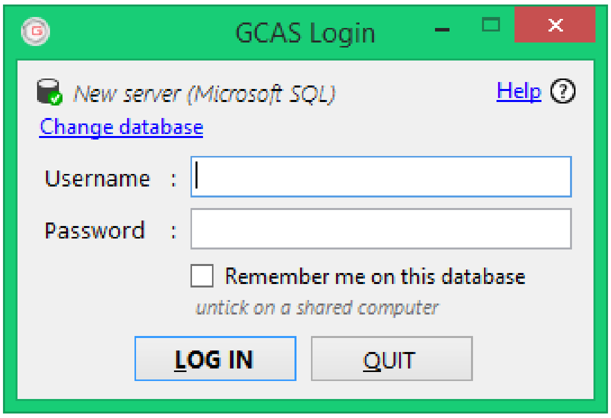
GCAS pauses the idle timer if you have data capture operation running in background, or if database synchronisation between database server and temporary database is in progress. However, GCAS does **not** pause the idle timer if GCAS is providing data through Modbus® server module. Your Modbus master software or device will stop getting data when the idle timer hits zero.

4 The User Interface

This chapter is a quick guide about GCAS user interface.

4.1 Login Form

When you launch GCAS, you see a splash screen for few seconds then you are presented with *login form*. Enter your GCAS username and password then click **Log in**.

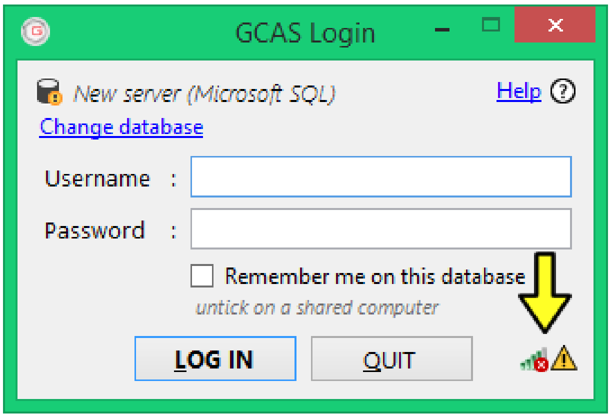


At the top, login form displays which database you are connected to. In case you frequently switch between databases, this information helps you to enter correct GCAS credential of current database. You can change database straight from here, simply click **Change database** link under the database name.

Icon on top-left corner indicates database connectivity status.

Icon	**Meaning**
	Database connection is closed. This may indicate network problem or I/O error. If you don't have GCAS feature *Work-offline Capability* in your GCAS licence, this icon is displayed during network problem.
 (spinning)	Database connection is in progress. You can enter credential but GCAS must wait until connection is opened successfully before validating your credential.
	Database connection is open.
	No database connection currently present. GCAS is in *offline mode* (see chapter 33.10) thus no connection is initiated until you log in.

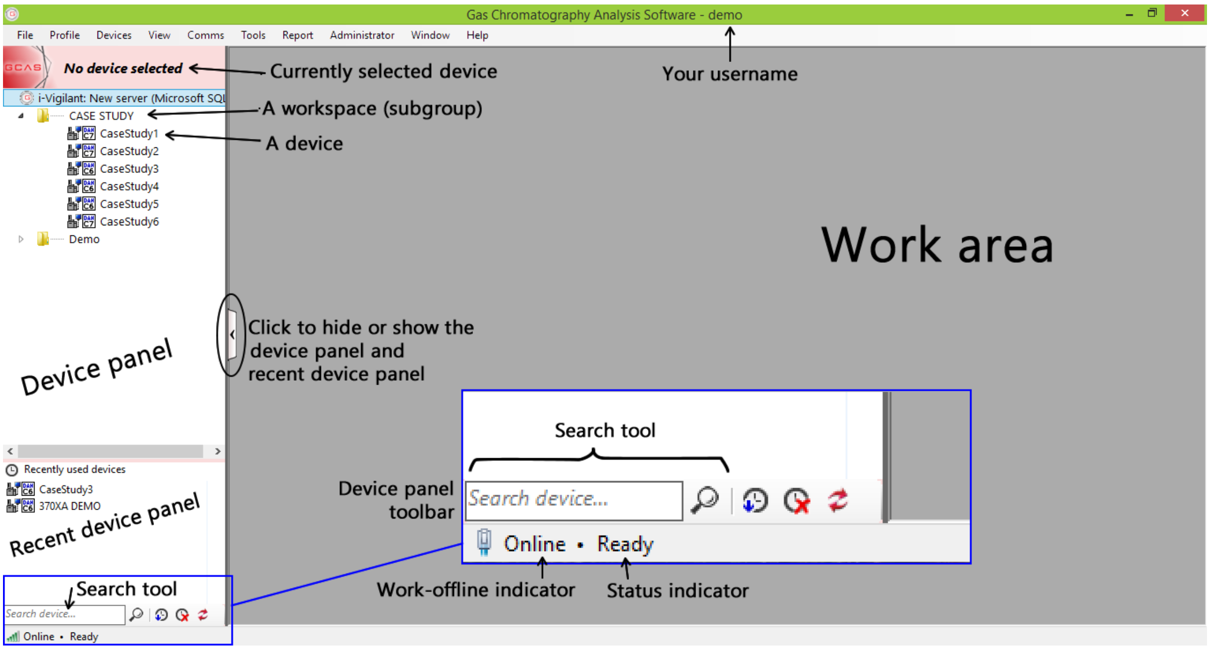
If you see the offline warning icon next to the Quit button similar to the screenshot on the next page, this indicates the login form is in *offline mode*. Read more on chapter 33.10 Login form in offline mode. You need the GCAS feature *Work-offline Capability* to be included in your GCAS licence to use offline mode.



The check box **Remember me on this database** is intended to speed up login process in case you have only one user in the GCAS database (thus you always use the same credential) and it is a private computer, meaning no one else uses that computer. Ticking this box causes GCAS to automatically fill in your username and password the next time GCAS is launched, therefore you can simply hit `Enter` key to log in. Never tick this box on a shared or public computer.

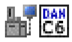
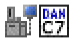
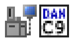
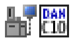
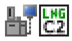
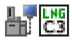
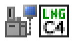
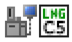
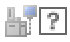
4.2 Main User Interface

Once you have entered your valid credential, you would see the main user interface.



4.2.1 Device Panel

The **device panel** lists all *workspaces* assigned to you and all GC devices under these workspaces. Click on a GC device to *select* it. Features such as Footprint, Calibration data, Mole Composition, or Uncertainty Calculator works with one device only, therefore make sure you select the correct device. The selected device name is displayed on the top of device panel. Learn more about workspaces.

Icon	Meaning*
	Daniel GC, C6+
	Daniel GC, C7+
	Daniel GC, C9+
	Daniel GC, C10+, both type A and type B**
	ABB GC, C6+
	ABB GC, C7+
	Siemens GC, C6+
	Siemens GC, C7+
	Siemens GC, C9+
	Siemens GC, C10+
	Elster GC, C6+
	Elster GC, C7+
	Elster GC, C9+
	Elster GC, C10+
	LNG device, C2−
	LNG device, C3−
	LNG device, C4−
	LNG device, C5−
	BTEX analyser
	H_2S analyser
	Moisture analyser (H_2O)
	Single gas analyser
	Unsupported GC

*Devices having pentane and above are split into two, the complete one (with neopentane) and without neopentane. These two variants on each device type share the same icon.

**Daniel C10+ type A has R^2 sequence of [C3-C4-C5-C6] and [C7-C8-C9-C10].
Daniel C10+ type B has R^2 sequence of [C3-C4-C5] and [C6-C7-C8-C9-C10].

4.2.2 Recent Device Panel

Under the device panel is known as **recent device panel**. This section lists your recently used devices. Clicking a device on this list also *selects* it, which is the same effect as selecting the same device from the device panel above. Recent device list is persistent, that is, this list is preserved after you exit GCAS and run it again the next time.

4.2.3 Search Tool and Toolbar

There is a small toolbar under recent device panel. It has a **search tool** to help you find a device if you have a lot of GC devices on your device panel. Type the device name and click **Search**. When you are in search mode, the *recent device* panel temporarily turns into *search results* panel. After you find the device in the search result list, click the device to *select* it or click **Finish searching** to close the search tool.

The toolbar also contains three more buttons.

Button	What it does
Hide recent devices	Hides the recent device panel. Your main device panel fills the entire sidebar.
Show recent devices	If the recent device panel is hidden, this button brings it back visible.
Clear recent devices	Clears your recent device list.
Refresh devices	Reloads all workspaces and GC devices on your device panel.

4.2.4 Status Bar

Status bar at the bottom of the form hosts two elements: work-offline indicator and status indicator.

Work-offline indicator appears if you have *Work-offline Capability* included in your GCAS licence and you are not using local-offline database. The indicator displays one of these symbols.

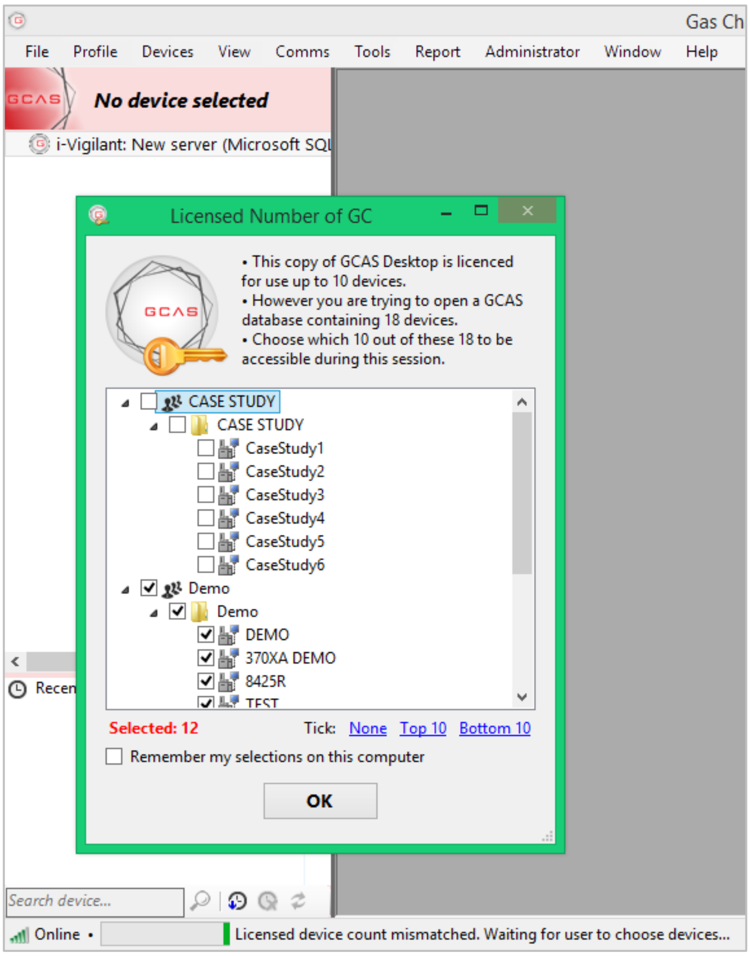
Icon (depending on network medium)	Text	Meaning
	Online	GCAS is working online and is connected to database server.
	Offline	GCAS is working offline and is connected to temporary database.
	Disconnected	GCAS is not connected to any database servers. Go to File menu > Reconnect Database to reconnect.

Status indicator displays general status of GCAS and status bar notifications, which are usually related to database, licence update, and later on–software updates. Specific status associated with specific module will not be displayed on the status bar, but on their own form instead. For example, Footprint form, Calibration Data form, Mole Composition form, and Data Analysis form have their own busy indicator on each user interface. Most of the time, status indicator reads "Ready".

In case you have *Modbus® Server over Serial* or *Modbus® Server over TCP* included in your licence and you have configured Modbus server module (engine and instances) for data provision, the status bar also displays a link "**Server is running**" after Modbus server finished starting up. Clicking that link would take you to Modbus Server Interface window.

4.3 Choose Devices Dialogue

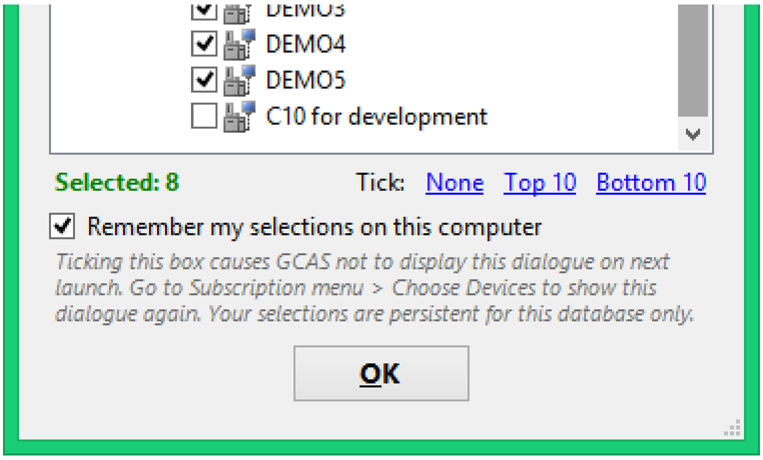
Choose Devices dialogue appears when you open a GCAS database having number of GC devices exceeding the limit permitted by your GCAS licence. This dialogue lets you choose which GC devices to be *accessible* during current session of GCAS.



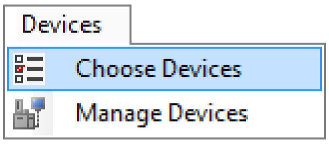
As an example, meet Frank. He is a talented GC specialist service engineer. He bought a GCAS licence of 5 GC devices. One day a customer called, requesting his help to analyse problems on their GCs. The customer exported part of their GCAS database to a Microsoft SQL server compact database and handed the .sdf file to Frank. Unfortunately this database has 8 devices. When Frank changes database to this .sdf file, GCAS presents *Choose Devices* dialogue when the main window is being loaded. As his licence only permits five GC devices maximum, Frank must choose which five out of these eight to be visible during this session. To see the other three, Frank needs to restart GCAS to end current session and start a new session, thus displaying the *Choose Devices* dialogue again. This time, he chooses the remaining three (and optionally two out of the other five).

4.3.1 Persistent Device Selection

Device selection made through *Choose Devices* dialogue is not persistent. Next time GCAS is launched, it presents *Choose Devices* dialogue again, allowing you to select the other devices that were not visible during previous session.



To make your device selection persistent, tick **Remember my selections on this computer**. This causes GCAS to remember your selection for the next time GCAS is launched and thereafter. The selection is valid for current GCAS database only. If you change into different GCAS database, *Choose Devices* dialogue may re-appear. Again, you have the option to remember your selections for that database as well.

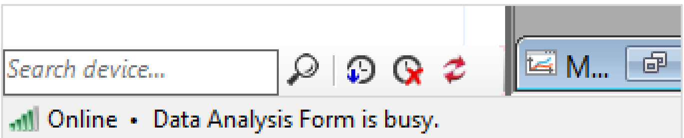


At some point you may change your mind. Go to the Devices menu > **Choose Devices** to display this dialogue again. Here you can change your selected devices to make visible, or simply untick **Remember my selections on this computer** to cancel the persistence. Unticking the check box causes GCAS to re-display *Choose Devices* dialogue the next time GCAS is launched. Please note this menu is not visible directly after making selection through *Choose Devices* dialogue. It will be there the next time GCAS is launched, so you need to spend one session with your current device selections first.

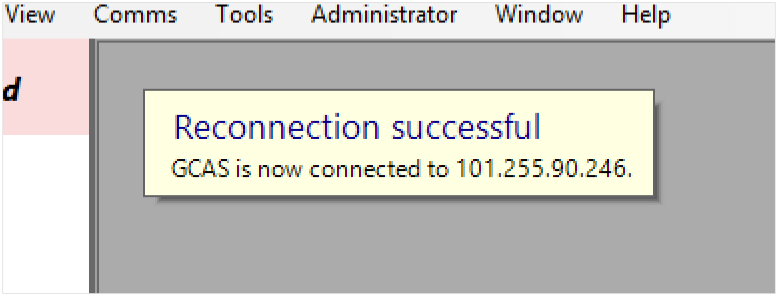
4.4 Notifications

GCAS has four kinds of notifications.

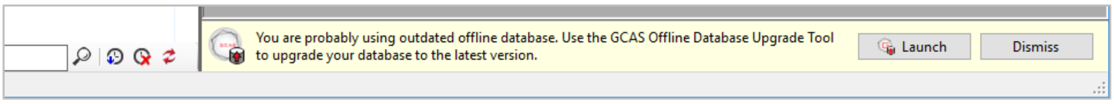
1. **Status bar notification**
   Status bar notification is displayed on—what else? —the status bar. This kind of notification usually contains less important messages. You probably see the message "xyz form is busy" most often when you attempt to close a form which was busy calculating. Status bar notifications dismiss themselves after few seconds.



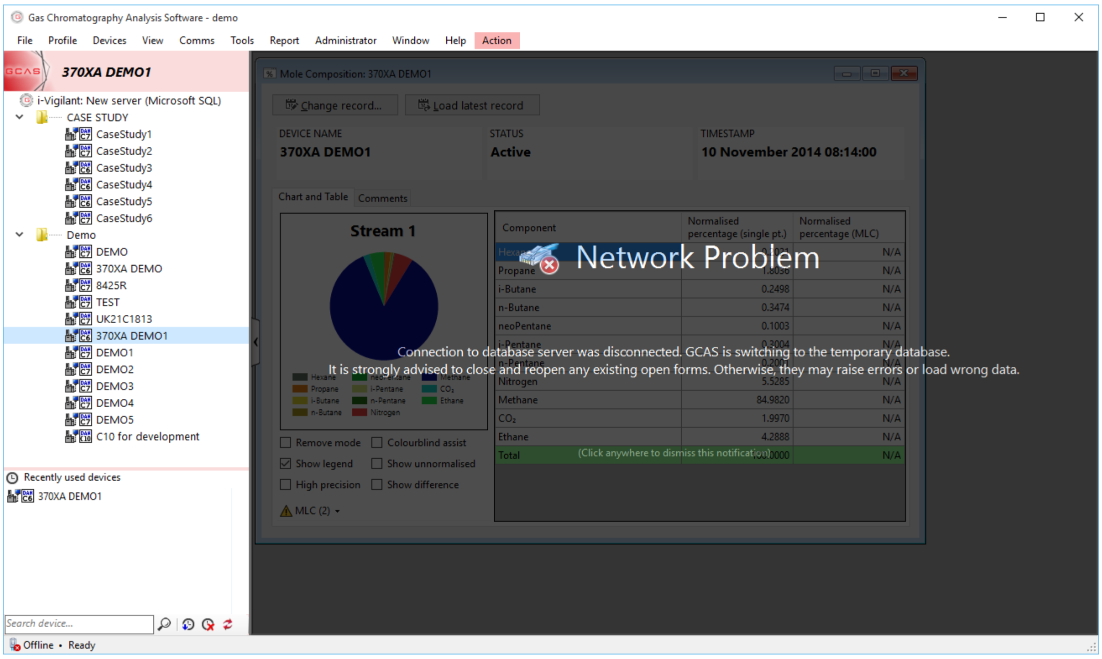
2. **Tooltip notification**
   Tooltip notifications contain only informational messages but GCAS needs to catch your attention. It appears at the top-left corner of work area. Tooltip notifications dismiss themselves after few seconds.



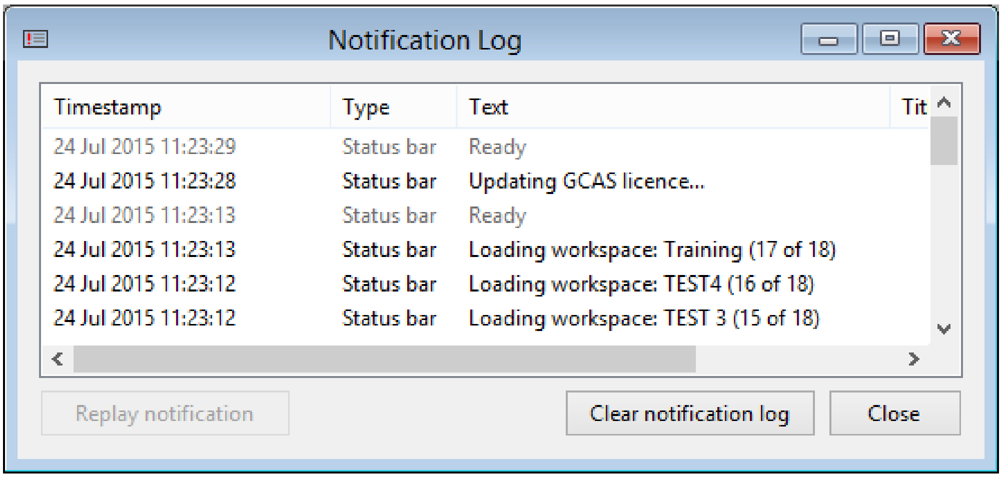
3. **Panel notification**
   GCAS uses panel notification to ask your decision. The notification is displayed at the bottom of work area. Panel notifications have up to three buttons. Click one of them to perform the appropriate action and dismiss the notification.



4. **Overlay notification**
   Possibly the most annoying one, overlay notification is the black transparent window which covers the entire work area. Overlay notifications interrupt your work therefore GCAS reserves them for urgent messages only. Click anywhere on the overlay to dismiss the notification.



In case you missed a notification, check the *Notification Log* from the **File** menu. *Notification Log* window displays the last 10,000 notifications. Click **Replay notification** to replay it. Replayed panel notifications still show decision buttons, but this time these buttons serve no function other than to dismiss the notification.



4.5 Standard Colour Palette

This chapter is hidden on the HTML version of GCAS manual. It only serves as a link destination target from chapters explaining alternative colour scheme for colourblind users.

This table lists the standard colour palette which GCAS uses for all charts across different modules.

Component	Colour	Red (0-255)	Green (0-255)	Blue (0-255)
Methane		8	13	145
Ethane		3	225	72
Propane		226	127	20
i-Butane		226	214	45
n-Butane		168	149	30
Neopentane		12	172	48
i-Pentane		205	226	118
n-Pentane		35	114	21
Hexane		97	109	95
Heptane		53	127	220
Octane		132	60	192
Nonane		76	34	110
Decane		4	2	0
Nitrogen		234	58	58
Carbon dioxide		21	210	198
Unnormalised total or R^2 pass limit		255	0	0
Mean		233	94	211
Mean + 2 standard deviations		241	136	136
Mean – 2 standard deviations		116	170	236

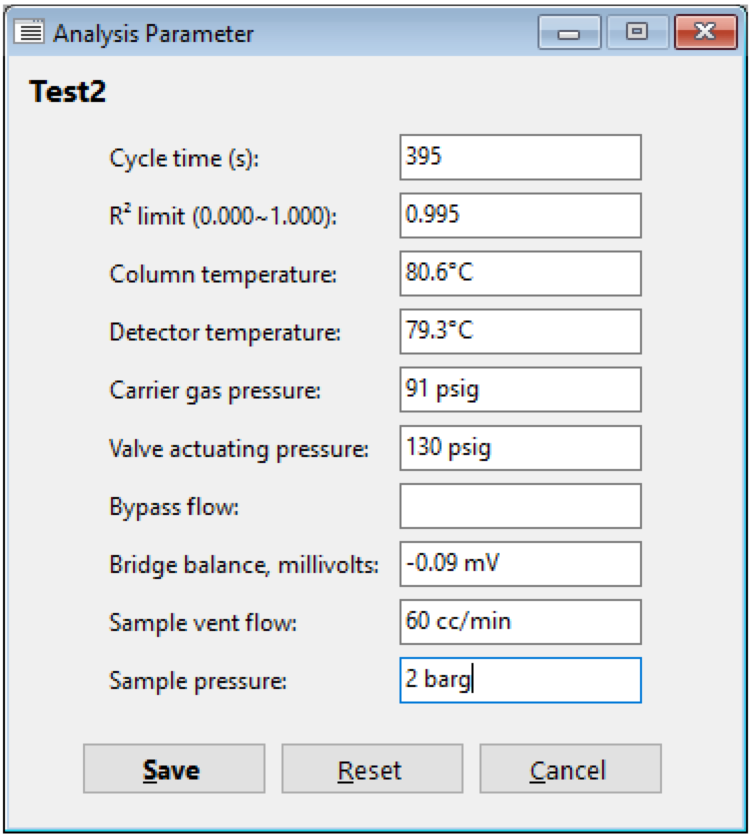
When **colourblind-assist** is turned on, GCAS switches to this alternative colour palette and turns on several visual assistances. This is to aid users with protanopia and deuteranopia.

Component	Colour	R	G	B	Line chart	Pie chart	Point chart
Methane		8	13	145	Solid line	Solid	▲
Ethane		214	185	90	Solid line	Solid	▲
Propane		180	134	20	Dashed line	Horizontal black dash	◆
i-Butane		255	255	0	Solid line + black shadow	Solid	▲
n-Butane		188	145	29	Solid line	Solid	■
Neopentane		151	125	46	Solid line	10% white-dotted	▲
i-Pentane		247	217	117	Dashed line + black shadow	10% black-dotted	◆
n-Pentane		119	92	20	Dash-dot	Vertical white dash	■
Hexane		109	106	94	Solid line	Solid	▲
Heptane		94	115	219	Solid line	Diagonal white stripes	▲
Octane		53	74	193	Dash-dot	Solid	★
Nonane		30	42	110	Dashed line	Diagonal white criss-cross	◆
Decane		4	2	0	Solid line	Solid	▲
Nitrogen		84	78	59	Dash-dot-dot	25% white-dotted	★
Carbon dioxide		156	163	195	Dash-dot + black shadow	Solid	■
Unnorm. total/R^2 pass		60	46	0	Solid line	Solid	◆
Mean		155	151	136	Solid line	Not applicable	
Mean + 2 std. dev		97	116	212	Solid line		
Mean – 2 std. dev		146	162	235	Solid line		

5 Analysis Parameter

Analysis parameters are collection of information that could assist users when analysing the GC performance. When something goes wrong, it is a good idea to compare the parameters stored in this form and the actual condition observed on the GC device.

To view or edit analysis parameter for a particular device, select that device on the device panel on the main user interface and then go to the View menu > **Analysis Parameter**.



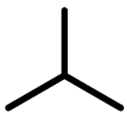
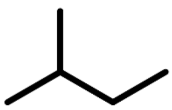
The first two fields, **cycle time** and **R^2 limit**, accept only numeric value. The rest can accept alphanumeric characters. If no R^2 limit entered, GCAS assumes the default R^2 threshold to be **0.995**. Click **Save** to commit the change, **Cancel** to discard the change, or **Reset** to reload previous values.

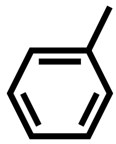
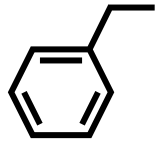
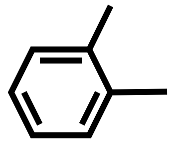
If all input fields are greyed out, your user account might not have sufficient action permission to edit Analysis Parameter. Contact your GCAS administrator.

6 Gas Acronyms

On GCAS Desktop and GCAS Web user interface, users might see C1, C2, C3, and so on. These are carbon atom count of supported alkane gases. GCAS supports C1 (methane) to C10 (decane). GCAS Web supports C1 to C7 (heptane) only.

Several device types do not read alkane gases therefore such devices use different gas acronyms.

Notation	**Alternative notation**	**Gas name**	**Alternative gas name**	**Formula**
C1	C1	Methane		CH_4
C2	C2	Ethane		C_2H_6
C3	C3	Propane		C_3H_8
C4	NC4	n-Butane		C_4H_{10} 
	IC4	i-Butane, Isobutane	Methylpropane	C_4H_{10} 
C5	NC5	n-Pentane		C_5H_{12} 
	IC5	i-Pentane, Isopentane	Methylbutane	C_5H_{12} 
	NEOC5	Neopentane	Dimethylpro-pane	C_5H_{12} 
C6	C6	Hexane		C_6H_{14}
C7	C7	Heptane		C_7H_{16}
C8	C8	Octane		C_8H_{18}
C9	C9	Nonane		C_9H_{20}
C10	C10	Decane		$C_{10}H_{22}$
N2	N2	Nitrogen		N_2
CO2	CO2	Carbon dioxide		CO_2
B	B	Benzene		C_6H_6 

Notation	**Alternative notation**	**Gas name**	**Alternative gas name**	**Formula**
T	T	Toluene	Methylbenzene	C_7H_8 
E	E	Ethylbenzene		C_8H_{10} 
X	X	Xylene o-Xylene, m-Xylene, p-Xylene	1,2-Dimethyl-benzene; 1,3- or 1,4-	C_8H_{10} 
H2S	H2S	Hydrogen sulfide		H_2S
H2O	H2O	Water vapour, moisture, dew		H_2O
G	G	"The gas" *		anything

In case of butane and pentane, C4 (without prefix N or I) refers to n-Butane while C5 means n-Pentane.

* "The gas" here refer to the gas used by  single gas analysers. It could be any gas, for example SO_2, SO_3, NO_x, oxygen, fluorine, or helium. GCAS does not know which gas the device is using, therefore we call it "*the*" gas.  H_2S analyser and  moisture analyser are specialised types of single gas analyser and use their appropriate gas names.

7 Footprint and Calibration Data

A *calibration data* is one record or snapshot of gas properties of the analyte read by the GC device. GCAS records two main properties, which are the response factor (RF) and retention time (RT).

GCAS assumes the response factor is calculated using *peak area* formula.

$$RF = \frac{peak\ area}{mole\ composition}$$

If your GC device uses *peak height* formula, that is, peak height divided by mole composition, unfortunately your GC device is not compatible with GCAS. Or to the least, the RF chart on both Footprint form and Calibration Data form may not help you in the analysis of GC health status.

Some GC devices use the inverted formula, which is mole composition divided by peak area. These devices are still compatible with GCAS however, with a few differences:

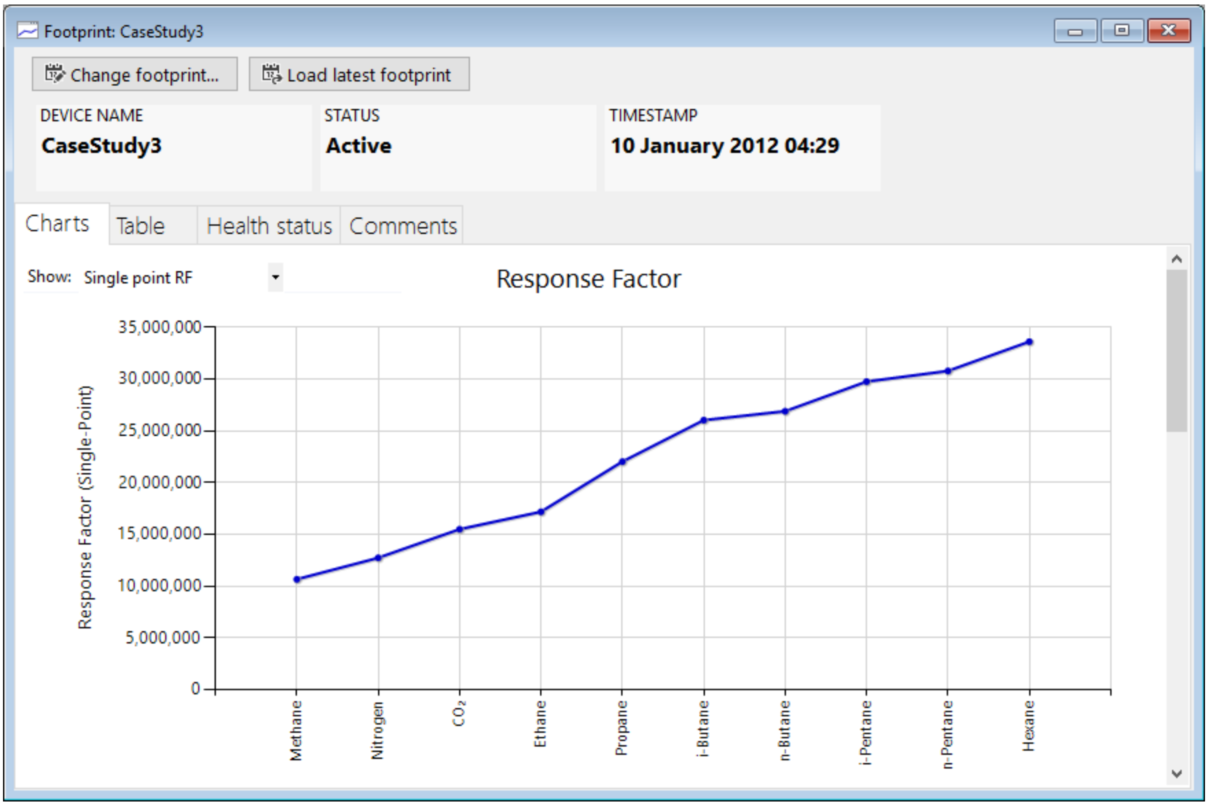
1. RF chart will descend downwards instead of the usual ascending shape,
2. RF values will be somewhere within the order of 10^{-6} to 10^{-8}, instead of 10^{6} to 10^{8}.
3. Correlation charts will show a downward slope or negative gradient, unlike the usual upward slope. Though, R^2 calculation stays the same.

Elster GC is one example of GC device using the inverted formula. GCAS automatically inverts RF values when you import data from CSV file or via Modbus data capture.

Footprint is a special type of calibration data which is usually:

1. The first data of a GC device, or
2. A known good data as a reference of comparison for future calibration data.

7.1 The *Footprint* Form



Principal purpose of *Footprint* form is to show footprint records. It has three sections of charts, which are:

1. Response factor chart,
2. RF-MW log charts,
3. Retention time chart.

To open Footprint form, select the device from the device panel then go to View menu > **Footprint**.

Response factor chart graphs the response factor from gas with lowest to highest molecular weight. It should have a nice ascending slope, otherwise it may indicate problems within your GC device. In case you wonder what the dropdown **Single-point RF** is doing at the top-left corner, that is for ISO 10723 conversion and you also need GCAS feature *ISO 10723* in your licence. Jump to chapter 7.12 for more.

RF-MW log charts plot the base-10 logarithm of response factor (RF) against molecular weight (MW) of certain sequence of gases. They also calculate the regression line, and computes the square of Pearson correlation coefficient (R) value. If R^2 value is less than threshold set in the Analysis Parameter (default is 0.995), the number turns red and this may indicate problems within GC device.

Depending on your GC device type, there may be one, two, three, or no RF-MW charts. Daniel, ABB, and Elster C6+ and C7+ devices have three correlation charts. GC devices with two ovens such as Daniel C9+ and C10+ have two correlation charts only. Siemens has none.

Retention time chart graphs the retention time value, or *peak time*, in the unit of seconds (s).

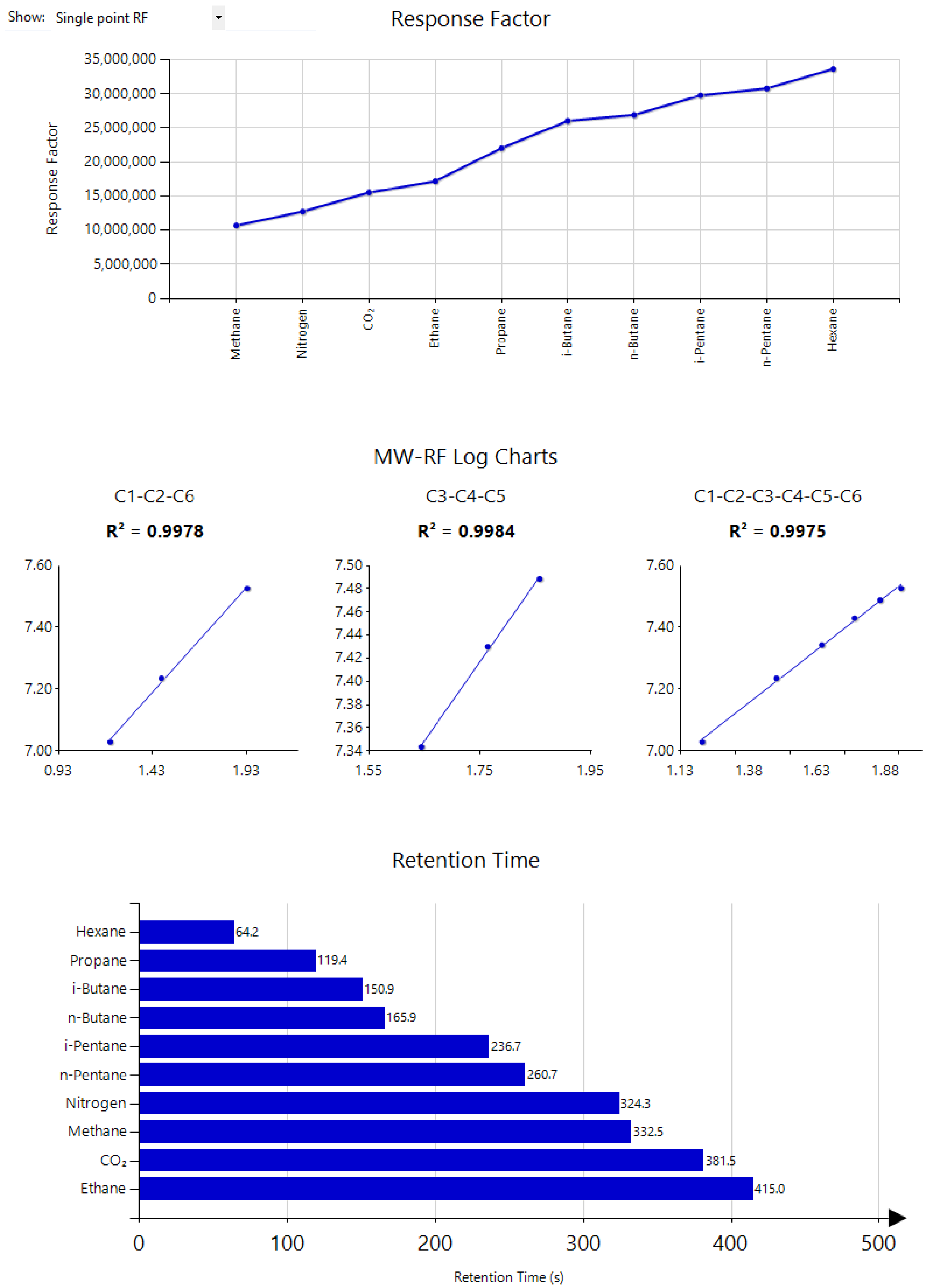
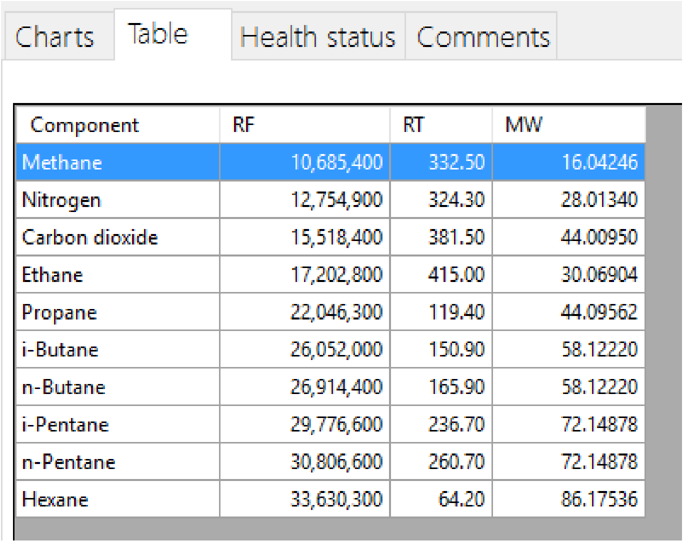


Chart view

To see the exact value of a data point on the charts, hover your mouse cursor over the dots. Otherwise, switch to table view. On table view, **MW** is the molecular weight in gram per mole.



Charts | Table | Health status | Comments

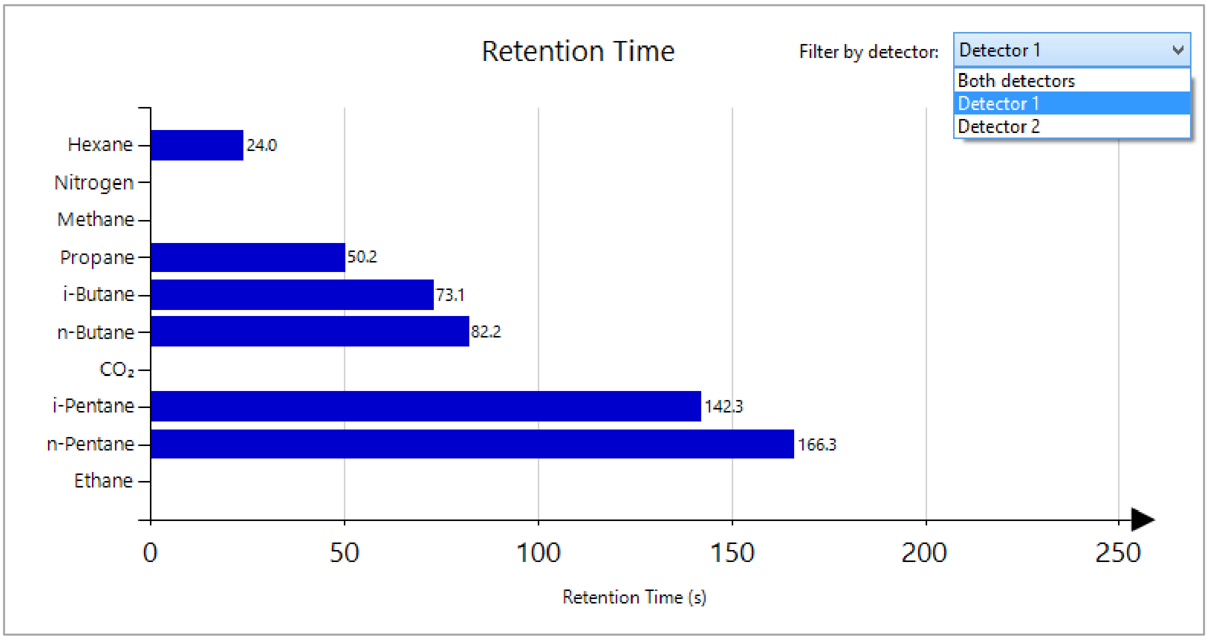
Component	RF	RT	MW
Methane	10,685,400	332.50	16.04246
Nitrogen	12,754,900	324.30	28.01340
Carbon dioxide	15,518,400	381.50	44.00950
Ethane	17,202,800	415.00	30.06904
Propane	22,046,300	119.40	44.09562
i-Butane	26,052,000	150.90	58.12220
n-Butane	26,914,400	165.90	58.12220
i-Pentane	29,776,600	236.70	72.14878
n-Pentane	30,806,600	260.70	72.14878
Hexane	33,630,300	64.20	86.17536

Table view

Special value −1

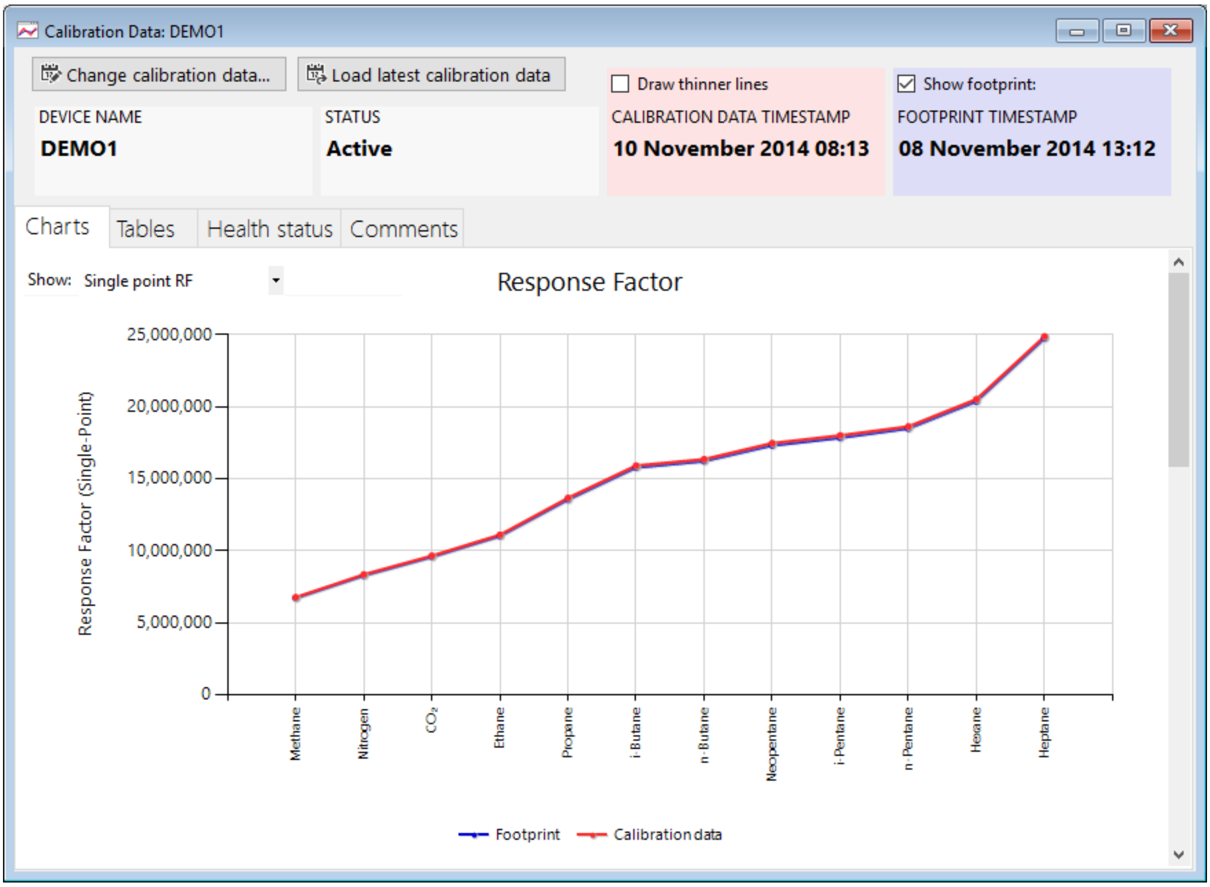
If you see −1 (negative one) for all RF values in this table view, this means the footprint does not have response factor data. This record may come from data capture operation but with an additional configuration to ignore incoming RF data. Similarly, if you see −1.00 for all RT values, the footprint does not have retention time data. Read more about incomplete footprint record.

Retention time chart behaves differently for several GC types. For example, ABB and Elster GCs have two detectors while Daniel GCs have one. Siemens GCs have four. Each detector has a predetermined sequence of gases coming out from the GC, hence every detector forms a subset of RT chart. For these kinds of device, you can show RT charts from both detectors, from the first detector only, or from the second detector only.



Example of retention time chart for ABB C6+ GCs. There is a filter dropdown on the right side.

7.2 The *Calibration Data* Form

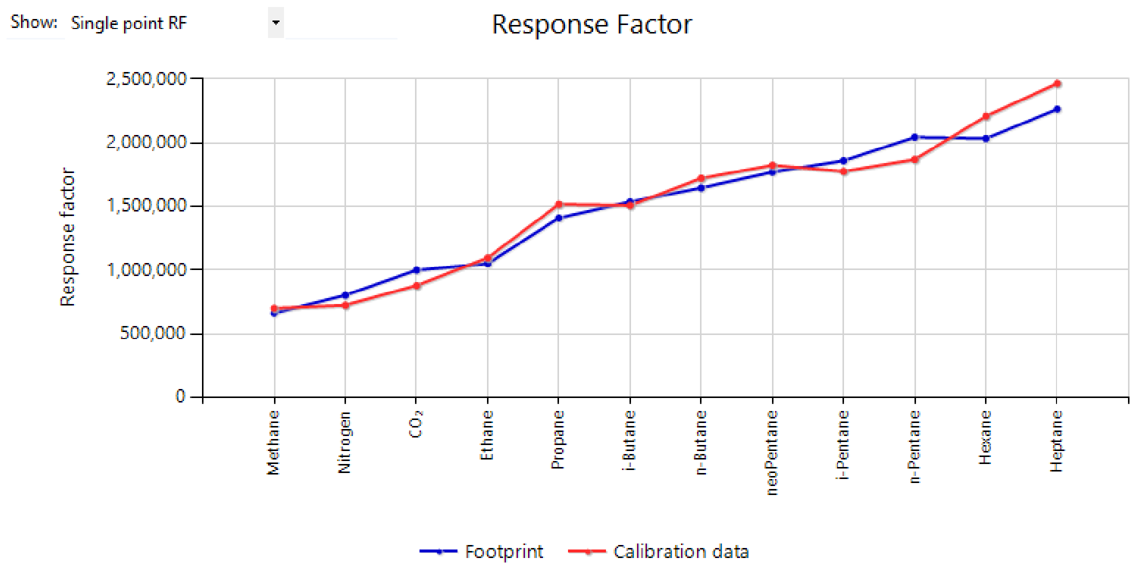


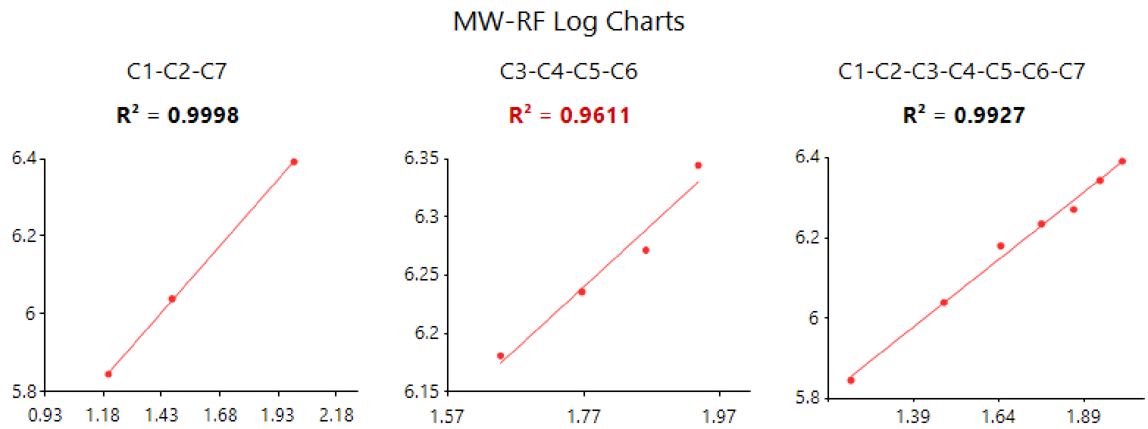
The main purpose of *Calibration Data* form is to show calibration data records and also to compare this calibration data to the immediate preceding footprint. Similar to Footprint form, the Calibration Data form has RF chart, RF-MW log charts, and RT chart.

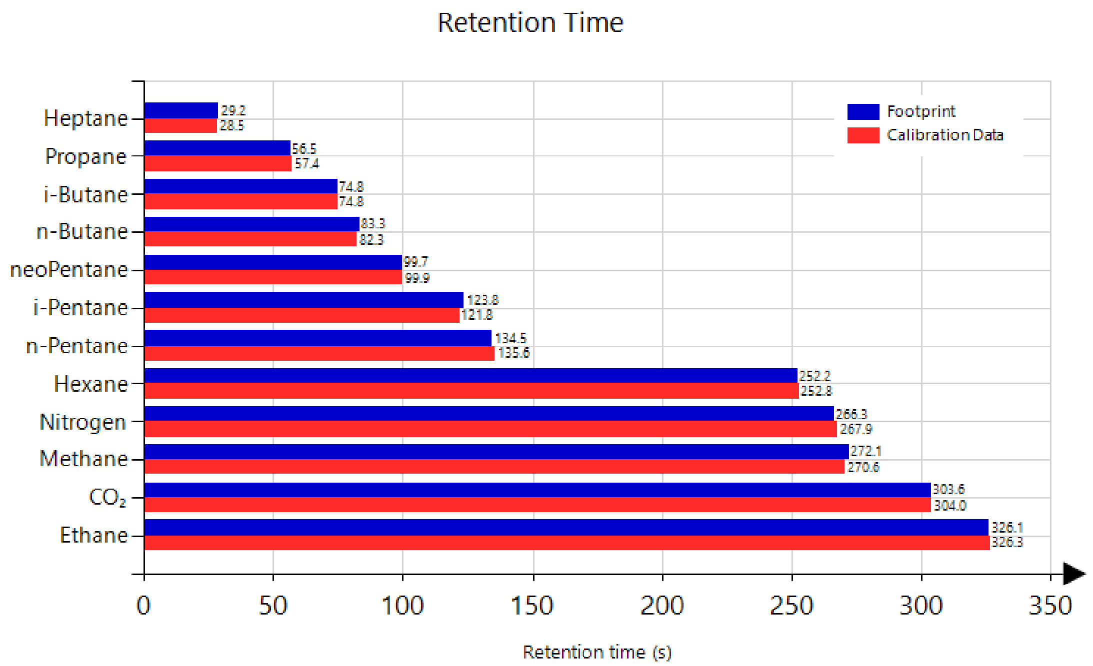
To open Calibration Data form, select the desired device on the device panel on main user interface, and afterwards go to the View menu > **Calibration Data**.

Response factor chart and retention time chart display the calibration data values in **red** and footprint values in **blue**. You can hide the footprint (blue) line or bar by unticking the **Show footprint** check box on top of footprint timestamp display.

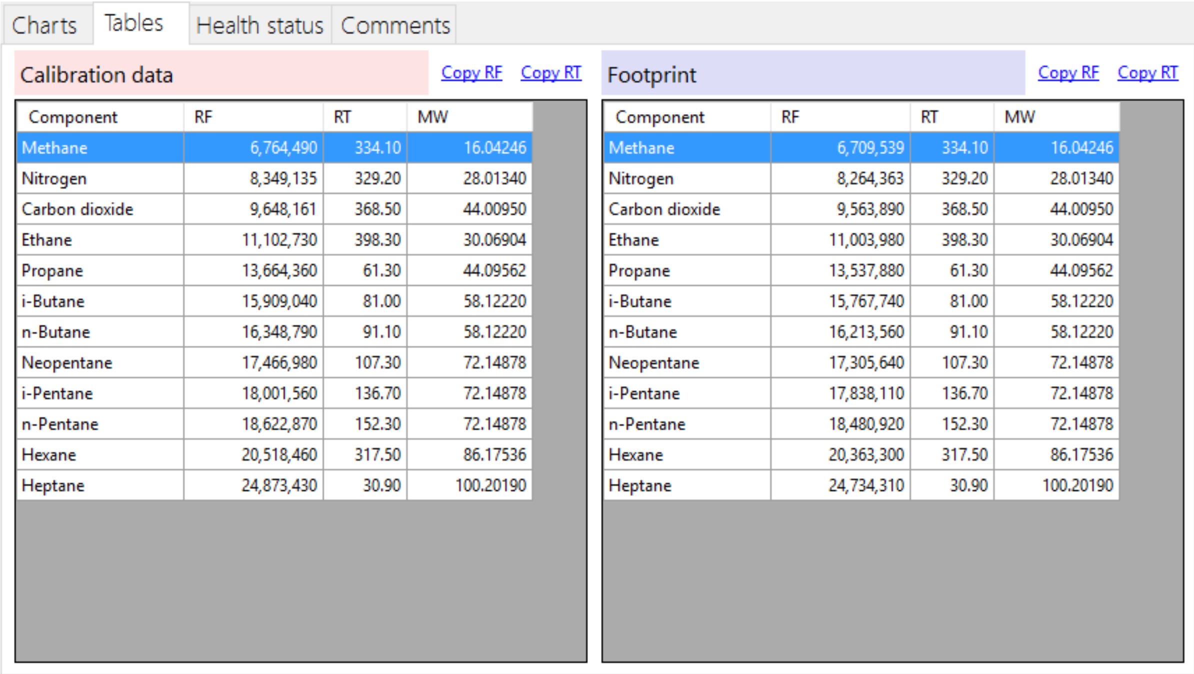
Unlike the other two charts, RF-MW logarithm charts only calculate the logarithm, regression line, and R^2 value of calibration data (red) record only.


Show: Single point RF
Response Factor
Response factor
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Methane
Nitrogen
CO2
Ethane
Propane
i-Butane
n-Butane
neoPentane
i-Pentane
n-Pentane
Hexane
Heptane
Footprint
Calibration data


MW-RF Log Charts
C1-C2-C7
R² = 0.9998
C3-C4-C5-C6
R² = 0.9611
C1-C2-C3-C4-C5-C6-C7
R² = 0.9927
6.4
6.2
6
5.8
0.93 1.18 1.43 1.68 1.93 2.18
6.35
6.3
6.25
6.2
6.15
1.57 1.77 1.97
6.4
6.2
6
5.8
1.39 1.64 1.89


Retention Time
Heptane
Propane
i-Butane
n-Butane
neoPentane
i-Pentane
n-Pentane
Hexane
Nitrogen
Methane
CO2
Ethane
29.2
28.5
56.5
57.4
74.8
74.8
83.3
82.3
99.7
99.9
123.8
121.8
134.5
135.6
252.2
252.8
266.3
267.9
272.1
270.6
303.6
304.0
326.1
326.3
Footprint
Calibration Data
0 50 100 150 200 250 300 350
Retention time (s)

In the same way as [Footprint form](), switch to table view to see exact numeric values. Here you will see the comparison to footprint value side-by-side.



Calibration data

Component	RF	RT	MW
Methane	6,764,490	334.10	16.04246
Nitrogen	8,349,135	329.20	28.01340
Carbon dioxide	9,648,161	368.50	44.00950
Ethane	11,102,730	398.30	30.06904
Propane	13,664,360	61.30	44.09562
i-Butane	15,909,040	81.00	58.12220
n-Butane	16,348,790	91.10	58.12220
Neopentane	17,466,980	107.30	72.14878
i-Pentane	18,001,560	136.70	72.14878
n-Pentane	18,622,870	152.30	72.14878
Hexane	20,518,460	317.50	86.17536
Heptane	24,873,430	30.90	100.20190

Footprint

Component	RF	RT	MW
Methane	6,709,539	334.10	16.04246
Nitrogen	8,264,363	329.20	28.01340
Carbon dioxide	9,563,890	368.50	44.00950
Ethane	11,003,980	398.30	30.06904
Propane	13,537,880	61.30	44.09562
i-Butane	15,767,740	81.00	58.12220
n-Butane	16,213,560	91.10	58.12220
Neopentane	17,305,640	107.30	72.14878
i-Pentane	17,838,110	136.70	72.14878
n-Pentane	18,480,920	152.30	72.14878
Hexane	20,363,300	317.50	86.17536
Heptane	24,734,310	30.90	100.20190

Special value −1

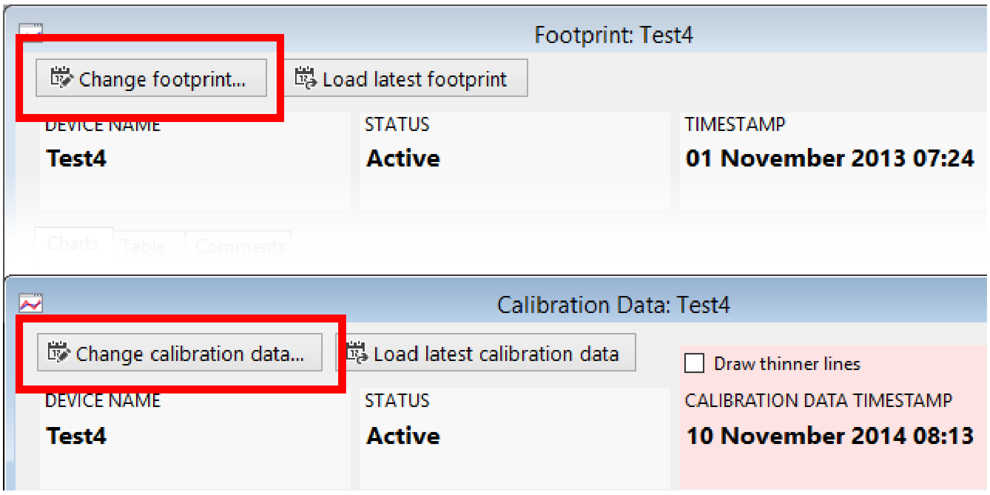
If you see −1 (negative one) for all RF values in one or both of the table views, this means the calibration data (or its footprint) does not have response factor data. This record may come from [data capture]() operation but with an additional configuration to [ignore incoming RF data](). Similarly, if you see −1.00 for all RT values, the calibration data (or its footprint) does not have retention time data. [Read more about incomplete calibration record]().

Click **Copy RF** or **Copy RT** above the desired table grid (calibration data or footprint) to copy RF or RT values respectively, because these grids have synchronised scrolling and row selection.

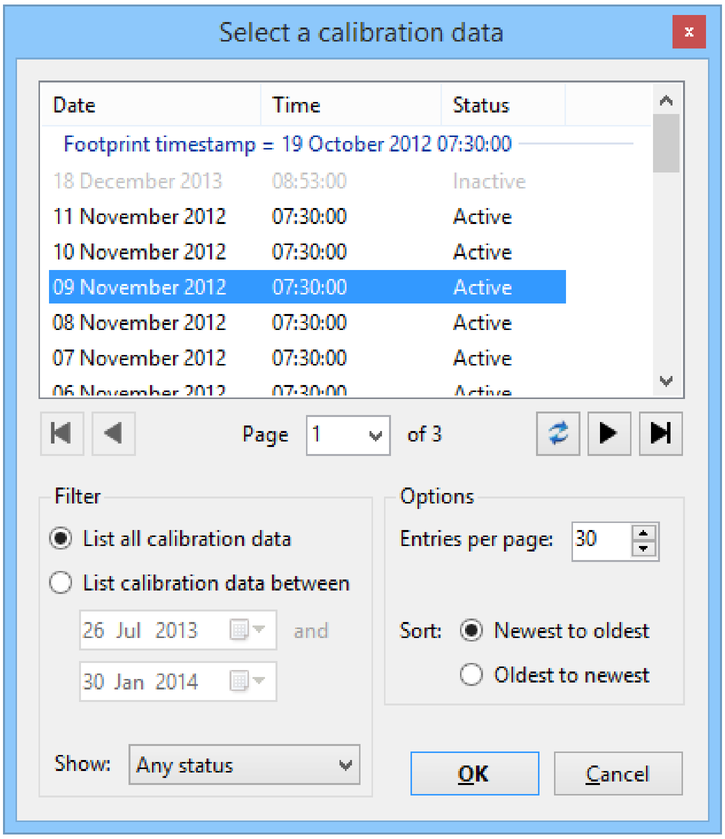
Retention time chart for several device type provides option to filter by detector in the same way as the [Footprint form]().

7.3 View Previous Footprints/Calibration Data

To browse previous record of footprint or calibration data, click **Change footprint** or **Change calibration data** button at the top region of the form.



Select a different record then click **OK** button or double click the record on this list.



You can always reload the latest record through **Load latest footprint** or **Load latest calibration data** button.

7.4 Import New Footprint/Calibration Data

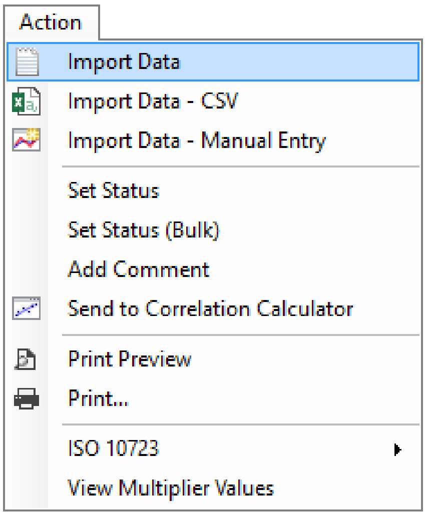
To import a new footprint or calibration data, follow the steps below.

1. Select the desired GC device on your device panel.

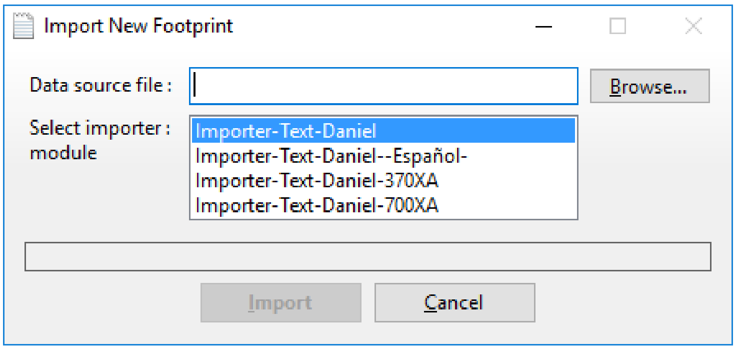
2. Open *Footprint* or *Calibration Data* form through the View > **Footprint** menu or View > **Calibration Data**.
   If you import new data through Footprint form, the imported data shall be marked as footprint. If you import new data through Calibration Data form, the data will be marked as a calibration data.
3. Notice the Action menu on the menu bar. To continue, pick one of the supported import formats.
   a. Text import
   b. CSV import
   c. Manual entry

7.4.1 Text Import

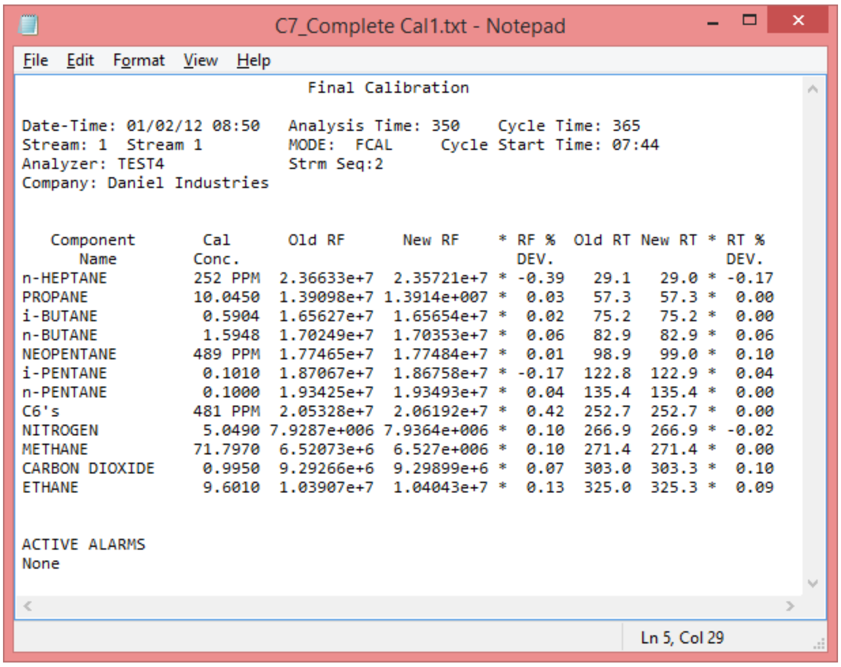
GCAS supports calibration report files generated by GC devices manufactured by Daniel Industries, ABB, and Siemens. Should you have the file ready, open the Action menu and select **Import Data**. If you don't see this menu, your user account may not have the action permission for it or the *Text Import* feature was not included in your GCAS licence. Contact your GCAS administrator.



Load the data source file and select the appropriate importer module. The *importer module* depends on the format of the file. For example, GCAS supports legacy Daniel report files, Daniel 370XA files, and Daniel 700XA files. These three report files have different formats and are not compatible to one another, therefore we include three Daniel importer modules to handle each of them.



The required files look similar to the screenshots below.



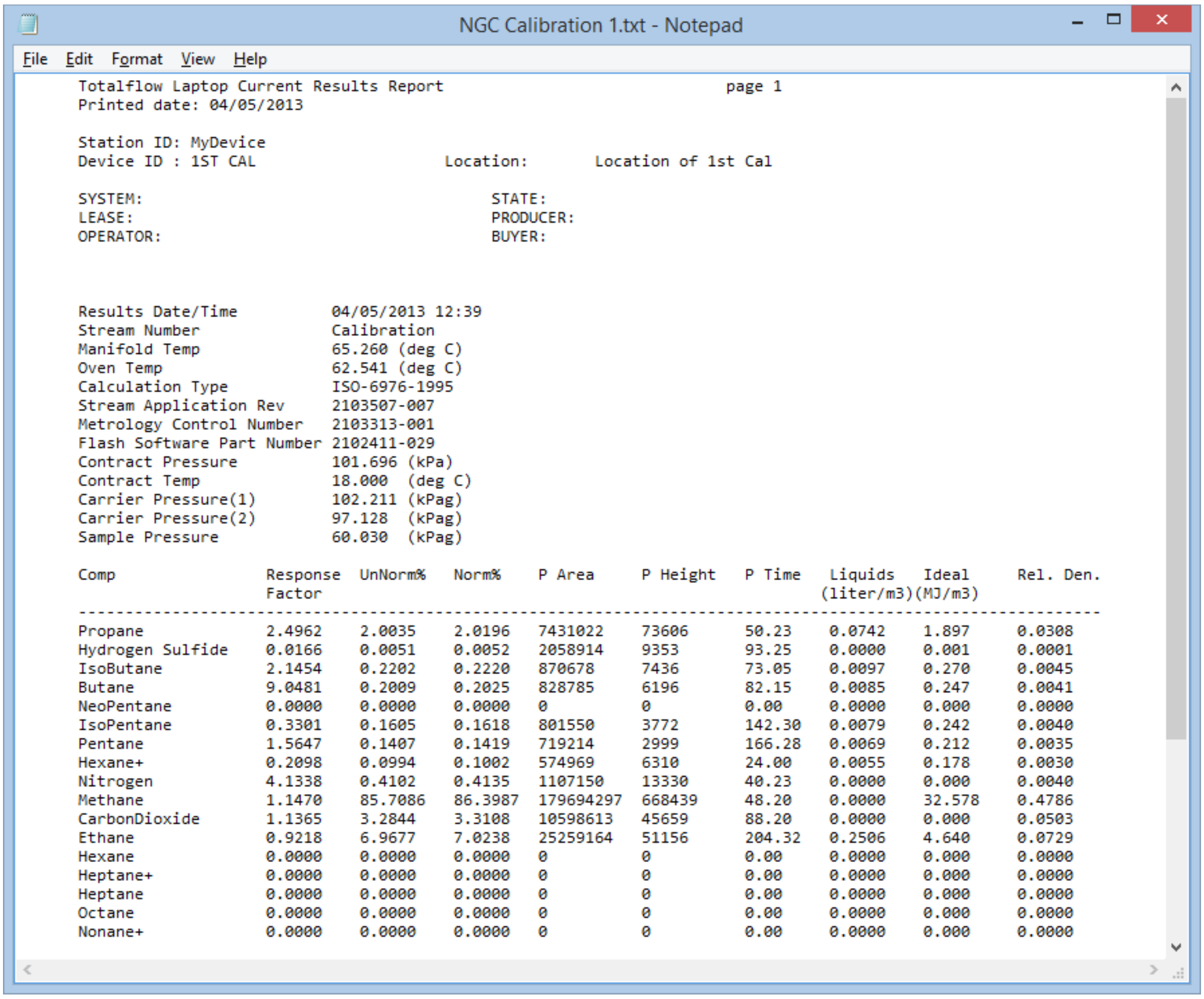
C7_Complete Cal1.txt - Notepad

File Edit Format View Help

```
                          Final Calibration

Date-Time: 01/02/12 08:50   Analysis Time: 350    Cycle Time: 365
Stream: 1  Stream 1         MODE:  FCAL     Cycle Start Time: 07:44
Analyzer: TEST4             Strm Seq:2
Company: Daniel Industries


   Component       Cal       Old RF       New RF      * RF %  Old RT New RT * RT %
      Name        Conc.                                 DEV.                  DEV.
n-HEPTANE         252 PPM  2.36633e+7  2.35721e+7 * -0.39   29.1    29.0 * -0.17
PROPANE           10.0450  1.39098e+7 1.3914e+007 *  0.03   57.3    57.3 *  0.00
i-BUTANE           0.5904  1.65627e+7  1.65654e+7 *  0.02   75.2    75.2 *  0.00
n-BUTANE           1.5948  1.70249e+7  1.70353e+7 *  0.06   82.9    82.9 *  0.06
NEOPENTANE        489 PPM  1.77465e+7  1.77484e+7 *  0.01   98.9    99.0 *  0.10
i-PENTANE          0.1010  1.87067e+7  1.86758e+7 * -0.17  122.8   122.9 *  0.04
n-PENTANE          0.1000  1.93425e+7  1.93493e+7 *  0.04  135.4   135.4 *  0.00
C6's              481 PPM  2.05328e+7  2.06192e+7 *  0.42  252.7   252.7 *  0.00
NITROGEN           5.0490 7.9287e+006 7.9364e+006 *  0.10  266.9   266.9 * -0.02
METHANE           71.7970  6.52073e+6  6.527e+006 *  0.10  271.4   271.4 *  0.00
CARBON DIOXIDE     0.9950  9.29266e+6  9.29899e+6 *  0.07  303.0   303.3 *  0.10
ETHANE             9.6010  1.03907e+7  1.04043e+7 *  0.13  325.0   325.3 *  0.09


ACTIVE ALARMS
None
```

Ln 5, Col 29

Example of calibration data generated by Daniel GC (legacy format)



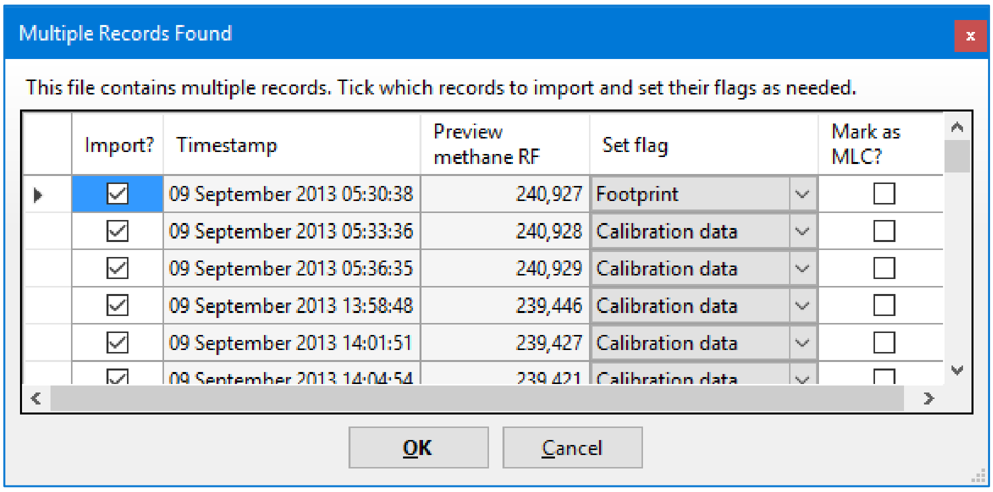
NGC Calibration 1.txt - Notepad

File Edit Format View Help

```
Totalflow Laptop Current Results Report                         page 1
Printed date: 04/05/2013

Station ID: MyDevice
Device ID : 1ST CAL                 Location:       Location of 1st Cal

SYSTEM:                                  STATE:
LEASE:                                   PRODUCER:
OPERATOR:                                BUYER:



Results Date/Time          04/05/2013 12:39
Stream Number              Calibration
Manifold Temp              65.260 (deg C)
Oven Temp                  62.541 (deg C)
Calculation Type           ISO-6976-1995
Stream Application Rev     2103507-007
Metrology Control Number   2103313-001
Flash Software Part Number 2102411-029
Contract Pressure          101.696 (kPa)
Contract Temp              18.000  (deg C)
Carrier Pressure(1)        102.211 (kPag)
Carrier Pressure(2)        97.128  (kPag)
Sample Pressure            60.030  (kPag)

Comp                Response  UnNorm%   Norm%    P Area     P Height   P Time   Liquids   Ideal     Rel. Den.
                    Factor                                                     (liter/m3)(MJ/m3)
----------------------------------------------------------------------------------------------------------
Propane             2.4962    2.0035    2.0196   7431022    73606      50.23    0.0742    1.897     0.0308
Hydrogen Sulfide    0.0166    0.0051    0.0052   2058914    9353       93.25    0.0000    0.001     0.0001
IsoButane           2.1454    0.2202    0.2220   870678     7436       73.05    0.0097    0.270     0.0045
Butane              9.0481    0.2009    0.2025   828785     6196       82.15    0.0085    0.247     0.0041
NeoPentane          0.0000    0.0000    0.0000   0          0          0.00     0.0000    0.000     0.0000
IsoPentane          0.3301    0.1605    0.1618   801550     3772       142.30   0.0079    0.242     0.0040
Pentane             1.5647    0.1407    0.1419   719214     2999       166.28   0.0069    0.212     0.0035
Hexane+             0.2098    0.0994    0.1002   574969     6310       24.00    0.0055    0.178     0.0030
Nitrogen            4.1338    0.4102    0.4135   1107150    13330      40.23    0.0000    0.000     0.0040
Methane             1.1470    85.7086   86.3987  179694297  668439     48.20    0.0000    32.578    0.4786
CarbonDioxide       1.1365    3.2844    3.3108   10598613   45659      88.20    0.0000    0.000     0.0503
Ethane              0.9218    6.9677    7.0238   25259164   51156      204.32   0.2506    4.640     0.0729
Hexane              0.0000    0.0000    0.0000   0          0          0.00     0.0000    0.000     0.0000
Heptane+            0.0000    0.0000    0.0000   0          0          0.00     0.0000    0.000     0.0000
Heptane             0.0000    0.0000    0.0000   0          0          0.00     0.0000    0.000     0.0000
Octane              0.0000    0.0000    0.0000   0          0          0.00     0.0000    0.000     0.0000
Nonane+             0.0000    0.0000    0.0000   0          0          0.00     0.0000    0.000     0.0000
```

Example of calibration data generated by ABB GC

Depending on the importer module, most text import will import *one* record at a time. Siemens importer and Daniel 700XA importer support multiple records inside one text file, thus allowing import of many records in one go. In such cases, GCAS prompts a dialogue asking which records to import. Click on the column header **Import?** to quickly tick or untick all records.



GCAS requires the device tag name in the text file must match the device name (tag) in GCAS database. The device tag name is the "`Analyzer`" in Daniel GC report file, or "`Station ID`" in ABB GC report file.

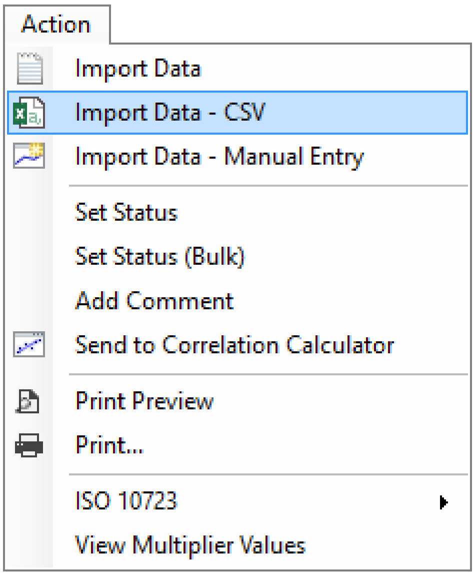
7.4.2 CSV Import

When you wish to upload multiple records in one click or if your GC device has no supported text importer module, you would need to use CSV import.

The CSV spreadsheet must follow the template to be recognised by GCAS (see chapter 7.4.4). The template defines column allocation within the spreadsheet. Failure to comply with this template will result in wrong data being associated with wrong gas or component.

CSV file template should be inside your installation directory. The default directory is `C:\GCAS`. Look for `CSV import file template.zip` in that folder. If you lose this template, you can easily recreate new one by following the guide in chapter 7.4.4.

When you are ready to import the CSV file, open the Action menu and choose **Import Data - CSV**.

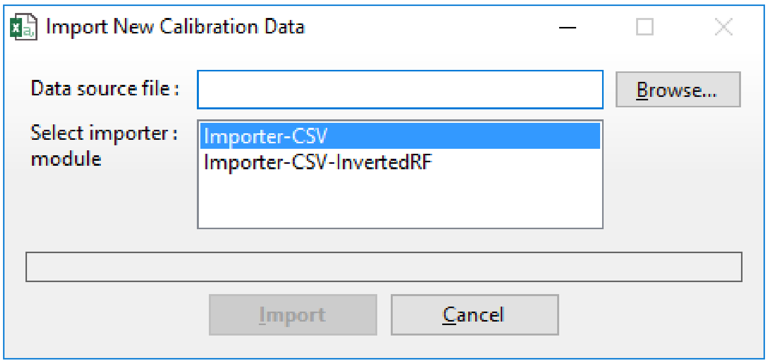


Likewise if you do not see this menu, your user account may not have the action permission for it or the *CSV Import* feature was not included in your GCAS licence. Contact your GCAS administrator.

Load the CSV file and click **Import**. Watch out for the importer module selection. **Importer-CSV-RFinverted** means the RF values are inverted before being committed to the database. This importer module is originally intended for Elster GCs which use the inverted RF formula, however it is made available for any GC using inverted RF.

$$\mathrm{RF}_{\mathrm{inverted}} = \frac{1}{\mathrm{RF}_{\mathrm{original}}}$$

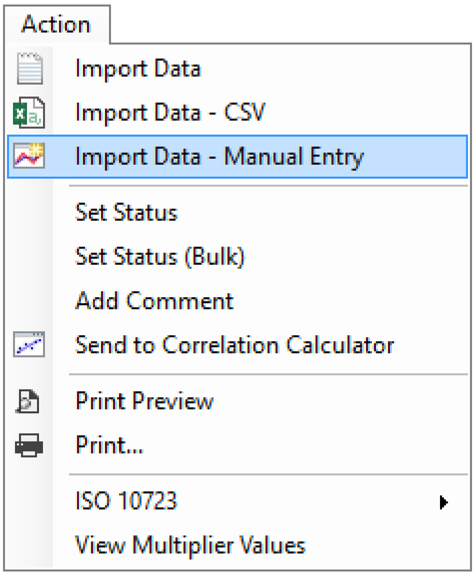
ABB devices, BTEX devices, and single gas analysers have their own CSV importer module because the expected number of columns in the CSV file is different from Daniel, Siemens, Elster, and LNG devices.

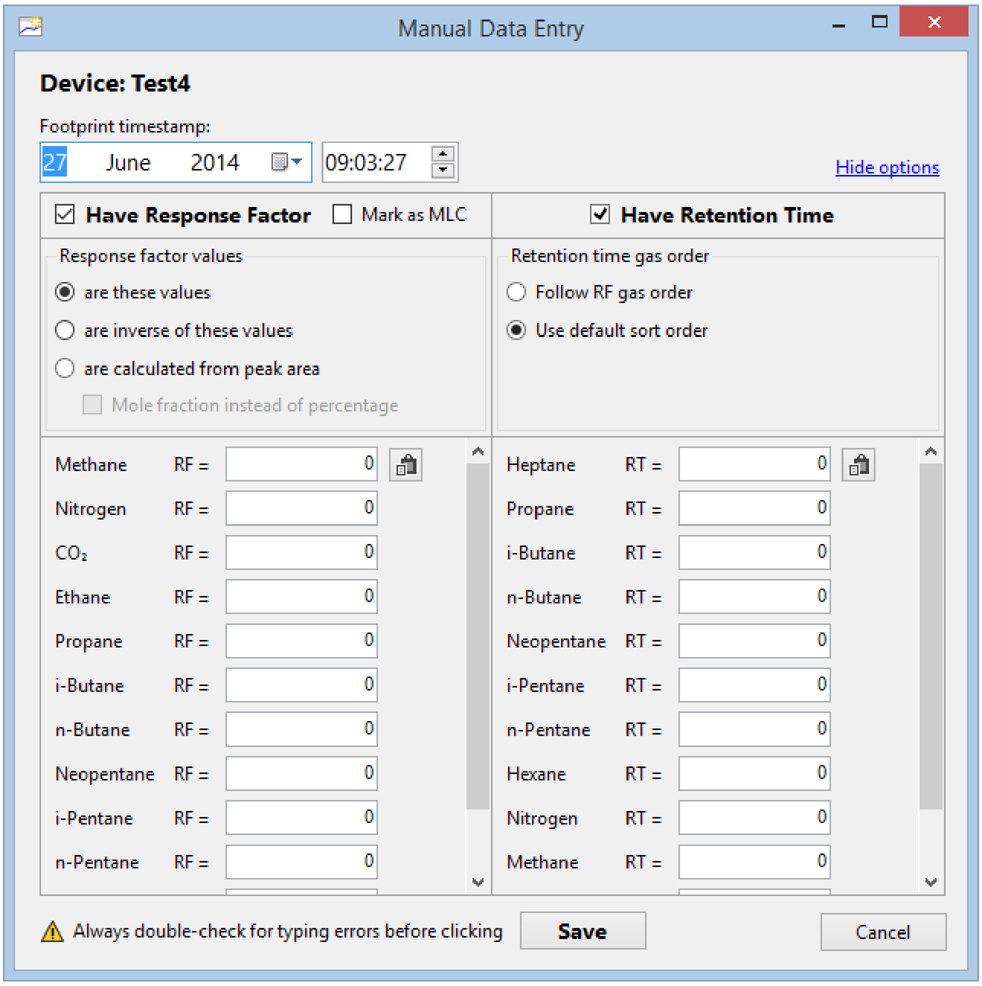


7.4.3 Manual Entry

Aside from text and CSV import, you also have an option to enter the RF and RT values by hand. Manual entry also provides additional options to accommodate some GC devices which calculate RF value using the inverted formula (i.e. mole percentage divided by peak area) or GC devices providing only the data of peak area. Nevertheless, this method is the least recommended way to import data because it is very susceptible to human error.

Open the action menu and select **Import Data - Manual Entry**. This menu displays the *Manual Data Entry* form. If you do not see this menu, your GCAS user account may not have the action permission for manual entry or your GCAS licence does not include *Manual Data Entry*. Contact your GCAS administrator.





First things first, set the footprint or calibration timestamp accordingly. Next you can begin entering RF and RT values in the available input fields.

If your footprint or calibration data does not have retention time data, untick **Have Retention Time**. This will disable all RT input fields. Similarly, if you do not wish to enter RF values, untick **Have Response Factor**. Read more about incomplete footprint or calibration data.

Response factor input has three options, described below.

- **Response factor values are these values**: RF data is the values you entered.
- **Response factor values are inverse of these values**: RF data is calculated from the reciprocal of the values you entered. If you type `1.567E-7` for example, the RF value will be $1 / 1.567 \times 10^{-7}$, which is 6,381,621 (rounded). Use this option if your GC device uses the inverted formula, that is mole percentage divided by peak area. This option is selected by default if you are entering RF and RT values for Elster GC.
- **Response factor values are calculated from peak area**: This option shows two input fields for every gas. First input field is for peak area as given by your GC device. Second input field is for mole percentage, as in the component data table or calibration gas certificate. RF values are then calculated using the formula peak area divided by mole percentage.
    - **Mole fraction instead of percentage**: This option changes mole percentage input into mole fraction. GCAS will convert mole fraction back into percentage at later stage.

Users with *ISO 10723* included in their licences should see an additional check box next to **Have Response Factor** box. This check box reads **Mark as MLC**. Check this box if you know you are going to enter multilevel-calibrated response factors.

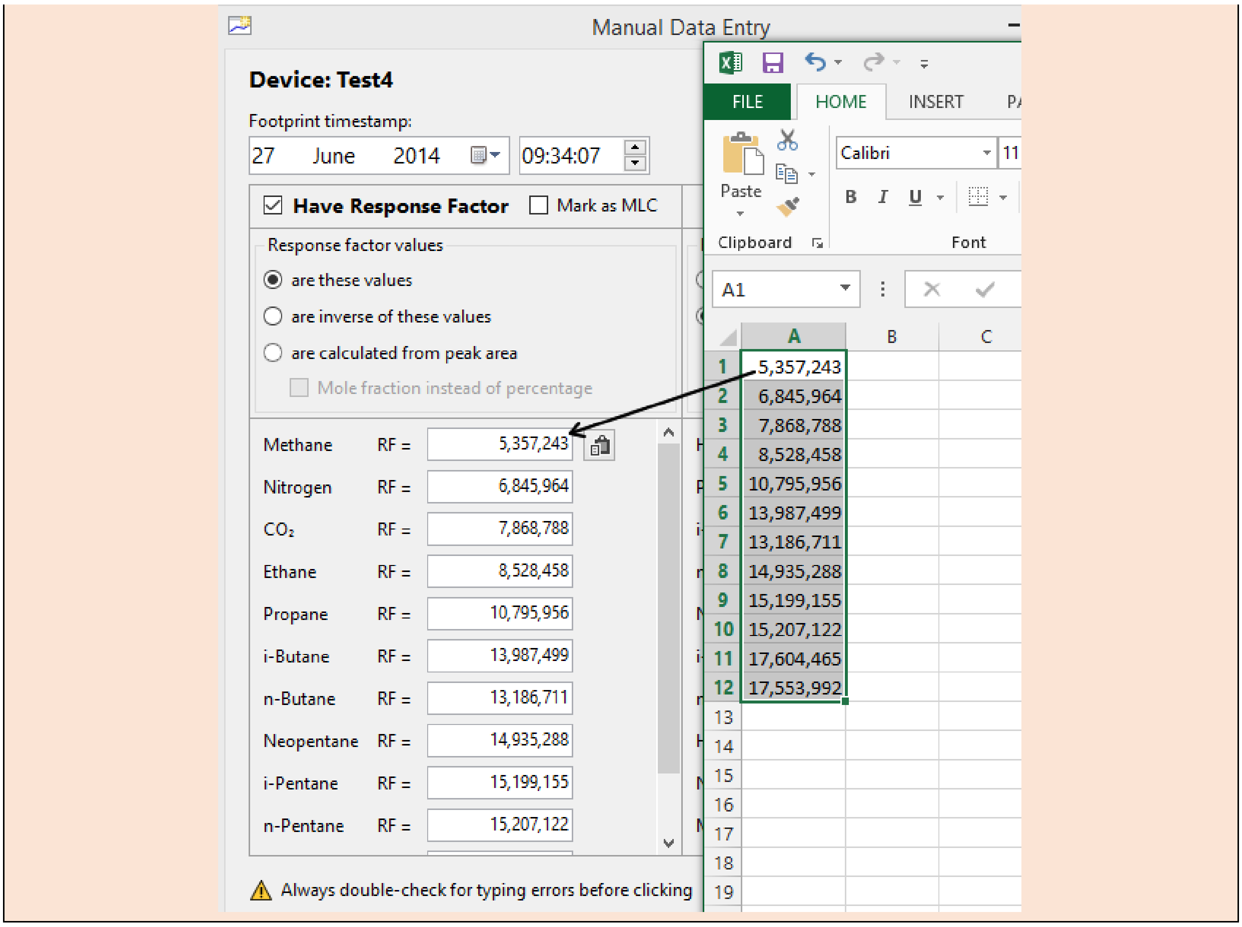
Retention time input has two options, and both are related to its gas order. To make RT input fields use the same gas order as RF input fields, choose **Follow RF gas order**. This is particularly useful if you want to paste the numbers from your spreadsheet (see tip box below) but the gas order in your spreadsheet is different from the default sort order.

Note

For ABB devices, the *Manual Data Entry* form will always input single-point RF values. Do not enter exponential RF values here.

Tip

You can copy numbers from Microsoft Excel or other spreadsheet processing software. Press `Ctrl+V` on the *first text box* and the rest will follow. Alternatively, click **Paste** next to the corresponding input field series.



Click **Hide options** link near the top-right corner to hide both option panels and to make larger room for the input fields.

Always check the numbers — and also the timestamp — before you click **Save**. Once it is saved, the record is not editable.

7.4.4 CSV Import Template Explained

Lost your CSV template? This chapter explains the structure and column assignments of CSV import templates for footprint and calibration data just in case the original template files are missing. There are templates for mole composition imports too, but those are going to be explained in chapter 8.3.3.

On the next page, there are CSV column assignments for footprint/calibration import of **regular GC devices except ABB** (Daniel, Siemens, Elster, and LNG). ABB devices have their own CSV template because they may include exponential RF values. For CSV template of BTEX devices, jump here. For single gas analysers, jump there.

CSV template for: Daniel, Siemens, Elster, LNG		
Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Record flag. Put **1** for footprint or **2** for calibration data.
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Methane response factor.
5	E	Nitrogen RF.
6	F	Carbon dioxide RF.
7	G	Ethane RF.
8	H	Propane RF.
9	I	i-Butane RF.
10	J	n-Butane RF.
11	K	Neopentane RF. *
12	L	i-Pentane RF.
13	M	n-Pentane RF.
14	N	Hexane RF.
15	O	Heptane RF. *
16	P	Octane RF. *
17	Q	Nonane RF. *
18	R	Decane RF. *
19	S	Are they multilevel-calibrated RF? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).
20	T	Methane retention time.
21	U	Nitrogen RT.
22	V	Carbon dioxide RT.
23	W	Ethane RT.
24	X	Propane RT.
25	Y	i-Butane RT.
26	Z	n-Butane RT.
27	AA	Neopentane RT. *
28	AB	i-Pentane RT.
29	AC	n-Pentane RT.
30	AD	Hexane RT.
31	AE	Heptane RT. *
32	AF	Octane RT. *
33	AG	Nonane RT. *
34	AH	Decane RT. *

* If your GC device doesn't read this gas, fill in **0** (zero).

On the next page there are CSV column assignments for footprint/calibration import of **ABB devices**. ABB has its own template because there are many more columns required as ABB data may have exponential RF. The number of columns goes to 66.

CSV template for: ABB

Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Record flag. Put **1** for footprint or **2** for calibration data.
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Methane response factor.
5	E	Nitrogen RF.
6	F	Carbon dioxide RF.
7	G	Ethane RF.
8	H	Propane RF.
9	I	i-Butane RF.
10	J	n-Butane RF.
11	K	Neopentane RF. *
12	L	i-Pentane RF.
13	M	n-Pentane RF.
14	N	Hexane RF.
15	O	Heptane RF. *
16	P	Octane RF. *
17	Q	Nonane RF. *
18	R	Decane RF. *
19	S	Are they multilevel-calibrated RF? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).
20	T	Are they exponential RF? Fill **0** for single-point or **1** for exponential. If you write **1** in both column 19 and 20, column 19 (MLC) takes over.
21	U	Methane retention time.
22	V	Nitrogen RT.
23	W	Carbon dioxide RT.
24	X	Ethane RT.
25	Y	Propane RT.
26	Z	i-Butane RT.
27	AA	n-Butane RT.
28	AB	Neopentane RT. *
29	AC	i-Pentane RT.
30	AD	n-Pentane RT.
31	AE	Hexane RT.
32	AF	Heptane RT. *
33	AG	Octane RT. *
34	AH	Nonane RT. *
35	AI	Decane RT. *
36	AJ	Methane peak area (PA).
37	AK	Nitrogen PA.
38	AL	Carbon dioxide PA.

CSV template for: ABB (continued)

Column	Excel name	Description
39	AM	Ethane PA.
40	AN	Propane PA.
41	AO	i-Butane PA.
42	AP	n-Butane PA.
43	AQ	Neopentane PA. *
44	AR	i-Pentane PA.
45	AS	n-Pentane PA.
46	AT	Hexane PA.
47	AU	Heptane PA. *
48	AV	Octane PA. *
49	AW	Nonane PA. *
50	AX	Decane PA. *
51	AY	Use existing calibration gas certificate? - If you put **1** (yes), column 52 to 66 are ignored and GCAS uses the calibration certificate installed before the record timestamp of first CSV row. - If you put **0** (no), GCAS reads column 52 to 66 as the mole percentage portion of the calibration certificate.
52	AZ	Methane mole percentage as in calibration certificate.
53	BA	Nitrogen mole percentage as in calibration certificate, and similarly to end.
54	BB	Carbon dioxide mole percentage.
55	BC	Ethane mole percentage.
56	BD	Propane mole percentage.
57	BE	i-Butane mole percentage.
58	BF	n-Butane mole percentage.
59	BG	Neopentane mole percentage. *
60	BH	i-Pentane mole percentage.
61	BI	n-Pentane mole percentage.
62	BJ	Hexane mole percentage.
63	BK	Heptane mole percentage. *
64	BL	Octane mole percentage. *
65	BM	Nonane mole percentage. *
66	BN	Decane mole percentage. *

* If your GC device doesn't read this gas, fill in **0** (zero).

On the next page there are CSV column assignments for footprint/calibration import of **BTEX devices**. For single gas analysers, jump here.

CSV template for: BTEX

Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Record flag. Put **1** for footprint or **2** for calibration data.
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Benzene response factor.
5	E	Toluene RF.
6	F	Ethylbenzene RF.
7	G	Xylene RF.
8	H	Are they multilevel-calibrated RF? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).
9	I	Benzene retention time.
10	J	Toluene RT.
11	K	Ethylbenzene RT.
12	L	Xylene RT.

And finally, below are CSV column assignments for footprint/calibration import of **single gas devices** (single gas analyser, H_2S analyser, and moisture analyser).

CSV template for: Single gas

Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Record flag. Put **1** for footprint or **2** for calibration data.
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Response factor of H_2S/moisture/"the gas".
5	E	Is it multilevel-calibrated RF? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).
6	F	Retention time of H_2S/moisture/"the gas".

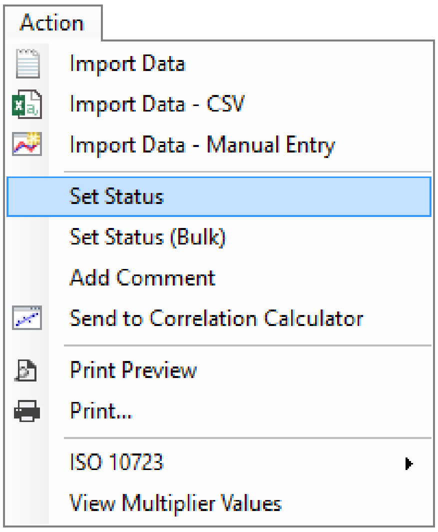
In case your GC device does not provide RF data at all, or no RT data at all, set all RF values or RT values to **-1** (negative one). This will cause GCAS to regard these data as incomplete footprint or calibration data. RF or RT chart will not be rendered instead of being graphed as all-zeroes.

7.5 Change Record Flag and Status (Single Record)

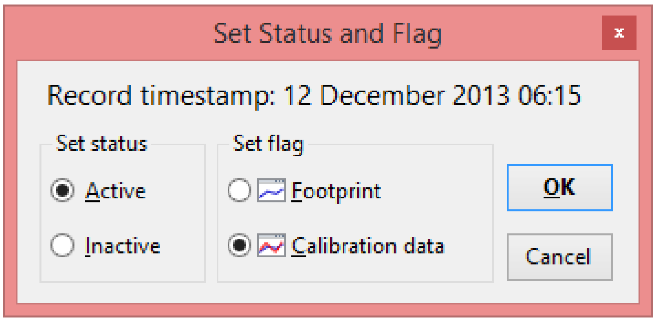
7.5.1 Change Record Flag

Footprint and calibration data share the same record structure in database, distinguished by a flag. This flag can flip from *footprint* to *calibration data* and vice versa. To change this flag, do the following.

1. From an open Footprint or Calibration Data form, go to Action menu > **Set Status**. If you do not see this menu, your user account may not have the action permission for it. Contact your GCAS administrator.



2. This will show *Set Status and Flag* dialogue.

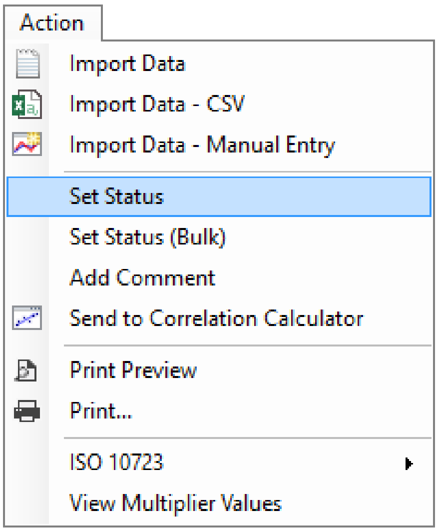


3. Choose one of the options in **Set flag** group, whether to set the record as a footprint or as a calibration data. Click **OK** to commit the change.
4. Notice that the record is reloaded using the other form. That is, for footprint it will be reloaded using Calibration Data form, and for calibration data it will be reopened using Footprint form.
5. The **Comments** tab opens automatically and it is advised to write a comment of why the record flag was changed. Comments tab will not open in case your GCAS user account doesn't have action permission to post comments.

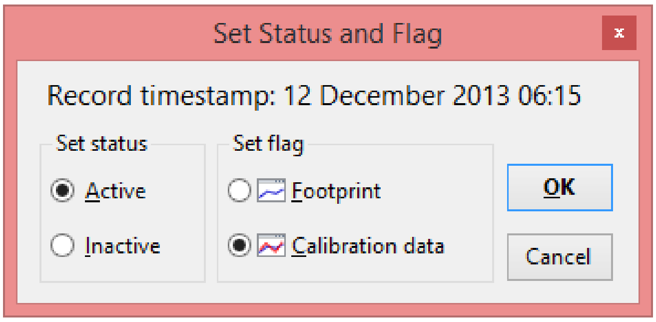
7.5.2 Change Status

Every footprint or calibration record has a status bit that can change from active to inactive or vice versa. Inactive records will not be included in data analysis therefore will not affect the calculation of mean and standard deviation in data analysis. Below are the steps to mark records as inactive or active.

1. From an open Footprint or Calibration Data form, go to Action menu > **Set status**. If you do not see this menu, your user account may not have the action permission for it. Contact your GCAS administrator.

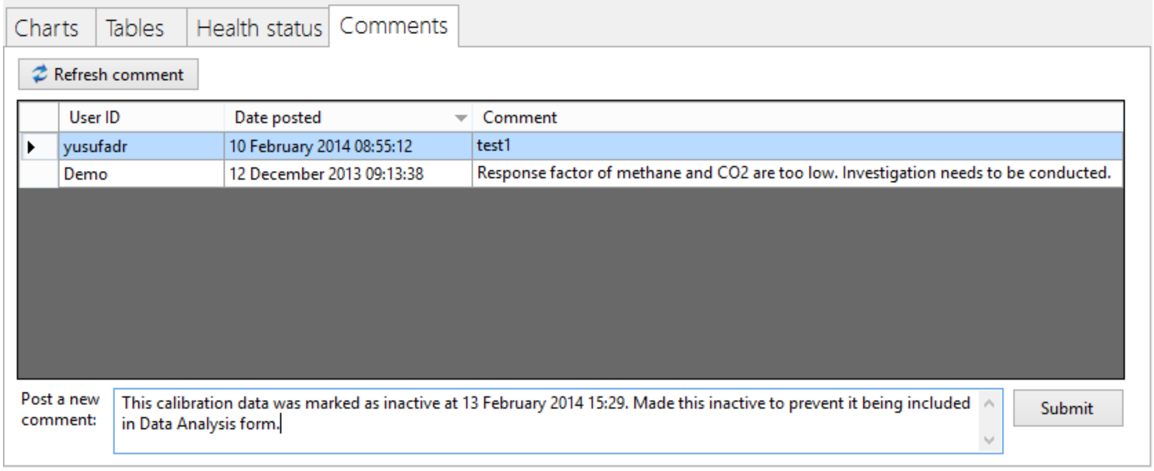


2. This will show *Set Status and Flag* dialogue.



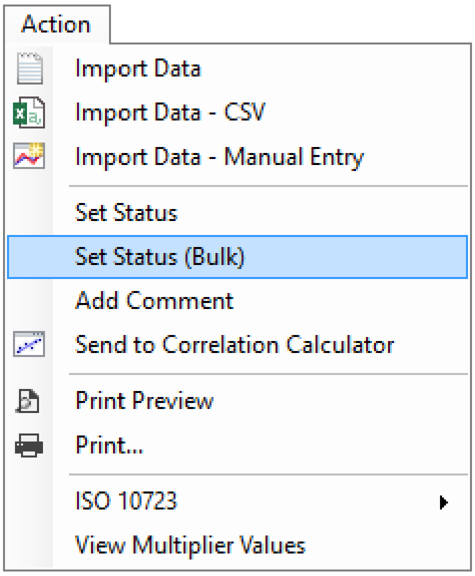
3. Choose one of the options in **Set status** group, whether to mark this record as active or inactive. Click **OK** to commit the change.
4. The form will reload the record and you should see the new status on the top section. Next, the **Comments** tab opens automatically and it is advised to write a comment of why the record status

was changed. Comments tab does not open if your GCAS user account doesn't have action permission to post comments.



7.6 Change Record Flag and Status (Multiple Records)

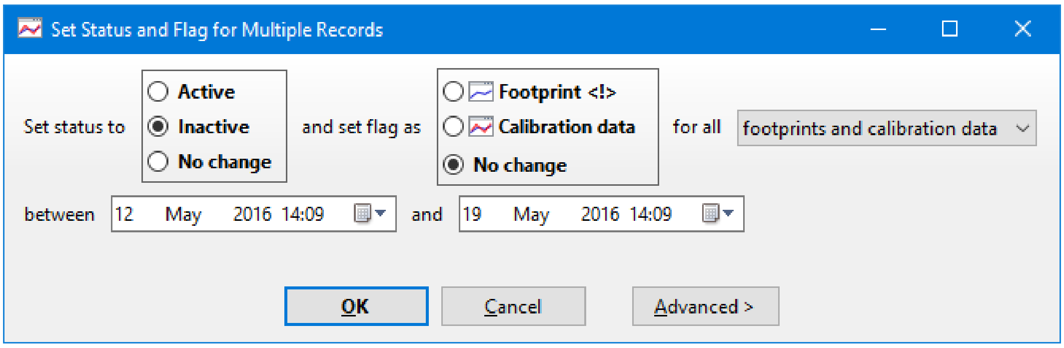
[Chapter 7.5](#) explained what record flag and status are, plus how to change them on the current calibration record. If you need to do it on a range of record, it is faster to use the bulk set status tool rather than repeating the same step on every record.



From an open Footprint or Calibration Data form, go to Action menu > **Set Status (Bulk)**. This menu brings forth *Set Status and Flag for Multiple Records* dialogue. This window has two views called *simple view* and *advanced view*. The first you see now is the simple view.

7.6.1 Simple View

In *simple view*, GCAS asks you whether to set status, set flag, or set both, while providing a flag filter and timestamp range.



To set status only, set flag as **No change** while setting the status as **Active** or **Inactive** as appropriate. Conversely, to set flag only, set status to **No change** while setting the flag to **Footprint** or **Calibration data**. To set both, don't select **No change** on either box.

Flag filter is the dropdown after the word "`for all`". This filter applies change to all records inside the selected date range (unfiltered), or just to the calibration records, or just to the footprint ones. Finally, set the date range and click **OK**.

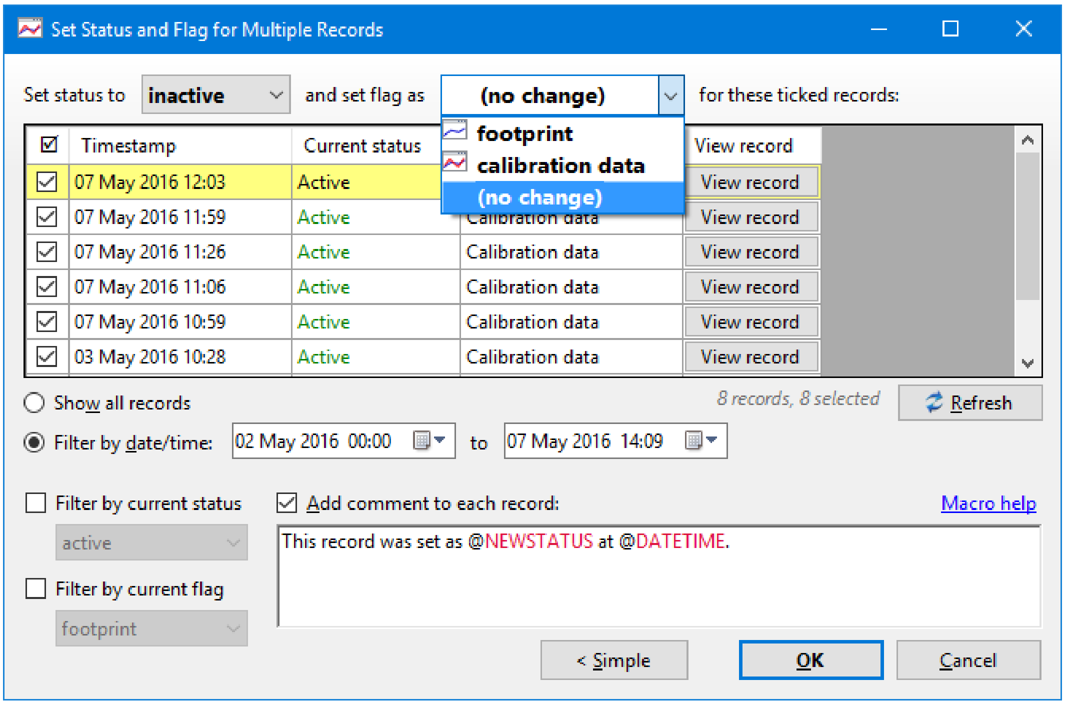
Note

A little note here if you set flag to footprint through bulk operation. Although it is perfectly permitted to have many sequential footprint records in GCAS database, they may mess up the mean and standard deviation calculation in Data Analysis.

GCAS does not add automatic comment like what it did on the single record status change for this bulk operation. If you need to add comment or to exclude some records from the bulk operation, you need to use the advanced view. Click **Advanced** button to move to the advanced view.

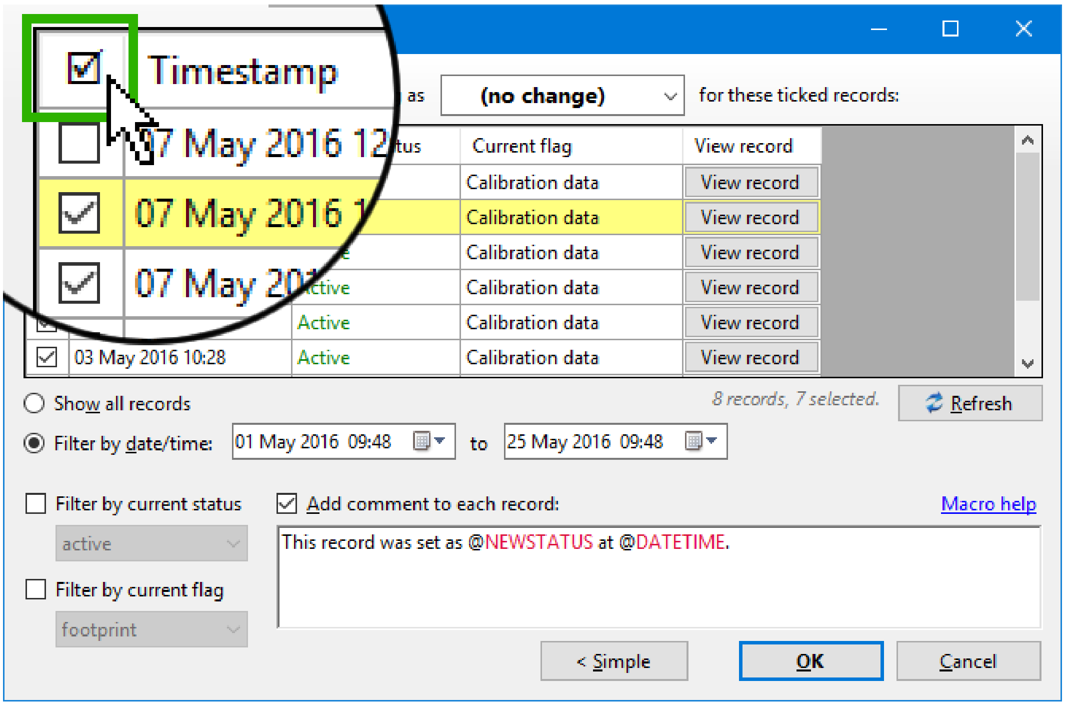
7.6.2 Advanced View

In *advanced view*, GCAS offers more customisations on this bulk operation. You can tune the list to display records matching the filters, tick exactly which records to apply changes on, and attach a comment to them.



First, decide whether to set status, set flag, or both. To set status only, set the flag to **(no change)**. To set flag only, set the status to **no change**. To set both, don't select **no change** on either side.

Select the option **Show all records** to display all footprint and calibration data, or set a date/time filter to limit the selection. Then, click **Refresh** to load records into the list. You can enforce additional filter by current status or by current flag (or both) at the bottom-left region of this dialogue if required. Click **Refresh** again to apply these filters. GCAS begins to load all records which fulfil these criteria. Once the list is populated completely, begin ticking or unticking records to include or exclude them from the bulk operation. To quickly select all or unselect all, click the column header.



Note

A little note here if you set flag to footprint through bulk operation. Although it is perfectly permitted to have many sequential footprint records in GCAS database, they may mess up the mean and standard deviation calculation in Data Analysis.

Once you make sure everything is correct, click **OK** to begin the bulk operation.

Want GCAS to put comment on every affected record? Check **Add comment to each record** and enter your comment. The comment box recognises seven keywords called *macro*(s) which it automatically highlights in red. Macro identifier starts with the '@' symbol and is all-uppercase. GCAS replaces these macros with actual values before writing them to database.

Macro keyword	Will be replaced with
@OLDSTATUS	Previous record status ("`active`" or "`inactive`")
@NEWSTATUS	New record status ("`active`" or "`inactive`")
@OLDFLAG	Previous record flag ("`footprint`" or "`calibration data`")
@NEWFLAG	New record flag ("`footprint`" or "`calibration data`")
@DATE	Current computer date, e.g. "`19 May 2016`".
@TIME	Current computer time in 24-hour format, e.g. "`14:47:36`".
@DATETIME	Current computer date and time, e.g. "`19 May 2016 14:47:36`".

For instance, this comment macro:

```
This record was set as @NEWSTATUS at @DATETIME because there was an error
in the Modbus data capture configuration.
```

will be replaced with actual values such as:

```
This record was set as inactive at 19 May 2016 14:51:12 because there was
an error in the Modbus data capture configuration.
```

Which you can easily verify by visiting any record included in this bulk set status after the operation completed.

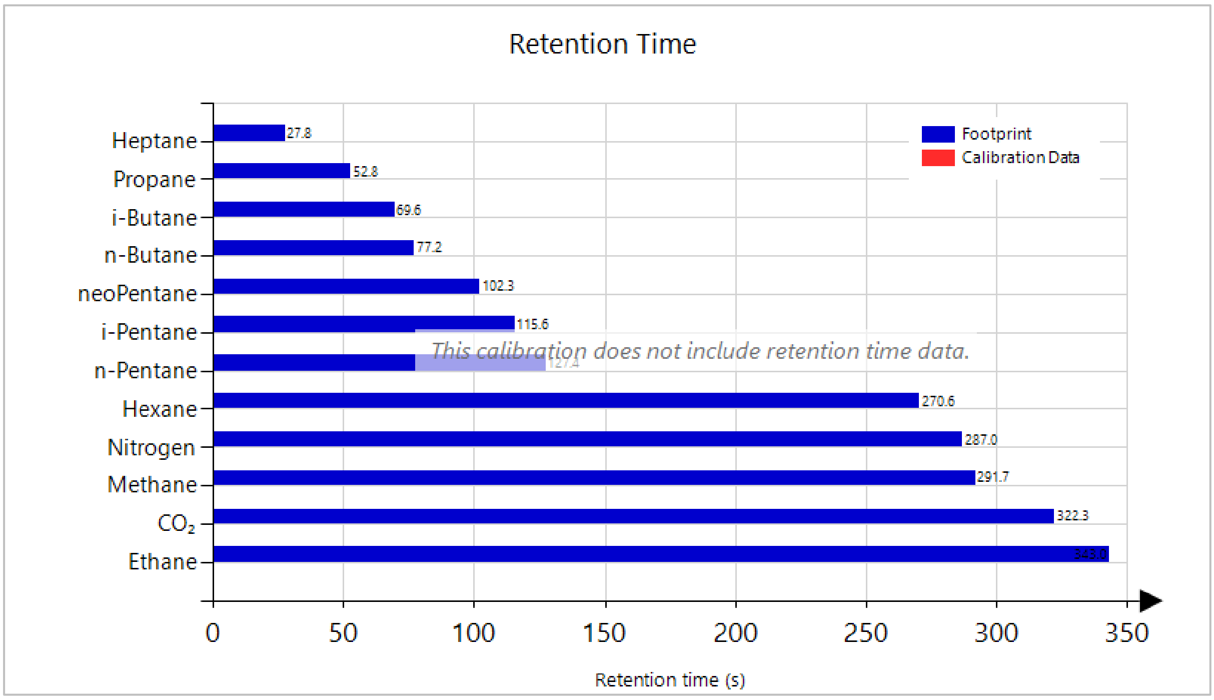
7.7 Incomplete Footprint or Calibration Data

There are cases of *incomplete* footprint record or incomplete calibration data. A footprint or calibration record is said to be *incomplete* if it has only response factor data, or only retention time data, *but not both*. Incomplete records usually come from data capture operation but with additional configuration to ignore RF data or ignore RT data.

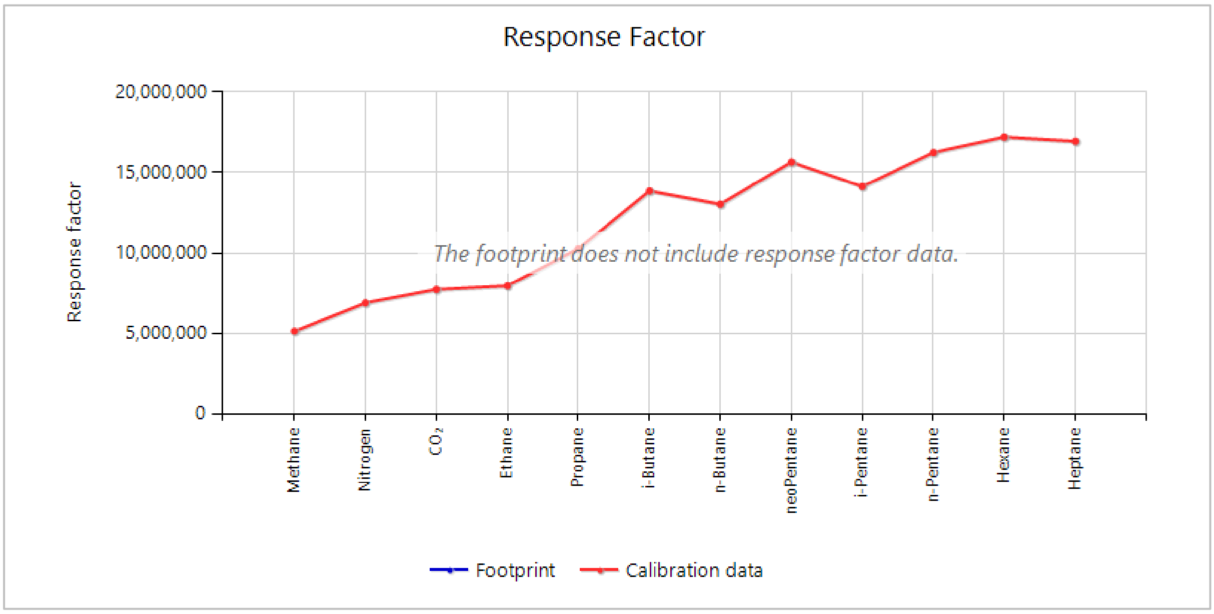
If GCAS was instructed to ignore RF data, it assigns the special value **−1** (negative one) to all RF values. The same goes for RT, which GCAS assigns −1 to all RT fields. You shall see this special −1 value when you switch to table view on either Footprint or Calibration Data form.

Why −1? This value is used to differentiate the **0** (zero) value, which indicates the gas is missing or not present in the calibration inlet. By default, GCAS will still plot zero values on RF or RT chart, but not the −1's. You can override this behaviour by starting GCAS with an additional **/drawincompleteRFRT** parameter.

When you view an incomplete record, its response factor chart or retention time chart will display a text annotation on top of itself. For example,

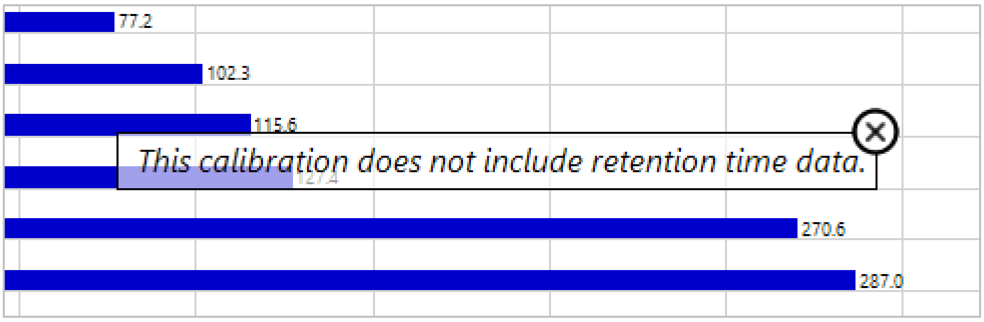


In the screenshot above, the calibration record does not have retention time data. You only see blue bars (footprint), but red bars (calibration) are missing. Another example,



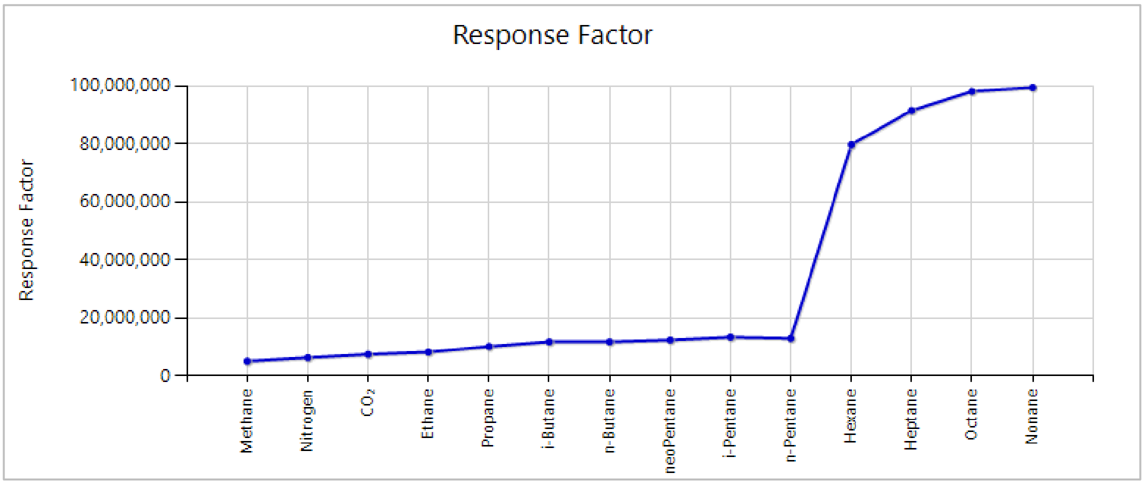
...the calibration record has RF data but its footprint does not. You only see red line (calibration) but blue line (footprint) is missing. The chart displays annotation that the footprint does not have RF data.

If you are on Calibration Data form, the annotation may obscure part of the chart. Click once on the annotation to reveal the ⊗ close icon. Click again on the ⊗ close icon to remove the annotation. (Footprint form does not have this feature.)



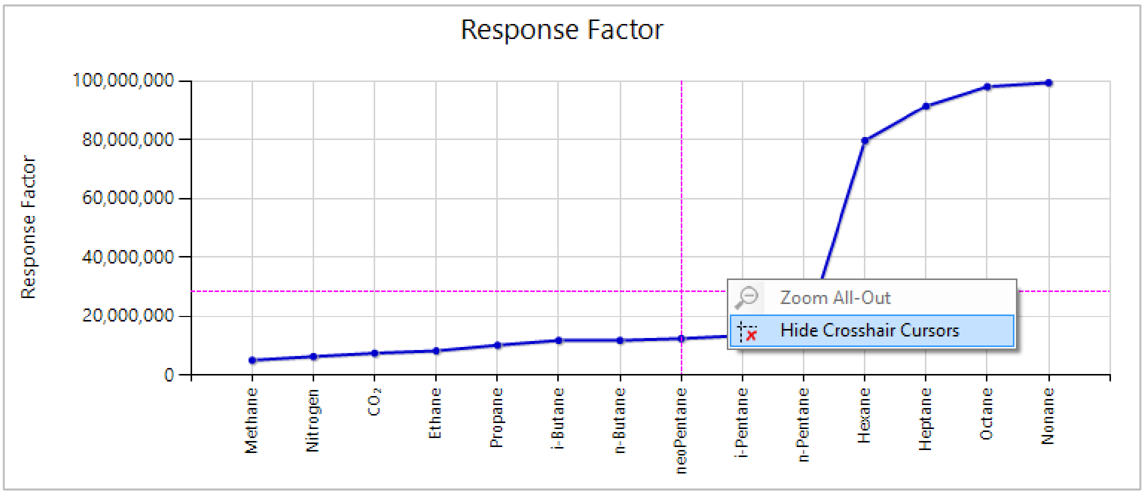
7.8 Zoom and Scroll (RF Chart Only)

Daniel C9+ and C10+ devices have a distinctive characteristic on their RF charts: The line chart rises slowly, but suddenly jumps to a much higher number starting at the first gas being detected by the second detector.



In order to zoom a part of this chart, drag a rectangle on the area you would like to zoom in.
Use the scroll bars to pan the zoomed chart.
To zoom in further, drag another rectangle area.
To zoom out, either click both circled minus buttons ⊖ or right click on the chart then select **Zoom All-Out**.

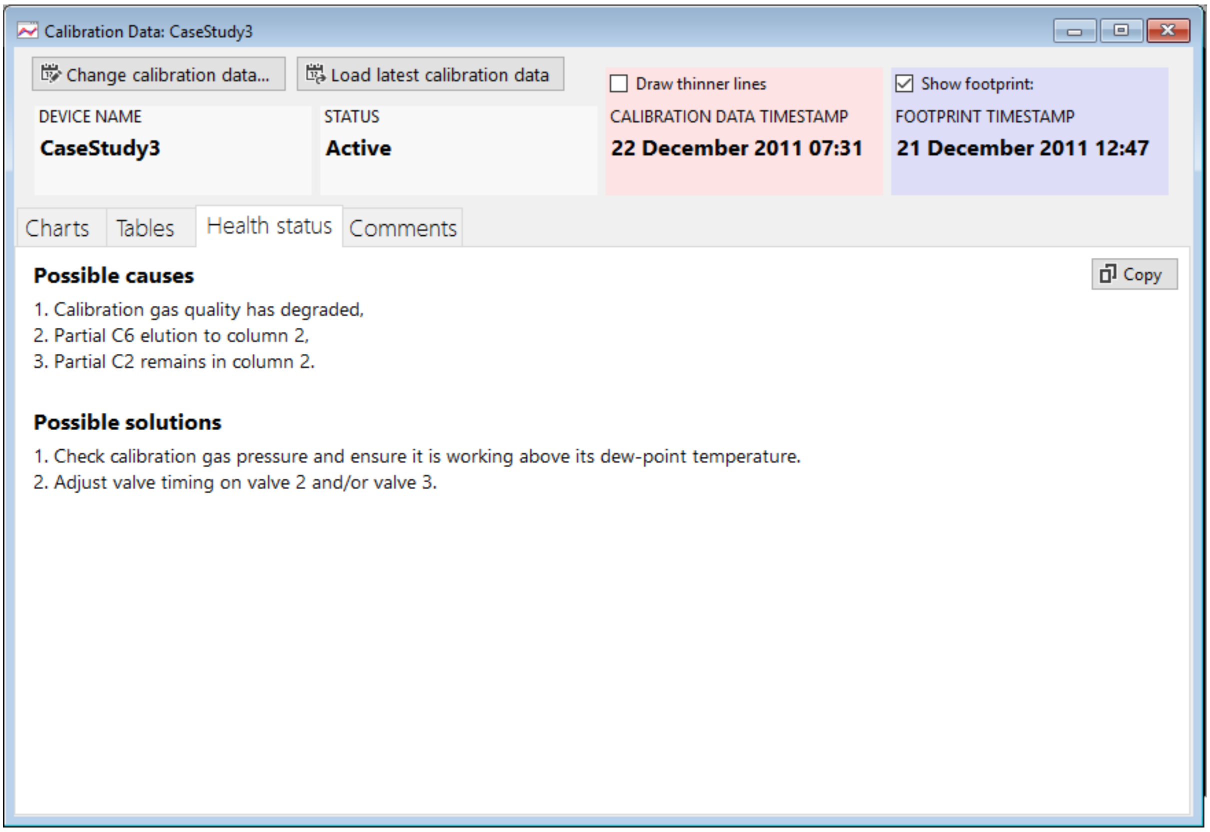
The *crosshair cursor* is the dotted magenta line which appeared when you click anywhere on the chart region or as a remnant of a zoom operation. These lines may act as a ruler or guide. To remove these lines, right click on the chart and select **Hide Crosshair Cursors**.



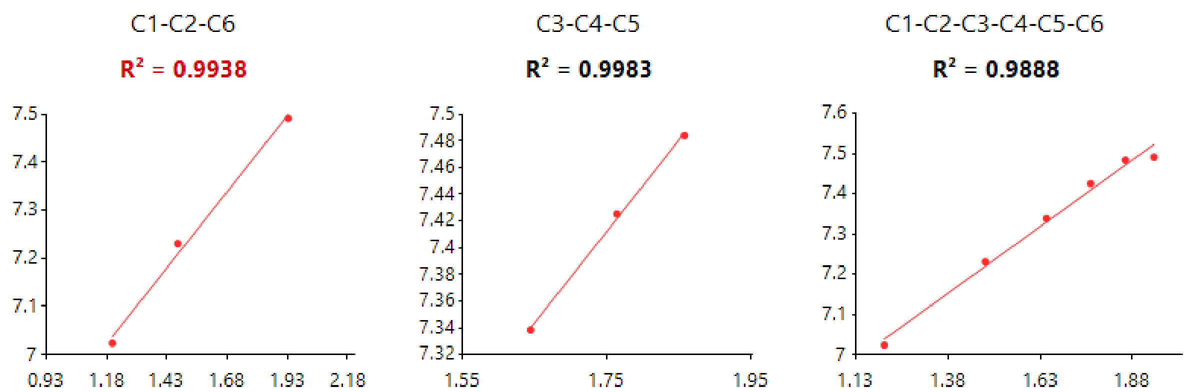
7.9 GC Health Status

GCAS may suggest an action should you see a fail alarm, which is R^2 (correlation) value being under the defined threshold. For the time being, this feature is only available to Daniel C6+ and C7+ GCs.

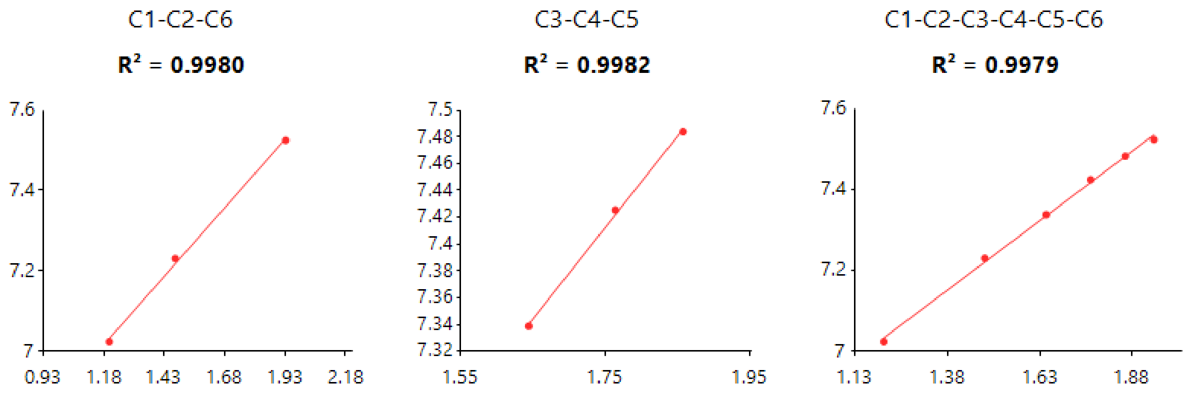
Go to the **Health status** tab on either Footprint form or Calibration Data form. In the example below, the correlation value of light-and-heavy components (methane, ethane, hexane) happened to be under the threshold.



Let's take a detour to the RF-MW charts. Here we see the R^2 (correlation) value of C1-C2-C6 is short under the threshold of 0.995. By looking at the third chart, we see that C6 is below the trend line. Hexane is lower than where it should be.



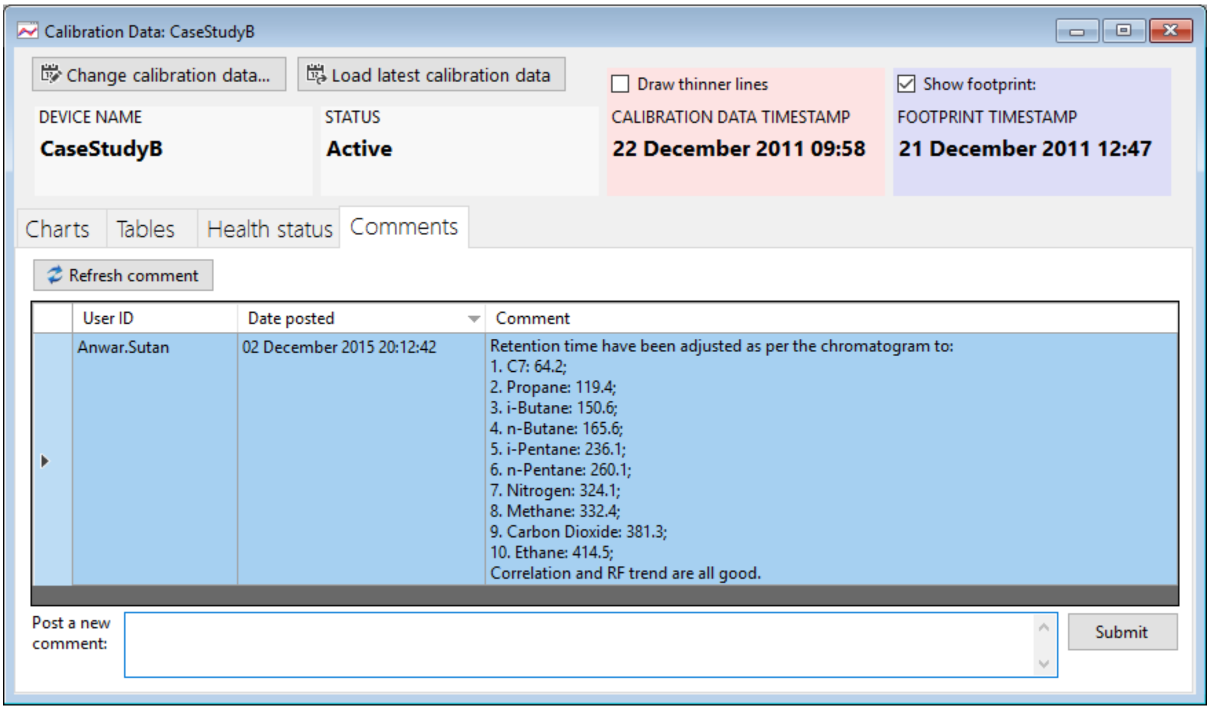
We can infer that the hexane backflush stage is late, so that a part of hexane eluted to the second column. To achieve the goal in this example, we need to adjust the timing of valve 2 to close a bit faster. After making such adjustment, we have a good correlation on the next calibration cycle:



GC health status is only available for Daniel C6+ and C7+ devices. Method of suggestion based on R^2 values for Daniel C9+, Daniel C10+, ABB GC, Siemens GC, Elster GC, and other GC types is currently not available.

7.10 Insert Comment

Users can comment on a record as a medium of communication between engineers or as an archive about what happened to the GC. It is useful to write comments when an action is being done upon GC device, or in case of unexpected behaviour has occurred. You are also taken to the comment section automatically whenever record property is changed (either record flag or record status). It is a good practice to provide explanation on why the record property was changed.

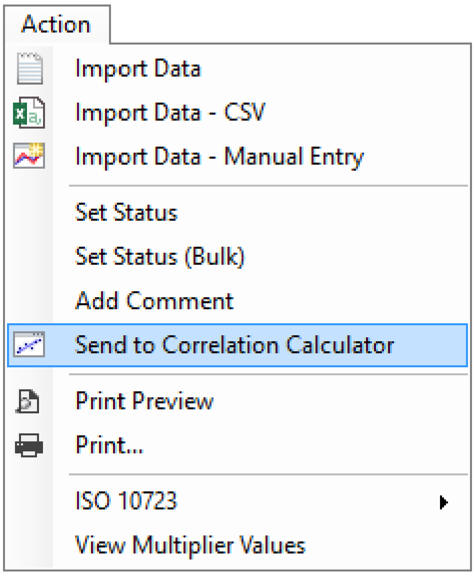


1. To insert comment, open the **Comments** tab or go to Action menu > **Add Comment**.
2. Write your comment on the text box at the lower section of the form then click on **Submit** button.
3. Make sure the comment is correct (e.g. free from spelling errors) because once inserted into database, you will not be able to remove the comment. This is a part of the requirement for audit trail.

If you do not see the textbox and the Submit button, i.e. the comment grid fills up the entire form, your user account may not have action permission to write comments or your user role is *Read-only*. Contact your GCAS administrator.

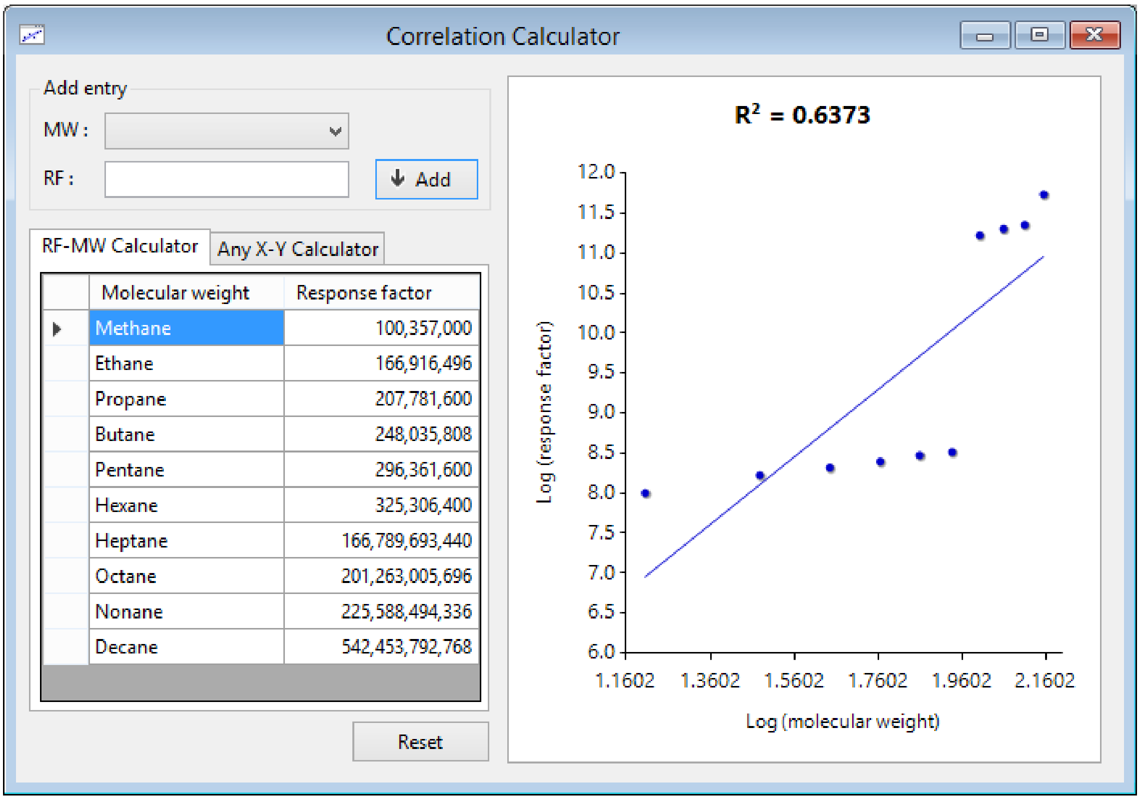
7.11 Send to Correlation Calculator

This shortcut is intended for unsupported GC or those in special needs. For example, your GC is Daniel C10+ complete type A, and was actually calibrated with C10 calibration gas (decane is present). But later on, your process gas is only up to C9 (decane is missing). This would break the correlation calculation (R^2) because the response factor of decane is zero. To work around this problem, open the Action menu from an open Footprint or Calibration Data form, then select **Send to Correlation Calculator**.



This menu will send all response factor values from methane (C1) to decane (C10) to Correlation Calculator. Only normal butane and normal pentane are included, their isomers are not. Once the Correlation Calculator form is open, simply delete any unwanted gases and the calculator will get you the correct R^2 result. In our example before, C10+ type-A device treated as C9+ should have R^2 of C6-C7-C8-C9, not C7-C8-C9-C10. In Correlation Calculator form, delete methane, ethane, propane, butane, pentane, and decane; this will give you the correlation of hexane, heptane, octane, and nonane. Visit chapter 19 to read more about correlation calculator.

Send to Correlation Calculator menu works with BTEX devices as well. It should be noted that both ethylbenzene and xylene have the same molar mass, therefore their log(MW) are the same so their dots look aligned on an invisible vertical line. For single gas devices however, this menu just simply opens Correlation Calculator but does not send any data—because correlation calculation requires at least three gases.



Correlation Calculator with data sent from Footprint or Calibration Data form. Delete unwanted gases to get the correct R^2 result. For example, to get the correlation of C7-C8-C9-C10, delete everything from methane to hexane.

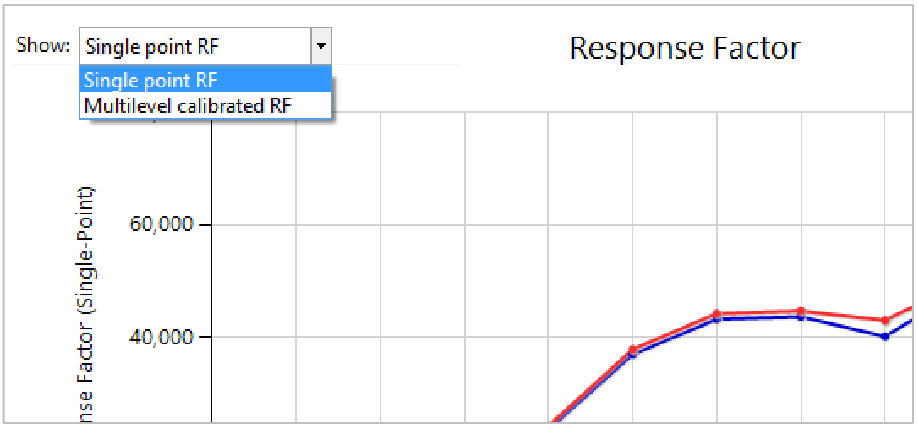
7.12 Multilevel-Calibrated RF (ISO 10723)

GCAS supports the traditional single-point response factors as well as multilevel-calibrated (MLC) response factors.

Note

This feature requires *ISO 10723* feature in your GCAS licence.

Users with *ISO 10723* feature in their licences will see **MLC selector** at top-left region of response factor chart. This dropdown lets you change the displayed RF whether the single-point or the MLC one. GCAS performs ISO 10723 conversion on-the-spot, therefore the actual RF values in the database are not affected. By default, GCAS displays single-point RF.

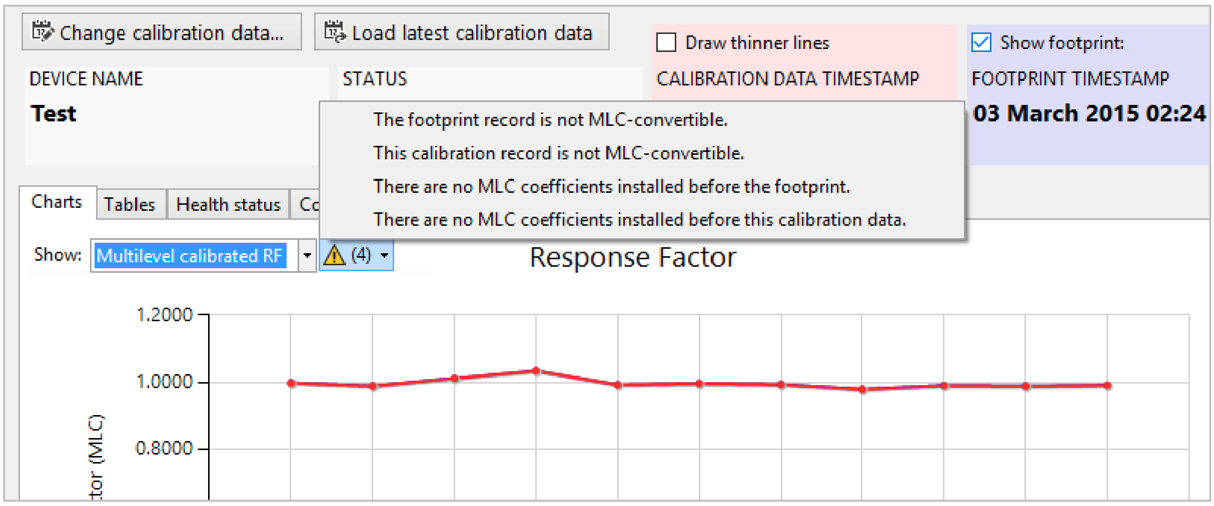


Single-point RF has the familiar graph as discussed so far, it has to be ascending and the values are in the range of millions to hundreds of millions. However multilevel-calibrated RF is different: All values are close to one (1.0), therefore its chart is somewhat horizontally flat. Multilevel-calibrated RF has no much use as it is not usable for correlation calculation, but you can easily detect anomalies if the chart is not flat.

ISO 10723 conversion for footprint/calibration data requires:

1. A multilevel calibration (MLC) coefficient set installed before the timestamp of the footprint/calibration record, and
2. An active calibration gas certificate installed before the timestamp of the footprint/calibration record.

If these two conditions are not met, the footprint or calibration record is said to be *not convertible*. For calibration data, these conditions must be fulfilled for *both* the calibration record itself and the preceding footprint. GCAS displays a ⚠ warning icon next to the MLC dropdown selector if your footprint or calibration data is not convertible; also if the calibration data is convertible but its preceding footprint isn't. In the latter case, the MLC coefficients probably sit between the footprint timestamp and calibration record timestamp. Click on the warning icon to see the detailed reason why the record is not convertible.



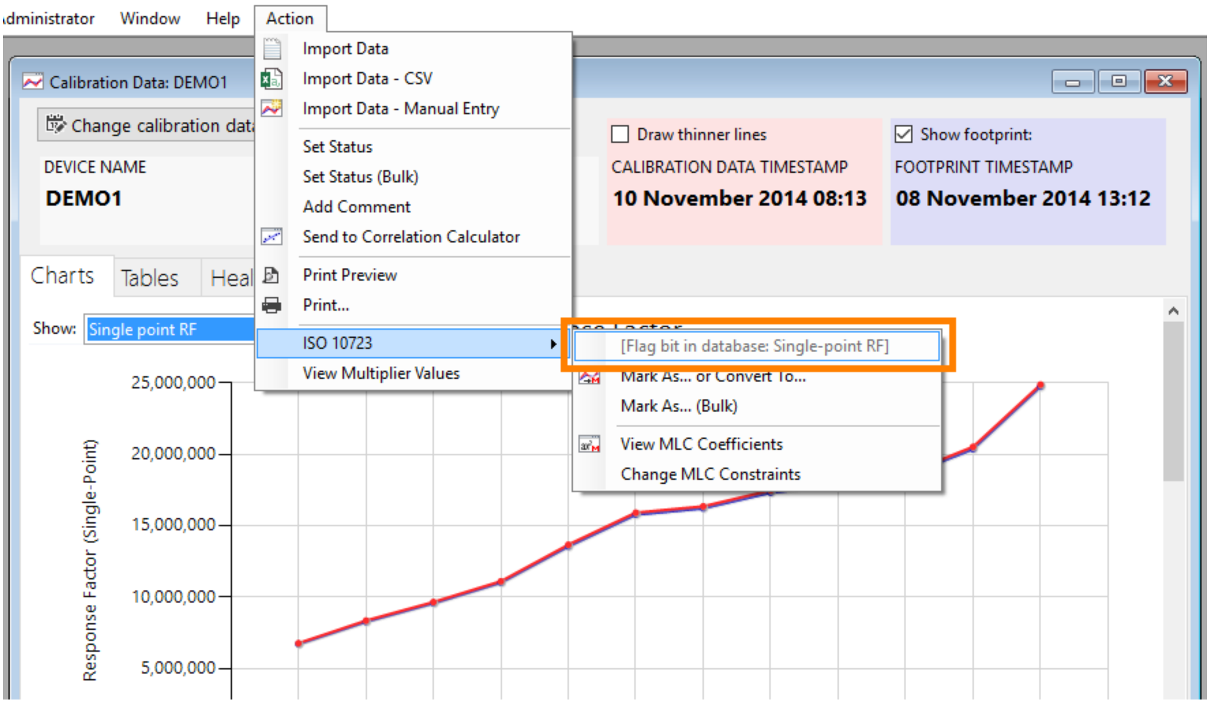
MLC conversion warning icon.

To see the MLC coefficients associated with current record, open the Action menu, select **ISO 10723**, then click **View MLC Coefficients**. This menu calls Multilevel Calibration Coefficients form and loads the correct coefficient set associated with current footprint or calibration data.

7.12.1 MLC Flag Bit

Footprint and calibration records have an additional flag bit to indicate whether the RF values are single-point or multilevel-calibrated. If you don't have *ISO 10723* feature in your licence, this flag bit is always set to single-point. To recap, footprints and calibration data have three flag bits: One to indicate active/inactive, another one to indicate whether it is a footprint or calibration data, and the last one to indicate whether its RF are single-point or MLC.

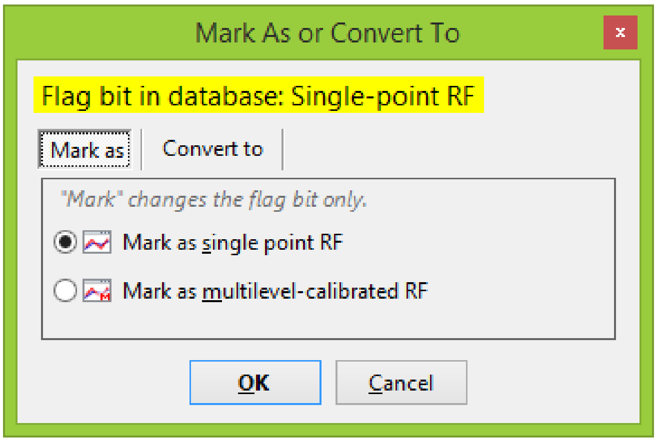
Open the Action menu and select **ISO 10723**. The first submenu is not clickable but it tells you what the flag bit of current record is. In the screenshot below, it tells us the flag bit for this record is single-point.



You can change the MLC flag bit if necessary, however there is one important difference between "Mark As" and "Convert To". Read more on the next chapter, 7.12.2.

7.12.2 Mark As versus Convert To

Open Action menu, select **ISO 10723**, then select **Mark As… or Convert To…** and GCAS reveals this dialogue box.



Current flag bit is highlighted in yellow to clarify what the current flag bit is. Next, decide whether you need to *mark* the flag bit or *convert* the whole record.

Mark As changes the flag bit only. The original numbers of all RF values are untouched. Use this if you notice:

- MLC selector shows "single-point" but the chart is horizontally flat and all numbers are close to one (1.0). Also when the selector is changed to multilevel-calibrated, the chart is still flat but all numbers become very close to zero. You need to **mark** the record **as** MLC.
- MLC selector shows "multilevel-calibrated" but the chart is not horizontally flat and instead the numbers skyrocket to scale of hundreds of billions or even trillions. Also when the selector is changed to single-point, the chart suddenly forms a nice ascending shape and the numbers now make sense. You need to mark the record as single-point.

Convert To changes the flag bit *and* converts all RF values, thus changing the actual numbers stored in database—permanently. Use this when you see the record is **good** (the numbers make sense), which is completely opposite condition of when to use *Mark As*.

Because *Convert To* also converts the actual RF values, you will get the desired numbers during data export. For example, you want to export footprint/calibration data into CSV. All records are marked as MLC. If you go to export directly, all RF values in the result CSV will also be close to one (1.0) as they were in MLC. On the contrary if you use *Convert To* single-point before the export, RF numbers will be in scale of millions like typical single-point RF values.

Mark As requires an action permission to "change MLC flag bit". On the other hand, the *Convert To* operation requires "change MLC flag bit" plus a permission called "MLC permanent conversion". Had your GCAS administrator not given you this permission, GCAS displays a message saying that you don't have sufficient permission to perform conversion when you select *Convert To* in this dialogue box.

Important

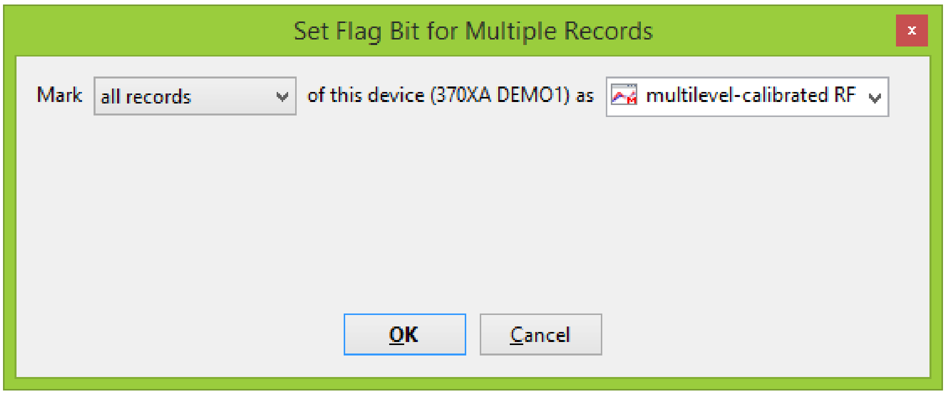
Be very cautious when using *Convert To*. Performing permanent conversion on wrong record will damage the record permanently. For instance, a calibration record is wrongfully marked as single-point where it should've been marked as MLC. You should use *Mark As* MLC here. But if you apply *Convert*

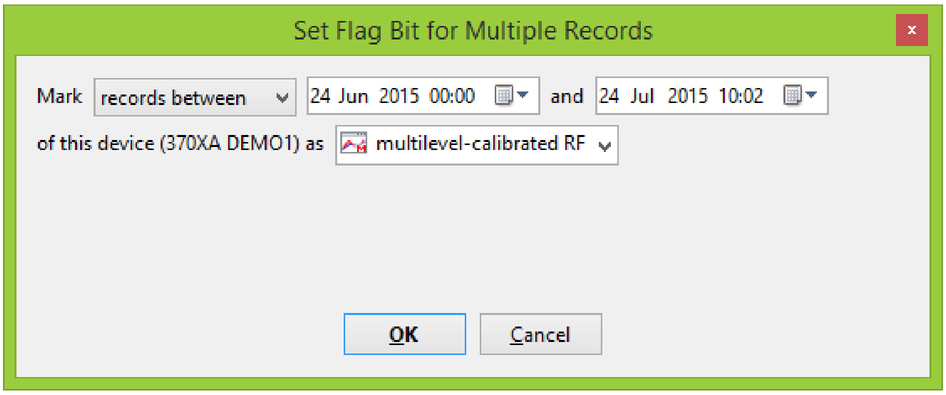
To MLC instead, the numbers will change to somewhere close to zero—destroying the record for good.

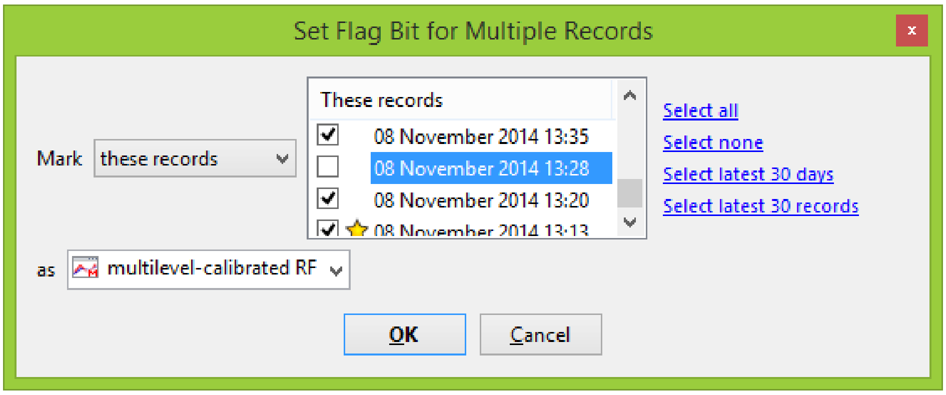
7.12.3 Change MLC Flag Bit (Multiple Records)

Changing MLC flag bit as described in chapter 7.12.2 only changes one record at a time. Sometimes you need to change flag bit of a bunch of records, such as when you notice calibration records coming from data capture should be marked as MLC but you forgot to set it in Modbus mapping. Therefore, all these records are still wrongly marked as single-point. To save time, go to the Action menu, select **ISO 10723**, then select **Mark As... (Bulk)**.

This dialogue lets you change MLC flag bit of *all* records of the selected GC device (no exceptions), or limited to certain date range, or specific selections of available records. For specific selections, a star indicates a footprint.







> **Note**
>
> There is no *Convert To* feature for bulk operation because it may damage multiple records.

7.12.4 MLC Constraints

We moved the explanation about concepts and application of MLC constraints to chapter 24.2. Most of the time, users need not to worry about MLC constraints. However, there is a slim chance the default MLC constraints causes nonsensical RF values, such as 300 billion where it should be about 17 million. In such cases, you may need to override the MLC constraints in order to get the correct result. Read more on chapter 24.2 about MLC constraints.

7.13 Exponential RF

This chapter applies to ABB devices only. If you have GC devices of other brands, skip ahead to chapter 7.14.

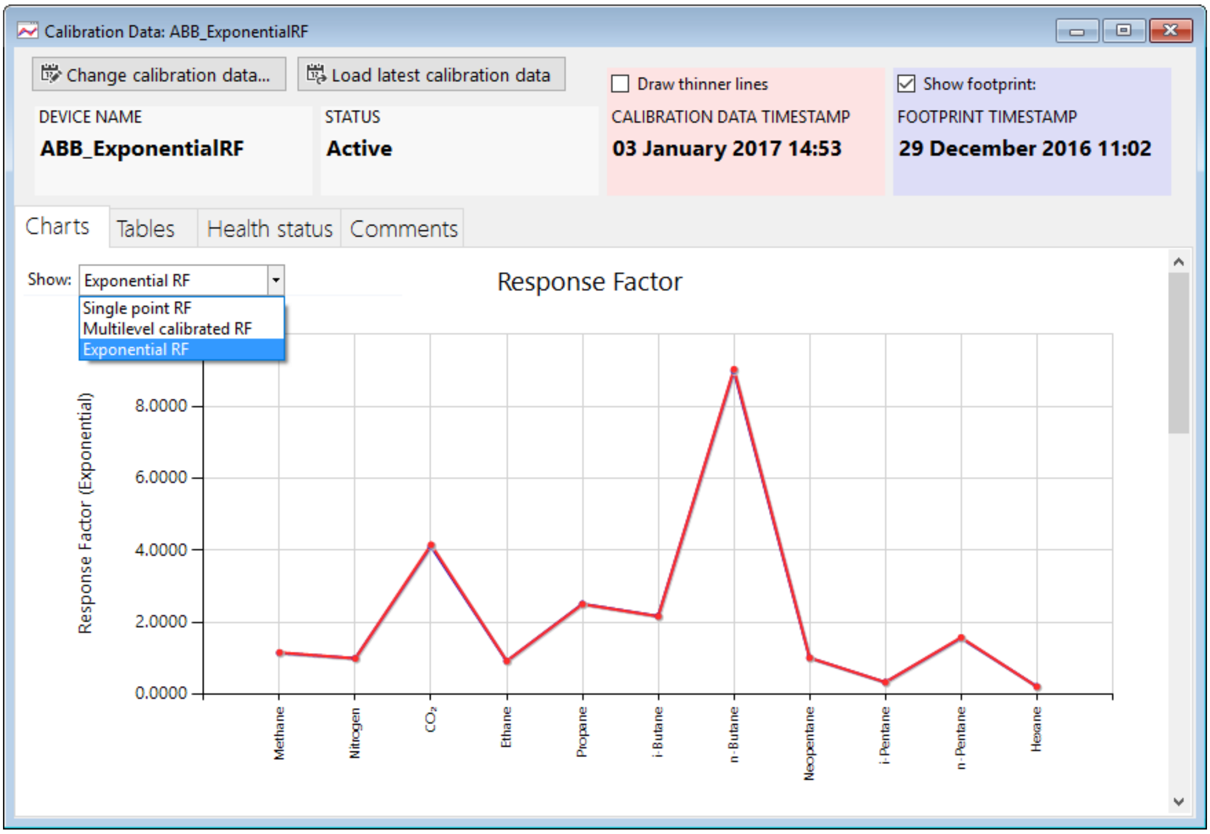
By default, ABB devices outputs *exponential* response factor instead of single-point RF. Single-point RF is what GCAS uses for all calculations. Exponential RF is called *exponential* because the conversion formula contains exponential function (e^x). This formula is proprietary of ABB.

Exponential response factor values are typically between 0 to 20, unlike the single-point RF that may go to billions. Conversion between exponential RF and single-point RF is computed through a proprietary formula and it involves a coefficient that we call **multiplier** (M). These multiplier values (one for each gas) are calculated automatically when you import a calibration data or capturing calibration data through Modbus connection.

Footprints and calibration data without multiplier values are said to be *not convertible* to exponential RF. Please note there is a distinction between being inconvertible to multilevel-calibrated and inconvertible to exponential RF. The state of *inconvertibility to multilevel-calibrated RF* is already explained in chapter 7.12.

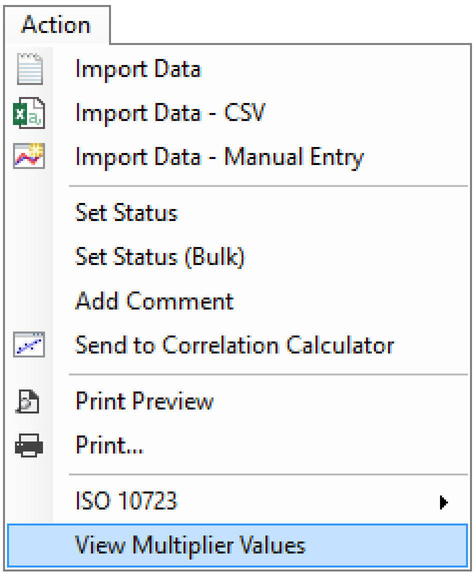
7.13.1 View Exponential RF

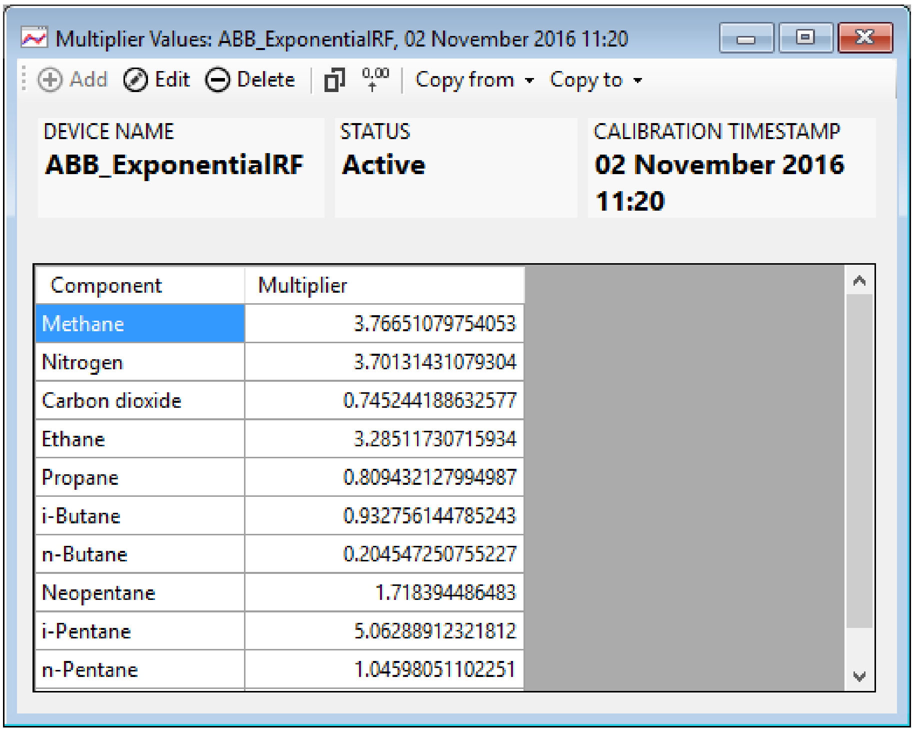
On ABB devices, the MLC selector provides one more option to select: *Exponential RF*. This option graphs the exponential RF values on the RF chart. Exponential RF chart does not produce nice ascending slope like single-point RF chart, thus the only use of exponential RF chart is to verify that GCAS captured the correct data from calibration report imports or data capture.



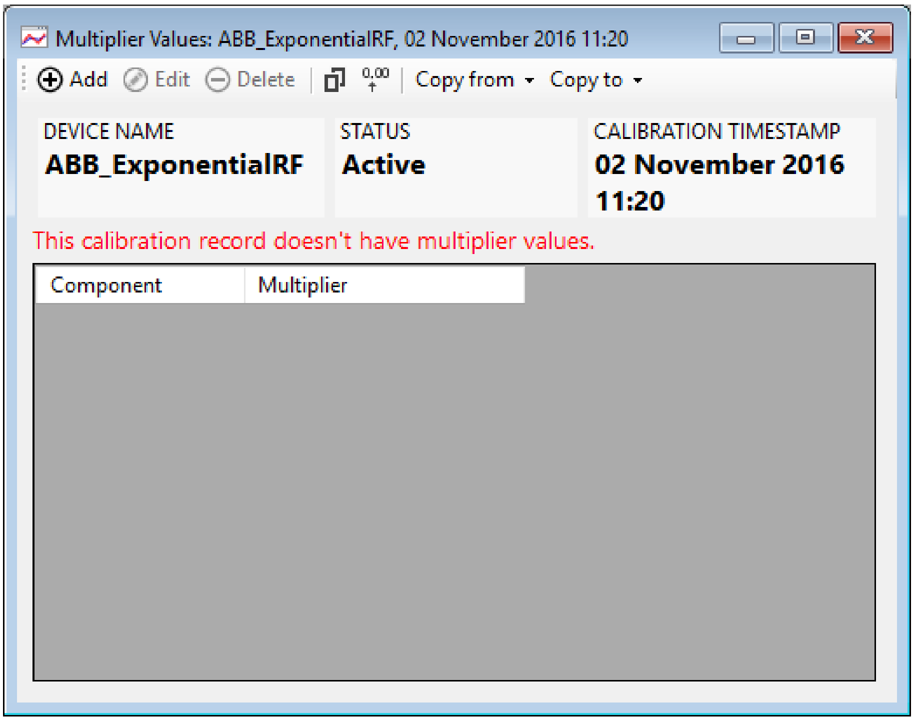
7.13.2 The Multiplier Form

Usually users don't think much about multiplier values. But they are still accessible from the Action menu in case the footprint/calibration record you are viewing doesn't have one. From an open Foot-print or Calibration Data form that is viewing an ABB calibration record, open the Action menu, and select **View Multiplier Values**.





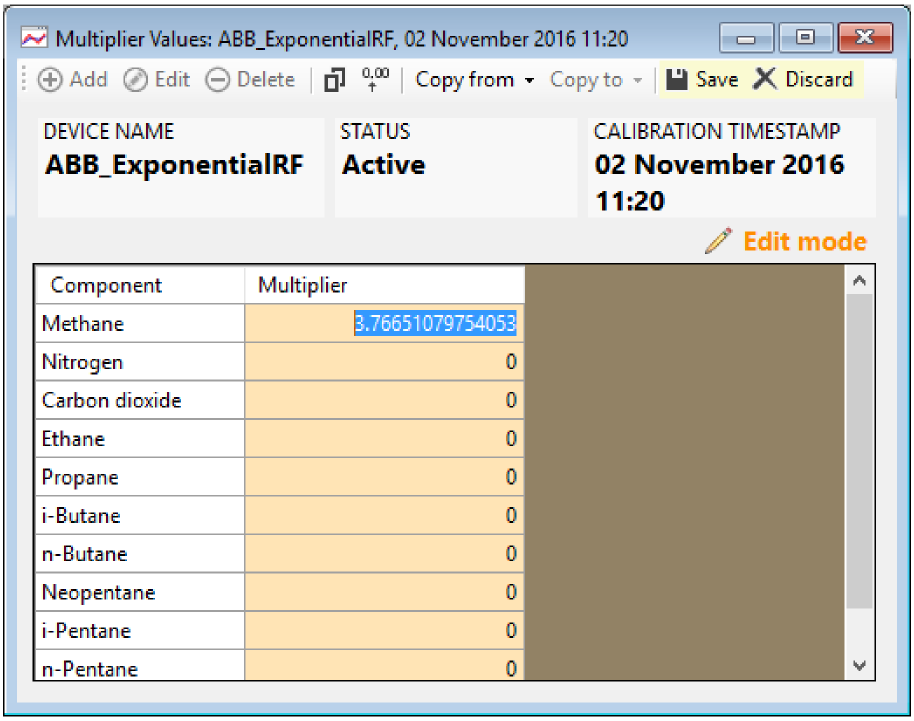
The *Multiplier* Form displays the associated multiplier values of this record. Otherwise if the footprint/calibration record does not have multiplier values, the form looks like this.



There is a toolbar at the top of the form. Click **Copy to clipboard** to copy multiplier values. To make every value displays the same number of decimal digits, activate **Align decimal**. Every button on the toolbar has the corresponding menu in the Action menu too.

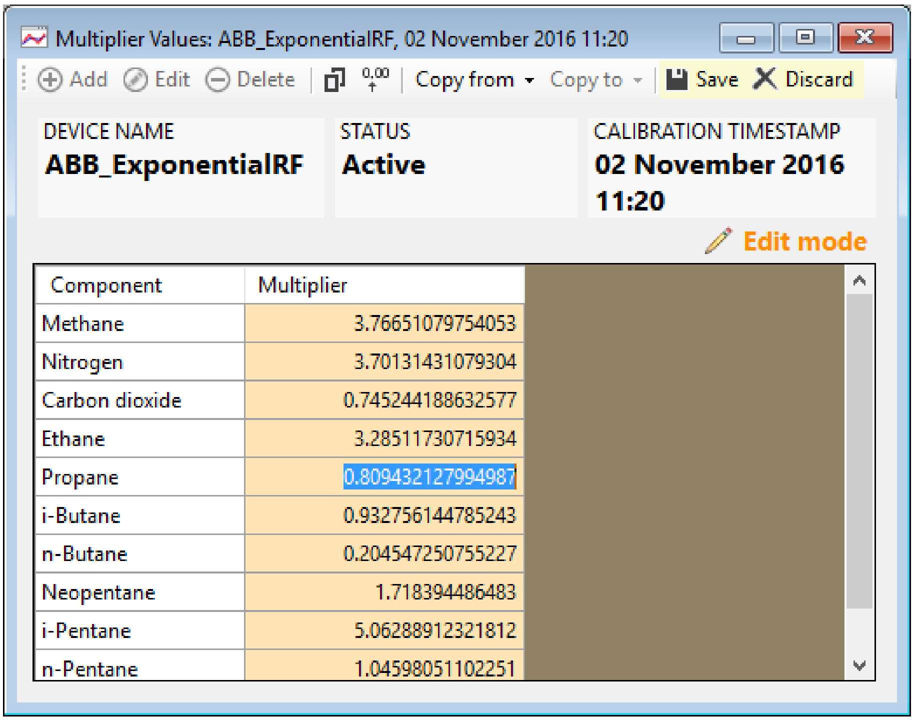
7.13.3 Add, Edit, or Delete Multiplier Values

When your calibration record does not have multipliers, GCAS can display its single-point RF values but not its exponential RF. To make it convertible, please supply multiplier values. Click **Add** button on the toolbar. The form enters *edit mode* and you can begin typing the numbers. If the form says `"This calibration record doesn't have multiplier values"` but the **Add** button is still disabled, probably your user account does not have the action permission to add multipliers. Contact your GCAS administrator.



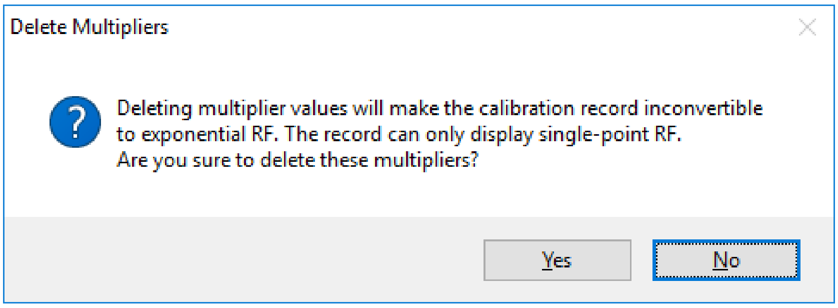
When you are done, double check everything for a potential typing error. Finally, click **Save**.

To edit an existing multiplier values, click **Edit** on the toolbar. Similar things happen—the form enters edit mode and you can start modifying the numbers. To commit your edit, click **Save**. To cancel and revert back to the original values, click **Discard**. If the **Edit** button is disabled even though there are multiplier values present to edit, your GCAS user account may not have the action permission to edit multipliers. Contact your GCAS administrator.



After saving, the parent Footprint form or Calibration Data form should refresh itself. Try reselecting the MLC selector to *Exponential RF* in order to verify the exponential RF values have been recalculated correctly.

And finally to delete multiplier values, click ⊖ **Delete**. Similar to **Add** and **Edit** action, the delete action is guarded by action permission. Deleting multiplier values will put your calibration record to inconvertible state (inconvertible to exponential RF). Deleting multipliers is also effectively the same as editing all multiplier values to zero.

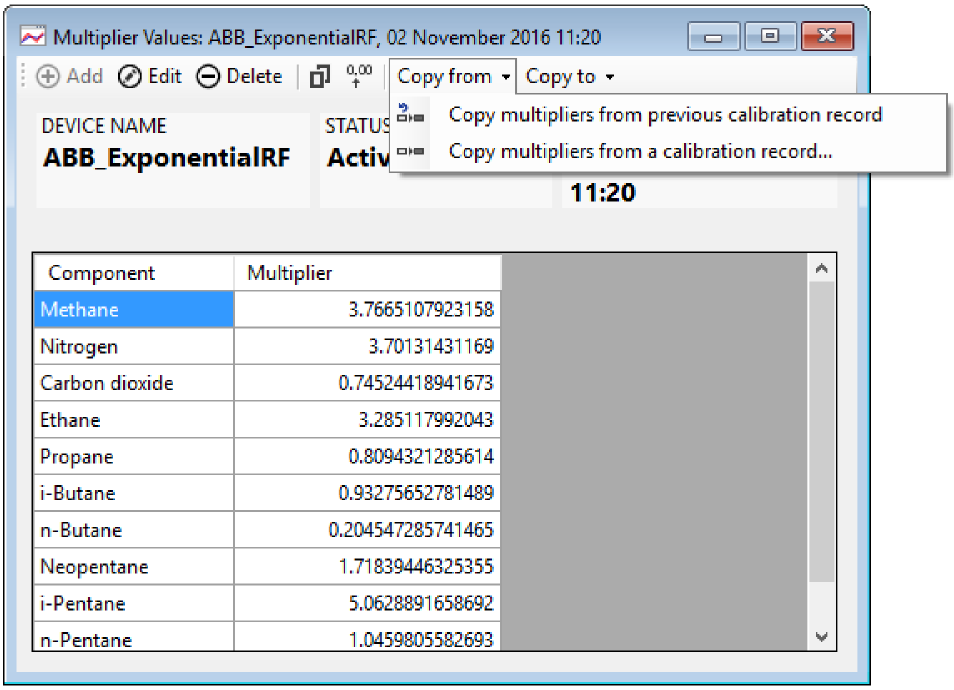


GCAS prompts this confirmation. Select **Yes** to proceed. After deletion, the form becomes empty and displays "`This calibration record doesn't have multiplier values`".

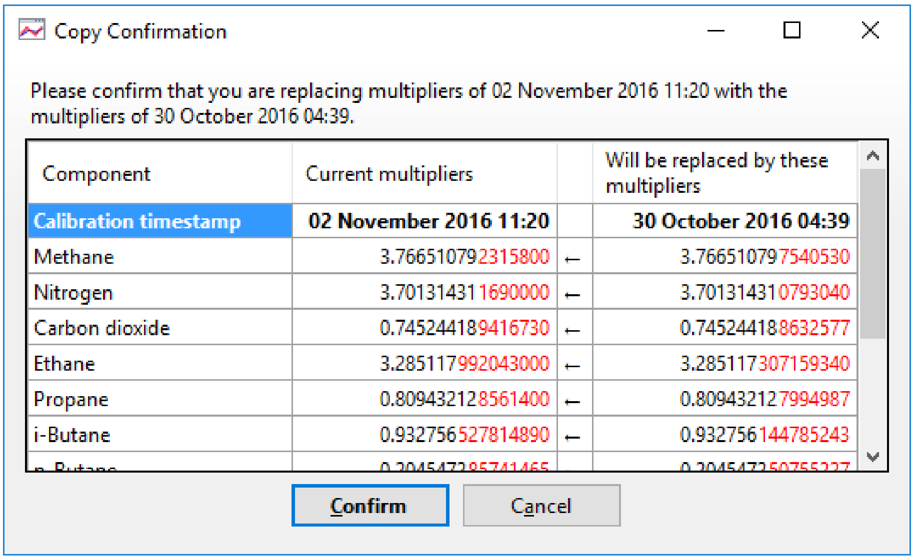
7.13.4 Copy Multipliers from Other Records

Multipliers are expected to stay the same between calibration records. If there are variations on the numbers, they should occur after quite insignificant decimal place. You can overwrite multiplier values of current calibration record by multiplier values of another calibration record. Your GCAS user account needs the action permission to edit multipliers. If you can edit, of course you can edit the multipliers to match the previous record, for instance.

To do that, click **Copy from** on the toolbar and select the appropriate submenu. **Copy multipliers from previous calibration record** will overwrite current multipliers using those belong to calibration record before the current one, while **Copy multipliers from a calibration record** pops a *Select Record* dialogue to let you choose which calibration record to be the copy source.



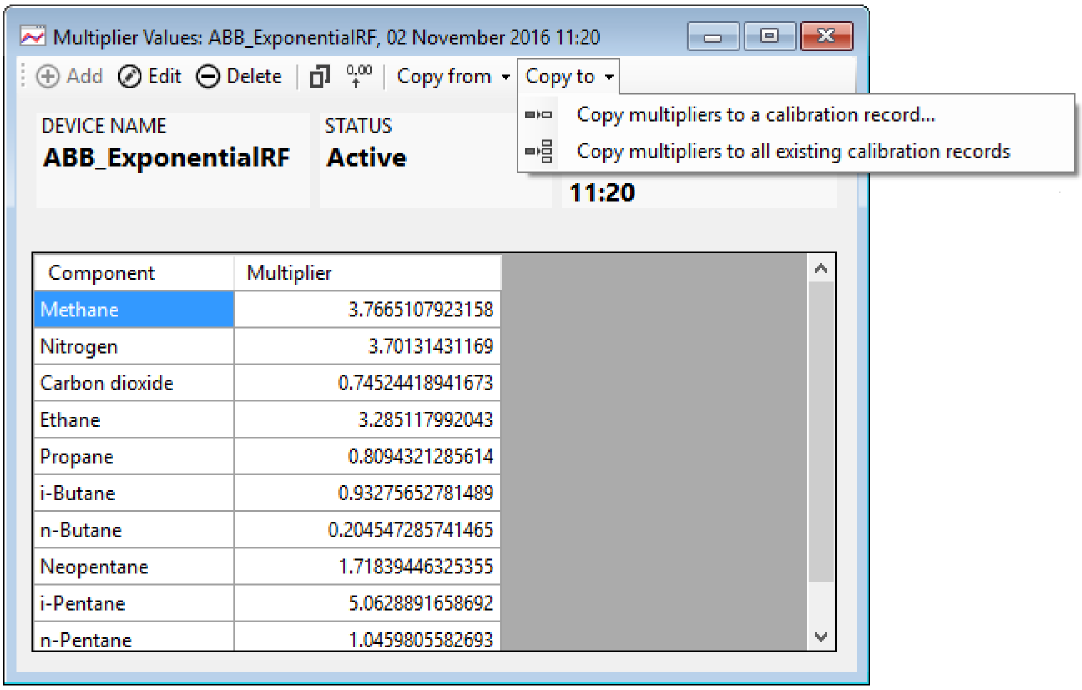
Next, GCAS shows a confirmation dialogue that the multipliers are about to be replaced by the new ones. Value differences are highlighted in red. Click **Confirm** to proceed. Multiplier form will update itself and the parent Footprint form or Calibration Data form should refresh too.



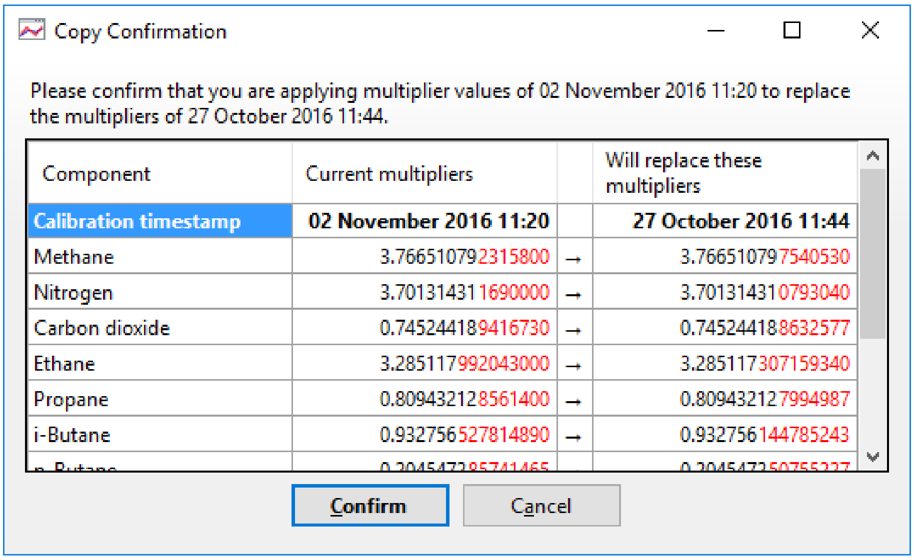
7.13.5 Copy Multipliers to Other Records

This action is the opposite of previous action. Suppose you have the latest calibration record with good multiplier values, but all of your previous calibrations didn't have multipliers yet. You can copy current multipliers to all those records because multiplier values are coefficients that are not expected to change much anyway. Likewise, your GCAS account needs the action permission to edit multipliers.

Click **Copy to** on the toolbar. Then decide whether to **Copy multipliers to a record** which shows the familiar *Select Record* dialogue to choose the copy target; or **Copy multipliers to all existing records** to update all calibration records of this GC device. Note that the latter (copy to all records) only updates calibration records already existing in the database. Future calibration records are not affected.

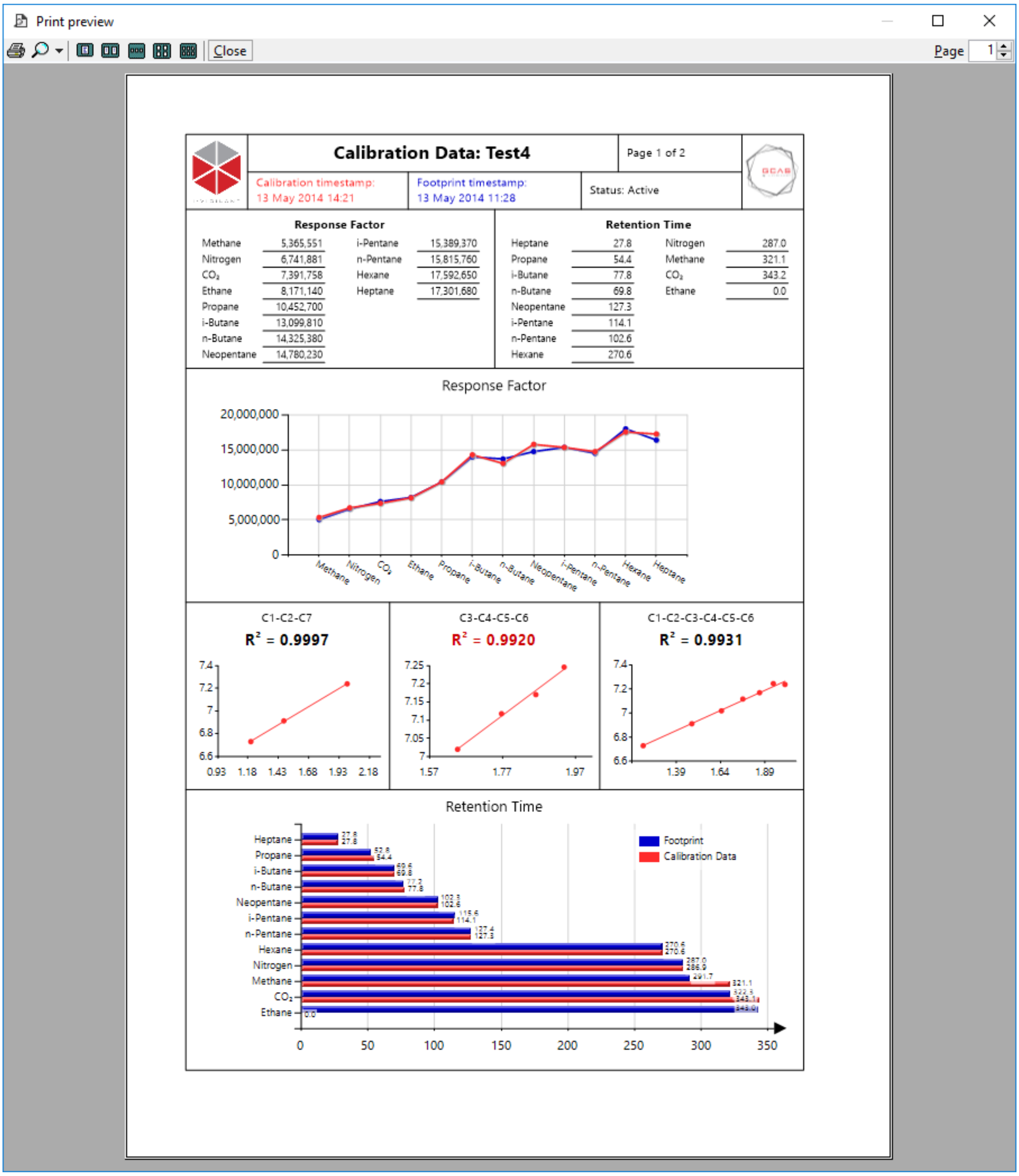


Likewise, GCAS displays a confirmation dialogue. But this time the arrow direction is reversed. Click **Confirm** to continue.



7.14 Printing

From an open Footprint or Calibration Data, go to the File menu on the main menu bar. Select **Page Setup** to configure paper size and print orientation. Select **Print Preview** to get a preview or **Print** to begin printing. Alternatively, the menu Print Preview and Print are also found inside the Action menu. The **Quick Print** menu immediately sends the footprint or calibration data to your *default printer* according to what has been set in Windows Control Panel, using current page setup (default is A4 portrait).



Print preview dialogue.

GCAS has different print layout for portrait and landscape orientation. GC health status and user comments are printed on subsequent pages.

8 Mole Composition

Mole composition (formerly “mole percentage”) is a record of, as its name suggests, mole composition of either calibration gas or process gas in one chromatography cycle.

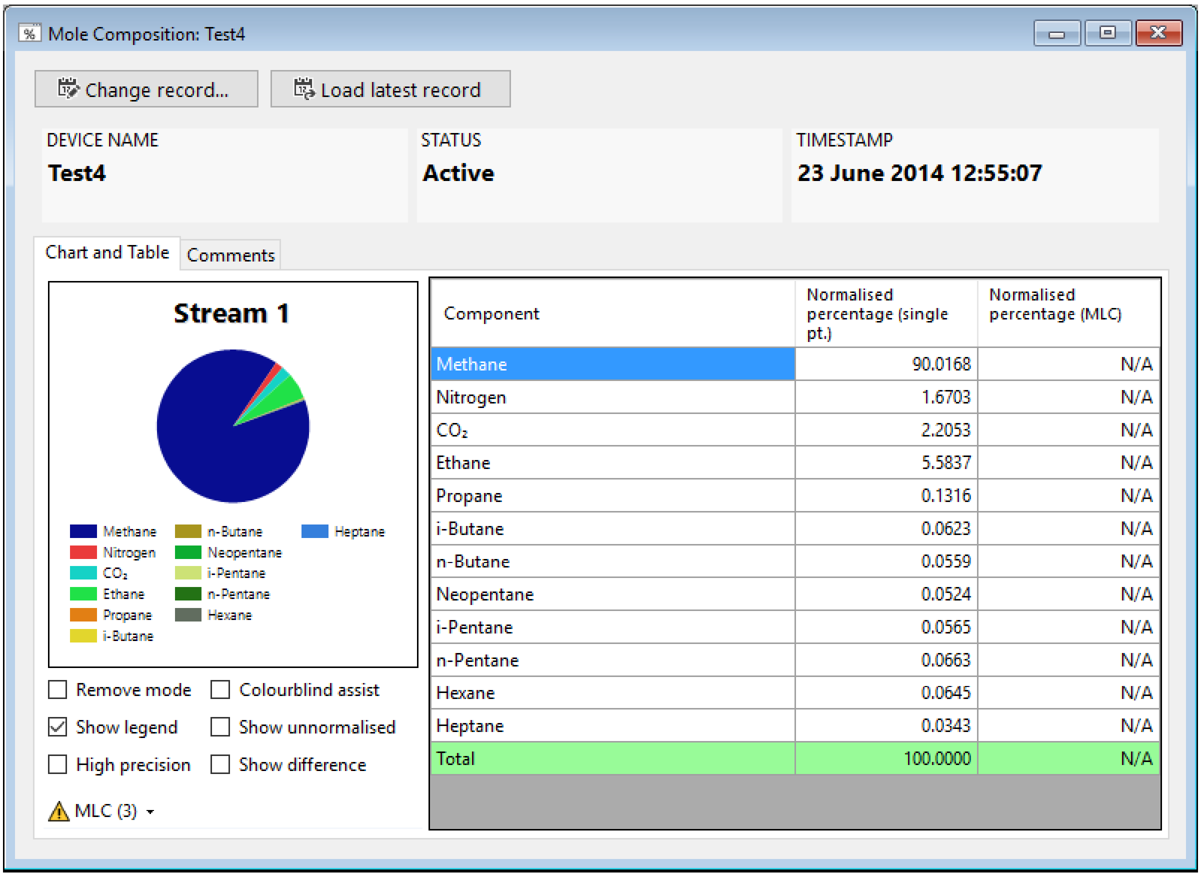
> **Note**
>
> In order to use features related to mole composition e.g. Mole Composition form, mole composition data capture, and mole composition data analysis, you need GCAS feature *Live Data Analysis* in your GCAS licence.

Early versions of GCAS recognised only mole percentage, but now GCAS can work with any scale. We generalise mole percentage, fraction, or whatever scale it is, into one name – mole composition. From this chapter onwards, the term “mole composition” may be abbreviated as “MC”.

8.1 The Mole Composition Form

Mole Composition form displays mole composition data presented in grid view. By default, numbers in this grid is the *normalised* composition. The pie chart next to the grid helps visualising the data, although in many cases methane composition overwhelms everything else. This is caused by the use of *balanced methane* in calibration gas.

To open Mole Composition form, select the device from device panel on the main user interface, then go to the View menu > **Mole Composition**.



Mole Composition form as seen by users with [ISO 10723] feature included in GCAS licence.
Users without ISO 10723 feature will not see features related to multilevel calibration (MLC).

As mole composition data may come from multiple streams, the stream number is displayed on top of the pie chart. Some GC designates stream 1 as the calibration stream and stream 2 as process stream, while some others specify stream numbers the other way around. GCAS can also handle GC devices with more than two streams, the appropriate stream number is always there on top of the pie chart.

Remove mode check box will hide the mode (Latin: *modus*) from the pie chart. That is, the datum with highest value among other data. For example, if you have methane composition at 90%, it would be difficult to see other gases cramped in the remaining 10%. Ticking this option will hide methane from the pie chart.

Show legend toggles show or hide the legend of pie chart.

High precision causes the form to show all numbers in 8-digit decimals instead of four digits. If you see some rounding errors, that is because GCAS uses 32-bit floating point for mole composition data to save database space.

Colourblind assist. To aid users with colour blindness (protanopia and deuteranopia), GCAS provides an alternative colour scheme for the pie chart.

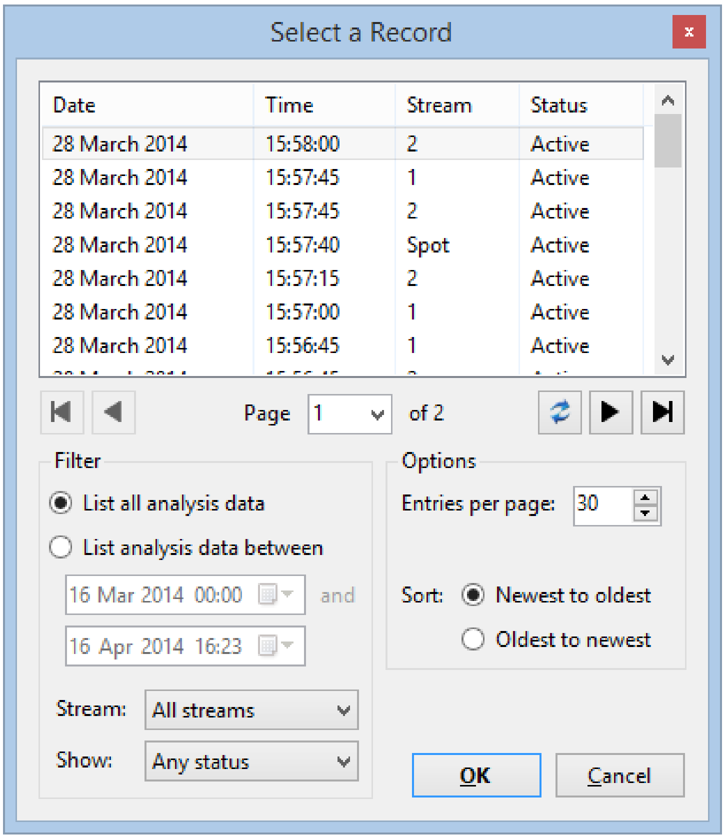
Show unnormalised reveals another set of columns in grid view: the unnormalised composition. If you have *ISO 10723* feature in your licence, this check box also reveals the unnormalised MLC composition as well. Nonetheless, the pie chart always displays normalised composition. This should be checked at all time for single gas devices.

> **Note**
>
> On ABB devices, there are three columns (or two if you don't have *ISO 10723* feature included). The additional column is allocated to display exponential mole composition.

Show difference check box is available for customers having *ISO 10723* feature in their licences or if the GC device is ABB. This check box reveals an additional column in grid view, called the *delta*. It contains the difference between normalised single-point composition and normalised MLC composition, or difference between normalised single-point composition and normalised exponential composition. Delta is computed as single-point minus MLC or single-point minus exponential.

8.2 View Previous Records

To load previous mole composition data, click **Change record** button at the top region of the form. Select a different record, then click **OK** or double click the list item.



Select Record dialogue. Timestamps on this screenshot are fictional, actual records are usually 4-7 minutes apart.

You can always load the latest mole composition data through **Load latest record** button.

8.3 Import New Composition Data

To import new mole composition data, follow these steps.

1) Select the desired GC device on your device panel.

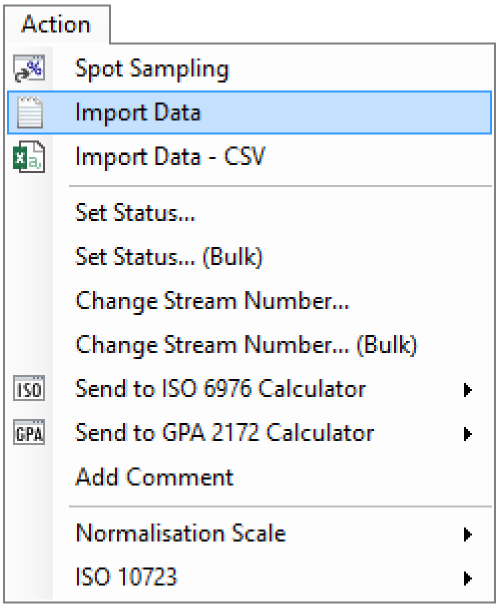
2) Open *Mole Composition* form through the View menu > Mole Composition.

3) Notice the Action menu on the menu bar. To continue, pick one of the supported import formats.
    a. Text import
    b. CSV import

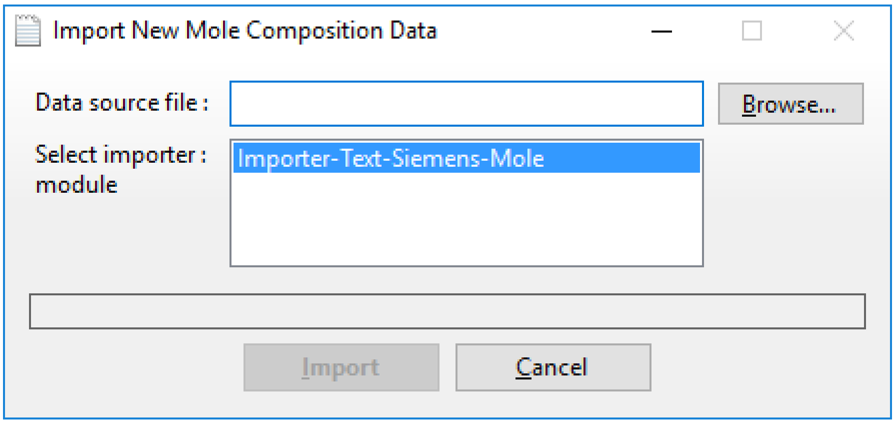
8.3.1 Text Import

For the time being, text import for mole composition is supported for Siemens GC and Daniel 700XA only. These two importer modules support multiple records inside one text file as well.

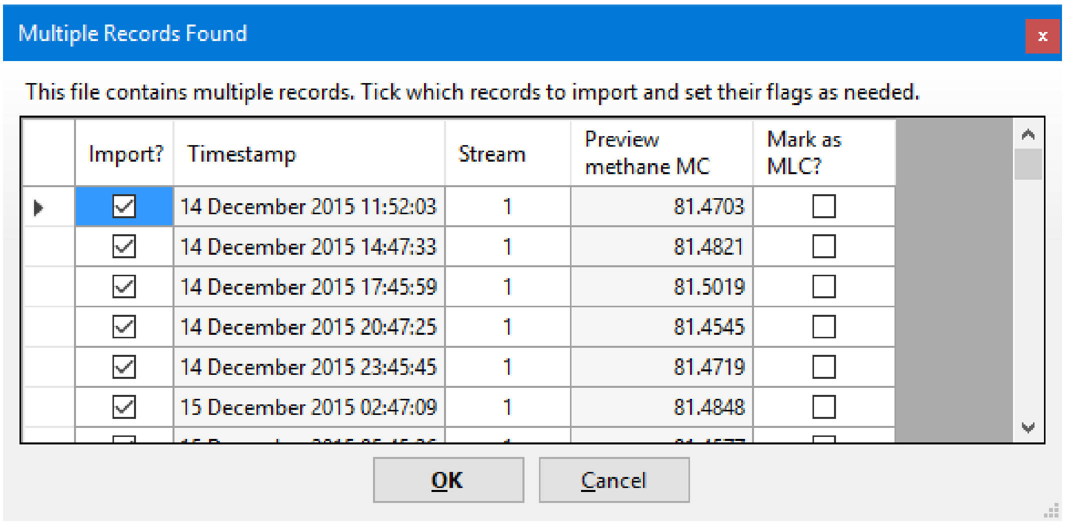
Continuing, open the Action menu and find **Import Data**. If you do not see this menu, your user account may not have the action permission for it or the text import feature is not included in your GCAS licence. Contact your GCAS administrator.



Load the text file and click **Import**. If the text file contains multiple records, GCAS presents additional dialogue to choose which records to import.



In this additional dialogue, click on the column header **Import?** to quickly select or unselect all records. Also you can change the stream number by navigating to the third column (**Stream**) at the desired row and then press F2 to enter edit mode.



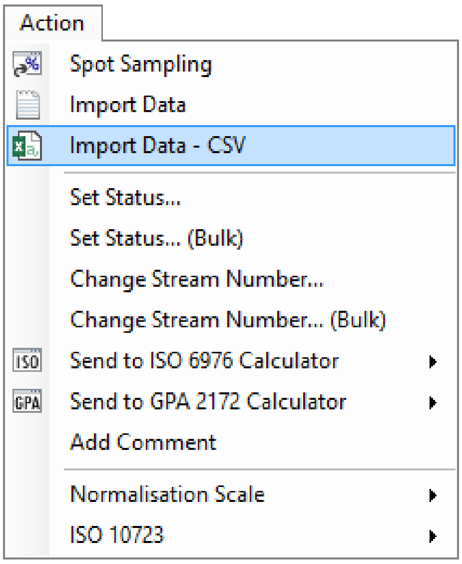
Additional dialogue to select which records to import. Column 3 (Stream) is editable.

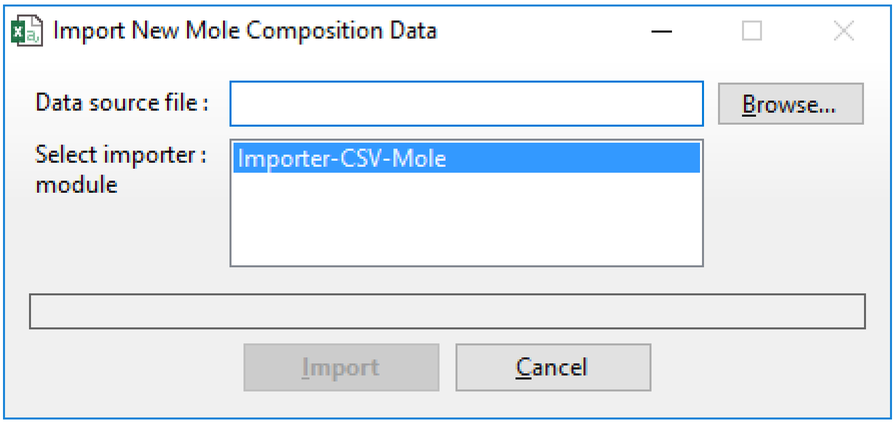
GCAS treats all numbers in the text file as *unnormalised* composition and will normalise them before they are committed to GCAS database.

8.3.2 CSV Import

The CSV file must follow the standard template for mole composition. Failure to comply with the template will cause wrong data to be associated with wrong gas or component. The template file should be in your installation directory or in the browser/HTML version of GCAS Manual. Look for `CSV import file template.zip` in your installation directory. If you lose this template, you can easily recreate new one by following the guide in chapter 8.3.3.

Now open the Action menu and select **Import Data - CSV**. Load the CSV file and then click **Import**.





If you do not see this menu, your user account may not have the action permission for it or the CSV import feature is not included in your GCAS licence. Contact your GCAS administrator.

GCAS treats all numbers in the CSV file as *unnormalised* composition and will normalise them before they are committed to GCAS database.

8.3.3 CSV Import Template Explained

Lost your CSV template? This chapter explains the structure and column assignments of CSV import templates for mole composition just in case the original template files are nowhere to be found. There are templates for footprint and calibration import too, but those have been explained in chapter 7.4.4.

Here are CSV column assignments for mole composition import of **regular GC devices except ABB** (Daniel, Siemens, Elster, and LNG). ABB devices have their own template because there is one additional column that is specific to ABB. For BTEX devices and single gas analysers, go to page 120.

CSV template for: Daniel, Siemens, Elster, LNG

Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Stream number.

CSV template for: Daniel, Siemens, Elster, LNG (continued)		
Column	Excel name	Description
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Methane mole composition.
5	E	Nitrogen MC.
6	F	Carbon dioxide MC.
7	G	Ethane MC.
8	H	Propane MC.
9	I	i-Butane MC.
10	J	n-Butane MC.
11	K	Neopentane MC. *
12	L	i-Pentane MC.
13	M	n-Pentane MC.
14	N	Hexane MC.
15	O	Heptane MC. *
16	P	Octane MC. *
17	Q	Nonane MC. *
18	R	Decane MC. *
19	S	Unnormalised total.
20	T	Are they multilevel-calibrated MC? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).

* If your GC device doesn't read this gas, fill in **0** (zero).

Here are CSV column assignments for mole composition import of **ABB devices**. The columns are similar to Daniel, Siemens, Elster, and LNG, but with addition of one column to indicate exponential MC.

CSV template for: ABB		
Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Stream number.
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Methane mole composition.
5	E	Nitrogen MC.
6	F	Carbon dioxide MC.
7	G	Ethane MC.
8	H	Propane MC.
9	I	i-Butane MC.
10	J	n-Butane MC.
11	K	Neopentane MC. *
12	L	i-Pentane MC.

CSV template for: ABB (continued)

Column	Excel name	Description
13	M	n-Pentane MC.
14	N	Hexane MC.
15	O	Heptane MC. *
16	P	Octane MC. *
17	Q	Nonane MC. *
18	R	Decane MC. *
19	S	Unnormalised total.
20	T	Are they multilevel-calibrated MC? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).
21	U	Are they exponential MC? Fill **0** for single-point or **1** for exponential. If you put **1** in both column 20 and 21, column 21 (MLC) takes over.

* If your GC device doesn't read this gas, fill in **0** (zero).

Below are CSV column assignments for mole composition import of **BTEX devices**.

CSV template for: BTEX

Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Stream number.
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Benzene mole composition.
5	E	Toluene MC.
6	F	Ethylbenzene MC.
7	G	Xylene MC.
8	H	Unnormalised total.
9	I	Are they multilevel-calibrated MC? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).

And lastly here are CSV column assignments for mole composition import of **single gas devices** (single gas analyser, H_2S analyser, and moisture analyser).

CSV template for: Single gas

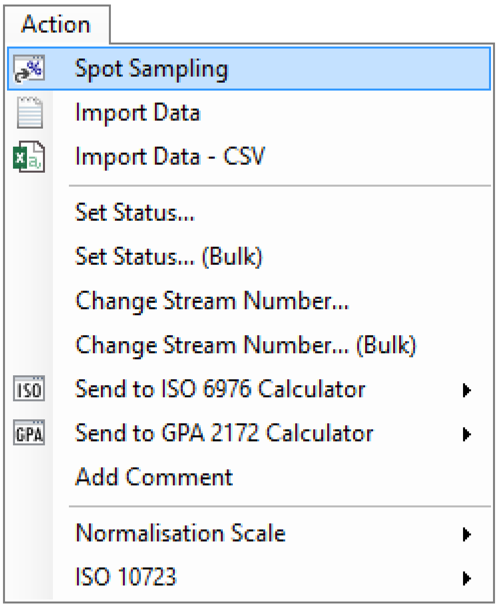
Column	Excel name	Description
1	A	Device tag name. (Yes, you can import data for multiple devices in one go.)
2	B	Stream number.
3	C	Record timestamp in the format of **dd/mm/yyyy hh:mm** or **mm/dd/yyyy hh:mm** depending on your device date format. Both use 24-hour clock.
4	D	Mole composition of H_2S/moisture/"the gas".
5	E	Unnormalised total (which is the same as column 4).
6	F	Is it multilevel-calibrated MC? Fill **0** for single-point or **1** for MLC. If you don't have *ISO 10723* in your licence, always fill **0** (zero).

8.4 Spot Sampling

A *spot sample* is a special mole composition record. Regular mole composition record is the composition of gases read by the GC device, but spot sample is the composition of gases *before* they enter GC device. Spot sampling is conducted directly on the pipeline (on the *sample probe*) before entering the pressure letdown system (hence the name "spot").

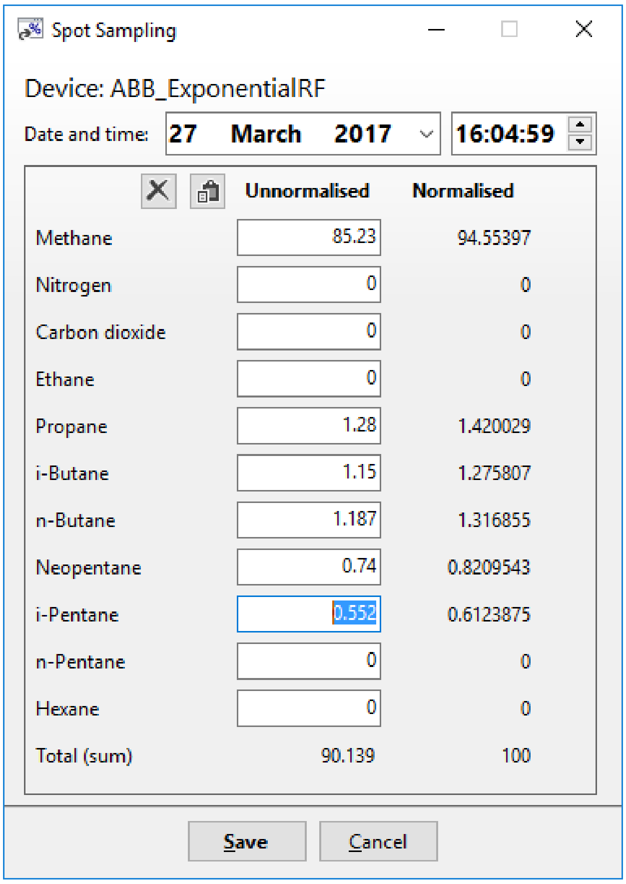
The purpose of spot sampling is to verify if your pressure letdown system works properly — no leakage, no condensation, no dropout, etc. If the spot sample record is very close to the regular mole composition record (taking the lag time into account), then generally speaking your pressure letdown system should be fine.

To enter spot sample data, select the device from the device panel then open the Mole Composition form through View menu > Mole Composition. Open the Action menu, then click **Spot Sampling**.



This brings forth the *Spot Sampling* form. **First thing first, enter the date and time of when the sample was taken**. This is a common mistake for leaving the date/time input to be current computer time. Once the record commits to database, you cannot change its timestamp but you can set it as inactive and re-enter a same record with the correct timestamp.

The next step is to key in mole composition value of each gas. The composition you are entering now is the *unnormalised* composition.

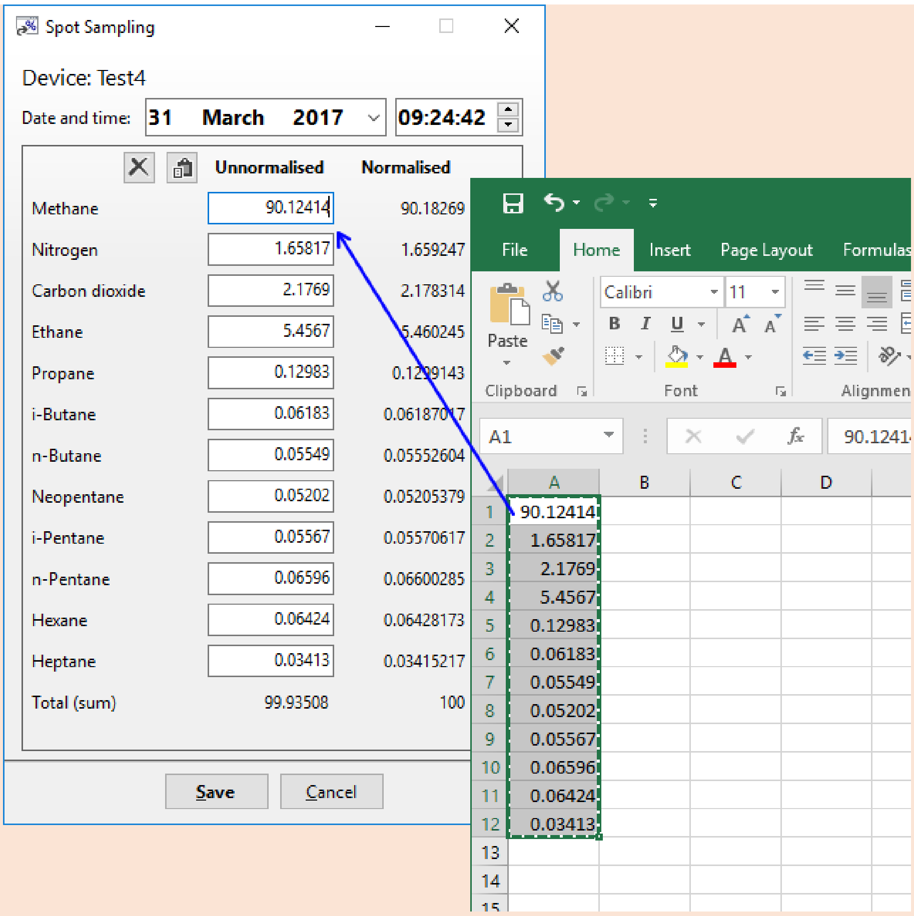


As you type, the total/sum is updated accordingly and all values are automatically normalised in the rightmost column. The form deduces the correct scale automatically. Therefore, for a few first gases, total/sum for normalised column may display 1 (mole fraction) or 10 (decimal). As you fill in more and more fields, the scale will change accordingly and typically end up in 100 (percentage).

Always double-check the numbers to avoid potential human error. When you are ready, click **Save** to commit the record.

Tip

You can copy values from Microsoft Excel or other spreadsheet processing software. Press `Ctrl+V` inside the **first text box** and the rest will follow. Alternatively, click **Paste** button.

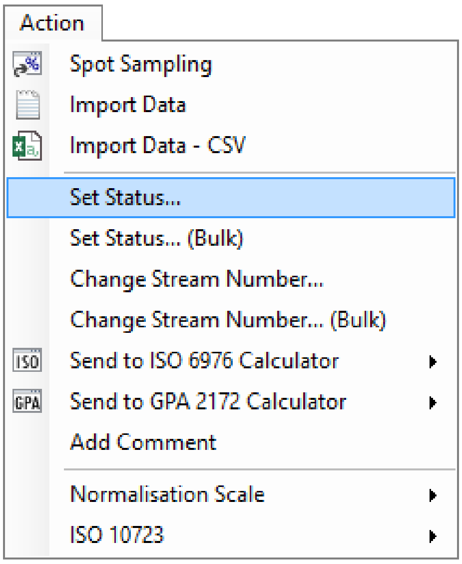


Click ✕ **Clear** to reset all fields back to zero.

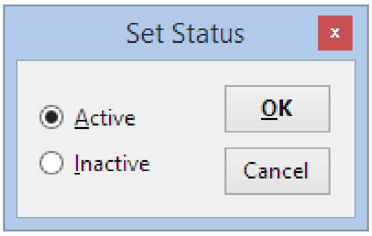
8.5 Change Record Status (Single Record)

Similar to footprint and calibration data record, every mole composition record has a status bit indicating either active or inactive. Similarly, inactive records will not appear in data analysis and will not affect the calculation of mean and standard deviation, uncertainty calculation, ISO 6976/GPA 2172 trend, and many others. To change record status of the mole composition record currently loaded, do the following:

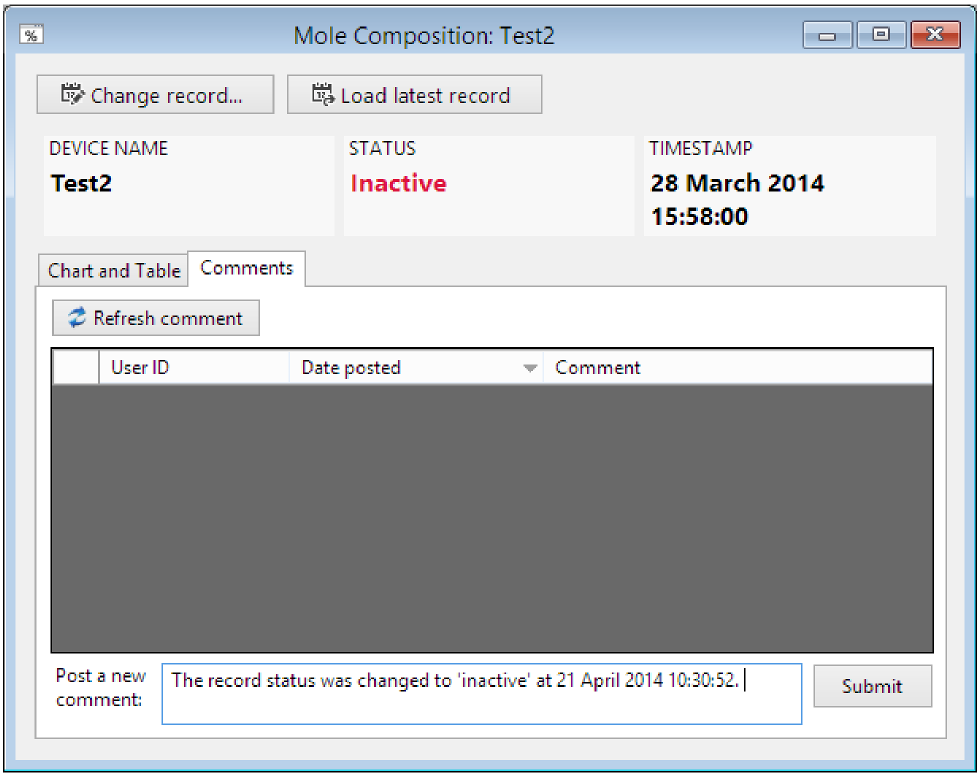
1. From an open Mole Composition form, go to Action menu > **Set Status**. If you do not see this menu, your user account may not have the action permission for it. Contact your GCAS administrator.



2. This will show *Set Status* dialogue. Choose the appropriate record status then click **OK**.



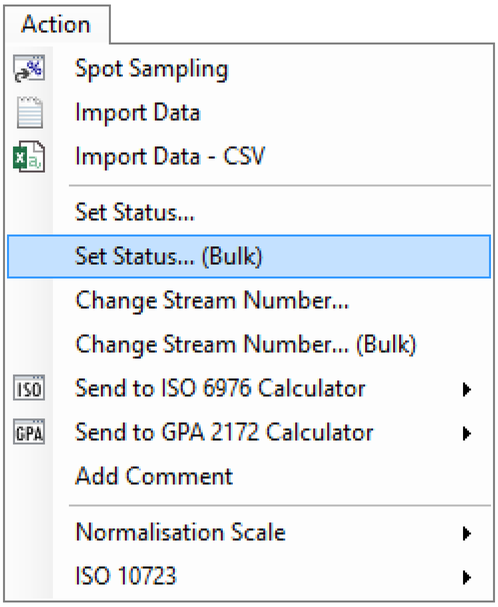
3. The form will reload the record and you should see the new status at the upper section. Afterwards, the **Comments** tab opens automatically and it is recommended to write a comment of why the record status was changed. Comments tab does not open in case your GCAS user account doesn't have the action permission to post comments



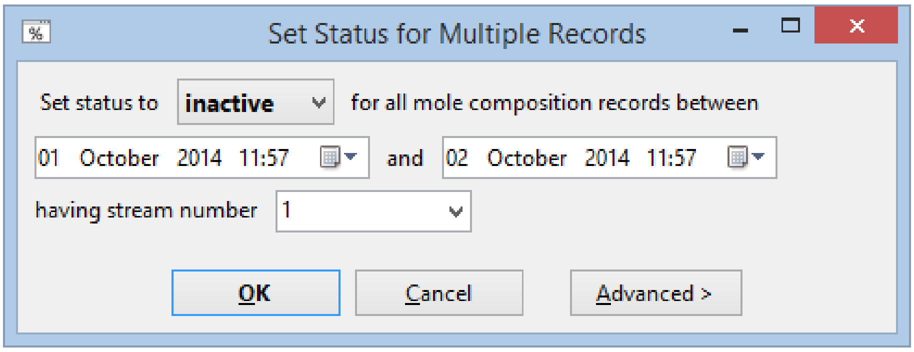
8.6 Change Record Status (Multiple Records)

Mole composition records mostly came from a data capture operation. To make it worse, many users set the data capture in unattended mode. If an error happened during unattended data capture, bad records will still be committed into database. This may lead to numerous unusable records in the database and it is a tedious work to set their status as inactive one by one. GCAS includes a tool to set record status in bulk (batch) operation.

From an open Mole Composition form, open the Action menu and select **Set Status (Bulk)**. If you do not see this menu, your user account may not have the action permission for it. Contact your GCAS administrator.



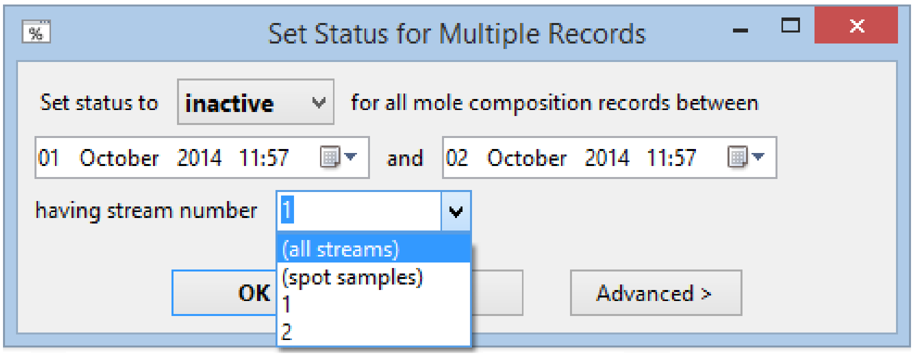
This menu brings the *Set Status for Multiple Records* dialogue. This window has two views, namely *simple view* and *advanced view*. The first time this dialogue opens, it is on simple view.



8.6.1 Simple View

Using *simple view*, you set the desired record status (active or inactive) for all mole composition records between the two date/time perimeters. This may or may not be filtered to a stream number.

The user interface in simple view is pretty straightforward. Depending on how many stream numbers ever recorded into the database, stream number selection may look like this.



If you choose **(all streams)**, that will change record status of all mole composition records within the defined date boundaries regardless of stream numbers *except spot samples*. If you choose **(spot samples)**, the status change only applies to spot sample records within the date interval. All next choices afterwards are the actual stream numbers available. You can also type the desired stream number if it is not on this list. To confirm, click **OK** and GCAS begins the batch operation.

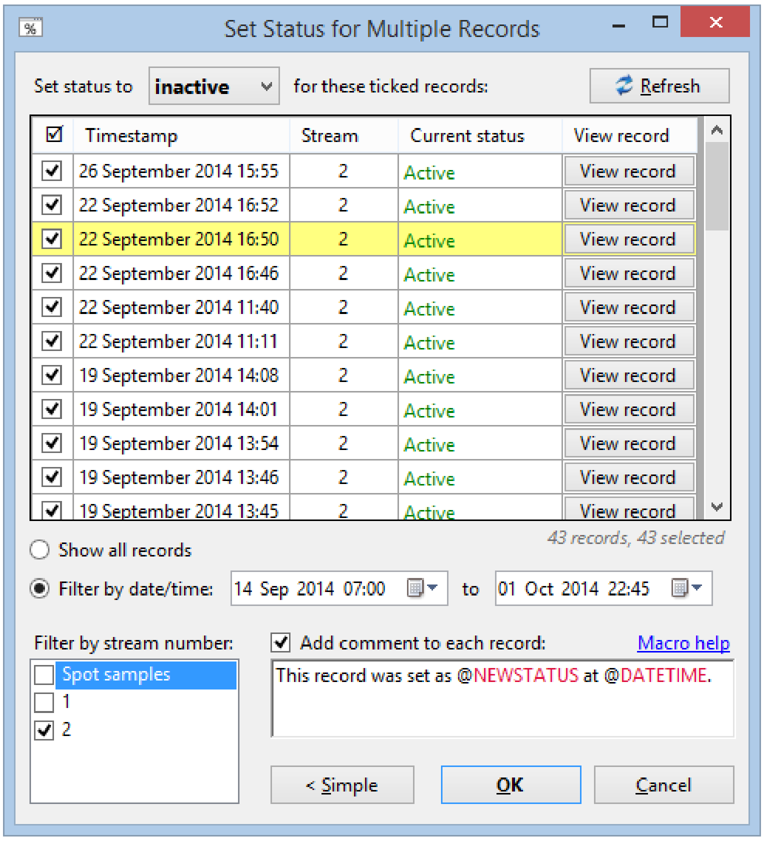
Note

GCAS does not add automatic comment such as "`This record status was changed to inactive at <current computer time>`" for bulk status change in simple view. Use advanced view if you want to attach comments to these records.

To switch into advanced view, click **Advanced** button.

8.6.2 Advanced View

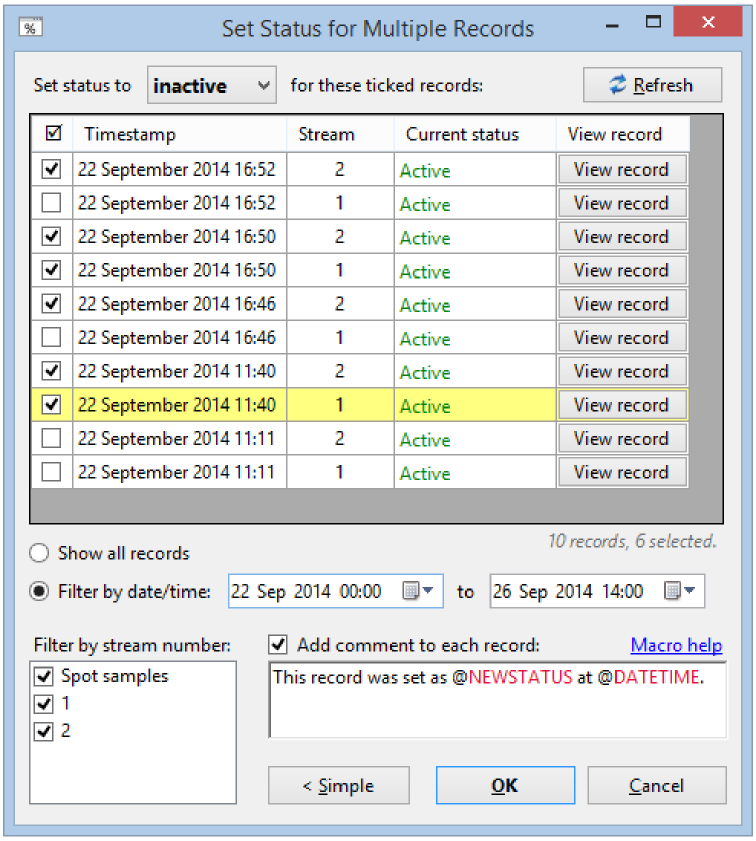
Advanced view offers more flexibility to set record status for multiple records. In advanced view, GCAS gives a list of mole composition records and you tick which ones to change status.



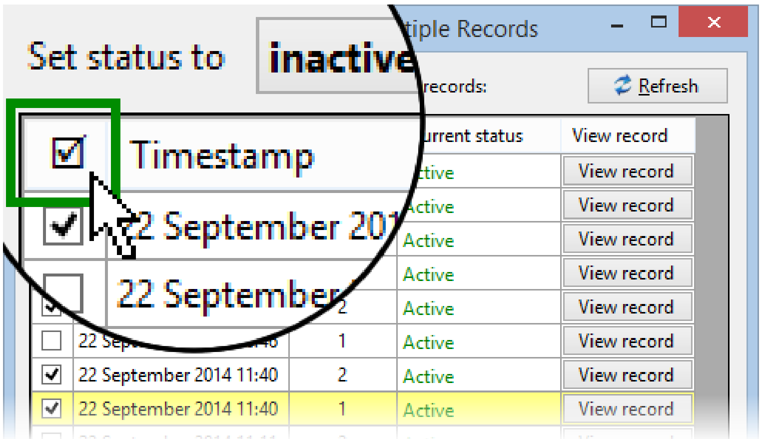
For the first time, GCAS lists all records within the last 24 hours. To change the date filter, choose **Filter by date/time** and enter the desired interval. If you choose **Show all records**, this turns off the date filter and you see all records ever exist for this GC device since the beginning. Click **Refresh** at the top right corner to apply the new date filter and reload the list.

At the bottom left corner, there is a selection of available stream numbers. Change which stream number to display on the record list, then click **Refresh** to apply the stream number filter and reload the list.

Tick or untick records you want to have their status to change. The **Current status** column displays current record status before the operation begins. To view the record content, click **View record** button available at each row. That button opens a new Mole Composition form and loads that particular record. In the example screenshot on the next page, there are 6 records to be set as **inactive** when you press OK button. The rest (those without check mark) are left untouched, thus their status remains active.



Click on the column header of the check boxes to quickly check all or uncheck all records in the list.



Click the column header to quickly tick all or untick all records.

You can also attach a comment to each record like [what GCAS does in single record status change](). To do so, give a check mark at **Add comment to each record**. Then write your comment at the text box provided. The same comment is applied to every ticked record when their statuses are being changed.

The comment box recognises five keywords called *macro*(s) which it automatically highlights in red. Macro identifier starts with the '@' symbol and is all-uppercase. GCAS replaces these macros with actual values before writing them into database.

Macro keyword	Will be replaced with
@OLDSTATUS	Previous record status ("active" or "inactive")
@NEWSTATUS	New record status ("active" or "inactive")
@DATE	Current computer date, e.g. "15 September 2014".
@TIME	Current computer time in 24-hour format, e.g. "16:28:44".
@DATETIME	Current computer date and time, e.g. "15 September 2014 16:28:44".

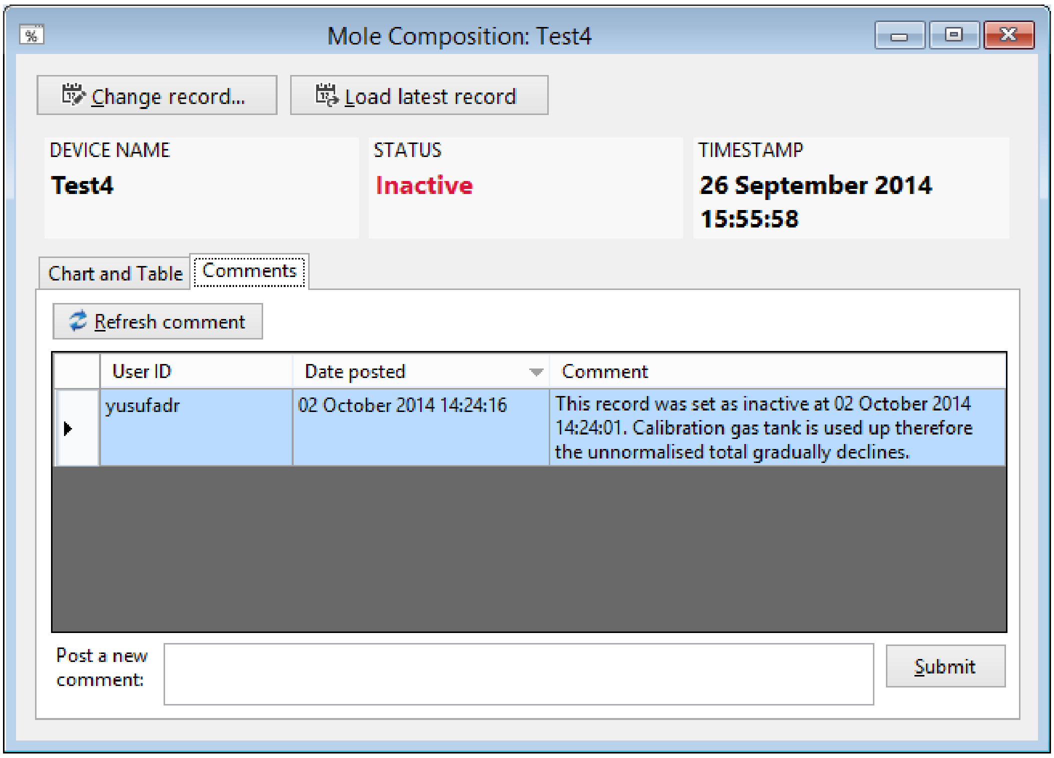
For instance, this comment macro:

```
This record was set as @NEWSTATUS at @DATETIME. Calibration gas tank is
used up therefore the unnormalised total gradually declines.
```

will be replaced with actual values such as:

```
This record was set as inactive at 02 October 2014 14:24:01. Calibration
gas tank is used up therefore the unnormalised total gradually declines.
```

Which you can easily verify by visiting any record included in bulk operation, like this one.

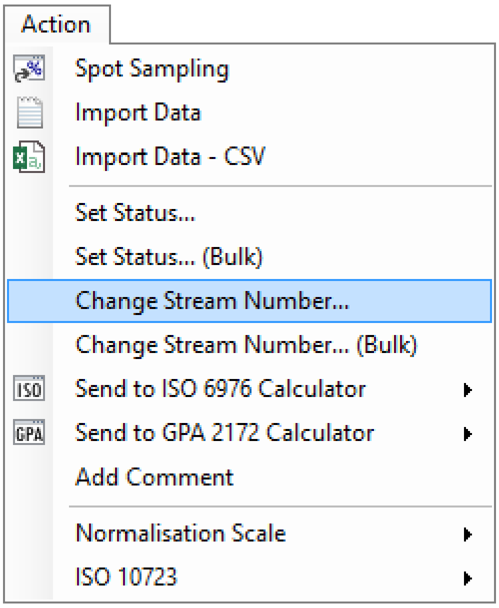


To switch back into simple view, click **Simple** button at the left side of **OK** button.

8.7 Change Stream Number

There are times a user may forget to set the correct stream number while importing mole composition data. Starting from GCAS version 1.8.2.0, Mole Composition form provides an option to change stream number. This is applicable to a single record or to multiple record via bulk operation.

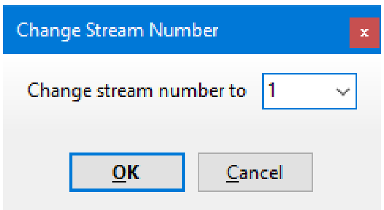
From an open Mole Composition form, open the Action menu and select either **Change Stream Number** or **Change Stream Number (Bulk)**. The former is for single record, and the latter is for multiple records.



Changing stream number requires action permission of the same name, "change stream number". If your GCAS administrator did not assign you this permission, both **Change Stream Number** menu and **Change Stream Number (Bulk)** will not be visible.

8.7.1 Single Record

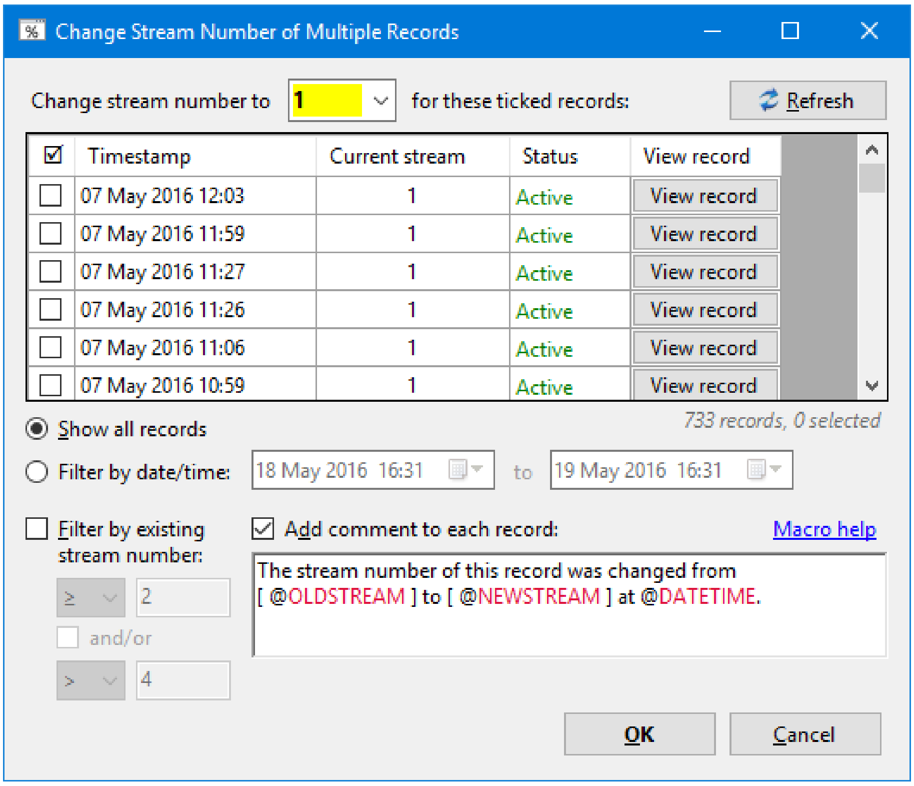
The dialogue for single record stream change is pretty straightforward. Select a new stream number from the dropdown list or manually type a number between 0 and 32,767, and finally click **OK**.



Once the stream number is changed, Mole Composition form switches to the **Comments** tab and writes a default comment for you. It is a good idea to provide an explanation about the reason of this stream number change. Edit this comment as required and click **Submit** to save the comment.

8.7.2 Multiple Records

The dialogue for bulk operation has similar workflow as change record status (multiple records, advanced view). Initially you set the desired stream number on the yellow dropdown, then configure whether to show all records or to filter them by date. Click **Refresh** to load the records and populate the list.



The dialogue also provides an optional filter by [old] stream number at the bottom-left corner. If you change these filters, be sure to click **Refresh** again to update the record list. Once the list is populated, tick or untick the records to include or exclude them from this bulk operation.

You can also make GCAS add a comment to every affected record just like what happened on single record stream change. Check **Add comment on each record** followed by entering your comment on the designated text box. The comment box recognises certain keywords, called *macro*(*s*) that are automatically highlighted as red. These macros are replaced by actual values before being written to database.

Macro identifiers start with '@' symbol and are all-uppercase. There are five keywords valid for bulk stream number change:

Macro keyword	Will be replaced with
@OLDSTREAM	Previous stream number.
@NEWSTREAM	New stream number.
@DATE	Current computer date, e.g. "`20 May 2016`".
@TIME	Current computer time in 24-hour format, e.g. "`16:53:14`".
@DATETIME	Current computer date and time, e.g. "`20 May 2016 16:53:14`".

For example, the default comment

```
The stream number of this record was changed from [ @OLDSTREAM ] to [ @NEWSTREAM ]
at @DATETIME.
```

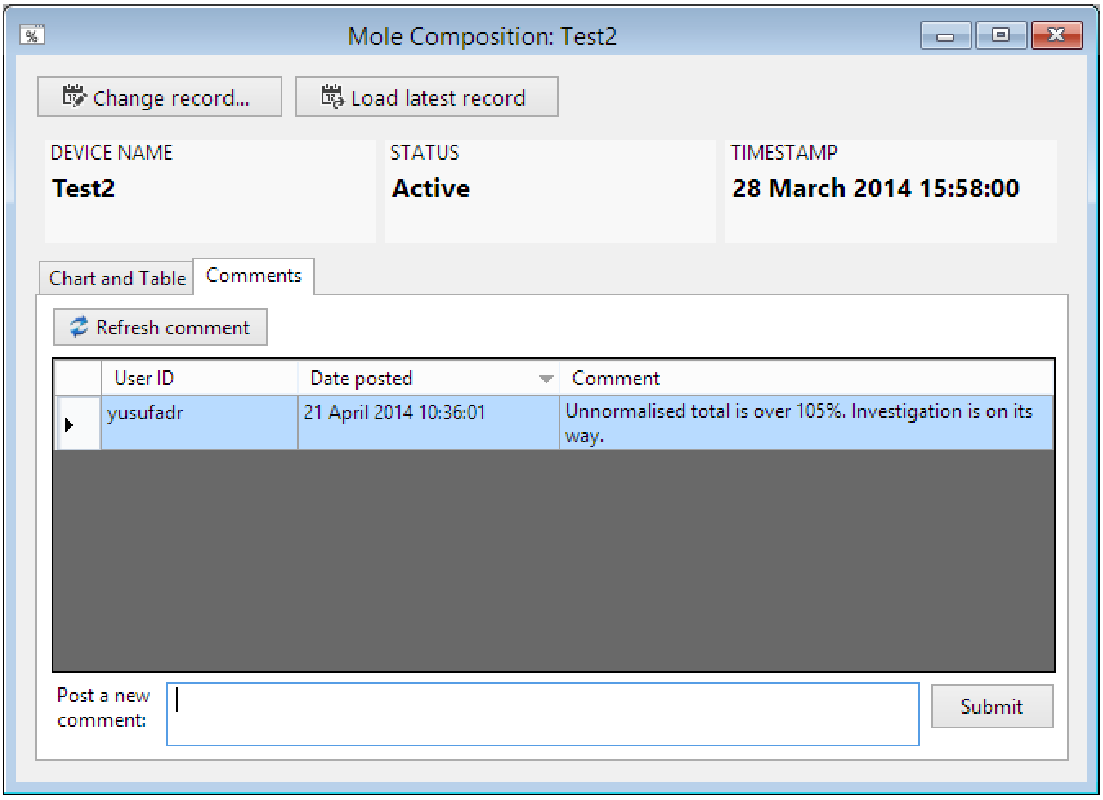
will become

```
The stream number of this record was changed from [ 1 ] to [ 2 ] at 19 May 2016
16:55:00.
```

depending on the new stream number and your current computer clock. Ultimately, click **OK** to begin bulk operation.

8.8 Insert Comment

Like footprint and calibration records, users can also put comments on a mole composition record.



1. To insert comment, open the **Comments** tab or go to Action menu > **Add Comment**.
2. Write your comment on the text box at the lower section of the form, then click **Submit**.
3. Make sure the comment is correct (e.g. free from spelling errors) because once inserted into database, you will not be able to remove the comment.

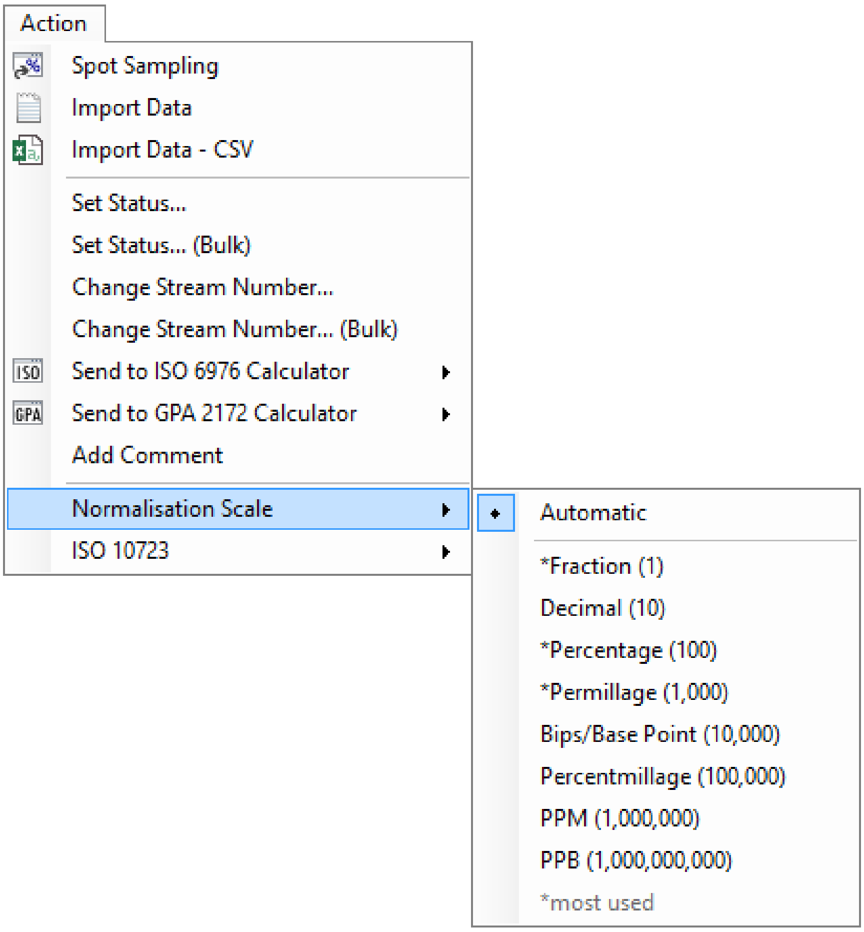
If you do not see the textbox and the Submit button, i.e. the comment grid fills up the entire form, your user account may not have action permission to write comments or your user role is *Read-only*. Contact your GCAS administrator.

8.9 Automatic or Fixed Scale

Early versions of GCAS worked with percentage scale only, but now it works with any scale up to parts per billion (PPB). GCAS automatically determines which scale to use according to the unnormalised total value. If the unnormalised total is around 100, then it is percentage. If it is around 1000, probably it is permillage (‰).

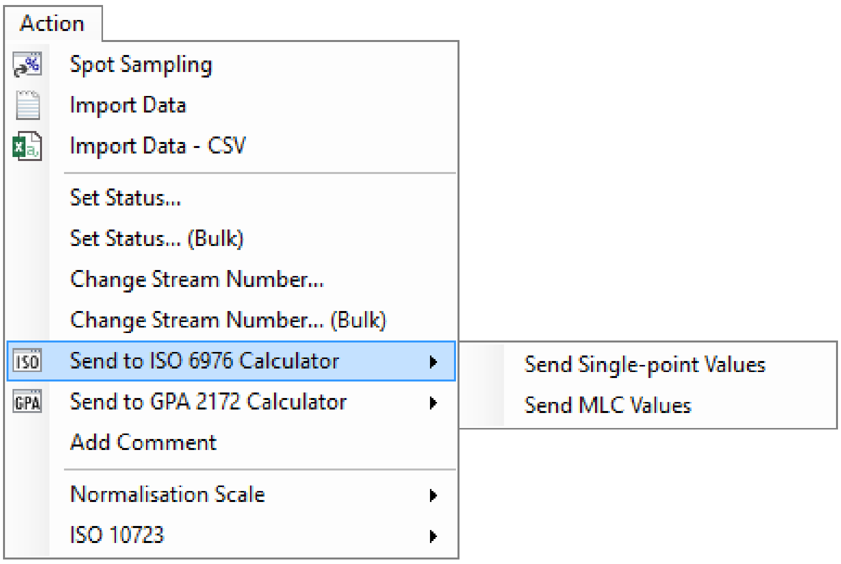
The automatic scale may not work as you expect. For example, a problem on the GC or the pipeline caused the unnormalised total to drop to 15%. This number is close to 10, therefore GCAS assumes the scale is decimal (0 to 10). You know the GC reads the composition in percentage scale, hence the decimal scale may hinder troubleshooting.

To override this automatic scaling, browse to the desired mole composition record then open the Action menu. Under **Normalisation Scale**, select which scale to use. Mole Composition form is now locked to the selected scale until it is closed.

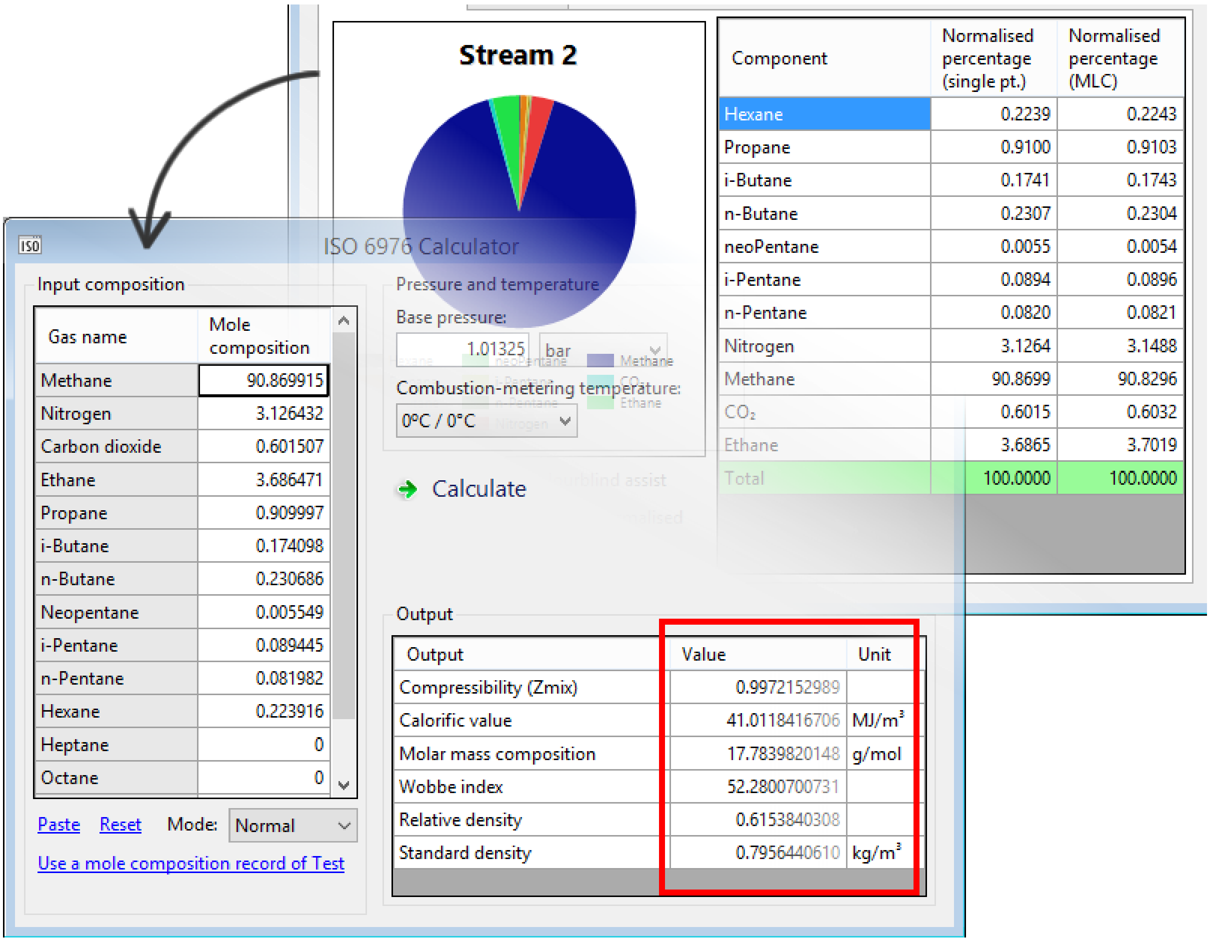


8.10 Send to ISO 6976 Calculator or GPA 2172 Calculator

Users whose GCAS licence includes GCAS feature *ISO 6976 Calculator* shall see an additional action menu called **Send to ISO 6976 Calculator**. This shortcut sends the mole composition record to ISO 6976 Calculator tool. It calculates the calorific value (CV) and other properties of this composition.



Users with *ISO 10723* feature included in their licences shall see two submenus. One will send normalised single-point composition, while the other will send normalised multilevel-calibrated composition. Users without *ISO 10723* see no submenus, as the menu itself will send normalised single-point composition. One exception is for ABB devices; you should see one additional submenu **Send Exponential Values**. This submenu grabs the normalised exponential composition and feeds it to ISO 6976 Calculator. For more information about ISO 6976 Calculator, visit chapter 20.



Sending mole composition record to GPA 2172 Calculator is very similar. Assuming you have *GPA 2172 Calculator* feature in your GCAS licence, open a Mole Composition form and browse to the desired record. In the Action menu, instead of selecting Send to ISO 6976 Calculator, you should choose **Send to GPA 2172 Calculator** instead. The submenus should be the same. You may choose to send normalised single-point compositions, normalised multilevel-calibrated compositions (requires *ISO 10723*), or normalised exponential composition (ABB devices only).

8.11 Multilevel-Calibrated MC (ISO 10723)

Multilevel-calibrated compositions exist because of multilevel calibrated response factor values. By taking MLC response factors, multiplying them with composition defined in the calibration certificate, and dividing them by original single-point compositions, you get MLC compositions.

Note

This feature requires *ISO 10723* feature in your GCAS licence.

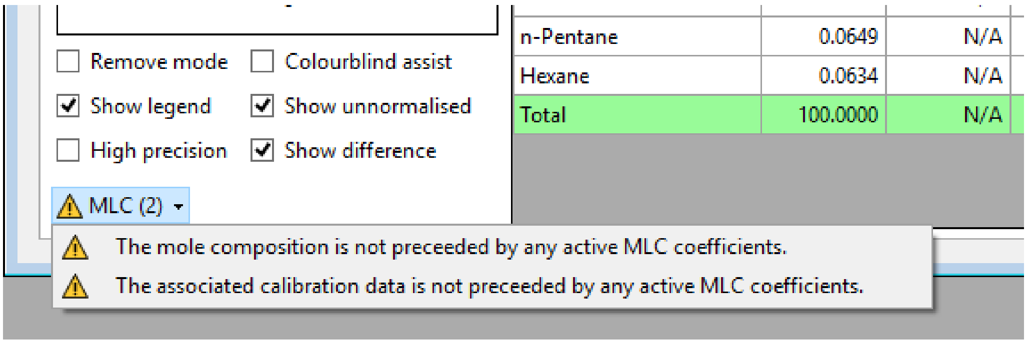
Users with *ISO 10723* feature included in their licences will see two columns when Mole Composition forms is loaded for the first time. First is normalised single-point composition, second is normalised MLC composition. Unlike multilevel-calibrated RF, multilevel-calibrated mole composition (MC) have values close to its single-point counterpart. The difference between single-point and MLC mole composition is usually called **bias**.

ISO 10723 conversion for mole composition requires:

1. A multilevel calibration (MLC) coefficient set installed before the timestamp of the mole composition record, and
2. An active, *MLC-convertible* calibration data or footprint before the timestamp of the mole composition record; which in turn requires:
3. A multilevel calibration (MLC) coefficient set installed before the timestamp of this footprint/calibration record, and finally
4. An active calibration gas certificate installed before the timestamp of this footprint/calibration record.

If one or more of these conditions are not met, the mole composition record is said to be *not convertible*. GCAS displays a ⚠ warning icon at the bottom of the form, under the pie chart, if:

1. One or more of the four conditions above are not fulfilled, or
2. The MLC coefficient set used by the mole composition record and coefficient set used by the preceding footprint/calibration data are different. This can happen if there is a new coefficient set installed between the timestamp of the calibration data and the timestamp of mole composition record.



Click on the warning icon to see the detailed reason why the record is not convertible. Some items on the warning dropdown are shortcuts. For example if it says the record is not preceded by any MLC coefficient sets, clicking on that item brings you the MLC Coefficients form in edit mode so you can enter the coefficients straight away.

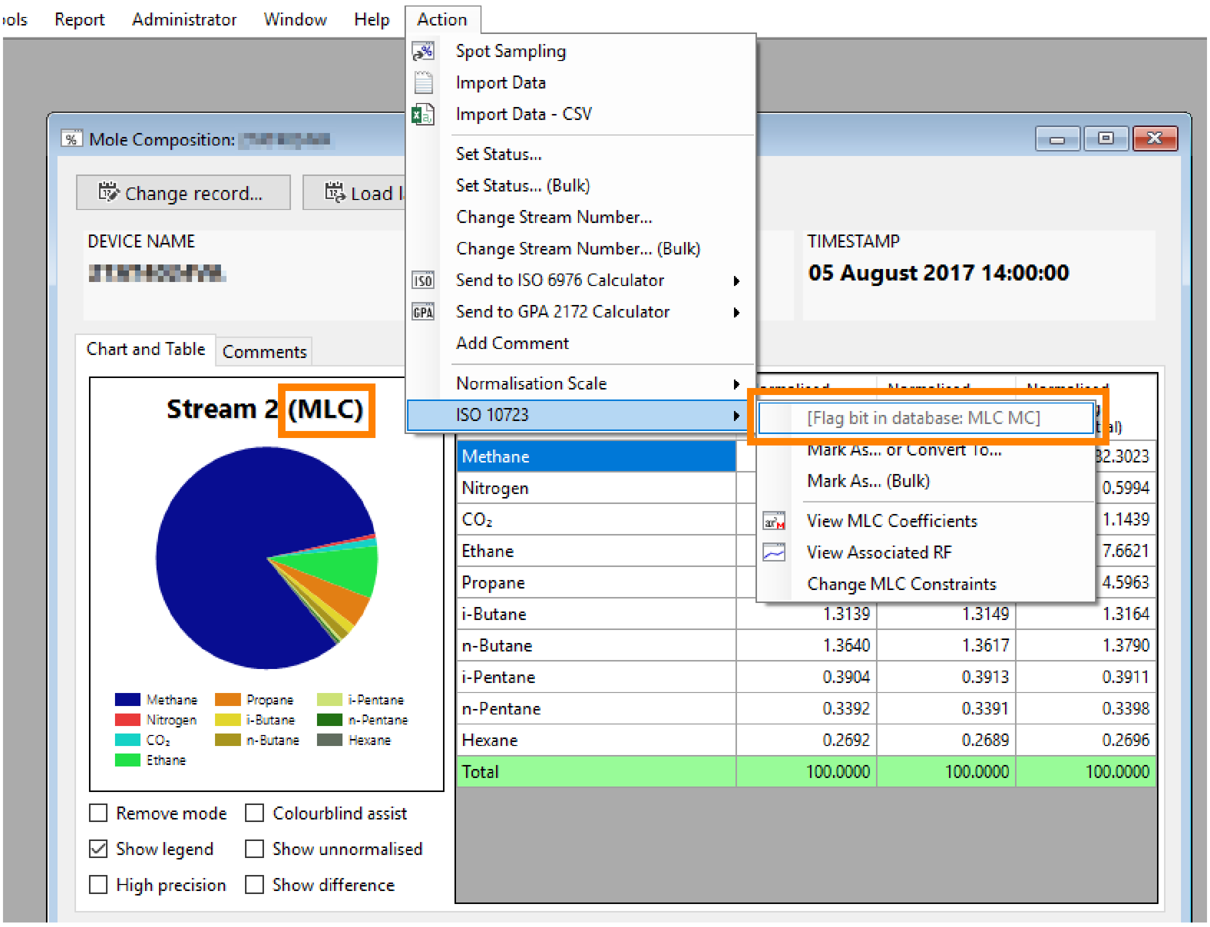
Non-convertible records display "N/A" in either single-point or MLC columns in both normalised and unnormalised, depending on its MLC flag bit. Records having flag bit marked as single-point which is not convertible into MLC will show "N/A" in MLC columns and vice versa. Additionally, the delta column (through *Show difference* check box) will be empty.

> **Note**
>
> Spot samples are never convertible. Spot samples are always marked as single-point compositions.

To see the MLC coefficients associated with current record, open the Action menu, select **ISO 10723**, then click **View MLC Coefficients**. This menu calls Multilevel Calibration Coefficients form and loads the correct coefficient set associated with current mole composition record. To see the calibration data or footprint which is used by current mole composition record, click **View Associated RF** in the same ISO 10723 menu.

8.11.1 MLC Flag Bit

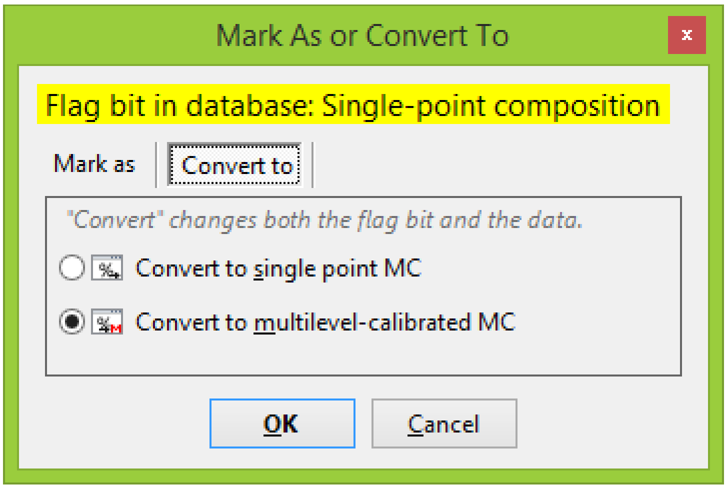
Similar to footprint and calibration data, all mole composition records have MLC flag bit to indicate whether it is single-point or multilevel-calibrated. The easiest way to see MLC flag bit is to look at the title of pie chart. It says the stream number, for example "`Stream 2`", and if the MLC flag bit is multilevel-calibrated then the title appends " `(MLC)` " after stream number. If there is no other text, then it is single-point. Alternatively, open the Action menu and select **ISO 10723**. The first submenu is not clickable but it states the MLC flag bit.



You can change MLC flag bit if necessary, however do this with caution. Because single-point compositions and MLC compositions are similar in values unlike single-point RF versus MLC RF which are completely different, it is easy to mistake which composition is single-point or MLC.

8.11.2 Mark As versus Convert To

Open Action menu, select **ISO 10723**, then select **Mark As... or Convert To...** and GCAS shows this dialogue box.



Current flag bit is highlighted in yellow to clarify what the bit value is. Next, decide whether you need to *mark* the flag bit or *convert* the whole record.

Mark As changes the flag bit only. The original numbers of all mole values are untouched. By contrast, **Convert To** changes the flag bit *and* converts all mole values, thus changing the actual numbers stored in database. Permanently.

Mark As operation requires an action permission called "change MLC flag bit". On the other hand, *Convert To* operation requires "change MLC flag bit" plus one additional action permission called “MLC permanent conversion”. Had your GCAS administrator not granted you this permission, GCAS displays a message saying that you don’t have sufficient permission to perform conversion when you select *Convert To* in this dialogue box.

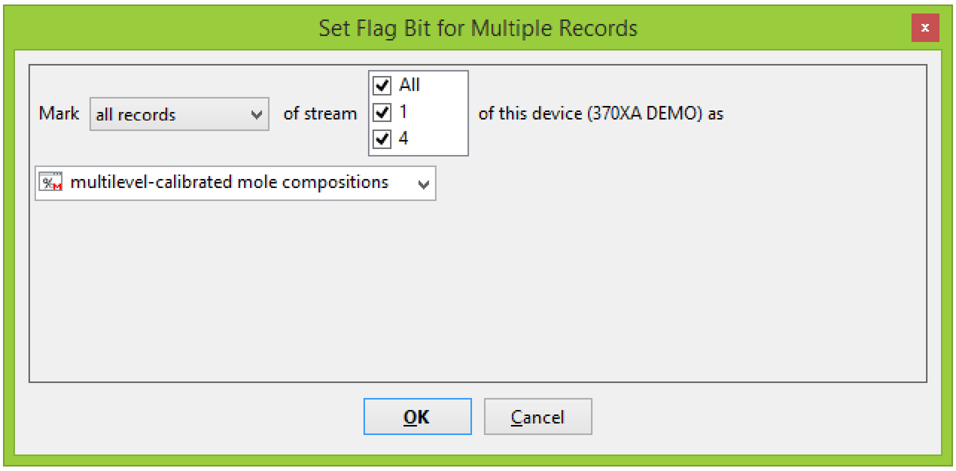
Important

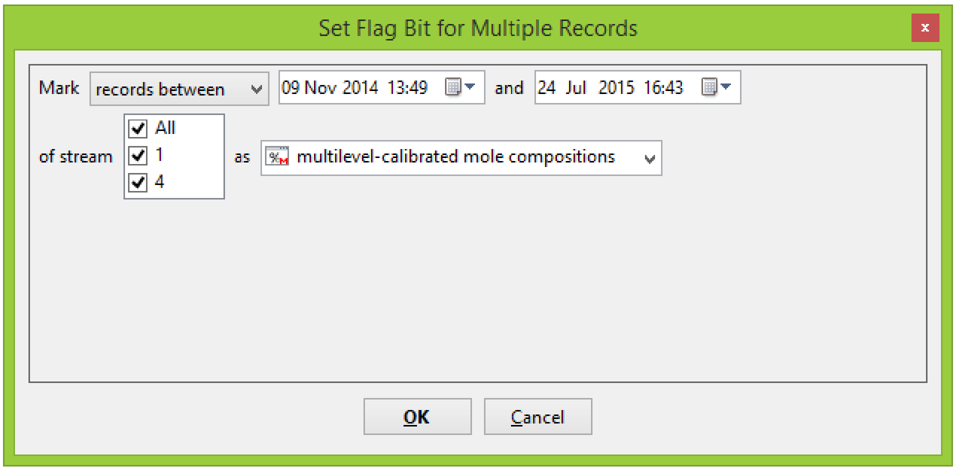
Be extra cautious when using *Convert To*. Performing permanent conversions on wrong record will damage the record permanently. Furthermore because single-point compositions and MLC compositions are similar in terms of numeric values, always double or triple check before using *Convert To*.

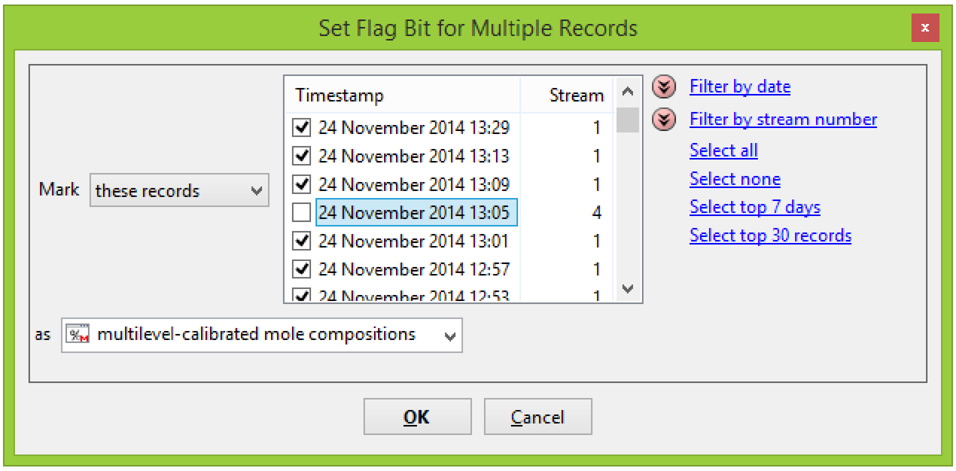
8.11.3 Change MLC Flag Bit (Multiple Records)

Chapter 8.11.2 explained how to change flag bit for one record. Mole composition records usually come from data capture operation, thus you may need to change flag bit of tens or even hundreds of records. To save your time, open the Action menu, select **ISO 10723** and then click **Mark As... (Bulk)**.

The dialogue box is slightly different from [*Set Flag Bit for Multiple Records* dialogue belonged to footprint and calibration data]. The *Set Flag Bit for Multiple Records* dialogue for mole compositions lets you filter by stream number, and later (optionally) by date or specific selections of records.



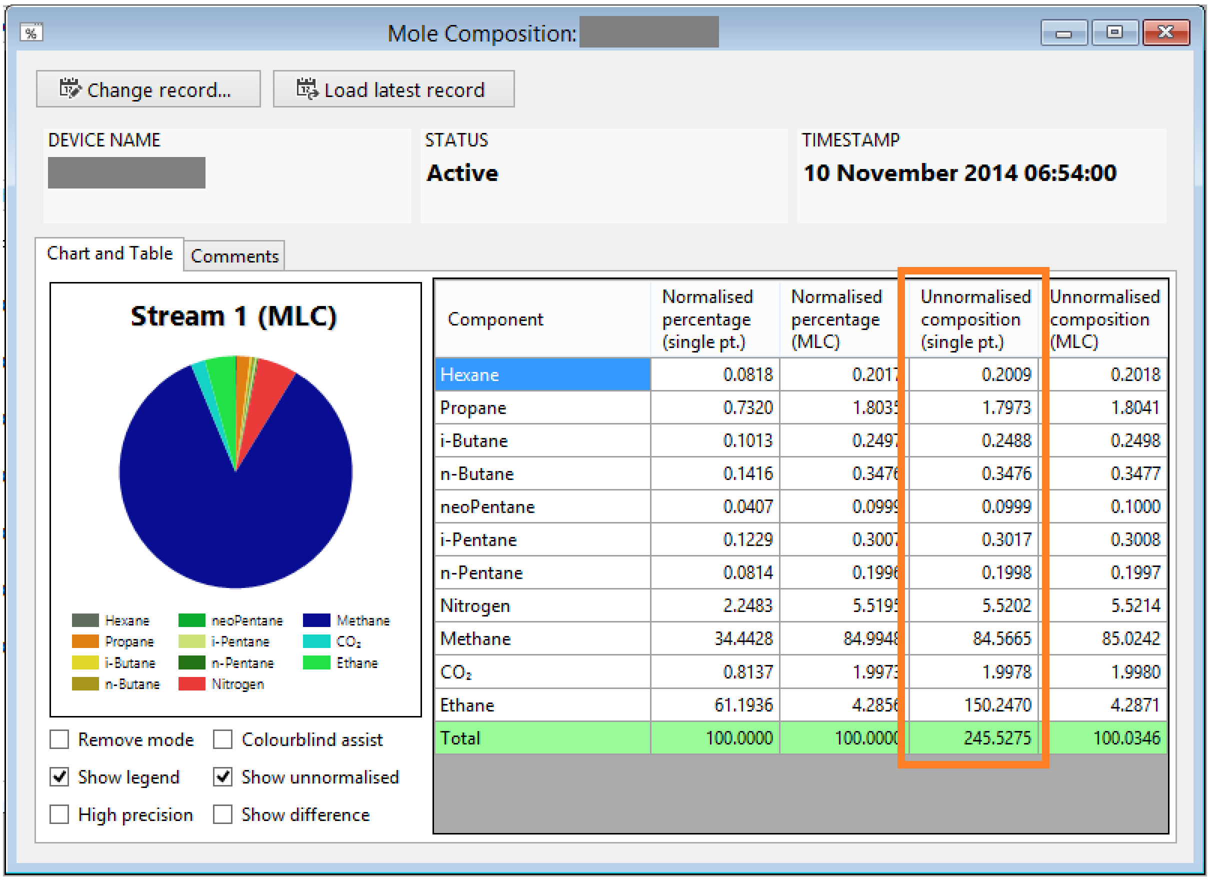




Note
There is no *Convert To* feature for bulk operation because it may damage multiple records.

8.11.4 MLC Constraints

We moved the explanation about concepts and application of MLC constraints to chapter 24.2. Most of the time, users need not to worry about MLC constraints. However, there is a slim chance the default MLC constraints generates silly unnormalised total such as in the screenshot below. The ethane exceeds 150% which is nonsense. In those rare cases, you may need to override the MLC constraints in order to get the correct result. Read more on chapter 24.2 about MLC constraints.



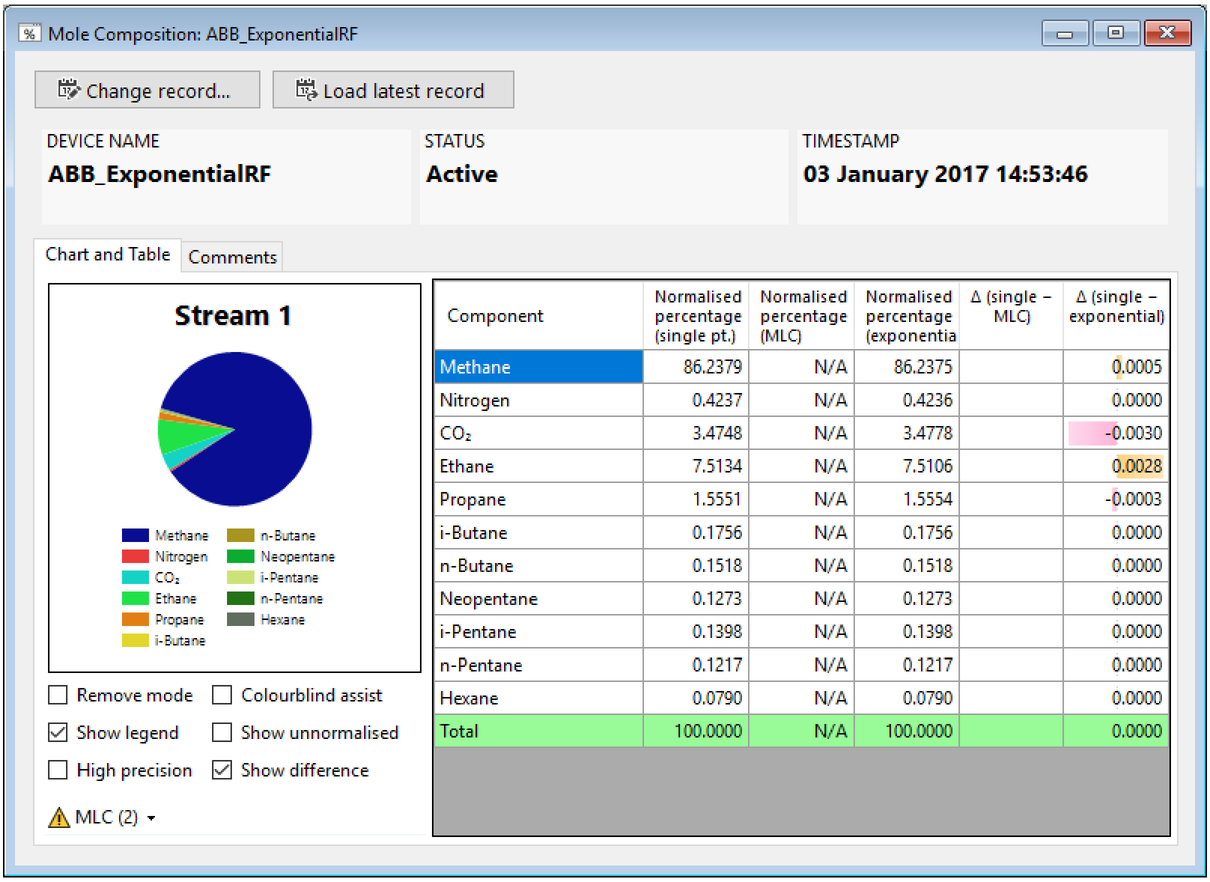
8.12 Exponential Composition

This chapter is specific for ABB devices only. If you have GC devices of other brands, skip ahead.

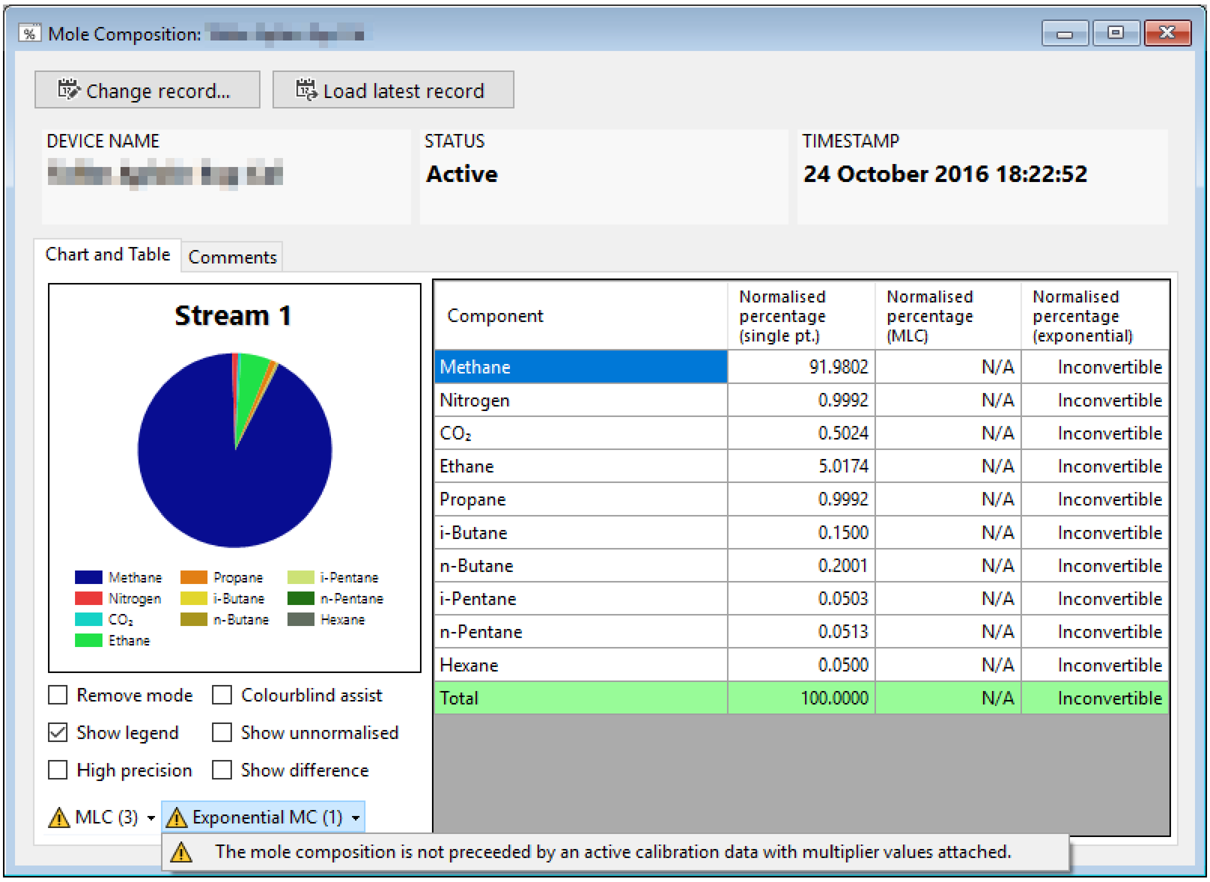
Chapter 7.13 Exponential RF has explained about exponential response factor and the need of *multipliers* (M). To make things more complicated, ABB devices that are configured to output exponential RF will also output exponential mole composition.

Although the name "exponential" may put some imagination that the values will skyrocket exponentially, in reality exponential composition values more-or-less look like multilevel-calibrated composition. The values are close to the single-point composition, differing by a thin bias. The name "exponential" comes from the formula behind the screen that involves exponential function (e^x). Once again, this formula is proprietary of ABB.

The Mole Composition form looks different on ABB devices. It includes additional column to display exponential composition straight away. In addition, there are two delta columns—one is the difference between single-point and multilevel-calibrated composition, while the other is the difference between single-point and exponential composition. The delta column for single-point minus MLC is not available for users without *ISO 10723* feature on their licences.



In the screenshot example above, the multilevel-calibrated column just shows "N/A" because this demo device does not have MLC coefficients in the database. ABB devices can have MLC coefficients too just like any other devices, therefore it is possible for all three columns display data. On another occasion, you may see the exponential column contains the word "`Inconvertible`" like the screenshot on the next page.



Check the **Exponential MC** warning at the bottom-left of the form to see why the single-point composition could not be converted to exponential. Usually the cause is missing multiplier values on the preceding calibration record. Click on that warning to open Calibration Data form on the said calibration record, then open Action menu and select **View Multiplier Values**, and finally follow chapter 7.13.3 to add multipliers.

9 Calibration Gas Certificate

Calibration gas certificate is a record of composition and uncertainty of a certified calibration gas package. These certificates usually come as a papers (hardcopies) or labels attached to the gas tank or canister. Calibration certificate module is required by Uncertainty Calculation module and is also used in ISO 10723 conversion.

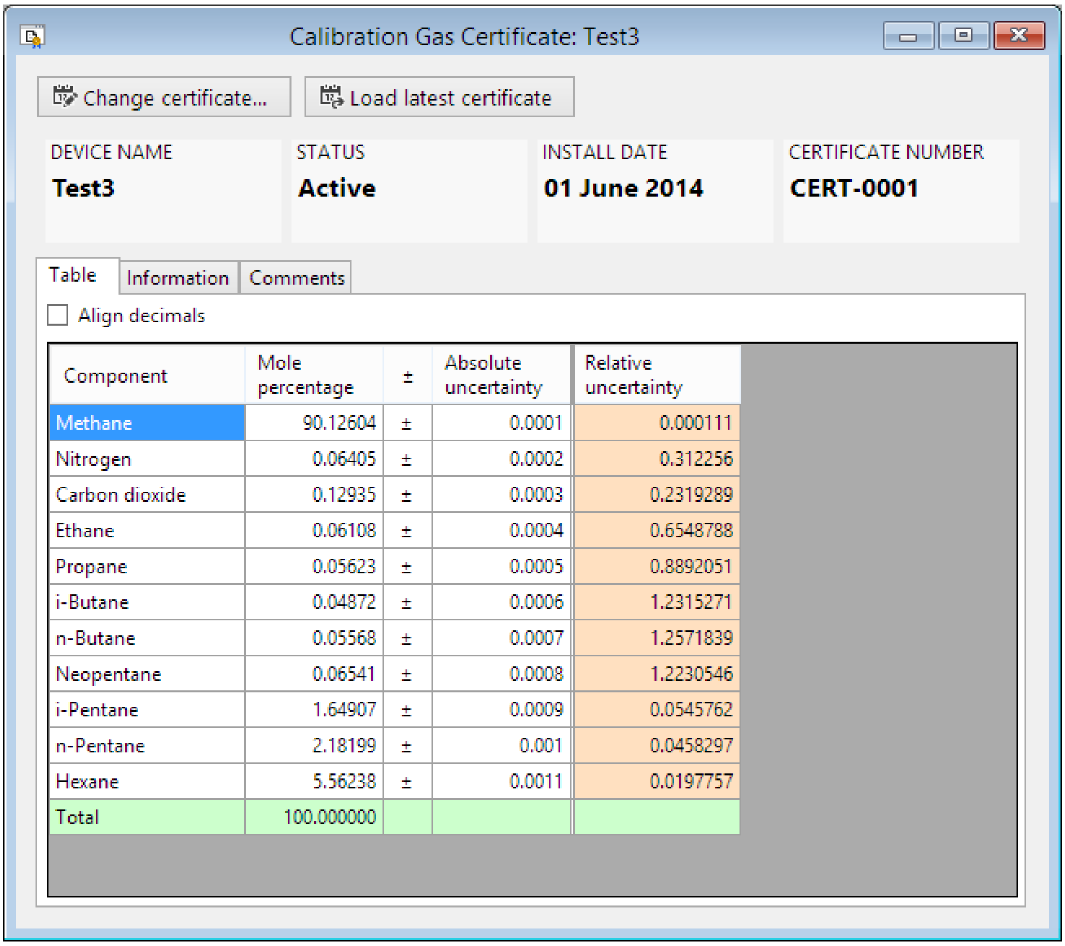
Note

To use Calibration Gas Certificate module, you need GCAS feature either *Calibration Gas Certificate* or *Uncertainty Calculation*, or *Uncertainty Trend* to be included in your licence.

GCAS feature *Calibration Gas Certificate* is given to customers who'd like to unlock Calibration Gas Certificate module but do not want the full Uncertainty Calculation module. If you purchased *Uncertainty Calculation* feature or *Uncertainty Trend*, you have access to Calibration Gas Certificate module automatically.

9.1 The Calibration Gas Certificate Form

Calibration Gas Certificate form displays the content of a calibration certificate and its properties. To open Calibration Gas Certificate form, select a device on your device panel and go to the View menu > **Calibration Certificate**.



Calibration Gas Certificate: Test3

Change certificate... | Load latest certificate

DEVICE NAME	STATUS	INSTALL DATE	CERTIFICATE NUMBER
Test3	**Active**	**01 June 2014**	**CERT-0001**

Table | Information | Comments

Align decimals

Component	Mole percentage	±	Absolute uncertainty	Relative uncertainty
Methane	90.12604	±	0.0001	0.000111
Nitrogen	0.06405	±	0.0002	0.312256
Carbon dioxide	0.12935	±	0.0003	0.2319289
Ethane	0.06108	±	0.0004	0.6548788
Propane	0.05623	±	0.0005	0.8892051
i-Butane	0.04872	±	0.0006	1.2315271
n-Butane	0.05568	±	0.0007	1.2571839
Neopentane	0.06541	±	0.0008	1.2230546
i-Pentane	1.64907	±	0.0009	0.0545762
n-Pentane	2.18199	±	0.001	0.0458297
Hexane	5.56238	±	0.0011	0.0197757
Total	100.000000			

Calibration Gas Certificate form. Data in this screenshot is fictional, for illustration purpose only.

First tab is called **Table**; here you see all mole percentage values and their corresponding *absolute* uncertainty (as written on your paper certificate). It also shows the *relative* uncertainty which is calculated from your absolute uncertainty. This relative uncertainty is calculated at the *k* value (coverage factor) that is embedded in the certificate record in GCAS database. To find out what is the *k* value for this record, switch to the second tab. Relative uncertainty (also known as $\mathbf{U}_{\text{cal gas}}$) is a part of uncertainty calculation.

Second tab is **Information** where other properties of the certificate is listed. Third tab is **Comments**, which like the other forms in GCAS, displays user comments for the certificate.

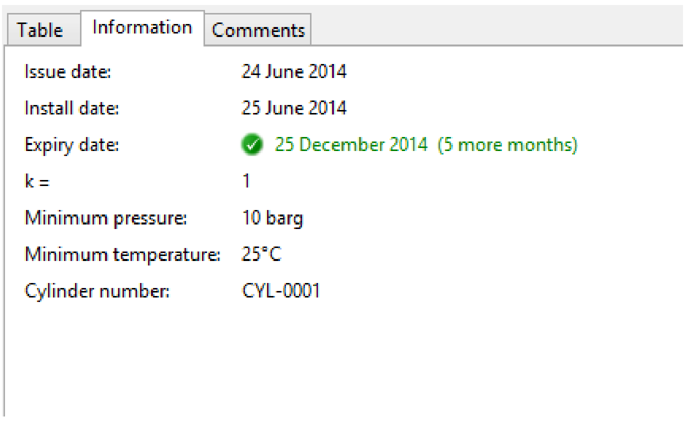


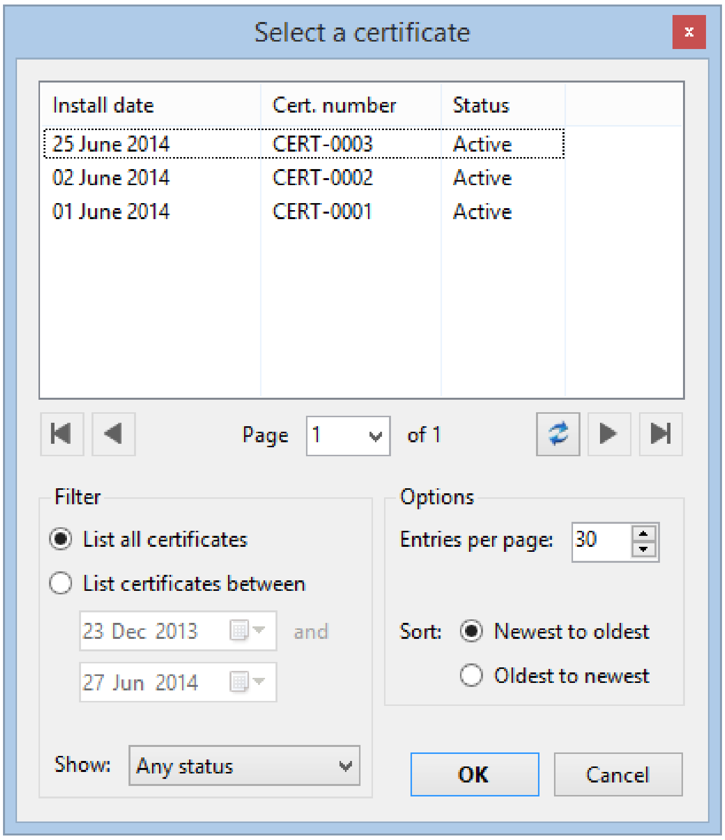
Table | Information | Comments

Issue date:	24 June 2014
Install date:	25 June 2014
Expiry date:	25 December 2014 (5 more months)
k =	1
Minimum pressure:	10 barg
Minimum temperature:	25°C
Cylinder number:	CYL-0001

The "Information" tab. Data is fictional.

9.2 View Previous Certificates

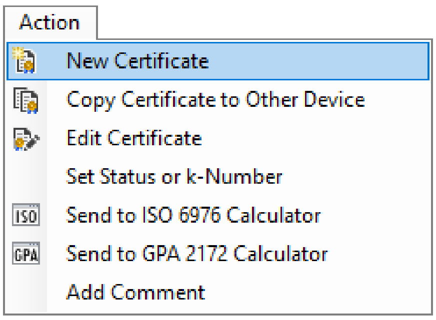
To view other calibration certificates, Click **Change certificate**. Select a different certificate, then click **OK** or double click the list item.



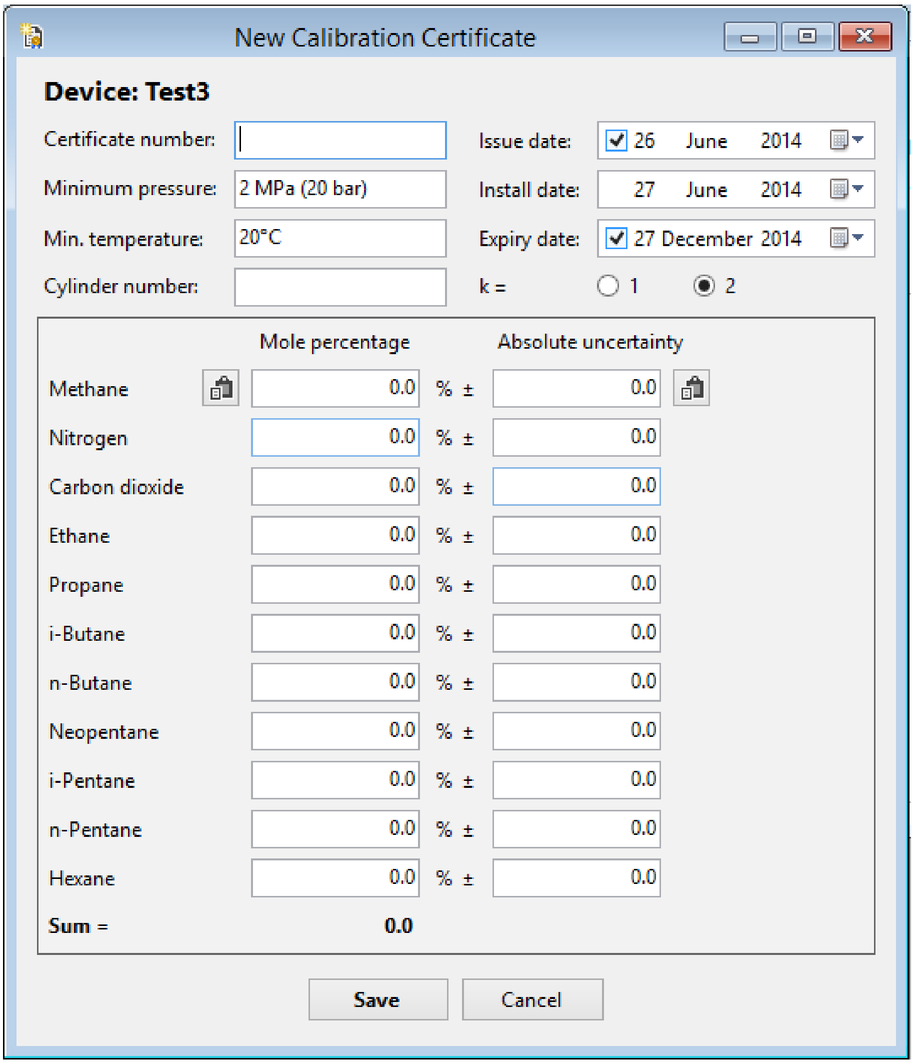
Click **Load latest certificate** to return to the most up-to-date certificate.

9.3 Input a New Certificate

As calibration certificates come as hardcopies, you need to enter the mole percentage and uncertainty values meticulously by hand. Open the Action menu and select **New Certificate**. If you do not see this menu, you may not have the action permission for it. Contact your GCAS Administrator.



The *New Calibration Certificate* entry form shall appear. Begin by entering certificate properties such as certificate number, issue date, install date, expiry date, minimum storage and/or usage pressure, minimum storage and/or usage temperature, cylinder/gas tank/canister serial number, and the *k* value (coverage factor).



Afterwards, enter the mole percentage and absolute uncertainty value of each gas in the certificate. Be alert for potential human error while typing. When you are confident with all entries, click **Save** to save the certificate record into database.

Note

Certificate number, *k* number (coverage factor) and install date must be specified. Other properties can have blank or null data. Typically, the next calibration cycle after the certificate install date is flagged as a footprint.

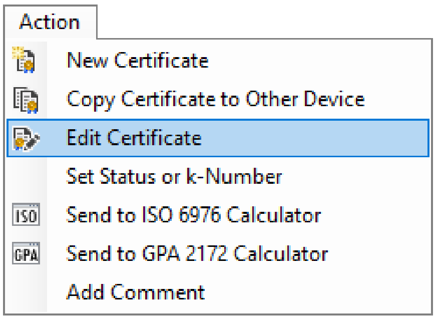
If the certificate does not specify minimum storage/usage pressure and temperature, set them blank. If the cylinder number is not available, leave it blank too. If there is no info about issue date and expiry date, untick the corresponding check box inside the date picker.

Unlike Mole Composition module which recognises any scale, calibration gas certificate must be expressed in percentage. *This rule also applies to BTEX devices and single gas analysers.*

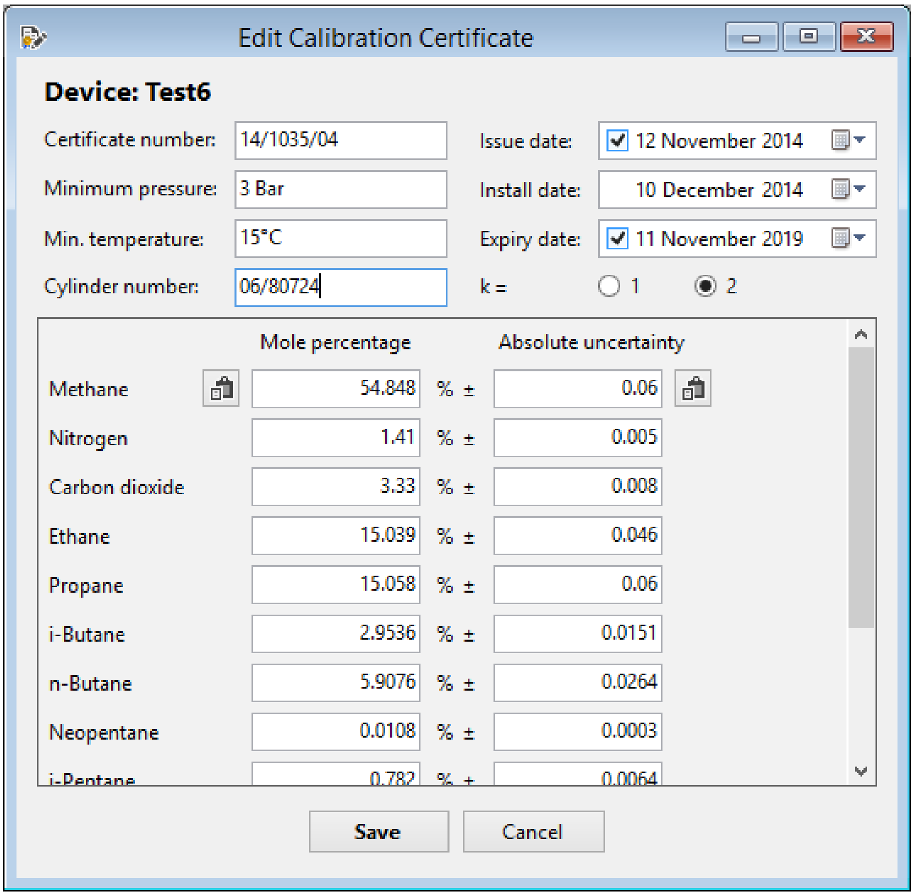
Like any other text box series in GCAS interface, you can paste numbers from Microsoft Excel or other spreadsheet processing software. Press `Ctrl+V` inside the **first text box** and the rest will follow. Alternatively, click **Paste**.

9.4 Edit a Certificate

Sometimes human errors happen. If you did a mistake when entering numbers in the previous chapter, go to the Action menu and select **Edit Certificate**. If you do not see this menu, you may not have the action permission for it. Contact your GCAS Administrator.



This menu brings forth *Edit Calibration Certificate* form which is the same form as *New Calibration Certificate* but its function now is to correct mistakes in the numbers. Correct every wrong value and then click **Save**.

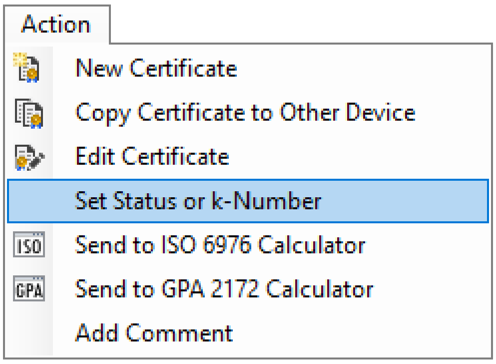


Although you can use *Edit Calibration Certificate* form to change the certificate install date, this can trigger unwanted side effect. If another certificate has already existed on the same date, GCAS will use whichever stored first in the database.

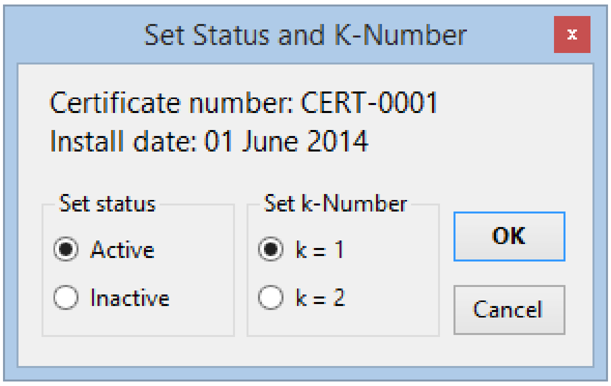
9.5 Change Certificate Status

Every certificate record has a status bit indicating whether the certificate is active or inactive. GCAS will not use inactive certificates in uncertainty calculation and ISO 10723 conversion.

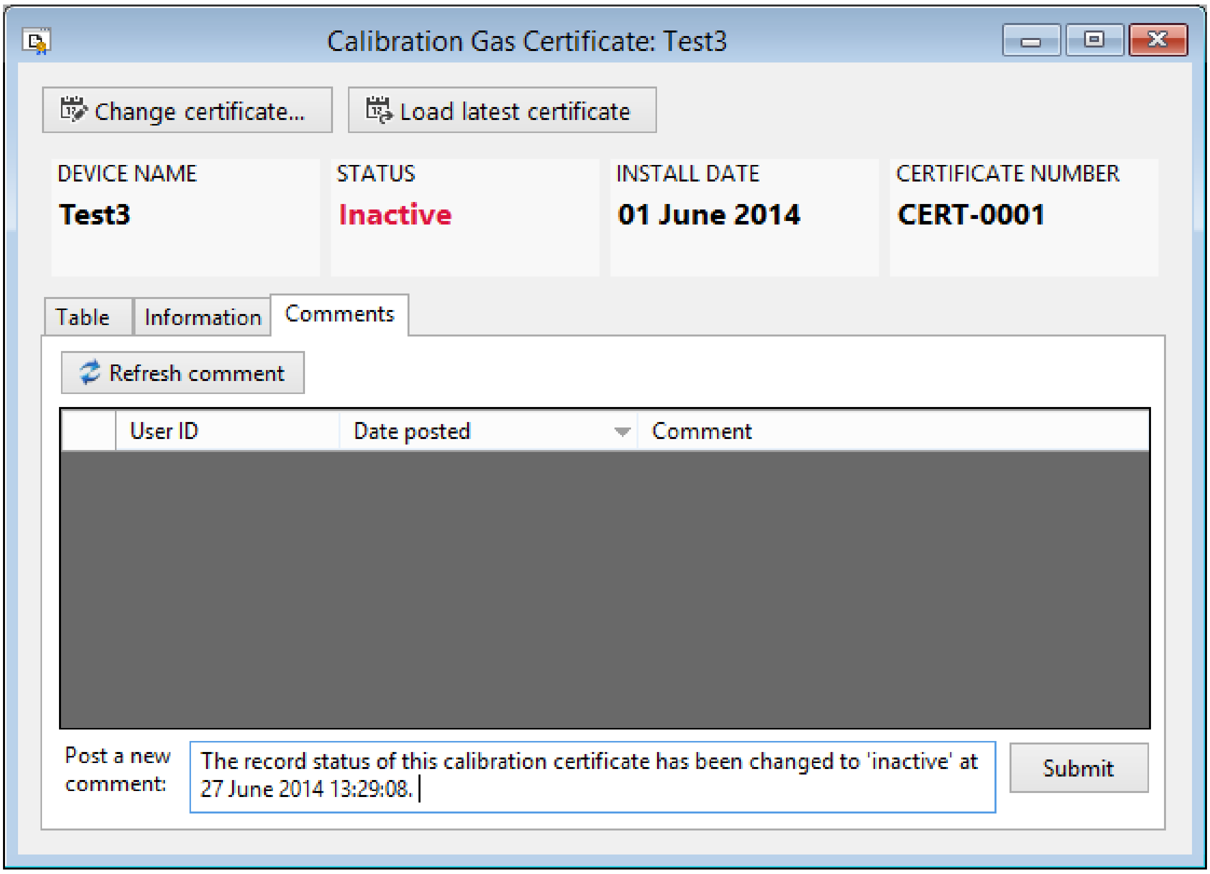
To change certificate status, open the Action menu and select **Set Status or k-Number**. If you do not see this menu, your GCAS user account does not have action permission for it.



This menu brings forth the *Set Status and k-Number* dialogue where you can flip records status from active to inactive or the other way round.

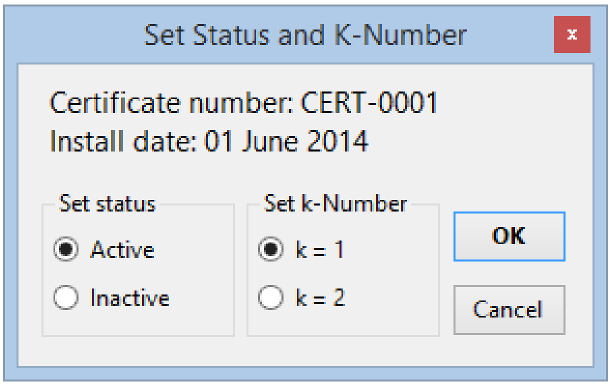


After you change the status, Calibration Gas Certificate form will reload the record and displays the new status at the top region of the form. It also switches to *Comments* and asks you to write a comment of why the status was changed. Comments tab does not open in case your GCAS user account doesn't have action permission to post comments.



9.6 Change *k* Number (Coverage Factor)

Use the same Action menu as the previous chapter, **Set Status or k-Number**. This menu calls the *Set Status and k-Number* dialogue, then go choose a new *k* value.



After you click **OK**, the form reloads the certificate and recalculates absolute uncertainty values according to the new coverage factor.

Component	Mole percentage	±	Absolute uncertainty
Methane	90.12604	±	0.0001
Nitrogen	0.06405	±	0.0002
Carbon dioxide	0.12935	±	0.0003
Ethane	0.06108	±	0.0004
Propane	0.05623	±	0.0005
i-Butane	0.04872	±	0.0006
Methane	0.05568	±	0.0007
Neopentane	0.06541	±	0.0008
i-Pentane	1.64907	±	0.0009
n-Pentane	2.18199	±	0.0010
Hexane	5.56238	±	0.0011
Total	100.00000		

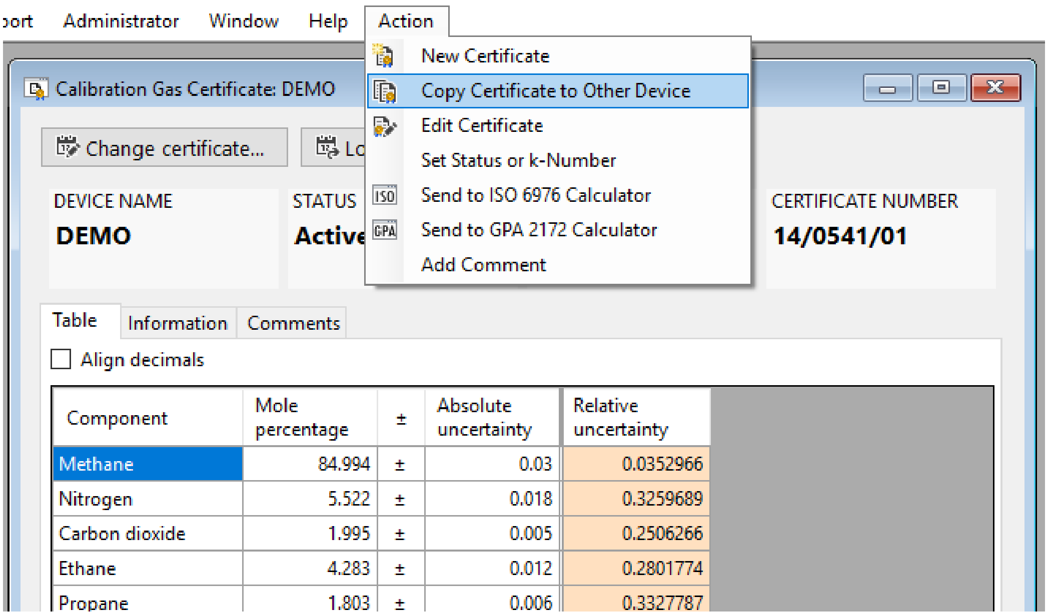
Component	Mole percentage	±	Absolute uncertainty
Methane	90.12604	±	0.0002
Nitrogen	0.06405	±	0.0004
Carbon dioxide	0.12935	±	0.0006
Ethane	0.06108	±	0.0008
Propane	0.05623	±	0.0010
i-Butane	0.04872	±	0.0012
Methane	0.05568	±	0.0014
Neopentane	0.06541	±	0.0016
i-Pentane	1.64907	±	0.0018
n-Pentane	2.18199	±	0.0020
Hexane	5.56238	±	0.0022
Total	100.00000		

Calibration certificate on k = 1 (left) and k = 2 (right). Data is fictional.

9.7 Copy/Share Certificate to Other Devices

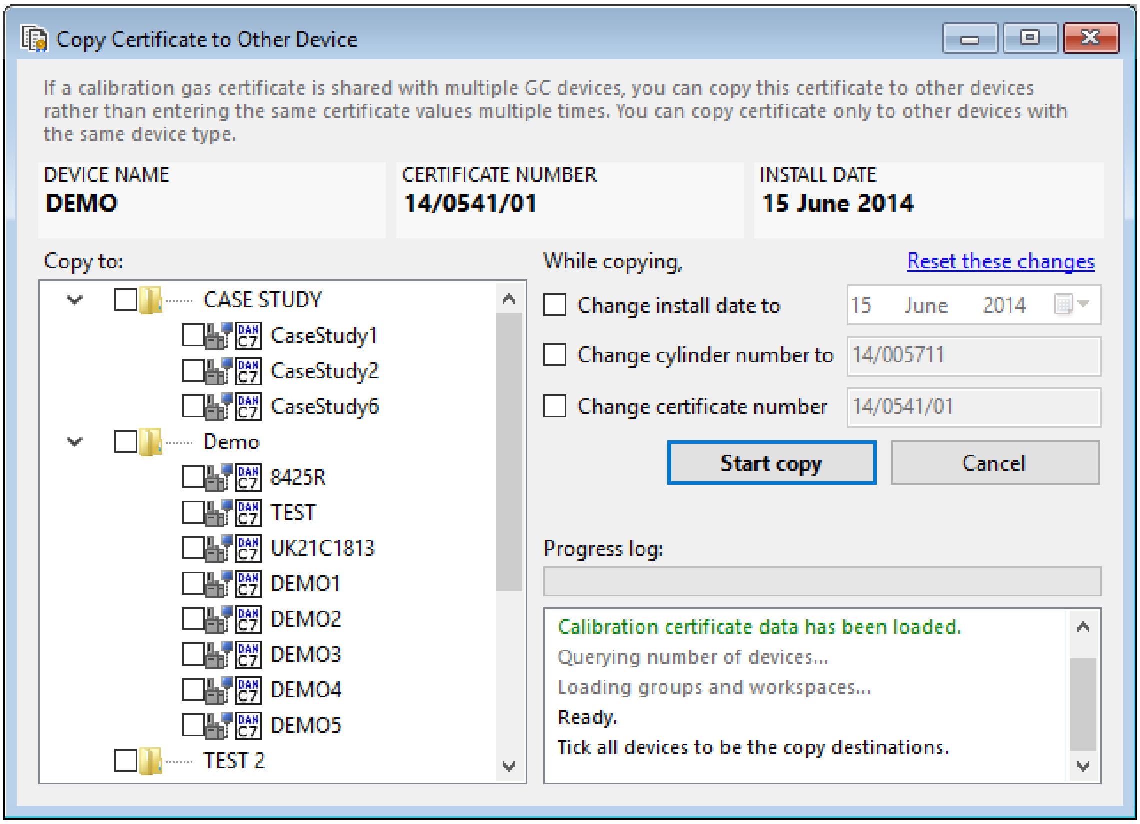
A calibration gas certificate may be used by two or more GC devices. Before GCAS version 1.9.0.0, the only way to share a certificate is by going to New Certificate menu then enter the numbers on each device repetitively. Those days were over as we have Copy Certificate tool now.

In order to copy certificate, first you need to open the source calibration certificate. Select the GC device on your device panel and go to View menu > **Calibration Gas Certificate**. Navigate to the certificate you want to copy. Next, open the Action menu > **Copy Certificate to Other Devices**.



Copying certificate uses the same action permission as creating new certificate. If your GCAS user account can input a new certificate, you can copy existing certificate as well.

That menu brings *Copy Certificate to Other Device* dialogue. Please allow a few moments as it loads all GC devices accessible to your account. Once it's done, tick the target device you want to copy this certificate to. Tick as many devices as required. The calibration certificate is copied to all ticked devices. Finally, click **Start copy**. Copy progress is displayed on the progress log box.



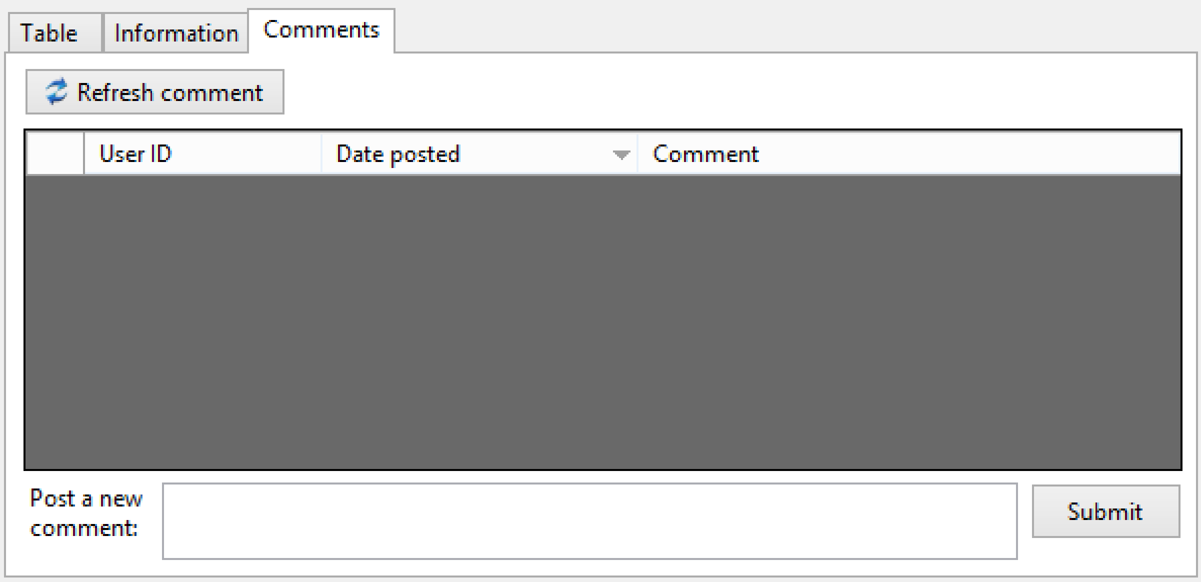
Note

You can copy certificate only to devices having the same device type. Reason for this is because other device types may not have the same gases as the source device, like neopentane or benzene for example. In the screenshot above, the source certificate is used by a Daniel C7+ complete device. Thus, the tree view on this window displays just Daniel C7+ complete devices. Other device types are excluded.

You have the option to change the certificate number, install date, and cylinder number if required. Check the corresponding property to enable the text box or date picker, then change the property value before you click **Start copy**.

9.8 Insert Comment

If you need to put notes or other properties that were not supported by New Calibration Certificate form, post them in comments.

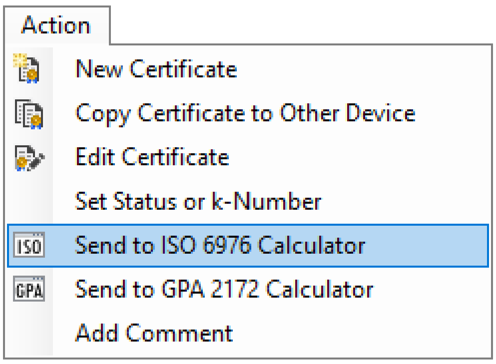


1. Open the **Comments** tab or go to Action menu > **Add Comment**.
2. Write your comment on the text box at the lower section of the form, then click **Submit**.
3. Make sure the comment is correct (e.g. free from spelling errors) because once inserted into database, you will not be able to remove the comment.

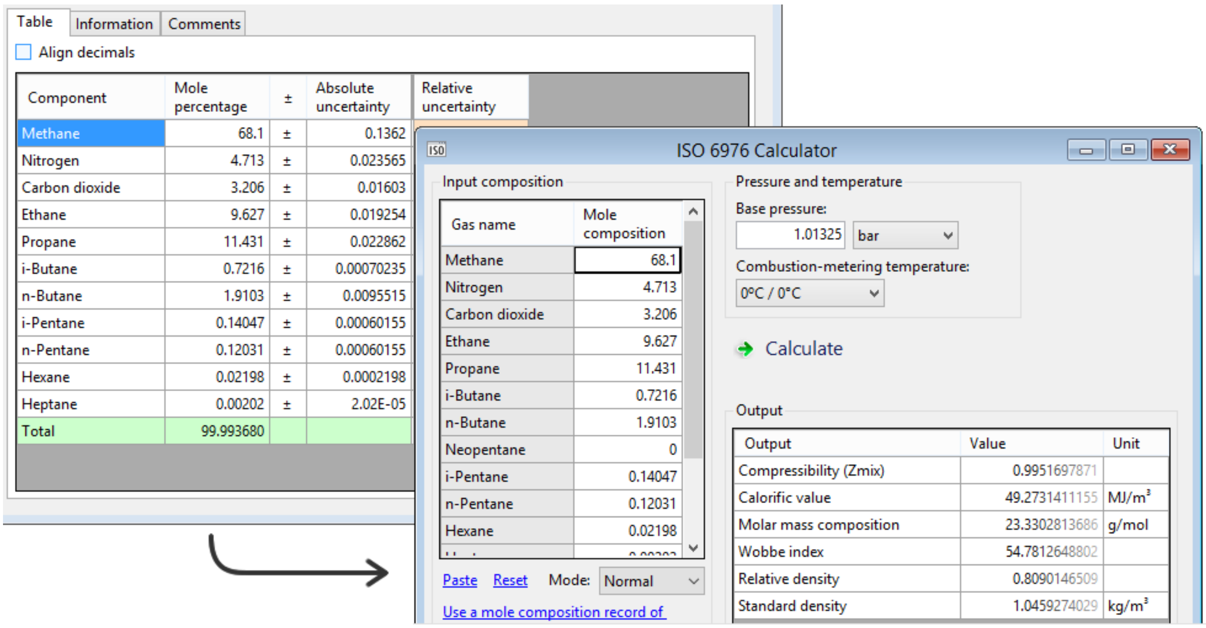
If you do not see the textbox and the Submit button, i.e. the comment grid fills up the entire form, your user account may not have action permission to write comments or your user role is *Read-only*. Contact your GCAS administrator.

9.9 Send to ISO 6976 Calculator or GPA 2172 Calculator

Although this feature is rarely used, calibration certificates *do* have mole composition. This means GCAS can calculate the calorific value and other properties of a calibration gas composition. Users whose GCAS licence includes GCAS feature *ISO 6976 Calculator* shall see an additional action menu **Send to ISO 6976 Calculator**. Users with *GPA 2172 Calculator* feature also see action menu **Send to GPA 2172 Calculator**.



Similar to Send to ISO 6976 Calculator menu on mole composition, this menu sends the mole composition part of the calibration certificate to ISO 6976 Calculator tool. Then it calculates the calorific value (CV) and other properties automatically.



The same can be applied for GPA 2172 calculation too. On the action menu, select **Send to GPA 2172 Calculator**.

10 Data Analysis

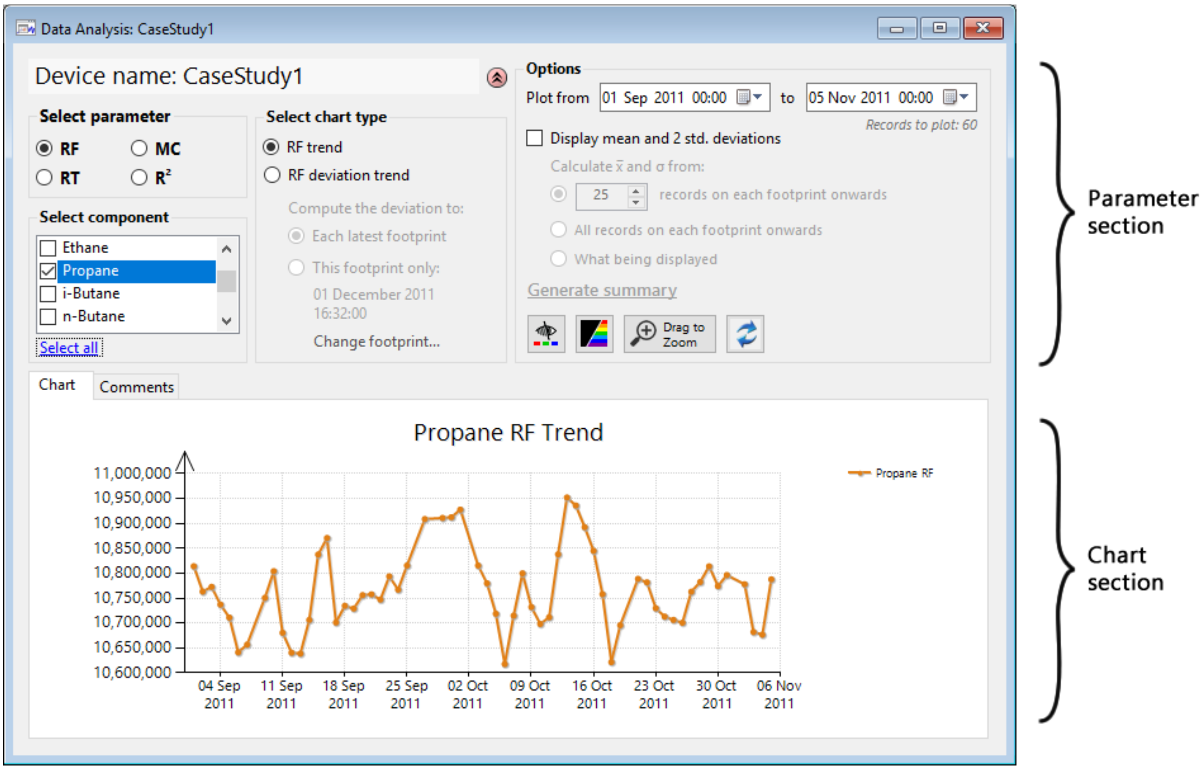
Data Analysis is a tool to see trend of GC parameters over time in history.

> **Note**
>
> This module requires GCAS feature *Data Analysis* to be included in your GCAS licence.

Data Analysis works for one device as it displays trends of various data for one device. The complement of Data Analysis is called *Data Comparison*, which consists of several modules and one of them is Mole Composition Comparison.

10.1 The Data Analysis Form

Select the desired GC device on the device panel, then go to the View menu > **Data Analysis**. The form consists of three sections: parameters, chart, and comments.

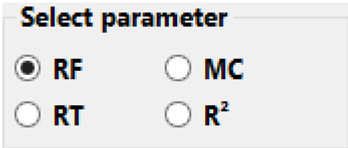


Parameters section at the top is where you set everything in order to get the chart you want. **Chart** section at the bottom graphs the chart. **Comments** tab is the place to write your comment.

10.2 Parameters, Chart Types, and Components

This chapter explains the contents of the **parameter** section of Data Analysis form.

10.2.1 Parameters



This is the main switch to select which parameter to be graphed on the chart. Users can graph the following parameters:

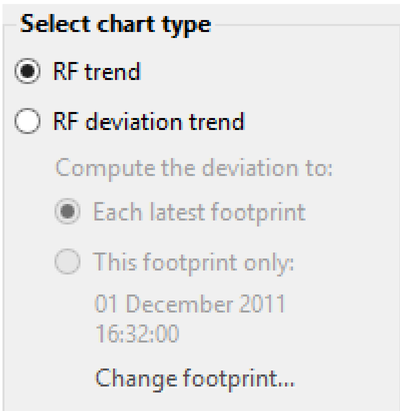
1. **RF** - Response factor
2. **RT** - Retention time
3. **MC** – Mole composition
4. **R^2** - Correlation parameter

If you see the **MC** (mole composition) option is disabled, it means you do not have *Live Data Analysis* feature in your GCAS licence.

10.2.2 Chart Types

Chart Types are more specialised options for the selected parameter. Available chart types vary, depending on the selected parameter.

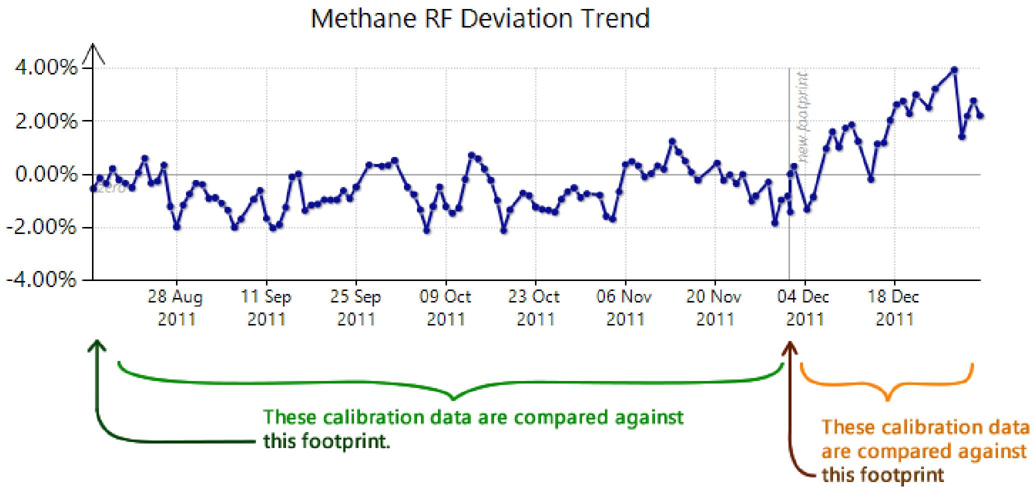
10.2.2.1 Selected parameter: RF (response factor)



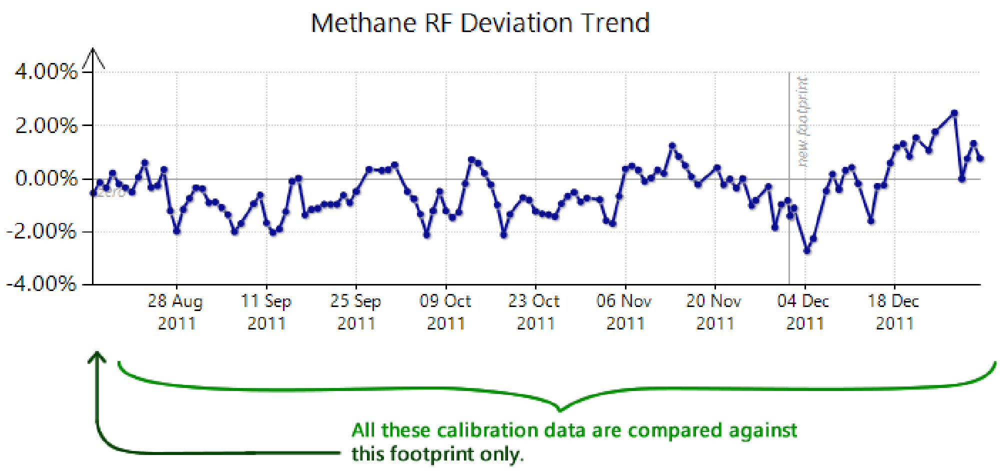
These options show up when the selected parameter is **response factor** (RF).

1. **RF trend** graphs the **actual** response factor values over time in history.
2. **RF deviation trend** graphs the **deviation** (difference) of RF values against footprints in percentage. This gives further options which are:

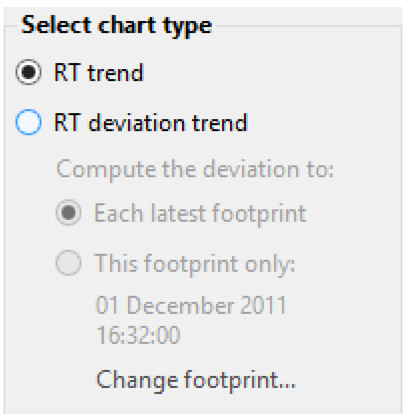
- **Each latest footprint**: Each RF value is compared against its latest footprint.



- **This footprint only**: All RF values are compared against a particular footprint value. The footprint to set as the comparison base is configurable through **Change footprint** link.



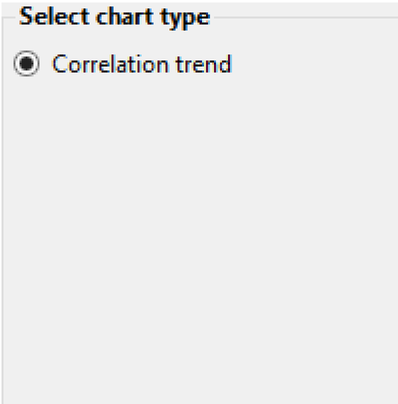
10.2.2.2 Selected parameter: RT (retention time)



These options show up when the selected parameter is retention time (RT). They are very similar to RF chart types.

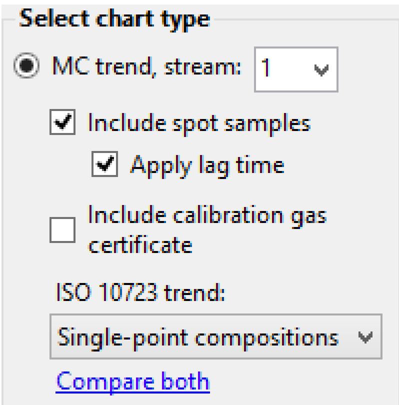
1. **RT trend** graphs the **actual** retention values over time in history. The unit of measurement is second (s).
2. **RT deviation trend** graphs the **deviation** (difference) of RT values against footprints, also in seconds (s). This also gives two further options:
   - **Each latest footprint**: Each RT value is compared against its latest footprint similar to RF deviation chart.
   - **This footprint only**: All RT values are compared against a particular footprint value. The footprint to set as the comparison base is configurable through **Change footprint** link.

10.2.2.3 *Selected parameter: R^2 (correlation)*



The chart will only show the actual value of R^2 calculations. This parameter is not compared against footprint values, but against a low alarm limit. The low alarm limit is configured in the Analysis Parameter form. If it is not set, the default limit **0.995** is used.

10.2.2.4 *Selected parameter: MC (mole composition)*



The chart will graph mole composition values of the selected stream. Refer to the user manual of your GC device to know which stream numbers deliver mole percentage data.

Available stream numbers are determined from data that has been existed in database and also the mole composition stream definition in Register Mapping form. If you know there is a stream number that is not on this dropdown list yet, simply type the stream number on the dropdown box manually then click the **Refresh** button or press F5.

You can also display spot sample records and/or calibration gas certificate alongside the regular mole composition record on the chart. Spot samples are displayed as triangles, calibration certificates are displayed as *bigger* triangles, while regular mole composition values appear as ordinary line charts. Tick the corresponding check box to show or hide these special records.

Apply lag time check box will shift all spot sample dots to the right amount of calculated lag time. Thus, the triangle points are closer to the regular mole composition line chart or even coincide. This way you can see if the spot sample dot and the line are far apart in terms of Y-axis value, it indicates problems within your pressure letdown system. This check box is available if you have GCAS feature *Lag Time Calculator* in your licence.

Users with GCAS feature *ISO 10723* included in their licences see an additional dropdown selection **ISO 10723 trend**. This dropdown contains three options:

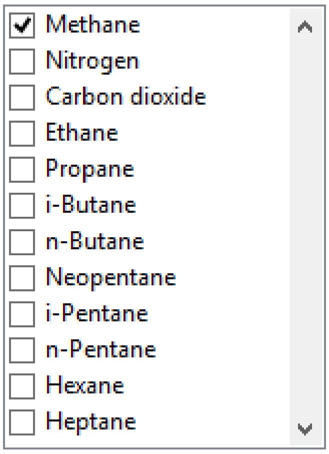
- **Single-point compositions** converts any multilevel-calibrated records within the plot range into single-point compositions before graphing them to the chart. Records already marked as single-point are plotted as usual.
- **MLC compositions** converts any single-point records within the plot range into multilevel-calibrated compositions before graphing them to the chart. Records already marked as multi-level-calibrated are plotted as usual.
- **Don't convert** ignores the MLC flag bit and plots all records within the plot range as they are. Use this if you have slow network connection to the database server and you are confident that this GC device never have mixed MLC records and single-point records. Never select this option if you are unsure whether the device has mixed MLC flag bit as it will produce invalid MC trend chart.

Users with both GCAS feature *ISO 10723* and *Data Comparison* included in their licences see a link **Compare both** under the ISO 10723 trend dropdown. This link is available if only one gas is selected. It calls Mole Composition Comparison form, sends the selected gas, date/time range, and stream number, then instructs Mole Composition Comparison form to compare single-point versus MLC compositions. If the single-point and MLC curves are overlap or very close to each other, your GC is more likely in a good condition. If they drift too far, your GC has too much bias.

10.2.3 Components

Components are selections of available gases to draw on the chart. In most use, usually only one gas is selected. GCAS can display multiple gases on one chart as required.

10.2.3.1 *Selected parameter: RF or RT*



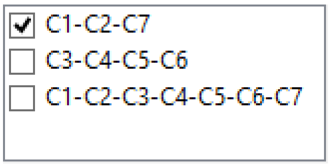
Components for C7-complete devices.

Depending on your GC device type, you would see between 1 to 15 gases. C6-without-neopentane have ten gases, while C10-complete devices have fifteen.

10.2.3.2 *Parameter selected: MC (mole composition)*

You should see all gases as in RF or RT, with one additional component at the bottommost of the list: **Unnormalised total**. GCAS always graphs *normalised* mole composition chart for gas component — except for, obviously, the unnormalised total.

10.2.3.3 *Parameter selected: R^2 (correlation)*



Available R^2 series for Daniel C7 devices.

For R^2 parameter, you may see one, two, three, or no items. Depending on your GC device type, the wording of these items may vary. These components graphs different R^2 values calculated from their RF-MW logarithm computation.

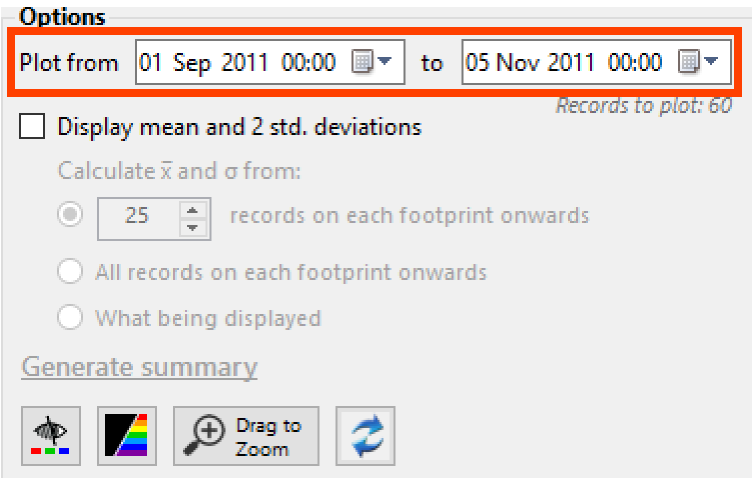
Device type	**Available R^2 trends**
Daniel C6+	C1-C2-C6 C3-C4-C5 C1-C2-C3-C4-C5-C6
Daniel C7+	C1-C2-C7 C3-C4-C5-C6 C1-C2-C3-C4-C5-C6-C7
Daniel C9+	C3-C4-C5 C6-C7-C8-C9
Daniel C10+ type A	C3-C4-C5-C6 C7-C8-C9-C10

Device type	Available R^2 trends
Daniel C10+ type B	C3-C4-C5 C6-C7-C8-C9-C10
ABB C6+	C3-C4-C5 C4-C5-C6 C3-C4-C5-C6
ABB C7+	C3-C4-C5-C6 C4-C5-C6-C7 C3-C4-C5-C6-C7
Siemens C6+, C7+, C9+, C10+	Siemens does not have R^2 trend.
Elster C6+	C3-C4-C5 C4-C5-C6 C3-C4-C5-C6
Elster C7+	C3-C4-C5-C6 C4-C5-C6-C7 C3-C4-C5-C6-C7
Elster C9+	C3-C4-C5-C6-C7-C8-C9 *
Elster C10+	C3-C4-C5-C6-C7-C8-C9-C10 *
LNG C2−, C3−, C4−, C5−	LNG devices do not have R^2 trend.
BTEX analyser	BTEX analysers do not have R^2 trend.
Single gas devices (H_2S, moisture, 1-gas)	Single gas analysers do not have R^2 trend.

*subject to change in the future.

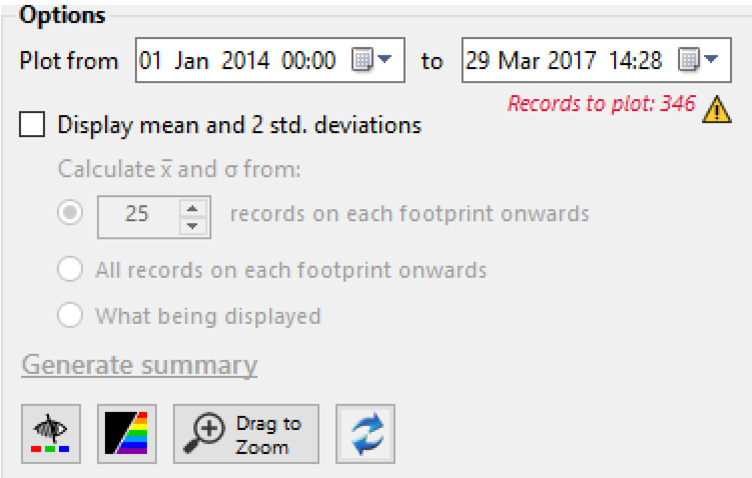
10.3 Date and Time Range (Plot Range)

When you open the Data Analysis form, it tries to load data from the last 30 days. To change this date and time range, set the desired range using the two date pickers inside the options box. The time uses 24-hour format. Click **Refresh** button to reload the chart.



When the chart is refreshed, chart data is cached in computer memory. So if you select or unselect some components, the requested data is loaded from memory instead of database as long as date and time range does not change. Every time you push the refresh button, it also refreshes this cache. Cache is cleared when the form is closed.

GCAS counts how many records are to be displayed, and displays this count under the date picker input fields. Would there be too many records to load, GCAS alerts you that the load-and-draw process may take a prolonged time. Also, the dots of the line chart may clutter the chart area thus makes it difficult to interpret. Alert limit is hardcoded to 150 records for RF, RT, and MC; and 100 records for R^2.



10.4 Mean and Standard Deviations

On certain parameters, GCAS can calculate the mean (average) and twice the standard deviations. The table below describes which parameter has this capability.

Parameter	Mean & 2 std. dev enabled?	Available options
RF	Yes	1. *x* records from footprint, 2. All records from footprint, 3. What being displayed
RT	Yes	1. *x* records from footprint, 2. All records from footprint, 3. What being displayed
MC	Yes	1. What being displayed
R^2	No	None

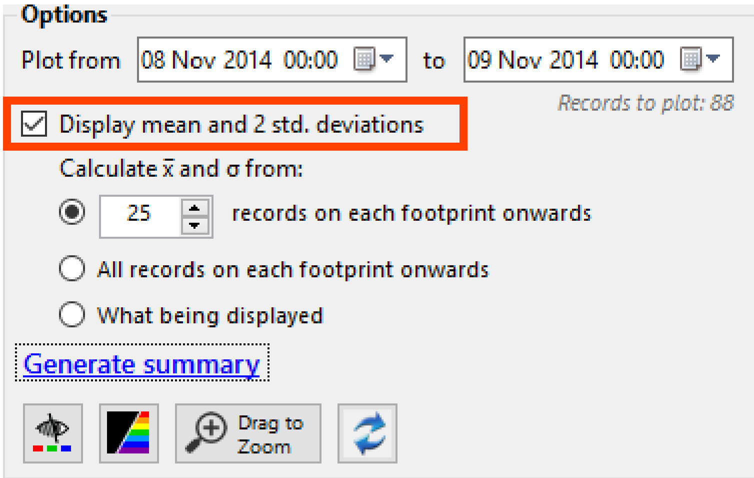
Note

GCAS can only calculate mean and standard deviations if only one component is selected. Mean and standard deviations cannot be computed for two or more active components on the chart.

Important

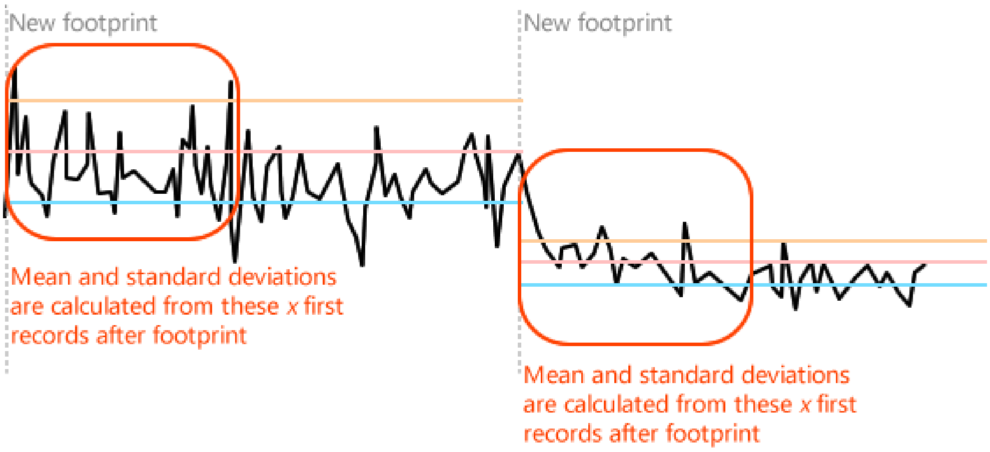
If you are working offline, computed mean and standard deviations may not be accurate because it depends on how much data available on your temporary database. GCAS displays offline warning icon to alert this potential source of inaccuracy. Try to stay in online mode as much as possible while working with Data Analysis module.

To show or hide the mean and twice standard deviations, use the checkbox **Display mean and ± 2 × standard deviations**.

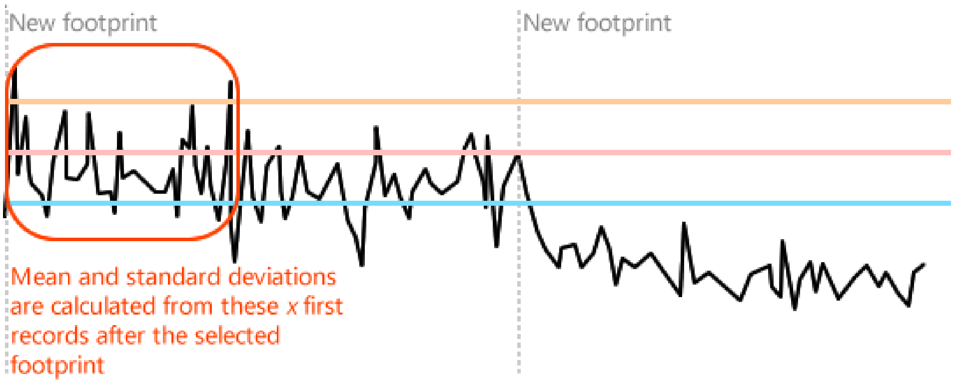


There are three options for mean and standard deviation calculation.

a) ***x* records from footprint** (default *x* = 25 records)
Mean and twice standard deviations are calculated from first *x* records (default is 25) after each footprint.

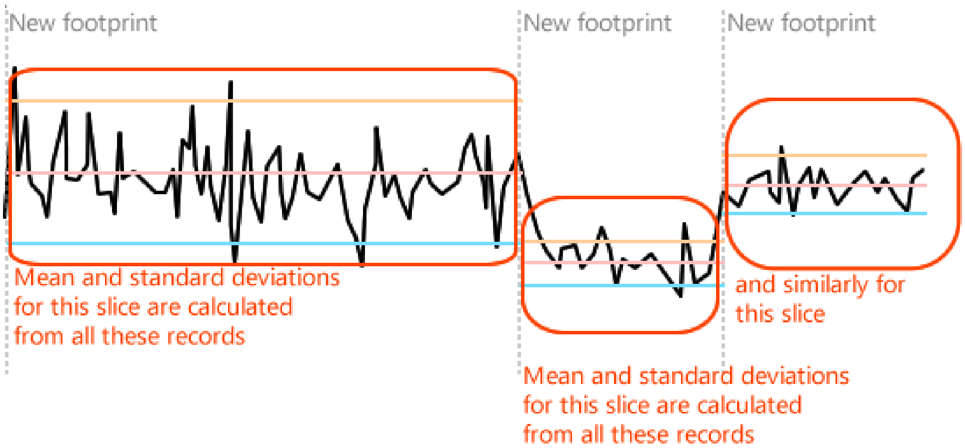


Special case if you are drawing RF or RT *deviation trend* and you have chosen a particular footprint as a comparison base, this option will calculate the mean and twice the standard deviations from *x* records after that footprint only.

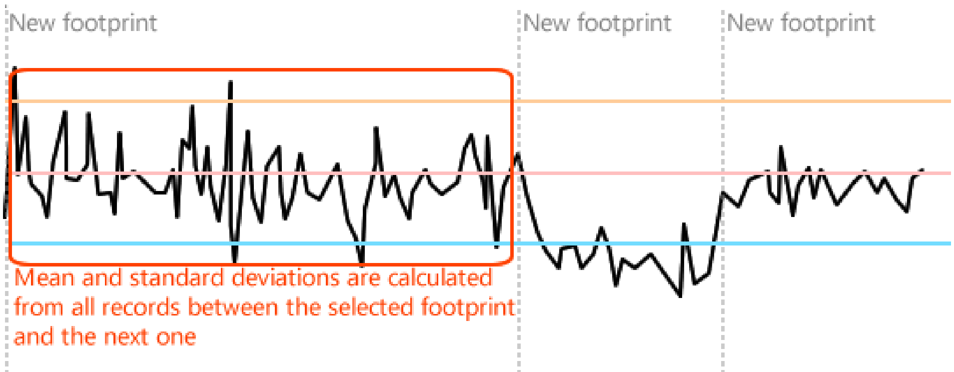


b) All records from footprint

Mean and twice standard deviations are calculated from all records between footprints.



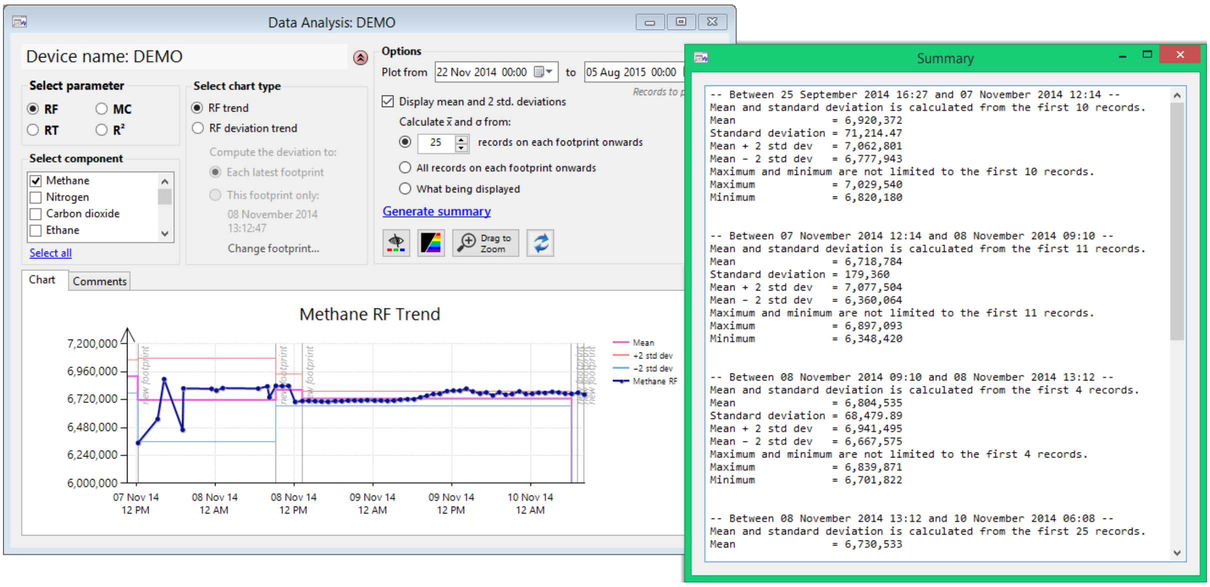
Special case if you are drawing RF or RT *deviation trend* and you have chosen a particular footprint as a comparison base, this option will calculate the mean and twice the standard deviations from all records between the selected footprint and one next footprint thereafter.



c) What being displayed

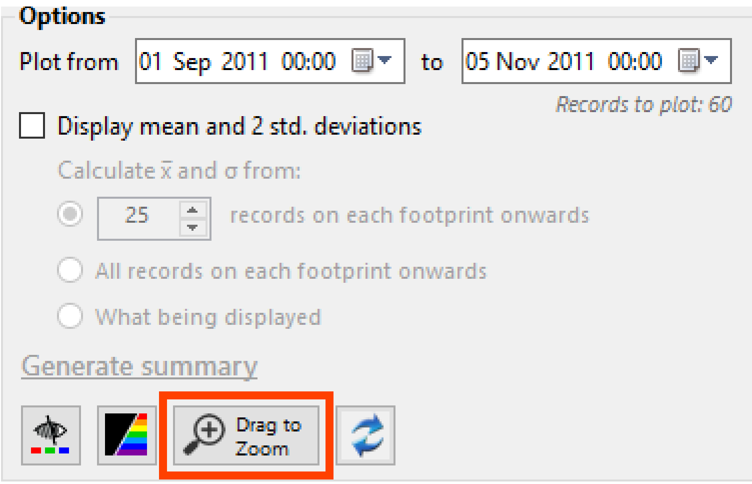
The mean and twice standard deviations are simply calculated from all the data points which have been drawn on the chart for your choice of date range. Unlike the other two options which require database reload through the **Refresh** button, this option uses the data already there on the chart area.

In addition, GCAS provides simple statistics when mean and standard deviation lines are on. Click **Generate summary** link under the three radio buttons, then the Data Analysis form generates a statistics summary for you.

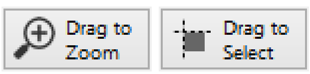


10.5 Zoom Mode and Selection Mode

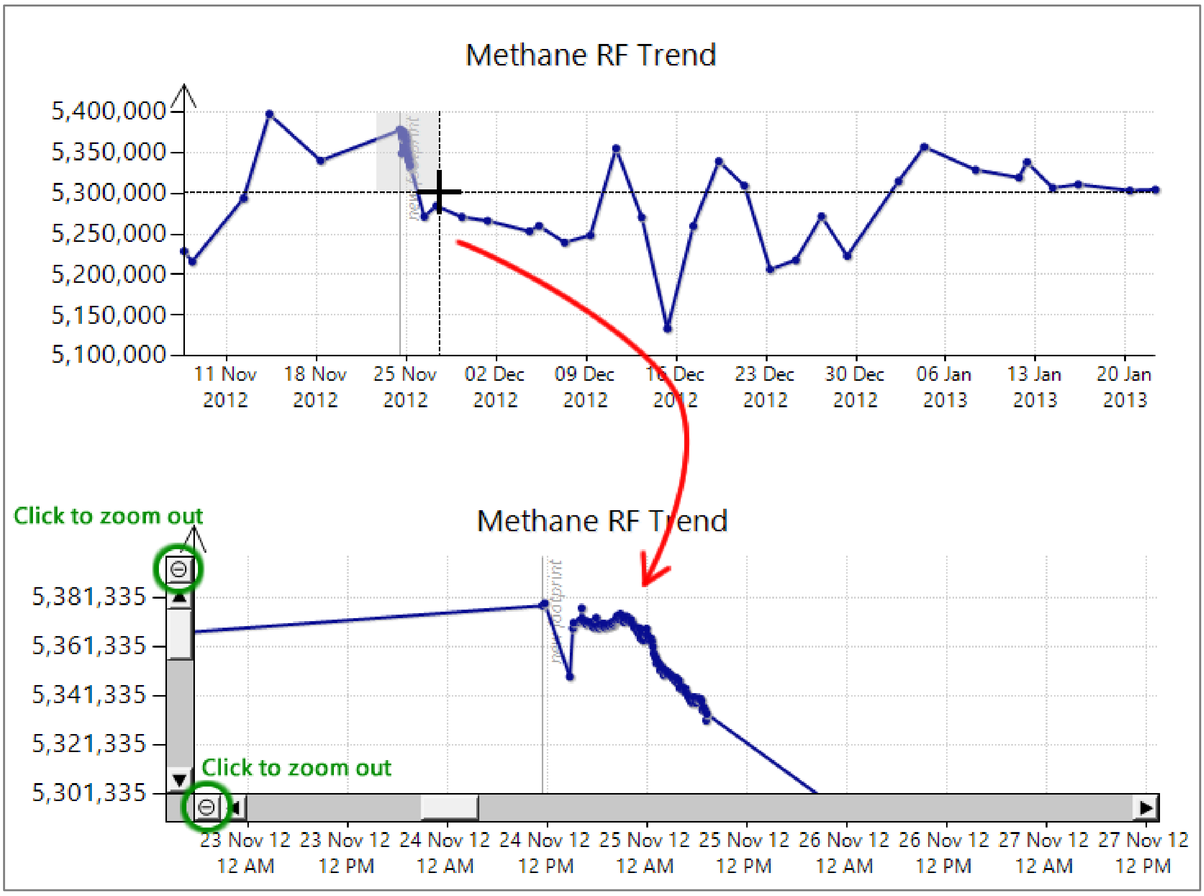
This button switches whether the chart is in *zoom mode* or *selection mode*. **Zoom mode** lets you zoom in to a particular area of the chart in case there are too many data points cramped on small area. **Selection mode** allows you to drag a rectangle to select a pack of data points and manipulate them using the available context menus.



As shown in the example screenshot above, the chart is now in *zoom mode*. Click it to toggle.



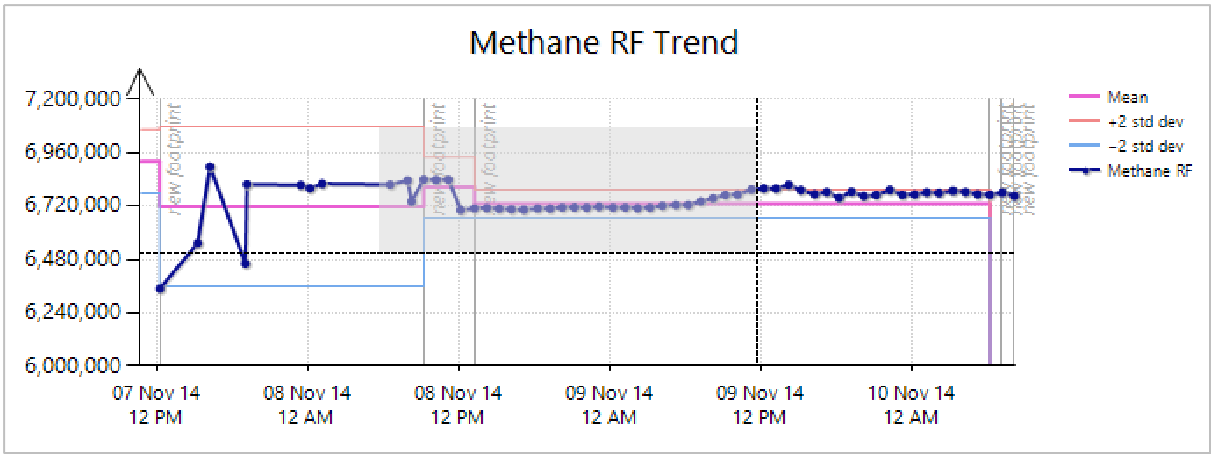
In *zoom mode*, drag a rectangle on the region you would like to zoom.



Use the scroll bars to pan the zoomed chart. To zoom in further, drag another rectangle on the area you would like to enlarge more.

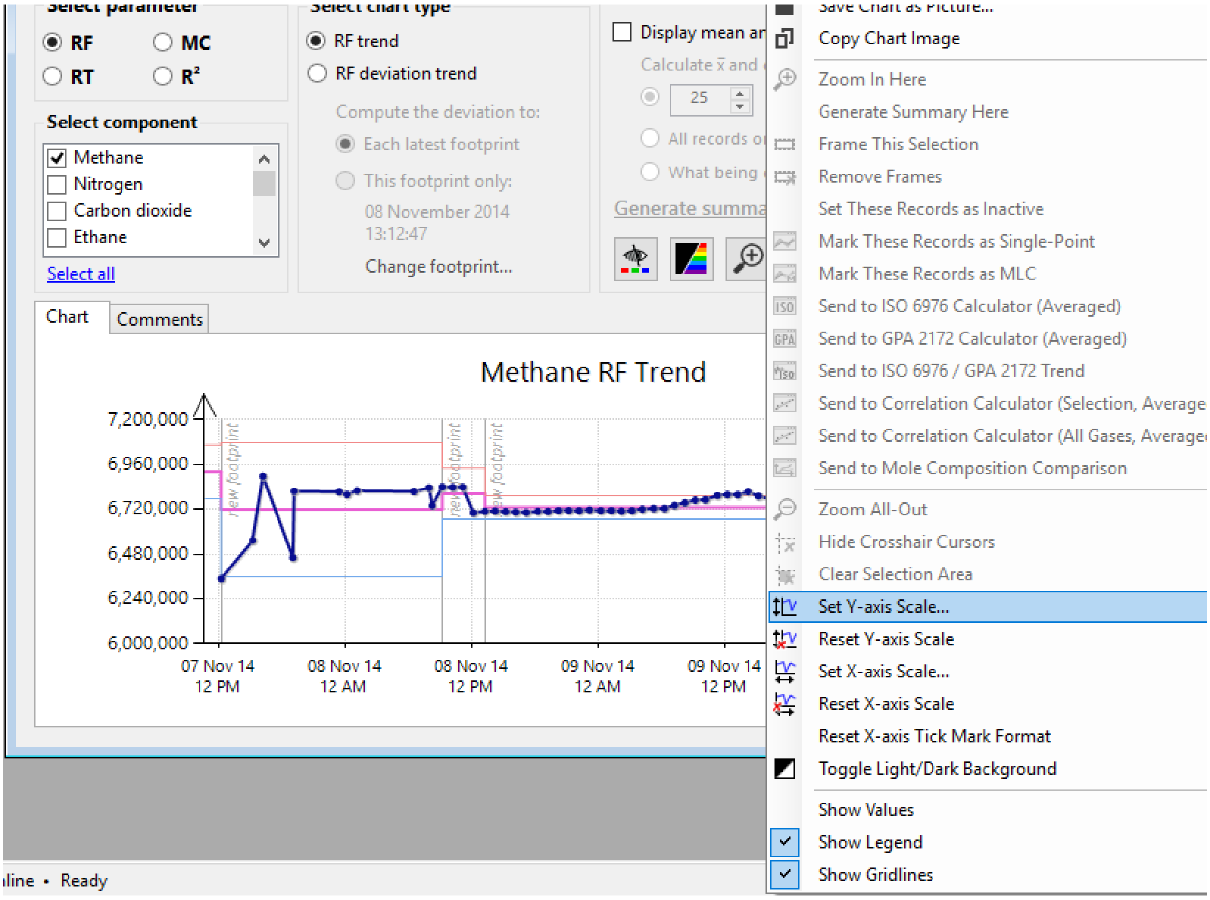
Click on the circled minus button ⊖ on both scroll bars to zoom out one step. To zoom all-out, simply press the Home button on your keyboard. Otherwise, right-click on the chart and select **Zoom All Out** submenu.

In *selection mode*, drag a rectangle to select an area on the chart. Right click the selection to open context menus and you see several menus available in selection mode. Chapter 10.9 will explain each function of these menus. To cancel selection, right click the chart and choose **Clear Selection Area**.



10.6 Change Axes Scale

When zoom is not enough, you can enforce a custom range for both X-axis and Y-axis of the chart. To do this, right-click on the chart and select either **Set X-axis Scale** or **Set Y-axis Scale**.



For Y-axis, specify the desired numeric range. The input fields accept decimal values. For example, take the chart screenshot above and let us enter this range:

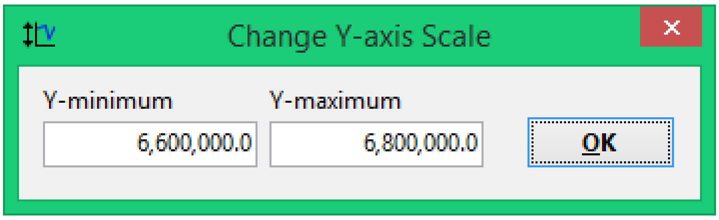
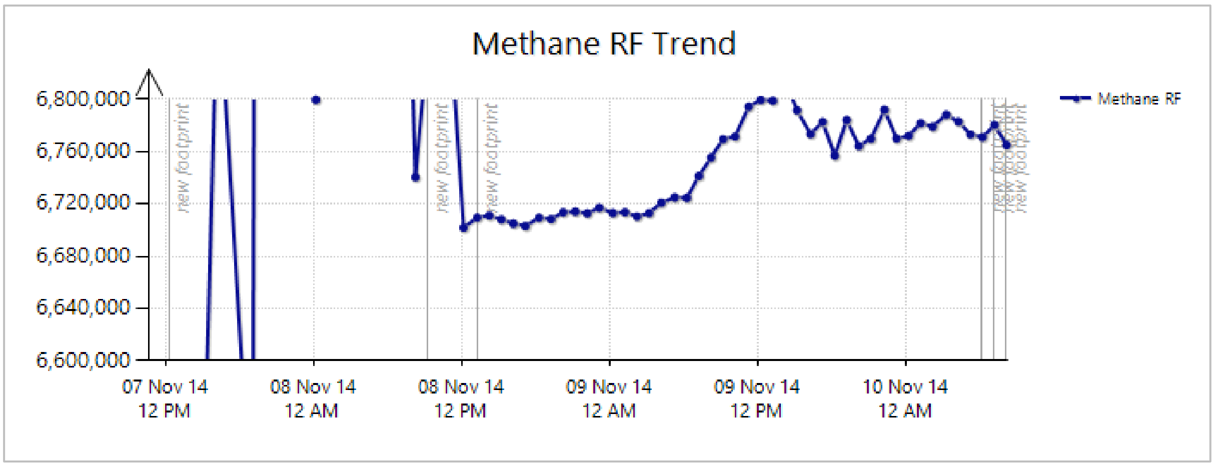
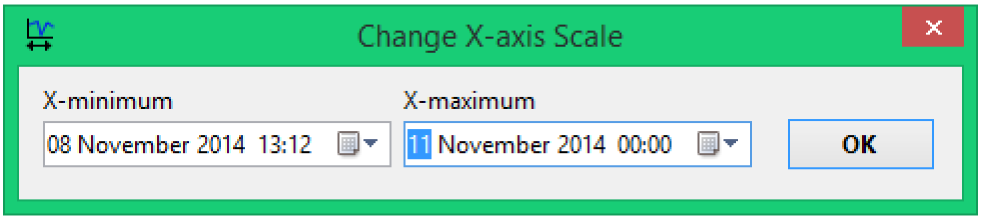


Chart is then drawn within the new, confined range similar to the screenshot on the next page. Notice that the chart line is truncated because there are data points having values outside of this range.



To revert back to the automatic scale, right-click the chart and select **Reset Y-axis scale**.

For X-axis, specify the desired date and time interval.

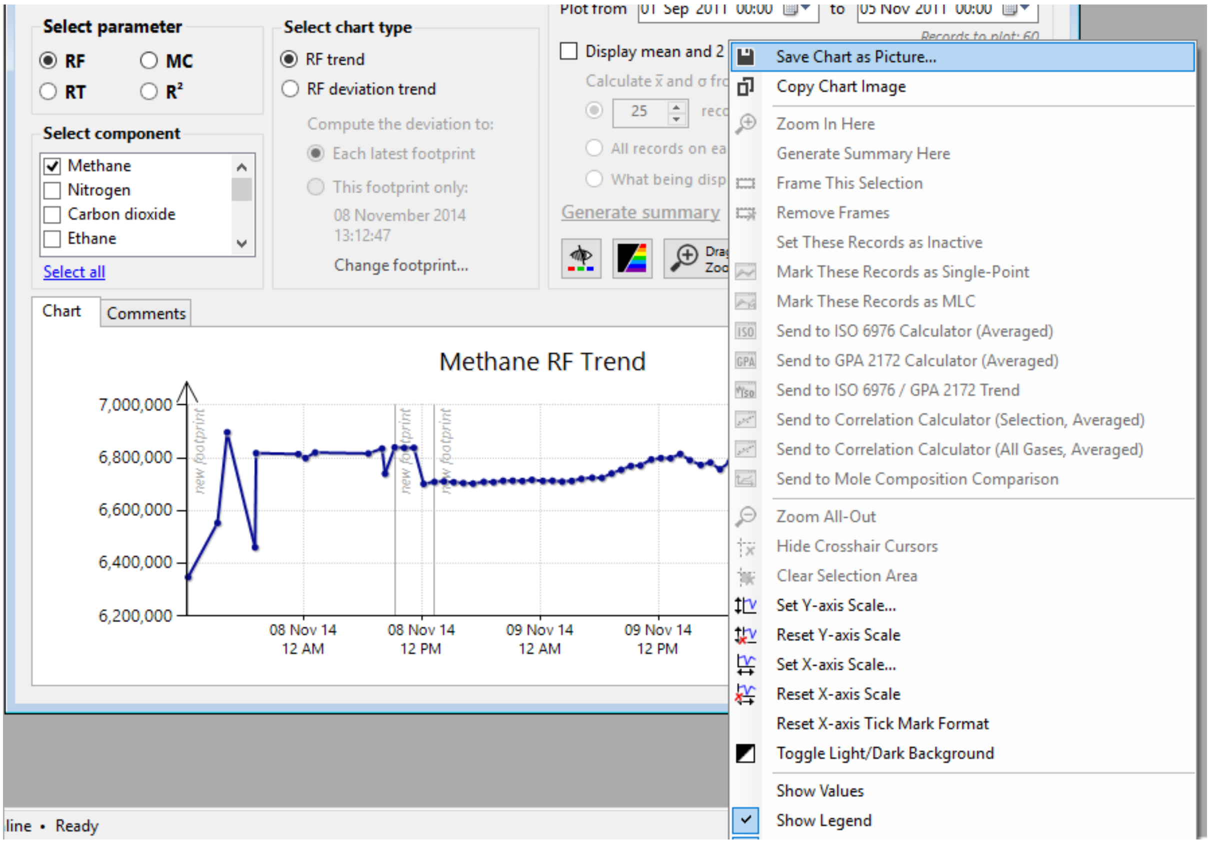


Similarly, to undo the scale you would right click on the chart and select **Reset X-axis scale**.

Depending on the custom date interval, the date mark on the X-axis may include the time. For more detailed interval such as from 00:00 to 08:00 of the same day, the X-axis would display the date and the time (hh:mm:ss) as well. When you reset X-axis scale but you notice the date/time marks on X-axis do not reset, right click on the chart and choose **Reset X-axis Tick Mark Format**.

10.7 Save or Copy the Chart

To save the chart as image file, right click on the chart and select **Save Chart as Picture**.



To copy the chart, right click and select **Copy Chart Image**. Then you may paste the image into Microsoft Paint, Microsoft Office, or any software that accepts bitmap image/picture data on clipboard.

Tips before saving or copying

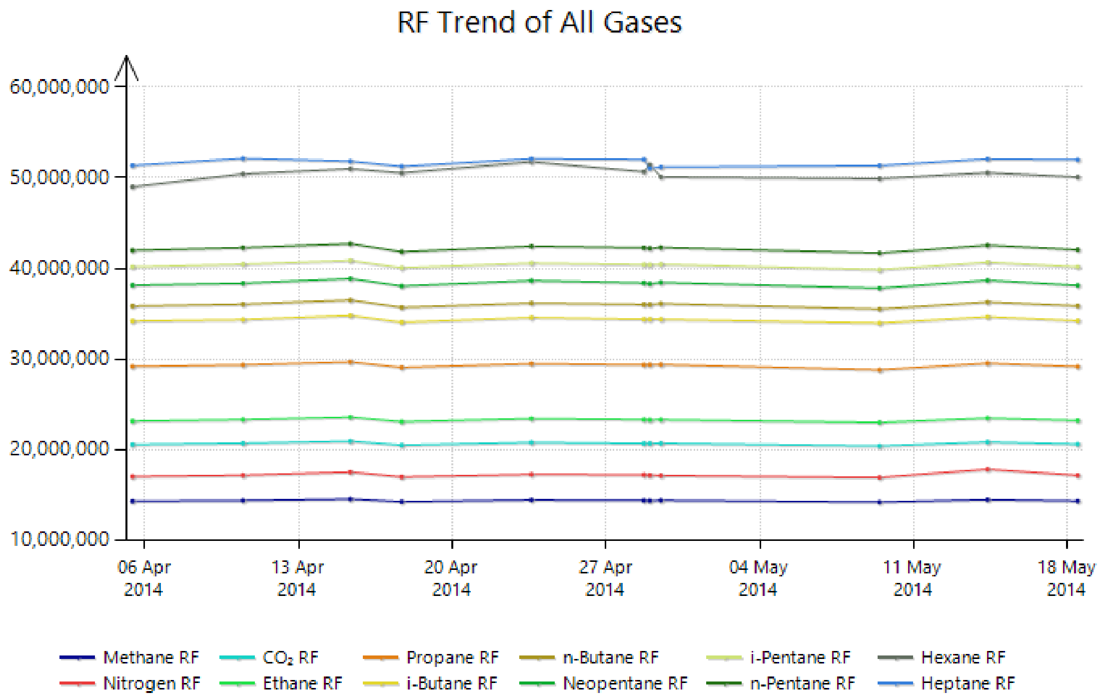
Enlarge the chart by maximising the Data Analysis form, collapsing the device panel, and expanding the chart area through the **Expand** button at the top of Data Analysis form.

To make the line chart black, use the toggle colour/black button on the options box. This button is available if only one component is ticked. Black line appears better on monochrome printers if the saved file or copied image is about to be printed.

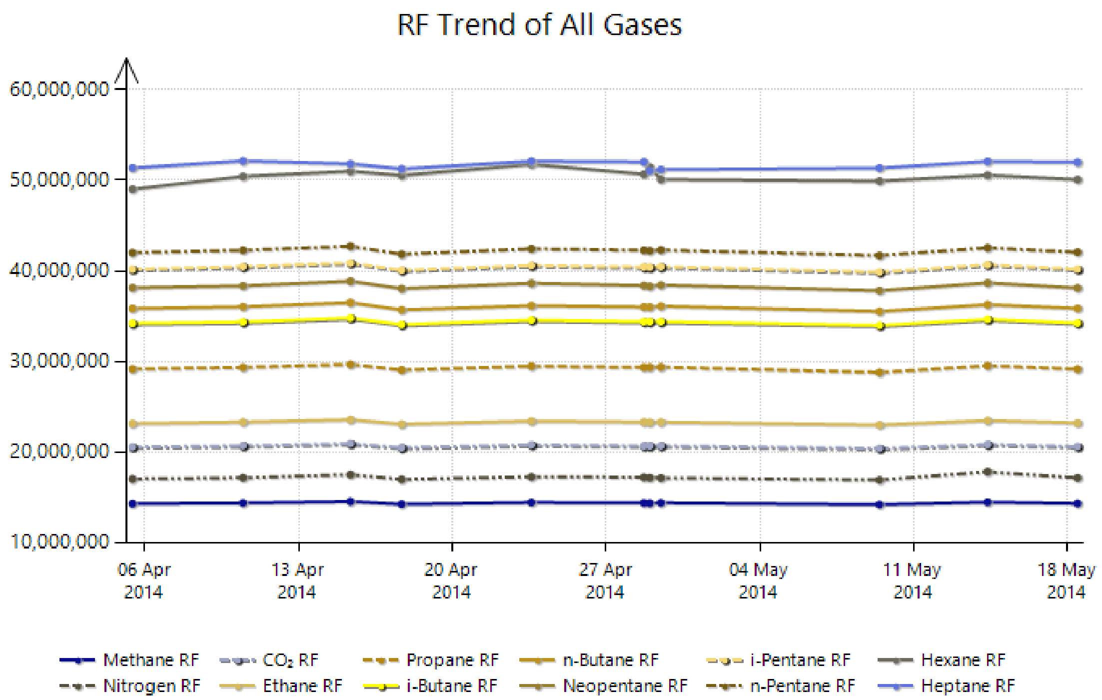
If you do not want the gridlines or chart legend to be included in the image file, right click on the chart and uncheck **Show Gridlines** or **Show Legend** or both.

10.8 Colourblind Assistance

To aid users with colour blindness (protanopia and deuteranopia), GCAS provides an alternative colour scheme for the chart. Use the **Colourblind assist** button on the options box.



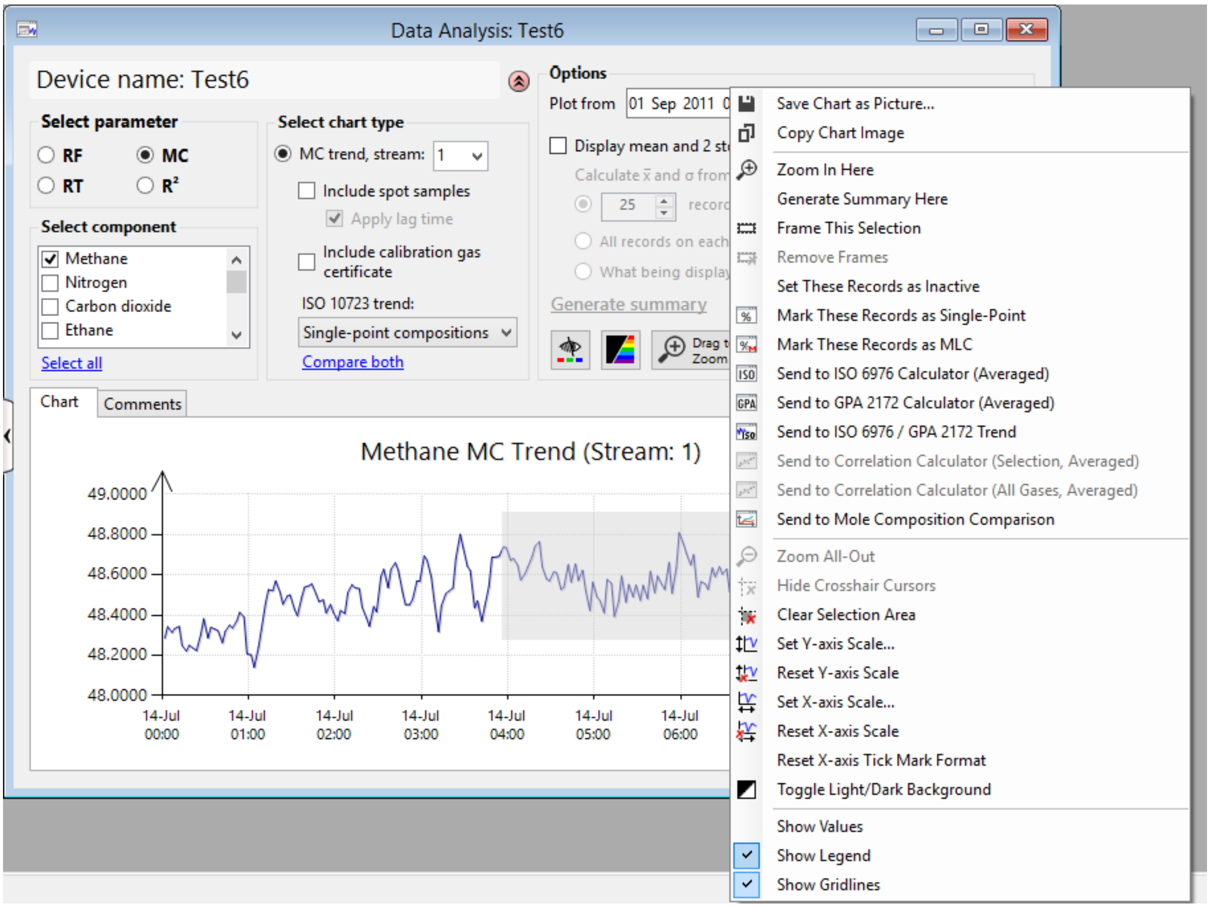
Normal colour scheme, colourblind assistance turned off.

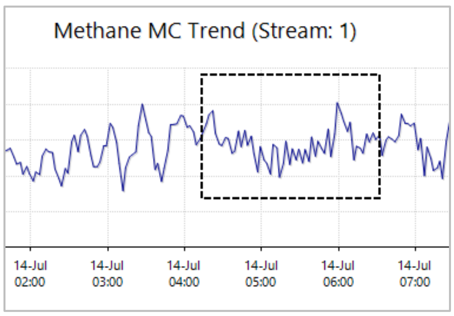


Alternative colour scheme, colourblind assistance turned on.
Similar colours are distinguished by dash or dotted style.

10.9 Selection Mode Menus

These menus are available if Data Analysis chart is in selection mode and there is a selection rectangle on the chart.



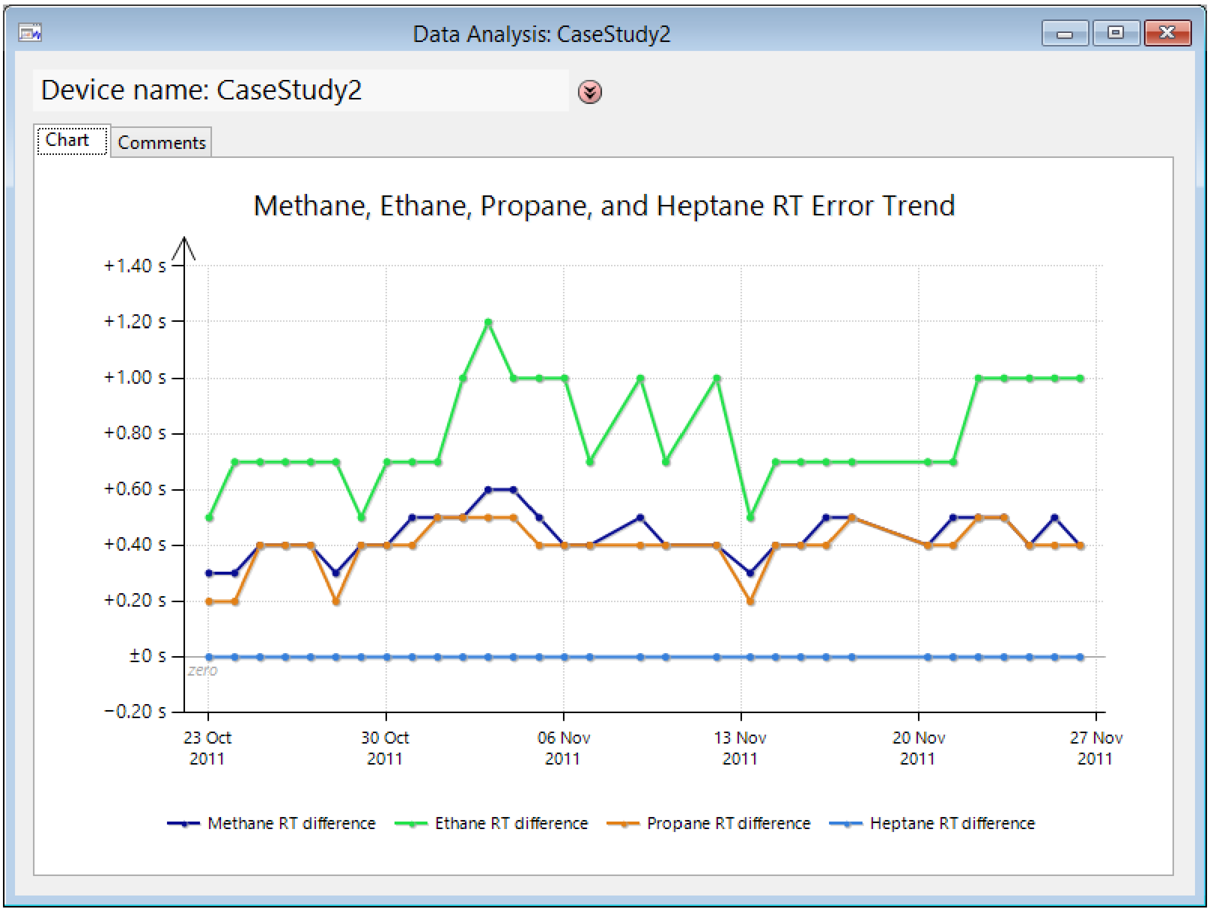
Menu	Which parameter?	Licence requirement	Function
Zoom In Here	Any	-	Zooms in to the selection area.
Generate Summary Here	Any	-	Generates statistical summary for the selected area (in contrast to **Generate summary** link which generates summary for the entire X-axis)
Frame This Selection	Any	-	Literally puts a rectangular frame around the selection, for presentation purpose. 

Menu	**Which parameter?**	**Licence requirement**	**Function**
Remove Frames	Any	-	Deletes all frames created through *Frame This Selection* menu.
Set These Records as Inactive	Any	-	Sets all records within the X-axis range of the selection area as inactive. If you are on R^2 trend chart, this sets the underlying footprint/calibration records as inactive.
Mark These Records as Single-Point	RF, MC	*ISO 10723*	Sets the MLC flag bit of all records within the X-axis range of the selection area as single-point RF or MC.
Mark These Records as MLC	RF, MC	*ISO 10723*	Sets the MLC flag bit of all records within the X-axis range of the selection area as multilevel-calibrated RF or MC.
Send to ISO 6976 Calculator (Averaged)	MC	*ISO 6976 Calculator*	Sends the averaged mole composition value of each gas of all records contained inside the selection area to ISO 6976 Calculator. The ISO 6976 output values may be different from the next menu (sending to ISO 6976/GPA 2172 Trend and then activating the mean and standard deviation lines).
Send to GPA 2172 Calculator (Averaged)	MC	*GPA 2172 Calculator*	Sends the averaged mole composition value of each gas of all records contained inside the selection area to GPA 2172 Calculator. The GPA 2172 output values may be different from the next menu (sending to ISO 6976/GPA 2172 Trend and then activating the mean and standard deviation lines).
Send to ISO 6976 / GPA 2172 Trend	MC	*ISO 6976 Trend* -or- *GPA 2172 Trend*	Loads ISO 6976/GPA 2172 Trend form and instructs it to plot the ISO 6976 or GPA 2172 values for mole composition records contained inside the selection area.
Send to Correlation Calculator (Selection, Averaged)	RF trend; not RF *error* trend	-	Sends the averaged RF value of any gases that intersects with the selection area, to Correlation Calculator. For example, if your selection area contains methane and ethane line, only methane and ethane are sent to Correlation Calculator. Their RF values inside the selection area are averaged and then sent.

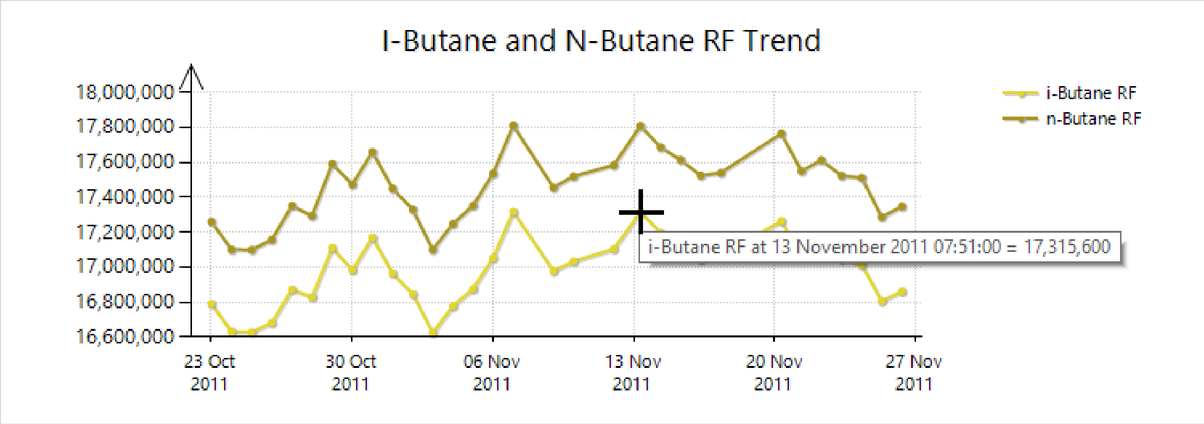
Send to Correlation Calculator (All Gases, Averaged)	RF trend; not RF *error* trend	-	Sends the <u>averaged</u> RF value of all gases of all records contained inside the selection area to [Correlation Calculator]().
Send to Mole Composition Comparison	MC; requires only one gas selected	*ISO 10723* and *Data Comparison*	Sends mole composition values of the selected gas of all records contained inside the selection area to [Mole Composition Comparison](); then instructs the form to compare the single-point versus MLC composition of that gas.

10.10 Other Visual Cues

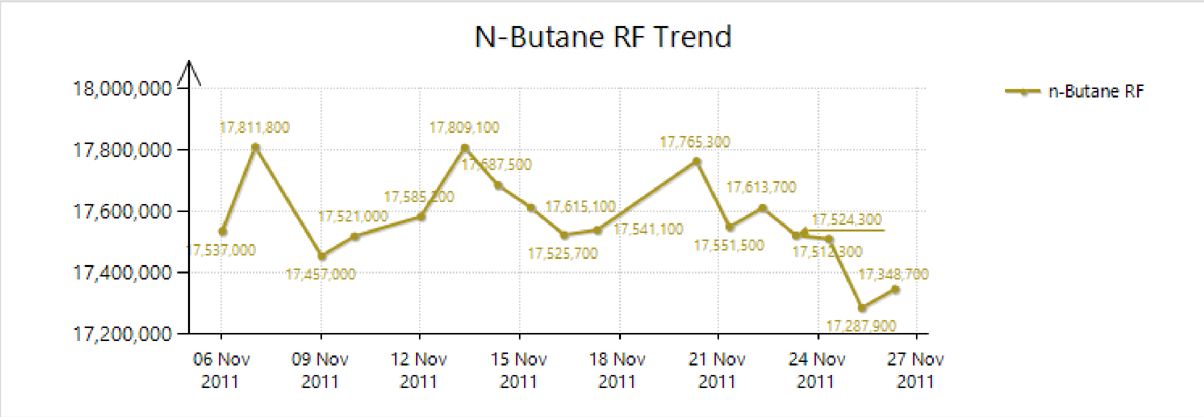
Enlarge chart area by hiding the parameters panel through the **Expand** button. To show the parameters panel again, click **Collapse**.



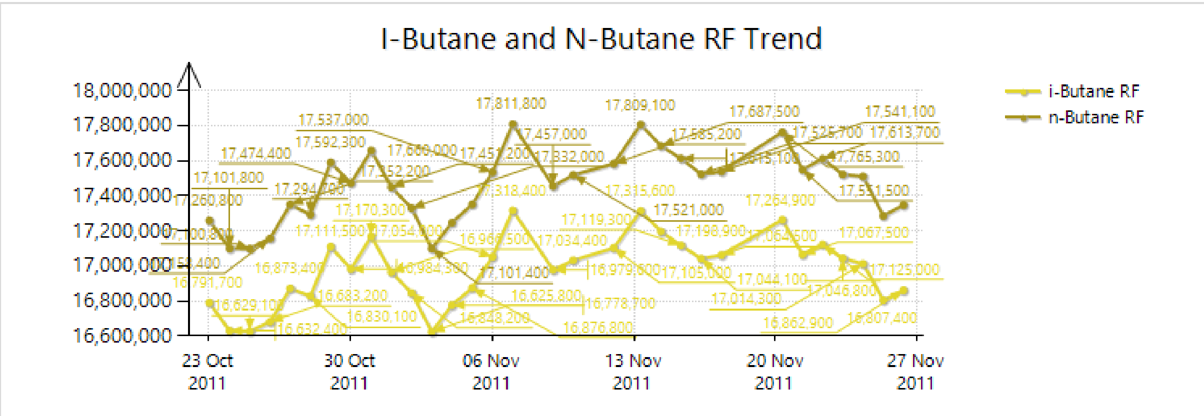
Hover your mouse cursor over a data point to see its value.



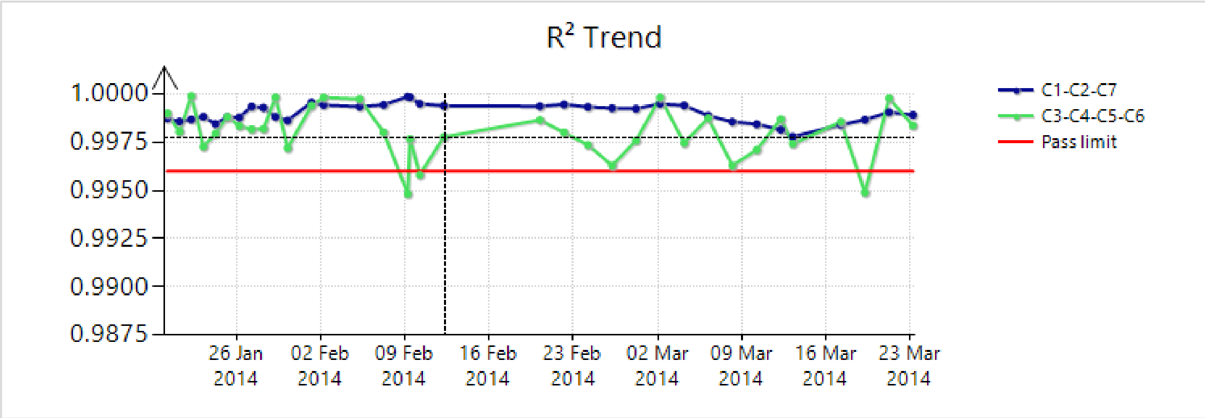
Alternatively, use the **Show values** button (or right click on the chart and choose **Show Values**).



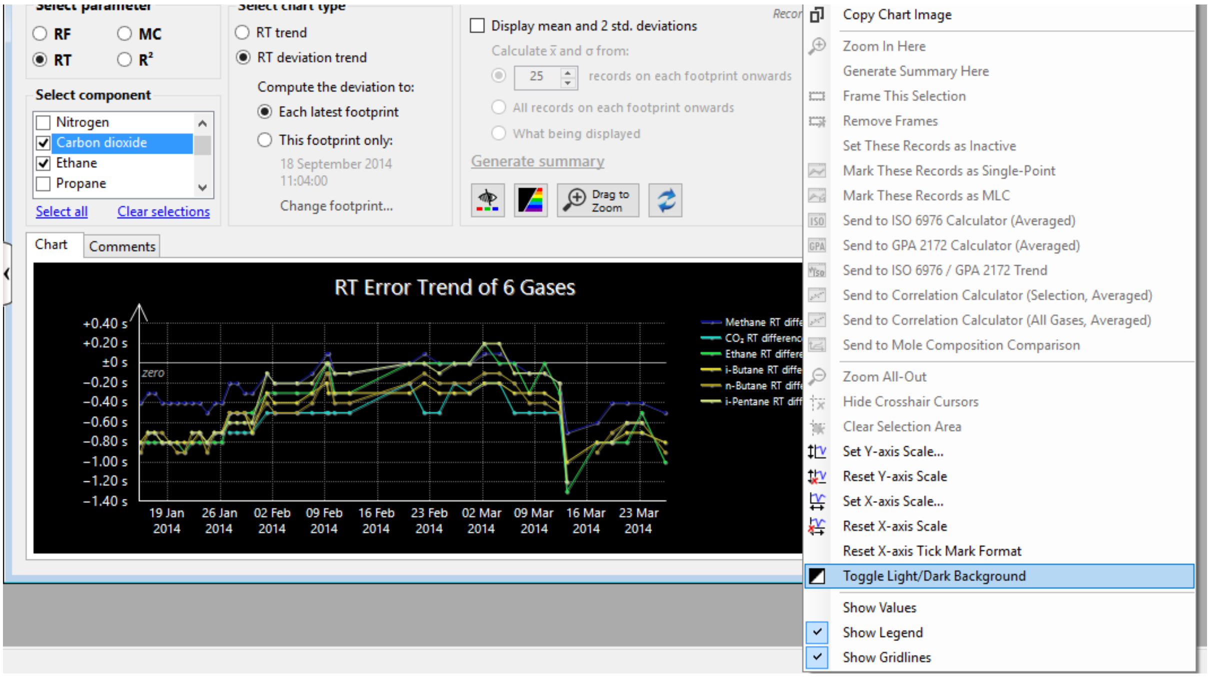
We don’t recommend to show values on chart with many data points as the number labels may flood the chart area — unless you have zoomed it in.



Crosshair cursors are the dashed lines appearing on the chart when you left-click on it or as a remnant of zoom operation. These may act as a ruler or guide. To remove them, click **Hide crosshair cursor** button (or right-click on the chart then select **Hide Crosshair Cursors**).

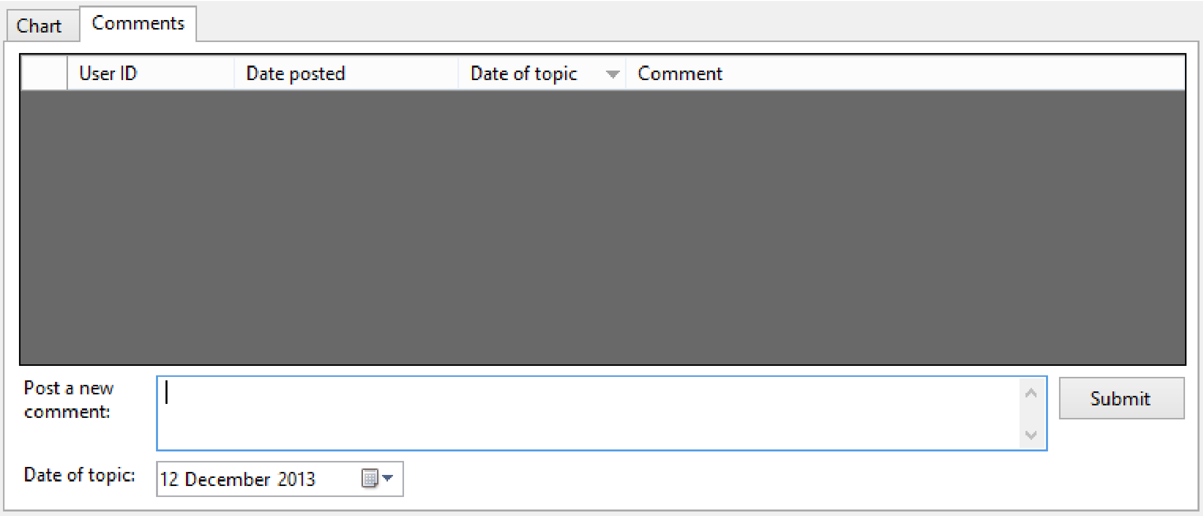


To use black background, right click on the chart and click **Toggle Light/Dark Background** menu. Use the same menu to revert back to white. The black background is permanent when you save the chart as image file or copy chart image to clipboard.



10.11 Insert Comment

To view or write comment, open the **Comments** tab.



Write your comment and set the appropriate date of topic, then click **Submit**. Your comment will have a yellow background to distinguish it from comments by other users. **Date of topic** is an additional information of which calibration data/footprint/mole composition record you are writing your comment for, thus other users know the correct data point to refer to.

Make sure that the comment is correct e.g. free from spelling errors, because once submitted you would not be able to remove your comment. This is a part of audit trail requirements.

The main **Refresh** button does also reload comments.

If you do not see the text box to write your comment, i.e. you only see the comment grid view, your GCAS user account doesn't have the action permission to write comment in Data Analysis. Contact your GCAS administrator.

11 Uncertainty Calculation

Uncertainty Calculation is a module to calculate the uncertainties of your GC device. This is related to condition-based maintenance which allows early detection of GC failures. Method to calculate GC uncertainties is described in the journal article
Sutan, A. and Daniel, P., "Gas Chromatography – Conditional Based Monitoring and Live Uncertainty Calculation", *North Sea Flow Measurement Workshop* (2012)
and
Sutan, A and Daniel, P., "Gas Chromatography Maintenance using Uncertainty-Based CBM", *The Americas Flow Measurement Conference* (2013).

> **Note**
>
> This module requires GCAS feature *Uncertainty Calculation* to be included in your GCAS licence.

Uncertainty calculation takes five input groups:

1. Uncertainty from the calibration gas — a calibration gas certificate is mandatory;
2. Uncertainty from GC repeatability and linearity,
3. Uncertainty from GC reproducibility,
4. ISO 6976:1995 inputs, and
5. GPA 2172-09 inputs.

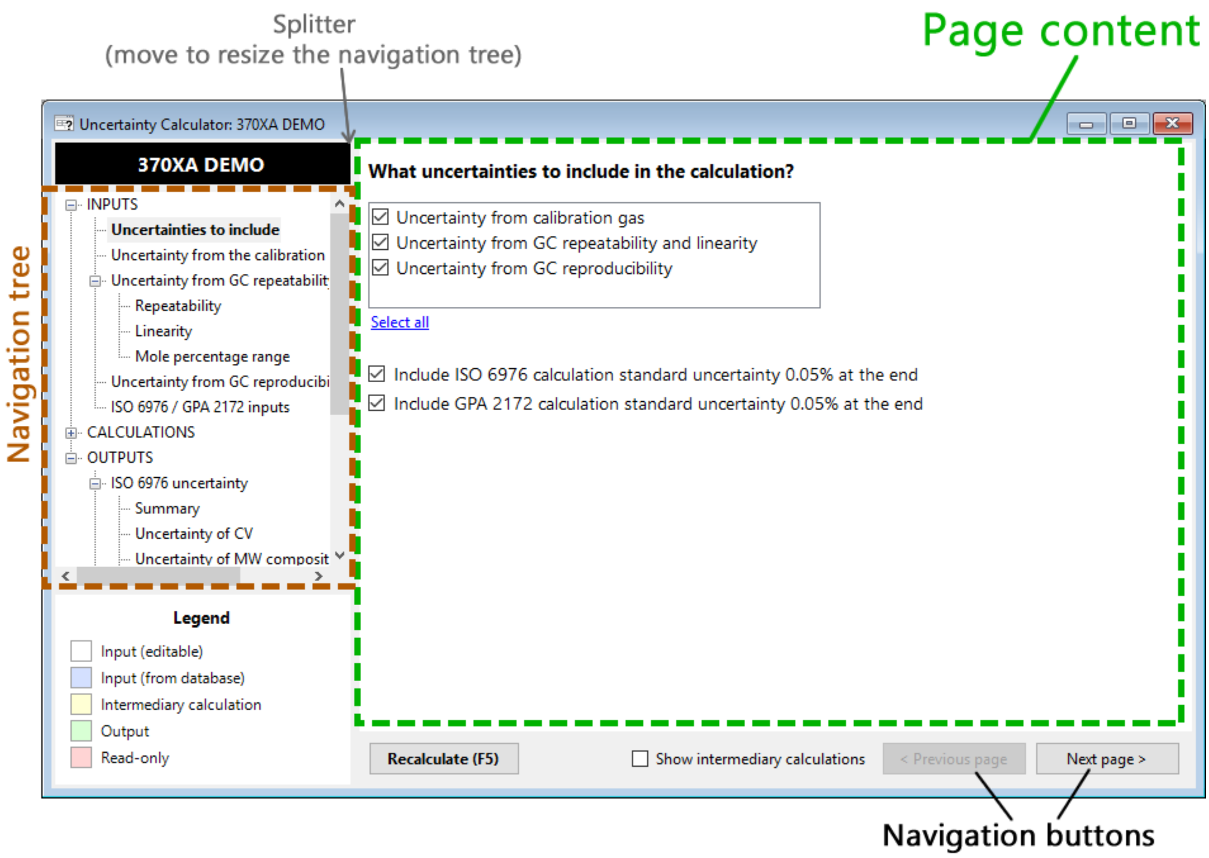
And it produces three output groups:

1. Uncertainties of ISO 6976:1995 outputs,
2. Uncertainties of GPA 2172-09 outputs, and
3. Uncertainties of GC for each gas component.

11.1 The *Uncertainty Calculator* Form

To calculate uncertainties of a particular GC device, select the device on your device panel or recent device panel. Then, go to the View menu > **Uncertainty Calculation**.

The form behaves like a wizard although it is not. It has a collection of *pages* categorised into three groups: inputs, calculation, and outputs. To navigate between pages, use the two buttons at the bottom-right corner **Next page** or **Previous page**; or you can also jump to the desired page straight away through the *navigation tree* on the left side.



Uncertainty Calculator form and its parts.

The form features 30 pages as laid out in the navigation tree. Each terminal item links to its page within the form. Click on any item below to read more about its part.

- Inputs
  - Uncertainties to include
  - Uncertainty from the calibration gas
  - Uncertainty from GC repeatability and linearity
    - Repeatability
    - Linearity
    - Mole percentage range
  - Uncertainty from GC reproducibility
  - ISO 6976 / GPA 2172 inputs
- Calculations (normally collapsed)
  - Uncertainty of calibration gas
  - WRM RF and standard deviation
  - Uncertainty of repeatability
  - Footprint and calibration data
  - Uncertainty of reproducibility
  - Standard relative uncertainty
  - Compressibility factor
  - ISO 6976 calculation
  - GPA 2172 calculation
  - ISO 6976 sensitivity analysis for $U_{calibration\ gas}$ and $U_{reproducibility}$

    - ISO 6976 sensitivity analysis for $U_{repeatability}$
    - GPA 2172 sensitivity analysis for $U_{calibration\ gas}$ and $U_{reproducibility}$
    - GPA 2172 sensitivity analysis for $U_{repeatability}$
- Outputs
    - ISO 6976 uncertainties
        - Summary page
        - Uncertainty of CV (calorific value)
        - Uncertainty of MW composition
        - Uncertainty of Wobbe index
        - Uncertainty of relative density/specific gravity
        - Uncertainty of standard density
    - GPA 2172 uncertainties
        - Summary page
        - Uncertainty of GHV (gross heating value)
        - Uncertainty of compressibility
        - Uncertainty of relative density

The navigation button **Next page** and **Previous page** change pages in sequential order. They may skip some pages depending on the selection you made on the previous page.

At any time you leave input pages, Uncertainty Calculator form should perform all calculations. Once you are at intermediary calculation pages or output pages and you notice a mistake, you can always go back to the input pages either by clicking **Previous page** button successively until the form arrives at the desired page, or jump straight away using the navigation tree. After you make some changes in the inputs and go forward to later page, the form shall perform automatic recalculation thus new output values will update accordingly. If you notice the form does not recalculate, click **Recalculate** button or press F5 key on your keyboard to force a recalculation.

11.2 Calculation Steps

The form calculates your GC uncertainty is using the sequence below.

1. Calculate $U_{cal\ gas}$ if selected.
2. Calculate $U_{repeatability}$ if selected.
3. Calculate $U_{reproducibility}$ if selected.
4. Calculate U_{GC} at k = 1 which is the *standard relative uncertainty*. (k is coverage factor.)
5. Calculate Z_{mix} (compressibility factor of mixture) and Z_{air} based on the given base temperature and combustion temperature.
6. Perform all ISO 6976 calculations.
7. Perform all GPA 2172 calculations.
8. Perform sensitivity analysis on ISO 6976 outputs.
9. Perform sensitivity analysis on GPA 2172 outputs.
10. Calculate U_{CV}, U_{MW}, U_{Wobbe}, U_{SG}, and U_{ρ} — all uncertainties of ISO 6976 outputs.
11. Calculate U_{GHV}, U_{Z}, and U_{RD} — all uncertainties of GPA 2172 outputs.

11.3 Input Pages

Input pages collect all required information before the form performs a calculation. Visit subchapters below to get help about a specific page.

11.3.1 Uncertainties to Include

You can select which uncertainties to include in the calculation of *standard relative uncertainty* (U_{GC}).

$$U_{GC} = \sqrt{(U_{\text{cal gas}})^2 + (U_{\text{repeatability}})^2 + (U_{\text{reproducibility}})^2}$$

For example, if you decide not to include uncertainty from the calibration gas, $U_{\text{cal gas}}$ is replaced by zero and the formula changes to

$$U_{GC} = \sqrt{(U_{\text{repeatability}})^2 + (U_{\text{reproducibility}})^2}$$

You must select at least one uncertainty component in order to proceed to the next page. If you don't, U_{GC} will be zero and all subsequent calculations afterwards will be meaningless.

Also in this page there is a check box to control whether to include ISO 6976 **standard measurement uncertainty of 0.05%** at the end of calculation. In the standard, ISO 6976 uncertainty is 0.1% at k = 2. Calculation of combined standard uncertainty uses k = 1, hence the ISO 6976 measurement uncertainty becomes 0.05%. Every result of ISO 6976 calculation shall carry this 0.05% uncertainty. The same thing is also available for GPA 2172 calculation through a separate check box. By default, these two check boxes are ticked.

Note

GPA 2172 calculation is not available for **BTEX devices**, **moisture analysers**, and **single gas devices that are not H_2S**. GPA 2172 calculation results for these device types will be all-zeroes and yield the uncertainty value of 0.1%.

11.3.2 Uncertainty from the Calibration Gas

Select a calibration certificate in GCAS database. By default, GCAS loads the last installed certificate. This certificate is used later on when calculating $U_{\text{cal gas}}$, $U_{\text{reproducibility}}$, ISO 6976 calculations, and GPA 2172 calculations.

You can see all installed calibration certificates through Calibration Gas Certificate form. That form also provides a way to submit a new certificate if the desired certificate has not been entered to the database.

11.3.3 Uncertainty from GC Repeatability and Linearity

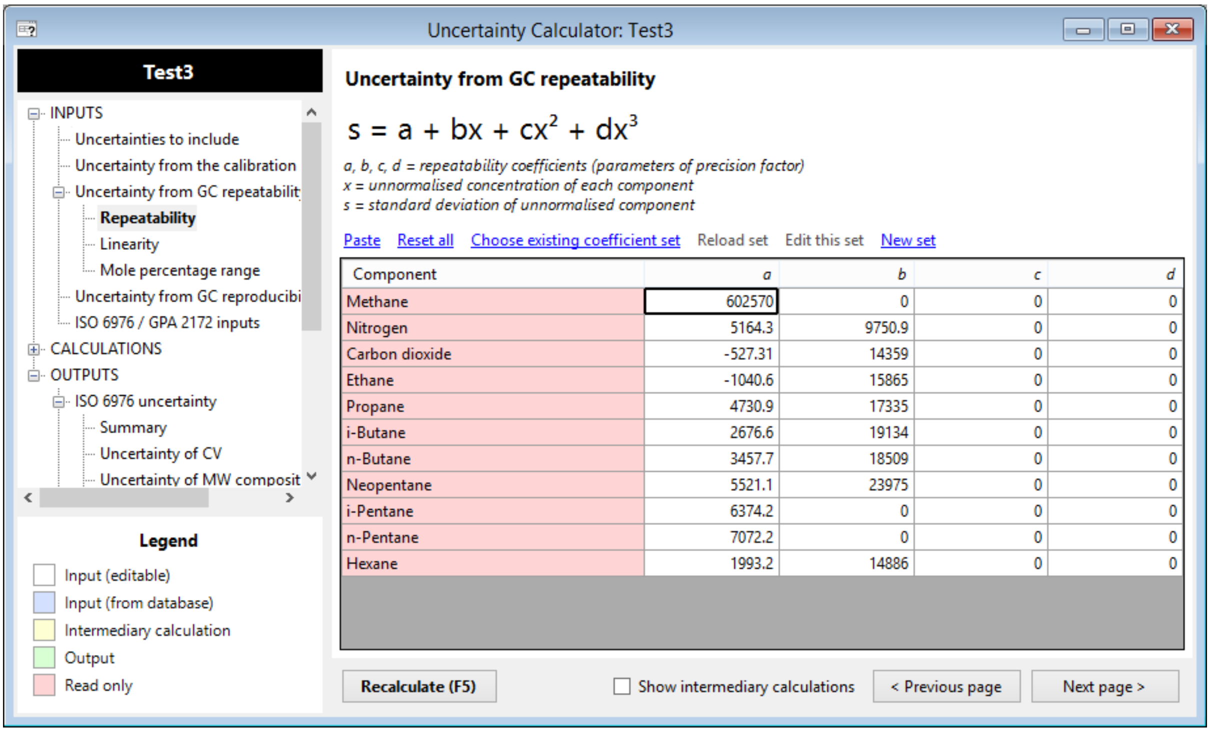
To calculate $U_{repeatability}$, GCAS requires three sets of information: repeatability coefficients, response concentration coefficients, and mole percentage range.

11.3.3.1 GC Repeatability

$$s_i = a + bx_i^* + cx_i^{*2} + dx_i^{*3}$$

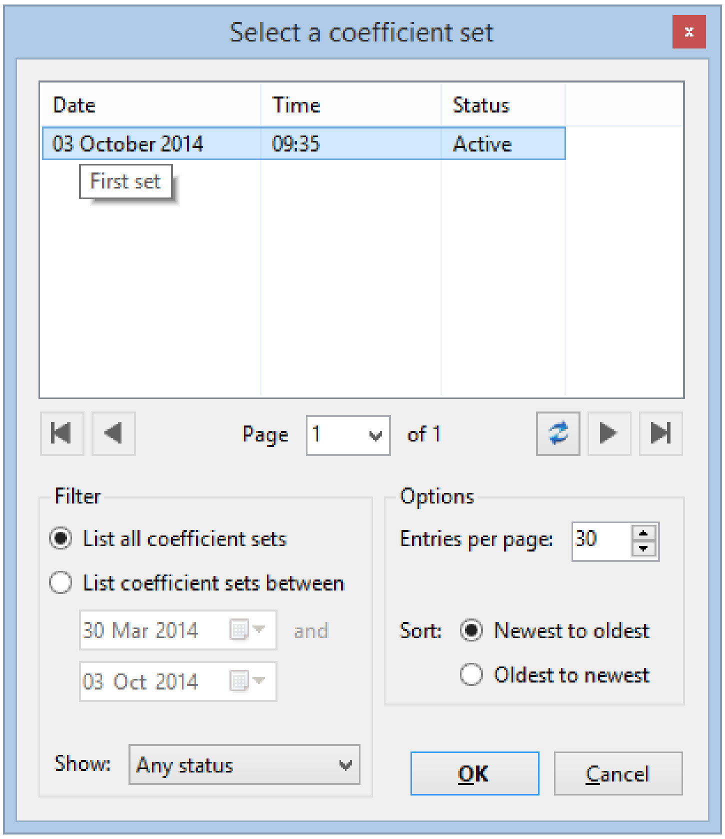
In this formula, s_i is the standard deviation of unnormalised component *i*. The letter *i* is a simplification of enumeration from methane (e.g. from *i* = 0) to the highest carbon count. Four coefficients *a*, *b*, *c*, and *d* are called ***repeatability coefficients*** or *parameters of precision factors*. Detailed explanation of this formula is available on journal article Sutan, A. and Daniel, P., "Gas Chromatography – Conditional Based Monitoring and Live Uncertainty Calculation", *North Sea Flow Measurement Workshop* (2012).

You need to enter these repeatability coefficients on the provided data grid. Double click the cell or press F2 to invoke edit mode. Alternatively, you can paste from Microsoft Excel or other spreadsheet processing software as long as there are 4 (four) columns and equal number of rows. Click the **Paste** link above the grid to do so. The next link **Reset all** will reset all numbers back to zero.



Because these coefficients rarely change (about once a year), we suggest you to store these coefficients in database and recall them the next time you open Uncertainty Calculator form. To store a new coefficient set, click **New set**. This link opens a blank Uncertainty Coefficients form and you type (or paste) the coefficient numbers there. Visit chapter 12 to get detailed explanation of Uncertainty Coefficients form.

If GCAS detects there is at least one coefficient set in database, GCAS loads the latest coefficient set automatically for you. Nonetheless, if this is not the coefficient set you want, you can change which coefficient set in the database to load. Click **Choose existing coefficient set**, then GCAS displays the familiar *Select a coefficient set* dialogue.



Hover your mouse over the list item, on its date column, to reveal a tooltip about the description of the coefficient set. (Due to Windows limitation, tooltip can only appear at the first column.) Click **OK** or double click the list item to load the coefficient set.

You can edit the coefficients after you load them from database too. Just go to the cell, double click or hit F2 to invoke edit mode, and enter the correct number. *However, this change is only temporary as it is only used in current session of uncertainty calculation*. If you need a permanent edit, you have to use Uncertainty Coefficients form then either create a new coefficient set or edit the existing one. Click **Edit this set** to open Uncertainty Coefficients form and invoke its edit mode. This link is only available if you haven't changed any numbers since the coefficient set is loaded from database. To undo all changes and revert back to the original coefficients from database, click **Reload set**.

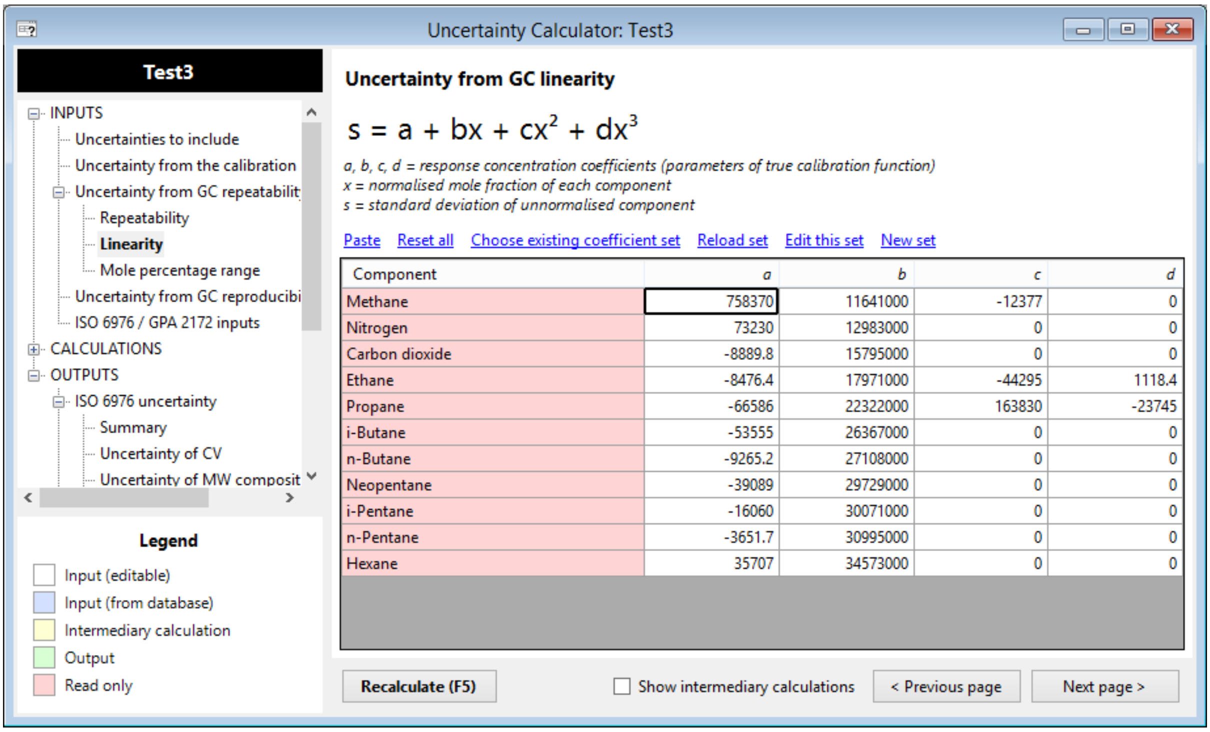
11.3.3.2 GC Linearity

Formula displayed on this wizard page is very similar to GC repeatability:

$$s_i = a + bx_i^* + cx_i^{*2} + dx_i^{*3}$$

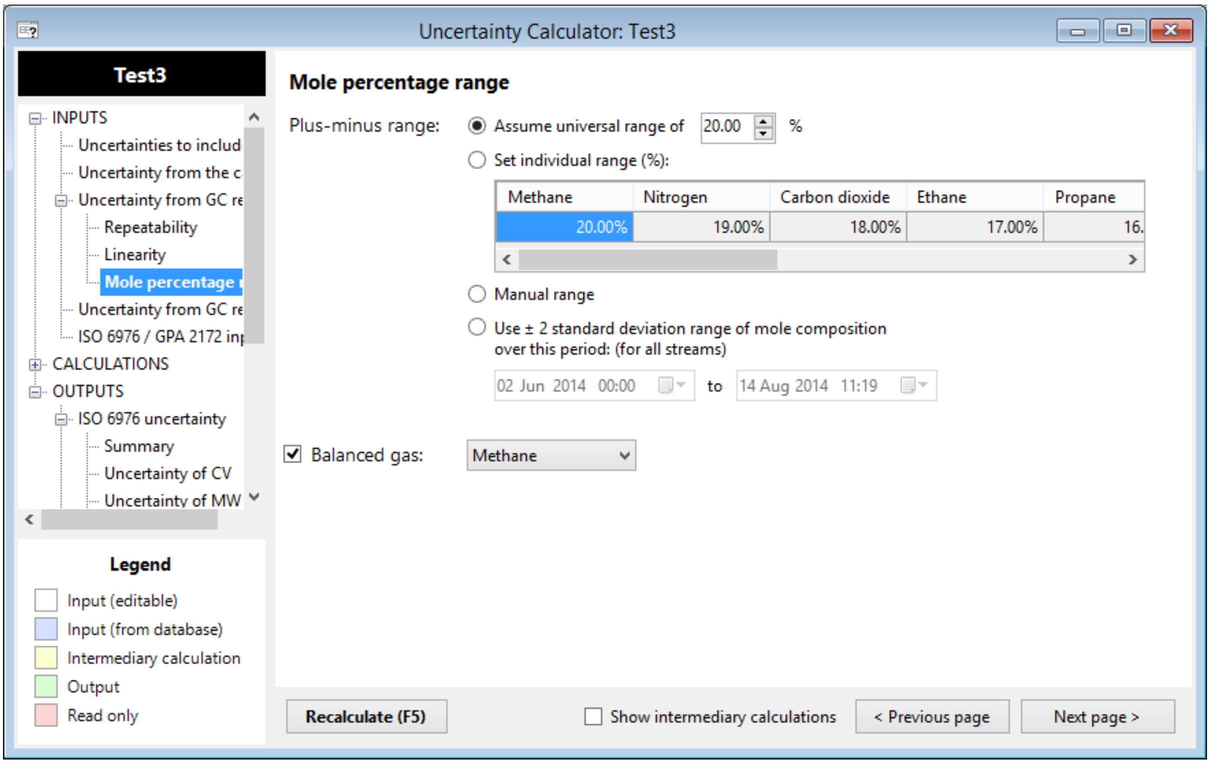
Yet, the *s* here is different from the previous *s*. This formula is used to calculate the standard deviation of mixture gas and sample gas. The coefficients *a*, *b*, *c*, and *d* here are called ***response concentration coefficients*** or *parameters of true calibration functions*.

Similarly, you need to enter these response concentration coefficients on the provided data grid. Double click the cell or press F2 to enter edit mode. Alternatively, you can paste from Microsoft Excel or other spreadsheet processing software as long as there are 4 (four) columns and equal number of rows.



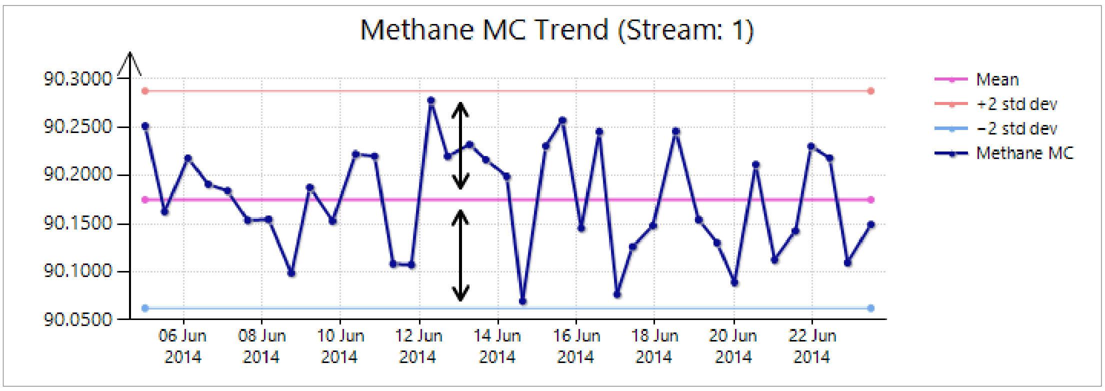
You can also load a coefficient set stored in database. If you already loaded a set for GC repeatability, it also loads for GC linearity. Go to page 180 to read more about loading a coefficient set from database.

11.3.3.3 *Mole Percentage Range*



Choose how the mole percentage plus-minus range be calculated. This plus-minus range will affect the final $U_{repeatability}$ value.

- **Assume universal range**: Every gas (component) uses the same range. This is the most inaccurate option but provides a fail-safe estimate if you do not have sufficient data in Mole Composition module.
- **Set individual range**: Each gas (component) has its own plus-minus range and is independent from one another. This option has better accuracy compared to the universal range.
- **Manual range**: You will type the minimum mole percentage and maximum mole percentage directly at WRM RF page later. Accuracy depends on these values. Use this option if you want to test some unexpected numbers.
- **Use ±2 standard deviation of mole composition**: The plus-minus range is taken from this standard deviation:



of mole composition records within the given period. This option provides the best accuracy.

Balanced gas option keeps your mole percentage low limit and high limit at 100%. This option is turned on by default and you can designate which one as the balanced gas. Typically, methane is the balanced gas because it is the largest component in the mixture and outnumbers other gases many times. To turn off this behaviour, untick **Balanced gas** check box.

Two tables below illustrate how the calculation will go if balanced gas option is turned off (top) and turned on (bottom). In this example, balanced gas is methane and a universal plus-minus range 15% is enforced.

Component	Mole percentages as in certificate	Mole percentages − 15%	Mole percentages + 15%
Methane	89.540070	76.1091	102.9711
Nitrogen	0.064110	0.0545	0.0737
CO_2	0.131230	0.1115	0.1509
Ethane	0.061000	0.0519	0.0702
Propane	0.055400	0.0471	0.0637
i-Butane	0.049180	0.0418	0.0566
n-Butane	0.056100	0.0477	0.0645
Neopentane	0.065100	0.0553	0.0749
i-Pentane	1.665080	1.4153	1.9148
n-Pentane	2.202900	1.8725	2.5333
Hexane	5.548780	4.7165	6.3811
Total	**99.43895**	**84.5232**	**114.3548**

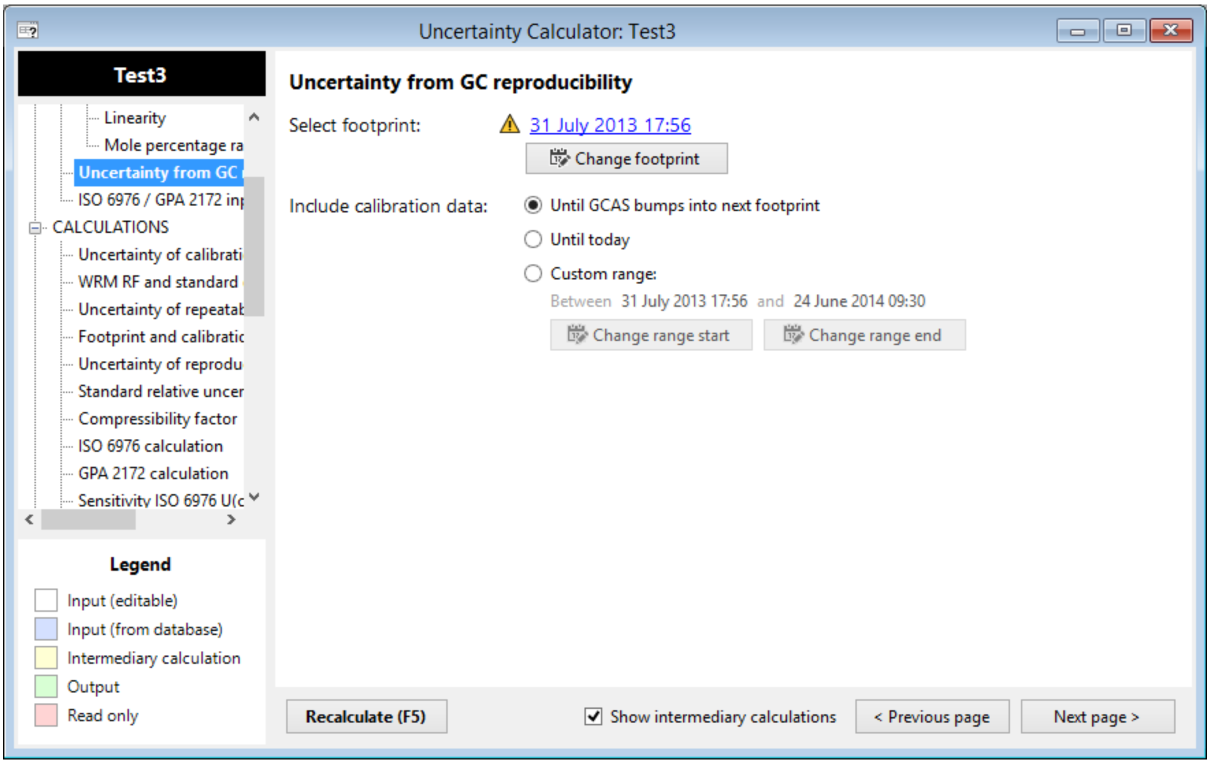
Balanced gas option is turned off.

Component	Mole percentages as in certificate	Mole percentages − 15%	Mole percentages + 15%
Methane*	89.540070	91.5860	88.6163
Nitrogen	0.064110	0.0545	0.0737
CO_2	0.131230	0.1115	0.1509
Ethane	0.061000	0.0519	0.0702
Propane	0.055400	0.0470	0.0637
i-Butane	0.049180	0.0418	0.0566
n-Butane	0.056100	0.0477	0.0645
Neopentane	0.065100	0.0553	0.0749
i-Pentane	1.665080	1.4153	1.9148
n-Pentane	2.202900	1.8725	2.5333
Hexane	5.548780	4.7165	6.3811
Total	**99.43895**	**100.0000**	**100.0000**

Balanced gas option is turned on for methane. While other gases follow ±15% range, methane is calculated by 100 – sum of the others.

However, if you choose another gas which has relatively small percentage as the balanced gas and it causes plus-minus range to fall onto negative number, GCAS replaces the negative percentage with zero and thus their summation is not guaranteed to be 100%. Always choose the component with largest percentage as the balanced gas.

11.3.4 Uncertainty from GC Reproducibility



Select a footprint as a reference. You can see all footprints through Footprint form. If you choose a footprint that happens before the certificate installation date, GCAS displays a warning icon.

Next, decide how many calibration data to include in the calculation. GCAS offers three choices:

- **Until GCAS bumps into next footprint**: The selected footprint itself and all calibration data up to one last calibration before next footprint are included in the calculation of $U_{reproducibility}$.
- **Until today**: The selected footprint itself and all calibration data *including subsequent footprints and all their calibration data afterwards*, all the way to this very moment (i.e. current computer time) are included in the calculation of $U_{reproducibility}$.
- **Custom range**: You can choose from which calibration record exactly to which calibration record that are included in the calculation of $U_{reproducibility}$. A star indicates a footprint.

11.3.5 ISO 6976/GPA 2172 Inputs

ISO 6976 and GPA 2172 calculation require five inputs:

1. Mole composition to use — here GCAS uses the selected calibration certificate as the mole composition,
2. Base pressure (ISO 6976). The default is 1 atmosphere (101325 Pa) absolute,

3. Base temperature (ISO 6976),
4. Combustion temperature (ISO 6976), and
5. Reference pressure (GPA 2172).

GCAS supports six pairs of combustion-base temperature:

- 0°C / 0°C
- 15°C / 0°C (combustion temperature = 15°C, base temperature = 0°C)
- 25°C / 0°C
- 15°C / 15°C
- 20°C / 20°C
- 25°C / 20°C

Split numbers are a set of numbers to indicate the composition of components higher than the device actually supports. For example, a C6+ device reads methane, ethane, propane, butane, pentane, and hexane (denoted "C6+"). The plus sign at "C6+" here indicates that higher C numbers such as C7 and C8 are merged into C6 because the device cannot distinguish them. Split numbers are obtained through lab testing and are expressed using the format *n*/*n*[/*n*[/*n*]...] where *n* is a number. Sum of all numbers should be 100. For example, a C6+ device has split numbers on hexane as 60/30/10. This means mole percentage of hexane is actually 60% of the current hexane, heptane is 30% of hexane, and octane is 10% of hexane. Split numbers increase the accuracy of ISO 6976 outputs.

If you have these split numbers, enter them at the designated input text box. For C6+ devices you can enter up to 5 splits—which are the division among C6/C7/C8/C9/C10. C7+ devices accept maximum 4 splits, and C9+ devices accept maximum two splits. C3− devices (LNG) may go up to 8 splits, but C10+, BTEX, and single gas devices cannot have a split number.

The split numbers being entered should add up to 100. If they don't, GCAS will normalise them before redistributing the certificate mole percentage. For example, 50/30 normalises to 62.5/37.5 so their sum becomes 100.

If you don't have split numbers, leave it blank. GCAS will treat hexane or heptane or whatever the highest carbon count as a single entity throughout the calculation.

11.4 Calculation Pages

When you finished with ISO 6976/GPA 2172 inputs, clicking **Next page** will take you directly to the output summary page and skipping the calculation pages. They were skipped because most users are only interested with the results. If you want to visit calculation pages, please check **Show intermediary calculations** before clicking **Next page**. Alternatively, expand the "CALCULATIONS" node at the navigation tree then pick an item to navigate.

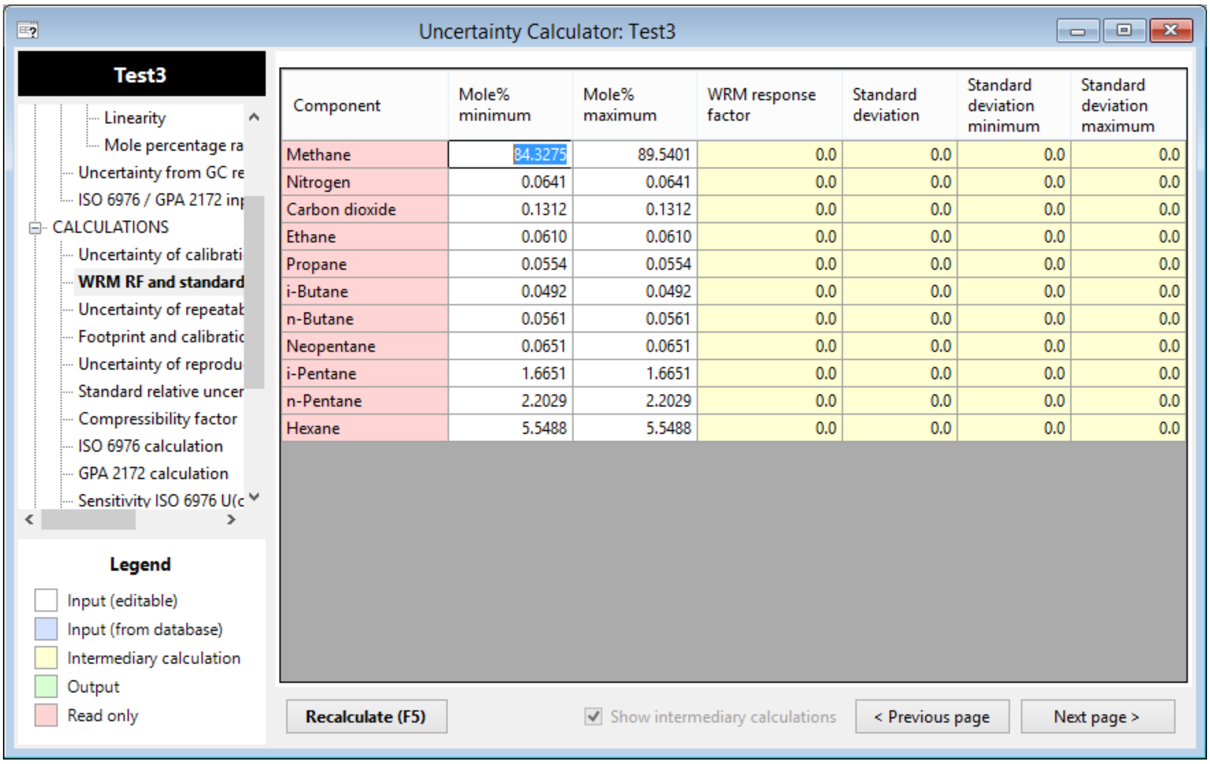
Calculation pages consist of thirteen pages:

1. **Uncertainty of calibration gas**
   This is the result of $U_{cal\ gas}$ calculation at *k* = 2.
   To obtain $U_{cal\ gas}$ at *k* = 1, divide these values by 2.
2. **WRM RF and standard deviation**
   This is the required calculation before we get $U_{repeatability}$. Here you see the mole percentage low limit and high limit according to the mole percentage range defined during input page. Also if you selected manual mole percentage range, you need to enter these low and high limits in this page. Head to chapter 11.4.1 to get help on that topic.
3. **Uncertainty of repeatability**
   This is the result of $U_{repeatability}$ calculation at *k* = 1.
4. **Footprint and calibration data**
   The form displays the response factor of the selected footprint and also average of all calibration data included in this calculation. To see where the average calculation of the calibration data came from, click on numbers that look like links. That will open another form to show the data feed. If you notice weird or unusual numbers at the average columns, open the detailed view to see if there are offending calibration records that should've been set as inactive.
5. **Uncertainty of reproducibility**
   This is the result of $U_{reproducibility}$ calculation at *k* = 1.
6. **Standard relative uncertainty**
   This is the result of U_{GC} at *k* = 1. To this point, we are half way finished with the calculation.
7. **Compressibility factor**
   It shows the calculation of Z_{mix} and Z_{air} based on the base pressure and temperature specified at ISO 6976/GPA 2172 input page.
8. **ISO 6976 calculation**
   This page is probably worth visiting if you are interested with the calorific value, relative density, or some other outputs of ISO 6976 calculation.
9. **GPA 2172 calculation**
   Similar to the ISO 6976 calculation page, this page presents the gross heating value and other outputs of GPA 2172 calculation.
10. **ISO 6976 sensitivity analysis (calibration gas & GC reproducibility)**
    This page displays the relative sensitivity of all ISO 6976 outputs for $U_{calibration\ gas}$ and $U_{reproducibility}$.
11. **ISO 6976 sensitivity analysis (GC repeatability)**
    This page displays the relative sensitivity of all ISO 6976 outputs for $U_{repeatability}$.
12. **GPA 2172 sensitivity analysis (calibration gas & GC reproducibility)**
    This page displays the relative sensitivity of all GPA 2172 outputs for $U_{calibration\ gas}$ and $U_{reproducibility}$.
13. **GPA 2172 sensitivity analysis (GC repeatability)**
    This page displays the relative sensitivity of all GPA 2172 outputs for $U_{repeatability}$.

11.4.1 Manual Mole Percentage Range

If you selected manual mole percentage range for the calculation of $U_{repeatability}$, you need to enter mole percentage range on the WRM RF and standard deviation page. The column turns white to indicate that it is editable. Initial numbers on these columns are copied from your calibration gas certificate. Enter a lower value for mole percentage low limit and higher value for the high limit. On all options other than manual range, these columns appear yellow and is read-only.

Double click the cell or press `F2` to enter edit mode. Type the minimum value or maximum value, then press `Enter` to commit. After you press `Enter`, you should see all columns on current row to the right side is recalculated. $U_{repeatability}$ is recalculated, thus U_{GC} and subsequent calculations also change.



Note

Manual mole percentage range is not balanced. The sum of low limit may be less than 100, and the sum of high limit can be more than 100.

11.4.2 Regarding Sensitivity Analysis

Starting from GCAS version 1.3.1.0, GCAS calculates two sensitivity sets. One for $U_{cal\ gas}$ and $U_{reproducibility}$, and the other for $U_{repeatability}$. Sensitivity of calibration gas and GC reproducibility is based on the mole percentages in your calibration certificate. Sensitivity of GC repeatability is based on the average between mole percentage lower bound and upper bound range.

If you chose *universal mole percentage range* or *individual mole percentage range* during that input page, the sensitivity of GC repeatability becomes the same as sensitivity of calibration gas and GC reproducibility. The reason is mole range for GC repeatability is also taken from the calibration certificate.

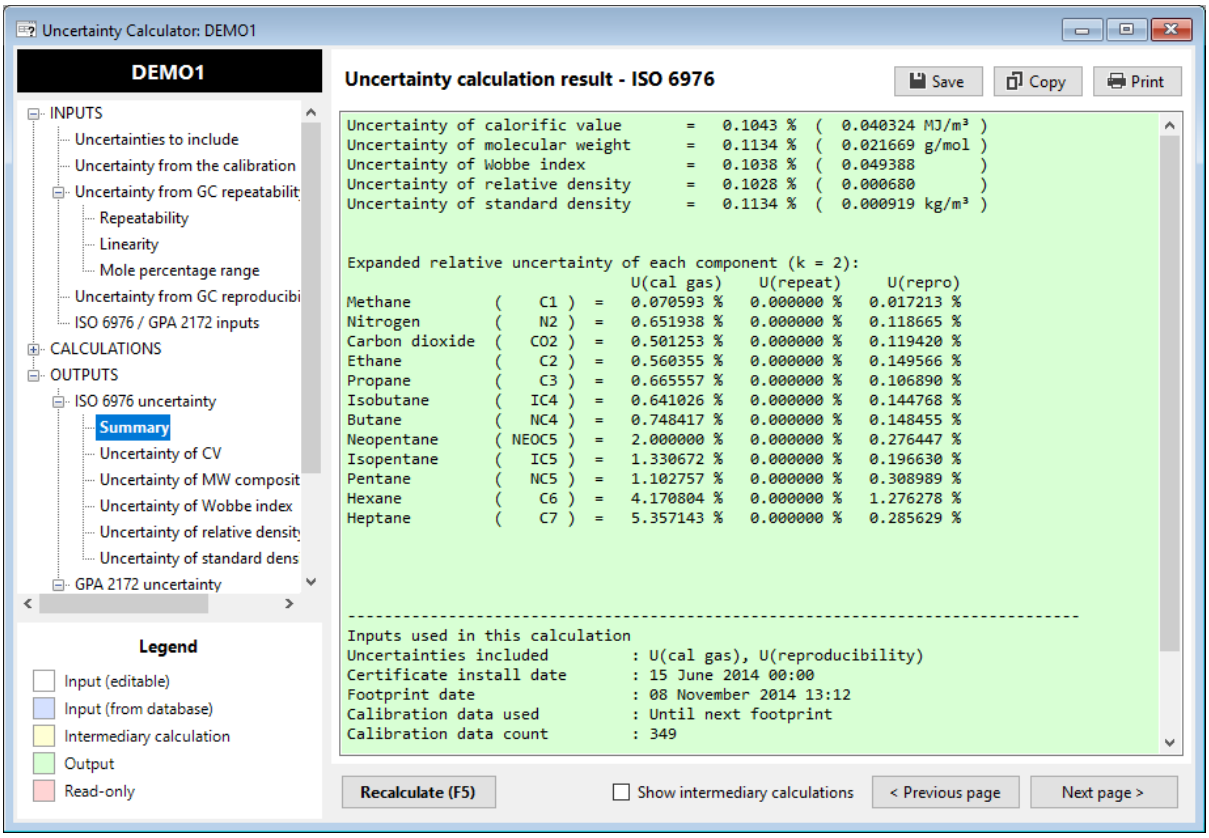
But if you selected *manual mole percentage range* or used ±2 standard deviations of [mole composition records](), the lower and upper bound of mole percentage range do not correspond to the calibration certificate anymore. Thus, GCAS calculates the correct sensitivity values and use these values for $U_{repeatability}$.

11.5 Output Pages

Output pages display calculation results. The output is divided into two categories, one for each standard (ISO 6976 and GPA 2172). In each category, there is one summary page plus as many detail pages as required. One detail page is for one ISO 6976/GPA 2172 output value.

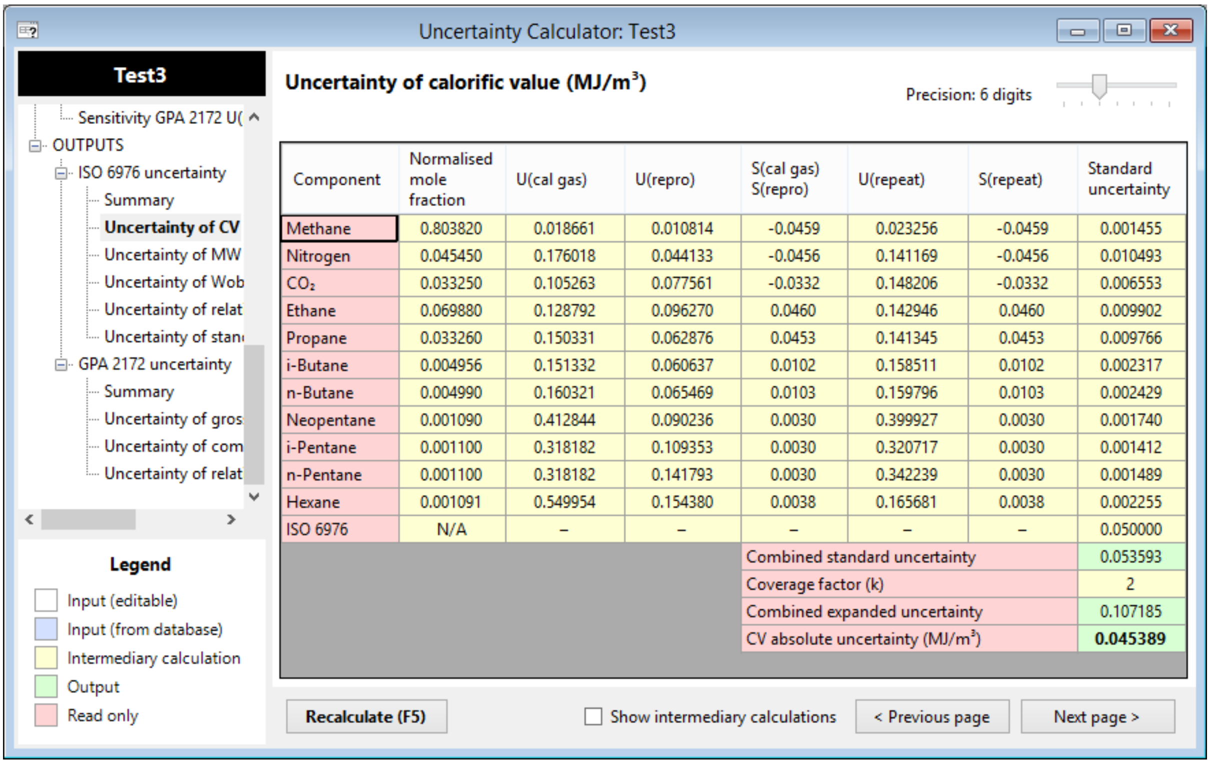
11.5.1 Summary Page

Summary page displays five uncertainties of ISO 6976 outputs or three uncertainties of GPA 2172 outputs, as well as *expanded relative uncertainty* (k = 2) of each component. You can copy the report to clipboard, save it to a text file, or print it.



11.5.2 Detailed Pages

There are five detail output pages for ISO 6976 outputs and three detail pages for GPA 2172 outputs. These pages share the same layout and same logic.



Component	Normalised mole fraction	U(cal gas)	U(repro)	S(cal gas) S(repro)	U(repeat)	S(repeat)	Standard uncertainty
Methane	0.803820	0.018661	0.010814	-0.0459	0.023256	-0.0459	0.001455
Nitrogen	0.045450	0.176018	0.044133	-0.0456	0.141169	-0.0456	0.010493
CO_2	0.033250	0.105263	0.077561	-0.0332	0.148206	-0.0332	0.006553
Ethane	0.069880	0.128792	0.096270	0.0460	0.142946	0.0460	0.009902
Propane	0.033260	0.150331	0.062876	0.0453	0.141345	0.0453	0.009766
i-Butane	0.004956	0.151332	0.060637	0.0102	0.158511	0.0102	0.002317
n-Butane	0.004990	0.160321	0.065469	0.0103	0.159796	0.0103	0.002429
Neopentane	0.001090	0.412844	0.090236	0.0030	0.399927	0.0030	0.001740
i-Pentane	0.001100	0.318182	0.109353	0.0030	0.320717	0.0030	0.001412
n-Pentane	0.001100	0.318182	0.141793	0.0030	0.342239	0.0030	0.001489
Hexane	0.001091	0.549954	0.154380	0.0038	0.165681	0.0038	0.002255
ISO 6976	N/A	–	–	–	–	–	0.050000
				Combined standard uncertainty			0.053593
				Coverage factor (k)			2
				Combined expanded uncertainty			0.107185
				CV absolute uncertainty (MJ/m³)			**0.045389**

Column names starting with **U** are uncertainties. **U(repro)** for example, is the uncertainty of GC reproducibility at k = 1. Column names starting with **S** are sensitivities. As already explained in chapter 11.4.2, sensitivity for GC repeatability becomes identical to sensitivity of calibration gas and GC reproducibility if the mole percentage range is set to universal or individual mode.

What may be the interest here are the cells coloured in green. For example, let's use the screenshot above. The screenshot tells us uncertainty of calorific value, but the same layout applies to other detail pages as well.

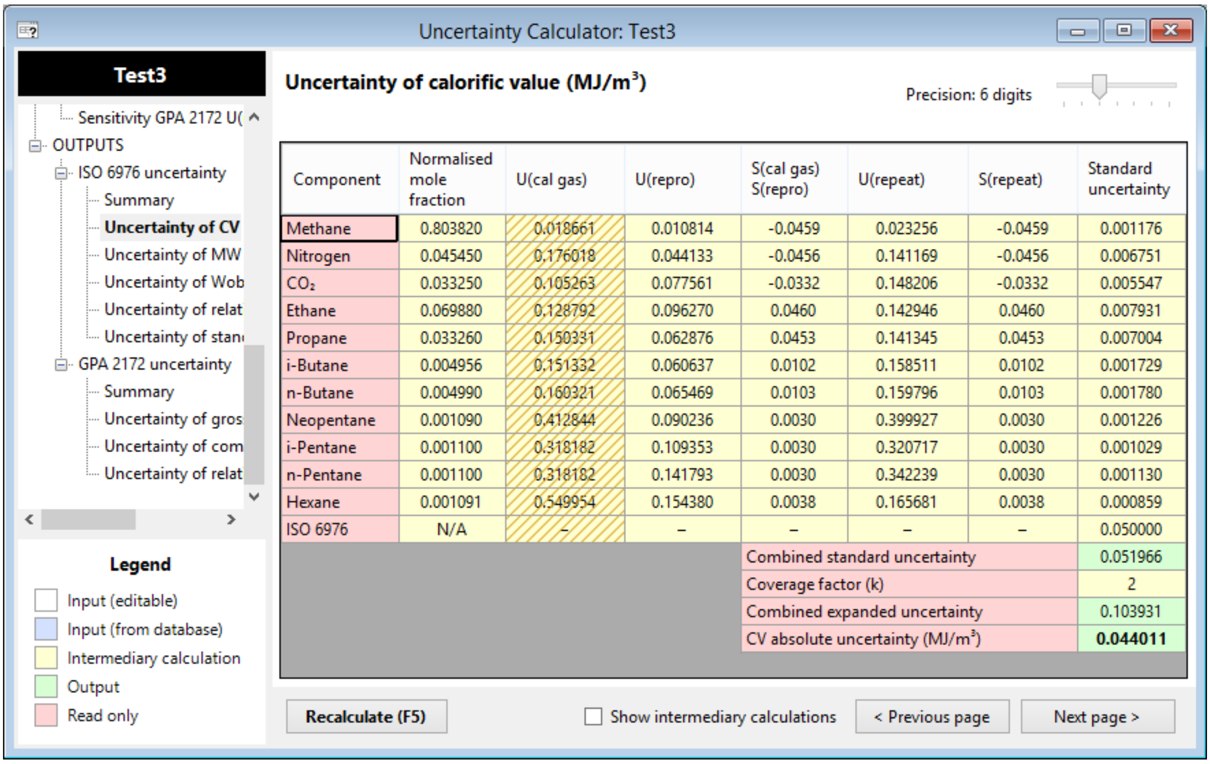
The cell at bottom-right corner rendered in bold font is the CV **absolute uncertainty**, or U_{CV}. It has a unit megajoules per cubic metre (MJ/m^3). If you want to see how much the CV itself is, visit the ISO 6976 calculation page. Note that not all ISO 6976 outputs have units—look for the unit at the title label. Relative density and Wobbe index do not have unit.

Above the absolute uncertainty is the **combined expanded uncertainty**. This is U_{CV} expressed in percentage, not in MJ/m^3. The percentage is measured against the CV (again, in the ISO 6976 calculation page). Expanded uncertainty implies k = 2. And there is also **combined standard uncertainty** which indicates k = 1.

Standard uncertainty is calculated using this formula:

$$\begin{aligned}&Standard\ uncertainty\\&= \sqrt{\left(U_{cal\ gas} \times S_{cal\ gas}\right)^2 + \left(U_{repeatability} \times S_{repeatability}\right)^2 + \left(U_{reproducibility} \times S_{reproducibility}\right)^2}\end{aligned}$$

where *U* and *S* are uncertainty and sensitivity respectively, given that all uncertainties are included. If you opt out the $U_{cal\ gas}$ for instance, the column **U(cal gas)** will be overlaid with a diagonal strokes indicating the values are disregarded. $U_{cal\ gas}$ is treated as zero, so the formula above only contains $U_{repeatability}$ and $U_{reproducibility}$.



Component	Normalised mole fraction	U(cal gas)	U(repro)	S(cal gas) S(repro)	U(repeat)	S(repeat)	Standard uncertainty
Methane	0.803820	0.018661	0.010814	-0.0459	0.023256	-0.0459	0.001176
Nitrogen	0.045450	0.176018	0.044133	-0.0456	0.141169	-0.0456	0.006751
CO_2	0.033250	0.105263	0.077561	-0.0332	0.148206	-0.0332	0.005547
Ethane	0.069880	0.128792	0.096270	0.0460	0.142946	0.0460	0.007931
Propane	0.033260	0.150331	0.062876	0.0453	0.141345	0.0453	0.007004
i-Butane	0.004956	0.151332	0.060637	0.0102	0.158511	0.0102	0.001729
n-Butane	0.004990	0.160321	0.065469	0.0103	0.159796	0.0103	0.001780
Neopentane	0.001090	0.412844	0.090236	0.0030	0.399927	0.0030	0.001226
i-Pentane	0.001100	0.318182	0.109353	0.0030	0.320717	0.0030	0.001029
n-Pentane	0.001100	0.318182	0.141793	0.0030	0.342239	0.0030	0.001130
Hexane	0.001091	0.549954	0.154380	0.0038	0.165681	0.0038	0.000859
ISO 6976	N/A	–	–	–	–	–	0.050000
				Combined standard uncertainty			0.051966
				Coverage factor (k)			2
				Combined expanded uncertainty			0.103931
				CV absolute uncertainty (MJ/m³)			**0.044011**

The Uncertainty Calculator form when $U_{cal\ gas}$ is excluded. Notice the CV absolute uncertainty is different from the previous screenshot (0.044011 versus 0.045389 MJ/m³).

There is a precision control at the top right region of these pages. This slider/track bar controls how many decimal digits to display on the grid. Each detail page is independent, a precision control for one page does not affect the other pages. By default, GCAS displays six digits after the decimal point.

12 Uncertainty Coefficients

Uncertainty Coefficients (capitalised C) is a tool to store uncertainty coefficients (repeatability coefficients and response concentration coefficients) in GCAS database so that you don't have to re-enter the same set of coefficients over and over again as they rarely change.

> **Note**
>
> This module requires GCAS feature either *Uncertainty Calculation* or *Uncertainty Trend* to be included in your licence.

As seen at chapter 11.3.3, the coefficient input page on Uncertainty Calculator form has several links related to Uncertainty Coefficients. This chapter explains about Uncertainty Coefficients form which is the place to enter the uncertainty coefficient set.

The term *coefficient set* refers to collection of uncertainty coefficients (*a*, *b*, *c*, *d*), two packages of them (repeatability and response concentration), of all gases. Every gas has their own coefficients and these coefficients are bundled together into one *coefficient set* record in GCAS database.

12.1 The Uncertainty Coefficients Form

Uncertainty Coefficients form is accessible from the View menu > **Uncertainty Coefficients**. But before that, you need to select the correct GC device from the device panel or recent device panel.

Uncertainty Coefficients: Test3

Browse another set... | Load latest set

DEVICE NAME **Test3** | STATUS **Active** | DATE OF TEST **21 October 2014**

Repeatability Coefficients | Response Concentration Coefficients

Copy Help

Component	a	b	c	d
Methane	602,570	0	0	0
Nitrogen	5,164.3	9,750.9	0	0
Carbon dioxide	-527.3	14,359	0	0
Ethane	-1,040.6	15,865	0	0
Propane	4,730.9	17,335	0	0
i-Butane	2,676.6	19,134	0	0
n-Butane	3,457.7	18,509	0	0
Neopentane	5,521.1	23,975	0	0
i-Pentane	6,374.2	0	0	0
n-Pentane	7,072.2	0	0	0
Hexane	1,993.2	14,886	0	0

Description:

First set

Uncertainty Coefficients: Test3

Browse another set... | Load latest set

DEVICE NAME **Test3** | STATUS **Active** | DATE OF TEST **21 October 2014**

Repeatability Coefficients | Response Concentration Coefficients

Copy Help

Component	a	b	c	d
Methane	758,370	11,641,000	-12,377	0
Nitrogen	73,230	12,983,000	0	0
Carbon dioxide	-8,889.8	15,795,000	0	0
Ethane	-8,476.4	17,971,000	-44,295	1,118.4
Propane	-66,586	22,322,000	163,830	-23,745
i-Butane	-53,555	26,367,000	0	0
n-Butane	-9,265.2	27,108,000	0	0
Neopentane	-39,089	29,729,000	0	0
i-Pentane	-16,060	30,071,000	0	0
n-Pentane	-3,651.7	30,995,000	0	0
Hexane	35,707	34,573,000	0	0

Description:

First set

Uncertainty Coefficients form has two tabs, one for repeatability coefficients and the other for response concentration coefficients. Repeatability coefficients are used to calculate standard deviation of GC repeatability, and response concentration coefficients are used to calculate standard deviation of GC linearity. At the bottom, there is a text box to display additional note or description about the coefficient set.

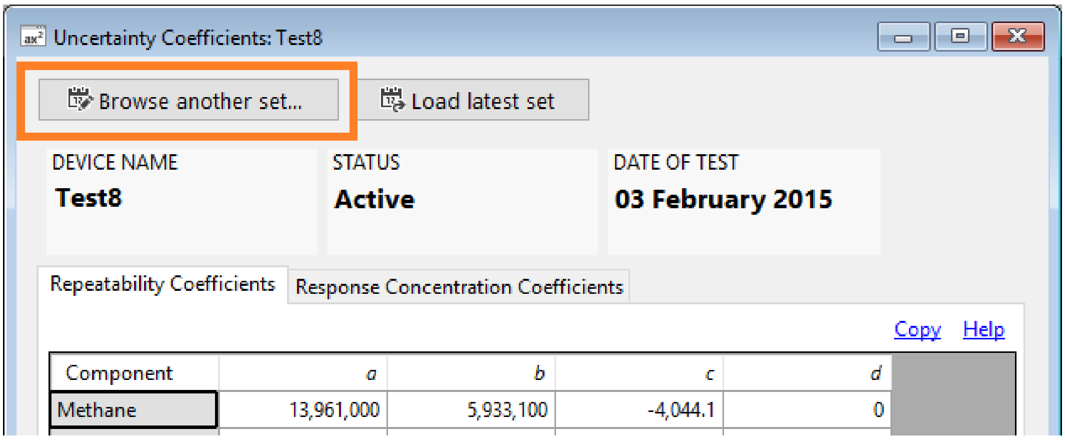
Each coefficient set consists of four coefficients, namely *a*, *b*, *c*, and *d* on both repeatability and response concentration. These are the coefficients of this formula:

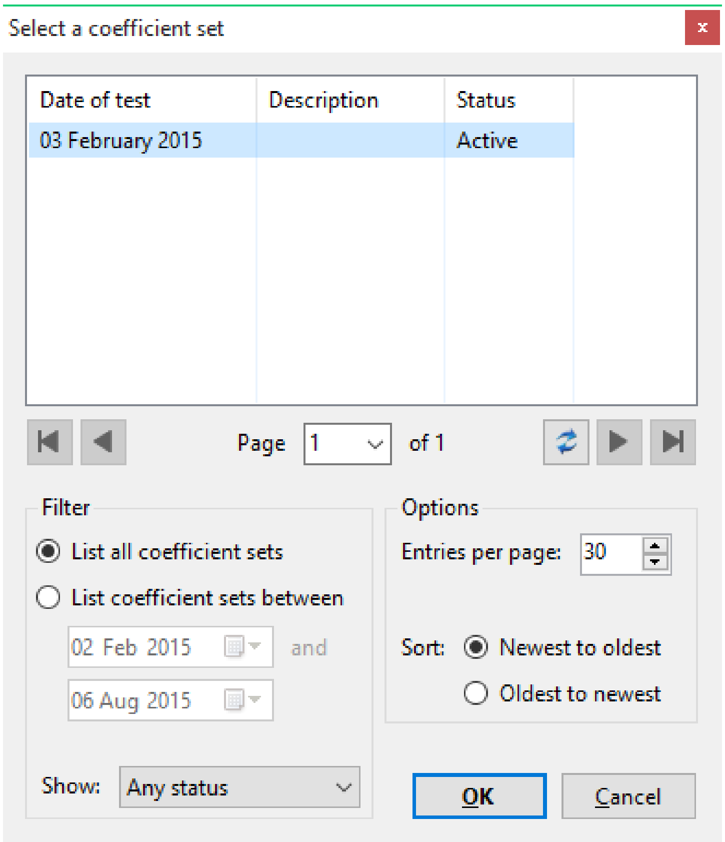
$$s_i = a + bx_i^* + cx_i^{*2} + dx_i^{*3}$$

Where s is the standard deviation of one gas/component used in the part of calculation, and x_i is mole fraction of this component.

12.2 View Previous Coefficient Sets

To view other uncertainty coefficient sets, click **Browse another set**. Select a different coefficient set, then click **OK** or double click the list item.



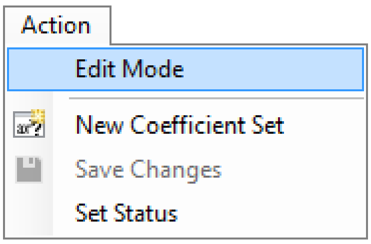


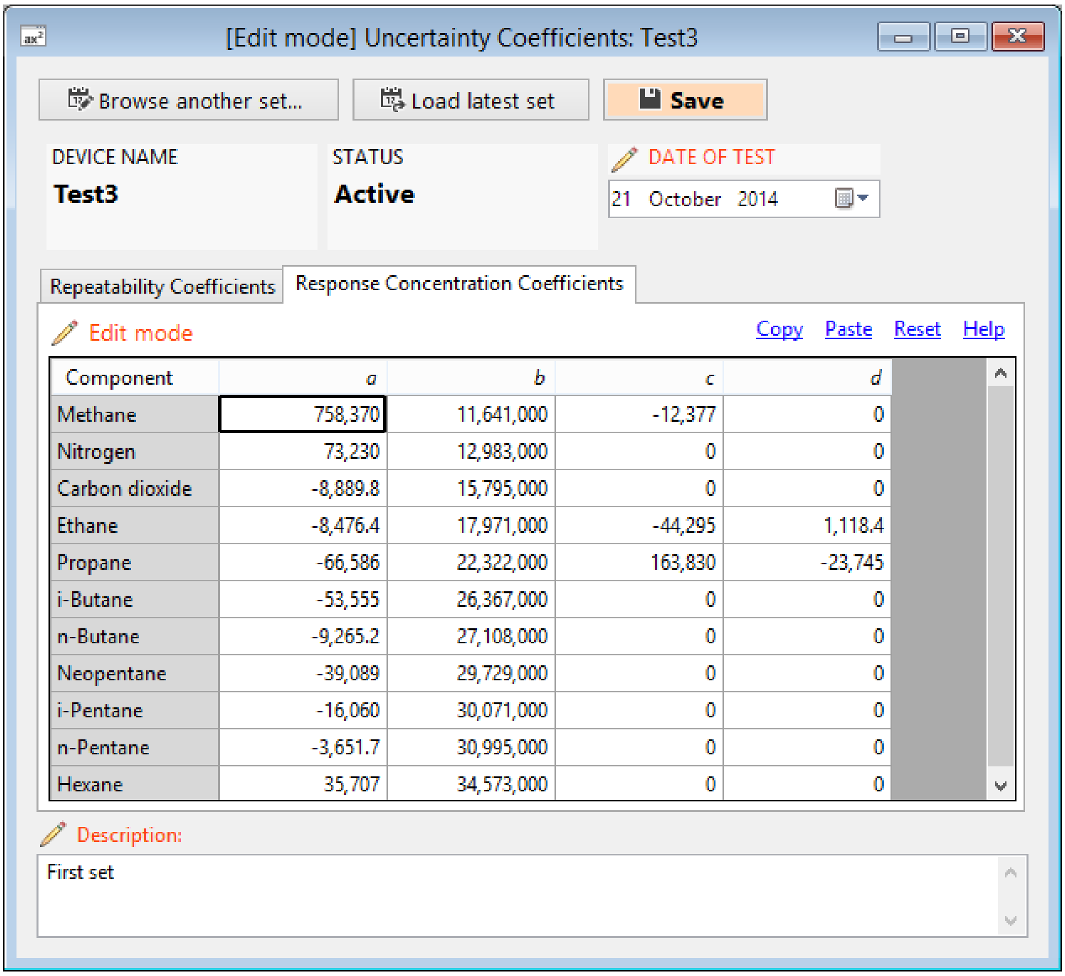
"Select a coefficient set" dialogue (Windows 10 doesn't render form border)

Click **Load latest set** to return to the most up-to-date uncertainty coefficient set.

12.3 Edit Mode

In order to edit the coefficients or the description, you need to put Uncertainty Coefficients form in *edit mode*. Open the Action menu and select **Edit Mode**. You know the form is on edit mode when you see pencil icon, some labels are coloured orange, and there is a **Save** button at the top region of the form.





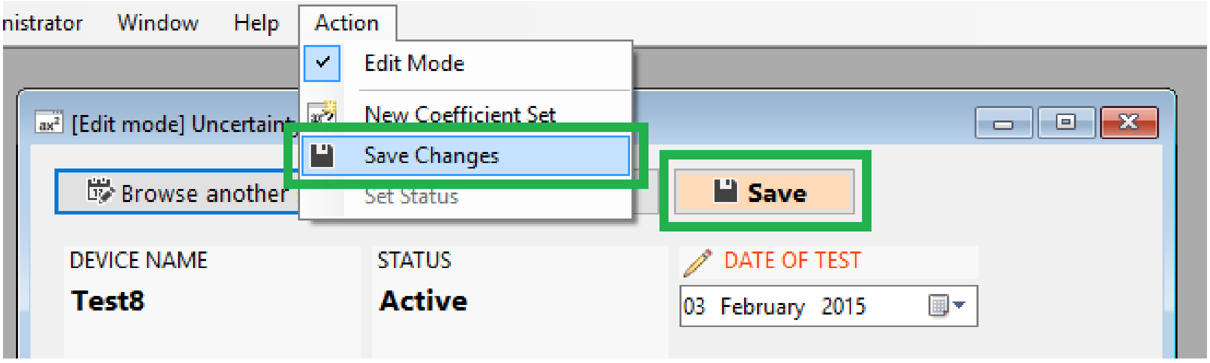
The Uncertainty Coefficients form in edit mode.

During edit mode, you can edit the numbers in both grids (repeatability coefficient grid and response concentration coefficient grid). **Date of test** field at the top and **Description** text box at the bottom of the form also become editable.

> **Note**
>
> Edit mode is mainly intended for editing the description or correcting minor mistakes. If there are too many coefficients to edit, we suggest you to create a new set and set this record to inactive instead.
>
> Uncertainty coefficients do not have comment feature. Put short comments in the description text box if you like.

You can paste the coefficient numbers from Microsoft Excel or other spreadsheet editing software, as long as there are 4 columns and equal number of rows. Click **Paste** link above the grid to paste the numbers. The **Reset** link resets all numbers in the grid back to zero. Both *Repeatability Coefficients* tab and *Response Concentration Coefficients* tab have their own Paste and Reset command link.

When you finished editing the numbers and the description, click **Save** button or go to Action menu > **Save Changes** to commit the change. The form exits its edit mode and becomes read-only again.



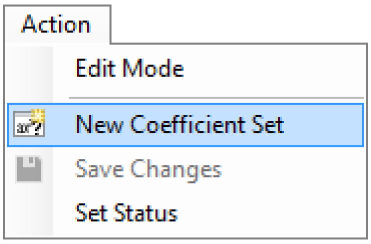
Otherwise to cancel editing and discard all of your changes, open Action menu and select **Edit Mode** again to remove its tick mark. This will exit edit mode and reload the coefficient set from the database.

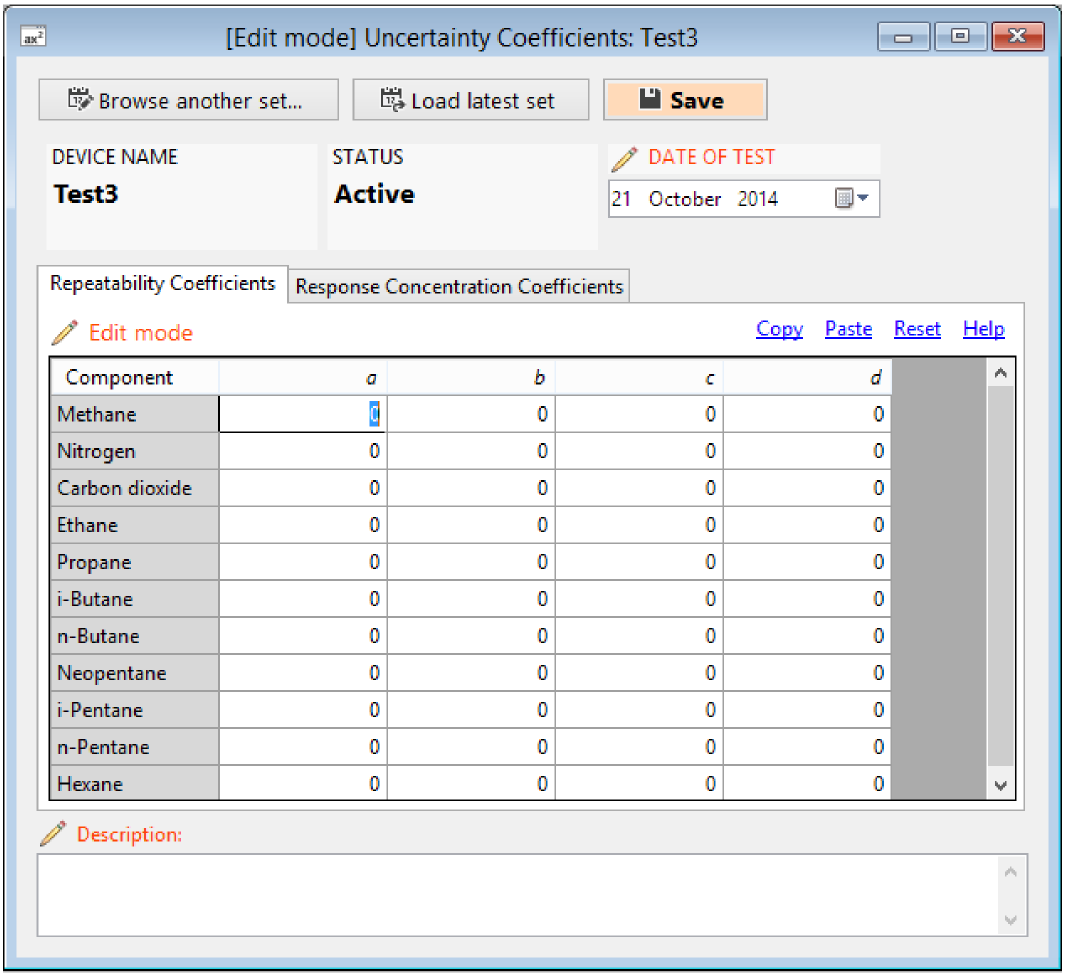
12.4 Create New Coefficient Set

Creating a new set instead of editing an existing set over and over again provides some advantages, such as

- You have a historical record of coefficient sets. When the annual multilevel calibration is conducted, it generates a new set and this should be entered as a new set too.
- You can test several sets with minor differences in the Uncertainty Calculator form. Make sure to write the correct description for the uncertainty set in order to avoid confusion when selecting the coefficient record in Uncertainty Calculator.

From an open Uncertainty Coefficients form, open the Action menu and select **New Coefficient Set**. This menu creates a blank coefficient set (all zeroes) with the timestamp set to current computer time.





Begin entering the coefficient numbers one by one. Be watchful for potential human error. Alternatively, you can paste the coefficients from Microsoft Excel or other spreadsheet editing software as long as there are 4 columns and equal number of rows. Click **Paste** to do so.

Enter both coefficient sets. Switch tab to move from repeatability coefficients to response concentration coefficients or vice versa. If you forget to enter coefficients for the other tab, GCAS will alert you if one tab has all zeroes upon save.

Don't forget to set the date of test. This is the date information of when the multilevel calibration was conducted, not the date of when these coefficient sets was entered.

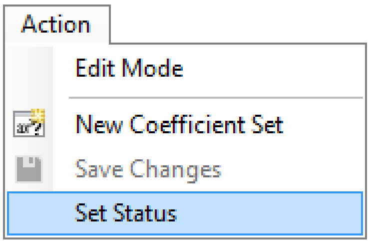
Write the description. It is a good practice to provide a description about this coefficient set.

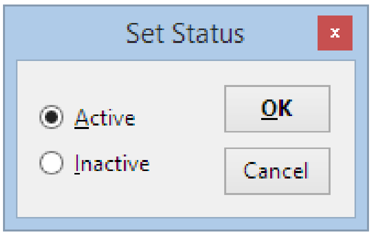
When you are finished, click **Save** button or go to the Action menu > **Save Changes** to save these coefficients into database. Otherwise to cancel all of these, go to the Action menu > **Edit Mode** to remove its tick mark. The form will revert to the last record viewed.

12.5 Change Record Status

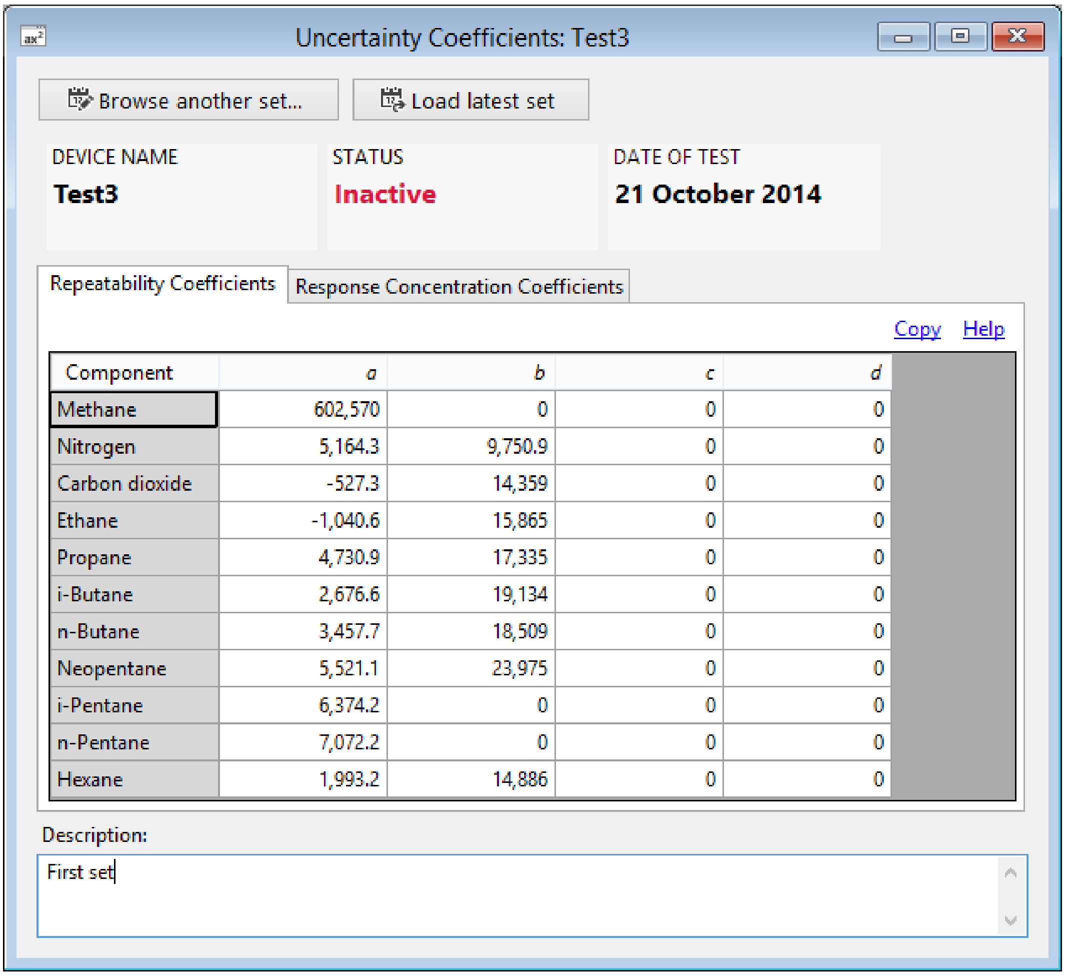
Like other types of record in GCAS database, uncertainty coefficient set has a status bit indicating whether the record is active or inactive.

To change status, open the Action menu and select **Set Status**. This menu brings the *Set Status* dialogue where you can flip the status bit from active to inactive or vice versa.





Click **OK** and GCAS instructs the Uncertainty Coefficients form to reload the set with the new status.



We believe it is a good practice to provide a short note of why the set was made inactive or active. To write this note, invoke edit mode from the Action menu, write the note on the description box, and finally click **Save**.

13 Uncertainty Trend

Uncertainty Trend is a module to graph uncertainties of a GC device over time. It is equivalent to running many individual uncertainty calculations, with the same configuration, for an increasing range of calibration data, and finally plotting result numbers on a graph.

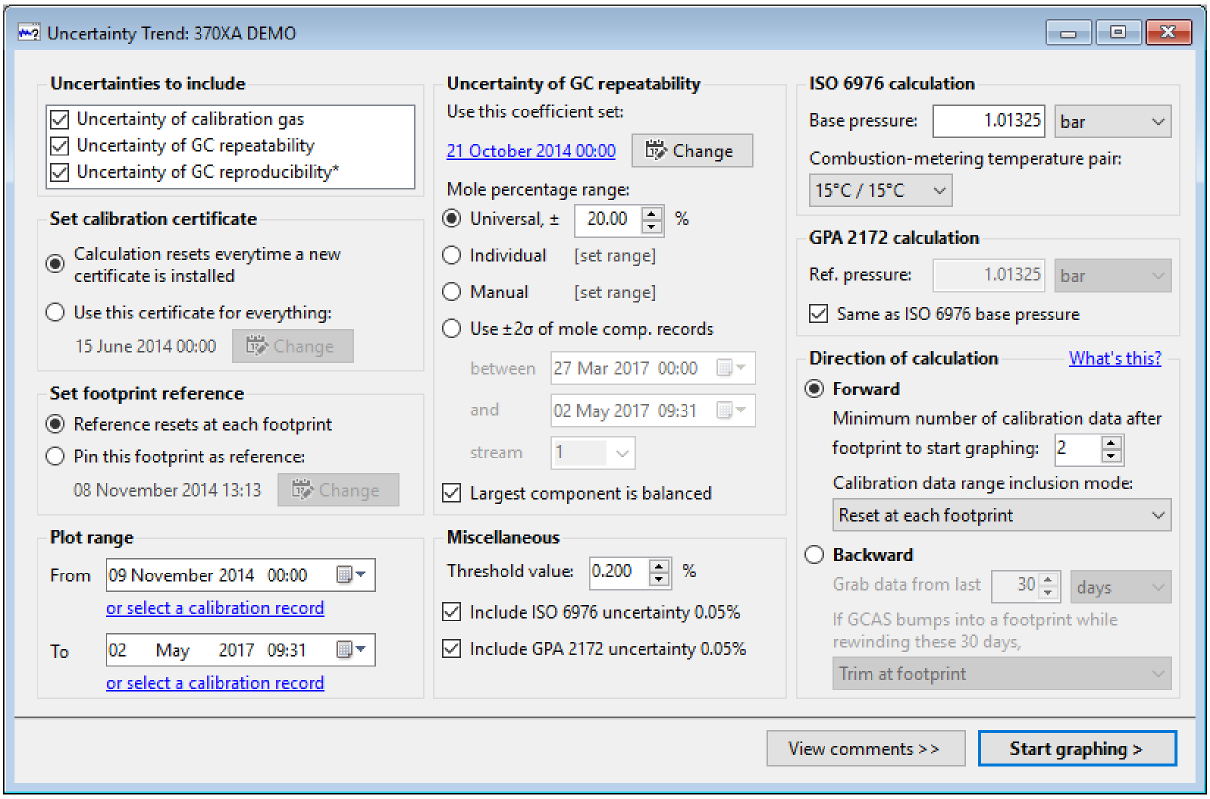
The chart has a threshold line. When uncertainty line crosses the threshold line, it is time to perform a preventive maintenance of the GC.

Note

This module requires *Uncertainty Trend* to be included in your GCAS licence.

13.1 The *Uncertainty Trend* Form

Select a device on your device panel or recent device panel, then go to the View menu > **Uncertainty Trend**.



This form has three pages: Parameter page, chart page, and comment page. The buttons at the bottom of the form do the navigation between these pages.

When Uncertainty Trend form is opened, it shows the *parameter page*. This page configures all parameters required to perform uncertainty calculation. These parameters are

- Uncertainties to include,

- Calibration certificate,
- Footprint reference,
- Plot range,
- Uncertainty coefficients*,
- Mole percentage range*,
- ISO 6976 parameters,
- GPA 2172 parameters,
- Direction, and
- Threshold line.

*available if Uncertainty of GC repeatability is ticked.

Each parameter is explained in chapter 13.2. After all parameters are set correctly, click **Start graphing** and GCAS will start the calculation.

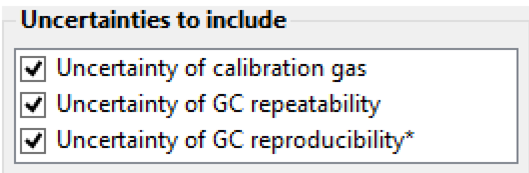
Note

Uncertainty calculation is slow because it loads many different data from database. Moreover, uncertainty trend calculation is a sequence of many uncertainty calculations. Depending on how wide your plot range and how many calibration records inside the plot range, one trend calculation may take from few seconds to ten minutes or even more. Fast CPU and good network connection between your computer and the database server help reducing the calculation time.

13.2 Uncertainty Trend Parameters

This chapter explains each uncertainty trend parameter.

13.2.1 Uncertainties to Include



As explained in chapter 11, uncertainty calculation takes up to three components: Uncertainty of calibration gas ($U_{\text{cal gas}}$), uncertainty of GC repeatability + linearity ($U_{\text{repeatability}}$), and uncertainty of GC reproducibility ($U_{\text{reproducibility}}$). These components may be included or excluded, which turns their values to zero if excluded.

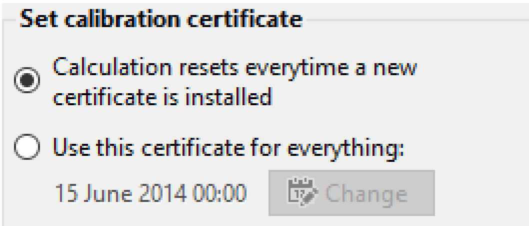
However in uncertainty trend, $U_{\text{reproducibility}}$ *must* be included. You see an asterisk (*) indicating that it should be left checked. Well, technically, you *can* uncheck $U_{\text{reproducibility}}$. Though, we strongly discourage it because excluding $U_{\text{reproducibility}}$ would graph a straight line across all available calibration records.

Note

The GC device must have a calibration gas certificate. Uncertainty Trend form cannot graph your chart if there are no certificates installed.

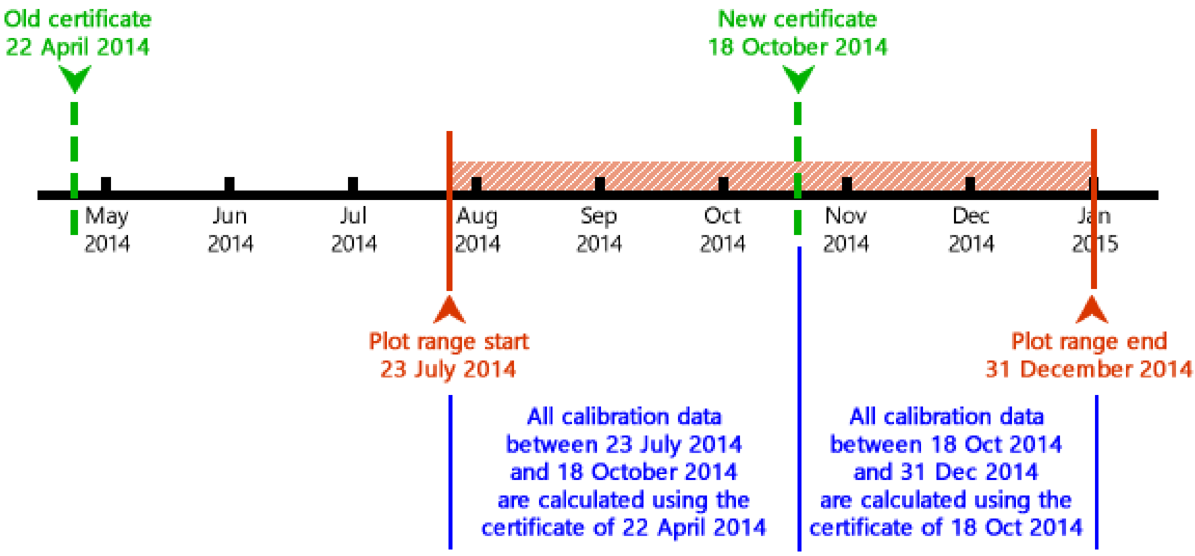
You cannot tick **Uncertainty of GC repeatability** if your GC device has no uncertainty coefficients stored in database. Uncertainty coefficient selection field and mole percentage range options will be disabled. To create a new coefficient set, rewind to chapter 12.4.

13.2.2 Calibration Certificate

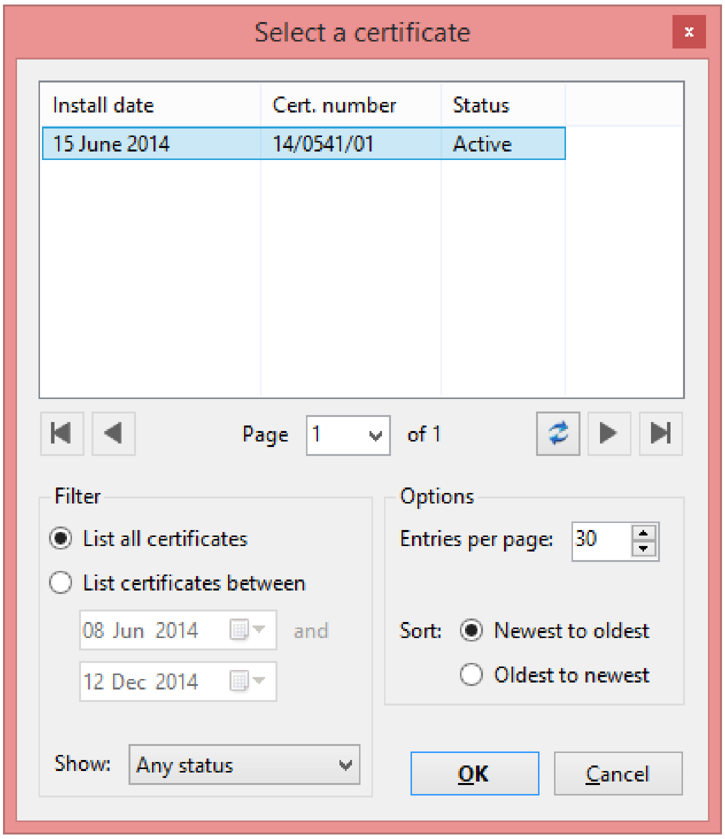


This section controls which certificates to use. There are two options: Reset calculation at each certificate, or pin a certificate for everything. The default is reset calculation at each certificate.

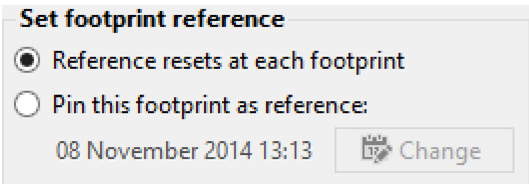
On first option, whenever a new calibration certificate installed, all data after the certificate are calculated using the new certificate.



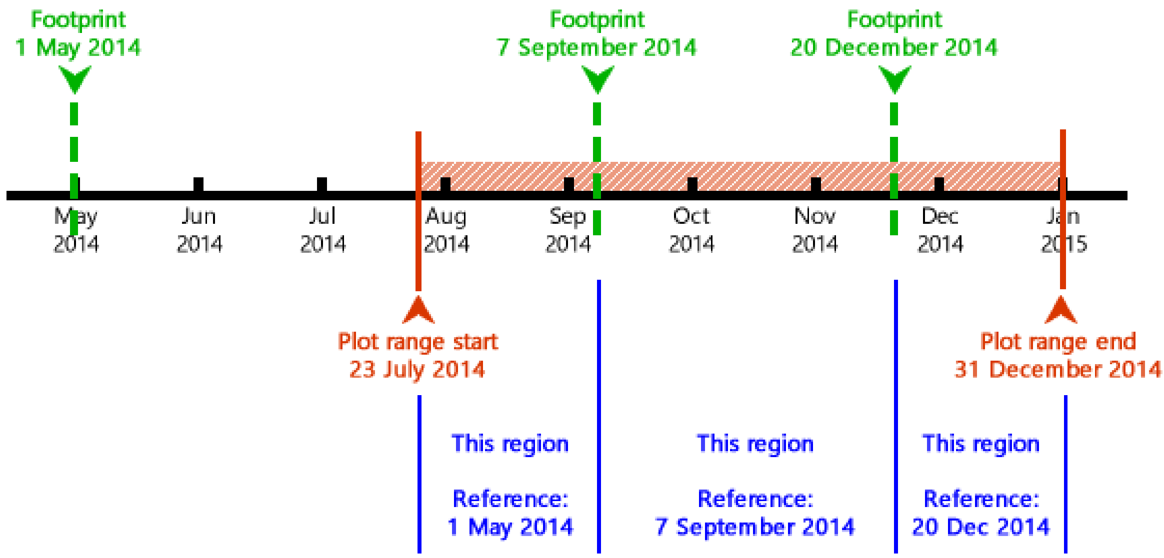
On the other hand, the second option forces the Uncertainty Trend form to use a particular calibration certificate for all data within entire plot range. Click **Change** to display the *Select Certificate* dialogue and select the desired certificate.



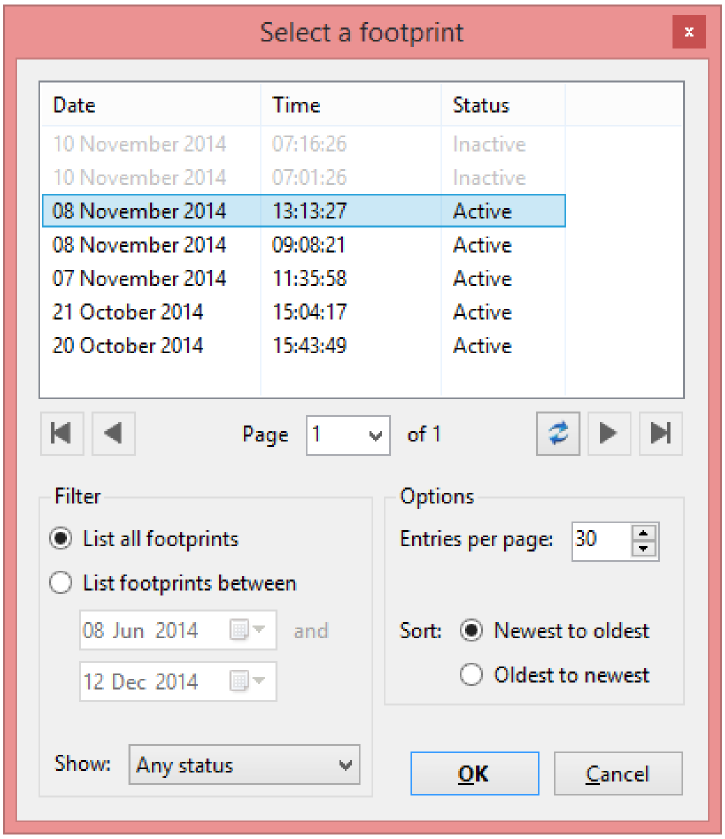
13.2.3 Footprint Reference



This section controls which footprints to use while calculating $U_{reproducibility}$. Similar to calibration certificate parameter, there are two options here: Reset reference at each footprint, or pin a particular footprint for all data. The default is reset reference at each footprint, as illustrated by the timeline in the next page.

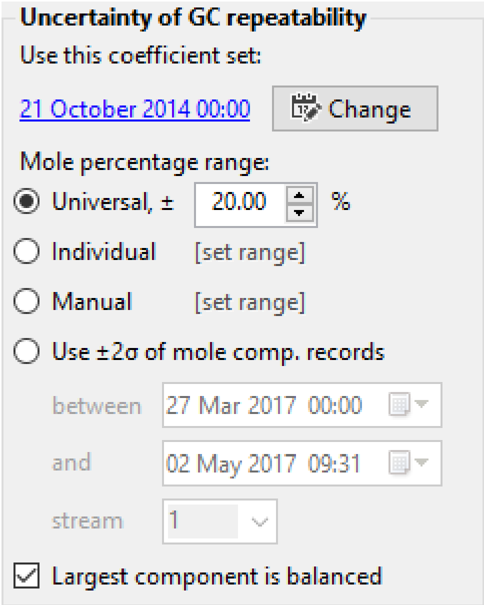


Sometimes users want to test how the uncertainty trend would turn out using several different foot-prints. Select the second option, then click **Change** to select the footprint.



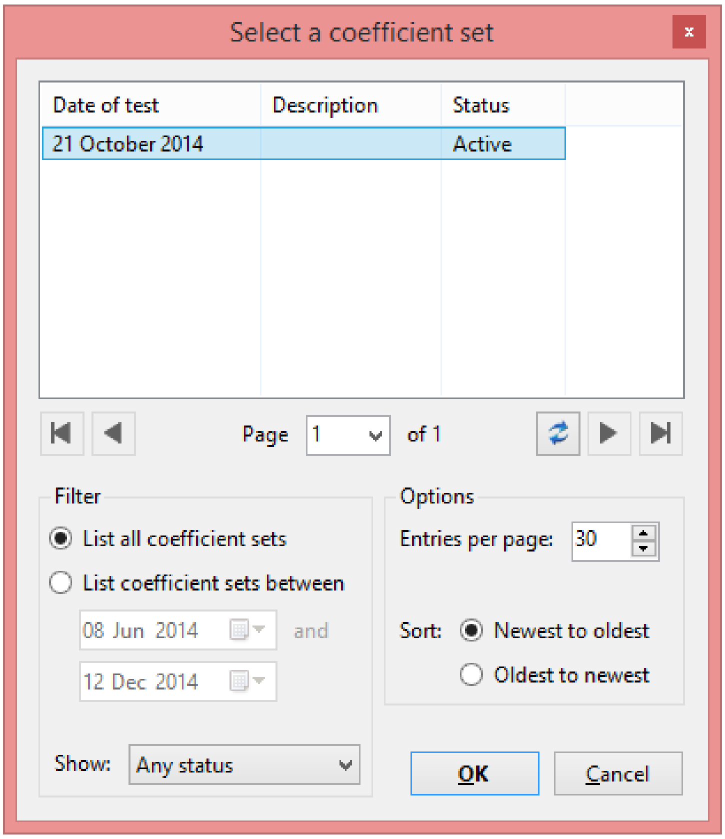
The footprint selected through this dialogue box is used to calculate $U_{reproducibility}$ of all data in the plot range, regardless of the timestamp of the footprint—even if the footprint occurs after the plot range ends.

13.2.4 Uncertainty Coefficients and Mole Percentage Range



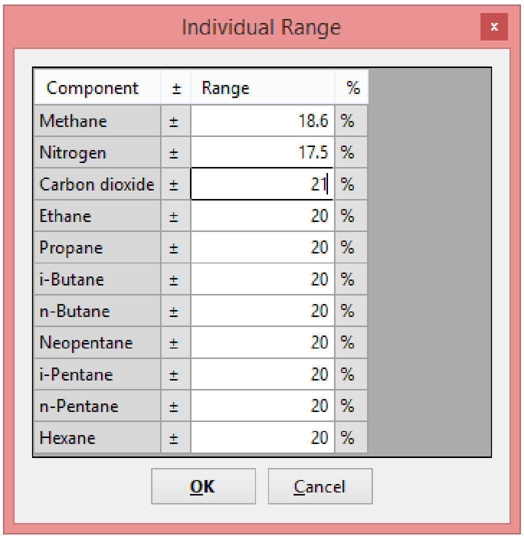
This section is available if uncertainty of GC repeatability is checked on the first section. Your GC device must have uncertainty coefficients stored in database, otherwise you cannot tick uncertainty of GC repeatability.

Select which coefficient set to use through **Change** button.



Next, choose one of the mole percentage range options.

1. **Universal**: Every component has the same plus-minus range. The default is ±20%.
2. **Individual**: Every component has its own plus-minus range. Click **Set range** to enter these individual ranges.

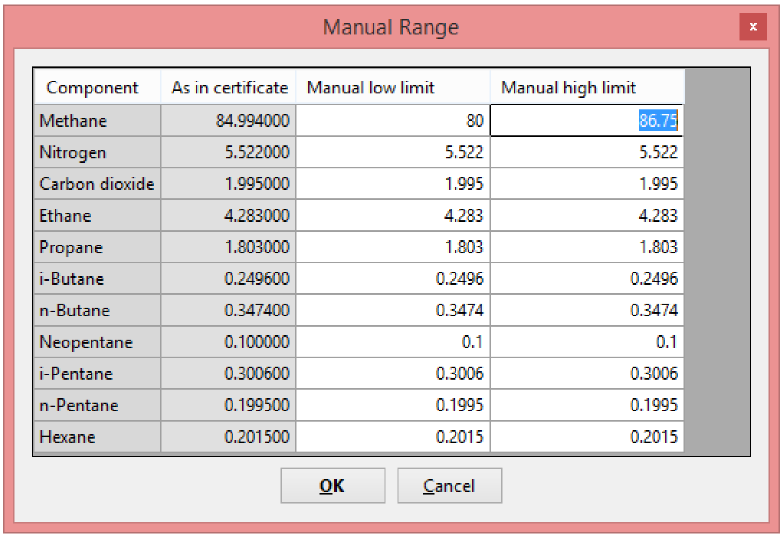


Individual Range

Component	±	Range	%
Methane	±	18.6	%
Nitrogen	±	17.5	%
Carbon dioxide	±	21	%
Ethane	±	20	%
Propane	±	20	%
i-Butane	±	20	%
n-Butane	±	20	%
Neopentane	±	20	%
i-Pentane	±	20	%
n-Pentane	±	20	%
Hexane	±	20	%

OK Cancel

3. **Manual**: You need to explicitly set the value of lower bound and upper bound of each component. For comparison, the mole composition from the calibration gas certificate is displayed in the second column.

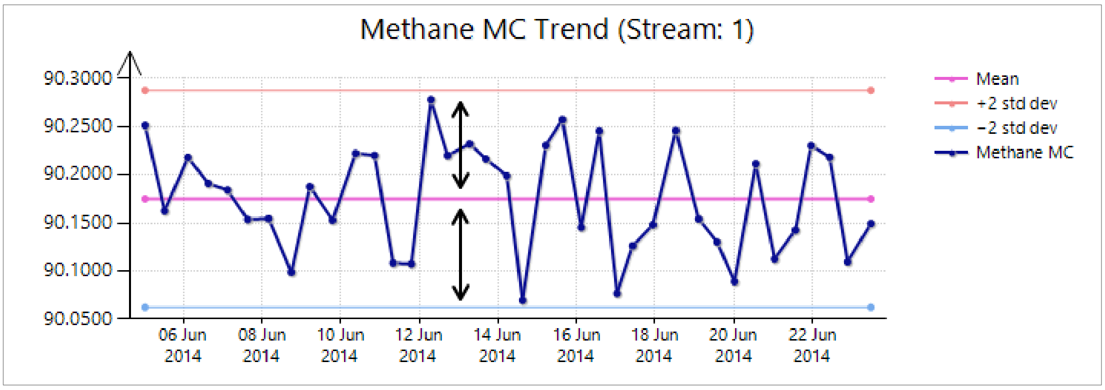


Manual Range

Component	As in certificate	Manual low limit	Manual high limit
Methane	84.994000	80	86.75
Nitrogen	5.522000	5.522	5.522
Carbon dioxide	1.995000	1.995	1.995
Ethane	4.283000	4.283	4.283
Propane	1.803000	1.803	1.803
i-Butane	0.249600	0.2496	0.2496
n-Butane	0.347400	0.3474	0.3474
Neopentane	0.100000	0.1	0.1
i-Pentane	0.300600	0.3006	0.3006
n-Pentane	0.199500	0.1995	0.1995
Hexane	0.201500	0.2015	0.2015

OK Cancel

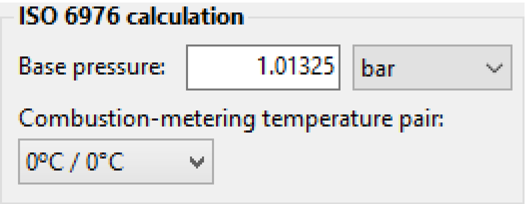
4. **Use plus-minus twice standard deviations**: The range is taken from twice of standard deviation of mole composition records over the specified period of time, filtered to the specified stream.



Finally, the last check box controls whether to treat the component having largest percentage as the balanced gas. Balanced component means its composition is not taken from the calibration certificate, but from 100% minus the others instead. Balanced gas keeps the mole percentage sum at 100%, while without balanced gas it may go over 100% and under 100%.

Unlike Uncertainty Calculator form which you can choose which one to become the balanced gas, Uncertainty Trend always selects the gas with largest mole percentage as balanced. For a rare occasion where there are multiple gases sharing the same largest percentage (e.g. two gases have 40% each), GCAS selects the first gas as the balanced one. Gases are sorted using RF sort order. *Balanced gas option is ignored if you chose manual mole percentage range*.

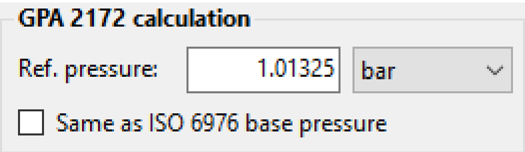
13.2.5 ISO 6976 and GPA 2172 Parameters



This section contains the base pressure and combustion-metering temperature pairs for ISO 6976 calculation. These parameters are used for all data within the plot range.

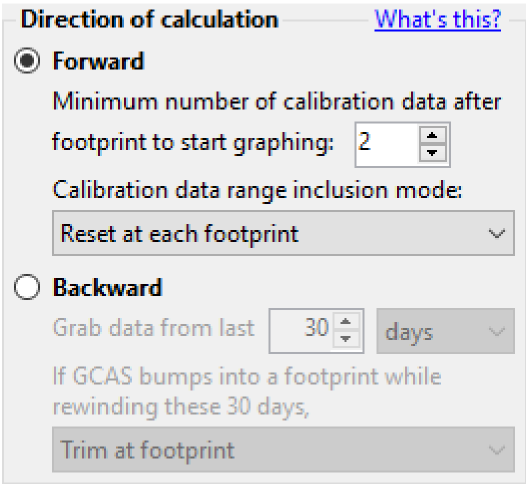
Default base pressure is one atmosphere, or 1.01325 bar. GCAS supports six combustion and metering temperature pairs, which are:

- 0°C / 0°C
- 15°C / 0°C (combustion temperature = 15°C, base temperature = 0°C)
- 25°C / 0°C
- 15°C / 15°C
- 20°C / 20°C
- 25°C / 20°C



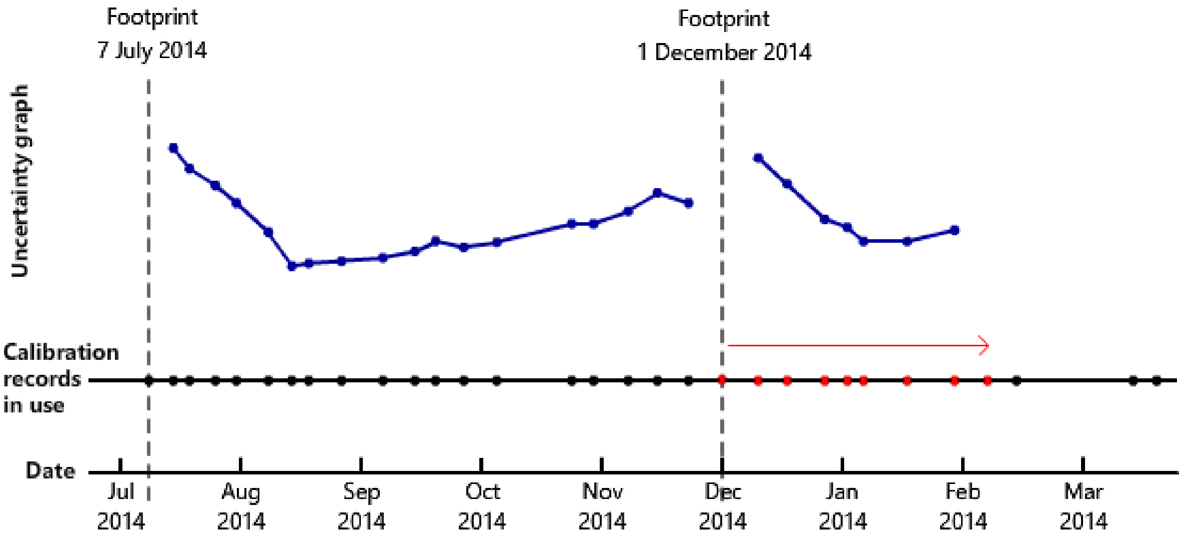
For GPA 2172, there is only one parameter to set—the reference pressure. The default is also one atmospheric pressure. You can make Uncertainty Trend form to use the same base pressure for both ISO 6976 and GPA 2172 calculation by ticking **Same as ISO 6976 base pressure**, or you can specify a different reference pressure for GPA 2172.

13.2.6 Direction



Direction of calculation determines which calibration records to include in the calculation. Uncertainty calculation may go *forward* or *backward*.

On **forward** direction, list of calibration data to include is enumerated from footprint. For every calibration data in the plot range, calculation of $U_{reproducibility}$ at that point will include all calibration data from the last footprint (including that footprint itself) and accumulatively go *forward* up to that point.



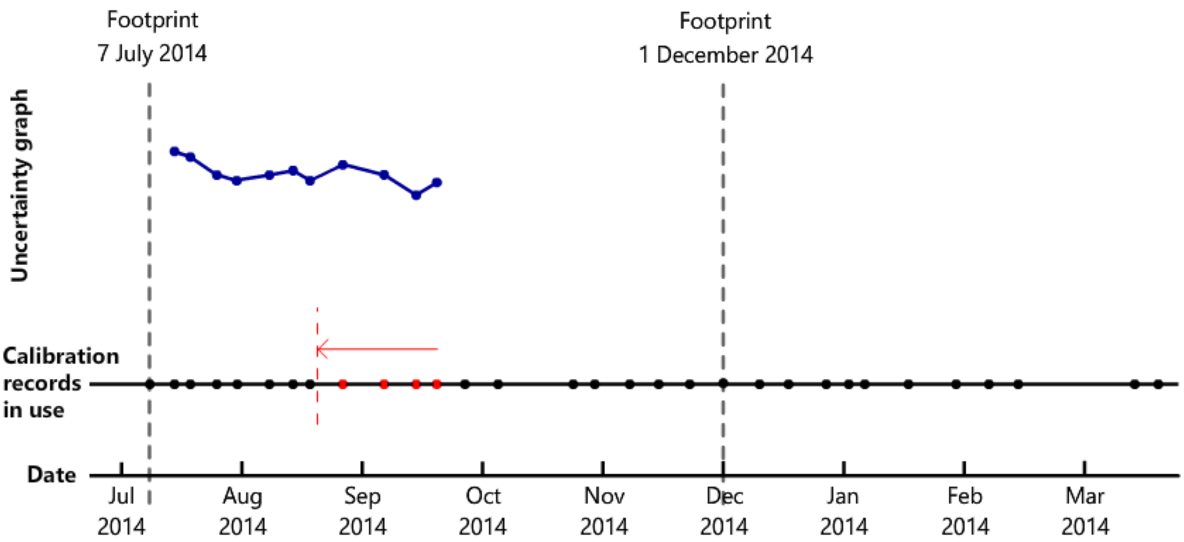
(This picture is animated in the HTML version of GCAS Manual.)

Do not confuse "the last footprint" in the previous paragraph with the "reference footprint". *Reference* footprint is set on this section. The *last* footprint only marks where the collection of calibration data begins. Reference footprint and "last" footprint may coincide, but that is not always the case. You can pin any footprint as a reference, but uncertainty calculation in forward direction uses one last footprint before every single dot on the chart. It uses the *timestamp* of last footprint, in order to query calibration records *from* the timestamp of last footprint *to* the timestamp of the current dot being calculated.

There is a minimum limit to start calculation. The default is one (1), which means forward calculation can start at one calibration data after every footprint within the plot range. You can set the minimum for example, ten, so the calculation starts after 10 calibrations following every footprint. You will see a gap on the chart after every footprint indicating the number of dots within those gaps is below the minimum limit, therefore calculation could not start.

At **Calibration data inclusion mode**, there are two options. If you select **Reset at each footprint**, the list of calibration record used for the calculation is restarted whenever a new footprint is encountered as GCAS goes forward. This option causes each calibration data is calculated together only with its immediate preceding footprint, and not the previous footprint before that one. If you see the animated image in the HTML version GCAS manual, that animation assumes *Reset at each footprint* is selected. The other option–**Continuous throughout plot range–**breaks this barrier. The list of calibration records in use just grow bigger along the timeline as GCAS goes forward, no matter whether a new footprint is encountered. When GCAS comes across the second footprint on the timeline, this footprint is included in the list as if it was a regular calibration data.

On **backward** direction, list of calibration data to include is counted from the calibration data being calculated. For every calibration data in the plot range, calculation of $U_{reproducibility}$ at that point will include all calibration data from that point and go *backward* to the last *x* days or last *x* record before that point.

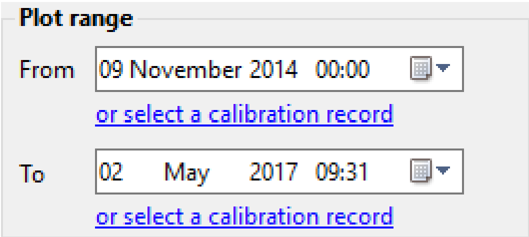


(This picture is animated in the HTML version of GCAS Manual.)

Set how many days or how many records to travel backwards. The default is 30 days. You can go backward to as far as 2 years (730 days). At some occasions, the GC devices has 30 data in one day; you might consider going backward 30 records, not days.

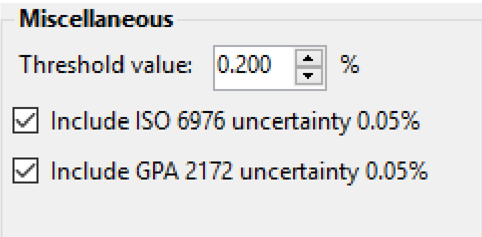
While GCAS is travelling backward, it may find a footprint before it fulfils the specified *x* days or *x* records. Decide what GCAS should do when it bumps into a footprint, whether to stop or to continue. The default is stop at footprint (trim at footprint). By stopping at footprint, the number of calibration data included in the calculation is less than *x* days or *x* records, but GCAS does not include data before the footprint which are usually calibrated under different configuration. If you see the animated image in the HTML version of GCAS manual, that animation shows what happens if *Trim at footprint* is selected.

13.2.7 Plot Range



Set the plot range start and end date. Or, select two calibration records as the starting and ending point of this range. GCAS displays a warning label if the footprint reference is a pinned footprint and that footprint occurs within this plot range or after this plot range.

13.2.8 Miscellaneous

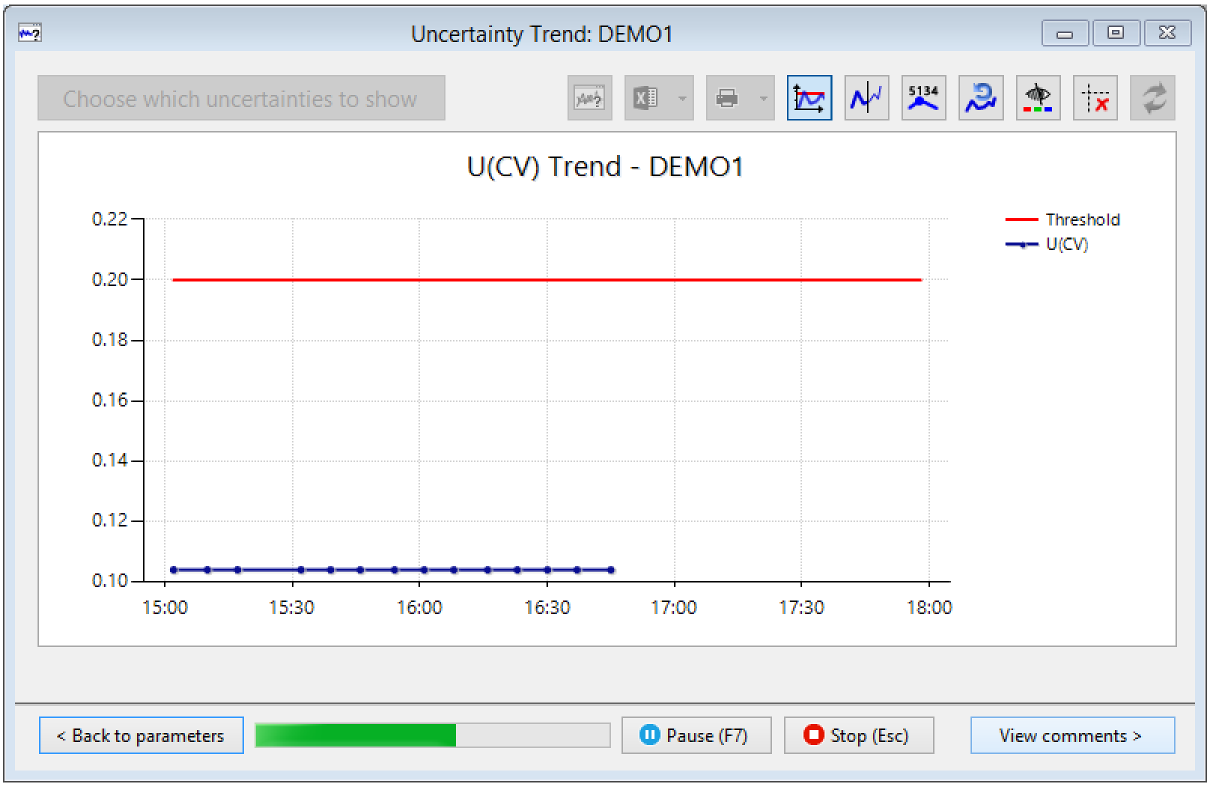


This section sets the threshold red line on the chart. The default is 0.2%. When the uncertainty chart line crosses this threshold line, it is recommended to perform a preventive maintenance on your GC.

The check box **Include standard calculation uncertainty 0.05%** controls whether ISO 6976 or GPA 2172 standard measurement error of 0.05% (0.1% at k = 2) should be included in the final calculation of each data point in the chart. By default, these two check boxes are ticked.

13.3 Uncertainty Trend Chart

Once you set all the required parameters, click **Start graphing** at the bottom of the form. Uncertainty Trend form switches to *chart* page and begins the calculation.



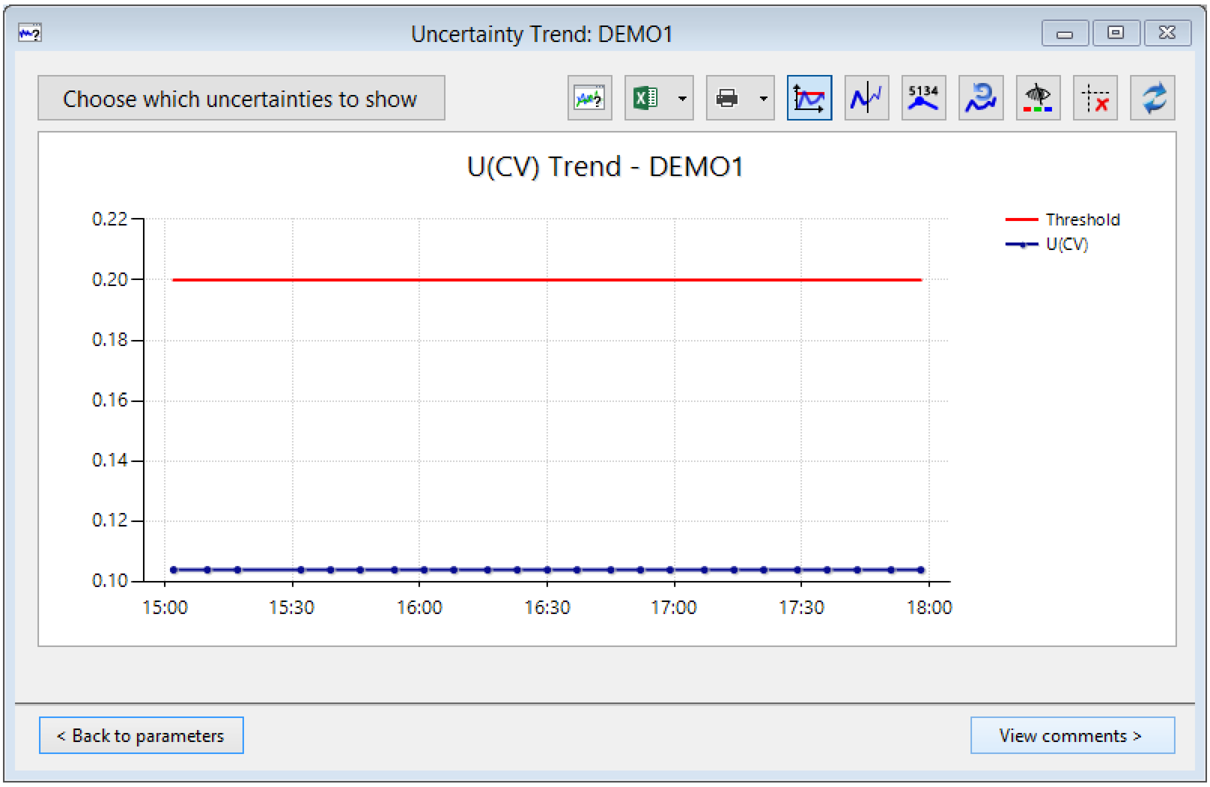
Calculation in progress.

Note

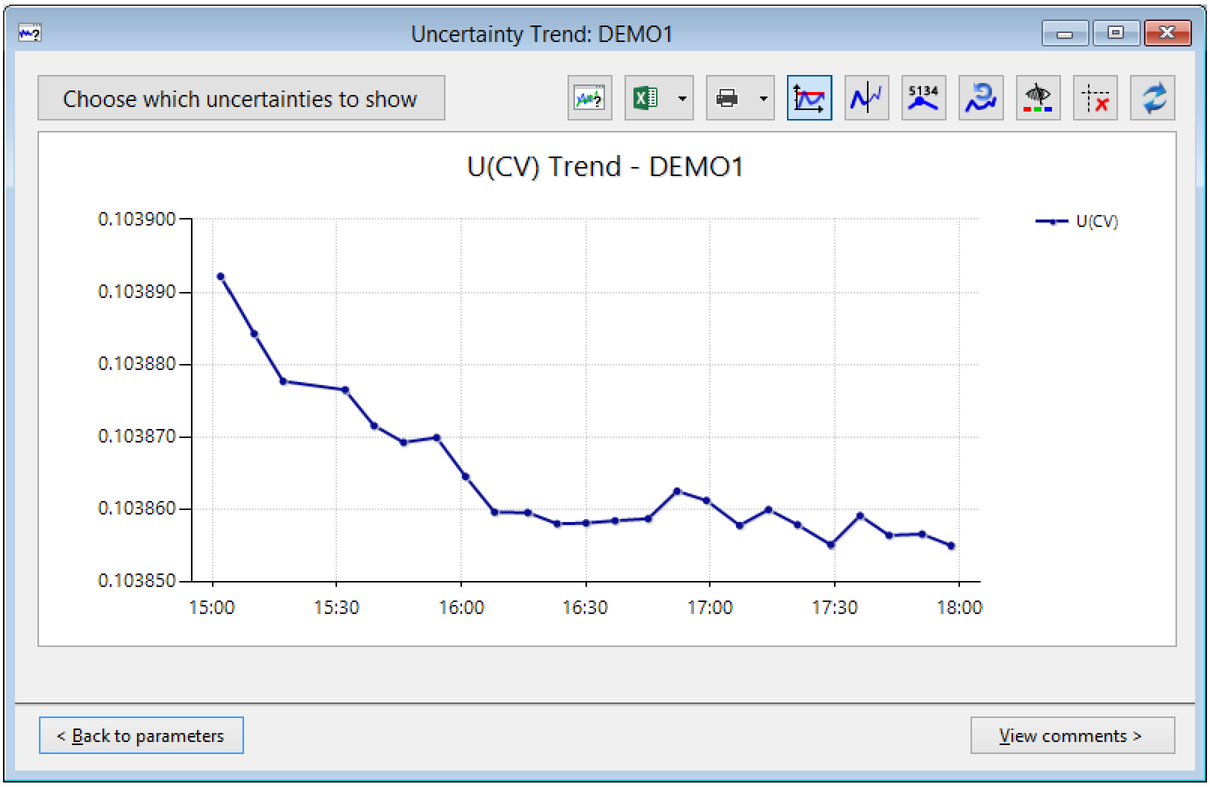
Uncertainty calculation is slow because it loads many different data from database. Moreover, uncertainty trend calculation is a sequence of many uncertainty calculations. Depending on how wide your plot range and how many calibration records inside the plot range, one trend calculation may take from few seconds to ten minutes or even more. Fast CPU and good network connection between your computer and the database server help reducing the calculation time.

Because uncertainty trend calculation is slow, GCAS provides **Pause** button to temporarily halt the calculation and **Stop** button to abort the calculation. The keyboard shortcut `F7` is designated for Pause button and `Esc` for Stop button. While calculation is in progress, you cannot use other modules or they will run slower than usual. This is because the database server is busy serving the data required for uncertainty calculation.

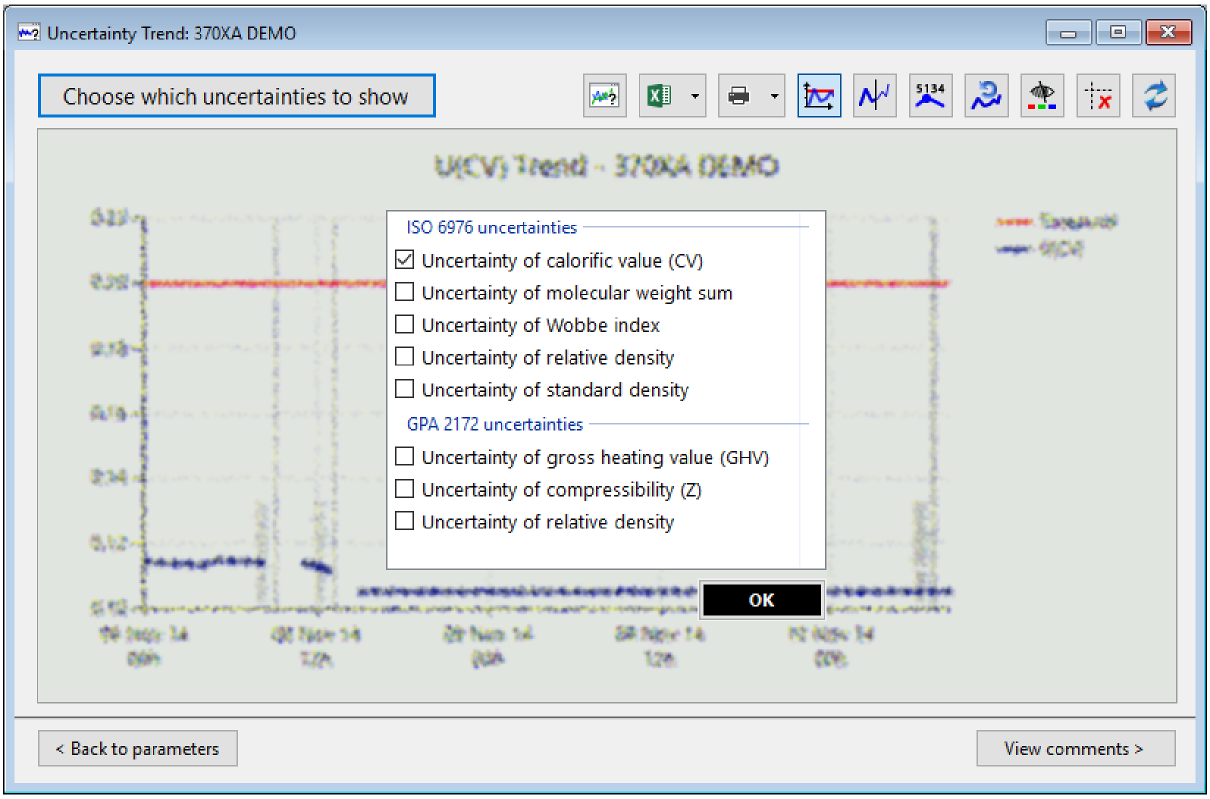
The screenshot on the next page is how the form looks like after the calculation is finished. It is an example of a healthy GC based on uncertainty of calorific value. The blue uncertainty line is well below the red threshold line.



Here is the same chart with the threshold line hidden from view. The Y-axis scale adjusts itself accordingly so the variations of the uncertainty values become clearer. To show or hide the threshold line, click **Show threshold line** or right click the chart and select **Show Threshold Line**.



Click the button **Choose which uncertainties to show** at the top-left corner to pick which uncertainty lines to display. There are five uncertainty lines for ISO 6976 outputs and three lines for GPA 2172 outputs. Tick which ones to show on the chart and click **OK**. Devices not supporting GPA 2172—such as BTEX analyser or moisture analyser—will have all GPA 2172 uncertainty lines lie flat at 0.1%.



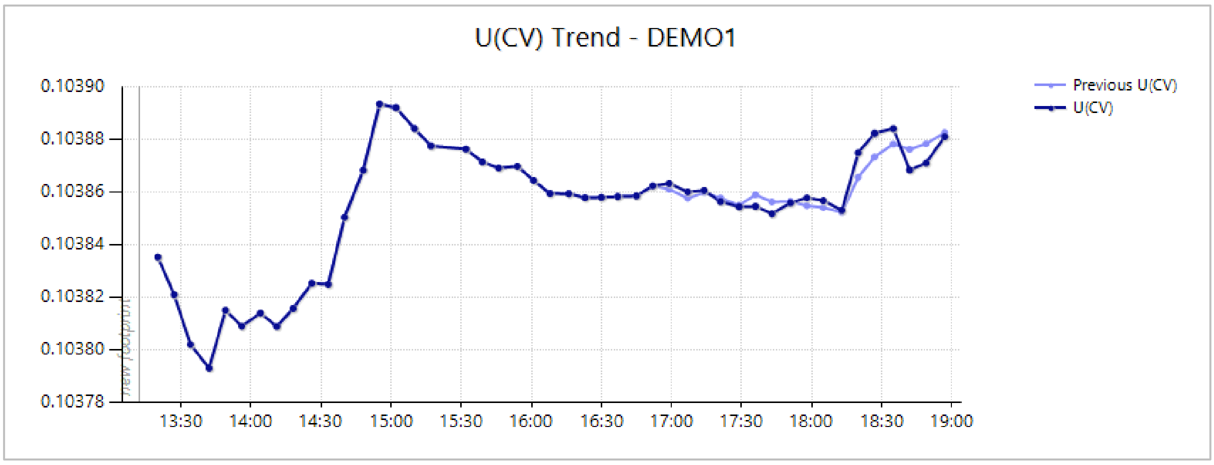
To go back to the parameter page, click **Back to parameters** at the bottom of the form. To read or write comments instead, click **View comments**.

> **Note**
>
> If you went back to the parameter page but didn't change anything then clicked **Start graphing**, the form quickly returns to the chart view. But if you changed one thing on the parameters, the **Start graphing** button will clear the chart and initiate a recalculation.

13.3.1 Comparing Previous Chart

Uncertainty Trend form remembers one last set of charts every time it performs a complete calculation. Once the calculation completes, you can compare the current chart to the previous chart. A typical scenario is first you graph a chart, go back to the parameters page, change one or two things, and finally graph a new chart.

Show previous chart button displays current chart (of current parameters) on top of previous chart (of previous parameters). Previous charts have the same colour, only lighter. All eight line charts have their "previous" lines.

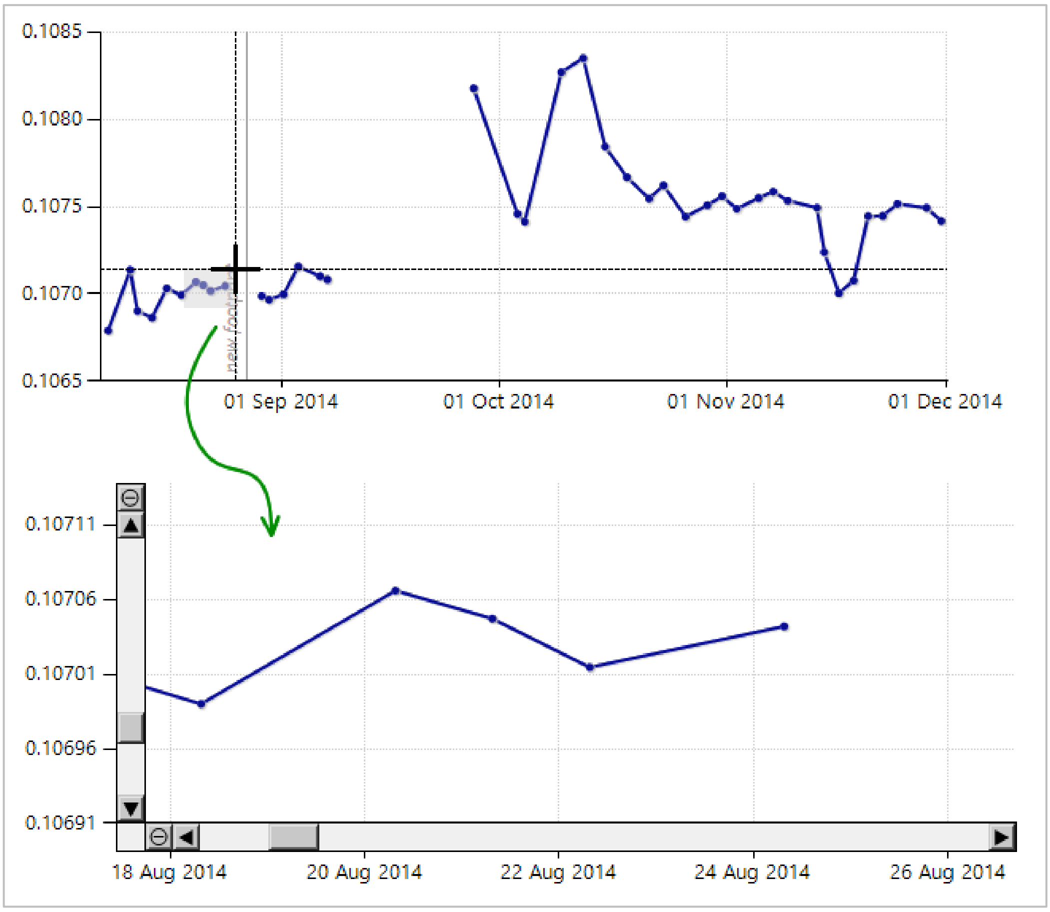


In the example screenshot above, previous U_{CV} (light blue) is forward calculation with minimum 2 data to start calculation. Current U_{CV} (dark blue) is backward calculation, going backward 30 records and trim at footprint. They coincide until the 30th dot then they start to diverge.

Be aware that **Refresh** button erases previous chart prior to the recalculation.

13.3.2 Zoom and Scroll

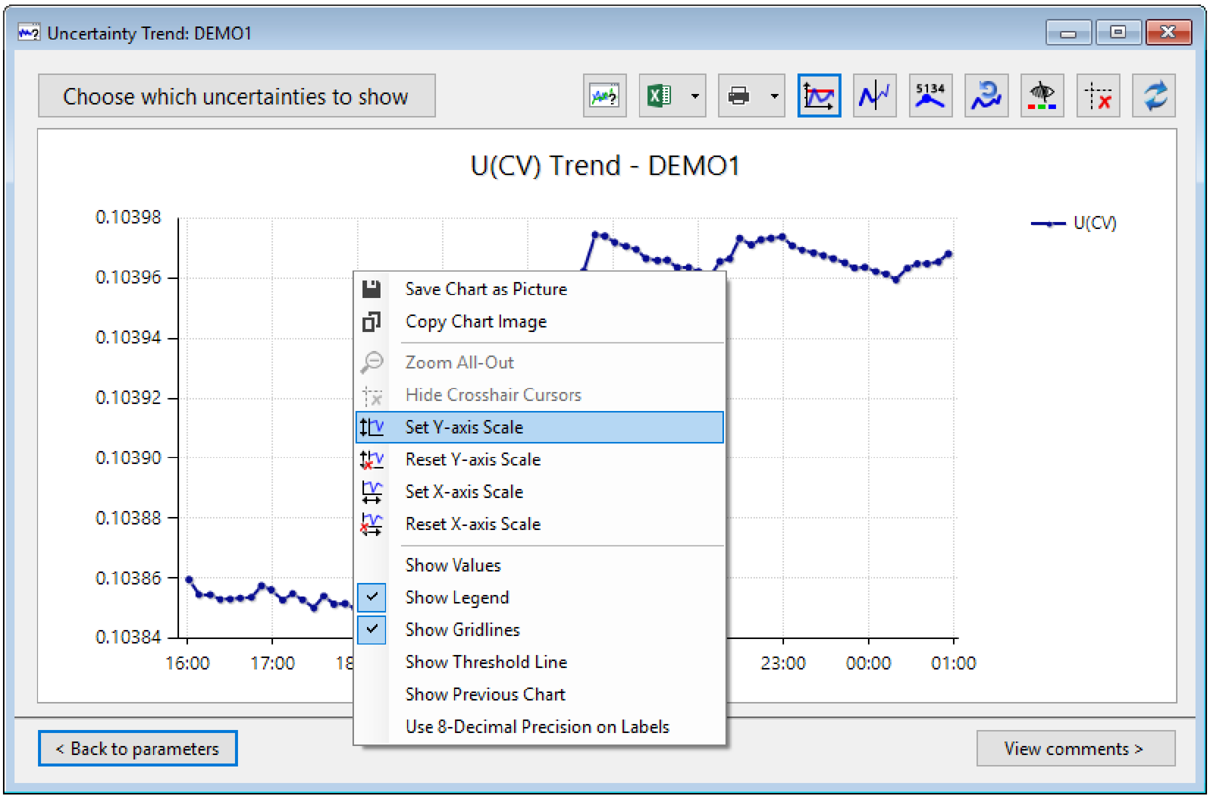
Drag a rectangle over the area you want to zoom in. Pan around the chart using the provided scroll bars. Drag another rectangle to zoom in further.



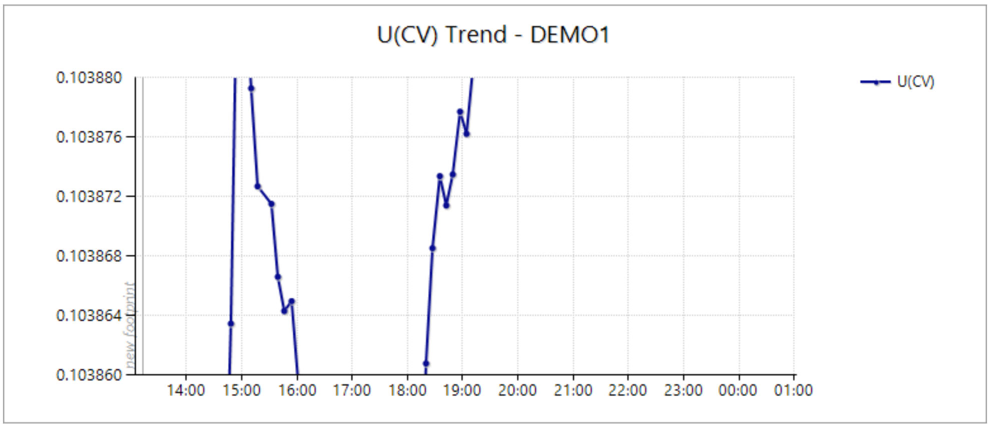
To zoom out, click the circled minus button ⊖ on both scroll bars. Press Home on your keyboard or right click the chart and select **Zoom All-Out** to undo all zoom-in operations.

13.3.3 Change Axes Scale

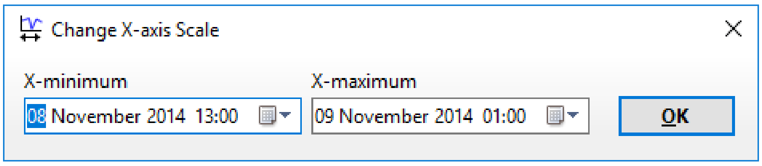
If zoom was not enough, you can enforce a custom range for both X-axis and Y-axis of the chart. Right-click the chart and select either **Set X-axis Scale** or **Set Y-axis Scale**.



For Y-axis, specify the desired numeric range. The input fields accept decimal values. If you set a custom axis range that is smaller than the actual range of the chart, then the chart will be truncated similar to this one.



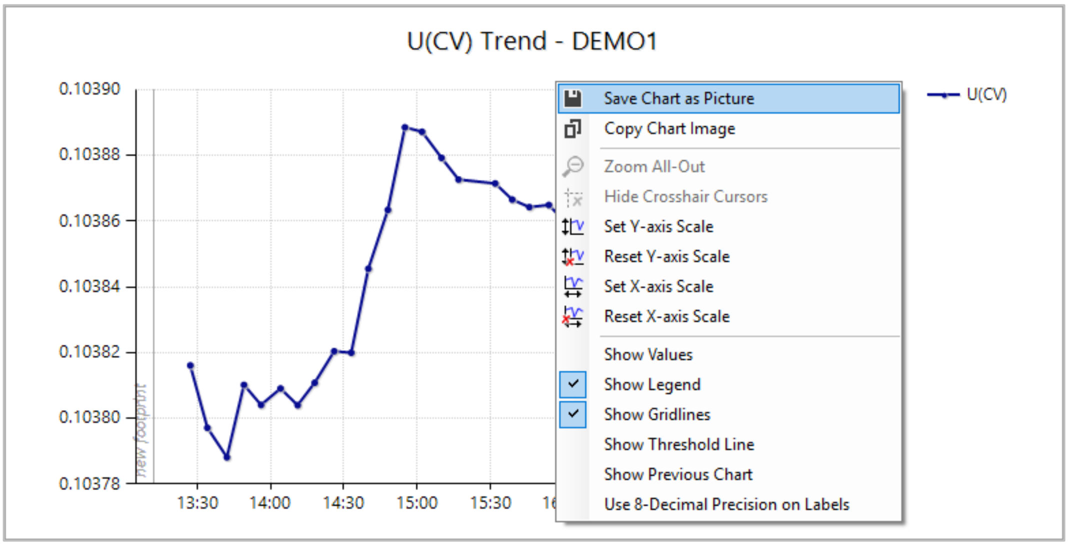
For X-axis, specify the date and time interval.



To cancel these custom scales and revert back to automatic scale, right-click the chart and select either **Reset X-axis Scale** or **Reset Y-axis Scale**.

13.3.4 Save or Copy the Chart

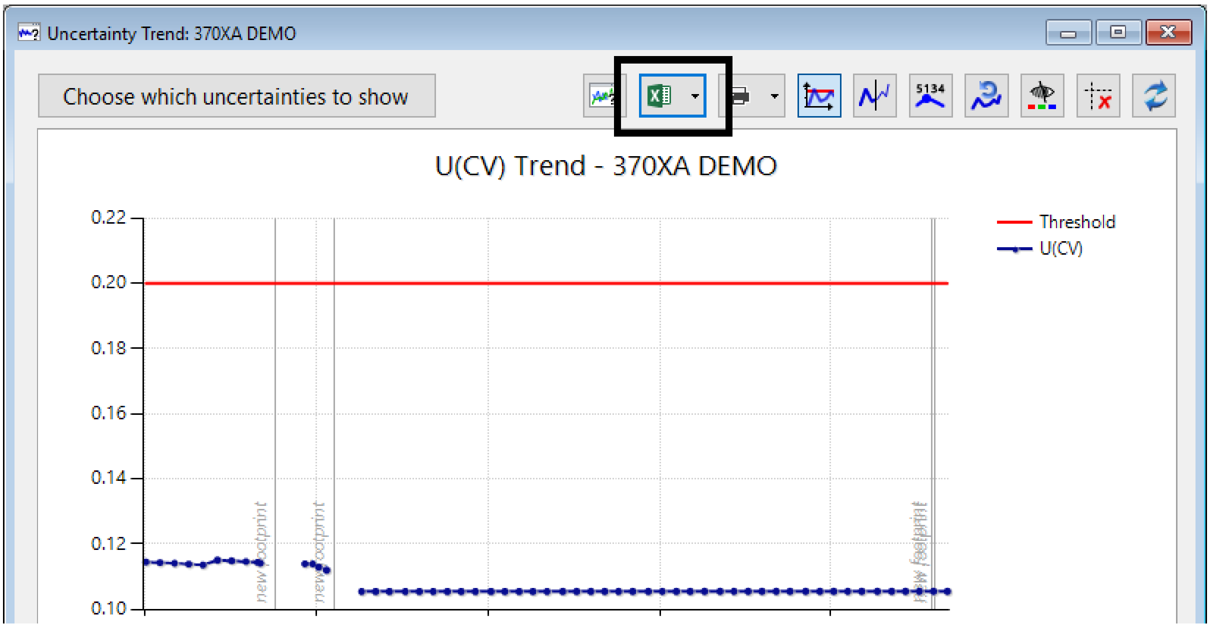
To save the chart as image file, right-click on the chart and select **Save Chart as Picture**.

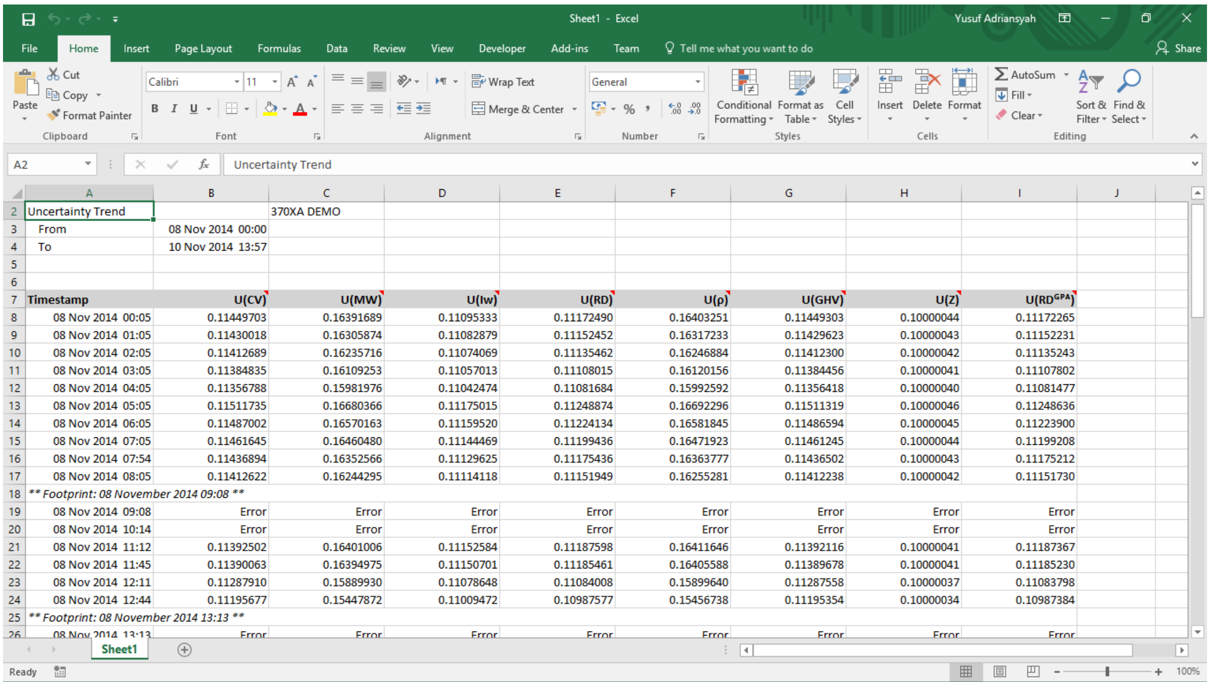


Similarly, to copy the chart into clipboard, right click and select **Copy Chart Image**. Then you may paste the image onto Microsoft Paint, Microsoft Word, or any software that accepts bitmap image.

13.3.5 Export Values to Microsoft Excel or CSV

Click **Copy to Excel** above the chart. This button launches Microsoft Excel and opens a new worksheet, then copies all eight uncertainty lines to the sheet. Only current uncertainty values are copied, the previous values are not. At the bottom of the sheet, GCAS writes all parameters that created such uncertainty values. This feature requires Microsoft Excel 2010, 2013, 2016, or later versions.

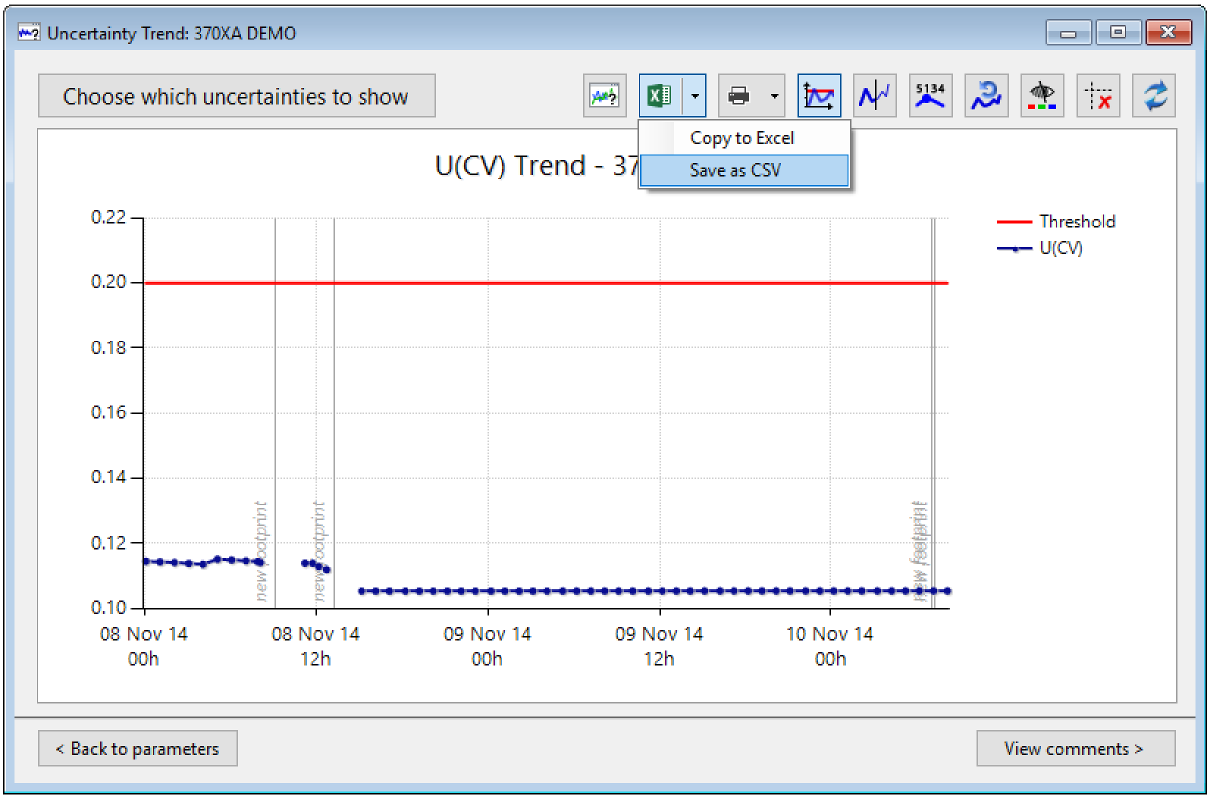




	A	B	C	D	E	F	G	H	I
2	Uncertainty Trend		370XA DEMO						
3	From	08 Nov 2014 00:00							
4	To	10 Nov 2014 13:57							
5									
6									
7	**Timestamp**	**U(CV)**	**U(MW)**	**U(Iw)**	**U(RD)**	**U(ρ)**	**U(GHV)**	**U(Z)**	**U(RD^GPA)**
8	08 Nov 2014 00:05	0.11449703	0.16391689	0.11095333	0.11172490	0.16403251	0.11449303	0.10000044	0.11172265
9	08 Nov 2014 01:05	0.11430018	0.16305874	0.11082879	0.11152452	0.16317233	0.11429623	0.10000043	0.11152231
10	08 Nov 2014 02:05	0.11412689	0.16235716	0.11074069	0.11135462	0.16246884	0.11412300	0.10000042	0.11135243
11	08 Nov 2014 03:05	0.11384835	0.16109253	0.11057013	0.11108015	0.16120156	0.11384456	0.10000041	0.11107802
12	08 Nov 2014 04:05	0.11356788	0.15981976	0.11042474	0.11081684	0.15992592	0.11356418	0.10000040	0.11081477
13	08 Nov 2014 05:05	0.11511735	0.16680366	0.11175015	0.11248874	0.16692296	0.11511319	0.10000046	0.11248636
14	08 Nov 2014 06:05	0.11487002	0.16570163	0.11159520	0.11224134	0.16581845	0.11486594	0.10000045	0.11223900
15	08 Nov 2014 07:05	0.11461645	0.16460480	0.11144469	0.11199436	0.16471923	0.11461245	0.10000044	0.11199208
16	08 Nov 2014 07:54	0.11436894	0.16352566	0.11129625	0.11175436	0.16363777	0.11436502	0.10000043	0.11175212
17	08 Nov 2014 08:05	0.11412622	0.16244295	0.11114118	0.11151949	0.16255281	0.11412238	0.10000042	0.11151730
18	*** Footprint: 08 November 2014 09:08 ***								
19	08 Nov 2014 09:08	Error	Error	Error	Error	Error	Error	Error	Error
20	08 Nov 2014 10:14	Error	Error	Error	Error	Error	Error	Error	Error
21	08 Nov 2014 11:12	0.11392502	0.16401006	0.11152584	0.11187598	0.16411646	0.11392116	0.10000041	0.11187367
22	08 Nov 2014 11:45	0.11390063	0.16394975	0.11150701	0.11185461	0.16405588	0.11389678	0.10000041	0.11185230
23	08 Nov 2014 12:11	0.11287910	0.15889930	0.11078648	0.11084008	0.15899640	0.11287558	0.10000037	0.11083798
24	08 Nov 2014 12:44	0.11195677	0.15447872	0.11009472	0.10987577	0.15456738	0.11195354	0.10000034	0.10987384
25	*** Footprint: 08 November 2014 13:13 ***								
26	08 Nov 2014 13:13	Error	Error	Error	Error	Error	Error	Error	Error

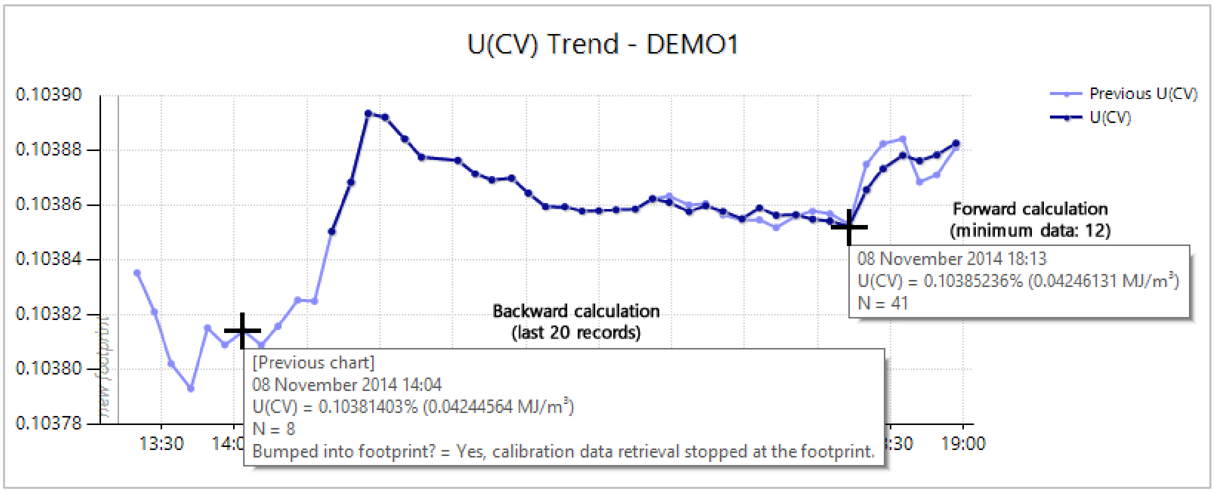
When you see "Error", it means the trend was calculated in forward direction and there were not enough data points after a footprint to start calculating.

If the chart contains so many data points, exporting to Excel may take longer time. Therefore, we recommend exporting to CSV files instead. Open the dropdown menu of **Copy to Excel** button and select **Save as CSV**.

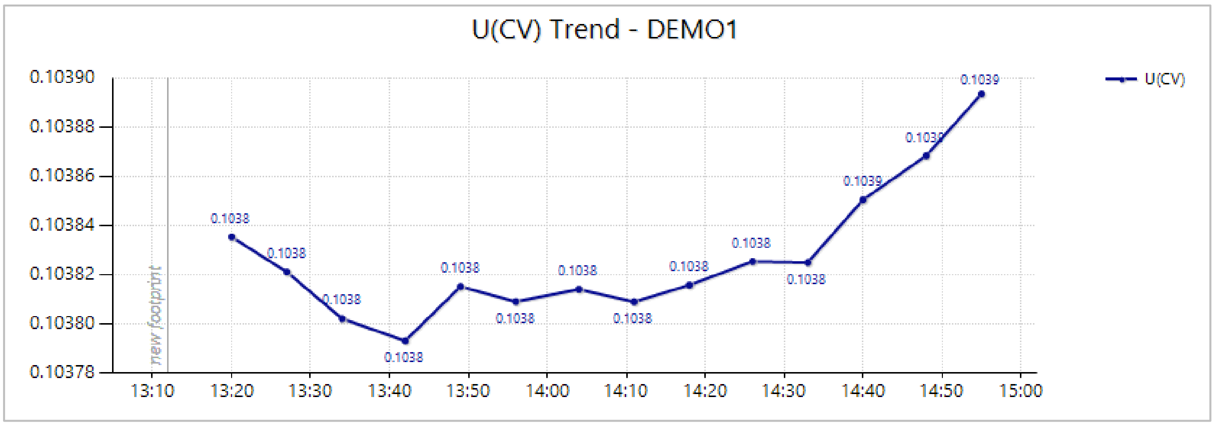


13.3.6 Other Visual Cues

Hover your mouse pointer over a data point on the chart to reveal a tooltip about that point. Typically, the tooltip displays the X-axis value (the date and time value), Y-axis value, and the *N* (number of calibration data used to calculate the uncertainty at this point). For backward calculation, the tooltip has additional info whether GCAS bumped into footprint, and if so, whether the backward iteration stopped at footprint or continued through.

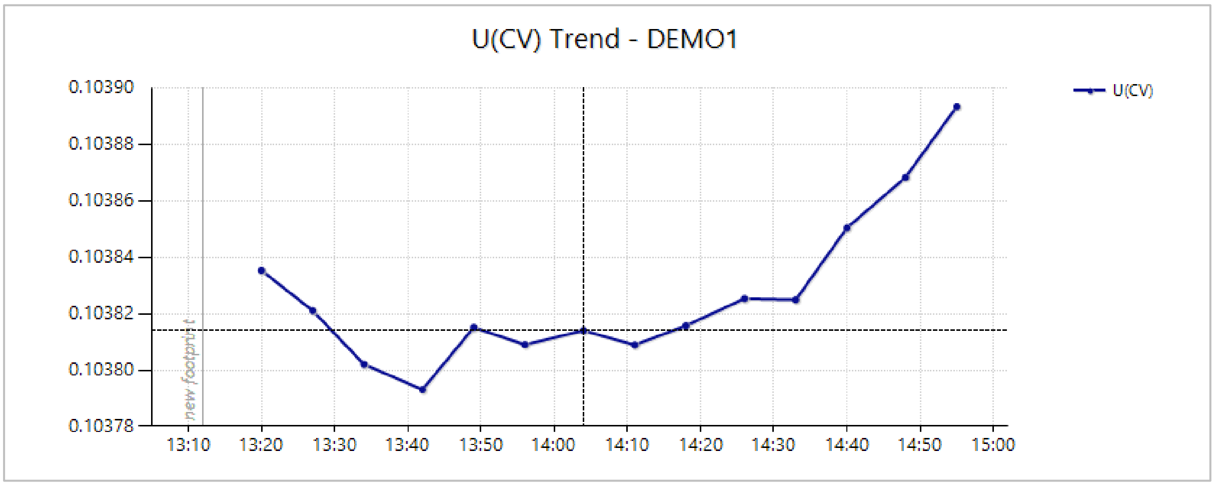


Press 5134 **Show values** or right-click the chart and select **Show Values** to display the uncertainty values. Be aware that too many data points on the chart will clutter the chart view.

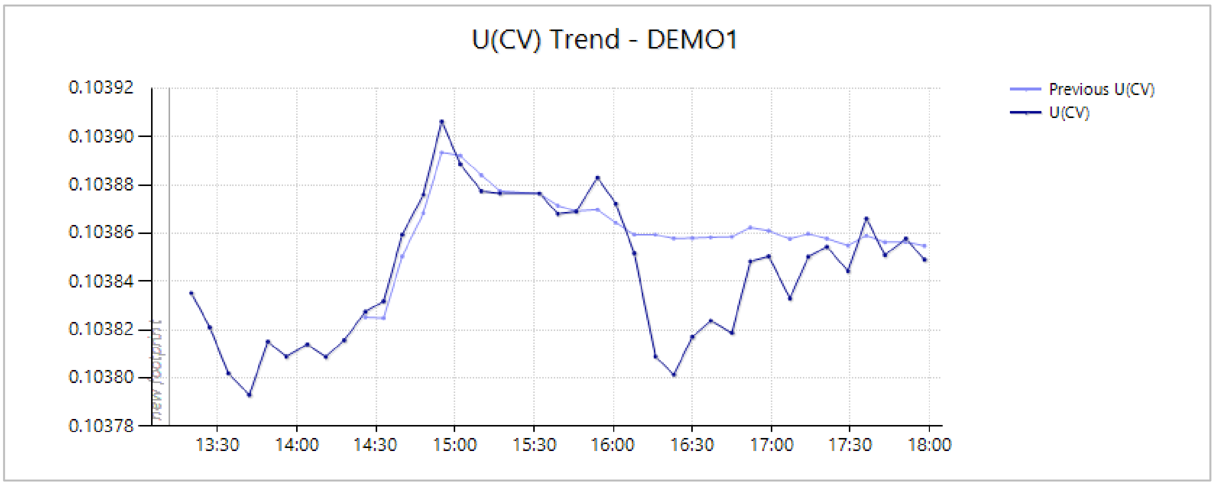


GCAS displays four digits after decimal points. Should you need a higher precision, right-click the chart and select **Use 8-Decimal Precision on Labels**. Now the labels display 8 digits after decimal point.

These dotted lines are called *cursors*. Cursors appear when you [left] click on a chart or as a remnant of zoom operation. Cursor may act as a guide to compare Y-axis values of two data points. Click **Hide crosshair cursors** or right-click on a chart and select **Hide Crosshair Cursors** to remove them from view.



In several occasions when you are comparing current chart to previous chart, the two lines come so close that the current line chart obscures the previous line chart. Click **Use thin lines** in order to make all line charts be one pixel wide, making it easier to see two lines that are too close to each other.

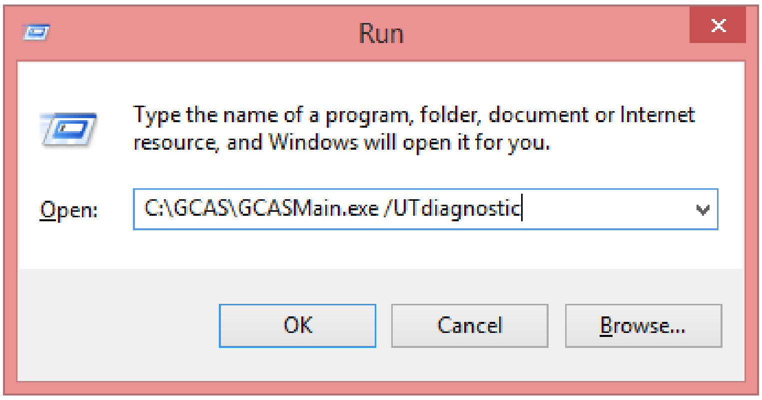


13.3.7 Colourblind Assistance

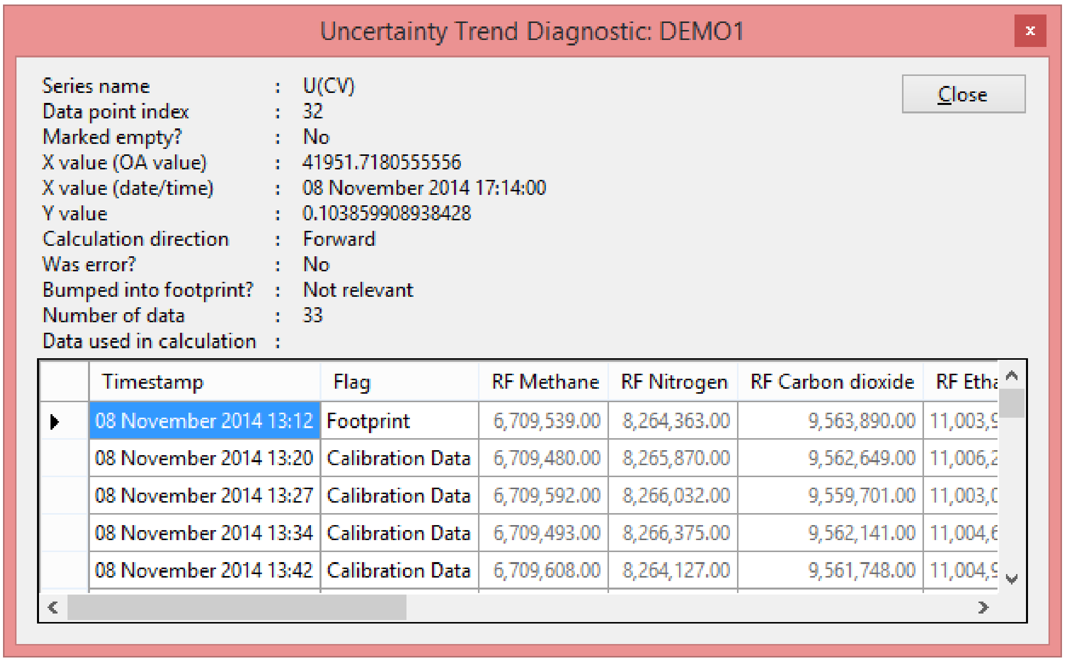
To aid users with colour blindness (protanopia and deuteranopia), GCAS provides an alternative colour scheme for the chart. Use the **Colourblind assist** button to switch colour scheme.

13.3.8 Uncertainty Trend Diagnostic

Should you notice the uncertainty trend chart has some erroneous data points, the calculation at that point might have included too few or too many calibration data. To see exactly which records were included in the calculation of a data point, run GCAS with additional **/UTdiagnostic** switch. (UT = Uncertainty Trend)



With uncertainty trend diagnostic mode activated, **click** on any dot on the chart. GCAS displays the *Uncertainty Trend Diagnostic* form that lists the calibration records used to calculate the uncertainties of this dot.



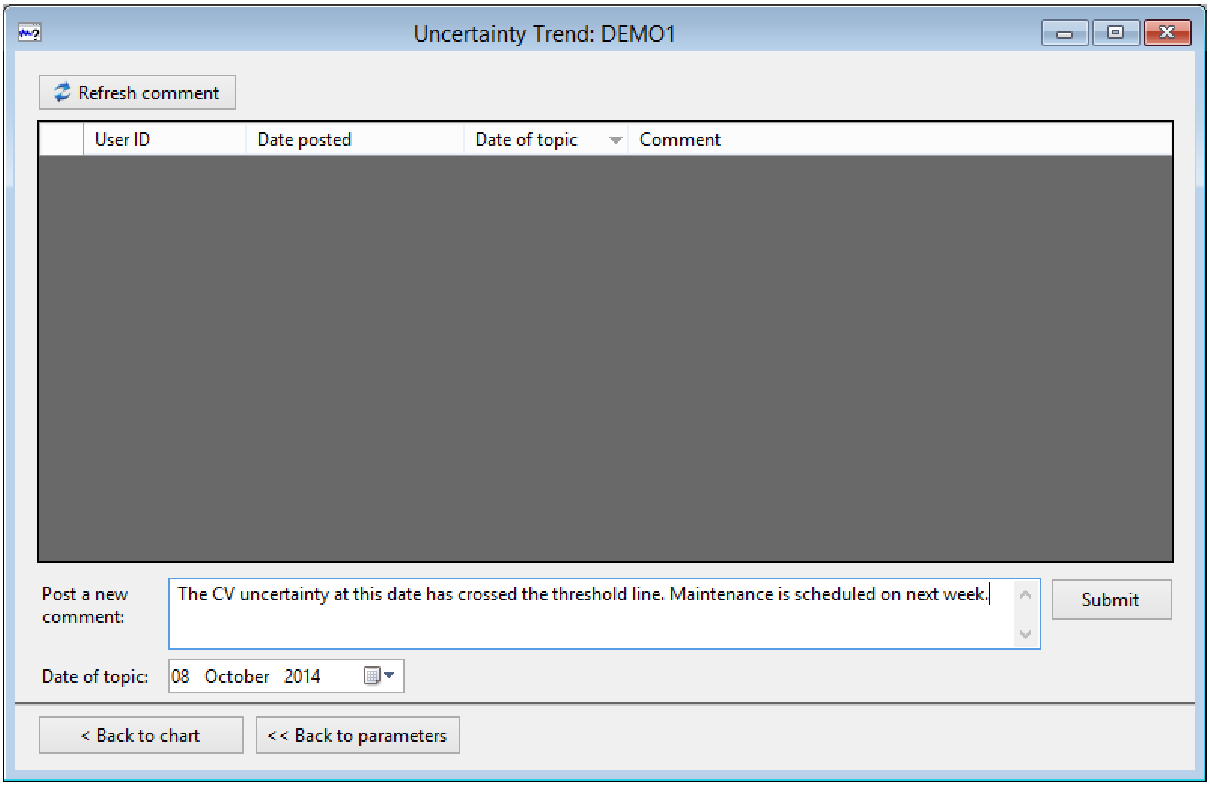
[Forward calculation](#) must include the last footprint before this data point. Hence this is what we meant by "last footprint" in [chapter 13.2.6](#), not the "[reference footprint](#)". This footprint should be at the first row on this grid.

[Backward calculation](#) may or may not have footprints in this grid view. For example, you are graphing uncertainty trend with backward calculation for 30 days. If the footprint was 40 days ago, that footprint won't be included in the calculation. On another data point where the footprint was 25 days before; this footprint should be at the last row if you set the form to trim at footprint. If you set to continue through (i.e. include data before footprint) there may be more records preceding this footprint.

Had the records on the displayed grid do not conform to the two paragraphs above, this indicates a bug. Kindly please report the bug to support@i-Vigilant.com.

13.4 Insert Comment

Click **View comments** button at the bottom of the Uncertainty Trend form. This button brings you to the *comment* page. Comments on this form is similar to [comments on Data Analysis](#); the comments aren't bound to a particular record. Instead, you need to provide the **date of topic** so other users know the background or context of your comment.



Write your comment with the appropriate date of topic, then click **Submit**. Your comment will have a yellow background to distinguish it from comments by other users.

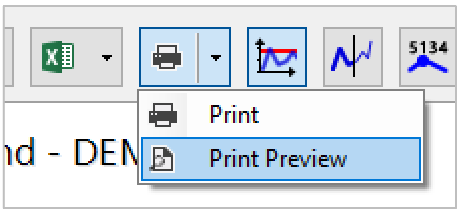
Make sure that the comment is correct e.g. free from spelling errors, because once submitted you would not be able to remove your comment. This is a part of audit trail requirements.

Click **Refresh comments** to reload comments.

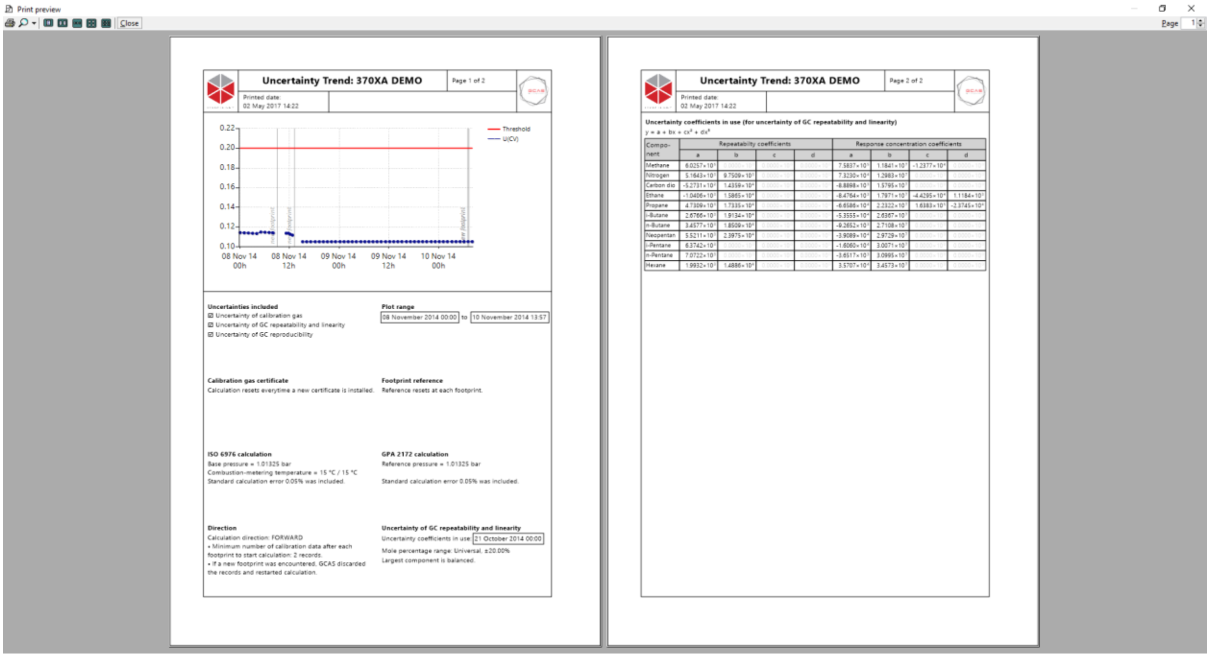
If you do not see the text box to write your comment, i.e. you only see the comment grid view, your GCAS user account doesn't have the action permission to write comment in Uncertainty Trend. Contact your GCAS administrator.

13.5 Printing

When you are viewing the chart, go to the File menu on the main menu bar. Select **Page Setup** to configure paper size and print orientation. There is **Print Preview** menu on the File menu or on the dropdown menu of this button. Click **Print** to begin printing. The **Quick Print** menu on the main File menu sends the uncertainty trend chart to your *default printer* according to what has been set in Windows Control Panel, using current page setup (default is A4 portrait).



GCAS lays out print content differently on portrait and landscape orientation. If your uncertainty trend calculation included uncertainty of GC repeatability and linearity, GCAS also prints the uncertainty coefficients used in the calculation. Individual or manual mole percentage range is also printed on page two. Moreover, any pinned calibration certificate or footprint reference will be included in the printout as well.



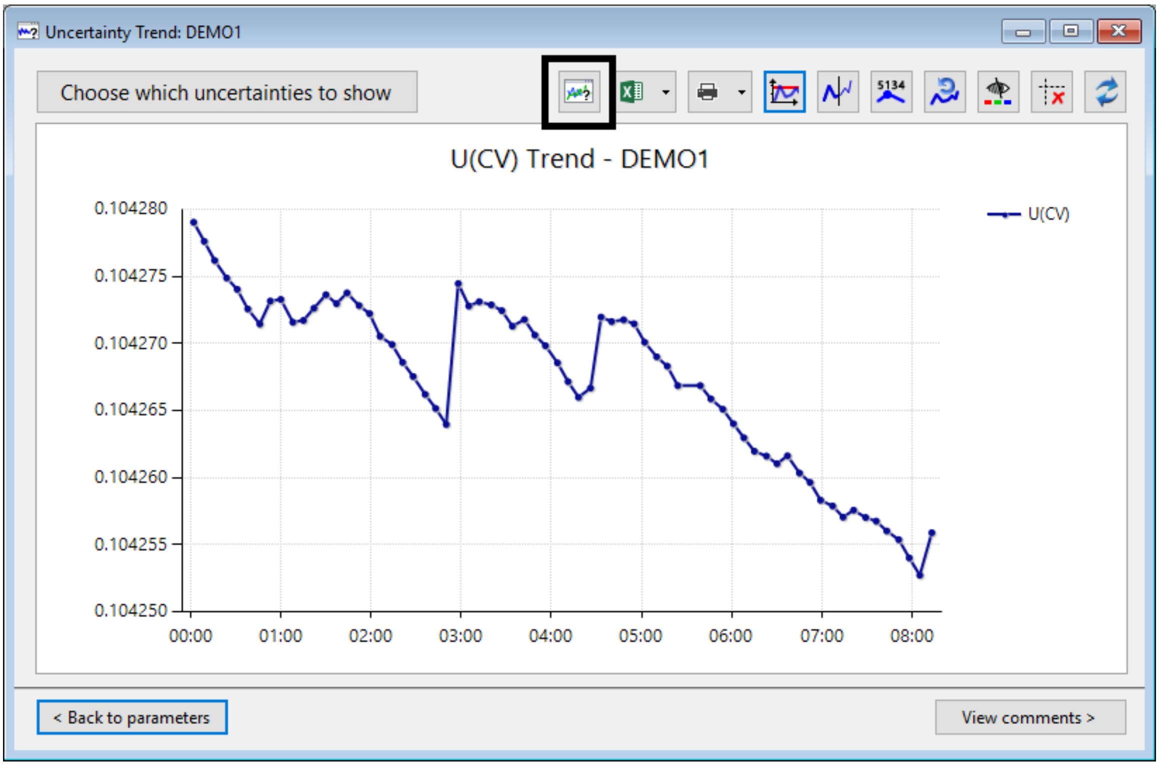
Print preview dialogue.

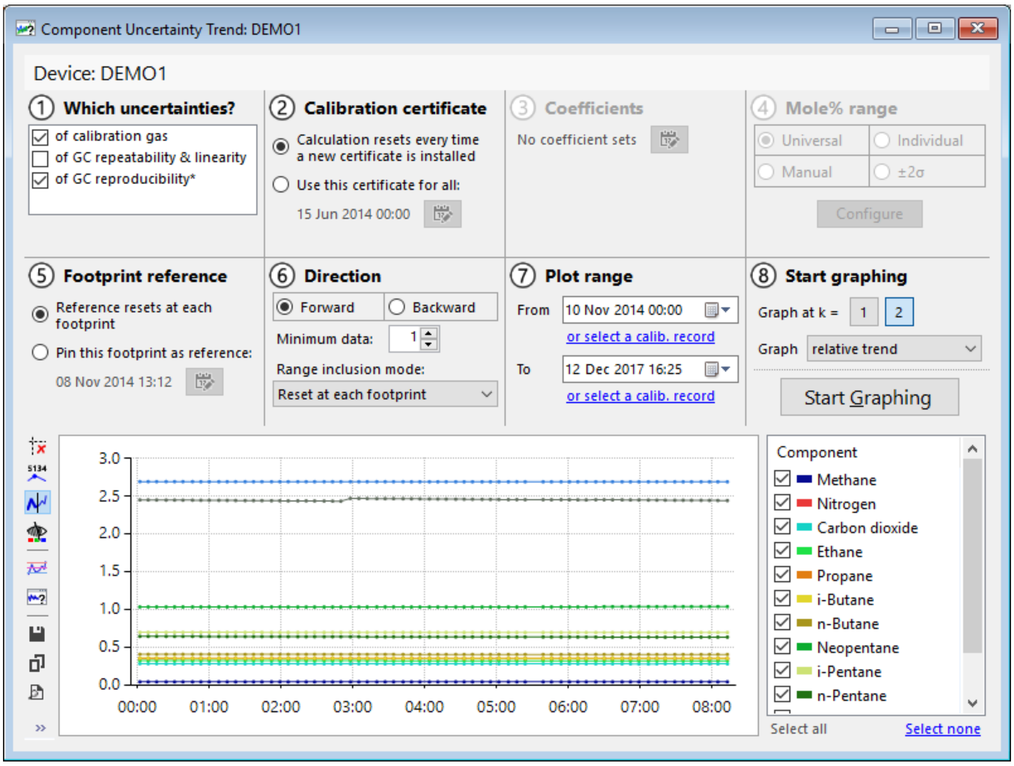
13.6 *Uncertainty Trend* Form to *Component Uncertainty Trend* Form Linkage

Now that you get an uncertainty trend chart, you may wonder how much the uncertainty values of each component (each gas) are. Component uncertainties are handled by another module named *Component Uncertainty Trend*—visit chapter 15 later on.

The usual way to get component uncertainty trend chart is by visiting the **View** menu on main menu bar and selecting **Component Uncertainty Trend**. This will bring forth the Component Uncertainty Trend form. Then, configure the component uncertainty parameters to match those set on Uncertainty Trend form. Finally, click **Start graphing** and in a few moments you shall get your component uncertainty trend chart.

There is a faster way to do this. Use this button  **View component uncertainty trend in the same plot range** (what a long name, sorry) at the top of uncertainty trend chart. This button opens Component Uncertainty Trend form, sends all your uncertainty trend settings, and instructs Component Uncertainty Trend form to begin graphing immediately.


Uncertainty Trend: DEMO1
Choose which uncertainties to show
U(CV) Trend - DEMO1
U(CV)
0.104280
0.104275
0.104270
0.104265
0.104260
0.104255
0.104250
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00
< Back to parameters
View comments >


Component Uncertainty Trend: DEMO1
Device: DEMO1
1 Which uncertainties?
of calibration gas
of GC repeatability & linearity
of GC reproducibility*
2 Calibration certificate
Calculation resets every time a new certificate is installed
Use this certificate for all:
15 Jun 2014 00:00
3 Coefficients
No coefficient sets
4 Mole% range
Universal
Individual
Manual
±2σ
Configure
5 Footprint reference
Reference resets at each footprint
Pin this footprint as reference:
08 Nov 2014 13:12
6 Direction
Forward
Backward
Minimum data: 1
Range inclusion mode:
Reset at each footprint
7 Plot range
From 10 Nov 2014 00:00
or select a calib. record
To 12 Dec 2017 16:25
or select a calib. record
8 Start graphing
Graph at k = 1 2
Graph relative trend
Start Graphing
3.0
2.5
2.0
1.5
1.0
0.5
0.0
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00
Component
Methane
Nitrogen
Carbon dioxide
Ethane
Propane
i-Butane
n-Butane
Neopentane
i-Pentane
n-Pentane
Select all
Select none

14 Uncertainty Trend Comparison

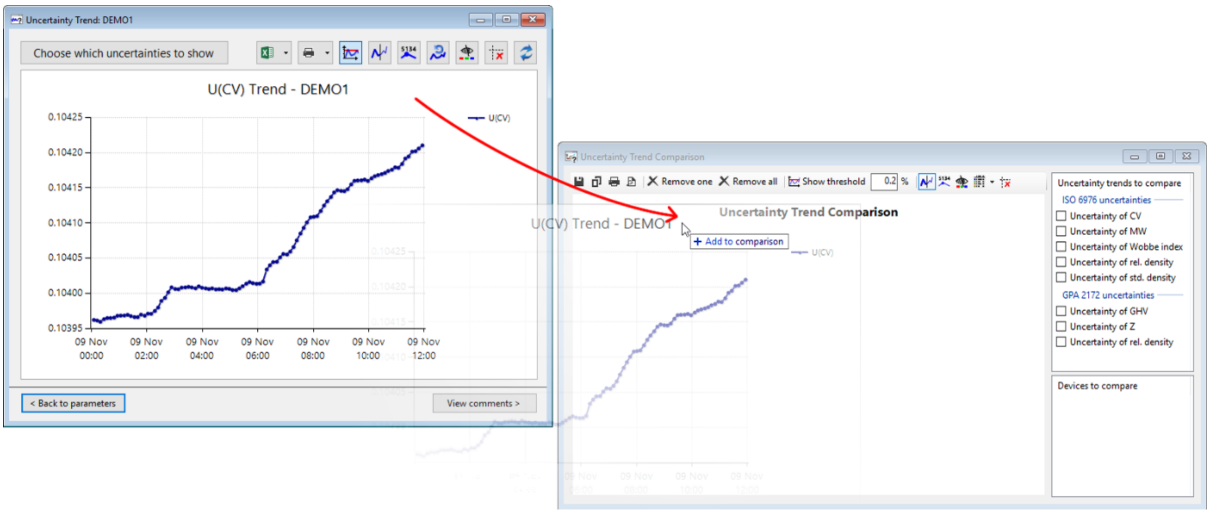
Uncertainty Trend Comparison is a module to display uncertainty trends across devices. This module is one of the three data comparison modules, the other two are Mole Composition Comparison and ISO 6976/GPA 2172 Trend Comparison. To access this module, go to the **Tools** menu and select **Uncertainty Trend Comparison**.

> **Note**
>
> This module requires two GCAS features to be included in GCAS licence: *Uncertainty Trend* and *Data Comparison*.

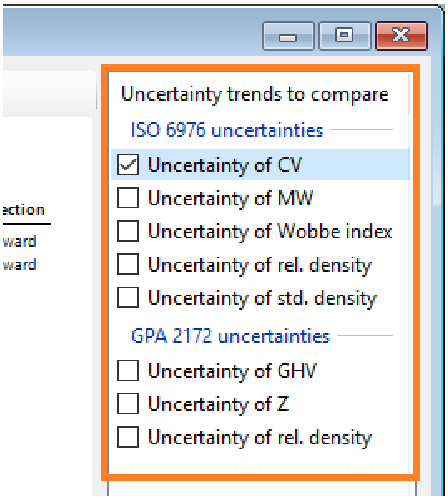
Uncertainty Trend Comparison form is no more than a place to show multiple uncertainty trend lines from different devices. It requires existing Uncertainty Trend forms that have their charts graphed already. Just drag the chart from Uncertainty Trend form and drop it on Uncertainty Trend Comparison form.

14.1 Add Uncertainty Trend to Compare

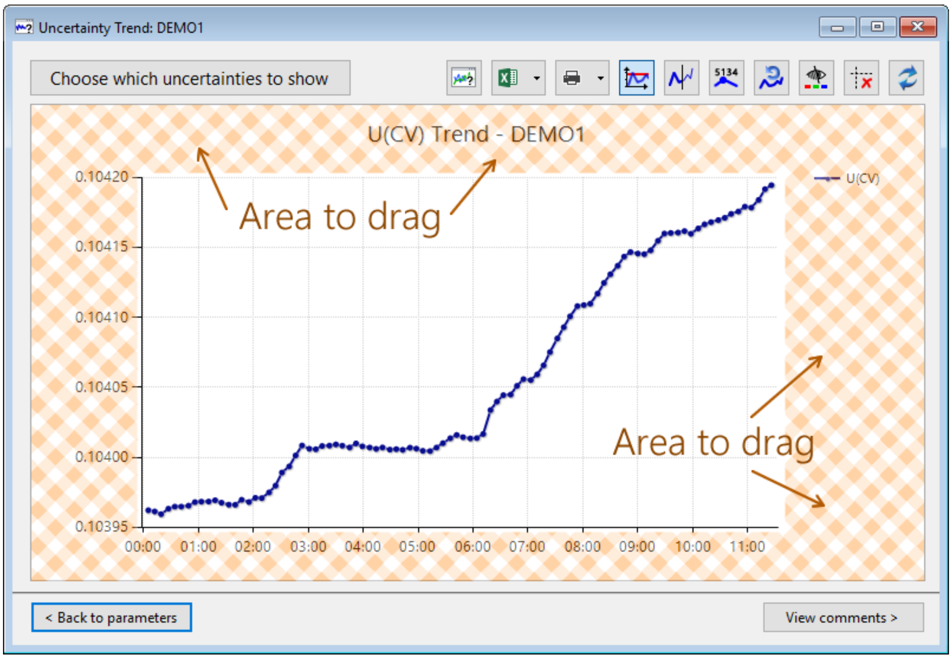
Drag the uncertainty trend chart of an existing Uncertainty Trend form and drop it on Uncertainty Trend Comparison form. When you release your mouse button, the Uncertainty Trend form sends uncertainty trend data of all eight trends, not just the ones being displayed. The comparison chart also features a legend showing the device name and its uncertainty trend direction.



Once the chart is dropped, select which ISO 6976 or GPA 2172 uncertainties to show or hide by ticking these check boxes shown in orange in the next page. By default, Uncertainty Trend Comparison form displays whichever uncertainty trends already visible on the originating Uncertainty Trend form.



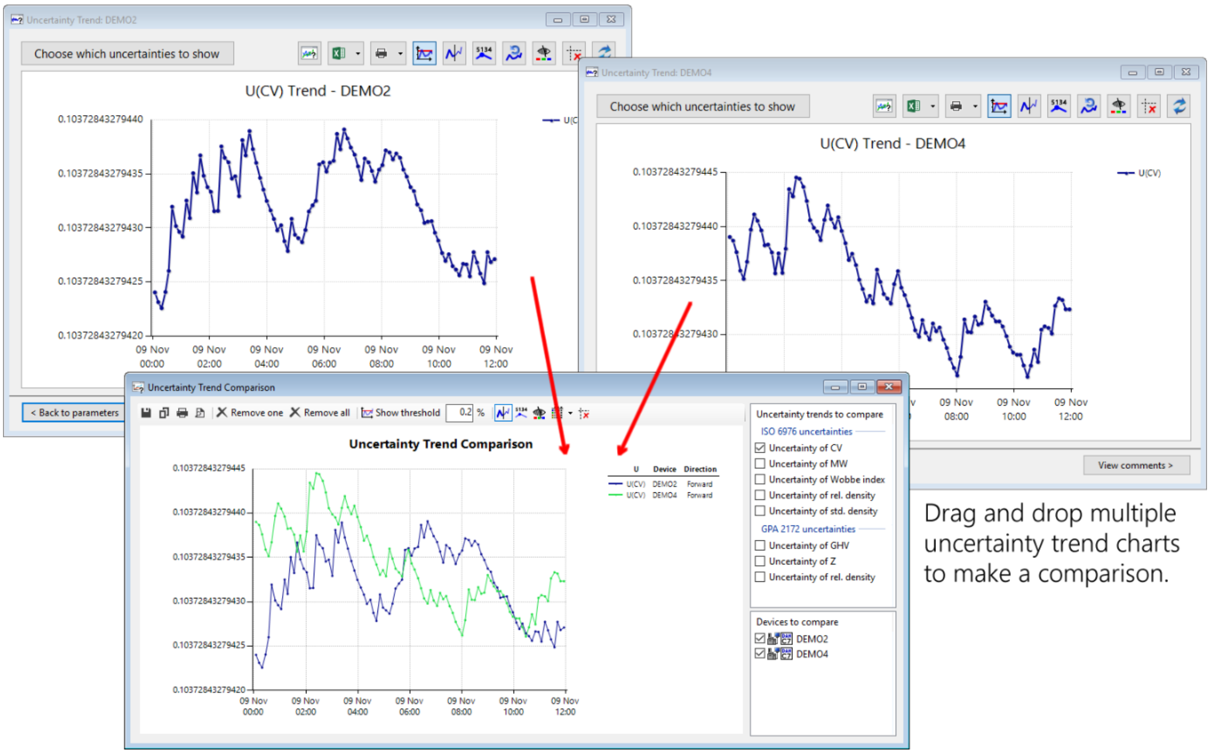
The screenshot down here illustrates the area to drag. Begin dragging on the orange area. If you drag *inside* the chart itself, you would zoom in the chart, not drag it.



Drag uncertainty trend charts from multiple devices to make a comparison. The maximum number of chart lines in Uncertainty Trend Comparison form is 18. These 18 chart lines can be distributed such as for example:

- two uncertainties (U_{CV} and U_{MW}) times 9 devices, or
- five uncertainties (U_{CV}, U_{GHV}, $U_{\text{Rel. density ISO 6976}}$, $U_{\text{Rel. density GPA 2172}}$, and $U_{\text{Std. density}}$) times three devices, or
- one uncertainty for 18 devices.

If you add more than 18 uncertainty trends, the form keeps displaying them but the chart line colours wrap over again so that it's difficult to distinguish two chart lines with the same colour.



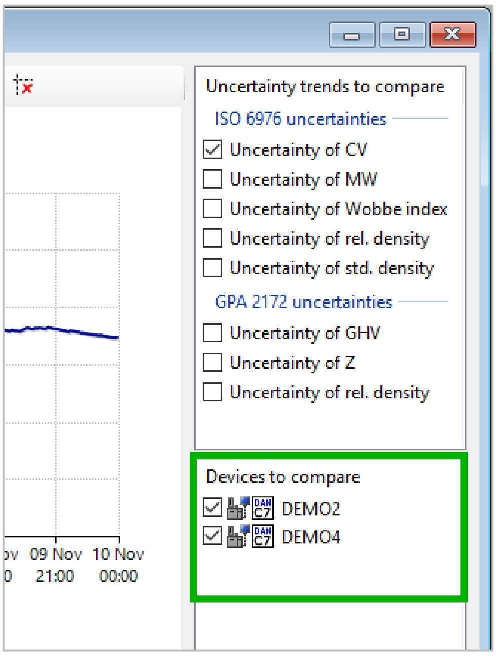
Drag and drop multiple uncertainty trend charts to make a comparison.

14.2 Update Existing Uncertainty Trend in Comparison

If you made a change in Uncertainty Trend form and redrew the chart, the trend chart in Uncertainty Trend Comparison form is not updated automatically. You need to push the update manually.

To do this, it's very simple. *Just re-drag the new chart and drop it once again on Uncertainty Trend Comparison form*. The comparison form detects that the associated GC device is already listed, so it redraws all existing chart lines with new data.

14.3 Remove or Hide Uncertainty Trend from the Comparison



To temporarily hide an uncertainty trend line of a particular device, untick the check box of that device in the list box shown in green (see right). To show it again, tick the box.

To remove chart lines of a device, highlight the device in the list of *Devices to compare* above (in green) and then click **Remove one** on the toolbar. Alternatively, highlight the device and press `Delete` on your keyboard. All uncertainty trend lines of this device should disappear.

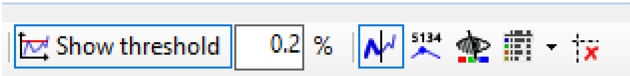
To remove all chart lines and start over from blank, click **Remove all** on the toolbar. Then you can drag new uncertainty trend charts and drop them on this form.

14.4 Save or Copy the Chart

To save the chart as an image file, click **Save** button on the toolbar.

To copy the chart as image, click **Copy** button on the toolbar. Then you can paste the image onto Microsoft Paint or any software accepting bitmap data.

14.5 Toolbar Items



Show threshold button toggles the red line in Y-axis that defines the maximum limit of healthy status of a GC device. Default threshold is set at 0.2%, but you can type your preferred threshold value in the text field next to the button.

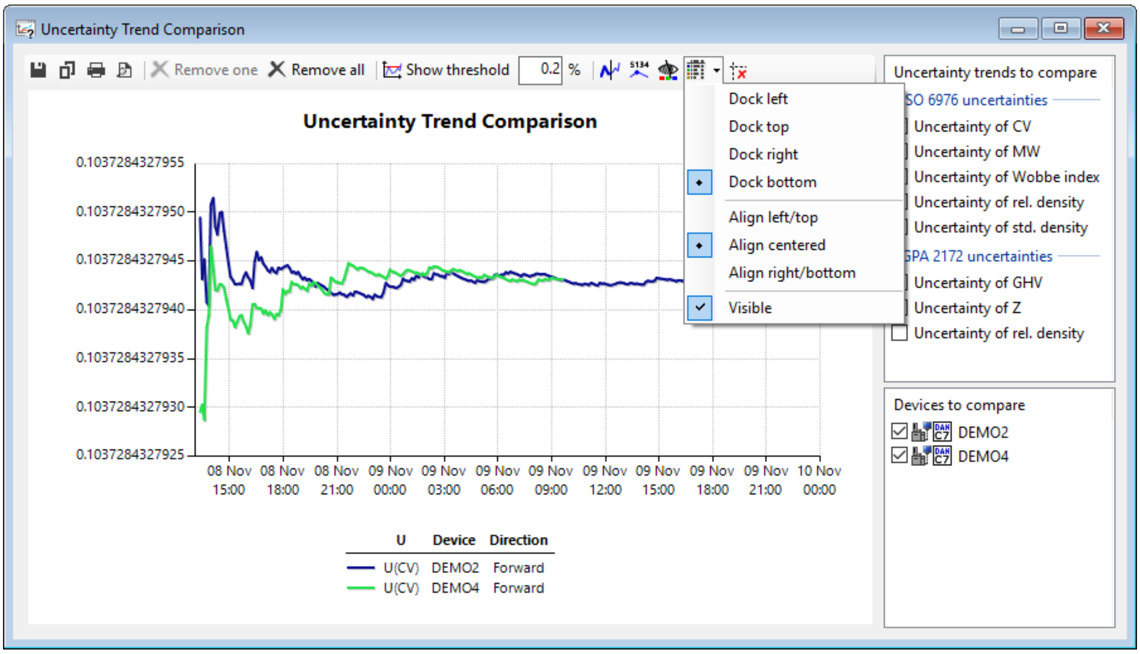
Unlike Uncertainty Trend form in which the red threshold line is *always visible* when the form is toggled to show threshold, the threshold line in Uncertainty Trend Comparison form is embedded in Y-axis. It does not show if Y-values of visible chart lines are all far below or above the threshold value.

Use thin lines. This button is pressed by default. It changes chart lines to either appear thin (1-pixel wide) or thick (2-pixel wide).

Show values button toggles whether Y-axis value of every dot should be displayed in labels. Do not activate this button if there are too many chart lines visible on the chart or if a chart line contains too many points, because it will clutter the chart.

Colourblind assist changes the colour scheme used by all chart lines. It also reverts the line thickness to thick (2-pixel wide).

Show legend. This button determines whether the chart legend is visible. Because chart legend displays the device name and uncertainty trend direction, it may occupy quite a lot of horizontal space. Hide the legend if you fancy the chart to use the full space available. This button also features a dropdown menu to position the chart legend around the chart. Screenshot in the next page is an example of chart legend being docked at bottom-centre of the chart.



Hide crosshair cursors button removes the cursor lines (the dotted magenta lines) from the chart. These magenta lines appear after you click once or as a remnant of a zoom operation. Yes, the uncertainty trend comparison chart is zoomable, and the way to zoom and scroll the chart is the same as uncertainty trend chart.

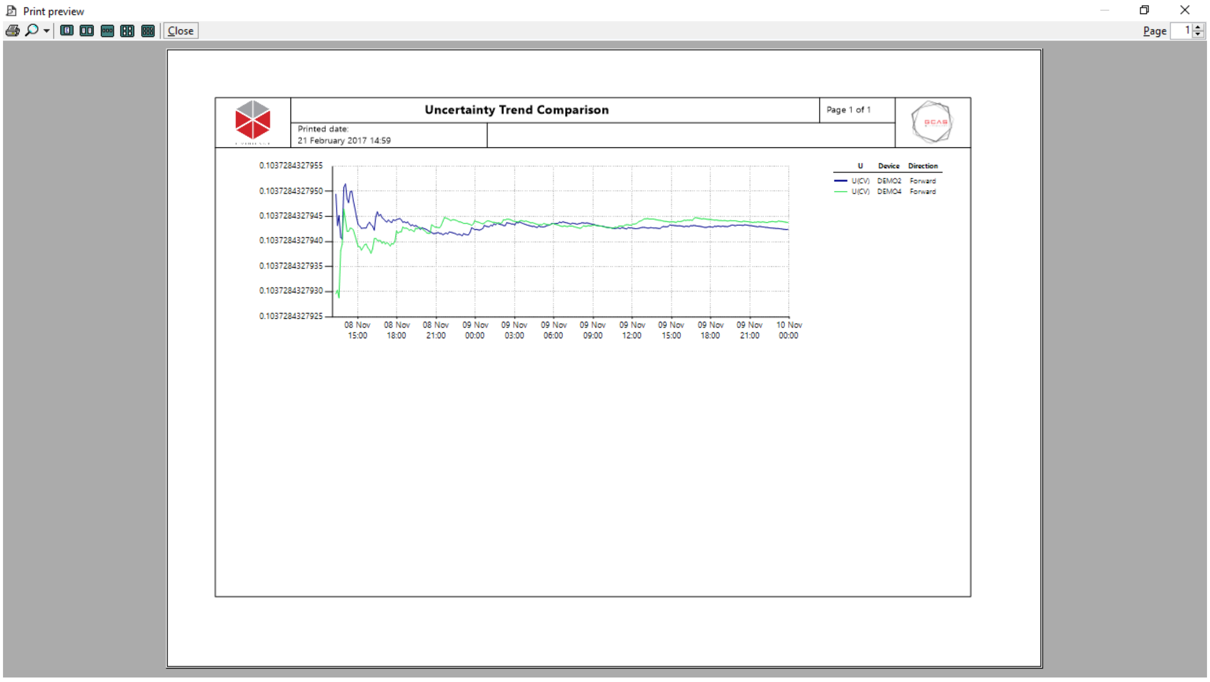
14.6 Printing

To print this uncertainty trend comparison chart, click **Print** on the toolbar. Alternatively click **Print preview** to get a preview before printing. The **Print** and **Print preview** command is also available from the **File** menu on main menu bar.

Tip

Chart legend is printed too. Because chart legend may take quite a lot of horizontal space, uncertainty trend comparison chart looks better on landscape orientation. Or alternatively, reposition the chart legend using the dropdown menu of **Show legend** button.

On portrait orientation, the printed chart occupies approximately ⅓ of page height. On landscape orientation, the chart occupies 40% of page height. GCAS uses this layout so that the chart will not be hideously stretched in vertical direction.



Print preview dialogue of uncertainty trend comparison.

15 Component Uncertainty Trend

Component Uncertainty Trend is a module to graph uncertainties of components (gases) of a GC device over time. So, it is similar to the regular Uncertainty Trend module but it is graphed for every gas instead of being aggregated into one metric such as the CV or the standard density.

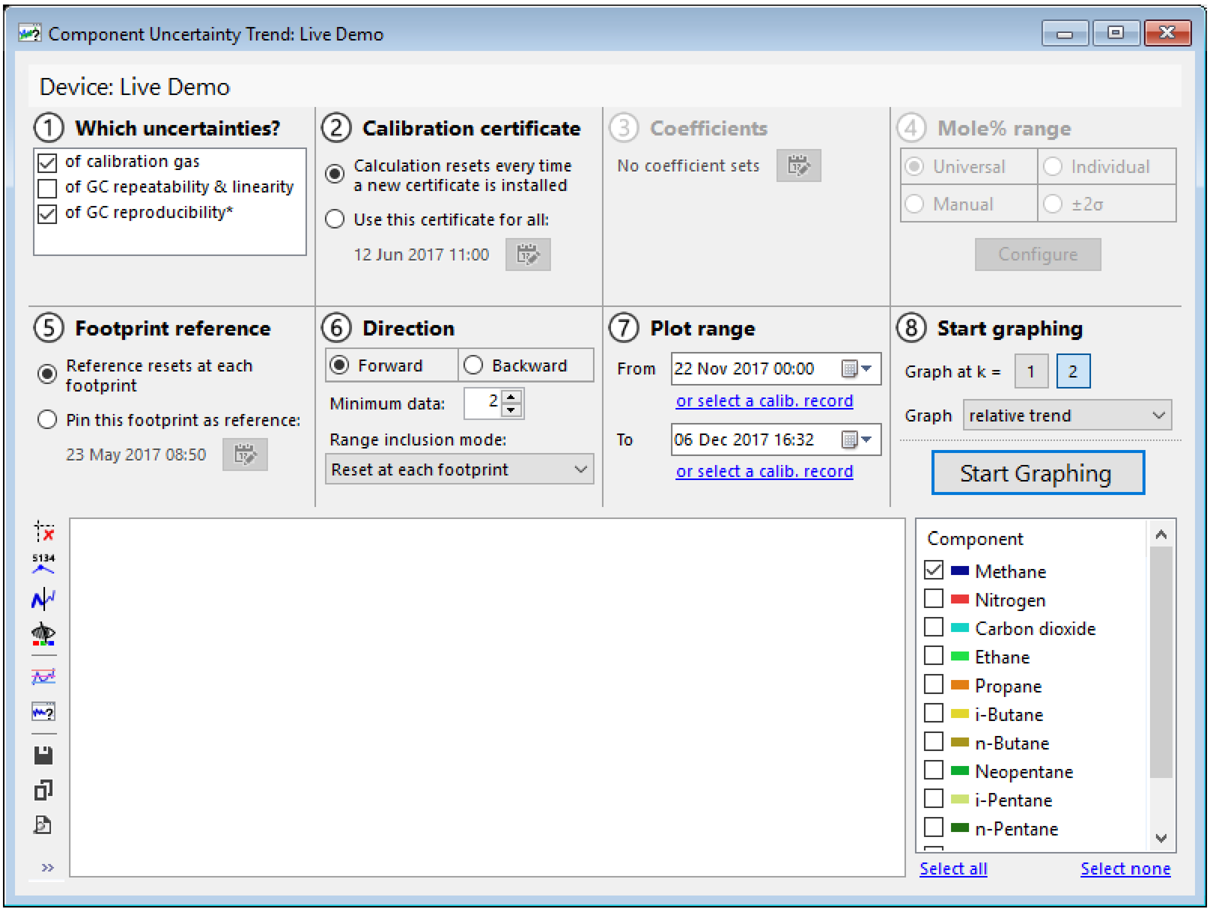
In case you notice the uncertainty trend graph started to increase at some point, you can switch to *component* uncertainty trend graph to find out which gas(es) causing this problem.

Note

Component Uncertainty Trend module uses the same GCAS feature *Uncertainty Trend* in your GCAS licence.

15.1 The *Component Uncertainty Trend* Form

Pick a device on your device panel or recent device panel, then go to the View menu > **Component Uncertainty Trend**.



Unlike the Uncertainty Trend form that is split into three "wizard"-y pages, Component Uncertainty Trend is a single page form. The parameters are at the top, while the chart is at the bottom. Component uncertainty trend parameters are the same as the regular uncertainty trend, but without ISO 6976 and GPA 2172 inputs. Also, component uncertainty trend graph does not have a threshold line.

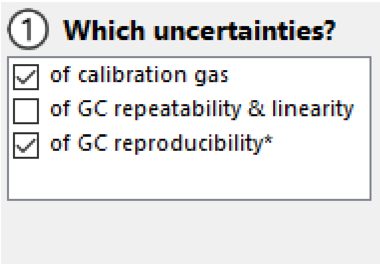
Note

Uncertainty calculation is slow because it loads many different data from database. Moreover, uncertainty trend calculation is a sequence of many uncertainty calculations. Depending on how wide your plot range and how many calibration records inside the plot range, one trend calculation may take from few seconds to ten minutes or even more. Fast CPU and good network connection between your computer and the database server help reducing the calculation time.

15.2 Component Uncertainty Trend Parameters

This chapter explains each component uncertainty trend parameter.

15.2.1 Uncertainties to Include



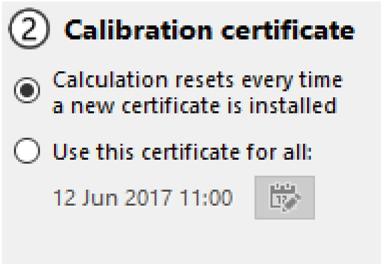
These check boxes control the uncertainties to include in the calculation. Similar to the regular uncertainty trend, $U_{reproducibility}$ is mandatory. Although technically you *can* untick $U_{reproducibility}$, it is strongly discouraged because excluding $U_{reproducibility}$ would graph a boring straight line on the chart.

Note

The GC device must have a calibration gas certificate. Component Uncertainty Trend form cannot graph your chart if there are no certificates installed.

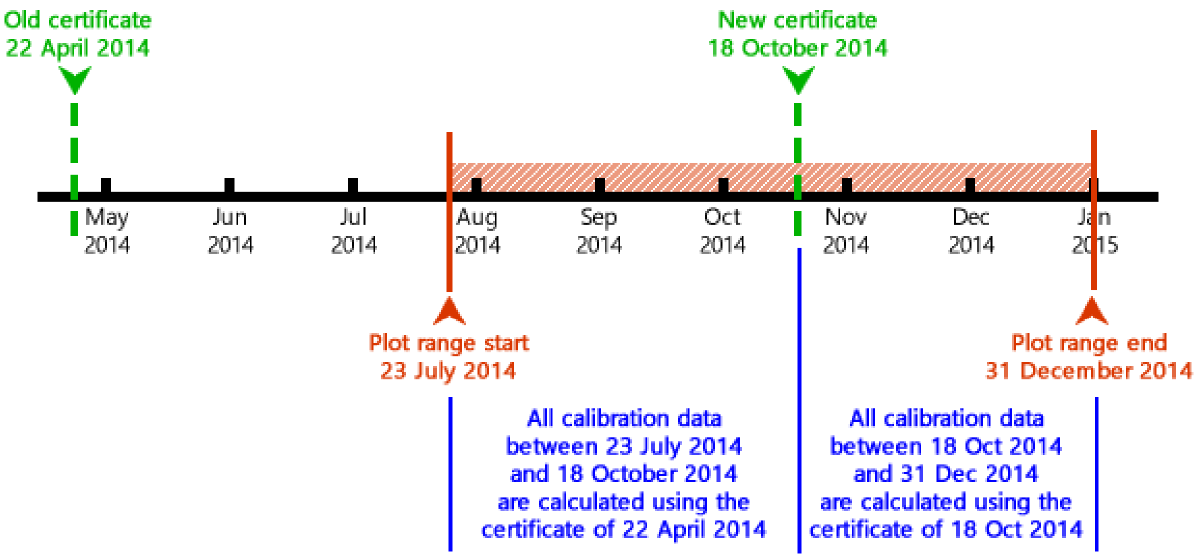
You cannot tick **Uncertainty of GC repeatability & linearity** if your GC device has no uncertainty coefficients stored in database. Uncertainty coefficient selection field and mole percentage range options will be disabled. To create a new coefficient set, rewind to chapter 12.4.

15.2.2 Calibration Certificate



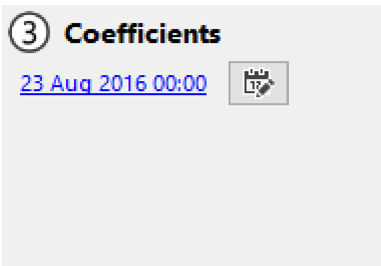
This section controls which certificates to use. There are two options: Reset calculation at each certificate, or pin a certificate for everything. The default is reset calculation at each certificate.

The same thing goes like the regular Uncertainty Trend module. The illustration below shows how thing goes if the first option (reset at each certificate) is selected.



On the other hand, the second option forces the Component Uncertainty Trend form to use a particular calibration certificate for all data within entire plot range. Click (Change) to display the *Select Certificate* dialogue and select the desired certificate.

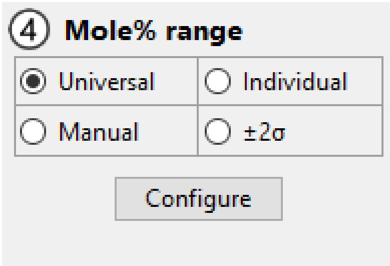
15.2.3 Uncertainty Coefficients



This section is available if uncertainty of GC repeatability is checked on the first section. Your GC device must have uncertainty coefficients stored in database, otherwise you cannot tick uncertainty of GC repeatability.

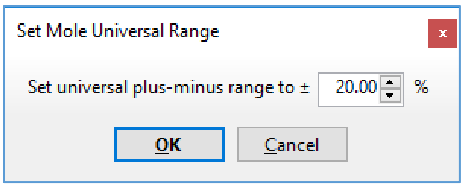
By default, Component Uncertainty Trend form loads the latest coefficient set for you. If this set is not the one you wanted, click this button to call *Select Coefficient Set* dialogue and pick the desired co-efficient set.

15.2.4 Mole Percentage Range

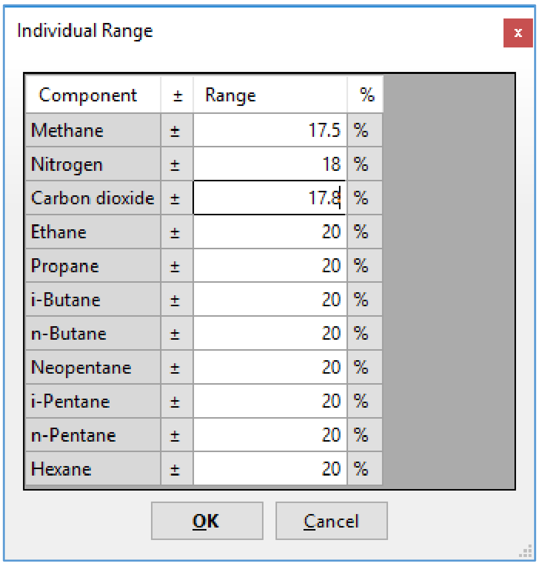


This section is also available if uncertainty of GC repeatability is checked on the first section. Here you are presented with four radio buttons. Pick one and click **Configure** to access more tailored options.

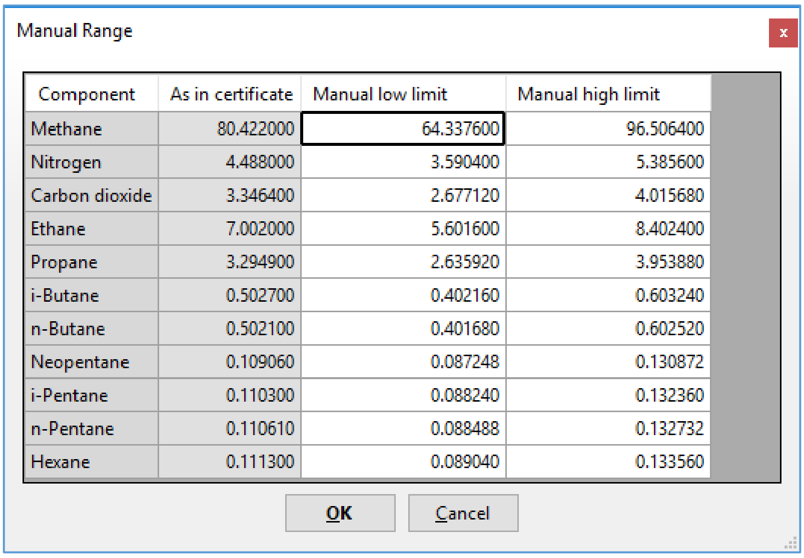
1. **Universal**: Every component has the same plus-minus range. When you click the **Configure** button, GCAS displays a dialogue to select the universal range. Default range is ±20%.



2. **Individual**: Every component has its own plus-minus range. When you click the **Configure** button, GCAS displays a dialogue to set a range of each gas independently.

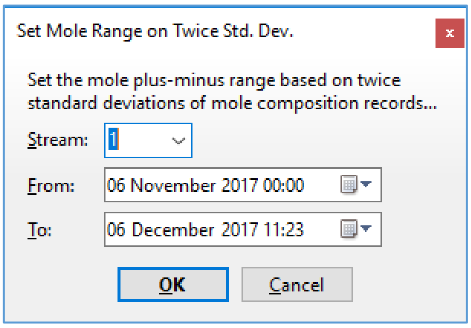


3. **Manual**: You can explicitly set the value of lower bound and upper bound of each component. Click **Configure** to enter these values. For comparison, the mole composition from the calibration gas certificate is displayed in the second column. Do not forget to balance the gas with the highest composition.



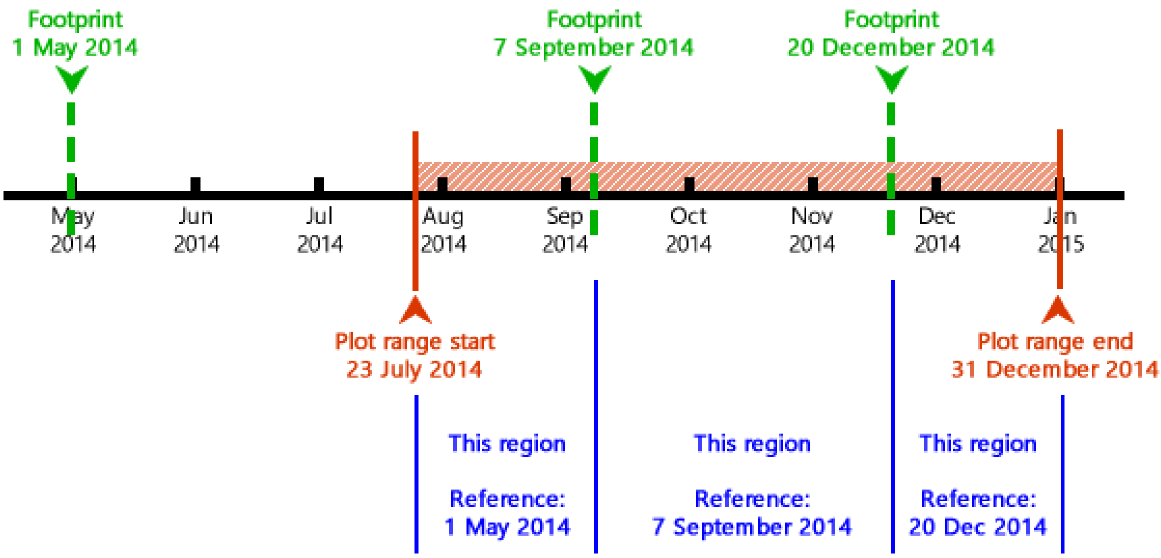
Component	As in certificate	Manual low limit	Manual high limit
Methane	80.422000	64.337600	96.506400
Nitrogen	4.488000	3.590400	5.385600
Carbon dioxide	3.346400	2.677120	4.015680
Ethane	7.002000	5.601600	8.402400
Propane	3.294900	2.635920	3.953880
i-Butane	0.502700	0.402160	0.603240
n-Butane	0.502100	0.401680	0.602520
Neopentane	0.109060	0.087248	0.130872
i-Pentane	0.110300	0.088240	0.132360
n-Pentane	0.110610	0.088488	0.132732
Hexane	0.111300	0.089040	0.133560

4. **±2σ** : This means "plus/minus twice the standard deviation". This option causes GCAS to take the standard deviation, times two, over a defined range of mole composition records. Click **Configure** to define this time period and the stream number.



15.2.5 Footprint Reference

This section controls which footprint(s) to use while calculating $U_{reproducibility}$. Similar to calibration certificate parameter, there are two options here: Reset reference at each footprint, or pin a particular footprint for all data. The default is to reset reference at each footprint, as illustrated by the timeline on the next page.

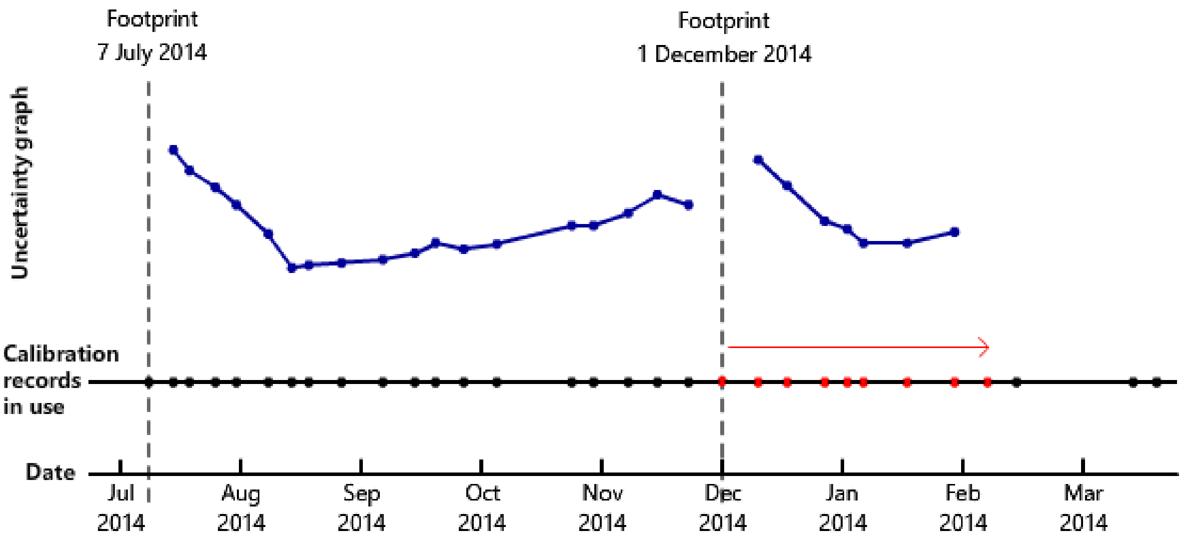


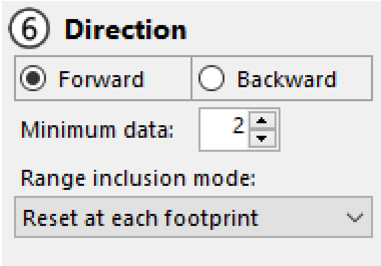
If you need to test how the result would turn out using different footprints, select the second option (pin a footprint) and then click the button with this icon . It calls the *Select Footprint* dialogue and you can pick the desired footprint.

15.2.6 Direction

Direction of calculation determines which calibration records to include in the calculation. As the trend calculation goes, GCAS accumulatively load more calibration records in the desired direction, up to the specified limit.

On **forward** direction, list of calibration records is enumerated from footprint. The calculation of $U_{reproducibility}$ starts from the footprint itself and accumulatively go *forward* until either GCAS finds the next footprint or up to the end of plot range, depending on the setting. The picture down here is animated in the HTML version of GCAS manual. The animation shows how the calibration records are used if the calculation is set in forward direction and the inclusion mode is set to "reset at footprint".

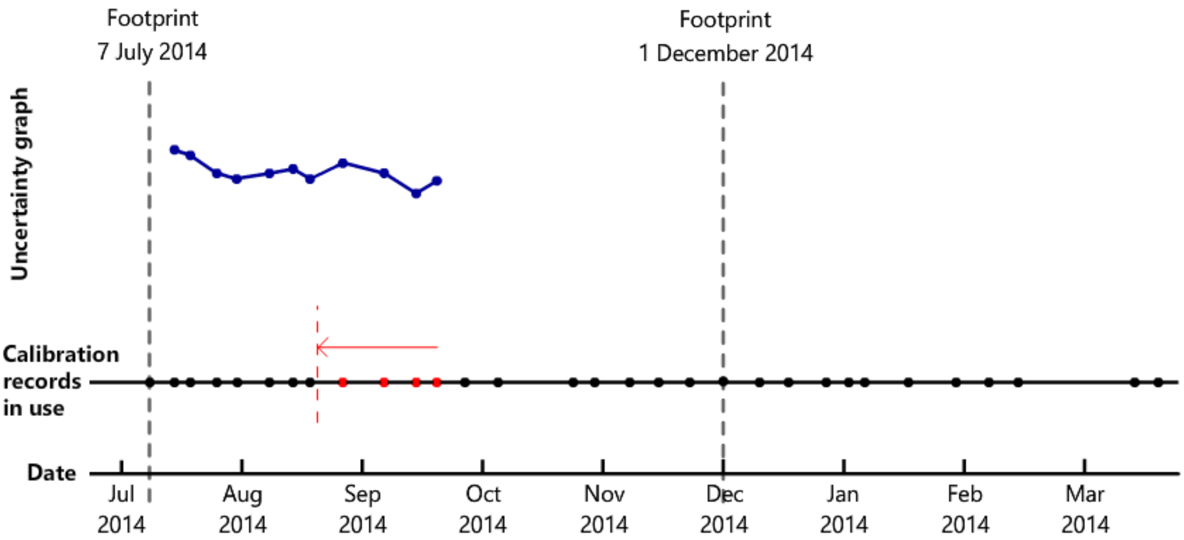




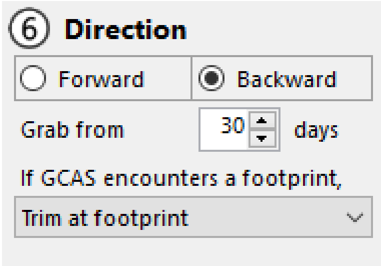
There is a minimum limit to start the calculation. The default is two (2), which means forward calculation can start at two calibration data after every footprint within the plot range. You can set the minimum for example, ten, so the calculation starts after 10 calibrations following every footprint. The bigger this minimum limit, the greater the gap you see on the chart after every footprint.

At **Range inclusion mode**, there are two options. If you select **Reset at each footprint**, the list of calibration record used for the calculation is restarted whenever a new footprint is encountered as GCAS goes forward. This option causes each calibration data is calculated together only with its immediate preceding footprint, and not the previous footprint before that one. If you see the animated image in the HTML version GCAS manual, that animation assumes *Reset at each footprint* is selected. The other option–**Continuous throughout plot range–**breaks this barrier. The list of calibration records in use just grow bigger along the timeline as GCAS goes forward, no matter whether a new footprint is encountered. When GCAS comes across the second footprint on the timeline, this footprint is included in the list as if it was a regular calibration data.

On **backward** direction, list of calibration data to include is counted from every single calibration data being calculated. For every calibration record in the plot range, calculation of $U_{reproducibility}$ at that point will include that calibration data plus all records going *backward* to the last *x* days before that point.



The picture above is animated in the HTML version of GCAS manual. The animation shows how backward direction applies to all calibration records in the plot range assuming the limit is set at 30 days and the bump behaviour set as "trim at footprint".



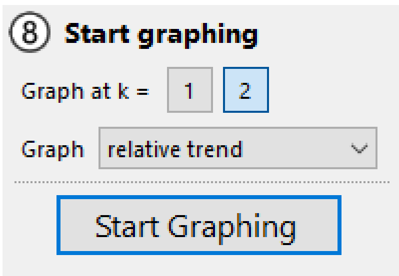
Default limit for backward direction is 30 days. You can go backward to as far as 2 years (730 days).

While GCAS is travelling backward, it may find a footprint before it fulfils the specified *x* days. Decide what GCAS should do when it bumps into a footprint, whether to stop or to continue. The default is stop at footprint (**trim at footprint**). By stopping at footprint, the number of calibration data included in the calculation may be less than *x* days, but GCAS does not include data before the footprint which are usually calibrated under different configuration. The other option—**Include data before footprint**—treats any footprints encountered along the way as regular calibration records.

15.2.7 Plot Range

Set the plot range start and end date. Or, select two calibration records as the starting and ending point of this range. Click the corresponding link to call the familiar *Select Record* dialogue where you can pick the desired record.

15.2.8 Coverage Factor and Graph Type

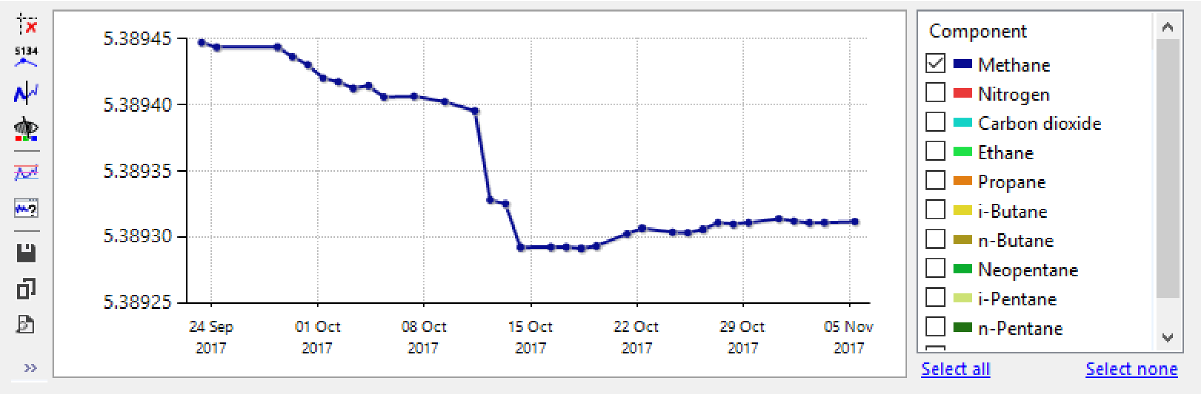


Before starting the calculation, Component Uncertainty Trend form asks you two last things. First, set the coverage factor (k). The default is $k = 2$. Second, select whether you want to graph the relative component uncertainty or absolute component uncertainty. Both types are measured in percentage. To distinguish them, use this formula:

$$\text{absolute uncertainty} = \frac{\text{relative uncertainty (drop the \% symbol)}}{100} \times \text{mole composition in certificate}$$

15.3 Component Uncertainty Trend Chart

Click **Start Graphing** at the component uncertainty trend parameter section 8 to begin the calculation.



Note

Uncertainty calculation is slow because it loads many different data from database. Moreover, uncertainty trend calculation is a sequence of many uncertainty calculations. Depending on how wide your plot range and how many calibration records inside the plot range, one trend calculation may take from few seconds to ten minutes or even more. Fast CPU and good network connection between your computer and the database server help reducing the calculation time.

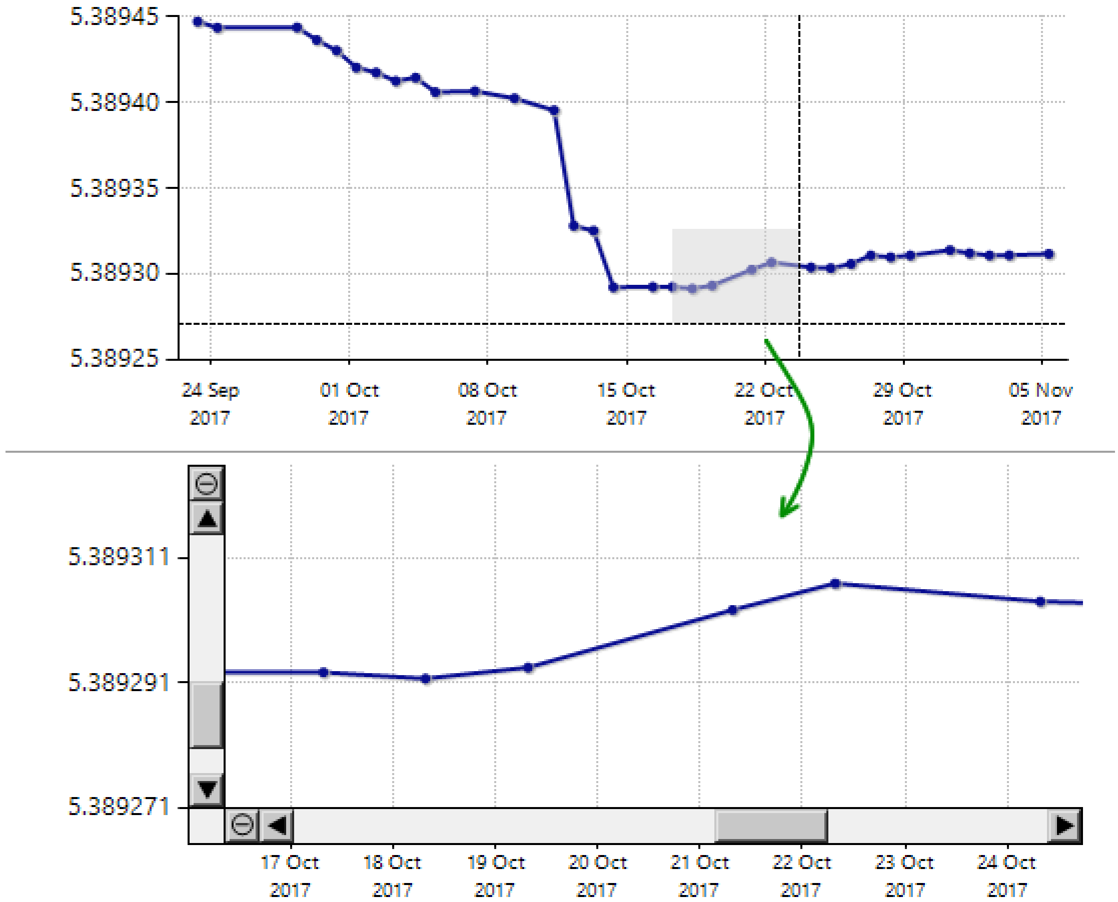
Because uncertainty trend calculation is slow, GCAS provides **Pause** button to temporarily halt the calculation and **Stop** button to abort the calculation. The keyboard shortcut `F7` is designated for Pause button and `Esc` for Stop button. While calculation is in progress, you cannot use other modules or they will run slower than usual. This is because the database server is busy serving the data required for uncertainty calculation.

Unlike the regular uncertainty trend chart, component uncertainty trend does not have a threshold line. The reason is, we have to draw different threshold lines for every single gas.

The check boxes next to the chart enlist the gases. These check boxes control whether the chart line of its associated gas should be displayed or hidden. By default, only the first gas is displayed.

15.3.1 Zoom and Scroll

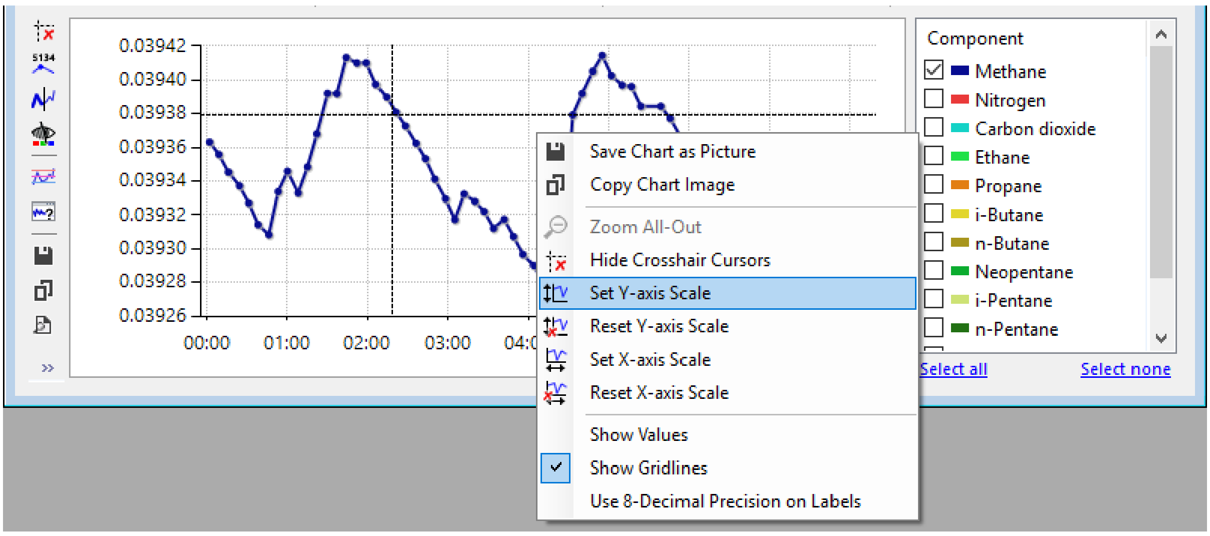
Drag a rectangle over the area you want to zoom in. Pan around the chart using the provided scroll bars. Drag another rectangle to zoom in further.



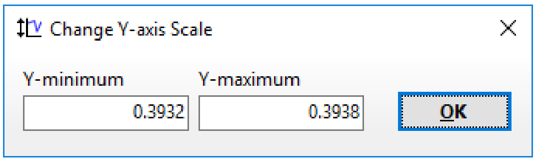
To zoom out, click the circled minus button ⊖ on both scroll bars. Press Home on your keyboard or right-click the chart and select **Zoom All-Out** to undo all zoom-in operations.

15.3.2 Change Axes Scale

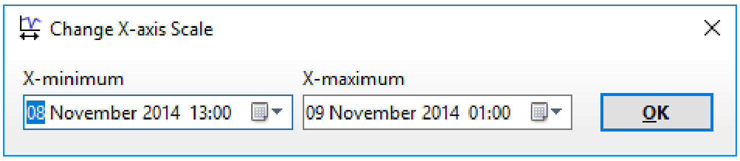
If zoom was not enough, you can make the chart axes use a custom scale. Right-click the chart and select either **Set Y-axis Scale** or **Set X-axis Scale** menu.



For Y-axis, enter the desired lower bound and upper bound. If the custom range defined between the Y-minimum and Y-maximum is smaller than the actual Y-value range of the chart, this will truncate the chart.



For X-axis, enter the desired starting and ending date. This may either cut or extend the chart.

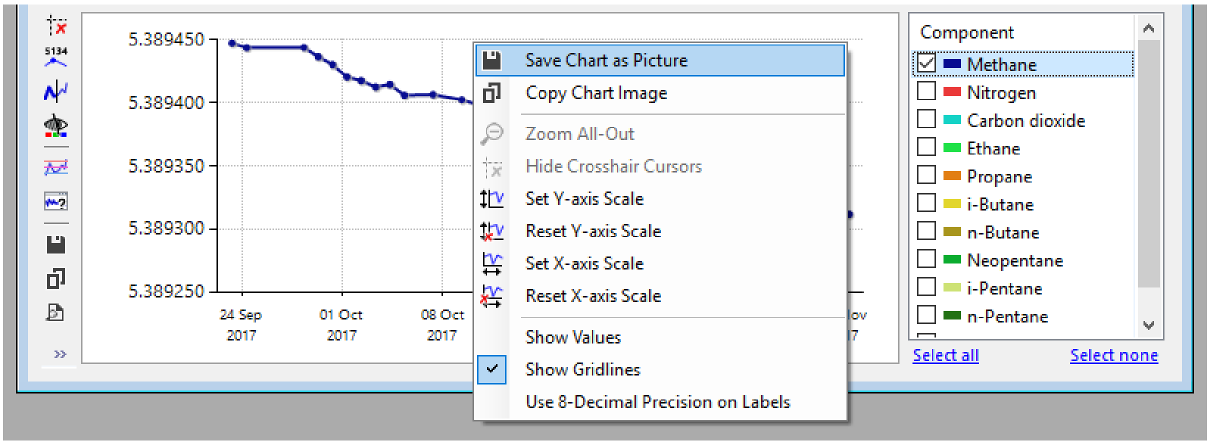


To undo the custom scale and go back to the automatic scale, right-click the chart and choose **Reset X-axis Scale** or **Reset Y-axis Scale** depending on which axis currently has the custom scale.

15.3.3 Save or Copy the Chart

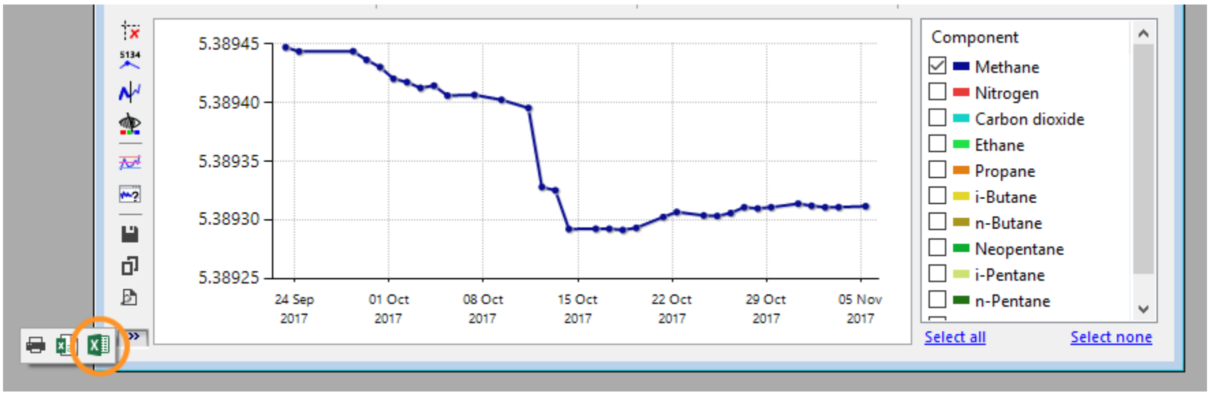
To save the chart as image file, click the **Save** button on the toolbar at the left side of the chart. Alternatively, right-click the chart and select **Save Chart as Picture**.

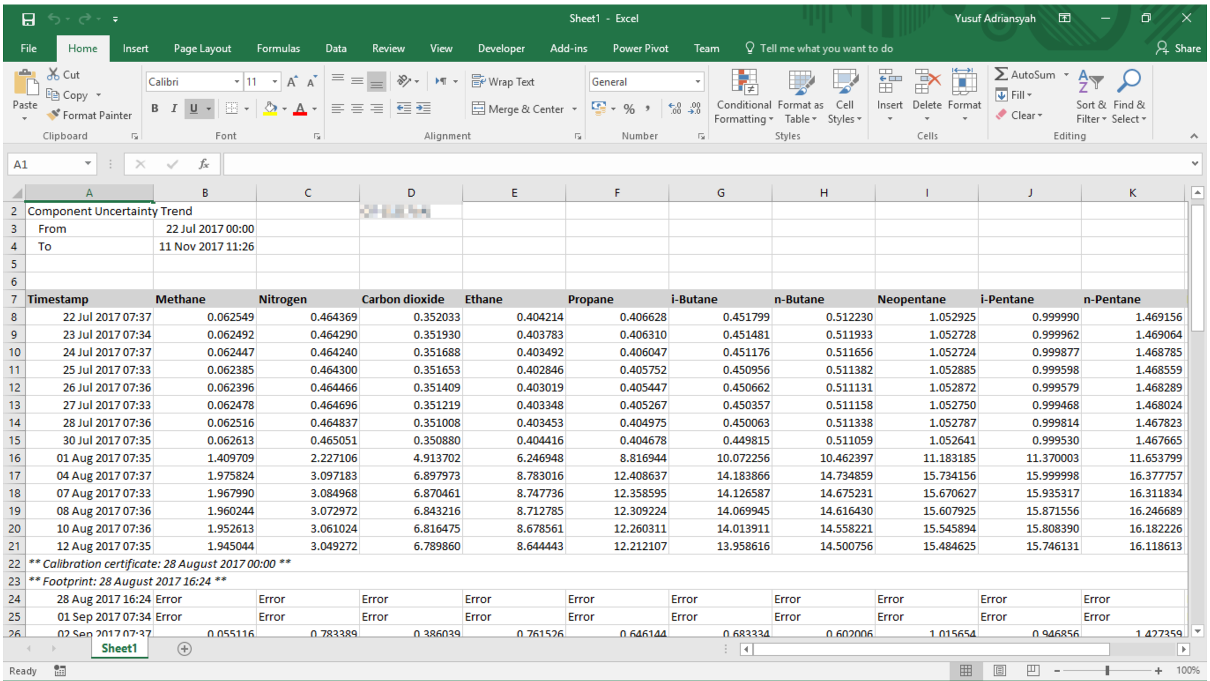
To copy the chart into clipboard, click **Copy** on the left toolbar, or right-click the chart and select **Copy Chart Image**.



15.3.4 Export Values to Microsoft Excel or CSV

On the toolbar at the left side, click **Copy to Excel**. This button launches Microsoft Excel and opens a new workbook, then copies the uncertainty values of each gas to the sheet. At the bottom of the sheet, GCAS writes all parameters that created such uncertainty values so other team member can re-create the same chart on their GCAS later. This feature requires Microsoft Excel 2010, 2013, 2016, or later versions.





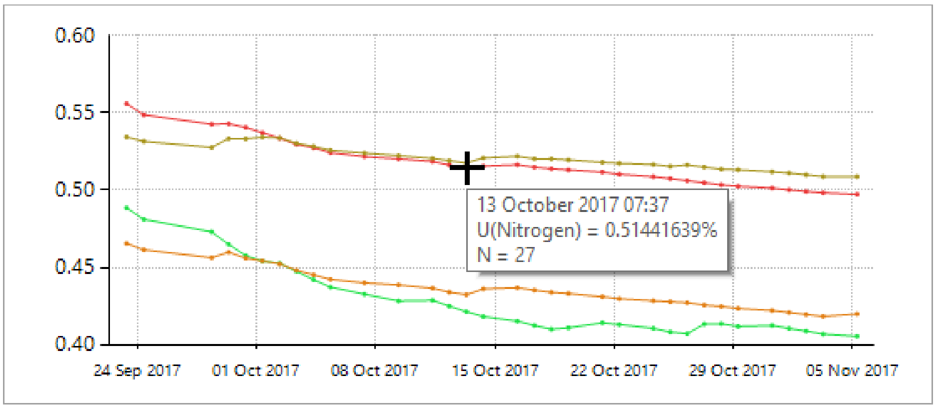
	A	B	C	D	E	F	G	H	I	J	K
2	Component Uncertainty Trend										
3	From	22 Jul 2017 00:00									
4	To	11 Nov 2017 11:26									
5											
6											
7	Timestamp	Methane	Nitrogen	Carbon dioxide	Ethane	Propane	i-Butane	n-Butane	Neopentane	i-Pentane	n-Pentane
8	22 Jul 2017 07:37	0.062549	0.464369	0.352033	0.404214	0.406628	0.451799	0.512230	1.052925	0.999990	1.469156
9	23 Jul 2017 07:34	0.062492	0.464290	0.351930	0.403783	0.406310	0.451481	0.511933	1.052728	0.999962	1.469064
10	24 Jul 2017 07:37	0.062447	0.464240	0.351688	0.403492	0.406047	0.451176	0.511656	1.052724	0.999877	1.468785
11	25 Jul 2017 07:33	0.062385	0.464300	0.351653	0.402846	0.405752	0.450956	0.511382	1.052885	0.999598	1.468559
12	26 Jul 2017 07:36	0.062396	0.464466	0.351409	0.403019	0.405447	0.450662	0.511131	1.052872	0.999579	1.468289
13	27 Jul 2017 07:33	0.062478	0.464696	0.351219	0.403348	0.405267	0.450357	0.511158	1.052750	0.999468	1.468024
14	28 Jul 2017 07:36	0.062516	0.464837	0.351008	0.403453	0.404975	0.450063	0.511338	1.052787	0.999814	1.467823
15	30 Jul 2017 07:35	0.062613	0.465051	0.350880	0.404416	0.404678	0.449815	0.511059	1.052641	0.999530	1.467665
16	01 Aug 2017 07:35	1.409709	2.227106	4.913702	6.246948	8.816944	10.072256	10.462397	11.183185	11.370003	11.653799
17	04 Aug 2017 07:37	1.975824	3.097183	6.897973	8.783016	12.408637	14.183866	14.734859	15.734156	15.999998	16.377757
18	07 Aug 2017 07:33	1.967990	3.084968	6.870461	8.747736	12.358595	14.126587	14.675231	15.670627	15.935317	16.311834
19	08 Aug 2017 07:36	1.960244	3.072972	6.843216	8.712785	12.309224	14.069945	14.616430	15.607925	15.871556	16.246689
20	10 Aug 2017 07:36	1.952613	3.061024	6.816475	8.678561	12.260311	14.013911	14.558221	15.545894	15.808390	16.182226
21	12 Aug 2017 07:35	1.945044	3.049272	6.789860	8.644443	12.212107	13.958616	14.500756	15.484625	15.746131	16.118613
22	** Calibration certificate: 28 August 2017 00:00 **										
23	** Footprint: 28 August 2017 16:24 **										
24	28 Aug 2017 16:24	Error	Error	Error	Error	Error	Error	Error	Error	Error	Error
25	01 Sep 2017 07:34	Error	Error	Error	Error	Error	Error	Error	Error	Error	Error
26	02 Sep 2017 07:37	0.055116	0.783389	0.386039	0.761526	0.646144	0.683334	0.602006	1.015654	0.946856	1.427359

When you see "Error", it means the trend was calculated in forward direction and there were not enough data points after a footprint to begin the calculation.

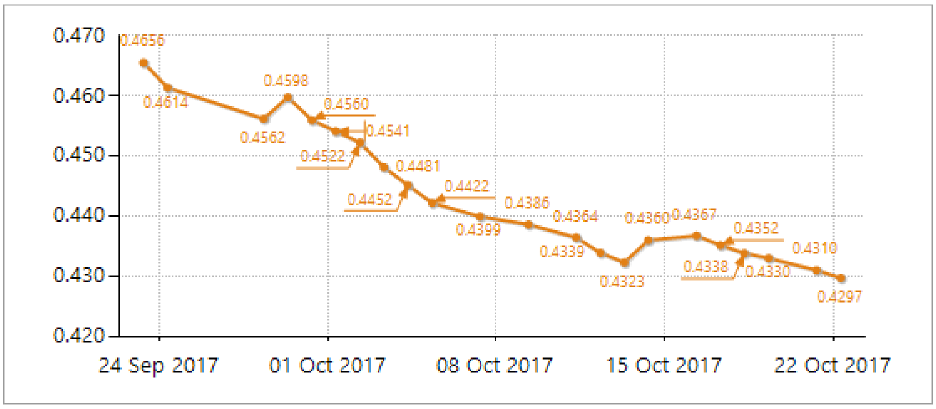
If the chart contains so many records, exporting to Excel may take longer time. Therefore, we recommend exporting to CSV files instead. On the left toolbar, click **Export to CSV**. Using CSV export is a lot faster but you lose the formatting and cosmetics of Excel worksheet.

15.3.5 Other Visual Cues

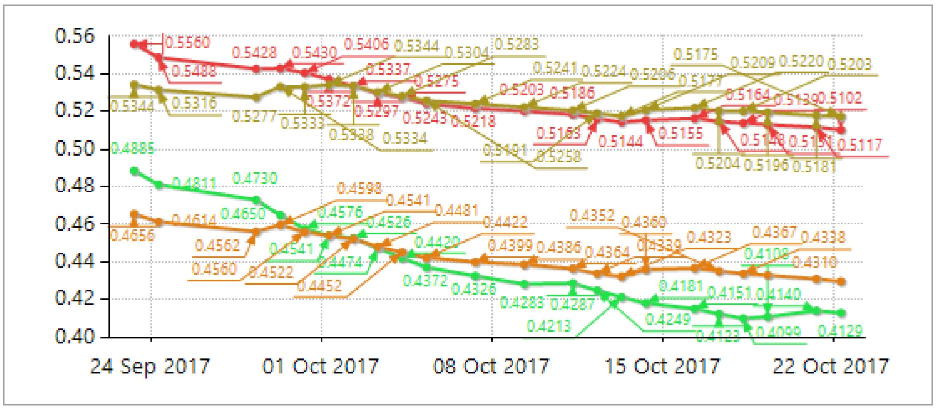
Hover your mouse pointer over a data point on the chart to reveal a tooltip about that point. Typically, the tooltip displays the X-axis value (the date and time value), Y-axis value, and the *N* (number of calibration data used to calculate the uncertainty at this point). For backward calculation, the tooltip has additional info whether GCAS bumped into footprint, and if so, whether the backward iteration stopped at footprint or continued through.



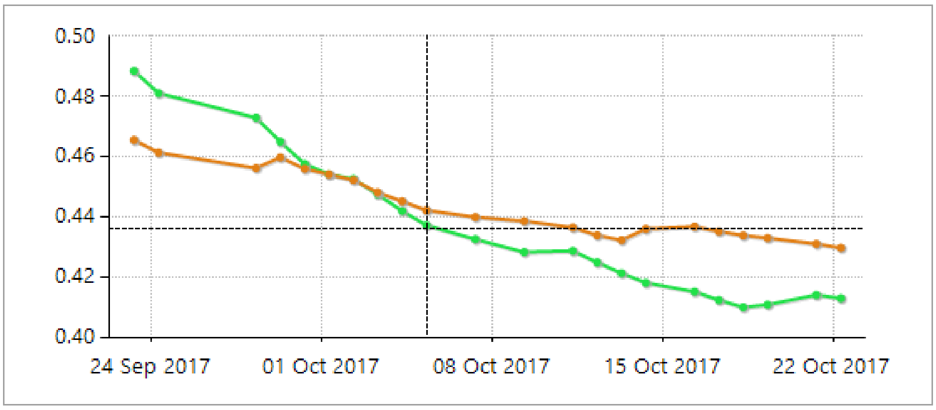
Press **Show values** or right-click the chart and check **Show Values** to display the uncertainty values on each dot. By default, these values are presented as 4-digit decimals. If you need 8-digit precision, right-click the chart and tick **Use 8-Decimal Precision on Labels**.



Beware that having too many data points, multiplied by the number of chart lines (number of gases being displayed), can clutter the chart like this one.



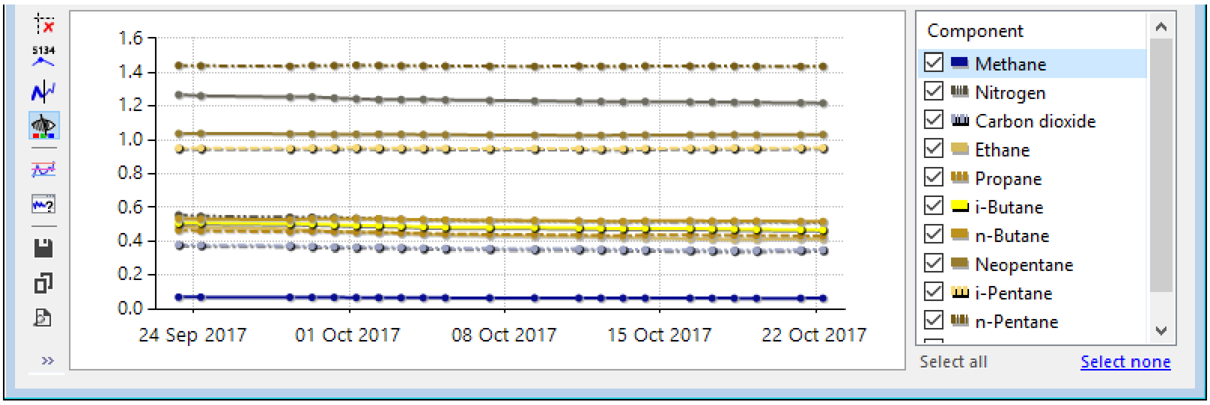
These dotted lines down here are called *cursors*. Cursors appear when you [left] click on a chart or as a remnant of zoom operation. Cursor may act as a guide to compare Y-axis values of two data points. Click **Hide crosshair cursors** on the toolbar or right-click the chart and select **Hide Crosshair Cursors** to remove them from view.



Component Uncertainty Trend form draws the chart using thick lines by default. But if you fancy thin lines or if you are displaying a lot of gases at once, toggle the **Use thin lines** button on the left side toolbar.

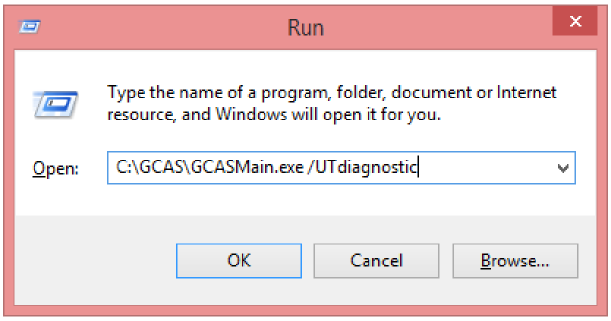
15.3.6 Colourblind Assistance

To aid users with colour blindness (protanopia and deuteranopia), GCAS provides an alternative colour scheme for the chart. Use the **Colourblind assist** button on the left-side toolbar to switch colour scheme.

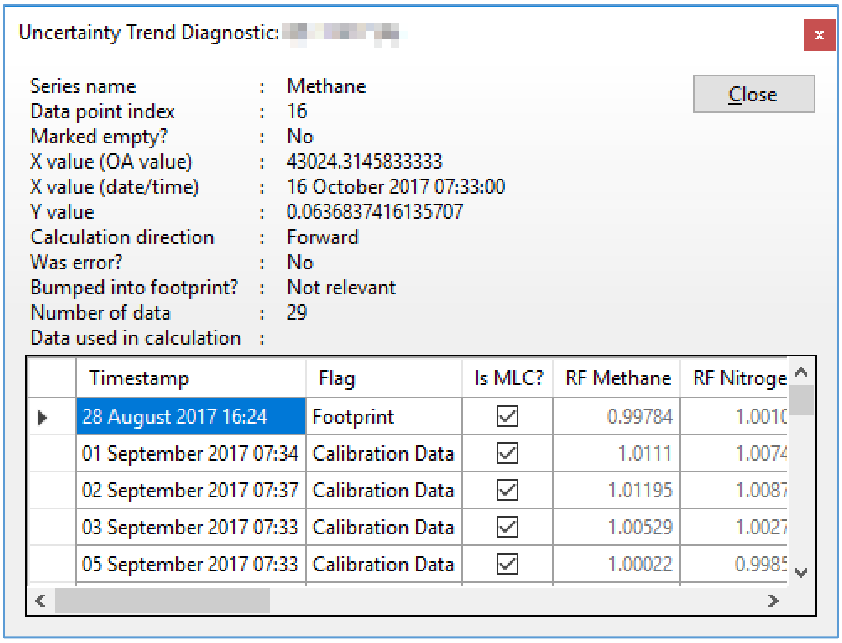


15.3.7 Uncertainty Trend Diagnostics

In case you notice the component uncertainty trend chart has some erroneous data points or just plain curious, you can use uncertainty trend diagnostics to see exactly which calibration records were included in the calculation of a data point in the chart. To enable uncertainty trend diagnostics, run GCAS with additional **/UTdiagnostic** switch. (UT = Uncertainty Trend)



With uncertainty trend diagnostic mode activated, **click** on any dot on the chart. GCAS displays the *Uncertainty Trend Diagnostic* form that lists the calibration records used to calculate the component uncertainties of this dot.



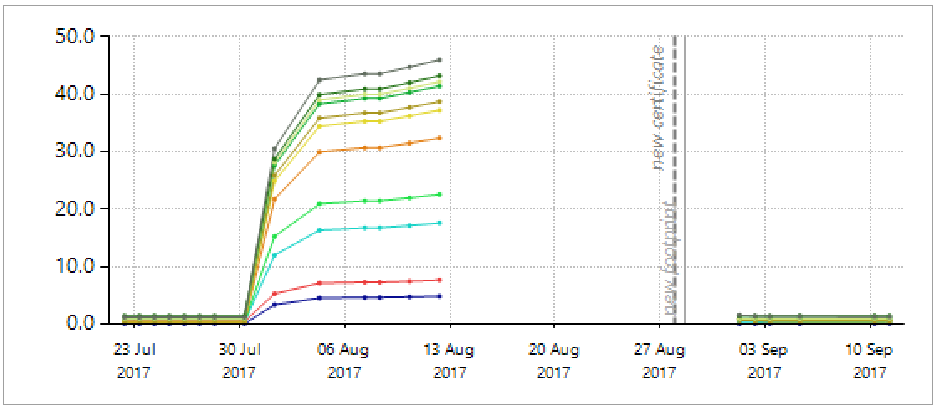
[Forward calculation](#) must include the *last* footprint before this data point. This footprint *may or may not be the same as the reference footprint*. (Refer to [chapter 13.2.6 Uncertainty trend direction](#) for more info about reference vs last footprint). This *last* footprint should be at the first row on this grid.

[Backward calculation](#) may or may not have footprints in this grid view. For example, you are graphing component uncertainty trend with backward calculation for 30 days. If the footprint was 40 days ago, that footprint won't be included in the calculation. On another data point where the footprint was 25 days before; this footprint should be at the last row if you set the form to trim at footprint. If you set to continue through (i.e. include data before footprint) there may be more records preceding this footprint.

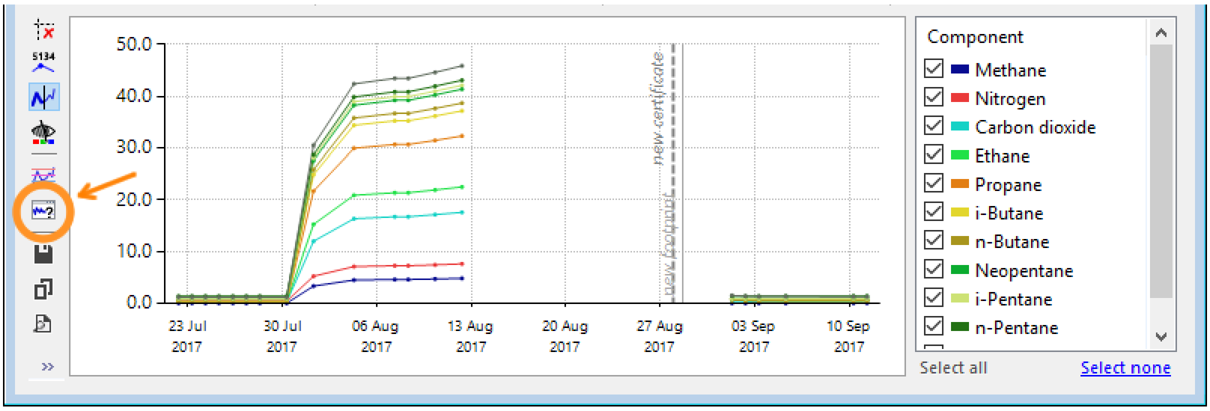
Had the records on the displayed grid do not conform to the two paragraphs above, this indicates a bug. Kindly please report the bug to support@i-Vigilant.com.

15.4 *Component Uncertainty Trend* Form to *Uncertainty Trend* Form Linkage

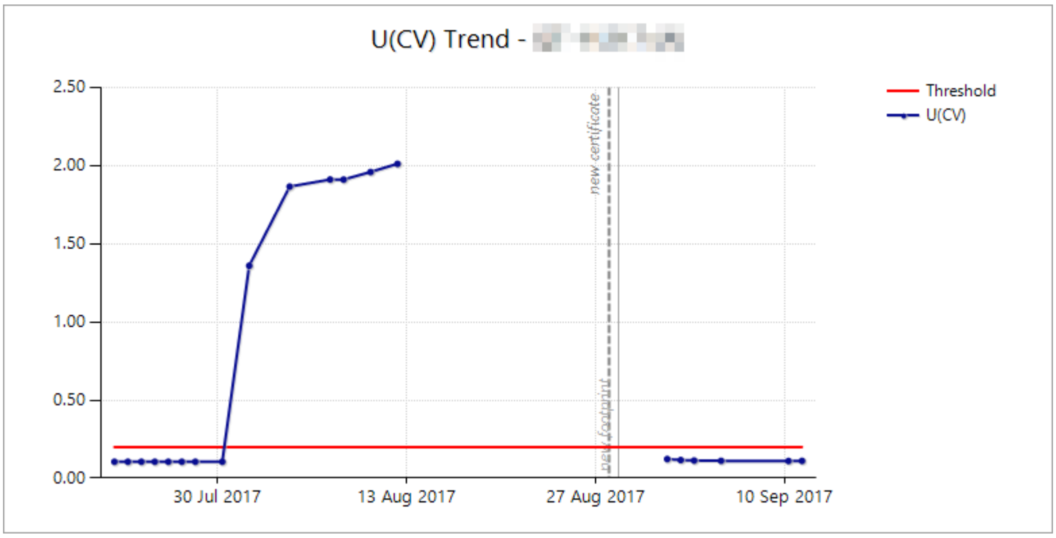
Let's see we found a case where the uncertainties of all gases rose at 1st of August 2017, like the one in this chart.



You might want to see how this increment of component uncertainties affect the overall CV uncertainties. The usual method is to fire up Uncertainty Trend form via the **View** menu on main menu bar, and configure the Uncertainty Trend form to match the parameters set in Component Uncertainty Trend form. But there is a shortcut: Use this button , called "View uncertainty trend in the same plot range", on the toolbar at the left side of component uncertainty trend chart.

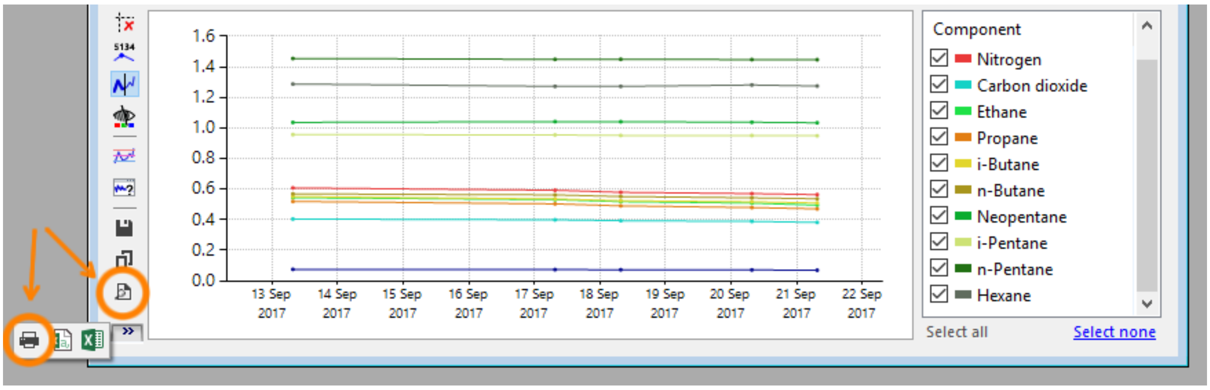


This button calls the Uncertainty Trend form, sends current component uncertainty trend parameters including the plot range, and instructs Uncertainty Trend form to start graphing immediately. Within a few moments, you will get the complete CV uncertainty graph.

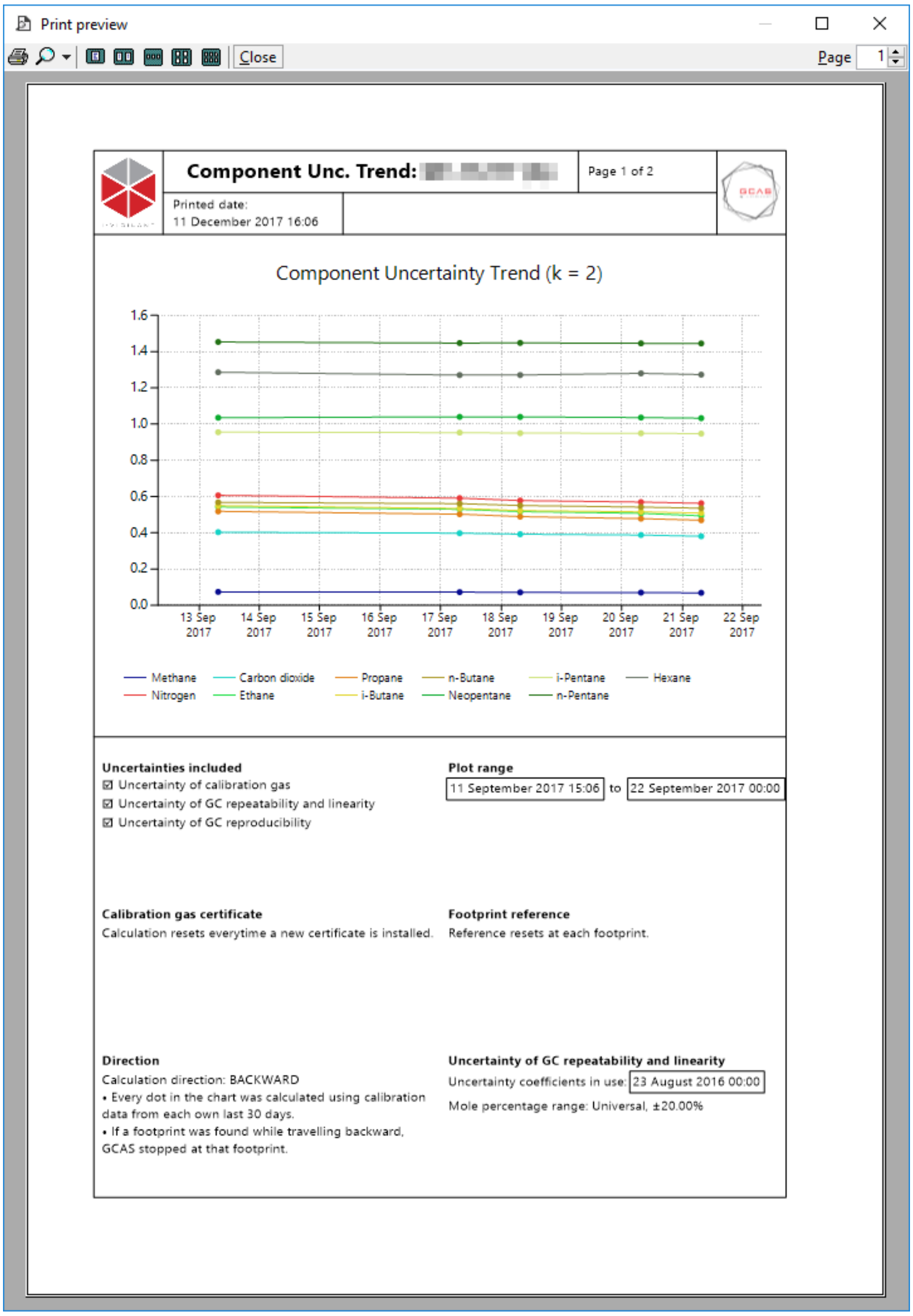


15.5 Printing

After Component Uncertainty Trend form finished graphing the chart, find the **Print preview** or **Print** button on the toolbar at the left side of the chart. Alternatively, you can print component uncertainty trend chart from the main File menu > **Quick Print**, **Print Preview**, or **Print**. The **Quick Print** menu sends the chart to your default printer as configured in Windows control panel.



GCAS lays out print content differently on portrait and landscape orientation. To change orientation, go to the File menu and select **Page Setup**. If your component uncertainty trend calculation included uncertainty of GC repeatability and linearity, GCAS also prints the uncertainty coefficients used in the calculation. Individual or manual mole percentage range is also printed on page two. Moreover, any pinned calibration certificate or footprint reference will be included in the printout as well.



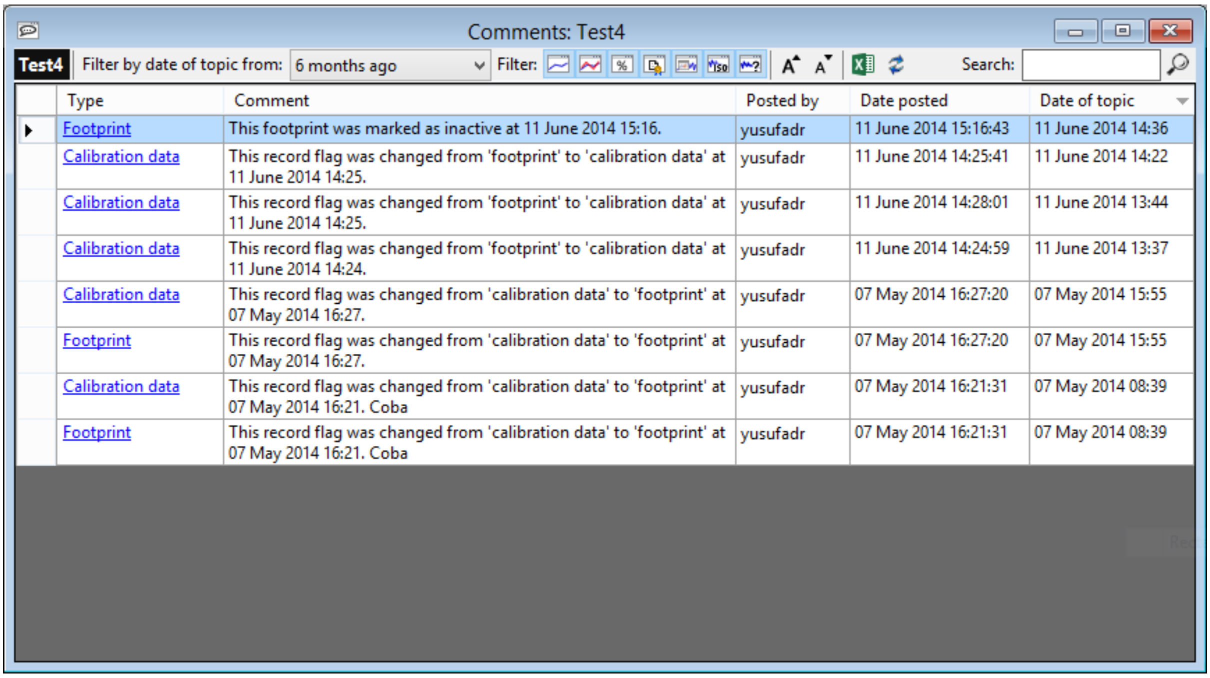
Print preview of component uncertainty trend.

16 Comments

All user comments, e.g. on Footprint form, Calibration Data form, Mole Composition form, Calibration Gas Certificate form, Data Analysis form, Repeatability Test module (only on GCAS Web), Uncertainty Trend form, and ISO 6976/GPA 2172 Trend form, are consolidated in the Comments form.

16.1 The *Comments* Form

To view user comments of a certain device, select that device on your device panel and go to the View menu > **Comments**.



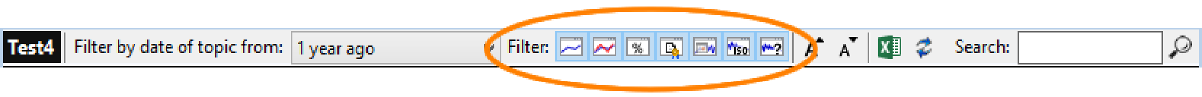
Type	Comment	Posted by	Date posted	Date of topic
Footprint	This footprint was marked as inactive at 11 June 2014 15:16.	yusufadr	11 June 2014 15:16:43	11 June 2014 14:36
Calibration data	This record flag was changed from 'footprint' to 'calibration data' at 11 June 2014 14:25.	yusufadr	11 June 2014 14:25:41	11 June 2014 14:22
Calibration data	This record flag was changed from 'footprint' to 'calibration data' at 11 June 2014 14:25.	yusufadr	11 June 2014 14:28:01	11 June 2014 13:44
Calibration data	This record flag was changed from 'footprint' to 'calibration data' at 11 June 2014 14:24.	yusufadr	11 June 2014 14:24:59	11 June 2014 13:37
Calibration data	This record flag was changed from 'calibration data' to 'footprint' at 07 May 2014 16:27.	yusufadr	07 May 2014 16:27:20	07 May 2014 15:55
Footprint	This record flag was changed from 'calibration data' to 'footprint' at 07 May 2014 16:27.	yusufadr	07 May 2014 16:27:20	07 May 2014 15:55
Calibration data	This record flag was changed from 'calibration data' to 'footprint' at 07 May 2014 16:21. Coba	yusufadr	07 May 2014 16:21:31	07 May 2014 08:39
Footprint	This record flag was changed from 'calibration data' to 'footprint' at 07 May 2014 16:21. Coba	yusufadr	07 May 2014 16:21:31	07 May 2014 08:39

Leftmost column is the comment type, which contains information of what the comment was written for. Clicking any link inside this column will take you to the corresponding form and load that particular record.

The **Refresh** button on the toolbar reloads comments for the selected date filter and type filter.

16.2 Filter Comments by Type

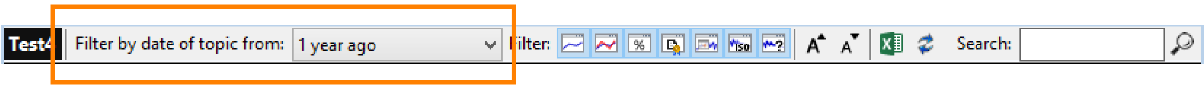
You can hide or show certain types of comments. For example, you can hide all comments for footprint records. Use the seven toggle buttons on the Filter section of the toolbar.



: Show or hide comments for footprint records.
: Show or hide comments for calibration data.
: Show or hide comments for mole composition records.
: Show or hide comments for calibration gas certificates.
: Show or hide comments for data analysis module.
: Show or hide comments for ISO 6976/GPA 2172 trends.
: Show or hide comments for uncertainty trends.

16.3 Filter Comments by Date

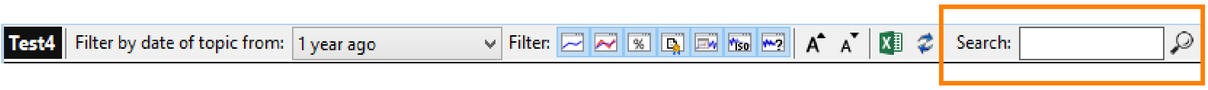
When you open the Comments form for the first time, it loads comments from the last three months. You can change the date filter by selecting the desired filter on the dropdown, or choose "Custom Range" and enter the desired date interval on subsequent dialogue box.



16.4 Search Comments

Type the search term in search box and then click **Search**. The search box accepts any of the following:

- Words in user comments
- Usernames,
- Full date in British English format (e.g. "07 February 2014") — this will search for any matches in both *Date of Topic* and *Date Posted* column.



Any match will be highlighted in yellow. If you do not see any results while you know there should be some, make sure the active filter does not hide some comment types or try changing the date range. To finish searching, click **Clear search results**.

16.5 Delete Comments

In order to maintain auditability, GCAS users are not allowed to remove any comments. Not even GCAS administrator can erase comments.

Some scenarios tolerate comment deletion. For example, you post comment in a wrong record. Or you double-post the same comment. The only way to delete your comments is to contact your database administrator (DBA) and ask him/her to remove your comments at database-level. Include

- your username,
- the selected GC device (or *date of topic* for comments on module not bound to any GC),
- the date and time when your comment was posted,
- timestamp of the record for which the comment was written, and
- the content of your comment

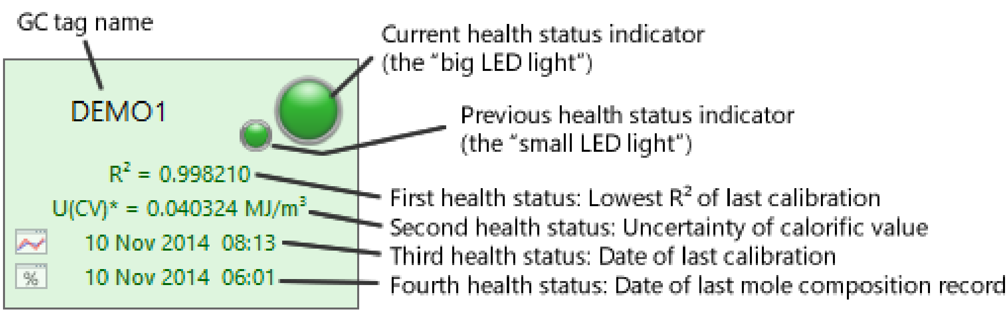
in your enquiry.

17 Dashboard

Dashboard is a place to see health status of all your GC devices in one place. This helps if you have numerous GC devices across different workspaces like one in the screenshot below. Health status of each GC device is represented by a "LED light" on its *dashboard tile*.

To access dashboard, go to the View menu > **Dashboard** or press Ctrl+D.

Each tile presents GC tag name, light indicators, and maximum 6 (six) health statuses. Choose between 1 to 6 out of 12 available health statuses to display.



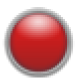
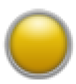
On the next page, we list all twelve GC health statuses to pick from. To customise which ones to display and the order of these items, visit chapter 17.1 Dashboard settings. Chapter 17.1.1 provides more detailed explanation on each item.

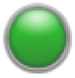
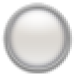
No.	Health status	GCAS licence feature requirement
1	Lowest correlation (R^2) of last calibration	None
2	Uncertainty of calorific value	*Uncertainty Calculation* + *ISO 6976 Calculator*
3	Uncertainty of molecular weight composition	
4	Uncertainty of Wobbe index	
5	Uncertainty of relative density (ISO 6976)	
6	Uncertainty of standard density	
7	Uncertainty of gross heating value	*Uncertainty Calculation* + *GPA 2172 Calculator*
8	Uncertainty of gas compressibility	
9	Uncertainty of relative density (GPA 2172)	
10	Date of last calibration record	None
11	Date of last mole composition record	*Live Data Analysis*
12	Unnormalised total of last mole composition record	

GCAS on its default setting displays four health statuses: lowest correlation (R^2), date of last calibration, date of last mole composition record, and uncertainty of calorific value (CV). If you use GPA 2172 instead of ISO 6976, you might want to substitute uncertainty of CV with uncertainty of gross heating value (GHV).

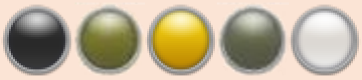
Date of last calibration is useful to find out which GC device has not been calibrated for a long time. Date of last mole composition record is useful to detect connection problems during unattended data capture. Unnormalised total of last mole composition is used to determine fault in the detector or a possibility of missing gases in the line.

The health status indicator may display one of the followings:

Appearance	Colour	Meaning
	Black	- GCAS is loading or calculating the data, or - Calculation was aborted through **Stop calculation** button on the toolbar, or - All rules are turned off. This should not happen (no users should ever turn off *every* rule).
	Red	GC is not healthy. At least one health status failed.
	Yellow	Yellow represents "error" state, which is probably caused by - One or more health statuses cannot be determined because some data was missing, - Calculation result yielded a "NaN" (*not-a-number*) which comes from a division by zero or taking logarithm of zero or negative number; or - Network connection to GCAS database server goes down or interrupted while calculation was in progress.

Appear-ance	Colour	Meaning
	Green	GC is healthy. All health statuses passed.
	White	GC has no data. There are no active calibration records, no active calibration certificates, or no active mole composition records.

Users with colour blindness

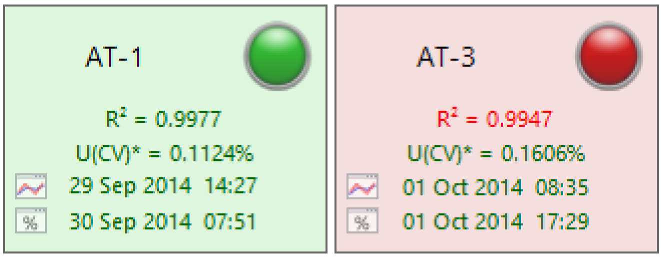


Simulated black, red, yellow, green, and white indicator in protanopia vision

GCAS Dashboard does not include alternative colour scheme for users with colour blindness. We apologise if this affects you.

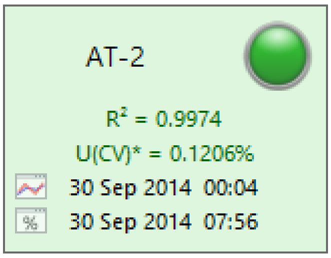
Click **Refresh** at the top toolbar to recalculate GC health status of all devices. During refresh, the Dashboard form displays a progress bar. On slow network connection, calculation of GC uncertainties may take longer time, like one or two seconds per device. You may abort this calculation via **Stop calculation** button.

A healthy GC has a green tile and all health statuses are displayed using a green font. If one health status (or several) fails, the tile turns red and the offending health status(es) is displayed using red font.



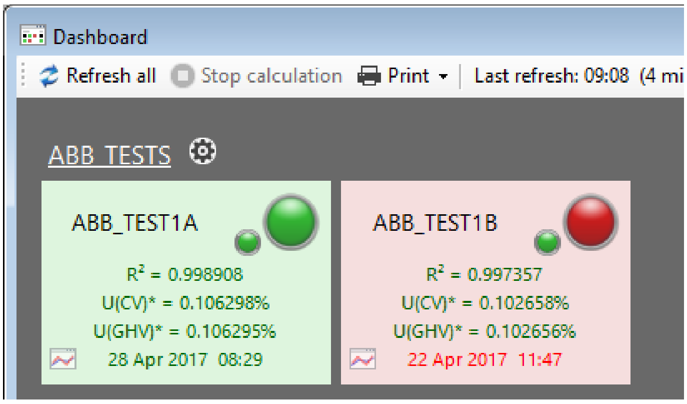
Example of a healthy GC and unhealthy GC.
In this example, we hid the previous status indicator (the "small LED") temporarily.

When you find a health status displayed using black font, it indicates the rule for that health status is turned off. Should a rule be turned off, it will not affect the final decision whether the dashboard tile becomes green or red—regardless of the health status itself passed or failed. More details about rules are on chapter 17.1.2.



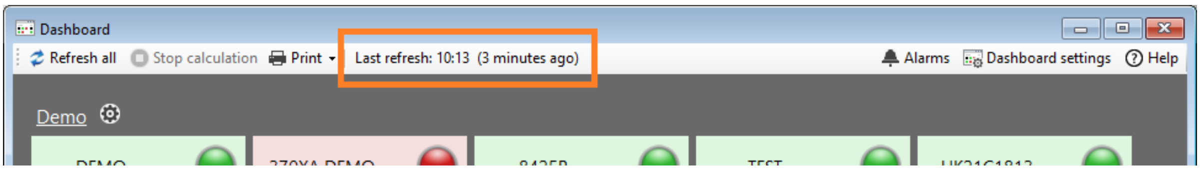
Example tile when rules for date of last calibration and last mole composition are turned off.

Dashboard tiles feature *previous status indicator* ("small light") next to the *current status indicator* (the "big light"). Whenever the Dashboard is refreshed, first the main status colour moves to the previous status indicator, and then the current status indicator updates its colour according to the latest health status data. By this way, you can quickly spot a device that was previously green now changed to red or previously red turned into green like the example on the next page. You can get rid of previous status indicator if you like. Jump to chapter 17.1.4 for more detailed customisation of tile appearance.



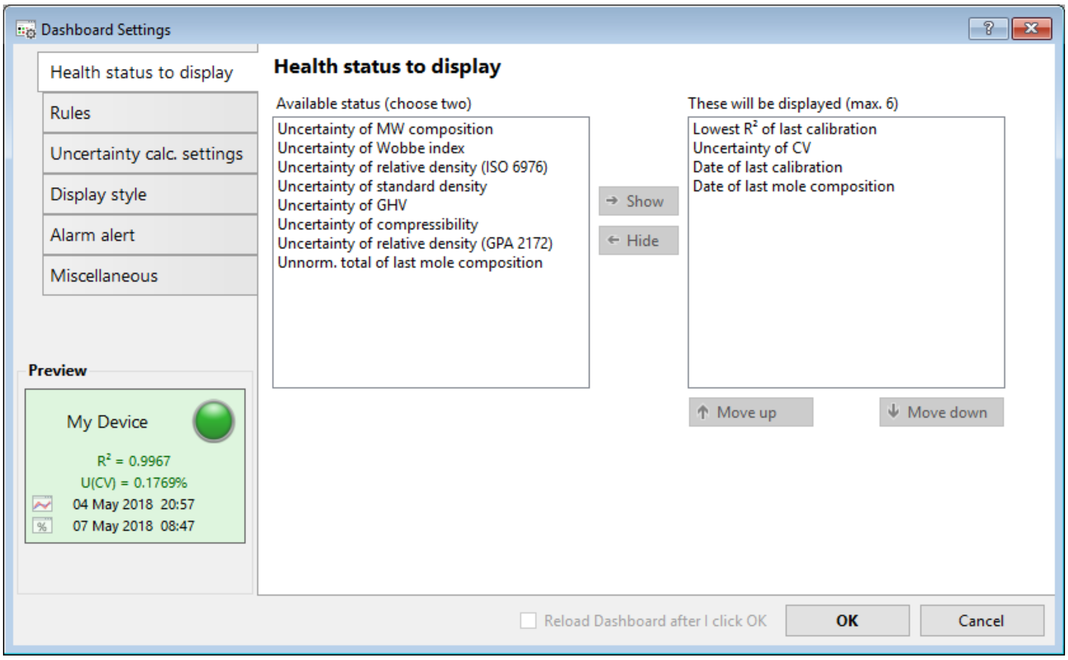
The device 1B was green, but turned red on last refresh.

Dashboard window also prints the time of last refresh on the toolbar. This information may help if you leave Dashboard open to monitor all your devices continuously. Moreover, if you leave Dashboard open for a prolonged time, we recommend turning off the idle timer in order to prevent automatic logout on inactivity. On a different topic, there is an auto-refresh timer which is configurable through Dashboard Settings dialogue.



17.1 Dashboard Settings

From an open Dashboard window, click **Dashboard settings** on the toolbar. Alternatively, return to GCAS main window and go to the View menu > Dashboard Settings. This shall bring forth the *Dashboard Settings* dialogue.



Dashboard Settings dialogue has five tabs, and each of them is explained in its own subchapters below. A preview tile is available at the left region reflecting new appearance as soon as you change a setting.

17.1.1 Health Status to Display

List box on the left contains all available GC health statuses to display. If you see some items missing, the missing items may require a GCAS feature in your GCAS licence.

No.	Health status	GCAS licence requirement
1	Lowest correlation (R^2) of last calibration	None
2	Uncertainty of calorific value	*Uncertainty Calculation + ISO 6976 Calculator*
3	Uncertainty of molecular weight composition	
4	Uncertainty of Wobbe index	
5	Uncertainty of relative density (ISO 6976)	
6	Uncertainty of standard density	
7	Uncertainty of gross heating value	*Uncertainty Calculation + GPA 2172 Calculator*
8	Uncertainty of gas compressibility	
9	Uncertainty of relative density (GPA 2172)	
10	Date of last calibration record	None
11	Date of last mole composition record	*Live Data Analysis*
12	Unnormalised total of last mole composition record	

Click an item and click **Show** to display the health status on the dashboard tile. Dashboard tiles hold maximum 4 items as laid out in list box on the right. Click an item on the right-hand list and click **Hide** to take this health status out of dashboard tiles. The list box on the right also determines the order/sequence of displayed health statuses. Reorder items through **Move up** or **Move down** button.

17.1.1.1 *Lowest correlation (R^2) of last calibration*

Depending on the device type, the table below summarises how the lowest R^2 is determined.

Device type	Lowest R^2 is the lowest among these R^2 values		
Daniel C6+	C1-C2-C6	C3-C4-C5	
Daniel C7+	C1-C2-C7	C3-C4-C5-C6	
Daniel C9+	C3-C4-C5	C6-C7-C8-C9	
Daniel C10+ type A	C3-C4-C5-C6	C7-C8-C9-C10	
Daniel C10+ type B	C3-C4-C5	C6-C7-C8-C9-C10	
ABB C6+	C3-C4-C5	C4-C5-C6	C3-C4-C5-C6
ABB C7+	C3-C4-C5-C6	C4-C5-C6-C7	C3-C4-C5-C6-C7
Elster C6+	C3-C4-C5	C4-C5-C6	C3-C4-C5-C6
Elster C7+	C3-C4-C5-C6	C4-C5-C6-C7	C3-C4-C5-C6-C7
Elster C9+	C3-C4-C5-C6-C7-C8-C9		
Elster C10+	C3-C4-C5-C6-C7-C8-C9-C10		

Notice that lowest R^2 for Daniel C6+ and C7+ devices are determined only by first two correlations. The third correlation (C1-C2-C3-C4-C5-C6 or C1-C2-C3-C4-C5-C6-C7) is ignored. If the lowest R^2 falls below the R^2 threshold defined in the Analysis Parameter of a device (typically 0.995), the tile for that device turns red. In case you need the tiles to turn red if the R^2 is below a certain custom threshold instead of using Analysis Parameter data, you can override the rules. Chapter 17.2 will explain more.

Siemens devices, LNG, BTEX, and single gas analysers do not have R^2 trend, therefore their R^2 is treated as green and you should see "`R² = N/A`" on the dashboard tile.

17.1.1.2 *Uncertainties*

There are eight uncertainty health statuses to display. Uncertainty of calorific value (CV) is probably the most used among the others. The calculation uses the inputs described below. All inputs are configurable through uncertainty calculation settings tab.

- **Calibration certificate**. Certificate is used by all three uncertainty components and thus is mandatory. If a device doesn't have any calibration certificates, GCAS aborts uncertainty calculation for this device, uncertainty health status on its dashboard tile turns grey, and presents the text "`no certificate`" on the tile.
- **Uncertainty coefficients**. This is used by uncertainty of GC repeatability. If no coefficient sets are available for a device, $U_{repeatability}$ is not included in the uncertainty calculation of that device.
- **Mole percentage range**. This is also used by uncertainty of GC repeatability. You can override all devices to use the same range (default is ±20%) or let each device use its own range based on each own last uncertainty calculation configuration.
- **Footprint**. Footprint is used by uncertainty of GC reproducibility. If a device doesn't have any footprints, $U_{reproducibility}$ is not included in the uncertainty calculation of that device.

- **Calibration data**. This is also used by uncertainty of GC reproducibility. Set how many calibration records to include in the calculation of each device.
- **ISO 6976 and GPA 2172 calculation**. All devices on GCAS Dashboard use the same ISO 6976 and GPA 2172 basic settings. Also, one base pressure is shared by both ISO 6976 and GPA 2172 calculation.

Last uncertainty calculation configuration is the configuration on the input pages the last time you opened Uncertainty Calculator form. Each device has its own last uncertainty configuration.

Complete uncertainty calculation—all three $U_{\text{cal gas}}$, $U_{\text{repeatability}}$, and $U_{\text{reproducibility}}$ are present—is indicated by no asterisk symbol on dashboard tile. Incomplete uncertainty calculation has asterisk symbol on it. For example, the dashboard tile displays `U(CV)* = 0.1206%`.

By default, dashboard tiles turn red if their combined expanded uncertainty exceeds 0.2%. You can change this threshold or the uncertainty type (absolute or combined expanded) at the rules tab. You can also override the threshold at per-device level or per-workspace level depending on your need. Chapter 17.2 explains more about overriding rules.

17.1.1.3 Date of last calibration

Date of last calibration record indicates how long time has passed since GC was last calibrated. On dashboard tiles, date of last calibration has calibration data icon. If last calibration was marked as footprint, it has footprint icon.

By default, the dashboard tile should've turned red if date of last calibration is older than 3 days. However due to various calibration policy among groups or platforms, this rule is turned off. To change the threshold (i.e. how many days to make it red) and turn on the rule, go to rules tab. Furthermore, you can override the rule for date of last calibration at per-workspace and per-device level. Visit chapter 17.2 Overriding rules for more information.

17.1.1.4 Date of last mole composition

Date of last mole composition shows the timestamp of latest mole composition record (among all streams). On dashboard tiles, date of last mole composition has mole composition icon.

Date of last mole composition is useful to monitor the connectivity between your GC device and GCAS running in another computer next to the GC device. Should a problem occurred and the data capture terminated, mole composition records stop coming and you notice the timestamp of last mole composition record is stationary after several dashboard refreshes.

Default setting dictates that dashboard tiles should turn red if date of last mole composition record is older than three hours. You can change the threshold, the time unit (minutes, hours, days), or turn off the rule at the rules tab. Do not put unrealistic threshold for instance, 1 minute, because mole composition records usually come every 4~7 minutes. Specifying the threshold to a value lower than GC cycle time will cause the dashboard tile to become everlasting red.

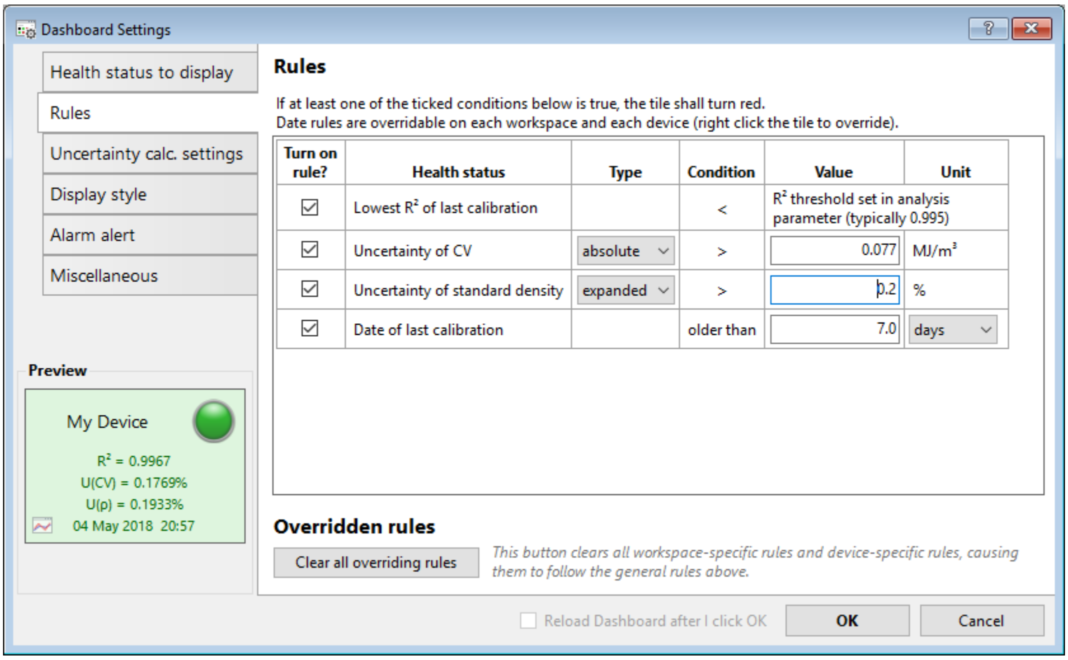
Rules for date of last mole composition is also overridable at per-workspace and per-device level. Visit chapter 17.2 Overriding rules for more information.

17.1.1.5 Unnormalised total of last mole composition

Unnormalised total of last mole composition displays the... well... total or sum of the latest mole record after unnormalisation, regardless of its stream number. Whatever stream number has the latest mole composition record, GCAS Dashboard takes its unnormalised total value to display. On dashboard tiles, this health status is represented as "Σ mole". You can use this health status to determine if there is a problem at the detector or if one or more gases are missing from the line.

GCAS defines a range where unnormalised total should be within, to make the tile green. Unnormalised total value outside this range will turn the tile red. GCAS employs three different ranges for unnormalised total rule—one for regular devices, one for single-gas devices, and the last one for BTEX devices. Regular devices encompass Daniel, Siemens, ABB, Elster, and LNG analysers. Single gas devices include H_2S and moisture/H_2O analysers. Go to the rules tab to set the range of all three. As usual, unnormalised total range at each device or each workspace can be overridden separately if required.

17.1.2 Rules



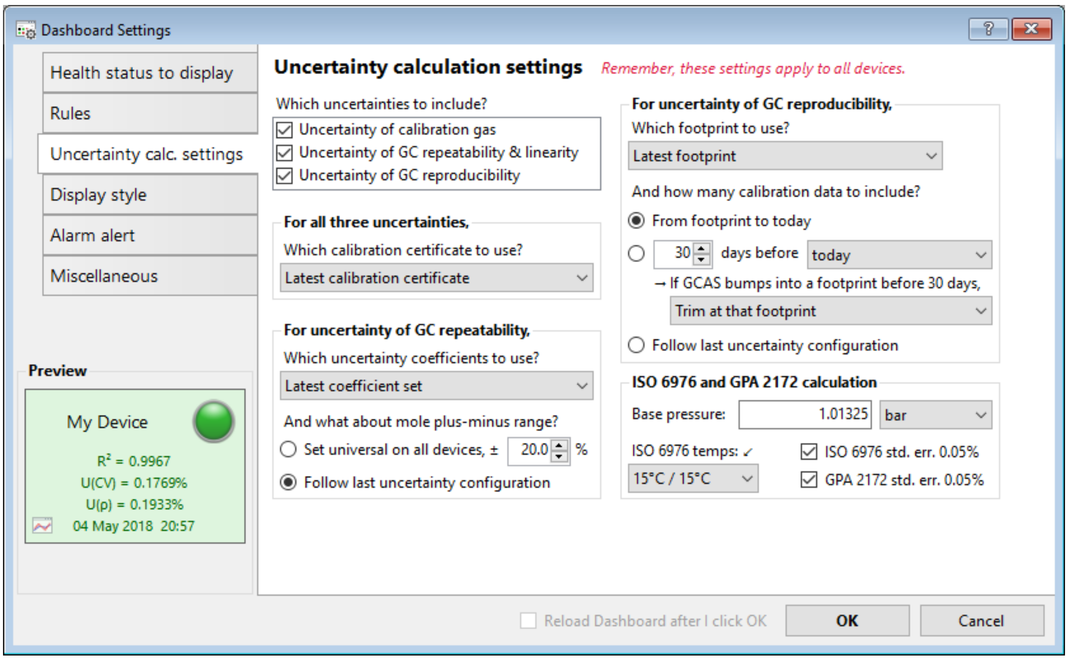
Simply put, *rules* are definitions of conditions causing a dashboard tile to become red. Every GC health status displayed on dashboard tiles has its own rules to define above what value or below what value the health status should make the dashboard tile red. For example, uncertainty of CV has a rule that if a device has combined expanded CV uncertainty more than 0.2%, it is unhealthy.

Rules can be turned on or off. When a rule is turned off, it doesn't affect the decision whether the dashboard tile should become green or red. For example, a user decided to display lowest R^2, uncertainty of CV, and date of last calibration. The rule for R^2 is turned on, rule for uncertainty of CV is turned on, but the rule for date of last calibration is turned off. After next refresh, it turned out that minimum R^2 is 0.9974, combined expanded uncertainty of CV is 0.1250%, and date of last calibration is seven days ago. Rule for R^2 makes the tile green, rule for U(CV) makes the tile green, but the rule for date of last calibration makes the tile red. We expect the tile to become red by now. However, as the rule for date of last calibration was turned off, the tile is only affected by the rule of R^2 and U(CV). Green meets green becomes green; hence the tile stays green. To turn off a rule, uncheck the corresponding check box on this tab.

- Rule for lowest R^2 (correlation) is the simplest rule of all: if a device has lowest R^2 below the threshold defined in its Analysis Parameter, it is unhealthy.
- Rule for uncertainties has two configurable fields: the uncertainty type (absolute or combined expanded), and the threshold value. Absolute uncertainty changes the unit to the absolute unit such as MJ/m^3 for uncertainty of CV, while expanded uncertainty changes the unit to percentage.
- Rule for date of last calibration has two configurable fields, which state how many days/hours/minutes to make the tile red. These fields accept decimal number. For example, 3.25 days translate to 3 days and 6 hours.
- Rule for date of last mole composition has two fields similar to the rule for date of last calibration—the threshold limit and its time unit. These fields accept decimal number too.
- Rule for unnormalised total of last mole composition has three rows. Each row defines the range on different device types—regular devices, single-gas, and BTEX. If the unnormalised total of a device falls within the appropriate range, the health status check is a pass. If it goes outside of the range, the health status is a fail.

Date rules, consisting of rule for date of last calibration and rule for date of last mole composition record, are overridable. More information about overriding a rule is on chapter 17.2. To delete all overriding rules in one go, click **Clear all overriding rules** on this tab.

17.1.3 Uncertainty Calculation Settings



This tab configures several inputs used by uncertainty calculation of all devices. If your GCAS licence doesn't include *Uncertainty Calculation*, this tab only displays a text `your GCAS licence does not include uncertainty calculation`.

Some inputs allow you to select "follow last uncertainty configuration". *Last uncertainty configuration* is the configuration you have set on the input pages the last time you opened Uncertainty Calculation form. Every device has its own last uncertainty configuration.

Which uncertainties to include: Choose the uncertainties to include in the calculation. This setting applies to all GC devices listed on GCAS Dashboard. If you untick $U_{cal\ gas}$ for example, all devices will exclude $U_{cal\ gas}$ in their uncertainty calculation. We recommend leaving the default setting which all uncertainties are ticked. There are two special cases though.

First, if a device does not have uncertainty coefficients but $U_{repeatability}$ is ticked here, GCAS will exclude $U_{repeatability}$ for that device only. Other devices are not affected. Second, if a device does not have any active footprint records but $U_{reproducibility}$ is ticked, GCAS will exclude $U_{reproducibility}$ for that device only. Either way, the uncertainty health status displayed on the dashboard tile will bear an asterisk mark (*) on them, indicating an incomplete uncertainty calculation.

For all three uncertainties, which calibration certificate to use: Choose whether to use latest calibration certificate of each device, or to follow last uncertainty configuration of each device.

For uncertainty of GC repeatability, which uncertainty coefficients to use: Choose whether to use latest uncertainty coefficient set, or to let each device follow its own last uncertainty configuration.

And what about mole plus-minus range: Either set a universal plus-minus range for all devices, or let them follow their last uncertainty configuration. To use the other three options that you saw on Uncertainty Calculator form—i.e. individual range, manual range, and use ±2 standard deviations—you must select "Follow last uncertainty configuration" and configure each GC device independently. The reason for that is, every device may have different stream numbers and different composition on their calibration gas certificate.

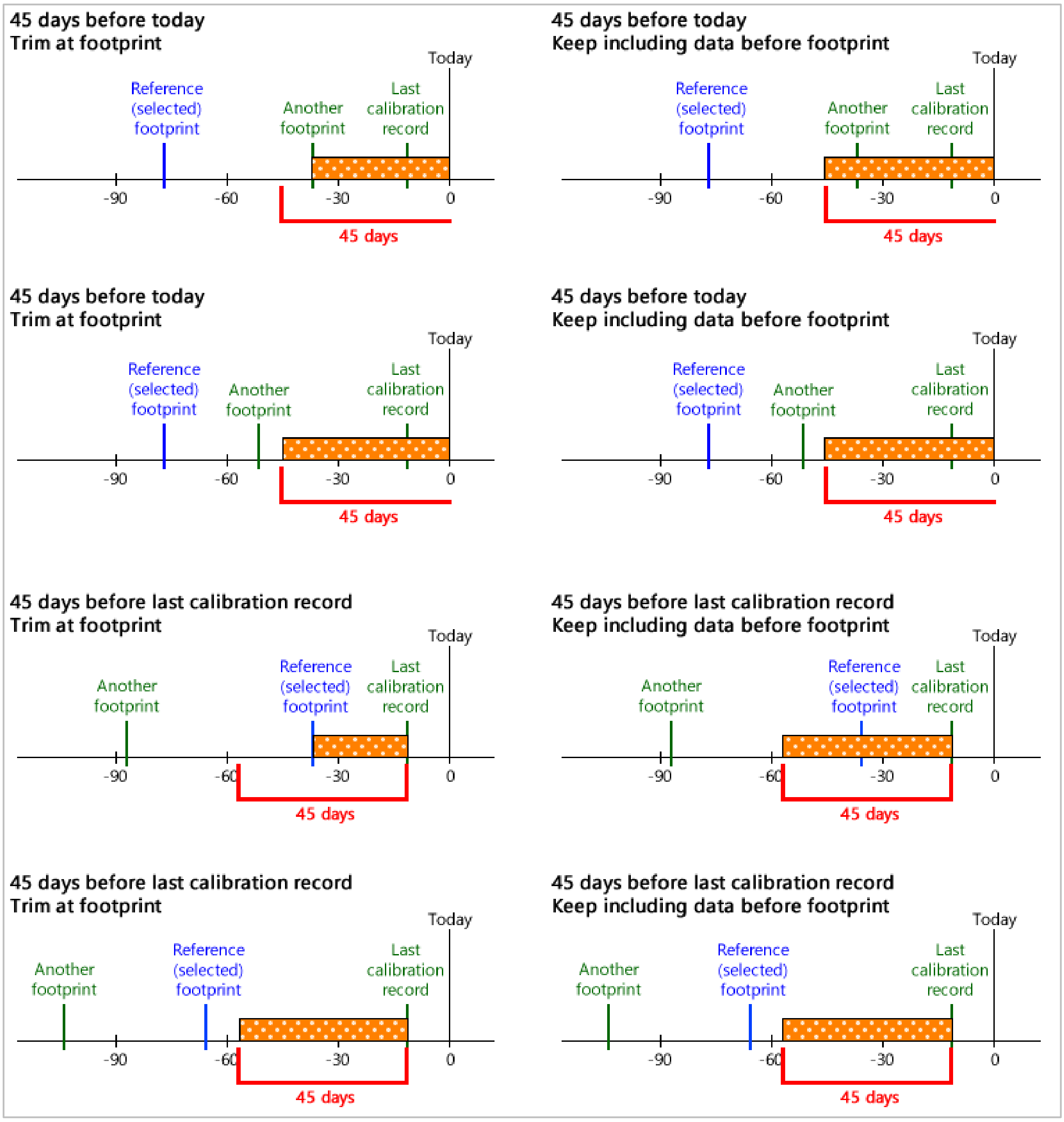
For uncertainty of GC reproducibility, which footprint to use: There are three choices. Use latest footprint, use first footprint found after the certificate timestamp, or follow last uncertainty configuration. If you selected first footprint after certificate but there are no actual footprints after certificate timestamp, GCAS falls back to the latest footprint.

And how many calibration data to include: Pick one of the choices.

- *From footprint to today* (the default) takes the footprint itself, all calibration data afterwards, all subsequent footprints, and all subsequent calibration data after them, all the way until current computer time.
- x *days from* y. The default *x* is 30 and *y* is "today". This option causes GCAS to take all calibration data counted down from today—or last calibration record, if selected—down to that starting point minus *x* days. You can also set what GCAS should do if it encounters a footprint during the countdown, either to stop the countdown (trim at footprint) or continue through. The figure on the next page illustrates how various settings affect the calibration data range.

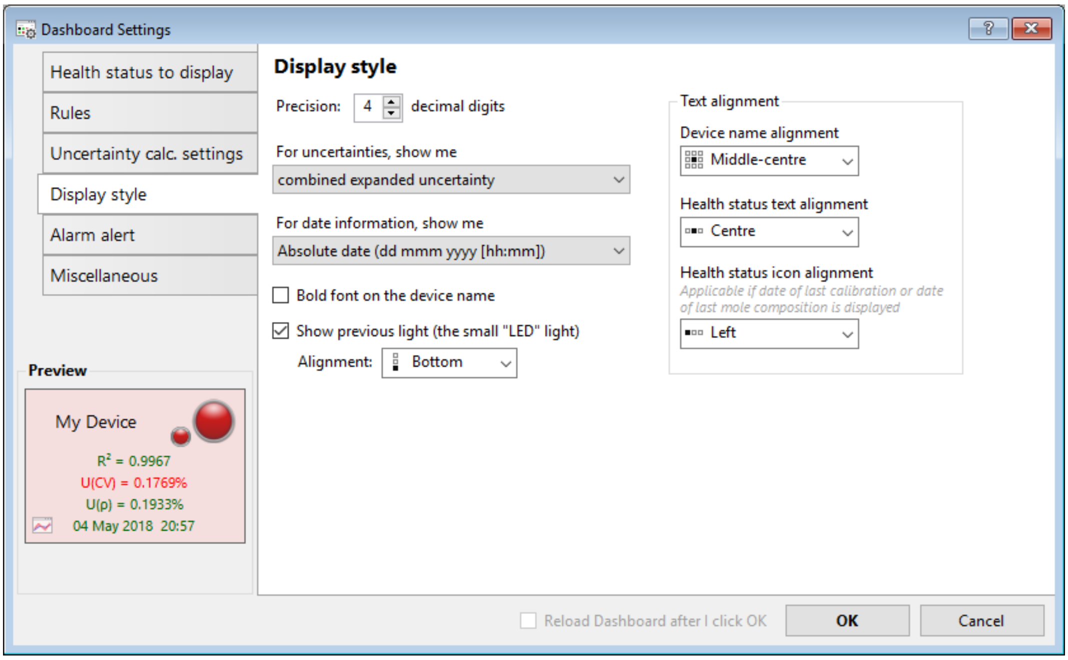
- *Follow last uncertainty configuration* causes GCAS to follow last uncertainty configuration of each device—including custom calibration data range if you have set them through [Uncertainty Calculator form]() beforehand.

ISO 6976 and GPA 2172 calculation: This section controls the base pressure used by both standards, as well as the combustion-metering temperature pair. These settings apply to all devices. Also, you have check boxes to control whether the standard measurement error 0.05% should be included after every ISO 6976 or GPA 2172 calculation.



Calibration data ranges under various settings.
These calibration data are used by the uncertainty calculation of GC reproducibility.

17.1.4 Display Style



Display style tab configures the appearance of dashboard tiles.

Precision: Select how many decimal digits to display on numeric health status (lowest R^2 and uncertainties). The default precision is 4 digits. However, if you opt to show both types of uncertainties (i.e. expanded and absolute), GCAS can only display 2 to 5 digits. If you choose to display uncertainty of CV and GHV together, we recommend cranking the precision up to 6 or 7 digits because these two values are so close to each other.

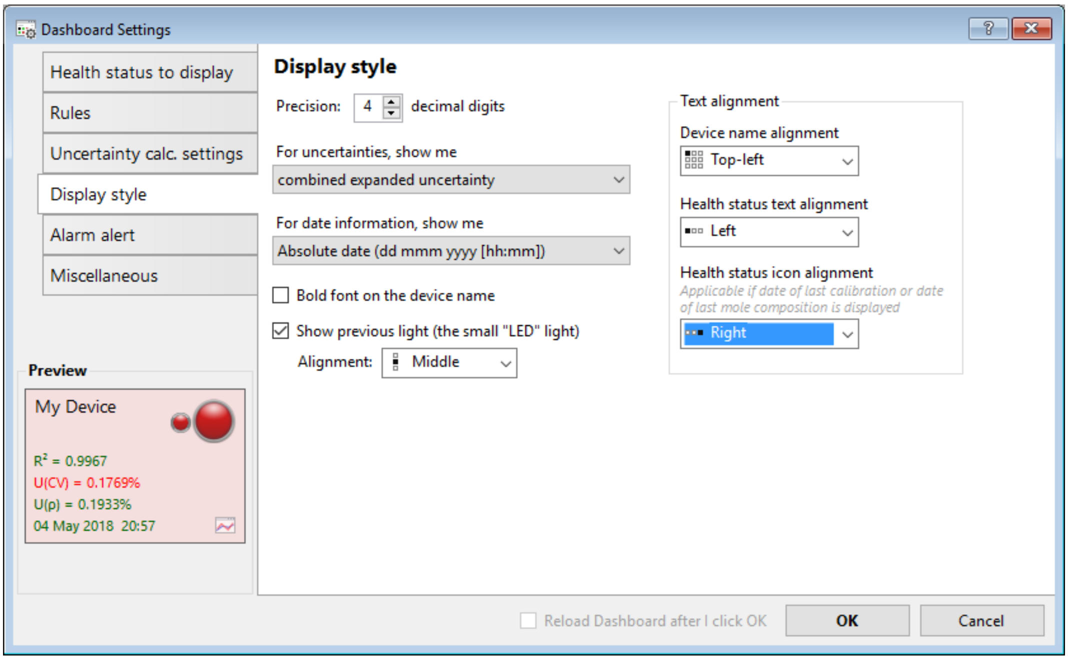
For uncertainties, show me: Select which type of uncertainties to display. This setting applies to uncertainty health statuses. Most users prefer combined expanded uncertainty (expressed in percentage) over absolute uncertainty (expressed in units such as MJ/m^3 for CV). There is also a choice to display both, however GCAS can only fit 2 to 5 decimal digits due to space limitation.

For date information, show me: Select date format to display. This setting applies to date of last calibration and date of last mole composition record. The default is absolute date which shows the exact date-month-year-hour-minute. GCAS Dashboard uses 24-hour clock. The other choice is rough relative timespan like "3 days ago" or "5 hours ago".

Bold font on the device name makes the device tag name on dashboard tiles use bold face. Look at the preview tile at the left side of this dialogue box to see if you fancy the bold font.

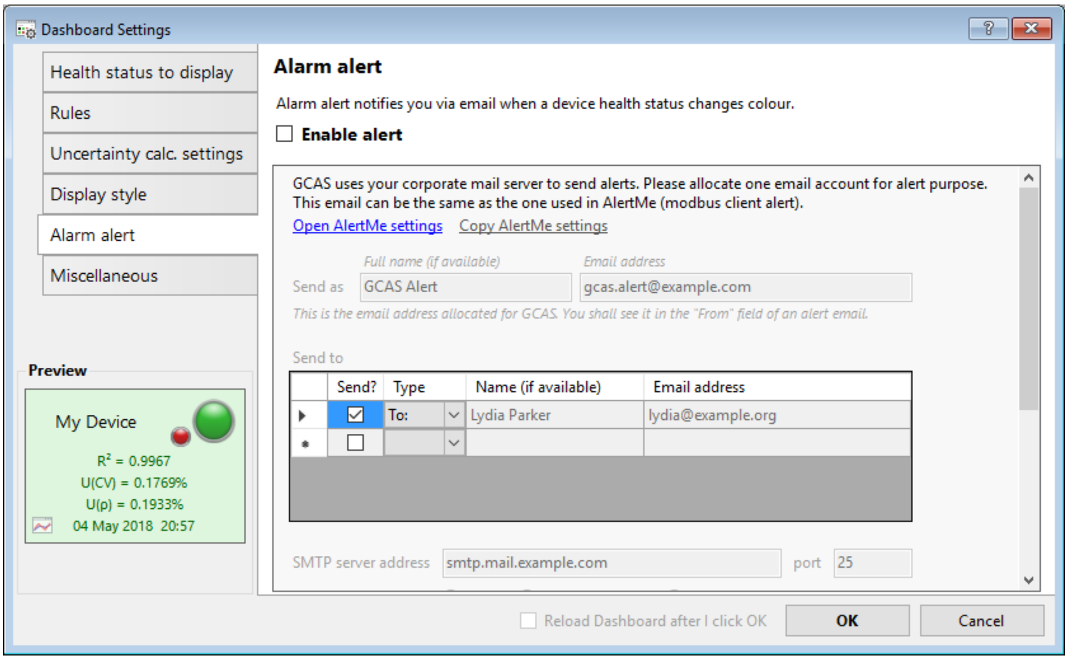
Show previous light (the small "LED" light) determines whether the previous status indicator light is visible. Uncheck this box and the tiles show the main status indicator (the big LED light) only. If the small light is set to visible, you can adjust its vertical position relative to the big light as well.

Text alignment box contains several options to change the text alignment of device name, all four health status texts, and health status icons when they are available. Date of last calibration and date of last mole composition use icons to distinguish between each other. The default alignment is middle-centre for device name, centre-align for health status texts, and left-align for health status icons. An example of tile customisation may look like this.

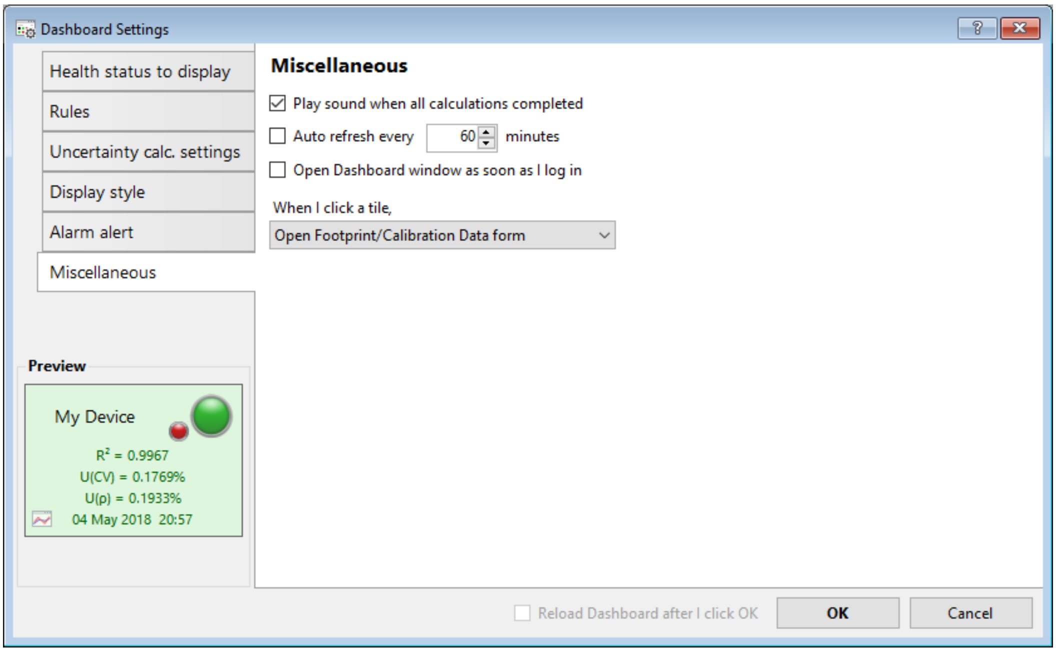


17.1.5 Alarm Alert

This tab configures email submission in order to send you alarm alerts. To explain this tab further, we need to explain first about what alarm itself is. Jump to chapter 17.4 to get started. Detailed explanation about alarm alerts is on chapter 17.4.2.



17.1.6 Miscellaneous



The *Miscellaneous* tab configures other behaviours which are not categorised into the other four tabs.

Play sound when all calculations completed makes GCAS play a "ding" sound after all calculations completed. On slow connection, a dashboard refresh may take minutes to complete so GCAS can notify you that dashboard refresh is finished.

Auto refresh causes the Dashboard form to refresh itself once every the-defined-interval. The default is 1 hour, but you can change it between 1 minute and 4320 minutes (3 days). By default, auto-refresh is turned off. If you turn auto-refresh on and leave Dashboard open for a long time, we recommend to turn off automatic logout on inactivity.

This auto refresh setting also affects data provision refresh schedule if you link Modbus server module with Dashboard on Modbus Server Interface window. Disabling Dashboard's auto refresh while Dashboard-Modbus server link is still active would cause Modbus server not refreshing at all; unless you click **Refresh** on Dashboard window—which Modbus server data refresh would follow after Dashboard refresh completes.

Open Dashboard window as soon as I log in instructs GCAS to open Dashboard immediately after all workspaces and devices have been loaded. This only works after GCAS login, not after changing database or refreshing device panel.

When I click a tile, select the action you want GCAS to do. There are four options.

- **Do nothing**.
- **Open Footprint/Calibration Data form**: This action opens the footprint or calibration record who has the lowest R^2 displayed on the dashboard tile.
- **Open Mole Composition form**: This action opens the latest mole composition record, assuming that the date of latest mole composition record is displayed on the dashboard tile. If your GCAS licence doesn't have *Live Data Analysis*, this option is not available.

- **Open Uncertainty Calculator form**: This action opens Uncertainty Calculator form for the device represented by the dashboard tile, but that's it. The settings at the Uncertainty Calculator form may be different from the settings defined by the uncertainty calculation settings tab, hence may produce different uncertainty values. Both dashboard tile and the Uncertainty Calculator form should produce the same values if everything on uncertainty settings tab was set to "follow last uncertainty configuration". If your GCAS licence doesn't have *Uncertainty Calculation* feature, this option is not available.

17.2 Overriding Rules

Rules for all GC health statuses are overridable at device level or workspace level. Overriding at *device level* causes the dashboard tile of this device to ignore the general rules and use the overridden rules instead. Overriding at *workspace level* causes all dashboard tiles under this workspace to use the overridden rules.

For example, you have set the general rule for *date of last calibration* stating all devices who were calibrated past 3 days ago shall be red. However, there's this one platform called Workspace X which enforces a different calibration policy, for instance, once every 7 days. This causes the dashboard tiles under Workspace X to become red if their last calibration date is, let's say, 5 days ago. By overriding calibration date rule for Workspace X, we can specify that all devices under Workspace X uses 7-day rule, not three.

Device-specific override has priority over workspace-specific override. For instance, Workspace X has five GC devices named X1, X2, X3, X4, and X5. These five devices were calibrated 9 days ago. Your general rule state 3-day calibration rule, but those under Workspace X are overridden to use 7-day calibration rule. Now let's override the date rule for device X4 to be 14 days. As a result, device X1, X2, X3, and X5 become red while device X4 is still green.

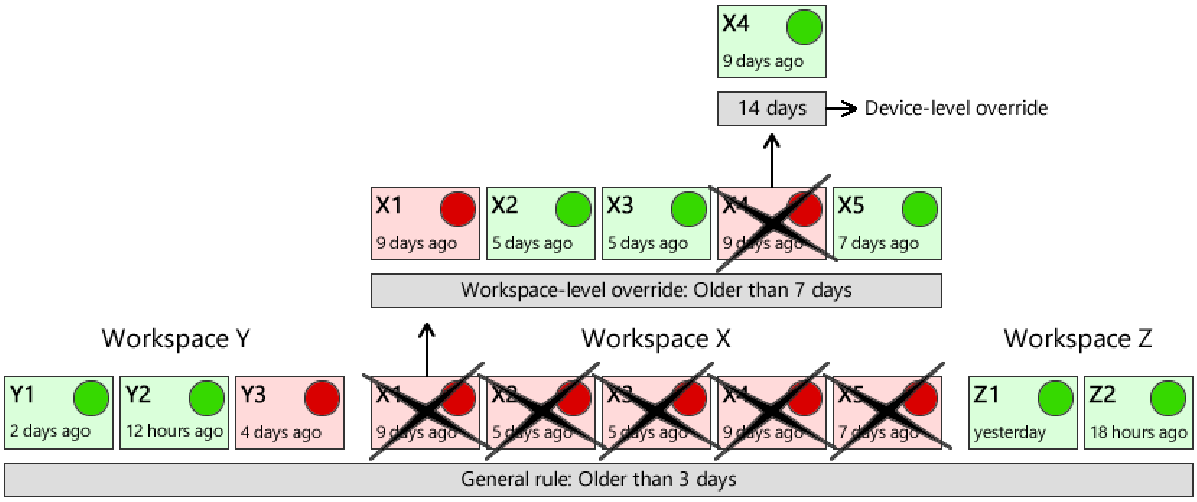
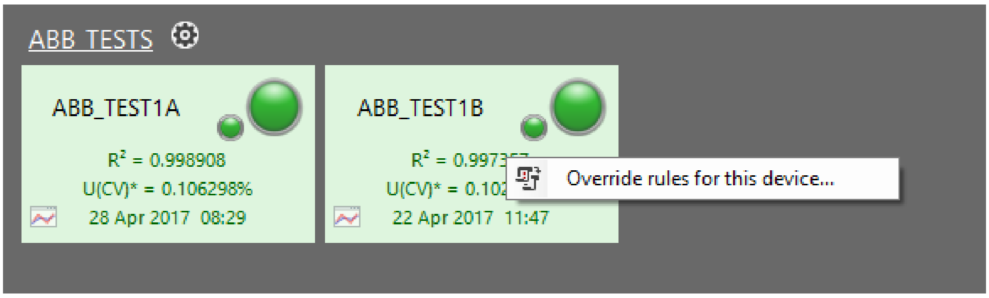


Illustration about how override levels work.

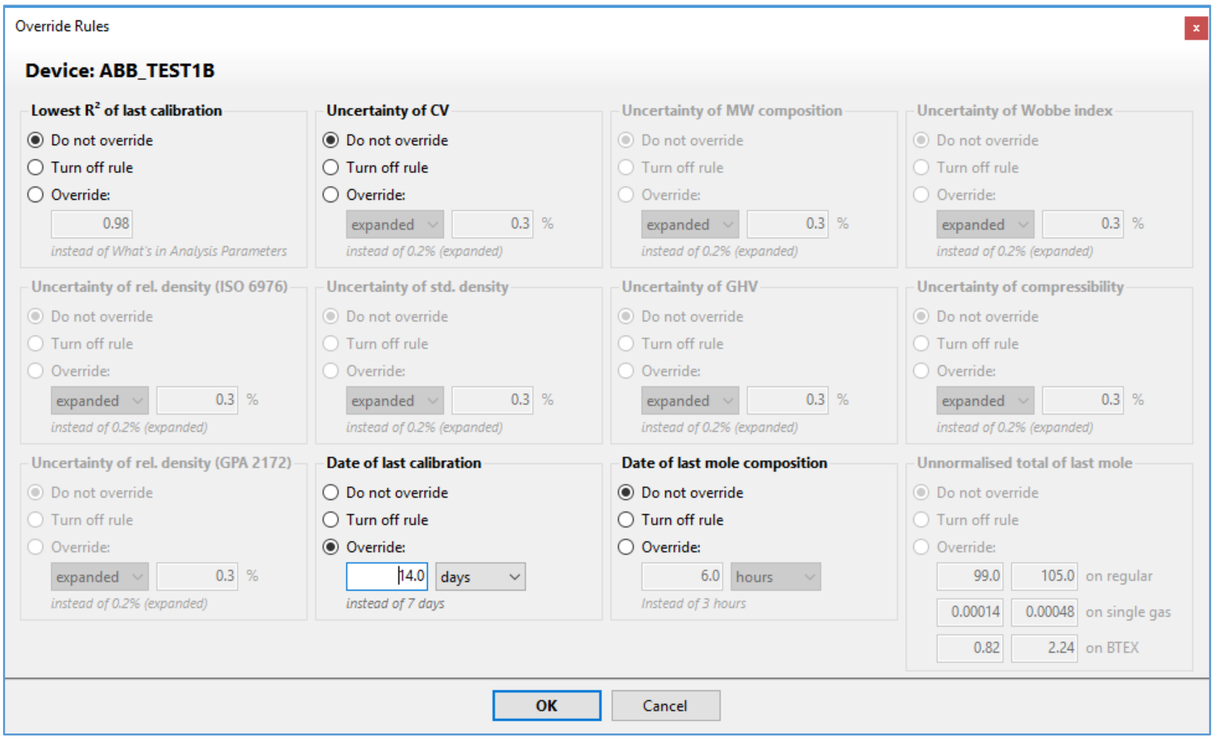
You can even override the on/off status of a rule. For example, the general rule for last calibration date is turned on, but this particular device is overridden as turned-off. You shall see other devices have green or red font on their dashboard tiles, while this device has black text for its last calibration date. The same applies for the other way around, if the general rule is turned off but you wish to turn on date rules for several devices or workspaces.

17.2.1 Per-Device Override

To override rules at device level, right-click the dashboard tile of the said device.



The menu brings us to the *Override Rules* dialogue box. All twelve health statuses are displayed on this dialogue but the ones you are not displaying are greyed out.



You can override each rule independently. Inside each section, there are three options:

Do not override. If this is selected, you are revoking the override—causing the device to fall back to either per-workspace override (if defined) or to the general rules set at the rules tab.

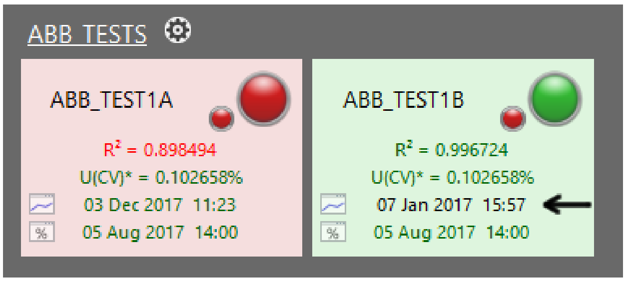
Turn off rule. Select this if you want to override the on/off status of the rule. If the general rule is turned on, this option turns off the rule just for this device. You should see the associated health status is presented in black text. Other devices are still following the rule, unaffected by this override.

Override. The last option overrides the actual threshold for this device. This device will follow the threshold defined here instead of the threshold defined at workspace-level override (if any) or the general rule. In addition, in case the general rule is turned off, selecting this option will turn on the rule just for this device.

The table below shows an example of overriding calibration date rule.

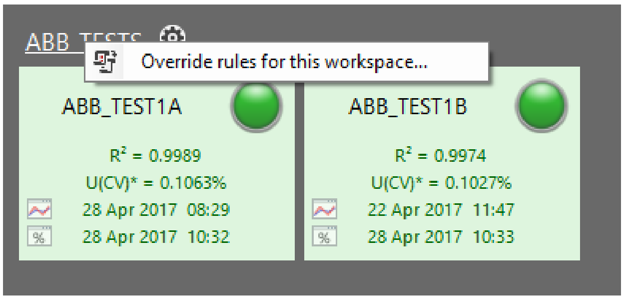
General rule	*Device-level override*	*Result: Dashboard tile becomes red if last calibration is older than*
ON, 3 days	Do not override	**3 days**
OFF	Do not override	Rule is turned off
ON, 3 days	Turn off rule	Rule is turned off
OFF	Turn off rule	Rule is turned off
ON, 3 days	**Override, 7 days**	**7 days**
OFF	**Override, 7 days**	**7 days**

When you are ready, click **OK** to close the dialogue window and you shall see the Dashboard window applies your new rules. For example, we overrode device ABB_TEST1B to turn off its calibration date rule in the screenshot down here.

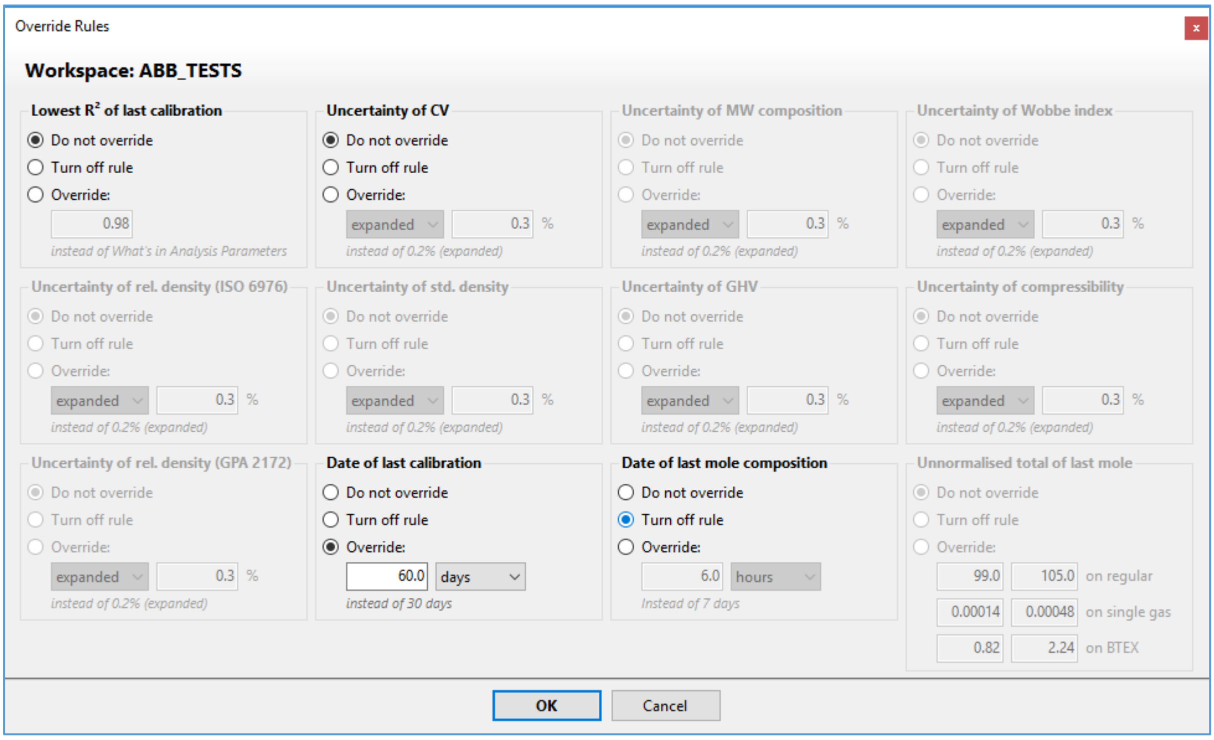


17.2.2 Per-Workspace Override

To override rules at workspace level, right-click the heading text or click the ⚙ gear icon.



This also brings the *Override Rules* dialogue box. But this time, it applies to all devices within this workspace.



Similar to per-device override, this dialogue shows override options for all GC health statuses but only the ones you are displaying are available to change. You can override each rule independently. Inside each section, there are three options:

Do not override. If this is selected, you are revoking the override—causing all devices within this workspace to fall back to the general rules set at the rules tab.

Turn off rule. Select this if you want to override the on/off status of the rule. If the general rule is turned on, this option turns off the rule just for devices within this workspace. You should see the corresponding GC health status of all devices in this workspace renders in black text. Devices in other workspaces are still following the rule, unaffected by this override.

Override. The last option overrides the actual threshold for all devices inside this workspace. These devices will follow the threshold defined here instead of the threshold defined at the general rule. In addition, in case the general rule is turned off, selecting this option will turn on the rule just for this workspace.

Remember, device-level overrides take priority over workspace-level overrides. Here is an example of a workspace-level override on calibration date rule:

General rule	*Workspace-level override*	*Device-level override*	*Result: Dashboard tiles turn red if last calibration is older than*
ON, 3 days	Do not override	Do not override	**3 days**
OFF	Do not override	Do not override	Rule is turned off
ON, 3 days	Do not override	Turn off rule	Rule is turned off
OFF	Do not override	Turn off rule	Rule is turned off
ON, 3 days	Do not override	**Override, 7 days**	**7 days**

General rule	*Workspace-level override*	*Device-level override*	*Result: Dashboard tiles turn red if last calibration is older than*
OFF	Do not override	**Override, 7 days**	**7 days**
ON, 3 days	Turn off rule	Do not override	Rule is turned off
OFF	Turn off rule	Do not override	Rule is turned off
ON, 3 days	Turn off rule	Turn off rule	Rule is turned off
OFF	Turn off rule	Turn off rule	Rule is turned off
ON, 3 days	Turn off rule	**Override, 7 days**	**7 days**
OFF	Turn off rule	**Override, 7 days**	**7 days**
ON, 3 days	**Override, 5 days**	Do not override	**5 days**
OFF	**Override, 5 days**	Do not override	**5 days**
ON, 3 days	**Override, 5 days**	Turn off rule	Rule is turned off
OFF	**Override, 5 days**	Turn off rule	Rule is turned off
ON, 3 days	**Override, 5 days**	**Override, 7 days**	**7 days**
OFF	**Override, 5 days**	**Override, 7 days**	**7 days**

17.2.3 Revoking (Cancelling) an Override

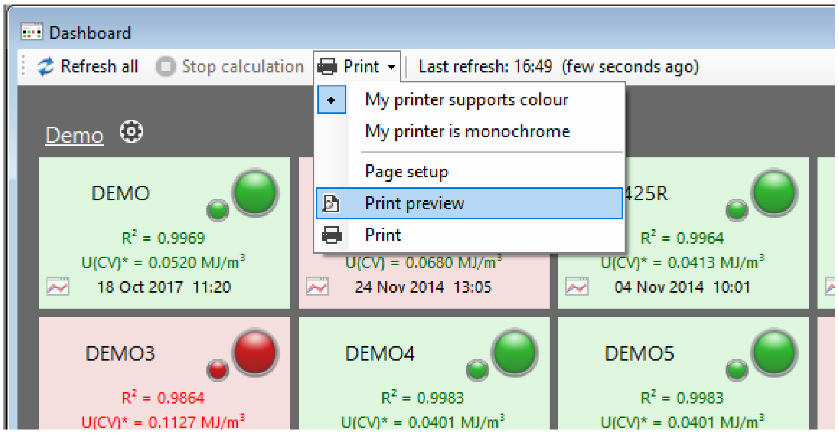
To revoke device-specific overriding rules, bring the *Override Rules* dialogue by right-clicking the appropriate dashboard tile. Next, select **Do not override** option at the corresponding rule. Click **OK** to commit the change and the Dashboard window shall update itself. The device should return to workspace-level override (if defined) or to the general rule.

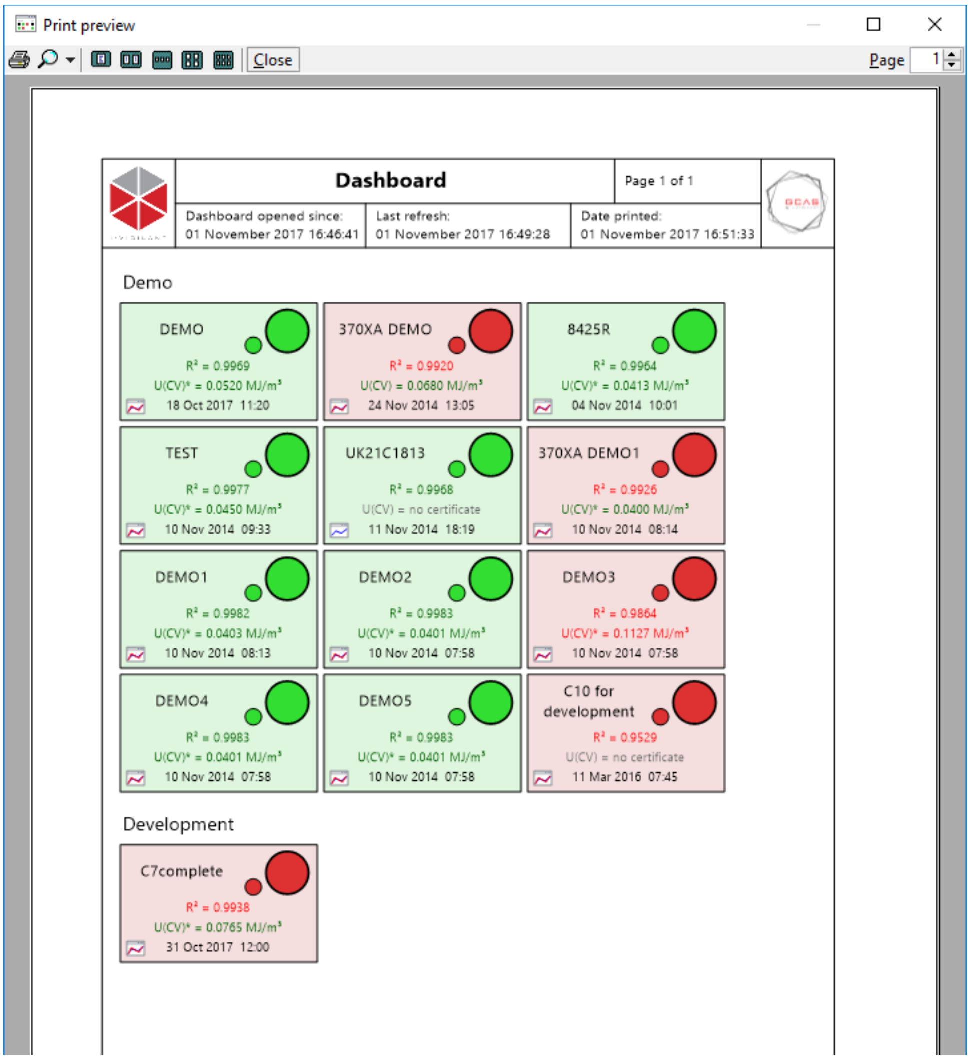
To revoke workspace-specific overriding rules, bring the *Override Rules* dialogue by right-clicking the heading text or through ⚙ gear icon. Then, select **Do not override** option at the corresponding rule. Click **OK** to commit the change. The devices in this workspace should return to the general rule.

To revoke all device-specific and workspace-specific overrides, open Dashboard Settings then go to the rules tab. Click **Clear all overriding rules** button at the bottom and finally finish it by clicking **OK**.

17.3 Printing

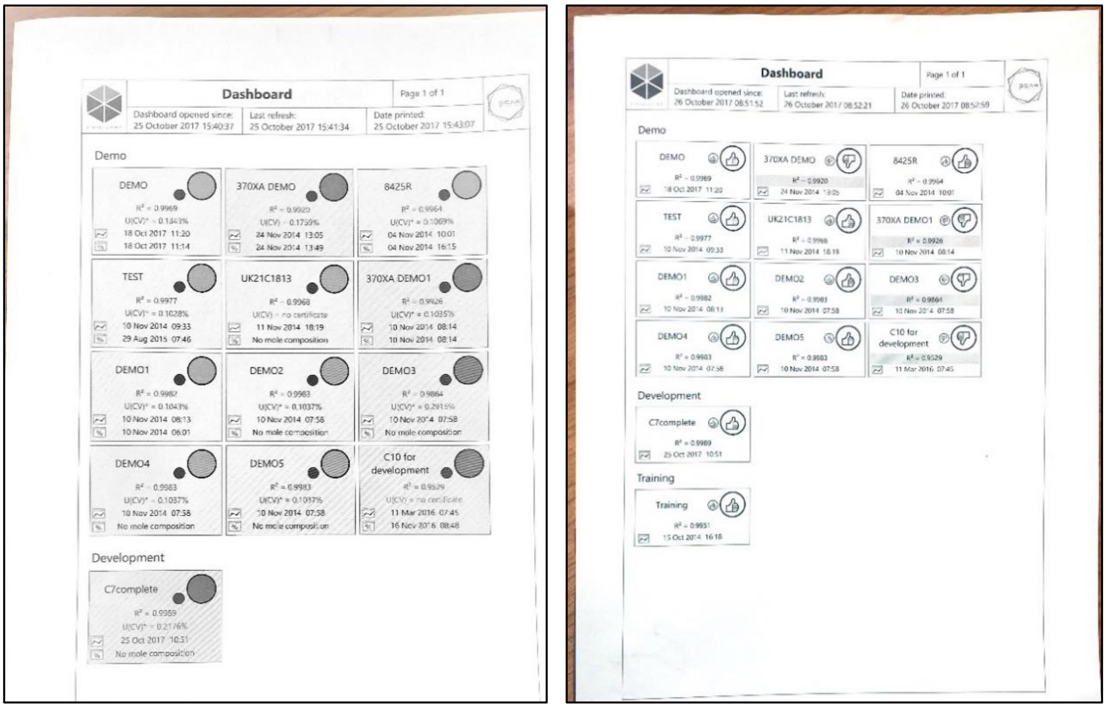
You can print GCAS Dashboard on a paper as a snapshot of current condition of your GC devices. To print, click the **Print** dropdown button on Dashboard toolbar. Use the familiar menu **Page setup**, **Print preview**, and **Print**. Alternatively, open the File menu on main menu bar and the printing menus are also available right there.





A note when you are printing GCAS Dashboard using monochrome printer, it may result in very similar shades of grey like the one on the next page.

To fix this problem, select the appropriate menu **My printer supports colour** or **My printer is monochrome** before you print. For monochrome printers, make sure to select **My printer is monochrome** because GCAS uses the thumbs-up or thumbs-down symbol to indicate device health status—much more distinguishable than shades of grey.



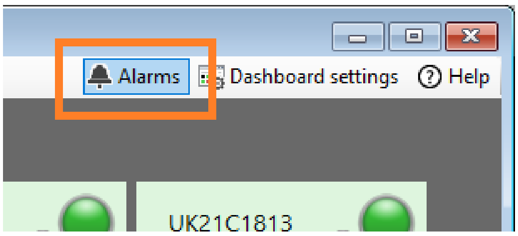
Left: *GCAS Dashboard, showing red and green on various devices, printed using a monochrome printer.* ***Right***: *The dashboard, printed using a monochrome printer, but with "My printer is monochrome" option selected.*

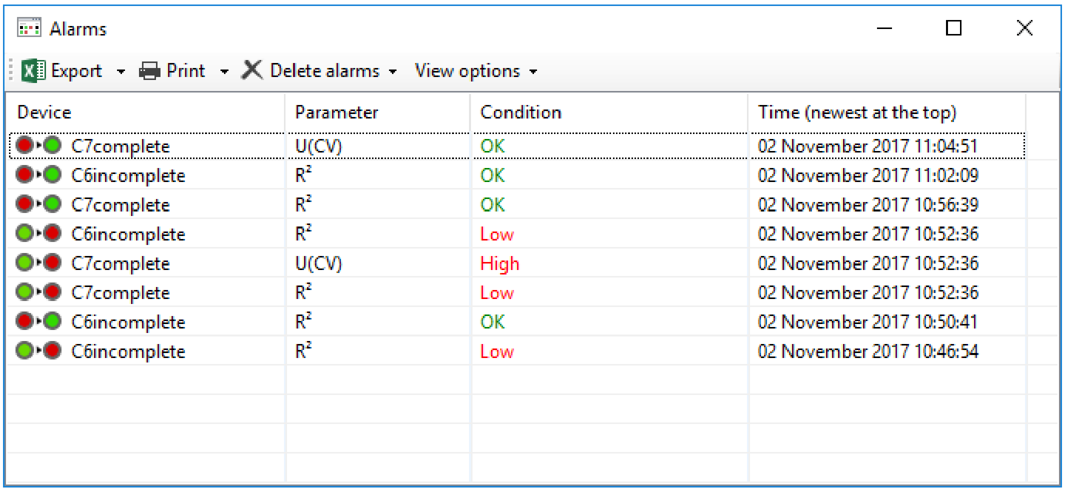
17.4 Alarms

Alarm is an event when a GC device changes status among red, yellow, or green. When a device goes from green to red, that is one alarm. The next day it changes back from red to green, that becomes another alarm. Colour change from and to black or white is not considered as an alarm.

GCAS raises alarms every time the Dashboard refreshes. After applying rules (colours) to all tiles, GCAS checks which ones changed colour. Those who changed are recorded in the *alarm log*.

To access alarm log, click the **Alarms** button on Dashboard toolbar.

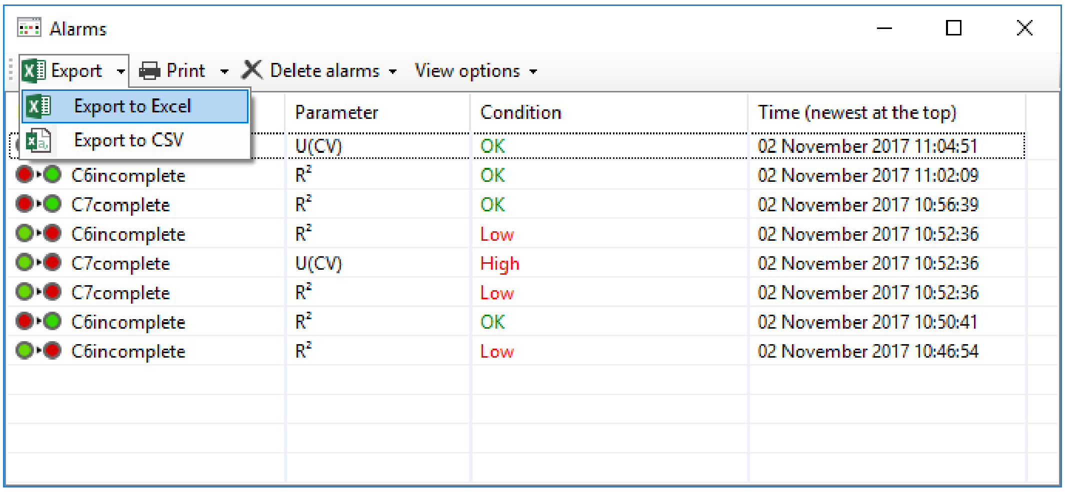




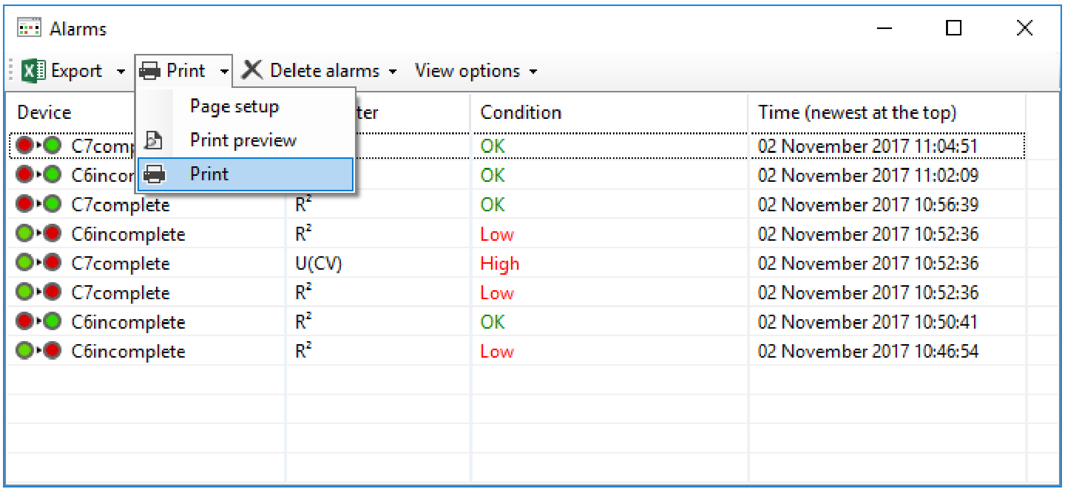
17.4.1 The *Alarms* Window

The *Alarms* window lists what parameter of a device that triggered the alarm and its value during the change. This icon indicates the device had been green but then became red. Similarly, this icon indicates the device had been yellow but later turned green.

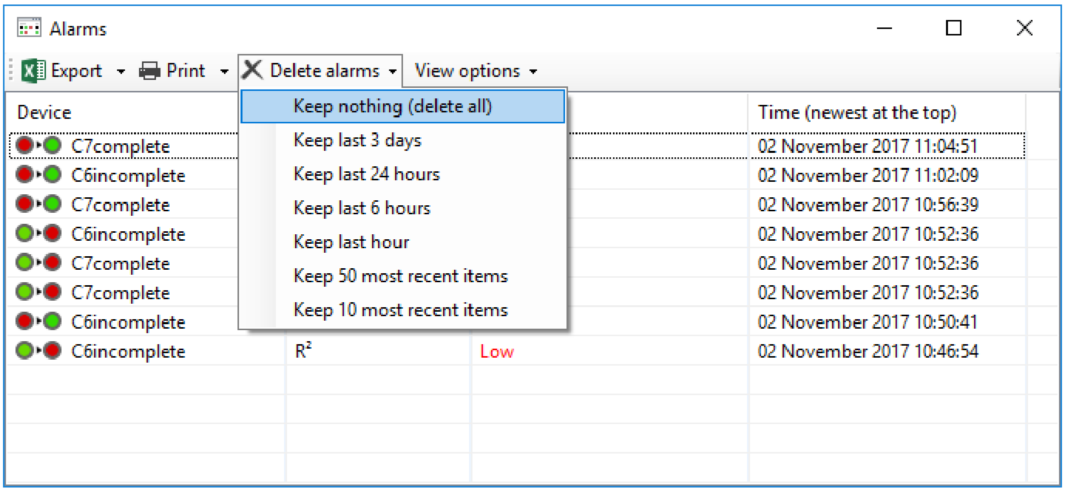
To export the alarm log, click **Export to Excel** or **Export to CSV** on the toolbar.



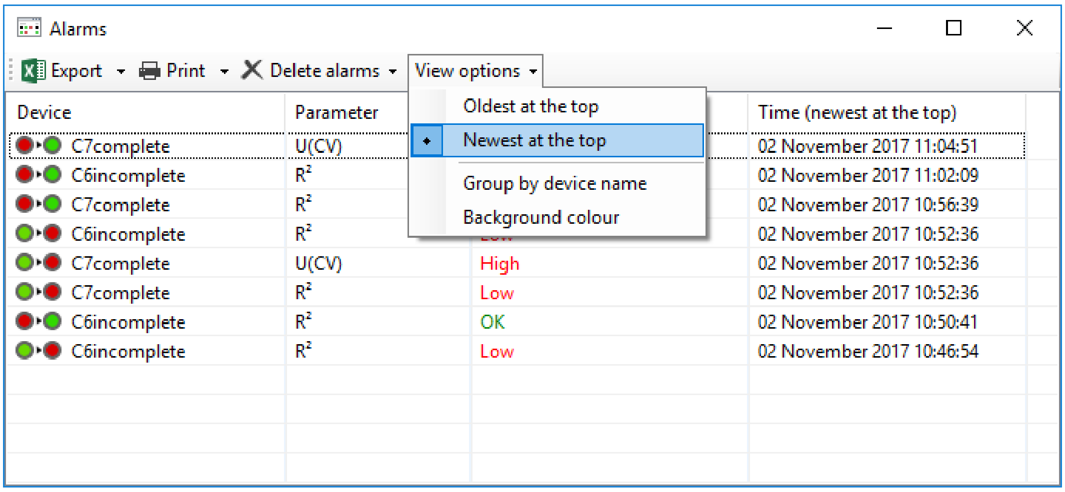
To print the alarm log, click **Print**. Or open the drop-down menu of the **Print** button to access the **Page setup** and **Print preview** menu.



To delete alarms, click **Delete alarms** and choose how many alarms to keep. If you want to delete all, select **Keep nothing**.

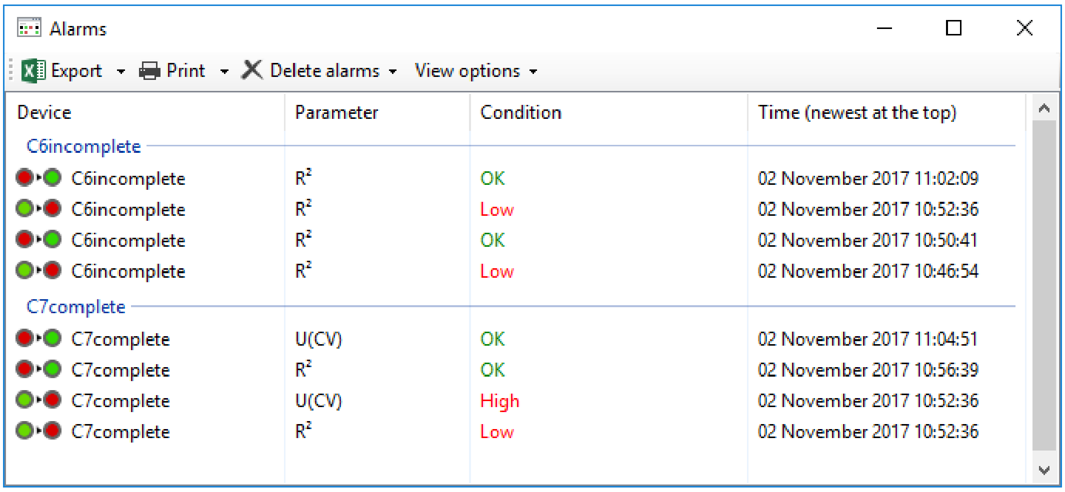


The **View options** menu configures how the alarm log should be displayed.



a. **Oldest to newest** or **Newest to oldest** changes the sort direction based on the alarm timestamp.

b. **Group by device name** would categorise alarm items based on device name and would result in something similar to this.



Device	Parameter	Condition	Time (newest at the top)
C6incomplete			
C6incomplete	R^2	OK	02 November 2017 11:02:09
C6incomplete	R^2	Low	02 November 2017 10:52:36
C6incomplete	R^2	OK	02 November 2017 10:50:41
C6incomplete	R^2	Low	02 November 2017 10:46:54
C7complete			
C7complete	U(CV)	OK	02 November 2017 11:04:51
C7complete	R^2	OK	02 November 2017 10:56:39
C7complete	U(CV)	High	02 November 2017 10:52:36
C7complete	R^2	Low	02 November 2017 10:52:36

c. **Background colour** gives a colour coding based on the health status of each alarm.

17.4.2 Alarm Alert

Alarm alert is a feature to notify you or the designated recipients via email when at least one alarm is triggered. GCAS sends one alert email every time the dashboard finishes refreshing, and this email contains all alarms raised during that refresh. To make this happen, please allocate one email account on your corporate mail server to GCAS.

Alarm alert works with a traditional SMTP server for email submission. GCAS cannot send alert through other types of mail transfer protocol such as Microsoft Exchange ActiveSync (EAS) protocol. Do not get mistaken between Microsoft *Exchange Server* and *Exchange ActiveSync*, for GCAS *works* with Microsoft Exchange Server provided that it is configured to allow SMTP connection in addition to EAS protocol.

Q: Why does GCAS need access to my internal mail server? Why don't you guys send me alerts from some address like alert@i-Vigilant.com?
A: There are reasons why we choose to use customer's own mail server.

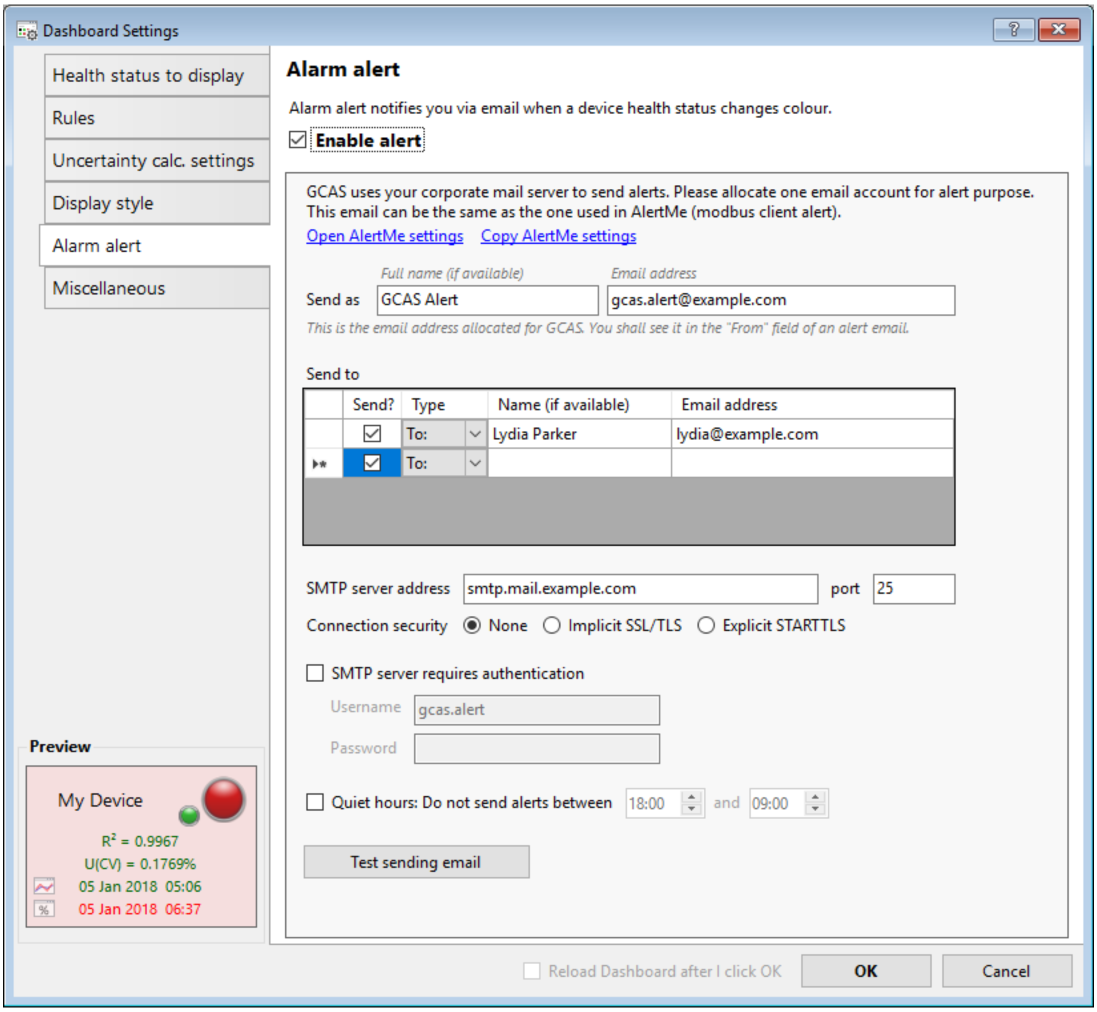
- Because the mail server is already inside your network, emails are delivered faster because they are treated as local (intranet) traffic.
- If we send alerts from external mail address such as alert@i-Vigilant.com, we have to persuade your network administrator to allow our email domain address to be in the whitelist. Otherwise the alert mails may end up marked as spam or junk. That also involves continual blocklist suppression request to public spam blocklist services such as SpamCop and Spam-Haus.
- External emails must go through several layers of corporate network security such as firewall packet scans, antivirus scans, and so on. This yields longer delivery time and increases the risk of alert mails get undelivered.

- If your corporate use Microsoft Exchange Server (with SMTP enabled), Exchange can deliver the alert through push mail. That's even better.

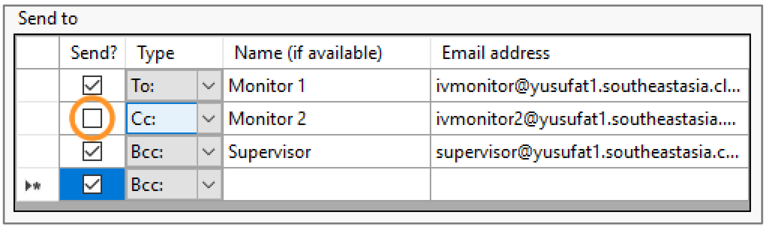
Using email as delivery method also poses several risks.

- GCAS requires a working network connection to the mail server. If the network is down, the emails won't get sent. This problem escalates if your network topology involves VPNs. When the public internet connection goes down, so does the VPN connection, and emails won't get sent either.
- Alarm alert emails are HTML emails. Some corporates impose a restriction on their mail servers such as only allowing plain text emails or requiring S/MIME signature. In these cases, GCAS cannot send emails.

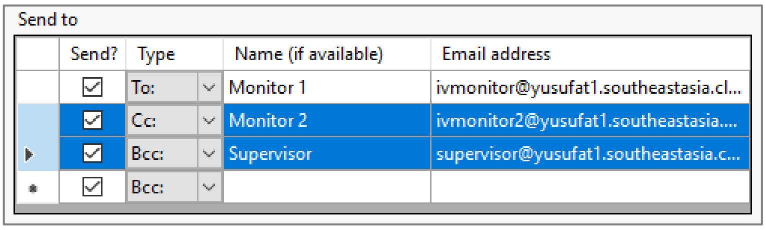
To set up alert, go to Dashboard Settings dialogue and navigate to **Alarm alert** tab. Check **Enable alert** to begin.



Fill these two mandatory fields: **Send as** and **Send to**. *Send as* is the email allocated for GCAS; it will become the "From:" field of an alert email. *Send to* contains the list of intended recipients. You can put multiple recipients and designate each one, who is the `To:` recipient (primary), who is the `Cc:` (carbon copy), and who becomes `Bcc:` (blind carbon copy).



*To temporarily exclude a recipient, untick the check box on the **Send?** column. Unticked recipients will not get emails.*



To remove one or more recipients, highlight their rows and press `Delete` *on your keyboard.*

Next, specify the mail server **host name** (or its IP address) and its **Port**. Your network administrator or IT department can provide this information. Afterwards, set one of the connection security options.

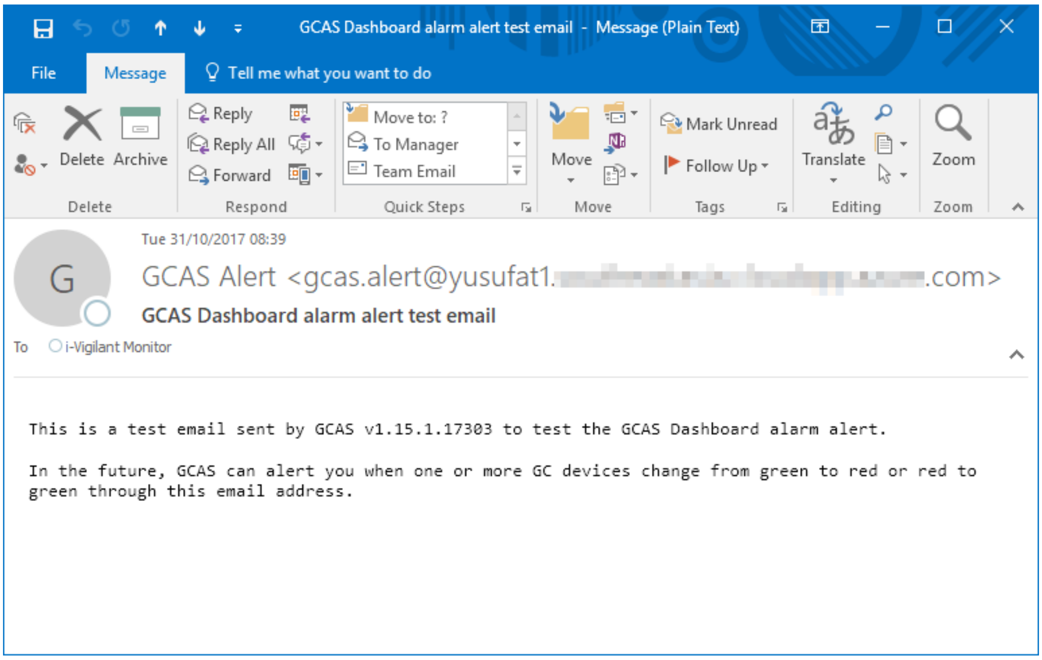
- **None**: Connection to the mail server is not encrypted.
- **Implicit SSL/TLS**: GCAS sets up SSL encryption at the time connection is established. Afterwards, email submission begins on secured communication.
- **Explicit STARTTLS**: The connection begins as an unsecured, then GCAS issues a STARTTLS command to upgrade the connection to be a secured one.

The port is typically 25 for unsecured connection, 465 for implicit TLS, and 587 for explicit TLS. But the port should be set according to the instruction given by your network administrator.

Moving down, depending on your mail server, it may require authentication before the server accepts email submission. If so, check **SMTP server requires authentication** and fill in the username and password of the mail account allocated for GCAS alert.

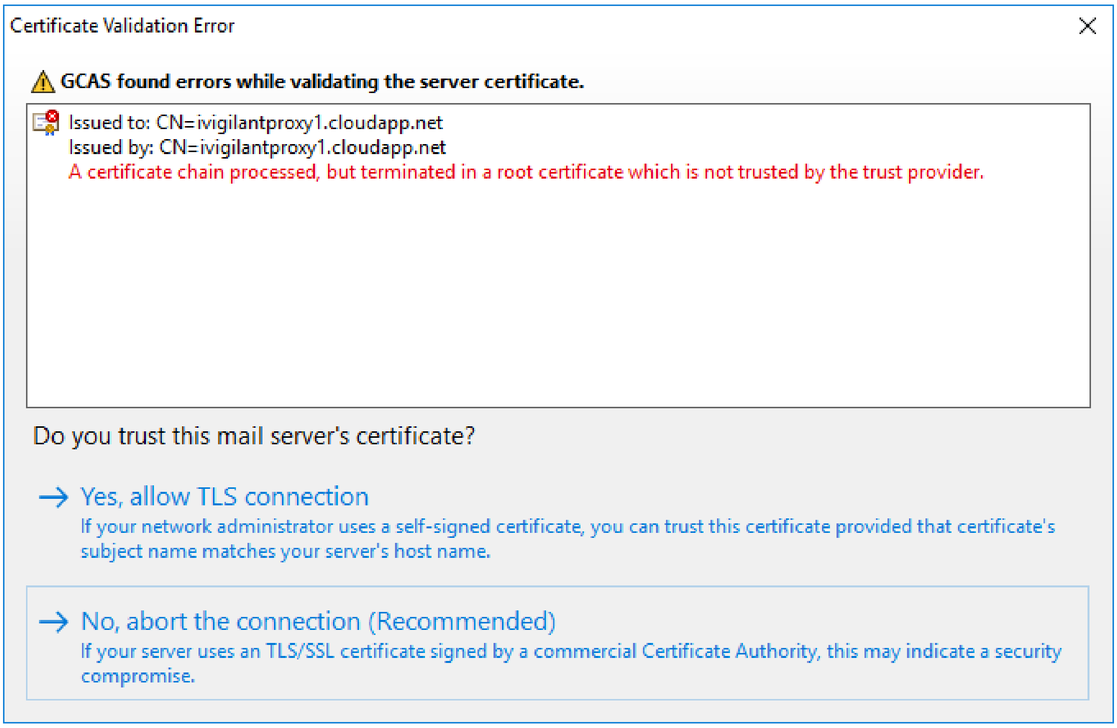
Continuing down, you see a check box to enable or disable **quiet hours**. Quiet hours are an interval period where GCAS would refrain from sending you alert emails. In case you need your evening time not to be disturbed, check the box and set the start and end time.

Click **Test sending email** to verify the configuration is correct. You should get this kind of email if the test succeeded.



In case your mail server enforces implicit or explicit TLS security, GCAS executes standard SSL certificate chain validation—the one that is performed by your internet browser all the time. If the SSL certificate is untrusted, GCAS presents you a dialogue illustrated on the next page.

Many corporate networks employ self-signed SSL certificate to create secured connections. Self-signed certificates are not trusted unless the root certificate is distributed and installed on every computer by your network administrator. If you trust the certificate, click **Yes, allow TLS connection** to continue email submission. You are prompted this dialogue only once per session.



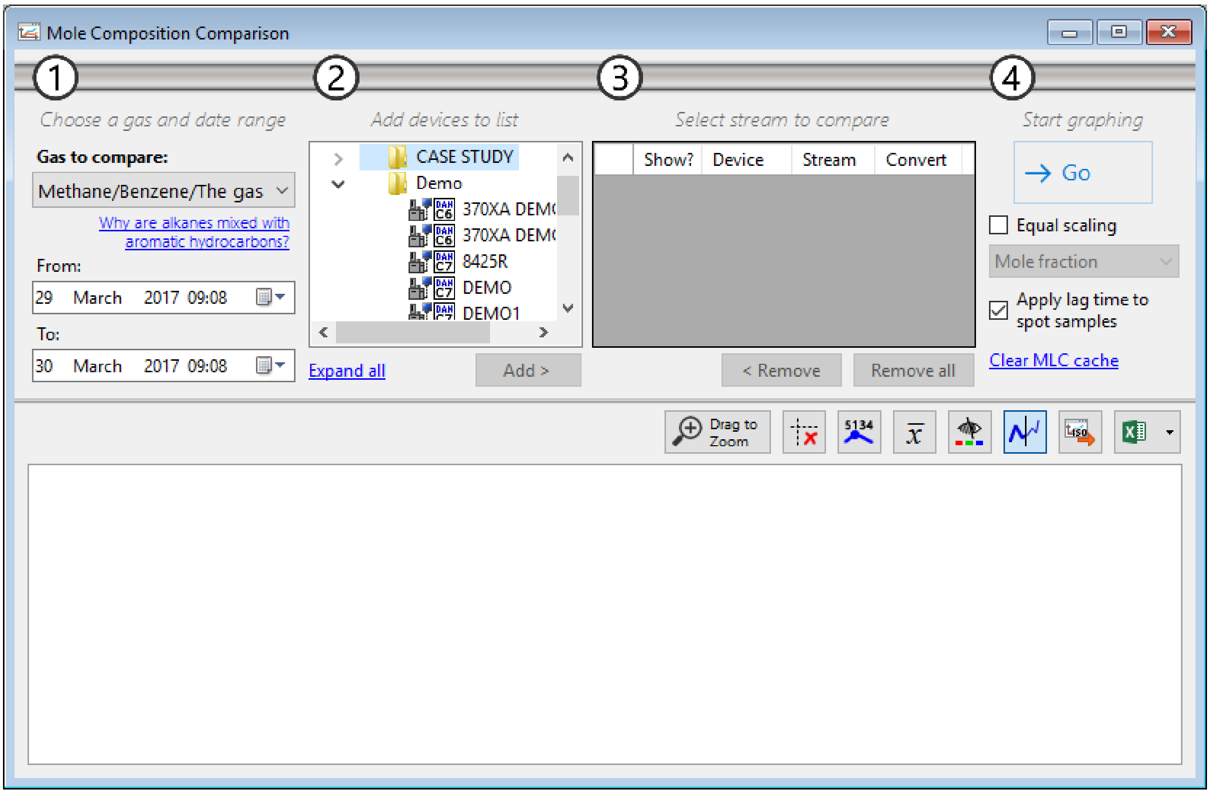
18 Mole Composition Comparison

Mole Composition Comparison is a tool to compare trends of mole composition across different devices. This module complements the Data Analysis module. Through Data Analysis you see mole composition trend of various gases for one device, now on Mole Composition Comparison you see mole composition trend of one gas for various devices.

> **Note**
>
> This module requires two GCAS features to be included in your GCAS licence: *Live Data Analysis* and *Data Comparison*.

18.1 The Mole Composition Comparison Form

To open Mole Composition Comparison form, go to the Tools menu > **Mole Composition Comparison**.

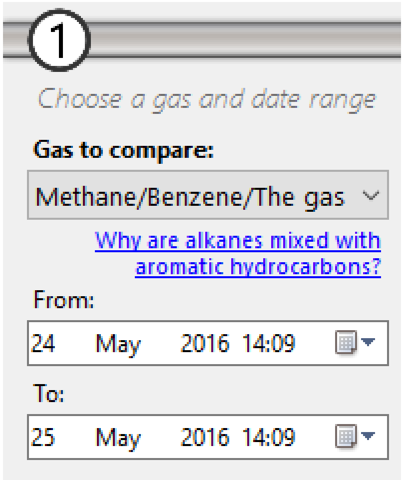


Mole Composition Comparison form has two resizable sections. Parameters and device list are at the top, while the comparison chart is at the bottom.

18.2 Parameters and Device List

The top section of the form has a linear flow. Select the gas and comparison date range (under section ❶), browse the devices to compare (❷) and add them to the comparison list (❸), select which stream of these devices (❸) and finally click **Go** (❹) to start graphing.

18.2.1 Gas and Date Range

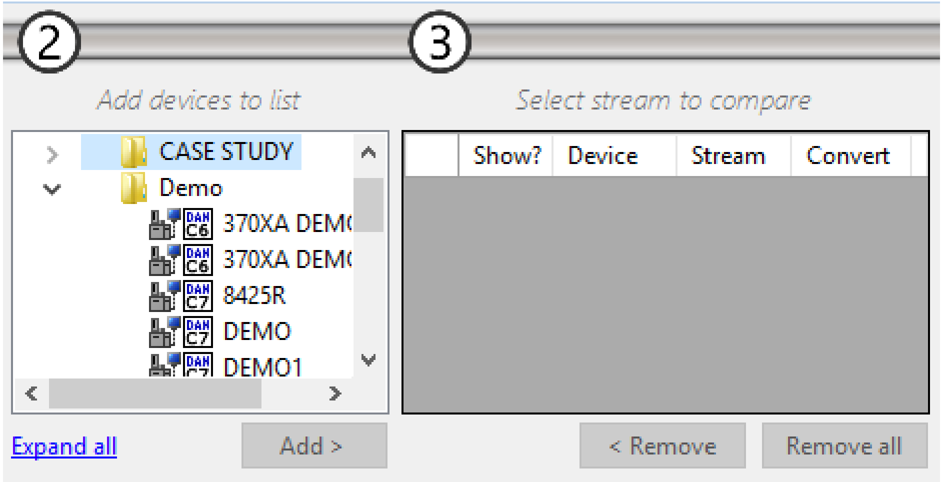


GCAS supports 20 gases to compare (15 + 4 + 1) across different devices. Please note that not all devices have a complete range of gases, for some do not have neopentane and some others do not have heptane and higher. When you set the gas octane to compare then tick a device which doesn't include octane for example, its line will lie on the X-axis because its Y-values are all zeroes.

One thing that may confuse users is that they see **Methane/Benzene/The gas** instead of just methane. Also, nitrogen is shared with toluene, CO_2 is shared with ethylbenzene, and ethane with xylene. This is because BTEX devices and single gas analysers reuse the same database columns as regular GC devices. We don't have special database columns for aromatic hydrocarbons because there would be too much rewriting of the entire software. Single gas devices use the methane table column to store values of their gas. Hence, methane is shared with benzene, "the gas", hydrogen sulfide, and moisture. Nitrogen is shared with toluene, carbon dioxide is shared with ethylbenzene, and ethane with xylene.

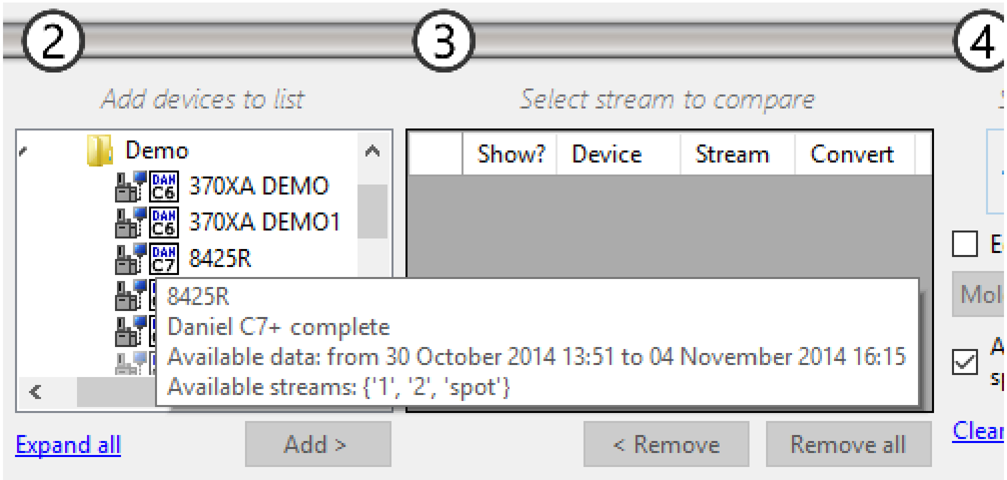
Mole Composition Comparison is a universal tool, that implies it isn't bound to a specific GC device. You can include multiple devices in the comparison list, each of different device type, and there is no way to predict whether you are going to compare regular GC to regular GC or BTEX to BTEX. This is why the dropdown says "Methane/Benzene/The gas" instead of just "Methane" or just "Benzene". Although comparing regular GC to a BTEX or single gas device is pretty much meaningless, rest assured that the selection "Methane/Benzene/The gas" behaves completely as "Methane" during a comparison of C6+ device to C7+ device.

18.2.2 Devices and Comparison List



On the left, you see the *device tree view*. It lists all your workspaces and devices within each workspace. The grid on the right is known as *comparison list*.

Hover your mouse pointer over a device to view more information about data availability and stream numbers. In the screenshot below, the device 8425R has stream 1, stream 2, and [spot samples](). Devices which don't have mole composition records at all are displayed as semi-transparent and cannot be added to the comparison list.

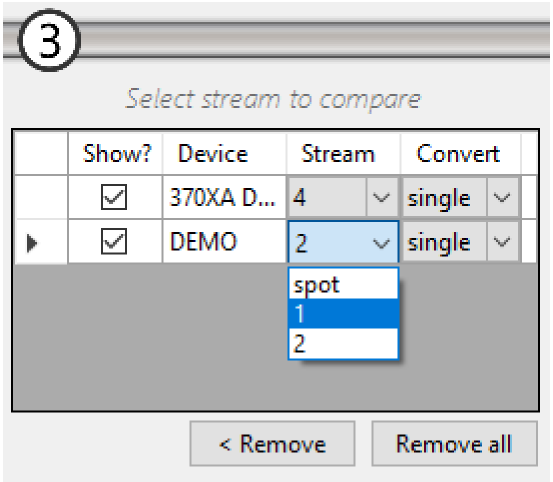


To compare devices, add the devices from the device tree view to the comparison list. Either select the device then click **Add**, or double click the device, or drag the device and drop it onto comparison list.

Note

A Mole Composition Comparison form which was opened through *Send to* shortcut from Data Analysis' *Send to Mole Composition Comparison* menu or *Compare both* link, is locked to one particular device and one particular stream number. Device tree view is empty and you cannot add another device into comparison list. The text above the chart should clearly indicate the form is locked. Click **Reset and reload device list** next to this text in order to unlock Mole Composition Comparison form back into normal mode.

Once the device has been added to the comparison list, select the stream number to compare. You can compare different streams of the same device too. To do so, add the device to the comparison list twice, then select different stream number for each of them. Moreover if you have *ISO 10723* feature which we will explain very soon, this tool can also compare the single-point composition vs. multi-level-calibrated composition of the same device, same stream number.



The column **Show?** contains check boxes which are used to hide or show the line chart of corresponding comparison entry after the chart has been rendered completely. Column **Device** lists device tag names. Column **Stream** lets you choose which stream to compare. If you find the stream "`spot`" in these dropdowns, you are comparing spot sample records. Spot samples are treated as a special stream.

The column **Convert** contains options for stream conversion. Typically, the available options are "`single`" (single-point) and "`MLC`" (multilevel-calibrated). Users without *ISO 10723* feature see these dropdowns contain only one option which is "`single`", thus the column **Convert** serves no use. Nevertheless, for ABB devices, the **Convert** dropdowns include additional option: "`exp.`" (exponential). This option converts the stream to exponential mole composition.

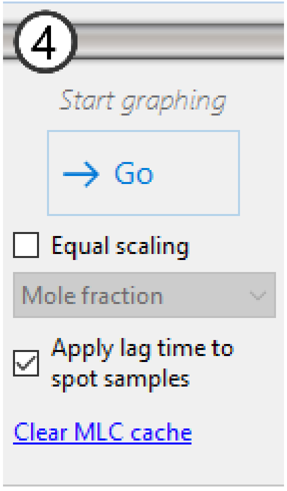
To remove an entry from the comparison list, highlight its row on the grid and then click **Remove** or press `Delete` on your keyboard. Every time a comparison entry is removed from the comparison list, its line chart is also removed. However, if you add it back, you need to redraw the chart because its data in the cache has already gone. This is the difference between removing an entry versus temporarily hiding it (by unticking the check box inside the **Show?** column). In addition, click **Remove all** to empty the comparison list and start over.

Note

Maximum number of entries in comparison list is 15 entries.

GCAS will alert you if there are duplicate comparison entries.
Duplicate = same GC device + same stream number + same stream conversion.

18.2.3 Start Graphing

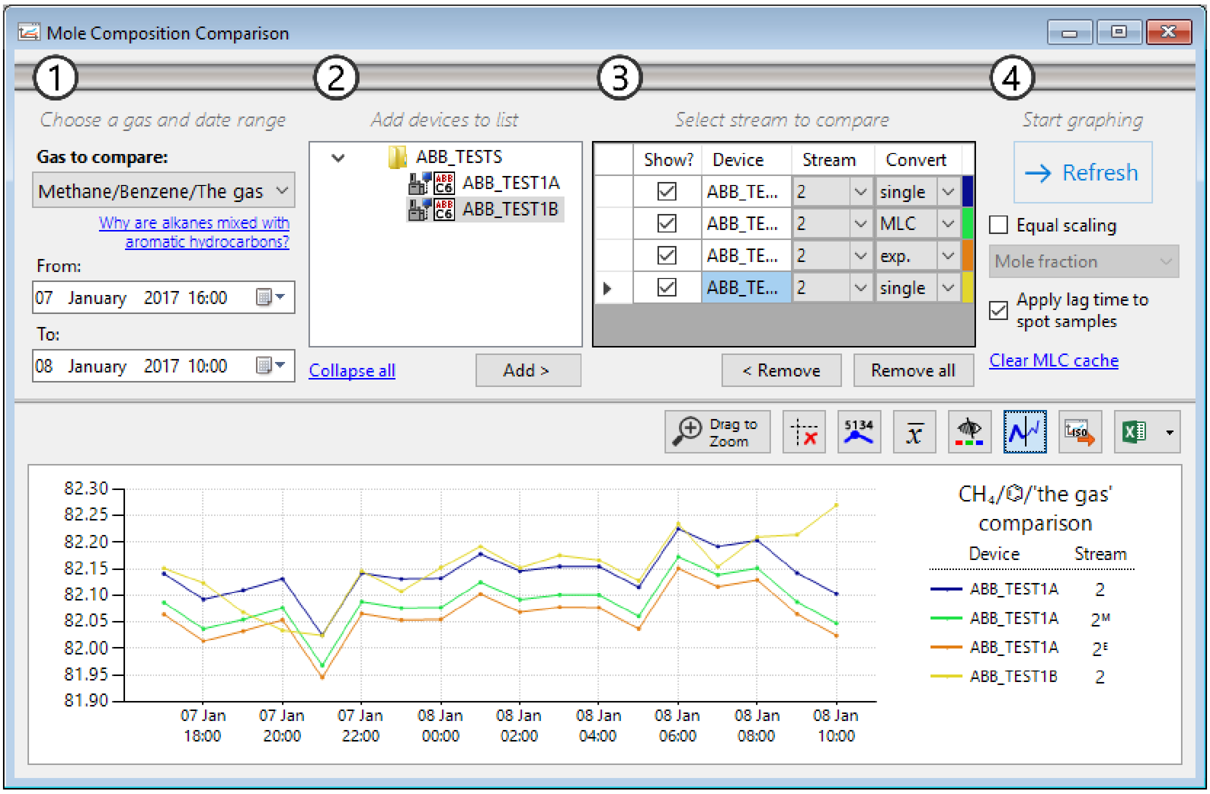


When everything else are correct, simply click **Go**. GCAS loads the required mole composition data and renders the chart. The **Go** button turns into **Refresh** button unless you change the selected gas, comparison date range, devices, stream numbers, or single-point/MLC switch.

Equal scaling, if ticked, forces all comparison entries to use the same normalisation scale. Tick this option if you are comparing multiple devices having different scales, such as this GC uses *fraction* and that GC uses *percentage*. More about scaling equalisation on chapter 18.3.2.

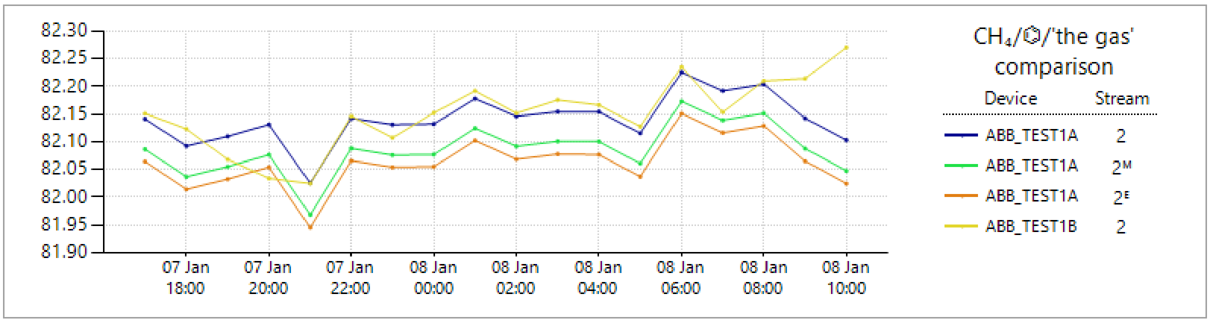
If you include one or more spot sample streams in the comparison list, the check box **Apply lag time to spot samples** shifts all spot sample dots to the right according to the amount of most recent lag time value of each dot. Jump to chapter 25.2 Lag Time form to create new lag time records.

Users with *ISO 10723* feature in their licences see an additional command link **Clear MLC cache**. This clears the cache used by ISO 10723 conversion. The cache contains MLC coefficients, calibration certificates, single-point RF, MLC RF, and MLC constraints. Click this link if you notice the multilevel-calibrated streams are graphed incorrectly. Once the MLC cache is emptied, refresh the chart.



18.3 Comparison Chart

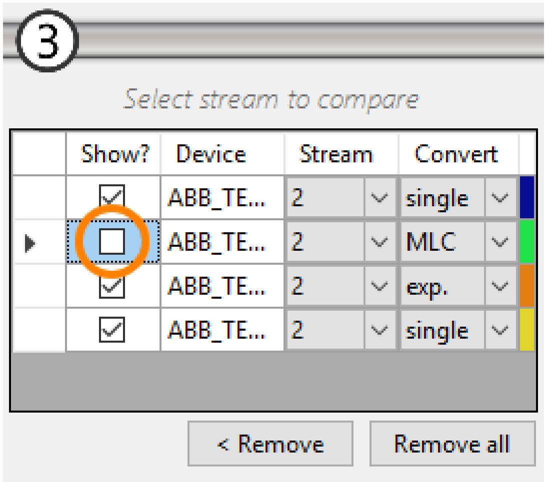
The chart graphs the historical mole composition of the selected gas over time, limited by your plot range, device, stream number (and single-point or MLC selection for ISO 10723) at a time. This chart has maximum capacity of 15 comparison entries. The legend at right side tells what gas it is, the devices, and their stream numbers. Multilevel-calibrated streams (ISO 10723) are indicated with superscript M after their number, like 1^M for stream 1. Exponential streams (only on ABB devices) are indicated with superscript E.



By default, GCAS draws the chart using thin lines, unlike all other charts in GCAS which use 2-pixel width. Line charts having data points less than 100 have small dot markers along its body. Line charts with more than 100 dots are presented without markers.

18.3.1 Show or Hide Some Devices

Untick the checkbox at the column **Show?** inside the comparison list to temporarily hide a device (a line) on the chart. Check the checkbox to bring the line visible.



If you *remove* a device from this list, its line chart is also removed. After you add the device back, you need a full refresh to redraw the lost line.

18.3.2 Scaling Equalisation

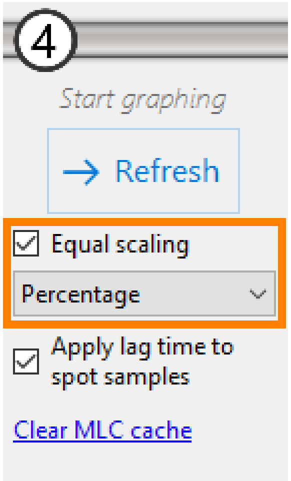
GCAS stores mole composition records as-they-are in the database. There is no information about its *scale* stored in database. Most devices use *percentage scale* (0 to 100). Some others output *fraction scale* (0 to 1). GCAS determines scaling by the unnormalised total. For example, if the unnormalised sum is near 1, the device uses fraction scale. If the sum is near 100, it is percentage. If near 1000, it is permillage (‰).

GCAS supports fraction scale (0 to 1) up to PPB scale (0 to 1,000,000,000) officially. This becomes a problem in mole composition comparison: What happens when you compare device A with percentage scale and device B with fraction scale?

The answer, GCAS plots mole composition records as they are. The two line charts will appear far apart as device A has methane composition about 70 (percentage scale) while device B has around 0.7 (fraction scale). Thus, the line chart of device A flies high up there while device B lies low near the X-axis.

To circumvent this problem, Mole Comparison Composition form is equipped with *scaling equalisation*. However, it is not enabled by default. The reason is most users have all GC devices generating mole composition records on the same scale, or at least *configured* to output on the same scale. Therefore, scaling problems rarely affect GCAS users.

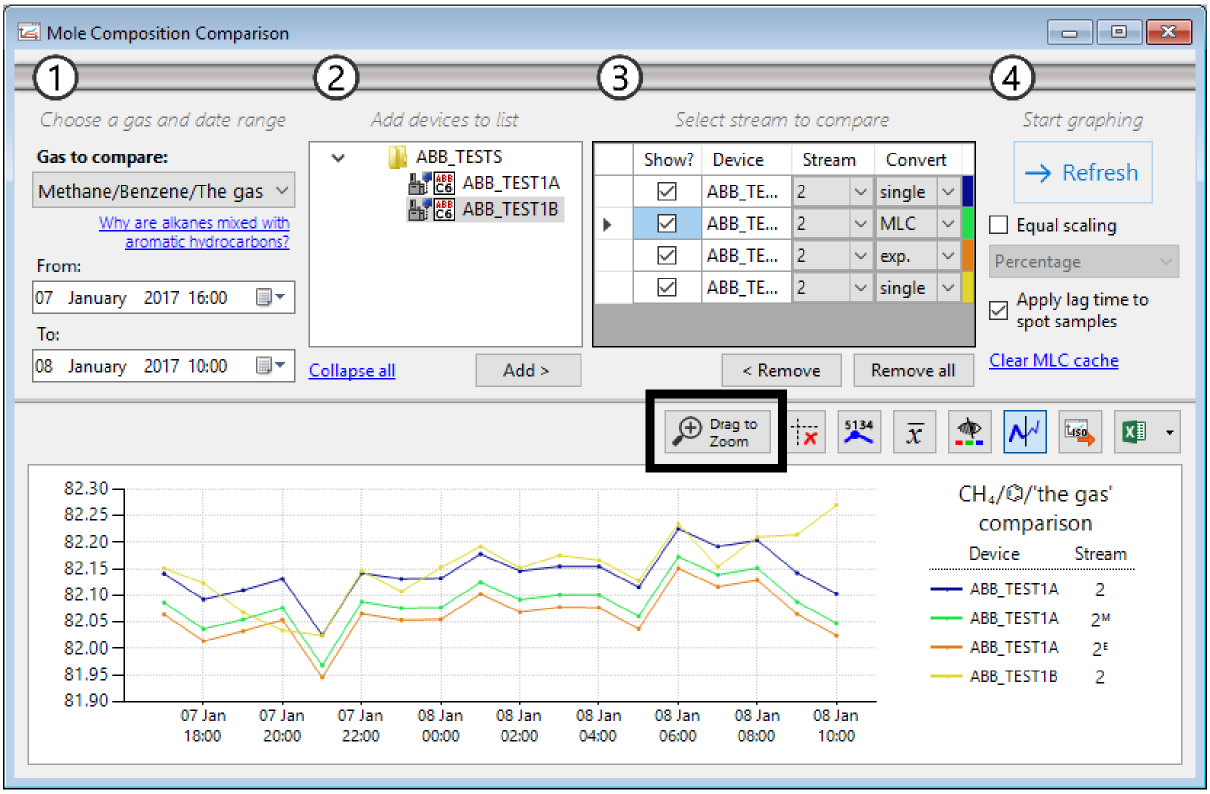
If you *do* compare devices with different scaling, be sure to tick **Equal scaling** before you click **Go**. Select one of four available scales: fraction, percentage, permillage, or parts-per-million (PPM).

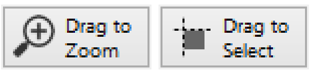


Continuing our example about device A and B, with *mole fraction* scaling equalisation, you are downscaling device A to fraction (0 to 1) while device B remains in fraction scale. If you select *percentage* on this dropdown, you are upscaling device B to percentage (0 to 100) instead.

18.3.3 Zoom Mode and Selection Mode

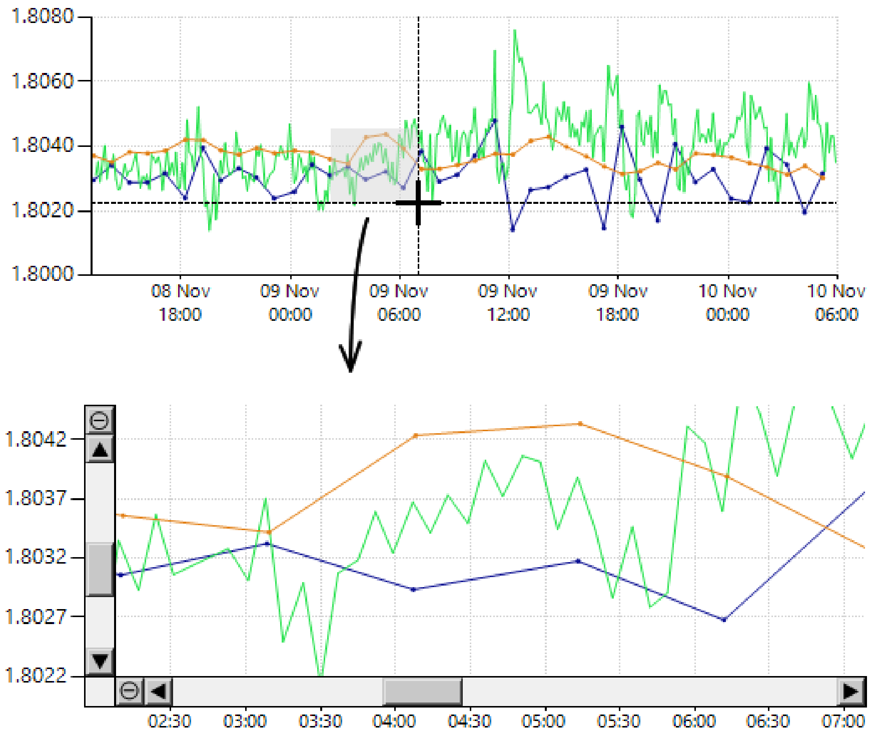
This toggle button controls whether the comparison chart is in *zoom mode* or *selection mode*.



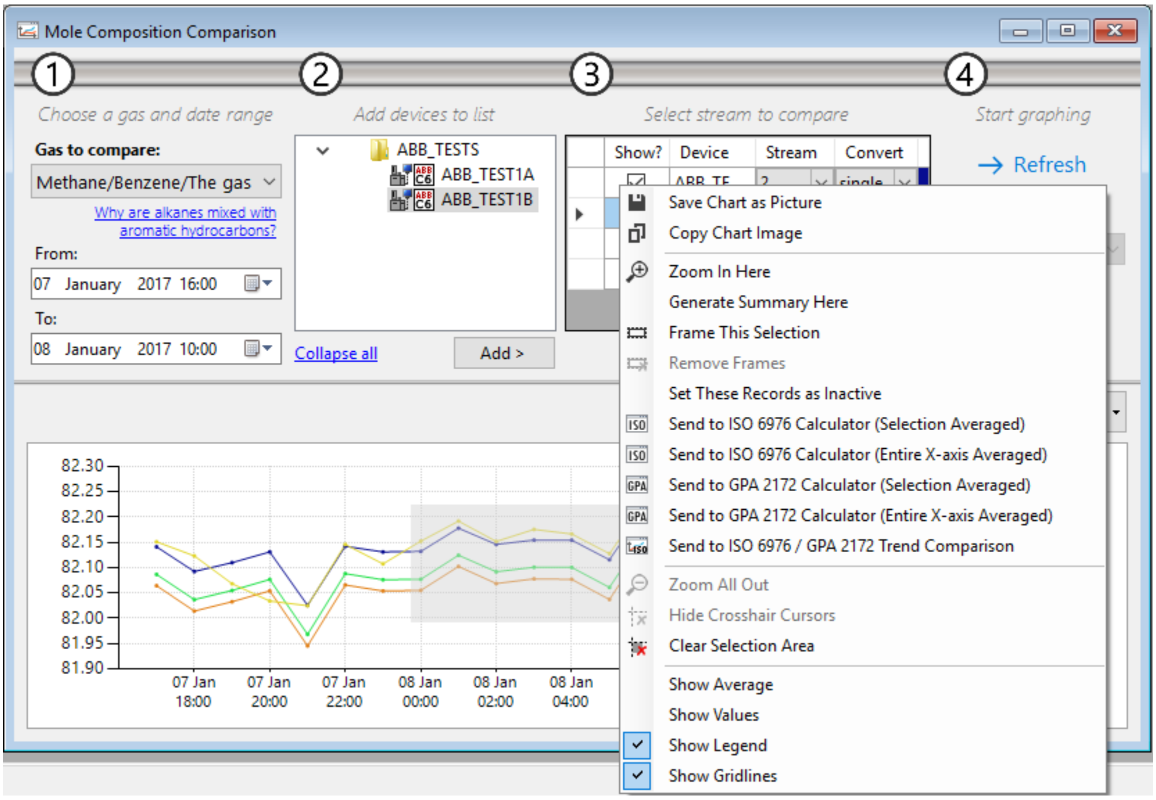


Toggle button to switch between zoom or selection mode.

Zoom mode lets you zoom to a specific area of the chart. Drag a rectangle over the area you want to zoom in. Pan around the chart using the provided scroll bars. Drag another rectangle to zoom in further. To zoom out, click the circled minus button ⊖ on both scroll bars. Press `Home` on your keyboard or right click the chart and select **Zoom All Out** to undo all zoom-in operations.

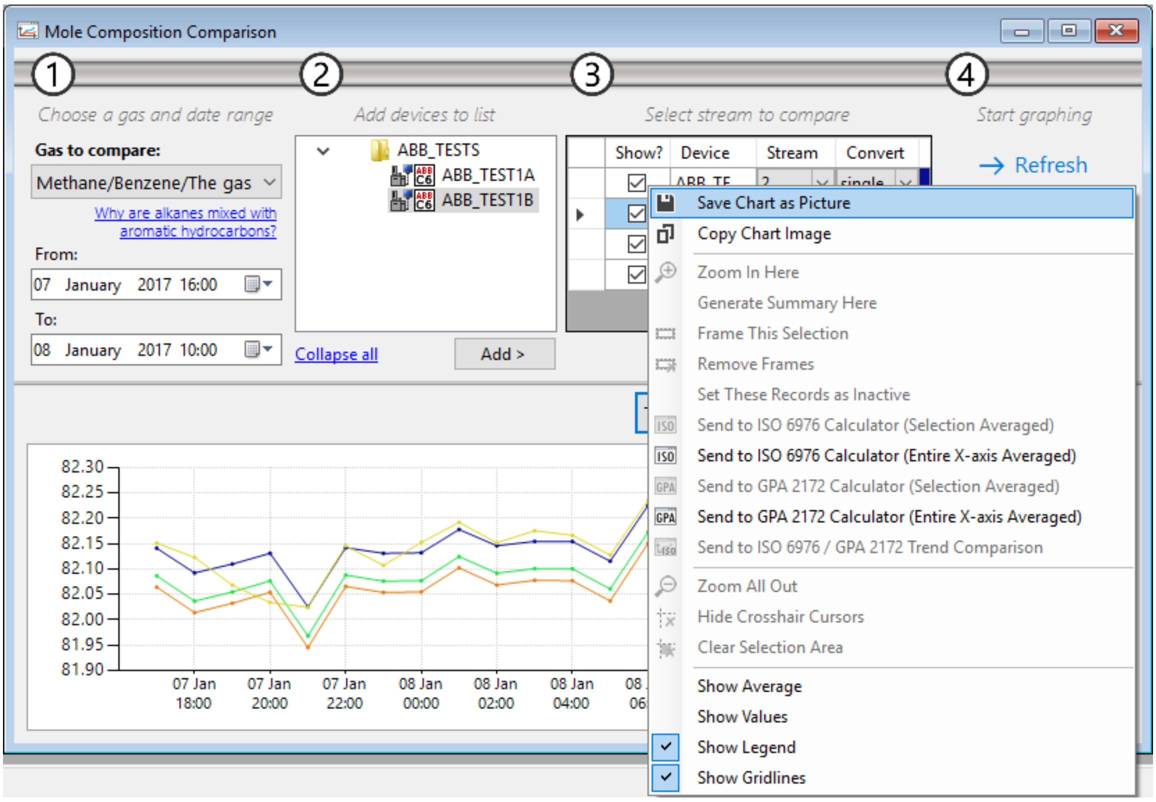


Selection mode enables you to create selection area on the chart, then you can manipulate the records contained inside the selection rectangle using available context menu. [Chapter 18.3.8](#) explains the function of each menu. To clear selection area, right click the chart and select **Clear Selection Area**.



18.3.4 Save or Copy the Chart

To save the chart as image file, right click on the chart and select **Save Chart as Picture**.

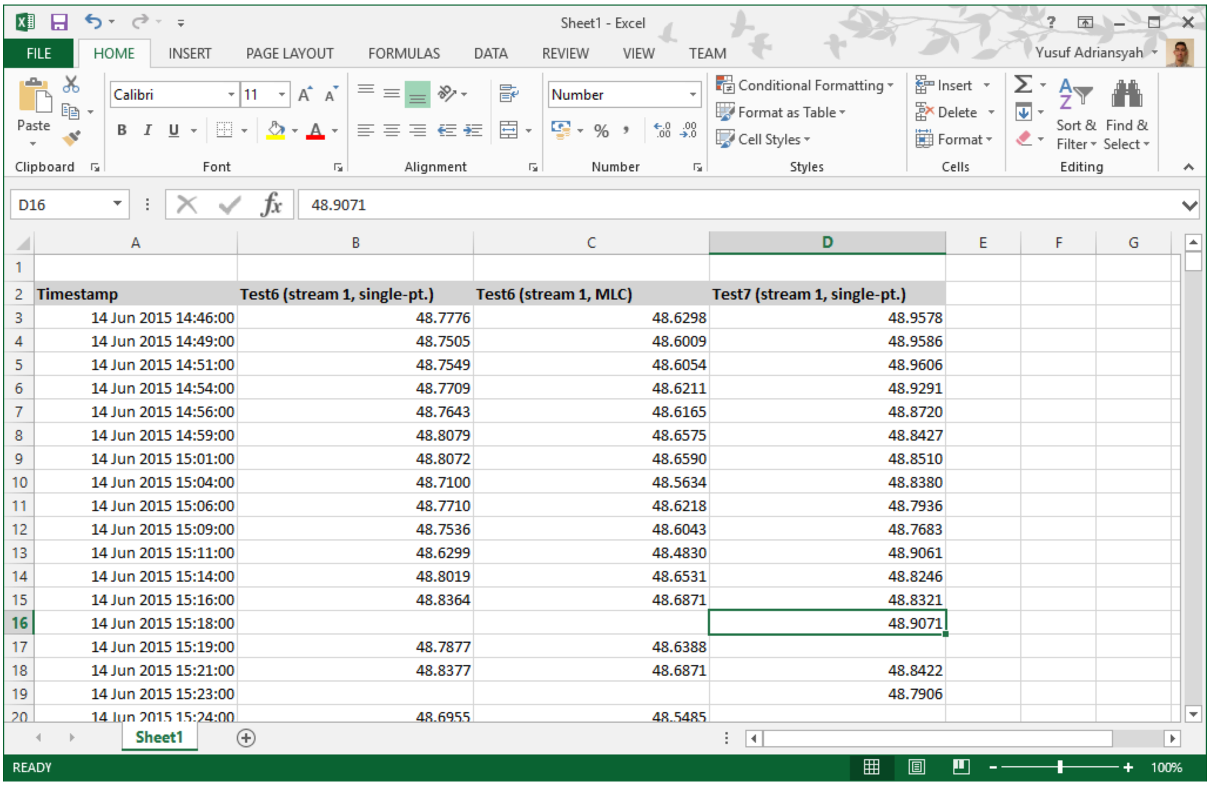


Similarly, to copy the chart into clipboard, right click and select **Copy Chart Image**. Then you may paste the image onto Microsoft Paint, Microsoft Word, or any software that accepts bitmap image.

18.3.5 Export Values to Microsoft Excel or CSV

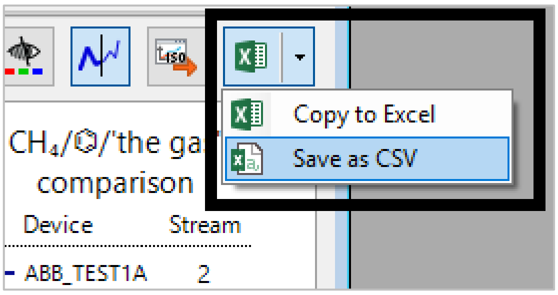
Once the chart has been graphed completely, click **Copy to Microsoft Excel**. This button opens a new Excel worksheet. Then GCAS writes all data point of all line charts available onto this worksheet.

> **Note**
>
> This feature requires Microsoft Excel 2010, 2013, 2016, or later, to be installed.
>
> GCAS prevents you from exporting to Excel if there are duplicate comparison entries.



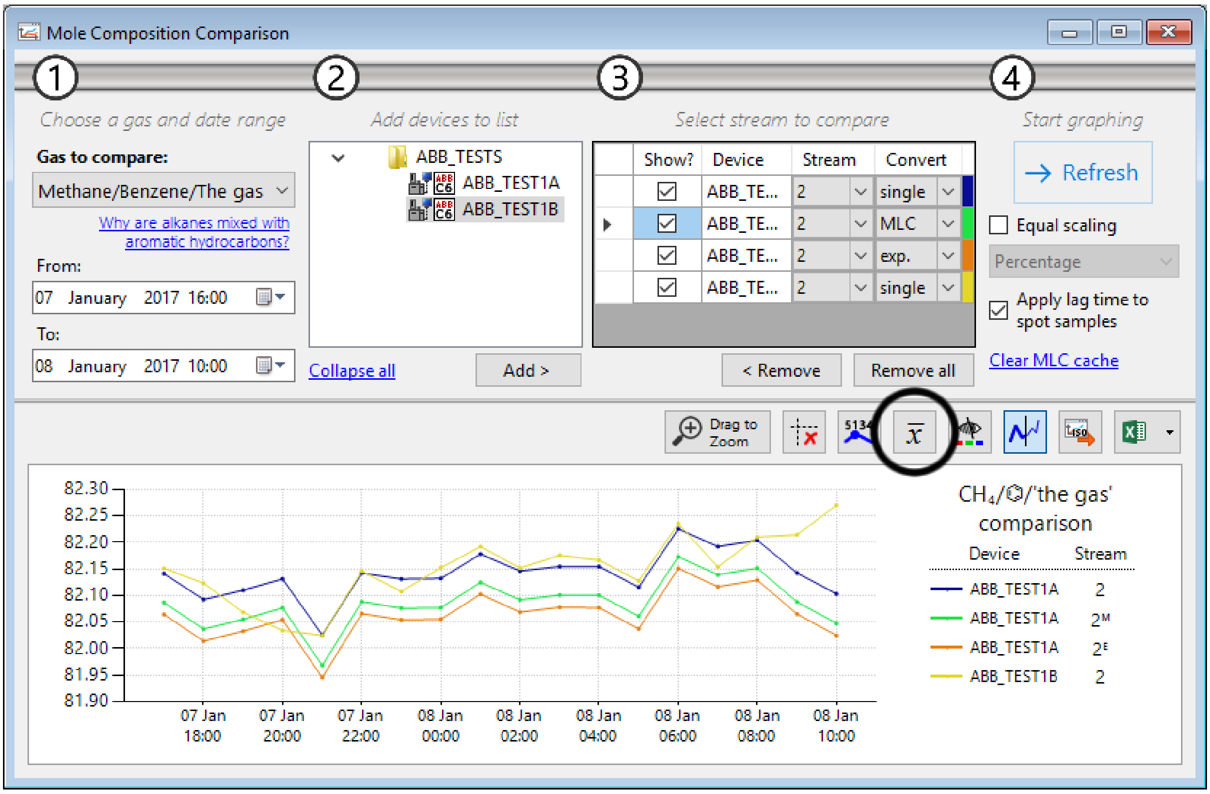
Every device or stream in comparison list has its own column and the rows are timestamps. If there are two or more data points from different devices or streams sharing the exact same timestamp, they are merged into one row in Excel worksheet.

In some scenarios where the comparison chart contains many records (> 200), it is faster to export to CSV file instead. Open the dropdown menu of **Copy to Microsoft Excel** button and find the **Save as CSV** menu.



18.3.6 Comparison of Averages

When you click **Go** or **Refresh**, GCAS renders the chart and at the same time computes the average of each line. These average values are presented on a secondary column chart. Click **Show average chart** button (having icon $\bar{x}$) to bring the average chart visible.



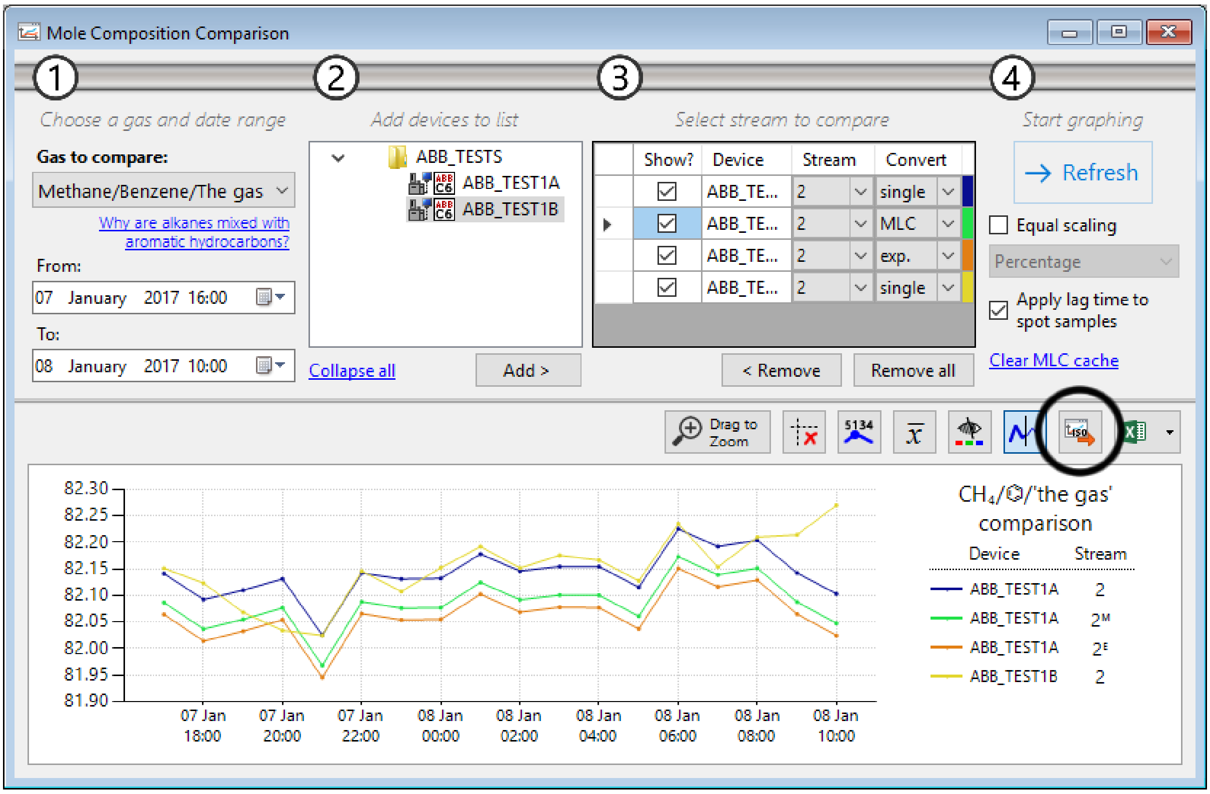
Each comparison entry has its own average bar (or technically ‘column’ as it is a column chart). Showing or hiding a line chart through the **Show?** check box in the comparison list also displays or conceals its average bar. You can also zoom the average chart in case all bars are of the same height thus making it difficult to see the difference among them, provided that the chart is in zoom mode.

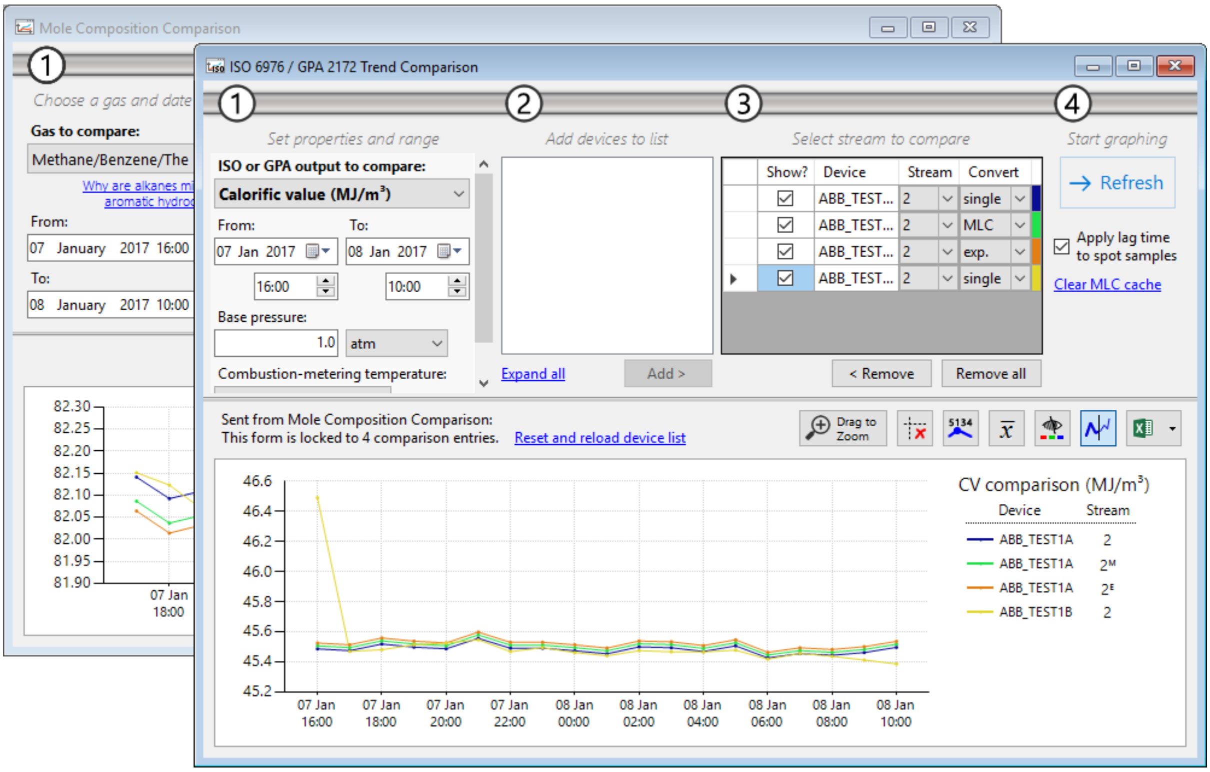
18.3.7 Send to ISO 6976/GPA 2172 Trend Comparison

Now that you have the mole composition trend of various devices or streams, ever wondered how much calorific value each stream would stack against one another? If you have the GCAS feature *ISO*

6976 Trend or *GPA 2172 Trend* included in your licence, you see the button **Send to ISO 6976/GPA 2172 Trend Comparison** is enabled next to Copy to Microsoft Excel button.

This button calls ISO 6976/GPA 2172 Trend Comparison form and communicates the necessary information such as the plot range and content of the comparison list. Then ISO 6976/GPA 2172 Trend Comparison form handles the rest. Because this "Send to" shortcut bypasses some of the ISO 6976/GPA 2172 Trend Comparison's standard startup routines, the ISO 6976/GPA 2172 Trend Comparison form is *locked* to your comparison list only. To unlock the form, click **Reset and reload device list**.

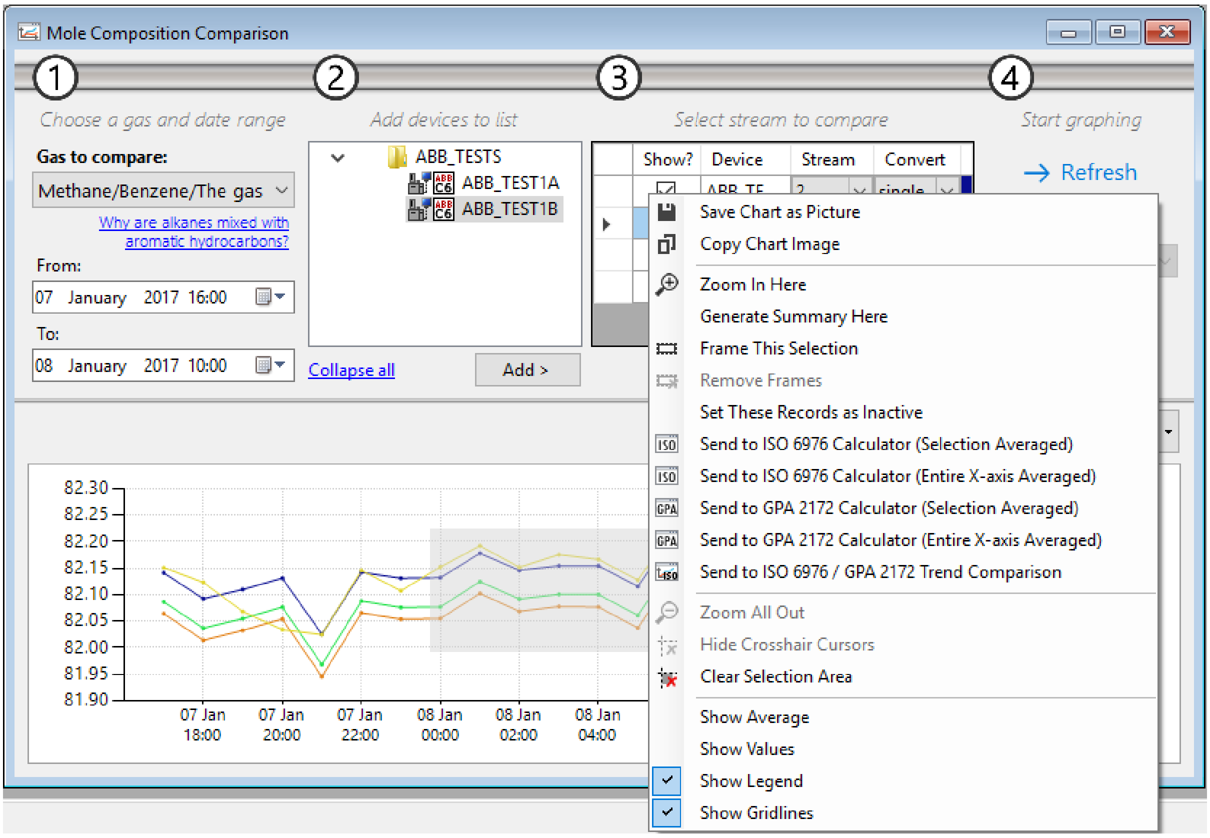




Send to ISO 6976/GPA 2172 Trend Comparison button transmits the entire plot range. To compare ISO 6976 or GPA 2172 trends of a limited range, switch Mole Composition Comparison form to selection mode and use the right-click menu **Send to ISO 6976/GPA 2172 Trend Comparison** as illustrated in chapter 18.3.8.

18.3.8 Selection Mode Menus

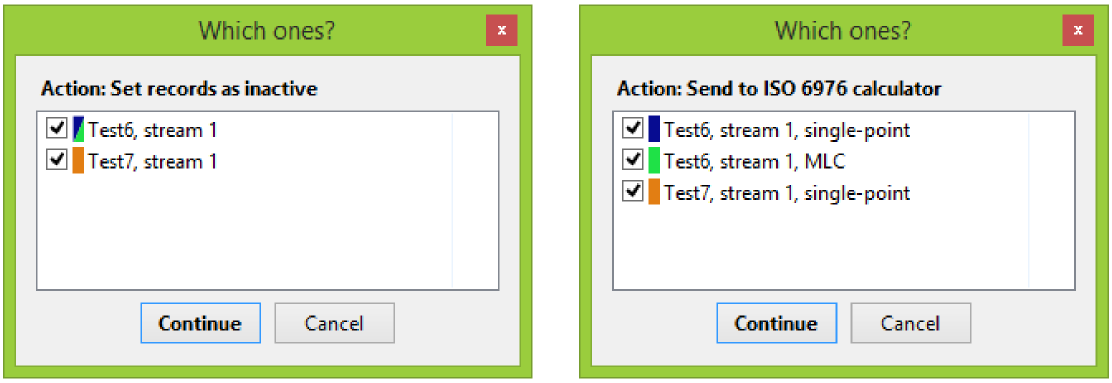
These menus are available if the form is in selection mode and there is a selection area. Unlike Data Analysis, Mole Composition Comparison requires the selection area to be *contiguous*, that is, no record (dots on chart) jumping out from selection rectangle then return back inside. If your selection area is not contiguous, GCAS will alert you and propose a corrected selection area. Nonetheless if you disagree with the new selection area, click Cancel on the message box.



Menu	Function
Zoom In Here	Zooms in to the selection area.
Generate Summary Here	Generates statistical summary for the selected area.
Frame This Selection	Literally puts a rectangular frame around the selection, for presentation purpose. This works on the average chart too.
Remove Frames	Deletes all frames created through *Frame This Selection* menu.
Set These Records as Inactive	Sets all records within the X-axis range of the selection area as inactive. GCAS displays an additional dialogue if your selection area covers several devices/stream numbers.
Send to ISO 6976 Calculator (Selection Averaged)	This menu requires *ISO 6976 Calculator* in GCAS licence. It sends the averaged mole composition value of all gases of all records contained inside the selection area to ISO 6976 Calculator. As the chart has only one gas, the entire data table is reloaded from the database. GCAS displays an additional dialogue if your selection area covers several devices/stream numbers.
Send to ISO 6976 Calculator (Entire X-axis Averaged)	This menu requires *ISO 6976 Calculator* in GCAS licence. It sends the averaged mole composition value of all gases of all records in the entire X-axis. Actually, it doesn't even need a selection area. GCAS displays an additional dialogue if you have more than one comparison entry in the comparison list.
Send to GPA 2172 Calculator (Selection Averaged)	This menu requires *GPA 2172 Calculator* in GCAS licence. It sends the averaged mole composition value of all gases of all records contained inside the selection area to GPA 2172 Calculator. As the chart

	has only one gas, the entire data table is reloaded from the database. GCAS displays an additional dialogue if your selection area covers several devices/stream numbers.
Send to GPA 2172 Calculator (Entire X-axis Averaged)	This menu requires *GPA 2172 Calculator* in GCAS licence. It sends the averaged mole composition value of all gases of all records in the entire X-axis. Actually, it doesn't even need a selection area. GCAS displays an additional dialogue if you have more than one comparison entry in the comparison list.
Send to ISO 6976 / GPA 2172 Trend Comparison	This menu requires *ISO 6976 Trend* or *GPA 2172 Trend* in GCAS licence. It loads the ISO 6976/GPA 2172 Trend Comparison form and instructs the form to compare ISO 6976 or GPA 2172 values based on the mole composition records contained inside the selection area. Contrast to Send to ISO 6976/GPA 2172 Trend Comparison button, this menu transmits the X-axis range of selection area rather than the entire plot range.

These menus **Set These Records as Inactive**, **Send to ISO 6976 Calculator** (plus the GPA 2172 counterpart), and **Send to ISO 6976/GPA 2172 Trend Comparison** may trigger a further confirmation if your selection area covers more than one device or one stream. Please confirm which device(s)/stream number(s) to have their records set as inactive or be sent to ISO 6976 Calculator, GPA 2172 Calculator, or to ISO 6976/GPA 2172 Trend Comparison tool. Setting as inactive merges two comparison entries having same device, same stream number, but different stream conversion option.

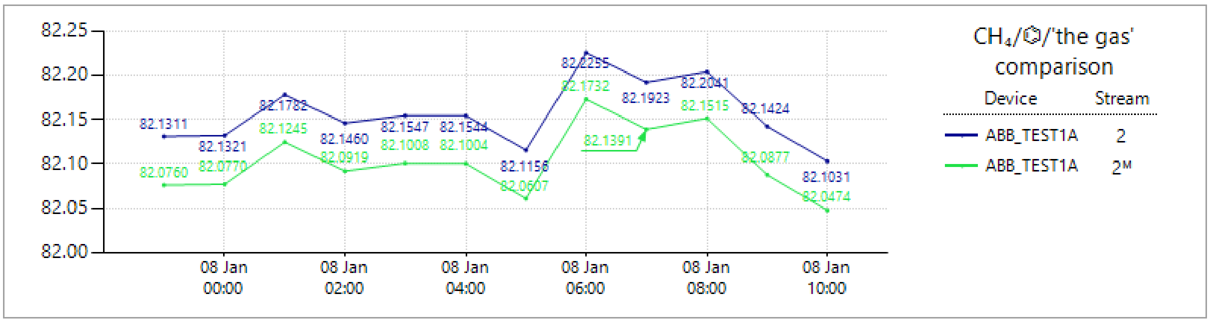


Confirmation dialogue boxes. Tick which device(s)/stream(s) then click Continue.

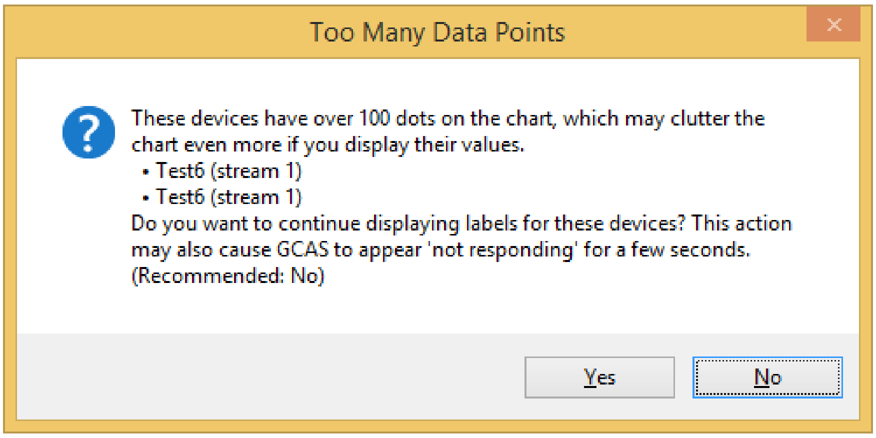
GCAS opens as many ISO 6976 Calculator or GPA 2172 Calculator forms as necessary and sets their descriptions accordingly, so you know which is which.

18.3.9 Other Visual Cues

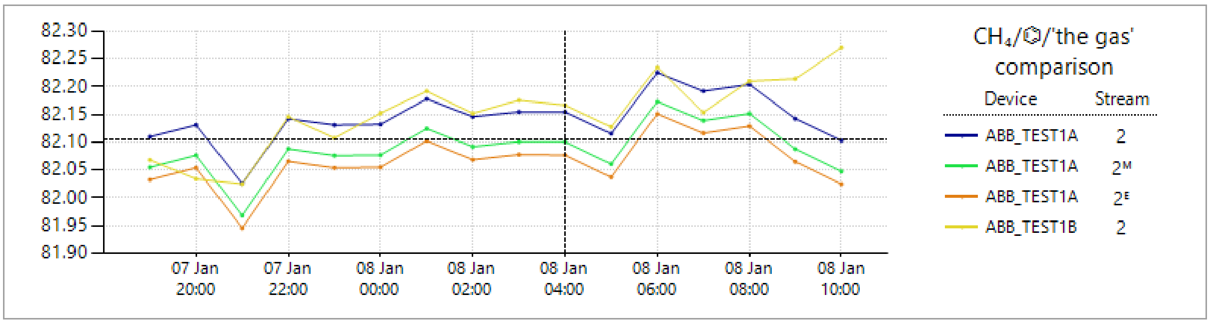
Click **Show values** or right click the chart and select **Show Values** to display the mole composition values.



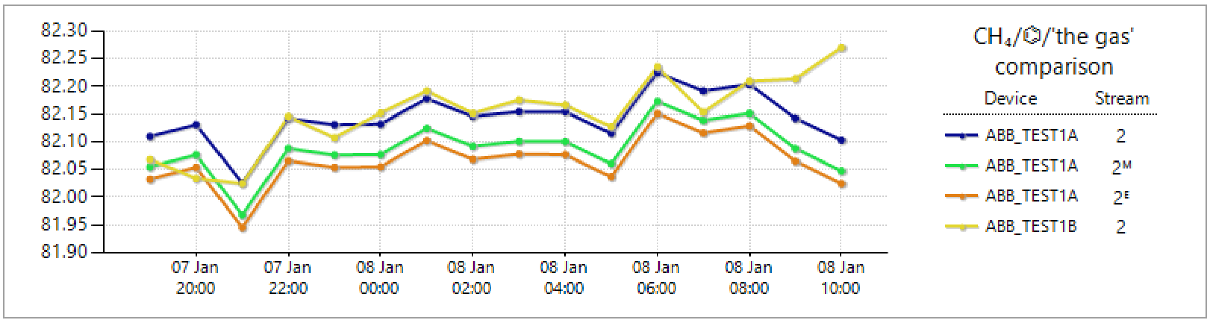
GCAS prompts a warning if one or more devices have over 100 dots on the chart. We do not recommend displaying value labels on line charts with over 100 dots because it will clutter the chart area. Nevertheless, you can choose to continue displaying labels despite the 100+ dots, just be informed that GCAS may appear 'not responding' for a while because the layout engine of the chart is busy.



These dashed lines are called *cursors*. Cursors appear when you click on a chart or as a remnant of zoom operation. Cursor may act as a guide to compare Y-axis values of two data points. Click **Hide crosshair cursors** or right click on a chart and select **Hide Crosshair Cursors** to hide these lines from view.

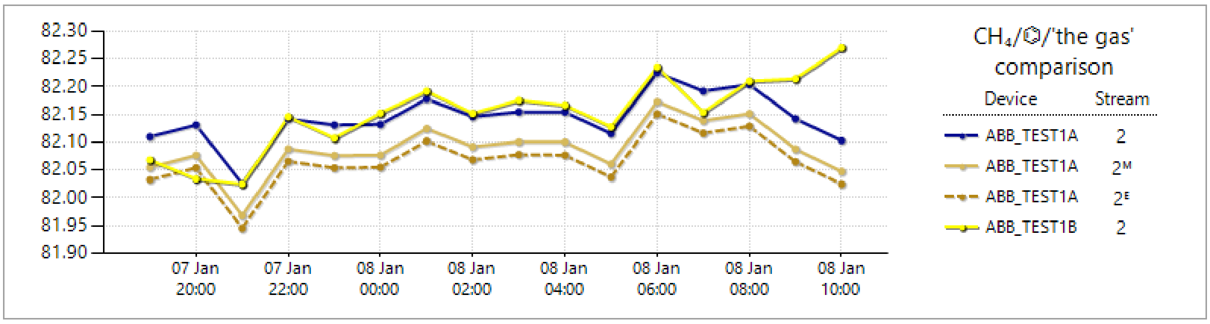


By default, GCAS draws the chart using a thin line. The toggle button **Use thin line** is pressed. If you prefer the usual thick lines, click this button to raise it from its pressed state.



18.3.10 Colourblind Assistance

To aid users with colour blindness (protanopia and deuteranopia), GCAS provides an alternative colour scheme for the chart. Use the **Colourblind assist** button to switch colour scheme.



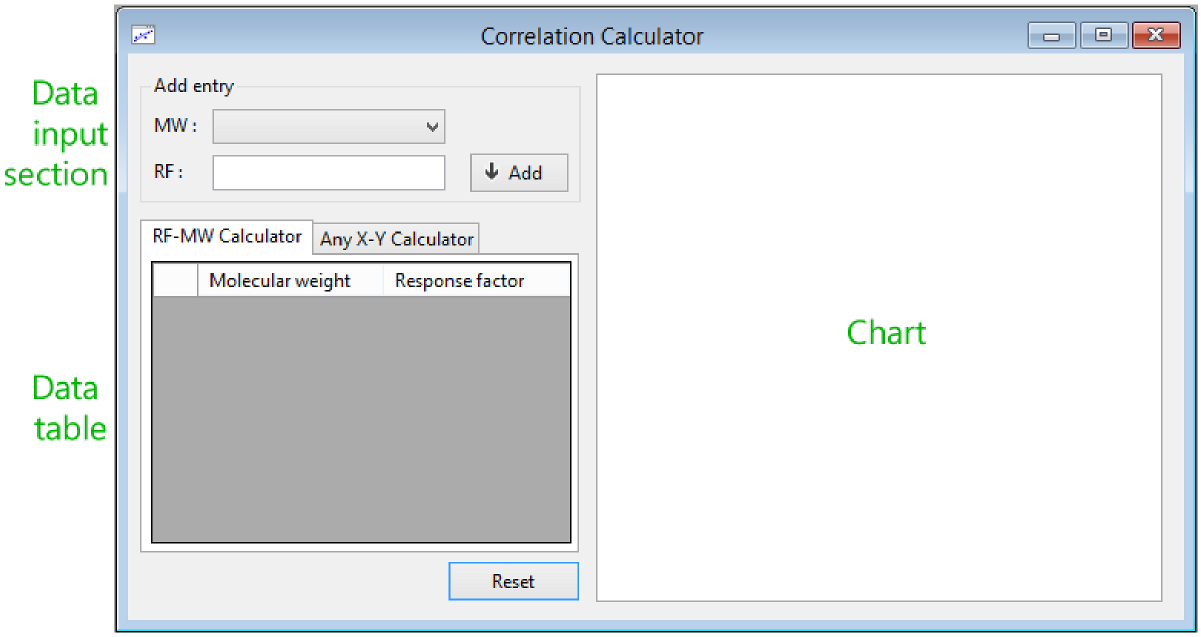
Alternative colour scheme when colourblind assist is turned on.
Colourblind assistance works better with thick lines like in this screenshot.

19 Correlation Calculator

Correlation Calculator is a tool to find the R^2 (correlation) value for arbitrary number of data. Footprint and Calibration Data already calculated R^2 value of the calibration record, however they follow a certain order of components/gases for each GC device type. If you need to calculate the correlation value without following those rules, use this Correlation Calculator tool instead. This tool does not only calculate RF-MW correlation like those in Footprint or Calibration Data, but also calculates correlation of any *x* and *y* number pair.

19.1 The Correlation Calculator Form

To open Correlation Calculator, go to the Tools menu > **Correlation Calculator**. Correlation Calculator can also be opened through *Send to* shortcut, such as from Footprint or Calibration Data or from Data Analysis. This Correlation Calculator form has three sections which are data input section, data table section, and chart section.



This calculator has two modes, named *RF-MW Calculator* and *Any X-Y Calculator*. The first mode calculates the correlation value for the given pairs of RF (response factor) and MW (molecular weight). On the other side, *Any X-Y Calculator* computes the correlation value for the given pairs of arbitrary X and Y values. Use this mode if you need the X-axis to be something other than the logarithm of molecular weight.

The active tab on the data table section indicates current active mode. Switch tab to change mode.

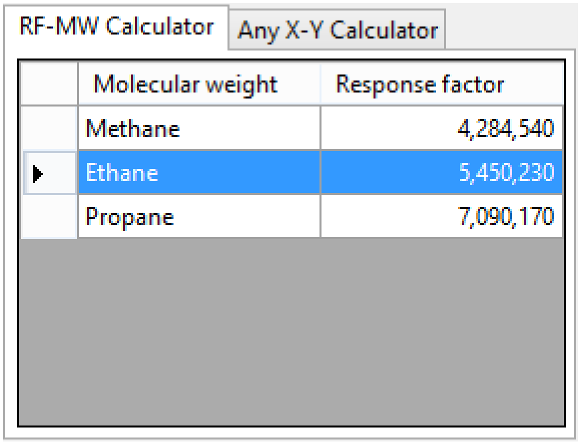
19.2 RF-MW Calculator

Switch to *RF-MW Calculator* tab on the data table section. This would change the data entry section to the screenshot below.

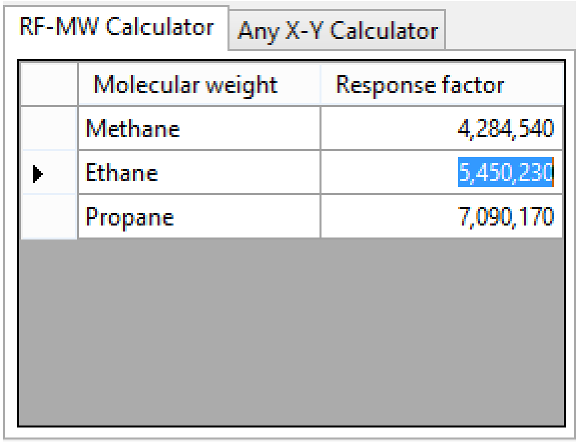
Add a new entry by selecting the desired gas from the *MW* (molecular weight) dropdown, and type its response factor value in the *RF* text box. Click ↓ **Add** to insert this entry into data table. This entry is also graphed on the chart immediately.

> **Note**
>
> You cannot add the same gas more than once. Should the selected gas has existed in the data table section, GCAS presents a warning message.
>
> You cannot put negative number in response factor entry field because logarithm of negative numbers is undefined.

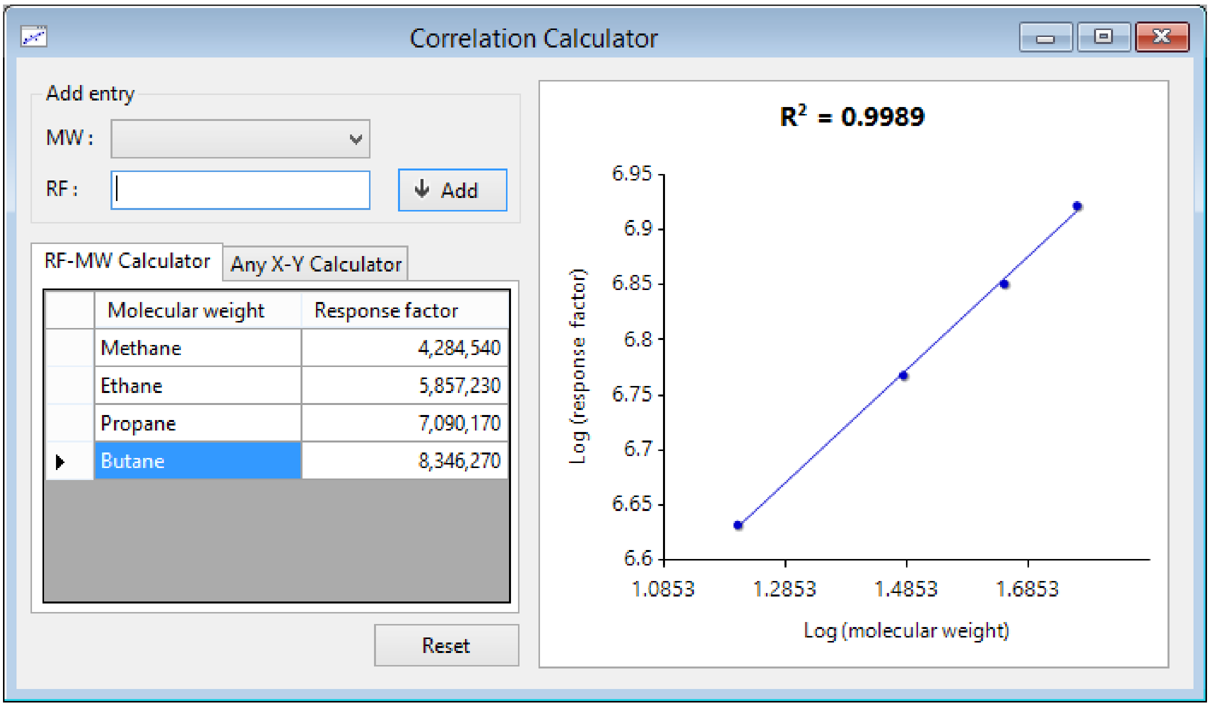
To remove one or more entries, click row header(s) to highlight data row(s) you wish to delete. Next, press `Delete` on your keyboard. The corresponding dot(s) on the chart will disappear as well.



You can edit the response factor value should a mistake happened. Double click the response factor cell, enter the correct value, then press `Enter` to commit. The corresponding dot on the chart shall move upwards or downwards according to the new response factor value.



Whenever there are minimum **three** entries in data table, GCAS computes the regression line and calculates their correlation. The R^2 value is displayed at the top of the chart. Regression line and R^2 value are also updated after changes of existing RF values are committed. If you remove several entries leaving less than three in data table, both regression line and R^2 value disappear from the chart.

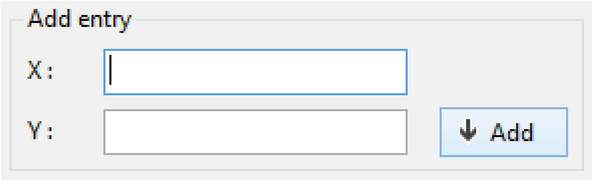


Note

Correlation data sent from Data Analysis' context menu *Send to Correlation Calculator* may include gases with non-relatable correlation such as i-butane, i-pentane, nitrogen, and carbon dioxide. GCAS displays these gases as red dots in the R^2 chart, indicating they should be removed.

19.3 Any *X-Y* Calculator

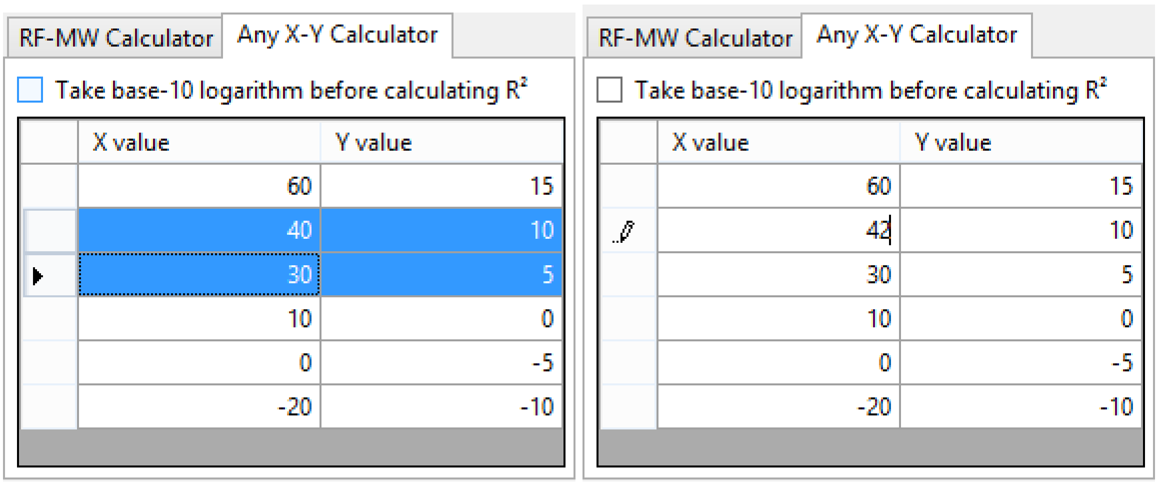
Switch to *Any X-Y Calculator* tab on the data table section. This would change the data entry section to the screenshot on the next page.



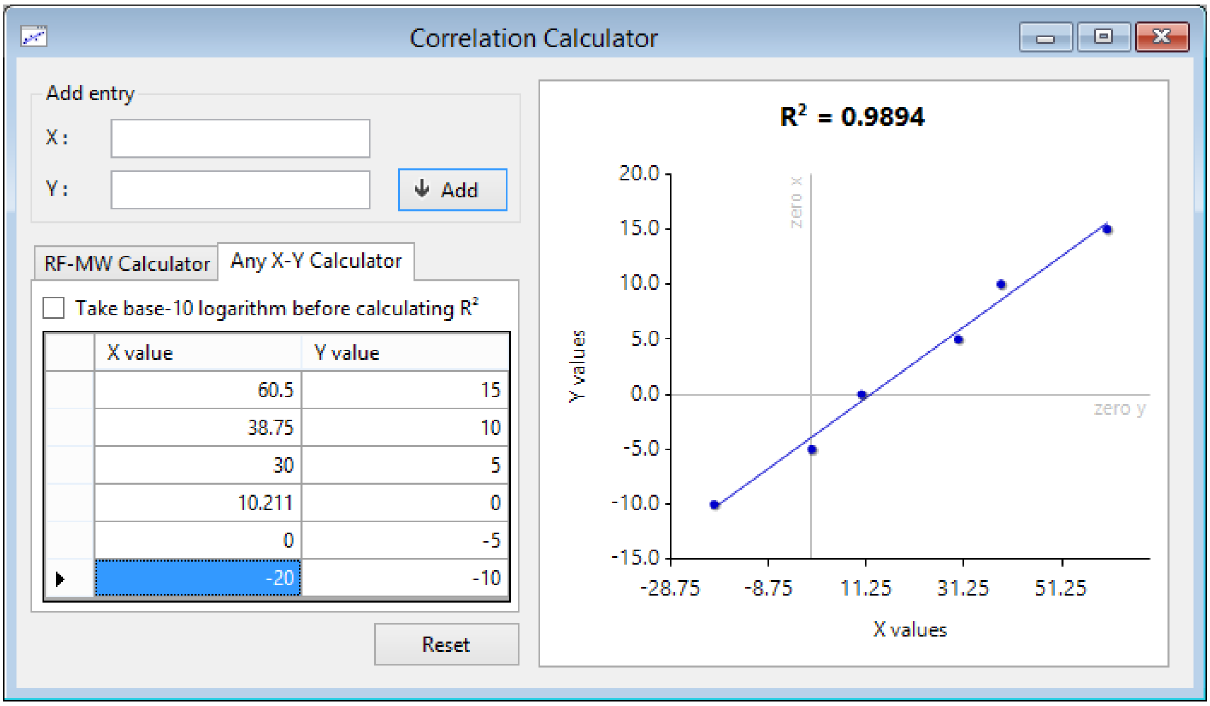
Unlike [RF-MW calculator](), here you can enter literally *any* real numbers for X and Y values. Click **Add** to insert this entry into data table. This entry is also graphed on the chart immediately.

> **Note**
>
> If you need to find the correlation of the *logarithm* of X and Y instead of just X and Y, visit the next chapter Any log(X)-log(Y) calculator.

Similar to RF-MW Calculator, to delete one or more entries you need to highlight the row(s) and then press `Delete` on your keyboard. In addition, to edit the X value or Y value, double click on the corresponding cell to enter edit mode. Press `Enter` on your keyboard to commit the change and to update the chart.



As soon as there are **three** entries or more, GCAS calculates the regression line and correlation value. This chart updates automatically if there are entries removed or edited.



19.4 Any log(X)-log(Y) Calculator

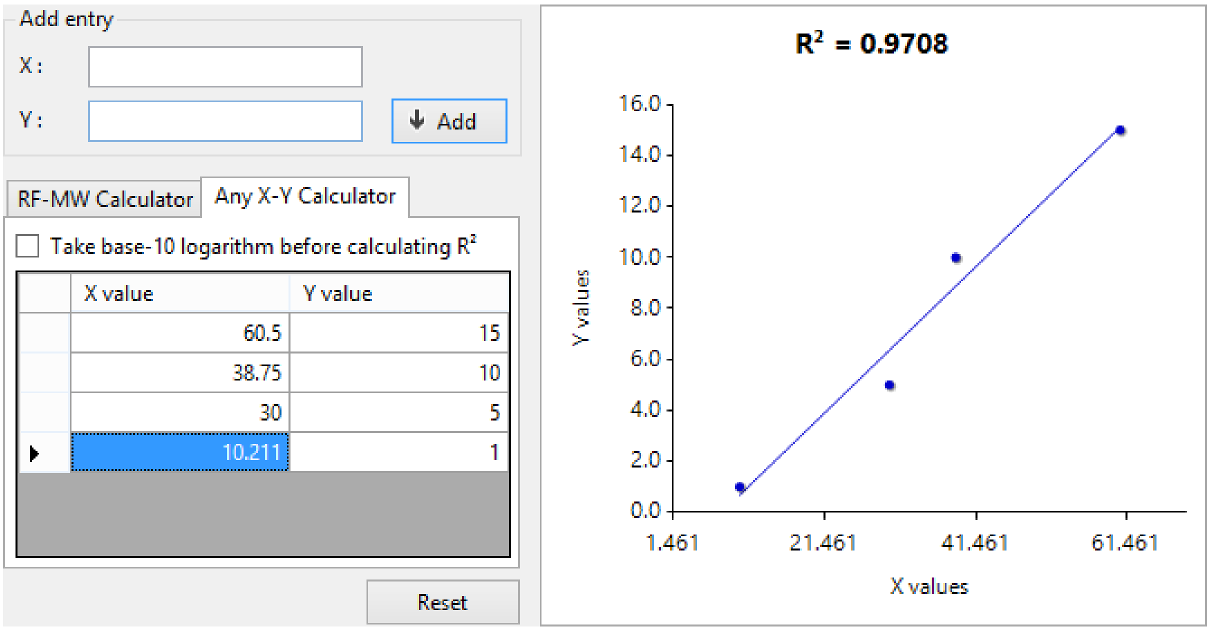
Any X-Y Calculator has another option calculate the correlation of ^{10}log X (base-ten logarithm of X) against ^{10}log Y, instead of just X against Y. To use this option, switch the Correlation Calculator to *Any X-Y Calculator* mode, then begin entering pairs of X and Y values as usual.

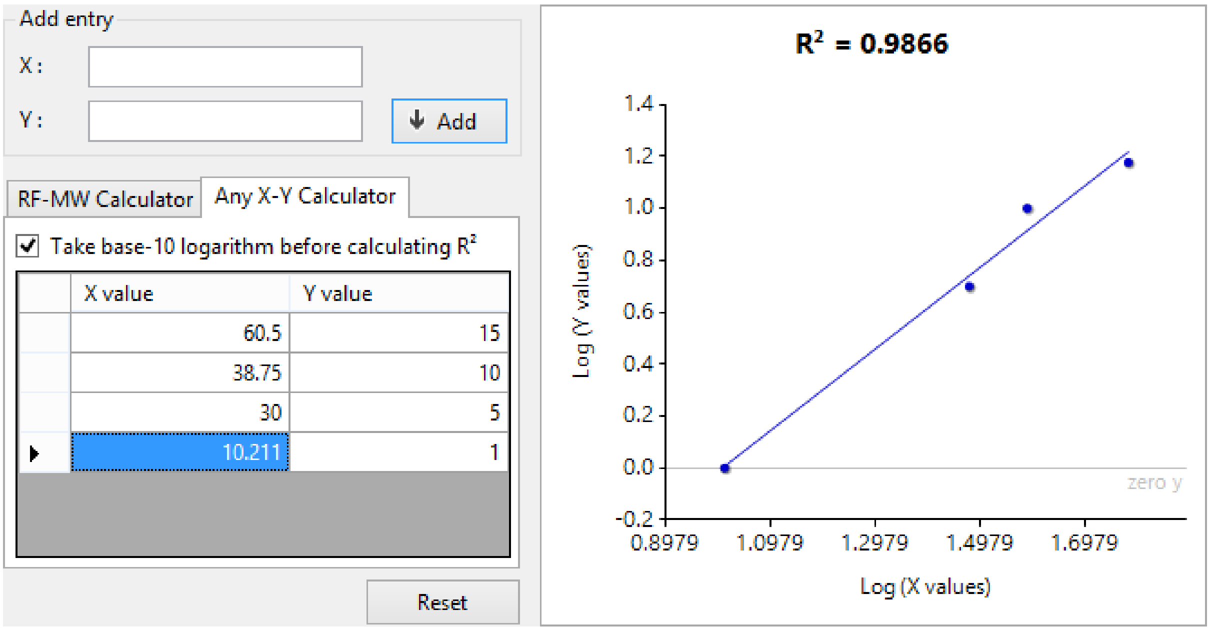
When you are done, tick the check box **Take base-10 logarithm before calculating R^2**. GCAS computes the logarithm of both X and Y value in each pair, updates the chart, and finally recalculates the regression line and the correlation (R^2 value).

Note

This time, do not enter zero or negative numbers in any X values or any Y values. Logarithm of 0 yields negative infinity and is not graphable. Logarithm of negative numbers are undefined. If GCAS encounters zero, it will change it to one (1). If GCAS finds a negative number, GCAS replaces it with the absolute value of that number.

Unticking the check box will revert this calculator tool to the regular *Any X-Y Calculator* mode.





Difference between regular X-Y correlation (top) and logarithmic X-Y correlation (bottom).

20 ISO 6976 Calculator

ISO 6976 Calculator is a tool to calculate the calorific value (CV), molar mass composition, Wobbe index, relative density, and standard density of any given mole composition, as defined by ISO 6976:1995 standard.

> **Note**
>
> To use ISO 6976 Calculator, you need the GCAS feature *ISO 6976 Calculator* in your GCAS licence.

ISO 6976 calculation takes four inputs:

1. Mole composition,
2. Base pressure,
3. Combustion temperature,
4. Metering (base) temperature.

Mole composition input may come from a manual input or an existing record. ISO 6976 Calculator treats the input composition as *unnormalised* so it will normalise them before performing calculation; **except in BTEX and single gas mode**. BTEX compositions are usually trace value (in ppm scale) acting as residual components from the normal alkane gases. Single gas devices just read one gas so it is meaningless to normalise its composition because it will end up in 100%.

> **Note**
>
> To force GCAS to always normalise input composition even it is BTEX or single gas, run GCAS with additional **/normaliseISO6976** switch.

Base pressure is typically the atmospheric pressure (1 atm or 101,325 Pa). GCAS support six pairs of combustion and metering temperature:

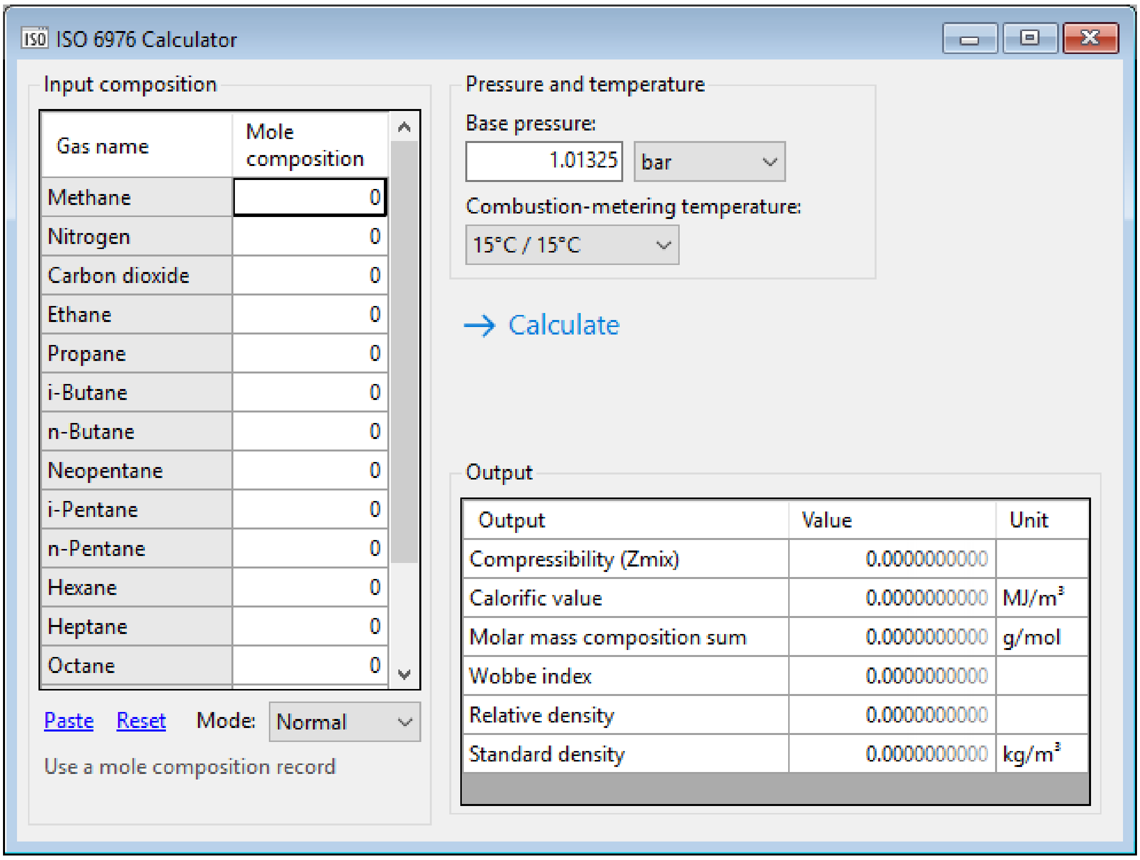
- 0°C / 0°C
- 15°C / 0°C (combustion temperature = 15°C, base temperature = 0°C)
- 25°C / 0°C
- 15°C / 15°C (the default)
- 20°C / 20°C
- 25°C / 20°C

20.1 The ISO 6976 Calculator Form

There are multiple ways to open ISO 6976 Calculator form:

1. For one-time offline calculation: Go to the **Tools** menu on GCAS main window and then select **ISO 6976 Calculator**. Through this menu, you will enter the mole composition *by hand* (manual input) or through copy-and-paste.

2. Sent by Mole Composition form. Open the desired mole composition record, go to the Action menu, and select **Send to ISO 6976 Calculator**. If you have GCAS feature *ISO 10723*, choose which one to send either the single-point or the MLC. If your device is ABB, you have the option to send exponential composition as well. Through this method, ISO 6976 Calculator form uses the selected mole composition record.
3. Sent by Calibration Gas Certificate. Open the desired calibration gas certificate, go to the Action menu, and select **Send to ISO 6976 Calculator**. By this way, ISO 6976 Calculator form uses the mole percentage portion of the selected calibration certificate.
4. Sent by Data Analysis. Graph some mole composition trend, put the Data Analysis form in selection mode, drag a selection rectangle, then right click the chart, and select **Send to ISO 6976 Calculator**. Records inside the selection area are averaged and then sent to ISO 6976 Calculator form.
5. Sent by Mole Composition Comparison. Load a range of records, then right click the comparison chart, and select either **Send to ISO 6976 Calculator (Selection)** or **Send to ISO 6976 Calculator (Entire X-axis)**. The former requires a selection area while the latter doesn't. You may need to confirm which device(s)/stream(s) to be sent to ISO 6976 Calculator.



The grid on the left is the mole composition input. Grey cells are not editable. Depending on the selected **mode** down there, the grid contains either one gas, 4 aromatic gases, or all 15 gases from methane to decane including neopentane. Default mode is **normal** which puts ISO 6976 Calculator to accept alkane gases. These two modes **H_2S** and **H_2O** are essentially the same (single gas), but the gases have different molar mass that would affect the final ISO 6976 calculation.

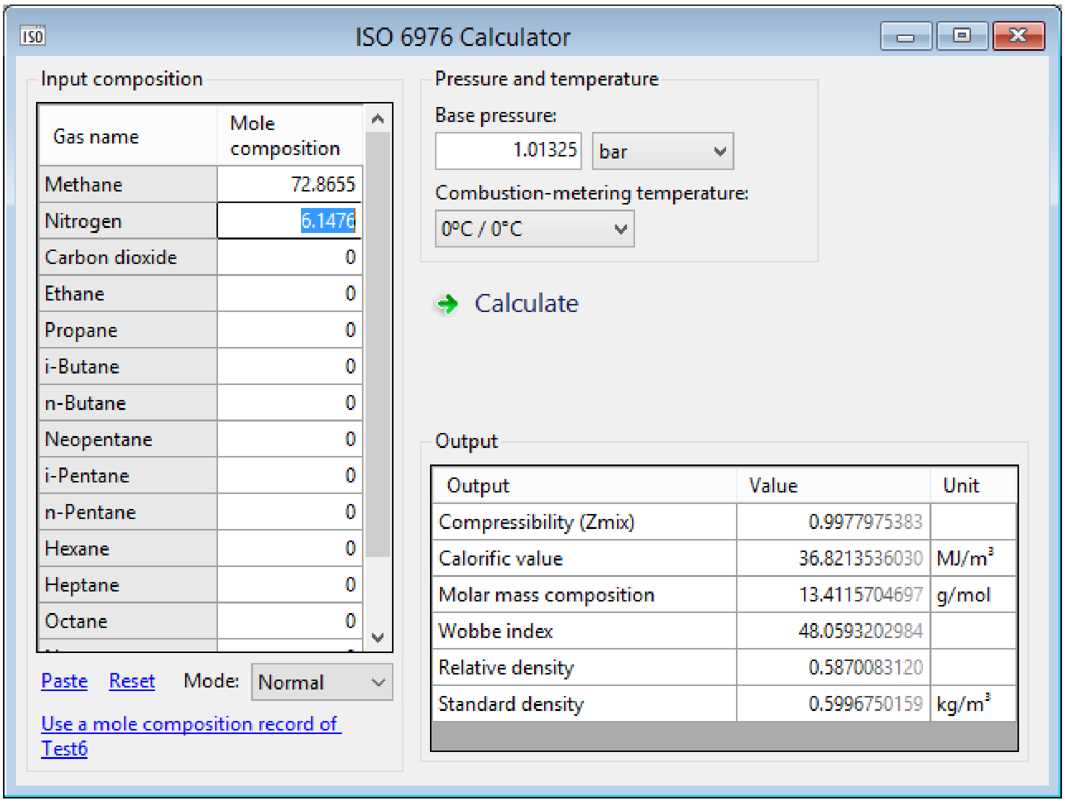
At the top centre region of the form, set the base pressure and combustion-metering temperature pair. When all inputs are correct, click **Calculate**. Calculation results are displayed on the grid at the bottom region. In addition of five properties of ISO 6976 standard, the calculator also displays the compressibility factor (Z) of the input composition.

20.2 Ways to Enter Composition

Input composition can come from a manual input, copy-and-paste, or an existing record.

20.2.1 Manual Input

Go to the input composition grid. Press F2 or double click the cell to invoke edit mode. There is *total* row at the bottom of the grid which updates every time you finish editing a cell. You might need to scroll the grid or resize the form.



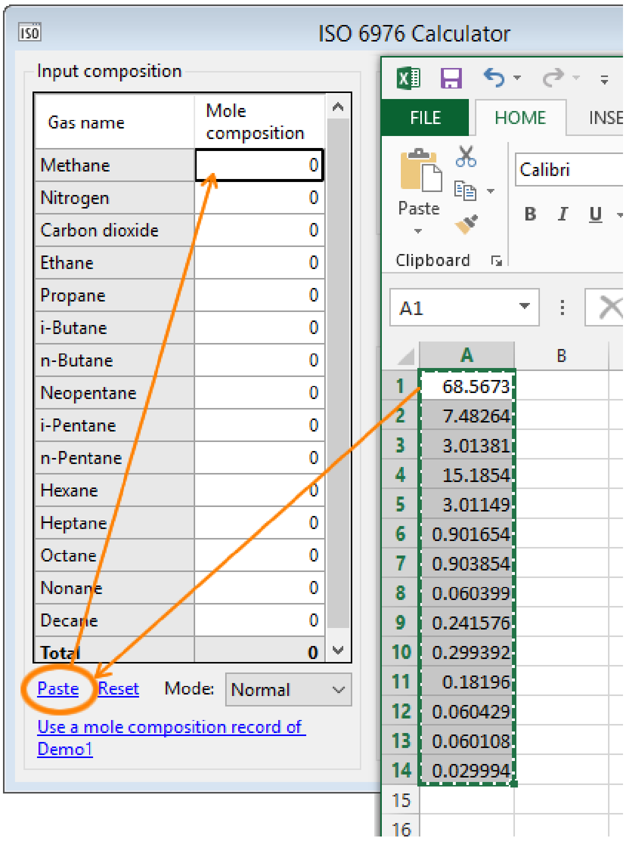
Take care about the gases your GC device doesn't read. For example, a C7+ device has no octane, nonane, and decane. Some GC devices do not read neopentane too. Set the composition of these un-available gases to zero.

Click **Reset** to reset all numbers back to zero.

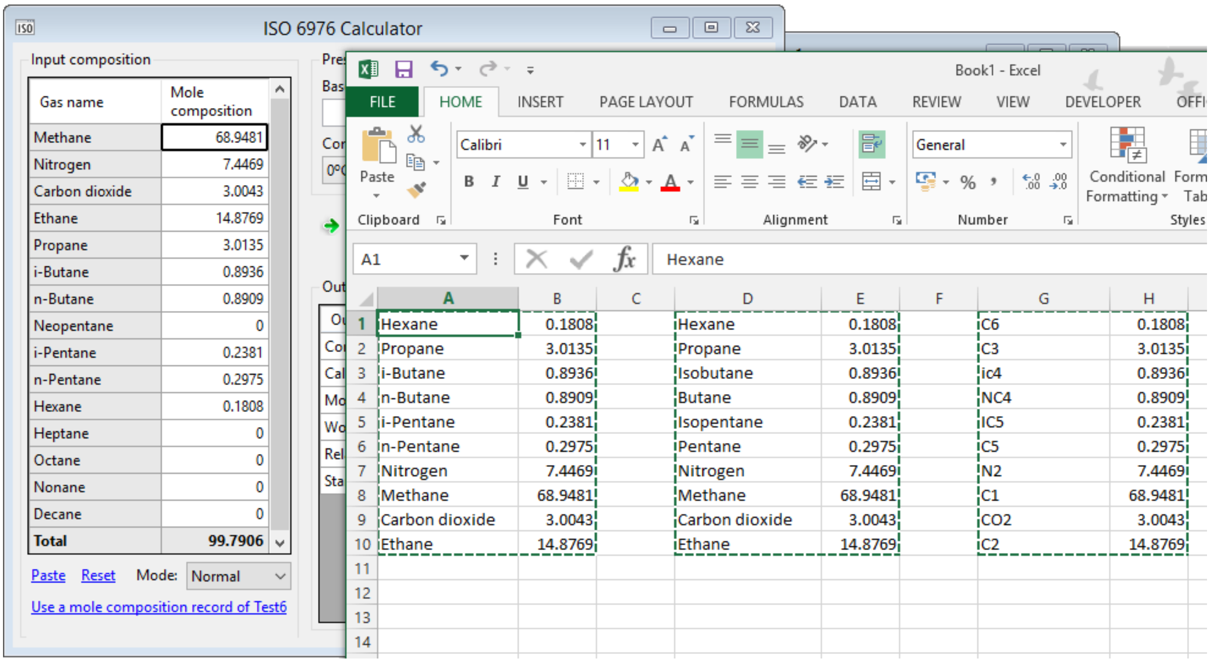
20.2.2 Normal Paste and Smart Paste

Copy a block of cells from Microsoft Excel or your favourite spreadsheet processing software, then click **Paste** at ISO 6976 Calculator form. If your block of cells has one column, GCAS processes a normal paste. If it has two, GCAS processes a smart paste.

Normal paste is like the Paste button on Microsoft Excel; it pastes the cells sequentially. Some safeguards implemented are cells containing non-number like alphabets will translate into zero, and negative numbers are converted into positive.



Smart paste works for two-column data. First column must be the gas name. Second column is the value. The good thing is, you don't have to worry about gas order as GCAS will reorder the gases into the correct sequence. GCAS recognises standardised gas names (e.g. "Methane", "Benzene", "i-Butane") as well as some well-known names (e.g. "Isobutane", "Pentane"—translated as normal pentane or n-Pentane), and even their acronyms. Gas names are not case-sensitive. Having said that, these three blocks of cells on the next page will work.



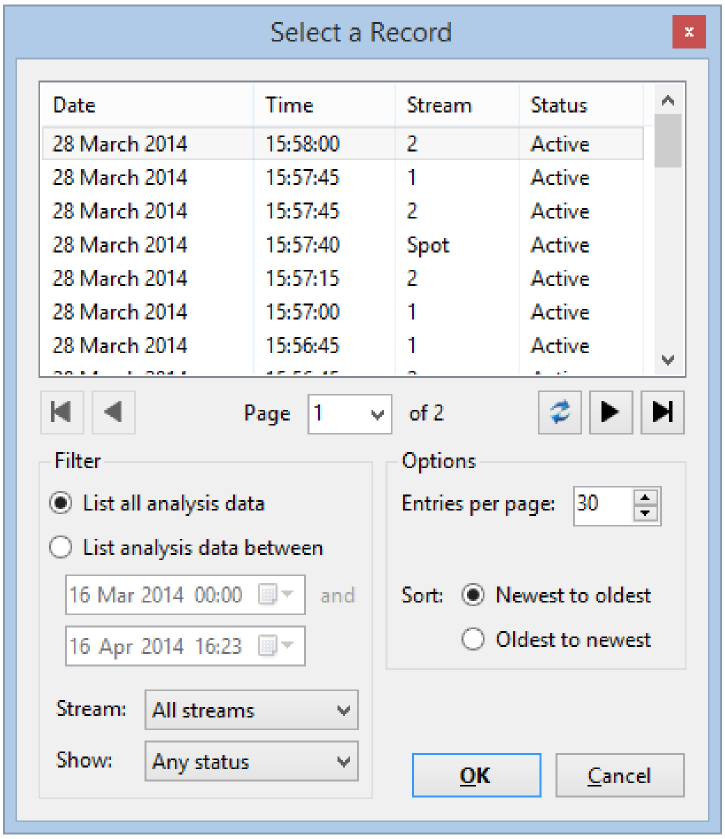
20.2.3 Load a Mole Composition Record

To use a mole composition record, we have two methods. Both require *Live Data Analysis* feature in your GCAS licence.

First method as already described in chapter 8.10: Open a Mole Composition form, go to the Action menu, and select **Send to ISO 6976 Calculator**.

Second method is described as the following.

1. Go to the Tools menu > ISO 6976 Calculator on GCAS main window.
2. While ISO 6976 Calculator window is open, select the device from your device panel or recent device panel.
3. Look under the input grid. Click **Use a mole composition record of <*device name*>**. The <*device name*> follows the actual device you are selecting, and is updated whenever you change the selected device on main window.
4. That link opens a *Select Record* dialogue. Pick a record and click **OK**.

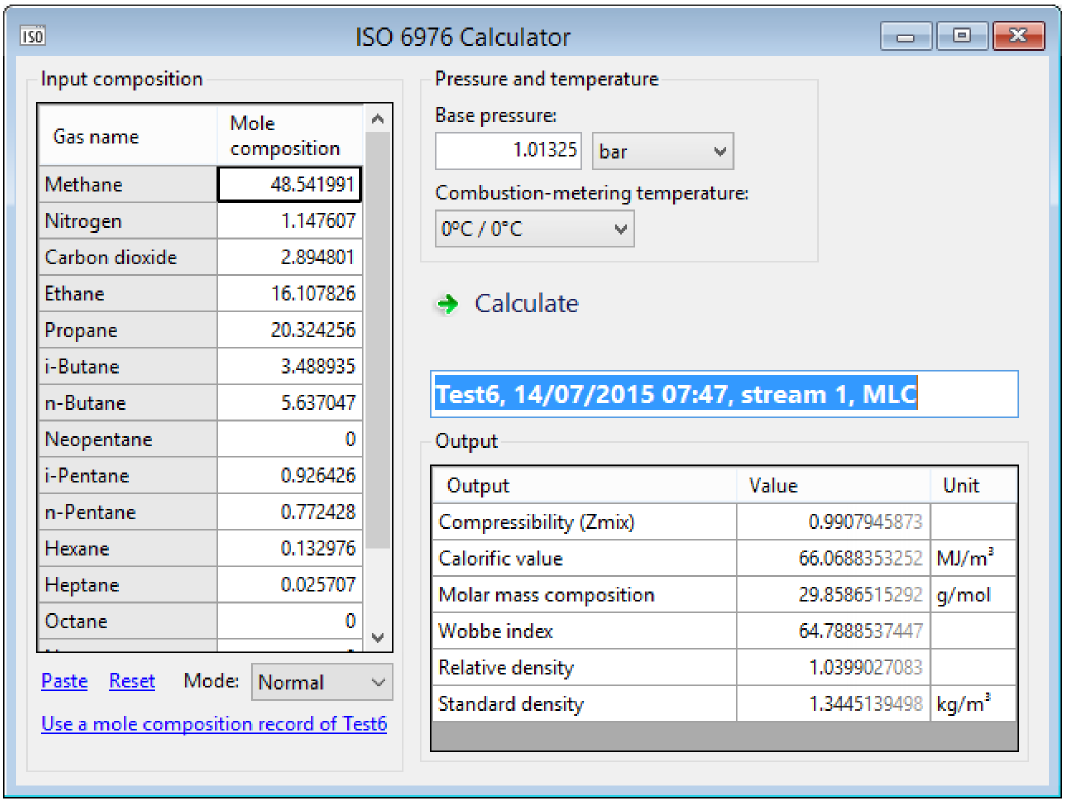


20.2.4 Load a Calibration Certificate

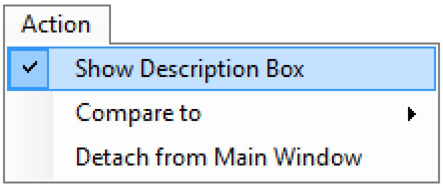
Open a Calibration Gas Certificate form, browse to the desired certificate, then go to the Action menu and select **Send to ISO 6976 Calculator**. The ISO 6976 Calculator form shall load the mole percentage portion of the calibration certificate.

20.3 Add Description

Description is an optional text for presentation purpose only. When there are multiple ISO 6976 Calculators open at the same time, add a text description to each of them hence you can easily identify which is which.



Open the Action menu and select **Show Description Box**. This reveals a text box above the output section of the form. Enter any description to this text box. To hide this text box, open the Action menu and clear the check mark on **Show Description Box**.

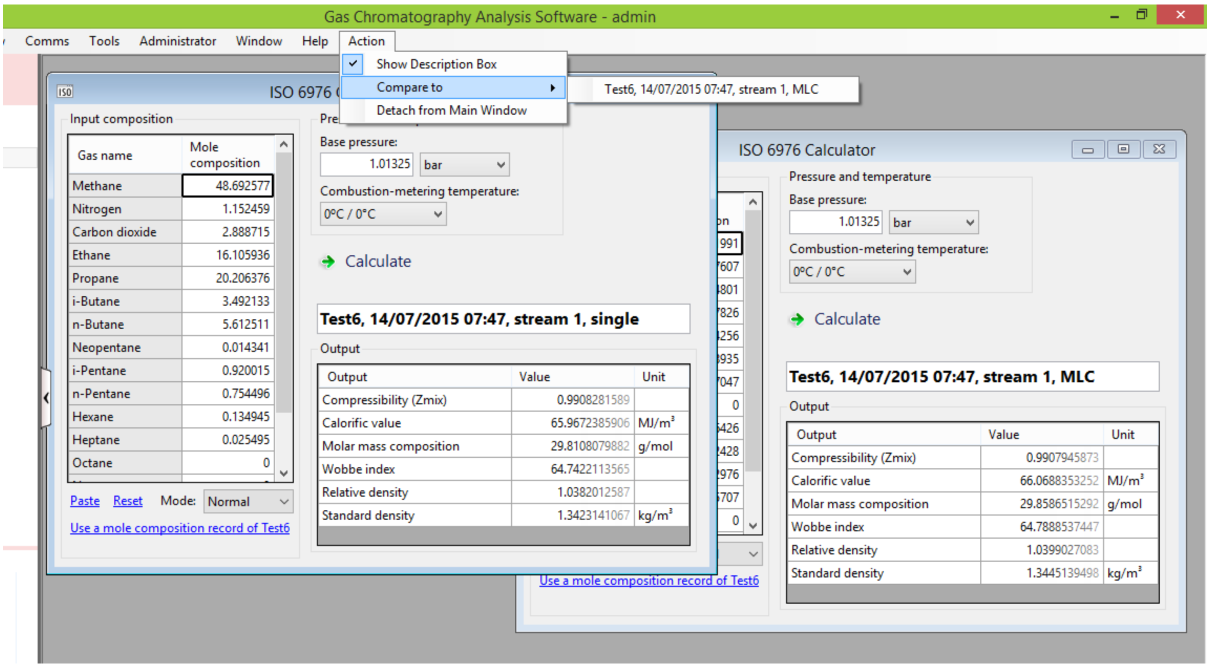


Description text is used when you are switching windows through the *Window* menu on the main menu bar, and when you are comparing two ISO 6976 Calculators. GCAS automatically fills the description text for cases where ISO 6976 Calculator is opened through a *Send to* shortcut from Data Analysis or Mole Composition Comparison.

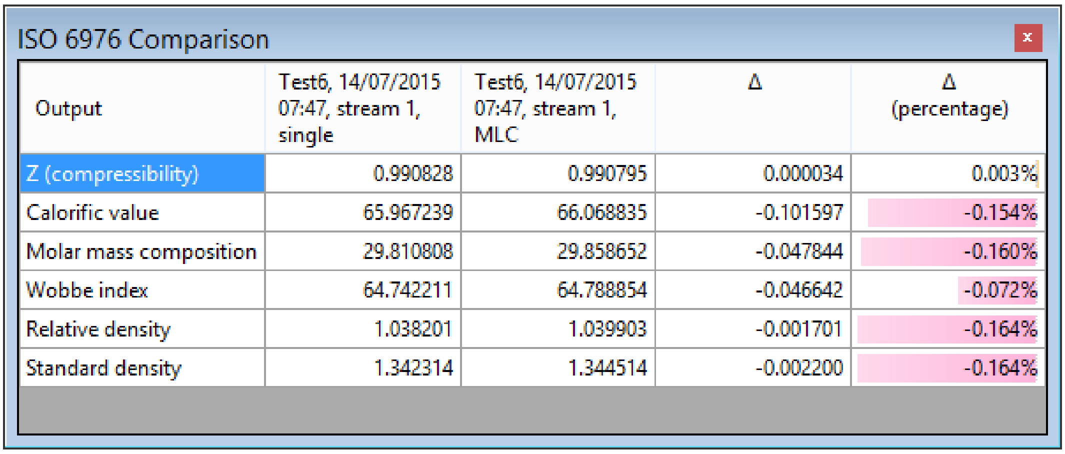
20.4 Compare Two ISO 6976 Calculators

Ever wondered how much is the difference of CV between two ISO 6976 Calculators? Wonder no more. Starting from GCAS version 1.7.3.0, ISO 6976 Calculator has been equipped with a comparison tool. Probably the most common use for comparing two ISO 6976 results is when you are calculating how much the CV difference is between single-point mole composition stream and its multilevel-calibration counterpart.

To make a comparison, first add description to each ISO 6976 Calculator form you wish to compare. Next, go to the Action menu and select **Compare to**, then choose the target ISO 6976 Calculator form which appeared on the submenu. If you didn't add description, the submenu simply says "`(no description)`". It will become problematic if there are three or more ISO 6976 Calculators open and none of them has description.



This is the *ISO 6976 Comparison* form. It compares all ISO 6976 outputs between the two calculator forms. Left column is the ISO 6976 Calculator which initiated comparison, let's call it A. The right column is the ISO 6976 Calculator selected as comparison target, let's call it B. Then you get the delta (difference) which is A minus B, and finally the delta expressed in percentage relative to A. Units in ISO 6976 Comparison form follows the ISO 6976 Calculator, like the CV is still in MJ/m³.


ISO 6976 Comparison

Output	Test6, 14/07/2015 07:47, stream 1, single	Test6, 14/07/2015 07:47, stream 1, MLC	Δ	Δ (percentage)
Z (compressibility)	0.990828	0.990795	0.000034	0.003%
Calorific value	65.967239	66.068835	-0.101597	-0.154%
Molar mass composition	29.810808	29.858652	-0.047844	-0.160%
Wobbe index	64.742211	64.788854	-0.046642	-0.072%
Relative density	1.038201	1.039903	-0.001701	-0.164%
Standard density	1.342314	1.344514	-0.002200	-0.164%

GCAS displays a warning if the two ISO 6976 Calculators did not have the same base pressure and combustion-metering temperature pair. Correct the mistake in the ISO 6976 Calculator (parent) form, click **Calculate** on the parent form to recalculate using the new pressure or temperature value, and finally click **Refresh** on ISO 6976 Comparison to re-compare.

ISO 6976 Comparison

⚠ These two have different combustion/metering temperatures. Refresh

Output	Test6, 14/07/2015 07:47, stream 1, MLC	Test6, 14/07/2015 07:47, stream 1, single	Δ	Δ (percentage)
Z (compressibility)	0.992355	0.990828	0.001527	0.154%
Calorific value	62.445218	65.967239	-3.522021	-5.640%
Molar mass composition	29.858652	29.810808	0.047844	0.160%
Wobbe index	61.278440	64.742211	-3.463771	-5.653%
Relative density	1.038444	1.038201	0.000242	0.023%
Standard density	1.272519	1.342314	-0.069795	-5.485%

21 GPA 2172 Calculator

GPA 2172 Calculator is a tool to calculate gross heating value (GHV) and relative density of any given mole composition, as defined by GPA 2172-09 standard. GPA 2172 is more commonly used in North America while other regions use ISO 6976.

> **Note**
>
> To use GPA 2172 Calculator, you need the GCAS feature *GPA 2172 Calculator* in your GCAS licence.

Unlike ISO 6976, GPA 2172 calculation takes two inputs:

1. Mole composition,
2. Reference pressure.

In addition, GPA 2172 is **not applicable for BTEX devices, moisture analysers, and single gas analysers that are not H_2S**. The mole composition input is treated as *unnormalised* so it will normalise them before performing calculation, **except for H_2S devices** which is left unnormalised.

> **Note**
>
> To force GCAS to always normalise input composition, run GCAS with additional **/normaliseGPA2172** switch.

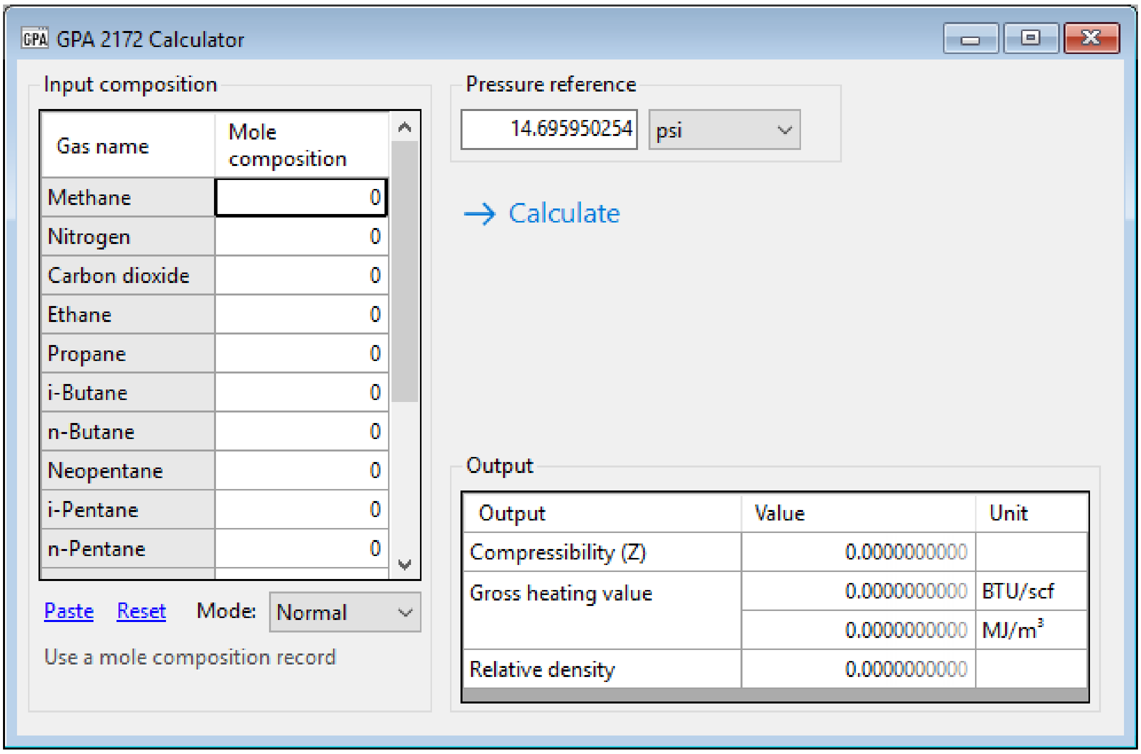
Reference pressure is typically the atmospheric pressure expressed in pounds per square inch (14.69595 psi). In case a GCAS module has both ISO 6976 and GPA 2172 calculation, both ISO 6976 *base pressure* and GPA 2172 *reference pressure* are combined into one input field. GPA 2172 does not have temperature input as it always assumes 60°F (15.55°C).

21.1 The GPA 2172 Calculator Form

Similar to ISO 6976 Calculator form, there are multiple ways to open GPA 2172 Calculator form.

5. For one-time offline calculation: Go to the **Tools** menu on GCAS main window and then select **GPA 2172 Calculator**. Through this menu, you will enter the mole composition *by hand* (manual input) or through copy-and-paste.
6. Sent by Mole Composition form. Open the desired mole composition record, go to the Action menu, and select **Send to GPA 2172 Calculator**. If you have GCAS feature ISO 10723, choose which one to send either the single-point or the MLC. If your device is ABB, you have the option to send exponential composition as well. Through this method, GPA 2172 Calculator form uses the selected mole composition record.
7. Sent by Calibration Gas Certificate. Open the desired calibration gas certificate, go to the Action menu, and select **Send to GPA 2172 Calculator**. By this way, GPA 2172 Calculator form uses the mole percentage portion of the selected calibration certificate.

8. Sent by Data Analysis. Graph some mole composition trend, put the Data Analysis form in selection mode, drag a selection rectangle, then right click the chart, and select **Send to GPA 2172 Calculator**. Records inside the selection area are averaged and then sent to GPA 2172 Calculator form.
9. Sent by Mole Composition Comparison. Load a range of records, then right click the comparison chart, and select either **Send to GPA 2172 Calculator (Selection)** or **Send to GPA 2172 Calculator (Entire X-axis)**. The former requires a selection area while the latter doesn't. You may need to confirm which device(s)/stream(s) to be sent to GPA 2172 Calculator.



The grid on the left is the mole composition input. Grey cells are not editable. Depending on the selected **mode** down there, the grid contains either all 15 gases or only one (hydrogen sulfide). Unlike ISO 6976 Calculator form, GPA 2172 Calculator does not support BTEX and H_2O mode.

At the top centre region, set the reference pressure. When all inputs are correct, click **Calculate**. Calculation results are displayed on the grid at the bottom region. GCAS displays the compressibility value (Z), gross heating value (GHV) in both imperial and metric units, as well as the relative density.

21.2 Ways to Enter Composition

Input composition can come from a manual input, copy-and-paste, or an existing record.

21.2.1 Manual Input

Go to the input composition grid. Press F2 or double-click the cell to invoke edit mode. There is *total* row at the bottom of the grid that updates every time you enter a value. You might need to scroll the grid or resize the form.

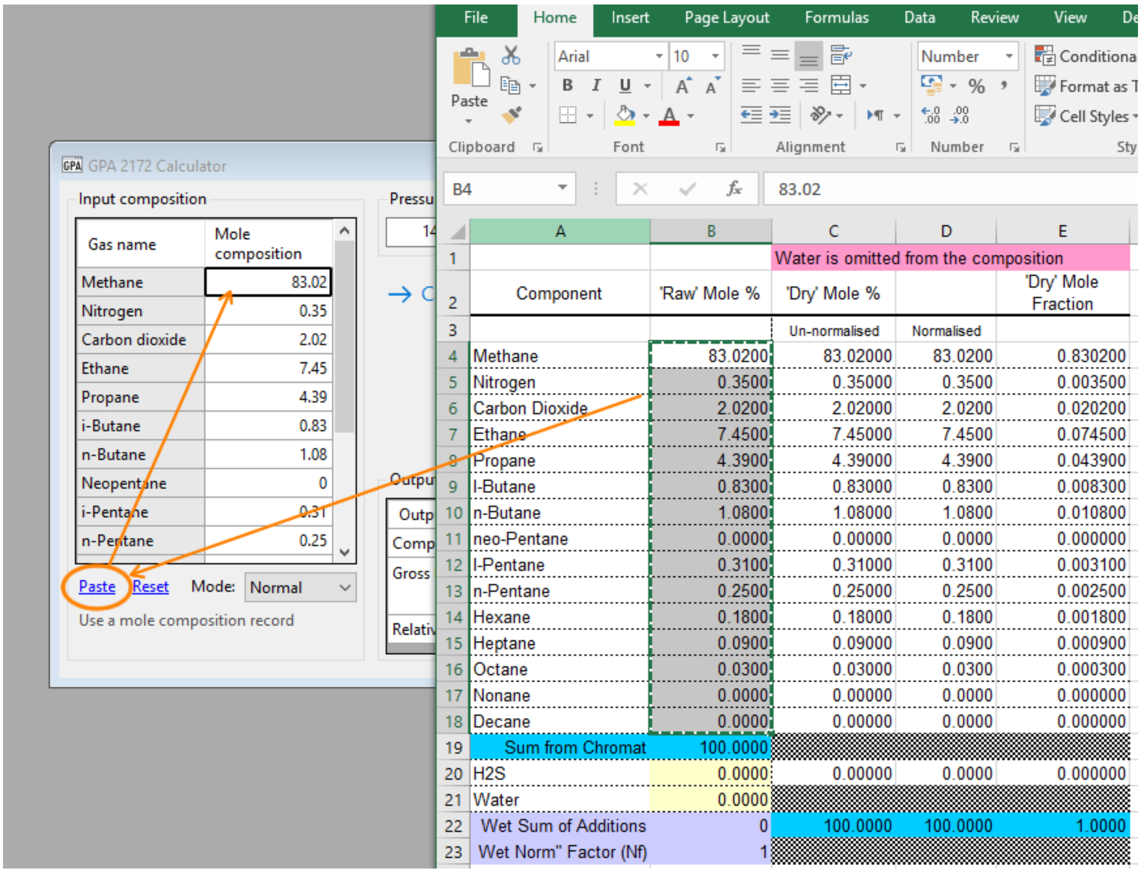
Take care about the gases your GC device doesn't read. For example, an LNG C5− device does not have hexane to decane. Set the composition of these unavailable gases to zero.

Click **Reset** to reset all numbers back to zero.

21.2.2 Normal Paste and Smart Paste

Copy a block of cells from Microsoft Excel or your favourite spreadsheet processing software, then click **Paste** at GPA 2172 Calculator form. If your block of cells has one column, GCAS processes a normal paste. If it has two, GCAS processes a smart paste.

Normal paste is like the Paste button on Microsoft Excel; it pastes the cells sequentially. Some safeguards implemented are cells containing non-number like alphabets will translate into zero, and negative numbers are converted into positive.



Smart paste works for two-column data. First column defines the gas name, while the second column contains values. The order of these gases does not matter as GCAS will reorder gases into the correct sequence. GCAS recognises standard gas names (e.g. "Methane", "Benzene", "i-Butane") as well as some well-known names (e.g. "Isobutane", "Pentane"), and even their acronyms. Gas names are not case-sensitive.

	A	B	C	D	E
1			Water is omitted from the composition		
2	Component	'Raw' Mole %	'Dry' Mole %		'Dry' Mole Fraction
3			Un-normalised	Normalised	
4	Methane	83.0200	83.02000	83.0200	0.830200
5	Nitrogen	0.3500	0.35000	0.3500	0.003500
6	Carbon Dioxide	2.0200	2.02000	2.0200	0.020200
7	Ethane	7.4500	7.45000	7.4500	0.074500
8	Propane	4.3900	4.39000	4.3900	0.043900
9	I-Butane	0.8300	0.83000	0.8300	0.008300
10	n-Butane	1.0800	1.08000	1.0800	0.010800
11	neo-Pentane	0.0000	0.00000	0.0000	0.000000
12	I-Pentane	0.3100	0.31000	0.3100	0.003100
13	n-Pentane	0.2500	0.25000	0.2500	0.002500
14	Hexane	0.1800	0.18000	0.1800	0.001800
15	Heptane	0.0900	0.09000	0.0900	0.000900
16	Octane	0.0300	0.03000	0.0300	0.000300
17	Nonane	0.0000	0.00000	0.0000	0.000000
18	Decane	0.0000	0.00000	0.0000	0.000000
19	Sum from Chromat	100.0000			
20	H2S	0.0000	0.00000	0.0000	0.000000
21	Water	0.0000			
22	Wet Sum of Additions	0	100.0000	100.0000	1.0000
23	Wet Norm" Factor (Nf)	1			

This block of cells would work with smart paste.

21.2.3 Load a Mole Composition Record

To use a mole composition record, you need *Live Data Analysis* feature in your GCAS licence.

Method one: As already described in chapter 8.10: Open a Mole Composition form, browse to the desired record, go to the Action menu, and finally select **Send to GPA 2172 Calculator**.

Method two:

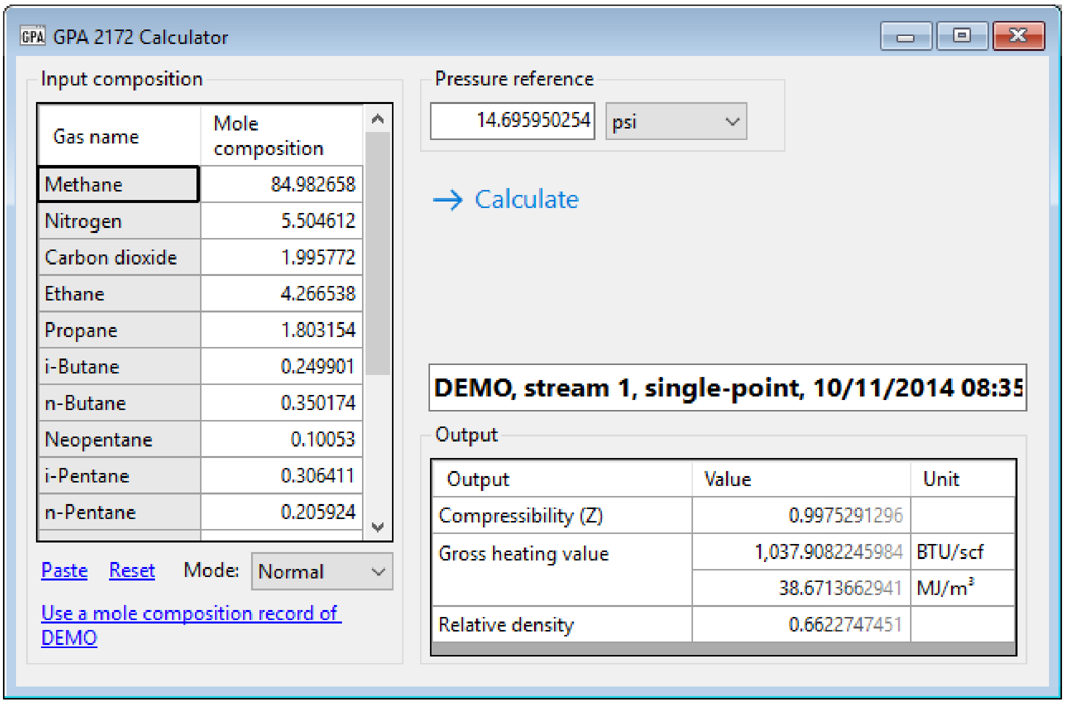
1. Go to the Tools menu > GPA 2172 Calculator on GCAS main window.
2. While GPA 2172 Calculator window is open, select the device from your device panel or recent device panel.
3. Look under the input grid. Click **Use a mole composition record of <*device name*>.** The <*device name*> follows the actual device you are selecting, and is updated whenever you change the selected device on main window.
4. That link opens a *Select Record* dialogue. Pick a record and click **OK**.

21.2.4 Load a Calibration Certificate

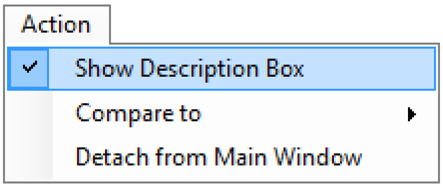
Open a Calibration Gas Certificate form, browse to the desired certificate, then go to the Action menu, and select **Send to GPA 2172 Calculator**. The GPA 2172 Calculator form shall load the mole percentage portion of the calibration certificate.

21.3 Add Description

Description is an optional text for presentation purpose only. When there are multiple GPA 2172 Calculators open at the same time, adding a text description to each of them would help you identify which window is which.



Open the Action menu and select **Show Description Box**. This reveals a text box above the output section of the form. Enter any description to this text box. To hide it, open the Action menu again and clear the check mark on this menu.



Description text is used when you are switching windows through the *Window* menu on the main menu bar. GCAS also fills in the description text automatically for cases where GPA 2172 Calculator is opened through a *Send to* shortcut from Data Analysis or Mole Composition Comparison.

22 ISO 6976/GPA 2172 Trend

ISO 6976/GPA 2172 Trend is a module to plot historical ISO 6976 output values or GPA 2172 output values over time. This module should not be confused with Uncertainty Trend which graphs the *uncertainty* of ISO 6976 or GPA 2172 outputs. ISO 6976/GPA 2172 Trend takes a collection of mole composition records then performs ISO 6976 and GPA 2172 calculation on each of them using the same parameters, and finally displays the trend on a line chart.

Note

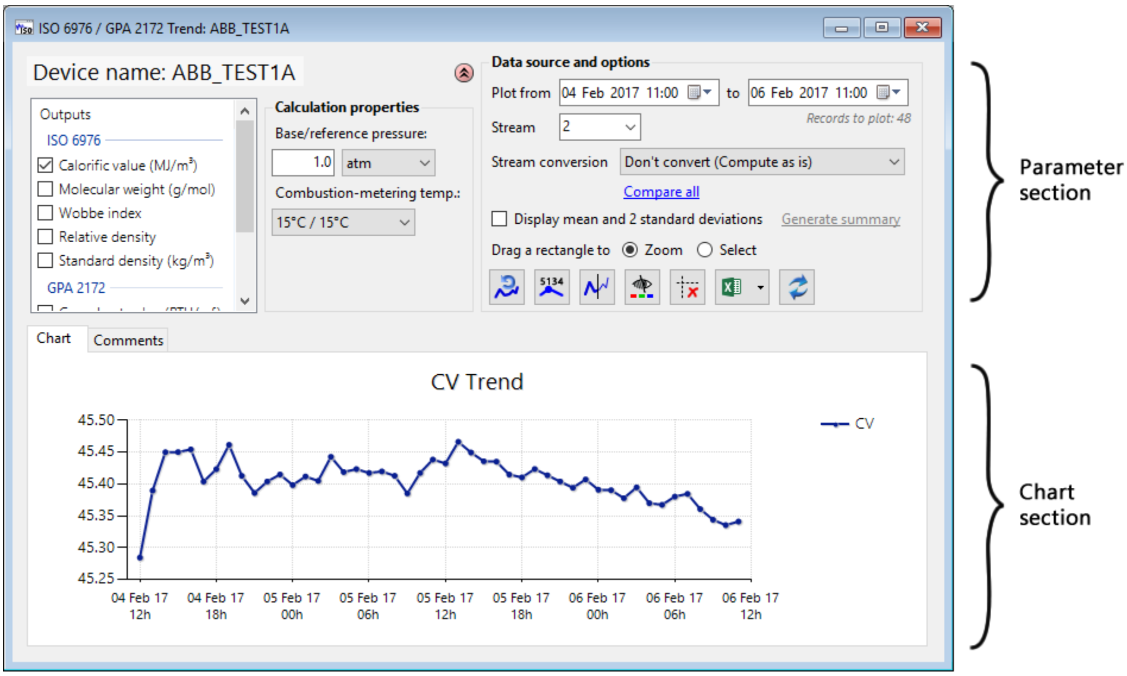
This module requires **at least one** GCAS feature *ISO 6976 Trend* or *GPA 2172 Trend* to be included in your GCAS licence. If you have both, fantastic!

Mole composition records of BTEX analysers and single gas devices are not normalised. To override this behaviour, run GCAS with additional **/normaliseISO6976** or **/normaliseGPA2172** switch (or both).

GPA 2172 calculation is not applicable for **BTEX analysers, H_2O analysers,** and **single-gas analysers that are not H_2S.** The resulting chart will be all-zeroes for these devices.

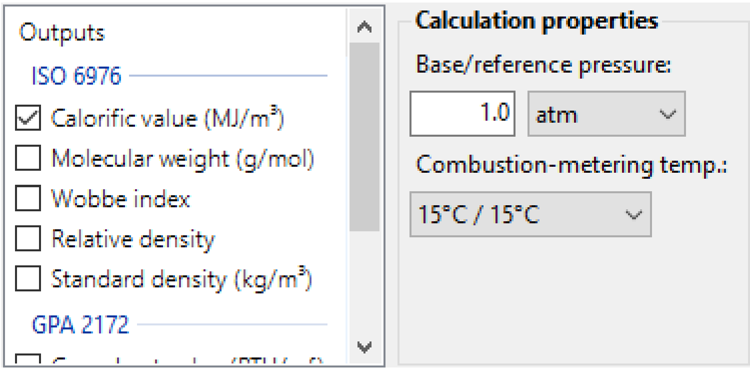
22.1 The ISO 6976/GPA 2172 Trend Form

Select the desired GC device on device panel or recent device panel, and then go to the View menu > **ISO 6976/GPA 2172 Trend**. Similar to Data Analysis, ISO 6976/GPA 2172 Trend form has three sections: parameters, chart, and comments.



Chapter 22.2 Calculation properties and 22.3 Plot range and stream conversion explain the parameter section in greater detail.

22.2 Calculation Properties



Check boxes on this list control which ISO 6976 and GPA 2172 outputs to show. Typically, only one output is checked. GCAS can graph two gross heating value (GHV) outputs, one in imperial unit (BTU/ft^3) and the other in metric unit (MJ/m^3).

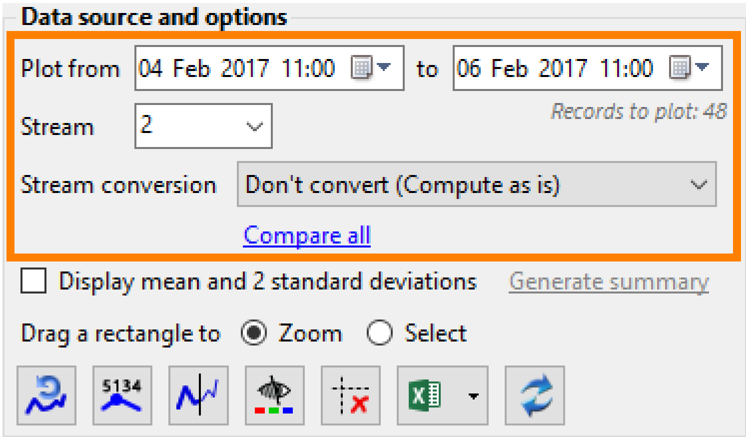
Set the base pressure and the combustion-metering temperature pair. These properties are used to calculate ISO 6976 outputs throughout the entire plot range. Default base pressure is one atmospheric pressure. There are six combustion-metering temperature pairs supported:

- 0°C / 0°C,
- 15°C / 0°C,
- 25°C / 0°C,
- 15°C / 15°C (default),
- 20°C / 20°C,
- 25°C / 20°C.

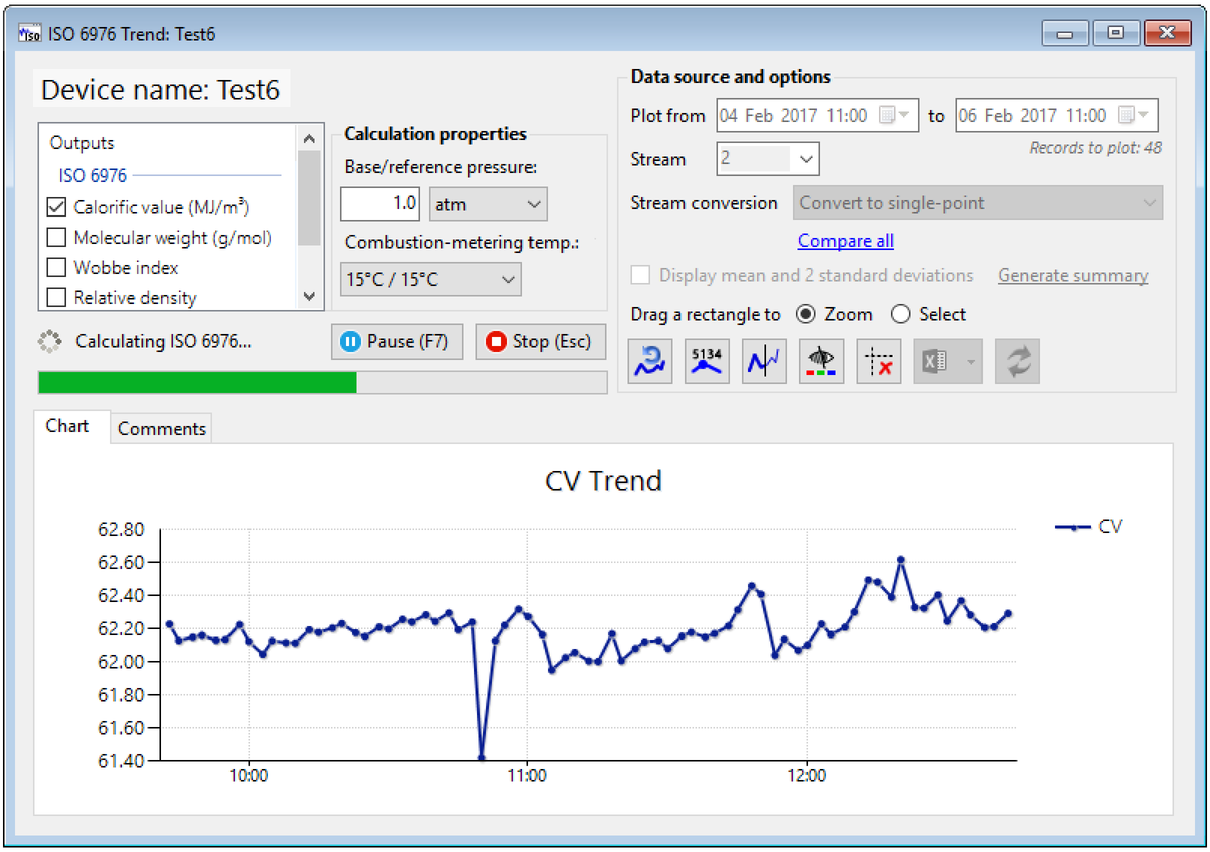
For GPA 2172 calculation, the base pressure is the same as reference pressure. GCAS performs the necessary unit conversion behind the screen hence entering a value of 1.0 atm will be interpreted as 14.6959 psi. Combustion-metering temperature selection has no effect on GPA 2172 calculation as it always assumes 60°F (15.55°C).

If your GCAS licence only has one trend feature—for example only *ISO 6976 Trend* is included, you will not see GPA 2172 outputs on the check box list.

22.3 Plot Range and Stream Conversion



These options control which data source to feed into ISO 6976 and GPA 2172 calculator inside ISO 6976/GPA 2172 Trend form. Set the date and time range as well as the stream number and finally click **Refresh** to start graphing. It may take a while to plot the complete chart on slow network connection to database server. GCAS provides **Pause** button to temporarily halt the operation (or press F7) and **Stop** button (or press Esc) to abort the calculation.



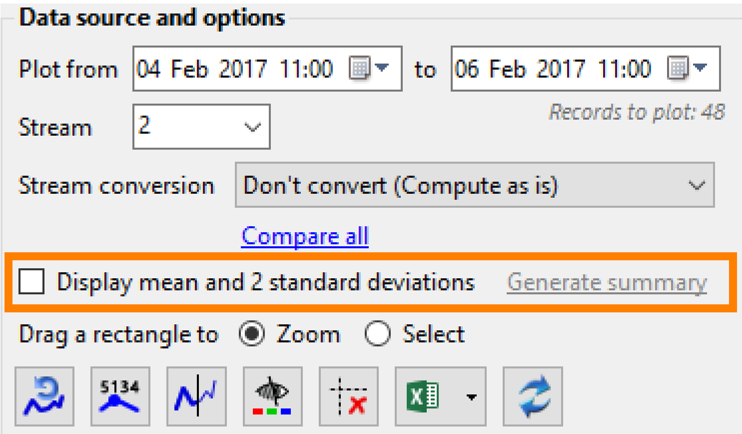
ISO 6976/GPA 2172 Trend form, calculation in progress. Dots disappear after 100 data points.

GCAS determines which stream numbers available based on the existing mole composition records and mole composition streams configuration in Modbus register mappings. Nevertheless, if the desired stream number is not listed on this dropdown, just type the number manually and hit **Refresh**. In addition, if your GC device has spot sample data, you can graph the ISO 6976 or GPA 2172 trend of those spot sample records too. The word "`spot`" will appear on stream selection.

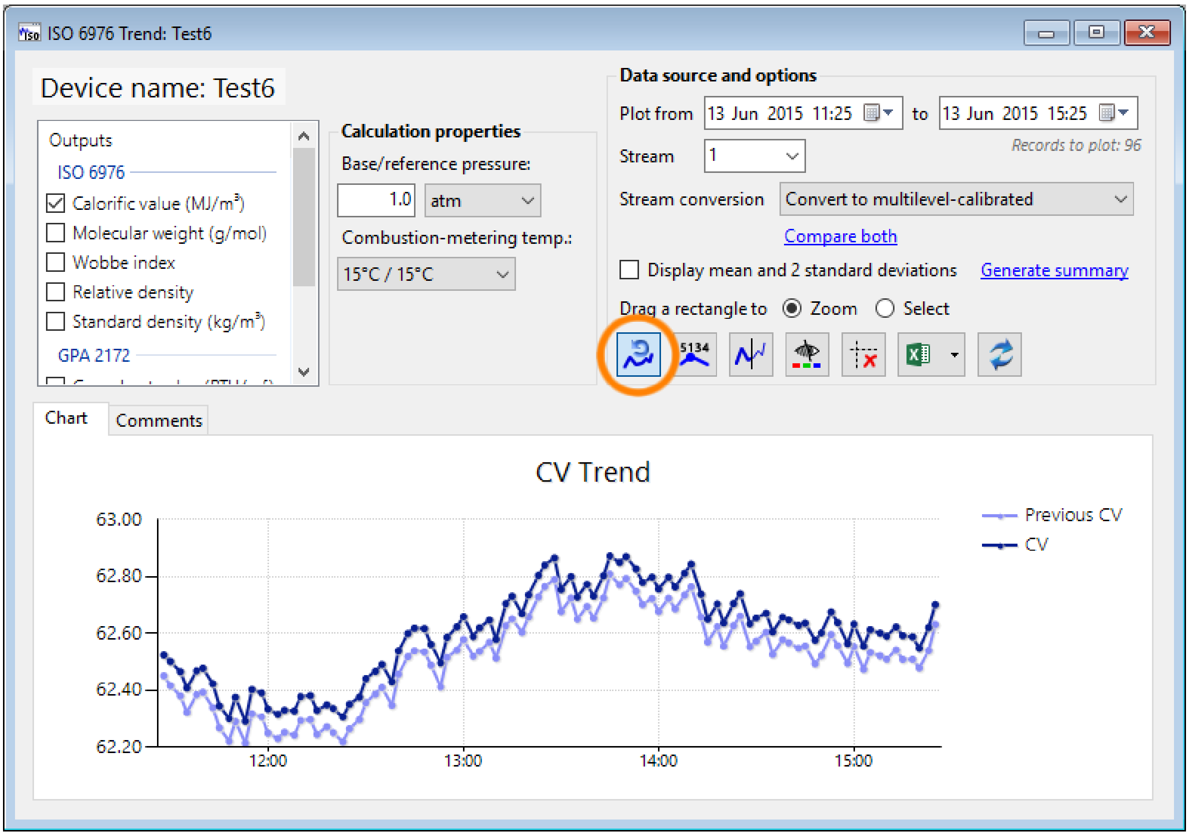
Given that you have *ISO 10723* feature included in your GCAS licence, you shall see an additional dropdown for stream conversion. This dropdown controls whether the underlying mole composition records should be converted to single-point or to multilevel-calibrated values prior to ISO 6976/GPA 2172 calculation. One special case, this dropdown will appear on ABB devices regardless of the ISO 10723 feature availability in your licence. For ABB devices, you have the option to convert the mole composition records into exponential composition as well. Non-convertible records will produce gaps on the ISO 6976/GPA 2172 trend chart. The default selection is **Don't convert (Compute as is)** which will bypass all ISO 10723 prerequisites and ABB exponential conversion prerequisites. This would let ISO 6976/GPA 2172 Trend form to plot the graph while ignoring the MLC flag bit of the underlying mole composition records. Do not select this option if you suspect the GC device might have mixed record types.

Under the stream conversion dropdown, there is a link named **Compare both**. Or if the device is ABB, this link may read **Compare all**. This link summons ISO 6976/GPA 2172 Trend Comparison tool and tells it to compare ISO 6976 trend or GPA 2172 trend based on single-point mole composition records versus the trend based on multilevel-calibrated mole composition records. It requires an additional GCAS feature *Data Comparison*.

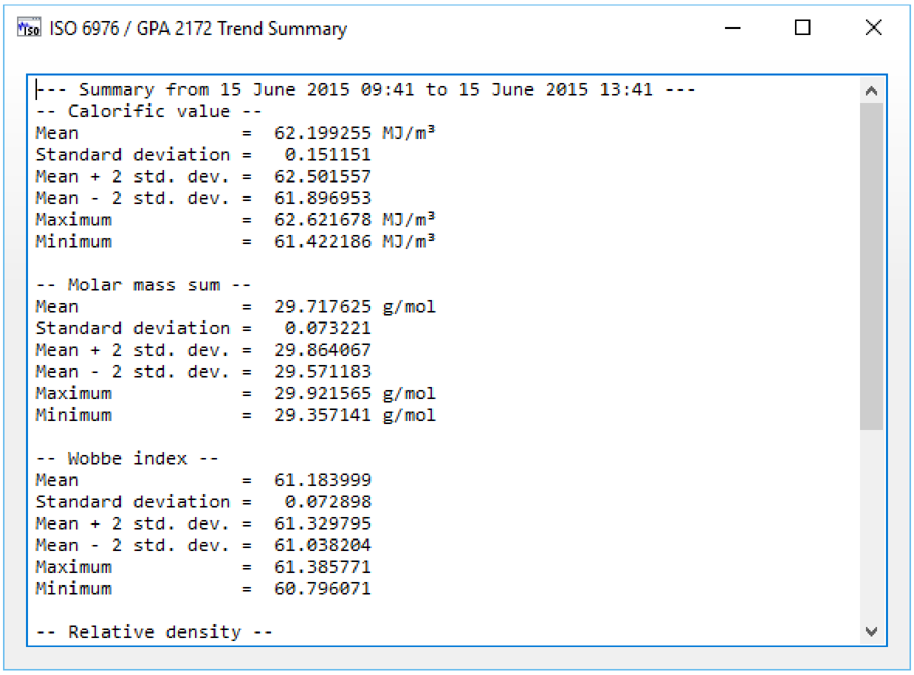
22.4 Mean and Standard Deviations



Mean and standard deviations are calculated based on all data points currently appearing on current ISO 6976/GPA 2172 trend chart. Tick this check box to reveal the mean and twice the standard deviation lines. GCAS cannot show mean and standard deviation lines for previous chart, they are for current chart only. Mean and standard deviations will not show if there are multiple ISO 6976 or GPA 2172 trends in the chart.

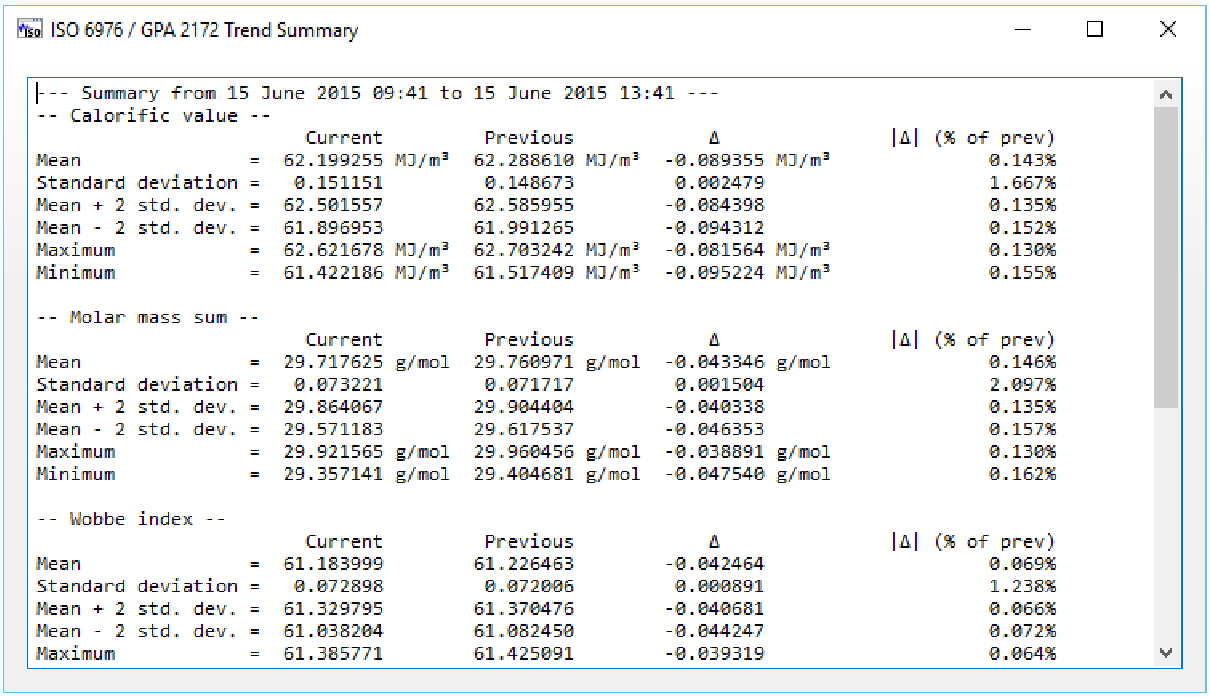


Next to the check box, you see a link called **Generate summary**. This link generates statistical summary for the entire X-axis. To generate summary on a certain portion of X-axis, switch to selection mode and use the right-click menu instead.


ISO 6976 / GPA 2172 Trend Summary

```
--- Summary from 15 June 2015 09:41 to 15 June 2015 13:41 ---
-- Calorific value --
Mean                =  62.199255 MJ/m³
Standard deviation  =   0.151151
Mean + 2 std. dev.  =  62.501557
Mean - 2 std. dev.  =  61.896953
Maximum             =  62.621678 MJ/m³
Minimum             =  61.422186 MJ/m³

-- Molar mass sum --
Mean                =  29.717625 g/mol
Standard deviation  =   0.073221
Mean + 2 std. dev.  =  29.864067
Mean - 2 std. dev.  =  29.571183
Maximum             =  29.921565 g/mol
Minimum             =  29.357141 g/mol

-- Wobbe index --
Mean                =  61.183999
Standard deviation  =   0.072898
Mean + 2 std. dev.  =  61.329795
Mean - 2 std. dev.  =  61.038204
Maximum             =  61.385771
Minimum             =  60.796071

-- Relative density --
```

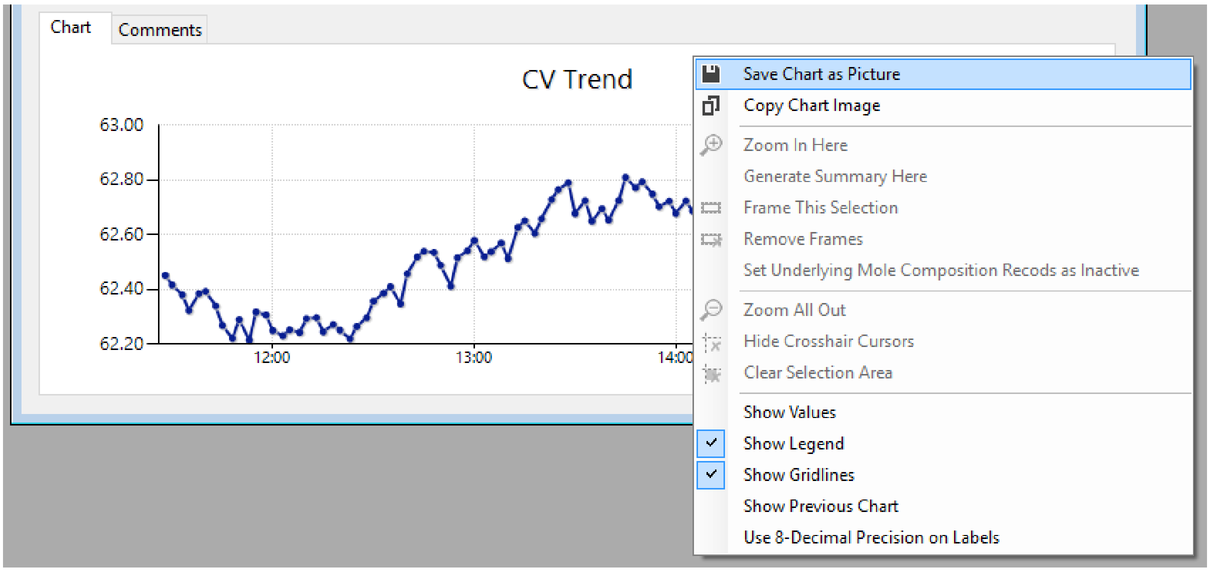
Had you opted to show previous chart as well, this summary includes the difference between current chart and previous chart.




```
--- Summary from 15 June 2015 09:41 to 15 June 2015 13:41 ---
-- Calorific value --
                        Current          Previous          Δ                 |Δ| (% of prev)
Mean               =  62.199255 MJ/m³  62.288610 MJ/m³  -0.089355 MJ/m³              0.143%
Standard deviation =   0.151151          0.148673          0.002479                  1.667%
Mean + 2 std. dev. =  62.501557        62.585955        -0.084398                    0.135%
Mean - 2 std. dev. =  61.896953        61.991265        -0.094312                    0.152%
Maximum            =  62.621678 MJ/m³  62.703242 MJ/m³  -0.081564 MJ/m³              0.130%
Minimum            =  61.422186 MJ/m³  61.517409 MJ/m³  -0.095224 MJ/m³              0.155%

-- Molar mass sum --
                        Current          Previous          Δ                 |Δ| (% of prev)
Mean               =  29.717625 g/mol  29.760971 g/mol  -0.043346 g/mol              0.146%
Standard deviation =   0.073221          0.071717          0.001504                  2.097%
Mean + 2 std. dev. =  29.864067        29.904404        -0.040338                    0.135%
Mean - 2 std. dev. =  29.571183        29.617537        -0.046353                    0.157%
Maximum            =  29.921565 g/mol  29.960456 g/mol  -0.038891 g/mol              0.130%
Minimum            =  29.357141 g/mol  29.404681 g/mol  -0.047540 g/mol              0.162%

-- Wobbe index --
                        Current          Previous          Δ                 |Δ| (% of prev)
Mean               =  61.183999        61.226463        -0.042464                    0.069%
Standard deviation =   0.072898          0.072006          0.000891                  1.238%
Mean + 2 std. dev. =  61.329795        61.370476        -0.040681                    0.066%
Mean - 2 std. dev. =  61.038204        61.082450        -0.044247                    0.072%
Maximum            =  61.385771        61.425091        -0.039319                    0.064%
```

22.5 Save or Copy the Chart

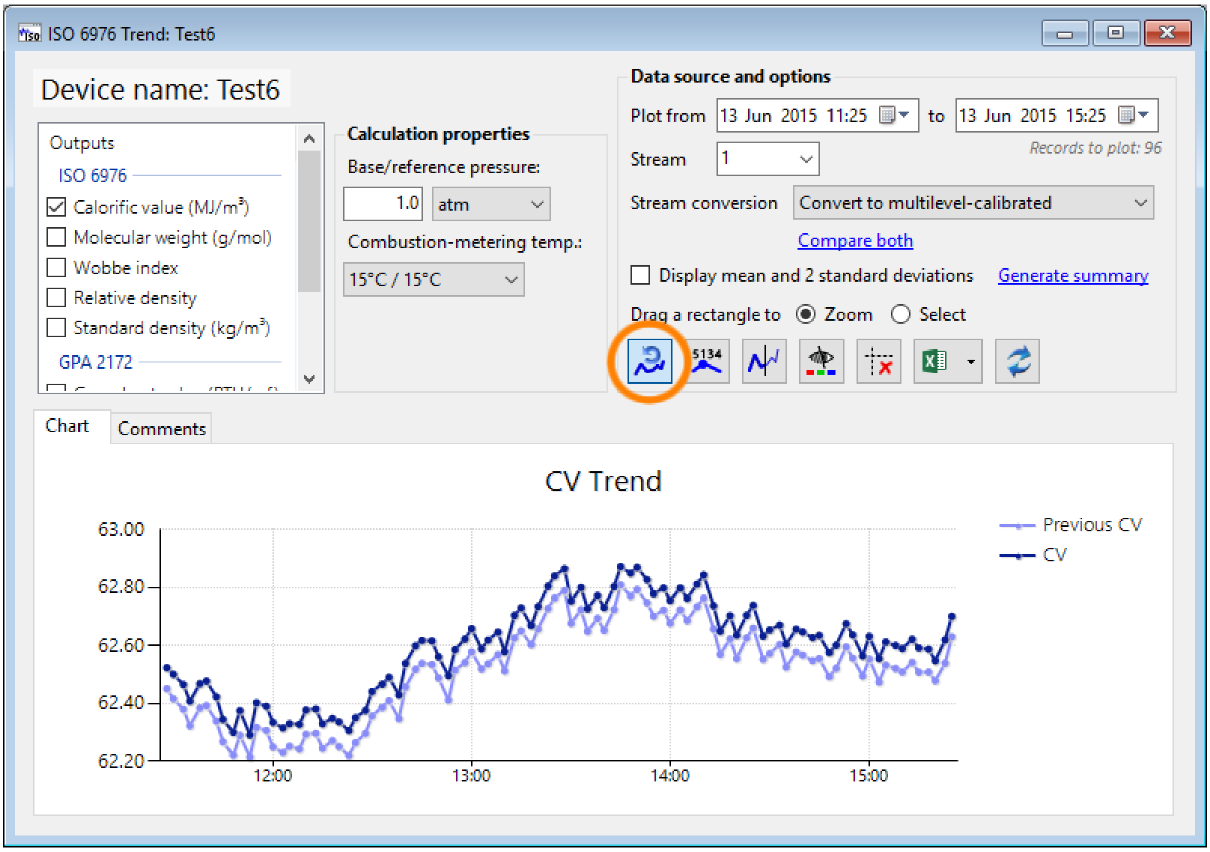
To save the chart as image file, right click on the chart and select **Save Chart as Picture**.



Similarly, to copy the chart into clipboard, right click and select **Copy Chart Image**. Then you may paste the image onto Microsoft Paint, Microsoft Word, or any software that accepts bitmap image.

22.6 Comparing Previous Chart

ISO 6976/GPA 2172 Trend form remembers the last ISO 6976 or GPA 2172 trend chart before you changed something. By this way, you can quickly compare current ISO 6976/GPA 2172 trend versus the one before parameter change. Typical use of previous chart is to compare calorific value (CV) based on single-point mole compositions versus CV based on multilevel-calibrated mole compositions. To do so, first graph a CV trend with stream conversion set to **single-point**. Next, change the stream conversion to **multilevel-calibrated** and hit **Refresh** to graph the CV trend on MLC. Finally, click **Show previous chart** button. Current chart (dark blue) is the CV based on MLC compositions, while previous chart (light blue) is the CV based on single-point compositions.

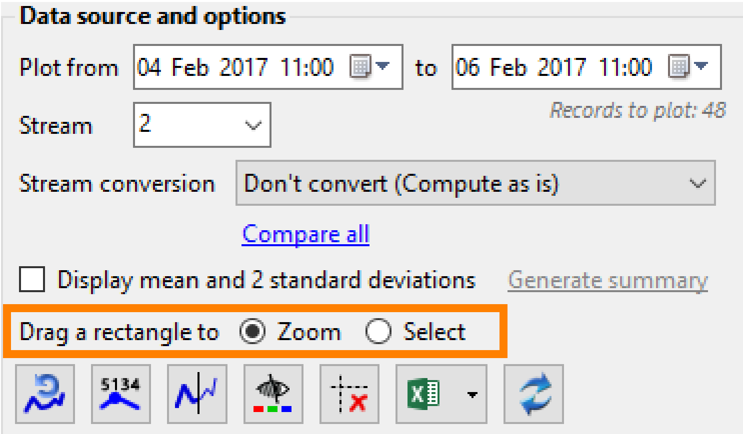


Example of a bad GC. Current CV (dark blue) is based on multilevel-calibrated compositions, while previous CV (light blue) is based on single-point compositions. If these two drift too far apart, this indicates problems within the GC. A good GC should have these two be really close or even coincide.

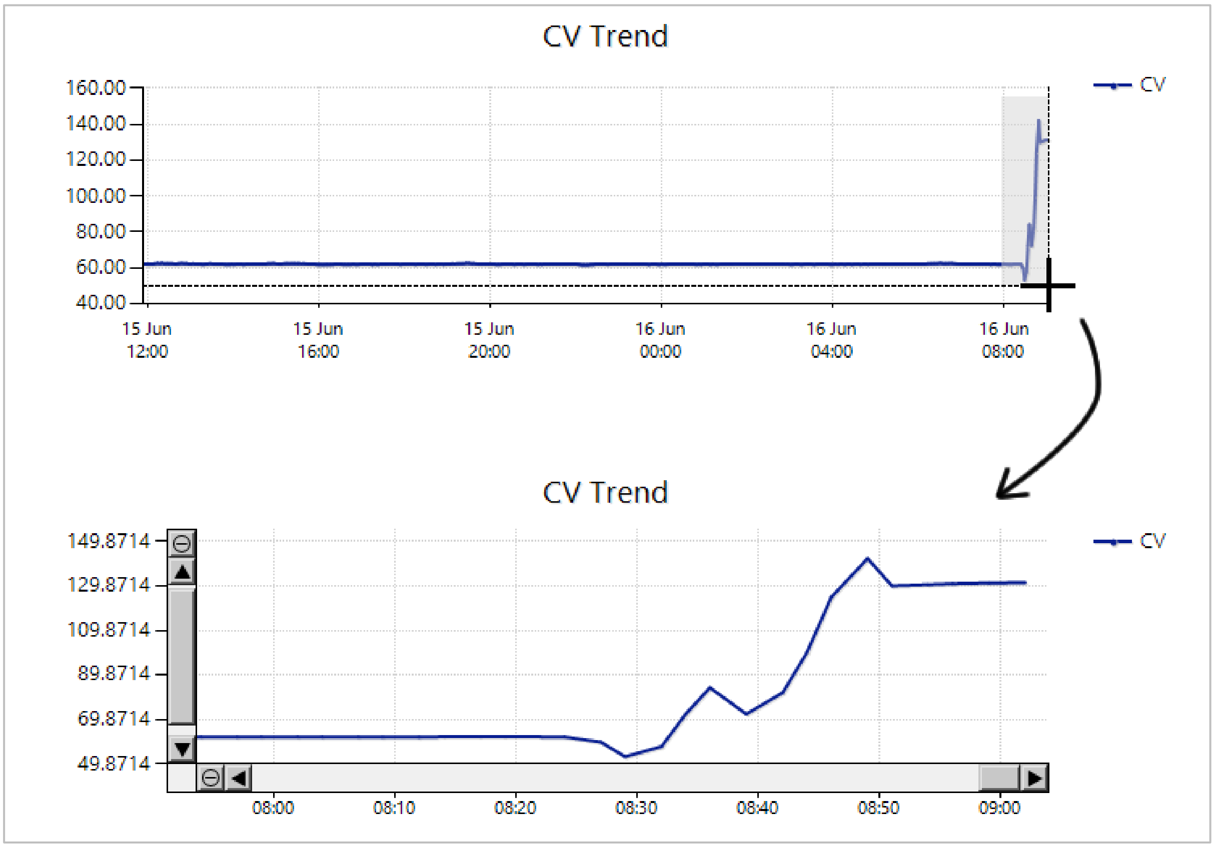
Be reminded that only one previous chart is cached. If you change a parameter the third time, first chart graphed is lost when you click **Refresh**.

22.7 Zoom Mode and Selection Mode

The radio buttons depicted on the next page control whether ISO 6976/GPA 2172 Trend form is in zoom mode or in selection mode.

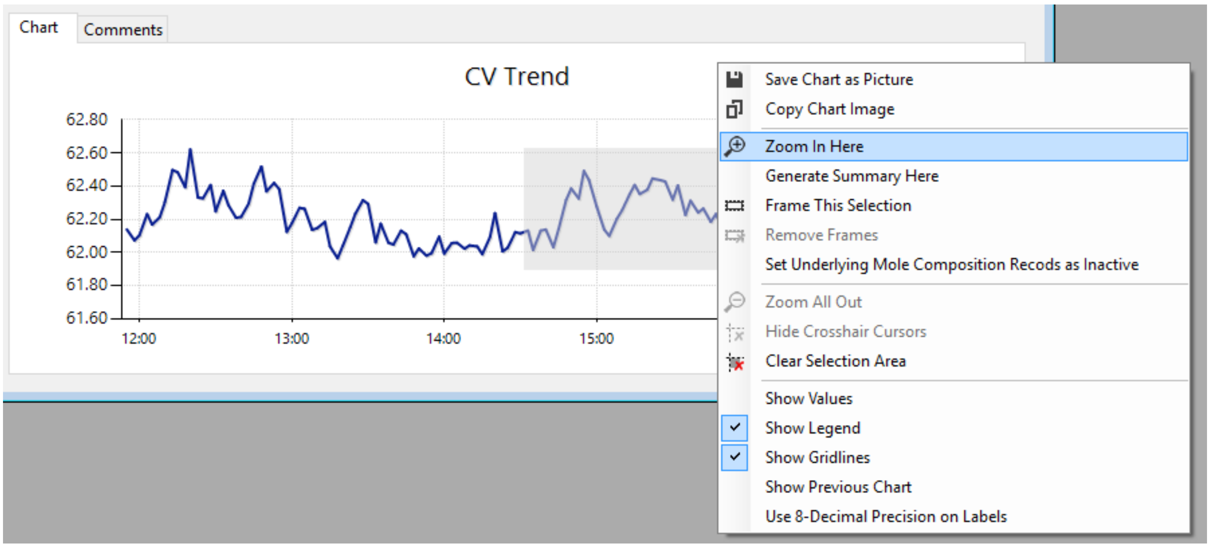


In *zoom mode*, drag a rectangle on a region you would like to zoom.



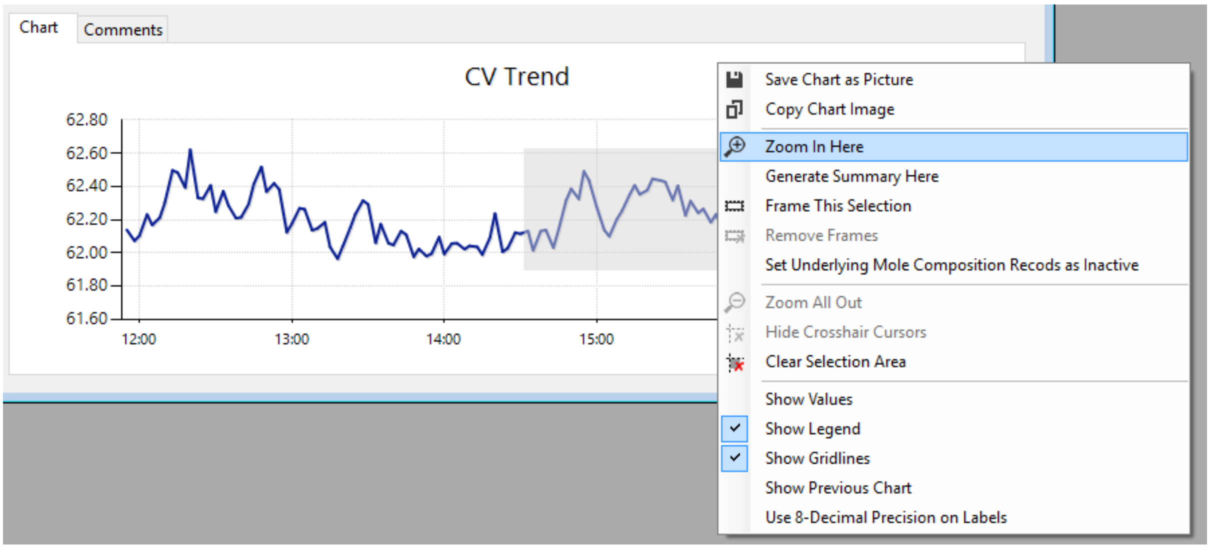
Pan the chart using the provided scroll bars. Drag another rectangle to zoom in further. To zoom out one step, click on the circled minus button ⊖ on both scroll bars. To zoom all-out, simply press the `Home` button on your keyboard or right-click on the chart and select **Zoom All Out** submenu.

In *selection mode*, drag a rectangle to create a selection area. Right click the chart and you see several menus are now available. [Chapter 22.8 Selection mode menus](#) will explain the function of each menu. To clear selection area, right click the chart and select **Clear Selection Area**.

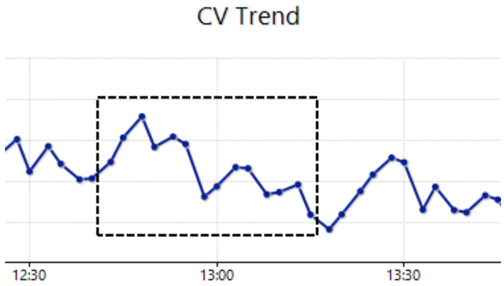


22.8 Selection Mode Menus

Assuming the chart is on selection mode and you have a selection rectangle, these menus are available.

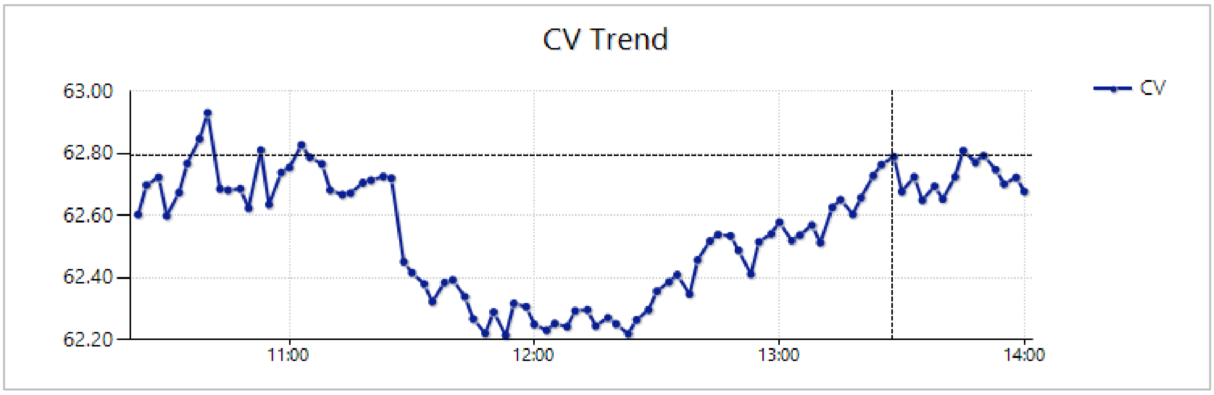


Menu	What it does
Zoom In Here	Zooms in to the selection rectangle.
Generate Summary Here	Generates statistical summary for all data points inside the selection rectangle. - If you activate previous chart alongside current ISO 6976/GPA 2172 trend chart, the summary also includes differences between the two. - GCAS looks at the X-axis range only. Data points excluded by the selection rectangle (having Y-axis values outside of selection rectangle) are also included for statistical calculation.

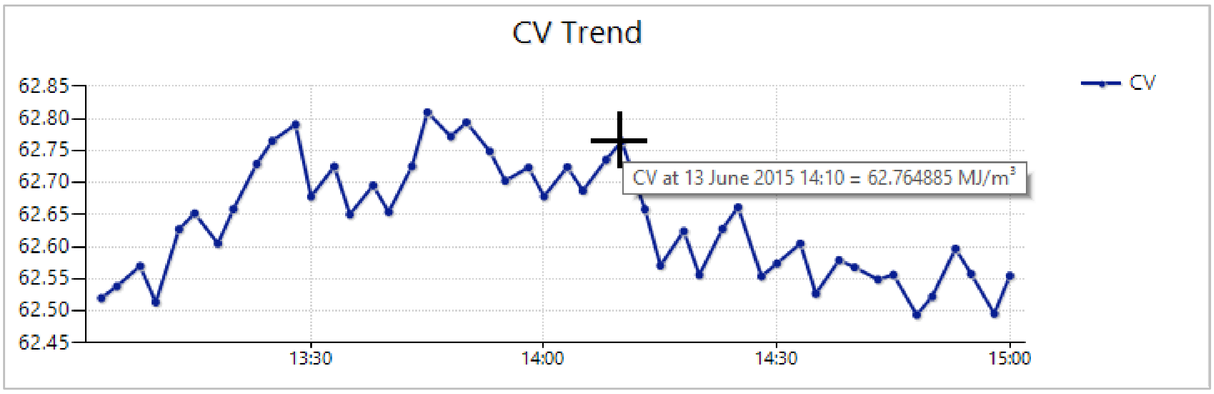
Frame This Selection	Literally puts a rectangular frame around the selection area, for presentation purpose only. 
Remove Frames	Removes all rectangular frames created through *Frame This Selection* menu.
Set Underlying Mole Composition Records as Inactive	As it says, this menu sets all underlying [mole composition records]() within the selection area as inactive. Once it's done, the ISO 6976/GPA 2172 trend lines will have a gap on it and the mean/standard deviation values are invalidated. Refresh the chart to get the correct values.

22.9 Other Visual Cues

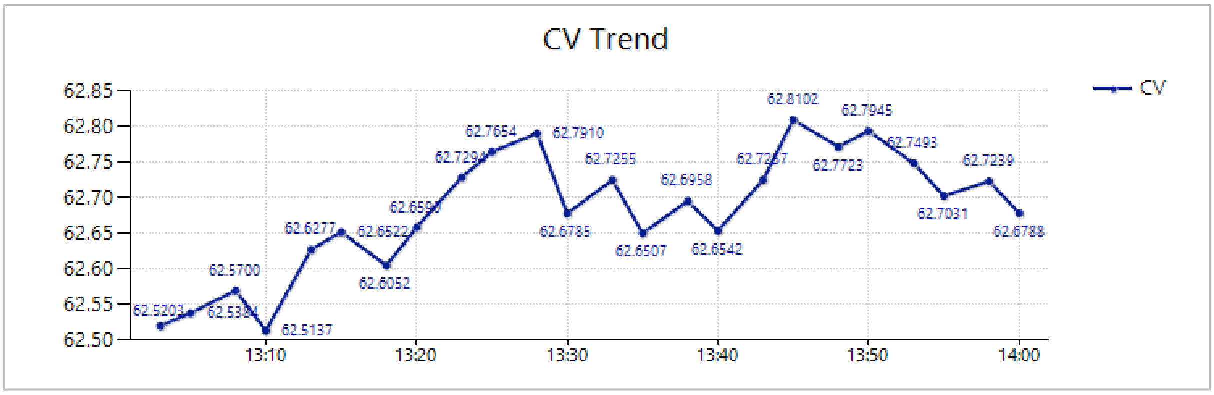
Set the chart to [zoom mode](). Click anywhere on the chart to place these *crosshair cursors*. These dotted pair of line acts as a ruler to compare Y-axis values between several data points. To remove them, click **Hide crosshair cursors**.



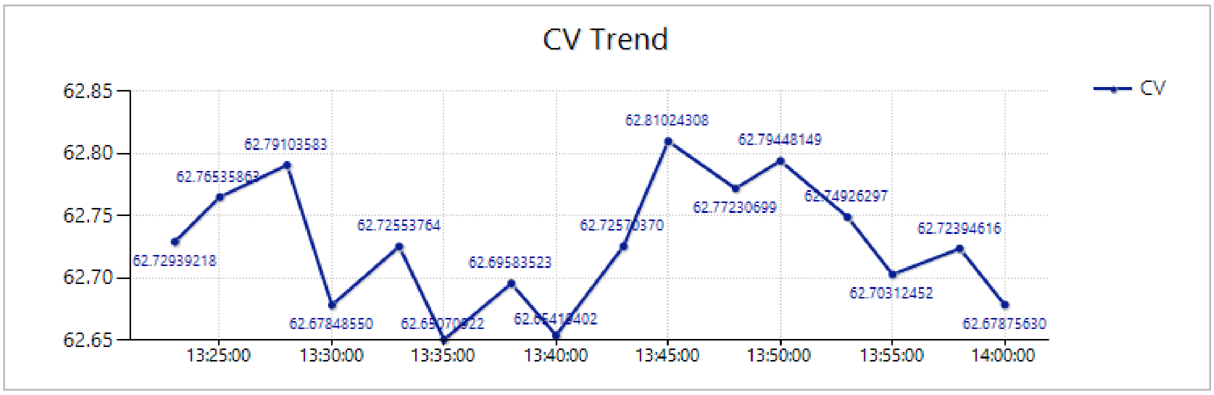
Hover your mouse pointer over a data point to show a tooltip about its value.



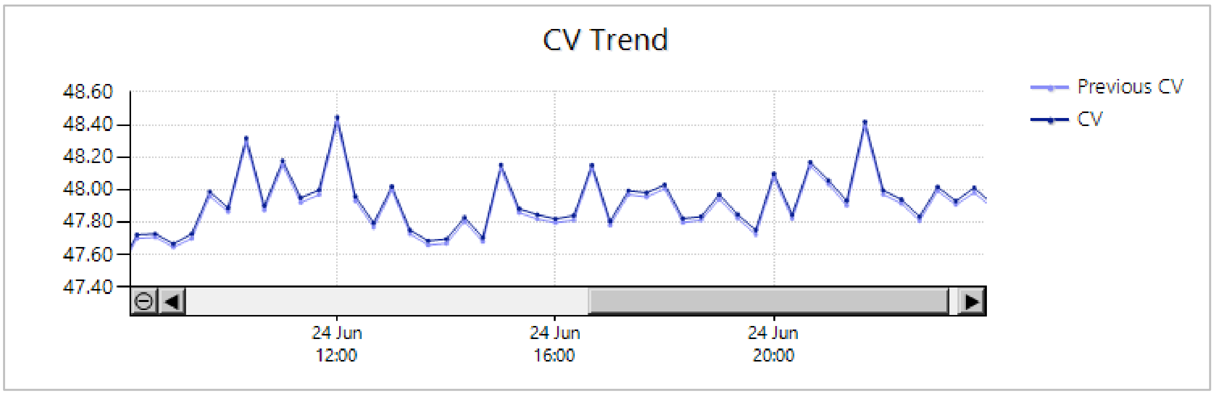
Or click **Show values** to display values on labels.



If you need higher precision, right click the chart and tick **Use 8-Decimal Precision on Labels**. Untick this menu to revert back to 4-digit decimals.

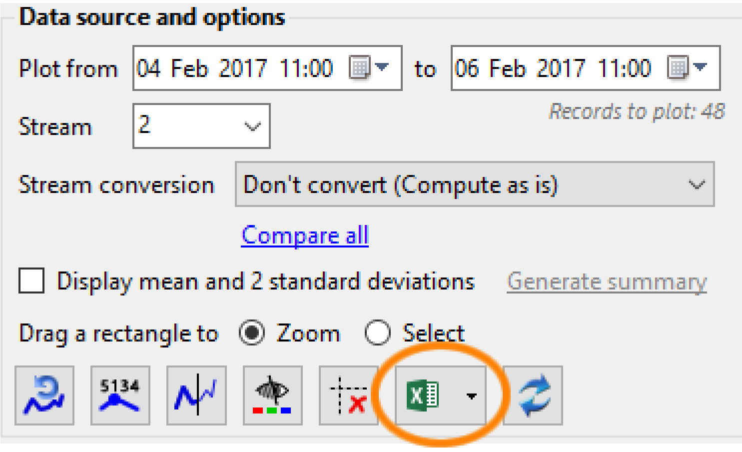


In case of current ISO 6976/GPA 2172 line and previous ISO 6976/GPA 2172 line are so close together, click **Use thin lines** to draw the chart using 1-pixel wide lines.



22.10 Export Values to Microsoft Excel or CSV

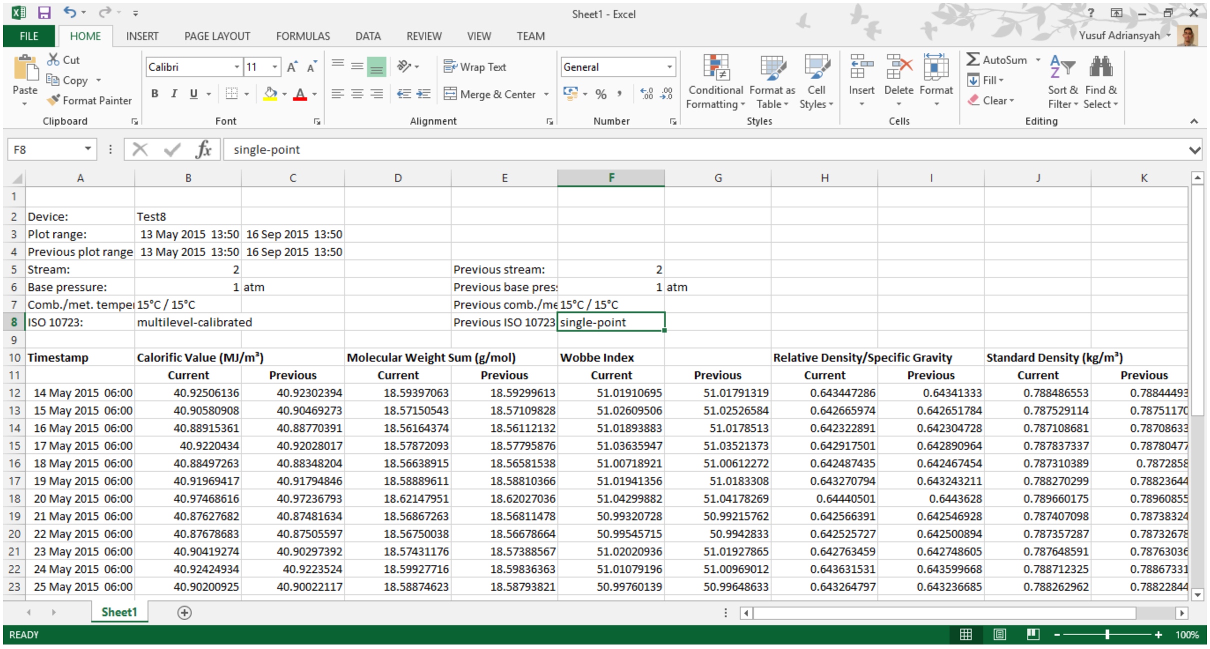
Once the chart has been graphed completely, click **Copy to Microsoft Excel**. This button opens a new Excel worksheet. Then GCAS writes all data points of all line charts onto this worksheet.



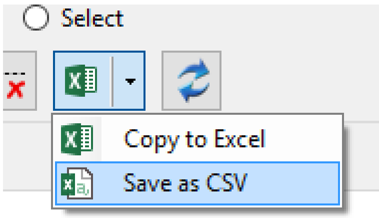
Note

This feature requires Microsoft Excel 2010, 2013, 2016 or later, to be installed.

GCAS writes all five ISO 6976 outputs plus three GPA 2172 outputs to a new Microsoft Excel worksheet, with both current ISO 6976/GPA 2172 trend and previous ISO 6976/GPA 2172 trend values. If there is no previous chart graphed before, previous ISO 6976/GPA 2172 trend values are all blanks. No worries, you can export to Microsoft Excel even if current ISO 6976/GPA 2172 trend chart has a different date/time range than the previous chart.

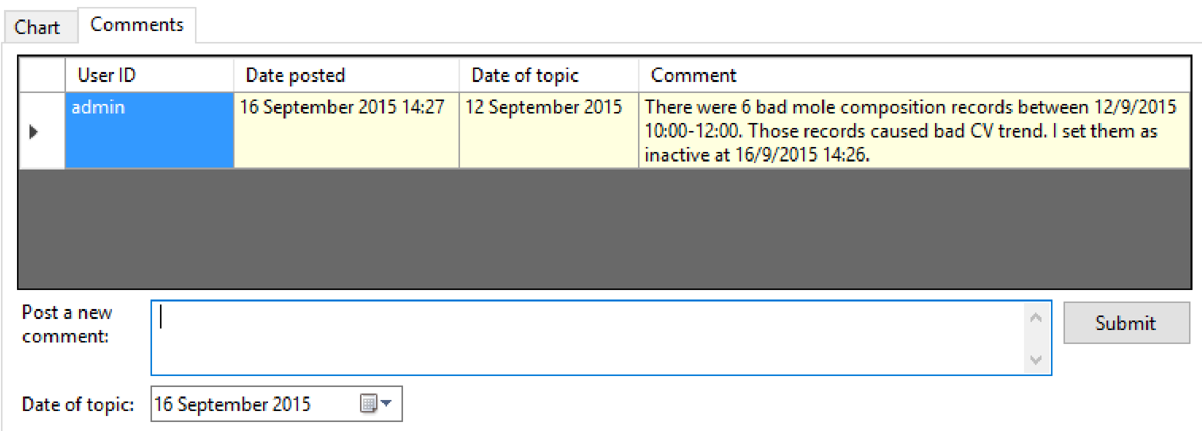


To export as CSV instead, open the dropdown menu of  **Copy to Microsoft Excel** button and then select **Save as CSV**.



22.11 Insert Comment

To view or write comments, open the **Comments** tab.



Write your comment and set the appropriate date of topic, then click **Submit**. Your comment will have a yellow background to distinguish it from comments by other users. **Date of topic** is an additional information of which mole composition record you are writing your comment for, thus other users know the correct data point to refer to.

Make sure that the comment is correct e.g. free from spelling errors, because once submitted you would not be able to edit nor remove your comment.

To refresh comments, click the same **Refresh** button.

If you do not see the text box to write your comment, i.e. you only see the comment grid, your GCAS user account doesn't have the action permission to write comment in ISO 6976/GPA 2172 trend. Contact your GCAS administrator.

23 ISO 6976/GPA 2172 Trend Comparison

ISO 6976/GPA 2172 Trend Comparison is a tool to compare ISO 6976 or GPA 2172 trends across devices. It is a part of *Data Comparison* feature, which stands in line after Mole Composition Comparison. Do not confuse ISO 6976 *trend* comparison with ISO 6976 comparison. The former is what we are going to talk in this chapter, while the latter is a bonus feature of ISO 6976 Calculator.

Note

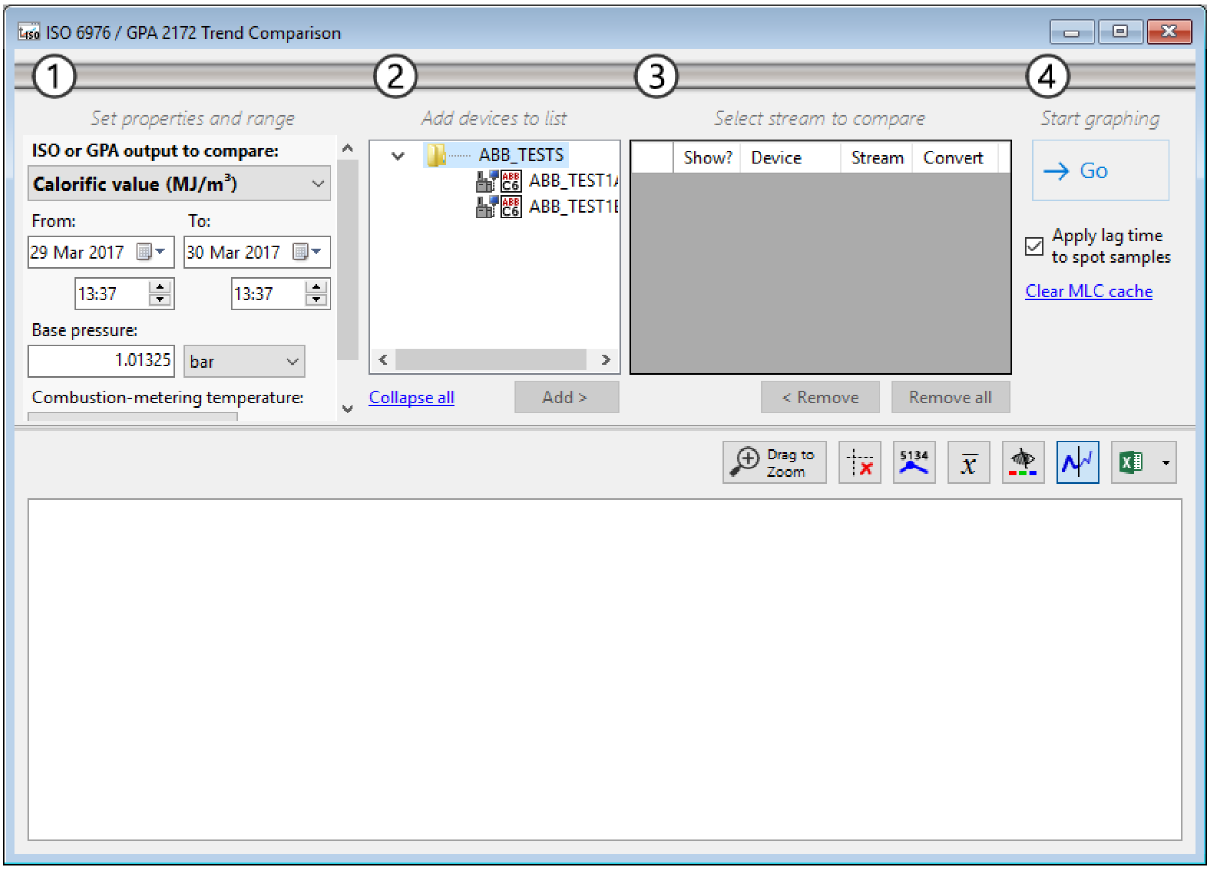
This module requires two or three GCAS features to be included in GCAS licence: *ISO 6976 Trend* or *GPA 2172 Trend* (or both), then combined with *Data Comparison*.

ISO 6976 calculation on BTEX devices and single gas analysers uses their underlying mole composition which are not normalised. To override this behaviour, run GCAS with additional **/normaliseISO6976** switch.

GPA 2172 calculation on H_2S devices is not normalised. To override this behaviour, run GCAS with additional **/normaliseGPA2172** switch.

23.1 The ISO 6976/GPA 2172 Trend Comparison Form

The form is accessible through the Tools menu > **ISO 6976/GPA 2172 Trend Comparison**.

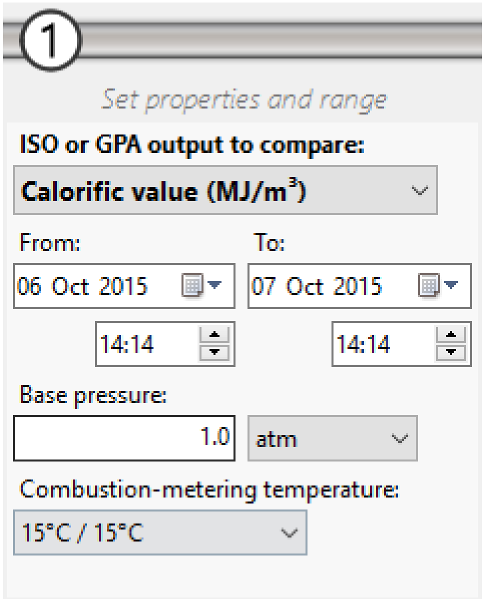


Similar to Mole Composition Comparison form, ISO 6976/GPA 2172 Trend Comparison form has two resizable sections. Parameters are at the top, chart is at the bottom. This form is designed with similar UI experience with Mole Composition Comparison therefore users can use it straight away without reading this chapter further.

23.2 Parameters and Device List

The top section of the form has a linear flow. Select what ISO 6976 or GPA 2172 output you need, the comparison date range, and ISO 6976 properties (❶), then browse the devices to compare (❷) and add them to the comparison list (❸), select which stream of these devices (❸) and finally click **Go** (❹) to start graphing.

23.2.1 Plot Range and Calculation Properties



First thing first, select which ISO 6976 or GPA 2172 output to compare. The default selection is calorific value (CV). There are two gross heating value (GHV) outputs, one in imperial unit and the other in metric. Going down, there are date and time pickers to set the plot range. Scroll down once more and you see the ISO 6976 and GPA 2172 properties (base pressure and combustion-metering temperature pair).

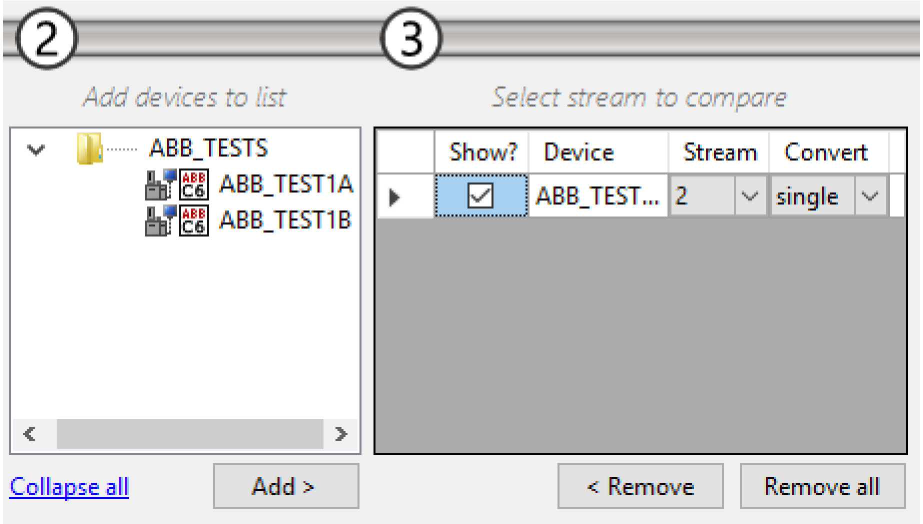
Default base pressure is the atmospheric pressure (1 atm). For GPA 2172 calculation, this base pressure becomes the reference pressure. GCAS performs unit conversion behind the screen, therefore entering a value of 1.01325 bar will be interpreted as 14.6959 psi.

GCAS supports six combustion-metering temperature pairs. This option is applicable to ISO 6976 calculation only, as GPA 2172 always assumes 60°F (15.55°C). These six pairs are:

- 0°C / 0°C
- 15°C / 0°C (combustion temperature = 15°C, base temperature = 0°C)

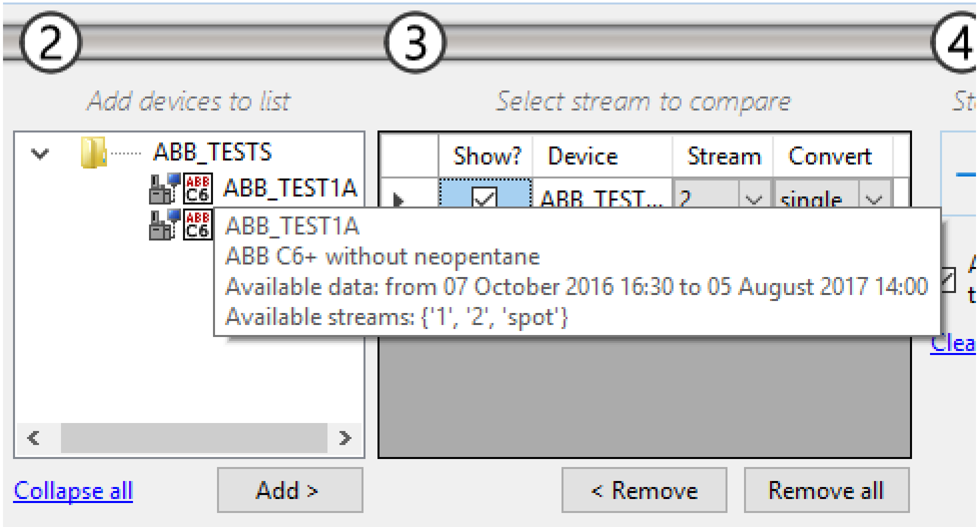
- 25°C / 0°C
- 15°C / 15°C (the default)
- 20°C / 20°C
- 25°C / 20°C

23.2.2 Devices and Comparison List



Device tree view is on the left. It lists all your workspaces and devices within each workspace. The grid on the right is known as *comparison list*.

Hover your mouse pointer over a device to view more information about data availability and stream numbers. In the screenshot below, the device ABB_TEST1A has three streams: stream 1, stream 2, and spot sample records. Because ISO 6976 and GPA 2172 calculation are based on mole composition records, devices having no mole composition records at all are displayed as semi-transparent and cannot be added to the comparison list.

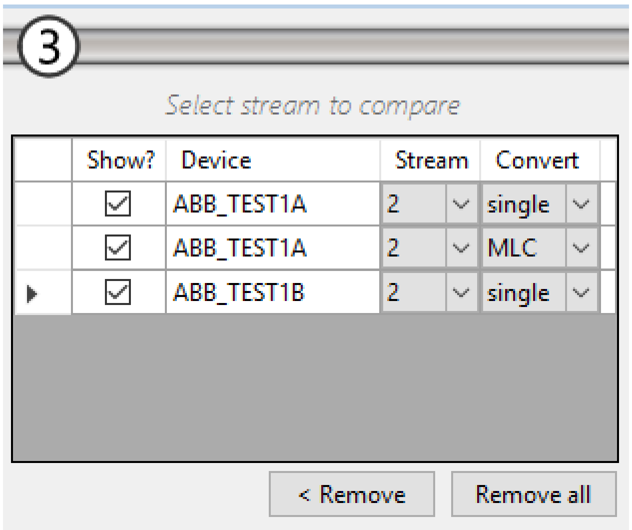


To compare devices, add the devices from the device tree view to the comparison list. Either select the device then click **Add**, or double click the device, or drag the device and drop it onto comparison list.

Note

An ISO 6976/GPA 2172 Trend Comparison form which was opened via *Send to* shortcut from Mole Composition Comparison's *Send to ISO 6976/GPA 2172 Trend Comparison* button or right-click menu, as well as through the *Compare both* link on ISO 6976/GPA 2172 Trend form; is locked to a certain number of comparison entries. Device tree view is empty and you cannot add another device into comparison list. The text above the chart should clearly indicate the form is locked. Click **Reset and reload device list** next to this text in order to unlock ISO 6976/GPA 2172 Trend Comparison form back into normal mode.

Once the device has been added to the comparison list, select the stream number. ISO 6976/GPA 2172 Trend Comparison form reads the mole composition records for this stream number. You can compare ISO 6976 or GPA 2172 trend values coming from different streams of the same device too. To do so, add the device to the comparison list twice, then select different stream number for each of them. In addition, if your devices have spot sample records, you shall find the word "`spot`" in the stream selector dropdown. Spot samples are treated as a regular mole composition stream here. And finally, if you have *ISO 10723* feature in your GCAS licence, this tool can also compare the ISO 6976/GPA 2172 trend values based on single-point composition vs. multilevel-calibrated composition of the same device, same stream number.



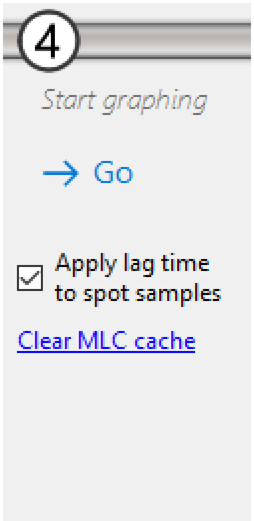
The column **Show?** contains check boxes which is used to hide or show the line chart of corresponding comparison entry after the chart has been rendered completely. Before you click **Go**, these check boxes have no effect.

The column **Convert** contains dropdowns to switch the conversion between "`single`" (single-point) and "`MLC`" (multilevel-calibrated). Users without *ISO 10723* feature in their licences will find these dropdowns contain only one item, that is "`single`", hence the **Convert** column serves no use. But regardless of ISO 10723 feature availability, these dropdowns will add one more selectable option for ABB devices: "`exp.`" (exponential). This last option converts the selected mole stream into exponential composition. As a result, you can compare all three stream conversions on an ABB device—single-point, multilevel-calibrated, and exponential.

To remove an entry from the comparison list, highlight its row on the grid and then click **Remove** or press `Delete` on your keyboard. Every time a comparison entry is removed from the comparison list, its line chart is also removed. However if you add it back, you need to redraw the chart because its data in the cache has already gone. This is the difference between removing an entry versus temporarily hiding it (by unticking the check box inside the **Show?** column). In addition, click **Remove all** to empty the comparison list and start over.

Note
Maximum number of entries in comparison list is 15 entries. GCAS will alert you if there are duplicate comparison entries. *Duplicate* = same GC device + same stream number + same stream conversion.

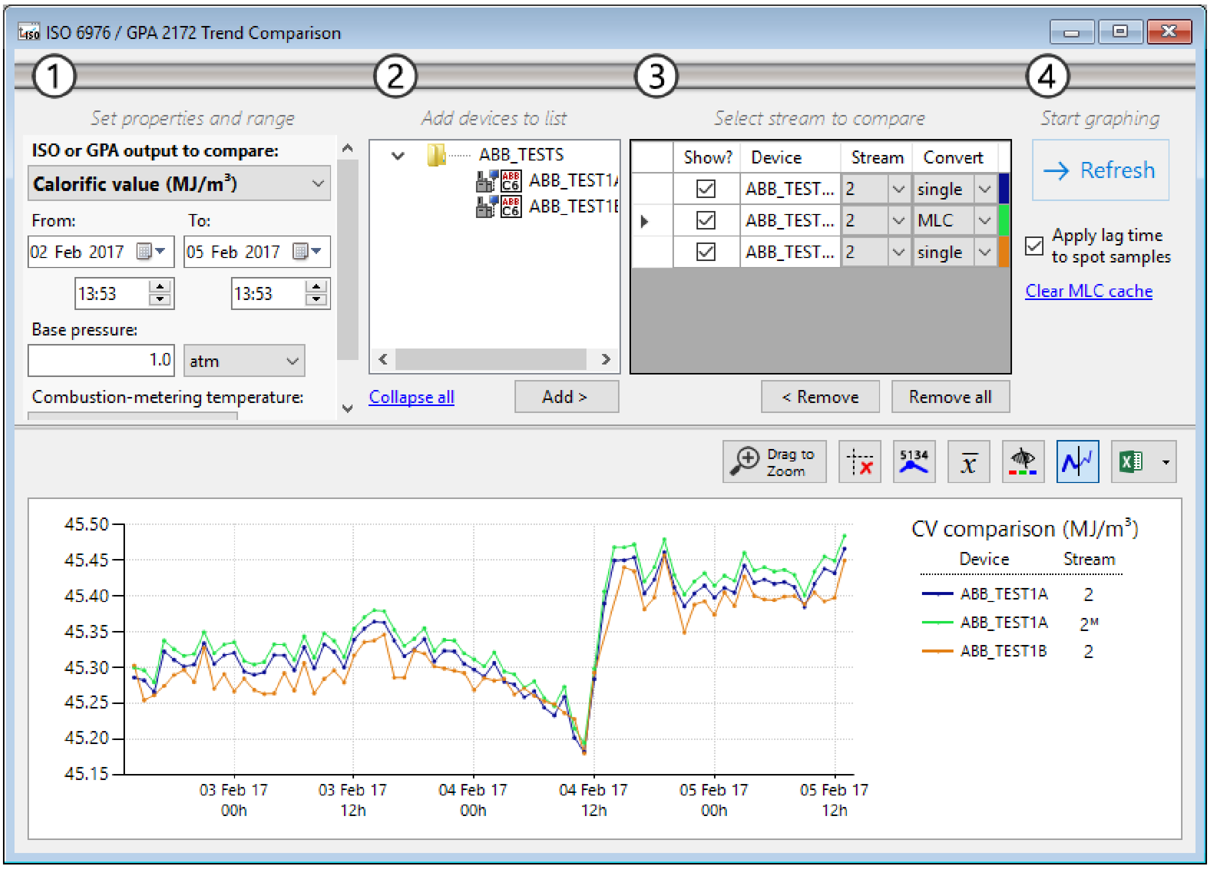
23.2.3 Start Graphing



When you are ready, click **Go**. GCAS loads the required mole composition data, calculates their ISO 6976 and GPA 2172 values, then renders the chart. The **Go** button turns into **Refresh** button unless you change the selected ISO 6976/GPA 2172 output, calculation properties, comparison date range, devices, stream numbers, or stream conversion.

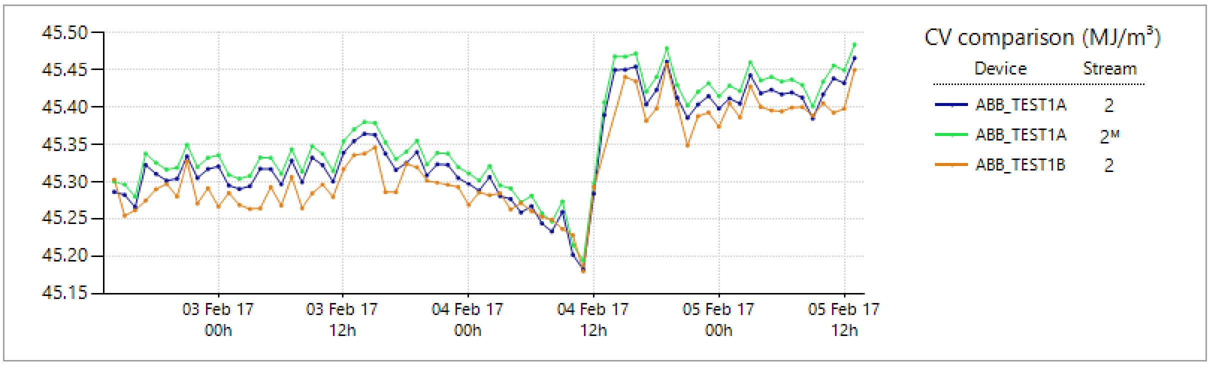
If you included one or more spot sample streams in the comparison list, the check box **Apply lag time to spot samples** shifts all spot sample dots to the right according to the amount of most recent lag time value of each dot. Head to chapter 25.2 Lag Time form to create new lag time records.

Users with *ISO 10723* feature in their licences see an additional command link **Clear MLC cache**. This clears the cache used by ISO 10723 conversion. The cache contains MLC coefficients, calibration certificates, single-point RF, MLC RF, and MLC constraints. Click this link if you notice ISO 6976/GPA 2172 trends based on multilevel-calibrated streams are not correct. Once the MLC cache is emptied, refresh the chart.



23.3 Comparison Chart

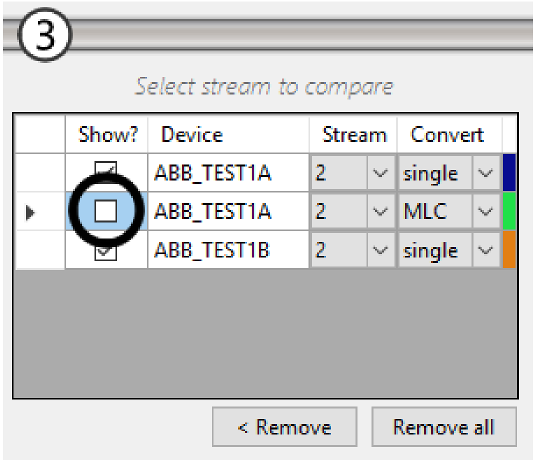
The chart graphs ISO 6976 or GPA 2172 output values based on mole composition records over time. This chart has maximum capacity of 15 comparison entries. The legend at your right-hand side tells the devices and their stream numbers. Multilevel-calibrated streams (ISO 10723) are indicated with superscript M after their number, like 2^M for stream 2. Exponential streams (only on ABB devices) are indicated with superscript E.



By default, GCAS renders the chart using thin lines, unlike all other charts in GCAS which use 2-pixel width. Line chart having data points less than 100 has small dot markers along its body. Line charts with more than 100 dots are presented without markers.

23.3.1 Show or Hide Some Devices

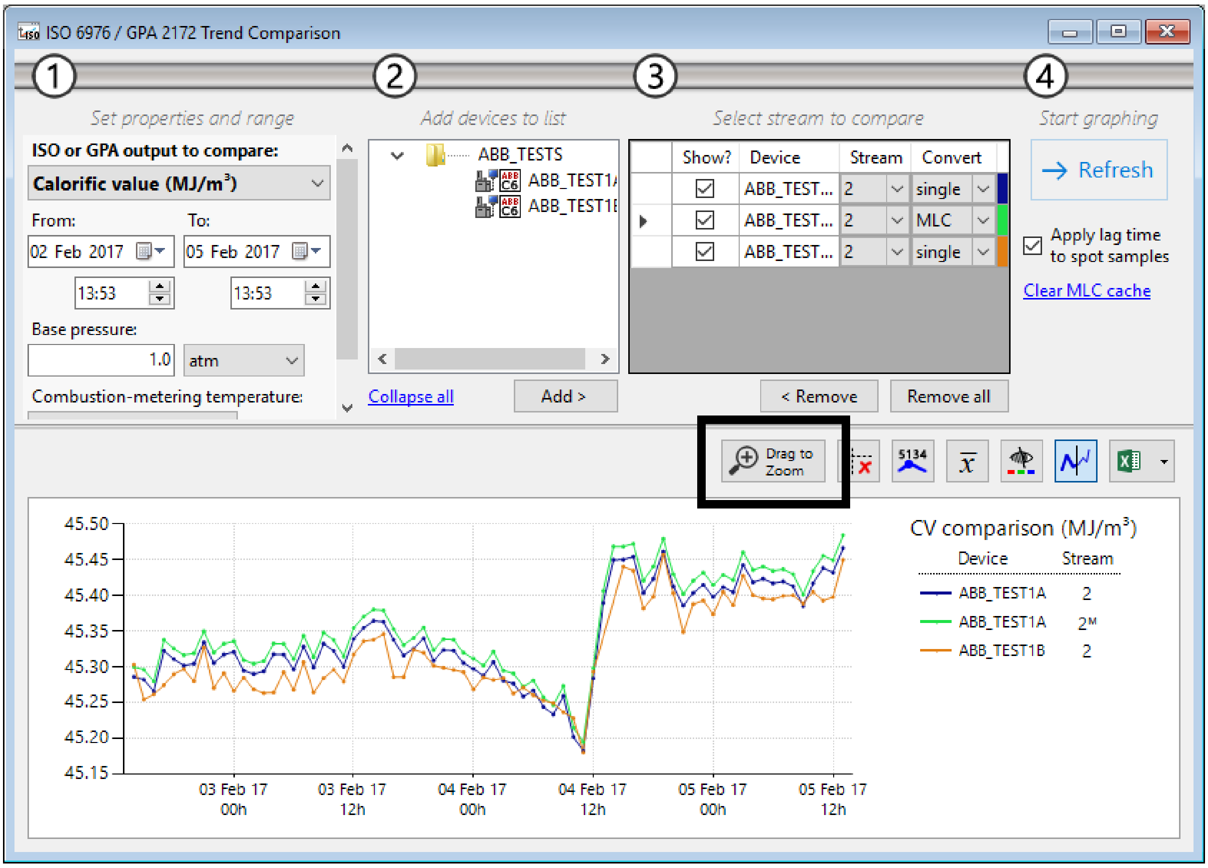
To temporarily take a comparison entry off the chart, untick its check box at the column **Show?** inside the comparison list. Check the check box to bring the line visible.



If you *remove* a device or stream from this list, its line chart is also removed. After you add the device or stream back, you need a full refresh to redraw the lost line.

23.3.2 Zoom Mode and Selection Mode

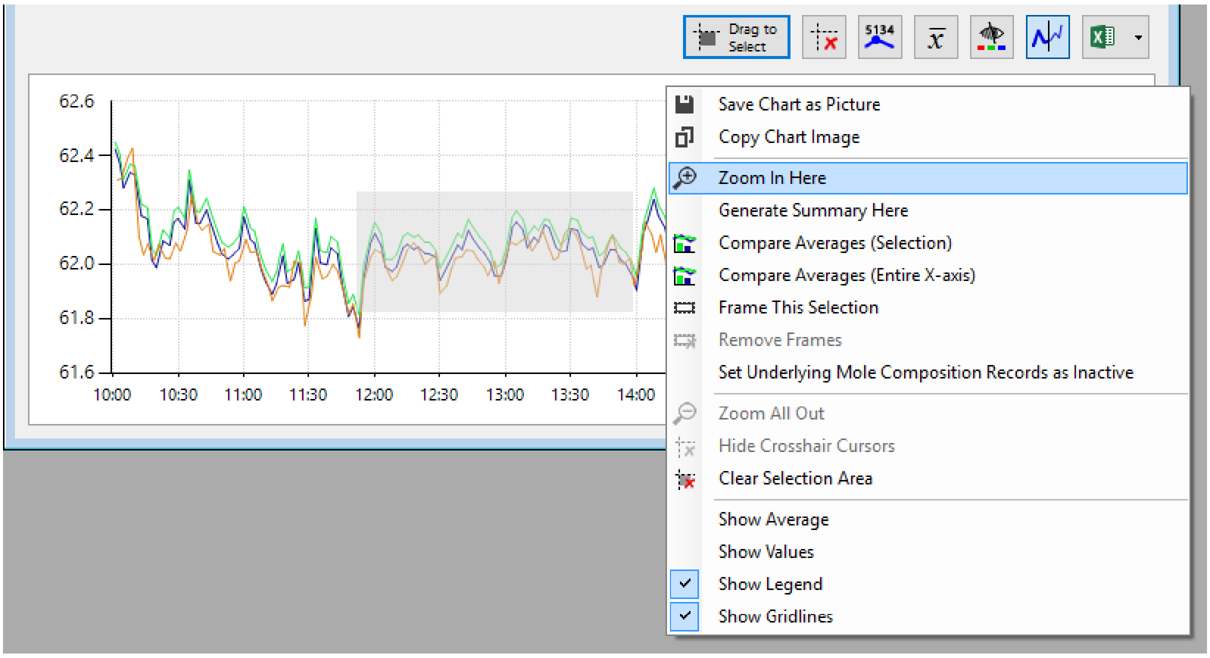
Click this button to switch between *zoom mode* and *selection mode*.



Toggle button to switch between zoom or selection mode.

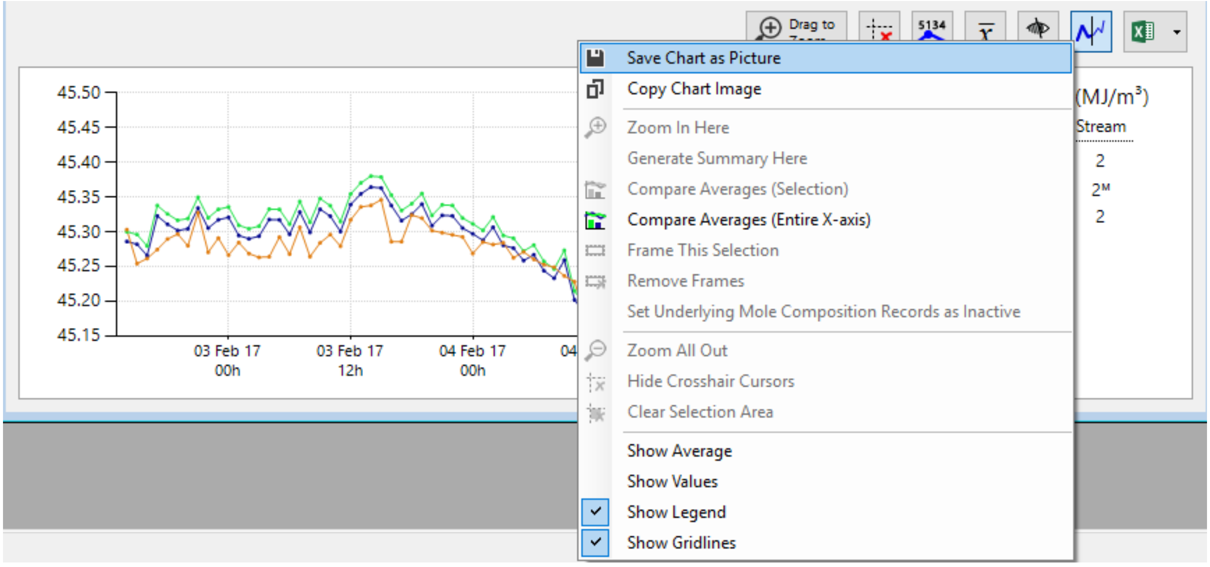
Zoom mode enables zooming to a specific area of the chart. Drag a rectangle over the area you want to zoom in. Pan around the chart using the provided scroll bars. Drag another rectangle to zoom in further. To zoom out, click the circled minus button ⊖ on both scroll bars. Press Home on your keyboard or right click the chart and select **Zoom All Out** to undo all zoom-in operations.

Selection mode lets you create a selection area on the chart, then makes some context menu available to manipulate the data inside this selection area. Chapter 23.3.5 explains the function of each menu. To clear selection area, right click the chart and select **Clear Selection Area**.



23.3.3 Save or Copy the Chart

To save the chart as image file, right click the chart and select **Save Chart as Picture**. Or if you prefer copying the image directly onto Microsoft Power Point for example (or any software accepting bitmap image), right click the chart and select **Copy Chart Image**.



23.3.4 Export Values to Microsoft Excel or CSV

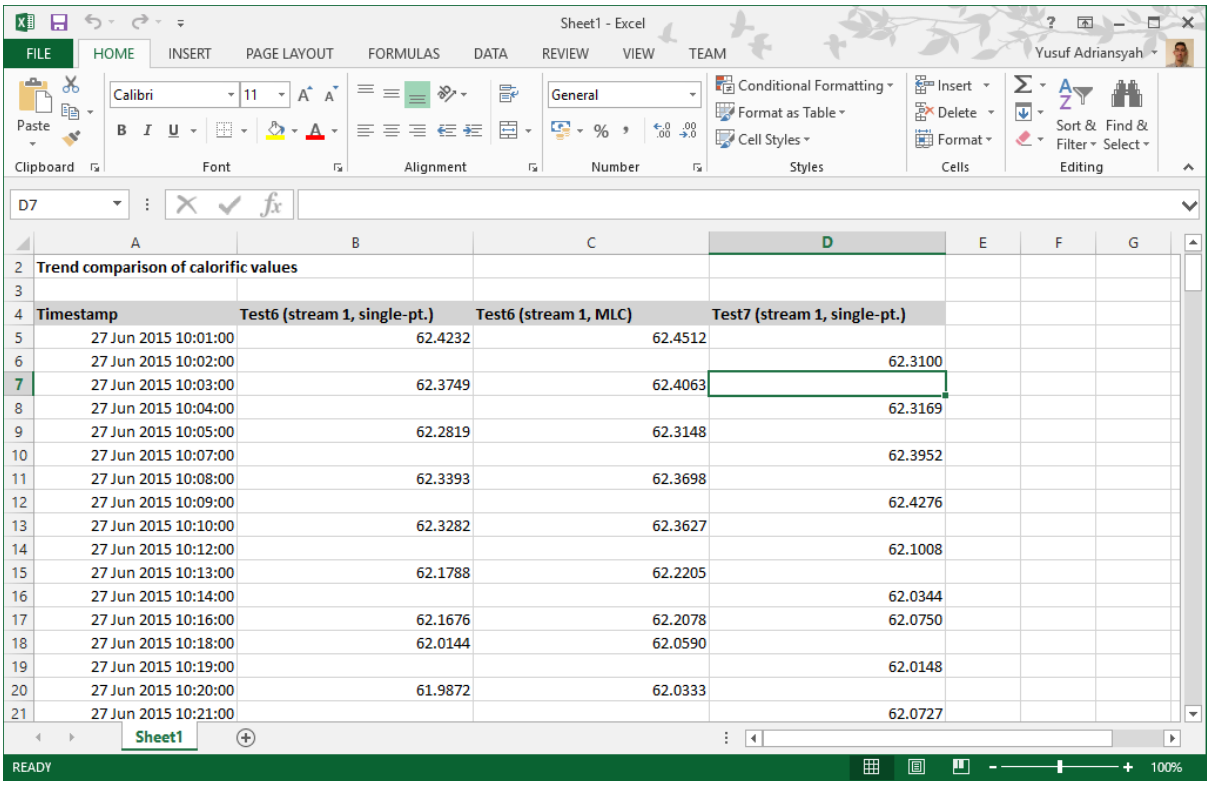
Above the chart, located at the rightmost button, click **Copy to Microsoft Excel**. This button opens a new Excel worksheet. Then GCAS writes all data points of all line charts available onto this worksheet.

Note

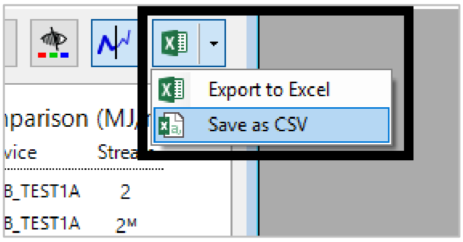
This feature requires Microsoft Excel 2010, 2013, 2016 or later, to be installed.

GCAS prevents you from exporting to Excel if there are duplicate comparison entries.
Duplicate = same GC device + same stream number + same conversion option.

Every device or stream in comparison list has its own column and the rows are timestamps. If there are two or more data points from different devices or streams sharing the exact same timestamp, they are merged into one row in Excel worksheet.

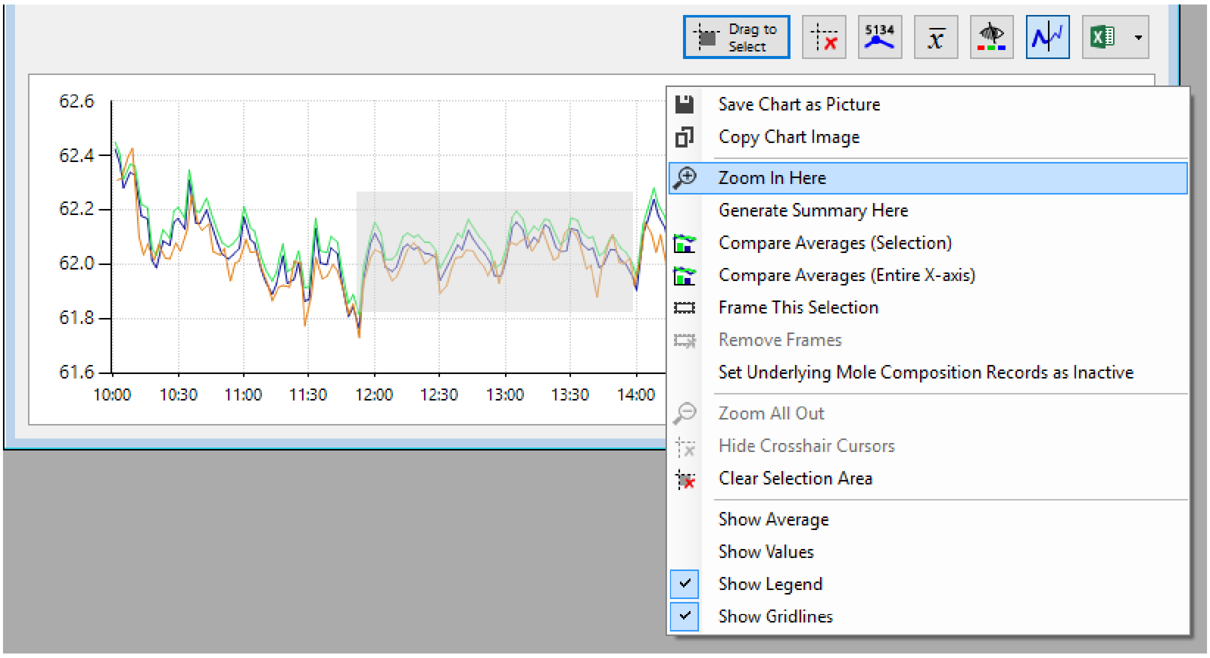


Should the comparison chart contain many records (> 200), it is much faster to export to CSV file instead. Open the dropdown menu of **Copy to Microsoft Excel** button and find the **Save as CSV** menu.



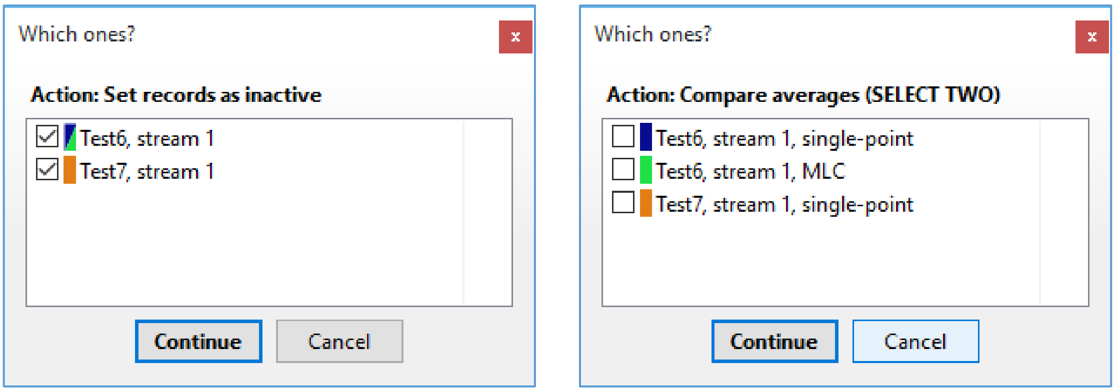
23.3.5 Selection Mode Menus

These menus are available if ISO 6976/GPA 2172 Trend Comparison form is in selection mode and there is a valid selection rectangle on the chart. Similar to Mole Composition Comparison, ISO 6976/GPA 2172 Trend Comparison requires a *contiguous* selection area. If there are several data points leaking out of your selection rectangle, GCAS alerts you while proposing a new selection area.



Menu	Function
Zoom In Here	Zooms in to the selection area.
Generate Summary Here	Generates statistical summary for the selected area.
Compare Averages (Selection)	Prompts you to select two comparison entries out of whichever available inside the selection area; then compares the average of the two, giving you the delta and difference in percentage. See chapter 23.3.6.2 for details.
Compare Averages (Entire X-axis)	Prompts you to select two comparison entries out of all lines available on the chart; then compares the average of the two, giving you the delta and difference in percentage. This menu does not even need a selection area. See chapter 23.3.6.2 for details.
Frame This Selection	Literally puts a rectangular frame around the selection, for presentation purpose. This works on the average chart too.
Remove Frames	Deletes all frames created through *Frame This Selection* menu.
Set Underlying Mole Composition Records as Inactive	As ISO 6976 and GPA 2172 calculation are based on mole composition records, this menu sets the underlying mole composition records contained inside the selection area as inactive. You need to refresh the chart afterwards. If your selection rectangle covers more than one line chart, GCAS prompts you to select which ones to set as inactive.

These menus **Compare Averages** (both of them) and **Set Underlying Mole Composition Records as Inactive** may display a confirmation dialogue like the ones in the next page. Setting mole composition records as inactive should merge a pair of single-point and MLC entries of the same device same stream number into one entity. Average comparison requires you to select exactly two entries.



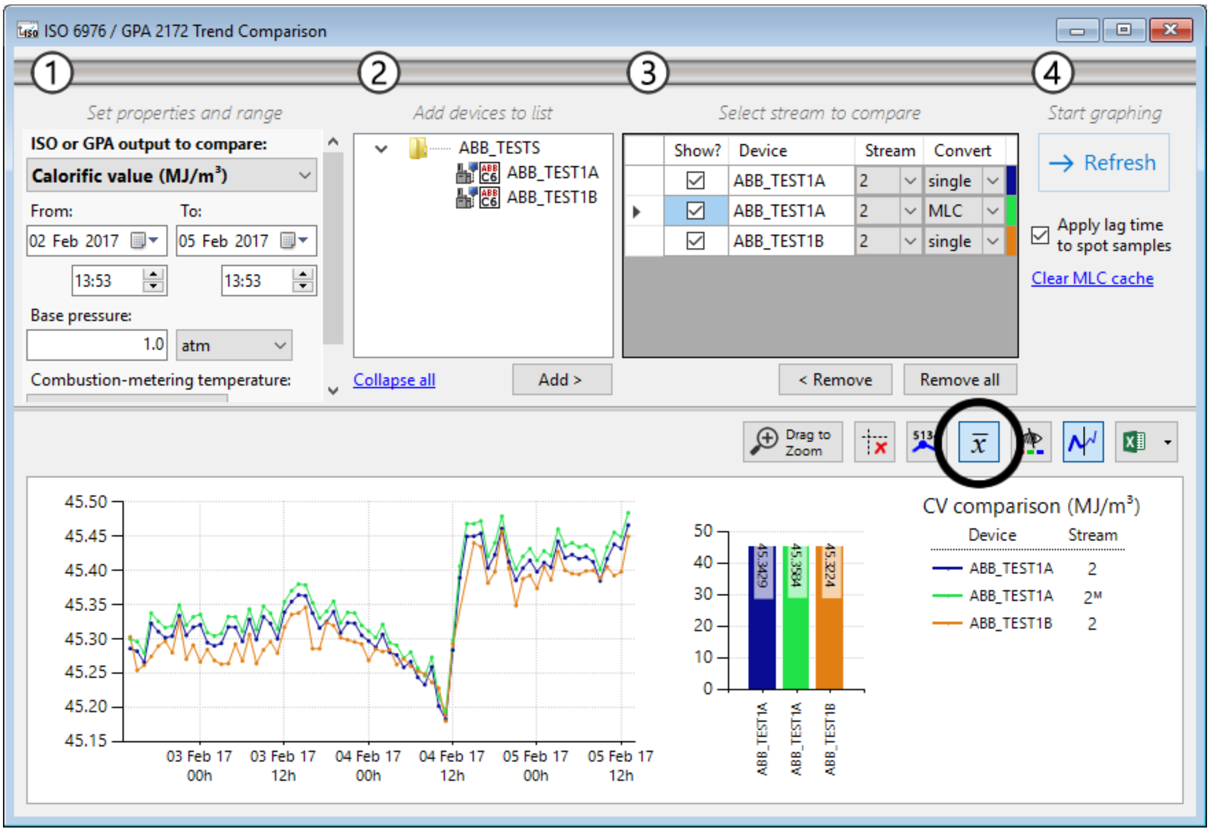
Confirmation dialogue boxes.

23.3.6 Comparison of Averages

ISO 6976/GPA 2172 Trend Comparison form offers two methods for average comparison. For quick and rough visual comparison, use the average chart. For detailed comparison, use the right-click menu **Compare Averages**.

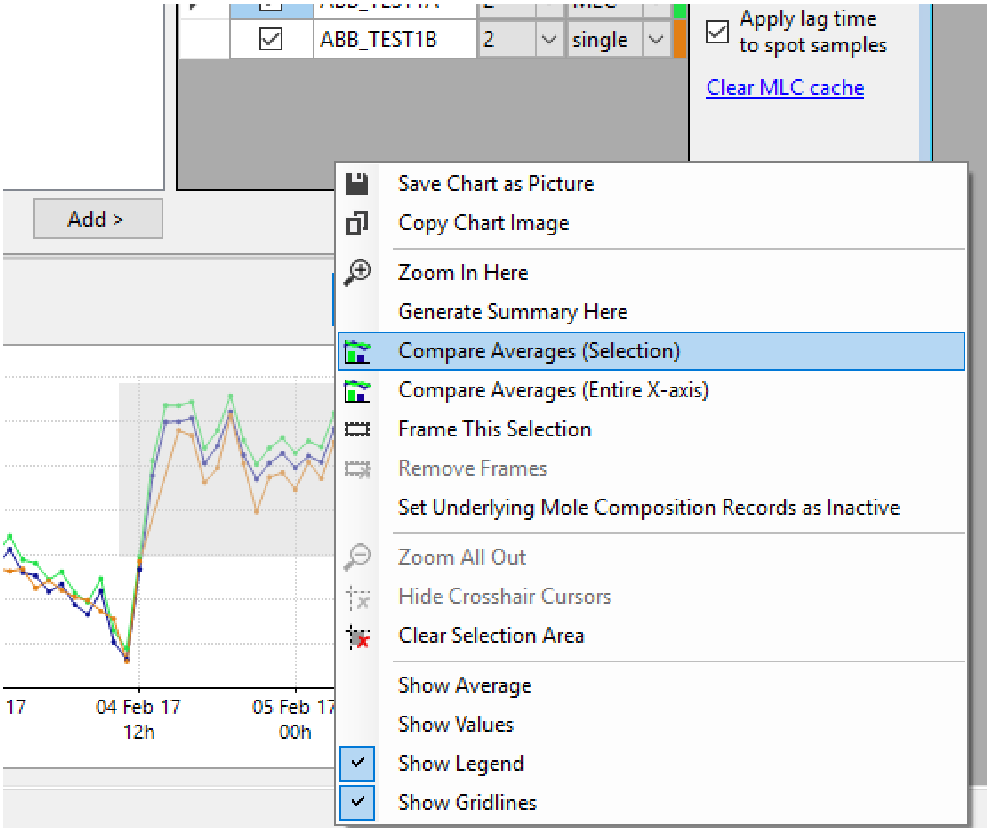
23.3.6.1 The 'Average' Chart

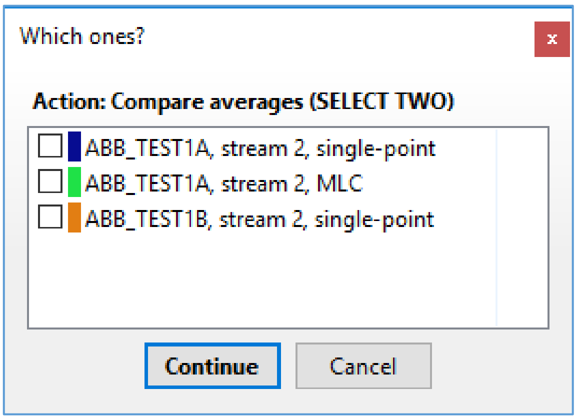
For a rough visual comparison, ISO 6976/GPA 2172 Trend Comparison form provides an additional bar chart that shows the average value of every comparison entry. Click **Show average** button (the one having $\bar{x}$ symbol) to reveal this chart. The average value of each bar is displayed on the label sitting at the top end of the bar.



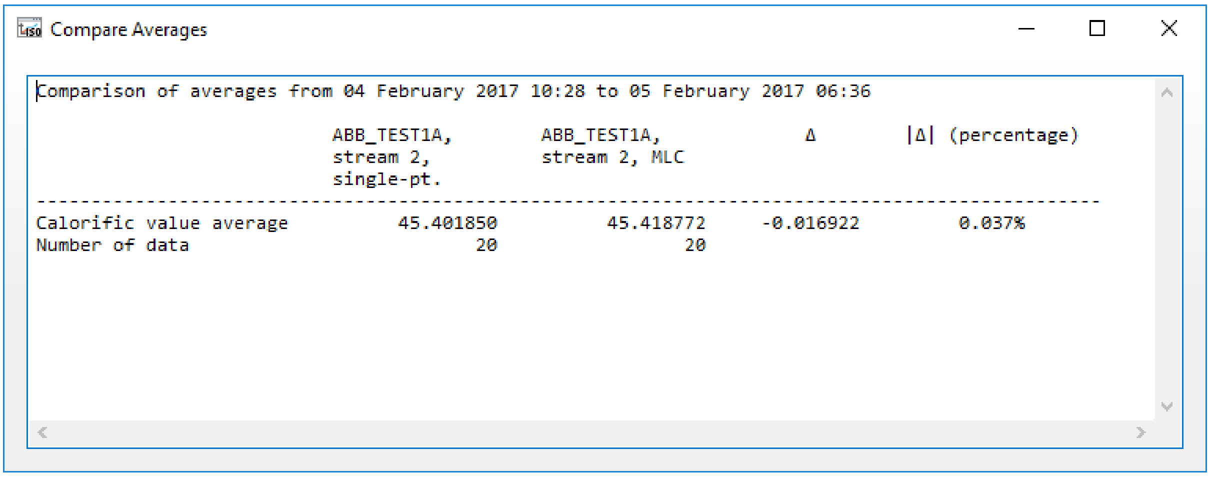
23.3.6.2 'Compare Averages' Menu

Sometimes users need a more detailed information of how two comparison entries differ to each other. To do this, switch the chart to selection mode. Afterwards, either draw a selection rectangle and right click then choose **Compare Averages (Selection)**, or right click without a selection and select **Compare Averages (Entire X-axis)**. If your chart or selection rectangle contains more than two lines, you are prompted to select two among them.





Next, GCAS builds a comparison and displays them on a text viewer window similar to this one on the next page.



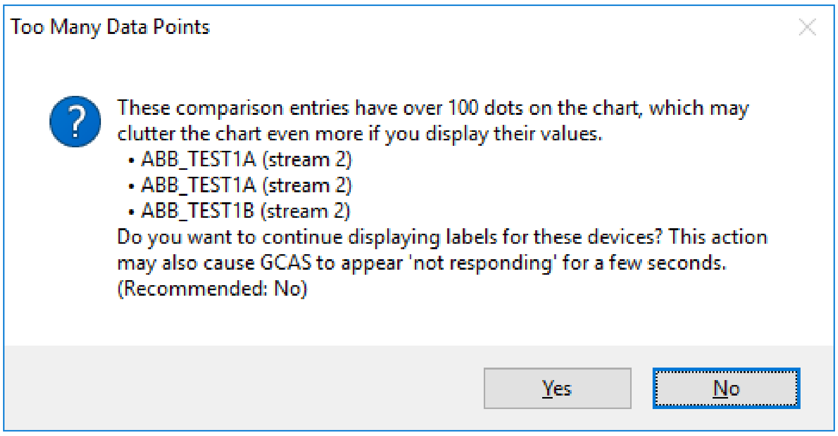
First row is the comparison. First column is the first comparison entry which was selected on the previous dialogue box, let's call it A. Next column is the second comparison entry, let's call it B. Then the delta is A minus B, and finally you get absolute difference in percentage relative to A.

Second row contains number of data (*N*) used to calculate the average. The reason is ISO 6976/GPA 2172 Trend Comparison form can compare trends between devices, and each GC device may not have the same number of data.

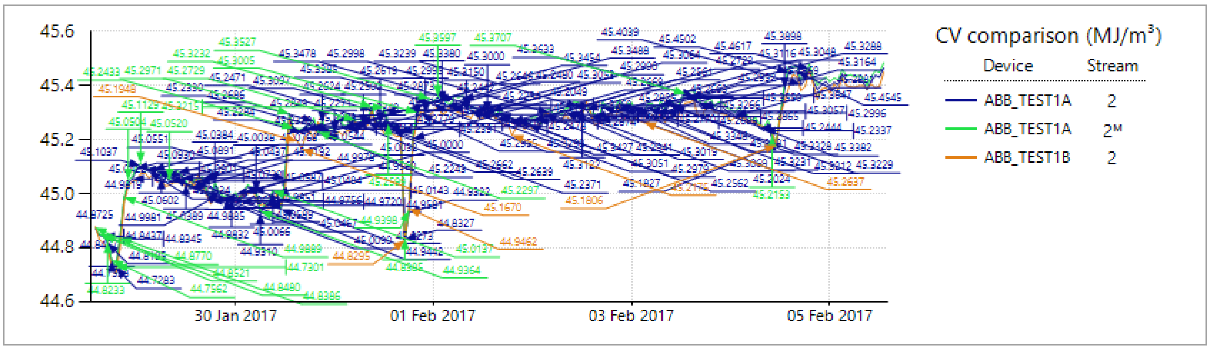
23.3.7 Other Visual Cues

By default, GCAS draws the chart using a thin line. The toggle button **Use thin lines** is pressed. If you prefer the usual thick lines, click this button to raise it from its pressed state.

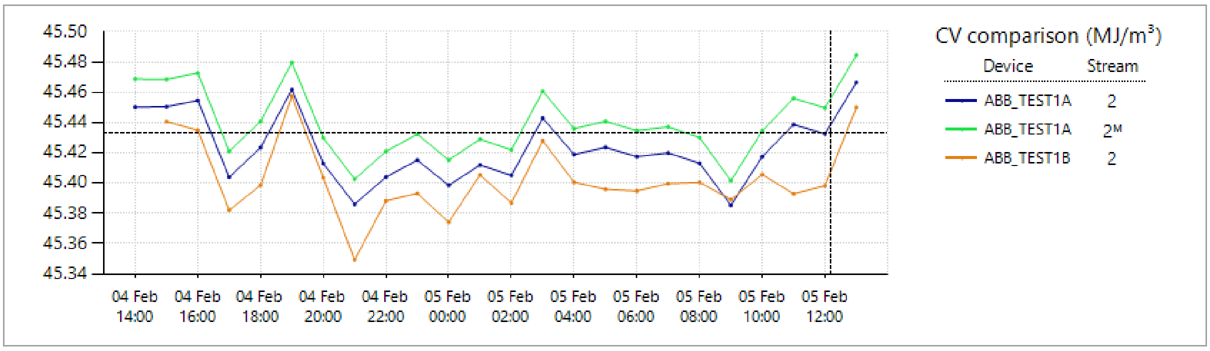
Click **Show values** or right click the chart and select **Show Values** to display the ISO 6976 or GPA 2172 values. GCAS presents a warning if one or more devices have over 100 dots on the chart. We do not recommend displaying value labels on line charts with over 100 dots because it will clutter the chart area.



This is how the chart would look like if the user clicked **Yes** anyway.

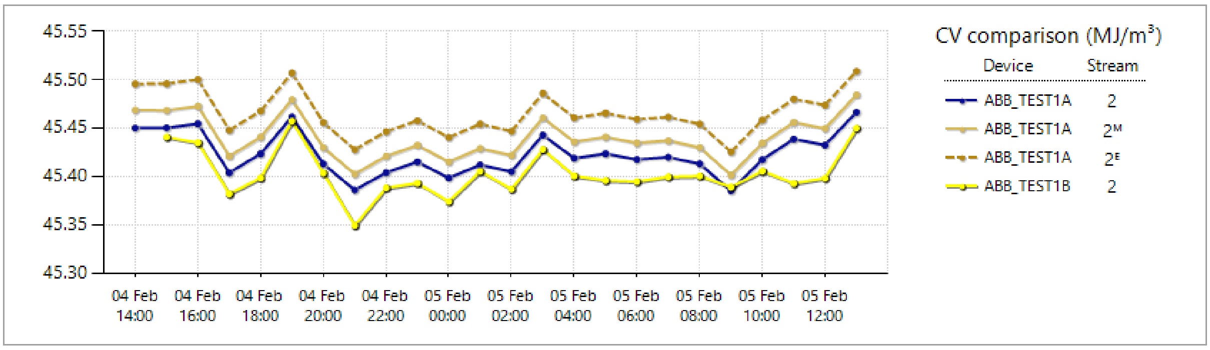


These dashed lines in the screenshot down here are *cursors*. Cursors appear when you click on a chart or as a remnant of zoom operation. Cursor may act as a ruler line to compare Y-axis values of two data points. Click **Hide crosshair cursors** or right click the chart and select **Hide Crosshair Cursors** to hide these lines from view.



23.3.8 Colourblind Assistance

To aid users with colour blindness (protanopia and deuteranopia), GCAS provides an alternative colour scheme for the chart. Use the **Colourblind assist** button to switch colour scheme.



CV trend comparison chart with colourblind assist turned on.

Colourblind assistance works better if you use thick lines because thick lines have subtle shadow to aid the user distinguishing the yellow line and white background.

24 ISO 10723

ISO 10723:2012 is a standard method used to adjust values in non-linear GC devices. Support for ISO 10723 first came in GCAS version 1.6.0.0. We gradually added more features and modules and finally full support of ISO 10723 was completed in version 1.7.3.0. With ISO 10723, GCAS makes a differentiation between *single-point* and *multilevel-calibrated* (MLC) response factor and mole composition.

All subchapters in this chapter assume you have GCAS feature *ISO 10723* included in your licence.

24.1 MLC Coefficients (Concept)

Multilevel calibration coefficients (abbreviated MLC coefficients) are the coefficients of the *analysis function* as described in ISO 10723 standard. Similar to uncertainty coefficients, although not about the same meaning, MLC coefficients consist of four coefficients. These four come from the equation

$$y = a + bx + cx^2 + dx^3$$

where y is multilevel-calibrated peak area, x is single-point peak area, and a, b, c, d are the MLC coefficients. Coefficient a and b are mandatory, and also b must not equal to zero. Coefficient c and d are not always present in the analysis function, depending on the GC.

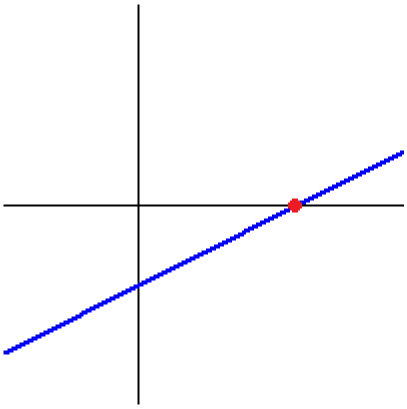
The term *coefficient set* refers to collection of MLC coefficients for all gases. Every gas has their own analysis function/equation, thus has their own coefficients. These coefficients are bundled together into one record of *MLC coefficient set* in GCAS database.

24.2 MLC Constraints (Concept)

Multilevel calibration constraints (abbreviated MLC constraints) are a set of rules to determine which root to use in polynomial MLC to single-point conversion. The opposite direction, single-point to MLC conversion, doesn't need constraints. MLC constraints consist of linear constraint, quadratic constraint, and cubic constraint. Recall the equation of analysis function:

$$y = a + bx + cx^2 + dx^3$$

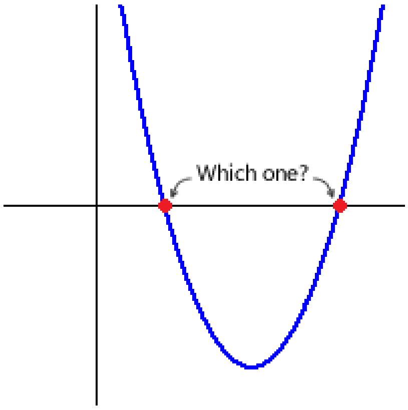
During MLC to single-point conversion, the task is "given this y value, find x that satisfies this equation". A polynomial function may have several roots (solutions) therefore MLC to single-point conversion requires constraints to select the correct root. On the other hand, single-point to MLC conversion is much easier. "Find y, given this x value" means GCAS simply substitutes the x and evaluate the function to get y.



Linear constraint

If the coefficient *c* and *d* are zero, the equation becomes $y = a + bx$ which is linear. Linear functions are guaranteed to have one root, but it can be negative.

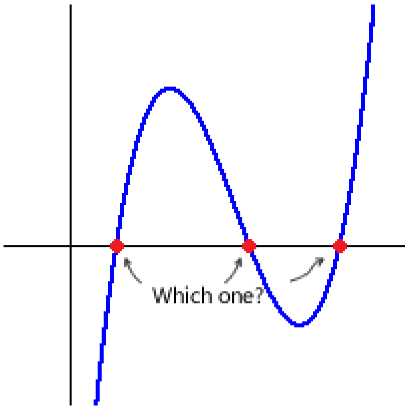
Linear constraint tells GCAS to disregard the negative root (then set *x* into zero), or to take absolute value in order to make the *x* positive. The default is to reject (disregard) negative root.



Quadratic constraint

If the coefficient *d* is zero, the equation becomes $y = a + bx + cx^2$ which is quadratic. Quadratic functions may have two real roots, one real root, or no real roots at all (solution is imaginary root).

GCAS always disregards imaginary root and sets *x* to zero, as well as any real roots which are negative. But in cases of one or two positive roots, quadratic constraint tells GCAS to use either the smallest positive or largest positive. The default is to use the smallest positive.



Cubic constraint

If all the coefficients are non-zero, the equation is cubic. Cubic functions may have one real root (+ 2 imaginaries), two real roots, or three real roots. Even though every possibility contains real roots, the roots may be negative. GCAS always rejects negative real roots. That leaves the positive ones, which are subject to the constraints described below. One exception: if all roots are negative, GCAS sets the *x* into zero.

GCAS has different cubic constraint depending what type of record is being converted. For response factor, GCAS offers four choices:

1. Use the smallest positive,
2. Use the largest positive,
3. Use the one which yields a single-point RF value inside a range, or
4. Use the one which yields a single-point RF value *inside or closest to* a range.

If you choose option 3 or 4, you have to set the range's lower and upper bound. The default is between 500,000 and

25,000,000 because typical single-point RF values fall between that range.

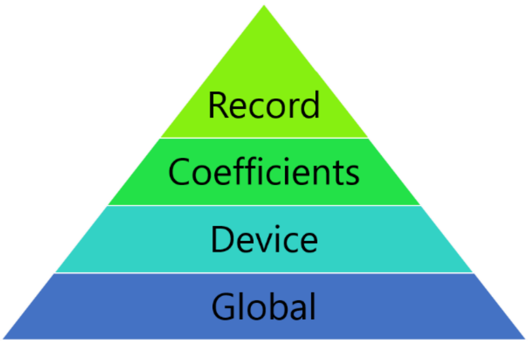
For mole composition, GCAS offers another four choices:

1. Use the smallest positive,
2. Use the middle one if there are 3 roots, or smallest one if there are 2 roots,
3. Use the middle one if there are 3 roots, or largest one if there are 2 roots, or
4. Use the largest positive.

In both cases, the default cubic constraint is option 1.

Most of the time, you don't have to worry about MLC constraints. As far as we tested, the default constraint has worked for vast, vast majority of RF and mole composition records. There is a tiny tiny chance the default constraints do not produce the expected result, which in this case you need to override the MLC constraints. Visit chapter 24.3 to read more about levels of MLC constraints override, or chapter 24.5 for how to actually override the MLC constraints.

24.3 MLC Constraints Override Level (Concept)



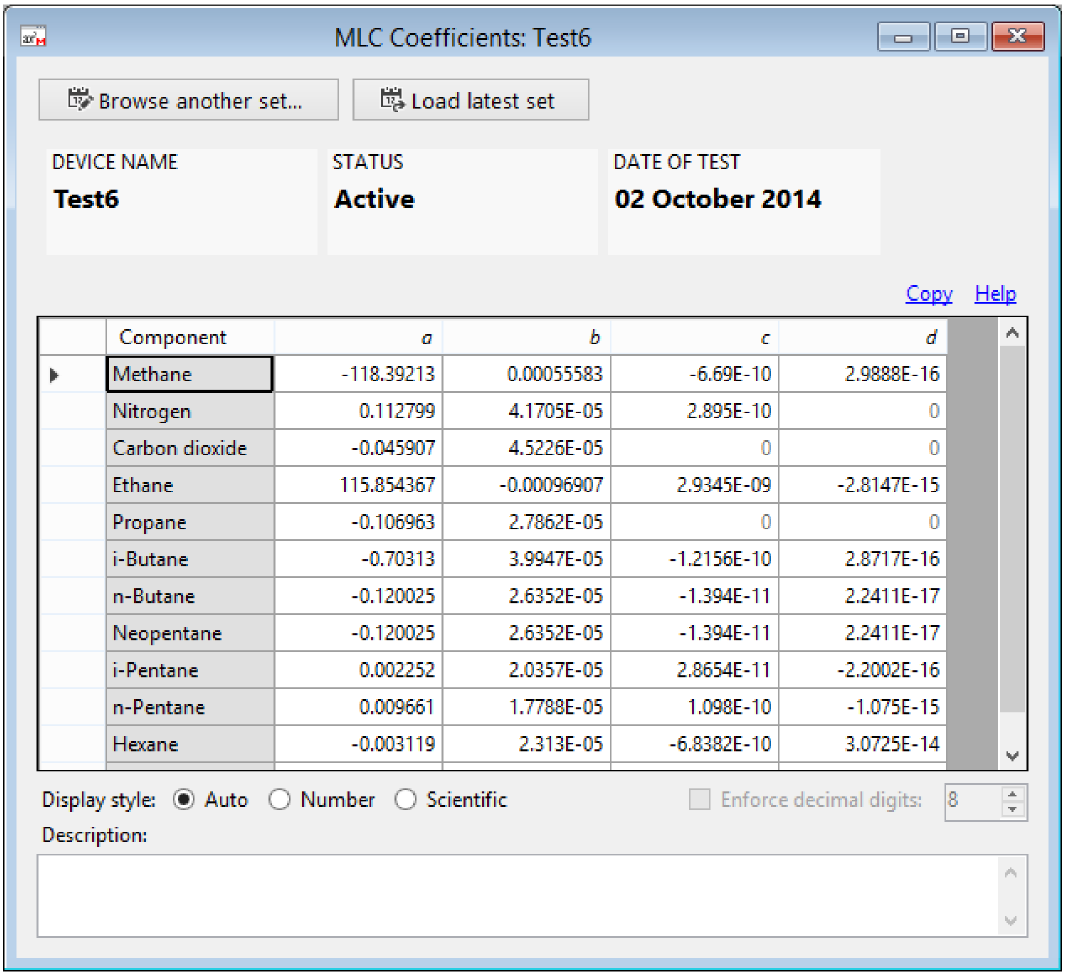
MLC constraints have a scope. From the most generic to the most specific, the order of scopes is: *global*, *device*, *coefficient*, and *record*.

Global constraints are hardcoded inside your GCAS database. The factory values are reject negative root for linear functions, use smallest positive for quadratic functions, and use smallest positive for cubic functions—although you can change these global constraints if required. Second level of override is **device-level**. All ISO 10723 conversions on this device will use these MLC constraints instead of global constraints. Third level of override is **coefficient-level**. All records using a particular MLC coefficient set shall use these constraints instead of the device-level constraints. But records using another MLC coefficient set will use other coefficient-level constraints if that coefficient set has one, or fall back onto device-level if not. Fourth level is **record-level**. On this level, the MLC constraints apply to that record only. Other records may have either their own record-level constraints, or fall back onto coefficient-level.

While GCAS is converting from MLC records to single-point, GCAS loads MLC constraints from the most specific which is at record-level. If current record has no record-level override, GCAS moves down one step and looks for coefficient-level override. If the MLC coefficients used by this record has no overridden MLC constraints, GCAS moves down one step again and looks for device-level override. If current GC device has no MLC constraints defined either, then GCAS falls back to the global MLC constraints.

24.4 The Multilevel Calibration Coefficients Form

Multilevel Calibration Coefficients form, abbreviated as *MLC Coefficients* form, is a form to enter or edit MLC coefficients of a GC device. Select the desired device from your device panel or recent device panel, then go to View menu > **Multilevel Calibration Coefficients**.


MLC Coefficients: Test6

Browse another set... | Load latest set

DEVICE NAME **Test6** | STATUS **Active** | DATE OF TEST **02 October 2014**

Copy Help

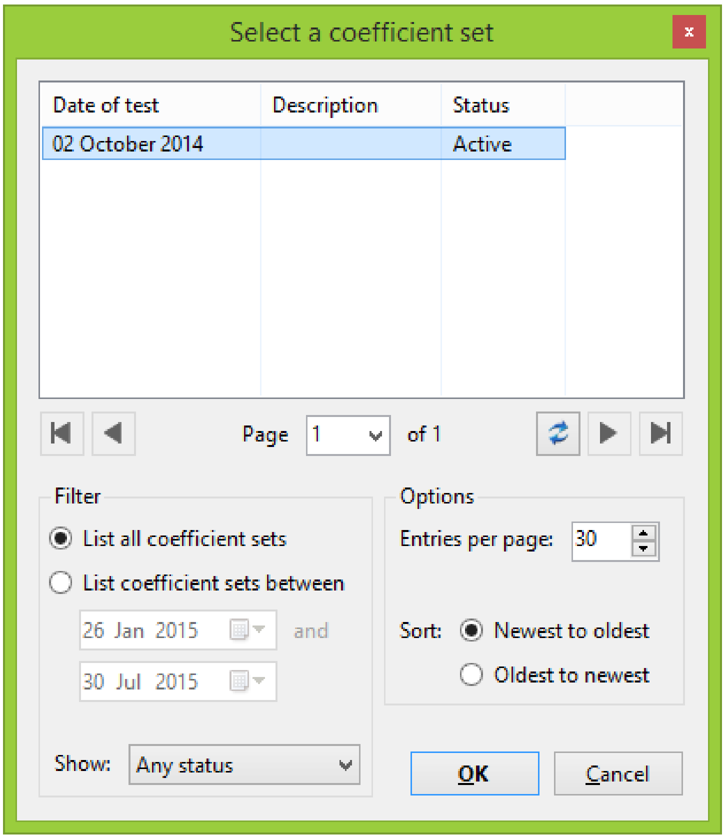
Component	a	b	c	d
Methane	-118.39213	0.00055583	-6.69E-10	2.9888E-16
Nitrogen	0.112799	4.1705E-05	2.895E-10	0
Carbon dioxide	-0.045907	4.5226E-05	0	0
Ethane	115.854367	-0.00096907	2.9345E-09	-2.8147E-15
Propane	-0.106963	2.7862E-05	0	0
i-Butane	-0.70313	3.9947E-05	-1.2156E-10	2.8717E-16
n-Butane	-0.120025	2.6352E-05	-1.394E-11	2.2411E-17
Neopentane	-0.120025	2.6352E-05	-1.394E-11	2.2411E-17
i-Pentane	0.002252	2.0357E-05	2.8654E-11	-2.2002E-16
n-Pentane	0.009661	1.7788E-05	1.098E-10	-1.075E-15
Hexane	-0.003119	2.313E-05	-6.8382E-10	3.0725E-14

Display style: Auto Number Scientific | Enforce decimal digits: 8

Description:

24.4.1 View Previous Coefficient Sets

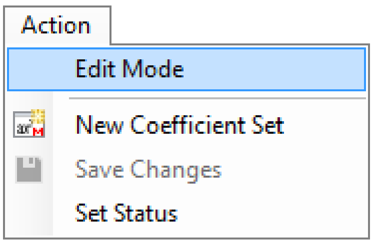
Click **Browse another set** at the top of the form. This button shows the *Select a coefficient set* dialogue. Select the desired coefficient set then click **OK** or double click on the list item.

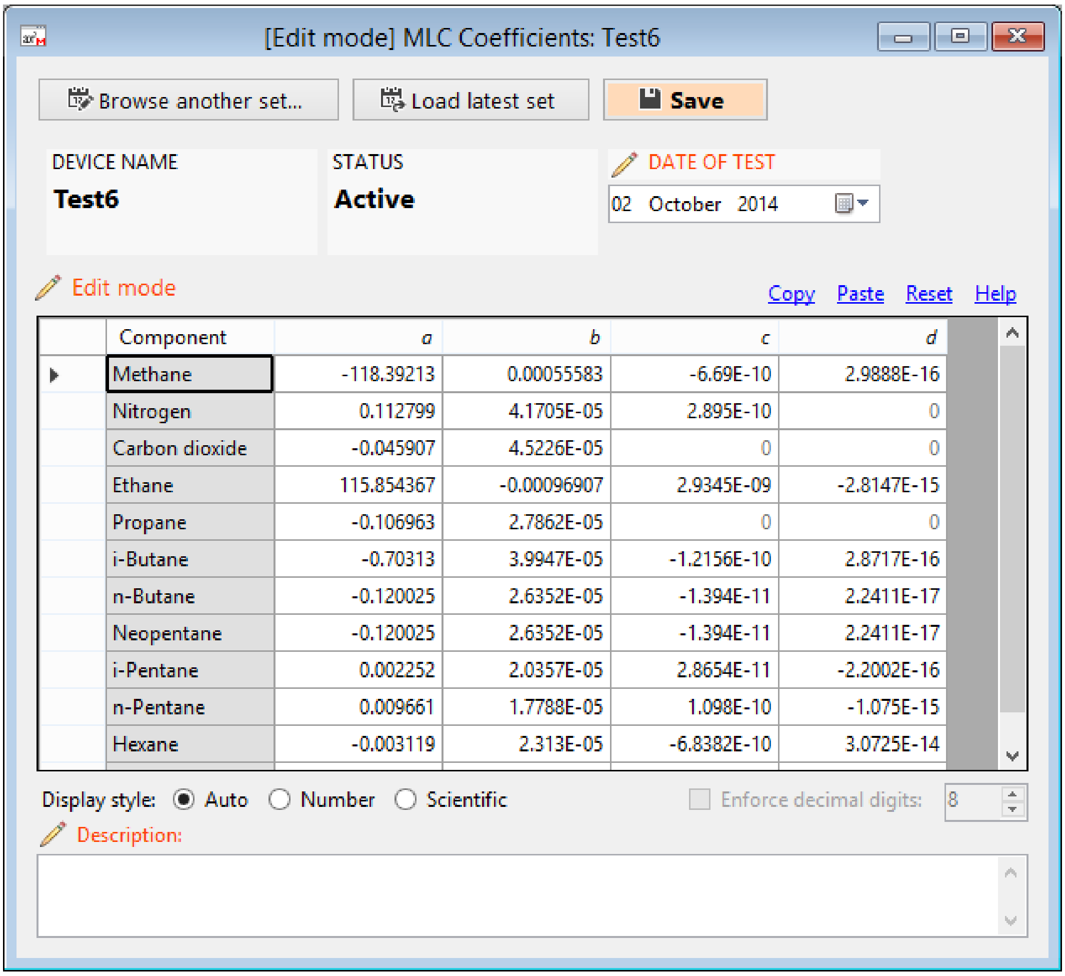


You can always return to the latest coefficient set through **Load latest set** button.

24.4.2 Edit Mode

In order to edit the coefficients or the description, you need to put MLC Coefficients form in *edit mode*. Open the Action menu and select **Edit Mode**. You know the form is on edit mode when you see pencil icon, some labels are coloured orange, and there is a **Save** button at the top region of the form.





During edit mode, you can edit the numbers in the grid. **Date of test** field at the top and **Description** text box at the bottom of the form also become editable.

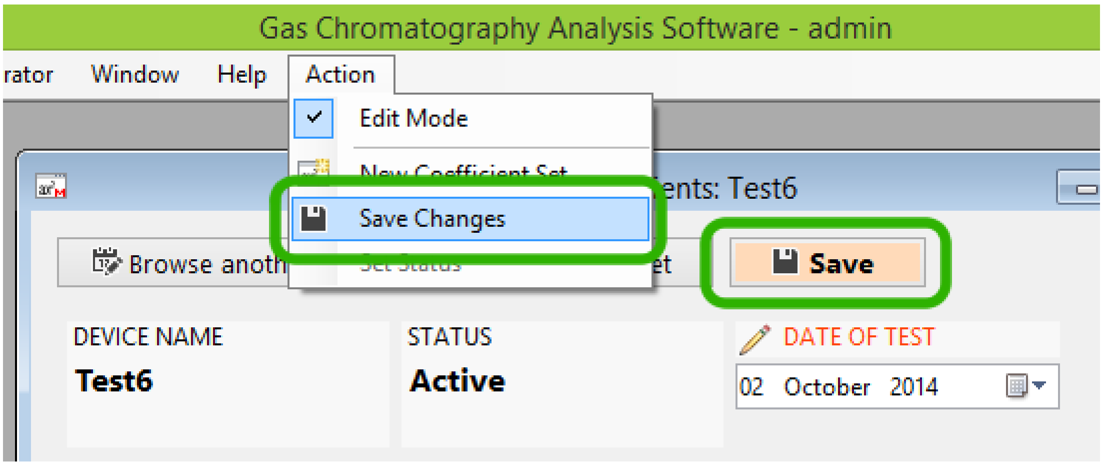
Note

Edit mode is mainly intended for editing the description or correcting minor mistakes. If there are too many coefficients to edit, we suggest you to create a new set and set this record to inactive instead.

MLC Coefficients form does not have comment feature. Put short comments in the description text box if you like.

You can paste the coefficient numbers from Microsoft Excel or other spreadsheet editing software, as long as there are 4 columns and equal number of rows. Click **Paste** link above the grid to paste the numbers. The **Reset** link resets all numbers in the grid back to zero.

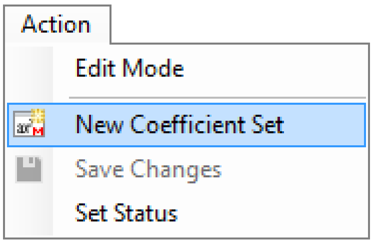
When you finished editing the numbers and the description, click **Save** button or go to Action menu > **Save Changes** to commit the change. The form exits its edit mode and becomes read-only again.



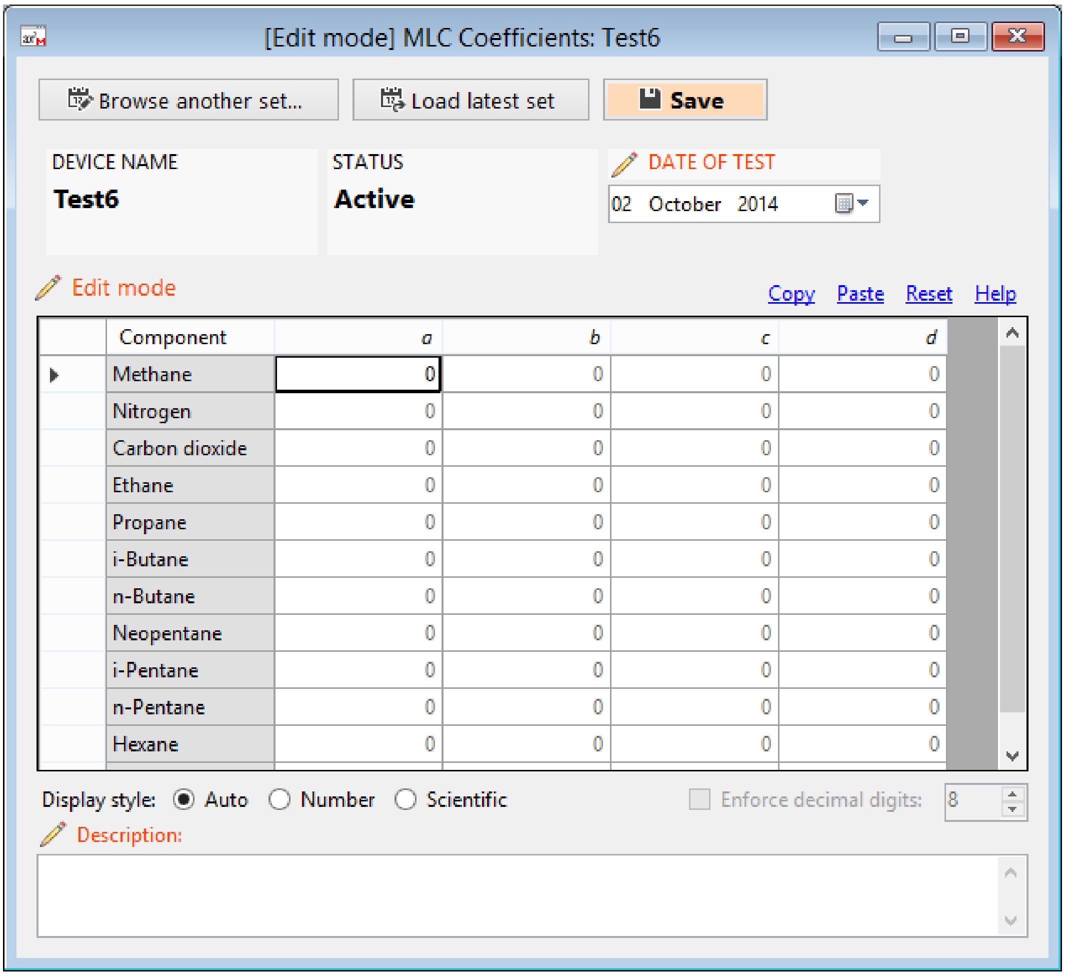
Otherwise to cancel editing and discard all of your changes, open Action menu and select **Edit Mode** again to remove its tick mark. This will exit edit mode and reload the coefficient set from the database.

24.4.3 Create New Coefficient Set

From an open MLC Coefficients form, open the Action menu and select **New Coefficient Set**. This menu creates a blank coefficient set (all zeroes) with the timestamp set to current computer time.



Begin entering the coefficient values one by one. Be alert for potential human error. Alternatively, you can paste the coefficients from Microsoft Excel or other spreadsheet editing software as long as there are 4 columns and equal number of rows. Click **Paste** to do so.



Don't forget to set the date of test. This is the date information of when the multilevel calibration was conducted, not the date of when the coefficients were entered.

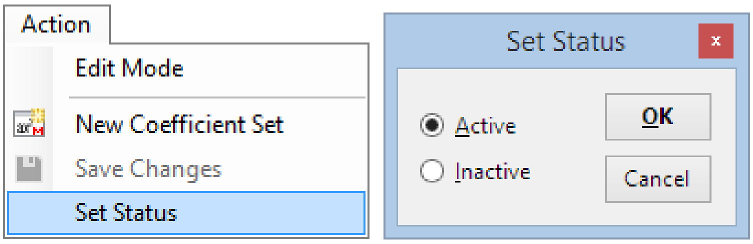
Write the description. It is a good practice to provide a description about this coefficient set.

When you are finished, click **Save** button or go to the Action menu > **Save Changes** to save these co-efficients into database. Otherwise to cancel all of these, go to the Action menu > **Edit Mode** to re-move its tick mark. The form will revert to the last record viewed.

24.4.4 Change Record Status

Like other types of record in GCAS database, MLC coefficient set has a status bit indicating whether the record is active or inactive. Inactive coefficient sets are not used for MLC conversions; thus GCAS will look further backward to find the previous active coefficient set.

To change status, open the Action menu and select **Set Status**. This menu brings the *Set Status* dia-logue where you can flip the status bit from active to inactive or vice versa.



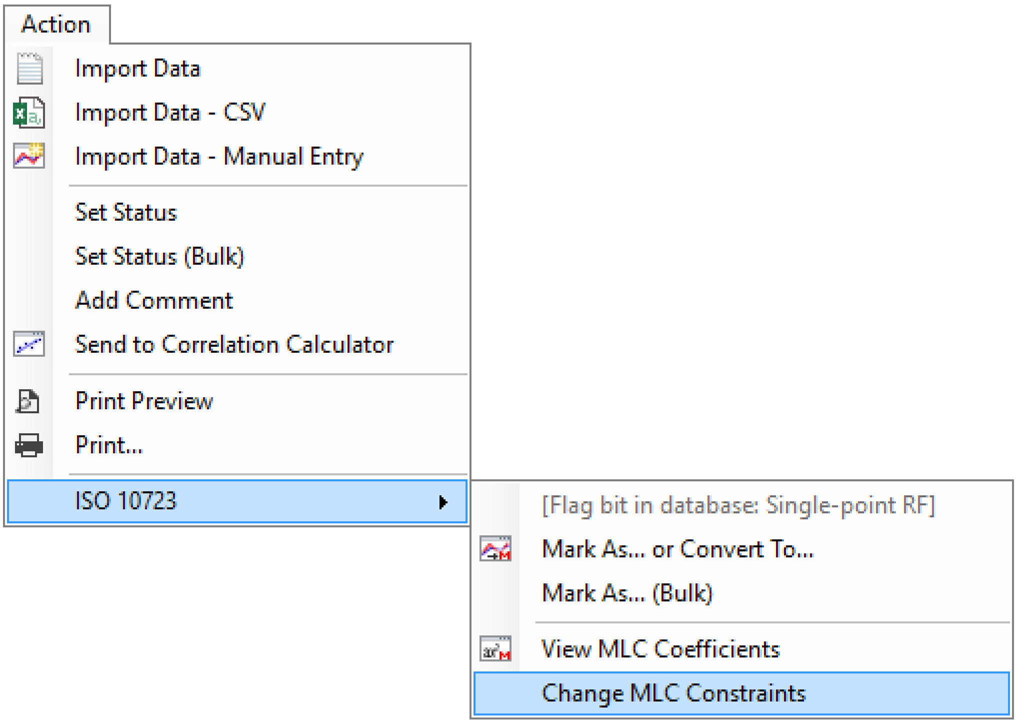
Click **OK** and GCAS will update the new status which then instructs the MLC Coefficients form to re-load the set with the new status.

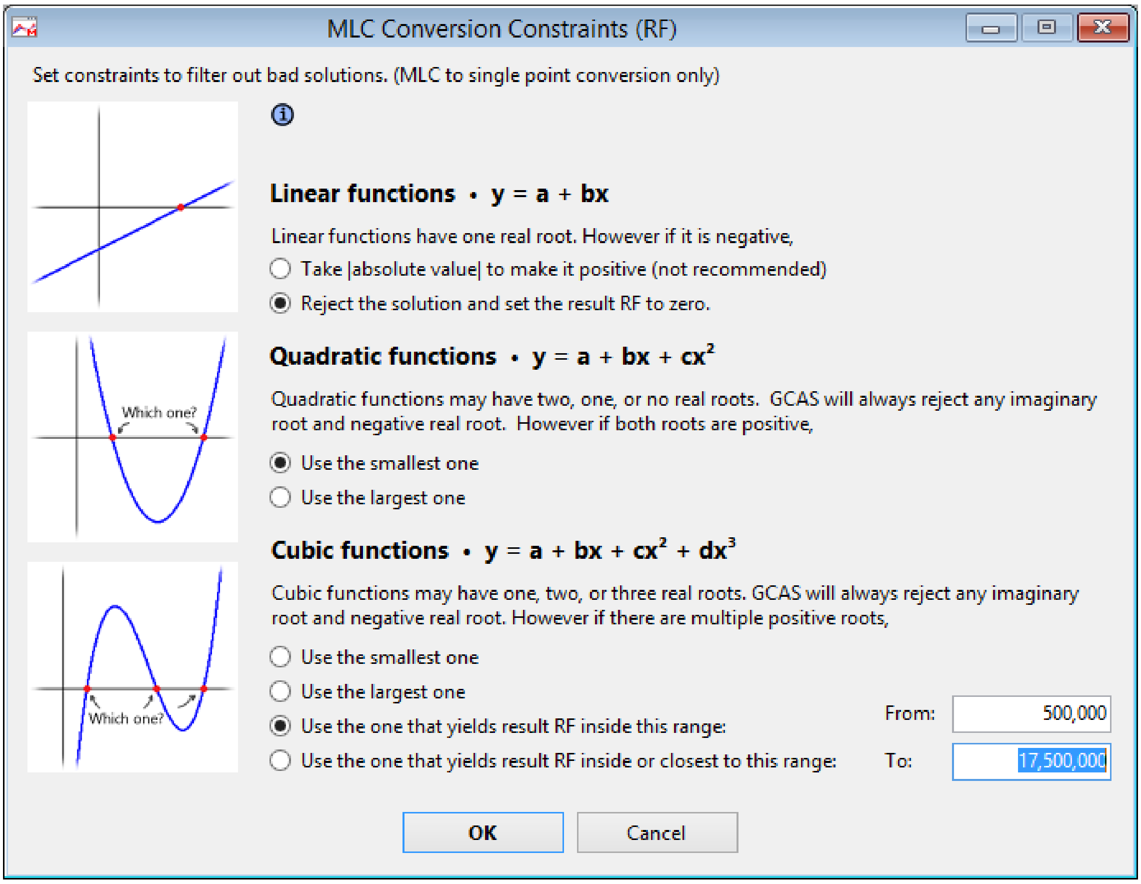
24.5 Overriding MLC Constraints

Chapter 24.2 already explained what MLC constraints are, and chapter 24.3 explained four levels of MLC constraints. This chapter explains how to actually override MLC constraints if the global or predefined constraints produce nonsensical RF or mole composition values.

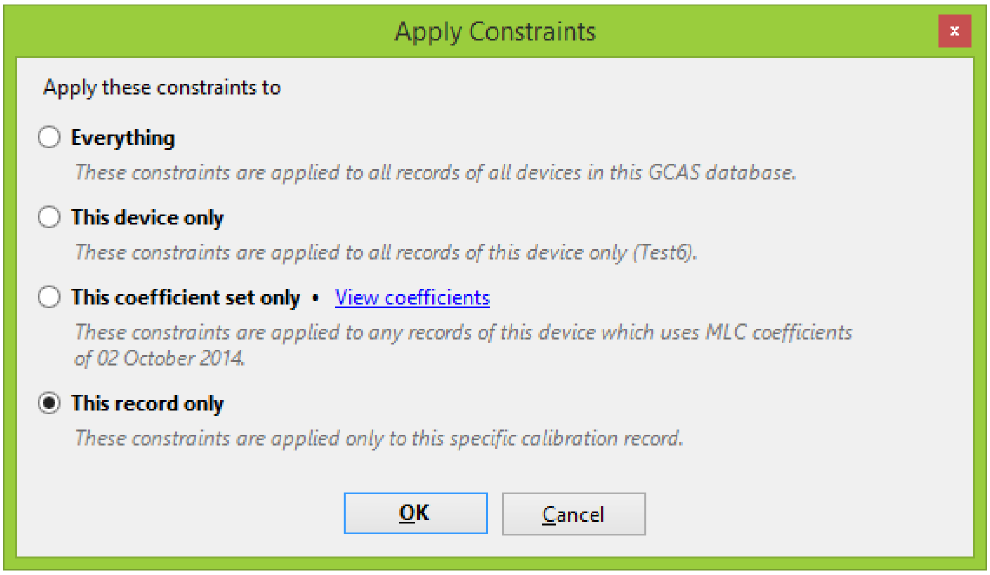
24.5.1 Overriding Constraints for Footprint/Calibration Data

From an open Footprint form or Calibration Data, open the Action menu, select **ISO 10723**, then select **Change MLC Constraints**. The *MLC Conversion Constraints (RF)* dialogue appears.





Make changes as necessary. In this screenshot example, we are changing the cubic constraint as well as changing the target RF value range. When you click **OK**, GCAS presents you another dialogue asking which override level these new constraints are about to be applied.



From top to bottom, each radio button corresponds to global constraints, device-level, coefficient-level, and finally record-level. Make a decision then click **OK**. The Footprint or Calibration Data form will reload the record and you may see the RF chart is now different from the previous one. If not, try another constraint values.

Note

Each option in this dialogue box requires its own action permission. The GCAS administrator has authority to assign which user roles can change global constraints, device-level, coefficient-level, or record-level. For example, an administrator may prohibit regular users to change global and device-level constraints, but permit them to change coefficient-level and record-level constraints. If your administrator didn't grant you permission for a specific override level, its radio button will be disabled. Ultimately if no permissions are given, you will not see *Change MLC Constraints* in the Action menu from the beginning.

Which override level should I apply to?

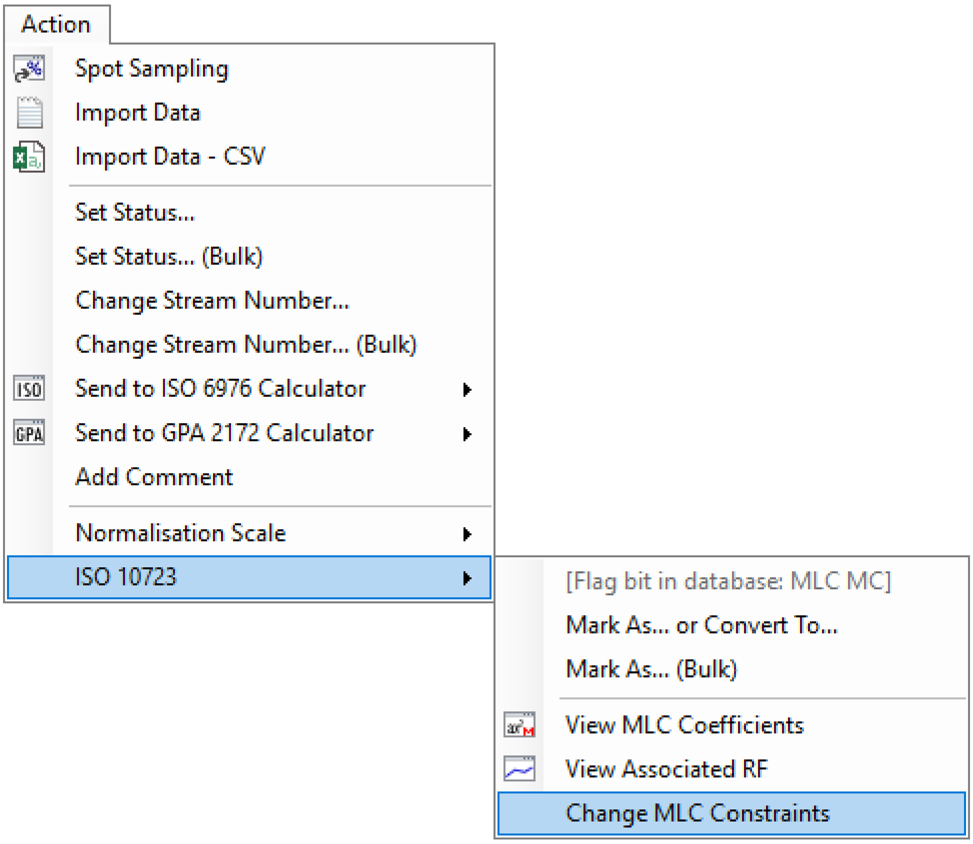
Be careful with the first option in *Apply Constraints* dialogue box. Yes, that option means you are changing the value of global constraints. All other devices in the same GCAS database will use the new constraint values you just specified.

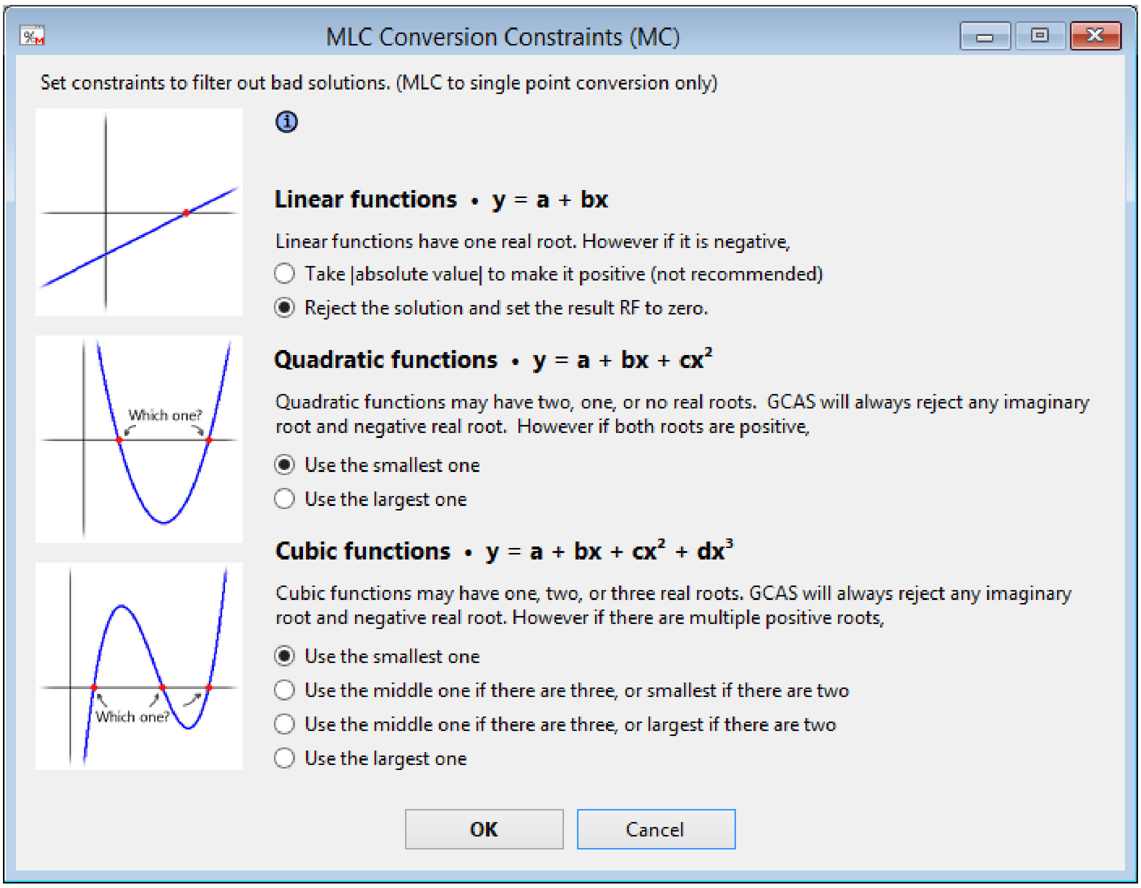
Condition	Recommended override level
You are unsure whether the new constraints would produce unwanted side-effects on other records.	Record-level
Some records are broken, while some others are not.	Coefficient-level if those broken records use the same MLC coefficients, otherwise apply record-level override to each of those one by one.
All records are broken, but records on other GC devices are not.	Device-level
All records are broken, regardless of what GC device they belong to. (A very ultra-rare case)	Global (Also check all MLC coefficient values for potential mistakes.)

24.5.2 Overriding Constraints for Mole Compositions

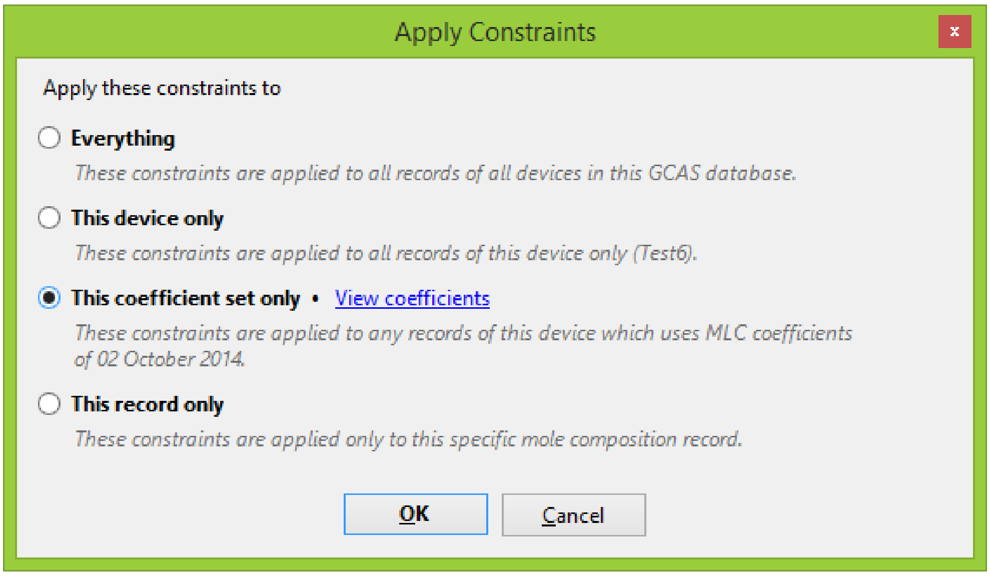
Many operations involving multilevel-calibrated mole compositions such as Data Analysis (MC value trending), uncertainty calculation, and ISO 6976 calculation, automatically load MLC constraints. Their MLC constraint overrides are set through Mole Composition form.

Open Mole Composition form, then browse to the desired record. Or if you plan to apply coefficient-level override, browse to any record which is using the MLC coefficient set in question. Then open Action menu, select **ISO 10723** and then **Change MLC Constraints**. The menu brings the *MLC Conversion Constraints (MC)* dialogue.


Action
Spot Sampling
Import Data
Import Data - CSV
Set Status...
Set Status... (Bulk)
Change Stream Number...
Change Stream Number... (Bulk)
Send to ISO 6976 Calculator
Send to GPA 2172 Calculator
Add Comment
Normalisation Scale
ISO 10723
[Flag bit in database: MLC MC]
Mark As... or Convert To...
Mark As... (Bulk)
View MLC Coefficients
View Associated RF
Change MLC Constraints


MLC Conversion Constraints (MC)
Set constraints to filter out bad solutions. (MLC to single point conversion only)
Linear functions • y = a + bx
Linear functions have one real root. However if it is negative,
Take |absolute value| to make it positive (not recommended)
Reject the solution and set the result RF to zero.
Which one?
Quadratic functions • y = a + bx + cx²
Quadratic functions may have two, one, or no real roots. GCAS will always reject any imaginary root and negative real root. However if both roots are positive,
Use the smallest one
Use the largest one
Which one?
Cubic functions • y = a + bx + cx² + dx³
Cubic functions may have one, two, or three real roots. GCAS will always reject any imaginary root and negative real root. However if there are multiple positive roots,
Use the smallest one
Use the middle one if there are three, or smallest if there are two
Use the middle one if there are three, or largest if there are two
Use the largest one
OK
Cancel

Change the constraints as necessary by paying attention to which gas that causes silly values followed by which degree of polynom the MLC coefficients of that gas is. Click **OK** and GCAS presents the familiar *Apply Constraints* dialogue box. Select an override level and hit **OK** again to commit.



Note

Each option in this dialogue box requires its own action permission. The GCAS administrator has authority to assign which user roles can change global constraints, device-level, coefficient-level, or record-level. For example, an administrator may prohibit regular users to change global and device-level constraints, but permit them to change coefficient-level and record-level constraints. If your administrator didn't grant you permission for a specific override level, its radio button will be disabled. Ultimately if no permissions are given, you will not see *Change MLC Constraints* in the Action menu from the beginning.

Which override level should I apply to?

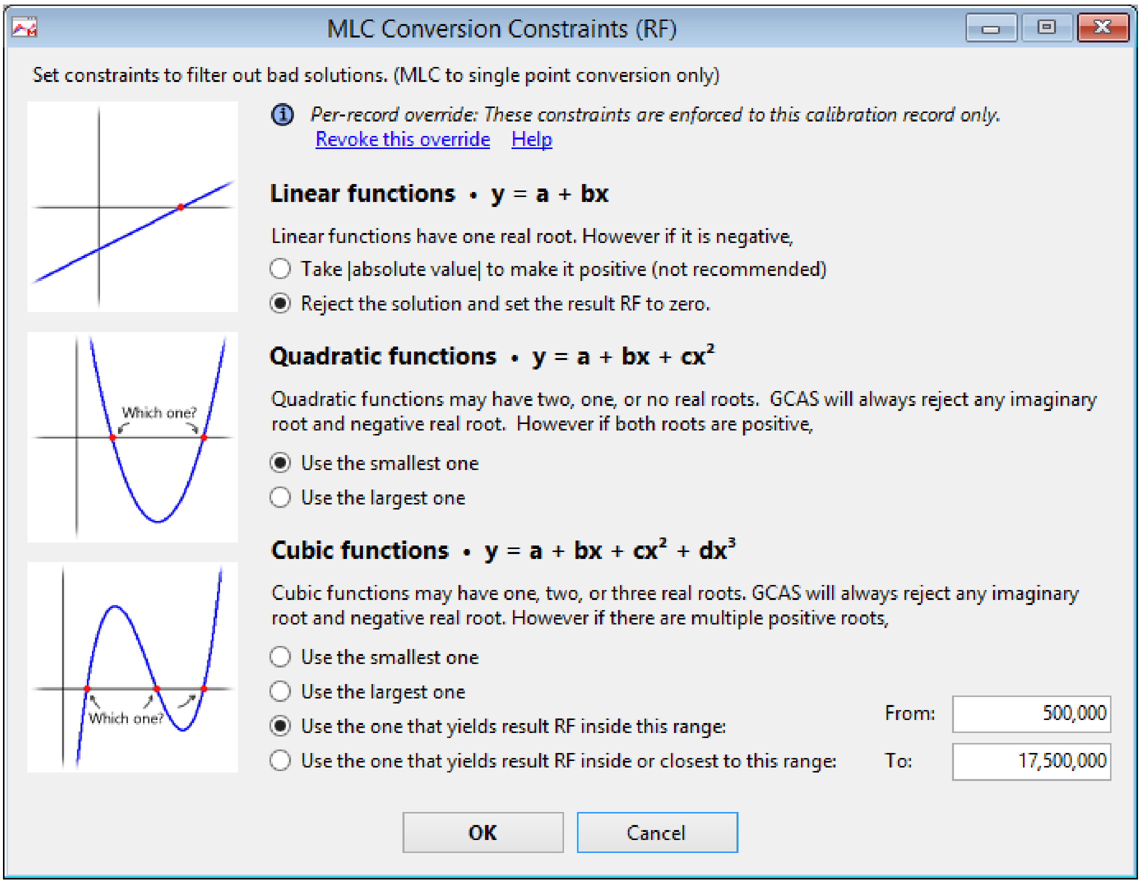
Be careful with the first option in *Apply Constraints* dialogue box. Yes, that option means you are changing the value of global constraints. All other devices in the same GCAS database will use the new constraint values you just specified.

Condition	Recommended override level
You are unsure whether the new constraints would produce unwanted side-effects on other records.	Record-level
Some records are broken, while some others are not.	Coefficient-level if those broken records use the same MLC coefficients, otherwise apply record-level override to each of those one by one.
All records are broken, but records on other GC devices are not.	Device-level

Condition	Recommended override level
All records are broken, regardless of what GC device they belong to. (A very ultra-rare case)	Global (Also check all MLC coefficient values for potential mistakes.)

24.5.3 Revoking (Cancelling) an Override

Open *MLC Conversion Constraints* dialogue again through **Change MLC Constraints** submenu in **ISO 10723** in the Action menu. Next to the blue info badge you shall see what override level the record is using. If no text is displayed, then the record is still on global MLC constraints.



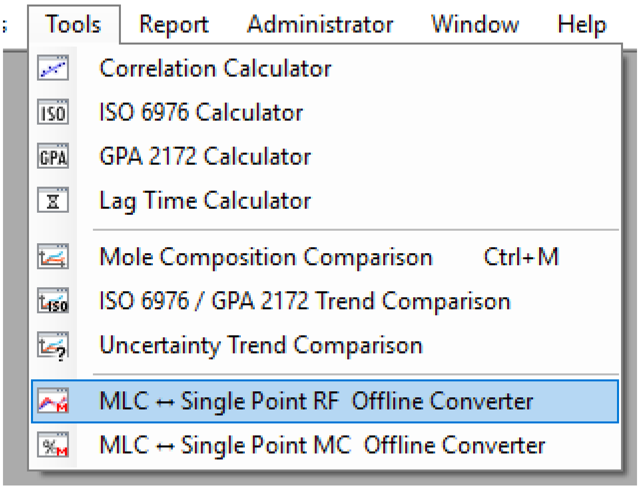
As an example, the screenshot above tells the calibration record is using record-level override. Now click **Revoke this override** to revoke it. Confirm the message box and then the dialogue will reload the MLC constraints from one level lower. Eventually it falls back to the global MLC constraints if there are no more overridden MLC constraints found. You know it's already on global MLC constraints when there is no text next to the blue icon badge.

Finally click **Cancel** (yep, Cancel button) to dismiss the dialogue. Clicking OK instead of Cancel button will show another *Apply Constraints* dialogue which you don't want anymore.

24.6 Offline Converter Tools

Offline converters are intended for one-time conversion of bulk records such as those in CSV files. The term 'offline' means it is not associated to any GC devices in GCAS database, which implies you can test any arbitrary MLC coefficients, calibration certificates, RF values, and custom constraints as conversion prerequisites without affecting any records in GCAS database.

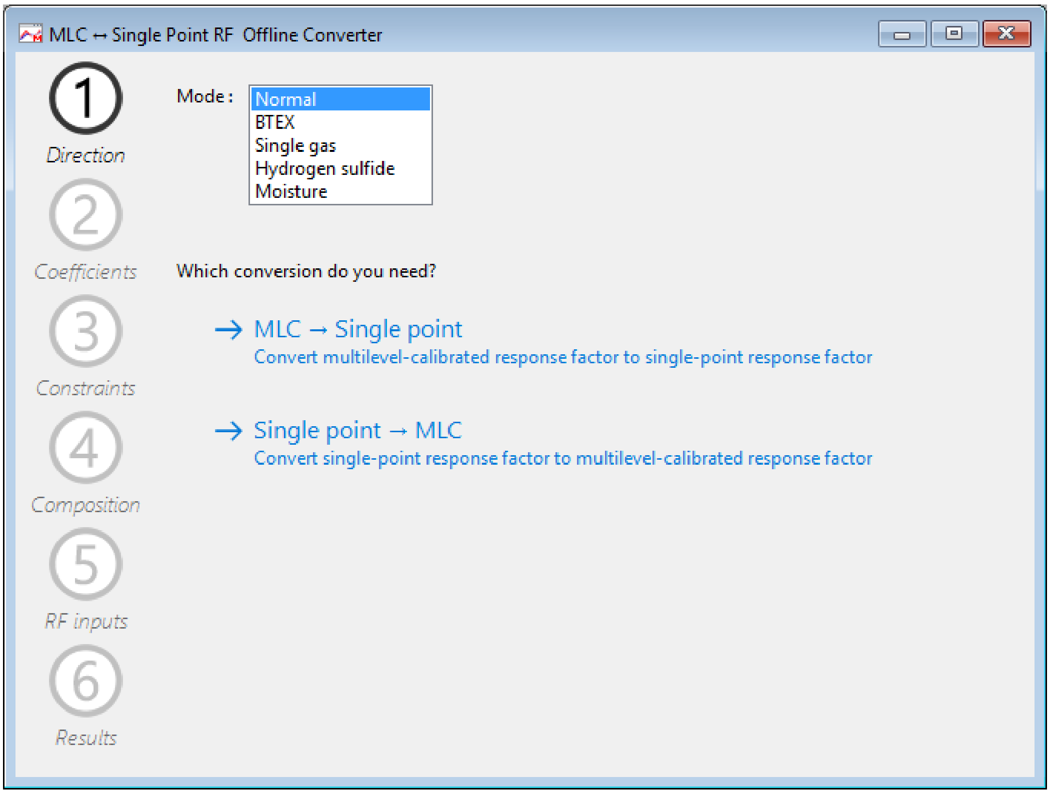
GCAS ships two converter tools. They can be found inside the Tools menu. Select **MLC ↔ Single-Point RF Offline Converter** to convert response factor values of footprint/calibration data, or **MLC ↔ Single-Point MC Offline Converter** to convert mole composition values.



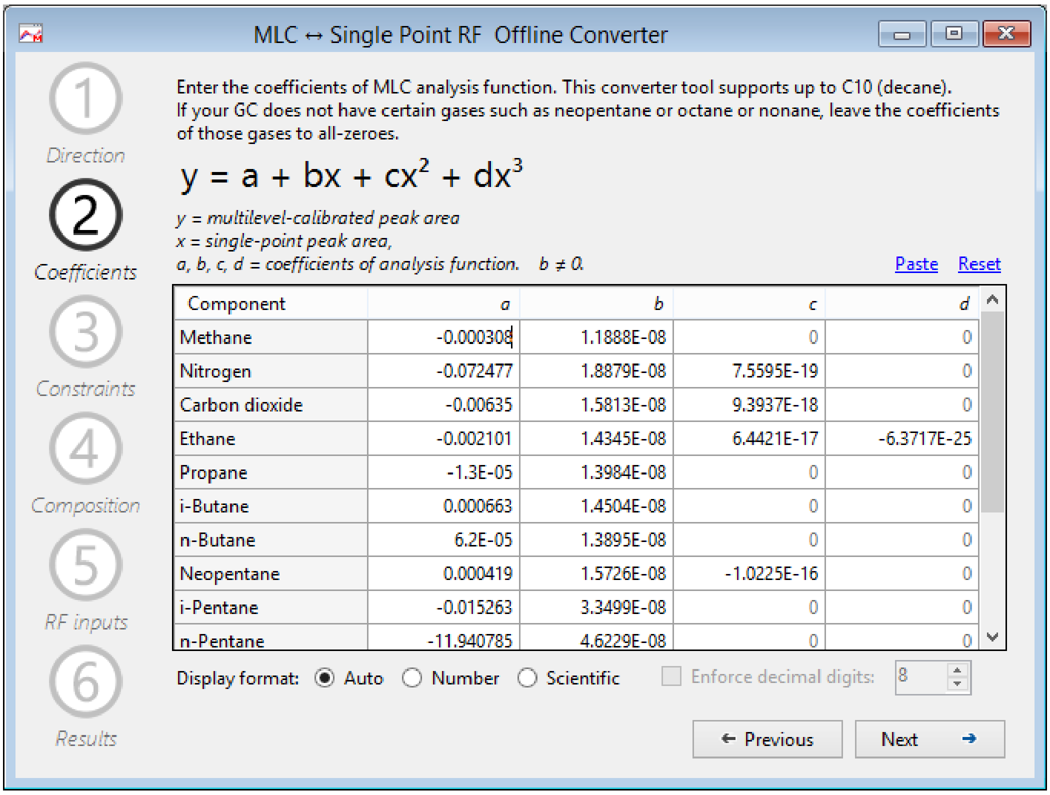
Converter tools have a wizard-like appearance. To get help about specific converter tool, read the following two chapters.

24.6.1 MLC ↔ Single-Point RF Offline Converter

This is an ISO 10723 converter tool for response factors. First, choose a **mode** to determine which gases are available. **Normal** mode gets you all alkane gases from methane to decane, **BTEX** mode gives you four aromatic hydrocarbons, and the rest (**Single gas**, **Hydrogen sulfide**, **Moisture**) are for single-gas calculation with different gas names. Next, click the desired conversion direction whether from MLC to single-point or single-point to MLC.

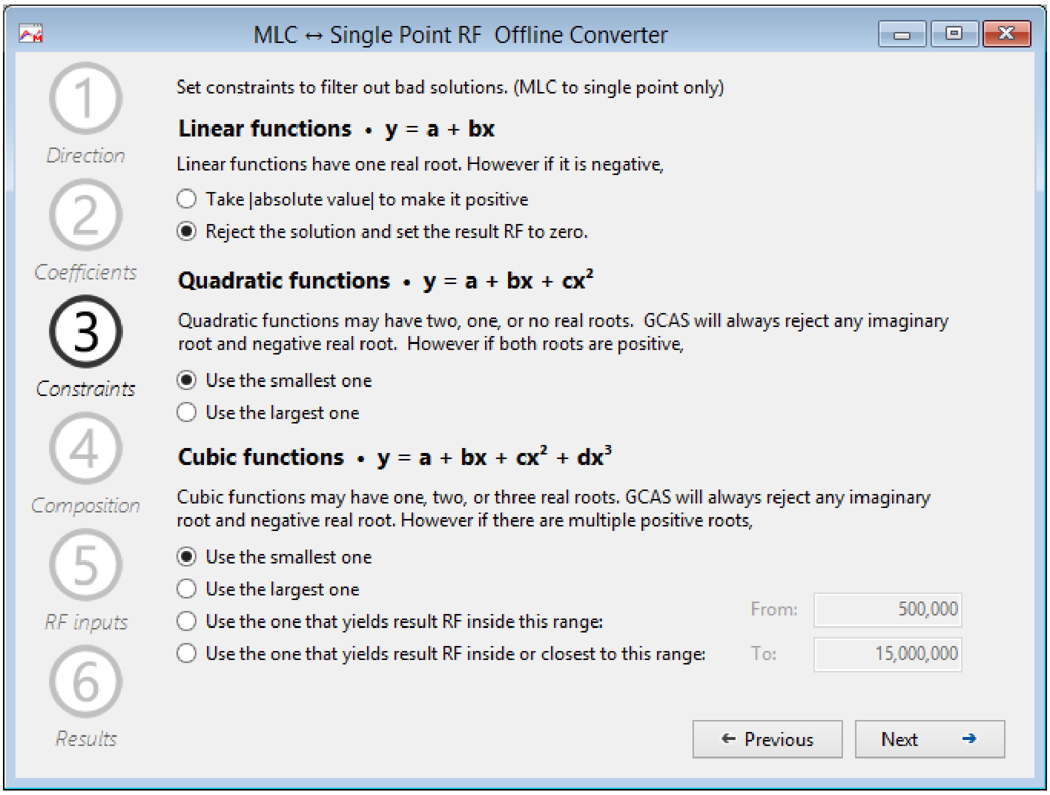


Next, enter the MLC coefficients. This page has similar layout to MLC Coefficients form. You can copy from Microsoft Excel or other spreadsheet processing software as long as the data has 4 columns and equal number of rows as the number of gases; click **Paste** to do so. If the footprints/calibration records to convert don't have gases such as octane, nonane, decane, or neopentane, leave the coefficients of those gases to all-zeroes.

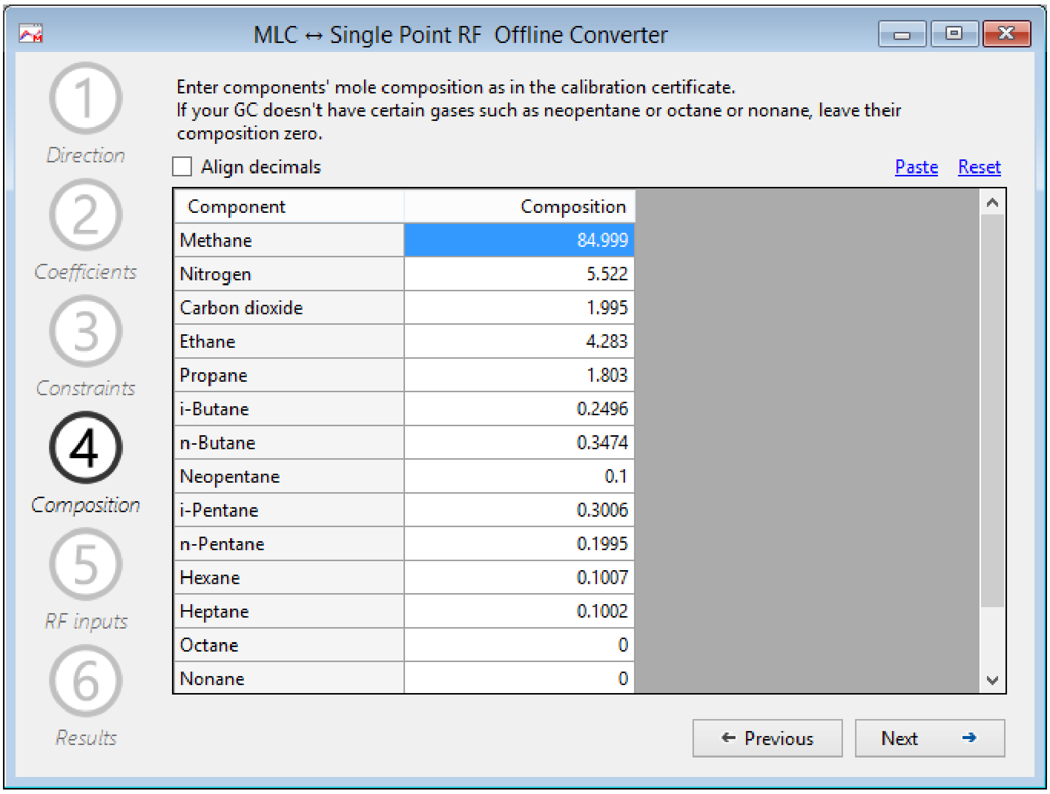


Click **Next**. Depending on conversion direction, the third page may be skipped. For MLC to single-point conversion, you are prompted to choose MLC constraints. Single-point to MLC conversion doesn't require constraints therefore this page is skipped.

Most of the time you don't have to worry about MLC constraints and you can click **Next** straight away. However, in case the conversion results having weird values, go back to this page and change the constraints to see whether the new constraints have corrected the results.

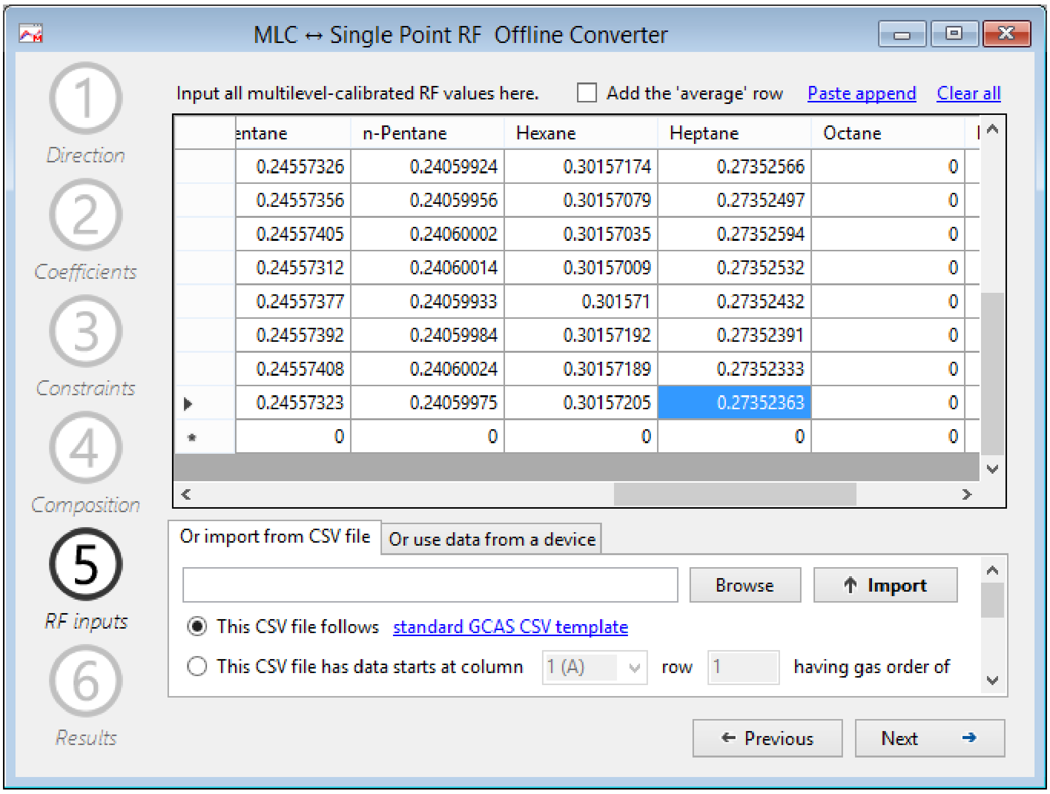


Afterwards, enter the mole composition part of the calibration gas certificate. You can copy from Microsoft Excel or other spreadsheet software, click **Paste** to do so. If the footprints/calibration records to convert do not have gases such as neopentane, octane, nonane, or decane, leave their values to zero.



Next wizard page is where you put the response factor values to convert. In this example, we are converting MLC RF into single-point RF. There are several ways to input RF values:

1. Orthodox method – typing them manually, row by row.
2. Copy and paste from Microsoft Excel or other spreadsheet processing software. Make sure the column ordering is correct as you may end up with wrong RF values in wrong gas. Click **Paste append** to paste from clipboard into new rows. Existing rows are not affected.
3. Import from CSV – please specify whether the CSV file follows standard GCAS CSV template or a custom template. More about this later.
4. Import from GC device in database – select a GC device and date range, then RF offline converter will load all active footprints and calibration data of that device between that date range. Note if you try to load footprints and calibration data from a device that does not match current mode (normal, BTEX, or single-gas), this converter tool will alert you and offer to switch to the correct mode.



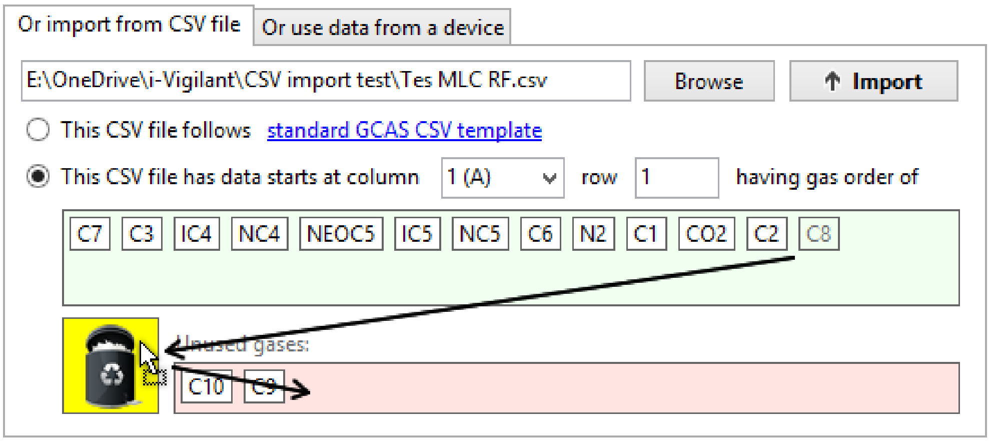
Above the grid there is a check box called **Add the 'average' row**. This check box inserts a special row at the very top, which contains the averaged value of all rows below it. Average row will be converted to MLC or single-point too, depending on selected direction during the first page. If you delete some rows or edit some rows or append new rows into this grid, the average values are updated automatically.

For CSV import, select whether the CSV file follows the standard template or you are using your own CSV file. Select the second radio button for CSV files with additional columns before the first gas, or with additional header rows before the first row, or with different gas ordering, or combination of these. Define at which column and which row the actual data start. If necessary, change the gas order definition to match your CSV file.

Note

The standard CSV template used by the offline converter tools under **Normal** mode (methane to decane) is the template used by Daniel, Siemens, Elster, and LNG—not ABB. For ABB devices, use the same template as Daniel cs. Make sure the response factor values to convert must be single-point and not the exponential one.

Reorder those gases using drag-and-drop operation inside the green area. Had there any gases not present in your CSV such as octane/C8, nonane/C9, or decane/C10, drag them to the trash bin icon and they will move to the *unused gases* (pink) area. Drag gases out of the pink area back into the green area to reuse them if necessary. In BTEX or single gas mode, the labels of these gases will adjust accordingly, such as "B", "T", "E", "X" instead of "C1", "N2", and so on.

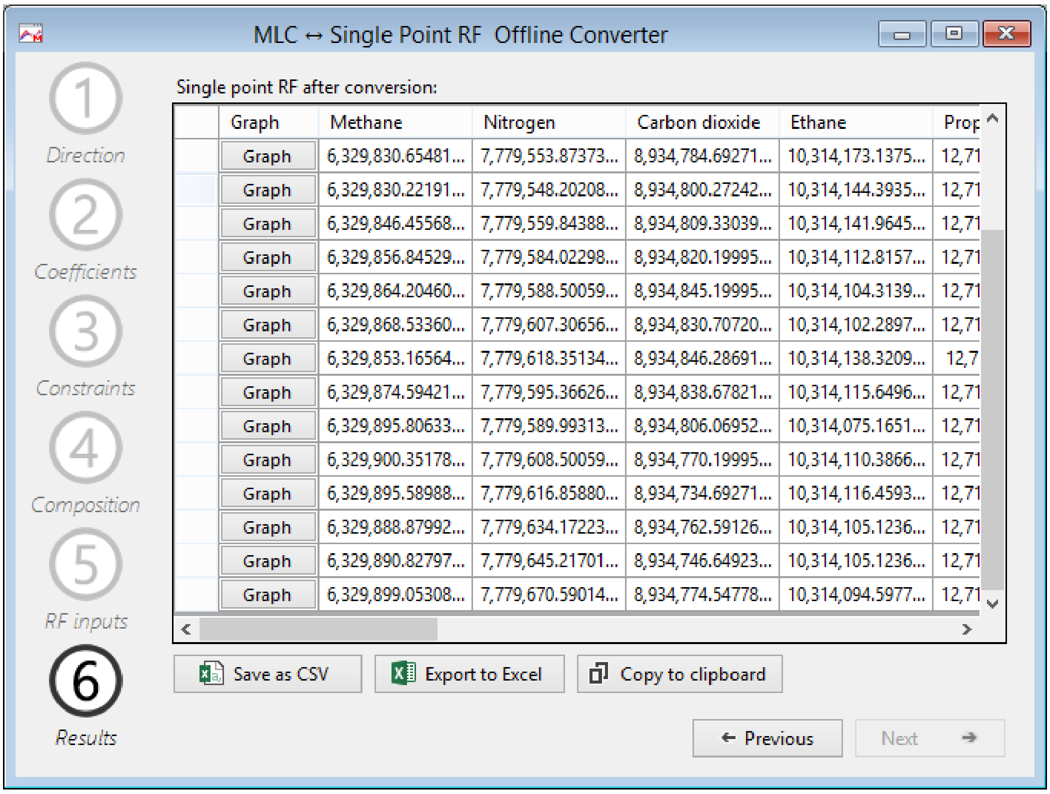


Finally, click **Import**. GCAS reads your CSV file and appends data into new rows. Existing rows are not affected. Also, the converter form reveals an additional column named **Notes** and writes the CSV file name followed by row number.

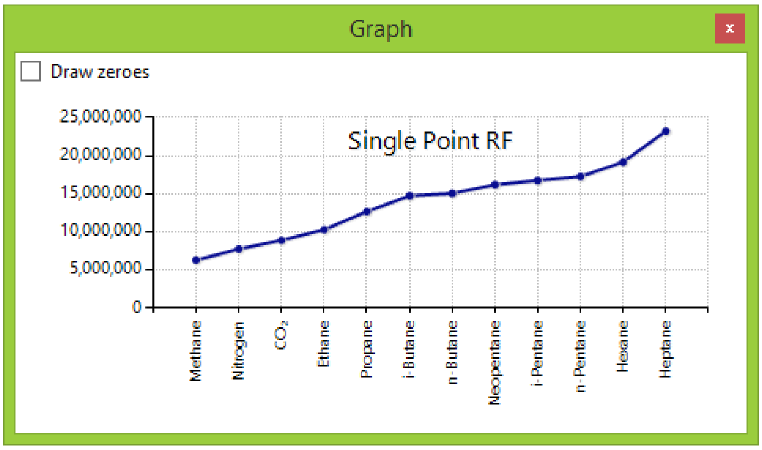
If you import data from a device (second tab of the tab pages under the grid), the converter form reveals the **Notes** column and writes device tag name followed by record timestamps. These notes help you differentiate which rows belong to which device in case you are converting bulk records from multiple GC devices, or converting mixed data coming from manual entry, CSV file, and device.

GCAS runs a validity check for invalid values such as negative RF. Should it find errors, the problematic rows will display red exclamation mark on their headers and are highlighted in light red. GCAS also refuses to move onto next wizard page unless the errors are fixed.

Ultimately, click **Next** to move onto next page and you should see GCAS is doing its job performing ISO 10723 conversion. It may take a while if you are converting hundreds or thousands of records. When the conversion is finished, you have options to **Save as CSV**, **Export to Excel**, or **Copy to Clipboard**. The average row, if ticked in previous wizard page, also appears in the conversion result at the very top. However, it is not the actual average of conversion results you see right now. It is simply the MLC or single-point conversion of the average value of all input rows before.



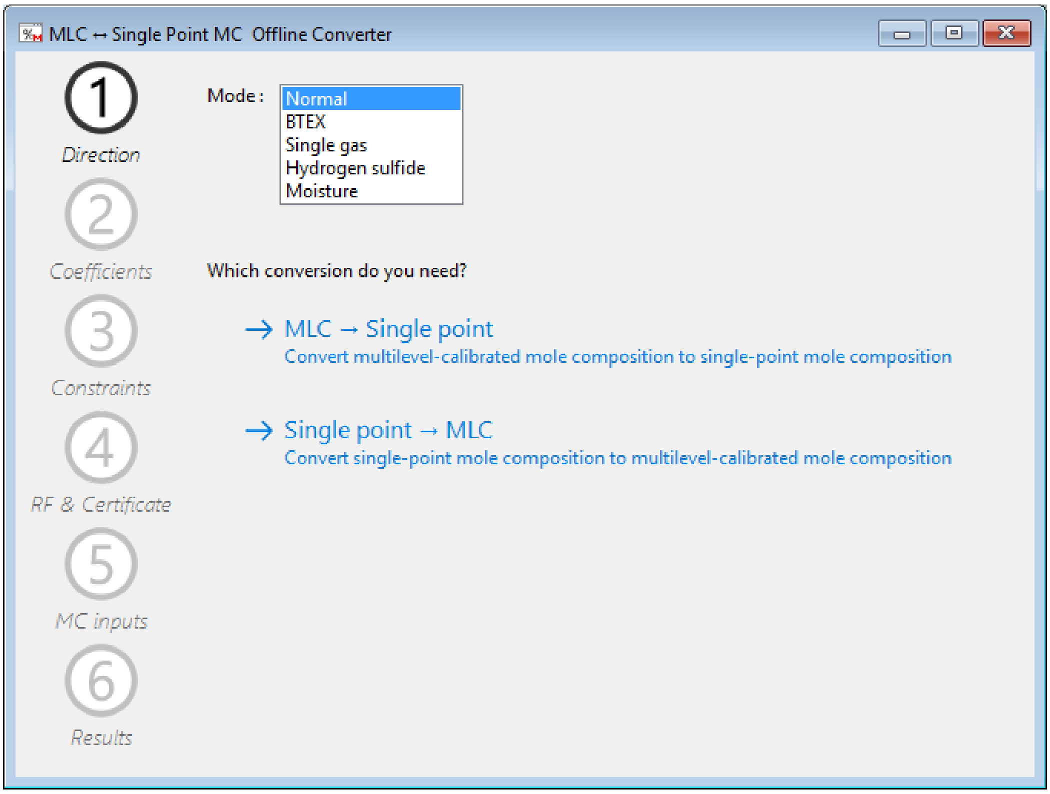
The leftmost column, **Graph**, provides a quick glance of how these converted records would look like in an RF chart. It generates a mini RF chart similar to the screenshot down here. By default, the chart omits zero values especially if the records don't have gases like C8, C9, or C10. You can override this behaviour by ticking **Draw zeroes**.



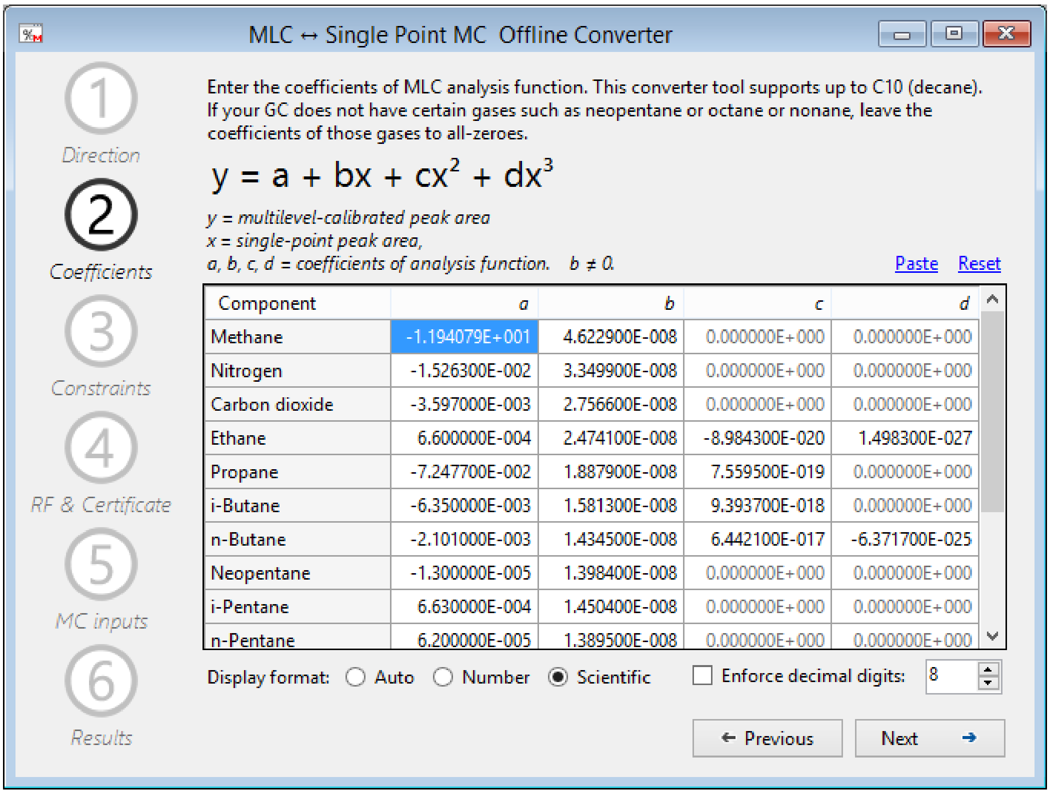
When you get a nice ascending chart for single-point RF or nice flat chart for MLC RF, most likely the three prerequisites (coefficients, certificate, and constraints) are correct. However, if you get a bad chart such as one or two dots skyrocket to hundreds of millions, it may indicate one or more among the three prerequisites are wrong.

24.6.2 MLC ↔ Single-Point MC Offline Converter

This is an ISO 10723 converter tool for mole compositions. First, choose a **mode** to determine which gases are available. **Normal** mode gets you all alkane gases from methane to decane, **BTEX** mode gives you four aromatic hydrocarbons, and the rest (**Single gas**, **Hydrogen sulfide**, **Moisture**) are for single-gas calculation with different gas names. Next, click the desired conversion direction whether from MLC to single-point or single-point to MLC.



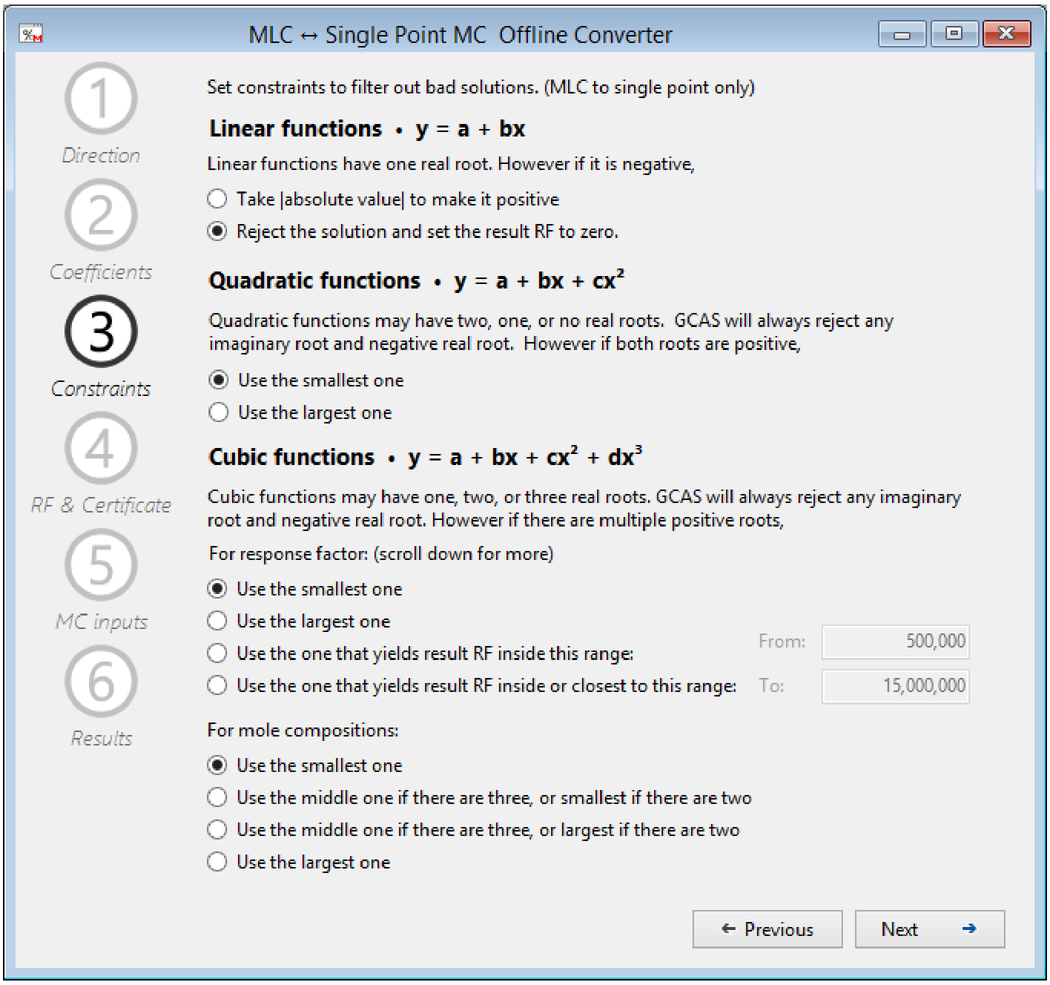
Next, enter the MLC coefficients. This page has similar layout to MLC Coefficients form. You can copy from Microsoft Excel or other spreadsheet processing software as long as the data has 4 columns and equal number of rows as the number of gases; click **Paste** to do so. If the mole composition data to convert don't have gases such as octane, nonane, decane, or neopentane, leave the coefficients of those gases to all-zeroes.



Click **Next**. Depending on conversion direction, the third page may be skipped. For MLC to single-point conversion, you are prompted to choose MLC constraints. Single-point to MLC conversion doesn't require constraints therefore this page is skipped.

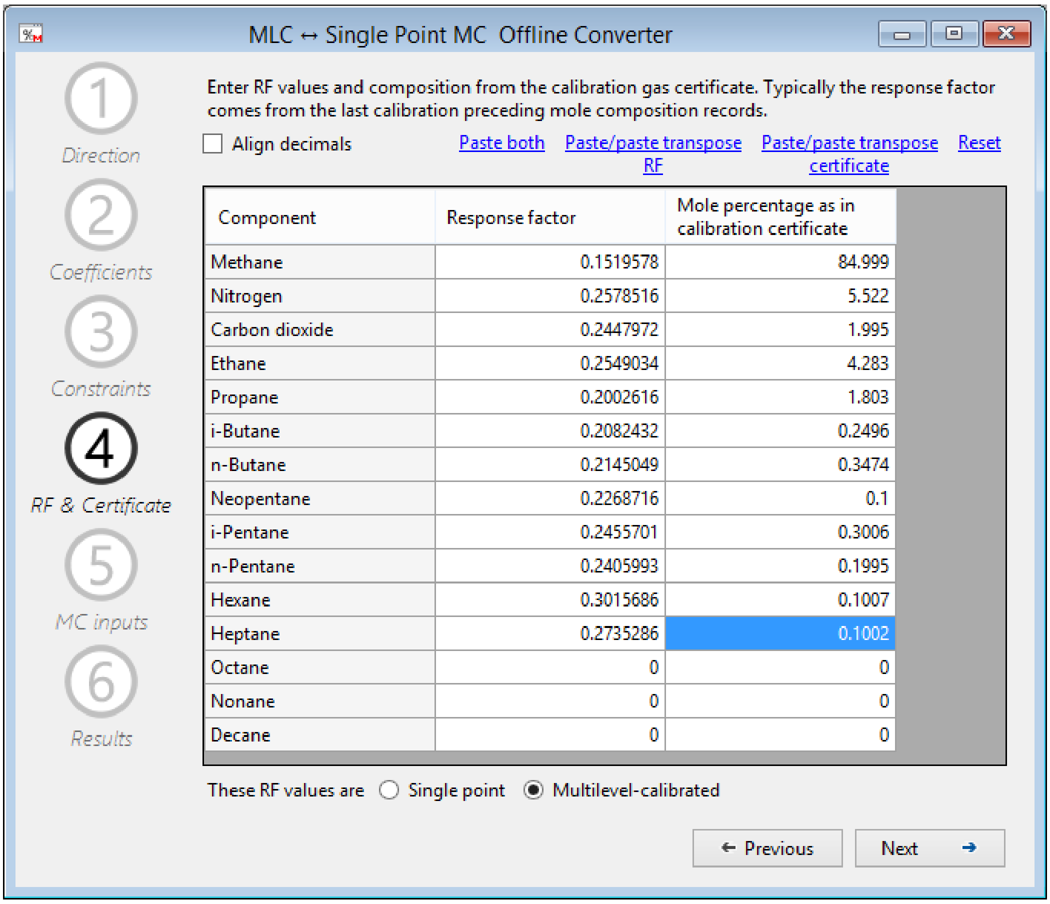
The third constraint (cubic constraint) has two parts: One for mole composition conversion, and the other for RF conversion. Mole composition conversion involves a set of RF values. These RF values must be convertible therefore they require their own MLC constraints and a calibration certificate (we'll see in the next step).

Most of the time you don't have to worry about MLC constraints and you can click **Next** straight away. However, in case of the conversion results having weird values, go back to this page and change the constraints to see whether the new constraints have corrected the conversion results.



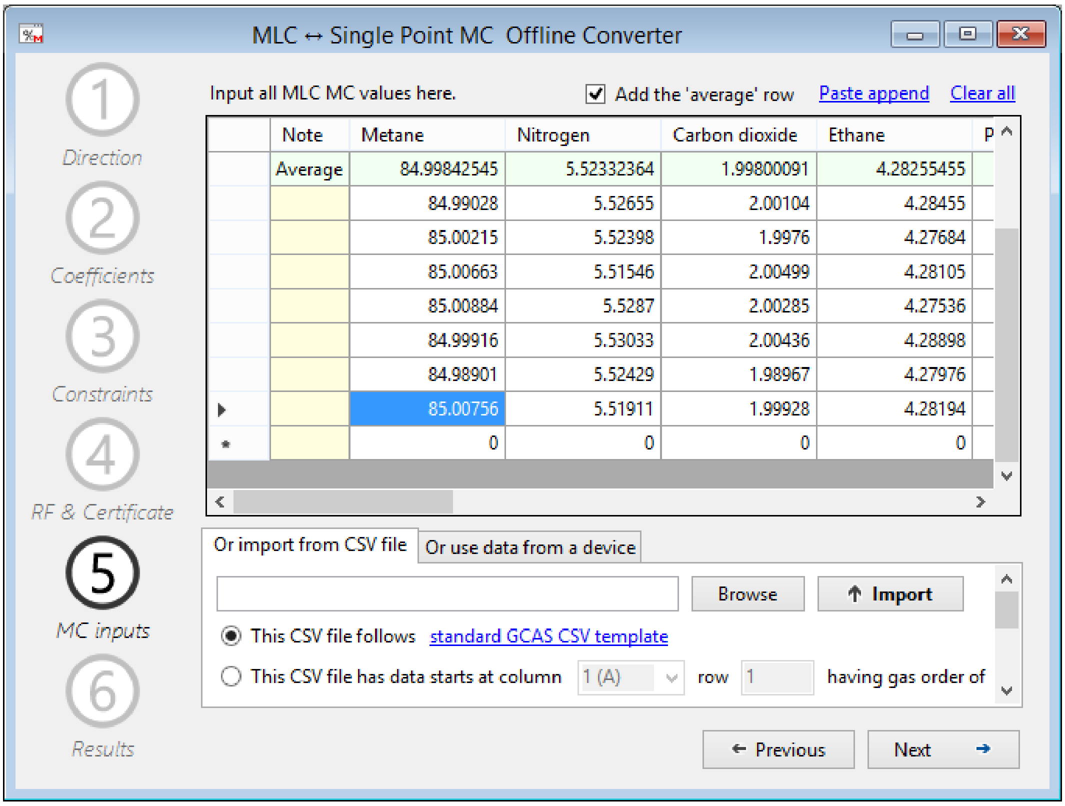
After MLC constraints, enter the mole composition part of the calibration gas certificate used by RF values followed by the RF values themselves. Save your time by copying and pasting from Microsoft Excel or other spreadsheet software. Click **Paste** if the copied data has 2 columns, click **Paste/paste transpose certificate** to paste calibration certificate only, or click **Paste/paste transpose RF** to paste RF values only. If the mole composition records to convert do not have gases such as neopentane, octane, nonane, or decane, leave both their certificate composition and RF value to zero.

Don't forget to specify whether the RF values are single-point or multilevel-calibrated. Under the grid, next to **These RF values are** [single-point or MLC], tick the correct radio button.



Click **Next** and you arrive at the input page. In this example, we are converting MLC composition into single-point composition. There are several ways to input mole composition (MC) values:

1. Orthodox method – typing them manually, row by row.
2. Copy and paste from Microsoft Excel or other spreadsheet processing software. Make sure the column ordering is correct as you may end up with wrong composition values in wrong gas. Click **Paste append** to paste from clipboard into new rows. Existing rows are not affected.
3. Import from CSV – please specify whether the CSV file follows standard GCAS CSV template or a custom template. Keep reading after the screenshot on the next page.
4. Import from GC device in database – select a GC device, date range, and the stream number too. More about this later.



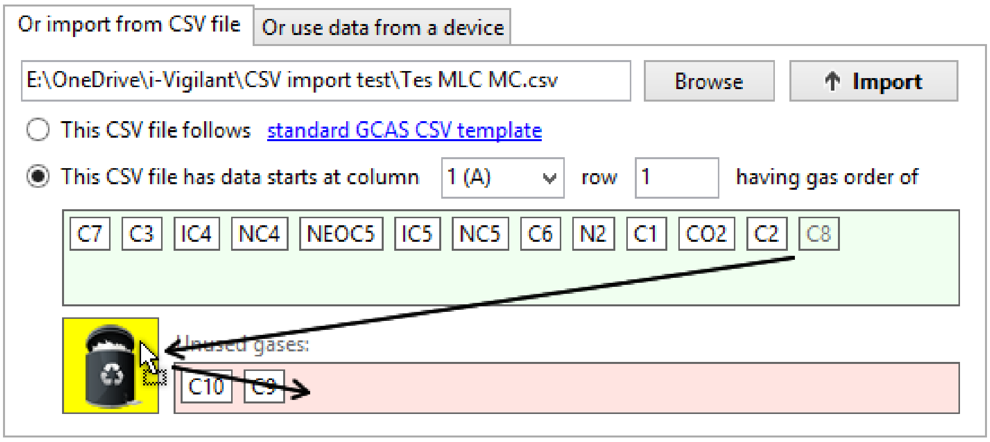
Above the grid there is a check box called **Add the 'average' row**. This check box inserts a special row at the very top, which contains the averaged value of all rows below it. Average row will be converted to MLC or single-point too, depending on selected direction in the first wizard page. If you delete some rows or edit some rows or append new rows into this grid, the average values are updated automatically. All numbers in this grid are treated as *unnormalised*.

For CSV import, select whether the CSV file follows the standard template or you are using your own CSV file. Select the second option for CSV files with additional columns before the first gas, or with additional header rows before the first row, or with different gas ordering, or combination of these. Define at which column and which row do the actual data start. If necessary, change the gas order definition to match your CSV file.

Note

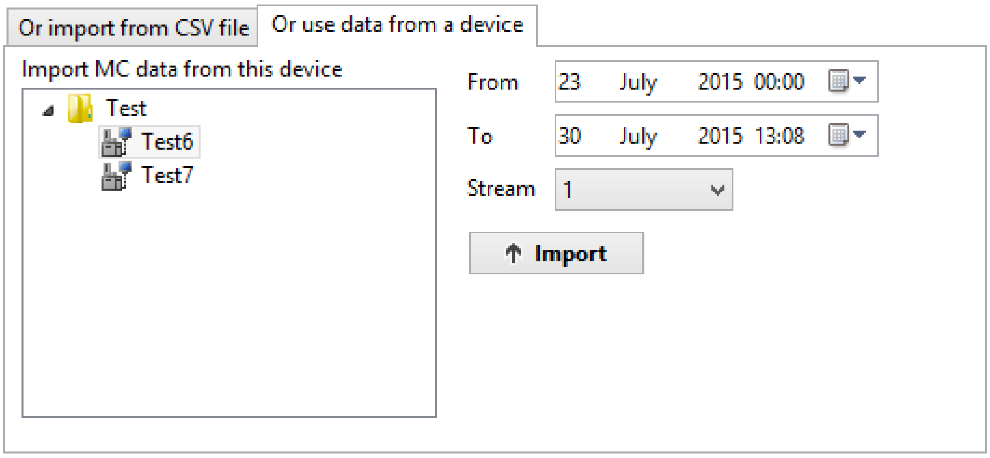
The standard CSV template used by the offline converter tools under **Normal** mode (methane to decane) is the template used by Daniel, Siemens, Elster, and LNG—not ABB. For ABB devices, use the same template as Daniel cs. Make sure the mole composition value to convert must be single-point and not the exponential one.

Reorder those gases using drag-and-drop operation inside the green area. Had there any gases not present in your CSV such as octane/C8, nonane/C9, or decane/C10, drag them to the trash bin icon and they will move to the *unused gases* (pink) area. Drag gases out of the pink area back into the green area to reuse them if necessary. In BTEX and single gas mode, the labels of these gases adjust accordingly such as "B", "T", "E", "X" instead of "C1", "N2", and so on.



Finally, click **Import**. GCAS reads your CSV file and appends data into new rows. Existing rows are not affected. Also, the converter form reveals an additional column named **Notes** and writes the CSV file name followed by row number.

For data import from a GC device, select the device followed by the desired date/time range and the stream number. Click **Import** and GCAS will query GCAS database to get these records. *GCAS will un-normalise mole composition values before putting them in new rows.* If you try to load mole composition data from a GC device of a device type not matching the current mode (normal, BTEX, or single-gas), this converter tool will alert you and offer to switch mode.

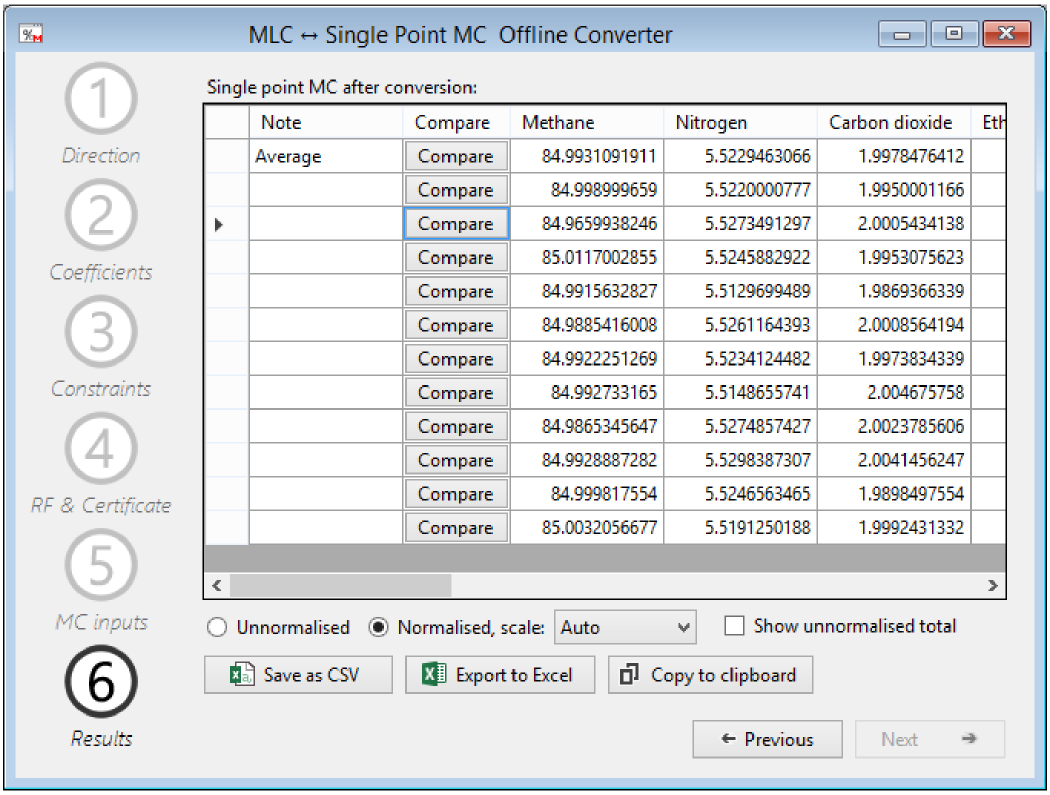


The converter form reveals the **Notes** column and writes device tag name followed by record timestamps. These notes help you differentiate which rows belong to which device in case you are converting bulk records from multiple GC devices, or converting mixed data coming from manual entry, CSV file, and device.

GCAS runs a validity check for invalid values such as negative composition. However, there is no check if sum of a composition record exceeds 100 because the record may be on a different scale, not only percentage. If GCAS finds errors, the problematic rows will display red exclamation mark on their headers and are highlighted in light red. GCAS also refuses to move onto next wizard page unless the errors are fixed.

Ultimately, click **Next** to move onto next page and you should see GCAS is doing its job performing ISO 10723 conversion. It may take a while if you are converting hundreds or thousands of records.

When the conversion is finished, you have options to **Save as CSV**, **Export to Excel**, or **Copy to Clipboard**. The average row, if ticked in previous wizard page, also appears in the conversion result at the very top. However, it is not the actual average of conversion results you see right now, it is simply the MLC or single-point conversion of the average value of all input rows before.



By default, the displayed result is normalised. Check **Show unnormalised total** to reveal the unnormalised total column (after decane). Select the radio button **Unnormalised** or **Normalised** to flip all numbers between the two.

Unlike RF converter, MC converter provides **Compare** column which contains buttons to compare normalised input (before conversion) versus normalised output (after conversion). These buttons call the *Compare* tool window similar to the screenshot on the next page. Check **Show difference** to reveal the absolute delta column, which is the absolute value of difference/bias between input composition and conversion result.

Compare

☑ Align decimals ☑ Show difference

Component	• Input • unnormalised MLC	→	• Input • normalised MLC	vs.	• Output • normalised single pt.	| Δ |
Methane	84.99032000	→	84.96445682	vs.	84.96599382	0.00153701
Nitrogen	5.52928000	→	5.52759740	vs.	5.52734913	0.00024827
Carbon dioxide	2.00126000	→	2.00065100	vs.	2.00054341	0.00010759
Ethane	4.28852000	→	4.28721497	vs.	4.28708514	0.00012983
Propane	1.80245000	→	1.80190150	vs.	1.80193813	0.00003663
i-Butane	0.25791000	→	0.25783152	vs.	0.25690255	0.00092897
n-Butane	0.35368000	→	0.35357237	vs.	0.35326421	0.00030816
Neopentane	0.09509000	→	0.09506106	vs.	0.09506093	0.00000013
i-Pentane	0.30923000	→	0.30913590	vs.	0.30920452	0.00006862
n-Pentane	0.19039000	→	0.19033206	vs.	0.19031441	0.00001766
Hexane	0.10665000	→	0.10661755	vs.	0.10677981	0.00016226
Heptane	0.10566000	→	0.10562785	vs.	0.10556393	0.00006392
Octane	0.00000000	→	0.00000000	vs.	0.00000000	0.00000000
Nonane	0.00000000	→	0.00000000	vs.	0.00000000	0.00000000
Decane	0.00000000	→	0.00000000	vs.	0.00000000	0.00000000

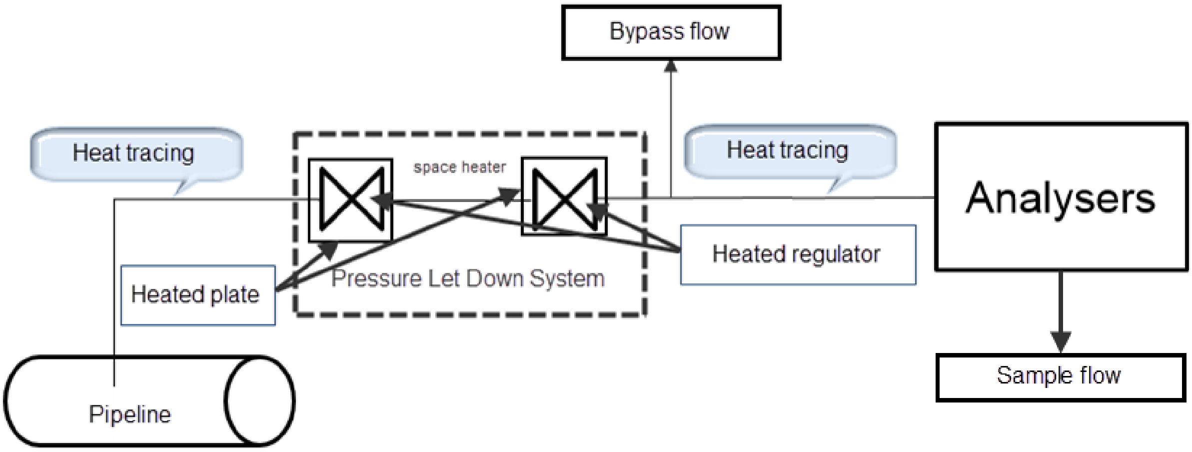
24.7 Low-Level ISO 10723 Implementation

Provided the GCAS feature *ISO 10723* is included in your licence, you already have ISO 10723 features in relevant modules such as Footprint, Calibration Data, Mole Composition, Data Analysis, Dashboard, and pretty much everything that uses response factor values or mole composition values. GCAS always checks the MLC flag bit of calibration or mole composition records and performs necessary actions before those modules use these records. For example, you cannot get a valid uncertainty of reproducibility from a collection of multilevel-calibrated RF. Therefore, in order to calculate $U_{reproducibility}$ GCAS needs to convert the RF records into single-point first. This is done on-the-spot and behind the screen. You didn't notice the Dashboard always gives correct R^2 value even though all calibration data are marked as MLC, did you?

Visit the appropriate chapter on the module to get help about ISO 10723 features. Footprint and calibration data are on chapter 7, Mole Composition is on chapter 8, Data Analysis is on chapter 10, and Mole Composition Comparison is on chapter 18.

25 Lag Time

Lag time is the total time of gas stream measured from the time it is sampled at the main pipeline to the time it exits the detector of your GC. After leaving the sample probe, the gas enters *pressure let-down system* to have its pressure reduced in order to be safe for the GC. The pressure letdown system is series of regulators, heating elements, and pipes with different diameter and length, which affect the travel time. Not to mention the GC device itself has a predefined cycle time and analysis time. Thus, when the gas finally reaches the detector within GC, it is no longer the same gas travelling inside main pipeline at the same exact moment. It can range from several minutes to few hours behind the pipeline.



Typical pressure letdown systems.

Lag time is used by spot samples. Its main purpose is to shift the date and time of the spot sample record. Spot sample values are then compared to the nearest mole composition data at the timestamp of spot sample *plus lag time*. Without lag time taken into account, spot sample will precede the mole composition record by several minutes to few hours ahead, making the spot sample values stay afar from the mole composition record. Hence, you cannot use it (or it becomes more difficult) to determine the health status of your pressure letdown system.

Lag time is calculated per *stage* and summed together at the end. One *stage* is one configuration of pipes and regulators. Typical pressure letdown system may have three to four stages, which in turn makes typical lag time calculation has five or six stages in total.

Note

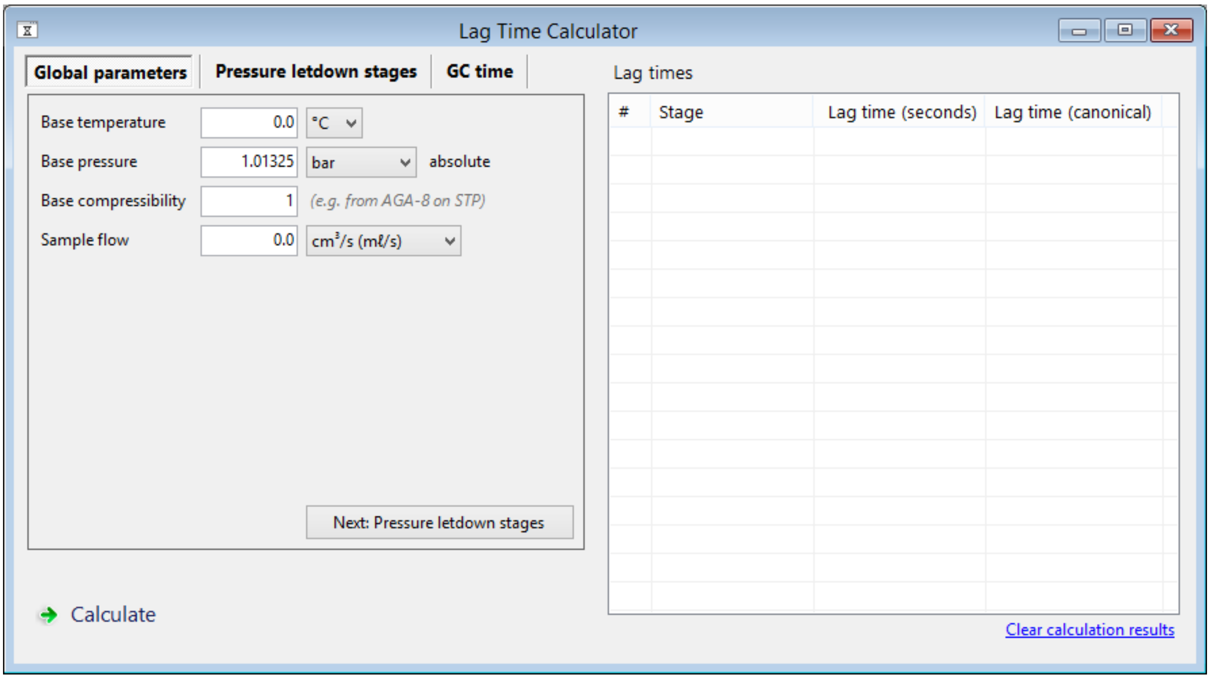
This module requires GCAS feature *Lag Time Calculator* to be included in GCAS licence.

Modules using lag time data are Data Analysis, Mole Composition Comparison, and ISO 6976/GPA 2172 Trend Comparison. On Data Analysis form, lag time is used when the user wants a mole composition trend, then ticked **Include spot samples**. By subsequently ticking **Apply lag time**, all spot sample dots on the chart will shift to the right by the amount of total lag time. For both Mole Composition Comparison and ISO 6976/GPA 2172 Trend Comparison, lag time data is used if the user put spot sample streams into comparison list and ticked **Apply lag time to spot samples** before graphing a comparison chart.

25.1 The Lag Time Calculator Form

Lag Time Calculator form takes your *stage data* as input then calculates the lag time as output. Lag Time Calculator form is designed for two uses, offline calculation and device-bound calculation. Offline calculation is one-time calculation that is not tied to any device in GCAS database. This chapter shows the Lag Time Calculator form for offline calculation. Steps for device-bound calculation is very similar to offline calculation, only tossing some extra steps of attaching an optional note and saving to database at the end.

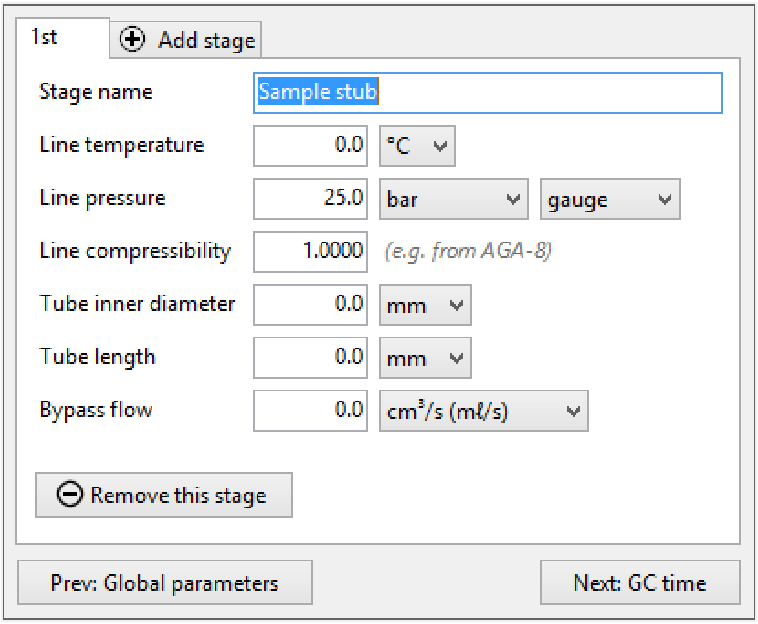
Go to the Tools menu and select **Lag Time Calculator**. If you do not see this menu, your GCAS user account may not have the menu permission for it. Contact your GCAS administrator.



Left side of the form are the inputs, while right side is the output. The input section consists of three tabs: Global parameters, pressure letdown stages, and GC time.

Global parameters have four inputs: Base temperature, base pressure, base compressibility, and sample flow. Base temperature is set at 0°C and base pressure is typically set at the atmospheric pressure (1 atm or 1.01325 bar). You need to provide the base compressibility factor (Z) and sample flow. When it's done, click **Next: Pressure letdown stages** to move onto the next tab.

Pressure letdown stages are the collection of stage data. A *stage data* consists of 7 inputs: stage name, line temperature, line pressure, line compressibility, tube inner diameter, tube length, and bypass flow.



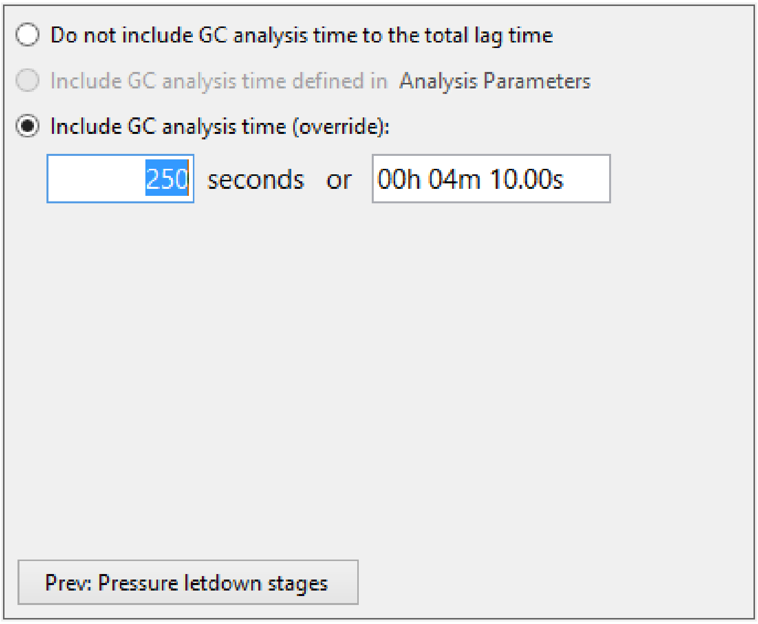
- **Stage name**: Enter a name as an identifier to distinguish this stage from other stages. This name will appear in the first column of the output list.
- **Line temperature**: Temperature at this pipe.
- **Line pressure**: Pressure at this pipe as conditioned by the regulator.
- **Line compressibility**: The compressibility factor (Z) of the gas at this stage.
- **Tube inner diameter**: Inside-diameter of this pipe.
- **Tube length**: Total length of the pipe.
- **Bypass flow**: How much gas being discarded before entering the next stage.

One stage data is contained in one tab. To add more stage, open the last tab (**Add stage**) then the form automatically creates a new tab for you. To remove a stage, click **Remove this stage** at bottom-left corner of a tab.

Note

You can add up to 32 stages maximum.

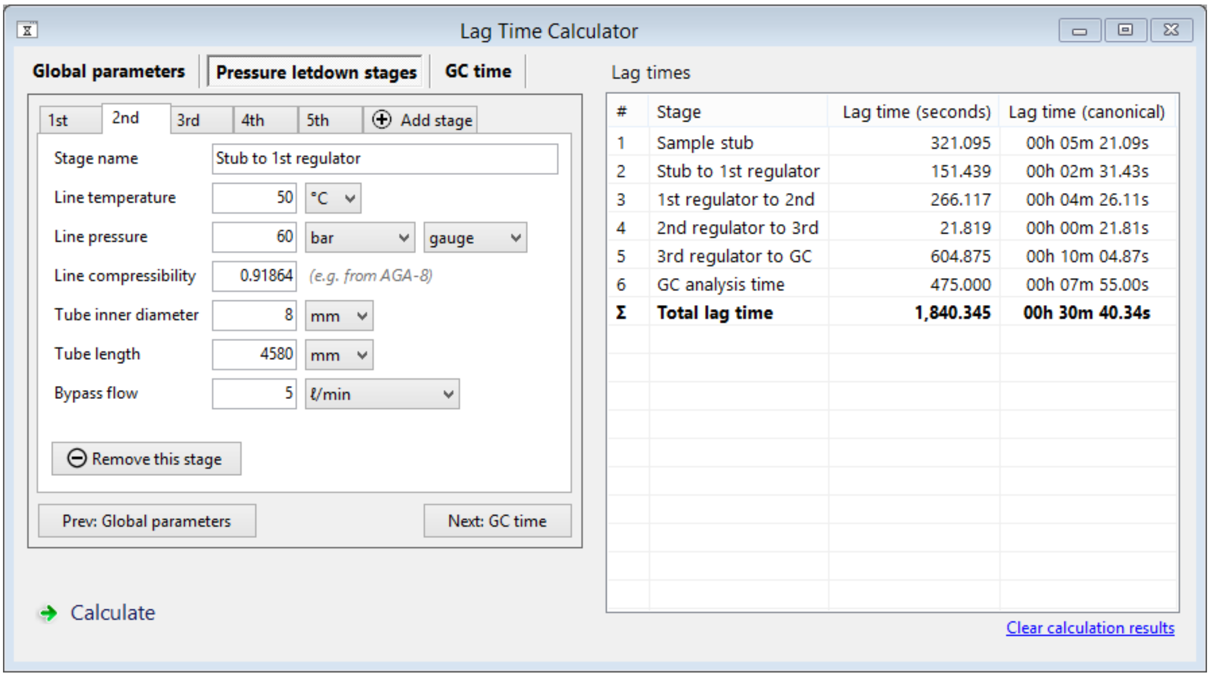
When you finished entering all stage data, click **Next: GC time** to move onto next tab.



GC time is cycle time plus analysis time of the GC device. This time value is added to the total lag time so far, but you have the option not to include GC analysis time if desired.

The second radio button is disabled because Lag Time Calculator form is in offline calculation mode. For device-bound calculation, this radio button extracts GC analysis time defined in Analysis Parameter.

Be cautious on the units of measurement as wrong unit will produce wrong result. When you are ready, click **Calculate** at the bottom-left corner of the form. Lag Time Calculator computes the lag time and displays the calculation result in the list view on the right-hand side. Total lag time is displayed in bold face.

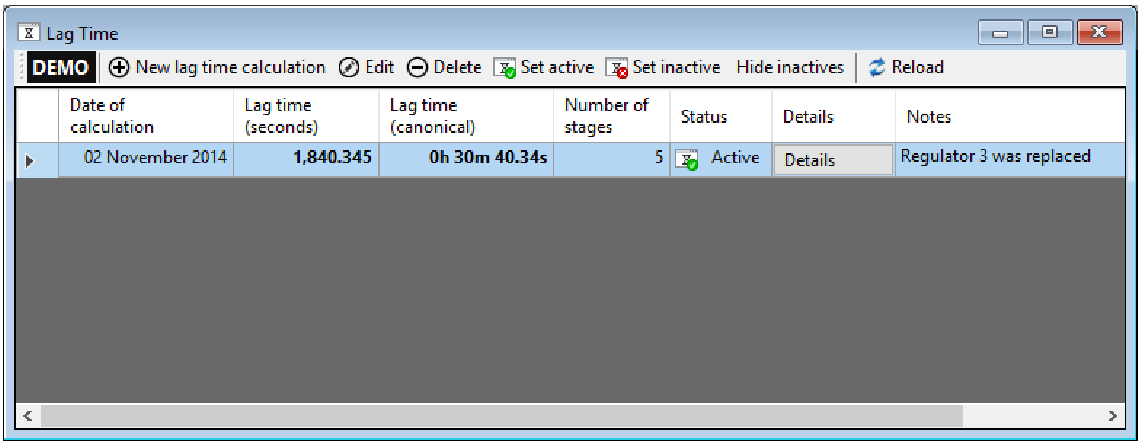


Click **Clear calculation results** to empty the list and start over.

25.2 The Lag Time Form

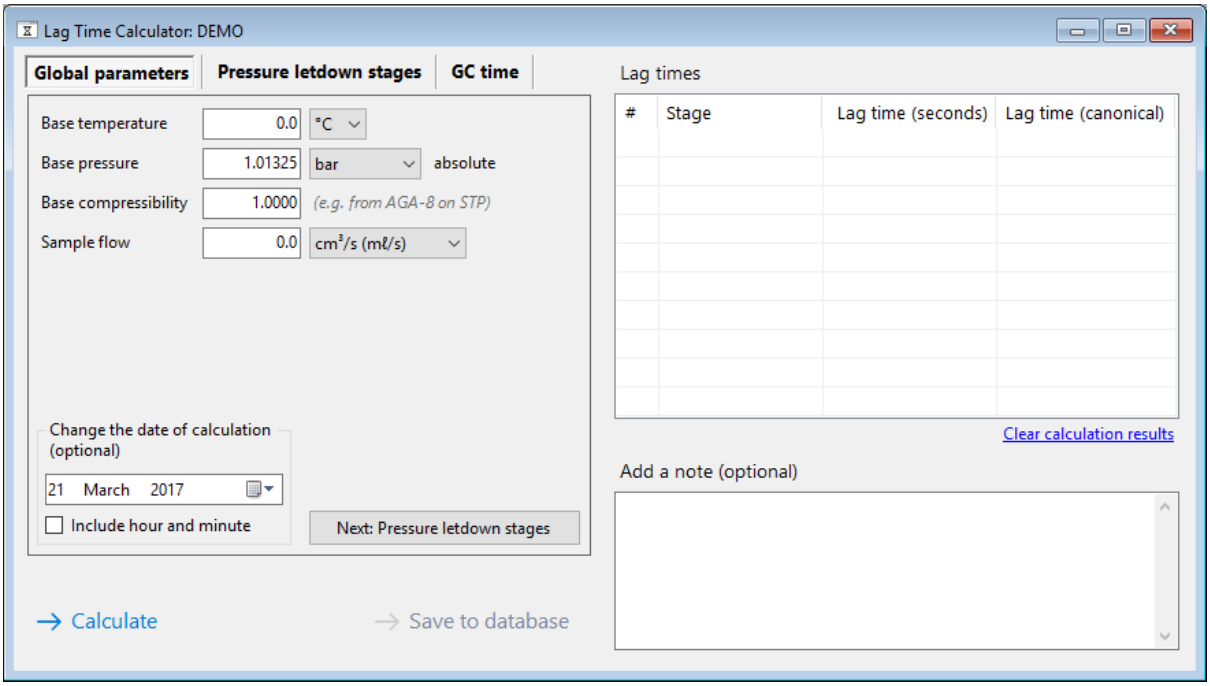
Lag Time form is a form to display historical lag time calculations of a GC device. One lag time record may survive for years because users need to calculate lag time when they change the piping or the design of pressure letdown systems, or when they replace the GC device.

Select a GC device on your device panel or recent device panel. Next, go to View menu and select **Lag Time**. If you do not see this menu, your GCAS user account may not have menu permission for it. Contact your GCAS administrator.



The Lag Time *form.*

On the toolbar, click ⊕ **New lag time calculation** to create a new lag time record. That button brings the Lag Time Calculator form in device-bound mode (as opposed to offline calculation mode in chapter 25.1). The form looks the same apart from **Save to database** button and a text field to add an optional note.



Within **Global parameters** tab, you can optionally change the date of calculation if you wish this lag time record affect certain spot sample records in the past. If you don't change it, the date of calculation will be today. A lag time record calculated today can only shift spot sample records in the future.

Provide the necessary inputs following the process described in chapter 25.1 to generate the lag time total value. At **GC time** section, all three options are available: Use GC's analysis time defined in Analysis Parameter, override its analysis time and provide a custom value, or not using GC analysis time at all. Once you finished, click **Save to database** to commit this lag time calculation. You can write some notes prior to saving. After the record is written to database, GCAS returns to the Lag Time form with the new record listed as the last row. Date of calculation would be today (if you didn't change it), along with the total lag time in *milliseconds* and *canonical format* (hours-minutes-seconds) as well as number of pressure letdown stages.

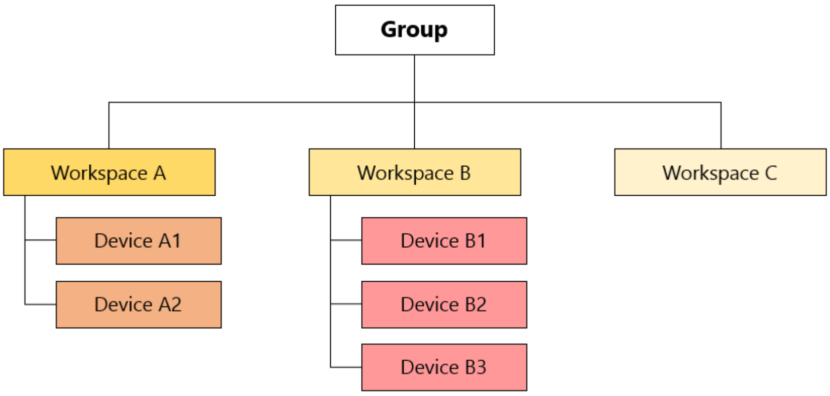
To edit a lag time record, highlight the row in Lag Time form and either click **Details** inside that row or **Edit** on the toolbar. Lag Time form should call Lag Time Calculator form with all global parameters and pressure letdown stages loaded. Now you can change a number or two, create or delete stages, or just edit the text note. If you changed input values, click **Calculate** to update lag time value of each stage as well as the total lag time. When you are satisfied, click **Save to database** to save the edit.

To delete a lag time record, highlight the row on the grid and then click **Delete** on the toolbar. Deleting records is not recommended because in case you need to recreate the record, the value of *date of calculation* field will be the date and time you finished creating that new record, not the date and time of the original record. We recommend setting the lag time record as inactive by clicking **Set inactive** button so the date of calculation is preserved. Conversely, click **Set active** to mark the record back as active.

Creating record, editing, deleting, and changing the active status are ruled by each own action permission. Your GCAS administrator can grant or deny access to these permissions. If you find a toolbar button being disabled while it shouldn't be, the action permission associated with it may be disabled.

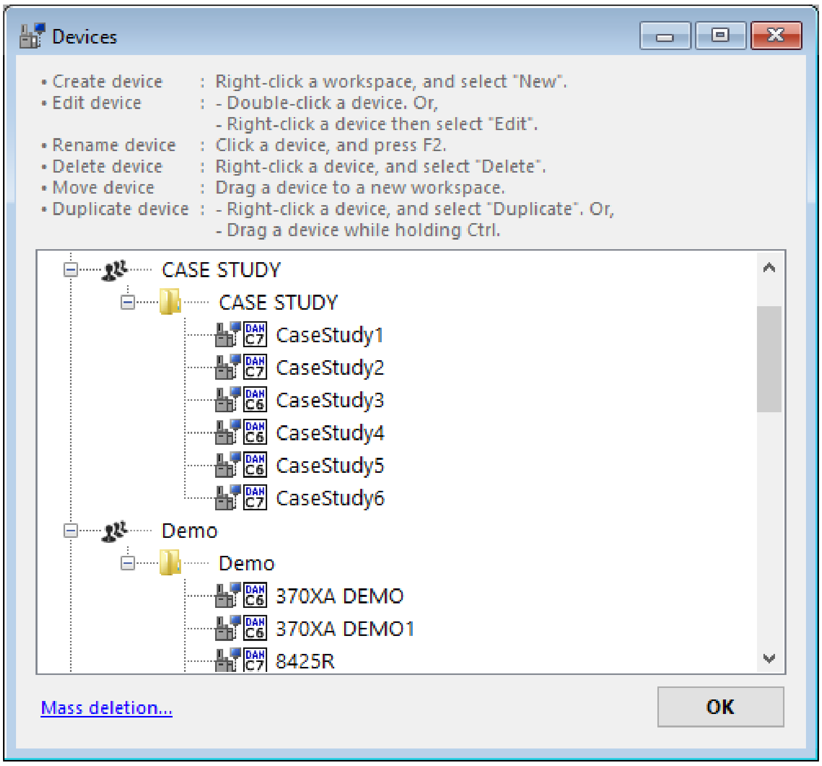
26 Device Management

A *device* is a representation of an actual, physical GC device. Device in GCAS database has several properties for example device name (also known as *device tag*), device type, and device date format (whether American or rest-of-the-world format). These properties should match the actual configuration of your physical GC device. Managing devices are conducted through the Devices form. Default installation of GCAS specifies only GCAS administrator and super users have access to this form.



- One group has several workspaces.
- Workspaces are a way to separate devices in the same group. This has been covered in chapter 3.2 Groups and workspaces.
- One device must belong to one workspace.

26.1 The *Devices* Form



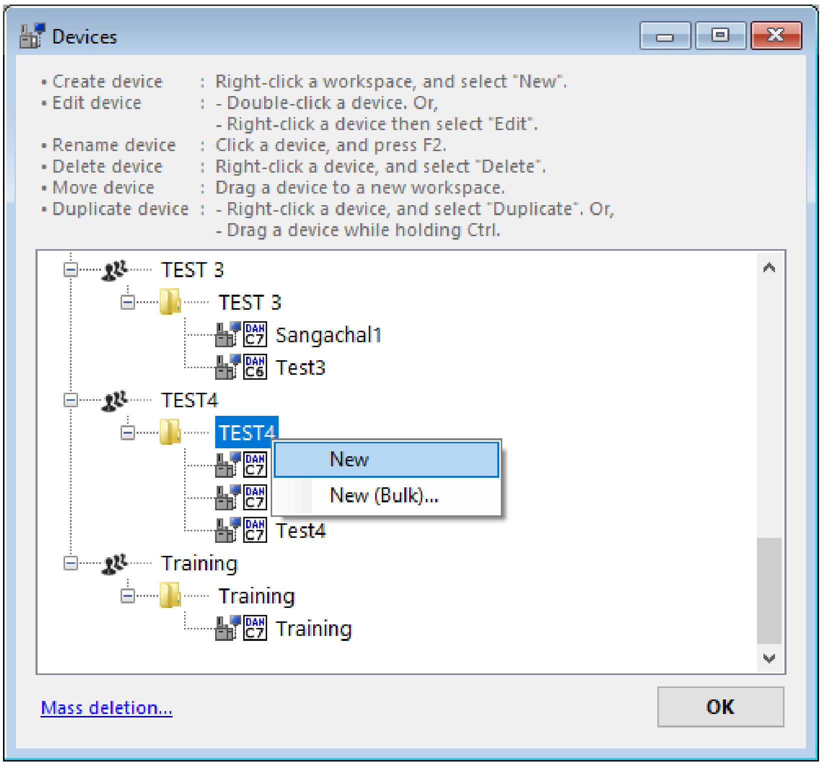
Go to the *Devices* menu > **Manage Devices**. This form lists all GC devices from all groups accessible from your user account. If the form shows a blank box, it means your GCAS user account is not assigned to any group, or the database is still blank that your GCAS administrator has not created any groups yet.

Note

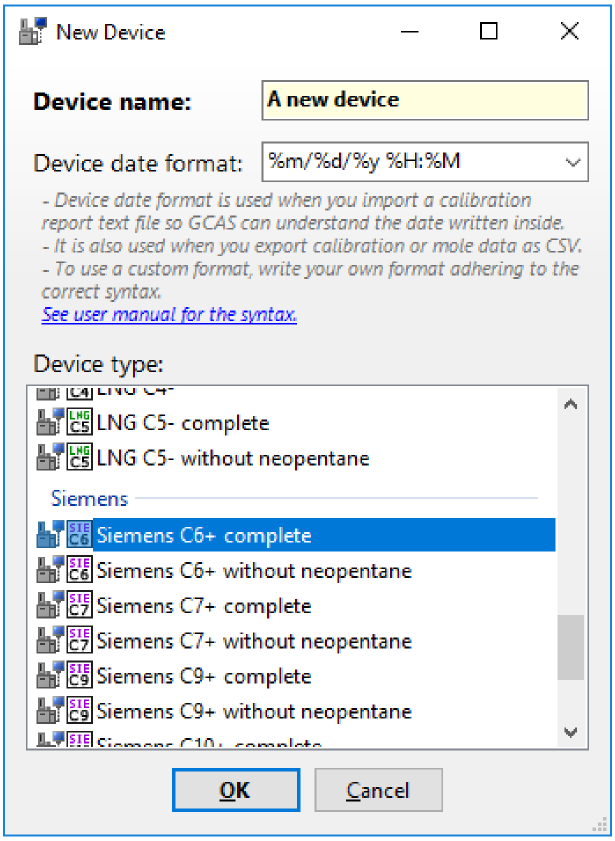
Default installation of GCAS specifies that you have to be at least a *super user* to access this form.

26.2 Create One Device

Right-click a  workspace node, and select **New**.



Next, give the new device a name, set its date format, and assign a device type from the list.



Device date format: Select one of the list, or type a custom date format. This date format follows MySQL convention. We recommend selecting from the dropdown list.

- **%m/%d/%y %H:%M** = USA format.
  For instance, 01/12/2013 07:55 is interpreted as 12 January 2013 07:55 AM.
- **%d/%m/%y %H:%M** = rest-of-the-world format.
  For example, 01/12/2013 07:55 translates to 1 December 2013 07:55 AM.

Custom format specifier	Date/time element
%d	date (2 digits)
%m	month (2 digits)
%y	year (4 digits)
%H	hour (2 digits, 24h format)
%M	minute (2 digits)

Device type: Select one from the list that matches your physical GC device.

Device type	C1	N2	CO2	C2	C3	IC4	NC4	NEOC5	IC5	NC5	C6	C7	C8	C9	C10	B	T	E	X	H2S	H2O	G
Daniel, ABB, Siemens, Elster																						
C6+ complete	•	•	•	•	•	•	•	•	•	•	•											
C6+ without neopentane	•	•	•	•	•	•	•		•	•	•											
C7+ complete	•	•	•	•	•	•	•	•	•	•	•	•										
C7+ without neopentane	•	•	•	•	•	•	•		•	•	•	•										
C9+ complete	•	•	•	•	•	•	•	•	•	•	•	•	•	•								
C9+ without neopentane	•	•	•	•	•	•	•		•	•	•	•	•	•								
C10+ complete	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•							
C10+ without neopentane	•	•	•	•	•	•	•		•	•	•	•	•	•	•							
LNG																						
C2–	•	•	•	•																		
C3–	•	•	•	•	•																	
C4–	•	•	•	•	•	•	•															
C5– complete	•	•	•	•	•	•	•	•	•	•												
C5– without neopentane	•	•	•	•	•	•	•		•	•												
BTEX																						
BTEX analyser																•	•	•	•			
Single gas																						
H_2S analyser																				•		
Moisture analyser																					•	
Single gas analyser																						•

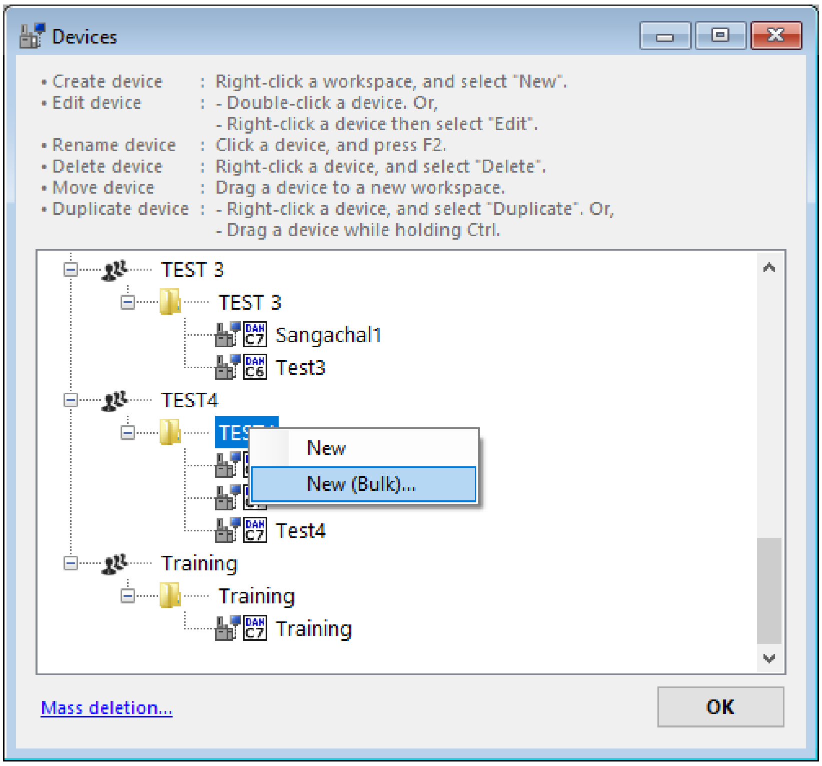
Help on abbreviations: go to chapter 6 Gas acronyms.

Click **OK** and you should see the new device is listed under this workspace node. When you close the *Devices* form, GCAS main window will refresh its device panel and your new device should be there.

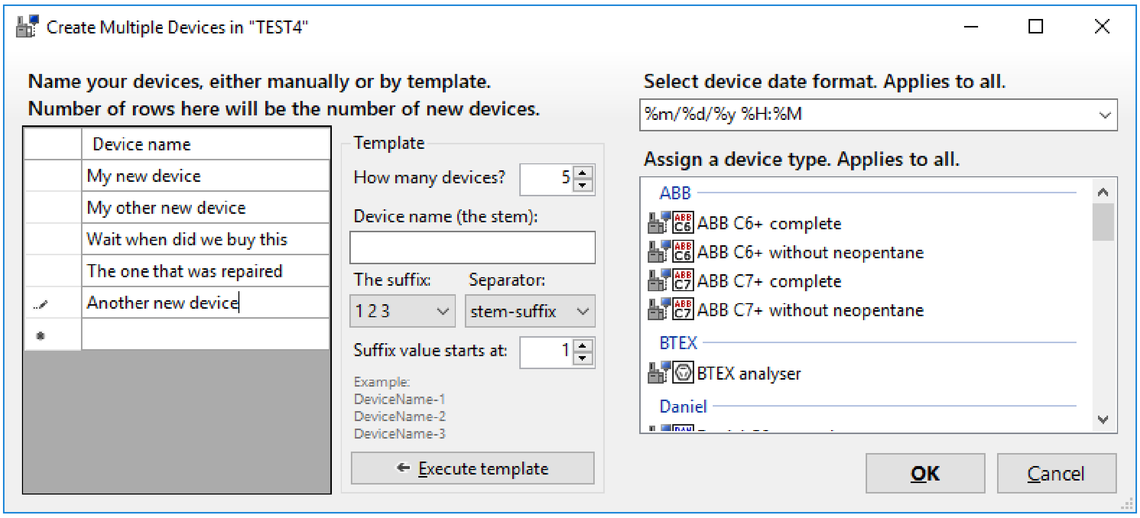
> **Note**
>
> Your GCAS licence specifies how many devices you can create. You should not create more devices than this limit. The next time you try opening a GCAS database containing number of devices exceeding this limit, you need to choose devices to be accessible during that session.
>
> If you use the old GCAS licence version 2, the limit of GC devices you can have is 10 (ten).

26.3 Create Multiple Devices in Bulk

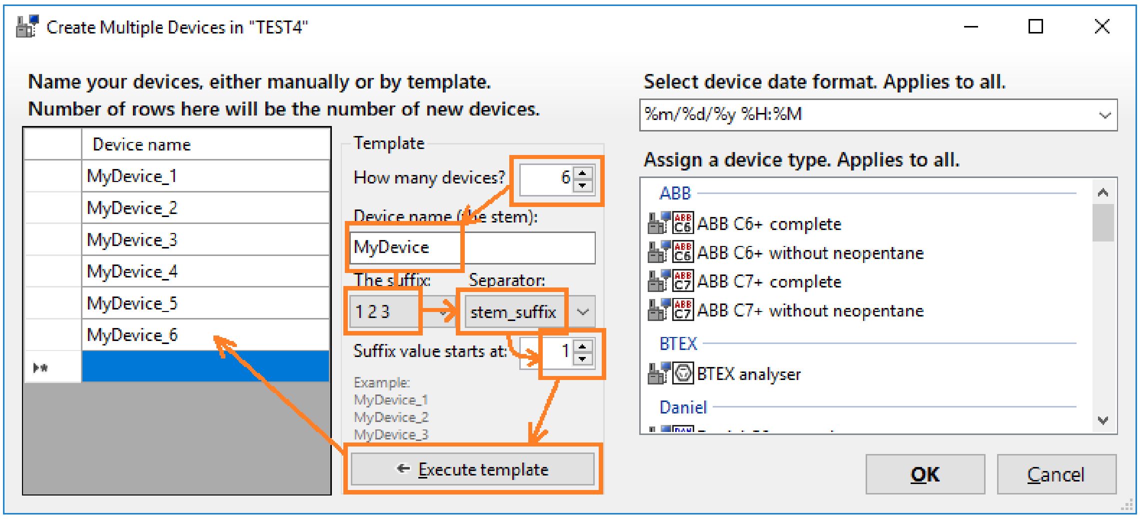
This action creates multiple devices with the same date format and device type in one batch therefore saves you time. To do this, right-click a workspace node and select **New (Bulk)**.



On the left side of *Create Multiple Devices* dialogue, enlist the names of your new devices. You can do it manually like this:



...or by utilising the name generator based on a template, like this one down here. In this screenshot, the "stem" is "MyDevice", suffix style is numerals (123), suffix starts from 1, and suffix separator is an underscore.



Moving to the right side, set a device date format and device type. These two properties apply to all your new devices. Rewind to chapter 26.2 for more information about device date format and device types.

Click **OK** to begin creating devices. These devices will be listed under the selected workspace node.

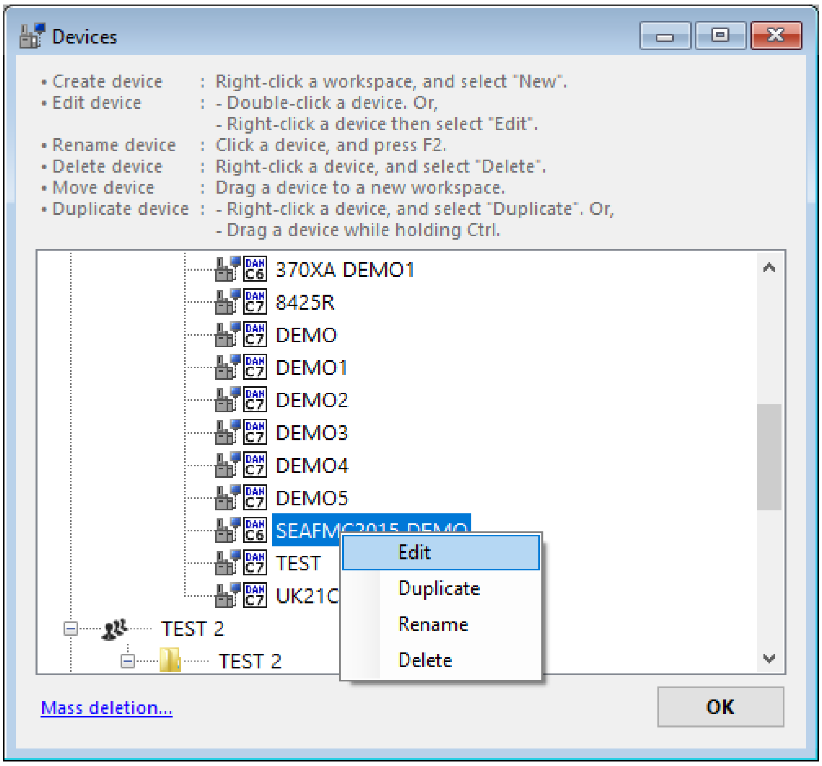
Note

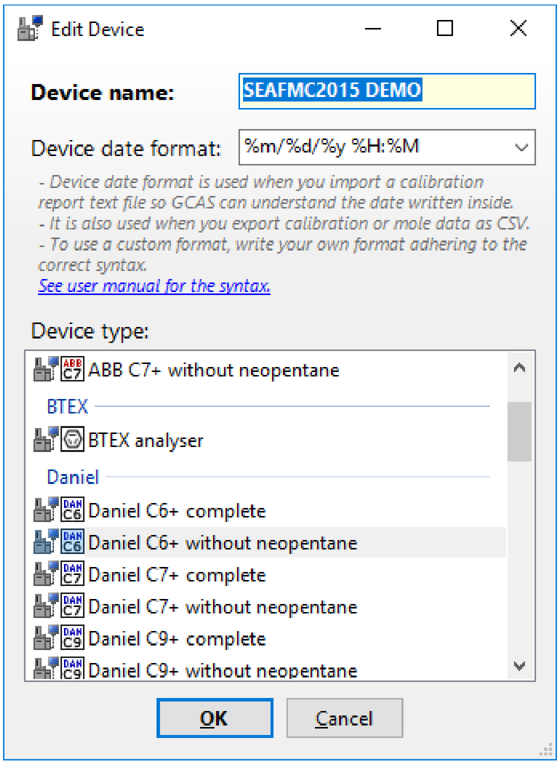
Your GCAS licence specifies how many devices you can create. You should not create more devices than this limit. The next time you try to open a GCAS database containing number of devices exceeding this limit, you need to choose devices to be accessible during that session.

If you use the old GCAS licence version 2, the limit of GC devices you can have is 10 (ten).

26.4 Edit Device

You can either double-click a device node, or right-click it and select **Edit**. This action brings up the *Edit Device* window. Here you can change the device name, date format, or device type.

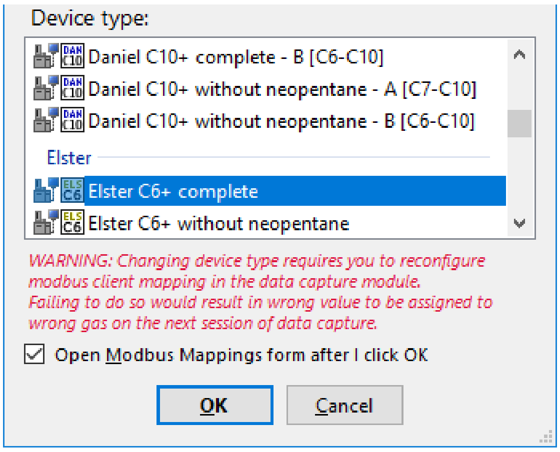




A note if you change the device type, we strongly recommend reconfiguring data capture register mappings immediately. Otherwise, there are three possible outcomes:

1. *Data capture refuses to start* because the number of gases does not match the expected one. This happens after you changed the device type to the one with a different carbon count such as from C9+ to C6+. This also happens after you changed the device type from a complete one to the non-neopentane one or vice versa
2. *Data capture works but the captured values are put into wrong gas*. This happens after you changed the device type to another one having the same gas count but different gas sequence. For example, ABB C6+ complete and ABB C7+ without neopentane both read 11 gases, but the captured value for hexane is assigned to heptane and captured value for neopentane now goes to hexane. This causes domino effect such as wrong correlation (R^2) value afterwards.
3. *Data capture works perfectly fine*. This rare case happens after you changed the device type to the most similar one, for instance from Daniel C7+ complete to Siemens C7+ complete. Both have the same number of gases, both have neopentane, and both do not require special handling like how ABB does.

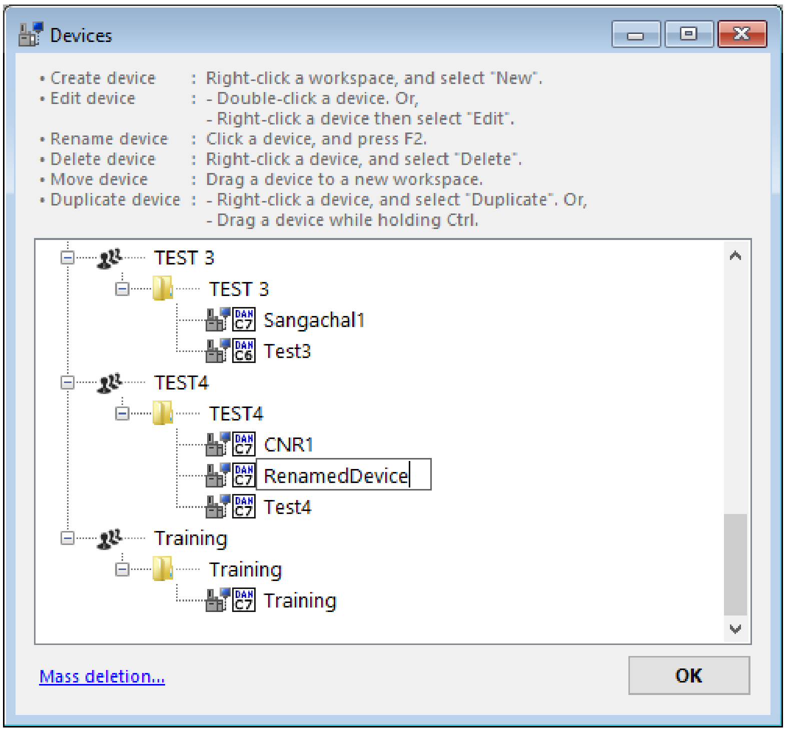
To prevent unwanted errors, it is better to reconfigure register mappings before you forget. The *Edit Device* dialogue offers a check box to open Modbus Client Mappings form after you click OK.



Another note: If you use data provision feature and this device is one of those included in data provision, recheck your server instance definition to avoid empty gas definitions due to device type change.

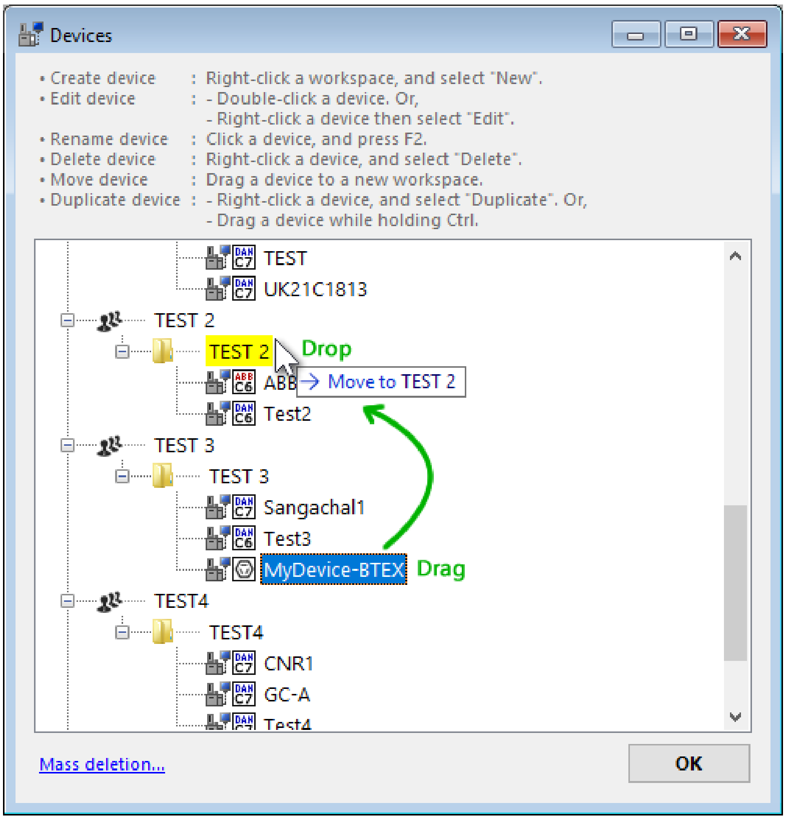
26.5 Rename Device

You could use the *Edit Device* dialogue to rename a device as explained in chapter 26.4, but there is a quicker way if all you want to do is just change the name. Click the device node and press F2. Alternatively, right-click that node and select **Rename**.



26.6 Move Device

To move a device from a workspace to another, drag the corresponding device node and drop it on the desired workspace node. This may change the association between the device and the group where the new workspace belongs.

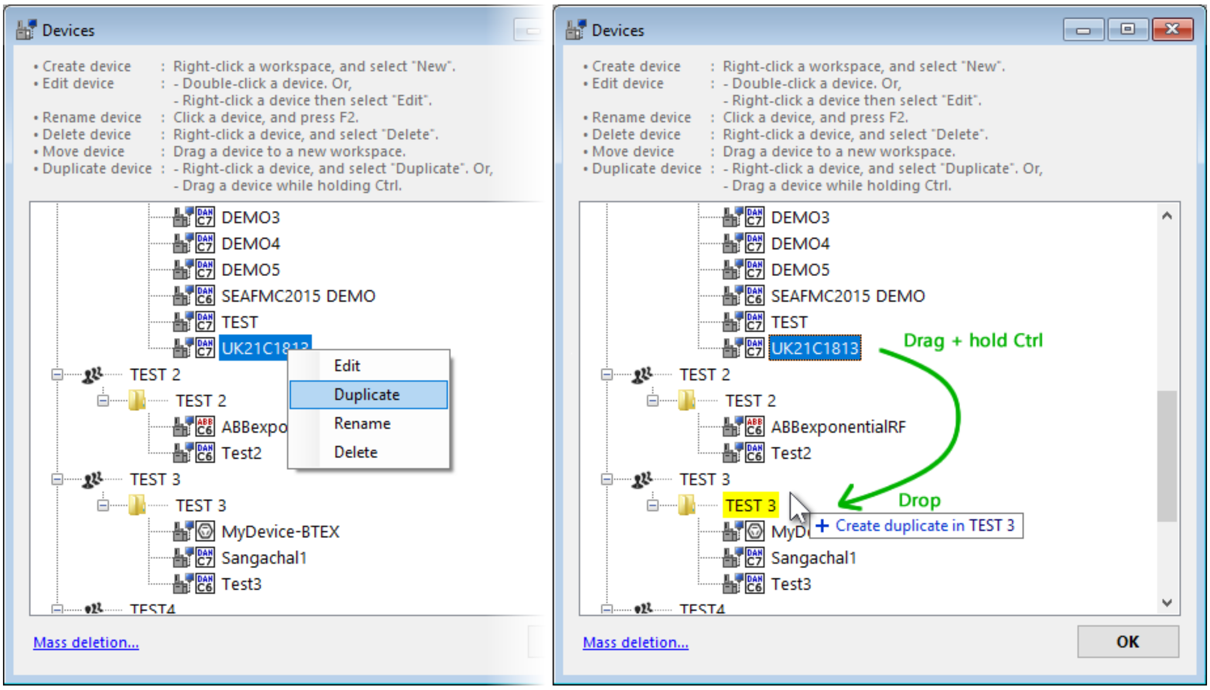


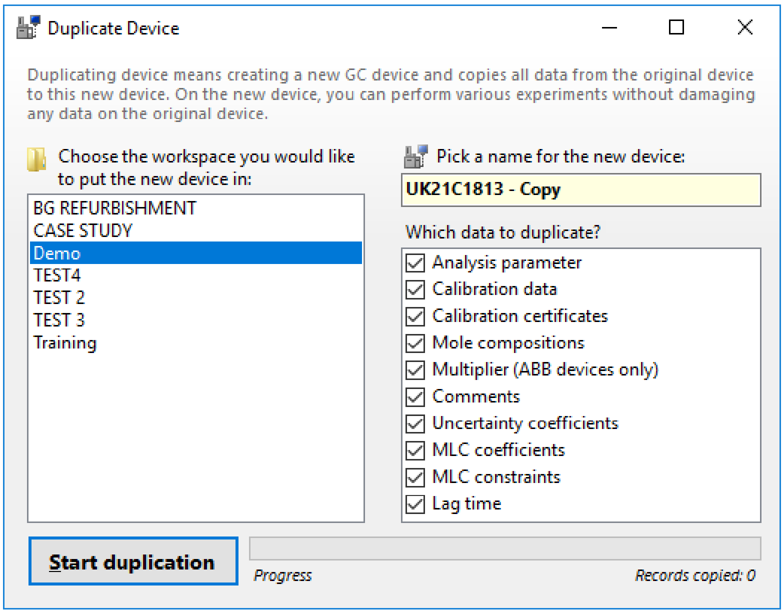
26.7 Duplicate Device

Duplicating a device means creating a new device and copies all records associated with the original device to the new device. Then you can conduct various experiments on the new device without having to worry about damaging the data of the original device.

> **Note**
>
> Duplicating a device is not intended as a regular backup feature because the original device and the clone both are still located inside the same database. It is more like a "fork" of this device (GitHub guys will understand). On another somewhat-related topic, you or your database administrator should back up the entire GCAS database periodically to a safe place.

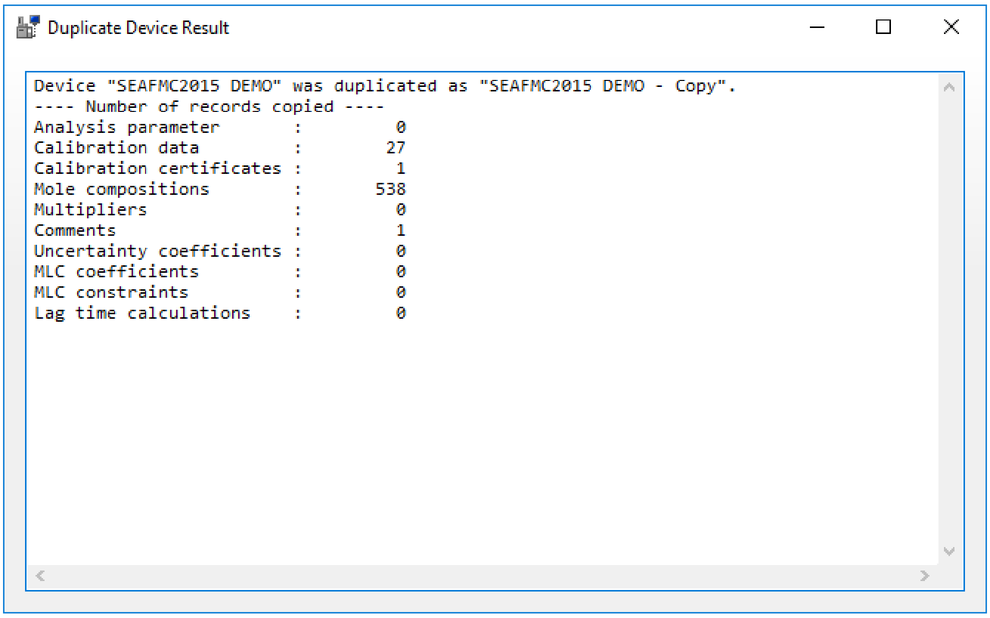
To clone a device, right-click the corresponding device node and select **Duplicate**. This method is mainly for duplicating the device within the same workspace. To duplicate the device while moving it to different workspace, drag the device node and hold `Ctrl`. Then drop it over the desired workspace node. Either action will show the *Duplicate Device* form.





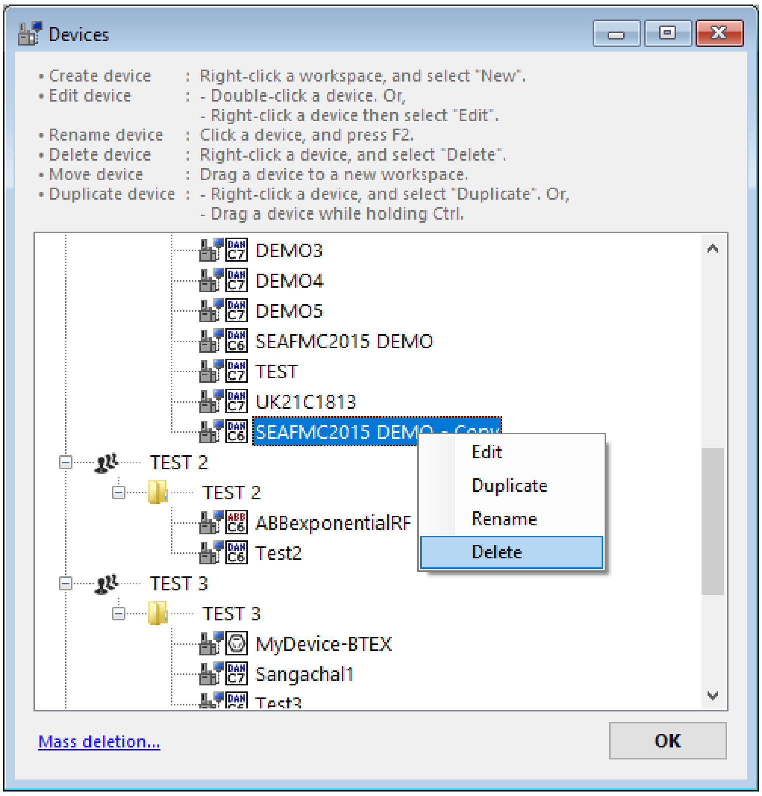
On the left side, select the workspace where the new device will belong to. There is no restriction that it has to be different workspace or it has to be the same workspace. It is up to you. Moving to the right side, specify the name of this new device. By default, GCAS uses the original device name plus "– `Copy`" at the end. Finally, under device name input box, you can tick or untick which data to copy during the duplication process.

When you are ready, click **Start duplication**. Once the process completes, GCAS presents a mini report of how many records copied to the new device.

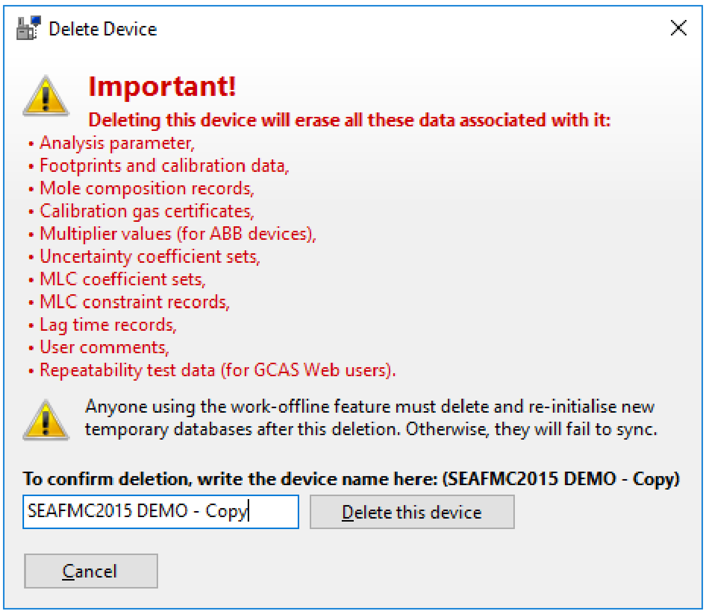


26.8 Delete One Device

To delete a device, right-click the device node and select **Delete**.



GCAS displays this confirmation dialogue. Read the important bits, and then confirm the deletion. To confirm, write the device name at the supplied text box. Write the name precisely because it is case-sensitive. Then, click **Delete this device**.

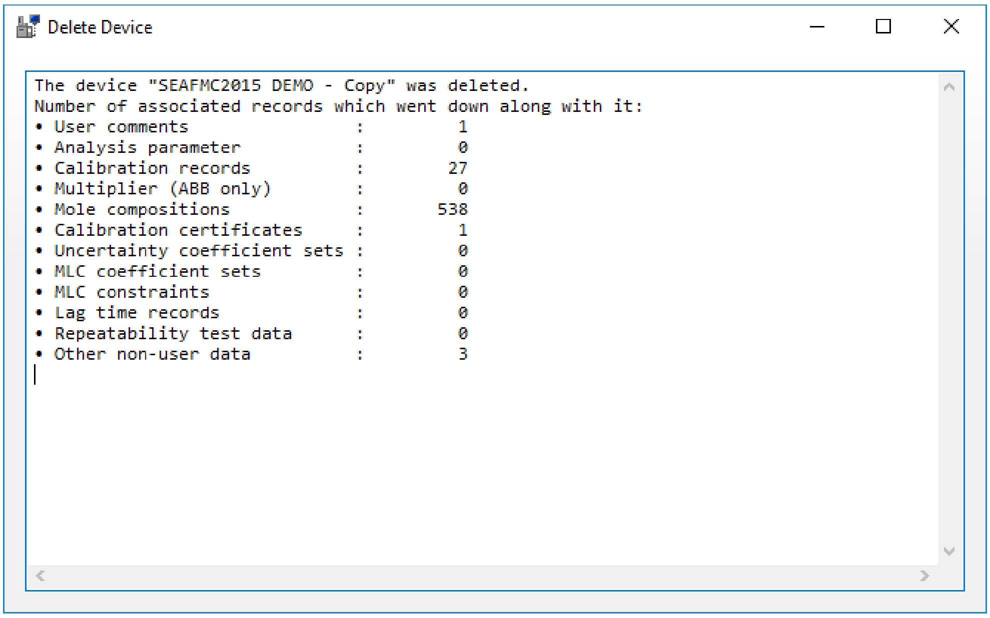


Important

Deleting device will erase all records associated with it. The deletion is **permanent** and cannot be undone. No, GCAS does not create restore point. No, GCAS database does not have the luxury of creating snapshot. Make sure you no longer use the existing data when you scrap this device. Or else, export its data as a backup.

Other users connected to the same database working with the device being deleted may see errors after deletion. Make sure everyone else is not touching this device before you delete.

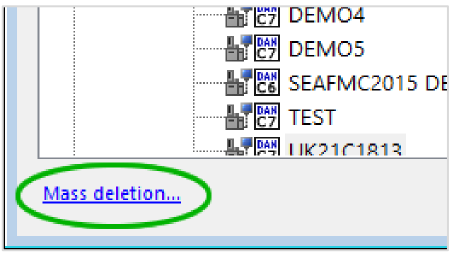
After deletion, GCAS presents a mini report of how many records were deleted.



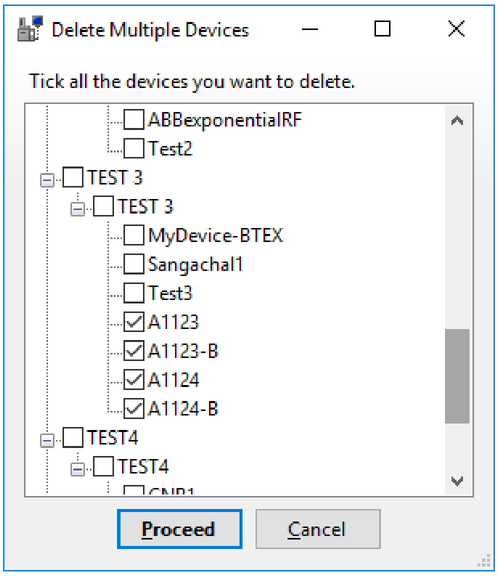
26.9 Delete Multiple Devices in Bulk

There are possible scenarios where you need to delete multiple devices at once. For instance, you created multiple devices in bulk as test beds for your experiment. After your experiment is finished, you may want to delete these devices. Another situation, you are using local offline database containing two workspaces. You already duplicated the .sdf file and want to have one workspace in each of them. Therefore, you want to remove devices of workspace B in first .sdf and remove devices of workspace A in second .sdf file.

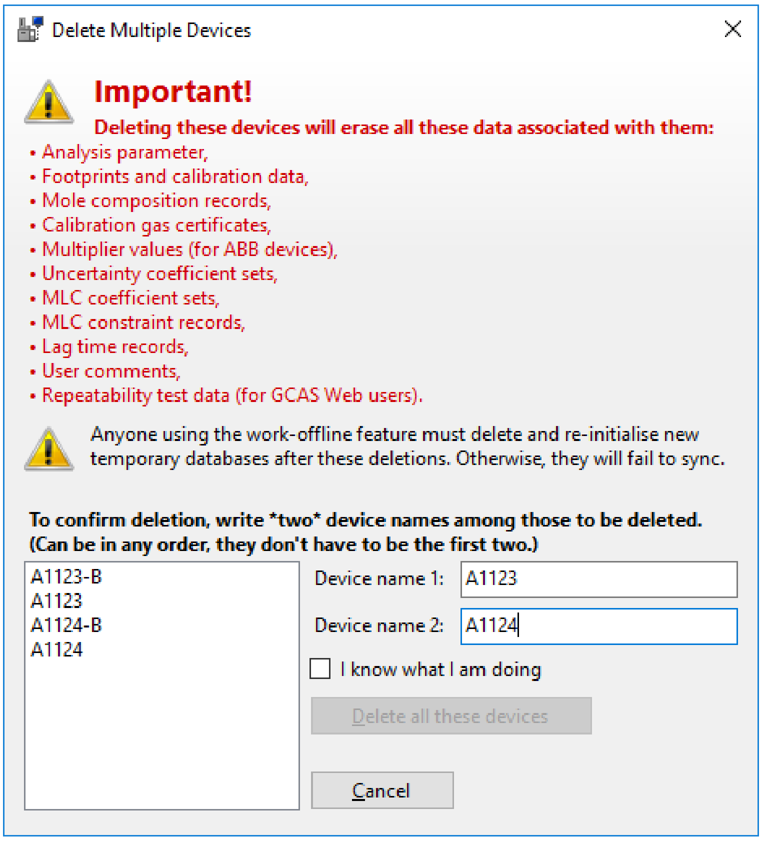
Obviously you can nuke the devices one by one using the method elaborated in chapter 26.8. But we have a faster way. Notice the blue link **Mass deletion** at the bottom-left corner of the *Devices* form? Yep, go click it.



GCAS then displays the same tree view with check boxes. Here, tick all the devices you wish to obliterate. When you are confident, click **Proceed**.



GCAS displays this confirmation dialogue. Read the important bits, and then confirm the deletion. There is a list of devices to delete at the bottom-left region of the dialogue. To confirm, write *two* of these device names at the supplied text boxes. They can be in any order and they don't have to be the top two of this list. Write the names precisely because they are case-sensitive. Give a check mark at the box **I know what I am doing** if you really are, and ultimately click **Delete all these devices**.



And once the deletion completed, GCAS presents a mini report of how many records were deleted. These number of records are aggregation (sum) of all deleted device.

Important

Deleting devices will erase all records associated with them. The deletions are **permanent** and cannot be undone. No, GCAS does not create restore point. No, GCAS database does not have the luxury of creating snapshot. Make sure you no longer use the existing data when you scrap these devices. Or else, export their data as a backup.

Other users connected to the same database working with the devices being deleted may see errors after deletion. Make sure everyone else is not touching these devices before you delete.

27 Data Capture (Modbus Client)

Instead of relying on CSV or text file import, GCAS has the ability to connect to your physical GC device via Modbus® protocol in order to get live data. GCAS captures response factor, retention time, and mole composition data.

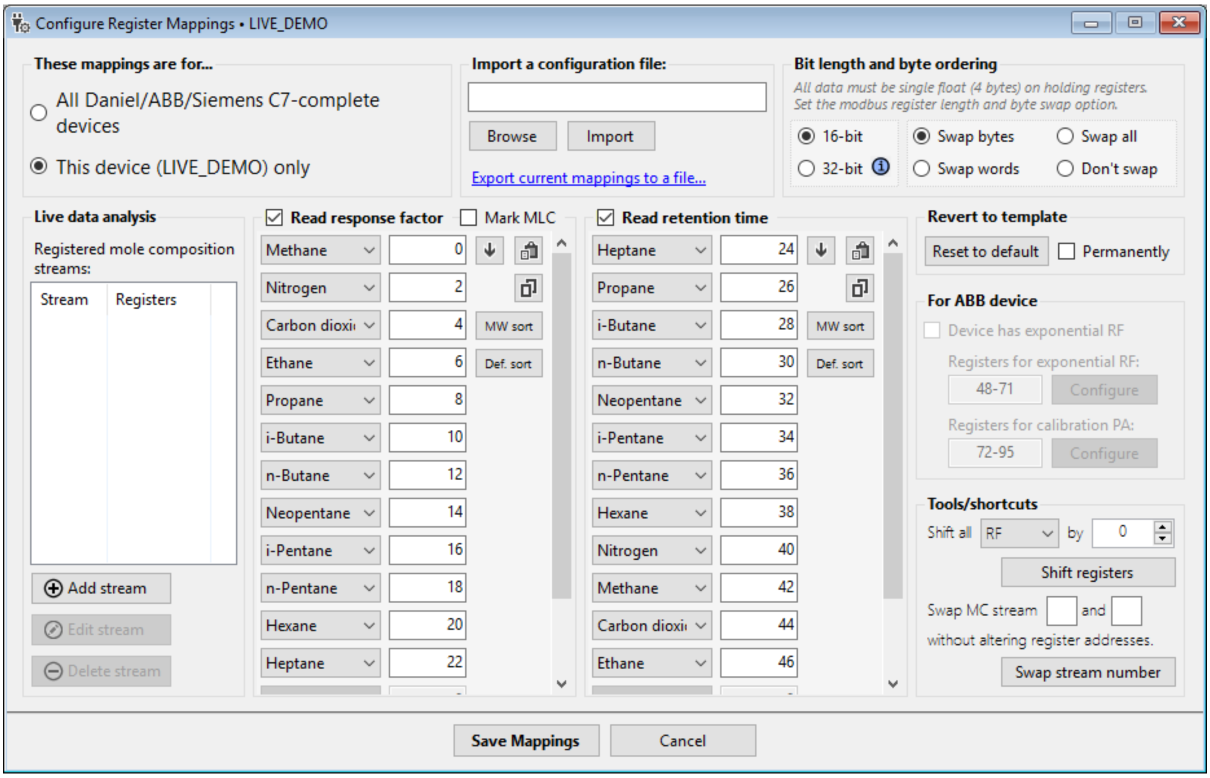
> **Note**
>
> To use this feature, you need the GCAS feature either *Modbus Client over Serial* or *Modbus Client over TCP* (or both) to be included in your GCAS licence. Additionally, to capture mole composition data you need another GCAS feature *Live Data Analysis* in your GCAS licence.

27.1 Configure Register Mappings

Before GCAS captures live data, you need to configure the Modbus registers. *Register* is small, volatile memory storage where your GC device outputs the data to. GCAS reads only *holding registers* on your GC device, therefore please configure your GC device to write the data to Modbus register 4:xxxxx. On GCAS side, configure GCAS to match those register addresses. This is administered through Register Mappings form.

27.1.1 The Register Mappings Form

Select the device you would like to configure on your device panel on the main interface. Then, click the Comms menu > **Register Mappings**.



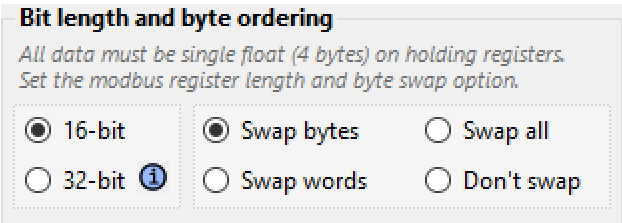
When the form opens, it tries to find the device configuration if you have ever configured it before. The configuration is stored in an XML file in `[Installation_directory]\Mappings-DeviceSpecific\` folder. If the corresponding XML file does not exist—implies that the device has never been configured, the form loads the appropriate **template**. The template being used depends on your GC device type.

Now you are ready to configure the register addresses for calibration data and for mole analysis data.

27.1.2 Bit Length and Byte Ordering

For data capture, GCAS accepts single-precision IEEE-754 floating point data (32-bit) only. GCAS does not accept integer data.

A standard Modbus register is 16 bits long, or 2 bytes. However, a standard single-precision float data requires 32 bits or 4 bytes. Two Modbus registers are then used to output one single floating-point datum. The floating-point byte swap options dictate how the bytes in these two registers be arranged to construct a 4-byte floating point value.



Several GC devices such as Daniel and Enron implement a non-standard Modbus protocol extension which uses 32-bit Modbus registers, or 4 bytes for each register. GCAS supports these 32-bit registers as well. Choose **16-bit** to use standard 16-bit Modbus registers or **32-bit** to use non-standard 32-bit registers.

Depending on how your GC device is configured, you need to match the byte ordering configuration on GCAS. *Also, please note that GCAS operates using little endian order.* Select one of four byte-ordering options:

- **Swap bytes**, also known as Modicon standard, swaps the bytes within each word (ABCD → BADC).
- **Swap words** swaps low and high word but not bytes inside each word (ABCD → CDBA).
- **Swap all** swaps both words and bytes inside words (ABCD → DCBA).
- **Don't swap** preserves the original byte order (ABCD → ABCD).

27.1.3 Calibration Parameter Registers

Calibration parameter refer to response factor and retention time. On Register Mappings form, set the registers for RF and RT data to match those on your physical GC device. Register address starts from `0` (zero). Address `0` translates to Modbus holding register `4:00001`. Address `1` translates to `4:00002`, and so on.

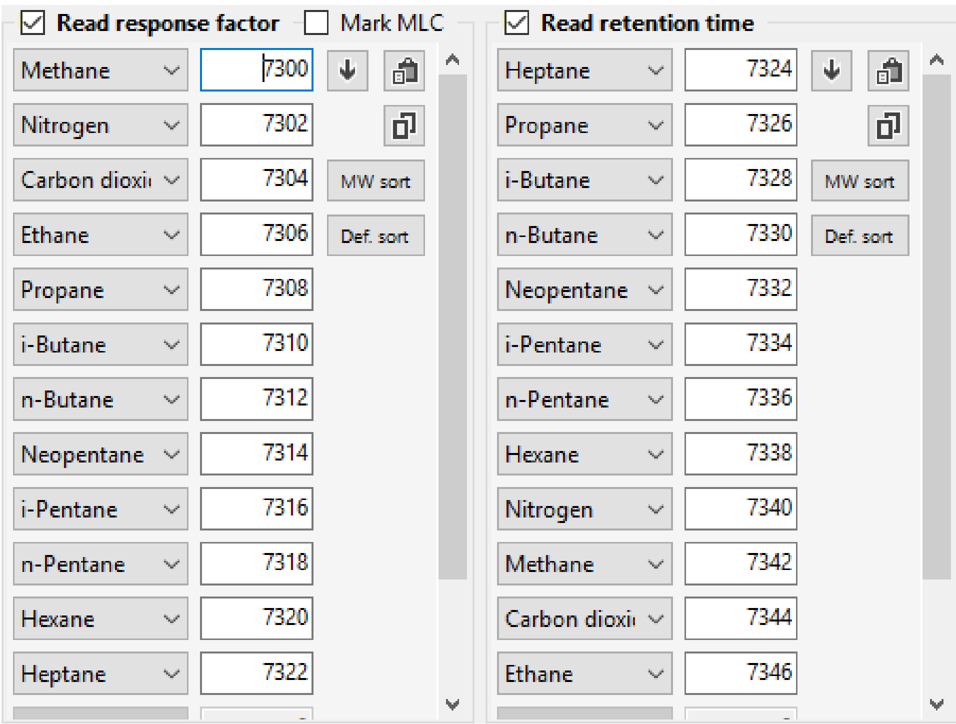
Change the gas order by selecting the correct gas names from the dropdown list. Depending on your GC device type, some input fields may be disabled. For instance, a GC device of C7+ without neopentane reads 11 gases only. Therefore, twelfth to fifteenth input fields would be greyed out.

To quickly change overall gas order, click either **MW sort** or **Def sort** button. **MW sort** will arrange gases per their molecular weight (MW). In this way, methane goes first. **Def sort** (default sort) on the other hand will arrange gases according to the sequence they exit the GC. On GC devices with backflush, the heavy-end comes first. On GC devices with two ovens (e.g. Daniel C9 and C10) **Def sort** button applies the default sort of oven 1 first, followed by the default sort of oven 2.

Ignore a part of incoming data

You can make GCAS *ignore* incoming RF data, for example, if you want to capture retention time only or mole composition streams only—or if your GC device doesn't provide one of either RF or RT. To ignore response factor data, untick **Read response factor**. The same applies for RT data, which you can control using **Read retention time** tick box.

On standard **16-bit** Modbus, one gas requires two Modbus registers. For instance in the screenshot below, methane RF is set to use register address `7300`. In practice, it uses register address `7300` and `7301` altogether. Set the next gas/nitrogen RF register to address `7302`.



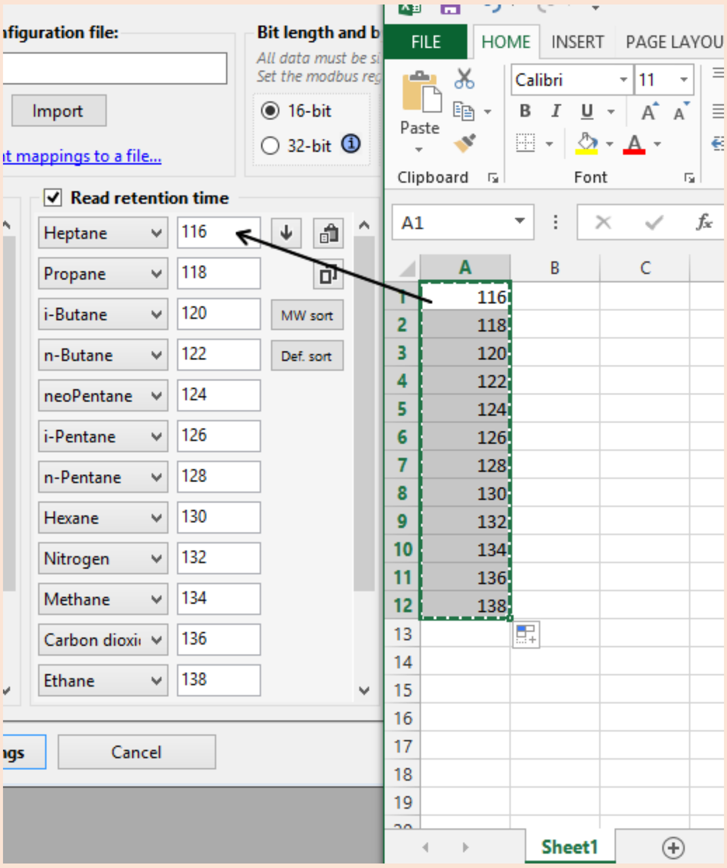
However in **32-bit** Modbus, one gas requires only one register. There is no need to skip register address once every two like in the prior example.

Users with GCAS feature *ISO 10723* included in their licences see an additional check box at the header of response factor fields called **Mark MLC**. This controls whether the incoming response factor data should be marked as multilevel-calibrated or not. Rewind to chapter 7.12 to read more about multilevel-calibrated RF.

Tip

To quickly define sequential Modbus registers, enter the first register address then click **Flash fill**. For example, type `110` in methane response factor, click **Flash fill**, and GCAS shall assign `112` for nitrogen response factor, `114` for carbon dioxide, `116` for ethane, and so on. If you are on 32-bit Modbus then GCAS assigns `111` for nitrogen, `112` for carbon dioxide, `113` for ethane, and so on.

You can also copy Modbus register addresses from Microsoft Excel or other spreadsheet processing software. Press `Ctrl+V` inside the **first text box** and the rest will follow. Alternatively, click **Paste**.



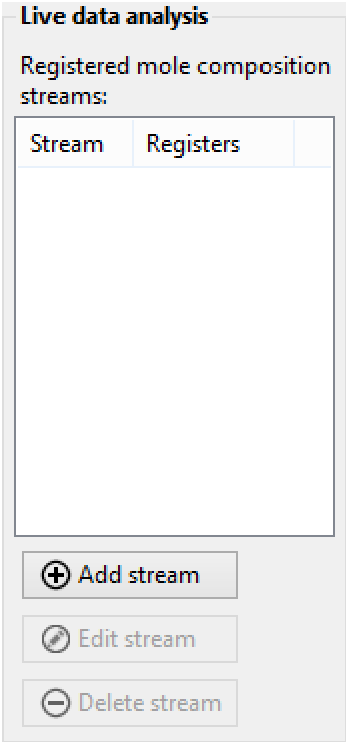
The **Copy** button does the opposite—it copies register addresses from GCAS so you can paste onto Microsoft Excel spreadsheet.

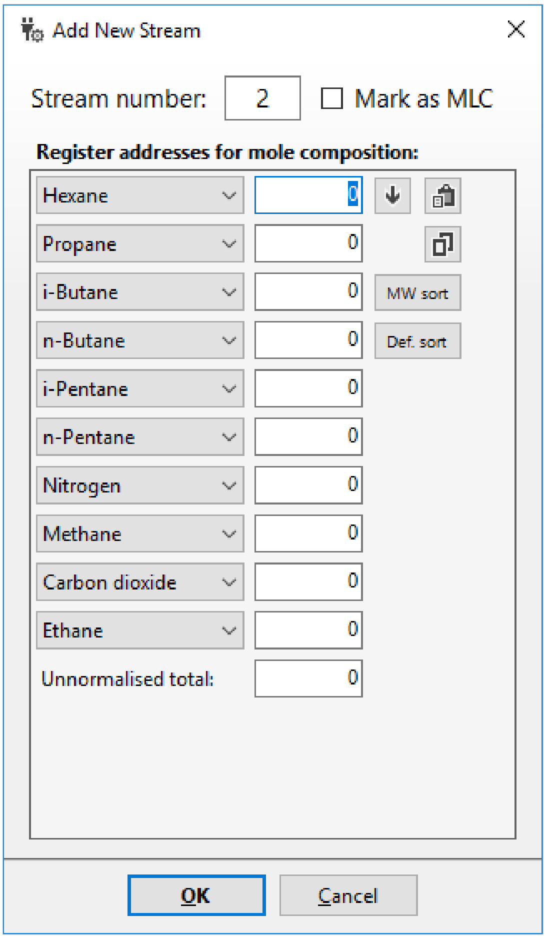
27.1.4 Mole Composition Streams

GCAS supports multiple streams of mole composition data, provided that each stream has its own unique set of register addresses and there are no address collisions between streams.

Note

You need the GCAS feature *Live Data Analysis* to be included in your licence in order to capture mole composition data.





Click **Add stream** button to define a new stream. This brings forth another dialogue (see left) where you can define gas names and their register addresses. Also remember that each gas consumes two Modbus registers on 16-bit mode, but only one for each on 32-bit mode.

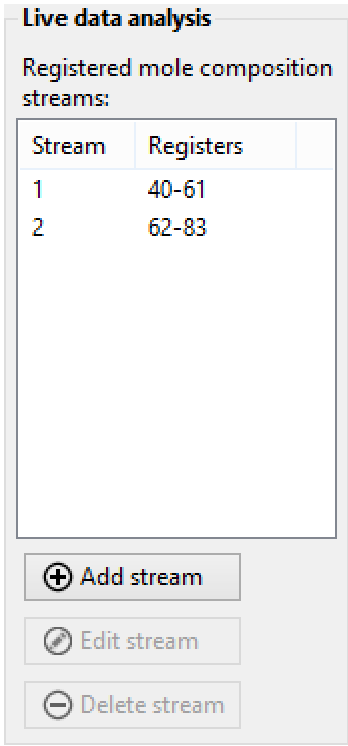
The last register address is reserved for unnormalised total. This is the sum of raw data read by GC device; for some devices may automatically normalise mole composition values so they add up to exact 100%.

Does your GC device not provide unnormalised total data? Visit chapter 27.1.5 for a workaround.

Users with GCAS feature *ISO 10723* in their licences shall see an additional check box near the top-right corner named **Mark as MLC**. This check box controls whether the incoming composition data on this stream should be marked as multi-level-calibrated or not. Rewind to chapter 8.11 to read more about multilevel-calibrated composition.

After you click **OK**, the new stream appears on the list. In this example, it displays `40-65` because we use standard 16-bit Modbus thus register `64` (unnormalised total) actually uses address `64` and `65`. Next register available for subsequent stream is `66`. If you use [32-bit Modbus](), it will display `40-52` instead, because each component only uses one Modbus register.

To edit a stream, click on the desired stream then click **Edit stream**. Likewise, to delete one, highlight the stream then the **Delete stream** button.

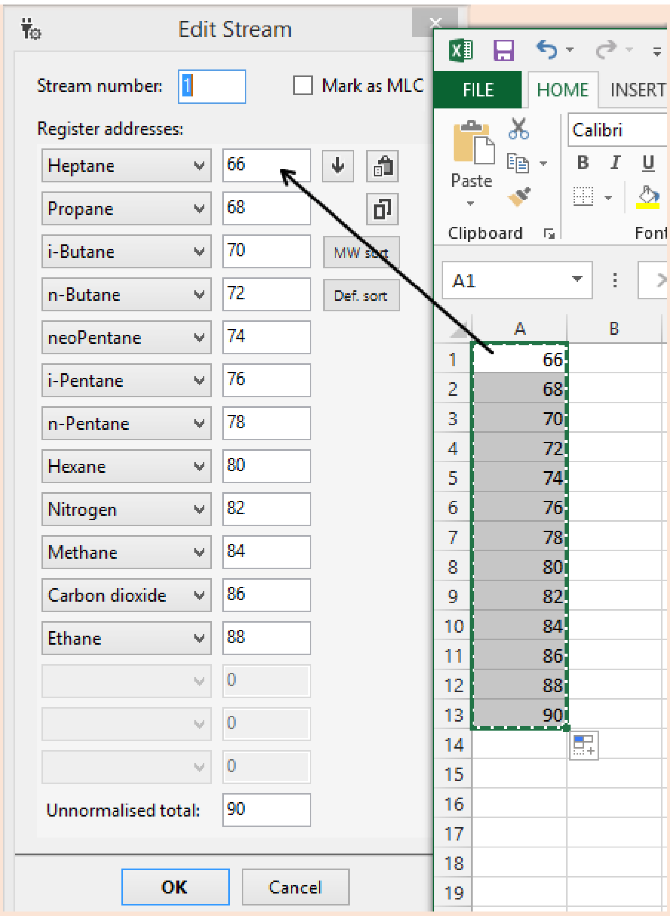


Tip

To quickly define sequential Modbus registers, enter the first register address then click **Flash fill**. For example, type `40` in heptane, click **Flash fill**, and GCAS shall assign `42` for propane, `44` for i-butane, `46` for n-butane, and so on. If you are on 32-bit Modbus then GCAS assigns `41` for propane, `42` for i-butane, `43` for n-butane, and so on.

However; if the register address for unnormalised total is not on sequential series as the other components, do not forget to edit the register address for the unnormalised total after clicking Flash fill. We emphasise this because many Daniel GCs are configured like this.

You can also copy Modbus register addresses from Microsoft Excel or other spreadsheet processing software. Press `Ctrl+V` inside the **first text box** and the rest will follow, skipping the greyed out fields. Alternatively, click **Paste**.



The **Copy** button does the opposite—it copies register addresses from GCAS so you can paste it onto Microsoft Excel spreadsheet. The greyed-out fields, if any, are also included in the copy operation.

MW sort button arranges gases according to their molecular weight (MW). **Def sort** (default sort) re-orders gases using the default sort, which is the sequence these gases exit the GC.

27.1.5 What if my GC device cannot provide some data?

Depending on the make, model, and configuration of your GC device, the device may not be able to provide some data. For example, a GC device does not provide data for unnormalised total of mole composition.

27.1.5.1 GC device does not provide retention time data

Simply untick **Read retention time** as described in chapter 27.1.3. The same applies if the GC device does not provide whole set of response factor data, you would untick **Read response factor**.

27.1.5.2 GC device does not provide response factor data, but it provides peak area

Unfortunately, GCAS does not have the tool to calculate response factor from peak area and mole composition right on the GC Connect form. We suggest two workarounds:

a) Do not capture live data through GCAS, but obtain the data of peak area through other means (e.g. via the bundled software or report output). Later, go to Footprint form or Calibration Data form, open the Action menu and choose **Import Data - Manual Entry**. Select the third option ("*Response factor values are calculated from peak area*") and enter the data. Have the component data table or calibration gas certificate ready because you will also need to input the mole percentage values. Click **Save** and GCAS will calculate the response factor values. Unfortunately, this workaround is effective only for one single record. Inputting multiple records through manual entry is a tedious work and very error-prone.

b) Designate the RF register addresses for peak area and run the data capture as usual. But **never** send the incoming data directly to database, use the option Save to CSVs instead. After the data capture session ended, you can convert the peak area to RF values in the CSV file using your favourite spreadsheet editing software. Afterwards, import the CSV.

27.1.5.3 GC device does not provide unnormalised total for mole composition streams

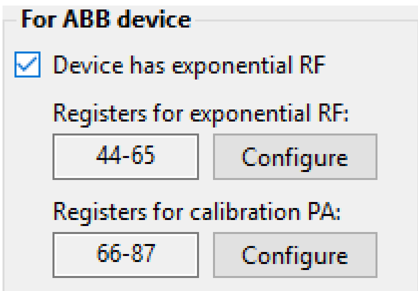
Define a special register on your physical GC device and hard-code its value to **100** (or any scale you like, 100 is for percentage). Use two sequential registers if you are on 16-bit Modbus. On GCAS, set the register address for unnormalised total to the address of this special register. Repeat this step for every defined stream.

27.1.5.4 GC device does not provide RF or RT data of one or several gases

Define a special register on your physical GC device and hardwire its value to **−1** (negative one). Use two sequential registers if you are on 16-bit Modbus. On GCAS, set the register address of the offending component(s) to the address of this special register. By this way, GCAS will record the value −1, thus will not display the component on RF or RT chart. The chart will have gap(s) at the offending component(s).

27.1.6 For ABB Devices

As ABB devices output exponential RF by default, there is a special setup to make them work with GCAS. To do that, GCAS needs to capture *both* single point RF and exponential RF, as well as peak area (PA).

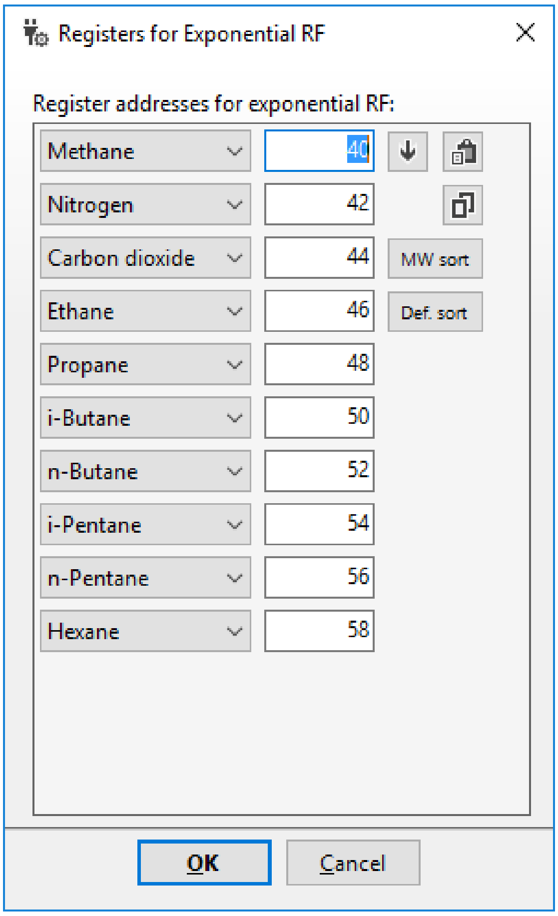


Fortunately, ABB devices have higher degree of flexibility in terms of configuration. If the device is configured to output single-point RF, you can leave the check box **Device has exponential RF** unchecked. By this way, GCAS treats the ABB GC just like Daniel or any other GCs—the response factor values are captured as single-point.

If the device outputs exponential RF however, GCAS needs these sets of data to construct a complete calibration record:

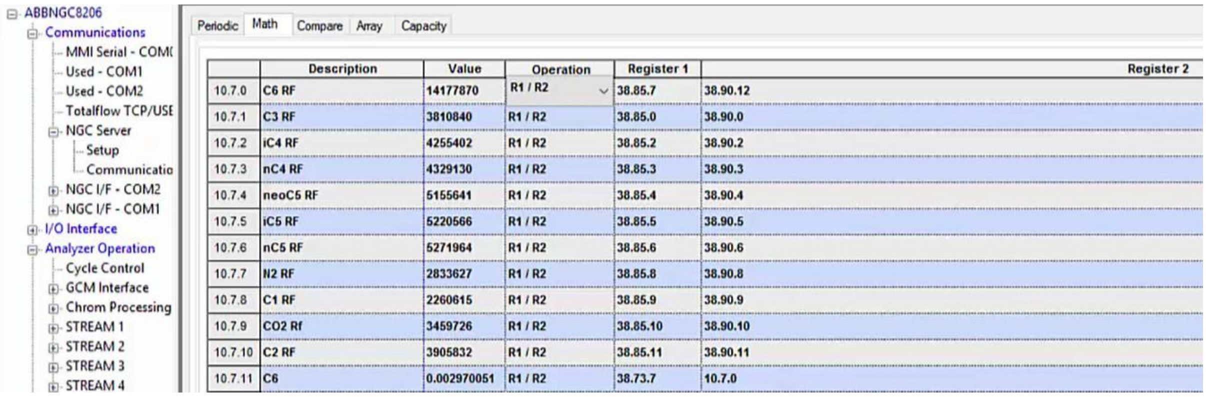
i) Single-point RF, this is what the response factor section of chapter 27.1.3 captures. You also need to configure the output formula in the Totalflow software which we will explain shortly.
ii) Exponential RF. Click **Configure** on the appropriate field.
iii) Retention time, this is what the retention time section of chapter 27.1.3 captures. Nothing new on this part.
iv) Peak area. Click **Configure** on the appropriate field.

All these data are captured as single-precision floating point. When you click **Configure** to set the registers of exponential RF or peak area, this is the dialogue window to expect:

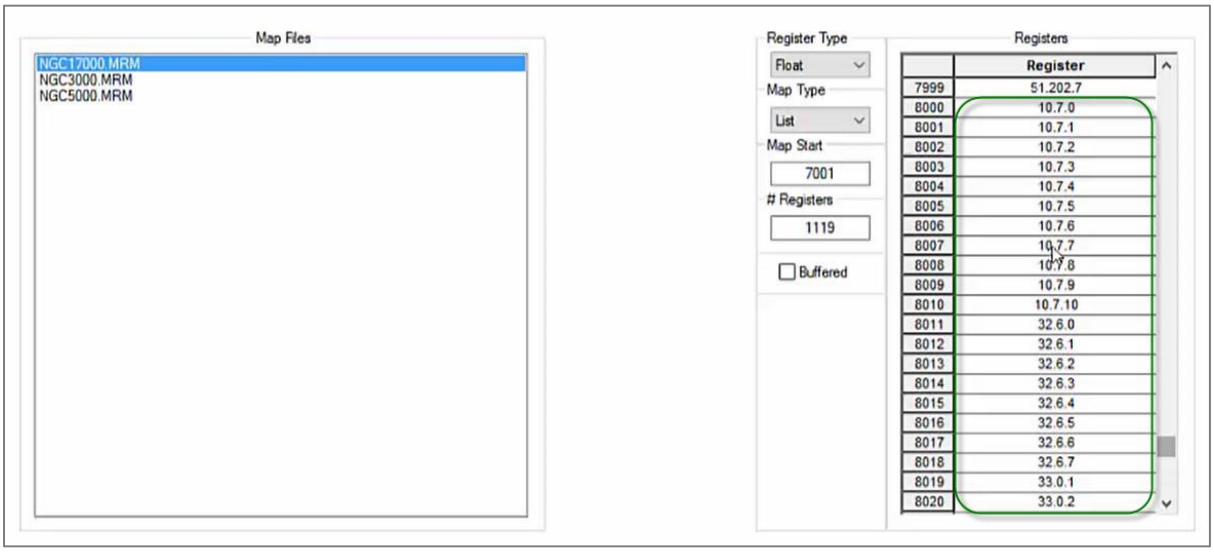


Same concepts apply—skip every other register address if the Modbus register length is 16 bits or don't skip if register length is 32 bits. All familiar buttons are also there. The **Flash fill**, the way to **Paste**, the **Copy** button, **MW sort** (molecular weight sort), and **Def sort** (default sort), are similar to the parent *Register Mappings* form. Make sure there is no address clash among the single-point RF set, exponential RF set, retention time, and peak area.

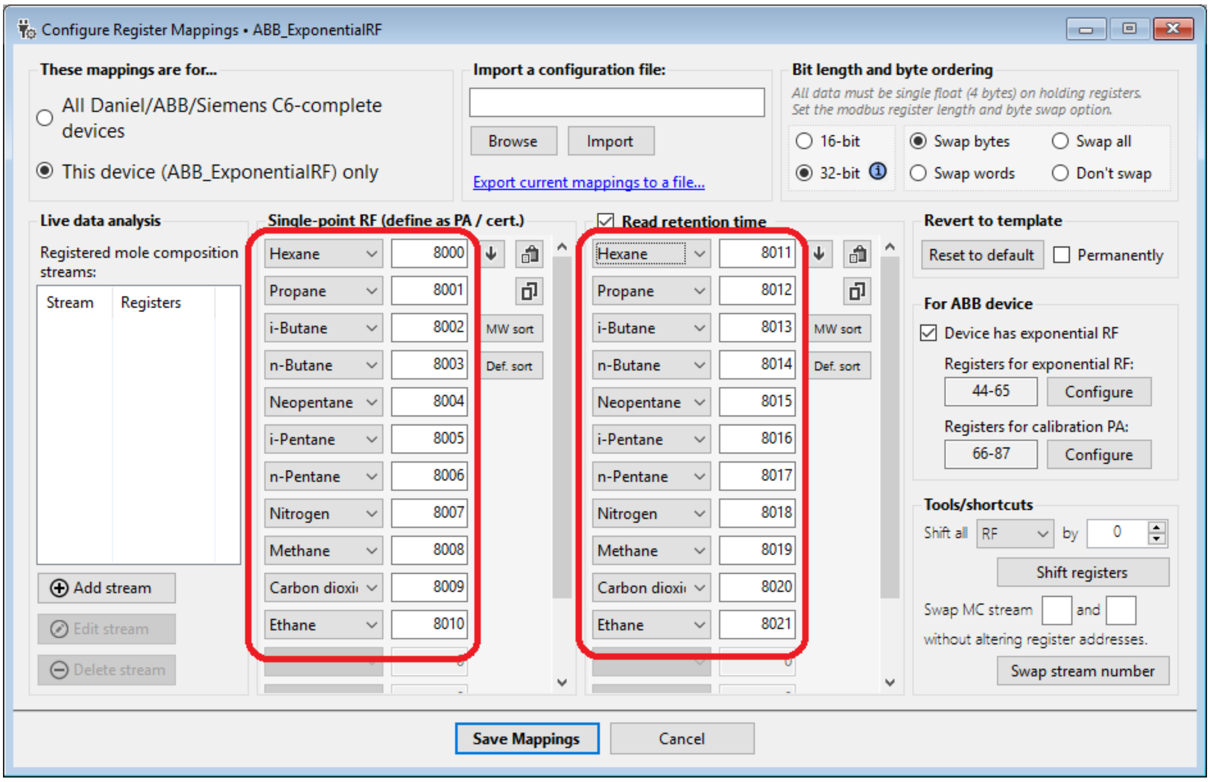
To get the single-point RF output, configure your GC using Totalflow software to output *peak area divided by mole percentage of calibration gas certificate*. First, create a maths operation. For example, the variable name `R1` is the peak area and `R2` is the mole composition. Here we define the single-point RF as `R1` divided by `R2`.



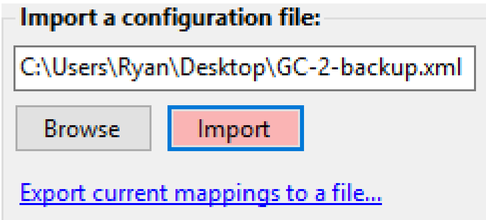
Then, create a register map range that outputs the result of this mathematical operation. In the example below, we are using register address 8000 to 8010 for single-point RF followed by 8011 to 8021 for retention time. Here the device has 32-bit holding registers.



Finally, put these register range 8000 to 8010 (for single-point RF) and 8011 to 8021 (for retention time) in GCAS. Pay attention to the gas order as they must match exactly. Here we clicked **Def sort** to make the RF gas order match the defined gas order in Totalflow. As this example uses 32-bit registers, we also match the register length to 32-bit in GCAS.



27.1.7 Backup and Restore Configuration



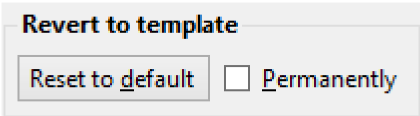
To back up your configuration, click on the **Export current mappings to a file** link. This will show the save file dialogue to save the XML file.

To restore your configuration, click **Browse** button and load that XML file. Next, click **Import** button and GCAS should read the content and display register addresses accordingly. Click **Save Mappings** at the bottom of the form to commit the change.

> **Note**
>
> Backup and restore facility is not intended for copying settings from one device to another because we cannot guarantee that the other device is the same type of the current device. You cannot use the XML file intended for one device on a different device. If you need to do this and you are sure that both devices are of the same type, a workaround is available in chapter 27.1.10 Troubleshooting.

27.1.8 Reset to Default

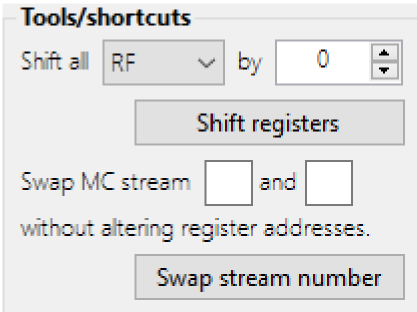
This section is only available if you have ever configured a device. For first-time configuration, this box is disabled.



Your register configuration is stored in an XML file in `[installation directory]\Mappings-DeviceSpecific\` directory. **Reset to default** button will revert all register addresses back to the default definition as defined in template file. When you click **Save Mappings** button at the bottom of the form, your XML file is overwritten.

If you first tick **Permanently** before clicking **Reset to default** button, not only GCAS restores all register addresses to the default definition as defined in template file, but also it deletes your XML file. Permanent reset will put your GC device in GCAS database into unconfigured state.

27.1.9 Tools/Shortcuts



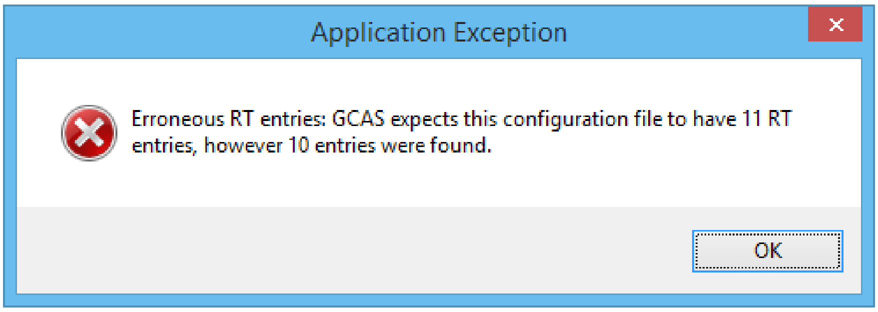
Instead of retyping all register addresses of RF and RT, use this section to shift registers addresses in one click. Choose which one to shift (RF or RT), enter the amount of address shift between −10,000 to +10,000, and then click **Shift registers**.

You can also swap mole composition stream numbers without changing their register addresses. Enter two existing stream numbers to switch place, then click **Swap stream number**.

27.1.10 Troubleshooting

a) **Q:** I see an error message "This file is not a valid configuration file".
A: There is a problem within the XML file. Open File explorer (Windows explorer), navigate to `[installation directory]\Mappings-DeviceSpecific\`. Default installation directory is `C:\GCAS`. Find the file of your device tag name.xml, then delete the file. This will reset the configuration of your device to follow template.

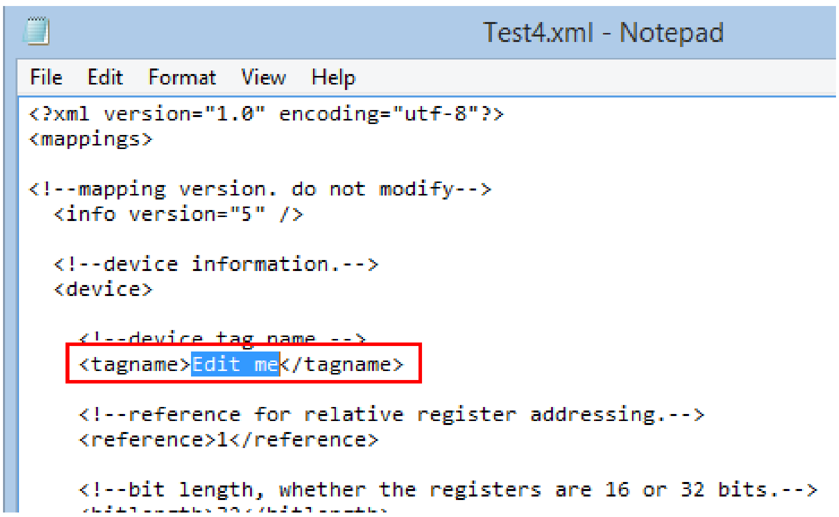
b) **Q:** I see an error message "Erroneous RF/RT entries" similar to this screenshot.



A: Again, there is a problem within the XML file. Open File explorer, navigate to `[installation directory]\Mappings-DeviceSpecific\`. Find the file of your device tag name.xml, then delete the file. This will reset the configuration of your device to follow template.

c) **Q:** I see an error message "Device type not supported".
A: GCAS cannot find the template file. Open File explorer, navigate to `[installation directory]\Mappings-Template\`. If the template file for your device type does not exist, either the device type is not yet supported by current version of GCAS or otherwise you might need to reinstall GCAS.

d) **Q:** When I import a configuration (XML) file, it says that the file belongs to other device.
A: The export configuration command link is not intended to copy settings among devices because we cannot guarantee that the other device is the same type as the device you are configuring. Their number of gases may differ. Therefore, we designed that the XML file belongs to a certain GC can only be used by that GC exclusively.
Nevertheless if you are very sure that both this GC device and the other device are of the same type, you would need to edit the XML file using Notepad or any text editor. Open the XML file, and find the `<devices>` element. It should be near the beginning of the file. Inside `<devices>`, find the `<tagname>` element. Change the device tag name between `<tagname>` and `</tagname>` to match the name of the device you are configuring. Save the file, and then try to import the XML file again.

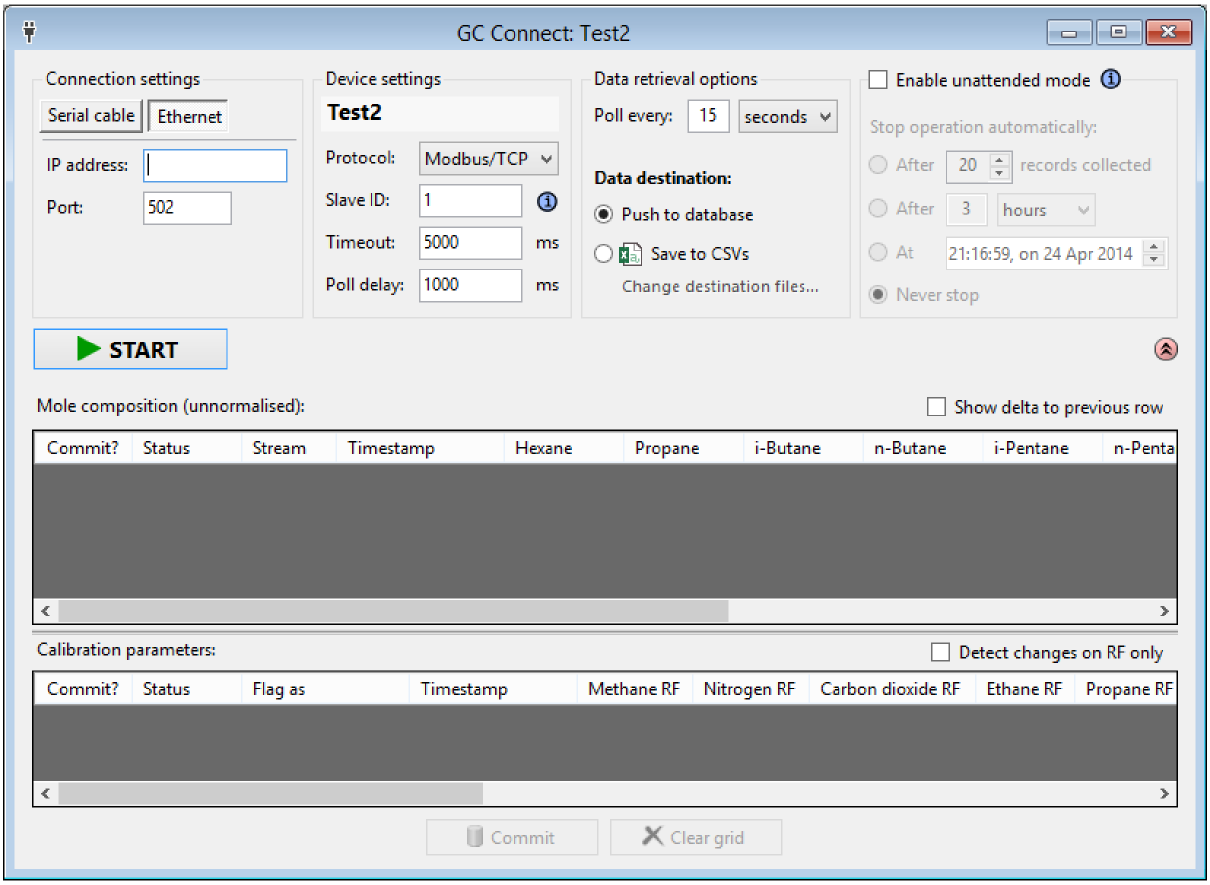


27.2 Capture Data

As the Modbus register configuration is ready, GCAS is ready to get some data from the GC device.

27.2.1 The GC Connect Form

Select the device you would like to get data for, then go to the Comms menu > **Connect to Device**. This menu brings the *GC Connect* form.



GC Connect form has two main parts, the options panel at the top and grid views at the bottom. Options panel consists of four parts, which are connection settings, device settings, data retrieval options, and unattended mode. If you see only three, resize the form so that it becomes larger to the right side. Unattended mode options may not be visible if your screen resolution is 1024×768.

There are two grids at the lower part of the form, one for calibration parameters and one for mole composition. If you only see the grid for calibration parameters, it means you do not have GCAS feature *Live Data Analysis* included in your licence.

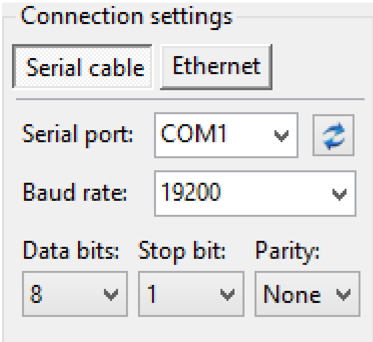
To expand the grids and hide the options panel, click the **Expand** button. On the opposite, to restore the options panel you would click **Collapse** button.

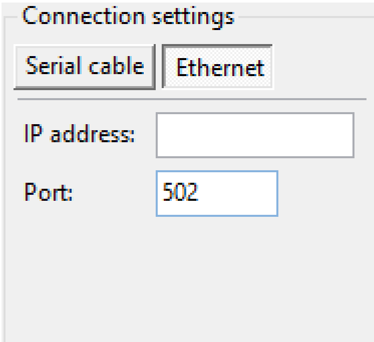
Note

On ABB device that is configured with exponential RF or MC, the GC Connect form also opens two additional child windows right after it opens. Chapter 27.2.10 explains this behaviour.

27.2.2 Connection Settings

This section configures the connection medium between your computer and your GC device. GCAS supports two media, serial cable/RS-232 and Ethernet (or Wi-Fi, if your GC device supports it).





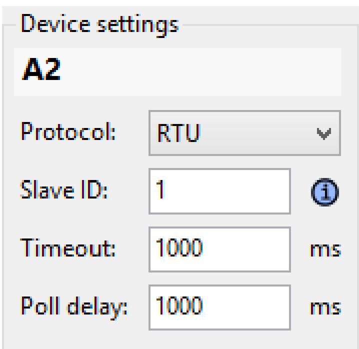
To use serial cable connection, you need a GCAS feature *Modbus Client over serial* to be included in your GCAS licence. Similarly to use Ethernet cable, you need a GCAS feature *Modbus Client over TCP*.

For serial cable connection, enter the appropriate COM port where the cable plugs to, followed by the baud rate, data bits, stop bit(s), and parity bit. These configurations should match the same configuration as your GC device (except the COM number).

For Ethernet or Wi-Fi connection, enter the IP address of your GC device and the TCP port. Refer to your GC device about the TCP port it listens. Modicon standard recommends 501, 502, or 1100 depending of the Modbus protocol set in the device settings.

27.2.3 Device Settings

This sections configures the Modbus protocol to communicate with GC device. Available Modbus protocol depends on the connection medium set in connection settings.



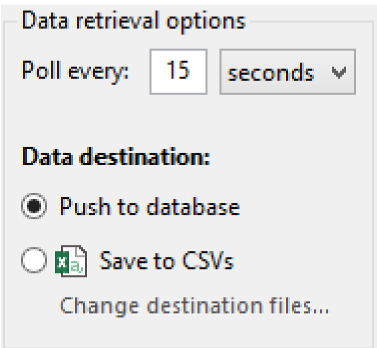
Connection medium	Available protocol
Serial cable	1. ASCII (plain text) 2. RTU (remote terminal unit)
Ethernet or Wi-Fi	1. Modbus/TCP 2. RTU over TCP

Slave ID is the Modbus device identifier that ranges from 1 to 255. In a typical one device to one computer configuration, usually the slave ID is 1 (one). Refer to the configuration on your GC device to get the slave ID.

Timeout is the period GCAS should wait after a Modbus command has been issued to the Device. Default value is 1000 milliseconds (one second) for serial cable and 5000 ms (5 seconds) for Ethernet or Wi-Fi. Note for RTU protocol (serial cable), this timeout starts counting *after the standard 3.5-second wait as specified in the RTU protocol specification itself*. Minimum value is 10 ms.

Poll delay is the period GCAS should wait after a timeout occurs before it retries to issue the same Modbus command to GC device. Default value is 1000 ms, but you can set it to zero if you don't want to wait.

27.2.4 Data Retrieval Options



You can set the poll interval at "**poll every**" input field starting from as frequent as every 5 seconds up to every 90 days. Typically, the poll interval is between 10 to 20 seconds. You can also match poll interval to the cycle time of your GC device, however please make sure time difference between the poll and the end of cycle is not too far apart.

Data destination: Choose where the captured data is being uploaded to.

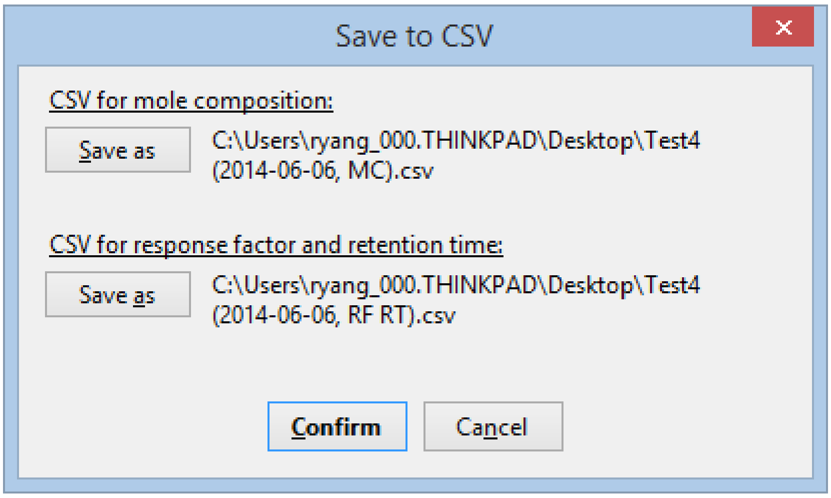
- **Push to database**: Data is uploaded to GCAS database.
- **Save to CSVs**: Data is saved as two CSV files.

For CSV option, GCAS creates two CSV files: One for RF and RT data, another for mole composition. If you do not have GCAS feature *Live Data Analysis* in your licence, the latter CSV is not created — GCAS writes only the RF and RT data into one CSV file.

The file for RF and RT data follows i-Vigilant CSV format so that it is usable for CSV import on Footprint or Calibration Data form. Similarly, CSV file for mole composition follows the format recognisable by CSV import on Mole Composition form.

Mole composition values are left unnormalised when GCAS writes to the CSV. When you import this CSV through the Mole Composition form, the values will be automatically normalised. If you choose to push to database however, GCAS always normalises all mole composition values before they are committed to database.

When you select **Save to CSVs** option, GCAS shows a dialogue. Here you set the CSV file names and their desired location. To change these later, click on the **Change destination files** link.

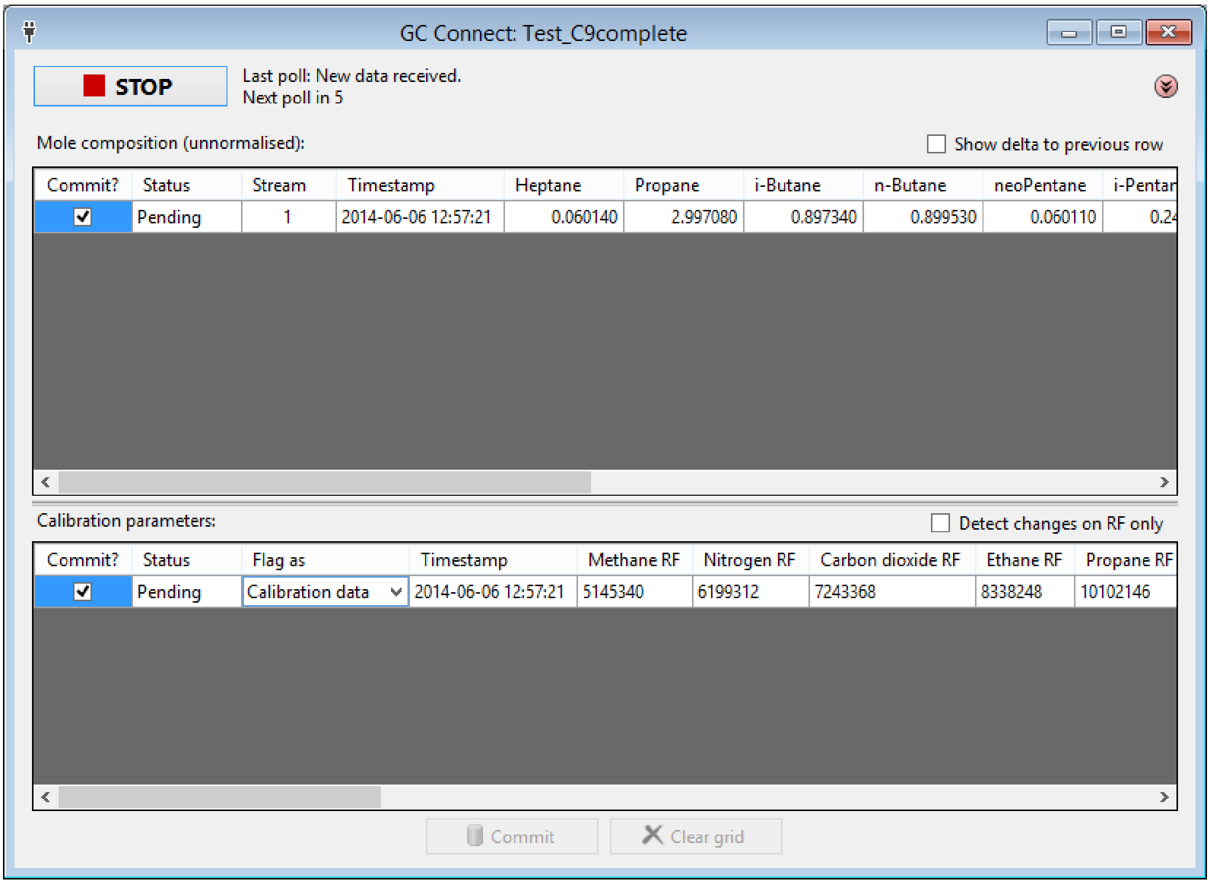


27.2.5 Start Capture

As the Modbus register mappings, connection settings, device settings, poll interval and data destination have been all configured, apparently now you are ready to get some data!

Hit the **Start** button to start the operation. GC Connect form will expand the grid view and poll the device for the first time after three seconds. After first poll, GC Connect form polls the device once every poll interval.

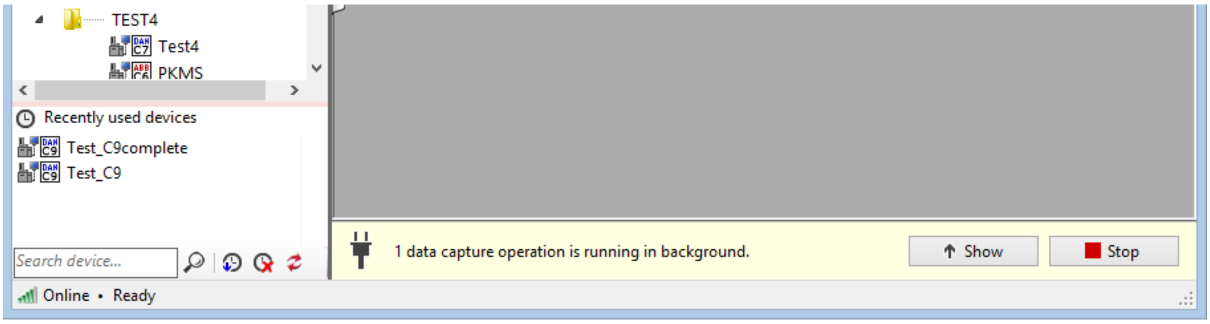
By default, response factor and retention time are given equal priority in calibration data. New incoming calibration data having same response factors as the previous row but with different retention time is still treated as new data. If you prioritise response factors over retention time, tick the check box **Detect changes on RF only**. By this way, incoming record having same RF but different RT from the previous one will not trigger a new row.



You can open multiple GC Connect forms and run multiple data capture sessions simultaneously, provided that no two GC Connect forms accessing the same device through the same COM port or same IP address. GCAS suspends the idle timer if there is at least one active connection to GC device.

To stop capture, hit the **Stop** button.

If you accidentally close a GC Connect form during an active data capture session, either by pressing `Ctrl+F4` or the close (×) button on its tile bar, the form is still running in background. The main interface displays a panel notification at the bottom region, thus you can bring the GC Connect form back into view or stop its capture operation instead. *Nevertheless, if you deliberately log out while a data capture is running in background, the capture operation will be stopped, form will close, and its pending records will be discarded.*

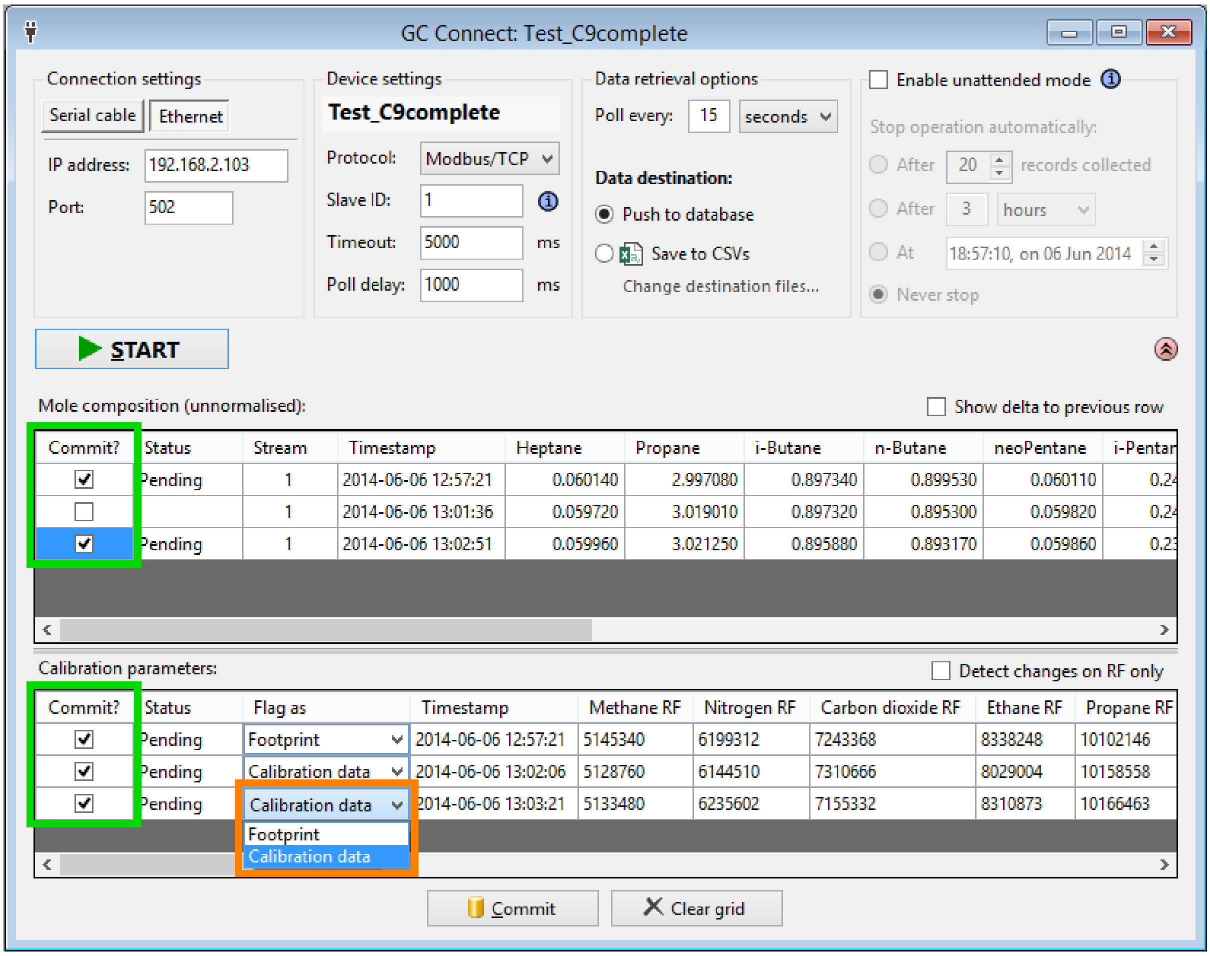


When multiple data capture operations are running in background, these two buttons become **Show all** and **Stop all**.

27.2.6 Stop Capture and Commit Data

Click the **Stop** button to stop the operation.

> **Note**
>
> If you click **Stop** button when GCAS is in the middle of polling GC device, GCAS waits two seconds in order to allow the poll to finish before terminating the connection. If the poll takes very long (e.g. on an extremely slow network or over VPN connection), GCAS waits for additional two seconds, up to five times (10 seconds) maximum.



Untick records to *ignore* them, see green rectangle on the screenshot above. Ignored records will not be written to database or CSV files. For calibration parameters, you can change its flag in the "**Flag as**" column whether to mark a record as a footprint or a regular calibration data. (See orange rectangle on the screenshot above.)

To commit (write) the data into database or CSV files, click either **Commit** button or **Save to CSVs** button. Otherwise, **Clear grid** button removes all *committed*, *pending*, *ignored*, and *failed* rows from display. Alternatively, click the **Start** button again to resume capturing data.

The **Status** column may display any of the following:

- No text/blank: The record is ignored and will not be committed to database nor CSV files.
- **Pending** (black): The record is awaiting commit or save operation.
- **Committed** (green): The record has been successfully written to database or CSV files. Click Clear grid button to clear all committed rows from both grid views.
- **Failed** (red): The record could not be written to database or CSV files.
  Usually the **Error log** button appears on the bottom-left corner of the form and you click that button to see why the record failed to commit. Otherwise, open the Action menu and select **View Error Log**.
  (Note if you are in unattended mode, first click **Collapse** button then deactivate unattended mode to see Error log button).

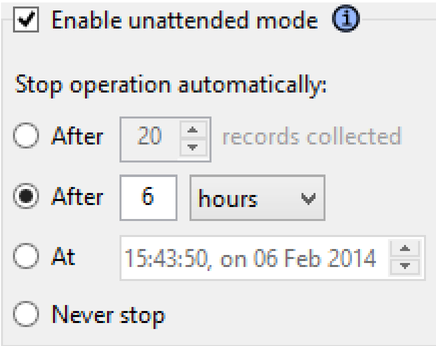
27.2.7 Unattended Mode

Unattended data capture is a data capture operation where all incoming data are committed to database or CSV files automatically. It is intended for remote sites where engineers rarely present in-situ while GCAS continuously captures data. You can then leave the computer on and come back later to stop the operation.

The regular way to capture data as described in chapter 27.2.5 Start capture and 27.2.6 Stop capture is known as *attended mode*. The table below summarises difference between attended and unattended mode.

Attended mode	Unattended mode
Incoming records await your decision whether to commit or ignore.	Incoming records are committed immediately.
You need to click **Commit** button or **Save to CSVs** button in order to commit the records.	**Commit** button, **Save to CSVs** button, and **Clear grid** button are not available in unattended mode.
You can review RF and RT records, giving you a time to change their flag either to footprint or calibration data.	**All records are automatically marked as calibration data.**
Click the **Stop** button to stop operation.	Click the **Stop** button to stop operation, or choose one of three available automatic stop triggers.

To activate unattended mode, first tick the check box **Enable unattended mode**.



Notice that the **Commit** button/**Save to CSVs** button and **Clear grid** button disappear from the bottom of the form. We don't need these buttons as the records would be committed automatically.

Choose one of the following automatic stop triggers.

1. **After *x* records collected** (default *x* = 20)
   GCAS stops the data capture operation after *x* new records have been collected. Operation stops whichever record type reaches *x* first, whether calibration parameter records or mole composition records.

2. **After *x* period of time**
   GCAS stops the data capture operation after *x* period of time, whether it is *x* seconds, *x* minutes, *x* hours, or *x* days. You can choose from as short as 15 seconds to as long as 90 days.

   Note

   To prevent GCAS consumes too much memory (RAM), GCAS only display the last 25 committed records. Old committed records are removed from the grid view. (They are not deleted from database or CSV files, though.) Failed records are never removed from view.

3. **At specific time**
   GCAS stops the data capture operation at the defined time.

   Note

   To prevent GCAS consumes too much memory (RAM), GCAS only display the last 25 committed records. Old committed records are removed from the grid view. (They are not deleted from database or CSV files, though.) Failed records are never removed from view.

4. **Never stop**
   GCAS does not stop data capture operation. Someone must come back to the computer later and stop the operation manually through the Stop button.

   Note

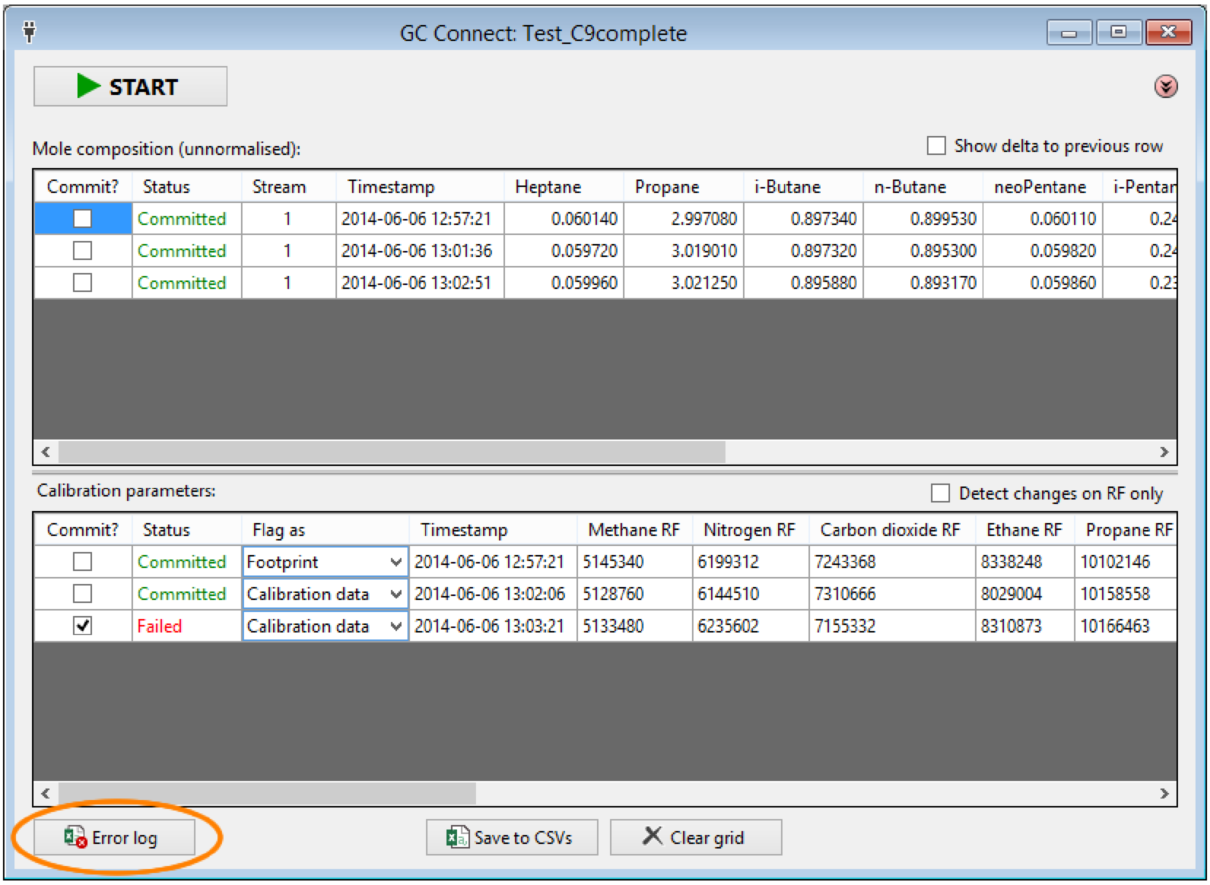
   To prevent GCAS consumes too much memory (RAM), GCAS only display the last 25 committed records. Old committed records are removed from the grid view. (They are not deleted from database or CSV files, though.) Failed records are never removed from view.

And finally, hit the **Start** button to start capturing data in unattended mode.

To deactivate unattended mode, stop the data capture operation and untick the check box **Enable unattended mode**.

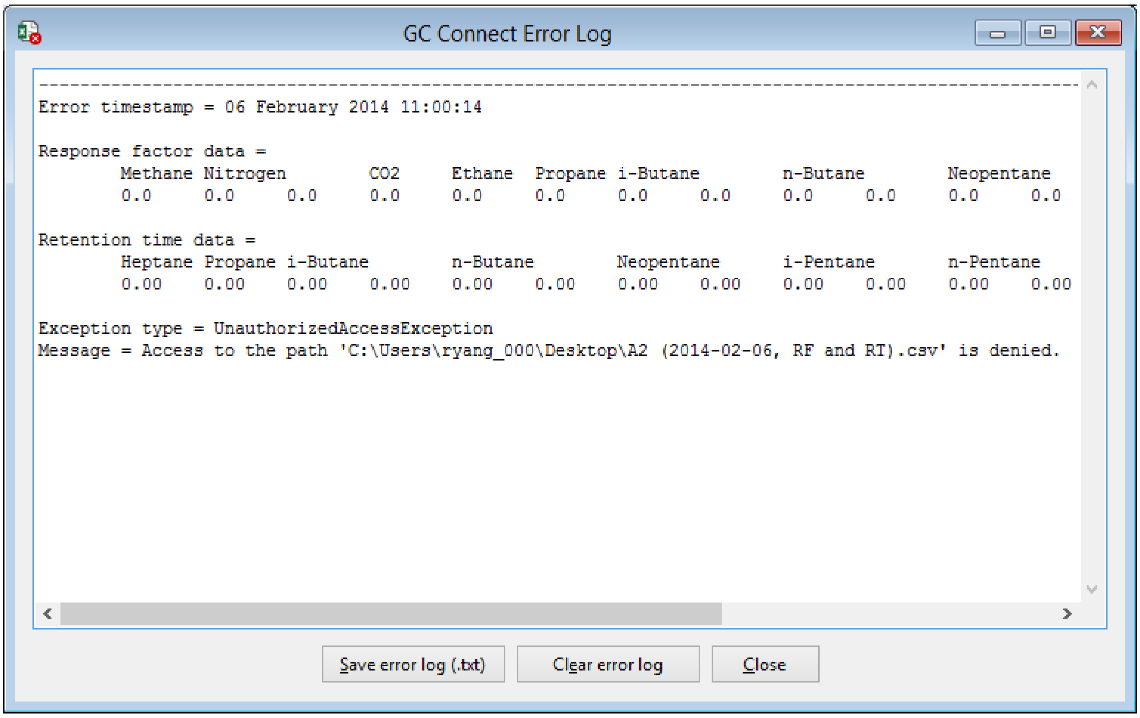
27.2.8 Data Capture Error Log

In case of records failing to commit, the **Error log** button usually appears at the bottom-left corner of the form.



If you are on unattended mode, first stop data capture operation, show the options panel via **Collapse** button and then deactivate the unattended mode to see this button. Alternatively, simply open Action menu and select **View Error Log**.

Error log shows you the error messages why the record could not commit on every occasion of failed record. In this example, `Unauthorised access exception` means either the CSV file was marked as read-only, or your Windows user account do not have write permission on the folder where the CSV file resides.

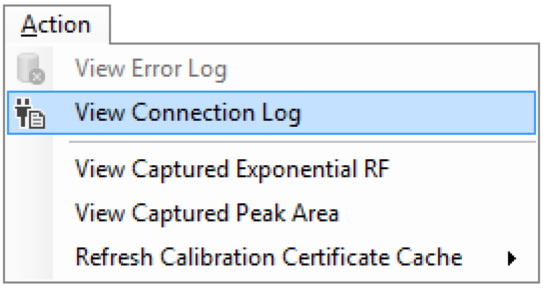


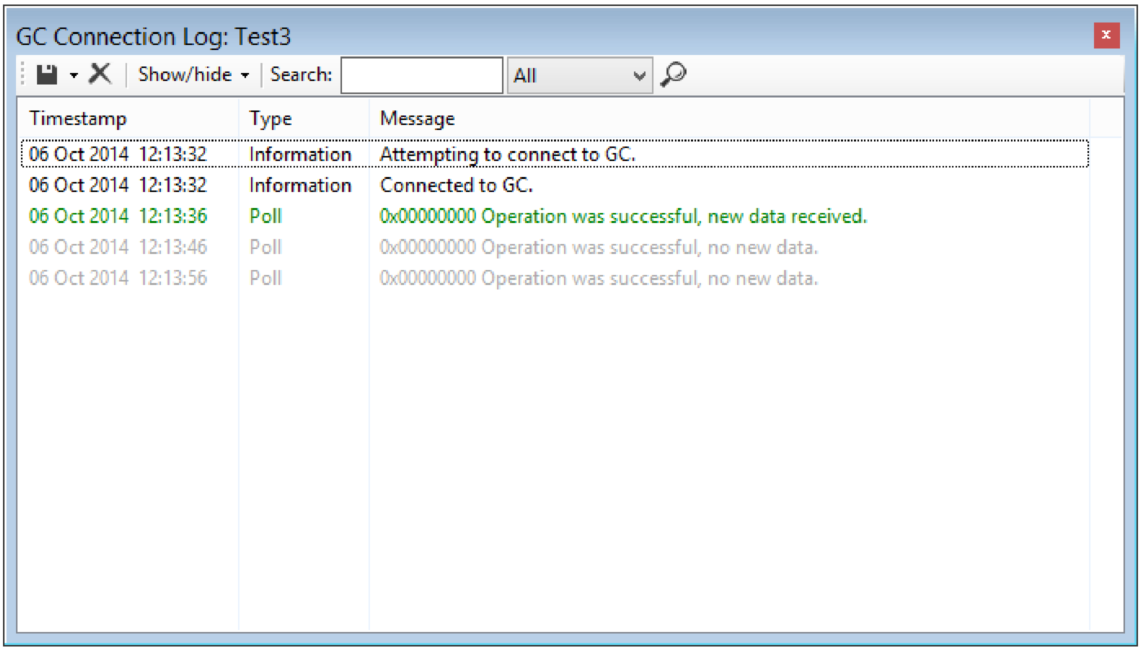
27.2.9 Data Capture Connection Log

The *connection log* records several types of event during data capture operation. For example, when the connection is started, connection is stopped, poll results, whether the record successfully committed (unattended mode only), and error codes.

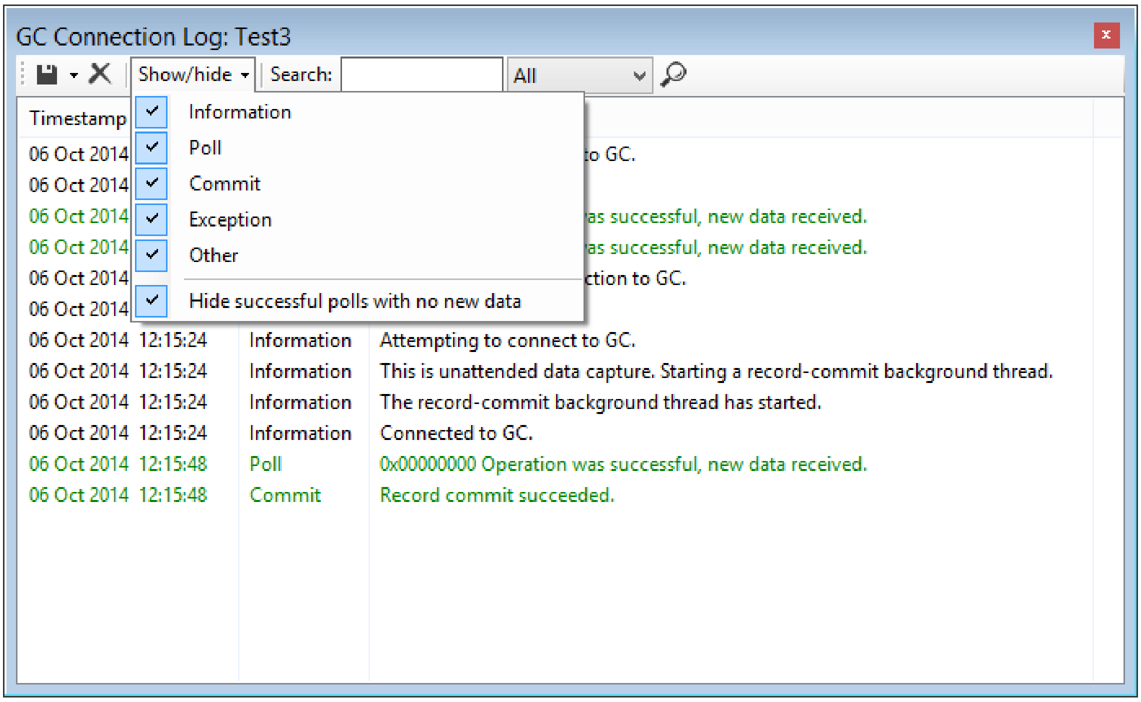
One device has one connection log and error log. If you run multiple data capture operations simultaneously, each GC Connect form has its own error log and connection log. Both logs are cleared when you close the GC Connect form.

To view the connection log, open the Action menu and select **View Connection Log**.

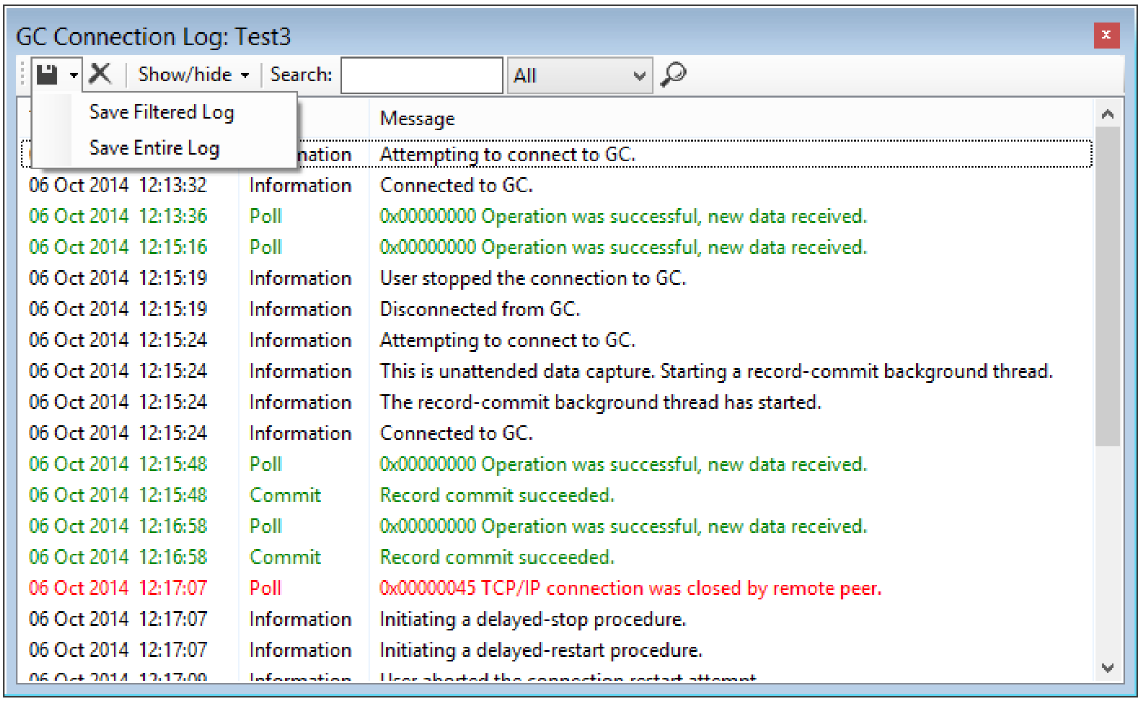




Click **Show/hide** to filter which types of event to display on the connection log window. Clicking a dropdown menu will toggle that filter to on or off. If you tick **Hide successful polls with no new data**, all polling events having 0x00000000 error code (which indicates "no error" or a successful poll) without new data will be hidden.

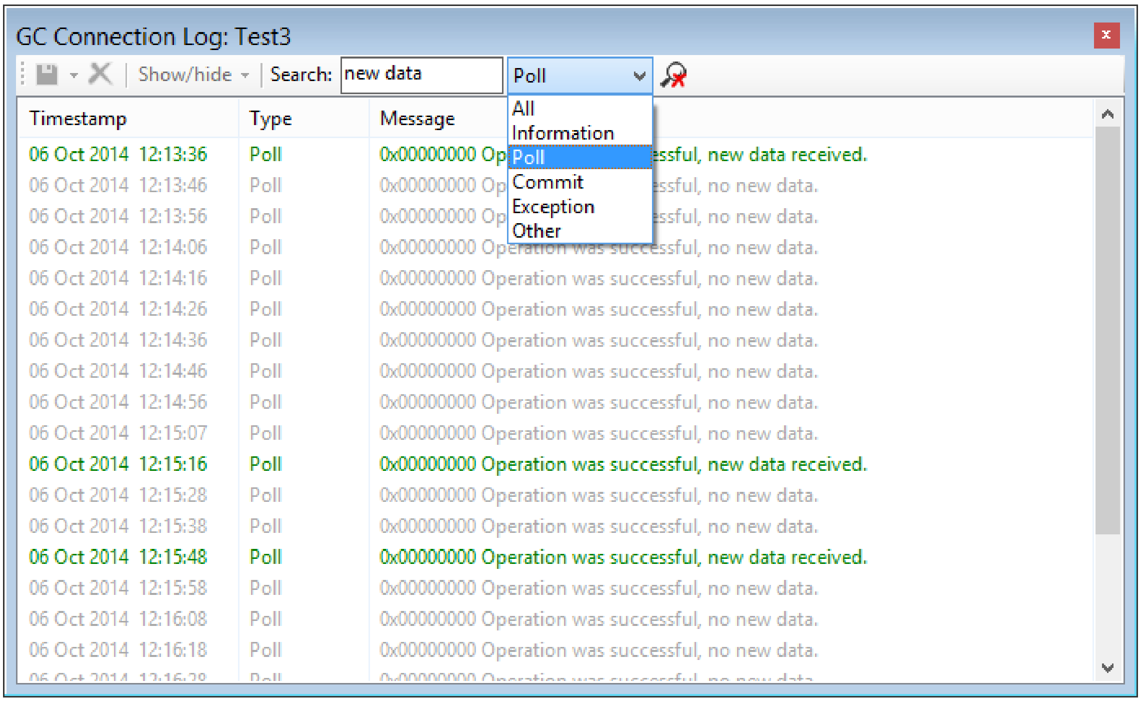


To save the error log, click **Save**. Connection log is saved in a CSV format. However, this button will save the *filtered log*, as only displayed items are saved. To save the *entire log* including those hidden items, open the small drop down menu near the Save button and select **Save Entire Log**.



In order to preserve computer memory, the connection log only retains the last 40,000 log items. When the connection log has reached 40,000 items, the oldest log items are discarded one by one. Click **Clear log** to empty the entire connection log immediately.

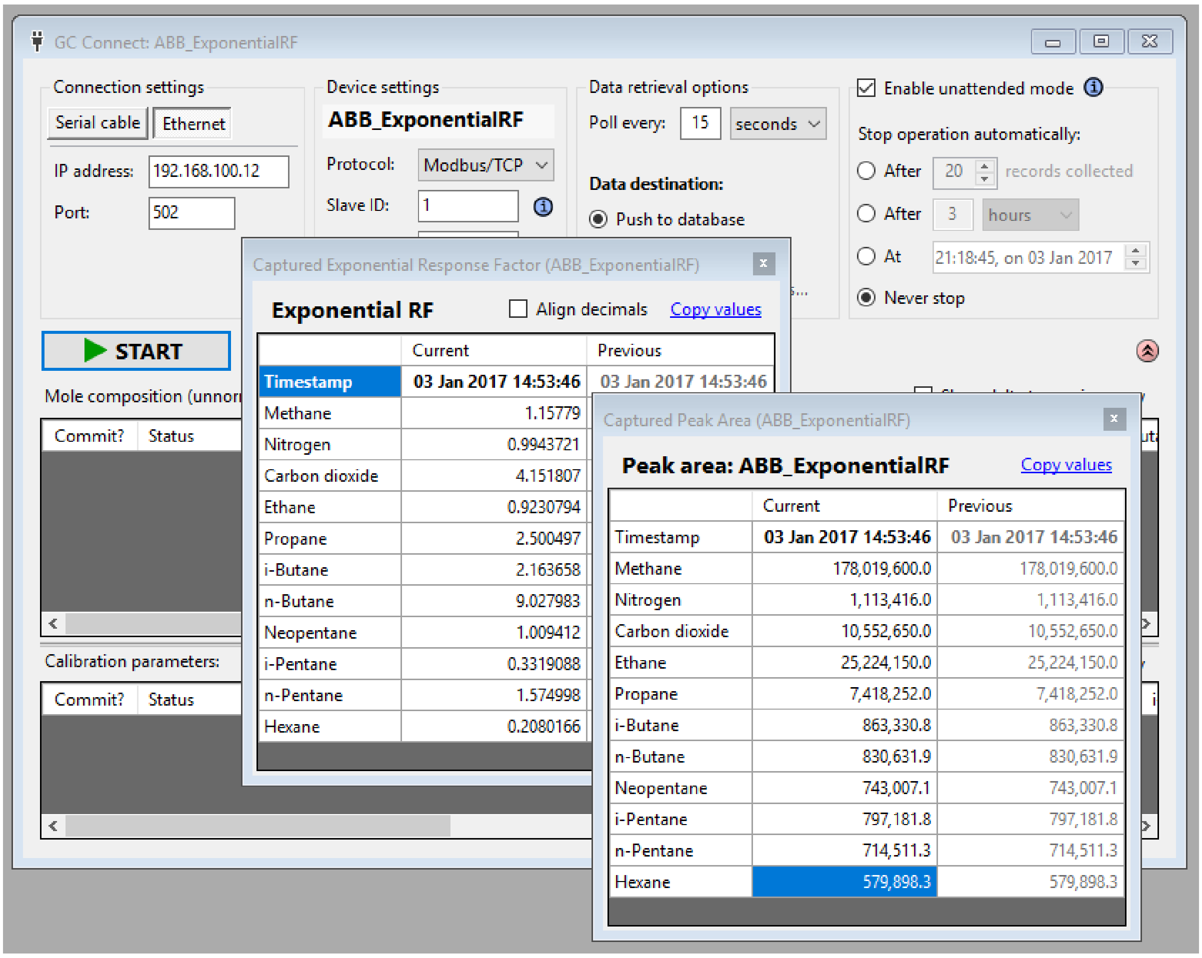
Type the search word in the search box and hit **Search** to find the word in the connection log. Before clicking **Search**, you can change the search filter dropdown to limit the searching area. Notice that searching a term in connection log will search the entire log, not only the filtered log. Click **Finish searching** to end the search mode.



27.2.10 Again, for ABB Devices

Oh ABB, you are so special. Again, this chapter applies only to ABB devices that are configured with [exponential RF and/or MC](#).

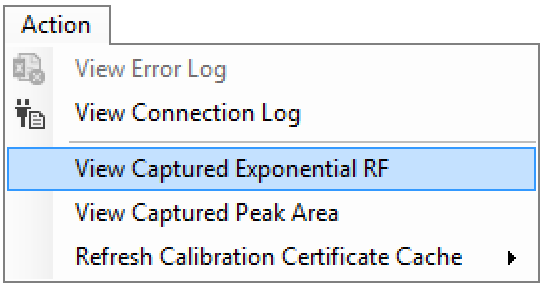
Users may be surprised that the [GC Connect form](#) opens two additional child windows after it starts. They may look like this.



GCAS developer team faced a dilemma when they were implementing exponential RF/MC support for ABB: Where should we put the captured exponential RF and peak area data on the [GC Connect form](#)? If they tried to cram two more data grids to GC Connect form, two downsides. First, it would look cluttered and won't be a nice UI to the users. Second, other GC brands don't make use of them; thus it would become a waste of space. Therefore, we decided to put these "optional" captured data on separate child forms. These child forms will not appear on other GC brands.

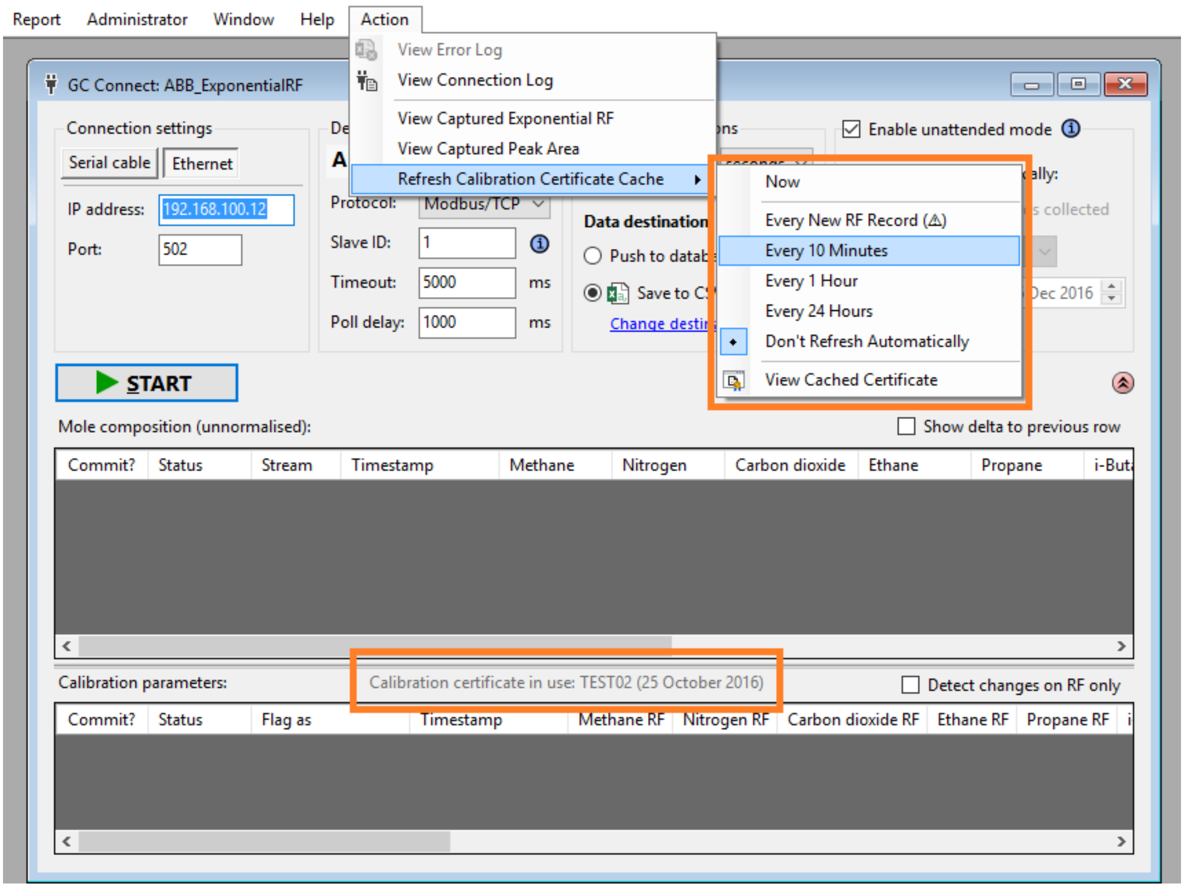
One window displays the captured [exponential RF](#), while the other displays captured calibration peak area. Unlike the data grid for single-point RF on the main [GC Connect window](#), exponential RF and peak area data are not displayed historically. Of course GCAS remembers every captured exponential RF and peak area data on every incoming record, but GCAS just use them to compute the multiplier values for the single-point RF. For that reason, GCAS just show the most recent data (**Current** column) and one record before it (**Previous** column). You can verify that GCAS captures the correct exponential RF data by comparing values displayed on this window and values on the GC. In addendum, if you see the date 1 January 1970, it simply means there are no previous data existing in GCAS database for this GC device.

You can close these child windows at any time to clean up your working area. To show them again, open the Action menu of GC Connect form and select the appropriate menu **View Captured Exponential RF** or **View Captured Peak Area**.



GC Connect form caches the latest calibration gas certificate because GCAS also requires it to convert the incoming exponential RF values into single-point RF. The form tries to load the latest certificate during startup. But GCAS does not know if a newer certificate is available— perhaps just installed by another user on another PC—because the database server cannot send any push notification about this. Therefore the Action menu has several options to automatically refresh this cache. The default is no automatic refresh because most likely users do not install new certificate *that* often.

The calibration certificate currently in use is displayed at the top-centre of the RF and RT grids (see screenshot below). This information is not available for devices other than ABB.



We do not recommend refreshing certificate cache every time a new RF record comes. This would lead to large overhead (processing time) querying the database server to check for a new certificate while it is unlikely for users to install certificate every hour for instance. To refresh the cache manually, open the Action menu and go to **Refresh Calibration Certificate Cache**. Click **Now**.

27.3 Modbus Error Codes and Handling

Bad things happen during data capture. Source of problems might be bad cables, aging hubs, overloaded router, Wi-Fi interference, and so forth. When GCAS does not get a proper response from the GC device, it raises an error code.

We make a distinction between *error codes* and *exceptions*. **Error code** indicates an error in the Modbus protocol communication. The cause may be the computer, the GC device, or the medium between computer and GC device. **Exception**, by definition in technical term, is an error caused by problems inside GCAS itself and not your GC device. Both error codes and exceptions are logged in the connection log.

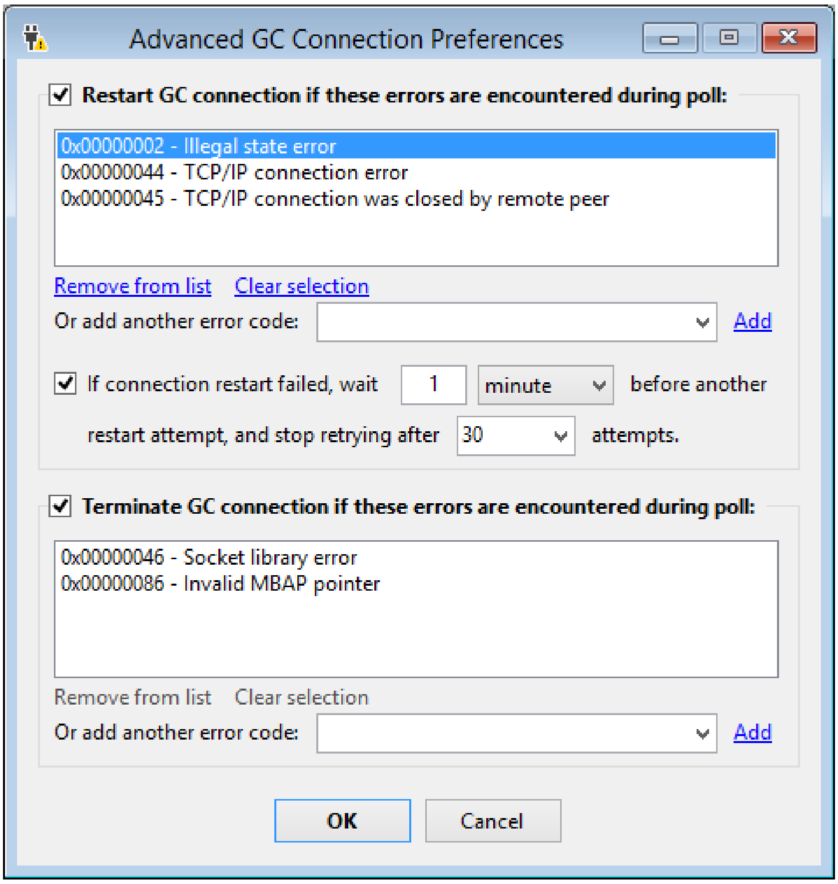
27.3.1 About Error Codes

If there was error in Modbus protocol communication during data capture, the GC Connect form will display the error code above the countdown. For example, the most common error is **0x00000044 TCP/IP connection error**. This error happens only in TCP connection — not in serial cable connection — and indicates problem such as congestion, corrupted TCP packet, wrong TCP checksum, or Wi-Fi connection between your computer and GC (if your GC supports Wi-Fi) is experiencing problems. Another common error code is **0x00000045 TCP/IP connection was closed by remote peer**. This error code indicates problems like the Ethernet cable is unplugged or the main power to GC was cut.

Some error codes are temporary, such as **0x00000084 Reply time out**. By *temporary* it means the error may vanish by the next poll. However some error codes are *persistent*, which means the error code will be repeated during next poll and next poll and next poll until you stop the connection. This is particularly bad for unattended mode. In order to avoid that, GCAS introduced automatic connection restart and automatic connection termination. This feature is turned on by default, and you will go to the Advanced GC Connection Preferences dialogue in order to configure which error codes trigger the automatic restart or termination.

27.3.2 Advanced GC Connection Preferences

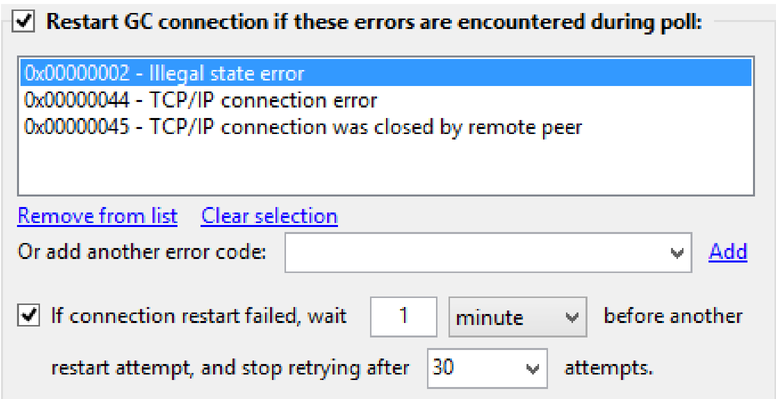
Go to the Comms menu > **Advanced Preferences**. This menu brings the *Advanced GC Connection Preferences* dialogue.



This dialogue configures the automatic connection restart and automatic connection termination. To get help on automatic connection restart, go to chapter 27.3.3. To read more about automatic connection termination, head to chapter 27.3.4.

27.3.3 Automatic Connection Restart

Automatic connection restart is a feature to stop GC connection temporarily and restart it immediately or with delay when GCAS encounters certain error codes. To turn on this feature, give a check mark on **Restart GC connection if these errors are encountered during poll**. This feature is already turned on by default for error codes 0x00000002 *Illegal state error*, 0x00000044 *TCP/IP connection error*, and 0x00000045 *TCP/IP connection was closed by remote peer*. When GCAS encounters any of these three error codes, it will trigger a connection restart.



To remove an error code from the trigger list, highlight the error code and click **Remove from list**. The next link **Clear selection** deselects any selected items.

To add an error code to this trigger list, choose one from the dropdown or type the error code in hexadecimal number (for example `0x00000084`) then click **Add**.

When GCAS restarts a connection, it stops the connection and restarts it immediately. However, there are chances that the first restart will still fail. If you want GCAS to keep retrying, give a tick mark on **If connection restart failed, wait *x* minute(s)** and set how much the delay GCAS should wait before another attempt of reconnection. During this wait time, you can abort the process by clicking **Stop** button on [GC Connect form](#) and the restart attempt will be cancelled. If this is not ticked, the GC Connect form will stay stopped after first restart attempt failed.

Set how many retries GCAS should try. The default is 30 attempts, which means GCAS will give up after 30 times of unsuccessful reconnection. Pick one from the drop down or type a number. Choose **infinite** to make GCAS keep retrying forever.

Note

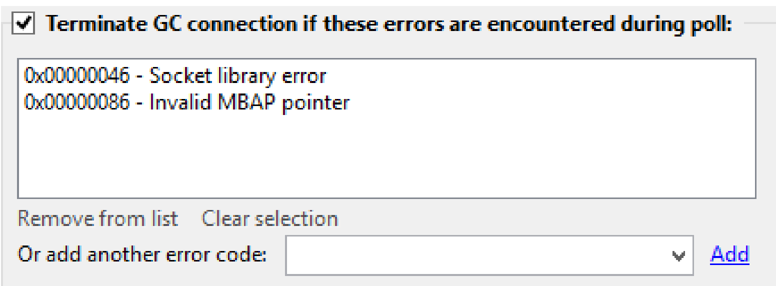
Automatic restart only works for the enlisted error codes during *poll*. It will not work if you get the error code *at the start of connection*.

For example, if you get 0x00000044 TCP/IP connection error *when you click* *Start button*, it means the IP address of your GC is wrong or the destination IP address does not listen to port 502 (or the defined port). Restarting GC connection for wrong IP address is useless, therefore GCAS will not attempt to reconnect to your GC.

It's a different story if you get 0x00000044 *at a regular poll*, it means there is network problem between your computer and your GC. This error code can be solved by restarting TCP connection.

27.3.4 Automatic Connection Termination

Automatic connection termination is a feature to stop GC connection permanently when GCAS encounters certain error codes. Typically the error codes in the auto-terminate list represent fatal errors. To turn on this feature, give a check mark on **Terminate GC connection if these errors are encountered during poll**. This feature is already turned on by default for error codes 0x00000046 *Socket library error* and 0x00000086 *Invalid MBAP pointer*. When GCAS encounters any of these two error codes, it will stop GC connection.



The error code 0x00000046 *Socket library error* indicates a problem within Microsoft Windows Socket (winsock). The way to fix this error is you need to open an elevated command prompt (run as administrator), enter this command:

```
netsh int ip reset
```

and restart the computer. It is not something GCAS can fix with a simple reconnection.

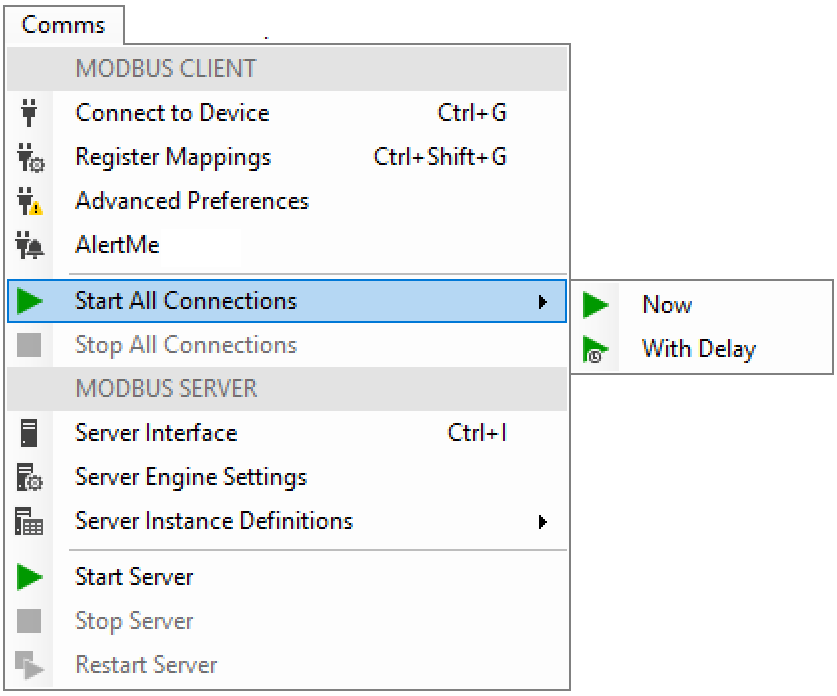
The error code 0x00000086 *Invalid MBAP pointer* may happen to a very limited number of GC devices (usually GC with old firmwares) on ethernet connection. It has something to do with the way GC respond back to the command issued by the computer.

Simply explained, MBAP stands for Modbus Application Protocol. When a computer issues a Modbus command to a machine (the GC), there is a "transaction ID", a number at the beginning of every data packet travelling along the network. When your GC device finished executing the command and ready to send back a response, it *must* echo the same transaction ID at the beginning of response. This is how Modbus protocol works as already defined in the Modbus protocol standard. However, some GC devices do not follow this standard. Instead of echoing back the transaction ID, they set the transaction ID to zero. Because GCAS follows Modbus standard, GCAS rejects this response and issues 0x00000086 error code. To fix this problem you might have to upgrade the firmware of GC device. Restarting GC connection won't help, therefore it is better for GCAS to terminate the connection.

Similar to automatic restart configuration, highlight an error code and click **Remove from list** to remove the error code from auto-terminate trigger list. To add an error code, select one from the dropdown list or type the error code in hexadecimal number and then click **Add**.

27.4 Controlling Multiple Data Captures

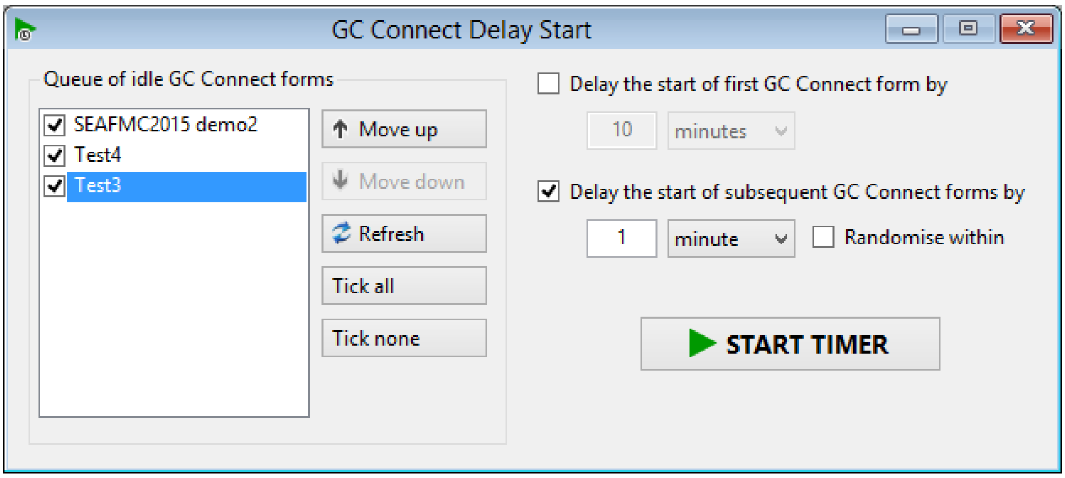
The Comms menu on the main user interface provides two shortcuts to control multiple data capture operations.



Start All Connections menu is a way to start multiple data captures simultaneously or with delay. **Stop All Connections** menu will attempt to stop all data capture operations and abort any GC Connect form in reconnecting state. If there are some GC Connect forms being hidden, the Comms menu displays another menu called **Reveal Hidden GC Connect Forms** which pretty straightforwardly will unhide all hidden GC Connect forms.

27.4.1 Start Multiple Data Captures with Delay

This menu is accessible if you open multiple GC Connect forms *but haven't started some or all of them*. Configure every GC Connect form to the correct parameters such as IP address or serial port, poll interval, data destination, and so on. However, leave them and do not start any data capture operation. Next, go to the Comms menu > Start All Connections > **With Delay**. This menu displays the *GC Connect Delay Start* form.



On the left side, there is a list of *idle* GC Connect forms. Those with check mark will be queued for delay start. Reorder this queue by selecting one item and click **Move up** or **Move down**. GC Connect form at the top will be started first, and subsequently so according to the order of this queue.

If you tick **Delay the start of first GC Connect form**, the start capture operation of first GC Connect form in the queue will be delayed by the specified amount of time.

If you tick **Delay the start of subsequent GC Connect forms**, the start capture operation of the second, third, and the rest of the queue will be delayed by specified amount of time one after another. Furthermore if you tick **Randomise within**, the delay between GC Connect forms is randomised within the specified delay. For example, let's use 1-minute delay. Without randomisation, GCAS will start GC Connect forms in the given order exactly 1 minute one after another. With randomisation, the delay is randomised between immediate (0 second) to 1 minute. As an example, GCAS may start the second GC Connect form after 27 seconds, the third GC Connect form 56 seconds afterwards, and the fourth GC Connect form 43 seconds after the third.

Hit **Start timer** to begin the delay start. While the timer is running, a command link **Cancel** will appear to the right side of **Start timer** button. Click **Cancel** to stop the timer and abort the delay start.

Delay first GC Connect form check box is…	**Delay subsequent GC Connect forms** check box is…	What would happen
Checked, 10 minutes	Checked, 1 minute	**1**. GCAS waits 10 minutes then starts the first GC Connect form. **2**. GCAS waits 1 minute then starts the second GC Connect form. **3**. GCAS waits 1 minute then starts the third GC Connect form, and similarly for the rest of queue.
Checked, 10 minutes	Unchecked	GCAS waits 10 minutes then starts all GC Connect forms in the queue simultaneously.
Unchecked	Checked, 1 minute	**1**. GCAS starts the first GC Connect form immediately. **2**. GCAS waits 1 minute then starts the second GC Connect form. **3**. GCAS waits 1 minute then starts the third GC Connect form, and similarly for the rest of queue.
Unchecked	Unchecked	GCAS starts all GC Connect forms in the queue simultaneously and immediately. This configuration is the same as Comms menu > Start All Connections > Now.

If any of *GC Connect* forms in the queue is started manually or is closed before the timer countdown reaches zero, it is automatically removed from the queue. The *GC Connect Delay Start* form shall skip to the next GC Connect form in the queue. When this queue becomes empty, the timer stops.

27.5 AlertMe

AlertMe is the name of data capture alert feature. It alerts you about problems happening during data capture process, especially an unattended one. If for some reason the data capture stopped while all engineers are away, GCAS can send you an alert so that you can send someone over to check and resolve the problem—hopefully saving some of the gas flowing through your GC but not captured by GCAS.

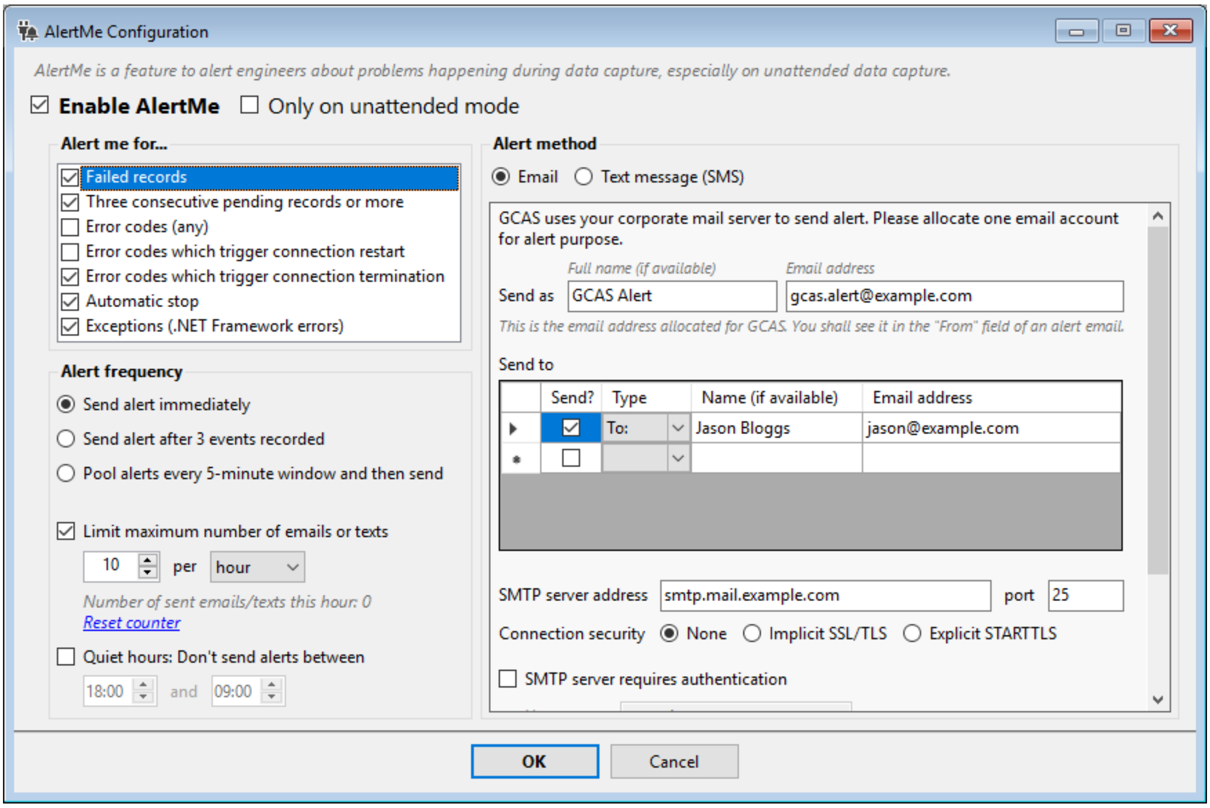
These are events that GCAS would alert you in case they actually occur during data capture.

1. Records failing to commit to database,
2. Three consecutive pending records or more,
3. Modbus error codes (any error code),
4. Modbus error codes that triggered reconnection,
5. Modbus error codes that triggered data capture termination,
6. Automatic stop (if set),
7. Exceptions (Microsoft .NET Framework errors).

Default setting defines event number 1, 2, 5, 6, and 7 are enabled. Event 3 and 4 won't make GCAS sends alert unless you enable them in AlertMe configuration dialogue. Speaking of default settings, AlertMe is also inactive when GCAS is installed. This is due to the prerequisites to use AlertMe depending on the alert method you choose.

27.5.1 AlertMe Configuration Dialogue

On GCAS main menu bar, open Comms menu and select **AlertMe**. This menu brings forth the AlertMe configuration dialogue.



At the top-left corner, you see the big check box **Enable AlertMe**. Check this box to allow GCAS to send alert. By default, GCAS alerts you **only on** [**unattended mode**](), as the next check box is ticked. If you prefer to get alert on attended data capture as well, remove the tick.

Moving down, at the check box list **Alert me for**, choose which events to trigger alert submission.

On **Alert frequency**, pick one of the three available options.

- **Send alert immediately**, as it sounds, causes GCAS to alert you straight after the trigger event happened.
- **Send alert after 3 events recorded** causes GCAS to wait for three trigger events to occur before sending one alert. Be warned that there may be long time gap between one event to the next.
- **Pool alerts within 5-minute interval and then send**. This option uses a timer that runs in the background at all time. This timer ticks every 5 minutes. GCAS pools all alerts occurring within this 5-minute window, and then sends all those alerts in one go when the timer ticks.

If you receive too many alerts, you can limit the number of alerts received per hour or per day. Check **Limit maximum number of emails or texts** and set the limit to your preferred value. In case the limit has reached but you still need to receive alerts, click **Reset counter** to bypass the limit temporarily. Moreover, you can also choose not to get alerts while off duty by enabling **Quiet hours**.

Moving to the right, there are options for alert method. GCAS supports two methods of alert delivery: emails and text messages (SMS). Each method has some prerequisites before GCAS can deliver alerts. To configure AlertMe using email, head to chapter 27.5.2. To get text messages delivered to your mobile phone, jump to chapter 27.5.3.

27.5.2 AlertMe by Email

To get alerts delivered via emails, GCAS needs to use your **corporate internal mail server**. Please allocate one email account for GCAS alerts. The email account does not even have to own a mailbox, GCAS just need an email address to impersonate an entity that you see at the "From:" field of an alert email—plus the associated credential if your mail server use it.

AlertMe works with a traditional SMTP server for email submission. GCAS cannot send alert through other types of mail transfer protocol such as Microsoft Exchange ActiveSync (EAS) protocol. Do not get mistaken between Microsoft *Exchange Server* and *Exchange ActiveSync*, for GCAS *works* with Microsoft Exchange Server provided that it is configured to allow SMTP connection in addition to EAS protocol.

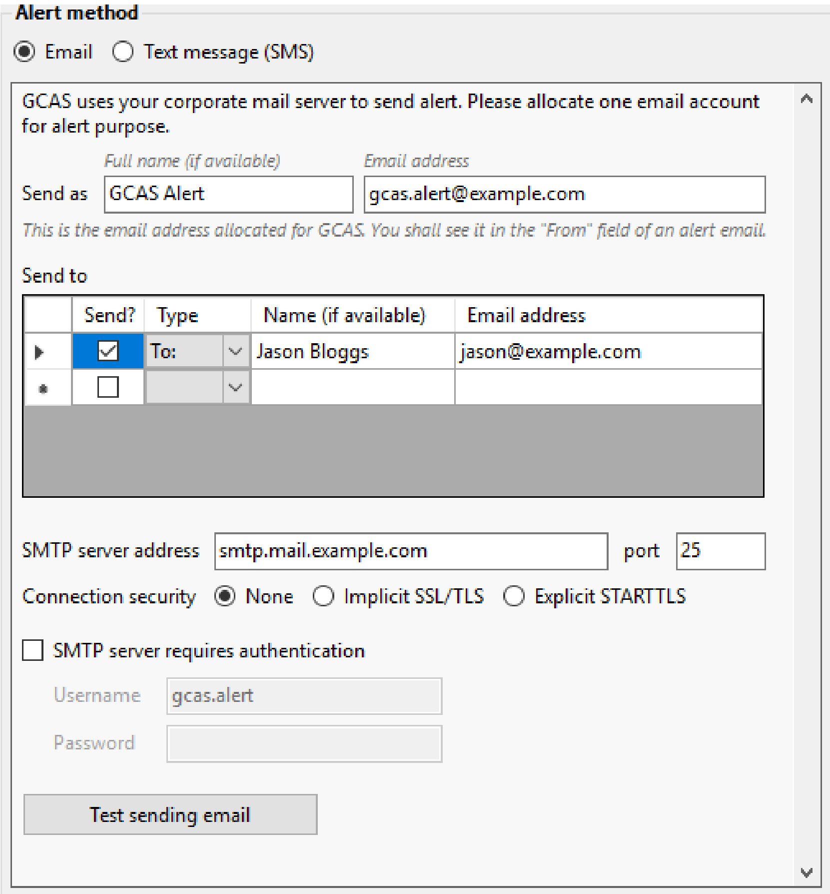
Q: Why does GCAS need access to my internal mail server? Why don't you guys send me alerts from some address like alert@i-Vigilant.com?
A: There are reasons why we choose to use customer's own mail server.

- Because the mail server is already inside your network, emails are delivered faster because they are treated as local (intranet) traffic.
- If we send alerts from external mail address such as alert@i-Vigilant.com, we have to persuade your network administrator to allow our email domain address to be in the whitelist. Otherwise the alert mails may end up marked as spam or junk. That also involves continual blocklist suppression request to public spam blocklist services such as SpamCop and SpamHaus.
- External emails must go through several layers of corporate network security such as firewall packet scans, antivirus scans, and so on. This yields longer delivery time and increases the risk of alert mails get undelivered.
- If your corporate use Microsoft Exchange Server (with SMTP enabled), Exchange can deliver the alert through push mail. That's even better.

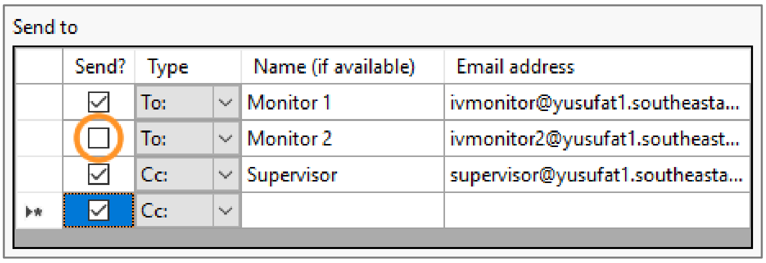
Using email as delivery method also poses several risks.

- GCAS requires a working network connection to the mail server. If the network is down, the emails won't get sent. This problem escalates if your network topology involves VPNs. When the public internet connection goes down, so does the VPN connection, and emails won't get sent either.
- AlertMe emails are HTML emails. Some corporates impose a restriction on their mail servers such as only allowing plain text emails or requiring S/MIME signature. In these cases, GCAS cannot send emails.

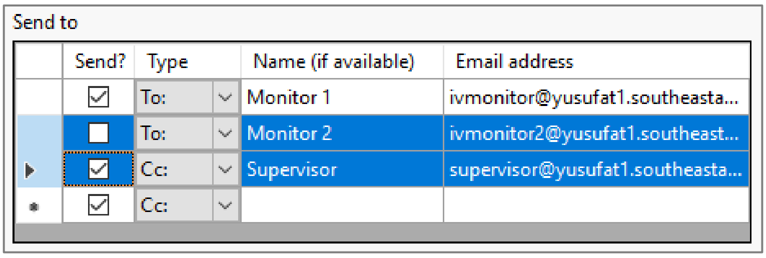
On AlertMe configuration dialogue, find the section depicted in the next page. At the *Alert method* part, select the radio button **Email**.



Fill the required details in **Send as** and **Send to**. The **Send as** part becomes the "From:" field of an email, which you need to put the email address that was allocated for GCAS alert. Next, enter the intended recipients in the provided table. You can enter as many recipients as needed, up to the limit enforced by your mail server. You can set who becomes the `To:` (primary recipient), who becomes the `Cc:` (carbon copy), and who becomes `Bcc:` (blind carbon copy).



*To temporarily block a recipient from getting emails, untick the check box in the **Send?** column.*



To remove one or more recipients, highlight their rows and press `Delete` *on your keyboard.*

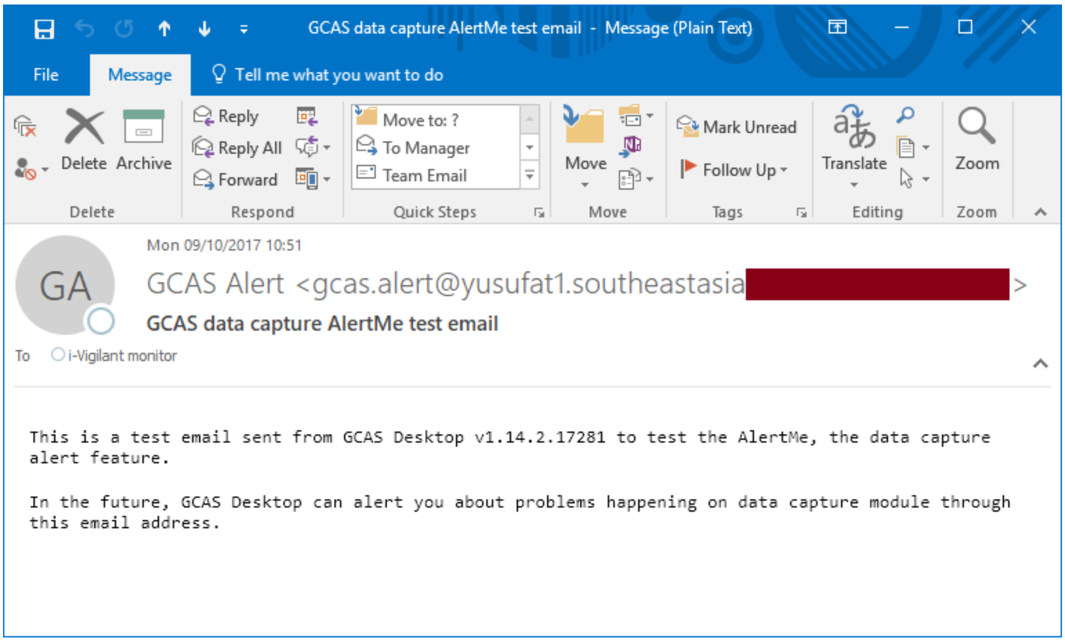
Next, specify the mail server **host name** (or its IP address) and its **port**. Your network administrator or IT department can provide this information. For connection security, pick one of the three.

- **None**: Connection to the mail server is not encrypted.
- **Implicit SSL/TLS**: GCAS negotiates SSL encryption at the time the connection is established. Afterwards, email submission begins on secured communication.
- **Explicit STARTTLS**: The connection begins as an unsecured, then GCAS issues a STARTTLS command to upgrade the connection to be a secured one.

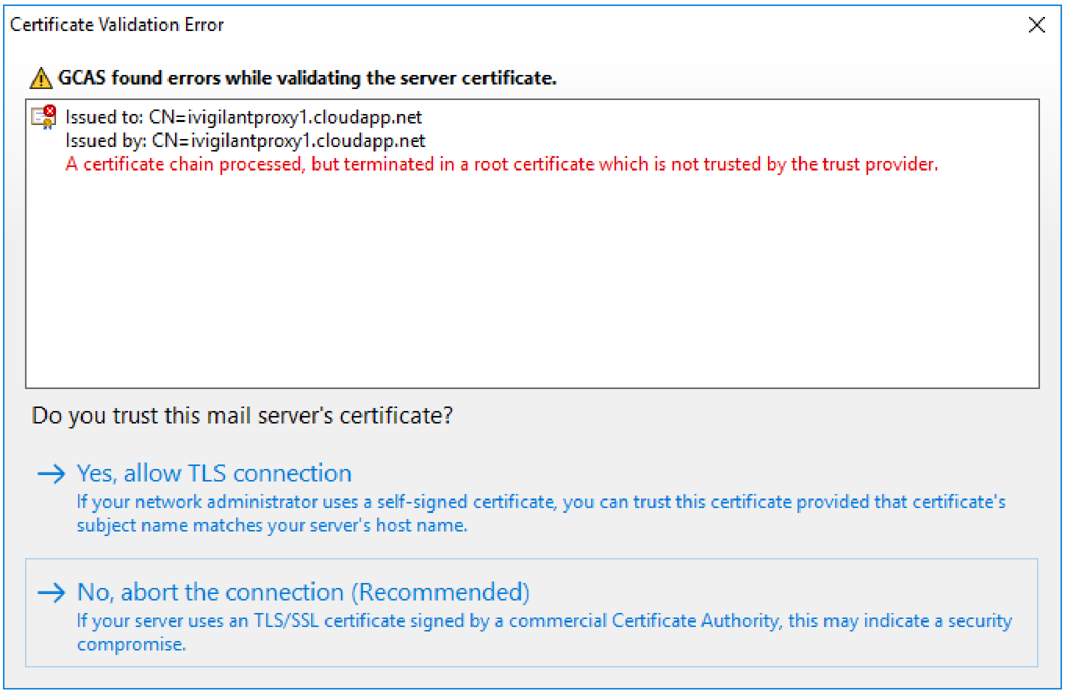
Typically, different connection security uses different port. Unsecured connection uses port 25, implicit TLS uses 465, and explicit TLS uses 587. But the port should be set according to the instruction given by your network administrator.

Moving down, depending on your mail server, it may require authentication before the server accepts email submission. If so, give a tick on **SMTP server requires authentication** and provide the credential of the mail account allocated for GCAS alert.

Click **Test sending email** to verify the configuration is correct. This is how test email would look like.



In case your mail server enforces implicit or explicit TLS security, GCAS executes standard SSL certificate chain validation—the one that is performed by your internet browser all the time. If the SSL certificate is untrusted, GCAS presents you this question.



Many corporate networks employ self-signed SSL certificate to create secured connections. Self-signed SSL certificates are not trusted unless the root certificate is distributed and installed on every corporate computer by your network administrator. If you trust the certificate, click **Yes, allow TLS connection** to continue email submission. You are prompted this dialogue only once per session.

27.5.3 AlertMe by Text Message (SMS)

Other than email, you can get alerts delivered as text messages to your mobile phone. Some pros and cons of using SMS to send alerts are:

+ Text messages do not require internet connection. Even if network connection to your mail server got disrupted, GCAS can still send texts.
+ Text messages may deliver faster than emails in case the mail server uses POP3 or IMAP4 to access mailboxes (which these two protocols do not support push mail and rely on periodic polls from your mail client software).
– You need to be in your mobile provider's coverage. Well, probably not if you are in offshore site.
– Sending text message costs money. Contact your mobile provider to see if they have some kind of SMS plan and get the best deal of it.

Hardware requirements

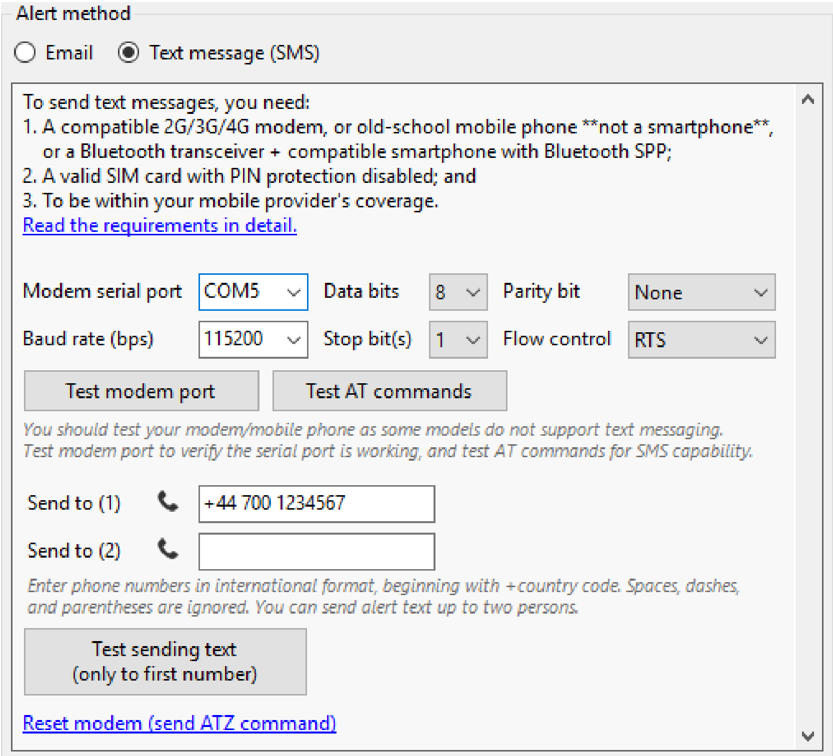
To send text messages, GCAS needs:

1) A **modem** that supports short messaging service. This modem can be
   a) A common GSM 2G/3G/4G USB modem card or stick. CDMA2000/EV-DO modems are welcome as long as they are compatible),
   b) A dedicated SMS modem using serial (RS-232) or USB,

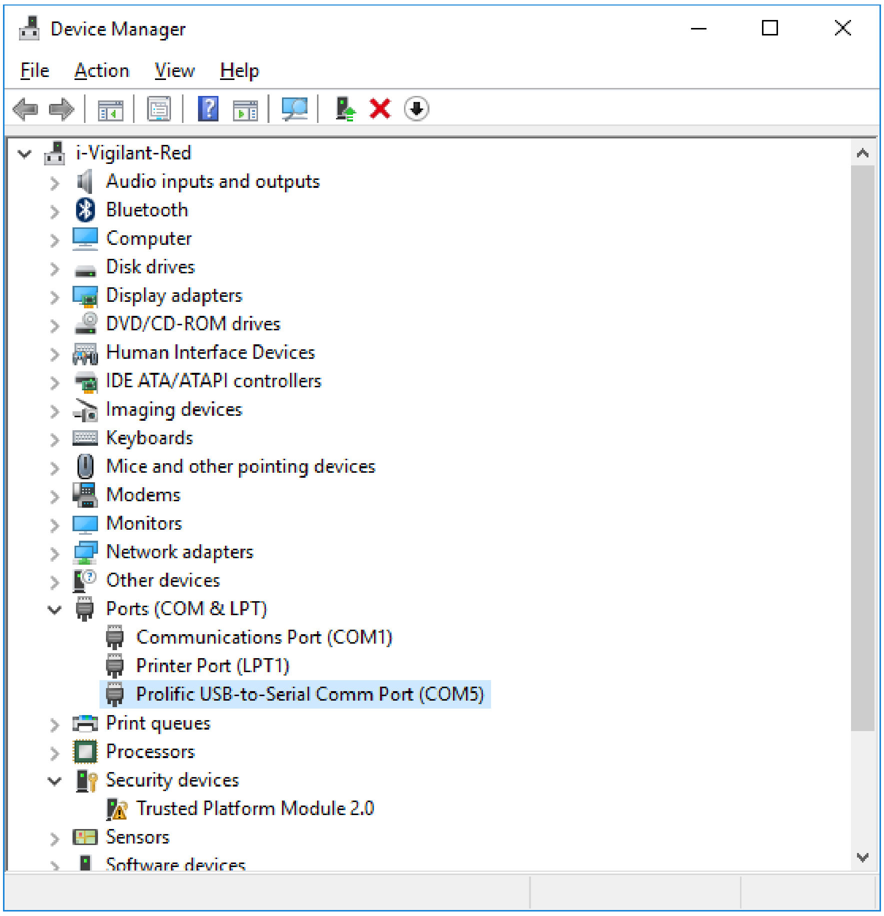
   c) An old-school mobile phone (not a smartphone), usually comes with a driver and a proprietary data cable or infrared link, or
   d) A Bluetooth transceiver + certain Android smartphones supporting Bluetooth Serial Port Profile (SPP). Not all smartphones support this feature. Congratulations if you happen to have one.
2) The modem must support **Hayes AT command set** and AT command extensions for SMS.
3) **Not all modems are compatible!** The point is, no matter what kind of "modem" it is, the modem must be registered as a serial port device in Device Manager on Windows operating system. Some USB modems or mobile phones do not appear as a serial device at all, thus are incompatible. Some USB modem sticks appear as serial port device *after* you run the software utility that comes with them. In such scenario, the software utility must be kept running though you should not use the modem stick to connect to internet—which makes its serial port interface "busy" (in use).
4) **Not all modems support AT commands for SMS!** Depending on the vendor, the modem may not recognise nor respond to certain AT commands necessary for sending text messages. That is what **Test AT commands** button for. GCAS will determine if the modem is usable.
5) A valid SIM/RUIM card with *PIN protection disabled*.
6) Be within your mobile provider's coverage and receive adequate signal strength.
7) Enough credit (for prepaid/PAYG SIM cards) or subscription (for postpaid SIM cards).
8) If your "modem" is a mobile phone, make sure its battery is charged.
   a) **Warning**: Leaving your phone connected to wall charger for prolonged period of time will damage the battery. Depending on the manufacturer, some phones can operate without battery—drawing power solely from the wall charger. But most mobile phones cannot, thus we recommend utilising a power outlet equipped with a timer to control the phone's battery charge and discharge cycle.

Example of a compatible modem. Wavecom Fastrack M1306B GSM modem (RS-232 model)

On AlertMe configuration dialogue, find this section. At the *Alert method* part, select **Text messages (SMS)**.



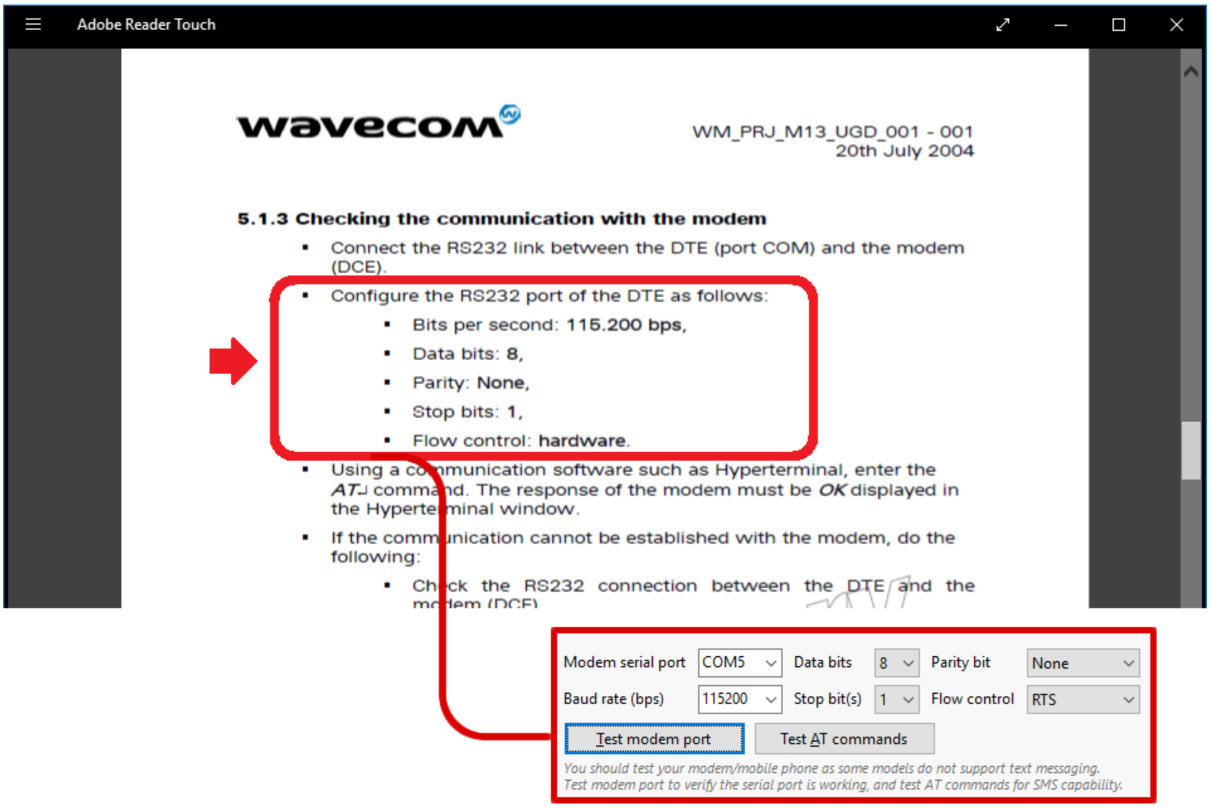
First thing you need to do is to find out which serial port your modem is using. Head to Device Manager in Windows control panel and navigate to the **Ports (COM & LPT)** node. For example, on the next page, the modem is on port COM 5.



Put the serial port in the corresponding input field. Next, fill in the **Baud rate, data bits, stop bits, parity bit, and flow control**. These things should be set according to the data provided by modem manufacturer. Try consulting the user manual of your modem. If you cannot find them, try using the value 9600 bps for serial devices or 115200 bps for USB devices, 8 data bits, 1 stop bit, no parity, and no flow control.

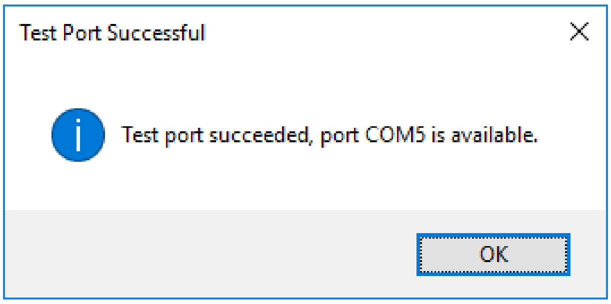
Flow control is a method to prevent buffer overflow on either side of serial port communication. The options for flow control are:

- **None**: No flow control mechanism.
- **XON/XOFF**: Software flow control. When the buffer is full, the modem or computer sends `XOFF` signal—ASCII code 19—so that the other end pauses any further transmission. After the buffer has enough space, the modem/computer sends `XON` signal—ASCII code 17—to resume receiving data.
- **RTS**: Hardware flow control. A voltage is applied on the pin 7 ("request to send", RTS) of the RS-232 port. The other end replies with a voltage on the pin 8 ("clear to send", CTS). Data communication occurs as long as the RTS and CTS pin are active. When the modem or computer detects its buffer is about to fill up, pin 7 is turned off to halt the transmission momentarily.
- **RTS + XON/XOFF**: A combination of software flow control and hardware flow control.

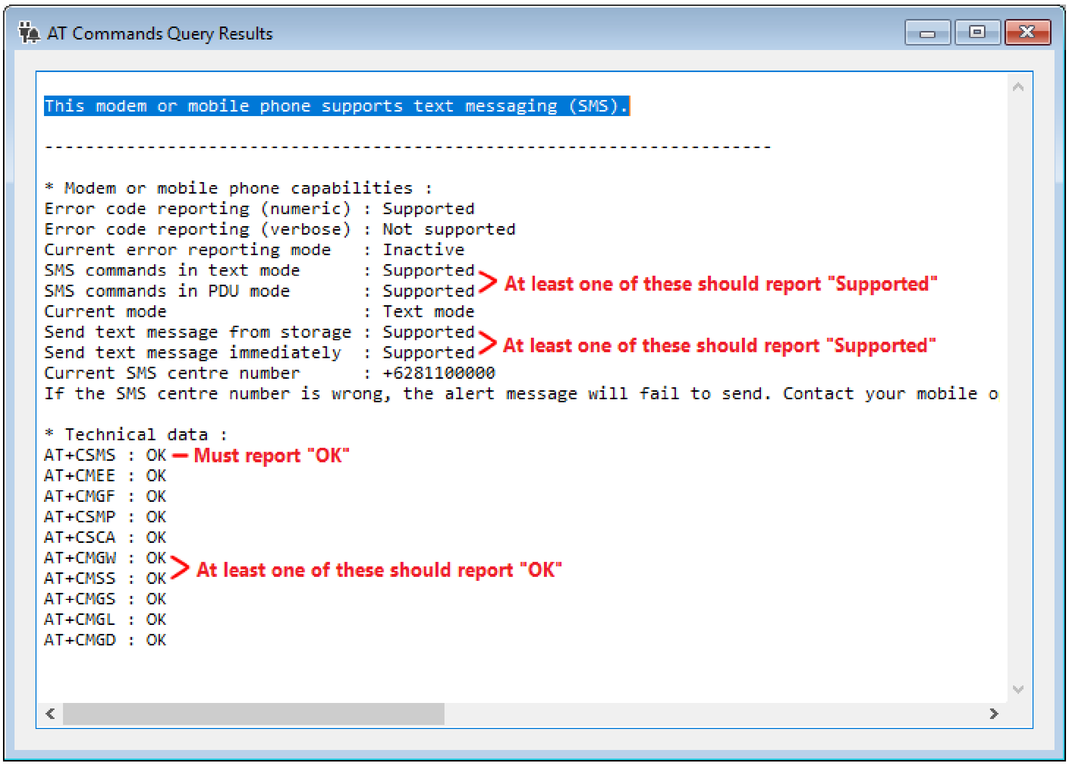


Example on Wavecom Fastrack M1306B GSM modem.

Click **Test modem port**. If no other software is using the modem, the serial port should be free thus GCAS can use it. This message should appear if the modem is available to use.



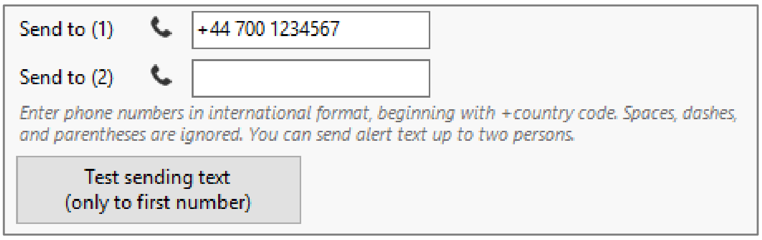
Next, GCAS needs to determine if the modem supports SMS. Click **Test AT commands** to run the examination. If your modem does support SMS, report window should look like the one in the next page.



A special note: Modems not supporting **SMS commands in PDU mode** (see report line 6 of the screenshot example above) will prevent GCAS from sending concatenated texts.
If the content of a text exceeds 160 characters, the text will be chopped after the 160th character.

Another special note: If the bottommost item **AT+CMGD** reports "`Error`", your modem *does not support message deletion from SIM card message store* through AT commands. The SIM card message store is—going back to early generations of GSM mobile phones—a storage area embedded in the SIM card to store a small number of text messages, usually 30 items. If this message store is full, your modem may refuse to send any more messages. GCAS always tries to delete every text message that was sent successfully, freeing space in SIM card message store. Some modems do not respond to `AT+CMGD` command and thus the message store must be cleared through other methods—such as a special command or button in the software utility created by the modem manufacturer.

At this point, we assume your modem supports text messaging. Congratulations! For the last part, specify up to two mobile numbers that will get the alert messages. If you need GCAS to alert only one person, leave the second mobile number blank. Enter the mobile number in **international format**. Put the +country code in front and omit the leading zero. GCAS ignores dashes, spaces, and parentheses.



Reminder

Sending text messages to recipients in different country may incur higher charge.

Final step, click **Test sending text**. Wait a few seconds. If the message is sent, verify that the text is delivered to the intended recipient(s). If the text failed to send, check if you get enough reception of your mobile provider's coverage or if the SIM card is in grace period.

The message has been delivered successfully.

The link **Reset modem (send ATZ command)** is used if you suspect you are not getting text alerts after a while. First thing to do is to check if your mobile account is in active period and have enough credits left (for prepaid/PAYG SIM cards), or the SMS plan is still working (for postpaid SIM cards). First, try sending a sample text message through the AlertMe configuration dialogue. If you get unusual response such as "The modem does not support AT commands" or "Response from the modem was incomplete", while usually it is able to send without problems, then you can click this link. It sends an `ATZ` command (AT Zero) to reset your modem to its default state, followed by an `ATE0` command (AT echo cancellation). Afterwards, try sending a text again.

28 Data Provision (Modbus Server)

Chapter 27 explained how GCAS gets data from your GC device, now it's time to switch role where your device or another software gets data from GCAS. GCAS provides data via Modbus® protocol whereas it acts as a Modbus slave device, so your Modbus master device or software can issue Modbus commands to query data.

Note

To use this feature, you need the GCAS feature either *Modbus Server over Serial* or *Modbus Server over TCP* (or both) to be included in your GCAS licence. On top of that, your GCAS licence should include various GCAS features in order to be able to provide those data. For example, to provide mole composition data, your GCAS licence should have *Live Data Analysis* included. To provide uncertainty values, your GCAS licence should have *Uncertainty Calculation* included.

Known limitations

Here are known limitations on the Modbus server module.

- Read-only registers (input registers) are always 16-bit long. Read/write registers (holding registers) can be configured to be 16 or 32-bit long.
- Modbus Server Instance Editor form can hold up to approximately 150 addresses (tiles). This is due to limitation in Win32 programming in terms of the number of window handles one window may have. These 150 addresses must be spread across four categories and across different slave IDs.
- To support more than 150-ish addresses, we have developed a separate utility called *GCAS Modbus Server Instance Editor*. You should find the executable in the same directory as the main GCAS software.
- Modbus diagnostic command (function 0x07) is supported but always returns zero.

Hardware requirements

Other than a PC having a serial port or Ethernet port or Wi-Fi, we recommend using multicore CPU because Modbus server utilises a lot of background threads. Especially if your Modbus master device or software polls GCAS really often, like every one second, the background threads will be quite occupied. For a modern physical desktop or laptop PC, this would not be a problem. But it becomes a different story when you run GCAS inside a virtualised environment having only one core processor. For example, inside a Microsoft Azure virtual machine A1 basic tier (1 core, 1.75 GB RAM).

28.1 Terminologies

Here is a list of terminologies used by Modbus server module.

Term	Description
Server engine	The module that listens on the designated TCP port or serial port, ready to serve incoming requests. One server engine is created for each serial port, but only one server engine is running to handle all TCP connections. Every server engine carries its own background thread executing the listen-serve loop.
Server instance	A data table containing the actual data to provide through server engines. Server instance is identified through its *Modbus slave ID*. Every instance is attached to all running server engines, so you can query the same data through any channel of connection. One server instance supports up to 4 × 65,536 addresses.
Server instance definition	List of slave IDs, and list of addresses on each slave ID, and the purpose plus all related properties of each address. Instance definition is saved as an XML file which is used during server instance creation on startup.
Slave ID	A number ranging from 1 to 255. Typically, the ID is 1 for single instance scenario. Slave ID 0 (zero) is reserved for broadcast destination and should never be used.
Server interface	A window to monitor the actual values of all registers and coils.
Tile	A representation of one address inside a server instance. Modbus Server Instance Editor form uses tile-based approach to create or delete addresses. Tiles are explained in greater detail in chapter 28.3.2. *GCAS Modbus Server Instance Editor* (a separate utility) uses grid/table view to create or delete even more addresses.
Address	The actual Modbus coil or register address. GCAS uses zero-based address (0 to 65535) to make it consistent with the Modbus client module. *Absolute address* has the form of `P:XXXXX` with P is a prefix of each category, while X is the address from 1 to 65536. Address 0 (zero) on read/write register maps to `4:00001`.
Category	Four divisions of a server instance. They are: - Read/write bit (`0:XXXXX`) - Read-only bit (`1:XXXXX`) - Read-only register (`3:XXXXX`) - Read/write register (`4:XXXXX`) Each category can hold 65,536 addresses.
Read/write	Both GCAS and your Modbus master software or system can write data to these addresses.
Read-only	GCAS can write to these addresses, but your Modbus master software/device cannot.
Read/write bit	Coil (1 bit)

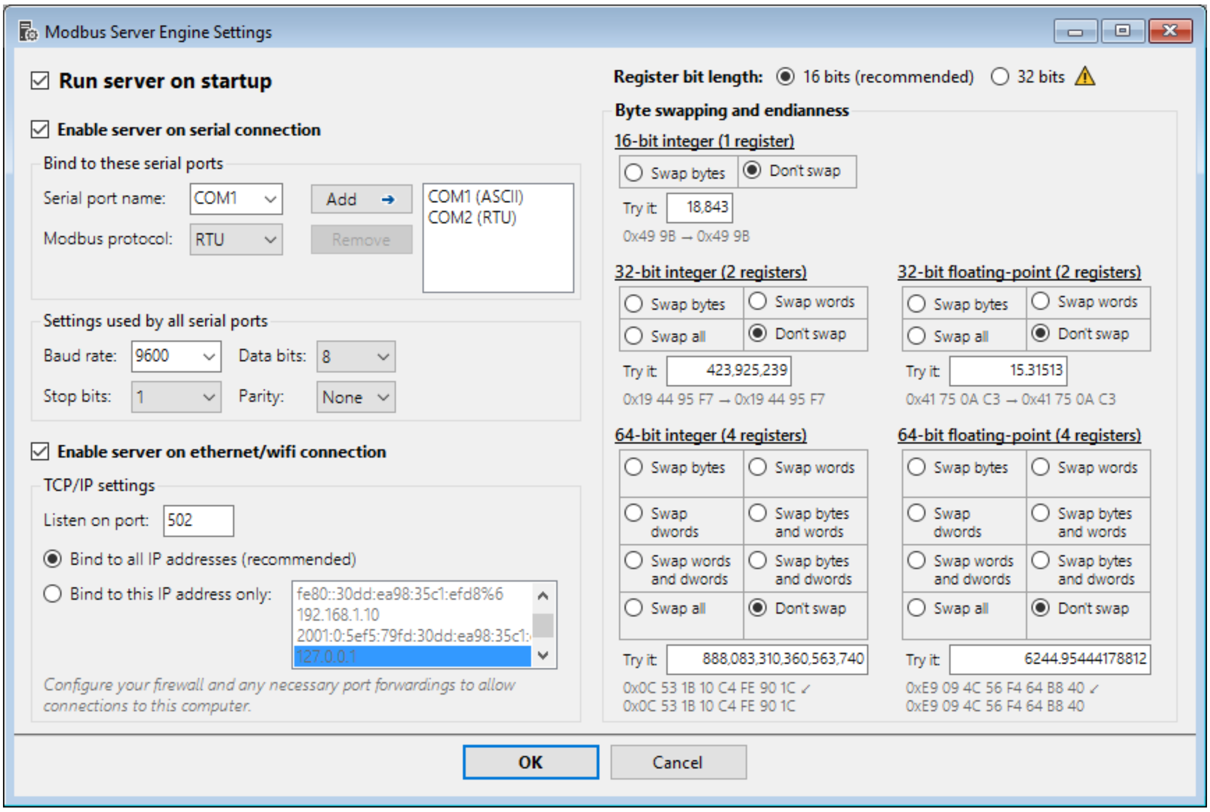
Term	Description
Read-only bit	Input discrete (1 bit)
Read-only register	Input register (16 bits)
Read/write register	Holding register (16 or 32 bits)

For first time configuration, you should visit server engine settings.

28.2 Server Engine Settings

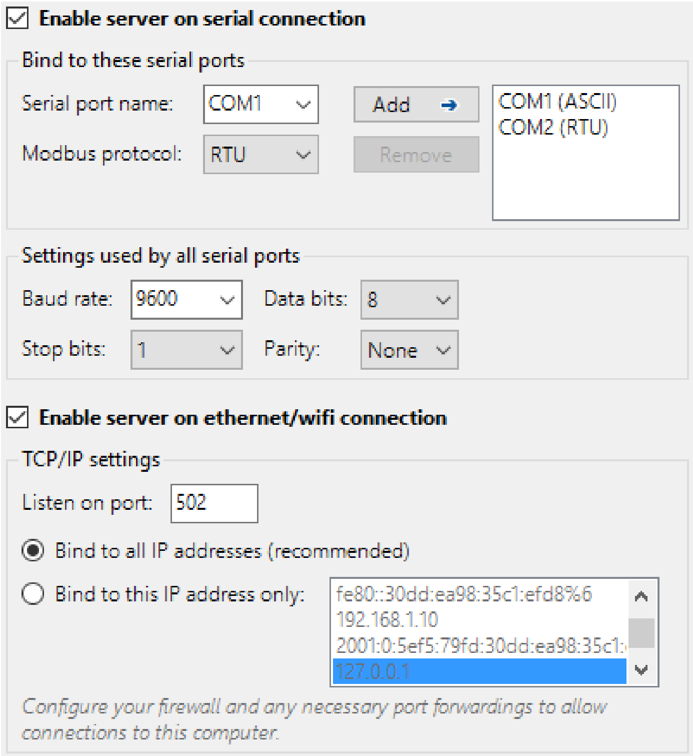
Server engine settings configure fundamental aspects of Modbus server module. They dictate whether you would like to use serial port connection, TCP connection, or both, and also the register length as well as byte swapping options.

On the main window, go to Comms menu and select **Server Engine Settings**. This menu calls *Modbus Server Engine Settings* dialogue.



At the top-left region you see a check box **Run server on startup**. By default, this option is ticked. As soon as you log in to GCAS and all GC devices have been loaded, Modbus server engines are ready to listen to incoming Modbus requests. If you prefer to start the server manually, untick this option.

28.2.1 Connection Settings



Give a check mark on either **Enable server on serial connection** or **Enable server on ethernet/wifi connection**, or both. Users may choose to purchase the serial connection only, or TCP connection only, or both. If either one is not included in the GCAS licence, the corresponding option group will be disabled on this form.

For serial connection, add a pair of serial port (COM) and the Modbus protocol. You may add as many serial ports as you want, as long as your PC has enough number of serial ports. GCAS will attempt to request use of these ports to the operating system during Modbus server startup. The protocol selection offers **ASCII** protocol and **RTU** protocol. Different serial port may use different protocol, for example, it is possible to set up COM1 using ASCII protocol but COM2 using RTU.

Moving down, you see a standard serial port configuration such as baud rate, parity, data bits, and stop bits. These settings are used by all serial ports added to the list.

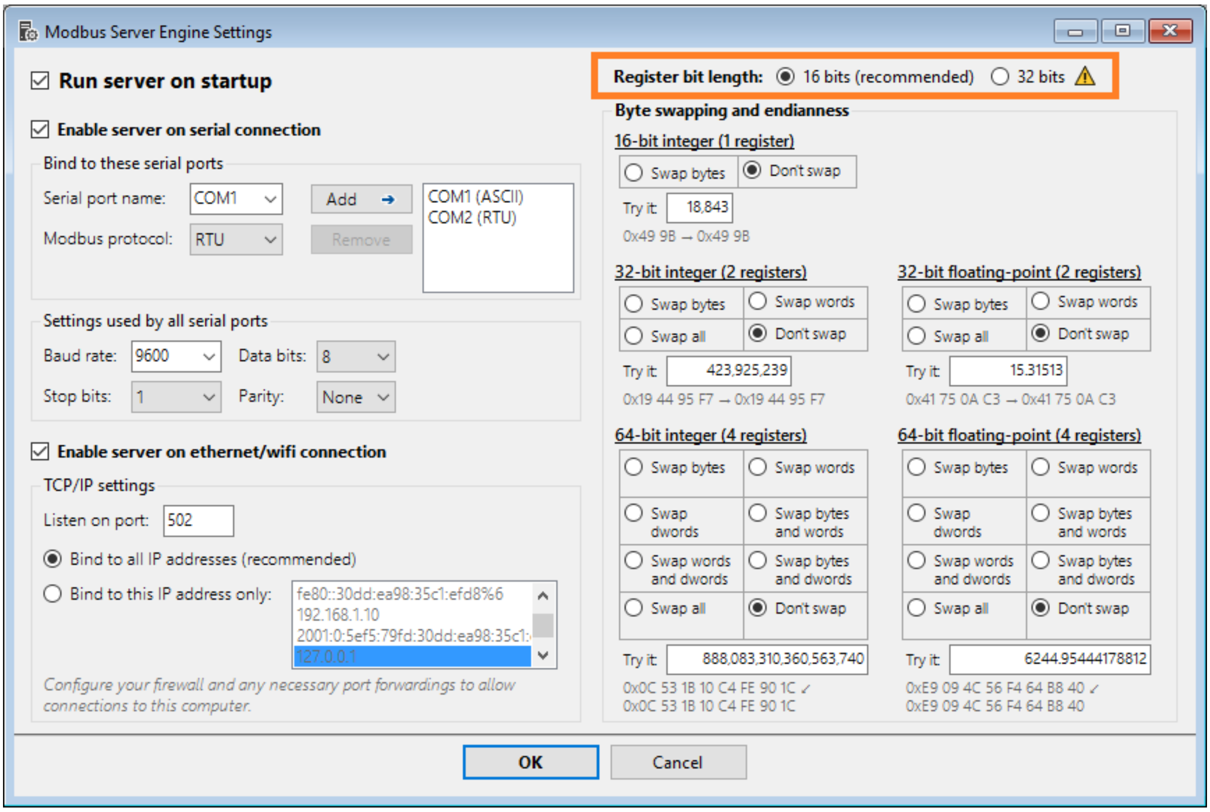
For TCP connection, GCAS supports **Modbus/TCP** protocol only. Modbus RTU-over-TCP protocol is not supported. Configure the TCP port which GCAS has to listen to. The default port is 502. Afterwards, configure the IP binding. By default, GCAS binds all IP addresses on your PC (first option). If you like GCAS to listen on specific IP address, choose the second option and select the desired IP address. The problem on second option is when you move your PC to another network environment, its IP address would change, thus you need to reconfigure this binding.

If your PC is behind a router or firewall and you need to access GCAS data from another network, you have to configure the appropriate port forwarding on your router and allow that incoming connection at your firewall as well. Otherwise, GCAS data is only accessible by computers on the same subnet.

Note

If you change these connection settings while Modbus server is running, you need to restart server in order to enforce the change.

28.2.2 Register Length

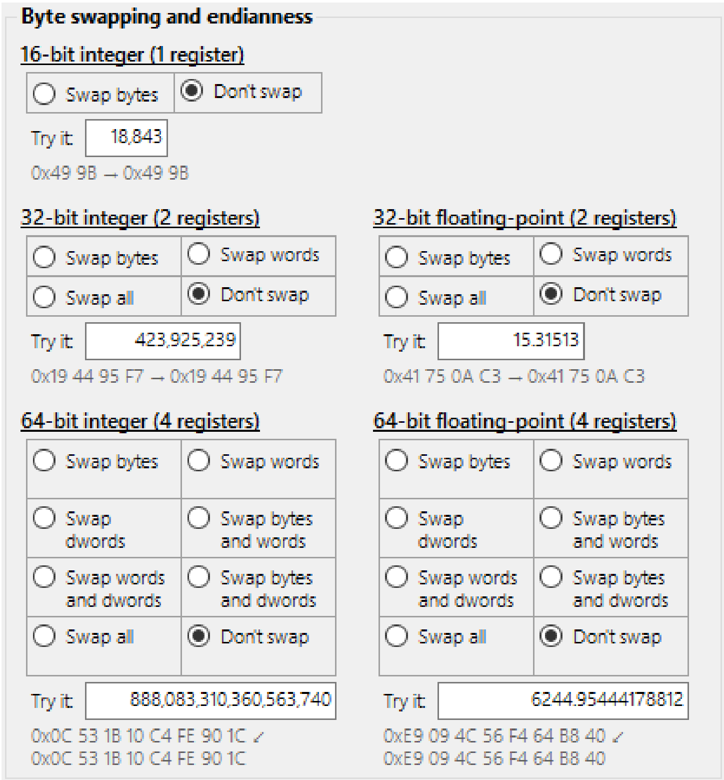


These radio buttons configure the bit length of Modbus registers. The default is 16 bits, adhering to the standard Modbus specification. GCAS supports 32-bit registers as well (known as Daniel/Enron extension), but input registers (`3:XXXXX`) are always 16-bit nevertheless.

Warning

Changing bit length would reset the instance definition. You need to reconfigure server instance definition and restart server. GCAS saves your instance definition to an XML file, and this XML contains two separate definitions for 16-bit and 32-bit mode. What we meant by the word "reset" was GCAS switches to the other definition group, leaving all the configuration for the previous bit length behind. If you changed back to the previous bit length and restarted server, your previous definitions would come back.

28.2.3 Byte Swapping



GCAS uses *little endian* byte order. For data types requiring multi-registers such as 32-bit or 64-bit integers, GCAS uses lowest address to write the least significant word (or dword) then goes up to the highest address. For example, consider a 32-bit floating point number `94.575`. In hexadecimal representation, this number is `42BD2666`. Assuming 16-bit Modbus, GCAS writes `0x2666` on the first register followed by `0x42BD` on the next address.

If your Modbus master software or device operates on different byte ordering, you need to configure byte swapping here. Default setting keeps all byte swapping to **don't swap**, but you are free to change swapping on each data type independently.

Configure swapping for 16-bit integers, 32-bit integers, 64-bit integers, as well as 32-bit floating point and 64-bit floating point data. Under the radio buttons, GCAS provides text boxes to input some test values. Enter a test number, press `Tab` to move the focus out of the text box, and GCAS displays its hexadecimal representation followed by the final byte order according to the selected byte swap option.

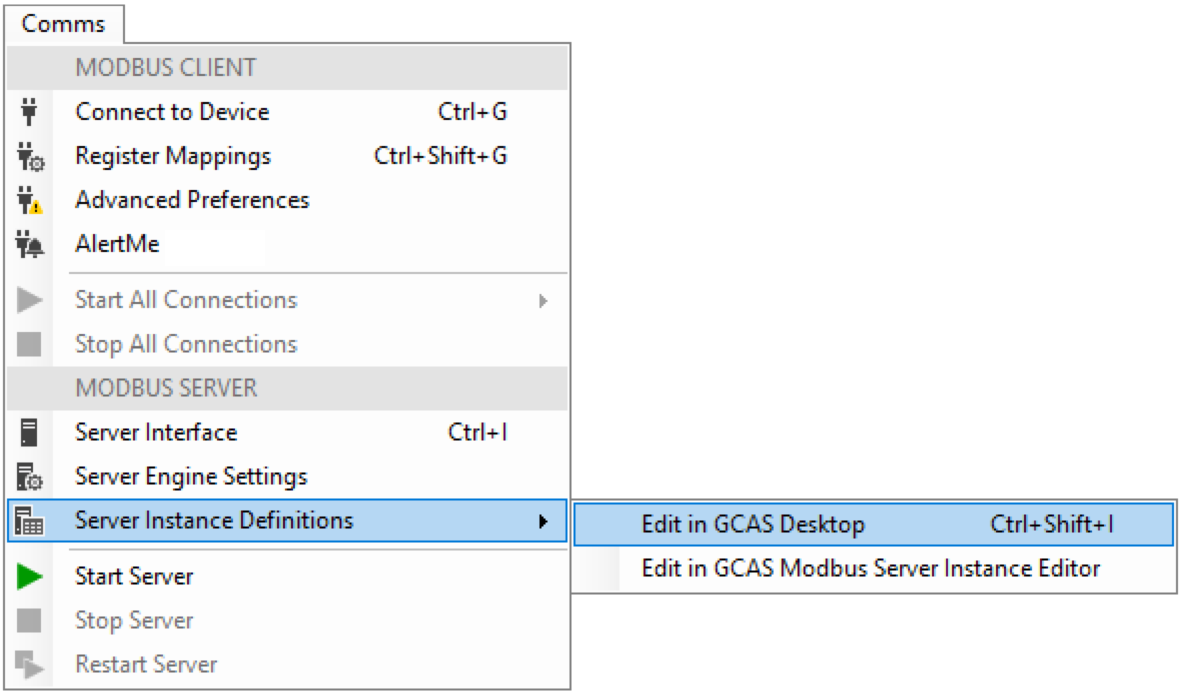
28.3 Server Instance Definition

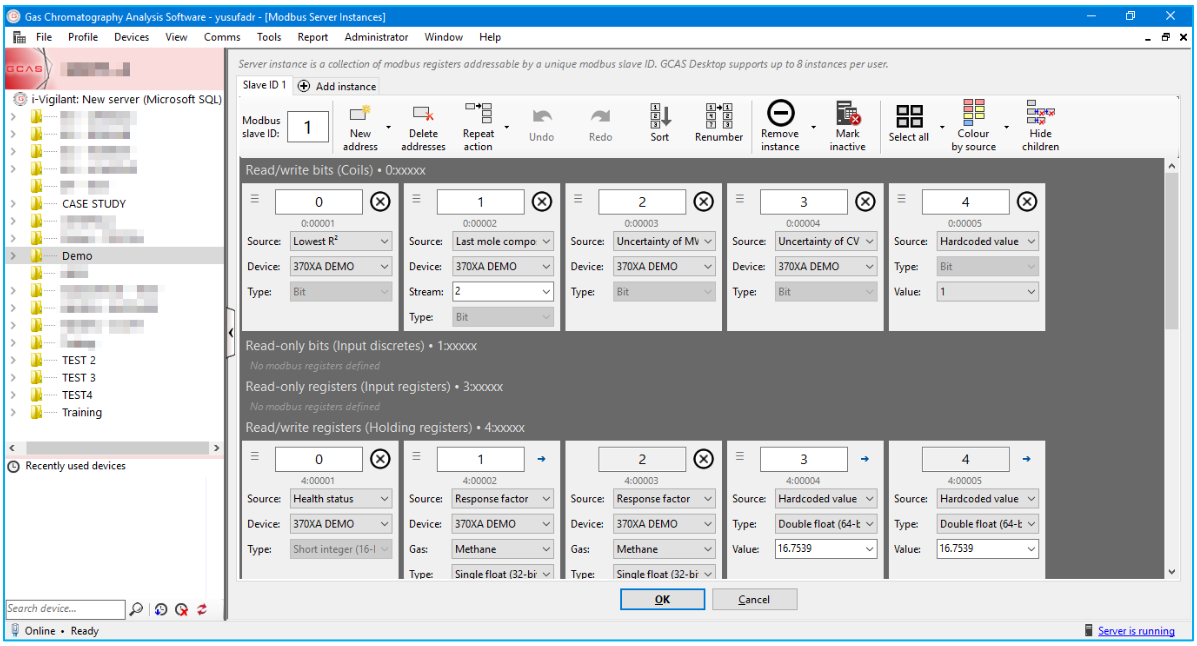
Server instance definition is a list of Modbus coil and register addresses, the purpose of each address, and all related properties of each address, for all configured slave IDs. GCAS reads this instance definition when Modbus server is starting up. Once the instance definition is successfully loaded, GCAS begins a *data refresh* to fill the registers and coils with the right data.

Server instance definition is configured through [Modbus Server Instance Editor form]() or through a separate utility called *GCAS Modbus Server Instance Editor*. This user manual doesn't cover GCAS Modbus Server Instance Editor as this document is intended for GCAS only.

28.3.1 The Modbus Server Instance Editor Form

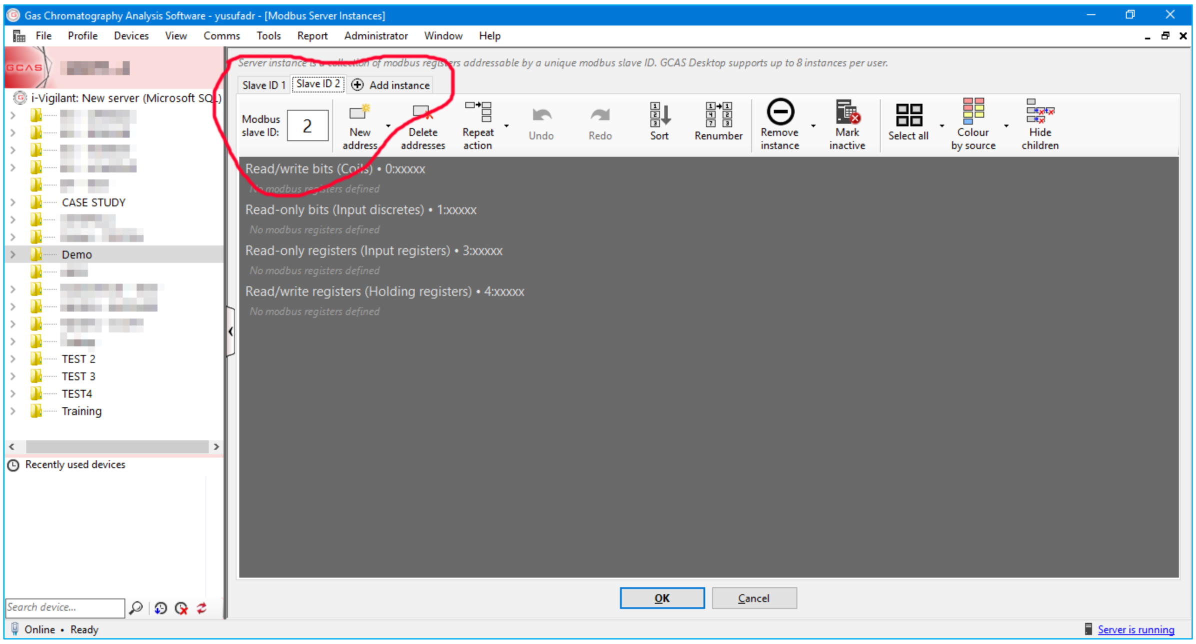
From GCAS main window, go to the Comms menu, choose **Server Instance Definition**, and select **Edit in GCAS Desktop**.





GCAS supports up to **8 (eight)** server instances. That means GCAS can act as a data provider with 8 different slave IDs. Each instance is represented by a tab on this window. When you open Modbus

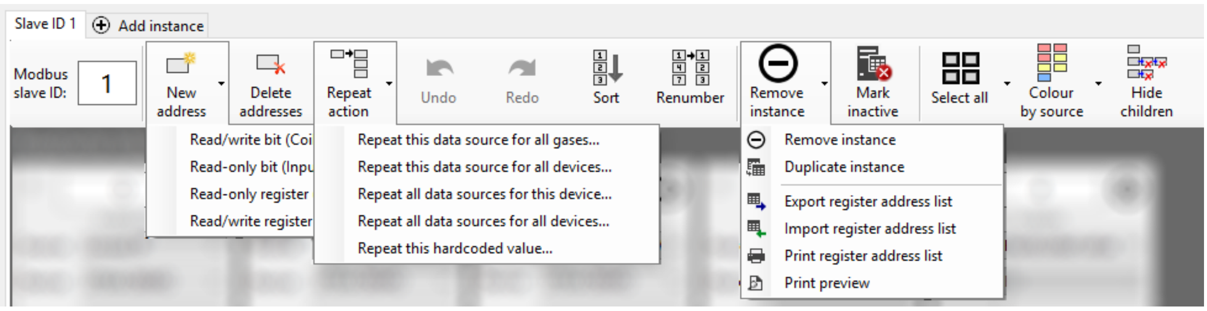
Server Instance Editor for the first time, there is only one tab (one server instance) with slave ID **1**. You can easily add another server instance by clicking **Add instance** on the tab header. Then GCAS will create another tab with a slave ID equal to the next number in sequential order.



To delete a server instance, click **Remove instance** on the toolbar of the desired tab. GCAS deletes the tab and all its contents after your confirmation, and the slave ID associated with that instance is now reusable on another tab.

Note
Server instance definitions are saved as an XML file in `[installation directory]\Server-Config\[your username].xml`. If you click **Remove instance** all the way until no tab exists on this window and then click **OK** down there, GCAS deletes your XML file too. Hence your user account looks like never configured any server instance.

Let's take a closer look at the toolbar.

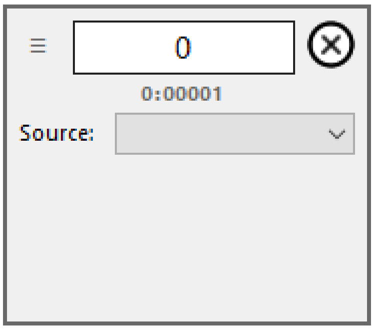


Element	Description
Modbus slave ID	Sets the slave ID of this instance. Slave ID is a number from 1 to 255. Do not clash one slave ID to another.

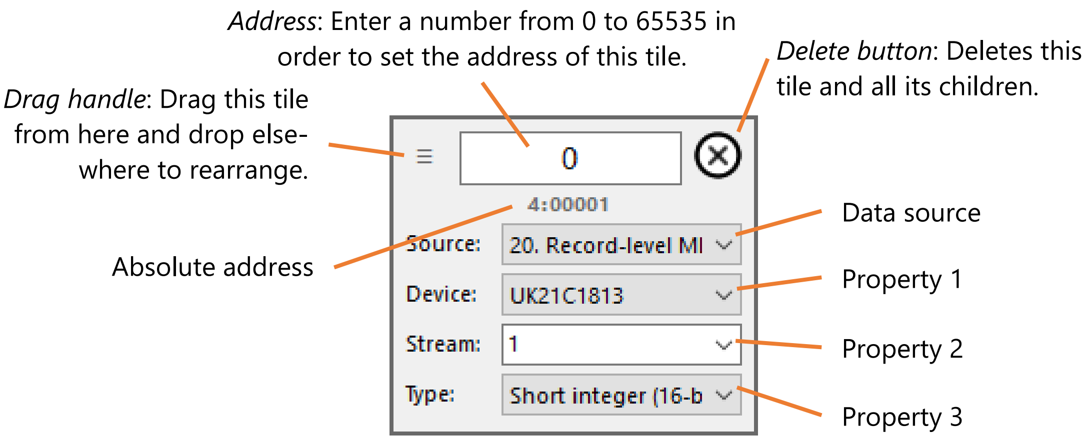
Element	Description
New address	Creates a new address (tile) on this instance.
New address > Read/write bit	Creates a new address for a read/write bit (coil).
New address > Read-only bit	Creates a new address for a read-only bit (input discrete).
New address > Read-only register	Creates a new address for a read-only register (input register)
New address > Read/write register	Creates a new address for a read/write register (holding register)
Delete addresses	Deletes all selected tiles.
Repeat action	Creates a successive sequence of addresses based on what address is currently selected. Chapter 28.3.5 explains more about repeat action.
Repeat action > Repeat this data source for all gases	Creates a sequence of address having the same data source but for different gases. *Works only for certain data sources, e.g. raw RF data.
Repeat action > Repeat this data source for all devices	Creates a sequence of address having the same data source but repeated for every selected device.
Repeat action > Repeat all data sources for this device	Creates a sequence of address having the same device but repeated for every selected data source.
Repeat action > Repeat all data sources for all devices	The two previous submenus combined. Beware while using this shortcut because it may generate a large number of tiles on the UI and may exhaust the limit of window handles of this form (Win32 programming limitation).
Repeat action > Repeat this hardcoded value	Creates a sequence of address having “hardcoded value” as the data source and copies the said value to the new tiles.
Undo	Undoes your previous action.
Redo	Redoes your previous action.
Sort	If you have a jumbled arrangement of tiles, this button sorts your tiles based on their addresses. Children tiles are always keep intact with their parent tile.
Renumber	If you have a jumbled arrangement of tiles, this button renumbers all tiles (or all selected tiles) so they have sequential addresses.
Remove instance	Deletes this server instance.
Remove instance > Remove instance	Deletes this server instance.
Remove instance > Duplicate instance	Creates a new server instance and copies all tiles from this instance to the new instance. It is faster than creating a new blank instance then recreating all tiles on that instance.
Remove instance > Export register address list	Exports all addresses (tiles) defined on this server instance to an XML file.
Remove instance > Import register address list	Reads the XML file generated by the previous submenu and recreates the tiles based on this file. If there are multiple instances defined in the XML, GCAS asks which one.

Element	Description
Remove instance > Print register address list	Sends a list of addresses plus their purposes and all related properties of this server instance to the printer.
Remove instance > Print preview	Generates a preview of what to be printed.
Mark inactive	Marks this server instance as inactive. *Inactive server instance cannot be accessed through Modbus server engines, as if its slave ID does not exist.*
Select all	Selects all tiles.
Select all and all of its submenus	Selects some tiles based on their category, their data sources, their devices, or unselects all tiles, or inverts selection.
Colour by source	Gives the tiles some background colours to distinguish one another based on their data sources.
Colour by source > Colour by device	Gives the tiles some background colours to distinguish one another based on their selected GC device.
Colour by source > Define colours	Configures the colour palette for this colouring cosmetic.
Hide children	Hides all children tiles. You only see parent tiles which may make it easier to manage addresses, however the delete (×) button on the last child tile would be hidden too.

28.3.2 Tile

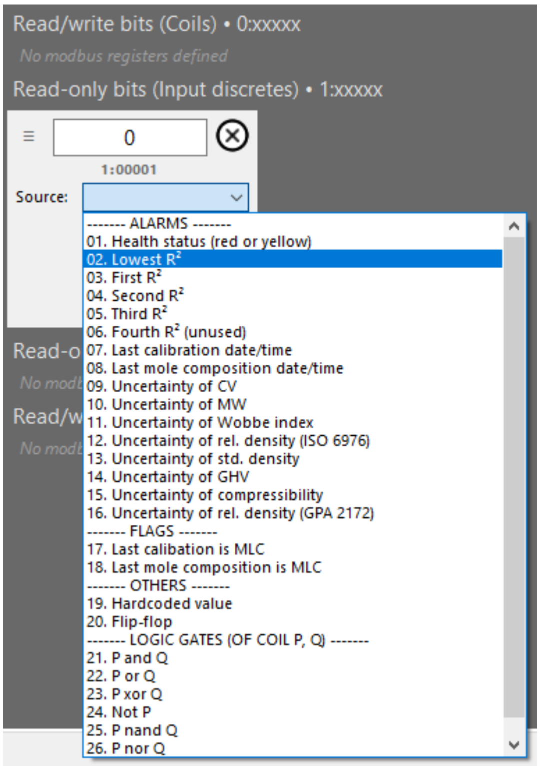


Modbus Server Instance Editor uses *tiles* to represent Modbus addresses. One tile is one address. On the left, we see a picture of an empty tile. A tile has *address*, *data source*, and up to three *properties*. Down here is a dissection of a tile into its parts.

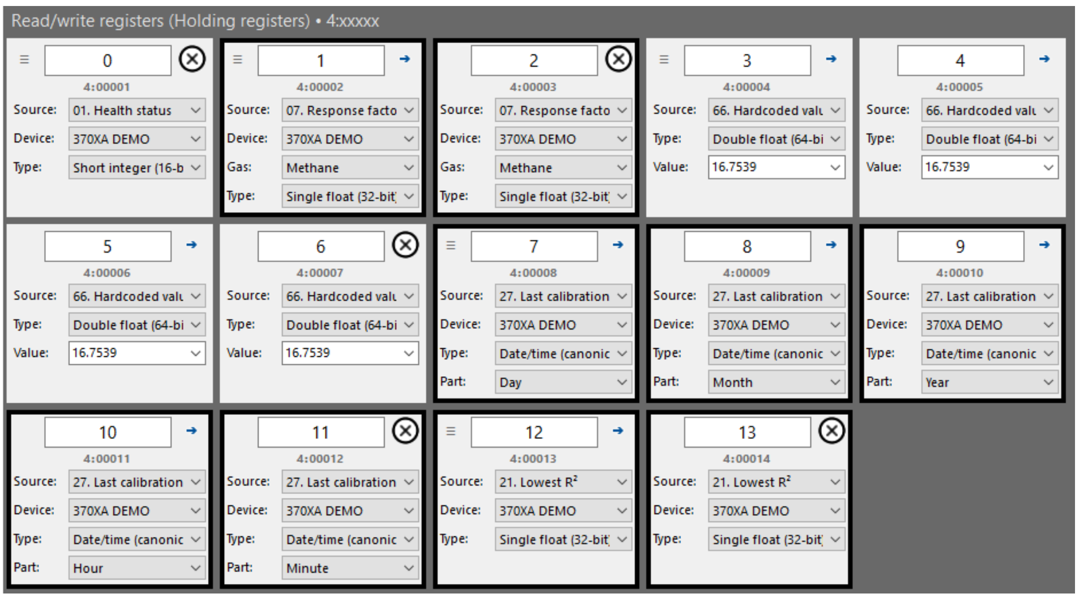


Creating and deleting tiles

To create a new tile, click **New address** on the toolbar and select which category. For example, try **Read-only bit**. An empty tile is created under "`Read-only bits (Input discrete) 1:XXXXX`". Next, select a data source from the dropdown list. After you select one, properties associated with this data source are unlocked.



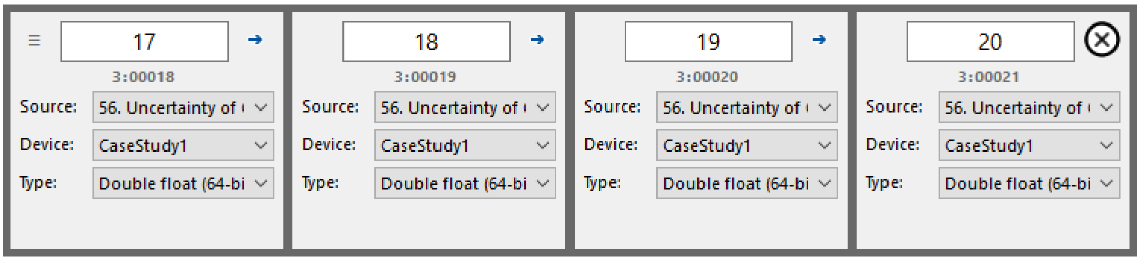
To delete a tile, click the delete button (×) at the top right corner of that tile. To delete a lot of tiles, it is quicker to *select* the tiles and hit **Delete addresses** on the toolbar. To select a tile, just click on the empty area of the tile. A thick border is rendered to indicate that the tile is selected.



A bunch of selected tiles

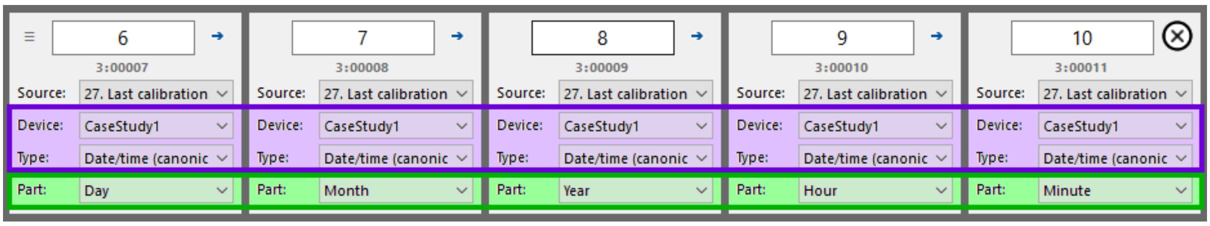
Linked tiles

For read/write and read-only **bits**, one tile is definitely one coil. But it is a different story for read/write and read-only **registers**. If a data type can fit into one register, that's good, and one address (tile) is dedicated for that data. Unfortunately, many data types such as floating point and date-time do not fit into one register. They require a span of registers which is represented by a chain of tiles like this one.



In this example, address 17 is the **parent tile** while address 18, 19, and 20 are its **children tiles**. Children tiles inherit properties from their parent, and a property change anywhere in this chain will propagate to other tiles. Selecting any of the tile will select the entire chain. Notice that you can set the address only at the parent tile. Children tiles update their addresses to keep them sequential. To rearrange this chain, start dragging from drag handle on the parent tile. By contrast, to delete a series of tiles, click delete button (×) on the last child tile.

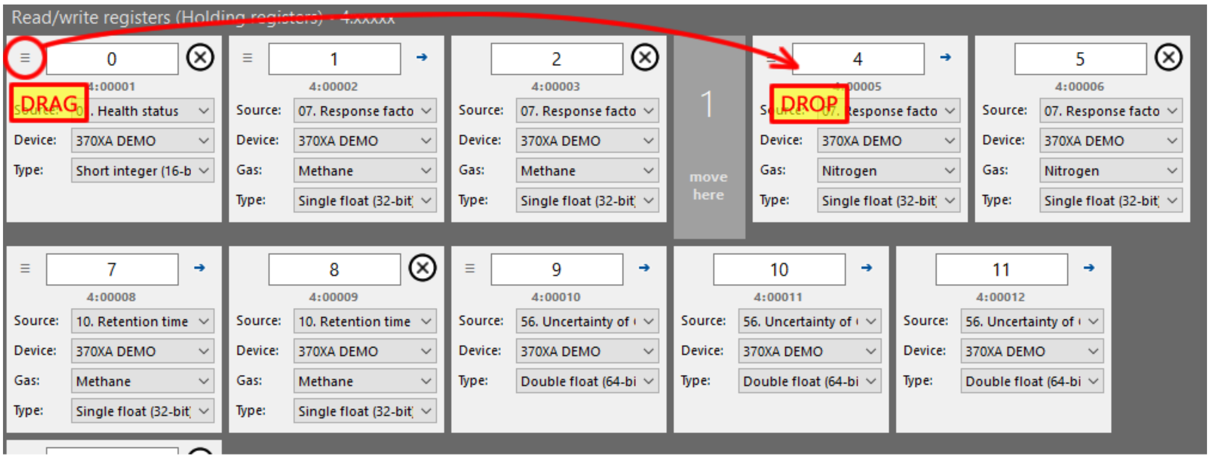
Some properties are configurable independently. For example, on data sources using "date/time canonical integer" type, the device and data type is linked across all tiles in this chain but the date/time part can be configured independently. This enables most users to use dd/mm/yyyy date format while providing US citizens option to use mm/dd/yyyy format.



Purple: Linked properties, shared by all children tiles.
Green: Property which is configurable independently.

Rearrange tiles

Rearranging tiles is performed through drag-drop operation. Drag a tile from its drag handle and drop on other tile to move it to the position before the target tile. Note that *you can only drag a tile and drop it on the same category*. For instance, you cannot move a tile under read/write bit section and drop it on read-only bit or read-only register section.



In the example above, the final address sequence will be 1, 2, 0, 3, 4, 5, 6, 7, and so forth. Don't forget to renumber the addresses so they become ascending again. *It doesn't have to be sequential, although sequential is good, but more importantly it* has *to be ascending*. As a shortcut, click **Renumber** on the toolbar.

Dragging a chain of tiles is the same. Drag from the drag handle of the *parent* tile, and drop it elsewhere as long as the drop target is in the same category. Instead of "1 move here", GCAS displays the number of tiles to move such as "4 move here". When you release the mouse button, the entire chain sit before the drop target tile. Children tiles are always tied to their parent.

28.3.3 Data Types

Before we talk about data source, let's talk about data types. GCAS supports one data type for coils and input discrete which is *bit* (because they contain single binary digit). For registers however, there are 10 data types—five numeric, and five for date/time.

Numeric data types:

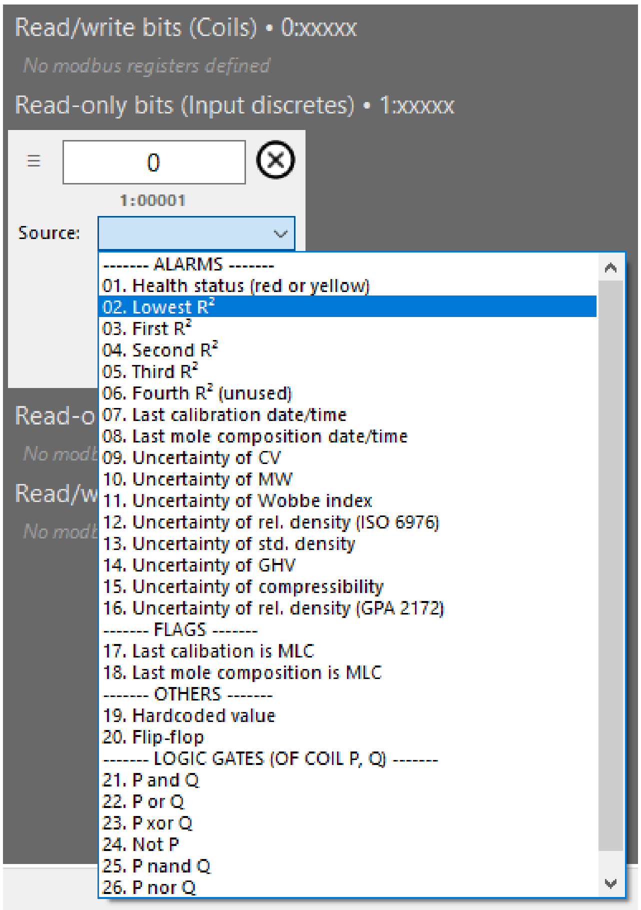
Name	Description	Range
Short Integer	Signed 16-bit integer	−32,768 +32,767
Integer	Signed 32-bit integer	−2,147,483,648 +2,147,483,647
Long integer	Signed 64-bit integer	− 9,223,372,036,854,775,808 + 9,223,372,036,854,775,807
Single float	32-bit IEEE-754 floating point	Max and min = $\pm$ 3.402823 × 10^{38} Smallest nonzero = $\pm\ 2^{-149}$ (≈ ±1.4 × 10^{-45}) Typical precision = 7~8 decimal digits Special values = "Infinity", "-Infinity", "NaN"
Double float	64-bit IEEE-754 floating point	Max and min = $\pm$ 1.79769313486232 × 10^{308} Smallest nonzero = $\pm\ 2^{-1074}$ (≈ ±4.94 × 10^{-324}) Typical precision = 14~15 decimal digits Special values = "Infinity", "-Infinity", "NaN"

Date/time data types:

Name	Description
Date/time canonical int	Date and time in canonical format (day, month, year, hour, minute). Each date part is put inside its own register; hence five registers are required. Each register is 16-bit integer, making them equivalent to five short integers in a row. You can configure the date part on each register, enabling alternative use of USA format (month-day-year-hour-minute) or east Asian format (year-month-day-hour-minute).
Date/time canonical float	Date and time in canonical format (day, month, year, hour, minute). Each date part is put inside its: - own pair of registers in 16-bit standard Modbus, or - own register in 32-bit Modbus. Depending on the register bit length setting, this data type requires 10 registers or 5 registers in a row. Each date part is 32-bit IEEE-754 floating point, making them equivalent to five single-float data in a row. You can configure the date part on each register or pair of registers, enabling alternative use of USA format (month-day-year-hour-minute) or east Asian format (year-month-day-hour-minute).
Date/time UNIX 32-bit	A signed 32-bit integer that represents number of seconds elapsed since the UNIX epoch (1 January 1970 00:00:00 **UTC**). The date/time value is first converted to UTC time zone, and then counted down to new year midnight of 1 January 1970. Time zone conversion is based on the time zone setting on your computer. **Caution: This data type will stop working after 19 January 2038**. Google "year 2038 problem" for more information.
Date/time UNIX 64-bit	A signed 64-bit integer that represents number of seconds elapsed since the UNIX epoch (1 January 1970 00:00:00 **UTC**). The date/time value is first converted to UTC time zone, and then counted down to new year midnight of 1 January 1970. Time zone conversion is based on the time zone setting on your computer. Unlike its 32-bit counterpart, the 64-bit UNIX time will exhaust after the heat death of our universe.
Date/time OLE automation format	A 64-bit IEEE-754 floating point with two parts: The integer part represents the day elapsed since 30 December 1899 midnight, and the decimal part represents time of that day divided by 24. The OLE epoch is much earlier than the UNIX epoch. Also, the date/time value is not converted to UTC time zone beforehand. For example, 29 February 2016 06:10 AM is 42,429.2569444. 42,429 is the number of days between 29 Feb. 2016 and 30 Dec. 1899; while 0.2569444 is 0.25 day (6 hours since midnight) + 0.0069444 day (10 minutes).

28.3.4 Data Source

Data source defines the purpose of an address by designating which data to output at that address. Choose a data source from the dropdown list on a tile. Once you have chosen a source, the properties associated with this data source are unlocked.



28.3.4.1 GC Data, Non-GC Data, and Computed Data

Data sources are categorised into three: GC data, non-GC data, and computed.

- **GC data** are data bound to a particular device. This includes health status, raw RF data, raw RT data, raw mole composition data, calibration certificates, uncertainty values, and many more.
- **Non-GC data** are data *not* bound to any device. For example, a hardcoded value. Or generic MLC constraints. Current computer time. List of dashboard items. Those kinds of data.
- **Computed data** encompass both mathematical and logic gate operations on one or two existing values. Thus, GCAS can provide precomputed values to your Modbus master software or device.

For computed data, GCAS uses the term **P** and **Q** to represent the referenced coil or register address. For example, register address `140` is defined to output "**P + Q**" (register source no. 73) with the **P** set to `132` and **Q** set to `136`. Therefore, GCAS takes whatever value already at address 132 and 136, sums them together, and outputs the sum value at address 140.

28.3.4.2 Coil Data Sources

For coils, there are 27 data sources.

No.	Group	Data source	Class	Description
1	Alarm	**Health status**	GC data	Outputs **1** if the health status of the selected GC device is red (unhealthy) or yellow (math error).
2	Alarm	**Lowest R^2**	GC data	Outputs **1** if the lowest of all R^2 values of the selected GC device is below the threshold defined in its Analysis Parameter module and the rule for lowest R^2 is enabled in Dashboard settings.
3	Alarm	**First R^2**	GC data	Outputs **1** if the first R^2 value of the selected device is below the threshold defined in its Analysis Parameter module. "First" R^2 means the first sequence of correlation calculation. For example, on Daniel C7+ devices, first R^2 is calculated from C1-C2-C7 sequence.
4	Alarm	**Second R^2**	GC data	Outputs **1** if the second R^2 value of the selected device is below the threshold defined in its Analysis Parameter module. "Second" R^2 means the second sequence of correlation calculation. For example, on Daniel C7+ devices, second R^2 is calculated from C3-C4-C5-C6 sequence.
5	Alarm	**Third R^2**	GC data	Outputs **1** if the third R^2 value of the selected device is below the threshold defined in its Analysis Parameter module. Some GC device types don't have third R^2 such as Daniel C9+ and C10+.
6	Alarm	**Fourth R^2**	GC data	Outputs **1** if the fourth R^2 value of the selected device is below the threshold defined in its Analysis Parameter module. At the time this document is written, **no device type has fourth R^2 sequence.** Therefore, the fourth R^2 value is always zero, which is definitely below the threshold, which in turn makes the coil always outputs 1. We provide this data source to prepare just in case there is a new device type definition in the future having four R^2 sequences.
7	Alarm	**Timestamp of last calibration data**	GC data	Outputs **1** if the timestamp of last calibration record of the selected device exceeds the threshold defined in Dashboard settings and the rule for timestamp of last calibration record is enabled in Dashboard settings.

No.	Group	Data source	Class	Description
8	Alarm	**Timestamp of last mole composition record**	GC data	Outputs **1** if the timestamp of last mole composition record of the selected device exceeds the threshold defined in Dashboard settings and the rule for timestamp of last mole composition is enabled in Dashboard settings. This requires *Live Data Analysis* in GCAS licence.
9	Alarm	**Uncertainty of CV**	GC data	These are alarms for ISO 6976 uncertainties. They output **1** if the corresponding uncertainty value of the selected device is above the threshold defined in Dashboard settings and the rule for that uncertainty is turned on in Dashboard settings. These five require *Uncertainty Calculation* and *ISO 6976 Calculator* in GCAS licence.
10	Alarm	**Uncertainty of MW**	GC data	
11	Alarm	**Uncertainty of Wobbe index**	GC data	
12	Alarm	**Uncertainty of relative density (ISO 6976)**	GC data	
13	Alarm	**Uncertainty of standard density**	GC data	
14	Alarm	**Uncertainty of GHV**	GC data	These are alarms for GPA 2172 uncertainties. They output **1** if the corresponding uncertainty value of the selected device is above the threshold defined in Dashboard settings and the rule for that uncertainty is turned on in Dashboard settings. These three require *Uncertainty Calculation* and *GPA 2172 Calculator* in GCAS licence.
15	Alarm	**Uncertainty of compressibility**	GC data	
16	Alarm	**Uncertainty of relative density (GPA 2172)**	GC data	
17	Flag	**Last calibration is MLC**	GC data	Outputs **1** if the last calibration record of the selected device is marked as multilevel-calibrated. This requires *ISO 10723* in GCAS licence.
18	Flag	**Last mole composition is MLC**	GC data	Outputs **1** if the last mole composition record of the given stream number (configurable) of the selected device is marked as multilevel-calibrated. This requires *Live Data Analysis* and *ISO 10723* in GCAS licence.
19	Others	**Hardcoded value**	Non-GC data	Outputs a custom binary value. You set the value to **0** or **1**, and it will stay like that.
20	Others	**Flip-flop**	Non-GC data	Outputs a binary value that changes from **0** to **1** to **0** to **1** and so forth every time GCAS receives a poll from Modbus master device. You set the *initial* value to **0** or **1**, and then it will flip and flop continuously.

No.	Group	Data source	Class	Description
21	Logic gate	**P and Q**	Com-puted	Outputs logic gate AND between coil **P** and **Q**. **P** **Q** **Output** 0 0 0 0 1 0 1 0 0 1 1 1
22	Logic gate	**P or Q**	Com-puted	Outputs logic gate OR between coil **P** and **Q**. **P** **Q** **Output** 0 0 0 0 1 1 1 0 1 1 1 1
23	Logic gate	**P xor Q**	Com-puted	Outputs logic gate XOR between coil **P** and **Q**. **P** **Q** **Output** 0 0 0 0 1 1 1 0 1 1 1 0
24	Logic gate	**Not P**	Com-puted	Inverts the output of coil **P**. If **P** is 0, then the output is 1. If **P** is 1, then the output becomes 0.
25	Logic gate	**P nand Q**	Com-puted	Outputs the logic gate NAND between coil **P** and **Q**. **P** **Q** **Output** 0 0 1 0 1 1 1 0 1 1 1 0
26	Logic gate	**P nor Q**	Com-puted	Outputs the logic gate NOR between coil **P** and **Q**. **P** **Q** **Output** 0 0 1 0 1 0 1 0 0 1 1 0
27	Logic gate	**P xnor Q**	Com-puted	Outputs the logic gate XNOR between coil **P** and **Q**. **P** **Q** **Output** 0 0 1 0 1 0 1 0 0 1 1 1

28.3.4.3 Register Data Sources

For registers, there are 96 data sources. The table is too long (horizontally) to fit this paper in portrait orientation, therefore we will switch temporarily to landscape starting from the next page.

Register data sources:

No.	Group	Data source	Class	Description	Available data types (bold = default)
1	General	**Health status**	GC data	Outputs the health status of the selected device. The output value follows a special convention. Read chapter 28.5 for more details.	Short integer on 16-bit Integer on 32-bit
2	General	**Device ID**	GC data	Outputs the ID number of this GC device in GCAS database.	Integer
3	General	**Device type**	GC data	Outputs the device type identifier of this device in GCAS database. The output value follows a special convention. Read chapter 28.5 for more details.	Short integer on 16-bit Integer on 32-bit
4	General	**Cycle time**	GC data	Outputs the cycle time of this device as defined in Analysis Parameter. The cycle time is in seconds.	Integer
5	General	**Device-level MLC constraints (calibration)**	GC data	Outputs the device-level override of MLC constraints for calibration records. The output value follows a special convention. Read chapter 28.5 for more details.	Short integer on 16-bit Integer on 32-bit
6	General	**Device-level MLC constraints (mole)**	GC data	Outputs the device-level override of MLC constraints for mole composition records. The output value follows a special convention. Read chapter 28.5 for more details.	Short integer on 16-bit Integer on 32-bit
7	Raw data	**Response factor (single-point)**	GC data	Outputs raw response factor value of the selected gas, of latest calibration record, of the selected device, converted to single-point.	- Integer* - Long integer* - **Single float**
8	Raw data	**Response factor (MLC)**	GC data	Outputs raw response factor value of the selected gas, of latest calibration record, of the selected device, converted to multilevel-calibrated. This requires *ISO 10723* in GCAS licence. If the record could not be converted, this outputs zero.	Single float

*The value will be rounded. For integer type (32-bit), if the RF value exceeds 2,147,483,647, the output value will stay at 2,147,483,647.

No.	Group	Data source	Class	Description	Available data types (bold = default)
9	Raw data	**Response factor (exponential)**	GC data	Outputs raw response factor value of the selected gas, of latest calibration record, of the selected device, converted to exponential. This data source works on ABB devices only. For all other device types, this outputs zero.	Single float
10	Raw data	**Retention time**	GC data	Outputs raw retention time value, of the selected gas, of latest calibration record, of the selected device.	- Short integer** - Integer** - **Single float**
11	Raw data	**Mole composition (single-point)**	GC data	Outputs raw mole composition value of the selected gas, of latest mole composition record, of the selected stream number, of the selected device, converted to single-point. This requires *Live Data Analysis* in GCAS licence.	Single float
12	Raw data	**Mole composition (MLC)**	GC data	Outputs raw mole composition value of the selected gas, of latest mole composition record, of the selected stream number, of the selected device, converted to multilevel-calibrated. This requires *Live Data Analysis* and *ISO 10723* in GCAS licence. If the record could not be converted, the output is zero.	Single float
13	Raw data	**Mole composition (exponential)**	GC data	Outputs raw mole composition value of the selected gas, of latest mole composition record, of the selected stream number, of the selected device, converted to exponential. This data source works on ABB devices only. For all other device types, this outputs zero.	Single float
14	Raw data	**Stream number of last record**	GC data	Outputs the stream number of latest mole composition record of the selected device. This requires *Live Data Analysis* in GCAS licence.	Short integer on 16-bit Integer on 32-bit

**The value will be rounded; thus you shall lose the decimal part.

No.	Group	Data source	Class	Description	Available data types (bold = default)
15	Raw data	**Calibration certificate, mole% part**	GC data	Outputs the raw mole percent part of the selected gas, of latest calibration gas certificate, of the selected device. This requires *Calibration Gas Certificate* feature in GCAS licence.	- Single float - **Double float**
16	Raw data	**Calibration certificate, absolute uncertainty**	GC data	Outputs the absolute uncertainty part (the plus-minus part) of the selected gas, of latest calibration gas certificate, of the selected device. This requires *Calibration Gas Certificate* feature in GCAS licence.	- Single float - **Double float**
17	Raw data	**Multiplier**	GC data	Outputs raw multiplier value of the selected gas, of last calibration record, of the selected device. Only ABB devices have multiplier values. For all other device types, this outputs zero.	- Single float - **Double float**
18	Raw data	**Lag time**	GC data	Outputs the total lag time in milliseconds. The lag time value is taken from the latest lag time calculation record. This requires *Lag Time Calculator* feature in GCAS licence.	- Integer - **Long integer** - Single float - Double float
19	Raw data	**Record-level MLC constraints (calibration)**	GC data	Outputs the record-level override of MLC constraints that applies to the last calibration record. The output value follows a special convention. Read chapter 28.5 for more details. This requires *ISO 10723* feature in GCAS licence.	Short integer on 16-bit Integer on 32-bit
20	Raw data	**Record-level MLC constraints (mole)**	GC data	Outputs the record-level override of MLC constraints that applies to the last mole composition record. The output value follows a special convention. Read chapter 28.5 for more details. This requires *ISO 10723* and *Live Data Analysis* feature in GCAS licence.	Short integer on 16-bit Integer on 32-bit
21	Correlation	**Lowest R^2**	GC data	Outputs the lowest of all available R^2 values calculated from the latest calibration record of the selected device.	- **Single float** - Double float

No.	Group	Data source	Class	Description	Available data types (bold = default)
22	Correlation	**First R^2**	GC data	Outputs the first R^2 value calculated from the latest calibration record of the selected device. "First" R^2 means the first sequence of correlation calculation. For example, on Daniel C7+ devices, first R^2 is computed from C1-C2-C7 sequence.	- **Single float** - Double float
23	Correlation	**Second R^2**	GC data	Outputs the second R^2 value calculated from the latest calibration record of the selected device. "Second" R^2 means the second sequence of correlation calculation. For example, on Daniel C7+ devices, second R^2 is computed from C3-C4-C5-C6 sequence.	- **Single float** - Double float
24	Correlation	**Third R^2**	GC data	Outputs the third R^2 value calculated from the latest calibration record of the selected device. "Third" R^2 means the third sequence of correlation calculation. For example, on Daniel C7+ devices, third R^2 is computed from C1-C2-C3-C4-C5-C6-C7 sequence.	- **Single float** - Double float
25	Correlation	**Fourth R^2**	GC data	Outputs the fourth R^2 value calculated from the latest calibration record of the selected device. At the time this document is written, **no device type has fourth R^2 sequence.** Therefore, the fourth R^2 value is always zero. We provide this data source to prepare just in case there is a new device type definition in the future having four R^2 sequences.	- **Single float** - Double float
26	Correlation	**R^2 assigned threshold**	GC data	Outputs the R^2 threshold defined for this device. If there is no threshold defined in Analysis Parameter, this will output the default value **0.995**.	- **Single float** - Double float

No.	Group	Data source	Class	Description	Available data types (bold = default)
27	Timestamp	**Last calibration date/time**	GC data	Outputs the timestamp of last calibration record of the selected device.	- **Date/time canonical int** - Date/time canonical float - Date/time UNIX 32-bit - Date/time UNIX 64-bit - Date/time OLE automation format
28	Timestamp	**Last mole composition date/time**	GC data	Outputs the timestamp of last mole composition record *regardless of its stream number*, of the selected device. This requires *Live Data Analysis* in GCAS licence.	
29	Timestamp	**Last certificate install date**	GC data	Outputs the installation date of last calibration gas certificate of the selected device. This requires *Calibration Gas Certificate* in GCAS licence.	
30	Timestamp	**Last lag time calculation date**	GC data	Outputs the calculation date of last lag time record of the selected device. This requires *Lag Time Calculator* feature in GCAS licence.	
31	Timestamp	**Last uncertainty-coefficient-set date**	GC data	Outputs the timestamp of last uncertainty coefficient set of the selected device. This requires *Uncertainty Calculation* feature in GCAS licence.	
32	Timestamp	**Last MLC-coefficient-set date**	GC data	Outputs the timestamp of last MLC coefficient set of the selected device. This requires *ISO 10723* in GCAS licence.	
33	Coefficients	**Repeatability coefficient A**	GC data	Outputs the coefficient **a**, **b**, **c**, or **d** of the repeatability coefficient part of the selected gas, of last uncertainty coefficient set, of the selected device. $y = \mathbf{a} + \mathbf{b}x + \mathbf{c}x^2 + \mathbf{d}x^3$. These require *Uncertainty Calculation* feature in GCAS licence.	- Single float - **Double float**
34	Coefficients	**Repeatability coefficient B**	GC data		
35	Coefficients	**Repeatability coefficient C**	GC data		
36	Coefficients	**Repeatability coefficient D**	GC data		

No.	Group	Data source	Class	Description	Available data types (bold = default)
37	Coefficients	**Response concentration coefficient A**	GC data	Outputs the coefficient **a**, **b**, **c**, or **d** of the response concentration coefficient part of the selected gas, of last uncertainty coefficient set, of the selected device. y = **a** + **b**x + **c**x^2 + **d**x^3. These require *Uncertainty Calculation* feature in GCAS licence.	- Single float - **Double float**
38	Coefficients	**Response concentration coefficient B**	GC data		
39	Coefficients	**Response concentration coefficient C**	GC data		
40	Coefficients	**Response concentration coefficient D**	GC data		
41	Coefficients	**MLC coefficient A**	GC data	Outputs the coefficient **a**, **b**, **c**, or **d** of the selected gas, of the last MLC coefficient set, of the selected device. y = **a** + **b**x + **c**x^2 + **d**x^3. These require *ISO 10723* feature in GCAS licence.	- Single float - **Double float**
42	Coefficients	**MLC coefficient B**	GC data		
43	Coefficients	**MLC coefficient C**	GC data		
44	Coefficients	**MLC coefficient D**	GC data		
45	Coefficients	**Coefficient-level MLC constraints (calibration)**	GC data	Outputs the coefficient-level override of MLC constraints for calibration records. The output value follows a special convention. Read chapter 28.5 for more details. This requires *ISO 10723* feature in GCAS licence.	Short integer on 16-bit Integer on 32-bit
46	Coefficients	**Coefficient-level MLC constraints (mole)**	GC data	Outputs the coefficient-level override of MLC constraints for mole composition records. The output value follows a special convention. Read chapter 28.5 for more details. This requires *ISO 10723* feature in GCAS licence.	Short integer on 16-bit Integer on 32-bit

No.	Group	Data source	Class	Description	Available data types (bold = default)
47	ISO 6976 actual values	**Calorific value**	GC data	Outputs the ISO 6976 calculation result which is based on the last mole composition record of the specified stream number, of the selected device. The units are: - Calorific value: MJ/m³ - Molecular weight: g/mol - Standard density: kg/m³ These six data sources require *ISO 6976 Calculator* feature in GCAS licence.	- **Single float** - Double float
48	ISO 6976 actual values	**Molecular weight sum**	GC data		
49	ISO 6976 actual values	**Wobbe index**	GC data		
50	ISO 6976 actual values	**Relative density**	GC data		
51	ISO 6976 actual values	**Standard density**	GC data		
52	ISO 6976 actual values	**Compressibility**	GC data		
53	GPA 2172 actual values	**Gross heating value**	GC data	Outputs the GPA 2172 calculation result which is based on the last mole composition record of the specified stream number, of the selected device. The units are: - Gross heating value: BTU/scf These three require *GPA 2172 Calculator* feature in GCAS licence.	- **Single float** - Double float
54	GPA 2172 actual values	**Compressibility**	GC data		
55	GPA 2172 actual values	**Relative density**	GC data		
56	ISO 6976 uncertainties	**Uncertainty of CV**	GC data	Outputs the uncertainty values of ISO 6976 properties. These uncertainty values can be *expanded* values (in percent) or *absolute values* (in each item's unit) depending on the configuration set in Dashboard settings. These five sources require *Uncertainty Calculation* and *ISO 6976 Calculator* in GCAS licence.	- **Single float** - Double float
57	ISO 6976 uncertainties	**Uncertainty of MW**	GC data		

No.	Group	Data source	Class	Description	Available data types (bold = default)
58	ISO 6976 uncertainties	**Uncertainty of Wobbe index**	GC data	Outputs the uncertainty values of ISO 6976 properties of the selected device. These can be *expanded* values (in percent) or *absolute* values (in each item's unit) depending on the configuration set in Dashboard settings. These five sources require *Uncertainty Calculation* and *ISO 6976 Calculator* in GCAS licence.	- **Single float** - Double float
59	ISO 6976 uncertainties	**Uncertainty of relative density (ISO 6976)**	GC data		
60	ISO 6976 uncertainties	**Uncertainty of standard density**	GC data		
61	GPA 2172 uncertainties	**Uncertainty of GHV**	GC data	Outputs the uncertainty values of GPA 2172 properties of the selected device. These can be *expanded* values (in percent) or *absolute* values (in each item's unit) depending on the configuration set in Dashboard settings. These three sources require *Uncertainty Calculation* and *GPA 2172 Calculator* in GCAS licence.	- **Single float** - Double float
62	GPA 2172 uncertainties	**Uncertainty of compressibility**	GC data		
63	GPA 2172 uncertainties	**Uncertainty of relative density (GPA 2172)**	GC data		
64	Others	**Generic MLC constraints (calibration)**	Non-GC data	Outputs the generic MLC constraints (lowest override level) for calibration records. The output value follows a special convention. Read chapter 28.5 for more details. This requires *ISO 10723* feature in GCAS licence.	Short integer on 16-bit Integer on 32-bit
65	Others	**Generic MLC constraints (mole)**	Non-GC data	Outputs the generic MLC constraints (lowest override level) for mole composition records. The output value follows a special convention. Read chapter 28.5 for more details. This requires *ISO 10723* feature in GCAS licence.	Short integer on 16-bit Integer on 32-bit
66	Others	**Hardcoded value**	Non-GC data	Outputs a custom value. You need to set the data type and supply the value accordingly.	All ten data types are available. The default is **short integer**.

No.	Group	Data source	Class	Description	Available data types (bold = default)
67	Others	**Increasing number**	Non-GC data	Outputs an integer that increases by 1 every time GCAS receives a poll from Modbus master device. You set the minimum and maximum value as a boundary. The number starts at the minimum value and it will increase by 1 on every poll, up to the set maximum value. Afterwards it shall wrap to the minimum value, starting over again. You can use increasing number, random number, or current computer time to verify that the current poll is different from the previous poll.	- Short integer - **Integer** - Long integer
68	Others	**Random number**	Non-GC data	Outputs a random number, can be integer or float, that updates every time GCAS receives a poll from Modbus master device. You set the minimum and maximum value as a boundary. The random number generator should produce numbers within this boundary. You can use increasing number, random number, or current computer time to verify that the current poll is different from the previous poll.	- Short integer - **Integer** - Long integer - Single float - Double float
69	Others	**Current computer time**	Non-GC data	Outputs current computer time. It updates in real-time as the clock ticks. Register source 69 is computer time in local time zone, while register source 70 is computer time converted to UTC. You can use increasing number, random number, or current computer time to verify that the current poll is different from the previous poll.	- **Date/time canonical int** - Date/time canonical float - Date/time UNIX 32-bit - Date/time UNIX 64-bit - Date/time OLE automation format
70	Others	**Current computer time (UTC)**	Non-GC data		

No.	Group	Data source	Class	Description	Available data types (bold = default)
71	Others	**Offset from UTC**	Non-GC data	Outputs how many minutes or hours your local time zone to the UTC is. If you select short integer data type or integer, it will output how many minutes. If you select single float, it will output how many hours. For instance, Darwin (Australia) is UTC+9:30. For short integer or integer, the output is 570 (= 9 × 60 + 30 minutes). For single float, the output is 9.5. Places located at the west of meridian have negative output value.	- Short integer - Integer - **Single float**
72	Others	**Dashboard items**	Non-GC data	Outputs the health status indicators shown on the Dashboard. The output value follows a special convention. Read chapter 28.5 for more details.	Short integer on 16-bit Integer on 32-bit
73	Maths	**P + Q**	Computed	Takes the existing value of register **P** and **Q**, then outputs the value of P plus Q.	- Short integer - **Integer** - Long integer - Single float - Double float
74	Maths	**P − Q**	Computed	Takes the existing value of register **P** and **Q**, then outputs the value of P minus Q.	- Short integer - **Integer** - Long integer - Single float - Double float
75	Maths	**P × Q**	Computed	Takes the existing value of register **P** and **Q**, then outputs the value of P times Q.	- Short integer - Integer - **Long integer** - Single float - Double float
76	Maths	**P ÷ Q**	Computed	Takes the existing value of register **P** and **Q**, then outputs the value of P divided by Q. This may result in decimal or floating-point number.	- **Single float** - Double float

No.	Group	Data source	Class	Description	Available data types (bold = default)
77	Maths	**P modulo Q**	Computed	Takes the existing value of register **P** and **Q**, then outputs the remainder of P ÷ Q. For example, if register P contains value **17** and register Q contains value **3**, 17 modulo 3 yields **2**. The closest multiple of 3 is 15, and then the gap from 15 to 17 is **2**.	- Short integer - **Integer** - Long integer - Single float - Double float
78	Maths	**P ÷ Q, integer division**	Computed	Takes the existing value of register **P** and **Q**, then outputs the value of P divided by Q and truncating the decimal part. For example, 17 ÷ 3 should return 5.6666...; but with integer division the result becomes **5**.	- Short integer - **Integer** - Long integer
79	Maths	**P ^ Q**	Computed	Takes the existing value of register **P** and **Q**, then outputs the value of P raised to the power Q.	- Integer - Long integer - **Single float** - Double float
80	Maths	**Logarithm P of base Q**	Computed	Takes the existing value of register **P** and **Q**, then outputs the value of $^{Q}\log P$.	- Single float - **Double float**
81	Maths	**P + constant**	Computed	Takes the existing value of register **P** and a constant **k**, then outputs the value of P plus k.	- Short integer - **Integer** - Long integer - Single float - Double float
82	Maths	**P – constant**	Computed	Takes the existing value of register **P** and a constant **k**, then outputs the value of P minus k.	- Short integer - **Integer** - Long integer - Single float - Double float

No.	Group	Data source	Class	Description	Available data types (bold = default)
83	Maths	**P × constant**	Computed	Takes the existing value of register **P** and a constant **k**, then outputs the value of P times k.	- Short integer - Integer - **Long integer** - Single float - Double float
84	Maths	**P ÷ constant**	Computed	Takes the existing value of register **P** and a constant **k**, then outputs the value of P divided by k.	- **Single float** - Double float
85	Maths	**P modulo constant**	Computed	Takes the existing value of register **P** and a constant **k**, then outputs the remainder of P ÷ k.	- Short integer - **Integer** - Long integer - Single float - Double float
86	Maths	**P ÷ constant, integer division**	Computed	Takes the existing value of register **P** and a constant **k**, then outputs the value of P divided by k and truncates the decimal part.	- Short integer - **Integer** - Long integer
87	Maths	**P ^ constant**	Computed	Takes the existing value of register **P** and a constant **k**, then outputs the value of P raised to the power k.	- Integer - Long integer - **Single float** - Double float
88	Maths	**e^P**	Computed	Takes the existing value of register **P** and outputs the value of constant *e* (2.78182...) raised to the power P.	- Single float - **Double float**
89	Maths	**Ln P**	Computed	Takes the existing value of register **P** and outputs the value of natural logarithm (base *e*) of P.	- Single float - **Double float**
90	Maths	**Log P**	Computed	Takes the existing value of register **P** and outputs the value of logarithm (base 10) of P.	- Single float - **Double float**

No.	Group	Data source	Class	Description	Available data types (bold = default)
91	Maths	**P << constant**	Computed	Takes the existing value of register **P** and a constant **k**, converts P into its binary representation, then performs bit-shift on P to the left for k times.	- Short integer - **Integer** - Long integer
92	Maths	**P >> constant**	Computed	Takes the existing value of register **P** and a constant **k**, converts P into its binary representation, then performs bit-shift on P to the right for k times.	- Short integer - **Integer** - Long integer
93	Bitwise	**P and Q**	Computed	Performs bitwise-AND (logic gate AND on every binary digit) between the value of register **P** and **Q**.	- Short integer - **Integer** - Long integer
94	Bitwise	**P or Q**	Computed	Performs bitwise-OR (logic gate OR on every binary digit) between the value of register **P** and **Q**.	- Short integer - **Integer** - Long integer
95	Bitwise	**P xor Q**	Computed	Performs bitwise-XOR (logic gate XOR on every binary digit) between the value of register **P** and **Q**.	- Short integer - **Integer** - Long integer
96	Bitwise	**Not P**	Computed	Takes the existing value of register **P**, converts P into its binary representation, then flips every bit from 0 to 1 or 1 to 0, and finally outputs it in decimal representation.	- Short integer - **Integer** - Long integer

28.3.5 Repeat Action

Repeat action is a shortcut on the toolbar of [Modbus Server Instance Editor form] to quickly define a series of addresses (tiles) based on the selected tile. You need to have one tile selected before opening the **Repeat action** dropdown button on the toolbar.

There are five repeat actions. Each of them is explained in their own subchapter.

28.3.5.1 Repeat This Data Source for All Gases

This repeat action is applicable if you select a register with data source demanding you to select a gas, which are these ones:

- Raw data → Response factor (all three kinds)
- Raw data → Retention time
- Raw data → Mole composition (all three kinds)
- Raw data → Calibration certificate (either part)
- Raw data → ABB Multiplier
- Coefficients → Repeatability coefficient A, B, C, D
- Coefficients → Response concentration coefficient A, B, C, D
- Coefficients → MLC coefficient A, B, C, D

First, select a compatible tile. For example, the selected tile source is set to Response factor (single-point), device set to DEMO1, and gas is set to Methane. Then click **Repeat action** on the toolbar and select **Repeat this data source for all gases**. The result is a series of tiles similar to this:

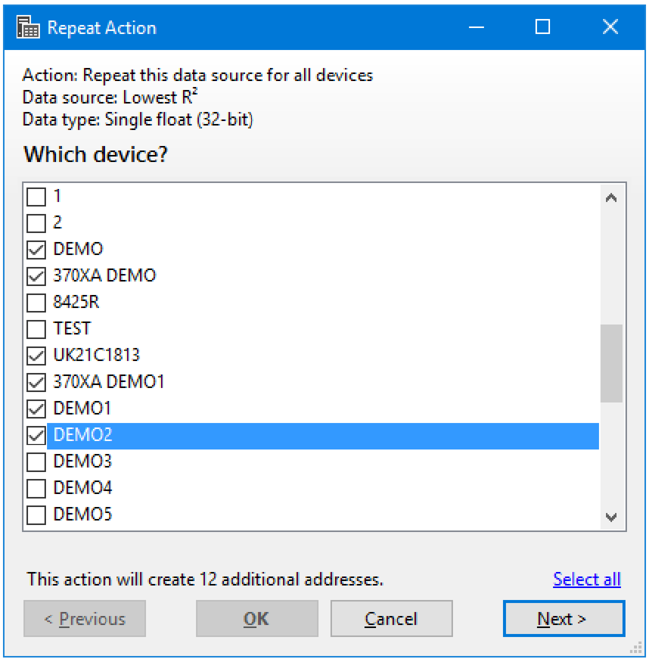
[Response factor single-point, DEMO1, methane]
[Response factor single-point, DEMO1, nitrogen]
[Response factor single-point, DEMO1, carbon dioxide]
[Response factor single-point, DEMO1, ethane]
[Response factor single-point, DEMO1, propane]
[Response factor single-point, DEMO1, i-butane]
[Response factor single-point, DEMO1, n-butane]
[Response factor single-point, DEMO1, neopentane]
[Response factor single-point, DEMO1, i-pentane]
[Response factor single-point, DEMO1, n-pentane]
[Response factor single-point, DEMO1, hexane]
[Response factor single-point, DEMO1, heptane]

The exact result depends on the type of GC device set at the originating tile. Some devices don't have neopentane, and some devices go full-range up to decane. Some read aromatic hydrocarbons, some have only one gas (repeat action doesn't produce any new tile for single gas devices).

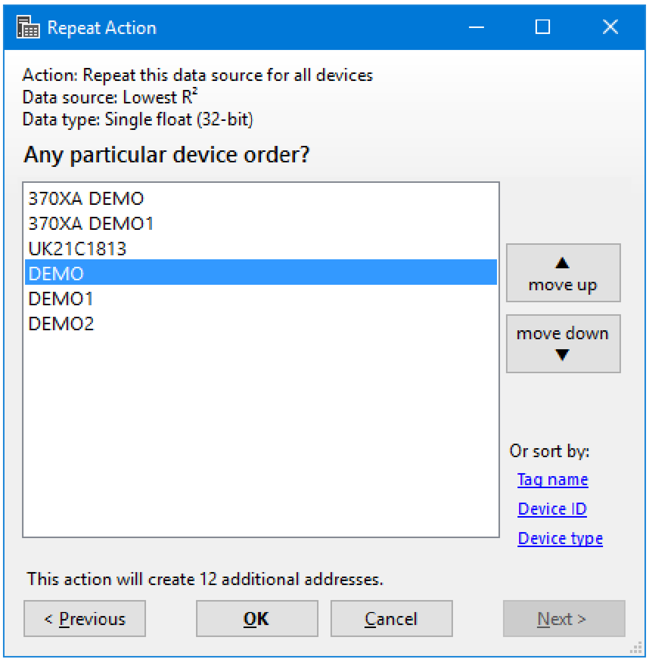
If you repeat a mole composition tile, GCAS creates an additional tile at the tail of this series to accommodate the *unnormalised total*. It is treated like a gas and appears on the dropdown list of gas selection property.

28.3.5.2 Repeat This Data Source for All Devices

This action creates a series of tiles sharing the same data source, but each tile is set for different GC device. First click on any tile (coil or register will do) to make it selected. The tile has to have a data source selected already. Then click **Repeat action** button on the toolbar and choose **Repeat this data source for all devices**. GCAS presents this *Repeat Action* dialogue.



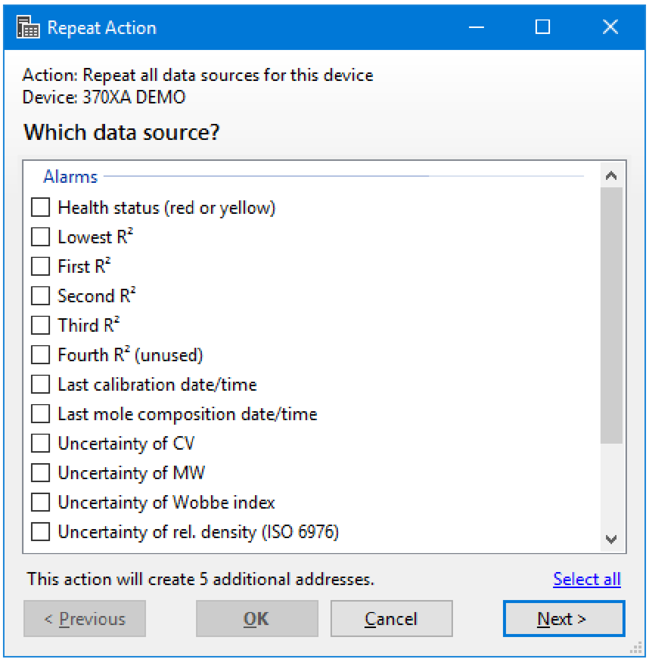
Select all devices you want to include in the repeat loop. Then click **Next** to decide the *order* of these devices. Finally, click **OK** and enjoy.



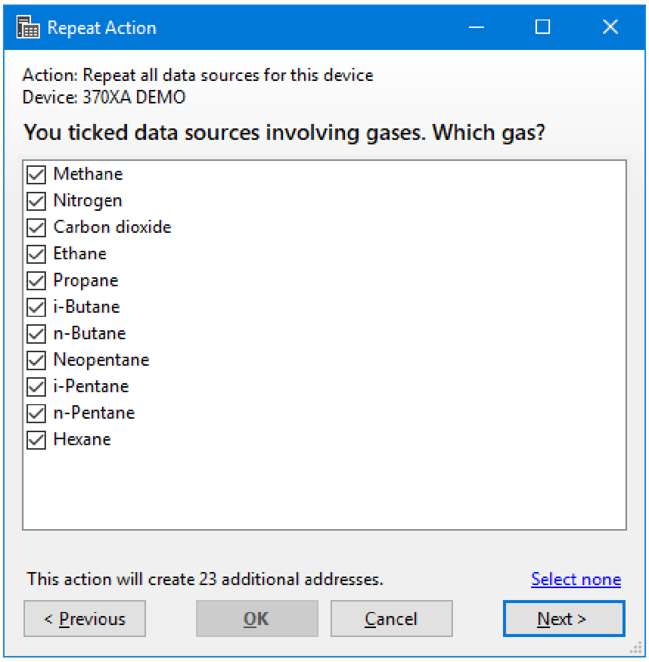
28.3.5.3 *Repeat All Data Sources for This Device*

This action is the opposite of the previous repeat action. This action creates a series of tiles sharing the same *device* but each tile is set for different data source.

First, select a tile having any data source categorised as GC data. Then go to **Repeat action** on the toolbar and select **Repeat all data sources for this device**. GCAS presents the familiar *Repeat Action* dialogue but now it asks what *data sources* to include in the repeat loop.



The screenshot here is for coils. For registers, it should display 63 register sources out of 96, because non-GC data and computed data cannot be repeated this way. Click **Next** to continue defining data source order and click **OK**.

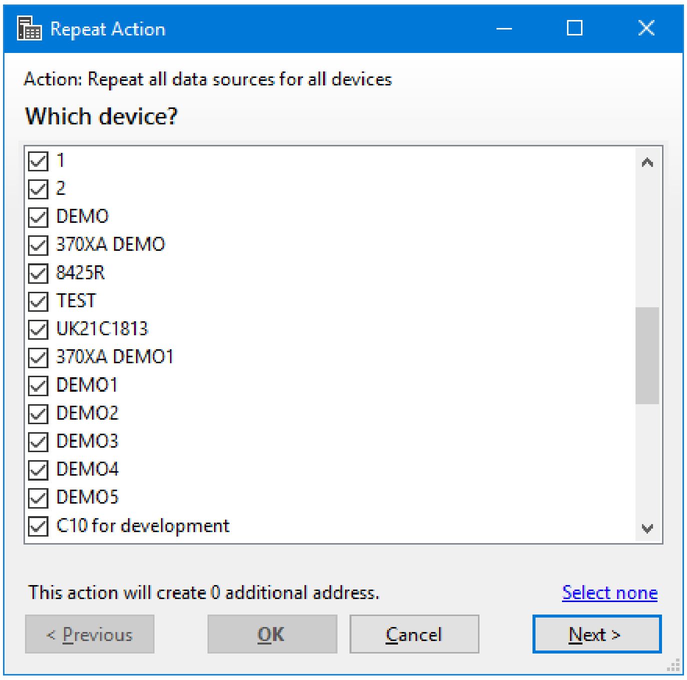


There is a special case where you perform a repeat action on a register. During the first step of the wizard, you ticked at least one data source that requires gas, such as RF, RT, mole composition, certificate, or uncertainty coefficients. For that reason, GCAS includes two additional steps on this wizard: *gas selection* and *gas order*. This becomes step three and four—choose which gas to include in the repeat loop as well as their order.

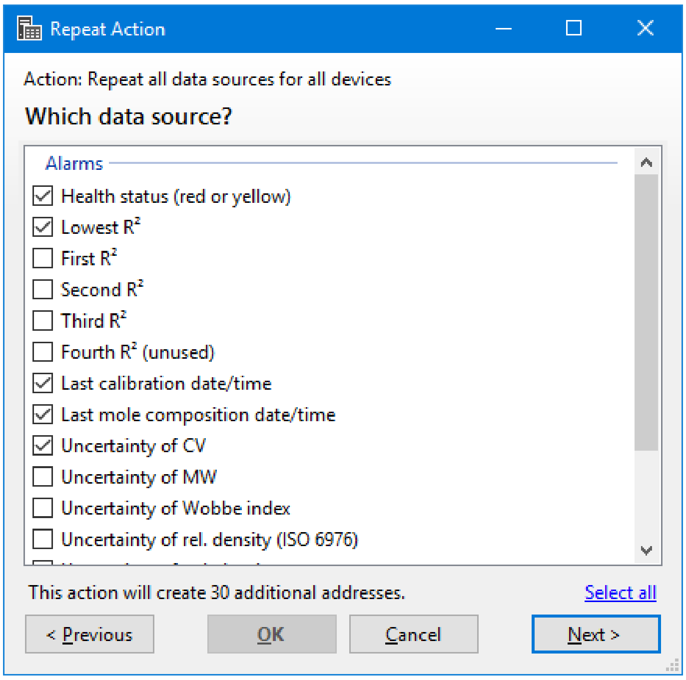
28.3.5.4 *Repeat All Data Sources for All Devices*

This action is combination of two previous repeat actions. This action creates a series of tiles consisting of various data sources for a particular GC device, then this whole thing is looped for various GC devices.

First, create an empty tile under desired category—read/write bits, read-only bits, read-only registers, or read/write registers. Why? Because GCAS needs to know whether you are repeating data sources for coils or registers, what data sources are available (coils and registers have different data sources), and to know where to put the resulting tiles. Click **Repeat action** on the toolbar and select **Repeat all data sources for all devices**.



Step one of the wizard is to tick which GC devices to include in the repeat loop. Step two defines the order of the selected devices.



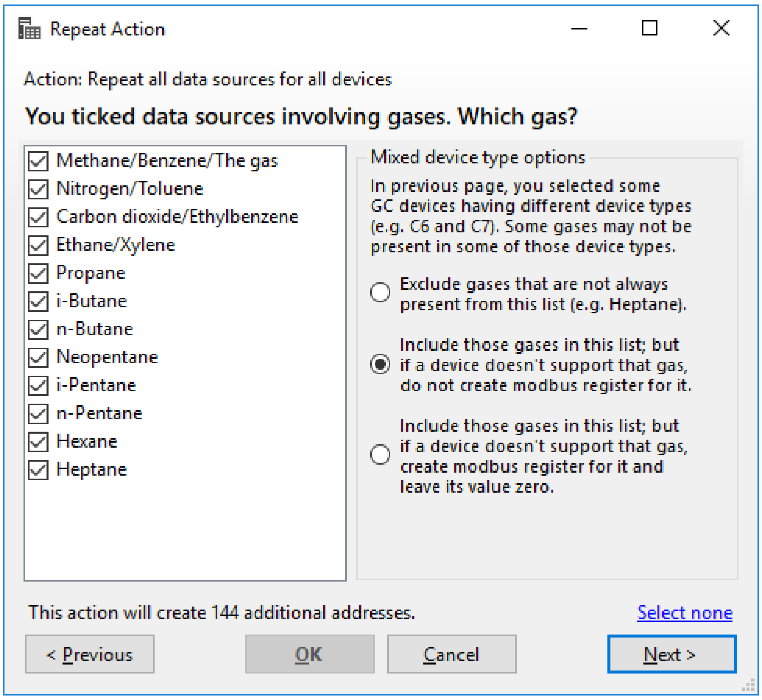
Step three is to define which data source to include in the repeat loop. Step four defines the order of these data sources. Finally, click **OK** and enjoy.

There is a special case which is when you use this menu to create a series of *register* tiles and you ticked at least one data source on step three which involves gases. This includes RF, RT, mole composition, ABB multipliers, certificates, and coefficients.

Now we have two problems:

1. These are data sources which can be defined for any gas. Which gas is it, or which gases are they?
2. Suppose you want to repeat methane to hexane (total 12 gases). During step one of the wizard, you already ticked several GC devices. But some of these devices don't have neopentane. What should GCAS do?

For this special case, GCAS displays two additional steps: *gas selection* and *gas order*. This is step five and six of the wizard. Choose the gases to repeat and what to do if GCAS encounters mixed device types in which some types do not include some gases.



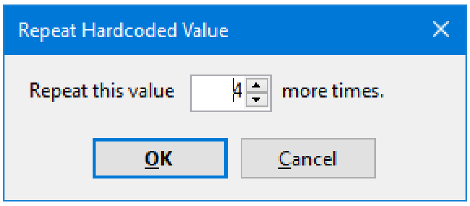
Again, here we see methane is shared with benzene and "the gas". Reason is because BTEX and single gas devices share the same database columns as regular GC devices. Anyway, on the right side there are three options. Choose the best one for you.

- **Exclude gases that are not always present from this list**. This option hides gases that are not available on at least one selected device. For example, you ticked three devices: Daniel C7 complete, Daniel C6 complete, and Daniel C6 without neopentane. The resulting set becomes: Methane, nitrogen, CO_2, ethane, propane, isobutane, butane, isopentane, pentane, and hexane. Here we don't see neopentane and heptane anymore.
- **Include those gases in this list; but if a device doesn't support that gas, do not create Modbus register for it**. This option does not hide any gas; but when GCAS encounters a device not supporting a particular gas, that gas is skipped.
- **Include those gases in this list; but if a device doesn't support that gas, create Modbus register for it and leave its value zero**. This option does not hide any gas; but when GCAS encounters a device not supporting a particular gas, GCAS creates a tile with the gas selection left empty. If you don't change the selected gas, the Modbus server will output zero.

28.3.5.5 Repeat This Hardcoded Value

Chapter 28.3.5.1 to 28.3.5.4 dealt with data sources classified as GC data. For non-GC data, you can only repeat one data source in this category—the hardcoded value. Other non-GC data and computed data cannot be repeated. Why would you repeat registers outputting computer time, for instance?

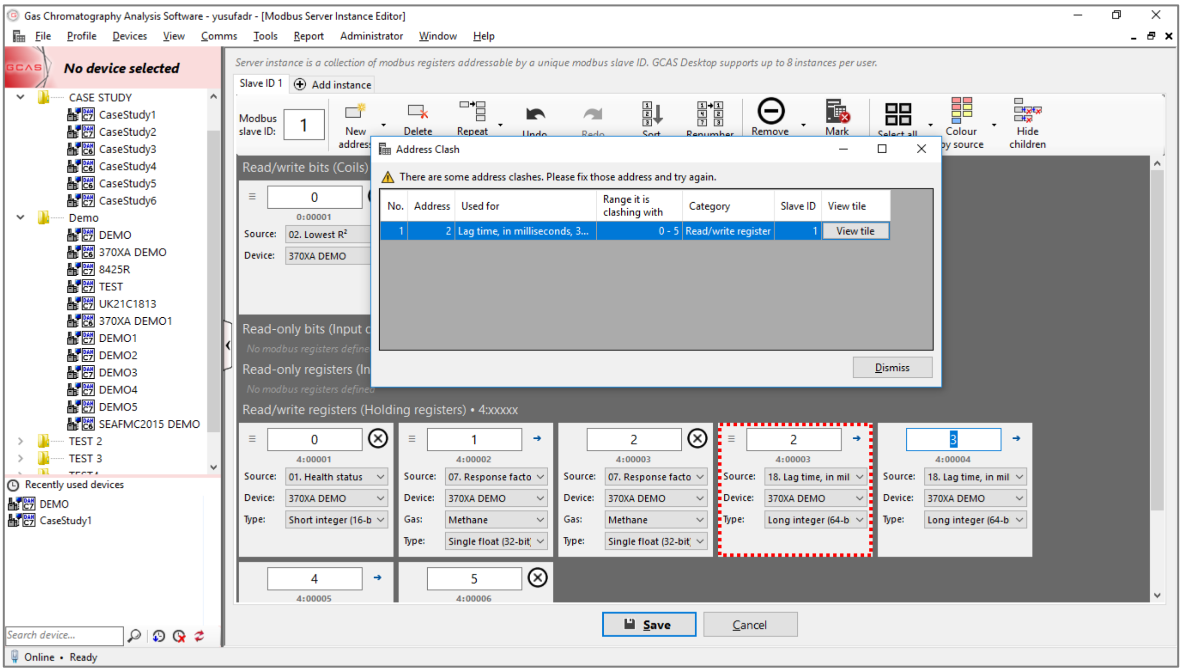
First, select a tile with data source set to hardcoded value. Then, go to **Repeat action** button on the toolbar and select **Repeat this hardcoded value**.



Enter how many times you wish to repeat this value. For example, let's repeat a hardcoded short integer register 4 more times. You get five hardcoded short integer tiles at the end: One original tile plus four new tiles. These new tiles copy their hardcoded value from the original tile.

28.3.6 Address Clash

When you are done defining addresses and their purposes, click **OK** at the bottom of Modbus Server Instance Editor form to save the instance definition. GCAS runs a check to ensure no address is used twice. On such cases, GCAS alerts you and renders dotted red border on the offending tiles.



*Address chain **2**-3-4-5 is conflicting with the previous chain (address 1-**2**) because address **2** is already used. We need to renumber this chain to 3-4-5-6 in order to resolve the conflict.*

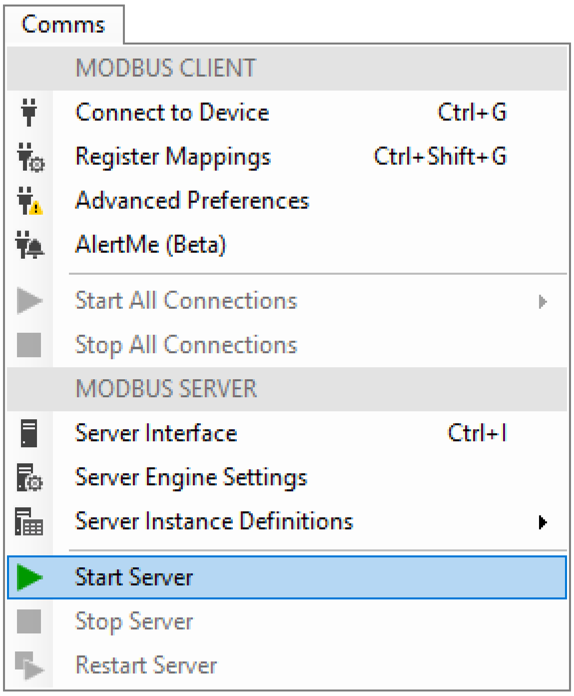
All conflicting addresses must be resolved before GCAS can save your instance definition.

28.4 Starting, Stopping, and Restarting Server

Start Server

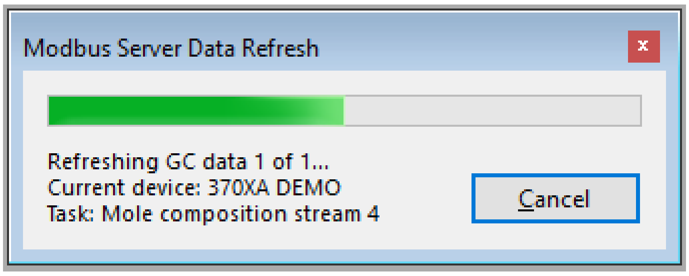
If you ticked **Run server at startup** check box at Server Engine Settings dialogue, Modbus server engine is already running by the time you log in to GCAS and after all the devices have been loaded from the database. Look for the status **Server is running** at the right corner of the status bar.

If you unticked this option or has stopped the server previously, open the Comms menu and select **Start Server**. Alternatively, open Modbus Server Interface and find the **Start** button at the top region. Note that you cannot run server if there are no server instance defined, or if all server instances are marked as inactive.



Shortly after the server engine starts, you see a *Modbus Server Data Refresh* progress window near the bottom-right corner of GCAS work area. This small window reports the progress of data refresh. A *data refresh* is a process where GCAS queries the database and performs necessary calculations to fill all data tables (all server instances) with real data. Once data refresh finished, your Modbus master software or device should get the correct data. GCAS initiates data refresh either every time Dashboard finished refreshing itself, or every certain period of time (default is every 30 minutes) depending on the configuration in server interface.

You can cancel the data refresh if it takes too long and you need to work on something else. Cancelling data refresh causes server instances to be partially updated, meaning some Modbus addresses still hold the old data.



Note

We recommend disabling idle timer if you leave GCAS unattended while it is providing data to your Modbus master device. GCAS idle timer will shut down Modbus server when it's time to log you out.

Stop Server

To stop Modbus server, open the Comms menu and select **Stop Server**. Alternatively, open Modbus Server Interface and hit **Stop** button (next to the **Start** button). *Please allow three seconds for the Modbus server module terminating all background threads gracefully*. Once it stops, GCAS is no longer accepting Modbus commands issued by your Modbus master software or device.

Note

GCAS stops providing data when you log out.

Restart Server

In a similar manner, go to Comms menu and select **Restart Server**. Or click **Restart** button on the server interface. This action is equivalent to stopping the server, waiting 3 seconds, and starting the server again. Some occasions where you may have to restart Modbus server module are:

- You changed the connection settings (added or removed some serial ports, or changed the IP binding) while Modbus server is running,
- You changed the register bit length while Modbus server is running,
- You edited the server instance definition while Modbus server is running, and
- For some magical reasons, your Modbus master device received *illegal state error* (0x00000001) reply from GCAS.

On the contrary, changing byte swap options in server engine settings *does not* require server restart. New swapping instructions apply immediately.

28.5 Output Values of Special Data Sources

This chapter documents the values of some register data sources because their output values follow a special convention.

28.5.1 Health Status (Register Source no. 1)

These are possible output values of registers defined for GC health status.

Value	Equivalent Dashboard light	Meaning
0	Red	Not healthy
1	Green	Healthy
2	Yellow	Math error or overflow (e.g. log 0 = $-\infty$)
4	White	GC has no data
8	Black	Calculation is pending, or aborted, or no Dashboard rules are active.

The reason why we use these values is because they are *bit fields*. Let's examine the values in binary.

Value	In binary	Error flags			Value	Equivalent Dashboard light
		Unknown-state bit	No-data bit	Math-error bit	Healthy-state bit	
0	0000	0	0	0	**0**	Red
1	0001	0	0	0	**1**	Green
2	0010	0	0	**1**	X	Yellow
4	0100	0	**1**	X	X	White
8	1000	**1**	X	X	X	Black

X = "don't care" as this bit should not be examined.

28.5.2 Device Type (Register Source no. 3)

These are possible output values of registers defined for GC device type.

Value	Meaning	Value	Meaning
1	Daniel C6+ complete	4	Daniel C7+ without neopentane
2	Daniel C6+ without neopentane	5	ABB C6+ complete
3	Daniel C7+ complete	6	ABB C6+ without neopentane

Value	Meaning	Value	Meaning
7	ABB C7+ complete	24	Siemens C10+ without neopentane
8	ABB C7+ without neopentane	25	Elster C6+ complete
9	Daniel C9+ complete	26	Elster C6+ without neopentane
10	Daniel C9+ without neopentane	27	Elster C7+ complete
11	Daniel C10+ complete, type A	28	Elster C7+ without neopentane
12	Daniel C10+ without neopentane, type A	29	Elster C9+ complete
13	BTEX analyser	30	Elster C9+ without neopentane
14	Single gas analyser	31	Elster C10+ complete
15	LNG C2−	32	Elster C10+ without neopentane
16	LNG C3−	33	H_2S analyser
17	Siemens C6+ complete	34	Moisture analyser (H_2O)
18	Siemens C6+ without neopentane	35	LNG C4−
19	Siemens C7+ complete	36	LNG C5− complete
20	Siemens C7+ without neopentane	37	LNG C5− without neopentane
21	Siemens C9+ complete	38	Daniel C10+ complete, type B
22	Siemens C9+ without neopentane	39	Daniel C10+ without neopentane, type B
23	Siemens C10+ complete		

Why the numbers are not clustered sequentially, you may ask. It has something to do with history, as more and more GC device types became supported by GCAS as the software version goes up. That is why LNG C4 and C5 are separated from their cousins LNG C2 and C3.

28.5.3 MLC Constraints (Register Source no. 5, 6, 19, 20, 45, 46, 64, and 65)

This applies to:

- Generic MLC constraints (register data source no. 64 and 65),
- Device-level MLC constraints (register data source no. 5 and 6),
- Coefficient-level MLC constraints (register data source no. 45 and 46), and
- Record-level MLC constraints (register data source no. 19 and 20).

To interpret the output of MLC constraints, you must read the value in *hexadecimal* base. MLC constraints are always provided as **short integer** (16-bit) and therefore will have four hexadecimal digits. On 32-bit Modbus, only the low 16 bits are used. The high word is zeroes and should be ignored.

The hexadecimal digits read from left to right (most significant to least significant) will take the format of **0XYZ**. First digit is zero and is safe to snub. The subsequent digits carry these meanings:

Hex digit	Is the constraint for	Value	Meaning
X	Linear equation	1	Take the absolute value of the negative solution.
		2	Reject the negative solution and set the result zero.
Y	Quadratic equation	1	Take the smallest positive root.
		2	Take the largest positive root.
Z on source no. 5, 19, 45, and 64	Cubic equation when converting MLC response factors to single-point response factors	1	Take the smallest positive root.
		2	Take the largest positive root.
		3	Take the first root that falls within the defined RF range.
		4	Take the root that falls within the defined RF range or the closest one to the RF range.
Z on source no. 6, 20, 46, and 65	Cubic equation when converting MLC mole composition to single-point mole composition	1	Take the smallest positive root.
		2	Take the middle root if there are three positive roots, or take the smallest one if there are two.
		3	Take the middle root if there are three positive roots, or take the largest one if there are two.
		4	Take the largest positive root.

A special value of **−1** (in hexadecimal becomes 0x**FFFF**) means the *MLC constraints at that level is not overridden*. GCAS will fall back to one override level lower when converting MLC records to single-point.

For example, a register is defined to output device-level MLC constraints for calibration records (data source no. 5). At runtime, this register outputs **545** (decimal). Convert this into hexadecimal and you get **0x0221**. Reading from left to right, we have:

2 = For linear equation, reject any negative solution,
2 = For quadratic equation, take the largest positive root, and
1 = For cubic equation, take the smallest positive root.

28.5.4 Dashboard Items (Register Source no. 72)

Register data source number 72, the *dashboard items*, takes six sequential short integer registers. Each register may output one of these values.

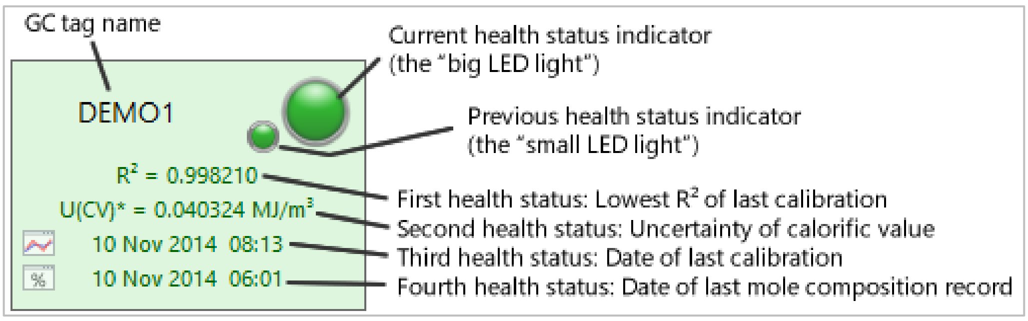
Value	GC health status displayed at this Dashboard order position
0	None (nothing is displayed at this position)
1	Lowest R^2
2	Uncertainty of CV

Value	[GC health status](#) displayed at this Dashboard order position
4	Uncertainty of molecular weight sum
8	Uncertainty of Wobbe index
16	Uncertainty of relative density (ISO 6976)
32	Uncertainty of standard density
64	Timestamp of last calibration record
128	Timestamp of last mole composition record
256	Uncertainty of GHV
512	Uncertainty of compressibility
1024	Uncertainty of relative density (GPA 2172)
2048	Unnormalised total of last mole composition record

As you might have noticed, these values are also bit fields. If your Modbus master software or device wants to know what health statuses displayed altogether, simply OR-gate all six values.

Value	In hexadecimal	In binary	GC health status at this order position
0	000	0000 0000 0000	None
1	001	0000 0000 000**1**	Lowest R^2
2	002	0000 0000 00**1**0	Uncertainty of CV
4	004	0000 0000 0**1**00	Uncertainty of molecular weight sum
8	008	0000 0000 **1**000	Uncertainty of Wobbe index
16	010	0000 000**1** 0000	Uncertainty of relative density (ISO 6976)
32	020	0000 00**1**0 0000	Uncertainty of standard density
64	040	0000 0**1**00 0000	Timestamp of last calibration record
128	080	0000 **1**000 0000	Timestamp of last mole composition record
256	100	000**1** 0000 0000	Uncertainty of GHV
512	200	00**1**0 0000 0000	Uncertainty of compressibility
1024	400	0**1**00 0000 0000	Uncertainty of relative density (GPA 2172)
2048	800	**1**000 0000 0000	Unnormalised total of last mole composition record

As an illustration, let's borrow a picture from chapter 17.

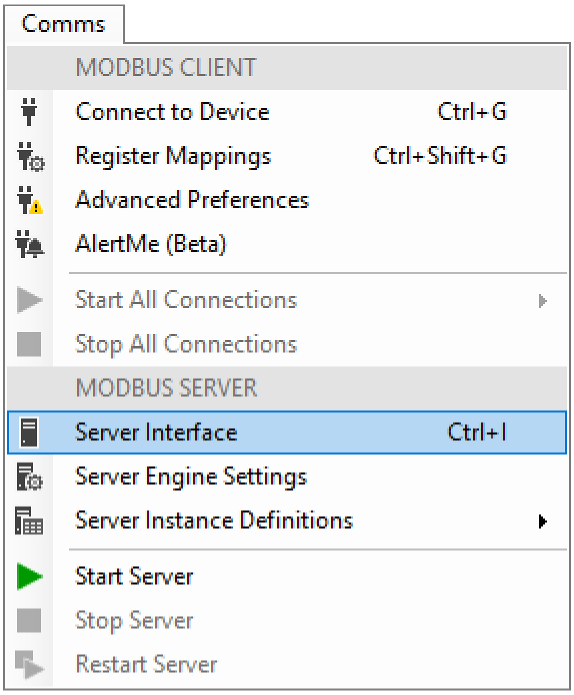


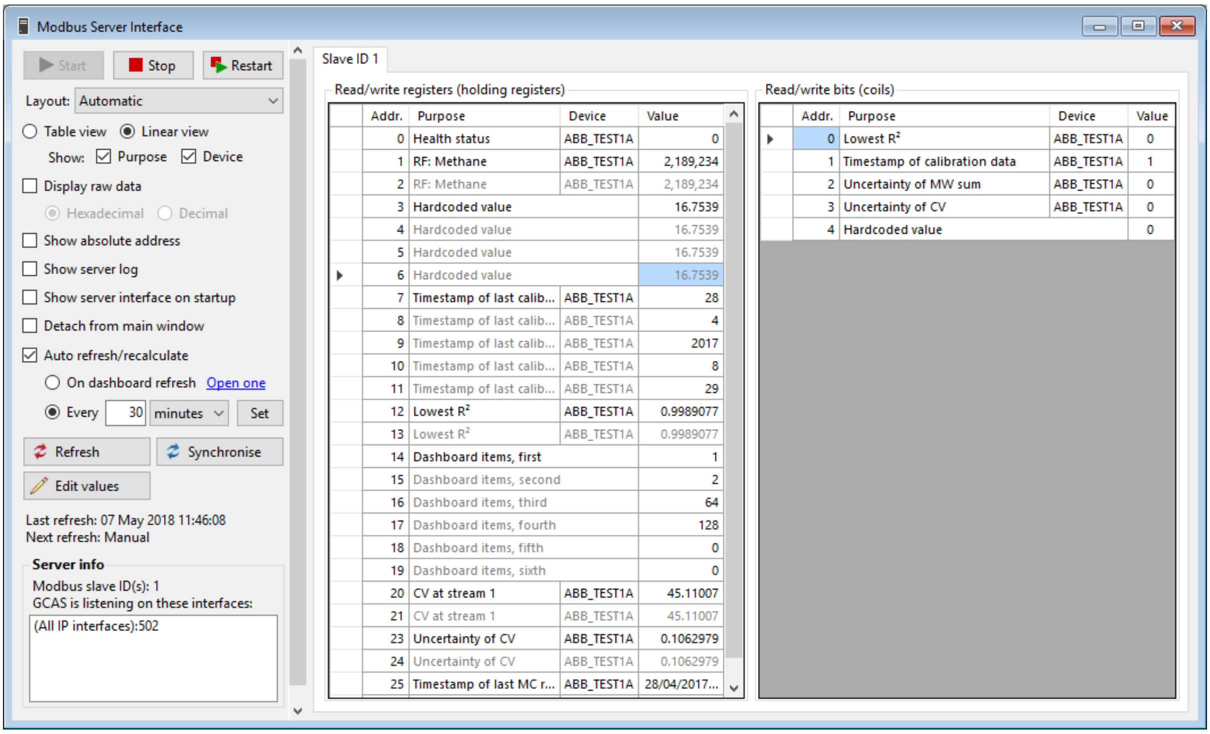
If the Dashboard module is configured that way and we define register address 20-25 to output dashboard items with register data source no. 72, then these registers will output these values:

Register address	Output value	Meaning
20	1	Lowest R^2
21	2	Uncertainty of CV
22	64	Timestamp of last calibration record
23	128	Timestamp of last mole composition record
24	0	Not used
25	0	Not used

28.6 Server Interface

Modbus Server Interface is a window to display the actual values of all Modbus coils and registers being provided to the Modbus master software or device at present time. To open server interface, go to the Comms menu and select **Server Interface** or press `Ctrl+I`.





This is an example of Modbus Server Interface window while server engine is running. If server engine is not running, server interface shows you a blank (white) window.

On the left side of server interface there are several check boxes and buttons to control Modbus server module. On the right side there are data grids containing the actual data being served by server engine. Data grids are contained in tabs, and one tab is one server instance (one slave ID). Let's take a closer look to the left side.

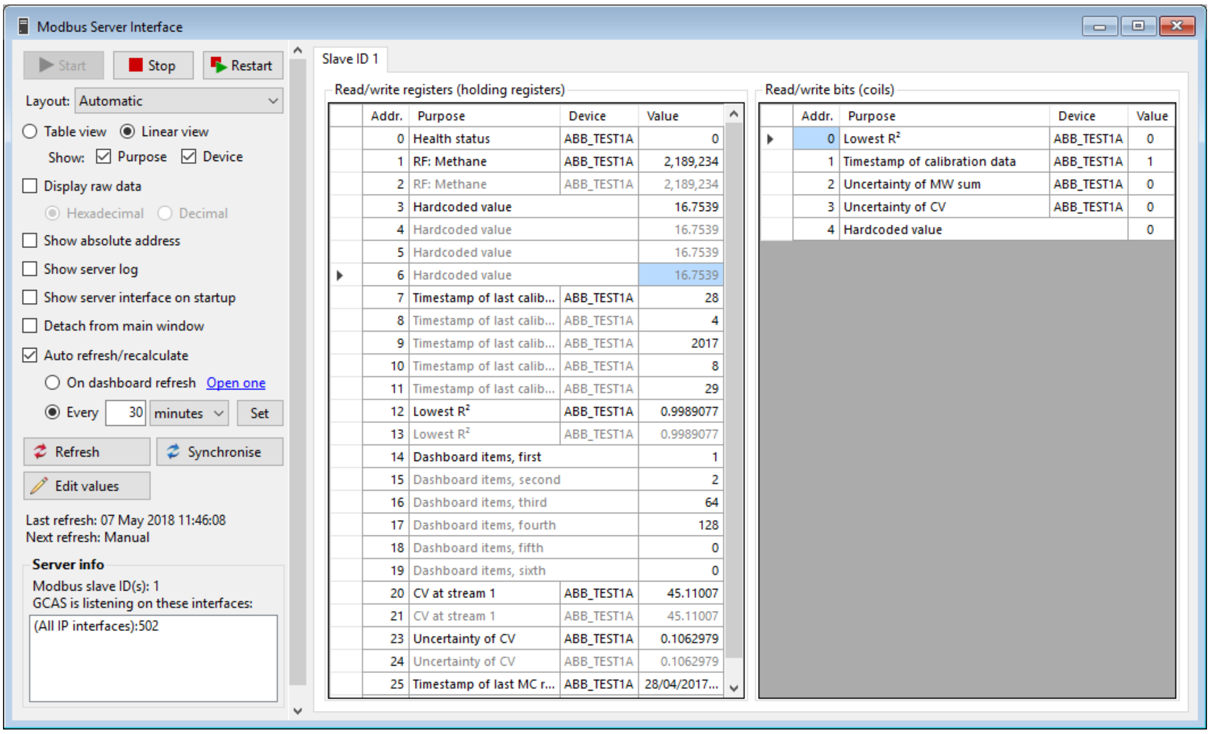
UI element	Purpose
Start	Starts Modbus server engine.
Stop	Shuts down Modbus server engine.
Restart	Restarts Modbus server engine.
Layout	Changes the layout of data grids on the right side. There are 8 layouts: 1. **Automatic**: Server interface positions the grids according to their category and number of addresses in each. 2. **All four**: All four grids are displayed in 2 x 2 formation. 3. **Read/write side-by-side**: *Read/write bits* on the left, *read/write registers* on the right. 4. **Read-only side by side**: *Read-only bits* on the left, *read-only registers* on the right. 5. **Read/write bits only:** Displays *read/write bits*' grid only. 6. **Read-only bits only**: And so do the remaining options. 7. **Read-only registers only** 8. **Read/write registers only**
Linear view	Switches all data grids to linear view.
Table view	Switches all data grids to table view.

UI element	Purpose
Show: **Purpose**	On linear view, shows or hides the *Purpose* column.
Show: **Device**	On linear view, shows or hides the *Device* column.
XX rows per column	On table view, controls how many rows for each column.
Display raw data	Displays the data in raw format (checked) or canonical format (unchecked).
Display raw data – **Hexadecimal**	Displays the data in raw format using hexadecimal (base-16) digits.
Display raw data – **Decimal**	Displays the data in raw format using decimal (base-10) digits.
Show absolute address	Displays the coil and register addresses in absolute address format (checked) or in zero-based format (unchecked).
Show server log	Shows or hides the server log.
Show server interface on startup	Controls whether to automatically open this server interface window after you log in to GCAS.
Detach from main window	Detaches or attaches the server interface from GCAS main window. Detached window can be dragged outside of main window boundary and is probably useful if you have multiple displays.
Auto refresh/recalculate	Enables or disables automatic data refresh. Unticking this check box will stop the timer.
Auto refresh/recalculate > **On dashboard refresh**	Links Modbus server module to an existing Dashboard window so that data refresh is performed after Dashboard has finished refreshing. Only the leftover tasks are performed, therefore it saves time. More about this on chapter 28.6.2.
Auto refresh/recalculate > **Every XX [minutes]**	Sets the automatic data refresh by timer, not by dependency to Dashboard window. You need to enter the value, select the time unit, and click **Set** to enforce the change. Minimum value is 5 minutes, and maximum value is 20 days. More about this on chapter 28.6.2.
Refresh	Initiates a manual data refresh. *Manual data refresh does not affect automatic data refresh triggered by the timer.*
Synchronise	Synchronises what server interface window displays with the actual values on all server instances. To sum it up, 1. Refresh = Refreshes all server instances + updates server interface, 2. Synchronise = Only updates server interface window.
Edit values	Enters edit mode.
Commit edit	Commits all changes you made during edit mode.
Cancel edit	Discards all changes and revert to the original values.
Last refresh, Next refresh	Displays information about the time of last data refresh and next automatic data refresh.

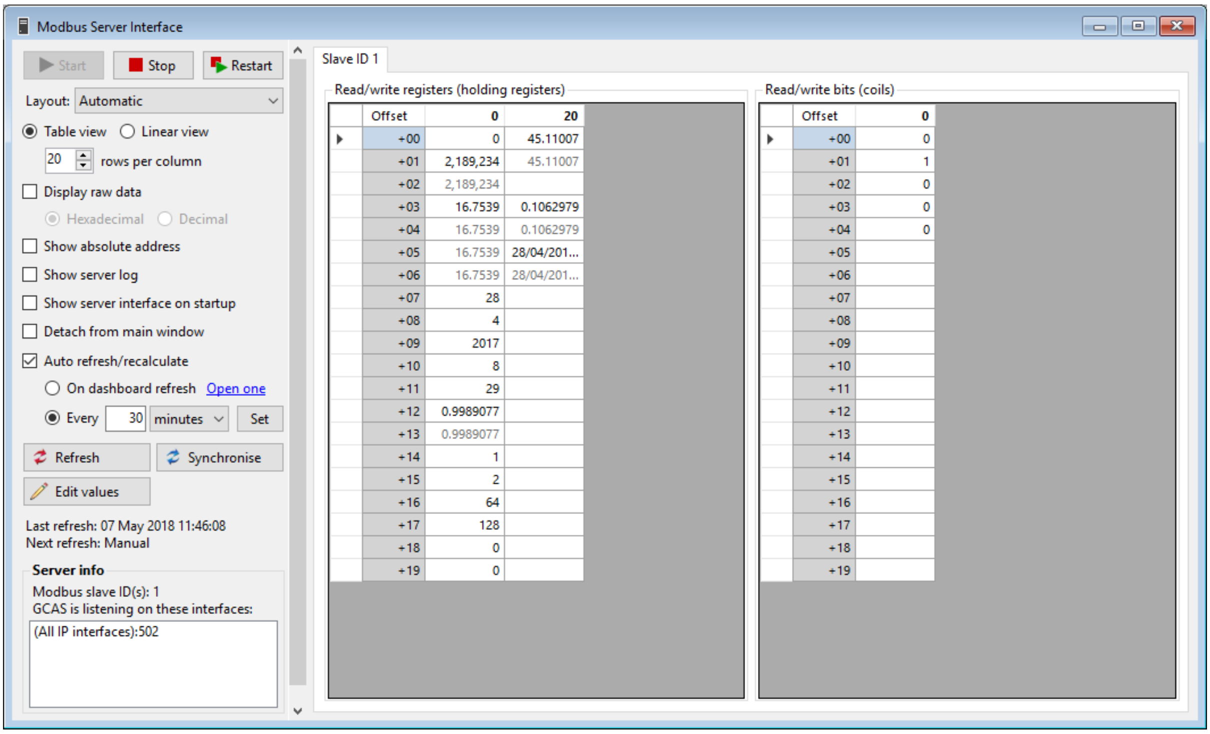
UI element	Purpose
Server information	Displays all slave IDs, followed by all COM (serial) ports GCAS is using, as well the IP address and TCP port GCAS is listening to.

28.6.1 Linear View vs. Table View

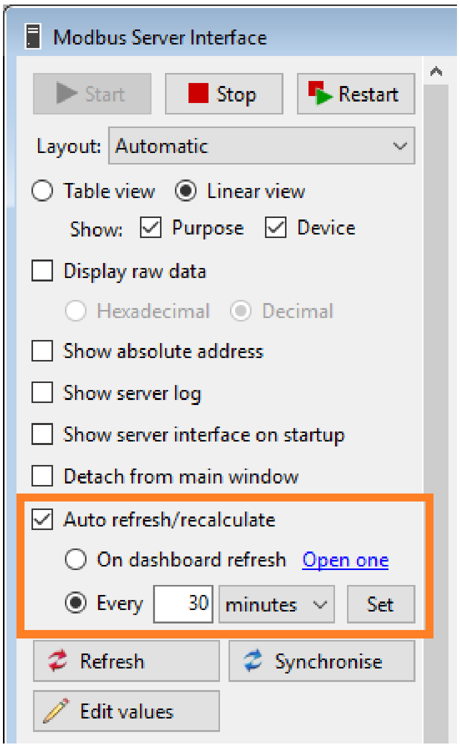
This screenshot on the next page is server interface in *linear view*. It lists all addresses in a long vertical list that contains the address, purpose of the address, GC device, and the actual value.



There is another view called *table view*. In table view, server interface focuses your view to the values only. Address is represented at the column header plus the *offset* written in the first column. While data grids in linear view grow downward, grids in table view propagate to the right. There is a control on the left side of server interface window to set how many rows per column before a new column is created to the right.



28.6.2 Data Refresh Schedule and Manual Refresh



These options control the automatic data refresh. By default, GCAS refreshes all server instances every 30 minutes.

The first option, **On dashboard refresh**, links Modbus server module with Dashboard. It causes Modbus server to wait for an open Dashboard window finishing its data refresh. Modbus server copies all available data from Dashboard and then continues its own data refresh but only for the remaining data not served by the Dashboard.

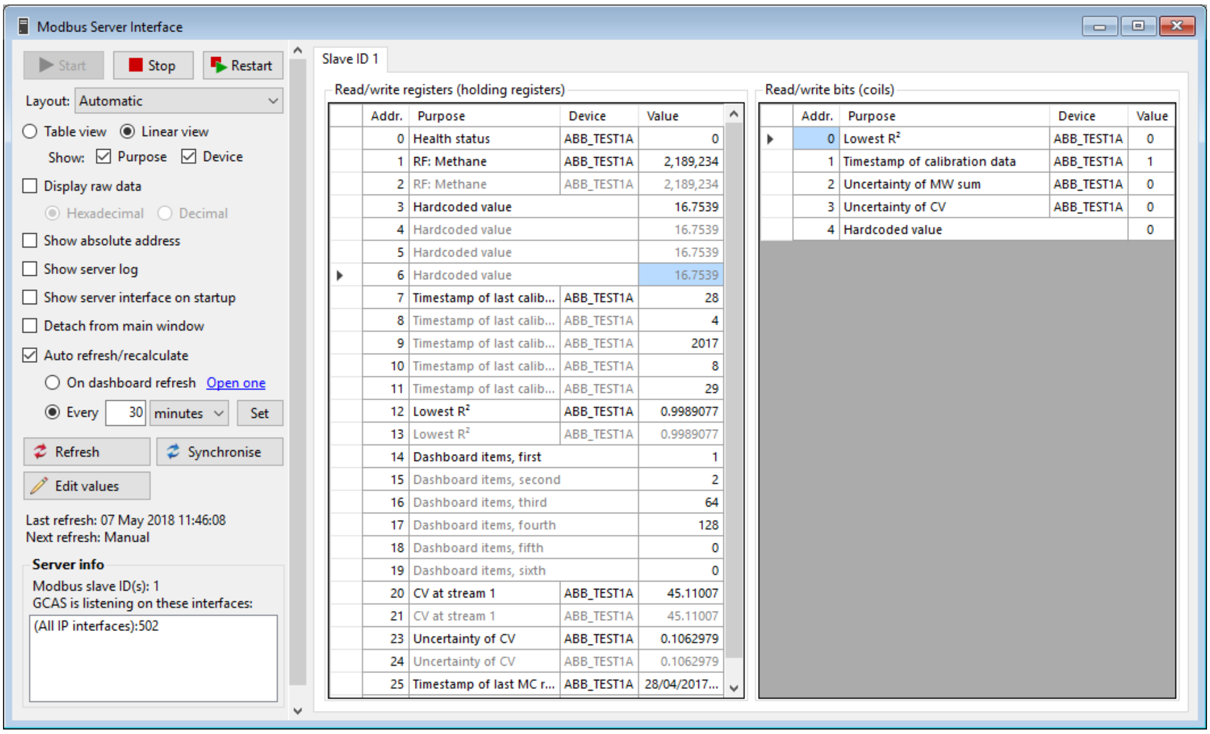
This Dashboard-Modbus server linkage saves time because the same data is not loaded twice (once by Dashboard, then by Modbus server). The downside is, Modbus server follows Dashboard's auto refresh schedule. Even dashboard's auto refresh could be disabled in Dashboard Settings form; which in turn, causes data refresh of Modbus server begins only after you click **Refresh** button on Dashboard window. Additionally, if you close Dashboard while Modbus server is linked to Dashboard, Modbus server reverts back to timer mode (the second option).

The second option utilises a timer. Modbus server sets the timer to the defined interval and starts data refresh when the countdown reaches zero. By this way, Modbus server does not have to wait for Dashboard. However, it may happen that Dashboard finished its data refresh and few minutes afterward the Modbus server data refresh begins, yet both of them load the same data. This option is best used if you don't plan to open Dashboard window at all. To change data refresh schedule, enter the number followed by time unit (minutes, hour) and click **Set**. Default setting is 30 minutes. The time of next data refresh is displayed under **Edit values** button.

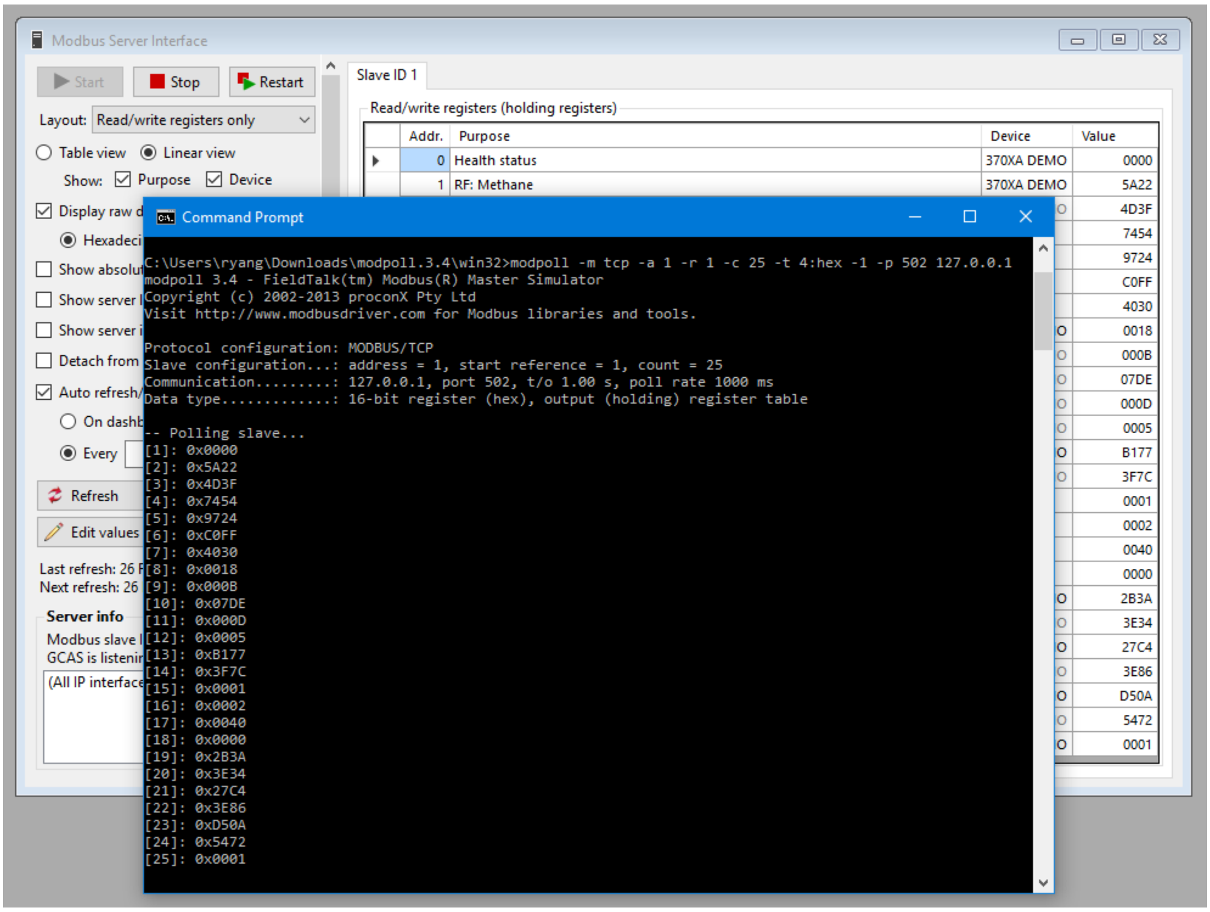
To disable automatic data refresh, uncheck **Auto refresh/recalculate** box. This puts Modbus server module in *manual refresh mode*, for you need to click **Refresh** button to commence another data refresh.

28.6.3 Raw Data and Absolute Address

Modbus Server Interface displays data in its *canonical* (human-readable) *format*. Therefore, any data requiring multiple registers are displayed in all part of the address chain. For example, take a look at read/write register address 3, 4, 5, and 6 on the screenshot down here.



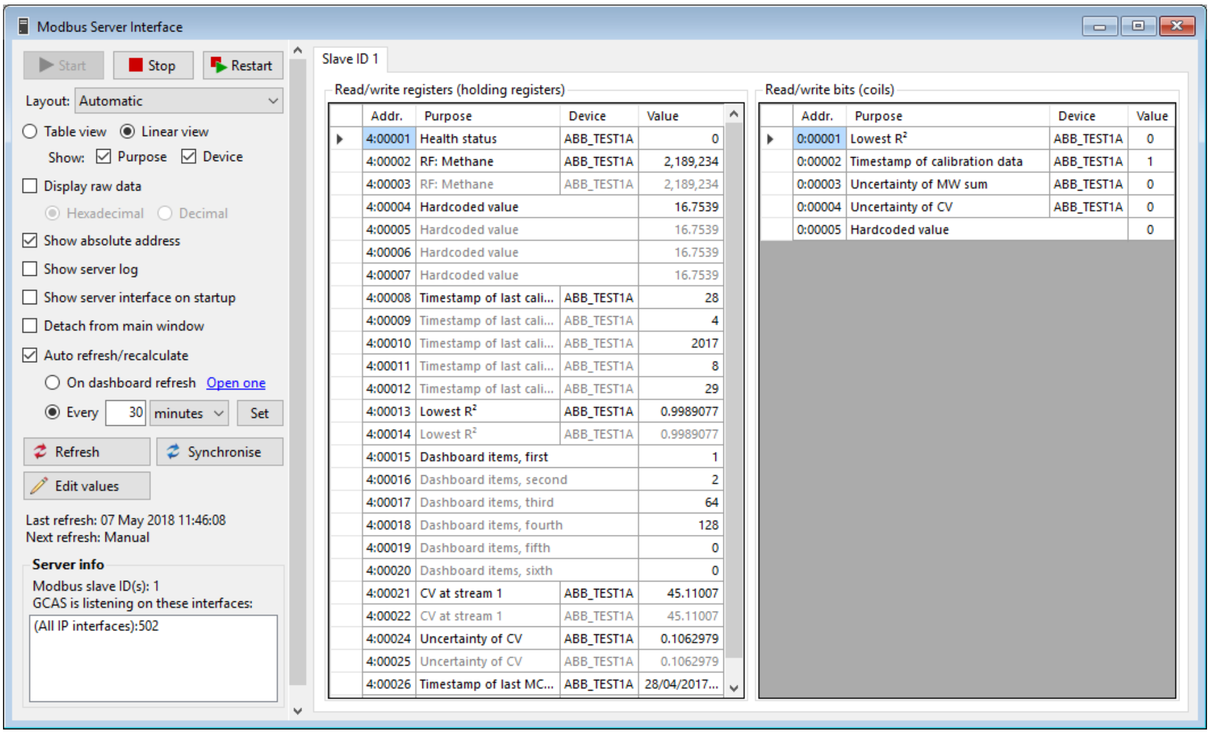
These four registers are defined to hold a double-float data (64-bit floating point). The value `16.7539` is duplicated in these four addresses. Parent address is presented in black text while its children addresses are rendered in grey. But behind the screen, every register is only 16 bits long. This 64-bit representation of `16.7539` must be broken down into four 16-bit words. To see the actual data in *raw format*, check **Display raw data** on the left side. Next, choose whether to use hexadecimal or decimal representation. Assuming hexadecimal is selected and byte swap option for 64-bit float was set to "no swap", users should see `0x7454` on address 3, `0x9274` on address 4, `0xC0FF` on address 5, and `0x4030` on address 6. Combine these four together in little endian order (because no byte swap), we get `0x4030C0FF92747454` which is exactly the IEEE-754 representation of `16.7539`.



Raw data view is useful to test whether the byte swapping configuration is correct. To verify, compare the hexadecimal displayed on the server interface to the hexadecimal received on your Modbus master software or device. Screenshot above is an example of Modbus master simulator software polling data to GCAS. Data provided by GCAS and data actually received at Modbus master should be the same.

You may notice a steady delay on registers outputting *increasing number* (register source no. 67) or *random number* (register source no. 68). The value received by your Modbus master device is not the one displayed at the server interface window. It seems to be off by one poll interval. The cause is, GCAS serves the existing value to your Modbus master device first, and then generating new value afterwards. When GCAS generates a new value, server interface picks up this new number and updates itself immediately, while your Modbus master device received the value before this one.

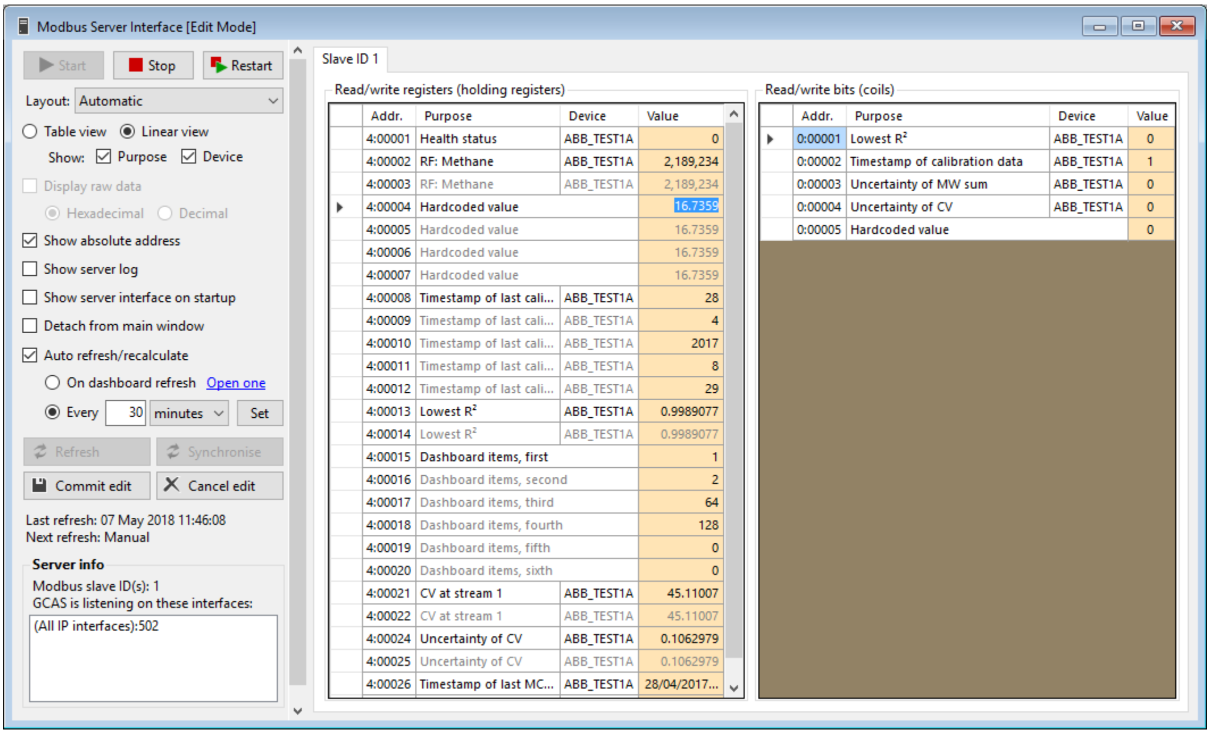
Along with raw data, GCAS can display raw address (absolute address) too. Give a tick mark on **Show absolute address** on the left side of server interface window.



28.6.4 Edit Mode

Edit mode is a way to edit (override) values of Modbus coils and registers. *It is intended to edit registers or coils defined to provide hardcoded values, not to override data coming from GCAS database such as* R^2 *values or ISO 6976 outputs.* While technically you *can* edit register values of data coming from GCAS database, the edited values will again be replaced with real values from GCAS database upon next automatic data refresh.

To enter edit mode, click **Edit values** button. The grids turn orange on cells you can edit, while **Edit values** button morphs into **Commit edit** button. Navigate to the desired cell and hit `F2`. Change the value and press `Enter`. Proceed to edit other cells as required.



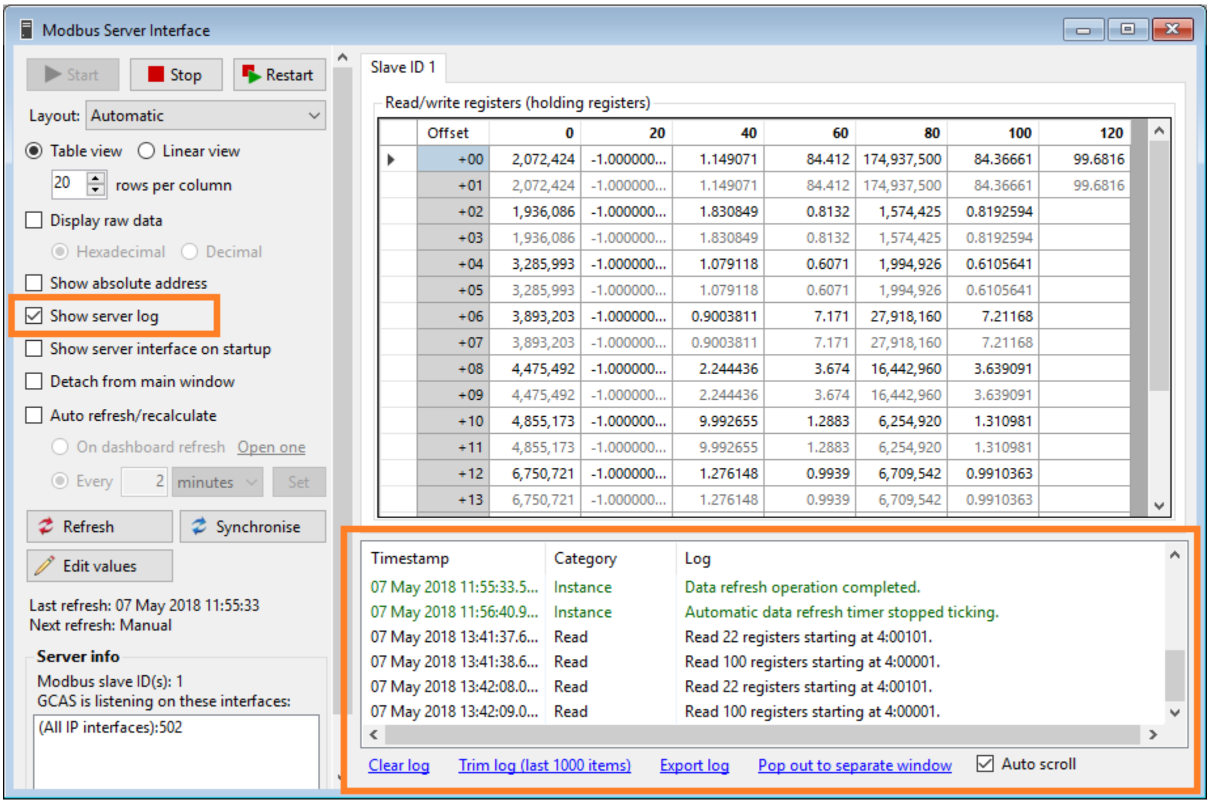
GCAS checks all new values against a standard validation algorithm. For example, if you are editing a date/time value on its 'month' part and you entered 15, this value will be rejected because there is no 15th month on Gregorian calendar. If you try to edit some registers with output values are bound to follow special convention (see chapter 28.5), GCAS checks your edited value against the special convention as well.

Once everything is done, click **Commit edit**. The new values are put inside the corresponding Modbus server instance data table. Next Modbus poll coming from your Modbus master software or device will see these new values immediately. Otherwise to cancel your edit, click **Cancel edit**. Modbus Server Interface reverts all server instances to their original values.

You cannot enter edit mode while the grids are showing raw data because this is dangerous. For example, editing a floating-point in raw may result in invalid binary combination which yields a *Not-a-Number* value (NaN). Modbus Server Interface disables **Display raw data** check box during edit mode.

28.7 Data Provision Log

Data provision log, or simply *server log*, records all activities the server engines and instances do. To access this log, fire up server interface window and check **Show server log**.



The log appears under the data grids. Click **Pop out to separate window** to separate the server log from the server interface window. **Clear log** deletes all log entries. **Trim log** deletes all logs except the latest 1000 entries. And finally **Export log** lets you save the server log to an HTML document.

29 Report

Report is a module to bring what have been presented on GCAS—RF chart, RT chart, correlation, historical data, uncertainty calculation, and so on—to physical papers.

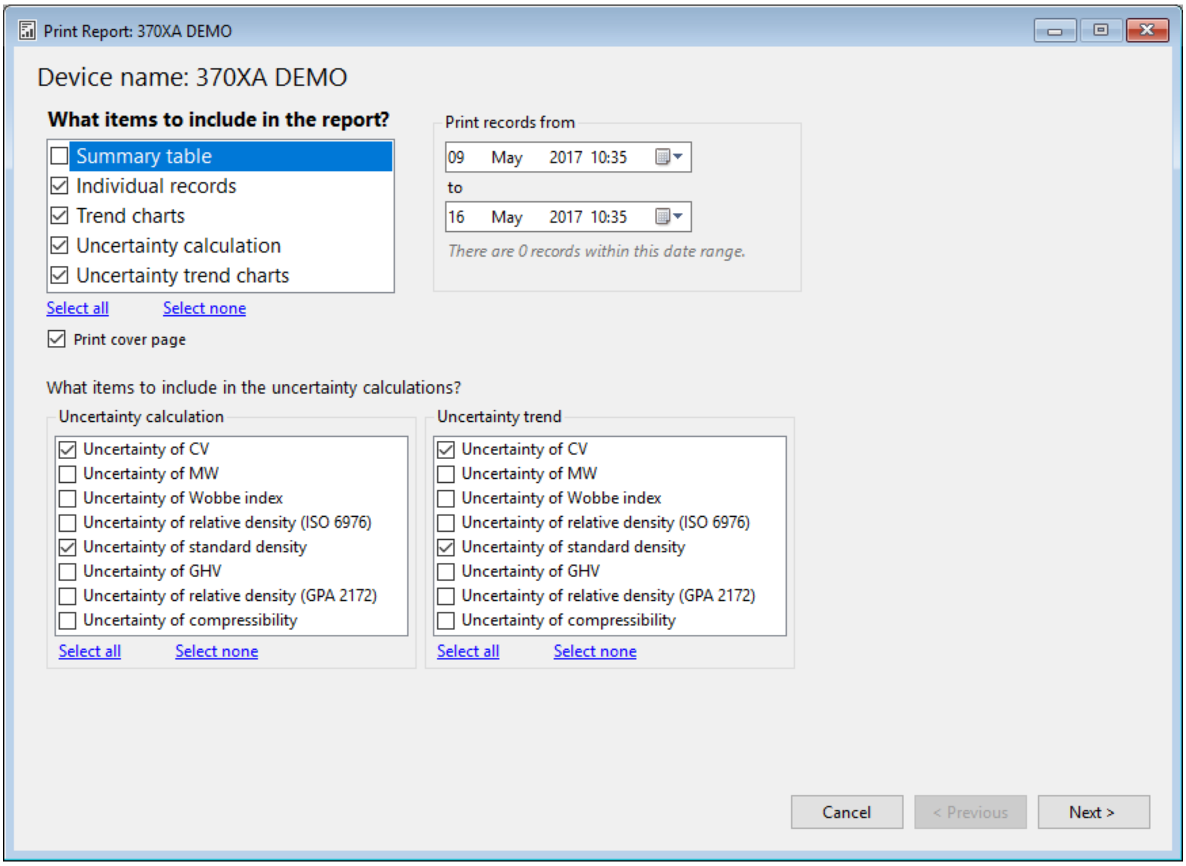
Note

To use this feature, you need the GCAS feature *Simple Report* to be included in your GCAS licence. On top of that, you also need the corresponding GCAS feature to be able to print report items. For example, you need *Data Analysis* to print trend charts.

A simple report typically contains latest calibration data, latest footprint, historical RF trend, RF deviation trend, RT trend, RT deviation trend, and correlation trend. Reports can also include uncertainty calculation and uncertainty trend.

Report Wizard

GCAS report is printed through the *Report Wizard* that is accessible through the **Report** menu on main menu bar. First, select a GC device on your device panel or recent device panel that you want to print. Next, go to the **Report** menu and select **Generate Report**.



The Report wizard.

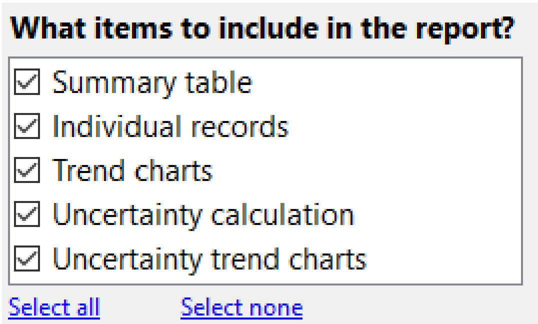
Hardware Requirements

A printer that supports A4 paper. Even better if the printer is not monochrome.

29.1 Overall Options

The first wizard page specifies which items to be included in the printout.

29.1.1 Items to Include



Tick an item in this list to include that report item in the printout. Some items may be missing if you don't have certain GCAS feature in your licence. *Trend charts* require *Data Analysis* feature, *Uncertainty calculation* requires *Uncertainty Calculation* feature, and *Uncertainty trend charts* require *Uncertainty Trend* feature.

- **Summary table**: A list of health status (pass or fail) of the device from every calibration record included in the selected date range.
- **Individual records**: The detailed calibration record including RF chart, RT chart, RF-MW logarithm chart, R^2 values, health status, system diagnostic comments, and user comments.
- **Trend charts**: The historical graph of calibration records of every gas as well as their deviation from the footprint; plus historical correlation values (R^2 trend charts).
- **Uncertainty calculation**: Uncertainty calculation result of the selected ISO 6976 outputs. Your GC device must have an active calibration gas certificate.
- **Uncertainty trend charts**: Graph of uncertainty values over a specified time range. Your GC device must have an active calibration gas certificate as well as an active footprint record.

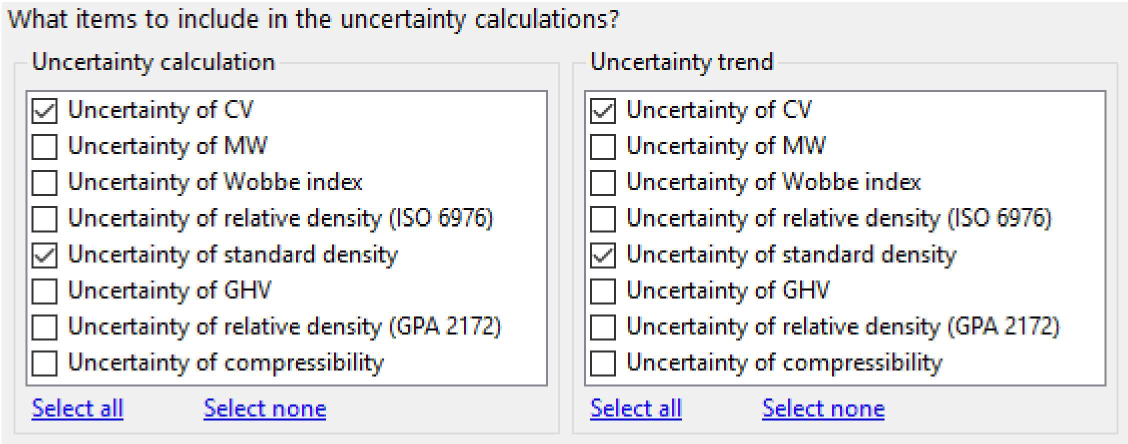
Cover page is optional to print. Check **Print cover page** to include it in the printout.

29.1.2 Uncertainty Results to Include

If you checked **Uncertainty calculation** or **Uncertainty trend charts** in this list box, there are two additional list of check boxes at the bottom of the wizard.

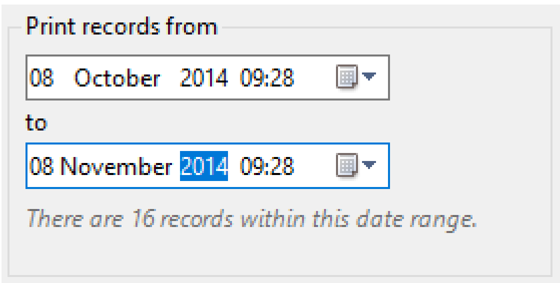
Note

Items shown in these lists depend on the availability of *ISO 6976 Calculator* and *GPA 2172 Calculator* feature in your GCAS licence. Uncertainty of CV, MW, Wobbe index, relative density (ISO 6976), and standard density require *ISO 6976 Calculator*; while uncertainty of GHV, relative density (GPA 2172), and uncertainty of compressibility require *GPA 2172 Calculator*.



These lists specify which uncertainty calculation tables to be included in the printout or which uncertainty trend graphs to print. You can configure items for uncertainty calculation and uncertainty trend independently. By default, GCAS prints uncertainty of calorific value and standard density if *ISO 6976 Calculator* is available; or uncertainty of gross heating value and compressibility if only *GPA 2172 Calculator* is available.

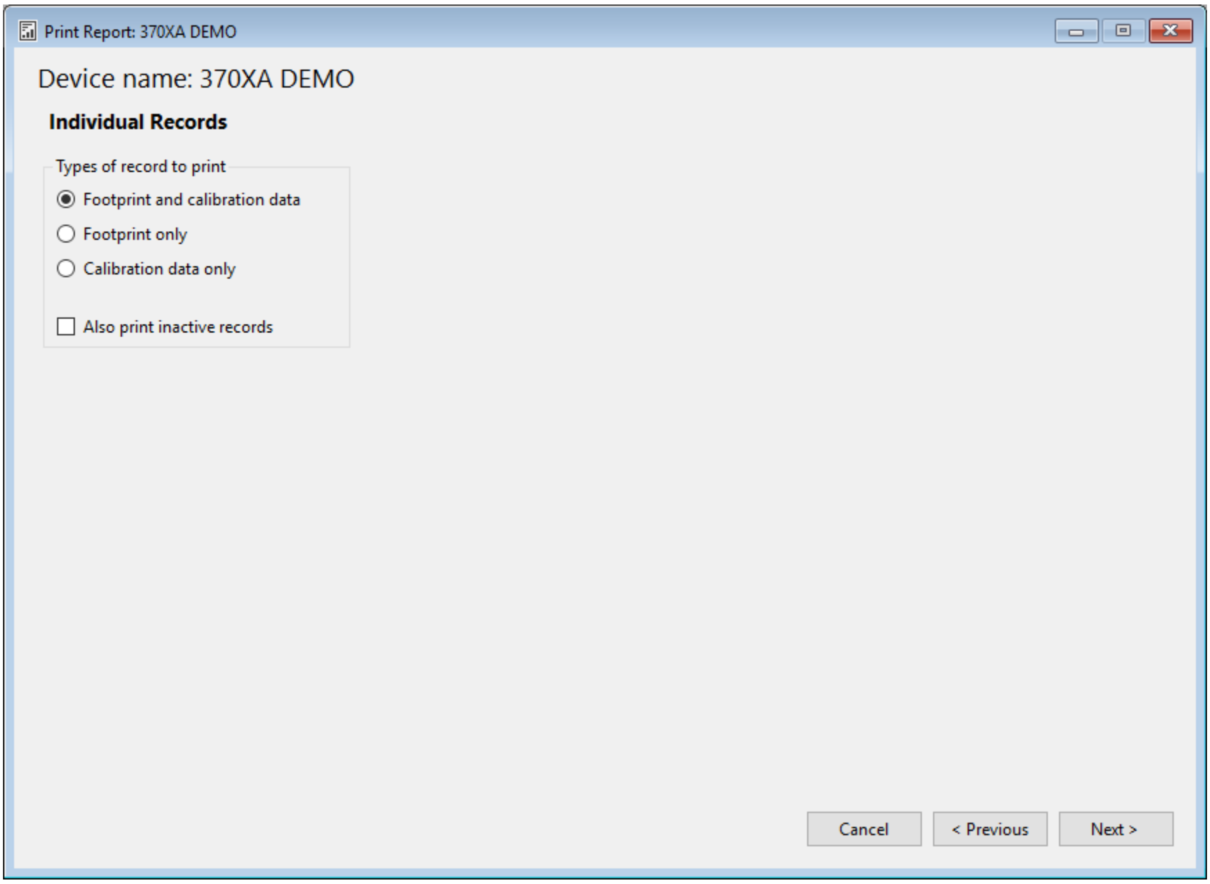
29.1.3 Date Range



These date pickers set the range of calibration records to be included in the summary table, individual record pages, and trend charts. By default, the wizard prints the last 7 days. These date pickers *do not* set the date range to compute uncertainty or uncertainty trend.

GCAS queries GCAS database to find out how many calibration records are there within this date range. The number of records are displayed below the date pickers to give you heads up about how many pages your printer will consume.

29.2 Individual Records

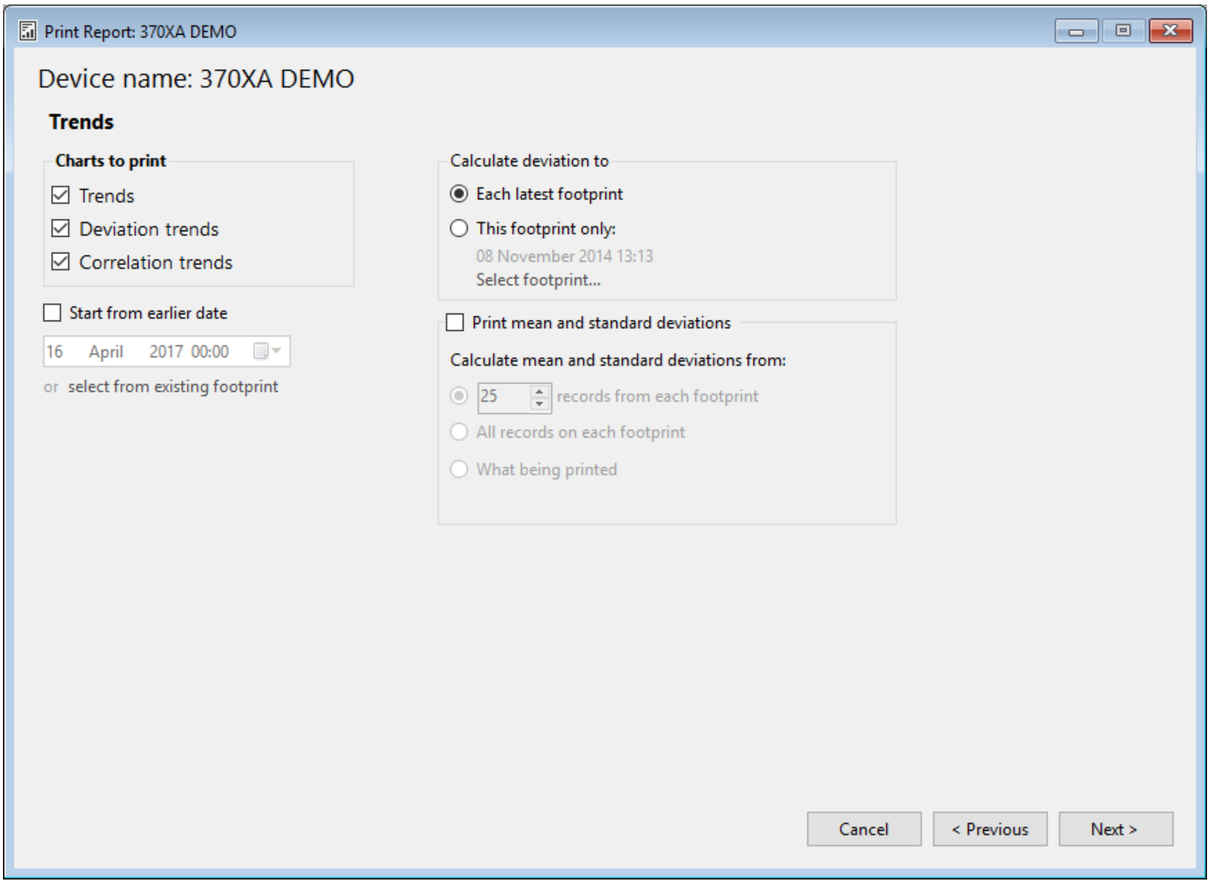


If you ticked **Individual records** on the first wizard page, you should see this page upon clicking **Next**. The options here control which type (i.e. flag) of calibration records to print.

- **Footprint and calibration data**: Include all records within the specified date range.
- **Footprint only**: Skip regular calibration records, print footprints only.
- **Calibration data only**: Skip footprint records, print the rest of calibration data.

Every record consumes one A4 page (or more if there are system comments or user comments). Inactive calibration records are *not* printed unless you tick **Also print inactive records**. If the GC device is configured to utilise multilevel-calibrated RF (ISO 10723), this wizard prints RF values converted to single-point. And at last, for ABB devices, Report wizard prints single-point RF values instead of exponential RF.

29.3 Trend Chart Options



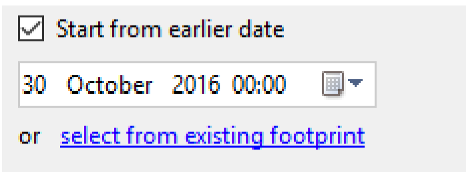
This page contains options for trend charts if you ticked **Trend charts** on the first wizard page. Select which charts to be included in the printout.

- **Trends**: This prints the actual RF and RT values over the specified date range.
- **Deviation trends**: This prints the deviation of RF and RT values from the footprint.
- **Correlation trends**: This prints the historical correlation (R^2) values over time.

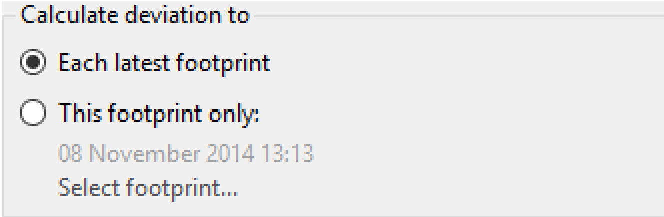
Note

You need the GCAS feature *Data Analysis* in your GCAS licence to print trend charts.

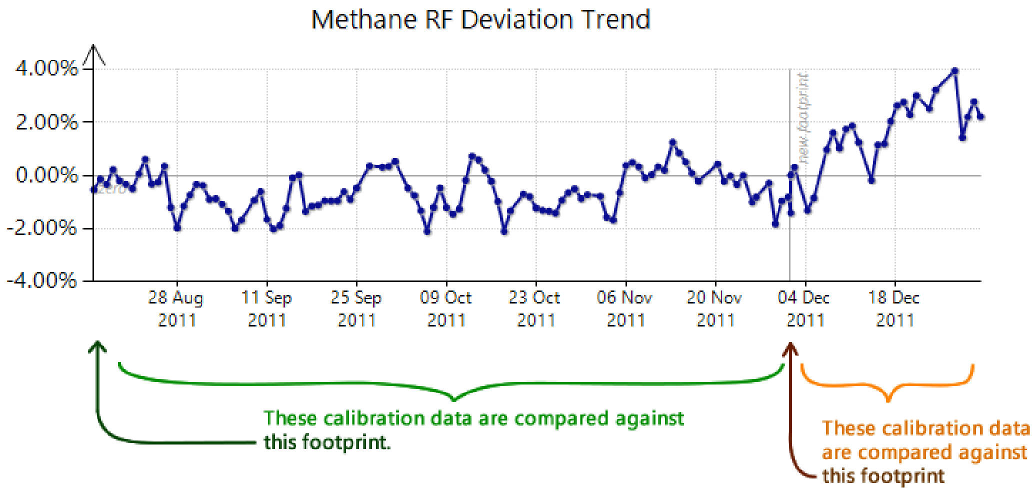
The plot range of trend charts starts and ends at the timestamp specified by date range dropdowns on the first wizard page. To extend this range into earlier time, check **Start from earlier date** check box and specify the starting boundary using the date picker below it. Alternatively, you can use the timestamp of any earlier footprint through **select from existing footprint** link beneath the date picker. That link brings the familiar *Select Record* dialogue to choose the footprint record.



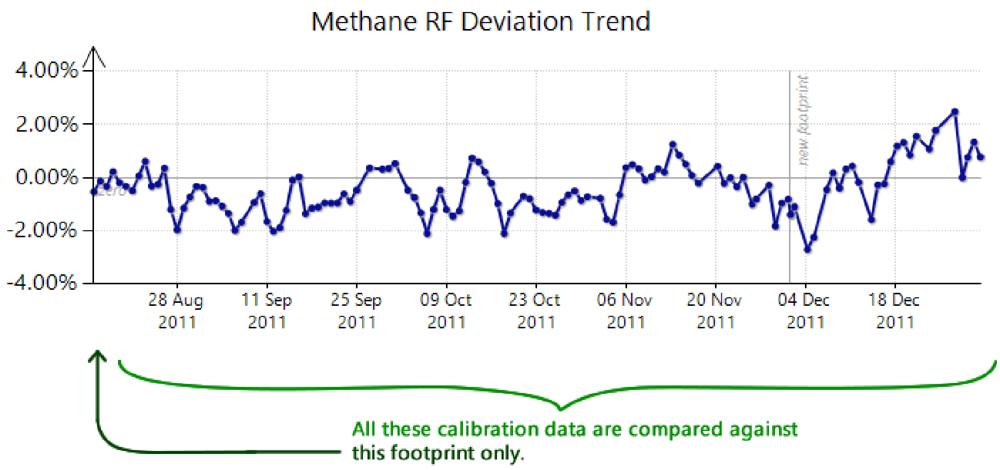
29.3.1 Deviation Reference



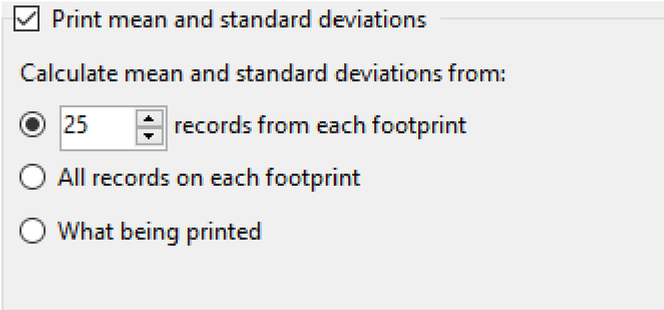
By default, GCAS calculates calibration deviation to each record's latest footprint, similar to the default RF/RT error trend calculation in Data Analysis.



If you need to compare all calibration data in range to a specific footprint, select **This footprint only** to pin one particular footprint as comparison reference. Then, use the link under it to select the desired footprint.

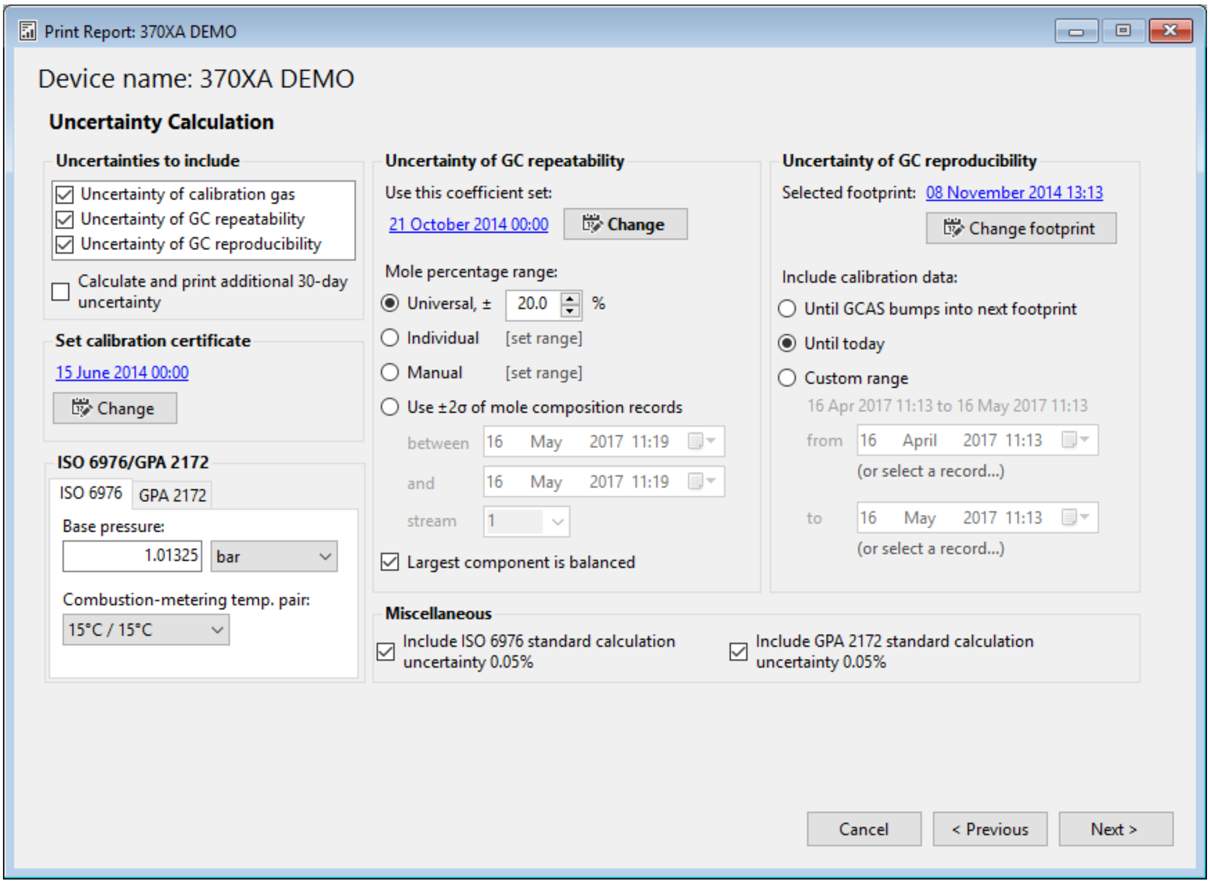


29.3.2 Mean and Standard Deviations



Check **Print mean and standard deviations** to include the mean and standard deviation lines on the printed RF and RT charts, on both trend charts and error trend charts. The options are the same as mean and standard deviation calculation in Data Analysis. Rewind to chapter 10.4 for more information.

29.4 Uncertainty Calculation

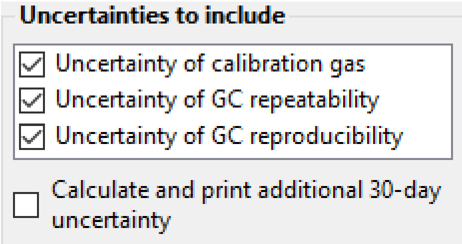


If you ticked **Uncertainty Calculation** on the first wizard page, you shall see this page at some point. In this page, you configure all input parameters for uncertainty calculation to print. For more detail about uncertainty calculation, jump back to chapter 11.

Note

You need the GCAS feature *Uncertainty Calculation* to be included in your GCAS licence in order to print uncertainty calculation tables.

29.4.1 Uncertainties to Include



The list box **Uncertainties to include** controls which part of uncertainty calculation to include. Remember that the uncertainty value of each gas is calculated using this formula

$$U_{GC} = \sqrt{\left(U_{\text{cal gas}}\right)^2 + \left(U_{\text{repeatability}}\right)^2 + \left(U_{\text{reproducibility}}\right)^2}$$

and by unticking one component, the corresponding uncertainty part under the square root is regarded as zero.

The check box **Calculate and print additional 30-day uncertainty** creates another separate uncertainty calculation in which the $U_{\text{reproducibility}}$ component is calculated using a collection of calibration records down to 30 days before the last record. This record range is fixed. The result will be printed in separate tables with distinct titles.

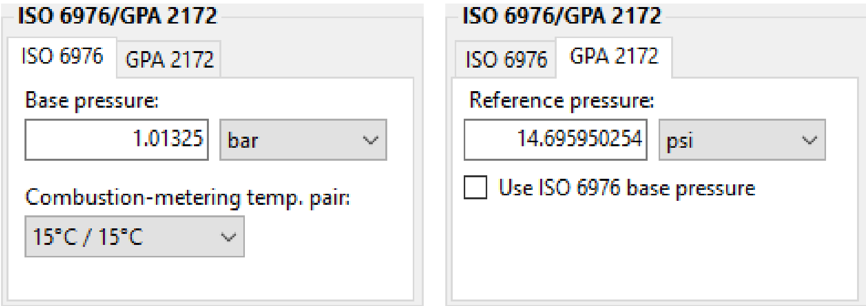
29.4.2 Calibration Certificate

Uncertainty calculation requires a calibration gas certificate. During wizard startup, GCAS loaded the latest certificate for you. To select another certificate, click **Change**. The button brings the familiar *Select Record* dialogue. Pick the certificate from the displayed list or double click the list item.

Note

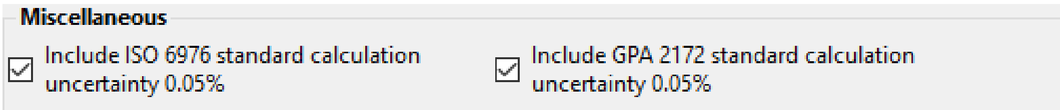
If there are no active calibration gas certificates for this GC device, both **Uncertainty calculation** and **Uncertainty trend** check box and associated options on the first Report wizard page will be disabled.

29.4.3 ISO 6976/GPA 2172 Calculation

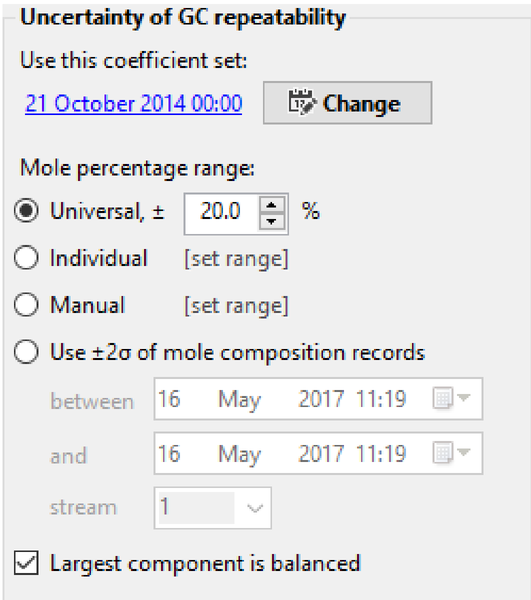


This section has two tabs. *ISO 6976* tab sets the base pressure and combustion-metering temperature pair for ISO 6976 calculation. The default pressure is 1 atmospheric pressure (1.01325 bar) and default combustion-metering temperature pair is 15°C/15°C. *GPA 2172* tab sets the reference pressure for GPA 2172 calculation. Tick **Use ISO 6976 base pressure** if you want to use the same pressure as in *ISO 6976* tab.

Either ISO or GPA standard carries a calculation uncertainty of 0.05% at k = 1. Head to the **Miscellaneous** section and find these check boxes. They control whether the 0.05% uncertainty should be included in the calculation. By default, both check boxes are ticked.



29.4.4 Uncertainty of GC Repeatability

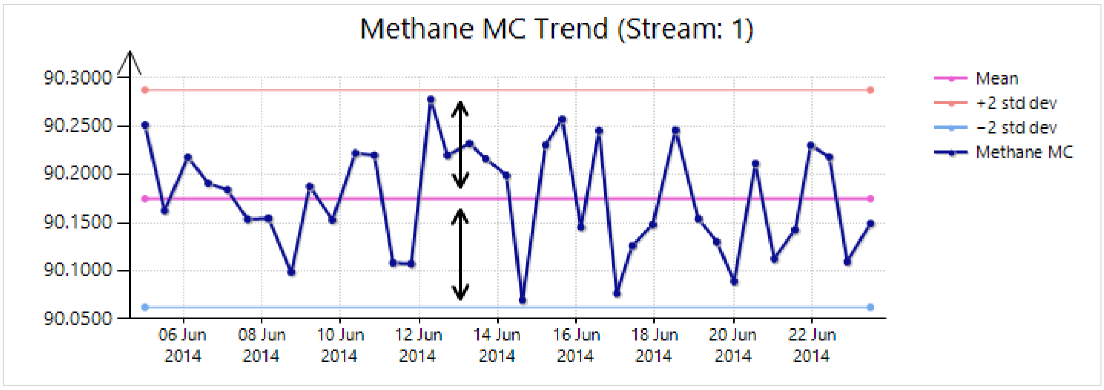


This section specifies all parameters for the calculation of uncertainty of GC repeatability and linearity. The device must have uncertainty coefficients available in GCAS database, otherwise you cannot tick *Uncertainty of GC repeatability* in the first place. If your device does not have uncertainty coefficients yet, use the Uncertainty Coefficients form to input a new set.

GCAS already loaded the last coefficient set before your selected calibration certificate. If you need to use another set, select an uncertainty coefficient set through the **Change** button.

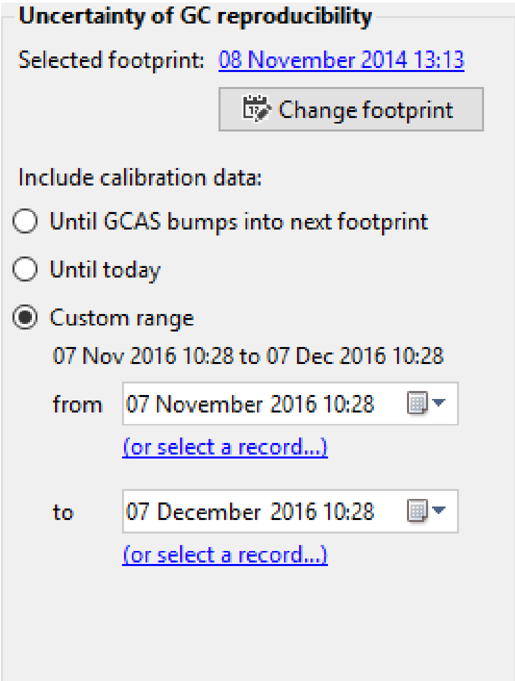
Next, choose one of the mole percentage range options. This mole range will affect the final $U_{repeatability}$ value.

- **Universal**: Every component has the same plus-minus range. The default is ±20%.
- **Individual**: Every component has its own plus-minus range. Click **Set range** to enter these range values.
- **Manual**: Explicitly set the lower and upper bound value of each component. Click **Set range** to enter the lower and upper bound. For comparison purpose, the initial mole composition from the selected calibration gas certificate is displayed in the second column.
- **Use ±2σ of mole composition records**: The range is taken from twice standard deviations of mole composition records over the specified period of time, filtered to the specified stream number; as illustrated in this chart:



The **Largest component is balanced** check box controls whether to treat the component having the largest percentage as *balanced gas*. It means the mole percentage value of said gas is replaced by 100% minus the sum of all other components. This option is ignored if you chose **Manual** mole range.

29.4.5 Uncertainty of GC Reproducibility



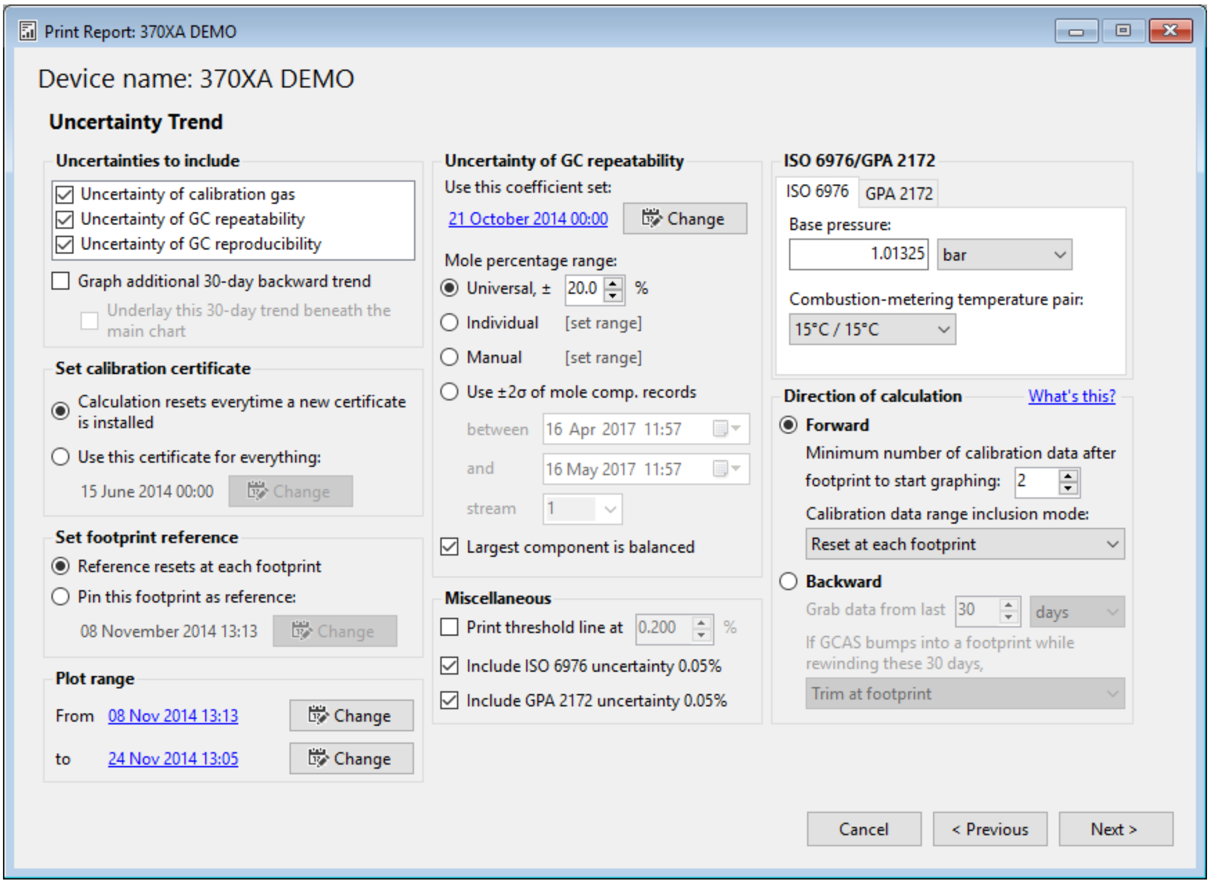
This section configures the required parameters for the calculation of uncertainty of GC reproducibility. First, select the footprint as starting reference. GCAS already loaded the latest footprint for you. If you want to start from another footprint, click **Change footprint**.

> **Note**
>
> It is not recommended to select a footprint that sits before the selected calibration certificate.

Next, decide how many calibration data to include in the calculation.

- **Until GCAS bumps into next footprint**: The selected footprint itself and all calibration data up to one last calibration before next footprint are included in the calculation of $U_{reproducibility}$.
- **Until today**: The selected footprint itself and all calibration data *including subsequent footprints and all their calibration data afterwards*, all the way to this very moment (i.e. current computer time) are included in the calculation of $U_{reproducibility}$.
- **Custom range**: You can define arbitrary date range, or choose from which calibration record exactly to which calibration record that are included in the calculation of $U_{reproducibility}$. A star symbol indicates a footprint.

29.5 Uncertainty Trend Charts



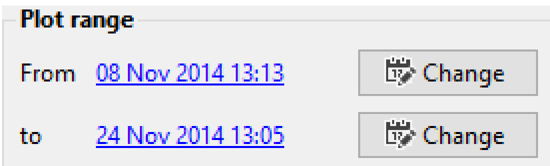
If you ticked **Uncertainty trend charts** on the first wizard page, you should see this page before the wizard begin printing. This page configures all parameters for uncertainty trend chart generation. Most elements are similar to Uncertainty Trend form and the uncertainty calculation page of this wizard. This chapter explains only the UI elements that differ. If you need help for other UI elements not explained in this chapter, refer to chapter 13 Uncertainty trend as they are very similar.

Note

To print uncertainty trend charts, you need the GCAS feature *Uncertainty Trend* to be included in your GCAS licence.

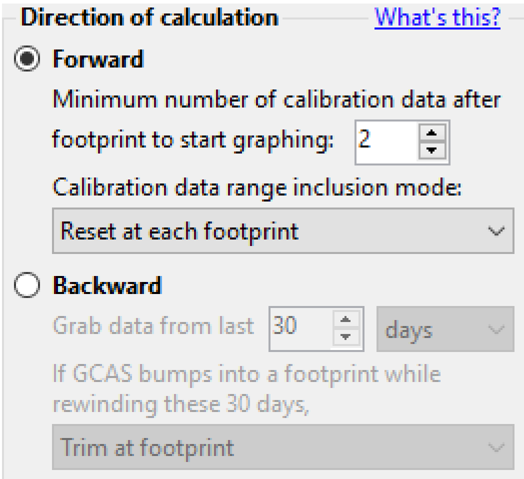
If no active calibration gas certificate is available for the device, you cannot tick **Uncertainty trend charts** on the first wizard page.

29.5.1 Plot Range



Unlike the Uncertainty Trend form that uses date pickers, Report wizard requires you to specify the first and last record in order to define the plot range. Click **Change** button on either side to set the start and end record boundary of the plot range. A star symbol on the subsequent *Select Record* dialogue indicates a footprint.

29.5.2 Direction of Calculation

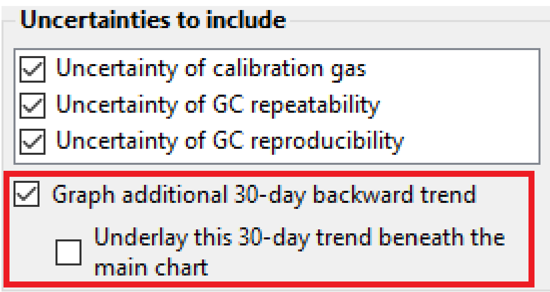


Direction of calculation determines which calibration record to include in the calculation. Uncertainty calculation may go *forward* or *backward*. Consult chapter 13.2.6 Uncertainty trend direction for more detailed information. The HTML version of GCAS manual guide also includes some animations to help.

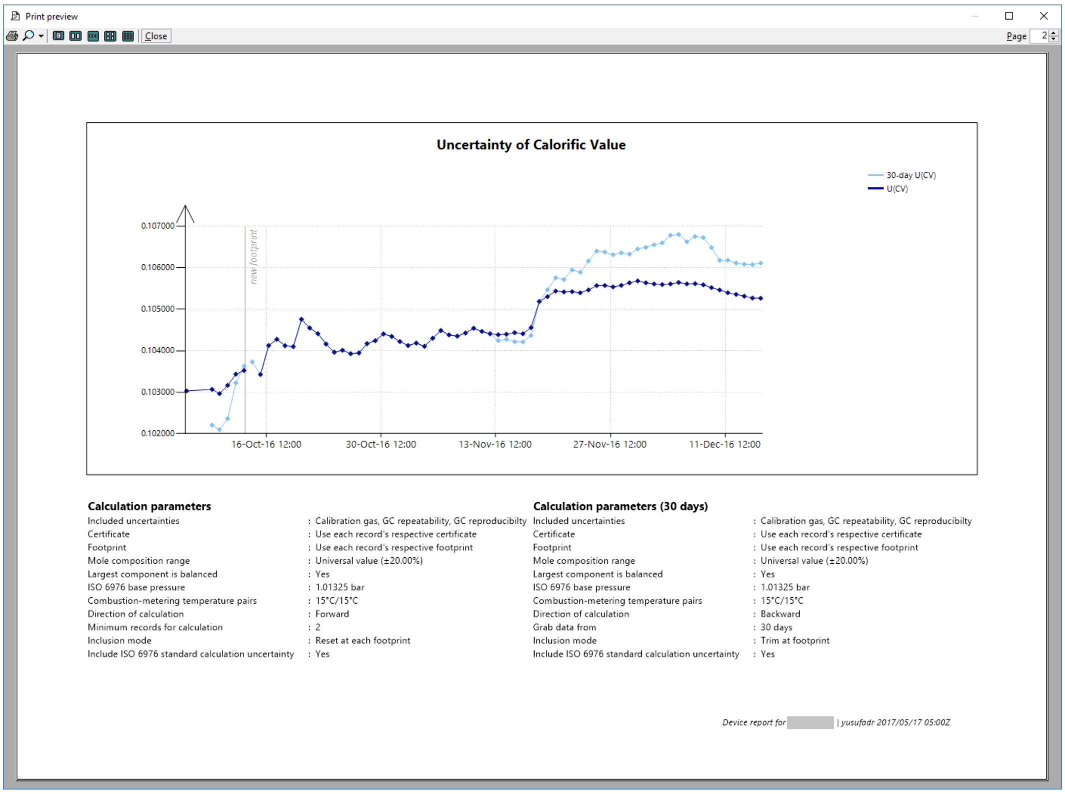
To recap, **forward direction** means the trend starts at a footprint and heads forward, including more and more calibration records as time goes by. There is a minimum number of calibration records for the Report wizard to start graphing the uncertainty trend graph. You can also set whether the trend line resets at every footprint record found along the way, or keep going.

Backward direction means for every calibration record *C* found in the plot range, the uncertainty is calculated from *C* minus *x* days to *C*, or *C* going *x* records backward then back to *C*. You can configure whether the backward travel stops if a footprint is encountered, or continues through.

29.5.3 30-Day Uncertainty Trend



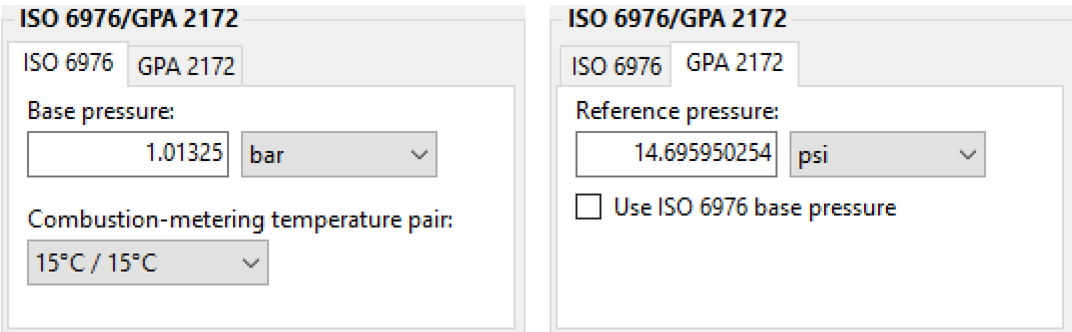
The **Graph additional 30-day backward trend** check box creates additional uncertainty trend calculation with predefined configuration: Backward direction of 30 days and trim at any footprint encountered. If **Underlay this 30-day trend beneath the main chart** is also checked, the additional trend line will be plotted in the same chart as the original uncertainty trend chart, with the original uncertainty trend line is overlaid on top of the 30-day trend line. Otherwise, GCAS prints a separate chart for the additional trend chart.



Example of 30-day backward trend (light blue) underlaid beneath the main uncertainty trend in forward direction (dark blue).

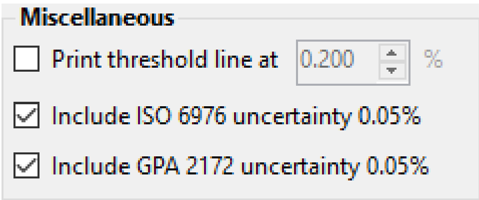
29.5.4 ISO 6976/GPA 2172 Calculation

This section looks different from what appeared in Uncertainty Trend form. Here, the Report Wizard separate the inputs into two tabs similar to the options for uncertainty calculation printout.



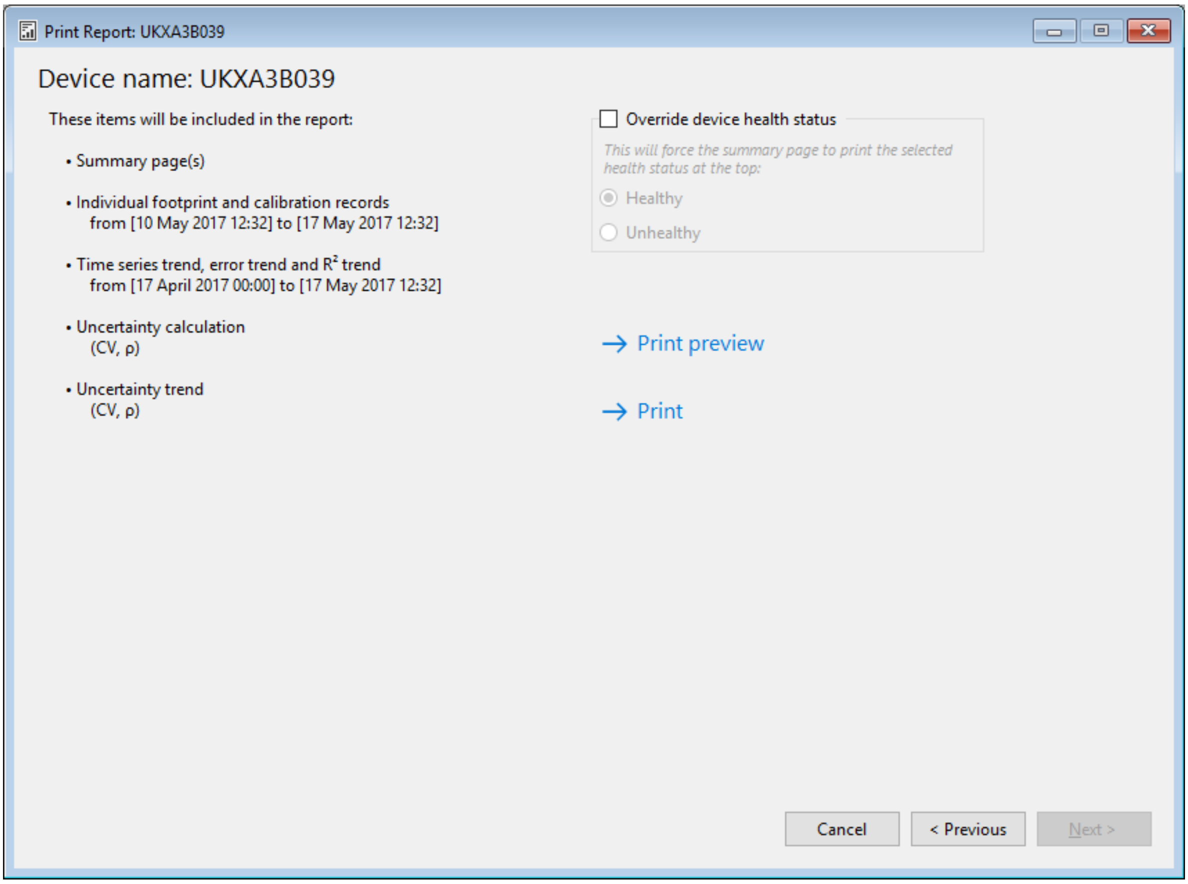
The *ISO 6976* tab configures the base pressure and combustion-metering temperature pair for ISO 6976 calculation. The *GPA 2172* tab configures the reference pressure for GPA 2172 calculation with the default to 14.6959 psi (about 1 atm). Tick **Use ISO base pressure** to use the same pressure on both ISO 6976 and GPA 2172 calculation.

Both ISO 6976 and GPA 2172 carry a standard measurement error of 0.05% at k = 1. Navigate to the **Miscellaneous** section and locate two check boxes that control whether these 0.05% uncertainties should be included in the calculation. By default, these two check boxes are ticked.



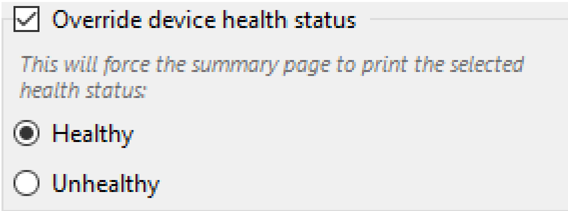
29.6 Print Confirmation

This is the last page of the Report wizard. The wizard lists what items to print so that you can review and go back if there are mistakes.



If you opted to print **Summary page**, the summary page has the overall pass/fail status printed at the top of the page. This pass or fail status is solely determined by the correlation values (R^2) of the last calibration record in the given date range. For devices without correlation values such as Siemens GCs and BTEX devices, this pass or fail status is governed by whether the last calibration record occurs within 30 days *before the report is printed*, not by the end date of the date range.

For any reason, you can override the pass/fail status of the summary page by ticking **Override device health status** and choose the desired status. We recommend inserting some pages manually, either from other printout or handwritten ones, explaining the reason and recommendation.



When you are ready, click **Print preview** to get a preview or **Print** to send the report to the printer.

30 Batch Report

Batch Report module enables you to generate report for multiple devices at once. It is like the Report wizard looped for many GC devices on one click.

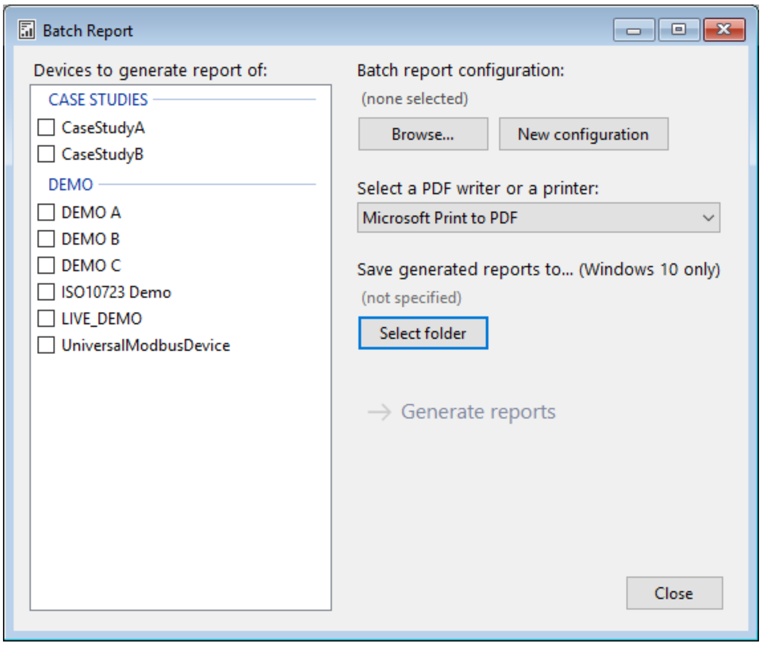
Note

To use this feature, you need the GCAS feature *Simple Report* to be included in your GCAS licence. This is the same requirement as the original Report module. On top of that, you also need the corresponding GCAS feature to be able to print report items. For example, you need *Data Analysis* to print trend charts.

Batch Report module consists of two parts: the thing called *batch report configuration* and the *Batch Report form* itself. Batch report "configuration" stores all settings to generate a particular batch report; thus, you can have multiple configurations such as "monthly report", "weekly report", or "last 90-day report". One batch report configuration is stored as one XML file and this XML can be loaded anytime you need. On the other hand, the *Batch Report form* is the dialogue to select which GC devices to have reports generated, which batch report configuration to use, and which printer to use.

30.1 The *Batch Report* Form

Batch Report form is the main user interface of Batch Report module. To access this form, go to the Report menu on main menu bar and select **Generate Batch Report**.



Devices to generate report of: This is a list of your GC devices. Tick the ones you want to include in the batch queue.

Batch report configuration: This lets you select which batch report configuration set to use. Click **Browse** to load a batch report configuration XML file; or click **New configuration** to create a new batch report configuration set. Clicking **New configuration** will bring the *Batch Report Configuration* form.

Select a PDF writer or a printer: This dropdown lists available printers to output the generated report. There are three kinds of printers in this list, each with different behaviour.

1. **Hardware printers**
   All of your hardware (physical) printers should be on this list. Hardware printers simply print the report pages sequentially. One GC device report becomes one print job. You can see these print jobs in the printer queue on Windows control panel. If you are on Windows 7 or 8, using a hardware printer is recommended.
2. **Third-party PDF printers or other virtual printers**
   These "printers" generate files such as PDF or XPS document instead of physical papers. Some popular third-party options are CutePDF writer or Foxit PDF creator. The problem with most virtual printers is that they display a save dialogue before they write the file. As one device report becomes one print job, you will see multiple save dialogues popping up one after another. We do not recommend using this type of printer.
3. **Microsoft Print to PDF** (Windows 10 only)
   Technically, Microsoft Print to PDF is still a virtual printer. But we can configure this virtual printer to output the PDF files to one folder and skip the save dialogues, thus no user intervention is required at all. When you select this printer, the *Batch Report* form displays an additional button called **Select folder** to choose where the PDF files will go to. Unfortunately, Microsoft Print to PDF is shipped with Windows 10 (or later) therefore Windows 7 and 8.1 users are out of luck. If you are using Windows 10, this is the most recommended printer to use.

To configure the paper size, margins, and orientation, go to the File menu on main menu bar and select **Page Setup**.

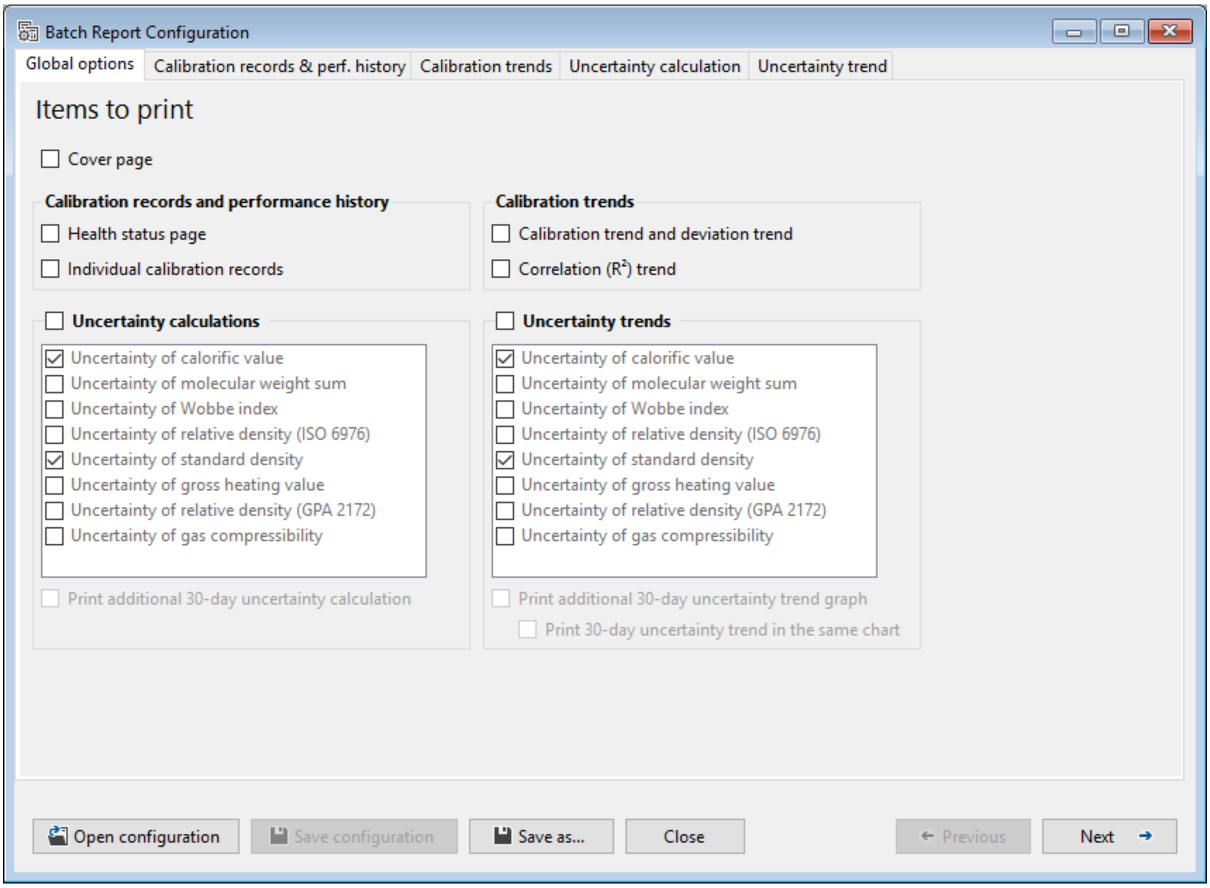
When you are ready, click the big button **Generate reports** down there. Batch Report module should start retrieving the required data from GCAS database and begin printing shortly thereafter. Note that depending on how big the data and how large the time range set in the batch report configuration, one GC device may produce hundreds of pages. If you are using a real physical printer, we recommend setting either duplex printing to save paper or draft quality print to save ink. Set these as the default printer settings because GCAS does not show any additional Print dialogue.

30.2 Batch Report Configuration

Batch report configuration stores all settings to generate one report, then the same settings are reapplied to the remaining GC devices in the batch queue. Imagine the regular Report wizard being saved as a profile and you can use the same profile on multiple devices. In practice, one batch report configuration is stored as one XML file. This makes it possible to have multiple configurations such as "monthly report", "weekly report", or "last 90-day report". Make sure to load the correct XML file on Batch Report form before you click **Generate report** button.

To create or edit a batch report configuration, use the *Batch Report Configuration* form. Use the Report menu on main menu bar, then select **Batch Report Configuration**.

30.2.1 The *Batch Report Configuration* Form



The form is organised in five tabs. They are:

1. **Global options**
   Determines what will be included in the report, which uncertainty calculation or trend to be printed, and whether 30-day uncertainty calculation or trend is included.
2. **Calibration records and performance history**
   Configures options if you include individual calibration records and performance history (the summary table with pass/fail status on each row) in the printout.
3. **Calibration trends**
   Configures options for RF/RT trend chart, RF/RT error trend chart, and R^2 chart.
4. **Uncertainty calculation**
   Configures options for uncertainty calculation.
5. **Uncertainty trend**
   Configures options for uncertainty trend calculation and the plot range.

To navigate between tabs, either click the tab header or use the **Previous**/**Next** button at the bottom-right corner.

30.2.2 Specifying Time Range

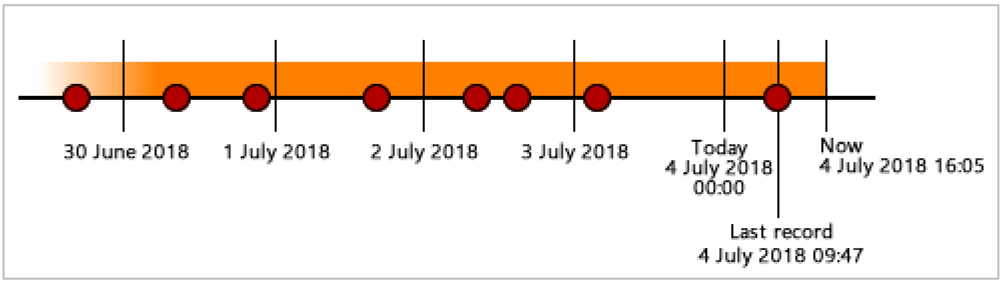
Batch Report module introduces a new method to specify start time and end time of a range, be it a range of individual calibration records, a range for calibration (RF/RT) trend, a range for correlation trend, a range for uncertainty trend calculation, or anything related. Why? Because it's all relative. We are talking about multiple GC devices to generate report of, each one has different calibration record dates, different footprint dates, and different certificate installation dates. Hence, we cannot simply set a start and end date and hope all GC devices in this batch report to have the same number of records in this fixed range—we can, actually, but that provides little use. In Batch Report module, start and end point are specified either as relative unit to footprint, as relative unit to a date/time point, or as fixed date/time values.

30.2.2.1 End point

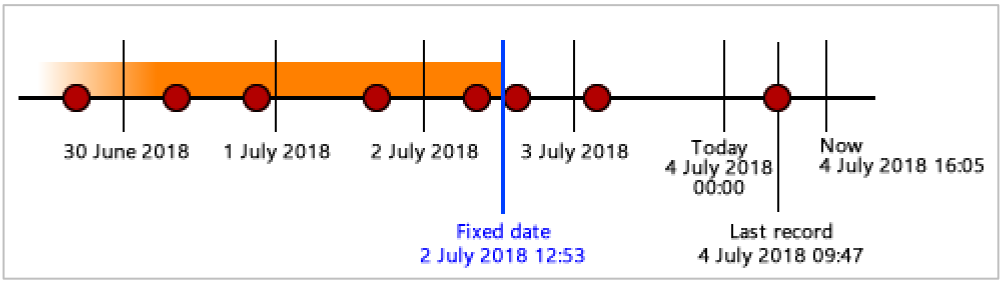
Typically, human brains expect a range definition from a *start* to an *end*, not the other way around. Unfortunately, the internals of Batch Report module work in backward. It asks you to specify an end point of a range, and later on, asks for a start point relative to this end point. The UI still shows start and end date input picker in the correct order to make it easier for you.

There are 7 types of end point specifier available:

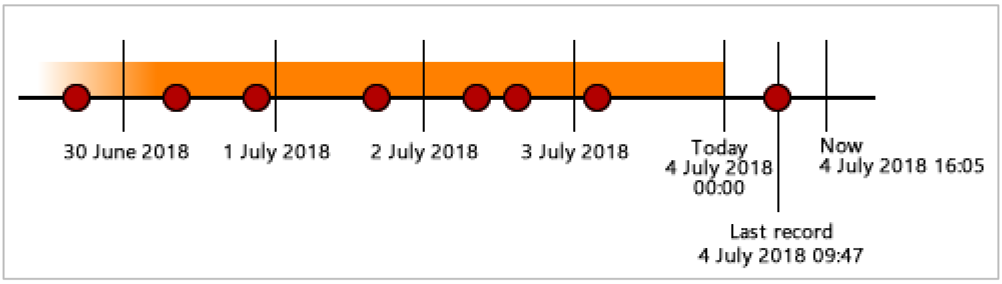
1. **Now**: The range ends at current computer time.



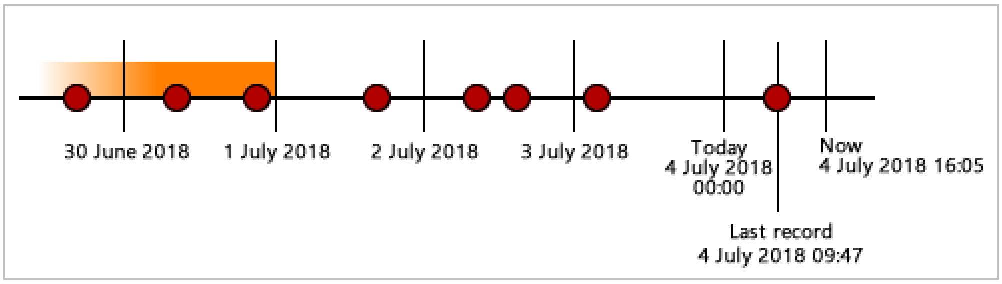
2. **Fixed date**: The range ends at the specific date and time you enter.



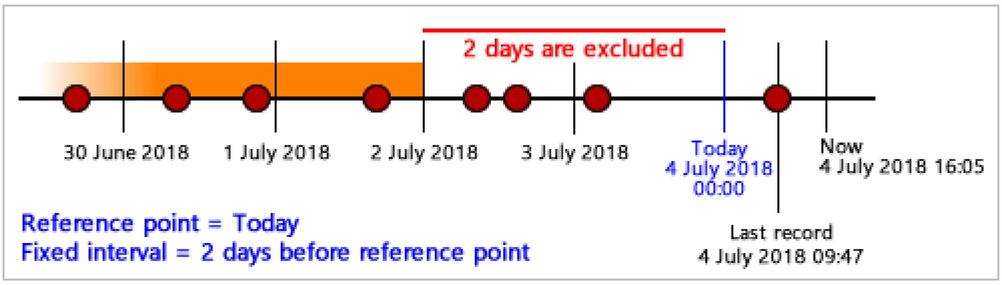
3. **Today**: The range ends at today 00:00 midnight.



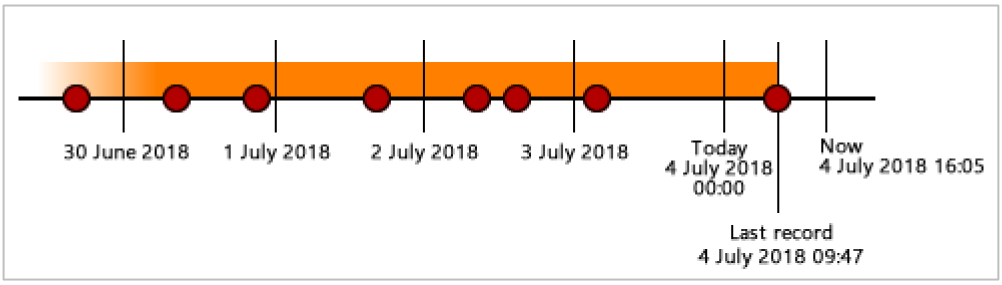
4. **Last day of previous month**: The range ends on 28th, 29th, 30th, or 31st of the previous month, depending on what month it was.



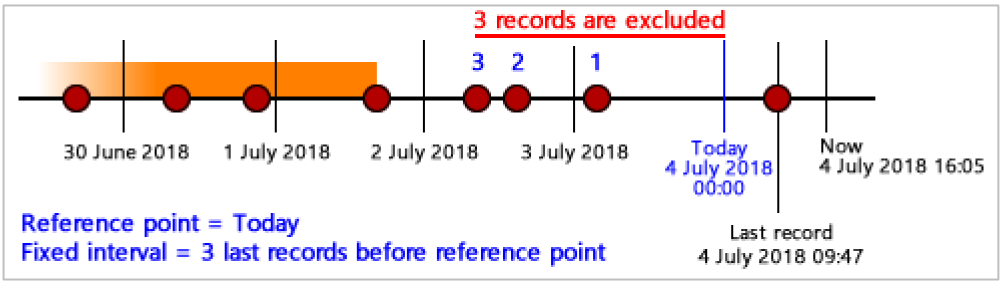
5. **Fixed interval**: The range ends on *x* days before another reference point.



6. **Last record**: The range ends at the last record of each GC device.



7. ***n* last records**: The range ends at (n − 1)th latest record before another reference point.



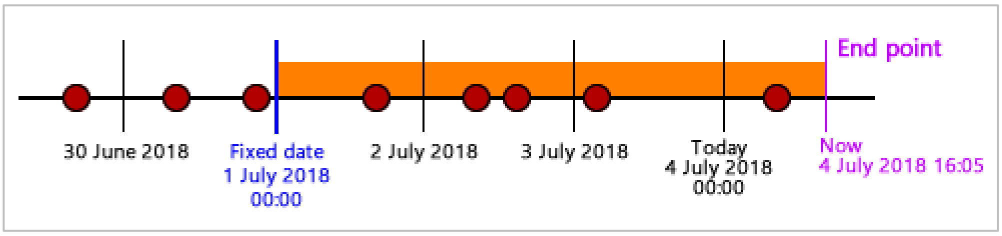
Option 5 and 7 require another *reference point*. There are 4 types of reference point:

1. **Now**: Current computer time.
2. **Today**: This day at 00:00 midnight.
3. **Last day of previous month**: Refers to the 28th, 29th, 30th, or 31st of the previous month, depending on what month it was.
4. **Fixed date**: A custom date/time point.

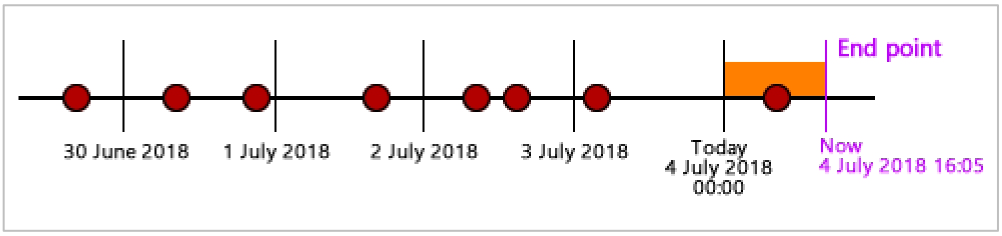
30.2.2.2 Start Point

Start point is defined as a relative time or relative record count before the end point, except for "Fixed date" and "Today". There are 5 types of start point specifier available:

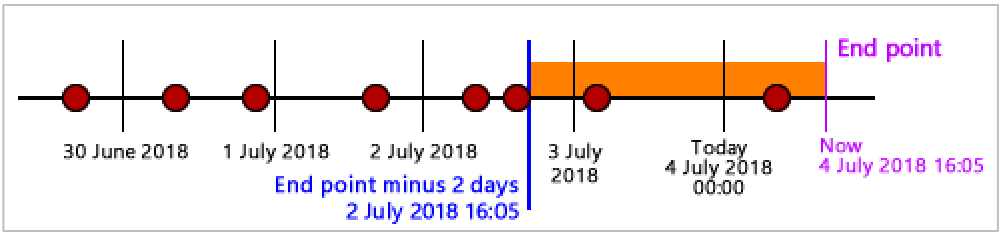
1. **Fixed date**: The range begins at the specific date and time you enter.



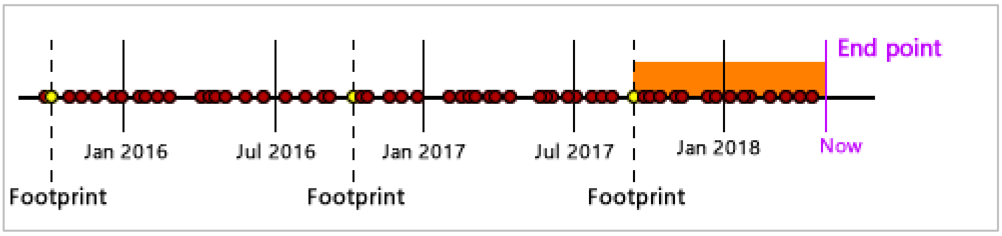
2. **Today**: The range begins at today 00:00 midnight.



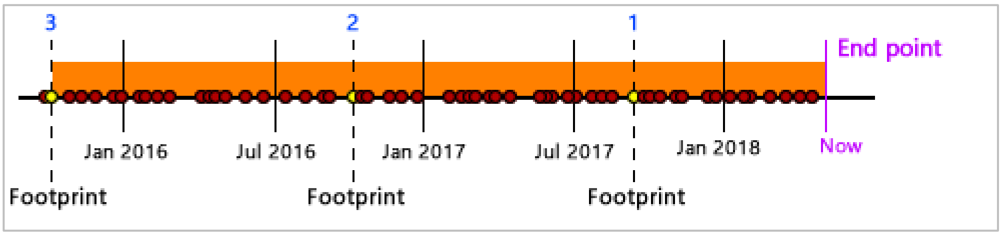
3. **Fixed interval**: The range begins on *x* days before the end point.



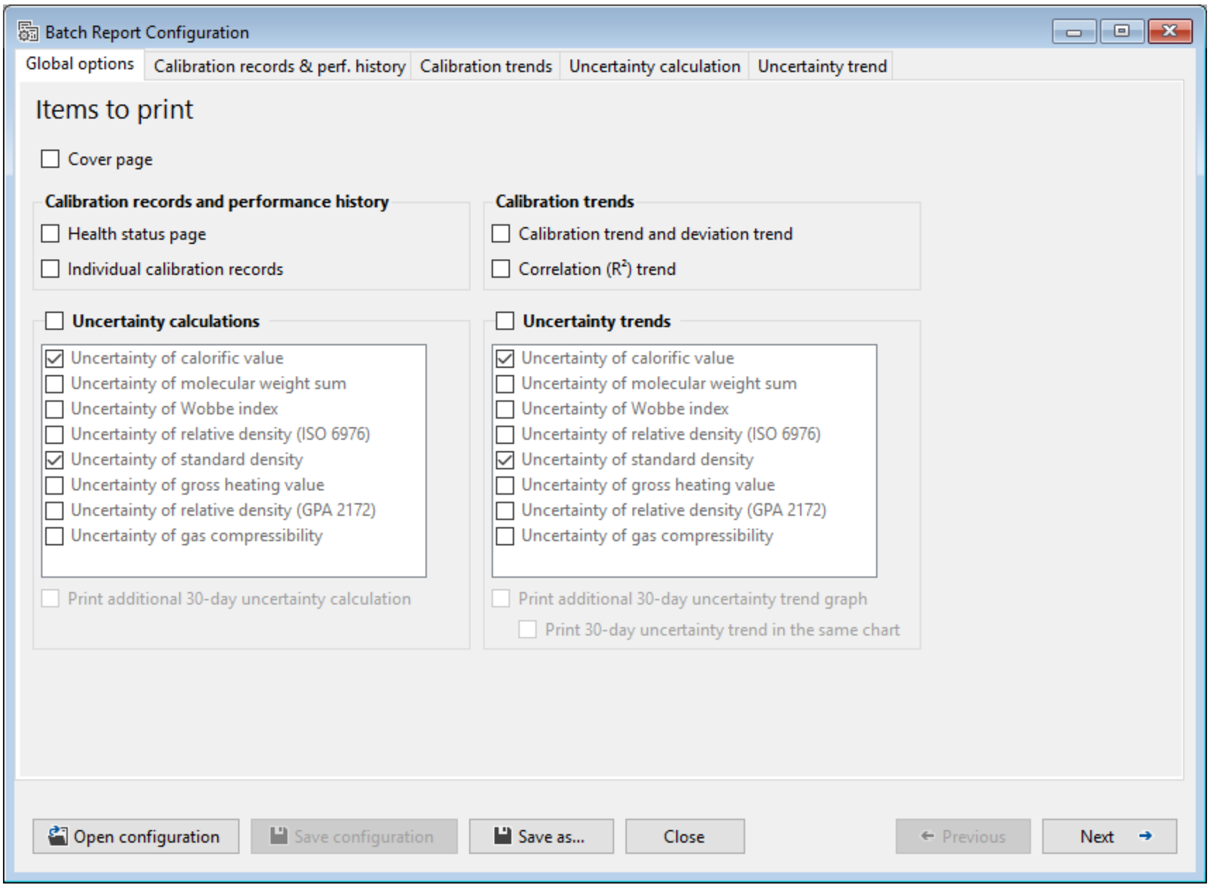
4. **Nearest footprint**: The range begins on the latest footprint before the end point.



5. ***n* last footprints**: The range begins on the *n*-th latest footprints before the end point. The diagram below shows example of 3 last footprints.



30.2.3 *Global Options* Tab



In this tab, you choose which parts to include in the report. Each part is represented as a check box, and they have additional settings in different tab.

Cover page: Check to include cover page in the report. It has the device name, user name who creates the report, and creation date. Each GC device in the batch queue has its own cover page.

Calibration records and performance history:

- **Health status page** holds a summary of performance history, listing all calibration dates in the selected range and their pass/fail status. This is the same as the summary page on regular Report wizard.

- **Individual calibration records**: This prints the RF chart, RT chart, correlation charts, and user comments on each calibration record found in the defined range.

Calibration trends:

- **Calibration trend and deviation trend**: This prints the RF/RT values over time as well as RF/RT deviations from footprints over time.
- **Correlation (R^2) trend**: This prints the R^2 values chronologically.

Uncertainty calculation:

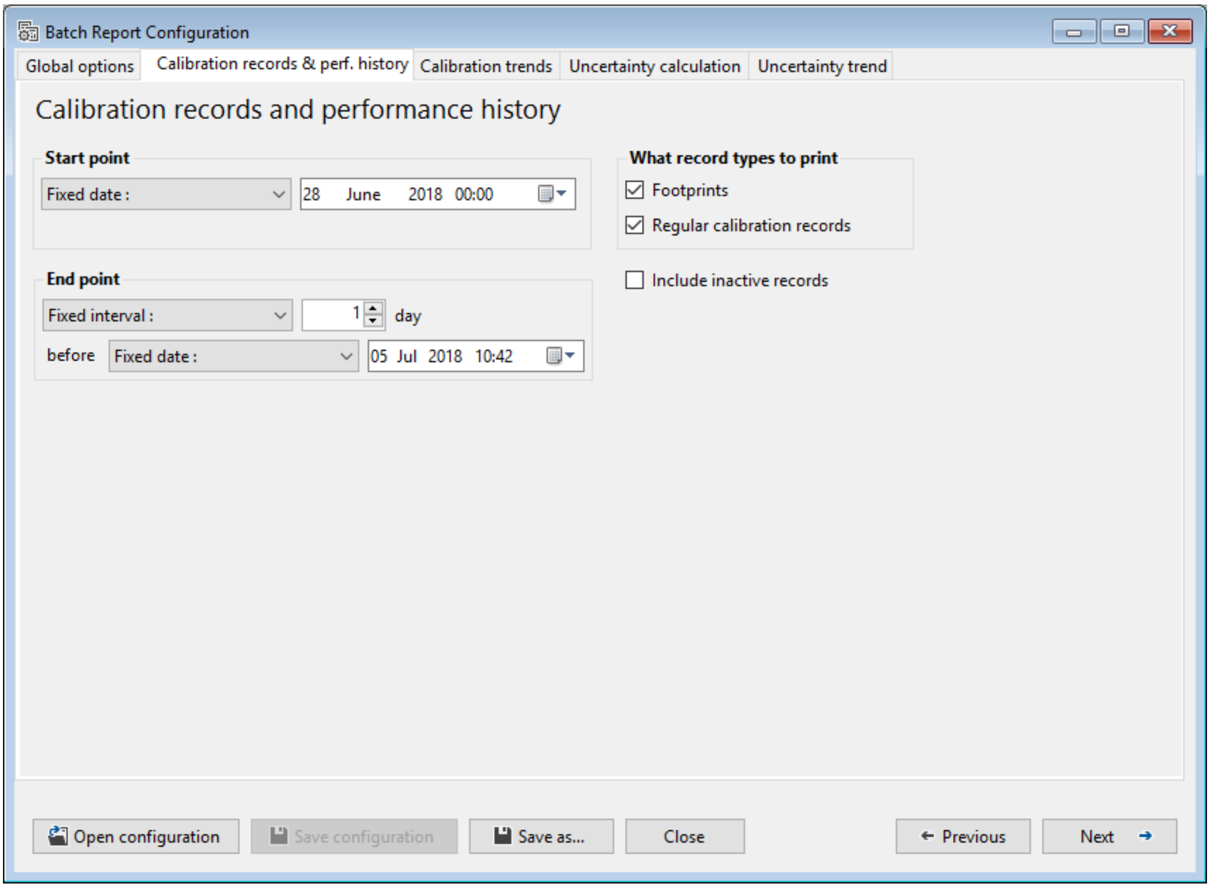
- Uncertainty results to print: Choose which ISO 6976 or GPA 2172 uncertainties to print. By default, uncertainty of CV and standard density are ticked.
- **Print additional 30-day uncertainty calculation**: This prints an extra uncertainty calculation result with $U_{reproducibility}$ calculated from today minus 30 days.

Uncertainty trend:

- Uncertainty results to print: Choose which ISO 6976 or GPA 2172 uncertainty trends to print.
- **Print additional 30-day uncertainty trend graph**: This prints an extra uncertainty trend graph with $U_{reproducibility}$ calculated from today minus 30 days.
- **Print 30-day uncertainty trend in the same chart**: If this is checked, the 30-day uncertainty lines would be printed under the main uncertainty trend lines. Otherwise, the 30-day uncertainty chart would be printed separately.

30.2.4 *Calibration Records and Performance History* Tab

This tab is relevant if you ticked either check boxes under *Calibration records and performance history* section in *Global options* tab.



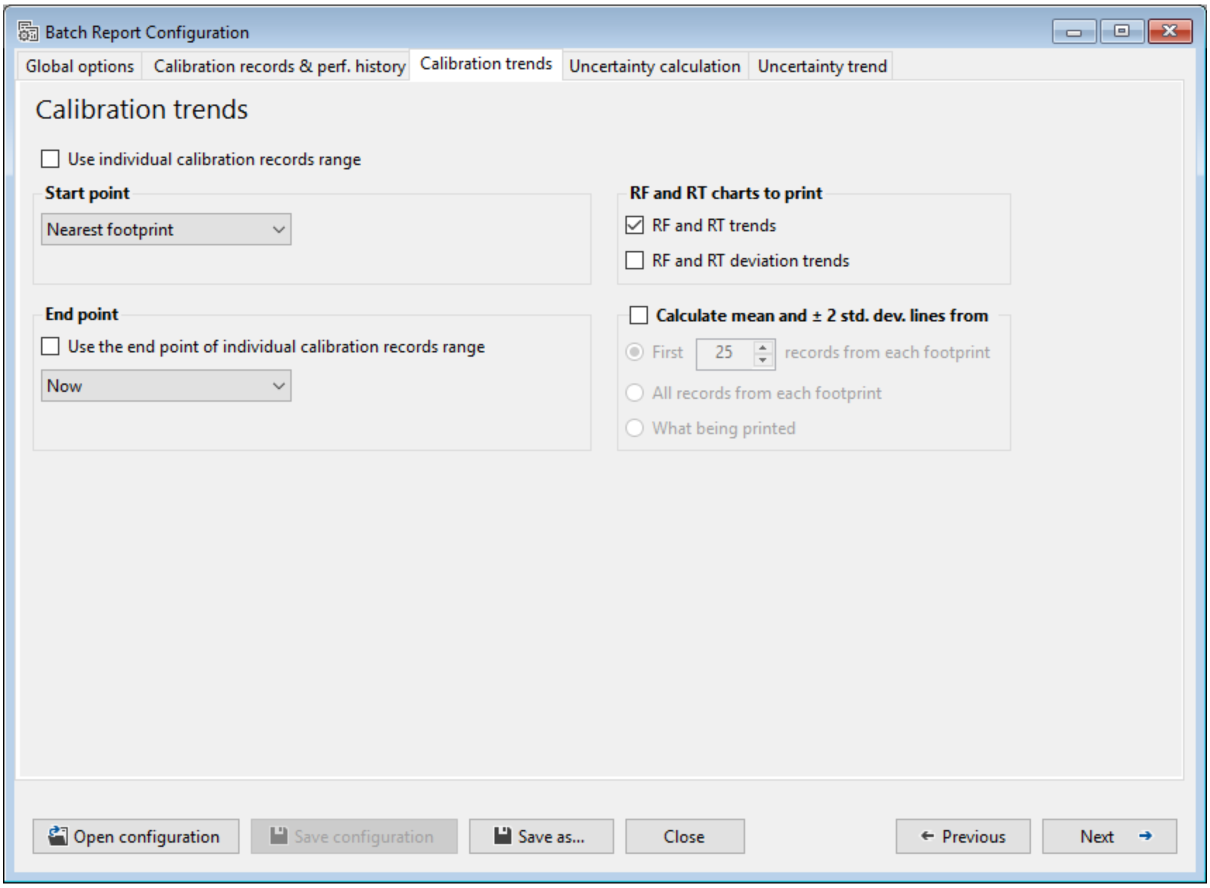
Start point, End point: These inputs configure the range of calibration records to grab from GCAS database. Refer to chapter 30.2.2 Specifying time range for more information about record range options.

What record types to print: Tick whether to print calibration data only or with footprints included. If you tick neither of these two, GCAS assumes you tick both.

Include inactive records: Tick this to include calibration records marked as inactive. If you don't, inactive records are not printed in both summary table and individual RF/RT/R^2 chart pages.

30.2.5 *Calibration Trends* Tab

This tab configures more options for RF and RT trend, if you include them under *Calibration trends* section in Global options tab.



Start point, End point: These inputs configure the range of calibration records to grab from GCAS database. Refer to chapter 30.2.2 Specifying time range for more information about record range options.

Use individual calibration records range: If this is ticked, the range to generate RF/RT trend chart copies the one defined in the previous tab, on both start and end point.

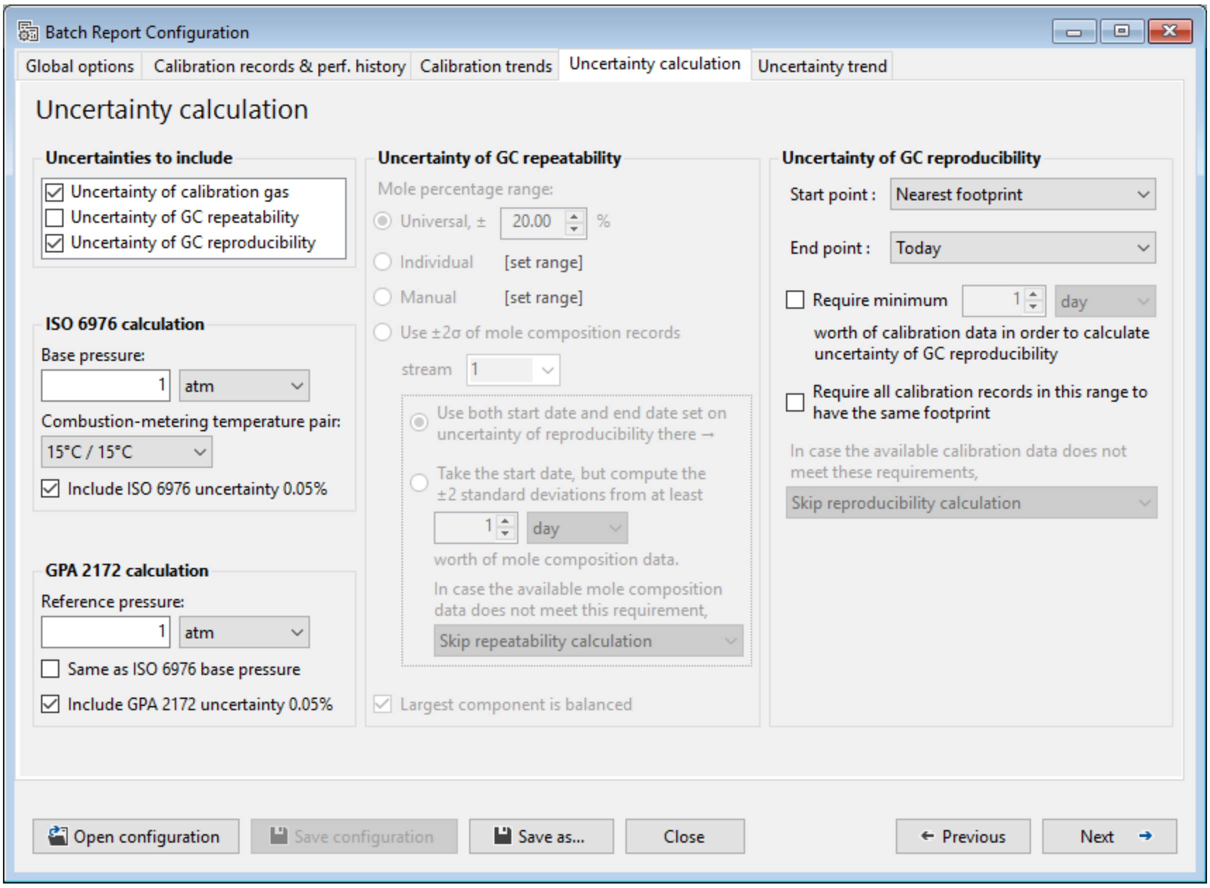
Use the end point of individual calibration records range: If this is ticked, the range to generate RF/RT trend chart goes from the start point defined in this tab to the end point defined in the previous tab.

RF and RT charts to print: Tick which trend charts to print, whether the normal RF/RT historical values or the deviation from footprints. If you tick neither, Batch Report module assumes you tick both. Note that the option to print R^2 charts is not here. It is in Global options tab.

Calculate mean and ±2 standard deviation lines: Select this to print the mean and 2 standard deviation lines below the RF/RT trend lines. Select one of the three option buttons to define how many records used to compute the mean and standard deviation. These three are the same options found in Data Analysis module.

30.2.6 *Uncertainty Calculation* Tab

Oh boy, this tab is where the user interface starts to get complicated. This tab sets the advanced options for uncertainty calculation in case you ticked that part under *Uncertainty calculation* section in Global options tab. But fear not, this tab has some similar elements to that part of the regular Report wizard.



First off, you don't see any option to choose which calibration certificate to use. Batch Report module always uses last certificate on each GC device.

Uncertainties to include: Controls which components to include in the calculation. Unchecked components are treated as zero.

ISO 6976 calculation and **GPA 2172 calculation** sets the base pressure/reference pressure and combustion-metering temperature pair for these calculation standards, as well as whether to include 0.05% standard measurement error at the end.

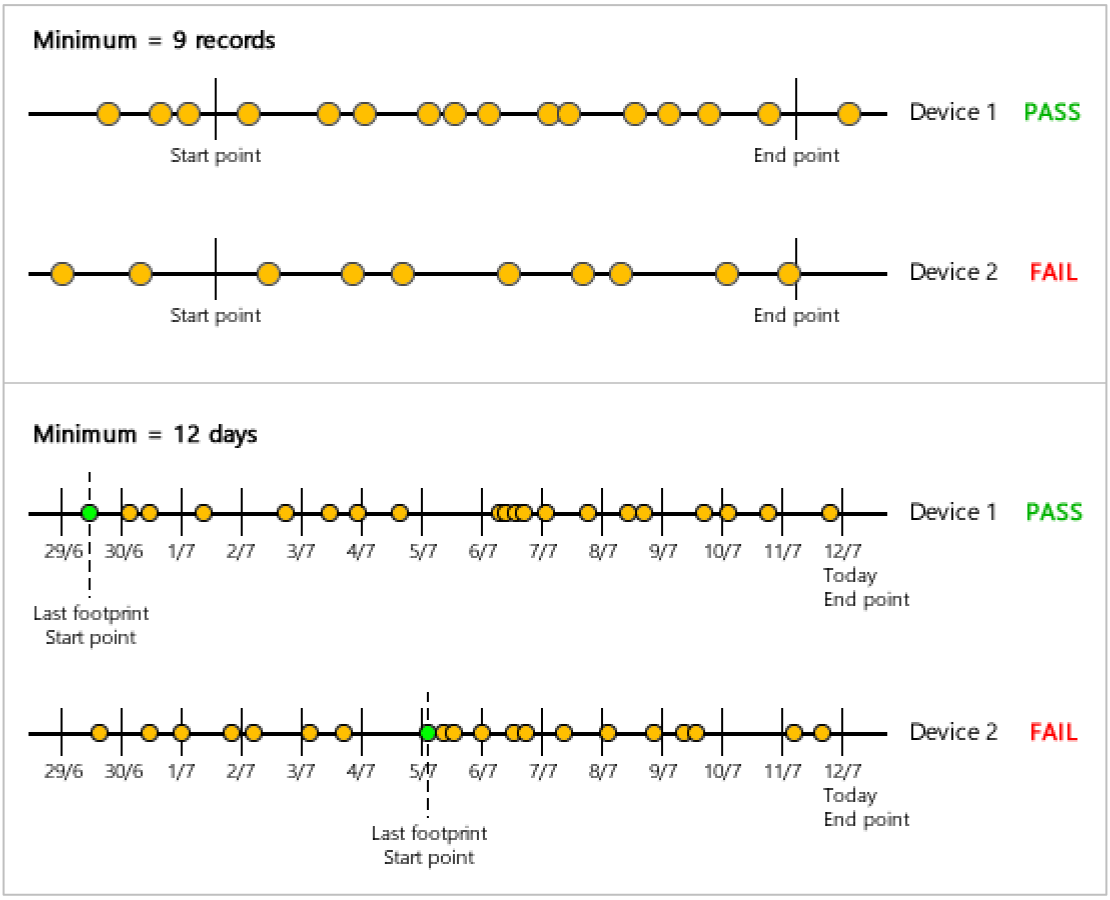
Uncertainty of GC repeatability section has options to select the desired mole composition plus-minus range of the calibration gas certificate in order to compute $U_{repeatability}$. The four options—universal, individual, manual, and standard deviation—are there, except for the standard deviation option there is a difference. We'll come back to that after the next paragraph. The check box **Largest component is balanced** adjusts the composition of the largest one to become (100 – the rest), therefore the sum would always be 100%. This option does not apply for manual percentage range.

Uncertainty of GC reproducibility section controls the range of calibration records used to calculate $U_{reproducibility}$. Refer to chapter 30.2.2 Specifying time range for more information about the start and end point specifier.

Okay, now let's discuss things that are new to this tab. Inside **Uncertainty of GC repeatability**, on the *±2 standard deviation* mole range option, you need to specify the stream number of mole composition records as well as the range. There are two options to define the range.

1. Use the range defined under *uncertainty of GC reproducibility* (see previous page, at the bottom). That implies take both the start point and end point of the range.

2. Use the range defined under uncertainty of GC reproducibility but take the start point only. The end point is counted *x* days or *x* records after this start point. This option has a further selection for what GCAS should do in case the number of mole composition records is not enough.



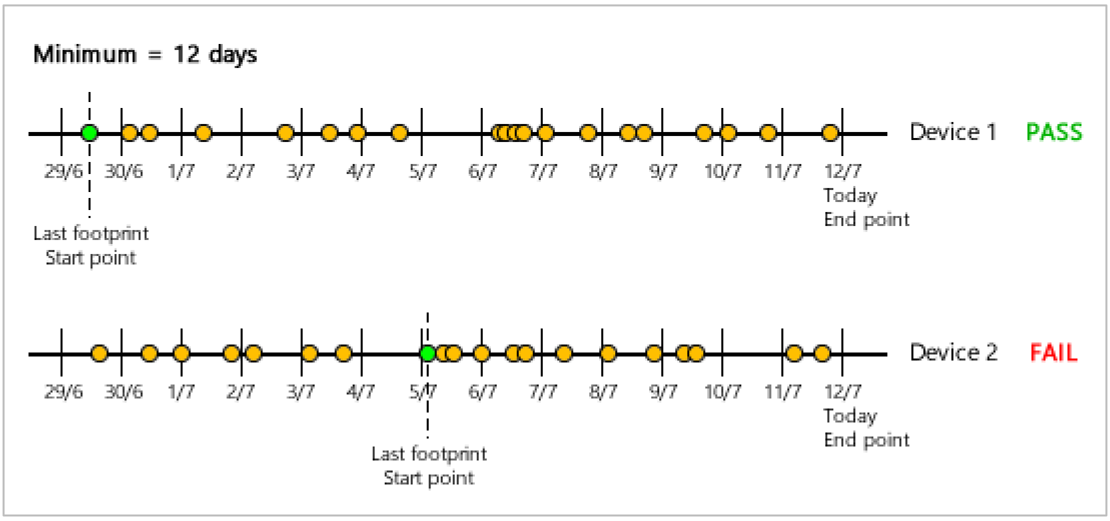
On "fail" cases, choose what GCAS should do. Note that these options would not affect the extra 30-day uncertainty calculation in case you ticked it in Global options tab.

a) **Skip repeatability calculation** causes GCAS to slap the final value zero to $U_{repeatability}$ calculation of current GC device in queue, making it feels like $U_{repeatability}$ was not ticked to begin with.

b) **Abort this uncertainty calculation** causes GCAS to cancel all uncertainty calculation and thus no uncertainty tables are printed for current GC device in queue.

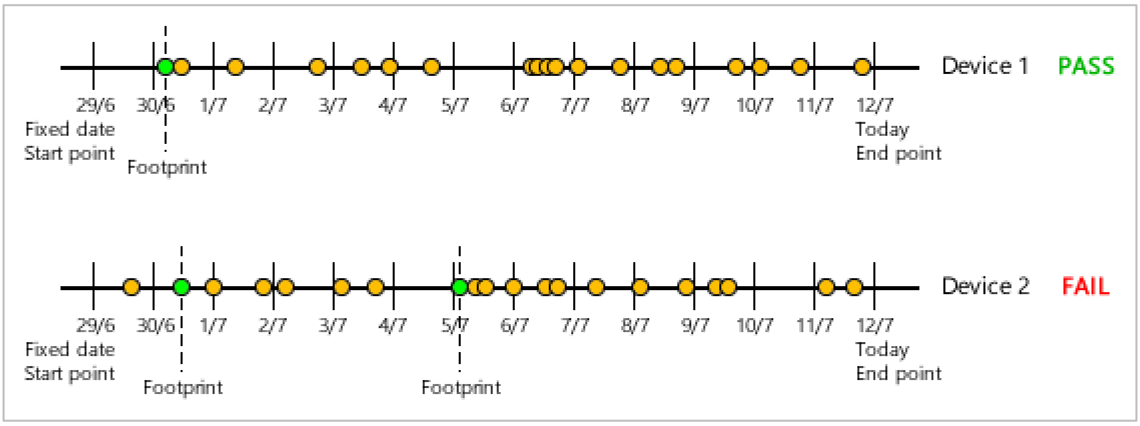
Inside **Uncertainty of GC reproducibility**, you have additional options to enforce calibration record policies. There are two options to enable if you require:

1. **Require minimum *x* days (or *x* records) of calibration data**: Enforces there should be enough calibration records within the defined range.
   Choosing *x* days as the unit is useful to weed out high uncertainty due to insufficient number of records—for example, the range starts at last footprint and ends at today. Depending on where the last footprint is and what date today is, there can be less than *x* days' worth of calibration data which in turn causes uncertainty values to go high.



   Choosing *x* records as the unit is useful in case there were problems on [data capture]() that might have caused calibration records stopped coming, thus the uncertainty values would be less valid.

2. **Require all calibration records in this range to have the same footprint**: As it sounds, this enforces a policy that there should be only one footprint in the defined range. Different footprints usually tell us a story about different GC configuration therefore their $U_{reproducibility}$ values should not mix. Do not enable this option if the start point of the range is set to "*n last footprints*" because you *will* have more than one footprints in the range.



Next, choose what GCAS should do if you enable at least one of these options, and there are not enough calibration records to pass the policy check.

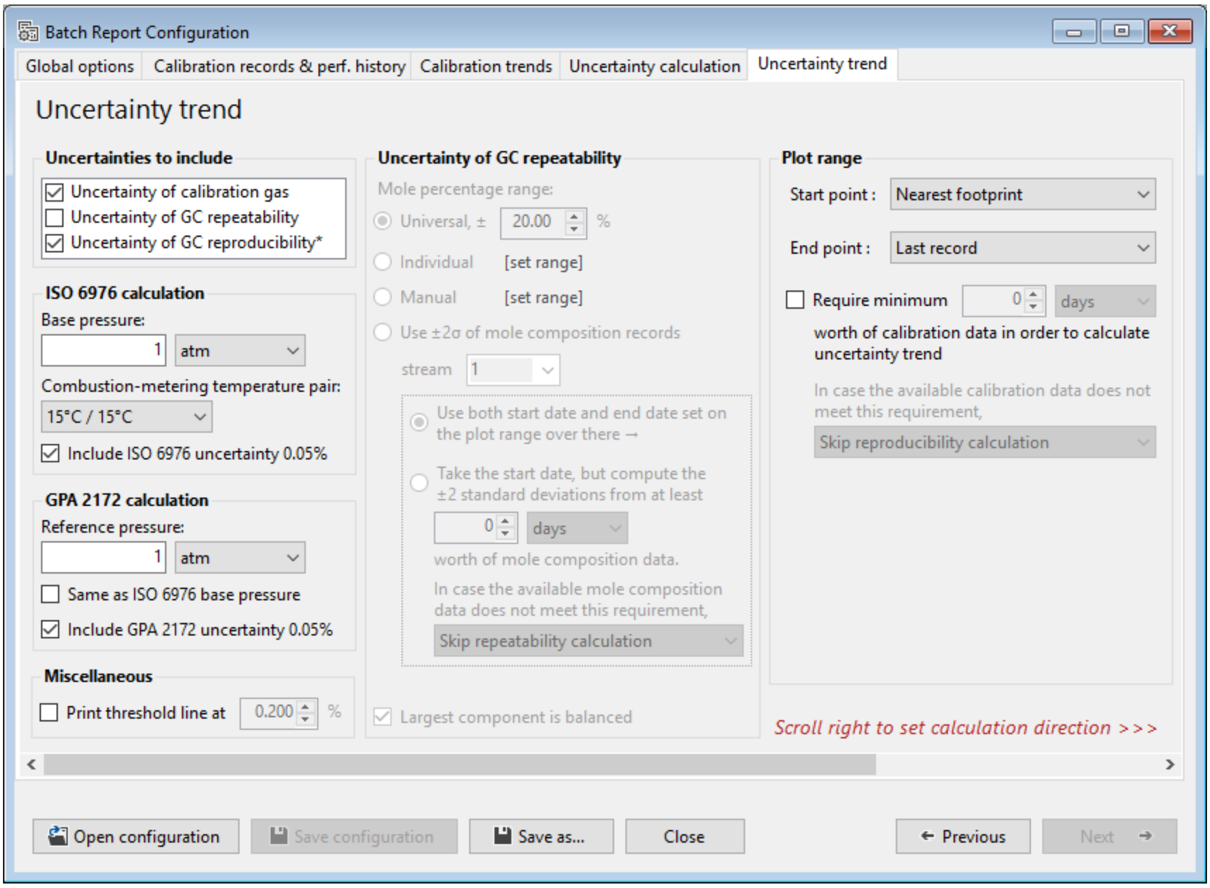
1. **Skip reproducibility calculation** causes GCAS to stick the final value zero to $U_{reproducibility}$ calculation of current GC device in queue, as if $U_{reproducibility}$ was not ticked in the first place.

2. **Abort this uncertainty calculation** causes GCAS to cancel all uncertainty calculation altogether; therefore, no uncertainty tables are printed for current GC device in queue.

Note that neither of the two actions above applies to the 30-day uncertainty calculation, if included.

30.2.7 *Uncertainty Trend* Tab

This tab controls the parameters and plot range for uncertainty trend charts, if you included *Uncertainty trends* in the Global options tab. Most options here are very similar to Uncertainty calculation tab.



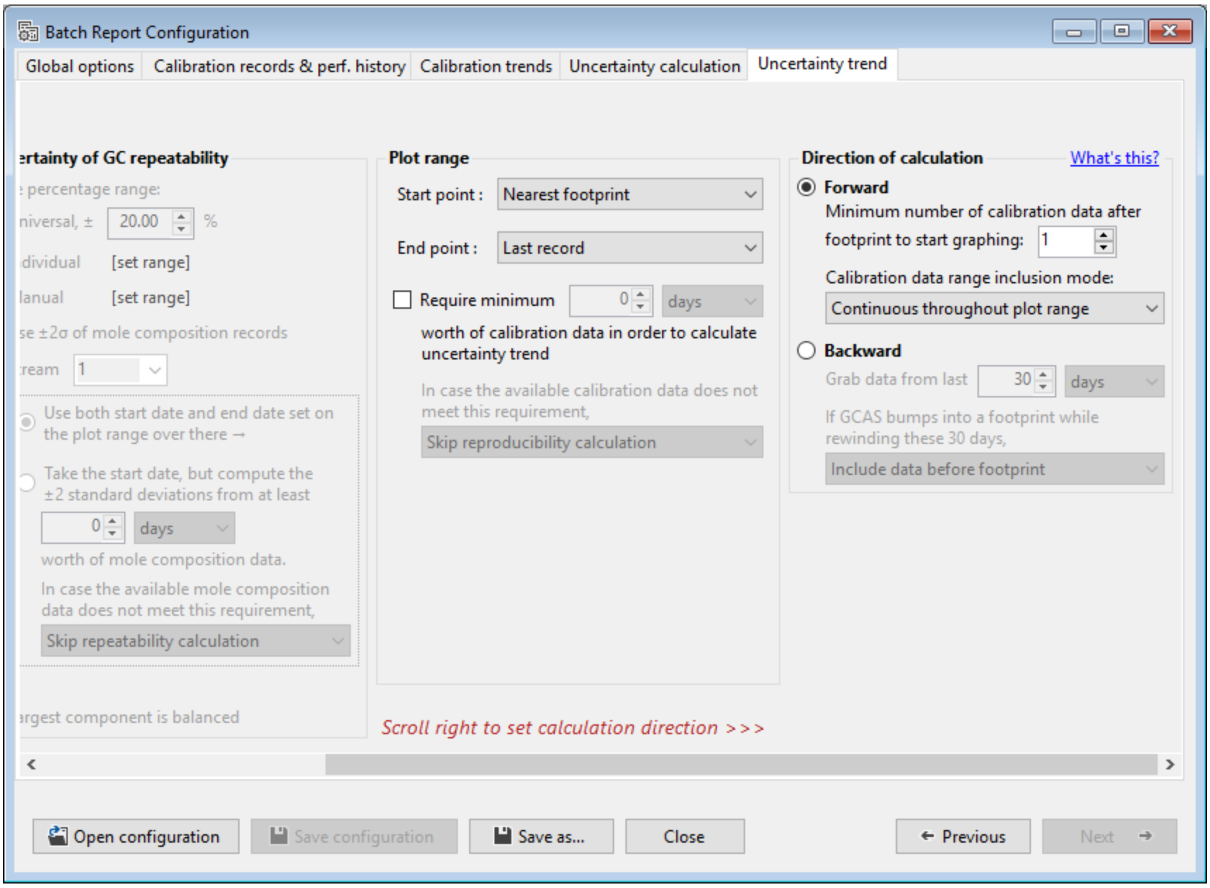
Uncertainties to include set the uncertainty components to include in the calculation. **ISO 6976 calculation** and **GPA 2172 calculation** set the base pressure and metering temperatures, while **Print threshold line** offers to draw a red line at the percentage mark of your choice.

Inside **Uncertainty of GC repeatability** things are pretty much the same with similar section in Uncertainty calculation tab—including the new options for ±2 standard deviation mole percentage range.

Inside **Plot range** (which controls the range for $U_{reproducibility}$), pick a start point and end point of the range. These point specifiers follow the same convention as what has been explained in chapter 30.2.2 Specifying time range.

There is only one additional optional policy for $U_{reproducibility}$, which is the option to enforce minimum number of days or records in the plot range. Uncertainty calculation tab offered two optional policies, but uncertainty trend calculation is highly likely to have multiple footprints inside the plot range. Hence, the second optional policy is not available. There are also two available actions in case the minimum number of calibration records is below the threshold: whether to **Skip reproducibility calculation** (treat $U_{reproducibility}$ as zero) or to **Abort this uncertainty calculation**—causing uncertainty trend charts not being printed for this GC device currently in queue.

Scroll right to see options about calculation direction:



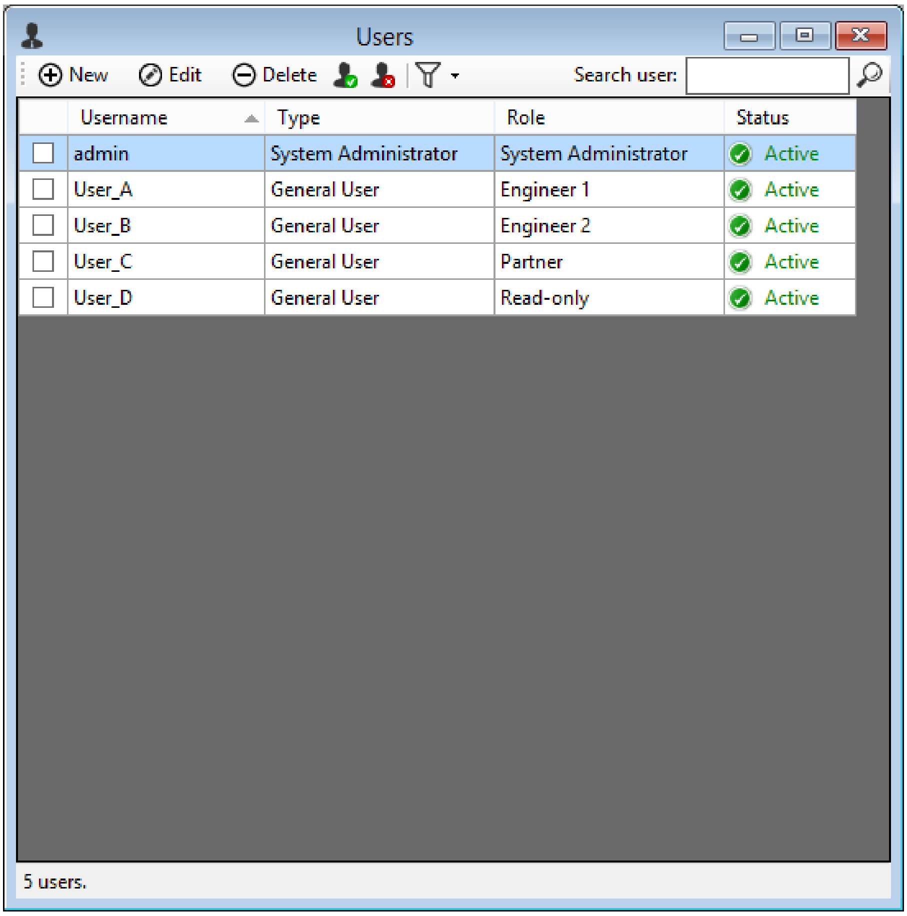
Quick recap, calculation direction sets how many calibration records are retrieved to calculate $U_{reproducibility}$ at each calibration data point. Refer to chapter 13.2.6 Direction for more information about specific options on either direction. If you are reading this user manual on HTML version, there are animations to explain how uncertainty trend direction works.

31 Administrator Menu

Administrator menu is available to GCAS administrators. Look for the "Administrator" menu on the menu bar of main user interface. Through this menu, GCAS administrators manage GCAS users, groups, and access control list.

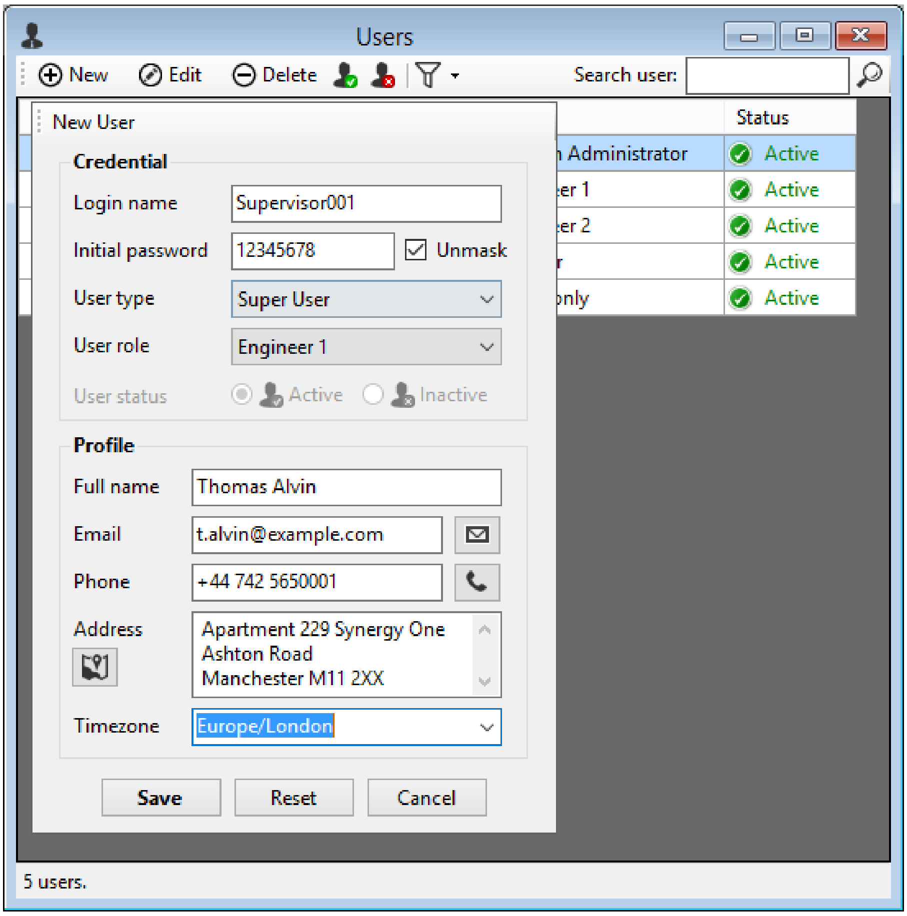
31.1 Manage Users

Go to Administrator menu > **Users**. This menu displays the *Users* form which lists all GCAS users registered in this GCAS database.



31.1.1 Create a New User

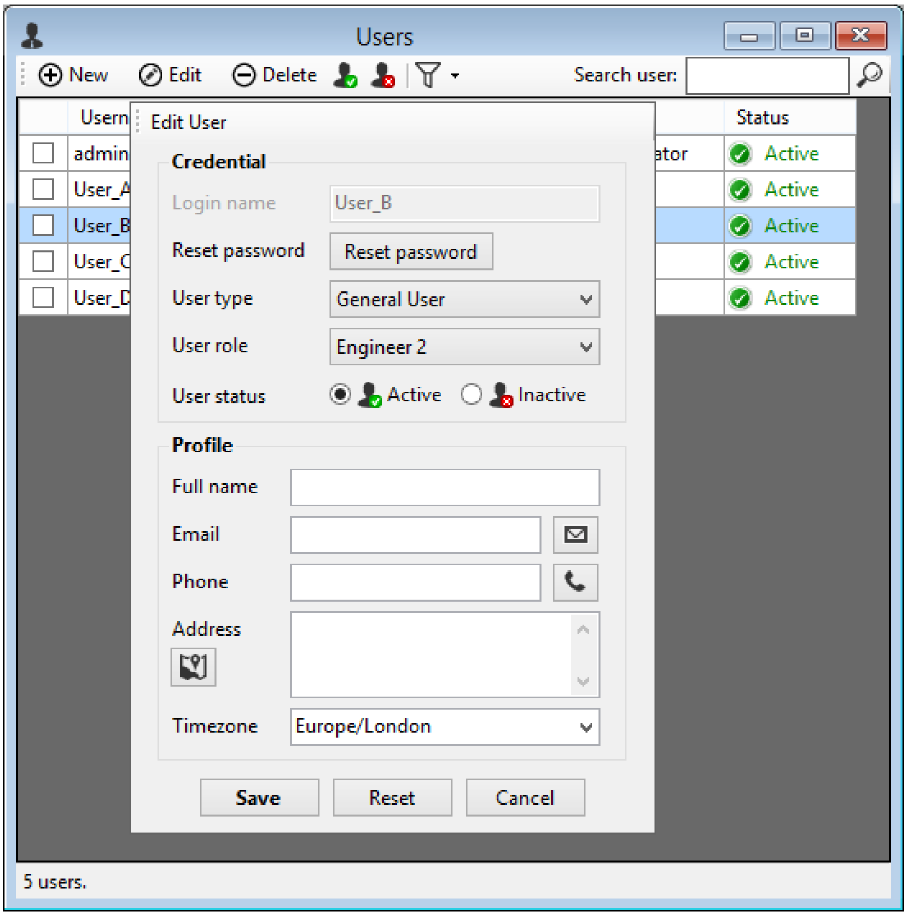
Click **New** button on the toolbar. Define the new username and initial password. Choose a user type and user role, and finally enter the information for his or her user profile. Finally, click **Save**.



Note
1. Username cannot contain spaces. 2. Empty time zone information is replaced by the default `Europe/London` time zone.

31.1.2 Edit an Existing User

To edit a user, tick the user on the list and click the **Edit** button on the toolbar. Make changes as required then click **Save**. Otherwise click **Reset** to roll back to the previous user profile.



About reset password

You cannot alter the user's password directly, but you can rather reset it to the default password "**password**" (all lowercase). Do this on an explicit request from the user himself to reset his password.

To set user as inactive, edit the user and set his status as **Inactive**. Alternatively, tick multiple users on the list then click **Set as Inactive** button on the toolbar. <u>Inactive users cannot log in to GCAS</u>.

To set the user back as active again, edit the user then set her status as **Active**. Alternatively, tick multiple users on the list then click **Set as Active** button on the toolbar.

31.1.3 Delete Users

To delete one or more users, tick the user(s) you want to delete on the list then click **Delete** button on the toolbar.

Note

You cannot delete yourself. Ask another GCAS administrator to delete your user account to do so.

Warning

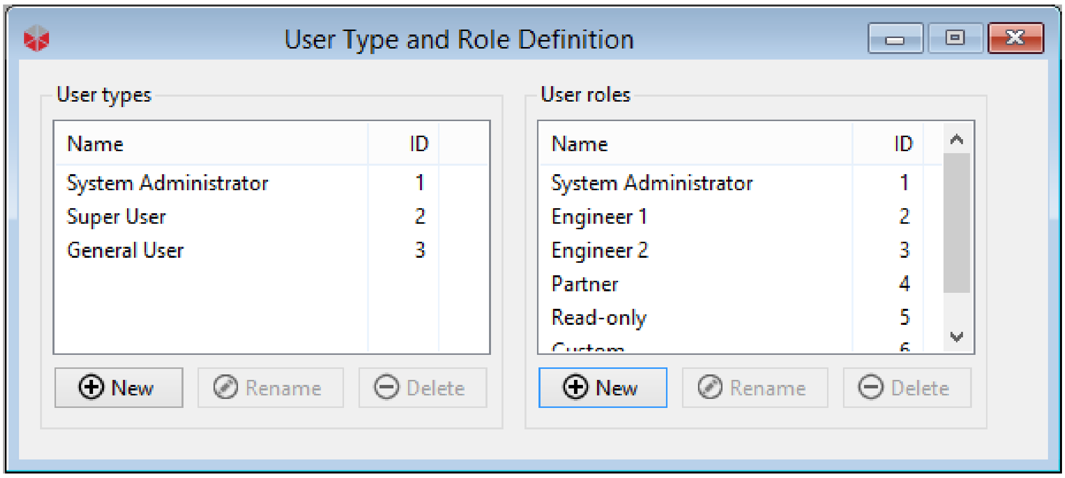
If the user being deleted is still logged in on another computer, deleting her account will cause errors on her computer. Make sure she has logged out beforehand.

Deleting users will also delete all their comments in any footprint, calibration data, mole composition, calibration gas certificate, data analysis, uncertainty trend, ISO 6976/GPA 2172 trend, and repeatability test* records. If you need to preserve their comments, set them as inactive instead.

*available only on GCAS Web version.

31.2 Define New User Types and Roles

Default installation of GCAS sets up three user types and six user roles. Should you need to create another user type or user role, you would go to the Administrator menu > **User Type and Role Definition**.



Click **New** to create one. Click an existing user type or role and you can rename it via **Rename** button or delete it through the **Delete** button.

Note

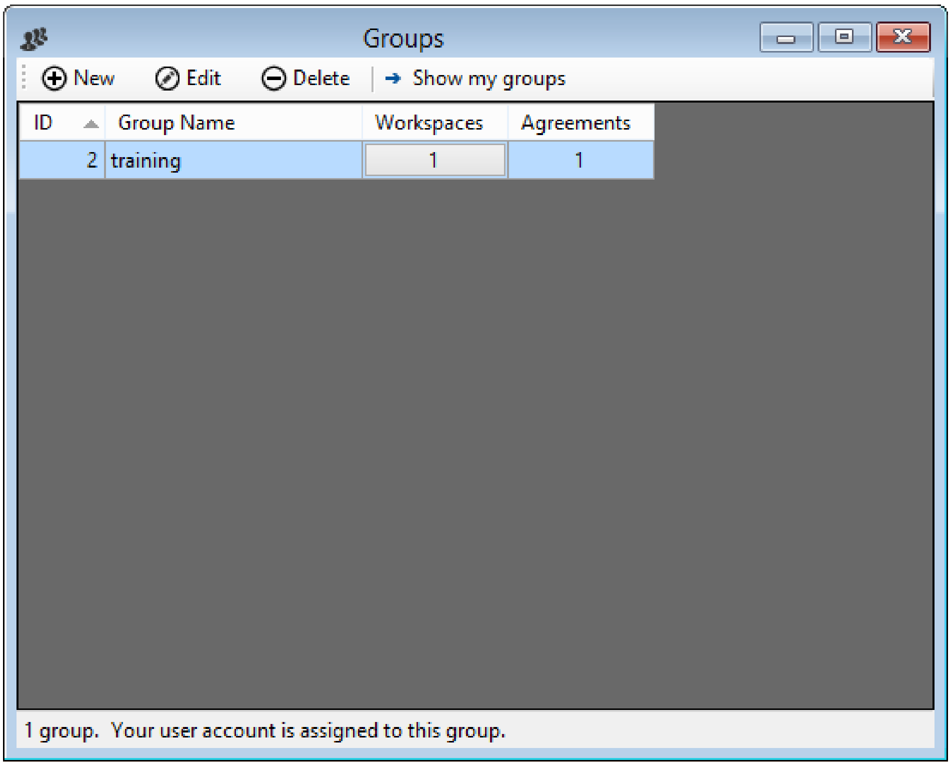
You cannot delete "System Administrator" user type and user role.

You cannot delete a user type or role if there are users of this type or role. Change the user type or role of these users before deleting the type or role.

Do not forget to assign menu permission for the new user type or action permission for the new user role, later.

31.3 Manage Groups

Go to the Administrator menu > **Groups and Workspaces** to manage groups. This menu displays the *Groups* form which lists all groups registered in the GCAS database. Note that your GCAS user account may not have been assigned to all these groups even though you are a GCAS administrator. Click **Show my groups** on the toolbar to highlight which groups are assigned to your user account.



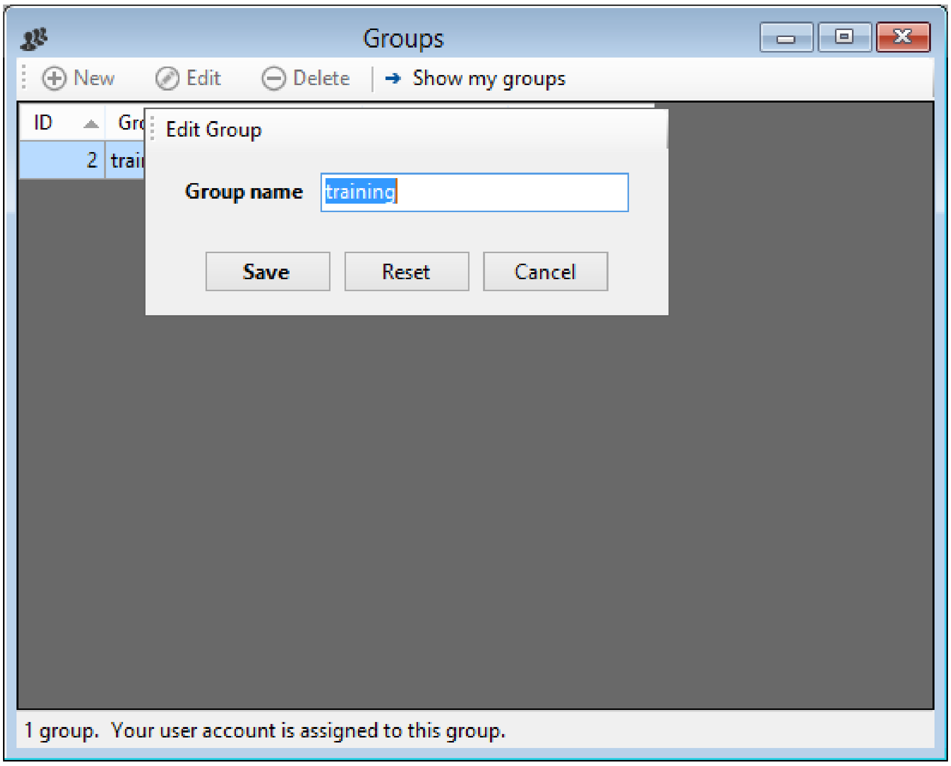
Note

The last column, **Agreements**, lists the number of agreements linked to the group. *Agreements are no longer part of GCAS*. However, the last column is preserved to maintain compatibility with older GCAS local-offline databases which were used before GCAS version 1.4. It will be gone in GCAS version 2 where the database uses a completely new schema, and won't be compatible with any GCAS 1.*x* databases.

Agreement column should contain `1` (one) for every row. If any other number appears here, that indicates your offline database must be upgraded. Otherwise, you won't be able to delete the group. Contact i-Vigilant customer support to upgrade your offline database or use the supplied GCAS database upgrade tool.

31.3.1 Create, Edit, Delete Groups

To create a new Group, click **New** on the toolbar. Enter the group name, followed by business information of the company that is being represented by this new group. Finally, click **Save**. To edit a group, highlight the group on the list and then click **Edit** button on the toolbar. Similarly, to delete a group, highlight the group then click **Delete**.



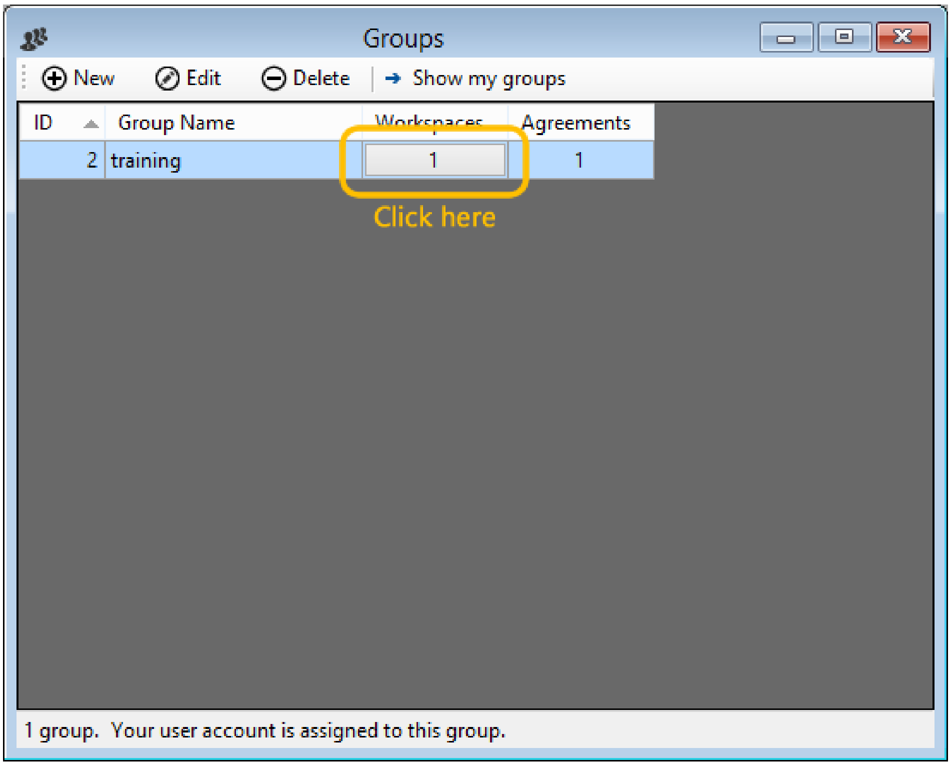
Note

Creating a group also creates one workspace within that group. The workspace has initially a same name as the group.

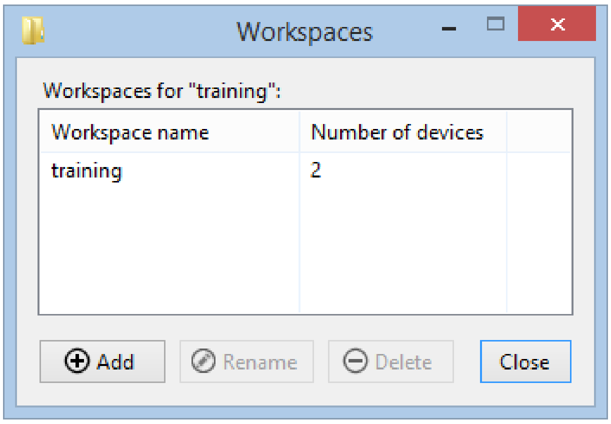
After a new group has been created, your user account is automatically assigned to the new group. Head to chapter 31.4 Assign users into groups if you don't like this assignment and to remove yourself from this group.

31.3.2 Add, Edit, Delete Workspace within Groups

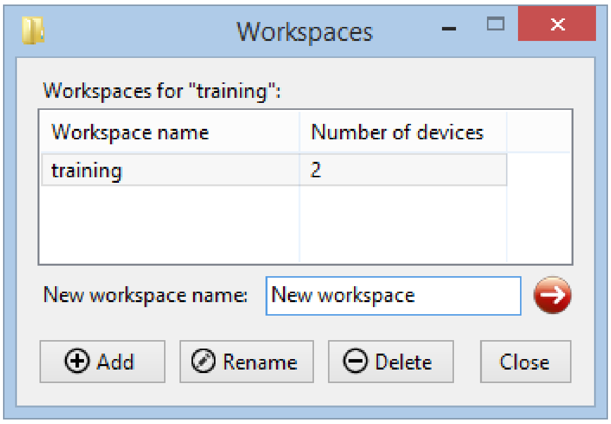
To edit workspaces within a group, click on the workspace count of that group.



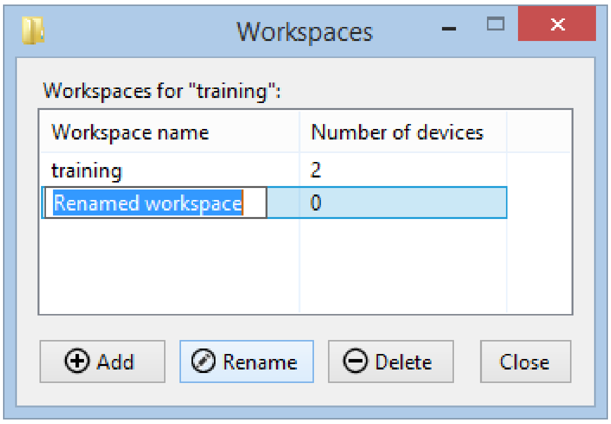
That button brings you to the *Workspaces* dialogue where you can manage workspaces for this group.



To define a new workspace, click **Add**. Enter the name of this new workspace then click the red arrow to commit.



Similarly, to rename a workspace you need to select the corresponding workspace on the list and then click **Rename**. Type the new name and press `Enter` on your keyboard to commit the change.



To delete a workspace, click the corresponding workspace on the list and then click **Delete**.

Note

You cannot delete a workspace if there are devices assigned to this workspace. Move them into a different workspace or delete the devices before deleting a workspace.

31.4 Assign Users into Groups

To assign users into groups or remove users from groups, go to the Administrator menu > **User-Group Relationship**. The menu takes you to the *User-Group Relationship* window.

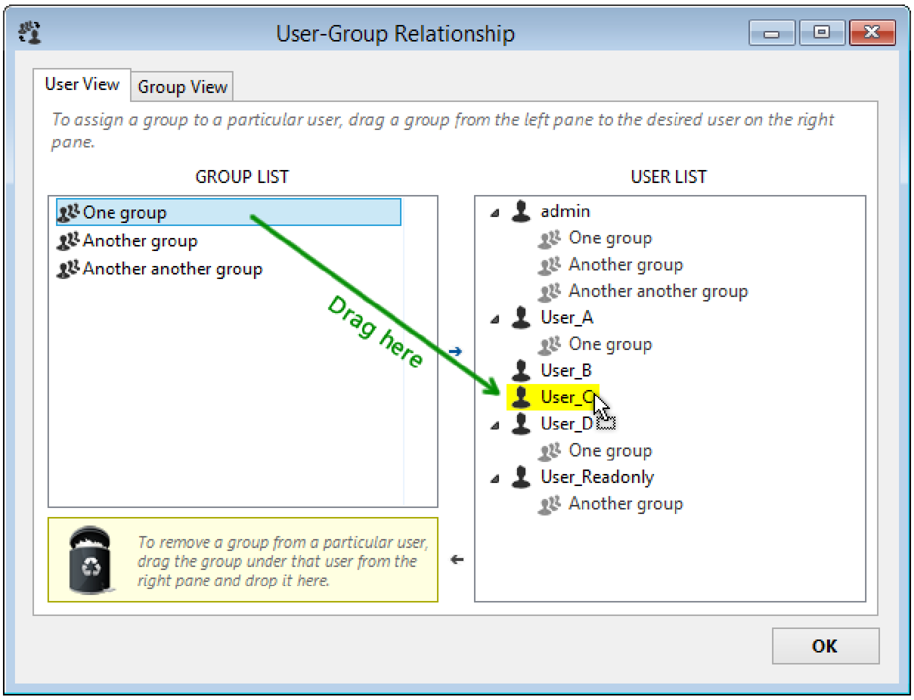
This form has two views: user view, and group view. Both carry the same information, but under different focus. Switch to user view if you want to focus on the users, i.e. how many groups one user has. Switch to group view if you want to focus on the groups, that is, how many users one group has.

Assigning and removing users or groups are conducted through drag-and-drop operations. Go to one of the oncoming subchapters to use the form using a particular view.

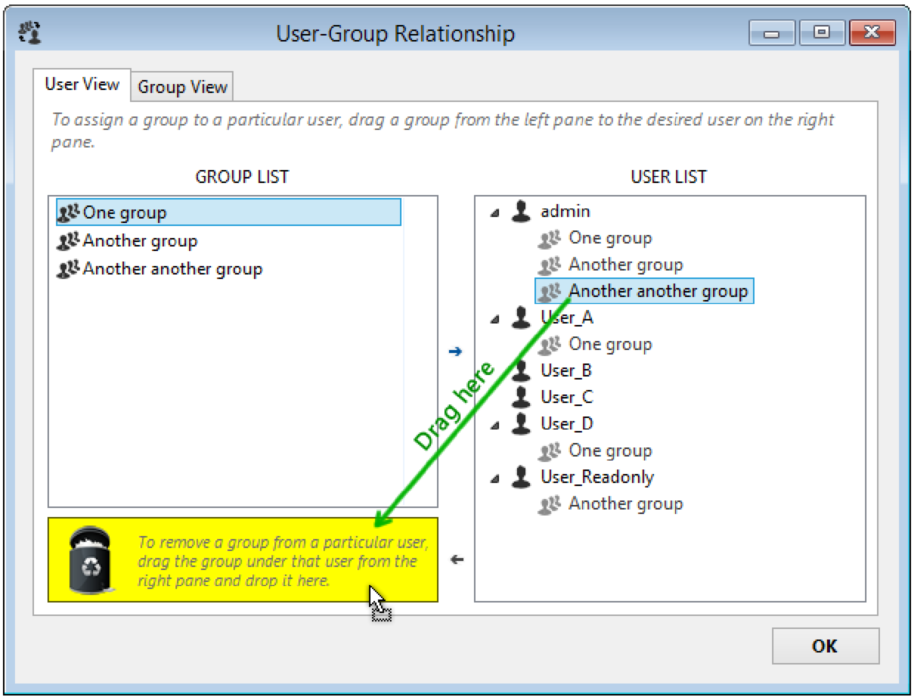
31.4.1 User View

User view focuses on the users. You see how many groups each user has.

Assign a group to a user: Drag the group from left pane to the user.



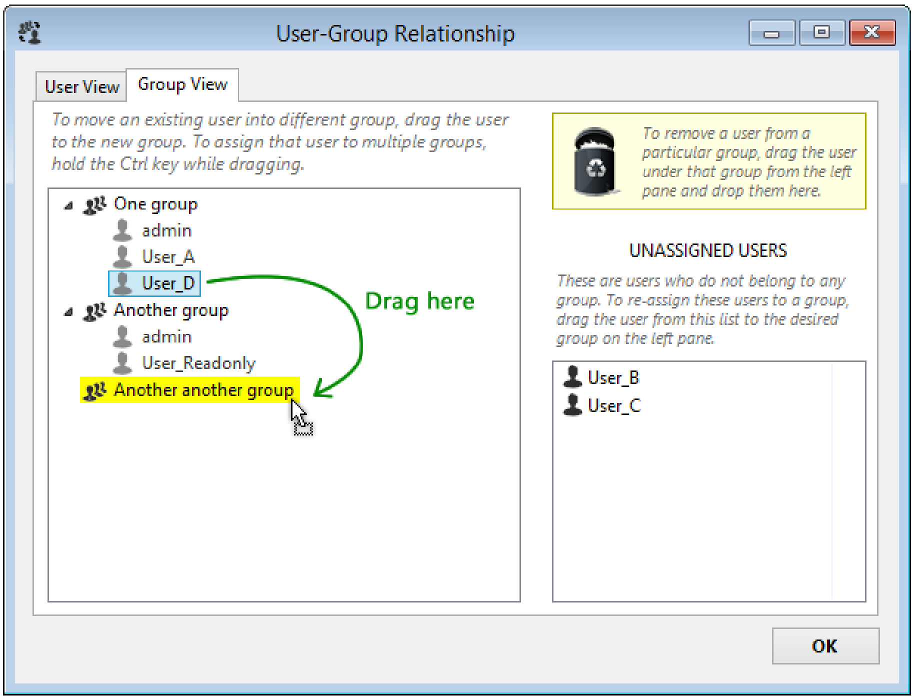
Remove a group from a user: Drag the group under a user and put it on the trash bin.



31.4.2 Group View

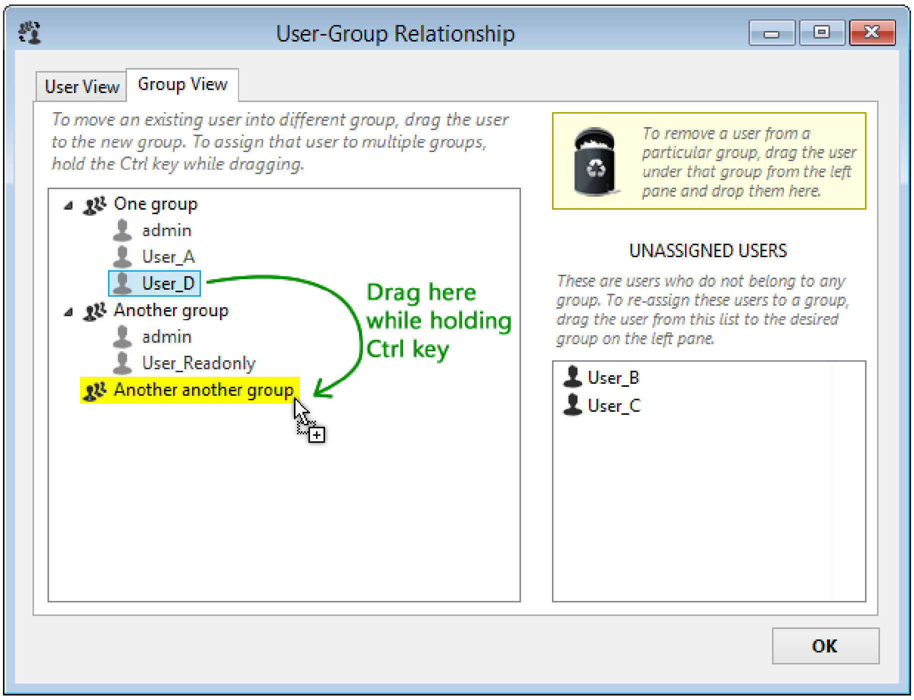
Group view focuses on the groups. You see how many users each group has.

Move a user to a new group: Drag a user to the new group. In this example, we are moving User D to a new group. User D loses access to *One group* but is given access to *Another another group*.

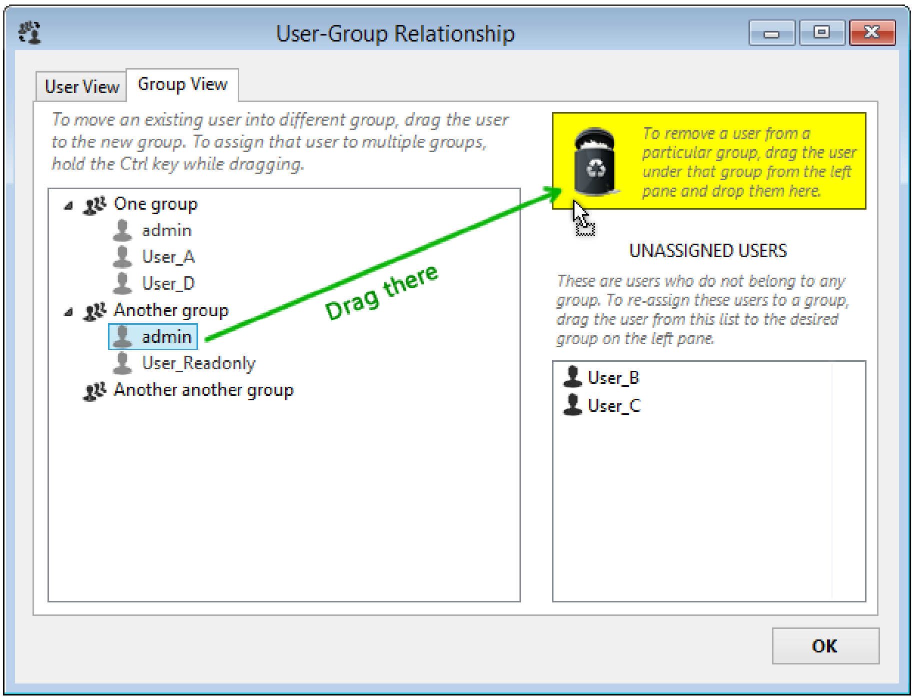


Assign a user to a new group while retaining the previous one:

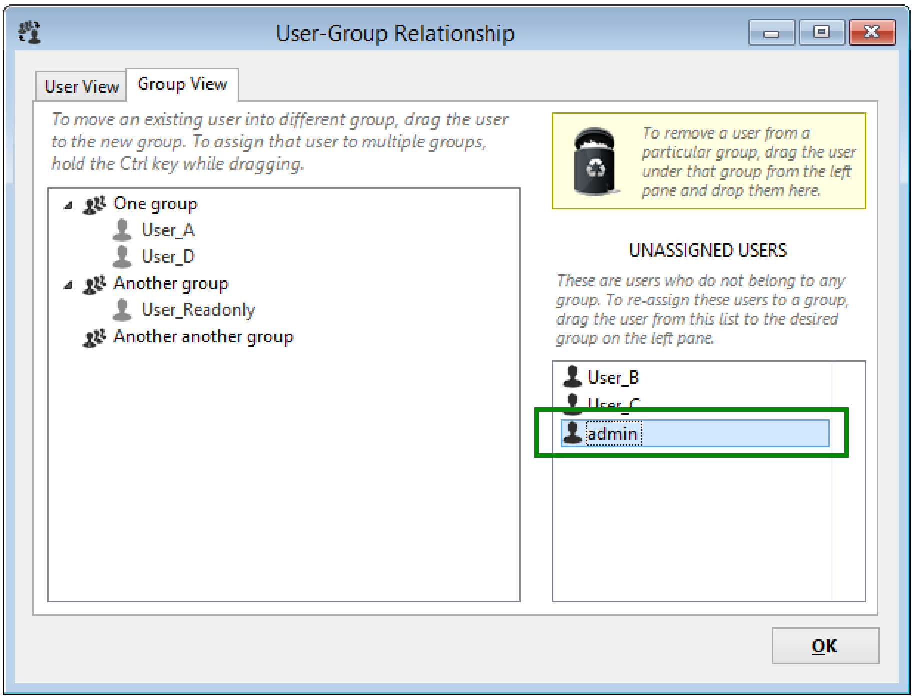
If you want to assign User D to both groups instead, hold the `Ctrl` key on your keyboard while dragging her to the new group. User D retains access to *One group* while is also being assigned to *Another another group*.



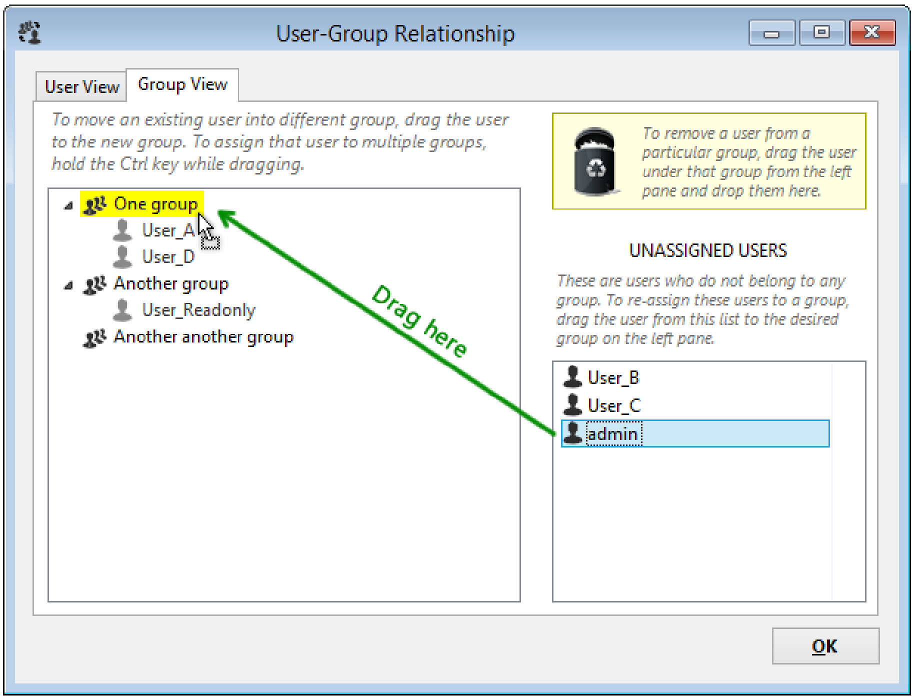
Remove a user from a group: Drag the user under a group and put him on the trash bin icon.



Unassigned users: If you remove the same user from *every* group she had, she will appear on the list of unassigned users.

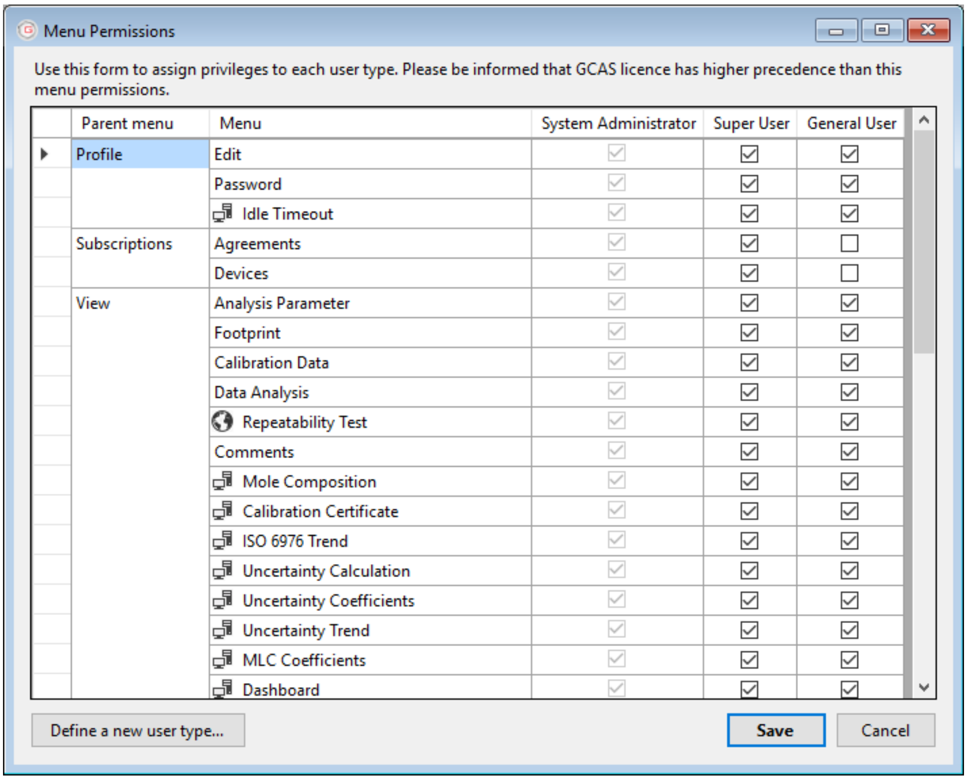


Reassign an unassigned user to a group: To reassign an unassigned user back to a group, drag her to the desired group.



31.5 Menu Permissions

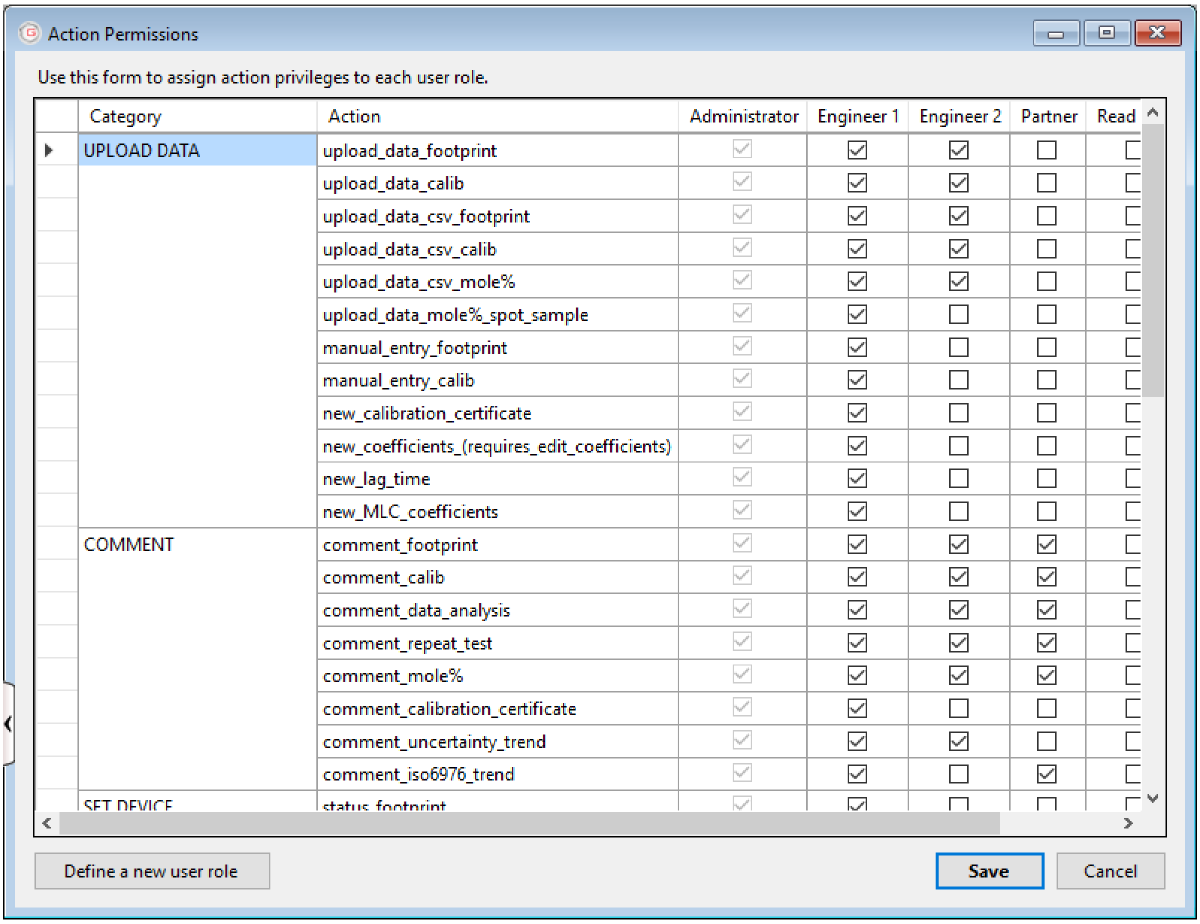
Menu permissions are a part of access control list (ACL) that controls which menu is available to each user type. Go to the Administrator menu > **Menu Permissions** to show the *Menu Permissions* form.



To grant or revoke permissions, tick or untick the corresponding check box. Administrator always has access to all menus. Click **Save** to enforce the change. If other GCAS users are currently logged in to GCAS database on other computers, the change will take effect on their user accounts after they log out or exit GCAS.

31.6 Action Permissions

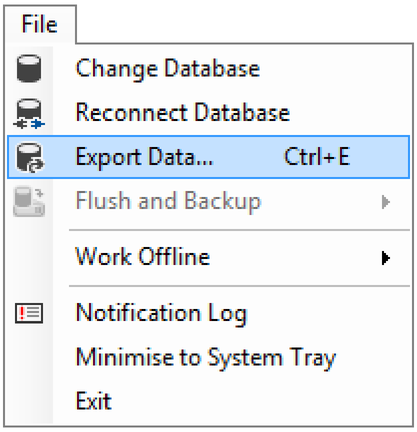
In tandem with menu permissions, action permissions constitute the access control list (ACL). Action permissions control which *action menus* — and in some cases, *actions* in literal meaning itself — available to each user role. Go to Administrator menu > **Action Permissions** to bring forth the *Action Permissions* form.

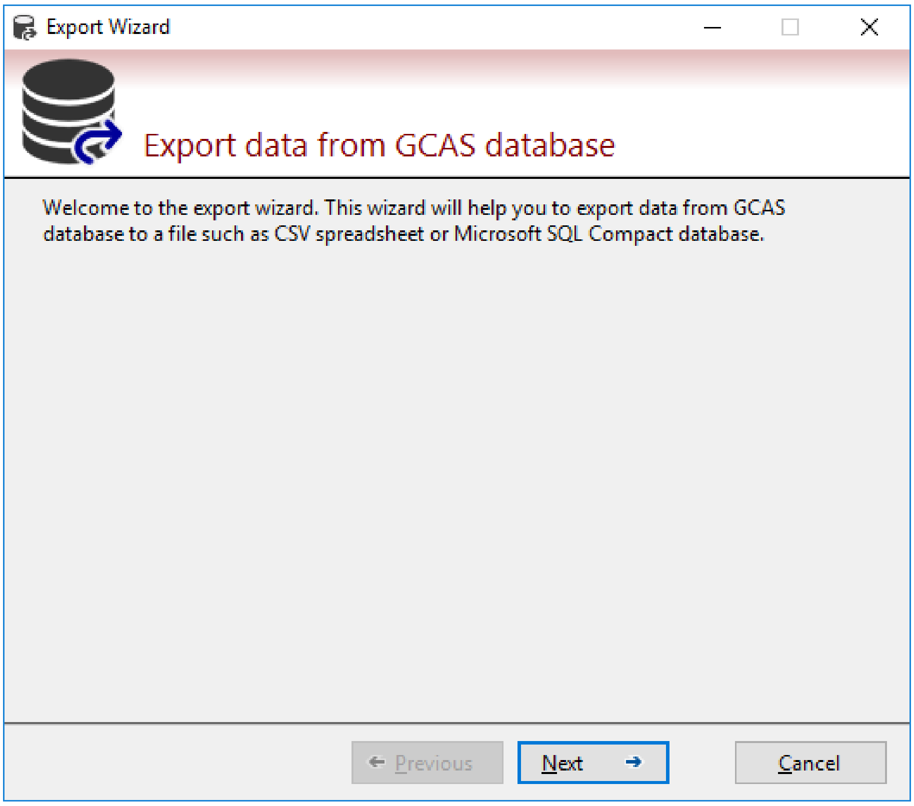


Similar to menu permissions, tick the check box to grant permission or untick to revoke. Click **Save** to enforce the change. If other GCAS users are currently logged in to GCAS database on other computers, the change will take effect on their user accounts after they log out or exit GCAS.

32 Export Data

GCAS can export a portion of GCAS database into several file formats for further analysis. Go to the File menu > **Export Data** and the *Export Wizard* window shall appear. If you don't see this menu, that means you do not have any GCAS feature related to data export in your GCAS licence.





The Export Wizard.

Note

If you are working offline, only the data available in your temporary database—which is a subset of GCAS database—can be exported. If you choose to synchronise your data for the latest 6 months for instance, you cannot export data beyond 6 months ago.

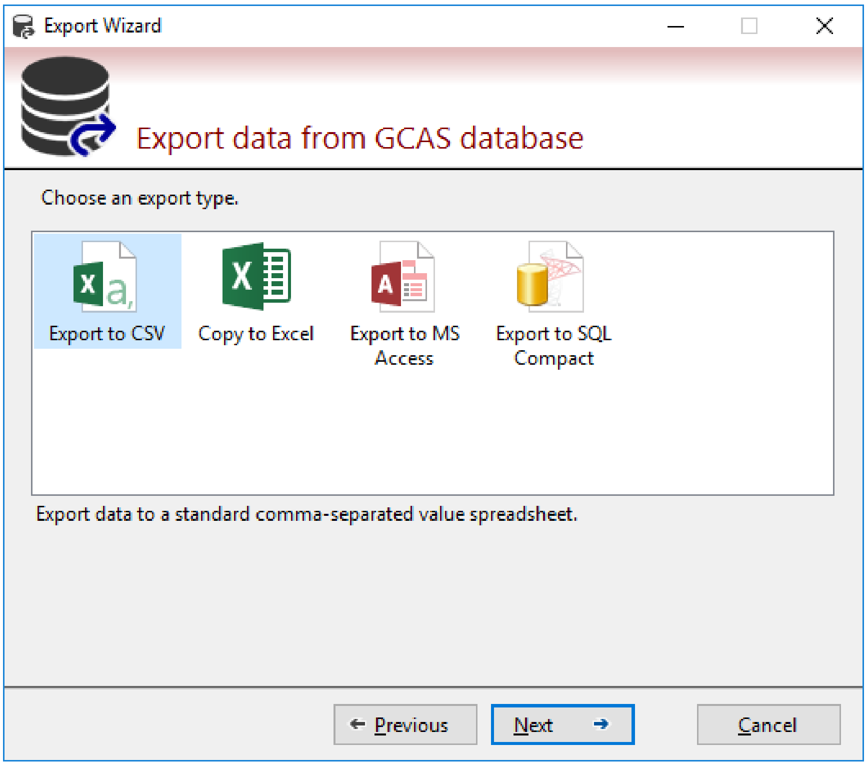
32.1 Export to CSV

This exporter module exports GCAS data into a standard comma-separated value (CSV) spreadsheet. The CSV file contains additional columns for extra information, but the sequence of columns is arranged in such a way so that you can copy and paste them into new CSV file for re-import, starting at column C. Even more, record timestamps of the output CSV file are matched with device date format (mostly mm/dd/yyyy) therefore the CSV file—starting at column C— conforms to the CSV template of both calibration data import and mole composition import.

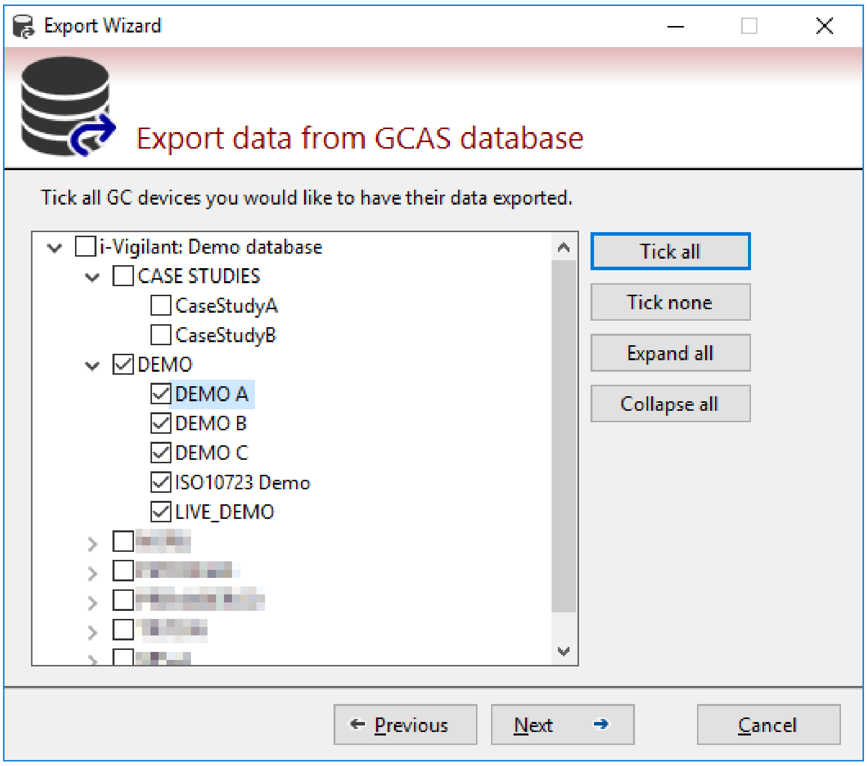
Choose **Export to CSV** to begin.

Note

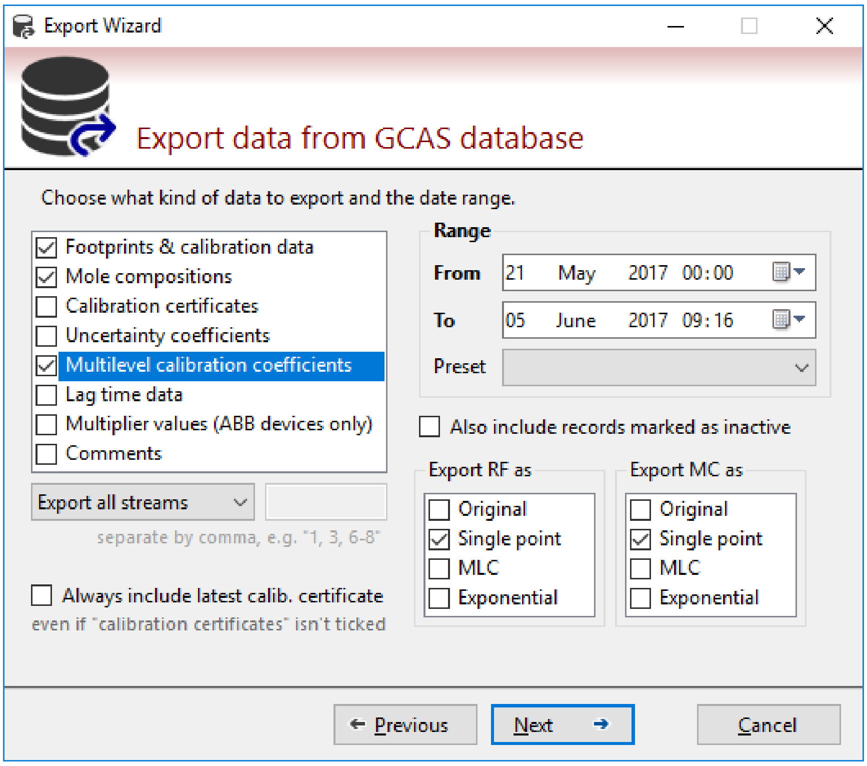
You need the GCAS feature *Export to CSV* to be included in your GCAS licence in order to use this feature.



Tick all GC devices you would like to have their data exported.



Choose which data to export and the date/time range.



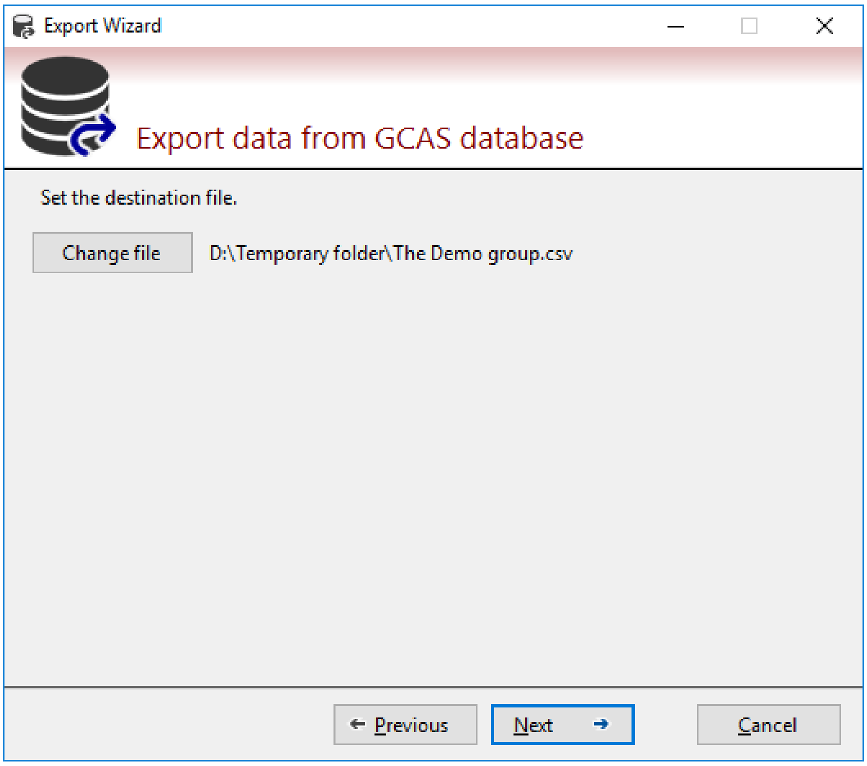
If you tick **Mole compositions**, there is an option to limit which streams to export. The default option is **Export all streams**. To export certain streams, change to **Only these streams** and put the desired stream numbers in the available box. Conversely to exclude certain streams from the export, change to **Except these streams** and input the stream numbers. Separate stream numbers by comma, for example `1, 2, 4`. You can use hyphen to create range such as `1-3, S`. Here, the letter `S` stands for spot samples. The mathematical operator `<`, `>`, `<=` or `≤`, and `>=` or `≥` are accepted too, so you can write something like "`1`, `2`, `> 4`, `<= 12`" to create a range. An open range looks like "`< 4`, `> 7`". A closed range goes similar to "`>= 4`, `< 10`". Only one range is supported, either open or closed, so you cannot enter something like "`> 3`, `< 6`, `>= 12`, `<= 18`" which has two closed ranges.

Moving down, the check box **Always include latest calib certificate** ensures the latest calibration gas certificate of every selected device is exported, even though you didn't tick **Calibration certificates** to export, or even though you ticked it but the latest certificate is outside of date range. We recommend ticking this box if you are going to re-import the CSV file and compute uncertainties on its data.

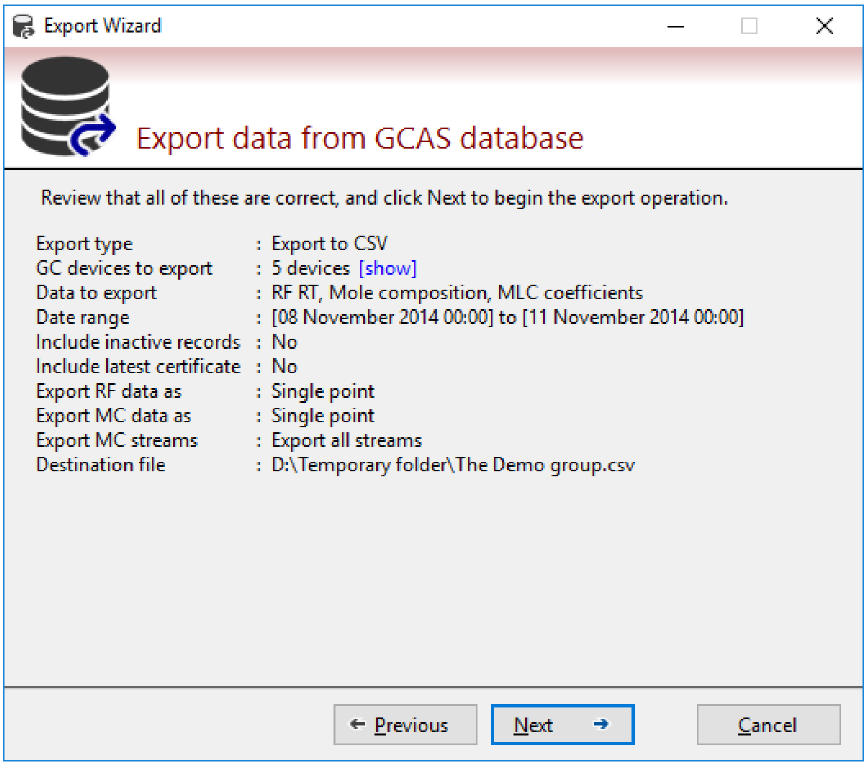
On the right side, there are date pickers to set the date range. Under those, there is a check box **Also include records marked as inactive**. This check box causes every inactive record within the set date range is exported along with all active records.

CSV exporter supports record conversion on calibration records and mole composition records. If you ticked **Footprint and calibration data** to export, you should see a list of check boxes titled **Export RF as**. Similarly, if you ticked **Mole compositions** to export, the list **Export MC as** should appear. Here you can set whether the RF values or mole composition values should be converted into one or more record types. Ticking **Original** will export calibration data or mole composition records as they are, no conversion performed. The option **Single point** and **MLC** (multilevel-calibrated) requires GCAS feature *ISO 10723* in your licence. The last option, **Exponential**, is applicable to ABB devices only.

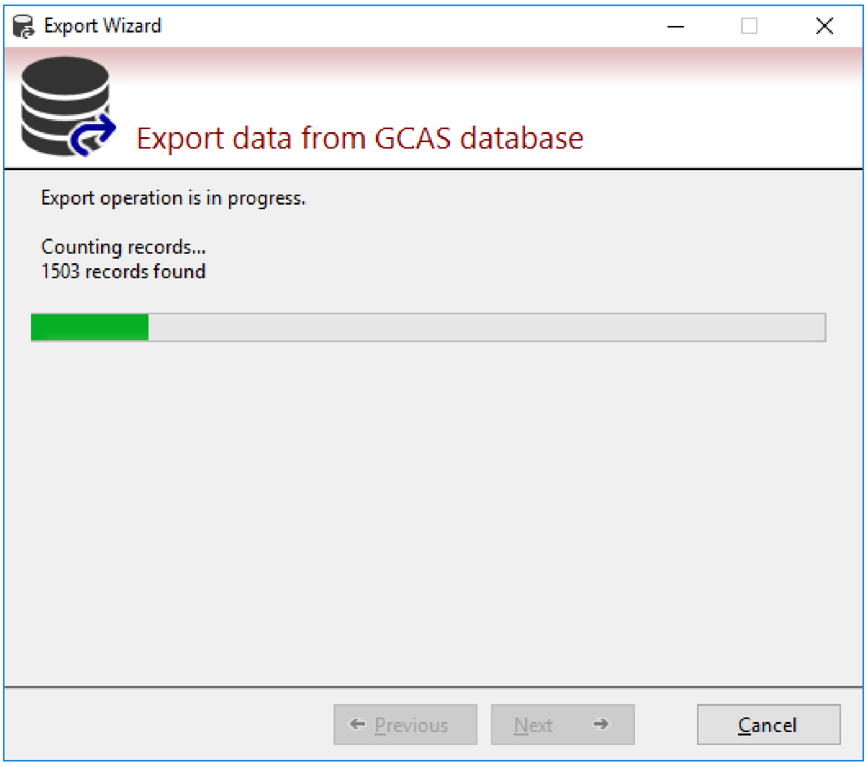
Next step, set the destination CSV file.



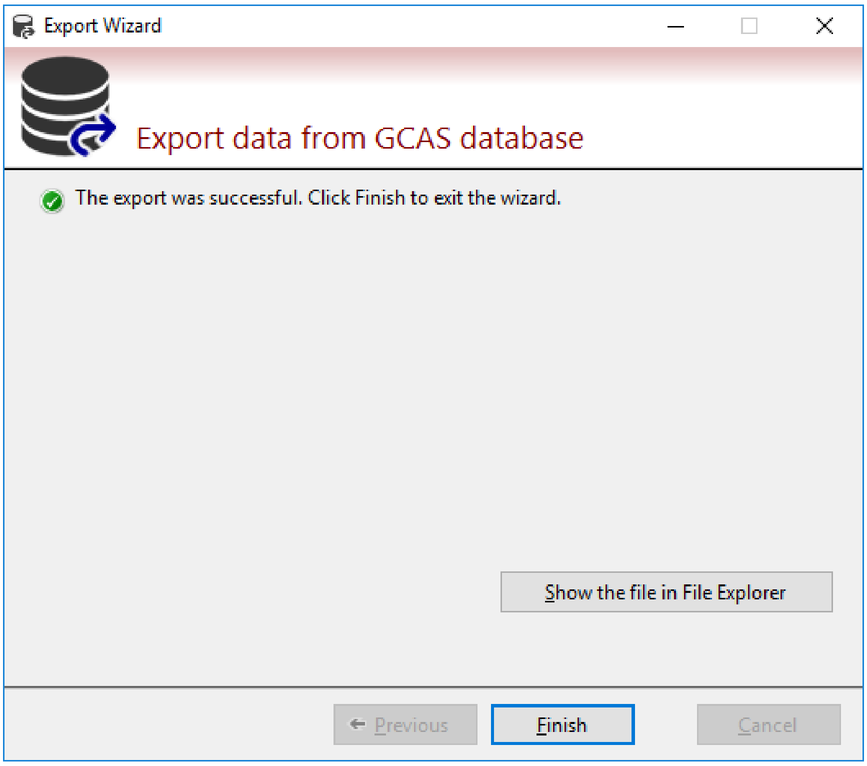
Review the export settings, and click **Next** to begin the export process.



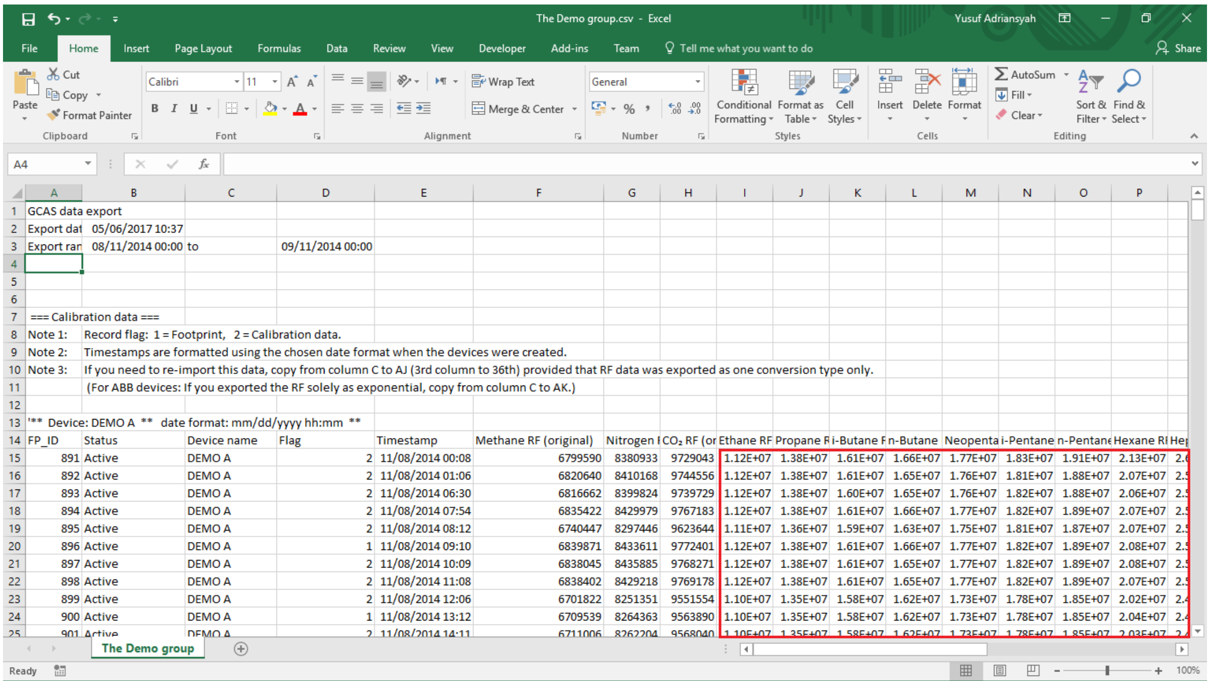
GCAS commences the export operation. For CSV export, this step is typically very fast — unless the number of records to export is way too many. If you are using i-Vigilant central database or local corporate database, the process of loading MLC and exponential conversion prerequisites may take a bit longer depending on your network connection.



This wizard page confirms that the export has been successful. You can now open the CSV file.



A quick note if you open the CSV file using Microsoft Excel. Excel tends to truncate large number into scientific notation up to 2 decimal place (the number of decimal place follows the regional settings on your Windows Control Panel). **This truncation may lead to large rounding error and is permanent**. As soon as you notice this Excel evildoing, change the number format for the selected cells to general numeric format before you save the file.



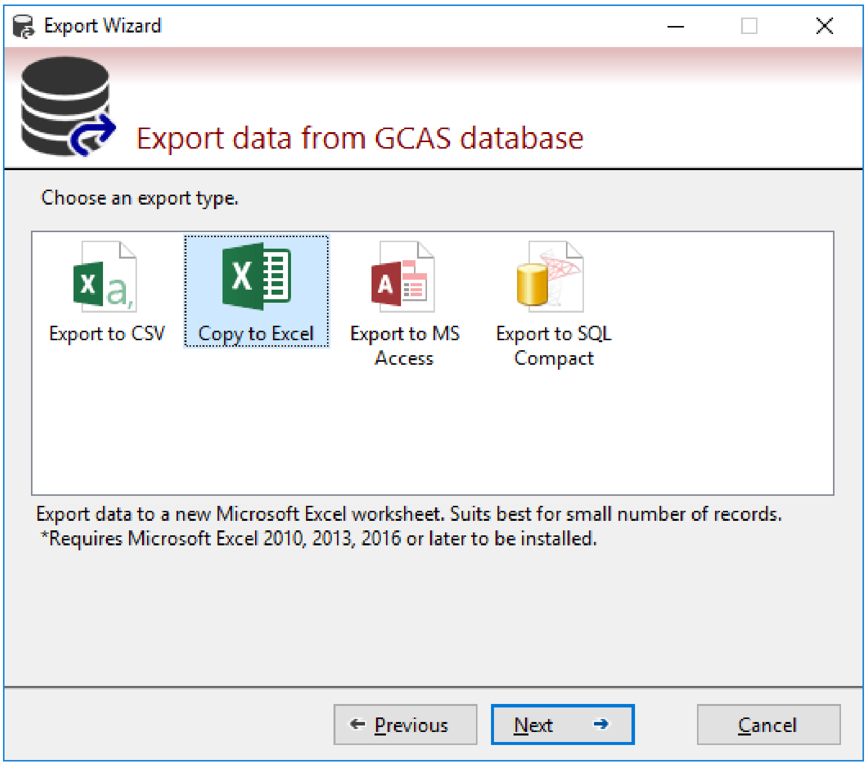
32.2 Copy to Microsoft Excel

This exporter module opens a new Microsoft Excel worksheet, formats the worksheet, and writes data to it. The process is much slower compared to other exporter module, so it is suitable for small number of records. But the upside is that the sheet is formatted and pretty. The process is faster if Microsoft Excel window is minimised while export is in progress. Anyway, choose **Copy to Excel** to begin.

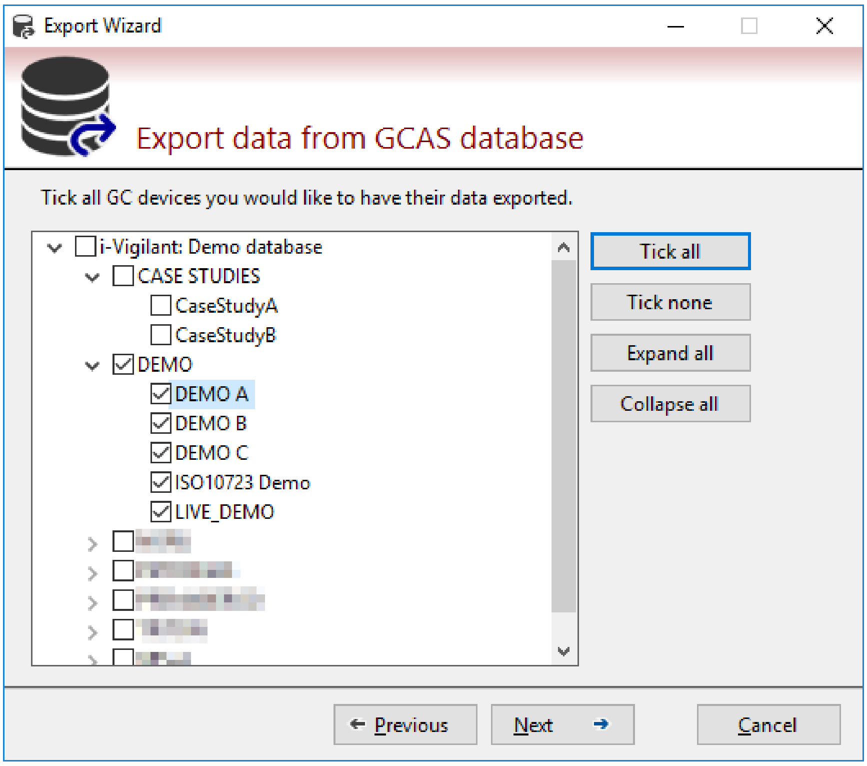
Note

You need the GCAS feature *Export to Microsoft Office* to be included in your GCAS licence in order to use this feature.

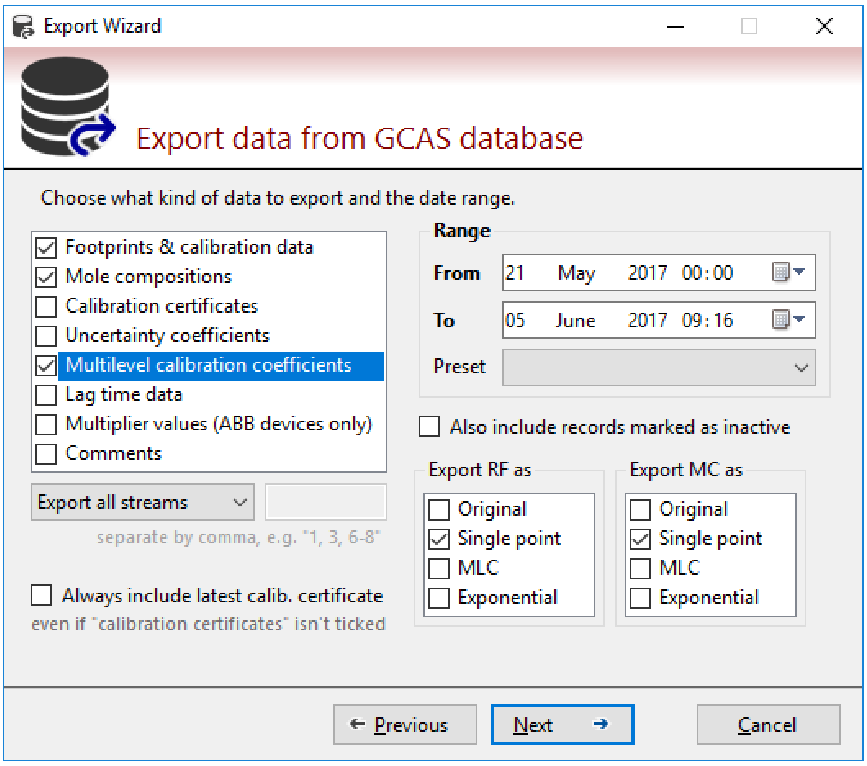
Moreover, this exporter also requires Microsoft Excel 2010, 2013, 2016, or later to be installed on your computer. Running this export module without Excel installed will raise an error.



Tick all GC devices you would like to have their data exported.



Choose which data to export and the date/time range.



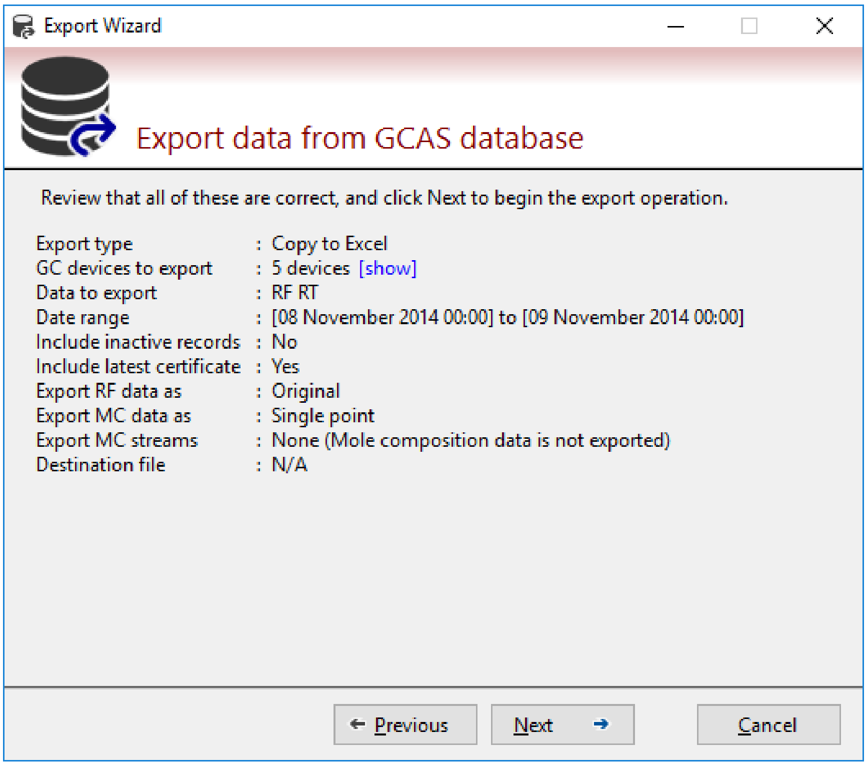
If you tick **Mole compositions**, there is an option to limit which streams to export. The default option is **Export all streams**. To export certain streams, change to **Only these streams** and put the desired stream numbers in the available box. Conversely to exclude certain streams from the export, change to **Except these streams** and input the stream numbers. Separate the stream numbers by comma, for example `1, 2, 4`. You can use hyphen to create range such as `1-3, S`. Here, the letter `S` stands for spot samples. The mathematical operator `<`, `>`, `<=` or `≤`, and `>=` or `≥` are accepted too, so you can write something like "`1`, `2`, `> 4`, `<= 12`" to create a range. An open range looks like "`< 4`, `> 7`". A closed range goes similar to "`>= 4`, `< 10`". Only one range is supported, either open or closed, so you cannot enter something like "`> 3`, `< 6`, `>= 12`, `<= 18`" which has two closed ranges.

Moving down, the check box **Always include latest calib certificate** ensures the latest calibration gas certificate of every selected device is exported, even though you didn't tick **Calibration certificates** to export, or even though you ticked it but the latest certificate is outside of date range.

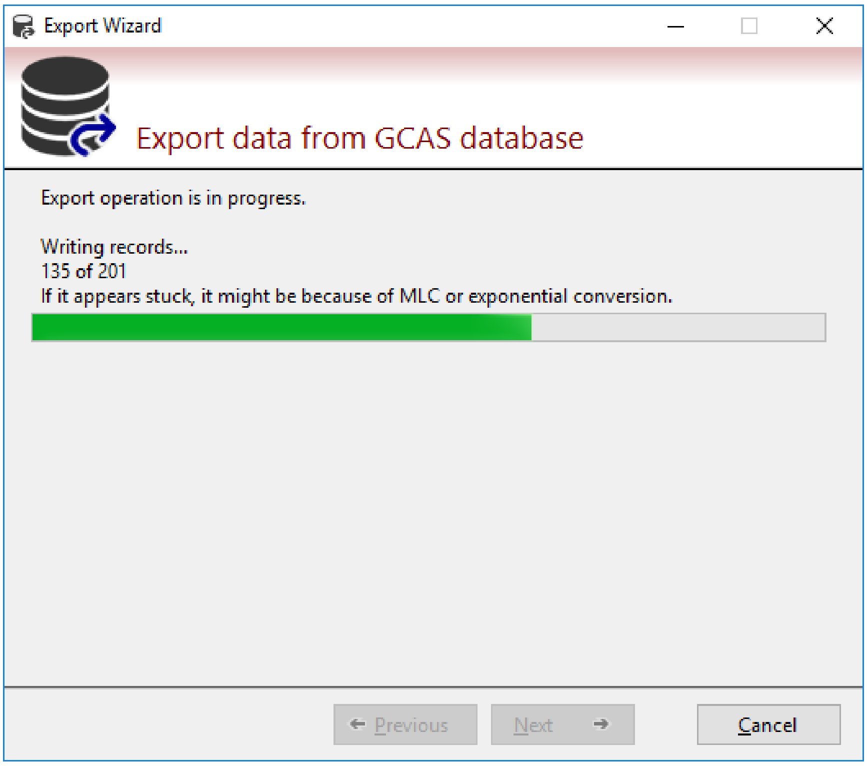
On the right side, there are date pickers to set the date range. Under those, there is a check box **Also include records marked as inactive**. This check box causes every inactive record within the set date range is exported along with all active records.

Excel exporter supports record conversion on calibration records and mole composition records. If you ticked **Footprint and calibration data** to export, you should see a list of check boxes titled **Export RF as**. Similarly, if you ticked **Mole compositions** to export, the list **Export MC as** should appear. Here you can set whether the RF values or mole composition values should be converted into one or more record types. Ticking **Original** will export calibration data or mole composition records as they are, no conversion performed. The option **Single point** and **MLC** (multilevel-calibrated) requires GCAS feature *ISO 10723* in your licence. The last option, **Exponential**, is applicable to ABB devices only.

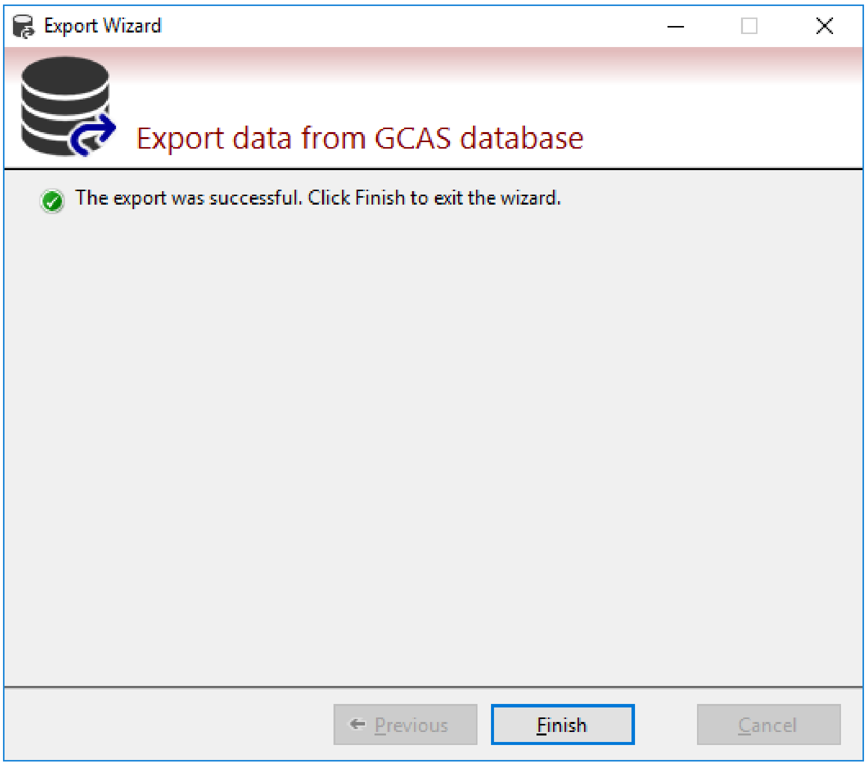
Click **Next**. Unlike other export modules, you don't set the output file. It goes straight to review page.



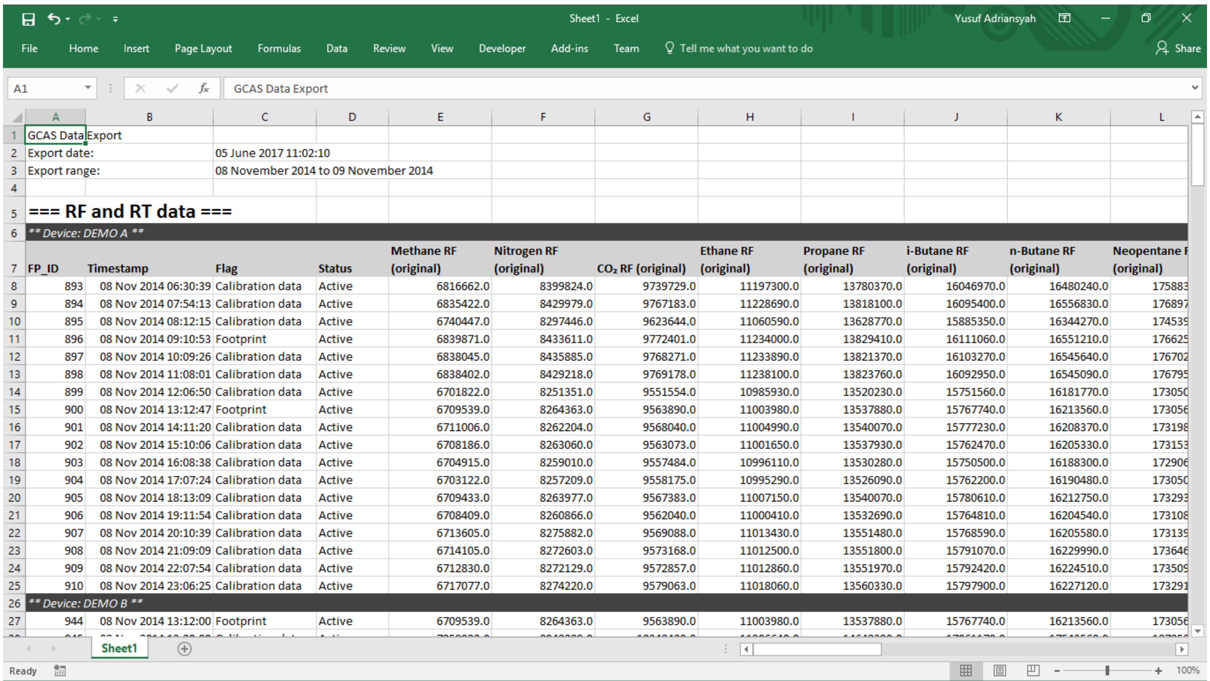
Click **Next** again to commence the export operation. On this screen you should see a new window of Microsoft Excel opening (possibly minimised in background). If you switch to that Microsoft Excel window, you see GCAS data is being written to the worksheet. Better keep that Excel window minimised in order to speed up the writing process until the wizard finishes.



For large number of records, the process may take a prolonged time. Do not close Microsoft Excel until GCAS display this final wizard page. To abort, click **Cancel** on the wizard instead.



This is an example Microsoft Excel worksheet after export process is finished.



GCAS Data Export
Export date: 05 June 2017 11:02:10
Export range: 08 November 2014 to 09 November 2014

=== RF and RT data ===

** Device: DEMO A **

FP_ID	Timestamp	Flag	Status	Methane RF (original)	Nitrogen RF (original)	CO₂ RF (original)	Ethane RF (original)	Propane RF (original)	i-Butane RF (original)	n-Butane RF (original)	Neopentane F (original)
893	08 Nov 2014 06:30:39	Calibration data	Active	6816662.0	8399824.0	9739729.0	11197300.0	13780370.0	16046970.0	16480240.0	175883
894	08 Nov 2014 07:54:13	Calibration data	Active	6835422.0	8429979.0	9767183.0	11228690.0	13818100.0	16095400.0	16556830.0	176897
895	08 Nov 2014 08:12:15	Calibration data	Active	6740447.0	8297446.0	9623644.0	11060590.0	13628770.0	15885350.0	16344270.0	174539
896	08 Nov 2014 09:10:53	Footprint	Active	6839871.0	8433611.0	9772401.0	11234000.0	13829410.0	16111060.0	16551210.0	176625
897	08 Nov 2014 10:09:26	Calibration data	Active	6838045.0	8435885.0	9768271.0	11233890.0	13821370.0	16103270.0	16545640.0	176702
898	08 Nov 2014 11:08:01	Calibration data	Active	6838402.0	8429218.0	9769178.0	11238100.0	13823760.0	16092950.0	16545090.0	176795
899	08 Nov 2014 12:06:50	Calibration data	Active	6701822.0	8251351.0	9551554.0	10985930.0	13520230.0	15751560.0	16181770.0	173050
900	08 Nov 2014 13:12:47	Footprint	Active	6709539.0	8264363.0	9563890.0	11003980.0	13537880.0	15767740.0	16213560.0	173056
901	08 Nov 2014 14:11:20	Calibration data	Active	6711006.0	8262204.0	9568040.0	11004990.0	13540070.0	15777230.0	16208370.0	173198
902	08 Nov 2014 15:10:06	Calibration data	Active	6708186.0	8263060.0	9563073.0	11001650.0	13537930.0	15762470.0	16205330.0	173153
903	08 Nov 2014 16:08:38	Calibration data	Active	6704915.0	8259010.0	9557484.0	10996110.0	13530280.0	15750500.0	16188300.0	172906
904	08 Nov 2014 17:07:24	Calibration data	Active	6703122.0	8257209.0	9558175.0	10995290.0	13526090.0	15762200.0	16190480.0	173050
905	08 Nov 2014 18:13:09	Calibration data	Active	6709433.0	8263977.0	9567383.0	11007150.0	13540070.0	15780610.0	16212750.0	173293
906	08 Nov 2014 19:11:54	Calibration data	Active	6708409.0	8260866.0	9562040.0	11000410.0	13532690.0	15764810.0	16204540.0	173108
907	08 Nov 2014 20:10:39	Calibration data	Active	6713605.0	8275882.0	9569088.0	11013430.0	13551480.0	15768590.0	16205580.0	173139
908	08 Nov 2014 21:09:09	Calibration data	Active	6714105.0	8272603.0	9573168.0	11012500.0	13551800.0	15791070.0	16229990.0	173646
909	08 Nov 2014 22:07:54	Calibration data	Active	6712830.0	8272129.0	9572857.0	11012860.0	13551970.0	15792420.0	16224510.0	173509
910	08 Nov 2014 23:06:25	Calibration data	Active	6717077.0	8274220.0	9579063.0	11018060.0	13560330.0	15797900.0	16227120.0	173291
** Device: DEMO B **											
944	08 Nov 2014 13:12:00	Footprint	Active	6709539.0	8264363.0	9563890.0	11003980.0	13537880.0	15767740.0	16213560.0	173056

32.3 Export to Microsoft Access

This exporter module exports GCAS data to Microsoft Access database file (.accdb). *Unlike the SQL Compact export, the export result is **not** a GCAS database thus you **cannot** use it as "local offline" database*. The export result is a simple Microsoft Access database intended for further analysis.

Note

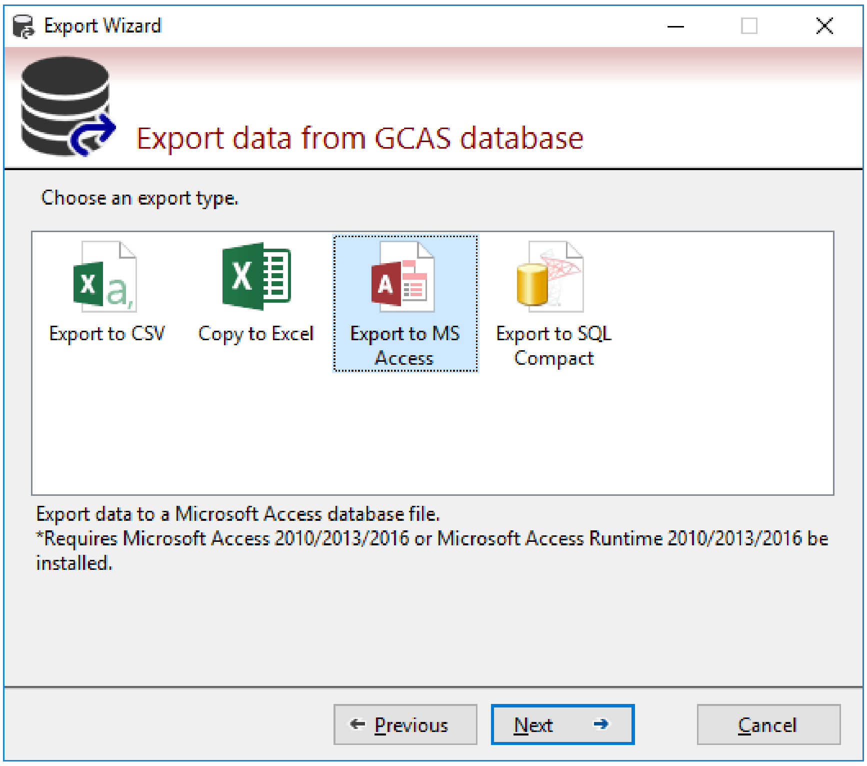
You need the GCAS feature *Export to Microsoft Office* to be included in your GCAS licence in order to use this feature. Additionally, this exporter also requires just one of these...

- Microsoft Access 2010,
- Microsoft Access Database Engine 2010,
- Microsoft Access 2013 **32-bit**,
- Microsoft Access Runtime 2013 **32-bit** (the 64-bit won't work),
- Microsoft Access 2016 **32-bit**, or
- Microsoft Access Runtime 2016 **32-bit** (the 64-bit won't work)

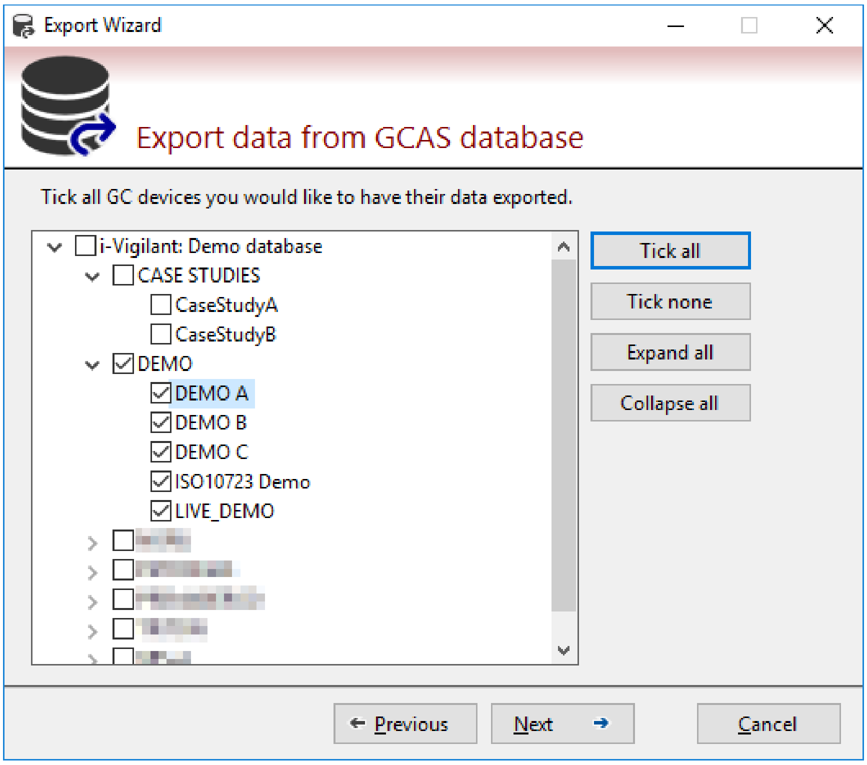
...to be installed on your computer.

There are some limitations on Microsoft Access export. First, spot samples will appear as normal mole composition records with stream number −1 (negative one). Second, some database columns are shared. For example, you see "RF_Methane_Benzene_TheGas" instead of just "RF_Methane". Regular GC devices use this column to store methane, but BTEX devices use this to store benzene.

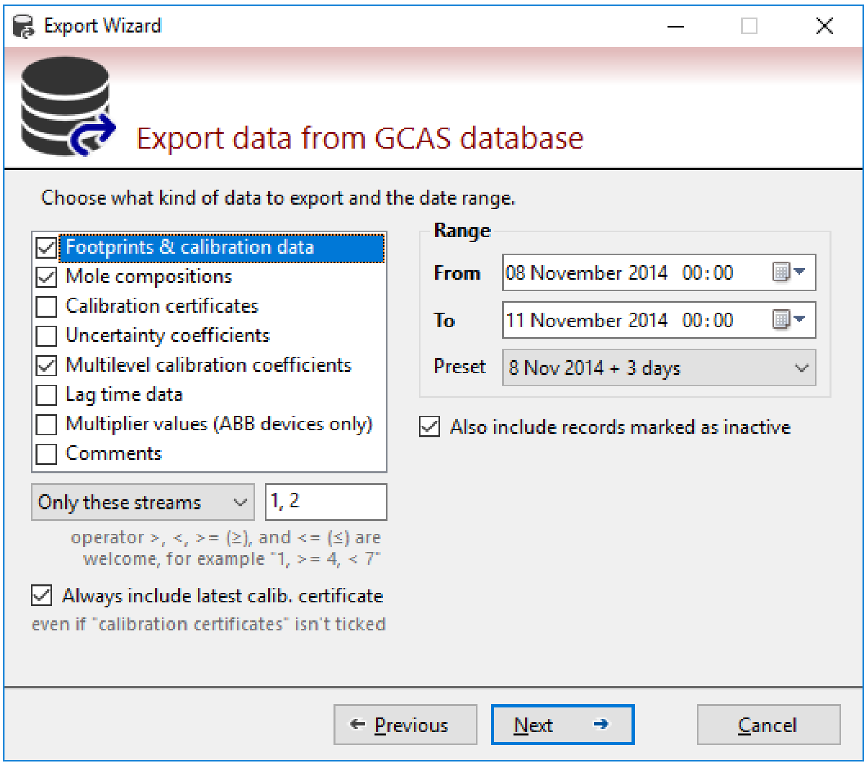
Choose **Export to MS Access** to begin.



Tick all GC devices you would like to have their data exported.



Choose which data to export and the date/time range.

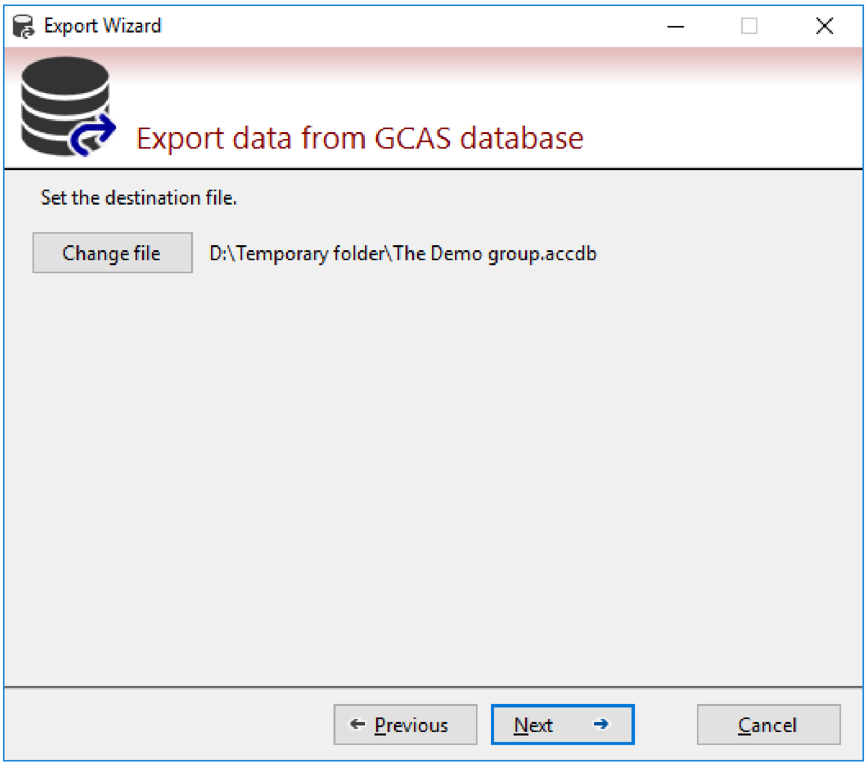


If you tick **Mole compositions**, there is an option to limit which streams to export. The default option is **Export all streams**. To export certain streams, change to **Only these streams** and put the desired stream numbers in the available box. Conversely to exclude certain streams from the export, change to **Except these streams** and input the stream numbers. Separate the stream numbers by comma, for example `1, 2, 4`. You can use hyphen to create range such as `1-3, S`. Here, the letter `S` stands for [spot samples](). The mathematical operator `<`, `>`, `<=` or `≤`, and `>=` or `≥` are accepted too, so you can write something like "`1`, `2`, `> 4`, `<= 12`" to create a range. An open range looks like "`< 4`, `> 7`". A closed range goes similar to "`>= 4`, `< 10`". Only one range is supported, either open or closed, so you cannot enter something like "`> 3`, `< 6`, `>= 12`, `<= 18`" which has two closed ranges.

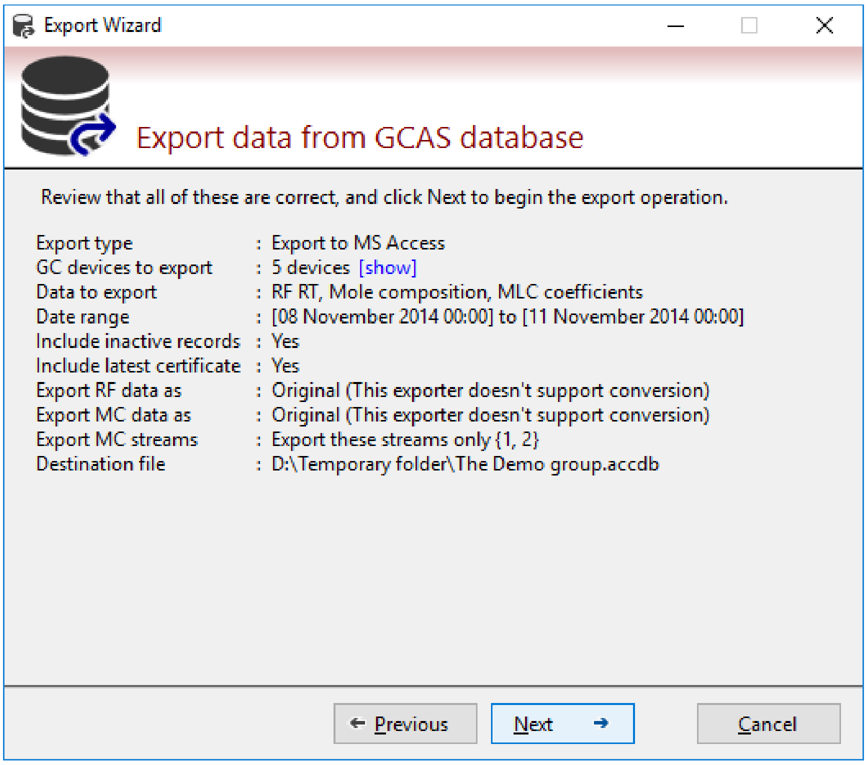
Moving down, the check box **Always include latest calib certificate** ensures the latest calibration gas certificate of every selected device is exported, even though you didn't tick **Calibration certificates** to export, or even though you ticked it but the latest certificate is outside of date range. On Microsoft Access exporter, this check box is ticked by default.

On the right side, there are date pickers to set the date range. Under those, there is a check box **Also include records marked as inactive**. This check box causes every inactive record within the set date range is exported along with all active records.

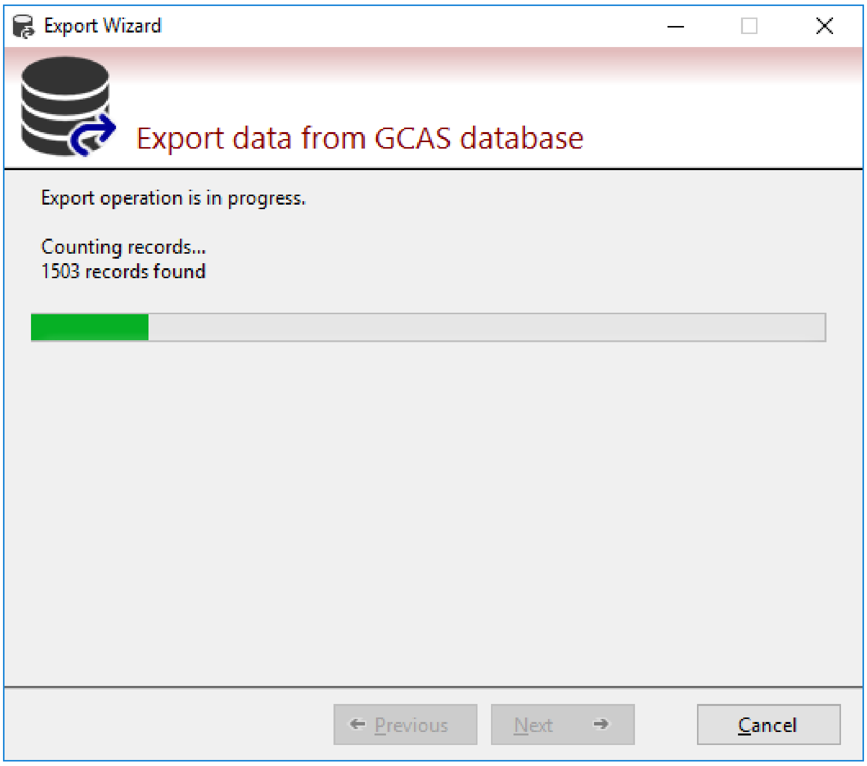
Next, set the destination Access database file.



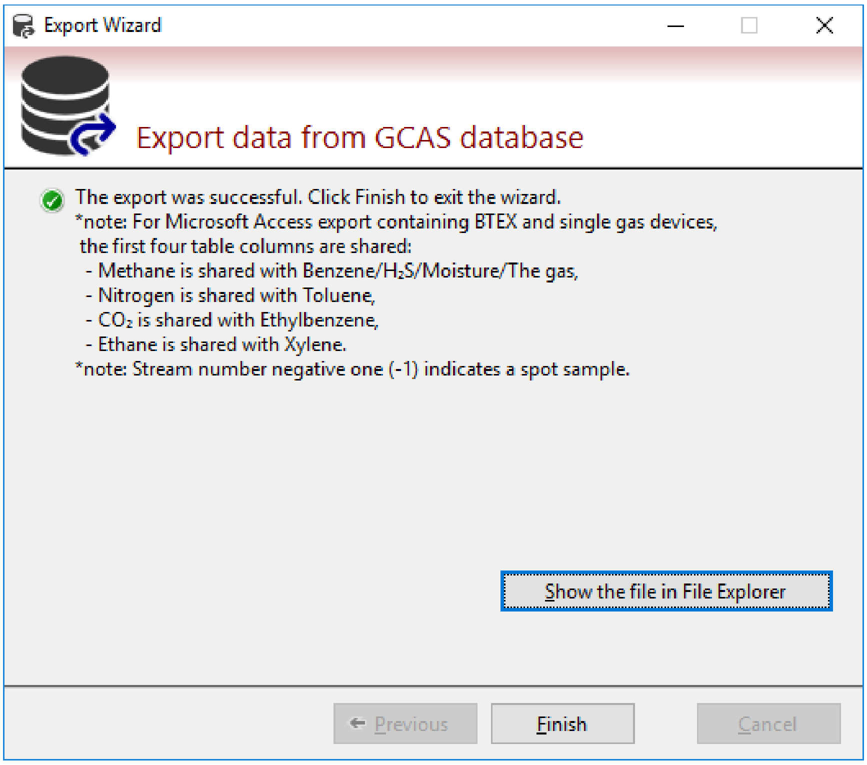
Review the export settings, then click **Next** to begin the export process.



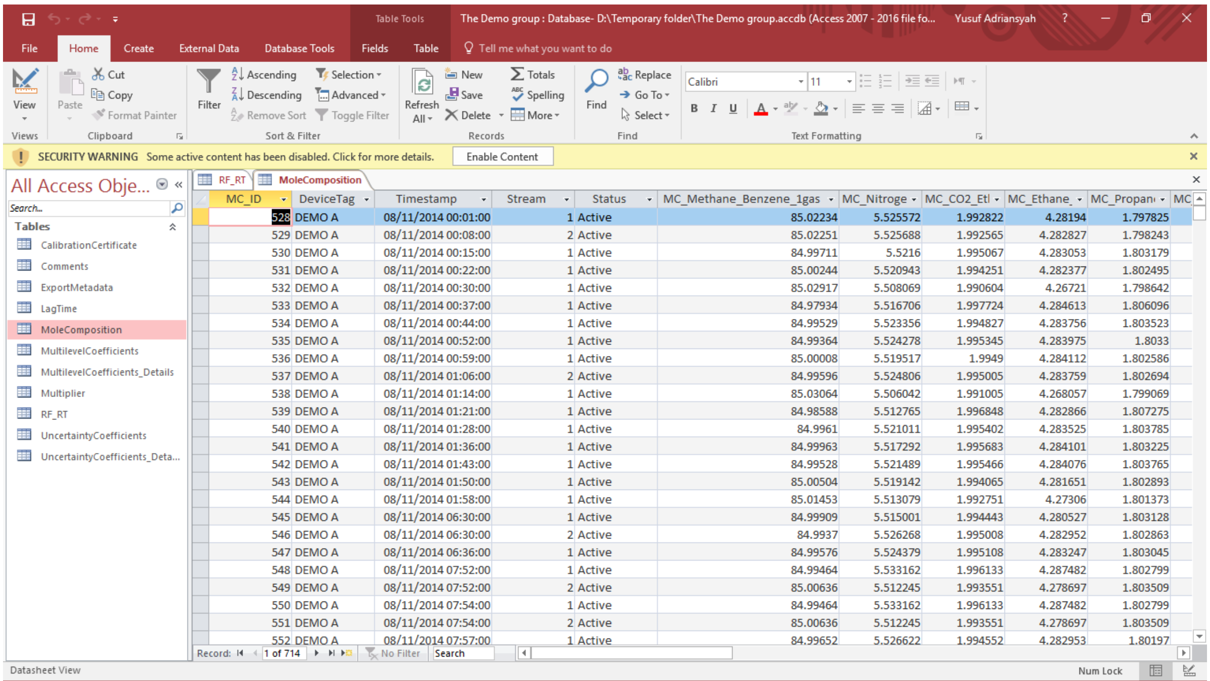
GCAS commences the export operation.



This wizard page confirms that the export has been successful. You can now open the ACCDB file.



Here is an example of export result Microsoft Access database file.



Note

If you opted to export uncertainty coefficients or MLC coefficients, the coefficients are stored in two separate tables: *UncertaintyCoefficients* and *UncertaintyCoefficients_Details* for uncertainty, or *Multi-levelCoefficients* and *MultilevelCoefficients_Details* for multilevel calibration.

The table *UncertaintyCoefficients* and *MultilevelCoefficients* store the principal metadata of the coefficient sets while *UncertaintyCoefficients_Details* and *MultilevelCoefficients_Detail* table contain the actual coefficients.

You only need to open *UncertaintyCoefficients* table because *UncertaintyCoefficients_Details* is already linked to this table. **Rep** stands for repeatability coefficient, while **Rcc** means response concentration coefficient. Likewise, you need to open *MultilevelCoefficients*, not the *_Details* one.

COEFF_ID	DeviceTag	DateOfTest	Status	Description	Click to Add
1	[illegible]	27/08/2014	Active	Data active from 27/8/2014	

DetailsID	GasName	Rep_A	Rep_B	Rep_C	Rep_D	Rcc_A	Rcc_B	Rcc_C	Rcc_D	Click to Add
1	Methane	621180	0	0	0	67861000	9777000	0	0	
2	Nitrogen	33237	5823.1	0	0	207910	13068000	-41238	2336.1	
3	Carbon dioxide	-277.06	13572	0	0	8925.4	15725000	0	0	
4	Ethane	18153	10996	0	0	1750.4	17794000	-34203	0	
5	Propane	4547.4	15521	0	0	-105690	22305000	122260	-18621	
6	i-Butane	3599.7	19235	0	0	-31355	26333000	-271010	0	
7	n-Butane	5931.2	19210	0	0	-64700	27800000	-449000	0	
8	Neopentane	7617.9	0	0	0	-17200	29200000	0	0	
9	i-Pentane	5146.5	14982	0	0	-4400	30000000	0	0	
10	n-Pentane	6434.8	23479	0	0	-16400	31100000	0	0	
11	Hexane	1272.7	24722	0	0	52500	33900000	0	0	
12	Heptane	0	0	0	0	0	0	0	0	
13	Octane	0	0	0	0	0	0	0	0	
14	Nonane	0	0	0	0	0	0	0	0	
15	Decane	0	0	0	0	0	0	0	0	
(New)		0	0	0	0	0	0	0	0	

32.4 Export to Microsoft SQL Server Compact Database

This exporter module exports GCAS data to Microsoft SQL Server Compact Edition database file (.sdf). *The export result is a **complete** GCAS database thus you **can** use it as a "local offline" database.*

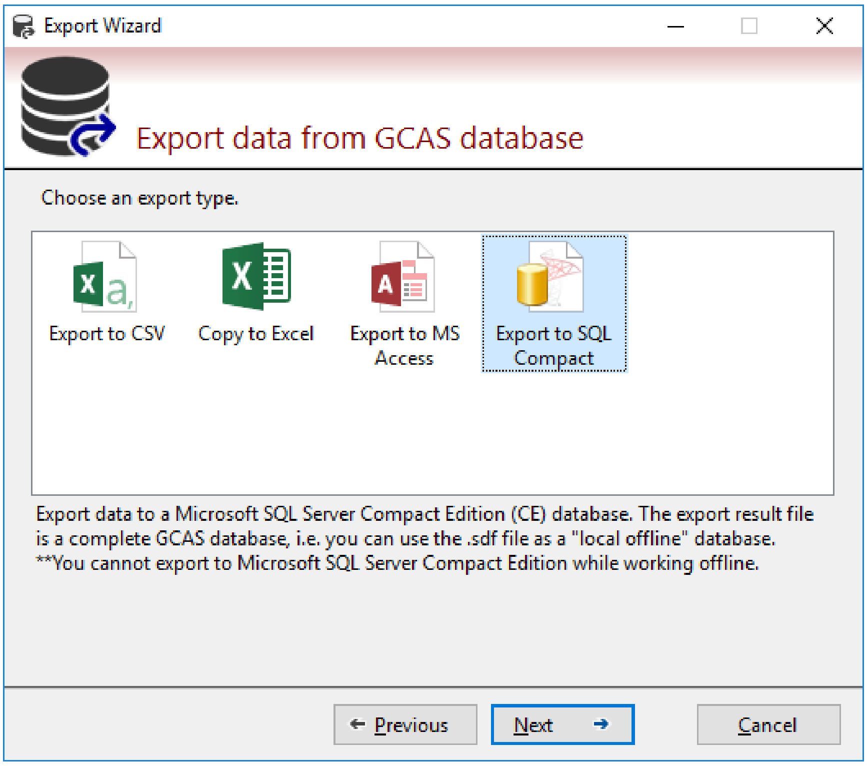
> **Note**
>
> You need the GCAS feature *Export to Microsoft SQL Server Compact Edition* to be included in your GCAS licence in order to use this feature. Additionally, make sure that Microsoft SQL Server Compact Edition v4.0 has been installed on your computer (it is already a pre-requisite anyway). Otherwise, the Export Wizard will raise an error.

What included in the export result will be:

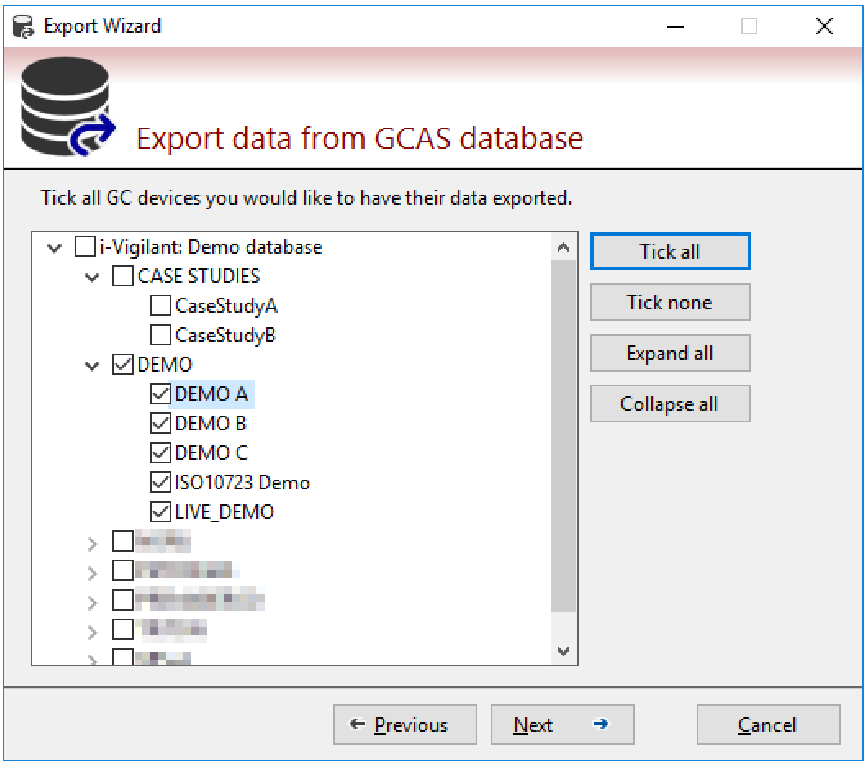
1. The information about of the selected devices in wizard step 1,
2. The agreement records for these devices,
3. Analysis parameter of these devices,
4. Footprint and calibration data of these devices (if selected in wizard step 2) *,
5. Multiplier values of these devices (if selected in wizard step 2 and if the selected device list has ABB devices in it) *,
6. Mole composition data of these devices (if selected in wizard step 2) *,
7. Calibration gas certificates of these devices (if selected in wizard step 2) *,
8. Uncertainty coefficients of these devices (if selected in wizard step 2) *,
9. Multilevel calibration coefficients of these devices (if selected in wizard step 2) *,
10. Lag time records of these devices (if selected in wizard step 2) *,
11. Comments for these devices (if selected in wizard step 2) *,
12. The groups to which these devices belong,
13. The workspaces belong to these groups,
14. Login data of all users who joined these groups (yes, they can log in to the exported database file too),
15. User profile data of all users who joined these groups,
16. All user types and roles including custom ones,
17. All menu permissions and action permissions.

*within the selected date range.

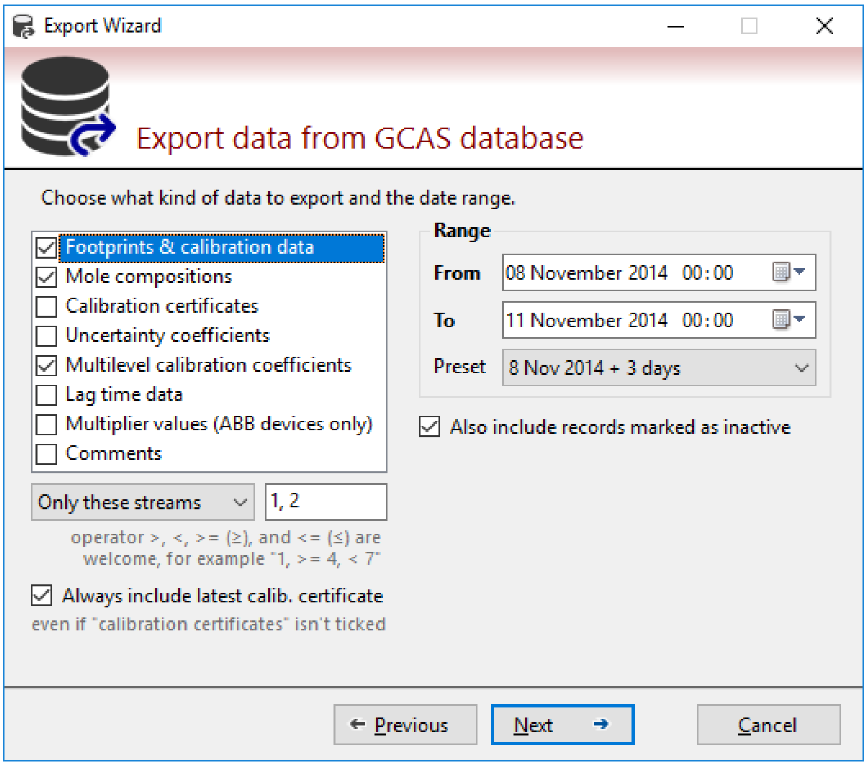
Choose **Export to SQL Compact** to begin. You cannot export to SQL Compact when you are working offline because database structure of full database and temporary database are different.



Tick all GC devices you would like to have their data exported.



Choose which data to export and the date/time range.

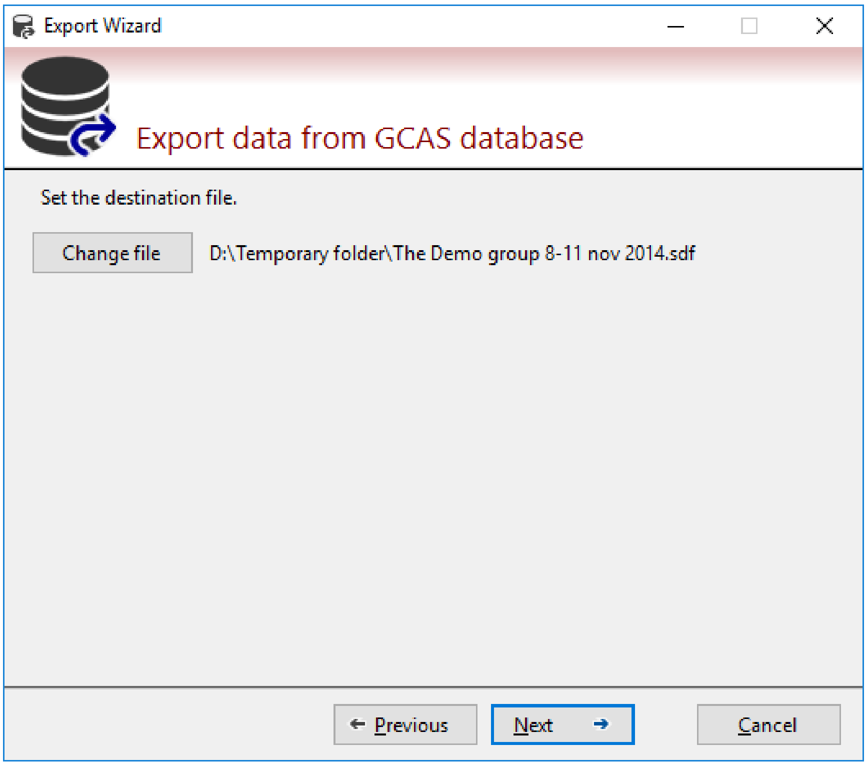


If you tick **Mole compositions**, there is an option to limit which streams to export. The default option is **Export all streams**. To export certain streams, change to **Only these streams** and put the desired stream numbers in the available box. Conversely to exclude certain streams from the export, change to **Except these streams** and input the stream numbers. Separate the stream numbers by comma, for example `1, 2, 4`. You can use hyphen to create range such as `1-3, S`. Here, the letter `S` stands for spot samples. The mathematical operator `<`, `>`, `<=` or `≤`, and `>=` or `≥` are accepted too, so you can write something like "`1`, `2`, `> 4`, `<= 12`" to create a range. An open range looks like "`< 4`, `> 7`". A closed range goes similar to "`>= 4`, `< 10`". Only one range is supported, either open or closed, so you cannot enter something like "`> 3`, `< 6`, `>= 12`, `<= 18`" which has two closed ranges.

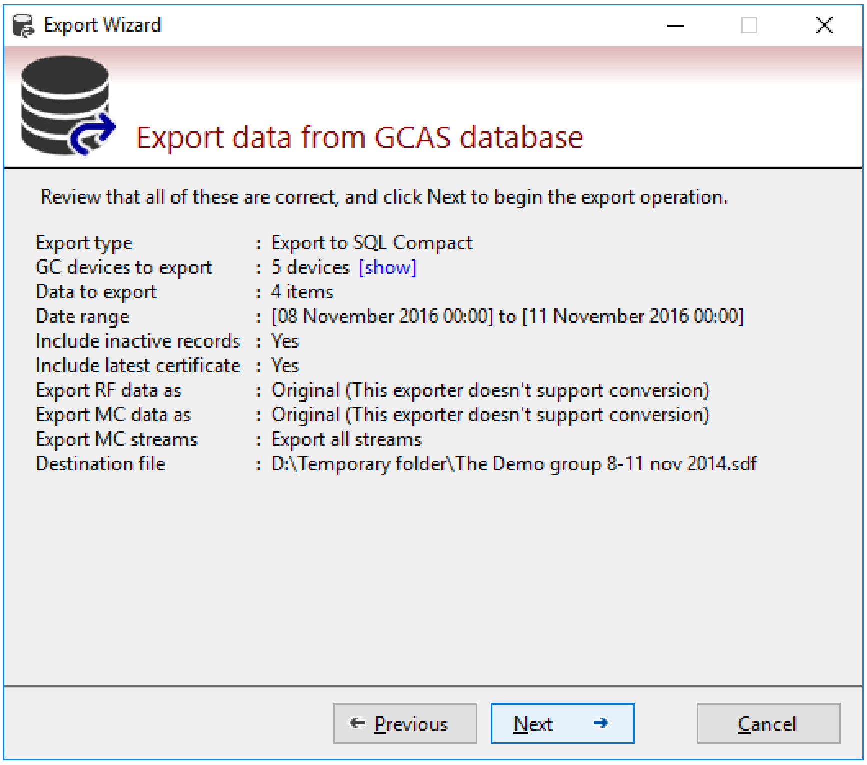
Moving down, the check box **Always include latest calib certificate** ensures the latest calibration gas certificate of every selected device is exported, even though you didn't tick **Calibration certificates** to export, or even though you ticked it but the latest certificate is outside of date range. We strongly recommend to tick this box as a lot of times customers send their exported database to us for analysis but because the certificates are out of date range, we could not compute uncertainty values or convert multilevel-calibrated records to single-point. P.S: Unique to SQL compact export, this check box also forces latest MLC coefficient set of every selected device to be included in the export.

On the right side, there are date pickers to set the date range. Under those, there is a check box **Also include records marked as inactive**. This check box causes every inactive record within the set date range is exported along with all active records.

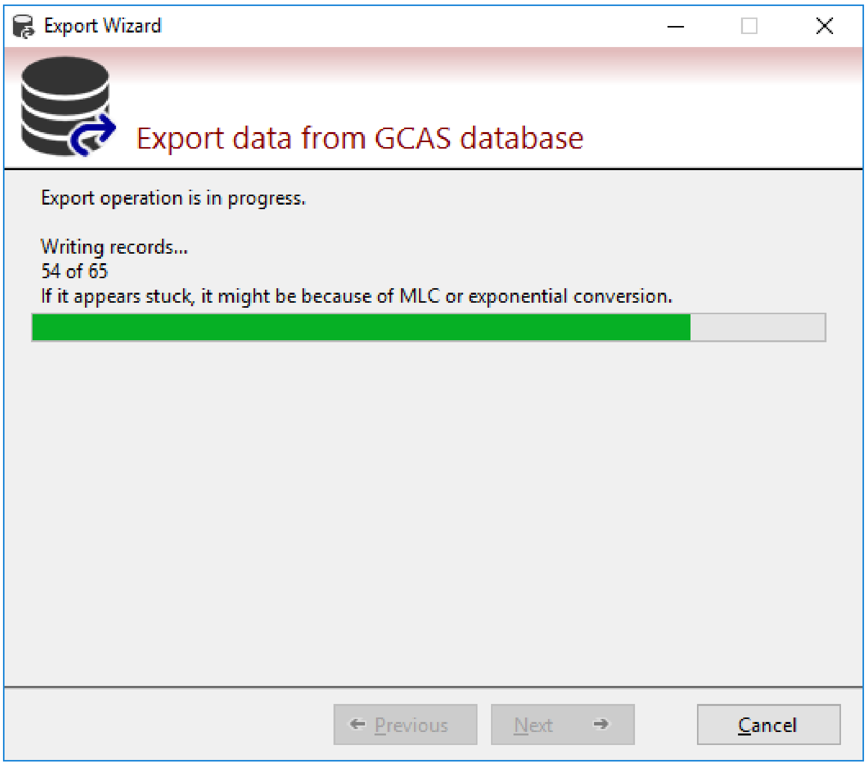
Set the destination database file.



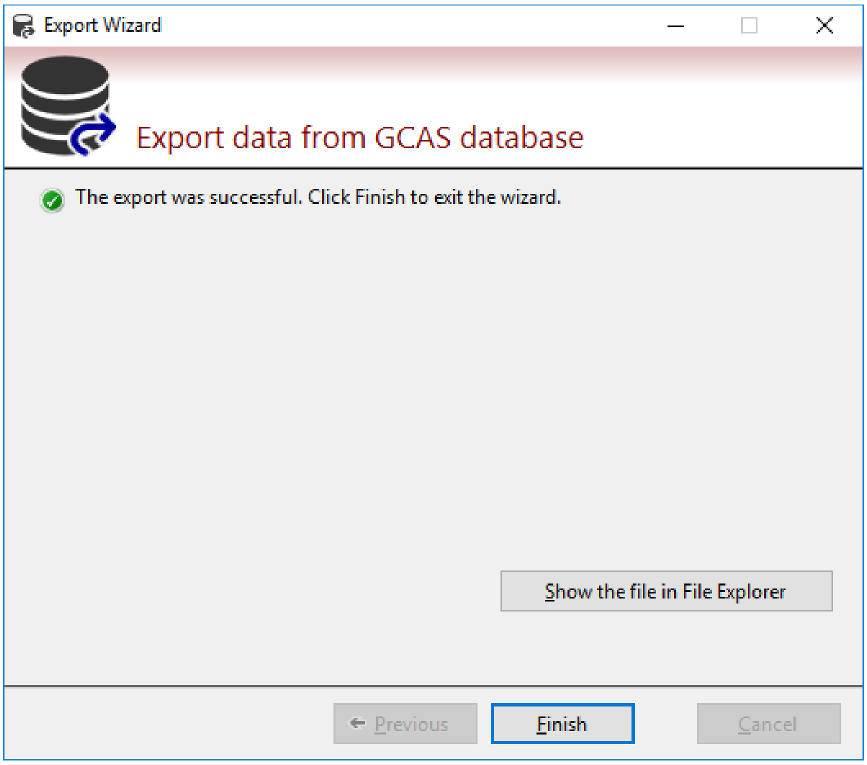
Review the export settings, and click **Next** to begin the export process.



GCAS commences the export operation.

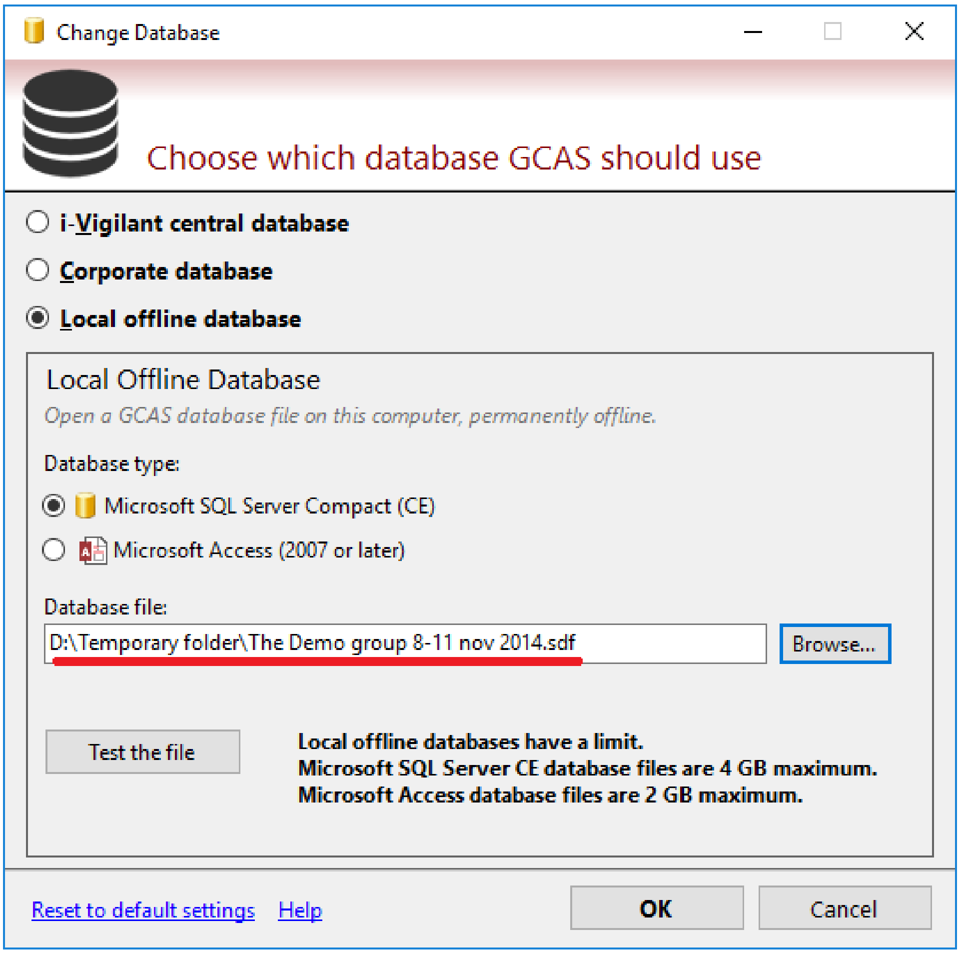


This wizard page confirms that the export has been successful. Click **Finish** to close the wizard.



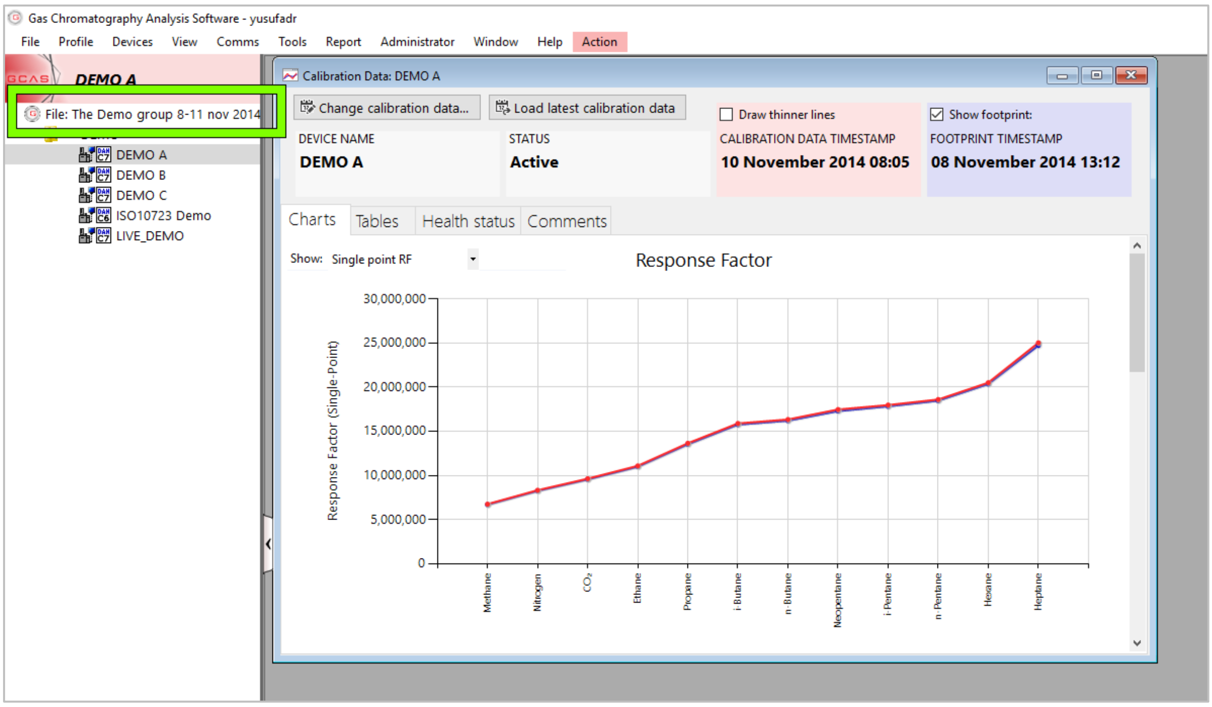
In order to verify the export result, try changing database to the SDF file. Use **local offline** option, choose **Microsoft SQL Server Compact** and point to the export file.

> **Note**
>
> If the option **Local offline database** as in the screenshot below is greyed out, it means you do not have GCAS feature *Local Offline Database* in your GCAS licence.



You should see the file name on your device panel and use GCAS as usual. However, you would notice several differences:

- This offline database file contains only the devices you have selected in wizard step 1,
- This offline database file contains data for the limited date range you have set in wizard step 2,
- Users who can log in to this offline database file are only *you* and *those who joined the same groups as you*.



Gas Chromatography Analysis Software - yusufadr
File Profile Devices View Comms Tools Report Administrator Window Help Action
DEMO A
File: The Demo group 8-11 nov 2014
DEMO A
DEMO B
DEMO C
ISO10723 Demo
LIVE_DEMO
Calibration Data: DEMO A
Change calibration data...
Load latest calibration data
Draw thinner lines
Show footprint:
DEVICE NAME
DEMO A
STATUS
Active
CALIBRATION DATA TIMESTAMP
10 November 2014 08:05
FOOTPRINT TIMESTAMP
08 November 2014 13:12
Charts
Tables
Health status
Comments
Show: Single point RF
Response Factor
Response Factor (Single-Point)
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
Methane
Nitrogen
Ethane
Propane
i-Butane
n-Butane
Neopentane
i-Pentane
n-Pentane
Hexane
Heptane

33 Work Offline

GCAS supports *offline mode* which might be useful in certain scenarios, such as when your network connection is disrupted or when you need to take your laptop away to a remote site where internet connection is a luxury. To work offline, you need to set up your own temporary database. GCAS uses this temporary database while in offline mode.

Note

To use this feature, you need the GCAS feature *Work-offline Capability* to be included in your GCAS licence.

Work-offline is available if your main database server is i-Vigilant central database or your local corporate database. *Offline working is not available for local offline database because it* is *already offline.*

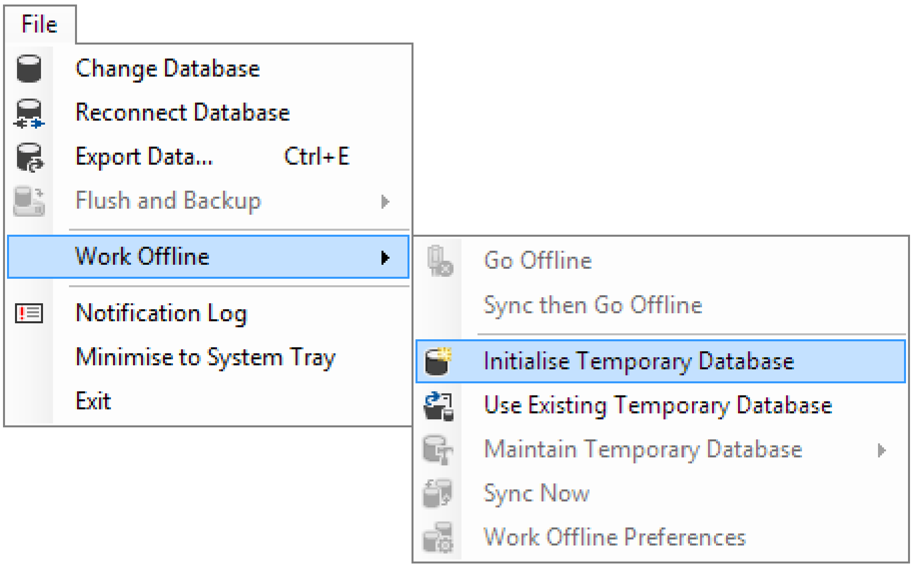
Some features are not available in offline mode. For instance, you cannot change database, edit your profile, edit your password, or use the Administrator menu while working offline.

33.1 Set Up Temporary Database

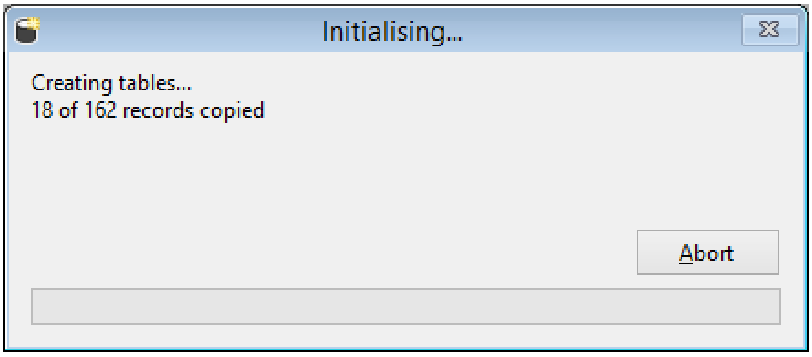
You can either create new temporary database or reuse an existing backup.

33.1.1 Create New Temporary Database

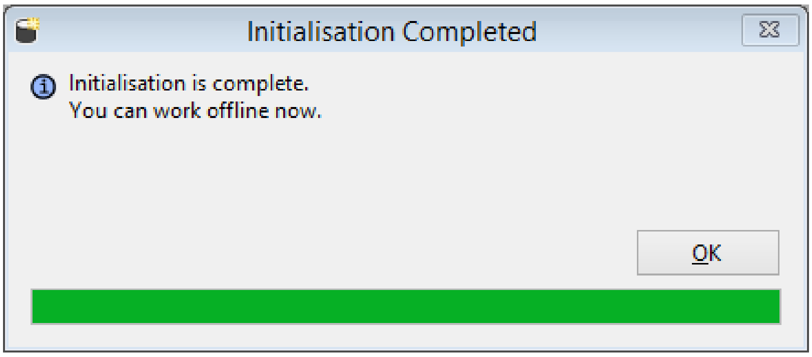
Close all open forms to make sure GCAS is not performing any operations to the GCAS database. Then, go to the File menu > Work Offline > **Initialise Temporary Database**.



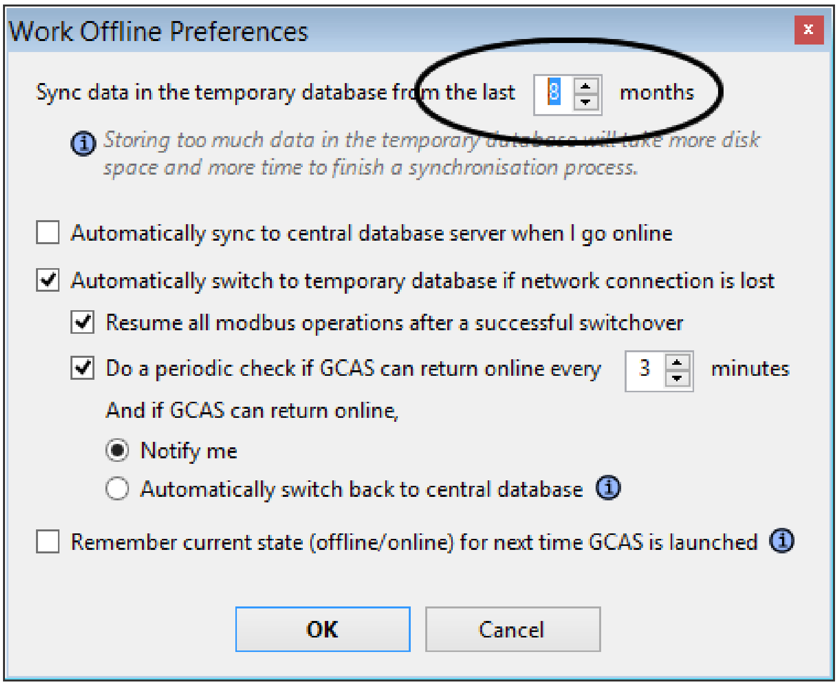
Do not open any forms or dialogue box while initialisation is in progress. This is to ensure no read or write operations are executed upon database.



GCAS creates your temporary database located in the `[installation directory] \DB-WorkOffline\your username.sdf`. GCAS then synchronises all data since last month from the main database server to your temporary database. That is, all data having timestamp greater than today minus one month. On completion, the progress window displays the confirmation message.

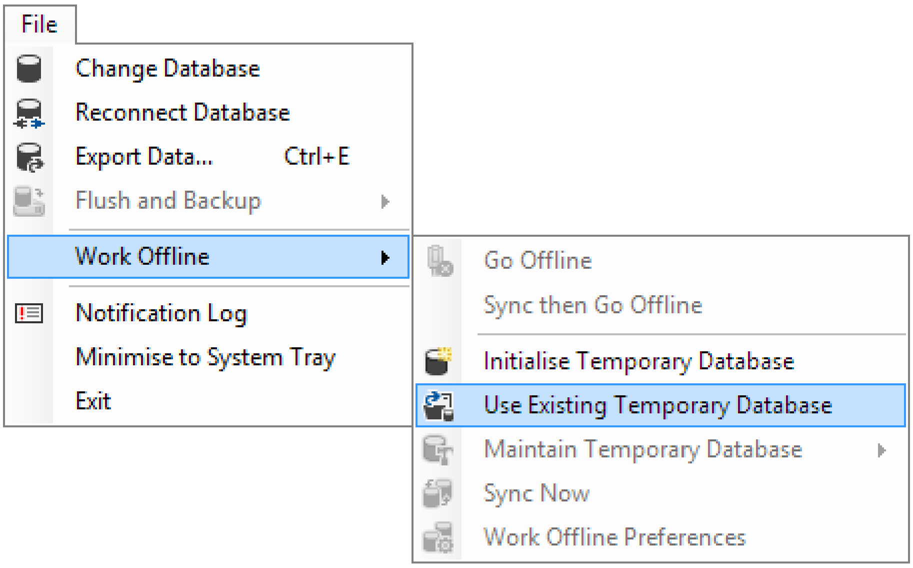


To change how much data to synchronise into temporary database, go to the File menu > Work Offline > **Work Offline Preferences**. Change how many months of data to store on your temporary database between 1 month and 24 months (2 years), then do a manual sync to enforce the change.



33.1.2 Restore a Backup

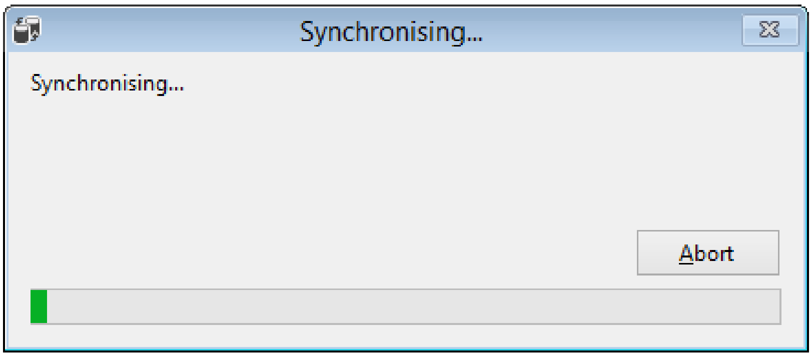
Open the File menu > Work Offline > **Use Existing Temporary Database**. A file open dialogue should appear and you can point GCAS to your backup.

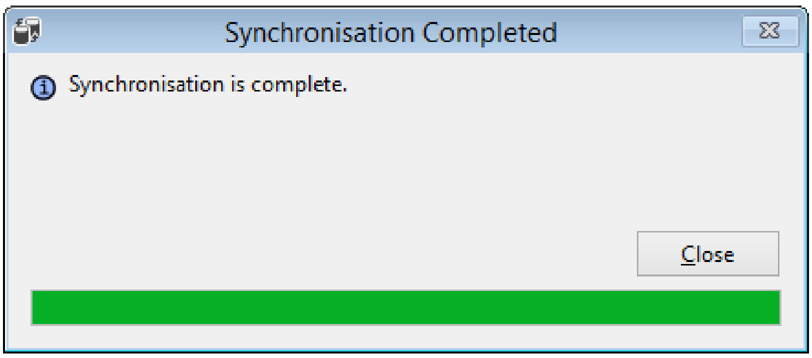


33.2 Synchronise Temporary Database

To initiate a manual sync between your temporary database and your main database server, first you need to work online. Look at the work-offline indicator on the status bar of main user interface, it should display “`Online`”. If not, follow chapter 33.3 to switch into online mode.

Go to the File menu > Work Offline > **Sync Now**.





Any changes made on the temporary database are first committed to the main database server, then your temporary database is refreshed with new data from server. Sync process may take a prolonged time if you have ten thousands of unsynchronised records, especially mole composition data.

Should the progress bar turn red and you see an error message, click on the **Error message** button to see the error log. Or if it turns yellow and you see conflicts, click **Resolve conflicts** to resolve them.

Note

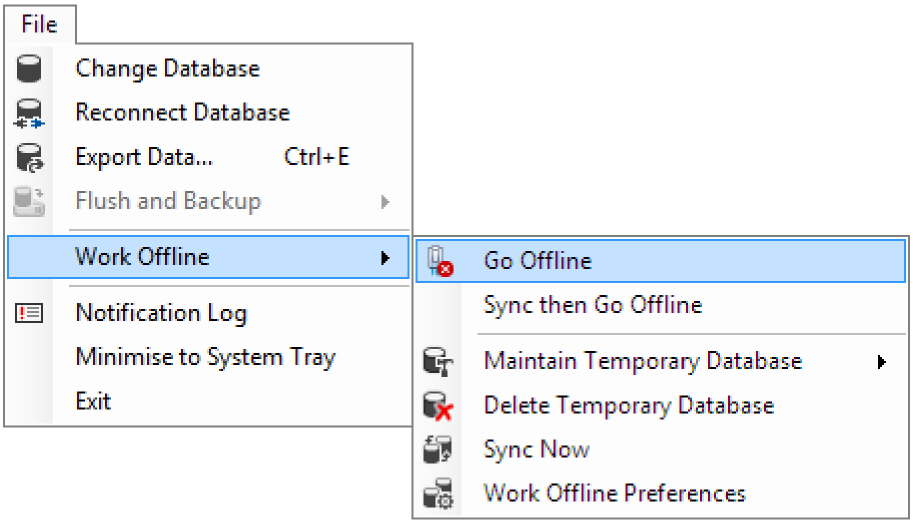
Some cases of *stale condition* bug (the progress bar halts but the computer does nothing) have been reported. Now we implemented stale prevention mechanism. If for any reason you clicked **Abort** in the middle of sync operation, GCAS tries to stop the sync sequence within 10 seconds. If the operation couldn't abort after 10 seconds, the form displays the **Force abort** button. Use this button to terminate all background threads immediately.

33.3 Going Offline, Going Online

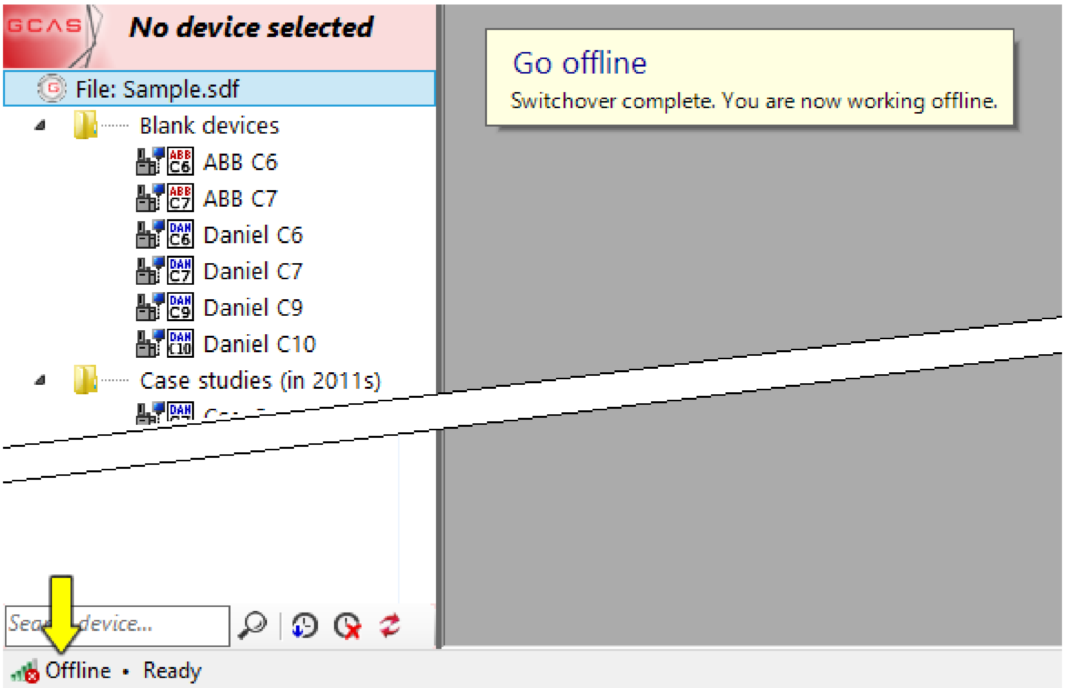
Manual switch between online and offline mode requires all open forms to be closed. This is to make sure that GCAS is not performing any operation onto GCAS database.

Switch into offline mode: Go to the File menu > Work Offline > **Go Offline** to switch immediately.

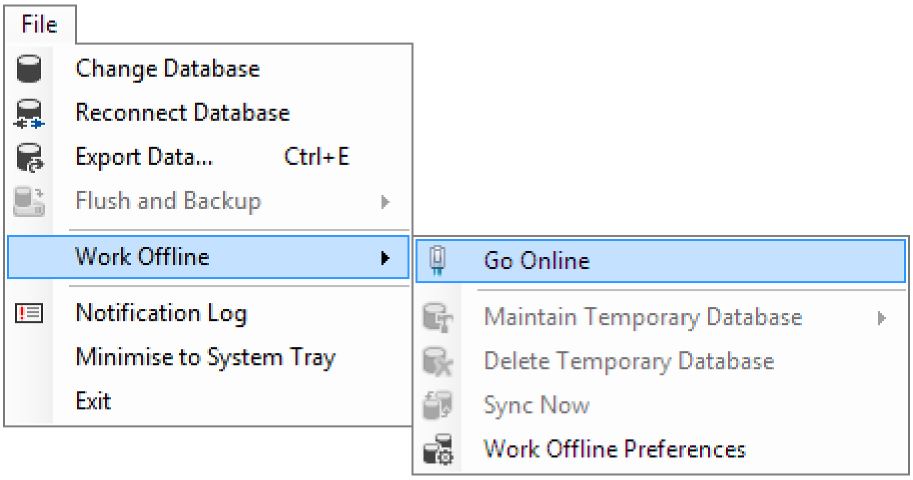
Alternatively, choose the second menu (**Sync then Go Offline**). The second menu will initiate a sync and afterward switches GCAS to offline mode.



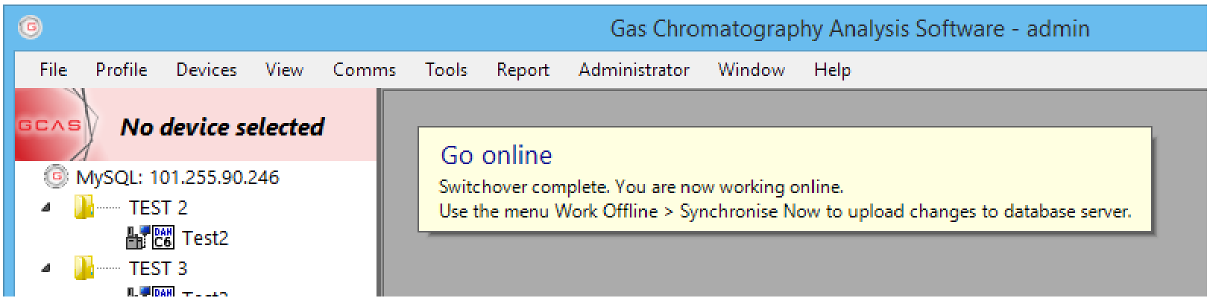
On successful switchover, the work-offline indicator displays "`Offline`" and there will be a notification that you are now working offline.



Switch into online mode: Similarly, go to the File menu > Work Offline > **Go Online**.

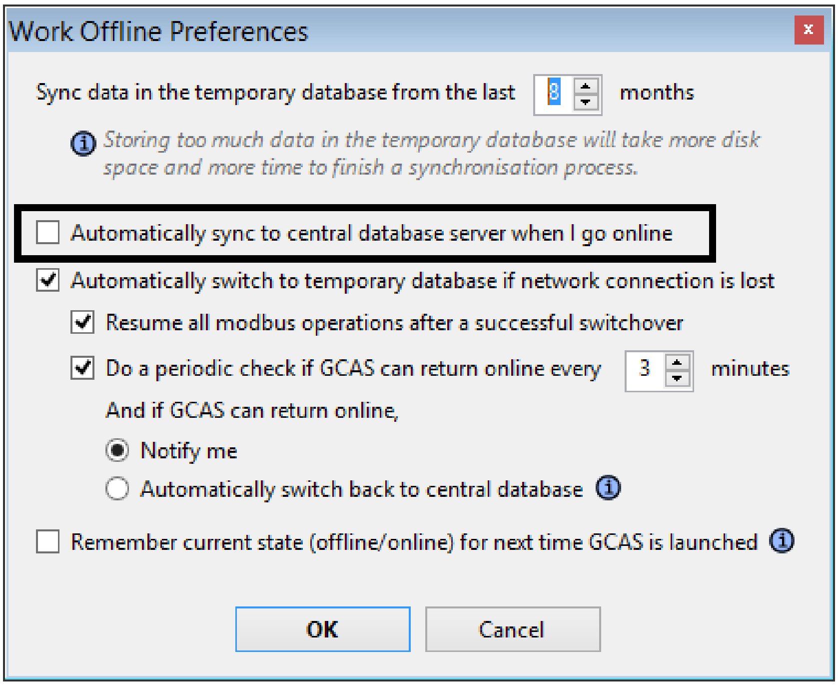


On successful switchover, the work-offline indicator on the status bar displays "`Online`" and also there will be a notification that you are now working online. If automatic sync on switchover is turned on, GCAS initiates a database sync automatically.



33.4 Automatic Sync when Returning Online

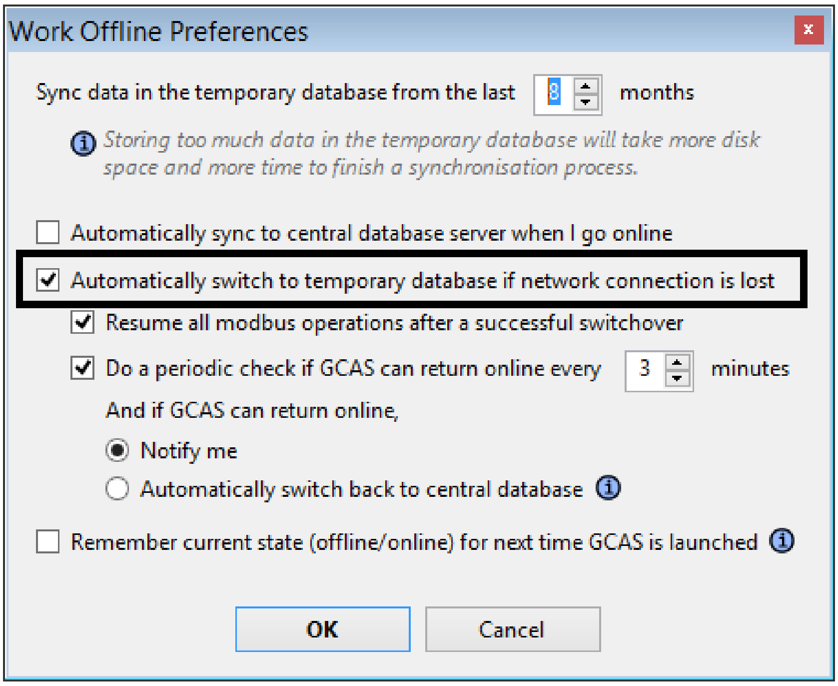
GCAS can start an automatic database sync when you go online. To enable this feature, open the *Work Offline Preferences* dialogue by opening the File menu > Work Offline > **Work Offline Preferences**.



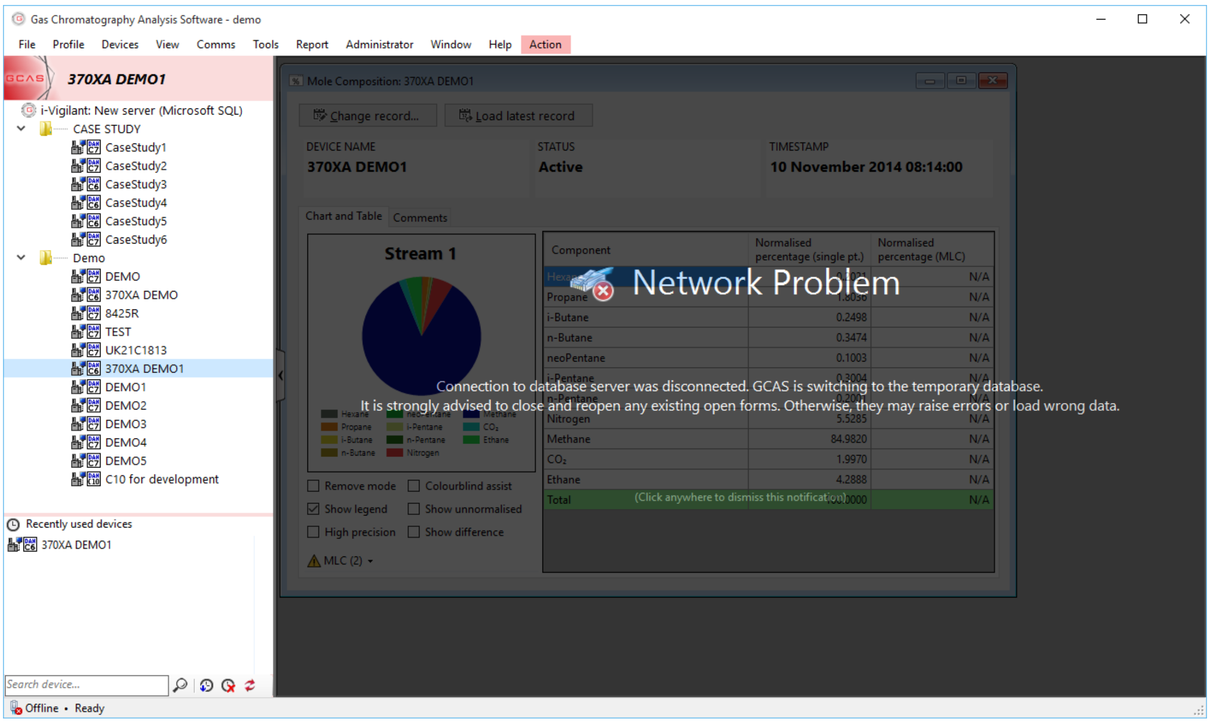
Tick **Automatically sync to central/online database server when I go online** to turn on this feature. Next time you work offline and is about to switch into online mode, GCAS synchronises the temporary database and the main database server as soon as it enters online mode.

33.5 Automatic Switchover on Network Problem

GCAS switches to your temporary database if the network connection between your computer and GCAS database server gets interrupted. To enable this feature, open *Work Offline Preferences* through the File menu > Work Offline > **Work Offline Preferences**. Give a tick mark on **Automatically switch to temporary database if network connection is lost**.

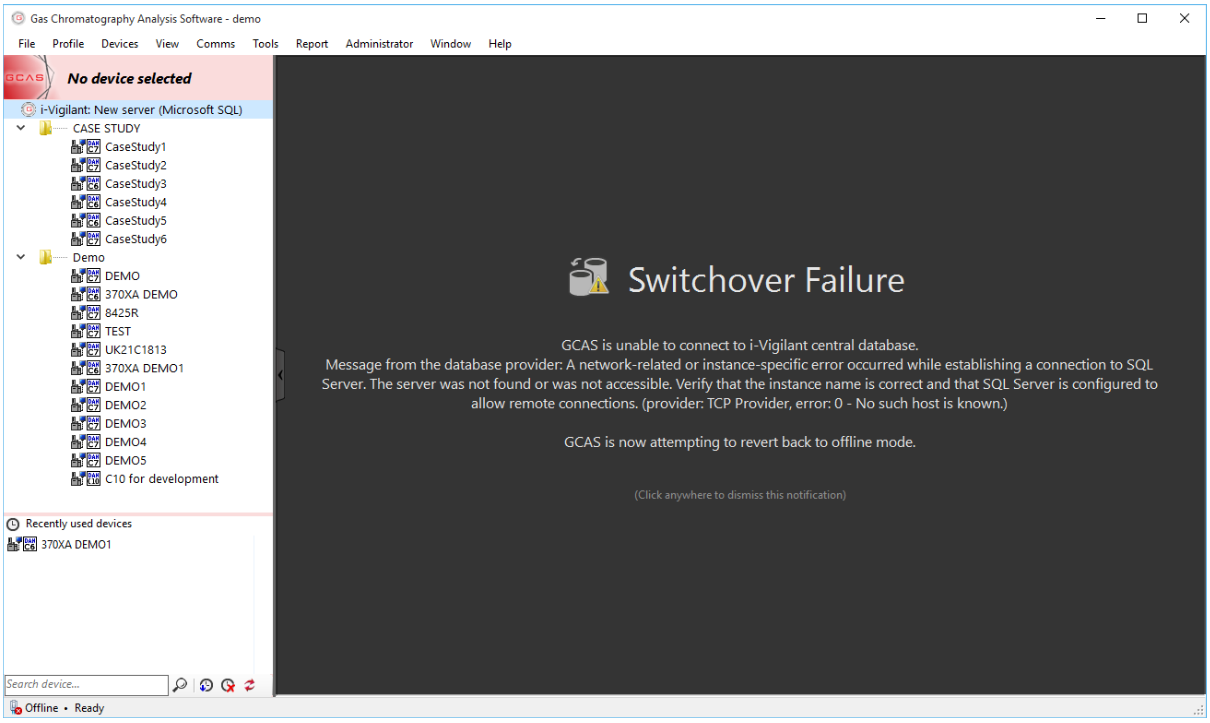


In case of network disturbance, GCAS displays an overlay notification telling you that GCAS has switched to offline mode. Click anywhere on the overlay to dismiss the notification.



We strongly recommend to close and reopen all open forms. This is because each form retains a connection to GCAS database server but the disruption cut this connection. Attempting to continue working on open forms may raise an error especially when there is a task to load or reload data from the database. Why? Because there is no guarantee the record ID of the same record is the same in both main database server and your temporary database. The form can reload the record (the ID still the same) but now the ID belongs to a different record, and that may cause wrong calculation.

Please do not attempt to go back online should your network connection had not recovered. Attempting to do so would make GCAS tries to connect to your main database server, finds it failing, and switches back to your temporary database.

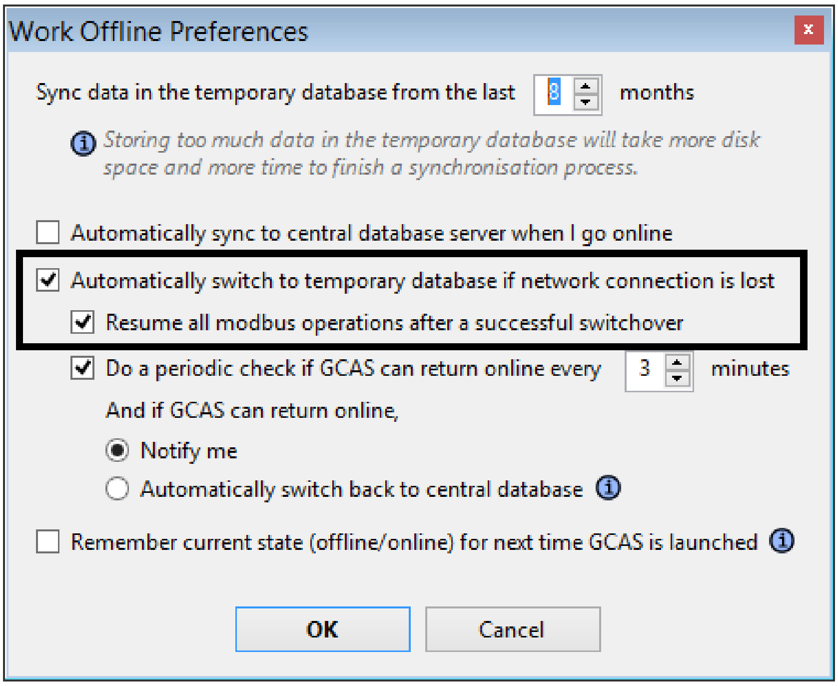


33.6 Automatic Resumption of Data Capture

GCAS stops all data capture operations immediately after it detects network connectivity problem. This is because the connection between GC Connect form and GCAS database server was cut during this disruption, thus an attempt to commit an incoming new record to database server would yield an error.

If you don't have GCAS feature *Work-offline Capability* in your GCAS licence, or if you never set up a temporary database beforehand, all GC Connect forms remain stopped after the disruption. This is particularly bad if you used unattended mode, as no one knows that the operation terminated until someone visits the computer.

With work-offline capability, GCAS can safely resume all data capture operations after switching to temporary database. To enable this feature, open *Work Offline Preferences* dialogue through the File menu > Work Offline > **Work Offline Preferences**.



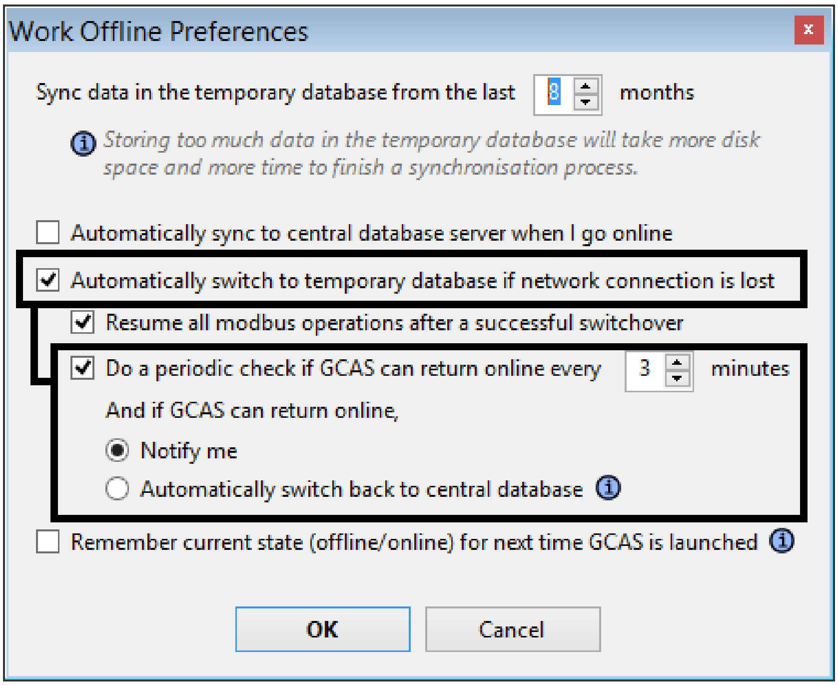
First, automatic switch on network problem must be checked. Then, give a check mark on **Resume all Modbus operations after a successful switchover**. Through this way, all unattended data capture operations stop temporarily and continue soon after GCAS enters offline mode. Records committed before network disruption are still available on your main database server but records committed after network disruption will be stored on your temporary database. You can synchronise records between these two databases later after the network connectivity is up again.

33.7 Automatic Detection of Online Connectivity

After all the fuss of automatic switchover on network problem, GCAS may ping the database server from time to time in order to see if you can return online. To activate this feature, open *Work Offline Preferences* dialogue through the File menu > Work Offline > **Work Offline Preferences**.

Note

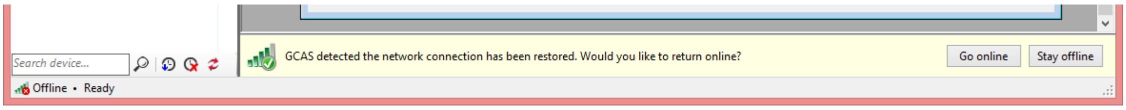
This feature works only for offline mode caused by network disruption. GCAS will *never* ping the database server if you *intentionally* switched into offline mode as described in chapter 33.3 Going offline.



First, automatic switch on network problem must be checked. Next, tick **Do a periodic check if GCAS can return online** and set the desired interval. You can choose ping interval from every single minute to every one hour.

And if GCAS can return online, choose one of the available sub options.

1. **Notify me**: GCAS displays a panel notification at the bottom of the main user interface saying you can return online. Pick the appropriate decision whether to go online or stay offline.



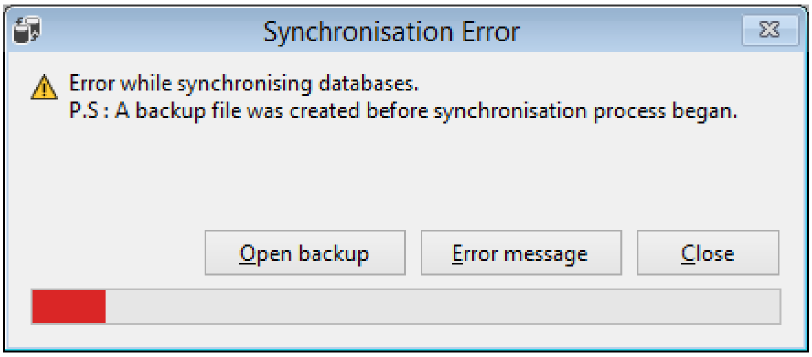
   As a reminder, when you choose to go online, make sure that all open forms have been closed. You can reopen these forms later after the switchover.

2. **Automatically switch back to central/online database**: GCAS performs another automatic switchover to online mode when possible. This is particularly useful for unattended data capture.

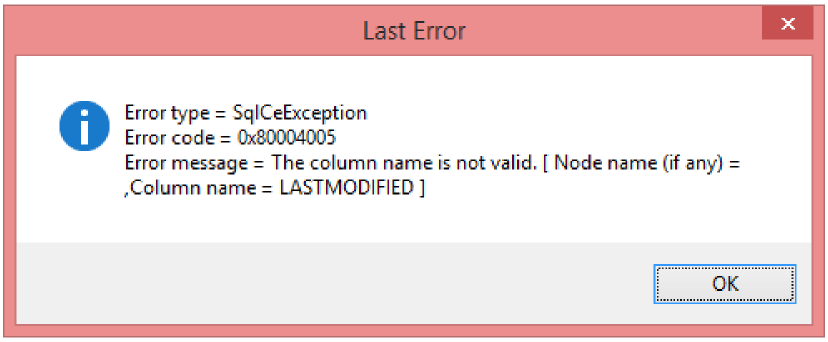
   If you choose this option, all data capture operations will once again be stopped during the switchover. Tick **Resume all Modbus operations after a successful switchover** to make GCAS resume all data capture operations after entering online mode. Special case if you also enabled automatic sync when returning online, the sequence is temporary database sync comes first then data capture resumption goes next.

33.8 Sync Error Log

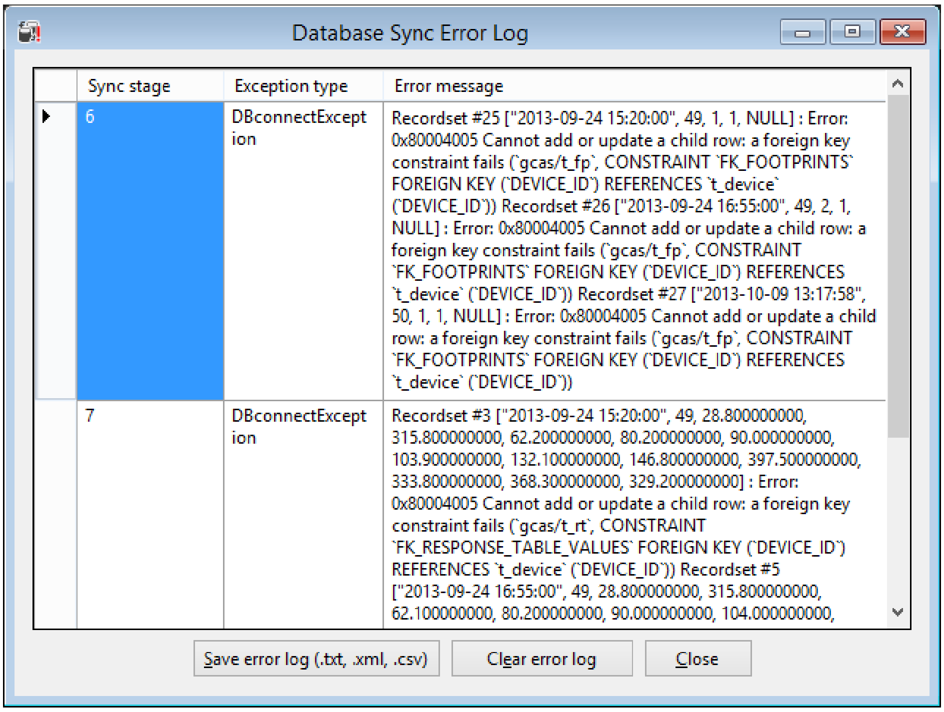
During a database sync, the process may stop when GCAS encounters errors. Red progress bar indicates serious errors, while yellow progress bar indicates less severe errors. Click the **Error message** button to see more details about the error.



Error messages can be as simple (yet fatal) as one message box like this one...



...or more complicated that the errors are displayed in a dedicated window.



These kinds of error are usually related to database. For example, the message in first example "**`Column name is not valid`**" means the database structure is incomplete. This indicates the file `[installation directory] \DB-Template\WorkOffline.sdf` is corrupt (or outdated) and you need to upgrade the GCAS database file. In the second example, "**`Cannot add or update a child row: a foreign key constrain fails`**" means there are some records missing in another table inside the database, but GCAS needs these records in order to write current record.

If you use i-Vigilant central database and see Database Sync Error Log such as in the second example, click **Save error log** button and send the file to our support team so that we can look for the cause of error. If you use local corporate database, your database administrator (DBA) might help you solve the problem.

GCAS tries to create a backup file of your temporary database before sync process begins. You can find the backup in the same directory as your temporary database. Some scenarios might prevent GCAS to create this backup though, such as if your hard disk is full. The file resides on `[installation directory] \DB-WorkOffline\your username.sdf.backup`. Should these sync errors render your temporary database unusable, follow these steps.

1. Go online and cancel automatic sync (if any; by pressing the **Abort** button).
2. Open the File Explorer ("Windows Explorer" on Windows Vista and 7) and navigate to `[installation directory] \DB-WorkOffline\` directory.
3. Delete your temporary database (`your username.sdf`)
4. Rename `your username.sdf.backup` into `your username.sdf`

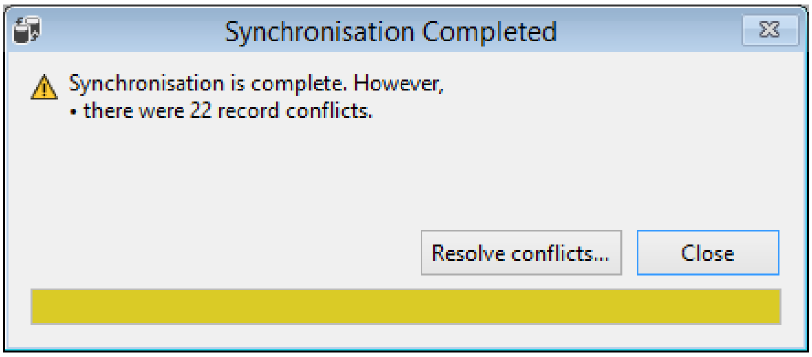
A better solution is available if you have ever made a proper backup of your temporary database.

1. Copy your current (broken) temporary database file to somewhere else.
2. Go online and stop any automatic sync by pressing the **Abort** button.
3. Open the File menu > Work Offline > **Delete Temporary Database**. This will delete the problematic temp database file.
4. Open the File menu > Work Offline > **Use Existing Temporary Database**.
5. Point to your backup .sdf file.
6. Do a manual sync to refresh the temporary database file.

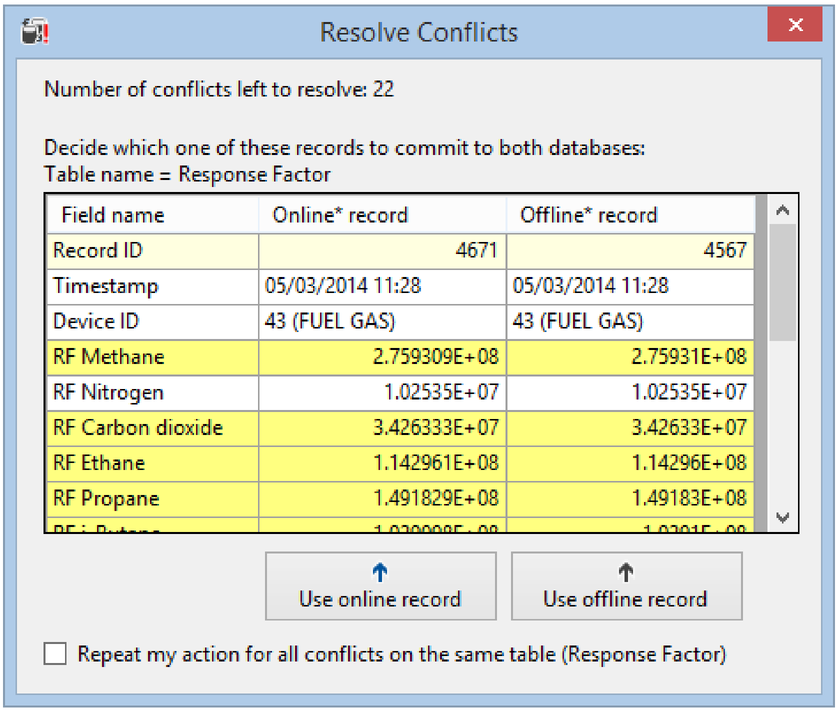
Should all the steps above did not provide remedy to the problem, you might need to delete your temporary database and recreate a new one. You may lose data which has not been synchronised to the main database server.

33.9 Conflict Resolution

A *conflict* is a mismatch between database record on your main database server and the corresponding record on your temporary database so that GCAS cannot determine which one to keep. GCAS keeps track of when a record was changed and uses this information to determine which one is the most recent. When a conflict happens, this last-modified information is either equal (meaning that both records were updated at the same time) or unavailable. The probability you would find a record conflict is quite rare, nevertheless a slim chance is not zero chance.



When conflicts arise, the sync progress bar turns yellow. Click **Resolve conflicts** to see what records are conflicting. The button brings the *Resolve Conflicts* dialogue similar to the screenshot down here. Conflicting fields are highlighted in yellow.



To resolve one conflict, click the appropriate button whether to **Use online record** or **Use offline record**. Using online record wins the record on your main database server and replaces the conflicting record on your temporary database. On the opposite side, using offline record wins the record on your temporary database and replaces the offending record on your main database server.

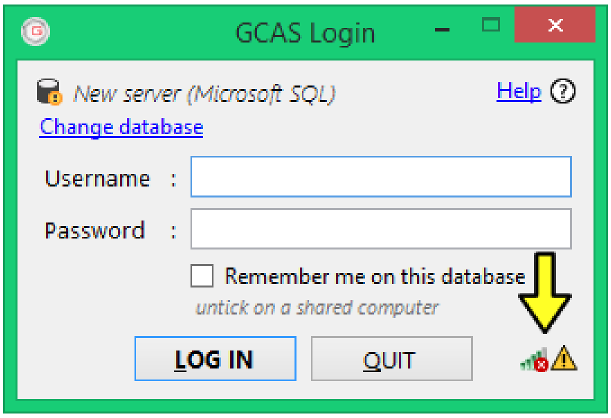
Once you clicked the appropriate button, GCAS applies change to both databases and moves on to the next conflict if any. To repeat your action whether using online record or offline record for a particular database table, first tick **Repeat my action for all conflicts on the same table** and then click the appropriate decision whether to **Use online record** or **Use offline record**. GCAS applies the same action for all conflicts on the same database table in the queue. Eventually GCAS may load a conflict of a different database table; GCAS will display both records and ask you to review and decide an action again. At the end, when all the conflicts have been resolved, the dialogue closes automatically.

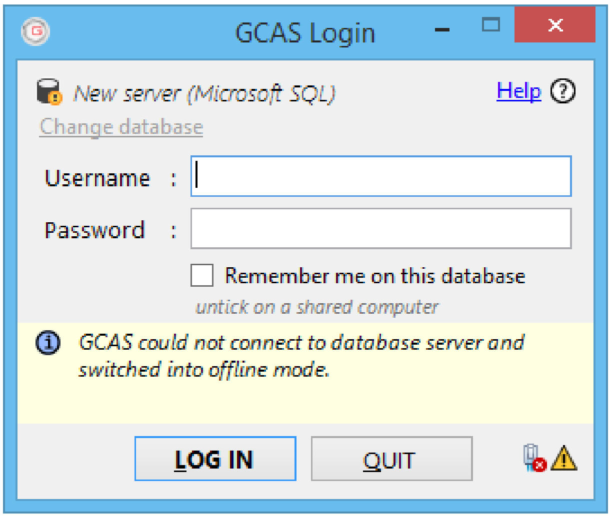
Note

To leave all conflicts as they are, i.e. to let the records be different between your main database and your temporary database, close the *Resolve Conflicts* dialogue using the close (×) button on the title bar. GCAS will ask you to resolve them later upon next sync operation.

33.10 Login Form in Offline Mode

When you are working offline, you can also log out from GCAS as usual (or be automatically logged out for inactivity). However please notice that the login form is in *offline mode* now. A warning icon appears on the right side of Quit button.



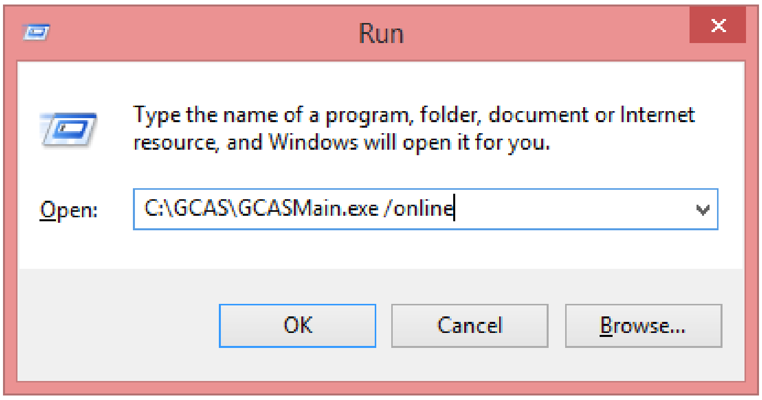


During offline mode, only users who already set up their temporary databases can log in.

Login form in offline mode behaves differently compared to normal (online) mode. As in online mode, GCAS is continuously connected to GCAS database server so that any login attempt is immediately verified against user credential in the database server. However in offline mode, the login form first checks if the user has his temporary database available, then verifies the login attempt against credential stored inside his temporary database. This is why users without temporary databases (i.e. never set them up before) cannot log in to GCAS.

In an unfortunate scenario where you have never set up your temporary database, you would not be able to log in during offline mode. You can force GCAS to return online and here are the steps to do so.

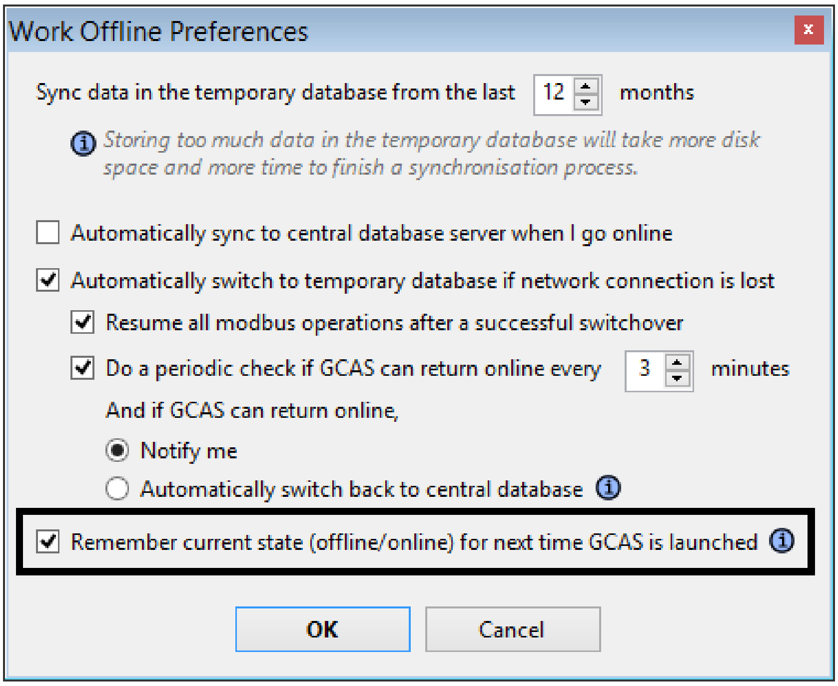
1. Verify that your network or internet connection is working.
2. Exit GCAS through the **Quit** button on the login form.
3. Run GCAS with an additional **/online** parameter.
4. GCAS is now back in online mode.
5. Log in as usual, and now is the chance to set up your temporary database.



33.11 Online/Offline Mode Persistence

By default, GCAS assumes online mode every time it is launched. If you choose to work offline, GCAS enters offline mode until you exit the software but returns to online mode on the next time you run the software again.

You can make GCAS stay in offline mode even after you exit GCAS. To do so, open *Work Offline Preferences* dialogue through the File menu > Work Offline > **Work Offline Preferences**. Give a tick on **Remember current state (offline/online) for the next time GCAS is launched**.



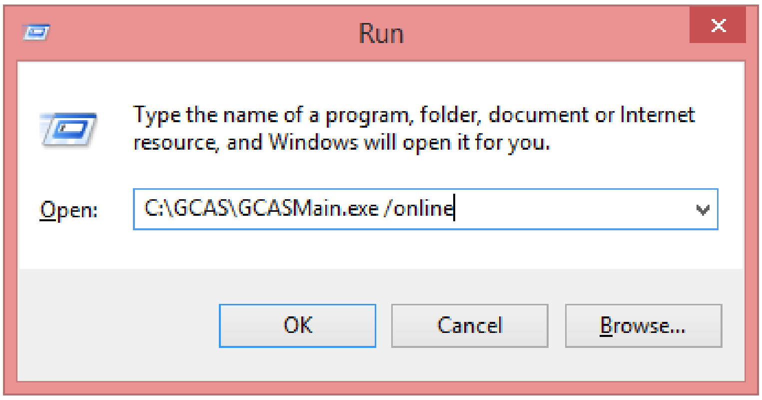
When you switch to offline mode and exit GCAS, the login form will stay in offline mode upon next time you launch GCAS.

Warning

Only users who have set up their temporary database can log in during offline mode.

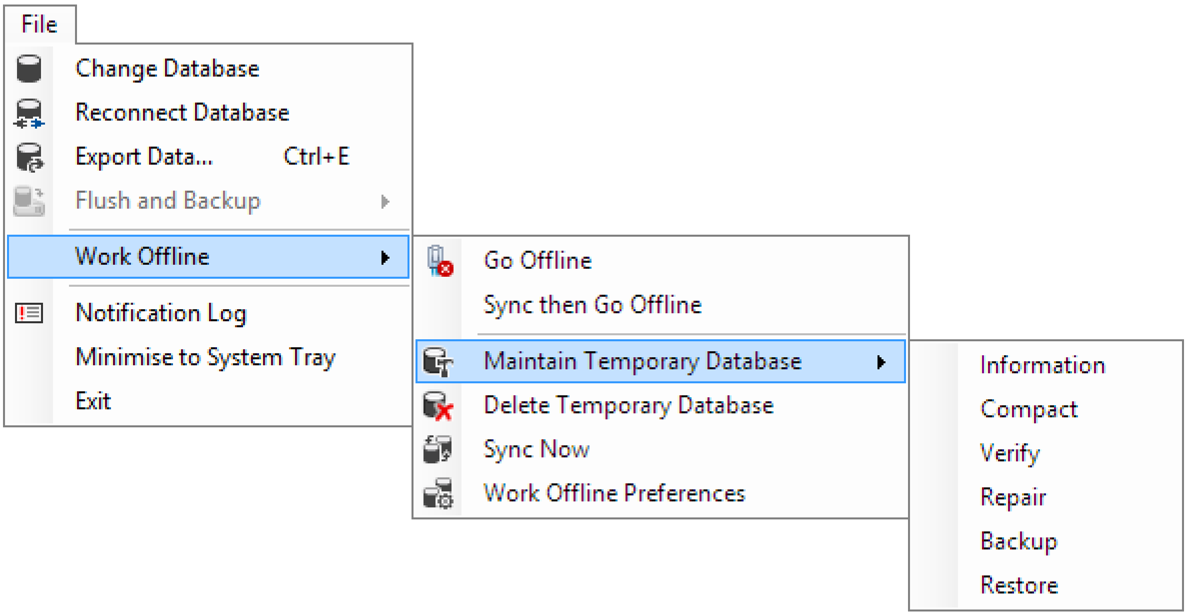
To override the initial mode, run GCAS with one of the following parameters:

- **/online** : Forces online mode.
- **/offline** : Forces offline mode.



33.12 Maintenance of Temporary Database

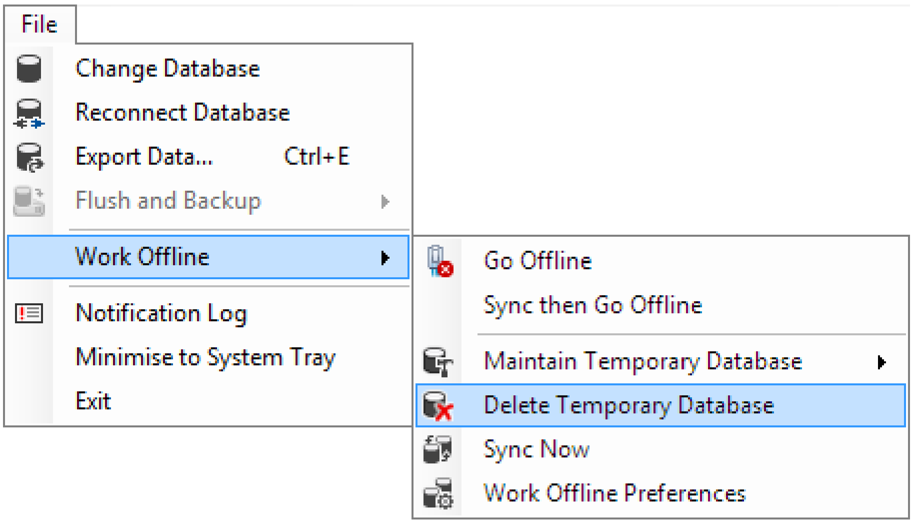
To perform maintenance, you need to go online. Then open the File menu > Work Offline > **Maintain Temporary Database**. It contains all submenus to perform database maintenance.



Menu	What it does
Information	Displays the size of your temporary database file, how much data stored in it (i.e. the timestamp of the earliest data available), and also the date and time of last sync operation.
Compact	Tries to shrink the size of your temporary database file by consolidating sparse free spaces similar to defragmenting a hard disk.
Verify	Uses the built-in verification feature on Microsoft SQL Server Compact Edition in order to check that all tables and indexes are not corrupt. If verification result says the database is corrupted, try the **Repair** menu.
Repair	Should the **Verify** menu reported a problem on your temporary database, this menu attempts to repair the file.
Backup	Makes a backup copy of your temporary database. To restore from this backup, use the **Restore** menu. Otherwise if you have deleted your temporary database, go to chapter 33.1.2 Restore a backup to reuse this backup file.
Restore	Replaces your current temporary database with a backup.

33.13 Deactivate Offline Working

To deactivate this work-offline feature, you need to go online. It is a good idea to synchronise your main database server with your temporary database for the last time, in order to make sure there are no pending data in your temporary database which have not been synchronised to your database server. Then, open the File menu > Work Offline > **Delete Temporary Database**.



This will delete your temporary database file. You cannot work offline until you set up a new temporary database or open an existing backup.

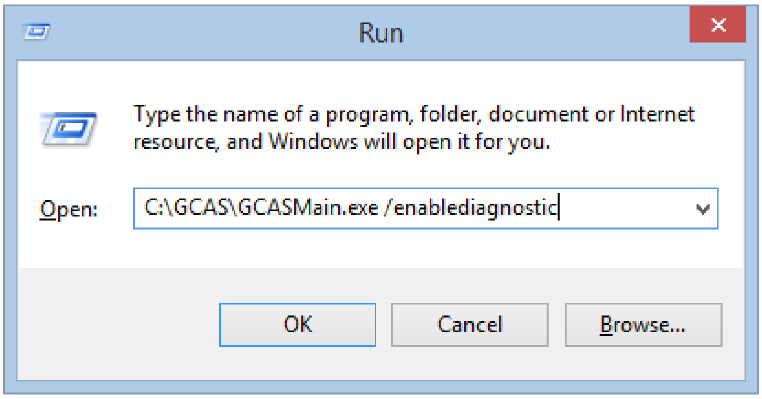
34 Diagnostic and Maintenance

This chapter attempts to assist you in case of errors and malfunctions of GCAS.

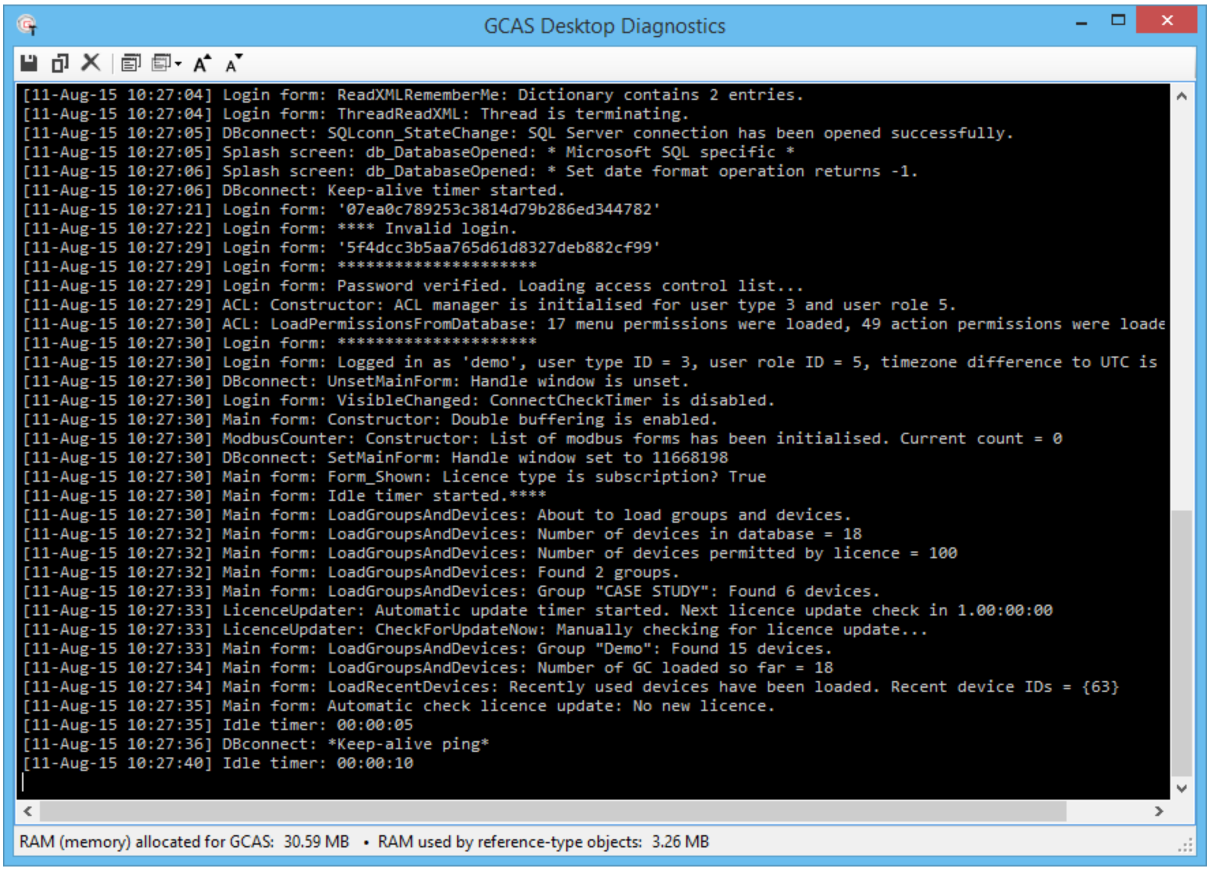
34.1 Diagnostic Mode

On rare occasions of malfunctions such as exceptions, unhandled exceptions, crashes, or wrong calculations, you can run GCAS in *diagnostic mode* to collect additional information about the reason for the malfunction to happen. On diagnostic mode, GCAS displays an additional window that acts like a debugger output window. When you report a bug to us, this diagnostic log helps us a lot in order to resolve the problem.

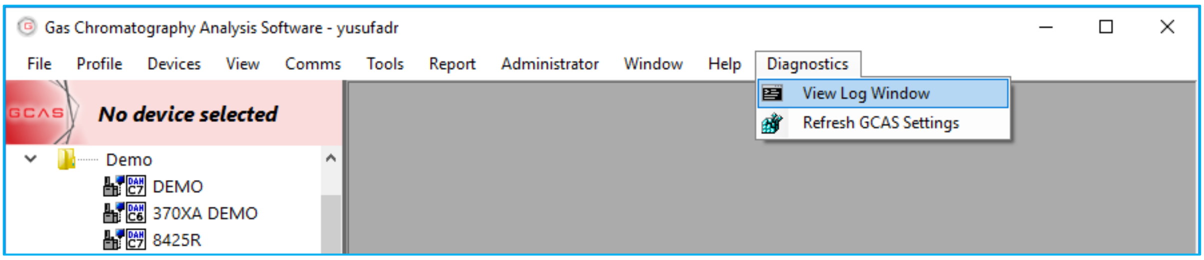
Start GCAS with an additional parameter **/enablediagnostic** to activate diagnostic mode. Formerly it was "/enablediagnostics" (with an incorrect "s" at the end of word), now it is "/enablediagnostic".



The diagnostic window looks like a console. GCAS runs normally alongside this window and you can use the software as usual.



You can minimise or close the diagnostic window at any time. The diagnostic window continues to output debug information even after it is closed. To show the window again, go to the Diagnostics menu > **View Log Window**.



To save the diagnostic information, use the **Save** button on the toolbar. Alternatively you can copy the contents through the **Copy** button then paste it onto notepad or any text editor.

Info

If GCAS crashed, it might not be possible to use the Save or Copy button on the toolbar because the user interface is frozen (white-shadowed) by Windows operating system. A screenshot of this frozen diagnostic window should suffice to help us understanding what the reason and at which point the error happened.

34.2 What Happened to Bug Report Wizard?

Unfortunately, we disabled Bug Report Wizard due to policy changes of our third-party mail provider. In the past, Bug Report Wizard worked by sending your report and all additional attachments (diagnostic log and optional screenshots) via email to our development team behind the screen. However, our mail provider didn't seem happy and made few changes in their terms of use. For that reason, we need to temporarily disable the Bug Report Wizard until we developed a new reporting mechanism which doesn't involve SMTP (email). Bug Report Wizard has disappeared since GCAS version 1.7.2.0.

For the time being, please send your bug report with any additional attachments such as diagnostic log, stack trace, or screenshots to support@i-Vigilant.com.

35 GCAS Startup Parameters

Startup parameters are optional arguments used to run GCAS or GCAS Activator, with the intention to enable or disable some advanced functionality.

Below is a list of additional start up parameters for GCAS (`GCASMain.exe`).

/changedatabase	:	Displays the Change Database dialogue only. GCAS terminates immediately after you click the **OK** button. This parameter cannot be combined with any other parameters.
/online	:	Forces online mode. Cannot be combined with **/offline** switch.
/offline	:	Forces offline mode. Cannot be combined with **/online** switch. Only users who have set up their temporary database can log in to GCAS.
/disablefilecheck	:	Disables the integrity check during startup. GCAS will not check the files inside the installation directory for any unauthorised changes.
/disablekeepalive	:	Turns off the database ping timer. Database ping timer sends a ping to your database server once every 30 seconds. This is because some database servers disconnect the client if there were no activity for a certain interval. By running GCAS with this parameter, ping timer will not run and GCAS database server may terminate your connection for extended period of inactivity.
/disableexcel	:	Disables the Microsoft Office interop module. That is, Export Data to Excel won't be available, *Copy to Excel* button on the Comments form will be greyed out, *Export Values to Excel* button on the Mole Composition Comparison form will be disabled, *Export to Excel* button on MLC offline converter tools will be unavailable, and pretty much everything that exports directly to Microsoft Excel. Use this switch if you see "COM exception" continuously every time you use features related to Microsoft Excel.
/enablediagnostic	:	Activates the diagnostic mode.
/confirmimport	:	Causes GCAS to display a confirmation dialog whenever you import a footprint or calibration data from a text file. Clicking **Cancel** on the confirmation dialog will abort the import process.
/modbusbase:X	:	Translates the base register address from the default `0` (zero) to any number you have specified. There is a colon (`:`) between "modbusbase" and the number, but there must not be any

spaces between modbusbase, the colon, and the number. This works Modbus client module only, not for Modbus server module.

For example, **/modbusbase:40000** specifies base address `40000` instead of `0`. This switch is only used for certain GC devices and on specific circumstances.

/disablecalibrationcache : By default, whenever you open GC Connect form, the latest RF and RT data for that device is cached. If the first poll returns the exact same RF and RT data, this incoming record is not regarded as a new data, thus GCAS avoids duplicated RF/RT data.

This switch disables the caching behaviour. If you run GCAS with /disablecalibrationcache, latest RF/RT data is not cached during the launch of GC Connect form.

/drawincompleteRFRT : If GCAS was instructed to ignore RF or RT data during data capture, GCAS assigns a special value −1 to all RF or RT values. This −1 value is not drawn on Data Analysis form. Using this switch overrides the behaviour; −1 values are always graphed.

/disabledoublebuffering : Disables double buffering on your graphic card when rendering GCAS main form. Use this switch if you experience display problem or performance drop when using GCAS.

/drawemptyUT : Forces GCAS to reveal empty points in Uncertainty Trend chart or Component Uncertainty Trend chart.

Empty points are data points that only has X value, without Y value or its Y value is undefined. Example of empty points is when you set the uncertainty trend in forward direction and the minimum number of data is 10, then the first 9 calibration data after a footprint are marked as *empty* (hence is not drawn on the chart and you see a gap).

With **/drawemptyUT**, GCAS draws grey dots for empty points. The X values of these grey dots are valid (correspond to dates and times on X-axis correctly), but their Y values are meaningless.

/disableUTcache : Disables cache in the Uncertainty Trend module. GCAS caches the calibration certificate and footprint reference while calculating uncertainty values. Disabling the cache means GCAS will always retrieve the footprint and certificate values from database. This makes calculation time becomes longer.

/excludefootprintUT : Forces GCAS to exclude the last footprint while calculating uncertainty values in Uncertainty Trend module.

On normal forward calculation, the data included to calculate the uncertainty at one point is taken from the last footprint (including the footprint itself) up to this point. This switch causes GCAS to exclude that last footprint, so data range starts from one calibration after the footprint.

On normal backward calculation, the data included to calculate the uncertainty at one point is taken from that point and travels backward. If you set GCAS to trim at footprint, the last footprint is included in the calculation but it stops (hence the footprint is the *last* data). With **/excludefootprintUT**, GCAS stops at one calibration after the footprint. Nevertheless, if you set GCAS to continue through (include data before footprint) then this switch has no effect.

/UTdiagnostic : Activates the Uncertainty Trend diagnostic.

/normaliseISO6976 : Forces ISO 6976 Calculator to always normalise input composition even if it is BTEX composition or single-gas composition.

/normaliseGPA2172 : Forces GPA 2172 Calculator to always normalise input composition even if it is H_2S composition.

/normaliseuncertainty : Forces Uncertainty Calculator, Uncertainty Trend, uncertainty calculation in Dashboard, and anything related to uncertainty calculation to always normalise the calibration certificate's mole composition values even if it is BTEX composition or single-gas composition.

/allowMLCzerocertmole : Disables a safeguard on ISO 10723 conversion where zero mole composition value of a gas in a calibration certificate would be replaced with 0.0001.

Using this switch will produce NaN (*Not-a-Number*) or infinity value on gases not present in the calibration certificate because the calculation will encounter divide-by-zero operation.

Additionally, these are a list of advanced start-up parameters for GCAS Activator (`GCASActivate.exe`).

/? : Displays a quick help in a console window or a message box.

/info	:	Displays the details of the licence and registration key installed on your computer.
/compcode	:	Displays the computer code of your computer.
/install <licence string>	:	Installs the specified GCAS licence, or replaces currently installed licence with a new one. Cannot be combined with **/revoke** parameter. Recommended to combine **/install** with **/regkey** parameter so that you install the licence and registration key in one go.
/regkey <6-digit registration key>	:	Installs the specified registration key, or replaces current registration key with a new one. Cannot be combined with **/revoke** parameter.
/revoke	:	Uninstalls the current licence and registration key from your computer. Cannot be combined with **/install** nor **/regkey**.
/silent	:	Do not display any message boxes or confirmation messages. Combine this switch with **/install**, **/regkey**, or **/revoke**.

Note

GCAS Activator (`GCASActivate.exe`) requires elevation. Run `GCASActivate.exe` on an elevated command prompt (run as administrator) to use the commands above.

End of Document