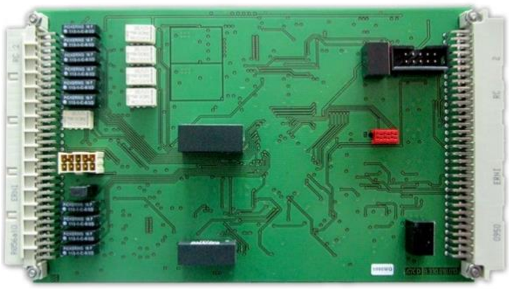
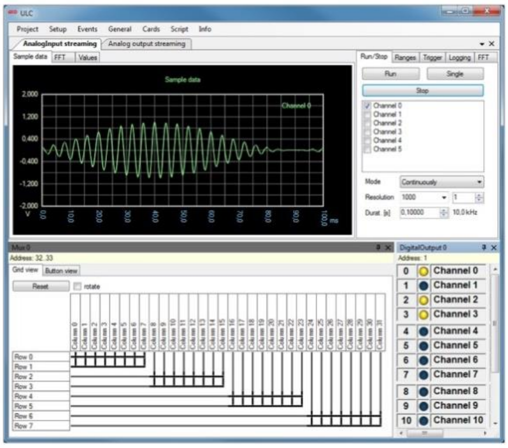
ELEKTRONIK GMBH

GET IN **touch** WITH SENSITIVE TESTING

Manual

ULC Multifunctional Card





Softline

Modline

Conline

Boardline

Avidline

Pixline

Application

MCD Elektronik GmbH
Hoheneichstr. 52
75217 Birkenfeld
Tel. +49 (0) 72 31/78 405-0
Fax +49 (0) 72 31/78 405-10
info@mcd-elektronik.de
www.mcd-elektronik.com
HQ: Birkenfeld
Managing CEO: Bruno Hörter
Register Court Mannheim
HRB 505692

Template version: 5.4 / 2018-04-09
V1.1 2018-09-204MR (JJ)

Table of Contents

1. General

The ULC Multifunctional Card consists of a circuit board and the software Toolmonitor ULC. With the measurement board a variety of signals can be recorded, generated and evaluated. The communication between the circuit board and the software takes place via a standard USB connection.

Order number:

ULC Multifunctional Card (USB): # 118928

ULC Multifunctional Card with base plate for cabinet applications: # 150066

Toolmonitor ULC (software): # 118955

2. Product Features

2.1. Hardware

The ULC multifunctional card is equipped with a complex FPGA - module making the many options (A / D, D / A, logic analyzer, counter, self-test, calibration…) available via USB interface.

The DAQ card has a total of six bipolar analog input channels. One of which is a differential input and the remaining others are single-ended. All channels are synchronously sampled. The sampling rate for all channels is up to 500 kHz.

The D/A converter has four identical channels. These channels can display DC values or any type of signal with a sampling rate of up to 1 MHz.

The counter inputs can evaluate pulses and frequencies. In addition, the inputs can be used for logic analysis.

AD + DA sections are equipped with an intelligent self - test device, which can also be used for self - calibration.

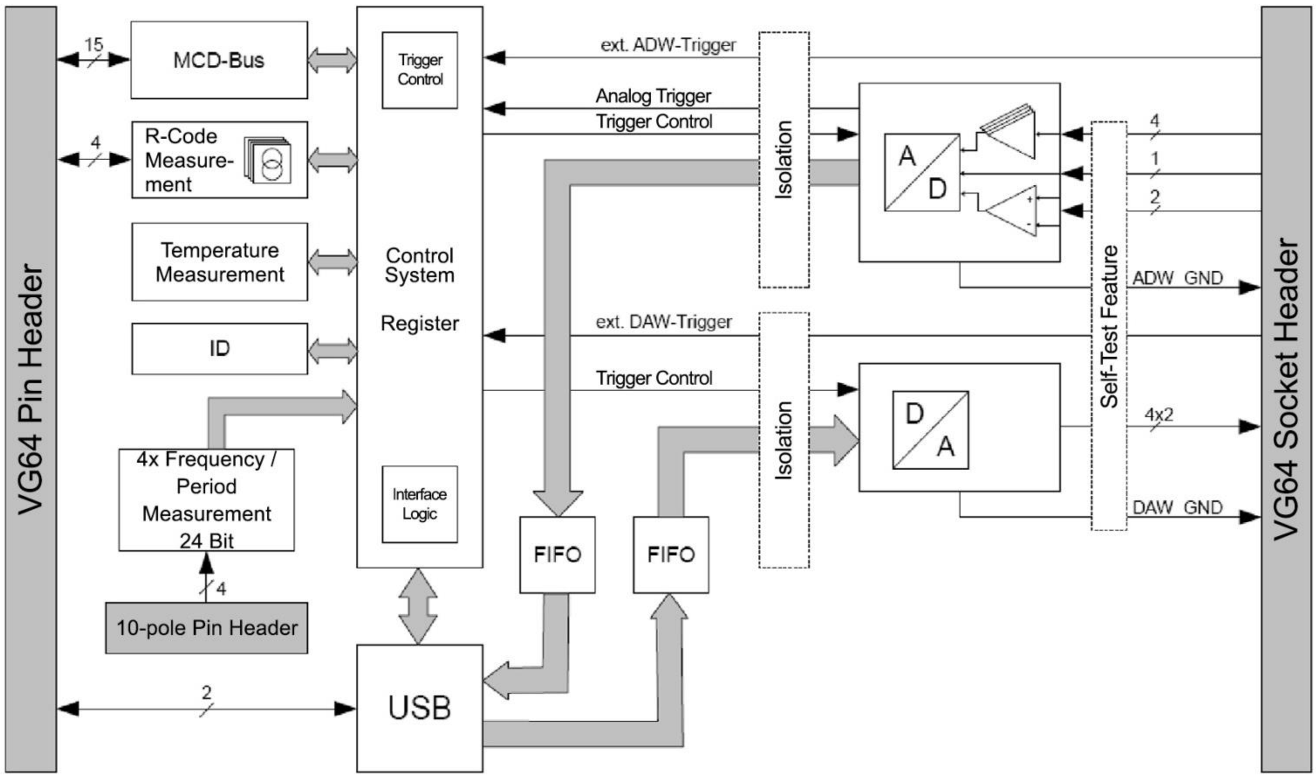


Figure 1: Block Diagram of the ULC Multifunctional Card

2.2. Software

The Toolmonitor (see Figure 2) for the ULC Multifunctional Card allows the operation and control of all functions provided by the measuring board. Via the analog, input and output voltages in various ranges are provided and measured. Powerful generators (Figure 4) allow the generation of complex waveforms including different modulation schemes.

Input signals can be filtered and analyzed in a variety of ways. The graphical display can be performed in both the time and frequency domain (FFT - Analysis). A variety of measurements can be retrieved in a tabular list.

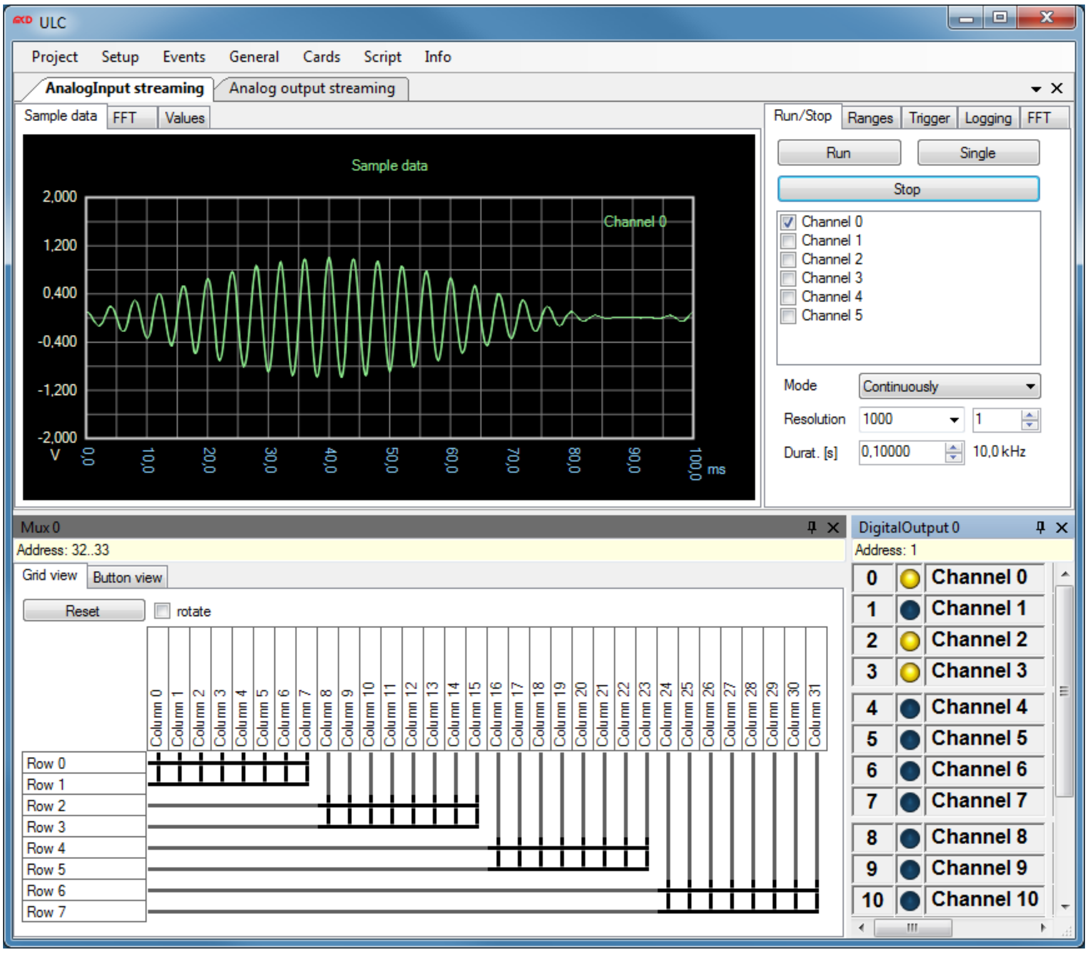


Figure 2: Toolmonitor ULC

Digital input / output cards, multiplexer, temperature modules, counter, and other measurement boards of the MCD measurement systems can be visualized and controlled.

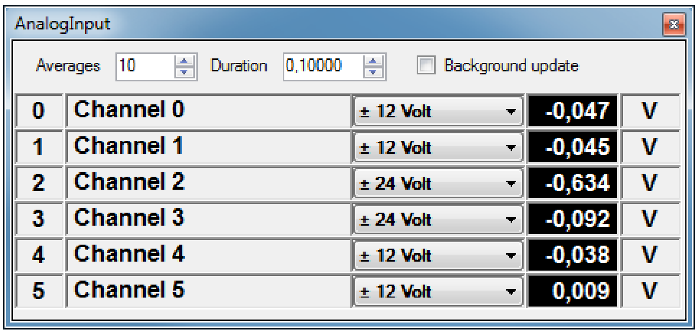


Figure 3: Modul of Analog Inputs

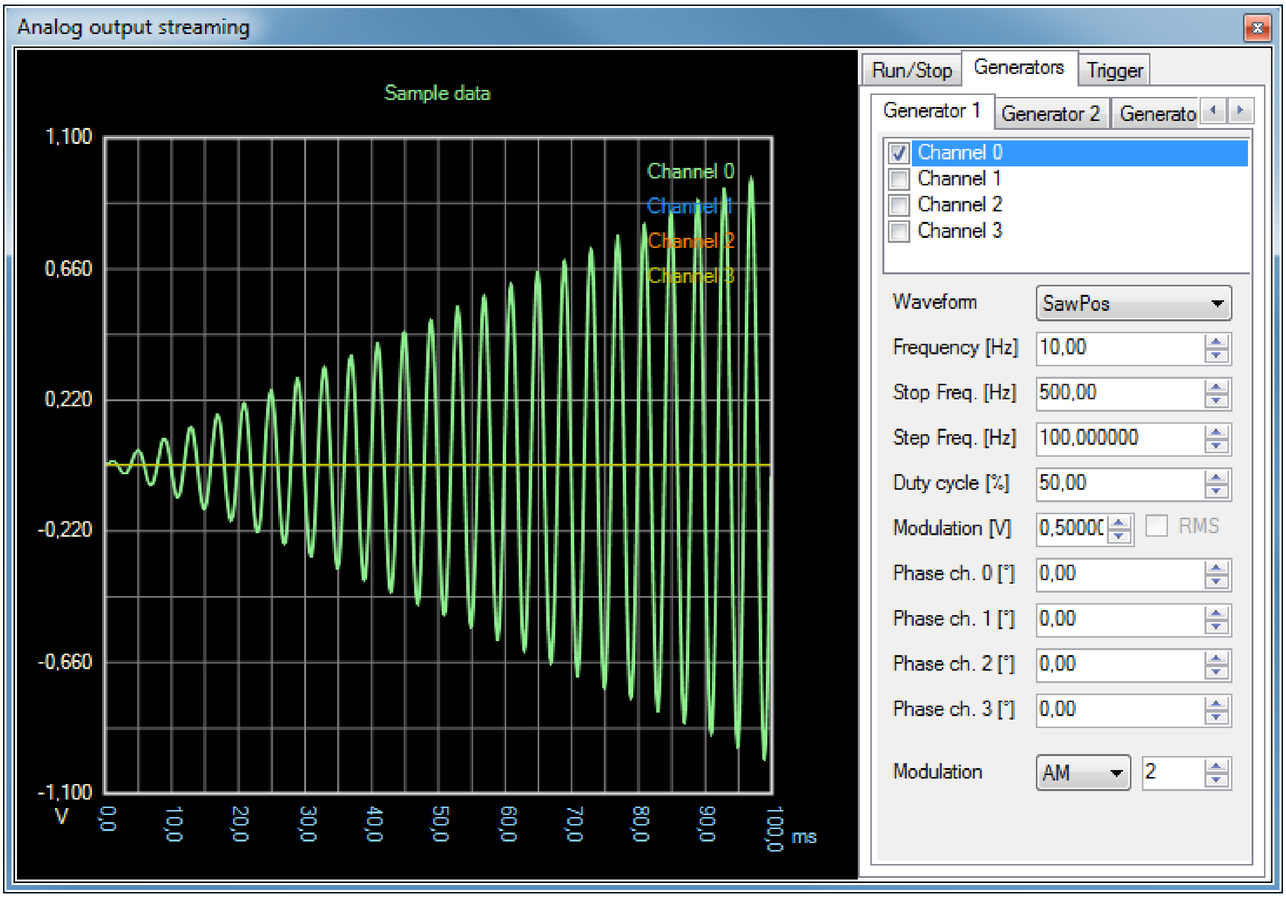


Figure 4: Generator Parameter and Graphical Display of the Generated Signal

All recorded signals and measured values can be exported in various formats. The program interface can be freely designed and widely adapted to user requirements. Once created configurations can be stored in the project file and loaded when needed.

Using an integrated script engine all measurements and settings can be automated.

Via third-party software the Toolmonitor can be completely operated remotely. As an interface, a COM / DCOM or a .Net - Assembly is used. This allows Toolmonitor to be integrated in a variety of applications (Microsoft Visual Studio® (C#, C++, Visual Basic), Microsoft Office® (e.g. Excel®), Open Office®, Lab View®, MCD TestManager CE).

3. Installation of the Software, Drivers and Hardware

3.1. System Requirements

- Operating system: Windows 2000®, Windows XP®, Windows 7®
- Architecture: 32 bit or 64 bit
- .Net Framework: starting at Version 3.5

3.2. Software Installation

To install the software Toolmonitor ULC, select the installer ULCInstall.msi. Open the Windows® Explorer and start the installer ULCInstall.msi.

You will then be guided through the installation of the software. Confirm the individual dialogs and adjust the installation path if necessary.

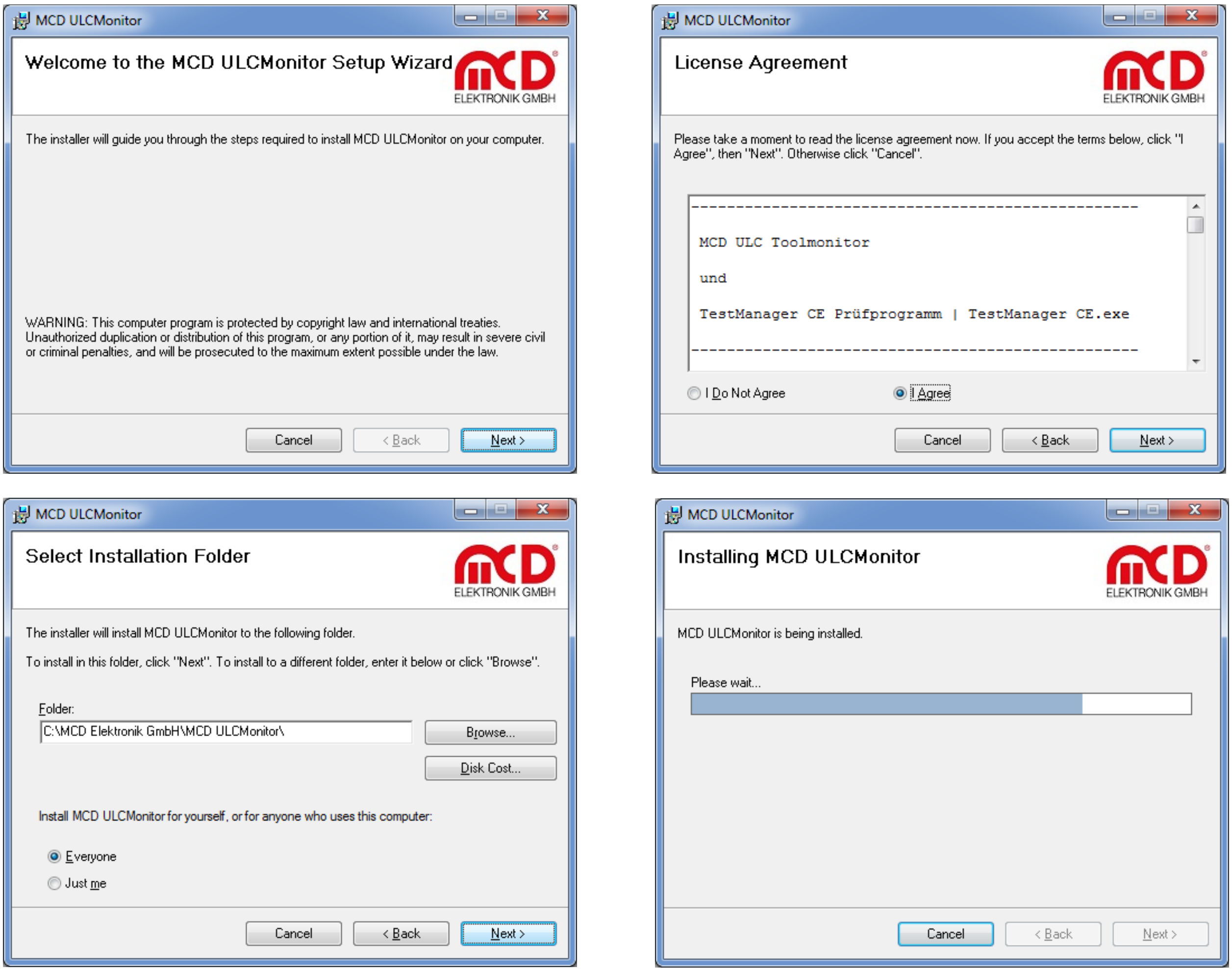


Figure 5: Toolmonitor Installation

After finishing the installation, exit the installer and continue with the installation of the driver. To test the installation and to install the driver / update please connect the ULC Multifunctional Card to your PC.

3.3. Connecting the Hardware

The USB port and the power supply and all other ports are available on the VG ledges. To facilitate the connection please use the optional adapter boards of MCD Elektronik.

Connect the ULC Multifunctional Card to your PC via a USB cable. Please also provide the measurement board with a voltage of 12 VDC / 0.5 A.

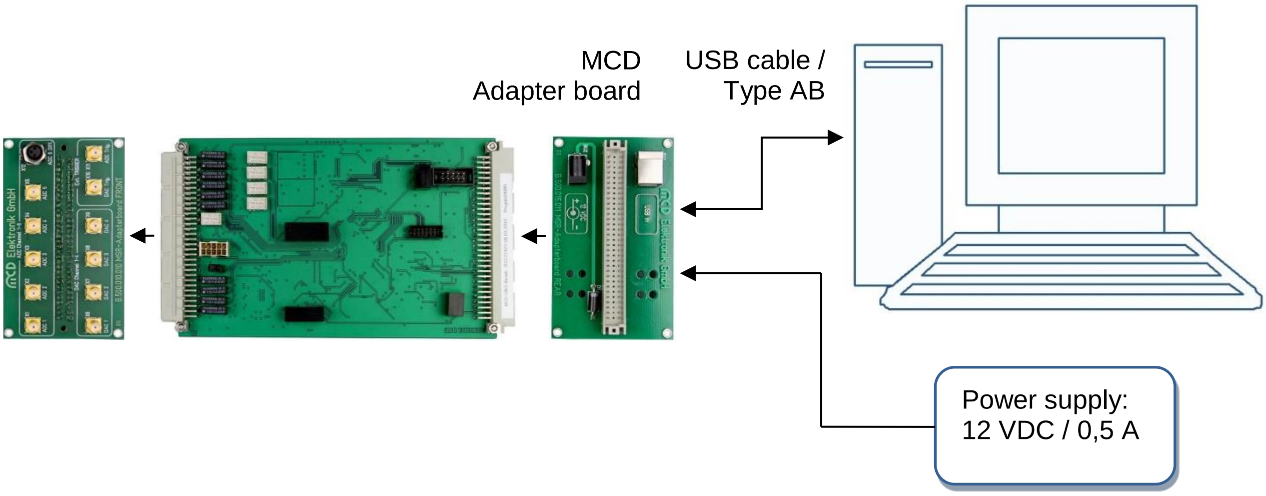


Figure 6: Connecting the Hardware

3.4. Installation / Updating the Driver

The driver to be installed is located in the application folder under:

<Laufwerkname>:\MCD Elektronik GmbH\MCD ULCMonitor\USB Driver

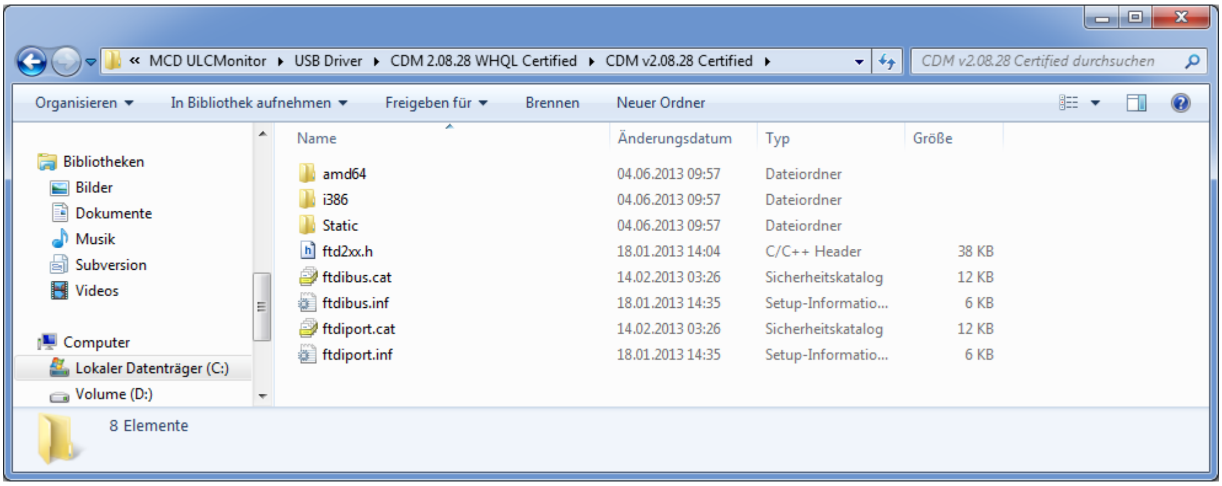


Figure 7: Storage Location of the Driver to Be Installed

To install the latest driver you can update the driver for the ULC Multifunctonal Card in *Windows® Device Manager*. To do this, select each **USB Serial Converter A** and **USB Serial Converter B**. Choose the folder displayed above for the driver installation.

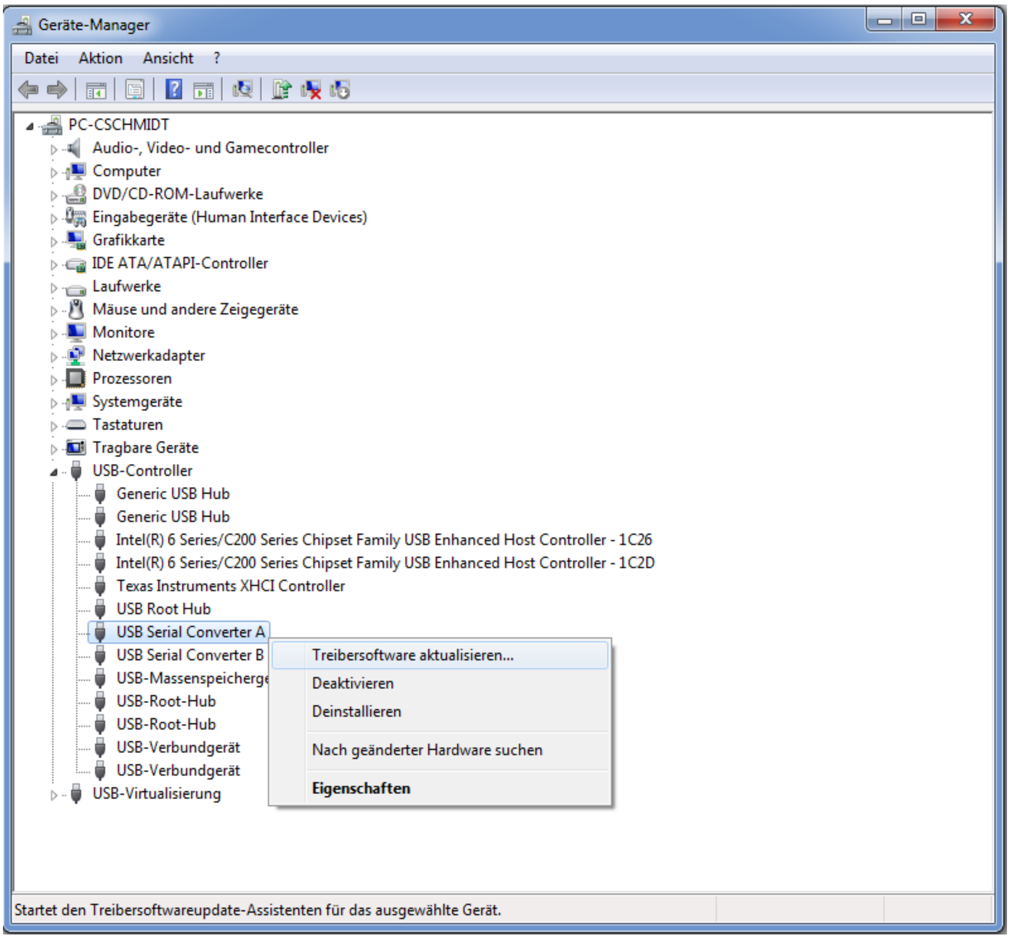


Figure 8: Updating Driver Software

3.5. Running the Installed Software

To use the ULC Multifunctinal Card, open the previously installed software from the start menu. With the software, the entire functionality of the MCD ULC Multifunctional Card is now available to you.

For more help please go to the software documentation under *Help → Help F1.*

4. Introduction to the Operation

1. Complete the software installation (see chapter 3).

2. Please connect your MCD ULC Multifunctinal Card using a USB cable (type AB) to your PC. In addition, please connect a power supply of 12 VDC / 0.5 A. The USB port and the power supply and all other ports are available on VG ledges. To facilitate the connection please use the optional MCD adapter boards (see chapter 3.3).

3. Now open the Toolmonitor ULC on the Windows® start menu. The connected Multifunctional Card is automatically detected and can now be used. Please refer to the chapter 3.4.

4. If you receive an error message after opening the software, open the *Setup menu → Options*. Here you can adjust settings for your ULC Multifunctional Card.

5. Please select the window *"Communication"* and make sure that the check is placed in the "*Active field"*.

6. Enter an " * " to display the description of the device connected to Port A and Port B. Confirm with *"OK"* after entering the " * " option.

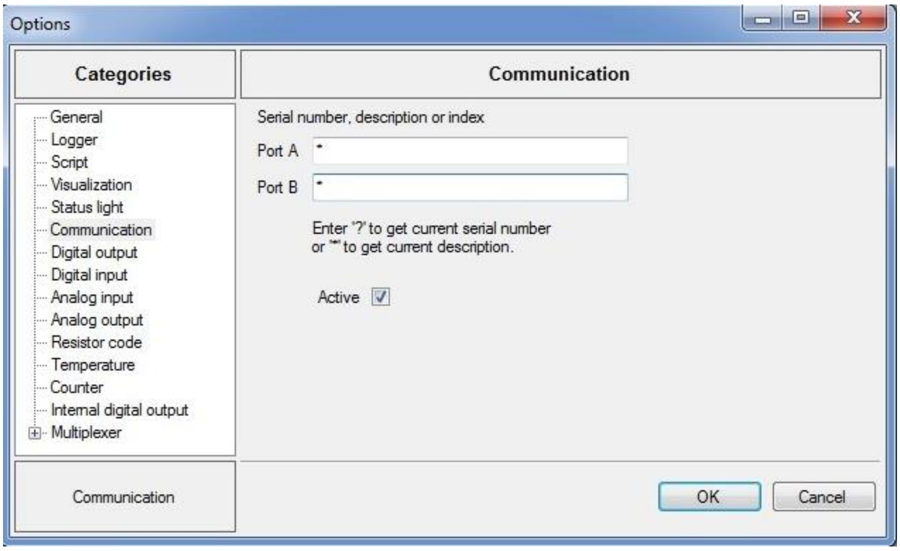


Figure 9: User Interface - Communications

7. Open the *Setup → Options* again. Now the description for the measurement board used is displayed. Make sure that the description of your MCD ULC measurement board is displayed here.

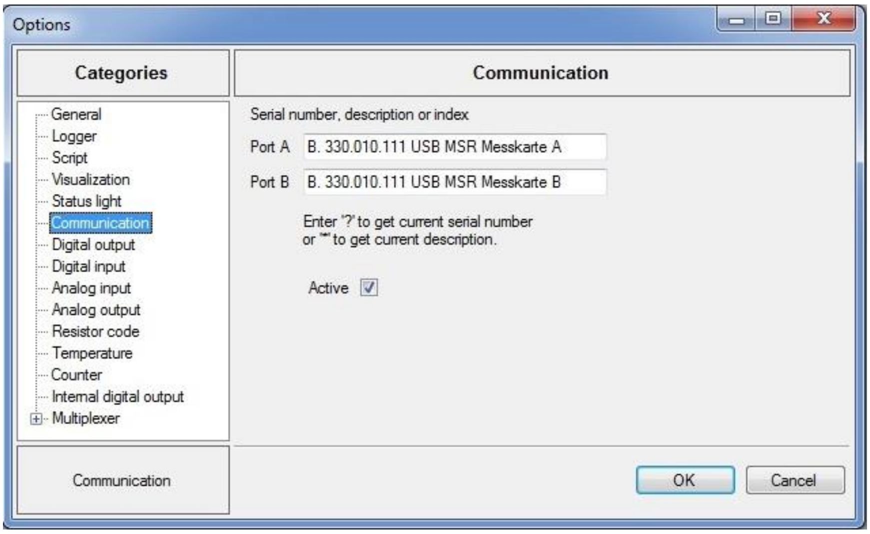


Figure 10: Display the Used Measurement Board

8. *Open Cards* → *AnalogInput* → *Single overview* in order to read the values of the input channels. Activate the *"Background update"* to display the current values.

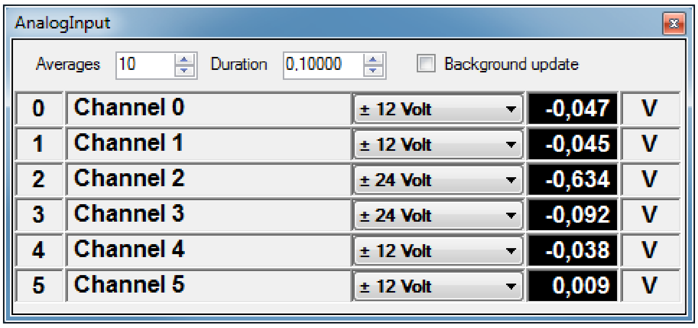


Figure 11: Display of Analog Inputs

9. Open *Cards* → *AnalogInput* → *Streaming* → *Streaming* setup to stream a desired channel and to graphically display. Activate for example Channel 0 and then press the *"Run"* button to permanently read the signal.

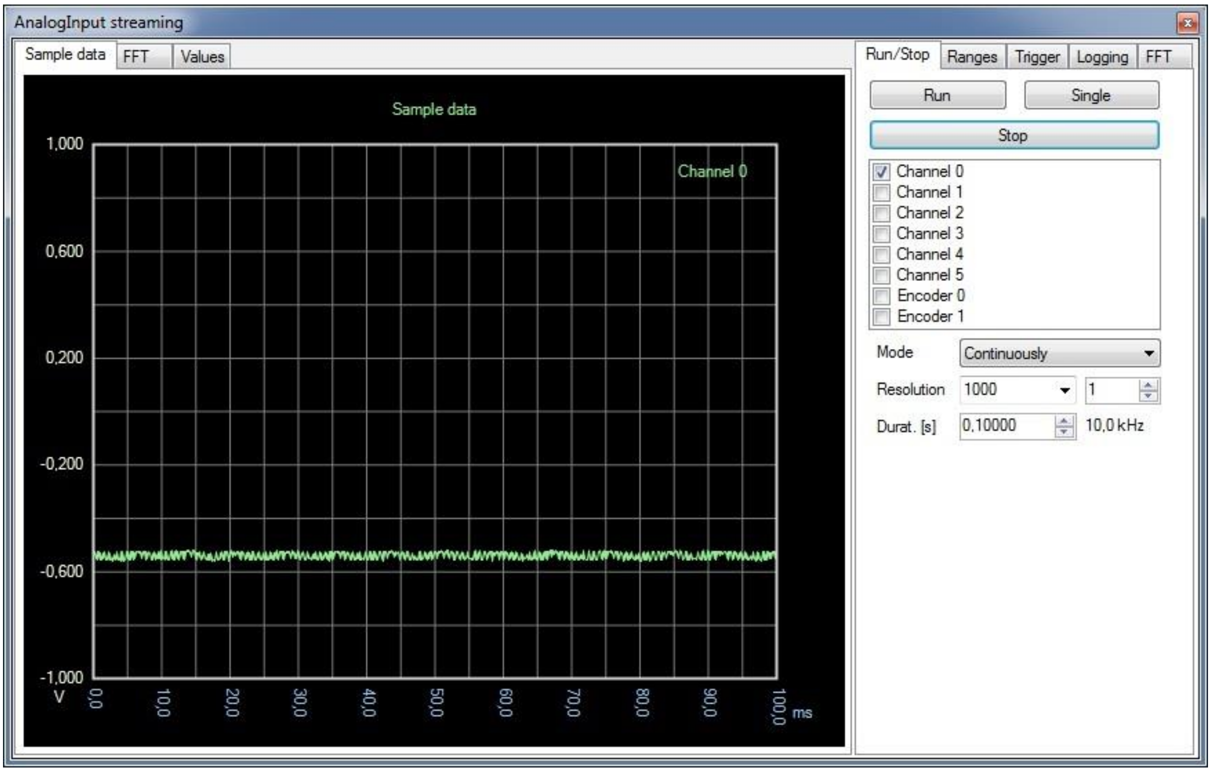


Figure 12: Analog Input Streaming

10. Open *Cards → Analogue Output → Analog Output* to output a fixed voltage value on an output channel. To output a value, you can set a desired voltage next to the values using the keyboard or the arrow buttons.

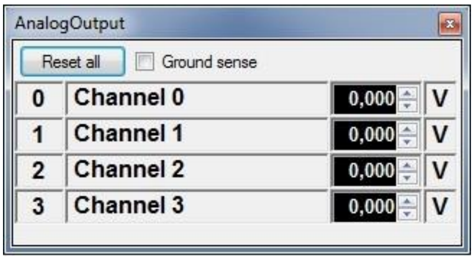


Figure 13: Display of Analog Outputs

11. *Open Cards → Analogue output → Analog Output Streaming* to output a desired waveform over a channel. Configure e.g. Generator 1 to output a sine signal to channel 0 (see figure). To start the output signal, press the *Run button in the Run / Stop window.*

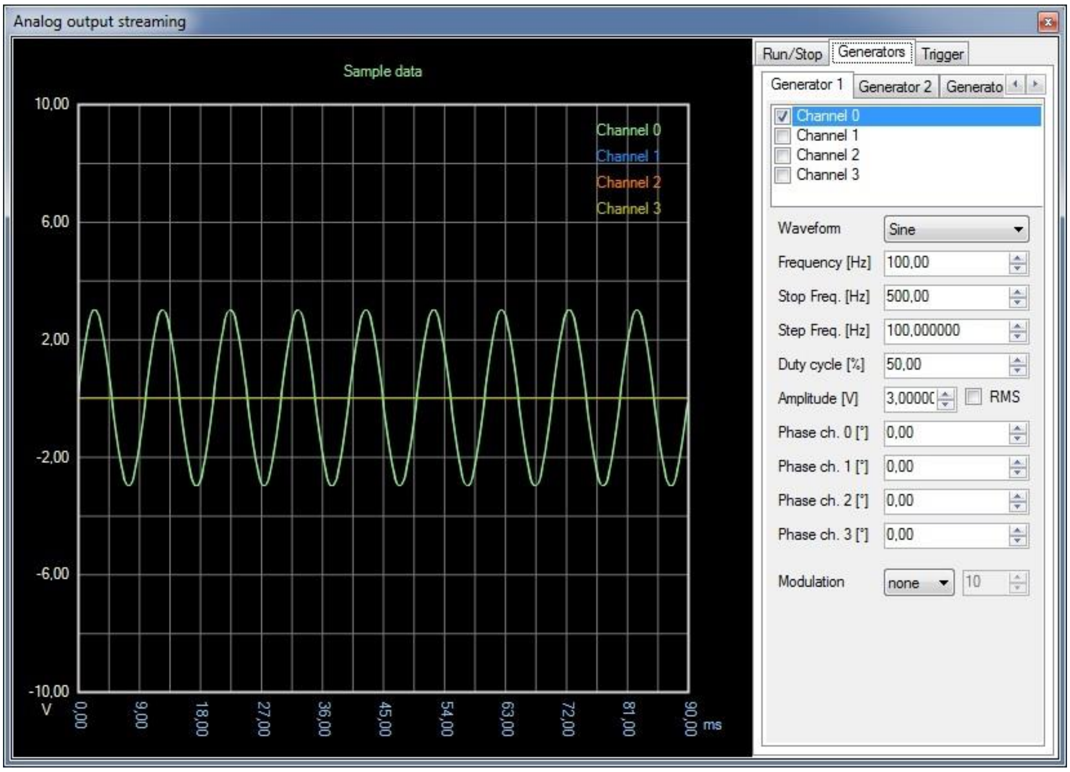


Figure 14: Analog Output Streaming

12. To determine the current status of the measurement board, please open the window *General → Status*.

Figure 15: Status Request

For more help please go to the software documentation under *Help -> Help F1.*

5. Hardware Manual

5.1. A / D Section

5.1.1. General

The ULC Multifunctional Card has a total of six bipolar analog input channels. Of these, one is a differential input and the remaining "single ended". One of these “single ended“ inputs is intended for internal self - test, but can also be used for measurement tasks.

Each input can be individually switched on and off. All switched channels are parallel sampled, so that the set sample rate is equal to all active channels.

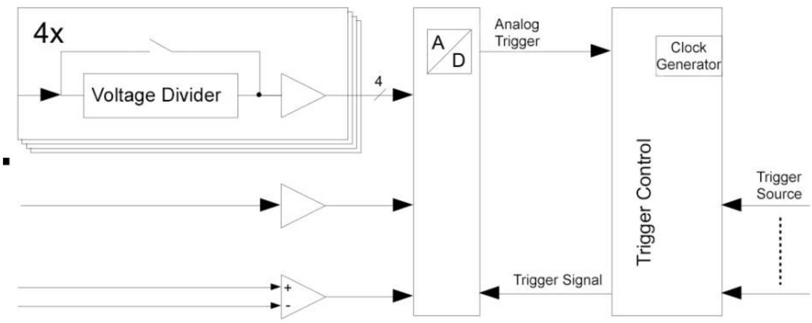


Figure 16: General Structure of the A / D Section

5.1.2. Triggering

An A / D conversion is triggered at each trigger signal input to the A / D converter. This trigger signal is generated from several possible input signals (trigger sources) from the trigger control.

It is also possible to limit the number measured values. For this, the desired limit value is passed to a 24 - bit counter. If this limit is reached, the measurement stops and can be restarted by command. A value of zero will be measured endlessly until the configuration will be changed accordingly.

Possible trigger sources are:

- Analog trigger:

  The analog value is recorded continuously at the set sampling rate. The data transfer starts when the threshold value is exceeded or fallen. Each active analog input can be used as input for the analog trigger.

- External ADW trigger:

  Digital trigger input with A / D converter mass relation

- External DAW trigger:

  Digital Trigger input with D / A converter mass relation

- Counter 0...3:

  Counter input with PC / system mass relation

- MCD bus MISO:

  Data input of the MCD bus

Trigger operation modes:

- Software Single Shot:

  Active singel measurement via software.

- With fixed sampling rate:

  Measuring with the set sampling rate.

- Edge triggered:

  Each rising or falling edge triggers a measurement. This allows the samping rate to be specified externally.

- Level triggered:

  Depending on the configuration, it is measured at the set sampling rate until a high or low level is present at the trigger input.

- Hardware Single Shot:

  A single measured value is recorded at the next rising or falling edge.

- Hardware Start:

  It is measured from the next edge with the set sampling rate.

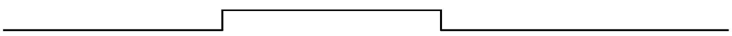
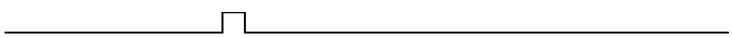
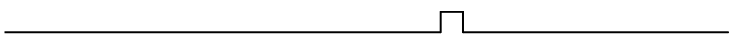
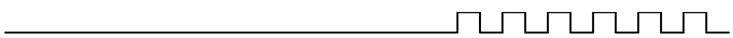
Source Signals		
Sampling beat		
Incoming trigger signal		
Trigger Signal to A / D Converter		
Describtion	Form	Level + Mode Select
Rising Edge		1001
Falling Edge		0001
High Level		1011
Low Level		0011
Rising Start		1101
Falling Start		0101

Figure 17: Source and Trigger Signals

The measured values are sent as two's complement data sets, with the reading of the lowest active channel in ascending order. Thus one record is *[active channels] x [2 bytes]* large.

If a record can not be sent because the PC is not ready to receive, then a flag is set in the status register (Overflow ADC) that indicates this fact. The measurements will continue automatically as soon as the PC accepts data again.

In addition to the analog values, the states of the digital inputs (MCD bus MISO and Counter 0 ... 3) as well as the counters of the encoder inputs (encoder 0 ... 1) can also be transmitted, which allows a allocation of digital values to the analog values in a chronological order. A data record increases by 1 byte when the digital inputs are transmitted and by 3 bytes for each transmitted encoder reading. The digital values are transferred according to the analog values in the order: Digital Inputs → Encoder 0 → Encoder 1.

5.2. D / A Section

5.2.1. General

The D / A converter has four identical channels. These can be set sequentially (successively) or together at the same time, as long as the lowest possible phase shift between the channels is important. The channel - to - channel time delay is less than one microsecond, so that with four set channels between the first and fourth channel a time delay of 4 µs exists.

The simultaneous setting of all channels eliminates this time delay, but requires an additional time of 1.2 µs. This reduces the maximum possible sample rate for a synchronous setting.

A special case is the setting all four channels to the same value. This is treated like updating a single channel, allowing for maximum sample rate. In this case, the setting is always synchronous.

5.2.2. Hardware

Each channel has a sensor cable ("DAWx neg") for the reference level. Based on these the desired output voltage will be issued. So smaller potential shifts, as they occur for example due to currents in the simulated circuit, are compensated.

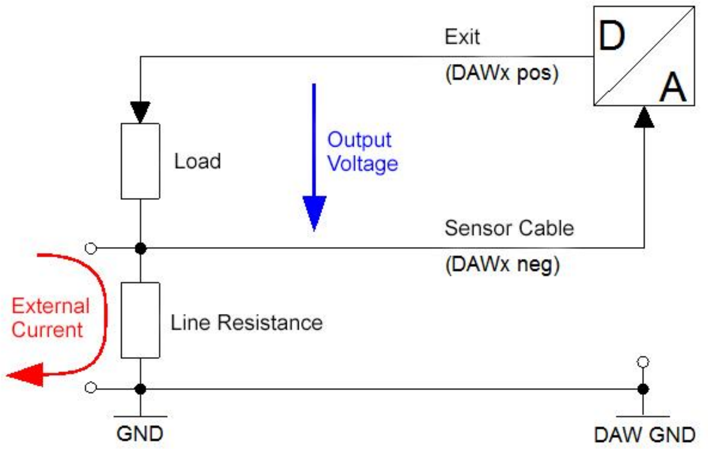


Figure 18: General Connection of a D / A Channel

Each D / A channel can be adjusted in the zero point and slope. The zero point adjustment has an extent of 16 LSB to +15.875 LSB in 1 / 8 LSB increments and the slope can be adjusted in the end range (-10 V or +10 V) from -32 LSB to +31 LSB in 1 LSB increments.

5.2.3. Triggering

The D / A converters can be controlled manually or by trigger events. For the manual adjustment the desired channels and the value to be set in a two's complement format is sufficient. The setting will then be made immediately for all specified channels with the same value. It should be noted that this may conflict with the trigger - controlled setting of another channel. In this case, the later arriving event will be deferred until the current one is completed.

For the trigger - controlled setting, the individual channels of the D / A converter can be activated. For each trigger event, a record is expected in the input FIFO.

Such a data set is in each case *[active channels] x [2 bytes]* big and consists of the values to be set, starting with the nominal smallest channel ascending (DAW0 → DAW1 → DAW2 → DAW3 → DAW0 → ...). For inactive channels, no values are passed. If all 4 channels should assume the same value (register 32 h, DACUP = 0000), a single value for all channels is sufficient.

Possible trigger sources are:

- A / D converter trigger signal:

  The D / A section receives the same trigger signal as the A / D section. This allows a synchronisation of both sections.

- External ADW trigger:

  Digital trigger input with A / D converter mass relation

- External DAW trigger:

  Digital Trigger input with D / A converter mass relation

- Counter 0...3:

  Counter input with PC / system mass relation

- MCD bus MISO:

  Data input oft he MCD bus

Trigger operation modes:

- Off:

  No trigger - controlled updates of the D / A channels.

- With fixed sampling rate:

  The active outputs are updated regularly with the set sample rate with new analog values.

- Edge triggered:

  Each rising or falling edge triggers a measurement. This allows the sampling rate to be specified externally.

- Level triggered:

  Depending on the configuration, new analog values are output at the set sample rate on the active D / A channels, as long as a high or a low level is present at the trigger input.

- Hardware Single Shot:

  A single measured value is recorded at the next rising or falling edge.

- Hardware Start:

  From the next edge with the set sampling rate to the active D / A channels analog values are issued.

If there is insufficient data in the FIFO at the time of a trigger event, this is signaled with a flag (Underflow DAC) in the status register. In the sequential operation, only the channels are updated which still have some data. The rest will continue as soon as data is available again. In the synchronous mode, the output stops until there is enough data in the input FIFO for all channels.

The D / A converter can also be configured so that all outputs go to 0 V and all channels become inactive (register 32 h, EMSTOP = 1) in the absence of data. This prevents, for example if communication with the PC is interrupted, potentially high voltages are present at the outputs for a long time.

In addition to the continuous output of new analog values, in which the PC constantly has to supply new values (streaming), a ring buffer operation is also possible. For this purpose, the D / A channels to be set are activated and the input FIFO filled with data records (up to 4096 values, with four active channels with different values corresponding to 1024 values per channel) while the triggering initially switched off.

Then the FIFO ring mode is switched on and the trigger is started. The content of the FIFO is now "played" in an endless loop or a definable number of cycles. Further incoming D / A values are ignored until ring buffer operation is terminated. The content of the FIFO is deleted automatically.

5.3. Self - Test

The A / D section and the D / A section have a self - test device, which allows to detect damage to the input buffers, the A / D - converter and the D / A - converter or to counteract a possible drift.

For the A / D section, there is an accurate and low drift 10 V reference voltage available. Each A / D channel can be switched from its input to 0 V or to this reference. In the D / A section, each individual channel can be switched to and from the unbuffered A / D channel. The ground covers of the two sections are automatically connected and the D / A channel is separated from the VG socket strip to avoid external influences. For test purposes, the D / A voltage is then available at the fifth A / D channel port (e.g., for external calibrators).

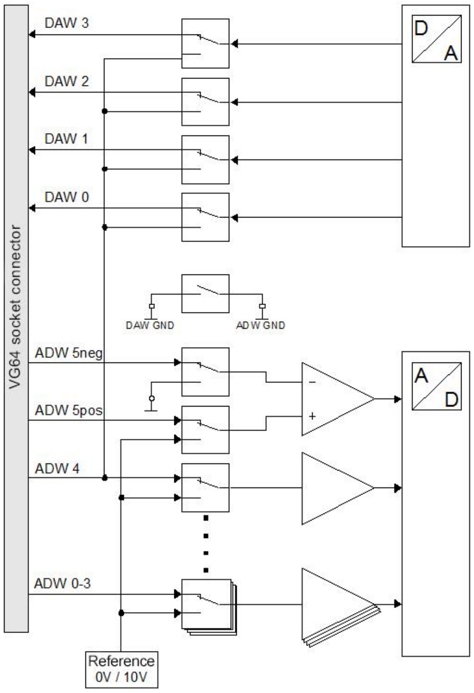


Figure 19: Structure of a Self - Test Establishment

5.4. Resistance Code Measurement

The Multifunctional Card has a simple four - channel measurement circuit that can detect resistance values in the range of 10 Ω to 10 kΩ with a resolution of 5 Ω.

The measured value is returned as a left - justified 16 - bit value with 12 - bit resolution in two's complement format:

Rcode0 high	Rcode0 low	Rcode1 high	Rcode1 low	Rcode2 high	Rcode2 low	Rcode3 high	Rcode3 low

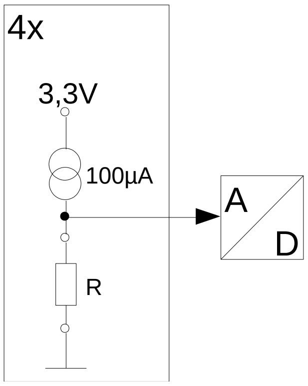


Figure 20: General Circuit Diagram of the Resistance Measurement Cycle

$$R = R_{code} \times \frac{5\Omega}{16}$$

Figure 21: Calculation of the Resistance Value of the Measured Value

5.5. Temperature Measurement

On the Multifunctional Card is a temperature sensor (type LM75). Register 13 h contains the measured temperature on the circuit board in 0.5 ° C increments in two's complement format. Only the 9 most significant bits are important. The seven least significant bits are always zero.

5.6. Digital Inputs

The four digital inputs can be evaluated parallel by different modules. Frequency counters, encoders for rotary encoders and a simple logic analyzer are available.

5.6.1. Frequency Counter

The four - channel frequency counter can record the length of incoming pulses with a resolution of 10 ns or the number of incoming pulses over a period of 10 ms (resolution 100 Hz). Impulses and breaks must be longer than 10 ns.

Each input must be configured independently of the others:

- Measurement of the pulse duration as a multiple of 10 ns
- Measurement of the break duration as a multiple of 10 ns
- Measurement of the period duration as a multiple of 10 ns
- Counting of incoming pulses over a period of 10 ms

The counters are 24 bits wide. A value of "FFFFFFh" signals a counter overflow. With the value 0, no pulse was detected. This results in the following measuring ranges:

- 10 ns to 167772,14 µs corresponding to approx.. 5,96 Hz to 100 MHz:

  To keep resolution - related measurement errors below 0.1 %, the signals to be measured should have a minimum duration of 10 µs.

- 100 Hz to 100 MHz:

  To keep measurement errors below 0.1 %, is the recommended measurement value 100 kHz to 100 MHz.

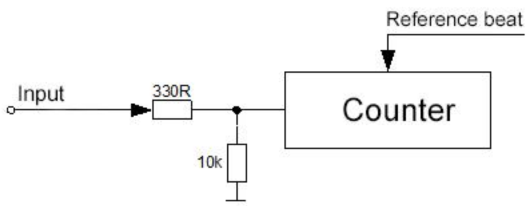


Figure 22: General Circuit Diagram of One of the 4 Digital Inputs

Before use, the digital inputs and outputs must be activated (Register 0x0C, OUT_DIS = 0).

5.6.2. Rotary Encoder

Each of the two rotary encoder inputs have a width of 24 bits and use two digital inputs. The encoder input 0 uses the digital inputs 0 and 1, while the encoder input 1 uses the digital inputs 2 and 3.

5.6.3. 4 Channel Logic Analysis

The counter inputs can also be used in parallel as a logic analyzer. To do this, the inputs are sampled in parallel with up to 10 MSps and the respective high / low level (1/0) is transmitted. Resources of the A / D section are used for this so this function is only available as an alternative to the A / D converter.

The trigger control of the A / D section is used with all its features except of the analog trigger as impulse generator.

The sampled data is output with two samples per byte with the older sample in the high nibble on the data channel of the A / D section:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Counter3 n	Counter2 n	Counter1 n	Counter0 n	Counter3 n+1	Counter2 n+1	Counter1 n+1	Counter0 n+1

If a record can not be sent because the PC is not ready to receive data, a flag will be set in the status register (Overflow Counter Scan) that indicates on this. The data acquisition will continue automatically as soon as the PC accepts data again.

Before use, the digital inputs and outputs must be activated (register 0x0C, OUT_DIS = 0).

5.7. Digital Outputs

5.7.1. General

The digital output has 4 channels of TTL level that can carry high level, low level, comparator signal or PWM signal from one of two existing PWM generators.

5.7.2. Comparator

The comparator signal is orginated from the analog input. The output goes to high level if the trigger threshold of the analog trigger is either exceeded or fallen. On request, a self - holding can be activated, so that the output signal remains and even after a trigger event, the trigger threshold is no longer exceeded or fallen.

5.7.3. PWM

The PWM generator creates a PWM signal by two 24 bit counters from a basic pulse code of 50 MHz. A counter determines the PWM period duration, another the duration of the high levels per each PWM period with 20 ns resolution.

5.8. MCD Busmaster

The MCD Busmaster is designed to control the MCD's own system control bus. It consists of a freely configurable synchronous serial data bus, a parallel address bus and a diagnostic bus

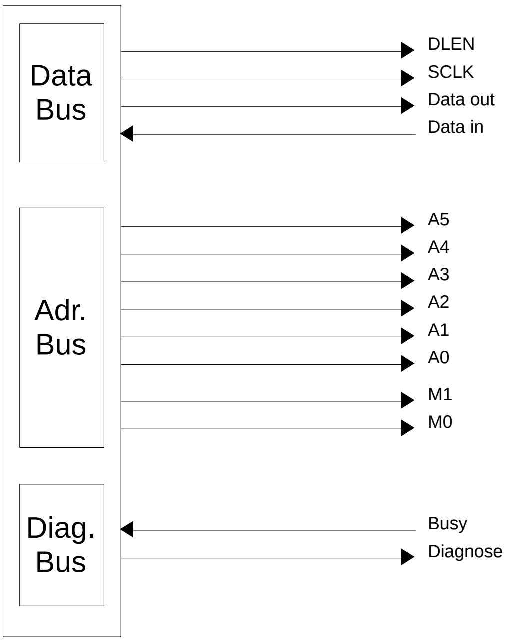


Figure 23: Structure of the MCD Bus

5.8.1. Data Bus

The data bus can be largely freely configured in terms of function and behavior.

Configurable properties are:

- Idle level DLEN high or low
- Idle level SCLK high or low
- "Data out" changes with rising or falling edge of SCLK
- “Data in" is read on by rising or falling edge of SCLK
- Number of bits to be read and written
- "DLEN" can be configured to remain active until the next data transfer

5.8.2. Address Bus

With the six address lines A0 ... A5, the individual cards can be addressed on the MCD bus. The module address lines M0 ... M1 are used to address individual areas on an addressed card, if this is supported.

5.8.3. Diagnostic Bus

Cards that perform complex functions can easily be queried for willingness of data exchange via the busy line. The diagnostic signal places the currently addressed card in diagnostic mode, which enables the identification of the addressed card as well as any firmware updates via the data bus.

6. Pin Assigment

6.1. Socket Connector BU1

ADW GND		ADW GND	
	ADW GND		ADW 0 in
ADW GND		ADW GND	
	ADW GND		ADW 1 in
ADW GND		ADW GND	
	ADW GND		ADW 2 in
ADW GND		ADW GND	
	ADW GND		ADW 3 in
ADW GND		ADW GND	
	ADW GND		ADW 4 in
ADW GND		ADW GND	
	ADW 5 gativ in		ADW 5 positiv in
ADW GND		ADW GND	
	ADW GND		ext. ADW-Trigger in
ADW GND		ADW GND	
	Test		Test
Test		Test	
	PC GND		PC GND
Reserve		Reserve	
	Reserve		Reserve
n.c.		n.c.	
	DAW GND		DAW GND
DAW GND		ext. DAW-Trigger in	
	DAW GND		DAW GND
DAW 0 GND-Sense in		DAW 0 out	
	DAW GND		DAW GND
DAW 1 GND-Sense in		DAW 1 out	
	DAW GND		DAW GND
DAW 2 GND-Sense in		DAW 2 out	
	DAW GND		DAW GND
DAW 3 GND-Sense in		DAW 3 out	
	DAW GND		DAW GND

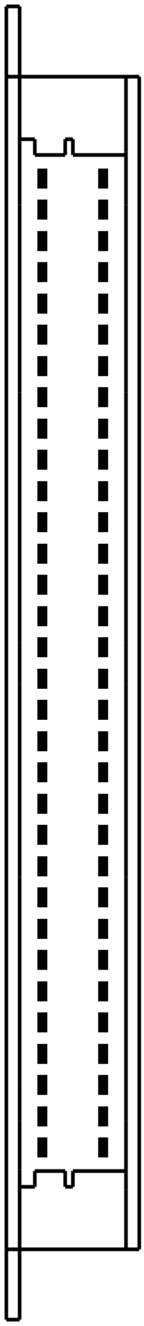
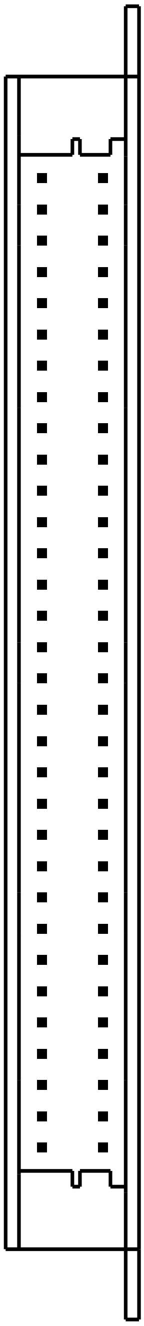


Figure 24: Pin Assigment Socket Connector BU1

6.2. Pin Header ST1



PC GND		PC GND	
	(Counter 3 in) n.c.		(Counter 2 in) n.c.
(Counter 1 in) n.c.		(Counter 0 in) n.c.	
	+12VDC		+12VDC
Data In		Data In	
	Data Out		Data Out
Clock		Clock	
	DLEN		DLEN
A0		A0	
	A1		A1
A2		A2	
	A3		A3
A4		A4	
	A5		A5
Sub-A0		Sub-A0	
	Sub-A1		Sub-A1
Ready/Busy#		Diagnose	
	Digi Out 1		Digi Out 0
Digi Out 3		Digi Out 2	
	PC GND		PC GND
Rmess 0 in		Rmess 1 in	
	PC GND		PC GND
Rmess 3 in		Rmess 2 in	
	PC GND		PC GND
n.c.		n.c.	
	n.c.		n.c.
n.c.		n.c.	
	PC GND		PC GND
USB DN		USB DN	
	USB DP		USB DP
USB 5V		USB 5V	
	n.c.		n.c.

Figure 25: Pin Assigment Pin Header ST1

6.3. Box Header ST3

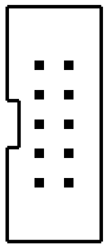
PC GND		Counter 0 in
PC GND		Counter 1 in
PC GND		Counter 2 in
PC GND		Counter 3 in
PC GND		n.c.

Figure 26: Pin Assigment Box Header ST3

7. Technical Data

Analog Input		
A / D Converter	16 Bit A / D Converter, up to 500 kSps simultaneous sampling of all channels	
A / D - FIFO	4k Measurement values	
Ground Reference / System Mass	ADW_GND	
Galvanic Isolation	A / D section separated from PC - / system mass and D / A mass	
Operating Modes	Single shot, predefined count of measurements; continuous	
Trigger Mode	Ext. digital trigger edge rising / falling	
Trigger Source Digital	Digital In 0…3	Reference to system ground
	Ext. A / D - Trigger	Reference to ADW_GND
	Ext. D / A - Trigger	Reference to DAW_GND
	DigiIn from MCD bus	Reference to system ground
Trigger Source Analog	Each active A / D channel	
Samplerate resolution	10 ns	
Delay between Trigger and Measurement	Approx. 100 ns	External clock
	Max. one sample period	Any other trigger source
Channel Count	4 x buffered single ended	Channel 0…3
	1 x buffered single ended	Channel 4
	1 x buffered differenziell	Channel 5
Input Range and Resolution	± 12 V; 366 µV / Digit ± 24 V; 732 µV / Digit	Channel 0…3
	± 12 V; 366 µV / Digit	Channel 4
	± 12 V; 366 µV / Digit	Channel 5
Accuracy	Type. < 0,5 %	Uncalibrated
Inputs	± 25 V (Measurement range ± 12 V) ± 48 V (Measurement range ± 24 V)	
Input Impedance Referenced to ADW_GND	10 MΩ (Measurement range ± 12 V) 1 MΩ (Measurement range ± 24 V)	

Analog Output		
Channel Count	4	
Resolution	16 Bit	
Samplerate	Channel output sequential: 1 channel: max. 1000 kSps 2 channels: max. 500 kSps 3 channels: max. 333 kSps 4 channels: max. 250 kSps	Output values are changed sequential starting with the lowest channel number.
	Channel output synchronous: 1 channel: max. 1000 kSps 2 channels: max. 312 kSps 3 channels: max. 238 kSps 4 channels: max. 192 kSps	Output values of all channels are changed simultaneaous.
D / A - FIFO	4 k Measurement values	
Ground Reference	DAW_GND	
Galvanic Isolation	D / A section separated from PC / System mass and A / D mass	
Operating Modes	Single shot, predefined count of measurements; continuous	
Trigger Mode	Ext. Digital trigger edge rising / falling	
Trigger Source Digital	Digital In 0…3	Reference to system ground
	Ext. A / D Trigger	Reference to ADW_GND
	Ext. D / A Trigger	Reference to DAW_GND
	DigiIn from MCD bus	Reference to system ground
	A / D Converter trigger source	
Delay between Trigger and Measurement	Approx. 100 ns	External clock
	Max. one sample period	Any other trigger source
Output Range	± 10 V single ended	
Offset	Type. < 0,5 mV	Uncalibrated
	Max. 50 µV	Calibrated
Deviation at ± 10 V	Type. < 2 mV	Uncalibrated
	Max. 0,5 mV	Calibrated
Linearity	INL: ± 1 LSB max.	
	DNL: ± 1 LSB max.	

Output Current	Max. 2 mA per channel	
	Type. 5 mA per channel	Shortet against DAW_GND
Settling Time	Type. 8 µs	Full scale (at ± 1LSB)
	Type. 2 µs	512LSB step
Voltage Rise	Type. 5 V / µs	

External Trigger Inputs		
Count	2	
Ground Reference	ADW_GND	Ext. A / D Trigger
	DAW_GND	Ext. D / A Trigger
Input Level	Low: - 30 V … + 0,5 V	
	High: 1,5 V … 30 V	
Pulslength	Min. 200 ns	
Slew Rate	Min. 50 V / ms	
Input Impedance	≥ 10 kΩ	

Measurement of Coding Resistors		
Channel Count	4	
Measurement Current	Type. 100 µA	
Measurement Voltage	Max. 3,3 V	
Ground Reference	PC / System mass	
Measurement Range	10 … 10000 Ω	
Resolution	5 Ω	

Temperature Measurement		
Sensor	LM75	
Measurement range	- 25 °C … 100 °C	
Resolution	0,5 °C	
Deviation	± 2 °C	

MCD Bus		
Input / Output Level	TTL	
Addressing	6+2Bit parallel	Card and Submodule
Communication	Synchron serial	
Chip Select	Idle level: high or low	
	Active or inactive until next data transmission	
Data Clock	Idle level: high or low	
	Period: 100 ns … 5100 ns	Adjustable in 20ns steps
Data Output	Idle level: high or low	
	Level change at clock edge: rising / falling	
Data Input	Data migration at clock edge: rising / falling	
Diagnose	dedicated select - signal	
Busy Request	Via 1 Bit status signal	

Digital Output		
Channel Count	4	
Output Level	TTL	
Output Impedance	330 Ω	
Signal	High	
	Low	
	A / D Converter analog comparator	Normal or inverted, latching is optional.
	PWM generator	Each output can output one of the two PWM generator signals.

PWM Generator		
Generator count	2	
Resolution	20 ns	
Counter lenght for duty - cycle and period	24 Bit	

Digital Input		
Channel Count	4	
Input Level	Low: 0 V … 0,8 V	
	High: 2 V … 5,0 V	
Function (parallel usage possible)	Counter input	
	Encoder input	
	Sampling	Max. samplerate is 10 MSps; using this function disables analog measurement.

Counter Input		
Count	4	
Used Connectors	Digital input 0 to 3	
Counter Width	24 Bit	
Pulse / Break Length	Min. 11 ns	
Mass Reference	PC / System mass	
Input Impedance	≥ 10 kΩ against PC / System mass	
Resolution (Time)	10 ns	Measurement of high time, low time or length of period
Resolution (Frequency)	100 Hz	Frequency measurement
Gate Time (Frequency)	10 ms	Frequency measurement
Accuracy	Type. ≤ 50 ppm	

Encoder - Eingang		
Input Count	2	
Used Connectors	Digital Input 0 und 1	Encoder Input 0
	Digital Input 2 und 3	Encoder Input 1

General		
Supply Voltage	12 VDC ± 5 %	
Power Consumption	Type. 4,5 W	
	Max. 6 W	
Dimensions	160 mm x 100 mm	Without connectors
Connectors	VG64 male connector	DIN 41612 Design C
	VG64 female connector	
	10 - pin shroud terminal strip	

PC Interface		
Interface	USB 2.0 High - Speed, self - powered	