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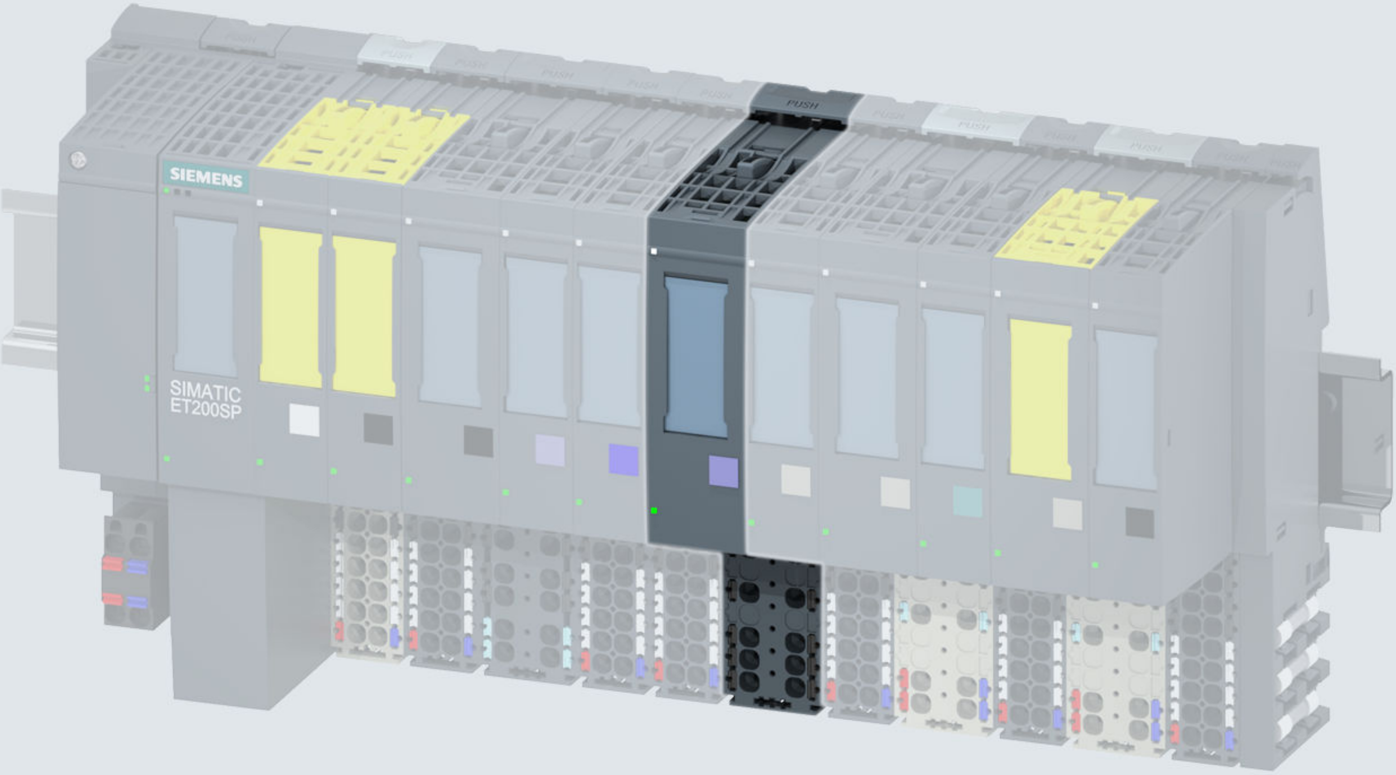

Manual

# SIMATIC

## ET 200SP

Analog input module
AI Energy Meter 480VAC ST
(6ES7134-6PA20-0BD0)

Edition 10/2017

support.industry.siemens.com

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# ET 200SP
# Analog input module AI Energy Meter 480VAC ST (6ES7134-6PA20-0BD0)

Manual

10/2017

A5E36061895-AB

# Legal information

## Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

| ⚠DANGER |
|---|
| indicates that death or severe personal injury **will** result if proper precautions are not taken. |

| ⚠WARNING |
|---|
| indicates that death or severe personal injury **may** result if proper precautions are not taken. |

| ⚠CAUTION |
|---|
| indicates that minor personal injury can result if proper precautions are not taken. |

| NOTICE |
|---|
| indicates that property damage can result if proper precautions are not taken. |

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

## Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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Note the following:

| ⚠WARNING |
|---|
| Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed. |

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We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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# Preface

## Purpose of the documentation

This manual supplements the system manual ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293). Functions that generally relate to the system are described in this manual.

The information provided in this manual and in the system/function manuals supports you in commissioning the system.

## Changes compared to previous version

Changes/enhancements described in this manual, compared to the previous version:

- "Quality information" section rearranged.
- "Measured variables for limit monitoring" section supplemented.
- Notes on the previous version of this manual have been taken into account in the current edition.

## Conventions

CPU: When the term "CPU" is used in this manual, it applies both to the CPUs of the S7-1500 automation system and to the CPUs/interface modules of the distributed I/O system ET 200SP.

STEP 7: In this documentation, "STEP 7" is used as a synonym for all versions of the configuration and programming software "STEP 7 (TIA Portal)".

Please also observe notes marked as follows:

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**Note**

A note contains important information on the product described in the documentation, on the handling of the product and on the section of the documentation to which particular attention should be paid.

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## Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

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For additional information on industrial security measures that may be implemented, please visit (http://www.siemens.com/industrialsecurity).

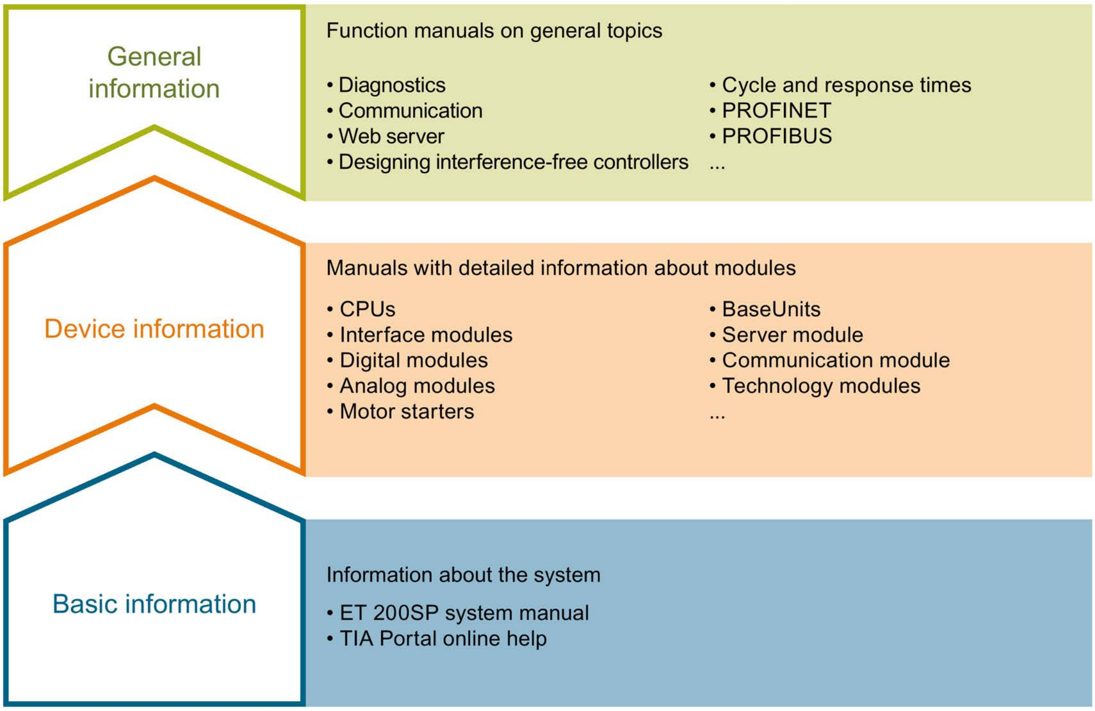
Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under (http://www.siemens.com/industrialsecurity).

# Table of contents

# 1 Documentation guide

The documentation for the SIMATIC ET 200SP distributed I/O system is arranged into three areas.
This arrangement enables you to access the specific content you require.



Function manuals on general topics

- Diagnostics
- Communication
- Web server
- Designing interference-free controllers
- Cycle and response times
- PROFINET
- PROFIBUS

...

Manuals with detailed information about modules

- CPUs
- Interface modules
- Digital modules
- Analog modules
- Motor starters
- BaseUnits
- Server module
- Communication module
- Technology modules

...

Information about the system

- ET 200SP system manual
- TIA Portal online help

### Basic information

The system manual describes in detail the configuration, installation, wiring and commissioning of the SIMATIC ET 200SP. distributed I/O system. The STEP 7 online help supports you in the configuration and programming.

### Device information

Product manuals contain a compact description of the module-specific information, such as properties, wiring diagrams, characteristics and technical specifications.

### General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC ET 200SP distributed I/O system, e.g. diagnostics, communication, Web server, motion control and OPC UA.

You can download the documentation free of charge from the Internet (http://w3.siemens.com/mcms/industrial-automation-systems-simatic/en/manual-overview/tech-doc-et200/Pages/Default.aspx).

Changes and supplements to the manuals are documented in a Product Information.

You can download the product information free of charge from the Internet (https://support.industry.siemens.com/cs/us/en/view/73021864).

## Manual Collection ET 200SP

The Manual Collection contains the complete documentation on the SIMATIC ET 200SP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (http://support.automation.siemens.com/WW/view/en/84133942).

## "mySupport"

With "mySupport", your personal workspace, you make the most of your Industry Online Support.

In "mySupport" you can store filters, favorites and tags, request CAx data and put together your personal library in the Documentation area. Furthermore, your data is automatically filled into support requests and you always have an overview of your current requests.

You need to register once to use the full functionality of "mySupport".

You can find "mySupport" in the Internet (https://support.industry.siemens.com/My/ww/en).

## "mySupport" - Documentation

In the Documentation area of "mySupport", you have the possibility to combine complete manuals or parts of them to make your own manual.
You can export the manual in PDF format or in an editable format.

You can find "mySupport" - Documentation in the Internet (http://support.industry.siemens.com/My/ww/en/documentation).

## "mySupport" - CAx Data

In the CAx Data area of "mySupport", you can have access the latest product data for your CAx or CAe system.

You configure your own download package with a few clicks.

In doing so you can select:

- Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files
- Manuals, characteristics, operating manuals, certificates
- Product master data

You can find "mySupport" - CAx Data in the Internet (http://support.industry.siemens.com/my/ww/en/CAxOnline).

## Application examples

The application examples support you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus in individual products.

You can find the application examples on the Internet (https://support.industry.siemens.com/sc/ww/en/sc/2054).

## TIA Selection Tool

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).
This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.
With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet (http://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool).

## SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to run commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independently of the TIA Portal.

The SIMATIC Automation Tool provides a multitude of functions:

- Scanning of a PROFINET/Ethernet network and identification of all connected CPUs
- Address assignment (IP, subnet, gateway) and station name (PROFINET device) to a CPU
- Transfer of the data and the programming device/PC time converted to UTC time to the module
- Program download to CPU
- Operating mode switchover RUN/STOP
- Localization of the CPU by means of LED flashing
- Reading out CPU error information
- Reading the CPU diagnostic buffer
- Reset to factory settings
- Updating the firmware of the CPU and connected modules

You can find the SIMATIC Automation Tool on the Internet (https://support.industry.siemens.com/cs/ww/en/view/98161300).

## PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the plant network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a system.

You can find SIEMENS PRONETA on the Internet (https://support.industry.siemens.com/cs/ww/en/view/67460624).

# Product overview

# 2

## 2.1 Area of application

### Introduction

Energy efficiency is playing an increasingly important role in industry. Rising energy prices, increasing pressure to improve profitability and the growing awareness of climate protection are important factors for reducing energy costs and for introducing an energy data management system.

### Where can you use the AI Energy Meter 480VAC ST?

AI Energy Meter 480VAC ST is designed for machine-level deployment in an ET 200SP distributed I/O system. AI Energy Meter 480VAC ST records over 200 different electrical measurement and energy values. It lets you create transparency about the energy requirements of individual components of a production plant even down to the machine level.

Using the measured values provided by the AI Energy Meter 480VAC ST, you can determine energy consumption and power consumption. You can determine consumption forecasts and efficiency from the measured values. Power consumption measurements are relevant for load management and maintenance. In addition, you can use the measurements for energy reporting and for determining the $CO_2$ footprint.

**Note**

**Measuring dangerous electrical quantities**

The AI Energy Meter 480VAC ST is not tested according to DIN EN 61010-2-030 and may therefore not be used to verify, measure or monitor protective measures according to DIN EN 61557.

Qualified personnel must ensure through additional measures that no danger ensues for humans and the environment in case of an incorrect display.

### TN and TT system

The AI Energy Meter 480VAC ST can be used in TN and TT systems.

## Measuring with AI Energy Meter 480VAC ST

A typical supply network of a production plant is usually divided into three voltage ranges:

- The infeed of the entire plant
- The subdistribution, for example, to individual lines within the plant
- The end consumers such as the machines in the lines.

The following figure shows the measurement in an electricity supply network:

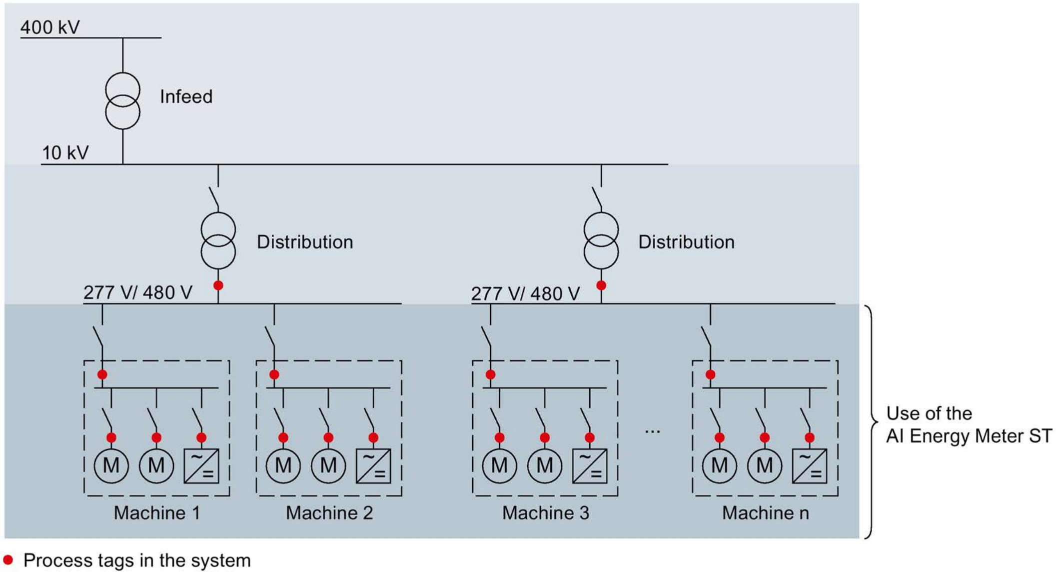


Figure 2-1 Use of the AI Energy Meter 480VAC ST

## Advantages of the AI Energy Meter 480VAC ST

The AI Energy Meter 480VAC ST has the following advantages:

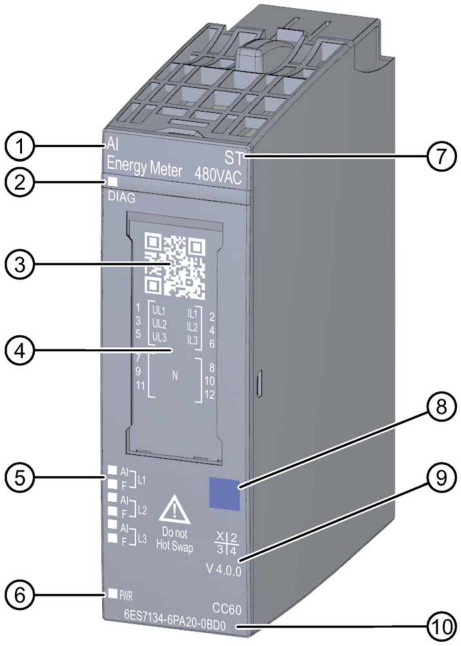
- Space-saving especially for use in control cabinet
- PROFINET IO or PROFIBUS DP (depending on the interface module in use)
- Multiple modules can be used with one interface module
- Extension of existing stations by components for energy recording

## 2.2 Properties of the AI Energy Meter 480VAC ST

### Article number

6ES7134-6PA20-0BD0

### View of the module



① Module type and name
② LED for diagnostics
③ 2D matrix code
④ Wiring diagram
⑤ LEDs for channel status
⑥ LED for supply voltage
⑦ Function class
⑧ Color identification label module type
⑨ Function and firmware version
⑩ Article number

Figure 2-2 View of the module AI Energy Meter 480VAC ST

## Properties

The module has the following technical properties:

- Measurement of electrical variables from single-phase, two-phase and three-phase supply networks
- Max. nominal voltage between two outer conductors 480 VAC
- Retentive storage of the counter values
- Recording of:
  - Voltages
  - Currents
  - Phase angles
  - Power
  - Energy / electrical work
  - Frequencies
  - Minimum and maximum values
  - Power factors
  - Operating hours
  - Limits

The module supports the following functions:

Table 2- 1 Version dependencies of the functions

| **Function** | **HW version** | **FW version** | **STEP 7** | | **GSD file** | |
|---|---|---|---|---|---|---|
| | | | **TIA Portal** | **V5.x** | **PROFINET IO** | **PROFIBUS DP** |
| Firmware update | FS01 | V4.0.0 or higher | V13 SP1 with update 4 and HSP or higher | V5.5 SP4 and hotfix 7 or higher | X | --- |
| Calibration in runtime | FS01 | V4.0.0 or higher | V13 SP1 with update 4 and HSP or higher | --- | --- | --- |
| Identification data I&M0 to I&M3 | FS01 | V4.0.0 or higher | V13 SP1 with update 4 and HSP or higher | V5.5 SP4 and hotfix 7 or higher | X | X |
| Reconfiguration in RUN | FS01 | V4.0.0 or higher | V13 SP1 with update 4 and HSP or higher | V5.5 SP4 and hotfix 7 or higher | X | X |
| Diagnostic interrupts | FS01 | V4.0.0 or higher | V13 SP1 with update 4 and HSP or higher | V5.5 SP4 and hotfix 7 or higher | X | X |
| Hardware interrupts | FS01 | V4.0.0 or higher | V13 SP1 with update 4 and HSP or higher | V5.5 SP4 and hotfix 7 or higher | X | --- |

## Accessories

The following accessories must be ordered separately:

- BaseUnit Type D0
- Labeling strips
- Reference identification label

You can find additional information on the accessories in the ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/es/58649293) system manual.

# Wiring

# 3

## 3.1 Terminal and block diagram

In an ET 200SP station, the AI Energy Meter 480VAC ST forms its own potential group together with its dark BaseUnit.

### General safety instructions

**WARNING**

**Danger to life due to electric shock**

Touching live parts can lead to death or severe injuries.

Before beginning any work deenergize the system and the Energy Meter and short-circuit installed transformers.

**WARNING**

**Danger to life, dangerous system conditions and material damage possible**

Removing and inserting the Energy Meter under live voltage is prohibited! For this reason the symbol "Do not Hot Swap" is located on the Energy Meter.

If you remove and insert the Energy Meter under live voltage during operation, the transformers used can produce dangerous induction voltages and electric arcs and dangerous system conditions can arise.

The Energy Meter may only be removed and inserted during operation if the measuring voltages supplied to the BaseUnit at terminals $U_{L1}$ , $U_{L2}$, $U_{L3}$ are disconnected at all poles **and** special current transformer terminals are used that short-circuit the transformer on the secondary side on removal.

**CAUTION**

**Use only in three-phase and AC networks**

Operation with direct voltage/direct current will destroy the Energy Meter.

Use the Energy Meter solely to measure electrical variables in three-phase and AC networks.

### Supplying the module

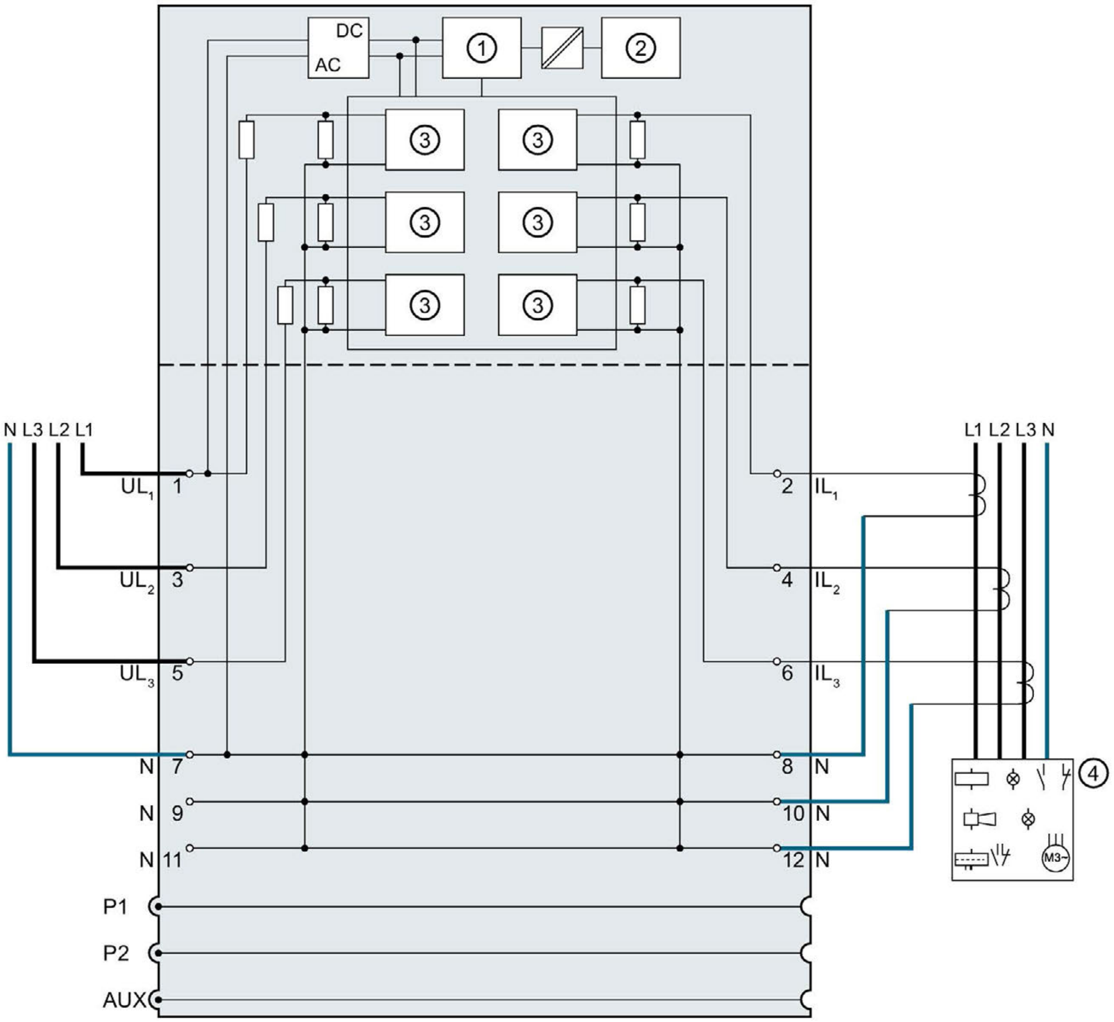
The Energy Meter is supplied through the terminals $U_{L1}$ and N. The required minimum voltage amounts to 85 VAC.

## Protecting the connection cables

To protect the connection cables at $U_{L1}$, $U_{L2}$ and $U_{L3}$, make sure there is adequate cable protection, especially after cross-section transitions.

If short-circuit resistance according to IEC 61439-1:2009 is ensured by the design, there is no need for separate cable protection for the AI Energy Meter 480VAC ST.

## Terminal and block diagram



| | | | |
|---|---|---|---|
| ① | Microcontroller | $UL_n$ | Voltage connection |
| ② | Backplane bus interface | $IL_n$ | Current connection |
| ③ | Analog-to-digital converter (ADC) | N | Neutral |
| ④ | Power measurement | | |

Figure 3-1 Block diagram of the AI Energy Meter 480VAC ST

## Usable BaseUnit

The ET 200SP Distributed I/O System manual explains that a potential group always starts with a light BaseUnit. The AI Energy Meter 480VAC ST makes an exception in this case and only uses the dark BaseUnits type D0, 6ES7193-6BP00-0B**D0**.

The BaseUnit is not in contact with the power bus and passes the potential through from the left to the right slot.

When using some older CPUs / interface modules, note that the first permissible place for AI Energy Meter 480VAC ST is slot 2.

## Connection types

The AI Energy Meter 480VAC ST supports the following connection types:

- 3P4W1, 3 phases, 4 conductors, balanced load
- 3P4W, 3 phases, 4 conductors
- 2P3W, 2 phases, 3 conductors
- 1P2W, 1 phase, 2 conductors
- 3 x 1P2W, 3 x 1 phase, 2 conductors

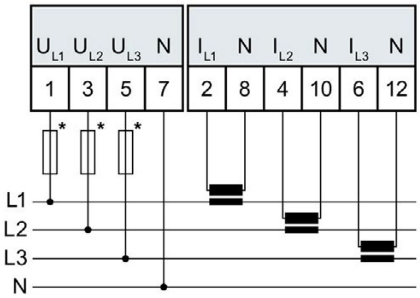
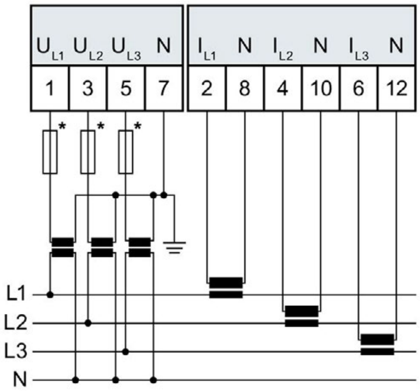
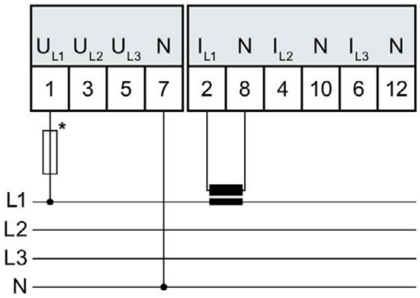
The input circuit of the module must correspond to one of the listed connection types. Select the appropriate connection type for the intended use.

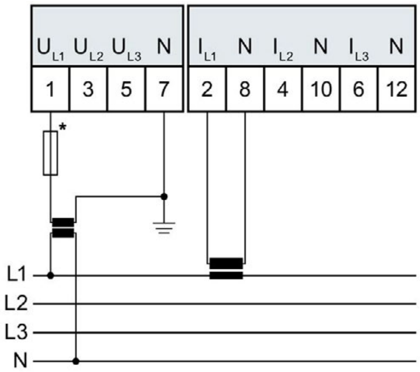
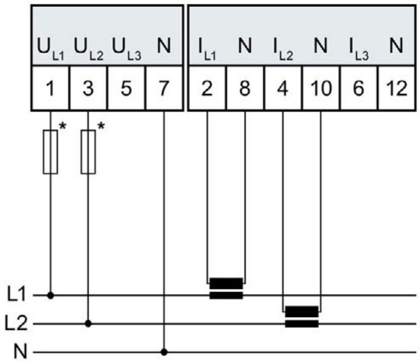
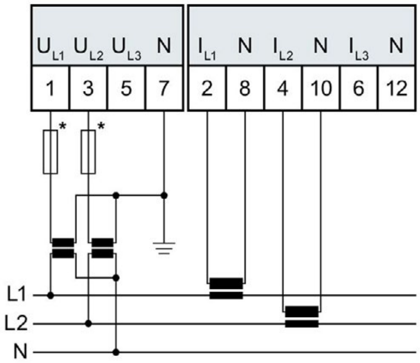
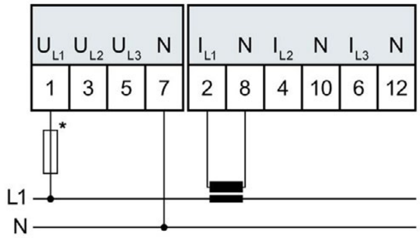
You will find examples of connections in the section Connection examples (Page 21).

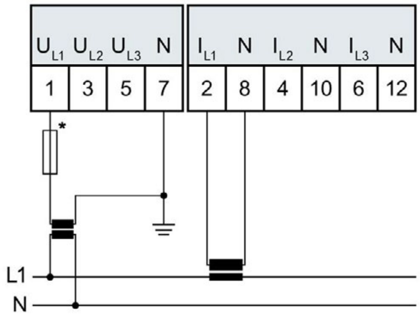
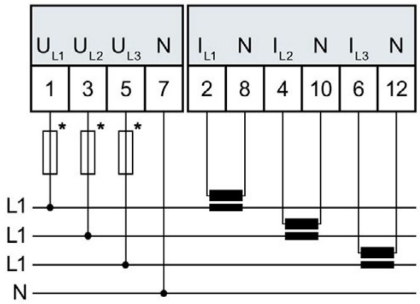
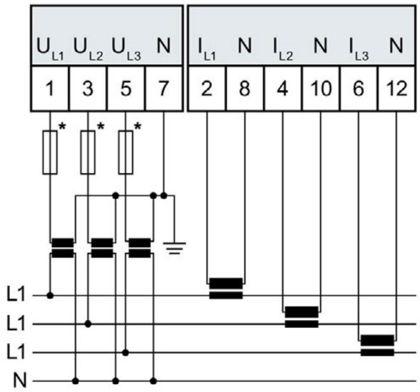
Information on the selection of a current transformer is available in the section Current transformer selection data (Page 24).

## 3.2 Connection examples

The following figures show the connection of the Energy Meter for three-phase, two-phase and single-phase measurements. Note that the Energy Meter must always be connected via a current transformer. The use of voltage transformers is optional.

| Connection type | Wiring diagram | Comment |
|---|---|---|
| **3P4W**<br>Three-phase measurement, 4 wires |  | Any load<br>Connection with three current transformers |
| **3P4W**<br>Three-phase measurement, 4 wires |  | Any load<br>Connection with three current and three voltage transformers |
| **3P4W1**<br>Three-phase measurement, 4 wires |  | Balanced load<br>Connection with one current transformer |

| Connection type | Wiring diagram | Comment |
|---|---|---|
| **3P4W1**<br>Three-phase measurement, 4 wires |  | Balanced load<br>Connection with one current and one voltage transformer |
| **2P3W**<br>Two-phase measurement, 3 conductors |  | Any load<br>Connection with two current transformers<br>Energy Meter supplies the value "0" for all measured values of Phase 3 as well as for some cross-phase measured values. |
| **2P3W**<br>Two-phase measurement, 3 conductors |  | Any load<br>Connection with two current and two voltage transformers<br>Energy Meter supplies the value "0" for all measured values of Phase 3 as well as for some cross-phase measured values. |
| **1P2W**<br>Single-phase measurement, 2 conductors |  | Measurement in an AC network with a current transformer<br>Energy Meter supplies the value "0" for all measured values of Phases 2 and 3 as well as for some cross-phase measured values. |

| Connection type | Wiring diagram | Comment |
|---|---|---|
| **1P2W**<br>Single-phase measurement, 2 conductors |  | Measuring the load in an AC network with a current and a voltage converter<br>Energy Meter supplies the value "0" for all measured values of Phases 2 and 3 as well as for some cross-phase measured values. |
| **3 x 1P2W**<br>3 x single-phase measurement |  | Measurement with three current transformers for any three loads that are each connected to one of the three phases<br>Max. permissible secondary current of the current transformer is 1 A |
| **3 x 1P2W**<br>3 x single-phase measurement |  | Measurement with three current transformers and three voltage transformers for any three loads that are each connected to one of the three phases<br>Max. permissible secondary current of the current transformer is 1 A |

* If short-circuit resistance according to IEC 61439-1:2009 is ensured by the design, there is no need for separate cable protection for the AI Energy Meter 480VAC ST.

## Current transformer connection requirements

DIN VDE 0100-557 and IEC 60364-5-55 require the following for the connection of current transformers:

- The secondary circuits of current transformers must not be grounded.
- Guards must not be used in the secondary circuits of current transformers.
- The insulation of the secondary cables of transformers must be designed for the highest voltage of all active components, or the secondary cables must be installed in such a way that their insulation cannot touch any active components, such as busbars.
- Connection points must be provided for temporary measurements.

# 3.3 Current transformer selection data

## Introduction

Connection via a current transformer is always required for the current measurement. Use toroids with an accuracy class of 0.5, 1 or 3.

## Dimensioning of the current transformer

The correct dimensioning of the current transformer is important for the following reasons:

- You achieve correct results from the measurements and
- You do not overload or damage the current transformers.

## Selecting a current transformer

Use current transformers with a burden capacity 1.5 to 2 times greater than the power dissipation in the terminal circuit (consisting of resistance of the connection cables and burden of energy meter). 1.5 times the power loss is required in order to prevent the transformer from overloading. 2 times the power dissipation is important to ensure the current limiting in case of a short-circuit.

## Maximum length of the connection cable

To avoid overloading or damaging the current transformer, the burden $Z_n$ specified on the data sheet of the current transformer (in VA) must not be exceeded. To prevent this being exceeded, the entire burden resistance (consisting of the resistance of the connection cable and the internal resistance of the AI Energy Meter 480VAC ST (see figure below) must be below a certain resistance value (depending on $Z_n$ and $I_{max}$).

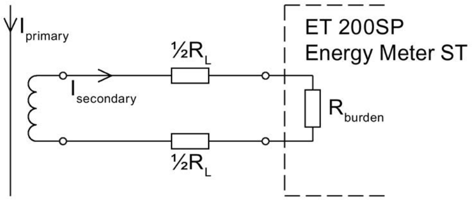


Figure 3-2 Maximum length of the connection cable

The maximum value of the resistance of the connection cable is obtained with the following formula:

$$R_{L,\,max} = \frac{Z_n}{I_{max}^{\;2}} - R_{burden}$$

| | | | |
|---|---|---|---|
| $R_L$ | Cable resistance in ohms | $I_{max}$ | Secondary current of the current transformer |
| $Z_n$ | Rated burden current transformer in VA | $R_{burden}$ | Resistance of the Energy Meter (25 mΩ) |

Figure 3-3 Maximum value for the resistance of the connection cable

Based on the maximum cable resistance in ohms, you then calculate the maximum length of the connection cable. To do this, check the data sheet of the connection cable you are using.

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**Note**

The length of the connection cable (outwards and return) must not exceed the value of 200 meters.

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## Example: Usage of a current transformer 500/5 A

You use a current transformer with a transmission ration of 500/5 A that has a rated burden $Z_n$ of 5 VA according to the data sheet.

The maximum primary current in the application amounts to 400 A. This means that the maximum secondary current $I_{max.}$ amounts to 4 A. The burden of the AI Energy Meter including connection resistance amounts to $R_{Burden}$ = 25 mΩ.

The maximum value of the resistance of the connection cable (outgoing and incoming line) is obtained using the following formula:

$$R_{L,\,max} = \frac{Z_n}{I_{max}^{\;2}} - R_{Burden} = \frac{5\ AV}{16\ A^2} - 25\ m\Omega = 312.5\ m\Omega - 25\ m\Omega = 287.5\ m\Omega$$

The maximum cable resistance between the transformer and the terminals of the Energy Meter may not exceed 287.5 mΩ in this case. The corresponding cable length (outgoing and incoming line) depends on the cross-section used of the copper line and can be determined by using the following table.

The following table shows the resistance values of copper cables for typical cross-sections with $\rho = 0.017857\ \Omega \times mm^2/m$

### Estimating the length for a connection cable

The value in the table must be less than the calculated terminal resistance $R_{L\ max}$ of the cable. For the resistance $R_{Lmax}$ of 287.5 mΩ used in the above example it is possible to use a connection cable (outgoing and incoming line) with a length of 10 m from a cross-section of 0.75 $mm^2$ upward.

| Cross-section | AWG | Cable overview for copper | | | | |
|---|---|---|---|---|---|---|
| | | 0.5 m | 1 m | 5 m | 10 m | 50 m |
| 0.25 $mm^2$ | 24 | 35.7 mΩ | 71.4 mΩ | 357.1 mΩ | 714.3 mΩ | 3571.4 mΩ |
| 0.34 $mm^2$ | 22 | 26.3 mΩ | 52.5 mΩ | 262.6 mΩ | 525.2 mΩ | 2626.0 mΩ |
| 0.5 $mm^2$ | 21 | 17.9 mΩ | 35.7 mΩ | 178.6 mΩ | 357.1 mΩ | 1785.7 mΩ |
| 0.75 $mm^2$ | 19/20 | 11.9 mΩ | 23.8 mΩ | 119.0 mΩ | 238.1 mΩ | 1190.5 mΩ |
| 1.0 $mm^2$ | 18 | 8.9 mΩ | 17.9 mΩ | 89.3 mΩ | 178.6 mΩ | 892.9 mΩ |
| 1.5 $mm^2$ | 16 | 6.0 mΩ | 11.9 mΩ | 59.5 mΩ | 119.0 mΩ | 595.2 mΩ |
| 2.5 $mm^2$ | 14 | 3.6 mΩ | 7.1 mΩ | 35.7 mΩ | 71.4 mΩ | 357.1 mΩ |

### Checking the ratio of burden load and power loss

The rated burden of the transformer must be 1.5 to 2 times greater than the power loss in the connection circuit to ensure that the transformer is not overloaded and that the current limitation is ensured during a short-circuit.

At a maximum secondary current of 4 A the power loss in the connection circuit is calculated in accordance with the following formula for a connection cable (outgoing and incoming line) with a length of 10 m and a cross-section of 1.0 mm² and a burden resistance of the Energy Meter of 25 mΩ:

$$P_{\text{Connection circuit}} = (R_{\text{Connection cable}} + R_{\text{Burden}}) \text{ x } I^2_{\text{Max. secondary}}$$

$$P_{\text{Connection circuit}} = (178.6\ \text{m}\Omega + 25\ \text{m}\Omega) \text{ x } 4^2\ \text{A}^2\ 3.26\ \text{W}$$

The ratio of the rated burden and the power loss in the connection circuit thus amounts to:

$$\frac{Z_{\text{N rated burden}}}{P_{\text{Connection circuit}}} = \frac{5\ \text{VA}}{3.26\ \text{W}} = 1.54$$

The required ratio of rated burden and power loss in the connection circuit lies within the required range. The transformer is dimensioned sufficiently large.

## See also

Technical specifications (Page 106)

# Configuration / address space

# 4

## 4.1 Configuring

### Introduction

To configure the AI Energy Meter 480VAC ST after connecting it, use configuration software such as STEP 7. In addition, you can also change numerous parameters of the AI Energy Meter 480VAC ST in RUN via the user program.

### Configuring

You configure the AI Energy Meter 480VAC ST with:

- STEP 7 (TIA Portal) V13 SP1 or higher with Update 4 and HSP
- STEP 7 V5.5 SP4 or higher and Hotfix 7
- GSD file for PROFIBUS or PROFINET

**Note**

**Consistency check of the parameter assignment only with STEP 7**

If you configure the AI Energy Meter 480VAC ST using STEP 7, STEP 7 already checks the various parameters for consistency while they are being entered.

If you configure the AI Energy Meter 480VAC ST using a GSD file, a consistency check is not carried out. The module does not recognize incorrect entries until after the parameter data record has been transferred. If the module recognizes an invalid parameter, the module rejects the complete data record.

Preferably use STEP 7 to configure the AI Energy Meter 480VAC ST.

The following instructions show the theoretical procedure for configuring the AI Energy Meter 480VAC ST with STEP 7 (TIA Portal) V13 SP1 or higher with Update 4 and HSP.

1. Select the ET 200SP distributed I/O system you are using in the hardware catalog.
2. Insert the module into your station.
3. Open the device view of the ET 200SP and insert the AI Energy Meter 480VAC ST.
4. Configure the AI Energy Meter 480VAC ST to suit your requirements.

   Once the configuration has been compiled without errors, you can download the configuration to the CPU and commission the ET 200SP station while the AI Energy Meter 480VAC ST is running.

## 4.2 Selecting the module versions

### Introduction

The AI Energy Meter 480VAC ST has different module versions.

During the configuration you use the selection of the module version to specify which measured values can be read.

Each module version supplies quality information via the input user data.

With the exception of the module version "2 I / 2 Q" you can read the measured values as user data cyclically from the process image. At each module version you have the option to read measured value records from the AI Energy Meter 480VAC ST by using the RDREC instruction asynchronously.

### Influence of the module version on the address space

---

**Note**

**Influence of the AI Energy Meter 480 VAC ST on the maximum configuration of the ET 200SP**

The available address space of the ET 200SP is influenced by the following factors:

- CPU or interface module
- Plugged I/O modules

The address space made **additionally** available by the AI Energy Meter 480 VAC ST is essentially influenced by the length of the user data supplied. The module version determines the length of the user data, which can be supplied by the AI Energy Meter 480VAC ST at maximum.

---

## 4.2.1 Module versions at configuration with STEP 7

### Module versions with fixed user data assignment

| Module version | User data | Address space | Comment |
|---|---|---|---|
| 2 I / 2 Q | No cyclic user data.<br>Access to measured values through "Read data record". | 2-byte inputs<br>2-byte outputs | Information about the structure of the 2 I / 2 Q module version is available in the appendix Module version "2 I / 2 Q" (Page 142). |
| EE@Industry E0 | User data in accordance with EE@Industry measurement data profiles | 12 byte inputs / 12 byte outputs | Information about the structure of the EE@Industry measured data profiles is available in the appendix Module version "EE@Industry measurement data profile E0 / E1 / E2 / E3" (Page 153). |
| EE@Industry E1 | | 4 byte inputs / 12 byte outputs | |
| EE@Industry E2 | | 12 byte inputs / 12 byte outputs | |
| EE@Industry E3 | | 104 byte inputs / 12 byte outputs | |

### Module versions with selectable user data variants

| Module version | User data | Address space | Comment |
|---|---|---|---|
| 32 I / 12 Q | User data selectable through defined user data variants | 32 byte inputs / 12 byte outputs | You can change over the user data variant during operation.<br>Information about the structure of the 32 I / 12 Q module version is available in the appendix Module version "32 I / 12 Q" (Page 145).<br>Information about the user data variants at 32 I / 12 Q is available in the appendix User data variants with 32 bytes input data / 12 bytes output data (Page 155). |
| User-specific | User data selectable through user data mapping or through defined user data variant | Variable* / 12 byte outputs | You have to activate the check box "User data-mapping" in STEP 7 to use the module version user-specifically.<br>You can change over the user data variant during operation.<br>Information about the structure of the user-specific module version is available in the appendix "User-specific" module version (Page 151). |

* 16 ... 256 bytes in steps of 16 bytes, depending on the mapped measured values

## 4.2.2 Module versions at configuration with GSD file

### Module versions with fixed user data assignment

| Module version | User data | Address space | Comment |
|---|---|---|---|
| 2 I / 2 Q | No cyclic user data.<br>Access to measured values through "Read data record". | 2-byte inputs<br>2-byte outputs | Information about the structure of the 2 I / 2 Q module version is available in the appendix Module version "2 I / 2 Q" (Page 142). |
| E0 | User data in accordance with EE@Industry measurement data profiles | 12 byte inputs / 12 byte outputs | Information about the structure of the EE@Industry measured data profiles is available in the appendix Module version "EE@Industry measurement data profile E0 / E1 / E2 / E3" (Page 153). |
| E1 | | 4 byte inputs / 12 byte outputs | |
| E2 | | 12 byte inputs / 12 byte outputs | |
| E3 | | 104 byte inputs / 12 byte outputs | |

### Module versions with selectable user data variants

| Module version | User data | Address space | Comment |
|---|---|---|---|
| 32 I / 12 Q | User data selectable through user data variants or through user-specific user data* | 32 byte inputs / 12 byte outputs | You can change over the user data variant during operation.<br>If you use user-specific user data, you write your measured value profile into the AI Energy Meter 480VAC ST with the data record 130. To do this use the WRREC instruction. Information about the structure of data record 130 is available in appendix Structure of the parameter data record 130 for user-data mapping (Page 125). |
| 64 I / 12 Q | | 64 byte inputs / 12 byte outputs | |
| 128 I / 12 Q | | 128 byte inputs / 12 byte outputs | |
| 256 I / 12 Q | | 256 byte inputs / 12 byte outputs | |

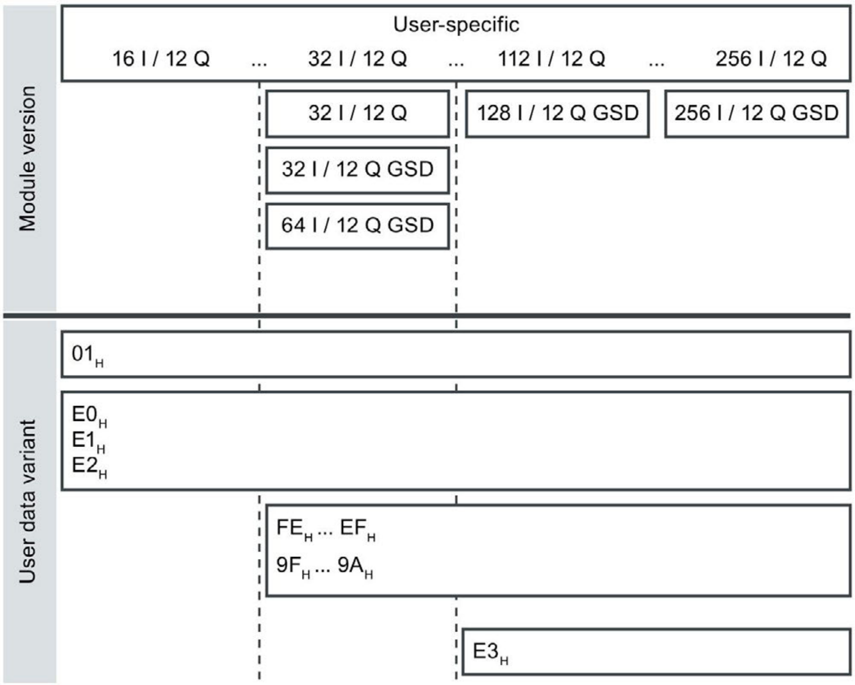
*Ensure that the user data do not exceed the size of the address space of the module version. If necessary, use a module version with a larger address space

## 4.2.3 Changing over the user data variant during operation

### Introduction

You change the user data variant in the output data of each user data variant in Byte 0.

The following figure shows to which user data you can change over at various module versions during operation.



### Requirement

- User program has been created.
- AI Energy Meter 480VAC ST is configured as one of the module versions mentioned in the illustration above.
- The start address of the module is known in the process image output.

### Procedure

1. Create one constant with the data type BYTE per user data variant.
2. Enter the user data ID as a value in each case.
3. Write the constant to the start address of the module in the process image output.

## Result

The user data variant is switched with the next cycle.

---

**Note**

**Information about user data changeover**

The parameterized user data variant is set in the following cases:

- A "0" is written in byte 0 in the output data of a user data variant.
- Byte 0 in the output data of a user data variant contains an invalid value:
  - Coding of the user data variant not available

    or
  - Available address space is not sufficient for the selected user data variant.

---

### 4.2.4 Recommendations for selecting the module version

The following table shows which module version is suitable for a given purpose.

| Module version | Application | Note |
|---|---|---|
| 2 I / 2 Q | • Use of many AI Energy Meter 480VAC ST in an ET 200SP or little address space is available | • Read the measured values solely via the RDREC instruction from a measured value data record.<br>• Quality information about the measured values is always available. |
| EE@Industry measurement data profile<br>E0 / E1 / E2 / E3 | • Cyclic measurement per phase<br>• Supplied measured values in accordance with the EE@Industry measured data profile | • Available measured values depend on the configured measurement data profile.<br>• The user data are fixed and cannot be changed dynamically. Alternatively, read the measured values acyclically from a measured value data record via the RDREC instruction.<br>• No quality information |
| 32 I / 12 Q | • Cyclic measurement per phase<br>• Flexibility by switching predefined user data variants | • Quality information about the measured values is always available.<br>• Depending on the user data variant, you must convert the measured values in the CPU to physical values using the supplied scaling factor.<br>• One cycle elapses for each user data changeover. Measured values from the next user data variant are thus supplied with a slight time offset.<br>Alternatively, read the measured values acyclically from a measured value data record via the RDREC instruction. Consistent measured values of a measuring cycle are supplied. |
| User-specific<br>With GSD configuration<br>• 32 I / 12 Q<br>• 64 I / 12 Q<br>• 128 I / 12 Q<br>• 256 I / 12 Q | • Cyclic measurement of up to 64 measured values configurable<br>• Flexibility by switching predefined user data variants | |

# 4.3 Applicable modules

## Configuring with STEP 7

The following table shows with which controllers the different module versions can be configured with STEP 7.

Table 4- 1 Module versions configured with STEP 7

| Controller | Module version | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2 I / 2Q** | **32 I / 12 Q** | **User-specific** | **EE@Industry measurement data profile** | | | |
| | | | | **E0** | **E1** | **E2** | **E3** |
| IM 155-6 PN ST | V1.0 or higher | | V1.0 or higher*<br>V3.1 or higher | V1.0 or higher | | | V3.1 or higher |
| IM 155-6 PN HF | V2.0 or higher | | V2.0 or higher*<br>V3.1 or higher | V2.0 or higher | | | V3.1 or higher |
| IM 155-6 PN BA | V3.2 or higher | | --- | V3.2 or higher | | | --- |
| IM 155-6 PN HS | V4.0 or higher | | | | | | |
| IM 155-6 DP HF | V1.0 or higher | | --- | V1.0 or higher | | | --- |
| CPU 1510SP-1 PN | V1.6 or higher | | V1.6 or higher*<br>V2.0 or higher | V1.6 or higher | | | V2.0 or higher |
| CPU 1510SP F-1 PN | V1.7 or higher | | V1.7 or higher*<br>V2.0 or higher | V1.7 or higher | | | V2.0 or higher |
| CPU 1512SP-1 PN | V1.6 or higher | | V1.6 or higher*<br>V2.0 or higher | V1.6 or higher | | | V2.0 or higher |
| CPU 1512SP F-1 PN | V1.7 or higher | | V1.7 or higher*<br>V2.0 or higher | V1.7 or higher | | | V2.0 or higher |
| CPU 1515SP PC | V1.7 or higher | | V1.7 or higher*<br>V2.0 or higher | V1.7 or higher | | | V2.0 or higher |

* Only up to 32 bytes

## Configuring with GSD file

The following table shows with which controllers the different module versions can be configured using a GSD file.

Table 4- 2 Module versions configuring with GSD file

| **Controller** | **Module version** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2 I / 2Q** | **32 I / 12 Q** | **64 I / 12 Q**<br>**128 I / 12 Q**<br>**256 I / 12 Q** | **EE@Industry measurement data profile** | | | |
| | | | | **E0** | **E1** | **E2** | **E3** |
| IM 155-6 PN ST | V1.0 or higher | | V3.1 or higher | V1.0 or higher | | | V3.1 or higher |
| IM 155-6 PN HF | V2.0 or higher | | V3.1 or higher | V2.0 or higher | | | V3.1 or higher |
| IM 155-6 PN BA | V3.2 or higher | | --- | V3.2 or higher | | | --- |
| IM 155-6 PN HS | V4.0 or higher | | | | | | --- |
| IM 155-6 DP HF | V1.0 or higher | | --- | --- | | | --- |

# Quick start

# 5

## Introduction

This section shows you how to read and view your first measured values on the Energy Meter 480 VAC ST in a particularly quick and easy way.

## Requirement

You have already connected the Energy Meter to your network with one of the connection types shown in the section Wiring (Page 18). The Energy Meter 480 VAC ST has already been integrated in your configuration tool (such as STEP 7), or the Energy Meter 480 VAC ST has been integrated in your hardware catalog with the GSD/GSDML file.

## Procedure

1. Configure an ET 200SP station

   Configure an ET 200SP station with a CPU 151xSP or an IM 155-6.

2. Plug module in ET 200S station

   Plug the Energy Meter 480 VAC ST into the ET 200SP station and use the module version with 32 bytes inputs and 12 bytes outputs.

3. Set the module parameters

   Set the following parameters for the Energy Meter 480 VAC ST:

   – Connection type that you have used for the Energy Meter 480 VAC ST (e.g. 3P4W)

   – Measuring range, i.e. the phase voltage (UL1-N) of your network (for example 230 V AC)

   – Frequency of your network (for example 50 Hz)

   – Primary and secondary current of the used current transformer (e.g. 100 A and 1 A)

   – Primary and secondary voltages of the used voltage transformer (e.g. 230 V and 230 V)

   Leave all other parameters at their default settings and do not change them.

4. Load configuration

   Switch on the ET 200SP station and download the configuration to the CPU.

## Result

After being switched on, the Energy Meter supplies the measured values for the "Total power L1L2L3" user data variant "Basic measurements" with the ID 254 or $FE_H$.

Read and check the measured values provided by the Energy Meter in the output data.

The table below shows the structure of the user data variant, the measured variables and the data type of the measured values in STEP 7 (TIA Portal) that are stored in the 32 bytes of output data of the module. Each measured variable is referenced via the measured value ID. An overview of all the measured variables with their measured value IDs is provided in the section Measured variables (Page 131).

Table 5- 1 Total power L1L2L3

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 254 ($FE_H$) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 6 ... 7 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 8 ... 9 | Total active power L1L2L3 | INT | 1 W | -27648 … 27648 | 66035 |
| 10 ... 11 | Total reactive power L1L2L3 | INT | 1 var | -27648 … 27648 | 66036 |
| 12 ... 13 | Total apparent power L1L2L3 | INT | 1 VA | -27648 … 27648 | 66034 |
| 14 ... 17 | Total active energy L1L2L3 | DINT | 1 Wh | -2147483647 to +2147483647 | 225 |
| 18 ... 21 | Total reactive energy L1L2L3 | DINT | 1 varh | -2147483647 to +2147483647 | 226 |
| 22 | Reserved | BYTE | - | 0 | - |
| 23 | Total power factor L1L2L3 | USINT | 0.01 | 0 … 100 | 66037 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling total active power L1L2L3 | USINT | - | 0 ... 255 | - |
| 28 | Scaling total reactive power L1L2L3 | USINT | - | 0 ... 255 | - |
| 29 | Scaling total apparent power L1L2L3 | USINT | - | 0 ... 255 | - |
| 30 | Scaling total active energy L1L2L3 | USINT | - | 0 ... 255 | - |
| 31 | Scaling total reactive energy L1L2L3 | USINT | - | 0 ... 255 | - |

## Additional information

If you require further information about the evaluation and interpretation of the measured values, please refer to the section Reading and processing measured values (Page 37).

# Reading and processing measured values 6

## 6.1 Basics for reading measured values

### Introduction

The AI Energy Meter 480VAC ST provides the measured values and variables through the following methods:

- Cyclic: User data
- Acyclic: Measured value data records

### User data

User data provide pre-defined measured values depending on the configured user data variant. The supplied measured values are cyclically written to the process image of the CPU. With some user data variants, the measured values are supplied as raw data, which you have to convert to the corresponding physical values using a supplied scaling factor.

### Measured value data records

Each measured value data record supplies physical values that you can further process immediately. You read the values of a measured value data record acyclically with the RDREC instruction in a PLC tag. You need a corresponding PLC tag for each measured value data record to be read.

You can display the read measured values in a watch table in STEP 7.

---

**Note**

If you are using CPUs other than S7-1200 or S7-1500, convert 64-bit measured values to 32-bit measured values. Note the conversion can cause loss of accuracy.

For more information, read FAQ: Processing 64-bit-floating-point numbers in S7-300/400 (https://support.industry.siemens.com/cs/ww/en/view/56600676)

---

### Validity of the measured values

After turning on the supply voltage UL1, the first measured values are available after approximately 2 seconds. In the input user data, the content of byte 0 is set to the selected user data variant. You can use this change in byte 0 as a trigger event.

As soon as the module has valid measured values, the value of this byte changes to a value within the value range.

## Initial module startup

After the first startup or restart of the module, the parameters are transferred to the module. You can preset a user data variant in the parameters of the hardware configuration. This remains in effect until a different user data variant is selected in the output data (byte 0). This allows input user data to be modified dynamically according to the requirements of the process.

The user data variant defined in parameter data record 128 is used under the following conditions:

- A "0" is written in byte 0 in the output data of a user data variant.
- Byte 0 in the output data of a user data variant contains an invalid value:
  - Coding of the user data variant not available, or
  - Available address space is not sufficient for the selected user data variant.

    See "Selecting the module versions (Page 28)".

## Current measured values become "0"

The current and all other measured values based on it are suppressed (or set to "0") in the data records and in the user data in the following cases:

- The incoming current of the current transformer is less than the configured "Low limit for measuring current" parameter
- Incoming secondary current at the channel is higher than 12 A

The following measured values and derived measured variables of the phase involved become "0":

- Effective current value
- Active power
- Reactive power
- Apparent power
- Neutral current
- Phase angle
- Power factor

A floating mean value is formed from the power values. These only become "0" after a corresponding time. The operating hours counter and the energy counter for active, reactive and apparent energy of the reset phase stops counting.

## Substitute value behavior

The substitute values for input values of the AI Energy Meter 480VAC ST amount to "0".

## See also

Reading measured values from user data cyclically (Page 45)

Read measured value from a measured value data record (Page 47)

## 6.2 Quality information

Use the quality information to evaluate the status for currents, voltage, operating quadrants and the rotating field.

The AI Energy Meter 480VAC ST provides quality information:

- In byte 1 of the user data
- In measured value IDs 65500 to 65503

#### See also

Module version "32 I / 12 Q" (Page 145)

### 6.2.1 Quality information in byte 1 of the user data

For all user data variants, the module provides brief quality information in an 8-bit field in byte 1 for:

- Currents ($I_{L1}$, $I_{L2}$, $I_{L3}$)
- Voltages ($U_1$, $U_2$, $U_3$)
- Operating quadrant for a phase

Please note that quality information assignment with user data variants for phase-specific measurement (ID 154 to ID 159) is different from user data variant assignment for 3-phase measurement (ID 244 to ID 254).

### Quality information in byte 1 of the user data for 3-phase measurement

The quality information for 3-phase measurement is provided by the module in user data variants ID 244 to ID 254.

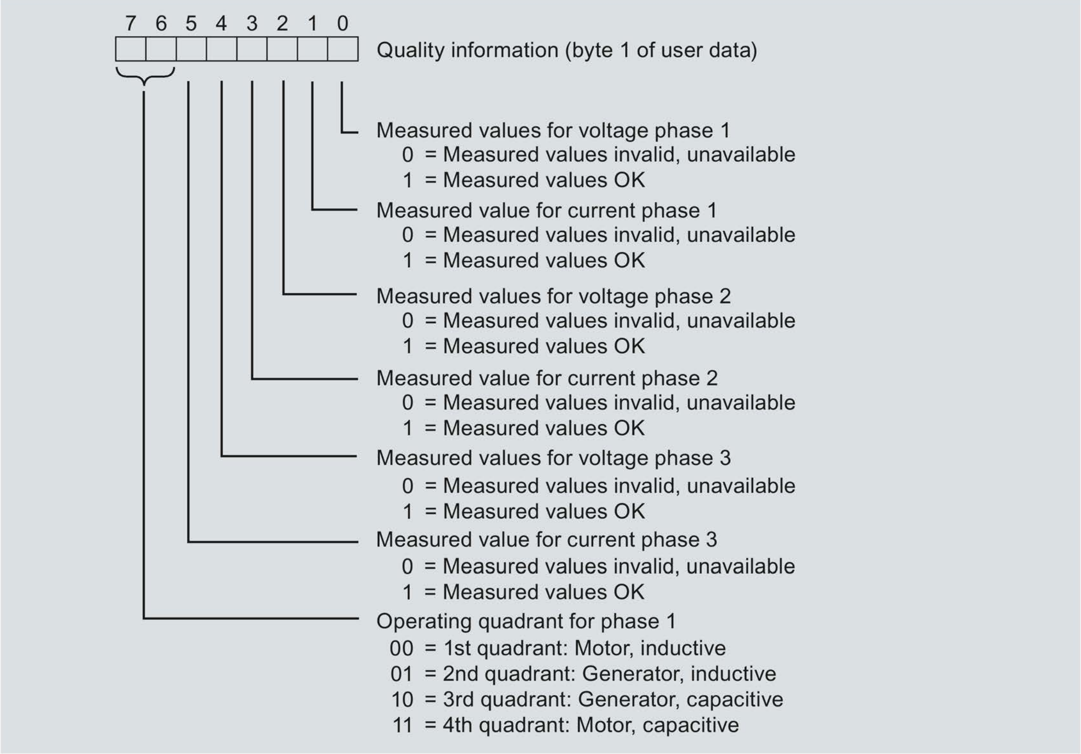


Figure 6-1 Assignment of byte 1 for user data variants ID 224 to ID 254

### Quality information in byte 1 for phase-specific measurement

The quality information for phase-specific measurement is provided by the module in user data variants ID 154 to ID 159.

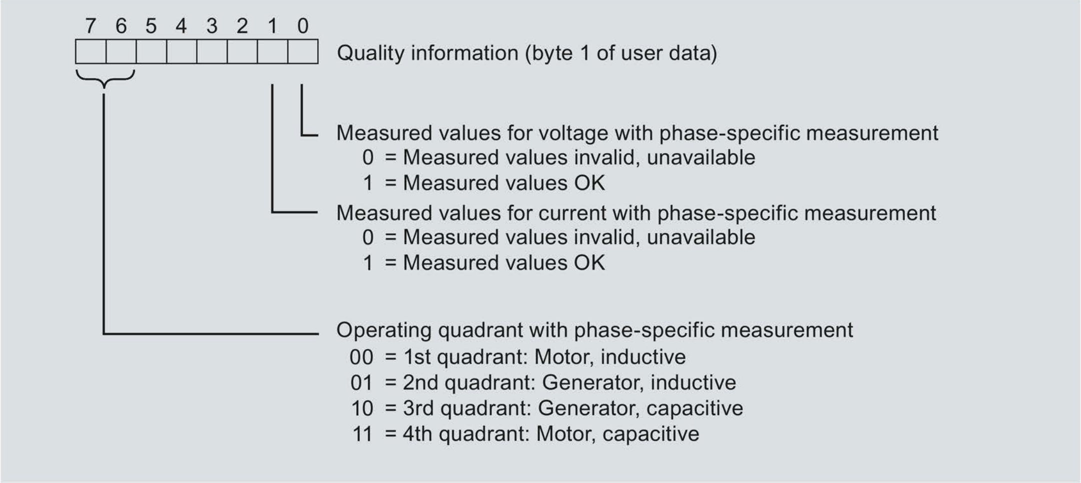


Figure 6-2 Byte 1 assignment for user data variants ID 154 to ID 159

## 6.2.2 Quality information with measured value IDs

Complete quality information is provided by the module in a 16-bit field with measured value IDs 65500 to 65503.

- Measured value ID 65503 for 3-phase measurement
- Measured value ID 65500, 65501 or 65502 for phase-specific measurement in phase 1, phase 2 or phase 3

### Quality information with measured value ID 65503 for 3-phase measurement

The quality information for 3-phase measurement is provided by the module with:

- User data variant "Basic variables quality values three-phase measurement (ID 240 or $F0_H$)
- User data (measured value ID 66503)
- Measured value data record 150

The measured value IDs 65503 provide information on:

- Currents ($I_{L1}$, $I_{L2}$, $I_{L3}$)
- Voltages ($U_1$, $U_2$, $U_3$)
- Operating quadrants for all 3 phases
- Rotating field for the 3-phase system

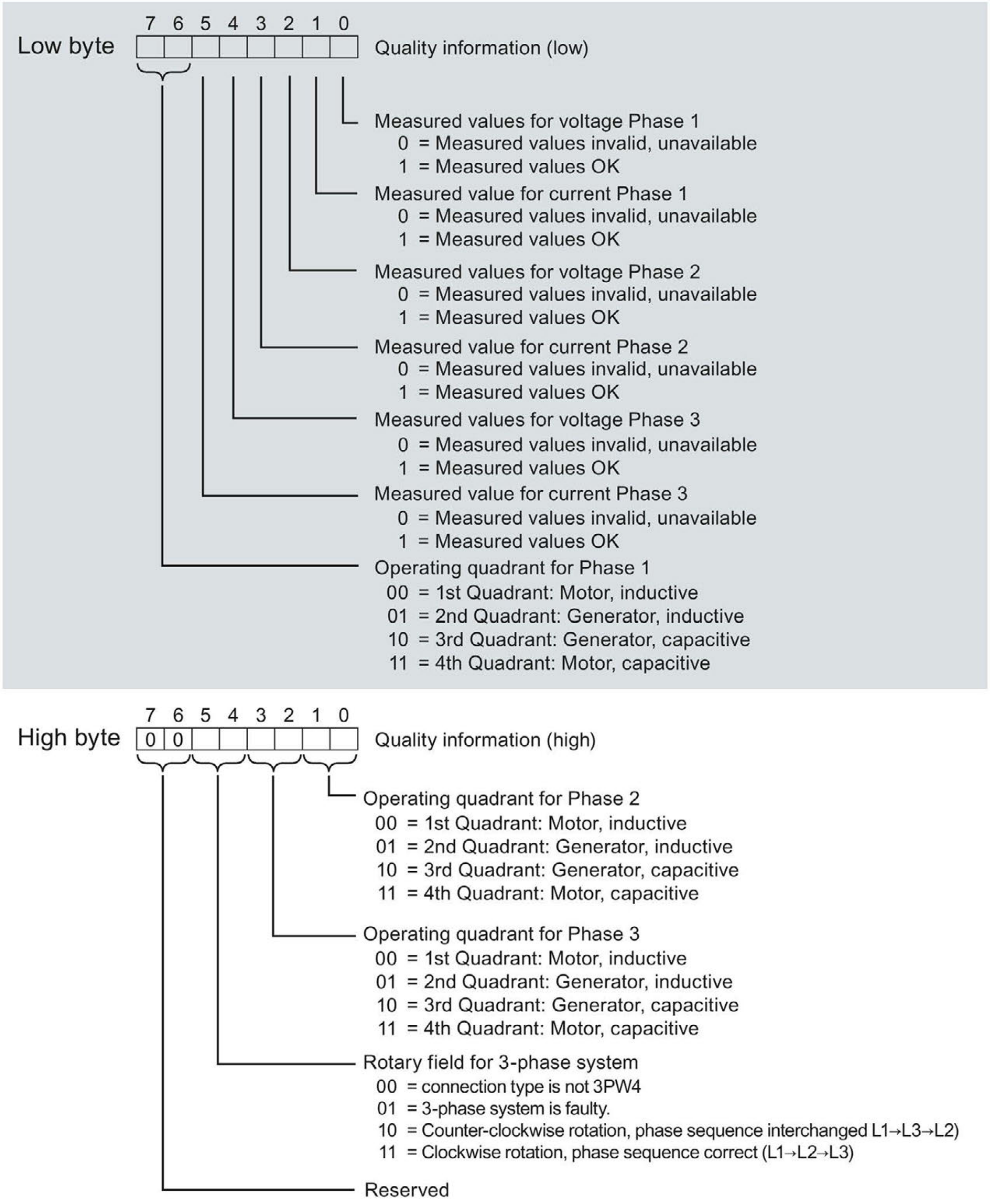


Figure 6-3 Quality information for low and high byte of the measured value ID 65503

### Quality information with measured value ID 65500, 65501 or 65502 for phase-specific measurement

The module provides quality information for phase-specific measurement in phase 1, phase 2 or phase 3 with:

- User data (with measured value ID 65500, 65501 or 65502)
- Measured value data record DS 147, 148 or 149

Measured value IDs 65500, 65501 and 65502 provide information on:

- Current of the phase in question
- Voltage of the phase in question
- Operating quadrant of the phase in question

In contrast to the assignment for measured value ID 65503 (figure above), measured value IDs 65500, 65501 and 65502 only contain the phase-specific information for current, voltage and operating quadrant. The information about the other phases and the rotating field have the value 0.

## 6.2.3 Operating quadrant

The figure below shows the quality information of the operating quadrants.

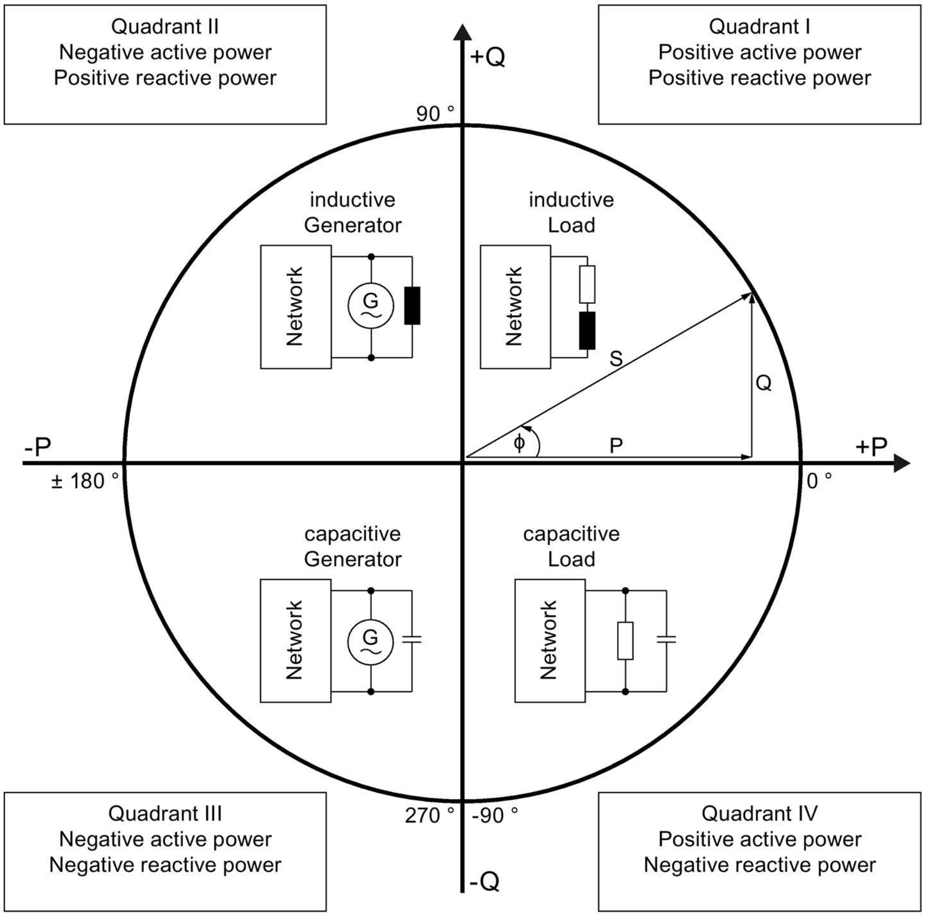


Figure 6-4 Quadrant in the quality bits

## 6.3 Reading measured values from user data cyclically

### Requirement

- STEP 7 is open.
- AI Energy Meter 480VAC ST is configured.

### Scaling of measured values in the user data

Since the value range of 16-bit values is often smaller than the value range of the physical value, a scaling factor is supplied together with the basic value in the user data for the respective measured or calculated values. You determine the actual value of the measured variable with the following formula:

Actual value of measured quantity = measured value in the user data x $10^{\text{scaling factor}}$

### Procedure

To read measured values from the user data cyclically, proceed as follows:

1. Read the relevant measured value from the input data.
2. Observe the scaling factor at scaled measured values and convert the read measured value using the scaling factor.

### Example

The user data variant 254 ($FE_H$) "Total power L1L2L3" is configured on the AI Energy Meter 480VAC ST. The measured value for "Current L1" should be read.

Table 6- 1 Total power L1L2L3

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 254 ($FE_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 6 ... 7 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| : | : | : | : | : | : |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| : | : | : | : | : | : |
| 31 | Scaling total reactive energy L1L2L3 | USINT | - | 0 ... 255 | - |

In the user data variant $FE_H$ (254) the measured value for the current L1 is stored in Byte 2 + 3. The current is supplied by the module as a 16-bit-fixed-point number in the value range from 0 to 65535 in the unit 1 mA. In addition the scaling factor for the current L1 has to be considered additionally. The module supplies the related scaling factor in Byte 24.

The actual value for current L1 is calculated as follows:

Actual value for current L1 = Current L1 x $10^{\text{Scaling current L1}}$

## See also

Basics for reading measured values (Page 37)

## 6.4 Read measured value from a measured value data record

### Introduction

To read measured values of a measured value data record, use the RDREC instruction. The read values are stored in a PLC variable with user-defined data type (UDT).

You can find more information on this in the STEP 7 documentation, under the keyword "RDREC".

### Requirement

- STEP 7 is open.
- AI Energy Meter 480VAC ST is configured.

### Procedure

1. In STEP 7 create a user-defined data type with the structure of the data record to be read.
2. Insert the number of structural elements, which corresponds to the number of entries contained in the measured value data record.
3. Insert the RDREC instruction in the user program.
4. Configure the RDREC instruction as follows:
   - ID: Hardware identifier or start address of the Energy Meter (depending on the CPU used).
   - INDEX: Number of measured value data record whose entries are read.
   - MLEN: Length of the measured value data record in bytes. "0" if all the entries are to be read.
   - RECORD: Target range for the read data record Length depends on MLEN.
5. Call the RDREC instruction with REQ = 1.

### Result

The values from the measured value data record were transferred into the target data area.

### See also

Basics for reading measured values (Page 37)

# Energy counters

# 7

## 7.1 How the energy meter works

### Introduction

The AI Energy Meter 480VAC ST provides 42 energy counters that detect both line-based and phase-based energy values.

- Active energy (total, outflow, inflow)
- Reactive energy (total, outflow, inflow)
- Apparent energy (total)

### How energy recording works

Based on the measured currents and voltages and the calculation cycle the Energy Meter calculates the active, reactive and apparent energy. The active, reactive and apparent energies are updated in each calculation cycle.

### Retentivity

All the counter states of the module are stored retentively in the Energy Meter. After an interruption (e.g. Power System Off → Power System On), the energy counting resumes with the retentively stored values.

### Configuring

You configure the following settings for the energy counters:

- Activation of the gate for the energy counter

  The gate allows you to start and stop the counters via output data (DQ bit). If you deactivate the gate, the count starts immediately when the Energy Meter is switched on.
- Modes of the energy counters

  The energy counters count either infinitely or periodically. For periodic counting, the adjustable full-scale values are $10^3$, $10^6$, $10^{12}$ and $10^{15}$. When the full-scale value is exceeded, the energy counter begins again at 0. At the same time the overflow counter is increased by 1 (see Resetting energy counters and overflow counters (Page 54)).

The settings apply to the energy counter of all phases.

## Changing properties in RUN

You can change the following properties of energy counters in runtime:

- Enable / disable energy counter
- Reset energy counter
- Set initial values for the energy counter
- Change the mode of the energy counter

## Automatic reset of the energy counter

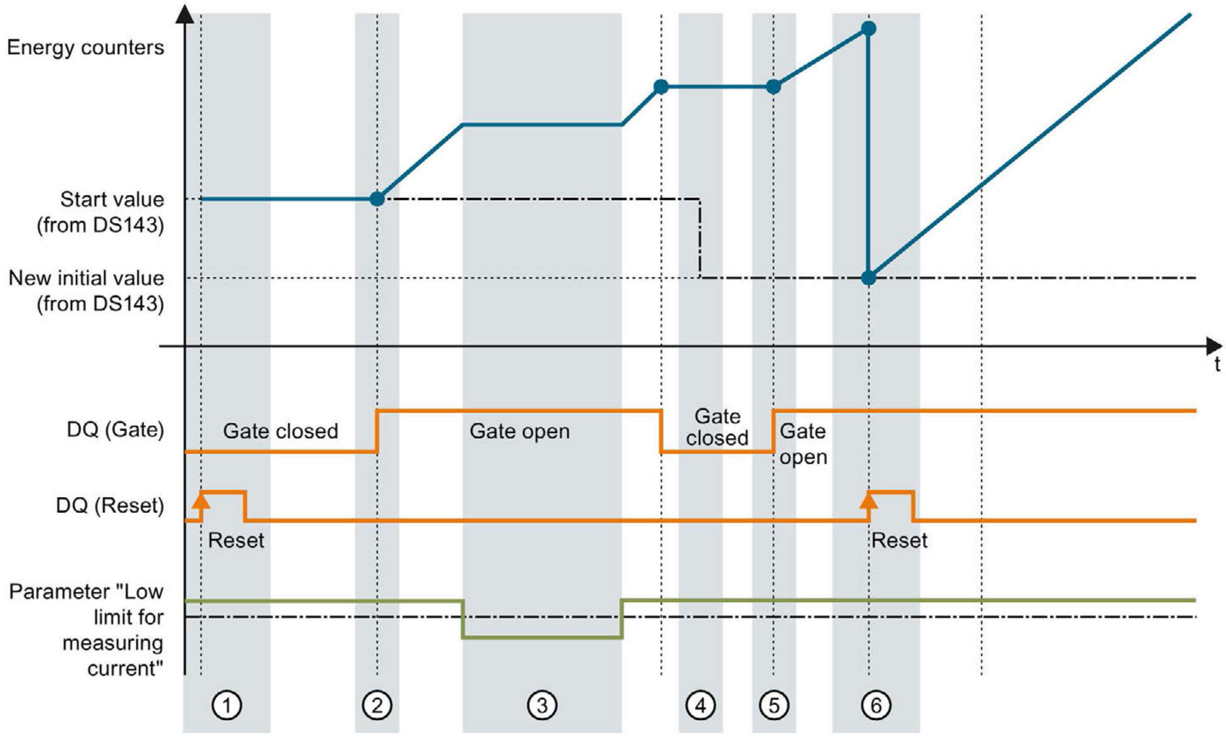
The energy counters are automatically reset to "0" when parameter settings relevant to the energy counter are changed. In the case of phase-specific changing of parameter settings relevant to the energy counter only the energy counters of the respective phases are reset.

Changing of the following parameters results in resetting of the energy counters:

- Measurement type or range
- Current transformer (primary current/secondary current)
- Voltage transformer (primary voltage/secondary voltage)
- Direction of current
- Full-scale value for energy counter
- Mode of the energy counter (infinite / periodic)

## Example

The following figure shows the effect of initial value, reset and start/stop parameters with activated gating using the energy counter as an example:



① The counter is reset to the value specified in the configuration. The gate is closed. The counter does not count.

② The gate is opened via the control byte 1 in the output data of the user data variant. The counter counts.

③ The configured current low limit has been violated. The counter does not count.

④ The gate is closed. The counter does not count. A new start value is written to the measured value data record 143 with the WRREC instruction.

⑤ The gate is opened again via the control byte 1 in the output data of the user data variant. The counter counts with the new start value.

⑥ The counter is reset via the control byte 1 in the output data of the user data variant. The counter counts from the new start value that was transferred via the measured value data record 143.

## See also

Evaluate energy counter and overflow counter (Page 53)

## 7.2 Configuring counters

### Overview

You can configure the energy counters of the AI Energy Meter 480VAC ST as follows:

- Activate / Deactivate
- Start / stop counters using gate
- Set and reset start value

### Energy counter gate

You have the option of starting and stopping the energy counter using the gate. To this purpose you have to:

- Select the "Enable gate control for the energy counter" parameter in the configuration of the AI Energy Meter 480VAC ST.
- Set the DQ bit for the "counter gate" in the user data in Control byte 1 of the output data (Bit 6 in Control byte 1).

The "Enable gate control for the energy counter" parameter and the DQ bit for the "counter date" behave like the parallel connection of contacts.

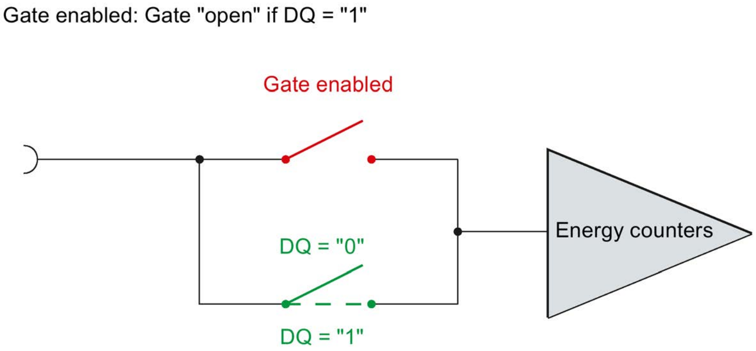


Figure 7-1 Gate enabled

If you deselect the "Enable gate control for the energy counter" parameter in the configuration of the AI Energy Meter 480VAC ST, the energy counters operate independently of the DQ bit as long as the current value lies above the configured "Low limit for measuring current".

Gate disabled: Gate is always "open" (signal path closed)

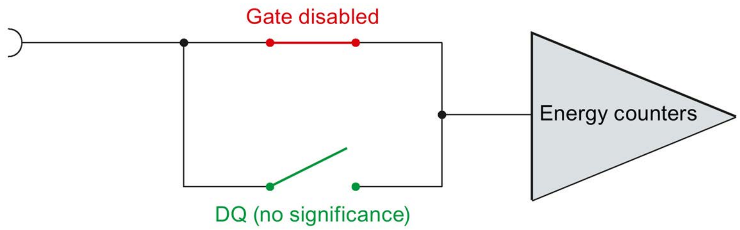


Figure 7-2 Gate disabled

## Set and reset start value

The counters can be set to their start value via the output data of each user data variant. With energy counters, you have to reset the bit of the energy counter in control byte 2 of the data record 143.

You can reset each energy counter to the start value or also specify a new start value via the data record 143. You define the moment for updating of the start values in the data record 143 and in Control byte 1 in the user data. Start values are either applied immediately or after a reset bit has been set from 0 to 1.

You can find a detailed description for this in section Resetting energy counters and overflow counters (Page 54).

# 7.3 Evaluate energy counter and overflow counter

## Evaluate energy counter and overflow counter

The energy counters are evaluated by

- Using the input data of the user data variants for energy
  - User data variant "Total energy L1 L2 L3" (ID 249 or $F9_H$)
  - User data variant "Energy L1" (ID 248 or $F8_H$)
  - User data variant "Energy L2" (ID 247 or $F7_H$)
  - User data variant "Energy L3" (ID 246 or $F6_H$)
- Using the input data of the user-defined user data variant with the use of the respective measuring value IDs for energy counters
- By reading data records
  - "Data record for basic measured values (DS 142)" for evaluation of the total energies L1 L2 L3.
  - "Data record for energy counter (DS 143)" for evaluation of the phase-specific energy.
  - "Data record for phase-specific measured values L1 - L3 (DS 147 - 149) for evaluation of the phase-specific energies.

The overflow counters are evaluated by:

- Using the input data of the user-defined user data variant with the use of the respective measuring value IDs for overflow counters
- Reading the "Data record for energy counter (DS 143)".

## Evaluate measured values

The evaluation of measured values via the input data of user data variants and reading of data records with the RDREC instruction is described in the section Reading and processing measured values (Page 37).

## 7.4 Resetting energy counters and overflow counters

### Introduction

At the beginning of a new work order, it may be useful to reset the energy and overflow counter of the Energy Meters Resetting here means setting the energy counters to their start values and resetting the overflow counters to 0.

The following sections describe how you

- Reset energy counters via the outputs of the user data.
- Reset energy counters and overflow counters via data record 143.

### See also

Structure for energy counters (DS 143) (Page 61)

## 7.4.1 Reset energy counters via user data

### Introduction

Due to the differing lengths of the output data resetting of the energy counters depends on the configured module version.

If you use module versions with 12 bytes of output data, you can

- Reset energy counters for **all** phases separately by active, reactive and apparent energy.
- Reset energy counters for each **individual** phase separately by active, reactive and apparent energy.

If you use the module version with 2 bytes output data, you always reset **all** the energy counters simultaneously.

## Procedure at module version with 12 bytes of output data

### Resetting energy counters for all 3 phases

1. Select the categories of energy counter that you want to reset in byte 2.
   - Set bit 5 for active energy counters.
   - Set bit 6 for reactive energy counters.
   - Set bit 7 for apparent energy counters.

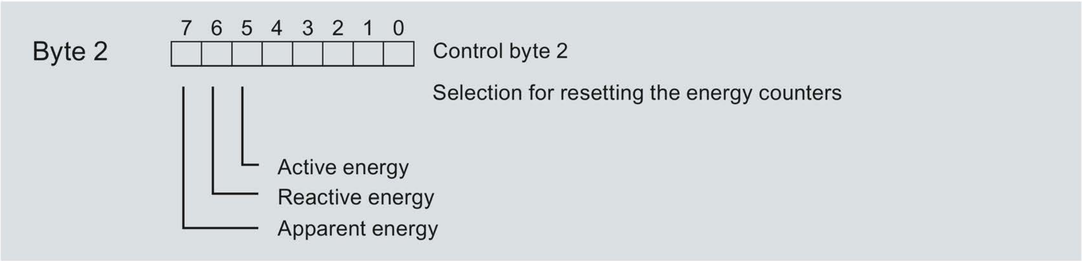


Figure 7-3 Selection of energy counters

2. Set the reset bit (bit 7) in byte 1.

   If there is an edge change of the reset bit for energy counters from 0 to 1, the module resets all energy counters that you previously selected in byte 2.

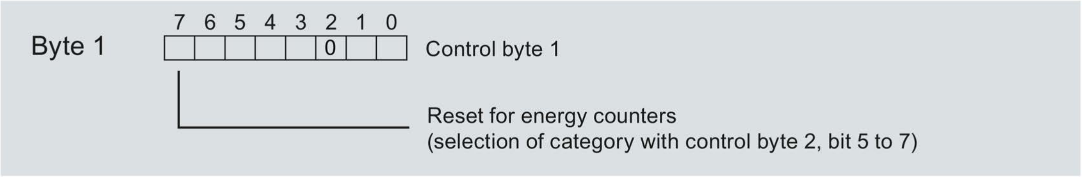


Figure 7-4 Reset bit for energy counters

### Resetting energy counters for phase-specific measurement

You can also reset the energy counters on a phase-specific basis using the output data.

Follow the procedure for "Resetting energy counters for all 3 phases" as applicable.

1. Select the categories of energy counter that you want to reset on a phase-specific basis.
   - Set the bits for the phase 1 energy counters in byte 7.
   - Set the bits for the phase 2 energy counters in byte 9.
   - Set the bits for the phase 3 energy counters in byte 11.
2. Set the reset bit (bit 7)
   - in byte 6 for phase 1
   - in byte 8 for phase 2
   - in byte 10 for phase 3

If there is an edge change of the phase-specific reset bit for energy counters from 0 to 1, the module resets the energy counters for the given phase:

### Procedure at module version with 2 bytes of output data

If you use the module version with 2 bytes of output data, you always reset **all** the energy counters simultaneously.

Set the reset bit (Bit 7) in Control byte 1 from 0 to 1 through an edge change.

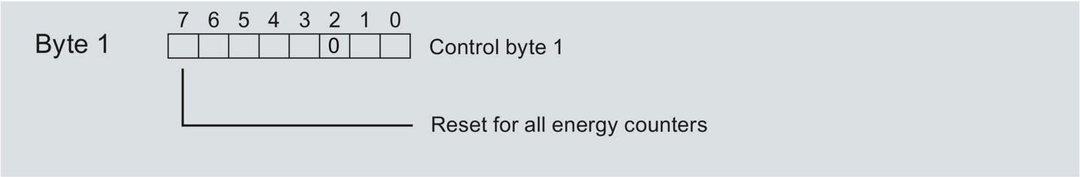


Figure 7-5 Resetting the energy counters at module version with 2 bytes of output data

### Start values

After the reset the energy counters count with the specified start values (default = 0). You can change the start values for the energy counters via data record DS 143, see section Resetting energy counters and overflow counters via data record DS 143 (Page 56).

You can also reset the counters on a phase-specific basis by active, reactive and apparent energy using data record 143.

## 7.4.2 Resetting energy counters and overflow counters via data record DS 143

### Introduction

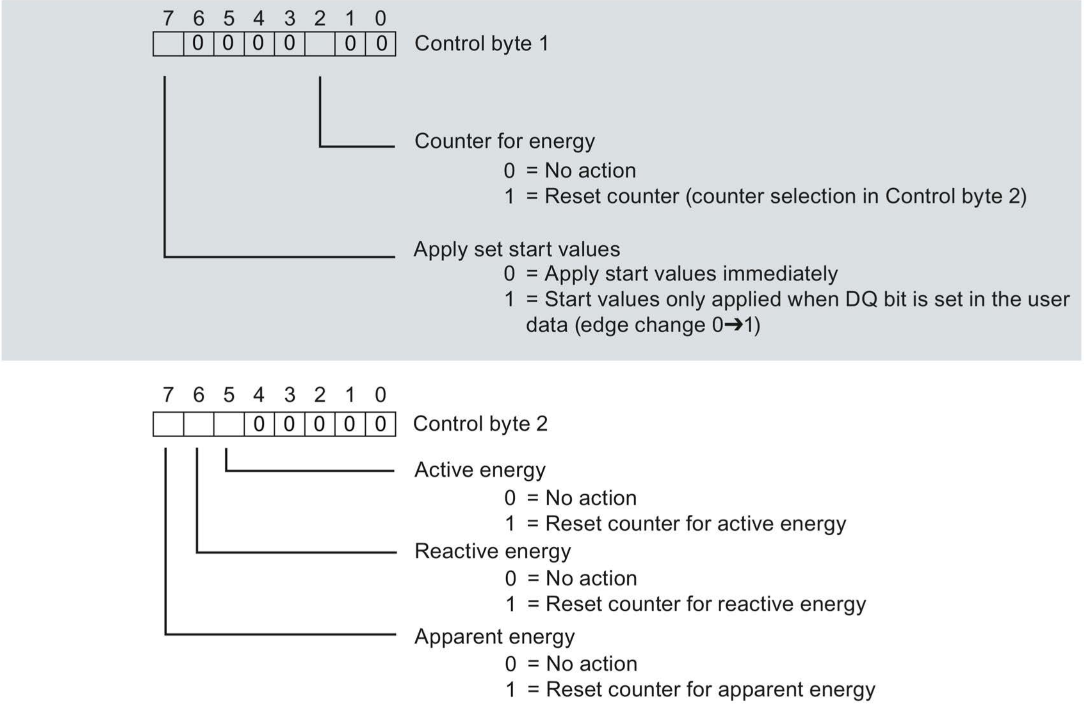
At all the module versions you can reset the energy counters and their overflow counters via the data record DS 143. Resetting is possible for:

- Energy counters and overflow counters for each **individual** phase separately by active, reactive and apparent energy.

### Procedure for all module versions using data record DS 143

1. In Control byte 1 of the DS 143 set the reset bit (Bit 2) to 1 and Bit 0 to 1 for the overflow counter.
2. In Control byte 2 of the DS 143 set the category of the energy counters (active, reactive, apparent energy) to 1 via Bits 5 to 7.
3. In Control byte 1 of the DS 143 set Bit 7 for the moment of application of the start values of the desired energy counters:
   - Bit 7 to 0, if the start value are to be applied immediately after the transfer of the data record
   - Bit 7 to 1, if the start value are only to be applied after the reset bit has been set in the output data of the user data.

In Control byte 1 of the DS 143 set the reset bit (Bit 2) to 1 and Bit 0 to 1 for the overflow counter.



Counter for energy
0 = No action
1 = Reset counter (counter selection in Control byte 2)

Apply set start values
0 = Apply start values immediately
1 = Start values only applied when DQ bit is set in the user data (edge change 0➔1)

Active energy
0 = No action
1 = Reset counter for active energy

Reactive energy
0 = No action
1 = Reset counter for reactive energy

Apparent energy
0 = No action
1 = Reset counter for apparent energy

Figure 7-6 Energy counter control information DS 143

4. Transfer the data record with the WRREC instruction.

## Start values

You specify the moment for the application of the start values in Control byte 1 via Bit 7. After the reset the energy counters count with the specified start values (default = 0) and the overflow counters begin again with 0. You can change the start values for the energy counters via data record DS 143.

### 7.4.3 Example for energy counters and overflow counters via data record DS 143

#### Introduction

Before you can transfer the data record DS 143 to the CPU you have to create a user-defined PLC data type in your user program that has an identical structure to data record DS 143.

#### Procedure

1. Create a PLC data type that has an identical structure to data record DS 143.

   Detailed information on the structure of data record 143 is available in section Structure for energy counters (DS 143) (Page 179).

| Byte | Measured variable | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | Version | BYTE | - | 1 | - |
| 1 | Reserved | BYTE | - | 0 | - |
| 2 | Control byte 1 - L1 | BYTE | Bit string | - | - |
| 3 | Control byte 2 - L1 | BYTE | Bit string | | |
| 4 | Control byte 1 - L2 | BYTE | Bit string | | |
| 5 | Control byte 2 - L2 | BYTE | Bit string | | |
| 6 | Control byte 1 - L3 | BYTE | Bit string | | |
| 7 | Control byte 2 - L3 | BYTE | Bit string | | |
| 8...15 | Active energy inflow (initial value) L1 | LREAL | Wh | See Section Structure for energy counters (DS 143) (Page 179) | 61180 |
| 16...23 | Active energy outflow (initial value) L1 | LREAL | Wh | | 61181 |
| : | : | : | : | : | : |
| 162...165 | Operating hours counter L2 (initial value) | REAL | h | See Section Structure for energy counters (DS 143) (Page 179) | 65506 |
| 166...169 | Operating hours counter L3 (initial value) | REAL | h | | 65507 |

2. Create a user-defined PLC data type and allocate the values of the data record in a DB or instance DB.

   **Byte 0 and byte 1:**

   Enter the value $01_H$ in Byte 0 and the value $00_H$ to Byte 1.

   **Byte 2 ... byte 7:** Control bytes for energy and overflow counter

   In the control byte for the respective phases, specify which energy and overflow counters you want to reset.

   The control bytes specify for each phase (L1, L2, L3) separately if and which energy meter values are to be reset.

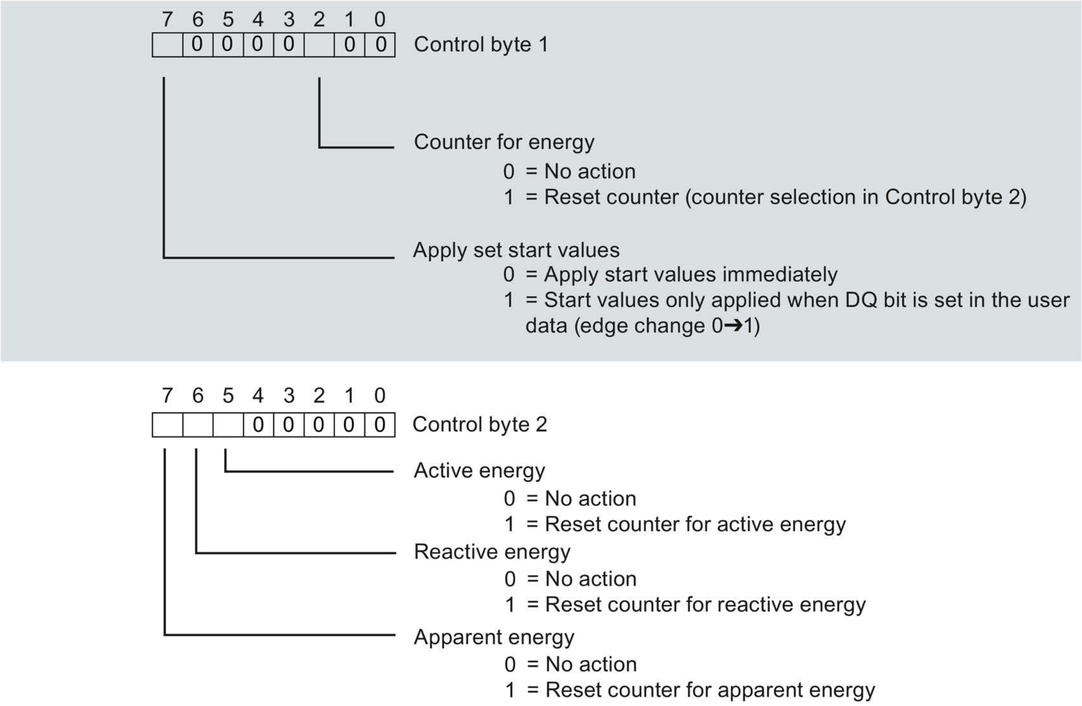


Figure 7-7 Control information DS 143 for energy and overflow counter

**Byte 8 ... byte 127**: Start values for the individual energy meters

The start values for energy counters in data record 143 are 64-bit floating point numbers. This corresponds to the data type LREAL in S7-1200 and in S7-1500.

**Byte 128 ... byte 157**: Initial values for overflow counters

The initial values for overflow counters in data record 143 are 16-bit integers. This corresponds to the data type UINT in S7-1200 and in S7-1500.

3. Write the data record to the AI Energy Meter 480VAC ST module using the "WRREC" instruction.

   The input parameters must be allocated as follows:

   – REQ: A new write job is triggered if REQ = TRUE.

   – ID: Hardware identifier or start address of the Energy Meter (depending on the CPU used).

   – INDEX: The data record number: 143

   – LEN: The maximum length of the data record: 170

   – RECORD: A pointer to the data area in the CPU which includes data record 143.

---

**Note**

If you want to write or read several AI Energy Meter 480VAC ST at the same time, keep in mind the maximum number of active jobs in communication with SFB52/SFB53.

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## See also

Structure for energy counters (DS 143) (Page 61)

# 7.5 Data record for energy counter (DS 143)

## 7.5.1 Structure for energy counters (DS 143)

### Energy meter data record 143 for different actions

The energy meter data record 143 includes all energy meters available on the module phase-by-phase. The data record can be used for different actions:

- Reset the energy counter to user-specific value (e.g. "0")
- Reading the current values of the energy counters
- Reading the overflow counters
- Reading the operating hours

### Energy meter data record 143

Table 7- 1 Energy meter data record 143

| Byte | Measured variable | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | Version | BYTE | - | 1 | - |
| 1 | Reserved | BYTE | - | 0 | - |
| 2 | Status / control byte 1 - L1 | BYTE | Bit string | - | - |
| 3 | Status / control byte 2 - L1 | BYTE | Bit string | | |
| 4 | Status / control byte 1 - L2 | BYTE | Bit string | | |
| 5 | Status / control byte 2 - L2 | BYTE | Bit string | | |
| 6 | Status / control byte 1 - L3 | BYTE | Bit string | | |
| 7 | Status / control byte 2 - L3 | BYTE | Bit string | | |
| 8...15 | Active energy inflow (initial value) L1 | LREAL | Wh | During reading:<br>0.0...1.8 x $10^{308}$<br>During writing<br>For continuous counting: | 61180 |
| 16...23 | Active energy outflow (initial value) L1 | LREAL | Wh | | 61181 |
| 24...31 | Reactive energy inflow (initial value) L1 | LREAL | varh | | 61182 |
| 32...39 | Reactive energy outflow (initial value) L1 | LREAL | varh | | 61183 |
| 40...47 | Apparent energy (initial value) L1 | LREAL | VAh | | 61184 |
| 48...55 | Active energy inflow (initial value) L2 | LREAL | Wh | | 61200 |
| 56...63 | Active energy outflow (initial value) L2 | LREAL | Wh | | 61201 |
| 64...61 | Reactive energy inflow (initial value) L2 | LREAL | varh | | 61202 |

| Byte | Measured variable | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 72...79 | Reactive energy outflow (initial value) L2 | LREAL | varh | 0.0...3.4 x $10^{12}$<br>During writing<br>For periodic counting:<br>0...configured full-scale value ($10^3$ ...$10^{15}$) | 61203 |
| 80...87 | Apparent energy (initial value) L2 | LREAL | VAh | | 61204 |
| 88...95 | Active energy inflow (initial value) L3 | LREAL | Wh | | 61220 |
| 96...103 | Active energy outflow (initial value) L3 | LREAL | Wh | | 61221 |
| 104...111 | Reactive energy inflow (initial value) L3 | LREAL | varh | | 61222 |
| 112...119 | Reactive energy outflow (initial value) L3 | LREAL | varh | | 61223 |
| 120...127 | Apparent energy (initial value) L3 | LREAL | VAh | | 61224 |
| 128...129 | Overflow counter active energy inflow L1 | UINT | - | During reading:<br>0...65535<br>During writing for continuous counting:<br>0<br>During writing for periodic counting:<br>0...65500 | 61190 |
| 130..131 | Overflow counter active energy outflow L1 | UINT | - | | 61191 |
| 132...133 | Overflow counter reactive energy inflow L1 | UINT | - | | 61192 |
| 134...135 | Overflow counter reactive energy outflow L1 | UINT | - | | 61193 |
| 136...137 | Overflow counter apparent energy L1 | UINT | - | | 61194 |
| 138...139 | Overflow counter active energy inflow L2 | UINT | - | | 61210 |
| 140...141 | Overflow counter active energy outflow L2 | UINT | - | | 61211 |
| 142...143 | Overflow counter reactive energy inflow L2 | UINT | - | | 61212 |
| 144...145 | Overflow counter reactive energy outflow L2 | UINT | - | | 61213 |
| 146...147 | Overflow counter apparent energy L2 | UINT | - | | 61214 |
| 148...149 | Overflow counter active energy inflow L3 | UINT | - | | 61230 |
| 150...151 | Overflow counter active energy outflow L3 | UINT | - | | 61231 |
| 152...153 | Overflow counter reactive energy inflow L3 | UINT | - | | 61232 |
| 154...155 | Overflow counter reactive energy outflow L3 | UINT | - | | 61233 |
| 156...157 | Overflow counter apparent energy L3 | UINT | - | | 61234 |
| 158...161 | Operating hours counter L1 (initial value) | REAL | h | During reading:<br>0...3.4x$10^{38}$<br>During writing:<br>0...$10^9$ | 65505 |
| 162...165 | Operating hours counter L2 (initial value) | REAL | h | | 65506 |
| 166...169 | Operating hours counter L3 (initial value) | REAL | h | | 65507 |

## Status information

When data record 143 is read with the RDREC instruction, Bytes 2 to 7 supply phase-specific status information for energy counters, overflow counters and operating hours counters.

The status information enables you can see which counters are returning their values in the data record 143. If energy counters return their values in the status byte 1, you can determine the type of energy counter with status byte 2.

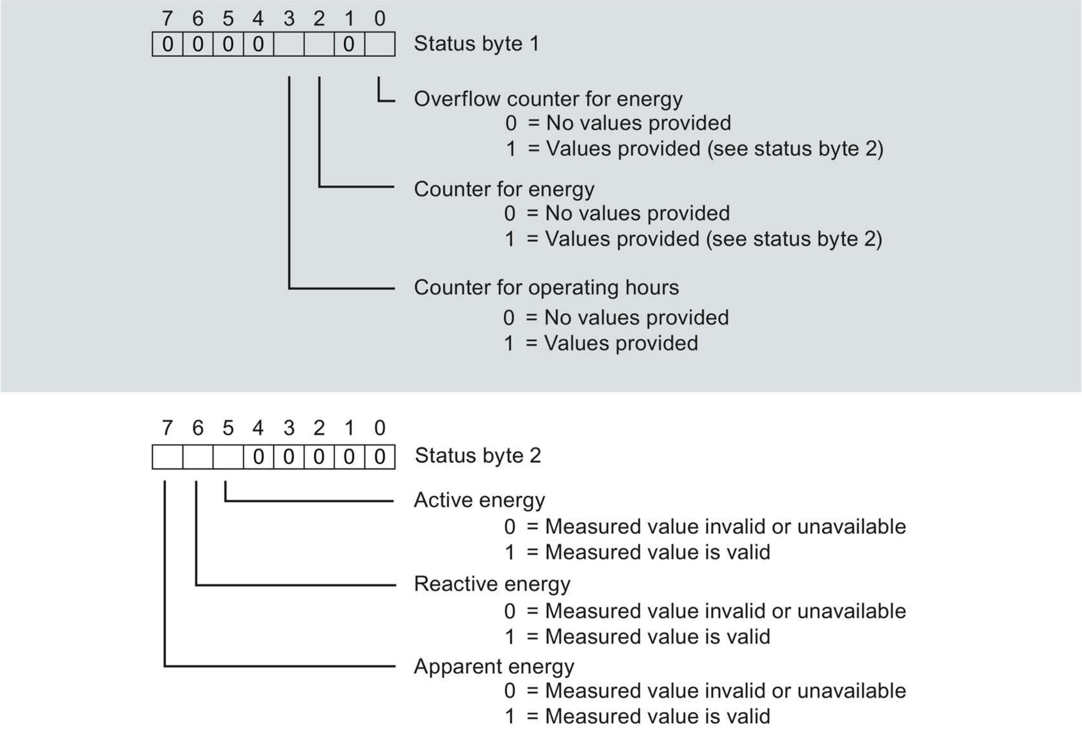


Figure 7-8 Status information DS 143 (read access)

## Control information

When data record 143 is written with the WRREC instruction, Bytes 2 to 7 are used as phase-specific control information for energy counters, overflow counters and operating hours counter. The length of the control information amounts to 2 bytes for each phase:

- In control byte 1 you determine which counter you want to reset and the time at which counters are reset.
- In Control byte 2 you determine which energy counters and which overflow counters you want to reset.

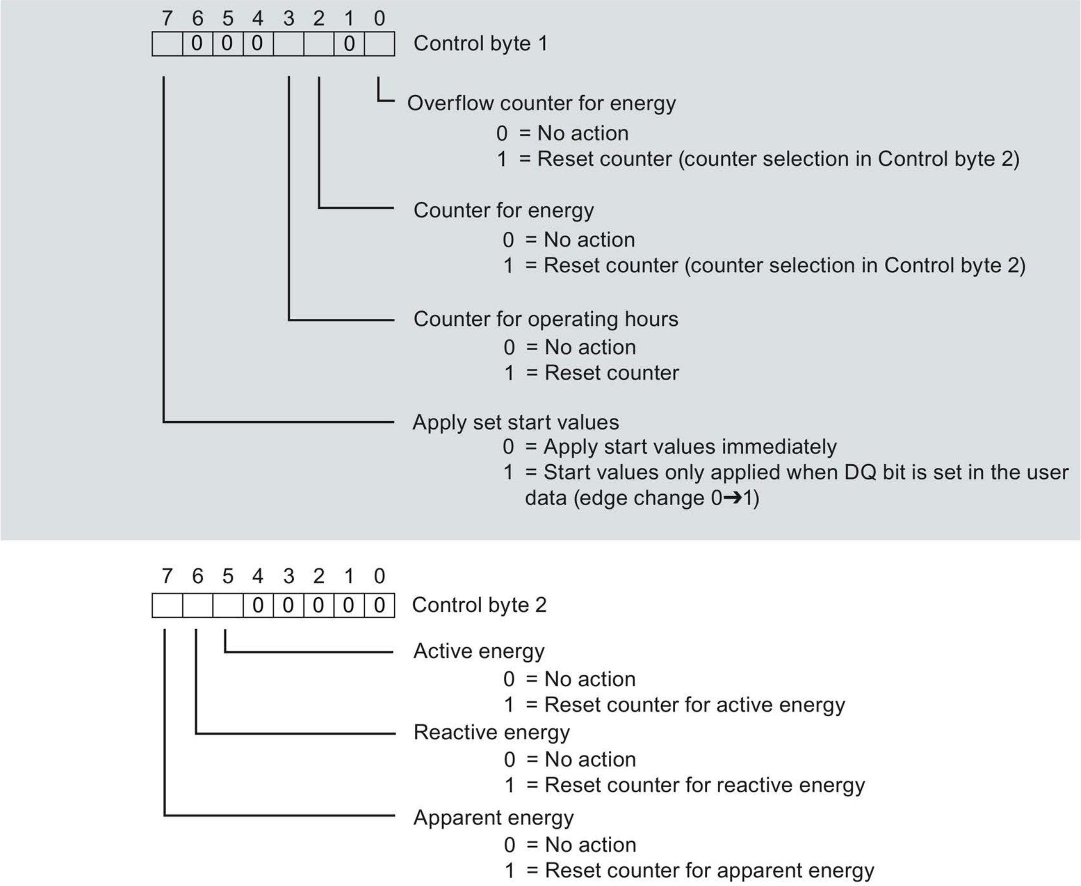


Figure 7-9 Control information DS 143 (write access)

## Error while transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module apply the values from the data record.

The WRREC instruction for writing data records returns corresponding error codes when errors occur in the STATUS parameter.

The following table shows the module-specific error codes and their meaning for the measured value data record 143:

| **Error code in STATUS parameter (hexadecimal)** | | | | **Meaning** | **Solution** |
|---|---|---|---|---|---|
| **Byte 0** | **Byte 1** | **Byte 2** | **Byte 3** | | |
| DF | 80 | B0 | 00 | Number of the data record unknown | Enter a valid number for the data record. |
| DF | 80 | B1 | 00 | Length of the data record incorrect | Enter a valid value for the data record length. |
| DF | 80 | B2 | 00 | Slot invalid or cannot be accessed. | Check the station whether the module is plugged or drawn.<br>Check the assigned values for the parameters of the WRREC instruction |
| DF | 80 | E1 | 01 | Reserved bits are not 0. | Check Byte 2...7 and set the reserved bits back to 0. |
| DF | 80 | E1 | 39 | Incorrect version entered. | Check Byte 0. Enter a valid version. |
| DF | 80 | E1 | 3A | Incorrect data record length entered. | Check the parameters of the WRREC instruction. Enter a valid length. |
| DF | 80 | E1 | 3C | At least one start value is invalid. | Check Bytes 8...103 and Bytes 158...169. The start values may not be negative. |
| DF | 80 | E1 | 3D | At least one start value is too large | Check Bytes 8...103 and Bytes 158...169. Observe the ranges of values for start values. |

## 7.5.2 Structure of the control and feedback interface for DS 143

### Introduction

Bytes 2 to 7 of data record 143 form the phase-based control and feedback interface for the measured value data record of the energy counter.

- Bytes 2 and 3: Control and feedback interface for phase 1
- Bytes 4 and 5: Control and feedback interface for phase 2
- Bytes 6 and 7: Control and feedback interface for phase 3

## Status information

When data record 143 is read with the RDREC instruction, Bytes 2 to 7 supply phase-specific status information for energy counters, overflow counters and operating hours counters.

The status information enables you can see which counters are returning their values in the data record 143. If energy counters return their values in the status byte 1, you can determine the type of energy counter with status byte 2.

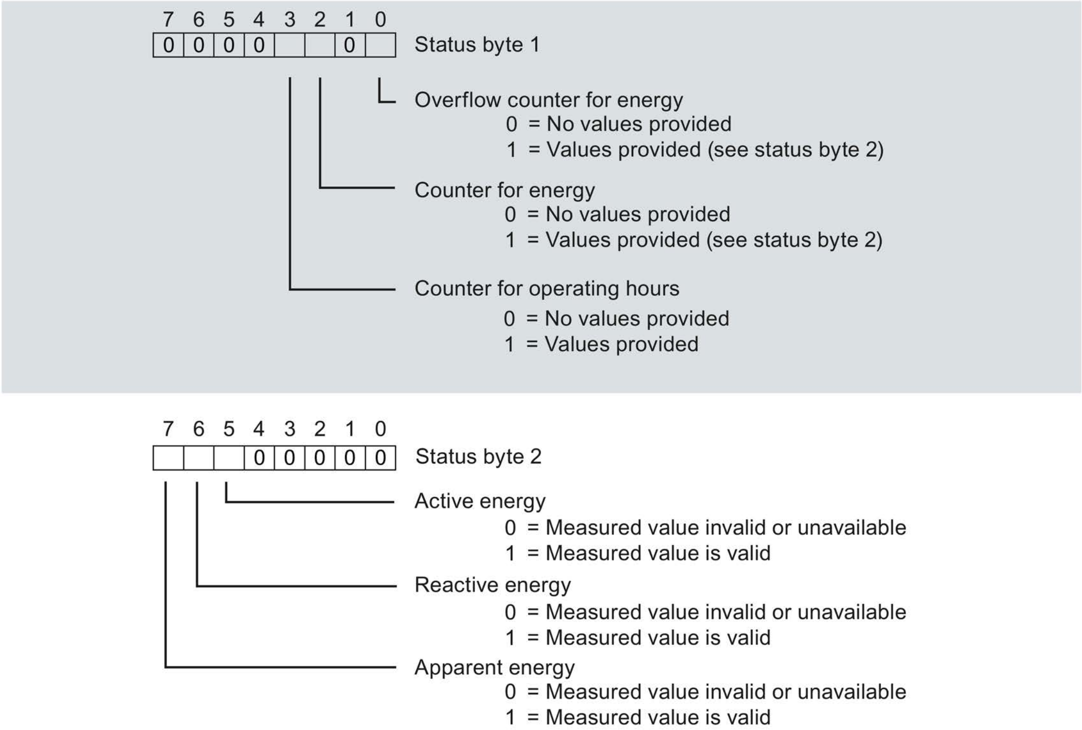


Figure 7-10 Status information DS 143 (read access)

## Control information

When data record 143 is written with the WRREC instruction, Bytes 2 to 7 are used as phase-specific control information for energy counters, overflow counters and operating hours counter. The length of the control information amounts to 2 bytes for each phase:

- In control byte 1 you determine which counter you want to reset and the time at which counters are reset.
- In Control byte 2 you determine which energy counters and which overflow counters you want to reset.

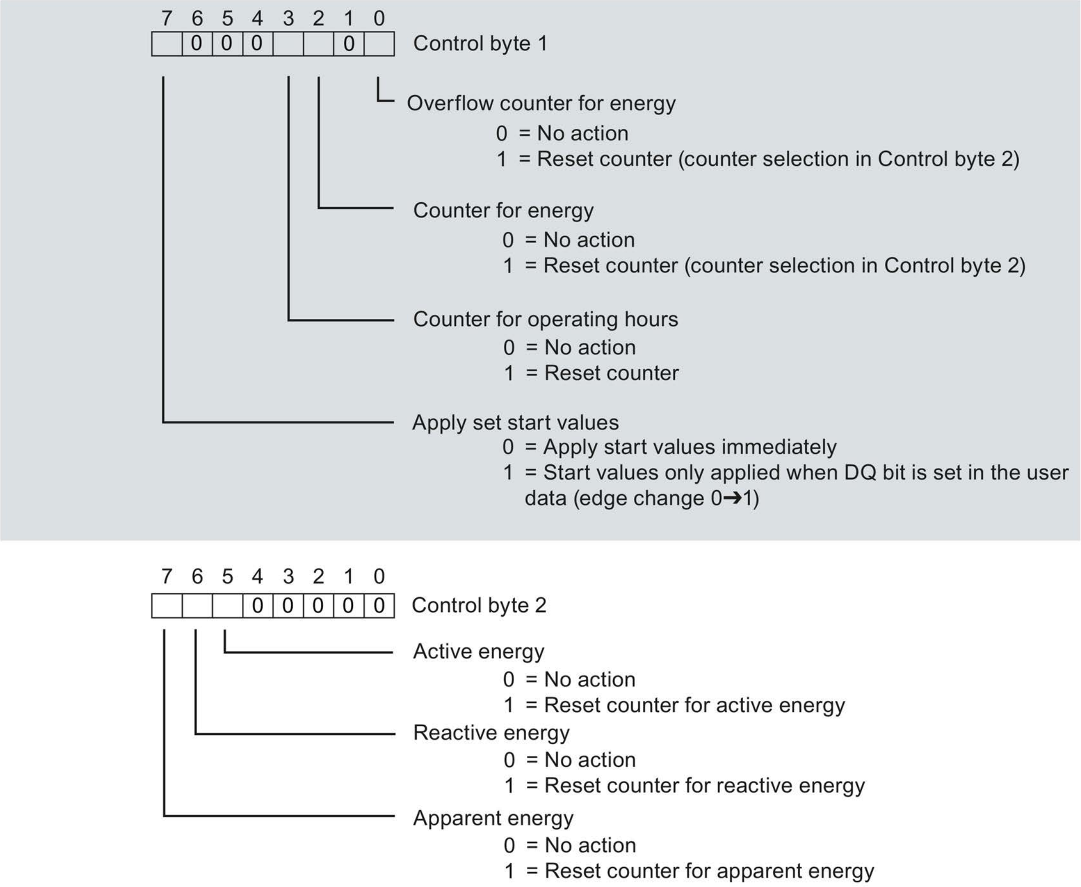


Figure 7-11 Control information DS 143 (write access)

# Operating hours counter 8

## 8.1 How the operating hours counter works

### Introduction

The AI Energy Meter 480VAC ST provides one operating hours counter for each phase, which counts the operating hours of the load connected to a phase when there is current greater than the configurable "Low limit for measuring current". The operating hours counter for the entire module is calculated from the sum of the operating hours of the individual phases. The operating hours counter has a value range from 0 to $3.4 \times 10^{38}$. The values are stored retentively in the module and can be read via the data record 143 (energy counter data record) and data record 150 (measured value for extended measuring and status values).

### Configuring

You configure the following operating hours counter settings in STEP 7:

- Activation of the gate for the operating hours counter

### Changing properties in RUN

The following table shows the supported control information:

| Control information | Default value | Available in |
|---|---|---|
| Open / close operating hours counter [1] | Closed | Module version starting at 2 bytes of output data |
| Set initial value | 0 | Data record 143 |
| Reset operating hours counter | 0 | Module version starting at 2 bytes of output data [2] |

[1] Effective only with enabled gate

[2] Only module-wide resetting is supported in module version "2 I / 2 Q".

### See also

Resetting energy counters and overflow counters (Page 54)

Module version "2 I / 2 Q" (Page 142)

Structure for energy counters (DS 143) (Page 179)

Measured value data record for advanced measurement and status values (DS 150) (Page 194)

## 8.2 Reset operating hours counters

### Introduction

At the beginning of a new work order, it may be useful to reset the operating hours counters of the Energy Meter. Resetting here means that the operating hours counters are reset to their start value.

The following section describes how you

- Reset operating hours counters via the outputs of the user data.
- Reset operating hours counters via data record 143.

### 8.2.1 Reset operating hours counters via user data

### Introduction

Due to the differing lengths of the output data resetting of the operating hours counters depends on the configured module version.

If you use module versions with 12 bytes output data, you can

- Reset operating hours counters for **all** phases.
- Reset operating hours counters for each **individual** phase.

If you use the module version with 2 bytes of output data, you always reset **all** the operating hours counters simultaneously. Differentiated resetting of the counters by phases is only possible via data set DS 143 for this module version, see section Structure for energy counters (DS 143) (Page 179).

### Procedure for module version with 12 bytes and 2 bytes of output data

Set the reset bit (Bit 5) in Control byte 1 from 0 to 1 through an edge change.

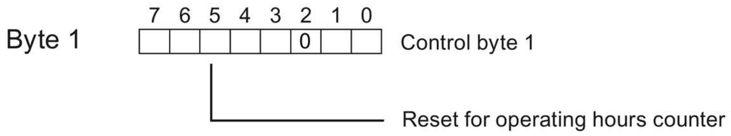


Figure 8-1 Resetting the operating hours counters for module version with 12 bytes and 2 bytes of output data

### Resetting operating hours counters on a phase-specific basis

You can also reset the operating hours counters on a phase-specific basis using the output data. Follow the procedure for "Resetting operating hours counters for all 3 phases" as applicable.

Set the reset bit (bit 5):

- in byte 6 for phase 1
- in byte 8 for phase 2
- in byte 10 for phase 3

### Start values

After the reset the operating hours counters count with the specified start values (default = 0). You can change the start values for the operating hours counters via data record DS 143, see section Structure for energy counters (DS 143) (Page 179).

## 8.2.2 Resetting operating hours counters via data record DS 143

### Introduction

At all the module versions you can reset the operating hours counters via the data record DS 143. Resetting is possible for:

- Operating hours counters for each **individual** phase.

## Procedure at all module versions via data record DS 143

1. Set the reset bit (Bit 3) in Control byte 1 to 1.

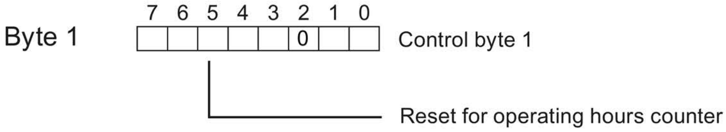


Figure 8-2 Resetting operating hours counters with data record 143

2. In Control byte 1 set Bit 7 for the moment of application of the start values:
   - Bit 7 to 0, if the start value are to be applied immediately after the transfer of the data record
   - Bit 7 to 1, if the start value are only to be applied after the reset bit has been set in the output data of the user data.

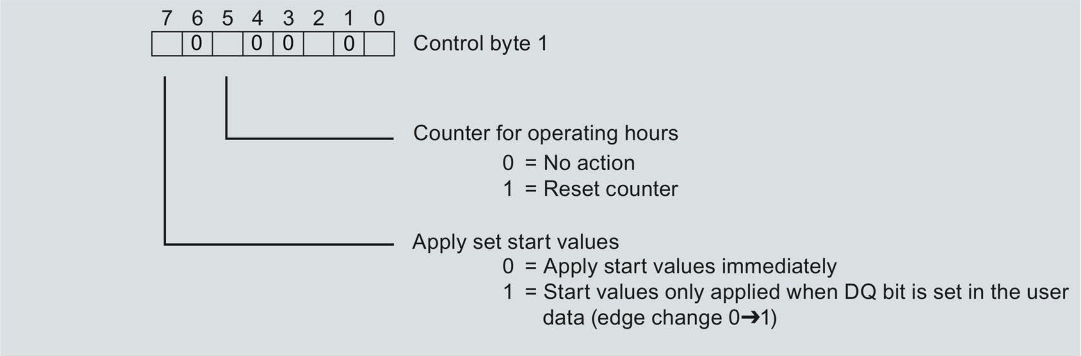


Figure 8-3 Operating hours counter control information DS 143

## Start values

You specify the moment for the application of the start values in Control byte 1 via Bit 7. After the reset the operating hours counters count with the specified start values (default = 0). You can change the start values for the operating hours counters via data record DS 143.

# Limit monitoring

# 9

## 9.1 How limit monitoring works

### Introduction

The AI Energy Meter 480VAC ST supports monitoring of parameterizable low **or** high limits for up to 16 analog measured or calculated variables.

You can also define multiple limits for each measured or calculated variable, in order to define a high or low value range.

The measured value data record 150 returns the current status limit violations and per limit one counter that displays the number of limit violations. In addition, a hardware interrupt may be generated for each limit violation.

The status of the limit violations can also be evaluated in the user data variant 240 ($F0_H$) or via the user-defined user data variant via the measured value ID 65509.

### Benefits

With activated limit monitoring you can already detect any irregularities in the measured value acquisition already in field level.

### Retentivity

All the counter states of the module are stored retentively in the Energy Meter. After an interruption (e.g. Power System Off → Power System On), the counting resumes with the retentively stored values.

### Configuring

You configure the following limit monitoring settings in STEP 7:

- Measured variable that is to be monitored.
- Activate / Deactivate limit monitoring.
- High or low limit values.
- Delay time and hysteresis for each limit.
- Activate / Deactivate hardware interrupts at limit violation.
- Measured value that is subject to limit monitoring.

## Hardware interrupt at a limit violation

The hardware interrupt provides the following information:

- Measured value ID of the monitored measured or calculated variable
- Number of the limit (0 = Limit 1. 15 = Limit 16)
- Information on whether limit was exceeded or fallen below

For more detailed information, refer to section Hardware interrupts (Page 101).

## Changing properties in RUN

The following table shows the supported control information:

| Control information | Default value | Available in |
|---|---|---|
| Enable/disable monitoring per limit[1] | Disabled | Module version with 12 bytes of output data |
| Reset number of total limit violations | 0 | Module version starting at 2 bytes of output data |

[1] Effective only with enabled gate

# 9.2 Influence of hysteresis and delay time on limit monitoring

## Delay time and hysteresis

In order to prevent the triggering of limit violations with small fluctuations, you have the following configuration options in STEP 7:

- Delay time in seconds (0 to 10 s)

  With the delay time, you filter faults and thereby prevent limit value monitoring from triggering too frequently. The limit violation is counted only when the limit violation is present for longer than the configured delay time. The deceleration time is also taken into consideration during outgoing of the limit violation.

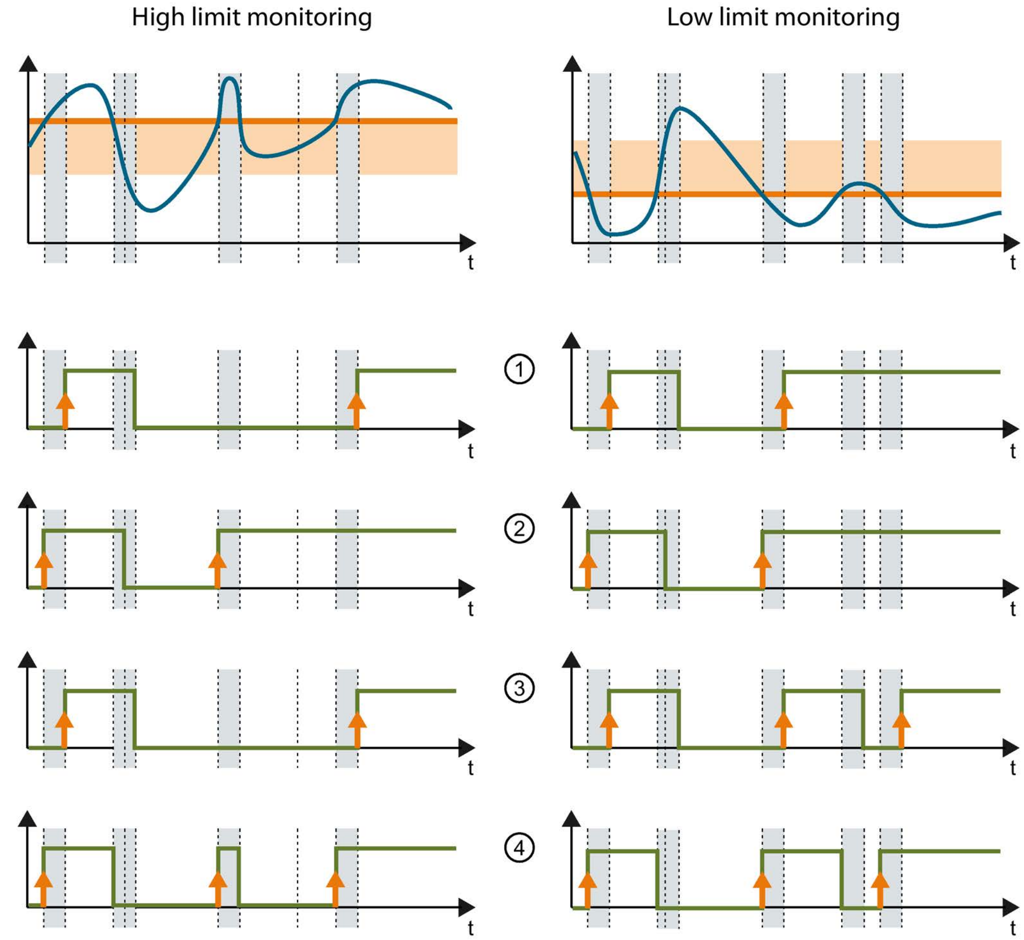
- Hysteresis as a percentage (0 to 20%)

  With the hysteresis, you suppress fluctuations around the limit. The hysteresis is a tolerance range that you define as a percentage deviation of the configured limit. The limit violation is considered to be corrected only when the monitored value leaves the tolerance range.

**Note**

You can get information about transient underflow and overflow from the calculation of minimum (Page 186) and maximum values (Page 184) of selected measured variables.

The following figure shows the value-over-time for two measured values using the example of a high and low limit as well as the influence of hysteresis and delay time on the counting of the limit violations.



| | | | |
|---|---|---|---|
| ━ | Configured limit. | ━ | Signal wave |
| ▨ | Configured delay time. Is taken into consideration during coming and going. | ① | Limit monitoring with hysteresis and delay time |
| ▧ | Hysteresis range. Only considered for outgoing. | ② | Limit monitoring with hysteresis, but without delay time |
| ━ | Value-over-time for which the limit is monitored. | ③ | Limit monitoring without hysteresis, but with delay time |
| ➡ | Edge change. Counter for limit violations is incremented by 1. If parameterized, a hardware interrupt is triggered. | ④ | Limit monitoring without hysteresis and delay time |

Figure 9-1 Influence of hysteresis and delay time on the limit

## See also

How limit monitoring works (Page 72)

Minimum and maximum values (Page 82)

## 9.3 Reset, activate and deactivate counters for limit violation

### Introduction

At the beginning of a new work order, it can be useful to reset or indeed also enable/disable the counters for limit violations of the Energy Meter.

Resetting here means that the counters for limit violations are reset to 0.

Due to the differing lengths of the output data resetting of the counters for limit violations depends on the configured module version.

### Resetting at module version with 12 bytes of output data

1. Select the counters for limit violations that you want to reset in control bytes 3 and 4; see "Enabling/disabling the counters for limit violations".
2. In control byte 1, set the rest bit (bit 3) with an edge change from 0 to 1; see "Resetting the counters for limit violations".

### Resetting at module version with 2 bytes of output data

Set the reset bit (Bit 3) in Control byte 1 from 0 to 1 through an edge change. Resetting acts globally on all the configured counters for limit violation.

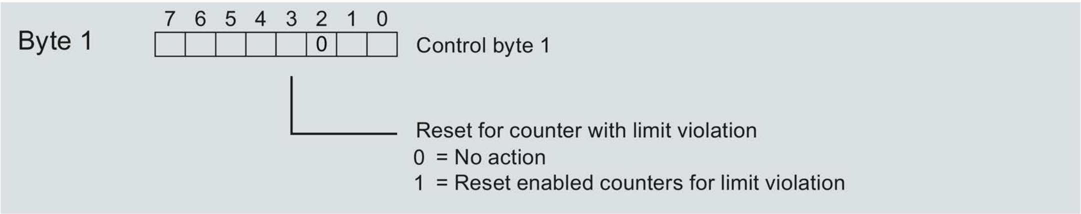


Figure 9-2 Resetting of the counters for limit violations

## Activating / Deactivating counters for limit violations

Activating / Deactivating of the counters for limit violations is only possible for module versions with 12 bytes of output data.

**Requirements:** "Gate for limit value monitoring" was parameterized during configuration of the module using STEP 7 or by writing the data record DS 128.

Select the counters for limit violations that you want to activate / deactivate in Control bytes 3 and 4.

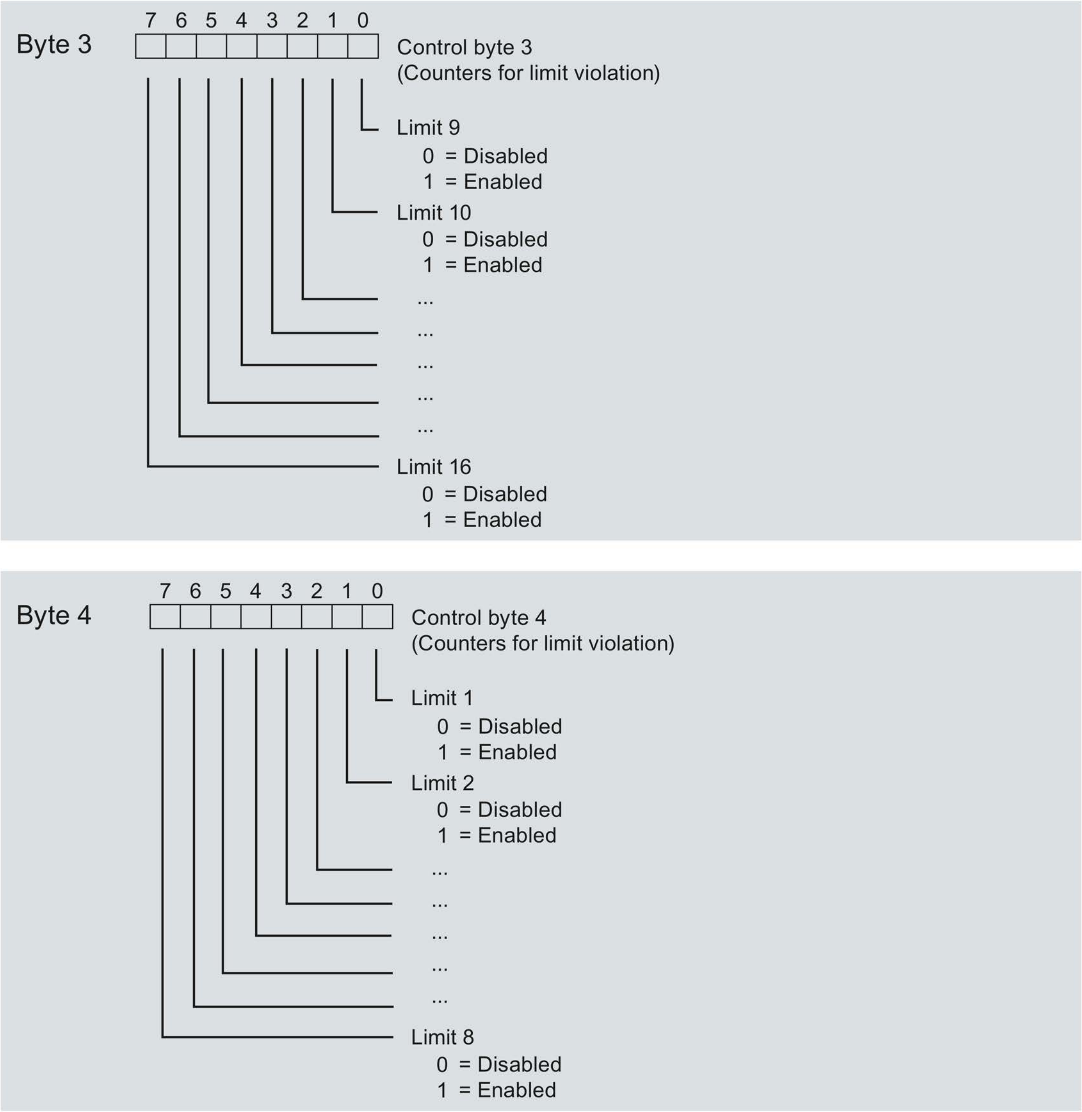


Figure 9-3 Activating / deactivating of the counters for limit violations

## 9.4 Measured variables for limit monitoring

The table below shows which measured variables are available for limit monitoring.

| Measured value ID | Measured variables | Use for limit monitoring |
|---|---|---|
| 1 | Voltage UL1-N | Yes |
| 2 | Voltage UL2-N | Yes |
| 3 | Voltage UL3-N | Yes |
| 4 | Voltage UL1- L2 | Yes |
| 5 | Voltage UL2- L3 | Yes |
| 6 | Voltage UL3- L1 | Yes |
| 7 | Current L1 | Yes |
| 8 | Current L2 | Yes |
| 9 | Current L3 | Yes |
| 10 | Apparent power L1 | Yes |
| 11 | Apparent power L2 | Yes |
| 12 | Apparent power L3 | Yes |
| 13 | Active power L1 | Yes |
| 14 | Active power L2 | Yes |
| 15 | Active power L3 | Yes |
| 16 | Reactive power L1 | Yes |
| 17 | Reactive power L2 | Yes |
| 18 | Reactive power L3 | Yes |
| 19 | Power factor L1 | Yes |
| 20 | Power factor L2 | Yes |
| 21 | Power factor L3 | Yes |
| 30 | Frequency | Yes |
| 34 | Total active power L1L2L3 | Yes |
| 35 | Total reactive power L1L2L3 | Yes |
| 36 | Total apparent power L1L2L3 | Yes |
| 37 | Total power factor L1L2L3 | Yes |
| 38 | Amplitude unbalance for voltage | Yes |
| 39 | Amplitude unbalance for current | Yes |
| 40 | Max. voltage UL1-N | Yes |
| 41 | Max. voltage UL2-N | Yes |
| 42 | Max. voltage UL3-N | Yes |
| 43 | Max. voltage UL1- L2 | Yes |
| 44 | Max. voltage UL2- L3 | Yes |
| 45 | Max. voltage UL3- L1 | Yes |
| 46 | Max. current L1 | Yes |
| 47 | Max. current L2 | Yes |
| 48 | Max. current L3 | Yes |
| 49 | Max. apparent power L1 | Yes |
| 50 | Max. apparent power L2 | Yes |
| 51 | Max. apparent power L3 | Yes |
| 52 | Max. active power L1 | Yes |
| 53 | Max. active power L2 | Yes |

| Measured value ID | Measured variables | Use for limit monitoring |
|---|---|---|
| 54 | Max. active power L3 | Yes |
| 55 | Max. reactive power L1 | Yes |
| 56 | Max. reactive power L2 | Yes |
| 57 | Max. reactive power L3 | Yes |
| 58 | Max. power factor L1 | Yes |
| 59 | Max. power factor L2 | Yes |
| 60 | Max. power factor L3 | Yes |
| 61 | Max. frequency | Yes |
| 65 | Max. total active power | Yes |
| 66 | Max. total reactive power | Yes |
| 67 | Max. total apparent power | Yes |
| 68 | Max. total power factor | Yes |
| 70 | Min. voltage UL1-N | Yes |
| 71 | Min. voltage UL2-N | Yes |
| 72 | Min. voltage UL3-N | Yes |
| 73 | Min. voltage UL1- L2 | Yes |
| 74 | Min. voltage UL2- L3 | Yes |
| 75 | Min. voltage UL3- L1 | Yes |
| 76 | Min. current L1 | Yes |
| 77 | Min. current L2 | Yes |
| 78 | Min. current L3 | Yes |
| 79 | Min. apparent power L1 | Yes |
| 80 | Min. apparent power L2 | Yes |
| 81 | Min. apparent power L3 | Yes |
| 82 | Min. active power L1 | Yes |
| 83 | Min. active power L2 | Yes |
| 84 | Min. active power L3 | Yes |
| 85 | Min. reactive power L1 | Yes |
| 86 | Min. reactive power L2 | Yes |
| 87 | Min. reactive power L3 | Yes |
| 88 | Min. power factor L1 | Yes |
| 89 | Min. power factor L2 | Yes |
| 90 | Min. power factor L3 | Yes |
| 91 | Min. frequency | Yes |
| 95 | Min. total active power | Yes |
| 96 | Min. total reactive power | Yes |
| 97 | Min. total apparent power | Yes |
| 98 | Min. total power factor | Yes |
| 200 | Total active energy inflow L1L2L3 | Yes |
| 201 | Total active energy outflow L1L2L3 | Yes |
| 202 | Total reactive energy inflow L1L2L3 | Yes |
| 203 | Total reactive energy outflow L1L2L3 | Yes |
| 204 | Total apparent energy L1L2L3 | Yes |
| 205 | Total active energy L1L2L3 | Yes |
| 206 | Total reactive energy L1L2L3 | Yes |
| 210 | Total active energy inflow L1L2L3 | - |

| Measured value ID | Measured variables | Use for limit monitoring |
|---|---|---|
| 211 | Total active energy outflow L1L2L3 | - |
| 212 | Total reactive energy inflow L1L2L3 | - |
| 213 | Total reactive energy outflow L1L2L3 | - |
| 214 | Total apparent energy L1L2L3 | - |
| 215 | Total active energy L1L2L3 | - |
| 216 | Total reactive energy L1L2L3 | - |
| 61140 | Overflow counter active energy inflow L1L2L3 | - |
| 61141 | Overflow counter active energy outflow L1L2L3 | - |
| 61142 | Overflow counter reactive energy inflow L1L2L3 | - |
| 61143 | Overflow counter reactive energy outflow L1L2L3 | - |
| 61144 | Overflow counter apparent energy L1L2L3 | - |
| 61149 | Neutral current | Yes |
| 61178 | Phase angle L1 | Yes |
| 61180 | Active energy inflow L1 | Yes * |
| 61181 | Active energy outflow L1 | Yes * |
| 61182 | Reactive energy inflow L1 | Yes * |
| 61183 | Reactive energy outflow L1 | Yes * |
| 61184 | Apparent energy L1 | Yes * |
| 61185 | Active energy L1 | Yes * |
| 61186 | Reactive energy L1 | Yes * |
| 61190 | Overflow counter active energy inflow L1 | - |
| 61191 | Overflow counter active energy outflow L1 | - |
| 61192 | Overflow counter reactive energy inflow L1 | - |
| 61193 | Overflow counter reactive energy outflow L1 | - |
| 61194 | Overflow counter apparent energy L1 | - |
| 61198 | Phase angle L2 | Yes |
| 61200 | Active energy inflow L2 | Yes * |
| 61201 | Active energy outflow L2 | Yes * |
| 61202 | Reactive energy inflow L2 | Yes * |
| 61203 | Reactive energy outflow L2 | Yes * |
| 61204 | Apparent energy L2 | Yes * |
| 61205 | Active energy L2 | Yes * |
| 61206 | Reactive energy L2 | Yes * |
| 61210 | Overflow counter active energy inflow L2 | - |
| 61211 | Overflow counter active energy outflow L2 | - |
| 61212 | Overflow counter reactive energy inflow L2 | - |
| 61213 | Overflow counter reactive energy outflow L2 | - |
| 61214 | Overflow counter apparent energy L2 | - |
| 61218 | Phase angle L3 | Yes |
| 61220 | Active energy inflow L3 | Yes * |
| 61221 | Active energy outflow L3 | Yes * |
| 61222 | Reactive energy inflow L3 | Yes * |
| 61223 | Reactive energy outflow L3 | Yes * |
| 61224 | Apparent energy L3 | Yes * |
| 61225 | Active energy L3 | Yes * |
| 61226 | Reactive energy L3 | Yes * |

| Measured value ID | Measured variables | Use for limit monitoring |
|---|---|---|
| 61230 | Overflow counter active energy inflow L3 | - |
| 61231 | Overflow counter active energy outflow L3 | - |
| 61232 | Overflow counter reactive energy inflow L3 | - |
| 61233 | Overflow counter reactive energy outflow L3 | - |
| 61234 | Overflow counter apparent energy L3 | - |
| 65500 | Qualifier L1 | - |
| 65501 | Qualifier L2 | - |
| 65502 | Qualifier L3 | - |
| 65503 | Qualifier L1L2L3 | - |
| 65504 | Total operating hours counter L1L2L3 | Yes |
| 65505 | Operating hours counter L1 | Yes |
| 65506 | Operating hours counter L2 | Yes |
| 65507 | Operating hours counter L3 | Yes |
| 65510 | Counter limit violation GW1 | Yes |
| 65511 | Counter limit violation GW2 | Yes |
| 65512 | Counter limit violation GW3 | Yes |
| 65513 | Counter limit violation GW4 | Yes |
| 65514 | Counter limit violation GW5 | Yes |
| 65515 | Counter limit violation GW6 | Yes |
| 65516 | Counter limit violation GW7 | Yes |
| 65517 | Counter limit violation GW8 | Yes |
| 65518 | Counter limit violation GW9 | Yes |
| 65519 | Counter limit violation GW10 | Yes |
| 65520 | Counter limit violation GW11 | Yes |
| 65521 | Counter limit violation GW12 | Yes |
| 65522 | Counter limit violation GW13 | Yes |
| 65523 | Counter limit violation GW14 | Yes |
| 65524 | Counter limit violation GW15 | Yes |
| 65525 | Counter limit violation GW16 | Yes |

* Can only be configured in REAL format

# Minimum and maximum values

# 10

## 10.1 Minimum and maximum values

### Introduction

The AI Energy Meter 480VAC ST determines the respective highest and lowest measured or calculated value for a series of measured and calculated values. The values are stored retentively in the module and can be read using measured value data records 144 and 145.

### Benefits

Using the stored minimum and maximum values, for example, you can detect further irregularities in addition to limit monitoring.

### Calculation of minimum and maximum values

Minimum and maximum values are only calculated for the phases in accordance with the configured connection type. Existing minimum and maximum values that have not been calculated are initialized with 0. If faults such as under or overcurrent occur during operation, new minimum and maximum values are calculated.

The measured and calculated values are initialized as follows during commissioning of the AI Energy Meter 480VAC ST so that the first calculation of minimum and maximum values supplies a plausible result:

- Maximum values for measured and calculated values: Minimum values
- Minimum values for measured and calculated values: Maximum values

### Configuring

You configure the following settings in STEP 7:

- Enable calculation of minimum and maximum values

## Changing properties in RUN

The following table shows the supported control information:

| Control information | Default value | Available in |
|---|---|---|
| Reset saved maximum values | 0 | Module version starting at 2 bytes of output data |
| Reset saved minimum values | 0 | Module version starting at 2 bytes of output data |

---

**Note**

**Automatic reset**

If you change the parameters for current or voltage transformers, the minimum and maximum values are reset automatically to their initial values.

---

## 10.2 Resetting minimum and maximum values

### Description

At the beginning of a new work order, it may be useful to reset the minimum and maximum values of the Energy Meter. Resetting means that the minimum and maximum values are reset to their initial values. Initial values are described, see section Measured value data record for maximum values (DS 144) (Page 184) and section Measured value data record for minimum values (DS 145) (Page 186).

As the output data differs in length, resetting the minimum and maximum values depends on the configured module version. If you use module versions with 12 bytes output data, you can

- Reset the minimum and maximum values for **all** phases.
- Reset minimum and maximum values for each **individual** phase.

If you use the module version with 2 bytes of output data, you always reset **all** the minimum and maximum values simultaneously.

## Procedure at module version with 12 bytes of output data

### Resetting the minimum and maximum values for all 3 phases.

1. Select the categories of minimum and maximum value that you want to reset in byte 2.
   - Set bit 0 for voltage and frequency.
   - Set bit 1 for current and power factor.
   - Set bit 2 for active power.
   - Set bit 3 for reactive power.
   - Set bit 4 for apparent power.

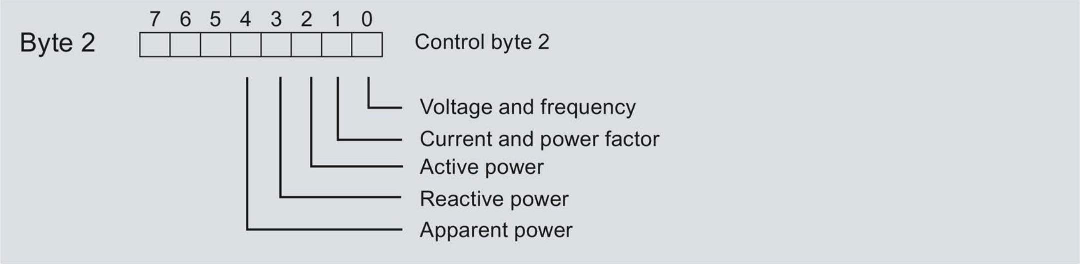


Figure 10-1 Selection of minimum and maximum value category

2. In byte 1, set reset bit 0 for minimum values or reset bit 1 for maximum values.
   If there is an edge change of the reset bits from 0 to 1, the module resets the selected minimum or maximum values for all 3 phases that you previously selected in byte 2.

Figure 10-2 Reset bit for minimum and maximum values

### Resetting minimum and maximum values for phase-specific measurement

You can also reset the minimum and maximum values on a phase-specific basis using the output data.

Follow the procedure for "Resetting minimum and maximum values for all 3 phases" as applicable.

1. Select the categories of minimum and maximum value that you want to reset on a phase-specific basis.
   - In byte 7, set the bits for the category of minimum and maximum values in phase 1.
   - In byte 9, set the bits for the category of minimum and maximum values in phase 2.
   - In byte 11, set the bits for the category of minimum and maximum values in phase 3.
2. Set the reset bit (bit 0 and bit 1) for minimum or maximum values.
   - in byte 6 for phase 1
   - in byte 8 for phase 2
   - in byte 10 for phase 3

If there is an edge change of the phase-specific reset bits from 0 to 1, the module resets the minimum or maximum values for the given phase.

## Procedure at module version with 2 bytes of output data

If you use the module version with 2 bytes of output data, you always reset **all** the minimum and maximum values simultaneously.

Set the reset bit (Bit 0 or Bit 1) in Control byte 1 from 0 to 1 through an edge change.

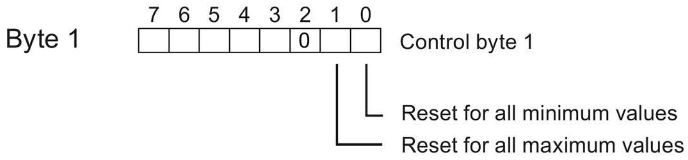


Figure 10-3 Resetting the minimum and maximum values at module version with 2 bytes of output data

# Phase-based measured values

# 11

## 11.1 Phase-based measured values

### Introduction

The AI Energy Meter 480VAC ST makes the measured values of individual phases available.

- Through the user data variants
  - Phase-specific measurement Phase L1 with user data variants 154 ($9A_H$) and 155 ($9B_H$)
  - Phase-specific measurement Phase L2 with user data variants 156 ($9C_H$) and 157 ($9D_H$)
  - Phase-specific measurement Phase L3 with user data variants 158 ($9E_H$) and 159 ($9F_H$)
- Via measured value data records
  - Phase-specific measurement for the phases L1, L2 and L3 with data record 142
  - Phase-specific measurement for phase L1 with data record 147
  - Phase-specific measurement for phase L2 with data record 148
  - Phase-specific measurement for phase L3 with data record 149

### User data variants

Through the user data variants 154 ($9A_H$) to 159 ($9F_H$) you can evaluate the following measured values for each phase of an AC / three-phase network:

- Quality information
- Current and voltage
- Active, reactive and apparent power
- Active, reactive and apparent energy
- Power factor

You can find the structure of the user data variants in section Measured value data record for phase-based measured values L1 (DS 147) (Page 188).

## Measured value data records

Through the measured value data records DS 142, DS 147, DS 148 and DS 149 you can evaluate the following measured values for each phase of an AC / three-phase network:

- Quality information
- Current and voltage
- Minimum current and minimum voltage
- Maximum current and maximum voltage
- Active, reactive and apparent power
- Minimum active, reactive and apparent power
- Maximum active, reactive and apparent power
- Active, reactive and apparent energy
- Minimum active, reactive and apparent energy
- Maximum active, reactive and apparent energy
- Power factor
- Minimum power factor
- Maximum power factor

You can find the structure of the measured value data records in section Measured value data record for phase-based measured values L1 (DS 147) (Page 188).

## See also

Measured value data record for phase-based measured values L2 (DS 148) (Page 190)

Measured value data record for phase-based measured values L3 (DS 149) (Page 192)

Minimum and maximum values (Page 82)

User data variants with 32 bytes input data / 12 bytes output data (Page 155)

Overview of all measured value data records (Page 175)

# Parameters

# 12

## 12.1 Parameters

### Parameters of the AI Energy Meter 480VAC ST (DS 128, DS 129, DS 130)

As a rule, the AI Energy Meter 480VAC ST is already integrated in the hardware catalog of STEP 7 (TIA Portal) or STEP 7 V5.5 or higher. In this case STEP 7 (TIA Portal) or STEP 7 V5.5 or higher checks the parameterized properties for plausibility during designing.

However, you can also assign parameters to the module using a GSD file and the configuration software of any provider. The module checks the validity of the configured properties only after the configuration has been downloaded. Note that some parameters depend on the selected connection type of the Energy Meter. For example in the connection type 1P2W for measurements in single-phase AC network it does not make sense to enter parameters for Phases 2 and 3 and they are also not checked by the system in this case.

The effective range of the parameters that can be set using a GSD file depends on the type of bus system used:

- Distributed operation on PROFINET IO in an ET 200SP system
- Distributed operation with PROFIBUS DP in an ET 200SP system

In addition you can change the parameterized properties via the user program in RUN mode. When you assign parameters in the user program, the "WRREC" instruction transfers the parameters to the module using data records (see appendix Configuration via parameter data records (Page 112)). The following table summarizes all the configurable parameters.

Table 12- 1 AI Energy Meter 480VAC ST parameters

| Parameters | Value range | Default setting | Reconfiguration in RUN | Effective range with configuration software, e.g. STEP 7 (TIA Portal) | |
|---|---|---|---|---|---|
| | | | | GSD file PROFINET IO | GSD file PROFIBUS DP |
| Hardware interrupt | • Disable<br>• Enable | Disable | Yes | Module | Module |
| Diagnostics line voltage | • Disable<br>• Enable | Disable | Yes | Module | Module |
| Connection type | • Disabled<br>• 1P2W - 1-phase alternating current<br>• 3x1P2W - 3x1 phase, 2 conductors each<br>• 2P3W - 2 phases, 3 conductors<br>• 3P4W - 3 phases, 4 conductors<br>• 3P4W1 - 3 phases, 4 conductors, balanced load | 3P4W - 3 phases, 4 conductors | Yes | Module | Module<br>(only 1P2W, 3P4W, 3P4W1<br>and deactivated) |
| Voltage measuring range | • 100 V<br>• 110 V<br>• 115 V<br>• 120 V<br>• 127 V<br>• 190 V<br>• 200 V<br>• 208 V<br>• 220 V<br>• 230 V<br>• 240 V<br>• 277 V | 230 V | Yes | Module | Module |
| Line voltage tolerance [%] | • 1 ... 50 % | 10 % | Yes | Module | Module |
| Line frequency | • 50 Hz<br>• 60 Hz | 50 Hz | Yes | Module | Module |

| **Parameters** | **Value range** | **Default setting** | **Reconfiguration in RUN** | **Effective range with configuration software, e.g. STEP 7 (TIA Portal)** | |
|---|---|---|---|---|---|
| | | | | **GSD file PROFINET IO** | **GSD file PROFIBUS DP** |
| Enable gate energy counter | • No<br>• Yes | No | Yes | Module | - |
| Full-scale value for energy counter | • No full-scale value - infinite counting<br>• $10^3$ - count periodically<br>• $10^6$ - count periodically<br>• $10^9$ - count periodically<br>• $10^{12}$ - count periodically<br>• $10^{15}$ - count periodically | No full-scale value - infinite counting | Yes | Module | -<br>(Default setting. No full-scale value - infinite counting) |
| User data variant | See the table Overview of the user data variants (Page 155) | Total energy L1 L2 L3 (ID 254 or $FE_H$) | Yes | Module | Module<br>(only user data variant $FE_H$, $FA_H$, $F9_H$, $F8_H$, $9F_H$, $F5_H$, $80_H$) |
| Minimum and maximum value calculation | • Disable<br>• Enable | Disable | Yes | Module | -<br>(Default setting: Disable) |
| Diagnostics overflow current | • Disable<br>• Enable | Disable | Yes | Channel/phase | Module |
| Diagnostics overflow voltage | • Disable<br>• Enable | Disable | Yes | Channel/phase | Module |
| Diagnostics underflow voltage | • Disable<br>• Enable | Disable | Yes | Channel/phase | Module |
| Diagnostics low limit voltage | • Disable<br>• Enable | Disable | Yes | Channel/phase | -<br>(blocking is preset) |
| Diagnostics overflow cumulative values | • Disable<br>• Enable | Disable | Yes | Channel/phase | Module |
| Overcurrent tolerance value [0.1 A] | • 10 ... 100 [0.1 A] | 100 [0.1 A] | Yes | Channel/phase | Module |
| Overcurrent tolerance time [ms] | • 1 ... 60000 ms | 40000 ms | Yes | Channel/phase | Module |

| Parameters | Value range | Default setting | Reconfiguration in RUN | Effective range with configuration software, e.g. STEP 7 (TIA Portal) | |
|---|---|---|---|---|---|
| | | | | GSD file PROFINET IO | GSD file PROFIBUS DP |
| Low limit for current measurement [mA] | • 2 ... 250 mA | 50 mA | Yes | Channel/phase | -<br>(Default setting: 2 mA) |
| Operating hours counter | • Disable<br>• Enable | Disable | Yes | Channel/phase | -<br>(Default setting: Disable) |
| Enable gate of operating hours counter | • No<br>• Yes | No | Yes | Channel/phase | - |
| Current transformer primary current [A] | • 1 ... 99999 A | 1 A | Yes | Channel/phase | Module<br>(Value range: 1...65535) |
| Current transformer secondary current | • 1 A<br>• 5 A | 1 A | Yes | Channel/phase | Module |
| Voltage transformer primary voltage [V] | • 1 ... 999999 V | 230 V | Yes | Channel/phase | Module |
| Voltage transformer secondary voltage [V] | • 1 ... 500 V | 230 V | Yes | Channel/phase | -<br>(same value as Voltage measuring range parameter) |
| Reverse current direction | • Disable<br>• Enable | Disable | Yes | Channel/phase | Module |
| Number of limits | • 0 ... 16 | 0 | Yes | Module | - |
| Limit monitoring for limit | • Disable<br>• Enable | Disable | Yes | Module | - |
| Measured variable for limit | • Measured value ID, see Table B-1 | None | Yes | Limit | - |
| Gate for limit via DQ | • Disable<br>• Enable | Disable | Yes | Channel/phase | - |
| Hardware interrupt for limit | • Disable<br>• Enable | Disable | Yes | Channel/phase | - |
| Limit | • depending on the selected measured variable | 0 | Yes | Limit | - |
| Type of limit | • High limit<br>• Low limit | High limit | Yes | Channel/phase | - |

| Parameters | Value range | Default setting | Reconfiguration in RUN | Effective range with configuration software, e.g. STEP 7 (TIA Portal) | |
|---|---|---|---|---|---|
| | | | | GSD file PROFINET IO | GSD file PROFIBUS DP |
| Hysteresis for limit monitoring [%] | • 0 ... 200 [0.1%] | 0% | Yes | Channel/phase | - |
| Delay time for limit monitoring [s] | • 0 ... 10 s | 0 s | Yes | Channel/phase | - |
| Number of measured values for user data mapping | • 0 ... 64 | 0 | Yes | Module | -<br>(no user data mapping) |
| Measured variable | • Measured value ID, see Table B-1 | None | Yes | Measured variable | -<br>(no user data mapping) |

## 12.2 Description of parameters

### Hardware interrupt

Enable the hardware interrupt for the entire module here.

### Diagnostics line voltage

Activate the diagnostics line voltage here. If there is no voltage or too little voltage at L1, the message "No supply voltage at L1" is output and a diagnostic interrupt is triggered.

### Connection type

Specify the connection type you used for the Energy Meter here.

For more detailed information, refer to "Connection examples (Page 21)".

### Voltage measuring range

Here you can set the voltage measuring range of the power supply system.

### Line voltage tolerance

Monitoring the supply voltage based on this tolerance band is a positive or negative value.

### Line frequency

Here you can set the line frequency of the power supply system.

### Enable gate energy counter

Enable the gate for the energy counter here. When the gate is enabled, the energy counter only counts when the corresponding output data bit (DQ bit) is set to "1".

### Full-scale value for energy counter

Select here the full-scale value for the periodic counting of the energy counter. You can also specify that the energy counter is to count without a full-scale value (infinite counting). The calculated energy counter values are stored retentively in the module.

### User data variant

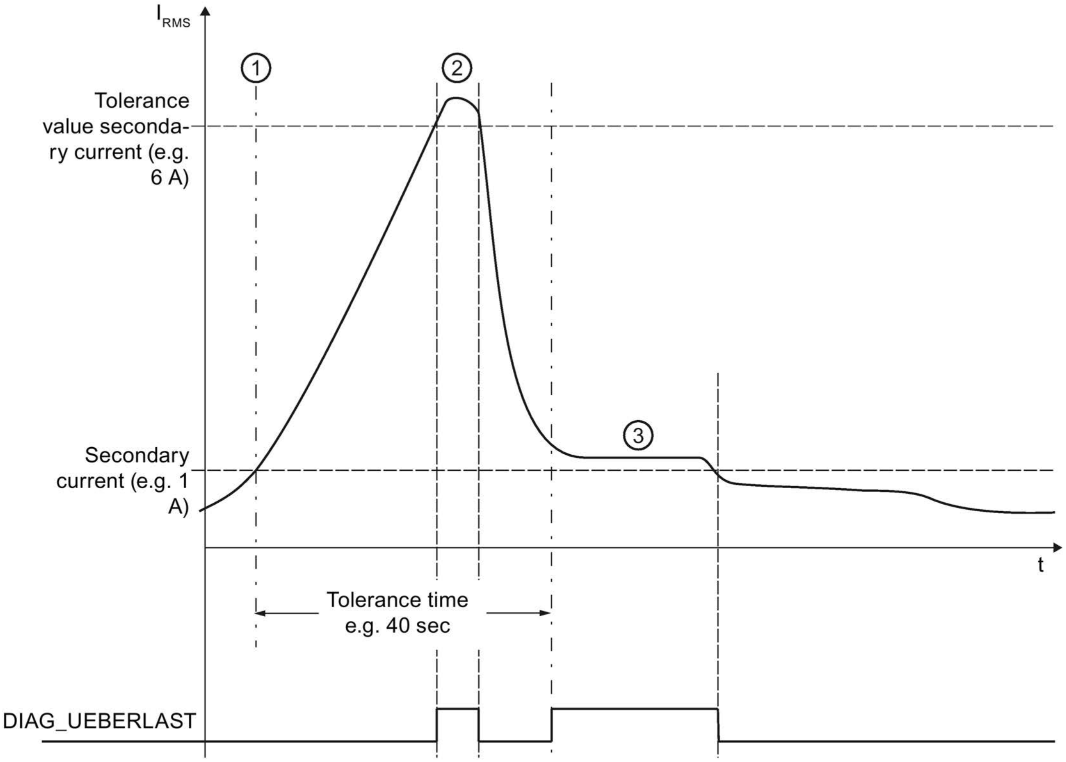
Select here the user data variant with which the module is to operate once it is switched on.

## Minimum and maximum value calculation

Enable calculation of the minimum and maximum values here. The minimum and maximum value are calculated from the start of the measurement. The calculated values are stored retentively in the Energy Meter.

## Diagnostics overflow current

The measured current is monitored after expiry of the "Tolerance time" for "Overcurrent [0.1 A] tolerance value". Exceeding this results in overflow current.



① The tolerance time starts as soon as the secondary current value (1 A, 5 A) is exceeded.

② DIAG_UEBERLAST diagnoses the affected phase if the tolerance value of the secondary current has been exceeded within the assigned tolerance time (or the maximum value of the secondary current (12 A) is exceeded).

③ After the set tolerance time has elapsed, the secondary current value (1 A, 5 A) is monitored. A violation of the secondary current value also returns DIAG_UEBERLAST.

Figure 12-1 Diagnostics response in the event of a current overload

## Diagnostics overflow voltage

Line voltage (measuring range) is monitored for tolerance. A violation of the overflow triggers a diagnostic interrupt.

## Diagnostics underflow voltage

Line voltage (measuring range) is monitored for tolerance. A violation of the underflow triggers a diagnostic interrupt.

## Diagnostics low limit voltage

Low limit for voltage is monitored. A violation of the low limit triggers a diagnostic interrupt.

## Diagnostics overflow cumulative values

A cumulative overflow in the calculated variables is displayed. The values stop at the high or low limit. A violation triggers a diagnostic interrupt.

## Overcurrent tolerance value [0.1 A]

The tolerance factor secondary overcurrent parameter (10 to 100) indicates the tolerable value of the secondary current in 0.1 A increments (10 = 1 A to 100 = 10 A). Always take note of the current class of the current transformer being used (1 A, 5 A).

## Overcurrent tolerance time

Monitoring time in ms in which the overcurrent is tolerated. 0 means that the monitoring time has been disabled.

## Low limit for measuring current

The configurable low limit for measuring current refers to the secondary currents and is used to avoid incorrect calculations in the case of very low currents. Incorrect measurements of very low currents in particular are a cause of inaccuracies in the current transformer used. Set the low limit for the current measurement to the required value depending on your process.

Tip: If you want to find the low limit for the current measurement experimentally, set it to a lower value. Then, feed in a very precise low current and determine the measurement error that can no longer be tolerated. Afterwards, set the low limit for the current measurement to the limit value you have determined.

If current falls below the low limit for the current measurement, the following measured values and derived variables of the affected phase are reset.

- Effective current value
- Neutral current
- Active power
- Reactive power
- Apparent power
- Phase angle
- Power factor

A moving mean value is formed from the power values and they only become "0" after a corresponding time. The energy meters for active, reactive and apparent energy of the reset phase do not measure any longer.

## Operating hours counter

Enable the operating hours counter here. The counting starts from a programmable minimum current value. The counter can be reset or pre-defined using data record or output bit.

## Enable gate of operating hours counter

Enable the gate for the operating hours counter here. When the gate is activated, the operating hours counter only counts when the corresponding output data bit (DQ bit) is set to "1".

## Current transformer primary current

Enter here the nominal value for the primary current of the current transformer used. The transformer ratio is calculated from the primary and secondary current.

## Current transformer secondary current

Enter here the nominal value for the secondary current (1 A or 5 A) of the current transformer used. The transformer ratio is calculated from the primary and secondary current.

## Voltage transformer primary voltage

To determine the voltage transformer ratio, enter the primary voltage here. The transformer ratio is calculated from the primary and secondary voltage.

## Voltage transformer secondary voltage

Enter the secondary voltage to determine the voltage transformer ratio here. The transformer ratio is calculated from the primary and secondary voltage.

## Reverse current direction

Setting to determine whether or not to reverse the direction of current.

In the event of inadvertent incorrect connection, this parameter can be used to correct the measured values, thus saving the hassle of rewiring. The direction of the current is only evident from the power measurement values. The current measurement value is an rms value.

## Number of limits

Enter the number of measured values that you want to monitor for limits.

### Limit monitoring

Enable the monitoring of the limit for a freely definable measured value here. Limit violations are counted and the count values stored retentively.

### Measured value ID for limit

Enter the ID of a measured value that you want to use for limit monitoring.

### Gate enabled with limit monitoring

Enable the gate via limit monitoring here. When the gate is enabled, the limit monitoring is only started when the corresponding bit of the associated output user data is set to "1".

### Hardware interrupt for limit

Enable the hardware interrupt here. The hardware interrupt is triggered if a high or low limit is violated. Without activation of a hardware interrupt, a limit violation is only displayed in the user data and in DS 150.

### Limit

Enter the limit here that is to trigger a limit violation when exceeded or fallen below. Limit violations are displayed in the user data and in DS 150.

### Type of limit

Select here, whether it is an high or low limit. Depending on this selection, the limit violation or hardware interrupt is triggered when a value exceeds (high limit) or falls below (low limit) the limit.

### Hysteresis for limit monitoring

Enter the hysteresis for limit in percent here. The percentage refers to the numerical value of the limit when the limit violation occurs. A message is only canceled if the measured value is outside the limit and its hysteresis range. As long as the measured value is in the hysteresis range, no new message is output.

### Delay time for limit monitoring

Here you can select the delay time for limit violation. The delay refers to the time that must elapse before an occurrence of a limit violation is reported. Faults can be filtered out by selection of the delay time. The deceleration time is also taken into consideration during outgoing of the limit violation.

### Number of measured values for user data mapping

Specify the number of measured values/variables that you want to use for the user-specific user data mapping.

### Measured variable

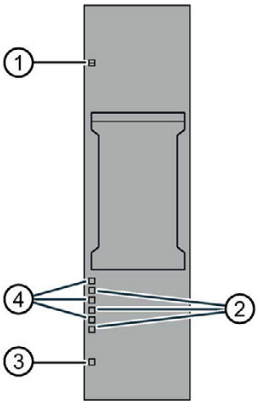
Select the measured variable (with the measured value ID) that you want to use for the user-specific user data mapping.

# Interrupts/diagnostic alarms

# 13

## 13.1 Status and error display

### LED display



① DIAG (green/red)
② Error (red)
③ PWR (green)
④ Status (green)

Figure 13-1 LED display

## Meaning of the LED displays

The following table explains the meaning of the status and error displays. Remedial measures for diagnostic alarms can be found in the section Diagnostic alarms (Page 103).

## DIAG LED

Table 13- 1 Meaning of the DIAG LED

| DIAG | Meaning |
|---|---|
| □<br>Off | Supply voltage of the ET 200SP not OK |
| ☼<br>Flashes | Module not ready for operation (no parameters assigned) |
| 🟩<br>On | Module parameters assigned and no module diagnostics |
| ☼<br>Flashes | Module parameters assigned and module diagnostics |

## Status LED

Table 13- 2 Meaning of the Status LED

| Status | Meaning |
|---|---|
| □<br>Off | Channel deactivated or error |
| 🟩<br>On | Channel activated and no error |

## Error LED

Table 13- 3 Meaning of the Error LED

| Status | Meaning |
|---|---|
| □<br>Off | Channel is OK |
| 🟥<br>On | Channel is faulty |

## PWR LED

Table 13- 4 Meaning of the PWR LED

| PWR | Meaning |
|---|---|
| □<br>Off | Line voltage missing |
| 🟩<br>On | Line voltage available |

## 13.2 Interrupts

The analog input module Energy Meter 480VAC ST supports hardware and diagnostic interrupts.

### 13.2.1 Hardware interrupts

#### Hardware interrupts

The module generates a hardware interrupt at the following events:

- Violation of low limit 1 to 16
- Violation of high limit 1 to 16

You can find detailed information on the event in the hardware interrupt organization block with the "RALARM" (read additional interrupt information) instruction and in the STEP 7 online help.

The module channel that triggered the hardware interrupt is entered in the start information of the organization block. The following figure shows the assignment of the local data double word 8 by the start information of the hardware interrupt organization block.

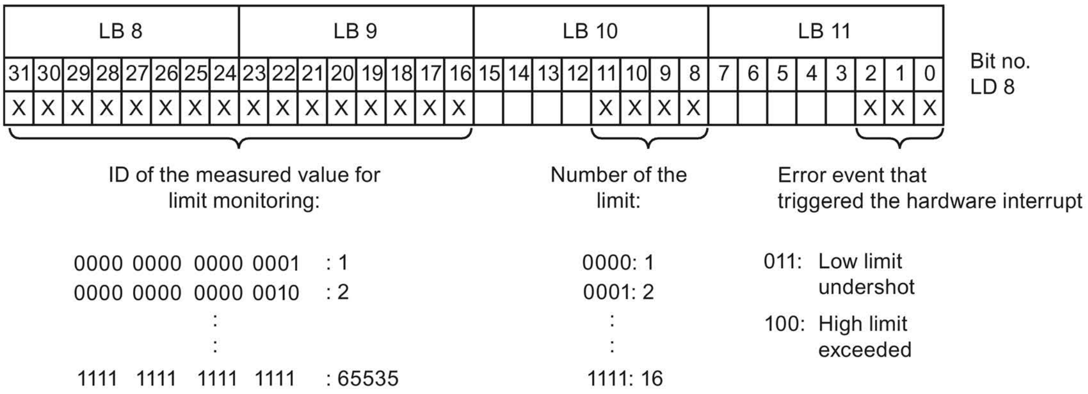


Figure 13-2 Start information of the organization block

#### Structure of the additional interrupt information

Table 13- 5 Structure of the additional interrupt information

| Data block name | | Contents | Comment | Bytes |
|---|---|---|---|---|
| Identifier | | W#16#0001 to W#16#FFFF | ID of the measured value for limit monitoring | 2 |
| Number of the limit (1 to 16), which has triggered the hardware interrupt | | | | |
| | **Channel** | B#16#00 to B#16#0F | Number of the limit | 1 |
| Event that triggered the hardware interrupt. | | | | |
| | **Event** | B#16#03 | Violation of low limit | 1 |
| | | B#16#04 | Violation of high limit | |

## 13.2.2 Diagnostics interrupt

### Diagnostic interrupt

The module generates a diagnostic error interrupt at the following events:

- Channel is temporarily unavailable
- Hardware interrupt lost
- Error
- Supply voltage missing
- Parameter assignment error
- Low limit voltage violated (measuring voltage < 80 V)
- High limit value voltage exceeded
- Underflow voltage (tolerance for supply voltage) violated
- Overflow voltage (tolerance for supply voltage) exceeded
- Overload (current measurement > 12 A or tolerance overcurrent exceeded after expiry of the tolerance time)
- Overflow of the calculated values (measured or calculated values screen exceed the representable range of values)

### See also

Diagnostic alarms (Page 103)

## 13.3 Diagnostic alarms

### Diagnostic alarms

---

**Note**

**Assignment channel in diagnostic message ⇔ Phase**

In the diagnostic messages the channels are counted from "Channel "0" on, in the AI Energy Meter 480VAC ST from Phase "1" on.

Note the following assignment:

- Channel "0" ⇔ Phase "1"
- Channel "1" ⇔ Phase "2"
- Channel "2" ⇔ Phase "3"

---

Table 13- 6 Error types

| Diagnostic message | Error code | Meaning | Solution |
|---|---|---|---|
| Undervoltage[1] | $2_H$ | Line voltage (measuring range) is monitored for tolerance. Violation leads to voltage overflow/underflow | Observe the line voltage range |
| Overvoltage | $3_H$ | | |
| Overload | $4_H$ | The measured current is monitored after expiry of the "Tolerance time" for "Tolerance value overcurrent [0.1 A]". Exceeding this results in overflow current.<br>The maximum value of the secondary current (12 A) has been exceeded. | Observe the current range |
| High limit | $7_H$ | Cumulative overflow in the calculated values | - |
| Low limit[1] | $8_H$ | Violation of the low limit for voltage measurement. The message occurs when the configured minimum current or voltage is below 80 V. | Observe the voltage range |
| Error | $9_H$ | Internal module error (diagnostic alarm on channel 0 applies to the entire module). | Replace the module |
| Parameter assignment error | $10_H$ | • The module cannot evaluate parameters for the channel.<br>• Incorrect parameter assignment. | Correct the parameter assignment |
| Load voltage missing | $11_H$ | Missing or insufficient line voltage on phase L1 | Check supply |
| Channel is temporarily unavailable | $1F_H$ | Firmware upgrade is being performed. Channel 0 applies to the entire module. The module is currently not performing any measurements. | -- |
| | | A user calibration is being executed at the channel. | Complete the user calibration |

[1] If the "Undervoltage" and "Low limit" diagnostics are active at the same time, the "Low limit" diagnostics has higher priority and deletes the "Undervoltage" diagnostics.

## 13.4 Diagnostics response

### Diagnostics response

This section describes the response of the AI Energy Meter 480VAC ST when diagnostics information is reported.

### Measured values in the case of diagnostics

Even in the case of diagnostics, measured values continue to be displayed as long as they can still be acquired. If measured values cannot be measured or calculated, "0" is displayed.

### Zero suppression

If the supplied current is less than the configured "Low limit for measuring current" parameter, the current measurement and all dependent variables are suppressed or set to "0".

### Overload limitation

If the secondary current fed in at the channel is higher than 12 A, the module changes to limitation and the measured value of the current and all dependent variables are set to "0".

### Value falls below "Low limit current measurement"

If current falls below the low limit for the current measurement, the following measured values and derived variables of the affected phase are reset.

- Effective current value
- Neutral current
- Active power
- Reactive power
- Apparent power
- Phase angle
- Power factor

A moving mean value is formed from the power values and they only become "0" after a corresponding time. The energy meters for active, reactive and apparent energy of the reset phase do not measure any longer.

## Loss of the supply voltage

At a loss of supply voltage at $U_{L1}$ (phase 1), all measurements are interrupted.

After the supply voltage is restored, the AI Energy Meter 480VAC ST operates again with the configuration / parameter assignment stored in the CPU. The retentively stored values are used at the following counters and calculations:

- Energy and overflow counters
- Operating hours counters
- Counters for limit violation
- Minimum values
- Maximum values

## Input data to "0"

**Note**

If the AI Energy Meter 480VAC ST is no longer recognized by the interface module (for example, because it is defective or not plugged in), all input data are set to "0".

# Technical specifications

# 14

## 14.1 Technical specifications

### Technical specifications of the AI Energy Meter 480VAC ST

| Article number | 6ES7134-6PA20-0BD0 |
|---|---|
| **General information** | |
| Product type designation | ET 200SP, AI Energy Meter 480 V AC ST, PU 1 |
| Firmware version | V4.0 |
| usable BaseUnits | BU type D0, BU20-P12+A0+0B |
| **Product function** | |
| • Voltage measurement | Yes |
| • Voltage measurement with voltage transformers | Yes |
| • Current measurement | Yes |
| • Phase current measurement without current transformers | No |
| • Phase current measurement with current transformers | Yes |
| • Energy measurement | Yes |
| • Frequency measurement | Yes |
| • Power measurement | Yes |
| • Active power measurement | Yes |
| • Reactive power measurement | Yes |
| • I&M data | Yes; I&M0 to I&M3 |
| • Isochronous mode | No |
| **Engineering with** | |
| • STEP 7 TIA Portal configurable/integrated as of version | V13 SP1 |
| • STEP 7 configurable/integrated as of version | V5.5 SP4 and higher |
| • PROFIBUS as of GSD version/GSD revision | GSD Revision 5 |
| • PROFINET as of GSD version/GSD revision | V2.3 |

| Article number | 6ES7134-6PA20-0BD0 |
|---|---|
| **Operating mode** | |
| • cyclic measurement | Yes |
| • acyclic measurement | Yes |
| • Acyclic measured value access | Yes |
| • Fixed measured value sets | Yes |
| • Freely definable measured value sets | Yes |
| **Configuration control** | |
| via dataset | Yes |
| **CiR – Configuration in RUN** | |
| Reparameterization possible in RUN | Yes |
| Calibration possible in RUN | Yes |
| **Installation type/mounting** | |
| Mounting position | Any |
| **Supply voltage** | |
| Design of the power supply | Supply via voltage measurement channel L1 |
| Type of supply voltage | AC 100 - 277 V |
| permissible range, lower limit (AC) | 90 V |
| permissible range, upper limit (AC) | 293 V |
| **Line frequency** | |
| • permissible range, lower limit | 47 Hz |
| • permissible range, upper limit | 63 Hz |
| **Power loss** | |
| Power loss, typ. | 0.6 W |
| **Address area** | |
| **Address space per module** | |
| • Address space per module, max. | 268 byte; 256 byte input / 12 byte output |
| **Hardware configuration** | |
| Automatic encoding | |
| • Mechanical coding element | Yes |
| **Time of day** | |
| **Operating hours counter** | |
| • present | Yes |
| **Analog inputs** | |
| Cycle time (all channels), typ. | 50 ms; Time for consistent update of all measured and calculated values (cyclic und acyclic data) |

| Article number | 6ES7134-6PA20-0BD0 |
|---|---|
| **Interrupts/diagnostics/status information** | |
| **Alarms** | |
| • Diagnostic alarm | Yes |
| • Limit value alarm | Yes |
| • Hardware interrupt | Yes; Monitoring of up to 16 freely selectable process values (exceeding or undershooting of value) |
| **Diagnostics indication LED** | |
| • Monitoring of the supply voltage (PWR-LED) | Yes |
| • Channel status display | Yes; Green LED |
| • for channel diagnostics | Yes; red Fn LED |
| • for module diagnostics | Yes; green/red DIAG LED |
| **Integrated Functions** | |
| **Measuring functions** | |
| • Measuring procedure for voltage measurement | TRMS |
| • Measuring procedure for current measurement | TRMS |
| • Type of measured value acquisition | seamless |
| • Curve shape of voltage | Sinusoidal or distorted |
| • Buffering of measured variables | Yes |
| • Parameter length | 74 byte |
| • Bandwidth of measured value acquisition | 2 kHz; Harmonics: 39 / 50 Hz, 32 / 60 Hz |
| **Operating mode for measured value acquisition** | |
| – automatic detection of line frequency | No; Parameterizable |
| **Measuring range** | |
| – Frequency measurement, min. | 45 Hz |
| – Frequency measurement, max. | 65 Hz |

| Article number | 6ES7134-6PA20-0BD0 |
|---|---|
| **Measuring inputs for voltage** | |
| – Measurable line voltage between phase and neutral conductor | 277 V |
| – Measurable line voltage between the line conductors | 480 V |
| – Measurable line voltage between phase and neutral conductor, min. | 90 V |
| – Measurable line voltage between phase and neutral conductor, max. | 293 V |
| – Measurable line voltage between the line conductors, min. | 155 V |
| – Measurable line voltage between the line conductors, max. | 508 V |
| – Measurement category for voltage measurement in accordance with IEC 61010-2-030 | CAT II; CAT III in case of guaranteed protection level of 1.5 kV |
| – Internal resistance line conductor and neutral conductor | 3.4 MΩ |
| – Power consumption per phase | 20 mW |
| – Impulse voltage resistance 1,2/50µs | 1 kV |
| **Measuring inputs for current** | |
| – measurable relative current (AC), min. | 1 %; Relative to the secondary rated current 5 A |
| – measurable relative current (AC), max. | 100 %; Relative to the secondary rated current 5 A |
| – Continuous current with AC, maximum permissible | 5 A |
| – Apparent power consumption per phase for measuring range 5 A | 0.6 V·A |
| – Rated value short-time withstand current restricted to 1 s | 100 A |
| – Input resistance measuring range 0 to 5 A | 25 mΩ; At the terminal |
| – Zero point suppression | Parameterizable: 2 ... 250 mA, default 50 mA |
| – Surge strength | 10 A; for 1 minute |

| Article number | 6ES7134-6PA20-0BD0 |
|---|---|
| **Accuracy class according to IEC 61557-12** | |
| – Measured variable voltage | 0,2 |
| – Measured variable current | 0,2 |
| – Measured variable apparent power | 0.5 |
| – Measured variable active power | 0.5 |
| – Measured variable reactive power | 1 |
| – Measured variable power factor | 0.5 |
| – Measured variable active energy | 0.5 |
| – Measured variable reactive energy | 1 |
| – Measured variable neutral current | 0.5; calculated |
| – Measured variable phase angle | ±1 °; not covered by IEC 61557-12 |
| – Measured variable frequency | 0.05 |
| **Potential separation** | |
| **Potential separation channels** | |
| • between the channels and backplane bus | Yes; 3 700V AC (type test) CAT III |
| **Isolation** | |
| Isolation tested with | 2 300V AC for 1 min. (type test) |
| **Ambient conditions** | |
| **Ambient temperature during operation** | |
| • horizontal installation, min. | 0 °C |
| • horizontal installation, max. | 60 °C |
| • vertical installation, min. | 0 °C |
| • vertical installation, max. | 50 °C |
| **Dimensions** | |
| Width | 20 mm |
| Height | 73 mm |
| Depth | 58 mm |
| **Weights** | |
| Weight (without packaging) | 45 g |
| **Data for selecting a current transformer** | |
| • Burden power current transformer x/1A, min. | As a function of cable length and cross section, see device manual |
| • Burden power current transformer x/5A, min. | As a function of cable length and cross section, see device manual |

## ATEX approval

In accordance with EN 60079-15 (Electrical apparatus for potentially explosive atmospheres; Type of protection "n") and EN 60079-0 (Electrical apparatus for potentially explosive gas atmospheres - Part 0: General Requirements)

II 3 G Ex nA IIC Tx Gc
DEKRA 12ATEX0038X

## Dimension drawing

See ET 200SP BaseUnits (http://support.automation.siemens.com/WW/view/en/59753521) manual

# Parameter data records

# A

## A.1 Configuration via parameter data records

The parameter data records of the module have an identical structure, regardless of whether you configure the module with PROFIBUS DP or PROFINET IO.

### Parameter assignment in the user program

You can reassign the module parameters in RUN mode, for example change the diagnostics behavior, define new limits or configure a modified user data mapping.

### Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module via the respective data record. The parameters set in STEP 7 do not change in the CPU, which means the parameters set in STEP 7 are still valid after a restart.

If you reconfigure a module (so that the user data size changes) and diagnostics are pending prior to the reconfiguration, these diagnostics are not signaled as "outgoing".

### STATUS output parameter

If errors occur during the transfer of parameters with the WRREC instruction, the module continues operation with the previous parameter assignment. However, a corresponding error code is written to the STATUS output parameter.

The description of the WRREC instruction and the error codes is available in the STEP 7 online help.

# A.2 Structure of the parameter data record 128 for the entire module

## Structure of data record 128

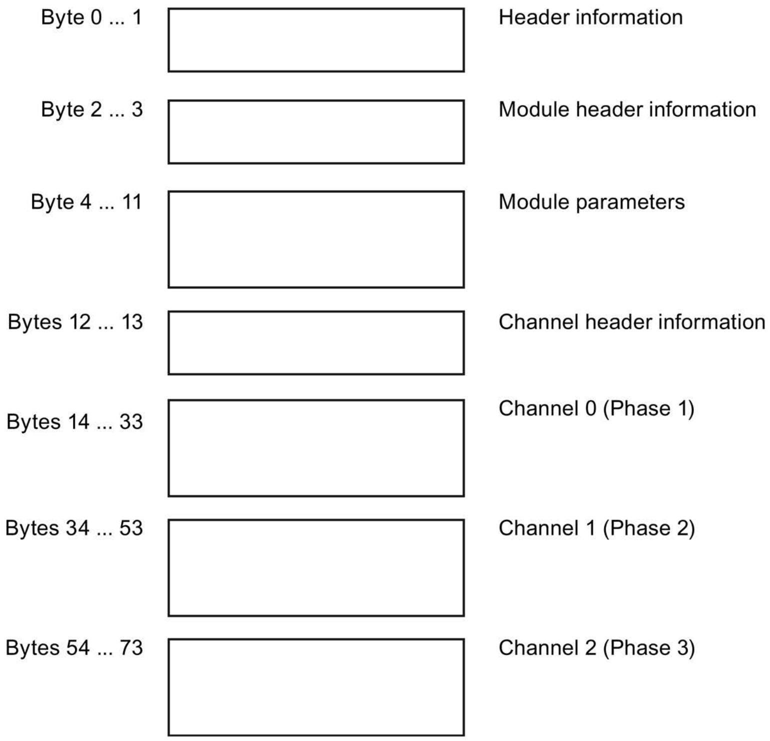


Figure A-1 Parameter data record 128

## Header information

The figure below shows the structure of the header information.

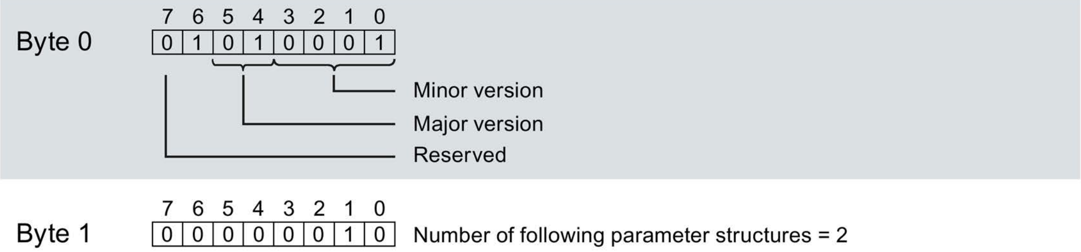


Figure A-2 Header information

## Module header information

The figure below shows the structure of the header information for a module.

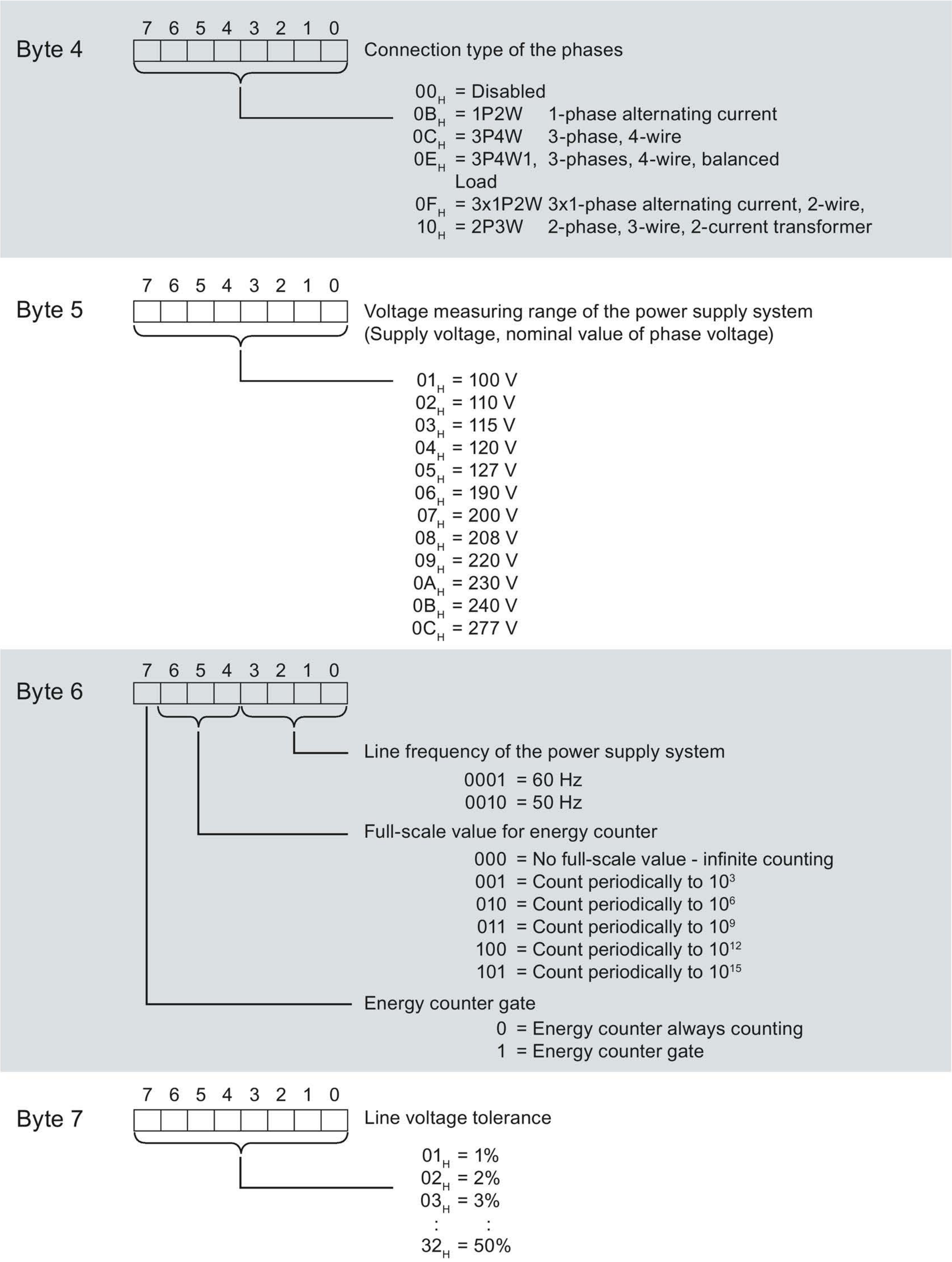
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| Byte 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | Number of the following module parameter blocks = 1 |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| Byte 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | Length of the following module parameter block = 8 |

Figure A-3 Module header information

## Module parameter block

The figure below shows the structure of the module parameter block.

Enable a parameter by setting the corresponding bit to "1".



Byte 4: Connection type of the phases

$00_H$ = Disabled
$0B_H$ = 1P2W 1-phase alternating current
$0C_H$ = 3P4W 3-phase, 4-wire
$0E_H$ = 3P4W1, 3-phases, 4-wire, balanced Load
$0F_H$ = 3x1P2W 3x1-phase alternating current, 2-wire,
$10_H$ = 2P3W 2-phase, 3-wire, 2-current transformer

Byte 5: Voltage measuring range of the power supply system (Supply voltage, nominal value of phase voltage)

$01_H$ = 100 V
$02_H$ = 110 V
$03_H$ = 115 V
$04_H$ = 120 V
$05_H$ = 127 V
$06_H$ = 190 V
$07_H$ = 200 V
$08_H$ = 208 V
$09_H$ = 220 V
$0A_H$ = 230 V
$0B_H$ = 240 V
$0C_H$ = 277 V

Byte 6:

Line frequency of the power supply system

0001 = 60 Hz
0010 = 50 Hz

Full-scale value for energy counter

000 = No full-scale value - infinite counting
001 = Count periodically to $10^3$
010 = Count periodically to $10^6$
011 = Count periodically to $10^9$
100 = Count periodically to $10^{12}$
101 = Count periodically to $10^{15}$

Energy counter gate

0 = Energy counter always counting
1 = Energy counter gate

Byte 7: Line voltage tolerance

$01_H$ = 1%
$02_H$ = 2%
$03_H$ = 3%
: :
$32_H$ = 50%

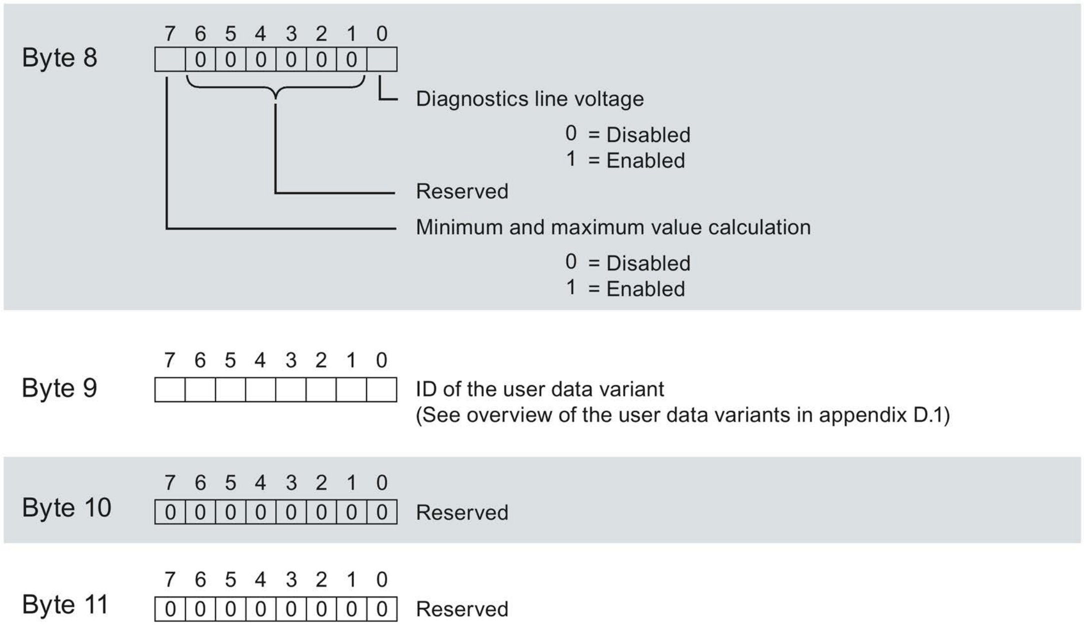


Figure A-4 Module parameter block

You can find the user data variant in the section Overview of the user data variants (Page 155).

## Channel header information

The following figure shows the structure of the header information for a channel.

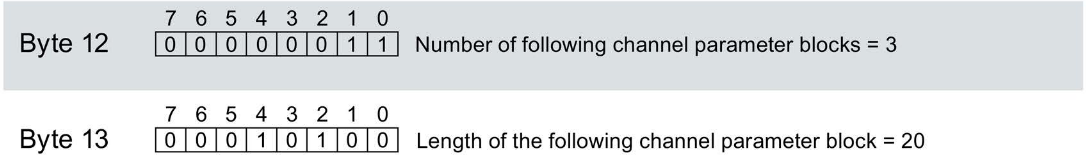
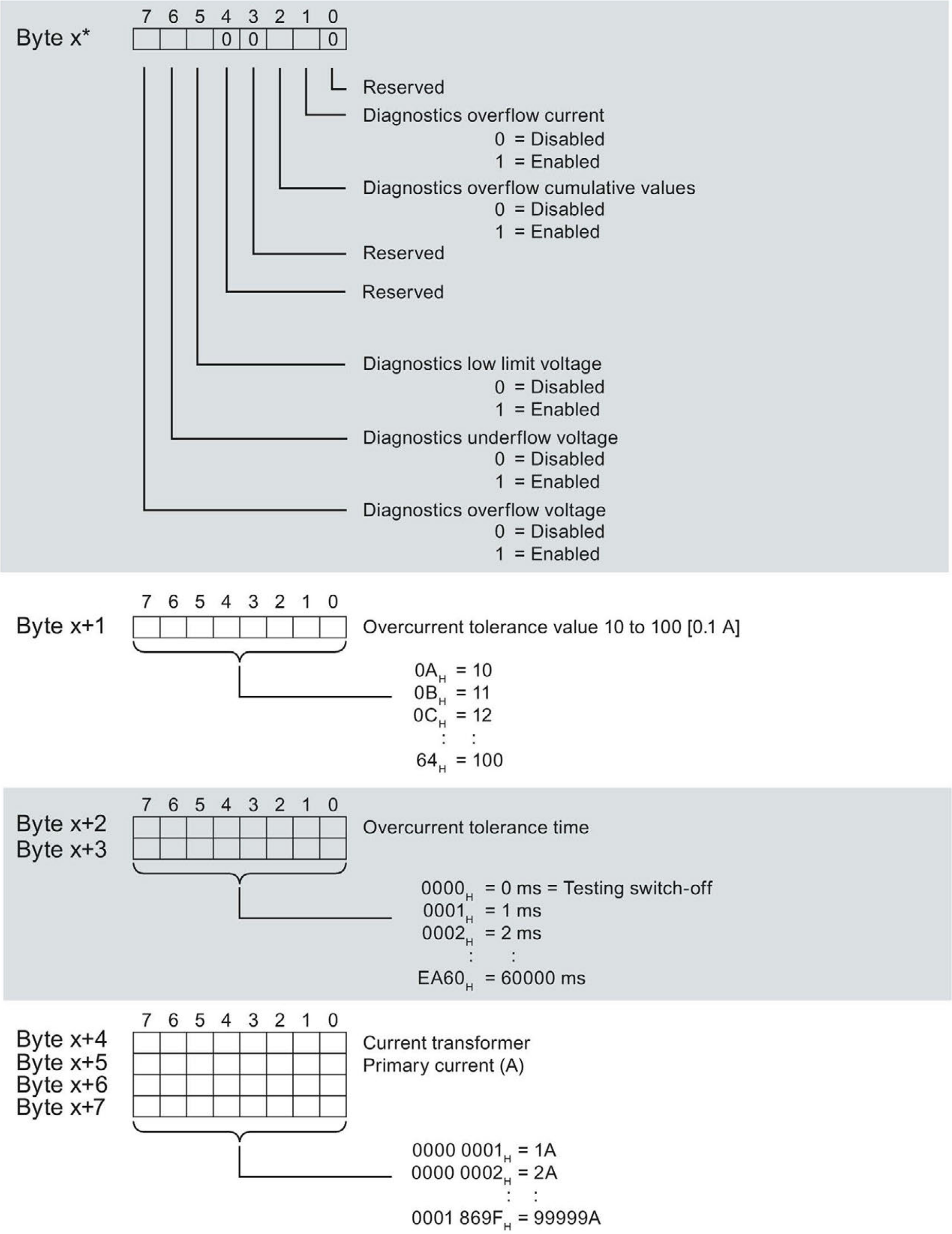


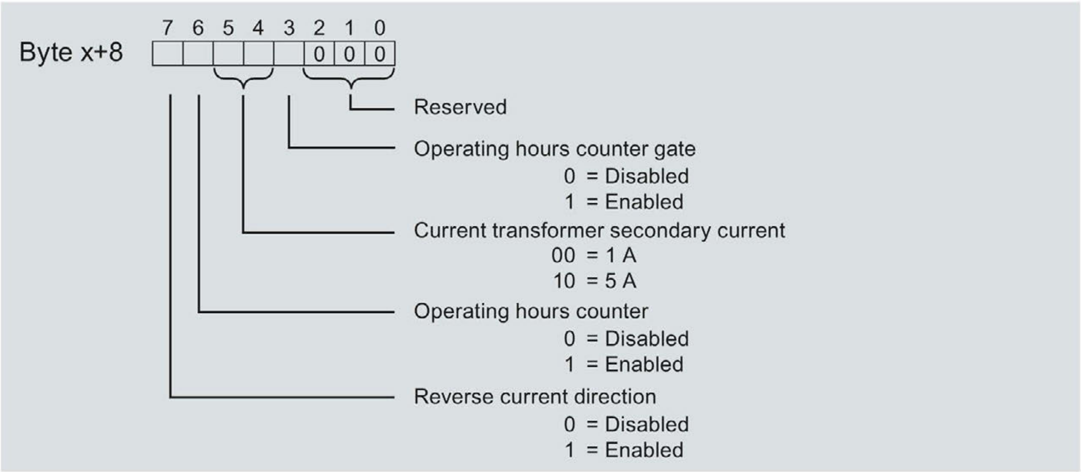
Figure A-5 Channel header information

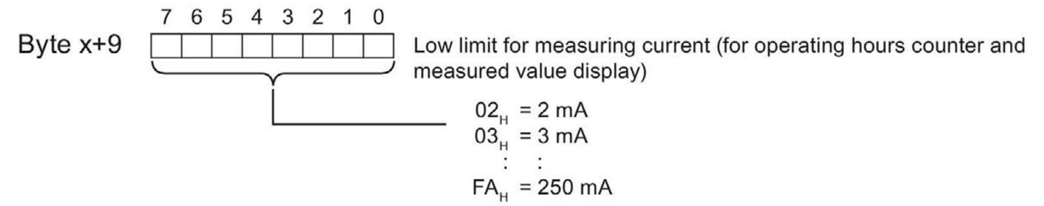
## Channel parameter block

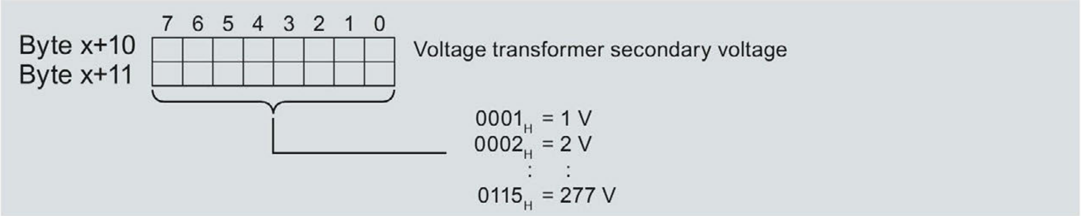
The figure below shows the structure of the channel parameter block.

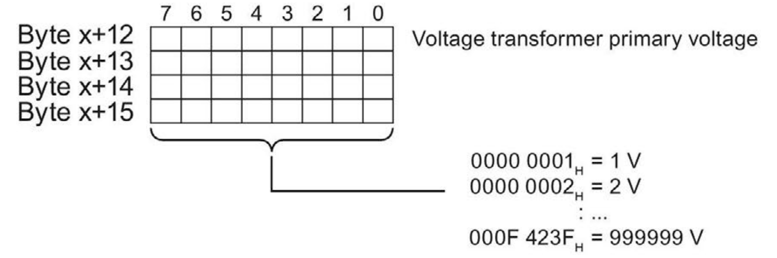
Enable a parameter by setting the corresponding bit to "1".




7 6 5 4 3 2 1 0
Byte x+8
0 0 0
Reserved
Operating hours counter gate
0 = Disabled
1 = Enabled
Current transformer secondary current
00 = 1 A
10 = 5 A
Operating hours counter
0 = Disabled
1 = Enabled
Reverse current direction
0 = Disabled
1 = Enabled


7 6 5 4 3 2 1 0
Byte x+9
Low limit for measuring current (for operating hours counter and measured value display)
02H = 2 mA
03H = 3 mA
: :
FAH = 250 mA


7 6 5 4 3 2 1 0
Byte x+10
Byte x+11
Voltage transformer secondary voltage
0001H = 1 V
0002H = 2 V
: :
0115H = 277 V


7 6 5 4 3 2 1 0
Byte x+12
Byte x+13
Byte x+14
Byte x+15
Voltage transformer primary voltage
0000 0001H = 1 V
0000 0002H = 2 V
: ...
000F 423FH = 999999 V

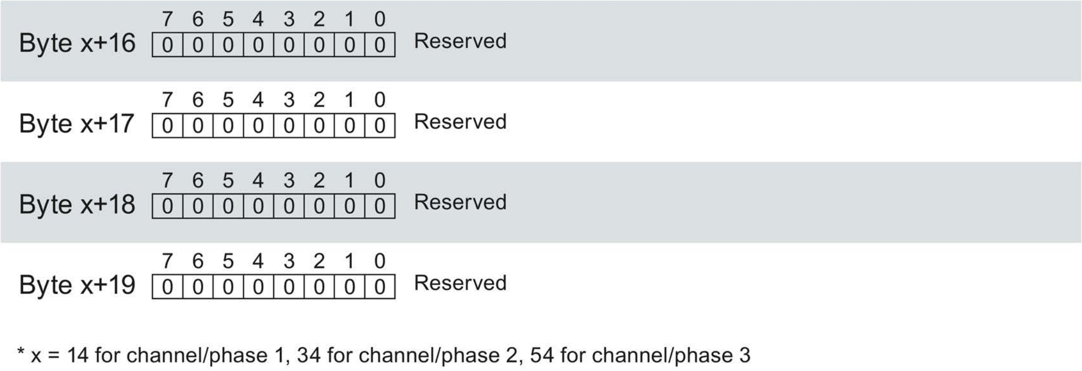


Figure A-6 Channel parameter block

## Error while transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module apply the values from the data record.

The WRREC instruction for writing data records returns corresponding error codes when errors occur in the STATUS parameter.

The following table shows the module-specific error codes and their meaning for the parameter data record 128.

| Error code in STATUS parameter (hexadecimal) | | | | Meaning | Solution |
|---|---|---|---|---|---|
| Byte 0 | Byte 1 | Byte 2 | Byte 3 | | |
| DF | 80 | B0 | 00 | Number of the data record unknown | Enter a valid number for the data record. |
| DF | 80 | B1 | 00 | Length of the data record incorrect | Enter a valid value for the data record length. |
| DF | 80 | B2 | 00 | Slot invalid or cannot be accessed. | Check the station whether the module is plugged or drawn.<br>Check the assigned values for the parameters of the WRREC instruction |
| DF | 80 | E0 | 01 | Incorrect version | Check Byte 0. Enter valid values. |
| DF | 80 | E0 | 02 | Error in the header information | Check Bytes 1 and 2. Correct the length and number of the parameter blocks. |
| DF | 80 | E1 | 01 | Reserved bits are not 0. | Check Byte 10, 11, 14, 22, 30...34, 42, 50...54, 70...74 and set the reserved bits back to 0. |
| DF | 80 | E1 | 02 | Reserved bits are not 0. | Check Byte 8 and set the reserved bits back to 0. |
| DF | 80 | E1 | 05 | Measuring range for voltage invalid. | Check Byte 5. Permitted values: $01_H$ to $0C_H$ |
| DF | 80 | E1 | 20 | Connection type invalid. | Check Byte 4. Permitted values: $00_H$, $0B_H$ ... $01_H$ |

| Error code in STATUS parameter (hexadecimal) | | | | Meaning | Solution |
|---|---|---|---|---|---|
| **Byte 0** | **Byte 1** | **Byte 2** | **Byte 3** | | |
| DF | 80 | E1 | 21 | Parameter for user data variant in DS 128 not possible or input data configuration not large enough. | Check Byte 9. Select a different user data variant in DS 128 or change the configuration. |
| DF | 80 | E1 | 22 | Parameter for user data variant is invalid. | Check Byte 9. Select a valid code for the user data variant. |
| DF | 80 | E1 | 23 | Parameter for frequency is invalid. | Check Byte 6. Enter valid values. |
| DF | 80 | E1 | 24 | Parameter for tolerance line voltage is invalid. | Check Byte 7. Enter valid values. |
| DF | 80 | E1 | 25 | Parameter for current transformer secondary is invalid. | Check Bit 4...5 in Byte 22, 42...62. Enter valid values. |
| DF | 80 | E1 | 29 | Parameter for tolerance value overcurrent invalid. | Check Byte 15, 35...55. Enter valid values. |
| DF | 80 | E1 | 2A | Parameter for tolerance time overcurrent invalid. | Check Byte 16...17, 36...37, 56...57. Enter valid values. |
| DF | 80 | E1 | 2B | Parameter for low limit measuring current invalid | Check Byte 23, 43...63. Enter valid values. |
| DF | 80 | E1 | 2C | Parameter for current transformer primary current is invalid. | Check Byte 18...21, 38...41, 48...61. Enter valid values. |
| DF | 80 | E1 | 2D | Parameter for voltage converter primary voltage invalid. | Check Byte 26...29, 46...49, 66...69. Enter valid values. |
| DF | 80 | E1 | 2E | Parameter for voltage converter secondary voltage invalid. | Check Byte 24...25, 44...45, 64...65. Enter valid values. |
| DF | 80 | E1 | 2F | Parameter for full-scale value for energy counters invalid. | Check Bit 4...6 in Byte 6. Enter valid values. |
| DF | 80 | E1 | 30 | Invalid data record number. | Check the data record number. Enter a valid data record number. |
| DF | 80 | E1 | 3E | Only for connection type 3P4W1.<br>Parameters for the different phases are not identical. | Check Bytes 14...33, 34...53, 54...73. Enter identical values at all three phases. |
| DF | 80 | E1 | 3F | Full-scale value for energy counter too small or transmission ratio of current and voltage too high. | Increase the full-scale value or reduce the transmission ratio of the current and voltage transformer. |

# A.3 Structure of the parameter data record 129 for limit monitoring

## Structure of data record 129

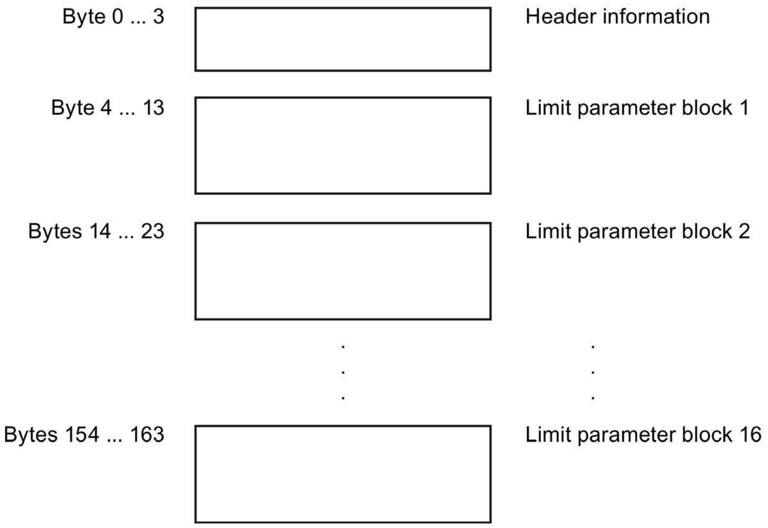


Figure A-7 Structure of data record 129

## Header information

The figure below shows the structure of the header information.

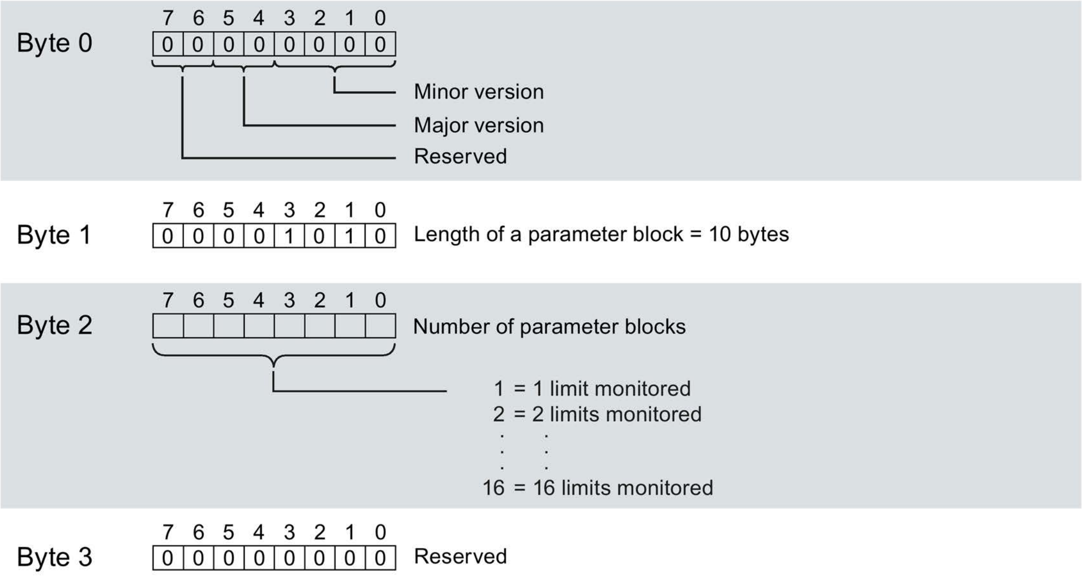
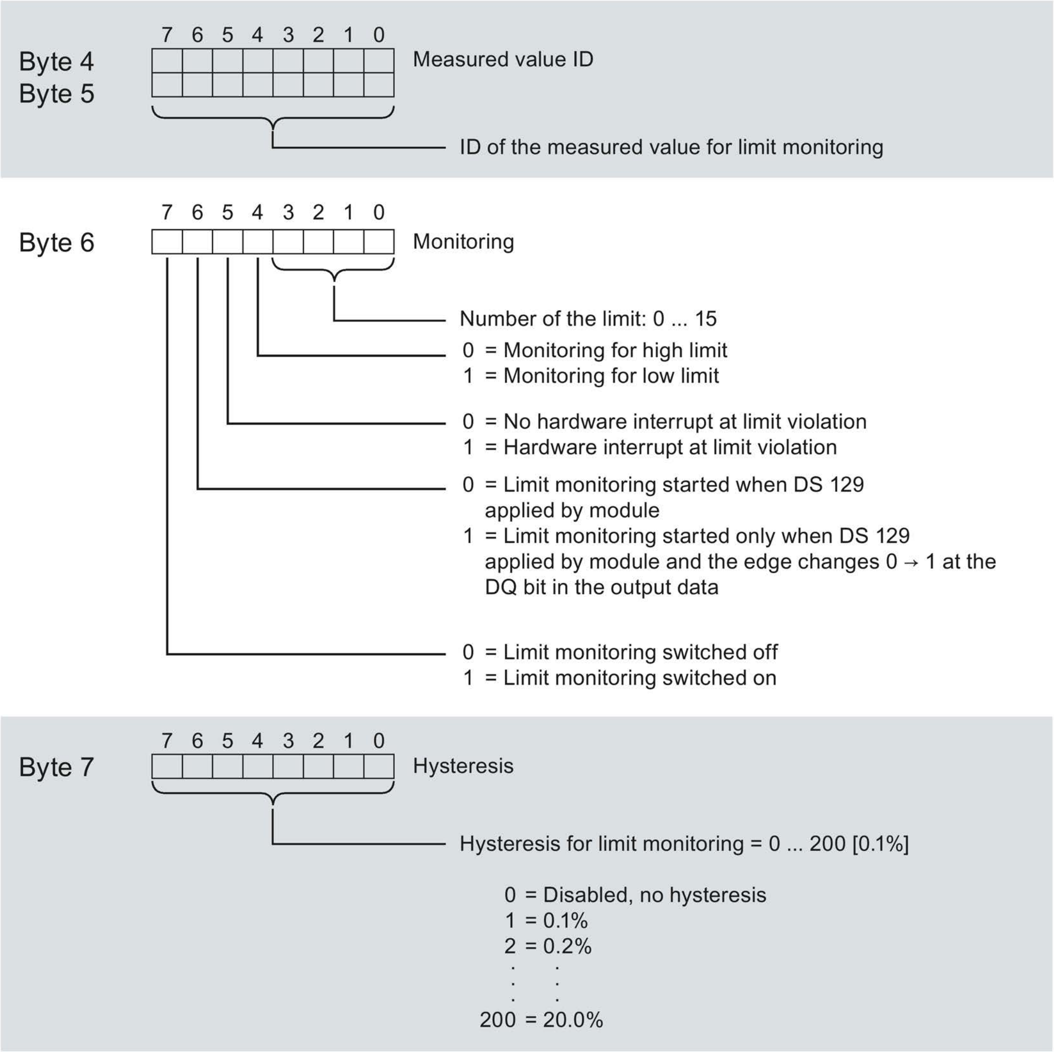


Figure A-8 Header information DS 129

## Limit parameter block

The following diagram shows the structure of the parameter blocks for limit monitoring.



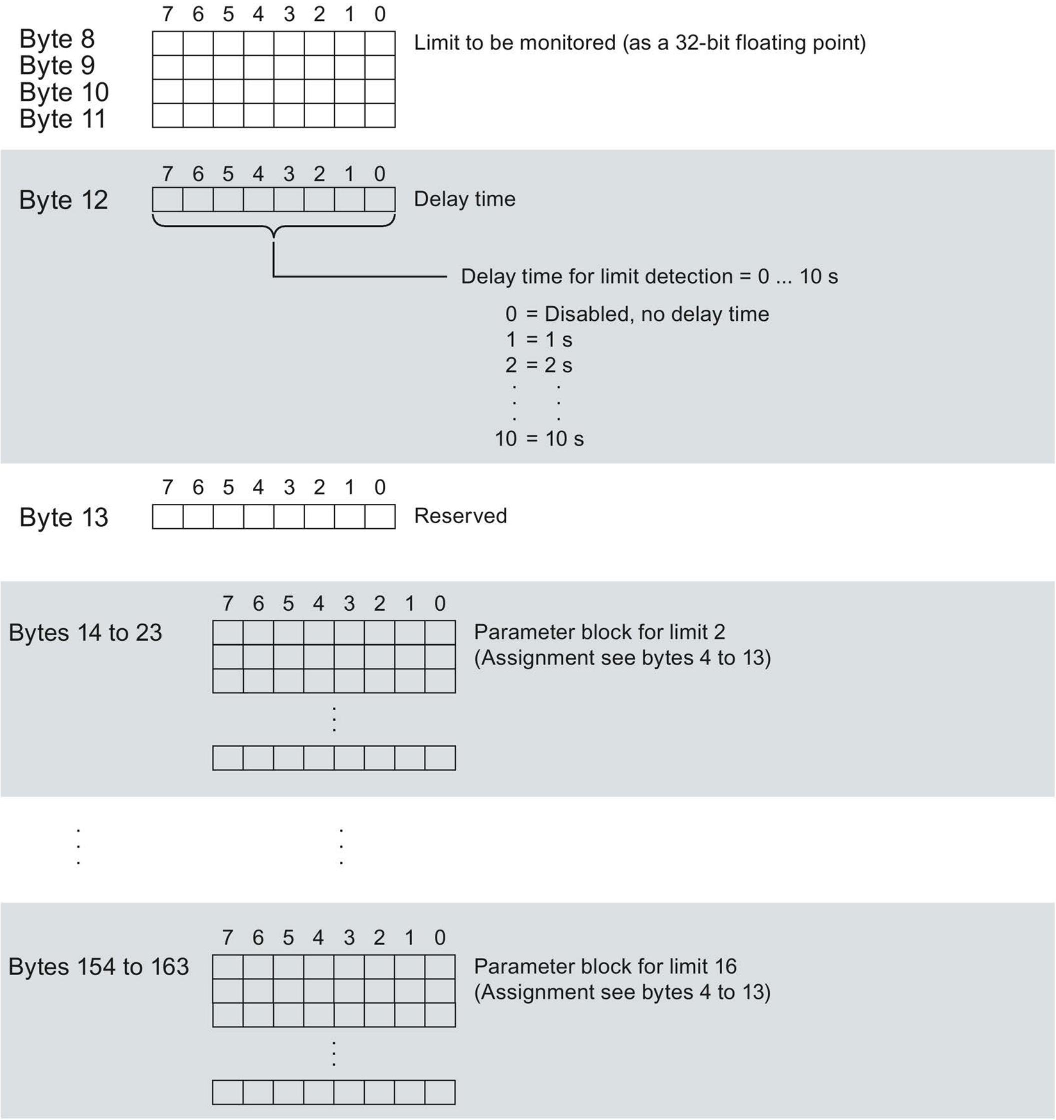


Figure A-9 Limit parameter data block

## Error while transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module apply the values from the data record.

The WRREC instruction for writing data records returns corresponding error codes when errors occur in the STATUS parameter.

The following table shows the module-specific error codes and their meaning for the parameter data record 129.

| **Error code in STATUS parameter (hexadecimal)** | | | | **Meaning** | **Solution** |
|---|---|---|---|---|---|
| **Byte 0** | **Byte 1** | **Byte 2** | **Byte 3** | | |
| DF | 80 | B0 | 00 | Number of the data record unknown | Enter a valid number for the data record. |
| DF | 80 | B1 | 00 | Length of the data record incorrect | Enter a valid value for the data record length. |
| DF | 80 | B2 | 00 | Slot invalid or cannot be accessed. | Check the station whether the module is plugged or drawn.<br>Check the assigned values for the parameters of the WRREC instruction |
| DF | 80 | E0 | 01 | Incorrect version | Check Byte 0. Enter valid values. |
| DF | 80 | E0 | 02 | Error in the header information | Check Bytes 1 and 2. Correct the length and number of the parameter blocks. |
| DF | 80 | E1 | 01 | Reserved bits are not 0. | Check Byte 10, 11, 14, 22, 30...34, 42, 50...54, 70...74 and set the reserved bits back to 0. |
| DF | 80 | E1 | 31 | Parameter for length of the parameter block invalid. | Check Byte 1. Length = 10 bytes |
| DF | 80 | E1 | 32 | Parameters for number of parameter blocks invalid. | Check Byte 2. Enter valid values. |
| DF | 80 | E1 | 33 | Parameter for measured value ID invalid. | Check Bytes 4 and 5. Enter valid values. |
| DF | 80 | E1 | 34 | Parameters for monitoring the limits | Check Bit 0...3 in Byte 6. Enter valid values. |
| DF | 80 | E1 | 35 | Number for limits in monitoring parameter assigned several times | Check Bit 0...3 in Byte 6. Do not use limit number several times. |
| DF | 80 | E1 | 36 | Parameters for hysteresis invalid | Check Byte 7. Enter valid values. |
| DF | 80 | E1 | 37 | Parameter for limit to be monitored invalid. | Check Byte 8...11. Enter valid values. |
| DF | 80 | E1 | 38 | Delay time in Hysteresis parameter invalid. | Check Byte 12. Enter valid values. |

# A.4 Structure of the parameter data record 130 for user-data mapping

## Structure of data record 130

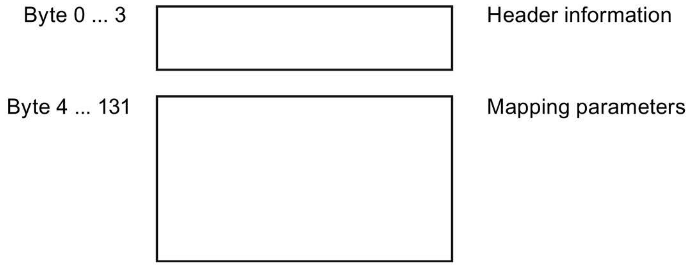


Figure A-10 Structure of data record 130

## Header information

The figure below shows the structure of the header information.

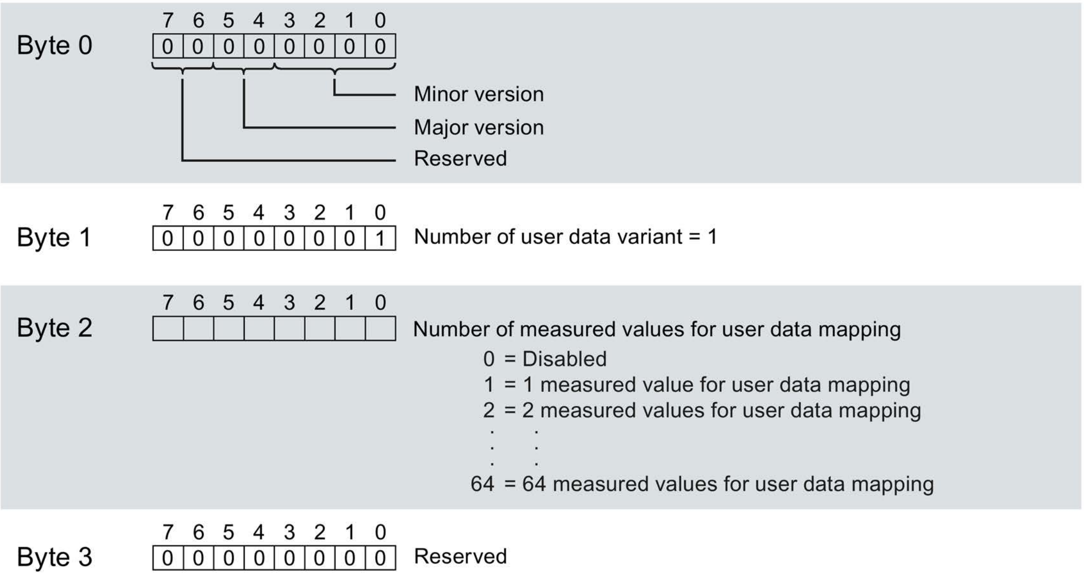


Figure A-11 Header information DS 130

## Parameter block for user data mapping

The following diagram shows the structure of the parameter blocks for user data mapping.

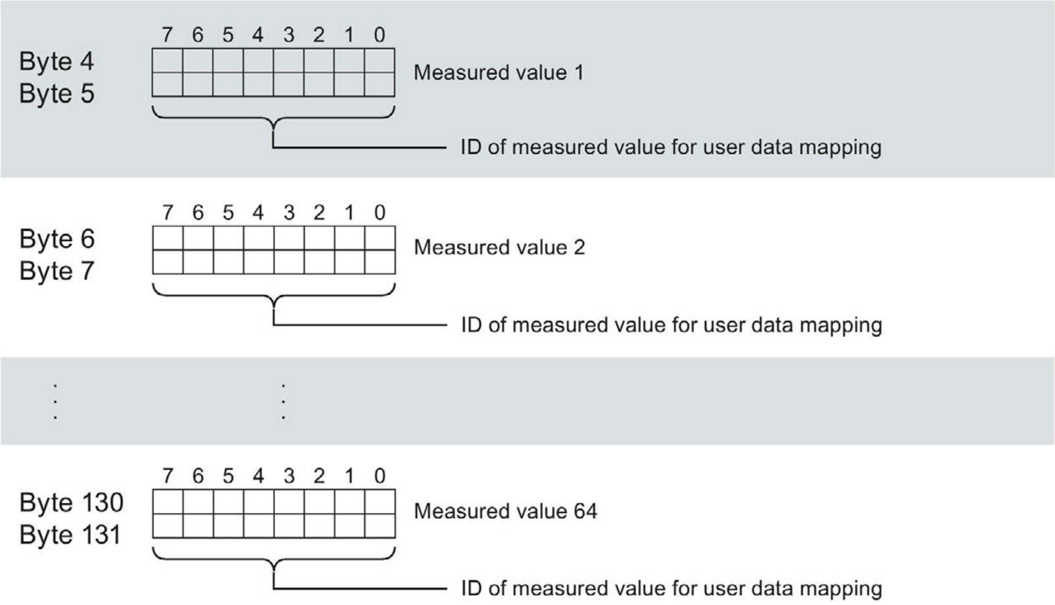


Figure A-12 Parameter block for user data mapping

## Error while transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module apply the values from the data record.

The WRREC instruction for writing data records returns corresponding error codes when errors occur in the STATUS parameter.

The following table shows the module-specific error codes and their meaning for the parameter data record 130.

| **Error code in STATUS parameter (hexadecimal)** | | | | **Meaning** | **Solution** |
|---|---|---|---|---|---|
| **Byte 0** | **Byte 1** | **Byte 2** | **Byte 3** | | |
| DF | 80 | B0 | 00 | Number of the data record unknown | Enter a valid number for the data record. |
| DF | 80 | B1 | 00 | Length of the data record incorrect | Enter a valid value for the data record length. |
| DF | 80 | B2 | 00 | Slot invalid or cannot be accessed. | Check the station whether the module is plugged or drawn.<br>Check the assigned values for the parameters of the WRREC instruction |
| DF | 80 | E0 | 01 | Incorrect version | Check Byte 0. Enter valid values. |
| DF | 80 | E0 | 02 | Error in the header information | Check Bytes 1 and 2. Correct the length and number of the parameter blocks. |

| Error code in STATUS parameter (hexadecimal) | | | | Meaning | Solution |
|---|---|---|---|---|---|
| **Byte 0** | **Byte 1** | **Byte 2** | **Byte 3** | | |
| DF | 80 | E1 | 01 | Reserved bits are not 0. | Check Byte 10, 11, 14, 22, 30...34, 42, 50...54, 70...74 and set the reserved bits back to 0. |
| DF | 80 | E1 | 21 | Parameter for user data variant in DS 128 not possible or input data configuration not large enough. | Check Byte 9. Select a different user data variant in DS 128 or change the configuration. |
| DF | 80 | E1 | 30 | Invalid data record number. | Check the data record number. Enter a valid data record number. |
| DF | 80 | E1 | 31 | Parameter for length of the parameter block invalid. | Check Byte 1. Length = 10 bytes |
| DF | 80 | E1 | 32 | Parameters for number of parameter blocks invalid. | Check Byte 2. Enter valid values. |
| DF | 80 | E1 | 33 | Parameter for measured value ID invalid. | Check Bytes 4 and 5. Enter valid values. |
| DF | 80 | E1 | 3B | Parameter for user data variant impermissible. | Check Byte 1. Number for user-specific user data variant has to be $01_H$. |

## Measured variables for user data mapping

The table below shows which measured variables are available for user data mapping.

| Measured value ID | Measured variables | Use for user data mapping |
|---|---|---|
| 1 | Voltage UL1-N | Yes |
| 2 | Voltage UL2-N | Yes |
| 3 | Voltage UL3-N | Yes |
| 4 | Voltage UL1- L2 | Yes |
| 5 | Voltage UL2- L3 | Yes |
| 6 | Voltage UL3- L1 | Yes |
| 7 | Current L1 | Yes |
| 8 | Current L2 | Yes |
| 9 | Current L3 | Yes |
| 10 | Apparent power L1 | Yes |
| 11 | Apparent power L2 | Yes |
| 12 | Apparent power L3 | Yes |
| 13 | Active power L1 | Yes |
| 14 | Active power L2 | Yes |
| 15 | Active power L3 | Yes |
| 16 | Reactive power L1 | Yes |
| 17 | Reactive power L2 | Yes |
| 18 | Reactive power L3 | Yes |
| 19 | Power factor L1 | Yes |
| 20 | Power factor L2 | Yes |
| 21 | Power factor L3 | Yes |
| 30 | Frequency | Yes |

| Measured value ID | Measured variables | Use for user data mapping |
|---|---|---|
| 34 | Total active power L1L2L3 | Yes |
| 35 | Total reactive power L1L2L3 | Yes |
| 36 | Total apparent power L1L2L3 | Yes |
| 37 | Total power factor L1L2L3 | Yes |
| 38 | Amplitude unbalance for voltage | Yes |
| 39 | Amplitude unbalance for current | Yes |
| 40 | Max. voltage UL1-N | Yes |
| 41 | Max. voltage UL2-N | Yes |
| 42 | Max. voltage UL3-N | Yes |
| 43 | Max. voltage UL1- L2 | Yes |
| 44 | Max. voltage UL2- L3 | Yes |
| 45 | Max. voltage UL3- L1 | Yes |
| 46 | Max. current L1 | Yes |
| 47 | Max. current L2 | Yes |
| 48 | Max. current L3 | Yes |
| 49 | Max. apparent power L1 | Yes |
| 50 | Max. apparent power L2 | Yes |
| 51 | Max. apparent power L3 | Yes |
| 52 | Max. active power L1 | Yes |
| 53 | Max. active power L2 | Yes |
| 54 | Max. active power L3 | Yes |
| 55 | Max. reactive power L1 | Yes |
| 56 | Max. reactive power L2 | Yes |
| 57 | Max. reactive power L3 | Yes |
| 58 | Max. power factor L1 | Yes |
| 59 | Max. power factor L2 | Yes |
| 60 | Max. power factor L3 | Yes |
| 61 | Max. frequency | Yes |
| 65 | Max. total active power | Yes |
| 66 | Max. total reactive power | Yes |
| 67 | Max. total apparent power | Yes |
| 68 | Max. total power factor | Yes |
| 70 | Min. voltage UL1-N | Yes |
| 71 | Min. voltage UL2-N | Yes |
| 72 | Min. voltage UL3-N | Yes |
| 73 | Min. voltage UL1- L2 | Yes |
| 74 | Min. voltage UL2- L3 | Yes |
| 75 | Min. voltage UL3- L1 | Yes |
| 76 | Min. current L1 | Yes |
| 77 | Min. current L2 | Yes |
| 78 | Min. current L3 | Yes |
| 79 | Min. apparent power L1 | Yes |
| 80 | Min. apparent power L2 | Yes |
| 81 | Min. apparent power L3 | Yes |
| 82 | Min. active power L1 | Yes |
| 83 | Min. active power L2 | Yes |

| Measured value ID | Measured variables | Use for user data mapping |
|---|---|---|
| 84 | Min. active power L3 | Yes |
| 85 | Min. reactive power L1 | Yes |
| 86 | Min. reactive power L2 | Yes |
| 87 | Min. reactive power L3 | Yes |
| 88 | Min. power factor L1 | Yes |
| 89 | Min. power factor L2 | Yes |
| 90 | Min. power factor L3 | Yes |
| 91 | Min. frequency | Yes |
| 95 | Min. total active power | Yes |
| 96 | Min. total reactive power | Yes |
| 97 | Min. total apparent power | Yes |
| 98 | Min. total power factor | Yes |
| 200 | Total active energy inflow L1L2L3 | Yes |
| 201 | Total active energy outflow L1L2L3 | Yes |
| 202 | Total reactive energy inflow L1L2L3 | Yes |
| 203 | Total reactive energy outflow L1L2L3 | Yes |
| 204 | Total apparent energy L1L2L3 | Yes |
| 205 | Total active energy L1L2L3 | Yes |
| 206 | Total reactive energy L1L2L3 | Yes |
| 210 | Total active energy inflow L1L2L3 | Yes |
| 211 | Total active energy outflow L1L2L3 | Yes |
| 212 | Total reactive energy inflow L1L2L3 | Yes |
| 213 | Total reactive energy outflow L1L2L3 | Yes |
| 214 | Total apparent energy L1L2L3 | Yes |
| 215 | Total active energy L1L2L3 | Yes |
| 216 | Total reactive energy L1L2L3 | Yes |
| 61140 | Overflow counter active energy inflow L1L2L3 | Yes |
| 61141 | Overflow counter active energy outflow L1L2L3 | Yes |
| 61142 | Overflow counter reactive energy inflow L1L2L3 | Yes |
| 61143 | Overflow counter reactive energy outflow L1L2L3 | Yes |
| 61144 | Overflow counter apparent energy L1L2L3 | Yes |
| 61149 | Neutral current | Yes |
| 61178 | Phase angle L1 | Yes |
| 61180 | Active energy inflow L1 | Yes |
| 61181 | Active energy outflow L1 | Yes |
| 61182 | Reactive energy inflow L1 | Yes |
| 61183 | Reactive energy outflow L1 | Yes |
| 61184 | Apparent energy L1 | Yes |
| 61185 | Active energy L1 | Yes |
| 61186 | Reactive energy L1 | Yes |
| 61190 | Overflow counter active energy inflow L1 | Yes |
| 61191 | Overflow counter active energy outflow L1 | Yes |
| 61192 | Overflow counter reactive energy inflow L1 | Yes |
| 61193 | Overflow counter reactive energy outflow L1 | Yes |
| 61194 | Overflow counter apparent energy L1 | Yes |
| 61198 | Phase angle L2 | Yes |
| 61200 | Active energy inflow L2 | Yes |
| 61201 | Active energy outflow L2 | Yes |
| 61202 | Reactive energy inflow L2 | Yes |
| 61203 | Reactive energy outflow L2 | Yes |
| 61204 | Apparent energy L2 | Yes |

| Measured value ID | Measured variables | Use for user data mapping |
|---|---|---|
| 61205 | Active energy L2 | Yes |
| 61206 | Reactive energy L2 | Yes |
| 61210 | Overflow counter active energy inflow L2 | Yes |
| 61211 | Overflow counter active energy outflow L2 | Yes |
| 61212 | Overflow counter reactive energy inflow L2 | Yes |
| 61213 | Overflow counter reactive energy outflow L2 | Yes |
| 61214 | Overflow counter apparent energy L2 | Yes |
| 61218 | Phase angle L3 | Yes |
| 61220 | Active energy inflow L3 | Yes |
| 61221 | Active energy outflow L3 | Yes |
| 61222 | Reactive energy inflow L3 | Yes |
| 61223 | Reactive energy outflow L3 | Yes |
| 61224 | Apparent energy L3 | Yes |
| 61225 | Active energy L3 | Yes |
| 61226 | Reactive energy L3 | Yes |
| 61230 | Overflow counter active energy inflow L3 | Yes |
| 61231 | Overflow counter active energy outflow L3 | Yes |
| 61232 | Overflow counter reactive energy inflow L3 | Yes |
| 61233 | Overflow counter reactive energy outflow L3 | Yes |
| 61234 | Overflow counter apparent energy L3 | Yes |
| 65500 | Qualifier L1 | Yes |
| 65501 | Qualifier L2 | Yes |
| 65502 | Qualifier L3 | Yes |
| 65503 | Qualifier L1L2L3 | Yes |
| 65504 | Total operating hours counter L1L2L3 | Yes |
| 65505 | Operating hours counter L1 | Yes |
| 65506 | Operating hours counter L2 | Yes |
| 65507 | Operating hours counter L3 | Yes |
| 65510 | Counter limit violation GW1 | Yes |
| 65511 | Counter limit violation GW2 | Yes |
| 65512 | Counter limit violation GW3 | Yes |
| 65513 | Counter limit violation GW4 | Yes |
| 65514 | Counter limit violation GW5 | Yes |
| 65515 | Counter limit violation GW6 | Yes |
| 65516 | Counter limit violation GW7 | Yes |
| 65517 | Counter limit violation GW8 | Yes |
| 65518 | Counter limit violation GW9 | Yes |
| 65519 | Counter limit violation GW10 | Yes |
| 65520 | Counter limit violation GW11 | Yes |
| 65521 | Counter limit violation GW12 | Yes |
| 65522 | Counter limit violation GW13 | Yes |
| 65523 | Counter limit violation GW14 | Yes |
| 65524 | Counter limit violation GW15 | Yes |
| 65525 | Counter limit violation GW16 | Yes |

# Measured variables

# B

## Measured variables for data records and user data

The following table provides an overview of all measured variables that are used in the data records and user data.

Note that the format and unit differ in the evaluation of records and user data.

Table B- 1 Measured variables for data records and user data

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 1 | Voltage UL1-N [1] | REAL | V | 0.0 ... 1000000.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2 | Voltage UL2-N [1] | REAL | V | 0.0 ... 1000000.0 | | ✓ | ✓ | ✓ | ✓ |
| 3 | Voltage UL3-N [1] | REAL | V | 0.0 ... 1000000.0 | | ✓ | | ✓ | ✓ |
| 4 | Voltage UL1-L2 [2] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 5 | Voltage UL2-L3 [2] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 6 | Voltage UL3-L1 [2] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 7 | Current L1 [1] | REAL | A | 0.0 … 100000.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 8 | Current L2 [1] | REAL | A | 0.0 … 100000.0 | | ✓ | ✓ | ✓ | ✓ |
| 9 | Current L3 [1] | REAL | A | 0.0 … 100000.0 | | ✓ | | ✓ | ✓ |
| 10 | Apparent power L1 [3] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 11 | Apparent power L2 [3] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 12 | Apparent power L3 [3] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | | ✓ | ✓ |
| 13 | Active power L1 [3] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 14 | Active power L2 [3] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | | | |
| 15 | Active power L3 [3] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | | ✓ | ✓ |
| 16 | Reactive power L1 [3][10] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 17 | Reactive power L2 [3][10] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 18 | Reactive power L3 [3][10] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | | ✓ | ✓ |
| 19 | Power factor L1 [3] | REAL | - | 0.0 ... 1.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 20 | Power factor L2 [3] | REAL | - | 0.0 ... 1.0 | | ✓ | ✓ | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 21 | Power factor L3 [3] | REAL | - | 0.0 ... 1.0 | | ✓ | | ✓ | ✓ |
| 30 | Frequency [4] | REAL | Hz | 45.0 ... 65.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 34 | Total active power L1L2L3 [5] | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 35 | Total reactive power L1L2L3 [5, 11] | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 36 | Total apparent power L1L2L3 [5] | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 37 | Total power factor L1L2L3 [6, 7] | REAL | - | 0.0 ... 1.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 38 | Amplitude balance for voltage [2] | REAL | % | 0 ... 100 | | | | ✓ | ✓ |
| 39 | Amplitude symmetry for current [2] | REAL | % | 0 ... 200 | | | | ✓ | ✓ |
| 40 | Max. voltage UL1-N [6] | REAL | V | 0.0 ... 1000000.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 41 | Max. voltage UL2-N [6] | REAL | V | 0.0 ... 1000000.0 | | ✓ | ✓ | ✓ | ✓ |
| 42 | Max. voltage UL3-N [6] | REAL | V | 0.0 ... 1000000.0 | | ✓ | | ✓ | ✓ |
| 43 | Max. voltage UL1-UL2 [6] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 44 | Max. voltage UL2-UL3 [6] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 45 | Max. voltage UL3-UL1 [6] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 46 | Max. current L1 [6] | REAL | A | 0.0 ... 100000.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 47 | Max. current L2 [6] | REAL | A | 0.0 ... 100000.0 | | ✓ | ✓ | ✓ | ✓ |
| 48 | Max. current L3 [6] | REAL | A | 0.0 ... 100000.0 | | ✓ | | ✓ | ✓ |
| 49 | Max. apparent power L1 [6] | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 50 | Max. apparent power L2 [6] | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 51 | Max. apparent power L3 [6] | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | | ✓ | | ✓ | ✓ |
| 52 | Max. active power L1 [6] | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 53 | Max. active power L2 [6] | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 54 | Max. active power L3 [6] | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | | ✓ | | ✓ | ✓ |
| 55 | Max. reactive power L1 [6] | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 56 | Max. reactive power L2 [6] | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 57 | Max. reactive power L3 [6] | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | | ✓ | | ✓ | ✓ |
| 58 | Max. power factor L1 [6] | REAL | - | 0.0 ... 1.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 59 | Max. power factor L2 [6] | REAL | - | 0.0 ... 1.0 | | ✓ | ✓ | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 60 | Max. power factor L3 [6] | REAL | - | 0.0 ... 1.0 | | ✓ | | ✓ | ✓ |
| 61 | Max. frequency [6] | REAL | Hz | 45.0 ... 65.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65 | Max. sum of active power [6] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66 | Max. sum of reactive power [6] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 67 | Max. sum of apparent power [6] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 68 | Max. total power factor [6] | REAL | - | 0.0 ... 1.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 70 | Min. voltage UL1-N [6] | REAL | V | 0.0 ... 1000000.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 71 | Min. voltage UL2-N [6] | REAL | V | 0.0 ... 1000000.0 | | ✓ | ✓ | ✓ | ✓ |
| 72 | Min. voltage UL3-N [6] | REAL | V | 0.0 ... 1000000.0 | | ✓ | | ✓ | ✓ |
| 73 | Min. voltage UL1-UL2 [6] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 74 | Min. voltage UL2-UL3 [6] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 75 | Min. voltage UL3-UL1 [6] | REAL | V | 0.0 ... 1000000.0 | | | | ✓ | ✓ |
| 76 | Min. current L1 [6] | REAL | A | 0.0 ... 100000.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 77 | Min. current L2 [6] | REAL | A | 0.0 ... 100000.0 | | ✓ | ✓ | ✓ | ✓ |
| 78 | Min. current L3 [6] | REAL | A | 0.0 ... 100000.0 | | ✓ | | ✓ | ✓ |
| 79 | Min. apparent power L1 [6] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 80 | Min. apparent power L2 [6] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 81 | Min. apparent power L3 [6] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | | ✓ | ✓ |
| 82 | Min. active power L1 [6] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 83 | Min. active power L2 [6] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 84 | Min. active power L3 [6] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | | ✓ | ✓ |
| 85 | Min. reactive power L1 [6] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 86 | Min. reactive power L2 [6] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | ✓ | ✓ | ✓ |
| 87 | Min. reactive power L3 [6] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | | ✓ | | ✓ | ✓ |
| 88 | Min. power factor L1 [6] | REAL | - | 0.0 ... 1.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 89 | Min. power factor L2 [6] | REAL | - | 0.0 ... 1.0 | | ✓ | ✓ | ✓ | ✓ |
| 90 | Min. power factor L3 [6] | REAL | - | 0.0 ... 1.0 | | ✓ | | ✓ | ✓ |
| 91 | Min. frequency [6] | REAL | Hz | 45.0 ... 65.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 95 | Min. sum of active power [6] | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 96 | Min. sum of reactive power [6] | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 97 | Min. sum of apparent power [6] | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 98 | Min. total power factor [6] | REAL | - | 0.0 ... 1.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 200 | Total active energy inflow L1L2L3 [6] | REAL | Wh | 0.0 ... 3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 201 | Total active energy outflow L1L2L3 [6] | REAL | Wh | 0.0 ... 3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 202 | Total reactive energy inflow L1L2L3 [6] | REAL | varh | 0.0 ... 3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 203 | Total reactive energy outflow L1L2L3 [6] | REAL | varh | 0.0 ... 3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 204 | Total apparent energy L1L2L3 [6] | REAL | VAh | 0.0 ... 3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 205 | Total active energy L1L2L3 [6] | REAL | Wh | -3.4 x $10^{38}$ ... +3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 206 | Total reactive energy L1L2L3 [6] | REAL | varh | -3.4 x $10^{38}$ ... +3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 210 | Total active energy inflow L1L2L3 [6] | LREAL | Wh | 0.0 ... 1.8 x $10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 211 | Total active energy outflow L1L2L3 [6] | LREAL | Wh | 0.0 ... 1.8 x $10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 212 | Total reactive energy inflow L1L2L3 [6] | LREAL | varh | 0.0 ... 1.8 x $10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 213 | Total reactive energy outflow L1L2L3 [6] | LREAL | varh | 0.0 ... 1.8 x $10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 214 | Total apparent energy L1L2L3 [6] | LREAL | VAh | 0.0 ... 1.8 x $10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 215 | Total active energy L1L2L3 [6] | LREAL | Wh | -1.8 x $10^{308}$ ... +1.8 x $10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 216 | Total reactive energy L1L2L3 [6] | LREAL | varh | -1.8 x $10^{308}$ ... +1.8 x $10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 220 | Total active energy inflow L1L2L3 [6] | UDINT | Wh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 221 | Total active energy outflow L1L2L3 [6] | UDINT | varh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 222 | Total reactive energy inflow L1L2L3 [6] | UDINT | varh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 223 | Total reactive energy outflow L1L2L3 [6] | UDINT | VAh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 224 | Total apparent energy L1L2L3 [6] | UDINT | Wh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 225 | Total active energy L1L2L3 [6] | DINT | Wh | -2147483647 ... +2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 226 | Total reactive energy L1L2L3 [6] | DINT | varh | -2147483647 ... +2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61140 | Overflow counter active energy inflow L1L2L3 | uint16 | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61141 | Overflow counter active energy outflow L1L2L3 | uint16 | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61142 | Overflow counter reactive energy inflow L1L2L3 | uint16 | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61143 | Overflow counter reactive energy outflow L1L2L3 | uint16 | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61144 | Overflow counter apparent energy L1L2L3 | uint16 | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61149 | Neutral current [1] | REAL | A | 0.0 ... 100000.0 | | | | ✓ | |
| 61178 | Phase angle L1 [3] | REAL | ° | 0.0 ... 360.0 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61180 | Active energy inflow L1 [6] | LREAL | Wh | 0.0 ... $1.8 \times 10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61181 | Active energy outflow L1 [6] | LREAL | Wh | 0.0 ... $1.8 \times 10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61182 | Reactive energy inflow L1 [6] | LREAL | varh | 0.0 ... $1.8 \times 10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61183 | Reactive energy outflow L1 [6] | LREAL | varh | 0.0 ... $1.8 \times 10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61184 | Apparent energy L1 [6] | LREAL | VAh | 0.0 ... $1.8 \times 10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61185 | Active energy L1 [6] | LREAL | Wh | $-1.8 \times 10^{308}$ ... $+1.8 \times 10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61186 | Reactive energy L1 [6] | LREAL | varh | $-1.8 \times 10^{308}$ ... $+1.8 \times 10^{308}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61190 | Overflow counter active energy inflow L1 [6] | UINT | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61191 | Overflow counter active energy outflow L1 [6] | UINT | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61192 | Overflow counter reactive energy inflow L1 [6] | UINT | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61193 | Overflow counter reactive energy outflow L1 [6] | UINT | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61194 | Overflow counter apparent energy L1 [6] | UINT | - | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 61198 | Phase angle L2 [3] | REAL | ° | 0.0 ... 360.0 | | ✓ | ✓ | ✓ | ✓ |
| 61200 | Active energy inflow L2 [6] | LREAL | Wh | 0.0 ... $1.8 \times 10^{308}$ | | ✓ | ✓ | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 61201 | Active energy outflow L2 [6] | LREAL | Wh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | ✓ | ✓ | ✓ |
| 61202 | Reactive energy inflow L2 [6] | LREAL | varh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | ✓ | ✓ | ✓ |
| 61203 | Reactive energy outflow L2 [6] | LREAL | varh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | ✓ | ✓ | ✓ |
| 61204 | Apparent energy L2 [6] | LREAL | VAh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | ✓ | ✓ | ✓ |
| 61205 | Active energy L2 [6] | LREAL | Wh | -1.8 x $10^{308}$ ... +1.8 x $10^{308}$ | | ✓ | ✓ | ✓ | ✓ |
| 61206 | Reactive energy L2 [6] | LREAL | varh | -1.8 x $10^{308}$ ... +1.8 x $10^{308}$ | | ✓ | ✓ | ✓ | ✓ |
| 61210 | Overflow counter active energy inflow L2 [6] | UINT | - | 0 ... 65535 | | ✓ | ✓ | ✓ | ✓ |
| 61211 | Overflow counter active energy outflow L2 [6] | UINT | - | 0 ... 65535 | | ✓ | ✓ | ✓ | ✓ |
| 61212 | Overflow counter reactive energy inflow L2 [6] | UINT | - | 0 ... 65535 | | ✓ | ✓ | ✓ | ✓ |
| 61213 | Overflow counter reactive energy outflow L2 [6] | UINT | - | 0 ... 65535 | | ✓ | ✓ | ✓ | ✓ |
| 61214 | Overflow counter apparent energy L2 [6] | UINT | - | 0 ... 65535 | | ✓ | ✓ | ✓ | ✓ |
| 61218 | Phase angle L3 [3] | REAL | | 0.0 ... 360.0 | | ✓ | | ✓ | ✓ |
| 61220 | Active energy inflow L3 [6] | LREAL | Wh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | | ✓ | ✓ |
| 61221 | Active energy outflow L3 [6] | LREAL | Wh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | | ✓ | ✓ |
| 61222 | Reactive energy inflow L3 [6] | LREAL | varh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | | ✓ | ✓ |
| 61223 | Reactive energy outflow L3 [6] | LREAL | varh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | | ✓ | ✓ |
| 61224 | Apparent energy L3 [6] | LREAL | VAh | 0.0 ... 1.8 x $10^{308}$ | | ✓ | | ✓ | ✓ |
| 61225 | Active energy L3 [6] | LREAL | Wh | -1.8 x $10^{308}$ ... +1.8 x $10^{308}$ | | ✓ | | ✓ | ✓ |
| 61226 | Reactive energy L3 [6] | LREAL | varh | -1.8 x $10^{308}$ ... +1.8 x $10^{308}$ | | ✓ | | ✓ | ✓ |
| 61230 | Overflow counter active energy inflow L3 [6] | UINT | - | 0 ... 65535 | | ✓ | | ✓ | ✓ |
| 61231 | Overflow counter active energy outflow L3 [6] | UINT | - | 0 ... 65535 | | ✓ | | ✓ | ✓ |
| 61232 | Overflow counter reactive energy inflow L3 [6] | UINT | - | 0 ... 65535 | | ✓ | | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 61233 | Overflow counter reactive energy outflow L3 [6] | UINT | - | 0 ... 65535 | | ✓ | | ✓ | ✓ |
| 61234 | Overflow counter apparent energy L3 [6] | UINT | - | 0 ... 65535 | | ✓ | | ✓ | ✓ |
| 62110 | Active energy inflow L1 [6] | DINT | Wh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 62111 | Active energy outflow L1 [6] | UDINT | Wh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 62112 | Reactive energy inflow L1 [6] | UDINT | Varh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 62113 | Reactive energy outflow L1 [6] | UDINT | Varh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 62114 | Apparent energy L1 [6] | UDINT | Wh | 0 ... 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 62115 | Active energy L1 total (inflow - outflow) [6] | DINT | Wh | -2147483647 ... + 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 62116 | Reactive energy L1 total (inflow - outflow) [6] | DINT | Varh | -2147483647 ... + 2147483647 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 62210 | Active energy inflow L2 [6] | UDINT | Wh | 0 ... 2147483647 | | ✓ | ✓ | ✓ | ✓ |
| 62211 | Active energy outflow L2 [6] | UDINT | Wh | 0 ... 2147483647 | | ✓ | ✓ | ✓ | ✓ |
| 62212 | Reactive energy inflow L2 [6] | UDINT | Varh | 0 ... 2147483647 | | ✓ | ✓ | ✓ | ✓ |
| 62213 | Reactive energy outflow L2 [6] | UDINT | Varh | 0 ... 2147483647 | | ✓ | ✓ | ✓ | ✓ |
| 62214 | Apparent energy L2 [6] | UDINT | VAh | 0 ... 2147483647 | | ✓ | ✓ | ✓ | ✓ |
| 62215 | Active energy L2 total (inflow - outflow) [6] | DINT | Wh | -2147483647 ... + 2147483647 | | ✓ | ✓ | ✓ | ✓ |
| 62216 | Reactive energy L2 total (inflow - outflow) [6] | DINT | Varh | -2147483647 ... + 2147483647 | | ✓ | ✓ | ✓ | ✓ |
| 62310 | Active energy inflow L3 [6] | UDINT | Wh | 0 ... 2147483647 | | ✓ | | ✓ | ✓ |
| 62311 | Active energy outflow L3 [6] | UDINT | Wh | 0 ... 2147483647 | | ✓ | | ✓ | ✓ |
| 62312 | Reactive energy inflow L3 [6] | UDINT | Varh | 0 ... 2147483647 | | ✓ | | ✓ | ✓ |
| 62313 | Reactive energy outflow L3 [6] | UDINT | Varh | 0 ... 2147483647 | | ✓ | | ✓ | ✓ |
| 62314 | Apparent energy L3 [6] | UDINT | VAh | 0 ... 2147483647 | | ✓ | | ✓ | ✓ |
| 62315 | Active energy L3 total (inflow - outflow) [6] | DINT | Wh | -2147483647 ... + 2147483647 | | ✓ | | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 62316 | Reactive energy L3 total (inflow - outflow) [6] | DINT | Varh | -2147483647 ... + 2147483647 | | ✓ | | ✓ | ✓ |
| 65500 | Qualifier L1 | WORD | Bit field | 0b 00 00 00 00<br>0b qq 00 00 xx | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65501 | Qualifier L2 | WORD | Bit field | 0b 00 00 00 00<br>0b qq 00 xx 00 | | ✓ | ✓ | ✓ | ✓ |
| 65502 | Qualifier L3 | WORD | Bit field | 0b 00 00 00 00<br>0b qq xx 00 00 | | ✓ | | ✓ | ✓ |
| 65503 | Qualifier L1L2L3 | WORD | Bit field | 0b 00 00 00 00<br>0b qq xx xx xx | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65504 | Total operating hours counter L1L2L3 [5] [8] [9] | REAL | h | 0.0 ... 3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65505 | Operating hours counter L1 [5] | REAL | h | 0.0 ... 3.4 x $10^{38}$ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65506 | Operating hours counter L2 [5] | REAL | h | 0.0 ... 3.4 x $10^{38}$ | | ✓ | ✓ | ✓ | ✓ |
| 65507 | Operating hours counter L3 [5] | REAL | h | 0.0 ... 3.4 x $10^{38}$ | | ✓ | | ✓ | ✓ |
| 65508 | Status of energy counter overflows | WORD | Bit field | 0x xxxx xxxx | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65509 | Status of limits | WORD | Bit field | 0x xxxx xxxx | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65510 | Counter limit violation GW1 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65511 | Counter limit violation GW2 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65512 | Counter limit violation GW3 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65513 | Counter limit violation GW4 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65514 | Counter limit violation GW5 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65515 | Counter limit violation GW6 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65516 | Counter limit violation GW7 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65517 | Counter limit violation GW8 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65518 | Counter limit violation GW9 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65519 | Counter limit violation GW10 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65520 | Counter limit violation GW11 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 65521 | Counter limit violation GW12 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65522 | Counter limit violation GW13 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65523 | Counter limit violation GW14 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65524 | Counter limit violation GW15 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 65525 | Counter limit violation GW16 [5] | UDINT | | 0 ... 4294967295 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66001 | Voltage UL1-N [1] | UINT | 0.01 V | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66002 | Voltage UL2-N [1] | UINT | 0.01 V | 0 ... 65535 | | ✓ | ✓ | ✓ | ✓ |
| 66003 | Voltage UL3-N [1] | UINT | 0.01 V | 0 ... 65535 | | ✓ | | ✓ | ✓ |
| 66004 | Voltage UL1-L2 [2] | UINT | 0.01 V | 0 ... 65535 | | | | ✓ | ✓ |
| 66005 | Voltage UL2-L3 [2] | UINT | 0.01 V | 0 ... 65535 | | | | ✓ | ✓ |
| 66006 | Voltage UL3-L1 [2] | UINT | 0.01 V | 0 ... 65535 | | | | ✓ | ✓ |
| 66007 | Current L1 [1] | UINT | 1 mA | 0 ... 65535 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66008 | Current L2 [1] | UINT | 1 mA | 0 ... 65535 | | ✓ | ✓ | ✓ | ✓ |
| 66009 | Current L3 [1] | UINT | 1 mA | 0 ... 65535 | | ✓ | | ✓ | ✓ |
| 66010 | Apparent power L1 [3] | INT | 1 VA | -27648 ... 27648 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66011 | Apparent power L2 [3] | INT | 1 VA | -27648 ... 27648 | | ✓ | ✓ | ✓ | ✓ |
| 66012 | Apparent power L3 [3] | INT | 1 VA | -27648 ... 27648 | | ✓ | | ✓ | ✓ |
| 66013 | Active power L1 [3] | INT | 1 W | -27648 ... 27648 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66014 | Active power L2 [3] | INT | 1 W | -27648 ... 27648 | | ✓ | ✓ | ✓ | ✓ |
| 66015 | Active power L3 [3] | INT | 1 W | -27648 ... 27648 | | ✓ | | ✓ | ✓ |
| 66016 | Reactive power L1 [3] [10] | INT | 1 var | -27648 ... 27648 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66017 | Reactive power L2 [3] [10] | INT | 1 var | -27648 ... 27648 | | ✓ | ✓ | ✓ | ✓ |

| Measured value ID | Measured variables | Data type | Unit | Value range | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 66018 | Reactive power L3 [3] [10] | INT | 1 var | -27648 ... 27648 | | ✓ | | ✓ | ✓ |
| 66019 | Power factor L1 [3] | USINT | 0.01 | 0 ... 100 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66020 | Power factor L2 [3] | USINT | 0.01 | 0 ... 100 | | ✓ | ✓ | ✓ | ✓ |
| 66021 | Power factor L3 [3] | USINT | 0.01 | 0 ... 100 | | ✓ | | ✓ | ✓ |
| 66030 | Frequency [4] | USINT | 1 Hz | 45 ... 65 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66034 | Total active power L1L2L3 [5] | INT | 1 W | -27648 ... 27648 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66035 | Total reactive power L1L2L3 [5] [11] | INT | 1 var | -27648 ... 27648 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66036 | Total apparent power L1L2L3 [5] | INT | 1 W | -27648 ... 27648 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66037 | Total power factor L1L2L3 [6] | USINT | 0.01 | 0 ... 100 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66038 | Frequency [4] | UINT | 0.01 Hz | 4500 ... 6500 | ✓ | ✓ | ✓ | ✓ | ✓ |

[1] Effective value

[2] IEC 61557-12

[3] Arithmetical mean value over 200 ms as floating mean

[4] Arithmetical mean value over 10 s as floating mean

[5] Simple summation

[6] Calculation from the start/restart (inflow and outflow values are positive numbers)

[7] Determined from ratio of active and apparent power

[8] For mapping both states as UINT (high: Energy counter overflow, low limit)

[9] Corresponds to the maximum of the phase-specific operating hours counters

[10] Measured value includes fundamental and harmonics, arithmetic mean over 200 ms as floating mean

[11] Measured value includes fundamental and harmonics, simple summation

## Format

Table B- 2 Format and its length in bytes

| Format in STEP 7 (TIA Portal) | Format to IEEE | Length in bytes | Comment |
|---|---|---|---|
| BYTE | BYTE | 1 byte | Bit field with 8 bit |
| WORD | WORD | 2 bytes | Bit field with 16 bit |
| USINT | INT8 (unsigned) | 1 byte | Fixed-point number 8 bits without sign |
| INT | INT16 (signed) | 2 bytes | Fixed-point number 16 bits with sign |
| UINT | INT16 (unsigned) | 2 bytes | Fixed-point number 16 bits without sign |
| UDINT | INT32 (unsigned) | 4 bytes | Fixed-point number 32 bits without sign |
| DINT | INT32 (signed) | 4 bytes | Fixed-point number, 32 bits with sign |
| REAL | Float32 | 4 bytes | Floating-point number 32 bits with sign |
| LREAL | Float64 | 8 bytes | Floating-point number 64 bits with sign |

# Module versions

# C

## C.1 Module version "2 I / 2 Q"

### User data of the module

The module has 2 bytes of input user data and 2 bytes of output user data for status and control information. At this module version measured variables can be read solely via measured value data records (no measured variables can be evaluated via user data).

### Structure of input user data

The structure of the input user data is fixed.

Table C- 1 Structure of input user data (2 bytes)

| Byte | Validity | Designation | Comment |
|---|---|---|---|
| 0 | Module | User data variant | Constant = 0x80 |
| 1 | Module | Quality information | Quality bits to describe the quality of the basic measured values |

## Allocation of the input user data

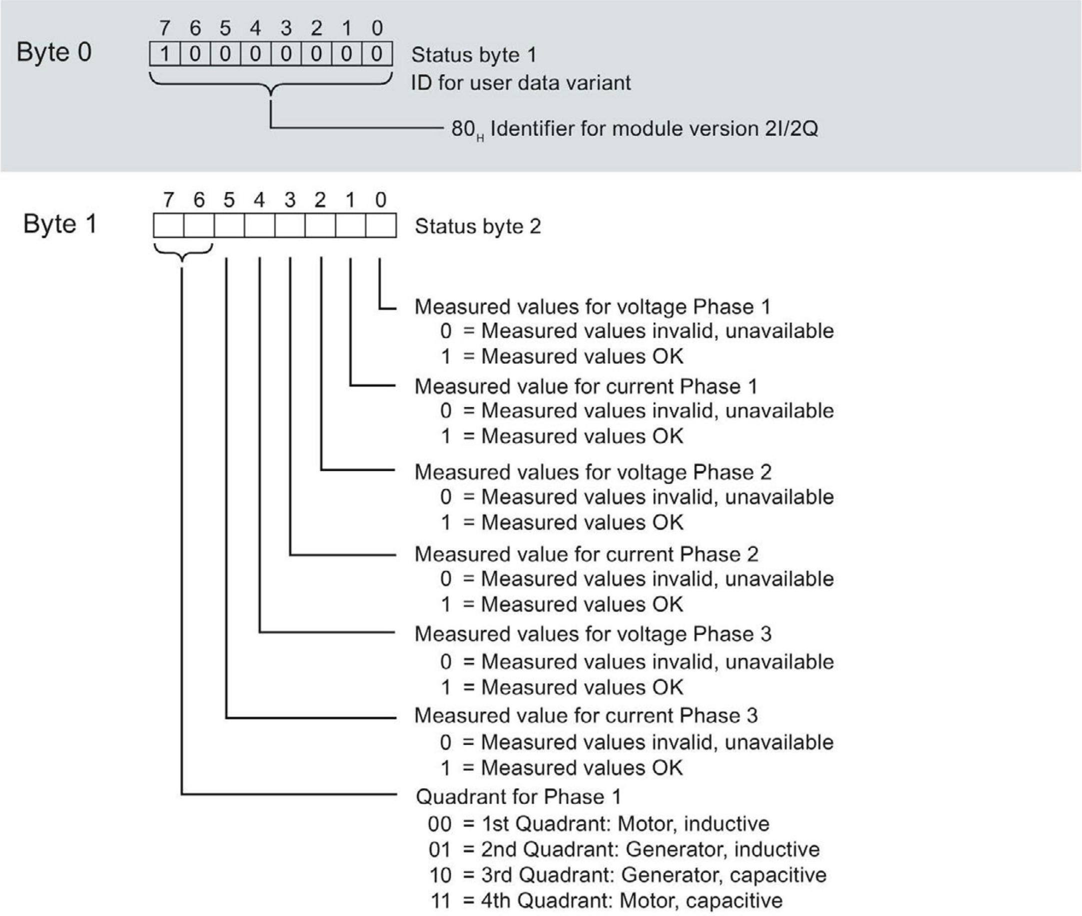


Figure C-1 Allocation of the status bytes in the input user data (2 bytes)

## Structure of output user data

The structure of the output user data is fixed.

Table C- 2 Structure of output user data (2 bytes)

| Byte | Validity | Designation | Comment |
|---|---|---|---|
| 0 | Module | Reserved | Reserved |
| 1 | Module | Control outputs | Reset of values and counters, gate |

## Assignment of the output user data

Via the output user data you control for all phases

- Resetting for all minimum values, maximum values, limits, operating hours counter and energy counters.
- The counter gates for operating hours counter and energy counters.

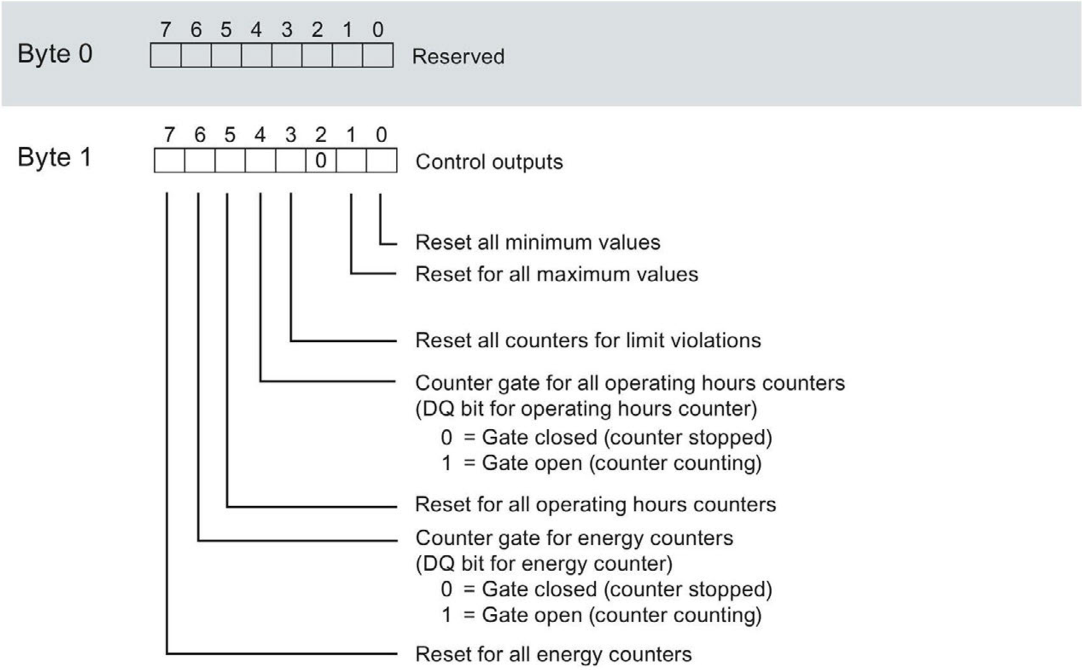


Figure C-2 Allocation of the control byte in the output user data (1 byte)

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**Note**

For module version 2 I / 2 Q, a reset of the selected variables always acts on **all** measured values/counter levels of the three phases.

- Reset energy counter: Acts on all active, reactive and apparent energies of all phases
- Reset operating hours counter: Acts on the counters of Phases 1 to 3
- Reset minimum / maximum values: Acts on the minimum and maximum value calculations of Phases 1-3
- Reset all counters for limit violations: Acts on all 16 limit values.

# C.2 Module version "32 I / 12 Q"

## User data of the module

The module occupies 32 bytes of input user data and 12 bytes of output user data. Of these the module uses 2 bytes input data for status information and 12 bytes output data for control information. Measured variables can be read cyclically via user data (Bytes 2 to 31) or acyclically via measured value data records

## Structure of input user data

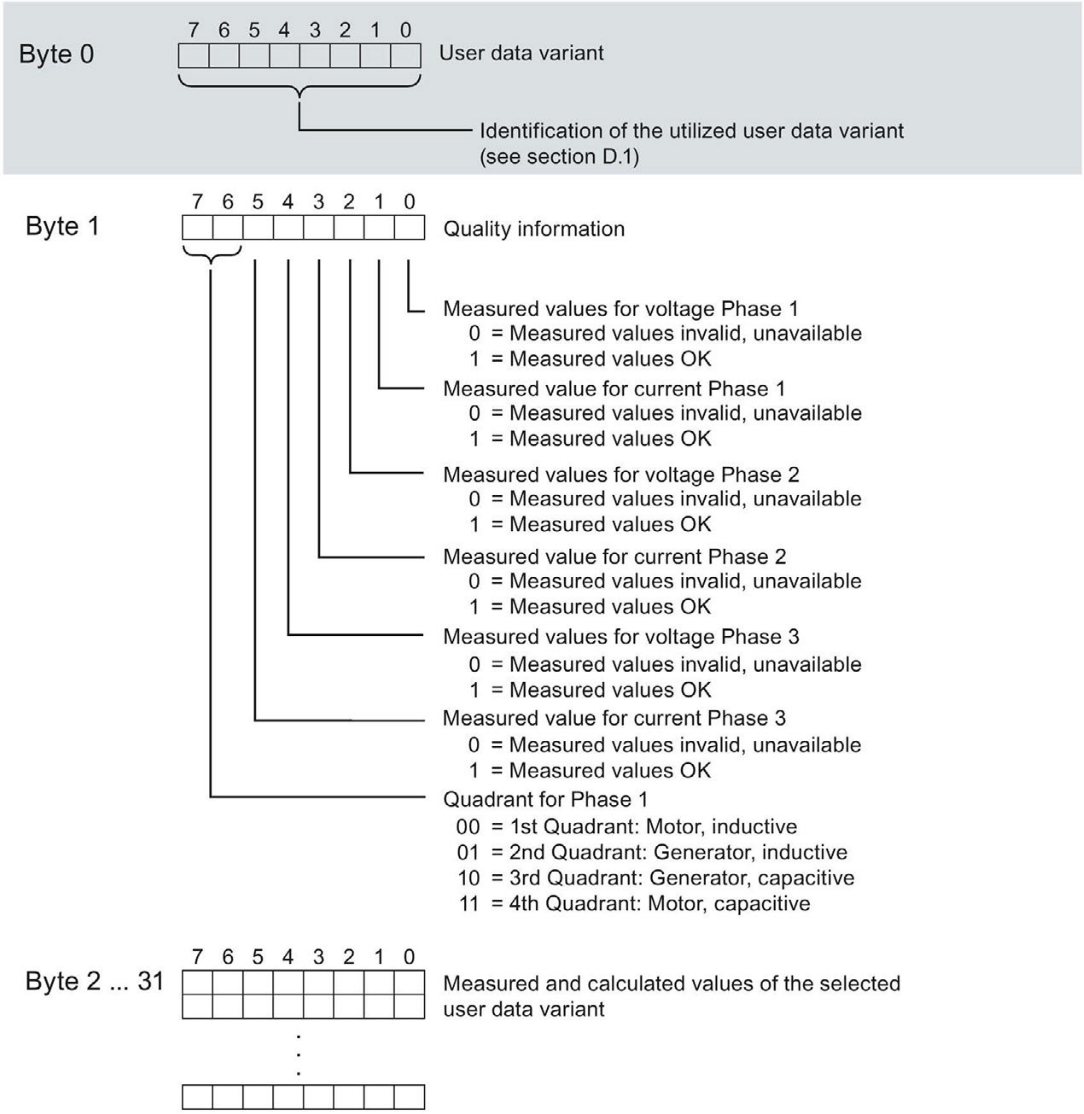
You can set the contents of the input user data dynamically. You can choose between different user data variants.

Table C- 3 Structure of input user data (12 bytes)

| Byte | Validity | Designation | Comment |
|---|---|---|---|
| 0 | Module | User data variant | - |
| 1 | Module | Quality information | Quality bits to describe the quality of the basic measured values |
| 2 ... 31 | Module or phase | Data | 2 or 4 bytes of measured values or calculated values according to user data variant |

## Allocation of the input user data

You can change the measured variables during operation. You can choose between different user data variants.



User data variant

Identification of the utilized user data variant (see section D.1)

Quality information

Measured values for voltage Phase 1
0 = Measured values invalid, unavailable
1 = Measured values OK

Measured value for current Phase 1
0 = Measured values invalid, unavailable
1 = Measured values OK

Measured values for voltage Phase 2
0 = Measured values invalid, unavailable
1 = Measured values OK

Measured value for current Phase 2
0 = Measured values invalid, unavailable
1 = Measured values OK

Measured values for voltage Phase 3
0 = Measured values invalid, unavailable
1 = Measured values OK

Measured value for current Phase 3
0 = Measured values invalid, unavailable
1 = Measured values OK

Quadrant for Phase 1
00 = 1st Quadrant: Motor, inductive
01 = 2nd Quadrant: Generator, inductive
10 = 3rd Quadrant: Generator, capacitive
11 = 4th Quadrant: Motor, capacitive

Measured and calculated values of the selected user data variant

Figure C-3 Assignment of the input user data (32 bytes)

## Structure of output user data

The structure of the output user data is fixed and is the same at all the selectable user data variants.

Via the output user data you control globally or phase-specifically

- Resetting for minimum values, maximum values, limits, operating hours counter and energy counters.
- The counter gates for operating hours counter and energy counters.

Table C- 4 Structure of output user data (12 bytes)

| Byte | Validity | Designation | Comment |
|---|---|---|---|
| 0 | Module | User data variant | Control byte for switching the user data variant |
| 1 | Module | Control byte 1 | Global resetting of values and counters, gate |
| 2 | Module | Control byte 2 | Selection of the energy counter to be reset |
| 3 | Module | Control byte 3 | Control of the limit monitoring of limit values 9 to 16 |
| 4 | Module | Control byte 4 | Control of the limit monitoring of limit values 1 to 8 |
| 5 | Module | Reserved | - |
| 6 | Phase L1 | Control byte 6 | Phase-specific resetting of values and counters, gate for Phase 1 |
| 7 | Phase L1 | Control byte 7 | |
| 8 | Phase L2 | Control byte 8 | Phase-specific resetting of values and counters, gate for Phase 2 |
| 9 | Phase L2 | Control byte 9 | |
| 10 | Phase L3 | Control byte 10 | Phase-specific resetting of values and counters, gate for Phase 3 |
| 11 | Phase L3 | Control byte 11 | |

## Control bytes for user data variant

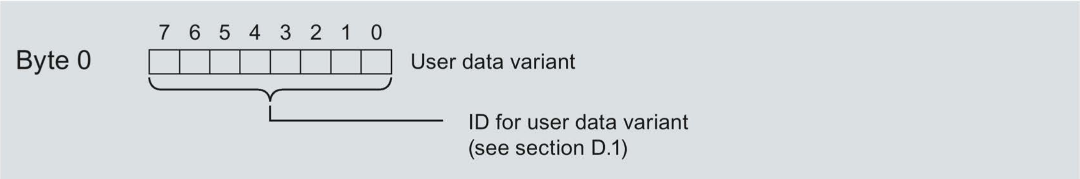


Figure C-4 Allocation of the control bytes for user data variant (Byte 0)

## Control bytes for all three phases

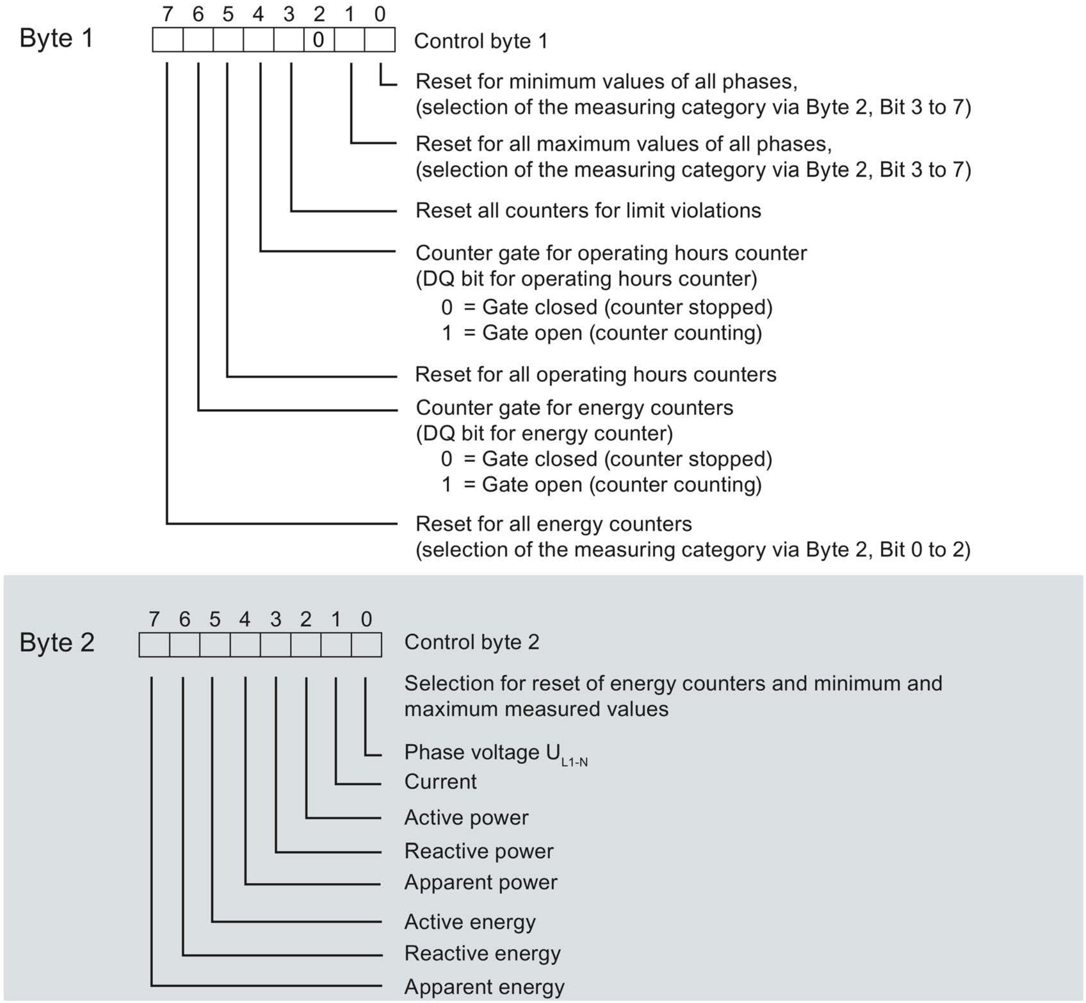


Figure C-5 Allocation of the control bytes for all three phases (bytes 1 and 2)

## Control bytes for limit monitoring

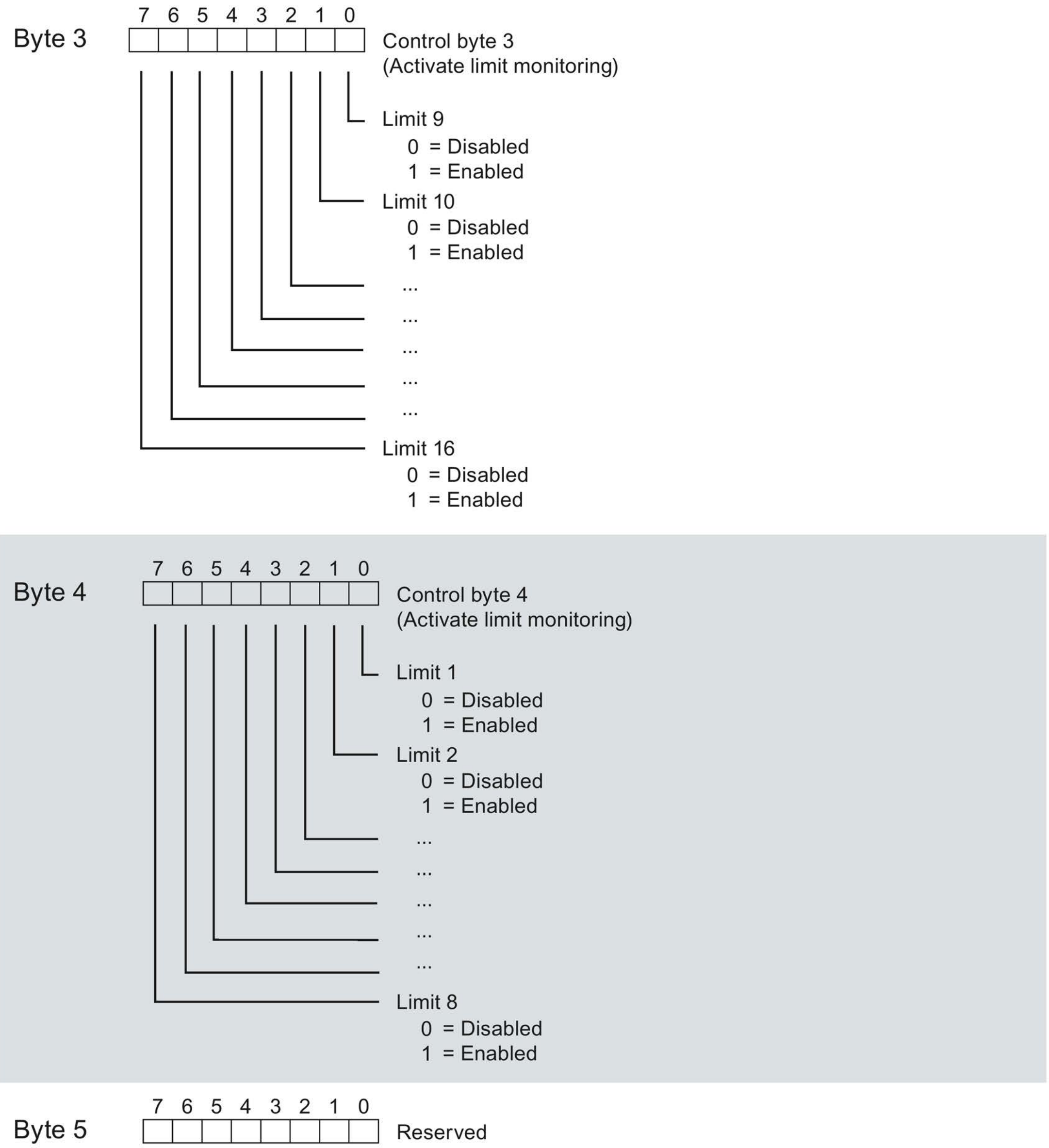


Figure C-6 Allocation of the control bytes for limit monitoring (bytes 3 to 5)

## Control bytes for each individual phase

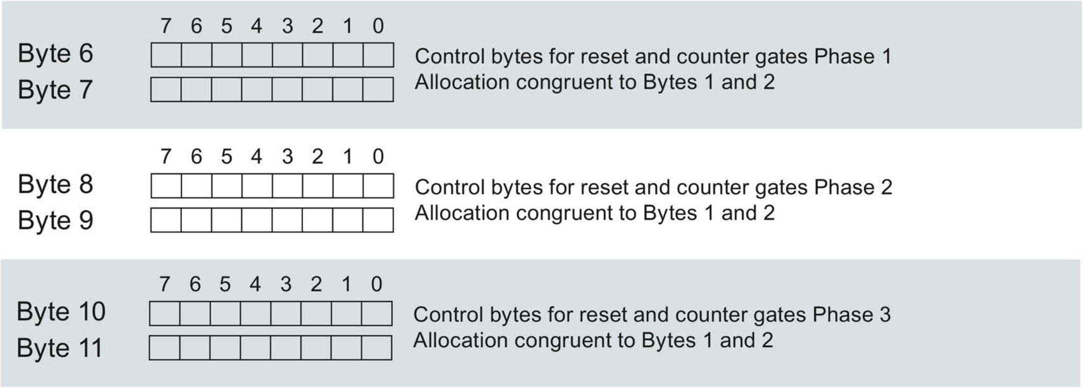


Figure C-7 Allocation of the control bytes for each individual phase (bytes 6 to 11)

# C.3 "User-specific" module version

## User data of the module

The module occupies between 16 and 256 bytes of input user data and 12 bytes of output user data. Of these the module uses 2 bytes input data for status information and 12 bytes output data for control information. Measured variables can be read cyclically via user data (as of Byte 2) or acyclically via measured value data records

## Structure of input user data

You configure the structure of the input user data starting at Byte 2 at this module version itself. An input user data length of 32 bytes also allows you to set the input user data dynamically. You can choose between different user data variants.

Table C- 5 Structure of input user data (16 to 256 bytes)

| Byte | Validity | Designation | Comment |
|---|---|---|---|
| 0 | Module | User data variant | - |
| 1 | Module | Quality information | Quality bits to describe the quality of the basic measured values |
| 2 ... 255 | Module or phase | Data | Measured values or calculated values in accordance with their configuration:<br>• At configuration in STEP 7 the size of the input user data is calculated automatically.<br>• At configuration via the GSD file the size of the input user data amounts to 32, 64, 128 or 256 bytes. The memory area has to be sufficiently large for the measured variables defined in parameter data record 130. |

## Allocation of the input user data

You can change the measured variables during operation. You can choose between different user data variants.

The allocation of the status information in Byte 0 and 1 corresponds to the module version 32 I / 12 Q, see appendix Module version "32 I / 12 Q" (Page 145).

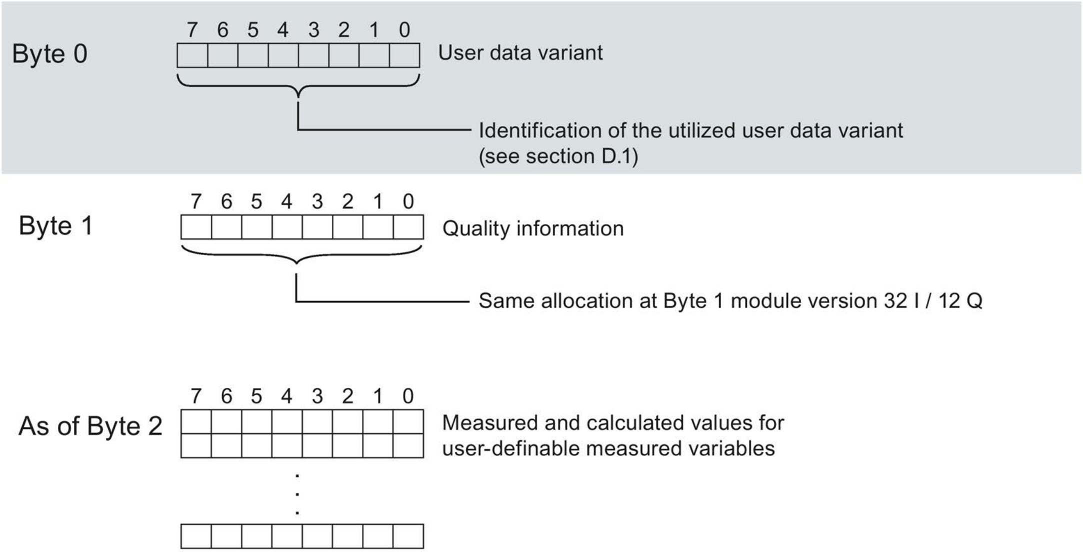


Figure C-8 Allocation of the input user data ("User-specific" module version"

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**Note**

**Behavior at switchover in case of the input user data being too small**

If the configured size of the variable input user data is smaller than the sized of the fixed user data variant, the response depends on the type of switchover:

- Re-configuration via parameter data record 128 / 130: Output of a parameter assignment error (33). No switchover.
- Switchover using output byte 0 of a user data variant: No switchover and no error message.

---

## Structure of output user data

The structure of the 12 output user data is fixed and is identical to the output user data (control bytes) of the Module version "32 I / 12 Q" (Page 145).

# C.4 Module version "EE@Industry measurement data profile E0 / E1 / E2 / E3"

## User data of the module

The four versions according to EE@Industry use between 4 and 104 bytes of input user data and 12 bytes of output user data. A dynamic switchover of the input user data is not possible.

## Structure of input user data

The structure of the input user data for the module versions according to the EE@Industry standard is fixed and depends on the selected measurement data profile.

Table C- 6 Measurement data profile E0

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0...3 | Current L1 | REAL | 1 A | 0.0 … 100000.0 | 7 |
| 4...7 | Current L2 | REAL | 1 A | 0.0 … 100000.0 | 8 |
| 8...11 | Current L3 | REAL | 1 A | 0.0 … 100000.0 | 9 |

Table C- 7 Measurement data profile E1

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0...3 | Total active power L1L2L3 | REAL | 1 W | $-3.0 \times 10^9$ ... $+3.0 \times 10^9$ | 34 |

Table C- 8 Measurement data profile E2

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0...3 | Total active power L1L2L3 | REAL | 1 W | $-3.0 \times 10^9$ ... $+3.0 \times 10^9$ | 35 |
| 4...7 | Total active energy L1L2L3 inflow | REAL | 1 Wh | 0 ... $1.8 \times 10^{38}$ | 200 |
| 8...11 | Total active energy L1L2L3 outflow | REAL | 1 Wh | 0 ... $1.8 \times 10^{38}$ | 201 |

Table C- 9 Measurement data profile E3

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0...3 | Active power L1 | REAL | 1 W | -3.0 x $10^9$ ... +3.0 x $10^9$ | 13 |
| 4...7 | Active power L2 | REAL | 1 W | -3.0 x $10^9$ ... +3.0 x $10^9$ | 14 |
| 8...11 | Active power L3 | REAL | 1 W | -3.0 x $10^9$ ... +3.0 x $10^9$ | 15 |
| 12...15 | Reactive power L1 | REAL | 1 var | -3.0 x $10^9$ ... +3.0 x $10^9$ | 16 |
| 16...19 | Reactive power L2 | REAL | 1 var | -3.0 x $10^9$ ... +3.0 x $10^9$ | 17 |
| 20...23 | Reactive power L3 | REAL | 1 var | -3.0 x $10^9$ ... +3.0 x $10^9$ | 18 |
| 24...31 | Total active energy L1L2L3 inflow | LREAL | 1 Wh | 0 ... 1.8 x $10^{308}$ | 210 |
| 32...39 | Total active energy L1L2L3 outflow | LREAL | 1 Wh | 0 ... 1.8 x $10^{308}$ | 211 |
| 40...47 | Total reactive energy L1L2L3 inflow | LREAL | 1 varh | 0 ... 1.8 x $10^{308}$ | 212 |
| 48...55 | Total reactive energy L1L2L3 outflow | LREAL | 1 varh | 0 ... 1.8 x $10^{308}$ | 213 |
| 56...59 | Voltage UL1-N | REAL | 1 V | 0.0 … 1000000.0 | 1 |
| 60...63 | Voltage UL2-N | REAL | 1 V | 0.0 … 1000000.0 | 2 |
| 64...67 | Voltage UL3-N | REAL | 1 V | 0.0 … 1000000.0 | 3 |
| 68...71 | Voltage UL1-UL2 | REAL | 1 V | 0.0 … 1000000.0 | 4 |
| 72...75 | Voltage UL2-UL3 | REAL | 1 V | 0.0 … 1000000.0 | 5 |
| 76...79 | Voltage UL3-UL1 | REAL | 1 V | 0.0 … 1000000.0 | 6 |
| 80...83 | Current L1 | REAL | 1 A | 0.0 … 100000.0 | 7 |
| 84...87 | Current L2 | REAL | 1 A | 0.0 … 100000.0 | 8 |
| 88...91 | Current L3 | REAL | 1 A | 0.0 … 100000.0 | 9 |
| 92...95 | Power factor L1 | REAL | - | 0.0 … 1.0 | 19 |
| 96...99 | Power factor L2 | REAL | - | 0.0 … 1.0 | 20 |
| 100...103 | Power factor L3 | REAL | - | 0.0 … 1.0 | 21 |

## Structure of output user data

The structure of the 12 byte output user data is fixed and is identical to the output user data (control bytes) of the Module version "32 I / 12 Q" (Page 145).

# User data variants

# D

## D.1 User data variants with 32 bytes input data / 12 bytes output data

### User data

30 bytes are available for transferring the measured values in a cycle at the module version 32 I / 12 Q. Therefore this module version supports dynamic switching between 22 preconfigured user data variants that contain a specific selection of measured values.

For more detailed information, refer to "Selecting the module versions (Page 28)".

Table D- 1 Overview of the user data variants

| User data | User data variant |
|---|---|
| Total power L1L2L3 | 254 (FE$_{H}$) - default setting |
| Active power L1L2L3 | 253 (FD$_{H}$) |
| Reactive power L1L2L3 | 252 (FC$_{H}$) |
| Apparent power L1L2L3 | 251 (FB$_{H}$) |
| Basic measured values L1L2L3 | 250 (FA$_{H}$) |
| Total energy L1L2L3 | 249 (F9$_{H}$) |
| Energy L1 | 248 (F8$_{H}$) |
| Energy L2 | 247 (F7$_{H}$) |
| Energy L3 | 246 (F6$_{H}$) |
| Basic variables three-phase measurement L1L2L3 | 245 (F5$_{H}$) |
| Quality values three-phase measurement | 240 (F0$_{H}$) |
| Energy measurement (periodic) overflow counter | 239 (EF$_{H}$) |
| EE@Industry measurement data profile E3 | 227 (E3$_{H}$) |
| EE@Industry measurement data profile E2 | 226 (E2$_{H}$) |
| EE@Industry measurement data profile E1 | 225 (E1$_{H}$) |
| EE@Industry measurement data profile E0 | 224 (E0$_{H}$) |
| Basic variables phase-specific measurement L1 | 159 (9F$_{H}$) |
| Basic variables phase-specific measurement L1a | 158 (9E$_{H}$) |
| Basic variables phase-specific measurement L2 | 157 (9D$_{H}$) |
| Basic variables phase-specific measurement L2a | 156 (9C$_{H}$) |
| Basic variables phase-specific measurement L3 | 155 (9B$_{H}$) |
| Basic variables phase-specific measurement L3a | 154 (9A$_{H}$) |
| User-defined user data structure | 1 (01$_{H}$) |

## Total power L1L2L3 (ID 254 or $FE_H$)

Table D- 2 Total power L1L2L3

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 254 ($FE_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 6 ... 7 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 8 ... 9 | Total active power L1L2L3 | INT | 1 W | -27648 … 27648 | 66034 |
| 10 ... 11 | Total reactive power L1L2L3 | INT | 1 var | -27648 … 27648 | 66035 |
| 12 ... 13 | Total apparent power L1L2L3 | INT | 1 VA | -27648 … 27648 | 66036 |
| 14 ... 17 | Total active energy L1L2L3 | DINT | 1 Wh | -2147483647 to +2147483647 | 225 |
| 18 ... 21 | Total reactive energy L1L2L3 | DINT | 1 varh | -2147483647 to +2147483647 | 226 |
| 22 | Reserved | BYTE | - | 0 | - |
| 23 | Total power factor L1L2L3 | USINT | 0.01 | 0 … 100 | 66037 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling total active power L1L2L3 | USINT | - | 0 ... 255 | - |
| 28 | Scaling total reactive power L1L2L3 | USINT | - | 0 ... 255 | - |
| 29 | Scaling total apparent power L1L2L3 | USINT | - | 0 ... 255 | - |
| 30 | Scaling total active energy L1L2L3 | USINT | - | 0 ... 255 | - |
| 31 | Scaling total reactive energy L1L2L3 | USINT | - | 0 ... 255 | - |

## Active power L1L2L3 (ID 253 or FD$_H$)

Table D- 3 Active power L1L2L3

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 253 (FD$_H$) | - |
| 1 | Quality information = QQ$_1$ I$_3$ U$_3$ I$_2$ U$_2$ I$_1$ U$_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 6 ... 7 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 8 ... 9 | Active power L1 | INT | 1 W | -27648 … 27648 | 66013 |
| 10 ... 11 | Active power L2 | INT | 1 W | -27648 … 27648 | 66014 |
| 12 ... 13 | Active power L3 | INT | 1 W | -27648 … 27648 | 66015 |
| 14 ... 15 | Total active power L1L2L3 | INT | 1 W | -27648 … 27648 | 66034 |
| 16 ... 19 | Total active energy L1L2L3 | DINT | 1 Wh | -2147483647 to +2147483647 | 225 |
| 20 | Power factor L1 | USINT | 0.01 | 0 … 100 | 66019 |
| 21 | Power factor L2 | USINT | 0.01 | 0 … 100 | 66020 |
| 22 | Power factor L3 | USINT | 0.01 | 0 … 100 | 66021 |
| 23 | Total power factor L1L2L3 | USINT | 0.01 | 0 … 100 | 66037 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling active power L1 | USINT | - | 0 ... 255 | - |
| 28 | Scaling active power L2 | USINT | - | 0 ... 255 | - |
| 29 | Scaling active power L3 | USINT | - | 0 ... 255 | - |
| 30 | Scaling active power L1L2L3 | USINT | - | 0 ... 255 | - |
| 31 | Scaling total active energy L1L2L3 | USINT | - | 0 ... 255 | - |

## Reactive power L1L2L3 (ID 252 or $FC_H$)

Table D- 4 Reactive power L1L2L3

| **Byte** | **Allocation** | **Data type** | **Unit** | **Value range** | **Meas-ured value ID** |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 252 ($FC_H$) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 6 ... 7 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 8 ... 9 | Reactive power L1 | INT | 1 var | -27648 … 27648 | 66016 |
| 10 ... 11 | Reactive power L2 | INT | 1 var | -27648 … 27648 | 66017 |
| 12 ... 13 | Reactive power L3 | INT | 1 var | -27648 … 27648 | 66018 |
| 14 ... 15 | Total reactive power L1L2L3 | INT | 1 var | -27648 … 27648 | 66035 |
| 16 ... 19 | Total reactive energy L1L2L3 | DINT | 1 varh | -2147483647 to +2147483647 | 226 |
| 20 | Power factor L1 | USINT | 0.01 | 0 … 100 | 66019 |
| 21 | Power factor L2 | USINT | 0.01 | 0 … 100 | 66020 |
| 22 | Power factor L3 | USINT | 0.01 | 0 … 100 | 66021 |
| 23 | Total power factor L1L2L3 | USINT | 0.01 | 0 … 100 | 66037 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling reactive power L1 | USINT | - | 0 ... 255 | - |
| 28 | Scaling reactive power L2 | USINT | - | 0 ... 255 | - |
| 29 | Scaling reactive power L3 | USINT | - | 0 ... 255 | - |
| 30 | Scaling reactive power L1L2L3 | USINT | - | 0 ... 255 | - |
| 31 | Scaling total reactive energy L1L2L3 | USINT | - | 0 ... 255 | - |

## Apparent power L1L2L3 (ID 251 or $FB_H$)

Table D- 5 Apparent power L1L2L3

| **Byte** | **Allocation** | **Data type** | **Unit** | **Value range** | **Meas-ured value ID** |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 251 ($FB_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 6 ... 7 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 8 ... 9 | Apparent power L1 | INT | 1 VA | -27648 … 27648 | 66010 |
| 10 ... 11 | Apparent power L2 | INT | 1 VA | -27648 … 27648 | 66011 |
| 12 ... 13 | Apparent power L3 | INT | 1 VA | -27648 … 27648 | 66012 |
| 14 ... 15 | Total apparent power L1L2L3 | INT | 1 VA | -27648 … 27648 | 66036 |
| 16 ... 19 | Total apparent energy L1L2L3 | DINT | 1 VAh | 0 to 2147483647 | 224 |
| 20 | Power factor L1 | USINT | 0.01 | 0 … 100 | 66019 |
| 21 | Power factor L2 | USINT | 0.01 | 0 … 100 | 66020 |
| 22 | Power factor L3 | USINT | 0.01 | 0 … 100 | 66021 |
| 23 | Total power factor L1L2L3 | USINT | 0.01 | 0 … 100 | 66037 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling apparent power L1 | USINT | - | 0 ... 255 | - |
| 28 | Scaling apparent power L2 | USINT | - | 0 ... 255 | - |
| 29 | Scaling apparent power L3 | USINT | - | 0 ... 255 | - |
| 30 | Scaling apparent power L1L2L3 | USINT | - | 0 ... 255 | - |
| 31 | Scaling total apparent energy L1L2L3 | USINT | - | 0 ... 255 | - |

## Basic measured values L1L2L3 (ID 250 or $FA_H$)

Table D- 6 Basic measured values L1L2L3

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 250 ($FA_H$) | - |
| 1 | Quality information = $QQ_1 I_3 U_3 I_2 U_2 I_1 U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 6 ... 7 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 8 ... 9 | Voltage UL1-N | UINT | 0.01 V | 0 … 65535 | 66001 |
| 10 ... 11 | Voltage UL2-N | UINT | 0.01 V | 0 … 65535 | 66002 |
| 12 ... 13 | Voltage UL3-N | UINT | 0.01 V | 0 … 65535 | 66003 |
| 14 ... 15 | Voltage UL1-UL2 | UINT | 0.01 V | 0 … 65535 | 66004 |
| 16 ... 17 | Voltage UL2-UL3 | UINT | 0.01 V | 0 … 65535 | 66005 |
| 18 ... 19 | Voltage UL3-UL1 | UINT | 0.01 V | 0 … 65535 | 66006 |
| 20 | Power factor L1 | USINT | 0.01 | 0 … 100 | 66019 |
| 21 | Power factor L2 | USINT | 0.01 | 0 … 100 | 66020 |
| 22 | Power factor L3 | USINT | 0.01 | 0 … 100 | 66021 |
| 23 | Total power factor L1L2L3 | USINT | 0.01 | 0 … 100 | 66037 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling voltage UL1-N (UL1-UL2) | USINT | - | 0 ... 255 | - |
| 28 | Scaling voltage UL2-N (UL2-UL3) | USINT | - | 0 ... 255 | - |
| 29 | Scaling voltage UL3-N (UL3-UL1) | USINT | - | 0 ... 255 | - |
| 30 ... 31 | Frequency | UINT | 0.01 Hz | 4500 ... 6500 | 66038 |

## Total energy L1L2L3 (ID 249 or F9$_H$)

Table D- 7 Total energy L1L2L3

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 249 (F9$_H$) | - |
| 1 | Quality information = QQ$_1$ I$_3$ U$_3$ I$_2$ U$_2$ I$_1$ U$_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 | Reserved | BYTE | - | - | - |
| 3 | Reserved | BYTE | - | - | - |
| 4 ... 7 | Total active energy inflow L1L2L3 | UDINT | 1 Wh | 0 to 2147483647 | 220 |
| 8 ... 11 | Total active energy outflow L1L2L3 | UDINT | 1 Wh | 0 to 2147483647 | 221 |
| 11 ... 15 | Total reactive energy inflow L1L2L3 | UDINT | 1 varh | 0 to 2147483647 | 222 |
| 16 ... 19 | Total reactive energy outflow L1L2L3 | UDINT | 1 varh | 0 to 2147483647 | 223 |
| 20 ... 23 | Total apparent energy L1L2L3 | UDINT | 1 VAh | 0 to 2147483647 | 224 |
| 24 | Reserved | BYTE | - | - | - |
| 25 | Scaling active energy, inflow | USINT | - | 0 ... 255 | - |
| 26 | Scaling active energy, outflow | USINT | - | 0 ... 255 | - |
| 27 | Scaling reactive energy, inflow | USINT | - | 0 ... 255 | - |
| 28 | Scaling reactive energy, outflow | USINT | - | 0 ... 255 | - |
| 29 | Scaling apparent energy | USINT | - | 0 ... 255 | - |
| 30 | Reserved | BYTE | - | - | - |
| 31 | Total power factor L1L2L3 | USINT | 0.01 | 0 … 100 | 66037 |

## Energy L1 (ID 248 or $F8_H$)

Table D- 8 Energy L1

| **Byte** | **Allocation** | **Data type** | **Unit** | **Value range** | **Meas-ured value ID** |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 248 ($F8_H$) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 7 | Active energy inflow L1 | UDINT | 1 Wh | 0 ... 2147483647 | 62110 |
| 8 ... 11 | Active energy outflow L1 | UDINT | 1 Wh | 0 ... 2147483647 | 62111 |
| 11 ... 15 | Reactive energy inflow L1 | UDINT | 1 varh | 0 ... 2147483647 | 62112 |
| 16 ... 19 | Reactive energy outflow L1 | UDINT | 1 varh | 0 ... 2147483647 | 62113 |
| 20 ... 23 | Apparent energy L1 | UDINT | 1 VAh | 0 ... 2147483647 | 62114 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active energy inflow L1 | USINT | - | 0 ... 255 | - |
| 26 | Scaling active energy outflow L1 | USINT | - | 0 ... 255 | - |
| 27 | Scaling reactive energy inflow L1 | USINT | - | 0 ... 255 | - |
| 28 | Scaling reactive energy outflow L1 | USINT | - | 0 ... 255 | - |
| 29 | Scaling apparent energy L1 | USINT | - | 0 ... 255 | - |
| 30 | Reserved | BYTE | - | - | - |
| 31 | Power factor L1 | USINT | 0.01 | 0 … 100 | 66019 |

## Energy L2 (ID 247 or F7$_H$)

Table D- 9 Energy L2

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 247 (F7$_H$) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 4 ... 7 | Active energy inflow L2 | UDINT | 1 Wh | 0 to 2147483647 | 62210 |
| 8 ... 11 | Active energy outflow L2 | UDINT | 1 Wh | 0 to 2147483647 | 62211 |
| 11 ... 15 | Reactive energy inflow L2 | UDINT | 1 varh | 0 to 2147483647 | 62212 |
| 16 ... 19 | Reactive energy outflow L2 | UDINT | 1 varh | 0 to 2147483647 | 62213 |
| 20 ... 23 | Apparent energy L2 | UDINT | 1 VAh | 0 to 2147483647 | 62214 |
| 24 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active energy inflow L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling active energy outflow L2 | USINT | - | 0 ... 255 | - |
| 27 | Scaling reactive energy inflow L2 | USINT | - | 0 ... 255 | - |
| 28 | Scaling reactive energy outflow L2 | USINT | - | 0 ... 255 | - |
| 29 | Scaling apparent energy L2 | USINT | - | 0 ... 255 | - |
| 30 | Reserved | BYTE | - | - | - |
| 31 | Power factor L2 | USINT | 0.01 | 0 … 100 | 66020 |

## Energy L3 (ID 246 or $F6_H$)

Table D- 10 Energy L3

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 246 ($F6_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 4 ... 7 | Active energy inflow L3 | UDINT | 1 Wh | 0 to 2147483647 | 62310 |
| 8 ... 11 | Active energy L3, outflow | UDINT | 1 Wh | 0 to 2147483647 | 62311 |
| 11 ... 15 | Reactive energy inflow L3 | UDINT | 1 varh | 0 to 2147483647 | 62312 |
| 16 ... 19 | Reactive energy outflow L3 | UDINT | 1 varh | 0 to 2147483647 | 62313 |
| 20 ... 23 | Apparent energy L3 | UDINT | 1 VAh | 0 to 2147483647 | 62314 |
| 24 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active energy inflow L3 | USINT | - | 0 ... 255 | - |
| 26 | Scaling active energy outflow L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling reactive energy inflow L3 | USINT | - | 0 ... 255 | - |
| 28 | Scaling reactive energy outflow L3 | USINT | - | 0 ... 255 | - |
| 29 | Scaling apparent energy L3 | USINT | - | 0 ... 255 | - |
| 30 | Reserved | BYTE | - | - | - |
| 31 | Power factor L3 | USINT | 0.01 | 0 … 100 | 66021 |

## Basic variables three-phase measurements (ID 245 or $F5_H$)

Table D- 11 Basic variables three-phase measurements

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 245 ($F5_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 5 | Total active power L1L2L3 | REAL | 1 W | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 35 |
| 6 ... 9 | Total active energy outflow L1L2L3 | REAL | 1 Wh | 0.0 ... $3.4 \times 10^{38}$ | 201 |
| 10 ... 13 | Total active energy inflow L1L2L3 | REAL | 1 Wh | 0.0 ... $3.4 \times 10^{38}$ | 200 |
| 14 ... 17 | Current L1 | REAL | 1 A | 0.0 … 100000.0 | 7 |
| 18 ... 21 | Current L2 | REAL | 1 A | 0.0 … 100000.0 | 8 |
| 22 ... 25 | Current L3 | REAL | 1 A | 0.0 … 100000.0 | 9 |
| 26 ... 27 | Voltage UL1-N | UINT | 0.01 V | 0 … 65535 | 66001 |
| 28 ... 29 | Voltage UL2-N | UINT | 0.01 V | 0 … 65535 | 66002 |
| 30 ... 31 | Voltage UL3-N | UINT | 0.01 V | 0 … 65535 | 66003 |

## Basic variables quality values three-phase measurement (ID 240 or $F0_H$)

Table D- 12 Basic variables quality values three-phase measurement

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 240 (F0H) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Status of the limit monitoring GW 1 ... 16 (*) | WORD | Bit string | xxxx xxxx xxxx xxxx | 65509 |
| 4 ... 5 | Status of the energy counter overflows (**) | WORD | Bit string | xxxx xxxx xxxx xxxx | 65508 |
| 6 ... 7 | Quality information = 00 DD $QQ_3$ $QQ_2$ $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | WORD | Bit string | xxxx xxxx xxxx xxxx | 65503 |
| 8 ... 9 | Reserved | WORD | - | - | - |
| 10 ... 11 | Reserved | WORD | - | - | - |
| 12 ... 13 | Reserved | WORD | - | - | - |
| 14 ... 15 | Reserved | WORD | - | - | - |
| 16 ... 17 | Reserved | WORD | - | - | - |
| 18 ... 19 | Reserved | WORD | - | - | - |
| 20 ... 21 | Reserved | WORD | - | - | - |
| 22 ... 23 | Reserved | WORD | - | - | - |
| 24 ... 25 | Reserved | WORD | - | - | - |
| 26 ... 27 | Reserved | WORD | - | - | - |
| 28 ... 29 | Reserved | WORD | - | - | - |
| 30 ... 31 | Reserved | WORD | - | - | - |

(*) Limit violation in:
Bit 0 = limit 1 to bit 15 = limit 16

(**) Energy counter count periodically - counter overflow at:
Bit 0 = 1: Active energy inflow L1
Bit 1 = 1: Active energy outflow L1
Bit 2 = 1: Reactive energy inflow L1
Bit 3 = 1: Reactive energy outflow L1
Bit 4 = 1: Apparent energy L1
Bit 5 = 1: Active energy inflow L2
Bit 6 = 1: Active energy outflow L2
Bit 7 = 1: Reactive energy inflow L2
Bit 8 = 1: Reactive energy outflow L2
Bit 9 = 1: Apparent energy L2
Bit 10 = 1: Active energy inflow L3
Bit 11 = 1: Active energy outflow L3
Bit 12 = 1: Reactive energy inflow L3
Bit 13 = 1: Reactive energy outflow L3
Bit 14 = 1: Apparent energy L3
Bit 15: Reserved

## Basic variables energy counter measurement (periodic) overflow counter (ID 239 or $EF_H$)

Table D- 13 Basic variables energy counter measurement (periodic) overflow counter

| **Byte** | **Allocation** | **Data type** | **Unit** | **Value range** | **Meas-ured value ID** |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 239 (EFH) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Overflow counter for active energy inflow L1 | UINT | - | 0 … 65535 | 65120 |
| 4 ... 5 | Overflow counter for active energy outflow L1 | UINT | - | 0 … 65535 | 65121 |
| 6 ... 7 | Overflow counter for reactive energy inflow L1 | UINT | - | 0 … 65535 | 65122 |
| 8 ... 9 | Overflow counter for reactive energy outflow L1 | UINT | - | 0 … 65535 | 65123 |
| 10 ... 11 | Overflow counter for apparent energy L1 | UINT | - | 0 … 65535 | 65124 |
| 12 ... 13 | Overflow counter for active energy inflow L2 | UINT | - | 0 … 65535 | 62220 |
| 14 ... 15 | Overflow counter for active energy outflow L2 | UINT | - | 0 … 65535 | 62221 |
| 16 ... 17 | Overflow counter for reactive energy inflow L2 | UINT | - | 0 … 65535 | 62222 |
| 18 ... 19 | Overflow counter for reactive energy outflow L2 | UINT | - | 0 … 65535 | 62223 |
| 20 ... 21 | Overflow counter for apparent energy L2 | UINT | - | 0 … 65535 | 62224 |
| 22 ... 23 | Overflow counter for active energy inflow L3 | UINT | - | 0 … 65535 | 62320 |
| 24 ... 25 | Overflow counter for active energy outflow L3 | UINT | - | 0 … 65535 | 62321 |
| 26 ... 27 | Overflow counter for reactive energy inflow L3 | UINT | - | 0 … 65535 | 62322 |
| 28 ... 29 | Overflow counter for reactive energy outflow L3 | UINT | - | 0 … 65535 | 62323 |
| 30 ... 31 | Overflow counter for apparent energy L3 | UINT | - | 0 … 65535 | 62324 |

## Basic variables measurement data profile (ID 227 or $E3_H$)

Table D- 14 Basic variables measurement data profile Energy E3

| **Byte** | **Allocation** | **Data type** | **Unit** | **Value range** | **Meas-ured value ID** |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 227 ($E3_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 5 | Active power L1 | REAL | 1 W | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 13 |
| 6 ... 9 | Active power L2 | REAL | 1 W | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 14 |
| 10 ... 13 | Active power L3 | REAL | 1 W | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 15 |
| 14 ... 17 | Reactive power L1 | REAL | 1 var | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 16 |

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 18 ... 21 | Reactive power L2 | REAL | 1 var | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 17 |
| 22 ... 25 | Reactive power L3 | REAL | 1 var | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 18 |
| 26 ... 33 | Total active energy L1L2L3 inflow | LREAL | 1 Wh | 0.0 ... $1.8 \times 10^{308}$ | 210 |
| 34 ... 41 | Total active energy L1L2L3 outflow | LREAL | 1 Wh | 0.0 ... $1.8 \times 10^{308}$ | 211 |
| 42 ... 49 | Total reactive energy L1L2L3 inflow | LREAL | 1 varh | 0.0 ... $1.8 \times 10^{308}$ | 212 |
| 50 ... 57 | Total reactive energy L1L2L3 outflow | LREAL | 1 varh | 0.0 ... $1.8 \times 10^{308}$ | 213 |
| 58 ... 61 | Voltage UL1-N | REAL | 1 V | 0.0 … 1000000.0 | 1 |
| 62 ... 65 | Voltage UL2-N | REAL | 1 V | 0.0 … 1000000.0 | 2 |
| 66 ... 69 | Voltage UL3-N | REAL | 1 V | 0.0 … 1000000.0 | 3 |
| 70 ... 73 | Voltage UL1-UL2 | REAL | 1 V | 0.0 … 1000000.0 | 4 |
| 74 ... 77 | Voltage UL2-UL3 | REAL | 1 V | 0.0 … 1000000.0 | 5 |
| 78 ... 81 | Voltage UL3-UL1 | REAL | 1 V | 0.0 … 1000000.0 | 6 |
| 82 ... 85 | Current L1 | REAL | 1 A | 0.0 … 100000.0 | 7 |
| 86 ... 89 | Current L2 | REAL | 1 A | 0.0 … 100000.0 | 8 |
| 90 ... 93 | Current L3 | REAL | 1 A | 0.0 … 100000.0 | 9 |
| 94 ... 97 | Power factor L1 | REAL | - | 0.0 … 1.0 | 19 |
| 98 ... 101 | Power factor L2 | REAL | - | 0.0 … 1.0 | 20 |
| 102 ... 105 | Power factor L3 | REAL | - | 0.0 … 1.0 | 21 |

## Basic variables measurement data profile (ID 226 or E2$_H$)

Table D- 15 Basic variables measurement data profile Energy E2

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 226 (E2$_H$) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 5 | Total active power L1L2L3 | REAL | 1 W | $-3.0 \times 10^9$ ... $+ 3.0 \times 10^9$ | 34 |
| 6 ... 9 | Total active energy inflow L1L2L3 | REAL | 1 W | $3.0 \times 10^9$ | 200 |
| 10 ...13 | Total active energy outflow L1L2L3 | REAL | 1 W | $3.0 \times 10^9$ | 201 |

## Basic variables measurement data profile (ID 225 or E1$_H$)

Table D- 16 Basic variables measurement data profile Energy E1

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 225 (E1$_H$) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 5 | Total active power L1L2L3 | REAL | 1 W | -3.0 x $10^9$ ... + 3.0 x $10^9$ | 34 |

## Basic variables measurement data profile (ID 224 or E0$_H$)

Table D- 17 Basic variables measurement data profile Energy E0

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 224 (E0$_H$) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 5 | Current L1 | REAL | 1 A | 0.0 … 100000.0 | 7 |
| 6 ... 9 | Current L2 | REAL | 1 A | 0.0 … 100000.0 | 8 |
| 10 ...13 | Current L3 | REAL | 1 A | 0.0 … 100000.0 | 9 |

## Basic variables phase-specific measurement (ID 159 or 9F$_H$)

Table D- 18 Basic variables phase-specific measurement L1

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 159 (9FH) | - |
| 1 | Quality information = QQ$_1$ I$_3$ U$_3$ I$_2$ U$_2$ I$_1$ U$_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Voltage UL1-N | UINT | 0.01 V | 0 … 65535 | 66001 |
| 6 ... 7 | Active power L1 | INT | 1 W | -27648 … 27648 | 66013 |
| 8 ... 9 | Reactive power L1 | INT | 1 var | -27648 … 27648 | 66016 |
| 10 ... 11 | Apparent power L1 | INT | 1 VA | -27648 … 27648 | 66010 |
| 12 ... 15 | Active energy L1 total (inflow - outflow) | DINT | 1 Wh | -2147483647 to +2147483647 | 62115 |
| 16 ... 19 | Reactive energy L1 total (inflow - outflow) | DINT | 1 varh | -2147483647 to +2147483647 | 62116 |
| 20 ... 23 | Apparent energy L1 | UDINT | 1 VAh | 0 to 2147483647 | 62114 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active power L1 | USINT | - | 0 ... 255 | - |
| 26 | Scaling reactive power L1 | USINT | - | 0 ... 255 | - |
| 27 | Scaling apparent power L1 | USINT | - | 0 ... 255 | - |
| 28 | Scaling active energy L1 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 29 | Scaling reactive energy L1 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 30 | Scaling apparent energy L1 | USINT | - | 0 ... 255 | - |
| 31 | Power factor L1 | USINT | 0.01 | 0 … 100 | 66019 |

## Basic variables phase-specific measurement (ID 158 or $9E_H$)

Table D- 19 Basic variables phase-specific measurement L1a

| Byte | Allocation | Data type | Unit | Value range | Meas- ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 158 (9EH) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L1 | UINT | 1 mA | 0 … 65535 | 66007 |
| 4 ... 5 | Voltage UL1-N | UINT | 0.01 V | 0 … 65535 | 66001 |
| 6 ... 7 | Active power L1 | INT | 1 W | -27648 … 27648 | 66013 |
| 8 ... 9 | Reactive power L1 | INT | 1 var | -27648 … 27648 | 66016 |
| 10 ... 11 | Apparent power L1 | INT | 1 VA | -27648 … 27648 | 66010 |
| 12 ... 15 | Active energy L1 total (inflow - outflow) | UDINT | 1 Wh | 0 … 4294967295 | 62115 |
| 16 ... 19 | Reactive energy L1 total (inflow - outflow) | UDINT | 1 varh | 0 … 4294967295 | 62116 |
| 20 ... 23 | Apparent energy L1 | UDINT | 1 VAh | 0 … 4294967295 | 62114 |
| 24 | Scaling current L1 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active power L1 | USINT | - | 0 ... 255 | - |
| 26 | Scaling reactive power L1 | USINT | - | 0 ... 255 | - |
| 27 | Scaling apparent power L1 | USINT | - | 0 ... 255 | - |
| 28 | Scaling active energy L1 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 29 | Scaling reactive energy L1 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 30 | Scaling apparent energy L1 | USINT | - | 0 ... 255 | - |
| 31 | Scaling voltage UL1-N | USINT | - | 0 ... 255 | - |

## Basic variables phase-specific measurement (ID 157 or $9D_H$)

Table D- 20 Basic variables phase-specific measurement L2

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 157 ($9D_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 4 ... 5 | Voltage UL2-N | UINT | 0.01 V | 0 … 65535 | 66002 |
| 6 ... 7 | Active power L2 | INT | 1 W | -27648 … 27648 | 66014 |
| 8 ... 9 | Reactive power L2 | INT | 1 var | -27648 … 27648 | 66017 |
| 10 ... 11 | Apparent power L2 | INT | 1 VA | -27648 … 27648 | 66011 |
| 12 ... 15 | Active energy L2 total (inflow - outflow) | DINT | 1 Wh | -2147483647 to +2147483647 | 62215 |
| 16 ... 19 | Reactive energy L2 total (inflow - outflow) | DINT | 1 varh | -2147483647 to +2147483647 | 62216 |
| 20 ... 23 | Apparent energy L2 | UDINT | 1 VAh | 0 to 2147483647 | 62214 |
| 24 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active power L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling reactive power L2 | USINT | - | 0 ... 255 | - |
| 27 | Scaling apparent power L2 | USINT | - | 0 ... 255 | - |
| 28 | Scaling active energy L2 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 29 | Scaling reactive energy L2 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 30 | Scaling apparent energy L2 | USINT | - | 0 ... 255 | - |
| 31 | Power factor L2 | USINT | 0.01 | 0 … 100 | 66020 |

## Basic variables phase-specific measurement (ID 156 or $9C_H$)

Table D- 21 Basic variables phase-specific measurement L2a

| Byte | Allocation | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 156 (9CH) | - |
| 1 | Quality information = $QQ_1\ I_3\ U_3\ I_2\ U_2\ I_1\ U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L2 | UINT | 1 mA | 0 … 65535 | 66008 |
| 4 ... 5 | Voltage UL2-N | UINT | 0.01 V | 0 … 65535 | 66002 |
| 6 ... 7 | Active power L2 | INT | 1 W | -27648 … 27648 | 66014 |
| 8 ... 9 | Reactive power L2 | INT | 1 var | -27648 … 27648 | 66017 |
| 10 ... 11 | Apparent power L2 | INT | 1 VA | -27648 … 27648 | 66011 |
| 12 ... 15 | Active energy L2 total (inflow - outflow) | DINT | 1 Wh | -2147483647 to +2147483647 | 62215 |
| 16 ... 19 | Reactive energy L2 total (inflow - outflow) | DINT | 1 varh | -2147483647 to +2147483647 | 62216 |
| 20 ... 23 | Apparent energy L2 | UDINT | 1 VAh | 0 to 2147483647 | 62214 |
| 24 | Scaling current L2 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active power L2 | USINT | - | 0 ... 255 | - |
| 26 | Scaling reactive power L2 | USINT | - | 0 ... 255 | - |
| 27 | Scaling apparent power L2 | USINT | - | 0 ... 255 | - |
| 28 | Scaling active energy L2 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 29 | Scaling reactive energy L2 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 30 | Scaling apparent energy L2 | USINT | - | 0 ... 255 | - |
| 31 | Scaling voltage UL2-N | USINT | - | 0 ... 255 | - |

## Basic variables phase-specific measurement (ID 155 or $9B_H$)

Table D- 22 Basic variables phase-specific measurement L3

| Byte | Allocation | Data type | Unit | Value range | Meas- ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 155 ($9B_H$) | - |
| 1 | Quality information = $QQ_1$ $I_3$ $U_3$ $I_2$ $U_2$ $I_1$ $U_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 4 ... 5 | Voltage UL3-N | UINT | 0.01 V | 0 … 65535 | 66003 |
| 6 ... 7 | Active power L3 | INT | 1 W | -27648 … 27648 | 66015 |
| 8 ... 9 | Reactive power L3 | INT | 1 var | -27648 … 27648 | 66018 |
| 10 ... 11 | Apparent power L3 | INT | 1 VA | -27648 … 27648 | 66012 |
| 12 ... 15 | Active energy L3 total (inflow - outflow) | DINT | 1 Wh | -2147483647 to +2147483647 | 62315 |
| 16 ... 19 | Reactive energy L3 total (inflow - outflow) | DINT | 1 varh | -2147483647 to +2147483647 | 62316 |
| 20 ... 23 | Apparent energy L3 | UDINT | 1 VAh | 0 to 2147483647 | 62314 |
| 24 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active power L3 | USINT | - | 0 ... 255 | - |
| 26 | Scaling reactive power L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling apparent power L3 | USINT | - | 0 ... 255 | - |
| 28 | Scaling active energy L3 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 29 | Scaling reactive energy L3 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 30 | Scaling apparent energy L3 | USINT | - | 0 ... 255 | - |
| 31 | Power factor L3 | USINT | 0.01 | 0 … 100 | 66021 |

## Basic variables phase-specific measurement (ID 154 or 9A$_H$)

Table D- 23 Basic variables phase-specific measurement L3a

| Byte | Allocation | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 0 | User data variant | BYTE | - | 154 (9A$_H$) | - |
| 1 | Quality information = QQ$_1$ I$_3$ U$_3$ I$_2$ U$_2$ I$_1$ U$_1$ | BYTE | Bit string | qq xx xx xx | - |
| 2 ... 3 | Current L3 | UINT | 1 mA | 0 … 65535 | 66009 |
| 4 ... 5 | Voltage UL3-N | UINT | 0.01 V | 0 … 65535 | 66003 |
| 6 ... 7 | Active power L3 | INT | 1 W | -27648 … 27648 | 66015 |
| 8 ... 9 | Reactive power L3 | INT | 1 var | -27648 … 27648 | 66018 |
| 10 ... 11 | Apparent power L3 | INT | 1 VA | -27648 … 27648 | 66012 |
| 12 ... 15 | Active energy L3 total (inflow - outflow) | DINT | 1 Wh | -2147483647 to +2147483647 | 62315 |
| 16 ... 19 | Reactive energy L3 total (inflow - outflow) | DINT | 1 varh | -2147483647 to +2147483647 | 62316 |
| 20 ... 23 | Apparent energy L3 | UDINT | 1 VAh | 0 to 2147483647 | 62314 |
| 24 | Scaling current L3 | USINT | - | 0 ... 255 | - |
| 25 | Scaling active power L3 | USINT | - | 0 ... 255 | - |
| 26 | Scaling reactive power L3 | USINT | - | 0 ... 255 | - |
| 27 | Scaling apparent power L3 | USINT | - | 0 ... 255 | - |
| 28 | Scaling active energy L3 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 29 | Scaling reactive energy L3 total (inflow - outflow) | USINT | - | 0 ... 255 | - |
| 30 | Scaling apparent energy L3 | USINT | - | 0 ... 255 | - |
| 31 | Scaling voltage UL3-N | USINT | - | 0 ... 255 | - |

# Measured value data records

# E

## E.1 Overview of all measured value data records

Energy Meter 480VAC ST writes the measured values in several data records that you can read acyclically using the RDREC instruction in the user program.

The following tables show the structure of the individual data records:

- Data record DS 142 for basic measured values (read only).
- Data record DS 143 for energy counters (read and write).
- Data record DS 144 for maximum values (read only).
- Data record DS 145 for minimum values (read only).
- Data record DS 147 for phase-specific measured values L1 (read only).
- Data record DS 148 for phase-specific measured values L2 (read only).
- Data record DS 149 for phase-specific measured values L3 (read only).
- Data record DS 150 for advanced measurement and status values (read only).

---

**Note**

- The cumulative value of the energy counters in 3-phase operation is obtained from the sums of the respective individual values of the phases.
- Inflow and outflow energy meters are always positive values.
- The operating hours counter for the entire module is calculated from the maximum of the operating hours of the individual phases.

---

# E.2 Measured value data record for base measurements (DS 142)

## Measured variables of the module

The following table provides an overview of all the measured variables that data record 142 supplies. Please note that, depending on the connection type used the display of some measured variables does not make sense and that the module deletes measured values that are not relevant.

The measured value identification (measured value ID) is an index which references the overview table of the measured variables in appendix B (Measured variables (Page 131)).

Table E- 1 Data record 142

| **Byte** | **Measured variable** | **Data type** | **Unit** | **Value range** | **Meas-ured value ID** |
|---|---|---|---|---|---|
| 0 | Version | BYTE | - | 1 | - |
| 1 | Reserved | BYTE | - | 0 | - |
| 2...5 | Voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 1 |
| 6...9 | Voltage UL2-N | REAL | V | 0.0 ... 1000000.0 | 2 |
| 10...13 | Voltage UL3-N | REAL | V | 0.0 ... 1000000.0 | 3 |
| 14...17 | Voltage UL1-L2 | REAL | V | 0.0 ... 1000000.0 | 4 |
| 18...21 | Voltage UL2-L3 | REAL | V | 0.0 ... 1000000.0 | 5 |
| 22...25 | Voltage UL3-L1 | REAL | V | 0.0 ... 1000000.0 | 6 |
| 26...29 | Current L1 | REAL | A | 0.0 … 100000.0 | 7 |
| 30...33 | Current L2 | REAL | A | 0.0 … 100000.0 | 8 |
| 34...37 | Current L3 | REAL | A | 0.0 … 100000.0 | 9 |
| 38...41 | Power factor L1 | REAL | - | 0.0 ... 1.0 | 19 |
| 42...45 | Power factor L2 | REAL | - | 0.0 ... 1.0 | 20 |
| 46...49 | Power factor L3 | REAL | - | 0.0 ... 1.0 | 21 |
| 50...53 | Total power factor L1L2L3 | REAL | - | 0.0 ... 1.0 | 37 |
| 54...57 | Frequency | REAL | 1 Hz | 45.0 ... 65.0 | 30 |
| 58...61 | Amplitude unbalance for voltage | REAL | % | 0 ... 100 | 38 |
| 62...65 | Amplitude unbalance for current | REAL | % | 0 to 100 | 39 |
| 66...69 | Apparent power L1 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 10 |
| 70...73 | Apparent power L2 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 11 |
| 74...77 | Apparent power L3 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 12 |
| 78...81 | Total apparent power L1L2L3 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 36 |
| 82...85 | Reactive power L1 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 16 |
| 86...89 | Reactive power L2 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 17 |
| 90...93 | Reactive power L3 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 18 |
| 94...97 | Total reactive power L1L2L3 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 35 |
| 98...101 | Active power L1 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 13 |

| Byte | Measured variable | Data type | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 102...105 | Active power L2 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 14 |
| 106...109 | Active power L3 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 15 |
| 110...113 | Total active power L1L2L3 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 34 |
| 114...117 | Phase angle L1 | REAL | ° | 0.0 ... 360.0 | 61178 |
| 118...121 | Phase angle L2 | REAL | ° | 0.0 ... 360.0 | 61198 |
| 122...125 | Phase angle L3 | REAL | ° | 0.0 ... 360.0 | 61218 |
| 126...129 | Total apparent energy L1L2L3 | REAL | VAh | 0.0 ... $3.4 \times 10^{38}$ | 204 |
| 130...133 | Total reactive energy L1L2L3 | REAL | varh | $-3.4 \times 10^{38}$ to $+3.4 \times 10^{38}$ | 206 |
| 134...137 | Total active energy L1L2L3 | REAL | Wh | $-3.4 \times 10^{38}$ to $+3.4 \times 10^{38}$ | 205 |
| 138...141 | Total reactive energy inflow L1L2L3 | REAL | varh | 0.0 ... $3.4 \times 10^{38}$ | 202 |
| 142...145 | Total reactive energy outflow L1L2L3 | REAL | varh | 0.0 ... $3.4 \times 10^{38}$ | 203 |
| 146...149 | Total active energy inflow L1L2L3 | REAL | Wh | 0.0 ... $3.4 \times 10^{38}$ | 200 |
| 150...153 | Total active energy outflow L1L2L3 | REAL | Wh | 0.0 ... $3.4 \times 10^{38}$ | 201 |
| 154...161 | Total apparent energy L1L2L3 | LREAL | VAh | 0.0 ... $1.8 \times 10^{308}$ | 214 |
| 162...169 | Total reactive energy L1L2L3 | LREAL | varh | $-1.8 \times 10^{308}$ to $+1.8 \times 10^{308}$ | 216 |
| 170...177 | Total active energy L1L2L3 | LREAL | Wh | $-1.8 \times 10^{308}$ to $+1.8 \times 10^{308}$ | 215 |
| 178...185 | Total reactive energy inflow L1L2L3 | LREAL | varh | 0.0 ... $1.8 \times 10^{308}$ | 212 |
| 186...193 | Total reactive energy outflow L1L2L3 | LREAL | varh | 0.0 ... $1.8 \times 10^{308}$ | 213 |
| 194...201 | Total active energy inflow L1L2L3 | LREAL | Wh | 0.0 ... $1.8 \times 10^{308}$ | 210 |
| 202...209 | Total active energy outflow L1L2L3 | LREAL | Wh | 0.0 ... $1.8 \times 10^{308}$ | 211 |
| 210...213 | Neutral current | REAL | A | 0.0 ... 100000.0 | 61149 |

## Neutral current

If you operate the AI Energy Meter 480VAC ST with connection type 3P4W, the neutral current is also measured under the following conditions:

- Transmission factors of all phase currents (primary and secondary currents) are identical.
- Measured phase currents are greater than the value of the "Low limit for measuring current parameter.

  The neutral current is subject to a "Low limit for measuring current" like all other measured current values. The lowest value of all three configured low limits is used as the minimum value.

If one of the conditions is not met, 0 is entered as the value for the neutral current. You can read the neutral current calculated using measured value data record 142.

## Procedure

Data record 142 is located on the AI Energy Meter 480VAC ST. Use SFB "RDREC" to read out the data record from the module. This system function block is stored in the STEP 7 library.

## Measured values in STEP 7 as of V5.5

Measured values are represented as negative values in STEP 7 as of V5.5 if the value range of the integer format (32767 dec) is exceeded. This is not an error in the measured value. Solution: Select hexadecimal representation.

## Conversion of 64-bit floating-point numbers

If you cannot process 64-bit floating-point numbers in your automation system, we recommend conversion to 32-bit floating-point numbers. Note the conversion can cause loss of accuracy. For a description of the conversion of the 64-bit floating-point numbers (data type LREAL) into 32-bit floating-point numbers (data type REAL) please refer to the Internet (http://support.automation.siemens.com/WW/view/en/56600676).

# E.3 Structure for energy counters (DS 143)

## Energy meter data record 143 for different actions

The energy meter data record 143 includes all energy meters available on the module phase-by-phase. The data record can be used for different actions:

- Reset the energy counter to user-specific value (e.g. "0")
- Reading the current values of the energy counters
- Reading the overflow counters
- Reading the operating hours

## Energy meter data record 143

Table E- 2 Energy meter data record 143

| Byte | Measured variable | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | Version | BYTE | - | 1 | - |
| 1 | Reserved | BYTE | - | 0 | - |
| 2 | Status / control byte 1 - L1 | BYTE | Bit string | - | - |
| 3 | Status / control byte 2 - L1 | BYTE | Bit string | | |
| 4 | Status / control byte 1 - L2 | BYTE | Bit string | | |
| 5 | Status / control byte 2 - L2 | BYTE | Bit string | | |
| 6 | Status / control byte 1 - L3 | BYTE | Bit string | | |
| 7 | Status / control byte 2 - L3 | BYTE | Bit string | | |
| 8...15 | Active energy inflow (initial value) L1 | LREAL | Wh | During reading:<br>0.0...1.8 x $10^{308}$<br>During writing<br>For continuous counting:<br>0.0...3.4 x $10^{12}$<br>During writing<br>For periodic counting: | 61180 |
| 16...23 | Active energy outflow (initial value) L1 | LREAL | Wh | | 61181 |
| 24...31 | Reactive energy inflow (initial value) L1 | LREAL | varh | | 61182 |
| 32...39 | Reactive energy outflow (initial value) L1 | LREAL | varh | | 61183 |
| 40...47 | Apparent energy (initial value) L1 | LREAL | VAh | | 61184 |
| 48...55 | Active energy inflow (initial value) L2 | LREAL | Wh | | 61200 |
| 56...63 | Active energy outflow (initial value) L2 | LREAL | Wh | | 61201 |
| 64...61 | Reactive energy inflow (initial value) L2 | LREAL | varh | | 61202 |
| 72...79 | Reactive energy outflow (initial value) L2 | LREAL | varh | | 61203 |
| 80...87 | Apparent energy (initial value) L2 | LREAL | VAh | | 61204 |
| 88...95 | Active energy inflow (initial value) L3 | LREAL | Wh | | 61220 |

| Byte | Measured variable | Data type | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 96...103 | Active energy outflow (initial value) L3 | LREAL | Wh | 0...configured full-scale value ($10^3$ ...$10^{15}$) | 61221 |
| 104...111 | Reactive energy inflow (initial value) L3 | LREAL | varh | | 61222 |
| 112...119 | Reactive energy outflow (initial value) L3 | LREAL | varh | | 61223 |
| 120...127 | Apparent energy (initial value) L3 | LREAL | VAh | | 61224 |
| 128...129 | Overflow counter active energy inflow L1 | UINT | - | During reading:<br>0...65535<br>During writing for continuous counting:<br>0<br>During writing for periodic counting:<br>0...65500 | 61190 |
| 130..131 | Overflow counter active energy outflow L1 | UINT | - | | 61191 |
| 132...133 | Overflow counter reactive energy inflow L1 | UINT | - | | 61192 |
| 134...135 | Overflow counter reactive energy outflow L1 | UINT | - | | 61193 |
| 136...137 | Overflow counter apparent energy L1 | UINT | - | | 61194 |
| 138...139 | Overflow counter active energy inflow L2 | UINT | - | | 61210 |
| 140...141 | Overflow counter active energy outflow L2 | UINT | - | | 61211 |
| 142...143 | Overflow counter reactive energy inflow L2 | UINT | - | | 61212 |
| 144...145 | Overflow counter reactive energy outflow L2 | UINT | - | | 61213 |
| 146...147 | Overflow counter apparent energy L2 | UINT | - | | 61214 |
| 148...149 | Overflow counter active energy inflow L3 | UINT | - | | 61230 |
| 150...151 | Overflow counter active energy outflow L3 | UINT | - | | 61231 |
| 152...153 | Overflow counter reactive energy inflow L3 | UINT | - | | 61232 |
| 154...155 | Overflow counter reactive energy outflow L3 | UINT | - | | 61233 |
| 156...157 | Overflow counter apparent energy L3 | UINT | - | | 61234 |
| 158...161 | Operating hours counter L1 (initial value) | REAL | h | During reading:<br>0...3.4x$10^{38}$<br>During writing:<br>0...$10^9$ | 65505 |
| 162...165 | Operating hours counter L2 (initial value) | REAL | h | | 65506 |
| 166...169 | Operating hours counter L3 (initial value) | REAL | h | | 65507 |

## Status information

When data record 143 is read with the RDREC instruction, Bytes 2 to 7 supply phase-specific status information for energy counters, overflow counters and operating hours counters.

The status information enables you can see which counters are returning their values in the data record 143. If energy counters return their values in the status byte 1, you can determine the type of energy counter with status byte 2.

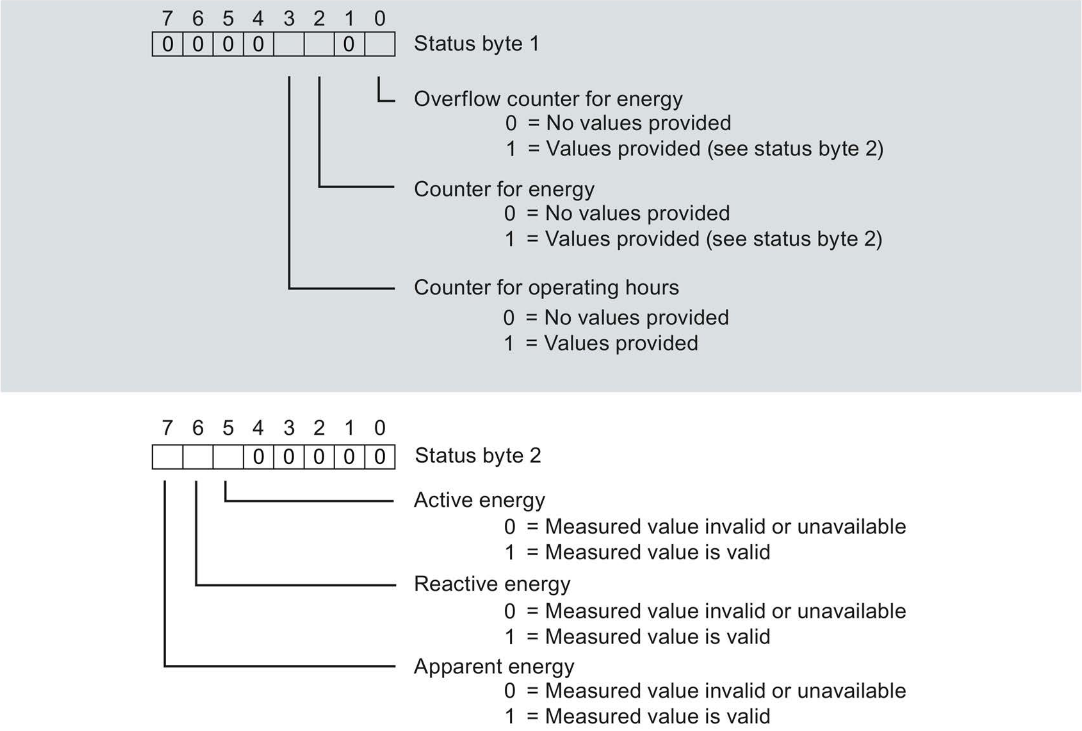
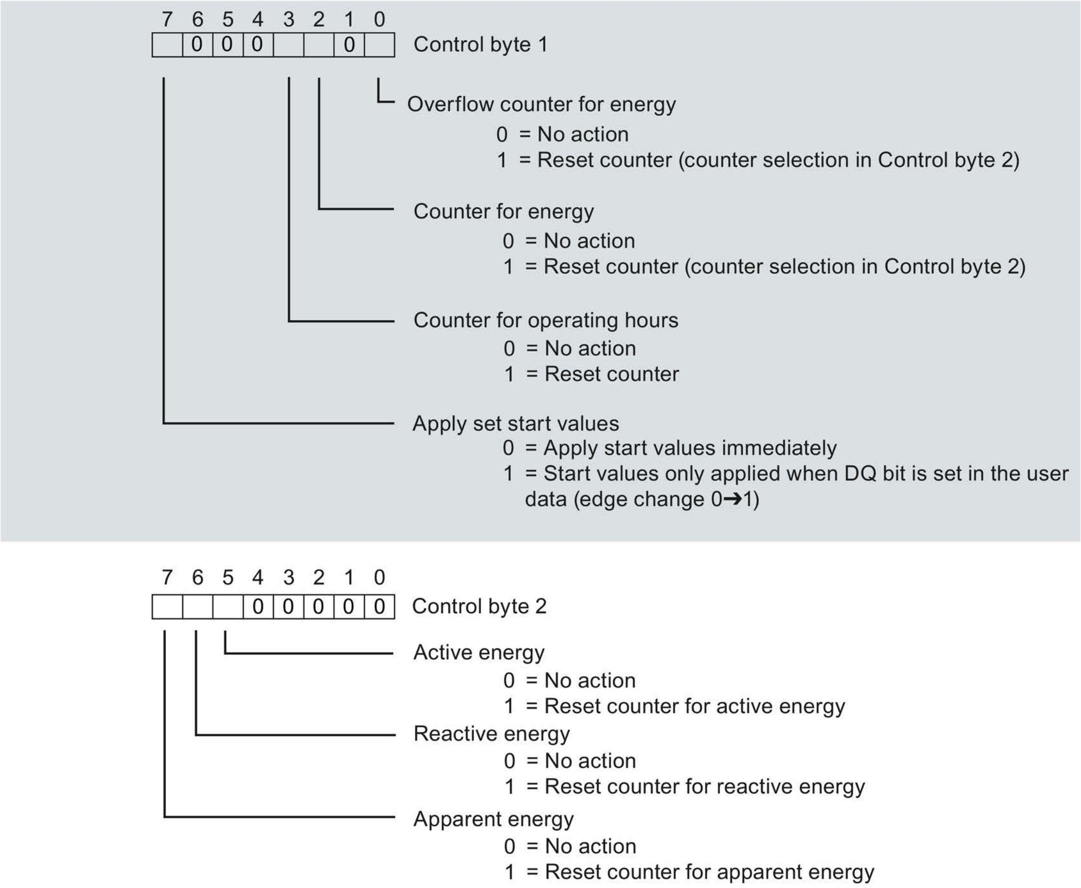


Figure E-1 Status information DS 143 (read access)

## Control information

When data record 143 is written with the WRREC instruction, Bytes 2 to 7 are used as phase-specific control information for energy counters, overflow counters and operating hours counter. The length of the control information amounts to 2 bytes for each phase:

- In control byte 1 you determine which counter you want to reset and the time at which counters are reset.
- In Control byte 2 you determine which energy counters and which overflow counters you want to reset.



Overflow counter for energy
0 = No action
1 = Reset counter (counter selection in Control byte 2)

Counter for energy
0 = No action
1 = Reset counter (counter selection in Control byte 2)

Counter for operating hours
0 = No action
1 = Reset counter

Apply set start values
0 = Apply start values immediately
1 = Start values only applied when DQ bit is set in the user data (edge change 0➔1)

Active energy
0 = No action
1 = Reset counter for active energy

Reactive energy
0 = No action
1 = Reset counter for reactive energy

Apparent energy
0 = No action
1 = Reset counter for apparent energy

Figure E-2 Control information DS 143 (write access)

## Error while transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module apply the values from the data record.

The WRREC instruction for writing data records returns corresponding error codes when errors occur in the STATUS parameter.

The following table shows the module-specific error codes and their meaning for the measured value data record 143:

| Error code in STATUS parameter (hexadecimal) | | | | Meaning | Solution |
|---|---|---|---|---|---|
| Byte 0 | Byte 1 | Byte 2 | Byte 3 | | |
| DF | 80 | B0 | 00 | Number of the data record unknown | Enter a valid number for the data record. |
| DF | 80 | B1 | 00 | Length of the data record incorrect | Enter a valid value for the data record length. |
| DF | 80 | B2 | 00 | Slot invalid or cannot be accessed. | Check the station whether the module is plugged or drawn.<br>Check the assigned values for the parameters of the WRREC instruction |
| DF | 80 | E1 | 01 | Reserved bits are not 0. | Check Byte 2...7 and set the reserved bits back to 0. |
| DF | 80 | E1 | 39 | Incorrect version entered. | Check Byte 0. Enter a valid version. |
| DF | 80 | E1 | 3A | Incorrect data record length entered. | Check the parameters of the WRREC instruction. Enter a valid length. |
| DF | 80 | E1 | 3C | At least one start value is invalid. | Check Bytes 8...103 and Bytes 158...169. The start values may not be negative. |
| DF | 80 | E1 | 3D | At least one start value is too large | Check Bytes 8...103 and Bytes 158...169. Observe the ranges of values for start values. |

# E.4 Measured value data record for maximum values (DS 144)

## Measured variables of the module

The largest values ever measured or calculated from the time AI Energy Meter 480VAC ST was started are stored in this data record.

| Byte | Measured variable | Format | Unit | Default | Measured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 0 | Version | BYTE | - | 0 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 1 | Reserved | BYTE | - | 0 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2...5 | Max. voltage UL1-N | REAL | V | 0 | 40 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6...9 | Max. voltage UL2-N | REAL | V | 0 | 41 | | ✓ | ✓ | ✓ | ✓ |
| 10...13 | Max. voltage UL3-N | REAL | V | 0 | 42 | | ✓ | | ✓ | ✓ |
| 14...17 | Max. voltage UL1-L2 | REAL | V | 0 | 43 | | | | ✓ | ✓ |
| 18...21 | Max. voltage UL2-L3 | REAL | V | 0 | 44 | | | | ✓ | ✓ |
| 22...25 | Max. voltage UL3-L1 | REAL | V | 0 | 45 | | | | ✓ | ✓ |
| 26...29 | Max. current L1 [1] | REAL | A | 0 | 46 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 30...33 | Max. current L2 [1] | REAL | A | 0 | 47 | | ✓ | ✓ | ✓ | ✓ |
| 34...37 | Max. current L3 [1] | REAL | A | 0 | 48 | | ✓ | | ✓ | ✓ |
| 38...41 | Max. apparent power L1 | REAL | VA | 0 | 49 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 42...45 | Max. apparent power L2 | REAL | VA | 0 | 50 | | ✓ | ✓ | ✓ | ✓ |
| 46...49 | Max. apparent power L3 | REAL | VA | 0 | 51 | | ✓ | | ✓ | ✓ |
| 50...53 | Max. active power L1 | REAL | W | $-3.0 \times 10^9$ | 52 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 54...57 | Max. active power L2 | REAL | W | $-3.0 \times 10^9$ | 53 | | ✓ | ✓ | ✓ | ✓ |
| 58...61 | Max. active power L3 | REAL | W | $-3.0 \times 10^9$ | 54 | | ✓ | | ✓ | ✓ |
| 62...65 | Max. reactive power L1 | REAL | var | $-3.0 \times 10^9$ | 55 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66...69 | Max. reactive power L2 | REAL | var | $-3.0 \times 10^9$ | 56 | | ✓ | ✓ | ✓ | ✓ |
| 70...73 | Max. reactive power L3 | REAL | var | $-3.0 \times 10^9$ | 57 | | ✓ | | ✓ | ✓ |

| Byte | Measured variable | Format | Unit | Default | Meas-ured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 74...77 | Max. power factor L1 | REAL | - | 0 | 58 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 78...81 | Max. power factor L2 | REAL | - | 0 | 59 | | ✓ | ✓ | ✓ | ✓ |
| 82...85 | Max. power factor L3 | REAL | - | 0 | 60 | | ✓ | | ✓ | ✓ |
| 86...89 | Max. frequency | REAL | Hz | 45 | 61 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 90...93 | Max. total apparent power | REAL | VA | 0 | 65 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 94...97 | Max. total active power | REAL | W | $-3.0 \times 10^9$ | 66 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 98...101 | Max. total reactive power | REAL | var | $-3.0 \times 10^9$ | 67 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 102 | Max. total power factor | REAL | - | 0 | 68 | ✓ | ✓ | ✓ | ✓ | ✓ |

[1] The values reference the amount of the current measured value

# E.5 Measured value data record for minimum values (DS 145)

## Measured variables of the module

The smallest values ever measured or calculated from the time AI Energy Meter 480VAC ST was started are stored in this data record.

| Byte | Measured variable | Format | Unit | Default | Meas-ured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 0 | Version | BYTE | - | 0 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 1 | Reserved | BYTE | - | 0 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2...5 | Min. voltage UL1-N | REAL | V | 1000000 | 70 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 6...9 | Min. voltage UL2-N | REAL | V | 1000000 | 71 | | ✓ | ✓ | ✓ | ✓ |
| 10...13 | Min. voltage UL3-N | REAL | V | 1000000 | 72 | | ✓ | | ✓ | ✓ |
| 14...17 | Min. voltage UL1-L2 | REAL | V | 1800000 | 73 | | | | ✓ | ✓ |
| 18...21 | Min. voltage UL2-L3 | REAL | V | 1800000 | 74 | | | | ✓ | ✓ |
| 22...25 | Min. voltage UL3-L1 | REAL | V | 1800000 | 75 | | | | ✓ | ✓ |
| 26...29 | Min. current L1 [1] | REAL | A | 100000 | 76 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 30...33 | Min. current L2 [1] | REAL | A | 100000 | 77 | | ✓ | ✓ | ✓ | ✓ |
| 34...37 | Min. current L3 [1] | REAL | A | 100000 | 78 | | ✓ | | ✓ | ✓ |
| 38...41 | Min. apparent power L1 | REAL | VA | +3.0 x $10^9$ | 79 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 42...45 | Min. apparent power L2 | REAL | VA | +3.0 x $10^9$ | 80 | | ✓ | ✓ | ✓ | ✓ |
| 46...49 | Min. apparent power L3 | REAL | VA | +3.0 x $10^9$ | 81 | | ✓ | | ✓ | ✓ |
| 50...53 | Min. active power L1 | REAL | W | +3.0 x $10^9$ | 82 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 54...57 | Min. active power L2 | REAL | W | +3.0 x $10^9$ | 83 | | ✓ | ✓ | ✓ | ✓ |
| 58...61 | Min. active power L3 | REAL | W | +3.0 x $10^9$ | 84 | | ✓ | | ✓ | ✓ |
| 62...65 | Min. reactive power L1 | REAL | var | +3.0 x $10^9$ | 85 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 66...69 | Min. reactive power L2 | REAL | var | +3.0 x $10^9$ | 86 | | ✓ | ✓ | ✓ | ✓ |
| 70...73 | Min. reactive power L3 | REAL | var | +3.0 x $10^9$ | 87 | | ✓ | | ✓ | ✓ |
| 74...77 | Min. power factor L1 | REAL | - | 1 | 88 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 78...81 | Min. power factor L2 | REAL | - | 1 | 89 | | ✓ | ✓ | ✓ | ✓ |
| 82...85 | Min. power factor L3 | REAL | - | 1 | 90 | | ✓ | | ✓ | ✓ |
| 86...89 | Min. frequency | REAL | Hz | 65 | 91 | ✓ | ✓ | ✓ | ✓ | ✓ |

| **Byte** | **Measured variable** | **Format** | **Unit** | **Default** | **Measured value ID** | **Connection type** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **1P2W** | **3x1P2W** | **2P3W** | **3P4W** | **3P4W1** |
| 90...93 | Min. total apparent power | REAL | VA | $+3.0 \times 10^9$ | 95 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 94...97 | Min. total active power | REAL | W | $+3.0 \times 10^9$ | 96 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 98...101 | Min. total reactive power | REAL | var | $+3.0 \times 10^9$ | 97 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 102 | Min. total power factor | REAL | - | 1 | 98 | ✓ | ✓ | ✓ | ✓ | ✓ |

[1] The values reference the amount of the current measured value

# E.6 Measured value data record for phase-based measured values L1 (DS 147)

## Measured variables of the module (DS 147)

| Byte | Measured variable | Format | Unit | Value range | Measured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 0 | Version | BYTE | - | 1 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 1 | Reserved | BYTE | - | 0 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2...3 | Qualifier L1 | WORD | Bit field | 0b 00 00 00 00<br>0b qq 00 00 xx | 65500 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4...7 | Voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 1 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 8...11 | Current L1 | REAL | A | 0.0 … 100000.0 | 7 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 12...15 | Apparent power L1 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 10 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 16...19 | Active power L1 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 13 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 20...23 | Reactive power L1 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 16 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 24...27 | Power factor L1 | REAL | - | 0.0 ... 1.0 | 19 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 28...31 | Phase angle L1 | REAL | ° | 0.0 ... 360.0 | 61178 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 32...39 | Apparent energy L1 | LREAL | VAh | 0.0 ... $1.8 \times 10^{308}$ | 61184 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 40...47 | Active energy (total) L1 | LREAL | Wh | $-1.8 \times 10^{308}$ ... $+1.8 \times 10^{308}$ | 61185 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 48...55 | Reactive energy (total) L1 | LREAL | varh | $-1.8 \times 10^{308}$ ... $+1.8 \times 10^{308}$ | 61186 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 56...59 | Max. voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 40 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 60...63 | Max. current L1 | REAL | A | 0.0 ... 100000.0 | 46 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 64...67 | Max. apparent power L1 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 49 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 68...71 | Max. active power L1 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 52 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 72...75 | Max. reactive power L1 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 55 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 76...79 | Max. power factor L1 | REAL | - | 0.0 ... 1.0 | 58 | ✓ | ✓ | ✓ | ✓ | ✓ |

| Byte | Measured variable | Format | Unit | Value range | Measured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 80...83 | Min. voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 70 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 84...87 | Min. current L1 | REAL | A | 0.0 ... 100000.0 | 76 | ✓ | | | | |
| 88...91 | Min. apparent power L1 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 79 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 92...95 | Min. active power L1 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 83 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 96...99 | Min. reactive power L1 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 85 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 100...103 | Min. power factor L1 | REAL | - | 0.0 ... 1.0 | 88 | ✓ | ✓ | ✓ | ✓ | ✓ |

# E.7 Measured value data record for phase-based measured values L2 (DS 148)

## Measured variables of the module (DS 148)

| Byte | Measured variable | Format | Unit | Value range | Measured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 0 | Version | BYTE | - | 1 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 1 | Reserved | BYTE | - | 0 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2...3 | Qualifier L2 | WORD | Bit field | 0b 00 00 00 00<br>0b qq 00 00 xx | 65501 | | ✓ | ✓ | ✓ | ✓ |
| 4...7 | Voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 2 | | ✓ | ✓ | ✓ | ✓ |
| 8...11 | Current L2 | REAL | A | 0.0 … 100000.0 | 8 | | ✓ | ✓ | ✓ | ✓ |
| 12...15 | Apparent power L2 | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | 11 | | ✓ | ✓ | ✓ | ✓ |
| 16...19 | Active power L2 | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | 14 | | ✓ | ✓ | ✓ | ✓ |
| 20...23 | Reactive power L2 | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | 17 | | ✓ | ✓ | ✓ | ✓ |
| 24...27 | Power factor L2 | REAL | - | 0.0 ... 1.0 | 20 | | ✓ | ✓ | ✓ | ✓ |
| 28...31 | Phase angle L2 | REAL | ° | 0.0 ... 360.0 | 61198 | | ✓ | ✓ | ✓ | ✓ |
| 32...39 | Apparent energy L2 | LREAL | VAh | 0.0 ... 1.8 x $10^{308}$ | 61204 | | ✓ | ✓ | ✓ | ✓ |
| 40...47 | Active energy (total) L2 | LREAL | Wh | -1.8 x $10^{308}$ to +1.8 x $10^{308}$ | 61205 | | ✓ | ✓ | ✓ | ✓ |
| 48...55 | Reactive energy (total) L2 | LREAL | varh | -1.8 x $10^{308}$ to +1.8 x $10^{308}$ | 61206 | | ✓ | ✓ | ✓ | ✓ |
| 56...59 | Max. voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 41 | | ✓ | ✓ | ✓ | ✓ |
| 60...63 | Max. current L2 | REAL | A | 0.0 ... 100000.0 | 47 | | ✓ | ✓ | ✓ | ✓ |
| 64...67 | Max. apparent power L2 | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | 50 | | ✓ | ✓ | ✓ | ✓ |
| 68...71 | Max. active power L2 | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | 53 | | ✓ | ✓ | ✓ | ✓ |
| 72...75 | Max. reactive power L2 | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | 56 | | ✓ | ✓ | ✓ | ✓ |
| 76...79 | Max. power factor L2 | REAL | - | 0.0 ... 1.0 | 59 | | ✓ | ✓ | ✓ | ✓ |

| **Byte** | **Measured variable** | **Format** | **Unit** | **Value range** | **Measured value ID** | **Connection type** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **1P2W** | **3x1P2W** | **2P3W** | **3P4W** | **3P4W1** |
| 80...83 | Min. voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 71 | | ✓ | ✓ | ✓ | ✓ |
| 84...87 | Min. current L2 | REAL | A | 0.0 ... 100000.0 | 77 | | | | | |
| 88...91 | Min. apparent power L2 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 80 | | ✓ | ✓ | ✓ | ✓ |
| 92...95 | Min. active power L2 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 84 | | ✓ | ✓ | ✓ | ✓ |
| 96...99 | Min. reactive power L2 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 86 | | ✓ | ✓ | ✓ | ✓ |
| 100...103 | Min. power factor L2 | REAL | - | 0.0 ... 1.0 | 89 | | ✓ | ✓ | ✓ | ✓ |

# E.8 Measured value data record for phase-based measured values L3 (DS 149)

### Measured variables of the module (DS 149)

| Byte | Measured variable | Format | Unit | Value range | Measured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 0 | Version | BYTE | - | 1 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 1 | Reserved | BYTE | - | 0 | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2...3 | Qualifier L3 | WORD | Bit field | 0b 00 00 00 00<br>0b qq 00 00 xx | 65502 | | ✓ | | ✓ | ✓ |
| 4...7 | Voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 3 | | ✓ | | ✓ | ✓ |
| 8...11 | Current L3 | REAL | A | 0.0 … 100000.0 | 9 | | ✓ | | ✓ | ✓ |
| 12...15 | Apparent power L3 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 12 | | ✓ | | ✓ | ✓ |
| 16...19 | Active power L3 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 15 | | ✓ | | ✓ | ✓ |
| 20...23 | Reactive power L3 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 18 | | ✓ | | ✓ | ✓ |
| 24...27 | Power factor L3 | REAL | - | 0.0 ... 1.0 | 21 | | ✓ | | ✓ | ✓ |
| 28...31 | Phase angle L3 | REAL | ° | 0.0 ... 360.0 | 61218 | | ✓ | | ✓ | ✓ |
| 32...39 | Apparent energy L3 | LREAL | VAh | 0.0 ... $1.8 \times 10^{308}$ | 61224 | | ✓ | | ✓ | ✓ |
| 40...47 | Active energy (total) L3 | LREAL | Wh | $-1.8 \times 10^{308}$ to $+1.8 \times 10^{308}$ | 61225 | | ✓ | | ✓ | ✓ |
| 48...55 | Reactive energy (total) L3 | LREAL | varh | $-1.8 \times 10^{308}$ to $+1.8 \times 10^{308}$ | 61226 | | ✓ | | ✓ | ✓ |
| 56...59 | Max. voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 42 | | ✓ | | ✓ | ✓ |
| 60...63 | Max. current L3 | REAL | A | 0.0 ... 100000.0 | 48 | | ✓ | | ✓ | ✓ |
| 64...67 | Max. apparent power L3 | REAL | VA | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 51 | | ✓ | | ✓ | ✓ |
| 68...71 | Max. active power L3 | REAL | W | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 53 | | ✓ | | ✓ | ✓ |
| 72...75 | Max. reactive power L3 | REAL | var | $-3.0 \times 10^9$ … $+3.0 \times 10^9$ | 57 | | ✓ | | ✓ | ✓ |
| 76...79 | Max. power factor L3 | REAL | - | 0.0 ... 1.0 | 60 | | ✓ | | ✓ | ✓ |

| Byte | Measured variable | Format | Unit | Value range | Measured value ID | Connection type | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1P2W | 3x1P2W | 2P3W | 3P4W | 3P4W1 |
| 80...83 | Min. voltage UL1-N | REAL | V | 0.0 ... 1000000.0 | 72 | | ✓ | | ✓ | ✓ |
| 84...87 | Min. current L3 | REAL | A | 0.0 ... 100000.0 | 78 | | | | | |
| 88...91 | Min. apparent power L3 | REAL | VA | -3.0 x $10^9$ … +3.0 x $10^9$ | 81 | | ✓ | | ✓ | ✓ |
| 92...95 | Min. active power L3 | REAL | W | -3.0 x $10^9$ … +3.0 x $10^9$ | 85 | | ✓ | | ✓ | ✓ |
| 96...99 | Min. reactive power L3 | REAL | var | -3.0 x $10^9$ … +3.0 x $10^9$ | 87 | | ✓ | | ✓ | ✓ |
| 100...103 | Min. power factor L3 | REAL | - | 0.0 ... 1.0 | 90 | | ✓ | | ✓ | ✓ |

# E.9 Measured value data record for advanced measurement and status values (DS 150)

## Measured variables of the module

Data record 150

| Byte | Measured variable | Format | Unit | Value range | Measured value ID |
|---|---|---|---|---|---|
| 0 | Version | BYTE | - | 1 | - |
| 1 | Reserved | BYTE | - | 0 | - |
| 2...5 | Operating hours counter L1L2L3 | REAL | h | 0.0 ... 3.4 x $10^{38}$ | 65504 |
| 6...9 | Operating hours counter L1 | REAL | h | 0.0 ... 3.4 x $10^{38}$ | 65505 |
| 10...13 | Operating hours counter L2 | REAL | h | 0.0 ... 3.4 x $10^{38}$ | 65506 |
| 14...17 | Operating hours counter L3 | REAL | h | 0.0 ... 3.4 x $10^{38}$ | 65507 |
| 18...19 | Status limit violation GW 1...16 | WORD | Bit string | xxxx xxxx xxxx xxxx | 65509 |
| 20...21 | Status of energy counter overflows [1] | WORD | Bit string | xxxx xxxx xxxx xxxx | 65508 |
| 22...25 | Counter limit violation GW 1 | UDINT | - | 0 ... 4294967296 | 65510 |
| 26...29 | Counter limit violation GW 2 | UDINT | - | 0 ... 4294967296 | 65511 |
| 30...33 | Counter limit violation GW 3 | UDINT | - | 0 ... 4294967296 | 65512 |
| 34...37 | Counter limit violation GW 4 | UDINT | - | 0 ... 4294967296 | 65513 |
| 38...41 | Counter limit violation GW 5 | UDINT | - | 0 ... 4294967296 | 65514 |
| 42...45 | Counter limit violation GW 6 | UDINT | - | 0 ... 4294967296 | 65515 |
| 46...49 | Counter limit violation GW 7 | UDINT | - | 0 ... 4294967296 | 65516 |
| 50...53 | Counter limit violation GW 8 | UDINT | - | 0 ... 4294967296 | 65517 |
| 54...57 | Counter limit violation GW 9 | UDINT | - | 0 ... 4294967296 | 65518 |
| 58...61 | Counter limit violation GW 10 | UDINT | - | 0 ... 4294967296 | 65519 |
| 62...65 | Counter limit violation GW 11 | UDINT | - | 0 ... 4294967296 | 65520 |
| 66...69 | Counter limit violation GW 12 | UDINT | - | 0 ... 4294967296 | 65521 |
| 70...73 | Counter limit violation GW 13 | UDINT | - | 0 ... 4294967296 | 65522 |
| 74...77 | Counter limit violation GW 14 | UDINT | - | 0 ... 4294967296 | 65523 |
| 78...81 | Counter limit violation GW 15 | UDINT | - | 0 ... 4294967296 | 65524 |

| Byte | Measured variable | Format | Unit | Value range | Meas-ured value ID |
|---|---|---|---|---|---|
| 82..85 | Counter limit violation GW 16 | UDINT | - | 0 ... 4294967296 | 65525 |
| 86..87 | Qualifier L1L2L3 | WORD | Bit string | xxxx xxxx xxxx xxxx | 65503 |

[1] Energy counters count periodically - counter overflow at:
Bit 0 = 1: Active energy inflow L1
Bit 1 = 1: Active energy outflow L1
Bit 2 = 1: Reactive energy inflow L1
Bit 3 = 1: Reactive energy outflow L1
Bit 4 = 1: Apparent energy L1
Bit 5 = 1: Active energy inflow L2
Bit 6 = 1: Active energy outflow L2
Bit 7 = 1: Reactive energy inflow L2
Bit 8 = 1: Reactive energy outflow L2
Bit 9 = 1: Apparent energy L2
Bit 10 = 1: Active energy inflow L3
Bit 11 = 1: Active energy outflow L3
Bit 12 = 1: Reactive energy inflow L3
Bit 13 = 1: Reactive energy outflow L3
Bit 14 = 1: Apparent energy L3
Bit 15: Reserved

# Tips and tricks

# F

## F.1 Tips and tricks

### Processing and visualizing energy data

On the basis of an application example we show you how the measured values of the AI Energy Meter can be processed further and visualized.

You can find this application example on the Internet (http://support.automation.siemens.com/WW/view/en/86299299)

### IT network

You must create an artificial N-conductor (for example, by means of a 1:1 voltage transformer) in IT networks due to the missing neutral conductor. You can then use the module.