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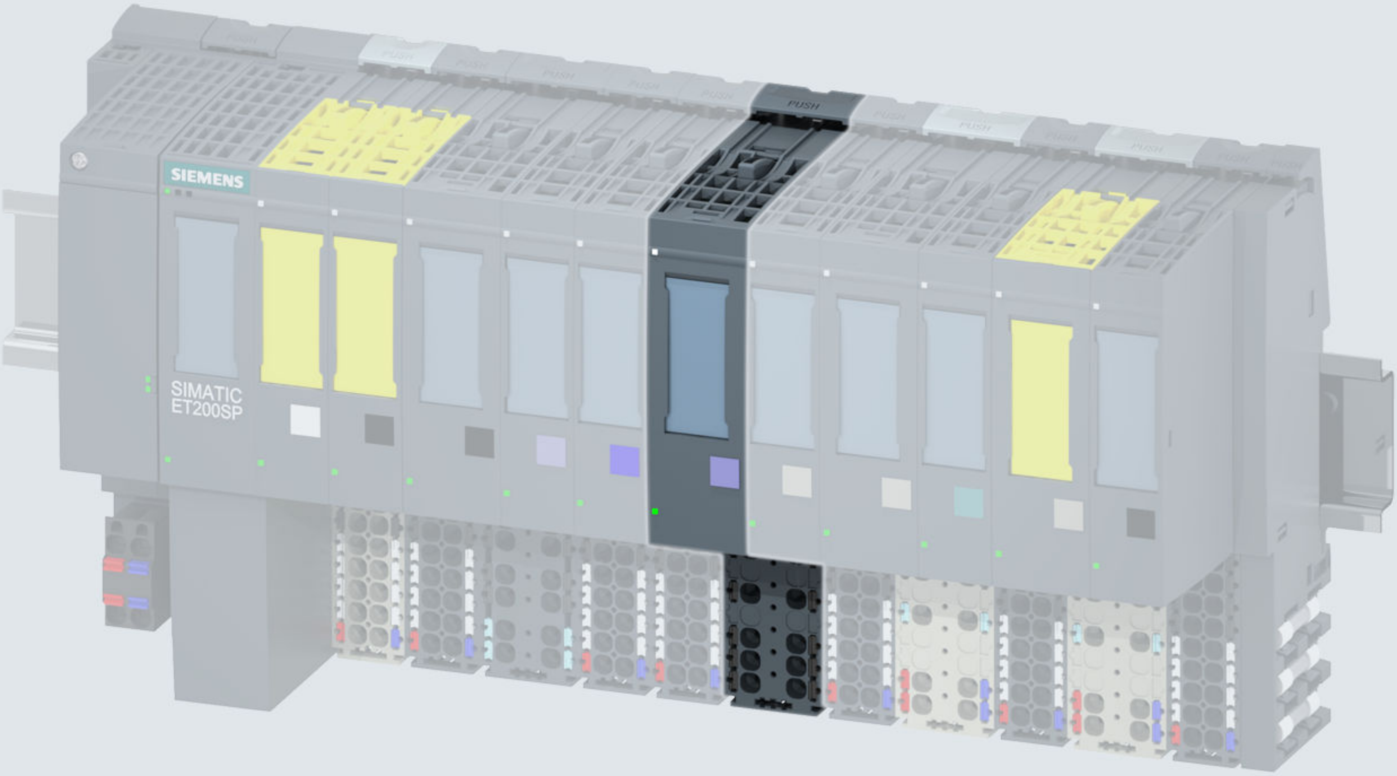

Manual

SIMATIC

ET 200SP

Analog input module
AI Energy Meter 400VAC ST
(6ES7134-6PA01-0BD0)

Edition 10/2017

support.industry.siemens.com

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SIMATIC

ET 200SP Analog input module AI Energy Meter 400VAC ST (6ES7134-6PA01-0BD0)

Manual

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10/2017

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Legal information

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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.

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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:

- User data variant: Basic variables phase-specific measurement (ID 159 or $9F_H$) added
- 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:

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.

Security information

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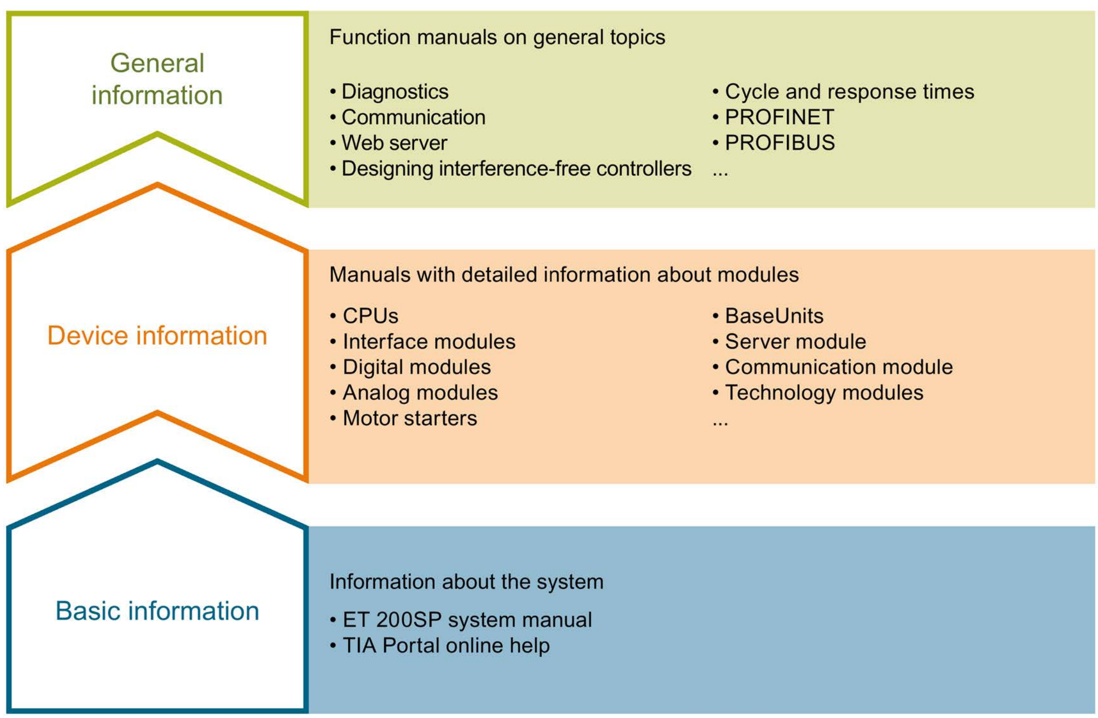
1 Documentation guide

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.



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).

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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).

2 Product overview

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 400VAC ST?

AI Energy Meter 400VAC ST is designed for machine-level deployment in an ET 200SP distributed I/O system. AI Energy Meter 400VAC 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 400VAC 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 400VAC 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 400VAC ST can be used in TN and TT systems.

Measuring with AI Energy Meter 400VAC 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:

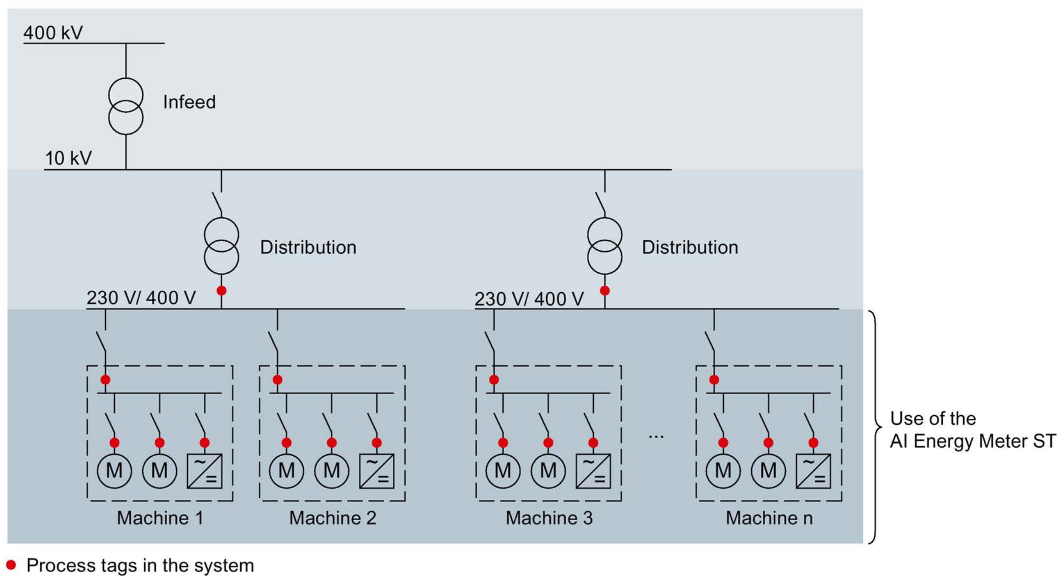


Figure 2-1 Use of the AI Energy Meter 400VAC ST

Advantages of the AI Energy Meter 400VAC ST

The AI Energy Meter 400VAC ST has the following advantages:

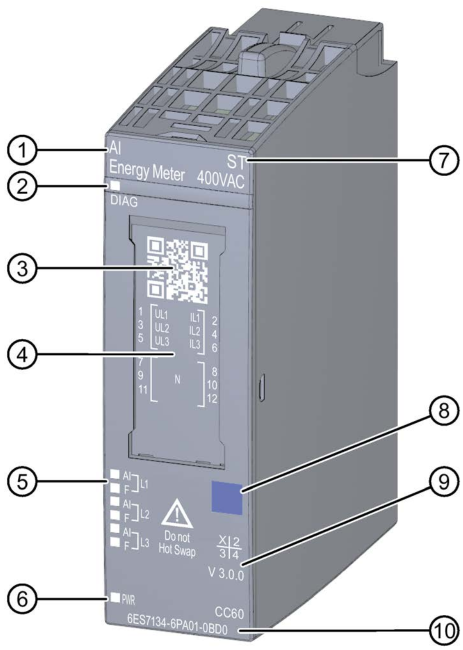
- Space-saving especially for use in control cabinet
- PROFINET IO or PROFIBUS DP (depending on the interface module in use)
- Multiple modules can be used with one interface module
- Extension of existing stations by components for energy recording

2.2 Properties of the AI Energy Meter 400VAC ST

Article number

6ES7134-6PA01-0BD0

View of the module



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

Figure 2-2 View of the module AI Energy Meter 400VAC ST

Properties

The module has the following technical properties:

- Measurement of electrical variables from single-phase and three-phase supply networks
- Max. nominal voltage between two outer conductors 400 VAC
- Recording of:
  - Voltages
  - Currents
  - Phase angles
  - Power
  - Energy / electrical work
  - Frequencies
  - Power factors

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	V3.0.0 or higher	V13 SP1 with update 4 and HSP or higher	V5.5 SP4 and hotfix 7 or higher	X	---
Identification data I&M0 to I&M3	FS01	V3.0.0 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	V3.0.0 or higher	V13 SP1 with update 4 and HSP or higher	V5.5 SP4 and hotfix 7 or higher	X	X
Diagnostic error interrupts	FS01	V3.0.0 or higher	V13 SP1 with update 4 and HSP or higher	V5.5 SP4 and hotfix 7 or higher	X	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.

3 Wiring

3.1 Terminal and block diagram

In an ET 200SP station, the AI Energy Meter 400VAC 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

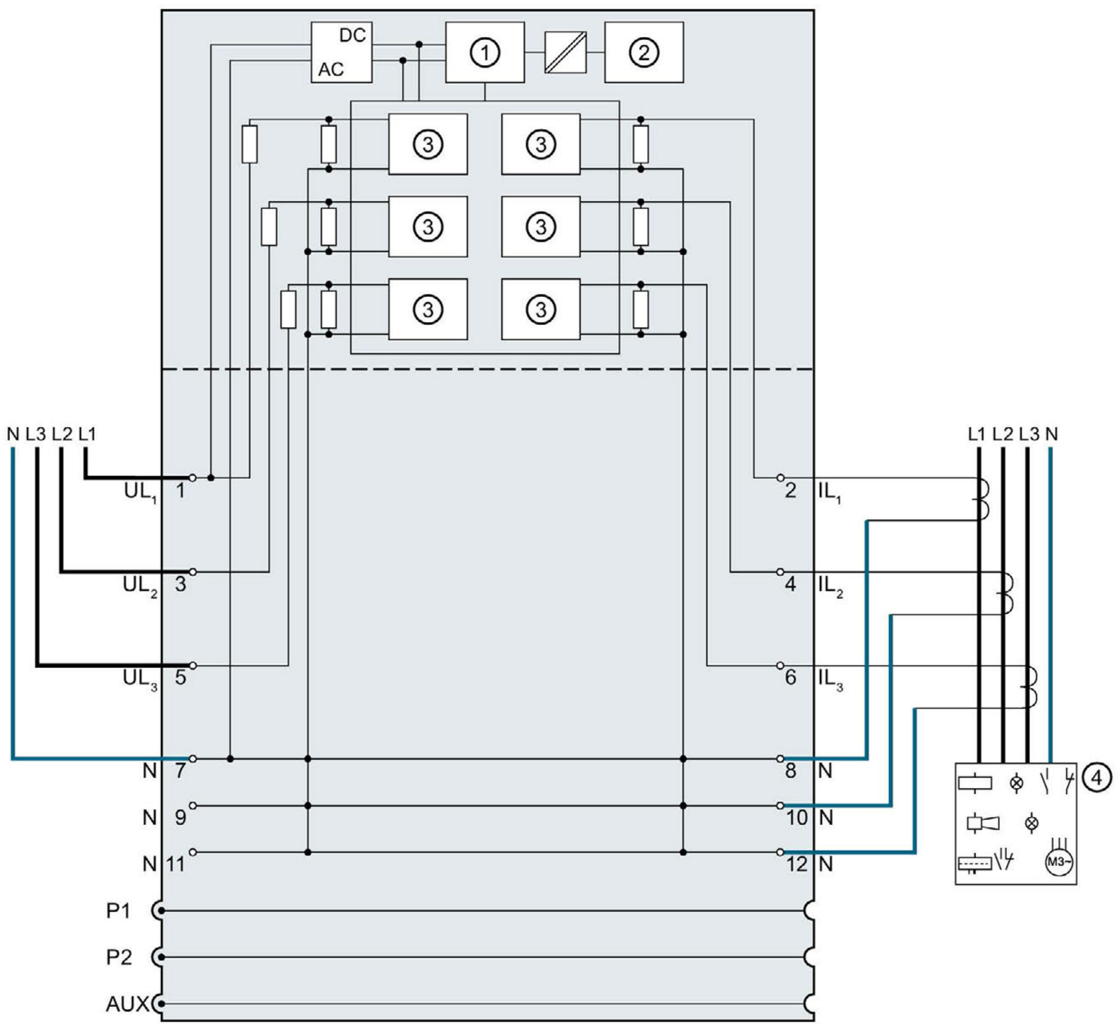
The Energy Meter is supplied through the terminals U_{L1} and N. The required minimum voltage amounts to 85 VAC.

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 400VAC 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 400VAC 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 400VAC 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 400VAC ST is slot 2.

Connection types

The AI Energy Meter 400VAC ST supports the following connection types:

- 3P4W, 3 phases, 4 conductors
- 1P2W, 1 phase, 2 conductors

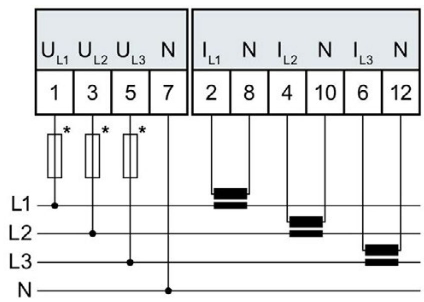
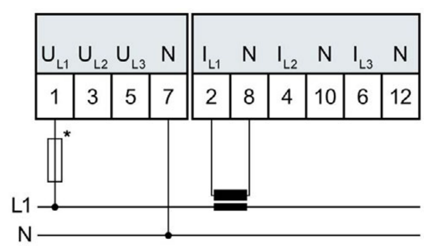
The input circuit of the module must correspond to one of the listed connection types. Select the appropriate connection type for the intended use.

You will find examples of connections in the section Connection examples (Page 19).

Information on the selection of a current transformer is available in the section Current transformer selection data (Page 20).

3.2 Connection examples

The following figures show the connection of the Energy Meter for three-phase and single-phase measurements. Note that the Energy Meter must always be connected via a current transformer.

Connection type	Wiring diagram	Comment
3P4W Three-phase measurement, 4 wires		Any load Connection with three current transformers
1P2W Single-phase measurement, 2 conductors		Measurement in an AC network with a current transformer Energy Meter supplies the value "0" for all measured values of Phases 2 and 3 as well as for some cross-phase measured values.

If short-circuit resistance is ensured by conformity to IEC 61439-1:2009, there is no need for separate line protection for the AI Energy Meter 400VAC 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.
- Transformer secondary cable insulation must be designed for the highest voltage of all active components, or the secondary cables must be laid 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 the 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 400VAC ST (see figure below) must be below a certain resistance value (depending on Z_n and I_{max}).

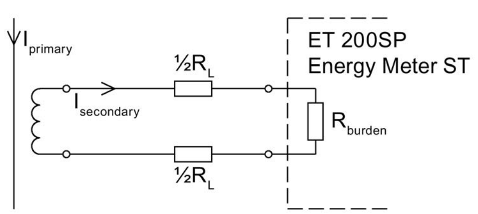


Figure 3-2 Maximum length of the connection cable

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.

Note

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

Example

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 is 400 A. This means that the maximum secondary current $I_{max.}$ is 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 ρ = 0.017857 Ω x 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 mm^2 and a burden resistance of the Energy Meter of 25 mΩ:

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

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

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 66)

4 Configuration / address space

4.1 Configuring

Introduction

To configure the AI Energy Meter 400VAC ST after connecting it, use configuration software such as STEP 7. In addition, you can also change numerous parameters of the AI Energy Meter 400VAC ST in RUN via the user program.

Configuring

You configure the AI Energy Meter 400VAC 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 400VAC 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 400VAC 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 400VAC ST.

The following instructions show the theoretical procedure for configuring the AI Energy Meter 400VAC 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 400VAC ST.
4. Configure the AI Energy Meter 400VAC 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 400VAC ST is running.

4.2 Selecting the module versions

Introduction

The AI Energy Meter 400VAC 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.

At the module version "32 I / 12 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 400VAC ST by using the RDREC instruction asynchronously.

Influence of the module version on the address space

Note

Influence of the AI Energy Meter 400 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 400 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 400VAC ST at maximum.

Module versions of the AI Energy Meter 400VAC Configuring with STEP 7

Module version	User data	Address space	Comment
2 I / 2 Q	No cyclic user data. Access to measured values through "Read data record".	2-byte inputs 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 85).
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. Information about the structure of the 32 I / 12 Q module version is available in the appendix Module version "32 I / 12 Q" (Page 88). 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 92).

4.2.1 Changing over the user data variant during operation

Introduction

At the module version 32 I / 12 Q you switch over the user data variant in the output data in Byte 0.

Requirement

- User program has been created.
- AI Energy Meter 400VAC ST is configured as the module version 32 I / 12 Q.
- 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

4.2.2 Recommendations for selecting the module version

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

Module version	Remarks on the field of application
2 I / 2 Q	• Solely acyclic reading of the measured values via the RDREC instruction from a measured value data record. • Use of many modules possible because little address space is used.
32 I / 12 Q	• Cyclic reading of the measured values from the user data. – Various measured variables can be read by switching over the user data variant. – One cycle elapses for each user data changeover. Measured values from the next user data variant are supplied with a slight time offset. – Depending on the user data variant, you must convert the measured values in the CPU to physical values using the supplied scaling factor. • Acyclic reading of the measured values via the RDREC instruction from a measured value data record. • Use of less modules possible because each module uses 32 bytes input and 12 bytes output.

4.3 Applicable modules

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

Controller	Module version	
	2 I / 2Q	32 I / 12 Q
IM 155-6 PN ST	V1.0 or higher	
IM 155-6 PN HF	V2.0 or higher	
IM 155-6 PN BA	V3.2 or higher	
IM 155-6 PN HS	V4.0 or higher	
IM 155-6 DP HF	V1.0 or higher	
CPU 1510SP-1 PN	V1.6 or higher	
CPU 1510SP F-1 PN	V1.7 or higher	
CPU 1512SP-1 PN	V1.6 or higher	
CPU 1512SP F-1 PN	V1.7 or higher	
CPU 1515SP PC	V1.7 or higher	

Quick start 5

Introduction

This section shows you how to read and view your first measured values on the Energy Meter 400 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 16). The Energy Meter 400 VAC ST has already been integrated in your configuration tool (such as STEP 7), or the Energy Meter 400 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 400 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 400 VAC ST:
   - Connection type that you have used for the Energy Meter 400 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)

   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 80).

Table 5- 1 Total power L1L2L3

Byte	Allocation	Data type	Unit	Value range	Mea-sured 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 30).

6 Reading and processing measured values

6.1 Basics for reading measured values

Introduction

The AI Energy Meter 400VAC 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 of the STRUCT data type. 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. Address the tag with the STRUCT data type directly.

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 startup of the module

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

Current measured values become "0"

The current and all other measured values based on it are suppressed (or set "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
- Phase angle
- Power factor

A floating mean value is formed from the power values. These only become "0" after a corresponding time. The energy meter for active, reactive and apparent energy of the reset phase does not count any longer.

Substitute value behavior

The substitute values for input values of the AI Energy Meter 400VAC ST amount to "0".

See also

Reading measured values from user data cyclically (Page 34)

Read measured value from a measured value data record (Page 36)

Selecting the module versions (Page 24)

6.2 Quality information

Introduction

The AI Energy Meter 400VAC ST supplies quality information about the measurement in a status word. This information can be used to evaluate the status:

- Currents (I_{L1}, I_{L2}, I_{L3}) and voltages (U_1, U_2, U_3) lie within the valid measuring range
- Operating quadrants for Phase 1.

You can evaluate the quality information at every module version in Byte 1 of the output user data.

Structure of the quality information

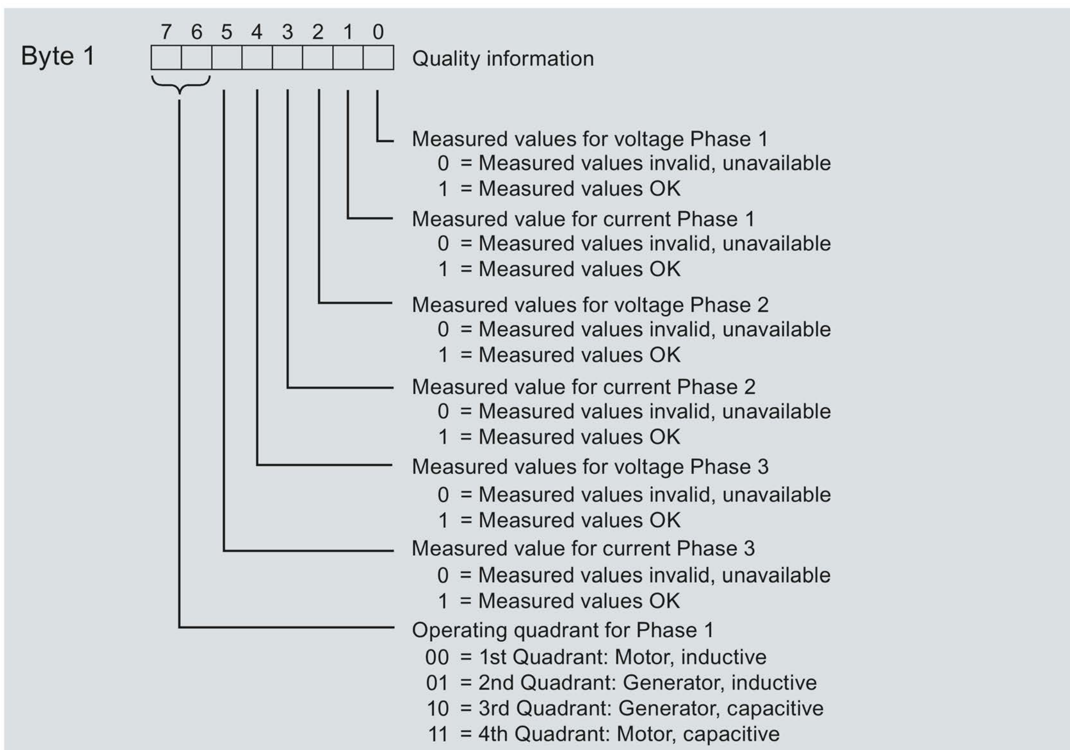


Figure 6-1 Quality information

Operating quadrant

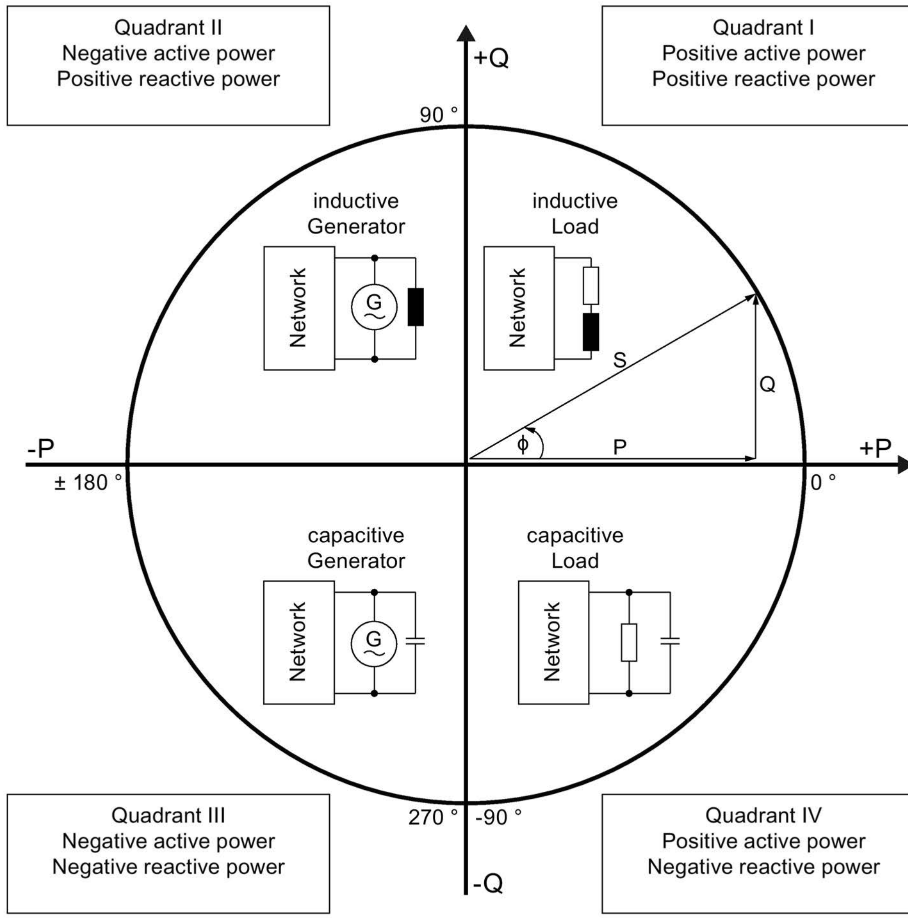


Figure 6-2 Quadrant in the quality bits

See also

Module version "32 I / 12 Q" (Page 88)

6.3 Reading measured values from user data cyclically

Requirement

- STEP 7 is open.
- AI Energy Meter 400VAC 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 400VAC 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 30)

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 400VAC ST is configured.

Procedure

1. Create a PLC tag of the STRUCT data type in STEP 7.
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 30)

7 Energy counters

7.1 How the energy meter works

Introduction

The AI Energy Meter 400VAC 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.

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 counter count endlessly.

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

Automatic reset of the energy counter

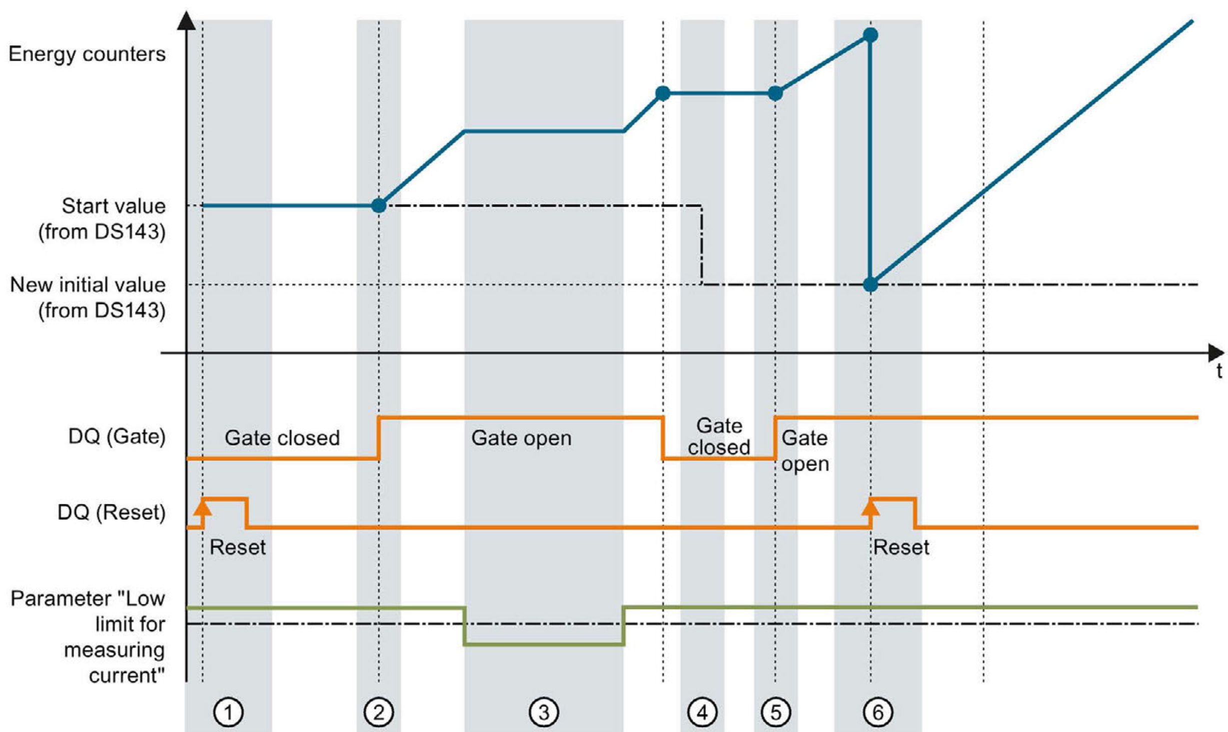
The energy counters are automatically reset to "0" when parameter settings relevant to the energy counter are changed. In the case of phase-specific changing of parameter settings relevant to the energy counter only the energy counters of the respective phases are reset.

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

- Measurement type or range
- Current transformer (primary current/secondary current)
- Direction of current

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

Evaluating energy counters (Page 41)

7.2 Configuring counters

Overview

You can configure the energy counters of the AI Energy Meter 400VAC 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 400VAC 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.

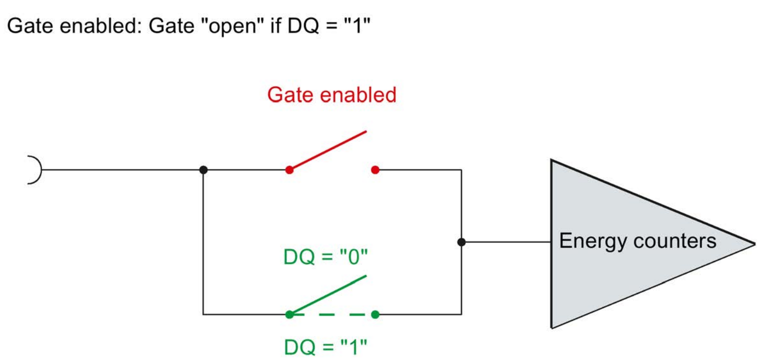


Figure 7-1 Gate enabled

If you deselect the "Enable gate control for the energy counter" parameter in the configuration of the AI Energy Meter 400VAC 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".

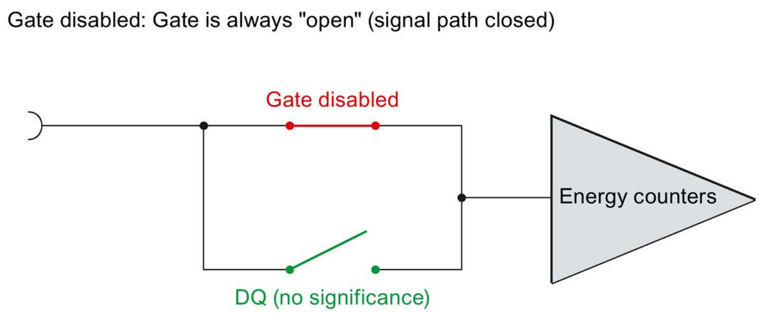


Figure 7-2 Gate disabled

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 Data record for energy counter (DS 143) (Page 49).

7.3 Evaluating energy counters

Evaluating energy counters

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 $F6_H$)
- 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 energies

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 30).

7.4 Reset energy counter

7.4.1 Introduction

Introduction

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

The following sections describe how you

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

7.4.2 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.

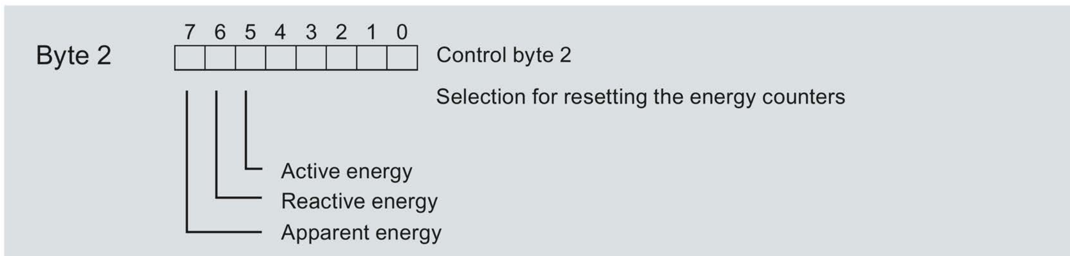


Figure 7-3 Selection of energy counters

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.

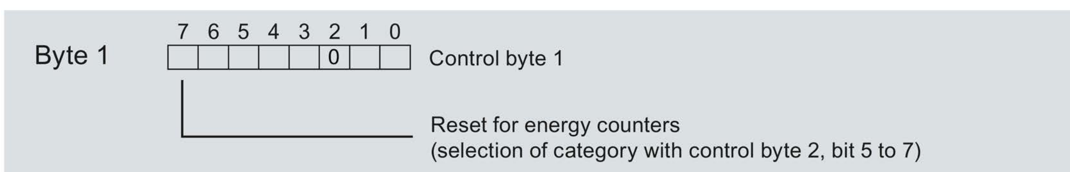


Figure 7-4 Reset bit for energy counters

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.

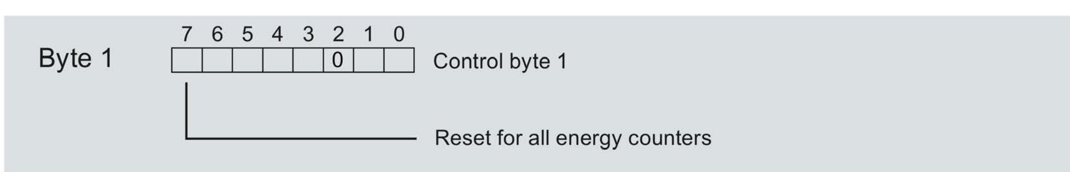


Figure 7-5 Resetting the energy counters at module version with 2 bytes of output data

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 Structure for energy counters (DS 143) (Page 49).

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

7.4.3 Resetting energy counters via data record DS 143

Introduction

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

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

Procedure at all module versions via 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:
   - 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.

4. Transfer the data record with the WRREC instruction.

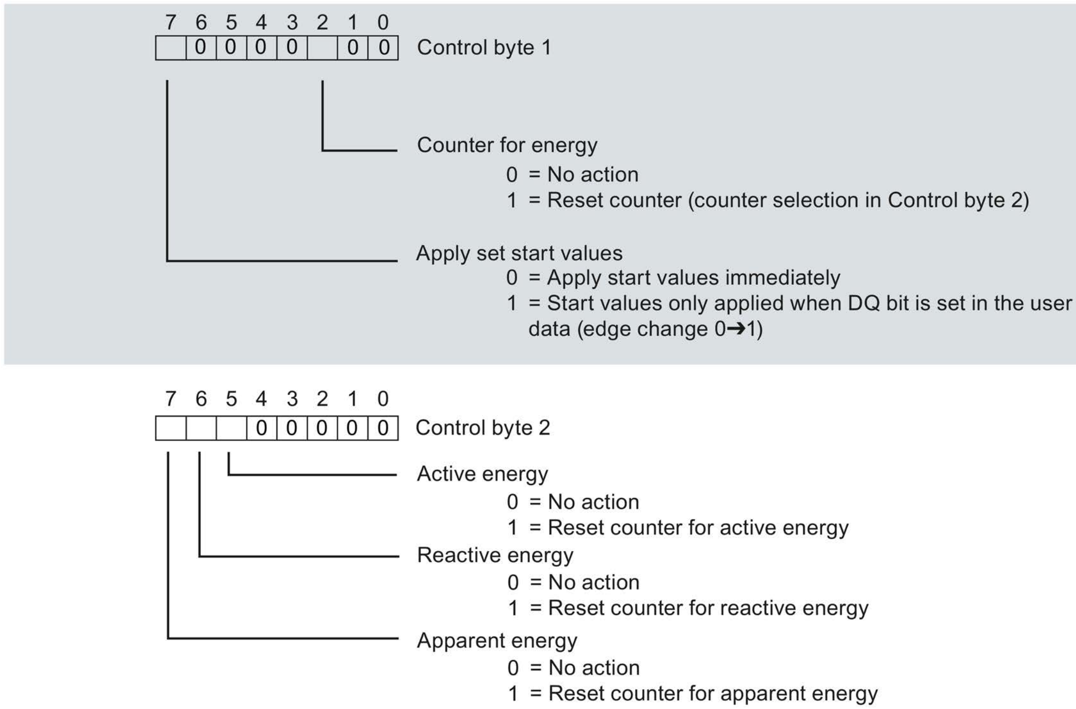


Figure 7-6 Energy counter control information DS 143

Start values

You specify the moment for the application of the start values in Control byte 1 via Bit 7. After the reset the 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.

7.4.4 Example for resetting energy counters via data record DS 143

Introduction

Before you can transfer the data record DS 143 to the CPU you have to create a 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 49).

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 49)	61180
16...23	Active energy outflow (initial value) L1	LREAL	Wh		61181
:	:	:	:	:	:

2. Create a DB or instance DB and allocate the values of the data record

   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 counters

   In the control bytes for the relevant phases, specify which energy 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.

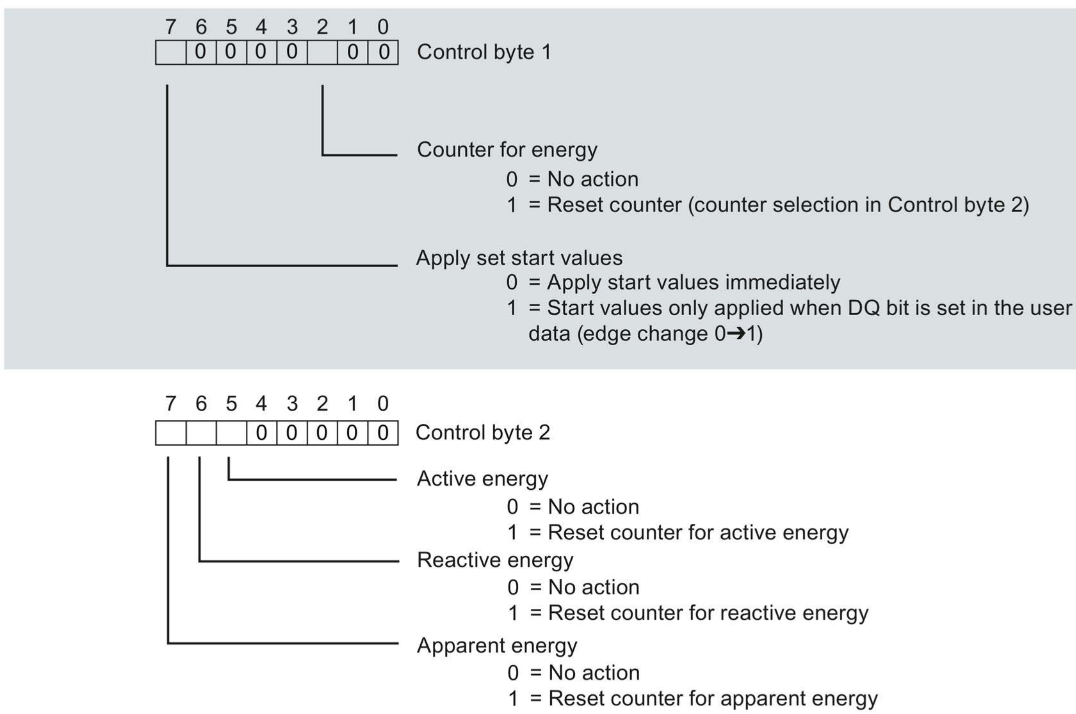


Figure 7-7 Control information DS 143 for energy counter

   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.

3. Write the data record to the AI Energy Meter 400VAC 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: 128
   – 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 400VAC ST at the same time, keep in mind the maximum number of active jobs in communication with SFB52/SFB53.

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

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	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		61180

Byte	Measured variable	Data type	Unit	Value range	Mea-sured value ID
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
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

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. 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.

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.

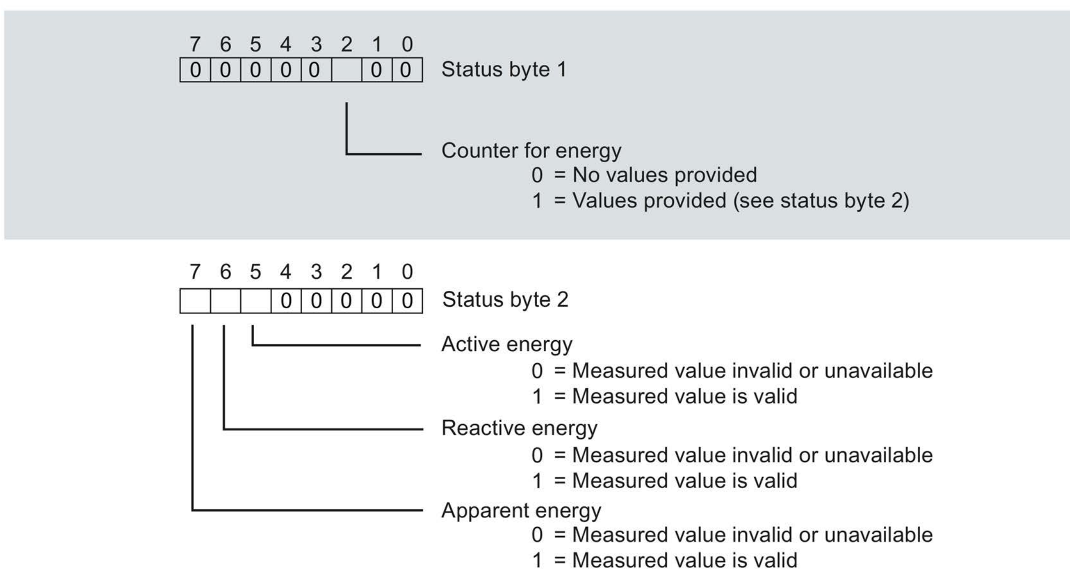


Figure 7-8 Status information DS 143 (read access)

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. The length of the control information amounts to 2 bytes for each phase:

- In Control byte 1 you determine how you reset the counter and the time at which the counter is reset.
- In Control byte 2 you determine which energy counter you want to reset.

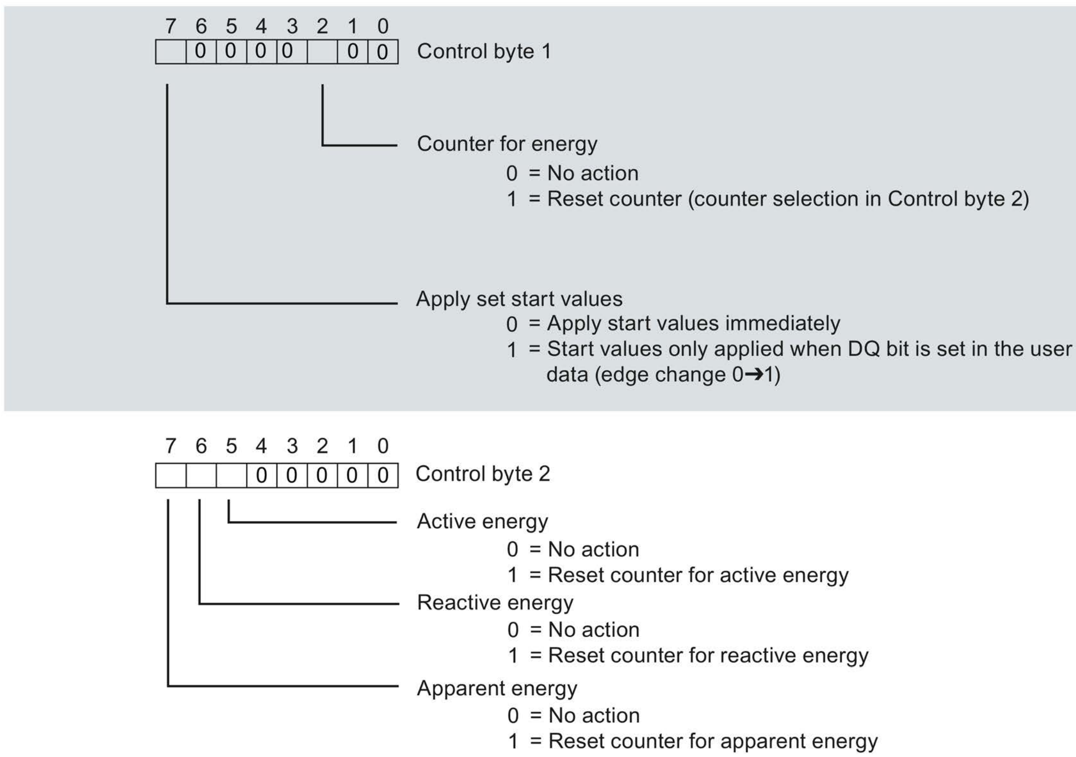


Figure 7-9 Control information DS 143 (write access)

Parameters 8

8.1 Parameters

Parameters of the AI Energy Meter 400VAC ST (DS 128)

As a rule the AI Energy Meter 400VAC 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 by means of the 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 72)). The following table summarizes all the configurable parameters.

Table 8- 1 AI Energy Meter 400VAC 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
Diagnostics line voltage	• Disable • Enable	Disable	Yes	Module	Module
Connection type	• Disabled • 1P2W - 1-phase alternating current • 3P4W - 3 phases, 4 conductors	3P4W - 3 phases, 4 conductors	Yes	Module	Module (only 1P2W, 3P4W and deactivated)
Voltage measuring range	• 100 V • 110 V • 115 V • 120 V • 127 V • 190 V • 200 V • 208 V • 220 V • 230 V	230 V	Yes	Module	Module
Line voltage tolerance [%]	• 1 ... 50 %	10 %	Yes	Module	Module
Line frequency	• 50 Hz • 60 Hz	50 Hz	Yes	Module	Module
Enable gate energy counter	• No • Yes	No	Yes	Module	-
User data variant	See the table Overview of the user data variants (Page 92)	Total energy L1 L2 L3 (ID 254 or FE_H)	Yes	Module	Module (only user data variant)
Diagnostics overflow current	• Disable • Enable	Disable	Yes	Channel/phase	Module
Diagnostics overflow voltage	• Disable • Enable	Disable	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
Diagnostics underflow voltage	• Disable • Enable	Disable	Yes	Channel/phase	Module
Diagnostics low limit voltage	• Disable • Enable	Disable	Yes	Channel/phase	- (blocking is preset)
Diagnostics overflow cumulative values	• Disable • 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
Low limit for current measurement [mA]	• 20 ... 250 mA	50 mA	Yes	Module	- (Default setting: 20 mA)
Current transformer primary current [A]	• 1 ... 10000 A	1 A	Yes	Channel/phase	Module (Value range: 1...65535)
Current transformer secondary current	• 1 A • 5 A	1 A	Yes	Channel/phase	Module
Reverse current direction	• Disable • Enable	Disable	Yes	Channel/phase	Module

8.2 Description of parameters

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 19)".

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

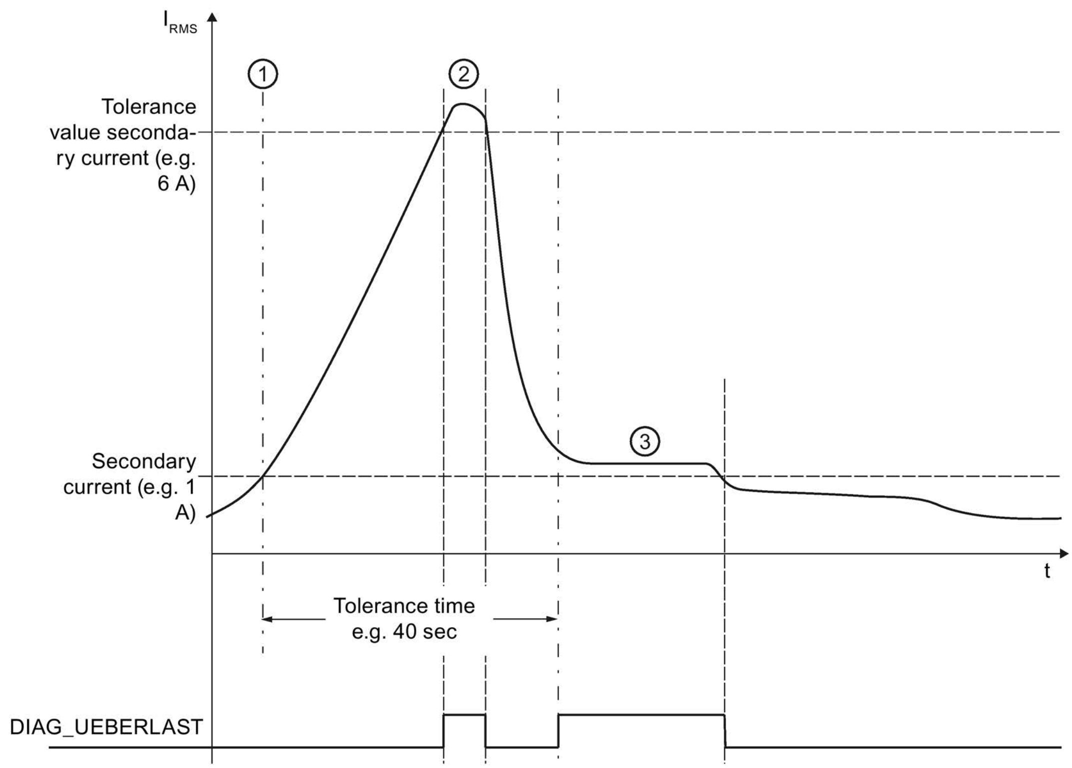
Here you can set the line frequency of the power supply system.

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".

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 8-1 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
- 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.

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.

Reverse current direction

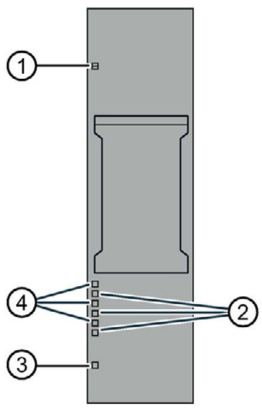
Setting to determine whether or not to reverse the direction of current.

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.

9 Interrupts/diagnostic alarms

9.1 Status and error display

LED display



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

Figure 9-1 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 64).

DIAG LED

Table 9- 1 Meaning of the DIAG LED

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

Status LED

Table 9- 2 Meaning of the Status LED

Status	Meaning
□ Off	Channel deactivated or error
■ On	Channel activated and no error

Error LED

Table 9- 3 Meaning of the Error LED

Status	Meaning
□ Off	Channel is OK
■ On	Channel is faulty

PWR LED

Table 9- 4 Meaning of the PWR LED

PWR	Meaning
□ Off	Line voltage missing
■ On	Line voltage available

9.2 Interrupts

The AI Energy Meter 400VAC ST analog input module supports diagnostic alarms.

9.2.1 Diagnostics interrupt

Diagnostic interrupt

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

- Channel is temporarily unavailable
- 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 64)

9.3 Diagnostic alarms

Diagnostic alarms

Note

Assignment channel in diagnostics alarm ⇔ Phase

Channels are counted in the diagnostic messages starting from channel "0" and in the AI Energy Meter 400VAC ST starting from phase "1".

Note the following assignment:

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

Table 9- 5 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. 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. • 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.

9.4 Diagnostics response

Diagnostics response

This section describes the response of the AI Energy Meter 400VAC 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
- 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 400VAC ST operates again with the configuration / parameter assignment stored in the CPU. The energy counter is used for retentively stored values.

Input data to "0"

Note

If the AI Energy Meter 400VAC 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 10

10.1 Technical specifications

Technical specifications of the AI Energy Meter 400VAC ST

Article number	6ES7134-6PA01-0BD0
General information	
Product type designation	ET 200SP, AI Energy Meter 400 V AC ST, PU 1
Firmware version	V3.0
usable BaseUnits	BU type D0, BU20-P12+A0+0B
Product function	
• Voltage measurement	Yes
• Voltage measurement with voltage transformers	No
• 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	6ES7134-6PA01-0BD0
Operating mode	
• cyclic measurement	Yes
• acyclic measurement	Yes
• Acyclic measured value access	Yes
• Fixed measured value sets	Yes
• Freely definable measured value sets	No
Configuration control	
via dataset	Yes
CiR – Configuration in RUN	
Reparameterization possible in RUN	Yes
Calibration possible in RUN	No
Installation type/mounting	
Mounting position	Any
Supply voltage	
Design of the power supply	Supply via voltage measurement channel L1
Type of supply voltage	100 - 240 V AC
permissible range, lower limit (AC)	90 V
permissible range, upper limit (AC)	264 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.	44 byte; 32 byte input / 12 byte output
Hardware configuration	
Automatic encoding	
• Mechanical coding element	Yes
Time of day	
Operating hours counter	
• present	No
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	6ES7134-6PA01-0BD0
Interrupts/diagnostics/status information	
Alarms	
• Diagnostic alarm	Yes
• Limit value alarm	No
• Hardware interrupt	No
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	No
• Parameter length	38 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	6ES7134-6PA01-0BD0
Measuring inputs for voltage	
– Measurable line voltage between phase and neutral conductor	230 V
– Measurable line voltage between the line conductors	400 V
– Measurable line voltage between phase and neutral conductor, min.	90 V
– Measurable line voltage between phase and neutral conductor, max.	264 V
– Measurable line voltage between the line conductors, min.	155 V
– Measurable line voltage between the line conductors, max.	460 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.	5 %; Relative to the secondary rated current; 1 A, 5 A
– measurable relative current (AC), max.	100 %; Relative to the secondary rated current; 1 A, 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: 20 ... 250 mA, default 50 mA
– Surge strength	10 A; for 1 minute

Article number	6ES7134-6PA01-0BD0
Accuracy class according to IEC 61557-12	
– Measured variable voltage	0.5
– Measured variable current	0.5
– Measured variable apparent power	1
– Measured variable active power	1
– Measured variable reactive power	1
– Measured variable power factor	0.5
– Measured variable active energy	1
– Measured variable reactive energy	2
– 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.

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

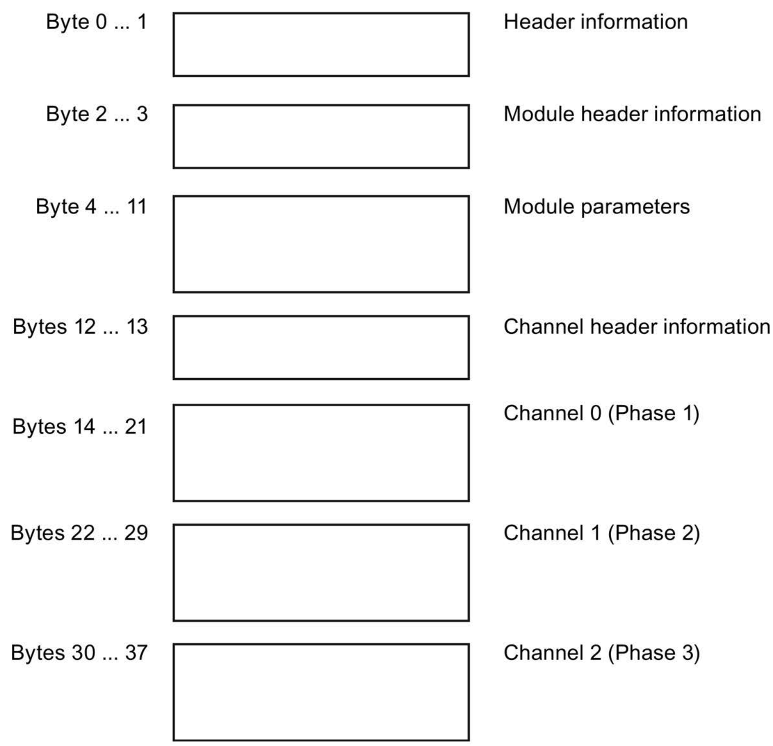


Figure A-1 Parameter data record 128

Header information

The figure below shows the structure of the header information.

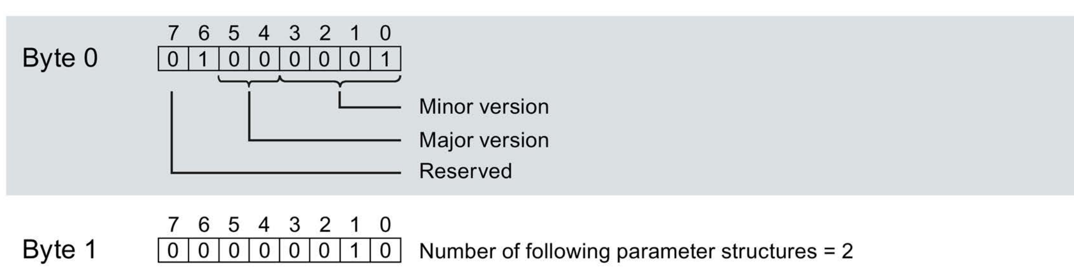


Figure A-2 Header information

Module header information

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

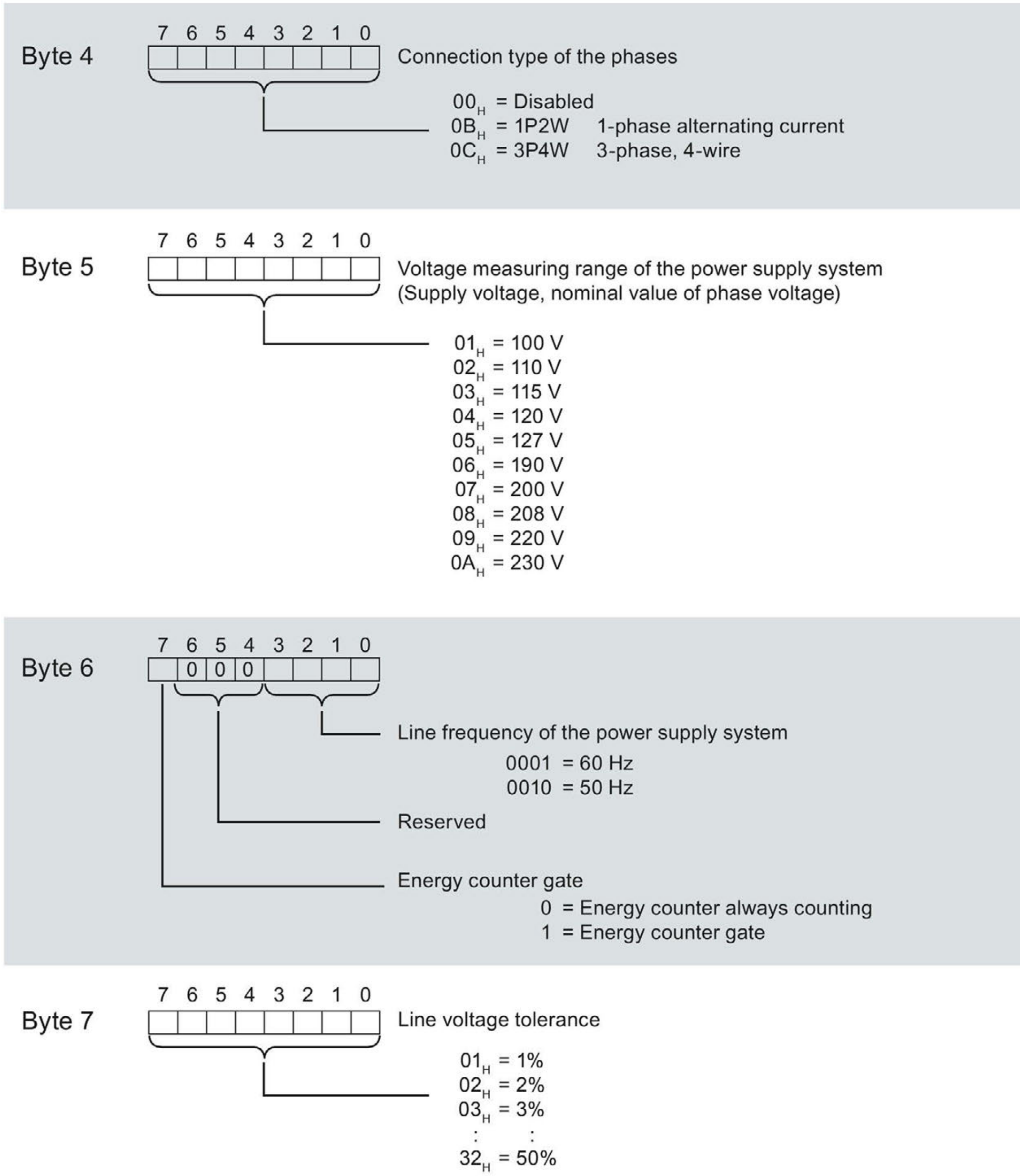
	7	6	5	4	3	2	1	0	
Byte 2	0	1	0	0	0	0	0	1	Number of the following module parameter blocks = 1
Byte 3	0	0	0	0	1	0	0	0	Length of the following module parameter block = 8

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
7 6 5 4 3 2 1 0
Connection type of the phases
00H = Disabled
0BH = 1P2W 1-phase alternating current
0CH = 3P4W 3-phase, 4-wire
Byte 5
7 6 5 4 3 2 1 0
Voltage measuring range of the power supply system
(Supply voltage, nominal value of phase voltage)
01H = 100 V
02H = 110 V
03H = 115 V
04H = 120 V
05H = 127 V
06H = 190 V
07H = 200 V
08H = 208 V
09H = 220 V
0AH = 230 V
Byte 6
7 6 5 4 3 2 1 0
0 0 0
Line frequency of the power supply system
0001 = 60 Hz
0010 = 50 Hz
Reserved
Energy counter gate
0 = Energy counter always counting
1 = Energy counter gate
Byte 7
7 6 5 4 3 2 1 0
Line voltage tolerance
01H = 1%
02H = 2%
03H = 3%
: :
32H = 50%

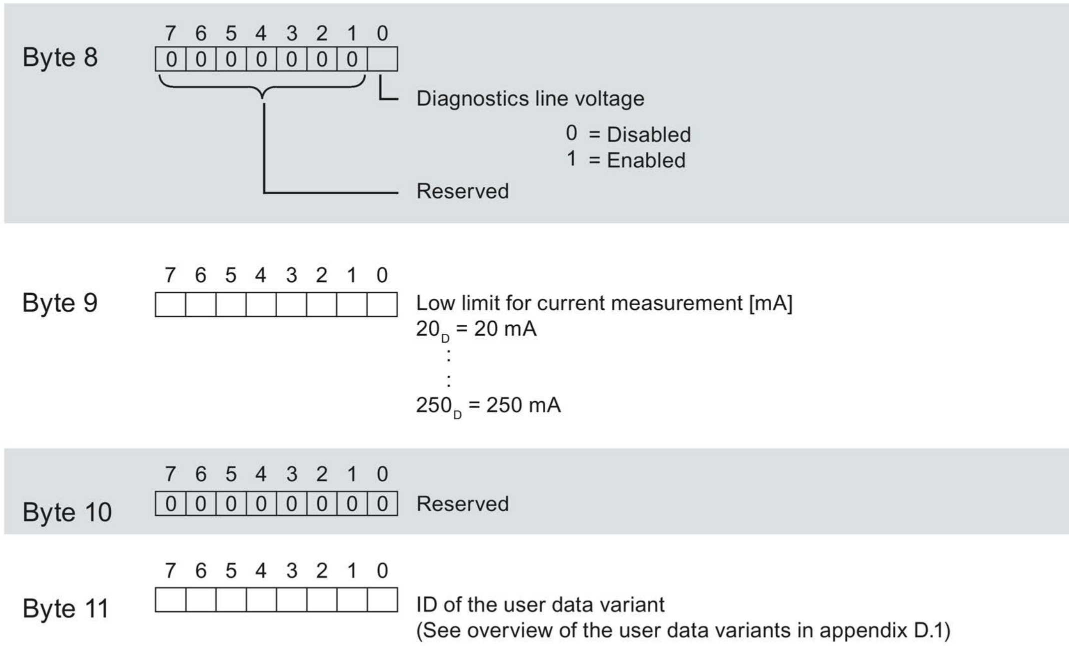


Figure A-4 Module parameter block

You can find the user data variant in the section Overview of the user data variants (Page 92).

Channel header information

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

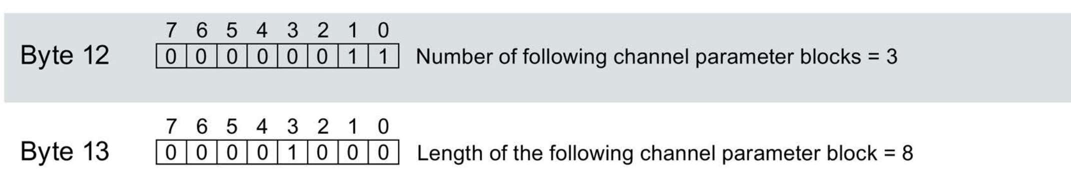
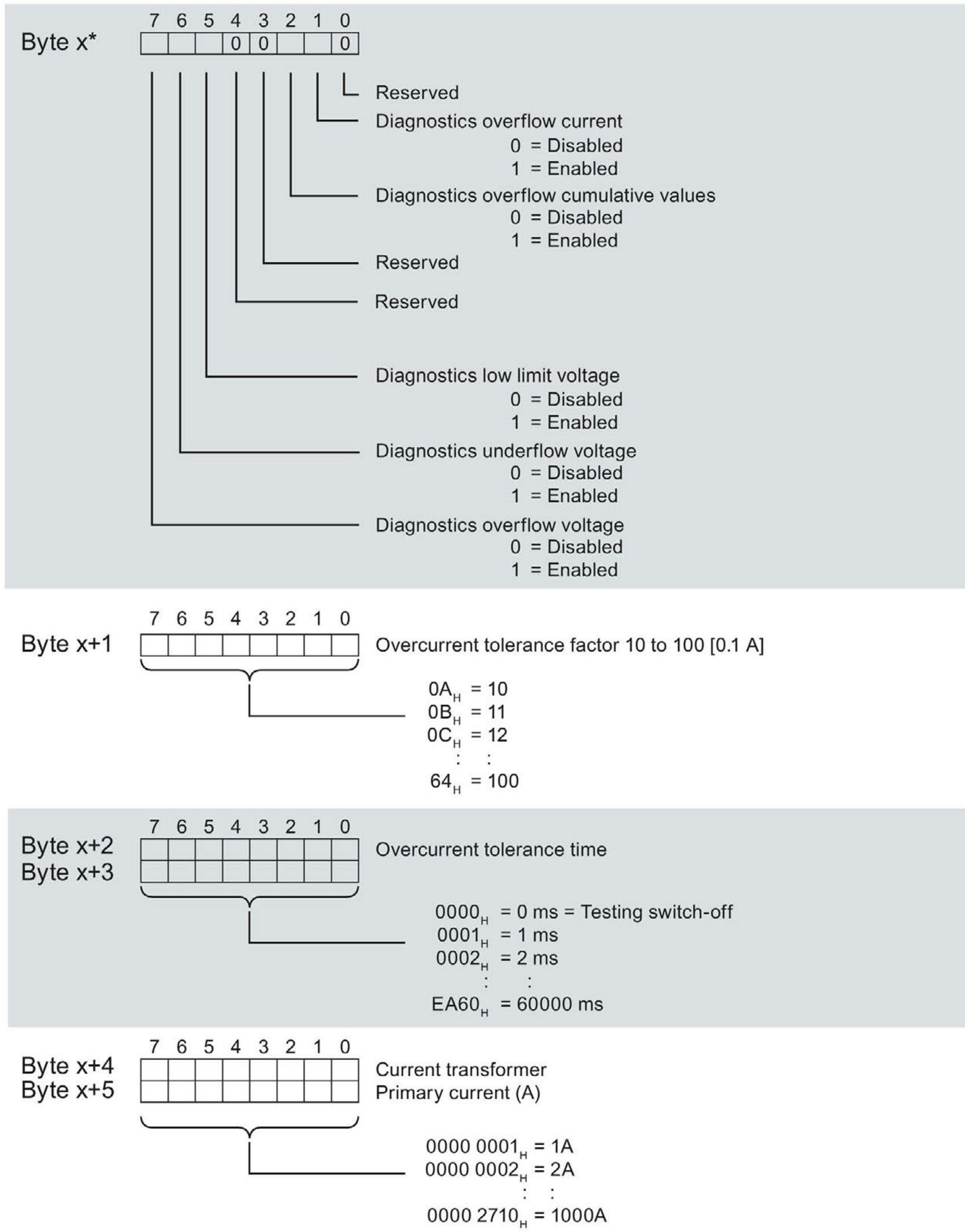


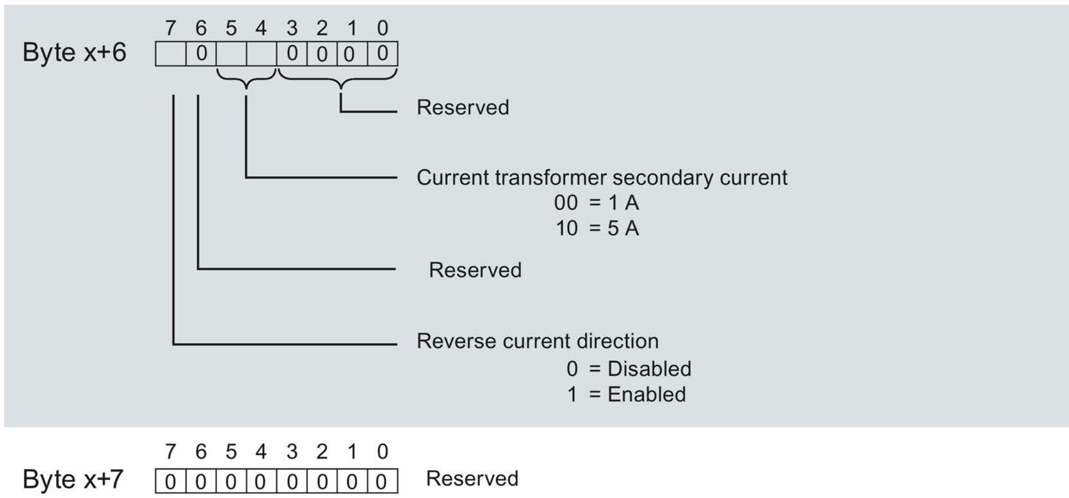
Figure A-5 Channel header information

Channel parameter block

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

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





* x = 14 for Channel 0 (Phase 1); 22 for Channel 1 (Phase 2); 30 for Channel 2 (Phase 3)

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. 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 Bytes 6, 10, 14, 20...22, 28...30, 36 and 37, and set reserved bits back to 0.
DF	80	E1	02	Reserved bits are not 0.	Check Byte 8 and set 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
DF	80	E1	21	Parameter for user data variant in DS 128 not possible or input data configuration not large enough.	Check Byte 11. Select a different user data variant or change the configuration.
DF	80	E1	22	Parameter for user data variant is invalid.	Check Byte 11. 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 current is invalid.	Check Bit 4...5 in Byte 20, 28, 36. Enter valid values.
DF	80	E1	26	Reserved parameter bits for current transformer on secondary side are not zero.	Enter 0 in Bytes 20, 28 and 36 and in Bits 0...3 and Bit 6.
DF	80	E1	29	Parameter for tolerance value overcurrent invalid.	Check Byte 15, 23, 31. Enter valid values.
DF	80	E1	30	Parameter for tolerance time overcurrent invalid.	Check Bytes 16...17, 24...25, 32...33. Enter valid values.
DF	80	E1	2B	Parameter for low limit measuring current invalid	Check Byte 9. Enter valid values.
DF	80	E1	2C	Parameter for current transformer primary current is invalid.	Check Bytes 18...19, 26...27, 34...35. Enter valid values.
DF	80	E1	30	Invalid data record number.	Check the data record number. Enter a valid data record number.

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	3P4W
1	Voltage UL1-N [1]	REAL	V	0.0 ... 300.0	✓	✓
2	Voltage UL2-N [1]	REAL	V	0.0 ... 300.0		✓
3	Voltage UL3-N [1]	REAL	V	0.0 ... 300.0		✓
4	Voltage UL1-L2 [2]	REAL	V	0.0 ... 600.0		✓
5	Voltage UL2-L3 [2]	REAL	V	0.0 ... 600.0		✓
6	Voltage UL3-L1 [2]	REAL	V	0.0 ... 600.0		✓
7	Current L1 [1]	REAL	A	0.0 … 10000.0	✓	✓
8	Current L2 [1]	REAL	A	0.0 … 10000.0		✓
9	Current L3 [1]	REAL	A	0.0 … 10000.0		✓
10	Apparent power L1 [3]	REAL	VA	-3.0×10^9 … $+3.0 \times 10^9$	✓	✓
11	Apparent power L2 [3]	REAL	VA	-3.0×10^9 … $+3.0 \times 10^9$		✓
12	Apparent power L3 [3]	REAL	VA	-3.0×10^9 … $+3.0 \times 10^9$		✓
13	Active power L1 [3]	REAL	W	-3.0×10^9 … $+3.0 \times 10^9$	✓	✓
14	Active power L2 [3]	REAL	W	-3.0×10^9 … $+3.0 \times 10^9$		
15	Active power L3 [3]	REAL	W	-3.0×10^9 … $+3.0 \times 10^9$		✓
16	Reactive power L1 [3]	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$	✓	✓
17	Reactive power L2 [3]	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$		✓
18	Reactive power L3 [3]	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$		✓
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	3P4W
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	-3.0×10^9 … $+3.0 \times 10^9$	✓	✓
35	Total reactive power L1L2L3 [5]	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$	✓	✓
36	Total apparent power L1L2L3 [5]	REAL	VA	-3.0×10^9 … $+3.0 \times 10^9$	✓	✓
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		✓
200	Total active energy inflow L1L2L3 [6]	REAL	Wh	0.0 ... 3.4×10^{38}	✓	✓
201	Total active energy outflow L1L2L3 [6]	REAL	Wh	0.0 ... 3.4×10^{38}	✓	✓
202	Total reactive energy inflow L1L2L3 [6]	REAL	varh	0.0 ... 3.4×10^{38}	✓	✓
203	Total reactive energy outflow L1L2L3 [6]	REAL	varh	0.0 ... 3.4×10^{38}	✓	✓
204	Total apparent energy L1L2L3 [6]	REAL	VAh	0.0 ... 3.4×10^{38}	✓	✓
205	Total active energy L1L2L3 [6]	REAL	Wh	-3.4×10^{38} to $+3.4 \times 10^{38}$	✓	✓
206	Total reactive energy L1L2L3 [6]	REAL	varh	-3.4×10^{38} to $+3.4 \times 10^{38}$	✓	✓
210	Total active energy inflow L1L2L3 [6]	LREAL	Wh	0.0 ... 1.8×10^{308}	✓	✓
211	Total active energy outflow L1L2L3 [6]	LREAL	Wh	0.0 ... 1.8×10^{308}	✓	✓
212	Total reactive energy inflow L1L2L3 [6]	LREAL	varh	0.0 ... 1.8×10^{308}	✓	✓
213	Total reactive energy outflow L1L2L3 [6]	LREAL	varh	0.0 ... 1.8×10^{308}	✓	✓
214	Total apparent energy L1L2L3 [6]	LREAL	VAh	0.0 ... 1.8×10^{308}	✓	✓
215	Total active energy L1L2L3 [6]	LREAL	Wh	-1.8×10^{308} to $+1.8 \times 10^{308}$	✓	✓
216	Total reactive energy L1L2L3 [6]	LREAL	varh	-1.8×10^{308} to $+1.8 \times 10^{308}$	✓	✓
220	Total active energy inflow L1L2L3 [6]	UDINT	Wh	0 to 2147483647	✓	✓
221	Total active energy outflow L1L2L3 [6]	UDINT	varh	0 to 2147483647	✓	✓
222	Total reactive energy inflow L1L2L3 [6]	UDINT	varh	0 to 2147483647	✓	✓
223	Total reactive energy outflow L1L2L3 [6]	UDINT	VAh	0 to 2147483647	✓	✓
224	Total apparent energy L1L2L3 [6]	UDINT	Wh	0 to 2147483647	✓	✓
225	Total active energy L1L2L3 [6]	DINT	Wh	-2147483647 to +2147483647	✓	✓
226	Total reactive energy L1L2L3 [6]	DINT	varh	-2147483647 to +2147483647	✓	✓

Mea-sured value ID	Measured variables	Data type	Unit	Value range	Connection type	
					1P2W	3P4W
61178	Phase angle L1 [3]	REAL	°	0.0 ... 360.0	✓	✓
61180	Active energy inflow L1 [6]	LREAL	Wh	0.0 ... 1.8 x 10^{308}	✓	✓
61181	Active energy outflow L1 [6]	LREAL	Wh	0.0 ... 1.8 x 10^{308}	✓	✓
61182	Reactive energy inflow L1 [6]	LREAL	varh	0.0 ... 1.8 x 10^{308}	✓	✓
61183	Reactive energy outflow L1 [6]	LREAL	varh	0.0 ... 1.8 x 10^{308}	✓	✓
61184	Apparent energy L1 [6]	LREAL	VAh	0.0 ... 1.8 x 10^{308}	✓	✓
61185	Active energy L1 [6]	LREAL	Wh	-1.8 x 10^{308} to +1.8 x 10^{308}	✓	✓
61186	Reactive energy L1 [6]	LREAL	varh	1.8 x 10^{308} to +1.8 x 10^{308}	✓	✓
61198	Phase angle L2 [3]	REAL	°	0.0 ... 360.0		✓
61200	Active energy inflow L2 [6]	LREAL	Wh	0.0 ... 1.8 x 10^{308}		✓
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} to +1.8 x 10^{308}		✓
61206	Reactive energy L2 [6]	LREAL	varh	-1.8 x 10^{308} to +1.8 x 10^{308}		✓
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} to +1.8 x 10^{308}		✓
61226	Reactive energy L3 [6]	LREAL	varh	-1.8 x 10^{308} to +1.8 x 10^{308}		✓
62110	Active energy inflow L1 [6]	UDINT	Wh	0 to 2147483647	✓	✓
62111	Active energy outflow L1 [6]	UDINT	Wh	0 to 2147483647	✓	✓
62112	Reactive energy inflow L1 [6]	UDINT	Varh	0 to 2147483647	✓	✓
62113	Reactive energy outflow L1 [6]	UDINT	Varh	0 to 2147483647	✓	✓
62114	Apparent energy L1 [6]	UDINT	Wh	0 to 2147483647	✓	✓
62210	Active energy inflow L2 [6]	UDINT	Wh	0 to 2147483647		✓
62211	Active energy outflow L2 [6]	UDINT	Wh	0 to 2147483647		✓
62212	Reactive energy inflow L2 [6]	UDINT	Varh	0 to 2147483647		✓
62213	Reactive energy outflow L2 [6]	UDINT	Varh	0 to 2147483647		✓
62214	Apparent energy L2 [6]	UDINT	VAh	0 to 2147483647		✓
62310	Active energy inflow L3 [6]	UDINT	Wh	0 to 2147483647		✓

Measured value ID	Measured variables	Data type	Unit	Value range	Connection type	
					1P2W	3P4W
62311	Active energy outflow L3 [6]	UDINT	Wh	0 to 2147483647		✓
62312	Reactive energy inflow L3 [6]	UDINT	Varh	0 to 2147483647		✓
62313	Reactive energy outflow L3 [6]	UDINT	Varh	0 to 2147483647		✓
62314	Apparent energy L3 [6]	UDINT	VAh	0 to 2147483647		✓
66001	Voltage UL1-N [1]	UINT	0.01 V	0 ... 30000	✓	✓
66002	Voltage UL2-N [1]	UINT	0.01 V	0 ... 30000		✓
66003	Voltage UL3-N [1]	UINT	0.01 V	0 ... 30000		✓
66004	Voltage UL1-L2 [2]	UINT	0.01 V	0 ... 30000		✓
66005	Voltage UL2-L3 [2]	UINT	0.01 V	0 ... 30000		✓
66006	Voltage UL3-L1 [2]	UINT	0.01 V	0 ... 30000		✓
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]	INT	1 var	-27648 ... 27648	✓	✓
66017	Reactive power L2 [3]	INT	1 var	-27648 ... 27648		✓
66018	Reactive power L3 [3]	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]	INT	1 var	-27648 ... 27648	✓	✓
66036	Total apparent power L1L2L3 [5]	INT	1 VA	-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

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

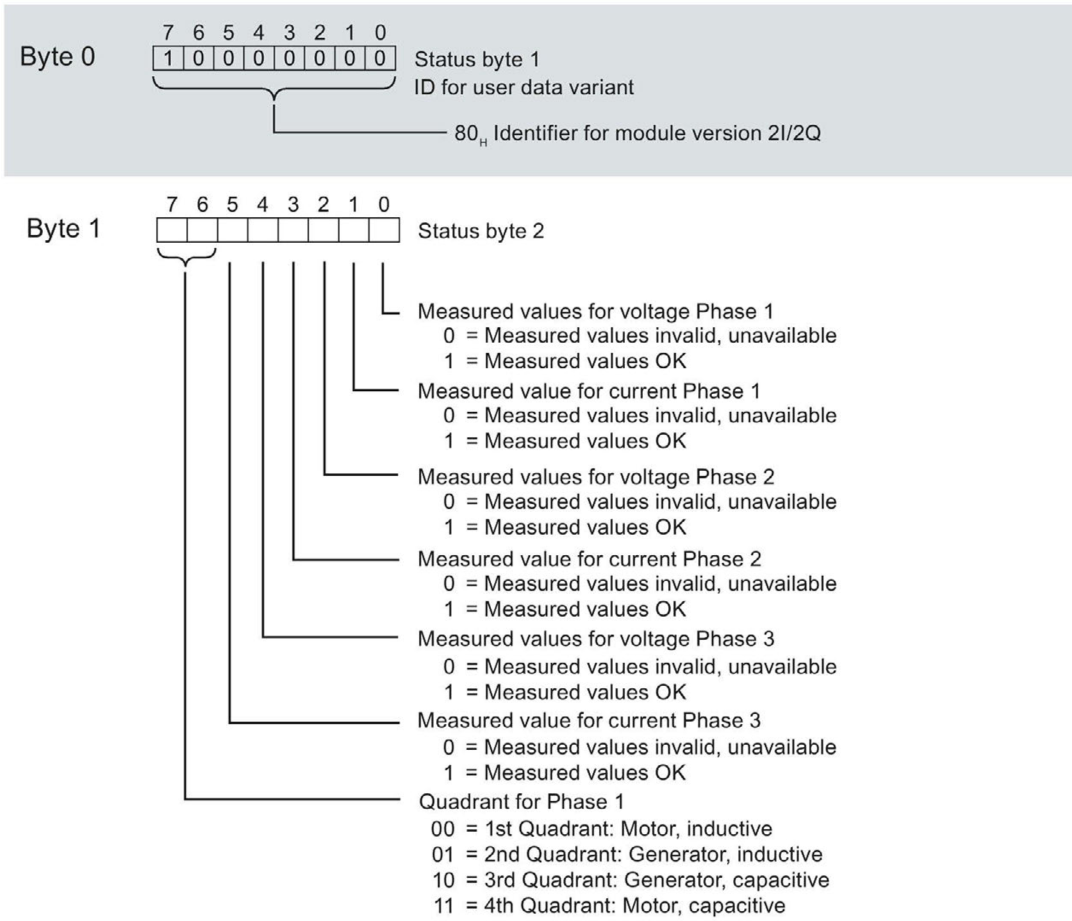


Figure C-1 Allocation of the status bytes in the input user data (2 bytes)

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

You control the counter gate for the energy counter via the output user data.

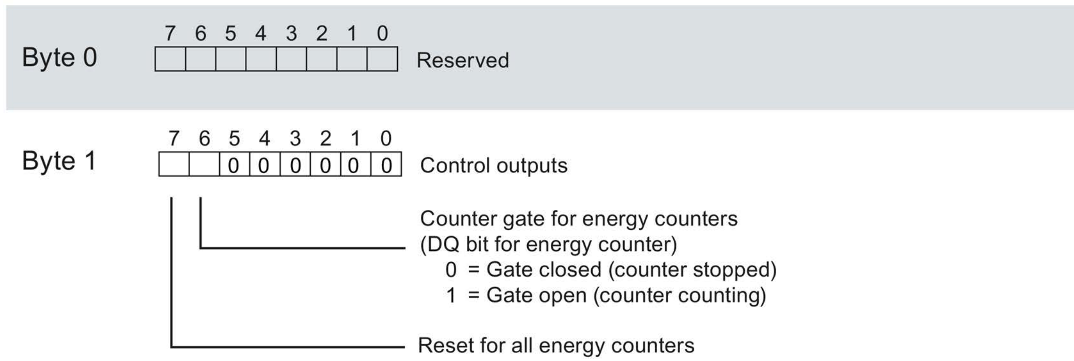


Figure C-2 Allocation of the control byte in the output user data (1 byte)

Note

For module version 2 I / 2 Q, a reset always acts on **all** energy counters of the three phases.

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 (32 bytes)

Byte	Validity	Designation	Comment
0	Module	User data variant	Display of the utilized 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.

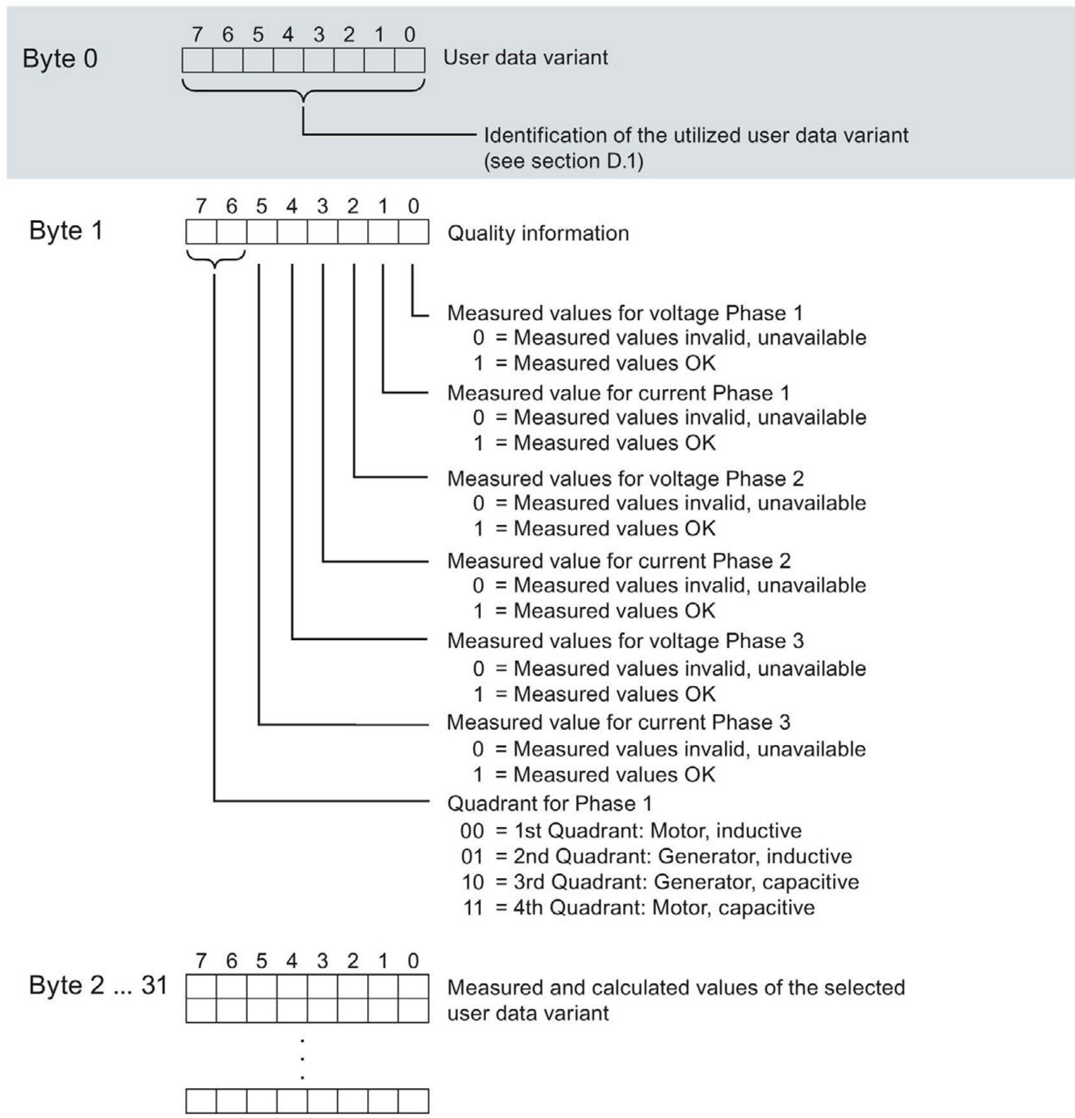


Figure C-3 Assignment of the input user data (32 bytes)

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 globally control

- Resetting for energy counter (reset via Byte 1 and selection via Byte 2)
- The counter gate for the energy counter.

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

Byte	Validity	Designation	Comment
0	Module	User data vari-ant	Switching the user data variant
1	Module	Control byte 1	Reset of values and counters, gate
2	Module	Control byte 2	Selection for resetting the energy counters
3 ... 11	Reserved		

Control byte for user data variant

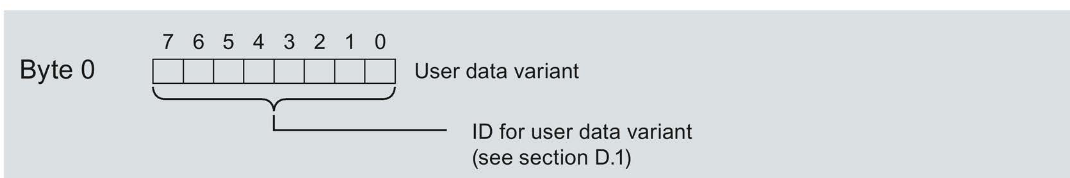


Figure C-4 Allocation of the control bytes for user data variant (Byte 0)

Control bytes for all three phases

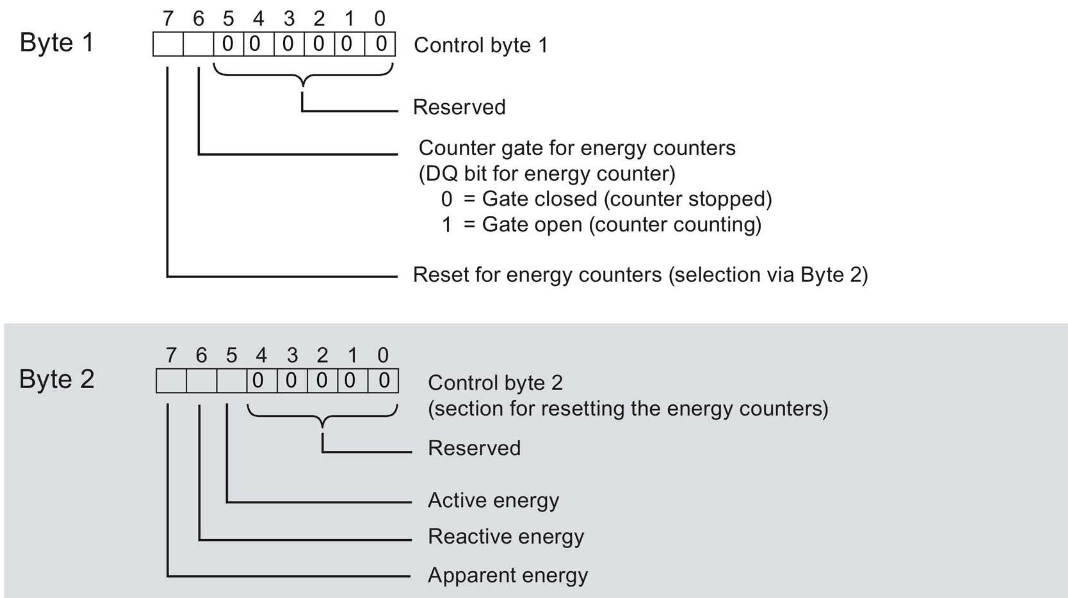


Figure C-5 Allocation of the control bytes for all three phases (bytes 1 and 2)

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. This module variant therefore supports dynamic switching between 11 preconfigured user data variants that contain a specific selection of measured values.

For more detailed information, refer to "Selecting the module versions (Page 24)".

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 ($F5_H$)
Basic variables phase-specific measurement L1	159 ($9F_H$)

Total power L1L2L3 (ID 254 or FE_H)

Table D- 2 Total power L1L2L3

Byte	Allocation	Data type	Unit	Value range	Mea-sured 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	Measured 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	Mea-sured 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	Mea-sured 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	UDINT	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	Mea-sured 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 … 30000	66001
10 ... 11	Voltage UL2-N	UINT	0.01 V	0 … 30000	66002
12 ... 13	Voltage UL3-N	UINT	0.01 V	0 … 30000	66003
14 ... 15	Voltage UL1-UL2	UINT	0.01 V	0 … 60000	66004
16 ... 17	Voltage UL2-UL3	UINT	0.01 V	0 … 60000	66005
18 ... 19	Voltage UL3-UL1	UINT	0.01 V	0 … 60000	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	Reserved	BYTE	-	-	-
28	Reserved	BYTE	-	-	-
29	Reserved	BYTE	-	-	-
30 ... 31	Frequency	UINT	0.01 Hz	0 ... 65535	66038

Total energy L1L2L3 (ID 249 or $F9_H$)

Table D- 7 Total energy L1L2L3

Byte	Allocation	Data type	Unit	Value range	Mea-sured 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	Mea-sured 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 to 2147483647	62110
8 ... 11	Active energy outflow L1	UDINT	1 Wh	0 to 2147483647	62111
11 ... 15	Reactive energy inflow L1	UDINT	1 varh	0 to 2147483647	62112
16 ... 19	Reactive energy outflow L1	UDINT	1 varh	0 to 2147483647	62113
20 ... 23	Apparent energy L1	UDINT	1 VAh	0 to 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	Mea-sured 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	Mea-sured 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	Mea-sured 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	-3.0×10^9 ... $+ 3.0 \times 10^9$	66034
6 ... 9	Total active energy outflow L1L2L3	REAL	1 Wh	0.0 ... 3.4×10^{38}	201
10 ... 13	Total active energy inflow L1L2L3	REAL	1 Wh	0.0 ... 3.4×10^{38}	200
14 ... 17	Current L1	REAL	1 A	0.0 … 10000.0	7
18 ... 21	Current L2	REAL	1 A	0.0 … 10000.0	8
22 ... 25	Current L3	REAL	1 A	0.0 … 10000.0	9
26 ... 27	Voltage UL1-N	UINT	0.01 V	0 … 30000	66001
28 ... 29	Voltage UL2-N	UINT	0.01 V	0 … 30000	66002
30 ... 31	Voltage UL3-N	UINT	0.01 V	0 … 30000	66003

Basic variables phase-specific measurement L1 (ID 159 or $9F_H$)

Table D- 12 Basic variables phase-specific measurement L1

Byte	Allocation	Data type	Unit	Value range	Mea-sured 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 to 3	Current L1	UINT	1 mA	0 to 65535	66007
4 to 5	Voltage UL1-N	UINT	0.01 V	0 to 65535	66001
6 to 7	Active power L1	INT	1 W	-27648 to 27648	66013
8 to 9	Reactive power L1	INT	1 var	-27648 to 27648	66016
10 to 11	Apparent power L1	INT	1 VA	-27648 to 27648	66010
12 to 15	Active energy L1 total (inflow - outflow)	UDINT	1 Wh	0 to 2147483647	62115
16 to 19	Reactive energy L1 total (inflow - outflow)	UDINT	1 varh	0 to 2147483647	62116
20 to 23	Apparent energy L1	UDINT	1 VAh	0 to 2147483647	62114
24	Scaling current L1	USINT	-	0 to 255	-
25	Scaling active power L1	USINT	-	0 to 255	-
26	Scaling reactive power L1	USINT	-	0 to 255	-
27	Scaling apparent power L1	USINT	-	0 to 255	-
28	Scaling active energy L1 total (inflow - outflow)	USINT	-	0 to 255	-
29	Scaling reactive energy L1 total (inflow - outflow)	USINT	-	0 to 255	-
30	Scaling apparent energy L1	USINT	-	0 to 255	-
31	Power factor L1	USINT	0.01	0 to 100	66019

Measured value data records E

E.1 Overview of all measured value data records

Energy Meter 400VAC 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).

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.

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 80)).

Table E- 1 Data record 142

Byte	Measured variable	Data type	Unit	Value range	Measured value ID
0	Version	BYTE	-	1	-
1	Reserved	BYTE	-	0	-
2...5	Voltage UL1-N	REAL	V	0.0 ... 300.0	1
6...9	Voltage UL2-N	REAL	V	0.0 ... 300.0	2
10...13	Voltage UL3-N	REAL	V	0.0 ... 300.0	3
14...17	Voltage UL1-L2	REAL	V	0.0 ... 600.0	4
18...21	Voltage UL2-L3	REAL	V	0.0 ... 600.0	5
22...25	Voltage UL3-L1	REAL	V	0.0 ... 600.0	6
26...29	Current L1	REAL	A	0.0 … 10000.0	7
30...33	Current L2	REAL	A	0.0 … 10000.0	8
34...37	Current L3	REAL	A	0.0 … 10000.0	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	-3.0×10^9 … $+3.0 \times 10^9$	10
70...73	Apparent power L2	REAL	VA	-3.0×10^9 … $+3.0 \times 10^9$	11
74...77	Apparent power L3	REAL	VA	-3.0×10^9 … $+3.0 \times 10^9$	12
78...81	Total apparent power L1L2L3	REAL	VA	-3.0×10^9 … $+3.0 \times 10^9$	36
82...85	Reactive power L1	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$	16
86...89	Reactive power L2	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$	17
90...93	Reactive power L3	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$	18
94...97	Total reactive power L1L2L3	REAL	var	-3.0×10^9 … $+3.0 \times 10^9$	35
98...101	Active power L1	REAL	W	-3.0×10^9 … $+3.0 \times 10^9$	13

Byte	Measured variable	Data type	Unit	Value range	Mea-sured value ID
102...105	Active power L2	REAL	W	-3.0×10^9 … $+3.0 \times 10^9$	14
106...109	Active power L3	REAL	W	-3.0×10^9 … $+3.0 \times 10^9$	15
110...113	Total active power L1L2L3	REAL	W	-3.0×10^9 … $+3.0 \times 10^9$	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 ... 3.4×10^{38}	204
130...133	Total reactive energy L1L2L3	REAL	varh	-3.4×10^{38} to $+3.4 \times 10^{38}$	206
134...137	Total active energy L1L2L3	REAL	Wh	-3.4×10^{38} to $+3.4 \times 10^{38}$	205
138...141	Total reactive energy inflow L1L2L3	REAL	varh	0.0 ... 3.4×10^{38}	202
142...145	Total reactive energy outflow L1L2L3	REAL	varh	0.0 ... 3.4×10^{38}	203
146...149	Total active energy inflow L1L2L3	REAL	Wh	0.0 ... 3.4×10^{38}	200
150...153	Total active energy outflow L1L2L3	REAL	Wh	0.0 ... 3.4×10^{38}	201
154...161	Total apparent energy L1L2L3	LREAL	VAh	0.0 ... 1.8×10^{308}	214
162...169	Total reactive energy L1L2L3	LREAL	varh	-1.8×10^{308} to $+1.8 \times 10^{308}$	216
170...177	Total active energy L1L2L3	LREAL	Wh	-1.8×10^{308} to $+1.8 \times 10^{308}$	215
178...185	Total reactive energy inflow L1L2L3	LREAL	varh	0.0 ... 1.8×10^{308}	212
186...193	Total reactive energy outflow L1L2L3	LREAL	varh	0.0 ... 1.8×10^{308}	213
194...201	Total active energy inflow L1L2L3	LREAL	Wh	0.0 ... 1.8×10^{308}	210
202...209	Total active energy outflow L1L2L3	LREAL	Wh	0.0 ... 1.8×10^{308}	211

Procedure

Data record 142 is located on the AI Energy Meter 400VAC 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

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	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		61180

Byte	Measured variable	Data type	Unit	Value range	Mea-sured value ID
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
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

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 modu-le is plugged or drawn. 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.

Error code in STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
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.

Tips and tricks

F

F.1 Tips and tricks

FAQ and application examples

Several FAQs and application examples are available to help you at work with the AI Energy Meter .

Measuring and visualizing energy data

You can find these application example at 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.