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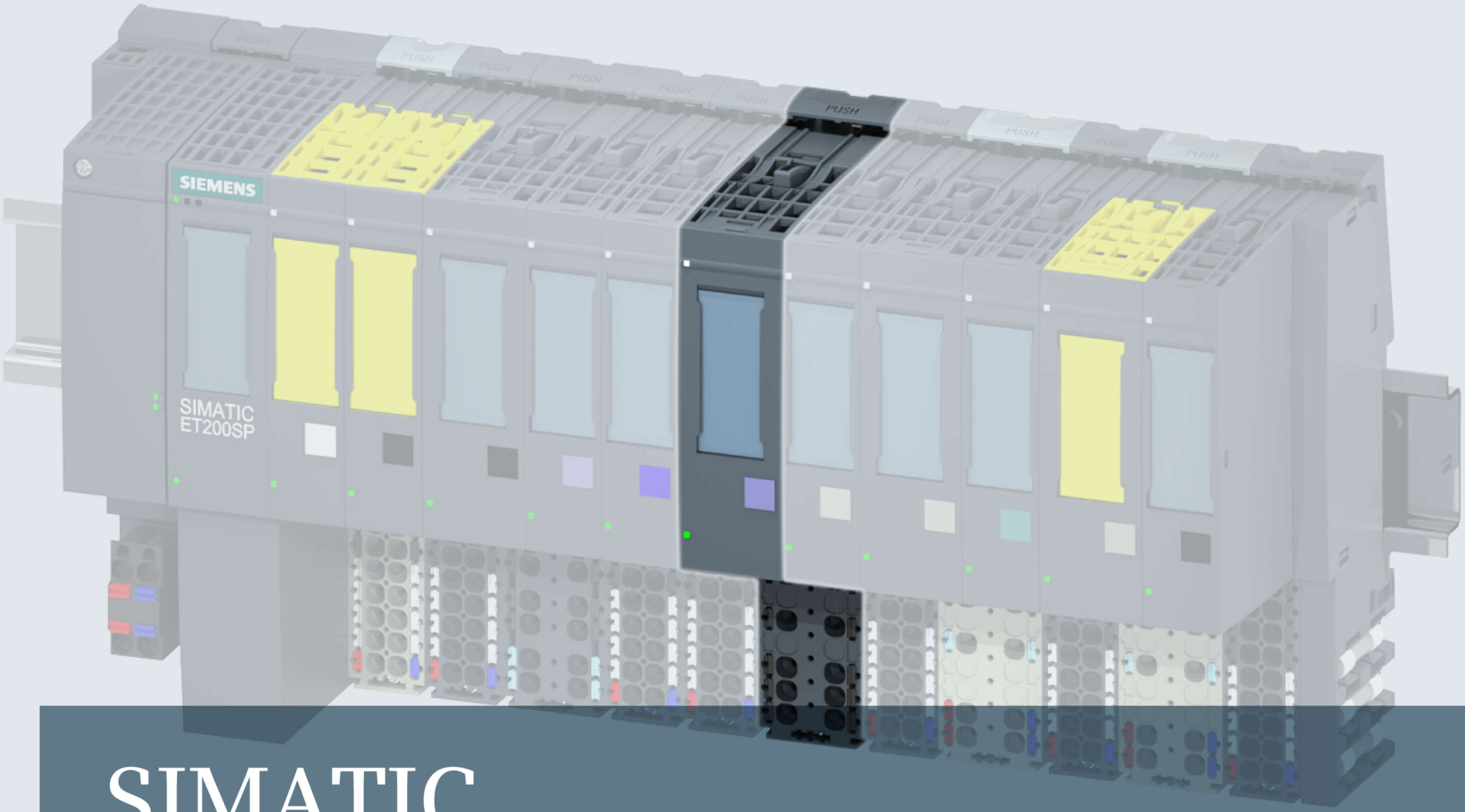

SIMATIC

ET 200SP

Analog input module AI Energy Meter ST (6ES7134-6PA00-0BD0)

Manual

Edition 07/2014

Answers for industry.

SIEMENS

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ET 200SP Analog input module AI Energy Meter ST (6ES7134-6PA00-0BD0)

Manual

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A5E03551812-AB

Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

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

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Preface

Purpose of the documentation

This device manual complements 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.

Conventions

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

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

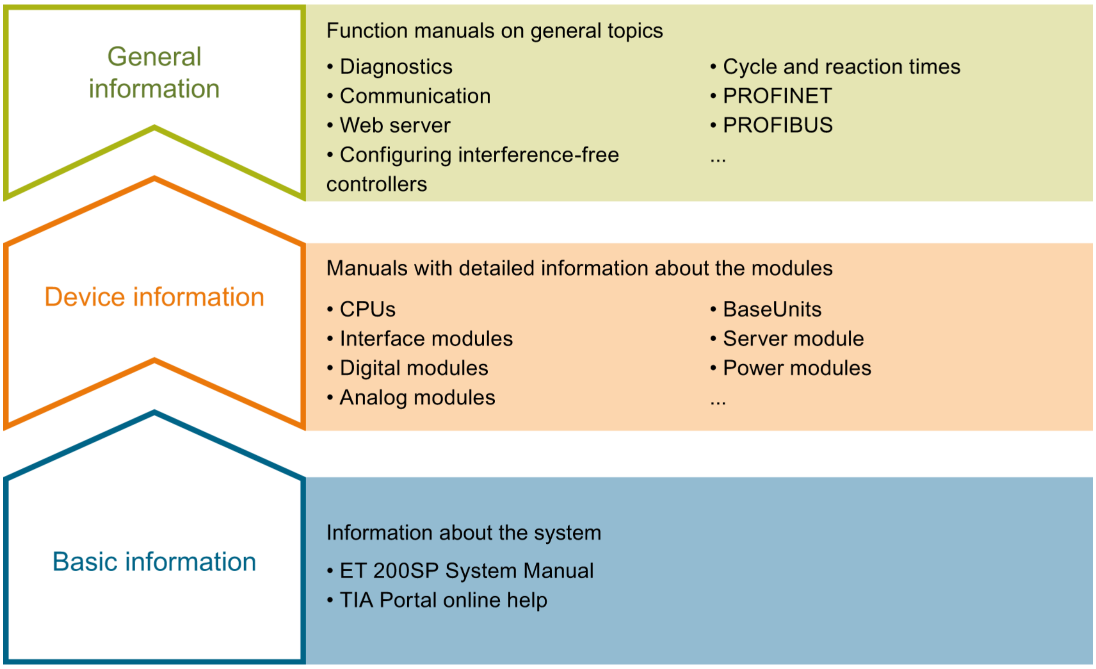
For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. You can find more information about industrial security on the Internet (http://www.siemens.com/industrialsecurity).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. You can find more information on the Internet (http://support.automation.siemens.com).

Table of contents

1 Documentation guide

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



Basic information

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

Device information

Manuals contain a compact description of the module-specific information, such as properties, terminal diagrams, characteristics, 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, Motion Control, Web server.

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

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

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).

My Documentation Manager

The My Documentation Manager is used to combine entire manuals or only parts of these to your own manual.
You can export the manual as PDF file or in a format that can be edited later.

You can find the My Documentation Manager on the Internet (http://support.automation.siemens.com/WW/view/en/38715968).

Applications & Tools

Applications & Tools supports 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 Applications & Tools on the Internet (http://support.automation.siemens.com/WW/view/en/20208582).

CAx Download Manager

The CAx Download Manager is used to access the current product data for your CAx or CAe systems.

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 the CAx Download Manager on the Internet (http://support.automation.siemens.com/WW/view/en/42455541).

Product overview 2

2.1 Properties of the AI Energy Meter ST

Article number

6ES7134-6PA00-0BD0

General safety instructions

DANGER

Hazardous voltage, risk of fatal or serious injury

Always disconnect the system and module from the power supply before commencing work.

NOTICE

Risk of hazardous system states

If you pull or plug the AI Energy Meter ST when the primary voltage for the current transformer is switched on, this can result in dangerous states in the system.

Damage to the ET 200SP may occur as a result.

- For this reason, pull and plug the AI Energy Meter ST only when the measuring voltage is switched off at the primary end or
- Only when a special current transformer terminal is used that short-circuits the secondary end of the transformer when a module is pulled. The AI Energy Meter ST should only be pulled or plugged after this current transformer terminal is removed.

View of the module

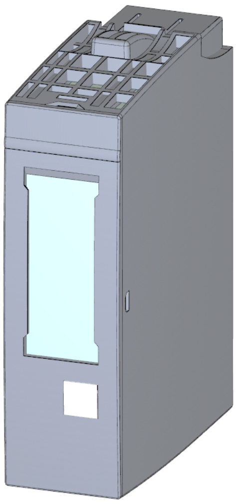


Figure 2-1 View of the AI Energy Meter ST module

Properties

The module has the following technical properties:

- Measurement of electrical data of a three-phase supply network
- Recording of:
  - Voltages
  - Currents
  - Phase angles
  - Power
  - Energy values
  - Frequencies

The module supports the following functions:

- Firmware update
- I&M identification data
- Reconfiguration in RUN

You can configure the module with STEP 7 V5.5 SPx (TIA Portal V13 SPy) and with a GSD(ML) file.

Table 2- 1 Version dependencies of other module functions

Function and properties	Product version of the module as of	Firmware version of the module as of
Increase in the resolution of the energy meter	1	V2.0.0
Selectable low measurement limit of the current values (zero suppression)	1	V2.0.0
User data variant 0xF5: Basic variables three-phase measurement L1L2L3	1	V2.0.0
All user data variants have the qualifier information in byte 2	1	V2.0.0

Accessories

The following accessories must be ordered separately:

- 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/en/58649293) system manual.

Firmware update

Note

Firmware update

Note that voltage must be applied to the L1 and N phases of the module during the firmware update. A minimum voltage of 85 V must be guaranteed during the update.

2.2 Area of application

What do you use the AI Energy Meter ST for?

To lower energy costs, it is necessary to make the energy consumption of machines and production plants transparent. A number of electrical measuring instruments are required for this purpose. Due to the limited space and the free bus selection between PROFINET and PROFIBUS, the AI Energy Meter ST is optimally suited to increasing the electrical transparency on the machine level. The module offers over 40 measured energy values for this purpose which can be measured with an accuracy of ±0.5% (with balanced load) in a single-phase and 3-phase network with up to 400 V AC.

You can use the AI Energy Meter ST to create transparency regarding:

- Energy consumption
  - Forecast of consumption
  - Efficiency
- Power consumption
  - Load management
  - Maintenance
- Emissions
  - Emission reporting (CO_2 certificate trading)
  - CO_2 footprint

Measuring with AI Energy Meter ST

The figure below shows the basic use and voltage range of the AI Energy Meter ST. A typical supply network of a production plant is divided into three voltage ranges in this example:

- 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.

We assume that the module is used in close proximity to the end consumer, meaning directly in a machine of a line in the voltage range of up to 400 V AC.

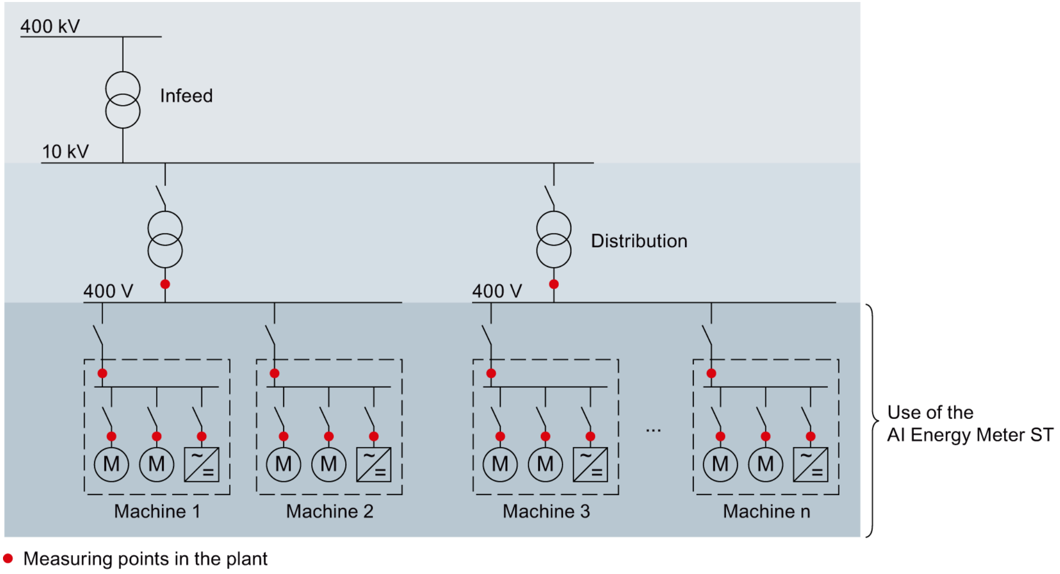


Figure 2-2 Use of the AI Energy Meter ST

Advantages of the AI Energy Meter ST

The AI Energy Meter 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
- Expansion of existing I/O stations by energy measurement

3 Wiring

3.1 Terminal and block diagram

Potential

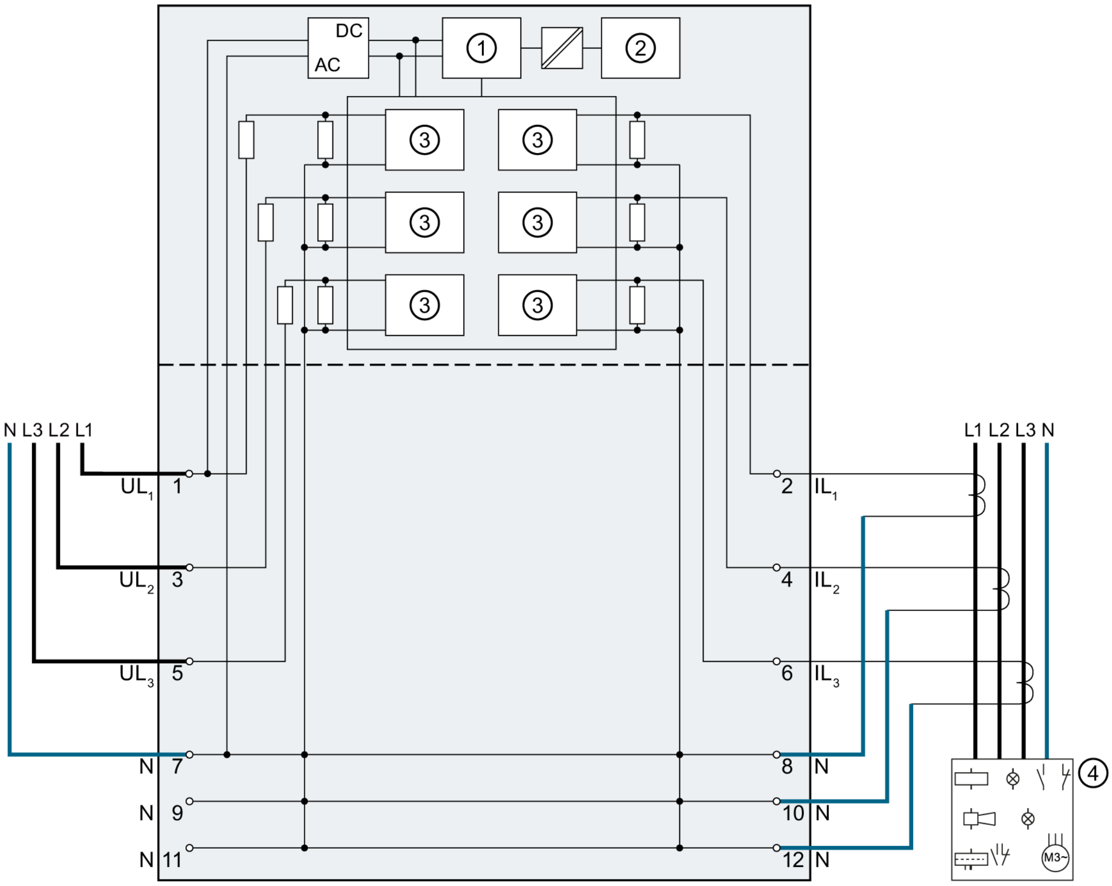
The AI Energy Meter ST forms its own potential together with its BaseUnit. The BaseUnit is not in contact with the power bus and passes the potential through from the left to the right slot.

General pin assignment

⚠ CAUTION
Measurement of alternating current only
The module is not suitable for the measurement of direct current.

⚠ CAUTION
Measurement of alternating voltage only
The module is not suitable for the measurement of direct voltage.

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 conductor
④	Power measurement		

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

Useable BaseUnit

As BaseUnit, use a BaseUnit of type D0, 6ES7193-6BP00-0B**D0**.

Pull the I/O module forwards and parallel out of the BaseUnit.

Connection types

There are 3 connection types for connection in two-wire or four-wire networks with balanced or unbalanced load:

- 3-phase, 4-wire, unbalanced load
- 3-phase, 4-wire, balanced load
- Single-phase alternating current

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 Application cases (Page 17).

Information on the selection of a current transformer is available in the section Current transformer selection data (Page 78).

3.2 Supplying the module

Supplying the module

The supply of the module always takes place via L1 and N. The required minimum voltage is 85 V AC.

These lines must always be connected regardless of the measurement type.

TN and TT system

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

Protecting the connection cables

To protect the connection cables at UL1, UL2 and UL3, 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 ST.

4 Application cases

4.1 Power measurement on a machine

Principle

Voltage is measured via terminals UL1, UL2, UL3 and N.

Current is measured by means of three current transformers via terminals IL1, IL2, IL3 and N.

There is unrestricted measurement of all values in all phases.

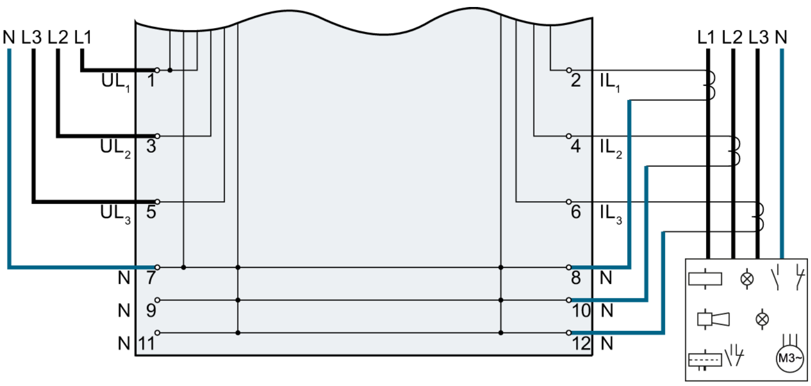


Figure 4-1 Power measurement on a machine

4.2 Current measurement on a motor

Principle

Current is measured by means of three current transformers via terminals IL1, IL2, IL3 and N.

The measurement is restricted to the currents of the 3 phases and voltage on channel L1.

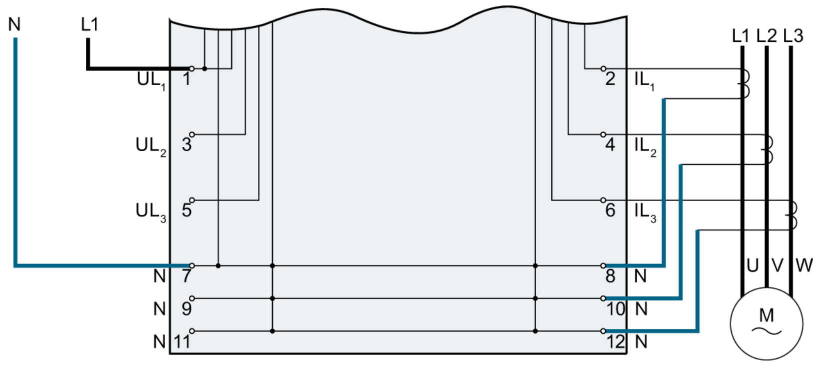


Figure 4-2 Current measurement on a motor

4.3 Single-phase power measurement on a machine

Principle

The voltage must be measured via terminals UL1 and N.

Current is measured by means of a current transformer via terminals IL1 and N.

There is unrestricted measurement of all values in phase L1.

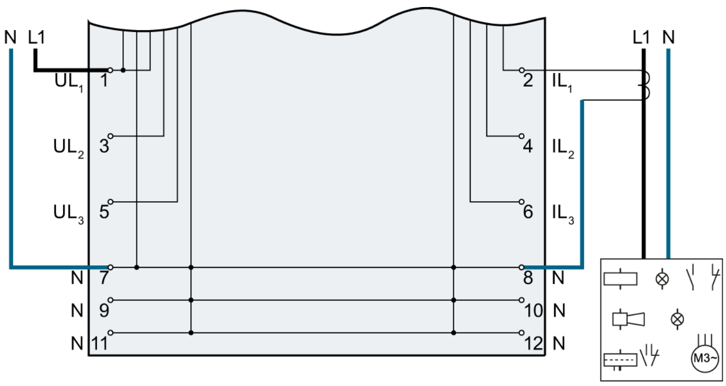


Figure 4-3 Single-phase power measurement on a machine

4.4 Power measurement on a machine without coupled neutral conductor

Principle

Voltage is measured via terminals UL1, UL2 and UL3.

Current is measured by means of three current transformers via the terminals IL1, IL2 and IL3.

With a grounded neutral conductor and negligible load on the grounding section, the neutral conductor connection of the AI Energy Meter ST can be grounded.

There is unrestricted measurement of all values in all phases.

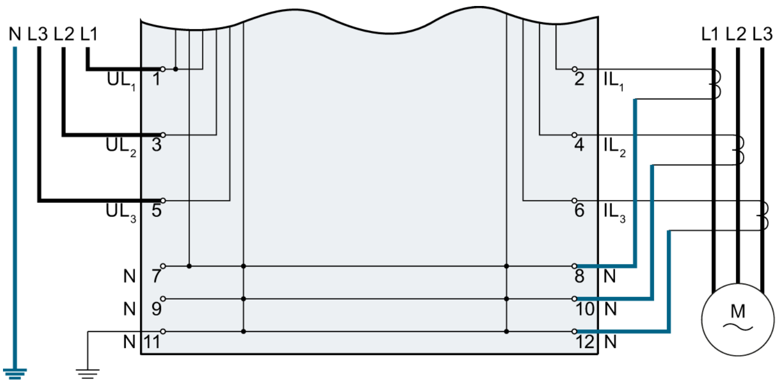


Figure 4-4 Power measurement on a machine without coupled neutral conductor

4.5 Measurement on a balanced consumer without neutral conductor connection

Principle

For balanced consumers without a neutral conductor connection, the neutral conductor of the four-wire system can be used for the measurements.

There is unrestricted measurement of all values in all phases.

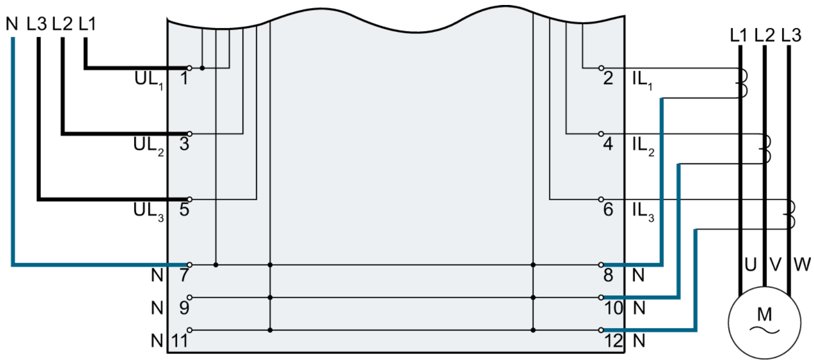


Figure 4-5 Power measurement on a machine without neutral conductor connection

Measured variables and measured values 5

5.1 Making the measured variables available

Measured values

There are two ways to read out measured values from the AI Energy Meter ST:

- acyclically via a measured value data record (section Measured value data record (Page 23))
- cyclically via the user data (section User data (Page 25))

Validity of the measured values

After turning on the supply voltage UL1, the first measured values are available after approximately 2 seconds. In the user input data, the content of byte 0 is set to the selected user data variant. The user data variant has a range of values from 159 and 246 to 254. You can use this change in byte 0 as a trigger event.

As soon as there are measured values in the module, the value of this byte changes to a value within the specified value range.

First 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 user input data to be modified dynamically according to the requirements of the process.

A user data variant = 0 in byte 0 of the output data is ignored and the previously valid selection remains.

Current measured values become "0"

The measured values for the current and all other measured values dependent on them are suppressed (or set to "0") in the data records and in the user data in the following situations:

- The current fed in is lower than the configured current low limit or
- The secondary current fed in on 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 moving mean value is formed from the power values. These 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.

5.2 Measured value data record

Measured variables of the module

The module provides the measured variables as data record 142.

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 74)).

Table 5- 1 Data record 142

Byte	Measured variable	Format	Measured value ID
0	Version	Byte	
1	Reserved	Byte	
2	Voltage UL1-N	Float	1
6	Voltage UL2-N	Float	2
10	Voltage UL3-N	Float	3
14	Voltage UL1-L2	Float	4
18	Voltage UL2-L3	Float	5
22	Voltage UL3-L1	Float	6
26	Current L1	Float	7
30	Current L2	Float	8
34	Current L3	Float	9
38	Power factor L1	Float	19
42	Power factor L2	Float	20
46	Power factor L3	Float	21
50	Total power factor L1L2L3	Float	37
54	Frequency	Float	30
58	Amplitude unbalance for voltage	Float	38
62	Amplitude unbalance for current	Float	39
66	Apparent power L1	Float	10
70	Apparent power L2	Float	11
74	Apparent power L3	Float	12
78	Total apparent power L1L2L3	Float	34
82	Reactive power L1	Float	16
86	Reactive power L2	Float	17
90	Reactive power L3	Float	18
94	Total reactive power L1L2L3	Float	36
98	Active power L1	Float	13
102	Active power L2	Float	14
106	Active power L3	Float	15
110	Total active power L1L2L3	Float	35
114	Phase angle L1	Float	62108
118	Phase angle L2	Float	62208

Byte	Measured variable	Format	Measured value ID
122	Phase angle L3	Float	62308
126	Total apparent energy L1L2L3	Float	204
130	Total reactive energy L1L2L3	Float	206
134	Total active energy L1L2L3	Float	205
138	Total reactive energy inflow L1L2L3	Float	202
142	Total reactive energy outflow L1L2L3	Float	203
146	Total active energy inflow L1L2L3	Float	200
150	Total active energy outflow L1L2L3	Float	201
154	Total apparent energy L1L2L3	double	214
162	Total reactive energy L1L2L3	double	216
170	Total active energy L1L2L3	double	215
178	Total reactive energy inflow L1L2L3	double	212
186	Total reactive energy outflow L1L2L3	double	213
194	Total active energy inflow L1L2L3	double	210
202	Total active energy outflow L1L2L3	double	211

Note

- The cumulative value in 3-phase operation is obtained from the sums of the individual values of the phases.
- Inflow and outflow energy meters are always positive values.
- The diagnostics information "Overflow cumulative values" is not triggered in connection with the maximum values of the energy meters.

Procedure

Data record 142 is located on the AI Energy Meter ST. Use SFB "RDREC" to read out the data record from the module. This system function 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. Remedy: Select hexadecimal representation.

Can 64-bit floats be processed in STEP 7 as of V5.x?

You will find an FAQ (http://support.automation.siemens.com/WW/view/en/56600676) on the Internet dealing with conversion of 64-bit float to 32-bit real.

You can process these values directly in STEP 7 (TIA Portal).

5.3 User data

5.3.1 Module versions

Input/output data

The input/output data are limited within an ET 200SP station depending on the interface module or CPU in use. The longer the input and output data of a module, the sooner the maximum configuration of the ET 200SP is reached.

Module versions

Table 5- 2 Comparison of the module versions

Module version **32 input data/12 output data**	**Module version** **2 input data/2 output data**
Measured values are mapped in different user data variants to 32 bytes of user data inputs. These user data variants are described as of User input data (Page 28). The user data variant can be dynamically changed by means of the output data. You can also read the measured values with data record 142.	Due to the low requirement for cyclical user data, more AI Energy Meter ST modules can be operated in the ET 200SP station. The measured values can then no longer be transferred with the user data but can only be read using data record 142.

Quality information

The quality bits are displayed in both module versions and in all user data variants.

In addition, the two bits 6 and 7 receive a code that describes the "quadrants of phase 1" in relation to the power.

NOTICE
Phase 1 only
The qualifier bits always describe the state of phase 1. This means they apply to all 3 phases in balanced mode.

Table 5- 3 Quality information

Byte	Allocation	Bit	Validity	Comment
1	Qualifier	7	Quadrant	See table below.
	Qualifier	6	Quadrant	
	I3	5	I-phase 3	Bit = 1: Measured value OK Bit = 0: Measured value has error or does not exist
	U3	4	U-phase 3	
	I2	3	I-phase 2	
	U2	2	U-phase 2	
	I1	1	I-phase 1	
	U1	0	U-phase 1	

Quadrant "QQ" in the quality bits

Table 5- 4 Quadrant in the quality bits

Quadrant	Code	Meaning	Criteria
I	0b 00xx xxxx	Motor, inductive	Active power +, cos ϕ + reactive power +
II	0b 01xx xxxx	Generator, inductive	Active power -, cos ϕ - reactive power +
II	0b 10xx xxxx	Generator, capacitive	Active power -, cos ϕ - reactive power -
IV	0b 11xx xxxx	Motor, capacitive	Active power +, cos ϕ + reactive power -

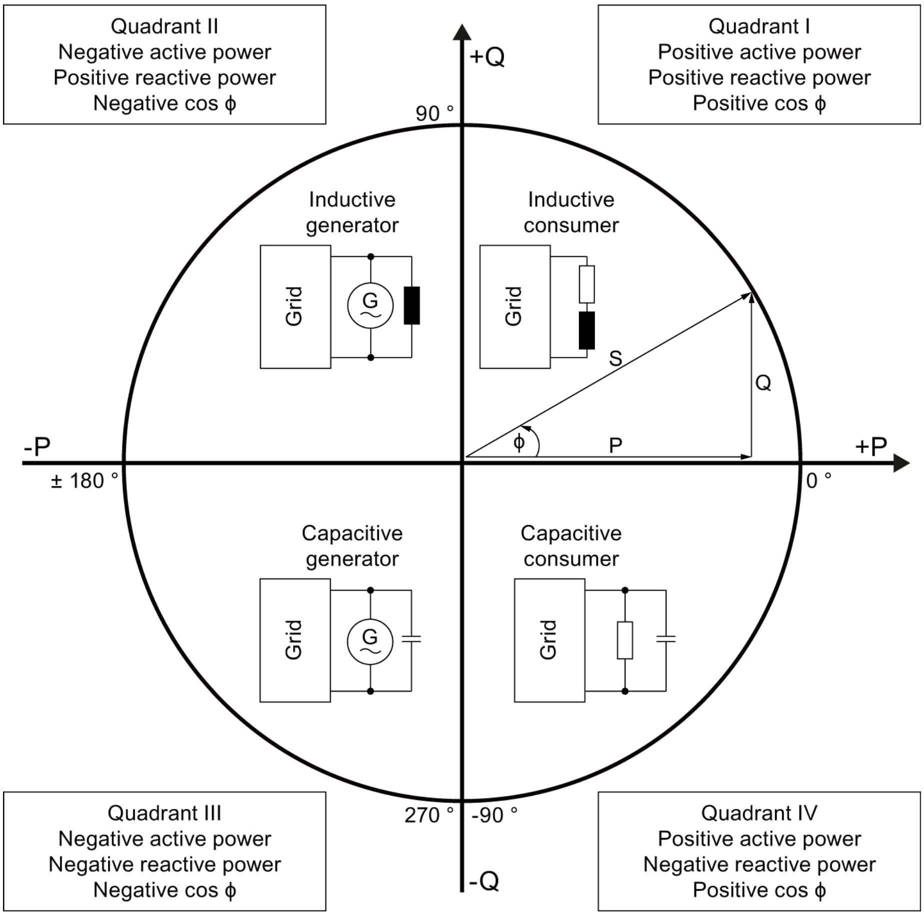


Figure 5-1 Quadrant in the quality bits

Quadrant "QQ" validity

The quadrant information only applies to phase 1 of the module.

Scaling of measured values in the user data

Due to the limited transmission length, the measured values which are transferred with the user data are scaled down from REAL values to INT values. An additional scaling value is also supplied in the user data for each value which was scaled this way and may have lost in accuracy or was falsified so that the correct value can be recalculated on the CPU.

Example: The current for phase L1 is transferred in bytes 2 + 3 in the user data variant 0x9F (159). This was scaled down from a REAL value with 4 bytes and 32 bits to an INT value with only 2 bytes. Because the area that is displayed with an INT value is much smaller than that of a REAL value, you may experience an overflow rather quickly. To derive the value correctly on the CPU or to prevent such an overflow, the scaling byte for the current is also supplied in byte 24.

The actual value on the CPU can be calculated with the following formula:

$\text{Measured value}_{\text{Real}} = \text{Measured value}_{\text{INT}} \cdot 10^{\text{Scaling factor}}$

5.3.2 Module version: User data with 32 bytes input data/12 bytes output data

User data of the module

The module has 32 bytes of user input data and 12 bytes of user output data.

5.3.2.1 User input data

User input data

The structure of the user input data can be set dynamically. You can choose from different variants. The structure variants of these 32 bytes of user input data are described below.

The user data variant is preset in parameter data record 128 and can be dynamically changed with the appropriate setting in the user output data (byte 0).

Table 5- 5 32 bytes user input data

Byte	Validity	Designation	Comment
0	Module	User data variant	Status and structure of the user data
1	Module	Quality information	Quality bits to describe the quality of the basic measured values
2 ... 31	Module or phase	Data	2 or 4 byte measured values or cumulative values according to user data variant

5.3.2.2 User output data

User output data

You can use the user output data to

- Switch the user input data variant
- Trigger the reset of the request command
- Open the energy meter gate.

With the first byte of the user output data, you can change the user input data variant dynamically (refer to the section Making the measured variables available (Page 21)).

The Reset on Request command of the energy meter data record 143 is still executed via the user output data. The values are adopted from energy meter data record 143 only when a high edge is generated on the seventh bit in the first byte of the user output data (refer to the section Structure of data record 143 (Page 45)).

With the sixth bit of the first byte of the user output data, the energy meter gate can be opened (=1) or closed (=0). To use this function, you need to enable the gate of the energy meter in parameter data record 128 (refer to the section Parameter assignment and structure of the parameter data record (Page 68)).

Table 5- 6 12 bytes user output data

Byte	Validity	Designation	Comment
0	Module	User data variant	For changing the user data variant dynamically (code corresponds to the parameter with the same name in data record 128)
1	Module	Digital control outputs	Bit 7 = 0→1: Reset energy meter
			Bit 6 = 1: Energy meter gate open
2 ... 11	Reserved	Reserved	Reserved

5.3.2.3 User data variants

User data

30 bytes are available for transmission to supply the measured values cyclically with the input/output data of the AI Energy Meter ST. Because only a limited number of measured values can be transmitted this way, you can select one of ten preconfigured user data variants. These include a specific selection of measured values.

User data	User data variant
Total power L1L2L3	254 (preset)
Active power L1L2L3	253
Reactive power L1L2L3	252
Apparent power L1L2L3	251
Basic measured values L1L2L3	250
Total energy L1L2L3	249
Energy L1	248
Energy L2	247
Energy L3	246
Basic variables three-phase measurement	245
Basic variables single-phase measurement L1	159

Total power L1L2L3 (ID 254 or FE_H)

The following structure is the default for the total power.

Table 5- 7 Total power L1L2L3

Byte	Allocation	Measured value ID
0	User data variant = 254 (FE_H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 5	Current L2	8
6 ... 7	Current L3	9
8 ... 9	Total active power L1L2L3	35
10 ... 11	Total reactive power L1L2L3	36
12 ... 13	Total apparent power L1L2L3	34
14 ... 17	Total active energy L1L2L3	200
18 ... 21	Total reactive energy L1L2L3	202
22	Reserved	
23	Total power factor L1L2L3	37
24	Scaling current L1	
25	Scaling current L2	
26	Scaling current L3	
27	Scaling total active power L1L2L3	
28	Scaling total reactive power L1L2L3	
29	Scaling total apparent power L1L2L3	
30	Scaling total active energy L1L2L3	
31	Scaling total reactive energy L1L2L3	

Active power L1L2L3 (ID 253 or FD_H)

Table 5- 8 Active power L1L2L3

Byte	Allocation	Measured value ID
0	User data variant = 253 (FD_H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 5	Current L2	8
6 ... 7	Current L3	9
8 ... 9	Active power L1	13
10 ... 11	Active power L2	14
12 ... 13	Active power L3	15
14 ... 15	Total active power L1L2L3	35
16 ... 19	Total active energy L1L2L3	205
20	Power factor L1	19
21	Power factor L2	20
22	Power factor L3	21
23	Total power factor L1L2L3	37
24	Scaling current L1	
25	Scaling current L2	
26	Scaling current L3	
27	Scaling active power L1	
28	Scaling active power L2	
29	Scaling active power L3	
30	Scaling active power L1L2L3	
31	Scaling total active energy L1L2L3	

Reactive power L1L2L3 (ID 252 or FC_H)

Table 5- 9 Reactive power L1L2L3

Byte	Allocation	Measured value ID
0	User data variant = 252 (FC_H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 5	Current L2	8
6 ... 7	Current L3	9
8 ... 9	Reactive power L1	16
10 ... 11	Reactive power L2	17
12 ... 13	Reactive power L3	18
14 ... 15	Total reactive power L1L2L3	36
16 ... 19	Total reactive energy L1L2L3	202
20	Power factor L1	19
21	Power factor L2	20
22	Power factor L3	21
23	Total power factor L1L2L3	37
24	Scaling current L1	
25	Scaling current L2	
26	Scaling current L3	
27	Scaling reactive power L1	
28	Scaling reactive power L2	
29	Scaling reactive power L3	
30	Scaling reactive power L1L2L3	
31	Scaling total reactive energy L1L2L3	

Apparent power L1L2L3 (ID 251 or FB_H)

Table 5- 10 Apparent power L1L2L3

Byte	Allocation	Measured value ID
0	User data variant = 251 (FB_H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 5	Current L2	8
6 ... 7	Current L3	9
8 ... 9	Apparent power L1	10
10 ... 11	Apparent power L2	11
12 ... 13	Apparent power L3	12
14 ... 15	Total apparent power L1L2L3	34
16 ... 19	Total apparent energy L1L2L3	204
20	Power factor L1	19
21	Power factor L2	20
22	Power factor L3	21
23	Total power factor L1L2L3	
24	Scaling current L1	
25	Scaling current L2	
26	Scaling current L3	
27	Scaling apparent power L1	
28	Scaling apparent power L2	
29	Scaling apparent power L3	
30	Scaling apparent power L1L2L3	
31	Scaling total apparent energy L1L2L3	

Basic measured values L1L2L3 (ID 250 or FA_H)

Table 5- 11 Basic measured values L1L2L3

Byte	Allocation	Measured value ID
0	User data variant = 250 (FA_H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 5	Current L2	8
6 ... 7	Current L3	9
8 ... 9	Voltage UL1-N	1
10 ... 11	Voltage UL2-N	2
12 ... 13	Voltage UL3-N	3
14 ... 15	Voltage UL1-UL2	4
16 ... 17	Voltage UL2-UL3	5
18 ... 19	Voltage UL3-UL1	6
20	Power factor L1	19
21	Power factor L2	20
22	Power factor L3	21
23	Total power factor L1L2L3	37
24	Scaling current L1	
25	Scaling current L2	
26	Scaling current L3	
27	Reserved	
28	Reserved	
29	Reserved	
30 ... 31	Frequency	62030

Total energy L1L2L3 (ID 249 or $F9_H$)

Table 5- 12 Total energy L1L2L3

Byte	Allocation	Measured value ID
0	User data variant = 249 ($F9_H$)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2	Reserved	
3	Reserved	
4 ... 7	Total active energy L1L2L3 inflow	210
8 ... 11	Total active energy L1L2L3 outflow	211
11 ... 15	Total reactive energy L1L2L3 inflow	212
16 ... 19	Total reactive energy L1L2L3 outflow	213
20 ... 23	Total apparent energy L1L2L3	214
24	Reserved	
25	Scaling active energy, inflow	
26	Scaling active energy, outflow	
27	Scaling reactive energy, inflow	
28	Scaling reactive energy, outflow	
29	Scaling apparent energy	
30	Reserved	
31	Total power factor	37

Energy L1 (ID 248 or $F8_H$)

Table 5- 13 Energy L1

Byte	Allocation	Measured value ID
0	User data variant = 248 ($F8_H$)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 7	Active energy inflow L1	62110
8 ... 11	Active energy outflow L1	62111
11 ... 15	Reactive energy inflow L1	62112
16 ... 19	Reactive energy outflow L1	62113
20 ... 23	Apparent energy L1	62114
24	Scaling current L1	
25	Scaling active energy inflow L1	
26	Scaling active energy outflow L1	
27	Scaling reactive energy inflow L1	
28	Scaling reactive energy outflow L1	
29	Scaling apparent energy L1	
30	Reserved	
31	Power factor L1	19

Energy L2 (ID 247 or $F7_H$)

Table 5- 14 Energy L2

Byte	Allocation	Measured value ID
0	User data variant = 247 ($F7_H$)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L2	8
4 ... 7	Active energy inflow L2	62210
8 ... 11	Active energy outflow L2	62211
11 ... 15	Reactive energy inflow L2	62212
16 ... 19	Reactive energy outflow L2	62213
20 ... 23	Apparent energy L2	62214
24	Scaling current L2	
25	Scaling active energy inflow L2	
26	Scaling active energy outflow L2	
27	Scaling reactive energy inflow L2	
28	Scaling reactive energy outflow L2	
29	Scaling apparent energy L2	
30	Reserved	
31	Power factor L2	20

Energy L3 (ID 246 or F6H)

Table 5- 15 Energy L3

Byte	Allocation	Measured value ID
0	User data variant = 246 (F6H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L3	9
4 ... 7	Active energy inflow L3	62310
8 ... 11	Active energy L3, outflow	62311
11 ... 15	Reactive energy inflow L3	62312
16 ... 19	Reactive energy outflow L3	62313
20 ... 23	Apparent energy L3	62314
24	Scaling current L3	
25	Scaling active energy inflow L3	
26	Scaling active energy outflow L3	
27	Scaling reactive energy inflow L3	
28	Scaling reactive energy outflow L3	
29	Scaling apparent energy L3	
30	Reserved	
31	Power factor L3	21

Basic variables three-phase measurements (ID 245 or F5H)

Table 5- 16 Basic variables three-phase measurements

Byte	Allocation	Measured value ID
0	User data variant = 245 (F5H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 5	Total active power L1L2L3	34
6 ... 9	Total active energy L1L2L3 outflow	62418
10 ... 13	Total active energy L1L2L3 inflow	62417
14 ... 17	Current L1	7
18 ... 21	Current L2	8
22 ... 25	Current L3	9
26 ... 27	Voltage UL1-N	1
28 ... 29	Voltage UL2-N	2
30 ... 31	Voltage UL3-N	3

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

You can use this structure when using the module on single-phase system L1.

Table 5- 17 Basic variables three-phase measurement

Byte	Allocation	Measured value ID
0	User data variant = 159 ($9F_H$)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 5	Voltage UL1-N	1
6 ... 7	Active power L1	13
8 ... 9	Reactive power L1	16
10 ... 11	Apparent power L1	66
12 ... 15	Active energy L1	62117
16 ... 19	Reactive energy L1	62119
20 ... 23	Apparent energy L1	62114
24	Scaling current L1	
25	Scaling active power L1	
26	Scaling reactive power L1	
27	Scaling apparent power L1	
28	Scaling active energy L1	
29	Scaling reactive energy L1	
30	Scaling apparent energy L1	
31	Power factor L1	19

5.3.3 Module version: User data with 2 bytes input data/2 bytes output data

This module version can only be configured with some interface modules, see ET 200SP Product information (http://support.automation.siemens.com/WW/view/en/73021864).

User data of the module

The module has 2 bytes of user input data and 2 bytes of user output data.

The structure of the input user data is fixed. The structure variants of these 2 bytes of input data are described below.

Table 5- 18 2 bytes user input data

Byte	2 byte variant	Validity	Designation	Comment
0	128 (0x80)	Module	User data variant	Constant = 0x80
1	Qualifier	Module	Quality information	Quality bits to describe the quality of the basic measured values

The structure variants of these 2 bytes of output data are described below.

Table 5- 19 2 bytes user output data

Byte	Validity	Designation	Comment
0	Module	Reserved	Reserved
1	Module	Digital control outputs	Bit 7 = 0 → 1: Reset energy meter
			Bit 6 = 1: Energy meter gate open

6 Energy meters

6.1 How the energy meter works

Introduction

The AI Energy Meter ST measures the voltage and the current. Depending on the time, the AI Energy Meter ST determines the energy meter which represents a typical indicator for the power consumption of a plant. Typical areas of application are in energy management, refer also to the section Area of application (Page 12).

Backing up energy meter values

Because the AI Energy Meter ST does not include retentive memory, saved actual values (e.g., the energy meters) are reset to "0" after a power failure.

To back up the energy values, you need to read data record 143 cyclically using SFB "RDREC" and save it in the CPU. You should select a cycle of ≥ 5 seconds for this purpose to not permanently block acyclic communication to the module.

You need to monitor the AI Energy Meter ST for failure of the power supply:

- The simplest method is to query whether the user data variant is not equal to 0x00. With the current implementation, the user data variant must always be greater than 0x00.

  Note

  Failure of the communication bus

  The user data variant is also reset to 0x00 in case of a communication bus failure.

- An alternative version to diagnose a power failure is to query the diagnostic error interrupt of the module intended for this purpose.

If a power failure is detected, the data record must be written back to the AI Energy Meter ST as soon as the module is available again. You can use SFB "WRREC" to do this and write the data saved last to data record 143.

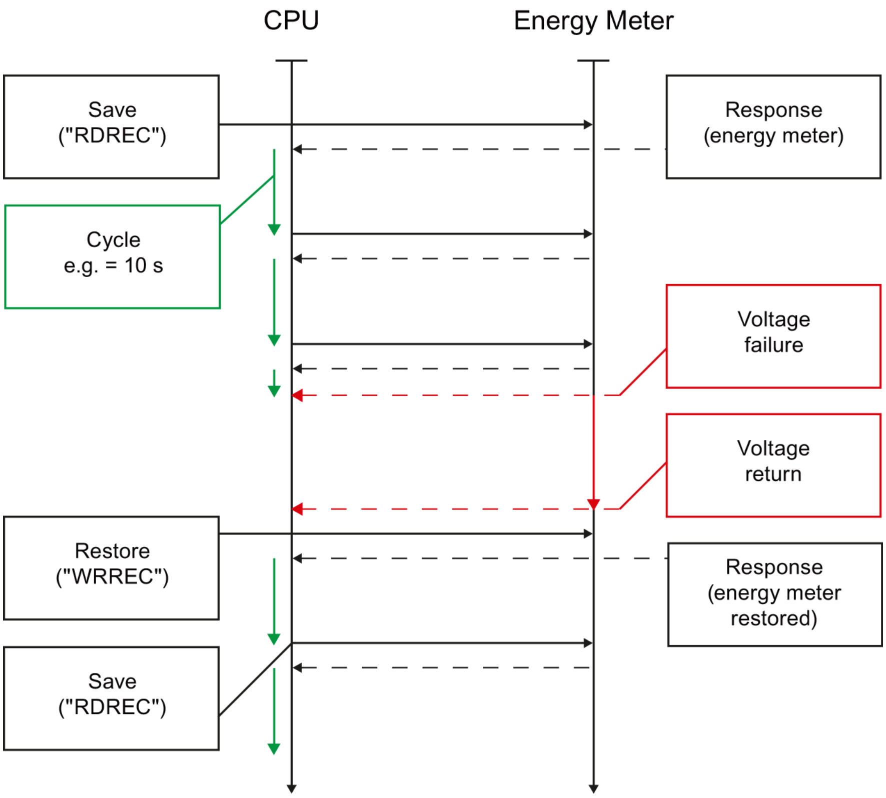


Figure 6-1 Writing back the values after a power failure

Energy meter is reset

The energy meter is reset when

- Parameter settings relevant to the energy meter are changed:
  - Measurement type or range
  - Current transformer (secondary current, primary current or transfer factor)
  - Direction of current
- The supply voltage fails at L1
- The wrong module is configured for this slot.

The energy measurement then begins again starting at the value "0".

Energy meter gate

If the "Energy meter gate" parameter is enabled in parameter 128, the energy meters only measure if the bit in the "Energy meter gate open" output data is set to "1" (refer to the section User output data (Page 29)).

If the parameter "Energy meter gate" is deactivated in parameter 128, the energy meters operate constantly and the gate is disabled. The enable bit in the user data therefore has no effect.

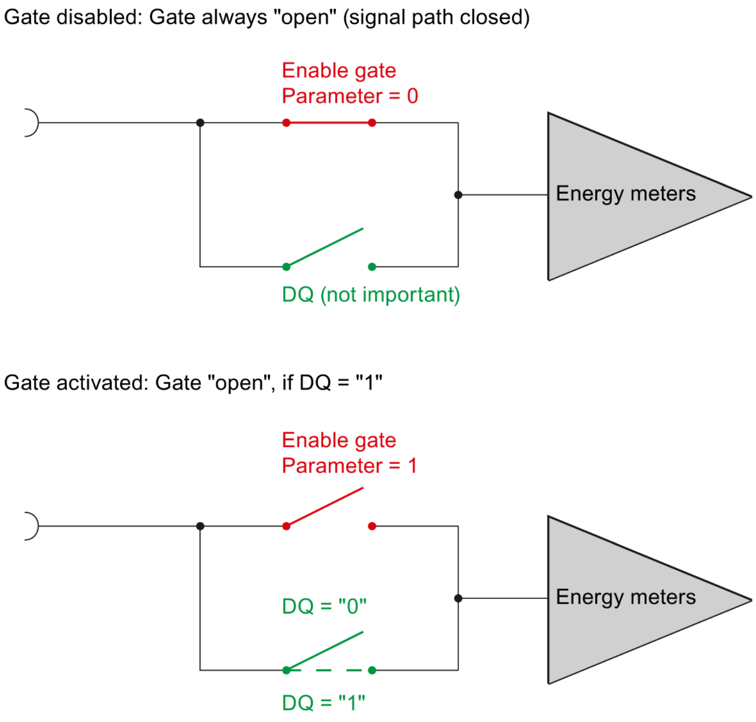


Figure 6-2 Gate

Display of energy values

To monitor the energy values using the tag table, you need to distinguish between the following:

- CPU S7-1200/1500 and STEP 7 (TIA Portal)

  These CPU types can process 64-bit data, i.e. the LREAL data type. With the help of a data block, you can monitor LREAL energy values in the watch table of STEP 7 (TIA Portal). To do this, you need to create a structure that corresponds exactly to the measured variable data record 142. The tag to be monitored must be called up in the watch table via the direct address name.

- Other CPUs and STEP 7 as of V5.5 or TIA Portal

  These CPUs are unable to process 64-bit data. Data therefore must be converted to a different data type before processing can continue. This may result in loss of precision and a restriction of the value range. Use the energy values of the float data type or convert 64-bit energy values for display with your user program and the LREAL2REAL function.

6.2 Energy meter data record 143

6.2.1 Structure of data record 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:

- Resetting the energy meter to user-specific value (e.g. "0"), see Restoring data record 143 (Page 47)
- Reading the current values of the energy meters, see Saving data record 143 (Page 49)
- Restoring the energy meters after a power failure

Energy meter data record 143

Table 6- 1 Energy meter data record 143

Byte		Format	Length in bytes	Unit	Value range	Meaning
0	Version	Unsigned 8	1	byte	0: 1. Version	Version control
1	Reserved	Unsigned 8	1		0	-
2	Control byte 1 - L1	Unsigned 8	1	8 bit	-	Restore: Controls the response of the module-internal calculations (Restoring data record 143 (Page 47)). Save: All energy meter values are supplied (Saving data record 143 (Page 49)).
3	Control byte 2 - L1	Unsigned 8	1	8 bit		
4	Control byte 1 - L2	Unsigned 8	1	8 bit		
5	Control byte 2 - L2	Unsigned 8	1	8 bit		
6	Control byte 1 - L3	Unsigned 8	1	8 bit		
7	Control byte 2 - L3	Unsigned 8	1	8 bit		
8	Active energy, inflow, start value L1	Double	8	Wh	Overflow 1.8e+308	Restore: If the individual variables are selected via bits, the start values starting from address 8 apply. Only the values selected
16	Active energy, outflow, start value L1	Double	8	Wh	Overflow 1.8e+308	
24	Reactive energy, inflow, start value L1	Double	8	vahr	Overflow 1.8e+308	
32	Reactive energy, outflow, start value L1	Double	8	varh	Overflow 1.8e+308	

Byte		Format	Length in bytes	Unit	Value range	Meaning
40	Apparent energy start value L1	Double	8	VAh	Overflow 1.8e+308	using control bits are applied and these energy calculations are restarted. (Restoring data record 143 (Page 47)). Save: Current energy meter values are supplied (Saving data record 143 (Page 49)).
48	Active energy, inflow, start value L2	Double	8	Wh	Overflow 1.8e+308	
56	Active energy, outflow, start value L2	Double	8	Wh	Overflow 1.8e+308	
64	Reactive energy, inflow, start value L2	Double	8	varh	Overflow 1.8e+308	
72	Reactive energy, outflow, start value L2	Double	8	varh	Overflow 1.8e+308	
80	Apparent energy start value L2	Double	8	VAh	Overflow 1.8e+308	
88	Active energy, inflow, start value L3	Double	8	Wh	Overflow 1.8e+308	
96	Active energy, outflow, start value L3	Double	8	Wh	Overflow 1.8e+308	
104	Reactive energy, inflow, start value L3	Double	8	varh	Overflow 1.8e+308	
112	Reactive energy, outflow, start value L3	Double	8	varh	Overflow 1.8e+308	
120	Apparent energy start value L3	Double	8	VAh	Overflow 1.8e+308	

6.2.2 Restoring data record 143

Control bytes 1 and 2

The control bytes 1 and 2 of the respective phases must be filled as follows to restore the energy meters:

Control byte 1 for energy meter data record 143 (restore)

Table 6- 2 Control byte 1 for energy meter data record 143 (restore)

<table>
<tr><th>Bit</th><th colspan="2">Meaning</th></tr>
<tr><td rowspan="2">7</td><td>Bit=1:</td><td>Values are only applied when the reset output (see user data outputs) receives a 0 → 1 edge.</td></tr>
<tr><td>Bit=0:</td><td>Start values are applied immediately</td></tr>
<tr><td>6</td><td colspan="2">Reserved</td></tr>
<tr><td>5</td><td colspan="2">Reserved</td></tr>
<tr><td>4</td><td colspan="2">Reserved</td></tr>
<tr><td>3</td><td colspan="2">Reserved</td></tr>
<tr><td>2</td><td colspan="2">Energy meters are reset</td></tr>
<tr><td>1</td><td colspan="2">Reserved</td></tr>
<tr><td>0</td><td colspan="2">Reserved</td></tr>
</table>

Control byte 2 for energy meter data record 143 (restore)

Table 6- 3 Control byte 2 for energy meter data record (restore)

Bit	Meaning
7	Apparent energy meters are to be restarted
6	Reactive energy meters are to be restarted
5	Active energy meters are to be restarted
4	Reserved
3	Reserved
2	Reserved
1	Reserved
0	Reserved

Values for control byte 2

Value	Meaning
00_H	No variable
20_H	Active energy meter is to be restarted
40_H	Reactive energy meter is to be restarted
60_H	Active energy meter and reactive energy meter are to be restarted
80_H	Apparent energy meter is to be restarted
$A0_H$	Active energy meter and apparent energy meter are to be restarted
$C0_H$	Reactive energy meter and apparent energy meter are to be restarted
$E0_H$	Active, reactive and apparent energy meters are to be restarted

Reset on Request

It is customary in production plants to reset the energy meters in specific situations (for example, after completing a production job). The function for this is "Reset on Request".

If the respective bit is set in the control byte 1 of the individual phases of the data record 143, all selected energy meters are applied in the firmware but are not yet effective.

The start values are only included in the calculation of the energy meter after the switching of a "0 → 1" edge at the respective digital output.

The selection of the energy meter is implemented via the control bytes 2 in the data record 143.

6.2.3 Saving data record 143

Control bytes 1 and 2

Control bytes 1 and 2 are supplied as follows for saving the energy meters:

Control byte 1 for energy meter data record 143 (save)

Table 6- 4 Control byte 1 for energy meter data record (save)

Bit	Meaning
7	Reserved
6	Reserved
5	Reserved
4	Reserved
3	Reserved
2	Energy meters are supplied
1	Reserved
0	Reserved

Control byte 2 for energy meter data record 143 (save)

Table 6- 5 Control byte 2 for energy meter data record (save)

Bit	Meaning
7	Apparent energy meters are supplied
6	Reactive energy meters are supplied
5	Active energy meters are supplied
4	Reserved
3	Reserved
2	Reserved
1	Reserved
0	Reserved

7 Parameters

7.1 Parameters

GSD file parameters

When you assign the module parameters in STEP 7, you use various parameters to specify the module properties. The following table lists the parameters that can be set. The effective range of the parameters depends on the type of configuration. The following configurations are possible:

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

When assigning the parameters in the user program, the "WRREC" instruction transfers the parameters to the module using data records (refer to the section Parameter assignment and structure of the parameter data record (Page 68)).

Table 7- 1 Parameters for the AI Energy Meter ST (GSD file)

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 [1]
Connection type of the phase(s)	• Disabled • 1P2W, single-phase alternating current • 3P4W, 3-phase, 4-wire	3P4W 3-phase, 4-wire	Yes	Module	Module
Voltage measuring range of the power supply system	• 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

Parameters	Value range	Default setting	Reconfigura-tion in RUN	Effective range with configuration software, e.g. STEP 7 (TIA Portal)	
				GSD file PROFINET IO	GSD file PROFIBUS DP [1]
Line frequency of the power supply system	• 50 Hz • 60 Hz	50 Hz	Yes	Module	Module
Energy meter gate [1]	• Energy meters measure continuously • Enable energy meter gate	Energy meters measure continuously	Yes	Module	-
Line voltage tolerance in %	• 1 ... 50%	10%	Yes	Module	Module
Line voltage diagnostics [1]	• Disable • Enable	Disable	Yes	Module	Module
User data variant [1]	• 0xFE - Total power L1, L2, L3 • 0xFD - Active power L1, L2, L3 • 0xFC - Reactive power L1, L2, L3 • 0xFB - Apparent power L1, L2, L3 • 0xFA - Basic measured values L1 L2, L3 • 0xF9 - Total energy L1, L2, L3 • 0xF8 - Energy L1 • 0xF7 - Energy L2 • 0xF6 - Energy L3 • 0xF5 - Basic variables three-phase measurement • 0x9F - Basic variables single-phase measure-ment L1	0xFE	Yes	Module	• 0xFE - Total power • 0xFA - Basic measured values L1 • 0xF9 - Total energy L1, L2, L3 • 0xF8 - Energy L1 • 0x9F - Basic variables single-phase measure-ment L1 • 0xF5 - Basic variables three-phase measure-ment
Low limit for measuring current	• 20 ... 250 mA	50	Yes	Module	-
Diagnostics overflow current [1]	• Disable • Enable	Disable	Yes	Channel	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 [1]
Diagnostics overflow cumulative values [1]	• Disable • Enable	Disable	Yes	Channel	Module
Diagnostics of low limit voltage [1]	• Disable • Enable	Disable	Yes	Channel	Module
Diagnostics underflow voltage [1]	• Disable • Enable	Disable	Yes	Channel	Module
Diagnostics overflow voltage [1]	• Disable • Enable	Disable	Yes	Channel	Module
Tolerance factor secondary overcurrent [1]	• 10 ... 100	100 [0.1 A]	Yes	Channel	Module
Tolerance time overcurrent [1]	• 1 ... 60,000 ms	0	Yes	Channel	Module
Current transformer transfer factor [1, 2]	• 1 ... 10000	1	Yes	Channel	Module
Current transformer primary current [1, 3]	• 1 ... 10000 A	1 A			
Current transformer secondary current [1]	• 1 A • 5 A	1 A	Yes	Channel	Module
Reverse current direction of current transformer [1]	• Do not reverse current direction • Reverse current direction	Do not reverse current direction	Yes	Channel	Module

1 Only for configuration using the PROFIBUS GSD file; does not affect configuration with STEP 7 using HSP: Due to the limited number of parameters for configuration using a PROFIBUS GSD file (maximum of 244 bytes per ET 200SP station), this parameter is not visible during configuration (all parameters apply to all 3 phases; there are fewer user data variants). If the parameter is not visible, the module operates with the listed default setting. If required, you can still set this parameter using data record 128 as described in the table above. The parameter length of the I/O module is 9 bytes.

2 Applies to firmware version V1.0.0

3 Applies to firmware version V2.0.0

7.2 Description of parameters

Connection type of the phase(s)

1P2W: Single-phase alternating current grid

You need to connect to phase 1 if there is only one phase (1P2W). The parameters of the phases 2 and 3 are therefore irrelevant.

3P4W: 3-phase alternating current grid in the 4-wire connection.

Voltage measuring range of the power supply system

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

Line frequency of the power supply system

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

Line voltage tolerance

Monitoring of supply voltage in accordance with this tolerance band, rates as plus/minus value.

Line voltage diagnostics

If you set "Enable", "Supply voltage at L1 missing" is displayed.

Diagnostics overflow/underflow voltage

Line voltage (measurement range) is monitored for tolerance. A violation results in a voltage overflow/underflow.

Diagnostics overflow cumulative values

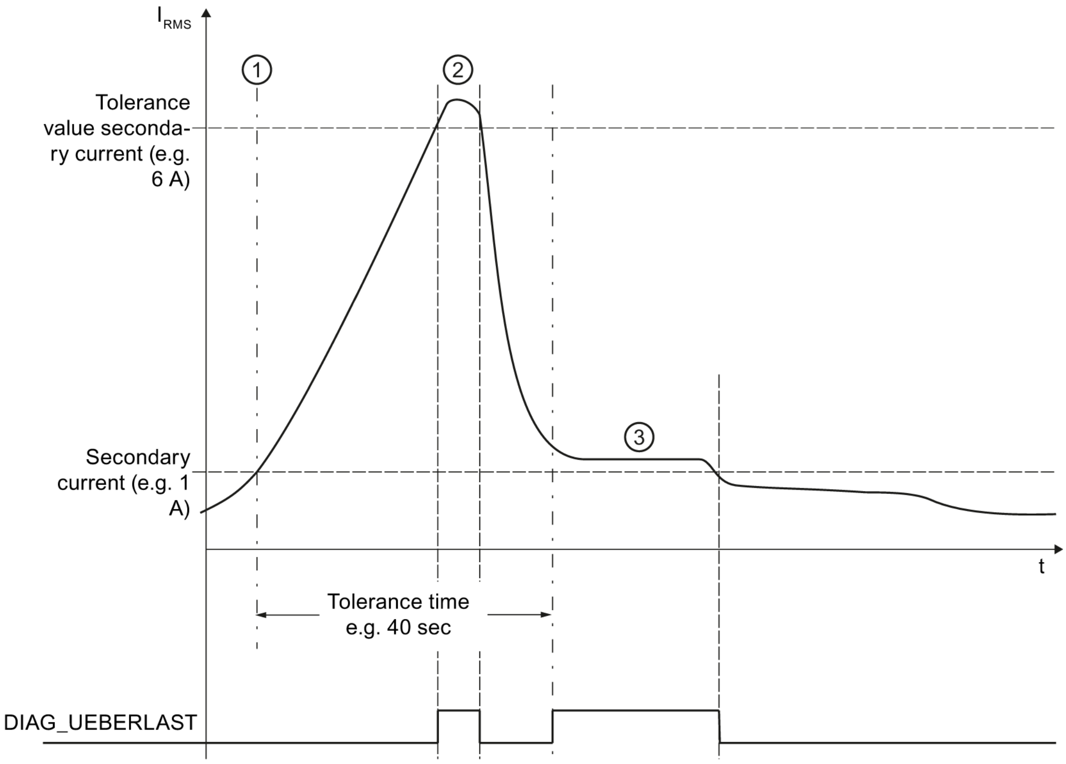
A cumulative overflow in the calculated values is displayed. The values stop at the upper or lower limit.

Secondary overcurrent tolerance value

The overcurrent tolerance value parameter specifies the tolerable value of the secondary current in 0.1 A increments. Always take note of the current class of the current transformer being used (1 A, 5 A).

Diagnostics overflow current

The measured current is monitored for "Tolerance factor × Measured current" after the "Tolerance time" elapses. A violation results in a current overflow.



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 (10 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 7-1 Diagnostics response in the event of a current overload

Tolerance factor secondary overcurrent

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 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. By default, the low limit for current measurement is set to 50 mA for the AI Energy Meter ST. 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 transfer factor

Setting for the transfer factor for the current transformer.

Describes a "multiplier" for the current value actually applied to the module. In other words, this "multiplier" is determined from the primary-secondary ratio of the converter used and the number of windings depending on the situation outlined above.

The "Current transformer transfer factor" parameter is only available in firmware version V1.0.0. The "Current transformer primary current" is not available in this version.

Current transformer primary current

Setting for the primary current of the current transformer in use. The module calculates the current transfer factor from the ratio of primary current and secondary current.

The "Current transformer primary current" parameter is only available in firmware version V2.0.0. The "Current transformer transfer factor" is not available in this version.

Current transformer secondary current

For firmware version V1.0.0: Setting for the class of the secondary current (1 A or 5 A) and is used for diagnostic purposes of the module only. The parameter does not have a direct effect on the measuring results.

As of firmware version V2.0.0: Setting for the secondary current of the current transformer in use. The module calculates the current transfer factor from the ratio of primary current and secondary current.

Reverse current direction of current transformer

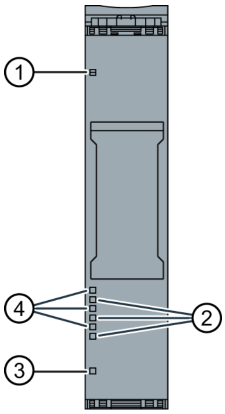
Setting to determine whether or not to reverse the direction of current.

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 (unsigned).

8 Interrupts/diagnostic alarms

8.1 Status and error display

LED display



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

Figure 8-1 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 60).

DIAG LED

Table 8- 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 8- 2 Meaning of the Status LED

Status	Meaning
Off	Channel deactivated or error
On	Channel deactivated and voltage present

Error LED

Table 8- 3 Meaning of the Error LED

Status	Meaning
Off	Channel is OK
On	Channel is faulty

PWR LED

Table 8- 4 Meaning of the PWR LED

PWR	Meaning
Off	Load voltage missing
On	Load voltage present

8.2 Interrupts

The analog input module AI Energy Meter ST supports diagnostic error interrupts.

Diagnostic error interrupts

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

- Channel is temporarily unavailable
- Error
- High limit
- Overload
- Overvoltage
- Undervoltage
- Load voltage
- Low limit

8.3 Diagnostic alarms

Diagnostic alarms

Table 8- 5 Error types

Diagnostic alarm	Error code	Meaning	Remedy
Undervoltage[1]	2_H	Line voltage (measurement range) is monitored for tolerance. Violation leads to voltage overflow/underflow	Observe line voltage
Overvoltage	3_H		
Overload	4_H	The measured current is monitored after expiration of the "Tolerance time" for "Tolerance factor × Measured current". Exceeding this results in overflow current. The maximum value of the secondary current (10 A) is exceeded.	Observe current
High limit	7_H	Cumulative overflow in the calculated values	-
Low limit[1]	8_H	Violation of the low limit for voltage measurement. This alarm is generated when the voltage falls below 80 V.	Maintain voltage
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	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.	--

[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.

8.4 Diagnostics response

Diagnostics response

This section describes the response of the AI Energy Meter 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 they cannot be measured or calculated, "0" is displayed.

Zero suppression

If the current fed in is lower than the configured low limit for current, the measured value of the current 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

If the supply voltage at L1 is lost, all measurements are interrupted. The accumulated consumption values are deleted in the module.

Return of the supply voltage starts the measurement from the beginning again. The energy meters also start to measure from "0". The configuration and parameter assignment stored in the system take effect again on the module.

Input data to "0"

Note

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

9 Technical specifications

9.1 Technical specifications

Technical specifications of the AI Energy Meter ST

	6ES7134-6PA00-0BD0
Product type designation	AI Energy Meter 400VAC ST
General information	
Usable BaseUnits	BU type D0, BU20-P12+A0+0B
Color code for module-specific color identification label	CC00
Product function	
Voltage measurement	Yes
Current measurement	Yes
Energy measurement	Yes
Frequency measurement	Yes
Active power measurement	Yes
Reactive power measurement	Yes
I&M data	Yes
Isochronous mode	No
Operating mode	
Cyclic measurement	Yes
Acyclic measurement	Yes
Installation type/mounting	
Rack mounting possible	Yes
Front installation possible	Yes
Rail mounting possible	Yes
Wall/direct mounting possible	No
Supply voltage	
Description	Supply via voltage measurement channel L1
Type of supply voltage	100 - 240 V AC
Relative symmetrical tolerance of the supply voltage	10%
Permissible range, low limit (AC)	90 V
Permissible range, high limit (AC)	264 V
Power consumption without expansion module, typ.	0.6 VA
Line frequency	
Permissible frequency range, low limit	47 Hz
Permissible frequency range, high limit	63 Hz

	6ES7134-6PA00-0BD0
Address area	
Address space per module	
Address space per module, max.	44 bytes; 32 bytes input/12 bytes output
Analog inputs	
Cycle time (all channels), typ.	50 ms
Analog value generation	
Integration and conversion time/ resolution per channel	
Resolution with overrange (bit including sign), max.	24 bits; sigma-delta converter, 1,024 MHz
Interrupts/diagnostics/status information	
Interrupts	
Diagnostic error interrupt	Yes
Limit interrupt	No
Diagnostic indicator LED	
Monitoring of supply voltage (PWR LED)	Yes
Channel status display	Yes
For channel diagnostics	Yes
For module diagnostics	Yes
Integrated functions	
Measuring functions	
Buffering of measured variables	No
Parameter length	44 bytes
Measuring method for voltage measurement	TRMS
Measuring method for current measurement	TRMS
Type of measured data acquisition	Complete
Voltage wave form	Sinusoidal or distorted
Operating mode for measured value acquisition	
• Automatic line frequency acquisition	No; can be assigned
• Fixing at 50 Hz	No; default setting
• Fixing at 60 Hz	No
Measuring range	
• Frequency measurement, min.	45 Hz
• Frequency measurement, max.	65 Hz
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

	6ES7134-6PA00-0BD0
• Measurable line voltage between the line conductors, min.	155 V
• Measurable line voltage between the line conductors, max.	460 V
• Measuring category for voltage measurement	CAT III according to IEC 61010 Part 1
• Power consumption, per phase	20 mW
Measuring inputs for current	
• Relative measurable current for AC, min.	5%; in relation to the secondary rated current; 1 A, 5 A
• Relative measurable current for AC, max.	100%; in relation to the secondary rated current; 1 A, 5 A
• Continuous current for AC, maximum permissible	5 A
• Apparent power consumption per phase for measuring range 5 A	0.6 VA
• Rated value of short-time current carrying capacity is restricted to 1 s	100 A
• Zero point suppression	Configurable: 20 - 250 mA, default 50 mA
• Surge overload capacity for 1 s	10 A; for 1 minute
Error limits	
• Reference condition for measuring accuracy	Symmetrical loading, rated current: 20-100%, 50 Hz; active power: LF = 1, reactive power: LF = 0
• For voltage measured variable	±0.5%
• For current measured variable	±0.5%
• For power measured variable	±0.5%
• For active power measured variable	±0.5%
• For reactive power measured variable	±0.5%
• For total active energy measured variable	Class 1 according to IEC 62053-21:2003
• For total reactive energy measured variable	Class 2 according to IEC 62053-23:2003
Ambient conditions	
Installation position	Horizontal, vertical
Dimensions	
Width	20 mm
Weights	
Weight (without packaging)	45 g
Miscellaneous	
Current transformer selection data	
Current transformer burden power x/1A, min.	1.25 VA
Current transformer burden power x/5A, min.	1.5 VA
Cable length (clamp-type transformer) depending on Zn and Imax	200 m

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 record A

A.1 Parameter assignment and structure of the parameter data record

The 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 have the option of assigning module parameters in RUN (e.g., the voltage or current values of selected channels can be edited in RUN without having an effect on the other channels).

Changing parameters in RUN

The WRREC instruction is used to transfer the parameters to the module using data record 128. The parameters set with STEP 7 are not changed in the CPU, which means the parameters set in STEP 7 will be valid after a restart.

If you reconfigure a module (so that the user data size changes) and diagnostics information is pending prior to the reconfiguration, this diagnostics information is 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.

Structure of data record 128 for entire module

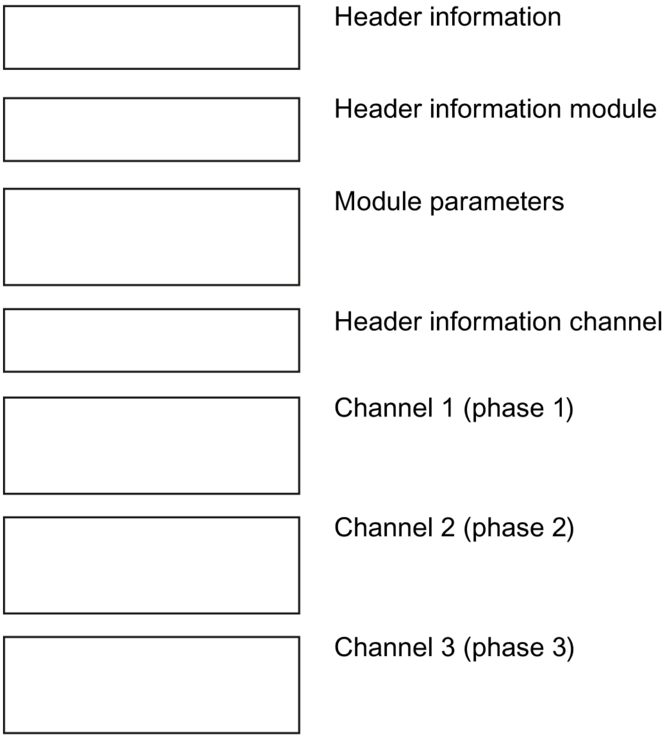


Figure A-1 Structure of data record 128

Header information

The figure below shows the structure of the header information.

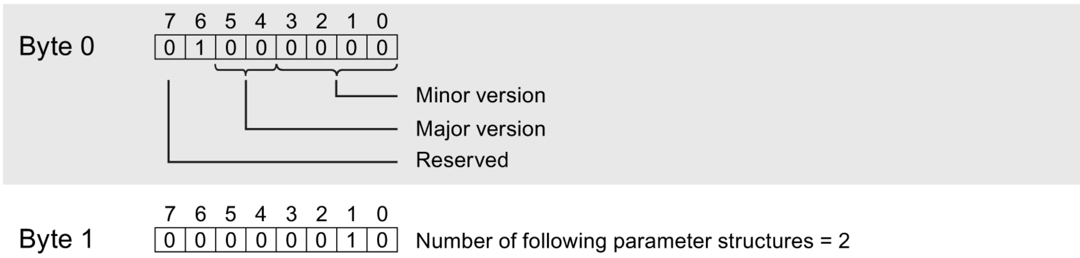


Figure A-2 Header information

Module header information

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

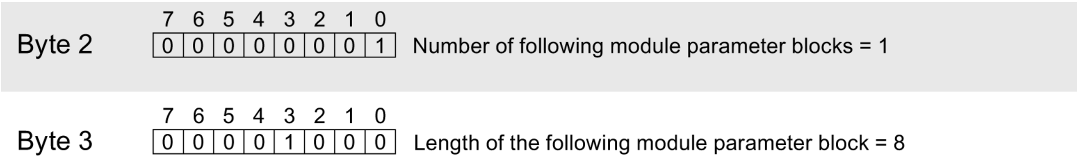
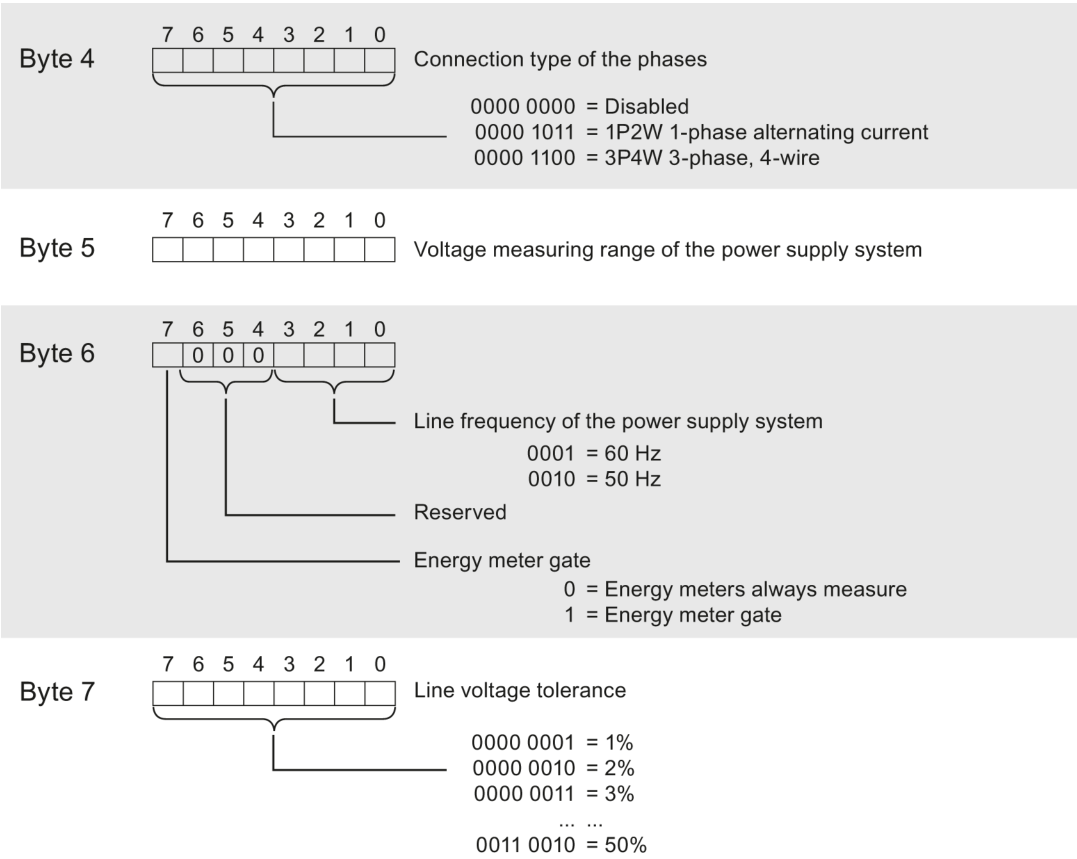


Figure A-3 Module header information

Module parameter block

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

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



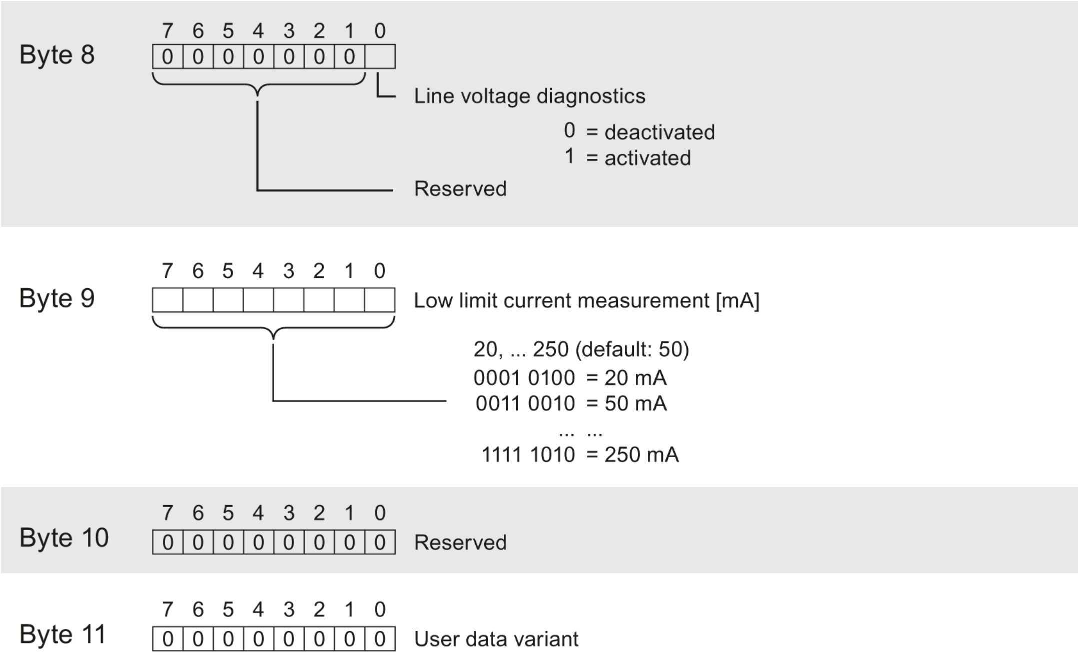


Figure A-4 Module parameter block

You can find the user data variant in the section User data (Page 25)

Channel header information

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

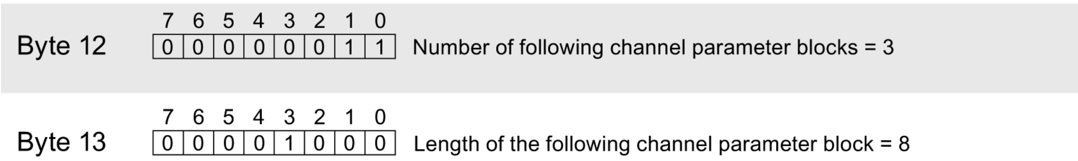
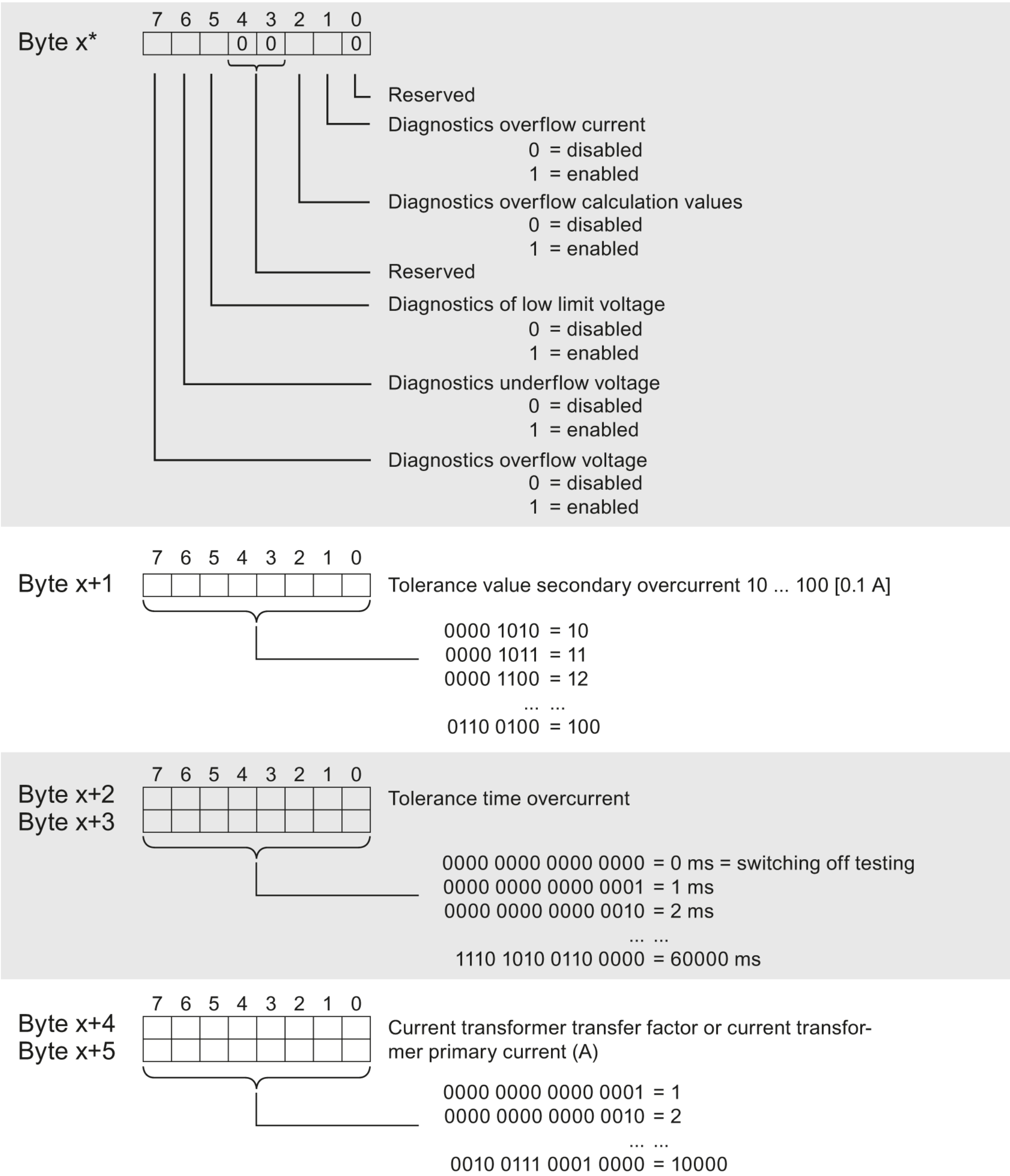


Figure A-5 Channel header information

Channel parameter block

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

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



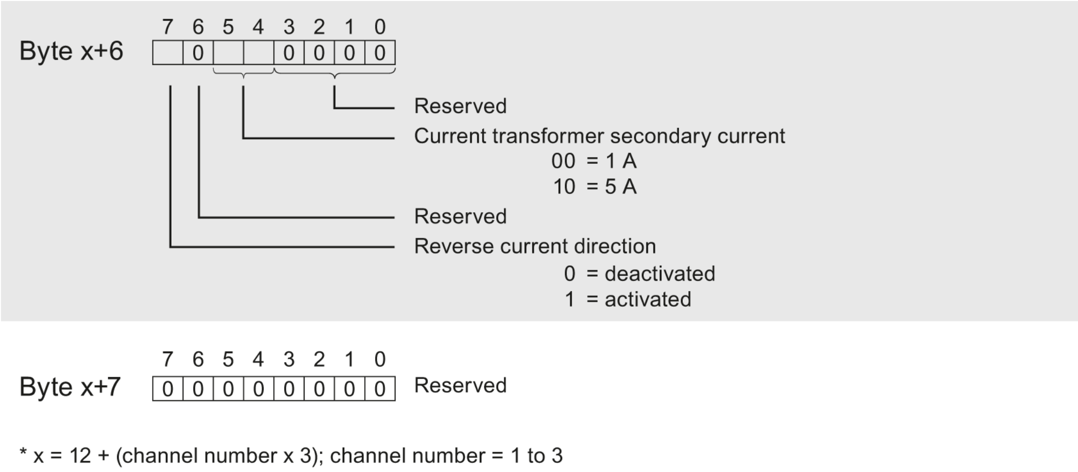


Figure A-6 Channel parameter block

Codes for voltage measuring range of the power supply system

The table below contains all voltage measuring ranges with their codes.

Table A- 1 Codes for voltage measuring range of the power supply system

Voltage measuring range of the power supply system in V	Code
100	0000 0001
110	0000 0010
115	0000 0011
120	0000 0100
127	0000 0101
190	0000 0110
200	0000 0111
208	0000 1000
220	0000 1001
230	0000 1010

Measured variables

B

B.1 Measured variables

Measured variables in data record 142 and user data

The table below is an overview of the measured values used in the user data and in data record 142.

The "Measured value ID" column is used as reference to the user data and data record description in the sections Measured value data record (Page 23) and User data variants (Page 30).

Table B- 1 Measured variables

Measured value ID	Measured variables	Data record 142			User data		
		Format	Unit	Value range	Format	Unit	Value range
1	Voltage UL1-N [1]	Float	V	0.0 ... 300.0	uint16	0.01 V	0 … 300000
2	Voltage UL2-N [1]	Float	V	0.0 ... 300.0	uint16	0.01 V	0 … 300000
3	Voltage UL3-N [1]	Float	V	0.0 ... 300.0	uint16	0.01 V	0 … 300000
4	Voltage UL1-L2 [2]	Float	V	0.0 ... 600.0	uint16	0.01 V	0 … 600000
5	Voltage UL2-L3 [2]	Float	V	0.0 ... 600.0	uint16	0.01 V	0 … 600000
6	Voltage UL3-L1 [2]	Float	V	0.0 ... 600.0	uint16	0.01 V	0 … 600000
7	Current L1 [1]	Float	A	0.0 … 100000.0	uint16	1 mA	0 … 65535
8	Current L2 [1]	Float	A	0.0 … 100000.0	uint16	1 mA	0 … 65535
9	Current L3 [1]	Float	A	0.0 … 100000.0	uint16	1 mA	0 … 65535
10	Apparent power L1 [3]	Float	VA	-3.0e+9 … +3.0e+9	int16	1 VA	-27648 … 27648
11	Apparent power L2 [3]	Float	VA	-3.0e+9 … +3.0e+9	int16	1 VA	-27648 … 27648
12	Apparent power L3 [3]	Float	VA	-3.0e+9 … +3.0e+9	int16	1 VA	-27648 … 27648
13	Active power L1 [3]	Float	W	-3.0e+9 … +3.0e+9	int16	1 W	-27648 … 27648
14	Active power L2 [3]	Float	W	-3.0e+9 … +3.0e+9	int16	1 W	-27648 … 27648
15	Active power L3 [3]	Float	W	-3.0e+9 … +3.0e+9	int16	1 W	-27648 … 27648
16	Reactive power L1 [3]	Float	var	-3.0e+9 … +3.0e+9	int16	1 var	-27648 … 27648
17	Reactive power L2 [3]	Float	var	-3.0e+9 … +3.0e+9	int16	1 var	-27648 … 27648
18	Reactive power L3 [3]	Float	var	-3.0e+9 … +3.0e+9	int16	1 var	-27648 … 27648
19	Power factor L1 [3]	Float	-	0.0 ... 1.0	uint8	0.10%	0 … 100
20	Power factor L2 [3]	Float	-	0.0 ... 1.0	uint8	0.10%	0 … 100
21	Power factor L3 [3]	Float	-	0.0 ... 1.0	uint8	0.10%	0 … 100
30	Frequency [4]	Float	Hz	45.0 ... 65.0	uint8	1 Hz	45 …65
34	Total apparent power L1L2L3 [5]	Float	VA	-3.0e+9 … +3.0e+9	int16	1 VA	-27648 … 27648

Measured value ID	Measured variables	Data record 142			User data		
		Format	Unit	Value range	Format	Unit	Value range
35	Total active power L1L2L3 [5]	Float	W	-3.0e+9 … +3.0e+9	int16	1 W	-27648 … 27648
36	Total reactive power L1L2L3 [5]	Float	var	-3.0e+9 … +3.0e+9	int16	1 var	-27648 … 27648
37	Total power factor L1L2L3 [5]	Float	-	0.0 ... 1.0	uint8	0.10%	0 … 100
200	Total active energy inflow L1L2L3 [6]	Float	Wh	0.0 ... (Overflow 3.4e+38)	-	-	-
201	Total active energy outflow L1L2L3 [6]	Float	Wh	0.0 ... (Overflow 3.4e+38)	-	-	-
202	Total reactive energy inflow L1L2L3 [6]	Float	varh	0.0 ... (Overflow 3.4e+38)	-	-	-
203	Total reactive energy outflow L1L2L3 [6]	Float	varh	0.0 ... (Overflow 3.4e+38)	-	-	-
204	Total apparent energy L1L2L3 [6]	Float	Vah	0.0 ... (Overflow 3.4e+38)	-	-	-
205	Total active energy L1L2L3 [6]	Float	Wh	0.0 ... (Overflow 3.4e+38)	-	-	-
206	Total reactive energy L1L2L3 [6]	Float	varh	0.0 ... (Overflow 3.4e+38)	-	-	-
210	Total active energy inflow L1L2L3 [6]	double	Wh	0.0 ... (Overflow 1.8e+308)	-	-	-
211	Total active energy outflow L1L2L3 [6]	double	Wh	0.0 ... (Overflow 1.8e+308)	-	-	-
212	Total reactive energy inflow L1L2L3 [6]	double	varh	0.0 ... (Overflow 1.8e+308)	-	-	-
213	Total reactive energy outflow L1L2L3 [6]	double	varh	0.0 ... (Overflow 1.8e+308)	-	-	-
214	Total apparent energy L1L2L3 [6]	double	Vah	0.0 ... (Overflow 1.8e+308)	uint32	1 Vah	0 … 4294967295
215	Total active energy L1L2L3 [6]	double	Wh	0.0 ... (Overflow 1.8e+308)	uint32	1 Wh	0 … 4294967295
216	Total reactive energy L1L2L3 [6]	double	varh	0.0 ... (Overflow 1.8e+308)	uint32	1 varh	0 … 4294967295
62108	Phase angle L1 [3]	Float	°	0.0 … 360.0	-	-	-
62208	Phase angle L2 [3]	Float	°	0.0 … 360.0	-	-	-
62308	Phase angle L3 [3]	Float	°	0.0 … 360.0	-	-	-
62030	Frequency (high accuracy) [4]	-	-	-	uint16	0.01 Hz	4500 …6500
62110	Active energy inflow L1	-	-	-	uint32	1 Wh	0 … 4294967295
62111	Active energy outflow L1	-	-	-	uint32	1 Wh	0 … 4294967295

Measured value ID	Measured variables	Data record 142			User data		
		Format	Unit	Value range	Format	Unit	Value range
62112	Reactive energy inflow L1	-	-	-	uint32	1 varh	0 … 4294967295
62113	Reactive energy outflow L1	-	-	-	uint32	1 varh	0 … 4294967295
62114	Apparent energy L1	-	-	-	uint32	1 Vah	0 … 4294967295
62117	Active energy L1	-	-	-	uint32	1 Wh	0 … 4294967295
62119	Reactive energy L1	-	-	-	uint32	1 varh	0 … 4294967295
62210	Active energy inflow L2	-	-	-	uint32	1 Wh	0 … 4294967295
62211	Active energy outflow L2	-	-	-	uint32	1 Wh	0 … 4294967295
62212	Reactive energy inflow L2	-	-	-	uint32	1 varh	0 … 4294967295
62213	Reactive energy outflow L2	-	-	-	uint32	1 varh	0 … 4294967295
62214	Apparent energy L2	-	-	-	uint32	1 Vah	0 … 4294967295
62217	Active energy L2	-	-	-	uint32	1 Wh	0 … 4294967295
62219	Reactive energy L2	-	-	-	uint32	1 varh	0 … 4294967295
62310	Active energy inflow L3	-	-	-	uint32	1 Wh	0 … 4294967295
62311	Active energy outflow L3	-	-	-	uint32	1 Wh	0 … 4294967295
62312	Reactive energy inflow L3	-	-	-	uint32	1 varh	0 … 4294967295
62313	Reactive energy outflow L3	-	-	-	uint32	1 varh	0 … 4294967295
62314	Apparent energy L3	-	-	-	uint32	1 Vah	0 … 4294967295
62317	Active energy L3	-	-	-	uint32	1 Wh	0 … 4294967295
62319	Reactive energy L3	-	-	-	uint32	1 varh	0 … 4294967295
62417	Total active energy, inflow	-	-	-	uint32	1 Wh	0 … 4294967295
62418	Total active energy, outflow	-	-	-	uint32	1 Wh	0 … 4294967295
62419	Total reactive energy, inflow	-	-	-	uint32	1 varh	0 … 4294967295
62420	Total reactive energy, outflow	-	-	-	uint32	1 varh	0 … 4294967295
62414	Total apparent energy	-	-	-	uint32	1 Vah	0 … 4294967295

Measured value ID	Measured variables	Data record 142			User data		
		Format	Unit	Value range	Format	Unit	Value range
38	Amplitude unbalance for voltage [2]	Float	%	0.0 ... 100.0	-	-	-
39	Amplitude unbalance for current [2]	Float	%	0.0 ... 100.0	-	-	-

[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)

Format

Table B- 2 Format and its length in bytes

Format	Length in bytes
uint8	1 byte
int16, uint16	2 bytes
float	4 bytes
double	8 bytes

Tips and tricks

C

C.1 Current transformer selection data

Description

Among other things, the AI Energy Meter ST is designed for measuring current for connection to toroidal-core current transformers.

You need to take certain requirements into account so that

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

Selecting a current transformer

To connect to the AI Energy Meter ST, transformer types of the accuracy classes 3, 1 and 0.5 are permitted. The minimum burden power of the transformers to be used is specified in the section Technical specifications (Page 63) of the AI Energy Meter ST.

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 ST (see figure below)) must be below a certain resistance value (depending on Z_n and I_{max}).

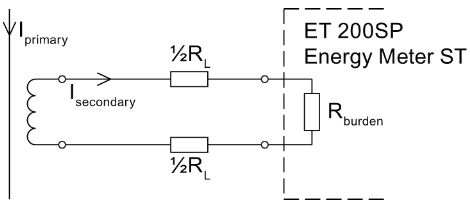


Figure C-1 Maximum length of the connection cable

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	Secondary current of the current transformer
Z_n	Rated burden current transformer in VA	R_{burden}	Resistance within the Energy Meter ST = 25 mΩ

Figure C-2 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 1

Current transformer 500/5 A

Maximum primary current in the application: 400 A → maximum secondary current: 4 A

Burden in the AI Energy Meter ST including connection resistance: R = 25 mΩ

Rated burden current transformer Z_n: 5 VA

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

This means that the maximum cable resistance between the toroidal-core current transformer and the ET 200SP terminal can be a maximum of 287.5 Ω.

Estimating the cable resistance

To allow you to make a fast estimate of typical resistance values of copper wires, there is a table in the FAQ Entry ID 85477190 (http://support.automation.siemens.com/WW/view/en/85477190).

C.2 How can I read all measured values of the AI Energy Meter ST at once?

Description

There are several options to read the measured values of the AI Energy Meter ST:

- Cyclic reading via the I/O data
- Acyclic reading via data record 143 or 142

This section describes how to read all measured values using data record 142.

Requirement

If the "Energy meter gate" parameter is enabled, the energy meters only measure if the bit "Energy meter gate open" in the output data (offset 1.6) is set to "1".

Instruction

The following instruction describes the procedure for acyclic reading of the measured values of the AI Energy Meter ST using data record 142.

Procedure for acyclic reading of measured values using data record 142:

1. Create a data type which has the same structure as data record 142. The example project already includes such a UDT.

   Information on the structure of data record 142 is available in section Measured value data record (Page 23).
2. Read the data record by means of SFB 52 "RDREC" from the AI Energy Meter ST module.

   The input parameters of the SFB must be allocated as follows:
   - REQ: A new read job is triggered if REQ = TRUE.
   - ID: The ID is available in the HWCN of STEP 7. The first input address is the same as the ID. The ID must be specified in hexadecimal form.
   - INDEX: The data record number: 142.
   - MLEN: The maximum length of the data record: 210
   - RECORD: A pointer to the data area in the CPU which includes data record 142

   The transfer of the data record is complete when the output parameter BUSY has the value FALSE.
3. This means all measured values listed in section Measured variables (Page 74) are transferred to the CPU and can be evaluated in the user program.

C.3 How do I determine my current measured value from the input/output data of the AI Energy Meter ST?

Description

There are several options to read the measured values of the AI Energy Meter ST:

- Cyclic reading using the input/output data
- Acyclic reading via data record 142

This section describes how to read the current measured values using the input/output data.

Instruction

1. Specify which measured values are to be available in the input/output data. You can choose from different user data variants (see section User data (Page 25)).
2. Use your user program to read the measured value relevant for you from the input/output data during operation.

Byte	Allocation	Measured value ID
0	User data variant = 254 (FE_H)	
1	Quality information = Ob QQ I3 U3 I2 U2 I1 U1	
2 ... 3	Current L1	7
4 ... 5	Current L2	8
6 ... 7	Current L3	9
8 ... 9	Total active power L1L2L3	35
10 ... 11	Total reactive power L1L2L3	36
12 ... 13	Total apparent power L1L2L3	34
14 ... 17	Total active energy L1L2L3	200
18 ... 21	Total reactive energy L1L2L3	202
22	Reserved	
23	Total power factor L1L2L3	37
24	Scaling current L1	
25	Scaling current L2	
26	Scaling current L3	
27	Scaling total active power L1L2L3	
28	Scaling total reactive power L1L2L3	
29	Scaling total apparent power L1L2L3	
30	Scaling total active energy L1L2L3	
31	Scaling total reactive energy L1L2L3	

3. The measured value is then calculated as follows:

   Measured value = "Value from input/output data" × 10 ^ "Scaling from input/output data"

C.4 How do I reset the energy meters of the AI Energy Meter ST?

Description

It may be useful to reset the energy meters of the AI Energy Meter ST module when you start a new work order. Resetting here means setting the energy meters to the initial value which can also be 0.

This section describes how you can reset the energy meters of the AI Energy Meter ST with data record 143.

Instruction

1. Create a data type which has the same structure as data record 143. The example project already includes such a UDT.

   Detailed information on the structure of data record 143 is available in section Structure of data record 143 (Page 45).

Byte		Format	Length in bytes	Unit	Value range
0	Version	Unsigned 8	1	byte	0: 1. Version
1	Reserved	Unsigned 8	1	-	0
2	Control byte 1 - L1	Unsigned 8	1	8 bit	00_H, 04_H
3	Control byte 2 - L1	Unsigned 8	1	8 bit	00_H, 40_H, 60_H, 80_H, $C0_H$, $E0_H$
4	Control byte 1 - L2	Unsigned 8	1	8 bit	00_H, 04_H
5	Control byte 2 - L2	Unsigned 8	1	8 bit	00_H, 40_H, 60_H, 80_H, $C0_H$, $E0_H$
6	Control byte 1 - L3	Unsigned 8	1	8 bit	00_H, 04_H
7	Control byte 2 - L3	Unsigned 8	1	8 bit	00_H, 40_H, 60_H, 80_H, $C0_H$, $E0_H$
8	Active energy, inflow, start value L1	Double	8	Wh	Overflow 1.8e+308
16	Active energy, outflow, start value L1	Double	8	Wh	Overflow 1.8e+308
24	Reactive energy, inflow, start value L1	Double	8	varh	Overflow 1.8e+308
32	Reactive energy, outflow, start value L1	Double	8	varh	Overflow 1.8e+308
40	Apparent energy start value L1	Double	8	VAh	Overflow 1.8e+308
48	Active energy, inflow, start value L2	Double	8	Wh	Overflow 1.8e+308
56	Active energy, outflow, start value L2	Double	8	Wh	Overflow 1.8e+308
64	Reactive energy, inflow, start value L2	Double	8	varh	Overflow 1.8e+308
72	Reactive energy, outflow, start value L2	Double	8	varh	Overflow 1.8e+308

2. Create a DB or IDB which includes this data type and allocate the values of the data record.

   Byte 0, byte 1: 16#00

   Byte 2 ... byte 7: control bytes

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

   Example:

   Control byte 1 = 16#04: The energy meters specified with control byte 2 are applied directly after writing the data record.

   Control byte 2 = 16#E0: Active, reactive and apparent energy meters are to be restarted.

Bit	Meaning	
7	Bit = 1:	Values are only applied when the reset output (see user data outputs) receives a 0 → 1 edge.
	Bit = 0:	Start values are applied immediately
6	Reserved	
5	Reserved	
4	Reserved	
3	Reserved	
2	Energy meters are reset	
1	Reserved	
0	Reserved	

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

   The start values in data record 143 have the "Double" format (64-bit floating-point number). This corresponds to the LREAL format in S7-1500 and in S7-1200.

Bit	Meaning
7	Apparent energy meters are to be restarted
6	Reactive energy meters are to be restarted
5	Active energy meters are to be restarted
4	Reserved
3	Reserved
2	Reserved
1	Reserved
0	Reserved

3. Write the data record to the AI Energy Meter ST module using SFB 53 "WRREC".

   The input parameters of the SFB must be allocated as follows:

   – REQ: A new write job is triggered if REQ = TRUE.
   – ID: The ID is available in the HWCN of STEP 7. The first input address is the same as the ID. The ID must be specified in hexadecimal form.
   – 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 ST at the same time, keep in mind the maximum number of active jobs in communication with SFB52/SFB53.

C.5 What do I have to keep in mind when setting up and configuring an ET 200SP with an AI Energy Meter ST?

Description

You must be aware of some special characteristics when you set up the ET 200SP distributed I/O system with the AI Energy Meter ST module and when configuring with STEP 7.

Setup

It is noted in the manual of the ET 200SP distributed I/O system that the first BaseUnit must always be a light BaseUnit to feed in the supply voltage L+.

The AI Energy Meter ST may only be used with dark BaseUnits D0 and may therefore not be inserted into the first slot after the interface module. The first permitted slot for the AI Energy Meter ST is slot 2.

Configuration

The following instruction shows the procedure for configuring an ET 200SP with an AI Energy Meter ST. The screenshots were created for PROFINET but also apply to the PROFIBUS module.

1. Find the ET 200SP distributed I/O system you are using in the hardware catalog.
2. Insert the module in your project and assign it to the PROFINET controller.
3. Open the ET 200SP device view and leave slot 1 empty for PROFINET or insert a module which can be used for slot 1.

Note

If the AI Energy Meter ST is not listed as module for ET 200SP in the hardware catalog, the latest HSP is available under Entry ID 72341852 (http://support.automation.siemens.com/WW/view/en/72341852) for STEP 7 V12 and under Entry ID 23183356 (http://support.automation.siemens.com/WW/view/en/23183356) for STEP 7 V5.5.

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4. Insert the AI Energy Meter ST you are using starting at slot 2 according to the maximum I/O data of the ET 200SP head-end station. Terminate the configuration with a server module.

   You can insert the following maximum number of AI Energy Meter ST depending on the header module and the configuration:

   – IM 155-6PN ST: maximum of 8 AI Energy Meter ST
   – IM 155-6PN HF: maximum of 42 AI Energy Meter ST
   – IM 155-6DP HF: maximum of 7 AI Energy Meter ST

5. Under "Properties", adapt the parameters of the AI Energy Meter ST to suit your requirements.

   After the configuration has been compiled without errors, you can download the configuration to the CPU and commission the ET 200SP with the AI Energy Meter ST.

Note

You can also configure the ET 200SP distributed I/O system accordingly in STEP 7 V5.5 SP3.

C.6 Tips and tricks

FAQ and application examples

There are many FAQs and application examples which support you in your work with the analog input module AI Energy Meter ST.

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.

Measuring and visualizing energy data

This application example is available in Internet (http://support.automation.siemens.com/WW/view/en/86299299).