

Instruction and Operation Manual

S110

Power and Energy Meter



Dear Customer,

Thank you for choosing our product.

The operating instructions must be read in full and carefully observed before starting up the device. The manufacturer cannot be held liable for any damage which occurs as a result of non-observance or non-compliance with this manual.

Should the device be tampered with in any manner other than a procedure which is described and specified in the manual, the warranty is cancelled and the manufacturer is exempt from liability.

The device is destined exclusively for the described application.

SUTO offers no guarantee for the suitability for any other purpose. SUTO is also not liable for consequential damage resulting from the delivery, capability or use of this device.

Revision: 2024-1

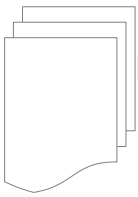


Last modifications: May, 2024

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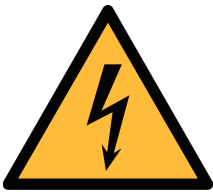
1 Safety Instructions



Please check if this instruction manual matches with the product type.

Please observe all notes and instructions indicated in this manual. It contains essential information which have to be observed before and during installation, operation and maintenance. Therefore this instruction manual has to be read carefully by the technician as well as by the responsible user / qualified personnel.

This instruction manual has to be available at the operation site of the power meter at any time. In case of any obscurities or questions, regarding this manual or the product, please contact the manufacturer.



WARNING!

Dangerous Voltage levels!

Any contact with energized parts of the product, may lead to a electrical shock which can lead to serious injuries or even death!

- Consider all regulations for electrical installations.
- The system must be disconnected from any power supply during maintenance work.
- Any electrical work on the system is only allowed by authorized qualified personal.



ATTENTION!

Permitted operating parameters!

Observe the permitted operating parameters, any operation exceeding this parameters can lead to malfunctions and may lead to damage on the instrument or the system.

- Do not exceed the permitted operating parameters.
- Make sure the product is operated in its permitted limitations.
- Do not exceed or undercut the permitted storage and operation temperature.
- The product should be maintained frequently, at least annually.

General safety instructions

- It is not allowed to use the product in explosive areas.
- Please observe the national regulations before/during installation and operation.

Remarks

- It is not allowed to disassemble the product.



ATTENTION!

Measurement values can be affected by malfunction!

The product must be installed properly and frequently maintained, otherwise it may lead to wrong measurement values, which can lead to wrong results.

Storage and transportation

- Make sure that the transportation temperature of device is between -30°C ... $+70^{\circ}\text{C}$.
- For transportation it is recommended to use the packaging which comes with the device.
- Please make sure that the storage temperature of the device is between -40°C ... $+85^{\circ}\text{C}$.
- Avoid direct UV and solar radiation during storage.
- For the storage the humidity has to be $<90\%$, no condensation.

2 Registered Trademarks

SUTO®

Registered trademark of SUTO iTEC

MODBUS®

Registered trademark of the Modbus Organization, Hopkinton, USA

3 Application

The Power and Energy Meter is designed to measure the actual power consumption in kW and accumulate the energy consumption in kWh of a 3-phase load. Additionally other measured parameters such as current, voltage, cos phi etc. are available as well.

4 Features

- Measurement of active and reactive power, frequency, voltage, currents, power factor
- Accumulates active energy [kWh]
- 3-phase 3-wire, 3-phase 4-wire, 1-phase 2-wire measurement
- Modbus / RTU output

5 Technical Data

5.1 General

CE	
Parameters (rms values)	Voltage of each phase and average voltage [V] Current of each phase and average current [A] Active Power [kW] Reactive Power [kvar] Apparent Power [kVA] Energy (per phase and summery) Power factors Frequency [Hz] Total Harmonic Distortion [%]
Measuring range	Nominal voltage: 100 V ... 500 V AC
	Power: up to 2500 kW (depends on Rogowski coil)
Frequency range	50 / 60 Hz
Harmonic	up to 52th
Sampling rate	8 k/sec
Connection	Terminal block
Available clamp sensors	Rogowski coil 1 ... 100 A 10 ... 1000 A 30 ... 3000 A

Operating temperature	-25 ... +55°C
Storage temperature	-40 ... +85°C
Protection class	IP20 conforming to IEC 60629
Dimensions	145 mm x 40 mm x 90 mm (L X W X H)
Weight	210 g

5.2 Electrical Data

Power supply	24 VDC, 1 W
Current consumption	Max. 50 mA

5.3 Input Signals

Rogowski Coil	0 mV ... 333 mV
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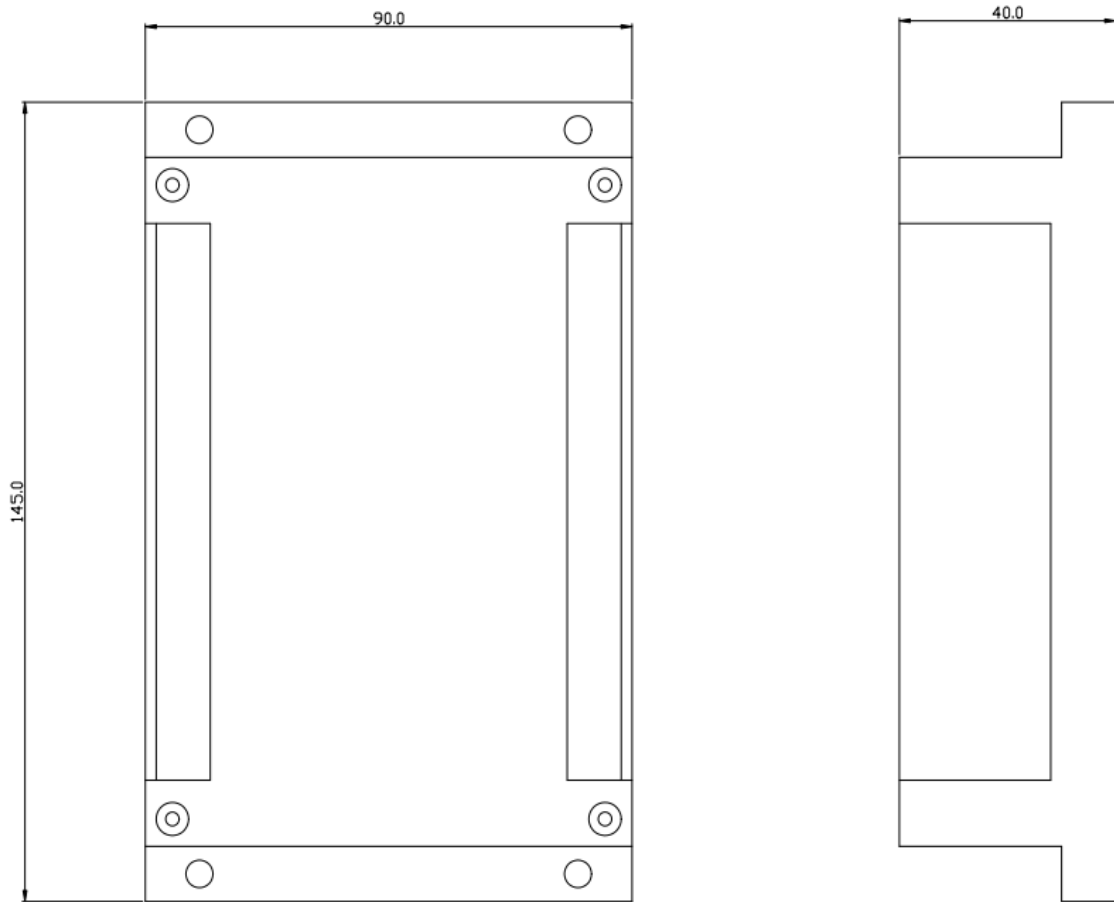
5.4 Output Signals

Modbus output	See chapter 9.1
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5.5 Accuracy

Voltage:	0.2% (100 ... 500 V)
Current:	0.5% (1% ... 120% of range)
Power factor:	0.005 from 10 ... 120%
Frequency:	0.01% from 45 ... 65 Hz
Active/Apparent Power:	IEC62053-22 Class 0.5
Reactive Power:	IEC62053-21 Class 2
Active Energy:	IEC62053-22 Class 0.5s
Reactive Energy:	IEC62053-21 Class 2

6 Dimensional Drawing (in mm)



7 Determination of the Installation Point

It is possible to install the Power and Energy Meter directly into the connection box on the compressor or into the connection cabinet where the power supply for the compressor is coming from.

8 Installation

Please make sure that all components listed below are included in your package.

Qty	Description	Item No.
1	Power and Energy Meter	D554 0130
3	Rogowski coils	S554 0140 or S554 0141 or S554 0142
1	Instruction manual	No P / N

8.1 Installation Requirements



ATTENTION!

Wrong measurement is possible, if the device is not installed correctly.

- The device is for indoor use only! At an outdoor installation, the device must be protected from solar radiation and rain.
- It is strongly recommend not to install S110 in wet environment.

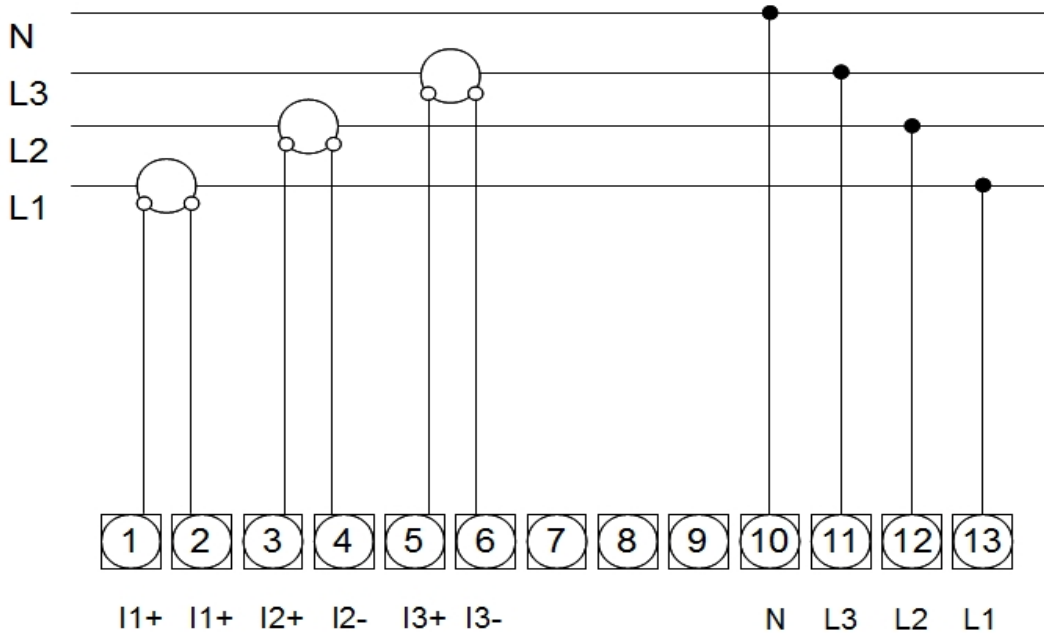
8.2 Installation Procedure

Installation of the S110 hat rail mountable

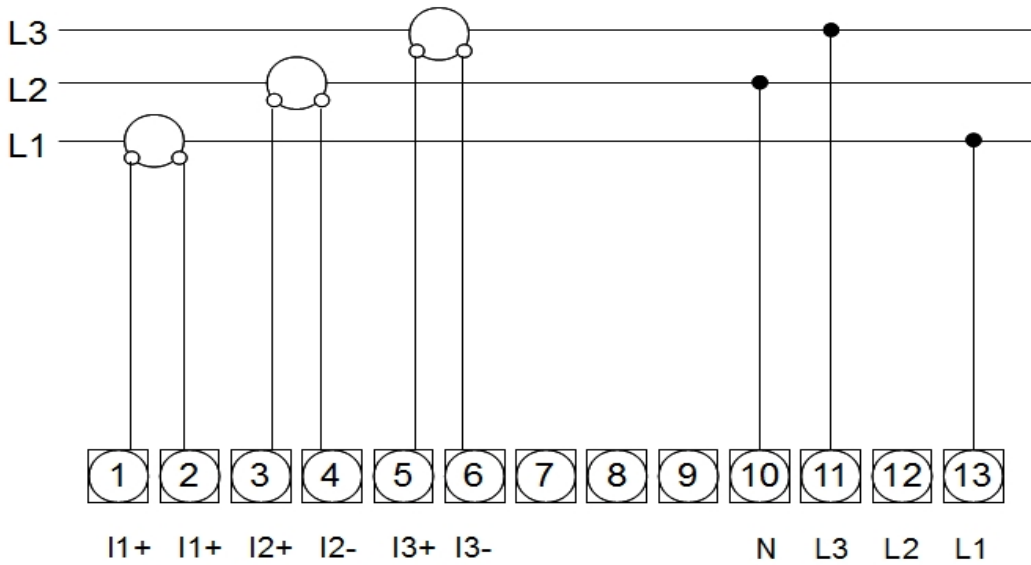
The S110 is hat rail mountable and recommended to be installed either in the power distribution cabinet or in the connection box of the compressor.

8.3 Voltage and Current Connection

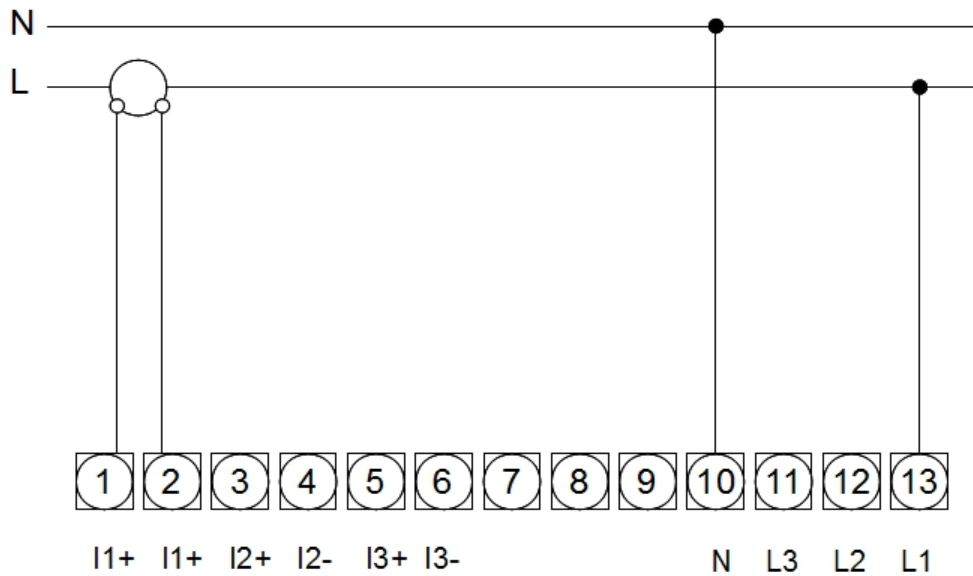
8.3.1 3-Phase / 4-Wire Connection



8.3.2 3-Phase / 3-Wire Connection

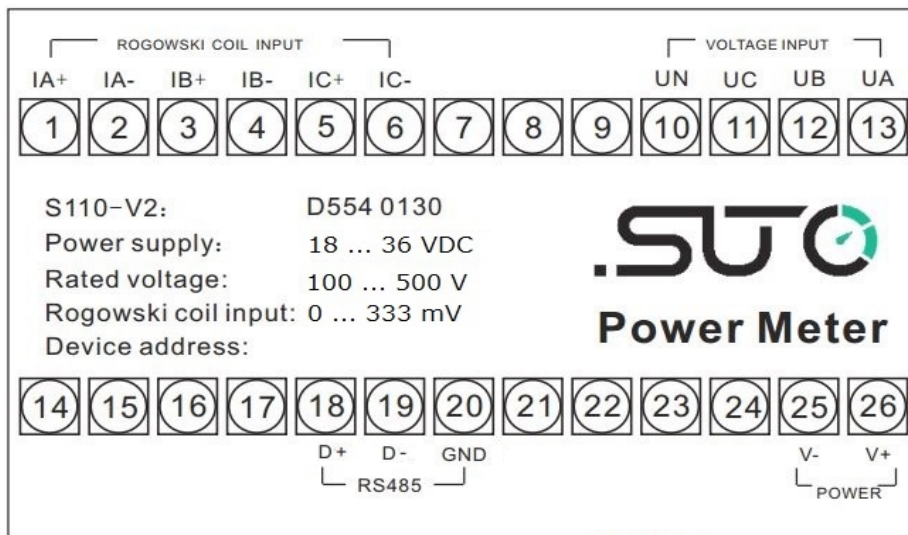


8.3.3 1-Phase / 2-Wire Connection



8.4 Electrical Connection

The power meter S110 can be connected to the S330 / 331. For the electrical installation please observe the following instructions.



Above is the connection diagram of the S110



ATTENTION!
 Do not connect any conventional coil to the Rogowski Coil inputs. Otherwise it will permanently damage the device!

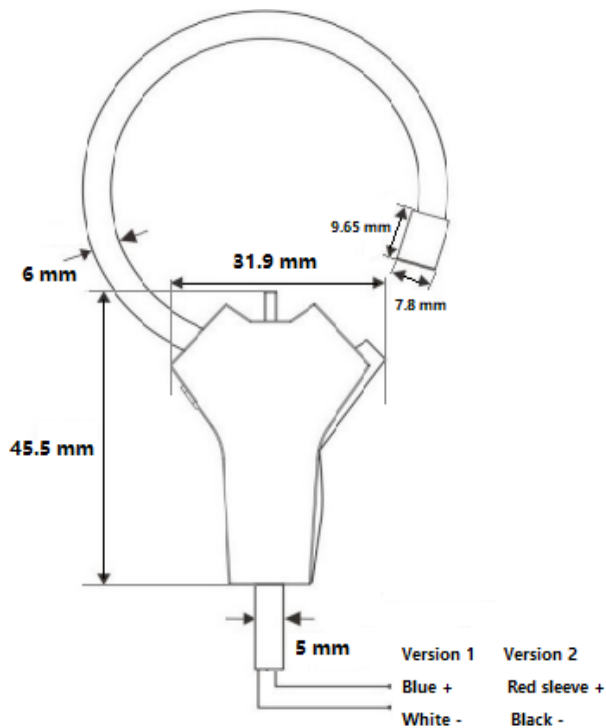
8.4.1 Connection to S330 / S331

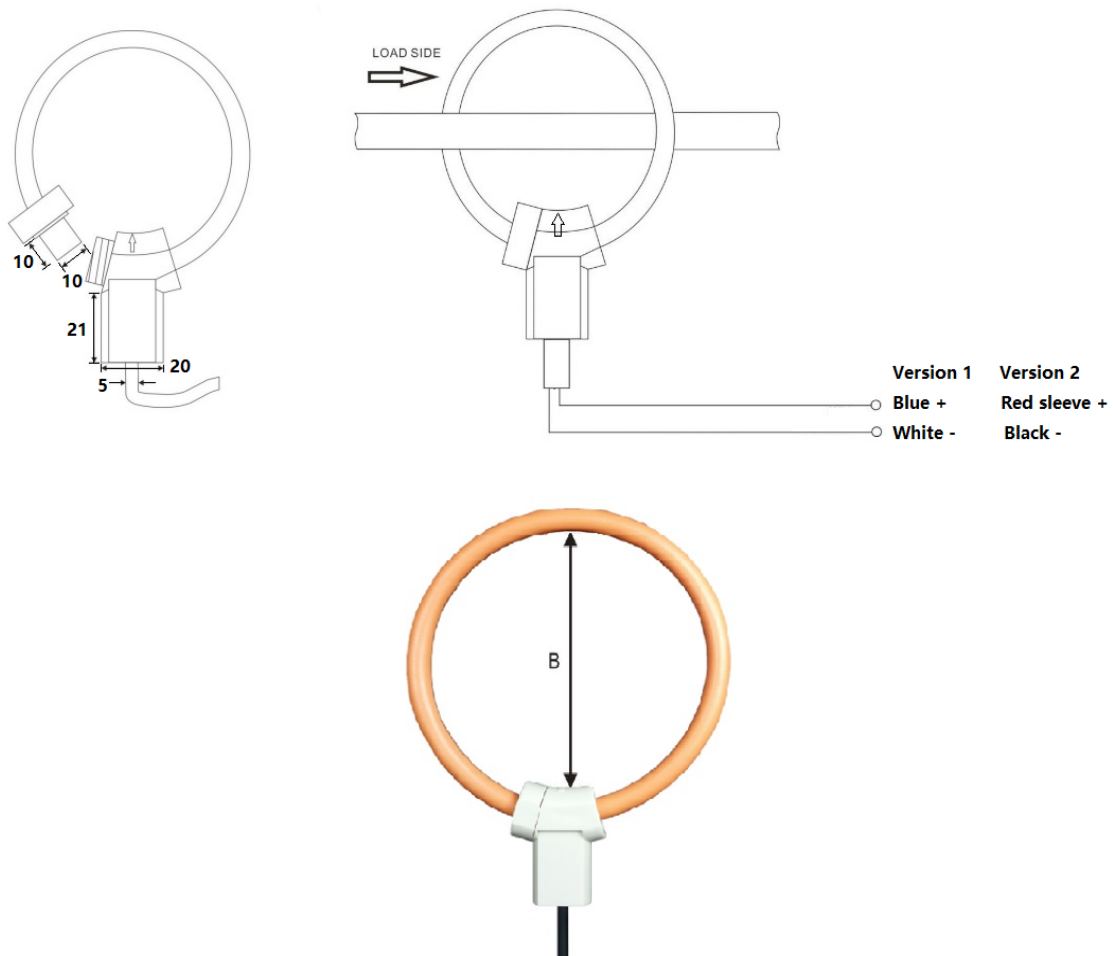
S330 / S331			S110	
Terminal	Pin	Signal	Pin	Signal
A or B	3	+ Vb	26	+ 24 V
	2	- Vb	25	0 V
	4	+ D	18	+ D
	5	- D	19	- D
	6	GND	20	GND

Legend to pin assignment	
+ Vb	Negative supply voltage
- Vb	Positive supply voltage
+ D	Modbus data +
- D	Modbus data -
GND	Ground for Modbus

8.4.2 Connection of the Rogowski Coils

Please observe the following steps to connect the coil.





1. Pay attention to the current direction, it is indicated with a direction arrow on the housing.
2. The color code of the cable has 2 versions, connect the + cable and - cable to the current signal input of S110-V2. Please refer to section 8.3 for connection details.

Order no.	S554 0142	S554 0140	S554 0141
Coil diameter (mm)	16	100	150

9 Signal Output

The S110 has a Modbus/RTU output to the S330/S331.

9.1 Modbus Interface

The default settings of the Modbus communication interface are as follows:

Mode	: RTU
Baud rate	: 19200
Device address	: Last two digits of serial number
Framing / parity / stop bit	: 8, N, 1
Response timeout	: 1 second
Response delay	: 0 ms
Inter-frame spacing	: 7 char

Response message that the device returns to the master:

- Function code: 03

The information for the byte order is shown in the table below:

Byte Order	Sequence				Data Type
	1st	2nd	3rd	4th	
1-0-3-2	Byte 1 (MMMMMMMM*)	Byte 0 (MMMMMMMM *)	Byte 3 (SEEEEEEE)	Byte 2 (EMMMMMMM *)	FLOAT
1-0-3-2	Byte 1	Byte 0 LSB	Byte 3 MSB	Byte 2	UINT32 INT32
1-0	Byte 1 MSB	Byte 0 LSB	---	---	UINT16 INT16
1-0	Byte 1 XXX *	Byte 0 DATA	---	---	UINT8 INT8

* S: Sign, E: Exponent, M: Mantissa, XXX: no value

Notes:

- The settings of the Modbus communication can be changed by the Modbus software.
- For more information on the Modbus commands, see chapter 13 Appendix: Modbus Commands.

9.2 Connect Modbus/RTU Devices to a Master

Sensors and devices with a Modbus/RTU output can be connected to a Modbus master device. This master can be either SUTO displays and gateways or any third-party Modbus/RTU master.

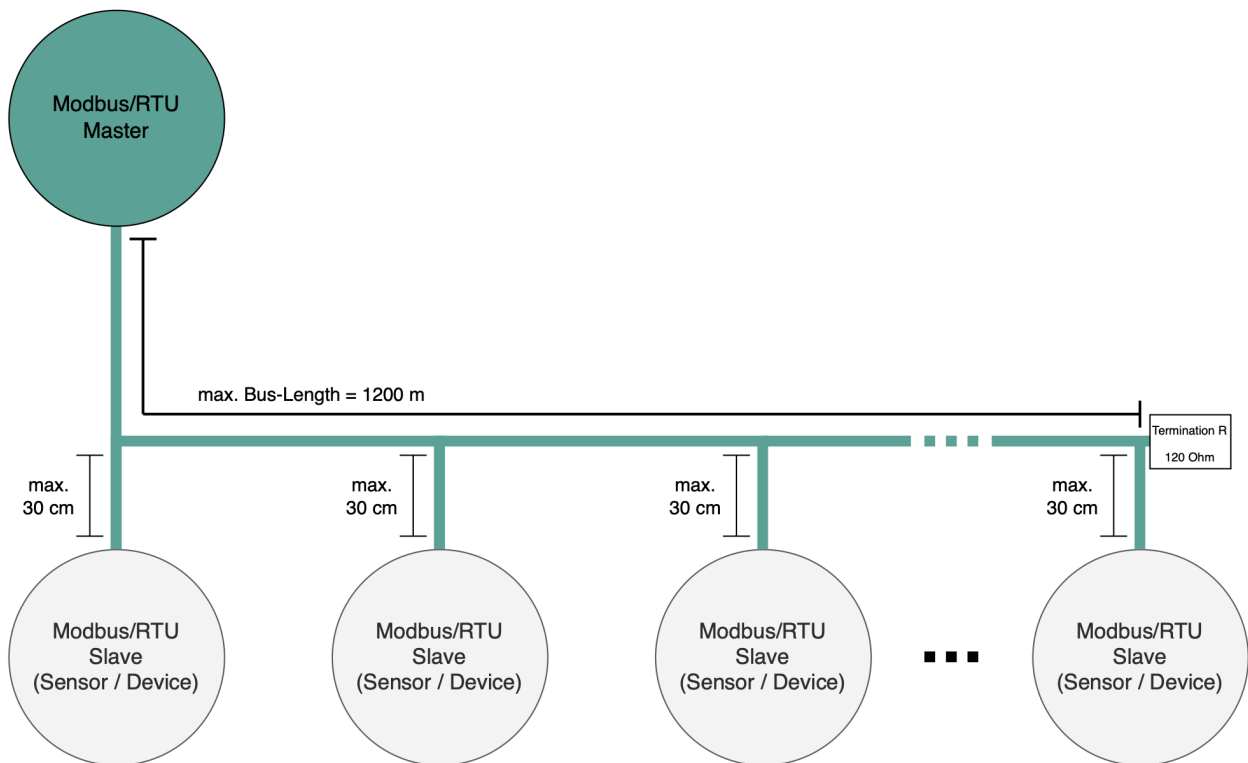
See below specifications of the Modbus/RTU connections.

9.2.1 Modbus/RTU Cable Length

A Modbus/RTU bus line has limitations which shall not be exceeded, otherwise the communication might not be stable.

- The maximum total bus length must not exceed 1200 m.
- The stub length to each node must not exceed 30 cm.

See the picture below for details.



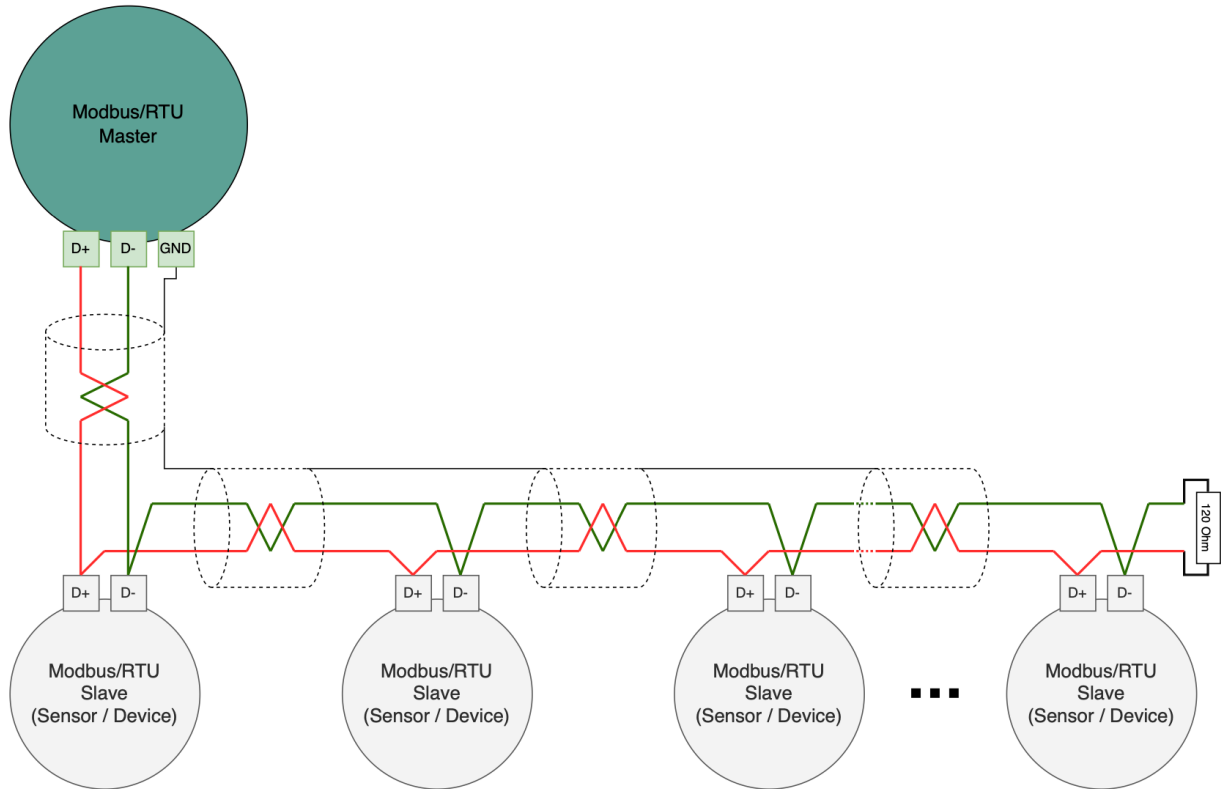
9.2.2 Modbus/RTU Wiring and Cable Type

To ensure a stable communication a twisted-pair bus cable must be chosen to set up the Modbus/RTU communication.

- Bus-cable specifications must follow the EIA485 Standard, must be twisted pair and shielded, for example 2 x 2 x 0.22 mm², Li-2YCY (A553 0123).

- The shield must be connected at one end to the master GND connection.
- At the end of the bus, a 120 Ohm resistor should be placed a termination resistor.

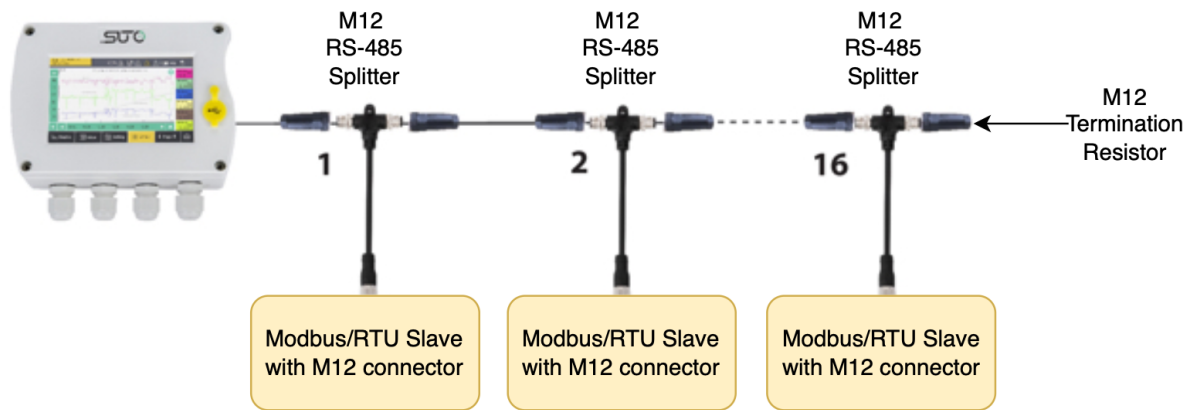
See the below picture for details.



9.2.3 Daisy-Chain using RS-485 Splitter

SUTO devices with M12 connectors can be easily connected in a Modbus/RTU daisy-chain using a M12 RS-485 splitter (A554 3310). Furthermore this allows to easily place the M12 termination resistor (C219 0055) at the last splitter in the bus-chain.

See below example for reference.

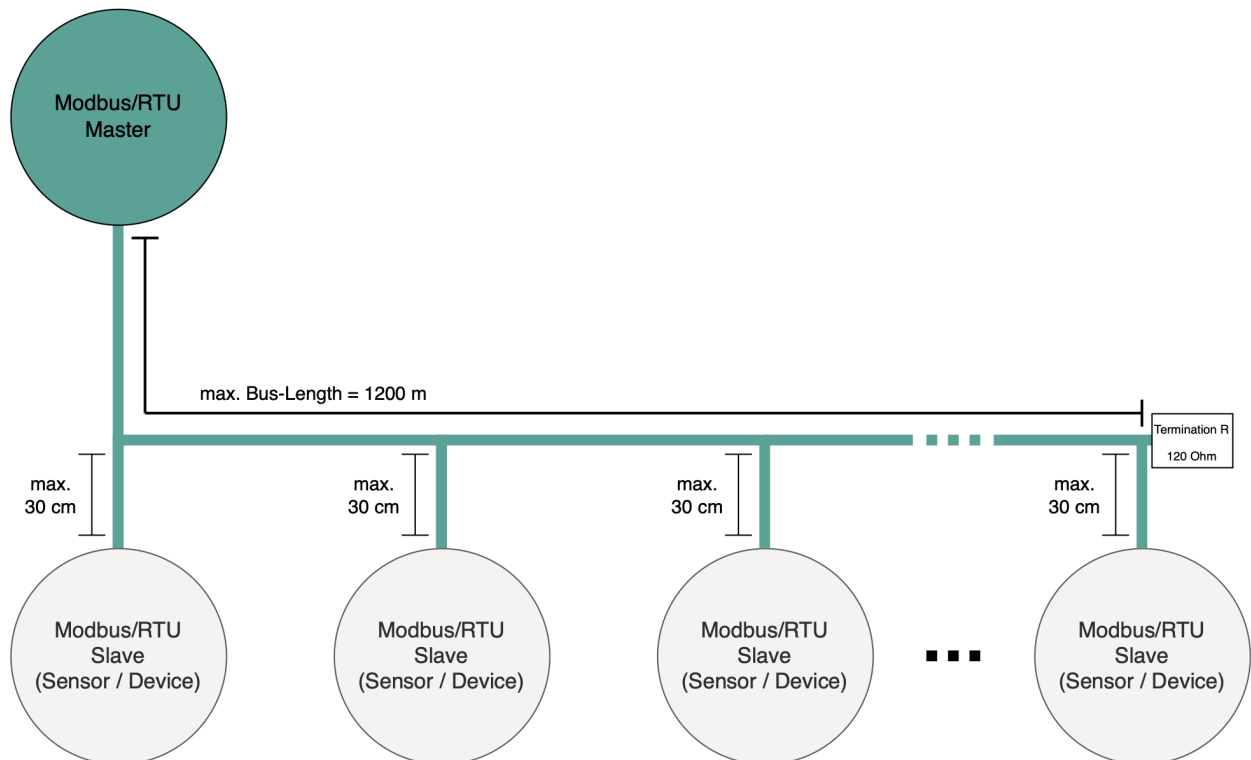


Connect Modbus/RTU slaves with M12 connectors to a daisy-chain using M12 RS-485 splitters.

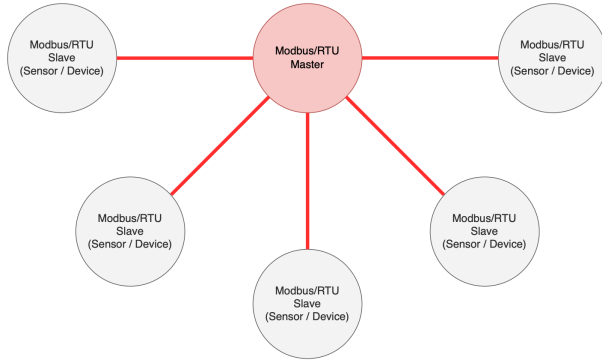
9.2.4 Topology of Modbus/RTU Daisy-Chain

The recommended bus topology is to connect devices as a daisy-chain. Other connection topologies are not recommended and should be avoided. Make sure that at the end of the bus line, the termination resistor of 120 Ohm is placed to avoid interferences.

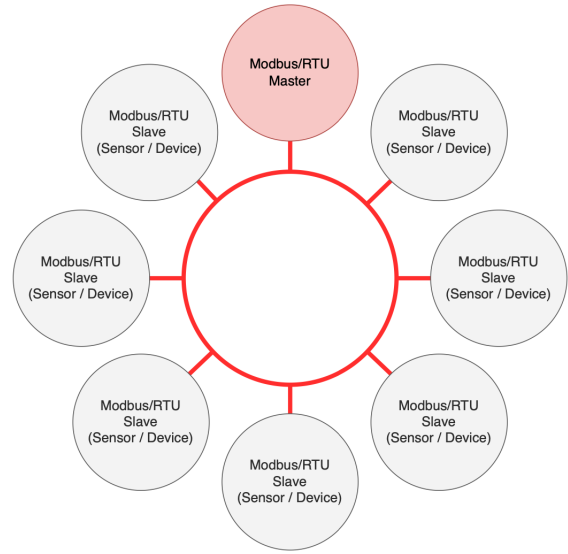
Recommended connection of Modbus/RTU slaves in a daisy-chain topology.



Avoid a connection of slaves to the master in ring or star topology.



Avoid a star topology



Avoid a ring topology

10 Optional Extra Accessories

The following extra accessories are available:

- Rogowski coil, 100 A, 16 mm diameter, 1.8 m cable, open ends.
- Rogowski coil, 1000 A, 100 mm diameter, 1.8 m cable, open ends.
- Rogowski coil, 3000 A, 150 mm diameter, 1.8 m cable, open ends.

11 Maintenance



ATTENTION!

Do not use isopropyl alcohol to clean the power meter!

12 Disposal or Waste



Electronic devices are recyclable material and do not belong in the household waste.

The sensor, the accessories and its packings must be disposed according to your local statutory requirements.

The dispose can also be carried by the manufacturer of the product, for this please contact the manufacturer.

13 Appendix: Modbus Commands

13.1 Command Request

Slave Address	Function Code	Command Block	CRC
8-Bit	8-Bit	N×8-Bit	16-Bit Checking

Functional code

Functional code tells what function addressed terminal equipment can execute. The following table lists the functional code that used by this instrument, as well as their significance and function.

Function Code		Function Name	Behavior
Decimal	Hexadecimal		
3	03H	Read Holding Registers	Read present HEX from one or more registers.
16	10H	Write Multiple Registers	Write present HEX on multiple registers.

Register table

Register tables have the following columns:

Register Alias	Register Address	Action R/WC	Size	Type	Units	Description
----------------	------------------	-------------	------	------	-------	-------------

Register Alias	The meaning of the register
Register Address	Modbus address of register encoded in the Modbus frame, in decimal (dec)
Action R/WC	The read/write by command register
Size	The data size in Int16
Type	The encoding data type
Units	The unit of the register value
Range	The permitted values for this variable, usually a subset of what the format allows
Description	Provides information about the register and the values that apply

Unit Table

The following data types appear in the Modbus register list:

Type	Description	Range
UInt16	16-bit unsigned integer	0 ... 65535
Int16	16-bit signed integer	-32768 ... +32767
UInt32	32-bit unsigned integer	0 ... 4, 294, 967, 295
UInt64	64 bit unsigned integer	0 ... 18, 446, 744, 073, 709, 551, 615
UTF8	8-bit field	multi-byte character encoding for Unicode
Float32	32-bit value	Standard representation IEEE for floating number (with single precision)
Bitmap	-	-
Date Time	-	-

Date Time Format:

Word	Unit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	Reserv- ed (0)	Year (0-99, year from 2000)														
2	Month (1-12)	Day (1-31)														
3	Hour (0-23)	Minute (0-59)														
4		Millisecond (0-59999)														

13.2 Configure Meter

You can configure the power meter by writing command and command parameters to corresponding command registers using Modbus function 16.

Command request

The following table describes a Modbus command request.

Slave Address	Function Code	Command Register Address	Command Register Number	Data Length	Command Register Value	CRC
1-247	16	300 (up to 423)	N	N×2		

Command Result

The command result can be obtained by reading registers 424 and 425. The following table describes the command result:

Register Address	Content	Size (Int16)	Data (example)
424	Requested Command Number	1	1001(set Date Time)
425	Result	1	0 = Valid Operation 80 = Invalid Command 81 = Invalid Parameter 82 = Invalid Number of Parameters 83 = Operation Not Performed

Command Request Example

The following table describes setting Date Time by Command Register:

Slave Address	Function Code	Command Register Address	Command Register Number	Data Length	Command Register Value	CRC
1	16	300	7	14	1001, 2016, 1, 1, 10, 10, 10	

Note:

All the reserved parameters can be considered as any value. e.g. 0.

13.3 Command List

Set System Date Time

Command Number	Action R/W	Size	Type	Units	Range	Description
1001	W	1	UInt16	-	2000-2099	Year
	W	1	UInt16	-	1-12	Month
	W	1	UInt16	-	1-31	Day
	W	1	UInt16	-	0-23	Hour
	W	1	UInt16	-	0-59	Minute
	W	1	UInt16	-	0-59	Second

Set Communications

Command Number	Action R/W	Size	Type	Units	Range	Description
1002	W	1	UInt16	-	1-247	Slave Address
	W	1	UInt16	-	0,1,2,3,4,5,6	Baud Rate 0=1200 1=2400 2=4800 3=9600 4=19200 5=38400 6=57600
	W	R/WC	UInt16	-	0,1,2	Parity 0 = ODD 1 = EVEN 2 = None

Set Power System

Command Number	Action R/W	Size	Type	Units	Range	Description
1003	W	1	UInt16	-	0,1,2,3,4	Wiring 0 = 1PH2W L-N 1 = 1PH2W L-L 2 = 3PH4W 3 = 3PH3W 4 = 1PH3W_LLN
	W	1	UInt16	Hz	50,60	Nominal Frequency
	W	2	UInt32	V	-	VT Primary
	W	1	UInt16	V	100,110,115,120	VT Secondary
	W	2	UInt32	A	-	coil Primary
	W	1	UInt16	mV	MaxValue: 333mV	coil Secondary
	W	2	UInt32	A	-	Rcoil Primary
	W	1	UInt16	mV	MaxValue: 333mV	Rcoil Secondary
	W	1	UInt16	-	0,1	Voltage Connection 0 = Direct Connect 1 = 3PH4W (3 VTs)

	W	1	UInt16	-	0,1	Current Connection 0 = Rogowski coil 1 = coil
--	---	---	--------	---	-----	---

Set harmonic times

Command Number	Action R/W	Size	Type	Units	Range	Description
1004	W	1	UInt16	-	2-52	HX harmonic times
	W	1	UInt16	-	2-52	HY harmonic times
	W	1	UInt16	-	2-52	HZ harmonic times

Set Digital Output

Command Number	Action R/W	Size	Type	Units	Range	Description
1005	W	1	UInt16	-	-	0 = Relay-Open 1 = Relay-Closed

Reset Energy

Command Number	Action R/W	Size	Type	Units	Range	Description
1006	W	1	UInt16	-	2050-2053	2050: Reset Phase 1 2051: Reset Phase 2 2052: Reset Phase 3 2053: Reset Phase 1,2,3

13.4 Modbus Register List

Meter

Register Alias	Register Address	Action R/WC	Size	Type	Units	Description
Meter Model	50	R	20	UTF8	-	
Serial Number	70	R	2	UInt32	-	
Firmware Version	72	R	1	UInt16	-	DLF format: X.Y.ZTT
Date time	73	R/WC	4	Date time	-	Date/Time Reg.73: Year 00-99 (year from 2000 to 2099) Reg.74: Month (b15:b8), day (b7:b0) Reg. 75: Hour (b15:b8) ,Minute (b7:b0) Reg. 76: Millisecond

Communications

Register Alias	Register Address	Action R/WC	Size	Type	Units	Description
Address	80	R/WC	1	UInt16	-	1-247
Baud Rate	81	R/WC	1	UInt16	-	0=1200 1=2400 2=4800 3=9600 4=19200 5=38400 6=57600
Parity	82	R/WC	1	UInt16	-	0 = ODD 1 = EVEN 2 = None

Power System

Register Alias	Register Address	Action R/WC	Size	Type	Units	Description
Wiring Type	90	R/WC	1	UInt16	-	0 = 1PH2W L-N 1 = 1PH2W L-L 2 = 3PH4W 3 = 3PH3W 4 = 1PH3W_LLN
Nominal Frequency	91	R/WC	1	UInt16	Hz	
VT Primary	92	R/WC	2	UInt32	V	
VT Secondary	94	R/WC	1	UInt16	V	
coil Primary	95	R/WC	2	UInt32	A	
coil Secondary	97	R/WC	1	UInt16	mV	MaxValue:333mV
Rcoil Primary	98	R/WC	2	UInt32	A	
Rcoil Secondary	100	R/WC	1	UInt16	mV	MaxValue:333mV
Voltage Connection	101	R/WC	1	UInt16	-	0 = Direct Connect 1 = 3PH3W (2 VTs) 2 = 3PH4W (3 VTs)
Current Connection	102	R/WC	1	UInt16	-	0 = Rogowski coil 1 = Coil

Digital Outputs

Register Alias	Register Address	Action R/WC	Size	Type	Units	Description
Digital Output Status	150	R/WC	1	Bitmap	-	0 = Relay-Open 1 = Relay-Closed

Command Register

Register Alias	Register Address	Action R/W/C	Size	Type	Units	Description
Command	300	R/W	1	UInt16	-	
Parameter 001	301	R/W	1	UInt16	-	
Parameter 002	302	R/W	1	UInt16	-	
...	...	R/W	1	UInt16	-	
Parameter 123	423	R/W	1	UInt16	-	
Requested Command	424	R	1	UInt16	-	
Command Result	425	R	1	UInt16	-	0 = Valid Operation 80 = Invalid Command 81 = Invalid Parameter 82 = Invalid Number of Parameters 83 = Operation Not Performed

Basic Data

Power factor ,frequency, harmonics, Current, voltage, power,

Register Alias	Register Address	Action R/W/C	Size	Type	Units	Description
Power Factor						
PF1	2000	R	2	Float32	-	Phase 1 Power Factor
PF2	2002	R	2	Float32	-	Phase 2 Power Factor
PF3	2004	R	2	Float32	-	Phase 3 Power Factor
PF Avg	2006	R	2	Float32	-	Average Of PF1, PF2, PF3
DPF1	2008	R	2	Float32	-	Phase 1 Displacement Power Factor

DPF2	2010	R	2	Float32	-	Phase 2 Displacement Power Factor
DPF3	2012	R	2	Float32	-	Phase 3 Displacement Power Factor
DPF Avg	2014	R	2	Float32	-	Average Of DPF1,DPF2, DPF3
Frequency						
Freq1	2016	R	2	Float32	Hz	Phase 1 Frequency
Freq2	2018	R	2	Float32	Hz	Phase 2 Frequency
Freq3	2020	R	2	Float32	Hz	Phase 3 Frequency
FreqAvg	2022	R	2	Float32	Hz	Average of Freq1, Freq2, Freq3
Harmonics Configuration						
HX harmonic times	2024	R/WC	1	UInt16	-	Range:2-52
HY harmonic times	2025	R/WC	1	UInt16	-	Range:2-52
HZ harmonic times	2026	R/WC	1	UInt16	-	Range:2-52
Current Harmonics						
I1THDx	2027	R	2	Float32	%	Phase 1 X times harmonics current distortion
I2THDx	2029	R	2	Float32	%	Phase 2 X times harmonics current distortion
I3THDx	2031	R	2	Float32	%	Phase 3 X times harmonics current distortion
ITHDx Avg	2033	R	2	Float32	%	Average of I1THDx, I2THDx, I3THDx
I1THDy	2035	R	2	Float32	%	Phase 1 y times harmonics current distortion

I2THDy	2037	R	2	Float32	%	Phase 2 y times harmonics current distortion
I3THDy	2039	R	2	Float32	%	Phase 3 y times harmonics current distortion
ITHDy Avg	2041	R	2	Float32	%	Average of U1THDy, U2THDy, U3THDy
I1THDz	2043	R	2	Float32	%	Phase 1 z times harmonics current distortion
I2THDz	2045	R	2	Float32	%	Phase 2 z times harmonics current distortion
I3THDz	2047	R	2	Float32	%	Phase 3 z times harmonics current distortion
ITHDz Avg	2049	R	2	Float32	%	Average of U1THDz, U2THDz, U3THDz
I1THD	2051	R	2	Float32	%	Phase 1 total harmonics current distortion
I2THD	2053	R	2	Float32	%	Phase 2 total harmonics current distortion
I3THD	2055	R	2	Float32	%	Phase 3 total harmonics current distortion
ITHD Avg	2057	R	2	Float32	%	Average of U1THD, U2THD, U3THD
I1THx	2059	R	2	Float32	V	Phase 1 x times harmonics current
I2THx	2061	R	2	Float32	V	Phase 2 x times harmonics current
I3THx	2063	R	2	Float32	V	Phase 3 x times harmonics current
ITHx Avg	2065	R	2	Float32	V	Average of U1THx, U2THx, U3THx
I1THy	2067	R	2	Float32	V	Phase 1 y times harmonics current
I2THy	2069	R	2	Float32	V	Phase 2 y times harmonics current

I3THy	2071	R	2	Float32	V	Phase 3 y times harmonics current
ITHy Avg	2073	R	2	Float32	V	Average of U1THy, U2THy, U3THy
I1THz	2075	R	2	Float32	V	Phase 1 z times harmonics current
I2THz	2077	R	2	Float32	V	Phase 2 z times harmonics current
I3THz	2079	R	2	Float32	V	Phase 3 z times harmonics current
ITHz Avg	2081	R	2	Float32	V	Average of U1THz, U2THz, U3THz

Voltage Harmonics

U1THDx	2083	R	2	Float32	%	Phase 1 X times harmonics voltage distortion
U2THDx	2085	R	2	Float32	%	Phase 2 X times harmonics voltage distortion
U3THDx	2087	R	2	Float32	%	Phase 3 X times harmonics voltage distortion
UTHDx Avg	2089	R	2	Float32	%	Average of U1THDx, U2THDx, U3THDx
U1THDy	2091	R	2	Float32	%	Phase 1 y times harmonics voltage distortion
U2THDy	2093	R	2	Float32	%	Phase 2 y times harmonics voltage distortion
U3THDy	2095	R	2	Float32	%	Phase 3 y times harmonics voltage distortion
UTHDy Avg	2097	R	2	Float32	%	Average of U1THDy, U2THDy, U3THDy
U1THDz	2099	R	2	Float32	%	Phase 1 z times harmonics voltage distortion

U2THDz	2101	R	2	Float32	%	Phase 2 z times harmonics voltage distortion
U3THDz	2103	R	2	Float32	%	Phase 3 z times harmonics voltage distortion
UTHDz Avg	2105	R	2	Float32	%	Average of U1THDz, U2THDz, U3THDz
U1THD	2107	R	2	Float32	%	Phase 1 total harmonics voltage distortion
U2THD	2109	R	2	Float32	%	Phase 2 total harmonics voltage distortion
U3THD	2111	R	2	Float32	%	Phase 3 total harmonics voltage distortion
UTHD Avg	2113	R	2	Float32	%	Average of U1THD, U2THD, U3THD
U1THx	2115	R	2	Float32	V	Phase 1 x times harmonics voltage
U2THx	2117	R	2	Float32	V	Phase 2 x times harmonics voltage
U3THx	2119	R	2	Float32	V	Phase 3 x times harmonics voltage
UTHx Avg	2121	R	2	Float32	V	Average of U1THx, U2THx, U3THx
U1THy	2123	R	2	Float32	V	Phase 1 y times harmonics voltage
U2THy	2125	R	2	Float32	V	Phase 2 y times harmonics voltage
U3THy	2127	R	2	Float32	V	Phase 3 y times harmonics voltage
UTHy Avg	2129	R	2	Float32	V	Average of U1THy, U2THy, U3THy
U1	2131	R	2	Float32	V	Phase 1 z times harmonics voltage
U2	2133	R	2	Float32	V	Phase 2 z times harmonics voltage
U3	2135	R	2	Float32	V	Phase 3 z times harmonics voltage
Voltage	2137	R	2	Float32	V	Average of U1THz,

Avg						U2THz, U3THz
Current						
I1	2139	R	2	Float32	A	Phase 1 Current
I2	2141	R	2	Float32	A	Phase 2 Current
I3	2143	R	2	Float32	A	Phase 3 Current
Current Avg	2145	R	2	Float32	A	Average of I1, I2, I3
Voltage						
U1	2147	R	2	Float32	V	Phase 1 Voltage
U2	2149	R	2	Float32	V	Phase 2 Voltage
U3	2151	R	2	Float32	V	Phase 3 Voltage
Voltage Avg	2153	R	2	Float32	V	Average of U1, U2, U3
Power						
P1	2155	R	2	Float32	kW	Active Power Phase 1
P2	2157	R	2	Float32	kW	Active Power Phase 2
P3	2159	R	2	Float32	kW	Active Power Phase 3
PTotal	2161	R	2	Float32	kW	Total Active Power
FQ1	2163	R	2	Float32	kVAR	Fundamental Reactive Power Phase 1
FQ2	2165	R	2	Float32	kVAR	Fundamental Reactive Power Phase 2
FQ3	2167	R	2	Float32	kVAR	Fundamental Reactive Power Phase 3
FQTotal	2169	R	2	Float32	kVAR	Total Fundamental Reactive Power
S1	2171	R	2	Float32	kVA	Apparent Power Phase 1
S2	2173	R	2	Float32	kVA	Apparent Power Phase 2
S3	2175	R	2	Float32	kVA	Apparent Power Phase 3
STotal	2177	R	2	Float32	kVA	Total Apparent Power

Energy

Most energy values are available in both unsigned 64-bit integer and 32-bit floating point format.

Energy values – 64-bit integer						
Register Alias	Register Address	Action R/WC	Size	Type	Units	Description
Active Energy						
EP1Imp	3000	R	4	UInt64	Wh	Active Energy Import Phase 1
EP2Imp	3004	R	4	UInt64	Wh	Active Energy Import Phase 2
EP3Imp	3008	R	4	UInt64	Wh	Active Energy Import Phase 3
EPImp	3012	R	4	UInt64	Wh	Total Active Energy Import
EP1Exp	3016	R	4	UInt64	Wh	Active Energy Export Phase 1
EP2Exp	3020	R	4	UInt64	Wh	Active Energy Export Phase 2
EP3Exp	3024	R	4	UInt64	Wh	Active Energy Export Phase 3
EPExp	3028	R	4	UInt64	Wh	Total Active Energy Export
Reactive Energy						
EQ1Imp	3032	R	4	UInt64	VARh	Reactive Energy Import Phase 1
EQ2Imp	3036	R	4	UInt64	VARh	Reactive Energy Import Phase 2
EQ3Imp	3040	R	4	UInt64	VARh	Reactive Energy Import Phase 3
EQImp	3044	R	4	UInt64	VARh	Total Reactive Energy Import
EQ1Exp	3048	R	4	UInt64	VARh	Reactive Energy Export Phase 1
EQ2Exp	3052	R	4	UInt64	VARh	Reactive Energy Export Phase 2
EQ3Exp	3056	R	4	UInt64	VARh	Reactive Energy Export Phase 3
EQExp	3060	R	4	UInt64	VARh	Total Reactive Energy Export
Apparent Energy						
ES1Imp	3064	R	4	UInt64	VAh	Apparent Energy Import Phase 1
ES2Imp	3068	R	4	UInt64	VAh	Apparent Energy Import Phase 2
ES3Imp	3072	R	4	UInt64	VAh	Apparent Energy Import Phase 3
ESImp	3076	R	4	UInt64	VAh	Total Apparent Energy

Register Alias	Register Address	Action R/WC	Size	Type	Units	Description
Import						
ES1Exp	3080	R	4	UInt64	VAh	Apparent Energy Export Phase 1
ES2Exp	3084	R	4	UInt64	VAh	Apparent Energy Export Phase 2
ES3Exp	3088	R	4	UInt64	VAh	Apparent Energy Export Phase 3
ESExp	3092	R	4	UInt64	VAh	Total Apparent Energy Export
Energy values – 32-bit floating point						
Active Energy						
EP1Imp	4000	R	2	Float32	Wh	Active Energy Import Phase 1
EP2Imp	4002	R	2	Float32	Wh	Active Energy Import Phase 2
EP3Imp	4004	R	2	Float32	Wh	Active Energy Import Phase 3
EPImp	4006	R	2	Float32	Wh	Total Active Energy Import Phase All
EP1Exp	4008	R	2	Float32	Wh	Active Energy Export Phase 1
EP2Exp	4010	R	2	Float32	Wh	Active Energy Export Phase 2
EP3Exp	4012	R	2	Float32	Wh	Active Energy Export Phase 3
EPExp	4014	R	2	Float32	Wh	Total Active Energy Export Phase All
EP1	4016	R	2	Float32	Wh	Total Active Energy Phase 1
EP2	4018	R	2	Float32	Wh	Total Active Energy Phase 2
EP3	4020	R	2	Float32	Wh	Total Active Energy Phase 3
EPSUM	4022	R	2	Float32	Wh	Total Active Energy Phase All
Reactive Energy						
EQ1Imp	4024	R	2	Float32	VARh	Reactive Energy Import Phase 1
EQ2Imp	4026	R	2	Float32	VARh	Reactive Energy Import Phase 2
EQ3Imp	4028	R	2	Float32	VARh	Reactive Energy Import Phase 3

EQImp	4030	R	2	Float32	VARh	Total Reactive Energy Import Phase All
EQ1Exp	4032	R	2	Float32	VARh	Reactive Energy Export Phase 1
EQ2Exp	4034	R	2	Float32	VARh	Reactive Energy Export Phase 2
EQ3Exp	4036	R	2	Float32	VARh	Reactive Energy Export Phase 3
EQExp	4038	R	2	Float32	VARh	Total Reactive Energy Export Phase All
EQ1	4040	R	2	Float32	VARh	Total Reactive Energy Phase 1
EQ2	4042	R	2	Float32	VARh	Total Reactive Energy Phase 2
EQ3	4044	R	2	Float32	VARh	Total Reactive Energy Phase 3
EQSUM	4046	R	2	Float32	VARh	Total Reactive Energy Phase All
Apparent Energy						
ES1Imp	4048	R	2	Float32	VAh	Apparent Energy Import Phase 1
ES2Imp	4050	R	2	Float32	VAh	Apparent Energy Import Phase 2
ES3Imp	4052	R	2	Float32	VAh	Apparent Energy Import Phase 3
ESImp	4054	R	2	Float32	VAh	Total Apparent Energy Import Phase All
ES1Exp	4056	R	2	Float32	VAh	Apparent Energy Export Phase 1
ES2Exp	4058	R	2	Float32	VAh	Apparent Energy Export Phase 2
ES3Exp	4060	R	2	Float32	VAh	Apparent Energy Export Phase 3
ESExp	4062	R	2	Float32	VAh	Total Apparent Energy Export Phase All
ES1	4064	R	2	Float32	VAh	Total Apparent Energy Phase 1
ES2	4066	R	2	Float32	VAh	Total Apparent Energy Phase 2
ES3	4068	R	2	Float32	VAh	Total Apparent Energy Phase 3

						3
ESSUM	4070	R	2	Float32	VAh	Total Apparent Energy Phase All

13.5 Harmonics Calculations

The power quality analysis values use the following abbreviations:

- Fundamental phase current rms: I1
- Fundamental phase voltage rms: V1
- Total harmonic distortion of the phase current
- Total harmonic distortion of the phase voltage
- Harmonic distortion on the phase current

$$HD_{I_x} = \frac{I_x}{I_1}, x = 2, 3, \dots, N$$

$$HD_{I_y} = \frac{I_y}{I_1}, y = 2, 3, \dots, N$$

$$HD_{I_z} = \frac{I_z}{I_1}, z = 2, 3, \dots, N$$

- Harmonic distortion on the phase voltage

$$HD_{V_x} = \frac{V_x}{V_1}, x = 2, 3, \dots, N$$

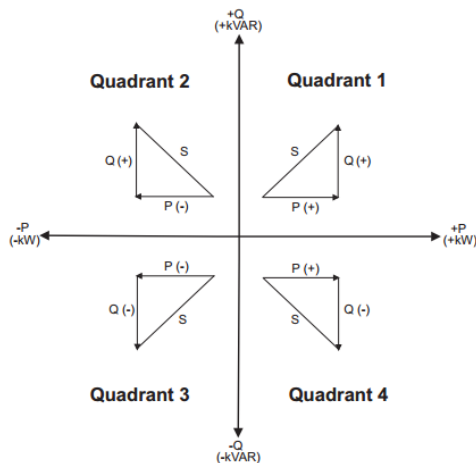
$$HD_{V_y} = \frac{V_y}{V_1}, y = 2, 3, \dots, N$$

$$HD_{V_z} = \frac{V_z}{V_1}, z = 2, 3, \dots, N$$

13.6 Power, Energy and Power Factor

Power and the PQ coordinate system

The meter uses the values of real power (P) and reactive power (Q) on the PQ coordinate system to calculate apparent power



Power flow

Positive power flow $P(+)$ and $Q(+)$ means power is flowing from the power source towards the load. Negative power flow $P(-)$ and $Q(-)$ means power is flowing from the load towards the power source.

Energy delivered (imported) / energy received (exported)

The meter interprets energy delivered (imported) or received (exported) according to the direction of real power (P) flow. Energy delivered (imported) means positive real power flow ($+P$) and energy received (exported) means negative real power flow ($-P$).

Power factor (PF)

Power factor (PF) is the ratio of real power (P) to apparent power (S), and is a number between 0 and 1.

An ideal, purely resistive load has no reactive components, so its power factor is one ($PF = 1$, or unity power factor). A purely inductive or capacitive load has no resistive components, so its power factor is zero ($PF = 0$).

True PF and displacement PF

The meter supports true power factor and displacement power factor values:

- True power factor includes harmonic content (PF).
- Displacement power factor only considers the fundamental frequency (DPF).

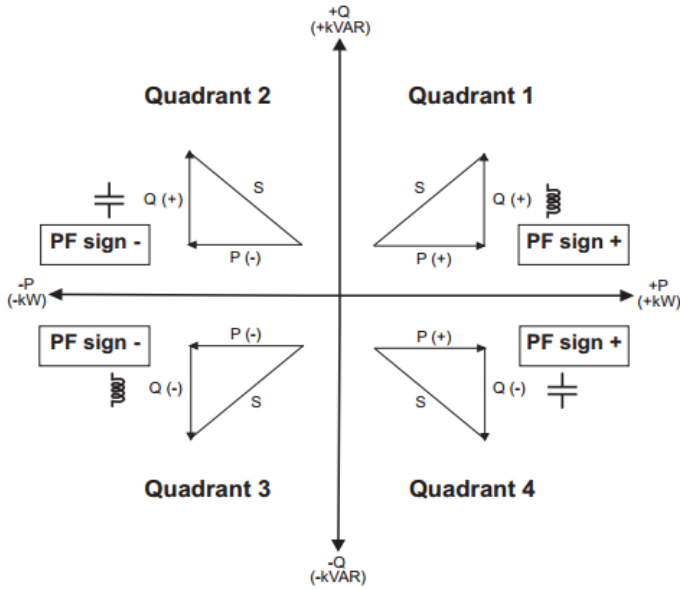
PF sign convention

The meter shows positive or negative power factor according to IEC standards.

PF sign in IEC mode

The meter correlates power factor sign (PF sign) with the direction of real power (P) flow.

- For positive real power (+P), the PF sign is positive (+).
- For negative real power (-P), the PF sign is negative (-).



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