Anerma bvba

Electronics

User Manual

Modular Power Meter
Volt1000
RoCo2000AN
Cube1000AN
Spark5A

Modular power meter with MODBUS interface for power distribution systems

PJ201
Version 1.0

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Revision History		
Version	**Date**	**Improvement**
0.1	12 Aug-2020	Initial version
0.2	30 Nov-2020	Revision
0.3	8 Feb-2021	Extended description of the modbus registers
0.4	27 Apr-2021	Added energy counters to the modbus registers
1.0	23 Jul-2021	Major soft- and hardware review RoCo2000AN or Cube1000AN can act as router MODBUS register map is changed Spark5A sensor is added

Limited Warranty and disclaimer

Anerma products are guaranteed to be free of defects in workmanship or materials. Any product that proves to be defective will be replaced or repaired at the discretion of Anerma.

LIMITATION
This limited warranty only covers conditions resulting from normal use of products. Anerma's warranty shall not apply to the following products: products or parts repaired, altered or modified by other than Anerma or an authorized repair representative, failure to follow proper installation, operation or maintenance instructions and damage resulting from improper storage conditions.

Contents

1. Purpose

This document describes the use and the functional specifications of the modular power meter sensors. This is identified by Project-ID PJ201.

2. Intended Audience

The intended audience is generally anybody who wants to measure power distribution systems.

3. Glossary

Arms	Ampere root-mean-square
As	Ampere-second, 1A current measured during 1 second
CF	Crest Factor
F	Frequency
Hz	Hertz, 1Hz = 1/second
I	current
Ithd	Total harmonic distortion of the current
N	Neutral line
L1, L2, L3	Power lines 1, 2 and 3
LSB	Least significant bit (value resolution in the MODBUS packet)
P	Real Power
PE	Protective Earth
PF	Power Factor (=Voltage or current peek/RMS)
PGA	Programmable Gain Amplifiers
Q	Reactive Power
RMS	Root Mean Square value
S	Apparent Power
U	Voltage
Uthd	Total harmonic distortion of the voltage
VAC	Voltage for alternating current
VDC	Voltage for direct current

4. Safety Regulations

4.1. Warning, caution and notes

Warnings, cautions and notes within this manual will be used as follows:

WARNING: Used to denote a danger to personnel of serious injury and/or death. The warning will be preceded by the caption WARNING and the detail of any warning will be in bold and uppercase.

CAUTION: Used to denote a possibility of damage to material or equipment but not a danger to personnel. The caution will be preceded by the caption CAUTION and the detail of any caution will be in bold and lowercase.

NOTE: used to draw attention to information that is extraneous to the immediate subject of the text. A note will be preceded by the caption NOTE and the detail will be in italics.

All warnings, cautions and notes will precede the relevant sections of the text.

4.2. General Safety Regulations

WARNING: THIS DEVICE IS NOT DESIGNED FOR AND THEREFORE NOT INTENDED FOR USE IN ANY ENVIRONMENT WHERE HUMAN LIFE DEPENDS DIRECTLY ON THE USE OF PROVEN RELIABILITY AND FAILSAFE TECHNIQUES AND COMPONENTS.

WARNING: THIS DEVICE MUST ONLY BE OPERATED IN ENVIRONMENTS LIMITED TO THE SPECIFIED TEMPERATURE AND HUMIDITY CONDITIONS.

WARNING: THIS DEVICE IS NOT PROTECTED AGAINST ANY CORROSION FROM ANY TOXICAL PARTICLE, FLUID OR GAS.

WARNING: THIS DEVICE MUST NOT BE USED IN NUCLEAR PLANTS OR IN ANY EXPLOSIVE ENVIRONMENT.

CAUTION: The maximum input voltages must not be exceeded.

5. Instrument Description

The modular power meter consists of voltage (Volt1000) and current (Cube1000AN/RoCo2000AN) meters with a modbus interface. The Spark5A can be added and has 5A (20Apeek) range with an ultrasonic microphone to detect partial discharges.

This meter is intended to be used together with a MODBUS RTU master (often a PLC). To avoid a lot of cabling, the different meters can be connected in a chain to become a cascaded multi-channel meter. Only one cable should be connected to the RTU master to measure up to 15 x 4 = 60 power lines.
This modular system consist of a voltage module (Volt1000) that measures L1,L2,L3,N, and one up to fifteen current modules (Cube1000AN/RoCo2000AN) measure power and current. In other words, for up to 15 3-phase+N outgoing power lines, it is possible to measure the voltage, current and power for the 3 phases and the voltage & current in the Neutral.

To accomplish this, the Volt1000 meter samples the voltage and sends the samples to the Cube1000AN/RoCo2000AN meters on the cascade bus. Each Cube1000AN/RoCo2000AN meter uses these samples to calculate the power components.
The Volt1000 meter acts as a bridge between the MODBUS master and the cascade bus.
If it is not necessary to measure the voltage, also the first Cube1000AN/RoCo2000AN can form the bridge between MODBUS and the other current sensors.

The meter uses a dual meter principle.
When buying a multi-meter, one has to choose between a manual- or an auto ranging one. The disadvantage of an auto ranging meter is that, during the range switch, no measurements are available. The disadvantage of a manual selection is that we lose all measurements if an erroneous range is selected.

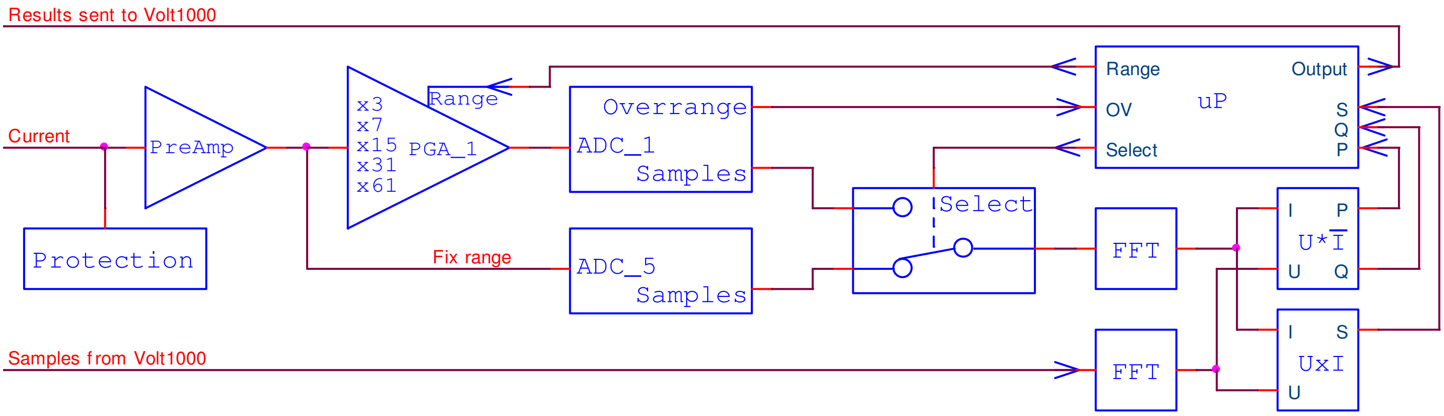


Figure 5-1 Block schematic of a current input, only one channel is shown

Our solution is the combination of both. Each voltage or current input goes to a fix range input and to an auto ranging input. The fix range input is set to the maximum range while the auto ranging one follows the input. Software selects the right measurement.
With this double meter principle, we get a maximum resolution by auto ranging, while peaks are always catched by the fixed range.
A second benefit is that we get a high crest factor, because the maximum range is always available.
Each input has his own analog to digital convertor, to get a full-bandwidth measurement with a maximum resolution.

5.1. Configurations.

Different configurations are possible, hereunder we show some as an indication.

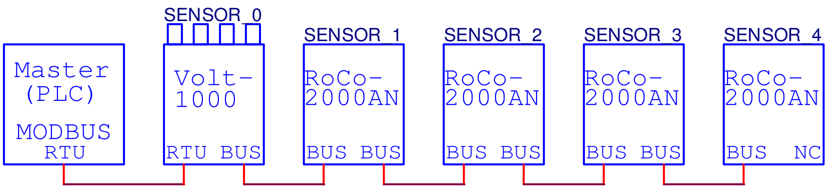


Figure 5-2 Volt sensor act as bridge from MODBUS to sensor bus

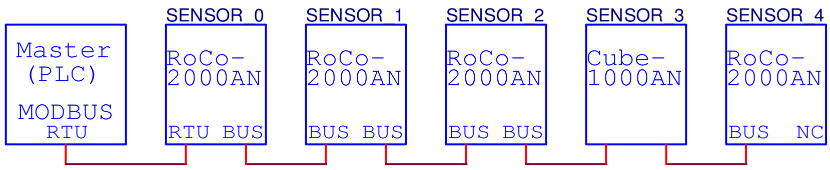


Figure 5-3 RoCo2000AN sensor act as bridge from MODBUS to sensor bus

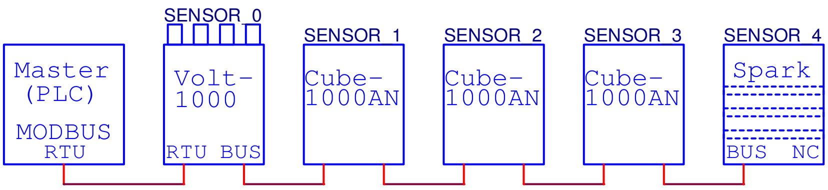


Figure 5-4 Sensors can be mixed, but Volt must be first and Spark must be the last

Figure 5-5 Volt or RoCo can be used as a single device

In all configurations, the first module acts for MODBUS as bridge to the other sensors. The modbus address equals the MODBUS address of the first sensor plus the position of the sensor in the cascade. I.e.: if the first sensor has the address 10, then the next will have 11, and so on. To make it easier for you, we call the first module sensor_0 the next module sensor_1, etc. so the number is the offset of the MODBUS address.

5.2. Chain Configuration

The different modules can be connected in a chain, so there is only one wire that's goes to the MODBUS-RTU master. The first module will be seen on the configured MODBUS address while the successors will have consecutive addresses.

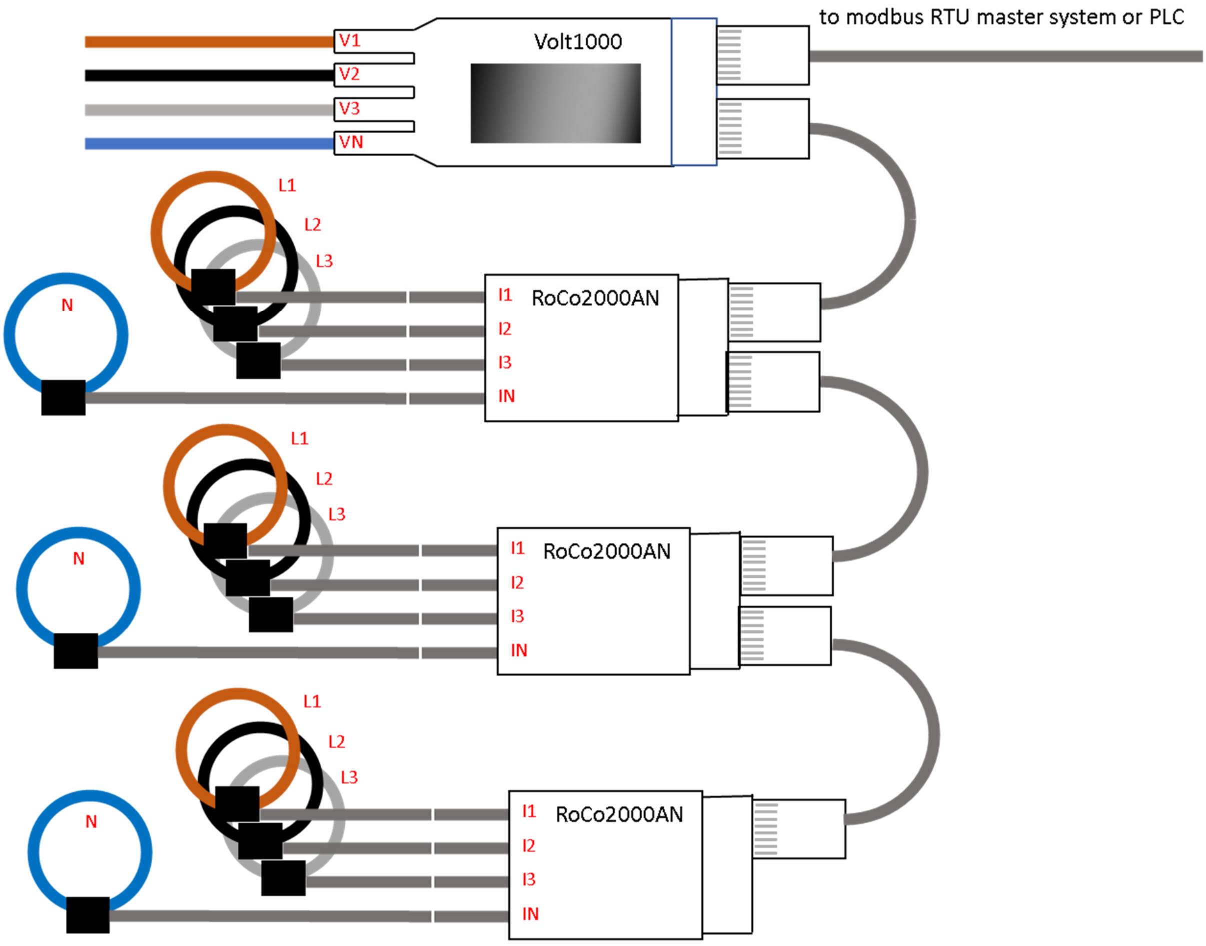


Figure 5-6 Volt1000, Cube1000AN & RoCo2000AN chain Configuration

5.3. MODBUS-RTU cable

This RTU cable, available in an order, has a standard length of 5m and with the cores of the free end freed over 50mm and stripped and tinned over 5mm.

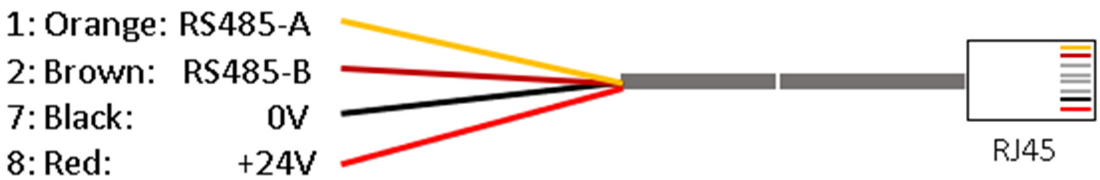


Figure 5-7 MODBUS RTU cable pinning

5.4. Interconnection or meter bus cables

Here standard Ethernet patch cables can be used, be aware that the cable contains 8 cores.
These cables are available in all lengths and colors on the market.
Note: Cables for industrial ethernet often have only 2 pairs of wires.
Warning: do not plug the RJ45 jack into a computer or ethernet switch, the 24V can damage the 1G-bit channel.

5.5. Volt1000

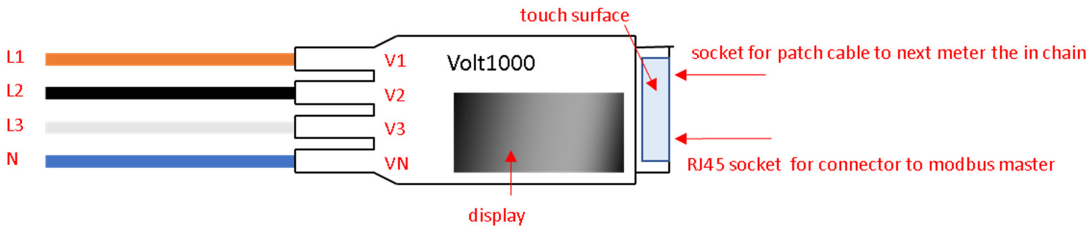


Figure 5-8 Volt1000 Module

The voltage sensor has the following properties:

- measure 3-phase voltage +N (connection for 3 phases and neutral wire);
- modbus interface.
- Two RJ45 sockets for chaining, standard Ethernet cables can be used.
- DIN-rail-TS35 mounting + magnet to fix it on an iron plate.
- CAT4.
- 2 meter long wires to connect with L1, L2, L3 and N.
- high creeping and clearance distance 15mm, not only for inputs to GND but also between phases.
- 1000V rms fix input range.
- 300V, 200V, 140V auto range for L1 - N, L2 - N, L3 – N.
- 300V, 200V, 100V, 63V, 32V auto range between N and GND (if the 0V pin is earthed in the MODBUS master).
- 10M-Ohm input impedance, 5kV, 15mm creeping distance.
- graphical 128x64 pixel OLED display with touch interface, this shows the measurements of the whole chain and can be used to set-up the system.
  Note: The OLED works only with a power supply of more than 14 Volts.
- 24V, power consumption: 15mA (30mA with OLED display on) + n x 15mA to feed n current modules.

5.6. RoCo2000AN 4 channel current sensor

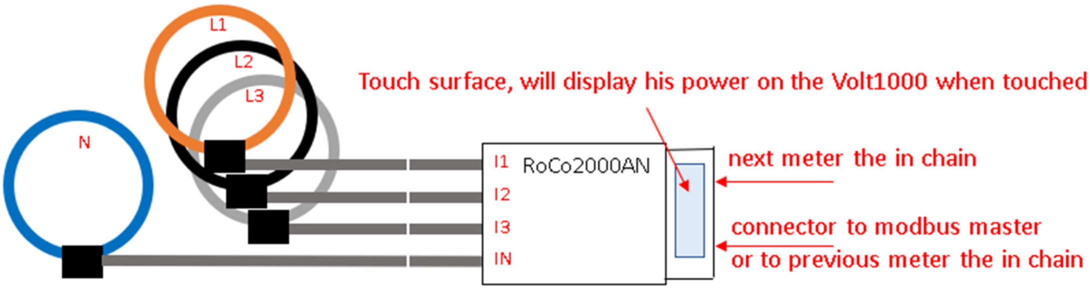


Figure 5-9 Current module with Rogowski coils

The current sensor with 4 Rogowski coils, has the following properties:

- measurement coils for 4 currents (3 phases and neutral wire);
- modbus interface.
- Two RJ45 sockets for chaining.
- DIN-rail-TS35 mounting + magnet to fix it on an iron plate.
- Measurements of current, voltage, active power (imported and exported), reactive power, power factor, cos(phi), frequency, distortion.
- Ranges:
  - 2000A rms fix input range.
  - 630A, 400A, 250A, 160A, 100A, 63A, 32A auto range for I1, I2, I3 and IN (independent selection)
- 24V power, 10mA power consumption.
- Stand-alone device: It can be connected directly to a modbus master.
- Chain mode: see 5.2

5.7. Cube1000AN 4 channel current sensor

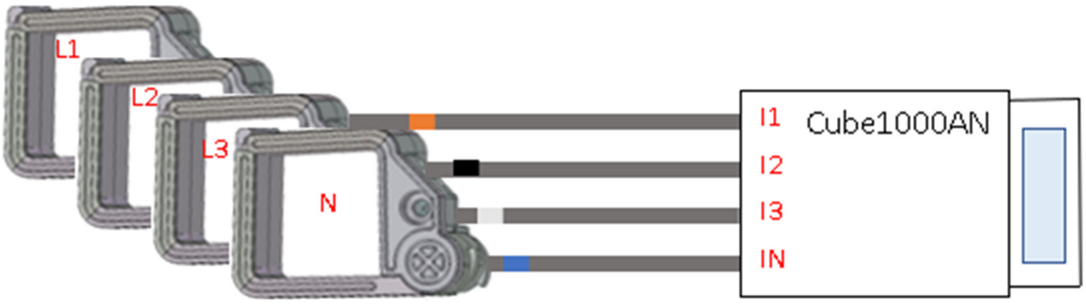
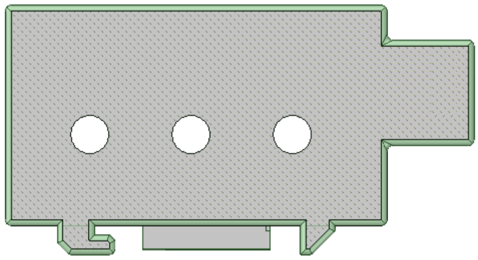


Figure 5-10 Cube 1000AN current sensor

The Cube1000 is almost identical, only the form and ranges of the current are different. This sensor is designed for cables where the space between cables is as low as 4mm.

- Ranges:
  - 1000A rms fix input range
  - 320A, 200A, 140A, 100A, 63A, 32A, 16A auto range for I1, I2, I3 and IN (independent selection)

5.8. Spark5A 3 x 5A + partial discharge sensor.



This current sensor is designed for installations with current transformers. Mostly the secondary of this transformers is already connected to a metering or control system. With this sensor this standard 5A or 1A currents can be measured in an contactless manner. Just put the 3 wires, though the holes of the sensor.

- Ranges:
  - 20A rms fix input range
  - 5A, 2A, 1A, 0.5A, 0,25A auto range for I1, I2, I3

In addition an ultrasonic microphone picks up the typical noise caused by partial discharge in high voltage installation. Our proprietary algorithm splits up this noise in different bands, and filters out the non 50 or 60 Hz related components.
A user should note that the detected level of partial discharge depends to the source distance and acoustic properties of the room. So, not absolute level, but the level increase is important to predict a potential explosion of the installation.

5.9. Placement

There are several possibilities to place the sensors:
- free hanging;
- fix with a cable tie;
- clicked on a DIN rail;
- attach to iron with the built in magnet.

5.10. Display with Touch Interface

The Volt1000 module has a display with touch interface. This allows to view the main measurements and to alter the modbus settings.

There are several screens with measurements:
- Pt, It, In: total power (W), total current (A) and neuter current (A) for all attached current sensors
- V, F: voltage (V) and frequency (Hz)
- I1..4, P1..4: current per phase (A), power per phase (W) per 3 current sensors

The settings screen shows the modbus address and baudrate. These can be altered and saved.

The touchscreen distinguishes between short and long (>2.5s) touches. When touching the screen longer than 0.5s, a progress bar at the top is shown as a visual aid.

The screen is enabled by touching it. It is disabled after no touches have been detected for 30s. It can also be disabled by a long touch in one of the measurement screens.

5.11. Software Upgrade

Easy program upgrade can be done in one of next ways:
- writing the upgrade file with a USB-RS485-RJ45 cable to the Volt1000 meter (this uses a PC program ModbusLink, see chapter 7);
- writing the upgrade with our proprietary protocol over MODBUS;

In a chain, the Volt1000 or first current meter can forward its upgrade to the attached Cube1000AN/RoCo2000AN/Spark5A meters. This has to be initiated via the display.

5.12. Ordering Codes

Code	Description
Volt1000	3-ph+N voltage sensor with MODBUS + master
RoCo2000AN	4x2000A Rogowsky coil current sensor
Cube1000AN	4x1000A current cube sensor
Spark5A	3x5A current sensor with measurement of partial discharge
ModbusCable5M	5m MODBUS RTU cable with RJ45 plug + striped end
ModbusLink	PC program to upgrade, configure and read out the sensors
USB-RS485	USB to modbus cable to be used with the MobusLink program

Table 5-1 Ordering Codes

6. Modbus Interface

6.1. Modbus Settings

The modbus address and baudrate can be set by the user.
The available baud rates are 4800, 9600, 19600, 38400, 57600 and 115200. The communication uses 8 data bits without parity and 1 stop bit. It is in binary format with most significant digits first and 16-bit CRC

Internally the receiver channel is doubled, while the first channel is used for the MODBUS communication at the selected baud rate, the second channel is fixed to 9600bd so a user can always communicate at 9600bd to configure the module.

The settings can be changed in several ways:

- via a ModbusLink PC program (see chapter 7);
- via the display with touch interface (Volt1000 only);
- via modbus on a fixed 9600 baudrate.
- via modbus on the (previously) configured baudrate

6.2. Modbus address

When used in a chain configuration, the first sensor on the bus takes its stored address and all connected Cube1000AN/RoCo2000AN meters get the address of the first sensor + 1..15 by default. The number 1..15 is the sensor position after the first sensor. Care must be taken that this does not overlap with the addresses of other modules on the bus!
A MODBUS bus termination resistor of 120Ω is fixed in the Volt1000/Cube1000/RoCo2000AN module. So this sensor is always the last element in the MODBUS-RTU

The first sensor is the only one that is directly connected to the modbus. It acts as a router for the chained Cube1000AN/RoCo2000AN meters so all meters can be reached from the modbus.

Example
A Volt1000 meter with address 10 has 3 Cube1000/RoCo2000 meters attached to it.
The bus addresses are:

- Volt1000: 10
- first Cube1000/RoCo2000: 11
- second Cube1000/RoCo2000: 12
- third Cube1000/RoCo2000: 13

6.3. Modbus Registers

6.3.1. Number formats

Number coding:

- 32-bit number (int32): The MSB always comes first, or register n contains bit 31..16 and register n+1 contains bit 15..0

- 64-bit number (int64): The MSB always comes first, or register n contains bit 63..48, register n+1 contains bit 47..32, register n+2 contains bit 31..16 and register n+3 contains bit 15..0
- Date = 32-bit number that contains the offset from 1/1/2000 in seconds.
  - Ex1: 10 => 1/1/2000 0h0m10s
  - Ex2: 3600 => 1/1/2000 1h00s
  - Ex3: 662774400 => 01/01/2021 0h0m0s
- Floating point numbers (32-bit) follows the IEEE754 standard (float32):
  - bit-31=sign
  - bit-30..23=binary exponent with offset 0hF
  - 1,bit22..0=mantissa (1 represents the hidden bit)
  - Ex1: 0h3F800000 => 1.0E0
  - Ex2: 0h40000000 => 2.0E0
- Half precision Floating point numbers (16-bit) follows the IEEE754 standard (float16):
  - bit-15=sign
  - bit-14..10=binary exponent with offset 0h7F
  - 1,bit9..0=mantissa (1 represents the hidden bit)
  - Ex1: 0h3C00 => 1
  - Ex2: 0h4000 => 2
  - Ex3: 0h7BFF => 65504 (maximum value)
  - Ex4: 0h1418 => 0.001

  The resolution remains relatively high, for a value of 230V we get 0.125V as resolution
  - 0h5B30 => 230.000
  - 0h5B31 => 230.125

All measurements (VAC,AAC,W,%,Hz) are floating point numbers

6.3.2. Register overview

Name	Register Address Range
Master table	0x0000-0x47FF
Individual table – Measurements	0x5000-0x50FF
Individual table – Info	0x5100-0x51FF
Settings table	0x5200-0x52FF
Commands table	0x5300-0x53FF
Energy table – Integers	0x6000-0x6FFF
Energy table – Floating point	0x7000-0x7FFF

Table 6-1 Modbus registers overview

6.3.3. Master table

The master table groups all measurements per type:
- voltage measurements (includes distortion and frequency) (U, Uthd, F)
- current measurements (I)
- real power measurements (P)

- reactive power measurements (Q)
- cos(ϕ) measurements (Cosphi)
- power factor measurements (PF)
- current distortion measurements (Ithd)
- apparent power measurements (S)

For all these measurements, several values are available:
- actual value in 32-bit floating point, the actual value is the value measured in the last second
- actual value in 16-bit floating point
- mean value in 16-bit floating point over the last interval
- maximum value in 16-bit floating point over the last interval
- minimum value in 16-bit floating point over the last interval

The sensors calculate the mean, maximum and minimum values for each measurement over a minute. These are stored for the last 15 minutes. Then it calculates the mean, maximum and minimum values over an interval. The length of the interval can be set (see 6.3.6). It is a value in minutes ranging from 1 to 15.

The master table is only available on the first sensor on the bus.

Value	Format	Measurement	Register Address Range
Actual value	float32	U, Uthd, F	0x0000-0x00FF
		I	0x0100-0x01FF
		P	0x0200-0x02FF
		Q	0x0300-0x03FF
		Cosphi	0x0400-0x04FF
		PF	0x0500-0x05FF
		Ithd	0x0600-0x06FF
		S	0x0700-0x07FF
Actual value	float16	U, Uthd, F	0x1000-0x10FF
		I	0x1100-0x11FF
		P	0x1200-0x12FF
		Q	0x1300-0x13FF
		Cosphi	0x1400-0x14FF
		PF	0x1500-0x15FF
		Ithd	0x1600-0x16FF
		S	0x1700-0x17FF
Mean value	float16	U, Uthd, F	0x2000-0x20FF
		I	0x2100-0x21FF
		P	0x2200-0x22FF
		Q	0x2300-0x23FF
		Cosphi	0x2400-0x24FF
		PF	0x2500-0x25FF
		Ithd	0x2600-0x26FF
		S	0x2700-0x27FF
Maximum value	float16	U, Uthd, F	0x3000-0x30FF
		I	0x3100-0x31FF
		P	0x3200-0x32FF
		Q	0x3300-0x33FF
		Cosphi	0x3400-0x34FF

		PF	0x3500-0x35FF
		Ithd	0x3600-0x36FF
		S	0x3700-0x37FF
Minimum value	float16	U, Uthd, F	0x4000-0x40FF
		I	0x4100-0x41FF
		P	0x4200-0x42FF
		Q	0x4300-0x43FF
		Cosphi	0x4400-0x44FF
		PF	0x4500-0x45FF
		Ithd	0x4600-0x46FF
		S	0x4700-0x47FF

Table 6-2 Modbus master table overview

Name	Register Address	Description	Units	Format
U1N	0x0000	Phase voltage L1	Vrms	float32
U2N	0x0002	Phase voltage L2	Vrms	float32
U3N	0x0004	Phase voltage L3	Vrms	float32
UN	0x0006	Neuter voltage (PE is reference)	Vrms	float32
U12	0x0008	Line voltage L1-L2	Vrms	float32
U23	0x000A	Line voltage L2-L3	Vrms	float32
U31	0x000C	Line voltage L3-L1	Vrms	float32
U1THD	0x000E	Total harmonic distortion – U1	%	float32
U2THD	0x0010	Total harmonic distortion – U2	%	float32
U3THD	0x0012	Total harmonic distortion – U3	%	float32
Frequency	0x0014	Frequency	Hz	float32
I1.1	0x0100	Current sensor 1 channel 1	Arms	float32
I1.2	0x0102	Current sensor 1 channel 2	Arms	float32
I1.3	0x0104	Current sensor 1 channel 3	Arms	float32
I1.4	0x0106	Current sensor 1 channel 4	Arms	float32
I2.1	0x0108	Current sensor 2 channel 1	Arms	float32
I2.2	0x010A	Current sensor 2 channel 2	Arms	float32
I2.3	0x010C	Current sensor 2 channel 3	Arms	float32
I2.4	0x010E	Current sensor 2 channel 4	Arms	float32
...				
I15.1	0x0170	Current sensor 15 channel 1	Arms	float32
I15.2	0x0172	Current sensor 15 channel 2	Arms	float32
I15.3	0x0174	Current sensor 15 channel 3	Arms	float32
I15.4	0x0176	Current sensor 15 channel 4	Arms	float32
P1.1	0x0200	Real power sensor 1 channel 1	W	float32
P1.2	0x0202	Real power sensor 1 channel 2	W	float32
P1.3	0x0204	Real power sensor 1 channel 3	W	float32
P1.4	0x0206	Real power sensor 1 channel 4	W	float32
P2.1	0x0208	Real power sensor 2 channel 1	W	float32
P2.2	0x020A	Real power sensor 2 channel 2	W	float32
P2.3	0x020C	Real power sensor 2 channel 3	W	float32
P2.4	0x020E	Real power sensor 2 channel 4	W	float32
...				
P15.1	0x0270	Real power sensor 15 channel 1	W	float32
P15.2	0x0272	Real power sensor 15 channel 2	W	float32
P15.3	0x0274	Real power sensor 15 channel 3	W	float32

P15.4	0x0276	Real power sensor 15 channel 4	W	float32
Q1.1	0x0300	Reactive power sensor 1 channel 1	var	float32
Q1.2	0x0302	Reactive power sensor 1 channel 2	var	float32
Q1.3	0x0304	Reactive power sensor 1 channel 3	var	float32
Q1.4	0x0306	Reactive power sensor 1 channel 4	var	float32
Q2.1	0x0308	Reactive power sensor 2 channel 1	var	float32
Q2.2	0x030A	Reactive power sensor 2 channel 2	var	float32
Q2.3	0x030C	Reactive power sensor 2 channel 3	var	float32
Q2.4	0x030E	Reactive power sensor 2 channel 4	var	float32
...				
Q15.1	0x0370	Reactive power sensor 15 channel 1	var	float32
Q15.2	0x0372	Reactive power sensor 15 channel 2	var	float32
Q15.3	0x0374	Reactive power sensor 15 channel 3	var	float32
Q15.4	0x0376	Reactive power sensor 15 channel 4	var	float32
CosPhi1.1	0x0400	Cos(φ) sensor 1 channel 1	-	float32
CosPhi1.2	0x0402	Cos(φ) sensor 1 channel 2	-	float32
CosPhi1.3	0x0404	Cos(φ) sensor 1 channel 3	-	float32
CosPhi1.4	0x0406	Cos(φ) sensor 1 channel 4	-	float32
CosPhi2.1	0x0408	Cos(φ) sensor 2 channel 1	-	float32
CosPhi2.2	0x040A	Cos(φ) sensor 2 channel 2	-	float32
CosPhi2.3	0x040C	Cos(φ) sensor 2 channel 3	-	float32
CosPhi2.4	0x040E	Cos(φ) sensor 2 channel 4	-	float32
...				
CosPhi15.1	0x0470	Cos(φ) sensor 15 channel 1	-	float32
CosPhi15.2	0x0472	Cos(φ) sensor 15 channel 2	-	float32
CosPhi15.3	0x0474	Cos(φ) sensor 15 channel 3	-	float32
CosPhi15.4	0x0476	Cos(φ) sensor 15 channel 4	-	float32
PF1.1	0x0500	Power factor sensor 1 channel 1	-	float32
PF1.2	0x0502	Power factor sensor 1 channel 2	-	float32
PF1.3	0x0504	Power factor sensor 1 channel 3	-	float32
PF1.4	0x0506	Power factor sensor 1 channel 4	-	float32
PF2.1	0x0508	Power factor sensor 2 channel 1	-	float32
PF2.2	0x050A	Power factor sensor 2 channel 2	-	float32
PF2.3	0x050C	Power factor sensor 2 channel 3	-	float32
PF2.4	0x050E	Power factor sensor 2 channel 4	-	float32
...				
PF15.1	0x0570	Power factor sensor 15 channel 1	-	float32
PF15.2	0x0572	Power factor sensor 15 channel 2	-	float32
PF15.3	0x0574	Power factor sensor 15 channel 3	-	float32
PF15.4	0x0576	Power factor sensor 15 channel 4	-	float32
Ithd1.1	0x0600	Current distortion sensor 1 channel 1	%	float32
Ithd1.2	0x0602	Current distortion sensor 1 channel 2	%	float32
Ithd1.3	0x0604	Current distortion sensor 1 channel 3	%	float32
Ithd1.4	0x0606	Current distortion sensor 1 channel 4	%	float32
Ithd2.1	0x0608	Current distortion sensor 2 channel 1	%	float32
Ithd2.2	0x060A	Current distortion sensor 2 channel 2	%	float32
Ithd2.3	0x060C	Current distortion sensor 2 channel 3	%	float32
Ithd2.4	0x060E	Current distortion sensor 2 channel 4	%	float32
...				
Ithd15.1	0x0670	Current distortion sensor 15 channel 1	%	float32
Ithd15.2	0x0672	Current distortion sensor 15 channel 2	%	float32

Ithd15.3	0x0674	Current distortion sensor 15 channel 3	%	float32
Ithd15.4	0x0676	Current distortion sensor 15 channel 4	%	float32
S1.1	0x0700	Apparent power sensor 1 channel 1	VA	float32
S1.2	0x0702	Apparent power sensor 1 channel 2	VA	float32
S1.3	0x0704	Apparent power sensor 1 channel 3	VA	float32
S1.4	0x0706	Apparent power sensor 1 channel 4	VA	float32
S2.1	0x0708	Apparent power sensor 2 channel 1	VA	float32
S2.2	0x070A	Apparent power sensor 2 channel 2	VA	float32
S2.3	0x070C	Apparent power sensor 2 channel 3	VA	float32
S2.4	0x070E	Apparent power sensor 2 channel 4	VA	float32
...				
S15.1	0x0770	Apparent power sensor 15 channel 1	VA	float32
S15.2	0x0772	Apparent power sensor 15 channel 2	VA	float32
S15.3	0x0774	Apparent power sensor 15 channel 3	VA	float32
S15.4	0x0776	Apparent power sensor 15 channel 4	VA	float32

Table 6-3 Modbus master table registers – Actual values in float32

The units for the power values are different in 32-bit floating point (W, var, VA) and 16-bit floating point (kW, kvar, kVA). All other units stay the same.

Name	Register Address	Description	Units	Format
U1N	0x1000	Phase voltage L1	Vrms	float16
U2N	0x1001	Phase voltage L2	Vrms	float16
U3N	0x1002	Phase voltage L3	Vrms	float16
UN	0x1003	Neuter voltage (PE is reference)	Vrms	float16
U12	0x1004	Line voltage L1-L2	Vrms	float16
U23	0x1005	Line voltage L2-L3	Vrms	float16
U31	0x1006	Line voltage L3-L1	Vrms	float16
U1THD	0x1007	Total harmonic distortion – U1	%	float16
U2THD	0x1008	Total harmonic distortion – U2	%	float16
U3THD	0x1009	Total harmonic distortion – U3	%	float16
Frequency	0x100A	Frequency	Hz	float16
I1.1	0x100B	Current sensor 1 channel 1	Arms	float16
I1.2	0x1100	Current sensor 1 channel 2	Arms	float16
I1.3	0x1101	Current sensor 1 channel 3	Arms	float16
I1.4	0x1102	Current sensor 1 channel 4	Arms	float16
I2.1	0x1103	Current sensor 2 channel 1	Arms	float16
I2.2	0x1104	Current sensor 2 channel 2	Arms	float16
I2.3	0x1105	Current sensor 2 channel 3	Arms	float16
I2.4	0x1106	Current sensor 2 channel 4	Arms	float16
...	0x1107			
I15.1		Current sensor 15 channel 1	Arms	float16
I15.2	0x1138	Current sensor 15 channel 2	Arms	float16
I15.3	0x1139	Current sensor 15 channel 3	Arms	float16
I15.4	0x113A	Current sensor 15 channel 4	Arms	float16
P1.1	0x113B	Real power sensor 1 channel 1	kW	float16
P1.2	0x1200	Real power sensor 1 channel 2	kW	float16
P1.3	0x1201	Real power sensor 1 channel 3	kW	float16
P1.4	0x1202	Real power sensor 1 channel 4	kW	float16
P2.1	0x1203	Real power sensor 2 channel 1	kW	float16

P2.2	0x1204	Real power sensor 2 channel 2	kW	float16
P2.3	0x1205	Real power sensor 2 channel 3	kW	float16
P2.4	0x1206	Real power sensor 2 channel 4	kW	float16
...	0x1207			
P15.1		Real power sensor 15 channel 1	kW	float16
P15.2	0x1238	Real power sensor 15 channel 2	kW	float16
P15.3	0x1239	Real power sensor 15 channel 3	kW	float16
P15.4	0x123A	Real power sensor 15 channel 4	kW	float16
Q1.1	0x123B	Reactive power sensor 1 channel 1	kvar	float16
Q1.2	0x1300	Reactive power sensor 1 channel 2	kvar	float16
Q1.3	0x1301	Reactive power sensor 1 channel 3	kvar	float16
Q1.4	0x1302	Reactive power sensor 1 channel 4	kvar	float16
Q2.1	0x1303	Reactive power sensor 2 channel 1	kvar	float16
Q2.2	0x1304	Reactive power sensor 2 channel 2	kvar	float16
Q2.3	0x1305	Reactive power sensor 2 channel 3	kvar	float16
Q2.4	0x1306	Reactive power sensor 2 channel 4	kvar	float16
...	0x1307			
Q15.1		Reactive power sensor 15 channel 1	kvar	float16
Q15.2	0x1338	Reactive power sensor 15 channel 2	kvar	float16
Q15.3	0x1339	Reactive power sensor 15 channel 3	kvar	float16
Q15.4	0x133A	Reactive power sensor 15 channel 4	kvar	float16
CosPhi1.1	0x133B	Cos(φ) sensor 1 channel 1	-	float16
CosPhi1.2	0x1400	Cos(φ) sensor 1 channel 2	-	float16
CosPhi1.3	0x1401	Cos(φ) sensor 1 channel 3	-	float16
CosPhi1.4	0x1402	Cos(φ) sensor 1 channel 4	-	float16
CosPhi2.1	0x1403	Cos(φ) sensor 2 channel 1	-	float16
CosPhi2.2	0x1404	Cos(φ) sensor 2 channel 2	-	float16
CosPhi2.3	0x1405	Cos(φ) sensor 2 channel 3	-	float16
CosPhi2.4	0x1406	Cos(φ) sensor 2 channel 4	-	float16
...	0x1407			
CosPhi15.1		Cos(φ) sensor 15 channel 1	-	float16
CosPhi15.2	0x1438	Cos(φ) sensor 15 channel 2	-	float16
CosPhi15.3	0x1439	Cos(φ) sensor 15 channel 3	-	float16
CosPhi15.4	0x143A	Cos(φ) sensor 15 channel 4	-	float16
PF1.1	0x143B	Power factor sensor 1 channel 1	-	float16
PF1.2	0x1500	Power factor sensor 1 channel 2	-	float16
PF1.3	0x1501	Power factor sensor 1 channel 3	-	float16
PF1.4	0x1502	Power factor sensor 1 channel 4	-	float16
PF2.1	0x1503	Power factor sensor 2 channel 1	-	float16
PF2.2	0x1504	Power factor sensor 2 channel 2	-	float16
PF2.3	0x1505	Power factor sensor 2 channel 3	-	float16
PF2.4	0x1506	Power factor sensor 2 channel 4	-	float16
...	0x1507			
PF15.1		Power factor sensor 15 channel 1	-	float16
PF15.2	0x1538	Power factor sensor 15 channel 2	-	float16
PF15.3	0x1539	Power factor sensor 15 channel 3	-	float16
PF15.4	0x153A	Power factor sensor 15 channel 4	-	float16
Ithd1.1	0x153B	Current distortion sensor 1 channel 1	%	float16
Ithd1.2	0x1600	Current distortion sensor 1 channel 2	%	float16
Ithd1.3	0x1601	Current distortion sensor 1 channel 3	%	float16
Ithd1.4	0x1602	Current distortion sensor 1 channel 4	%	float16

Ithd2.1	0x1603	Current distortion sensor 2 channel 1	%	float16
Ithd2.2	0x1604	Current distortion sensor 2 channel 2	%	float16
Ithd2.3	0x1605	Current distortion sensor 2 channel 3	%	float16
Ithd2.4	0x1606	Current distortion sensor 2 channel 4	%	float16
...	0x1607			
Ithd15.1		Current distortion sensor 15 channel 1	%	float16
Ithd15.2	0x1638	Current distortion sensor 15 channel 2	%	float16
Ithd15.3	0x1639	Current distortion sensor 15 channel 3	%	float16
Ithd15.4	0x163A	Current distortion sensor 15 channel 4	%	float16
S1.1	0x163B	Apparent power sensor 1 channel 1	kVA	float16
S1.2	0x1700	Apparent power sensor 1 channel 2	kVA	float16
S1.3	0x1701	Apparent power sensor 1 channel 3	kVA	float16
S1.4	0x1702	Apparent power sensor 1 channel 4	kVA	float16
S2.1	0x1703	Apparent power sensor 2 channel 1	kVA	float16
S2.2	0x1704	Apparent power sensor 2 channel 2	kVA	float16
S2.3	0x1705	Apparent power sensor 2 channel 3	kVA	float16
S2.4	0x1706	Apparent power sensor 2 channel 4	kVA	float16
...	0x1707			
S15.1		Apparent power sensor 15 channel 1	kVA	float16
S15.2	0x1738	Apparent power sensor 15 channel 2	kVA	float16
S15.3	0x1739	Apparent power sensor 15 channel 3	kVA	float16
S15.4	0x173A	Apparent power sensor 15 channel 4	kVA	float16

Table 6-4 Modbus master table registers – Actual values in float16

Name	Register Address	Description	Units	Format
U1N	0x2000	Phase voltage L1	Vrms	float16
U2N	0x2001	Phase voltage L2	Vrms	float16
U3N	0x2002	Phase voltage L3	Vrms	float16
UN	0x2003	Neuter voltage (PE is reference)	Vrms	float16
U12	0x2004	Line voltage L1-L2	Vrms	float16
U23	0x2005	Line voltage L2-L3	Vrms	float16
U31	0x2006	Line voltage L3-L1	Vrms	float16
U1THD	0x2007	Total harmonic distortion – U1	%	float16
U2THD	0x2008	Total harmonic distortion – U2	%	float16
U3THD	0x2009	Total harmonic distortion – U3	%	float16
Frequency	0x200A	Frequency	Hz	float16
I1.1	0x200B	Current sensor 1 channel 1	Arms	float16
I1.2	0x2100	Current sensor 1 channel 2	Arms	float16
I1.3	0x2101	Current sensor 1 channel 3	Arms	float16
I1.4	0x2102	Current sensor 1 channel 4	Arms	float16
I2.1	0x2103	Current sensor 2 channel 1	Arms	float16
I2.2	0x2104	Current sensor 2 channel 2	Arms	float16
I2.3	0x2105	Current sensor 2 channel 3	Arms	float16
I2.4	0x2106	Current sensor 2 channel 4	Arms	float16
...	0x2107			
I15.1		Current sensor 15 channel 1	Arms	float16
I15.2	0x2138	Current sensor 15 channel 2	Arms	float16
I15.3	0x2139	Current sensor 15 channel 3	Arms	float16
I15.4	0x213A	Current sensor 15 channel 4	Arms	float16
P1.1	0x213B	Real power sensor 1 channel 1	kW	float16

P1.2	0x2200	Real power sensor 1 channel 2	kW	float16
P1.3	0x2201	Real power sensor 1 channel 3	kW	float16
P1.4	0x2202	Real power sensor 1 channel 4	kW	float16
P2.1	0x2203	Real power sensor 2 channel 1	kW	float16
P2.2	0x2204	Real power sensor 2 channel 2	kW	float16
P2.3	0x2205	Real power sensor 2 channel 3	kW	float16
P2.4	0x2206	Real power sensor 2 channel 4	kW	float16
...	0x2207			
P15.1		Real power sensor 15 channel 1	kW	float16
P15.2	0x2238	Real power sensor 15 channel 2	kW	float16
P15.3	0x2239	Real power sensor 15 channel 3	kW	float16
P15.4	0x223A	Real power sensor 15 channel 4	kW	float16
Q1.1	0x223B	Reactive power sensor 1 channel 1	kvar	float16
Q1.2	0x2300	Reactive power sensor 1 channel 2	kvar	float16
Q1.3	0x2301	Reactive power sensor 1 channel 3	kvar	float16
Q1.4	0x2302	Reactive power sensor 1 channel 4	kvar	float16
Q2.1	0x2303	Reactive power sensor 2 channel 1	kvar	float16
Q2.2	0x2304	Reactive power sensor 2 channel 2	kvar	float16
Q2.3	0x2305	Reactive power sensor 2 channel 3	kvar	float16
Q2.4	0x2306	Reactive power sensor 2 channel 4	kvar	float16
...	0x2307			
Q15.1		Reactive power sensor 15 channel 1	kvar	float16
Q15.2	0x2338	Reactive power sensor 15 channel 2	kvar	float16
Q15.3	0x2339	Reactive power sensor 15 channel 3	kvar	float16
Q15.4	0x233A	Reactive power sensor 15 channel 4	kvar	float16
CosPhi1.1	0x233B	Cos(φ) sensor 1 channel 1	-	float16
CosPhi1.2	0x2400	Cos(φ) sensor 1 channel 2	-	float16
CosPhi1.3	0x2401	Cos(φ) sensor 1 channel 3	-	float16
CosPhi1.4	0x2402	Cos(φ) sensor 1 channel 4	-	float16
CosPhi2.1	0x2403	Cos(φ) sensor 2 channel 1	-	float16
CosPhi2.2	0x2404	Cos(φ) sensor 2 channel 2	-	float16
CosPhi2.3	0x2405	Cos(φ) sensor 2 channel 3	-	float16
CosPhi2.4	0x2406	Cos(φ) sensor 2 channel 4	-	float16
...	0x2407			
CosPhi15.1		Cos(φ) sensor 15 channel 1	-	float16
CosPhi15.2	0x2438	Cos(φ) sensor 15 channel 2	-	float16
CosPhi15.3	0x2439	Cos(φ) sensor 15 channel 3	-	float16
CosPhi15.4	0x243A	Cos(φ) sensor 15 channel 4	-	float16
PF1.1	0x243B	Power factor sensor 1 channel 1	-	float16
PF1.2	0x2500	Power factor sensor 1 channel 2	-	float16
PF1.3	0x2501	Power factor sensor 1 channel 3	-	float16
PF1.4	0x2502	Power factor sensor 1 channel 4	-	float16
PF2.1	0x2503	Power factor sensor 2 channel 1	-	float16
PF2.2	0x2504	Power factor sensor 2 channel 2	-	float16
PF2.3	0x2505	Power factor sensor 2 channel 3	-	float16
PF2.4	0x2506	Power factor sensor 2 channel 4	-	float16
...	0x2507			
PF15.1		Power factor sensor 15 channel 1	-	float16
PF15.2	0x2538	Power factor sensor 15 channel 2	-	float16
PF15.3	0x2539	Power factor sensor 15 channel 3	-	float16
PF15.4	0x253A	Power factor sensor 15 channel 4	-	float16

Ithd1.1	0x253B	Current distortion sensor 1 channel 1	%	float16
Ithd1.2	0x2600	Current distortion sensor 1 channel 2	%	float16
Ithd1.3	0x2601	Current distortion sensor 1 channel 3	%	float16
Ithd1.4	0x2602	Current distortion sensor 1 channel 4	%	float16
Ithd2.1	0x2603	Current distortion sensor 2 channel 1	%	float16
Ithd2.2	0x2604	Current distortion sensor 2 channel 2	%	float16
Ithd2.3	0x2605	Current distortion sensor 2 channel 3	%	float16
Ithd2.4	0x2606	Current distortion sensor 2 channel 4	%	float16
...	0x2607			
Ithd15.1		Current distortion sensor 15 channel 1	%	float16
Ithd15.2	0x2638	Current distortion sensor 15 channel 2	%	float16
Ithd15.3	0x2639	Current distortion sensor 15 channel 3	%	float16
Ithd15.4	0x263A	Current distortion sensor 15 channel 4	%	float16
S1.1	0x263B	Apparent power sensor 1 channel 1	kVA	float16
S1.2	0x2700	Apparent power sensor 1 channel 2	kVA	float16
S1.3	0x2701	Apparent power sensor 1 channel 3	kVA	float16
S1.4	0x2702	Apparent power sensor 1 channel 4	kVA	float16
S2.1	0x2703	Apparent power sensor 2 channel 1	kVA	float16
S2.2	0x2704	Apparent power sensor 2 channel 2	kVA	float16
S2.3	0x2705	Apparent power sensor 2 channel 3	kVA	float16
S2.4	0x2706	Apparent power sensor 2 channel 4	kVA	float16
...	0x2707			
S15.1		Apparent power sensor 15 channel 1	kVA	float16
S15.2	0x2738	Apparent power sensor 15 channel 2	kVA	float16
S15.3	0x2739	Apparent power sensor 15 channel 3	kVA	float16
S15.4	0x273A	Apparent power sensor 15 channel 4	kVA	float16

Table 6-5 Modbus master table registers – Mean values

Name	Register Address	Description	Units	Format
U1N	0x3000	Phase voltage L1	Vrms	float16
U2N	0x3001	Phase voltage L2	Vrms	float16
U3N	0x3002	Phase voltage L3	Vrms	float16
UN	0x3003	Neuter voltage (PE is reference)	Vrms	float16
U12	0x3004	Line voltage L1-L2	Vrms	float16
U23	0x3005	Line voltage L2-L3	Vrms	float16
U31	0x3006	Line voltage L3-L1	Vrms	float16
U1THD	0x3007	Total harmonic distortion – U1	%	float16
U2THD	0x3008	Total harmonic distortion – U2	%	float16
U3THD	0x3009	Total harmonic distortion – U3	%	float16
Frequency	0x300A	Frequency	Hz	float16
I1.1	0x300B	Current sensor 1 channel 1	Arms	float16
I1.2	0x3100	Current sensor 1 channel 2	Arms	float16
I1.3	0x3101	Current sensor 1 channel 3	Arms	float16
I1.4	0x3102	Current sensor 1 channel 4	Arms	float16
I2.1	0x3103	Current sensor 2 channel 1	Arms	float16
I2.2	0x3104	Current sensor 2 channel 2	Arms	float16
I2.3	0x3105	Current sensor 2 channel 3	Arms	float16
I2.4	0x3106	Current sensor 2 channel 4	Arms	float16
...	0x3107			
I15.1		Current sensor 15 channel 1	Arms	float16

I15.2	0x3138	Current sensor 15 channel 2	Arms	float16
I15.3	0x3139	Current sensor 15 channel 3	Arms	float16
I15.4	0x313A	Current sensor 15 channel 4	Arms	float16
P1.1	0x313B	Real power sensor 1 channel 1	kW	float16
P1.2	0x3200	Real power sensor 1 channel 2	kW	float16
P1.3	0x3201	Real power sensor 1 channel 3	kW	float16
P1.4	0x3202	Real power sensor 1 channel 4	kW	float16
P2.1	0x3203	Real power sensor 2 channel 1	kW	float16
P2.2	0x3204	Real power sensor 2 channel 2	kW	float16
P2.3	0x3205	Real power sensor 2 channel 3	kW	float16
P2.4	0x3206	Real power sensor 2 channel 4	kW	float16
...	0x3207			
P15.1		Real power sensor 15 channel 1	kW	float16
P15.2	0x3238	Real power sensor 15 channel 2	kW	float16
P15.3	0x3239	Real power sensor 15 channel 3	kW	float16
P15.4	0x323A	Real power sensor 15 channel 4	kW	float16
Q1.1	0x323B	Reactive power sensor 1 channel 1	kvar	float16
Q1.2	0x3300	Reactive power sensor 1 channel 2	kvar	float16
Q1.3	0x3301	Reactive power sensor 1 channel 3	kvar	float16
Q1.4	0x3302	Reactive power sensor 1 channel 4	kvar	float16
Q2.1	0x3303	Reactive power sensor 2 channel 1	kvar	float16
Q2.2	0x3304	Reactive power sensor 2 channel 2	kvar	float16
Q2.3	0x3305	Reactive power sensor 2 channel 3	kvar	float16
Q2.4	0x3306	Reactive power sensor 2 channel 4	kvar	float16
...	0x3307			
Q15.1		Reactive power sensor 15 channel 1	kvar	float16
Q15.2	0x3338	Reactive power sensor 15 channel 2	kvar	float16
Q15.3	0x3339	Reactive power sensor 15 channel 3	kvar	float16
Q15.4	0x333A	Reactive power sensor 15 channel 4	kvar	float16
CosPhi1.1	0x333B	Cos(φ) sensor 1 channel 1	-	float16
CosPhi1.2	0x3400	Cos(φ) sensor 1 channel 2	-	float16
CosPhi1.3	0x3401	Cos(φ) sensor 1 channel 3	-	float16
CosPhi1.4	0x3402	Cos(φ) sensor 1 channel 4	-	float16
CosPhi2.1	0x3403	Cos(φ) sensor 2 channel 1	-	float16
CosPhi2.2	0x3404	Cos(φ) sensor 2 channel 2	-	float16
CosPhi2.3	0x3405	Cos(φ) sensor 2 channel 3	-	float16
CosPhi2.4	0x3406	Cos(φ) sensor 2 channel 4	-	float16
...	0x3407			
CosPhi15.1		Cos(φ) sensor 15 channel 1	-	float16
CosPhi15.2	0x3438	Cos(φ) sensor 15 channel 2	-	float16
CosPhi15.3	0x3439	Cos(φ) sensor 15 channel 3	-	float16
CosPhi15.4	0x343A	Cos(φ) sensor 15 channel 4	-	float16
PF1.1	0x343B	Power factor sensor 1 channel 1	-	float16
PF1.2	0x3500	Power factor sensor 1 channel 2	-	float16
PF1.3	0x3501	Power factor sensor 1 channel 3	-	float16
PF1.4	0x3502	Power factor sensor 1 channel 4	-	float16
PF2.1	0x3503	Power factor sensor 2 channel 1	-	float16
PF2.2	0x3504	Power factor sensor 2 channel 2	-	float16
PF2.3	0x3505	Power factor sensor 2 channel 3	-	float16
PF2.4	0x3506	Power factor sensor 2 channel 4	-	float16
...	0x3507			

PF15.1		Power factor sensor 15 channel 1	-	float16
PF15.2	0x3538	Power factor sensor 15 channel 2	-	float16
PF15.3	0x3539	Power factor sensor 15 channel 3	-	float16
PF15.4	0x353A	Power factor sensor 15 channel 4	-	float16
Ithd1.1	0x353B	Current distortion sensor 1 channel 1	%	float16
Ithd1.2	0x3600	Current distortion sensor 1 channel 2	%	float16
Ithd1.3	0x3601	Current distortion sensor 1 channel 3	%	float16
Ithd1.4	0x3602	Current distortion sensor 1 channel 4	%	float16
Ithd2.1	0x3603	Current distortion sensor 2 channel 1	%	float16
Ithd2.2	0x3604	Current distortion sensor 2 channel 2	%	float16
Ithd2.3	0x3605	Current distortion sensor 2 channel 3	%	float16
Ithd2.4	0x3606	Current distortion sensor 2 channel 4	%	float16
...	0x3607			
Ithd15.1		Current distortion sensor 15 channel 1	%	float16
Ithd15.2	0x3638	Current distortion sensor 15 channel 2	%	float16
Ithd15.3	0x3639	Current distortion sensor 15 channel 3	%	float16
Ithd15.4	0x363A	Current distortion sensor 15 channel 4	%	float16
S1.1	0x363B	Apparent power sensor 1 channel 1	kVA	float16
S1.2	0x3700	Apparent power sensor 1 channel 2	kVA	float16
S1.3	0x3701	Apparent power sensor 1 channel 3	kVA	float16
S1.4	0x3702	Apparent power sensor 1 channel 4	kVA	float16
S2.1	0x3703	Apparent power sensor 2 channel 1	kVA	float16
S2.2	0x3704	Apparent power sensor 2 channel 2	kVA	float16
S2.3	0x3705	Apparent power sensor 2 channel 3	kVA	float16
S2.4	0x3706	Apparent power sensor 2 channel 4	kVA	float16
...	0x3707			
S15.1		Apparent power sensor 15 channel 1	kVA	float16
S15.2	0x3738	Apparent power sensor 15 channel 2	kVA	float16
S15.3	0x3739	Apparent power sensor 15 channel 3	kVA	float16
S15.4	0x373A	Apparent power sensor 15 channel 4	kVA	float16

Table 6-6 Modbus master table registers – Maximum values

Name	Register Address	Description	Units	Format
U1N	0x4000	Phase voltage L1	Vrms	float16
U2N	0x4001	Phase voltage L2	Vrms	float16
U3N	0x4002	Phase voltage L3	Vrms	float16
UN	0x4003	Neuter voltage (PE is reference)	Vrms	float16
U12	0x4004	Line voltage L1-L2	Vrms	float16
U23	0x4005	Line voltage L2-L3	Vrms	float16
U31	0x4006	Line voltage L3-L1	Vrms	float16
U1THD	0x4007	Total harmonic distortion – U1	%	float16
U2THD	0x4008	Total harmonic distortion – U2	%	float16
U3THD	0x4009	Total harmonic distortion – U3	%	float16
Frequency	0x400A	Frequency	Hz	float16
I1.1	0x400B	Current sensor 1 channel 1	Arms	float16
I1.2	0x4100	Current sensor 1 channel 2	Arms	float16
I1.3	0x4101	Current sensor 1 channel 3	Arms	float16
I1.4	0x4102	Current sensor 1 channel 4	Arms	float16
I2.1	0x4103	Current sensor 2 channel 1	Arms	float16
I2.2	0x4104	Current sensor 2 channel 2	Arms	float16

I2.3	0x4105	Current sensor 2 channel 3	Arms	float16
I2.4	0x4106	Current sensor 2 channel 4	Arms	float16
...	0x4107			
I15.1		Current sensor 15 channel 1	Arms	float16
I15.2	0x4138	Current sensor 15 channel 2	Arms	float16
I15.3	0x4139	Current sensor 15 channel 3	Arms	float16
I15.4	0x413A	Current sensor 15 channel 4	Arms	float16
P1.1	0x413B	Real power sensor 1 channel 1	W	float16
P1.2	0x4200	Real power sensor 1 channel 2	W	float16
P1.3	0x4201	Real power sensor 1 channel 3	W	float16
P1.4	0x4202	Real power sensor 1 channel 4	W	float16
P2.1	0x4203	Real power sensor 2 channel 1	W	float16
P2.2	0x4204	Real power sensor 2 channel 2	W	float16
P2.3	0x4205	Real power sensor 2 channel 3	W	float16
P2.4	0x4206	Real power sensor 2 channel 4	W	float16
...	0x4207			
P15.1		Real power sensor 15 channel 1	W	float16
P15.2	0x4238	Real power sensor 15 channel 2	W	float16
P15.3	0x4239	Real power sensor 15 channel 3	W	float16
P15.4	0x423A	Real power sensor 15 channel 4	W	float16
Q1.1	0x423B	Reactive power sensor 1 channel 1	var	float16
Q1.2	0x4300	Reactive power sensor 1 channel 2	var	float16
Q1.3	0x4301	Reactive power sensor 1 channel 3	var	float16
Q1.4	0x4302	Reactive power sensor 1 channel 4	var	float16
Q2.1	0x4303	Reactive power sensor 2 channel 1	var	float16
Q2.2	0x4304	Reactive power sensor 2 channel 2	var	float16
Q2.3	0x4305	Reactive power sensor 2 channel 3	var	float16
Q2.4	0x4306	Reactive power sensor 2 channel 4	var	float16
...	0x4307			
Q15.1		Reactive power sensor 15 channel 1	var	float16
Q15.2	0x4338	Reactive power sensor 15 channel 2	var	float16
Q15.3	0x4339	Reactive power sensor 15 channel 3	var	float16
Q15.4	0x433A	Reactive power sensor 15 channel 4	var	float16
CosPhi1.1	0x433B	Cos(φ) sensor 1 channel 1	-	float16
CosPhi1.2	0x4400	Cos(φ) sensor 1 channel 2	-	float16
CosPhi1.3	0x4401	Cos(φ) sensor 1 channel 3	-	float16
CosPhi1.4	0x4402	Cos(φ) sensor 1 channel 4	-	float16
CosPhi2.1	0x4403	Cos(φ) sensor 2 channel 1	-	float16
CosPhi2.2	0x4404	Cos(φ) sensor 2 channel 2	-	float16
CosPhi2.3	0x4405	Cos(φ) sensor 2 channel 3	-	float16
CosPhi2.4	0x4406	Cos(φ) sensor 2 channel 4	-	float16
...	0x4407			
CosPhi15.1		Cos(φ) sensor 15 channel 1	-	float16
CosPhi15.2	0x4438	Cos(φ) sensor 15 channel 2	-	float16
CosPhi15.3	0x4439	Cos(φ) sensor 15 channel 3	-	float16
CosPhi15.4	0x443A	Cos(φ) sensor 15 channel 4	-	float16
PF1.1	0x443B	Power factor sensor 1 channel 1	-	float16
PF1.2	0x4500	Power factor sensor 1 channel 2	-	float16
PF1.3	0x4501	Power factor sensor 1 channel 3	-	float16
PF1.4	0x4502	Power factor sensor 1 channel 4	-	float16
PF2.1	0x4503	Power factor sensor 2 channel 1	-	float16

PF2.2	0x4504	Power factor sensor 2 channel 2	-	float16
PF2.3	0x4505	Power factor sensor 2 channel 3	-	float16
PF2.4	0x4506	Power factor sensor 2 channel 4	-	float16
...	0x4507			
PF15.1		Power factor sensor 15 channel 1	-	float16
PF15.2	0x4538	Power factor sensor 15 channel 2	-	float16
PF15.3	0x4539	Power factor sensor 15 channel 3	-	float16
PF15.4	0x453A	Power factor sensor 15 channel 4	-	float16
Ithd1.1	0x453B	Current distortion sensor 1 channel 1	%	float16
Ithd1.2	0x4600	Current distortion sensor 1 channel 2	%	float16
Ithd1.3	0x4601	Current distortion sensor 1 channel 3	%	float16
Ithd1.4	0x4602	Current distortion sensor 1 channel 4	%	float16
Ithd2.1	0x4603	Current distortion sensor 2 channel 1	%	float16
Ithd2.2	0x4604	Current distortion sensor 2 channel 2	%	float16
Ithd2.3	0x4605	Current distortion sensor 2 channel 3	%	float16
Ithd2.4	0x4606	Current distortion sensor 2 channel 4	%	float16
...	0x4607			
Ithd15.1		Current distortion sensor 15 channel 1	%	float16
Ithd15.2	0x4638	Current distortion sensor 15 channel 2	%	float16
Ithd15.3	0x4639	Current distortion sensor 15 channel 3	%	float16
Ithd15.4	0x463A	Current distortion sensor 15 channel 4	%	float16
S1.1	0x463B	Apparent power sensor 1 channel 1	VA	float16
S1.2	0x4700	Apparent power sensor 1 channel 2	VA	float16
S1.3	0x4701	Apparent power sensor 1 channel 3	VA	float16
S1.4	0x4702	Apparent power sensor 1 channel 4	VA	float16
S2.1	0x4703	Apparent power sensor 2 channel 1	VA	float16
S2.2	0x4704	Apparent power sensor 2 channel 2	VA	float16
S2.3	0x4705	Apparent power sensor 2 channel 3	VA	float16
S2.4	0x4706	Apparent power sensor 2 channel 4	VA	float16
...	0x4707			
S15.1		Apparent power sensor 15 channel 1	VA	float16
S15.2	0x4738	Apparent power sensor 15 channel 2	VA	float16
S15.3	0x4739	Apparent power sensor 15 channel 3	VA	float16
S15.4	0x473A	Apparent power sensor 15 channel 4	VA	float16

Table 6-7 Modbus master table registers – Minimum values

6.3.4. Individual table – Measurements

The individual tables can be read at the modbus address of each sensor in the chain.

Name	Register Address	Description	Units	Format
U1-N	0x5000	Phase voltage L1	Vrms	float32
U2-N	0x5002	Phase voltage L2	Vrms	float32
U3-N	0x5004	Phase voltage L3	Vrms	float32
N	0x5006	Neuter voltage (PE is reference)	Vrms	float32
U1-U2	0x5008	Line voltage L1-L2	Vrms	float32
U2-U3	0x500A	Line voltage L2-L3	Vrms	float32
U3-U1	0x500C	Line voltage L3-L1	Vrms	float32
U1thd	0x500E	Total harmonic distortion – U1	%	float32
U2thd	0x5010	Total harmonic distortion – U2	%	float32

U3thd	0x5012	Total harmonic distortion – U3	%	float32
Frequency	0x5014	Frequency	Hz	float32
Rotation field	0x5016	-	-	float32
I1	0x5018	Current channel 1	Arms	float32
I2	0x501A	Current channel 2	Arms	float32
I3	0x501C	Current channel 3	Arms	float32
I4	0x501E	Current channel 4	Arms	float32
P1	0x5020	Real Power channel 1	W	float32
P2	0x5022	Real Power channel 2	W	float32
P3	0x5024	Real Power channel 3	W	float32
P4	0x5026	Real Power channel 4	W	float32
Q1	0x5028	Reactive Power channel 1	var	float32
Q2	0x502A	Reactive Power channel 2	var	float32
Q3	0x502C	Reactive Power channel 3	var	float32
Q4	0x502E	Reactive Power channel 4	var	float32
CosPhi1	0x5030	Cos(φ) channel 1	-	float32
CosPhi2	0x5032	Cos(φ) channel 2	-	float32
CosPhi3	0x5034	Cos(φ) channel 3	-	float32
CosPhi4	0x5036	Cos(φ) channel 4	-	float32
PF1	0x5038	Power factor channel 1	-	float32
PF2	0x503A	Power factor channel 2	-	float32
PF3	0x503C	Power factor channel 3	-	float32
PF4	0x503E	Power factor channel 4	-	float32
I1thd	0x5040	Total harmonic distortion – I1	%	float32
I2thd	0x5042	Total harmonic distortion – I2	%	float32
I3thd	0x5044	Total harmonic distortion – I3	%	float32
I4thd	0x5046	Total harmonic distortion – I4	%	float32
S1	0x5048	Apparent power channel 1	VA	float32
S2	0x504A	Apparent power channel 2	VA	float32
S3	0x504C	Apparent power channel 3	VA	float32
S4	0x504E	Apparent power channel 4	VA	float32

Table 6-8 Modbus individual table registers – Measurements

6.3.5. Individual table – Info

Name	Register Address	Description	Units	Format
SerialNbr	0x5100	Device serial number	-	int32
ProdDate	0x5102	Production date	-	date
Type	0x5104	Type: - 201.0.0.1 = voltage sensor - 201.0.0.2 = current sensor	-	int32
Subtype	0x5106	Subtype for I sensor: - 1.1.25.4 = 25cm Rogowsky coils - 9.0.0.4 = current cube	-	int32
Software	0x5108	Software version number	-	int32
Hardware	0x510A	Hardware version number	-	int32
Status	0x510C	Sensor status (for test purposes only)	-	int32
Master flag	0x510E	<>0 for the first sensor on the bus =0 for other sensors on the bus	-	int32

ConnectCnt	0x5110	Number of connected sensors	-	int32

Table 6-9 Modbus individual table registers – Info

6.3.6. Settings table

These registers are write only.

Name	Register Address	Description	Units	Format
Interval	0x5200	Interval length in minutes for mean/max/min calculations default: 15	min	int16

Table 6-10 Modbus settings registers

6.3.7. Commands table

These registers are write only.

Each entry requires the user to write a 32-bit date value. Zero values are not accepted.

Name	Register Address	Description	Units	Format
Restore	0x5300	Restore to default settings All settings are set to default values. They are not automatically saved in permanent memory. The default values are: - modbus address = 1 - modbus baudrate = 9600 - interval = 15 minutes	-	Date
Save	0x5302	Save the current settings in permanent memory.	-	Date
Reset energy	0x5304	Reset the energy counters	-	Date

Table 6-11 Modbus command registers

6.3.8. Energy table – Integers

The Volt1000 sensor counts the energy for every input of every current sensor (4 inputs per sensor). There are 4 counters for every input:

- consumed real energy
- injected real energy
- positive reactive energy
- negative reactive energy.

This leads to 240 energy counters:

- up to 15 current sensors
- 4 inputs per current sensor
- 4 counters per input.

All counters are available in 64-bit binary format with a resolution/step of one Joule, as well as in 32-bit floating point format in kWh.

All counters are available per input (labeled "Exxx") and per sensor (labeled "ESxxx"). The values per sensor add together the values for the 4 inputs for that sensor.

Name	Register Address	Description	Units	Units
Econsumed-ch1	0x6000	Consumed real energy for sensor 1 channel 1	Joule	int64
Econsumed-ch2	0x6004	Consumed real energy for sensor 1 channel 2	Joule	int64
...				
Econsumed-ch60	0x60EC	Consumed real energy for sensor 15 channel 4	Joule	int64
Einjected-ch1	0x6100	Injected real energy for sensor 1 channel 1	Joule	int64
Einjected-ch2	0x6104	Injected real energy for sensor 1 channel 2	Joule	int64
...				
Einjected-ch60	0x61EC	Injected real energy for sensor 15 channel 4	Joule	int64
Etotal-ch1	0x6200	Total real energy for sensor 1 channel 1	Joule	int64
Etotal-ch2	0x6204	Total real energy for sensor 1 channel 2	Joule	int64
...				
Etotal-ch60	0x62EC	Total real energy for sensor 15 channel 4	Joule	int64
Econsumed-s1	0x6300	Consumed real energy for sensor 1	Joule	int64
Econsumed-s2	0x6304	Consumed real energy for sensor 2	Joule	int64
...				
Econsumed-s15	0x6338	Consumed real energy for sensor 15	Joule	int64
Einjected-s1	0x6400	Injected real energy for sensor 1	Joule	int64
Einjected-s2	0x6404	Injected real energy for sensor 1	Joule	int64
...				
Einjected-s15	0x6438	Injected real energy for sensor 15	Joule	int64
Etotal-s1	0x6500	Total real energy for sensor 1	Joule	int64
Etotal-s2	0x6504	Total real energy for sensor 1	Joule	int64
...				
Etotal-s15	0x6538	Total real energy for sensor 15	Joule	int64
Eqpos-ch1	0x6600	Positive reactive energy for sensor 1 channel 1	Joule	int64
Eqpos-ch2	0x6604	Positive reactive energy for sensor 1 channel 2	Joule	int64
...				
Eqpos-ch60	0x66EC	Positive reactive energy for sensor 15 channel 4	Joule	int64
Eqneg-ch1	0x6700	Negative reactive energy for sensor 1 channel 1	Joule	int64
Eqneg-ch2	0x6704	Negative reactive energy for sensor 1 channel 2	Joule	int64
...				
Eqneg-ch60	0x67EC	Negative reactive energy for	Joule	int64

		sensor 15 channel 4		
Eqtot-ch1	0x6800	Total reactive energy for sensor 1 channel 1	Joule	int64
Eqtot-ch2	0x6804	Total reactive energy for sensor 1 channel 2	Joule	int64
...				
Eqtot-ch60	0x68EC	Total reactive energy for sensor 15 channel 4	Joule	int64
Eqpos-s1	0x6900	Positive reactive energy for sensor 1	Joule	int64
Eqpos-s2	0x6904	Positive reactive energy for sensor 2	Joule	int64
...				
Eqpos-s15	0x6938	Positive reactive energy for sensor 15	Joule	int64
Eqneg-s1	0x6A00	Negative reactive energy for sensor 1	Joule	int64
Eqneg-s2	0x6A04	Negative reactive energy for sensor 2	Joule	int64
...				
Eqneg-s15	0x6A38	Negative reactive energy for sensor 15	Joule	int64
Eqtot-s1	0x6B00	Total reactive energy for sensor 1	Joule	int64
Eqtot-s2	0x6B04	Total reactive energy for sensor 2	Joule	int64
...				
Eqtot-s15	0x6B38	Total reactive energy for sensor 15	Joule	int64
Seconds	0x6C00	Amount of seconds that the energy was counted	s	int32

Table 6-12 Modbus energy counter registers – int64

Name	Register Address	Description	Units	Units
Econsumed-ch1	0x7000	Consumed real energy for sensor 1 channel 1	KWh	float32
Econsumed-ch2	0x7002	Consumed real energy for sensor 1 channel 2	KWh	float32
...				
Econsumed-ch60	0x7076	Consumed real energy for sensor 15 channel 4	KWh	float32
Einjected-ch1	0x7100	Injected real energy for sensor 1 channel 1	KWh	float32
Einjected-ch2	0x7102	Injected real energy for sensor 1 channel 2	KWh	float32
...				
Einjected-ch60	0x7176	Injected real energy for sensor 15 channel 4	KWh	float32
Etotal-ch1	0x7200	Total real energy for sensor 1 channel 1	KWh	float32
Etotal-ch2	0x7202	Total real energy for sensor 1 channel 2	KWh	float32
...				
Etotal-ch60	0x7276	Total real energy for sensor 15 channel 4	KWh	float32
Econsumed-s1	0x7300	Consumed real energy for sensor 1	KWh	float32
Econsumed-s2	0x7302	Consumed real energy for sensor 2	KWh	float32
...				
Econsumed-s15	0x731C	Consumed real energy for sensor 15	KWh	float32

Einjected-s1	0x7400	Injected real energy for sensor 1	KWh	float32
Einjected-s2	0x7402	Injected real energy for sensor 1	KWh	float32
...				
Einjected-s15	0x741C	Injected real energy for sensor 15	KWh	float32
Etotal-s1	0x7500	Total real energy for sensor 1	KWh	float32
Etotal-s2	0x7502	Total real energy for sensor 1	KWh	float32
...				
Etotal-s15	0x751C	Total real energy for sensor 15	KWh	float32
Eqpos-ch1	0x7600	Positive reactive energy for sensor 1 channel 1	Kvarh	float32
Eqpos-ch2	0x7602	Positive reactive energy for sensor 1 channel 2	Kvarh	float32
...				
Eqpos-ch60	0x7676	Positive reactive energy for sensor 15 channel 4	Kvarh	float32
Eqneg-ch1	0x7700	Negative reactive energy for sensor 1 channel 1	Kvarh	float32
Eqneg-ch2	0x7702	Negative reactive energy for sensor 1 channel 2	Kvarh	float32
...				
Eqneg-ch60	0x7776	Negative reactive energy for sensor 15 channel 4	Kvarh	float32
Eqtot-ch1	0x7800	Total reactive energy for sensor 1 channel 1	Kvarh	float32
Eqtot-ch2	0x7802	Total reactive energy for sensor 1 channel 2	Kvarh	float32
...				
Eqtot-ch60	0x7876	Total reactive energy for sensor 15 channel 4	Kvarh	float32
Eqpos-s1	0x7900	Positive reactive energy for sensor 1	Kvarh	float32
Eqpos-s2	0x7902	Positive reactive energy for sensor 2	Kvarh	float32
...				
Eqpos-s15	0x791C	Positive reactive energy for sensor 15	Kvarh	float32
Eqneg-s1	0x7A00	Negative reactive energy for sensor 1	Kvarh	float32
Eqneg-s2	0x7A02	Negative reactive energy for sensor 2	Kvarh	float32
...				
Eqneg-s15	0x7A1C	Negative reactive energy for sensor 15	Kvarh	float32
Eqtot-s1	0x7B00	Total reactive energy for sensor 1	Kvarh	float32
Eqtot-s2	0x7B02	Total reactive energy for sensor 2	Kvarh	float32
...				
Eqtot-s15	0x7B1C	Total reactive energy for sensor 15	Kvarh	float32

Table 6-13 Modbus energy counter registers – float32

<u>Example:</u>
As an example, input 1 of sensor 1 has the following counters:

Name	Value [Joule]	64-bit int (hex)	Value [kWh]	32-bit float (hex)
Econsumed	120 GJ	$0000 001B F08E B000	33333.333 kWh	$4702 3556
Einjected	30 GJ	$0000 0006 FC23 AC00	8333.333 kWh	$4602 3556
Etotal	90 GJ	$0000 0014 F46B 0400	25000 kWh	$46C3 5000

The following table shows all registers for these values.

Name	Format	Register Address	Value (hex)	Value (decimal)
Econsumed	64-bit int	0x6000	$0000	0
		0x6001	$001B	27
		0x6002	$F08E	61582
		0x6003	$B000	45056
Einjected	64-bit int	0x6100	$0000	0
		0x6101	$0006	6
		0x6102	$FC23	64547
		0x6103	$AC00	44032
Etotal	64-bit int	0x6200	$0000	0
		0x6201	$0014	20
		0x6202	$F46B	62571
		0x6203	$0400	1024
Econsumed	32-bit float	0x7000	$4702	18178
		0x7001	$3556	13654
Einjected	32-bit float	0x7100	$4602	17922
		0x7101	$3556	13654
Etotal	32-bit float	0x7200	$46C3	18115
		0x7201	$5000	20480

6.4. Protocol functions

For reading the 16 bit values, modbus supports the commands "Read Holding Registers" (0x03).
When addressing registers, the command contains the register address as found in the tables above.

6.5. Set baudrate and address

The modbus baudrate and address can be set with a single modbus command sent at baudrate 9600.
The packet uses function $17: Write/Read Multiple registers. It contains 3 parameters the user has to fill in:

- the serial number of the meter that has to be accessed
- the baudrate to set
- the address to set.

Apart from these 3 values and the CRC, the rest of the packet is fixed.
The new baudrate and address settings are saved immediately in the sensor permanent memory.

If, and only if, the Volt1000 sensor is the only one on the MODBUS-bus, then you can use 0 (zero) as a special serial number, that is always accepted.

Byte	Value	Description
0..17	$00 $17 $FE $FF $00 $01 $FF $03 $00 $09 $12 $B5 $7E $3A $1D $C8 $F9 $00	This is an 18-bytes password, if this password is correct then the MOBUS address is neglected. It's a good idea to use the new modbus address already in th packet.
18	**Baudrate**	communication settings 0=4800 1=9600 2=19200 3=38400 4=57600 5=115200
19..22	$00 $13 $00 $00	
23..26	**Serial number**	serial number
27	$00	
28	**Address**	MODBUS address
29..30	**CRC**	

Table 6-14 Modbus settings packet

The meter will respond with the following packet, also at baudrate 9600.

Byte	Value	Description
0..6	$00 $17 $02 $00 $00 $80 $74	

Table 6-15 Modbus settings response

Example:

This example contains the packet with the following parameters:

- the meter serial number is 2029004 (0x001EF5CC)
- baudrate 38400 (communication setting=0x03)
- address 13 (0x0D)

The resulting packet is (the 3 parameters are underlined):

```
00 17 FE FF 00 01 FF 03 00 09 12 B5 7E 3A 1D C8 F9 00 03 00 13 00 00
00 1E F5 CC 00 0D F5 DE
```

```
Alternatively, this works also with the target address 13 (OD):
0D 17 FE FF 00 01 FF 03 00 09 12 B5 7E 3A 1D C8 F9 00 03 00 13 00 00
00 1E F5 CC 00 0D 35 D6
```

7. ModbusLink

ModbusLink is a PC program that can be used to control the sensors. A USB-RS485 cable is required to connect to the sensors. The program has a user interface at the top and an information window below. This includes an option to show all modbus communication.

There are 3 main functions:

- Read registers: Either read a selected number of registers starting at a selected address or use a command file to initiate multiple read operations.
- Upgrade: Upgrade a single sensor from a selected upgrade file.
- Config: Configure a single sensor from a selected configuration file.

8. Specifications

8.1. Volt1000

Specification physical dimensions	Units	Value
Housing W x H x D	mm	92 x 36,5 x 30

Table 8-1 Volt1000 Mechanical

Specification Volt1000 meter	Units	Value
Minimum supply voltage	V_{DC}	4,5 (*15)
Maximum supply voltage	V_{DC}	32
Typical power consumption @24V	mA	10 (display disabled) 25 (display enabled)
Maximum voltage	Vrms	1000
Crest factor	-	2

Table 8-2 Volt1000 Electrical
* The minimum supply voltage for the display is 15V, it remain dark at a lower voltage.

8.2. Cube1000AN/RoCo2000AN

Specification physical dimensions	Units	Value
Housing W x H x D	mm	72 x 36,5 x 30
Maximum wire Ø	mm	25
Current clamp housing W x H x D	mm	33 x 44 x 39

Table 8-3 Cube1000AN/RoCo2000AN Mechanical

Specification current meter	Units	Value
Minimum supply voltage	V_{DC}	4,5
Maximum supply voltage	V_{DC}	32
Typical power consumption @24V	mA	10
Maximum current	Arms	1000 (Cube1000) 2000 (RoCo2000)
Crest factor	-	2

Table 8-4 Cube1000AN/RoCo2000A Electrical

List of figures

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