eCap

Modbus Register Description

Version 1.5 – 08/2024

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1. Modbus RTU Device

Tele devices provide the ability to communicate with other devices via Modbus over serial line with RTU transmission mode. The eCap delivers measured and calculated values via this communication interface. Through the Master-Slave protocol, a single master can send and receive information. eCap is such a slave device and provides different Modbus values that can be read. The configuration parameters, that are required for communication, can be read directly from the eCap frontside. Typically, the baud rate, data bits, parity and stop bit of the Modbus master must match the communication parameters on the front of the eCap.

1.1. Register Representation

Two 16-bit Modbus register values are used to represent 32-bit floating-point, 32-bit integer and unsigned integer. The Modbus address 3238 represents the two lower order bytes and the higher order bytes are represented in the 3239 Modbus address of a corresponding current transformer floating-point value. Note, that the byte order depends on the Modbus master device.

1.2. Modbus Register and Function Code

The protocol data unit (PDU) includes the slave address field, function code, data, and cyclical redundancy check (CRC) value. The supported function codes are listed in the following table:

Modbus Function Code	Function according to Modbus specification
0x03	Read Holding Registers
0x06	Write Single Register
0x10	Write Multiple Registers

According to official Modbus specifications, an error and exception code are returned to the master if an error occurred. The required Modbus address registers detailed information are listed in the following tables.

1.2.1. Measured Values

Register Address	Read / Write	Measured Values	Unit	Format
0	Read	Line to neutral voltage U1rms	V	32-bit floating-point
2	Read	Line to neutral voltage U2rms	V	32-bit floating-point
4	Read	Line to neutral voltage U3rms	V	32-bit floating-point
6	Read	Current I1rms	A	32-bit floating-point
8	Read	Current I2rms	A	32-bit floating-point
10	Read	Current I3rms	A	32-bit floating-point
12	Read	Line to line voltage U12rms	V	32-bit floating-point
14	Read	Line to line voltage U23rms	V	32-bit floating-point
16	Read	Line to line voltage U31rms	V	32-bit floating-point
18	Read	Frequency f	Hz	32-bit floating-point
32	Read	Active power P1	W	32-bit floating-point
34	Read	Active power P2	W	32-bit floating-point
36	Read	Active power P3	W	32-bit floating-point
38	Read	Total active power Ptotal	W	32-bit floating-point
40	Read	Apparent power S1	VA	32-bit floating-point
42	Read	Apparent power S2	VA	32-bit floating-point
44	Read	Apparent power S3	VA	32-bit floating-point
46	Read	Total apparent power Stotal	VA	32-bit floating-point
48	Read	Reactive power Q1	VAr	32-bit floating-point
50	Read	Reactive power Q2	VAr	32-bit floating-point
52	Read	Reactive power Q3	VAr	32-bit floating-point
54	Read	Total reactive power Qtotal	VAr	32-bit floating-point
56	Read	Power factor PF1	-	32-bit floating-point
58	Read	Power factor PF2	-	32-bit floating-point
60	Read	Power factor PF3	-	32-bit floating-point
62	Read	Total power factor PFtotal	-	32-bit floating-point
96	Read	Active energy W1	kWh	32-bit floating-point
98	Read	Active energy W2	kWh	32-bit floating-point
100	Read	Active energy W3	kWh	32-bit floating-point
102	Read	Total active energy Wtotal	kWh	32-bit floating-point
104	Read	Apparent energy ES1	kVAh	32-bit floating-point
106	Read	Apparent energy ES2	kVAh	32-bit floating-point
108	Read	Apparent energy ES3	kVAh	32-bit floating-point
110	Read	Total apparent energy EStotal	kVAh	32-bit floating-point
112	Read	Reactive energy EQ1	kVArh	32-bit floating-point
114	Read	Reactive energy EQ2	kVArh	32-bit floating-point
116	Read	Reactive energy EQ3	kVArh	32-bit floating-point
118	Read	Total reactive energy EQtotal	kVArh	32-bit floating-point

These Modbus registers provide the electrical measured quantities in 32-bit floating-point format. It is possible to read the contents of a contiguous block of registers in a single transfer.

1.2.2. Aquired Peak Values

Register Address	Read / Write	Measured Peak Values	Unit	Format
322	Read	Line to neutral voltage U1rms peak	V_{peak}	32-bit floating-point
324	Read	Line to neutral voltage U2rms peak	V_{peak}	32-bit floating-point
326	Read	Line to neutral voltage U3rms peak	V_{peak}	32-bit floating-point
328	Read	Current I1rms peak	A_{peak}	32-bit floating-point
330	Read	Current I2rms peak	A_{peak}	32-bit floating-point
332	Read	Current I3rms peak	A_{peak}	32-bit floating-point
334	Read	Line to line voltage U12rms peak	V_{peak}	32-bit floating-point
336	Read	Line to line voltage U23rms peak	V_{peak}	32-bit floating-point
338	Read	Line to line voltage U31rms peak	V_{peak}	32-bit floating-point
340	Read	Active power P1 peak	W_{peak}	32-bit floating-point
342	Read	Active power P2 peak	W_{peak}	32-bit floating-point
344	Read	Active power P3 peak	W_{peak}	32-bit floating-point
346	Read	Total active power Ptotal peak	W_{peak}	32-bit floating-point
348	Read	Apparent power S1 peak	VA_{peak}	32-bit floating-point
350	Read	Apparent power S2 peak	VA_{peak}	32-bit floating-point
352	Read	Apparent power S3 peak	VA_{peak}	32-bit floating-point
354	Read	Total Apparent power Stotal peak	VA_{peak}	32-bit floating-point
356	Read	Reactive power Q1 peak	VAr_{peak}	32-bit floating-point
358	Read	Reactive power Q2 peak	VAr_{peak}	32-bit floating-point
360	Read	Reactive power Q3 peak	VAr_{peak}	32-bit floating-point
362	Read	Total reactive power Qtotal peak	VAr_{peak}	32-bit floating-point

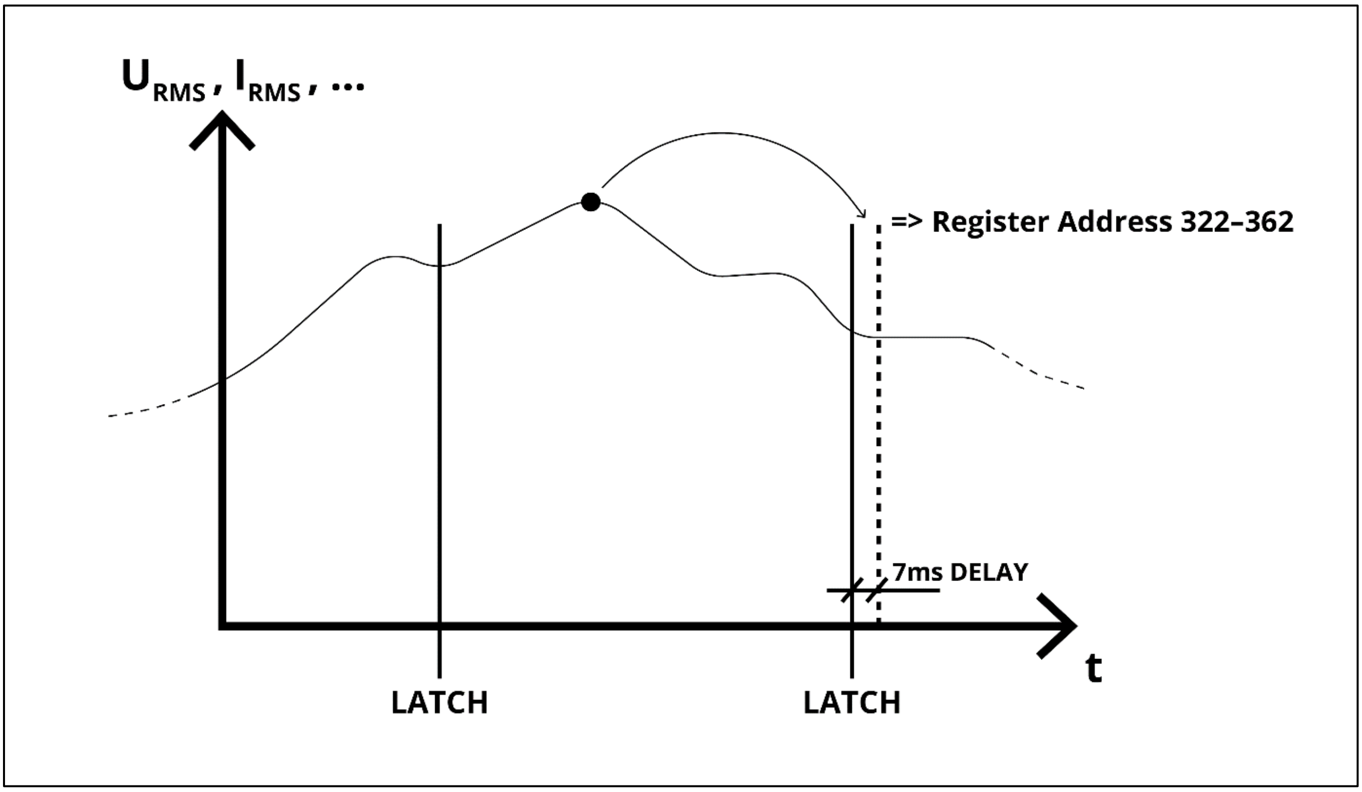
The Acquired Peak Values are the according latched peak values for the live values (voltage, current, power) listed in 1.2.1. Measured Values and stored for a period. This period is determined by the Latch Peak Values Modbus register. Each time a 1 is written to the Latch Peak Values register the actual period ends and the peak values for this period are acquired and loaded into the Measured Peak Values Modbus register entries. Additionally, a new period is started automatically. A delay of 7 milliseconds is required between a write Reset Peak Values and the read Measured Peak Values Modbus communication. (see process in figure 1: latched peak values)

In case of peak active and reactive power the values can be negative and the resulting value in the Modbus register is negative. If positive and negative values for a single Modbus register entry are calculated the absolute value of both negative and positive will be compared and the bigger value will be selected. The Measured Peak Values is available from Firmware Version V1.3.

Register Address	Read / Write	Reset	Value	Format
320	Write	Latch Peak Values	1	16-bit unsigned integer

Application note:

A Modbus master device, e.g. a PLC or IoT gateway, can latch the measured peak values with the Latch Peak Values Modbus register and read all the acquired peak values at once directly afterwards. Minimum Latch time 7 milliseconds. See acquired peak values in the figure below:



1.2.3. THD (Total harmonic distortion) measured values

To keep this document readable, there is only a compact range of modbus registers, which displays the possible registers for each measured THD value type.

Register Address	Read / Write	Measured Peak Values	Unit	Format
384	Read	Line to neutral voltage U1rms THD	%* 100	16-bit unsigned integer
385	Read	Line to neutral voltage U2rms THD	%* 100	16-bit unsigned integer
386	Read	Line to neutral voltage U3rms THD	%* 100	16-bit unsigned integer
387	Read	Current I1rms THD	%* 100	16-bit unsigned integer
388	Read	Current I2rms THD	%* 100	16-bit unsigned integer
389	Read	Current I3rms THD	%* 100	16-bit unsigned integer
390	Read	Line to line voltage U12rms THD	%* 100	16-bit unsigned integer
391	Read	Line to line voltage U23rms THD	%* 100	16-bit unsigned integer
392	Read	Line to line voltage U31rms THD	%* 100	16-bit unsigned integer
417-436	Read	U1 HARMONIC 1 - U1 HARMONIC 20	%* 100	16-bit unsigned integer
468-487	Read	U2 HARMONIC 1 – U2 HARMONIC 20	%* 100	16-bit unsigned integer
519-538	Read	U3 HARMONIC 1 – U3 HARMONIC 20	%* 100	16-bit unsigned integer
570-589	Read	I1 HARMONIC 1 - I1 HARMONIC 20	%* 100	16-bit unsigned integer
621-640	Read	I2 HARMONIC 1 – I2 HARMONIC 20	%* 100	16-bit unsigned integer
672-691	Read	I3 HARMONIC 1 – I3 HARMONIC 20	%* 100	16-bit unsigned integer
723-742	Read	U12 HARMONIC 1 - U12 HARMONIC 20	%* 100	16-bit unsigned integer
774-793	Read	U23 HARMONIC 1 – U23 HARMONIC 20	%* 100	16-bit unsigned integer
825-844	Read	U31 HARMONIC 1 – U31 HARMONIC 20	%* 100	16-bit unsigned integer

The THD measurement provides precise information about the harmonic signals in the measured signal and is capable of capturing harmonics up to the 20th harmonic. Attention for application information:

- minimum Input Voltage: 20V
- minimum Input Current: 20mA (after CT)
- frequency Range see technical data
- each 1st harmonic shows 100% value=10000
- % * 100 value shows 2 digits after comma

e.g. value of register #419 = 1533 equals 15,33%

1.2.4. Current Transformer

Up to 3 current transformers can be wired to the terminal of the eCap and can be individually adjusted by using the table below. The default factory value of the CTF1 – CTF3 Current Transformer Factor is 1.0f and is represented by two 16-bit Modbus register entries. A common Tele current transducer would be a 100A/5A unit and has a ratio of 100: 5 which means that a value of 20.0f must be applied as a CTF*. A value of 0.2f must be applied to the corresponding Modbus address register for a 1A/5A transformer and a value of 1.0f for a 5A/5A transformer. The CTF1 value corresponds to I1i and I1k terminal on the eCap.

Register Address	Read / Write	Configuration	Value	Unit	Format
3238	Read	Current Transformer Factor CTF1	x* ... 500.0f	-	32-bit floating-point
3240	Read	Current Transformer Factor CTF2	x* ... 500.0f	-	32-bit floating-point
3242	Read	Current Transformer Factor CTF3	x* ... 500.0f	-	32-bit floating-point
6438	Write	Current Transformer Factor CTF1	x* ... 500.0f	-	32-bit floating-point
6440	Write	Current Transformer Factor CTF2	x* ... 500.0f	-	32-bit floating-point
6442	Write	Current Transformer Factor CTF3	x* ... 500.0f	-	32-bit floating-point

Separated read and write configuration registers are available for each parameter. x* ... means that the value should be bigger than 0.0f. The Modbus read registers contains the latest assigned CFT* values after restart or power on. Different factor values can be written to the write registers and can be read back with the read registers. The Modbus master must wait until the written values appear in the read registers before the eCap is restarted to apply the new CTF* factor values. The Device Restart section provides detailed information how to restart the eCap via Modbus. The CTF* values also applied after power on. 500.0f is automatically set if the value is bigger. A current transformer factor of 1.0f is automatically set if a negative or equal to 0.0f value is assigned.

Application note:

A Modbus master device, e.g. a PLC or IoT gateway, can be preconfigured with the Current Transformer Factor values to automatically setup the eCap if it contains the factory values. In this case no configuration software is needed for CTF* configuration. The CTF* values must be written into eCap to Modbus write address 6438, 6440 and 6442. Afterwards, the CTF* values should be read back until the same values that are written appear in the Modbus read address 3238, 3240 and 3242. It can take more than one read operations until the values appear in the Modbus read address registers. A restart of the eCap with the device restart Modbus address must be done afterwards to apply the CTF* values. Device Restart section provides detailed information how to restart the eCap. The power supply LED on the front will disappear for a short time and can be checked visually. Another read of the CTF* values after device restart of the eCap is used for correct operation.

Another way to apply the Current Transformer Factor values is the usage of the program eCapConfigurator which can be downloaded on the Tele website. Additional information can be found within the configurator software.

1.2.5. Zero Adjustment

If no load and no voltage is applied to the terminals, the eCap has a base noise in the range of 10mV and 100µA on the measurement inputs. These values can be round down to 0.0f in case of energy measurement because these values will also be accumulated. The factory value of the according Adjustment Modbus Register Address is 3. All negligible voltages and currents values will be set to 0.0f.

Register Address	Read / Write	Adjustment	Format
3232	Read	Current and Voltage Quantities	16-bit unsigned integer
6432	Write	Current and Voltage Quantities	16-bit unsigned integer

This Modbus register provides the ability to round low currents and voltages down to 0.0f.

Adjustment

Quantity	Value (Hex)	Value (Binary)
3 Voltages	0x0001	0b0000 0000 0000 0001
3 Currents	0x0002	0b0000 0000 0000 0010

The values in the Adjustment table trim the according quantity values. It is also valid to adjust the voltages and currents in a single Modbus write command with a value of 0x0003 (0b0011). These values are automatically stored internally and applied after restart or "power on". The Device Restart and **Error! Reference source not found.** section provides detailed information how to setup and restart the eCap via Modbus. The Zero Adjustment values must be assigned once and will be restored after each restart.

Application note:

A Modbus master device, e.g. a PLC or IoT gateway, can be preconfigured with the Zero Adjustment values. A check directly after "power on" can detect an exchanged eCap with default values. In this case the Modbus master can write the Zero Adjustment values in the eCap. Afterwards a restart of the eCap is required to apply these values.

With the eCapConfigurator software the zero adjustment values can be applied as well. Any Software can be downloaded on the Tele website. Additional information can be found within the configurator software.

1.2.6. Reset Energy Values

Register Address	Read / Write	Reset	Valide Write Values	Format
120	Read, Write	Energy	Energy Reset Values	16-bit unsigned integer

This Modbus register provides the ability to reset one or more energy values with a single Modbus write command.

Energy Reset Values

Energy	Value (Hex)	Value (Binary)
Active energy W1	0x0001	0b0000 0000 0000 0001
Active energy W2	0x0002	0b0000 0000 0000 0010
Active energy W3	0x0004	0b0000 0000 0000 0100
Apparent energy ES1	0x0008	0b0000 0000 0000 1000
Apparent energy ES2	0x0010	0b0000 0000 0001 0000
Apparent energy ES3	0x0020	0b0000 0000 0010 0000
Reactive energy EQ1	0x0040	0b0000 0000 0100 0000
Reactive energy EQ2	0x0080	0b0000 0000 1000 0000
Reactive energy EQ3	0x0100	0b0000 0001 0000 0000

The entries in the Energy Reset Values table set the according energy value to 0.0f. It is also valid to reset the energy Wp1 and Wp2 in a single Modbus write command with the energy reset value of 0x0003 (0b0011). The value 0x01FF is required to reset all energy values at once. The total energy values are calculated based on single energy values. A change to a single energy value is automatically applied to the according total energy. New energy values are accumulated after an energy reset has been performed. Note that the energy values are stored every 15 minutes. They are restored automatically after power on.

Application note:

An external PLC can store the energy values periodically and reset the energy values afterwards. For example, a recommended period can be three months for energy accumulation. This allows a comparison between different periods.

1.2.7. Digital Input and Output

Register Address	Read / Write	Digital Input and Outputs	Value	Format
64	Read	Digital Input 1 (DI1)	0 ... 1	16-bit unsigned integer
66	Read / Write	Digital Output 1 (DO1)	0 ... 1	16-bit unsigned integer
67	Read / Write	Digital Output 2 (DO2)	0 ... 1	16-bit unsigned integer

These Modbus registers represent the current digital state of the output and input terminal of the device. An output can be set to 0 or 1. After power on both outputs are set to the logical value 0.

1.2.8. Device Restart

Register Address	Read / Write	Control	Value	Format
16000	Read / Write	Device Restart	0xADEE	16-bit unsigned integer

This register can restart the eCap. A restart is necessary if e.g. the current transformer factor values should be applied. Note that the Modbus master must wait for the eCap to be ready. The green power supply LED Uv+ on the front of the eCap will disappear for a short time and can be checked visually. The default value after power on is 0x0000. To trigger the Device Restart 0xADEE must be written to the register. The device restart is available from Firmware Version V1.1.

1.2.9. Device Information

Register Address	Read / Write	Device Information	Format
9600	Read	Hardware Version	16-bit unsigned integer
9601	Read	Hardware ID	16-bit unsigned integer
9602	Read	Software Version	16-bit unsigned integer
9603	Read	Software ID	16-bit unsigned integer
9604	Read	Configuration Version	16-bit unsigned integer
9605	Read	Configuration ID	16-bit unsigned integer
9606	Read	Firmware Version	16-bit unsigned integer
9607	Read	Firmware ID	16-bit unsigned integer
9608	Read	Bootloader Version	16-bit unsigned integer
9609	Read	Bootloader ID	16-bit unsigned integer
9612	Read	Product ID	64-bit unsigned integer

The Modbus registers above provide device specific information. The interpretation of the version number in the eCapConfigurator Software is in byte format. The hexadecimal format is used for the IDs.

1.2.10. Device Name

Register Address	Read / Write	Device Name	Format
32320	Read	two ASCII bytes	16-bit unsigned integer
32321	Read	two ASCII bytes	16-bit unsigned integer
...	Read	...	16-bit unsigned integer
32327	Read	two ASCII bytes	16-bit unsigned integer
32328	Read	NULL termination	16-bit unsigned integer

The device name can be read via Modbus in human readable format e.g., G4SR480V5A02CAA and is NULL terminated after the last 'A' character. The following characters are undefined. The 'G' character of the device name is in the higher order byte of the 16-bit unsigned integer Modbus register value located.

2. Version History

Date	Documentation Version No.	Details
08/2024	1.5	THD Register information added
9. February 2024	1.4	Measured Peak Values added, fixed address for device name
30. August 2023	1.3	Device Reset section added, small changes to formatting, application note added
1. December 2022	1.2	terms and designation revised, additional information to device name, current transformer, zero adjustment and Digital Input and Output added
22. September 2022	1.1	frequency and additional Modbus register added to this document, wrong energy unit in 1.2.1. Electrical Quantities
13. July 2022	1.0	initial release

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