



**User's Manual – Modbus  
EMX-IP – User Interface and Modbus  
Communications Guide  
Senva Sensors  
1825 NW 167th PL  
Beaverton, OR 97006**



**154-0050-0A**

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## EMX-IP User Interface and Modbus

| Rev. | Release Date | By  | Description of Change | ECR   |
|------|--------------|-----|-----------------------|-------|
| 0A   | 10/14/2024   | CJL | Initial Release       | 01350 |
|      |              |     |                       | —     |
|      |              |     |                       | —     |
|      |              |     |                       | —     |
|      |              |     |                       |       |

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### See Also:

- 152-0430 EMX-IP Installation Instructions
- 154-0049 EMX-IP BACnet Protocol Guide
- 154-0051 EMX-IP Navigation Guide

## Display Navigation

Congratulations on installing your new Senva EMX-IP energy meter! This Modbus Protocol Guide assumes the first stage of installation is complete, with the meter and any CTs connected and powered. The OLED display should show the home screen when any

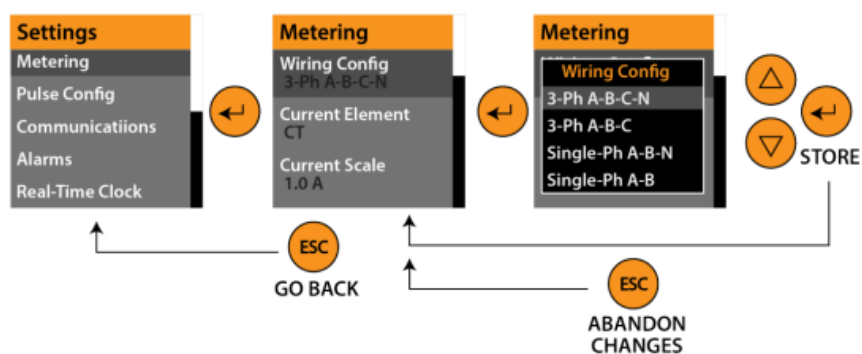
button is pressed. If not, refer to the separate Installation Instructions before continuing.

Now, only the network configuration remains between you and the data.

**From any screen, press the ENTER button to access the settings menu.**

You can make selections using the UP and DOWN arrows and then pressing ENTER to proceed to that menu or setting.

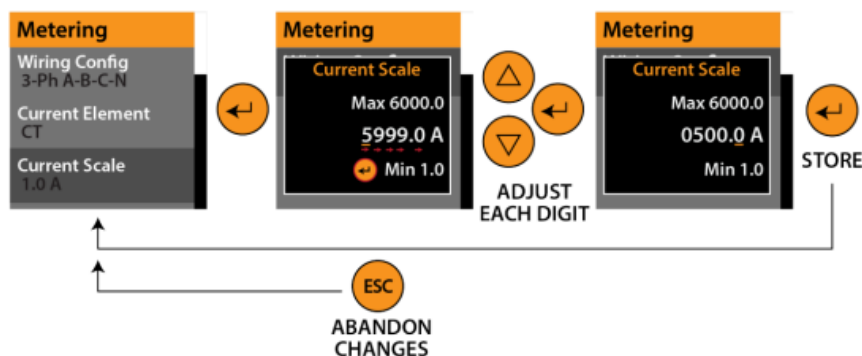
From any menu, press the ESC button to go back one menu.



To change a value, use the UP and DOWN arrows to set each digit and the ENTER button to move the cursor left.

Once each digit has been set, hit ENTER a final time to return to the previous menu.

To abandon changes at any time, you may hit ESC.



## Setup Registers and Parameters

Setup registers and parameters are available in 5 groups in the settings menu using the display or they may also be accessed using Modbus communications.

## Settings

Settings are available in the following groups on the display. A parameter list is provided in the following sections.

- Metering – Adjust metering parameters such as voltage and current scaling, phase sequencing, and display units.
- Pulse Config – Read the count of the two pulse inputs.
- Communications – See IPv4 and IPv6 values.
- Alarms – Enable or disable alarms and set trip points.
- Real-Time Clock – Set the date and time.
- Logging – Enable or disable logging as well as setting trigger source and what is logged.
- Passcode – Choose a passcode to lock device.
- Advanced – View firmware versions or initiate a factory reset.

The following sections detail how to adjust settings over the Modbus interface. All settings are stored in non-volatile memory. Stored values will not be lost if the meter experiences a power loss.

### R/W:

R = Readable Only

R/W = Read and writeable

### Type, Min, Max:

ENUM = UINT16 16-bit unsigned integer that maps to a defined list of values

U8 = UINT8 8-bit unsigned integer; 0 to 1

U16 = UINT16 16-bit unsigned integer; min/max values listed

I16 = INT16 16-bit integer; -768 to 768

### Scale:

Values must be multiplied by this scale factor to be read correctly.  $15 * 0.1 = 1.5$ . When writing the value should be divided by the scale before being written.  $1.5 / 0.1 = 15$ .

### Modbus Function Codes:

The EMX setting registers support the following Modbus function codes:

- 0x03 Read Holding Registers
- 0x04 Read Input Register
- 0x06 Read Single Holding Register
- 0x10 Write Multiple Holding Registers

## Metering

| Description                |                                                                       | Reg. | R/W | Type | Min | Max   | Default | Scale | Units                |
|----------------------------|-----------------------------------------------------------------------|------|-----|------|-----|-------|---------|-------|----------------------|
| <b>Phase Configuration</b> | 0-3PH ABCN,<br>1-3PH ABC,<br>2-1PH ABN,<br>3-1PH AB,<br>4-SplitPH ABN | 2000 | R/W | ENUM | 0   | 4     | 0       | N/A   | N/A                  |
| <b>Current Element</b>     | 0-Current Transformer,<br>1-Rogowski Coil                             | 2001 | R/W | ENUM | 0   | 1     | 0       | N/A   | N/A                  |
| <b>Current Scale</b>       | See note 1                                                            | 2002 | R/W | U16  | 10  | 60000 | 10      | 0.1   | Amps per 0.333 Volts |

|                            |                                                                                                                                     |      |     |      |    |       |     |      |          |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------|-----|------|----|-------|-----|------|----------|
| <b>Current Orientation</b> | For phases A, B, C:<br>0- +, +, +<br>1- +, +, -<br>2- +, -, +<br>3- +, -, -<br>4- -, +, +<br>5- -, +, -<br>6- -, -, +<br>7- -, -, - | 2003 | R/W | ENUM | 0  | 7     | 0   | N/A  | N/A      |
| <b>Voltage Scale</b>       | See note 2                                                                                                                          | 2004 | R/W | U16  | 10 | 32000 | 100 | 0.01 | Unitless |
| <b>Display Units</b>       | 0- IEC Units,<br>1- IEEE Units                                                                                                      | 2005 | R/W | ENUM | 0  | 1     | 1   | N/A  | N/A      |

1. Current scale is the primary side current of a 0.333V CT. CTs with an output voltage exceeding 0.333V should not be used. For a CT ratio of 20A / 0.333 V this will be  $20.0 * 10 = 200$ . If a Rogowski coil is installed this value will need to be calculated from the coils mV/1000A rating. Rogowski conversion is calculated by  $(333.33 \text{ mV} / x \text{ mV}) * 1000A * 10(\text{scale})$ .
2. Voltage scale is the PT ratio expressed as a decimal and multiplied by 100. A potential transformer of 25:10 would give a ratio of  $25 / 10 = 2.5$ , appropriately scaled it would be  $2.5 * 100 = 250$ .

## Alarms

| Description | Reg. | R/W | Type | Min | Max | Default | Scale | Units |
|-------------|------|-----|------|-----|-----|---------|-------|-------|
|-------------|------|-----|------|-----|-----|---------|-------|-------|

|                                               |                                                                                              |      |     |      |    |       |      |     |       |
|-----------------------------------------------|----------------------------------------------------------------------------------------------|------|-----|------|----|-------|------|-----|-------|
| <b>Alarm – Voltage Out of Range Enable</b>    | 0-Disable 1-Enable                                                                           | 2016 | R/W | ENUM | 0  | 1     | 0    | N/A | N/A   |
| <b>Alarm – Voltage Out of Range Nominal</b>   | Set nominal L-L voltage for out-of-range alarm, least significant digit is 1/10th of a Volt. | 2017 | R/W | U16  | 10 | 60000 | 2400 | 0.1 | Volts |
| <b>Alarm – Voltage Out of Range Threshold</b> | The percent above or below the nominal voltage setting (2017) at which a fault will trigger. | 2018 | R/W | U16  | 1  | 20    | 10   | 1   | %     |
| <b>Alarm – Current Out of Range Enable</b>    | 0-Disable 1-Enable                                                                           | 2019 | R/W | ENUM | 0  | 1     | 0    | N/A | N/A   |
| <b>Alarm – Current Out of Range Nominal</b>   | Set nominal current for out-of-range alarm, least significant digit is 1/10th of an Amp.     | 2020 | R/W | U16  | 10 | 60000 | 50   | 0.1 | Amps  |

|                                                    |                                                                                                 |      |     |      |    |       |    |     |      |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------|------|-----|------|----|-------|----|-----|------|
| <b>Alarm – Current Out of Range Threshold</b>      | The percent above or below the nominal current setting (2020) at which a fault will trigger.    | 2021 | R/W | U16  | 1  | 20    | 10 | 1   | %    |
| <b>Alarm Ground Current Out of Range Enable</b>    | 0-Disable 1-Enable                                                                              | 2022 | R/W | ENUM | 0  | 1     | 0  | N/A | N/A  |
| <b>Alarm Ground Current Out of Range Nominal</b>   | Set nominal ground current for out-of-range alarm, least significant digit is 1/10th of an Amp. | 2023 | R/W | U16  | 10 | 60000 | 50 | 0.1 | Amps |
| <b>Alarm Ground Current Out of Range Threshold</b> | The percent above the nominal ground current setting (2023) which a fault will trigger.         | 2024 | R/W | U16  | 1  | 20    | 10 | 1   | %    |



|                                               |                                                                                                |      |     |      |     |     |     |     |     |
|-----------------------------------------------|------------------------------------------------------------------------------------------------|------|-----|------|-----|-----|-----|-----|-----|
| <b>Alarm Frequency Out of Range Enable</b>    | 0-Disable 1-Enable                                                                             | 2025 | R/W | ENUM | 0   | 1   | 1   | N/A | N/A |
| <b>Alarm Frequency Out of Range Nominal</b>   | Set nominal frequency for out-of-range alarm, least significant digit is 1/100th of a Hertz.   | 2026 | R/W | U16  | 450 | 650 | 600 | 0.1 | Hz  |
| <b>Alarm Frequency Out of Range Threshold</b> | The percent above or below the nominal frequency setting (2026) at which a fault will trigger. | 2027 | R/W | U16  | 1   | 20  | 10  | 1   | %   |
| <b>Alarm Voltage Phase Loss Enable</b>        | 0-Disable 1-Enable                                                                             | 2028 | R/W | ENUM | 0   | 1   | 1   | N/A | N/A |

|                                             |                                                                                                                                                                                                                                                                                |          |     |         |   |    |    |     |     |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----|---------|---|----|----|-----|-----|
| <b>Alarm Voltage Phase Loss Threshold</b>   | A phase-to-phase comparison of L-N voltages is performed. If any phase's L-N voltage is below the others by the threshold amount, a fault will trigger. Only applicable to 3Φ configurations (ABC or ABCN). Single phase installations will power off during phase loss event. | 20<br>29 | R/W | U1<br>6 | 1 | 20 | 10 | 1   | %   |
| <b>Alarm Voltage Phase Imbalance Enable</b> | 0-Disable,<br>1-Enable                                                                                                                                                                                                                                                         | 20<br>30 | R/W | ENUM    | 0 | 1  | 1  | N/A | N/A |

|                                                |                                                                                                                                                                                                                                                       |      |     |      |   |    |    |      |          |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|------|---|----|----|------|----------|
| <b>Alarm Voltage Phase Imbalance Threshold</b> | The percent of phase-to-phase imbalance above which a fault will trigger. For a three-phase Y system, both VL-L and VL-N are examined. For a three-phase delta, only VL-L measurements are compared. In a single split-phase, only VL-N are compared. | 2031 | R/W | U16  | 1 | 20 | 10 | 1    | %        |
| <b>Alarm Power Factor Low Enable</b>           | 0-Disable 1-Enable                                                                                                                                                                                                                                    | 2032 | R/W | ENUM | 0 | 1  | 1  | 1    | N/A      |
| <b>Alarm Power Factor Low Threshold</b>        | Set the (unitless) PF value, below which a fault will trigger.                                                                                                                                                                                        | 2033 | R/W | U16  | 1 | 99 | 50 | 0.01 | Unitless |

## Advanced

| Description                     |                                                                                                                                                           | Reg. | R/W | Type | Min | Max   | Default |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|------|-----|-------|---------|
| <b>Reset Wh</b>                 | Writing 1 will reset all the stored Wh, VAh and VARh values.                                                                                              | 2034 | R/W | U16  | 0   | 1     | 0       |
| <b>Count of Wh Resets</b>       | Number of times the Wh has been reset.                                                                                                                    | 2035 | R   | U16  | 0   | 65535 | 0       |
| <b>Reset Run time</b>           | Writing 1 will reset the system run time (37 and 38), but not the system power on time (35 and 36).                                                       | 2036 | R/W | U16  | 0   | 1     | 0       |
| <b>Count of run time Resets</b> | Number of times the system run time has been reset.                                                                                                       | 2037 | R   | U16  | 0   | 65535 | 0       |
| <b>Reset Pulse Counts</b>       | Writing 1 will reset the pulse input counters (41 through 44).                                                                                            | 2038 | R/W | U16  | 0   | 1     | 0       |
| <b>Reboot EMX</b>               | Reboots the EMX. When written, this point may not give a response or may return an error due to the reset process. The point will still accept the value. | 2042 | R/W | U8   | 0   | 1     | 0       |

|                                 |                                                                                                                                                                                                                                                                                                                                     |      |     |     |      |      |   |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|-----|------|------|---|
| <b>Reset Log Content</b>        | Writing a 1 value to this register reset all the stored log entries. This will break communications and display connection for approx. 25 seconds. Do not remove power during this update. When written, this point may not give a response or may return an error due to the reset process. The point will still accept the value. | 2043 | R/W | U16 | 0    | 1    | 0 |
| <b>Phase Angle Compensation</b> |                                                                                                                                                                                                                                                                                                                                     | 2044 | R/W | I16 | -768 | 768  | 0 |
| <b>Passcode</b>                 | Set display passcode                                                                                                                                                                                                                                                                                                                | 2045 | R/W | U16 | 0    | 9999 | 0 |

## Metering Registers

The following table describes each of the power and energy readings provided over Modbus from the device.

### R/W:

R = Read Only

R/W = Read and Write

### Type, Min, Max:

ENUM = UINT16 16-bit unsigned integer that maps to a defined list of values

U8 = UINT8 8-bit unsigned integer; 0 to 255, unless otherwise noted

U16 = UINT16 16-bit unsigned integer; 0 to 65535 (0xFFFF), unless otherwise noted

I16 = INT16 16-bit integer; -32768 to 32767, unless otherwise noted

U32 = UINT32 32-bit unsigned integer; 0 to 4294967295 (0xFFFFFFFF), unless otherwise noted

U64 = UINT64 64-bit unsigned integer; 0 to 18.466e+18

I64 = INT64 64-bit signed integer; -9.233e+18 to 9.233e+18

### Scale:

Values must be multiplied by this scale factor to be read correctly. For some power, current, and voltage readings, the scale factor will be automatically set based on the user settings for voltage and current scale. These multipliers can be read in registers 030-032.

### Store:

Values marked “yes” will be stored in non-volatile memory. Stored values will not be lost if the meter experiences a power loss.

### Modbus Function Codes:

The EMX metering registers support the following Modbus function codes:

- 0x03 Read Holding Registers
- 0x04 Read Input Register

Some registers span multiple Modbus addresses. Two consecutive registers defined as XXX/YYY indicates a pair of aligned registers, that must be merged into a 32-bit value. Four consecutive registers require merging the results into a 64-bit value. See data type conversions section for more information and examples.

| Description  | Reg. | R/W | Type | Min | Max   | Scale   | Units  | Store |
|--------------|------|-----|------|-----|-------|---------|--------|-------|
| V-LN Average | 001  | R   | U16  | 0   | 65535 | V-scale | V(rms) | No    |
| V-LL Average | 002  | R   | U16  | 0   | 65535 | V-scale | V(rms) | No    |

|                             |         |   |         |        |       |         |            |    |
|-----------------------------|---------|---|---------|--------|-------|---------|------------|----|
| <b>Current Average</b>      | 00<br>3 | R | U1<br>6 | 0      | 65535 | I-scale | A(rms<br>) | No |
| <b>Current Sum</b>          | 00<br>4 | R | U1<br>6 | 0      | 65535 | I-scale | A(rms<br>) | No |
| <b>Real power total</b>     | 00<br>5 | R | I16     | -32768 | 32767 | P-scale | W          | No |
| <b>Reactive power total</b> | 00<br>6 | R | I16     | -32768 | 32767 | P-scale | VAR        | No |
| <b>Apparent power total</b> | 00<br>7 | R | I16     | -32768 | 32767 | P-scale | VA         | No |
| <b>V-LN Phase A</b>         | 00<br>8 | R | U1<br>6 | 0      | 65535 | V-scale | V(rms<br>) | No |
| <b>V-LN Phase B</b>         | 00<br>9 | R | U1<br>6 | 0      | 65535 | V-scale | V(rms<br>) | No |
| <b>V-LN Phase C</b>         | 01<br>0 | R | U1<br>6 | 0      | 65535 | V-scale | V(rms<br>) | No |
| <b>V-LL Phase A-B</b>       | 01<br>1 | R | U1<br>6 | 0      | 65535 | V-scale | V(rms<br>) | No |
| <b>V-LL Phase B-C</b>       | 01<br>2 | R | U1<br>6 | 0      | 65535 | V-scale | V(rms<br>) | No |
| <b>V-LL Phase C-A</b>       | 01<br>3 | R | U1<br>6 | 0      | 65535 | V-scale | V(rms<br>) | No |
| <b>Current Phase A</b>      | 01<br>4 | R | U1<br>6 | 0      | 65535 | I-scale | A(rms<br>) | No |
| <b>Current Phase B</b>      | 01<br>5 | R | U1<br>6 | 0      | 65535 | I-scale | A(rms<br>) | No |

|                               |         |   |         |       |       |         |            |    |
|-------------------------------|---------|---|---------|-------|-------|---------|------------|----|
| <b>Current Phase C</b>        | 01<br>6 | R | U1<br>6 | 0     | 65535 | I-scale | A(rms<br>) | No |
| <b>Power Factor Phase A</b>   | 01<br>7 | R | I16     | -1000 | 1000  | 0.001   | Unitless   | No |
| <b>Power Factor Phase B</b>   | 01<br>8 | R | I16     | -1000 | 1000  | 0.001   | Unitless   | No |
| <b>Power Factor Phase C</b>   | 01<br>9 | R | I16     | -1000 | 1000  | 0.001   | Unitless   | No |
| <b>Frequency (Phase A)</b>    | 02<br>0 | R | U1<br>6 | 480   | 620   | 0.1     | Hz         | No |
| <b>Real power Phase A</b>     | 02<br>1 | R | I16     | 32768 | 32767 | P-scale | W          | No |
| <b>Real power Phase B</b>     | 02<br>2 | R | I16     | 32768 | 32767 | P-scale | W          | No |
| <b>Real power Phase C</b>     | 02<br>3 | R | I16     | 32768 | 32767 | P-scale | W          | No |
| <b>Reactive power Phase A</b> | 02<br>4 | R | I16     | 32768 | 32767 | P-scale | VAR        | No |
| <b>Reactive power Phase B</b> | 02<br>5 | R | I16     | 32768 | 32767 | P-scale | VAR        | No |
| <b>Reactive power Phase C</b> | 02<br>6 | R | I16     | 32768 | 32767 | P-scale | VAR        | No |
| <b>Apparent power Phase A</b> | 02<br>7 | R | I16     | 32768 | 32767 | P-scale | VA         | No |
| <b>Apparent power Phase B</b> | 02<br>8 | R | I16     | 32768 | 32767 | P-scale | VA         | No |



|                                       |                                                                                                                  |     |   |     |       |       |         |     |    |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------|-----|---|-----|-------|-------|---------|-----|----|
| <b>Apparent power Phase C</b>         |                                                                                                                  | 029 | R | I16 | 32768 | 32767 | P-scale | VA  | No |
| <b>Voltage Scale Factor (V-scale)</b> | -4:0.0001<br>-3:0.001<br>-2:0.01<br>-1:0.1<br>0:1<br>1:10<br>2:100<br>3:1000<br>4:10000<br>5:100000<br>6:1000000 | 030 | R | I16 | -2    | 2     | 1       | N/A | No |
| <b>Current Scale Factor (I-scale)</b> |                                                                                                                  | 031 | R | I16 | -3    | 1     | 1       | N/A | No |
| <b>Power Scale Factor (P-scale)</b>   |                                                                                                                  | 032 | R | I16 | -4    | 6     | 1       | N/A | No |

| <b>Description</b> |                                                                                               | <b>Reg.</b> | <b>R/W</b> | <b>Type</b> | <b>Min</b> | <b>Max</b> | <b>Scale</b> | <b>Units</b> | <b>Store</b> |
|--------------------|-----------------------------------------------------------------------------------------------|-------------|------------|-------------|------------|------------|--------------|--------------|--------------|
|                    | Bit 0: Pulse configuration error<br>Bit 1: Pulse overrun error<br>Bit 2: Voltage out of range |             |            |             |            |            |              |              |              |

|                                      |                                                                                                                                                                                                                                                                                                                                           |     |   |      |   |        |   |     |    |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---|------|---|--------|---|-----|----|
| <b>Alarm<br/>Status<br/>Bitfield</b> | Bit 3: Current out of range<br>Bit 4: Current sum (neutral current) out of range<br>Bit 5: Frequency out of range<br>Bit 6: Voltage phase loss<br>Bit 7: Voltage phase unbalance<br>Bit 8: Power factor low<br>Bit 9: Accumulator loss<br>Bit 10: RTC error<br>Bit 11: Logs full<br>Bit 12: Meter settings error<br>Bit 13 – 15: Reserved | 033 | R | U16  | 0 | 0xFFFF | 1 | N/A | No |
|                                      |                                                                                                                                                                                                                                                                                                                                           |     |   |      |   |        |   |     |    |
| <b>Load<br/>Status</b>               | 0: No load detected<br>1: Load above threshold                                                                                                                                                                                                                                                                                            | 034 | R | ENUM | 0 | 1      | 1 | N/A | No |

|                              |                                          |   |     |                    |                |                |         |     |
|------------------------------|------------------------------------------|---|-----|--------------------|----------------|----------------|---------|-----|
| <b>System power on time</b>  | 03<br>5<br>03<br>6                       | R | U32 | 0                  | 429496<br>7295 | 1              | Seconds | Yes |
| <b>System run time</b>       | 03<br>7<br>03<br>8                       | R | U32 | 0                  | 429496<br>7295 | 1              | Seconds | Yes |
| <b>Power Reset Count</b>     | 03<br>9<br>04<br>0                       | R | U32 | 0                  | 429496<br>7295 | 1              | N/A     | Yes |
| <b>Pulse Count 1</b>         | 04<br>1<br>04<br>2                       | R | U32 | 0                  | 429496<br>7295 | 1              | N/A     | Yes |
| <b>Pulse Count 2</b>         | 04<br>3<br>04<br>4                       | R | U32 | 0                  | 429496<br>7295 | 1              | N/A     | Yes |
| <b>Real Net Energy total</b> | 04<br>5<br>04<br>6<br>04<br>7<br>04<br>8 | R | I64 | -9.23<br>3e+1<br>8 | 9.233e+<br>18  | 0.00000<br>001 | Wh      | Yes |

|                                |                                          |   |     |                    |               |                |    |     |
|--------------------------------|------------------------------------------|---|-----|--------------------|---------------|----------------|----|-----|
| <b>Real Net Energy Phase A</b> | 04<br>9<br>05<br>0<br>05<br>1<br>05<br>2 | R | I64 | -9.23<br>3e+1<br>8 | 9.233e+<br>18 | 0.00000<br>001 | Wh | Yes |
| <b>Real Net Energy Phase B</b> | 05<br>3<br>05<br>4<br>05<br>5<br>05<br>6 | R | I64 | -9.23<br>3e+1<br>8 | 9.233e+<br>18 | 0.00000<br>001 | Wh | Yes |

| Description                    | Re<br>g.                                 | R/<br>W | Typ<br>e | Min            | Max           | Scale          | Units | Sto<br>re |
|--------------------------------|------------------------------------------|---------|----------|----------------|---------------|----------------|-------|-----------|
| <b>Real Net Energy Phase C</b> | 05<br>7<br>05<br>8<br>05<br>9<br>06<br>0 | R       | I64      | -9.233e<br>+18 | 9.233e+<br>18 | 0.00000<br>001 | Wh    | Yes       |

|                                    |                                          |   |     |                |               |                |      |     |
|------------------------------------|------------------------------------------|---|-----|----------------|---------------|----------------|------|-----|
| <b>Reactive Net Energy total</b>   | 06<br>1<br>06<br>2<br>06<br>3<br>06<br>4 | R | I64 | -9.233e<br>+18 | 9.233e+<br>18 | 0.00000<br>001 | VARh | Yes |
| <b>Reactive Net Energy Phase A</b> | 06<br>5<br>06<br>6<br>06<br>7<br>06<br>8 | R | I64 | -9.233e<br>+18 | 9.233e+<br>18 | 0.00000<br>001 | VARh | Yes |
| <b>Reactive Net Energy Phase B</b> | 06<br>9<br>07<br>0<br>07<br>1<br>07<br>2 | R | I64 | -9.233e<br>+18 | 9.233e+<br>18 | 0.00000<br>001 | VARh | Yes |

|                                        |                                          |   |     |                |               |                |      |     |
|----------------------------------------|------------------------------------------|---|-----|----------------|---------------|----------------|------|-----|
| <b>Reactive Net Energy<br/>Phase C</b> | 07<br>3<br>07<br>4<br>07<br>5<br>07<br>6 | R | I64 | -9.233e<br>+18 | 9.233e+<br>18 | 0.00000<br>001 | VARh | Yes |
| <b>Apparent Net<br/>Energy total</b>   | 07<br>7<br>07<br>8<br>07<br>9<br>08<br>0 | R | I64 | -9.233e<br>+18 | 9.233e+<br>18 | 0.00000<br>001 | VAh  | Yes |
| <b>Apparent Net<br/>Energy Phase A</b> | 08<br>1<br>08<br>2<br>08<br>3<br>08<br>4 | R | I64 | -9.233e<br>+18 | 9.233e+<br>18 | 0.00000<br>001 | VAh  | Yes |

|                                        |                                          |   |         |                |                |                |     |     |
|----------------------------------------|------------------------------------------|---|---------|----------------|----------------|----------------|-----|-----|
| <b>Apparent Net<br/>Energy Phase B</b> | 08<br>5<br>08<br>6<br>08<br>7<br>08<br>8 | R | I64     | -9.233e<br>+18 | 9.233e+<br>18  | 0.00000<br>001 | VAh | Yes |
| <b>Apparent Net<br/>Energy Phase C</b> | 08<br>9<br>09<br>0<br>09<br>1<br>09<br>2 | R | I64     | -9.233e<br>+18 | 9.233e+<br>18  | 0.00000<br>001 | VAh | Yes |
| <b>Real Import Energy t<br/>otal</b>   | 09<br>3<br>09<br>4<br>09<br>5<br>09<br>6 | R | U6<br>4 | 0              | 18.446e<br>+18 | 0.00000<br>001 | Wh  | Yes |

|                                       |                                          |   |         |   |                |                |    |     |
|---------------------------------------|------------------------------------------|---|---------|---|----------------|----------------|----|-----|
| <b>Real Import Energy<br/>Phase A</b> | 09<br>7<br>09<br>8<br>09<br>9<br>10<br>0 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | Wh | Yes |
| <b>Real Import Energy<br/>Phase B</b> | 10<br>1<br>10<br>2<br>10<br>3<br>10<br>4 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | Wh | Yes |
| <b>Real Import Energy<br/>Phase C</b> | 10<br>5<br>10<br>6<br>10<br>7<br>10<br>8 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | Wh | Yes |

| <b>Description</b> | <b>Re<br/>g.</b> | <b>R/<br/>W</b> | <b>Typ<br/>e</b> | <b>Min</b> | <b>Max</b> | <b>Scale</b> | <b>Units</b> | <b>Sto<br/>re</b> |
|--------------------|------------------|-----------------|------------------|------------|------------|--------------|--------------|-------------------|
|--------------------|------------------|-----------------|------------------|------------|------------|--------------|--------------|-------------------|



|                                       |                                          |   |         |   |                |                |      |     |
|---------------------------------------|------------------------------------------|---|---------|---|----------------|----------------|------|-----|
| <b>Reactive Import Energy total</b>   | 10<br>9<br>11<br>0<br>11<br>1<br>11<br>2 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VARh | Yes |
| <b>Reactive Import Energy Phase A</b> | 11<br>3<br>11<br>4<br>11<br>5<br>11<br>6 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VARh | Yes |
| <b>Reactive Import Energy Phase B</b> | 11<br>7<br>11<br>8<br>11<br>9<br>12<br>0 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VARh | Yes |

|                                |    |   |     |   |            |            |      |     |
|--------------------------------|----|---|-----|---|------------|------------|------|-----|
| Reactive Import Energy Phase C | 12 | R | U64 | 0 | 18.446e+18 | 0.00000001 | VARh | Yes |
|                                | 1  |   |     |   |            |            |      |     |
|                                | 12 |   |     |   |            |            |      |     |
|                                | 2  |   |     |   |            |            |      |     |
|                                | 12 |   |     |   |            |            |      |     |
|                                | 3  |   |     |   |            |            |      |     |
|                                | 12 |   |     |   |            |            |      |     |
|                                | 4  |   |     |   |            |            |      |     |
| Apparent Import Energy total   | 12 | R | U64 | 0 | 18.446e+18 | 0.00000001 | VAh  | Yes |
|                                | 5  |   |     |   |            |            |      |     |
|                                | 12 |   |     |   |            |            |      |     |
|                                | 6  |   |     |   |            |            |      |     |
|                                | 12 |   |     |   |            |            |      |     |
|                                | 7  |   |     |   |            |            |      |     |
|                                | 12 |   |     |   |            |            |      |     |
|                                | 8  |   |     |   |            |            |      |     |
| Apparent Import Energy Phase A | 12 | R | U64 | 0 | 18.446e+18 | 0.00000001 | VAh  | Yes |
|                                | 9  |   |     |   |            |            |      |     |
|                                | 13 |   |     |   |            |            |      |     |
|                                | 0  |   |     |   |            |            |      |     |
|                                | 13 |   |     |   |            |            |      |     |
|                                | 1  |   |     |   |            |            |      |     |
|                                | 13 |   |     |   |            |            |      |     |
|                                | 2  |   |     |   |            |            |      |     |

|                                |    |   |     |   |            |            |     |     |
|--------------------------------|----|---|-----|---|------------|------------|-----|-----|
| Apparent Import Energy Phase B | 13 | R | U64 | 0 | 18.446e+18 | 0.00000001 | VAh | Yes |
|                                | 3  |   |     |   |            |            |     |     |
|                                | 13 |   |     |   |            |            |     |     |
|                                | 4  |   |     |   |            |            |     |     |
|                                | 13 |   |     |   |            |            |     |     |
|                                | 5  |   |     |   |            |            |     |     |
|                                | 13 |   |     |   |            |            |     |     |
|                                | 6  |   |     |   |            |            |     |     |
| Apparent Import Energy Phase C | 13 | R | U64 | 0 | 18.446e+18 | 0.00000001 | VAh | Yes |
|                                | 7  |   |     |   |            |            |     |     |
|                                | 13 |   |     |   |            |            |     |     |
|                                | 8  |   |     |   |            |            |     |     |
|                                | 13 |   |     |   |            |            |     |     |
|                                | 9  |   |     |   |            |            |     |     |
|                                | 14 |   |     |   |            |            |     |     |
|                                | 0  |   |     |   |            |            |     |     |
| Real Export Energy total       | 14 | R | U64 | 0 | 18.446e+18 | 0.00000001 | Wh  | Yes |
|                                | 1  |   |     |   |            |            |     |     |
|                                | 14 |   |     |   |            |            |     |     |
|                                | 2  |   |     |   |            |            |     |     |
|                                | 14 |   |     |   |            |            |     |     |
|                                | 3  |   |     |   |            |            |     |     |
|                                | 14 |   |     |   |            |            |     |     |
|                                | 4  |   |     |   |            |            |     |     |

|                               |    |   |         |   |                |                |    |     |
|-------------------------------|----|---|---------|---|----------------|----------------|----|-----|
| Real Export Energy<br>Phase A | 14 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | Wh | Yes |
|                               | 5  |   |         |   |                |                |    |     |
|                               | 14 |   |         |   |                |                |    |     |
|                               | 6  |   |         |   |                |                |    |     |
|                               | 14 |   |         |   |                |                |    |     |
|                               | 7  |   |         |   |                |                |    |     |
|                               | 14 |   |         |   |                |                |    |     |
|                               | 8  |   |         |   |                |                |    |     |
| Real Export Energy<br>Phase B | 14 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | Wh | Yes |
|                               | 9  |   |         |   |                |                |    |     |
|                               | 15 |   |         |   |                |                |    |     |
|                               | 0  |   |         |   |                |                |    |     |
|                               | 15 |   |         |   |                |                |    |     |
|                               | 1  |   |         |   |                |                |    |     |
|                               | 15 |   |         |   |                |                |    |     |
|                               | 2  |   |         |   |                |                |    |     |
| Real Export Energy<br>Phase C | 15 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | Wh | Yes |
|                               | 3  |   |         |   |                |                |    |     |
|                               | 15 |   |         |   |                |                |    |     |
|                               | 4  |   |         |   |                |                |    |     |
|                               | 15 |   |         |   |                |                |    |     |
|                               | 5  |   |         |   |                |                |    |     |
|                               | 15 |   |         |   |                |                |    |     |
|                               | 6  |   |         |   |                |                |    |     |



|                                       |                                          |   |         |   |                |                |      |     |
|---------------------------------------|------------------------------------------|---|---------|---|----------------|----------------|------|-----|
| <b>Reactive Export Energy Phase C</b> | 16<br>9<br>17<br>0<br>17<br>1<br>17<br>2 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VARh | Yes |
| <b>Apparent Export Energy total</b>   | 17<br>3<br>17<br>4<br>17<br>5<br>17<br>6 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VAh  | Yes |
| <b>Apparent Export Energy Phase A</b> | 17<br>7<br>17<br>8<br>17<br>9<br>18<br>0 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VAh  | Yes |

|                                       |                                          |   |         |   |                |                |         |     |
|---------------------------------------|------------------------------------------|---|---------|---|----------------|----------------|---------|-----|
| <b>Apparent Export Energy Phase B</b> | 18<br>1<br>18<br>2<br>18<br>3<br>18<br>4 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VAh     | Yes |
| <b>Apparent Export Energy Phase C</b> | 18<br>5<br>18<br>6<br>18<br>7<br>18<br>8 | R | U6<br>4 | 0 | 18.446e<br>+18 | 0.00000<br>001 | VAh     | Yes |
| <b>Meter Time Since Boot</b>          | 18<br>9<br>19<br>0                       | R | U3<br>2 | 0 | 429496<br>7295 | 1              | Seconds | No  |

## Real-Time Clock Registers

| Description            | Reg<br>. | R/W | Type | Min  | Max  | Sc<br>ale | Unit<br>s | Stor<br>e |
|------------------------|----------|-----|------|------|------|-----------|-----------|-----------|
| <b>RTC – Set Year</b>  | 400<br>0 | R/W | U16  | 2022 | 2060 | 1         | N/A       | No        |
| <b>RTC – Set Month</b> | 400<br>1 | R/W | U8   | 1    | 12   | 1         | N/A       | No        |

|                                   |                            |      |     |      |      |      |   |      |     |
|-----------------------------------|----------------------------|------|-----|------|------|------|---|------|-----|
| <b>RTC – Set Day of Month</b>     |                            | 4002 | R/W | U8   | 1    | 31   | 1 | N/A  | No  |
| <b>RTC – Set Day of Week</b>      |                            | 4003 | R/W | ENUM | 0    | 6    | 1 | N/A  | No  |
| <b>RTC – Set Hours</b>            |                            | 4004 | R/W | U8   | 0    | 23   | 1 | Hrs  | No  |
| <b>RTC – Set Minutes</b>          |                            | 4005 | R/W | U8   | 0    | 59   | 1 | Mins | No  |
| <b>RTC – Set Seconds</b>          |                            | 4006 | R/W | U8   | 0    | 23   | 1 | Secs | No  |
| <b>RTC – Commit time</b>          |                            | 4007 | R/W | ENUM | 0    | 1    | 1 | N/A  | Yes |
| <b>RTC – Current Year</b>         |                            | 4100 | R   | U16  | 2022 | 2060 | 1 | N/A  | Yes |
| <b>RTC – Current Month</b>        |                            | 4101 | R   | U8   | 1    | 12   | 1 | N/A  | Yes |
| <b>RTC – Current Day of Month</b> |                            | 4102 | R   | U8   | 1    | 31   | 1 | N/A  | Yes |
| <b>RTC – Current Day of Week</b>  | 0 = Sunday<br>6 = Saturday | 4103 | R   | ENUM | 0    | 6    | 1 | N/A  | Yes |
| <b>RTC – Current Hours</b>        |                            | 4104 | R   | U8   | 0    | 0    | 1 | Hrs  | Yes |
| <b>RTC – Current Minutes</b>      |                            | 4105 | R   | U8   | 0    | 0    | 1 | Mins | Yes |



|                                       |                                                                       |      |   |      |   |   |   |      |     |
|---------------------------------------|-----------------------------------------------------------------------|------|---|------|---|---|---|------|-----|
| <b>RTC – Current Seconds</b>          |                                                                       | 4106 | R | U8   | 0 | 0 | 1 | Secs | Yes |
| <b>RTC – Current AM/PM Flag, or 0</b> | If in 24-hour mode, will return 0, if in 12-hour mode: 1 = AM, 2 = PM | 4107 | R | ENUM | 0 | 2 | 1 | N/A  | Yes |

## Logging Registers

Log Source 1 through Log source 12 sets the source for the logging. Write the Modbus register 1-190 to the desired source to log that point. If a log source register has multiple registers all registers need to be set. For example, if Real Net Energy total is desired to be logged all four registers need to be set.

To trigger a log event register 5000 (Logging – Trigger Source) needs to be set to the desired trigger mode, by default it is set to be disabled. Logging can be triggered with the timer, set on Modbus point 5001 (Logging – Trigger Interval) in seconds from 15-3600. Triggering can be set over COMMS by writing a ‘1’ to point 5015 (Logging – Trigger log creation), or Pulse In 1 or 2 can be set to trigger a log whenever a pulse is detected.

| Description                     |                                                                            | Reg. | R/W | Type | Min | Max | Scale | Units | Store |
|---------------------------------|----------------------------------------------------------------------------|------|-----|------|-----|-----|-------|-------|-------|
| <b>Logging – Trigger Source</b> | 0 = Disabled<br>1 = Timer<br>2 = Comms<br>3 = Pulse In 1<br>4 = Pulse in 2 | 5000 | R/W | ENUM | 0   | 4   | 1     | N/A   | Yes   |

|                                   |                                                                              |          |     |      |    |      |   |          |     |
|-----------------------------------|------------------------------------------------------------------------------|----------|-----|------|----|------|---|----------|-----|
| <b>Logging – Trigger Interval</b> |                                                                              | 500<br>1 | R/W | U16  | 15 | 3600 | 1 | Sec<br>s | Yes |
| <b>Logging – Mode Select</b>      | 0 – “Continuous” – continue logging and overwrite old entries, sequentially  | 500<br>2 | R/W | ENUM | 0  | 1    | 1 | N/A      | Yes |
|                                   | 1 – “One Shot” – log until EEPROM is full, then stop logging and throw alarm |          |     |      |    |      |   |          |     |
| <b>Logging – Log Source 1</b>     |                                                                              | 500<br>3 | R/W | U16  | 1  | 190  | 1 | N/A      | Yes |
| <b>Logging – Log Source 2</b>     |                                                                              | 500<br>4 | R/W | U16  | 1  | 190  | 1 | N/A      | Yes |
| <b>Logging – Log Source 3</b>     |                                                                              | 500<br>5 | R/W | U16  | 1  | 190  | 1 | N/A      | Yes |
| <b>Logging – Log Source 4</b>     |                                                                              | 500<br>6 | R/W | U16  | 1  | 190  | 1 | N/A      | Yes |
| <b>Logging – Log Source 5</b>     |                                                                              | 500<br>7 | R/W | U16  | 1  | 190  | 1 | N/A      | Yes |
| <b>Logging – Log Source 6</b>     |                                                                              | 500<br>8 | R/W | U16  | 1  | 190  | 1 | N/A      | Yes |

|                                       |      |     |     |   |       |   |     |     |
|---------------------------------------|------|-----|-----|---|-------|---|-----|-----|
| <b>Logging – Log Source 7</b>         | 5009 | R/W | U16 | 1 | 190   | 1 | N/A | Yes |
| <b>Logging – Log Source 8</b>         | 5010 | R/W | U16 | 1 | 190   | 1 | N/A | Yes |
| <b>Logging – Log Source 9</b>         | 5011 | R/W | U16 | 1 | 190   | 1 | N/A | Yes |
| <b>Logging – Log Source 10</b>        | 5012 | R/W | U16 | 1 | 190   | 1 | N/A | Yes |
| <b>Logging – Log Source 11</b>        | 5013 | R/W | U16 | 1 | 190   | 1 | N/A | Yes |
| <b>Logging – Log Source 12</b>        | 5014 | R/W | U16 | 1 | 190   | 1 | N/A | Yes |
| <b>Logging – Trigger log creation</b> | 5015 | R/W | U16 | 0 | 1     | 1 | N/A | Yes |
| <b>Logging – Read log at index</b>    | 5016 | R/W | U16 | 0 | 4096  | 1 | N/A | Yes |
| <b>Logging – Oldest Index</b>         | 5100 | R   | U16 | 0 | 4096  | 1 | N/A | Yes |
| <b>Logging – Count of log entries</b> | 5101 | R   | U16 | 0 | 4096  | 1 | N/A | Yes |
| <b>Logging – Current Index</b>        | 5102 | R   | U16 | 0 | 4096  | 1 | N/A | Yes |
| <b>Logging – Log data 1</b>           | 5103 | R   | U16 | 0 | 65535 | 1 | N/A | Yes |
| <b>Logging – Log data 2</b>           | 5104 | R   | U16 | 0 | 65535 | 1 | N/A | Yes |

|                                              |          |   |     |   |           |   |     |     |
|----------------------------------------------|----------|---|-----|---|-----------|---|-----|-----|
| <b>Logging – Log data 3</b>                  | 510<br>5 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 4</b>                  | 510<br>6 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 5</b>                  | 510<br>7 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 6</b>                  | 510<br>8 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 7</b>                  | 510<br>9 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 8</b>                  | 511<br>0 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 9</b>                  | 511<br>1 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 10</b>                 | 511<br>2 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 11</b>                 | 511<br>3 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log data 12</b>                 | 511<br>4 | R | U16 | 0 | 6553<br>5 | 1 | N/A | Yes |
| <b>Logging – Log time stamp year</b>         | 511<br>5 | R | U16 | 0 | 256       | 1 | N/A | Yes |
| <b>Logging – Log time stamp month</b>        | 511<br>6 | R | U16 | 0 | 12        | 1 | N/A | Yes |
| <b>Logging – Log time stamp day of month</b> | 511<br>7 | R | U16 | 0 | 31        | 1 | N/A | Yes |

|                                         |      |   |     |   |       |   |     |     |
|-----------------------------------------|------|---|-----|---|-------|---|-----|-----|
| <b>Logging – Log time stamp hours</b>   | 5118 | R | U16 | 0 | 23    | 1 | N/A | Yes |
| <b>Logging – Log time stamp minutes</b> | 5119 | R | U16 | 0 | 59    | 1 | N/A | Yes |
| <b>Logging – Log time stamp seconds</b> | 5120 | R | U16 | 0 | 59    | 1 | N/A | Yes |
| <b>Logging – CRC</b>                    | 5121 | R | U16 | 0 | 65535 | 1 | N/A | Yes |

## Modbus Functions

The EMX supports the following functions of the Modbus Application Protocol Specification, v1.1b3. Examples are intended to be representative; refer to the full specification for questions or clarification.

### Notes:

- The device address defaults to 247 (0xF7).
- Refer to the Modbus standard for CRC/LRC calculation procedures.

## Data Types

Natively, Modbus holding register functions only support the UINT16 type (2 bytes). The meter constructs additional types from two or more consecutive registers. Client interface software must support the same construction for proper communication:

| # of Registers |   | Range (hexadecimal)                         |
|----------------|---|---------------------------------------------|
| <b>BOOL</b>    | 1 | 0 to 1                                      |
| <b>ENUM</b>    | 1 | 0 to specified upper limit                  |
| <b>UINT8</b>   | 1 | 0 to 255 (0x00FF), unless otherwise noted   |
| <b>UINT16</b>  | 1 | 0 to 65535 (0xFFFF), unless otherwise noted |

|               |   |                                                                      |
|---------------|---|----------------------------------------------------------------------|
| <b>INT16</b>  | 1 | -32768 to -32767 (0xFFFF), unless otherwise noted                    |
| <b>UINT32</b> | 2 | 0 to 4294967295 (0xFFFFFFFF), unless otherwise noted                 |
| <b>UINT64</b> | 4 | 0 to 18.446e+18 (0xFFFFFFFFFFFFFFFF), unless otherwise noted         |
| <b>INT64</b>  | 4 | -9.233e+18 to 9.233e+18 (0xFFFFFFFFFFFFFFFF), unless otherwise noted |

UINT32, UINT64, and INT64 data always occupies two or four registers (4 and 8 bytes) in network byte order (MSB first). Read and write operations should address both registers.

The following examples show UINT32 encodings in a Modbus PDU beginning at byte [n], register [r]:

| Value             | Decimal    | [n]  | [n+1]        | [n+2] | [n+3] |
|-------------------|------------|------|--------------|-------|-------|
| <b>0xAABBCCDD</b> | 2864434397 | 0xAA | 0xBB         | 0xCC  | 0xDD  |
| <b>0x01234567</b> | 19088743   | 0x12 | 0x34         | 0x56  | 0x78  |
| <b>0x00010000</b> | 65536      | 0x00 | 0x01         | 0x00  | 0x00  |
| <b>REGISTER</b>   | <b>[r]</b> |      | <b>[r+1]</b> |       |       |

### 0x03 Read Holding Registers

Returns one or more registers in a contiguous block:

| Request              | Size | Notes                                                            |
|----------------------|------|------------------------------------------------------------------|
| [0] Device Address   | 1    | Always 0x03<br>? = 0 to 65535 (0xFFFF)<br>? = 1 to 125 registers |
| [1] Function Code    | 1    |                                                                  |
| [2] Starting Address | 2    |                                                                  |
| [3] Register Count   | 2    |                                                                  |

|         |   |
|---------|---|
| [4] CRC | 2 |
|---------|---|

Successful reads return the contents of the requested registers:

| Response           | Size  | Notes             |
|--------------------|-------|-------------------|
| [0] Device Address | 1     | Always 0x03 2 * ? |
| [1] Function Code  | 1     |                   |
| [2] Byte Count     | 1     |                   |
| [3] Register Data  | 2 * ? |                   |
| [4] CRC            | 2     |                   |

Example 1: Read the line frequency of  $\Phi A$  (020).

Request = 0x F7 03 00 14 00 01 B1 5B  
                   [0] [1] [2] [3] [4]

Response = 0x F7 03 02 02 59 B1 0B  
                   [0] [1] [2] [3] [4]

[3]  $Frequency = 0x0259 = 601 = 60.1 \text{ (Hz)}$

## 0x04 Read Input Register

Reads one or more read only registers in a contiguous block:

| Request              | Size | Notes                                                            |
|----------------------|------|------------------------------------------------------------------|
| [0] Device Address   | 1    | Always 0x04<br>? = 0 to 65535 (0xFFFF)<br>? = 1 to 125 registers |
| [1] Function Code    | 1    |                                                                  |
| [2] Starting Address | 2    |                                                                  |
| [3] Register Count   | 2    |                                                                  |
|                      |      |                                                                  |





|         |   |  |
|---------|---|--|
| [4] CRC | 2 |  |
|---------|---|--|

Successful writes echo the original request:

| Response             | Size |                       |
|----------------------|------|-----------------------|
| [0] Device Address   | 1    | Always 0x06<br>?<br>? |
| [1] Function Code    | 1    |                       |
| [2] Register Address | 2    |                       |
| [3] Register Value   | 2    |                       |
| [4] CRC              | 2    |                       |

Example 1: Change the phase configuration (2000).

Request = Response = 0x F7 06 07 D0 00 01 5C 11  
                                  [0] [1]    [2]    [3]    [4]

## 0x10 Write Multiple Registers

Writes one or more registers in a contiguous block:

| Request              | Size  | Notes                                                                                     |
|----------------------|-------|-------------------------------------------------------------------------------------------|
| [0] Device Address   | 1     | Always 0x10<br>? = 0 to 65535 (0xFFFF)<br>? = 1 to 123 registers<br>Always 2 * ?<br>? ... |
| [1] Function Code    | 1     |                                                                                           |
| [2] Starting Address | 2     |                                                                                           |
| [3] Write Count      | 2     |                                                                                           |
| [4] Byte Count       | 1     |                                                                                           |
| [5] Write Registers  | 2 * ? |                                                                                           |



|    |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01 | ILLEGAL FUNCTION     | The function code received in the query is not an allowable action for the server (or slave). This may be because the function code is only applicable to newer devices and was not implemented in the unit selected. It could also indicate that the server (or slave) is in the wrong state to process a request of this type, for example because it is unconfigured and is being asked to return register values.                                                                                                                                                                                                                                                                                                                                                                        |
| 02 | ILLEGAL DATA ADDRESS | The data address received in the query is not an allowable address for the server (or slave). More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, the PDU addresses the first register as 0, and the last one as 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 4, then this request will successfully operate (address-wise at least) on registers 96, 97, 98, 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 5, then this request will fail with Exception Code 0x02 “Illegal Data Address” since it attempts to operate on registers 96, 97, 98, 99 and 100, and there is no register with address 100. |
| 03 | ILLEGAL DATA VALUE   | A value contained in the query data field is not an allowable value for server (or slave). This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register.                                                                                                                                                                                                                                                                                                      |

## Data Type Conversions

The following sections provide information on how to convert from the standard U16 registers that Modbus provides into other formats. Some controllers or Modbus interfaces provide these conversions, in which case the user should utilize those methods, instead of the following conversions.

### U16 to I16 Conversion

Conversion from a signed requires checking if the value is value returned (VALUE) is greater than the maximum for a 16-bit integer (32767), if the value is greater than the value 65536 must be subtracted off to calculate a negative value.

If  $VALUE > 32767$

Then:  $VALUE = VALUE - 65536$

Otherwise:  $VALUE = VALUE$  (do nothing)

### **Example:**

Reading register 005 (Real power total) the device responds with 64536. This value is greater than 32767, which means it must be adjusted. By subtracting 65536 we get  $64536 - 65536 = -1000$ , which is the correct value for the real power. Please note that in practice a scale value will need to be determined and applied to this output to get the value into watts or whatever units are applicable.

### **U16 to U32 Conversion**

Conversion from two unsigned 16-bit registers into a 32-bit value can be done by reading the two necessary registers and multiplying the first (lower register address) register by 65536 and adding the second register.

$VALUE = (REGISTER\_LOW * 65536) + REGISTER\_HIGH$

### **Example:**

Reading registers 035 and 036 which together are the system power on time. Register 035 has a value (REGISTER\_LOW) of 6, register 036 (REGISTER\_HIGH) has a value of 38784. Using the calculation we get  $(6 * 65536) + 38784 = 432000$ . This corresponds to the time in seconds that the device has been powered on. 5 Days =  $5 * 24 * 60 * 60 = 432000$  seconds.

### **U16 to U64 Conversion**

Conversion from 4 unsigned 16-bit registers to a 64-bit register is necessary for using the energy accumulators on the EMX. This is done to maintain system accuracy over long operating durations, and to avoid conditions where the energies appear to cease updating. This follows a similar pattern as the U32 conversion. All four registers must be read, preferably simultaneously with a multi-register read operation. The lowest address register is REG\_1, the highest is REG\_4.

$VALUE = REG\_1 * 2^{48} + REG\_2 * 2^{32} + REG\_3 * 2^{16} + REG\_4$  Or without the

power notation

$$\text{VALUE} = \text{REG\_1} * 281,474,976,710,656 + \text{REG\_2} * 4,294,967,296 + \text{REG\_3} * 65536 + \text{REG\_4}$$

**Example:**

Reading registers 093/094/095/096 which corresponds to the Real Import Energy Total (how much energy has been consumed by downstream devices). Register 093 (REG\_1) reads 0, register 094 (REG\_2) reads 13, register 095 (REG\_3) reads 63559 and register 096 (REG\_4) reads 22528.

The calculation is  $0 * 281,474,976,710,656 + 13 * 4,294,967,296 + 63559 * 65536 + 22528 = 60000000000$  when scaled down by the scale of 0.00000001 given in the table it's 600.0 which is the number of Watt Hours of energy that the device has metered at that point.

**U16 to I64 Conversion**

All the net energy registers are signed values. A negative sign indicates that net power has been exported, a positive sign indicates that net power has been imported (consumed). To convert from four U16 registers to an I64 register first perform a conversion as described above. Next perform the following step:

If  $\text{VALUE} > (2^{63}) - 1$

Then  $\text{VALUE} = \text{VALUE} - 2^{64}$

Otherwise  $\text{VALUE} = \text{VALUE}$  (do nothing).

**Appendix D: Hex and ASCII Conversions**

|      |     |       |      |    |   |      |     |   |      |     |   |
|------|-----|-------|------|----|---|------|-----|---|------|-----|---|
| HEX  | DEC | ASCII | 0x41 | 65 | A | 0x83 | 131 | f | 0xC5 | 197 | Å |
| 0x00 | 0   | NULL  | 0x42 | 66 | B | 0x84 | 132 | „ | 0xC6 | 198 | Æ |

|      |   |  |      |    |   |      |     |     |      |     |   |
|------|---|--|------|----|---|------|-----|-----|------|-----|---|
| 0x01 | 1 |  | 0x43 | 67 | C | 0x85 | 133 | ... | 0xC7 | 199 | Ç |
| 0x02 | 2 |  | 0x44 | 68 | D | 0x86 | 134 | †   | 0xC8 | 200 | È |
| 0x03 | 3 |  | 0x45 | 69 | E | 0x87 | 135 | ‡   | 0xC9 | 201 | É |
| 0x04 | 4 |  | 0x46 | 70 | F | 0x88 | 136 | ^   | 0xCA | 202 | Ê |
| 0x05 | 5 |  | 0x47 | 71 | G | 0x89 | 137 | ‰   | 0xCB | 203 | Ë |
| 0x06 | 6 |  | 0x48 | 72 | H | 0x8A | 138 | Š   | 0xCC | 204 | ì |
| 0x07 | 7 |  | 0x49 | 73 | I | 0x8B | 139 | ‹   | 0xCD | 205 | í |
| 0x08 | 8 |  | 0x4A | 74 | J | 0x8C | 140 | Œ   | 0xCE | 206 | î |
| 0x09 | 9 |  | 0x4B | 75 | K | 0x8D | 141 |     | 0xCF | 207 | ï |

|      |    |  |      |    |   |      |     |   |          |             |   |
|------|----|--|------|----|---|------|-----|---|----------|-------------|---|
| 0x0A | 10 |  | 0x4C | 76 | L | 0x8E | 142 | Ž | 0xD<br>0 | 2<br>0<br>8 | Đ |
| 0x0B | 11 |  | 0x4D | 77 | M | 0x8F | 143 |   | 0xD<br>1 | 2<br>0<br>9 | Ñ |
| 0x0C | 12 |  | 0x4E | 78 | N | 0x90 | 144 |   | 0xD<br>2 | 2<br>1<br>0 | Ò |
| 0x0D | 13 |  | 0x4F | 79 | O | 0x91 | 145 | ‘ | 0xD<br>3 | 2<br>1<br>1 | Ó |
| 0x0E | 14 |  | 0x50 | 80 | P | 0x92 | 146 | ’ | 0xD<br>4 | 2<br>1<br>2 | Ô |
| 0x0F | 15 |  | 0x51 | 81 | Q | 0x93 | 147 | “ | 0xD<br>5 | 2<br>1<br>3 | Õ |
| 0x10 | 16 |  | 0x52 | 82 | R | 0x94 | 148 | ” | 0xD<br>6 | 2<br>1<br>4 | Ö |
| 0x11 | 17 |  | 0x53 | 83 | S | 0x95 | 149 | • | 0xD<br>7 | 2<br>1<br>5 | × |
| 0x12 | 18 |  | 0x54 | 84 | T | 0x96 | 150 | — | 0xD<br>8 | 2<br>1<br>6 | Ø |

|      |    |  |      |    |   |      |     |   |          |             |   |
|------|----|--|------|----|---|------|-----|---|----------|-------------|---|
| 0x13 | 19 |  | 0x55 | 85 | U | 0x97 | 151 | — | 0xD<br>9 | 2<br>1<br>7 | Ù |
| 0x14 | 20 |  | 0x56 | 86 | V | 0x98 | 152 | ~ | 0xD<br>A | 2<br>1<br>8 | Ú |
| 0x15 | 21 |  | 0x57 | 87 | W | 0x99 | 153 | ™ | 0xD<br>B | 2<br>1<br>9 | Û |
| 0x16 | 22 |  | 0x58 | 88 | X | 0x9A | 154 | š | 0xD<br>C | 2<br>2<br>0 | Ü |
| 0x17 | 23 |  | 0x59 | 89 | Y | 0x9B | 155 | › | 0xD<br>D | 2<br>2<br>1 | Ý |
| 0x18 | 24 |  | 0x5A | 90 | Z | 0x9C | 156 | œ | 0xD<br>E | 2<br>2<br>2 | Þ |
| 0x19 | 25 |  | 0x5B | 91 | [ | 0x9D | 157 |   | 0xD<br>F | 2<br>2<br>3 | ß |
| 0x1A | 26 |  | 0x5C | 92 | \ | 0x9E | 158 | ž | 0xE<br>0 | 2<br>2<br>4 | à |
| 0x1B | 27 |  | 0x5D | 93 | ] | 0x9F | 159 | ÿ | 0xE<br>1 | 2<br>2<br>5 | á |

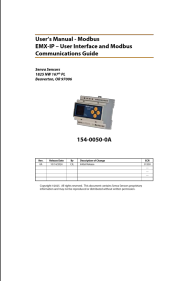


|      |    |    |      |     |   |      |     |   |      |     |   |
|------|----|----|------|-----|---|------|-----|---|------|-----|---|
| 0x1C | 28 |    | 0x5E | 94  | ^ | 0xA0 | 160 |   | 0xE2 | 226 | â |
| 0x1D | 29 |    | 0x5F | 95  | — | 0xA1 | 161 | ı | 0xE3 | 227 | ã |
| 0x1E | 30 |    | 0x60 | 96  | ` | 0xA2 | 162 | ¢ | 0xE4 | 228 | ä |
| 0x1F | 31 |    | 0x61 | 97  | a | 0xA3 | 163 | £ | 0xE5 | 229 | å |
| 0x20 | 32 |    | 0x62 | 98  | b | 0xA4 | 164 | ¤ | 0xE6 | 230 | æ |
| 0x21 | 33 | !  | 0x63 | 99  | c | 0xA5 | 165 | ¥ | 0xE7 | 231 | ç |
| 0x22 | 34 | “  | 0x64 | 100 | d | 0xA6 | 166 | ı | 0xE8 | 232 | è |
| 0x23 | 35 | #  | 0x65 | 101 | e | 0xA7 | 167 | § | 0xE9 | 233 | é |
| 0x24 | 36 | \$ | 0x66 | 102 | f | 0xA8 | 168 | ¨ | 0xEA | 234 | ê |

|      |    |   |      |     |   |      |     |   |          |             |   |
|------|----|---|------|-----|---|------|-----|---|----------|-------------|---|
| 0x25 | 37 | % | 0x67 | 103 | g | 0xA9 | 169 | © | 0xE<br>B | 2<br>3<br>5 | ë |
| 0x26 | 38 | & | 0x68 | 104 | h | 0xAA | 170 | ª | 0xE<br>C | 2<br>3<br>6 | ì |
| 0x27 | 39 | ‘ | 0x69 | 105 | i | 0xAB | 171 | « | 0xE<br>D | 2<br>3<br>7 | í |
| 0x28 | 40 | ( | 0x6A | 106 | j | 0xAC | 172 | ¬ | 0xE<br>E | 2<br>3<br>8 | î |
| 0x29 | 41 | ) | 0x6B | 107 | k | 0xAD | 173 | – | 0xE<br>F | 2<br>3<br>9 | ï |
| 0x2A | 42 | * | 0x6C | 108 | l | 0xAE | 174 | ® | 0xF<br>0 | 2<br>4<br>0 | ð |
| 0x2B | 43 | + | 0x6D | 109 | m | 0xAF | 175 | - | 0xF<br>1 | 2<br>4<br>1 | ñ |
| 0x2C | 44 | , | 0x6E | 110 | n | 0xB0 | 176 | ° | 0xF<br>2 | 2<br>4<br>2 | ò |
| 0x2D | 45 | — | 0x6F | 111 | o | 0xB1 | 177 | ± | 0xF<br>3 | 2<br>4<br>3 | ó |

|      |    |   |      |     |   |      |     |   |      |     |   |
|------|----|---|------|-----|---|------|-----|---|------|-----|---|
| 0x2E | 46 | . | 0x70 | 112 | p | 0xB2 | 178 | ² | 0xF4 | 244 | ô |
| 0x2F | 47 | / | 0x71 | 113 | q | 0xB3 | 179 | ³ | 0xF5 | 245 | õ |
| 0x30 | 48 | 0 | 0x72 | 114 | r | 0xB4 | 180 | ´ | 0xF6 | 246 | ö |
| 0x31 | 49 | 1 | 0x73 | 115 | s | 0xB5 | 181 | µ | 0xF7 | 247 | ÷ |
| 0x32 | 50 | 2 | 0x74 | 116 | t | 0xB6 | 182 | ¶ | 0xF8 | 248 | ø |
| 0x33 | 51 | 3 | 0x75 | 117 | u | 0xB7 | 183 | · | 0xF9 | 249 | ù |
| 0x34 | 52 | 4 | 0x76 | 118 | v | 0xB8 | 184 | ¸ | 0xFA | 250 | ú |
| 0x35 | 53 | 5 | 0x77 | 119 | w | 0xB9 | 185 | ¹ | 0xFB | 251 | û |
| 0x36 | 54 | 6 | 0x78 | 120 | x | 0xBA | 186 | º | 0xFC | 252 | ü |

|            |                 |              |            |            |                     |            |            |                |          |             |   |
|------------|-----------------|--------------|------------|------------|---------------------|------------|------------|----------------|----------|-------------|---|
| 0x37       | 55              | 7            | 0x79       | 121        | y                   | 0xBB       | 187        | »              | 0xF<br>D | 2<br>5<br>3 | ý |
| 0x38       | 56              | 8            | 0x7A       | 122        | z                   | 0xBC       | 188        | ¼              | 0xF<br>E | 2<br>5<br>4 | þ |
| 0x39       | 57              | 9            | 0x7B       | 123        | {                   | 0xBD       | 189        | ½              | 0xF<br>F | 2<br>5<br>5 | ÿ |
| 0x3A       | 58              | :            | 0x7C       | 124        |                     | 0xBE       | 190        | ¾              |          |             |   |
| 0x3B       | 59              | ;            | 0x7D       | 125        | }                   | 0xBF       | 191        | ¿              |          |             |   |
| 0x3C       | 60              | <            | 0x7E       | 126        | ~                   | <b>HEX</b> | <b>DEC</b> | <b>LATIN-1</b> |          |             |   |
| 0x3D       | 61              | =            | 0x7F       | 127        | 0xC0                | 192        | À          |                |          |             |   |
| 0x3E       | 62              | ≥            | <b>HEX</b> | <b>DEC</b> | <b>LATI<br/>N-1</b> | 0xC1       | 193        | Á              |          |             |   |
| 0x3F       | 63              | ?            | 0x80       | 128        | €                   | 0xC2       | 194        | Â              |          |             |   |
| <b>HEX</b> | <b>DE<br/>C</b> | <b>ASCII</b> | 0x81       |            | 129                 | 0xC3       | 195        | Ã              |          |             |   |
| 0x40       | 64              | @            |            | 0x82       | ,130                | 0xC4       | 196        | Ä              |          |             |   |



## SENVA EMX-IP User Interface and Modbus [pdf] User Manual

154-0050-0A, EMX-IP User Interface and Modbus, EMX-IP, User Interface and Modbus, Modbus

## References

- [User Manual](#)

 154-0050-0A, EMX-IP, EMX-IP User Interface and Modbus, ModBus, SENVA, User Interface and

 SENVA    Modbus

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