APPLICATION NOTE: USING SEL-735 METERS WITH TESLA PRODUCTS

Contents

Reference Documents

- SEL (Schweitzer Engineering Laboratories) Content
  - *SEL Web site* -- https://selinc.com/
  - *SEL on YouTube* -- https://www.youtube.com/user/selincvideo

- Tesla Content
  - *SCADA Design Manual* - https://partners.tesla.com/home/en-US/content/download/SCADA_Design_Manual.pdf
  - *Megapack 2 XL Design and Installation Manual* – *https://partners.tesla.com/home/en-US/content/download/Megapack_2_XL_Design_and_Installation_Manual.pdf*
  - *Megapack 2 Design and Installation Manual* – https://partners.tesla.com/home/en-US/content/download/Megapack_2_Design_and_Installation_Manual.pdf
  - *Tesla Industrial Energy Approved Vendor List* – https://partners.tesla.com/home/en-US/content/download/Tesla_IndustrialEnergy_Approved_Vendor_List.pdf

Symbols

This manual uses the following symbols to highlight essential information:

WARNING

Indicates a hazardous situation which, if not avoided, could result in injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor injury or damage to the equipment.

NOTE *Indicates a crucial step or tip that leads to best results but is not safety or damage related.*

1 Overview

Tesla Megapack 2 and Megapack 2 XL systems require a SEL-735 Power Quality and Revenue Meter (SEL-735 meter) that has a TCP/IP network connection to the Tesla System Controller. The SEL-735 meter is used for industrial applications and is the only meter that is supported for projects using Megapack 2 and Megapack 2 XL.

The purpose of this document is to consolidate supplemental information for easy reference when configuring a SEL-735 meter (by Schweitzer Engineering Laboratories) after it has been installed in a Tesla System. This document is not intended to replace guides or manuals for the SEL-735 meter.

For supported hardware, refer to the *Tesla Industrial Energy Approved Vendor List*.

1.1 Why Use the SEL-735 Meter?

C37.118 is the IEEE Standard for Synchrophasor Measurements for Power Systems, which defines a method for exchange of synchronized phasor measurement data between Phasor Measurement Units (PMUs) and other applications or devices. The SEL-735 meter supports the C37.118 protocol, which enables the high-speed measurements of voltage, frequency, and current used by the Tesla System Controller to:

- Calculate power readings for the meter, and
- Comply with voltage and frequency ride-through requirements defined in interconnection agreements.

Additionally, the SEL-735 meter is well established in the power industry and is suitable for both commercial & industrial (C&I) and utility-scale sites.

1.2 Contact and Support

- Schweitzer Engineering Laboratories (SEL)
  - Web Site: https://selinc.com/
  - Tel: 1-509-338-3838
- Tesla
  - Tesla Industrial Storage Support Ticket: https://ion.tesla.com
  - Tel: 1-650-681-6060

2 Specification and Design

2.1 Design Notes

For considerations when provisioning and designing your Tesla system with an SEL-735 meter, refer to the product's *Design and Installation Manual* or contact your Tesla representative.

2.2 Meter Configuration

The meter configuration process occurs prior to commissioning the Tesla System Controller and energized commissioning testing. The customer is responsible for ensuring the meter .rdb configuration file includes the settings described in Section 4: Meter Configuration Settings Description and performing validation steps described in Section 5: Verification.

Upon request, Tesla provides a generic .rdb configuration file that includes the baseline settings needed for the SEL 735 meter to interface with the Tesla System Controller. The generic .rdb configuration file must be reviewed and updated by the customer to ensure it includes correct site-specific settings, such as IP address and instrument transformer ratios. After modifications, the customer must submit the edited .rdb file for Tesla to review. This publication provides descriptions of these baseline configuration settings to be programmed during commissioning. Refer to the *SEL-735 Power Quality and Revenue Meter Instruction Manual* for specific details of individual settings.

2.3 Firmware

The customer is responsible for any firmware upgrades that may be available for the SEL-735 meter, unless the SEL-735 meter is included in the Tesla service agreement. For more information on firmware updates, contact your SEL-735 meter representative or refer to the SEL-735 meter manual on firmware upgrade instructions. Ensure that the SEL-735 meter is updated to the latest firmware version prior to project commissioning.

NOTE *SEL periodically updates firmware. Contact your representative at SEL to ensure you have the latest firmware version.*

3 Connecting and Applying Settings

3.1 Network Protocols

The Tesla System Controller communicates with the SEL-735 using both C37.118 and Modbus TCP protocols. Table 1 shows the measurements that the Tesla System Controller uses for monitoring and control using Modbus TCP and C37.118 protocols.

Table 1: SEL-735 Meter and Tesla System Controller Communications

IEEE C37.118 Protocol	Modbus TCP Protocol
Per-phase voltage	Serial number
Per-phase current	--
Frequency	--
Power (calculated from C37.118 voltage and current)	--
Imported energy	--
Exported energy	--

3.2 Networking Setup Requirements

Set up the network configuration as follows:

- The meters required for operation of the Tesla System should be on the same VLAN as the Tesla System Controller. This is to facilitate effective communication and specifically to avoid issues with routing of C37 UDP communications traffic. See Section 4.3: Configure PMU Session Settings for C37.118 Protocol for more details.
- Network switches should be configured to process data at a message rate of 60 messages per second for C37.118 data streaming on the ethernet port. Refer to the *SCADA Design Manual* for guidance on IP addressing and network bandwidth requirements.
- An open Telnet port is required to allow Tesla personnel to access the meter for configuration and troubleshooting. The Telnet port number may be configured during SEL-735 meter configuration.

NOTE *C37.118 and Modbus protocols are only supported on Ethernet TCP/IP port/connection. Serial RS485 and RS232 protocols are not supported. The SEL-735 meter only supports Multi-Mode Fiber optic or RJ45 connections depending on the model/part number option selected.*

Table 2 shows the ports and protocols that need to be enabled between the meter and the Tesla System Controller.

Table 2: Required SEL-735 Meter Communication Ports

Port Number	Protocol
23 (configurable)	Telnet
502	Modbus TCP
4712	PMU output TCP/IP data port number
4713	PMU output UDP/IP data port number
21	FTP (settings backup/logging)

3.3 Applying Meter Configuration

3.3.1 Connecting Ethernet via Port 1

To configure the SEL-735 meter using the AcSELerator QuickSet software (Quickset) connect a laptop to PORT 1 of the device by either using a standard RJ45 connector or through the network. Alternately, connect a laptop to the serial port on the front panel of the SEL-735 meter using a USB serial cable.

3.3.2 Configuring the QuickSet Software

QuickSet software provides the capability to view, edit, and templatize online or offline meter settings. The SEL-735 meter software solution requires downloading QuickSet to your computer. Communication to the meter is accomplished through a serial or Ethernet port.

Use the link to download the software: https://selinc.com/products/5030/support/#tab-downloads

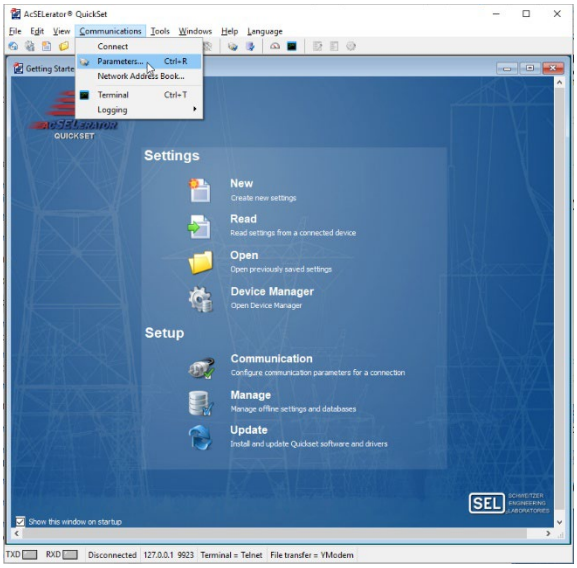
To configure the software:

1. Connect the appropriate communications cable between the SEL-735 meter and your PC.
2. Ensure power is supplied to the SEL-735 meter.
3. Start QuickSet.
4. Select **Communications** from the main menu bar, then select **Parameters.**
5. Configure the PC port to match the meter communications settings.
6. Select "Serial" for serial port connections and "Network" for Ethernet port connections under "Active Connection Type."

If "Network" is selected, your computer must be on the same subnet as the meter.

7. Click **OK** after the proper settings have been filled out to connect to the meter.

Figure 1: Configuring QuickSet

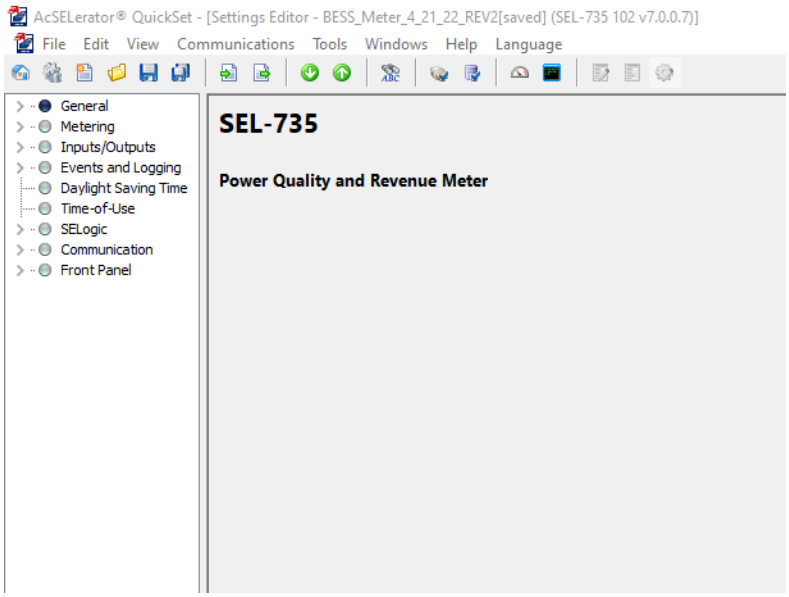


3.3.3 Using Quickset Software to Modify Meter Settings

Perform the following steps to edit the meter settings:

1. Establish network connection to the SEL-735 meter.
2. Read the current settings of the connected device.
3. Browse the explorer window or use the shortcut CTRL + F to find the specific setting you want to change.
4. After changing the setting, send the active settings to the device by uploading an .rdb file.

Figure 2: QuickSet User Interface



3.3.4 Uploading an RDB Settings File to the Meter

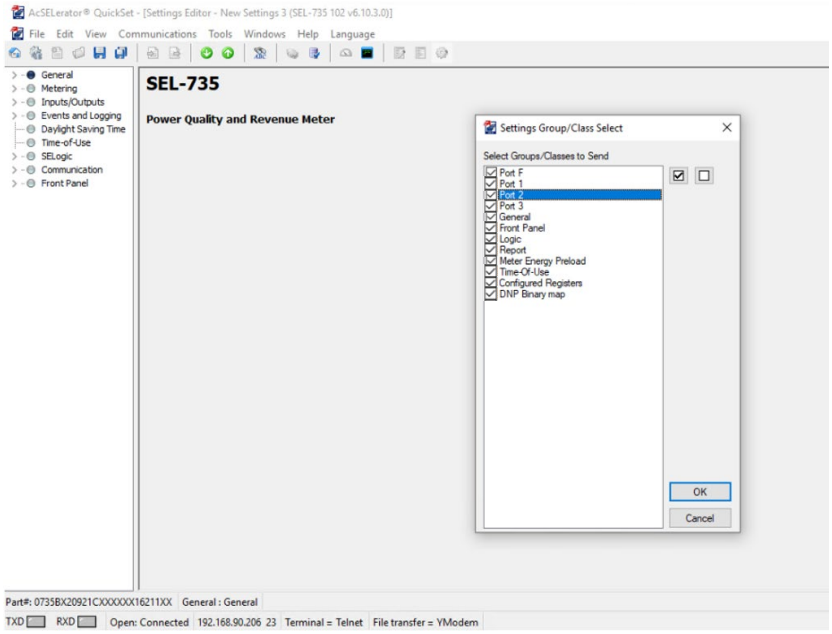
To upload an existing .rdb files containing settings for the SEL-735 meter:

1. Enable communication with the meter through the PC as described in Section 3.3.2: Configuring the Quickset Software.
2. Open the .rdb file you want to upload using the QuickSet software.
3. With the file open, click the **Send active settings** icon in the toolbar. This initiates the upload and asks you to confirm which subset you want to upload. Make sure you know which network settings are set in "Port 1" of your .rdb file before uploading.
4. Click **Select All** and deselect **Port 1** if sending over Ethernet. If sending over Serial front port, deselect **Port F** and upload settings.
5. Once all remaining settings are uploaded, click **Send active settings** again and select only **Port 1** for Ethernet connection and **Port F** for serial and upload settings.

   (**NOTE**: There will be a warning message when port settings are sent. Ignore/accept the warning and proceed with upload).

   The meter **will reboot** when Port 1 settings are uploaded.

Figure 3: Quickset Settings Group/Class Selection



4 Meter Configuration Settings Description

This section describes the specific settings that must be configured on the SEL-735 meter to communicate with the Tesla System Controller.

NOTE *All figures show sample values. Use the values appropriate for the project configuration.*

4.1 SEL-735 Meter Communication Settings

The SEL-735 meter allows a maximum of six simultaneous Ethernet-based connections. The Tesla System Controller requires one PMU connection, one Telnet connection, and 1 Modbus connection at all times. The Tesla System Controller also leverages the FTP connection to retrieve and backup the meter settings to the cloud every 24 hours. Therefore, the maximum number of additional customer connections (Modbus/DNP3) is limited to 2.

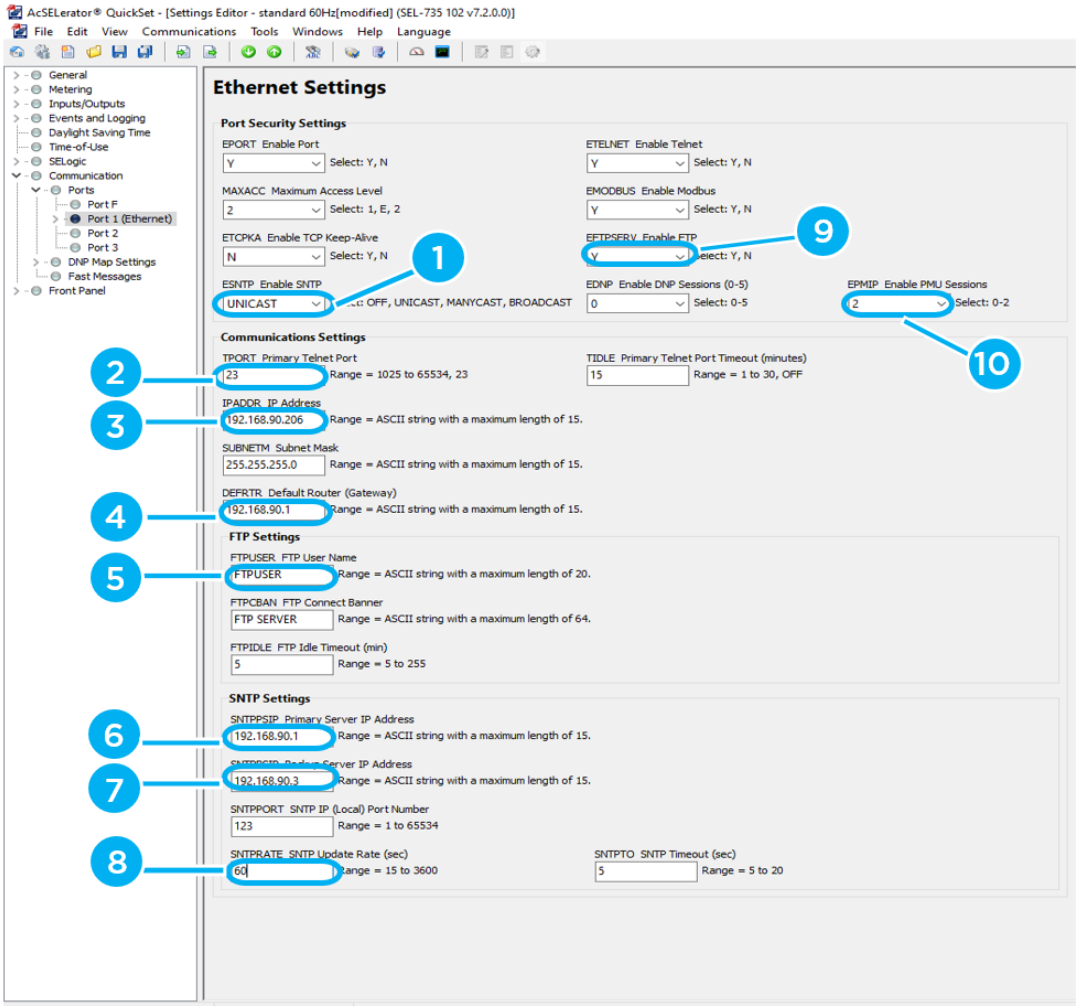
Telnet port number (TPORT) is configurable however only one Telnet connection is allowed at a time to the meter. **The Telnet connection is required by Tesla at all times and must not be used by other applications.**

Update the Port 1 communication setting as identified in Table 3 and Figure 4.

Table 3: Communications Settings

Setting	Value	QuickSet Path
TPORT Primary Telnet Port	23 (Default)	Communications > Ports > Port 1 (Ethernet)
IPADDR IP Address	Site-specific	
SUBNETM Subnet Mask	Site-specific	
DEFRTR Default Router (Gateway)	Site-specific	
EMODBUS Enable Modbus	Y	
EPMIP Enable PMU Sessions	2	
EFTPSERV Enable FTP	Y	

Figure 4: Quickset Ethernet Port Time Synchronization and PMU Settings



1. ESNTP – to enable SNTP
2. TPORT - to select the Telnet port, default 23
3. IPADDR – to set the meter IP address, site specific
4. DEFRTR – default router (gateway), site specific
5. FTPUSER - This is the FTP username. It should be kept as default so Tesla settings management system can periodically request and back up settings.
6. SNTPPSIP – primary SNTP server IP address. Refer to Section: 4.2: Configure Time Synchronization
7. SNTPSSIP – backup SNTP server IP address. Refer to Section 4.2: Configure Time Synchronization
8. SNTPRATE – SNTP update rate. Refer to Section: 4.2: Configure Time Synchronization
9. EFTPSERV - to enable FTP
10. EPMIP – to enable PMU Sessions

4.2 Configure Time Synchronization

Tesla requires that the meters used for operation of the Tesla System be time synchronized (SNTP or IRIG-B) to a source that is aligned with the Tesla System Controller. This is required to facilitate the troubleshooting of operational issues with the Tesla System by comparing the meter's SER logs with the Tesla System Controller's logs.

If CAISO grid event logging is required, reach out to a Tesla representative to confirm additional time synchronization requirements.

To configure the SEL-735 meter as an SNTP client, refer to the settings in Table 4.

Table 4: Time Synchronization Settings

Setting	Value	Description	QuickSet Path
ESNTP ENABLE SNTP	UNICAST	Enable SNTP	Communications > Ports > Port 1 (Ethernet)
SNTPPSIP	Tesla System Controller LAN2 IP address* / GPS clock NTP address	Primary Server IP Address	
SNTPBSIP	Tesla System Controller LAN2 IP address* / GPS clock NTP address	Backup Server IP Address	
SNTPPORT	123 (Default)	SNTP IP (Local) Port Number	
SNTPRATE	15 (Default)	SNTP Update Rate (sec)	
SNTPTO	5 (Default)	SNTP Timeout	

**The Tesla System Controller can function as an SNTP server over its LAN2 ethernet port. Therefore, the meter can only be an SNTP client to the Tesla System Controller when it is connected to the Tesla Network, as defined in the SCADA Design Manual.*

4.3 Configure PMU Session Settings for C37.118 Protocol

The Tesla System Controller requires at least one stream of C37.118 telemetry from the meter. Systems with two Tesla System Controllers configured for automatic failover will require at least one stream of C37.118 telemetry from the meter to each Tesla System Controller.

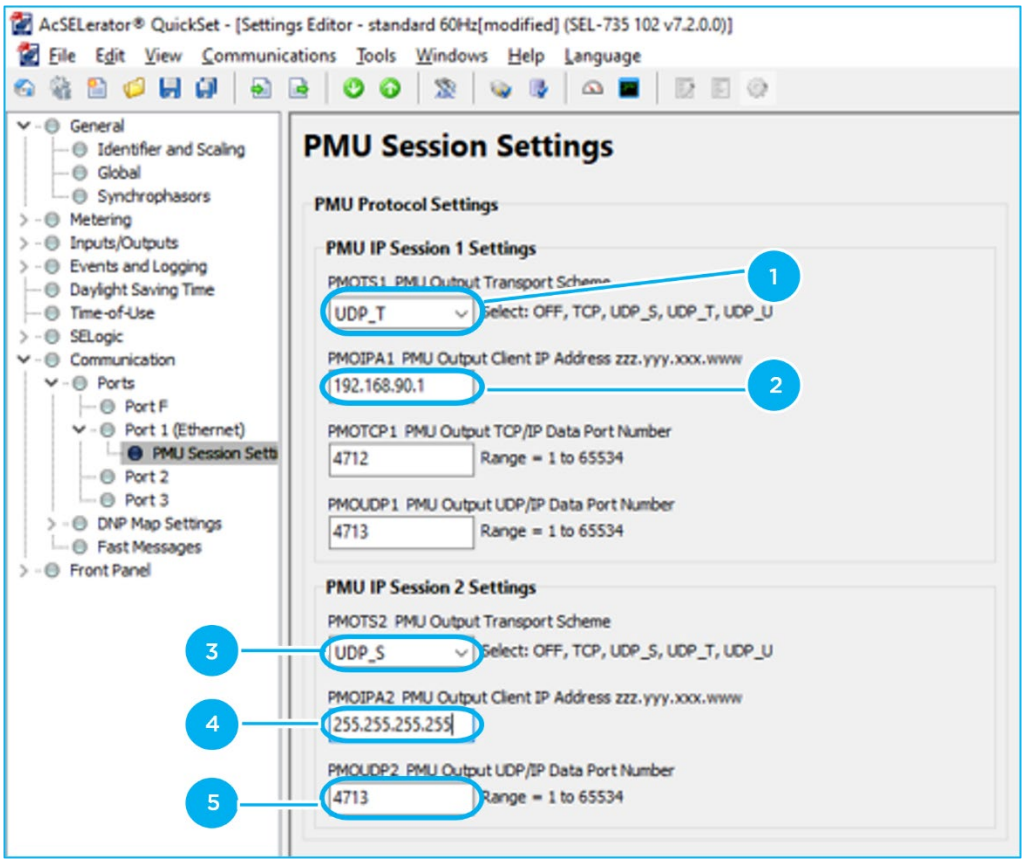
The meter has two PMU sessions to facilitate these communication streams, each of which can be configured for UDP_T or UDP_S traffic to the Tesla System Controller:

- UDP_T is preferred as it has a faster reconnection time after a loss of communication with the Tesla System Controller compared to UDP_S, which can take up to 60 seconds.
- However, UDP_S allows for the simultaneous broadcast of C37.118 telemetry to multiple devices. This traffic is non-routable and therefore only devices on the same VLAN as the meter will be able to receive this telemetry stream.
- Where feasible, it is recommended to configure redundant UDP_S and UDP_T streams to the Tesla System Controller for redundancy, as is shown in Table 5.

Table 5: Example PMU Settings

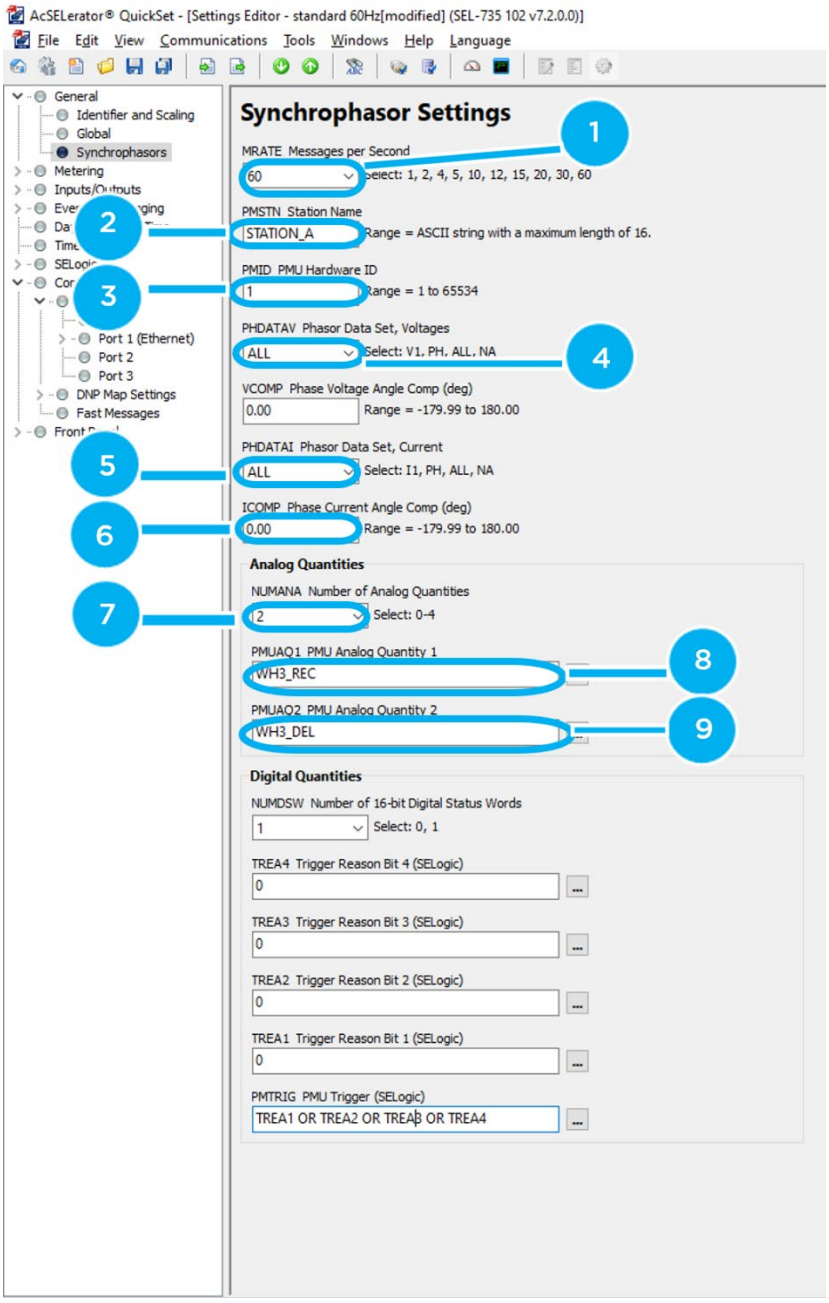
Setting	Value	Description	QuickSet Path
PMOTS1	UDP_T	PMU Output Transport Scheme	Communications > Ports > Port 1 (Ethernet) > PMU Session Settings
PMOIPA1	Tesla System Controller IP address	PMU Output 1 Client IP Address	
PMOTCP1	4712 (Default)	PMU Output TCP/IP Data Port Number	
PMOUDP1	4713 (Default)	PMU Output UDP/IP Data Port Number	
PMOTS2	UDP_S	PMU Output Transport Scheme	
PMOIPA2	Tesla System Controller IP address OR 255.255.255.255 (broadcast IP)	PMU Output 2 Client IP Address	
PMOUDP2	4713	PMU Output UDP/IP Data Port Number	
MRATE	60 - 60 Hz system 50 - 50 Hz system	Messages per second	General > Synchrophasors
PMSTN	STATION A (Default)	Station Name	General > Synchrophasors
PMID	1 (Default)	PMU Hardware ID	
PHDATAV	All	Phasor Data Set, Voltages	
PHDATAI	All	Phasor Data Set, Current	
ICOMP	0	Phase Current Angle Compensation	
NUMANA	2	Number of Analog Quantities	
PMUAQ1	WH3_REC	PMU Analog Quantity 1	
PMUAQ2	WH3_DEL	PMU Analog Quantity 2	

Figure 5: Quickset PMU Session Settings



1. PMOTS1 (Primary PMU session Output Transport Scheme).
2. PMOIPA1 (Tesla System Controller IP address)
3. PMOTS2 (Second PMU session Output Transport Scheme)
4. PMOIPA2 (PMU Output Client IP Address)
5. PMOUDP2 (PMU UDP/IP Port Number

Figure 6: Synchrophasor Settings



1. MRATE
2. PMSTN Station Name
3. PMID
4. PHDATAV
5. PHDATAI
6. ICOMP
7. NUMANA
8. PMUAQ1
9. PMUAQ2

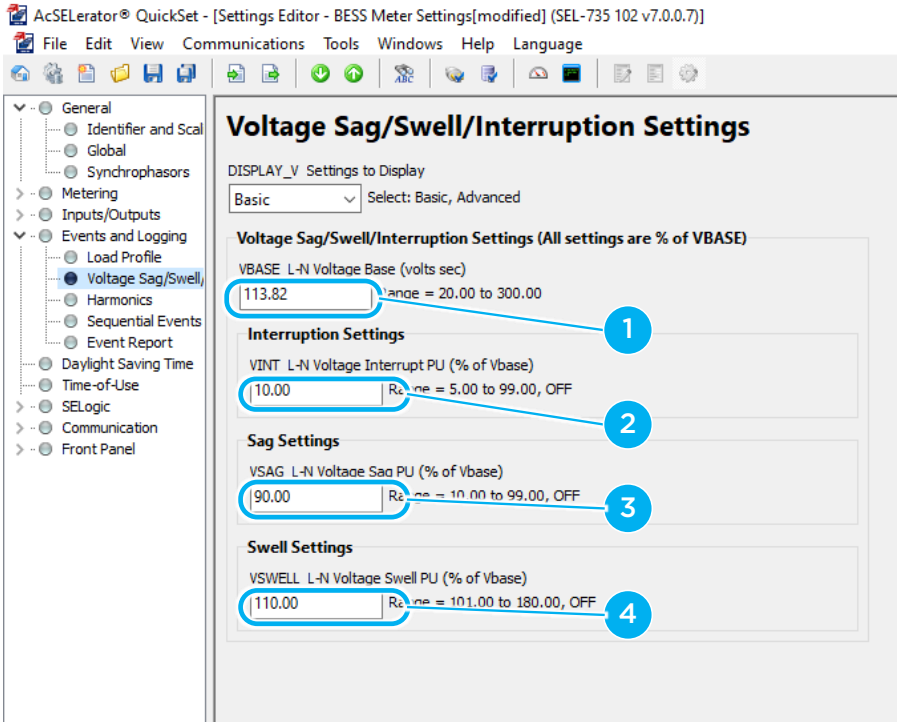
4.4 Configure Voltage Base

Configure the voltage base settings as described in Table 6.

Table 6: Voltage Base Settings

Setting	Value	Description	QuickSet Path
VBASE L-N Voltage Base	Site-specific	Set this VBASE value to match the expected nominal voltage value of the system at the secondary of the PTs.	Events and Logging > Voltage Sag/Swell/ Interruption
VINT L-N	10 (default)	Voltage Interrupt PU (% of Vbase)	
VSAG L-N	90 (default)	Voltage Sag PU (% of Vbase)	
VSWELL L-N	110 (default)	Voltage Swell PU (% of Vbase)	

Figure 7: Voltage Sag/Swell/Interruption Settings



1. VBASE
2. VINT
3. VSAG
4. VSWELL

4.5 Configure Identifier and Scaling Settings

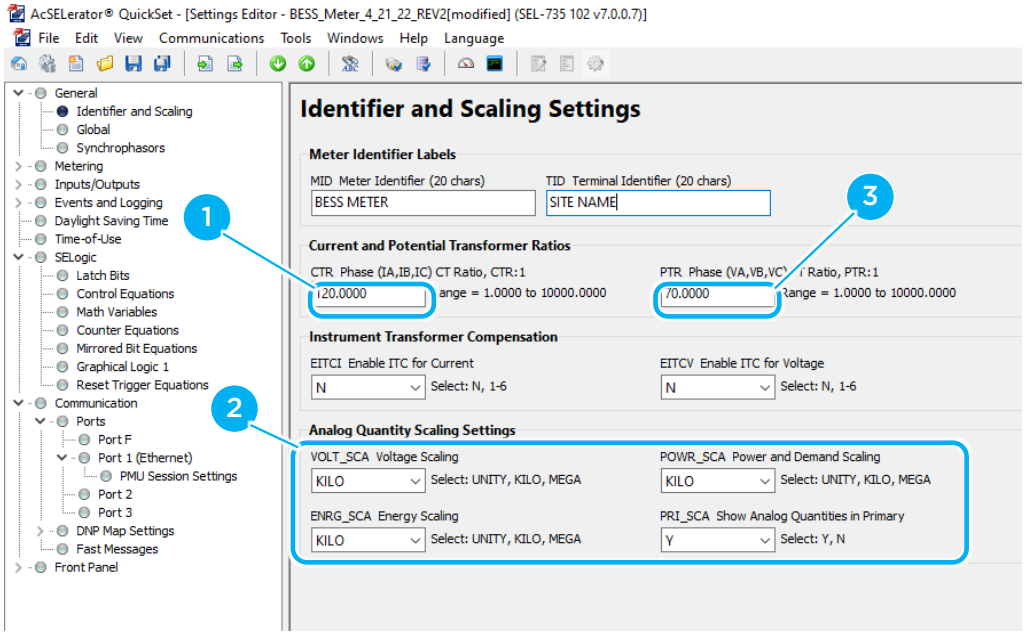
Configure the voltage base as described in Table 7.

Figure 8 shows the fields used for the Table 7 values.

Table 7: Identifier and Scaling Settings

Setting	Value	Notes	QuickSet Path
CTR Phase (IA, IB, IC) CT Ratio	Site-specific	Current Transformer Ratio	General > Identifier and Scaling Settings
PTR Phase (VA, VB, VC) CT Ratio	Site-specific	Potential Transformer Ratio	
VOLT_SCA	Site-specific	Voltage scaling, Default setting = KILO	
POWR_SCA	Site-specific	Power and demand scaling, Default setting = KILO	
ENRG_SCA	Site-specific	Energy Scaling, Default setting = KILO	
PRI_SCA	Y	Analog quantity scaling - KILO	

Figure 8: Quickset Identifier and Scaling Settings



1. CT Ratio
2. Analog Quantity Scaling Settings
3. PT Ratio

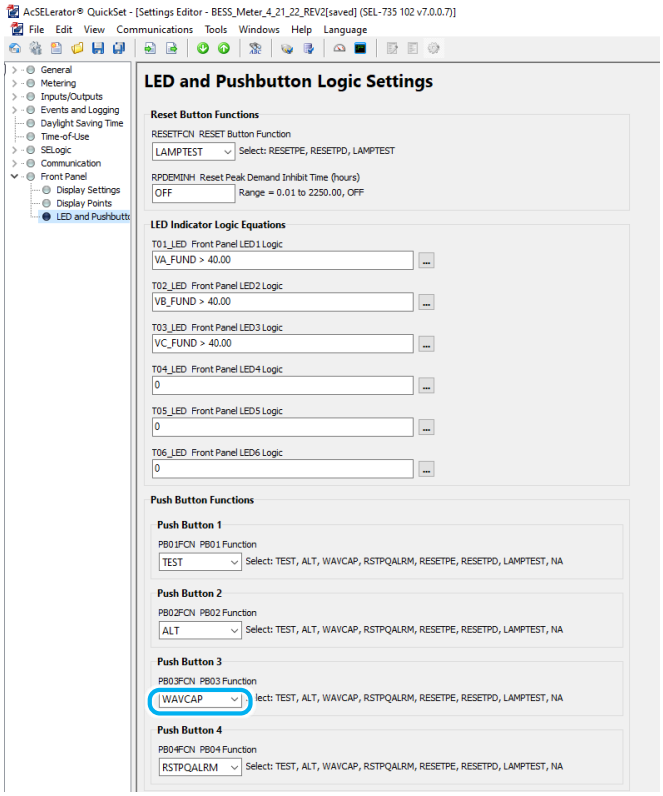
4.5.1 Configure Waveform Event Capture Settings

Configure the event report settings as described in Table 8.
Figure 9 and Figure 10 show the fields used for the Table 8 values.

Table 8: Event Report Settings

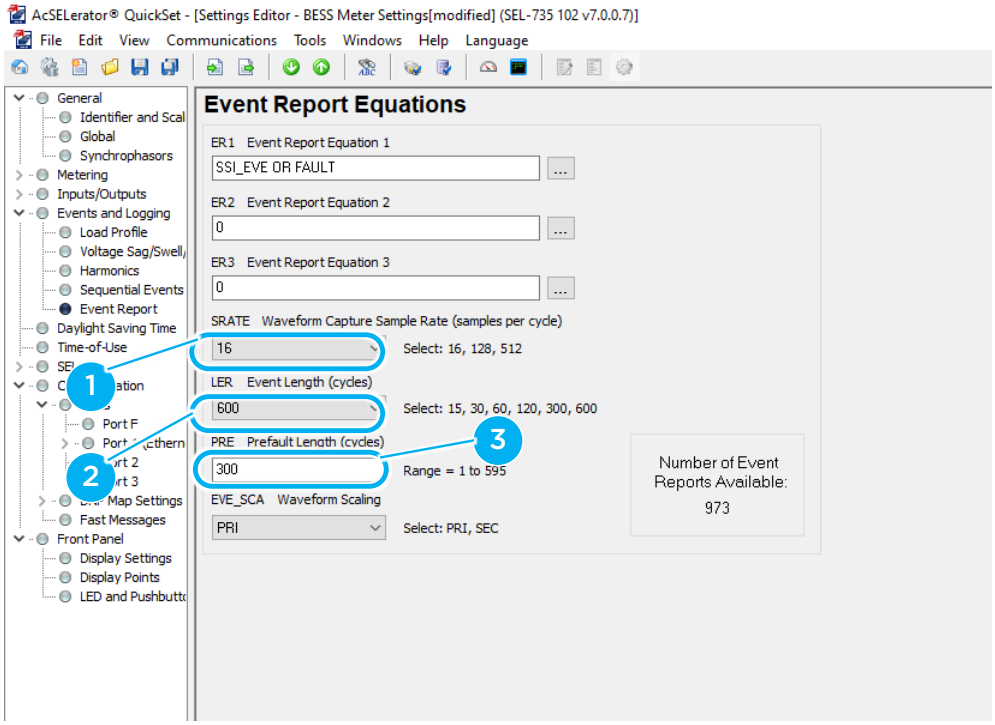
Setting	Value	Description	QuickSet Path
PB03FCN	WAVCAP (Default)	Pushbutton 3 function	Front Panel > LED and Pushbutton
SRATE	16 or 128	The appropriate SRATE depends on project-specific response time requirements. For most projects 16 samples/cycle is sufficient.	Events and Logging > Event Report
LER	600	Set event length to 600 cycles (10 seconds).	
PRE	300	Set Prefault Length to 300 cycles (5 seconds). This may need to be adjusted depending on your network latency.	

Figure 9: Quickset LED and Pushbutton Logic Settings



PB03FCN (Pushbutton 2 Function)

Figure 10: Quickset Event Report Equations



1. SRATE (Waveform Capture Sample Rate)
2. LER (Even Length)
3. PRE (Prefault Length)

4.6 Optional Configuration for UL 1741 PCS Abnormal Conditions

If the Megapack installation uses the UL 1741 PCS (non-export) certification, the meter must be configured to detect CT and voltage sense abnormal conditions. When these abnormal conditions are detected, the Megapack system turns off.

4.6.1 Configure Event Report Settings

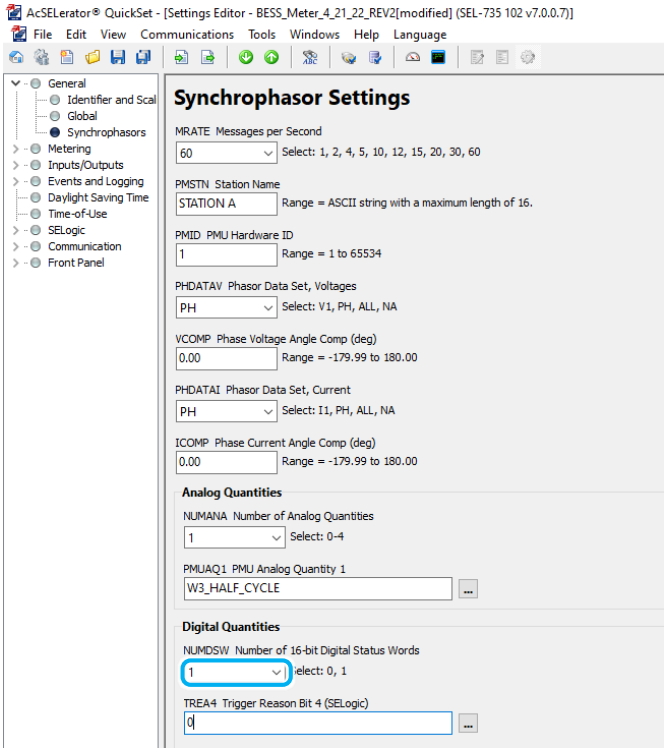
Configure the event report settings described in Table 9.

Figure 11 shows the fields used for the Table 9 value.

Table 9: Event Report Settings

Setting	Value	Description	QuickSet Path
NUMDSW	1	Number of 16-bit digital status words	General > Synchrophasors > Digital Quantities

Figure 11. Synchrophasor Digital Quantities



NUMDSW (Number of 16-bit Digital Status Words)

4.6.2 Configure SELogic

Configure the settings under SELogic with the equations shown in Table 10 and Table 11, and the values in Table 12.

Table 10: Required Math Variables

Variable Name	Equation
MV01	VA / MV04
MV02	VB / MV04
MV03	VC / MV04
MV04	Use same value as VBASE

Table 11: Required Control Equations

Variable Name	Equation	SV_ Timer Pickup	SV_ Timer Dropout
SV01	IA < 0.01	0.000	0.000
SV02	IB < 0.01	0.000	0.000
SV03	IC < 0.01	0.000	0.000
SV04	NOT SV01T OR NOT SV02T OR NOT SV03T	0.000	0.000
SV05	SV01T AND SV04T	86400.000	0.000
SV06	SV13T	0.000	0.000
SV07	LT01 OR LT02 OR LT03	0.000	0.000
SV08	SV02T AND SV04T	86400.000	0.000
SV09	SV03T AND SV04T	86400.000	0.000
SV10	-	-	-
SV11	MV01 < 0.13 OR MV02 < 0.13 OR MV03 < 0.13	0.000	0.000
SV12	MV01 > 0.5 OR MV02 > 0.5 OR MV03 > 0.5	0.000	0.000
SV13	SV11 AND SV12	20.000	0.000

Table 12: Latch Bits

Variable Name	SET	RST
01	SV05T	NOT SV01
02	SV08T	NOT SV02
03	SV09T	NOT SV03

5 Verification

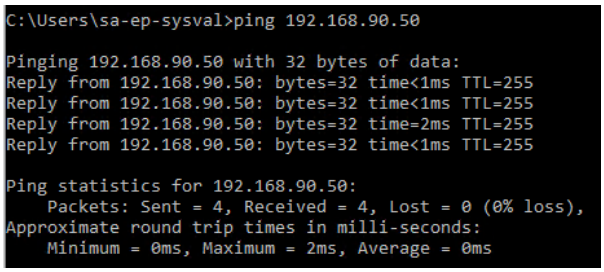
This section describes steps to validate that the SEL-735 meter has been configured correctly and to test communications between the meter and the Tesla System Controller.

5.1 Communication Network Installation

To verify network connectivity for Tesla integration, connect the meter to a computer on the same subnet as the SEL-735 meter as follows:

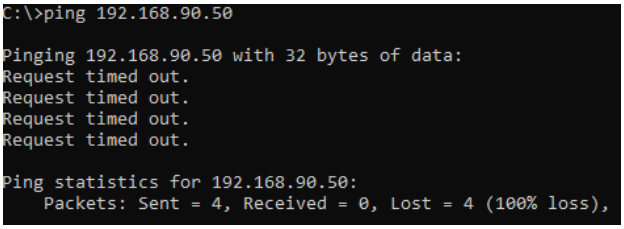
1. Confirm that you can ping the meter at the specific IP address. Open the Command Prompt (cmd) window and type **ping <ip_address_of_sel_735>**.
    a. The IPv4 settings are correct if the cmd window returns the correct IP address for the SEL-735 meter.

Figure 12: Testing IPv4 Settings on the Command Line



    b. If a request timeout occurs:
        i. Confirm that your computer network settings are on the same subnet as the SEL-735 meter.
        ii. Confirm that the network settings of the SEL-735 meter are what you expected.
        iii. Ensure EPORT is set to Y, which is the raw value of the setting.

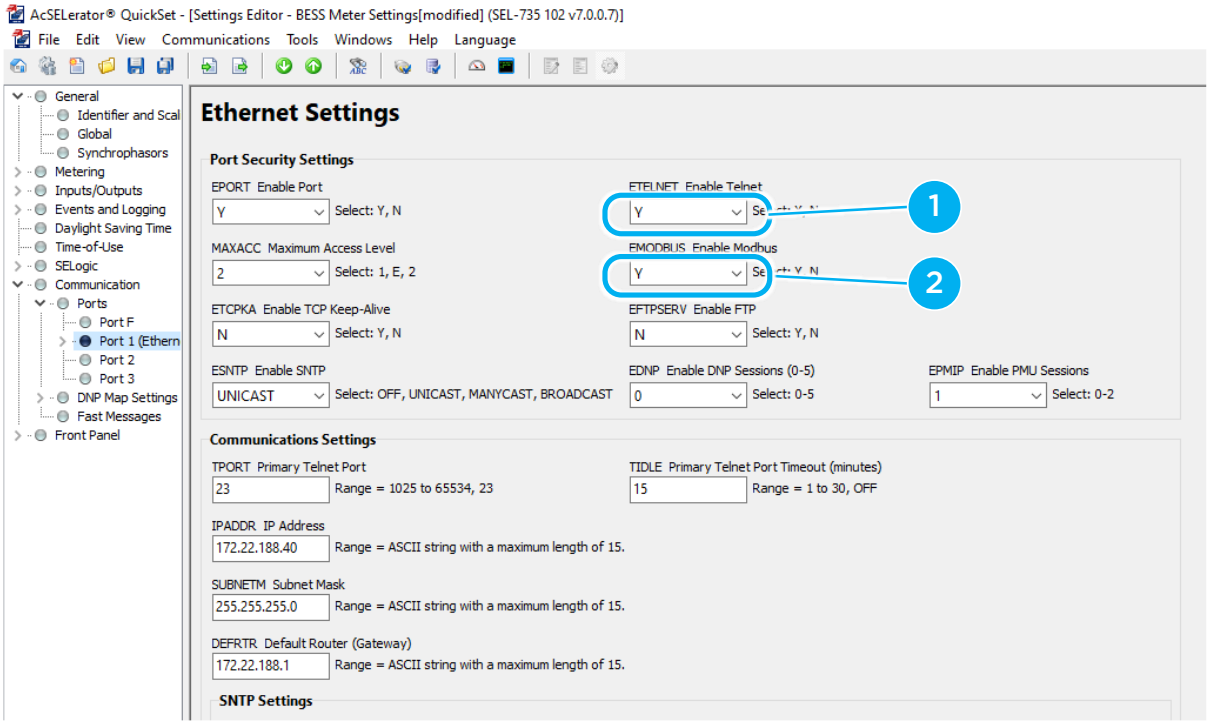
Figure 13: Troubleshooting Request Timeout



2. To confirm the Telnet connection is enabled, connect to the meter with Quickset software, and open the terminal window. If Telnet is not enabled, the terminal window cannot be opened.
    a. Ensure the assigned Telnet port is open on the network.
    b. If Telnet is not enabled, ensure ETELNET is set to Y.

3. Confirm Modbus is enabled.
    a. Check that EMODBUS is set to Y.
    b. Ensure port 502 is open on the network.

Figure 14: ETELNET and EMODBUS Settings



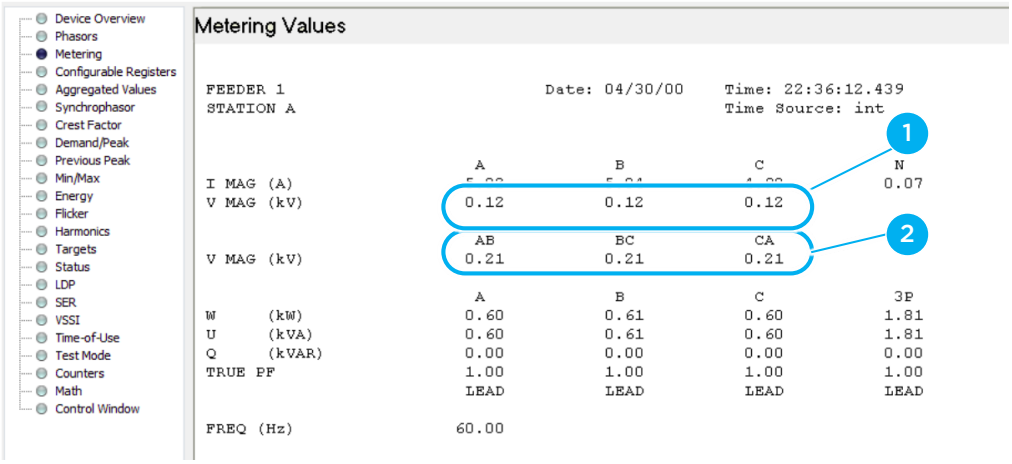
1. ETELNET
2. EMODBUS

5.2 PT Voltage Verification

With grid power available, use the AcSELerator Quickset HMI to verify:

1. Independently metered grid voltages and SEL-735 line voltages on the HMI are equal:
    a. VAB/ VA
    b. VBC/ VB
    c. VCA/ VC

Figure 15: HMI Metering Values



1. HMI Line-to-neutral voltages (VA, VB, VC)
2. HMI Line-to-line voltages (VAB, VBC, VCA)

2. If there are multiple meters on the same bus or feeder, confirm independently metered voltages and the SEL-735 voltage on the HMI are equal.

5.3 CT Polarity Verification

The polarity of a CT is determined by the direction of the coils, which are arranged around the core of the CT (clockwise or counterclockwise). An incorrect CT polarity and power flow sign convention can result in an inadvertent power excursion during initial site energization. The customer and installation contractor are responsible for verifying that CT polarity supports the power flow according to the guidance in the meter design sections in the relevant *Design and Installation Manual*.

5.4 Phase Rotation

The phase rotation (PHROT) defines an installed phase standard in the SEL-735 meter.

- Set PHROT to "ABC" when B-Phase lags A-Phase by 120 degrees.
- Set PHROT to "ACB" when B-Phase leads A-Phase by 120 degrees.

Figure 16. Phase Rotation Definition

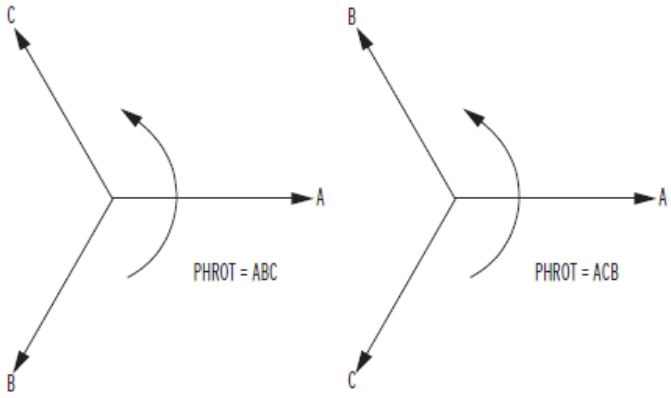
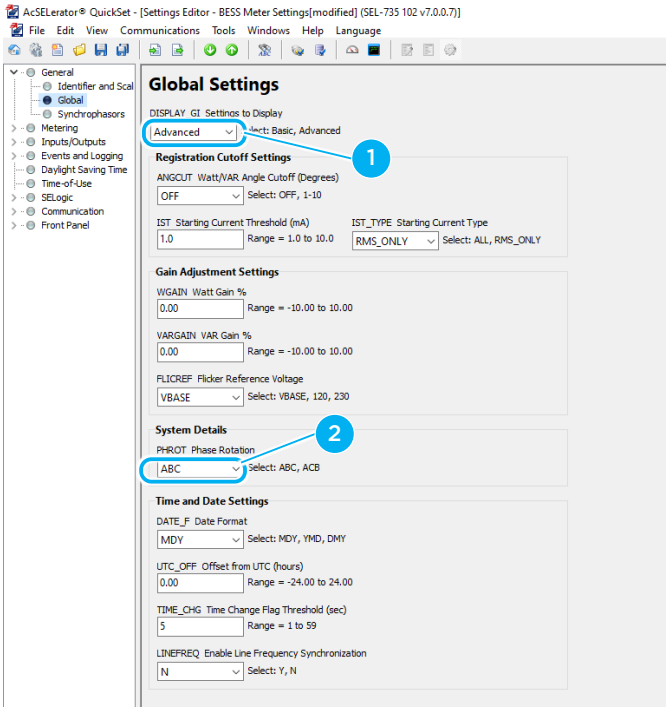


Figure 17: Phase Rotation Global Setting

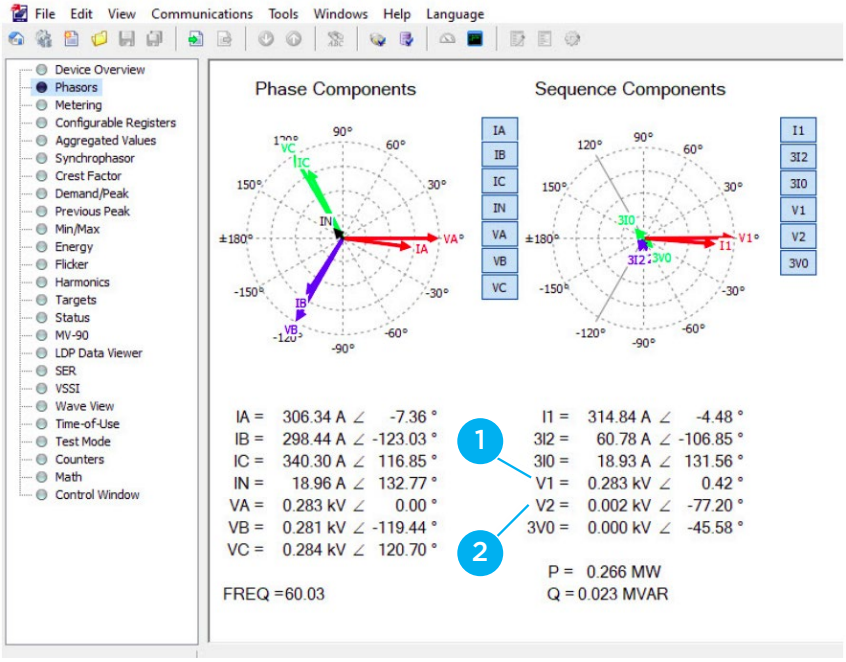


1. Display_GI Settings display option (Select Advanced)
2. PROT Phase Rotation (PHROT)

Ensure the PHROT is set correctly in the meter by checking the metering values, specifically positive (V1) and negative (V2) sequence voltages. High negative-sequence voltage along with very low positive-sequence quantities indicate an incorrect phase rotation setting in the meter.

1. If V2 > V1, change the setting of PHROT to match site conditions.
2. Check to ensure V1 is much greater than V2.

Figure 18: HMI Positive and Negative Sequence Voltage



1. Positive sequence voltage (V1)
2. Negative sequence voltage (V2)

6 Event Waveform Capture and Review

6.1 Initiate Event Waveform Capture

Perform the following steps to manually trigger an event waveform capture:

1. Ensure 10 second waveform capture is configured using the Quickset software.
2. Use either Option 1 or Option 2 to initiate an event waveform capture. To manually trigger a waveform event capture use option 1. To automatically trigger a waveform event capture based on a defined criterion, use option 2.
    a. **Option 1**: Concurrent with sending a real power command to the Tesla System Controller, press the waveform button to trigger a 10 second waveform capture.

Figure 19: Waveform Capture Pushbutton

Waveform capture pushbutton

    b. **Option 2**: Set a trigger to automatically capture an event report when phase current exceeds a specified value during power command. Event Report Equation 2 must be set to trigger on the rising edge of latch bit SET01. Latch bit SET01 changes state when phase current rises above the specified value.

    NOTE: The current and power measurements used by event equations are raw values and reflect the secondary current. Therefore, the trigger conditions should be scaled accordingly.

To establish the event report trigger conditions:

1. Set SET01 to current trigger for Phase A.
2. Set RST01 to < 0.
3. Set ER2 (Event Report Equation 2) to R_TRIG SET01.

Refer to Figure 20 and Figure 21 for example latch bit settings and event report equations.

Figure 20: Latch Bit Settings

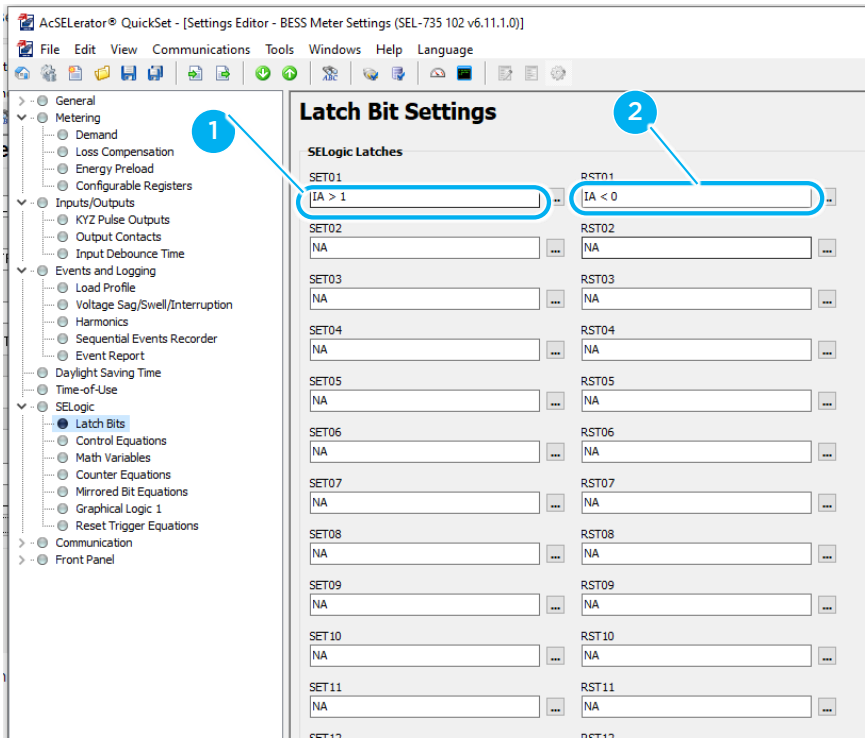
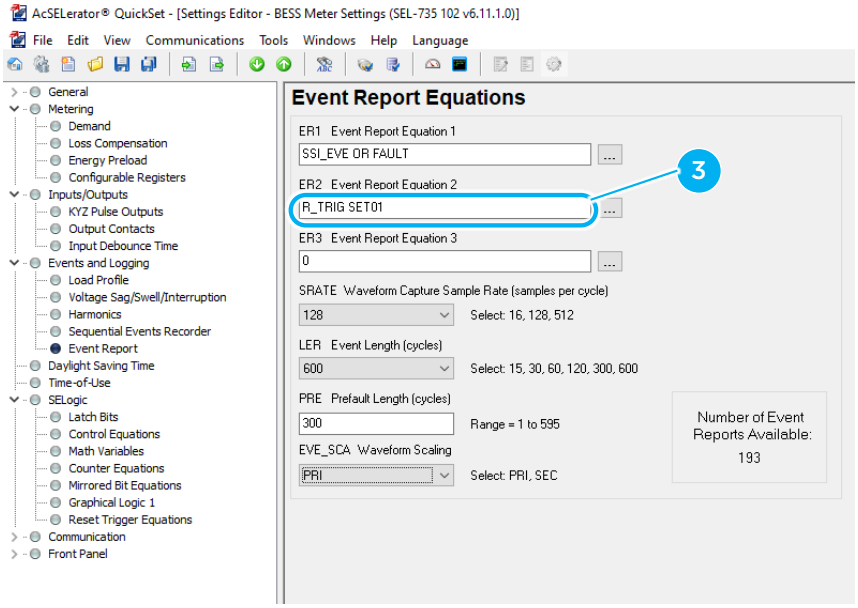


Figure 21: Event Report Equations



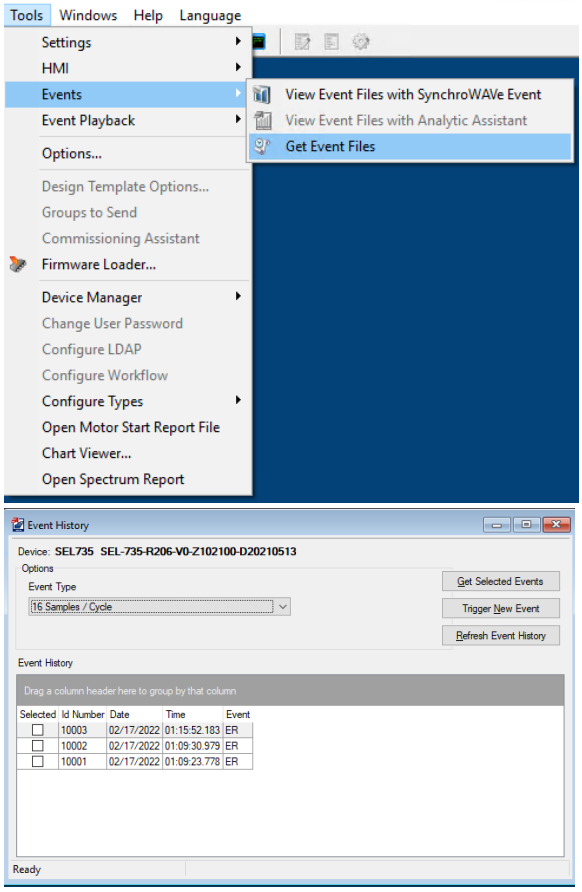
1. SET01
2. RST01
3. ER2 (Event Report Equation 2).

6.2 Calculating Response Time using Waveform Data

Plot real power (MW) output from even waveform data and calculate the response time of a transient as follows:

1. Retrieve events via **Tools** > **Events** > **Get Event Files** from the Quickset toolbar.

Figure 22: Download Event Report File

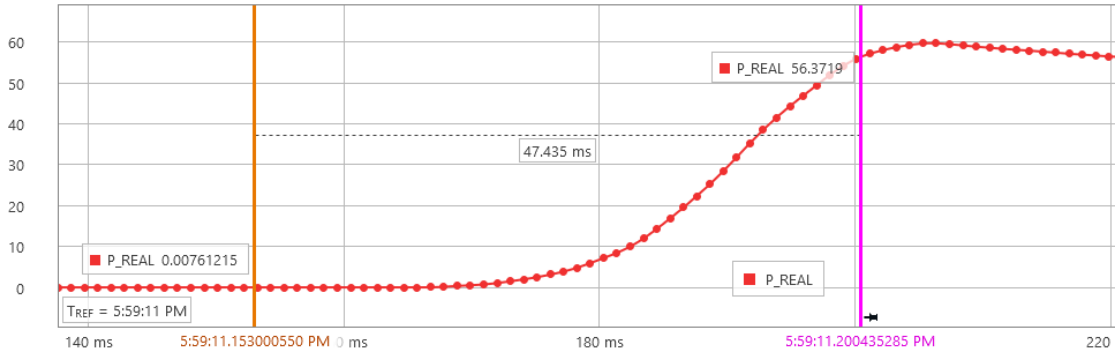


2. Export the event report file and open in the SEL-735 meter SynchroWAV software.
3. Select New Calculation.
4. Calculate the real power output in MW using the following formula:

```
P_REAL=(VA.Mag*IA.Mag*COS(VA.Ang-IA.Ang)+VB.Mag*IB.Mag*COS(VB.Ang-
IB.ANG)+VC.Mag*IC.Mag*COS(VC.Ang-IC.Ang))*0.000001
```

5. Plot P_REAL and align the time markers to appropriate points to measure response time.

Figure 23: Response Time Plot in SynchroWAV Software



Revision History

Revision	Date	Description
1.4	October 23, 2024	• Revised and clarified guidance in Section 4.2: Configure Time Synchronization • Revised and clarified guidance on C37.118 communications in Section 4.3: Configure PMU Session Settings for C37.118 Protocol • Removed meter design information into the *Megapack 2 XL Design and Installation Manual*
1.3	February 29, 2024	• Updated the requirements for advanced meters. • Updated the Intermediate Form 5 and Form 9- part numbers. • Updated Sections 4.1, 4.2, and 4.3 with additional details. • Updates include better information on CT wiring, networking requirements related to VLANs, protocol limitations, additional PMU configuration and analog value parameters.
1.2	May 18, 2023	• Added PT Forms 5 and 9; also added corresponding footnote regarding requirement for compliance with UL 1741 PCS. • Added required PT and CT values. • Added warning for importance of meter installation with a correct polarity in section 5.3 CT Polarity Verification.
1.1	April 27, 2023	• Changed terminology to Tesla System Controller from Tesla Site Controller. • Updated Figure 4 and Figure 5.
1.0	February 10, 2023	Initial Revision.