User Manual

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PACSystems™ RX3i

POWER SYNC AND MEASUREMENT SYSTEM
USER MANUAL

Contents

Warnings, Caution Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury to exist in this equipment or may be associated with its use.
In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Notes: Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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Chapter 1: PSM Module Description and Specifications

The Power Sync and Measurement (PSM) system monitors two independent three-phase power grids. It incorporates advanced digital signal processor (DSP) technology to continuously process three voltage inputs and four current inputs for each grid.

Measurements include RMS voltages, RMS currents, RMS power, frequency, and phase relationship between the phase voltages of both grids.

The PSM module performs calculations on each captured waveform, with the DSP processing the data in less than two-thirds of a power line cycle. The PSM module can be used with wye or delta type three-phase power systems or with single-phase power systems.

The PSM system can be used for applications such as:

- Electrical power consumption monitoring and reporting
- Fault monitoring
- Generator control features for generator to power grid synchronization
- Demand penalty cost reduction/load shedding

The PSM system consists of:

- **PSM module** – A standard IC694 module that mounts in an RX3i main rack. The PSM module provides the DSP capability.
- **Terminal Assembly** – A panel-mounted unit that provides the interface between the PSM module and the input transformers.
- **Interface cables** – Provide the GRID 1 and GRID 2 connections between the PSM module and the Terminal Assembly.

1.1 PSM System Features

- Uses standard, user-supplied current transformers (CTs) and potential transformers (PTs) as its input devices.
- Accurately measures RMS voltage and current, power, power factor, frequency, energy, and total, three-phase, 15-minute power demand.
- Provides two isolated relays that close when the voltage phase relationships between the two monitored grids are within the specified ANSI 25 limits provided by the RX3i host controller. These contacts can be used for general-purpose, lamp duty or pilot duty loads. Voltage and current ratings for these load types are provided on page 5.
- Provides a cable monitoring function that indicates when the cables linking the PSM module and Terminal Assembly are correctly installed.
- Can be easily calibrated using the PAC™ Machine Edition software to enter calibration constants for the PSM module and Terminal Assembly.

- The PSM001 module supports hot swap (removal and replacement in an RX3i rack that is under power).

1.2 PSM Module

In addition to configuring the PSM module upon project download from PME, the RX3i CPU can control the PSM module by updating configuration data from the RX3i in the form of %AQ data words and %Q mode control bits during each sweep.

The PSM module provides calculated data to the CPU in the form of %AI data words and %I status bits each sweep. The information sent by the PSM module includes power system measurements and discrete fault status.

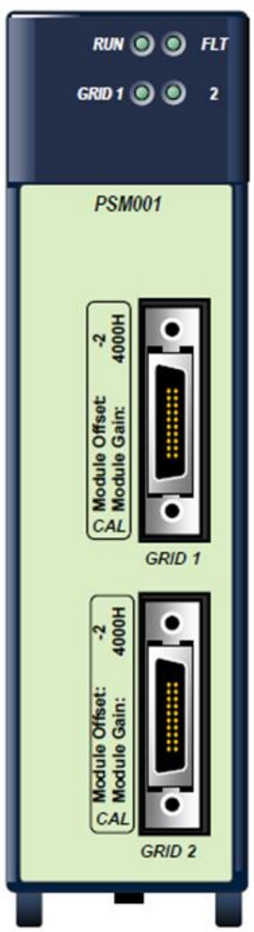
Connectors

The PSM module provides two Mini-D 20-pin connectors that accept the GRID 1 and GRID 2 voltage and current signals from the Terminal Assembly.

Indicators

Four LEDs provide status indications for the PSM system.

Figure 1



RUN	Green	The module is operating correctly and communicating with the RX3i.
	Red	The module is operating without backplane communication.
	Off	The module is not operating.
FLT	Green, blinking	During the period when GREEN is ON, Grid 2 can be connected to Grid 1.
	Green, steady	Grid 1 and Grid 2 can be connected and there are no faults.
	Red	The module has detected a fault condition.
	Off	The module has not detected a fault and the grids are not synchronized.
GRID 1	Green	Indicates a voltage signal has been detected on Grid 1.
	Red	A frequency out-of-range condition has been detected on Grid 1.
	Off	No zero-crossing signal of Grid 1 has been detected during the last 250 ms time period.
GRID 2	Green	Indicates a voltage signal has been detected on Grid 2
	Red	A frequency out-of-range condition has been detected on Grid 2.
	Off	No zero-crossing signal of Grid 2 has been detected during the last 250 ms time period.

1.3 Terminal Assembly

The Terminal Assembly accepts three voltage inputs and four current inputs for each of two grids. The Terminal Assembly translates the 0–5 A current signals and the 45–690 VAC RMS voltage signals to low voltage signals for use by the PSM module.

Voltage inputs are connected through external, user-supplied potential transformers (PT). External, appropriately-sized current transformers (CT) are used to translate grid or load currents down to the 0–5 A range required by the Terminal Assembly.

1.4 Connectors

The Terminal Assembly provides two terminal blocks, each with 12 screw terminals, for the voltage and current inputs from the grids. The terminals accept up to 10 AWG wire commonly used in power utility applications.

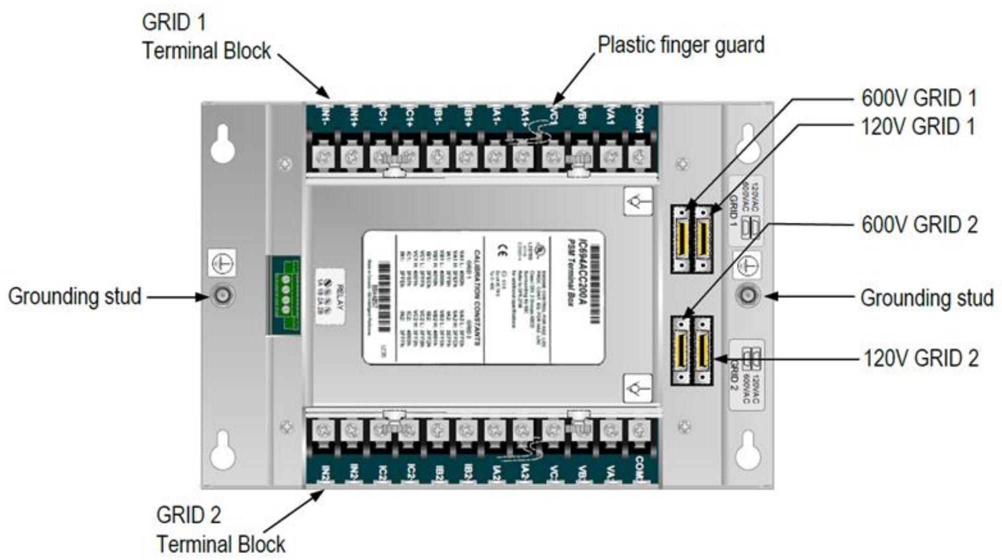
The Terminal Assembly provides two pairs of Mini-D 20-pin connectors for connection to the PSM module using the interface cables. The 45–120 VAC or 120–690 VAC range is selected by connecting the interface cables to the corresponding pair of Mini-D connectors.

When the cables are connected to the correct grid and matching voltage ranges, the PSM module provides an indication that the cables are correctly attached to the unit.

A four-pin pluggable connector provides two isolated solid-state relay contacts that close when the correct voltage, phase, and relative frequency differences match the configured criteria for synchronization of the GRID1 and GRID2 signals

Note: *The Terminal Assembly is not equipped with CT shorting-bars. These must be provided separately by the user.*

Figure 2



1.5 User-Supplied Equipment

The user must supply the following components depending upon the application. This equipment includes:

- Current transformers, 5 Amps
- Potential transformers
- Fuses (1 Amp each) for each voltage lead connected to the Terminal Assembly.
- A fuse (1 Amp) for the common or return line for the voltage lead on the Terminal Assembly.
- A CT shorting block for each current transformer (CT) connection used on the Terminal Assembly when used with external CTs.

1.6 PSM Part Numbers

Part Number	Description
IC694PSK001	PSM System. Includes a PSM module, a Terminal Assembly and two interface cables
IC694PSM001	Replacement PSM module
IC694ACC200	Replacement Terminal Assembly

Part Number	Description
IC694CBL200	One replacement 2m (6.56 ft.) interface cable
IC694ACC201	PSM replacement parts: two finger guards four thumb screws one relay connector two grounding lug nuts

1.7 Specifications

PSM Module Power Requirements	
Backplane Power Consumption	400 mA max. at 5 VDC
Total Power Dissipation	2.0 W max.
Isolation from Backplane	1500 VDC
Host Controller Compatibility	
RX3i CPUs	For specific versions supported, refer to "Functional Compatibility" in the Important Product Information document, GFK-2748.
Maximum number of PSM modules per RX3i system	No restrictions, as long as the power supply has sufficient capacity
Sync Relay contacts	
Two isolated relay outputs	General purpose: 125 VAC / 125 VDC maximum at 1 amp Lamp duty: 125 VAC / 125 VDC maximum at 1 amp Pilot duty: 125 VAC / 125 VDC maximum at 0.35 amp
Switching speeds	
Turn-on time	20ms
Turn-off time	5ms
Measurement Specifications	
Three voltage inputs per grid	All voltage data is scaled in 0.1 VAC units.
Impedance	>1 MΩ
Range Low range High range	 45–150 VAC RMS (120VAC nominal) 120–690 VAC RMS (600VAC CAT IV; 690 VAC CAT III)
Frequency	40–70 Hz
Four current inputs per grid	All current data is scaled in 0.001 Amp units.
Impedance	<5 milliohms
Range	0–5 A RMS (5 A nominal)

Frequency	40–70 Hz
Phase difference between grids:	±180°
Measurement Accuracy [1]	
Voltage	0.2% of Full Scale (see page 52)
Current	0.2% of Full Scale (see page 51)
kW, kVAR, kVA	0.4%
kWH, kVARH, kVAH	0.4%
Power factor	1%
Frequency	0.01 Hz
Phase angle	0.1°

Terminal Assembly Input Terminal Ratings	
Current	15 Amps continuous maximum
Voltage	690 VAC RMS
Sync Relay contacts	150 VAC/VDC at 1 Amp Resistive, maximum ***Note:*** *Actual contact ratings depend on load type. See "Sync Relay contacts" on page 5.*
RX3i CPU Memory Requirement for Automatic Data Exchange	
%I	80 bits
%Q	32 bits
%AI	64 words
%AQ	2 words
Data Exchange Time Between RX3i CPU and PSM	
A complete data exchange between the PSM and RX3i occurs during each controller scan. Minimum scan time is 3.5ms per PSM module in the backplane. Minimum data update rate is one power line period. See "System Operation" on page 7 and "PSM Status Flags" in Chapter 3:.	
ANSI Protective Functions	
ANSI 25 – Generator and Public Grid Synchronization	
ANSI 27 – Under-voltage Protection	
ANSI 32 – Reverse Power Protection	
ANSI 47 – Voltage Phase Sequence Protection	
ANSI 50 – Instantaneous Over-current Protection	
ANSI 59 – Over-voltage Protection	
ANSI 60 – Voltage (Current) Imbalance Protection	
ANSI 81U – Under-frequency Protection	
ANSI 81O – Over-frequency Protection	

Power Measurement Configurations	
Four-wire three phase wye systems: 3 PTs and 3 CTs plus Neutral CT (optional)	
Three-wire three phase delta systems: 2 PTs and 2 CTs	
Three independent single phase systems: 1 PT and 1 CT for each phase	
Three-wire single phase systems: 120/240 (2 PTs and 2 CTs)	
Operating Environment	
Enclosure mounting	Required. PSM module and Terminal Assembly must be installed in a NEMA/UL Type 1 enclosure or an IP20 rating providing at least a pollution degree 2 environment. When this system is installed in an area designated as Class 1 Zone 2 in Europe, compliance with the ATEX Directive requires an enclosure with a minimum rating of IP54.

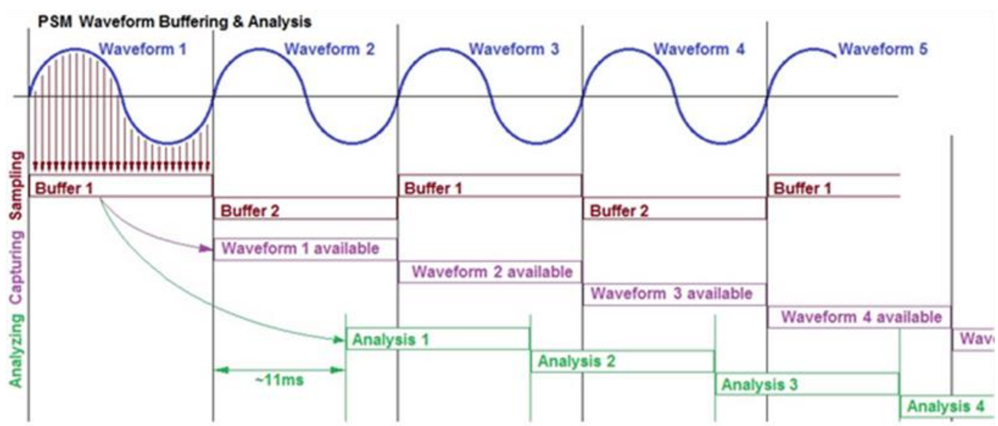
1.8 System Operation

The PSM digitizes the voltage and current input waveforms from Grid 1 and Grid 2, storing the results into internal memory buffers. Data is updated every power line cycle.

Therefore, the data is updated every 20ms on a 50Hz power grid, or every 16.67ms on a 60Hz power grid.

While background processes analyze a set of waveforms stored in one memory buffer, the next set of waveforms is captured and stored in another buffer. In this way, calculations are performed on each waveform with the DSP processing the data in about two-thirds of a power line cycle.

Figure 3



1.8.1 Autonomous Operation

The PSM is a semi-autonomous module running on the RX3i backplane. If the PLC goes to Stop Mode, or the CPU is lost due to over temperature or a watchdog timeout, the PSM continues to operate with the last directive received from the CPU. If the CPU had requested the synchronization of Grid 1 and Grid 2, when all sync parameters are met, the PSM will assert RelayCloseOK and close its relay output contacts, **even when the PLC is in Stop Mode.** Care must be taken to leave the Sync request in a known state when transitioning to stop mode.

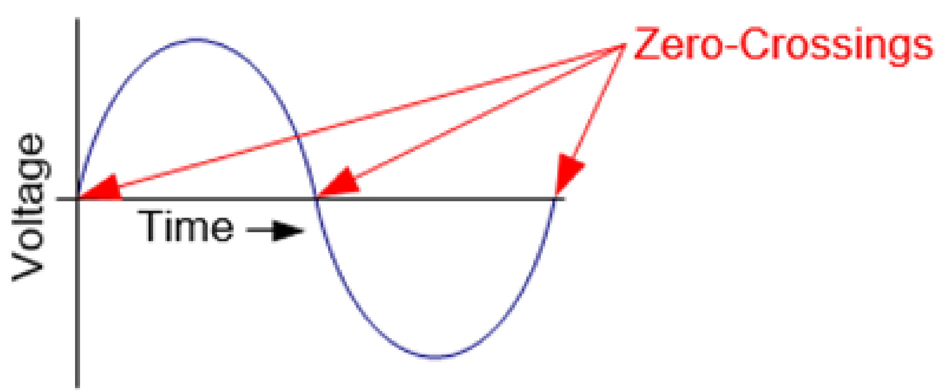
When Grid 1 and Grid 2 are synchronized, the PSM **cannot** be reset or cleared, and it **will not** accept a new hardware configuration from the CPU. Once synchronized, the PSM can only be cleared in preparation for receiving a new configuration by first commanding the PSM to release the grid synchronization (simultaneously set %Q offset 16 to 1, and clear %Q offset 32 to 0), or by removing power from the PSM module. Mission Critical applications must have a redundant PSM system to take over the grid synchronization from the Primary PSM if the primary controller can no longer perform its function.

1.8.2 Frequency Measurement

Healthy three-phase power systems produce three almost identical sinusoidal voltage waveforms that swing from positive to negative voltage at a frequency of either 50 or 60 times per second (50–60Hz).

The PSM determines the frequency of the power line by looking for the zero crossings, which are places where the voltage crosses zero volts going from positive to negative or from negative to positive. Only phase A voltages are used for the zero-crossing detection, so phase A must be always present on one or the other grid.

Figure 4



Frequency Measurement Notes

PSM preferentially chooses Grid 1 VA zero crossing as the reference for signal sampling.

In the absence of Grid 1 VA, PSM uses Grid 2 VA zero crossing.

In the absence of either VA signal, grid frequencies will be reported as 0Hz, and the remaining inputs will be sampled at a rate of 128 samples per 25ms. New data will be updated at 25ms intervals. This may create sporadic looking individual readings, but a 10-cycle average will be fairly steady and accurate.

When the difference in frequency between Grid 1 and Grid 2 is large, the Grid 2 RMS readings will vary from cycle to cycle, however a 10-cycle average will be fairly steady and accurate.

1.9 ANSI Functions Supported

The Grid 1 and Grid 2 functions are similar, but with differences in implementation. Grid 1 is assumed to be the most stable power source, such a utility. Grid 2 is assumed to be a less stable power source, such as a back-up generator. Either or both grids can be connected for load monitoring, such as motors, lighting, HVAC or server room power.

1.9.1 ANSI Functions for GRID 1 (Public Grid/Load) Protection

ANSI 27 – Under-voltage Protection

Under-voltage Protection monitors voltages to protect motors against voltage sags. The PSM monitors the phase-to-phase voltage in a delta power system, or phase-to-neutral voltage in a wye power system, as a percentage of the Nominal Voltage parameter. An alarm will be triggered if any voltage falls below the specified UNDER_VOLT_THR value for a time period longer than UNDER_VOLT_DELAY. The alarm is cleared when the grid voltage rises above the UNDER_VOLT_THR value for a time period longer than UNDER_VOLT_DELAY. The UNDER_VOLT_THR is a percentage of the nominal voltage.

ANSI 32 – Reverse Power Protection

Reverse Power Protection provides protection from excessive reverse active power produced by motors running as generators (supplying power). An alarm will be triggered if a circuit's active power exceeds the REV_PWR_THR for a time period longer than REV_PWR_DELAY. The Alarm will be cleared when the active power exceeds the REV_PWR_THR for a time period longer than REV_PWR_DELAY. The REV_PWR_THR is a percentage of the nominal power, which in a 3-phase system, is three times the nominal voltage multiplied by the nominal current.

ANSI 47 – Voltage Phase Sequence Protection

This function monitors the sequence of the phase A, B and C voltages. Detection of a wrong sequence (A, C, B for example) triggers an alarm.

An entire cycle of waveforms is required to make this Phase Sequence determination. There is no user settable delay parameter, so the moment a Phase Sequence error is detected, the alarm is set. In both systems (Delta and WYE), the signal at the VA terminal is expected to lead the signal at the VB terminal by 120 degrees. The signal at the VB terminal is expected to lead the signal on the VC terminal by 120 degrees. Unused "reconstructed" signal inputs are ignored for Phase Sequence detection. The current signals are not monitored for Phase Sequence.

ANSI 50 – Instantaneous Over-current Protection

This function provides three-phase protection against overloads and phase-to-phase short-circuits. An alarm will be triggered if any phase current exceeds the specified OVER_CURR_THR value for a time period longer than OVER_CURR_DELAY. This alarm is cleared when the current value stays below the OVER_CURR_THR value for a time period longer than OVER_CURR_DELAY. The OVER_CURR_THR is a percentage of the nominal current.

ANSI 59 – Over-voltage Protection

This function provides detection of abnormally high phase voltage. It works with phase-to-phase voltage in delta power systems, or phase-to-neutral voltage in wye power systems. Each voltage is monitored separately. An alarm will be triggered if any voltage exceeds the specified OVER_VOLT_THR value, as a percentage of the Nominal Voltage parameter, for a time period longer than OVER_VOLT_DELAY. This alarm is cleared when the voltage drops below the OVER_VOLT_THR value for a time period longer than the OVER_VOLT_DELAY. The OVER_VOLT_THR is a percentage of the nominal voltage.

ANSI 60 – Voltage (Current) Imbalance Protection

An alarm will be triggered if any phase voltage or current reading varies from the average of all three phases by more than VI_IMBALANCE_THR for a time period longer than VI_IMBALANCE_DELAY. The alarm is cleared when the imbalance condition is corrected for a time period longer than VI_IMBALANCE_DELAY. IV_IMBALANCE_THR is a percentage of the average of the three phase voltages (for voltage imbalance) or the three phase currents (for current imbalance) on a given grid. It works with phase-to-phase voltage in Delta power systems, or phase-to-neutral voltage in WYE Power systems. No comparison is performed between the two grids. Neutral current is not monitored for imbalance.

ANSI 81U – Under-frequency Protection

Detection of abnormally low frequency compared to the nominal frequency, to monitor power supply quality. An alarm will be triggered if a circuit's frequency falls below the nominal frequency minus the UNDER_FRQ_THR for a time period longer than UNDER_FRQ_DELAY. The alarm is cleared when the frequency rises above the nominal frequency minus UNDER_FRQ_THR for a time period longer than UNDER_FRQ_DELAY. UNDER_FREQ_THR is an absolute frequency, in Hz, that is subtracted from the nominal frequency to determine the lowest acceptable frequency for the grid.

ANSI 81O – Over-frequency Protection

Detection of abnormally high frequency compared to the nominal frequency, to monitor power supply quality. The alarm will be triggered if a circuit's frequency is above the nominal frequency plus OVER_FRQ_THR for a time period longer than OVER_FRQ_DELAY. The alarm will be cleared when a circuit's frequency falls below the nominal frequency plus OVER_FRQ_THR for a time period longer than OVER_FRQ_DELAY. OVER_FREQ_THR is an absolute frequency, in Hz, that is added to the nominal frequency to determine the highest acceptable frequency for the grid.

ANSI Functions for GRID 2 (Generator/Generator Grid) Protection

⚠ WARNING

It is the responsibility of the user to verify that the system has sufficient frequency stability to maintain the current phase trend during the synchronization process. This requirement is especially true for long breaker delays. Failure to maintain frequency stability during synchronization may result in personal injury, equipment damage, or both.

ANSI 25 – Generator & Public Grid Synchronization

The PSM module can synchronize two sources from either a static phase angle or a rotating phase angle.

In static phase angle synchronization, the overall PLC control system holds the two grids at the same amplitudes, frequencies and phase angles, and then requests that the PSM module synchronize the grids. To select this mode, set the Breaker Delay parameter to 0ms.

In rotating phase angle synchronization, the overall PLC control system holds the two grids at the same amplitudes while keeping the frequencies at slightly different values so the two grids gradually go in and out of phase. The PLC then requests that the PSM module synchronize the grids whenever it is safe to do so. To select this mode, set the Breaker Delay parameter to the non-zero value that corresponds to the time required for the synchronization contacts to close. See “ANSI Protection Parameters” in chapter 3 for more details on setting the breaker delay.

For safe synchronizing (i.e. connecting the generator grid with the public grid), in addition to having no faults in either the public or generator grids, the following three parameters must be within their specified limits:

- **voltage matching** (Delta Voltage between public grid and generator grid, all measured phase voltages considered)
- **frequency difference** (Delta Frequency between public grid and generator grid).
- **angle** (Phase Shift between public grid and generator grid — using phase A voltages)

Voltage Matching

For synchronization, the Grid 2 RMS voltage must be within ±DELTA_VOLT_THR of the Grid 1 RMS voltage. DELTA_VOLT_THR is a percentage of the measured Grid 1 voltage. There is no delay for setting or clearing this DeltaVoltOK status bit.

Voltage Matching

For synchronization, the Grid 2 frequency must be within ±DELTA_FREQ_THR of the Grid 1 frequency. DELTA_FREQ_THR is an absolute frequency difference in Hz.

Phase Angle

For synchronization, the two grids must be connected when the phase angle difference between the grids is in the range of ±PHASE_SHIFT_THR, and ideally at the point when the two grids are exactly in phase. The phase shift threshold represents an angle window in electrical degrees (usually ±10°) around the 0° value, where it is safe to connect the two grids. The phase shift between the grids can be a rapidly changing value in a rotating system.

Additionally, the breaker delay can be significant (hundreds of milliseconds). Therefore, in rotating phase synchronization, the moment for commanding the sync relay to close must shift forward to compensate for the time it takes for the contacts to close. For example, the window of opportunity for commanding relay closure could happen between 25° and 15°, in order for the contacts to close when the grids are truly in-phase. This angle offset is a function of the frequency difference (and therefore the rate of change of the phase shift) and the breaker delay.

Once the CloseRelayOK bit is set, it remains set until either the breaker delay + 24 power cycles passes, or the phase shift enters and then leaves the ±Phase_Shift_Thr window. This gives the contacts time to settle, and the two grids time to stabilize into synchronization.

Angle Delay

Angle Delay is a value, in degrees, that accounts for both the rate of change of the phase shift between the grids and the breaker delay. Angle Delay is the angle through which the synchroscope needle travels between the moment the PSM sets the CloseRelayOK bit to close the IC694ACC200 relay contacts, and when the physical contacts on the sync relay actually close:

Angle Delay = (360º x ΔF x Bdly)

Where:

ΔF = Grid 2 Frequency – Grid 1 Frequency

Bdly = breaker delay in seconds

The Breaker Delay PSM configuration parameter must include all the delays introduced between the PSM module and the synchronizing contacts. For example, the IC694ACC200 Terminal Assembly relay outputs have a turn on time of 20ms (see “Specifications” on page 5), and a given contactor has a published closing time of 80ms.

The Breaker Delay parameter should be set to the sum of all delays, or 100ms in this example. Ideally, the actual breaker delay time will be measured during installation commissioning and used in the application to compensate for component variations.

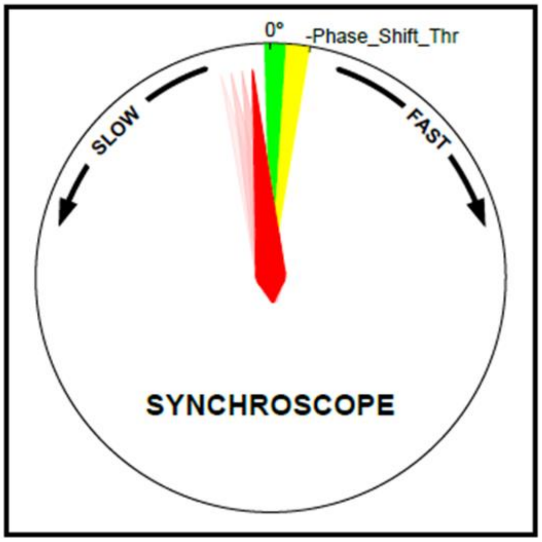
Slow Rotating Phase Angles

In rotating phase angle synchronization, the PSM sets and clears the PhaseShiftOK status bit based on the Angle Delay value. In slowly rotating phase angles where Angle Delay ≤ (Phase_Shift_Thr - 2º)/2, noise-induced jitter in the zero-crossing detection can make the phase angle difference from one power line cycle to the next appear to change direction. For this reason, 2º of hysteresis is added to the trailing edge of the PhaseShiftOK window:

PhaseShiftOK = On @ Angle Delay

PhaseShiftOK = Off @ –(Angle Delay+2º)

Figure 5 Slow Rotation: Angle Delay ≤ (Phase_Shift_Thr - 2º)/2



If the request to sync is on or received by the PSM module at any time in the green region (while PhaseShiftOK = on), the CloseRelayOK status bit will be set and the IC694ACC200 output contacts will close.

Once CloseRelayOK is on and the IC694ACC200 output contacts are closed, they remain on and closed, regardless of grid alarms, until after the breaker delay plus 24 power line cycles pass, to allow the newly synchronized grids to settle. After the settling time, all ANSI protections are reinstated and the PSM monitors the Delta Frequency, Delta Voltage and Phase Shift status bits again.

In the absence of other alarms, the phase shift is allowed to drift within the phase shift threshold (the yellow region) indefinitely as the PSM waits for the physical contacts to synchronize the grids.

Example: Angle Delay ≤ (Phase_Shift_Thr - 2º)/2

Phase_Shift_Thr = 10º

Breaker Delay = 200ms

Grid 1 Frequency = 60.00Hz Grid 2 Frequency = 60.01Hz ΔF (slip frequency) = 0.01Hz

Angle Delay = (360º x 0.01Hz x 0.200sec) = 0.72º

PhaseShiftOK = On @ 0.72º {Angle Delay}

PhaseShiftOK = Off @ -2.72º {-(Angle Delay + 2º)}

If Sync is requested while PhaseShiftOK = On, then CloseRelayOK will be set to On for the Angle Delay + 24 cycles. At ΔF = 0.01HZ and 60Hz, the PhaseShiftOK window is 200ms (0.72º) + 400ms = 600ms.

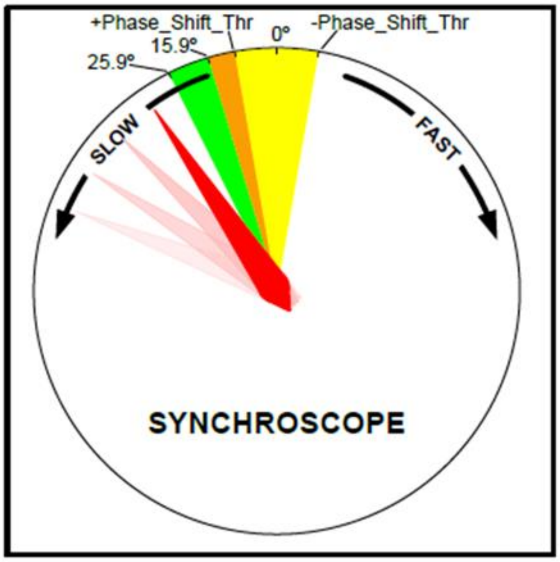
Fast Rotating Phase Angles

For faster rotating phase angles where Angle Delay > (Phase_Shift_Thr - 2º)/2, these equations apply:

PhaseShiftOK = On @ Angle Delay

PhaseShiftOK = Off @ Angle Delay – Phase_Shift_Thr

Figure 6 Fast Rotation: Angle Delay > (Phase_Shift_Thr - 2º)/2



If a request to sync is on or received by the PSM module at any time in the green region (while PhaseShiftOK = on), the CloseRelayOK status bit will be set and the IC694ACC200 output contacts will close.

Once CloseRelayOK is on and the IC694ACC200 output contacts are closed, they remain on and closed through the green, orange and yellow regions, regardless of grid alarms, until after the breaker delay plus 24 power line cycles pass, to allow the newly synchronized grids to settle. After the settling time, all ANSI protections are reinstated and the PSM monitors the Delta Frequency, Delta Voltage and Phase Shift status bits again. In the absence of other alarms, the phase angle is allowed to drift within the phase shift threshold (the yellow region) indefinitely as the PSM waits for the physical contacts to synchronize the grids.

Example: Angle Delay > (Phase_Shift_Thr - 2º)/2

Phase_Shift_Thr = 10º

Breaker Delay = 800ms

Grid 1 Frequency = 60.00Hz

Grid 2 Frequency = 60.09Hz

ΔF (slip frequency) = 0.09Hz

Angle Delay = (360º x 0.09Hz x 0.800sec) = 25.9º

PhaseShiftOK = On @ 25.9º {Angle Delay}

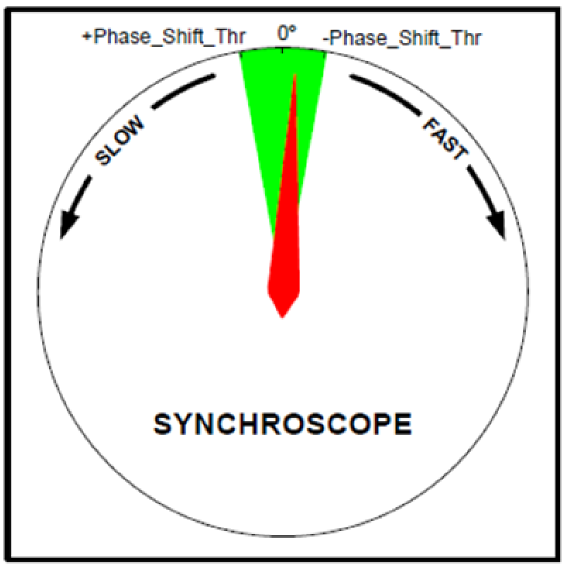
PhaseShiftOK = Off @ 15.9º {Angle Delay – Phase_Shift_Thr}

If Sync is requested while PhaseShiftOK = On, then CloseRelayOK will be set to On for the Angle Delay + 24 cycles. At ΔF = 0.09Hz and 60Hz, the PhaseShiftOK window is 800ms (25.9º) + 400ms = 1.2 seconds.

Static Phase Angle Synchronization

In static phase angle synchronization, the PSM will set PhaseShiftOK bit between ±Phase_Shift_Thr, regardless of the Delta Frequency (Slip Frequency). This mode is selected by setting the Breaker Delay hardware configuration parameter to zero.

Figure 7



With no breaker delay information, the PSM reverts to classic synchronization. Either the control system holds the phase angle within the Phase_Shift_Thr before requesting Synchronization, or the rate of change of the phase angle and the breaker delay are known and the control system holds the Delta Frequency (Slip Frequency) at a value calculated to bring the contacts to closure at or near 0º phase angle.

ANSI 27 – Under-voltage Protection

This function monitors voltages to detect abnormally low grid voltage. It works with phase to-phase voltage in delta power systems, or phase-to-neutral voltage in wye power systems. Each phase voltage is monitored separately. An alarm will be triggered if any voltage falls below the specified UNDER_VOLT_ THR voltage value for a time period longer than UNDER_VOLT_DELAY. The alarm Is cleared if any voltage rises above the specified UNDER_VOLT_ THR voltage value for a time period longer than UNDER_VOLT_DELAY. The UNDER_VOLT_THR is a percentage of the nominal voltage.

ANSI 32 – Reverse Power Protection

Reverse Power Protection prevents the generator from motoring on loss of the prime mover. An alarm will be triggered if the prime mover power falls below the REV_PWR_THR for a time period longer than REV_PWR_ DELAY. The alarm will be cleared when the prime mover power rises above the REV_PWR_THR for a time period longer than REV_PWR_DELAY. The REV_PWR_THR is a percentage of the nominal power which, in a 3-phase system, is three times the nominal voltage multiplied by the nominal current.

ANSI 47 – Voltage Phase Sequence Protection

The sequence of the phase A, B and C voltages is monitored. Detection of a wrong sequence (A, C, B for example) will trigger an alarm.

ANSI 50 – Instantaneous Over-current Protection

Provides three-phase protection against overloads and phase-to-phase short-circuits. The alarm will be triggered if any phase current exceeds the specified OVER_CURR_ THR voltage value for a time period longer than OVER_CURR_DELAY. The OVER_CURR_THR is a percentage of the nominal current.

ANSI 59 – Over-voltage Protection

This provides detection of abnormally high phase voltage. It works with phase-to-phase voltage in Delta power systems, or phase-to-neutral voltage in WYE Power systems. Each voltage is monitored separately. An alarm will be triggered if any voltage exceeds the specified OVER_VOLT_THR value, as a percentage of the Nominal Voltage parameter, for a time period longer than OVER_VOLT_DELAY. This alarm is cleared when the voltage drops below the OVER_VOLT_THR value for a time period longer than the OVER_VOLT_DELAY. The OVER_VOLT_THR is a percentage of the nominal voltage.

ANSI 60 – Voltage (current) Imbalance

An alarm will be triggered if any phase voltage or current reading varies from the average of all three phases by more than VI_IMBALANCE_THR for a time period longer than VI_IMBALANCE_DELAY. The alarm is cleared when the imbalance condition is corrected for a time period longer than VI_IMBALANCE_DELAY. IV_IMBALANCE_THR is a percentage of the average of the three phase voltages (for voltage imbalance) or the three phase currents (for current imbalance) on a given grid. It works with phase-to-phase voltage in Delta power systems, or phase-to-neutral voltage in WYE Power systems. No comparison is performed between the two grids. Neutral current is not monitored for imbalance.

ANSI 81U – Under-frequency Protection

Detection of abnormally low frequency compared to the nominal frequency, to monitor power supply quality. An alarm will be triggered if a circuit's frequency falls below the nominal frequency minus the UNDER_FRQ_THR for a time period longer than UNDER_FRQ_DELAY. The alarm is cleared when the frequency rises above the nominal frequency minus UNDER_FRQ_THR for a time period longer than UNDER_FRQ_DELAY.

UNDER_FREQ_THR is an absolute frequency, in Hz, that is subtracted from the nominal frequency to determine the lowest acceptable frequency for the grid.

ANSI 81O – Over-frequency Protection

Detection of abnormally high frequency compared to the nominal frequency, to monitor power supply quality. The alarm will be triggered if a circuit's frequency is above the nominal frequency plus OVER_FRQ_THR for a time period longer than OVER_FRQ_DELAY. The alarm will be cleared when a circuit's frequency falls below the nominal frequency plus OVER_FRQ_THR for a time period longer than OVER_FRQ_DELAY. OVER_FREQ_THR is an absolute frequency, in Hz, that is added to the nominal frequency to determine the highest acceptable frequency for the grid.

Chapter 2: Installation

2.1 General Warnings/Cautions

⚠ WARNING

Installation and wiring procedures must be performed by qualified personnel, as defined below.

Qualified personnel are people who, because of their education, experience and instruction and their knowledge of relevant standards, regulations, accident prevention and service conditions, have been authorized by those responsible for the safety of the plant to carry out any required operations and who are able to recognize and avoid any possible dangers. (Definitions for skilled workers according to EN50110-1.)

⚠ WARNING

HIGH VOLTAGE; HIGH CURRENT

DO NOT TOUCH the connectors or wiring after powering up the PSM system. Hazardous voltages exist, and death or injury may result.

The Terminal Assembly frame ground connection must always be installed and must be installed before any other wiring is attached.

To reduce risk of electric shock or damage to the attached CTs, always open or disconnect all voltage circuits and apply the shorting bar connections to the current inputs before installing or servicing the connections to the Terminal Assembly.

Never disconnect the GRID 1 or GRID 2 field wiring while power is present. Personal injury or equipment damage may result. Finger guards must be installed on the Terminal Assembly before energizing the field wiring.

⚠ WARNING

This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D , Zone 2, OR non-hazardous locations only.

EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.

EXPLOSION HAZARD - Substitution of components may impair suitability for Class I, Division 2 or Zone 2 Areas.

2.2 Enclosures

The Terminal Assembly and PSM module are considered open equipment (having live electrical parts that may be accessible to users) and must be installed in a protective enclosure or incorporated into other assemblies manufactured to provide safety. As a minimum, the enclosure or assemblies shall provide a degree of protection against solid objects up to 12mm (e.g. fingers). This equates to a NEMA/UL Type 1 enclosure or an IP20 rating providing at least a pollution degree 2 environment.

When this system is installed into an area designated as Class 1 Zone 2 in Europe, compliance with the ATEX Directive requires an enclosure with a minimum rating of IP54. The enclosure must be able to adequately dissipate the heat generated by all components mounted inside so that no components overheat. Heat dissipation is also a factor in determining the need for enclosure cooling options such as fans and air conditioning.

2.3 Installing the PSM Module

⚠CAUTION

Due the nature of the power systems monitored by the PSM system, careful consideration must be given to the effects on these systems before the PSM module is either hot-removed or hot-inserted into the host controller backplane.

The PSM module must be installed in a main (CPU) rack in an RX3i system. For system level installation information, refer to the PACSystems RX3i System Manual, GFK-2314. The IC694PSM001 Module can be hot-swapped in an RX3i backplane.

2.4 Installing the Terminal Assembly

The Terminal Assembly must be securely installed on a rigid, conductive, 12 – 14-gauge steel panel using four user supplied M4 - M5 or #8 - #10 SAE bolts. The Terminal Assembly should be mounted near the host controller rack containing the PSM module, close enough to accommodate the 2-meter interface cables provided.

⚠ WARNING

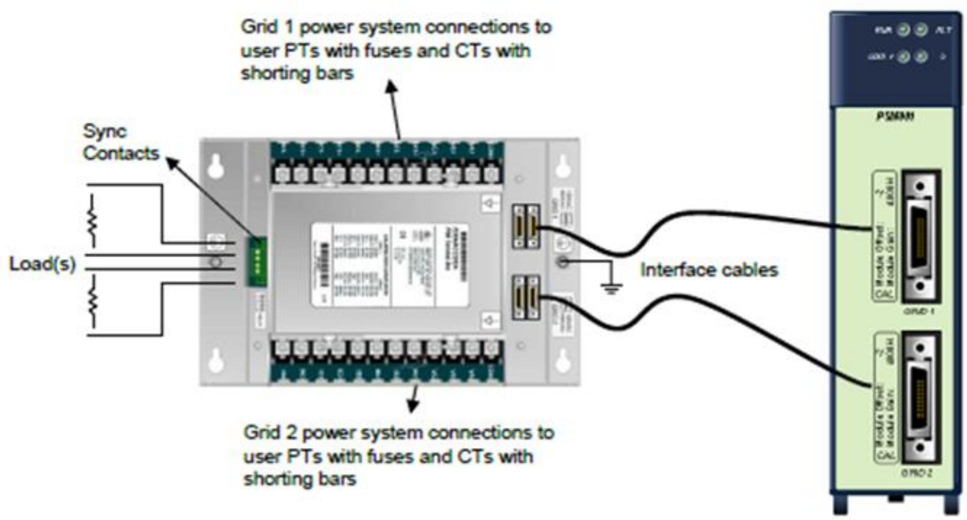
HIGH VOLTAGE; HIGH CURRENT

After connecting the power system wiring and before applying power, the plastic finger guards must be installed on the Terminal Assembly.

2.5 Connector and Cabling Information

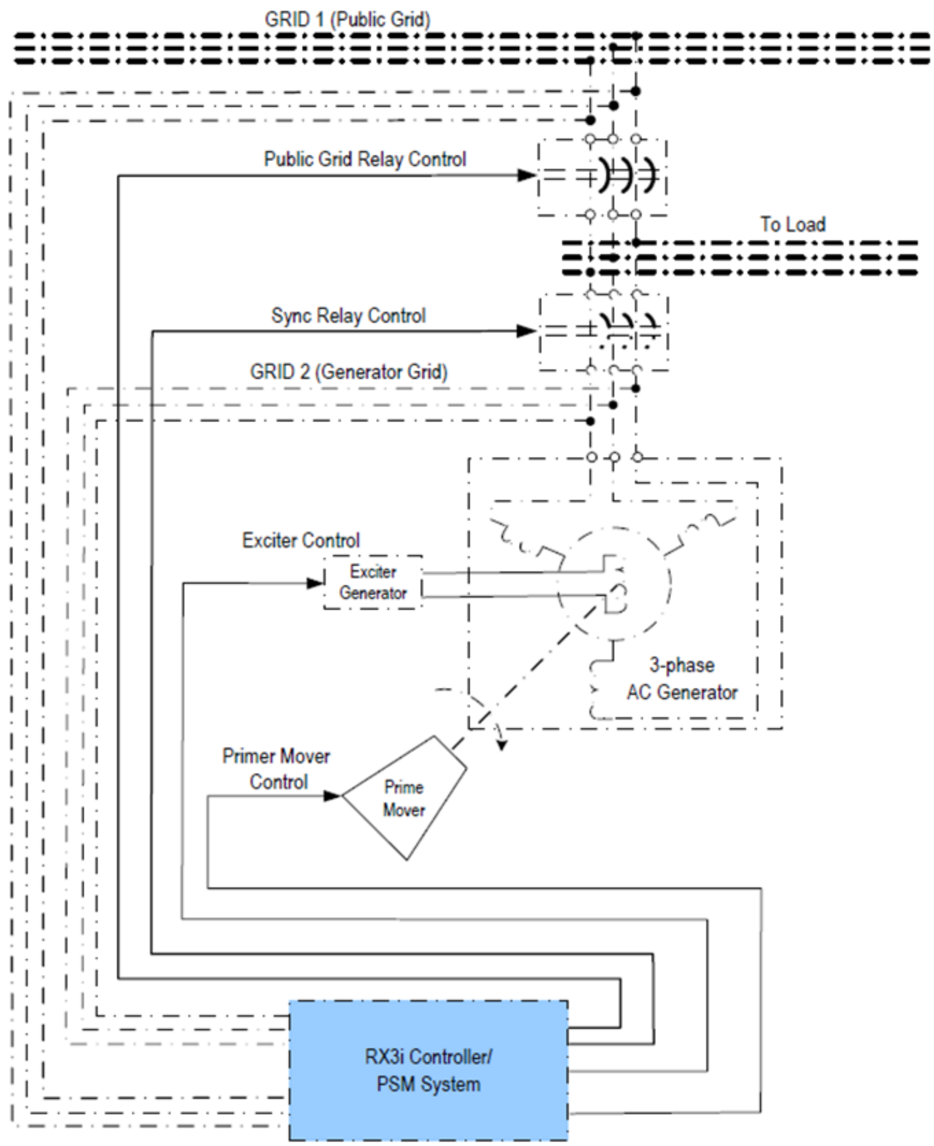
2.5.1 Basic PSM System Connections

Figure 8



2.5.2 Overview of PSM System Connection to Public Grid and Generator

Figure 9



2.5.3 Power System Connections

The Grid 1 and Grid 2 terminal blocks connect the Terminal Assembly to the power systems being measured.

Each side of the Terminal Assembly has a 12-position terminal block for user connections. The screw terminals accommodate solid or stranded wires from 8 – 18AWG

The following table lists the Grid 1 and Grid 2 signal inputs to the Terminal Assembly. The Grid 1 common (COM1) and Grid 2 common (COM2) are internally connected and must always be at the same potential.

Grid 1 Power System Connections	**Grid 2 Power System Connections**
COM1	COM2
Grid 1, VA	Grid 2, VA
Grid 1, VB	Grid 2, VB
Grid 1, VC	Grid 2, VC
Grid 1, IA+	Grid 2, IA+
Grid 1, IA-	Grid 2, IA-
Grid 1, IB+	Grid 2, IB+
Grid 1, IB-	Grid 2, IB-
Grid 1, IC+	Grid 2, IC+
Grid 1, IC-	Grid 2, IC-
Grid 1, IN+	Grid 2, IN+
Grid 1, IN-	Grid 2, IN-

PSM Module to Terminal Assembly Connections

Two identical 2-meter cables (Emerson part number IC694CBL200) connect the PSM module to the Terminal Assembly. These cables are to be used only for Grid 1 and Grid 2 connections to the IC694PSM001.

⚠ WARNING

The PSM Terminal Assembly connects to hazardous voltages. Before installing, testing, or troubleshooting this module, you should refer to the complete instructions in this manual. Failure to follow the published guidelines may result in personal injury, equipment damage, or both.

The interface cables connect to a circuit board that has hazardous voltages present. These cables are carefully made to ensure the safety of the user and associated equipment. Therefore, we recommend you use only factory-built cables.

Secure the cables between the Terminal Assembly and the PSM module to maintain at least 1/4-inch (6mm) distance to other wiring unless it is Class 2 or Communication wiring. The cables are for interconnection within the same enclosure only.

If hot swapping the IC694PSM001 module becomes necessary, the IC694CBL200 cables should be disconnected from the IC694ACC200 terminal assembly end first, to remove any potential from the cables.

Note whether the cables were plugged into the 120V or 600V connectors on the terminal assembly, so they can be returned to the proper connector.

Note: *The following information is supplied only for diagnostics (making continuity checks of the cable):*
These cables have straight through connections (pin 1 connects to pin 1; pin 2 connects to pin 2, etc.). The cables are twisted-pair type, connected to minimize noise and crosstalk between signals.

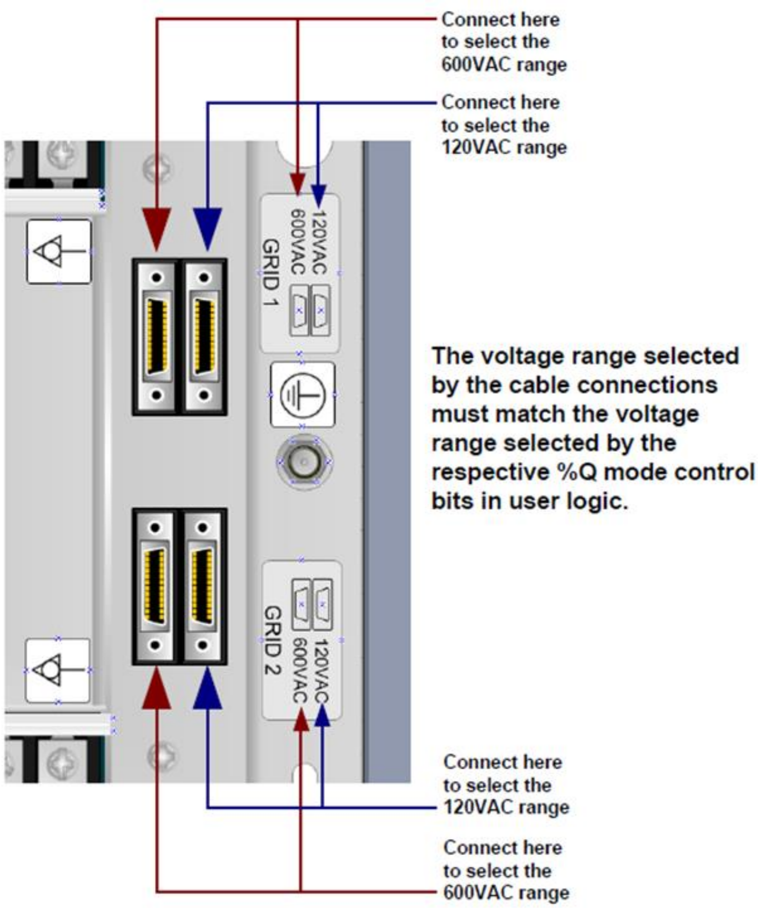
Voltage Range Selection

The voltage range of each grid can be selected independently. Note that the PSM ConnectionOK status bit is only meaningful when both grids are used with the same voltage range. If different voltage ranges are chosen, the status bit must be ignored, and extra attention must be given to correct connections.

The voltage range selected by the cable connections must match the voltage range configured with the %Q Mode Control bits shown in Chapter 3. For Grid 1, connecting the cable to the 120VAC range correlates to a %Q bit offset 2 being cleared to zero. Similarly, connecting the cable to the 600VAC range correlates to a %Q bit offset 2 being set to 1.

Likewise, for Grid 2, the range selected by the Grid 2 cable connection must match the range configured by the %Q bit offset 18. Failure to match the cable connection and Mode control range selections will result in inaccurate values being reported to the user logic.

Figure 10



2.5.4 Relay Connector for Sync Contacts

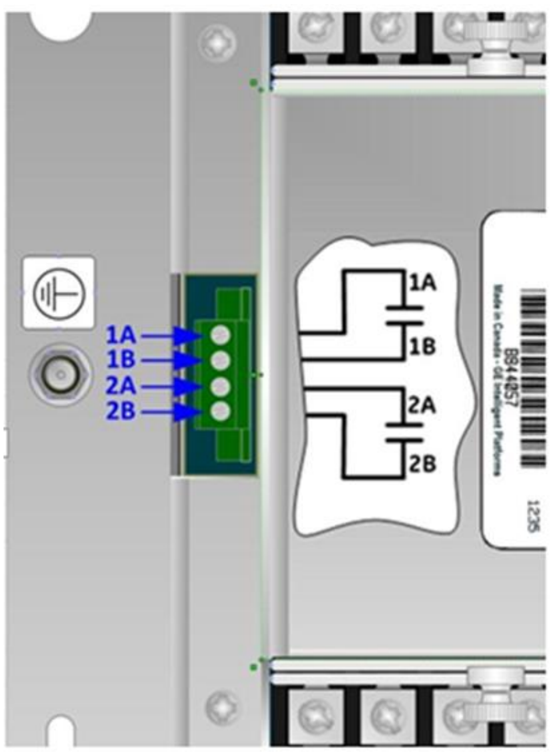
The Sync contacts are two redundant, isolated solid-state outputs that signal when it is safe to close the contacts that will parallel Grid 1 to Grid 2. When the PSM module determines that the synchronization parameters have been met, relay contact 1A closes to relay contact 1B, and relay contact 2A closes to relay contact 2B. These outputs can carry either AC or DC signals. In DC systems, the outputs can either be high-side (sourcing) or low side (sinking) outputs. Since these are isolated outputs, the two relays can be connected either in series or in parallel, depending on the needs of a specific installation. Connecting the contacts in parallel does not increase the current carrying capacity of the system.

If safety is the primary concern for a given installation, connect the relays in series, increasing reliability of breaking the connection when synchronization is no longer desired.

If reliable power is the primary concern for a given installation, connect the relays in parallel, increasing the reliability of making the connection when synchronization is desired.

Pin No.	Signal
1	Relay contact 1A
2	Relay contact 1B
3	Relay contact 2A
4	Relay contact 2B

Figure 11



2.6 Wiring

⚠ WARNING

HIGH VOLTAGE; HIGH CURRENT

DO NOT TOUCH the connectors or wiring after powering up the PSM system. Hazardous voltages exist, and death or injury may result.

The Terminal Assembly frame ground connection must always be installed and must be installed before any other wiring is attached.

Fuses on the voltage inputs are mandatory.

Potential transformers are mandatory. Fuses on input and output leads for the PTs are mandatory. The COM1 and COM2 terminals must be connected to frame ground to maintain a common reference.

COM1 and COM2 terminals shall not be used for neutral or protective earth connections. Certain fault conditions can cause the neutral line to be pulled to the full phase to neutral voltage, posing a danger to personnel and potentially damaging the Terminal Assembly.

Current Transformer (CT) shorting bars are mandatory. One leg of each CT secondary should be solidly connected to frame ground to ensure that the current inputs remain at a safe potential, and to reduce the noise induced into the system.

To reduce risk of electric shock or damage to the attached CTs, always open or disconnect all voltage circuits and apply the shorting bar connections to the current inputs before installing or servicing the connections to the Terminal Assembly.

Never disconnect the GRID 1 or GRID 2 field wiring while power is present. Personal injury or equipment damage may result. Finger guards must be installed on the Terminal Assembly before energizing the field wiring.

Wiring to the PSM consists of

- Frame ground connections from the Terminal Assembly to the chassis.
- The connection cable between the Terminal Assembly and the PSM
- The leads to user-supplied potential transformers and current transformers
- ync relay output connections

Note: *No CT shorting bars are provided on the PSM Terminal Assembly; these must be supplied by the user.*

2.6.1 General Wiring Notes

In the following connection diagrams, the line connections are labeled L1, L2, and L3. When you wire the Terminal Assembly into a system, you must decide which line will correspond to which phase. Usually, L1 will correspond to phase A, L2 with phase B, and L3 with phase C. Once you decide how to connect the system, the labels L1, L2 and L3 can be changed to A, B, and C according to your system configuration. Then the diagrams can be followed, and the connections made.

Although Grid 1 and Grid 2 are interchangeable, you should connect the most stable source to Grid 1. Between a utility grid and a generator, the utility grid is the best choice for connection to the PSM Grid 1 inputs. This will yield the most accuracy and the least reading-to-reading fluctuation.

Requirements for Terminal Assembly Connections

Terminal Assembly connections above 600VAC required prepared wire ends, such as tinning of the conductors, or use of crimpled or soldered forked connectors or ferrules.

Terminal connections for COM1, COM2, voltage sensing and current sensing terminals

Terminal torque: 1.81 Nm (16 in-lb)

Wiring size/type: 0.823 mm^2– 5.26 mm^2 (18–10 AWG) solid/stranded

Relay output terminal connections

Terminal torque: 0.8 Nm (7 in-lb)

Wiring size/type: 0.205 mm^2– 0.410 mm^2 (30–12 AWG) solid/stranded

⚠ WARNING

Potential transformers MUST be used for voltage isolation and scaling purposes. Current Transformers must be used for all current measurements. Please refer to the following diagrams.

2.6.2 Terminal Assembly Frame Ground Connection

The basic system configuration consists of the host controller, the PSM and the Terminal Assembly. Interface cables are used to connect the PSM to the Terminal Assembly. **The Terminal Assembly must have frame ground connected to ensure that the metal case on the Terminal Assembly is safely at ground potential.** In the diagrams following, specific wiring configurations are detailed. Make sure that the safety features detailed in the drawings are included in your installation. **Failure to do so could result in personal injury or death and equipment damage.**

2.6.3 Wiring Diagrams

⚠ WARNING

Be sure you read and understand all safety-related information in this manual before attempting to wire or use the PSM.

Connections for 120/240 VAC system with CTs

The connections shown below detail the installation for a typical North American 120/240-volt AC three-wire single phase connection. The neutral is connected to a ground point, usually at the main power distribution panel.

Mandatory equipment includes CT shorting blocks and protection fuses for the voltages. These will allow replacement of the PSM Terminal Assembly with the system still energized.

⚠ WARNING

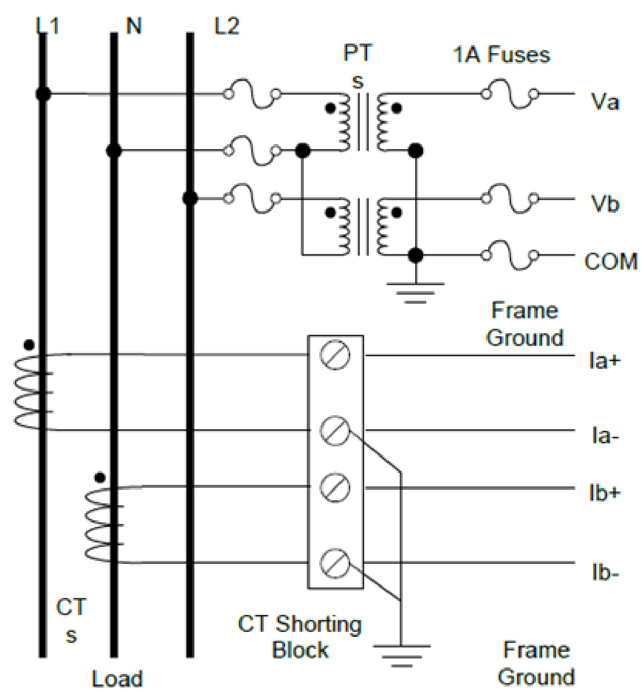
The following procedure should be performed only by qualified field personnel.

To replace the Terminal Assembly, the Va, COM and Vb fuses are first removed and the CTs shorted. Then the connections on the Terminal Assembly can be removed safely and the module replaced.

The PSM module can be replaced simply by powering off the host controller and replacing the module, or by hot-swapping the module when the field conditions are safe to do so.

The IC694CBL200 cables can be disconnected from either the PSM module or the terminal assembly when the host controller is powered off. This can be done without disturbing the wiring field wiring on the Terminal Assembly.

Figure 12

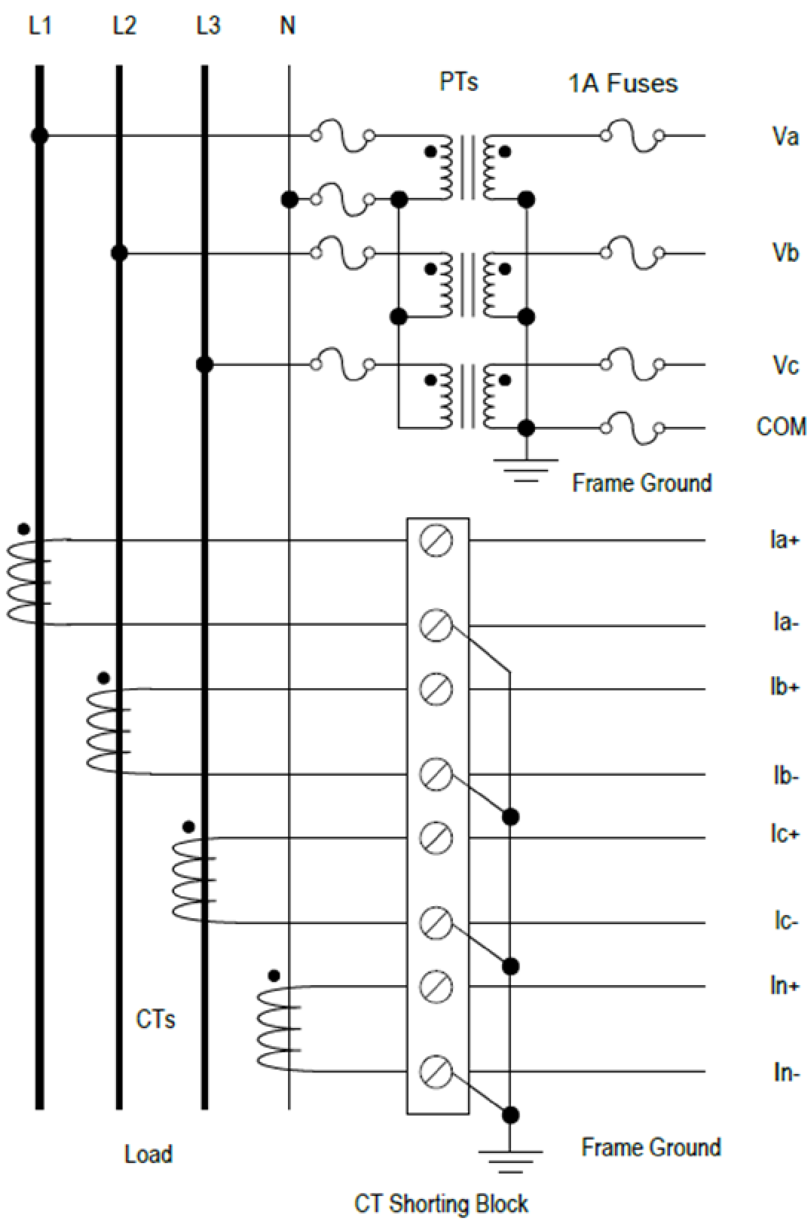


Connection to Three-Phase Four-Wire WYE System with Three PTs

The connections for a typical three-phase, four-wire system are shown below. The PTs are selected to take the nominal line voltage down to the nominal 120VAC, or 600VAC that can be processed by the Terminal Assembly/PSM system. Note that the additional scaling for each CT and PT must be applied to all the results given by the PSM through the host controller.

The primaries and secondaries of each potential transformer should be fused for maximum protection. A fuse failure is an indication of wiring problems within the system.

Figure 13



Configuration for Three-Wire Delta system with Two PTs (Two Wattmeter Method) for Load Monitoring

The systems detailed below show two PTs being used in an open delta configuration connected to the Terminal Assembly. The PSM module can be configured for either B phase common, or C phase common. In this mode (selected through the configuration parameters) the line to line voltage is typically scaled down to the level of 120VAC nominal. The third voltage and current are reconstructed from the other two by the PSM.

The reconstructed signals must be configured as not used. All additional scaling factors must be applied to the values being returned by the PSM by the host controller logic program.

For safety considerations, both the primaries and secondaries of the potential transformers must be fused. A fuse failure is an indication of wiring problems within the system. Note that in this configuration, the phasing of the potential transformers is slightly different.

Figure 14

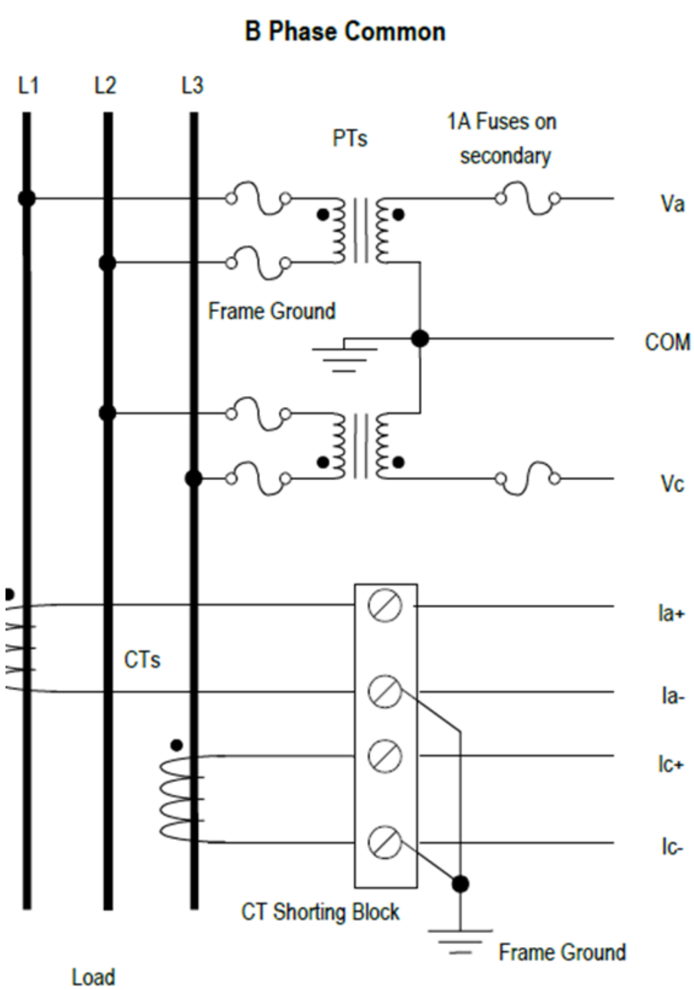
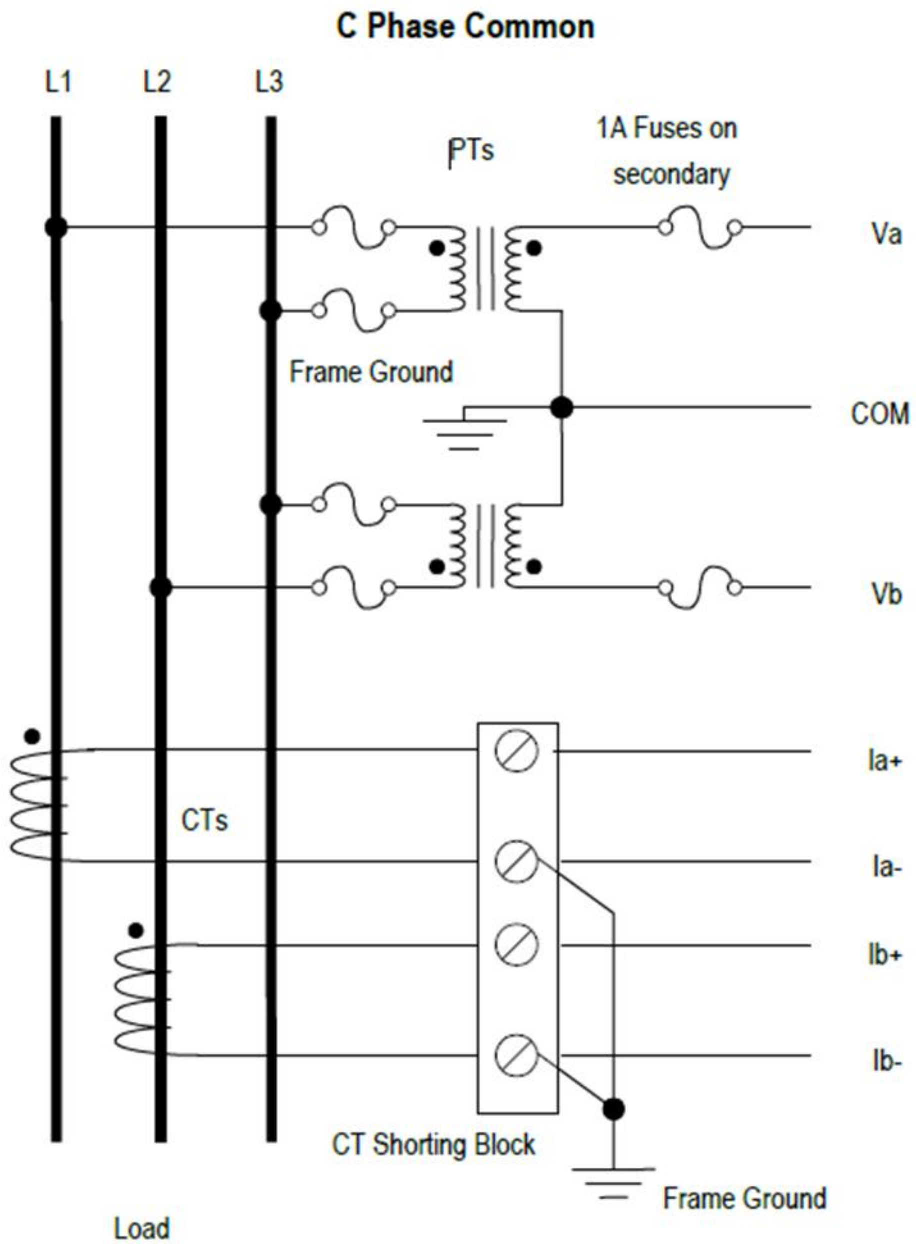


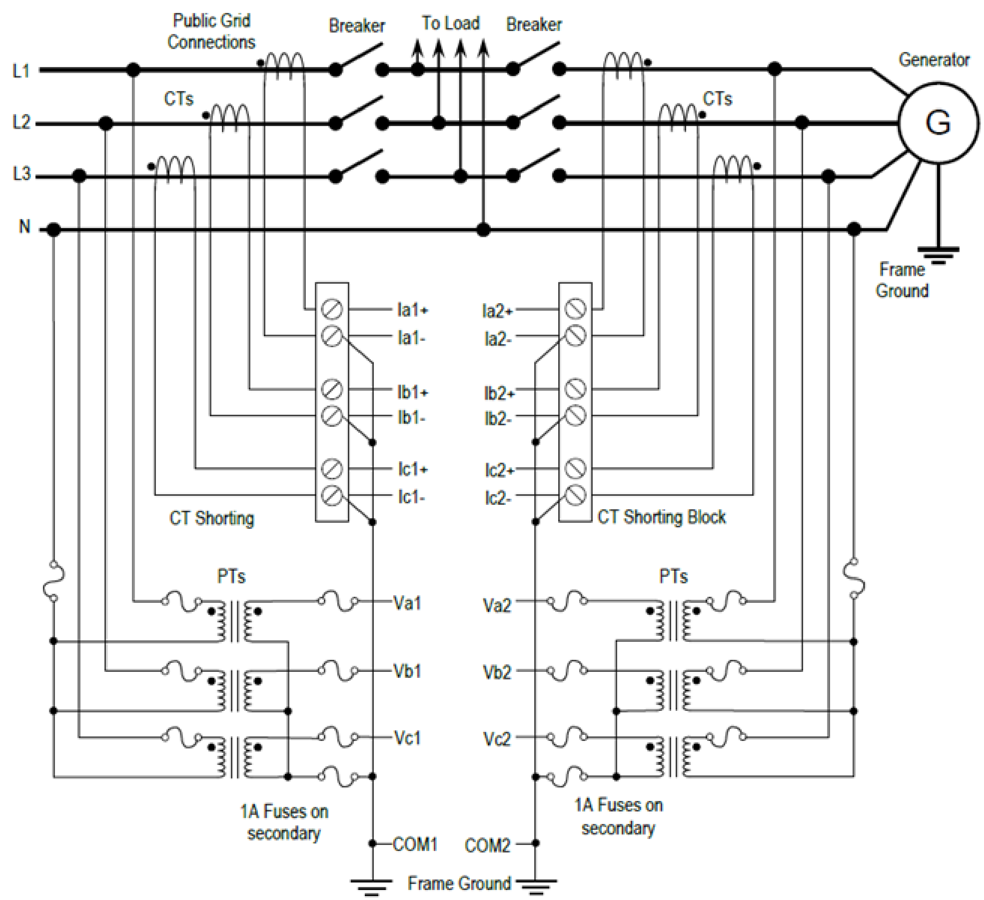
Figure 15



WYE Synchro/Power Control Connection

In the following figure the PSM system is connected between two systems, the Public Grid and Generator sub-systems. This connection scheme gives the PSM module all the information needed to make decisions about paralleling the two grids. Fuses on the PT primaries and secondaries are required. A fuse failure indicates wiring problems within the system.

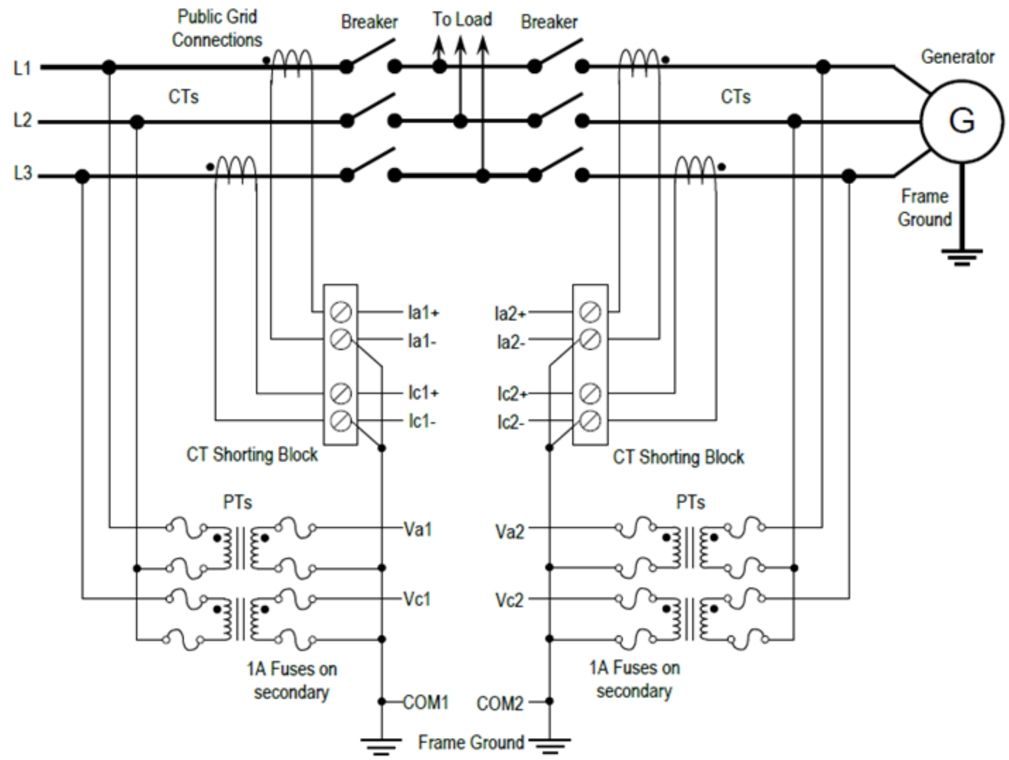
Figure 16



Delta Synchro/Power Monitor Connection (Two Wattmeter Method)

This diagram illustrates the wiring of an open delta system utilizing the two-wattmeter method of measurement. When used for paralleling the two grids, the missing voltage and current inputs must be configured as unused, so the PSM can reconstruct those signals Fuses on the PT primaries and secondaries are required. A fuse failure is an indication of wiring problems within the system.

Figure 17



2.7 Scaling for PT and CT Ratios

The IC694PSM001 module reports the voltages and currents measured at the IC694ACC200 terminals. Therefore, the application logic must correct for PT and CT ratios to reflect the actual power grid voltages, currents, powers and energies.

2.7.1 Example:

Using 480V:120V PTs requires the application logic to multiply the reported voltage values by 4. Using 100:5 CTs requires the application logic to multiply the reported current values by 20. Since power and energy combine voltage and current, the reported power and energy values must both be multiplied by 80 (4 x 20).

Chapter 3: Configuration and Data Transfer

The PSM module is configured using the Emerson programming software. Configuration parameters are used to set nominal values for Grid1 and Grid2 voltage, current and frequency, and to calibrate the PSM system for specific Potential Transformer and Current Transformer gains, increasing the accuracy of the measured values.

Configuration parameters are also used to set ANSI device threshold and delay values. A Mode Control register, consisting of 32 bits in %Q memory, selects operational and measurement modes. The application must apply initial values to these bits and can change them while the PSM is running.

The application can change a single configuration parameter in run mode by modifying the two-word Parameter Write register in %AQ memory.

3.1 Configuration Parameters

To configure the PSM module in PAC Machine Edition under Hardware Configuration, right click and select Add a Module, then select IC694PSM001 from the Specialty Modules tab.

3.1.1 PSM001 Settings Parameters

Parameter	Function
Status Input Address	Starting address in %I memory for the array of status flags sent from the PSM module to the RX3i CPU. For details, see page 41.
Status Input Length	(Read-only.) The number of %I reference addresses used by the PSM module. 80 bits
Signal Input Address	Starting address in %AI memory for the data reported from the PSM module to the RX3i CPU. For details, see page 45.
Signal Input Length	(Read-only.) The number of %AI reference addresses used by the PSM module. 64 words
Mode Control Address	Starting address in %Q memory for the configuration data that is sent every scan from the RX3i CPU to the PSM module. For details, see page 50.
Mode Control Length	(Read-only.) The number of %Q reference addresses used by the PSM module. 32 bits
Parameter Write Address	Starting address in %AQ memory for the location of a single parameter and its value, which can be changed in run mode. For details, see page 54.
Parameter Write Length	(Read-only.) The number of %AQ reference addresses used by the PSM module. 2 words

Parameter	Function
Inputs Default	The state of the channel value reference addresses when the module providing those inputs is not available or the module collecting those inputs is not available. Choices: • Force Off: The affected channel values are set to zero, and all alarm flags are cleared. • Hold Last State: The affected channel values retain the state they were in before the module became unavailable.
I/O Scan Set	The scan set, as defined in the CPU's Scan Sets tab, to be assigned to this module. The scan set determines how often the CPU polls the data.

3.1.2 Grid1 and Grid2 Parameters

The Grid1 tab is used to set the parameters for GRID 1 (Public Grid/Load 1). The Grid 2 tab is used to set the parameters for GRID 2 (Generator Grid/load 2) These parameters include the gain and offset calibration constants required for the module and the gain calibration constant of each of the input channels. These calibration constants are on the side label of the PSM module and on the front plate of the Terminal Assembly. There are two sets of the voltage channel (VA, VB and VC) gain constants because there are two voltage ranges available for the user.

The other parameters select the nominal values of the voltages, currents and frequencies that will be used by the ANSI functions to monitor voltage, current, power and frequency deviations to set and clear alarms.

Parameter	Function
Voltage Selection	Select 120 for input voltages in the 45-150 VAC range. Select 600 for voltages in the 120 to 690 VAC range. The Voltage Selection must match both the physical cable connection to the IC694ACC200 terminal assembly and the %Q offset 2 (Grid 1) and %Q offset 18 (Grid 2) configuration bits. Refer to chapter 2 for proper wiring and configuration information.
Nominal Voltage [Volts]	Enter the actual voltage expected on the grid. This value is used by the ANSI calculations to determine under/over voltage, VI imbalance and in setting the fault status bits. Range and Default: Depends on Voltage Selection

Parameter	Function
Nominal Current [Amps]	Enter the maximum anticipated current delivered by the external Current Transformers. All process currents must be scaled to a value of 5 Amps or less. This value is used by the ANSI calculations to determine overcurrent, VI Imbalance and in setting the fault status bits **Note:** *Setting a negative Nominal Current value implies that the IC694ACC200 grid inputs are connected to a load (drawing power) instead of a power source (producing power). The power and energy values will be reported as negative numbers. The CTs must be wired with the correct polarity to achieve the negative power and energy values. You are responsible for the correct PTs/CTs connections to obtain the negative sign of each reported phase (and the total) active power. RMS current is necessarily reported as a positive number, due to the RMS calculations* Range: -7.5 to 7.5 Default: 5.0
Nominal Frequency [Hz]	Select the steady-state frequency of the grid. This value is used by the ANSI calculations to determine under/over frequency. Choices: 50, 60 Default: 60
Module Offset	**Calibration constant**. Value provided on the PSM001 module label. Setting this value allows maximum measurement accuracy. Range: -1000 to +1000 Default: 0
Module Gain	**Calibration constant**. Value provided on the PSM001 module label. Setting this value allows maximum measurement accuracy. Range: 0h to FFFFh Default: 4000h
VAxL Gain	**Calibration constant**. Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the 120V range of channel 1 (VA). This value can be further adjusted to compensate for inaccuracies of external Potential Transformers and wiring. Range: 0h to FFFFh Default: 4000h

Parameter	Function
VAxH Gain	**Calibration constant.** Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the 600V range of channel 1 (VA). This value can be further adjusted to compensate for inaccuracies of external Potential Transformers and wiring. Range: 0h to FFFFh Default: 4000h
IAx Gain	**Calibration constant**. Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the current measurement of channel 2 (IA). This value can be further adjusted to compensate for inaccuracies of external Current Transformers and wiring. Range: 0h to FFFFh Default: 4000h
VBxL Gain	**Calibration constant.** Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the 120V range of channel 3 (VB). This value can be further adjusted to compensate for inaccuracies of external Potential Transformers and wiring. Range: 0h to FFFFh Default: 4000h
VBxH Gain	**Calibration constant.** Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the 600V range of channel 3 (VB). This value can be further adjusted to compensate for inaccuracies of external Potential Transformers and wiring. Range: 0h to FFFFh Default: 4000h
IBx Gain	**Calibration constant**. Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the current measurement of channel 4 (IB). This value can be further adjusted to compensate for inaccuracies of external Current Transformers and wiring. Range: 0h to FFFFh Default: 4000h
VCxL Gain	**Calibration constant.** Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the 120V range of channel 5 (VC). This value can be further adjusted to compensate for inaccuracies of external Potential Transformers and wiring. Range: 0h to FFFFh Default: 4000h

Parameter	Function
VCxH Gain	**Calibration constant.** Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the 600V range of channel 5 (VC). This value can be further adjusted to compensate for inaccuracies of external Potential Transformers and wiring. Range: 0h to FFFFh Default: 4000h
ICx Gain	**Calibration constant**. Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the current measurement of channel 6 (IC). This value can be further adjusted to compensate for inaccuracies of external Current Transformers and wiring. Range: 0h to FFFFh Default: 4000h
INx Gain	**Calibration constant.** Value provided on the ACC200 Terminal Assembly label. Improves the accuracy of the current measurement of channel 7 (IN). This value can be further adjusted to compensate for inaccuracies of external Current Transformers and wiring. Range: 0h to FFFFh Default: 4000h

3.1.3 ANSI Protection Parameters

Use this tab to configure the ANSI functions for Grid 1 (Public Grid/Load) and Grid 2 (Generator/Generator Grid).

These parameters specify the ANSI alarm thresholds and debounce time periods.

Parameter	Function
ANSI 25 Phase Shift Threshold (degrees)	The angle window, in electrical degrees, around the zero degree phase angle difference between Grid 1 and Grid 2 that will be allowed. For example, a value of 10 means the PSM module is allowed to close the synchronizing relay when the Grid 2 voltage phase is within $\pm 10^0$ of the Grid 1 voltage phase. Range: 0.1 to 45.0 Default: 10.0

Parameter	Function
ANSI 25 Breaker Delay (msec)	Breaker Delay allows the PSM module to compensate for the delay from CloseRelayOK (%I offset 7) being asserted until the synchronizing breaker contacts actually make electrical contact. Set to 0 to use static phase angle synchronization Set to actual closure delay for rotating phase angle synchronization. Enter the ACC200 turn-on time plus the published closing delay, or measured closing delay from energizing the breaker, until the contacts are closed. **Note:** *When the ANSI 25 Breaker Delay parameter is set to a non-zero value, the phase angle difference at which RelayCloseOK is set and the IC694ACC200 relay outputs close varies in direct proportion to the rate of change of the phase angle of Grid 2 relative to Grid 1. Higher rates of phase angle change and larger breaker delays require that the PSM assert RelayCloseOK earlier to ensure that the breaker contacts close within the safe region set by the ANSI 25 Phase Shift Threshold parameter.* Range: 0 to 1000 Default: 0 (implies static phase angle synchronization)
ANSI 25 Delta Voltage Threshold (%)	The maximum difference between the Grid 2 RMS voltage and the Grid 1 RMS voltage, as a percentage of Grid 1, where the grids may be connected. Grid 1 is assumed to be a stable utility grid. Grid 2 is assumed to be a variable generator grid. This value is a tolerance around the Grid 1 voltage. Range: 1 to 100 Default: 10
ANSI 25 Delta Frequency Threshold (Hz)	The maximum difference between the Grid 2 frequency and the Grid 1 frequency, in Hz, where the grids may be connected. Grid 1 is assumed to be a stable utility grid. Grid 2 is assumed to be a variable generator grid. This value is a tolerance around the Grid 1 frequency. Range: 0.01 to 5.00 Default: 0.1
ANSI 27 Under Voltage Threshold (%)	The voltage below which the Under-Voltage Alarm status is set (after the Under-Voltage Delay), as a percentage of the Nominal Voltage parameter. Range: 0 to 99 Default: 90
ANSI 27Under Voltage Delay [1] (sec)	The amount of time a phase voltage must remain below the Under-Voltage Threshold before the Under-Voltage Alarm status is set. Range: 0.1 to 3276.7 Default: 10.0

Parameter	Function
ANSI 32 Reverse Power Threshold (%)	The percentage of nominal power that determines when the Reverse Power Alarm status is set (after the Reverse Power Delay). Nominal Power = Nominal Voltage x Nominal Current. For Grid 1, the Reverse Power alarm will be triggered if a circuit's active power exceeds the Reverse Power Threshold for a time period longer than Reverse Power Delay. For Grid 2, the Reverse Power alarm will be triggered if a circuit's active power falls below the Reverse Power Threshold for a time period longer than Reverse Power Delay. Range: -100 to 99 Default: -10
ANSI 32 Reverse Power Delay [1] (sec)	The amount of time a grid must remain below the Reverse Power Threshold before the Reverse Power Alarm status is set. Range: 0.1 to 3276.7 Default: 10.0
ANSI 50 Over Current Threshold (%)	The current above which the Over Current Alarm status is set (after the Over Current Delay), as a percentage of the Nominal Current parameter. Range: 110 to 250 Default: 110
ANSI 50 Over Current Delay [1] (sec)	The amount of time a phase current must remain above the Over Current Threshold before the Over Current Alarm status is set. Range: 0.1 to 3276.7 Default: 10.0
ANSI 59 Over Voltage Threshold (%)	The phase voltage above which the Over Voltage Alarm status is set (after the Over Voltage Delay), as a percentage of the Nominal Voltage parameter. Range: 101 to 250 Default: 115
ANSI 59 Over Voltage Delay [1](sec)	The amount of time a phase voltage must remain above the Over Voltage Threshold before the Over Voltage Alarm status is set. Range: 0.1 to 3276.7 Default: 10.0

[1] For all alarm conditions, the clear time is the same as the set time. In order for the alarm to be cleared, the alarm condition must be absent continuously for the entire Delay.

Parameter	Function
ANSI 60 VI Imbalance Threshold (%)	The amount any one phase voltage or phase current reading must vary, as a percentage of the average of all three phases within the same grid, to trigger the VI Imbalance alarm (after the VI Balance Delay). The VI Imbalance alarm compares voltage phases to voltage phases, and current phases to current phases within a grid. No comparison is made between grids. If any voltage varies from the average of all three voltages, or if any current varies from the average of all three currents (by more than the VI Imbalance Threshold) for longer than the VI Imbalance Delay, that grid's VI Imbalance Alarm is set. Range: 1 to 100 Default: 10
ANSI 60 VI Imbalance Delay [2] (sec)	The amount of time anyone phase voltage or phase current reading can exceed the VI Balance Threshold before the VI Balance Alarm status is set. Range: 0.1 to 3276.7 Default: 10.0
ANSI 81U Under Frequency Threshold (Hz)	The frequency difference from the Nominal Frequency below which the Under-Frequency Alarm status is set (after the Under-Frequency Delay). 0Range: 0.01 to 10.0 Default: 0.5
ANSI 81U Under Frequency Delay (sec) [2]	The amount of time a grid's frequency must remain below the Under-Frequency Threshold before the Under-Frequency Alarm status is set. Range: 0.1 to 3276.7 Default: 10.
ANSI 81O Over Frequency Threshold (Hz)	The frequency difference from the Nominal Frequency above which the Over Frequency Alarm status is set (after the Over Frequency Delay). Range: 0.01 to 10.0 Default: 0.5
ANSI 81O Over Frequency Delay (sec) [2]	The amount of time a grid's frequency must remain Above the Over Frequency Threshold before the Over Frequency Alarm status is set. Range: 0.1 to 3276.7 Default: 10

[2] For all alarm conditions, the clear time is the same as the set time. The alarm condition must be absent continuously for the Delay Time for the alarm to be cleared.

Imbalance Threshold Examples

Example 1:

VI Imbalance is set to 20%, VA1 = 126V, VB1 = 90V, VC1 = 124V

The difference between VB1 and the average of the three voltages is greater than 20%, so the VI Imbalance alarm will be set.

Example 2:

VI Imbalance is set to 25%, IA2 = 4.2A, IB2 = 3.6A, IC2 = 5.5A

The difference between IC2 and the average of the three currents is less than 25%, so the VI Imbalance alarm will not be set.

3.1.4 Power Consumption

This tab displays the current that the module consumes for each voltage provided by the power supply.

3.1.5 Terminals

If Variable Mode is selected in the module Properties, you can use this tab to map I/O variables to the reference memory addresses used by the PSM module.

3.2 Data Transfer

3.2.1 PSM Status Flags

The PSM returns 80 status flag bits to the RX3i controller. Those 80 bits are grouped into five 16-bit words.

- The first status word (%I1 – %I16) contains the overall PSM status flags.
- The following two words (%I17 – %I48) contain the individual grid measurement faults. These flags identify the voltage/current channel experiencing a measurement problem. It can be one or multiple problems related to:
  - Input signal not present, that is, it is indicated as not measured in the corresponding %Q flag bit AND it cannot be reconstructed by the PSM module firmware.
  - Input signal is measured but it is clamped due to a higher peak voltage/current value than the maximum value allowed to be applied to the interface unit
- The last two status words (%I49 – %I80) contain the individual grid status flags, including the ANSI alarms.

Offset	Definition	Value	Status/Alarm Timing A, B, AB: See "Status/Alarm Timing" on page 45	Alarm[3] Availability	
				1ø	3ø
1	PSM HeartBeatBit:	Toggled with every scan/sweep	Updated every scan		
2	PSM ConnectionOK:	1 = OK 0 = PSM to Terminal Assembly connection failure	A		
3	PSM PhaseShiftOK:	1 = OK 0 = ANSI 25/1 Alarm	A		
4	PSM DeltaVoltOK:	1 = OK 0 = ANSI 25/2 Alarm	A		
5	PSM DeltaFreqOK:	1 = OK 0 = ANSI 25/3 Alarm	A		
6	PSM AllGridAlarmsOK	1 = OK 0 = At least one alarm on either grid is set	AB		
7	PSM RelayCloseOK:	1 = OK 0 = Do not close relay	A		
8	PSM New Data	1 = The current PLC sweep is the first sweep this power line cycle data is being delivered by the PSM to the PLC. 0 = Data has not changed from previous sweep.	A		
9 - 16	Reserved				
17	GRID 1 FaultVA	0 = OK 1 = Fault – clamped or not calculated/measured	A		
18	GRID 1 FaultIA		A		
19	GRID 1 FaultVB		A		
20	GRID 1 FaultIB:		A		

[3] Alarm availability: A checkmark indicates whether an alarm is available for use in either the 1-Phase (1ø) or the 3-Phase (3ø) Grid Operational Mode (see "Mode Control Bits Sent to PSM module" on page 50). All alarms are available in 3-Phase mode. An absent checkmark indicates that the value of the bit is indeterminate and the bit should be ignored.

Offset	Definition	Value	Status/Alarm Timing A, B, AB: See "Status/Alarm Timing" on page 45	Alarm[3] Availability	
				1ø	3ø
21	GRID 1 FaultVA/VBA; VB/VAC; VC/VBC		A		
22	GRID 1 FaultIC		A		
23	GRID 1 FaultIN		A		
24-32	Reserved				
33	GRID 2 FaultVA_VCA	0 = OK 1 = Fault – clamped or not calculated/measured	A		
34	GRID 2 FaultIA		A		
35	GRID 2 FaultVB_VCB		A		
36	GRID 2 FaultIB:		A		
37	GRID 2 FaultVC:		A		
38	GRID 2 FaultIC		A		
39	GRID 2 FaultIN		A		
40 - 48	Reserved				
49	GRID 1 ClampedFreq	0 = OK 1 = Line Frequency outside the range (30 - 70 Hz)	A		
50	GRID 1 ClampedInput:	0 = OK 1 = some inputs have signal clamped	A		
51	GRID 1 MixedPolarity	0 = OK 1 = At least one phase PT/CT has wrong polarity	B		
52	GRID 1 VoltPhSeqAlarm	0 = OK 1 = ANSI 47 Alarm	B		
53	GRID 1 UnderVoltAlarm	0 = OK 1 = ANSI 27 Alarm	B		
54	GRID 1 ReversPwrAlarm	0 = OK 1 = ANSI 32 Alarm	B		

Offset	Definition	Value	Status/Alarm Timing A, B, AB: See "Status/Alarm Timing" on page 45	Alarm[3] Availability 1ø	 3ø
55	GRID 1 OverCurrAlarm	0 = OK 1 = ANSI 50 Alarm	B		
56	GRID 1 OverVoltAlarm	0 = OK 1 = ANSI 59 Alarm	B		
57	GRID 1 VIImbalanceAlarm	0 = OK 1 = ANSI 60 Alarm	B		
58	GRID 1 UnderFreqAlarm	0 = OK 1 = ANSI 81U Alarm	B		
59	GRID 1 OverFreqAlarm	0 = OK 1 = ANSI 81O Alarm	B		
60 - 64	Reserved				
65	GRID 2 ClampedFreq:	0 = OK 1 = Line Frequency outside the range (30 - 70 Hz)	A		
66	GRID 2 ClampedInput:	0 = OK 1 = some inputs have signal clamped	A		
67	GRID 2 MixedPolarity	0 = OK 1 = At least one phase PT/CT has wrong polarity	B		
68	GRID 2 VoltPhSeqAlarm	0 = OK 1 = ANSI 47 Alarm	B		
69	GRID 2 UnderVoltAlarm	0 = OK 1 = ANSI 27 Alarm	B		
70	GRID 2 ReversPwrAlarm	0 = OK 1 = ANSI 32 Alarm	B		
71	GRID 2 OverCurrAlarm	0 = OK 1 = ANSI 50 Alarm	B		
72	GRID 2 OverVoltAlarm	0 = OK 1 = ANSI 59 Alarm	B		
73	GRID 2 VIImbalanceAlarm	0 = OK 1 = ANSI 60 Alarm	B		
74	GRID 2 UnderFreqAlarm	0 = OK 1 = ANSI 81U Alarm	B		

Offset	Definition	Value	Status/Alarm Timing A, B, AB: See "Status/Alarm Timing" on page 45	Alarm[3] Availability	
				1ø	3ø
75	GRID 2 OverFreqAlarm	0 = OK 1 = ANSI 81O Alarm	B		
76 – 80	Reserved				

Status/Alarm Timing

Timing A – The PSM buffers an entire power line cycle and takes 11ms to perform calculations on the waveforms. The new status bits are available to the application code after the next PLC input data scan.

Total latency = 1-cycle + 11ms + (0 to PLC scan time)

Update rate = 1-cycle or the PLC scan rate (whichever is longer)

Timing B – The PSM updates this information every 100ms. The new status bits are available to the application code after the next PLC input data scan.

Update rate = 100ms or the PLC scan rate (whichever is longer)

Timing AB – AllGridAlarmsOK follows the timing of the alarm that causes it to be cleared or set.

PSM Signal Input Data

The PSM module reports its analog data in 16-bit integer, pseudo-actual values. The integer values are a fixed power of 10 offset from the actual measured value at the Terminal Assembly. The following table lists the units of measure of each type of signal. (For example, voltage is reported in 0.1V units, so a voltage reading of 1256 = 125.6V.)

Units of Measure

Physical Variable	Unit	Example
VOLTAGE – V	0.1 [V]	2791= 279.1VACrms
CURRENT – I	0.001 [A]	4278 = 4.278Arms
ACTIVE POWER – P	1 [W]	2478 = 2,478W
REACTIVE POWER – Q	1 [VAR]	965 = 965VAR
ACTIVE ENERGY – Ept	1 [Wh]	2158349 = 215,349Wh
REACTIVE ENERGY – Eqt	1 [VARh]	37892 = 37,892VARh
POWER FACTOR - PF[4]	0.001	923 = 0.923
LINE FREQUENCY – LF	0.01 [Hz]	6001 = 60.01Hz
PHASE SHIFT – PS	0.1 [electrical degree]	257 = 25.7º

[4] Although the PSM reports power factor information using three decimal places, the information is only accurate to two decimal places.

Signal Data from the PSM Module for Two 3-Phase or Three 1-Phase Systems

If the PSM module is configured as two 3-phase (or 3 x single phase) systems, the following data is reported data to the host controller.

Note: *Not all values are updated for all configuration types.*

%AI Word Offset	Value	Comments
1	GRID 1– Phase An Voltage – RMS value (phase-to-neutral)	WYE configuration only In Delta configuration always 0
2	GRID 1– Phase Ap Voltage – RMS value (phase-to-phase)	WYE and Delta configurations
3	GRID 1– Phase A Voltage – DC component	
4	GRID 1– Phase A Current – RMS value	
5	GRID 1– Phase A Active Power	
6	GRID 1– Phase A Reactive Power	
7	GRID 1– Phase Bn Voltage – RMS value (phase-to-neutral)	WYE configuration only In Delta configuration always 0.
8	GRID 1– Phase Bp Voltage – RMS value (phase-to-phase)	WYE and Delta C-common configurations Delta B-common always 0
9	GRID 1– Phase B Voltage – DC component	
10	GRID 1– Phase B Current – RMS value	WYE and Delta C-common configurations Delta B-common always 0
11	GRID 1– Phase B Active Power	
12	GRID 1– Phase B Reactive Power	
13	GRID 1– Phase Cn Voltage – RMS value (phase-to-neutral)	WYE configuration, only In Delta configuration always 0
14	GRID 1– Phase Cp Voltage – RMS value (phase-to-phase)	WYE and Delta B-common configurations Delta C-common always 0
15	GRID 1– Phase C Voltage – DC component	
16	GRID 1– Phase C Current – RMS value	WYE and Delta B-common configurations Delta C-common always 0
17	GRID 1– Phase C Active Power	
18	GRID 1– Phase C Reactive Power	
19	GRID 1– Neutral Current – RMS value	
20	GRID 1– Total Active Power	
21	GRID 1– Total Reactive Power	

%AI Word Offset	Value	Comments
22	GRID 1– Total Power Factor	
23	GRID 1– Line Frequency	
24	GRID 1– Total 15-minute Active Power Demand	
25	GRID 1– Total 15-minute Reactive Power Demand	
26	GRID 1– Total Active Energy - LSW	
27	GRID 1– Total Active Energy - MSW	
28	GRID 1– Total Reactive Energy - LSW	
29	GRID 1– Total Reactive Energy - MSW	
30	GRID 2– Phase A Voltage – RMS value (phase-to-neutral)	WYE configuration only In Delta configuration always 0
31	GRID 2– Phase Ap Voltage – RMS value (phase-to-phase)	WYE and Delta configurations
32	GRID 2– Phase A Voltage – DC component	
33	GRID 2– Phase A Current – RMS value	
34	GRID 2– Phase A Active Power	
35	GRID 2– Phase A Reactive Power	
36	GRID 2– Phase Bn Voltage – RMS value (phase-to-neutral)	WYE configuration only In Delta configuration always 0.
37	GRID 2– Phase Bp Voltage – RMS value (phase-to-phase)	WYE and Delta C-common configurations Delta B-common always 0
38	GRID 2– Phase B Voltage – DC component	
39	GRID 2– Phase B Current – RMS value	WYE and Delta C-common configurations Delta B-common always 0
40	GRID 2– Phase B Active Power	
41	GRID 2– Phase B Reactive Power	
42	GRID 2– Phase Cn Voltage – RMS value (phase-to-neutral)	WYE configuration, only In Delta configuration always 0
43	GRID 2– Phase Cp Voltage – RMS value (phase-to-phase)	WYE and Delta B-common configurations Delta C-common always 0
44	GRID 2– Phase C Voltage – DC component	

%AI Word Offset	Value	Comments
45	GRID 2– Phase C Current – RMS value	WYE and Delta B-common configurations Delta C-common always 0
46	GRID 2– Phase C Active Power	
47	GRID 2– Phase C Reactive Power	
48	GRID 2– Neutral Current – RMS value	
49	GRID 2– Total Active Power	
50	GRID 2– Total Reactive Power	
51	GRID 2– Total Power Factor	
52	GRID 2– Line Frequency	
53	GRID 2– Total 15-minute Active Power Demand	
54	GRID 2– Total 15-minute Reactive Power Demand	
55	GRID 2– Total Active Energy - LSW	
56	GRID 2– Total Active Energy - MSW	
57	GRID 2– Total Reactive Energy - LSW	
58	GRID 2– Total Reactive Energy - MSW	
59	Phase Shift between GRID 1 and GRID 2 Phase A/CA voltages	
60	FW version / Captured sample / Diagnostic data	
61 - 64	Reserved	

Signal Data from the PSM Module for One 3-Wire 1-Phase System

If the PSM module is configured as one 3-wire single phase system (600/1200 or 120/240), the data returned to the PLC are as follows:

%AI Word Offset	Value
1	GRID 1-Section A Voltage – RMS value (phase-to-neutral)
2	N/A
3	GRID 1-Section A Voltage – DC component
4	GRID 1-Section A Current – RMS value
5	GRID 1-Section A Active Power
6	GRID 1-Section A Reactive Power
7	GRID 1-Section B Voltage – RMS value (phase-to-neutral)
8	N/A
9	GRID 1-Section B Voltage – DC component

%AI Word Offset	Value
10	GRID 1-Section B Current – RMS value
11	GRID 1-Section B Active Power
12	GRID 1-Section B Reactive Power
13 – 18	N/A
19	GRID 1-Neutral Current – RMS value
20	GRID 1 – Total Active Power
21	GRID 1 – Total Reactive Power
22	GRID 1-Total Power Factor
23	GRID 1-Line Frequency
24	GRID 1-Total 15-minute Active Power Demand
25	GRID 1-Total 15-minute Reactive Power Demand
26	GRID 1-Total Active Energy – LSW
27	GRID 1-Total Active Energy – MSW
28	GRID 1-Total Reactive Energy – LSW
29	GRID 1-Total Reactive Energy – MSW
30	GRID 2-Section A Voltage – RMS value
31	N/A
32	GRID 2-Section A Voltage – DC component
33	GRID 2-Section A Current – RMS value
34	GRID 2-Section A Active Power
35	GRID 2-Section A Reactive Power
36	GRID 2-Section B Voltage – RMS value
37	N/A
38	GRID 2-Section B Voltage – DC component
39	GRID 2-Section B Current – RMS value
40	GRID 2-Section B Active Power
41	GRID 2-Section B Reactive Power
42 – 47	N/A
48	GRID 2-Neutral Current – RMS value
49	GRID 2 – Total Active Power
50	GRID 2 – Total Reactive Power
51	GRID 2-Total Power Factor
52	GRID 2-Line Frequency
53	GRID 2-Total 15-minute Active Power Demand
54	GRID 2-Total 15-minute Reactive Power Demand
55	GRID 2-Total Active Energy - LSW
56	GRID 2-Total Active Energy - MSW

%AI Word Offset	Value
57	GRID 2-Total Reactive Energy - LSW
58	GRID 2-Total Reactive Energy - MSW
59	Phase Shift between GRID 1 and GRID 2 Voltages
60	FW version / Captured sample / Diagnostic data
61 - 64	Reserved

Data Sent from the Host Controller to the PSM Module

The RX3i CPU sends 32 %Q bits of Mode Control data and 2 %AQ Parameter words every sweep to the PSM module.

3.2.2 Mode Control Bits Sent to PSM module

The application logic must apply initial values to these bits on the first RX3i scan. The application can change these settings during operation to modify measurement modes in response to changing conditions.

%Q Bit Offset	Function
1	GRID 1 Operation: 0 = disabled, 1 = enabled If disabled, the PSM system does no measurements for the GRID 1 power grid. **Note:** *Both grids (bits Q1 and Q17) must be enabled in order for the PSM module to act as a 2-source synchronizer.*
2	GRID 1 Voltage Selection: 0 = low voltage range (120VAC), 1 = high voltage range (600VAC) **⚠CAUTION** The voltage range is determined by the physical connections in the system. Changing this bit to a value that does not match the physical configuration will result in erroneous power system measurements. Do not change this value in run mode
3	GRID 1 Grid Operational Mode: 0 = single phase, 1 = three-phase
4	GRID 1 Connection mode. Works with the Operational Mode setting to determine system type. • For single phase mode: 0 = Three single phases 1 = Three-wire, single phase (120/240) using PTA and PTB • For three-phase mode: 0 = WYE, 1 = DELTA

%Q Bit Offset	Function
5	**GRID 1 PTA_CA measurement: 0 = not measured, 1 = measured Refer to**
6	GRID 1 CTA measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
7	GRID 1 PTB measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
8	GRID 1 CTB measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
9	GRID 1 PTC measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
10	GRID 1 CTC measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
11	GRID 1 CTN measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
12	GRID 1 Waveform Capture: changing from 0 to 1 When the PSM detects a change of this bit from a zero to one, it captures all 128 samples of all seven variables belonging to the grid.
13	GRID 1 Delta Mode: 0 = B phase is common, 1= C phase is common This bit must be set to 0 if the phase B is used as the common connection for the other two voltages (North American standard). If the phase C is used as the common phase in a Delta connection, this bit must be set to 1.
14	Reserved
15	GRID 1 Energy reset: When set, the accumulated energy for Grid 1 is reset and held at 0 Wh and 0 VARh. When cleared, the Grid 1 energy value represents the accumulated energy since power-up, or the last reset.
16	Relay open: Works with bit 32 to control the Sync Relay operation. For more information, see "
17	GRID 2 Operation: 0 = disabled, 1 = enabled If disabled, the PSM system does no measurements for the GRID 2 power grid. **Note:** *If you are installing the ground plate on a painted surface, the paint must be removed where the ground plate is to be mounted to ensure a good ground connection between the plate and mounting surface. Both grids (bits Q1 and Q17) must be enabled in order for the PSM module to act as a 2-source synchronizer.*

%Q Bit Offset	Function
18	GRID 2 Voltage selection: 0 = low voltage range (120VAC), 1 = high voltage range (600VAC) **⚠CAUTION** The voltage range is determined by the physical connections in the system. Changing this bit to a value that does not match the physical configuration will result in erroneous power system measurements.
19	GRID 2 Grid Operational mode: 0 = single phase, 1 = three-phase
20	GRID 2 Connection mode: Works with the Operational mode setting to determine system type. • For single phase mode: 0 = 3 single phases , 1 = 3-wire single phase using PTA and PTB • For 3-phase mode: 0 = WYE, 1 = DELTA
21	GRID 2 PTA_CA measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
22	GRID 2 CTA measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
23	GRID 2 PTB measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
24	GRID 2 CTB measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
25	GRID 2 PTC measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
26	GRID 2 CTC measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
27	GRID 2 CTN measurement: 0 = not measured, 1 = measured Refer to "Reconstructed Variables ", p. 53.
28	GRID 2 1 Waveform Capture: changing from 0 to 1 When the PSM detects a change of this bit from a zero to one, it captures all 128 samples of all seven variables belonging to the grid.

%Q Bit Offset	Function
29	GRID 2 Delta Mode: 0 = B phase is common, 1= C phase common This bit must be set to 0 if the phase B is used as the common connection for the other two voltages (North American standard). If the phase C is used as the common phase in a Delta connection, this bit must be set to 1.
30	Reserved
31	GRID 2 Energy reset: When set, the accumulated energy for Grid 2 is reset and held at 0 Wh or 0 VARh. When cleared, the Grid 2 energy value represents the accumulated energy since power-up, or the last reset.
32	Relay close: Works with bit 16 to control the Sync Relay operation. For more information, see “

Reconstructed Variables

If a PTn/CTn control bit is set, the corresponding voltage/current is measured and the PSM system can use it. If cleared, the variable is not measured and the PSM module will try to reconstruct the missing samples from the other measured variables. The following table explains which variable in which measured system configuration can be reconstructed.

Dependence of reconstructed variable on measured variables

Variable	Conditions
GRIDx In	Missing Neutral in a 3-phase WYE connection if all phase currents are measured
GRID In	Missing Neutral in a 3-WIRE single phase system
GRIDx Vac/Vab	Missing (common phase) voltage in a 3-phase DELTA system (default is Vac)
GRIDx Ib/Ic	Missing (common phase) current in a 3-phase DELTA system (default is Ib)

In the three-phase Delta mode when only two voltages/currents are required to be measured (non-measured variable can be reconstructed), the two available channels can be used for an independent single voltage and/or current measurement

Note: *If the PSM system will be used for generator synchronization with a Delta system it is required that in both grids, the channels of non-measured voltage and current are left unused so that these variables can be reconstructed.*

Relay Open/Relay Close Operation

The Relay Open/Relay Close bits (%Q16 / %Q32) control the PSM's Sync controller function. The PSM can close the Sync contacts only if no ANSI alarm has been detected. The PSM opens the Sync contacts immediately (i.e. without waiting for the PLC to issue the 1-0-bit combination) if any of the ANSI alarms has been detected. It is recommended that after a successful Sync relay connection, the PLC sets those two bits to either a 0-0 or 1-1 (no action) state. Then, after a sync relay disconnection unintentional (e.g. due to some ANSI alarm) the PSM will not be able to close the Sync contacts without PLC intervention.

Relay Open (%Q16)	Relay Close (%Q32)	PSM Action
0	0	No action
0	1	Closes Sync contacts
1	0	Opens Sync contacts
1	1	No action

3.2.3 Parameters sent to PSM Module

Many of the configuration parameters can be modified by the application logic during runtime. These parameters are set initially when the hardware configuration is downloaded but can be modified during runtime to adjust to changing conditions.

Parameters are changed using two Word Parameter Write registers in %AQ memory. The first word contains the parameter index number and the second word contains the parameter value. One parameter can be changed per RX3i controller scan. Both %AQ locations should be set to a value of 0 when parameter values are not being changed.

It is recommended that the %AQ Word 2 be set to the desired value first, followed by the %AQ Word 1 being set to the index for at least one PLC scan. Then the %AQ Word 1 should be set to zero, followed by the %AQ Word being set to zero.

Index (%AQ Word 1)	Parameter Value (%AQ Word 2)	Default value	Value Limits
1	GRID 1 MODULE OFFSET	0	Calibrated value, -1000 to +1000
2	GRID 1 MODULE GAIN	0x4000	Calibrated value, 0h to FFFFh
3	GRID 1 VA1 GAIN LOW	0x4000	Calibrated value, 0h to FFFFh
4	GRID 1 VA1 GAIN HIGH	0x4000	Calibrated value, 0h to FFFFh
5	GRID 1 IA1GAIN	0x4000	Calibrated value, 0h to FFFFh
6	GRID 1 VB1 GAIN LOW	0x4000	Calibrated value, 0h to FFFFh
7	GRID 1 VB1 GAIN HIGH	0x4000	Calibrated value, 0h to FFFFh
8	GRID 1 IB1 GAIN	0x4000	Calibrated value, 0h to FFFFh
9	GRID 1 VC1 GAIN LOW	0x4000	Calibrated value, 0h to FFFFh
10	GRID 1 VC1 GAIN HIGH	0x4000	Calibrated value, 0h to FFFFh
11	GRID 1 IC1 GAIN	0x4000	Calibrated value, 0h to FFFFh
12	GRID 1 IN1 GAIN	0x4000	Calibrated value, 0h to FFFFh

Index (%AQ Word 1)	Parameter Value (%AQ Word 2)	Default value	Value Limits
13	GRID 1 Nominal Voltage	1200 [0.1 V]	450 to 1500 or 1200 to 7500
14	GRID 1 Nominal Current	5000 [0.001 A]	-7500 to 7500[5]
15	GRID 1 Nominal Frequency	6000 [0.01 Hz]	5000 or 6000
16	GRID 2 MODULE OFFSET	0	Calibrated value, -1000 to +1000
17	GRID 2 MODULE GAIN	0x4000	Calibrated value, 0h to FFFFh
18	GRID 2 VA2 GAIN LOW	0x4000	Calibrated value, 0h to FFFFh
19	GRID 2 VA2 GAIN HIGH	0x4000	Calibrated value, 0h to FFFFh
20	GRID 2 IA2 GAIN	0x4000	Calibrated value, 0h to FFFFh
21	GRID 2 VB2 GAIN LOW	0x4000	Calibrated value, 0h to FFFFh
22	GRID 2 VB2 GAIN HIGH	0x4000	Calibrated value, 0h to FFFFh
22	GRID 2 IB2 GAIN	0x4000	Calibrated value, 0h to FFFFh
23	GRID 2 VC2 GAIN LOW	0x4000	Calibrated value, 0h to FFFFh
26	GRID 2 VC2 GAIN HIGH	0x4000	Calibrated value, 0h to FFFFh
26	GRID 2 IC2 GAIN	0x4000	Calibrated value, 0h to FFFFh
27	GRID 2 IN2 GAIN	0x4000	Calibrated value, 0h to FFFFh
28	GRID 2 Nominal Voltage	1200 [0.1 V]	450 to 1500 or 1200 to 7500
29	GRID 2 Nominal Current	5000 [0.001 A]	-7500 to 7500[6]
30	GRID 2 Nominal Frequency	6000 [0.01 Hz]	5000 or 6000
31	PHASE_SHIFT_ THR (ANSI 25/1a)	100 [0.1 el°]	1 to 450
32	Breaker Delay (ANSI 25/b1)	0 (msec)	1 to 1000
33	DELTA_VOLT_THR (ANSI 25/2)	10 [%]	1 to 1000
34	DELTA_FREQ_THR (ANSI 25/3)	10 [0.01 Hz]	1 to 500
35	UNDER_VOLT_THR (ANSI 27a)	90 [%]	0 to 99
36	UNDER_VOLT_DELAY (ANSI 27b)	100 [0.1 sec]	1 to 32767
37	PWR_REV_THR (ANSI 32a)	-10 [%]	-100 to +99
38	PWR_REV_DELAY (ANSI 32b)	100 [0.1 sec]	1 to 32767
39	OVER_CURR_THR (ANSI 50a)	110 [%]	101 to 250
40	OVER_CURR_DELAY (ANSI 50b)	100 [0.1 sec]	1 to 32767
41	OVER_VOLT_THR (ANSI 59a)	115 [%]	101 to 250
42	OVER_VOLT_DELAY (ANSI 59b)	100 [0.1 sec]	1 to 32767
43	VI_IMBALANCE_THR (ANSI 60a)	10 [%]	1 to 100
44	VI_IMBALANCE_DELAY (ANSI	100 [0.1 sec]	1 to 32767
45	UNDER_FRQ_THR (ANSI 81Ua)	50 [0.01 Hz]	1 to 1000

[5] A negative value of the Grid 1 or Grid 2 nominal current (Parameter # 14 or #29) means that the Grid's total active power under normal conditions is expected to have a negative sign. The user is responsible for the correct PT/CT connections to get the negative sign for the active power of each phase

[6] A negative value of the Grid 1 or Grid 2 nominal current (Parameter # 14 or #29) means that the Grid's total active power under normal conditions is expected to have a negative sign. The user is responsible for the correct PT/CT connections to get the negative sign for the active power of each phase.

Index (%AQ Word 1)	Parameter Value (%AQ Word 2)	Default value	Value Limits
46	UNDER_FRQ_DELAY (ANSI	100 [0.1 sec]	1 to 32767
47	OVER_FRQ_THR (ANSI 81Oa)	50 [0.01 Hz]	1 to 1000
48	OVER_FRQ_DELAY (ANSI 81Ob)	100 [0.1 sec]	1 to 32767
49	Reserved	0	NA
50	Zero / Capture / Diagnostic	0	0 to 1896

Zero Capture Diagnostic Operation

The value written to parameter index 50 selects the variable that will be written to the Diagnostic Data word (%AI offset 60) in the PSM Signal Input Data. The Diagnostic Data word (%AI offset 60) can contain one of the following:

- PSM module firmware version
- One value of the most recently captured waveform for Grid 1 or Grid 2

Diagnostic Type	Parameter 50 Value	Variable (reported in %AI offset 64)
Firmware Version	0	PSM Module Firmware Version
Grid 1 Waveform Capture address	1	Grid 1 V_A[1]
	2	Grid 1 I_A[1]
	3	Grid 1 V_B[1]
	4	Grid 1 I_B[1]
	5	Grid 1 V_C[1]
	6	Grid 1 I_C[1]
	7	Grid 1 I_N[1]
	8	Grid 1 V_A[2]
	…	
	896	Grid 1 I_N[128]
Grid 2 Waveform Capture address	1001	Grid2 V_A[1]
	1002	Grid 2 I_A[1]
	1003	Grid 2 V_B[1]
	1004	Grid 2 I_B[1]
	1005	Grid 2 V_C[1]
	1006	Grid 2 I_C[1]
	1007	Grid 2 I_N[1]
	1008	Grid 2 V_A[2]
	…	
	1896	Grid 2 I_N[128]

Absolute Maximum (Full Scale) Readings

The peak values that the PSM system is capable of reading are detailed below. Applying higher voltages than 1064.9V on the high voltage range, or 212.4V on the low voltage range (peak value) or higher currents than 10.652A (peak value) to the PSM Interface Module will lead to the erroneous results. Such a situation will be accompanied by the appropriate fault bits (FaultXX and ClampedInput) in the %I status bits being set to 1 with the LED "FLT" flashing or steady red. These are the Full-Scale values for their respective ranges and are used as the basis for the accuracies in chapter 1, Specifications. Extended operation at or above the peak values may shorten the mean time between failure (MTBF) of the PSM system.

High Voltage Range Peak	Equivalent RMS	Low voltage Range Peak	Equivalent RMS
1064.9V	753.0V	212.4V	150.2V
10.652A	7.532A	10.652A	7.532A

3.3 Example Configurations

A portion of the PSM configuration is downloaded with the PAC Machine Edition hardware configuration (see "Configuration Parameters" on page 33). The remaining details must be set, in the form of %Q bits, in application logic when the PLC goes to run mode. Below are example configurations for typical applications.

3.3.1 Configuration for 120/240 VAC Single Phase System

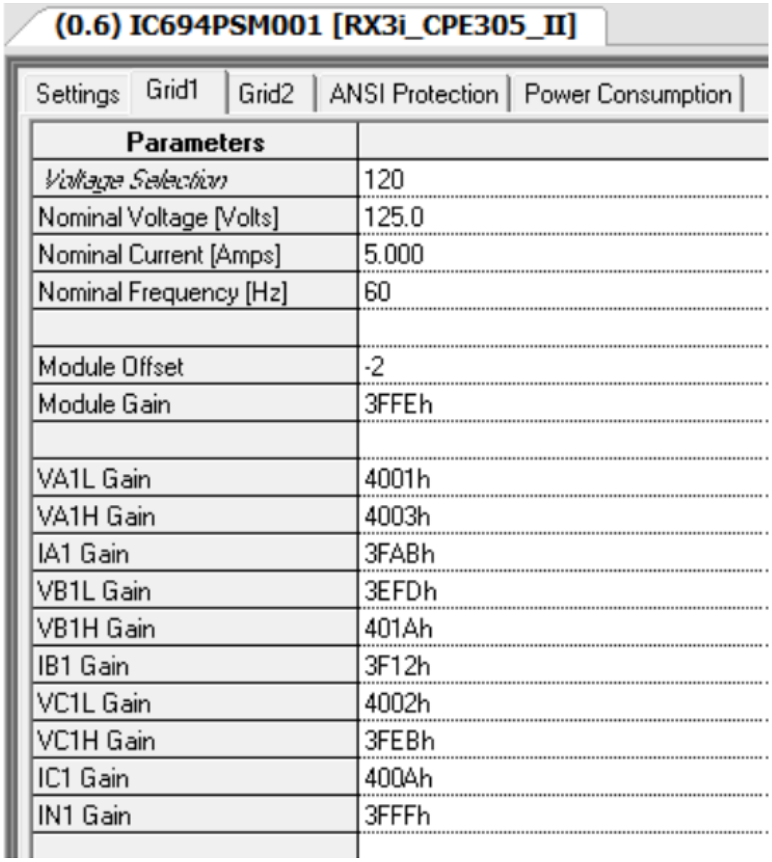
The following shows a typical hardware configuration for a signal phase, 3-wire power monitoring application. This example shows settings for Grid 1; all the settings can be applied to the respective Grid 2 parameters. Note that the offset and gain values were found on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal

assembly label. Note that the 120V range will accurately measure voltages slightly above 120VAC RMS. In the example below, 125VAC RMS is chosen as the nominal voltage.

The Nominal Voltage is the anticipated Phase-to-Neutral voltage in the single-phase configuration.

Grid 1 or Grid 2 Tab

Figure 18



(0.6) IC694PSM001 [RX3i_CPE305_II]

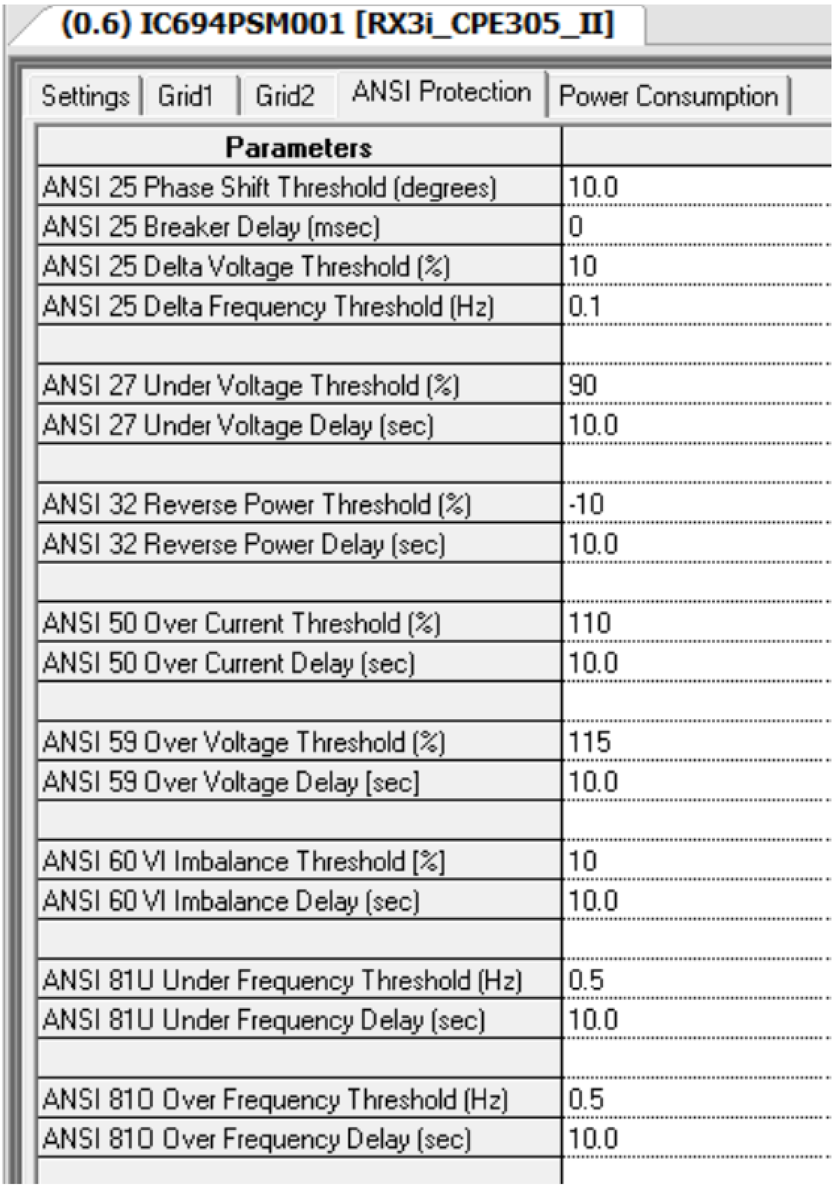
Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
Voltage Selection	120
Nominal Voltage [Volts]	125.0
Nominal Current [Amps]	5.000
Nominal Frequency [Hz]	60
Module Offset	-2
Module Gain	3FFEh
VA1L Gain	4001h
VA1H Gain	4003h
IA1 Gain	3FABh
VB1L Gain	3EFDh
VB1H Gain	401Ah
IB1 Gain	3F12h
VC1L Gain	4002h
VC1H Gain	3FEBh
IC1 Gain	400Ah
IN1 Gain	3FFFh

ANSI Protection Tab

Note that synchronization is not an option in single phase mode, so the ANSI 25 parameters have no effect and can be left at their default values.

Figure 19



Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	0
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for Grid 1. The same settings apply to the Grid 2 control bits. These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions.

%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	0	120VAC range
3	GRID 1 Grid Operational Mode	0	Single phase
4	GRID 1 Connection mode	1	3-wire, single phase using PTA and PTB
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on
7	GRID 1 PTB measurement	1	VB1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	0	VC1 measurement is off
10	GRID 1 CTC measurement	0	IC1 measurement is off
11	GRID 1 CTN measurement	0	IN1 measurement is off
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	0	Delta Mode is for 3-phase
14	Reserved	0	Always zero
15	GRID 1 Energy reset	0	Set this to reset Energy value to Zero
16	Relay open	1	Always 1 for signal phase
17 – 31	Grid 2 control bits	X	Set for desired operation of Grid 2
32	Relay close	0	Always 0 for signal phase

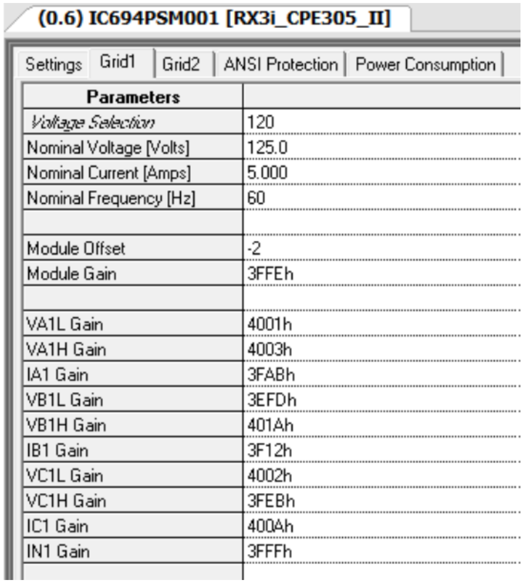
3.3.2 Configuration for 600VAC Single Phase System

The following shows a typical hardware configuration for a signal phase, 3-wire power monitoring application. This example shows settings for Grid 1; all the settings can be applied to the respective Grid 2 parameters. Empirical measurement showed that the system runs, nominally, around 595VAC RMS with a maximum load, after the CT ratio, of 3.7A RMS. The offset and gain values are shown at their default values. For maximum accuracy, the offset and gain values must be set, based on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal assembly label calibration constants.

Note that the 600V range will accurately measure voltages to slightly above 690VAC RMS. The Nominal Voltage is the anticipated Phase-to-Neutral voltage in the single-phase configuration.

Grid 1 or Grid 2 Tab

Figure 20



(0.6) IC694PSM001 [RX3i_CPE305_II]

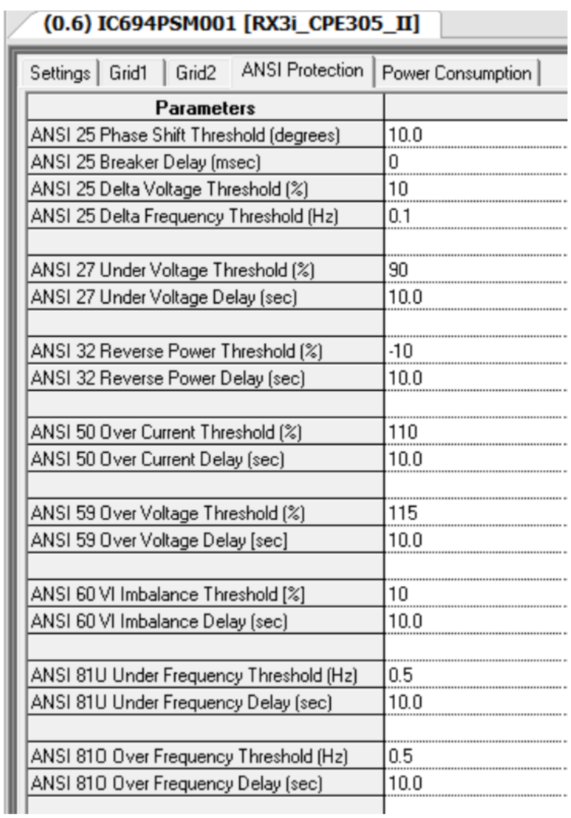
Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
Voltage Selection	120
Nominal Voltage [Volts]	125.0
Nominal Current [Amps]	5.000
Nominal Frequency [Hz]	60
Module Offset	-2
Module Gain	3FFEh
VA1L Gain	4001h
VA1H Gain	4003h
IA1 Gain	3FABh
VB1L Gain	3EFDh
VB1H Gain	401Ah
IB1 Gain	3F12h
VC1L Gain	4002h
VC1H Gain	3FEBh
IC1 Gain	400Ah
IN1 Gain	3FFFh

ANSI Protection Tab

Note that synchronization is not an option in single phase mode, so the ANSI 25 parameters have no effect and can be left at their default values.

Figure 21



(0.6) IC694PSM001 [RX3i_CPE305_II]

Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	0
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for Grid 1. The same settings apply to the Grid 2 control bits.

These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions.

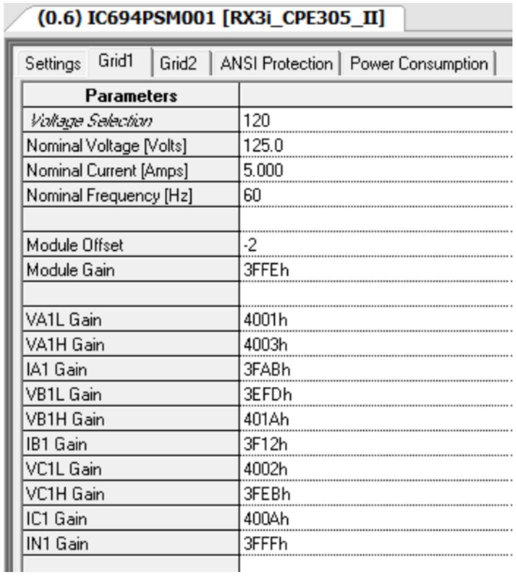
%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	0	120VAC range
3	GRID 1 Grid Operational Mode	0	Single phase
4	GRID 1 Connection mode	1	3-wire, single phase using PTA and PTB
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on
7	GRID 1 PTB measurement	1	VB1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	0	VC1 measurement is off
10	GRID 1 CTC measurement	0	IC1 measurement is off
11	GRID 1 CTN measurement	0	IN1 measurement is off
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	0	Delta Mode is for 3-phase
14	Reserved	0	Always zero
15	GRID 1 Energy reset	0	Set this to reset Energy value to Zero
16	Relay open	1	Always 1 for signal phase
17 – 31	Grid 2 control bits	X	Set for desired operation of Grid 2
32	Relay close	0	Always 0 for signal phase

3.3.3 Configuration for 120/208 WYE Three-Phase Four-Wire System

The following shows a typical hardware configuration for a 3-phase, 4-wire WYE power monitoring application. This example shows settings for Grid 1; all the settings can be applied to the respective Grid 2 parameters. Note that the offset and gain values were found on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal assembly label. The Nominal Voltage is the anticipated Phase-to-Neutral voltage in the WYE configuration.

Grid 1 or Grid 2 Tab

Figure 22



(0.6) IC694PSM001 [RX3i_CPE305_II]

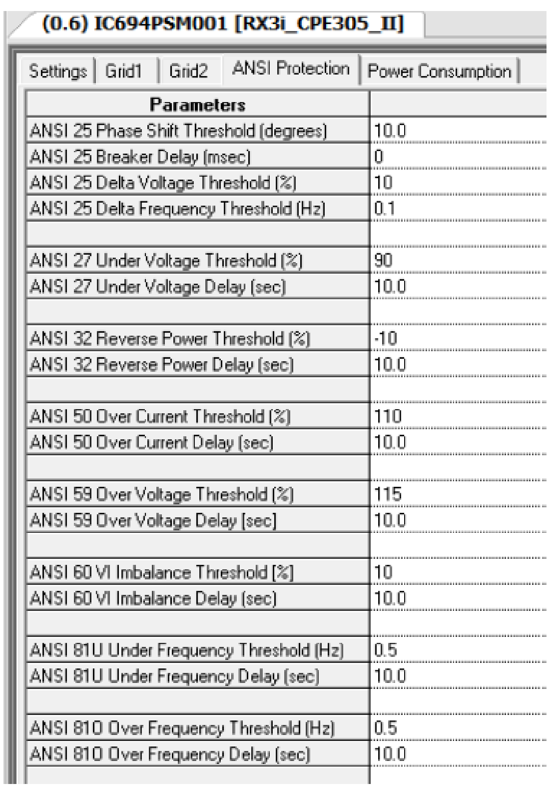
Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
Voltage Selection	120
Nominal Voltage [Volts]	125.0
Nominal Current [Amps]	5.000
Nominal Frequency [Hz]	60
Module Offset	-2
Module Gain	3FFEh
VA1L Gain	4001h
VA1H Gain	4003h
IA1 Gain	3FABh
VB1L Gain	3EFDh
VB1H Gain	401Ah
IB1 Gain	3F12h
VC1L Gain	4002h
VC1H Gain	3FEBh
IC1 Gain	400Ah
IN1 Gain	3FFFh

ANSI Protection Tab

Note that synchronization is an option in 3-phase mode, so the ANSI 25 parameters can be left at their default values or changed to suit the application. Since the Breaker Delay is set to the special case value of zero, a static phase angle synchronization is anticipated.

Figure 23



(0.6) IC694PSM001 [RX3i_CPE305_II]

Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	0
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for Grid 1. The same settings apply to the Grid 2 control bits. These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions.

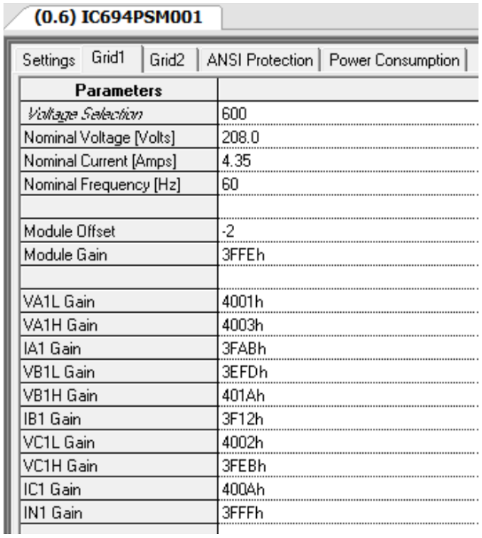
%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	0	120VAC range
3	GRID 1 Grid Operational Mode	1	3-phase
4	GRID 1 Connection mode	0	4-wire, WYE power system
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on
7	GRID 1 PTB measurement	1	VB1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	1	VC1 measurement is on
10	GRID 1 CTC measurement	1	IC1 measurement is on
11	GRID 1 CTN measurement	1	IN1 measurement is on
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	0	Delta Mode only affects Delta
14	Reserved	0	configurations
15	GRID 1 Energy reset	0	Always zero
16	Relay open	1	Set this to reset Energy value to Zero
17 – 31	Grid 2 control bits	X	Clear this bit (AND set bit 32) to
32	Relay close	0	request synchronizing the Grids

3.3.4 Configuration for 120/208 3-Wire Delta system with Two PTs (Two Wattmeter Method), B-Common

The following shows a typical hardware configuration for a 3-phase, 3-wire Delta power monitoring application with the B-Phase used as common. This example shows settings for Grid 1; all the settings can be applied to the respective Grid 2 parameters. Note that the offset and gain values were found on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal assembly label. The Nominal Voltage is the anticipated Phase-to-Phase voltage in the Delta configuration. Though phase-to-ground is 120VAC, the 1:1 PTs will be connected from phase-to-phase, so the range must be set to 600VAC to accommodate the 208V phase-to-phase voltage. The maximum Load Current of 87.0A, through 100:5 CTs will deliver 4.350A to the IC694ACC200 Terminal Assembly.

Grid 1 or Grid 2 Tab

Figure 24



(0.6) IC694PSM001

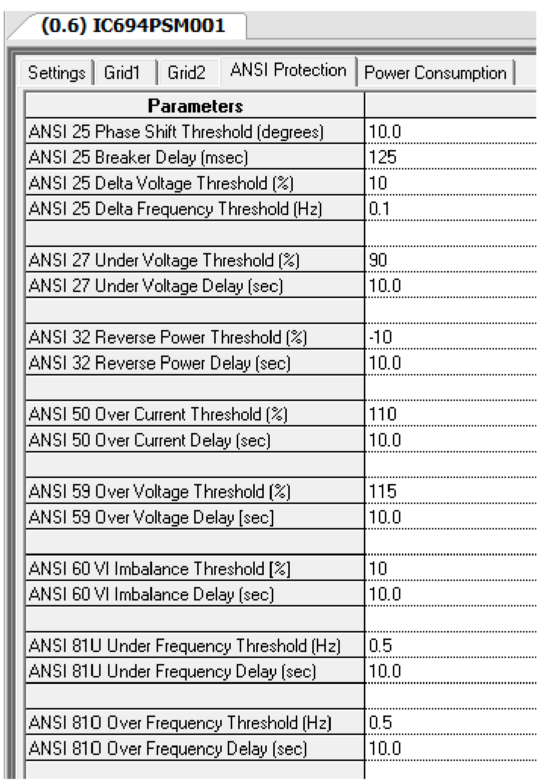
Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
Voltage Selection	600
Nominal Voltage [Volts]	208.0
Nominal Current [Amps]	4.35
Nominal Frequency [Hz]	60
Module Offset	-2
Module Gain	3FFEh
VA1L Gain	4001h
VA1H Gain	4003h
IA1 Gain	3FABh
VB1L Gain	3EFDh
VB1H Gain	401Ah
IB1 Gain	3F12h
VC1L Gain	4002h
VC1H Gain	3FEBh
IC1 Gain	400Ah
IN1 Gain	3FFFh

ANSI Protection Tab

Note that synchronization is an option in 3-phase mode, so the ANSI 25 parameters can be left at their default values or changed to suit the application. The Breaker Delay value of 125ms allows the PSM to perform a rotating phase angle synchronization, closing the contacts right at 0º when the grid frequencies are held steady during the sync process.

Figure 25



(0.6) IC694PSM001

Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	125
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for Grid 1. The same settings apply to the Grid 2 control bits.

These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions. Turning off the Phase B measurements sets the PSM to reconstruct the Vbc phase voltage and the IB current values

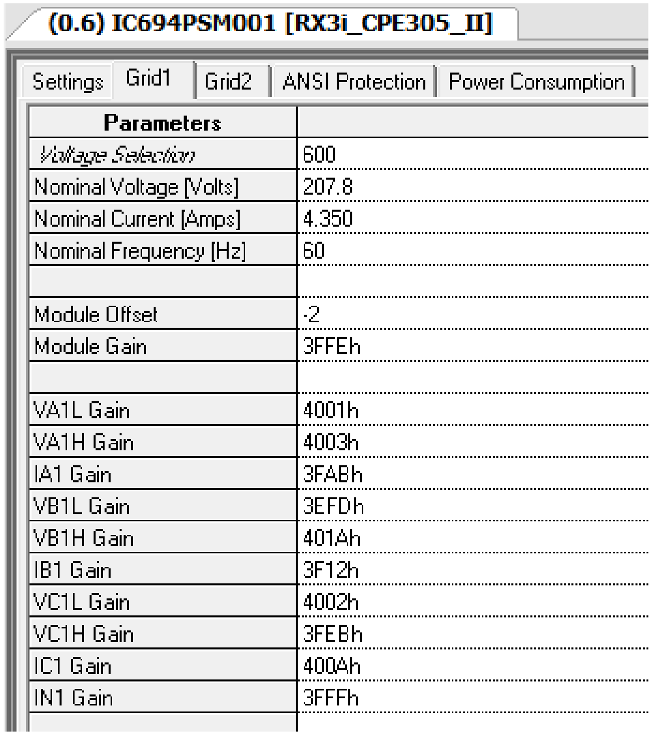
%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	0	120VAC range
3	GRID 1 Grid Operational Mode	1	3-phase
4	GRID 1 Connection mode	0	4-wire, WYE power system
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on
7	GRID 1 PTB measurement	1	VB1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	1	VC1 measurement is on
10	GRID 1 CTC measurement	1	IC1 measurement is on
11	GRID 1 CTN measurement	1	IN1 measurement is on
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	0	Delta Mode only affects Delta
14	Reserved	0	Always zero
15	GRID 1 Energy reset	0	Set this to reset Energy value to Zero
16	Relay open	1	Clear this bit (AND set bit 32) to
17 – 31	Grid 2 control bits	X	Set for desired operation of Grid 2
32	Relay close	0	Set this bit (AND clear bit 16) to

3.3.5 Configuration for 120/208 3-Wire Delta system with Two PTs (Two Wattmeter Method), C-Common

The following shows a typical hardware configuration for a 3-phase, 3-wire Delta power monitoring application with the C-Phase used as common. This example shows settings for Grid 1; all the settings can be applied to the respective Grid 2 parameters. Note that the offset and gain values were found on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal assembly label. The Nominal Voltage is the anticipated Phase-to-Phase voltage in the Delta configuration. Though phase-to-ground is 120VAC, the PTs will be connected from phase-to-phase, so the range must be set to 600VAC to accommodate the 208V phase-to-phase.

Grid 1 or Grid 2 Tab

Figure 26


(0.6) IC694PSM001 [RX3i_CPE305_II]

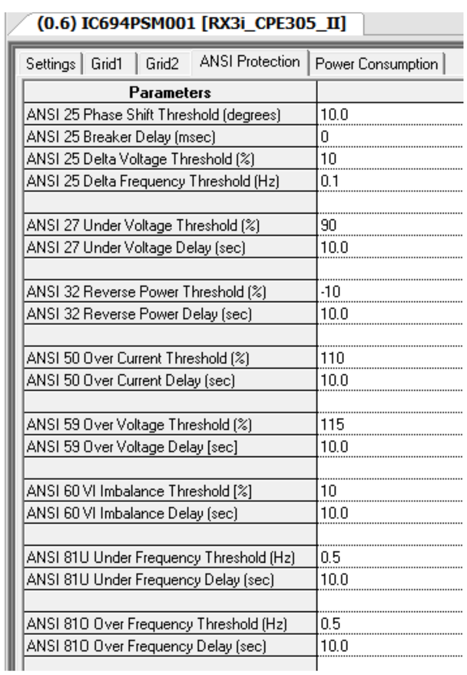
Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
Voltage Selection	600
Nominal Voltage [Volts]	207.8
Nominal Current [Amps]	4.350
Nominal Frequency [Hz]	60
Module Offset	-2
Module Gain	3FFEh
VA1L Gain	4001h
VA1H Gain	4003h
IA1 Gain	3FABh
VB1L Gain	3EFDh
VB1H Gain	401Ah
IB1 Gain	3F12h
VC1L Gain	4002h
VC1H Gain	3FEBh
IC1 Gain	400Ah
IN1 Gain	3FFFh

ANSI Protection Tab

Note that synchronization is an option in 3-phase mode, so the ANSI 25 parameters can be left at their default values or changed to suit the application.

Figure 27


(0.6) IC694PSM001 [RX3i_CPE305_II]

Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	0
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for both grids. These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions.

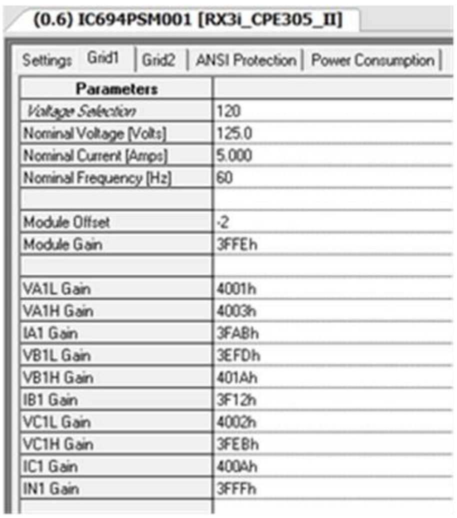
%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	1	600VAC range
3	GRID 1 Grid Operational Mode	1	3-phase
4	GRID 1 Connection mode	1	3-wire, Delta power system
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on
7	GRID 1 PTB measurement	1	Vb1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	0	C-Phase is common
10	GRID 1 CTC measurement	0	C-Phase is common
11	GRID 1 CTN measurement	0	IN1 measurement is off
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	1	Set this bit for C-Phase Common
14	Reserved	0	Always zero
15	GRID 1 Energy reset	0	Set this to reset Energy value to Zero
16	Relay open	1	Clear this bit (AND set bit 32) to
17– 31	Grid 2 control bits	X	request synchronizing the Grids
32	Relay close	0	Set for desired operation of Grid 2

3.3.6 Configuration for 120/208 4-Wire WYE Synchro/Power Control Connection

The following shows a typical hardware configuration for a 3-phase, 4-wire WYE power paralleling/synchronizing application. Note that the offset and gain values were found on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal assembly label. The Voltage Selection is set to 120, since the PSM can measure up to 150VAC in this range. The Nominal Voltage is the anticipated Phase-to-Neutral voltage in the WYE configuration.

Grid 1 Tab

Figure 28

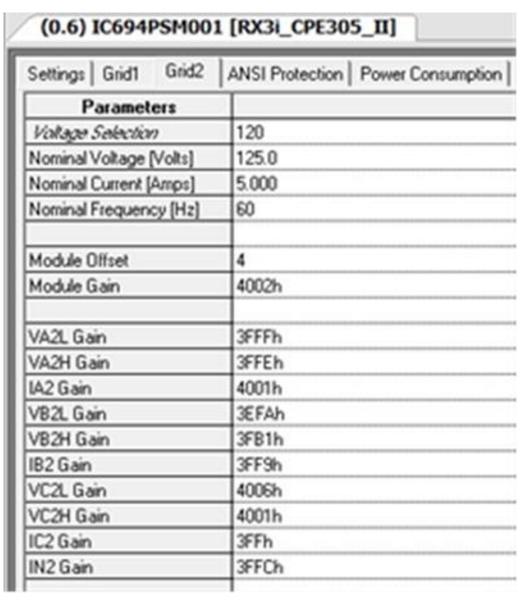

(0.6) IC694PSM001 [RX3i_CPE305_II]

Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
Voltage Selection	120
Nominal Voltage [Volts]	125.0
Nominal Current [Amps]	5.000
Nominal Frequency [Hz]	60
Module Offset	-2
Module Gain	3FFEh
VA1L Gain	4001h
VA1H Gain	4003h
IA1 Gain	3FABh
VB1L Gain	3EFDh
VB1H Gain	401Ah
IB1 Gain	3F12h
VC1L Gain	4002h
VC1H Gain	3FEBh
IC1 Gain	400Ah
IN1 Gain	3FFFh

Grid 2 Tab

Figure 29


(0.6) IC694PSM001 [RX3i_CPE305_II]

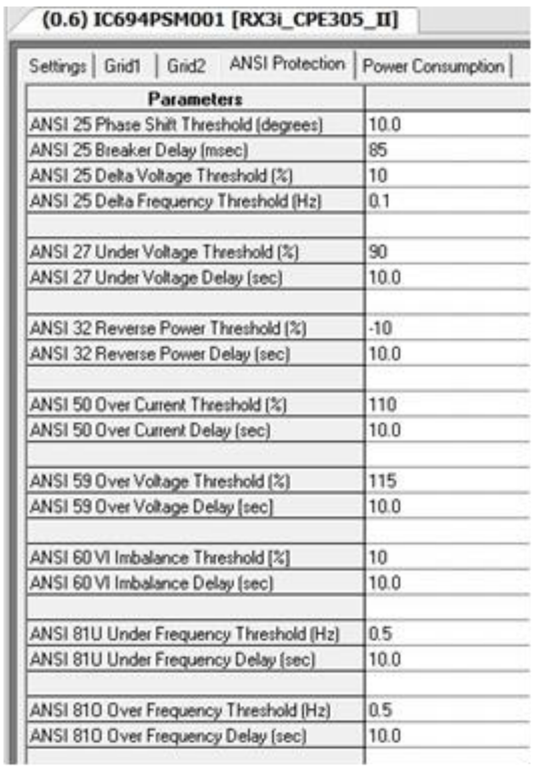
Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
Voltage Selection	120
Nominal Voltage [Volts]	125.0
Nominal Current [Amps]	5.000
Nominal Frequency [Hz]	60
Module Offset	4
Module Gain	4002h
VA2L Gain	3FFFh
VA2H Gain	3FFEh
IA2 Gain	4001h
VB2L Gain	3EFAh
VB2H Gain	3FB1h
IB2 Gain	3FF9h
VC2L Gain	4006h
VC2H Gain	4001h
IC2 Gain	3FFh
IN2 Gain	3FFCh

ANSI Protection Tab

Note that synchronization is an option in 3-phase mode, so the ANSI 25 parameters can be left at their default values or changed to suit the application. In this example, the breaker delay has been set to 85ms (the total contact closure time from CloseRelayOK signal to contacts physically closing). This allows the PSM to calculate the precise timing to close the sync relay as close as possible to 0º phase angle in a rotating phase angle synchronization.

Figure 30



Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	85
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for both grids. These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions.

%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	0	120VAC range
3	GRID 1 Grid Operational Mode	1	3-phase
4	GRID 1 Connection mode	0	4-wire, Wye power system
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on

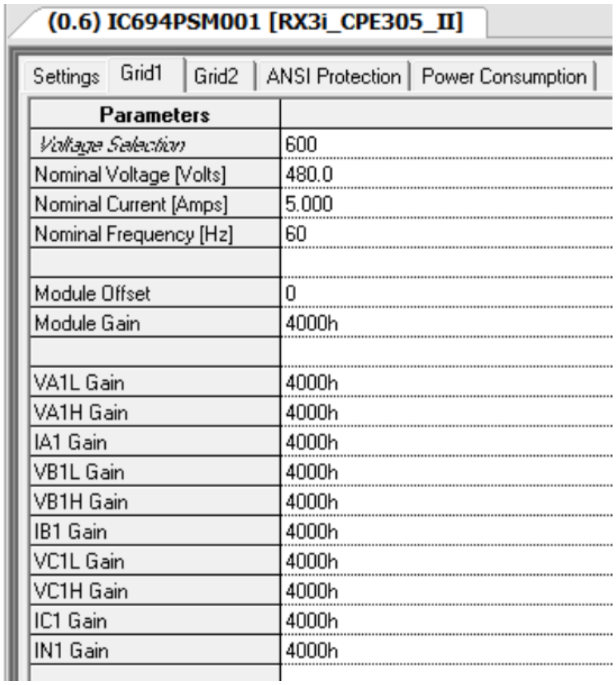
%Q Bit Offset	Function	Value	Comment
7	GRID 1 PTB measurement	1	VB1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	1	VC1 measurement is on
10	GRID 1 CTC measurement	1	IC1 measurement is on
11	GRID 1 CTN measurement	1	IN1 measurement is on
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	0	Delta Mode only affects Delta
14	Reserved	0	Always zero
15	GRID 1 Energy reset	0	Set this to reset Energy value to Zero
16	Relay open	1	Clear this bit (AND set bit 32) to
17	GRID 2 Operation	1	Enable grid 1
18	GRID 2 Voltage Selection	0	120VAC range
19	GRID 2 Grid Operational Mode	1	3-phase
20	GRID 2 Connection mode	0	4-wire, Wye power system
21	GRID 2 PTA_CA measurement	1	VA2 measurement is on
22	GRID 2 CTA measurement	1	IA2 measurement is on
23	GRID 2 PTB measurement	1	VB2 measurement is on
24	GRID 2 CTB measurement	1	IB2 measurement is on
25	GRID 2 PTC measurement	1	VC2 measurement is on
26	GRID 2 CTC measurement	1	IC2 measurement is on
27	GRID 2 CTN measurement	1	IN2 measurement is off
28	GRID 2 Waveform Capture	0	Set this to capture a waveform
29	GRID 2 Delta Mode	0	Delta Mode only affects Delta configurations
30	Reserved	0	Always zero
31	GRID 2 Energy reset	0	Set this to reset Energy value to Zero
32	Relay close	0	Set this bit (AND clear bit 16) to request synchronizing the Grids

3.3.7 Configuration for 480V 4-Wire WYE Synchro/Power Control Connection

The following shows a typical hardware configuration for a 3-phase, 4-wire WYE power paralleling/synchronizing application. The offset and gain values are shown at their default values. For maximum accuracy, the offset and gain values must be set, based on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal assembly label calibration constants. Choose the 600V range and enter 480.0V as the nominal voltage. The Nominal Voltage is the anticipated Phase-to-Neutral voltage in the WYE configuration.

Grid 1 Tab

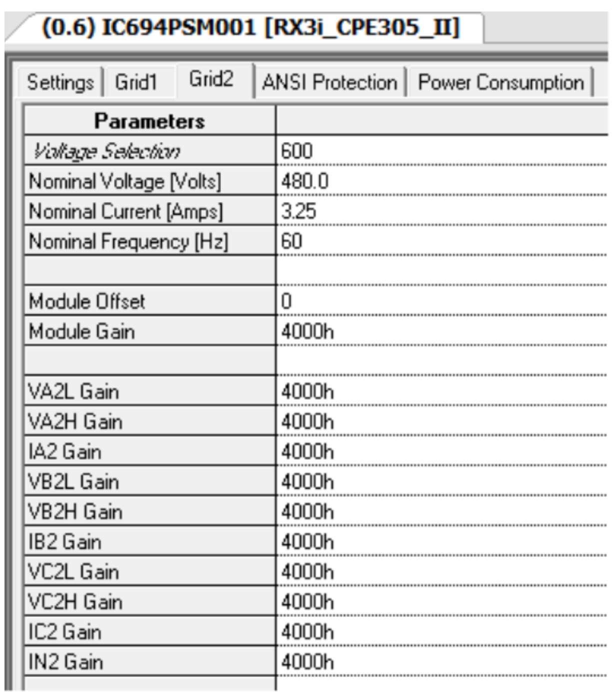
Figure 31



Parameters	
Voltage Selection	600
Nominal Voltage [Volts]	480.0
Nominal Current [Amps]	5.000
Nominal Frequency [Hz]	60
Module Offset	0
Module Gain	4000h
VA1L Gain	4000h
VA1H Gain	4000h
IA1 Gain	4000h
VB1L Gain	4000h
VB1H Gain	4000h
IB1 Gain	4000h
VC1L Gain	4000h
VC1H Gain	4000h
IC1 Gain	4000h
IN1 Gain	4000h

Grid 2 Tab

Figure 32

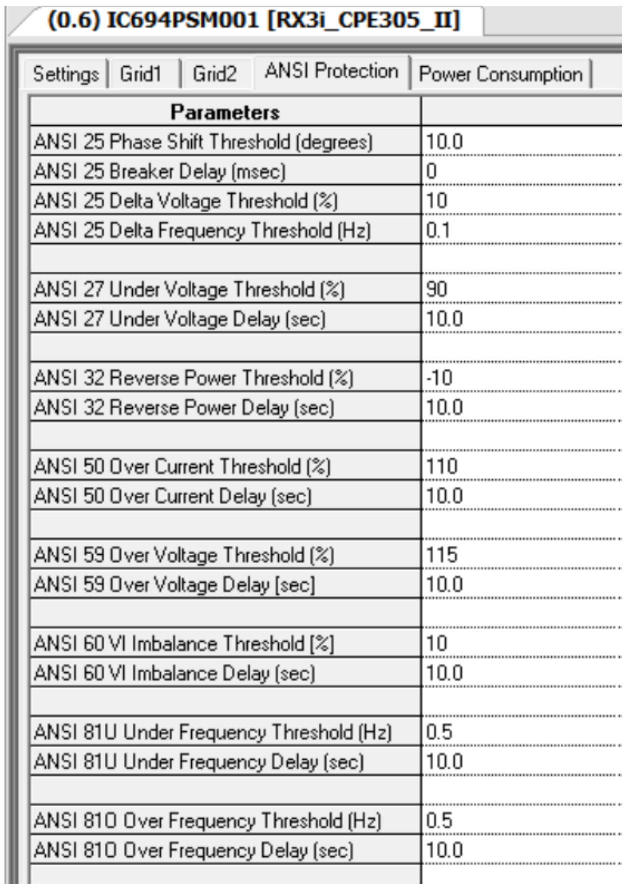


Parameters	
Voltage Selection	600
Nominal Voltage [Volts]	480.0
Nominal Current [Amps]	3.25
Nominal Frequency [Hz]	60
Module Offset	0
Module Gain	4000h
VA2L Gain	4000h
VA2H Gain	4000h
IA2 Gain	4000h
VB2L Gain	4000h
VB2H Gain	4000h
IB2 Gain	4000h
VC2L Gain	4000h
VC2H Gain	4000h
IC2 Gain	4000h
IN2 Gain	4000h

ANSI Protection Tab

Note that synchronization is an option in 3-phase mode, so the ANSI 25 parameters can be left at their default values or changed to suit the application.

Figure 33


(0.6) IC694PSM001 [RX3i_CPE305_II]

Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	0
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for both grids. These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions.

%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	0	120VAC range
3	GRID 1 Grid Operational Mode	1	3-phase
4	GRID 1 Connection mode	0	4-wire, Wye power system
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on

%Q Bit Offset	Function	Value	Comment
7	GRID 1 PTB measurement	1	VB1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	1	VC1 measurement is on
10	GRID 1 CTC measurement	1	IC1 measurement is on
11	GRID 1 CTN measurement	1	IN1 measurement is on
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	0	Delta Mode only affects Delta configurations
14	Reserved	0	Always zero
15	GRID 1 Energy reset	0	Set this to reset Energy value to Zero
16	Relay open	1	Clear this bit (AND set bit 32) to request synchronizing the Grids
17	GRID 2 Operation	1	Enable grid 1
18	GRID 2 Voltage Selection	0	120VAC range
19	GRID 2 Grid Operational Mode	1	3-phase
20	GRID 2 Connection mode	0	4-wire, Wye power system
21	GRID 2 PTA_CA measurement	1	VA2 measurement is on
22	GRID 2 CTA measurement	1	IA2 measurement is on
23	GRID 2 PTB measurement	1	VB2 measurement is on
24	GRID 2 CTB measurement	1	IB2 measurement is on
25	GRID 2 PTC measurement	1	VC2 measurement is on
26	GRID 2 CTC measurement	1	IC2 measurement is on
27	GRID 2 CTN measurement	1	IN2 measurement is off
28	GRID 2 Waveform Capture	0	Set this to capture a waveform
29	GRID 2 Delta Mode	0	Delta Mode only affects Delta configurations
30	Reserved	0	Always zero
31	GRID 2 Energy reset	0	Set this to reset Energy value to Zero
32	Relay close	0	Set this bit (AND clear bit 16) to request synchronizing the Grids

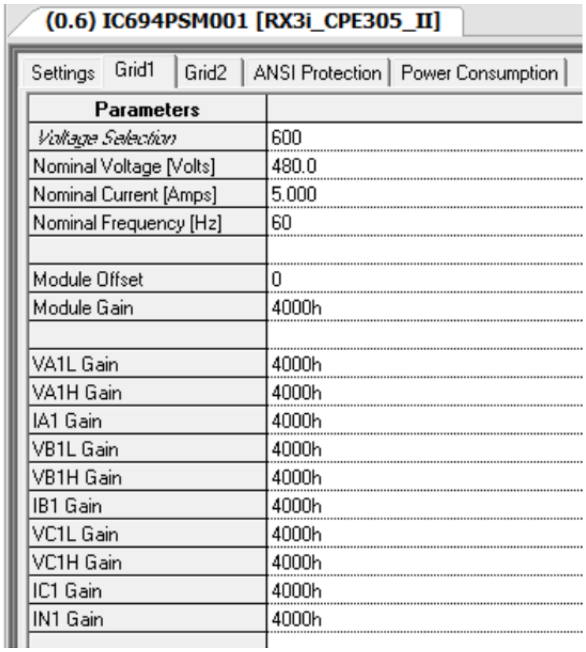
3.3.8 Configuration for 480V 4-Wire WYE Synchro/Power Control Connection

The following shows a typical hardware configuration for a 3-phase, 4-wire WYE power paralleling/synchronizing application. The offset and gain values are shown at their default values. For maximum accuracy, the offset and gain values must be set, based on the IC694PSM001 module faceplate label and on the IC694ACC200 terminal assembly label calibration constants. Choose the 600V range and enter 480.0V as the nominal voltage.

The Nominal Voltage is the anticipated Phase-to-Neutral voltage in the WYE configuration.

Grid 1 Tab

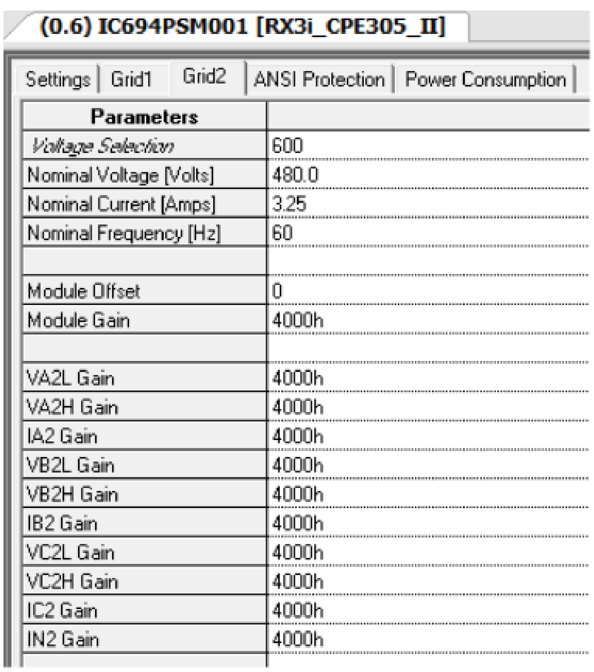
Figure 34



Parameters	
Voltage Selection	600
Nominal Voltage [Volts]	480.0
Nominal Current [Amps]	5.000
Nominal Frequency [Hz]	60
Module Offset	0
Module Gain	4000h
VA1L Gain	4000h
VA1H Gain	4000h
IA1 Gain	4000h
VB1L Gain	4000h
VB1H Gain	4000h
IB1 Gain	4000h
VC1L Gain	4000h
VC1H Gain	4000h
IC1 Gain	4000h
IN1 Gain	4000h

Grid 2 Tab

Figure 35

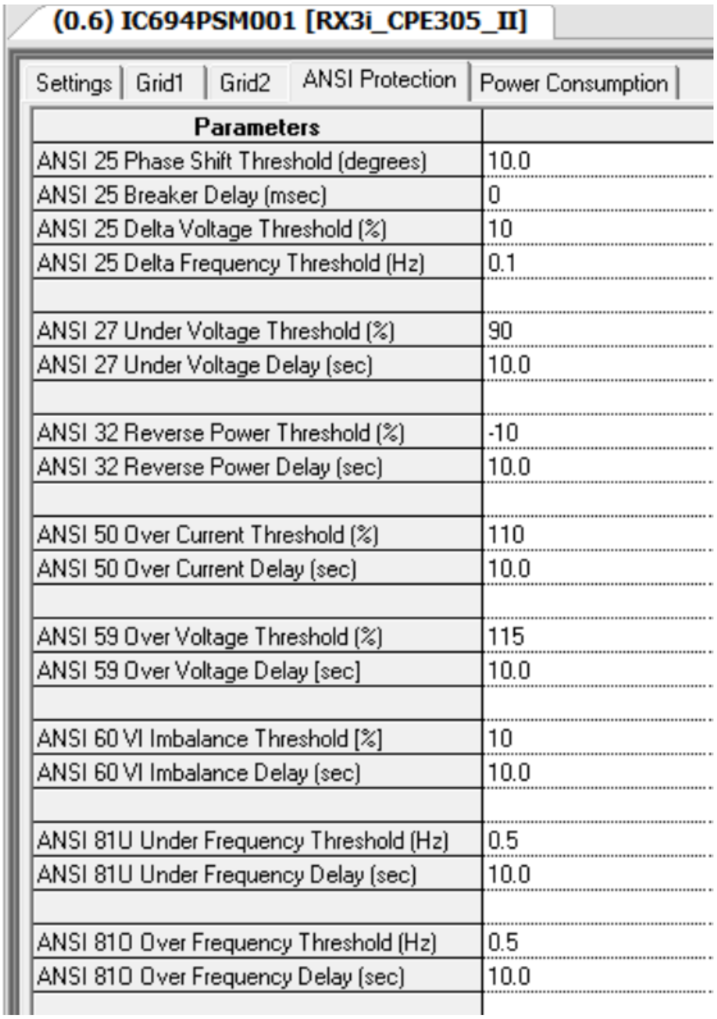


Parameters	
Voltage Selection	600
Nominal Voltage [Volts]	480.0
Nominal Current [Amps]	3.25
Nominal Frequency [Hz]	60
Module Offset	0
Module Gain	4000h
VA2L Gain	4000h
VA2H Gain	4000h
IA2 Gain	4000h
VB2L Gain	4000h
VB2H Gain	4000h
IB2 Gain	4000h
VC2L Gain	4000h
VC2H Gain	4000h
IC2 Gain	4000h
IN2 Gain	4000h

ANSI Protection Tab

Note that synchronization ***is*** an option in 3-phase mode, so the ANSI 25 parameters can be left at their default values or changed to suit the application.

Figure 36



(0.6) IC694PSM001 [RX3i_CPE305_II]

Settings | Grid1 | Grid2 | ANSI Protection | Power Consumption

Parameters	
ANSI 25 Phase Shift Threshold (degrees)	10.0
ANSI 25 Breaker Delay (msec)	0
ANSI 25 Delta Voltage Threshold (%)	10
ANSI 25 Delta Frequency Threshold (Hz)	0.1
ANSI 27 Under Voltage Threshold (%)	90
ANSI 27 Under Voltage Delay (sec)	10.0
ANSI 32 Reverse Power Threshold (%)	-10
ANSI 32 Reverse Power Delay (sec)	10.0
ANSI 50 Over Current Threshold (%)	110
ANSI 50 Over Current Delay (sec)	10.0
ANSI 59 Over Voltage Threshold (%)	115
ANSI 59 Over Voltage Delay (sec)	10.0
ANSI 60 VI Imbalance Threshold (%)	10
ANSI 60 VI Imbalance Delay (sec)	10.0
ANSI 81U Under Frequency Threshold (Hz)	0.5
ANSI 81U Under Frequency Delay (sec)	10.0
ANSI 81O Over Frequency Threshold (Hz)	0.5
ANSI 81O Over Frequency Delay (sec)	10.0

%Q Configuration Values

This table shows the settings for both grids. These bits must be set during the first PLC scan when the PLC transitions to run mode. %Q offset 2, 3 & 4 and 18, 19 & 20 set the PSM for the field voltage and power configuration. Setting these values incorrectly will yield invalid readings. All remaining bits may be changed during run mode to adapt to changing field conditions.

%Q Bit Offset	Function	Value	Comment
1	GRID 1 Operation	1	Enable grid 1
2	GRID 1 Voltage Selection	1	600VAC range
3	GRID 1 Grid Operational Mode	1	3-phase

%Q Bit Offset	Function	Value	Comment
4	GRID 1 Connection mode	0	4-wire, Wye power system
5	GRID 1 PTA_CA measurement	1	VA1 measurement is on
6	GRID 1 CTA measurement	1	IA1 measurement is on
7	GRID 1 PTB measurement	1	VB1 measurement is on
8	GRID 1 CTB measurement	1	IB1 measurement is on
9	GRID 1 PTC measurement	1	VC1 measurement is on
10	GRID 1 CTC measurement	1	IC1 measurement is on
11	GRID 1 CTN measurement	1	IN1 measurement is on
12	GRID 1 Waveform Capture	0	Set this to capture a waveform
13	GRID 1 Delta Mode	0	Delta Mode only affects Delta configurations
14	Reserved	0	Always zero
15	GRID 1 Energy reset	0	Set this to reset Energy value to Zero
16	Relay open	1	Clear this bit (AND set bit 32) to request synchronizing the Grids
17	GRID 2 Operation	1	Enable grid 1
18	GRID 2 Voltage Selection	1	600VAC range
19	GRID 2 Grid Operational Mode	1	3-phase
20	GRID 2 Connection mode	0	4-wire, Wye power system
21	GRID 2 PTA_CA measurement	1	VA2 measurement is on
22	GRID 2 CTA measurement	1	IA2 measurement is on
23	GRID 2 PTB measurement	1	VB2 measurement is on
24	GRID 2 CTB measurement	1	IB2 measurement is on
25	GRID 2 PTC measurement	1	VC2 measurement is on
26	GRID 2 CTC measurement	1	IC2 measurement is on
27	GRID 2 CTN measurement	1	IN2 measurement is off
28	GRID 2 Waveform Capture	0	Set this to capture a waveform
29	GRID 2 Delta Mode	0	Delta Mode only affects Delta configurations
30	Reserved	0	Always zero
31	GRID 2 Energy reset	0	Set this to reset Energy value to Zero
32	Relay close	0	Set this bit (AND clear bit 16) to request synchronizing the Grids

Chapter 4: Diagnostics

4.1 PSM Module LED Indicators

For details on the system status information provided by the LEDs, refer to page 2.

4.2 PSM Module Health Status

The %I offset 1 bit is a PSM heartbeat. It toggles every RX3i Controller scan as an indication that the PSM module is communicating with the CPU.

The %I offset 2 bit is set to 1 when both cables between the PSM module and the Terminal Assembly are installed correctly. This means:

- GRID1 on the Terminal Assembly is connected to GRID 1 on the PSM module
- GRID2 on the Terminal Assembly is connected to GRID 2 on the PSM module
- The same voltage range is used for these connections.

Under special installations, the user can use a different arrangement but then must ignore this indication.

%I offset 8 bit is the "new data" bit that indicates this is the first PLC scan where this power data is available.

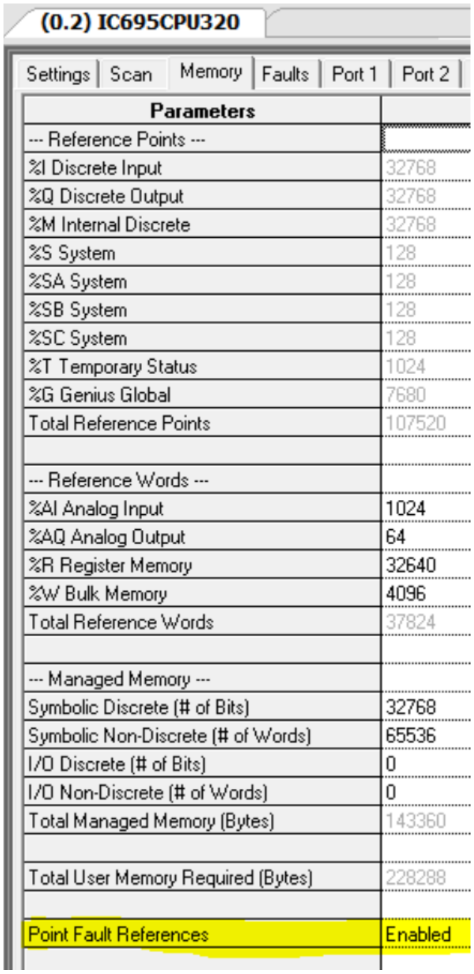
The remaining %I status bits indicate alarms, ANSI functions and signal quality information. For the functions of the %I bits, refer to "PSM Status Flags" in chapter 3.

4.3 Point Faults

Enabling Point Faults on the CPU Memory tab allows the use of Fault and No Fault contacts to alert the PLC logic to an issue with the PSM module. See the PACSystems CPU Reference Manual, GFK-2222 for more details.

4.3.1 Point Fault Configuration

Figure 37



(0.2) IC695CPU320

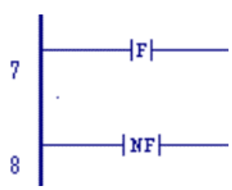
Settings | Scan | Memory | Faults | Port 1 | Port 2

Parameters	
--- Reference Points ---	
%I Discrete Input	32768
%Q Discrete Output	32768
%M Internal Discrete	32768
%S System	128
%SA System	128
%SB System	128
%SC System	128
%T Temporary Status	1024
%G Genius Global	7680
Total Reference Points	107520
--- Reference Words ---	
%AI Analog Input	1024
%AQ Analog Output	64
%R Register Memory	32640
%W Bulk Memory	4096
Total Reference Words	37824
--- Managed Memory ---	
Symbolic Discrete (# of Bits)	32768
Symbolic Non-Discrete (# of Words)	65536
I/O Discrete (# of Bits)	0
I/O Non-Discrete (# of Words)	0
Total Managed Memory (Bytes)	143360
Total User Memory Required (Bytes)	228288
Point Fault References	Enabled

4.3.2 Fault and No-Fault Contacts

Fault and No-Fault contacts are set to the first %I bit reference address of the module to be monitored. If the Fault bit is set and the No Fault bit is cleared, the CPU is not communicating with the module. If the Fault bit is cleared and the No Fault bit is set, the CPU is communicating with the module.

Figure 38



Appendix A: Product Certifications and Installation Guidelines for Conformance

This appendix describes the compliance markings that appear on the PSM module and/or Terminal Assembly and the corresponding standards to which they have been certified. This appendix also provides installation requirements for conformance to standards and additional safety guidelines for installing in the European Union.

A.1 Agency Approvals

Description	Agency Standard or Marking	Comments
N.A. Safety for Generator Control Equipment	c UL us LISTED	Certification by Underwriter's Laboratories to UL 6200 standard and equivalent CSA C22.2 No 14 -2010 standard
N.A. Safety for Process Control Equipment	c UL us LISTED	Certification by Underwriter's Laboratories to UL 61010-1 standard and equivalent CSA C22.2 No 61010-1standard
N.A. Safety for Hazardous Areas Class I, Div. 2, Groups A, B, C, D	c UL us LISTED	Certification by Underwriter's Laboratories to ANSI/ISA 12.12.01 standard and equivalent CSA C22.2 No 213-M1987 standard
Low Voltage Directive European Safety for Industrial Control Equipment	CE	Self-Declaration in accordance with European Directives; Refer to Declaration of Conformity found at http://www.Emerson.com/Industrial-Automation-Controls for a complete list of approved products
Electromagnetic Compatibility Directive European EMC for Industrial Control Equipment	CE	Certification by Competent Body in accordance with European Directives; Refer to Declaration of Conformity found at http://www.Emerson.com/Industrial-Automation-Controls for a complete list of approved products

Description	Agency Standard or Marking	Comments
Explosive Atmospheres Directive European Safety for Hazardous Areas Equipment Group II, Category 3, Gas Groups A, B, C	Ex	Certification in accordance with European Directives and Independent 3rd Party Assessment Certificate; Refer to Declaration of Conformity found at http://www.Emerson.com/Industrial-Automation-Controls for complete list of approved products

Note: *The agency approvals listed above and on the Declaration of Conformities are believed to be accurate; however, a product's agency approvals should be verified by the marking on the unit itself.*

A.2 Environmental Specifications

Vibration	IEC60068-2-6, JISC0911	10 - 57 Hz, 0.006" displacement peak- peak 57 - 500 Hz, 1.0g acceleration
Shock	IEC60068-2-27, JISC0912	15G, 11ms
Operating Temperature	0°C to 60°C: [surrounding air] (32° F to 140°F)	
Storage Temperature	-40°C to +85°C (-40° F to 185°F)	
Humidity	5% to 95%, non-condensing	
EMC Emissions		
Radiated, Conducted	CISPR 11/EN 55011/ EN55016-2-3 47 CFR 15	Group 1, Class A 30 – 230 Mhz 50.4 dBuV/m 230 – 1000 Mhz 57.4 dBuV/m 30 – 88 Mhz 49.5 dBuV/m 88 – 216 Mhz 53.9 dBuV/m 216 -960 Mhz 56.8 dBuV/m > 960Mhz 59.9 dBuV/m
EMC Immunity		**[applies to CE Marked modules]**
EMC Requirements & Test for Programmable Controllers	EN 61131-2	Zone B
Electrostatic Discharge	EN 61000-4-2[1]	8KV Air, 4KV Contact
RF Susceptibility	EN 61000-4-3[1]	10 Vrms /m: 0.80 -1.0GHz, 3 Vrms/m : 1.4 - 2.0GHz 1 Vrms/m: 2.0 - 2.7Ghz
Fast Transient Burst2	EN 61000-4-4[1]	Unshielded I/O Signal: 1KV

Surge Withstand	EN 61000-4-5[1]	Unshielded I/O Signal[3]: 1kV CM, 0.5kV DM
Damped Oscillatory Wave	ANSI/IEEE C37.90a, EN 61000-4-12[1] EN 61000-4-18	Unshielded I/O Signal: ±2.5kV CM (200Ω) 1MHz, 400Hz rep rate
Conducted RF	EN 61000-4-6[1]	Unshielded I/O Signal[4]: $10V_{rms}$

1. EN 61000-4-x series of tests are technically equivalent to the IEC 61000-4-x series.
2. Not applicable for communication, I/O, I/O power, Auxiliary power output or DC Input power lines whose maximum installed length is less than 3m (9.1ft).
3. Not applicable to RS232 ports and those ports limited to 30m (98ft.) or less.
4. Not applicable to communication or I/O lines whose maximum installed length is 3m (09.1ft) or less.

A.3 Government Regulations

U.S., Canadian, Australian, and European regulations are intended to prevent equipment from interfering with approved transmissions or with the operation of other equipment through the AC power source.

The PACSystems RX3i family of products has been tested and found to meet or exceed the requirements of U.S. (47 CFR 15), Canadian (ICES-003), Australian (AS/NZS 3548), and European (EN55011) regulations for Class A digital devices when installed in accordance with the guidelines noted in this manual. These various regulations share commonality in content and test levels with that of CISPR 11 and based on this commonality testing to each individual standard was deemed inappropriate.

The FCC requires the following note to be published according to FCC guidelines:

Note: *This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

Industry Canada requires the following note to be published:

Note: *This Class A digital apparatus complies with Canadian ICES-003.*

USER MANUAL
GFK-2749A
Jan 2020

Technical Support & Contact Information

Home link: http://www.Emerson.com/Industrial-Automation-Controls

Knowledge Base: https://www.emerson.com/Industrial-Automation-Controls/support

Note: If the product is purchased through an Authorized Channel Partner, please contact the seller directly for any support.

Emerson reserves the right to modify or improve the designs or specifications of the products mentioned in this manual at any time without notice. Emerson does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Emerson product remains solely with the purchaser.

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