Allen-Bradley

Line
Synchronization
Module
(Bulletin 1402 LSM)

Installation and Operation Manual

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. “Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls” (Publication SGI-1.1) describes some important differences between solid state equipment and hard–wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will the Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, the Allen-Bradley Company cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Allen-Bradley Company with respect to use of information, circuits, equipment, or software described in this manual.

Throughout this manual we use notes to make you aware of safety considerations.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.

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Using This Manual

What This Manual Contains

Review the table below to familiarize yourself with the topics contained in this manual.

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For More Information on Additional Power Quality Products

For this information:	Refer to:
Catalog Number 1400–PD Installation and Operation Manual	Publication 1400–5.2
Catalog Number 1400–SP Installation and Operation Manual	Publication 1400–801
Installing the Communications Card Instructions Catalog Number 1400–DCU	Publication 1400–5.0
RS–232C and RS–485 Convertor Instructions Catalog Number 1400–CC	Publication 1400–5.1
LSM Application Notes	Publication 1402-
Catalog Number 1403-MM Powermonitor II Instruction Sheet	Publication 1403-5.0
Catalog Number 1003-NSC Smart Communications Card Instruction Sheet	Publication 1403-5.1
Powermonitor II Tutorial	Publication 1403-1.0.2

Terms and Conventions

In this manual, the following terms and conventions are used:

Abbreviation	Term
AWG	American Wire Gage
BTR	Block Transfer Read
BTW	Block Transfer Write
CT	Current Transformer
EEPROM	Electrically Erasable Programmable ROM
EMI	Electromagnetic Interference
ID	Identification
LED	Light Emitting Diode
I/O	Inputs and Outputs should be considered with respect to the PLC processor
LSM	Line Synchronization Module
PT	Potential Transformer
RAM	Random Access Memory
RFI	Radio Frequency Interference
RMS	Root–mean–square
ROM	Read Only Memory
VA	Volt–ampere
VAR	Volt–ampere Reactive

Chapter 1

Product Description

Chapter Objectives

After reading this chapter, you should be able to identify the product features and system applications.

Introduction

The Bulletin 1402, Line Synchronization Module (LSM), is designed to meet the needs of manufacturers, system integrators, and users of 3 phase alternators and cogeneration systems or for applications that require two three–phase systems to be synchronized with each other. The module provides means for automatic synchronization, load sharing, and high speed power system monitoring.

General Description

The Line Synchronization Module (LSM) is a two slot 1771 form factor module that fits into a standard Allen–Bradley 1771 I/O chassis. It performs three functions:

1. Measures appropriate parameters from the two three–phase systems and provides control and error signals to implement engine governor control for synchronization.

2. Provides an analog output that is representative of the ratio of the power being supplied by the alternator to the output rating of the alternator, reads an analog input that represents the ratio of the total system load being supplied to the total system capacity, and provides an error signal to adjust the alternator for proper load sharing based on the instantaneous load requirements.

3. Performs as a multi–function digital power monitor for the system.

These functions provide data and control signals which are communicated to the PLC-5® via the 1771 backplane.

Synchronization and Load Share Errors

In order to synchronize two three phase systems without high instantaneous energy transfer, the voltage, frequency, and phase displacement of the two systems must be matched. Kilowatt Load Sharing can be implemented by matching the ratio of power system load to system capacity to the ratio of actual alternator power to rated alternator power. The LSM provides the following information to allow the user's system to achieve the necessary control actions.

- Voltage Match Error (in steps of 0.05 percent)
- Frequency Match Error, or slip (in steps of 0.01 Hz)
- Synchronizing Bus to Reference Bus Phase Match Error (in steps of 1 degree)
- Load Sharing Error (scalar quantity between 0.000 and $\pm$ 1.000)
- Synchronization Status
  - — Frequency Within Limits
  - — Voltage Within Limits
  - — Phase Within Limits
  - — Synchronization Mode Conflict Failure
  - — Phase Rotation Mismatch Failure (3 phase synchronization mode only)
  - — No Reference Bus Voltage Present Failure
  - — No Synchronizing Bus Voltage Present Failure
  - — Reference Bus Over Voltage Failure
  - — Synchronizing Bus Over Voltage Failure

Measurements

In addition to the synchronization function, the LSM provides an extensive array of monitoring information for systems wired in Wye, Delta, or Open Delta. The monitored data is shown below:

Table 1.1

Synchronizing Bus	Current in Amps (per phase & neutral)
	Average Current in Amps
	Positive Sequence Current in Amps
	Negative Sequence Current in Amps
	Percent Current Unbalance
	Voltage in Volts (per phase L–L, also L–N on 4–wire systems)
	Average Voltage in Volts (L–L, also L–N on 4–wire systems)
	Positive Sequence Voltage in Volts
	Negative Sequence Voltage in Volts
	Percent Voltage Unbalance
	Frequency in Hz
	Phase Rotation (ABC, ACB)
	Power Factor in Percent (total, also per phase on 4–wire systems)
	Watts (total & per phase on 4–wire systems)
	VA (total & per phase on 4–wire systems)
	VAR (total & per phase on 4–wire systems)
	Power Consumption in kW Hours
	Reactive Power Consumption in kVAR Hours
	Demand (Amps, VA, & Watts)
Reference Bus	Voltage per phase in Volts (per phase L–L, also L–N on 4–wire systems)
	Average Voltage in Volts (L–L, also L–N on 4–wire systems)
	Frequency in Hz
	Phase Rotation (ABC, ACB)

All voltage and current measurements are true RMS. The power measurements are calculated from the instantaneous voltage and current measurements. The remainder of the monitoring information is derived from these values.

Module Configuration

Before the LSM can perform its intended functions, it must be configured by the user. The module is configured by providing the required data via a block transfer to the module. The block transfer data can be entered into the PLC-5 manually or with the 6200 Version 4.4 I/O Configuration Software. The 6200 Software can also be used to monitor the operation of the module.

Chapter 2

Installation

Location

The Bulletin 1402 Line Synchronization Module (LSM) should be installed in a Bulletin 1771 I/O chassis that is located in a dry, dirt free environment away from heat sources and very high electric or magnetic fields. The module is designed to operate in an ambient temperature between 0 and 60° Celsius. The LSM is typically installed in a local rack in order to maximize data transfer rates.

Enclosure

This equipment is classified as open equipment and must be installed (mounted in an enclosure during operation as a means of providing safety protection. The enclosure chosen should protect the LSM from atmospheric contaminants such as oil, moisture, dust, corrosive vapors, or other harmful airborne substances. A steel enclosure is recommended to guard against EMI (Electromagnetic Interference) & RFI (Radio Frequency Interference).

The enclosure should be mounted in a position that allows the doors to open fully. This will allow easy access to the wiring of the LSM and related components so that servicing is convenient.

When choosing the enclosure size, extra space should be allowed for associated application equipment such as, transformers, fusing, disconnect switch, master control relay, and terminal strips.

Mounting

The LSM mounts in two slots of a Bulletin 1771 Series B, I/O chassis. Mounting dimensions will vary with the size of the chassis selected. Refer to the appropriate 1771 literature for specific dimensions.

Power Supply

The LSM backplane power requirement is 1.1A at 5V DC. Refer to the appropriate 1771 literature for additional information on available power supply current.

Chassis Grounding

For correct and reliable performance, the grounding recommendations specified for Allen–Bradley PLC® systems must be followed.

Swing Arm

The LSM requires the use of a Cat. No. 1771-WC (10 position, gold contacts) Swing Arm.

Wiring

There are two sets of terminals associated with the LSM; a 10 position swingarm and an 8 position fixed terminal block. All customer wiring to the LSM is accomplished via these terminals on the front of the module. The 10–position swingarm is used to make all of the voltage (PT) connections to the module as well as the Load Share connections. These connections are designed to accommodate wire size 0.5 mm^2 (22 AWG) through size 2.0 mm^2 (14 AWG). The 8–position fixed terminal block is used to make all of the current (CT) connections. These connections are designed to accommodate gauge wire size 0.5 mm^2 (22 AWG) through ring lugs size 3.25 mm^2 (12 AWG).

Phasing and polarity of the AC current and voltage inputs and their relationship are critical for the correct operation of the unit. Figure 2.1 through Figure 2.5 shown on Pages 2–7 through 2–11 provide wiring diagrams to help ensure correct installation.

Two (2) conductor shielded wire (22 gauge or greater) should be used for Load Share wiring. The shield shall be grounded at the PLC Chassis ground point only.

Prevent Electrostatic Discharge

ATTENTION: Electrostatic discharge can damage integrated circuits or semiconductors if you touch backplane connector pins. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential.
- Wear an approved wrist-strap grounding device.
- Do not touch the backplane connector or connector pins.
- Do not touch circuit components inside the module.
- If available, use a static-safe work station.
- When not in use, keep the module in its static-shield box.

PT and CT Transformer Selection

For proper monitoring and synchronization, correct selection of current transformers (CT's) and potential transformers (PT's) is critical. The following paragraphs provide the information required to choose these transformers. Also refer to transformer operational characteristics Pages 3–2 and "Factory Configuration Parameters" listed on Page B–2.

PT Selection

The LSM is designed for a nominal full scale input voltage of 120V AC. The user must supply transformers to scale down the system L–N (Wye) or L–L (Delta) voltage to the full scale input rating of the module. The PT's should be selected as follows:

- Wye (Star) Configuration – PT primary rating = L–N voltage or nearest higher standard size. PT secondary rating = 120 Volts.
- Delta or Open–Delta Configuration – PT primary rating = system L–L voltage. PT secondary rating = 120 Volts.

PT quality directly affects system accuracy. The PT's must provide accurate linearity and maintain the proper phase relationship between voltage and current in order for the Phase Error, Volts, kW, and Power Factor readings to be valid. Instrument accuracy Class 1 or better is recommended. The LSM PT inputs represent a Ø.Ø2 VA burden.

CT Selection

The LSM uses current transformers (CT's) to sense the current in each phase of the power feed from the synchronizing voltage source, and may optionally be included in the ground or neutral conductor. The precision of the selected CT's will directly affect the device accuracy.

The CT secondary should have a rating of 5A full scale and a burden capacity greater than 3VA. The LSM Module CT Inputs represent a burden of 0.0025VA.

ATTENTION: The CT primary rating is normally selected to be equal to the current rating of the power feed protection device. However, if the peak anticipated load is much less than the rated system capacity, then improved accuracy and resolution can be obtained by selecting a lower rated CT. Generally, the CT size should be the maximum expected peak current +25%, rounded up to the nearest standard CT size.

Other factors may affect CT accuracy. The length of the CT cabling should be minimized because long cabling could contribute to excessive power load on the CT and inaccuracy. The CT burden rating must exceed the combined burden of the LSM plus cabling plus any other devices connected in the measuring circuit (burden is the amount of load being fed by the CT, measured in Volt–Amps calculated at 5A full scale.).

Overall accuracy is dependent on the combined accuracy of the Bulletin 1402, the CT's, and the PT's. Instrument accuracy Class 1 or better is recommended.

ATTENTION: A CT circuit must not be opened under power. Wiring between the CT's and the LSM should include a terminal block for shorting the CT's. Open CT's secondaries can produce hazardous voltages, which can lead to personal injury or death, property damage or economic loss.

PT and CT Wiring Connections

Connection for Three Phase WYE (Star), 4 Wire Systems

Figure 2.1 shown on Page 2–7 provides a wiring diagram for 4–wire WYE (Star) systems. The "Voltage Mode" of the LSM should be set to "1" (as described in Chapter 3, "General Operation") for 4–wire WYE systems.

The LSM senses the line to neutral (or ground) voltage of each phase. The PT primaries and secondaries must be wired in a WYE (Star) configuration as shown in the figure. Voltage input leads should be protected by circuit breakers or fuses at their source. If the power rating of the PT's is over 25 Watts, secondary fuses should be used. Wiring and polarity marks must be exactly as shown for correct operation.

Connection for Three Phase WYE (Star), 3 Wire Systems

Figure 2.2 shown on Page 2–8 provides a wiring diagram for 3–wire WYE (Star) systems. The "Voltage Mode" of the LSM should be set to "1" (as described in Chapter 3, "General Operation") for 3–wire WYE systems.

The LSM senses the line to neutral voltage of each phase. The PT primaries and secondaries must be wired in a WYE (Star) configuration as shown in the figure. Voltage input leads should be protected by circuit breakers or fuses at their source. If the power rating of the PT's is over 25 Watts, secondary fuses should be used. Wiring and polarity marks must be exactly as shown for correct operation.

PT and CT Wiring Connections Continued

Connection for Three Phase Delta, 3 Wire Systems with 3 PT's & 3 CT'S

When configured for ungrounded (floating) Delta operation, the LSM senses the L–L voltages between each of the phases. The "Voltage Mode" of the LSM should be set to "2" (as described in Chapter 3, "General Operation"). Figure 2.3 shown on Page 2–9 provides the wiring diagram for this configuration. Wiring and polarity marks must be exactly as shown for correct operation.

Connection for Three Phase Open Delta, 3 Wire Systems with 2 PT's & 3 CT'S

When configured for ungrounded or Open Delta operation, the LSM senses the L–L voltages between each of the phases. The "Voltage Mode" of the LSM should be set to "4" (as described in Chapter 3, "General Operation"). Figure 2.4 shown on Page 2–10 provides the wiring diagram for this configuration. Wiring and polarity marks must be exactly as shown for correct operation.

Connection for Three Phase Open Delta, 3 Wire Systems with 2 PT's & 2 CT'S

When configured for ungrounded (floating) Open Delta operation, the LSM senses the L–L voltages between each of the phases. The "Voltage Mode" of the LSM should be set to "4" (as described in Chapter 3, "General Operation"). Figure 2.5 shown on Page 2–11 provides the wiring diagram for this configuration. Wiring and polarity marks must be exactly as shown for correct operation.

Neutral Connection

The voltage reference terminal, "Neutral", of the LSM serves as the zero voltage reference for voltage readings. A low impedance Neutral connection is essential for accurate measurement. The length of the wire should be as short as possible. It should be made using a dedicated size 2.0 mm^2 (14 AWG) wire, or larger, to a point in close proximity to the LSM. This will provide minimal voltage error due to other distribution voltage drops.

The connection point for "Neutral" is the point where the PT secondary leads are common.

Current Transformer Connections

The LSM is equipped with four CT inputs, designated I1 – I4. Inputs I1 – I3 are used to measure the current in the synchronizing circuit. These inputs are wired as shown on Pages 2–7 through 2–11 in Figure 2.1 through Figure 2.5. Input I4 is optional and is typically used to measure current in the neutral or ground conductor. The primary rating for I4 can be different than the primary rating for transformers I1 – I3. However, the secondary rating for all of the CT's must be 5 Amps.

Current connections may remain unused for a system that only performs synchronization. Unused terminals should be wired to chassis ground for noise immunity.

Maintenance

The LSM does not require any special maintenance.

Calibration

The calibration interval for the LSM depends on the user's accuracy requirements. To meet general operating requirements, regular calibration is not necessary.

Contact your nearest Allen–Bradley Sales Office for calibration or service information.

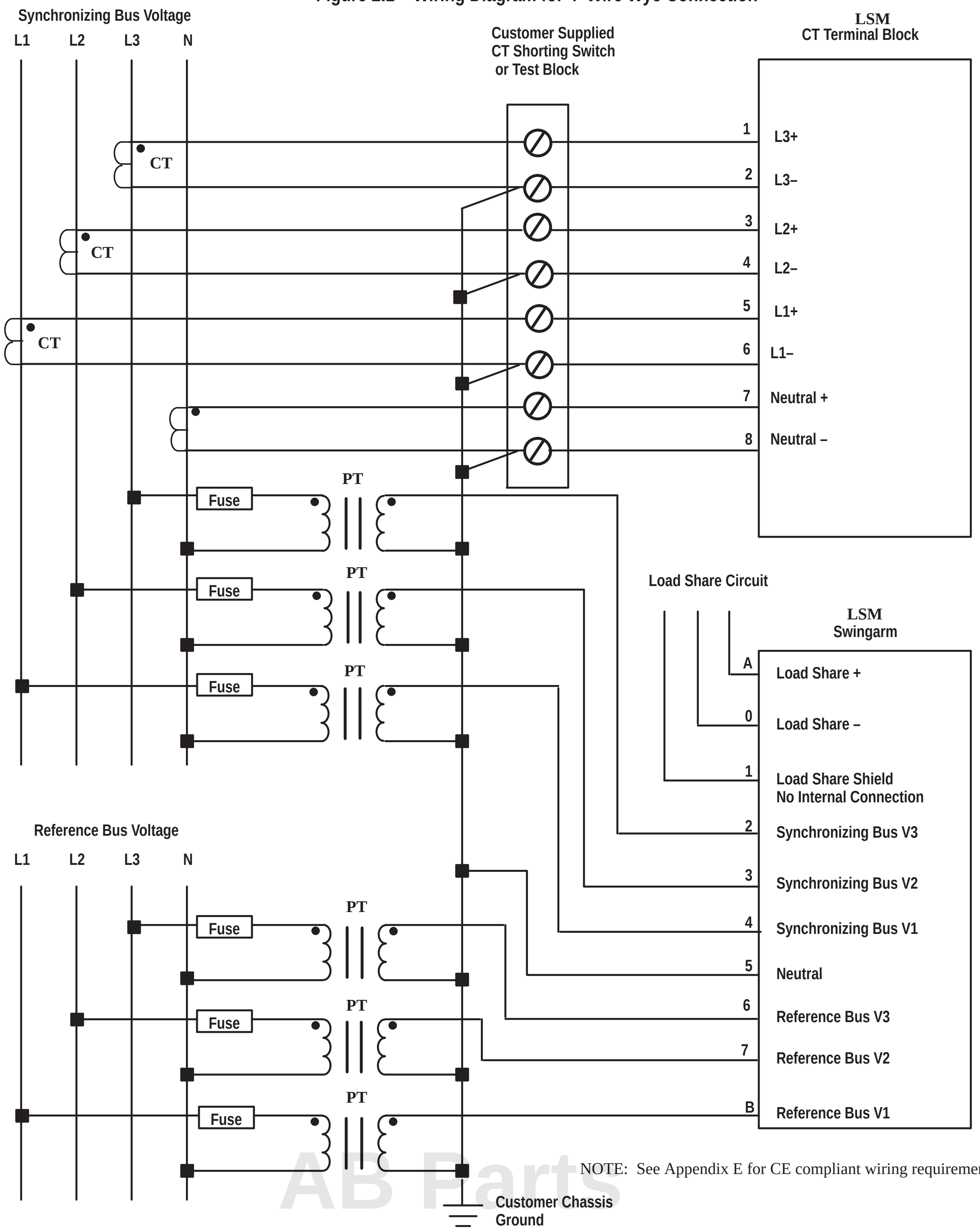
Field Service Considerations

If the LSM requires servicing, please contact your nearest Allen-Bradley Sales Office. To minimize your inconvenience, the initial installation should be performed in a manner which makes removal easy.

1. A CT shorting block should be provided to allow the LSM current inputs to be disconnected without open circuiting the user supplied CTs. The shorting block should be wired to prevent any effect on the external protective relays.
2. All wiring should be routed to allow easy maintenance at connections to the LSM terminal strips, the swing-arm, and the LSM itself.

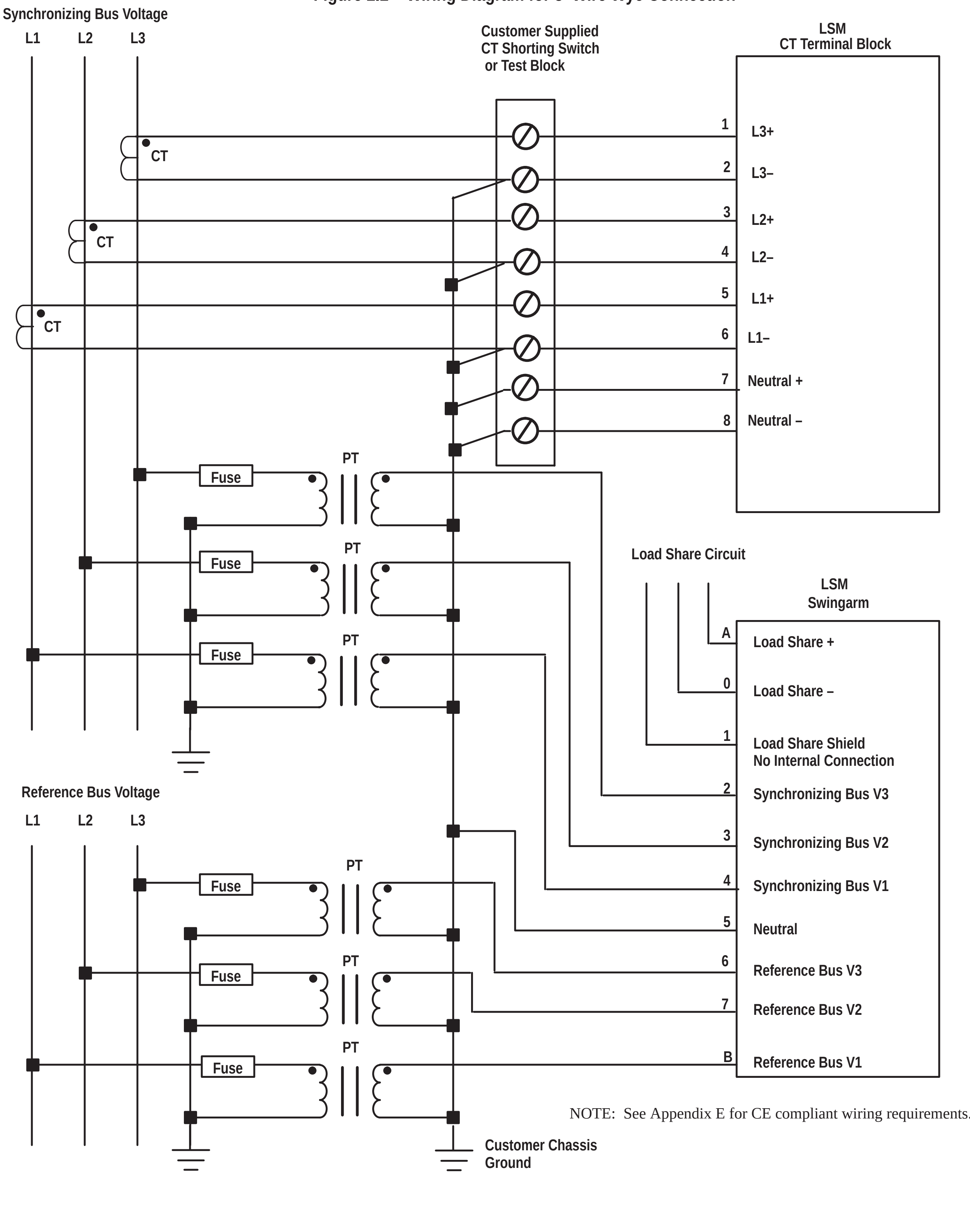
ATTENTION: A CT circuit must not be opened with primary current present.. Wiring between the CT's should include a terminal block for shorting the CT's. Open CT secondaries will produce hazardous voltages, which can lead to personal injury or death, property damage, economic loss or CT failure.

Figure 2.1 – Wiring Diagram for 4–Wire Wye Connection



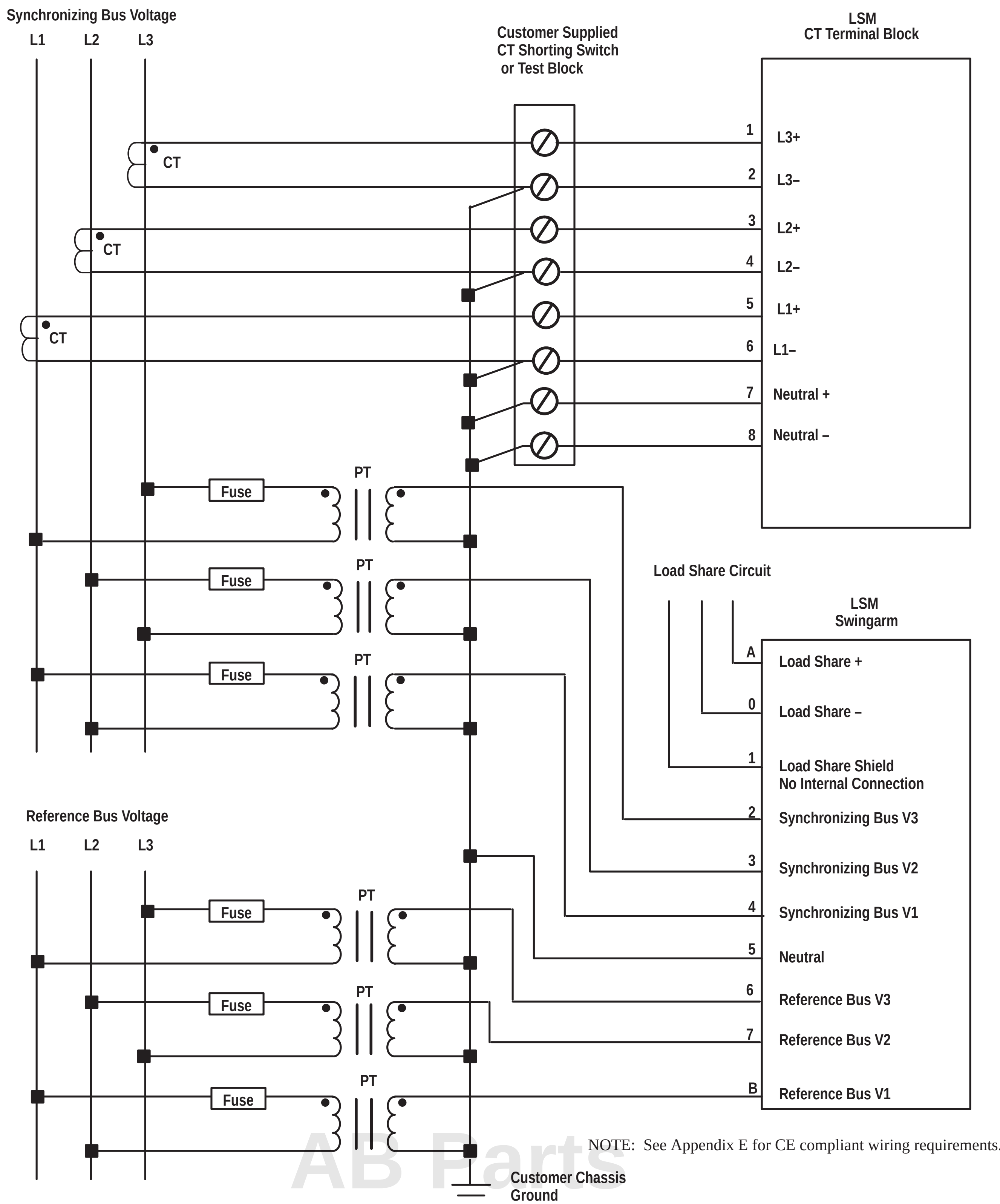
NOTE: See Appendix E for CE compliant wiring requirements.

Figure 2.2 – Wiring Diagram for 3–Wire Wye Connection



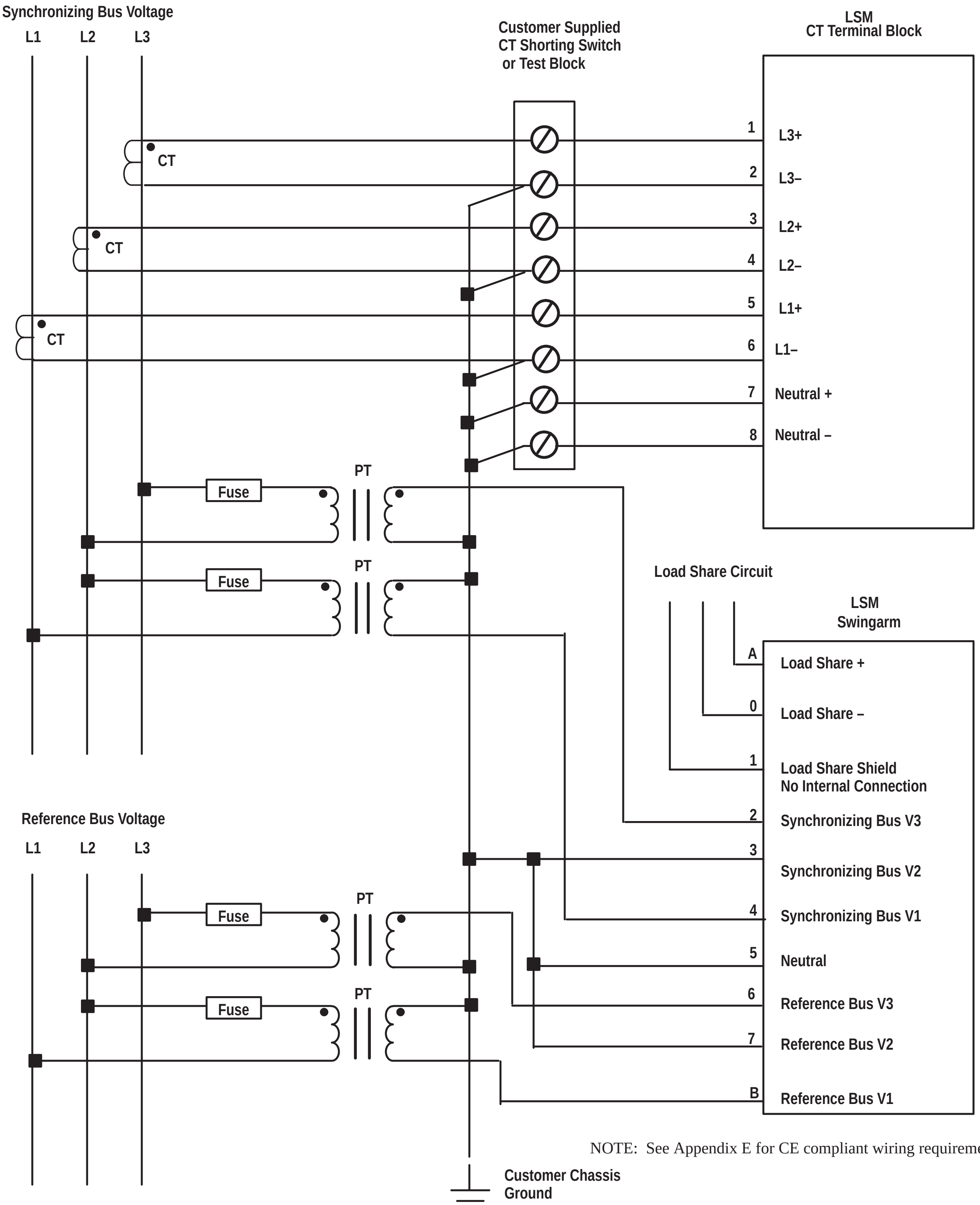
NOTE: See Appendix E for CE compliant wiring requirements.

Figure 2.3 – Wiring Diagram for 3 Transformer Delta Connection



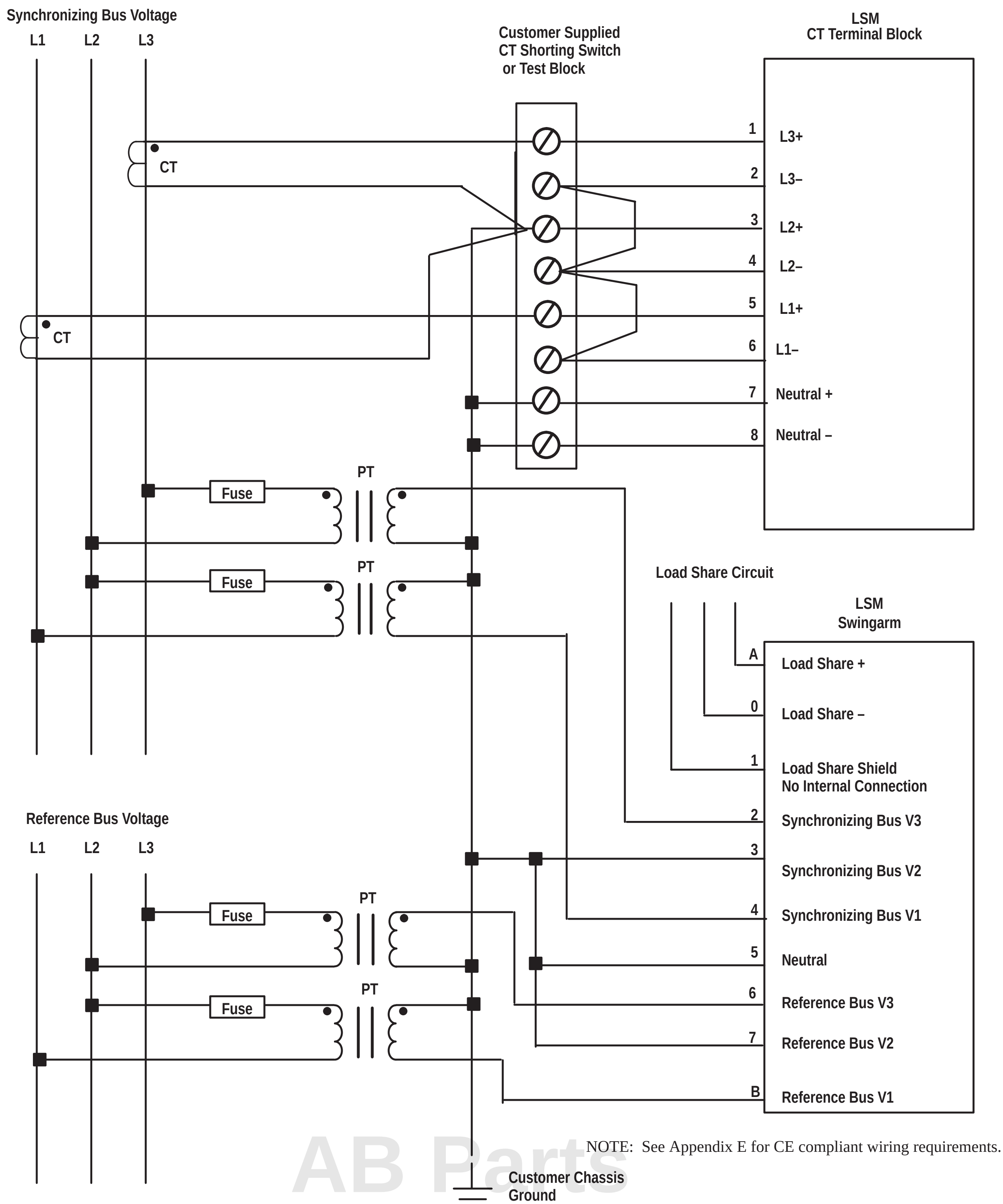
NOTE: See Appendix E for CE compliant wiring requirements.

Figure 2.4 – Wiring Diagram for 2 Transformer Open–Delta Connection



NOTE: See Appendix E for CE compliant wiring requirements.

Figure 2.5 – Wiring Diagram for 2 Transformer Open–Delta Connection With 2 CT's



NOTE: See Appendix E for CE compliant wiring requirements.

Chapter 3

General Operation

Chapter Objectives

This chapter:

- introduces the user to the controls and operation
- describes each function
- defines operating parameters

Operational Characteristics

Functional

The LSM has six different modes of operation. These modes are described below.

Configuration

Before the LSM can perform its intended functions, it must be configured by the integrator/OEM or user. Configuration is accomplished by sending the appropriate information to the module via the "Block Transfer Write" mechanism. Configuration data is compared with acceptable values. The user can obtain acknowledgment of the configuration data by using the "Block Transfer Read" mechanism for access to the module's response. If out–of–range or illegal values were entered, an error indication that identifies the illegal or out–of–range entries is returned. If the data is acceptable, an acknowledgment indication is returned. The new configuration data is then used to scale the monitoring data and to set up the synchronization and load sharing functions.

Whenever new configuration data is sent to the LSM, all module functions (synchronization, load–sharing, and monitoring) are terminated, and the values for "Amps Demand", "kVA Demand", and "kW Demand" are cleared. The values for "kW Hours" and "kVAR Hours" are maintained at the values present before the new configuration data was sent. The new configuration data is then evaluated. Upon acceptance of the new configuration data, the module resumes normal operation.

A detailed description of the required configuration data follows. See "Block Transfer Communications", on Page 4–2 in the Application Information chapter of this manual and Appendix B, "Block Transfer Tables and Discrete I/O Definition", for a detailed description of how the module performs block transfers and how the associated data is organized.

Operational Characteristics Continued

Voltage Mode

This entry is used to indicate if the system being monitored is wired in a WYE, a Delta, or an open Delta. A value of “1” will indicate a WYE system, a value of “2” will indicate a three transformer Delta system, and a value of “4” will indicate a two transformer Open Delta system. Line–to–Neutral values will be provided only when a WYE is configured.

PT Primary Rating

This entry is used to indicate the primary voltage rating of the user supplied potential transformers. This information is used for scaling purposes. The value of this parameter must be between 120 and 115,000.

Line and Neutral CT Primary Ratings

These entries are used to indicate the primary ampere rating of the user supplied line and neutral current transformers. This information is used for scaling purposes. The value of this parameter must be between 5 and 10,000.

Synchronization Method

This configuration entry is used to indicate which method of synchronization is to be implemented. A value of “0” indicates the delayed acceptance window method.

ATTENTION: The following acceptance limit values must be set to fit the customer applications.

Voltage Match Error Upper and Lower Acceptance Limits

These entries are used to specify the upper and lower acceptance limits for matching Synchronizing Bus voltage to the Reference Bus voltage. The value is specified in steps of 0.05% and must be between 0.00 and $\pm$25.00 percent.

Frequency Match Error Upper and Lower Acceptance Limits

These entries are used to specify the upper and lower acceptance limits for matching Synchronizing Bus frequency to the Reference Bus frequency. The value is specified in steps of 0.01 Hz and must be between 0.00 and $\pm$1.00.

Operational Characteristics Continued

Phase Match Error Upper and Lower Acceptance Limits

These entries are used to specify the upper and lower acceptance limits for matching Synchronizing Bus phasing to the Reference Bus phasing. The value is specified in degrees and must be between 0 and ±45.

Acceptance Window Delay

This entry is used for the delayed acceptance window method of synchronization. The value is specified in steps of 0.05 seconds and must be between 0.00 and 10.00.

Maximum Synchronizing Bus Output Power

This entry is used to specify the power level at which the load sharing output voltage will be at its maximum value. The ratio of the actual power output to the value of this parameter is used to adjust the load sharing output voltage. This value will be specified in kW and must be between 0 and 999,999.

Load Share Full–scale Voltage

This entry is used to specify the load share circuit's full scale output voltage. The value is specified in steps of 0.01 volts and must be between 2.00 and 4.00.

Load Share Excess

This entry is used to specify the threshold for initiating action to decrease the Synchronizing Bus output power to the appropriate portion of the total system load. The value is a scalar quantity between 0.000 and –0.500.

Load Share Deficit

This entry is used to specify the threshold for initiating action to increase the Synchronizing Bus output power to the appropriate percentage of the total system load. The value is a scalar quantity between 0.000 and +0.500.

Operational Characteristics Continued

Demand Period

This entry is used to specify the desired period for demand measurement. The value is specified in minutes and must be between 1 and 99.

Number Of Demand Periods

This entry specifies the number of demand periods that should be averaged to determine the actual demand. The value must be between 1 and 15.

Synchronization

The functionality of the synchronization process is based on the synchronization discrete outputs from the PLC–5 received via the PLC backplane. The “Initiate Synchronization” output from the PLC–5 begins the synchronization process when it is asserted. It must remain asserted during the entire process. If the initiate signal is removed, the synchronization process is terminated. In addition to the initiate signal, one of the “Auto–Synchronization”, “Check Synchronization”, or the “Permissive Synchronization” discrete outputs from the PLC–5 must be asserted. If more than one of those signals is present, the synchronization fails and the “Synchronization Failure” discrete input to the PLC–5 will be asserted.

Additional information pertaining to the cause of the failure may be obtained by reading the appropriate block transfer data from the “Synchronizing Bus Error Parameters” table. (See Appendix B, “Block Transfer and Discrete I/O Definition”, for additional information.) If new setup information is received via block transfer while the LSM is in the Synchronization mode, synchronization is terminated. The new configuration data is evaluated and normal operation is resumed upon acceptance of the data.

The “Auto–Synchronization” discrete output from the PLC–5 causes the LSM to issue the appropriate error signals, both continuous discrete inputs and via block transfer, to cause, via the PLC–5, the synchronizing bus voltage, frequency, and phase to align with the reference bus. Once these conditions are satisfied, the “Close Breaker” discrete input to the PLC–5 is asserted based on the synchronization configuration. In the event a “dead reference bus” condition exists, the “Synchronization Failure” discrete input to the PLC–5 is asserted. Additional information pertaining to the cause of the failure may be obtained by reading the appropriate block transfer data from the “Synchronizing Bus Error Parameters” table. (See Appendix B, “Block Transfer and Discrete I/O Definition”, for additional information.)

The “Check Synchronization” discrete output from the PLC–5 causes the LSM to function in the same manner as the “Auto–Synchronization” discrete output from the PLC–5 except it will not assert the “Close Breaker” discrete input to the PLC–5. This mode is useful for testing the system.

Operational Characteristics Continued

Synchronization Continued

The “Permissive Synchronization” discrete output from the PLC–5 prevents the LSM from issuing any error signals, but it asserts the “Close Breaker” discrete input to the PLC–5 if the synchronization criteria are satisfied. This mode also recognizes a “dead reference bus” condition and asserts the “Close Breaker” discrete input to the PLC–5 to allow an operator to bring the synchronizing bus on line when the reference bus has failed.

The “Enable Single Phase Synchronization” discrete output from the PLC-5 allows for single phase synchronization. In this mode, only the voltages applied to the V3 inputs of the synchronization bus and reference bus are used for synchronization. Any voltages applied to the V1 and/or V2 inputs are not used for synchronization purposes (i.e. phase rotation, dead-bus conditions and over-voltage conditions). Other than not using the V1 and V2 inputs, single phase synchronization does not change the operation of Auto, Check or Permissive synchronization functions.

- Voltage Match Error = 100 × (Reference Bus Voltage – Synchronizing Bus Voltage) /(Reference Bus Voltage)
- Frequency Match Error = (Reference Bus Frequency) – (Synchronizing Bus Frequency)
- Phase Match Error = (Reference Bus Voltage Zero–cross Degrees) – (Synchronizing Bus Voltage Zero–cross Degrees) [This calculation is performed on either both rising zero–crosses or both falling zero–crosses and the result is adjusted to provide a value between –180 degrees and +180 degrees.]

In the “Delayed Acceptance Window” method of synchronization, the “Close Breaker” discrete input to the PLC–5 is asserted after the “Voltage Match Error”, the “Frequency Match Error”, and the “Phase Match Error” have all remained continuously within their respective acceptance windows for the configured delay time, called: “Acceptance Window Delay”.

In the event the reference bus and synchronizing bus systems are opposite in phase rotation, the synchronization fails. This is indicated by the “Synchronization Failure” discrete input to the PLC–5. Additional information pertaining to the cause of the failure may be obtained by reading the appropriate block transfer data from the “Synchronizing Bus Error Parameters” table. (See Appendix B, “Block Transfer and Discrete I/O Definition”, for additional information.)

Important: While still indicated in single phase synchronization mode, phase rotation mismatch will not set the “synchronization failure” discrete input to the PLC-5.

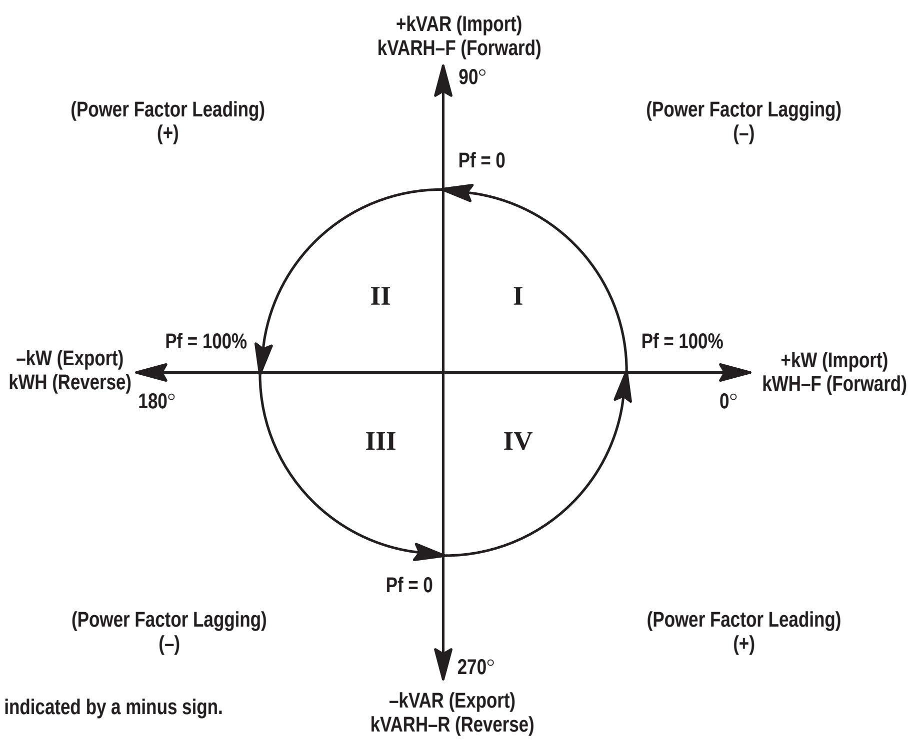
Operational Characteristics Continued

Power Monitoring

In addition to the synchronization function, the LSM provides an extensive array of monitoring information. This data is accessible through one of several different block transfers. (See Appendix B, "Block Transfer Tables and Discrete I/O Definition", for additional information.) All voltage and current measurements presented by the LSM are true RMS. The power measurements are calculated from the instantaneous voltage and current measurements. The remainder of the monitoring information is calculated from these values.

The LSM will clip the input voltages at approximately 1.25 times the maximum voltage input level. If this clipping takes place, the value 999 will be returned in every data field affected by the clipped channel.

The monitored values are scaled and reported based on the configuration entries that were provided by the user. This function is terminated if new configuration data is received. The new configuration data is evaluated and normal operation is resumed upon acceptance of the data. During synchronization those parameters not required for synchronization are monitored at a reduced priority. This allows critical synchronization data to be updated at a faster rate.



NOTE: Lagging Factor indicated by a minus sign.

Operational Characteristics Continued

Load Sharing

The load sharing function allows multiple synchronizing buses to split the load requirements on a power system based on the relative capacity of each of the alternators. To use this function, the LSM must be configured with a “Maximum Alternator Output Power” entry, a “Load Share Full–Scale Voltage” entry, a “Load Share Deficit” entry, and a “Load Share Excess” entry. The first entry specifies the maximum desired power output for the alternator. The second entry specifies the load share output voltage that will be created when the alternator is operating at maximum power. The third and fourth entries define the regions where load sharing activity will take place. The region between these two entries is the dead–band where no corrective action takes place if the discrete inputs are being utilized for control. The full–scale voltage is configurable to be between 2 and 4 volts.

The load sharing function is enabled when the “Load Share Disable” discrete output from the PLC–5 is *not* asserted and the “Isochronous/Droop” discrete output from the PLC–5 indicates isochronous mode. If new setup information is received via block transfer while this function is enabled, load sharing is terminated. The new configuration data is evaluated and normal operation is resumed upon acceptance of the data.

The LSM provides a “Load Sharing Output” voltage that is resistively coupled to the dual function input/output terminals. The magnitude of the output voltage is calculated from the following formula:

(“Load Share Full–Scale Voltage”) (Actual Power) / (“Maximum Alternator Output Power”)

The “Load Sharing Input” voltage is measured from the dual function input/output terminals. The load sharing input is calculated by:

(“Load Sharing Input Voltage”) / (“Load Share Full–Scale Voltage”)

The “Load Share Error” is a fraction and is expressed as:

(Load Sharing Input Voltage) / (Load Share Full–Scale Voltage) – (Actual Power) / (Maximum Alternator Output Power)

If the error is negative, the alternator is supplying too much of the load requirements and the “Reduce Power – load share adjust” discrete input to the PLC–5 is asserted when the error exceeds the “Load Share Excess” entry. If the error is equal to zero, the load is being properly shared. If the error is positive, the alternator is not supplying enough of the load requirements and the “Raise Power – load share adjust” discrete input to the PLC–5 is asserted when the error exceeds the “Load Share Deficit” entry.

The LSM load sharing circuit is isolated from the external circuitry whenever load sharing is disabled, droop mode is indicated, or if power is removed from the module.

Operational Characteristics Continued

Control

The user can direct the LSM to perform several different functions by sending the appropriate block transfer data to the “Control Parameters Table”. (See Appendix B, “Block Transfer Tables and Discrete I/O Definition”, for additional information.) The functions that can be initiated are as follows:

- Execute Self–Test (If the Execute Self–Test option is selected, no other control options will be executed.)
- Clear kW–HR Counter
- Clear kVAR–HR Counter

Self–test

The LSM automatically performs a complete self–test every time the module is powered up or when commanded by an instruction embedded in the data sent via the control parameters block transfer write. The content of the data memory before the test is executed will be destroyed. However, the configuration parameters are maintained. If the self–test request is sent via the block transfer, it is performed once. The request must be repeated for additional tests. The self–test verifies the contents of the program memory, verifies performance of data memory, verifies the stored configuration data, checks the watchdog circuitry, and checks the performance of the analog input and analog output circuits to the extent possible.

A limited self–test that checks the validity of the stored configuration data and a limited test of the performance of the analog inputs is automatically performed at periodic intervals during normal operation.

Results of the self–test, either the full version or the limited version, are indicated in the module diagnostics available from the block transfer read data. (See Appendix B, “Block Transfer Tables and Discrete I/O Definition”, for additional information.) The diagnostic information that is available from the module is as follows:

- Bulletin Number
- Options
- Firmware Version
- ROM Status
- RAM Status
- EEPROM Status
- Analog Power Supply Status
- Data Acquisition Status
- Load Share D/A and A/D Converter Status
- Watchdog Timer Status
- Module Date / Time

Operational Characteristics Continued

Self–test Continued

The red Fault LED flashes while the complete self–test is being performed. The Fault LED will remain on continuously if the self–test fails. The Fault LED will turn off if the self–test is successfully completed.

The green Run LED is illuminated during the self–test and then turned off after the test is completed. The Run LED also flashes each time a block transfer is executed.

Update Rate

- Synchronizing Bus Error Parameters: 100 milliseconds
- Monitoring Parameters: 200 milliseconds (Synchronization Inactive) 1 second (Synchronization Active)
- Diagnostic Parameters: 1 second

Accuracy

The accuracy of the measurements and calculations made by the LSM are directly affected by the quality of the user supplied current and voltage transformers. Accuracy is affected by both the amplitude and phase errors introduced by the user supplied transformers. It is recommended that these transformers be Instrument Accuracy, Class 1 or better. The following accuracy values are relative to the signals that are present at the input terminals of the LSM.

- Current Measurement = + /– 0.2 % of Full Scale (Full Scale = 1.4 × CT Primary)
- Voltage Measurement = + /– 0.2 % of Full Scale (Full Scale = 1.25 × PT Primary)
- Frequency Measurement = + /– 0.05 Hz (within the 47 to 63 Hz range)
- Slip Frequency = + /– 0.05 Hz (within the 47 to 63 Hz range)
- Power, Power Factor, VA + /– 0.4 % of Full Scale Power Consumption (Full Scale = 1.75 × CT Primary × PT Primary)

PLC Interface

The LSM exchanges data with the PLC backplane via both discrete I/O and block transfers. Due to the physical size of the module’s internal components, the LSM requires two slots in the I/O chassis. However, addressing assignments are made to the lower numbered slot of the two slots used.

Discrete I/O Interface

The LSM accepts six discrete outputs from the PLC–5, and provides twelve discrete inputs to the PLC–5. See Appendix B, “Block Transfer Tables and Discrete I/O Definition”, for additional information.

PLC Interface Continued

Discrete Outputs (From the PLC Processor)

The following discrete output control signals will be provided from the PLC–5 processor via the back plane:

- Initiate Synchronization
- Auto–Synchronization Mode
- Check Synchronization Mode
- Permissive Synchronization Mode
- Load Share Disable
- Isochronous/Droop Mode
- Enable Single Phase Synchronization

Discrete Inputs (To the PLC Processor)

The following discrete input control signals will be provided to the PLC–5 processor via the back plane:

- Module Status
- Raise Voltage
- Lower Voltage
- Raise Speed — frequency adjust
- Lower Speed — frequency adjust
- Raise Speed — phase adjust
- Lower Speed — phase adjust
- Raise Power — load share adjust
- Reduce Power — load share adjust
- Close Breaker
- Synchronization Failure
- Power–up Bit

Block Transfer Data Interface

The LSM is capable of exchanging large amounts of data with the PLC processor via the Block Transfer mechanism. The amount of data greatly exceeds that which could be accommodated by a single block transfer. As a result, the data is divided into several different “files” and can be obtained through the use of multiple Block Transfers. The sizes, structure, and contents of the block transfer reads and writes supported by the LSM are provided in Appendix B. See “Block Transfer Communications”, listed on Page 4–2 in the Application Information chapter of this manual for further details on using Block Transfers.

PLC Interface Continued

Configuration Software Support

6200 Software

Setup assistance for the LSM module is provided through the 6200 version 4.4 or later I/O Configuration Software. This configuration software contains the functionality to configure the module and to monitor the data produced by an operating module.

To make use of the configuration software, the ladder must exist with block transfer instructions programmed as shown in Appendix C. (See Sample Ladder listings in Appendix C) The BTR instructions must occur through the ladder to read data from the module. These are done through the use of the sequencer and the data table values to insure that only one block transfer is active at a given time.

This software also supports the setup of the Bulletin 1400 family of power monitoring equipment. More 6200 I/O Configuration Software information on the actual use of this tool is available in the 6200 Series software user's manual.

Chapter 4

Application Information

Overview

Modes of Operation

The Line Synchronization Module (LSM) has several modes of operation. Upon successful configuration, or on power up with a previously configured module, the LSM will be in one of the following modes:

- Monitor Only
- Monitor with Load Share
- Synchronization and Monitor
- Synchronization and Monitor with Load Share

The state of the discrete outputs from the PLC–5 to the LSM controls the mode of operation of the LSM. This relationship is shown in Table 4.1.

Table 4.1

LSM Modes of Operation	Discrete Outputs From The PLC–5 to LSM		
	Initiate Synchronization	Load Share Disable	Isochronous/Droop Mode
Monitor Only	0	1	0 or 1
	0	0	0
Monitor with Load Share	0	0	1
Synchronization and Monitor	1	1	0 or 1
	1	0	0
Synchronization and Monitor with Load Share	1	0	1

Monitor Only

In this mode of operation, data is returned for Synchronizing Bus voltage, current, and power values, and Reference Bus voltage values. All error values and discrete inputs to the PLC–5 will be set to zero.

Monitor with Load Share

In this mode of operation, data is returned for Synchronizing Bus voltage, current, and power values, and Reference Bus voltage values. The error values and discrete inputs to the PLC–5 for load share are modified, while all synchronization errors and discrete inputs to the PLC–5 remain set to zero.

Synchronization and Monitor

In this mode of operation, data is returned for Synchronizing Bus voltage, current, and power values, and Reference Bus voltage values. The error values and discrete inputs to the PLC–5 for synchronization are modified while the load share errors and discrete inputs to the PLC–5 remain set to zero.

Overview Continued

Synchronization and Monitor with Load Share

In this mode of operation, data is returned for Synchronizing Bus voltage, current, and power values, and reference bus voltage values. The error values and discrete inputs to the PLC–5 for synchronization and load share are modified.

Interfacing to the LSM

Block Transfer Communications

The LSM is capable of exchanging large amounts of data with the PLC processor via the Block Transfer mechanism. The amount of data greatly exceeds that which could be accommodated by a single block transfer. As a result, the data is divided into many different “files” and can be obtained through the use of multiple Block Transfers.

The LSM uses a unique scheme for differentiating between sets of parameters, or “files”, being written to or read from the module. The size of the block transfer operation is used to define the size of the transaction and is also used as a block type ID. Each of the “files” that the LSM recognizes has a unique size and can therefore be identified by the module. This is a very important aspect of understanding how the LSM communicates with the PLC–5. The size, structure, and content of the block transfer reads and writes supported by the LSM are provided in Appendix B.

ATTENTION: Only one block transfer at a time may be issued to the LSM. This means that until a BTR or BTW to the LSM has completed, another block transfer to the LSM must not be initiated. Failure to observe this requirement will result in improper operation of the data exchange with the module.

Only one block transfer at a time may be issued to the LSM. This means that until a BTR or BTW to the LSM has completed, another block transfer to the LSM must not be initiated. Failure to observe this requirement will result in improper operation of the data exchange with the module.

The LSM uses a modulus method of accepting and returning numbers greater than 1000 or between 0 and 1. The modulus method splits these types of numbers into two or more words with the range 0– 999. The modulus is given in the form 10^6, 10^3, 10^0, or 10^{-3}.

For example, the number 10,000 would be represented by a 10 in the modulus 10^3 word and a 0 in the modulus 10^0 word. The number 10.5 would be represented by a 10 in the modulus 10^0 word and a 500 in the modulus 10^{-3} word.

To process numbers received from the LSM in this format, the number in the modulus 10^3 word must be multiplied by 1000 and added to the number in the modulus 10^0 word.

Interfacing to the LSM Continued

Block Transfer Communications Continued

For example, the words 10 modulus 10^3 and 0 modulus 10^0 would be processed in this manner: (10 * 1000) + 0. The words 10 modulus 10^0 and 500 modulus 10^{-3} would be processed in this manner: 10 + (500 /1000).

To process numbers to be sent to the LSM in this format, a number greater than 1,000 needs to be divided by 1,000 to obtain the modulus 10^3 word. This word must then be re–multiplied by 1,000 and subtracted from the original number to obtain the modulus 10^0 word.

For example, the number 12,345 would be processed **as** follows:

- modulus 10^3 word = (12,345 /1,000) truncated to 12
- modulus 10^0 word = 12,345 – (modulus 10^3 word $\times$ 1000) = 345

Numbers such as 12.345 need to be processed **as** follows:

- modulus 10^0 word = 12.345 truncated to 12
- modulus 10^{-3} word = (12.345 – modulus 10^0 word) $\times$ 1000 = 345

Configuration

The only method of configuring the LSM module is via the block transfer operation of the PLC–5. The data to be sent to the LSM must be stored in a data file of the PLC. There are two separate block transfer writes necessary to completely configure the LSM. The address of these data files must be used as the data file parameter of the BTW instruction with sizes of 35 and 12. Again, the correct sizes are necessary to identify to the LSM what type of data is being sent. The size, configuration, and contents of the block transfer tables accepted by the LSM are discussed in Appendix B.

The parameters sent to the LSM must be valid before the LSM will respond and begin normal operation. The validity of data sent to the LSM may be checked by requesting the Acknowledge Factory (or User) Configuration Parameters tables from the LSM. This is accomplished by initiating BTRs of size 25 or 15 from the LSM. The final non–reserved word of these tables is the overall configuration status of the previous configuration BTR. If this word is 0, the configuration succeeded and the LSM is running in one of the modes previously described. If this word is 4, one or more of the configuration parameters was out of range or illegal and all set up data is not accepted. Each word of the Acknowledge Configuration Parameters table should then be examined to determine which parameter was invalid.

Interfacing to the LSM Continued

Acquiring Data From the LSM

The data from the LSM is returned in four tables. These tables are again differentiated by the size/ID of the BTR instruction. These tables are Synchronizing Bus Error Parameters, Synchronizing Bus Voltage/Current Parameters, Synchronizing Bus Power Parameters, and Reference Bus Voltage Parameters. The sizes and contents of these tables are provided in Appendix B of this document.

To acquire the table Synchronizing Bus Error Parameters from the LSM, the PLC–5 must issue a BTR instruction with the size of this table. The data file entry of the BTR is where the table from the LSM will be placed. Any operations using this data must then be directed to this file within the PLC–5.

Discrete Input / Output Control of the LSM

The LSM uses both discrete outputs from the PLC–5 and inputs to the PLC–5 in addition to its block transfer capabilities.

Discrete Outputs From The PLC–5

The discrete outputs from the PLC–5 to the LSM are as follows:

Table 4.2

Octal Bit Number	Decimal Bit Number	Output Description	State Values
17	15	Initiate Synchronization	1 = Initiate
16	14	Auto–Synchronization Mode	1 = Assert this mode
15	13	Check Synchronization Mode	1 = Assert this mode
14	12	Permissive Synchronization Mode	1 = Assert this mode
13	11	Load Share Disable	1 = Disable Load Share
12	10	Isochronous/Droop Mode	1 = Isochronous Mode
11	9	Unused	N/A
10	8	Enable Single Phase Synchronization	1 = Single Phase 0 = 3-Phase

The Initiate Synchronization output from the PLC–5 controls the operation mode of the LSM. This output from the PLC–5 operates as shown in Table 4.1 on Page 4–1.

The Auto Synchronization Mode output from the PLC–5, Check Synchronization Mode output from the PLC–5, and the Permissive Synchronization Mode output from the PLC–5 are only used when the module is in a Synchronization mode (i.e. the Initiate Synchronization output from the PLC–5 is set). Only one of these Synchronization Mode outputs from the PLC–5 may be set at one time. If more than one of those signals is

Interfacing to the LSM Continued

Discrete Outputs From The PLC–5 Continued

present, the synchronization fails and the “Synchronization Failure” discrete input to the PLC–5 will be asserted. Additional information pertaining to the cause of the failure may be obtained by reading the appropriate block transfer data from the “Synchronizing Bus Error Parameters” table. (See Appendix B, “Block Transfer and Discrete I/O Definition”, for additional information.)

The Auto Synchronization Mode discrete output from the PLC–5 causes the LSM to issue the appropriate error signals, both continuous discrete inputs to the PLC–5 and via block–transfer, to cause via the PLC–5 the alternator voltage, frequency, and phase to align with the Reference Bus. Once these conditions are satisfied, the Close Breaker discrete input to the PLC–5 will be asserted based on the synchronization configuration.

The Check Synchronization Mode discrete output from the PLC–5 causes the LSM to function in the same manner as the Auto Synchronization Mode output from the PLC–5, except it will not assert the Close Breaker discrete input to the PLC–5. This mode is useful for testing the system.

The Permissive Synchronization discrete output from the PLC–5 will not cause the LSM to issue any error signals, but it will assert the Close Breaker discrete input to the PLC–5 if the synchronization criteria are satisfied.

The Load Share Disable discrete output from the PLC–5 when set to 1 will cause the load share function of the LSM to be disabled.

The Isochronous/Droop Mode discrete output from the PLC–5 when set to 1 indicates Isochronous mode of load share operation. If this output from the PLC–5 is cleared to 0 the LSM will operate in the droop mode of load share. While the LSM is in Droop mode, all load share errors and discrete inputs to the PLC–5 will be set to 0. The load share terminals on the front of the module will be disconnected from internal circuitry, therefore, the load share function is effectively disabled.

The Enable Single Phase Synchronization discrete output from the PLC-5, when set to 1, allows the synchronization function to ignore the V1 and V2 inputs. In this mode, phase rotation mismatch does not cause a synchronization failure, and the V1 and V2 inputs are not used for features such as dead-bus detect or over-voltage detection. This mode allows connection of the V3 inputs to single phase systems, or those systems with a single transformer per 3-phase system.

Interfacing to the LSM Continued

Discrete Inputs to the PLC–5

The discrete inputs to the PLC–5 are as follows:

Table 4.3

Octal Bit Number	Decimal Bit Number	Input Description	State Values
17	15	Module Status	1 = Module Failed
16	14	Raise Voltage	1 = Raise
15	13	Lower Voltage	1 = Lower
14	12	Raise Speed – Frequency Adjust	1 = Raise
13	11	Lower Speed – Frequency Adjust	1 = Lower
12	10	Raise Speed – Phase Adjust	1 = Raise
11	9	Lower Speed – Phase Adjust	1 = Lower
10	8	Raise Power – Load Share Adjust	1 = Raise
7	7	Reserved	N/A
6	6	Reserved	N/A
5	5	Reserved	N/A
4	4	Reduce Power – Load Share Adjust	1 = Lower
3	3	Close Breaker	1 = Close Breaker
2	2	Synchronization Failure	1 = Failure
1	1	Powered Up Bit	1 = Module Ready
0	0	Reserved	N/A

The Module Status discrete input to the PLC–5 when set to 1 indicates that the LSM has identified a potential problem. A value of 0 indicates normal operation of the LSM. Additional information pertaining to the cause of the problem may be obtained by reading the appropriate block transfer data from the “Diagnostic Parameters” Table B.11. (See Appendix B, “Block Transfer Tables and Discrete I/O Definition”, for additional information.)

If the Module Status discrete input to the PLC–5 is set to 1, all block transfer writes will be ignored and only the Diagnostic Parameters block transfer read will return valid data. Any other block transfers should not be executed at this time.

The Raise Voltage synchronization error discrete input to the PLC–5 indicates that the Synchronizing Bus has a lower voltage level than that of the Reference Bus.

The Lower Voltage synchronization error discrete input to the PLC–5 indicates that the Synchronizing Bus has a higher voltage level than that of the Reference Bus.

The Raise Speed – Frequency Adjust synchronization error discrete input to the PLC–5 indicates that the Synchronizing Bus is producing voltage at a frequency lower than that of the Reference Bus.

Interfacing to the LSM Continued

Discrete Inputs to the PLC–5 Continued

The Lower Speed – Frequency Adjust synchronization error discrete input to the PLC–5 indicates that the Synchronizing Bus is producing voltage at a frequency higher than that of the Reference Bus.

The Raise Speed – Phase Adjust synchronization error discrete input to the PLC–5 indicates that the Synchronizing Bus is producing a voltage which is between 0 and 180 degrees behind the Reference Bus.

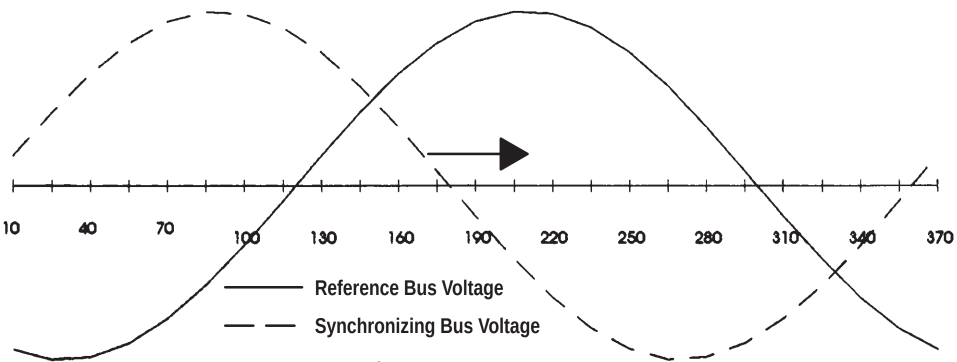


Figure 4.1

The Lower Speed – Phase Adjust synchronization error discrete input to the PLC–5 indicates that the Synchronizing Bus is producing a voltage which is between 0 and 180 degrees ahead of the Reference Bus .

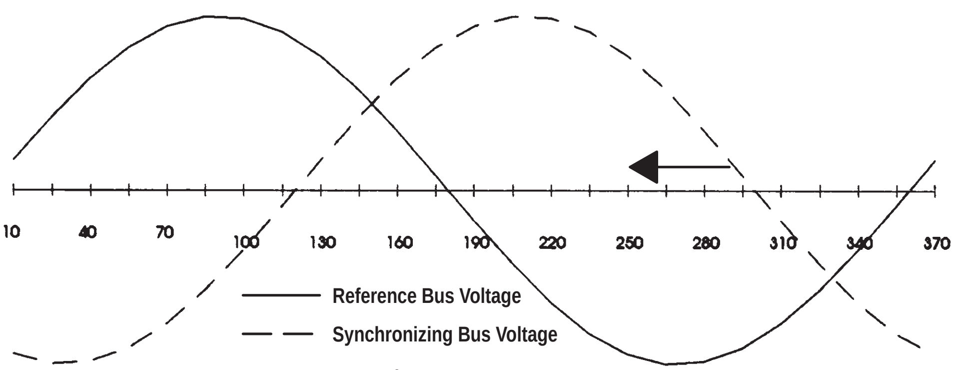


Figure 4.2

ATTENTION: If the Synchronization Bus and the Reference Bus are moving towards synchronization, the discrete inputs to the PLC–5 for Phase Adjust will not be asserted.

The Raise Power– Load Share Adjust discrete input to the PLC–5 indicates the prime mover is not producing enough power. The RPM must be increased.

The Reduce Power–Load Share Adjust discrete input to the PLC–5 indicates the prime mover is producing an excess of power. The RPM must be decreased.

Interfacing to the LSM Continued

Discrete Inputs to the PLC–5 Continued

The Close Breaker discrete input to the PLC–5 indicates that all synchronization criteria have been met and it is acceptable to close the breaker between the Synchronizing Bus and the Reference Bus.

The Synchronization Failure discrete input to the PLC–5 indicates a synchronization error. When this bit is set, the LSM cannot perform Synchronizing Bus / Reference Bus synchronization.

When the Synchronization Failure discrete input to the PLC–5 is set, the Synchronization Status word in the Synchronizing Bus Error Parameters indicates the reason for synchronization failure.(See Appendix B Table B.6)

The Powered–up Bit discrete input to the PLC–5 indicates that the LSM has completed internal self– tests and is ready to perform block transfers with the PLC–5.

Ladder Program Description

Included in Appendix B is a sample PLC–5 ladder program that interfaces with the LSM. The data files used are described in Tables 4.4 and 4.5.

ATTENTION: Executing the Control Request BTW from the sequencer file, or at a similar rate of speed could cause improper operation of the LSM.

Ladder Program Description Continued

Data Files Used

Table 4.4

Data File	Data	Description
B3		b3/0 Internal Trigger
		b3/1 Config Mode Enable
		b3/2 Data Reset
		b3/3 Run mode Sequence Complete
		b3/4 Valid Config Data
		b3/5 Config Sequence Complete/Data Valid
		b3/6 Module Config Complete
		b3/9 One–shot bit
		b3/10 One–shot bit
N10		n10:0 Sequencer output (BT select word)
N21		Config mode sequencer input file.
		For proper configuration with the sequencer at rung 2:7 set to a length of 4 words, the following data MUST be in file N21.
N21:0	59	• Factory Configuration Parameters
N21:1	59	• Factory Configuration Parameters
N21:2	52	• Factory Acknowledge Configuration
N21:3	60	• User Configuration Parameters
N21:4	53	• User Acknowledge Configuration Parameters
N22		Run mode sequencer input file
		For proper configuration with the sequencer at rung 2:8 set to a length of 8 words, the following data MUST be in file N22.
N22:0	54	• Synchronizing Bus Error Parameters
N22:1	54	• Synchronizing Bus Error Parameters
N22:2	50	• Factory Configuration Parameters
N22:3	51	• User Configuration Parameters
N22:4	55	• Synchronizing Bus Voltage/Current Parameters
N22:5	54	• Synchronizing Bus Errors
N22:6	56	• Synchronizing Bus Power Parameters
N22:7	57	• Reference Bus Voltage Parameters
N22:8	58	• Diagnostic Parameters

Ladder Program Description Continued

Data Files Used Continued

The following description applies to both files N21 and N22.

The data at word 0 of N21 and N22: 1 must be the same. N2x:0 is the reset word for the sequencer and N2x:1 is the first word in the rotation of the sequencer.

The data held in file N21 consists of the block transfer numbers needed to complete configuration in the order necessary to perform that task. This data must be as shown in the file N21 description for a sequencer size of 4. See Data File Table 4.5. The sequencer size may be altered, but no smaller than 4. If the size is expanded, the pattern of data in file N21 MUST be extended in the same fashion as it is shown below in the file N21 description.

The data held in file N22 consists of the block transfer numbers of the data desired in run mode. With the sequencer size set to 8, eight different block transfers may be executed sequentially. The numbers entered in file N22 may be altered to change the order of “run mode” block transfers being executed. The sample data as shown in the file N22 description ensures that the BTR for Synchronizing Bus Error Parameters occurs at regular intervals (i.e. 3 BTRs apart) and twice as frequently as any of the other block transfers. See Data File Table 4.5.

Note: Even though the block transfers may occur at a certain rate, the data they are transferring may not have been updated internally by the LSM. Changing the BT order in the sequencer may not significantly change the update rate of “new” data.

If more or different block transfers are desired, the sequencer size can be expanded and the files N21 and N22 MUST be expanded by the same amount.

Important: Failure to expand the data in files N21 and N22 will result in improper operation of the block transfer ladder, and possibly even a FAULT of the processor due to invalid indirect offsets. See Data File table 4–5.

Ladder Program Description Continued

Data Files Used Continued

Table 4.5

File	Description
N30	Factory Configuration Parameters BTR Destination
N31	User Configuration Parameters BTR Destination
N32	Acknowledge Factory Configuration Parameters BTR Destination
N33	Acknowledge User Configuration Parameters BTR Destination
N34	Synchronizing Bus Error Parameters BTR Destination
N35	Synchronizing Bus Voltage/Current Parameters BTR Destination
N36	Synchronizing Bus Power Parameters BTR Destination
N37	Reference Bus Voltage Parameters BTR Destination
N38	Diagnostic Parameters BTR Destination
N39	Factory Configuration Parameters BTW Source
N40	User Configuration Parameters BTW Source
N41	Control Request BTW Source
R6:0	Sequencer Control–Configuration
R6:1	Sequencer Control–Run
I	Discrete Inputs to the PLC–5
O	Discrete Outputs from the PLC–5

Accessing BTR Data from PLC Ladder

To access a specific parameter from any of the BTRs, the BTR destination file must be known as well as the parameter number of the parameter desired. An illustration of this is an example taken directly from the Block Transfer Tables document and the example ladder diagram. (See Appendix B & C).

To obtain Synchronizing Bus Frequency in Hz from the Synchronizing Bus Voltage/Current Parameters BTR, the following words need to be read: N35:37 and N35:38.

Since the frequency is divided in 10^0 and 10^{-3} formats, the following operations need to be performed to create a floating point representation of this number:

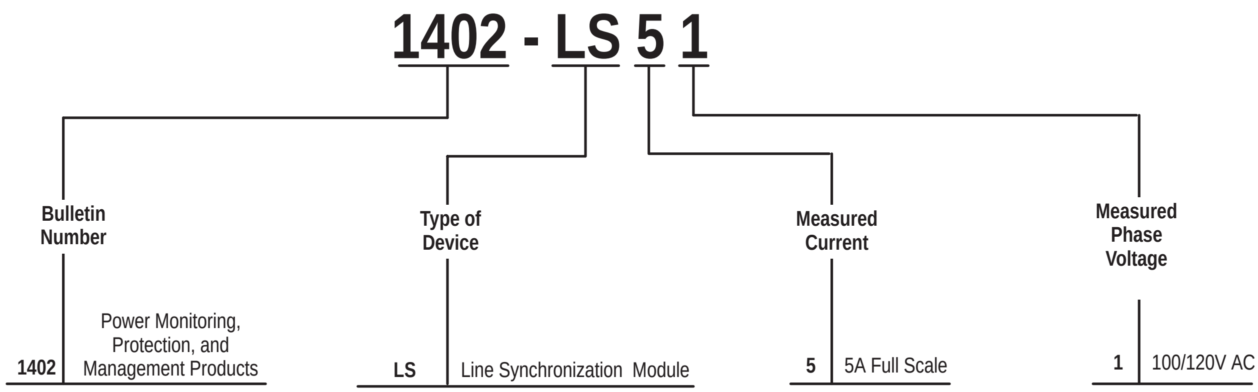
(N35:37 /1000) + N35:38 = frequency in floating point

For display purposes on a panel view terminal for example, it may not be necessary to perform this operation if the data can be divided into two fields and displayed as follows: N35:38. N35:37.

Appendix A

Catalog Number Explanation

LINE SYNCHRONIZATION MODULE



Appendix **B**

Block Transfer and Discrete I/O Definition

Table B.1
LSM Data Table List

Table Name	Number of Parameters	ID/Number of Words	Type of Table
Factory Configuration Parameters Page B–2	24	35	Block Transfer Read / Block Transfer Write
User Configuration Parameters Page B–4	12	12	Block Transfer Read / Block Transfer Write
Acknowledge Factory Configuration Parameters Page B–5	25	25	Block Transfer Read
Acknowledge User Configuration Parameters Page B–6	15	15	Block Transfer Read
Synchronizing Bus Error Parameters Page B–7	13	18	Block Transfer Read
Synchronizing Bus Voltage / Current Parameters Page B–8	28	46	Block Transfer Read
Synchronizing Bus Power Parameters Page B–10	21	54	Block Transfer Read
Reference Bus Voltage Parameters Page B–12	17	26	Block Transfer Read
Control Request Parameters Page B–13	14	14	Block Transfer Write
Diagnostic Parameters Page B–14	22	24	Block Transfer Read
Module Time Parameters ① Page B–16	11	11	Block Transfer Write
Discrete Input / Output Data Page B–17	16 / 16 bits	——	——
Reserved for Factory Use		42	——
Reserved for Factory Use		63	——

① 6200 Software Support Not Provided

Table B.2
Factory Configuration Parameters

Parameter Number	Word Num-ber	Description	Range	Modulus
1	1	Voltage Mode	1 – Wye 2 – Delta 4 – Open Delta	10^0
2	2	PT Primary Rating – Volts	0 – 999	10^0
	3	[Limits 120 – 115,000]	0 – 115	10^3
3	4	Line CT Primary Rating – Amps	0 – 999	10^0
	5	[Limits 5 – 10,000]	0 – 10	10^3
4	6	Neutral CT Primary Rating – Amps	0 – 999	10^0
	7	[Limits 5 – 10,000]	0 – 10	10^3
5	8	Synchronization Method	0=Delayed Accep-tance Window	10^0
6	9	Voltage Match Error Upper Acceptance Limit in Percent (Step size is 0.05 %)	±0 – 999	10^{-3}
	10	[Limits 0 – 25 %]	± 0 – 25	10^0
7	11	Voltage Match Error Lower Acceptance Limit in Percent (Step size is 0.05 %)	±0 – 999	10^{-3}
	12	[Limits 0 – 25 %]	±0 – 25	10^0
8	13	Frequency Match Error Upper Acceptance Limit in Hz (Step size is 0.01 Hz)	±0 – 999	10^{-3}
	14	[Limits 0 – 1]	±0 – 1	10^0
9	15	Frequency Match Error Lower Acceptance Limit in Hz (Step size is 0.01 Hz)	±0 – 999	10^{-3}
	16	[Limits 0 – 1]	±0 – 1	10^0
10	17	Phase Match Error Upper Acceptance Limit in Degrees	±0 – 20	10^0
11	18	Phase Match Error Lower Acceptance Limit in Degrees	±0 – 20	10^0
12	19	Acceptance Window Delay in Seconds (Step size 0.05 sec.)	0 – 999	10^{-3}
	20	[Limits 0 – 10]	0 – 10	10^0
13	21	Reserved for Product Expansion	—	—
	22		—	—

Table B.2
Factory Configuration Parameters (Continued)

Parameter Number	Word Number	Description	Range	Modulus
14	23	Maximum Alternator Output Power in Kilowatts [Limits 0 – 999,999]	0 – 999	10^{0}
	24		0 – 999	10^{3}
15	25	Load Share Full–Scale Voltage in Volts (Step size 0.01 volts) [Limits 2 – 4]	0 – 999	10^{-3}
	26		2 – 4	10^{0}
16	27	Load Share Excess [Limits –0.500 – 0]	500 – 0	10^{-3}
17	28	Load Share Deficit [Limits 0 – 0.500]	0 – 500	10^{-3}
18	29	Reserved for Product Expansion	—–	—–
19	30	Reserved for Product Expansion	—–	—–
20	31	Reserved for Product Expansion	—–	—–
21	32	Reserved for Product Expansion	—–	—–
22	33	Reserved for Product Expansion	—–	—–
23	34	Reserved for Product Expansion	—–	—–
24	35	Reserved for Product Expansion	—–	—–

Table B.3
User Configuration Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Demand Period in Minutes [Limits 1 – 99]	1 – 99	10^0
2	2	Number of Demand Periods [Limits 1 – 15]	1 – 15	10^0
3	3	Reserved for Product Expansion	—	—
4	4	Reserved for Product Expansion	—	—
5	5	Reserved for Product Expansion	—	—
6	6	Reserved for Product Expansion	—	—
7	7	Reserved for Product Expansion	—	—
8	8	Reserved for Product Expansion	—	—
9	9	Reserved for Product Expansion	—	—
10	10	Reserved for Product Expansion	—	—
11	11	Reserved for Product Expansion	—	—
12	12	Reserved for Product Expansion	—	—

Table B.4
Acknowledge Factory Configuration Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Voltage Mode	See Response Code	—
2	2	PT Primary Rating	See Response Code	—
3	3	Line CT Primary Rating	See Response Code	—
4	4	Neutral CT Primary Rating	See Response Code	—
5	5	Synchronization Method	See Response Code	—
6	6	Voltage Match Error Upper Acceptance Limit	See Response Code	—
7	7	Voltage Match Error Lower Acceptance Limit	See Response Code	—
8	8	Frequency Match Error Upper Acceptance Limit	See Response Code	—
9	9	Frequency Match Error Lower Acceptance Limit	See Response Code	—
10	10	Phase Match Error Upper Acceptance Limit	See Response Code	—
11	11	Phase Match Error Lower Acceptance Limit	See Response Code	—
12	12	Acceptance Window Delays	See Response Code	—
13	13	Reserved for Product Expansion	—	—
14	14	Maximum Alternator Output Power	See Response Code	—
15	15	Load Share Full–Scale Voltage	See Response Code	—
16	16	Load Share Excess	See Response Code	—
17	17	Load Share Deficit	See Response Code	—
18	18	Overall Configuration Status	See Response Code	—
19	19	Reserved for Product Expansion	—	—
20	20	Reserved for Product Expansion	—	—
21	21	Reserved for Product Expansion	—	—
22	22	Reserved for Product Expansion	—	—
23	23	Reserved for Product Expansion	—	—
24	24	Reserved for Product Expansion	—	—
25	25	Reserved for Product Expansion	—	—

Response Codes	
Bit Status	Indication
All clear	Entry Acknowledged
Bit 0 set	Entry > Limit
Bit 1 set	Entry < Limit
Bit 2 set	Entry is Illegal Value
Bits 3 – 15	Reserved

Table B.5
Acknowledge User Configuration Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Demand Period	See Response Code	——
2	2	Number of Demand Periods	See Response Code	——
3	3	Reserved for Product Expansion	——	——
4	4	Reserved for Product Expansion	——	——
5	5	Overall Configuration Status	See Response Code	——
6	6	Reserved for Product Expansion	——	——
7	7	Reserved for Product Expansion	——	——
8	8	Reserved for Product Expansion	——	——
9	9	Reserved for Product Expansion	——	——
10	10	Reserved for Product Expansion	——	——
11	11	Reserved for Product Expansion	——	——
12	12	Reserved for Product Expansion	——	——
13	13	Reserved for Product Expansion	——	——
14	14	Reserved for Product Expansion	——	——
15	15	Reserved for Product Expansion	——	——

Response Codes	
Bit Status	Indication
All clear	Entry Acknowledged
Bit 0 set	Entry > Limit
Bit 1 set	Entry < Limit
Bit 2 set	Entry is Illegal Value
Bits 3 – 15	Reserved

Table B.6
Synchronizing Bus Error Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Voltage Match Error in Percent (Step Size of 0.05 %)	±0 – 999	10^{-3}
	2		±0 – 100	10^{0}
2	3	Frequency Match Error in Hz (Step Size of 0.01 Hz)	±0 – 999	10^{-3}
	4		±0 – 99	10^{0}
3	5	Synchronizing Bus to Reference Bus Phase Match Error in Degrees	±0 to 180	10^{0}
4	6	Load Sharing Error	±0 – 999	10^{-3}
	7		±0 – 1	10^{0}
5	8	Power in Watts – Total	±0 – 999	10^{0}
	9		±0 – 999	10^{3}
	10		±0 – 999	10^{6}
6	11	Synchronization Status Bit 0 Frequency Within Limits Bit 1 Voltage Within Limits Bit 2 Phase Within Limits Bit 3 Synchronization Mode Conflict Failure Bit 4 Phase Rotation Mismatch Failure Bit 5 Reserved for Product Expansion Bit 6 No Reference Bus Voltage Present Failure Bit 7 Synchronizing Bus No Voltage Present Failure Bit 8 Reference Bus Overvoltage Failure Bit 9 Synchronizing Bus Overvoltage Failure Bit 10 – Bit 15 Reserved	Sixteen Bits	—
7	12	Synchronizing Bus Average Voltage L–L in Volts (same as parameter 15 in Table B.7)	0–999	10^{0}
	13		0–999	10^{3}
8	14	Power Factor in Percent – Total (same as parameter 1 in Table B.8)	± 0–100	10^{0}
9	15	Reactive Power in VAR – Total (same as parameter 13 in Table B.8)	± 0–999	10^{0}
	16		± 0–999	10^{3}
	17		± 0–999	10^{6}
10	18	Reserved for Product Expansion	—	—

Table B.7
Synchronizing Bus Voltage/Current Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Synchronizing Bus Current L1 in Amps	0 – 999	10^0
	2		0 – 999	10^3
2	3	Synchronizing Bus Current L2 in Amps	0 – 999	10^0
	4		0 – 999	10^3
3	5	Synchronizing Bus Current L3 in Amps	0 – 999	10^0
	6		0 – 999	10^3
4	7	Synchronizing Bus Neutral Current in Amps	0 – 999	10^0
	8		0 – 999	10^3
5	9	Synchronizing Bus Average Current in Amps	0 – 999	10^0
	10		0 – 999	10^3
6	11	Synchronizing Bus Positive Sequence Current in Amps	0 – 999	10^0
	12		0 – 999	10^3
7	13	Synchronizing Bus Negative Sequence Current in Amps	0 – 999	10^0
	14		0 – 999	10^3
8	15	Synchronizing Bus Percent Current Unbalance	0 – 100	10^0
9	16	Synchronizing Bus Voltage L1–L2 in Volts	0 – 999	10^0
	17		0 – 999	10^3
10	18	Synchronizing Bus Voltage L2–L3 in Volts	0 – 999	10^0
	19		0 – 999	10^3
11	20	Synchronizing Bus Voltage L3–L1 in Volts	0 – 999	10^0
	21		0 – 999	10^3
12	22	Synchronizing Bus Voltage L1–N in Volts	0 – 999	10^0
	23		0 – 999	10^3
13	24	Synchronizing Bus Voltage L2–N in Volts	0 – 999	10^0
	25		0 – 999	10^3
14	26	Synchronizing Bus Voltage L3–N in Volts	0 – 999	10^0
	27		0 – 999	10^3
15	28	Synchronizing Bus Average Voltage L–L in Volts	0 – 999	10^0
	29		0 – 999	10^3
16	30	Synchronizing Bus Average Voltage L–N in Volts	0 – 999	10^0
	31		0 – 999	10^3
17	32	Synchronizing Bus Positive Sequence Voltage L–L in Volts	0 – 999	10^0
	33		0 – 999	10^3

Table B.7
Synchronizing Bus Voltage/Current Parameters (Continued)

Parameter Number	Word Number	Description	Range	Modulus
18	34	Synchronizing Bus Negative Sequence Voltage L–L in Volts	0 – 999	10^0
	35		0 – 999	10^3
19	36	Synchronizing Bus Percent Voltage Unbalance	0 – 100	10^0
20	37	Synchronizing Bus Frequency in Hz	0 – 999	10^{-3}
	38		0 – 999	10^0
21	39	Synchronizing Bus Phase Rotation	0 – ABC	—
			1 – ACB	
22	40	Reserved for Product Expansion	—	—
23	41	Reserved for Product Expansion	—	—
24	42	Reserved for Product Expansion	—	—
25	43	Reserved for Product Expansion	—	—
26	44	Reserved for Product Expansion	—	—
27	45	Reserved for Product Expansion	—	—
28	46	Reserved for Product Expansion	—	—

Table B.8
Synchronizing Bus Power Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Power Factor in Percent – Total	± 0 – 100	10^0
2	2	Power Factor in Percent – (L1–N)	± 0 – 100	10^0
3	3	Power Factor in Percent – (L2–N)	± 0 – 100	10^0
4	4	Power Factor in Percent – (L3–N)	± 0 – 100	10^0
5	5	Power in Watts – Total	± 0 – 999	10^0
	6		± 0 – 999	10^3
	7		± 0 – 999	10^6
6	8	Power in Watts – (L1–N)	± 0 – 999	10^0
	9		± 0 – 999	10^3
	10		± 0 – 999	10^6
7	11	Power in Watts – (L2–N)	± 0 – 999	10^0
	12		± 0 – 999	10^3
	13		± 0 – 999	10^6
8	14	Power in Watts – (L3–N)	± 0 – 999	10^0
	15		± 0 – 999	10^3
	16		± 0 – 999	10^6
9	17	Apparent Power in VA – Total	± 0 – 999	10^0
	18		± 0 – 999	10^3
	19		± 0 – 999	10^6
10	20	Apparent Power in VA – (L1–N)	± 0 – 999	10^0
	21		± 0 – 999	10^3
	22		± 0 – 999	10^6
11	23	Apparent Power in VA – (L2–N)	± 0 – 999	10^0
	24		± 0 – 999	10^3
	25		± 0 – 999	10^6
12	26	Apparent Power in VA – (L3–N)	± 0 – 999	10^0
	27		± 0 – 999	10^3
	28		± 0 – 999	10^6
13	29	Reactive Power in VAR – Total	± 0 – 999	10^0
	30		± 0 – 999	10^3
	31		± 0 – 999	10^6
14	32	Reactive Power in VAR – (L1–N)	± 0 – 999	10^0
	33		± 0 – 999	10^3
	34		± 0 – 999	10^6

Table B.8
Synchronizing Bus Power Parameters (Continued)

Parameter Number	Word Number	Description	Range	Modulus
15	35	Reactive Power in VAR – (L2–N)	± 0 – 999	10^0
	36		± 0 – 999	10^3
	37		± 0 – 999	10^6
16	38	Reactive Power in VAR – (L3–N)	± 0 – 999	10^0
	39		± 0 – 999	10^3
	40		± 0 – 999	10^6
17	41	Power Consumption in kW – Hours	± 0 – 999	10^0
	42		± 0 – 999	10^3
	43		± 0 – 999	10^6
18	44	Reactive Power Consumption in kVAR – Hours	± 0 – 999	10^0
	45		± 0 – 999	10^3
	46		± 0 – 999	10^6
19	47	Current Demand – AMPs	± 0 – 999	10^0
	48		± 0 – 999	10^3
20	49	Apparent Power Demand – VA	± 0 – 999	10^0
	50		± 0 – 999	10^3
	51		± 0 – 999	10^6
21	52	Power Demand – Watts	± 0 – 999	10^0
	53		± 0 – 999	10^3
	54		± 0 – 999	10^6

Table B.9
Reference Bus Voltage Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Reference Bus Voltage in Volts L1–L2	0 – 999	10^0
	2		0 – 999	10^3
2	3	Reference Bus Voltage in Volts L2–L3	0 – 999	10^0
	4		0 – 999	10^3
3	5	Reference Bus Voltage in Volts L3–L1	0 – 999	10^0
	6		0 – 999	10^3
4	7	Reference Bus Voltage in Volts L1–N	0 – 999	10^0
	8		0 – 999	10^3
5	9	Reference Bus Voltage in Volts L2–N	0 – 999	10^0
	10		0 – 999	10^3
6	11	Reference Bus Voltage in Volts L3–N	0 – 999	10^0
	12		0 – 999	10^3
7	13	Reference Bus Average Voltage in Volts L–L	0 – 999	10^0
	14		0 – 999	10^3
8	15	Reference Bus Average Voltage in Volts L–N	0 – 999	10^0
	16		0 – 999	10^3
9	17	Reference Bus Frequency in Hz	0 – 999	10^{-3}
	18		0 – 999	10^0
10	19	Reference Bus Phase Rotation (ABC, ACB)	0 – ABC 1 – ACB	—
11	20	Reserved for Product Expansion	—	—
12	21	Reserved for Product Expansion	—	—
13	22	Reserved for Product Expansion	—	—
14	23	Reserved for Product Expansion	—	—
15	24	Reserved for Product Expansion	—	—
16	25	Reserved for Product Expansion	—	—
17	26	Reserved for Product Expansion	—	—

Table B.10
Control Request Parameters

Parameter Number	Word Number	Description	Range Individual Bits	Modulus
1	1	Self Test	Bit 0 – set; Do Command [1] Bit 0 – clear; Do Nothing [0]	—
2	2	Clear kW Hours Counter	Bit 0 – set; Do Command [1] Bit 0 – clear; Do Nothing [0]	—
3	3	Clear kVAR Hours Counter	Bit 0 – set; Do Command [1] Bit 0 – clear; Do Nothing [0]	—
4	4	Reserved for Product Expansion	—	—
5	5	Reserved for Product Expansion	—	—
6	6	Reserved for Product Expansion	—	—
7	7	Reserved for Product Expansion	—	—
8	8	Reserved for Product Expansion	—	—
9	9	Reserved for Product Expansion	—	—
10	10	Reserved for Product Expansion	—	—
11	11	Reserved for Product Expansion	—	—
12	12	Reserved for Product Expansion	—	—
13	13	Reserved for Product Expansion	—	—
14	14	Reserved for Product Expansion	—	—

Table B.11
Diagnostic Parameters

Parameter Number	Word Number	Description	Range	Modulus
1	1	Bulletin Number	0 – 999	10^0
	2		0 – 999	10^3
2	3	Option Bit Field	Sixteen Bits	—
3	4	Firmware Version Number	0 – 999	10^0
4	5	ROM Status Bit 0 Overall Status Bit 1 Checksum Failed Bit2 – Bit 15 Reserved	Sixteen Bits #	—
5	6	ROM Checksum	0 – 65,535	10^0
6	7	RAM Status Bit 0 Overall Status Bit 1 Odd Memory Failure Bit 2 Even Memory Failure Bit 3 Failure in 0000H – 1FFFH Range Bit 4 Failure in 2000H– 3FFFH Range Bit 5 Failure in 4000H – 5FFFH Range Bit 6 Failure in 6000H – 7FFFH Range Bit 7 Failure in 8000H – 9FFFH Range Bit 8 Failure in A000H – BFFFH Range Bit 9 Failure in C000H – DFFFH Range Bit 10 Failure in E000H – FFFFH Range Bit 11 R/W Failure Bit 12 – Bit 15 Reserved	Sixteen Bits #	—
7	8	E^2 Prom Status Bit 0 Overall Status Bit 1 Invalid Configuration Data Bit 2 Checksum Failure Bit 3 R/W Failure Bit 4 – Bit 7 Reserved Bit 8 – Bit 15 Reserved	Sixteen Bits #	—

Table B.11
Diagnostic Parameters (Continued)

Parameter Number	Word Number	Description	Range	Modulus
8	9	Analog Supply Status Bit 0 Overall Status Bit 1 15 Volt Supplies Over Range Bit 2 15 Volt Supplies Under Range Bit 3 5 Volt Supplies Over Range Bit 4 5 Volt Supplies Under Range Bit 5 – Bit 15 Reserved	Sixteen Bits #	—
9	10	Data Acquisition Status Bit 0 Overall Status Bit 1 FIFO–Full Interrupt Failure Bit 2 FIFO Minor Sample Interrupt Failure Bit 3 FIFO Empty Indicator Failure Bit 4 FIFO Overflow Failure Bit 5 A/D Converter Conversion Time Failure Bit 6 State Machine Failure Bit 7 – Bit 15 Reserved	Sixteen Bits #	—
10	11	Load Share A/D:D/A Status Bit 0 Overall Status Bit 1 Load Share Read / Write Failure Bit 2 – Bit 7 Reserved Bits 8–15 Last Byte Read from A/D Converter	Sixteen Bits #	—
11	12	Load Share Failure Data Bit 0 – Bit 7 Byte Written Bit 8 – Bit 15 Byte Read	Sixteen Bits #	—
12	13	Watchdog Status Bit 0 Overall Status Bit 1 Response Time Failure Bit 2 Watchdog Fired Bit 3 – Bit 15 Reserved	Sixteen Bits #	—
13	14	Year	0 – 999	10^0
	15		0 – 999	10^3
14	16	Month	1 – 12	10^0
15	17	Date	1 – 31	10^0
16	18	Hours	0 – 23	10^0
17	19	Minutes	0 – 59	10^0

Table B.11
Diagnostic Parameters (Continued)

Parameter Number	Word Number	Description	Range	Modulus
18	20	Seconds	0 – 59	10^0
19	21	Reserved for Product Expansion	——	——
20	22	Reserved for Product Expansion	——	——
21	23	Reserved for Product Expansion	——	——
22	24	Reserved for Product Expansion	——	——

Bit value of ”0” indicates test passed Bit value of ”1” indicates that test failed.

Table B.12
Module Time Parameters – No 6200 Software Interface Provided

Parameter Number	Word Number	Description	Range	Modulus
1	1	Current Year	0 – 9999	10^0
2	2	Current Month	1 – 12	10^0
3	3	Current Date	1 – 31	10^0
4	4	Current Hours	0 – 23	10^0
5	5	Current Minutes	0 – 59	10^0
6	6	Current Seconds	0 – 59	10^0
7	7	Reserved for Product Expansion	——	——
8	8	Reserved for Product Expansion	——	——
9	9	Reserved for Product Expansion	——	——
10	10	Reserved for Product Expansion	——	——
11	11	Reserved for Product Expansion	——	——

Table B.13
Discrete Input/Output Data

Decimal Bit Number	Octal Bit Number	Discrete Output (from Processor)	Discrete Input (to Processor)
15	17	Initiate Synchronization 1 = Assert Operation	Module Status 1 = Module Failure
14	16	Auto Synchronization Mode 1 = Select Mode	Raise Voltage 1 = Assert Operation
13	15	Check Synchronization Mode 1 = Select Mode	Lower Voltage 1 = Assert Operation
12	14	Permissive Synchronization Mode 1 = Select Mode	Raise Speed – Frequency Adjust 1 = Assert Operation
11	13	Load Share Disable 1 = Assert Operation	Lower Speed – Frequency Adjust 1 = Assert Operation
10	12	Isochronous / Droop Mode 1 = Isochronous Mode 0 = Droop Mode	Raise Speed – Phase Adjust 1 = Assert Operation
9	11	Unused	Lower Speed – Phase Adjust 1 = Assert Operation
8	10	Enable Single Phase Synchronization 1 = Single Phase 0 = 3 Phase	Raise Power – Load Share Adjust 1 = Assert Operation
7	7	Reserved for Internal Use	Reserved for Internal Use
6	6	Reserved for Internal Use	Reserved for Internal Use
5	5	Unused	Reserved for Internal Use
4	4	Unused	Reduce Power – Load Share Adjust 1 = Assert Operation
3	3	Unused	Close Breaker 1 = Close Breaker 0 = Open Breaker
2	2	Unused	Synchronization Failure 1 = Failure
1	1	Unused	Power Up Bit 1 = Block Transfers Inhibited 0 =Block Transfers Enabled
0	0	Unused	Reserved for Internal Use

Appendix **C**

Sample Ladder Listing

This is a sample ladder. It shows a way to configure the block transfers for the 1402–LSM and the Power I/O Configuration software.

ATTENTION: Proper operation of the ladder program is the responsibility of the user. No warranty is expressed or implied by using this ladder configuration.

This ladder is subject to change.

Rung 2:0
Assigns an external trigger to set an internal trigger. The timer allows the internal trigger to be set for a prescribed time. It also serves as a one shot.

```
Rung 2:0

    Assign trigger bit from desired trigger.


| User                                                                         |
| Supplied                                           Trigger                   |
| Input                                              Timer          Trigger    |
|   I:003                                               T4:0            B3     |
+----] [-------------------------------------------+---]/[------------( )----+---+
|      00                                          |     DN              0   |   |
|                                                  |                         |   |
|                                                  |       Trigger           |   |
|                                                  |       Timer             |   |
|                                                  |+TON---------------+    |   |
|                                                  ++TIMER ON DELAY    +-(EN)+   |
|                                                   |Timer         T4:0|         |
|                                                   |Time base     0.01+-(DN)    |
|                                                   |Preset          40|         |
|                                                   |Accum            0|         |
|                                                   +------------------+         |
```

Rung 2:1
In the event that the module status input is set the ladder will only read the diagnostic parameters.

```
Rung 2:1

     Internal Module Status Bit.

| Module                                                                         |
| Status                                                            Module       |
| Input                                                             Status       |
|   I:000                                                               B3       |
+----] [-----------------------------------------------------------------( )-------+
|      17                                                                 7      |
```

Rung 2:2
When the trigger is present and the run sequence is completed, the config mode is enabled until the Module configuration sequence is completed.

```
Rung 2:2

    The trigger must be present and the run sequence must be complete for the
    config mode to be enabled.  Unless it is the first pass.
|                        |Config                                                   |
|           |Run         |Sequence,&                                               |
|           |Mode        |BT'S Done.                                 Config        |
|           |Sequence    |Status                                     Mode          |
|  Trigger  |complete    |Data Valid                                 Enable        |
|      B3          B3          B3                                        B3        |
+-+---] [--------] [----+---]/[----------------------------------------( )-------+
| |      0          3   |      6                                         1       |
| | Config              |                                                        |
| | Mode                |                                                        |
| | Enable              |                                                        |
| |     B3              |                                                        |
| ++---] [----+---------+                                                        |
|  |      1   |                                                                  |
|  |First     |                                                                  |
|  |Pass      |                                                                  |
|  |Bit       |                                                                  |
|  |   S:1    |                                                                  |
|  +---] [----+                                                                  |
|        15                                                                       |
```

Rung 2:3
Used to reset the module configuration complete Bit.

```
Rung 2:3

     Used to reset the valid data bits when the configuration sequence begins.
|               Config                                                           |
|               Mode                                                 Data        |
|  Trigger      Enable                                               Reset       |
|      B3           B3                                                  B3       |
+-+---] [------+---]/[-------------------------------------------------( )-------+
| |      0     |      1                                                  2       |
| | First      |                                                                 |
| | Pass       |                                                                 |
| | Bit        |                                                                 |
| |    S:1     |                                                                 |
| ++---] [----++                                                                 |
|  |     15   |                                                                  |
|  |Data      |                                                                  |
|  |Reset     |                                                                  |
|  |    B3    |                                                                  |
|  +---] [----+                                                                  |
|         2                                                                       |
```

Rung 2:4
Moves word zero into the sequencer output (Block transfer control) on the first pass. If not used the processor may fault.

```
Rung 2:4

     Moves word zero of configuration sequence into N10:0 on First Pass.
| First                                                                          |
| Pass                                                        Sequencer          |
| Bit                                                         output             |
|    S:1     +NEQ---------------+                         +MOV---------------+   |
+----] [-----+NOT EQUAL         +-------------------------+MOVE              +---+
|      15    |Source A     N21:0|                         |Source       N21:0|   |
|            |                59|                         |                59|   |
|            |Source B     N10:0|                         |Destination  N10:0|   |
|            |                54|                         |                54|   |
|            +------------------+                         +------------------+   |
```

Rung 2:5
Resets the configuration sequencer to position zero when in the run mode.

```
Rung 2:5

     Resets configuration mode sequencer when in the run mode.

|  Config                                                           Config       |
|  Mode                                                             Sequencer    |
|  Enable                                                           Control      |
|      B3       B3                                                     R6:0      |
+-+---]/[----+[ONS]-------------------------------------------------(RES)------+
| |       1   |   11                                                            |
| |Module     |                                                                 |
| |Status     |                                                                 |
| |    B3     |                                                                 |
| +---] [----+                                                                  |
|        7                                                                       |
```

Rung 2:6
Resets the run sequencer to position zero when in the configuration mode.

```
Rung 2:6

      Resets run mode sequencer when in the configuration mode.

|                                                                   Run          |
|  Config                                                           Mode         |
|  Mode                                                             Sequencer    |
|  Enable                                                           Control      |
|      B3       B3                                                     R6:1      |
+-+---] [----+[ONS]-------------------------------------------------(RES)------+
| |       1   |   10                                                            |
| |Module     |                                                                 |
| |Status     |                                                                 |
| |    B3     |                                                                 |
| +---] [----+                                                                  |
|        7                                                                       |
```

Rung 2:7
Ensures that the run sequence is complete.

```
Rung 2:7

     Run mode sequence is complete and active block transfer is finished.

|           |Run        |Active                                     Run          |
|           |Mode       |Transfer                                   Mode         |
|           |Sequencer  |Done                                       Sequence     |
| Trigger   |Control    |Bit                                        complete     |
|     B3        R6:1    N[N10:0]:0                                      B3       |
+----] [----+---] [--------] [----+------------------------------------( )-------+
|       0   |     DN         13   |                                       3      |
|           |Run                  |                                              |
|           |Mode                 |                                              |
|           |Sequence             |                                              |
|           |complete             |                                              |
|           |    B3               |                                              |
|           +---] [---------------+                                              |
|                 3                                                              |
```

Rung 2:8
Sequences through block transfers pre–selected by the Data file #N21. The sequencer is triggered when the previous block transfer has completed or failed. The sequence continues until the module has valid data.

```
Rung 2:8
    Sequence through pre–selected block transfers when the active
    block transfer has completed or has encountered an error.  The
   configuration sequence is located in #N21:0.

|                                 |Config    |                                   |
|           |Active    |          |Sequence,&|                                   |
| Config    |Transfer  |Config    |BT'S Done.|              Config               |
| Mode      |Done      |Sequencer |Status    |Module        Sequencer            |
| Enable    |Bit       |Control   |Data Valid|Status        Control              |
|     B3     N[N10:0]:0    R6:0        B3         B3   +SQO---------------+      |
+----] [----+---] [----+---]/[--------]/[--------]/[---+SEQUENCER OUTPUT  +-(EN)-+
|       1   |     13   |    EN          6          7  |File        #N21:0|      |
|           |Active    |                               |Mask          FFFF+-(DN) |
|           |Transfer  |                               |Destination  N10:0|      |
|           |Error     |                               |Control       R6:0|      |
|           |Bit       |                               |Length           4|      |
|           |N[N10:0]:0|                               |Position         1|      |
|           +---] [----+                               +------------------+      |
|                 12
```

Rung 2:9
Sequences through block transfers pre–selected by the Data file #N22. The sequencer is triggered when the previous block transfer has completed or failed. The sequence continues until the ladder is in the config mode.

```
Rung 2:9
    Sequence through pre–selected block transfers when the active
    block transfer has completed or has encountered an error.  The
   run sequence is located in #N22:0.

|           |Active    |Run       |                         Run                  |
| Config    |Transfer  |Mode      |                         Mode                 |
| Mode      |Done      |Sequencer |Module                   Sequencer            |
| Enable    |Bit       |Control   |Status                   Control              |
|     B3     N[N10:0]:0    R6:1        B3            +SQO---------------+        |
+----]/[----+---] [----+---]/[--------]/[------------+SEQUENCER OUTPUT  +-(EN)---+
|       1   |     13   |    EN          7            |File       #N22:0|        |
|           |Active    |                             |Mask         FFFF+-(DN)   |
|           |Transfer  |                             |Destination  N10:0|        |
|           |Error     |                             |Control      R6:1|        |
|           |Bit       |                             |Length          8|        |
|           |N[N10:0]:0|                             |Position        5|        |
|           +---] [----+                             +------------------+        |
|                 12                                                             |
```

Rung 2:10
Performs block transfer read of the factory configuration parameters.

```
Rung 2:10
    Perform BTR Factory Configuration Parameters

|                                                         Factory                |
|                                                         Config.                |
|      Sequencer                                          BT                     |
|      output                                             Read                   |
| +CMP---------------+                          +BTR--------------------+        |
+-+COMPARE           +--------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression        |                          |Rack                 00|        |
| |N10:0 = 50        |                          |Group                 0+-(DN)   |
| +------------------+                          |Module                0|        |
|                                               |Control block     N50:0+-(ER)   |
|                                               |Data file         N30:1|        |
|                                               |Length               35|        |
|                                               |Continuous            N|        |
|                                               +-----------------------+        |
```

Rung 2:11
Performs block transfer read of user configuration parameters.

```
Rung 2:11

     Perform BTR User Configuration Parameters.

|                                                         User                    |
|      Sequencer                                          Config.                 |
|      output                                             BTR                     |
| +CMP----------------+                          +BTR--------------------+        |
+-+COMPARE            +--------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression         |                          |Rack                 00|        |
| |N10:0 = 51         |                          |Group                 0+-(DN)   |
| +-------------------+                          |Module                0|        |
|                                                |Control block     N51:0+-(ER)   |
|                                                |Data file         N31:1|        |
|                                                |Length               12|        |
|                                                |Continuous            N|        |
|                                                +-----------------------+        |
```

Rung 2:12
Performs block transfer read of acknowledge factory configuration parameters.

```
Rung 2:12

     Perform BTR for Acknowledge Factory Configuration Parameters.

|                                                         Ack.                    |
|                                                         Factory                 |
|      Sequencer                                          Config.                 |
|      output                                             BTR                     |
| +CMP----------------+                          +BTR--------------------+        |
+-+COMPARE            +--------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression         |                          |Rack                 00|        |
| |N10:0 = 52         |                          |Group                 0+-(DN)   |
| +-------------------+                          |Module                0|        |
|                                                |Control block     N52:0+-(ER)   |
|                                                |Data file         N32:1|        |
|                                                |Length               25|        |
|                                                |Continuous            N|        |
|                                                +-----------------------+        |
```

Rung 2:13
Performs block transfer read of Acknowledge user configuration parameters.

```
Rung 2:13

     Perform BTR for Acknowledge User Configuration Parameters.

|                                                         Ack.                    |
|                                                         User                    |
|      Sequencer                                          Config.                 |
|      output                                             BTR                     |
| +CMP----------------+                          +BTR--------------------+        |
+-+COMPARE            +--------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression         |                          |Rack                 00|        |
| |N10:0 = 53         |                          |Group                 0+-(DN)   |
| +-------------------+                          |Module                0|        |
|                                                |Control block     N53:0+-(ER)   |
|                                                |Data file         N33:1|        |
|                                                |Length               15|        |
|                                                |Continuous            N|        |
|                                                +-----------------------+        |
```

Rung 2:14
Performs block transfer read of Sync bus error parameters.

```
Rung 2:14

     Perform BTR Synchronizing Bus Error Parameters.

|                                                        Sync. Bus               |
|      Sequencer                                          Error                  |
|      output                                             BTR                    |
| +CMP---------------+                          +BTR--------------------+        |
+-+COMPARE           +--------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression        |                          |Rack                 00|        |
| |N10:0 = 54        |                          |Group                 0+-(DN)   |
| +------------------+                          |Module                0|        |
|                                               |Control block     N54:0+-(ER)   |
|                                               |Data file         N34:1|        |
|                                               |Length               18|        |
|                                               |Continuous            N|        |
|                                               +-----------------------+        |
```

Rung 2:15
Performs block transfer read of Sync bus Voltage/Current parameters.

```
Rung 2:15

     Perform BTR Synchronizing Bus Voltage/Current Parameters.

|                                                         Sync. Bus              |
|      Sequencer                                          Volt/Curr              |
|      output                                             BTR                    |
| +CMP---------------+                          +BTR--------------------+        |
+-+COMPARE           +--------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression        |                          |Rack                 00|        |
| |N10:0 = 55        |                          |Group                 0+-(DN)   |
| +------------------+                          |Module                0|        |
|                                               |Control block     N55:0+-(ER)   |
|                                               |Data file         N35:1|        |
|                                               |Length               46|        |
|                                               |Continuous            N|        |
|                                               +-----------------------+        |
```

Rung 2:16
Performs block transfer read of Sync bus Power parameters.

```
Rung 2:16

     Perform BTR Synchronizing Bus Power Parameters.

|                                                         Sync. Bus              |
|      Sequencer                                          Power                  |
|      output                                             BTR                    |
| +CMP---------------+                          +BTR--------------------+        |
+-+COMPARE           +--------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression        |                          |Rack                 00|        |
| |N10:0 = 56        |                          |Group                 0+-(DN)   |
| +------------------+                          |Module                0|        |
|                                               |Control block     N56:0+-(ER)   |
|                                               |Data file         N36:1|        |
|                                               |Length               54|        |
|                                               |Continuous            N|        |
|                                               +-----------------------+        |
```

Rung 2:17
Performs block transfer read of Reference bus Voltage parameters.

```
Rung 2:17

     Perform BTR Reference Bus Voltage Parameters.

|                                                        Ref. Bus        |
|      Sequencer                                          Volt.          |
|      output                                             BTR            |
| +CMP---------------+                           +BTR-----------------------+        |
+-+COMPARE           +---------------------------+BLOCK TRANSFER READ    +-(EN)---+
| |Expression        |                           |Rack                 00|        |
| |N10:0 = 57        |                           |Group                 0+-(DN)   |
| +------------------+                           |Module                0|        |
|                                                |Control block     N57:0+-(ER)   |
|                                                |Data file         N37:1|        |
|                                                |Length               26|        |
|                                                |Continuous            N|        |
|                                                +-----------------------+        |
```

Rung 2:18
Performs block transfer read of Diagnostic parameters.

```
Rung 2:18

     Perform BTR Diagnostic Parameters.

|       Sequencer                                          Diagnostic            |
|       output                                             BTR                   |
|  +CMP---------------+                          +BTR-----------------------+        |
+-++COMPARE           +-+------------------------+BLOCK TRANSFER READ    +-(EN)---+
| ||Expression        | |                        |Rack                 00|        |
| ||N10:0 = 58        | |                        |Group                 0+-(DN)   |
| |+------------------+ |                        |Module                0|        |
| |          |Diagnostic|                        |Control block     N58:0+-(ER)   |
| |          |BTR       |                        |Data file         N38:1|        |
| |Module    |Enable    |                        |Length               24|        |
| |Status    |Bit       |                        |Continuous            N|        |
| |    B3       N58:0   |                        +-----------------------+        |
| +---] [--------]/[----+                                                         |
|        7         15                                                             |
```

Rung 2:19
Performs block transfer write of Factory Configuration parameters.

```
Rung 2:19

     Perform BTW for Factory Configuration Parameters.

|                                                         Factory        |
|      Sequencer                                          Config.        |
|      output                                             BTW            |
| +CMP---------------+                           +BTW-----------------------+        |
+-+COMPARE           +---------------------------+BLOCK TRANSFER WRITE   +-(EN)---+
| |Expression        |                           |Rack                 00|        |
| |N10:0 = 59        |                           |Group                 0+-(DN)   |
| +------------------+                           |Module                0|        |
|                                                |Control block     N59:0+-(ER)   |
|                                                |Data file         N39:1|        |
|                                                |Length               35|        |
|                                                |Continuous            N|        |
|                                                +-----------------------+        |
```

Rung 2:20
Performs block transfer write of User Configuration parameters.

```
Rung 2:20

     Perform BTW for User Configuration Parameters.

|                                                              User                    |
|      Sequencer                                               Config.                 |
|      output                                                  BTW                     |
| +CMP–––––––––––––––+                          +BTW––––––––––––––––––––+              |
+–+COMPARE           +––––––––––––––––––––––––––+BLOCK TRANSFER WRITE   +–(EN)–––+
| |Expression        |                          |Rack                 00|            |
| |N10:0 = 60        |                          |Group                 0+–(DN)      |
| +––––––––––––––––––+                          |Module                0|            |
|                                               |Control block     N60:0+–(ER)      |
|                                               |Data file         N40:1|            |
|                                               |Length               12|            |
|                                               |Continuous            N|            |
|                                               +–––––––––––––––––––––––+            |
```

Rung 2:21
Used by the 6200 software to perform block transfer write of Control Request.

**** Do not include this BTW number in the sequencer input file! ****

```
Rung 2:21

     Used by the 6200 software for initiating the self–test and clearing
     KW hours and KVAR hour counters.

     * NOTE: Do not include this BTW number in the sequencer input file!(N:22)

|                                                                                    |
|      Sequencer                                               CONTROL               |
|      output                                                  REQUEST BTW           |
| +CMP–––––––––––––––+                          +BTW––––––––––––––––––––+            |
+–+COMPARE           +––––––––––––––––––––––––––+BLOCK TRANSFER WRITE   +–(EN)–––+
| |Expression        |                          |Rack                 00|            |
| |N10:0 = 61        |                          |Group                 0+–(DN)      |
| +––––––––––––––––––+                          |Module                0|            |
|                                               |Control block     N61:0+–(ER)      |
|                                               |Data file         N41:1|            |
|                                               |Length               14|            |
|                                               |Continuous            N|            |
|                                               +–––––––––––––––––––––––+            |
```

Rung 2:22
Checks the overall configuration status words of the Acknowledge factory and Acknowledge user configuration parameters to make sure the data is valid.

```
Rung 2:22

     Configuration status received through block transfer is valid.

|                                                                    Valid       |
|                                                                    Config      |
|                                                                    Data        |
| +CMP–––––––––––––––+ +CMP–––––––––––––––+                              B3      |
+–+COMPARE           +–+COMPARE           +––––––––––––––––––––––––––––( )–––––––+
| |Expression        | |Expression        |                               4      |
| |N32:18 = 0        | |N33:5 = 0         |                                      |
| +––––––––––––––––––+ +––––––––––––––––––+                                      |
```

Rung 23
Configuration data is valid and the configuration sequencer is done.

```
Rung 2:23

     Configuration data is valid and the sequence is complete.

|                                                                    Config        |
|                                                                    Sequencer     |
|           |Config    |Valid                                       Complete      |
| Data      |Sequencer |Config                                      data          |
| Reset     |Control   |Data                                        valid         |
|     B3        R6:0        B3                                           B3        |
+----]/[----+---] [--------] [----+------------------------------------( )-------+
|       2   |     DN          4   |                                       5        |
|           |Config               |                                                |
|           |Sequencer            |                                                |
|           |Complete             |                                                |
|           |data                 |                                                |
|           |valid                |                                                |
|           |    B3               |                                                |
|           +---] [---------------+                                                |
|                5                                                                 |
```

Rung 2:24
Configuration is complete and all configuration block transfers successful. Return to run mode.

```
Rung 2:24

            Configuration is complete, return to run mode.

|       |Config    |          |Ack.     |Ack.     |                   Config      |
|       |Sequencer |Active    |Factory  |User     |Factory  |User     Sequence,&  |
|       |Complete  |Transfer  |Config.  |Config.  |Config.  |Config.  BT'S Done.  |
| Data  |data      |Done      |BTR      |BTR      |BTW      |BTW      Status      |
| Reset |valid     |Bit       |Done Bit |Done Bit |Done Bit |Done Bit Data Valid  |
|   B3       B3    N[N10:0]:0    N52:0     N53:0     N59:0     N60:0      B3      |
+--]/[--+---] [---------] [---------] [--------] [--------] [--------] [--+---( )-----+
|    2  |      5         13          13        13        13        13   |    6    |
|       |                                                               |
|       |Config                                                         |
|       |Sequence,&                                                     |
|       |BT'S Done.                                                     |
|       |Status                                                         |
|       |Data Valid                                                     |
|       |    B3                                                         |
|       +---] [---------------------------------------------------------+
|             6
```

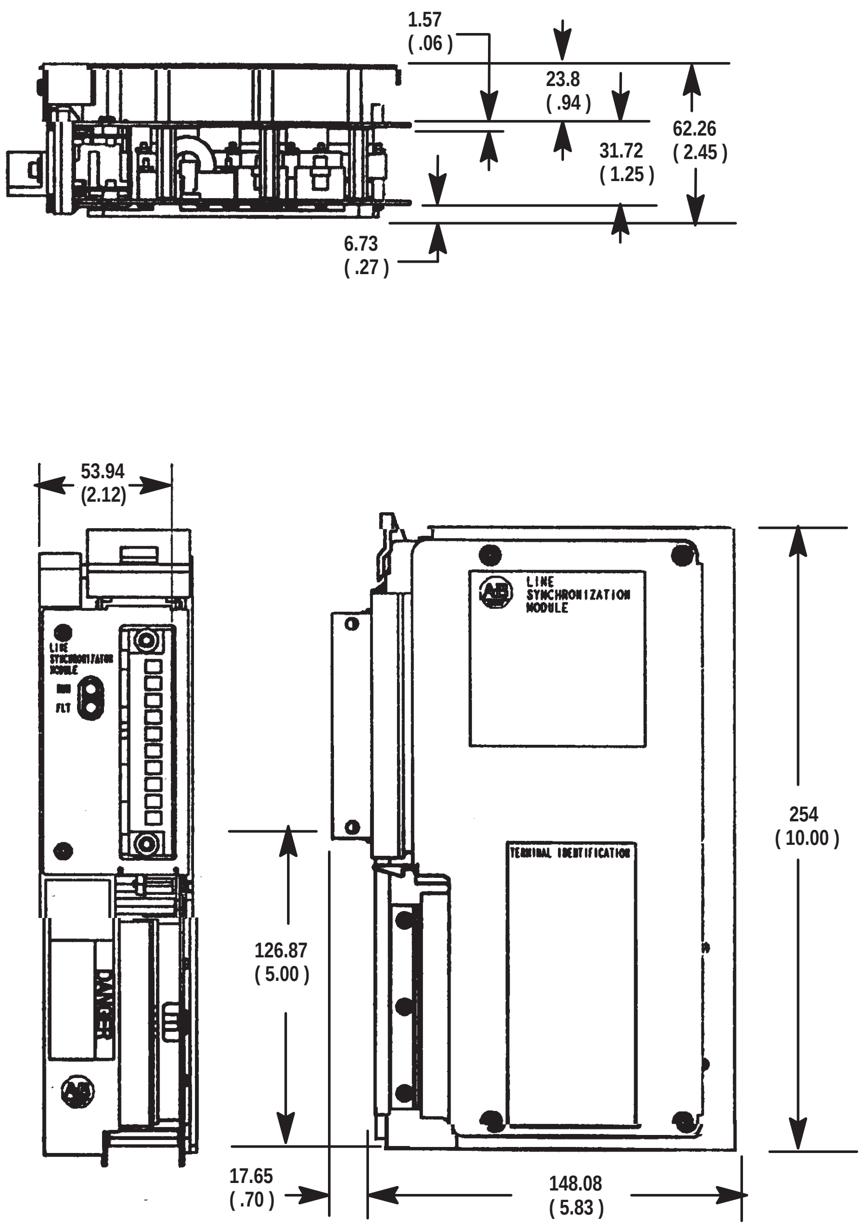
Rung 25
End of file.

```
Rung 2:25

|
+--------------------------------[END OF FILE]-----------------------------------+
```

Line Synchronization Module Mechanical Dimensions

Figure 1
Dimensions for Line Synchronization Module



NOTES:
1. Dimensions shown in millimeters (inches).
2. All dimensions are approximate and not intended for manufacturing purposes.
3. Approximate shipping weight 2.72 kg (6.0 Lbs).

Bulletin 1402 Technical Specifications

INPUTS:	
Current	0 to 5A RMS Cont., 200A RMS 1 Second
Frequency	40 to 100 Hz (steady-state)
Dielectric Withstand Voltage	2500V RMS
Current Input Burden	0.05 VA
Voltage	120V RMS (339 Vpk-pk) Maximum Peak
Voltage Input Impedance/Burden	728K Ω/0.02 VA
SYNCHRONIZATION WINDOW: Independent Upper & Lower Thresholds	
Voltage	0.05% steps
Frequency	0.01 Hz steps
Phase	1 degree steps
ISOLATED LOAD SHARING INPUT/OUTPUT:	
Max. Common Mode Voltage	240V AC
Continuous Voltage	2 to 4V DC
Input Impedance	45K Ω
BACK PLANE POWER REQUIREMENTS:	1.1A at 5V DC (2.2A, 5 ms Inrush)
ENVIRONMENTAL:	
Operating Temperature	0° to +60° C
Storage Temperature	–40° to +100° C
Humidity	5% to 95%, non-condensing
UPDATE RATE:	
Synchronizing Bus Error Parameters — 100 milli-seconds Load Share and Monitor Parameters — 200 milliseconds (Synchronization Inactive) 1 second (Synchronization Active)	
ACCURACY: @ 25° C	
Current Measurement= +/–0.2% of Full Scale (Full Scale=1.4 x CT Primary) Voltage Measurement= +/–0.2% of Full Scale (Full Scale=1.25 x PT Primary) Frequency Measurement= +/–0.05 Hz (Within the 47 to 63 Range) Slip Frequency= +/–0.05 Hz (Within the 47 to 63 Range) Power, Power Factor, VA= +/–0.4% of Full Scale Power Consumption (Full Scale=1.75 x CT Primary x PT Primary)	
CERTIFICATION	
Agency Certification (when product or packaging is marked)	• CSA certified • CSA Class I, Division 2 Groups A, B, C, D certified • UL listed • CE marked for all applicable directives

CSA HAZARDOUS LOCATION APPROVAL

CSA certifies products for general use as well as for use in hazardous locations. Actual CSA certification is indicated by the product label as shown in the example below, and not by statements in any user documentation.

OPERATING
TEMPERATURE
CODE T3C

CLASS 1, GROUPS A, B, C AND D, DIV. 2

To comply with CSA certification for use in hazardous locations, the following information becomes a part of the product literature for CSA-certified Allen-Bradley industrial control products.

- This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D, or non-hazardous locations only.
- The products having the appropriate CSA markings (that is, Class I, Division 2, Groups A, B, C, D), are certified for use in other equipment where the suitability of combination (that is, application or use) is determined by the CSA or the local inspection office having jurisdiction.

Important: Due to the modular nature of a PLC system, the product with the highest temperature rating determines the overall temperature code rating of a PLC system in a Class I, Division 2 location. The temperature code rating is marked on the product label as shown.

The following warnings apply to products having CSA certification for use in hazardous locations.

ATTENTION – Explosion Hazard:

- Substitution of components may impair suitability for Class I, Division 2.
- Do not replace components or disconnect equipment unless power has been switched off and the area is known to be non-hazardous.
- Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.
- Do not disconnect connectors unless power has been switched off or the area is known to be non-hazardous. Secure any user-supplied connectors that mate to external circuits on an Allen-Bradley product using screws, sliding latches, threaded connectors, or other means such that any connection can withstand a 15 Newton (3.4 lb.) separating force applied for a minimum of one minute.

Approbation d'utilisation dans des emplacements dangereux par la CSA

La CSA certifie les produits d'utilisation générale aussi bien que ceux qui s'utilisent dans des emplacements. La certification CSA en vigueur est indiquée par l'étiquette du produit et non par des affirmations dans documentation à l'usage des utilisateurs.

OPERATING
TEMPERATURE
CODE T3C

CLASS 1, GROUPS A, B, C AND D, DIV. 2

Pour satisfaire à la certification de la CSA dans des endroits dangereux, les informations suivantes font partie intégrante de la documentation des produits industriels de contrôle Allen-Bradley certifiés par la CSA.

- Cet équipement convient à l'utilisation dans des emplacements de Classe 1, Division 2, Groupes A, B, C, D, ou ne convient qu'à l'utilisations dans des endroits non dangereux.
- Les produits portant le marquange approprié de la CSA (c'est à dire, Classe 1, Division 2, Groupes A, B, C, D) sont certifiés à l'utilisation pour d'autres équipements ou la bureau local d'inspection qualifié.

Important: Par suite de la nature modulaire du systéme PLC®, le produit ayant le taux le plus élevé de température détermine le taux d'ensemble du code de température du système d'un PLC dans un emplacement de Classe 1, Division 2. Le taux du code de température est indiqué sur l'étiquette du produit.

OPERATING
TEMPERATURE
CODE T3C

CLASS 1, GROUPS A, B, C AND D, DIV. 2

Les avertissements suivants s'appliquent aux produits ayant la certification CSA pour leur utilisation dans de emplacements dangereux.

AVERTISSEMENT – Risque d'explosion:

- La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2.
- Couper le courant ou s'assurer que l'emplacement est désigné non dangereux avant de remplacer les composants.
- Avant de débrancher l'équipement, couper le courant ou s'assurer que l'emplacement est désigné non dangereux.
- Avant de débrancher les connecteurs, couper le courant ou s'assurer que l'emplacement est reconnu non dangereux. Attacher tous connecteurs fournis par l'utilisateur et reliés aux circuits externes d'un appareil Allen-Bradley à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens permettant aux connexions de résister à une force de séparation de 15 newtons (3,4 lb. - 1,5 kg) appliquée pendant au moins une minute.

Le sigle CSA est la marque déposée de l'Association des Standards pour le Canada.
PLC est une marque déposée de Allen-Bradley Company, Inc.

Compliance to European Union Directives

If this product has the CE mark it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2 EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2 EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131–2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information required by EN 61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- Industrial Automation Wiring and Grounding Guidelines For Noise Immunity, publication 1770-4.1
- Automation Systems Catalog, publication B111

This equipment is classified as open equipment and must be installed (mounted) in an enclosure during operation as a means of providing safety protection.

Wiring Requirements for CE Compliance

For CE compliance, line filters are required for all voltage input lines. (Comcor P/N 10VB1 or equivalent suggested.) Filters should be placed within 0.5 meters of LSM swing-arm.

Notes

Notes

Notes

Notes

Rockwell Automation

Allen-Bradley

Allen-Bradley, a Rockwell Automation Business, has been helping its customers improve productivity and quality for more than 90 years. We design, manufacture and support a broad range of automation products worldwide. They include logic processors, power and motion control devices, operator interfaces, sensors and a variety of software. Rockwell is one of the world's leading technology companies.

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