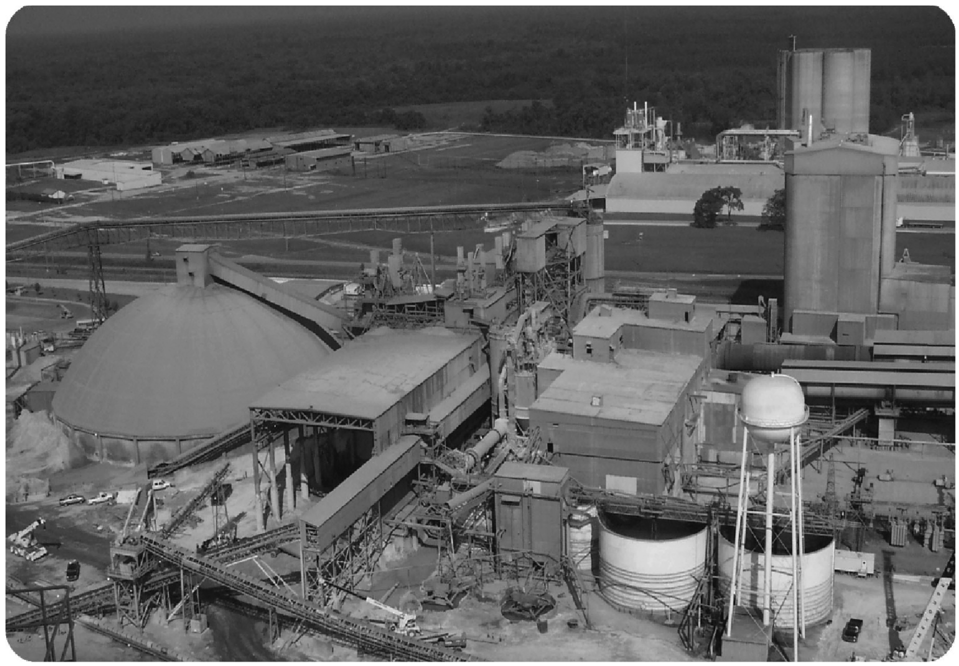
User Manual

Original Instructions

Allen-Bradley

SyncPro IIB Brush-type Synchronous Motor Field Application and Protection System

Catalog Number 1902



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Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. 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, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	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 a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Preface

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About this Publication

This user manual provides you with the information that is required to install, commission, monitor, and troubleshoot your SyncPro IIB protection system.

The manual assumes you have previous experience and basic understanding of electrical terminology, configuration procedures, required equipment, and safety precautions.

For safety of maintenance personnel and others who might be exposed to electrical hazards associated with maintenance activities, follow all local safety-related work practices. Maintenance personnel must be trained in the safety practices, procedures, and requirements that pertain to their respective job assignments.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
PanelView 800 HMI Terminals User Manual, publication 2711R-UM001	Provides information on installation, configuration, and troubleshooting the PanelView 800 terminal.
Bulletin 1900 Synchronous Motor Control, Measurement Requirements for Brush-Type Motors, publication 1900-2.10	Measuring for Synchronous Motor Data
Safety Guidelines for Application, Installation, and Maintenance, publication SGI-1.1	Describes important differences between solid-state equipment and electromechanical devices.
CompactLogix 5370 Controllers User Manual, publication 1769-UM021	Describes the necessary tasks to install, configure, program, and operate a CompactLogix™ 5370 controller.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.rockwellautomation.com/global/certification/overview.page	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at
http://www.rockwellautomation.com/global/literature-library/overview.page.
To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Notes:

Product Description

Introduction

The SyncPro IIB system consists these components:

- CompactLogix™ L2 Controller
- PanelView™ 800 HMI Terminal
- Power Factor Transducer
- Analog/Digital Pulse Board
- Conditioning Resistors
- Interposing Relays FSR and ESR

The SyncPro IIB system is designed to provide supervisory protection and field control to a brush-type synchronous motor controller, proper field application timing, squirrel-cage protection against long acceleration, stall conditions, and running pullout protection by monitoring motor power factor. When combined with a suitable induction motor protection relay, the SyncPro IIB system provides the necessary overload protection to the brush-type synchronous motor.

IMPORTANT	Although the SyncPro IIB system uses some standard CompactLogix L2 programmable controller components, the controller must be a dedicated unit expressly for the control and protection of the field of one synchronous motor. The firmware and hardware configuration must only be used for its designed purpose. Do not modify the controller in any way. Do not add additional PLC control cards and do not modify the firmware or program.

Synchronous Motor Theory

The synchronous motor is a commonly used industrial motor that is favored for its higher efficiency, superior power factor, and low inrush currents. Synchronous motors are well suited to low RPM applications. The synchronous brush-type motor is composed of a three-phase stator winding, a DC rotor winding, and a squirrel-cage winding.

The stator winding is identical to that of an induction motor and, as such, the direction of motor rotation depends on the rotation of the stator flux. The direction can be changed by reversing two of the stator leads, just as it does with induction motors.

The rotor contains laminated poles that carry the DC field coils that are terminated at the slip rings. It also has a squirrel-cage winding that is composed of bars that are embedded in the pole faces and shorted by end rings. The squirrel-cage winding is also known as “damper” or “amortisseur” winding. This winding enables the motor to accelerate to near synchronous speed so that the DC supply can be applied to the field windings for synchronizing the motor to the line (typically 95%).

These field windings are connected through slip rings to a discharge resistor during start up. The resistor is required to dissipate the high voltages that are induced into the field windings from the stator, and it is removed from the circuit when the DC field voltage is applied. The synchronous motor can be compared to a transformer, with the three-phase stator resembling the primary and the field winding acting like a secondary. Through this transformer action, an induced voltage is generated in the motor field during starting. The induced signal can be used to protect the squirrel-cage winding by monitoring the motor speed during acceleration and to determine when the DC field can be excited for synchronization. At zero speed, the frequency that is induced into the field is 60 Hz, at 95% speed the frequency induced is 3 Hz (for a 60 Hz system).

Once at 95% speed, the DC field is supplied with either 125V DC or 250V DC and the discharge resistor is removed from the circuit. The excitation in the field windings creates north and south poles in the rotor, which lock into the rotating magnetic field of the stator. The slip rings are used to connect the field windings to the discharge resistor and static exciter. It is at these slip rings that the field resistance of the motor can be measured to confirm the required field voltage and current at rated power factor. If, for example, the field voltage is 125V DC and the current is 20 amps DC, then the resistance that is measured should be about 6 Ω, based on Ohms Law.

Protection Theory

Theory of Operation

When the NOT STOP and START signals go high, an internal timer is started (see Figure 4 and Figure 5). The START signal must be dropped before another start can be initiated. The timer is preset based on the slip frequency of the motor. If the timer expires before achieving the maximum asynchronous speed, the starting sequence halts, the TRIP output is dropped and the PanelView™ displays a message that indicates the faulted condition. The TRIP signal is restored when there are no faults and the Fault/Reset PB input is received.

The NOT STOP and START can be tied together to indicate a RUN condition to control the device without separate signals. The RUN output follows the start input if the motor is permitted to start (in other words, no faults and the EQUIPMENT SHUTDOWN is high).

If the programmed percentage of synchronous speed is obtained within set time limits, the FIELD RELAY is energized. The power factor is now monitored and displayed on the PanelView. If the power factor drops below the programmed values, the TRIP and FIELD RELAY outputs are dropped, and the PanelView 800 HMI displays a faulted condition. Under normal conditions, the FIELD RELAY is maintained until the NOT STOP signal is removed.

Slip frequency is calculated from a square wave input representing the slip frequency. Based on this frequency, the allowable starting time is calculated. This calculation is based on three setpoints that the user enters, and a 'function order' used to shape the curve. The required setpoints for squirrel-cage protection trip time are:

- Setpoint 4: at synchronizing = 95%
- Setpoint 5: at 50% speed
- Setpoint 6: at stalled

The time curve between stalled frequency and 50% speed is assumed to be linear. The time between 50% speed and the synchronizing speed is to the *n*th order such that unity makes it linear, 2-5 makes it exponential in nature. The higher the order, the shorter the times near to 50% speed and the higher the times near the synchronous speed setpoint.

If the time setpoint at the maximum programmed percentage of synchronous speed is set below that of the extended stall (i.e. 50% speed curve), the function between 50% speed and synchronous speed is treated as linear. For example, the slope between 50% speed and synchronizing speed is flatter than the slope between stalled and 50% speed.

When the maximum programmed percentage of synchronous speed (setpoint) is obtained, the field coil is energized on the falling pulse of the negative square wave (a rising sinusoid) from the slip frequency generator. A fixed time period after synchronization, the autoload signal is raised. The field coil is energized only if the TRANSITION COMPLETE has been received.

Squirrel-Cage Winding Protection	Protects the squirrel-cage winding from long acceleration and stall conditions during starting.
Field Winding Application Control	The signal that triggers application of the field excitation when the programmed asynchronous speed is obtained.
Incomplete Sequence Timing Relay	Trips the system if the overall starting time is exceeded.
Pull Out Protection	Monitors the lagging power factor during running to detect a loss of synchronism
Field Voltage Failure Relay Input	Monitors the condition of the static exciter output. This relay must be supplied by the customer if the SyncPro IIB system is not supplied as a configured unit within an Allen-Bradley® motor controller.

Optional Equipment

- Field Current Failure Relay
- Load and Unload Auxiliary Contacts – The outputs are energized 2 sec. after the field is applied and is maintained until the field is removed.

Display/Metering Features

The product with the PanelView 800 HMI performs the following metering/display functions:

- Display all detected fault conditions
- Display the slip frequency and starting time during startup
- Display the power factor during run mode.
- Accept setpoints for the following:
  - Maximum % asynchronous speed (% of synchronous speed)
  - Power factor setpoint and trip delay
  - Maximum allowable time at stalled state (maximum slip)
  - Maximum allowable time at 50% speed
  - Maximum allowable time at synchronizing speed (typically at 95% speed)
  - Function order (allows adjustment of the slope of the acceleration/stall time trip curve).
  - Incomplete sequence timer trip delay
  - Fault mask for PF transducer diagnostics

See Chapter 5 for details.

Typical Synchronous Starter Components

The following sections outline typical synchronous starter components.

Motor Contactor (M)

The following details outline some of the common components that the SyncPro IIB system can be connected to or are part of the SyncPro IIB system.

The motor contactor provides and switches the power that is supplied to the motor stator. The contactor is controlled by the SyncPro IIB system, and is necessary to remove stator power if a stop command or a trip condition occurs. Two normally open contactor auxiliaries may be required; one mandatory N.O. contact to give contactor status information to the SyncPro IIB system, and one may be needed as a hold-in contact for the main control circuit.

Motor Contactor Pilot Relay (CR1 or MR)

This interposing relay allows the SyncPro IIB system output to pick up the main contactor coil. The power requirements of the pick-up coils that are used in most medium voltage motor starters would exceed the switching capability of the 1764-24BWA or 1769-L24ER-QBFC1B output.

Field Voltage Relay (FVR)

When energized, this DC relay indicates that the DC exciter supply is healthy and produces an adequate level of DC excitation. The field voltage relay prevents starting the motor unless DC excitation is available. A field voltage relay is recommended, as the SyncPro IIB system cannot determine the level of the exciter output voltage. It prevents unnecessary starts when synchronization cannot occur.

Equipment Shutdown Relay (ESR)

The ESR relay combines the status of customer supplied protective and interlock devices to one contact input on the SyncPro IIB system.

When ESR is energized, it is an indication that all external trip and interlock contacts to the SyncPro IIB system are in a "not tripped" condition. All external trips and interlocks must be wired in series with the ESR coil to be properly addressed by the SyncPro IIB system.

Phase Angle Transducer

The phase angle transducer provides a conditioned 4…20 mA signal to the analog module of the SyncPro IIB system. The transducer is factory-calibrated to provide a specific output at zero lagging power factor, at 1.0 or unity power factor, and at zero leading power factor. These factory settings must not be altered.

The SyncPro IIB system scales and interprets this signal to compare it to the power factor trip setpoint and to cause a trip to occur if the power factor drops below the programmed value for more than the specified power factor trip time delay. If the DC excitation is lost, a low voltage condition exists, or the motor is being overloaded to a point where the motor can no longer maintain synchronous speed, the motor power factor will react by dropping to a very lagging value. This indicates that the motor is slipping poles and the controller should be shut down to protect the motor.

The phase angle transducer monitors voltage across lines 1 and 2, along with the current in line 3 to obtain a power factor reading. When the reading is below the setpoints programmed, the SyncPro IIB system shuts down the starter.

Discharge Resistor

The discharge resistor is specified by the motor manufacturer for a specific application to obtain correct starting and pull in torques and to provide a means of discharging the motor induced field voltage when starting and stopping the motor. The field winding has more turns than the stator winding and when power is applied to the stator, the field acts like the secondary windings of a current transformer. A field winding without a discharge path produces a voltage greater than its insulation rating, and as such, requires a means to discharge or limit the voltage. If the discharge resistor is not connected during a start, the induced voltage can build to a point where the field winding insulation can be damaged. The resistor is also used to provide reference points to the SyncPro IIB synchronous motor protector (see Chapter 4).

Field Contactor (FC)

The field contactor provides two normally open and one normally closed power poles. The normally open contacts apply DC power to the motor field windings when the contactor is energized. Before energization and after de-energization, the normally closed pole makes the path to the discharge resistor to allow the dissipation of energy that is induced in the field during starting. It also provides a path to discharge the stored energy in the large inductive motor field winding on stopping of the motor.

Resistors RF1 and RF2

These resistors are used to attenuate the voltage that reaches the analog/digital pulse board. Set up of these resistors is important because if the signal voltage to the board is too low (too much resistance) then pulses will not be produced. If too little resistance is used, the voltage may be too high, which could damage the analog/digital pulse board (see Figure 10 on page 35).

Analog/Digital Pulse Board

This board converts the voltage sinusoidal waveform across the discharge resistor and, by examining the zero crossings, creates a digital pulse train of an equal frequency to the induced slip frequency occurring in the discharge resistor. At start (zero speed), the frequency is 60 Hz, at 95% speed, the frequency is 3 Hz (for a 60 Hz system). This feedback is used by the SyncPro IIB system to determine the speed of the motor at any time during acceleration and when the motor has reached the desired speed setpoint to synchronize.

Input/output Descriptive Control

Listing

NOT STOP INPUT
Local:5:I.Data.0

This signal must be maintained high for the SyncPro IIB system to operate. When the signal is taken low, the software identifies this as a normal stop for the motor.

The NOT STOP signal must be given in parallel to that of the hardware. For example, from the same PLC output or push button.

START INPUT
Local:5:I.Data.1

The rising edge of this signal starts the operation of the SyncPro IIB system. This signal is maintained high for two-wire control or may be dropped after initial starting if three-wire control is used. In both cases, this signal controls the START output. After a fault has occurred, this input must be taken low before another start command is recognized (see Figure 4 and Figure 5).

RUN OUTPUT
Local:1:O.Data.1

This output is used to control motor starting. It is the START input conditioned by all permissives. This output follows the state of the input as long as all permissives are met. In two-wire control, this output is actually a RUN command and stays high until either a fault occurs, or a stop is issued. In three-wire control, the output is maintained only as long as the input is maintained, a fault occurs, or a stop is issued.

EQUIPMENT SHUTDOWN RELAY (ESR) INPUT
Local:5:I.Data.7

This fault input is used to group all external faults. It notifies the SyncPro IIB system that the system has stopped for an external reason. The SyncPro IIB system sends a message indicating the reason for the stoppage. In the normal state, this signal is held high, going low on a fault condition. While this signal is low, a start signal is not accepted. Typically, all emergency stops or external faults are wired to an ESR relay. This relay is then fed into the SyncPro IIB system for logging and control and also tied into the hardware to stop the motor.

TRIP OUTPUT
Local:1:O.Data.0

This output is high during normal conditions. When the SyncPro IIB system detects a fault, the output goes low and the SyncPro IIB system stops the motor. The trip output is typically wired into the ESR circuit. It is set high when there are no faults and the FAULT RESET PB is momentarily raised high.

Field Application

TRANSITION COMPLETE CONTACT INPUT
Local:5:I.Data.6 (OPTIONAL)

The field relay output does not energize until this input permissive is given. Once the field relay is picked up, this permissive is no longer required. If the permissive is not given before the squirrel-cage protection timing out or the incomplete sequence timing out, the SyncPro IIB system will fault and stop the motor.

If unused, it must be tied high. This input is intended for an external input such as the RUN contact of an autotransformer starter. It prevents synchronization until the autotransformer starter has first transitioned to full voltage RUN mode.

FIELD RELAY OUTPUT
Local:1:O.Data.2

This output controls the field contactor relay, which applies the field to the motor. This output is energized when the transition complete permissive is given and the synchronous setpoint has been reached. The field is then applied either on the rising waveform or after a fixed time period of 1 second if the motor synchronizes on reluctance torque. The output is dropped whenever the NOT STOP is removed, the EQUIPMENT SHUTDOWN RELAY is removed, or a fault is detected.

Feedback

MOTOR CONTACTOR FEEDBACK CONTACT INPUT
Local:5:I.Data.8

This input indicates to the SyncPro IIB system that the motor contactor is closed, confirming that the motor is running. It also allows the SyncPro IIB system to detect a fault in the contactor circuit.

FIELD CONTACTOR FEEDBACK CONTACT INPUT
Local:5:I.Data.5

This input indicates to the SyncPro IIB system that the field contactor has picked up, confirming that the field has been applied. The signal must come from the auxiliary of the coil, which ultimately applies the field. If missing, the SyncPro IIB system detects a fault in the field circuit.

TRIP/RESET PB INPUT
Local:5:I.Data.2

This push button on the panel resets any fault condition in the SyncPro IIB system. Once no fault exists, the fault condition is removed from the PanelView and the TRIP output is set.

Fault Detection

FIELD VOLTAGE RELAY INPUT
Local:5:I.Data.3

When the signal is low, it indicates a lack of field voltage. This input is monitored for a fault condition only while starting, before applying the field. Tie this input high if it is not used. When this contact is high, it verifies that the static exciter is providing an appropriate DC voltage.

FIELD CURRENT RELAY INPUT
Local:5:I.Data.4 (OPTIONAL)

When the signal is low, it indicates a lack of field current. This input is monitored for a fault condition after the field has been applied. Tie this input high if it is not used. This optional input verifies that there is DC current flowing from the static exciter to the motor field. It is redundant since the power factor trip feature trips if the field current is lost.

POWER FACTOR INPUT
Local:4:I.Ch0Data

The signal that is supplied to the SyncPro IIB system is from the Phase Angle Transducer, which represents a power factor of zero lagging to zero leading respectively. The SyncPro IIB system firmware has been tailored to this specific transducer. No substitution is allowed.

SLIP GENERATOR POWER INPUT
Local:3:I.InputStateZ0

This fault input is monitored during idle and starting periods. It is normally held high by the power supply to the Slip Pulse Generator.

SLIP GENERATOR NEGATIVE INPUT (-)
Local:3:I.InputStateB0

Connect to the negative terminal (N) of the Slip Pulse Generator.

SLIP GENERATOR POSITIVE INPUT (+)
Local:3:I.InputStateA0

Connect to the positive terminal (P) of the Slip Pulse Generator.

Status

AUTO LOAD OUTPUT
Local:1:O.Data.3

Output is energized 2 seconds after the field is applied and remains closed until the field is removed from the motor by a stop or a fault.

SCP TRIP OUTPUT
Local:1:O.Data.8

Output is set high when a Squirrel-Cage Protection Fault occurs. It is reset when the TRIP output goes high after pushing the reset button. This signal can be used for indication, via a pilot light, or it can be used as an optional trip output.

MOTOR PULLOUT TRIP OUTPUT
Local:1:O.Data.9

Output is set high when the power factor lags for longer than the programmed trip time delay indicating that the motor has pulled out. It is reset when the TRIP output goes high after pushing the reset button. This signal can be used for indication, via a pilot light, or it can be used as an optional trip output.

INCOMPLETE SEQUENCE TRIP OUTPUT
Local:1:O.Data.10

Output is set high when an Incomplete Start Sequence Fault occurs. It is reset when the TRIP output goes high. This signal can be used for indication, via a pilot light, or it can be used as an optional trip output.

Custom

Local:5:I.Data.10…Local:5:I.Data.10 are custom fault inputs. If any are true, they trip the unit off.

Specifications

General

Operating Power	
Input Line Voltage	120V AC, 50/60 Hz
Input Current	0…5 A
Temperature and Humidity	
Temperature (Maximum Ambient)	Operating: 0…40 °C (32…104 °F)
	Storage: -20…+65 °C (-4…+149 °F)
Humidity	5…95% (noncondensing) Maximum temperature: 40 °C (104 °F)

For Phase Angle Transducer

General	
Accuracy	3% span
Housing	Flame retardant plastic case
Weight	2.4 kg maximum
Climate	
Storage	-20…+70 °C (-4…+158 °F)
Temperature range	Operational at 0…60 °C (32…140 °F) Calibrated at 23 °C (73 °F)
Humidity	Up to 95% relative humidity, noncondensing
Input	
Frequency	50/60 Hz
Current	0.2…10 A
Range (A)	20…120%
Burden	5VA maximum
Voltage	115…230V, ±10%
Range (V)	±20% (20…120% with separate auxiliary) Burden 1VA maximum
Overload Capacity	
Six times rated current for 30 s	
1.25 rated voltage for 10 s	
Electrical Tests	
Dielectric Test	2 kV RMS per BS 5458
Impulse Test	5 kV transient as BEAMA 219 and BS 923
Surge Withstand	ANSI C37-90A
Certification	CSA Approved

PanelView 800 Specifications

See publication 2711R-UM001.

CompactLogix 5370 Specifications

See publication 1769-UM021.

Notes:

Receiving and Storage

Receiving

Upon receiving the controller, remove the packing and check for damage that may have occurred during shipping. Report any damage immediately to the claims office of the carrier.

IMPORTANT	If the SyncPro IIB system is an integral component of a brush-type synchronous starter, special receiving and handling instructions apply. For details, see the service manual that is provided with the equipment.

Storage

It is important to consider the following storage requirements if you are not installing your controller immediately after receiving it.

- Store the controller in a clean, dry, dust-free environment.
- Maintain storage temperature between -20…+65 °C (-4…+149 °F).
- Relative humidity must not exceed 95%, noncondensing.

Notes:

Installation

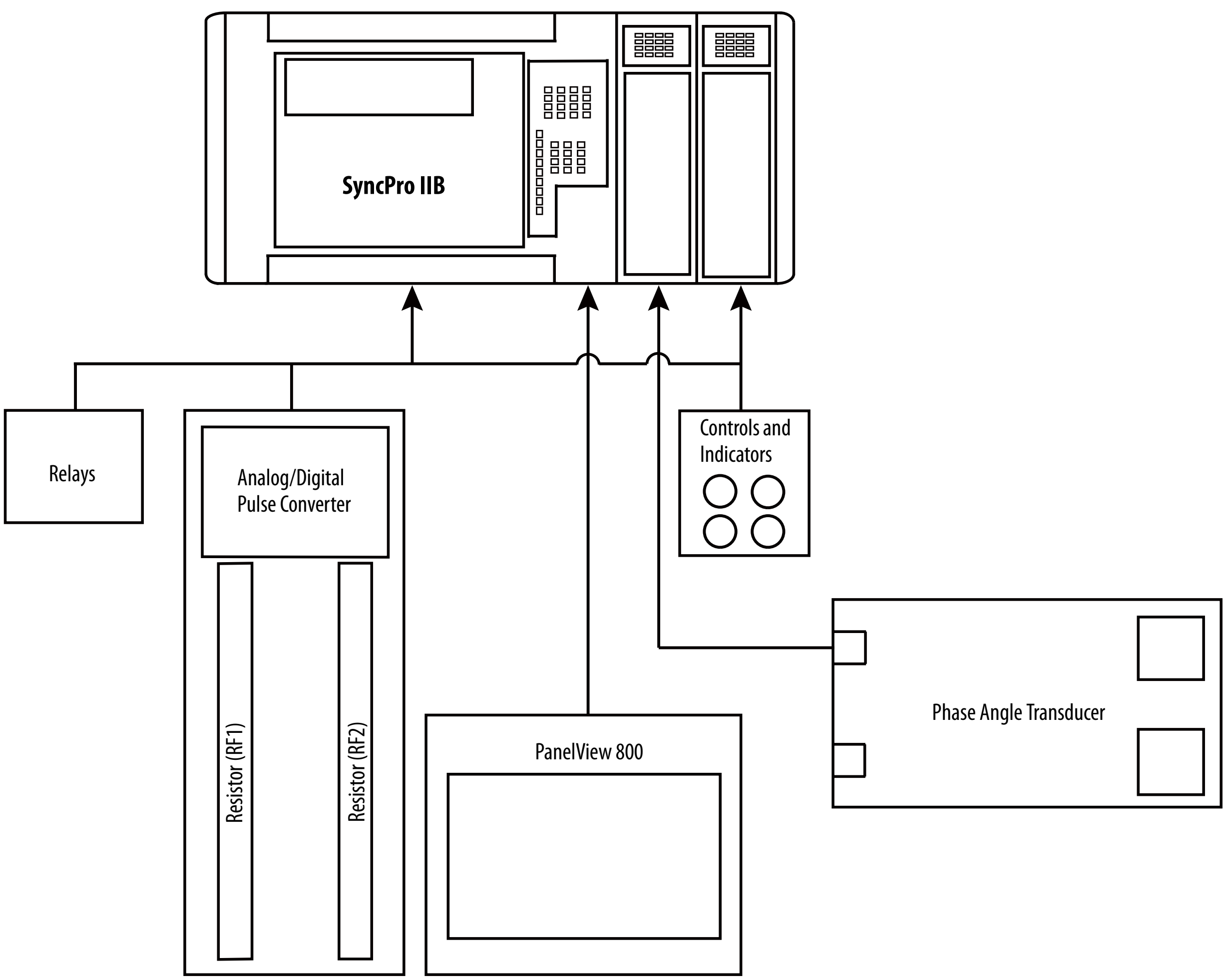
Arrangements

The SyncPro IIB system is offered in three arrangements.

Component Level

The SyncPro IIB system may be ordered as individual components for maximum flexibility when installing the controller. You can mount the components in a configuration most suitable to your main motor controller equipment layout. The SyncPro IIB system processor must have adequate ventilation. See Figure 6 for typical wiring of the components.

Figure 1 - SyncPro IIB Component Configuration



Open Frame Configuration

The SyncPro IIB system components are mounted on a panel, except the PanelView™ display module and the illuminated push button. See Figure 2 for mounting dimensions of the main unit panel. Quick installation within the main controller is possible with this arrangement.

IMPORTANT	The PanelView is supplied with a 2 m (6.6 ft) cable to connect to the SyncPro IIB system processor. Mount the PanelView in a suitable location to make this connection.

Figure 2 - Mounting Dimensions

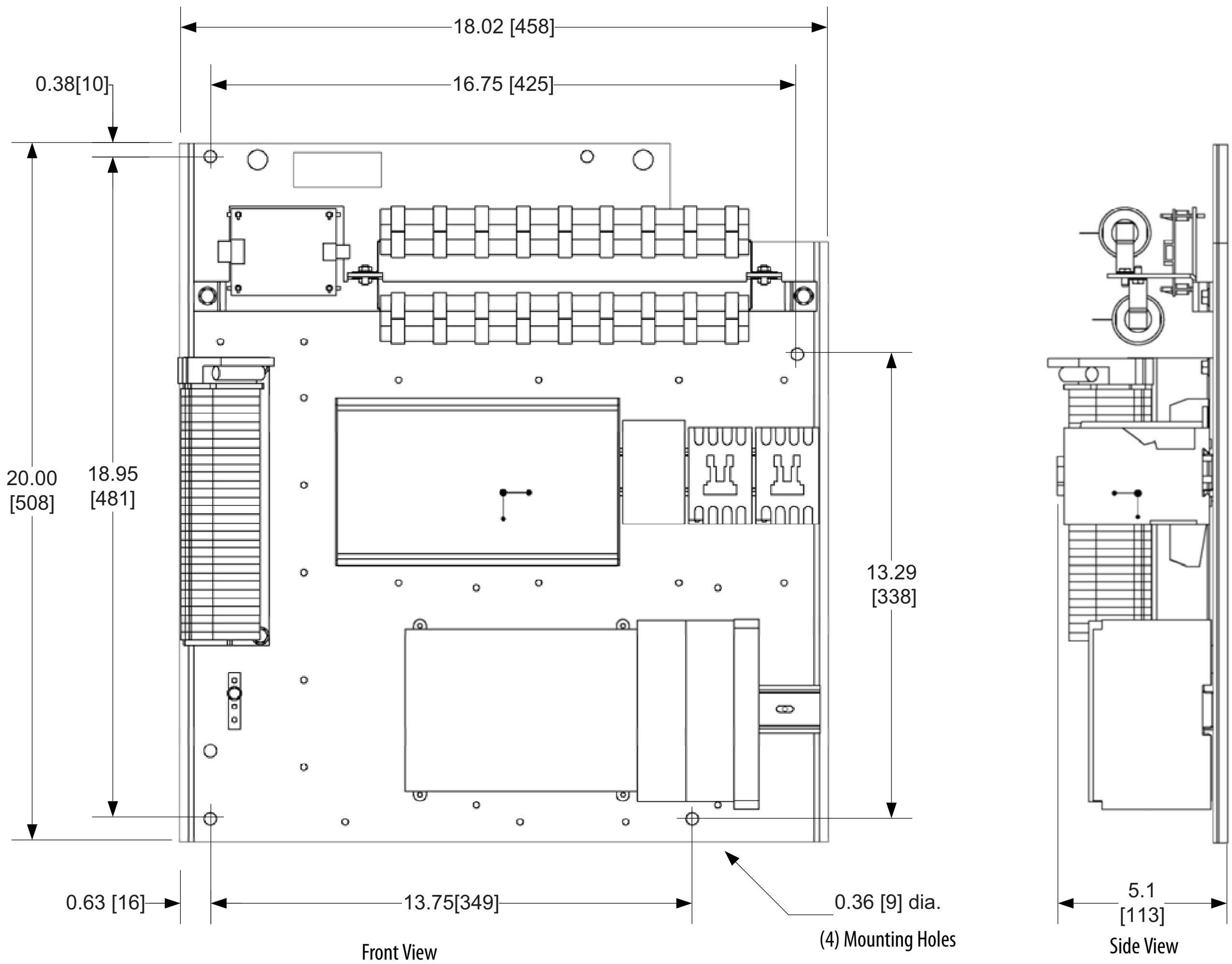
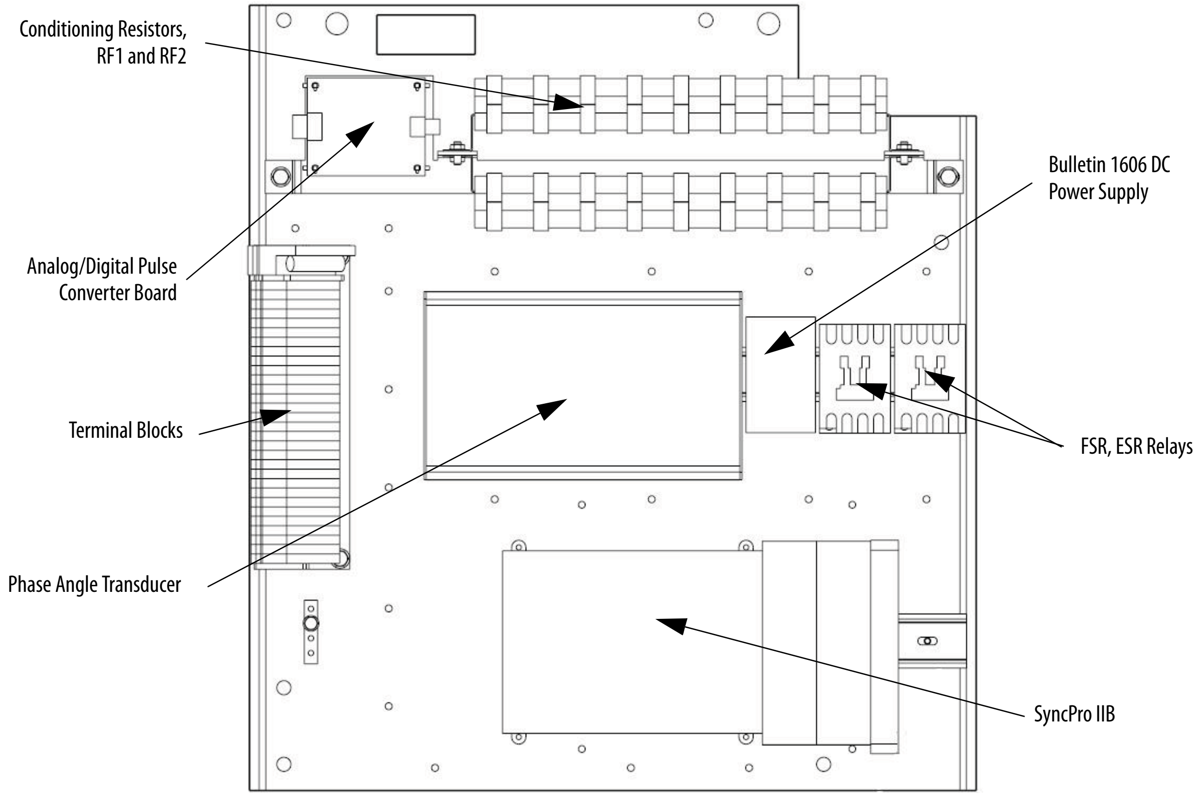


Figure 3 - Component Layout



Integral to a Completed Low Voltage or Medium Voltage Controller

The SyncPro IIB system is also available as a component of an Allen-Bradley® synchronous motor controller, which incorporates the components shown in Figure 3. Although the layout in the controller is different, control and functionality remain the same.

Grounding

The grounding that is required by the SyncPro IIB panel is brought to a common grounding bar mounted on the panel. Once the unit is installed, the grounding bar must be wired to the starter ground bus.

ATTENTION: Proper ground is essential as the SyncPro IIB system has a number of low voltage signals that may otherwise be vulnerable to noise, causing erratic operation.

Wiring Guidelines

The SyncPro IIB system can accept either two- or three-wire control. The control that is chosen determines the configuration of the control hardware. Consider the following two inputs and single output when selecting the type of control.

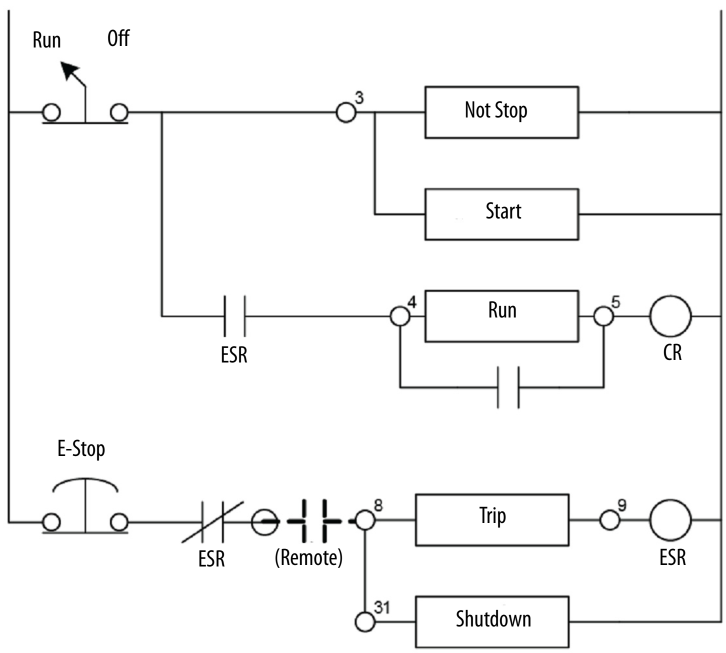
Table 1 - Input Configuration

Input	SyncPro IIB
NOT STOP	Local:5:I.Data.0
START	Local:5:I.Data.1
RUN	Local:1:O.Data.1

If using two-wire control, the NOT STOP and START inputs are tied together. They are both low to stop the SyncPro IIB (see Summary on page 34) and both high to run the device. To start the device after a fault, the START input must be taken low and then closed again. In this configuration, the RUN output acts as a run command (see Figure 4).

If using three-wire control, the NOT STOP input must be maintained high to run the device. Momentarily opening this input causes the SyncPro IIB system to stop (see Summary on page 34). Momentarily closing the START input starts the SyncPro IIB (given that all permissives are satisfied). In this configuration, the RUN output acts as a start command (see Figure 5).

Figure 4 - Two-wire Control



In both cases, the RUN output will follow the state of the START input, provided that all starting conditions are met. Note that in all cases, stopping the motor is done via the hardwired control circuit logic, and notification only is given to the SyncPro IIB system.

Figure 4 shows a typical two-wire control circuit. The selector switch is used to control the NOT STOP and the START as a pair. It is also used to verify the motor is stopped via the hard-wired control circuit logic (even though in this case, the RUN output is removed when the selector switch is turned off).

The ESR circuit verifies the motor is stopped for any fault condition occurring either externally or when detected by the SyncPro IIB. Once the ESR has dropped out, the selector switch must be switched off and on to initiate a start. This prevents a premature start if the fault condition is cleared and the selector switch is still in the run position.

Figure 5 shows a typical three-wire control circuit. The STOP PB must be maintained high to initiate a start and to run the system. The button also ensures that the motor is stopped via the hardware circuit. The momentary START PB is used to create a RUN (START) output signal of the same duration as the input signal as long as there are no faults detected by the SyncPro IIB system.

Figure 5 - Three-wire Control

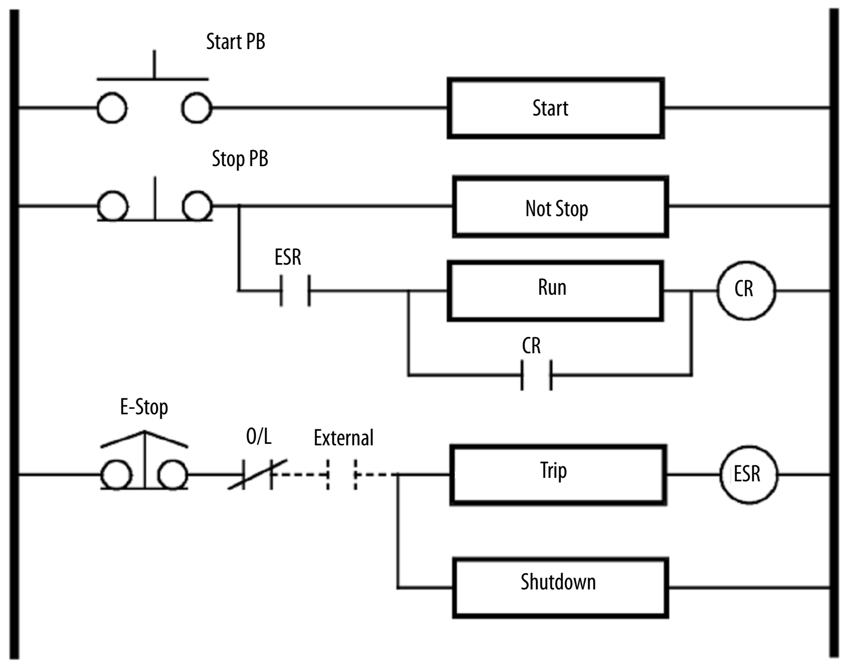


Figure 6 - Typical Wiring A (1 of 4)

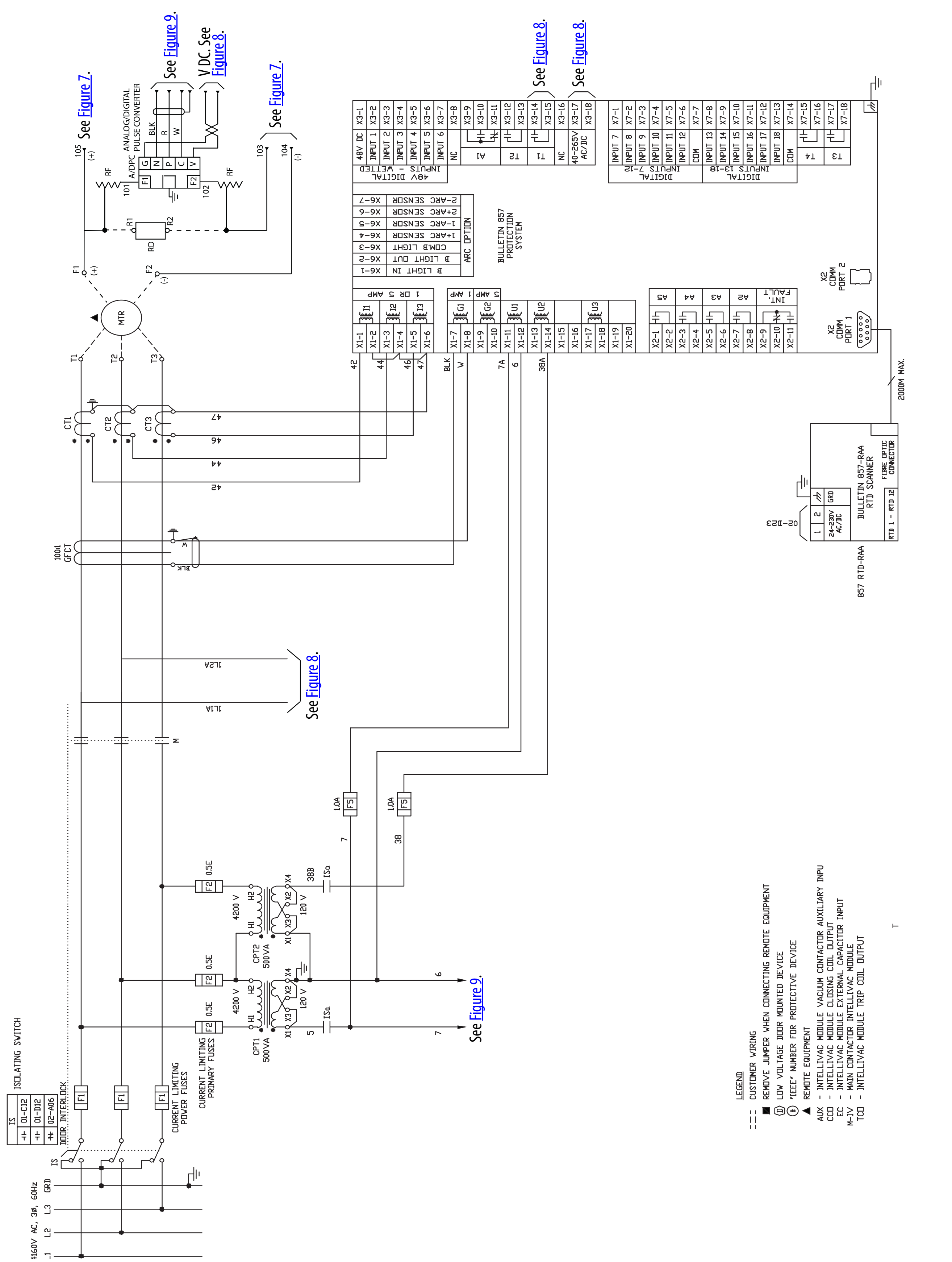


Figure 7 - Typical Wiring B (2 of 4)

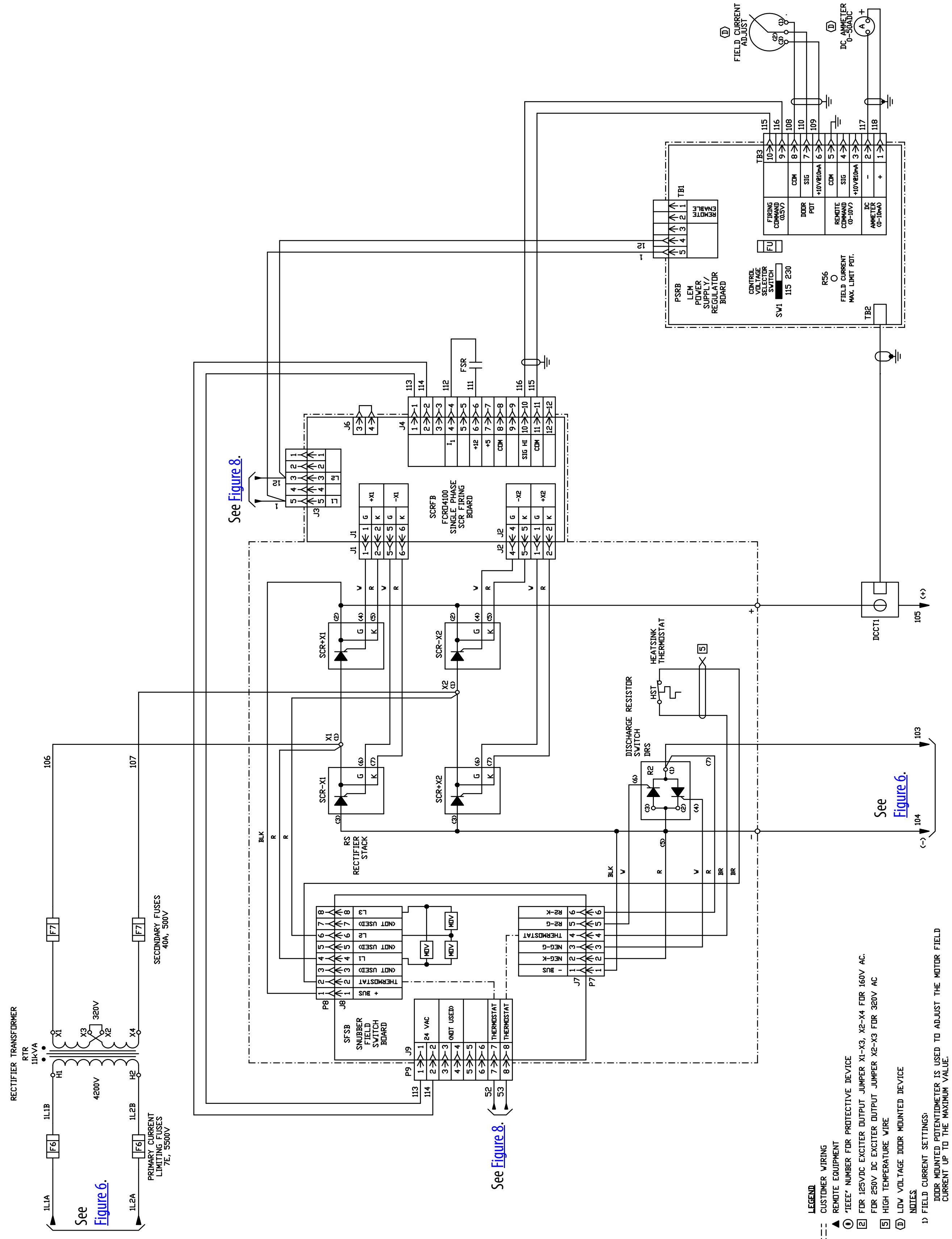


Figure 8 - Typical Wiring C (3 of 4)

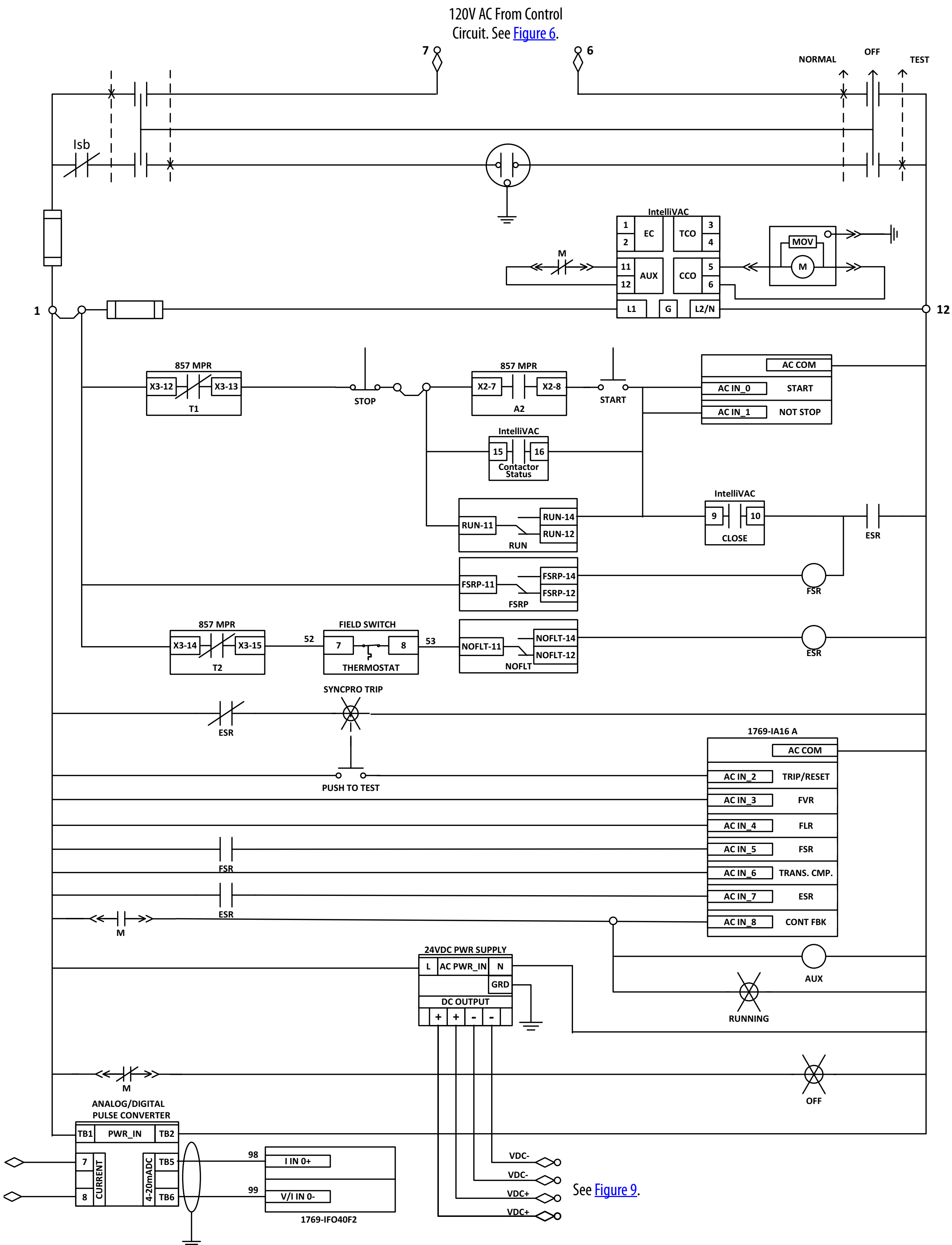
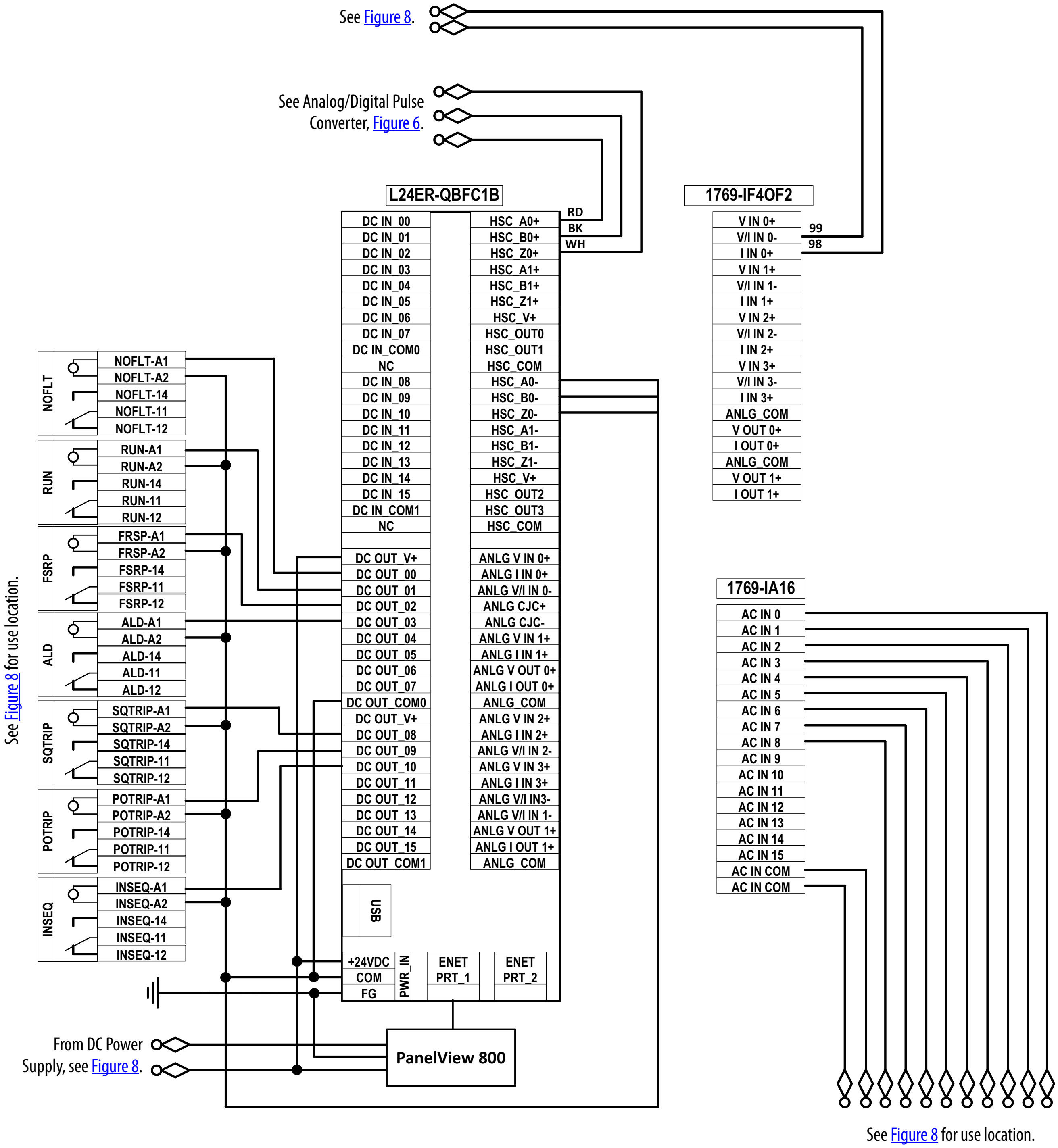


Figure 9 - Typical Wiring D (4 of 4)



In this case (three-wire) since the START signal is only momentary, the hardware must perform the sealing function using the control relay, CR. The START output is really an extension of the START input, except that the output is conditioned by any fault conditions.

The ESR circuit ensures the motor is stopped for any fault condition occurring either externally or when detected by the SyncPro IIB system. Once the ESR has dropped out, a start is not permitted until the fault condition is reset.

In all cases, the TRIP output is removed when a fault is detected. This fault includes both external hardware faults (as recognized by the EQUIPMENT SHUTDOWN signal) and faults that the SyncPro IIB system generates, such as a power factor trip.

Summary

1. The RUN output follows the state of the START input, provided there are no faults that are detected by the SyncPro IIB system.
2. Once a fault is detected, the START input must be taken low before the RUN output is allowed to operate.
3. All motor stopping is controlled by hard-wired control circuit logic. The SyncPro IIB is only notified of the stoppage to determine what is happening. Any time the motor stops without first removing NOT STOP input, an error condition is detected.
4. When using three-wire control, a contact from the CR relay must be used to seal in around the RUN output.

Setup and Commissioning

Setup

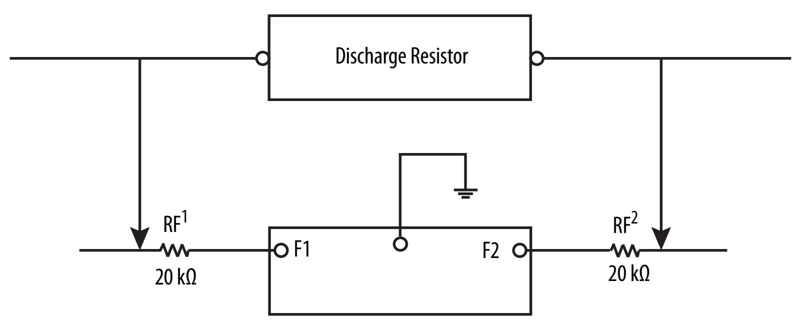
Check the following components of the SyncPro IIB system once it has been installed.

RF1 and RF2 Resistor Setup

The synchronous motor field discharge resistor feedback resistors (RF1, RF2) are necessary to attenuate the induced voltage waveform that appears across the field discharge resistor during starting (Figure 11). The resistors (RF1, RF2) reduce the voltage that is seen at the terminals of the analog/digital pulse converter to a level that is acceptable to the optoisolators on the board. Guidelines for resistor settings are contained in Table 2 on page 38.

The resistance value that is shown is the amount of resistance that is required on each lead that is connected to the A/D pulse board (F1, F2). For example, if the induced voltage on the discharge resistor is 1000V at zero speed and 600V at 95% speed (across the entire discharge resistor), then it is necessary to select taps on the RF1 and RF2 to provide 20 kΩ at RF1 and 20 kΩ at RF2.

Figure 10 - Discharge Resistor Installation



These settings must be made prior to any start attempt.

Determining the induced voltage that appears across the discharge resistor during starting can be done two ways.

1. If motor data is available the voltage can be determined by multiplying the discharge resistance by the induced currents at zero and 95% speed as given by the motor manufacturer.

EXAMPLE

Induced current @ 0% speed: 20 A

Induced current @ 95% speed:12 A

Discharge resistance: 50 Ω

Therefore:

Induced voltage @ 0% speed: 20 A x 50 Ω = 1000V

Induced voltage @ 95% speed: 12 A x 50 Ω = 600V

2. A measurement can be taken using an oscilloscope or a strip chart recorder, see publication 1900-2.10 for correct setpoint values. The waveform that is obtained has a peak value that must be converted to an rms value. This is done by dividing the peak-to-peak value by $2\sqrt{2}$ or 2.828.

When doing this, a portion of the discharge resistor only should be used, 1 Ω can then be used to determine the value that is on the entire resistor.

EXAMPLE

A strip chart recording is taken across a 1 Ω portion of a 50 Ω discharge resistor. The following peak to peak values are obtained:

0 speed: 56V p-p

95% speed: 34V p-p

Therefore:

0 speed rms voltage across 1 Ω	56 / 2.828 = 20V rms
95% speed rms voltage across 1 Ω	34 / 2.828 = 12V rms
0 speed rms current across 1 Ω	20V / 1 Ω = 20A rms
95% speed rms current across 1 Ω	12V / 1 Ω= 12A rms

Once the induced voltage has been determined, make the appropriate selection from Table 2 on page 38. Wires from each end of the discharge resistor should then be determined to the appropriate taps on the RF1 and RF2 resistors. Both the 0% and 95% speed induced voltages must fall between the upper and lower limits that are defined on the chart.

Procedure for Selection of Resistors

RD = Discharge resistance	___________ Ω
RSD = Sample resistance	___________ Ω
Vpp0 = 0% speed peak to peak voltage	___________ V (Vpeak@0)
Vpp95 = 95% speed peak to peak voltage	___________ V (Vpeak@95)
Vrms 0 = Induced voltage (0% speed)	___________ V (Vrms@0) Vp0/2.828
Vrms 95 = Induced voltage (95% speed)	___________ V (Vrms@95) Vp95/2.828
Io = Induced current (0% speed)	___________ A (Arms@0)Vrms0/Rs
I95 = Induced current (95% speed)	___________ A (Arms@95)Vrms95/Rs
V0 = Induced voltage (0% speed)	___________ V I0 x Rd
V95 = Induced voltage (95% speed)	___________ V I95 x Rd
0 speed induced voltage across the entire discharge resistor	50 Ω * 20 A= 1000V
95% speed induced voltage across the entire discharge resistor	50 Ω * 12 A = 600V
RF1/RF2 Resistance Required	___________ Ω

RF1 and RF2 Resistor

RF Resistor Tap Settings

Figure 11 - Discharge Resistor Setup

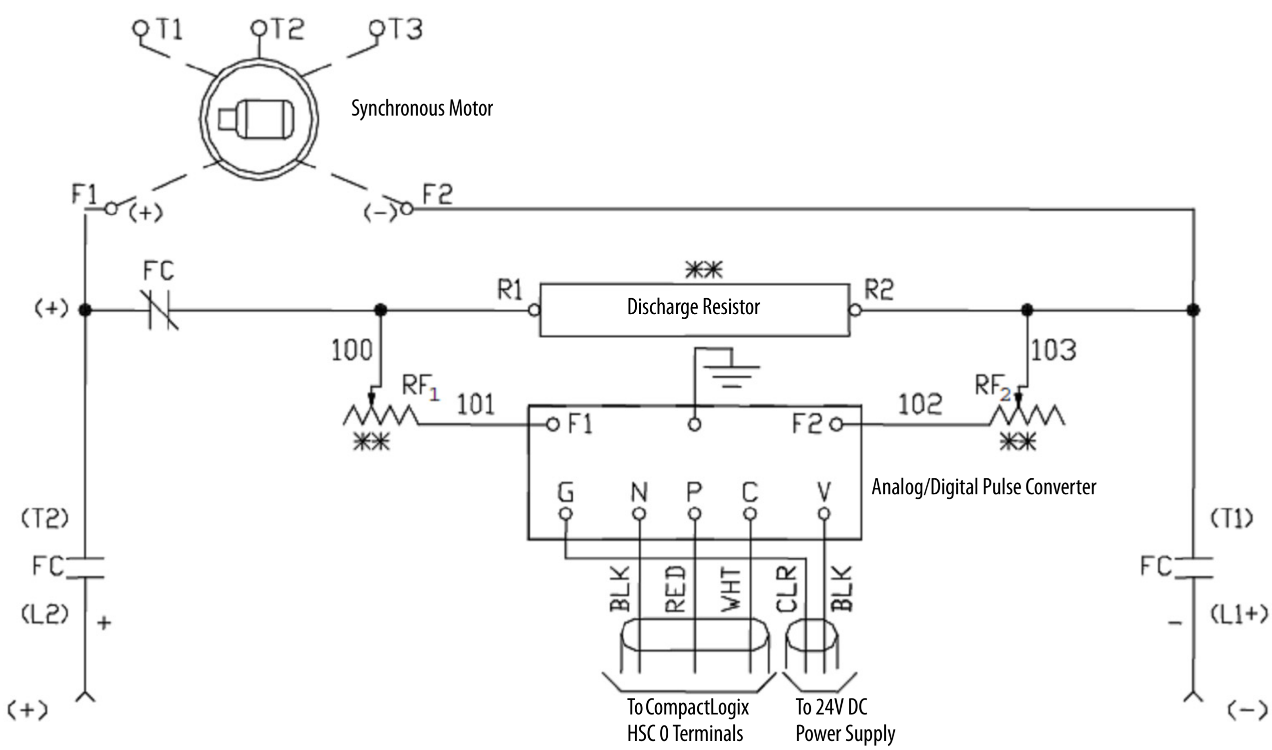


Table 2 - Feedback Resistor Values • Synchronous Field Feedback Board

RF1/RF2 Resistance (KΩ)(1)	Usable Voltage Range	
	Lower Limit	Upper Limit
2.5	80	160
5	160	320
7.5	230	480
10	320	640
12.5	400	800
15	490	950
17.5	560	1100
20	640	1300

(1) Resistance value is per resistor (two required).

Motor induced currents cause a voltage to be produced across the synchronous motor starter field discharge resistor. This voltage is connected to the feedback resistors and the tap to be selected on these resistors is dependent on this voltage level. For example, if the discharge resistor value is 20 Ω and the induced currents are 30 A at 0 speed and 18 A at 95% speed, then the induced voltage that is seen by the feedback resistors ranges from 600V (0 speed) to 360V (95% speed). The selection would then be 10 kΩ on each of the two resistors.

If the induced voltage proves to be higher than allowed by the chart, it is necessary to tap the field discharge resistor at a point that allows the value to fall within the chart. Contact Rockwell Automation for assistance.

Commissioning

1. Complete and verify that the setup procedures (see page 35) have been completed. This should include verifying that the parameters programmed into the SyncPro IIB system are appropriate for the motor. See Chapter 5 for further details on programming.
2. Verify that the SyncPro IIB system has been wired into the motor starter circuit as indicated by the wiring diagram.
3. Remove the wire from the Field Contactor Relay (FCR) coil either at the FIELD RELAY OUTPUT or at the FCR coil itself. Tie back and insulate the wire so that it cannot accidentally short out to ground or another electrical point. This disables the field contactor so that the starter does not attempt to synchronize.

IMPORTANT	The contactor must be disabled in this manner rather than removing the field cables from the contactor. The discharge path through the discharge resistor must be maintained; otherwise, a voltage high enough to damage the field insulation occurs at the open field windings. This is similar to the effect that occurs if a current transformer secondary winding is left open circuited.

4. If during the previous setup procedure for the discharge resistors RF1 and RF2, the induced currents were not known, bump the motor with the RF1 and RF2 resistors disconnected. Perform the method detailed in publication 1900-2.10 to determine the motor data by measurement using a strip chart recorder. Configure the RF1 and RF2 resistors as shown in Figure 11 with the data obtained. Use jumpers at the SyncPro IIB system trip output, and the run output, for the motor bump.

ATTENTION: During the bumping procedure, the SyncPro IIB system does not protect the motor. Monitor the procedure closely to avoid damage to the motor.

ATTENTION: Do not use jumpers at the ESR contact as this eliminates any external protective trips such as line overcurrent, fault protection, etc. which are still necessary for the bump. See Figure 8 for the jumper placement, and the points at which to disconnect the wires.

ATTENTION: During synchronization, voltages that may exceed 1000V are present at the RF1 and RF2 resistors. To avoid shock hazard, do not touch the resistors.

The phase angle transducer, as wired from the factory, is set up for the customer to run his wiring with an ABC line orientation. If this was not observed, you have two options. Either the line cables can be moved (switching any two incoming lines) so that ABC now exists (BCA or CAB are also acceptable), OR the current transformer leads to the transducer can be swapped at the transducer.

5. If the RF1/RF2 connections were removed for step 4, reconnect them at this point and set to the appropriate tap. The motor may now be bumped for rotation. Allow the motor to accelerate to rated sub-synchronous speed and monitor the following items:
   - The time to accelerate to rated sub-synchronous speed
   - The point at which the FIELD INPUT RELAY picks up (which normally would energize the field contactor) occurs to see if it appears to be occurring at 95% speed
   - Monitor power factor during acceleration. It should be lagging.
   - This proves that the power factor transducer connection is in the correct orientation with the incoming current and voltages. If the polarity is incorrect, switching the C3A and C3B connections should correct the situation.

The phase angle transducer connections are correct if the transducer power and voltage reference inputs are connected to Line 1 and 2, and the current reference is Line 3. If the incoming connections into the starter have been made B-A-C, rather than A-B-C, the polarity will also be incorrect even though the correct starter lines have been brought to the transducer. In either event, the correction is the same, reverse the C3A and the C3B current transformer connections.

ATTENTION: To avoid damage to the motor, do not allow the motor to run without synchronizing (at 95% speed) for longer than required to perform this test. Most motors are only capable of running for about 60 seconds at 95% speed without synchronizing.

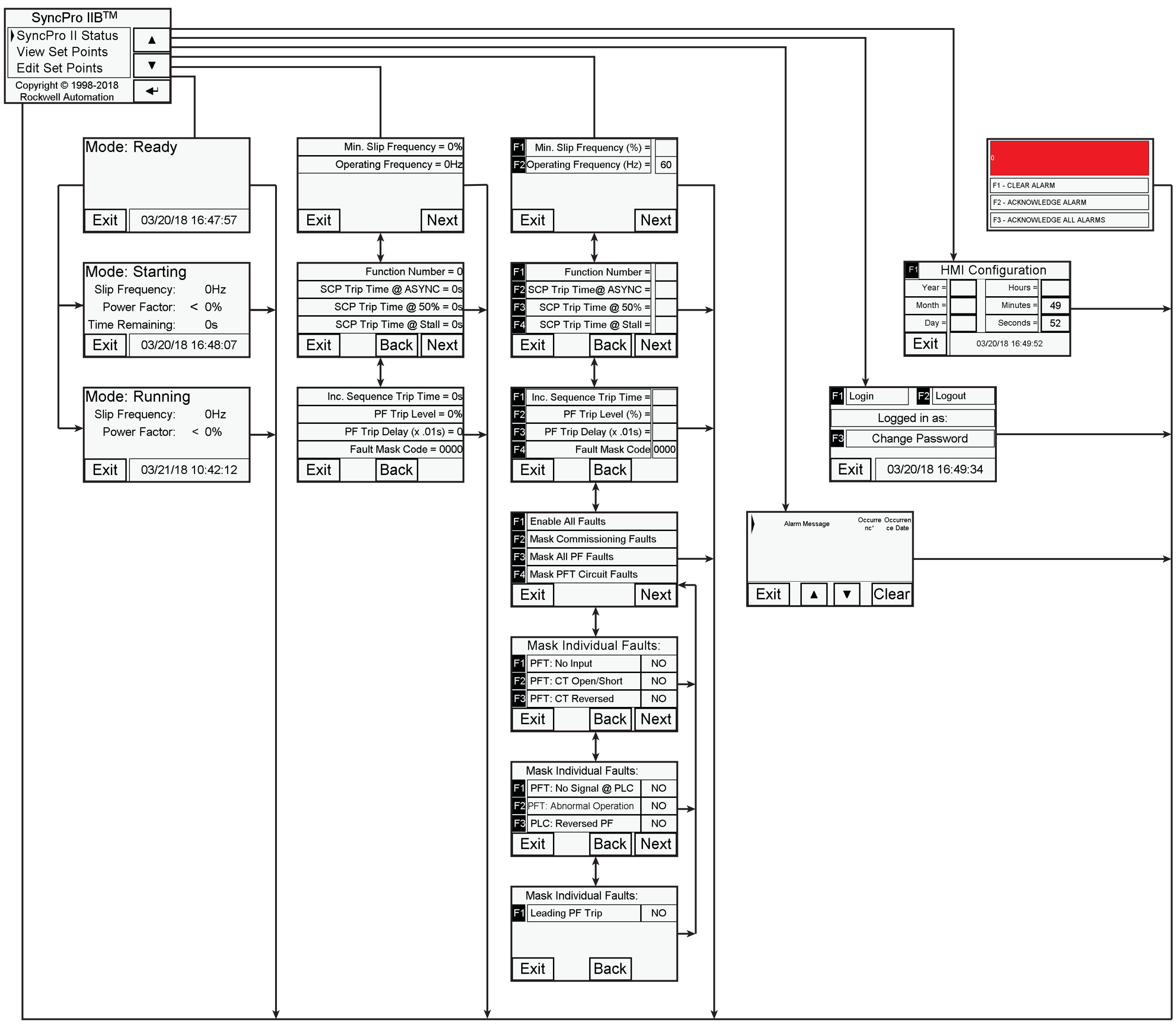
6. After completing the actions in Step 5, if the equipment appears to be operating in the correct manner, then the leads can be reconnected to the FCR coil that was removed in Step 3.
7. The motor can now be normally started. Once the motor has synchronized, a good check is to vary the DC excitation. Verify that when the DC current to the field is reduced, the motor power factor becomes more lagging and if increased, the motor power factor becomes more leading. Verify that the CompactLogix controller is getting the inputs according to the circuit diagram.

Programming SyncPro IIB

Overview

System programming is performed via the PanelView™ display unit. The SyncPro IIB system menu structure has been designed to optimize workflow.

Figure 12 - Programming Menu Map



Main Menu

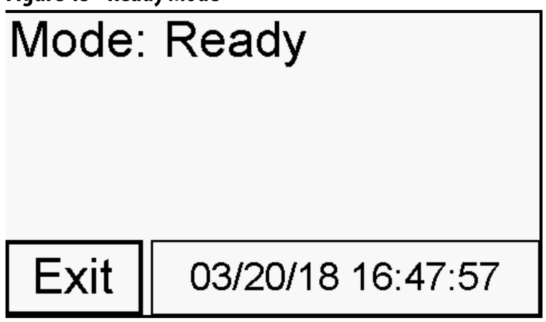
The main menu provides access to the following screens.

SyncPro IIB Status	Provides idle, starting, running status information
View Set Points	Allows viewing of SyncPro IIB system operation and protection set points.
Edit Set Points	Allows viewing of SyncPro IIB system operation and protection set points
Alarm History	Lists alarm/fault history recorded with relative time stamping
Access Code	Allows users to log in or log out to provide access control to operation and protection set points.
Settings	Allow editing of general HMI configuration such as language, relative time/date stamp

SyncPro IIB Status

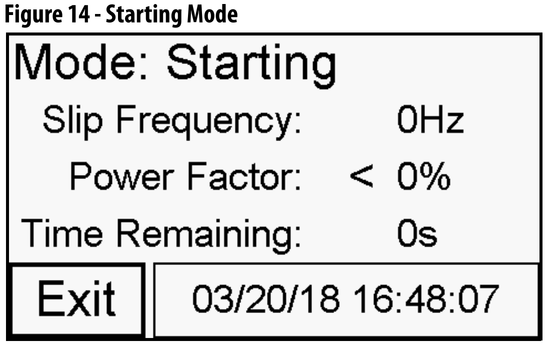
These screens are displayed when the motor is idle, starting, or running. The PanelView 800 automatically switches to one of the following screens after a period of inactivity.

Figure 13 - Ready Mode



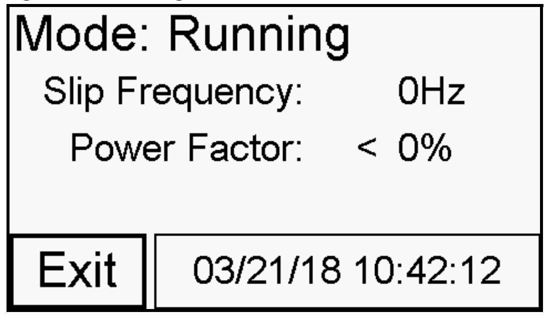
Ready mode (Figure 13) indicates the SyncPro IIB system has not detected any software or hardware faults and is ready to start.

Figure 14 - Starting Mode



During the *Starting* mode (Figure 14), the motor slip frequency in Hz power factor in %, and time to a squirrel cage protection in seconds are displayed. The power factor value is accompanied by either a < or > symbol to indicate lagging or leading power factor. Typical power factor readings during staring are lagging. If leading power factor is displayed, please confirm voltage and current input connections for proper sequencing (for example, V_{ab}, I_c).

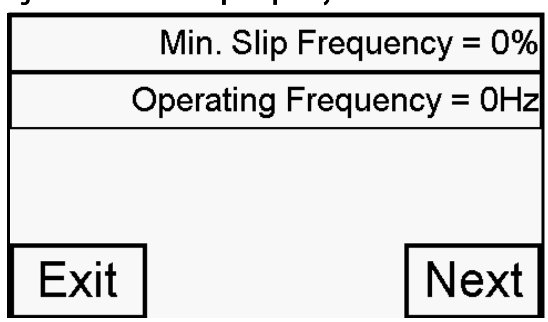
Figure 15 - Running Mode



In the *Running* mode, the slip frequency and power factor is displayed. During normal operation, the slip frequency is 0 Hz, and power factor is approximately 100% for unity.

View Set Points

Figure 16 - Minimum Slip Frequency



Set Point 1: Minimum Percent Synchronous Slip Frequency

This set point determines the percentage of synchronous speed at which the DC voltage is to be applied by the field switch/contactor. The SyncPro IIB system monitors the frequency of the induced voltage across the discharge resistor during starting. When this frequency indicates that the motor has achieved the desired sub synchronous speed at which it is allowable to synchronize, the SyncPro IIB energizes the coil of the field switch/contactor. The SyncPro IIB system ensures that the application of the field contactor coincides with the rising edge of the induced voltage waveform which makes for a smooth transition. If the motor pulls into synchronism due to reluctance torque, the SyncPro IIB system will detect no pulses and then will apply DC voltage to the field after a one second delay.

$$SP_1 = \frac{f_{Minimum\_slip}}{f_{operating}}$$

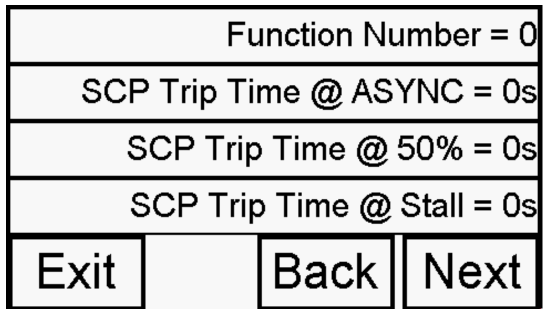
Set Point 2: Operating Frequency

This set point determines the operating system frequency. This allows the SyncPro IIB system to properly determine the appropriate minimum percent slip frequency.

$$SP_2 = f_{operating}$$

Set Point 3: Function Number

Figure 17 - Function Number



The function number entry determines the slope of the curve between the 50% speed trip time and the 95% speed trip time – set point 4 and 5. Although the trip time is set as 50% and 95% speed, the intermediate points between these values can be shaped to cause the trips for 51% and 94% to occur more or less quickly depending on which function number is selected. According to Figure 17, more time is allowed when function 1 is selected, and less time is allowed when function 5 is selected.

$$SP_3 = F(f, t_a, t_b)$$
$$SP_3 = t_b \ , if\ f < f_{50\%}$$
$$SP_3 = t_a , if\ f_{50\%} \le f < f_{sp2}$$

$$M = \frac{t_{sp5} - t_{sp6}}{f_{50\%} - f_{sp6}}, \quad B = t_{sp6} - Mf_{sp2}$$

$$k_a = \frac{(f_{50\%} - f_{sp1})^x}{t_{sp4} - Mf_{sp1} - B}, \quad k_b = \frac{(f_{50\%} - f)^x}{k_a}$$

$$ta = Mf + B, \quad t_b = t_a + k_b$$

Table 3 - Function Numbers

Variable	Function Number
t_{sp4}	Squirrel Cage Protection Trip Time (at 95% speed)
t_{sp5}	Squirrel Cage Protection Trip Time (at 50% speed)
t_{sp6}	Squirrel Cage Protection Trip Time (at stall)
f	Detected slip frequency
f_{sp1}	Minimum Percent Synchronous Slip Frequency
$f_{50\%}$	Squirrel Cage Protection Trip Frequency
f_{sp2}	Operating Frequency

Set Point 4: Squirrel Cage Protection Trip Time (at 95% Speed)

This time setting determines the maximum length of time the synchronous motor may run at 95% speed before it is shut down. The squirrel-cage winding of the synchronous motor is not rated to run the motor continuously even at no load and therefore must be shut down if synchronism does not occur. Time should be set to motor manufacturer's specifications.

$$SP_4 = t_{sp4}$$

Set Point 5: Squirrel Cage Protection Trip Time (at 50% Speed)

It is possible that a synchronous motor can accelerate only to an intermediate speed and either not accelerate further or take too long to accelerate further due to overloading. This would cause the squirrel-cage windings to overheat if allowed to continue unchecked. This setting limits the time that the motor can operate at 50% speed to the safe maximum recommended by the manufacturer.

$$SP_5 = t_{sp5}$$

Set Point 6: Squirrel Cage Protection Trip Time (at Stall)

In the event that a synchronous motor fails to accelerate at start up it will go into a stall condition at zero speed. This can occur if the motor is overloaded at start. The time entered at this set point should be the maximum allowable stall time on the squirrel-cage winding as defined by the motor manufacturer.

$$SP_6 = t_{sp6}$$

IMPORTANT	The squirrel cage winding of a synchronous motor has a very limited capability. Generally, the stall time allowed by the squirrel cage winding is less than the time that the stator winding is capable of. It is possible that a motor with a stator capable of a 20 second stall would have a rotor which can only endure a stall condition of 5 seconds.

Set Point 7: Incomplete Sequence Trip Time Delay

Once a synchronous starter has been commissioned, the acceleration and synchronization times should remain fairly consistent provided that the starting load does not vary significantly. The incomplete sequence timer can be set to a time delay that is slightly higher than the longest acceleration time. The aforementioned squirrel-cage protection features protect the motor, but they also let it go to its thermal limitations. The Incomplete Sequence Timing Relay (ISTR) set point can be adjusted to take the starter off-line earlier than the squirrel-cage protection trip time (set point 5) in the event of a field contactor failure or some other mechanical problem that prevents synchronization. This action minimizes motor heating during an equipment failure.

$$SP_7 = t_{IST}$$

Set Point 8: Power Factor Trip

As discussed earlier, power factor can be used to determine if a motor has pulled out of synchronism due to loss of excitation, overloading or a severe undervoltage. At this time, the motor should be taken off line to protect the stator and field.

$$SP_8 = PF_{trip}$$

Set Point 9: Power Factor Trip Time Delay

Once it is determined that the motor has a lagging power factor due to a pullout condition, the trip condition can be time delayed to allow the motor a brief opportunity to pull back into synchronism.

$$SP_9 = t_{PF\_Delay}$$

Set Point 10: Diagnostic Fault Mask

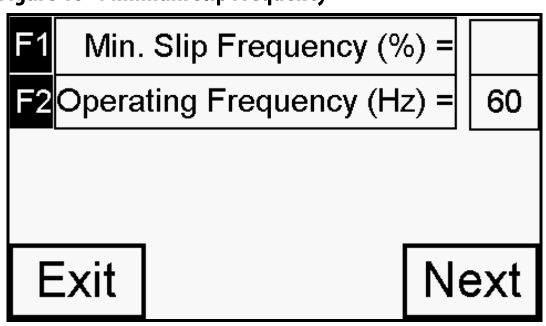
This parameter/screens are used to define a fault mask code that will disable individual diagnostic faults. The value is based on the 16 bit Fault Mask Word. See Edit Set Points for additional information.

Table 4 - Mask Description

Code	Mask Description
0	Enable All Faults
272	Mask Commissioning Faults
2000	Mask All Power Factor Faults
1984	Mask Power Factor Transducer Circuit Faults
64	Mask Power Factor Transducer No Input Fault
128	Mask Power Factor Transducer CT Open/Shorted Fault
256	Mask Power Factor Transducer CT Input Reversed Fault
512	Mask Power Factor Transducer No Signal at PLC Fault
1024	Mask Power Factor Transducer Abnormal Operation Fault
16	Mask PLC Reversed Power Factor Fault

Edit Set Points

Figure 18 - Minimum Slip Frequency



Set Point 1: Minimum % Synchronous Slip Frequency

Allowable Range: 2…10% (slip at which synchronization will occur as a percentage of synchronous speed)

Factory Default setting: 5% (95% speed)

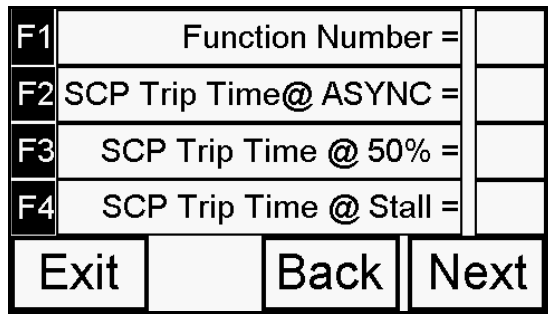
Typically set at: 5%

Set Point 2: Operating Frequency

Allowable Range: 50 or 60 Hz

Factor Default: 60 Hz

Figure 19 - Function Number



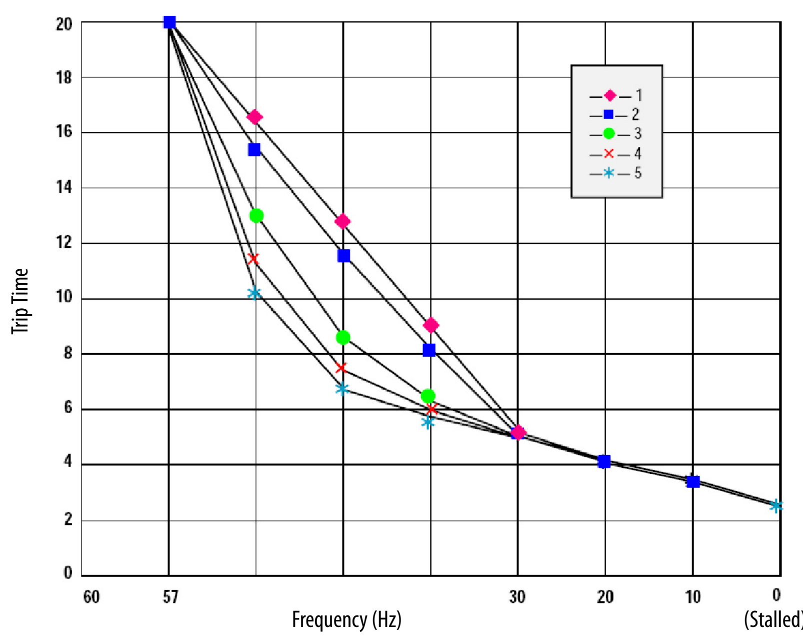
Set Point 3: Function Number

Allowable Range: 1…5

Factory Default Setting: 3 (Function curve 3)

In Figure 20, the 50% speed has been set to 5 seconds, and the 95% speed is set to 20 seconds for a 60 Hz system.

Figure 20 - Trip Time



Set Point 4: Squirrel Cage Protection Trip Time (at 95% speed)

Allowable Range: 5…80 s

Factory Default Setting: 5 s

Set Point 5: Squirrel Cage Protection Trip Time (at 50% speed)

Allowable Range: 2 s to Value in Set Point 4

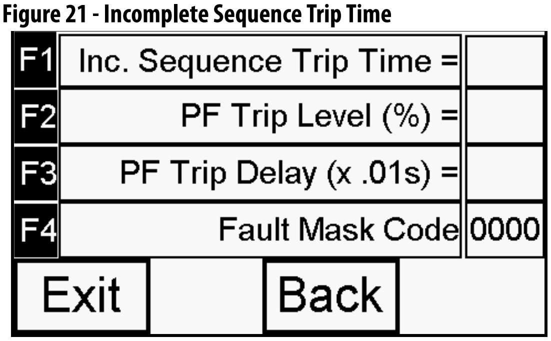
Factory Default Setting: 2 s

Set Point 6: Squirrel Cage Protection Trip Time (at stall)

Allowable Range: 1 s to Value in Set Point 5

Factory Default Setting: 1 s

Figure 21 - Incomplete Sequence Trip Time



Set Point 7: Incomplete Sequence Trip Time Delay

Allowable Range: 1…80 s

Factory Default Setting: 3 s

Set Point 8: Power Factor Trip

Allowable Range: 60…100 (% of unity)\

Factory Default Setting: 80 (0.8 lagging power factor)

Set Point 9: Power Factor Trip Time Delay

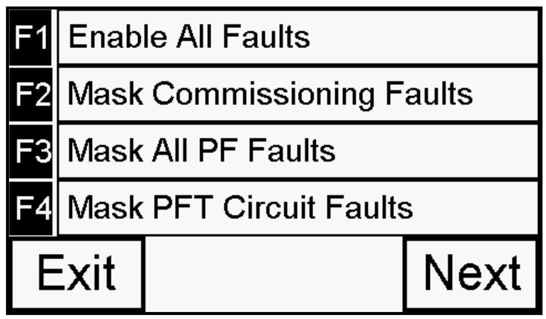
Allowable Range: 0...100 s (0.01 second units)

Factory Default Setting: 50 s (0.5 s delay)

Set Point 10: Diagnostic Fault Mask

The Fault Mask value can be calculated by selecting either a Fault Mask groups or individual faults. When switching between mask groups it is recommended that the fault code be cleared/reset by selecting "Enable All Faults".

Figure 22 - Diagnostic Fault Mask



Either group or individual mask can be used at one time. The resultant fault mask code will be function of the 16 bit fault mask word use. It is possible to selectively mask individual faults by adding up the fault values and entering the result. For example, to disable the Reversed PF and No Signal, the mask value would be 528 (16 +512). See Table 5 on page 51 for additional information.

Figure 23 - Mask Individual Faults

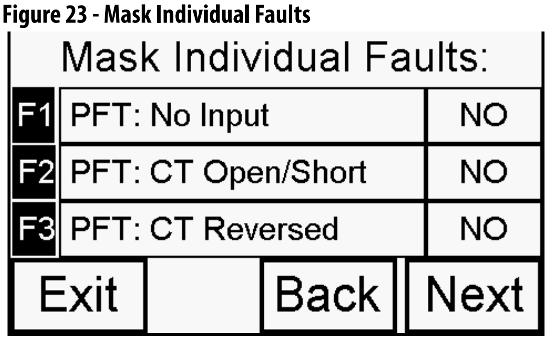


Figure 24 - Individual Faults

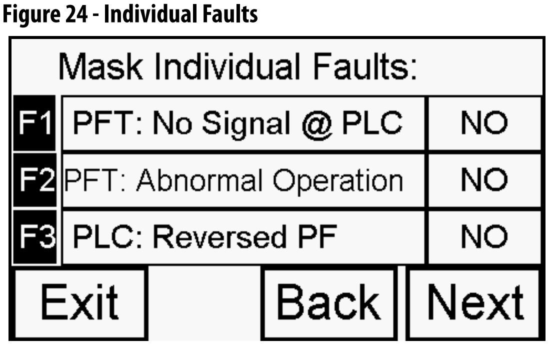
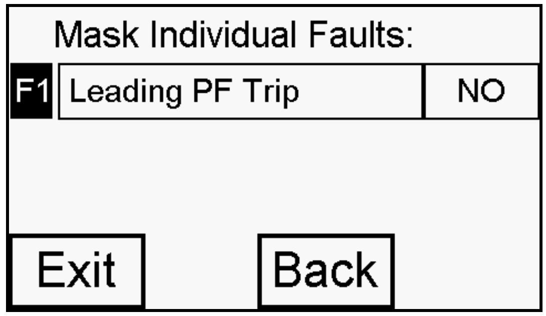


Figure 25 - Individual Faults (cont'd)



The value entered during prompting may not be the same value displayed if the value can be represented more clearly by some other combination of faults. The value of 272 (16 + 256) corresponds to 1.

Table 5 - Fault Mask Word

Mask Code	Fault Mask Word (16bit)																Mask Description
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Enable All Faults
272	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	Mask Comm. Faults
2000	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	Mask All PF Faults
1984	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	Mask PFT Circuit Faults
64	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	PFT: No Input
128	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	PFT: CT Open/Short
256	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	PFT: CT Reversed
512	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	PFT: No Signal @ PLC
1024	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	PFT: Abnormal Operation
16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	PLC: Reversed PF

Alarm History

The Alarm Banner screen will appear if any alarm condition exists in the system. The screen provides three user options:

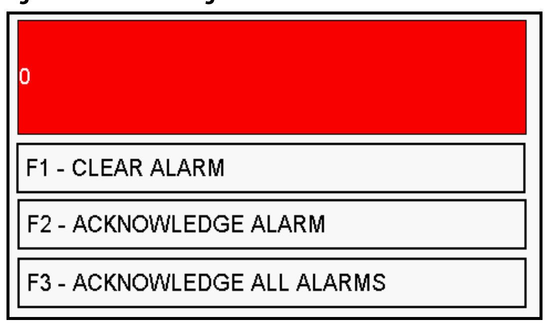
- Clear Alarm
- Acknowledge Alarm
- Acknowledge All Alarms

The clear Alarm option will remove the currently displayed fault and not record the fault in the Alarm History.

The Acknowledge Alarm option will remove the currently displayed fault and record the fault in the Alarm History with the relative time stamp. After a single alarm has been acknowledged, the next unacknowledged on if any will appear on the screen. If none unacknowledged alarms are left and all faults have been cleared the Main Menu Screen will be displayed.

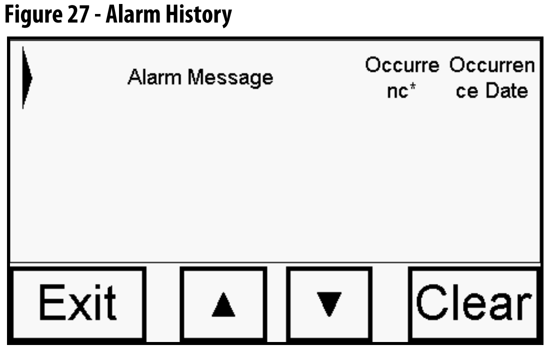
The Acknowledge All Alarm option will remove the currently displayed fault along with all additional faults in the fault stack/buffer and record all the fault(s) in the Alarm History with the relative time stamp.

Figure 26 - Acknowledge All Alarm Screen



The Alarm History Screen displays all the acknowledged alarms with date and time. Using the arrow keys you can scroll through up to 50 previous alarm conditions. The Alarm History may be cleared with the Clear key.

Figure 27 - Alarm History

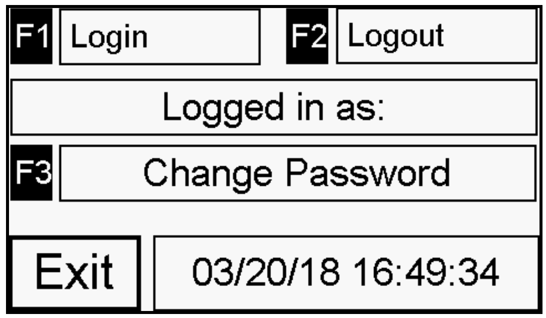


Access Code

The Access Code Screen allows authorized users to log in to secured screens and modify their own password. To log in, press the F1 key and enter your user ID and password using the alphanumeric keypad that opens during a login request. Login is successful if the “Logged in as:” indicator displays the correct username.

To change your password, press F3 and enter the current and new password to make the change. If both passwords match, then it successfully changes. Press F2 key to log out in the end of the session. The “Logged in as:” indicator username will disappear.

Figure 28 - Log In/Log Out

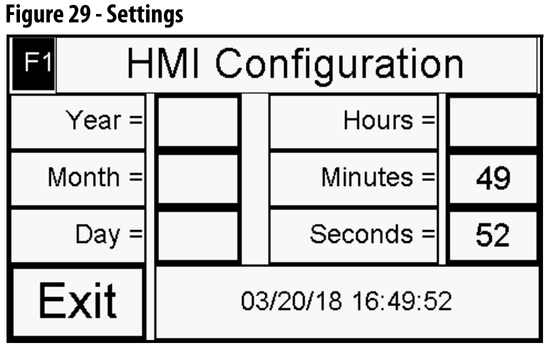


Prior to programming the unit, you must log in with full access permissions. The default administrator (admin) Access Code is “12345”. It is recommended this is changed during product commissioning.

Settings

The Settings Screen provides access to PanelView 800 built-in HMI configuration screen and offers capability to set up a relative time stamp. The time stamp is reset when power is removed.

Figure 29 - Settings



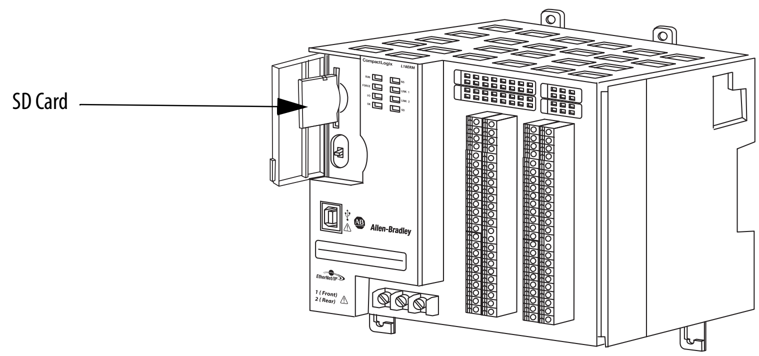
Replace the CompactLogix Controller

These instructions detail how to install the SyncPro IIB program on a replacement CompactLogix™ controller.

TIP Before any installation, be sure to download the as-commissioned parameters from the controller that is being replaced. If these parameters are not saved, you will have to recommission the controller when you have completed the procedure.

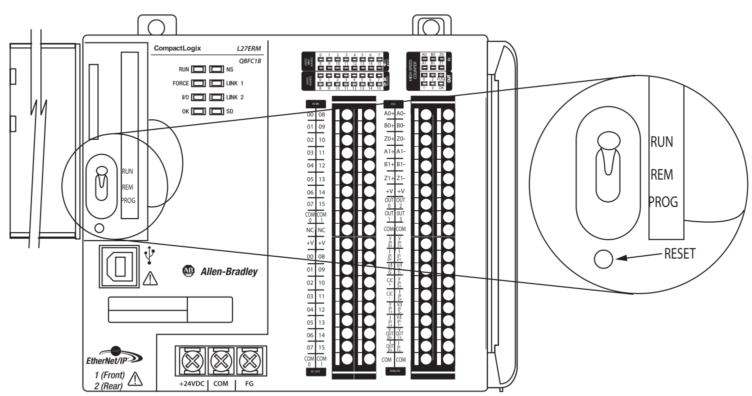
TIP The CompactLogix controller must be installed per publication 1769-UM021, and according to the electrical drawings supplied for that controller.

1. Install the pre-programmed SD card (PN-457957) in the CompactLogix controller per publication 1769-UM021.



2. Confirm that the RUN-REM-PROG switch is set to REM (Remote).

WARNING: When you change switch settings while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.



3. Cycle power to the controller.

   The program automatically loads from the SD card and is complete when the Power and Run status indicators are solid green.

4. Configure all SyncPro IIB parameters as were previously recorded.

   If the parameters are not available, see Commissioning on page 38 and proceed accordingly.

Monitoring

Phase Angle/Power Factor

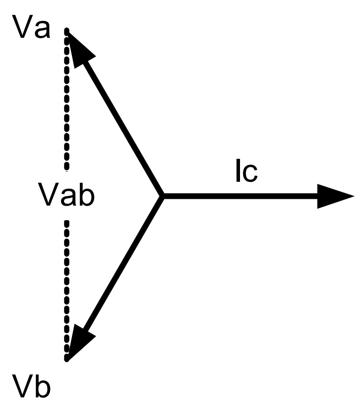
A key protection component of the SyncPro IIB system is to monitor Power Factor. Monitoring Power Factor is one of the most reliable methods to determine if the synchronous motor is running properly. The SyncPro /IIB system uses a Phase Angle Transducer that provides a proportional signal to the measured phase angle (the angle difference between motor voltage and current).

The phase angle transducer board provides a 4…20mA output proportional to -90…90°. The SyncPro IIB system use this input to calculated Power Factor.

$$PF = Cos(\theta)$$

To provide an accurate measurement the voltage and current inputs must be in the proper relationship, V_{ab} and I_c.

Figure 30 - Voltage and Current Inputs Relationship



Faults

Fault Detection and Diagnostics

The product incorporates numerous fault detections, starting squirrel-cage protection, and running pullout protection.

Before starting the motor, diagnostics are performed that detect the:

a. Lack of 24V supply to the slip frequency generator.
b. Reversed Power Factor Leads between the SyncPro IIB system and transducer.
c. Lack of the EQUIPMENT SHUTDOWN (external fault) signal.
d. Loss of Setpoint Data.

Upon starting the motor, additional diagnostics are performed. Any of these conditions aborts the start. Diagnostics performed are:

a. Lack of either pulse signal from the slip frequency generator.
b. Lack of field voltage or field current (if applicable).
c. Power Factor Transducer Circuit Fault.

Power Factor Circuit Fault

This fault covers a number of possibilities such as reversed leads at the CT, shorted CT input, loss of control power to transducer or a faulted transducer.

An incomplete start sequence timer (Setpoint 7) is used to abort the starting if abnormal long periods are encountered. This time is set independent of the squirrel-cage protection times.

While the motor is running, the motor is protected by monitoring fault conditions for:

a. Loss of synchronization. Minimum power factor lag is selectable, as is the duration of running.
b. Loss of feedback from the field contactor.
c. Loss of the EQUIPMENT SHUTDOWN caused by an external fault.

In all cases, faults are displayed on the PanelView 800 HMI and can be reset via the RESET push button.

Troubleshooting

Last Trip Table

To aid in troubleshooting, the unit stores the last 50 recorded faults. These can be accessed by viewing the contents of the alarm history.

Table 6 - Troubleshooting Guide

Problem or Trip Indicated	Indication of the following conditions	Possible Solutions
Pullout trip (power factor) [PULL OUT TRIP (POWER FACTOR)]	• Motor overloaded • Loss of DC excitation • Static exciter DC current level set too low	• Lessen the motor loading and/or overload • Repair static exciter • Increase current setting on static exciter if lagging • Decrease current setting on static exciter if leading • Mask leading power factor trip if application/ motor is designed for it
Squirrel-cage Protection Trip [SQUIRREL-CAGE PROTECTION TRIP]	• Motor overloaded at start	• Remove or lessen load for start
Incomplete Start Sequence Time Exceeded [INCOMPLETE START SEQUENCE TRIP]	• Motor overloaded at start • Field contactor or FC pilot relay coil failure	• Remove or lessen load for start • Replace coil(s)
No Transducer Input [POWER FACTOR XDCR – NO INPUTS]	• The transducer is putting out less than 12 mA when the motor is off (must be 12 mA)	• Check the wiring for the voltage sensing on the transducer board. • Replace phase angle transducer board if necessary. • Replace analog card in SyncPro IIB system chassis
CT Open/Shorted [POWER FACTOR XDCR – CT OPEN/SHORT]	• The CT is either open or shorted.	• Check the wiring between the CT and the transducer board. • Replace the CT if necessary.
CT Reversed [POWER FACTOR XDCR– CT REVERSED]	• The CT is incorrectly wired to the transducer board.	• Reverse the leads of the CT at the transducer board.
No Signal @ SLC [POWER FACTOR XDCR– NO SIGNAL AT PLC]	• There is no signal at the PLC analog card from the PF transducer board.	• Check the wiring between the transducer board and the PLC analog card. • Ensure that there is power to the transducer board. • Replace the PLC analog card or transducer board as required.
Transducer Problem [POWER FACTOR XDCR CIRCUIT FAULT]	• The transducer is behaving unpredictably.	• This is an all-encompassing fault and could include anything from the CT, the transducer board, or the PLC analog card

Table 6 - Troubleshooting Guide (Continued)

Problem or Trip Indicated	Indication of the following conditions	Possible Solutions
Pulse Board 24 V Failure [PULSE BOARD 24 VDC FAILURE]	• Connection has not been made between the analog/digital pulse board and the SyncPro IIB DC input card or from the discharge resistor to the same A/D pulse board. • 24VDC power supply has had a failure	• Check the connections at the A/D pulse board. • Check fuse in power supply. Check for 24 V at power supply. Replace power supply if necessary. • Replace A/D pulse board.
Field Voltage Loss [FIELD VOLTAGE LOSS]	• The static exciter is not actively producing DC or the FVR relay coil has failed. • Wrong polarity on FVR coil. • Incorrect voltage rating of FVR coil. • Exciter Enable (EE) relay did not pick up.	• Service the static exciter or repair the FVR relay. • AC Voltage to the bridge absent • 10V DC on Op Amp Board Absent • Check polarity on FVR coil. • Check voltage rating of FVR coil. • Verify the control circuit.
Field Current Loss [FIELD CURRENT LOSS]	• The current relay which monitors the motor field current is not providing an energized contact to verify that the static is functional.	• Check both the field current relay and the static exciter for possible failures.
No Field Coil Feedback [NO FIELD COIL FEEDBACK]	• The SyncPro IIB system has requested the field contactor to energize but the feedback contact from this contactor is not showing as closed.	• The field contactor coil has failed. Replace the coil. The connection to the FC auxiliary has not been made. Check the wiring. • The FC auxiliary contact has failed. Replace the contact.
Reversed PF @ SyncPro IIB [REVERSED PF AT PLC]	• The connections from the PF transducer to the analog card have been accidentally reversed.	• Switch the positive and negative transducer output leads at the analog card.
External Hardware Fault [EXTERNAL HARDWARE FAULT]	• An external device to the SyncPro IIB system is not functioning as expected.	• Check external devices.
Pulse Board Positive and Negative Pulse Missing [PULSE BOARD POSITIVE MISSING] [PULSE BOARD NEGATIVE MISSING]	• The SyncPro IIB system is not seeing a pulse train being supplied from the A/D board at the time of starting. • The RF1/RF2 resistor selection is not correct. The signal is too weak to provide the necessary pulse train	• Pulse train would be lost if either the A/D card failed, the RF1/RF2 selection is incorrect, or if the connection is not made from the A/D board to the SyncPro IIB. • Review the RF1/RF2 setup parameter and verify the procedure on page 39.
Contactor Feedback Lost [NO MOTOR CONTACTOR FEEDBACK]	• The SyncPro IIB system monitors the status of the synchronous motor stator contactor while running. • The male/female connector of the vacuum contactor is not matched properly. • The PLC I/O card slot 2 input 8 is faulty.	• The main contactor coil has failed. Replace the coil. The connection of the M auxiliary contact has not been made. Check the wiring. • The contact has failed. Replace. • Ensure the connector is matched properly. • Replace the I/O board. • Check the fuse.
Halt Synch Relay	• The program/remote/run switch on the PLC processor may be in program mode.	• Turn the key switch to the «RUN» mode position.

The phase angle transducer, as wired from the factory, is set up for the customer to run his wiring with and ABC line orientation. If this was not observed, the user has two options. First, the line cables can be moved (switching any two incoming lines will do) so that ABC now exists (BCA or CAB are also acceptable), OR the current transformer leads to the transducer can be swapped at the transducer.

Spare Parts

SyncPro IIB

Table 7 - Spare Parts

Part Number	Designation	Description	Quantity
1606-XLP50E	—	DC Power Supply	1
1585J-M8HBJM1M6	—	RJ45 Ethernet Media	1
1769-L24ER-QBFC1B	—	CompactLogix Controller	1
700-HLT1U24 A	—	Relay	1
PN-457957	—	Pre-programmed SD Card	1
1769-IA16	—	Digital Input Module	1
1769-IF4XOF2	—	Analog I/O Module	1
2711R-T4T	—	PanelView 800 HMI	1
700-CF220D	FCR, ESR	Relay	1
700DC-P200Z1	FVR	Field Voltage Relay – 125V DC exciter	1
700DC-P200Z2		Field Voltage Relay – 250V DC exciter	1
80025-817-01-R	20 kΩ tapped	Power Resistor 20 kΩ tapped	2
800H-PRTH1GR	Trip/Reset	Red Illuminated Push Button	1
800T-N318R		Lens for Red Push Button	1
800T-N65		Lamp for Red Push Button	1
80165-778-51-R	—	Analog/Digital Board	1
80190-020-01-R	120V	Phase Angle Transducer Board	1
80190-020-02-R	240V		1
X-251089	F3	Fuse 4 amp.	1

Notes:

Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

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