RediStart™

Solid State Starter

MX² SEP Synchronous Control

MX SEP Models

User Manual

890040-01-01

Hardware Version: 300063-01
Software Version: 810027-01-08

BENSHAW
ADVANCED CONTROLS & DRIVES


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Important Reader Notice

Congratulations on the purchase of your new Benshaw MX^2 SEP Controller. This manual contains the information to install and program the MX2 SEP Controller.

This manual may not cover all of the applications for the MX^2 SEP. Also, it may not provide information on every possible contingency concerning installation, programming, operation, or maintenance specific to the MX^2 SEP Controller.

The content of this manual will not modify any prior agreement, commitment or relationship between the customer and Benshaw. The sales contract contains the entire obligation of Benshaw. The warranty enclosed within the contract between the parties is the only warranty that Benshaw will recognize and any statements contained herein do not create new warranties or modify the existing warranty in any way.

Any electrical or mechanical modifications to Benshaw products without prior written consent of Benshaw will void all warranties, and may also void UL listings or other safety certifications. Unauthorized modifications may result in product damage, operation malfunctions, or personal injury.

Incorrect handling of the controller may result with an unexpected fault or damage to the controller. For best results on operating the MX^2 SEP, carefully read this manual, and all warning labels attached to the controller before installation and operation. Keep this manual on hand for reference.

Do not attempt to install, operate, maintain or inspect the controller until you have thoroughly read this manual and related documents carefully and can use the equipment correctly. Do not use the controller until you have a full knowledge of the equipment, safety procedures and instructions. This instruction manual classifies safety instruction levels under “WARNING” or “CAUTION”.

WARNING: Indicates situations in which a high voltage can cause physical injury, or death.

CAUTION: Indicates situations in which damage to equipment may occur.

NOTE: Marks an important point in the documentation.

Please follow the instructions of both safety levels as they are important to personal safety and equipment protection.

High Voltage

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing starters and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electronic controllers or rotating machinery.

Trademark Notice

Benshaw and BENSHAW are registered trademarks of Benshaw Incorporated. UL is a trademark of Underwriters Laboratories, Incorporated.

SAFETY PRECAUTIONS

Electric Shock Prevention

- This controller contains high voltage which can cause electric shock resulting in personal injury or loss of life.
- Do not open the front cover while power is on or the controller is running.
- Be sure all AC power is removed from the controller before servicing.
- More than one disconnect switch may be required to de-energize the equipment before servicing.
- Do not connect or disconnect the wires to or from the controller when power is applied.
- Make sure ground connection is in place.
- Always install the controller before wiring.
- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.

Injury Prevention

- Service must be performed by qualified personnel only.
- Ensure that the power-up restart feature is off to prevent any unexpected operation of the motor.
- Make certain proper shield installation is in place.
- Apply only the voltage specified in this manual to the terminals to prevent damage.

Transportation and Installation

- To prevent injury, use proper lifting gear when carrying products.
- Ensure that the installation position and materials can withstand the weight of the controller. Refer to the installation information in this manual for correct installation.
- If parts are missing, or the synchronous controller is damaged, do not operate the MX^2 SEP.
- Do not stand or rest heavy objects on the controller, as equipment damage may result.
- Do not subject the controller to impact or dropping.
- Make certain to prevent screws, wire fragments, conductive bodies, oil or other flammable substances from entering the synchronous controller.

Trial Run

- Check all parameters, and ensure that the application will not be damaged by a sudden start-up.

Emergency Stop

- To prevent the machine and equipment from hazardous conditions if the controller fails, provide a safety backup such as an emergency brake.

Disposal

- Never dispose of electrical components via incineration. Contact your state environmental agency for details on disposal of electrical components and packaging in your area.

Table of Contents

7 - THEORY OF OPERATION

8 - TROUBLESHOOTING & MAINTENANCE


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1 - Introduction

Using This Manual

Layout

This manual is divided into 9 sections. Each section contains topics related to the section. The sections are as follows:

- Introduction
- Technical Specifications
- Installation
- Keypad Operation
- Parameter Groups
- Parameter Descriptions
- Theory of Operation
- Troubleshooting & Maintenance
- Appendices

Notations

There are 3 notations used in this manual to highlight important information. These notations appear as the following:

WARNING: Indicates situations in which high voltages can cause physical injury, or death.

CAUTION: Indicates situations in which damage to equipment may occur.

NOTE: Marks an important point in the documentation.

WARNING: HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Only qualified personnel familiar with low or medium voltage equipment are to perform work described in this set of instructions.
- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- Turn off all power before working on or inside equipment.
- Use a properly rated voltage sensing device to confirm that the power is off.
- Before performing visual inspections, tests, or maintenance on the equipment, disconnect all sources of electric power. Assume that circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Replace all devices, doors, and covers before turning on power to this equipment.

Failure to follow these instructions may result in death or serious injury

Benshaw Services

General Information

Benshaw offers its customers the following:

- Start-up services
- On-site training services
- Technical support
- Detailed documentation
- Replacement parts

NOTE: Information about products and services is available by contacting Benshaw, refer to Page 11.

Start-Up Services

Benshaw technical field support personnel are available to customers with the initial start-up of the MX^2 SEP Controller. Information about start-up services and fees are available by contacting Benshaw.

On-Site Training Services

Benshaw technical field support personnel are available to conduct on-site training on MX^2 SEP operations and troubleshooting.

Technical Support

Benshaw technical support personnel are available at no charge to answer customer questions, and provide technical support over the telephone. For more information about contacting technical support personnel, refer to Page 11.

Documentation

Benshaw provides all customers with:

- Operations manual.
- Wiring diagrams.

All drawings are produced in AutoCAD format. The drawings are available via e-mail by contacting Benshaw.

Replacement Parts

Spare and replacement parts can be purchased from Benshaw Technical Support.

Software Number

This manual pertains to software version number 810027-01-08.

Hardware Number

This manual pertains to the hardware version number 300063-01.

Publication History

See inside back cover.

Warranty

Benshaw provides a 1 year standard warranty with its controllers. An extension to the 3 year warranty is provided when a Benshaw or Benshaw authorized service technician completes the installation and initial start up. The warranty data sheet must also be signed and returned. The cost of this service is not included in the price of the Benshaw controller and will be quoted specifically to each customers needs. All recommended maintenance procedures must be followed throughout the warranty period to ensure validity.

Contacting Benshaw

Information about Benshaw products and services is available by contacting Benshaw at one of the following offices:

Benshaw Corporate Headquarters

615 Alpha Drive
Pittsburgh, PA 15116
Phone: 412-968-0100
Fax: 412-968-5415

Tech Support: 1-800-203-2416
E-mail: bpg-usatechnicalsupport@regalbeloit.com

Benshaw Canada

550 Bright Street East
Listowel, Ontario N4W 3W3
Phone: 519-291-5112
Fax: 519-291-2595

Tech Support: 1-877-291-5112

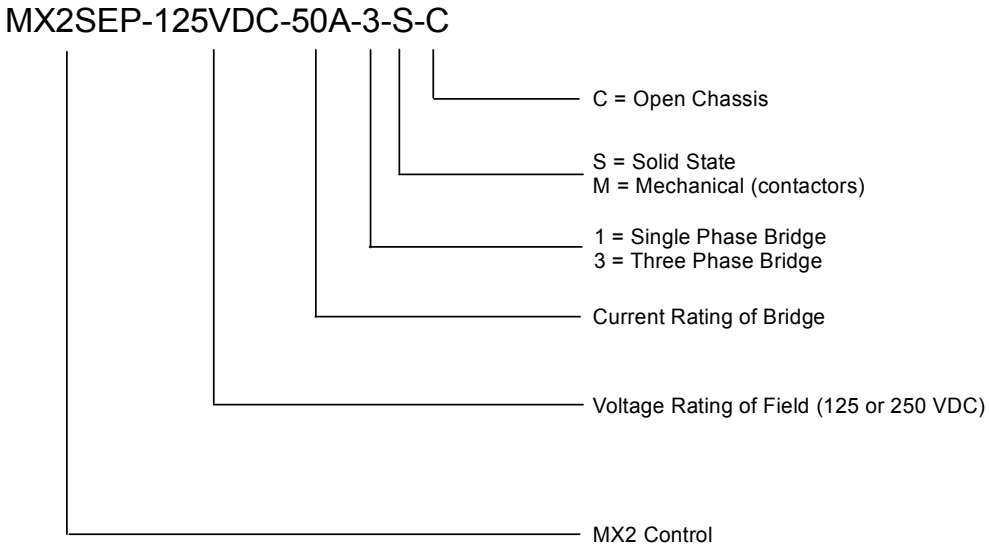
Technical support for the MX^2 SEP Controller is available at no charge by contacting the Benshaw Customer Service department at one of the above telephone numbers. A service technician is available Monday through Friday from 8:00 a.m. to 5:00 p.m. EST.

NOTE: An on-call technician is available after normal business hours and on weekends by calling Benshaw and following the recorded instructions. To help assure prompt and accurate service, please have the following information available when contacting Benshaw:

- Name of Company
- Telephone number where the caller can be contacted
- Fax number of caller
- Benshaw product name
- Benshaw model number
- Benshaw serial number
- Name of product distributor
- Approximate date of purchase
- Voltage of motor attached to Benshaw product
- FLA of motor attached to Benshaw product
- A brief description of the application

Interpreting Model Numbers

Figure 1: RediStart MX^2 SEP Series Model Numbers



General Overview of a Synchronous Field Controller

General Overview

The RediStart MX^2 SEP synchronous field controller is a microprocessor based controller for single or three-phase field supply. The synch controller can be custom designed for specific applications. A few of the features are:

- Solid state design
- Closed-loop motor current control
- Programmable operating parameters
- Programmable metering

Each MX^2 SEP can operate within applied line voltage of 100VAC to 600VAC (optional 1000VAC) and frequency values 23 to 72Hz.

The field controller can be programmed for synchronous motor fields. The RediStart MX^2 SEP can also protect the motor and its load from damage that could be caused by incorrect phase order wiring.

The controller continually monitors the amount of current being delivered to the motor. This protects the motor from overheating or drawing excess current.

Features

Enhanced engineering features of the controller include:

- Multiple frame sizes
- Universal voltage operation
- Universal frequency operation
- Phase rotation protection
- Regulated current control
- Electronic over/under current protection
- Single phase protection
- Programmable metering
- Passcode protected
- Programmable Relays
- Analog output with digital offset and span adjustment
- Analog input with digital offset and span adjustment
- Voltage and Current Accuracy of 3%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2 - Technical Specifications

2.1 General Information

The physical specifications of the controller vary depending upon its configuration. The applicable motor current determines the configuration and its specific application requirements. *Specifications are subject to change without notice*.

This document covers the control electronics:

- MX^2 Control Card Set

2.2 Electrical Ratings

2.2.1 Terminal Points and Functions

Table 1: Terminals

Function	Terminal Block	Terminal Number	Description
Control Power	TB1	G ground N 120VAC neutral N 120VAC neutral L 120VAC line L 120VAC line	96 – 144 VAC input, 50/60 Hz 45VA required for Control Card
Relay 1 (R1)	TB2	NO1: Normally Open Contact RC1: Common NC1: Normally Closed Contact	Relay Output, SPDT form C **NO Contact (resistive)** / **NC Contact (resistive)** 5A at 250VAC / 3A at 250VAC 5A at 125VAC / 3A at 125VAC 5A at 30VDC / 3A at 30VDC 1250VA / 750VA
Relay 2 (R2)	TB2	NO2: Normally Open Contact RC2: Common Contact NC2: Normally Closed Contact	Relay Output, SPDT form C **NO Contact (resistive)** / **NC Contact (resistive)** 5A at 250VAC / 3A at 250VAC 5A at 125VAC / 3A at 125VAC 5A at 30VDC / 3A at 30VDC 1250VA / 750VA
Relay 3 (R3)	TB2	NO3: Normally Open Contact RC3: Common Contact NC3: Normally Closed Contact	10A at 250VAC 10A at 125VAC 10A at 30VDC 2500VA
Digital Inputs	TB3	1: Start 2: DI1 3: DI2 4: DI3 5: Common	120VAC digital input 2500V optical isolation 4mA current draw Off: 0 – 35VAC On: 60 – 120VAC
Serial Comm	TB4	1: B + 2: A – 3: COM	Modbus RTU serial communication port. RS-485 interface 19.2k baud maximum 2500V Isolation

Table 1: Terminals (Continued)

Function	Terminal Block	Terminal Number	Description
Analog I/O (Hall Effect Input)	TB5	1: Ain Power 2: M 3: Common 4: Ground (Shield) 5: Aout 6: Common 7: Shield	*Input:* Voltage or Current Voltage: 0 – 10VDC, 67KΩ impedance Current: 0 – 20mA, 500Ω impedance *Output:* Voltage or Current Voltage: 0 – 10VDC, 120mA maximum Current: 0 – 20mA, 500Ω load maximum
Display	RJ45	—	Door Mounted Display Connector
SCR	J6 to J11	1: Gate 2: Cathode	SCR Gate Connections

Wire Gauge: The terminals can support 1–14 AWG wire or 2–16 AWG wires or smaller.

Torque Rating: The terminals on the control cards have a torque rating of 5.0-inch lb. or 0.56Nm.

This MUST be followed or damage will occur to the terminals.

NOTE: Refer to Control Card Layouts on Pages 29 and 30.

2.2.2 Measurements and Accuracies

Table 2: Measurements and Accuracies

Internal Measurements	
Hall Effect Input	Conversion: True RMS, Sampling @ 1.562kHz Range: 1 – 1000A
Line Voltage Inputs	Conversion: True RMS, Sampling @ 1.562kHz Range: 100 – 1,250VAC, 23 to 72 Hz
Metering	Current: 0 – 40,000 Amps ± 3% Slip %: 0.0 – 100% Voltage: 0 – 1,250 Volts ± 3% Line Frequency: 23 – 72 Hz ± 0.1 Hz Run Time: ± 3 seconds per 24 hour period Analog Input: Accuracy ± 3% of full scale (10 bit) Analog Output: Accuracy ±2% of full scale (12 bit) **NOTE:** Percent accuracy is percent of full scale of the given ranges, Current = Motor FLA, Voltage = 8,000V, Watts/Volts-Amps/Watt-Hours = Motor & Voltage range

2.2.3 List of Motor Protection Features

- ANSI 27 / 59 - Adjustable over/under voltage protection (Off or 1 to 40%, time 0.1 to 90.0 sec. in 0.1 sec. intervals, independent over and under voltage levels)
- ANSI 37 - Undercurrent detection (Off or 5 to 100% and time 0.1 to 90.0 sec. in 0.1 sec. intervals)
- ANSI 47 - Phase rotation (selectable ABC, CBA, Insensitive, or Single Phase)
- ANSI 48 - Adjustable up-to-speed / stall timer (1 to 900 sec. in 1 sec. intervals)
- ANSI 51 - Overcurrent detection (Off or 50 to 800% and time 0.1 to 90.0 sec. in 0.1 sec. intervals)
- ANSI 56 - Field Application
- ANSI 74 - Alarm relay output available
- ANSI 81 - Over / Under Frequency
- ANSI 95 - Reluctance torque sync
- ANSI 96 - Autoloading
- Single Phase Protection
- Shorted SCR Detection

2.3 *Environmental Conditions*

Table 3: Environmental Ratings

Operating Temperatures	–10°C to +40°C (14°F to 104°F) enclosed –10°C to +50°C (14°F to 122°F) open
Storage Temperatures	–20°C to +70°C (–4°F to 155°F)
Humidity	0% to 95% non condensing
Altitude	1000m (3300ft) without derating
Maximum Vibration	5.9m/s^2 (19.2ft/s^2) [0.6G]
Cooling	Natural convection (Fans optional)

2.4 *Altitude Derating*

Benshaw controllers are capable of operating at altitudes up to 3,300 feet (1000 meters) without requiring altitude derating. Table 6 provides the derating percentage to be considered when using a controller above 3,300 feet (1000 meters).

Table 4: Altitude Derating

Altitude		Percent Derating (Amps)
3300 Feet	1006 meters	0.0%
4300 Feet	1311 meters	3.0%
5300 Feet	1615 meters	6.0%
6300 Feet	1920 meters	9.0%
7300 Feet	2225 meters	12.0%
8300 Feet	2530 meters	15.0%
9300 Feet	2835 meters	18.0%

For derating above 10,000 feet consult Benshaw Inc.

2.5 *Approvals*

The MX^2 SEP Control Card is UL, cUL Recognized

2.6 *Certificate of Compliance*

CE Mark, see Appendix D on Page 117.

3 - Installation

3.1 *Before You Start:*

3.1.1 Inspection

Before storing or installing the RediStart MX^2 SEP Series sync controller, thoroughly inspect the device for possible shipping damage. Upon receipt:

- Remove the controller from its package and inspect exterior for shipping damage. If damage is apparent, *notify the shipping agent and your sales representative*.
- Open the enclosure and inspect the controller for any apparent damage or foreign objects. Ensure that all of the mounting hardware and terminal connection hardware is properly seated, securely fastened, and undamaged.
- Ensure all connections and wires are secured.
- Read the technical data label affixed to the controller, and ensure that the correct cuurent and input voltage for the application has been purchased.

3.1.2 Installation Precautions

Installation of some models may require halting production during installation. If applicable, ensure that the controller is installed when production can be halted long enough to accommodate the installation. Before installing the controller, ensure:

- The wiring diagram (supplied separately with the controller) is correct for the required application.
- The controller is the correct current rating and voltage rating for the motor being started.
- All installation safety precautions are followed.
- The correct power source is available.
- The control method has been selected.
- The connection cables, and associated mounting hardware, have been obtained (lugs).
- The necessary installation tools and supplies are procured.
- The installation site meets all environmental specifications for the controller NEMA/CEMA rating.
- The motor being started has been installed and is ready to be started.

3.1.3 Safety Precautions

To ensure the safety of the individuals installing the sync controller, and the safe operation of the controller, observe the following guidelines:

- Ensure that the installation site meets all required environmental conditions (refer to Site Preparation, Section 3.2.1).
- ***Lock out all sources of power.***
- Install circuit disconnecting devices (i.e., circuit breaker, fused disconnect or non-fused disconnect) if not previously installed by the factory as part of the package.
- Install short circuit protection (i.e., circuit breaker or fuses) if not previously installed by the factory as part of the package.
- Follow all NEC (National Electrical Code) and/or C.S.A. (Canadian Standards Association) standards or Local Codes as applicable.
- Remove any foreign objects from the interior of the enclosure, especially wire strands that may be left over from installation wiring.
- Ensure that a qualified electrician installs wiring.
- Ensure that the individuals installing the controller are wearing ALL protective eye wear and clothing.
- Ensure the controller is protected from debris, metal shavings and any other foreign objects.

NOTE: The opening of the branch circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of electrical shock, current carrying parts and other components of the controller should be inspected and replaced if damaged.

3.2 *Installation Considerations*

3.2.1 Site Preparation - General Information

Before the sync controller can be installed, the installation site must be prepared. The customer is responsible for:

- Providing the correct power source
- Providing the correct power protection
- Selecting the control mechanism
- Obtaining the connection cables, lugs, and all other hardware
- Ensuring the installation site meets all environmental specifications for the enclosure NEMA rating
- Installing and connecting the motor

Power Cables

The power cables for the controller must have the correct NEC/CSA current rating for the unit being installed. Depending upon the model, the power cables can range from a single #14 AWG conductor to four 750 MCM cables. (Consult local and national codes for selecting wire size).

Site Requirements

The installation site must adhere to the applicable controller NEMA/CEMA rating. For optimal performance, the installation site must meet the appropriate environmental and altitude requirements.

3.2.2 EMC Installation Guidelines

General In order to help our customers comply with European electromagnetic compatibility standards, Benshaw Inc. has developed the following guidelines.

Attention This product has been designed for Class A equipment. Use of the product in domestic environments may cause radio interference, in which case the installer may need to use additional mitigation methods.

Enclosure Install the product in a grounded metal enclosure.

Grounding Connect a grounding conductor to the screw or terminal provided as standard on each controller. Refer to layout/power wiring schematic for grounding provision location.

Wiring Refer to Wiring Practices on Page 22.

Filtering To comply with Conducted Emission Limits (CE requirement), a high voltage (1000V or greater) 0.1 uF capacitor should be connected from each input line to ground at the point where the line enters the cabinet.

3.2.3 Application Considerations

Although the MX SEP controls and provides protection for the motor field current, protection of the motor's stator windings must be addressed separate from the MX SEP package. For example, if the motor is started using a Benshaw motor starter, the overcurrent protection on the starter can be set to provide overcurrent protection of the stator windings in cases such as the rotor puling out of synchronization. Additionally, a low Power Factor trip can be used to detect when the rotor is no longer synchronized.

3.3 *Mounting Considerations*

Provisions should be made to ensure that the temperature inside the enclosure never rises above 122^{o}F / 50^{o}C. If the temperature inside the enclosure is too high, the controller can be damaged, and the operational life can be reduced.

Table 5: Ventilation Requirements

Current Range	Bottom of Enclosure	Top of Enclosure
< 200 amps	Fans or grills depending on enclosure size	
200 to 300 amps	2 x 4" grills (12 sq. in.)	2 x 4" grills (12 sq.in.)
301 to 400 amps	1 x 4" fan (115 cfm)	2 x 4" grills (12 sq.in.)
401 to 600 amps	2 x 4" fan (230 cfm)	2 x 6" grills (28 sq.in.)
601 to 700 amps	2 x 6" fan (470 cfm)	2 x 6" grills (28 sq.in.)
> 700 amps	Consult Factory	Consult Factory

The field supply produces 4 watts of heat per amp of current, and 26 square inches of enclosure surface is required per watt of heat generation. Contact Benshaw and ask for the enclosure sizing technical note for more information concerning controllers in sealed enclosures. Benshaw supplies controllers under 124 amps non-bypassed, with the heat sink protruding from the back of the enclosure. This allows a small enclosure size, while still maintaining the cooling capability of the controller.

3.4 *Wiring Considerations*

3.4.1 Wiring Practices

When making power and control signal connections, the following should be observed:

- Power wiring to the motor must have the maximum possible separation from all other wiring. Do not run control wiring in the same conduit; this separation reduces the possibility of coupling electrical noise between circuits. Minimum spacing between metallic conduits containing different wire groups should be three inches (8cm).
- Minimum spacing between different wiring groups in the same tray should be six inches.
- Wire runs outside an enclosure should be run in metallic conduit, or have shielding/armor with equivalent attenuation.
- Whenever power and control wiring cross, it should be at a 90 degree angle.
- Different wire groups should be run in separate conduits.

NOTE: Local electrical codes *must* be adhered to for all wiring practices.

3.4.2 Considerations for Control and Power Wiring

Control wiring refers to wires connected to the control terminal strip that normally carries 24V to 115V. Power wiring refers to wires connected to the line and load terminals that normally carry 208VAC to 600VAC respectively. Select power wiring as follows:

- Use only UL or CSA recognized wire.
- Wire voltage rating must be a minimum of 300V for 230VAC systems and 600V (Class 1 wire) for 460VAC and 600VAC systems.
- Grounding must be in accordance with NEC, CEC, or local codes. If multiple controllers are installed near each other, each must be connected to ground. Take care to not form a ground loop. Grounds should be connected in a STAR configuration.
- Wire must be made of copper and rated 60/75°C for units 124 Amps and below. Larger amp units may use copper or aluminum wire. Refer to NEC table 310-16 or local codes for proper wire selection.

3.4.3 Considerations for Signal Wiring

Signal wiring refers to the wires connected to the control terminal strip that are low voltage signals, below 15V.

- Shielded wire is recommended to prevent electrical noise interference from causing improper operation or nuisance tripping.
- Signal wire rating should carry as high of a voltage rating as possible, normally at least 300V.
- Routing of signal wire is important to keep as far away from control and power wiring as possible.

3.4.4 Meggering a Motor

If the motor needs to be meggered, remove the motor leads from the controller before conducting the test. Failure to comply may damage the SCRs and WILL damage the control board, which *will not* be replaced under warranty.

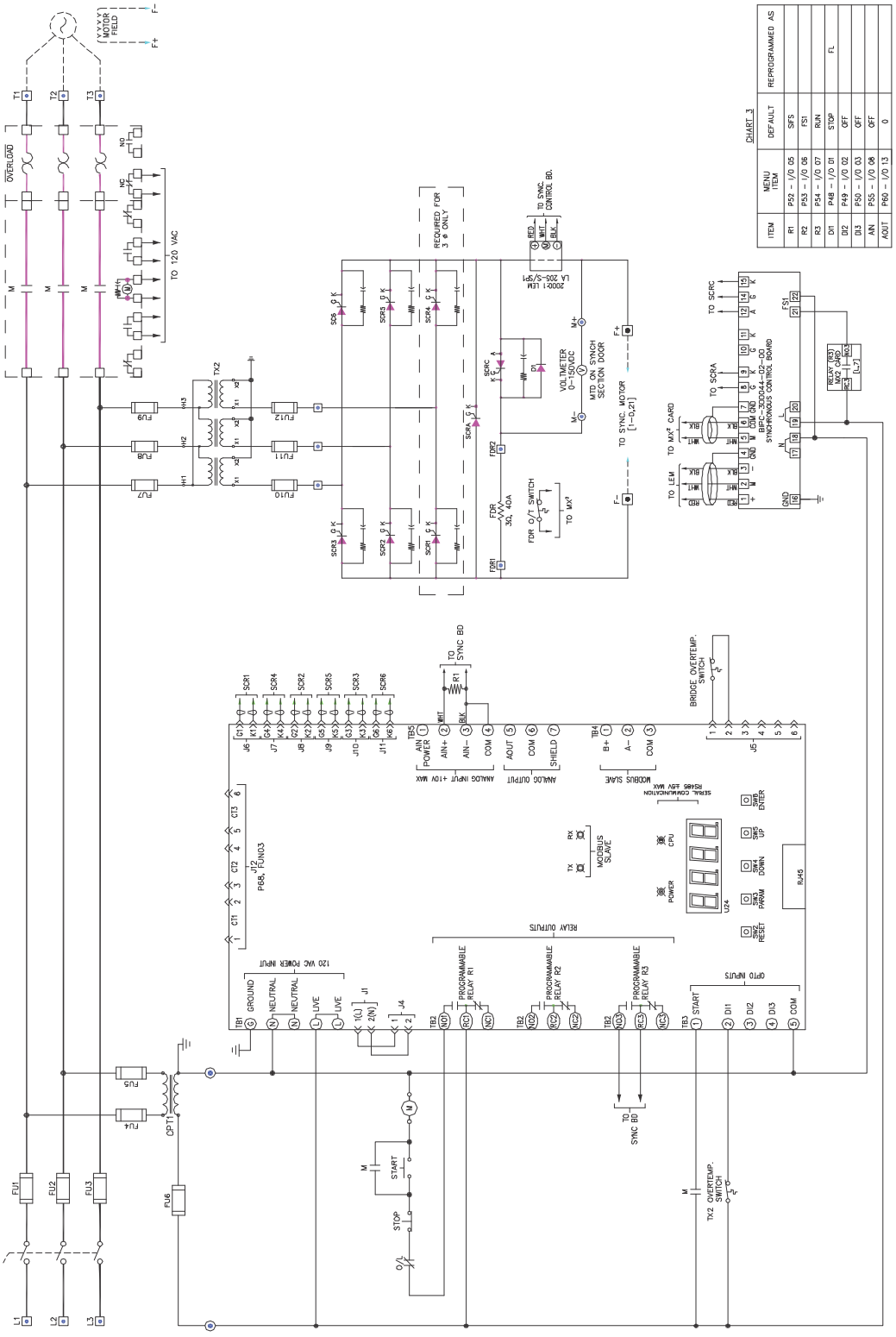
3.4.5 High Pot Testing

CAUTION: If the controller must be high pot tested, perform a DC high pot test. The maximum high pot voltage must not exceed 2.0 times rated RMS voltage + 1000VAC (High pot to 75% of factory). Failure to comply *will* damage the control board, which *will not* be replaced under warranty. An example to find the maximum high pot voltage is (2.0 * rated RMS voltage + 1000) * 0.75.

3.5 *Power and Control Drawings*

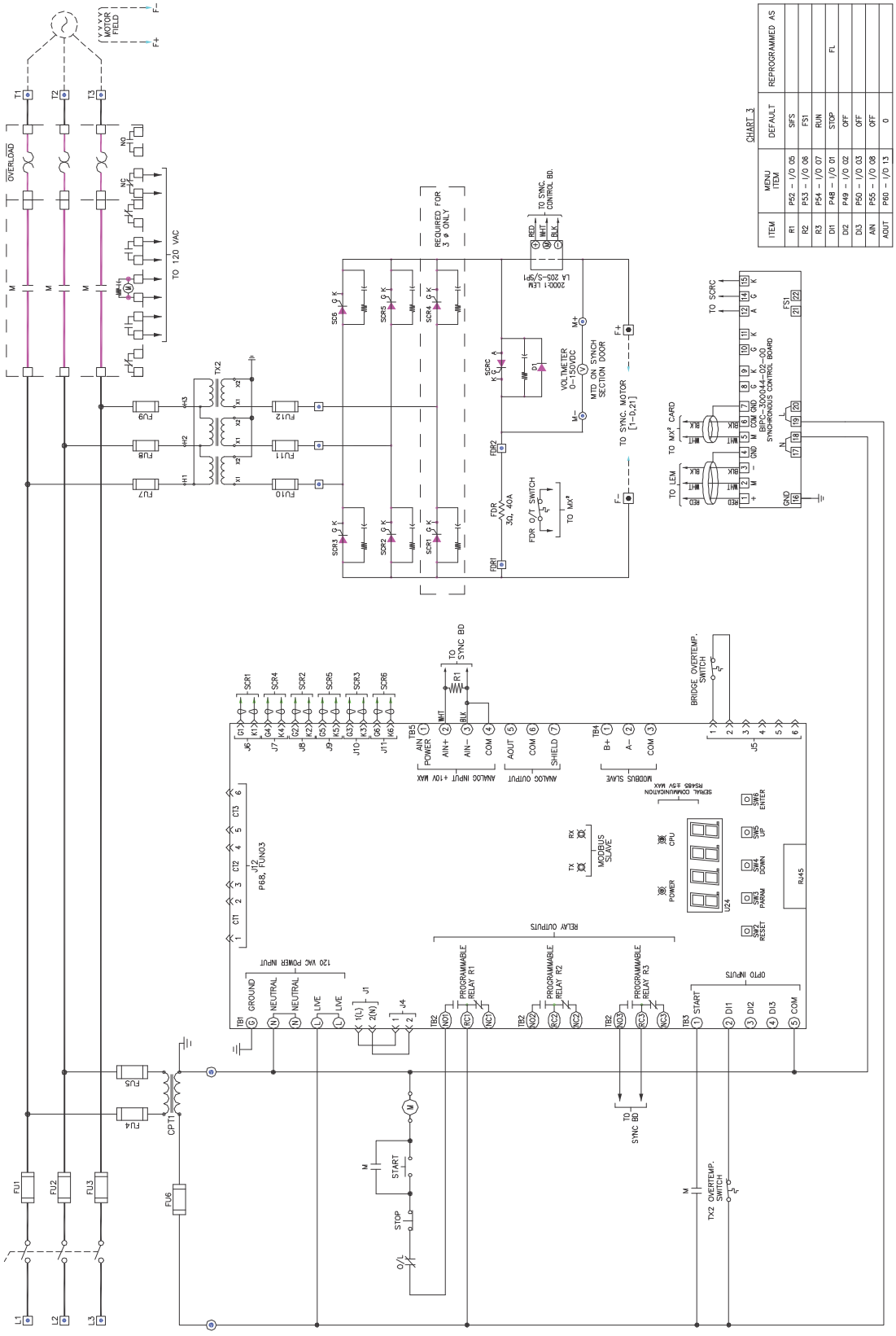
3.5.1 MX^2 ATL Synchronous Brushtype (Field Control) Solid State

Figure 2: Sample Power Schematic for RB2 Low HP



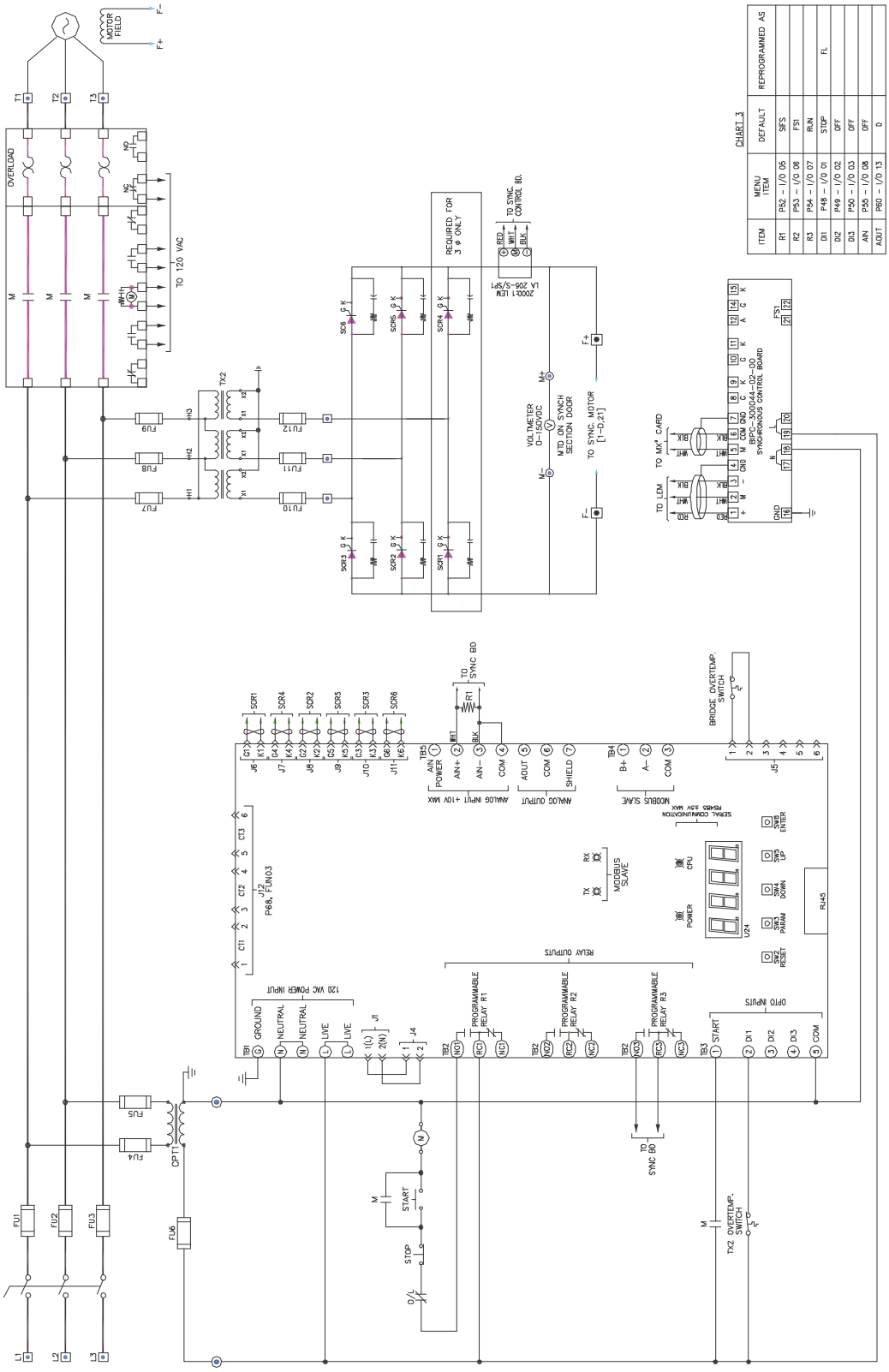
3.5.2 MX2 ATL Synchronous Brushtype with contactors

Figure 3: Sample MX2 Power Schematic ATL Synchronous Brushtype with contactors



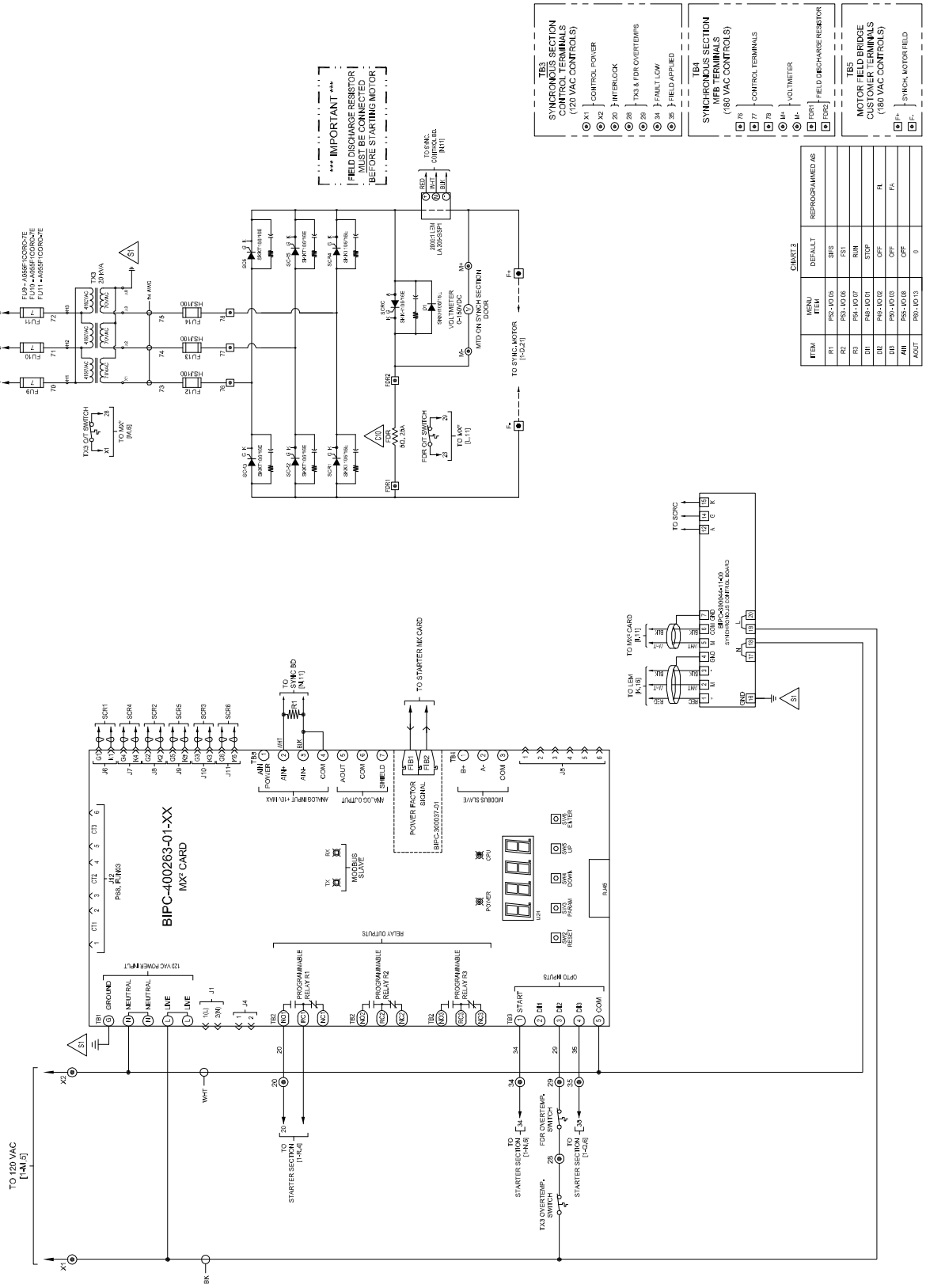
3.5.3 MX² ATL Synchronous Brushless

Figure 4: Sample MX² Power Schematic ATL Synchronous Brushless



3.5.4 Synch Controller with Power Factor Control

Figure 4: Sample Power Schematic Synch Controller with Power Factor Control



3.6 *Power Wiring Input Line Requirements*

The input line source must be an adequate source to start the motor, generally 2 times the rating of the motor FLA. (This may not apply in some cases, such as being connected to a generator).

3.6.1 Recommended Incoming Line Protection

A semi-conductor fuse is needed. The fuse shall be 150% of the DC Field Amps from motor. An HCJ fuse is recommended.

Input Line Requirements
The input line source needs to be an adequate source, generally 2 times the rating of the motor rotor FLA. (This may not apply in some cases such as being connected to a generator).

3.6.2 Recommended Wire Gauges

The wire gauge selection is based on the FLA of the motor. Refer to NEC table 310-16 or CEC Part 1, Table 2 or local code requirements for selecting the correct wire sizing. Ensure appropriate wire derating for temperature is applied. If more than three current carrying conductors are in one conduit, ensure NEC table 310.15(B)(2) or CEC Part 1 Table 5C is adhered to. In some areas, local codes may take precedence over the NEC. Refer to your local requirements.

3.6.3 Power Wire Connections

Attach the motor cables:
- Use the F+ and F- terminals. Use lugs/crimps or terminals (Lugs and Crimps are to be provided by the user).

Attach the power source cables:
- Use the L1, L2 and L3 terminals. Use lugs/crimps or terminals (Lugs and Crimps are to be provided by the user).

3.6.4 Compression Lugs

The following is a list of the recommended crimp-on wire connectors manufactured by Penn-Union Corp. for copper wire.

Table 6: Single Hole Compression Lugs

Wire Size	*Part #*	*Wire Size*	*Part #*	*Wire Size*	*Part #*	*Wire Size*	*Part #*
1/0	BLU-1/0S20	300 MCM	BLU-030S	600 MCM	BLU-060S1	1500 MCM	BLU-150S
2/0	BLU-2/0S4	350 MCM	BLU-035S	650 MCM	BLU-065S5	2000 MCM	BLU-200s
3/0	BLU-3/0S1	400 MCM	BLU-040S4	750 MCM	BLU-075S	—	—
4/0	BLU-4/0S1	450 MCM	BLU-045S1	800 MCM	BLU-080S	—	—
250 MCM	BLU-025S	500 MCM	BLU-050S2	1000 MCM	BLU-100S	—	—

Table 7: Two Hole Compression Lugs

Wire Size	*Part #*	*Wire Size*	*Part #*	*Wire Size*	*Part #*	*Wire Size*	*Part #*
1/0	BLU-1/0D20	300 MCM	BLU-030D	600 MCM	BLU-060D1	1500 MCM	BLU-150D
2/0	BLU-2/0D4	350 MCM	BLU-035D	650 MCM	BLU-065D5	2000 MCM	BLU-200D
3/0	BLU-3/0D1	400 MCM	BLU-040D4	750 MCM	BLU-075D	—	—
4/0	BLU-4/0D1	450 MCM	BLU-045D1	800 MCM	BLU-080D	—	—
250 MCM	BLU-025D	500 MCM	BLU-050D2	1000 MCM	BLU-100D	—	—

3.6.5 Torque Requirements for Power Wiring Terminations

Table 8: Slotted Screws and Hex Bolts

Wire size installed in conductor		Tightening torque, pound-inches (N-m)							
		Slotted head NO. 10 and larger				Hexagonal head-external drive socket wrench			
AWG or kcmil	(mm2)	Slot width-0.047 inch (1.2mm) or less and slot length ¼ inch (6.4mm) or less		Slot width-over 0.047 inch (1.2mm) or slot length – over ¼ inch (6.4mm) or less		Split- bolt connectors		Other connectors	
18 – 10	(0.82 – 5.3)	20	(2.3)	35	(4.0)	80	(9.0)	75	(8.5)
8	(8.4)	25	(2.8)	40	(4.5)	80	(9.0)	75	(8.5)
6 – 4	(13.3 – 21.2)	35	(4.0)	45	(5.1)	165	(18.6)	110	(12.4)
3	(26.7)	35	(4.0)	50	(5.6)	275	(31.1)	150	(16.9)
2	(33.6)	40	(4.5)	50	(5.6)	275	(31.1)	150	(16.9)
1	(42.4)	—	—	50	(5.6)	275	(31.1)	150	(16.9)
1/0 – 2/0	(53.5 – 64.4)	—	—	50	(5.6)	385	(43.5)	180	(20.3)
3/0 – 4/0	(85.0 – 107.2)	—	—	50	(5.6)	500	(56.5)	250	(28.2)
250 – 350	(127 – 177)	—	—	50	(5.6)	650	(73.4)	325	(36.7)
400	(203)	—	—	50	(5.6)	825	(93.2)	375	(36.7)
500	(253)	—	—	50	(5.6)	825	(93.2)	375	(42.4)
600 – 750	(304 – 380)	—	—	50	(5.6)	1000	(113.0)	375	(42.4)
800 – 1000	(406 – 508)	—	—	50	(5.6)	1100	(124.3)	500	(56.5)
1250 – 2000	(635 – 1010)	—	—	—	—	1100	(124.3)	600	(67.8)

NOTE: For a value of slot width or length not corresponding to those specified above, the largest torque value associated with the conductor size shall be marked. Slot width is the nominal design value. Slot length is measured at the bottom of the slot.

Table 9: Tightening Torque for Hex Screws

Socket Size Across Flats		Tightening Torque	
inches	(mm)	Pound-inches	(N-m)
1/8	(3.2)	45	(5.1)
5/32	(4.0)	100	(11.3)
3/16	(4.8)	120	(13.6)
7/32	(5.6)	150	(16.9)
1/4	(6.4)	200	(22.6)
5/16	(7.9)	275	(31.1)
3/8	(9.5)	275	(42.4)
1/2	(12.7)	500	(56.5)
9/16	(14.3)	600	(67.8)

NOTE: For screws with multiple tightening means, the largest torque value associated with the conductor size shall be marked. Slot length shall be measured at the bottom of the slot.

3.7 Control Card Layout

Figure 5: Control Card Layout

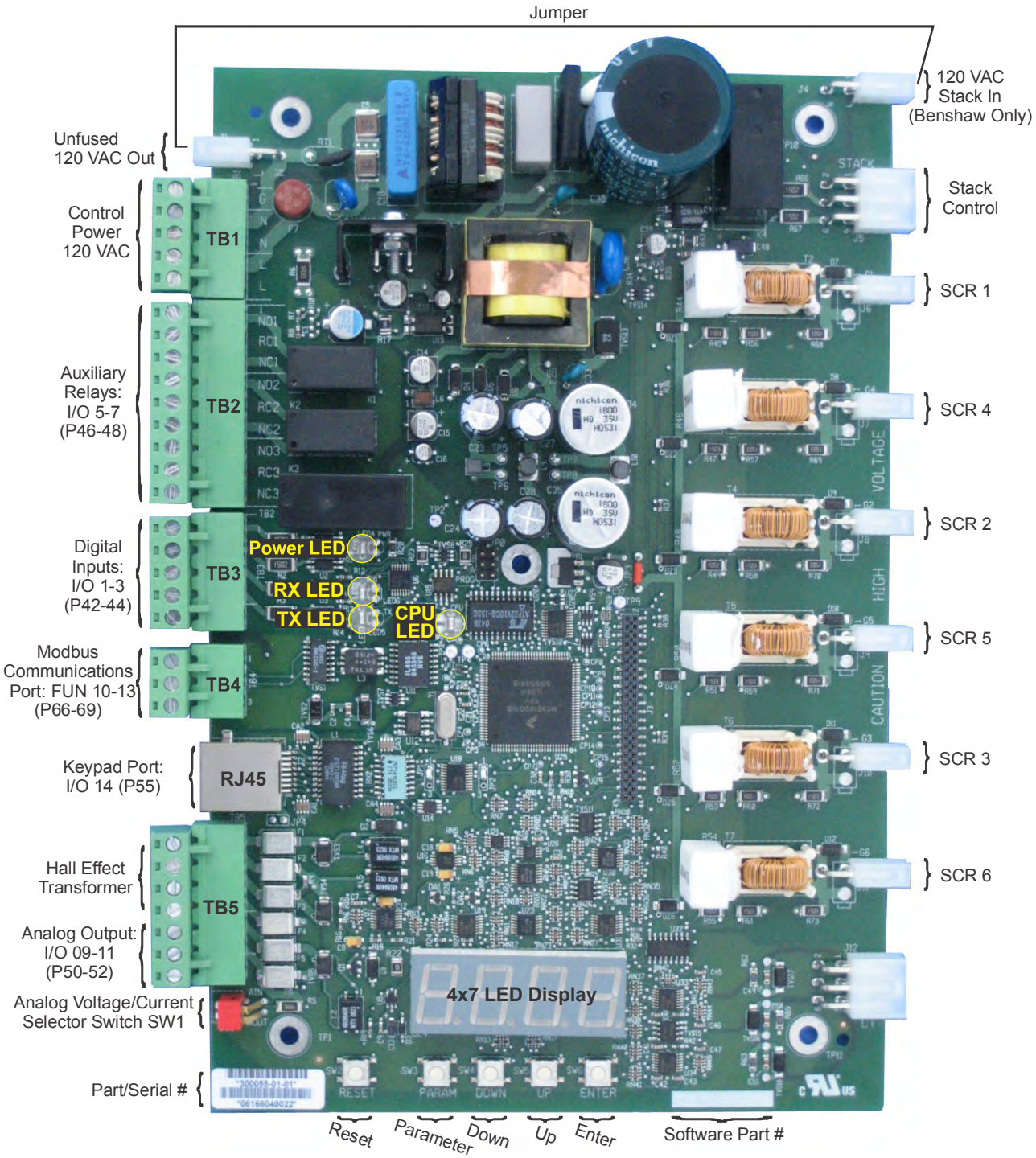
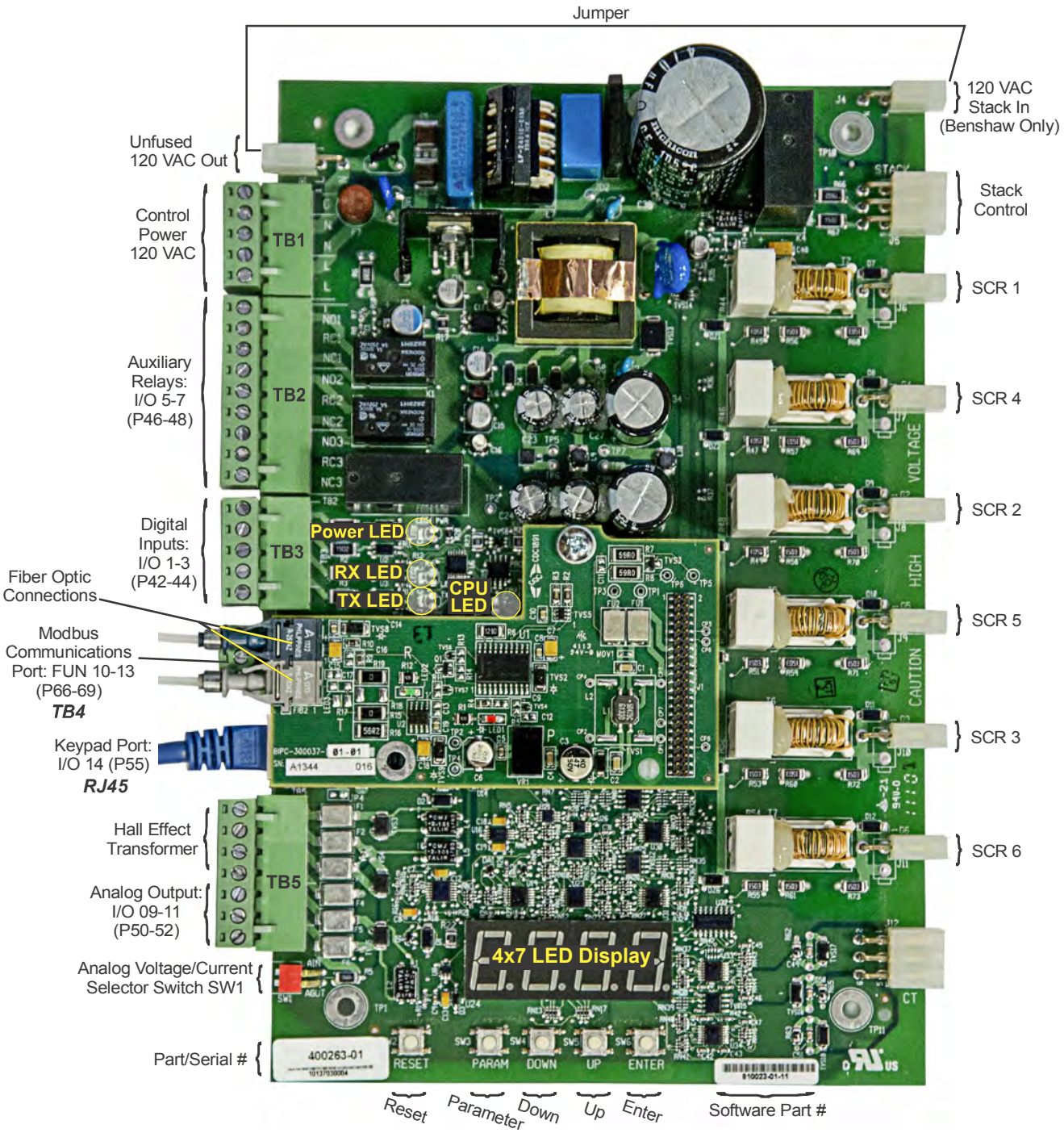


Figure 6: Control Card Layout (with Communication Card for Power Factor Control)



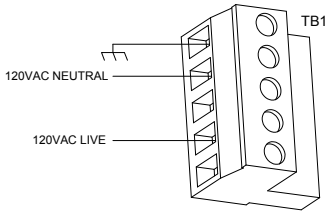
3.8 *Control Wiring*

3.8.1 Control Power

120VAC control power is supplied to TB1. The connections are as follows:

- 1 - Ground
- 2 - Neutral
- 3 - Neutral
- 4 - Line (120VAC)
- 5 - Line (120VAC)

Figure 7: Control Power Wiring Example

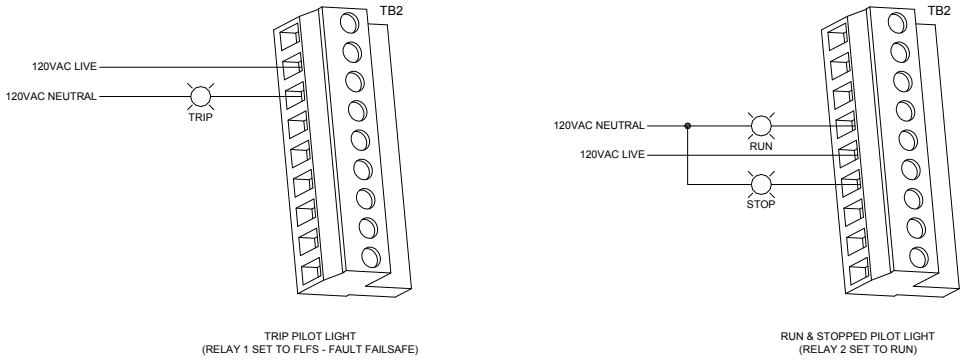


3.8.2 Output Relays

TB2 is for output relays R1, R2 and R3. These relays connect as follows:

- 1 - NO1: Relay 1 normally open
- 2 - RC1: Relay 1 common
- 3 - NC1: Relay 1 normally closed
- 4 - NO2: Relay 2 normally open
- 5 - RC2: Relay 2 common
- 6 - NC2: Relay 2 normally closed
- 7 - NO3: Relay 3 normally open
- 8 - RC3: Relay 3 common
- 9 - NC3: Relay 3 normally closed

Figure 8: Relay Wiring Examples



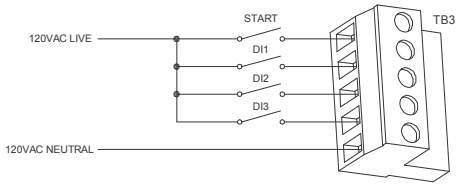
See Also: Relay Output Configuration (I/O 05–07 / P44-46) on Page 76.

3.8.3 Digital Input

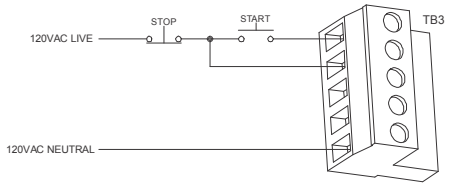
TB3 is for digital inputs Start, DI1, DI2 and DI3. These digital inputs use 120VAC. These digital inputs connect as follows:

- 1 - Start: Start Input
- 2 - DI1: Digital Input 1
- 3 - DI2: Digital Input 2
- 4 - DI3: Digital Input 3
- 5 - Com: 120VAC neutral

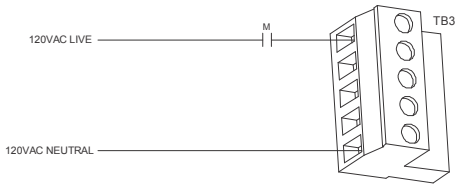
Figure 9: Digital Input Wiring Examples



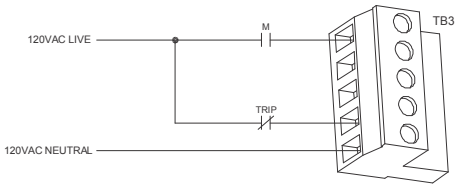
DIGITAL INPUT WIRING



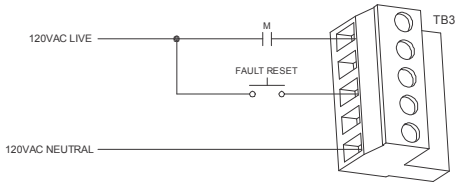
3-WIRE START / STOP BUTTONS
(DI1 SET TO STOP)



2-WIRE CONTACT CONTROL



EXTERNAL TRIP INPUT
(DI3 SET TO FL - FAULT LOW)



FAULT RESET BUTTON
(DI2 SET TO Fr - FAULT RESET)

See Also: Digital Input Configuration (I/O 01 – 03 / P40-42) on Page 75.

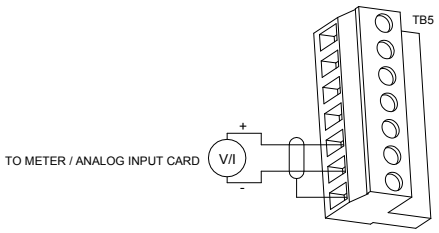
3.8.4 Analog Output

The analog output can be configured for Voltage or Current loop. The output is shipped in the Voltage loop configuration unless specified in a custom configuration. Below, TB5 is SW1-2. When the switch is in the off position, the output is current. When on, it is a Voltage loop output. The control is shipped with the Switch on.

NOTE: The analog output is a low voltage output, maximum of 15VDC. The output will be damaged if control power (115VAC) or line power is applied to the analog output.

The terminals are as follows:

Figure 10: Analog Output Wiring Example



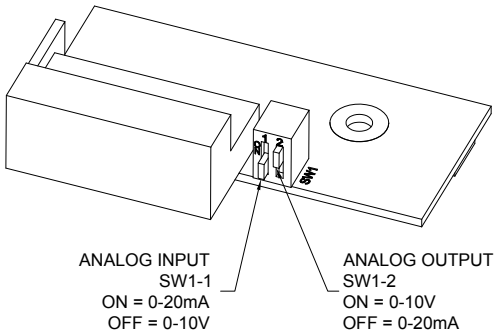
- 5) analog output
- 6) common
- 7) shield

See Also: Analog Output Configurations (I/O 9 - 11 / P54 - 56) on Pages 77 and 78.

3.8.5 SW1 DIP Switch

The SW1 DIP switch on the card allows selecting the analog input and output values of 0–10V or 0–20mA. The picture below represents how to adjust the switch to select the desired signal.

Figure 11: SW1 DIP Switch Settings



3.9 *Remote LCD Keypad/Display*

The display has a NEMA 3R / IP65 service rating when properly mounted to an enclosure door with the correct gasket. The display is available in 2 versions, a small display as P/N KPMX3SLCD, and large display as P/N KPMX3LLCD.

3.9.1 Remote Display

The LCD keypad is mounted remotely from the MX^2 Control via a straight through display cable, which connects between the MX^2 and remote display's RJ45 terminals.

3.9.2 Display Cutout

Figure 12: Small Display Keypad Mounting Dimensions

Part # KPMX3SLCD

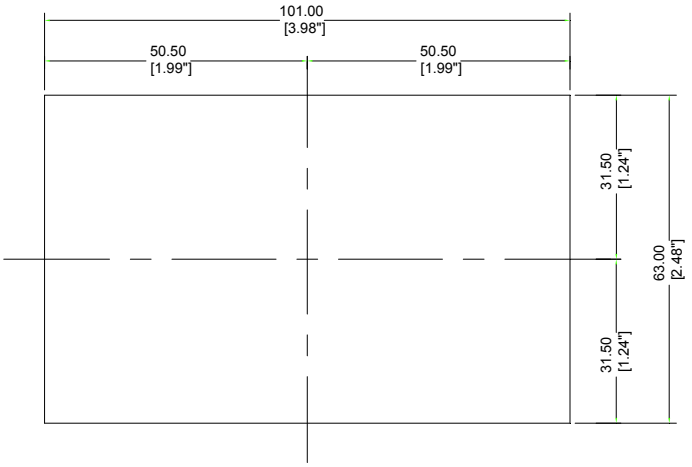
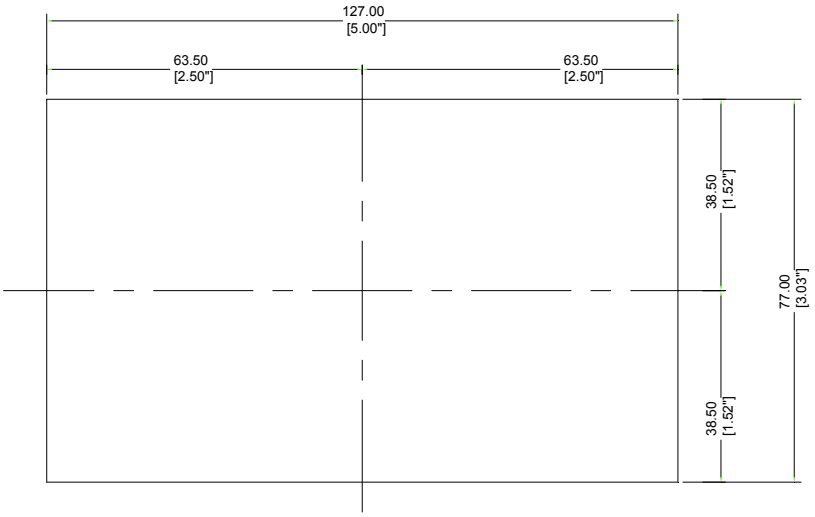


Figure 13: Large Display Keypad Mounting Dimensions

Part #: KPMX3LLCD

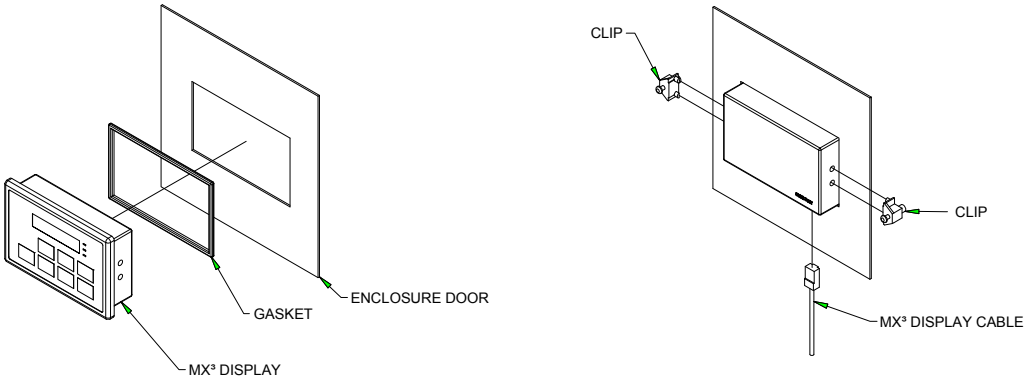


3.9.3 Installing Display

The remote display is installed as follows:

- Install the gasket onto the display.
- Insert the display through the door cutout.
- Insert the mounting clips into the holes in each side of the display.
- Tighten the mounting clips until they hold the display securely in place. (Torque requirements are 0.7 NM or 6.195 in lbs.)
- Plug the cable into the display connector on the MX^2 card. See Figures 5 and 6 on Pages 29 and 30 for the connector location.
- Route the cable through the enclosure to the display. Observe the wiring considerations as listed in Section 3.4 on Page 22.
- Plug the other end of the cable into the LCD display.

Figure 14: Mounting Remote Keypads




BENSHAW
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4 - Keypad Operation

4.1 *Introduction*

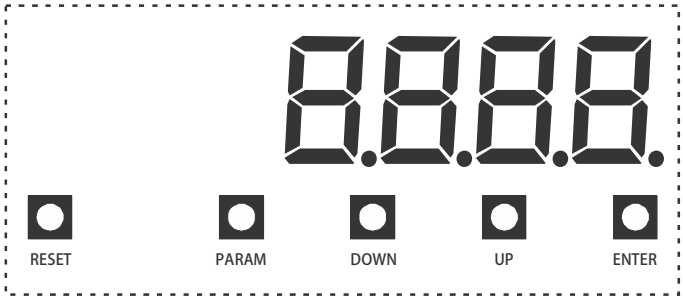
The MX^2 SEP provides a comprehensive set of parameters. While the controller can meet the requirements of many applications right out of the box, customization of parameter values to better suit your particular application is easily accomplished with the standard on-board, 4-digit, 7-segment LED display/keypad.

The MX^2 SEP has an optional 2x16 character, back-lit LCD display/keypad that may be mounted remotely from the MX^2 SEP control card. The remote LCD keypad has the same keys as the standard display with several additional keys including start and stop keys for operation of the controller from the keypad. When the remote LCD keypad is connected, the local display is disabled.

4.2 *Standard Keypad and Display*

The LED display provides information on controller operation and programming. The 4-digit, 7-segment display shows controller meter outputs and programming data. Special symbols provide further information about the controller operation (see the following section).

Figure 15: Standard Keypad and Display



4.3 *Viewing Parameter Values for the Standard Keypad*

Parameter view mode can be entered by:

1. At the default meter display, press the [PARAM] key to enter parameter mode. “P1” is displayed to indicate Parameter 1.
2. Use the [UP] and [DOWN] keys to scroll through the available parameters.
3. Pressing the [UP] key from “P1” advances to parameter “P2”.
4. Pressing the [DOWN] key from “P1” wraps around to the highest parameter.
5. The value of the parameter can be viewed by pressing the [ENTER] key.
6. To view another parameter without changing/saving the parameter, press the [PARAM] key to return to the parameter number display.

To return to the default meter display, either:

1. Press the [PARAM] key while in the parameter number display mode, *or*
2. Wait 60 seconds and the display returns to the default meter display.

4.4 Changing Parameter Values

Parameter change mode can be entered by:

1. At the default meter display, press the [PARAM] key to enter parameter mode.
2. Use the [UP] and [DOWN] keys to scroll through the available parameters.
3. The value of the parameter can be viewed by pressing the [ENTER] key.
4. When viewing the parameter value, the parameter can be changed by using the [UP] and [DOWN] keys.
5. To store the new value, press the [ENTER] key. When the [ENTER] key is pressed the value is saved and the display goes back to parameter # "P_".

To exit parameter change mode without saving the new parameter value, either:

1. Press the [PARAM] key to return to the parameter number display, or
2. Wait 60 seconds and the display returns to the default meter display.

4.5 *Messages Displayed*

In addition to being able to view and change parameters, various special messages may be displayed during different conditions. Here is a summary of the possible special messages.

The following sections provide more detail for some of the conditions that cause special messages to be displayed.

LED Display

noL	No Line Voltage
rdY	Ready
run	Controller active
SYnc	Motor running and synchronized
FF	Motor running, synchronized, with field forcing being applied
PO	Motor pullout / pole slip detected.
inch	Inching field control mode active
dYnb	Dynamic braking active.
L CP	Low Control Power – A start is not allowed because the control power is low.
L Ot	Power Stack Over Temperature Lockout
LOC	Lockout State
AbC	Phase order meter showing ABC phasing
CbA	Phase order meter showing CBA phasing
SPH	Phase order meter showing single phase
P XX	XX = parameter code
A XX	XX = alarm code. If the condition persists, a fault will occur
F XX	XX = fault code
b AL	BIST mode, waiting for line voltage to be applied
b FL	BIST mode, field supply active
b -	BIST mode, BIST complete
dFLt	Default – Flashes when parameter defaults are loaded.
FLSH	In Reflash mode, waiting for download
Prog	In Reflash mode, programming
rEAd	In Reflash mode, verifying
donE	In Reflash mode, complete

LCD Display

Stopped	Controller stopped
Fault	Controller tripped on a Fault
Lockout	Controller is locked out due to a unusual condition being present
Wait	Controller is monitoring start and waiting for command and/or timer to expire before applying field current.
Syncing	Controller is attempting to apply field and synchronize motor
Synced	Motor running synchronized
Sync FF	Motor running synchronized with field forcing active
Pullout	Motor pullout / pole slip detected.
B Ctl	Brushless motor control active
Cntr	Current Control mode active
Inching	Inching field control mode active
Braking	Dynamic braking active
Shtdwn	Controller shutting down
BIST	Controller in Built In Self Test mode.

4.5.1 Power Up

The software version is displayed as a series of single digits once power has been applied to the MXSEP. If the parameters were being reset on power up, "dFLt" is flashed on the display for three seconds, and then the software version is displayed.

4.5.2 Stopped

When the controller is not in the run mode, the display shows the status condition of the controller, such as "rdy" (ready) or "noL" (No Line).

4.5.3 Running

When running, the display shows the selected meter function. The following meters can be selected using the Meter display parameter (P17 / FUN 01–02).

Ave Current	Slip Percent	Run Days
Ave Volts	Phase Order	Run Hours
L1-L2 Volts (Input)	Line Freq	Starts
L2-L3 Volts (Input)	Analog Input	
L3-L1 Volts (Input)	Analog Out	

4.5.4 Alarm Condition

When an alarm condition exists, the display alternates between displaying the selected meter and the alarm code. The alarm code is displayed as “A XX”, where XX is the alarm code.

- When a no line alarm condition exists, “noL” is displayed.

When the controller is stopped, the selected meter is not displayed.

4.5.5 Lockout Condition

When a lockout condition exists, the display shows the lockout code. The lockout code is displayed as “L XX”: where XX is the lockout code. Following are the defined lockout conditions and their codes:

- When a power stack thermal overload lockout condition exists, “L Ot” is displayed.
- When a low control power lockout condition exists, “L CP” is displayed.

When there are multiple lockout codes, each is displayed at 2 second intervals.

4.5.6 Faulted Condition

When a fault condition exists, the display shows the fault code. The exceptions to this are as follows:

- When the fault is Instantaneous Over Current, “ioc” is displayed.

4.5.7 Quick Meters

Although any meter may be viewed by changing the Meter parameter (P17 / FUN 01–02), there are 3 “Quick Meters” that are always available with a single key press. When the controller is in the normal display mode, the display may be toggled between the information currently displayed, and the following quick meters. Quick meters are only used with the LED keypad.

Status Meter
Toggle between the programmed meter display and the controller operational status display (rdY, run, dcL, etc) by pressing the [ENTER] key.

Phase Order Meter
Toggle between the programmed meter display and the phase order by pressing the [UP] key. The phase order is displayed as “AbC” or “CbA”.

DC Current
Toggle between the programmed meter display and the DC Current by pressing the [DOWN] key.

4.6 Jump Code

At the beginning of each parameter group, there is a Jump Code parameter. By changing the value of this parameter and pressing [ENTER], you can jump directly to any parameter within that group.

4.7 Restoring Factory Parameter Settings

To restore ALL parameters to the factory default settings, press and hold the [PARAM] and [ENTER] pushbutton switch on power up. The display blinks “dFLt”. Parameters unique to the controller applications need to be set again to appropriate values before motor operation.

P23 / FUN06 - Rated RMS Voltage (set to specified equipment rating) I/O 01 / P40 - Digital Input #1
P41 / I/O 02 - Digital Input #2
P42 / I/O 03 - Digital Input #3
P44 / I/O 05- Relay #1
P45 / I/O 06 - Relay #2
P46 / I/O 07 - Relay #3

NOTE: Consult the wiring schematic for digital inputs and relay output configuration.

4.8 Resetting a Fault

To reset from a fault condition, press [RESET].

4.9 Remote LCD Keypad and Display

The MX^2 Sync Controller can be equipped with an optional 2x16 character, back-lit LCD display/keypad that is mounted remotely from the control card. The remote keypad is NEMA 3R / IP65 when mounted directly on the door of an enclosure with the correct gasket.

Like the standard keypad, the remote LCD keypad has the same basic functions with enhancements that allow using plain text instead of codes and a menu structure instead of a straight line of parameters.

Additional keys have been added, such as [MENU], [STOP], and a [LEFT] arrow for moving the cursor around in the LCD display. Status indicators provide additional information for controller operation.

NOTE: The Start push button does not operate with a synchronous controller.

Figure 16: Remote LCD Keypad

4.10 Description of the LEDs on the Keypad

The keypad provides three LED indicators in addition to the 2x16 character display. The LEDs provide controller status information.

Table 10: Remote Keypad LED Functions

LED	State	Indication
STOP	On	Stopped
	Flashing	Faulted
RUN	On	Running and up-to-speed
	Flashing	Running and not up-to-speed (ramping, decelerating, braking etc).
ALARM	Flashing	Alarm condition exists. If condition persists, a fault occurs.

NOTE: By default, the [STOP] key is always active, regardless of selected control source (Local Source and Remote Source parameters). It may be disabled though using the Keypad Stop Disable (I/O 14) parameter. For more information refer to the Keypad Stop Disable (I/O 14) parameter on Page 80.

4.11 Description of the Keys on the Remote LCD Keypad

The [UP] arrow, [DOWN] arrow, [ENTER] and [MENU] keys on the LCD keypad perform the same functions as the [UP], [DOWN], [ENTER] and [PARAM] keys on the standard keypad. Three keys have been added, with one key serving a dual function:

Table 11: LCD Keypad Key Functions

Key	Function
start	• The [START] key triggers has no assigned function with a synchronous controller.
	• Increases the value of a numeric parameter. • Advances to the next value of an enumerated parameter. • Scrolls forward through a list of parameters within a group (when the last parameter is displayed, it scrolls to the beginning of the list). • When a list of faults is displayed, it moves from one fault to the next. • When the controller is in the Operate Mode, pressing [UP] allows you to change which group of meter values is monitored.
	• Decreases the value of a numeric parameter. • Reverts to the previous value of an enumerated parameter. • Scrolls backward through a list of parameters within a group (when the first parameter is displayed, it scrolls to the end of the list). • When a list of faults is displayed, it moves from one fault to the previous fault. • When the controller is in the Operate Mode, pressing [DOWN] allows you to change which group of meter values is monitored.
	• When editing a numeric parameter, the [LEFT] arrow key moves the cursor one digit to the left. If cursor is already at the most significant digit, it returns to the least significant digit on the right. • When in Menu mode, the [LEFT] arrow allows groups to be scrolled through in the opposite direction of the [MENU] Key.
enter	• Stores the change of a value. • When in Fault History, [ENTER] key scrolls through information logged when a fault occurred. • When an alarm condition exists, [ENTER] scrolls through all active alarms.
menu	• [MENU] scrolls between the operate screen and the available parameter groups. • When viewing a parameter, pressing [MENU] jumps to the top of the menu. • When a parameter is being edited and [MENU] is pressed, the change is aborted and the parameter's old value is displayed.
stop reset	• The [STOP/RESET] key halts the operation of the controller (Stop Key) and causes a fault 68 to occur. • If a fault has occurred, the [STOP/RESET] key is used to clear the fault (Reset Key).

4.12 *Alphanumeric Display*

The remote LCD keypad and display uses a 32-character alphanumeric LCD display. All controller functions can be accessed by the keypad. The keypad allows easy access to controller programming with parameter descriptions on the LCD display.

4.12.1 Power Up Screen

On power up, the software part numbers are displayed for a few seconds. Pressing any key immediately changes the display to the operate screen.

```
Software PN
810027-01-08
```

4.12.2 Operate Screen

The Operate Screen is the Main Screen. The Operate Screen is used to indicate the status of the controller: if it is running, what state it is in, and display the values of Meter 1 and Meter 2, which are selectable.

The Operate Screen is divided into five sections:

- Sections A and B display status information
- Sections C and D display the meters selected by the Meter 1 and 2 parameters, see FUN 01–02
- Section S displays the source for the start command

Figure 17: Operate Screen

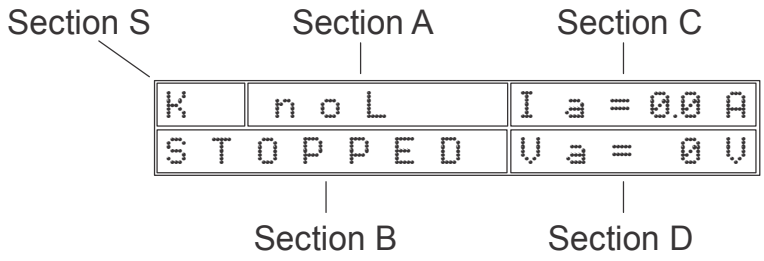


Table 12: Operate Screen Section A

Display	Description
noL	L1, L2, L3 not present
Ready	Controller ready to run
Alarm	A fault condition is present. If it continues, a fault occurs
Run	Controller is running

Table 13: Operate Screen Section B

Display	Description
Stopped	Controller is stopped and no Faults
Fault	Controller tripped on a Fault
Lockout	Controller is Locked Out due to an unusual condition being present

Table 13: Operate Screen Section B

Display	Description
Syncing	Controller is attempting to apply field and synchronize motor
Synced	Motor running synchronized
Sync FF	Motor running synchronized with field forcing active
Pullout	Motor pullout / pole slip detected
B Ctl	Brushless motor control active
Cntr	Current Control mode active
Inching	Inching field control mode active
Braking	Dynamic braking active
Shtdown	Controller shutting down
BIST	Controller in Built In Self Test mode

Table 14: Operate Screen Section S

Display	Description
T	Terminal Block Wiring Control
S	Serial Communication Connection Control

4.12.3 Parameter Group Screens

From the Operate Screen, the parameter groups are accessed by pressing either the Menu or the [LEFT] arrow keys. The parameter group screens display the parameter groups: **QST** (Quick Start), **CFN** (Control Functions), **PFN** (Protection Functions), **I/O** (Input/Output Functions), **FUN** (Function) and **FL1** (Faults).

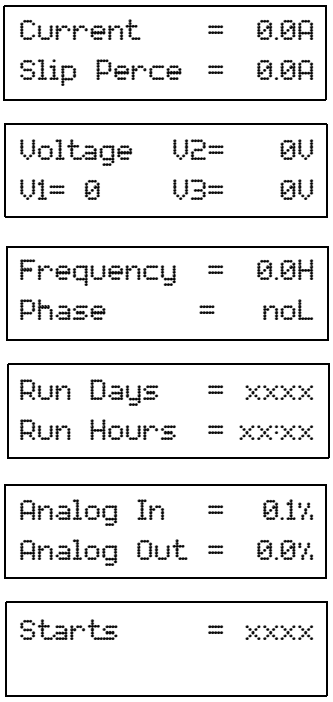
```
MMM: PPPPPPPPPP
MI VVVVVVVVVV
```

- MMM: = Parameter Group
- MI: = Menu Index
- PPP: = Parameter Name
- VVV: = Parameter Value and Units

Refer to Section 5 for a listing of the parameters and ranges.

4.12.4 Meter Pages

Although any meter may be viewed by changing the two meter parameters (FUN 01, FUN 02), there are 6 “Meter Pages” that are easily accessed to view all of the meter information. These meter pages are scrolled through by pressing the [UP] or [DOWN] arrows from the operate screen.



NOTE:

Run Hours	00:00 - 23:59
Run Days	0 – 2730 days or 7.5 years
Starts	0 – 65535

4.12.5 Fault Log Screen

Information regarding each fault is available through the remote MX^2 SEP LCD display.

```
FL#: Fault ##
NNNNNNNNNNNN
```

- FL#: = Fault Log Number. FL1 is the most recent fault and FL9 is the oldest fault.
- Fault ## = Fault Code
- NNN... = Fault Name, or the condition when the fault occurred.

Press [MENU] until you can view the FL1 parameter.

Pressing the [UP] and [DOWN] keys navigates through older and newer faults in the log.

Once the fault is displayed on the screen, begin pressing the [ENTER] key to cycle through the steps shown below, which detail the controller conditions when the fault occurred.

Enter Step	
1	Fault Number and Description.
2	Status when the fault occurred, Run, Stopped, etc.
3	The current at the time of the fault.
4	L1-2 voltage at the time of the fault.
5	L2-3 voltage at the time of the fault.
6	L3-1 voltage at the time of the fault.
7	Frequency at the time of the fault.
8	Run time since last run time reset.

4.12.6 Fault Screen

When a Fault occurs, the Main Screen is replaced with a Fault Screen. The screen shows the fault number and the name of the fault. The Main Screen is not shown until the fault is reset.

When a fault occurs, the STOP LED flashes.

```
Fault ##
Fault Name
```

NOTE: For a list of the Faults, refer to Appendix B - Fault Codes on Page 113.

4.12.7 Lockout Screens

When a lockout is present, one of the following screens will be displayed. The Main Screen is not shown until the lockout is cleared.

The stack over temperature lockout will be displayed if a stack over temperature is detected.

```
Stack Overload
Lockout
```

The control power lockout will be displayed if control power is not within specifications.

```
Control Power
Lockout
```

4.12.8 Alarm Screen

When an alarm is present, the word “Alarm” is displayed on the operate screen (and the Alarm LED indicators on the Control Board are illuminated). Pressing the [ENTER] key displays more information about the alarm.

```
Alarm ##
Alarm Name
```

4.13 *Procedure for Setting Data*

Select a parameter that is to be changed. To change the Current Setpoint from 10 Amps to 30 Amps:

From the main screen:

```
T Ready Ia =  0.0A
Stopped Va = 480V
```

Press [MENU] key, the display shows QST (Quick Start) screen.

```
QST: Jump Code
00          1
```

Press [UP] key once to access Motor FLA (QST 01).

```
QST: Cur Setpoint
01       10 Amp
```

Press [ENTER] key once, the cursor starts to flash in the “ones” place.

```
QST: Cur Setpoint
01       10 Amp
```

Press [LEFT] key once, the cursor flashes in the “tens” place.

```
QST: Cur Setpoint
01       10 Amp
```

Press [UP] arrow to increase the value, for a value of 30, press twice.

```
QST: Cur Setpoint
01       30 Amp
```

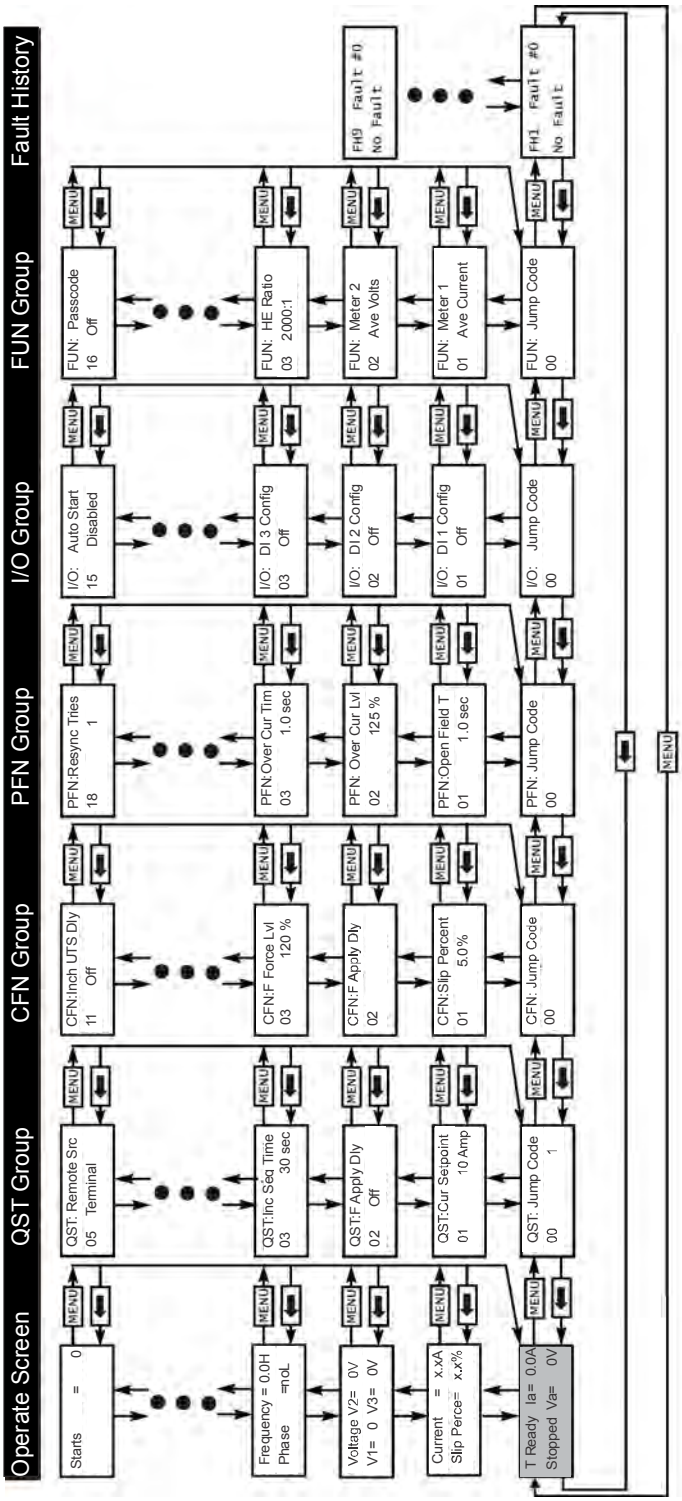
Press [ENTER] to store the value.

```
QST: Cur Setpoint
01       30 Amp
```

Press [UP] arrow to change another parameter in QST.

Press [MENU] to change another parameter in another group.

Press [LEFT] arrow to go back to the main screen.



In any of the parameter groups, the user can jump to a specific parameter code by following these steps:

- Select a parameter group that requires a change.
- At the beginning of each program group the menu will read [Jump Code]. Press the [ENTER] key.
- Enter the code number of the parameter needed to be changed then press [ENTER].
- There is no jump code for [Operate Screen].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5 - Parameter Groups

5.1 *Introduction*

The MX^2 SEP incorporates a number of parameters that allow you to configure the controller to meet the special requirements of your particular application. The parameters are organized two ways, depending on the display being used:

- When the remote LCD display is used, the parameters are divided into groups of related functionality, and within the groups the parameters are identified by a short, descriptive name. The parameters are subdivided into six groups. The groups are **QST** (Quick Start), **CFN** (Control Functions), **PFN** (Protection Functions), **I/O** (Input/Output Functions), **FUN** (Function) and **FL1** (Faults).

- When the standard, on-board LED display is used, the parameters are in a single group and numbered P1, P2, P3… etc.

LCD parameters are divided into groups of related functionality, and within the groups the parameters are identified by a short, descriptive name. They are numbered by the group name, followed by an index within the group.

The Quick Start group provides a collection of parameters most commonly changed when commissioning a controller. Many of the parameters in the Quick Start group are duplicates of parameters in other groups.

This section lists all of the parameters and possible values, and the tables provide a convenient place to record the parameter settings for your system.

5.2 *LED / LCD Parameter Cross-Reference*

Table 15: LED / LCD Cross-Reference

Parameter Number	Group	Control Mode	Parameter Name	Page #	Parameter Number	Group	Control Mode	Parameter Name	Page #
P1	QST 01	B, BL, CF	Current Setpoint	60	P40	I/O 01	B, BL, CF	DI 1 Function	75
P3	QST 02	B, BL	Field Application Delay Time	60	P41	I/O 02	B, BL, CF	DI 2 Function	75
P6	QST 03	B	Incomplete Sequence Time	61	P42	I/O 03	B, BL, CF	DI 3 Function	75
P36	QST 04	B, BL, CF	Local Control Source	61	P43	I/O 04	B, BL, CF	DI Trip Time	76
P37	QST 05	B, BL, CF	Remote Control Source	61	P44	I/O 05	B, BL, CF	Relay 1 Function	76
P2	CFN 01	B	Slip Percentage	63	P45	I/O 06	B, BL, CF	Relay 2 Function	76
P3	CFN 02	B, BL	Field Application Delay Time	63	P46	I/O 07	B, BL, CF	Relay 3 Function	76
P4	CFN 03	B	Field Force Level	64	P47	I/O 08	B, BL	FCA Delay	77
P5	CFN 04	B	Field Force Time	64	P54	I/O 09	B, BL, CF	Analog Output Function	77
P10	CFN 05	B	Stop Mode	64	P55	I/O 10	B, BL, CF	Analog Output Span	78
P11	CFN 06	B	Dynamic Brake Level	65	P56	I/O 11	B, BL, CF	Analog Output Offset	78
P12	CFN 07	B	Dynamic Brake Time	65	P49	I/O 12	B, BL, CF	Inline Configuration	79
P13	CFN 08	B	Dynamic Brake Delay	65	P48	I/O 13	B, BL	Field Contactor(s) Feedback Time	79
P14	CFN 09	B	Inch Field Level	66	P58	I/O 14	B, BL, CF	Keypad Stop Enabled	80
P15	CFN 10	B	Inch Field Application Time	66	P57	I/O 15	B, BL, CF	Auto Start	80
P16	CFN 11	B	Inch UTS Relay Delay Time	66	P17	FUN 01	B, BL, CF	LCD Meter 1	81
P18	PFN 01	B	Open Field Trip Time	67	N/A	FUN 02	B, BL, CF	LCD Meter 2	81
P19	PFN 02	B, BL, CF	Over Current Level	68	P35	FUN 03	B, BL, CF	HE Sensor Ratio (x:1)	82
P20	PFN 03	B, BL, CF	Over Current Time	68	P36	FUN 04	B, BL, CF	HE Sensor Turns	82
P21	PFN 04	B, BL, CF	Under Current Level	69	P34	FUN 05	B, BL, CF	Input Phase Sensitivity	83
P22	PFN 05	B, BL, CF	Under Current Time	69	P23	FUN 06	B, BL, CF	Rated RMS Voltage	83
P24	PFN 06	B, BL, CF	Over Voltage Level	70	P60	FUN 07	B, BL, CF	Rated Power Factor	84
P25	PFN 07	B, BL, CF	Under Voltage Level	70	P61	FUN 08	B, BL, CF	Min PF Control Current	84
P26	PFN 08	B, BL, CF	Over/Under Voltage Trip Time	70	P39	FUN 09	B, BL, CF	Control Type	84
P27	PFN 09	B, BL, CF	Phase Loss Trip Time	71	P52	FUN 10	B, BL, CF	COM Address (Drop #)	85
P28	PFN 10	B, BL, CF	High Line Frequency Trip	71	P51	FUN 11	B, BL, CF	COM Baud Rate	85
P29	PFN 11	B, BL, CF	Low Line Frequency Trip	71	P50	FUN 12	B, BL, CF	COM Timeout	85
P30	PFN 12	B, BL, CF	Frequency Trip Time	72	P53	FUN 13	B, BL, CF	COM Parity	86
P31	PFN 13	B, BL, CF	Auto Fault Reset Time	72	P62	FUN 14	B, BL, CF	Software Number	86
P32	PFN 14	B, BL, CF	Auto Fault Reset Maximum Count	72	P59	FUN 15	B, BL, CF	Miscellaneous Commands	87
P33	PFN 15	B	Controlled Fault Shutdown	73	P63	FUN 16	B, BL, CF	Passcode	88
P7	PFN 16	B	Pullout Mode	73	P64	FL 1-9	B, BL, CF	Fault Log	—
P8	PFN 17	B	Resynchronization Time	74	—	—	—	—	—
P9	PFN 18	B	Resynchronization Attempts	74	—	—	—	—	—

NOTE: The Control Mode column shows which parameters apply to the three different types of control.

B = Brush type control (Field control)
BL = Brushless type control
CF = Current Follower control

See "Control Type" (FUN 09 / P39) on Page 84.

5.3 *Parameter Tables*

LCD Parameters are subdivided into six groups: QST (Quick Start), CFN (Control Functions), PFN (Protection Functions), I/O (Input/Output Functions), FUN (Function), and FL1 (Fault Log).

The Quick Start Group provides a collection of the parameters that are most commonly changed when commissioning a controller. Many of the parameters in the Quick Start group are duplicates of the same parameters in other groups.

The following tables show the menu structure for the LCD display, the corresponding LED code, as well as the text displayed and pertinent information for each parameter.

If the LCD is not connected, parameters will only be shown on the MX^2 Control Card LED display.

5.3.1 Quick Start Group

Table 16: Quick Start Parameter Group

Group	LED	Display	Parameter	Setting Range	Units	Default	Adjust During Run?	Page	Setting
QST 00	—	Jump Code	Jump to Parameter	1 – 5	—	1	—	60	
QST 01	P1	Current Setpoint	Current Setpoint	1 – 1000	Amps	10	Y	60	
QST 02	P3	Field Application Time	Field Application Time	OFF, 0.1 – 20.0	sec	OFF	Y	60	
QST 03	P6	Incomplete Sequence Time	Incomplete Sequence Time	1 – 200	sec	30	Y	61	
QST 04	P37	Local Control Source	Local Control Source	tEr:Terminal SEr:Serial	—	Terminal	Y	61	
QST 05	P38	Remote Control Source	Remote Control Source	tEr:Terminal SEr:Serial	—	Terminal	N	61	

5.3.2 Control Function Group

Table 17: Control Function Group

Group	LED	Display	Parameter	Setting Range	Units	Default	Adjust During Run?	Page	Setting
CFN 00	—	Jump Code	Jump to Parameter	1 – 11	—	1	—	63	
CFN 01	P2	Slip Percent	Slip Percentage	0.5 – 10.0	%	5.0	Y	63	
CFN 02	P3	F Apply Dly	Field Application Delay Time	OFF, 0.1 – 20.0	sec	OFF	Y	63	
CFN 03	P4	F Force Lvl	Field Forcing Level	50 – 125	%	120	Y	64	
CFN 04	P5	F Force Time	Field Forcing Time	OFF, 0.1 – 90.0	sec	0.1	Y	64	
CFN 05	P10	Stop Mode	Stop Mode	CoS:Coast dCb:Dynamic Brake	—	Coast	N	64	
CFN 06	P11	Brake Level	Dynamic Braking Level	10 – 125	%	25	Y	65	
CFN 07	P12	Brake Time	Dynamic Braking Time	1 – 180	sec	5	Y	65	
CFN 08	P13	Brake Delay	Dynamic Brake Delay	0.1 – 5.0	sec	0.5	Y	65	
CFN 09	P14	Inch Field	Inch Field Level	75 – 125	%	100	Y	66	
CFN 10	P15	Inch F App T	Inch Field Application Time	0.1 – 90.0	sec	2.0	Y	66	
CFN 11	P16	Inch UTS Dly	Inch UTS Relay Delay Time	OFF, 0.1 – 90.0	sec	OFF	Y	66	

5.3.3 Protection Group

Table 18: Protection Group

Group	LED	Display	Parameter	Setting Range	Units	Default	Adjust During Run?	Page	Setting
PFN 00	—	Jump Code	Jump to Parameter	1 – 18	—	1	—	67	
PFN 01	P18	Open Field T	Open Field Trip Time	OFF, 0.1 – 90.0	sec	1.0	Y	67	
PFN 02	P19	Over Cur Lvl	Over Current Level	OFF, 50 – 200	%	125	Y	68	
PFN 03	P20	Over Cur Tim	Over Current Time	OFF, 0.1 – 90.0	sec	1.0	Y	68	
PFN 04	P21	Undr Cur Lvl	Under Current Level	OFF, 5 – 99	%	OFF	Y	69	
PFN 05	P22	Undr Cur Tim	Under Current Time	OFF, 0.1 – 90.0	sec	1.0	Y	69	
PFN 06	P24	Over Vlt Lvl	Over Voltage Level	OFF, 1 – 40	%	OFF	Y	70	
PFN 07	P25	Undr Vlt Lvl	Under Voltage Level	OFF, 1 – 40	%	OFF	Y	70	
PFN 08	P26	Vlt Trip Tim	Over/Under Voltage Trip Time	0.1 – 90.0	sec	0.1	Y	70	
PFN 09	P27	Ph Loss Time	Phase Loss Trip Time	0.1 – 5.0	sec	0.2	Y	71	
PFN 10	P28	Over Frq Lvl	High Line Frequency Trip	24 – 72	Hz	72	Y	71	
PFN 11	P29	Undr Frq Lvl	Low Line Frequency Trip	23 – 71	Hz	23	Y	71	
PFN 12	P30	Frq Trip Tim	Frequency Trip Time	0.1 – 90.0	sec	0.1	Y	72	
PFN 13	P31	Auto Reset	Auto Fault Reset Time	OFF, 1 – 900	sec	OFF	Y	72	
PFN 14	P32	Auto Rst Lim	Auto Fault Reset Max Count	OFF, 1 – 10	—	OFF	Y	72	
PFN 15	P33	Ctrl Flt En	Controlled Fault Stop Enable	OFF, ON	—	ON	Y	73	
PFN 16	P7	Pullout Mode	Pullout Mode Response	trIP: Fault Immediate rtrY: Retry after delay rt: Ride Through	—	Fault Immed	Y	73	
PFN 17	P8	Resync Time	Resynchronization Delay Timer	1 – 30	sec	5	Y	74	
PFN 18	P9	Resync Tries	Resynchronization Retries	1 – 10	—	1	Y	74	

5.3.4 I/O Group

Table 19: I/O Group

Number	LED	Display	Parameter	Setting Range	Units	Default	Adjust During Run?	Page	Set-ting
I/O 00	—	Jump Code	Jump to Parameter	1 – 15	—	1	–	75	
I/O 01	P40	DI 1 Config	DI 1 Configuration	OFF: Off StOP: Stop inch: Inching FH: Fault High FL: Fault Low Fr: Fault Reset FS1: FS1 Confirm FS2: FS2 Confirm FF: Field Force FLdA: Field Apply bd IS: Brake Disabl bEn: Brake Enable InLn: Inline Cnfrm L-r: Local/Remote	—	OFF	N	75	
I/O 02	P41	DI 2 Config	DI 2 Configuration						
I/O 03	P42	DI 3 Config	DI 3 Configuration						
I/O 04	P43	Din Trp Time	Digital Fault Input Trip Time	0.1 to 90.0	sec	0.1	Y	76	
I/O 05	P44	R1 Config	R1 Configuration (Relay #1)	OFF: Off FLFS: Fault FS (Fail Safe) FLnF: Fault NFS (Non Fail Safe) S IFS: Interlock FS S InF: Interlock NFS run: Running SYnc: Synced inch: Inching inES: Inching UTS AL: Alarm rdYr: Ready LOC: Locked Out OC: Overcurrent UC: Undercurrent ShFS: Shunt Trip FS ShnF: Shunt Trip NFS FS1: Field supply contactor FS2: Field discharge resistor contactor FcA: Field Contactor Aux. dYnb: Dyn. Braking FAn: Cool Fan Ctl		SIFS			
I/O 06	P45	R2 Config	R2 Configuration (Relay #2)			FS1			
I/O 07	P46	R3 Config	R3 Configuration (Relay #3)		—	Running	N	76	
I/O 08	P47	FCA Delay	FCA Time Delay	OFF, 0.1 – 90.0	sec	OFF	Y	77	
I/O 09	P54	Aout Fctn	Analog Output Function	0: OFF (no output) 1: DC Current (0 – 200%) 2: Ave. Voltage (0 – 150%) 3: Motor Slip % 4: Analog Input 5: Output Voltage (based on firing angle) 6: Calibrate (full 100% output)	—	0	Y	77	
I/O 10	P55	Aout Span	Analog Output #1 Span	1 – 125	%	100	Y	78	
I/O 11	P56	Aout Offset	Analog Output #1 Offset	0 – 99	%	0	Y	78	
I/O 12	P49	Inline Confg	Inline Delay	OFF, 1.0 – 10.0	sec	3.0	Y	79	
I/O 13	P48	Cont Fbk Tim	Field Contactor Feedback Time	0.1 – 5.0	sec	1.0	Y	79	
I/O 14	P58	Keypad Stop	Keypad Stop Enabled	On: Enabled OFF:Disabled	—	Enabled	N	80	
I/O 15	P57	Auto Start	Auto Start	0: Disabled 1: Power 2: Fault 3: Power & Fault	—	Disabled	Y	80	

5.3.5 Function Group

Table 20: Function Group

Number	LED	Display	Parameter	Setting Range	Units	Default	Adjust During Run?	Page	Setting
FUN 00	—	Jump Code	Jump to Parameter	1 – 16	—	1	—	81	
FUN 01	P17	Meter 1	LCD Meter 1	0: Status 1: Ave Current 2: Ave Volts 3: L1-L2 Volts 4: L2-L3 Volts 5: L3-L1 Volts 6: Slip Percent 7: Phase Order 8: Line Freq 9: Analog Input 10: Analog Output 11: Run Days 12: Run Hours 13: Starts	—	Ave Current	Y	81	
FUN 02	—	Meter 2	LCD Meter 2			Ave Volts	Y	81	
FUN 03	P35	HE Ratio	Current Sensor Ratio	1000, 2000, 5000	—	2000:1	N	82	
FUN 04	P36	HE Turns	Current Sensor Turns	1 – 10	—	1	N	82	
FUN 05	P34	Phase Order	Phase Order	ABC, CBA, INS, SPH	—	INS	N	83	
FUN 06	P23	Rated Volts	Rated Input Voltage	100, 110, 120, 200, 208, 220, 230, 240, 320, 350, 380, 400, 415, 440, 460, 480, 500, 525, 575, 600, 660, 690, 800, 1000, 1140	Vrms	120	N	83	
FUN 07	P60	Rated PF	Rated Power Factor	-0.10 – +0.10	—	1.0	Y	84	
FUN 08	P61	Min PF Curr	Minimum PF Control Current	40 – 100	%	60	Y	84	
FUN 09	P39	Control Type	Controller Type	FLd: Field Control bruS: Brushless Control Cur: Current Control PF: Power Factor Control PFbL: PF Control Brushless Motor	—	Field Ctrl	N	84	
FUN 10	P52	Com Drop #	Modbus Address	1 – 247	—	1	N	85	
FUN 11	P51	Com Baudrate	Modbus Baud Rate	1.2, 2.4, 4.8, 9.6, 19.2	Kbps	19.2	N	85	
FUN 12	P50	Com Timeout	Modbus Timeout	OFF, 1 – 120	sec	OFF	Y	85	
FUN 13	P53	Com Parity	Modbus Framing	0: Even Parity, 1 Stop Bit 1: Odd Parity, 1 Stop Bit 2: No Parity, 1 Stop Bit 3: No Parity, 2 Stop Bits	—	0	N	86	
FUN 14	P62	Software 1	Software Part Number	Displays SW part number	—	—	—	86	
FUN 15	P59	Misc Command	Miscellaneous Command	0: No command 1: Powered BIST 2: Reset Run Time 3: Reflash Mode 4: Store Parameters 5: Load Parameters 6: Factory Reset	—	0	N	87	
FUN 16	P63	Passcode	Passcode	—	—	—	—	88	

5.3.6 LCD / LED Fault Groups

The LCD and LED Fault Groups contain a rotating list of the last 9 fault conditions recorded by the controller. Record any values displayed for troubleshooting purposes. Refer to Appendix B.

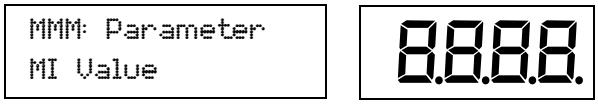
6 - Parameter Descriptions

6.1 *Parameter Descriptions*

The detailed parameter descriptions in this section are organized in the same order as they appear on the LCD display. Each parameter has a detailed description, displayed in the following format:

MMM__ / P__ Parameter Name

LCD / LED Displays



Range Parameter Value Range

Description The description of the function.

See Also Cross references to related parameters or other sections.

In the above format, the top of each parameter listing contains the parameter group number (as it appears in the menu on the LCD display), the P number (as it appears in the menu on the LED display), and the parameter name.

The **LCD / LED Displays** portion shows an example of what actually appears on the remote mounted LCD keypad and the built in display, respectively. On the LCD, the parameter group (represented above by “MMM”) and the (possibly abbreviated) parameter name are shown on the first line. The parameter group number (represented above by “MI” for “menu index”), and the parameter’s value (and units) are shown on the second line.

Some parameters appear in two different menus of the LCD display. This is normally the case for those parameters in the Quick Start Group.

For some parameters, the **Range** section is enough to describe the parameter. For others, there may be an additional **Options** section to describe each of the options that can be selected for a parameter. The form that the options take may be different for the LED and LCD displays, so this section shows how the options appear on both displays.

The **See Also** portion lists cross-references to other related parameters, as well as references to further detail in other chapters.

QST 00 Jump to Parameter

LCD Display

```
QST: Jump Code
00     1
```

Description By changing the value of this parameter and pressing [ENTER], you can jump directly to any parameter within that group.

QST 01 / P1 Current Setpoint

LCD / LED Displays

```
QST: Cur Setpoint
01     10 Amp
```

Range 1 – 1000 Amps DC (Default: 10)

Description The Current Setpoint sets the field current supplied to the motor.

QST 02 / P3 Field Apply Delay

LCD / LED Displays

```
QST: F Apply Dly
02   Off
```

Range Off, 0.1 – 20.0 (Default: Off)

Description *The following is when (FUN 09 / P39) is set to "Brush Type":*

The field apply delay timer will delay the application of the field after the motor has reached the slip speed (CFN 01 / P2).

The following is when (FUN 09 / P39) is set to "Brushless Control":

The field apply delay timer will delay the application of the field when a start command is received. In most cases, this should be set to a long enough time to allow the motor to reach it's operating speed before applying the field.

NOTE: See Theory of Operation for complete descriptions of Control Modes on Page 89.

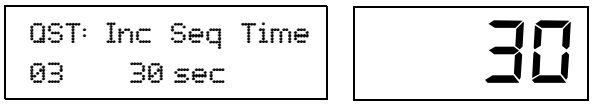
NOTE: Not used in Current Controller mode.

See Also

- Controller Type (FUN 09 / P39) on Page 84.
- Digital Inputs (I/O 01–03 / P40–42) on Page 75.
- Theory of Operation, Control Modes of Synchronous Motor Controls on Page 89.

QST 03 / P3 Inc Seq Time

LCD / LED Displays



Range Off, 1 – 200 (Default: 30)

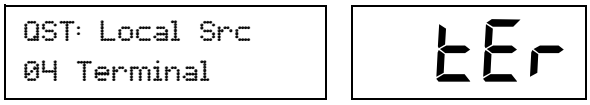
Description The Incomplete sequence timer sets how long the motor has to reach synchronization before the controller trips on an incomplete sequence fault. The motor has to be synchronized for 3 seconds before the synchronizing sequence is considered complete.

NOTE: The Incomplete seq timer starts when the start command is given.

NOTE: Not used in Current Control mode.

QST 04 / P36 Local Source

LCD / LCD Displays



Range

LCD	*LED*	*Description*
Terminal	tEr	The start/stop control is from the terminal strip inputs. (Default)
Serial	SEr	The start/stop control is from the network.

Description The MX^2 SEP can have two sources of start and stop control: Terminal and Serial. Two parameters, Local Source (QST 04 / P37), and Remote Source (QST 05 / P38), select the source of the start and stop control.

If a digital input is programmed as Local / Remote, then that input selects the control source. When the input is low, the local source is used. When the input is high, the remote source is used. If no digital input is programmed as Local / Remote, then the local/remote bit in the controller control Modbus register selects the control source. The default value of the bit is Local (0).

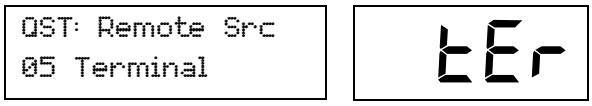
NOTE: By default, the [STOP] key is always enabled, regardless of selected control source. It may be disabled though using the Keypad Stop Disable (I/O 14) parameter.

See Also

- Local Source (QST 05 / P37) parameter on Page 61.
- Digital Input Configuration (I/O 01–03 / P40–42) parameters on Page 75.

QST 05 / P37 Remote Source

LCD / LED Displays



Range

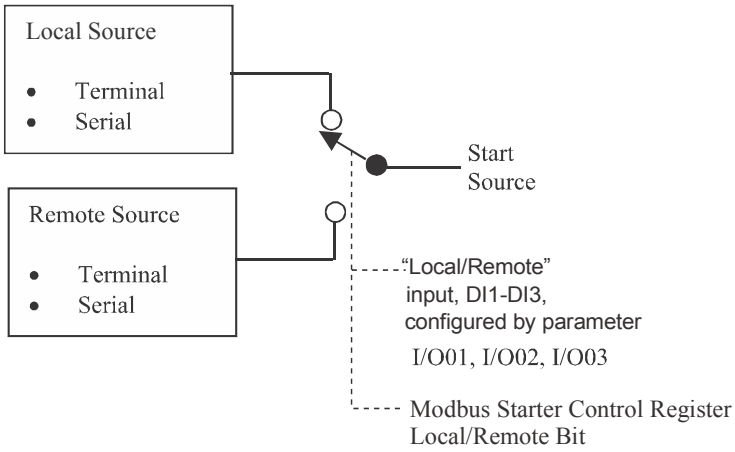
LCD	LED	Description
Terminal	tEr	The start/stop control is from the terminal strip inputs. (Default)
Serial	SEr	The start/stop control is from the network.

Description

The MX2 SEP can have two sources of start and stop control: Terminal and Serial. Two parameters, Local Source (QST 04 / P37), and Remote Source (QST 05 / P38), select the source of the start and stop control.

If a digital input is programmed as Local / Remote, then that input selects the control source. When the input is low, the local source is used. When the input is high, the remote source is used. If no digital input is programmed as Local / Remote, then the local/remote bit in the controller control Modbus register selects the control source. The default value of the bit is Local (0).

Figure 16: Local / Remote Source



See Also

- Local Source (QST 04 / P36) parameter on Page 61.
- Digital Input Configuration (I/O 01–03 / P40–42) parameters on Page 75.
- Keypad Stop Disable (I/O 14 / P58) parameter on Page 80.
- Modbus Register Map - Appendix E

CFN 00 Jump to Parameter

LCD Display

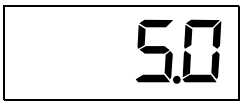
```
CFN: Jump Code
00          1
```

Description By changing the value of this parameter and pressing [ENTER], you can jump directly to any parameter within that group.

CFN 01 / P2 Slip Percent

LCD / LED Displays

```
CFN: Slip Percent
01        5.0%
```



Range 0.5 – 10.0% (Default: 5.0)

Description The slip percentage sets how close to synchronous speed the motor must be before synchronization is attempted. The motor speed is calculated by subtracting the slip from 100%. For example, 5% slip equals 95% motor speed.

NOTE: Setting this parameter too low can cause the speed to never be reached, and synchronization to never be attempted.

NOTE: Brush type motor only. (FUN 09 / P39) set to “Field Type”.

CFN 02 / P3 Field Apply Dly

LCD / LED Displays

```
CFN: F Apply Dly
02     Off
```

Range Off, 0.1 – 20.0 (Default: Off)

Description The following is when (FUN 09 / P39) is set to “Brush Type”

The field apply delay timer will delay the application of the field after the motor has reached the slip speed (CFN 01 / P2).

The following is when (FUN 09 / P39) is set to “Brushless Control”

The field apply delay timer will delay the application of the field when a start command is received. In most cases, this should be set to a long enough time to allow the motor to reach it's operating speed before applying the field.

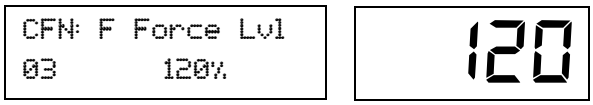
NOTE: Not used in Current control mode.

See Also

- Controller Type (FUN 09 / P39) on Page 84.
- Digital Inputs (I/O 01–03 / P40–42) on Page 75.
- Theory of Operation, Control Modes of Synchronous Motor Controls on Page 89.

CFN 03 / P4 Field Force Level

LCD / LED Displays



Range 50 – 125% (Default: 120)

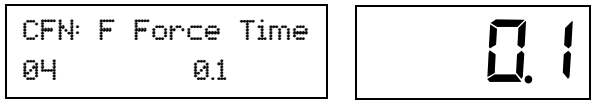
Description The Field Force Level allows a user to over drive the field at synchronization for a programmed time. This is most commonly used where the load takes more time to stabilize or the application requires a higher magnitude of torque to synchronize.

NOTE: May require a higher voltage field supply transformer to produce the desired current.

NOTE: Not used in Current control mode.

CFN 04 / P5 Field Force Time

LCD / LED Displays



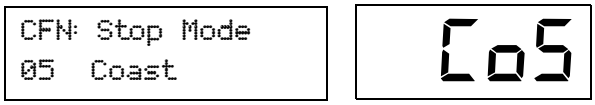
Range Off, 0.1 – 90.0 (Default: 0.1)

Description The Field Force Time sets how long the system will apply the field forcing current before dropping to the programmed current.

NOTE: Not used in Current Control mode (FUN 09 / P39).

CFN 05 / P10 Stop Mode

LCD / LED Displays



Range Coast, Dyn Brake (Default: Coast)

Description One of two Stop Modes can be chosen.

Coast:
When Coast mode is selected the controller will immediately remove the DC field when a stop command is received. The controller will perform a sequenced stop to ensure the motor field is properly removed.

Dynamic Braking:
When Dynamic brake mode is selected the controller will perform a dynamic braking sequence. The controller will maintain the motor field current and sequence a braking resistor to quickly stop the motor.

NOTE: The motor controller must have a contactor and dynamic braking resistor installed to use dynamic braking.

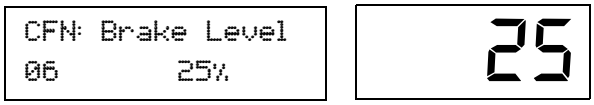
NOTE: Brush type motor only. (FUN 09 / P39) set to “Field Type”.

See Also

- Dynamic Brake Level (CFN 06 / P11) on Page 65.
- Dynamic Brake Time (CFN 07 / P12) on Page 65.
- Dynamic Brake Delay (CFN 08 / P13) on Page 65.

CFN 06 / P11 Dynamic Brake Level

LCD / LED Displays



Range 10 – 125% (Default: 25)

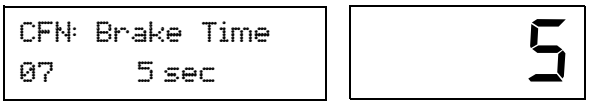
Description The Dynamic Brake Level sets the level of DC field current when in Dynamic Braking mode.

NOTE: See Dynamic Braking in Theory of Operation on Page 97.

NOTE: Brush type motor only: (FUN 09 / P39) set to "Field Type".

CFN 07 / P12 Dynamic Brake Time

LCD / LED Displays



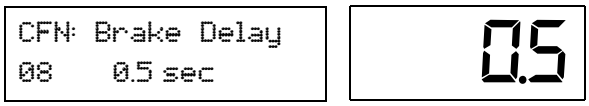
Range 1 – 180 seconds (Default: 5)

Description The dynamic brake time sets the amount of time that the brake relay is energized. The brake relay is used to connect the dynamic braking resistor.

NOTE: See Dynamic Braking in Theory of Operation on Page 97.

CFN 08 / P13 Dynamic Brake Delay

LCD / LED Displays



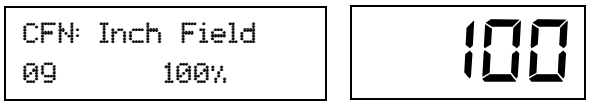
Range 0.1 – 5.0 seconds (Default: 0.5)

Description The dynamic brake delay parameter sets the delay time between the stop command being received and the brake relay being energized. This parameter sets a coasting time for the motor.

NOTE: See Dynamic Braking in Theory of Operation on Page 97.

CFN 09 / P14 Inch Field Level

LCD / LED Displays

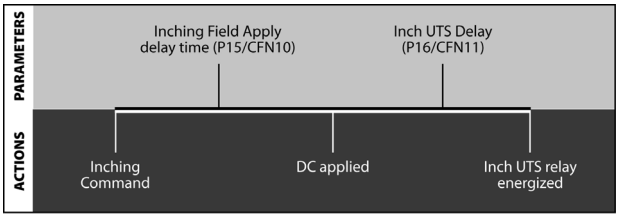


Range 75 – 125% (Default: 100%)

Description The inching field level parameter sets the field current level that will be applied when the controller is in inching mode. This current will be applied when a digital input programmed to “inch” is energized and the inch field application delay time (CFN 10 / P15) has expired.

The inching is used to sequence the application of the field when the motor is being inched. The actual motor inching is performed by the stator controller.

Inching operating sequence

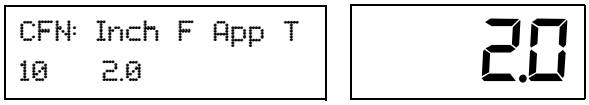


See Also

- Inch Field Application Time (CFN 10 / P15) on Page 66.
- Inch UTS Delay (CFN 11 / P16) on Page 66.
- Digital Inputs (I/O 01–03 / P40–42) on Page 75.

CFN 10 / P15 Inch Field Application Delay Time

LCD / LED Displays



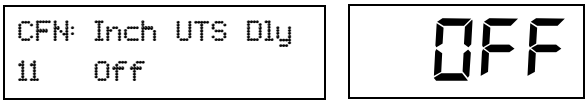
Range 0.1 – 90.0 seconds (Default: 2.0)

Description The Delay before Inching Field Application time delay sets the delay time between the “inching” digital input being energized and the inching field current being applied to the motor.

NOTE: See (CFN 09 / P14) for inching operating sequence.

CFN 11 / P16 Inch UTS Delay

LCD / LED Displays



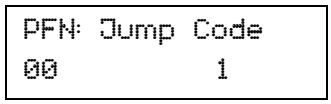
Range Off, 0.1 – 90.0 seconds (Default: Off)

Description The Inch UTS delay starts timing after the inching field has been applied and delays the energizing of any relay that is programmed as Inching UTS.

NOTE: See (CFN 09 / P14) for inching operating sequence.

PFN 00 Jump to Parameter

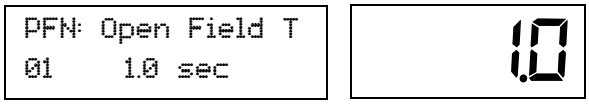
LCD / LED Displays



Description By changing the value of this parameter and pressing [ENTER], you can jump directly to any parameter within that group.

PFN 01 / P18 Open Field Trip Time

LCD / LED Displays



Range Off, 0.1 – 90.0 seconds (Default: 1.0)

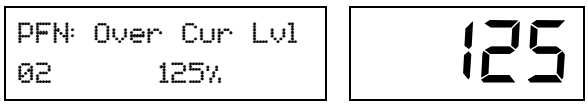
Description The Open field trip time parameter sets how long before the controller will trip if an open field is detected during starting.

NOTE: If the motor is still spinning and a start is attempted, the unit may trip on open field.

NOTE: Brush type motor only, (FUN 09 / P39) set to "Field Type".

PFN 02 / P19 Over Current Level

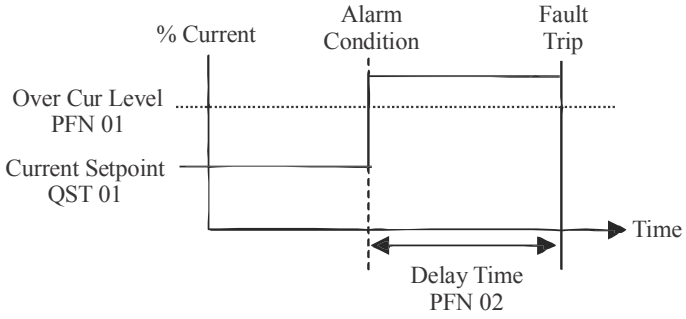
LCD / LED Displays



Range Off, 50 – 200% (Default: 125)

Description The Over Current Trip Level sets the high field current trip level. This parameter should be set to the highest continuously allowable field current. Usually this value is 125% of rated field current. Consult the motor manufacturer if necessary.

A relay can be programmed to change state when an over current alarm condition is detected.

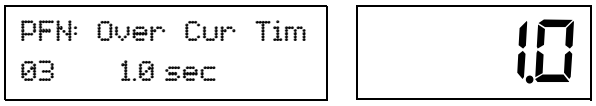


See Also

- Over Current Level (PFN 02 / P19) parameter on Page 68.
- Relay Output Configuration (I/O 05–07 / P44–46) parameters on Page 76.

PFN 03 / P20 Over Current Time

LCD / LED Displays



Range Off, 0.1 – 90.0 seconds (Default: 1.0)

Description The Over Current Trip Time parameter sets the period of time that the motor field current must be greater than the Over Current Level (PFN 02) parameter before an over current fault and trip occurs.

If “Off” is selected, the over current timer does not operate and the controller does not trip. It energizes any relay set to Over current until the current drops.

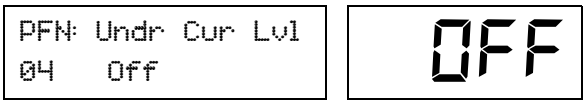
A shear pin function can be implemented by setting the delay to its minimum value.

See Also

- Over Current Level (PFN 02 / P19) on Page 68.

PFN 04 / P21 Under Current Level

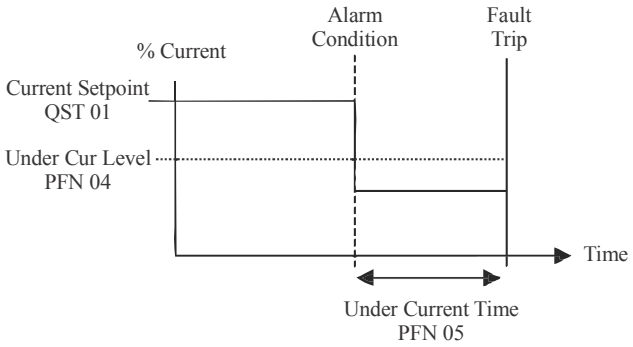
LCD / LED Displays



Range Off, 5 – 100% (Default: Off)

Description The Under Trip Current Level sets the low field current trip level. This parameter should be set to the lowest continuously allowable field current. Consult the motor manufacturer if necessary.

A relay can be programmed to change state when an over current alarm condition is detected.

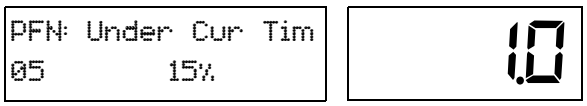


See Also

- Under Current Time (PFN 05 / P22) on Page 69.

PFN 05 / P22 Under Current Time

LCD / LED Displays



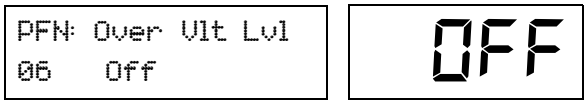
Range Off, 0.1 – 90.0 seconds (Default: 1.0)

Description The Under Current Trip Time parameter sets the period of time that the motor field current must be less than the Under Current Level (PFN 04) parameter before an under current fault and trip occurs.

If “Off” is selected, the over current timer does not operate and the controller does not trip. It energizes any relay set to Under current until the current raises or the controller trips on an overload.

PFN 06 / P24 Over Voltage Level

LCD / LED Displays



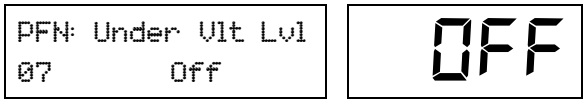
Range Off, 1 – 40% FLA (Default: Off)

Description If the controller detects a one cycle input phase voltage that is above the Over Voltage Level, the Voltage Trip Timer (PFN 08 / P26) begins counting. The delay time must expire before the controller faults. The Over voltage condition and the phase is displayed.

NOTE: For the over voltage protection to operate correctly, the rated voltage parameter (FUN 06 / P23) must be set correctly.

PFN 07 / P25 Under Voltage Level

LCD / LED Displays



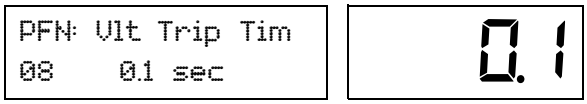
Range Off, 1 – 40% (Default: Off)

Description If the controller detects a one cycle input phase voltage that is below the Under Voltage Level, the Voltage Trip Timer (PFN 08 / P26) begins counting. The delay time must expire before the controller faults. The Under voltage condition and the phase is displayed.

NOTE: For the under voltage protection to operate correctly, the rated voltage parameter (FUN 06 / P23) must be set correctly.

PFN 08 / P26 Voltage Trip Time

LCD / LED Displays



Range 0.1 – 90.0 seconds (Default: 0.1)

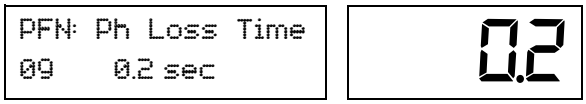
Description The Voltage Trip Time parameter sets the period of time that either an Over Voltage (PFN 06) or Under Voltage (PFN 07 / P25) condition must exist before a fault occurs.

See Also

- Over Voltage Level (PFN 06 / P24) on Page 70.
- Under Voltage Level (PFN 07 / P25) on Page 70.

PFN 09 / P27 Phase Loss Time

LCD / LED Displays

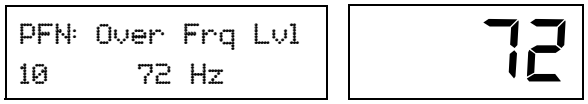


Range 0.1 – 5.0 seconds (Default: 0.2)

Description The Phase Loss Time parameter sets the delay time on Fault 27 “Phase Loss”. This fault detects a loss of proper phase timing even when the phasing remains valid; Example: loss of line when the motor back generates a voltage

PFN 10 / P28 Over Frequency Level

LCD / LED Displays



Range 24 – 72 Hz (Default: 72)

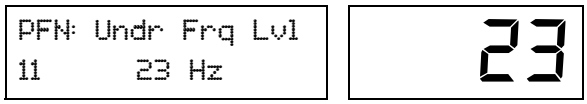
Description The Over Frequency Level parameter sets the highest line frequency that the controller will operate on.

When operating on line power, the default setting will usually suffice. If the application is speed sensitive, or the line power is suspect, the high frequency parameter can be set to the highest acceptable frequency. When operating on generator power, the high frequency parameter should be set to the highest acceptable frequency. This will ensure that a generator problem will not cause unnecessarily large fluctuations in the speed of the motor.

The frequency must be above the high frequency setting for the frequency delay parameter before the controller will recognize a high frequency condition. Once a high frequency condition exists, the controller will shut down and display a fault 13, “High Line Frequency” Trip.

PFN 11 / P29 Under Frequency Level

LCD / LED Displays



Range 23 – 71 Hz (Default: 23)

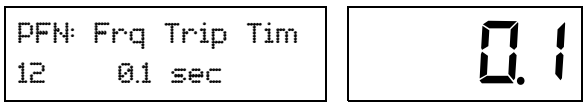
Description The Under Frequency Level parameter sets the lowest line frequency that the controller will operate on.

When operating on line power, the default setting will usually suffice. If the application is speed sensitive, or the line power is suspect, the low frequency parameter can be set to the lowest acceptable frequency. When operating on generator power, the low frequency parameter should be set to the lowest acceptable frequency. This will ensure that a generator problem will not cause unnecessarily large fluctuations in the speed of the motor.

The frequency must be below the low frequency setting for the frequency delay parameter before the controller will recognize a low frequency condition. Once a low frequency condition exists, the controller will shut down and display a Fault 12, “Low Line Frequency” Trip.

PFN 12 / P30 Frequency Trip Time

LCD / LED Displays



Range 0.1 – 90.0 seconds (Default: 0.1)

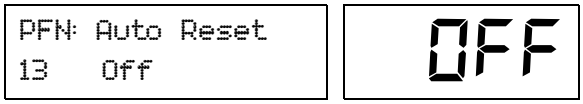
Description The frequency delay parameter sets the time that the line frequency must go above the over frequency trip point or below the under frequency trip parameter before a high or low frequency fault will occur.

See Also

- Over Freq Level (PFN 10) on Page 71.
- Under Freq Level (PFN 11) on Page 71.

PFN 13 / P31 Auto Fault Reset Time

LCD / LED Displays

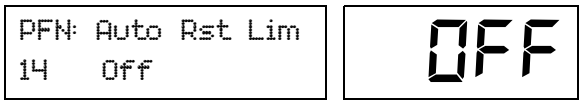


Range Off, 1 – 900 seconds (Default: Off)

Description The Auto Fault Reset Time parameter sets the time delay before the controller will automatically reset a fault. For the list of faults that can be auto reset, refer to Appendix B - Fault Codes on Page 113.

PFN 14 / P32 Auto Reset Limit

LCD / LED Displays



Range Off, 1 – 10 (Default: Off)

Description The Auto Reset Limit parameter sets the number of times that an auto reset may occur. Once the Auto Reset Limit is reached, faults will no longer be automatically reset.

NOTE: If the maximum reset count has been reached and the controller has locked out, only a user reset will clear the reset counts.

NOTE: If a few auto resets have been performed but the count has not reached the limit, the number of accumulated resets will be cleared after 15 minutes if another fault does not occur.

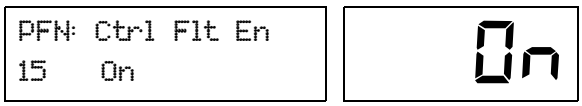
NOTE: The count can be always cleared by power cycling the controller.

See Also

- Auto Reset Time (PFN 13 / P31) on Page 72.

PFN 15 / P33 Controlled Fault Stop Enable

LCD / LED Displays



Range Off – On (Default: On)

Description A Controlled Fault Stop can occur if this parameter is “On”. If this parameter is on, the controller will brake the motor before faulting when the Stop Mode (CFN05 / P10) is set to “Dyn brake”. If the Stop mode is set to “Coast” then this parameter has no effect on the operation.

NOTE: Only certain faults can initiate a controlled fault stop. Some faults are considered too critical and cause the controller to trip immediately regardless of the Controlled Fault Stop Enable parameter.

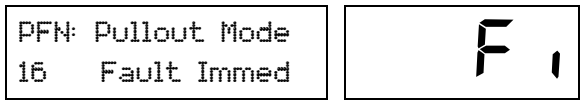
Refer to Appendix B - Fault Codes on Page 113 to determine if a fault may perform a controlled stop.

See Also

- Stop Mode (CFN 05 / P10) on Page 64.
- Appendix B - Fault Codes on Page 113.

PFN 16 / P7 Pullout Mode

LCD / LED Displays



Range
Fault Immed (Default)
Retry
Ride Thru

Description The pullout mode selects the controllers response to a slipped pole. The controller can be set to either trip immediately, try a number of resynchronization attempts, or attempt to ride through the situation. A resynchronization attempt consists of removing the field for the delay time and then reapplying the field.

Fault Immed:
Immediately trips the controller on a loss of sync fault, if a slipped pole or pullout is detected.

Retry:
In this mode the controller will try to resynchronize the motor a maximum of the selected number (1 - 10) of times. If a slipped pole is detected, the field will be removed. The system will wait the user selected Resync Time (PFN 17 / P8), then resynchronization will be attempted. The controller will try the selected number of Resync Tries (PFN 18 / P9), waiting the delay period in between each resynchronization attempt. If resynchronization is not achieved after the selected number of attempts, the controller will fault on a Loss of Sync fault.

Ride Thru:
If a slipped pole is detected, the system will keep the field applied. If resynchronization is NOT detected in the user selected Resync Time (PFN 17 / P8), the controller will trip on a Loss of Sync fault.

NOTE: Selecting the Ride Through option can result in very large torque pulsations and large line current oscillations when the motor is slipping poles with the field still applied. The user should verify that the motor, mechanical, and electrical systems are capable of supporting this situation without damage.

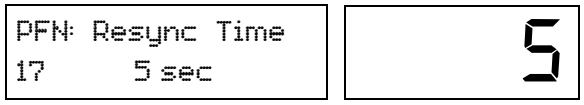
NOTE: Brush type motor only. (FUN 09 / P39) set to “Field Type”.

See Also

- Resync Time (PFN 17 / P8) on Page 74.
- Resync Tries (PFN 18 / P9) on Page 74.

PFN 17 / P8 ReSync Time

LCD / LED Displays



Range 1 – 30 seconds (Default 5)

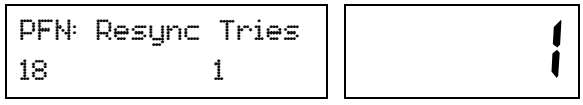
Description Sets how long the field is removed if a slipped pole is detected when the controller is set to "Retry" in (PFN / P7 16).

When Pullout Mode (PFN 16 / P7) is set as "Ride Thru" and resynchronization is NOT detected within the Resync Time then a fault will occur.

NOTE: Brush type motor only. (FUN 09 / P39) set to “Field Type”.

PFN 18 / P9 ReSync Tries

LCD / LED Displays



Range 1 – 10 (Default: 1)

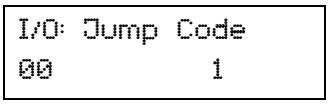
Description When Pullout Mode (PFN 16 / P7) is set as “Retry” the controller will try to resync the motor the number of times this parameter is set to.

The Resync Tries counter is reset each time the motor is stopped.

NOTE: Brush type motor only. (FUN 09 / P39) set to “Field Type”.

I/O 00 Jump to Parameter

LCD Display

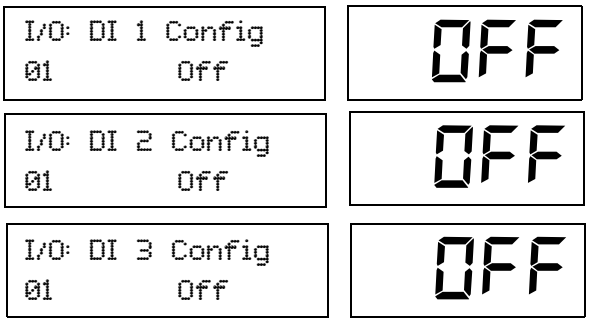


Description

By changing the value of this parameter and pressing [ENTER], you can jump directly to any parameter within that group.

I/O 01- 03 / P40 - 42 Digital Input Configuration

LCD / LED Displays



Range

LCD	*LED*	*Description*
Off	OFF	Off, Not Assigned, Input has no function. (Default DI 1, DI 2, DI3)
Stop	StOP	Stop Command for 3-wire control.
Inching	inch	Start the inching DC field application sequence.
Fault High	FH	Fault High, Fault when input is asserted, 120V applied.
Fault Low	FL	Fault Low, Fault when input is de-asserted, 0V applied.
Fault Reset	Fr	Reset when input asserted, 120V applied.
FS1 Confirm	FS1	aux FS1 contact input to confirm FS1 contactor operation.
FS2 Confirm	FS2	aux FS2 contact input to confirm FS2 contactor operation.
Field Force	FF	Switch to the field force current setting when energized.
Field Apply	FLdA	Allow DC field application. This input must energize after all other conditions for field applications are met before the field will be applied.
Brake Disabl	bdLS	Disable DC injection braking.
Brake Enable	bEn	Enable DC injection braking.
Inline Cnfrm	InLn	Inline contactor feedback.
Local/Remote	L-r	Local/Remote control source, Selects whether the Local Source parameter or the Remote Source parameter is the control source. Local Source is selected when input is de-asserted, 0V applied. Remote Source selected when input asserted, 120V applied.

Description

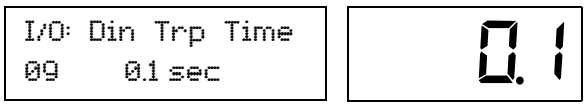
I/O parameters 1 - 3 configure which features are performed by the D1 to D3 terminals.

See Also

- Local Source (QST 04 / P37) parameter on Page 61.
- Remote Source (QST 05 / P38) parameter on Page 61.
- Incomplete Sequence Timer (QST 03 / P6) on Page 61.

I/O 04 / P43 Digital Input Trip Time

LCD / LED Displays



Range 0.1 – 90.0 Seconds (Default: 0.1 Sec)

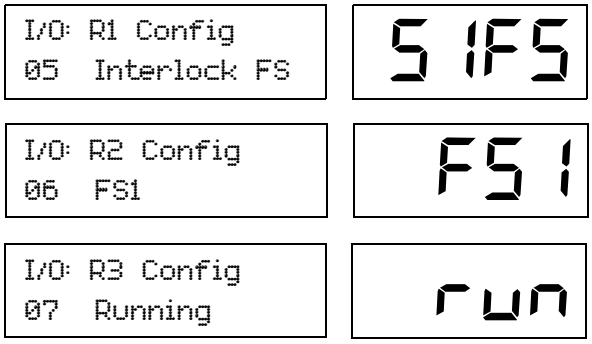
Description The Digital Input Trip Time parameter sets the length of time that the digital input must be high or low before a trip occurs. This delay time only functions for fault high and fault low.

See Also

- Digital Input Configuration parameters on Page 75.

I/O 5 - 7 / P44 - 46 Relay Output Configuration

LCD / LED Displays



Range

LCD	*LED*	*Description*
Off	OFF	Off, Not Assigned. May be controlled over Modbus
Fault FS	FLFS	Faulted – Fail Safe operation. Energized when no faults present,de-energized when faulted.
Fault NFS	FLnF	Faulted– Non Fail Safe operation. Energized when faulted.
Interlock FS	SIFS	Interlock relay, fail safe operation. This relay will energize when the controller is ready for a start command. The interlock relay must be used to interlock the stator controller. **(Default R1)**
Interlock NFS	SInF	Interlock relay, non fail safe operation. This relay will be energized when the controller is not ready for a start command. The interlock relay must be used to interlock the stator controller.
Running	run	Motor is running. **(Default R3)**
Synced	Sync	The controller has synchronized the motor.
Inching	inch	Controller is in inching mode.
Inch UTS	iutS	Controller is in inching mode and the inching UTS timer has expired.
Alarm	AL	Alarm, any alarm condition present.
Ready	rdyr	Ready, controller ready for start command.
Locked Out	LOC	Locked Out.
Overcurrent	OC	Overcurrent Alarm, overcurrent condition detected.
Undercurrent	UC	Undercurrent Alarm, undercurrent condition detected.
Shunt FS	ShFS	Shunt Trip Relay – Fail Safe operation, energized when no shunt trip fault present, de-energized on shunt trip fault.
Shunt NFS	ShnF	Shunt Trip Relay – Non Fail Safe operation, de-energized when no shunt trip fault present, energized on shunt trip fault.
FS1	FS1	Used to control a field application contactor. **(Default R2)**
FS2	FS2	Used to control a field discharge resistor contactor.

Fld Cont Aux	FcA	Controller is synchronized and the FCA Delay timer (P47 / I/O 08) has expired.
Dyn Brake	dYnb	Used to control the dynamic braking resistor contactor.
Cool Fan Ctl	FAn	Heatsink fan control.

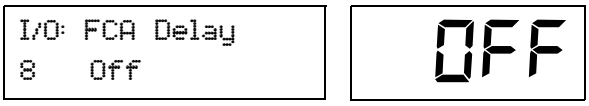
Description I/O parameters 1 - 3 configure which functions are performed by the R1 to R3 relays.

See Also

- Over Current Level (PFN 02 / P19) parameter on Page 68.
- Under Current Level (PFN 04 / P25) parameter on Page 69.
- Inline Configuration (I/O 12 / P49) parameter on Page 79.
- Appendix B - Fault Codes on Page 113.

I/O 8 / P47 FCA Delay Timer

LCD / LED Displays



Range Off, 0.1 – 90.0 seconds (Default: Off)

Description The FCA delay timer controls the “Fld Cont Aux” relay. Once the controller has synchronized the motor, it will count down this timer and then energize any relay programmed as “Fld Cont Aux” relay.

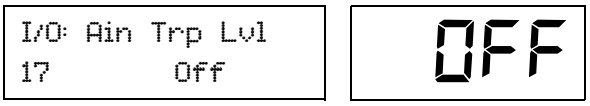
NOTE: Not used in Current control mode.

See Also

- Relay Output Configuration (I/O 05–07 / P44–46) on Page 76.

I/O 9 / P54 Analog Output Function

LCD / LED Displays



Range

LCD	*LED*	*Description*
Off	0	Disabled (Default)
0-200% Curr	1	Based on per cycle RMS values
0-150% Volt	2	Based on per cycle RMS values
0-100% Slip	3	Motor speed, 100% = stopped, 0% = full speed
0-100% Ain	4	The output value takes into account the inputs span and offset settings
0-100% Firing	5	Output Voltage to Motor, based on SCR firing angle
Calibration	6	Calibration, full (100%) output

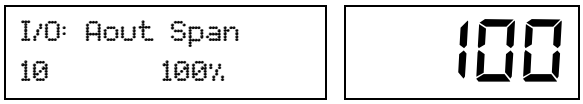
Description The Analog Output Function parameter selects the function of the analog output. The available analog output function selections and output scaling are shown below. The analog output is updated every 25 msec.

See Also

- Analog Output Span (I/O 10 / P55) parameter on Page 78.
- Analog Output Offset (I/O 11 / P56) parameter on Page 78.

I/O 10 / P55 Analog Output Span

LCD / LED Displays



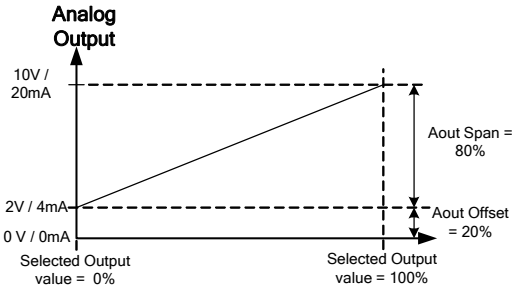
Range 1 – 125% (Default: 100%)

Description The analog output signal can be scaled using the Analog Output Span parameter. For a 0-10V output or 0-20mA output, a 100% scaling outputs the maximum voltage (10V) or current (20mA) when the selected output function requests 100% output. A scale of 50% outputs 50% voltage/current when the analog output function requests a 100% output.

NOTE: For a 4-20mA output, set the Analog Output Span to 80% and the Analog Output Offset (I/O 11 / P56) parameter to 20%.

NOTE: The output does not exceed 100% (10V or 20mA).

Example: 0% output => 4mA, 100% output => 20ma

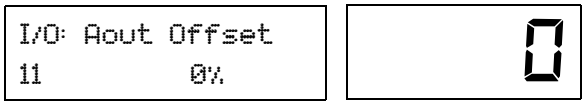


See Also

- Analog Output Offset (I/O 11 / P56) parameter on Page 78.

I/O 11 / P56 Analog Output Offset

LCD / LED Displays



Range 0 – 99% (Default: 0%)

Description The analog output signal can be offset using the Analog Output Offset parameter. A 50% offset outputs a 50% output (5V in the 10V case) when 0% is commanded. If the selected variable requests 100% output, the span should be reduced to (100 minus offset) so that a 100% output request causes a 100% output voltage (x% offset + (100-x)%span) =100%.

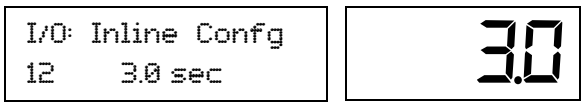
NOTE: For a 4-20mA output, set the Analog Output Span (I/O 10) to 80% and the Analog Output Offset to 20%.

See Also

- Analog Output Span (I/O 10 / P55) parameter on Page 78.

I/O 12 / P49 Inline Configuration

LCD / LED Displays



Range Off, 0 – 10.0 seconds (Default: 3.0)

Description The Inline Configuration parameter controls the behavior of the No Line warning, No Line fault, and the Ready relay function.

If the Inline Configuration parameter is set to “Off”, then the MX^2 SEP assumes that there is no Inline contactor and that line voltage should be present while stopped. If no line is detected, then a No Line alarm condition exists and the ready condition does not exist. If a start is commanded, then a No Line fault is declared.

If the Inline Configuration parameter is set to a time delay, then the MX^2 SEP assumes that there is an Inline contactor and that line voltage need not be present while stopped. If no line is detected, then the No Line alarm condition does not exist and the ready condition does exist. If a start is commanded and there is no detected line voltage for the time period defined by this parameter, then a “noL” (No Line) fault is declared.

In order to control an inline contactor, program a relay as a “Running” relay.

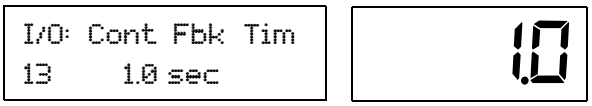
NOTE: This fault is different than over/under voltage trip delay time (PFN 08 / P26) since it detects the presence of NO line.

See Also

- Relay Output Configuration (I/O 05–07 / P44–46) parameters on Page 76.

I/O 13 / P48 Contactor Feedback Time

LCD / LED Displays



Range 0.1 – 5.0 seconds (Default: 1.0 sec)

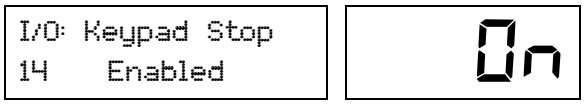
Description FS1 and FS2. This is the delay to allow the contactor to operate, and the feedback to appear once the MX changed its output relay, which is operating the contactor.

See Also

- Digital Input Configuration (I/O 01–03 / P40–42) on Page 75.

I/O 14 / P58 Keypad Stop Disable

LCD / LED Displays



Range

LCD	*LED*	*Description*
Disabled	OFF	Keypad Stop does not stop the controller
Enabled	On	Keypad Stop does stop the controller (Default)

Description

If "Disabled"
When this parameter is set to "Disabled", the keypad [STOP] button is de-activated; this should be done with caution, as the [STOP] button will not stop the controller.

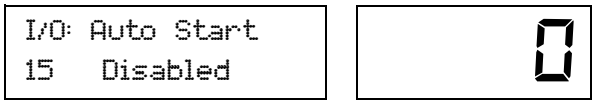
If "Enabled"
When this parameter is set to "Enabled", the keypad [STOP] button is enabled and trips the controller on a keypad stop fault regardless of the selected control source (QST 04 / P37 *or* QST 05 / P38) selected as (terminal or serial).

See Also

- Local Source (QST 04 / P37) parameter on Page 61.
- Remote Source (QST 05 / P38) parameter on Page 61.

I/O 15 / P57 Auto Start Selection

LCD / LED Displays



Range

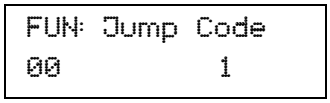
LCD	*LED*	*Description*
Disabled	0	When disabled, the Start input must always transition from low to high for a start to occur. *(Default)*
Power	1	When set to Power, a start will occur if the Start input is high while control power is applied.
Fault	2	When set to Fault, a start will occur if the Start input is high when a fault is reset.
Power, Fault	3	When set to Power and Fualt, a start will occur if the Start input is high while control power is applied, and a start will occur if the Start input is high when a fault is reset.

Description

The Auto Start parameter determines whether or not a transition from low to high is required on the Start input for a start to occur after either a power up or a fault reset.

FUN 00 Jump to Parameter

LCD Display

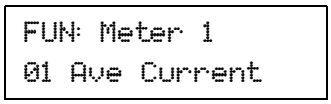


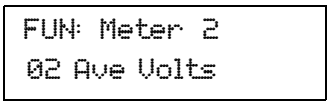
Description

By changing the value of this parameter and pressing [ENTER], you can jump directly to any parameter within that group.

FUN 01- 02 / P17 Meter 1 - Meter 2

LCD / LED Displays





Range

LCD	*LED*	*Description*
Status	0	Running State. *(LED Meter only, Default LED meter)*
Ave Current	1	DC field current. *(Default LCD Meter 1)*
Ave Volts	2	Average Voltage L-L RMS. *(Default LCD Meter 2)*
L1-L2 Volts	3	Voltage in, L1 to L2 RMS.
L2-L3 Volts	4	Voltage in, L2 to L3 RMS.
L3-L1 Volts	5	Voltage in, L3 to L1 RMS.
Slip Percent	6	The percentage of rotor slip.
Phase Order	7	Phase rotation.
Line Freq	8	Line Frequency.
Analog Input	9	Analog Input %.
Analog Out	10	Analog Output %
Run Days	11	Running time in days, wraps at 2,750 days.
Run Hours	12	Running time in Hours and Minutes, wraps at 24:00.
Starts	13	Number of Starts, wraps at 65,536.

Description

For the LED display, this parameter configures which single meter is displayed on the main screen. For the LCD display, parameters FUN 01 and FUN 02 configure which meters are displayed on the two lines of the main display screen.

FUN 03 / P35 Hall Effect Ratio

LCD / LED Displays

Range 1000:1, 2000:1, 5000:1 (Default: 2000:1)

Description

Hall Effect Ratio	Number of Turns (FUN04 / P36)	Burden Resistance (Ohms)	Current Low	Current High
1000:1	6	100 ohm, 0.5W, 1%	1	8
	4	100 ohm, 0.5W, 1%	9	12
	2	100 ohm, 0.5W, 1%	13	25
	1	100 ohm, 0.5W, 1%	26	50
2000:1	6	56.2 ohm, 1W, 1%	5	35
	4	56.2 ohm, 1W, 1%	36	50
	2	56.2 ohm, 1W, 1%	51	100
	1	56.2 ohm, 1W, 1%	101	200
5000:1	1	56.2 ohm, 1W, 1%	201	400
	1	15 ohm, 0.5W, 1%	401	600
	1	10 ohm, 0.5W, 1%	600	900

NOTE: The 5000:1 hall effect sensor requires +/- 24VDC.

FUN 04 / P36 Hall Effect Turns

LCD / LED Displays

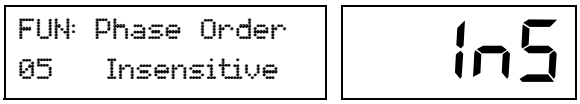
Range 1 – 10 Turns (Default: 1)

Description See above parameter (FUN 03 / P35) for Number of Turns.

The Hall Effect turns parameter sets the number of times the field power wire passes through the window of the Hall Effect current sensor.

FUN 05 / P34 Input Phase Sensitivity

LCD / LED Displays



Range

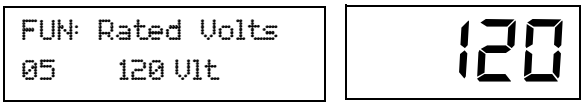
LCD	*LED*	*Description*
Insensitive	InS	Runs with any three phase sequence. (Default)
ABC	AbC	Only runs with ABC phase sequence.
CBA	CbA	Only runs with CBA phase sequence.
Single Phase	SPH	Single Phase.

Description

The Input Phase Sensitivity parameter sets the phase sensitivity of the controller. This can be used to protect the motor from a possible change in the incoming phase sequence. If the incoming phase sequence does not match the set phase rotation, the controller displays an Alarm while stopped and faults if a start is attempted.

FUN 06 Rated RMS Voltage

LCD / LED Displays



Range

100, 110, 120, 200, 208, 220, 230, 240, 340, 350, 380, 400, 415, 440, 460, 480, 500, 525, 575, 600, 660, 690, 800, 1000, 1140 *(Default: 120)*

Description

The Rated Voltage parameter sets the line voltage that is used when the controller performs Over and Under line voltage calculations. This value is the supply voltage, NOT the motor utilization voltage.

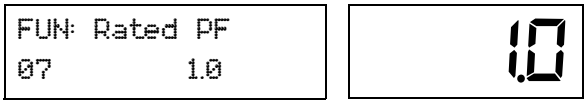
NOTE: Rated Voltage must be set properly for the controller to operate properly.

See Also

- Meter (FUN 01 / P17) parameter on Page 81.
- Under Voltage Level (PFN 07 / P25) parameter on Page 70.
- Voltage Trip Time (PFN 08 / P26) parameter on Page 70.

FUN 07 / P60 Rated Power Factor

LCD / LED Displays



Range -0.10 – +0.10 (Default: 1.0)

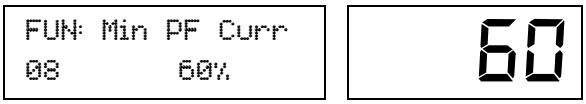
Description The Rated Power Factor parameter sets the reference point for the PF controller algorithm. The PF will adjust the field current to achieve this motor power factor

See Also

- Min PF Control Current (FUN 08 / P61) parameter on Page 84.

FUN 08 / P61 Min PF Control Current

LCD / LED Displays



Range 40% – 100% (Default: 60%)

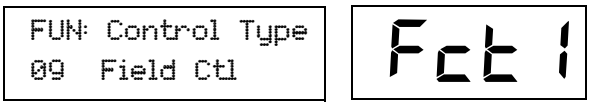
Description The Minimum Power Factor Control Current parameter sets the minimum field current that will be allowed when operating in Power Factor Control Mode.

See Also

- Rated Power Factor (FUN 07 / P60) parameter on Page 84.

FUN 09 / P39 Control Type

LCD / LED Displays



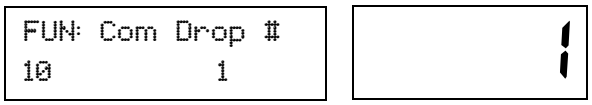
Range

LCD	*LED*	*Description*
Field Ctl	Fct 1	Brush type motor field controller. See Brushtype control in Section 7.1.1 on Page 89.
Brushless	brus	Brushless type field controller. See Brushless control in Section 7.1.2 on Page 90.
Curr Follow	cFoL	DC current controller See Current Follower in Section 7.1.3 on Page 90.
PF Control	PF	Power Factor Control See Power Factor Control in Section 7.1.4 on Page 91.
PF Control BL	PFbL	Power Factor Control - Brushless Motor See Power Factor Control in Section 7.1.4 on Page 91.

NOTE: Control Types are described in the Theory of Operation section beginning on Page 89.

FUN 10 / P52 Com Address (Drop #)

LCD / LED Displays



Range 1 – 247 (Default: 1)

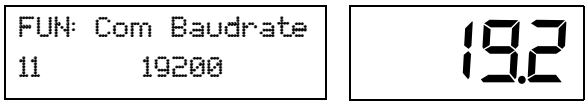
Description The Communication Address parameter sets the controller's address for Modbus communications.

See Also

- Local Source (QST 04 / P37) parameter on Page 61.
- Remote Source (QST 05 / P38) parameter on Page 61.

FUN 11 / P51 Communication Baudrate

LCD / LED Displays



Range 1200, 2400, 4800, 9600, 19200 bps (Default: 19200)

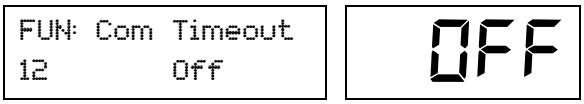
Description The Communication Baud Rate parameter sets the baud rate for Modbus communications.

See Also

- Local Source (QST 04 / P36) parameter on Page 61.
- Remote Source (QST 05 / P37) parameter on Page 61.

FUN 12 / P50 Communication Timeout

LCD / LED Displays



Range Off, 1 – 120 (Default: Off)

Description The Communication Timeout parameter sets the time that the controller continues to run without receiving a valid Modbus request. If a valid Modbus request is not received for the time that is set, the controller declares a F82 (Modbus Timeout Fault). The controller performs a controlled stop.

See Also

- Local Source (QST 04 / P37) parameter on Page 61.
- Remote Source (QST 05 / P38) parameter on Page 61.
- Stop Mode (CFN 05 / P10) parameter on Page 64.
- Controlled Fault Stop Enable (PFN 15 / P33) parameter on Page 73.
- Communication parameters (FUN 10–13 / P50–53) on Pages 85–86.

FUN 13 / P53 Communication Parity

LCD / LED Displays

Range

LCD	*LED*
Even, 1 Stop **(Default)**	0
Odd, 1 Stop	1
None, 1 Stop	2
None, 2 Stop	3

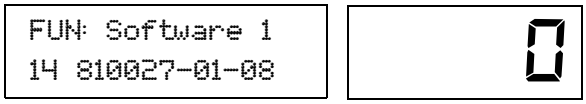
Description The Communication Parity parameter sets both the parity and number of stop bits.

See Also

- Communication parameters (FUN 10–13 / P50–53) on Pages 85–86.

FUN 14 / P62 Software 1

LCD / LED Displays



Description The Software Part Number parameter displays the MX^2 SEP software version, for hardware BIPC-300063-01. When calling Benshaw for service, this number should be recorded so it can be provided to the service technician.

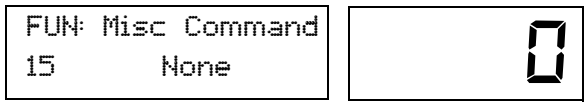
In addition to viewing the software version with this parameter, the software version is also displayed on power up. On the LED display, the software version is flashed one character at a time on power up. On the LCD display, the software PN is fully displayed on power up.

NOTE: The seven segment LED in position one will flash the current software version currently in use when first powered on. The full software part number will flash consecutively (one digit per second).

For Example: 8...1...0...0...2...7...-...0...1...-...0...8

FUN 15 / P59 Miscellaneous Commands

LCD / LED Displays



Range

LCD	*LED*	*Description*
None	0	No commands (Default)
Powered BIST	1	Built In Self Test with line voltage applied to the controller
Reset RT	2	Reset Run Time Meter
Reflash Mode	3	Activate Reflash Mode
Store Params	4	The current parameter values are stored in non-volatile memory
Load Params	5	All parameter are retrieved from non-volatile memory
Factory Rst	6	All parameters are restored to the factory defaults

Description

The Miscellaneous Commands parameter is used to issue various commands to the MX^2 SEP controller.

The powered BIST command will put the controller into a powered BIST test. See section 8.7.1 on Page 107.

The Reset Run Time command resets the user run time meters back to zero (0).

The Reflash Mode command puts the MX^2 SEP into a reflash program memory mode. The reflash mode can only be entered if the MX^2 SEP controller is idle. When the reflash mode is entered, the MX^2 SEP waits to be programmed. The onboard LED display shows “FLSH”. The remote display is disabled after entering reflash mode. The MX^2 SEP does not operate normally until reflash mode is exited. Reflash mode may be exited by cycling control power.

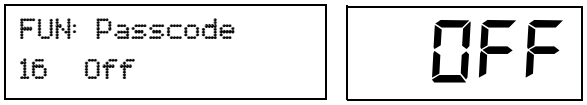
The Store Parameters command allows the user to copy the parameters into non-volatile memory as a backup. If changes are being made, store the old set of parameters before any changes are made. If the new settings do not work, the old parameter values can be loaded back into memory.

The Load Parameters command loads the stored parameters into active memory.

The Factory Reset command restores all parameters to the factory defaults. These can be found in chapter 5.

FUN 16 / P63 Passcode

LCD / LED Displays



Description

The MX^2 SEP supports a 4-digit passcode. When the passcode is set, parameters may not be changed.

The MX^2 SEP provides a means of locking parameter values so that they may not be changed. Once locked, the parameters values may be viewed on the display, but any attempt to change their values by pressing the [UP] or [DOWN] key is ignored.

Viewing the Passcode parameter indicates whether or not the parameters are locked. If they are locked, the Passcode parameter displays "On". If they are not locked, the Passcode parameter displays “Off”.

To lock the parameters, press the [ENTER] key while viewing the Passcode parameter. This allows entry of a 4-digit number. Press the [UP] or [DOWN] keys and [ENTER] for each of the four digits. After entering the fourth digit, the number is stored as the passcode and the parameters are locked.

Once parameters are locked, the same 4-digit number must be re-entered into the Passcode parameter in order to unlock them. Any other 4-digit number entered will be ignored.

When a passcode is set and an attempt is made to change a parameter through the display/keypad, the [UP] and [DOWN] keys simply have no effect. When a passcode is set and an attempt is made to change a parameter through Modbus, the MX^2 SEP returns an error response with an exception code of 03 (Illegal Data) to indicate that the register can not be changed.

LED Display

The following steps must be performed to set a passcode using the LED Display:

1. At the default meter display, press the [PARAM] key to enter the parameter mode.
2. Press the [UP] or [DOWN] keys to get to the Passcode parameter (FUN 16).
3. Press the [ENTER] key. “Off” is displayed to indicate that no passcode is currently set.
4. Press the [UP] or [DOWN] keys and [ENTER] for each digit to be defined, select a value from 0000 to 9999 starting at the most significant digit.
5. Press the [ENTER] key to set the passcode.

The following steps must be performed to clear a passcode:

1. At the default meter display, press the [PARAM] key to enter the parameter mode.
2. Press the [UP] or [DOWN] keys to get the Passcode parameter (FUN16).
3. Press the [ENTER] key. “On” is displayed to indicate that a passcode is presently set.
4. Press the [UP] or [DOWN] keys and [ENTER] after each digit to select the previously set passcode value.
5. Press the [ENTER] key. The passcode is then cleared.

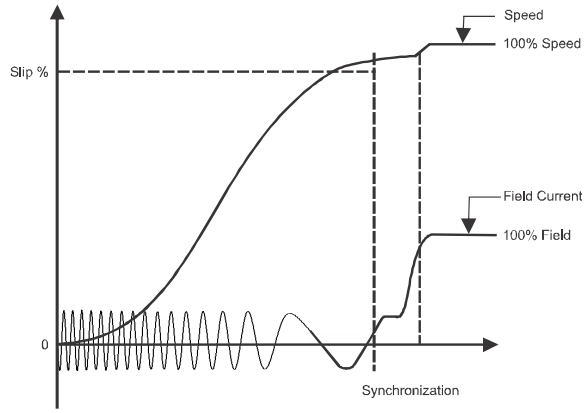
7 - Theory of Operation

7.1 Control Modes of Synchronous Motor Operation

7.1.1 Brush Type (Field Control) Synchronous Motor Operation

The brush type (field control) synchronous motor will start as an induction motor. The field winding will generate an AC voltage during starting, and a resistor must be connected to the winding to control the voltage levels generated. The size of the resistor is also partly responsible for the torque the motor generated during starting. Once the motor has reached synchronizing speed, the field is applied and the motor synchronizes.

Figure 18: Brush Type Synchronous Motor Operation Curve



Synchronizing Conditions:

The following conditions must be true before the controller will apply the DC field to a brush type motor:

- A start command must be given.
- Motor slip must be less than the slip percentage (CFN 01 / P2) or the motor speed must be greater than 100% - slip parameter (CFN 01 / P2).
- The Field Application delay Timer (QST 02 / P3) must expire.
- The digital input(s) (I/O 01–03 / P40–42) programmed as “Field Apply”.

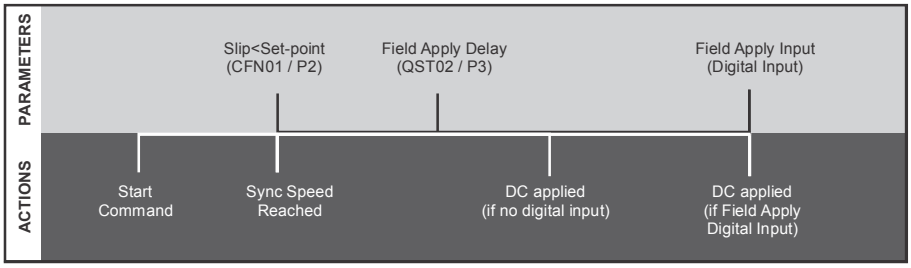
See Also

- Slip Percentage (CFN 01 / P2) on Page 63.
- Field Application Delay Timer (QST 02 / P3) on Page 60.
- Digital Inputs (I/O 01–03 / P40–42) on Page 75.

Stator Protection must be set up for:

- Lagging Power Factor to trip, in the case of loss of synchronization.
- Stator IOC (Over Current) must be set for a level approximately 1.5 to 3 times the motor stator FLA that will indicate if the rotor has pulled out, and is slipping poles. Contact the motor manufacturer or Benshaw for more information.

Timeline



7.1.2 Brushless Type Synchronous Motor Operation

The brushless type synchronous motor will start as an induction motor. All of the field controls are installed on the rotor of the motor. The external motor controller just has to provide the DC field current for the auxiliary generator at the appropriate time.

Synchronizing Conditions:

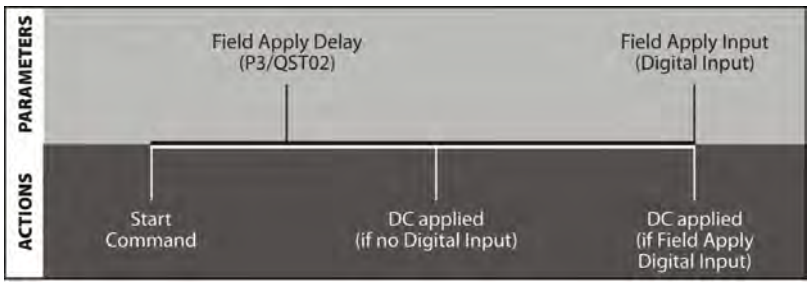
The following conditions must be true before the controller will apply the DC field to a brush type motor:

- A start command must be given.
- The Field Application Delay Timer (QST 02 / P3) must expire.
- The digital input(s) programmed as “Field Apply” must be energized.
- If the Field Application Delay Timer is turned “OFF” and there is a digital input programmed for “Field Apply” then the field will be applied when the input is energized.
- If the Field Application Delay Timer is turned “OFF” and there is no digital input programmed then the field will be applied as soon as the run command is received.

See Also

- Slip Percentage (CFN 01 / P2) on Page 63.
- Field Application Delay Timer (QST 02 / P3) on Page 60.
- Digital Inputs (I/O 01–03 / P40–42) on Page 75.

Timeline



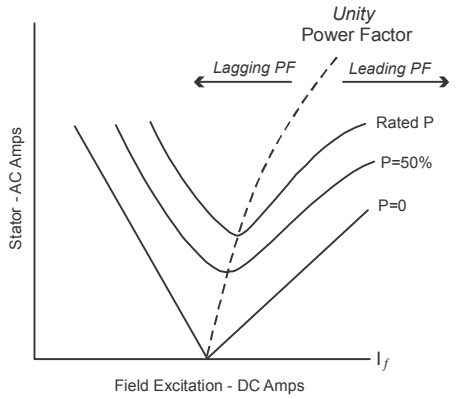
7.1.3 Current Follower

The Current Follower is used to provide a regulated DC current. This controller can be used any place that a regulated DC current is required.

When the controller is used in Current Follower mode it will provide the DC current when a start is provided. There are no other conditions that have to be met before the DC is provided.

7.1.4 Closed Loop Power Factor Control

The MX^2 SEP controller optionally provides closed loop motor power factor (PF) control. In this mode the motor will be started as described in Sections 7.1.1 and 7.1.2 for the brush type or brushless type motor. After motor synchronization has been completed, active PF control will be enabled. As the load and stator voltage of a synchronous motor changes, the motor's operating power factor will change. Typically a motor manufacturer will provide what is called the "V" curves of a motor (see example below) that describe the motor power factor and stator current, relative to the motor load and the field excitation current level.



In this example, the load curves are drawn at 0% load, 50% load, and 100% load. The dotted unity PF line is drawn through the curves. When the motor is operating to the left of the unity PF line the motor's PF will be lagging (reactive) and when operating right of the unity PF line the motor's PF will be leading (capacitive). What can be seen from these curves is that the motor PF varies depending on motor load and DC field current level. For example, if a motor is operating at unity PF at 50% load, and the load is increased to 100%, the motor PF will become lagging. When MX^2 SEP PF control is used, the field current will be automatically increased so that the motor continues to operate at its defined PF level.

Closed loop PF control has multiple benefits:

1. As the mechanical load changes on the motor, the motor PF will change. PF control will actively raise or lower the field excitation current so that the motor operates at the desired PF set point. Also by operating at the optimal PF, the stator current magnitude can be minimized, which minimizes losses. By raising the field current as load increases, in order to keep a constant PF, the pull out torque capability of the motor will also be increased as the field current is raised.
2. As input voltage levels vary, the PF control can stabilize the PF of the motor to prevent swings in motor power factor that can occur.
3. A synchronous motor can be used to drive a mechanical load, as well as provide leading (capacitive) Vars to a plant power system. These leading Vars can be used to improve the overall PF of the facility. Closed loop PF control allows the user to set a given PF set point; then the PF control will adjust the motor field excitation current to operate the motor at the desired set point.

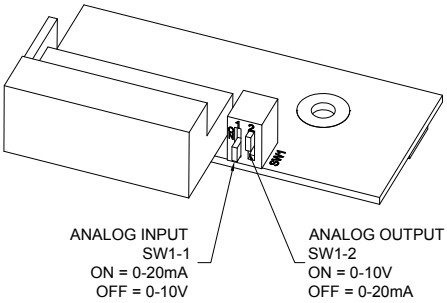
7.2 Hall Effect Current Sensor

The Hall Effect Current sensor is connected to the analog input of the MXSEP card along with a burden resistor. The analog input must be set to be a 0-10V voltage input for correct operation. The sensor scaling and burden resistance are factory selected. Please consult factory if changes to either the sensor scaling or burden resistance is required.

7.2.1 Analog Input

The analog input is used for Hall Effect input. The SW1 switch must be set to the voltage loop configuration.

Figure 19: SW1 DIP Switch Settings



The terminals for the Analog input on the MX2 card (TB5) are as follows:

2) + input (white)
3) - input (black)
4) Common (black)

NOTE: The analog input (Hall Effect) is a low voltage input, maximum of 15VDC. The input will be damaged if control power (115VAC) or line power is applied to the analog input.

The terminals for the synchronous controller card (LEM) are as follows:

To LEM	*To MX2 card*
1) + (to LEM, red)	5) M (white)
2) M (to LEM, white)	6) Com (black)
3) - (to LEM, black)	7) GND (shield)
4) GND (shield)	

Figure 20: LEM Connections

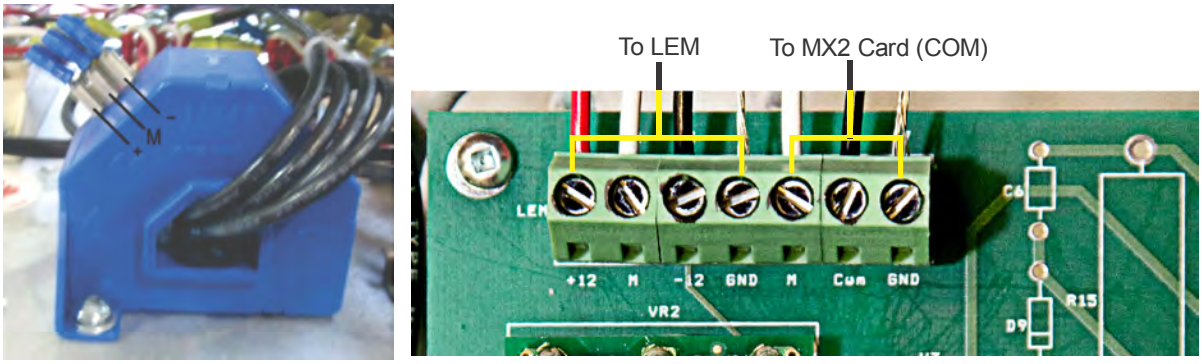
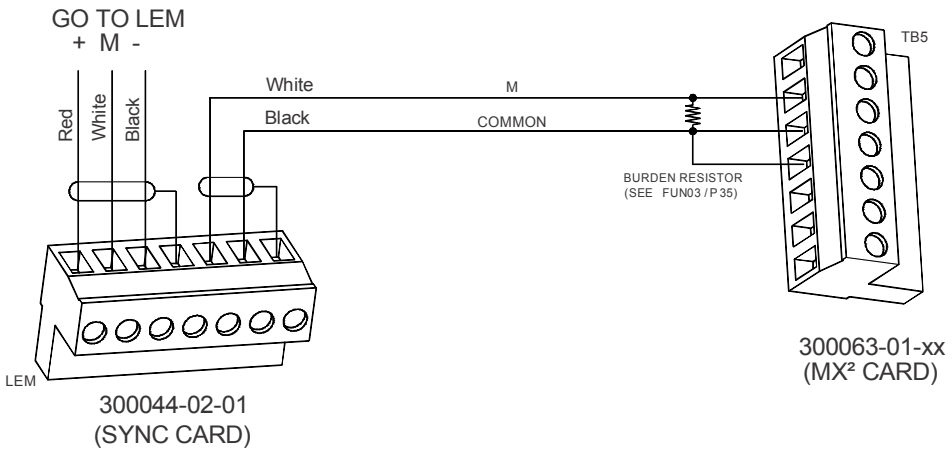


Figure 21: Hall Effect Connections (0 - 700 Amps)



7.3 *Simplified I/O Schematics*

Figure 22: Digital Input Simplified Schematic

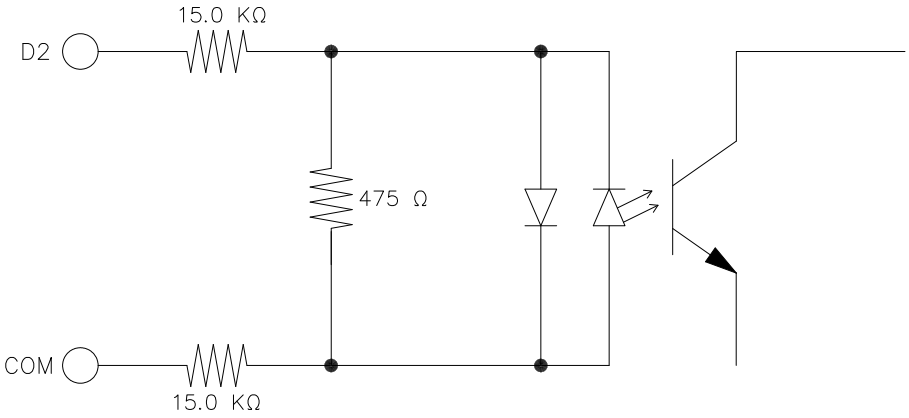


Figure 23: Analog Input Simplified Schematic

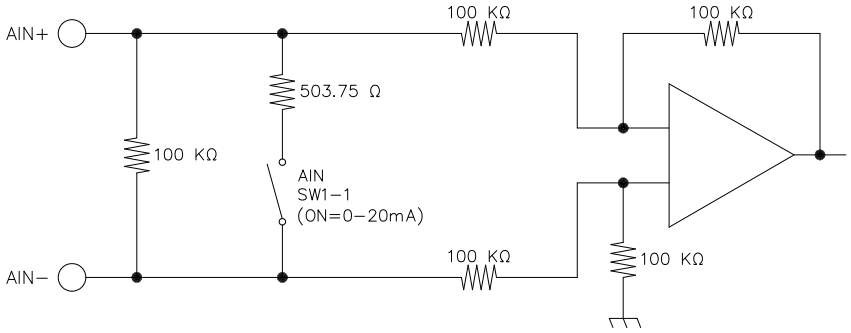
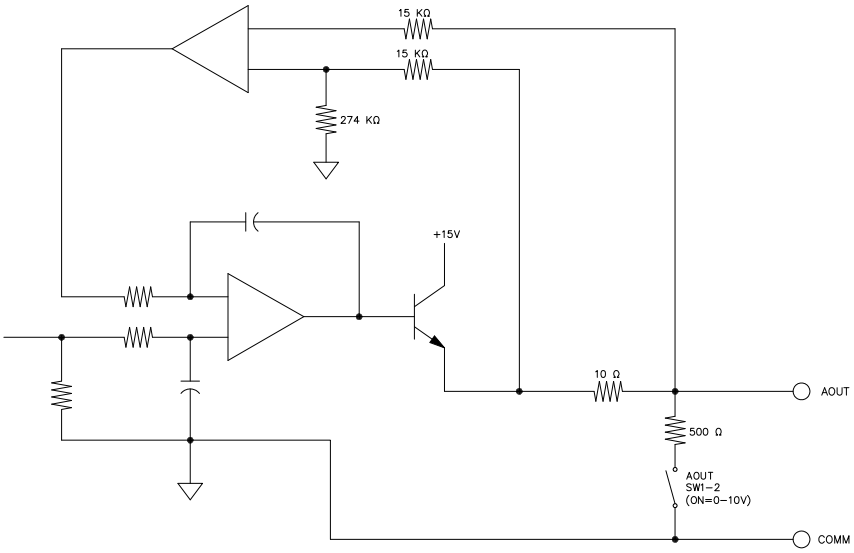


Figure 24: Analog Output Simplified Schematic



7.4 *Remote Modbus Communications*

The MX^2 SEP controller provides a Modbus RTU to support remote communication.

The communication interface is RS-485, and allows up to 247 slaves to be connected to one master (with repeaters when the number of drops exceeds 31). Please refer to Figures 24 and 25 for connection diagrams.

7.4.1 Supported Commands

The MX^2 SEP supports the following Modbus commands:

- Read Holding Registers (03 hex)
- Read Input Registers (04 hex)
- Preset Single Register (06 hex)
- Preset Multiple Registers (10 hex)

Up to 64 registers may be read or written with a single command.

7.4.2 Modbus Register Addresses

The Modbus specification defines holding registers to begin at 40001 and input registers to begin at 30001. Holding registers may be read and written. Input registers may only be read.

In the MX^2 SEP, the register maps are identical for both the holding registers and the input registers. For example, the Motor FLA parameter is available both in holding register 40101 and in input register 30101. This is why the register addresses in the Modbus Register Map are listed with both numbers (e.g. 30101/40101).

7.4.3 Cable Specifications

Good quality twisted, shielded communications cable should be used when connecting to the Modbus port on the MX^2 SEP. The cable should contain two twisted pairs and have an overall shield. Use one pair of conductors for the A(-) and B(+) signals. Use the other pair of conductors for the Common signal. The cable should adhere to the following specifications:

- Conductors: 2 twisted pair
- Impedance: 100 Ohm to 120 Ohm
- Capacitance: 16 pF/ft or less
- Shield: Overall shield or individual pair shields

Examples of cables that meet these specifications:

- Belden part number 9842
- Alpha Wire part number 6412.

7.4.4 Terminating Resistors

The MX2 SEP does not have a terminating resistor for the end of the trunk line. If a terminating resistor is required, the resistor must be wired to the terminal block.

The purpose of terminating resistors is to eliminate signal reflections that can occur at the end of a network trunk line. In general, terminating resistors are not needed unless the bit rate is very high, or the network is very long. In fact, terminating resistors place a large load on the network and may reduce the number of drops that may be placed on the network.

The maximum baudrate of 19,200 supported by the MX2 SEP is not high enough to warrant a terminating resistor unless the network is extremely long (3,000 feet or more). A terminating resistor should only be installed on the MX2 SEP if signal reflection is known to be a problem and only if the MX2 SEP is at the end of the network. Terminating resistors should never be installed on nodes that are not at the end of the network.

7.4.5 Grounding

RS-485 buses with isolated nodes are most immune to noise when the bus is not connected to earth ground at any point. If electrical codes require that the bus be connected to earth ground, then the Common signal should be connected to earth ground at one point and one point only. If the Common signal is connected to earth ground at more than one point, then significant currents can flow through the Common signal when earth ground potentials are different at those points. This can cause damage to devices attached to the bus.

7.4.6 Shielding

The shield should be continuous from one end of the trunk to the other. The shield must be tied to the RS-485 Common signal at one point and one point only. If the shield is not tied to Common at any point or is tied to Common at more than one point, then its effectiveness at eliminating noise is greatly reduced.

7.4.7 Wiring

Figure 22 shows the wiring of TB4 to a Modbus-485 Network. If the controller is the end device in the network, a 120Ω, 1/4W terminating resistor may be required. Please refer to Figure 24 for wire and termination.

Figure 25: TB4 Connector

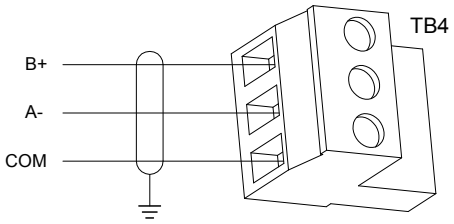
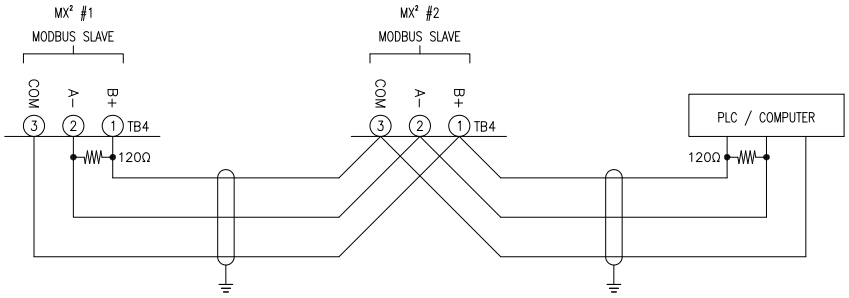
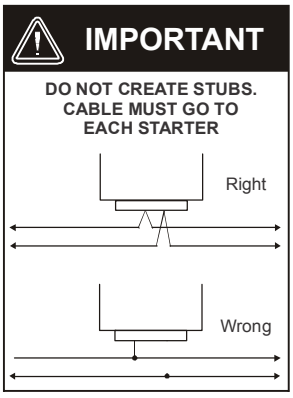


Figure 26: Modbus Network Wiring Example





7.5 *Dynamic Braking*

The dynamic braking can be used to quickly stop the motor. The motor is used as a generator and the energy from the motor is dissipated into resistors. **Dynamic Braking only works on Brush type motors.**

Braking Operation Sequence

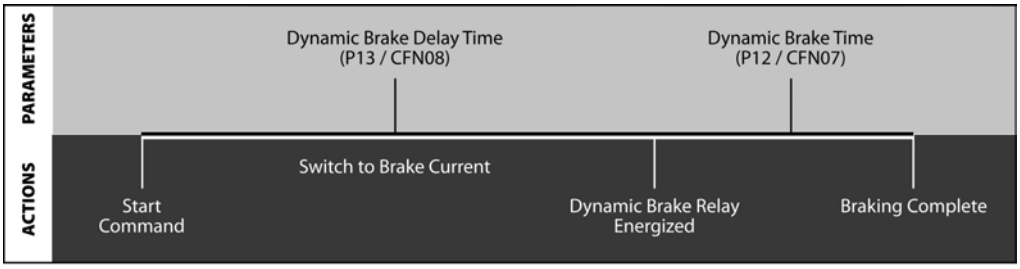
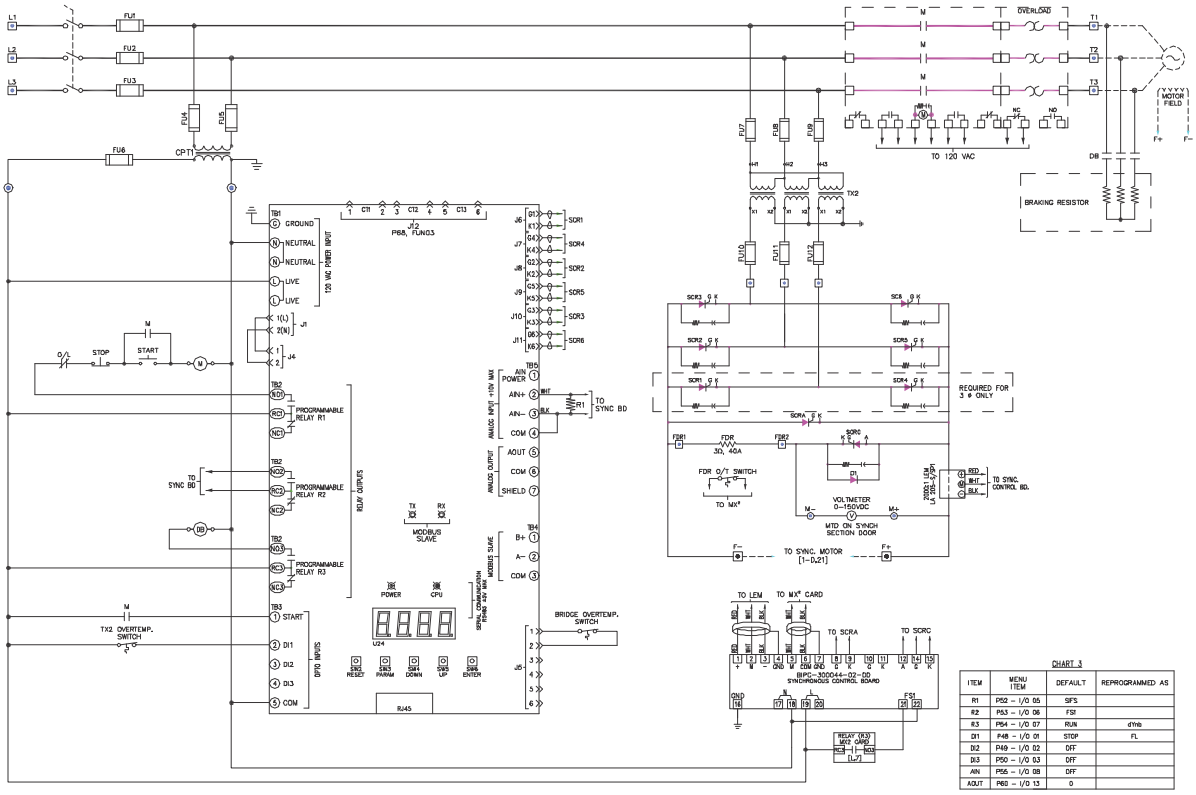


Figure 27: MX2 ATL Synchronous Brushtype with DB Braking Resistor.



The dynamic braking resistor is sized to 3X the motor FLA at rated motor voltage. For example, motor with stator rated 600VAC, 380A, rated 2 starts/hour hot.

Resistor is sized to draw 1140A when 600VAC is applied:

- 600 / (sqrt3 x 1140) = 0.304 ohms/phase Y connected
- 600 / (1140/sqrt3) = 0.912 ohms / phase delta connected

The resistor must be capable of dissipating the energy in the rotating assembly. The energy is calculated as:

$E = 0.0002311 \times I \times rpm^2$, where: I = total inertia in $lb.ft^2$

E = energy in J = w.s


BENSHAW
ADVANCED CONTROLS & DRIVES

8 - Troubleshooting & Maintenance

8.1 *Safety Precautions*

For the safety of maintenance personal, as well as others who might be exposed to electrical hazards associated with maintenance activities, the safety related work practices of NFPA 70E, Part II, should always be followed when working on electrical equipment. Maintenance personnel must be trained in the safety practices, procedures, and requirements that pertain to their respective job assignments.

WARNING: To avoid shock hazard, disconnect main before working on controller, motor, or control devices such as start/stop pushbuttons. Procedures which require parts of the equipment to be energized during troubleshooting, testing, etc, must be performed by properly qualified personnel, using appropriate work practices and precautionary measures as specified in NFPA70, Part II.

CAUTION: Disconnect the controller from the motor before measuring insulation resistance (IR) or the motor windings. Voltages used for insulation resistance testing can cause failure of SCRs. Do not make any measurements on the controller with an IR tester (megger).

8.2 *Preventive Maintenance*

8.2.1 General Information

Preventive maintenance performed on a regular basis will help to ensure that the controller continues to operate reliably and safely. The frequency of preventive maintenance depends upon the type of maintenance, and the installation site environment.

NOTE: Preventive maintenance should always be performed by a trained technician.

8.2.2 Preventive Maintenance

During Commissioning:

- Torque all power connections during commissioning, including factory wired equipment.
- Check all of the control wiring in the package for loose connections.
- If fans are installed, ensure proper operation.

After the controller has been put in operation:

- Re-torque all power connections, including factory wired equipment.
- Inspect the cooling fans after two weeks to ensure proper operation.

After the first month of operation:

- Clean any accumulated dust from the controller using a clean source of compressed air or a vacuum cleaner.
- Re-torque all power connections, then repeat annually.
- Inspect the cooling fans every three months to ensure proper operation.
- Clean or replace any air vent filters on the controller every three months.

NOTE: If mechanical vibrations are present at the installation site, inspect the electrical connections more frequently.

8.3 General Troubleshooting Charts

The following troubleshooting charts can be used to help solve many of the common issues that may occur.

8.3.1 Motor does not start, no output to motor

Condition	Cause	Solution
Display Blank, CPU Heartbeat LED on MX2 board not blinking.	Control voltage absent.	Check for proper control voltage input. Verify fuses and wiring.
	MX2 SEP control board problem.	Consult factory.
Fault Displayed.	Fault Occurred.	See fault code troubleshooting table for more details.
Start command given but nothing happens.	Start/Stop control input problems.	Verify that the start/stop wiring and start input voltage levels are correct.
	Control Source parameters (QST 04–05 / P4–5) not set correctly.	Verify that the parameters are set correctly.
NOL or No Line is displayed and a start command is given, it will fault in F28.	No line voltage has been detected by the MX2 SEP when a start command is given.	Check input supply for inline contactor, open disconnects, open fuses, open circuit breakers, or disconnected wiring.
		Verify that the SCR gate wires are properly connected to the MX2 SEP control board.
		On medium voltage systems, verify wiring of the voltage feedback measurement circuit.
		See fault code troubleshooting table for more details.

8.3.2 During starting, motor rotates but does not reach full speed

Condition	Cause	Solution
Fault Displayed.	Fault Occurred.	See fault code troubleshooting table for more details.

8.3.3 Motor stops unexpectedly while running

Condition	Cause	Solution
Fault Displayed.	Fault Occurred.	See fault code troubleshooting table for more details.
Ready Displayed.	Start command lost.	Verify start command input signal is present or serial communications start command is present.
		Check any permissive that may be wired into the run command (Start/Stop)
Display Blank, Heartbeat LED on MX2 card not blinking.	Control voltage absent.	Check for proper control voltage input. Verify wiring and fuses.
	MX2 control card problem.	Consult factory.

8.3.4 Metering incorrect (Hall Effect)

Condition	Cause	Solution
Current or Voltage meters fluctuating with steady load.	Loose connections.	Shut off all power and check all connections.
	SCR fault.	Verify that the SCRs gate leads are connected properly and the SCRs are ok.
	Load actually is not steady.	Verify that the load is actually steady and that there are not mechanical issues.
	Other equipment on same power feed causing power fluctuations and/or distortion.	Fix cause of power fluctuations and/or distortion.
Current Metering not reading correctly.	HE ratio parameter (FUN03 / P34) set incorrectly.	Verify that the HE ratio parameter is set correctly

8.3.5 Other Situations

Condition	Cause	Solution
Erratic Operation	Loose connections	Shut off all power and check all connections
Controller cooling fans do not operate (When Present)	Fan power supply lost	Verify fan power supply, check fuses.
	Fan wiring problem	Check fan wiring.
	Fan failure	Replace fan.
Analog Output not functioning properly	Voltage/Current output switch (SWI-2) not set correctly	Set switch SW1 to give correct output.
	Wiring problem	Verify output wiring.
	Analog Output Function parameter (I/O09 / P53) set incorrectly	Verify that the Analog Output Function parameter is set correctly.
	Analog Output Offset and/or Span parameters (I/O11 / P55 and I/O10 / P54) set incorrectly	Verify that the Analog Output Span and Offset parameters are set correctly.
	Load on analog output too high	Verify that load on analog output meets the MX2 analog output specifications.
	Ground loop or noise problems	Verify correct grounding of analog output connection to prevent noise and/or ground loops from affecting output.
Remote Keypad does not operate correctly	Keypad cable not plugged in properly or cable is damaged	Verify that the remote keypad cable has not been damaged and that it is properly seated at both the keypad and the MX2 control card.
	Remote display damaged	Replace remote display.
Cannot change parameters	Passcode is set	—
	Controller is running	—
	Modbus is overriding	—

8.4 *Fault Code Table*

The following is a list of possible faults that can be generated by the MX2 SEP controller:

Fault Code	Description	Detailed Description of Fault / Possible Solutions
F01	Incomplete Sequence	Slip percentage (CFN 01 / P2) is set too low.
		Incomplete Sequence Time (QST 03 / P6) is set too low.
F09	Loss of Synchronous	Slip percentage (CFN 01 / P2) is set too low.
		Incomplete Sequence Time (QST 03 / P6) is set too low.
F12	Low Line Frequency	Line frequency below Setpoint (PFN11 / P29) was detected for longer than the Freq Trip Time (PFN12 / P30).
		Verify input line frequency.
		If operating on a generator, check generator speed governor for malfunctions.
		Check input supply for open fuses or open connections.
		Line power quality problem / excessive line distortion.
F13	High Line Frequency	Line frequency above Setpoint (PFN10 / P28) was detected for longer than the Freq Trip Time (PFN12 / P30).
		Verify input line frequency.
		If operating on a generator, check generator speed governor for malfunctions.
		Line power quality problem / excessive line distortion.
F14	Input power not single phase	Three-phase power has been detected when the controller is expecting single-phase power.
		Verify that input power is single phase.
		Verify that single-phase power is connected to the L1 and L3 inputs. Correct wiring if necessary.
		Verify that the SCR gate wires are properly connected to the MX2 SEP control card.
F15	Input power not three phase	Single-phase power has been detected when the controller is expecting three-phase power.
		Verify that input power is three phase. Correct wiring if necessary.
		Verify that the SCR gate wires are properly connected to the MX2 SEP control card.
F21	Low Line L1-L2	Low voltage below the Under voltage Trip Level parameter setting (PFN07 / P25) was detected for longer than the Over/Under Voltage Trip delay time (PFN08 / P26).
		Verify that the actual input voltage level is correct.
		Verify that the Rated Voltage parameter (FUN06 / P23) is set correctly.
		Check input supply for open fuses or open connections.
F22	Low Line L2-L3	Low voltage below the Under voltage Trip Level parameter setting (PFN07 P25) was detected for longer than the Over/Under Voltage Trip delay time (PFN08 / P26).
		Verify that the actual input voltage level is correct.
		Verify that the Rated Voltage parameter (FUN06 / P23) is set correctly.
		Check input supply for open fuses or open connections.
F23	Low Line L3-L1	Low voltage below the Under voltage Trip Level parameter setting (PFN07 / P25) was detected for longer than the Over/Under Voltage Trip delay time (PFN08 / P26).
		Verify that the actual input voltage level is correct.
		Verify that the Rated Voltage parameter (FUN06 / P23) is set correctly.
		Check input supply for open fuses or open connections.

Fault Code	Description	Detailed Description of Fault / Possible Solutions
F24	High Line L1-L2	High voltage above the Over Voltage Trip Level parameter setting (PFN 06 / P24) was detected for longer than the Voltage Trip Time (PFN 08 / P26)
		Verify that the actual input voltage level is correct
		Verify that the Rated Voltage parameter (FUN 06 / P23) is set correctly
F25	High Line L2-L3	High voltage above the Over Voltage Trip Level parameter setting (PFN 06 / P24) was detected for longer than the Voltage Trip Time (PFN 08 / P26)
		Verify that the actual input voltage level is correct
		Verify that the Rated Voltage parameter (FUN06 / P23) is set correctly.
		Check input supply for open fuses or open connections.
F26	High Line L3-L1	High voltage above the Over Voltage Trip Level parameter setting (PFN 06 / P24) was detected for longer than the Voltage Trip Time (PFN 08 / P26)
		Verify that the actual input voltage level is correct.
		Verify that the Rated Voltage parameter (FUN06 / P23) is set correctly.
		Check input supply for open fuses or open connections.
F27	Phase Loss	The MX^2 SEP has detected the loss of one or more input or output phases when the controller was running. Can also be caused by line power dropouts.
		Check input supply for open fuses.
		Check power supply wiring for open or intermittent connections.
		Check motor wiring for open or intermittent connections.
		Check Gate and Cathode connections to MX^2 SEP card.
F28	No Line	No input voltage was detected for longer than the Inline Configuration time delay parameter setting (P49/ I/O12) when a start command was given to the controller.
		If an inline contactor is being used, verify that the setting of the Inline Configuration time delay parameter (I/O12 / P49) allows enough time for the inline contactor to completely close.
		Check input supply for open disconnects, open fuses, open circuit breakers or disconnected wiring.
		Verify that the SCR gate wires are properly connected to the MX2 SEP control card.
		On medium voltage systems, verify wiring of the voltage feedback measurement circuit.
F31	Field Overcurrent	Motor current exceeded the Over Current Trip Level setting (PFN02 / P19) for longer than the Over Current Trip Delay Time setting (PFN03 / P20).
		Check motor wiring for short circuits or ground faults.
		Check motor for short circuits or ground faults.
		Verify that the motor FLA (QST01 / P1) and HE Sensor Ratio (FUN03 / P35) & HE Sensor Turns (FUN04 / P36) settings are correct.
F34	Field Undercurrent	Motor current exceeded the Undercurrent Trip Level (PFN04 / P21) for longer than the Under Current Trip Delay Time (PFN05 / P22).
		Check system for cause of under current condition.
F39	No Current at Run / Open Field during Run	Motor current dropped under the Under Current Trip Level setting (PFN04 / P21) for longer than the Under Current Trip Delay time setting (PFN05 / P22).
		Check system for cause of under current condition.
F40	Open Field at Start	No current was detected in the Field winding during a motor start.
F41	Current at Stop	Check motor wiring for ground faults.
		Check motor for ground faults.
		Megger motor and cabling (disconnect from controller before testing).
		Verify that the Current Setpoint (QST01 / P1) and HE Sensor Ratio (FUN03 / P35) & HE Sensor Turns (FUN04 / P36) settings are correct.

Fault Code	Description	Detailed Description of Fault / Possible Solutions
F48	FS1 or FS2 Contactor Fault	The FS1, FS2 contactor did not close.
		Check wiring to coil of contactor.
		Check feedback wiring from contactor to digital input
		Check Cont Feedback Time (I/O13 / P48).
F49	Inline Contactor Fault	The in-line contactor did not close.
		Check wiring to coil of contactor.
		Check feedback wiring from auxiliary contactor to digital input.
		Check in-line fault delay (I/O12 / P49).
F50	Control Power Low	Low control power (below 90V) has been detected while running.
		Check control power transformer tap setting, fuses (if available).
		Verify that the control power input level is correct, especially during starting when there may be significant line voltage drops.
		Check wiring between control power source and controller.
F51	Current Sensor Offset Error	Indicates that the MX^2 control card self-diagnostics have detected a problem with one or more of the current sensor inputs.
		Verify that the Current Setpoint (QST01 / P1) and HE Sensor Turns (FUN04 / P36) and burden switch settings are correct.
		Verify that no actual current is flowing through any of the controllers CTs when the controller is not running.
F55	BIST Overcurrent fault	During powered BIST, the measured field current is 10% or more over the reference current setpoint.
		Check motor wiring for short circuits or ground faults.
		Check motor for short circuits or ground faults.
		Verify that the Current Setpoint (QST01 / P1), HD Sensor Ratio (FUN03 / P35), and HE Sensor Turns (FUN04 / P36) settings are correct.
		Verify that the SCR gate wires are properly connected to the MX^2 SEP Control card.
F56	BIST Undercurrent fault	During powered BIST, the measured field current is 10% or more below the reference current setpoint.
		Check motor wiring for short circuits or ground faults.
		Check motor for short circuits or ground faults.
		Verify that the Current Setpoint (QST01 / P1), HD Sensor Ratio (FUN03 / P35), and HE Sensor Turns (FUN04 / P36) settings are correct.
		Verify that the SCR gate wires are properly connected to the MX^2 SEP Control card.
		Verify that the wiring between the MX^2 card and the Hall Effect sensor is correct.
F59	External Fault on Stack Input	The MX^2 SEP electronic power stack OL protection has detected an overload condition.
		Thermal switch on Power stack has opened.
F60	External Fault on DIN#1 Input	DI#1 has been programmed as a fault type digital input and the input indicates a fault condition is present.
		Verify that the appropriate Digital Input Configuration parameter has been programmed correctly.
		Verify wiring and level of input.
F61	External Fault on DIN#2 Input	DI#2 has been programmed as a fault type digital input and the input indicates a fault condition is present.
		Verify that the appropriate Digital Input Configuration parameter has been programmed correctly.
		Verify wiring and level of input.

Fault Code	Description	Detailed Description of Fault / Possible Solutions
F62	External Fault on DIN#3 Input	DI#3 has been programmed as a fault type digital input and the input indicates a fault condition is present.
		Verify that the appropriate Digital Input Configuration parameter has been programmed correctly.
		Verify wiring and level of input.
F68	LCD Keypad Stop Button Fault	Indicates that the unit was stopped by pressing the keypad stop.
F81	Keypad Communication Fault	Indicates that communication has been lost with the remote keypad. (This fault normally occurs if the remote keypad is disconnected while the MX2 SEP controller is running. Only connect and disconnect a remote keypad when the control power is off).
		Verify that the remote keypad cable has not been damaged and that its connectors are firmly seated at both the keypad and the MX^2 SEP control card.
		Route keypad cables away from high power and/or high noise areas to reduce possible electrical noise pickup.
F82	Modbus Timeout Fault	Indicates that the controller has lost serial communications. Fault occurs when the controller has not received a valid serial communications within the Communication Timeout parameter (FUN12 / P50) defined time.
		Verify communication parameter settings (FUN10 – FUN13).
		Check wiring between the remote network and the MX^2 SEP control card.
		Examine remote system for cause of communication loss.
F94	CPU Error – SW fault	Typically occurs when attempting to run a version of control software that is incompatible with the MX^2 SEP control card hardware being used. Verify that the software is a correct version for the MX^2 SEP control card being used. Consult factory for more details.
		Fault can also occur if the MX^2 SEP control has detected an internal software problem. Consult factory.
F95	CPU Error – Parameter EEPROM Checksum Fault	The MX^2 SEP found the non-volatile parameter values to be corrupted. Typically occurs when the MX^2 SEP is re-flashed with new software.
		Perform a Factory Parameter reset and then properly set all parameters before resuming normal operation.
		If fault persists after performing a Factory Parameter reset, consult factory.
F96	CPU Error	The MX^2 SEP has detected an internal CPU problem. Replace card.
F97	CPU Error – SW Watchdog Fault	The MX^2 SEP has detected an internal software problem. Replace card
F98	CPU Error	The MX^2 SEP has detected an internal CPU problem. Replace card.
F99	CPU Error – Program EPROM Checksum Fault	The non-volatile program memory has been corrupted. Replace card.
		Consult Factory. Control software must be reloaded in to the MX^2 SEP control card before normal operation can resume.

8.5 *SCR Testing*

8.5.1 Resistance

The SCRs in the controller can be checked with a standard ohmmeter to determine their condition.

Remove power from the controller before performing these checks.

- Check L to F+ for each phase. The resistance should be over 50k ohms.
- Check L to F- for each phase. The resistance should be over 50k ohms
- Check between the gate leads for each SCR (red and white twisted pair). The resistance should be from 8 to 50 ohms.

NOTE: The resistance measurements may not be within these values and the SCR may still be good. The checks are to determine if an SCR is shorted or if the gate in an SCR is shorted or open. An SCR could also still be damaged even though the measurements are within the above specifications.

8.5.2 Voltage

Extreme caution must be observed while performing these checks since the controller has lethal voltages applied while operating.

Using a DC voltmeter, check between the gate leads for each SCR (red and white twisted pair). The voltage should between 0.5 and 2.0 volts.

8.6 *Field Discharge Resistor Sizing*

The induced field voltage (product of induced field in amperes and discharge resistance in ohms) must be between 200 and 1000 VAC at zero and 95% speed. When the motor is between 0% and 95% speed, there is an AC voltage applied. After 95% speed, the DC field will kick in. Refer to the example below.

- Induced field current: 0% speed, 30 A; 95% speed, 17 A
- Recommended field discharge resistance: 25 ohms
    - 25 ohm x 28 A = 700 V (zero speed check)
    - 25 ohm x 15 A = 375 V (95% speed check)

The requirements are met for this example.

If the induced field voltage is greater than 1000 volts, contact the factory.

8.7 *Built-In Self Test (BIST)*

The MX^2 SEP has a line powered test that is used to verify the current transformer's locations and connections and to test for shorted SCRs/power poles, open or non-firing SCRs/power poles, and ground fault conditions.

8.7.1 Powered BIST Tests

The powered BIST tests are designed to be run with normal line voltage applied to the controller and a motor connected. Powered BIST verifies that the power poles are good, the Hall Effect sensor is connected and positioned correctly, and that the motor is connected.

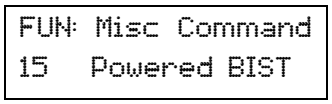
Powered BIST mode can be entered by entering the appropriate value into the FUN 15 – *Miscellaneous Command* user parameter.

NOTE: The load wiring MUST be fully connected before starting the powered BIST tests. Also the motor must be at rest (stopped). Otherwise the powered BIST tests will not function correctly.

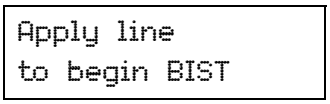
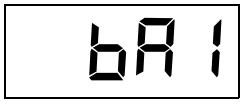
NOTE: Before using the powered BIST test function, the following MX^2 SEP user parameters MUST be set for correct operation of the powered BIST test: Current Setpoint (QST 01 / P1), HE Sensor Ratio (FUN 03 / P35), Hall Effect Sensor Turns (FUN 04 / P36), Phase Order (FUN 05 / P34), Rated Voltage (FUN 06 / P23), and Control Type (FUN 09 / P39).

8.7.2 BIST Programming / Test Instructions

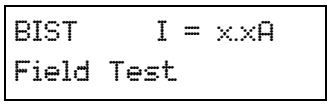
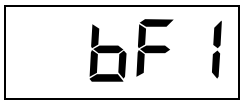
Step 1

LCD Display	*LED Display*
Access FUN 15 then press [ENTER].	Access P59 then press [ENTER].
Increment up to “Powered BIST” then press [ENTER].	Press [UP] button to #6 then press [ENTER].
Powered BIST test will commence.	Powered BIST test will commence.
	

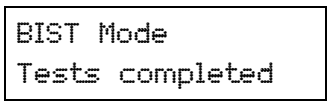
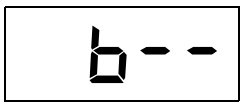
Step 2 - Apply Line
The MX2 SEP will indicate that line power must be applied if line power is not present.

LCD Display (BIST Mode)	**LED Display**
	

Step 3 - DC Field Test
The MX^2 SEP will provide the programmed field current to the motor. Measure the DC current with an ammeter to verify the proper current is being applied. This level will be maintained for 60 seconds before moving to the next step, or the start button can be pressed at any time to move on.

LCD Display (BIST Mode)	**LED Display**
	

Step 4

LCD Display (BIST Mode)	**LED Display**
	

The controller will reset back to normal operation once the BIST is complete.

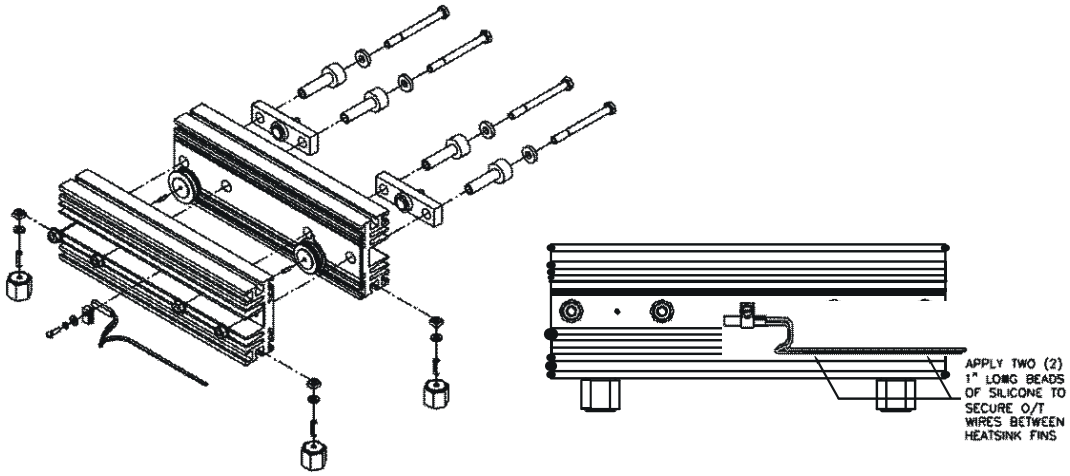
Pressing [ENTER] on the keypad at any time will abort the BIST test.

NOTE: The powered BIST tests will verify that the input phase order is correct. If the measured phase order is not the same as the “Phase Order” (FUN 05 / P34) parameter a phase order fault will occur.

8.8 *SCR Replacement*

This section is to help with SCR replacements on stack assemblies. Please read prior to installation.

8.8.1 Typical Stack Assembly



8.8.2 SCR Removal

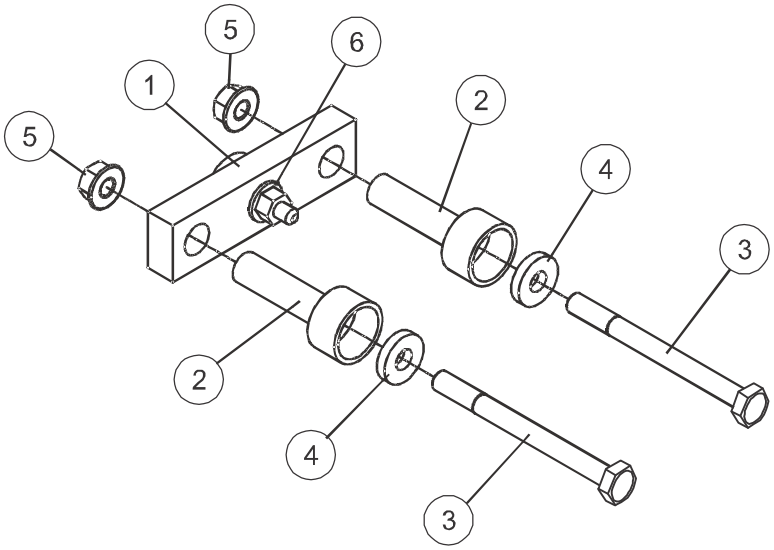
To remove the SCR from the heatsink, loosen the two bolts (3) on the loader bar side of the clamp. Do not turn on the nuts (5). The nuts have a locking ridge that sink into the aluminum heatsink. Do ¼ turns until the SCR comes loose. Remove the SCRs from the heatsink.

NOTE: Do not loosen nut on indicator washer (6). This will change the clamping pressure of the clamp and the clamp will be defective.

8.8.3 SCR Installation

- Coat the faces of the SCRs to be installed with a thin layer of EJC (Electrical Joint Compound).
- Place the SCRs onto the dowel pins. The top SCR will have the cathode to the left and the bottom SCR will have the cathode to the right. The SCR symbol has a triangle that points to the cathode.
- Finger tighten nuts on the bolts.

8.8.4 SCR Clamp



SCR Clamp Parts

Item #	Quantity	Description
1	1	Loader Bar
2	2	Insulator cup
3	2	Bolt
4	2	Washer
5	2	Serrated nut (larger style clamp has 1 support bar)
6	1 or 2	Indicator Washer – *Quantity dependant on style of clamp*

8.8.5 Tightening the Clamp

Finger tighten the clamp. Ensure that both bolts are tightened an equal amount so that the loader bar (item 1) is square in the heatsink. Tighten the bolts equally in 1/8 turn increments until the indicator washer(s) (item 6), which are under the nut(s) in the center of the loader bar, becomes loose indicating the clamp is tight. On the loader bars with two indicator washers, it may be necessary to tighten or loosen one side of the clamp to get both indicator washers free.

8.8.6 Tightening the SCR

After the SCRs have been replaced, conduct the resistance test as outlined in Section 8.5.

Appendix A - Alarm Codes

Alarm Codes

The following is a list of all MX^2 alarm codes. The alarm codes correspond to associate fault codes. In general, an alarm indicates a condition that if continued, will result in the associated fault.

Alarm Code	Description	Notes
A02	Motor Overload Alarm	This occurs when the motor thermal content reaches 90%. The MX^2 SEP trips when it reaches 100%. The alarm continues until the overload trip lockout is reset
A10	Phase Rotation not ABC	This alarm exists while the MX^2 SEP is stopped, line voltage is detected and phase sensitivity parameter is set to ABC. If a start is commanded, a Fault 10 occurs.
A11	Phase Rotation not CBA	This alarm exists while the MX^2 SEP is stopped, line voltage is detected and phase sensitivity parameter is set to CBA. If a start is commanded, a Fault 11 occurs.
A12	Low Line Frequency	This alarm exists when the MX^2 SEP has detected a line frequency below the user defined low line frequency level. The alarm continues until either the line frequency changes to be in range or the fault delay timer expires.
A13	High Line Frequency	This alarm exists when the MX^2 SEP has detected a line frequency above the user defined high line frequency level. The alarm continues until either the line frequency changes to a valid frequency or the fault delay timer expires.
A14	Input power not single phase	This alarm exists while the MX^2 SEP is stopped, set to single phase mode, and line voltage is detected that is not single phase. If a start is commanded, a Fault 14 occurs.
A15	Input power not three phase	This alarm exists while the MX^2 SEP is stopped, set to a three-phase mode, and single-phase line voltage is detected. If a start is commanded, a Fault 15 occurs.
A21	Low Line L1–L2	This alarm exists while the MX^2 SEP is stopped and low line voltage is detected. If a start is commanded, a Fault 21 may occur.
A22	Low Line L2–L3	This alarm exists while the MX^2 SEP is stopped and low line voltage is detected. If a start is commanded, a Fault 22 may occur.
A23	Low Line L3–L1	This alarm exists while the MX^2 SEP is stopped and low line voltage is detected. If a start is commanded, a Fault 23 may occur.
A24	High Line L1–L2	This alarm exists while the MX^2 SEP is stopped and high line voltage is detected. If a start is commanded, a Fault 24 may occur.
A25	High Line L2–L3	This alarm exists while the MX^2 SEP is stopped and high line voltage is detected. If a start is commanded, a Fault 25 may occur.
A26	High Line L3–L1	This alarm exists while the MX^2 SEP is stopped and high line voltage is detected. If a start is commanded, a Fault 26 may occur.
A27	Phase Loss	This alarm exists while the MX^2 SEP is running and a phase loss condition is detected, but the delay for the fault has not yet expired. When the delay expires, a Fault 27 occurs.
A28	No Line	This alarm exists while the MX^2 SEP needs to be synchronized or is trying to sync to the line and no line is detected.
A31	Overcurrent	This alarm exists while the MX^2 SEP is running and the average current is above the defined threshold, but the delay for the fault has not yet expired. When the delay expires, a Fault 31 occurs.
A34	Undercurrent	This alarm exists while the MX^2 SEP is running and the average current is below the defined threshold, but the delay for the fault has not yet expired. When the delay expires, a Fault 34 occurs.

Alarm Code	Description	Notes
A37	Current Imbalance	This alarm exists while the MX^2 SEP SEP is running and a current imbalance above the defined threshold is detected, but the delay for the fault has not yet expired. When the delay expires, a Fault 37 occurs.
A38	Ground Fault	This alarm exists while the MX^2 SEP is running and a ground current above the defined threshold is detected, but the delay for the fault has not yet expired. When the delay expires, a Fault 38 occurs.
A47	Stack Over temperature Alarm	This occurs when the stack thermal rises above 105%.
A60	External Alarm on DI 1 Input	This occurs when a digital input is in its fault state but before the fault state has expired.
A61	External Alarm on DI 2 Input	
A62	External Alarm on DI 3 Input	
A71	Analog Input Level Trip Alarm	This alarm exists if the analog input exceeds the defined threshold, but the delay for the fault has not yet expired. When the delay expires, a Fault 71 occurs.

Appendix B - Fault Codes

Fault Codes

Fault Code	Description	Controlled Fault Stop	Shunt Trip Fault	Auto-Reset Allowed
F00	No fault	—	—	—
F01	Incomplete Sequence	Y	N	Y
F09	Loss of Synchronization	Y	N	Y
F12	Low Line Frequency	N	N	Y
F13	High Line Frequency	N	N	Y
F14	Input power not single phase	N	N	Y
F15	Input power not three phase	N	N	Y
F21	Low Line L1-L2	Y	N	Y
F22	Low Line L2-L3	Y	N	Y
F23	Low Line L3-L1	Y	N	Y
F24	High Line L1-L2	Y	N	Y
F25	High Line L2-L3	Y	N	Y
F26	High Line L3-L1	Y	N	Y
F27	Phase Loss	N	N	Y
F28	No Line	N	N	Y
F31	Field Overcurrent	Y	N	Y
F34	Field Undercurrent	Y	N	Y
F39	No Current at Run / Open Field during Run	N	N	Y
F40	Open Field at Start	N	N	Y
F41	Current at Stop	N	Y	N
F48	FS1 or FS2 Contactor Fault	Y	N	N
F49	Inline Contactor Fault	Y	N	N
F50	Control Power Low	N	N	Y
F51	Current Sensor Offset Error	—	Y	N
F55	BIST Overcurrent fault	N	N	N
F56	BIST Undercurrent fault	N	N	N
F59	External Fault on Stack Input	N	N	Y
F60	External Fault on DIN#1 Input	N	N	Y
F61	External Fault on DIN#2 Input	N	N	Y
F62	External Fault on DIN#3 Input	N	N	Y
F68	LCD Keypad Stop Button Fault	Y	N	N
F81	Keypad Communication Fault	Y	N	N
F82	Modbus Timeout Fault	Y	N	Y
F94	CPU Error - SW fault	N	N	N
F95	CPU Error - Parameter EEPROM Checksum Fault	N	N	N
F96	CPU Error - Illegal Instruction Trap	N	Y	N
F97	CPU Error - SW Watchdog Fault	N	Y	N
F98	CPU Error - Spurious Interrupt	N	N	N
F99	CPU Error - Program EPROM Checksum Fault	N	N	N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Appendix C - Replacement Parts

Replacement Parts

Description	Part Number	Size	Quantity
LCD Display (small)	KPMX3SLCD	H=63mm(2.48"), W=101mm(4")	
LCD Display (large)	KPMX3LLCD	H=77mm(3.03"), W=127mm(5")	
LCD display cable	RI-100008-00 RI-100009-00	3' or 1 meter 6' or 2 meter	
Remote RTD Module	SPR-100P	—	
Communication Modules	Consult Factory	—	
Cooling Fans	—	4" – 6"	
Stack O/T Switch	—	—	3
Hall Effect Ratio	1000:1, 2000:1, 5000;1	—	
MX^2 SEP Card	PC-300063-01	—	
DV/DT Board	PC-300048-01-02	—	3
Control Power Transformers	VA & Voltage Specific	Consult Factory	
SCRs	BISCR5016x BISCR10016x BISCR13216x BISCR16116x BISCR25016x	—	3 / Controller
	BISCR66018x BISCR88018x BISCR150018x		6 / Controller
Contactors	RSC-9-6AC120 RSC-12-6AC120 RSC-18-6AC120 RSC-22-6AC120 RSC-32-6AC120 RSC-40-6AC120 RSC-50-6AC120 RSC-75-6AC120 RSC-85-6AC120 RSC-85/4-6AC-120 RSC-100-4120 RSC-125-4120 RSC-150-4120 RSC-180-4120 RSC-220-4120 RSC-300-4120 RSC-400-4120 RSC-600-4120 RSC-800-4120	—	


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Appendix D - EU Declaration of Conformity

EU Declaration of Conformity

According to the EMC — Directive 89/336/EEC, as Amended by 92/31/EEC and 93/68/EEC.

Product Category Motor Controller

Product Type Reduced Voltage Solid State Motor Controller

Model Numbers

MX2SEP-125VDC-025A-1-S-C	MX2SEP-250VDC-025A-1-S-C
MX2SEP-125VDC-050A-1-S-C	MX2SEP-250VDC-050A-1-S-C
MX2SEP-125VDC-100A-1-S-C	MX2SEP-250VDC-100A-1-S-C
MX2SEP-125VDC-200A-1-S-C	MX2SEP-250VDC-200A-1-S-C
MX2SEP-125VDC-400A-1-S-C	MX2SEP-250VDC-400A-1-S-C
MX2SEP-125VDC-600A-1-S-C	MX2SEP-250VDC-600A-1-S-C

Manufacturer's Name Benshaw, Inc.

Manufacturer's Address 615 Alpha Drive
Pittsburgh, PA 15238
United States of America

The before mentioned products comply with the following EU directives and Standards:

Safety UL 508 Standard for Industrial Control Equipment covering devices for starting, stopping, regulating, controlling, or protecting electric motors with ratings of 1500 volts or less.

Electromagnetic Compatibility

- EN 50081-2 Emissions Radiated/Conducted
- EN 55011/05.98+A1:1999
- EN 50082-2 Immunity/Susceptibility which includes:
- EN 61000-4-2 Electrostatic Discharge
- EN 61000-4-3 Radiated RF
- EN 61000-4-4 Electrical Fast Transient/Burst
- EN 61000-4-6 Injected Currents

The products referenced above are for the use of control of the speed of AC motors. The use in residential and commercial premises (Class B) requires an optional EMC series filter. Via internal mechanisms and Quality Control, it is verified that these products conform to the requirements of the Directive and applicable standards.

Pittsburgh, PA USA - 1 January 2008

Neil Abrams
Quality Control Manager


BENSHAW
ADVANCED CONTROLS & DRIVES

Appendix E - MODBUS Register Map

Modbus Register Map

NOTE: All information may be accessed either through the Input registers (30000 addresses), or through the Holding registers (40000 addresses).

Absolute Register Address	Description	R/W	Range	Units
30020/40020	Controller Control	R/W	Bit Mask: Bit 0: Run/Stop Bit 1: Fault Reset Bit 13: Relay 3 Bit 14: Relay 2 Bit 15: Relay 1	—
30021/40021	Controller Status	R	Bit Mask: Bit 0: Ready Bit 1: Running Bit 2: Synced Bit 3: Alarm Bit 4: Fault Bit 5: Lockout	—
30022/40022	Input Status	R	Bit Mask: Bit 0: Start Bit 1: DI 1 Bit 2: DI 2 Bit 3: DI 3	—
30023/40023	Alarm Status 1	R	Bit Mask: Bit 0: “A 09” – Loss of Sync Bit 1: Not Used, Reserved Bit 2: Not Used, Reserved Bit 3: "A 12" – Low Line Frequency Bit 4: "A 13" – High Line Frequency Bit 5: "A 14" – Phase rotation not SPH Bit 6: "A 15" – Phase rotation not 3 Phase Bit 7: "A 21" – Low Line L1 - L2 Bit 8: "A 22" – Low Line L2 - L3 Bit 9: "A 23" – Low Line L3 - L1 Bit 10: "A 24" – High Line L1 - L2 Bit 11: "A 25" – High Line L2 - L3 Bit 12: "A 26" – High Line L3 - L1 Bit 13: "A 27" – Phase Loss Bit 14: Not Used, Reserved Bit 15: "noL" – No line	—
30024/40024	Alarm Status 2	R	Bit 0: "A 31" – Field Overcurrent Bit 1: "A 34" – Field Undercurrent Bit 2: "A 39" – Open Field / No Current at Run Bits 3 – 15: *Not Used, Reserved*	—
30025/40025	Lockout Status	—	Bit 0: Not Used, Reserved Bit 1: Not Used, Reserved Bit 2: "L CP" – Control Power	—
30026/40026	Input Current	—	—	Arms
30027/40027	Average Voltage	—	—	Vrms
30028/40028	L1–L2 Voltage	—	—	Vrms
30029/40029	L2–L3 Voltage	—	—	Vrms
30030/40030	L3–L1 Voltage	—	—	Vrms

Absolute Register Address	Description	R/W	Range	Units
30031/40031	Phase Current	—	0: no line 1: ABC 2: CBA 3: SPH	—
30032/40032	Line Frequency	—	230 – 720, or 0 if no line	0.1 Hz
30033/40033	Analog Input %	—	-1000 to +1000 (in 16-bit two's compliment signed format)	0.1%
30034/40034	Motor Slip %	—	0 – 1000	0.1%
30035/40035	Running Time	—	0 – 65535	hours
30036/40036	Running Time	—	0 – 59	minutes
30037/40037	Number of Starts	—	0 – 65535	
30100/40100	Current Setpoint Parameter	R/W	1 – 1000	Arms
30101/40101	Slip Percentage	R/W	5 – 100	0.1%
30102/40102	Field Application Delay Enable	R/W	0: Disable 1: Enable	—
30103/40103	Field Application Delay	R/W	1 – 200	0.1 sec
30104/40104	Field Forcing Level	R/W	50 - 125	%
30105/40105	Field Forcing Enable	R/W	0: Disable 1: Enable	—
30106/40106	Field Forcing Time	R/W	1 – 900	0.1 sec
30107/40107	Incomplete Sequence Time	R/W	1 – 200	Sec
30108/40108	Pullout Mode	R/W	0: fault immediately 1: retry after delay 2: ride through	—
30109/40109	Pullout Delay Time	R/W	1 – 30	Sec
30110/40110	Resync Retry Attempts	R/W	1 – 10	—
30111/40111	Stop Mode	R/W	0: Coast 1: Dyn brake	—
30112/40112	Dynamic Brake Level	R/W	10 – 110	% RFA
30113/40113	Dynamic Brake Time	R/W	1 – 180	Sec
30114/40114	Dynamic Brake Delay	R/W	1 – 50	0.1 Sec
30115/40115	Inching Field Current	R/W	75 - 125	% RFA
30116/40116	Inching Field Application Delay Time	R/W	0 – 900	0.1 Sec
30117/40117	Inching UTS Relay Delay	R/W	1 – 900	0.1 Sec
30118/40118	Meter	R/W	0: Status 1: Ave Current 2: Ave Voltage L-L 3: L1-L2 Voltage 4: L2-L3 Voltage 5: L3-L1 Voltage 6: Phase Order 7: Slip % 8: Line Frequency 9: Analog Input 10: Analog Output 11: Running Days 12: Running Hours 13: Starts	—
30119/40119	Open Field Trip Enable	R/W	0: Disable 1: Enable	—
30120/40120	Open Field Trip Time	R/W	1 – 900	Sec
30121/40121	Overcurrent Trip Enable	R/W	0: Disable 1: Enable	—

Absolute Register Address	Description	R/W	Range	Units
30122/40122	Overcurrent Trip Level	R/W	50 – 200	% RFA
30123/40123	Overcurrent Trip Delay Time	R/W	1 – 900	0.1 Sec
30124/40124	Undercurrent Trip Enable	R/W	0: Disable 1: Enable	—
30125/40125	Undercurrent Trip Level	R/W	5 – 99	% RFA
30126/40126	Undercurrent Trip Delay Time	R/W	1 – 900	0.1 Sec
30127/40127	Rated RMS Voltage	R/W	0: 100 1: 110 2: 120 3: 200 4: 208 5: 220 6: 230 7: 240 8: 320 9: 350 10: 380 11: 400 12: 415 13: 440 14: 460 15: 480 16: 500 17: 525 18: 575 19: 600 20: 660 21: 690 22: 800 23: 1000 24: 1140	Vrms
30128/40128	Over Voltage Trip Enable	R/W	0: Disable 1: Enable	—
30129/40129	Over Voltage Trip Level	R/W	1 – 40	%
30130/40130	Under Voltage Trip Enable	R/W	0: Disable 1: Enable	—
30131/40131	Under Voltage Trip Level	R/W	1 – 40	%
30132/40132	Over/Under Voltage Delay Time	R/W	1 – 900	0.1 Sec
30133/40133	Phase Loss Delay Time	R/W	1 – 50	0.1 Sec
30134/40134	High Line Freq. Trip Level	R/W	24 – 72	Hz
30135/40135	Low Line Freq. Trip Level	R/W	23 – 71	Hz
30136/40136	High/Low Line Freq. Delay Time	R/W	1 – 900	0.1 Sec
30137/40137	Auto Fault Reset Timer Enable	R/W	0: Disable 1: Enable	—
30138/40138	Auto Fault Reset Delay Time	R/W	1 – 900	Sec
30139/40139	Auto Fault Reset Cnt Enable	R/W	0: Disable 1: Enable	—
30140/40140	Auto Fault Reset Cnt	R/W	1 – 10	—
30141/40141	Input Phase Sensitivity	R/W	0: AbC 1: Cba 2: InS 3: SPH	—
30142/40142	Hall Effect Ratio (x:1)	R/W	0: 1000 1: 2000 2: 5000	—
30143/40143	Hall Effect Turns	R/W	1 – 10	—

Absolute Register Address	Description	R/W	Range	Units
30144/40144	Local Control Source	R/W	0: Terminal 1: Network	—
30145/40145	Remote Control Source	R/W	0: Terminal 1: Network	—
30146/40146	Controller Type	R/W	0: Field Controller 1: Brushless Controller 2: Current Controller 3: Power Factor Control 4: Power Factor Control Brushless	—
30147/40147	DI 1 Function	R/W	0: Off 1: Stop 2: Prestart Monitor 3: Inching 4: Fault High 5: Fault Low 6: Fault Reset 7: FS1 Confirm 8: FS2 Confirm 9: Field Force 10: Field Apply 11: Brake enable 12: Brake disable 13: Inline confirm 14: Local/Remote Control Source	—
30148/40148	DI 2 Function			
30149/40149	DI 3 Function			
30150/40150	DI Trip Time	R/W	1 – 900	0.1 Sec
30151/40151	Relay 1 Function	R/W	0: Off 1: Faulted FS 2: Faulted NFS 3: Running 4: Synced 5: Inching 6: Inching UTS 7: Alarm 8: Ready 9: Locked Out 10: Overcurrent 11: Undercurrent 12: Shunt Trip FS 13: Shunt Trip NFS 14: Field supply contactor 15: Field discharge resistor contactor 16: Field Contactor Aux. 17: Dyn. Braking 18: Cooling Fan	—
30152/40152	Relay 2 Function			
30153/40153	Relay 3 Function			
30154/40154	FCA Delay Enable	R/W	0: Disable 1: Enable	—
30155/40155	FCA Delay	R/W	1 – 900	0.1 Sec
30156/40156	Field Contactor Feedback Time	R/W	1 – 50	0.1 Sec
30157/40157	Inline Enable	R/W	0: Disable 1: Enable	—
30158/40158	Inline Configuration	R/W	10 – 100	0.1 Sec
30159/40159	Modbus Timeout Enable	R/W	0: Disable 1: Enable	—
30160/40160	Modbus Timeout	R/W	1 – 120	Sec
30161/40161	Analog Output #1 Function	R/W	0: OFF (no output) 1: Ave. Current (0 – 200% RFA) 2: Ave. Voltage (0 – 150% Rated Voltage) 3: Motor Slip % 4: Analog Input 5: Output Voltage (based on firing angle) 6: Calibrate (full 100% output)	—

Absolute Register Address	Description	R/W	Range	Units
30162/40162	Analog Output #1 Span	R/W	1 – 125	%
30163/40163	Analog Output #1 Offset	R/W	0 – 99	%
30164/40164	Auto Start	R/W	0: Disabled 1: Power 2: Fault 3: Power and Fault	-
30165/40165	Keypad Stop Disable	R/W	0: Disable 1: Enable	-
30166/40166	Miscellaneous Command	R/W	0: No command 1: Reset Run Time 2: Reflash Mode 3: Store Parameters 4: Load Parameters 5: Factory Reset 6: Powered BIST	-
30167/40167	Rated PF	R/W	1–99 = -0.01 to -0.99 lag 100–199 = 1.00 - +0.01 lead	-
30168/40168	Minimum Field current under PF control	R/W	40 – 100	%
30169/40169	Software Part Number	R	Displays the software part and revision number	—
30601/40601	Fault Code – Most Recent Fault Log Entry	R	—	—
30602/40602	Fault Code – 2nd Most Recent Fault Log Entry	R	—	—
30603/40603	Fault Code – 3rd Most Recent Fault Log Entry	R	—	—
30604/40603	Fault Code – 4th Most Recent Fault Log Entry	R	—	—
30605/40603	Fault Code – 5th Most Recent Fault Log Entry	R	—	—
30606/40603	Fault Code – 6th Most Recent Fault Log Entry	R	—	—
30607/40603	Fault Code – 7th Most Recent Fault Log Entry	R	—	—
30608/40603	Fault Code – 8th Most Recent Fault Log Entry	R	—	—
30609/40603	Fault Code – 9th Most Recent Fault Log Entry	R	—	—
30611/40611	System State – Most Recent Fault Log Entry	R	—	—
30612/40612	System State – 2nd Most Recent Fault Log Entry	R	—	—
30613/40613	System State – 3rd Most Recent Fault Log Entry	R	—	—
30614/40614	System State – 4th Most Recent Fault Log Entry	R	—	—
30615/40615	System State – 5th Most Recent Fault Log Entry	R	—	—
30616/40616	System State – 6th Most Recent Fault Log Entry	R	—	—
3061740617	System State – 7th Most Recent Fault Log Entry	R	—	—
30618/40618	System State – 8th Most Recent Fault Log Entry	R	—	—

Absolute Register Address	Description	R/W	Range	Units
30619/40619	System State – 9th Most Recent Fault Log Entry	R	—	—
30621/40621	Current – Most Recent Fault Log Entry	R	—	Arms
30622/40622	Current – 2nd Most Recent Fault Log Entry	R	—	Arms
30623/40623	Current – 3rd Most Recent Fault Log Entry	R	—	Arms
30624/40624	Current – 4th Most Recent Fault Log Entry	R	—	Arms
30625/40625	Current – 5th Most Recent Fault Log Entry	R	—	Arms
30626/40626	Current – 6th Most Recent Fault Log Entry	R	—	Arms
30627/40627	Current – 7th Most Recent Fault Log Entry	R	—	Arms
30628/40628	Current – 8th Most Recent Fault Log Entry	R	—	Arms
30629/40629	Current – 9th Most Recent Fault Log Entry	R	—	Arms
30631/40631	Voltage L1 – Most Recent Fault Log Entry	R	—	Vrms
30632/40632	Voltage L1 – 2nd Most Recent Fault Log Entry	R	—	Vrms
30633/40633	Voltage L1 – 3rd Most Recent Fault Log Entry	R	—	Vrms
30634/40634	Voltage L1 – 4th Most Recent Fault Log Entry	R	—	Vrms
30635/40635	Voltage L1 – 5th Most Recent Fault Log Entry	R	—	Vrms
30636/40636	Voltage L1 – 6th Most Recent Fault Log Entry	R	—	Vrms
30637/40637	Voltage L1 – 7th Most Recent Fault Log Entry	R	—	Vrms
30638/40638	Voltage L1 – 8th Most Recent Fault Log Entry	R	—	Vrms
30639/40639	Voltage L1 – 9th Most Recent Fault Log Entry	R	—	Vrms
30641/40641	Voltage L2 – Most Recent Fault Log Entry	R	—	Vrms
30642/40641	Voltage L2 – 2nd Most Recent Fault Log Entry	R	—	Vrms
30643/40641	Voltage L2 – 3rd Most Recent Fault Log Entry	R	—	Vrms
30644/40641	Voltage L2 – 4th Most Recent Fault Log Entry	R	—	Vrms
30645/40641	Voltage L2 – 5th Most Recent Fault Log Entry	R	—	Vrms
30646/40641	Voltage L2 – 6th Most Recent Fault Log Entry	R	—	Vrms
30647/40641	Voltage L2 – 7th Most Recent Fault Log Entry	R	—	Vrms
30648/40641	Voltage L2 – 8th Most Recent Fault Log Entry	R	—	Vrms

Absolute Register Address	Description	R/W	Range	Units
30649/40641	Voltage L2 – 9th Most Recent Fault Log Entry	R	—	Vrms
30651/40651	Voltage L3 – Most Recent Fault Log Entry	R	—	Vrms
30652/40652	Voltage L3 – 2nd Most Recent Fault Log Entry	R	—	Vrms
30653/40653	Voltage L3 – 3rd Most Recent Fault Log Entry	R	—	Vrms
30654/40654	Voltage L3 – 4th Most Recent Fault Log Entry	R	—	Vrms
30655/40655	Voltage L3 – 5th Most Recent Fault Log Entry	R	—	Vrms
30656/40656	Voltage L3 – 6th Most Recent Fault Log Entry	R	—	Vrms
30657/40657	Voltage L3 – 7th Most Recent Fault Log Entry	R	—	Vrms
30658/40658	Voltage L3 – 8th Most Recent Fault Log Entry	R	—	Vrms
30659/40659	Voltage L3 – 9th Most Recent Fault Log Entry	R	—	Vrms
30661/40661	Line Period – Most Recent Fault Log Entry	R	—	micro-seconds
30662/40662	Line Period – 2nd Most Recent Fault Log Entry	R	—	micro-seconds
30663/40663	Line Period – 3rd Most Recent Fault Log Entry	R	—	micro-seconds
30664/40664	Line Period – 4th Most Recent Fault Log Entry	R	—	micro-seconds
30665/40661	Line Period – 5th Most Recent Fault Log Entry	R	—	micro-seconds
30666/40661	Line Period – 6th Most Recent Fault Log Entry	R	—	micro-seconds
30667/40661	Line Period – 7th Most Recent Fault Log Entry	R	—	micro-seconds
30668/40661	Line Period – 8th Most Recent Fault Log Entry	R	—	micro-seconds
30669/40669	Line Period – 9th Most Recent Fault Log Entry	R	—	micro-seconds
30671/40671	Software State – Most Recent Fault Log Entry	R	—	—
30672/40672	Software State – 2nd Most Recent Fault Log Entry	R	—	—
30673/40673	Software State – 3rd Most Recent Fault Log Entry	R	—	—
30674/40674	Software State – 4th Most Recent Fault Log Entry	R	—	—
30675/40675	Software State – 5th Most Recent Fault Log Entry	R	—	—
30676/40676	Software State – 6th Most Recent Fault Log Entry	R	—	—
30677/40677	Software State – 7th Most Recent Fault Log Entry	R	—	—
30678/40678	Software State – 8th Most Recent Fault Log Entry	R	—	—

Absolute Register Address	Description	R/W	Range	Units
30679/40679	Software State – 9th Most Recent Fault Log Entry	R	—	—
30681/40681	Motor Slip % – Most Recent Fault Log Entry	R	—	—
30682/40682	Motor Slip % – 2nd Most Recent Fault Log Entry	R	—	—
30683/40683	Motor Slip % – 3rd Most Recent Fault Log Entry	R	—	—
30684/40684	Motor Slip % – 4th Most Recent Fault Log Entry	R	—	—
30685/40685	Motor Slip % – 5th Most Recent Fault Log Entry	R	—	—
30686/40686	Motor Slip % – 6th Most Recent Fault Log Entry	R	—	—
30687/40687	Motor Slip % – 7th Most Recent Fault Log Entry	R	—	—
30688/40688	Motor Slip % – 8th Most Recent Fault Log Entry	R	—	—
30689/40689	Motor Slip % – 9th Most Recent Fault Log Entry	R	—	—

Control Register:

Bit 0 — Run/Stop	0 to 0: Stop 0 to 1: Start 1 to 1: No action 1 to 0: Stop
Bit 1 — Fault Reset	0 to 0: No action 0 to 1: Fault Reset 1 to 1: No action 1 to 0: No action
Bit 13 — Relay 3	0 to 0: No action 0 to 1: Relay 1 energized when programmed as OFF 1 to 1: No action 1 to 0: Remote Relay 1 de-energized when programmed as OFF
Bit 14 — Relay 2	Same as above
Bit 15 — Relay 1	Same as above

The control source must be serial for the controller to be started through Modbus. The Run/Stop bit must transition from 0 to 1 for a start to occur. If the controller stops due to a fault, the action of the controller depends on the state of the Auto Start parameter (I/O 27).

The fault reset bit must transition from 0 to 1 for a fault to be reset.

If any of the programmed digital inputs are programmed as Local/Remote inputs, then the local/Remote bit has no effect.

When the relays are programmed as “Off”, the relay bits may be written in order to control the relays. When the relays are programmed for any function other than “Off” (Fault, Run, UTS for example), then the bits may be read to determine the state of the relays.

Status Register

Bit 0 — Ready	0: Initializing *or* Faulted and Braking *or* Faulted and Stopped *or* Lockout 1: Otherwise
Bit 1 — Running	0: Run Relay not energized 1: Run Relay energized
Bit 2 — Synced	0: Sync Relay not energized 1: Sync Relay energized
Bit 3 — Alarm	0: No alarm conditions 1: 1 or more alarm conditions
Bit 4 — Fault	0: Fault Relay energized (No Fault Condition) 1: Fault Relay not energized (Fault Condition)
Bit 5 — Lockout	0: Start or Fault Reset not locked out. 1: Start or Fault Reset locked out. Possible cause: Overload Lockout State

Watts, VA, vars, and kW hour Registers

Meter registers present 32 bit meters in two consecutive 16 bit registers. The least significant 16 bits are in the first register, followed by the most significant 16 bits in the second register.

Reading the least significant register latches data into the most significant register to enable the data to remain synchronized between the two.

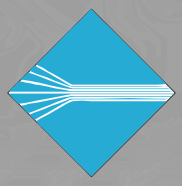
Parameter Registers

For those parameters that can be set either to “Off”, or some value within a range (many of the protection parameters, for example), there are two Modbus registers. One is an “enable” register, and the other sets the value within the range.


BENSHAW
ADVANCED CONTROLS & DRIVES

Publication History

Revision	Date	ECO#
00	12/15/06	Initial Release
01	12/04/15	E4926



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