MICROFUSION

SCR Power Controller

USER'S MANUAL

APPENDIX E: 1Ø PART NUMBERS

uF1 □□□□ - □ - □□□□□

Board Type
SX = Standard
HX = High Performance

Terminal
L = Lug (100 - 400 A)
T = Pluggable Terminal Block (8 - 80 A)
R = Ring Terminal[1] (8 - 80 A)

Frame Style
A = 16 - 32 A (Panel Mount / DIN Rail)
B = 50 - 80 A (Panel Mount / DIN Rail)
E = 8 A (Panel Mount / DIN Rail)
G = 100 - 160 A (Panel Mount)
H = 200 - 240 A (Panel Mount)
I = 320 - 400 A (Panel Mount)

Option Board
0 = None
I = EtherNet/IP
E = Modbus TCP
N = PROFINET

Amp Size
8 = 8 A[2]
16 = 16 A
32 = 32 A
50 = 50 A
80 = 80 A
100 = 100 A
130 = 130 A
160 = 160 A
200 = 200 A
240 = 240 A
320 = 320 A
400 = 400 A

Performance
Available with SX:
S = Standard
L = Adjustable Current Limit and Current Feedback
Available with HX:
L = Adjustable Current Limit, Current Feedback, Load Voltage Feedback, and Voltage Limit.
P = Load Voltage Feedback, True RMS Power Control, Current Limit, Power Limit, High Resolution Control Loop

I/O
0 = None[3]
1 = Alarm Relay (1x Form C)
2 = General Purpose Input, Analog Input Channel 2, Pusle Width Modulation Input[3]
3 = Alarm Relay and General Purpose Input, Analog Input Channel 2, Pulse Width Modulation
4 = Isolated I/O[3]
5 = Isolated I/O with Alarm Relay
6 = Isolated I/O with Gen. Purpose Input, Analog Input Channel 2, Pulse Width Modulation[3]
7 = Isolated I/O with Alarm Relay and Gen. Purpose Input, Analog Input Channel 2/ Pulse Width Modulation

Retransmits
0 = None
R = Retransmits[2] (Two 16-bit analog retransmits for Voltage, Load Resistance, Current, and Power)

Sync
0 = None
S = Digital SYNC - GUARD™

Zero Cross Transformer Mode (ZCT)
0 = None
Z = Zero Cross Transformer Mode[2]

[1]Contact factory for availablitiy
[2]Only available with HX type board
[3]Only applicable for SX; Alarm Relay is standard for HX

1. OVERVIEW

MicroFUSION is an ultra-compact high-performance microprocessor-based power controller, available in single phase, three phase - 4 SCR, or three phase 6 SCR models to control AC loads. Resistive or transformer-connected loads can be controlled in either Phase Angle, Zero Cross, Zero Cross Transformer (ZCT) Mode, HiPER, and Fast Zero Cross. Output is controlled linearly with respect to command signal and can be set to the average or RMS value of the voltage and current, true instantaneous power, or external feedback.

MicroFUSION Series power controllers are available in current ratings from 8-400 Amps AC. Auto-ranging voltage circuitry enables main supply voltage from 24-600* VAC (45- 65 Hz), eliminating the need for hardware jumpers or stocking multiple controllers for international voltages. A separate 24 Vdc power source supplies the control electronics and maintains critical communications to your control system when the mains are absent. Front facing Status LEDs make operation and troubleshooting simple. A plug-n-play USB interface and free Control Concepts, Inc. Control Panel Software which is compatible with PCs, Tablets, and Laptops further simplifies installing and configuring the controller to its intended application. Controller settings can be duplicated simply by loading a configuration file saved from a previous unit.

Setpoints can be controlled through the standard analog or optional digital fieldbus interface. The analog setpoint signal ranges are factory set to a range of 0 - 5 Vdc and 4 - 20 mA, both of which are field scalable from 0 - 10 Vdc or 0 - 20 mA. The fieldbus interface options include EtherNet/IP, EtherCAT, PROFINET, or Modbus TCP. These can be used to communicate with a PLC or factory control system. PROFINET, Modbus TCP, and EtherNet/IP are also available as internal fieldbus options. All interfaces are available through an external module. A single external network module, the Control Concepts, Inc. Connect Gateway Module, can control up to ten zones/devices simultaneously, thus reducing network/system installation costs. The robust design of MicroFUSION allows for continuous full-frame current operation - without derating - at up to 50° C / 6000 ft altitude. Cooling is accomplished through either natural convection, forced air, or an optional external panel mount.

The optional Control Concepts, Inc. Remote Display provides clear readouts of key electrical parameters and alarm statuses. Setpoints, Limits and Alarms are accessible using the touch pad and are easily customized. For additional convenience, a panel mounting kit is also provided, eliminating the need for costly external meters / indicators / switches and the associated costs of wiring and labor.

This manual will provide an overview of all MicroFUSION models features, tips and considerations for installation, diagrams of correct wiring of all MicroFUSION devices, explanation of device features, an overview of how to operate and select settings for a MicroFUSION device, basic troubleshooting tips, and a brief overview of the CCI Link™ and Connect Gateway Module.

*CE Rated voltage is 24-690 VAC

1.1 Certifications / Markings

c UL us LISTED · CE EN60947-4 · 100kA SHORT CIRCUIT CURRENT RATING · FC Part 15 Subpart B Class A Device · RoHS COMPLIANT · Pb Pb-Free

In addition to certification markings, the controllers will also be marked with:

- Model Number
- Voltage Range (24 - 600 VAC)
- Control Concepts contact information
- Serial Number
- Current Size
- Frequency (50 - 60 Hz)
- Torque Information

External EMI filters must be used in conjunction with the FUSION series power controllers to maintain CE immunity* approval. The following filters were used during the immunity testing.

Universal input power:
Schaffner filter
P/N: FN 2030-3-06

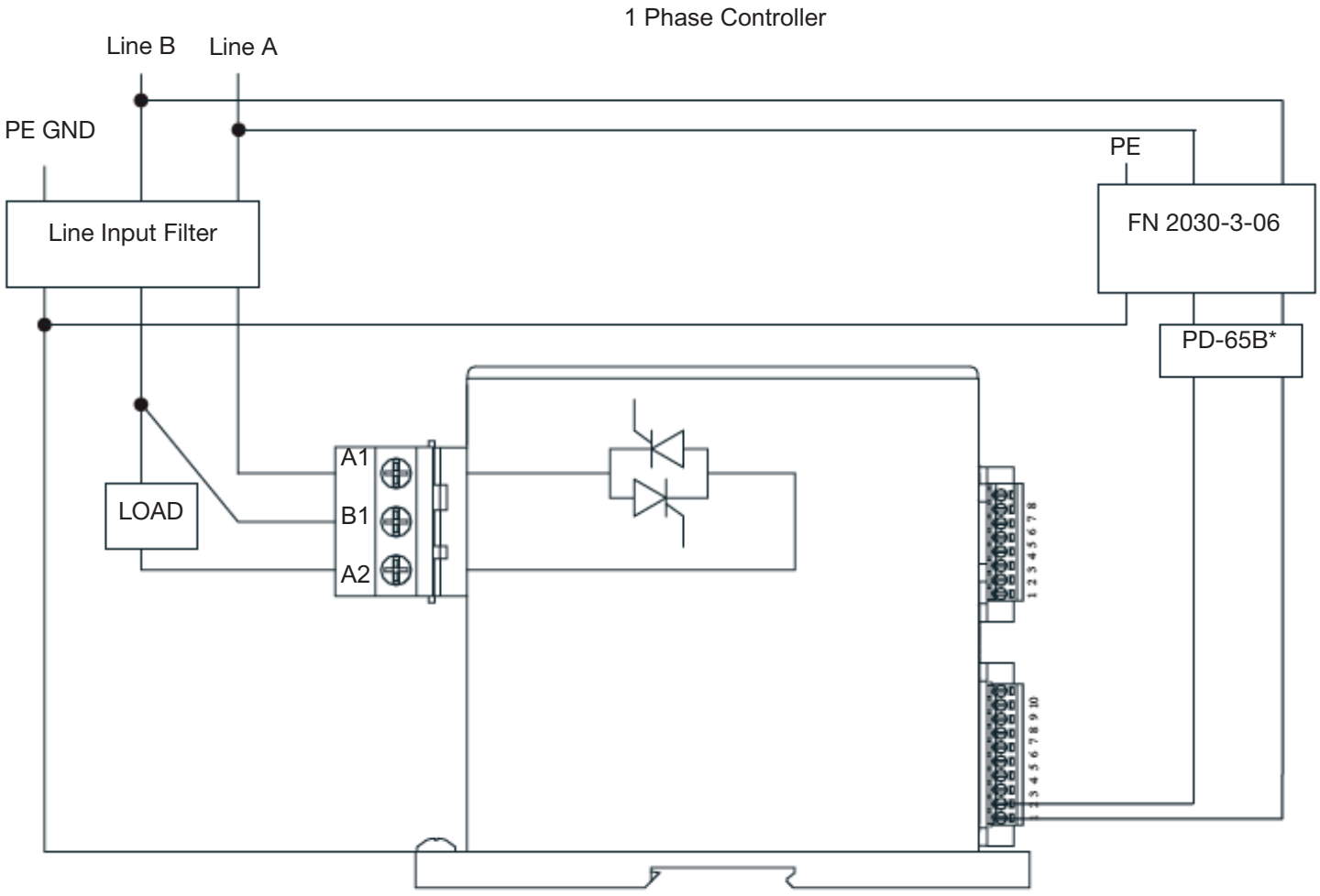
Line input power:
Schaffner filter
P/N: FN 3270H-35-33

The Schaffner filter for universal input power, or it's equivalent, may be used as listed above. The line input power filter however, will need to be sized accordingly for your load. Please contact Schaffner EMC Inc. for help finding the appropriate filter.

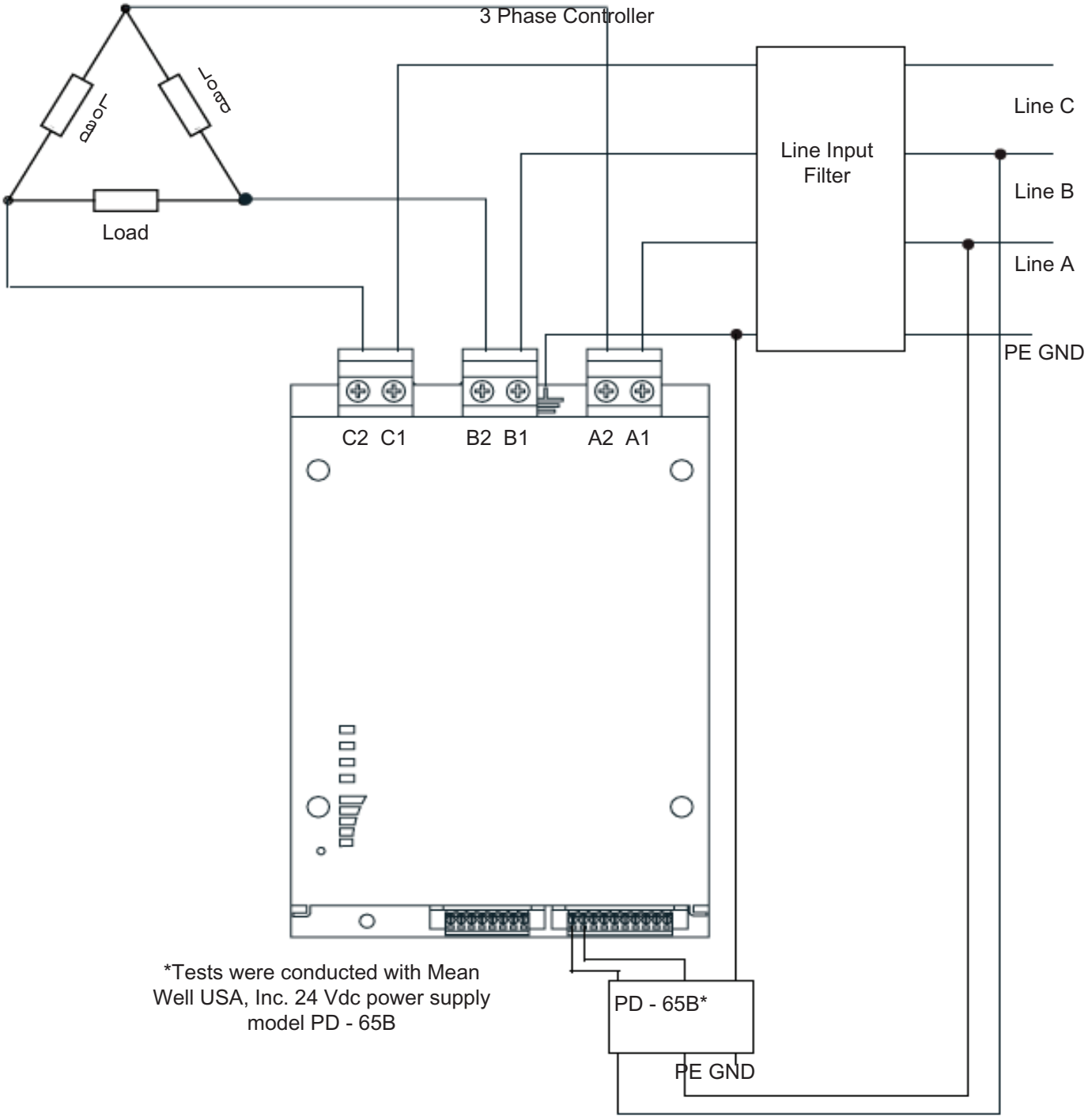
Schaffner EMC Inc.
52 Mayfield Avenue | Edison, New Jersey 08837 / USA
T 1-800-367-5566 | T 732-225-9533 | F 732-225-4789
usasales@schaffner.com | http://www.schaffner.com/us

*No filtering is required for emissions.

Wire filters as shown below:



*Tests were conducted with Mean Well USA, Inc. 24 Vdc Power Supply model PD - 65B



Other wire diagrams are available, for models not listed here, by contacting Control Concepts, Inc.

ATTENTION
This product has been designed for class A equipment. Use of this product in domestic environments may cause radio interference, in which case the user may be required to employ additional mitigation methods.

NOTICE
This product has been designed for environment A. Use of this product in environment B may cause unwanted electromagnetic disturbances, in which case the user may be required to take adequate mitigation measures.

1.2 Points of Interest

A. CCI LINK™
A proprietary deterministic digital bus that enables multiple Control Concepts devices to communicate with each other.

B. DIGITAL COMMUNICATIONS OPTION
PROFINET, Modbus TCP, and EtherNet/IP are available as internal fieldbus options.

C. RETRANSMITS & RELAY CONNECTIONS
(P2) Retransmits and Relay.

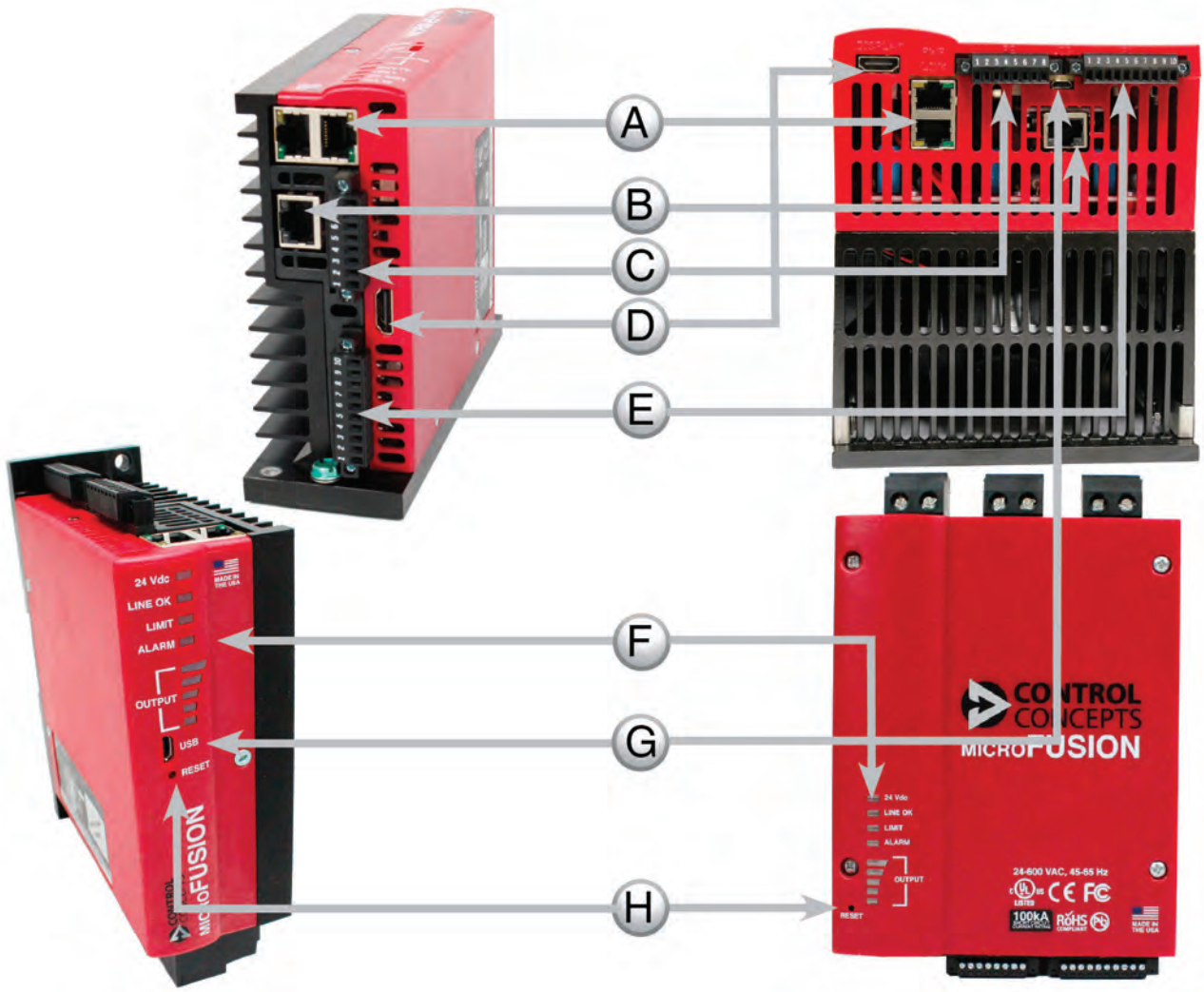
D. OPTIONAL REMOTE DISPLAY
Shows parameter name with information such as setpoints, limit settings, monitor features, alarms, and more. The display can be easily mounted outside an electrical panel for efficiency.

E. COMMAND CONNECTIONS
(P1) Analog inputs, general purpose input, + 24 Vdc supply, $\overline{\text{RUN}}$/STOP.

F. INDICATOR LEDs
Assist with Diagnostics.

G. USB PORT
Streamlines controller setup with the use of Control Panel.

H. CONTROLLER RESET
MicroFUSION processor can be reset externally.



1.4 Model Options & Description

Single Phase AC
The single phase AC power controller is a phase angle or zero cross fired controller. It linearly controls, with respect to the setpoint, the AC voltage, current or true power applied to an electrical load. Control is achieved by means of a pair of inverse parallel SCRs.

Three Phase - Two Leg
The three phase two leg AC power controller is a zero cross fired controller. It linearly controls, with respect to the setpoint, the AC voltage, current, or true power applied to an electrical load. Control is achieved by two pairs of inverse parallel SCRs.

Three Phase - Three Leg
The three phase three leg AC power controller is a phase angle or zero cross fired controller. It linearly controls, with respect to the setpoint, the AC voltage, current or true power applied to an electrical load. Control is achieved by three pairs of inverse parallel SCRs.

1.5 Load Types

Loads / Applications

1. Constant Resistive Loads (Nickel Chromium)
2. Variable Resistive Loads
   a. Silicon Carbide
   b. Molybdenum Disilicide
   c. Graphite
   d. Tungsten Lamps
3. Transformer Coupled Loads
4. Inductive (not intended for motor applications)
5. Gas Discharge
   a. Ultra Violet
6. Electron Beam
7. Crystal Growing and Processing

Transformers
Scott-T & Wye transformers: Excessive voltage transients can occur when operating Scott-T transformers with an open or unloaded secondary. It is recommended that Scott-T transformer be limited to a maximum of 480 Volts.

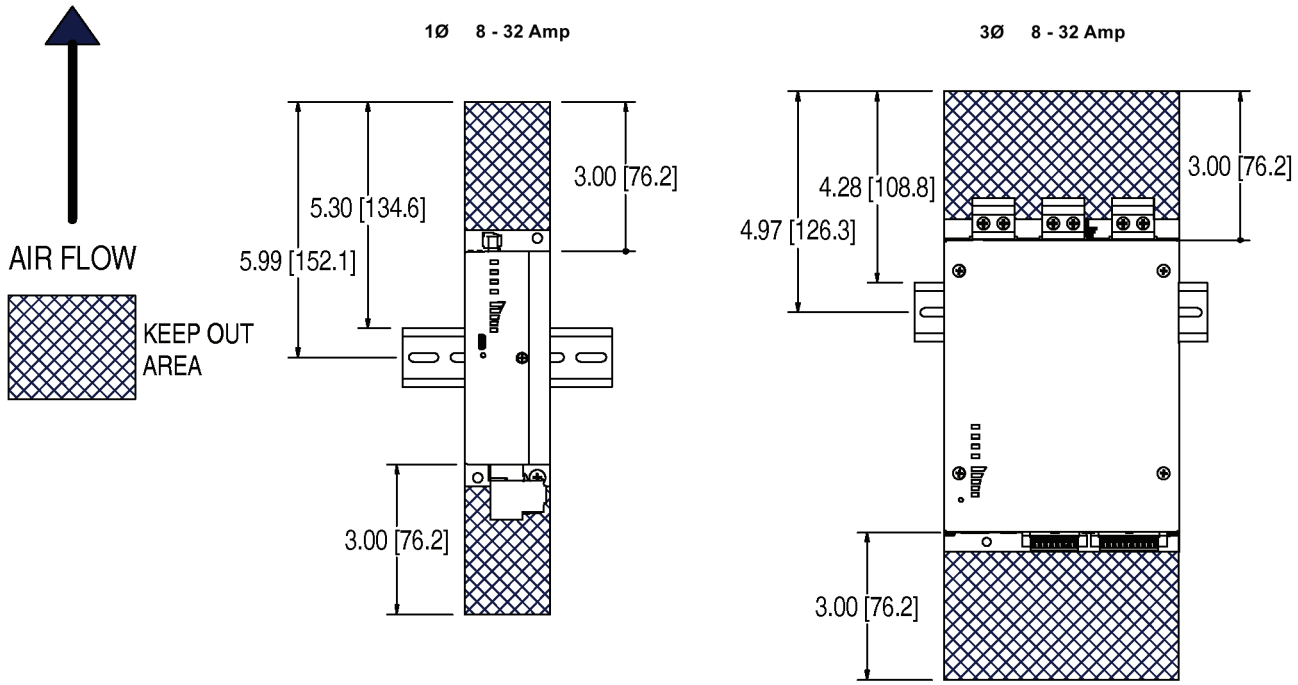
NOTE

It is recommended that a Delta to 4-Wye transformer be used to power a 4-wire Wye load. Delta to 3-wire Wye transformers are acceptable, but Wye to Wye transformers are not suited for use between the controller and load due to possible transient conditions.

2. INSTALLATION

2.1 Mounting Considerations

Dimensions: Inches [mm]



Mount controllers vertically.

The cross-hatched area on the top and bottom of the pictured controllers, designates a keep out area for air circulation. The top and bottom of the controllers must have a minimum of 3.00 [76.2] free from obstructions as measured from the edge of the heatsink fins, outwards.

Mounting hardware (Not included):
Figures above show dimensions for din rail mounting. For mounting hardware when not using din rail, use the following:

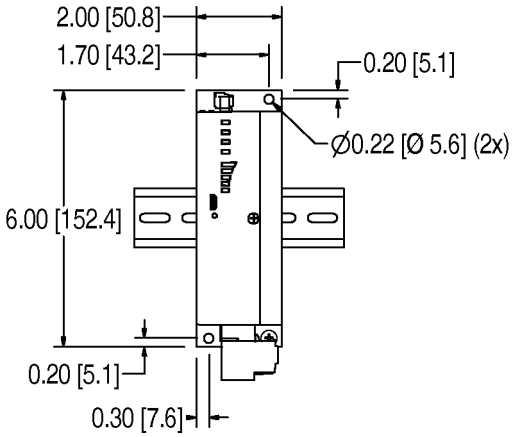
Single Phase	#10 or M5 screws with star washers
Three Phase	#8 or M4 screws with star washers

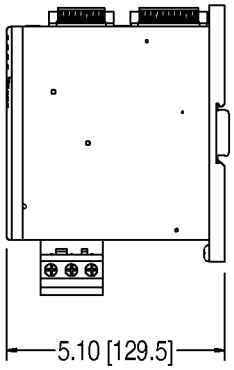
Din rail and/or screws are not provided.

Note: Next page shows keep out area (shaded area) for the listed models.

2.1.1 Single Phase (8 - 32 Amps)

Dimensions: Inches [mm]



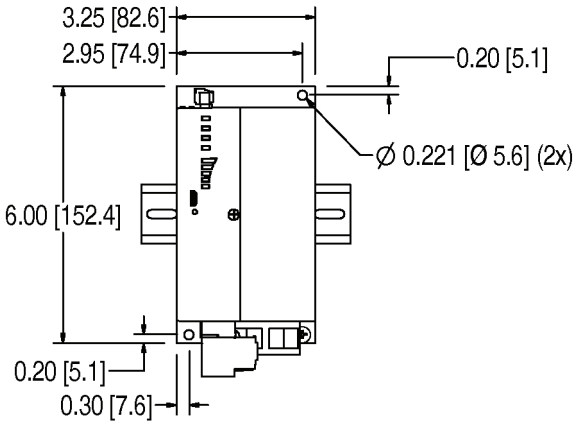


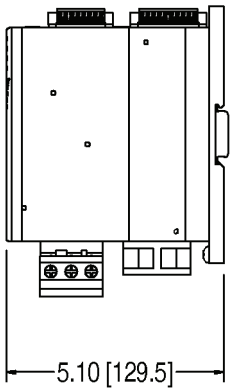
Height
6.00 [152.4]
Width
2.00 [50.8]
Depth
5.10 [129.5]
Weight
1.80 lb [0.8 kg]

2.1.2 Single Phase (50 - 80 Amps)

Dimensions: Inches [mm]

The Single Phase (50 - 80 Amp) controller below is shown with a fan (below the connector block). This fan is only present on 80 Amp controllers.



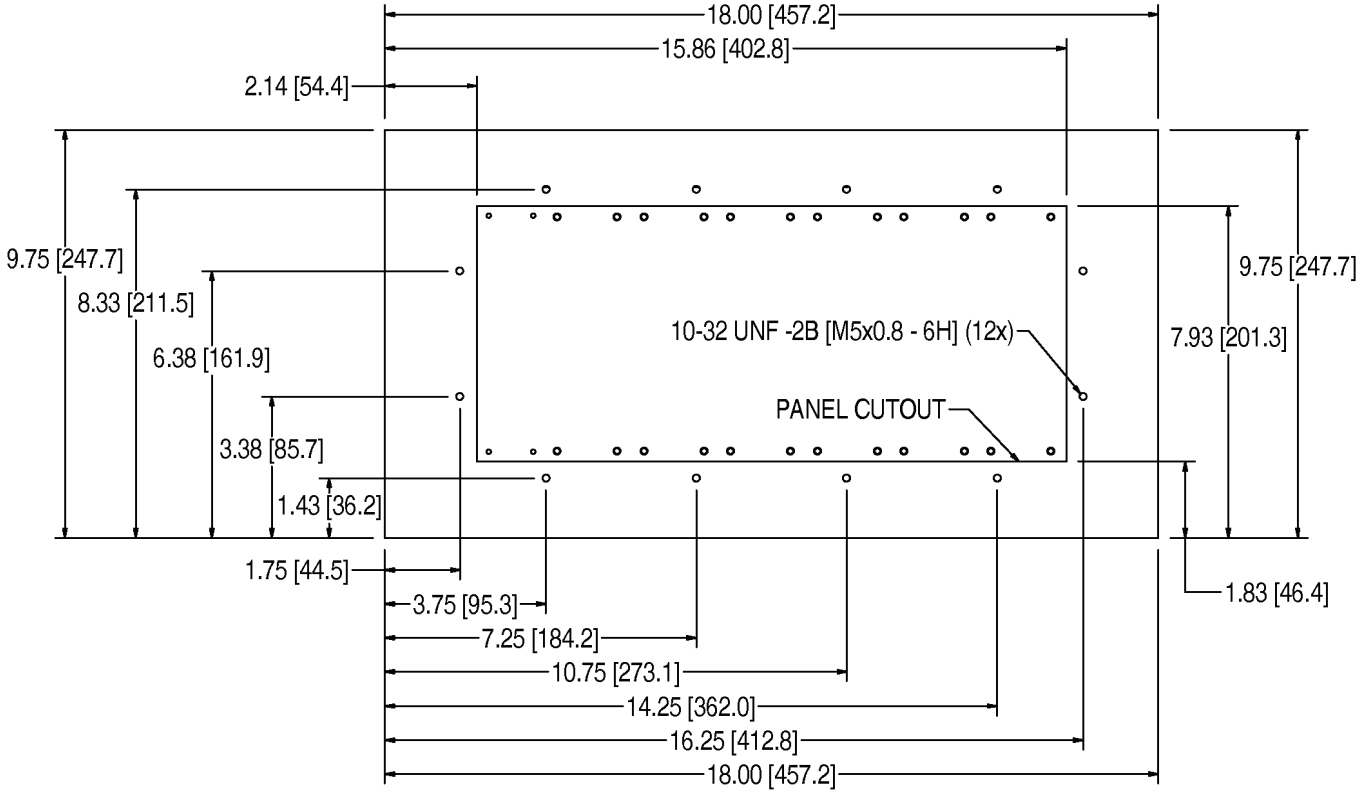


Height
6.00 [152.4]
Width
3.25 [82.6]
Depth
5.10 [129.5]
Weight
3.00 lb [1.4 kg]

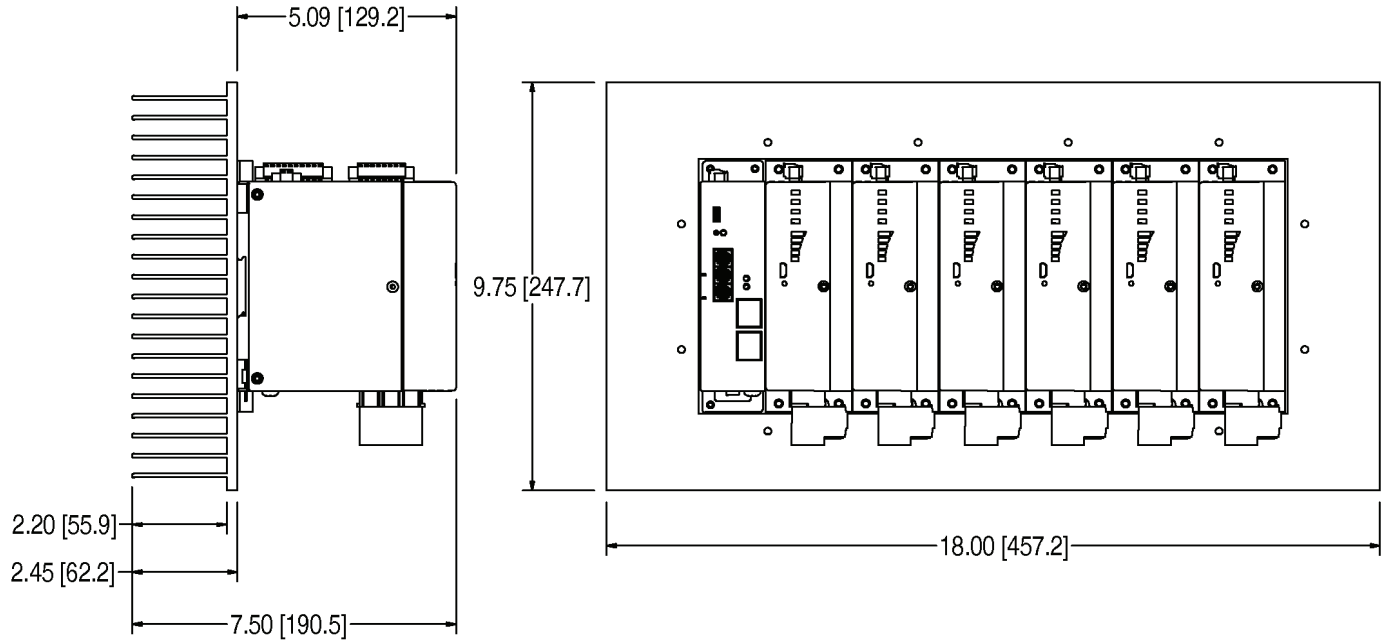
2.1.8 Six Position Multizone - External Mount

Dimensions: Inches [mm]

Fins must be mounted vertically. Gasket and gasketed washers included.
There are multiple configurations for the Multizone units, the weight shown in this manual reflects the maximum possible weight for the unit.



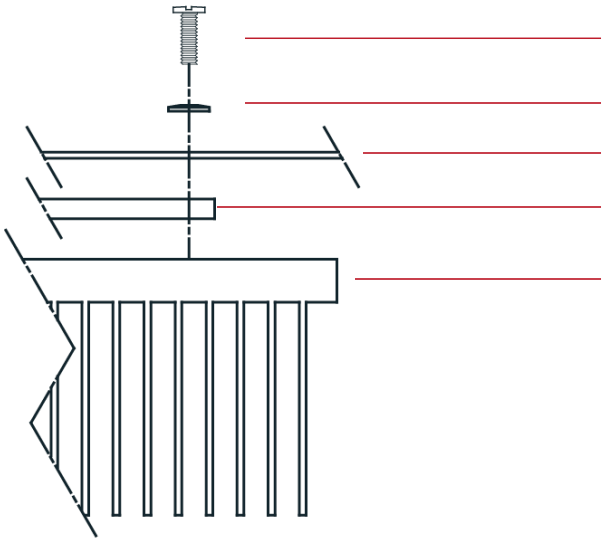
Height
9.75 [247.7]
Width
18.00 [457.2]
Controller Depth
5.09 [129.2]
Full Depth
7.50 [190.5]
Weight
21.80 lb [9.9 kg]



SCR-10 **LCI Furnaces - TP Solar**

2.3 Mounting Instructions

Finned External Mount



*Tighten to 32 in/lbs [3.6 Nm] to ensure proper seal for gasketed washer. Do not over tighten, damage may occur to washer. Gasket should compress approximately 50%.

Note: When correctly mounted, fins should be vertical.

The gasket has an adhesive on one side. It is intended to be installed on the heatsink prior to the final installation of the heatsink on the enclosure. This is to prevent any damage to the gasket during shipping or initial stages of installation.

3. WIRING

Control Concepts configures and tests each controller before shipping. Once received, the controller is ready to install. The following sections will describe how to properly wire the unit with the recommended protection.

For line and load connections use copper conductors rated 75°C minimum. See torque tables for proper tightening.

NOTE

Wire controllers to conform with the National Electric Code (NEC) and/or other local wiring codes.

A ground wire is recommended for proper operation. Use 10 AWG or larger wire.

3.1 Torque Specifications

1 phase 8-80 A *
3 phase 8 - 32 Amps *

Recommended Tightening Torque for Line/Load Connectors	
Wire Size (AWG)	Torque
3 - 14	24 IN - LBS [2.7 Nm]

8 - 400 Amps

Recommended Tightening Torque for P1 & P2 Connectors		
Number of Wires	Wire Size (AWG)	Torque
1	16 - 26	3.0 IN - LBS [0.34 Nm]
2	20	3.0 IN - LBS [0.34 Nm]

50 - 240 Amps *

Recommended Tightening Torque for Line/Load Connectors	
Wire Size (AWG)	Torque
6 - 4	110 IN - LBS [12.4 Nm]
2 -1	150 IN - LBS [16.9 Nm]
1/0 - 2/0	180 IN - LBS [20.3 Nm]
3/0 - 4/0	250 IN - LBS [28.2 Nm]
250 - 350	325 IN - LBS [36.7 Nm]

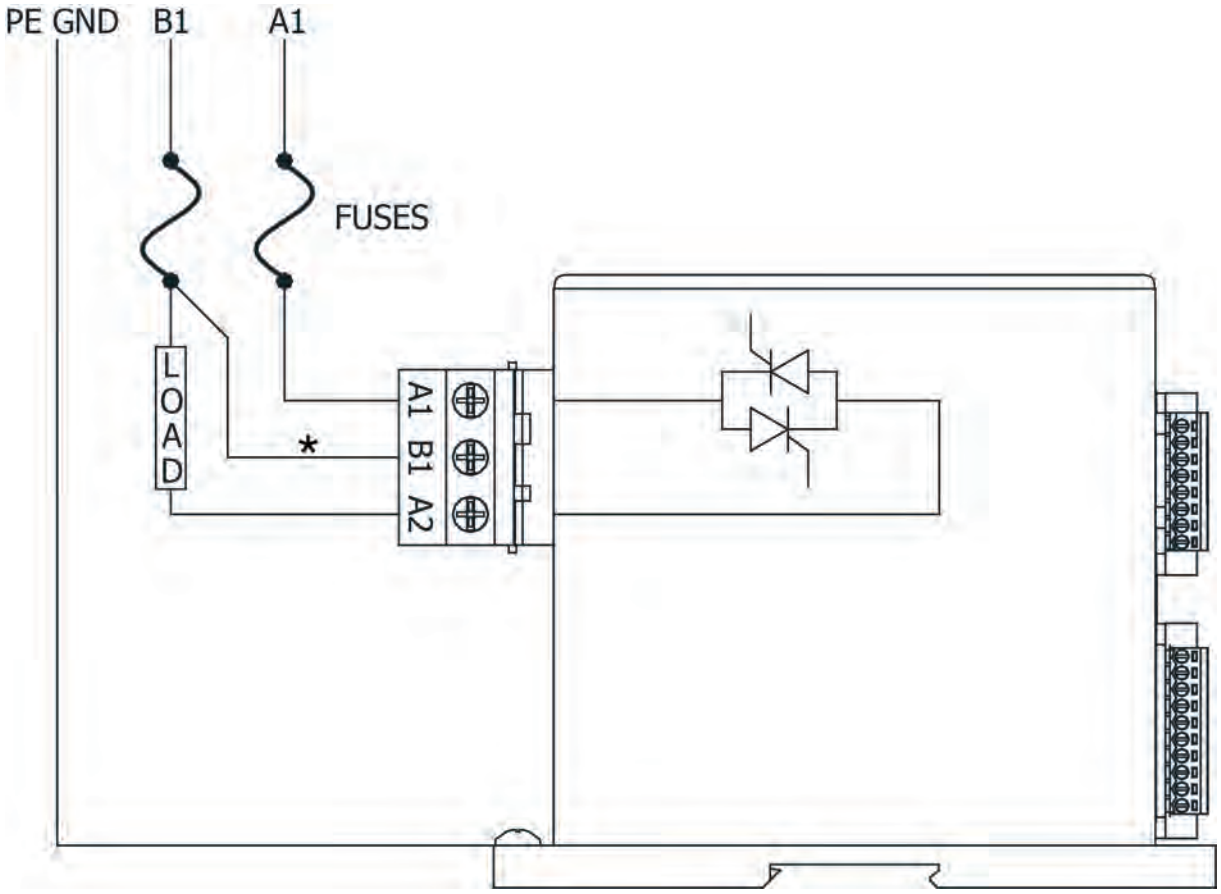
320 - 400 Amps

Recommended Tightening Torque for Line/Load Connectors	
2 Conductors Per Terminal	
AWG	10mm Hex Drive
1/0 - 250	611 IN - LBS [69.0 Nm]
1 Conductor Per Terminal	
AWG	10mm Hex Drive
350 - 750	611 IN - LBS [69.0 Nm]

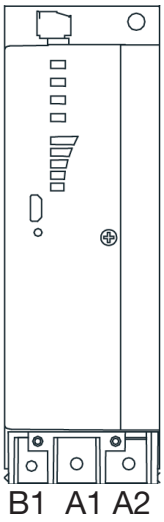
* Connectors on 8 to 240 amp units are not multi-conductor rated per UL. Only 1 conductor is allowed per terminal.

3.2 AC Line / Load Connections

3.2.1 Single Phase (8 - 80 Amp)



* = 0.60 mA maximum through B1 connection at 600 VAC; 14 AWG Minimum wire size required for connector.



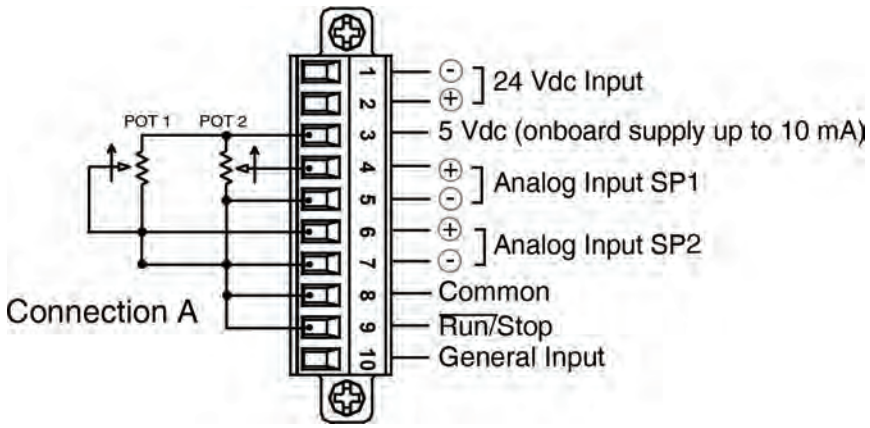
B1 uses #6 or M3.5 ring terminal.
A1 and A2 use #10 or M5 ring terminal.

(See drawing above for proper wiring)

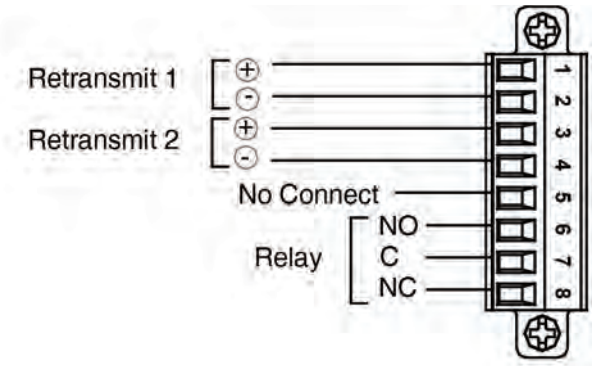
3.3 Connectors

3.3.1 P1 - (10 Pin) Command Connector

Diagram below demonstrates how to hook up a potentiometer input into SP1 and SP2. Connection A represents a connection between pin 9,8 which places the controller in Run mode.



3.3.2 P2 - (8 Pin) Command Connector



4. INDICATOR LEDs

See chart below for LED Colors and indicated Operation.

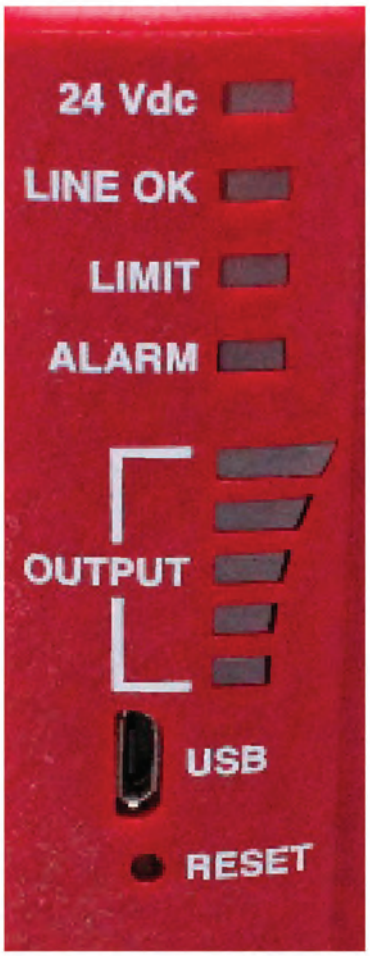
24 Vdc	
Green	+24 Vdc present
Red	+24 Vdc Wired Backwards

LINE OK	
Off	No AC Line Voltage
Green	Ok, Locked
Orange	Boot Segment
Red	Phase Lock Loss

LIMIT	
Off	Ok, No Limits
Orange	Voltage Limit
Red	Current Limit
Alternating Red / Green	Power Limit

ALARM	
Off	Ok, No Alarms, in “STOP”
Green	Ok, No Alarms, in “RUN”
Orange	Warning Alarm
Red	Inhibit Alarm

OUTPUT	
Green	LEDs turn green in proportion to output
Top LED Red	Indicates 100% ON



5. USB INTERFACE

5.1 USB Interface

A USB interface is standard on all controllers, which allows the controllers to connect the controller to a computer with the Control Panel software installed. Control Concepts stocks 15 foot USB cables for customers to purchase (P/N: 0058006-0000-15).

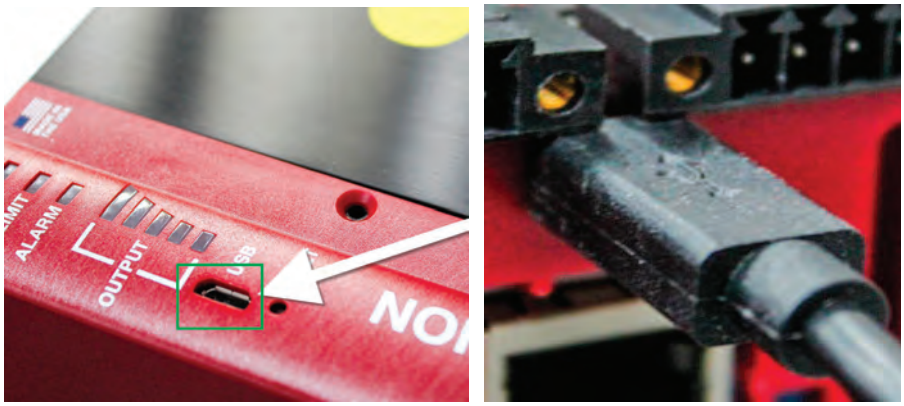


Figure 5.00: (Left) Location of the MicroUSB port of 1Ø Units;
(Right) 3Ø Units have the MicroUSB port located between the P1 / P2 Connectors.

For Control Panel Software and USB issues, see Troubleshooting section 11.8 USB Communication Issues.

The following pages give a brief overview of the MicroFUSION Control Panel Software.
For detailed information regarding the Control Panel, consult the separate MicroFUSION Control Panel User's Manual.

The most up to date product manuals are available for all Control Concepts controllers and devices on our website at www.controlconcepts.com. Contact our sales, marketing, or technical support departments at 1-800-756-2799 with any questions regarding usage and operation not covered in the provided manuals and documentation.

5.2 Control Panel Software

The Control Panel software assists with the installation, parameter setup, operation, and troubleshooting of Control Concepts, Inc. devices. The installer for the Control Panel software (CCIControlPanelSetup.exe) can be found on the CD packaged with your Control Concepts, Inc. device or on our website at www.ccipower.com. Refer to the Control Panel User's Manual available on the Control Concepts, Inc. website for additional information.

The Control Panel User's Manual describes some controller features that are not included in this manual:

- Updating device firmware
- Scope / Data trace
- Trap and Fault History
- Save / Restore manufacturing and user default settings
- Diagnostics tests
- Device configuration files
- Device feature upgrades

This document contains many "Find in Control Panel" tips. These notes identify the area of the Control Panel software (listed next to "Category") that a parameter or group of parameters exist in the software. The example shows that the controller's limit and trip parameters are located in the "Limits" subcategory within the "Control" main category of the Control Panel application.

5.3 Quick Setup

Use the “Quick Setup” wizard in Control Panel to quickly configure the basic settings needed for the controller to output. To access the “Quick Setup” wizard, select the desired device and click the “Quick Setup” button in the Control Panel “Actions” drop-down menu. The dialog shown in Figure 5.00 will appear. For more information on using the “Quick Setup” wizard, refer to the Control Panel User’s Manual.

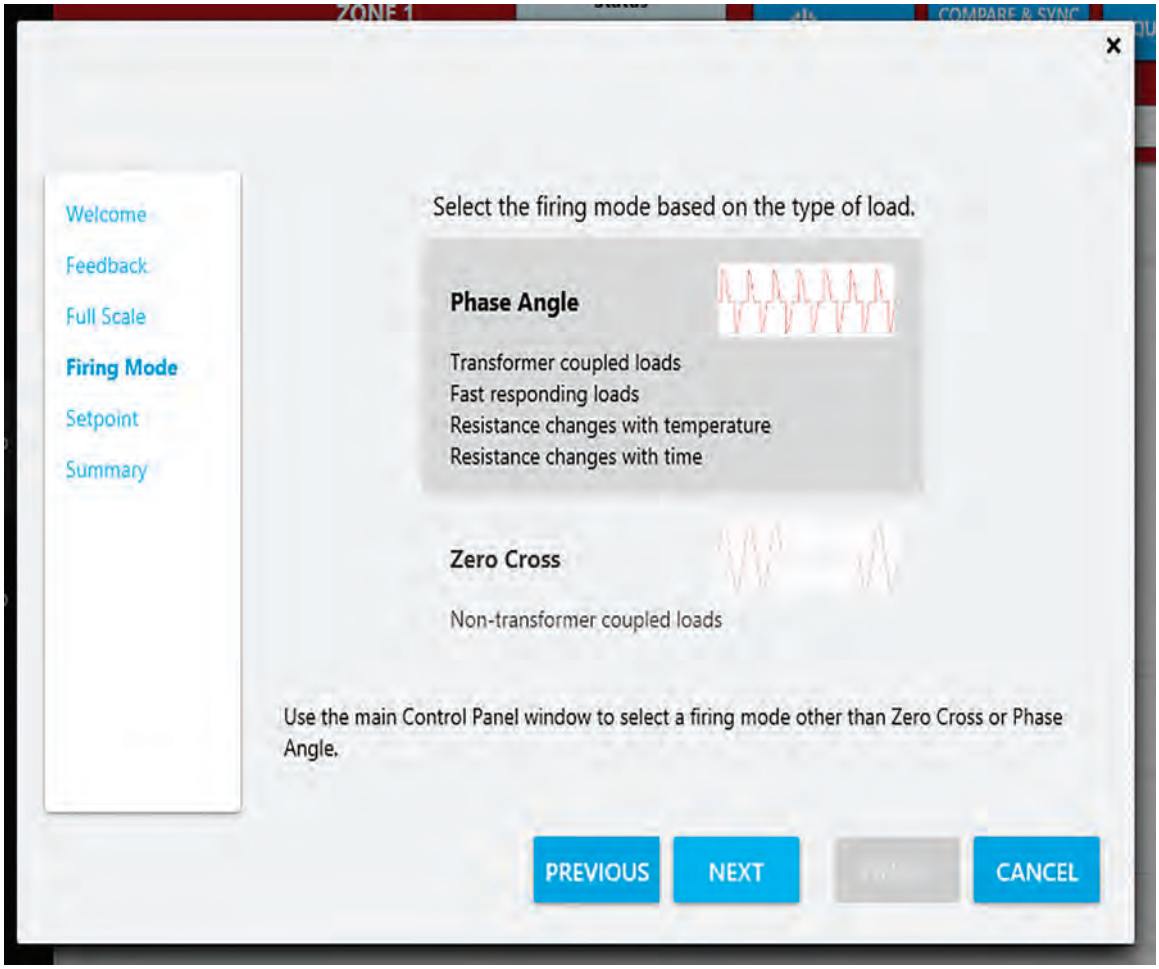


Figure 5.00: Use the MicroFUSION “Quick Setup” wizard to configure basic settings for the controller output.

Note: You may switch these settings at any time using the Control Panel Software.

6. OPTION BOARD

6.1 Internal Factory Industrial Communications

A fieldbus interface (optional) can be used to communicate with a PLC or factory control system. PROFINET, Modbus TCP, and EtherNet/IP are available as internal fieldbus options.

Control Concepts, Inc. highly recommends the use of shielded wiring and offers a variety of lengths to purchase.

NOTE

Only one type of interface is available per unit. For example, a controller with EtherNet/IP cannot also have Modbus TCP.

6.2 External Factory Industrial Communications

EtherNET/IP, EtherCAT, PROFINET, or Modbus TCP are available through the Connect Gateway Module. The Connect Gateway Module can control up to 10 zones, reducing system installation costs.

See Connect Gateway Module in the Accessories section of this manual for more details, or contact Control Concepts, Inc.

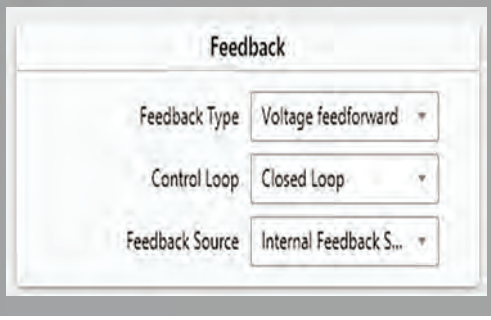
7. BASIC OPERATION & SETTINGS

7.1 Feedback [SP 1]

FIND IN CONTROL PANEL

FEEDBACK [SP1]

Category: Control > Feedback



	SX-S	SX-L	HX-L	HX-P
FF Voltage[1]	Standard	Standard	Standard	Standard
RMS Voltage [2]			Standard	Standard
AVG Voltage			Standard	Standard
RMS Current	Optional	Standard	Standard	Standard
AVG Current	Optional	Standard	Standard	Standard
Real Power			Optional	Standard
Apparent Power			Optional	Standard

[1] Default for SX [2] Default for HX

The Feedback type selected through the Control Panel Software, determines the control loop feedback. If multiple MicroFUSION controllers are networked using the Connect Gateway Module, each device may have a different control loop feedback setting.

Setting	Description
FF Voltage[1]	Selects Voltage feedforward as the control loop feedback. The control loop makes adjustments to the controller's output according to the setpoint and the controller's AC line supply voltage.
RMS Voltage[2]	Selects RMS Voltage as the control loop feedback. The control loop monitors the RMS load voltage and adjusts the output to supply the desired RMS voltage to the load according to the setpoint.
AVG Voltage	Selects Average Voltage as the control loop feedback. The control loop monitors the average load voltage and adjusts the output to supply the desired average voltage to the load according to the setpoint.
RMS Current	Selects RMS Current as the control loop feedback. The control loop monitors the RMS load current and adjusts the output to supply the desired RMS current to the load according to the setpoint.
AVG Current	Selects Average Current as the control loop feedback. The control loop monitors the average load current and adjusts the output to supply the desired average current to the load according to the setpoint.
Real Power	Selects Real Power as the control loop feedback. The control loop monitors the real load power and adjusts the output to supply the desired real power to the load according to the setpoint.
Apparent Power	Selects Apparent Power as the control loop feedback. The control loop monitors the apparent load power and adjusts the output to supply the desired apparent power to the load according to the setpoint.

[1] Default for SX [2] Default for HX

7.1.1 Feedback Type Calculations

Here are the formulas for how the feedback is measured:

RMS Voltage

$$V_{rms} = \sqrt{\frac{\sum_{i=1}^{n} (V^i)^2}{n}} \approx 0.707 V_{pk}$$

RMS Current

$$I_{rms} = \sqrt{\frac{\sum_{i=1}^{n} (I^i)^2}{n}} \approx 0.707 I_{pk}$$

Power

The output is adjusted via the real Power.

$$\text{Real Power} = \frac{\sum_{i=1}^{n} V^i I^i}{n}$$

$$\text{Apparent Power} = V_{rms} I_{rms}$$

$$\text{Power Factor} = \frac{RealPower}{ApparentPower}$$

AVG Voltage

$$V_{avg} = 1.11 \frac{\sum_{i=1}^{n} |V^i|}{n} \approx 0.707 V_{pk}$$

AVG Current

$$I_{avg} = 1.11 \frac{\sum_{i=1}^{n} |I^i|}{n} \approx 0.707 I_{pk}$$

V_{pk} = Peak Voltage

I_{pk} = Peak Current

V^i = Instantaneous Voltage sample

I^i = Instantaneous Current sample

n = Number of samples in 1 AC line cycle

7.1.2 External Feedback

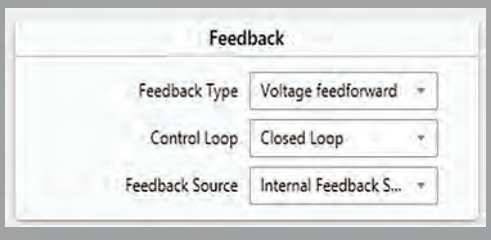
External feedback uses an external analog signal to represent the output to the load. These types of signals often come from a transducer that measures voltage, current, temperature or power and scales it proportionally to a 0 – 5 Vdc or 4 – 20 mA signal. Connect the external feedback signal to an analog setpoint. Select the correct Feedback Source [SP 19]. Scale the external feedback by setting up the analog setpoint, as described in Section 9.5, “Analog Inputs.”

7.1.3 Feedback Source [SP 19]

FIND IN CONTROL PANEL

FEEDBACK SOURCE [SP 19]

Category: Control > Feedback



	SX	HX
Internal	*Included	*Included
Analog Input 1	Included	Included
Analog Input 2	Optional	Optional

* = Default. The Analog Input 2 source is only available if the I/O section of the model number contains a “2”, “3”, “6”, or a “7”.

Feedback Source [SP 19] selects the type of feedback used. For external feedback select Analog Input 1 or Input 2.

Setting	Description
Internal	Use the internal feedback signal (Voltage, Current, or Power)
Analog in 1	Use Analog Setpoint 1
Analog in 2	Use Analog Setpoint 2
Transducer 1	Uses feedback provided by the Control Concepts Transducer card using the CCI Link™

* = Default.

7.2 Firing Mode [SP 2]

Knowing the application and the type of load the user is trying to control is critical for choosing the correct mode of operation. The MicroFUSION series power controllers are capable of Phase Angle, Zero Cross, Zero Cross Transformer, HiPER and Fast Zero Cross operations.

	SX	HX
Zero Cross	*Included	* Included
Phase Angle	** Included	** Included
Zero Cross Transformer	N/A	Optional
HiPER	Included	Included
Fast Zero Cross	Included	Included

* = Default for three phase 2 leg; ** = Default for all other models

The Zero Cross Transformer mode is only available if the Zero Cross Transformer Mode section of the model number contains a “Z”.

Setting	Description
Zero Cross[1]	The load power is turned ON for a number of complete electrical half-cycles and then turned OFF for a number of complete half-cycles.
Phase Angle [2]	The SCR is on for a variable portion of the half-cycle.
Zero Cross Transformer Mode	Zero Cross firing method specifically for firing into a transformer. This uses Phase ZC Switch Time [SP7] for determining the number of soft start cycles before switching to Zero Cross firing.
HiPER	Useful for stable and accurate load resistance at low phase angle firing. The controller will phase angle fire above the HiPER Threshold [SP 33]. Below the threshold, the controller will lock the phase angle at the threshold level and fire the output discontinuously in order to supply the correct amount of power to the load as commanded by the setpoint.
Fast Zero Cross	This firing mode is similar to Zero Cross, except that it allows less minimum ON and OFF half cycles, which produces faster switching between ON & OFF periods to create a smoother distribution of power to the load. (The Sync-Guard™ feature can not be used when firing Fast Zero Cross.)

[1] Default for 3Ø 2 Leg devices [2] Default for all other models

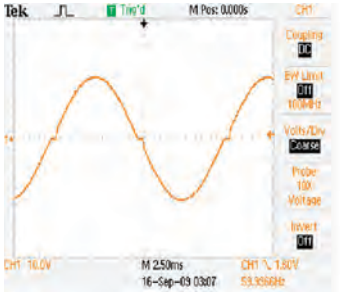
Correct wiring is critical for proper load operation. For safe operation, please review the Chapter 2: Installation, and Chapter 3: Wiring, found within this manual.

7.2.1 Phase Angle

In Phase Angle control, each SCR of the back-to-back pair is turned on for a variable portion of the half-cycle that it conducts. Power is regulated by advancing or delaying the point at which the SCR is turned ON within each half cycle. Light dimmers are an example of Phase Angle control.

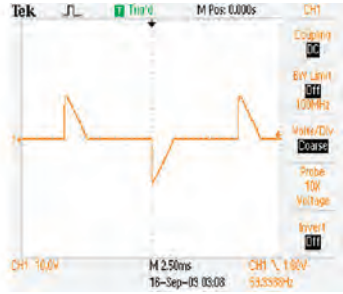
Phase Angle control provides a very fine resolution of power and is used to control fast responding loads such as tungsten-filament lamps or loads in which the resistance changes as a function of temperature.

Single Phase Operation



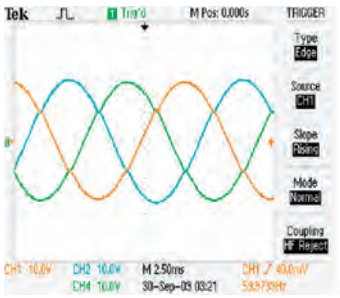
100% Load Power

50% Load Power

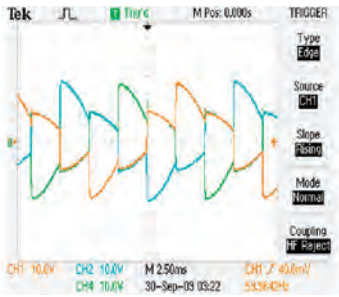


25% Load Power

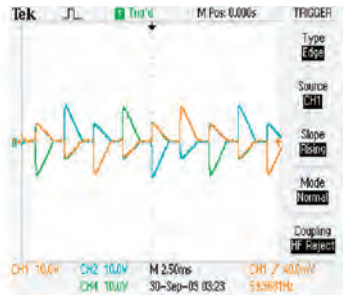
Three Phase Operation



100% Load Power



100% Load Power



100% Load Power

Ramp Time [SP 4] and Slew Rate Factor [SP 5] are considered when using phase-angle firing mode. These parameters will appear in Control Panel when Phase Angle is selected.

Ramp Time [SP 4]

Default Value: 0 Seconds

This parameter allows the user to set a maximum ramp time (in seconds) for the controller to reach the full scale value from 0% output. The ramp time is not used if the setpoint is changed from something other than 0% output.

Example: If the controller is set for Voltage Feedback and the Full Scale Voltage is set to 100 Volts and the Ramp Time is set for 10 seconds, when a setpoint is applied the output will rise at 10 volts per second. So if the setpoint is set to 40% the ramp time will be 4 seconds.

Slew Rate [SP 5]

Default Value: 10

In contrast to giving the user individual PID values, which are prone to user error and control loop instability, microFUSION uses a concept of Slew Rate to adjust the time the microprocessor control loop takes to respond to a change in feedback signal or setpoint. The Slew Rate is dependent upon accurately setting Full Scale Line Voltage, Load Current, and Load Power for the actual load.

Failure to properly set the Full Scale settings will result in either an overly aggressive or overly sluggish control loop.

The following table lists the Slew Rate time constants relative to the [SP 5] parameter 'Rate' setting.

Rate	T (msec)	5 T (msec)
1	33.333	0.1666
5	100	0.5
10	200	1.0
20	300	1.5
30	400	2.0
40	500	2.5
50	600	3.0
60	675	3.4
70	750	3.75
80	850	4.25
90	900	4.5
100	1000	5

Slew Rate time constants

Time constant T (63.2% of final value) and 5T (99.3% of final value) for the various Slew Rate entries.

As you can observe, a smaller number represents a faster responding system, while a larger value represents a slower responding system.

NOTE

These times are for reference only and the actual times may vary depending on the source, the load, as well as the accuracy of the Full Scale settings.

7.2.2 Zero Cross

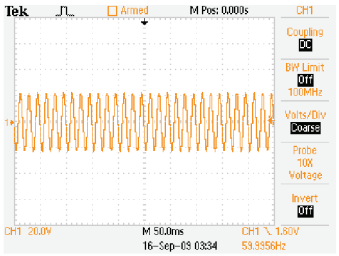
In zero-cross control, load power is turned ON and OFF only when the instantaneous value of the sinusoidal waveform is zero. Load power is controlled by switching the SCR's "ON" for a number of complete electrical half-cycles, and then "OFF" for a number of complete electrical half-cycles.

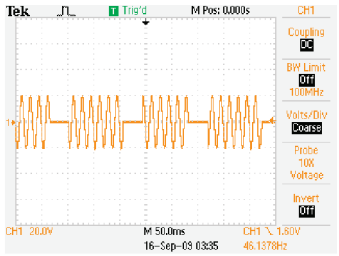
The wave form in the top left of the diagram below, shows the 1 phase AC waveform into the controller. This would also be the representation of the output with the command at 100%. The rest of the waveforms show the "ON" and "OFF" cycles of the output at various setpoints.

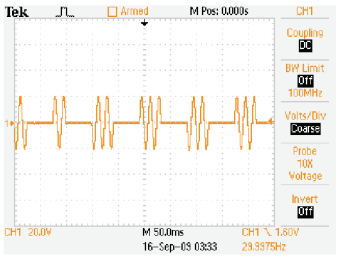
The Load Power Timing tabulation shows the sequence of "ON" and "OFF" electrical half-cycles that are applied to the load to achieve the percentage of load power indicated. The percentage of load power is equal to the ratio of the number of electrical half-cycles that power is applied, to the total number of electrical half-cycles.

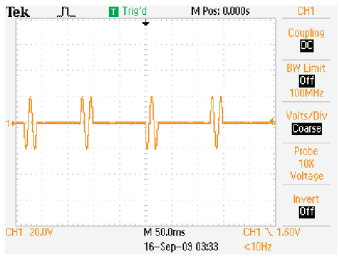
From the tabulation, it can be seen that power is applied for 16 out of 32 electrical half-cycles to achieve 50% load power and that power is applied for 136 out of 160 electrical half-cycles to obtain 85% power. When operating with a 60 Hz supply, the sequence of ON and OFF cycles repeats every 0.266 seconds on 50% and every 1.33 seconds at 85% power.

Load Power Timing				
10%	25%	50%	75%	85%
5 ON	5 ON	9 ON	17 ON	23 ON
46 OFF	14 OFF	8 OFF	6 OFF	4 OFF
5 ON	5 ON	7 ON	19 ON	23 ON
44 OFF	16 OFF	8 OFF	6 OFF	4 OFF
				23 ON
				4 OFF
				23 ON
				4 OFF
				23 ON
				4 OFF
				21 ON
				4 OFF









NOTE

Even though it takes 1.33 seconds to obtain precisely 85% power, the load power during the 23 On and 4 OFF cycles is 23/27 or 85.185% power and this cycle is repeated every 0.225 seconds

7.2.3 Zero Cross Transformer Mode (ZCT)

This is a Control Concepts, Inc. proprietary algorithm that uses hybrid control to avoid the excessive inrush currents that can occur when firing into inductive or variable resistive loads.

In this firing mode the (on-off) duty cycle is adjusted to obtain the desired amount of power to the load. The “ON” portion of the output begins with a set number of cycles that increase to full conduction, then it remains at full conduction for a number of cycles, and then turns off. This pattern restarts with each subsequent duty cycle.

When utilizing the “Zero Cross Transformer” (ZCT) firing mode, the Power Factor measured by the controller is typically 0.90 with a setpoint that is greater than or equal to 50%. When the setpoint is less than 50% the controller will maintain a measured Power Factor of approximately 0.70.

Current Limit is enabled during the “phase-up” section of each “ON” portion of the duty cycle. A Power Factor of 0.90 (Setpoint > 50%), or 0.70 (Setpoint < 50%), may not be able to be achieved if the controller was current limiting the output to the load during the phase-up time.

P.A. to Z.C. Switch Threshold [SP 7]

When using the ZCT firing mode, P.A. to Z.C. Switch Threshold is used to specify the desired number of cycles during ramp up to full conduction. This parameter is adjustable from 5 to 20 cycles (default is 20 cycles). If the controller is firing into a transformer, the value entered should be high enough so that the transformer does not saturate during the start section of the “ON” portion of the duty-cycle.

P.A. to Z.C. Switch Threshold appears in Control Panel when “Zero Cross Transformer” is selected for the Firing Mode.

Transformer Selection

A transformer of at least 1.3 Tesla (13000 Gauss) is preferred for best performance, up to 1.5 Tesla (15000 Gauss) is permissible.

7.2.4 HiPER Mode

HiPER Mode is a firing mode designed to provide stable and accurate load resistance at low phase angles. HiPER Mode is intended to be used in a resistance control system such as a Temperature Control Loop when the resistance is proportional to temperature.

HiPER Threshold [SP 33] sets the Phase Angle threshold where the controller will switch from Phase Angle to HiPER firing, or from HiPER to Phase Angle. When the output power calls for a Phase Angle that is below this threshold value, the controller will enter HiPER firing, with the Phase Angle locked at the threshold. When the angle is above the threshold, the controller will fire in standard Phase Angle. The default HiPER Threshold value is factory set to 833, with a minimum settable value of 10, and a maximum of 5000. Use the following equation to calculate the targeted threshold value to enter:

If a Phase Angle of 20° is desired: (20° x 10000) / 180° = 1111.111

Enter the value: 1111 for a Phase Angle value of 20°.

7.2.5 Fast Zero Cross

In standard Zero Cross firing, the applied power is ON for 9 half-cycles and OFF for 2 half-cycles. In Fast Zero Cross firing mode, applied power is ON for 2 half-cycles and OFF for 1 half-cycle. The quick change in applied power cycles allows the controller to provide smoother output at a lower power value.

For a temperature dependent system, the Fast Zero Cross firing mode allows for a more controlled heating over time, at a lower input power level. Because the applied power is on a 2-On, 1-OFF half cycle routine, the output will have a decrease in temperature dips and spikes, which are often found in a simple Zero Cross firing mode.

Note: Due to the decrease in time between cycles, the Synch-Guard™ feature is unable to be utilized if the controller is in Fast Zero Cross.

Configuration of the Fast Zero Cross feature occurs within the Full Scale category of the Control Panel. The user can set Full Scale Voltage [SP 8] ranging from 5.0 - 600.0 V, Current [SP 9] ranging from 1.0 - 80.0 A, and Power [SP 10] ranging from 0.1 - 158.4 kW.

In addition, the user can set the Ramp Up Time [SP 4] ranging from 0 - 300 seconds.

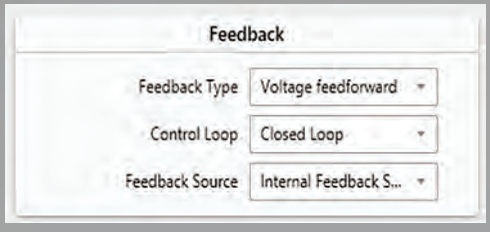
7.3 Control Mode [SP 3]

* = Default	SX	HX
Open Loop	Included	Included
Closed Loop*	Included	Included

Closed Loop adjusts the output so that the feedback equals the setpoint. Consult with Control Concepts, Inc. before attempting to use Open Loop. This type of control does not use feedback, which means the output percentage is directly proportional to the setpoint. Changing the control mode using the Control Panel software requires a passcode from Control Concepts, Inc.

FIND IN CONTROL PANEL

CONTROL MODE [SP 3]
Category: Control > Feedback



7.4 Full Scale Settings

Feedback type selects the signal you desire to control. These settings deal directly with the full scale settings (Full Scale Voltage, Full Scale Current, Full Scale Power). When using one of the voltage feedback settings, the setpoint will be proportional to the full scale voltage. Likewise if using one of the current feedback settings the setpoint will correspond to Full Scale Current. Power works in the same way.

The Full Scale settings are used throughout the system for command input scaling, limits, and control loop response. It is also used for retransmits. These values may be set within the range of the allowable limits for the parameters (see Parameter List Manual for limits).

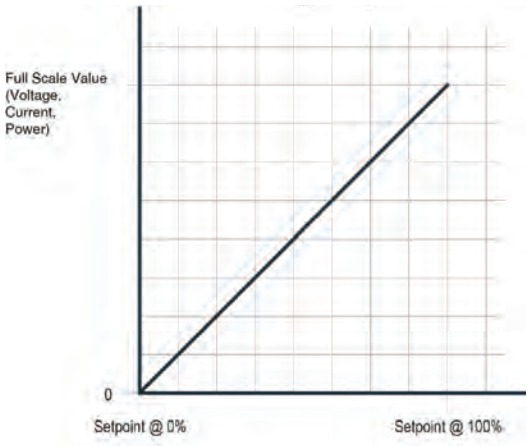


Figure 7.00: This figure shows how the setpoint corresponds to the full scale value.

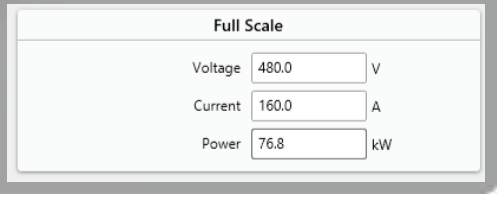
The controller has limit parameters that prohibit the controller from reaching values that are too large for the controller. For example, an 80 Amp controller can have the Full Scale Current set to 1000 Amps but limit parameters will prevent the controller from exceeding 105% (84 Amps) of the frame rating of 80 Amps. **It is recommended that the Full Scale settings should not be set to more than 2X the actual full load operating valve.**

7.4.1 Full Scale Voltage [SP 8]

The Full Scale Voltage is the voltage that will be applied when the load is at full capacity. The closer the Full Scale Voltage is to the actual voltage, the more accurate the controller will be. Setting this slightly higher than the actual voltage is common. This should not be set to more than 2X the actual voltage. The factory default is set to 480 V.

FIND IN CONTROL PANEL

FULL SCALE SETTINGS [SP 8, 90, 10]
Category: Control > Full Scale



7.4.2 Full Scale Current [SP 9]

The Full Scale Current is the current that the load will draw when the load is at full capacity. The closer the Full Scale Current is to the actual current, the more accurate the controller

will be. Setting this slightly higher than the actual current is common. This should not be set to more than 2X the actual current. The factory default is set to the frame rating of the controller.

7.4.3 Full Scale Power [SP 10]

The Full Scale Power is the power consumed by the load when at full capacity. This should not be set to more than 2X of the actual power. The default value is calculated from the following:

1 Phase AC	3 Phase AC	
	Delta, 3 & 4 Wire Wye	Inside Delta
[Full Scale V] x [Full Scale I]	[Full Scale V] x [Full Scale I] x [$\sqrt{3}$]	[Full Scale V] x [Full Scale I] x [3]

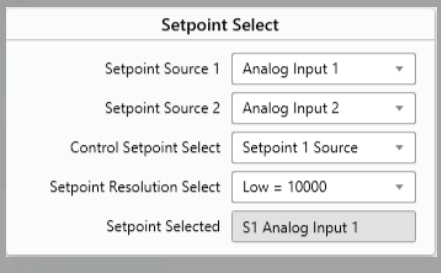
Note: In the Control Panel software there is a “Calculate Power & Limits” button for these equations. This will automatically fill in the full scale power value and define the Limit settings.

7.5 Setpoints

There are seven possible setpoints: four digital, two analog, and one pwm. To designate which setpoint the controller uses, the Setpoint Source [SP 102, SP 103] and Control Setpoint Select [SP 104] need to be setup within the Setpoint tab of the Control Panel software.

FIND IN CONTROL PANEL

CONTROL SETPOINT SELECT [SP 104]
Category: Setpoint > Setpoint Select



	SX	HX
Digital Fieldbus	Included	Included
Digital Keypad	Included	Included
Analog Input 1	* Included	* Included
Analog Input 2	Optional	Optional

* = Default
The Analog Input 2 is only available if the I/O section of the model number contains a “2”, “3”, “6”, or “7”.

7.5.1 Setpoint Source [SP 102] & [SP 103]

	SX	HX
Analog Input 1*	Included	Included
Analog Input 2**	Optional	Optional
Digital Fieldbus***	Included	Included
Digital Keypad	Included	Included
PWM Input	Optional	Optional
FBU Setpoint	Included	Included
NV Setpoint	Included	Included

The Analog Input 2 and the Pulse Width Modulated (PWM) input are only available if the I/O section of the model number contains a “2”, “3”, “6”, or “7”.
* Default for [SP 102]; ** Default for [SP 103]; *** Default for [SP 102] when the digital fieldbus option is Modbus TCP, EtherNet/IP or PROFINET.

Setpoint 1 Source and Setpoint 2 Source can both be set to digital or analog, or a combination of the two. The controller will use the Control Setpoint Select [SP 104] parameter to determine which setpoint to use.

Note: To change Setpoint Resolution [SP 115], the controller must be in STOP.

Setting	Description
Analog In 1	Analog Input 1 is used
Analog In 2	Analog Input 2 is used
Fieldbus1	Fieldbus Digital Input is used
Keypad	Keypad Digital Setpoint is used
PWM Input	Pulse Width Modulation setpoint is used

Defaults:

[SP 102] Setpoint 1 Source: Analog Input 1, or Digital Fieldbus if a communication module is on-board.
[SP 103] Setpoint 2 Source: Analog Input 2, or Digital Keypad if the Analog Input 2 feature is not enabled.

For a PWM input the signal must be connected to Analog Input 1.

7.5.2 Control Setpoint Select [SP 104]

	SX	HX
Setpoint 1 Source [SP 102]	Included	Included
Setpoint 2 Source [SP 103]	Included	Included

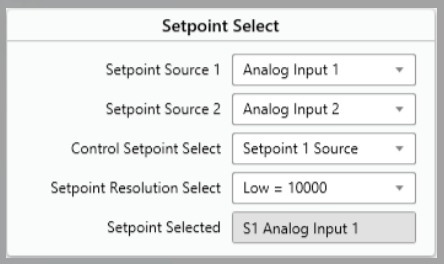
The Control Setpoint Select determines which setpoint source the controller will use.

Setting	Description
Setpoint 1*	Uses the setpoint that is selected in Setpoint 1 Source [SP 102]
Setpoint 2	Uses the setpoint that is selected in Setpoint 2 Source [SP 103]

* = Default

FIND IN CONTROL PANEL

CONTROL SETPOINT SELECT [SP 102, 103,104]
Category: Setpoint > Setpoint Select



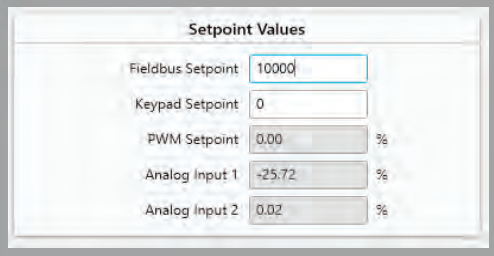
7.5.3 Digital Setpoints [SP 100] & [SP 101]

There are four digital setpoints: [SP 100, 101, 105 - 106, & 107]. The setpoints can be sent via USB, a fieldbus interface, or from the remote display keypad.

Note: When using digital setpoints the Digital Run/Stop [SP 129] must be used.

FIND IN CONTROL PANEL

DIGITAL SETPOINTS [SP 100, 101]
Category: Setpoint > Setpoint Values



The active setpoint is also available in the Control Panel dashboard.

7.5.4 Setpoint Resolution [SP 115]

	SX	HX
10,000 Counts	*Included	*Included
64,000 Counts	N/A	Included

* = Default

The Setpoint Resolution sets the setpoint entry value that equates to 100% output.
The count value equates to:
0 counts = 0% output
[SP 115] setting (10,000 or 64,000) = 100% output

Note: To change Setpoint Resolution [SP 115], the controller must be in STOP.

7.5.5 Analog Setpoints

The controller's analog inputs and PWM input can be used for both setpoints 1 and 2. Refer to section 9.5 for information on the analog inputs capabilities and setup.

7.6 Run / Stop

The Run / Stop state is used when determining if the controller can output. When in Run state, the controller is able to output. However, Run state does not mean the controller is outputting — the command/setpoint must be present (digital or analog) and there must be no inhibit alarms active for the controller to output. When in Stop state, the controller cannot output.

The Run/Stop state is set using the Digital Run/Stop parameter [SP 129], the $\overline{\text{Run}}$/Stop hardware switch, or both, depending on the value of the Run/Stop configuration parameter [SP 3400].

7.6.1 Controller State [MP 248]

The Controller State monitor parameter shows whether the controller is in Run/Stop or Fault/Fault Reset. Fault means an inhibit alarm or critical issue occurred while the controller was outputting. Fault Reset occurs when changing back to the Stop state (preparing to Run the controller again) after being in the Fault state.

7.6.2 $\overline{\text{Run}}$ / Stop Hardware Switch

The $\overline{\text{Run}}$/Stop hardware input are Pins 8 & 9 of the P1 connector. Pin 9 is directly connected to the gates and monitored by the processor. When Pin 9 is pulled low (connected to Pin 8), the state will be in Run and the output of the controller is enabled (depending on the value of [SP 3400]). With no connection between these two pins the controller will remain in Stop state (depending on the value of [SP 3400]).

7.6.3 Digital Run / Stop [SP 129]

Digital Run/Stop provides digital control for Run/Stop that can be used along with or as an alternative to the hardware switch (depending on the value of [SP 3400]). The digital Run/Stop will typically be used when a digital setpoint is used. The Digital Run/Stop Power-up Default [SP 3401] parameter may be used to set the Digital Run/Stop [SP 129] to "Run (1)" after a processor reset or power cycle.

7.6.4 Run / Stop Configuration [XP 3400]

The Run/Stop Configuration parameter controls when the setpoint will be used and whether the Digital Run/Stop [SP 129] parameter is used in conjunction with the $\overline{\text{Run}}$/Stop hardware switch for setting the controller's Run/Stop state.

Setting	Description
Analog Use Switch Digital Use Both*	Analog use switch only, Digital use the Digital Run/Stop and switch
Never Use Digital RUN/STOP	Never use Digital Run/Stop, use the switch only
Always use Digital Run/Stop	Always use Digital Run/Stop and switch

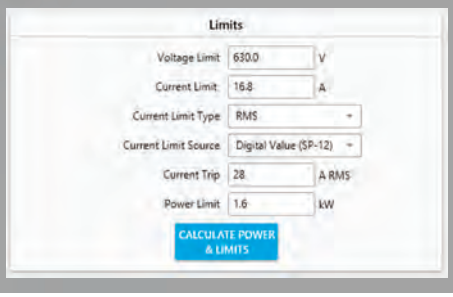
* = Default

7.7 Limits and Trip Parameters

FIND IN CONTROL PANEL

LIMIT AND TRIP PARAMETERS

Category: Control > Limits



	SX	HX
Voltage Limit	N/A	Optional
Current Limit	Included	Included
Over Current Trip	Included	Included
Power Limit	N/A	Optional

Note: The Limit and Trip adjustment parameters are only available if the Performance section of the model number contains an “L” or “P”.

These are safety features are designed to help protect the load from excessive Voltage, Current, and/or Power.

7.7.1 Voltage Limit [SP 11]

	SX	HX
Adjustable	N/A	Optional

Limits the load voltage to prevent the controller from exceeding this value. If the voltage reaches the limit value, a Warning Alarm will be triggered indicating the Voltage Limit has been reached. The recommended setting is 105% of the full scale voltage. The default value is set to 630 V which is 105% of a 600 VAC frame voltage.

7.7.2 Current Limit [SP 12]

	SX	HX
Fixed	Included	N/A
Adjustable	Optional	Included

Note: To adjust the Current Limit value for SX models the Performance section of the model number must contain an “L”.

Limits the load current, to prevent the controller from exceeding this value. If the current reaches the limit value, a Warning Alarm will be triggered indicating that the Current Limit has been reached. The recommended setting is 105% of the full scale current. The default value is set to 105% of the frame rating. The current can be limited by the RMS or AVG value. Use the Current Limit Type parameter [SP 13] to change between RMS or AVG.

7.7.3 Adjustable Current Limit (Analog Input)

The analog input can be used to adjust the value of the Current Limit. When using an analog input signal to adjust the Current Limit [SP 12], it will display the Current Limit setting as set by the analog input. The analog input signal will adjust the current limit setting over the full allowable range for the current limit. When the analog input is at 100%, the Current Limit will be set to 105% of the controller’s frame rating. When the analog input is at 0%, the Current Limit will be set to 20% of the controller’s frame rating.

[SP 26] Current Limit Source

Setting	Description
[SP 12] Current Limit Set*	Explicitly set the Current Limit using [SP 12]
Analog Input 1	Set the Current Limit using Analog Input 1
Analog Input 2	Set the Current Limit using Analog Input 2

* = Default

7.7.4 Current Trip [SP 14]

	SX	HX
Adjustable	Included	Included

If the current exceeds the Over-Current Trip [SP 14] setting the controller will shut down. This setting responds faster than the Current Limit setting. When experiencing an Over-Current Trip the controller will disable the output, display the condition on the LED indicators (and remote display, if present), and activate an inhibit alarm. This feature is designed to protect the controller from experiencing surge currents that could damage the controller. To reset the controller refer to the instructions from section 8.3.2 Current Trip.

Recommended settings:
Phase Angle firing mode: 175% of frame rating.
Zero Cross firing mode: 350% of frame rating.

Note: Setting [SP] values lower than recommended may result in the controller experiencing nuisance trips.

7.7.5 Over Current Trip Retry [SP 20]

This value determines how many times the controller will automatically restart after a Current Trip fault event occurs. For example, a value of 2 will have the controller restart up to 2 more times after the first Current Trip event. Therefore, allowing 3 current trip events before remaining in the fault shutdown state.

7.7.6 Power Limit [SP 15]

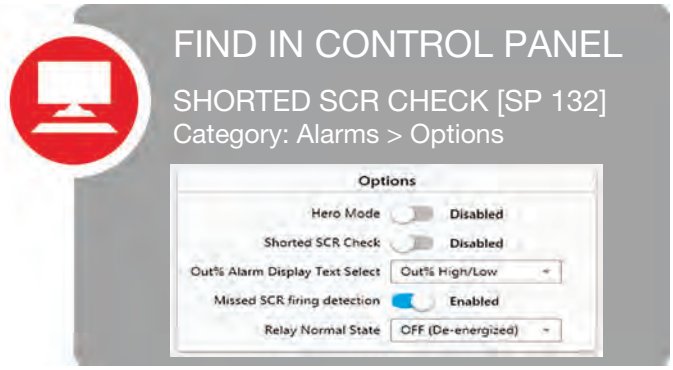
	SX	HX
Adjustable	N/A	Optional

Limits the power applied to the load. The controller will continue to operate but will not exceed the value specified. The controller will ship from the factory with a default value at 105% of the Full Scale Power.

7.7.7 Shorted SCR Check [SP 132]

Setting	Description
Disabled	Shorted SCR Detection is disabled
Enabled*	Shorted SCR Detection is enabled

* = Default



To determine if the SCR has a short, make sure that the line and the load has been disconnected from the controller. Then, with a multimeter measure the resistance from the line connection to the load connection. If this measures less than 50Ω, the SCR is likely to have a short and will be in need of repair.

With the use of some particular load types, the controller will detect false Shorted SCRs and trigger the alarm. By disabling Shorted SCR Detection, the controller will no longer trigger an alarm. If a Shorted SCR is thought to be present, contact Control Concepts, Inc. for assistance.

7.8 Three Phase Settings

7.8.1 Three Phase Load Imbalance [SP 87]

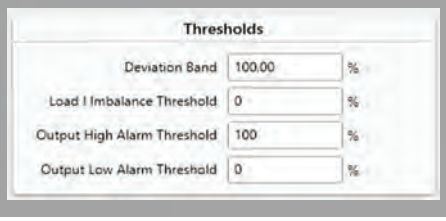
Default Value: 0% (Disabled)

This sets the percent of the Full Scale difference threshold for the phase currents used to indicate a load imbalance. If any phase current is different than another phase current by the amount determined by [SP 87], then a “Load Imbalance” is indicated. The comparison value determined by [SP 87] is a percent of Full Scale Current [SP 9].

Note: 3Ø 2 Leg Frames @ 80 A and less: For these units without the 3rd leg current transformer an imbalance on C would not be shown. If an external current transducer is connected then all 3 legs would be compared.

FIND IN CONTROL PANEL

THREE PHASE LOAD BALANCE [SP 87]
Category: Alarms > Thresholds



7.8.2 Load Current C Source [SP 86]

Note: This parameter applies to 3 Phase 2-Leg controllers only.

Use this parameter when connecting an external CT to either analog input as a way to monitor Load Current C. When the analog input is at 100%, Load Current C will be at the Full Scale Current setting [SP 9]. When the analog input is at 0%, Load Current C will be at 0. Refer to Section 9.5 Analog Inputs for information on the analog inputs capabilities and setup.

FIND IN CONTROL PANEL

LOAD CURRENT C SOURCE [SP 86]
Category: Control > Load Configuration

Setting	Description
Internal Feedback	For 3 Phase 2-Leg Controllers rated equal or more than 80 Amps, there is no Load Current C measurement. For 3 Phase 3-Leg Controllers, the Load Current C measurement comes from the on-board control circuitry.
Analog Input 1	The Load Current C measurement comes from Analog Input 1
Analog Input 2	The Load Current C measurement comes from Analog Input 2

* = Default

7.9 Tap Change Indication

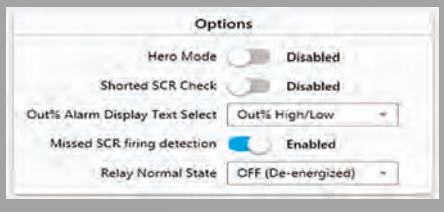
Certain types of loads change resistance over their lifespan, which can affect the power factor when controlled with a phase angle power controller to achieve a constant output power. To improve power factor, a transformer with multiple voltage taps may be used. The tap change indication signals the user when to change these voltage taps to a higher or lower setting to achieve the user’s desired output. This feature uses the controller’s output percent along with the thresholds set by the user to determine the indication. These indications can be mapped to the dry contact relays, read on the user display, or read digitally via the warning alarm monitor parameter.

7.9.1 Setting Tap Change Via Control Panel

To enable Tap Change Indication, set the “Out% Alarm Display Text Select” [SP 3410] to “Tap Change Up/Down”, which is located in the “Options” subcategory of “Alarms”. To set the High/Low thresholds, select “Tap Change Up Threshold” [SP 3402] and “Tap Change Down Threshold” [SP 3403], found in the “Thresholds” subcategory of “Alarms”. These are also referred to as Output% High/Low Alarm Threshold, as described in Section 11.2.8.

FIND IN CONTROL PANEL

OUT% ALARM DISPLAY TEXT SELECT [SP 3410]
Category: Alarms > Options



When enabling the Tap Change indicator there are a few visual changes to the Control Panel:
1. Warning alarm text is changed from Out% High/Low to Tap Change Up/Down.
2. Output High/Low Alarm Threshold parameter title changes to Tap Change Up/Down Threshold.
3. Relay Alarm text changes from Output% High/Low change to Tap Change Up/Down.

7.9.2 High/Low Out% Alarm Display Text Select [SP 3410]

Setting	Description
Out% High/Low*	Upon a High Out% Alarm due to an Output % greater than the High Threshold Setting, the display will indicate the alarm with “OUT% HIGH.” Likewise, upon a Low Out% Alarm due to an output % lower than the Low Threshold Setting, the display will indicate the alarm with “OUT% LOW”
Tap Change Up/Down	Same as above except High will read: “TAP CHANGE UP” and Low will read: “TAP CHANGE DOWN”

* = Default

7.10 Heater Bakeout

When Heater Bakeout is enabled [SP 24] and the controller is switched into Run state, it will ramp up at a linear rate, phase angle firing, to full-on for the time set by the value entered to the parameter [SP 21]. During Heater Bakeout the control loop will run in open-loop. When the controller’s output reaches full-on, Heater Bakeout will terminate at the end of the set time. Then the controller will transition into normal run state with the selected firing mode and follow the selected setpoint command.

FIND IN CONTROL PANEL

HEATER BAKEOUT [SP 24]
Category: Heater Bakeout

7.10.1 Heater Bakeout Time [SP 21]

The time period Heater Bakeout will use to ramp the output. Check Appendix A: Specifications for the range of allowable values.

7.10.2 Heater Bakeout Voltage Limit [SP 22]

If, at any time during the Heater Bakeout ramp-up, the load voltage reaches the Voltage Limit, the output will be limited at the Voltage Limit setting [SP 22]. When limiting, the controller will continue to output until the Heater Bakeout time [SP 21] expires.

7.10.3 Heater Bakeout Current Trip [SP 23]

If, at any time during the Heater Bakeout ramp-up, an Over Current Trip fault event occurs, the controller will immediately transition into FAULT state which will terminate the output. When a Current Trip Fault event occurs, the ramp will be reset and Heater Bakeout will remain enabled. In addition the user may manually/digitally restart the device. Restarting from fault state requires the Run/Stop switch or the digital run enable [SP 129] to be toggled to stop, then back to run. The controller can be configured to use the Over Current Trip Retry setting [SP 20] in order to retry for the specified number of times before transitioning into FAULT state.

7.10.4 Heater Bakeout Time Remaining [MP 371]

The amount of time remaining for the controller to ramp its output using Heater Bakeout.

7.10.5 Enabling Heater Bakeout

Heater Bakeout can be enabled a number of different ways. It can be enabled by setting Heater Bakeout Enable [SP 24] to enable (1), with the general purpose digital input [SP 133], or it can be set to be enabled with a power cycle [SP 25]. To use the general purpose input, set [SP 13] GP Digital Input function to (3) Heater Bakeout Enable. Then connecting the general purpose input terminal to common will enable Heater Bakeout. Disconnecting it from common will disable Heater Bakeout. If it's desirable to have Heater Bakeout enabled after a power-cycle then set [SP 25] Heater Bakeout Enable with Power Cycle to (1) enable Heater Bakeout at power-up.

Heater Bakeout may be enabled while in RUN state during normal operation. However, the Heater Bakeout ramp-up operation will not become active until the controller is stopped and restarted. Putting the controller into STOP state will reset the Heater Bakeout ramp, but not disable Heater Bakeout. If Heater Bakeout is disabled during a Heater Bakeout ramp-up cycle, the Heater Bakeout operation will continue until complete.

7.11 Partial Load Fault

The Partial Load Fault Detection is a "watch-dog" feature that monitors the system for a change in resistance. This is useful for detecting an element failure for loads with multiple parallel elements. The partial load fault check is disabled when the controller's output is less than 5% phase angle for controllers in phase angle firing mode. If this is the case, the "Out of Range" status will be active for the Partial Load Fault Status parameter (MP 369). The feature reads a user set tolerance value that determines the drift from the target resistance in the system. This value can be entered manually, or set from the current resistance value of the system, using the 'Teach' function.

7.11.1 Detection Enable [SP 34]

When Partial Load Fault Detection Enable is set to ON (1), the resistance of the load will be compared against the target value. If the resistance deviates from the expected value, the Partial Load Fault warning alarm will become active. This check is not performed if the parameter is set to OFF (0).

7.11.2 Partial Load Fault Teach Mode [SP 42]

Setting	Description
Single Point *	Most often used in a constant resistance load, this mode pairs well with the Zero Cross and Fast Zero Cross firing modes. In single Point mode, Control Panel will monitor the drift from the Target Resistance A [SP 38]. For a Three Phase controller, Target Resistance A [SP 38], B [SP 39], and C [SP 40] will be used.
Ramp Down	Used in variable resistance loads, the Ramp Down mode takes multiple points over a range set by the user. The range is determined by, Teach Max Setpoint [SP 43] and Teach Min Setpoint [SP 45]. The controller will then monitor the range of points for a drift in resistance using the Tolerance A [SP 35]. For a Three Phase controller, Tolerance A [SP 35], B [SP 36], and C [SP 37] will be used.

* = Default

Because this is a “watch-dog” feature, if the drift exceeds the Tolerance A/B/C values, an alarm will be displayed in Control Panel, but power WILL NOT be discontinued.

7.11.3 Partial Load Fault Tolerance [SP 35, 36, 37]

The tolerance specifies what percent the load resistance can deviate from the target value before a partial load fault is indicated. The tolerance should be set according to the stability of your load and the number of parallel elements. For a single phase device, only [SP 34] is required for phase A. For a three phase device, a separate tolerance is required for phases A [SP 34], B [SP 35], and C [SP 36].

The minimum entry value for Partial Load Fault Tolerance [SP 35] is limited by the model version.

Settings by Version		
Model	**Default Setting**	**Minimum Setting**
SX-S	50%	50%
SX-L	13%	13%
HX-L	8%	0%
HX-P	8%	0%

7.11.4 Partial Load Fault Target Resistance [SP 38, 39, 40]

The expected load resistance when using Single Point mode (as set with [SP 42]). The target resistance is not available when load fault detection is set to Ramp Down mode [SP 42]. If the load resistance deviates from the target value by more than the tolerance percent [SP 34, 35, 36], the Partial Load Fault warning alarm will become active. For a Single Phase device, only SP 38 is required for phase A. For a Three Phase device, a separate target resistance is required for Phases A, B, and C.

7.11.5 Partial Load Fault Alarm Delay Time [SP 114]

The Alarm Delay Time [SP 114] feature allows a user to designate the amount of allowable time before Control Panel displays/triggers an alarm associated with any of the Partial Load Fault alarms. The default time is set to a delay time of 60 seconds and can be set to a value from 1 - 120 seconds.

7.11.6 Partial Load Fault Teach [SP 41]

The Teach button will save the resistance characteristics of your load to be used when determining if a partial load fault has occurred. The controller must be in RUN state to enable the load fault teach.

When Partial Load Fault is in Single Point mode [SP 42], the teach button will save the current resistance of your load to be used throughout the controller's entire output range. The resistance values are saved to parameters [SP 38, 39, 40]. The controller must be applying power to the load in order to record an accurate resistance.

When Partial Load Fault is in Ramp Down mode [SP 42], teach button will apply power to the load and record resistance values while ramping down the controller's output. This is useful for loads where the resistance changes throughout the output range. You can specify the max Setpoint value [SP 43] that is used for the ramp down in order to limit the power applied to the load. The teach procedure in Ramp Down mode will take about 1 minute.

Instead of using the teach button, writing a value of (1) to parameter [SP 41] will either record the current resistance value or initiate the ramp down, depending on the selected mode.

7.11.7 Partial Load Fault Teach Max Setpoint [SP 43]

The maximum Setpoint to use during the Teach procedure when partial load fault detection is in Ramp Down mode [SP 42]. During the Teach procedure, the controllers output will begin at this Setpoint and ramp down from there. Use this option if you cannot or do not wish to run your load at 100% output. If a max setpoint is used, the partial load fault detection will be disabled when the controller's output is above the selected setpoint. If this is the case, the "Out of Range" status will be active for the Partial Load Fault Status parameter [MP 369].

7.12 Hero Mode [SP 84]

Note: **Controller warranty is considered void when Hero Mode is Enabled AND an over-temperature condition occurs.** When the controller is operating within proper environment and specifications it is extremely rare that the SCR would exhibit an Over-Temperature condition. Contact factory for details about this feature.

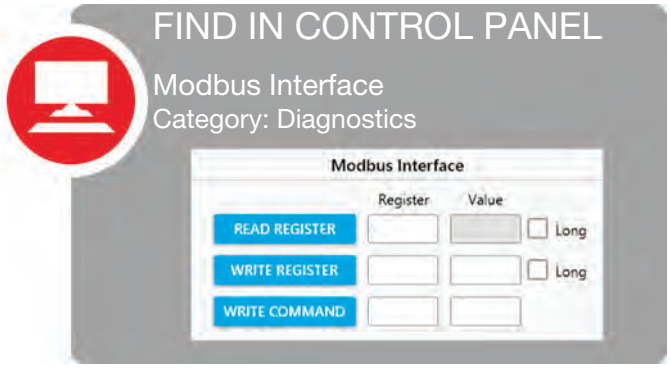
If Hero Mode is enabled, the Over-Temperature Inhibit Alarm will be disabled. The Over-Temp alarm is designed to shut the controller down when the SCR temperature exceeds its safety ratings. This function is intended to be used for customers that need to keep their process in operation, even if it may damage the SCR power controller - hence, Hero Mode. When enabled and an Over-Temp condition occurs, Inhibit Alarm [MP 210] will still indicate the Over-Temp condition. If a Relay Mask [SP 16] has "Heatsink Over Temp" Selected, the relay will energize. Meanwhile the controller will stay in the Run State. The display, if present, will register "Warning Alarm Heatsink Temp" and the Alarm LED on the controller will flash orange. The Over-Temp indications will clear when the temperature drops below the Over-Temp limit threshold, (which can be set via Control Panel).

7.13 Low Output Alarm Enable [SP 113]

When enabled the Low Output Alarm will trigger a Warning Alarm that will be displayed in Control Panel. This feature works hand in hand with [SP 3403] Output Low Alarm Threshold. Use [SP 3403] to set the point at which the Low Output Alarm will be triggered. In addition, using [SP 16] Relay Alarm Mask, an external alarm indicator can be triggered in the event of a Low Output event (See Section 9.1: Alarm Relay, for more information). If Low Output Alarm [SP 113] is disabled, then Control Panel will not display or trigger an alarm in the event of a Low Output event.

7.14 Diagnostics

7.14.1 Modbus Interface



Read Register
Enter the number of the parameter you wish to read into the Register box next to the Read Register button. Selecting this button will read the parameter's value and display it in the Value box.

'Long' Parameters
The 'Long' check box is for reading parameters that have MSW and LSW. It calculates the 32 bit value from the parameter entered and the following parameter. When entering the register value, use the parameter's MSW. Do not use the single length parameters.

Write Register
Enter the number of the parameter into the Register box and the value that you wish to write into the Value box next to the Write Register button. Selecting this button will write the value to the parameter. This feature is not often used, as writing to the parameter from the "Control" category in Control Panel is the recommended procedure.

Write Command
Do not use unless under direct support from Control Concepts, Inc.

8. MONITORING

8.1 Power Consumption

The MicroFUSION (HX, high performance) controllers have a Kilowatt hour meter ([MP 305] KWh Consumption HI, [MP 306] KWh Consumption LO). The KWh Consumption value is the energy consumed by the power controller over a period of time (not including the 24VDC supply). Kilowatt hour is equivalent to one kilowatt of power used continuously for one hour.

KWh Consumption [MP 305, 306]
Maximum: 214748364.7 KWh

The MicroFUSION (HX, high performance) controllers have a Kilovolt-ampere hour meter (MP-303 KVAh Consumption HI, MP-304 KVAh Consumption LO). The KVAh Consumption value is the apparent power (KVA) consumed by the power controller over a period of time (not including the 24VDC supply). Kilovolt-ampere hour is equivalent to 1000 volt-amperes (1 KVA) of power used continuously for one hour.

KVAh Consumption [MP 303, 304]
Maximum: 214748364.7 KVAh

9. I / O

9.1 Alarm Relay [SP 16] & [SP 85]

	SX	HX
Relay Alarm Mask [SP 16]	Optional	Optional
System Relay Mask [SP 85]	Optional	Optional

Note: There is one relay available on the MicroFUSION controller. Both the Relay Alarm Mask [SP 16] and the System Relay Mask [SP 85] map to the same relay. All alarms mapped to the relay are OR'ed together.

Relay Alarm Mask

Alarm	Description	Alarm	Description
Output % Low	Controllers output % has dropped lower than the Low Alarm Threshold.	Current Limit	If Current Limit is present the relay will energize.
Output % High	Controllers output % has risen above the High Alarm Threshold.	Power Limit	If Power Limit is present the relay will energize.
Deviation Alarm	Controller output has exceeded the Deviation Band % tolerance.	Shorted SCR	If a Shorted SCR is present the relay will energize.
Low Output	Controller is at max output, but cannot reach targeted value.	AC Line Phase Loss	If a phase loss is detected the relay will energize.
3 Phase Load Imbalance	If the Three Phase Load Balance [SP 87] has been enabled and a load imbalance has been detected, the relay will energize.	Heatsink High Temp Warning	If the heatsink temperature reaches within 5°C of the over-temperature alarm the relay will energize.
Output On	Controller is outputting power to the load.	Current Trip	If a Current Trip occurs the relay will energize. This will keep the relay energized until the fault condition is reset.
Digital Run Enable	If the bit for the Digital System Command [SP 129] is set to run, the relay will energize.	Heatsink Over Temp	If the heatsink temperature reaches the over-temperature alarm the relay will energize. When the temperature drops into a safe range, the relay will automatically de-energize. The controller will remain in a fault state.
Voltage Limit	If Voltage Limit is reached the relay will energize.	Partial Load Fault	System is ready to detect a Partial Load Fault based off the parameters set in the Partial Load Fault Detection section.

System Relay Mask

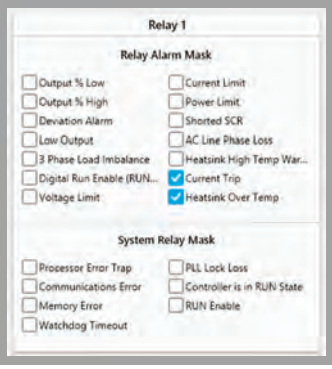
Alarm	Description	Alarm	Description
Processor Error Trap	Rare error type where the controller will not be functioning. Connect to Control Panel to clear.	PLL Lock Loss	Phase Locked Loop lost its lock on the AC Line [MP 210 bit 2].
Communications Error	A communication problem when using digital Communications only.	Controller is in RUN State	When the Controller State [MP 248] is in Run.
Memory Error	EEPROM check failure [MP 210 bit 6]. See Diagnostics 2 tab for errors.	RUN Enable	The Run/Stop switch is set to the run position on the P1 Connector.
Watchdog Timeout	Specific processor error trap [MP 210 bit 7].		

In Control Panel, select the check box next to the alarm/function that you wish to energize the relay if the alarm condition is met. Any number of conditions may be mapped to the relay.

For relay electrical specifications, see Appendix A

FIND IN CONTROL PANEL

ALARM RELAYS [SP 16, 18]
Category: Alarms



9.2 Isolated I / O (Optional)

The Isolated I/O provides 500 VAC of isolation to the Analog Inputs, General Purpose Input, $\overline{\text{Run}}$/Stop, and the Retransmits. The option is only available when ordering from the factory and is not field upgradeable.

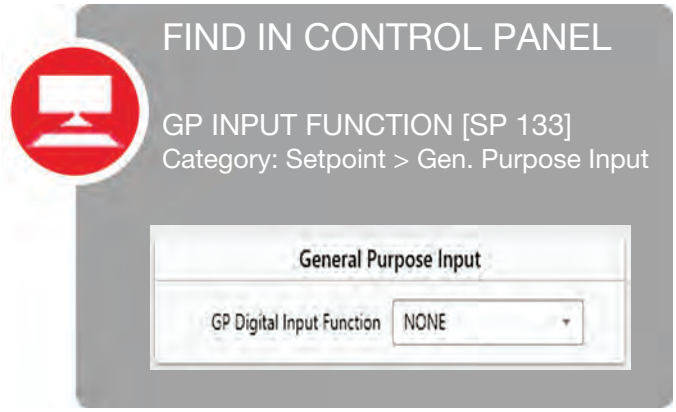
9.3 General Purpose Input

	SX	HX
Pin 10 functionality of P1 Connector	Optional	Optional

Note: The General Purpose Input is only available if the I / O section of the model number contains a "2", "3", "6", or "7".

The General Purpose Input uses pins 8 and 10 of the P1 connector. When using this feature the General Purpose Input Function [SP 133] must be defined. When pin 10 is pulled low (connected to pin 8) the controller will toggle the function defined in the General Purpose Input Function parameter.

9.4 General Purpose Input Function [SP 133]



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Opening and closing the connection between pin 8 & pin 10 of the P1 connector toggles:

[SP 133] Function	Selections	See this parameter for reference
Control Setpoint Select	Setpoint 1 Source (Open) Setpoint 2 Source (Closed)	Control Setpoint Select [SP 104]
Open / Closed Loop	Open Loop (Open) Closed Loop (Closed)	Control Mode [SP 3]
Heater Bakeout Enable	Disable (Open) Enabled (Closed)	Heater Bakeout Enable [SP 24]
Local Mode Enable	Disabled (Open) Enabled (Closed)	Local Mode Enable [SP 120]
Phase Angle Firing	Disabled (Open) Enabled (Closed)	Phase Angle Firing Mode [SP 2]

Other selections may be available. Contact factory for special requests.

9.5 Analog Inputs

The controller's analog inputs can be used to control the setpoint and/or an adjustable current limit. To control a setpoint, the setpoint source [SP 102] or [SP 103] must be set to Analog Input 1 or Analog Input 2. To use an adjustable current limit, Current Limit Source [SP 24] must be set to Analog Input 1 or Analog Input 2.

	Default	Range
Analog Input 1 (Vdc)	0 - 5 Vdc	0 -10 Vdc
Analog Input 1 (mA)	* 4 -20 mA	0 - 20 mA
Analog Input 2 (Vdc)	* 0 - 5 Vdc	0 - 10 Vdc
Analog Input 2 (mA)	4 - 20 mA	0 - 20 mA

* = Default; The Analog Input 2 is only available if the I / O section of the model number contains a "2", "3", "6", or "7".

Analog Input 1 Type [SP 90]

Setting	Description
Voltage	Voltage input scalable from 0 - 10 Vdc
Current*	Current input scalable from 0 - 20 mA (default 4 -20 mA)

* = Default

Analog Input 1 Type [SP 90] selects the input signal type for Analog Setpoint 1. The wiring diagram for the inputs can be found in the Installation and Maintenance manual.

Analog Input 1 Lo Cmd [SP 91]
Default value: 4.00 mA

Analog Input 1 Lo Cmd [SP 91] paired with Analog Input 1 Lo Out [SP 92]. This parameter is the signal value at the percent set in [SP 92]. This is typically your lowest possible signal value that can be achieved.

Analog Input 1 Lo Out [SP 92]
Default value: 0.00 %

Analog Input 1 Lo Out [SP 92] is paired with Analog Input 1 Lo Cmd [SP 91]. This parameter is the percentage at the signal value set in [SP 91].

Analog Input 1 Hi Cmd [SP 93]
Default value: 20.00 mA

Analog Input 1 Hi Cmd [SP 93] is paired with Analog Input 1 Hi Out [SP 94]. This parameter is the signal value at the percent set in [SP 94]. This is typically the highest possible signal value that can be achieved.

Analog Input 1 Hi Out [SP 94]
Default value: 100.00 %

Analog Input 1 Hi Out [SP 94] is paired with Analog Input 1 Hi Cmd [SP 93]. This parameter is the percentage at the signal value set in [SP 93].

Analog Input 1 Monitor Full Scale [SP 136]
Default value: 1000

Analog Input 1 Monitor Full Scale [SP 136] is used for scaling the Analog Setpoint 1 - Monitor Value [MP 208]. This value can be scaled for any type of user input. If this value is desired to be monitored on the Display, it can be viewed by adding [MP 208] to the custom screen list. On the custom screen list window a four-character title can be edited and up to three characters may be entered for units to be displayed with [MP 208].

Analog Input 2 Function Select [SP 89]

Setting	Description
None*	Analog Input 1 functions normally
Scale Analog Input 1	Analog Input 2 scales Analog Input 1

* = Default

Analog input 2 can be used to scale analog input 1.

Scaled Ain 1 = (Ain 1 x Ain 2) / 100%

Analog Input 2 Type [SP 95]

Setting	Description
Voltage*	Voltage input scalable from 0 - 10 Vdc (default 0 - 5 Vdc)
Current	Current input scalable from 0 - 20 mA

* = Default

Analog Input 2 Type [SP 95] selects the input signal type for Analog Setpoint 2. The wiring diagram for the input can be found in the Installation and Maintenance manual.

Analog Input 2 Lo Cmd [SP 96]
Default value: 0.00 V

Analog Input 2 Lo Cmd [SP 96] is paired with Analog Input 2 Lo Out [SP 97]. This parameter is the signal value at the percent set in [SP 97]. This is typically your lowest possible signal value that can be achieved.

Analog Input 2 Lo Out [SP 97]
Default value: 0.00 %

Analog Input 2 Lo Out [SP 97] is paired with Analog Input 2 Lo Cmd [SP 96]. This parameter is the percentage at the signal value set in [SP 96].

Analog Input 2 Hi Cmd [SP 98]
Default value: 5.00 V

Analog Input 2 Hi Cmd [SP 98] is paired with Analog Input 2 Hi Out [SP 99]. This parameter is the signal value at the percent set in [SP 99]. This is typically your highest possible signal value that can be achieved.

Analog Input 2 Hi Out [SP 99]
Default value: 100.00 %

Analog Input 2 Hi Out [SP 99] is paired with Analog Input 2 Hi Cmd [SP 98]. This parameter is the percentage at the signal value set in [SP 98].

Analog Input 2 Monitor Full Scale [SP 137]
Default value: 1000

Analog Input 2 Monitor Full Scale [SP 137] is used for scaling the Analog Setpoint 2 - Monitor Value [MP 209]. This value can be scaled for any type of user input. If this value is desired to be monitored on the Display, it can be viewed by adding [MP 209] to the custom screen list. On the custom screen list window a four-character title can be edited and up to three characters may be entered for units to be displayed with [MP 209].

FIND IN CONTROL PANEL

ANALOG INPUT SCALING
Category: Analog Inputs > Analog Input 1/2

9.6 Pulse Width Modulation Input

A pulse width modulation signal may be used as a setpoint. The signal must be connected to Analog Input 1 to function. The setpoint source [SP102] or [SP103] must also be set to PWM input.

Input Range:
20 Hz ≤ Frequency ≤ 2 kHz
0 - 5 Vdc maximum

PWM Input LO Duty Cycle [SP 155]
Default value: 0 %

PWM Input LO Duty Cycle [SP 155] is paired with PWM Input LO Command [SP 156]. This parameter is the percentage at the signal value set in [SP 156].

PWM Input LO Command [SP 156]
Default value: 0 %

PWM Input LO Command [SP 156] is paired with PWM Input LO Duty Cycle [SP 155]. This parameter is the signal value at the percent set in [SP 155]. This is typically your lowest possible signal value that can be achieved.

PWM Input HI Duty Cycle [SP 157]
Default value: 100 %

PWM Input HI Duty Cycle [SP 157] is paired with PWM Input HI Command [SP 158]. This parameter is the percentage at the signal value set in [SP 158].

PWM Input HI Command [SP 158]
Default value: 100 %

PWM Input HI Command [SP 158] is paired with PWM Input HI Duty Cycle [SP 157]. This parameter is the signal value at the percent set in [SP 157]. This is typically your highest possible signal value that can be achieved.

9.7 Retransmits

FIND IN CONTROL PANEL

RETRANSMITS
Category: Analog Outputs (Retransmits)

The Retransmits are configured similarly to the analog inputs. The two Retransmits can be configured independently as either a current source (0 – 20 mA) or as a voltage source (0 – 10 Vdc). The Retransmits may be mapped to Load Voltage, Current, Resistance or Power and can also be set to a direct out signal.

	SX	HX
Retransmit 1	N / A	Optional
Retransmit 2	N / A	Optional

Note: The Retransmits are only available if the Retransmits section of the model number contains an “R”.

Meter 1 Signal [SP 141] / Meter 2 Signal [SP 148]

Setting	Description
Load Voltage A [Meter 1 Default]	The load voltage for Phase A
Load Current A [Meter 2 Default]	The load current for Phase A
Load Voltage B	The load voltage for Phase B
Load Current B	The load current for Phase B
Load Voltage C	The load voltage for Phase C
Load Current C	The load current for Phase C
Real Power	The real power
Apparent Power	The apparent power
Direct Out	Use Meter 1 Out Direct [SP 146] or Meter 2 Out Direct [SP 153] to set the value of the output
Load Resistance A	The load resistance for Phase A
Load Resistance B	The load resistance for Phase B
Load Resistance C	The load resistance for Phase C

Meter 1 Out Type [SP 140] / Meter 2 Out Type [SP 147]

Setting	Description
Voltage*	Voltage output scalable from (0 -10) Vdc (Default 0 - 5 Vdc)
Current	Current output scalable from (0 -20) mA

* = Default

Meter 1 Lo Value [SP 142] / Meter 2 Lo Value [SP 149]
Default value: 0.00 %

These are paired with Meter 1 Lo Out [SP 143] / Meter 2 Lo Out [SP 150]. These parameters are the percentage at the signal value set in [SP 143 / SP 150].

Meter 1 Lo Out [SP 143] / Meter 2 Lo Out [SP 150]
Default value: 0.00 V

These are paired with Meter 1 Lo Value [SP 142] / Meter 2 Lo Value [SP 149]. These parameters are the signal value at the percent set in [SP 14] / [SP 149]. This is typically your lowest possible signal value that is the desired output.

Meter 1 Hi Value [SP 144] / Meter 2 Hi Value [SP 151]
Default value: 100.00 %

These are paired with Meter 1 Hi Out [SP 145] / Meter 2 Hi Out [SP 152]. These parameters are the percentage at the signal value set in [SP 145] / [SP 152].

Meter 1 Hi Out [SP 145] / Meter 2 Hi Out [SP 152]
Default value: 5.00 V

These are paired with Meter 1 Out Direct [SP 146] / Meter 2 Out Direct [SP 153]. These parameters are the signal value at the percent set in [SP 146] / [SP 153]. This is typically your lowest possible signal value that is the desired output.

Meter 1 Out Direct [SP 146] / Meter 2 Out Direct [SP 153]
Default value: 0.00 V

Meter (1/2) Out Direct [SP 146, 153] is only used when Meter 1 Signal [SP 141] / Meter 2 Signal [SP 148] is set to Direct Out. This will give a constant output signal at the value entered.

Load Resistance Maximum [SP 154]
Default value: 50 Ohms

Load Resistance Maximum is used to scale the analog output signal when using Load Resistance A, B, or C as a meter signal, such that the maximum signal output will equate to the load resistance value of [SP 154] Load Resistance Maximum. Load Resistance Maximum must be set to the approximate expected maximum resistance of the load (in ohms). When configuring the retransmit output for Load Resistance, a value of 100.00% for the Meter Command HI Value [SP 144], [SP 151] will equate to the [SP 154] Load Resistance Maximum value.

10. CCI LINK™

This is a proprietary deterministic digital bus that enables multiple Control Concepts, Inc. devices to communicate with each other.

Figure 10.00: Side view of a MicroFUSION to show location of LEDs.

10.1 Network LED Indicators

The CCI Link™ connector has 4 LEDs: 2 yellow and 2 green. There is one LED in each corner of the connector.

Network State	Green	Yellow	Description
Non-existent	OFF	OFF	Initializing
On-Line Unallocated	Flashing	OFF	No Connections
On-Line Allocated	ON	OFF	OFF
“Wait-4-Who’s There”	OFF	Blink (5 second intervals)	Not on the network, waiting
Identify	N / A (Maintains previous State)	OFF - Flash - OFF	Response to identify request
Timeout	ON	ON	Connection timed out
Comm Fault	OFF	ON	Bus-OFF, DUP MAC failure

When the controller does not detect any other devices on the CCI Link™ network the green LED will be OFF and the yellow LED will flash every 5 seconds. The yellow network LED is also used to identify a specific controller on the CCI Link™ network. When a controller is commanded to identify itself, the yellow network LED will flash 5 times.

10.2 Auto Terminating Resistor Circuit

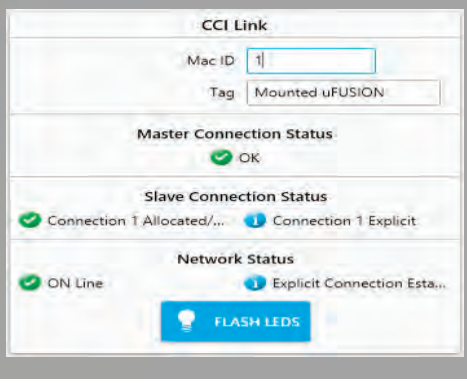
When connecting multiple devices on the CCI Link™ network, a terminating resistor must be pulled in at each end of the network trunk line. With the Auto Terminating Resistor Circuit the device automatically determines if the resistor needs to be pulled in by determining if its connected to one or two devices. When the resistor is pulled in the green LED on the CCI Link™ connector furthest away from the heatsink will be illuminated.

Note: Locations and LED usage is uniform across all devices, including extended range.

10.3 CCI Link Parameters

FIND IN CONTROL PANEL

CCI LINK PARAMETERS
Category: Communication > CCI Link



TAG NAME
This is a 16-character alpha-numeric identifier.

MAC ID [SP 118]
Default Value: 63

The device’s address on the CCI Link™ network. Each drive must have a unique MAC ID between 1 - 63.

Local Mode Enable [SP 120]
Use Local Mode Enable to make changes to device settings using the keypad or Control Panel without CCI Link™ (Connect Module) or a Fieldbus module overriding the settings.

Setting	Description
Disabled*	CCI Link™ or a Fieldbus module is allowed to change settable parameters [SP].
Enabled	Changes to parameters via CCI Link™ or a Fieldbus module are not allowed.

* = Default

Network Timeout Action [SP 128]
The Network Timeout Action specifies the behavior that should occur when the device loses communication with CCI Link™ or the Fieldbus module (depending on the device hardware options).

Setting	Description
NONE, Continue*	The device continues operating normally, and a warning alarm is activated.
STOP, fault shutdown	The device enters an inhibit state and stops outputting.
Use Network Timeout Setpoint [SP 108]	the output is changed to the value specified by Network Timeout Setpoint [SP 108], and a warning alarm is activated.

* = Default

Network Timeout Setpoint [SP 108]
If Network Timeout Action [SP 128] is set to “Use Network Timeout Setpoint,” the value of this parameter will be used as the setpoint for the controller output. The range of the Network Timeout Setpoint is determined by the Setpoint Resolution parameter [SP 115].

Transducer MAC ID [SP 160]
Default Value: 0

Sets the MAC ID of a transducer card server node on CCI Link™, causing the MicroFUSION controller to become a client node with respect to the specified transducer card.

Transducer Feedback Select [SP 161]

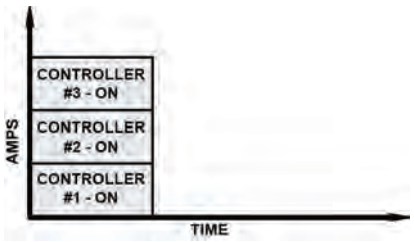
Setting	Description
V1*	Channel 1 Voltage
I1	Channel 1 Current
V2	Channel 2 Voltage
I2	Channel 2 Current
V3	Channel 3 Voltage
I3	Channel 3 Current
P1	Channel 1 Power
P2	Channel 2 Power
P3	Channel 3 Power
POW 3PH	Three Phase Power

* = Default

Use to select the feedback signal from the transducer card server node on CCI Link™ when feedback source is set to transducer card.

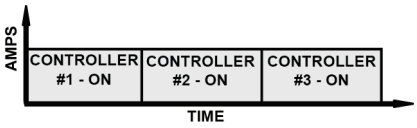
Network Error Count [MP 348]
The number of CCI Link™ message errors detected.

10.4 SYNC - GUARD™

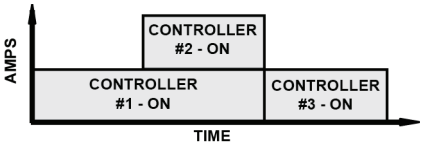


The SYNC-GUARD™ feature reduces the possibility of synchronous operation of two or more zero cross controllers. This feature does not alter the power applied to the load, but adjusts the time when power is applied in such a manner as to reduce the possibility of two or more controllers being ON and OFF in unison.

SYNC-GUARD™ is useful whenever there are two or more power controllers connected to the same power source with a zero-cross firing mode selected. The SYNC-GUARD™ feature can significantly reduce the peak current required from a source that is connected to multiple power controllers while all are zero cross firing.



Zero cross firing is an ON-OFF type of control where the desired voltage, current, or power is delivered to the load by varying the controller's ON-OFF duty cycle. With zero cross firing, when the controller's output is ON, full supply voltage and current are provided to the load.



Without SYNC-GUARD™, multiple zero cross firing controllers could potentially be ON and OFF all at the same time. This would require heavy current to be drawn from the source while the controllers are all ON and no current when they are all OFF. The SYNC-GUARD™ feature works to reduce the peak current draw required from the source over time by causing each controller to attempt to find a time to turn ON when fewer, or no other, controllers are firing.

Limitations
The SYNC-GUARD™ feature works to reduce the peak current draw required from the source for multiple controllers over time. However, each controller cannot predict when another controller is going to fire. Therefore the probability of multiple controllers firing at the same time exists even when using the SYNC-GUARD™ feature. The probability of this happening is highest when many controllers transition into the RUN state, and therefore turn ON at the same time. It is recommended that no more than 10 controllers be linked together with SYNC-GUARD™ over CCI Link™.

SYNC-GUARD™ Enable [SP 131]

Setting	Description
Disabled*	SYNC-GUARD™ is disabled
Enabled	SYNC-GUARD™ is enabled

* = Default

For more information:

Visit the Control Concepts, Inc. YouTube Channel, which features video tutorials for our products. Search for the SYNC-GUARD™ Overview, video.

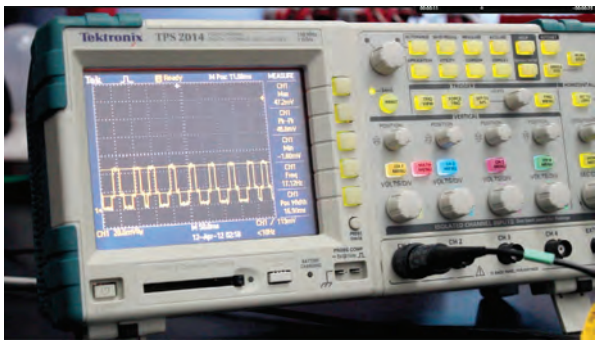


Figure 11.01: An Oscilloscope used in conjunction with SYNC-GUARD™

11. TROUBLESHOOTING

11.1 Processor and Fault Resets

Fault Resets

- Toggle the $\overline{\text{Run}}$/Reset pin on the P1 controller.
- Disable, then Enable the Digital System command.
- Press the Clear Fault State button on the Control Panel software located in the Diagnostics category.

Note: To use the Clear Fault state buttons the Controller must be in the Fault Reset state.

Processor Resets*

- Using the Control Panel software, navigate to the Actions drop down menu and select the Reset feature.
- Cycle the controller power.

Processor Reset Key Sequence:

- Press and hold the Up and Down arrow keys for three seconds.
- Press enter when the "**SYSTEM RESET**" message displays.
- If the Arrow keys are released, the controller returns to normal operation.
- When the Enter key is pressed, Line 2 changes to "Release Key."
- When all keys are released, the Processor resets.

(*Processor resets also clear faults)

The following table indicates which inhibit alarms require fault resets. Warning alarms never require resets.

Alarm	Requires Fault Reset
AC Line Sync PLL	No
Current Trip	Yes
Line Loss	No
Heatsink Temp	Yes

11.2 Warning Alarms

During a warning alarm the STATUS LED will be flashing orange. For all controllers with the remote display, when a warning alarm is present it will be displayed on the LCD.

11.2.1 Voltage Limit

The controller will not be allowed to exceed the voltage limit setting. The voltage limit setting is recommended to be 105% of the Full Scale Voltage setting.

11.2.2 Current Limit

The controller will not be allowed to exceed the current limit setting. The current limit setting is recommended to be 105% of the Full Scale Current setting.

11.2.3 Power Limit

The controller will not be allowed to exceed the power limit setting. The power limit setting is recommended to be 105% of the Full Scale Power setting.

11.2.4 Heat Sink Temp

Indicates that the heat sink is within 5°C of the maximum temperature rating for the SCR. Check the fans for proper operation or for any possible obstructions in the air flow.

11.2.5 Shorted SCR

The controller is detecting a shorted SCR.

All controllers have shorted SCR detection. This will detect any shorted SCR in any phase, with any load type, and any phase rotation with the following exception.

Only certain SCRs can be detected in a three phase Zero Cross controller with a delta or 3-wire wye load. The phase rotation also affects which phase can be detected.

This feature is user-selectable. A user may disable the Shorted SCR alarm in the case of nuisance warnings.

	Phase Rotation 123			Phase Rotation 321		
	Zone			Zone		
Phase	A	B	C	A	B	C
Zero Cross	Yes	No	Yes	No	Yes	Yes

11.2.6 Low Output

The controller is at 100% output and the Set Point Reference (or command signal) is higher than the Feedback. In other words the controller is being asked to provide a higher output than it can provide to the load from the power source.

11.2.7 Network Timeout

The controller did not receive any communications via CCI Link™ or the Fieldbus module, in a timeout period. For a device with a Fieldbus module, the timeout period is configurable using Communications Heartbeat Time [SP 125]. CCI Link™ uses its own timeout mechanism ([SP 125] is not considered).

11.2.8 Output% Low / High

The Output % Low alarm occurs when the controller output % is at a value lower than the threshold set using the “Output% Low Alarm Threshold” parameter [SP 3402]. The Output % High alarm occurs when the controller output % is at a value higher than the threshold set using the “Output% High Alarm Threshold” parameter [SP 3403].

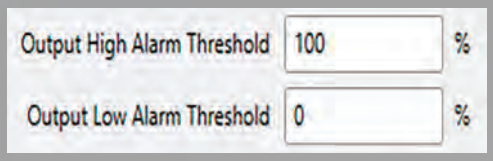
When using the “Tap Change” functionality, these alarms change to “Tap Change Up” and “Tap Change Down.”

Output% High Alarm Threshold [SP 3402]
Default value: 100%
Sets a threshold in % so that when the controller’s output % is above this value it will indicate a HIGH OUTPUT % Alarm or TAP CHANGE UP Alarm.

Output% Low Alarm Threshold [SP 3403]
Default value: 0%
Sets a threshold in % so that when the controller output % is below this value it will indicate a LOW OUTPUT % Alarm or TAP CHANGE DOWN Alarm.

FIND IN CONTROL PANEL

OUTPUT% ALARM THRESHOLDS [SP 3402, 3404]
Category: Alarms > Thresholds



11.3 Inhibit Alarms

During an Inhibit Alarm the STATUS LED will be RED. The display will indicate the alarm that is present.

The Inhibit Alarms can be mapped to Relay 1 using the Control Panel software.

FIND IN CONTROL PANEL

INHIBIT ALARMS
Active Inhibit Alarms are displayed with a red icon in the “Status” section of he device dashboard

11.3.1 AC Line Sync PLL

The controller is not registering any line voltage. The line voltage is not present or too low for the controller to operate.

11.3.2 Current Trip

The controller has exceeded the Current Trip setting. This feature will shut the controller down and display an alarm. To get the controller operating once again, a few different methods will remove the current trip alarm. Only one of the following must be done:

1. With hardware: Open, then Close the $\overline{\text{Run}}$/Reset jumper on P1 (pins 8 & 9).
2. With software: Un-check and check the zone digital “Enable” button.

11.3.3 Line Loss

An AC line connection has been lost.

11.3.4 Heatsink Temp

A heatsink has exceeded the temperature rating for the SCR. Check the display to find which zone has triggered the alarm. Check for obstructions preventing the fans from operating correctly.

11.3.5 Network Timeout

The controller did not receive any communications via CCI Link™ or the Fieldbus module, depending on controller hardware, in a timeout period. The Network Timeout inhibit alarm will only be active if the Network Timeout Action [SP

128] is set to “STOP, fault shutdown.” For a device with a Fieldbus module, the timeout period is configurable using Communications Heartbeat Time [SP 125]. CCI Link™ uses its own timeout mechanism ([SP 125] is not considered).

11.3.6 Other Non-Typical Alarms

“SRAM ERROR, ROM ERROR, WATCHDOG TIMEOUT, MODULE EEPROM”
These types of errors are uncommon but may occur under specific conditions. Turn off the control power and reapply it. If any of these warnings continue to appear, contact Control Concepts, Inc.

11.4 Heatsink Warning/Inhibit Alarm Temperatures

Controller Frame Amp Rating	Warning (°C)	Inhibit (°C)
8, 16, 32	100	105
50	94	99
80	83.5	88.5
100, 130, 160	99	104
200, 240	91	96
320, 400	99	104

11.5 Additional Controller Statuses

11.5.1 AC Line Status [MP 342]

AC Line LED Indications for Single Phase Controllers		
Color	Possible Conditions	Description
Red		
	ADC Timing / Control Timing	One or both is not true (Bit return: 0), but AC Line Voltage is detected.
Green		
	ADC Timing / Control Timing	Both are true. (Bit return:1), and AC Line Voltage is detected.
Off		
	No AC Line Voltage	AC Line Voltage is off or to low to detect.

Note: See Phase Rotation [MP 342 bit 5] for Three Phase controllers.

Phase A [MP 342 bit 0] Absent / Present
Indicates if the AC line is present for Phase A

Phase B [MP 342 bit 1] Absent / Present
Indicates if the AC line is present for Phase B

Phase C [MP 342 bit 2] Absent / Present
Indicates if the AC line is present for Phase C

Phase Rotation [MP 342 bit 4] TBD / OK
Indicates that the phase rotation has been determined.

Phase Rotation [MP 342 bit 5] 1-2-3 / 3-2-1
Indicates the phase rotation. Phase Rotation [MP 342 bit 5] is only applicable for Three Phase controllers. Connect controller to Control Panel to troubleshoot if any color other than Green is displayed for the AC Line Status LED.

Control Timing [MP 342 bit 6] Blank / OK
The timing for SCR firing. This must be OK in order for the SCR to turn ON.

ADC Timing [MP 342 bit 7] Blank / OK
The timing for feedback data collection synchronization.

11.5.2 Main EEProm Status [MP 336]

					Status Color: (Red)	(Green)
Bit Definition:	Bit	15	=	TBD		
		14	=	TBD		
		13	=	EE SP Def	Update Req	OK
		12	=	EE Write Protected	Fail	OK
		11	=	User SP Backup	Fail	OK
		10	=	Not Used		
		9	=	Not Used		
		8	=	Repair Record Table	Fail	OK
		7	=	Error Record Table	Fail	OK
		6	=	MFG Table	Fail	OK
		5	=	Cal Table	Fail	OK
		4	=	Cal V Table	Fail	OK
		3	=	MFG SP V Table	Fail	OK
		2	=	User SP V Table	Fail	OK
		1	=	Blank	Init Required	Initialized
	Bit	0	=	Read/Write	Fail	OK

Read / Write [MP 336 bit 0] OK/Fail
During power up, checks to see if the EEPROM is functional.

Initialized [MP 336 bit 1] Init/Init Required
The EEPROM is blank and needs initialization.

User SP V Table [MP 336 bit 2] OK/Fail
Status of the user setup parameter table.

MFG SP V Table [MP 336 bit 3] OK/Fail
Status of the manufacturing setup parameter table.

Cal V Table [MP 336 bit 4] OK/Fail
Status of the calibration setup parameter table.

Cal Table [MP 336 bit 5] OK/Fail
Status of the calibration data table.

MFG Table [MP 336 bit 6] OK/Fail
Status of manufacturing data table.

Error Record Table [MP 336 bit 7] OK/Fail
Status of the error record table.

Repair Record Table [MP 336 bit 8] OK/Fail
Status of the repair record table.

User SP Backup [MP 336 bit 11] OK/Fail
Status of the backup user setup parameter table.

EE Write Protected [MP 336 bit 12] OK/Fail
The status of the EEPROM write protection.

EE SP Def [MP 336 bit 13] OK/Update Required
The status of the setup parameter definition table.

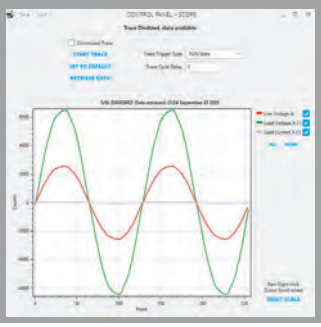
11.5.3 Misc Status [MP 335]

Waiting for Enter Key [MP 335 bit 3]
The controller has halted during initialization. Press the "Enter" button on the Diagnostic 1 tab.

Note: Only bit that has user significance is Bit 3. All other Bits are used for manufacturing use only.

FIND IN CONTROL PANEL

DATA TRACE
Category: Side Bar > Scope



11.6 Data Trace

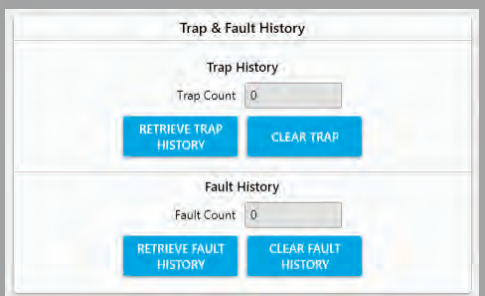
The data trace feature in the MicroFUSION power controller records the controller's line voltages, load voltages, and load current waveforms for a period of 2 cycles. The scope feature in Control Panel allows the user to change data trace settings and view the data trace signals in a graph. Refer to the Control Panel User's Manual for more information on the controller data trace and scope features.

11.7 Trap and Fault History

The controller saves event information for when an alarm, processor error, or other event occurs. Use Control Panel, in the "Diagnostics" category, to view and clear this information. Refer to the Control Panel User's Manual for more information.

FIND IN CONTROL PANEL

TRAP & FAULT HISTORY
Category: Diagnostics > Trap & Fault History



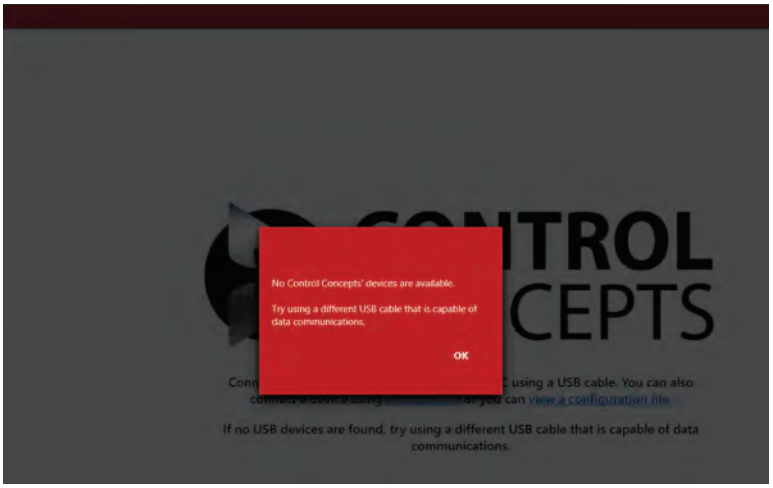
11.8 USB Communication Issues

A failure to connect to the MicroFUSION controller with the Control Panel software can occur when using microUSB cables of unknown manufacture.

A USB communication session could not be established.

Ensure the MicroFUSION controller has 24Vdc applied and is on with the indicator lights on the device showing normal operation.
See Chapter 4, Indicator LED's.

A delay of 30 seconds or more can occur when first connecting a controller to a PC before it will respond to Control Panel connections.



Common issues of no communication with the Control Panel software, identified by the Control Panel reporting '*No Control Concepts' devices are available*" have often been traced to the quality of the USB cable used.

Many micro USB cables that are being manufactured and sold through common vendors and retail outlets often do not meet minimum specifications for conductivity and data communications.*

USB hubs, adapters, extension cables, isolators, or repeaters are not recommended and may cause communication issues when connected to a PC communicating with a MicroFUSION device.

While the MicroFUSION controller has been tested and validated to work with cable lengths of 15 feet (3 meters), cable routing and external electrical interference may also cause communication failures.

If a no communication error or no device available message occurs during connection or operation of a MicroFUSION device, it is recommended to try a different brand of USB cable. Recheck connections and ensure the USB port on the PC running the Control Panel software is functioning normally. Disconnect other USB devices connected to the PC and recheck device communication before contacting technical support.

Control Concepts, Inc sells USB cables validated to work with our digital controllers.
Contact our sales and support line at 1-800-756-2799, or visit our website at www.ccipower.com for ordering information.

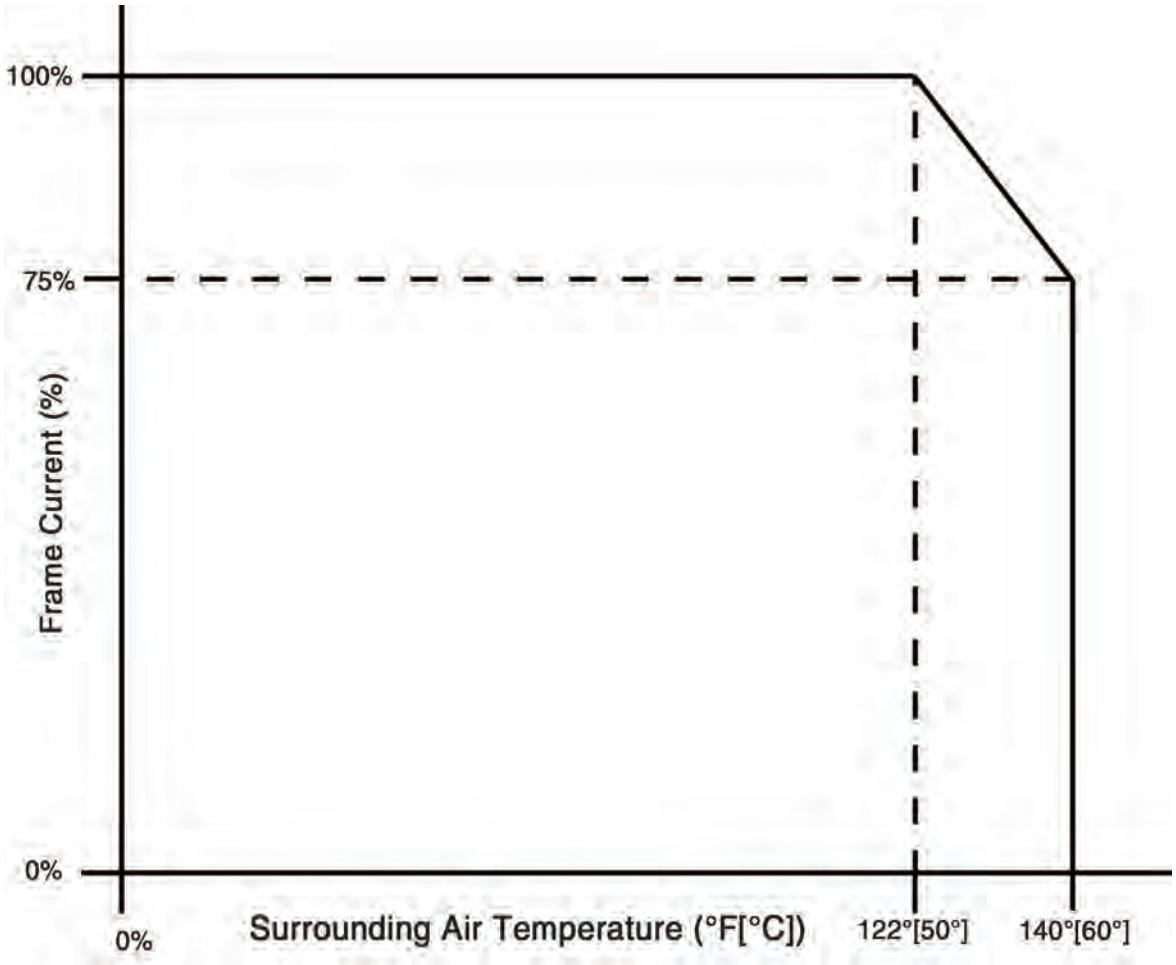
* USB cables sold for use with cellphones, tablets, and other devices may not support data transfer.

APPENDIX A: SPECIFICATIONS

MicroFUSION User's Manual

POWER	
Line Voltage (Auto Ranging)	UL/cUL: 24 - 600 Vac (Nominal) [+10% / -15%] (Contact CCI for other options) CE: 24 - 690 Vac (Nominal) [+10% / -15%] (Contact CCI for other options)
Line Frequency (Auto Ranging)	45 - 65 Hz
Frame Current Ratings (Amps)	Continuous RMS (AC) 8 | 16 | 32 | 50 | 80 | 100 | 130 | 160 | 200 | 240 | 320 | 400
Current Rating - Peak Surge	20x Frame Rating for 10 ms
Minimum Hold / Latch Current	500 mA up to 160 A 1 A at 200 - 400 A
Max Leakage Current	10.6 mA @ 600 Vac 50/60 Hz
SCR Rating (PIV)	1600 V peak forward & reverse
Fusing	Optional external Class T, branch-rated, touch-safe fusing
Thermal	Integrated heat sink thermal sensor
Current Limit	105% (SX-S), 20 - 105% (SX-L, HX) of continuous rating of Frame Amp Rating
Current Trip	50% - 450% of continuous rating
Power Dissipation	1.3 W per A of load current per phase
Control Power / Operates Internal Control Electronics	24 Vdc (+10 /-15)%

TEMPERATURE DERATING
Surrounding Air Temperature effect on the Controller



PERFORMANCE		
	Standard (SX)	High Performance Option (HX)
Setpoint Resolution	10k	10k or 64k
Internal Control Loop Resolution	16k	64k
Output Resolution	12k @ 50 Hz, 10k @ 60 Hz	50k @ 50 Hz, 42k @ 60 Hz
Response Time	Adjustable from 50 ms to 2 s	Adjustable from 50 ms to 2 s
Accuracy (Full Conduction)		
Voltage	3.0% of frame rating	0.5% of frame rating
Current	3.0% of frame rating	0.5% of frame rating
Power	3.0% of frame rating	1.0% of frame rating
Output Linearity	4.0% from (5 - 100%) output range	1.0% from (5 - 100%) output range
Accuracy	A (+10/-15)% line voltage change will result in a max output change of 0.5% from (5 - 100%) output range	A (+10/-15)% line voltage change will result in a max output change of 0.05% from (5 - 100%) output range
Temperature Drift	Output shall not change greater than 0.5% per degree C max over the operating temperature range from (5 - 100%) output range	Output shall not change greater than 0.2% per degree C max over the operating temperature range from (5 - 100%) output range

ENVIRONMENTAL	
Surrounding Air Operating Temp	32°F [0°C] - 122°F [50°C] with derating for 140°F [60°C]
Humidity	20% to 90% RH Non-Condensing
Rated Operating Altitude	Up to 6000 ft [1829 m] at full rated current
Contaminates	RoHS Compliant, CE Pollution Degree 2
Storage Temperature	-4°F [-20°C] to 176°F [80°C]

RELIABILITY	
Mean Time Between Failure (MTBF)	Designed for 50,000 Hours

ISOLATION	
Signal to Line / Load	3750 VAC Minimum
Line / Load to Ground	2500 VAC Minimum
Signal to Ground	1500 VAC Minimum
Network	1500 VAC Minimum
USB	2500 VAC Minimum
Signal to Processor	1500 VAC Minimum
Remote Display	2500 VAC Minimum

ANALOG SETPOINT INPUTS		
Voltage	0 - 10 Vdc (0 to 65535)	Update period: 6 ms
Voltage Impedance	200 kΩ	
Max Voltage	+/- 15 Vdc	
Current	0 - 20 mA (0 to 32767)	
Current Impedance	249 Ω	
Max Current	+/- 31 mA or +/- 7.8 Vdc	
Pulse Width Modulation	0 - 100%	Frequency Range: 20 Hz to 2 kHz, or up to 2 kHz max

RELAY (125 VAC Form C)	
Max Voltage Rating	125 VAC / 60 VDC
Max Switching Current	1 A
VAC Rating	125 VAC / 0.3 A
VDC Rating	30 VDC / 1 A

COOLING	
Din Rail / Panel Mount	Forced Air
External Panel Mount	Natural Convection

DC POWER CONSUMPTION	
8 - 50 A Single Phase	7 W
80 A Single Phase	9 W
100 - 160 A Single Phase	7 W
200 - 240 A Single Phase	11 W
320 - 400 A Single Phase	17 W
8 - 160 A Three Phase	24 W
200 - 400 A Three Phase	33 W
On-board Fieldbus Module	Add 0.7 W
CCI Connect Module	Add 6 W

ENCLOSURE PROTECTIVE RATING	
International	IP 20
Remote Display	IP 65, UL Type 1 & 12
External Panel Mount	IP 65, UL Type 4

I^2t DATA (8.3 - 10 msec)		
Frame Size	**Conditions**	**I^2t Data**
0 - 80	Junction Temp 125°C	16200 A^2s
100 - 160	Junction Temp 125°C	80000 A^2s
200 - 240	Junction Temp 125°C	125000 A^2s
320 - 400	Junction Temp 125°C	320000 A^2s

SCCR - Type 1 Coordination		
Frame 1Ø / 3Ø	**Recommended Fusing***	**SCCR Rating****
8 A	10 A Fast Acting J or T	100 kA
16 A	20 A Fast Acting J or T	100 kA
32 A	40 A Fast Acting J or T	100 kA
50 A	60 A Fast Acting J or T	100 kA
80 A	100 A Fast Acting J or T	100 kA
100 A	125 A Fast Acting J or T	100 kA
130 A	175 A Fast Acting J or T	100 kA
160 A	200 A Fast Acting J or T	100 kA
200 A	250 A Fast Acting J or T	100 kA
240 A	300 A Fast Acting J or T	100 kA
320 A	400 A Fast Acting J or T	100 kA
400 A	500 A Fast Acting J or T	100 kA

*** Maximum fuse Amps shown above, fuses with lower Amp ratings can also be used.**
**** To meet SCCR rating Fast acting J or T fusing must be used.**

SCR-60 **LCI Furnaces - TP Solar**

APPENDIX B: PARAMETERS

Setup Parameters, User List, Range: 1 to 199

[SP 1] Feedback Type	
Units:	N/A
Minimum:	1
Maximum:	7
Default:	1 for SX, 2 for HX
Selections:	
1 =	Voltage Feedforward
2 =	RMS Voltage
3 =	AVG Voltage
4 =	RMS Current
5 =	AVG Current
6 =	Real Power
7 =	Apparent Power

[SP 2] Firing Mode	
Units:	N/A
Minimum:	1
Maximum:	5
Default:	2 (1 for 3 Phase 2 Leg)
Selections:	
1 =	Zero Cross
2 =	Phase Angle
3 =	Zero Cross Transformer (ZCT)
4 =	HiPER
5 =	Fast Zero Cross (FZC)

[SP 3] Control Loop	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	1
Selections:	
0 =	Open Loop
1 =	Closed Loop

When Open Loop is selected the Control Loop does not use feedback to control the output, but sets the output directly proportional to the Setpoint. Closed Loop sets the output so that the feedback matches the Setpoint.

[SP 4] Ramp Time	
Units:	Seconds
Minimum:	0.0
Maximum:	300.0
Default:	0.0

The Ramp Time sets the time for the controller to command the output from zero (0) to the Full Scale Feedback value. When the time is set to zero, the ramp is disabled.
When the time is non-zero the Ramp is used whenever the setpoint starts from 0%.

[SP 5] Slew Rate	
Units:	N/A
Minimum:	1
Maximum:	100
Default:	10

[SP 6] Reserved
N/A

[SP 7] ZCT Phase Angle to ZC Switch Thresh.	
Units:	AC Line Cycles
Minimum:	5
Maximum:	20
Default:	20

[SP 8] Full Scale Voltage	
Units:	Volts
Minimum:	5.0
Maximum:	690.0
Default:	480.0

Full Scale Voltage is used to scale the Meter Analog Output Signal for the Meter Output used to represent Load Voltage (Default for Meter output 2).

[SP 9] Full Scale Current	
Units:	Amps
Minimum:	1.0
Maximum:	400.0
Default:	Set to Amp Rating

Full Scale Current is set to the maximum allowable Output Current commanded by the Setpoint. This value is also used to scale the Meter Analog Output signal for the Meter Output used to represent Load Current (Default for Meter Output 1).

[SP 10] Full Scale Power	
Units:	kW
Minimum:	0.4
Maximum:	828.0
Default:	Set according to Amp Rating & 480 V

Full Scale Power is used to scale the Meter Analog Output Signal for a Meter Output used to represent Load Power.

[SP 11] Voltage Limit	
Units:	Volts (RMS or AVG)
Minimum:	4.0
Maximum:	724.5
Default:	600.0

Voltage Limit is used to set the maximum allowable Output Voltage. The controller will not allow the Output Voltage to be higher than this setting.

[SP 12] Current Limit	
Units:	Amps (RMS or AVG)
Minimum:	8.0
Maximum:	420.0
Default:	Set to 105% of Amp Rating

Current Limit sets the Absolute Maximum Output current allowed by the controller. The value set for Current Limit is 105% of the Full Scale Current value.

[SP 13] Current Limit Type	
Units:	N/A
Minimum:	1
Maximum:	2
Default:	1
Selections:	
1 =	RMS
2 =	AVG

[SP 14] Over Current Trip	
Units:	Amps RMS
Minimum:	2
Maximum:	1800
Default:	175% for Phase Angle, 400% for Zero Cross

Over Current Trip sets the Threshold for the Output Current such that if the output current reaches this threshold the controller will immediately shut down the output and transition to FAULT state.

[SP 15] Power Limit	
Units:	kW
Minimum:	0.4
Maximum:	869.4
Default:	Set to 105% of Amp Rating & 480 V

Power Limit sets the Absolute Maximum Output Power allowed by the controller.

[SP 16] Relay 1 Alarm Mask	
Units:	N/A
Minimum:	0000_0000_0000_0000
Maximum:	1111_1111_1111_1111
Default:	0000_0000_0000_0110 = 24576
Bit Definitions:	
BIT 15	Partial Load Fault
BIT 14	Heatsink Over Temp.
BIT 13	Current Trip
BIT 12	Heatsink High Temp. Warning
BIT 11	AC Line Phase Loss
BIT 10	Shorted SCR
BIT 9	Power Limit
BIT 8	Current Limit
BIT 7	Voltage Limit
BIT 6	Digital RUN Enable (RUN State Request)
BIT 5	TBD
BIT 4	3 Phase Load Imbalance
BIT 3	Low Output
BIT 2	Deviation Alarm
BIT 1	Output % High or Tap Change Up
BIT 0	Output % Low or Tap Change Down

Relay 1 Alarm Mask determines the Alarm Events that will energize the on-board relay. When a Bit is set to 1 and the corresponding event occurs the relay will energize.

[SP 18] Deviation Band	
Units:	Percent
Minimum:	0.00
Maximum:	100.00
Default:	100.00

[SP 19] Feedback Source	
Units:	N/A
Minimum:	1
Maximum:	4
Default:	1
Selections:	
1 =	Internal Feedback Signal (V, I, P)
2 =	Analog Input 1
3 =	Analog Input 2
4 =	Transducer Card

[SP 20] Over-Current Trip Retry Setting	
Units:	Retry Count
Minimum:	0
Maximum:	3
Default:	0

Use the Over-Current Trip Retry Setting [SP 20] to allow the controller to automatically clear the fault and restart after an Over-Current Trip Fault Event. This parameter sets the number of times the controller will retry after an Over-Current Trip Event. The controller will latch into fault state after attempting the number of retries set by this parameter.

[SP 21] Heater Bakeout Time	
Units:	Minutes
Minimum:	1
Maximum:	10000
Default:	60

Cannot be changed when heater bakeout is enabled and the controller is in RUN state.

[SP 22] Heater Bakeout Voltage Limit	
Units:	Volts (RMS or AVG)
Minimum:	4.0
Maximum:	660.0
Default:	600.0

[SP 23] Heater Bakeout Current Trip	
Units:	Amps RMS
Minimum:	50% of Current Rating
Maximum:	450% of Current Rating
Default:	150% of Current Rating

[SP 24] Heater Bakeout Enable (RAM)	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	0 (Refer to [SP 25] for Power Up Default)
Selections:	
0 =	Disable
1 =	Enable

[SP 25] Heater Bakeout Enable with Power-Cycle	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Disabled at Power-Up
1 =	Enable Heater Bake out at Power-Up

[SP 26] Current Limit Source	
Units:	N/A
Minimum:	1
Maximum:	3
Default:	1
Selections:	
1 =	[SP 12] Current Limit
2 =	Analog Input 1
3 =	Analog Input 2

[SP 27] Setpoint Trigger Threshold	
Units:	%
Minimum:	0.00
Maximum:	100.00
Default:	0.00

When the active setpoint is at or below this threshold, the MicroFUSION will hold load resistance at the last calculated resistance value and periodically increase the controllers output, calculate the load resistance, and then return the output back to follow the active setpoint.

[SP 28] Pulse Level	
Units:	Volts
Minimum:	0.50
Maximum:	600.00 (Limited by [SP 8])
Default:	10.00

When the output is at or below the trigger threshold, the controller will pulse the voltage output to the entered value.

[SP 29] Pulse Frequency

Units:	Seconds
Minimum:	0.1
Maximum:	3600.00
Default:	1.0

This parameter sets the amount of time between increases in power output and resistance calculation, when the setpoint is at or below the threshold [SP 27].

[SP 30] Pulse Duration

Units:	Cycles
Minimum:	1
Maximum:	999
Default:	16

Sets the number of AC Line cycles for the increased power controller output and load resistance calculation when the setpoint is at or below the threshold.

[SP 31] Pulse Enable

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Disabled (OFF)
1 =	Enabled (ON)

Enables or Disables the periodic power increases, which are paired with load resistance sampling and hold calculations.

[SP 32] Pulse at Zero Setpoint Enable

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Disabled (OFF)
1 =	Enabled (ON)

This parameter enables or disables the periodic power controller output increases with load resistance sample and hold calculation. If disabled, the controller will NOT pulse the output if the setpoint is zero. Enable this parameter to allow the controller to pulse the output when the setpoint is zero, and the Pulse Enable [SP 31] is also set to enable.

[SP 33] HiPER Threshold

Units:	Counts
Minimum:	10
Maximum:	5000
Default:	833 (833 x 180° / 10000 = 14.994°)

HiPER Threshold sets the point at which the controller will switch from phase angle firing to HiPER firing, or from HiPER to Phase Angle. Above this value, the controller will fire in phase angle, below this value the controller will enter HiPER and fire with the phase angle locked at the threshold.

[SP 34] Partial Load Fault Detection Enable

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Disabled (OFF)
1 =	Enabled (ON)

When Partial Load Fault Detection is enabled, it will detect a change in resistance of the load. When it is disabled, it will not.

[SP 35] Partial Load Fault Tolerance A

Units:	%
Minimum:	0.0
Maximum:	100.0
Default:	8.0

This parameter designates the percentage of allowable deviation from the expect load resistance. If the deviation is outside of the tolerance, the Partial Load Fault warning will trigger for phase A.

[SP 36] Partial Load Fault Tolerance B

Units:	%
Minimum:	0.0
Maximum:	100.0
Default:	8.0

This parameter designates the percentage of allowable deviation from the expect load resistance. If the deviation is outside of the tolerance, the Partial Load Fault warning will trigger for phase B.

[SP 37] Partial Load Fault Tolerance C

Units:	%
Minimum:	0.0
Maximum:	100.0
Default:	8.0

This parameter designates the percentage of allowable deviation from the expect load resistance. If the deviation is outside of the tolerance, the Partial Load Fault warning will trigger for phase C.

[SP 38] Partial Load Fault Target Resistance A

Units:	Ohms
Minimum:	0.00
Maximum:	655.35
Default:	8.00

The expected load resistance for phase A when using Single Point mode, as set by [SP 42].

[SP 39] Partial Load Fault Target Resistance B

Units:	Ohms
Minimum:	0.00
Maximum:	655.35
Default:	8.00

The expected load resistance for phase B when using Single Point mode, as set by [SP 42].

[SP 40] Partial Load Fault Target Resistance C

Units:	Ohms
Minimum:	0.00
Maximum:	655.35
Default:	8.00

The expected load resistance for phase C when using Single Point mode, as set by [SP 42].

[SP 41] Partial Load Fault Teach

Units:	N/A
Minimum:	0
Maximum:	1

[SP 41] Partial Load Fault Teach

Default:	0
Selections:	
0 =	OFF
1 =	Start (ON)

The Teach procedure will save the resistance values of the load, which will be used to determine if a Partial Load Fault has occurred. Controller must be in RUN state to enable the Teach function.

When Partial Load Fault is in Single Point mode [SP 42], the teach mode will save the current resistance of the load, which will be used throughout the entire output range. The resistance values are saved to [SP 38, 39, & 40]. In order to record accurate resistance, the controller must apply power to the load.

When Partial Load Fault is in Ramp Down mode [SP 42], Teach mode will apply power to the load and record the resistance values while ramping down the controller's output. This is useful for loads where the resistance changes throughout the output range. Specify the max Setpoint value [SP 43], that is used for the ramp down in order to limit the power applied to the load. The Teach procedure in Ramp Down mode will take about 1 minute.

[SP 42] Partial Load Fault Teach Mode

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Single Point
1 =	Ramp Down

Specifies the mode used for Partial Load Fault detection.

Single Point: a single resistance value will be used throughout the entire output range when evaluating whether a Partial Load Fault has occurred. This resistance value is specified using [SP 36].

Ramp Down: multiple resistance values will be used throughout the controller's output range. To use Ramp Down, the Partial Load Fault functionality must be initialized using the Teach parameter [SP 37].

[SP 43] Partial Load Fault Teach Maximum Setpoint

Units:	N/A
Minimum:	0
Maximum:	64000 (See [SP 115])
Default:	10000

The maximum Setpoint to use during the Teach procedure when in Ramp Down mode. During the Teach procedure, the controllers output will begin at this Setpoint and ramp down from there.

[SP 44] Over Current Trip Retry Delay Time

Units:	Second
Minimum:	0
Maximum:	20
Default:	0

This is will add time delay between an Over Current Trip event and the automatic retry. This delay is only active if the value for Over Current Trip retries [SP 20] is not zero (0).

[SP 45] Partial Load Fault Teach Min. Setpoint

Units:	N/A
Minimum:	0
Maximum:	64000 (See [SP 115] Setpoint Resolution Select)
Default:	500

The minimum Setpoint to use during the Teach procedure when in Ramp Down mode. During the Teach procedure, the controllers output will begin at Maximum Setpoint [SP 43] and ramp down to this setpoint.

[SP 46] Load Resistance at Zero Output

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	LOW = 0.00
1 =	HIGH = 655.35

This parameter sets the load resistance value, assigned when the controller output is zero (0), when the controller is not in RUN state or is disabled due to PLL Lock Loss or Line Phase Loss.

[SP 47 - 83]

Reserved

[SP 84] Hero Mode Enabled

Units:	Enabling Hero Mode will VOID MFG warranty
Minimum:	0
Maximum:	1 (Ignore Temperature Alarms) *
Default:	0
Selections:	
0 =	0 = Disabled
1 =	1 = Enabled

* A heat sink temperature fault will still be logged during an over-termperature condition.

[SP 85] System Relay Mask

Units:	N/A
Minimum:	0000_0000_0000_0000
Maximum:	1111_1111_1111_1111
Default:	0000_0000_0000_0000 = 0
Bit Definitions:	
BIT 15	TBD
BIT 14	TBD
BIT 13	TBD
BIT 12	TBD
BIT 11	TBD
BIT 10	TBD
BIT 9	TBD
BIT 8	TBD
BIT 7	TBD
BIT 6	RUN Enable via Switch Input
BIT 5	In RUN state
BIT 4	PLL Lock Loss
BIT 3	Watchdog Timeout
BIT 2	Memory Error
BIT 1	Communications Error
BIT 0	Processor Error Trap

System Alarm Mask determines the system events that will energize the on-board relay.

[SP 86] Load Current C Source (for 3 Phase 2-Leg)

Units:	N/A
Minimum:	0
Maximum:	2
Default:	0
Selections:	
0 =	Internal Feedback
1 =	Analog Input 1
2 =	Analog Input 2

[SP 87] 3 Phase Load Current Imbalance Threshold

Units:	%
Minimum:	0
Maximum:	200
Default:	0 (Disabled)

[SP 89] Analog Input 2 Function Select

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	None
1 =	Scale Analog Input 1

[SP 90] Analog Input 1 Type

Units:	N/A
Minimum:	1
Maximum:	2
Default:	2
Selections:	
1 =	Voltage Input
2 =	Current Input

Analog Input type is used to inform the controller about the type of signal that is connected to the analog input terminals. Set to voltage if the signal is 0 to 10 Volts. Set to current if the signal is 0 to 20 mA.

[SP 91] Analog Input 1 Lo Command

Units:	V, mA
Minimum:	-5.00
Maximum:	25.00
Default:	4.00

This sets the analog input signal level that corresponds to the command value set by [SP 92] Analog Input Lo Output.

[SP 92] Analog Input 1 Lo Output

Units:	% (Based on Full Scale value)
Minimum:	0.00
Maximum:	125.00
Default:	0.00

This sets the commanded percent, of the Full Scale Feedback Value for the Feedback Type selected, that corresponds to the signal level set by [SP 91] Analog Input Lo Command.

[SP 93] Analog Input 1 Hi Command

Units:	V, mA
Minimum:	-5.00
Maximum:	25.00
Default:	20.00

This sets the Analog Input Signal level that corresponds to the command value set by [SP 94] Analog Input Hi Output.

[SP 94] Analog Input 1 Hi Output

Units:	% (Based on Full Scale value)
Minimum:	0.00
Maximum:	125.00
Default:	100.00

This sets the commanded percent, of the Full Scale Feedback Value for the Feedback Type selected, that corresponds to the signal level set by the [SP 93] Analog Input Hi Command.

[SP 95] Analog Input 2 Type

Units:	N/A
Minimum:	1
Maximum:	2
Default:	1
Selections:	
1 =	Voltage Input
2 =	Current Input

Analog Input type is used to inform the controller about the type of signal that is connected to the analog input terminals. Set to voltage if the signal is 0 to 10 Volts. Set to current if the signal is 0 to 20 mA.

[SP 96] Analog Input 2 Lo Command

Units:	V, mA
Minimum:	-5.00
Maximum:	25.00
Default:	0.00

This sets the analog input signal level that corresponds to the command value set by [SP 97] Analog Input Lo Output.

[SP 97] Analog Input 2 Lo Output

Units:	% (Based on Full Scale value)
Minimum:	0.00
Maximum:	125.00
Default:	0.00

This sets the commanded percent, of the Full Scale Feedback Value for the Feedback Type selected, that corresponds to the signal level set by [SP 96] Analog Input Lo Command.

[SP 98] Analog Input 2 Hi Command	
Units:	V, mA
Minimum:	-5.00
Maximum:	25.00
Default:	5.00

This sets the Analog Input Signal level that corresponds to the command value set by [SP 99] Analog Input Hi Output.

[SP 99] Analog Input 2 Hi Output	
Units:	% (Based on Full Scale value)
Minimum:	0.00
Maximum:	125.00
Default:	100.00

This sets the commanded percent, of the Full Scale Feedback Value for the Feedback Type selected, that corresponds to the signal level set by the [SP 98] Analog Input Hi Command.

[SP 100] Fieldbus Setpoint [RAM]	
Units:	NONE (Counts)
Minimum:	0
Maximum:	64000 (See [SP 115] Setpoint Resolution Select)
Default:	0

[SP 101] Keypad Setpoint [RAM]	
Units:	NONE (Counts)
Minimum:	0
Maximum:	64000 (See [SP 115] Setpoint Resolution Select)
Default:	0

[SP 102] Setpoint 1 Source	
Units:	N/A
Minimum:	1
Maximum:	7
Default:	1
Selections:	
1 =	Analog Input 1
2 =	Analog Input 2
3 =	Fieldbus Setpoint
4 =	Keypad Setpoint
5 =	PWM Setpoint
6 =	FBU Setpoint
7 =	EE Setpoint

Default = 3, when the Digital Fieldbus option is Modbus TCP, EtherNet/IP, or PROFINET.

[SP 103] Setpoint 2 Source	
Units:	N/A
Minimum:	1
Maximum:	7
Default:	2
Selections:	
1 =	Analog Input 1
2 =	Analog Input 2
3 =	Fieldbus Setpoint
4 =	Keypad Setpoint
5 =	PWM Setpoint
6 =	FBU Setpoint
7 =	EE Setpoint

Default = 1, when Modbus TCP, EtherNet/IP or Profinet; Default = 4, if Analog Setpoint 2 feature is not enabled

[SP 104] Control Setpoint Select	
Units:	N/A
Minimum:	1
Maximum:	2
Default:	1
Selections:	
1 =	Setpoint 1 Source
2 =	Setpoint 2 Source

This determines the Setpoint Source that is used as the setpoint for the Control Loop (See [SP 103] and [SP 104]).

[SP 105] Feedback Unit Setpoint (HI Word) [RAM] [SP 106] Feedback Unit Setpoint (LO Word) [RAM]	
Units:	V, A, W
Minimum:	0.0 or 0
Maximum:	* Limited by the Full Scale setting for the feedback type selection
Default:	0.0 or 0

The Feedback unit setpoint is entered in units of the feedback type selected by [SP 1]. When either Voltage or Current is selected as the feedback type, this parameter has one (1) digit to the right of the decimal point. When Power is selected as the feedback type, there are no digits to the right of the decimal point (entry resolution is 1 watt).

[SP 107] EE Setpoint	
Units:	NONE (Counts)
Minimum:	0
Maximum:	64000 (see [SP 115])
Default:	0

This setpoint value is saved to EEPROM each time it is changed. The value of this setpoint is retained through a power cycle.

[SP 108] Network Timeout Setpoint	
Units:	NONE (Counts)
Minimum:	0.00
Maximum:	See [SP 115] Setpoint Resolution Select
Default:	0

This sets the commanded percent, of the Full Scale Feedback Value for the Feedback Type selected, used as the Control Loop setpoint when [SP 128] Network Timeout Action is set to 2 = use Network Timeout Setpoint and the Heartbeat Timer (See [SP 125]) expires resulting in a Network Timeout Event.

[SP 109] Clear Error Latch [RAM]	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Do Not Clear
1 =	Clear the Latch Bits to 0

[SP 110] Clear Fault [RAM]	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Do Not Clear
1 =	Clear the Fault State

[SP 111] I / O Power Supply Failure Inhibit Enable	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	1
Selections:	
0 =	Disable
1 =	Enable

When [SP 111] is set to Enable (1) and the I / O Power Supply fails, an inhibit alarm will be indicated and the controller will transition to FAULT state which will shut down the output. The FAULT state shut down can be disabled by setting this parameter to Disable (0). The inhibit alarm will still be present, however when set to Disable (0), the controller will not be put into FAULT state.

[SP 112] Reserved
Reserved

** Single Phase Only **

[SP 113] Low Output Alarm Enable	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	1
Selections:	
0 =	Disable
1 =	Enable

** Single Phase Only **

[SP 114] Partial Load Fault Alarm Delay Time	
Units:	Seconds
Minimum:	1
Maximum:	120
Default:	60

[SP 115] Setpoint Resolution Select	
Units:	N/A
Minimum:	1
Maximum:	2
Default:	1
Selections:	
1 =	LOW = 10000
2 =	HIGH = 64000

Locked out during RUN state

[SP 116] Display Auto Scroll Enable	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	1
Selections:	
0 =	Disabled
1 =	Enabled

[SP 117] Reserved
Reserved

[SP 118] MAC ID (CCI Link)	
Units:	N/A
Minimum:	0
Maximum:	63
Default:	63

[SP 119] Auto Configuration

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	Disabled
1 =	Enabled

[SP 120] Local Mode Enabled [RAM]

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0 (Value at Power-Up unless controlled by GP Input)
Selections:	
0 =	OFF (Not Enabled)
1 =	ON (Enabled)

[SP 121 -124]

Reserved

[SP 125] Communications Heartbeat Time

Units:	Seconds
Minimum:	0
Maximum:	65535
Default:	0

Communications Heartbeat Time sets the interval (in seconds) so that the controller will wait for a message packet before indicating communication timeout, and executing the selected Timeout Action set by [SP 128].

[SP 126] IP Address HI

Units:	N/A	
Minimum:	0	(0. 0)
Maximum:	65535	(255.255)
Default:	65535	

This sets the two most significant octets of the controller's base IP Address.

[SP 127] IP Address LO

Units:	N/A	
Minimum:	0	(0. 0)
Maximum:	65535	(255.255)
Default:	65535	

This sets the two least significant octets of the controller's base IP Address.

[SP 128] Network Timeout Action

Units:	N/A
Minimum:	0
Maximum:	2
Default:	0
Selections:	
0 =	NONE, Continue
1 =	STOP, Fault Shutdown
2 =	Use Network Timeout Setpoint [SP 108]

This setting determines how the controller will react to a Network Timeout Event that occurs when the Heartbeat Timer expires waiting for a message packet.
A setting of 0 = NONE will result in no action: the controller will indicate the Timeout, but continue to operate as before.
A setting of 1 = STOP will result in the controller immediately transitioning to FAULT shutdown state with the output power OFF when a timeout occurs.
When this parameter is set to 2 the controller will use the Network Timeout Setpoint [SP 108] immediately after a timeout occurs, until the timeout is cleared by the reception of another message packet.

[SP 129] Digital Run/Stop [RAM]

Units:	N/A
Minimum:	0
Maximum	1
Default:	See [XP 3401]
Selections:	
0 =	STOP
1 =	RUN

This may be used to command the controller into RUN or STOP state via digital communications (USB or Ethernet/Modbus TCP). This parameter is used in conjunction with the $\overline{\text{RUN}}$/STOP switch input on the P1 connector (PIN 9).

[SP 130] Relay Normal State

Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	OFF (De-Energized)
1 =	ON (Energized)

[SP 131] SYNC-GUARD Enable

Units:	N/A
Minimum:	0

[SP 131] SYNC-GUARD Enable	
Maximum:	1
Default:	0
Selections:	
0 =	OFF (not enabled)
1 =	ON (enabled)

[SP 132] Shorted SCR Check Enable	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	OFF
1 =	ON

[SP 133] GP Digital Input Function	
Units:	N/A
Minimum:	0
Maximum:	5
Default:	0
Selections:	
0 =	NONE
1 =	[SP 104] Control Setpoint Select
2 =	[SP 3] Control Loop
3 =	[SP 24] Heater Bakeout Enable
4 =	[SP 120] Local Mode Enable
5 =	[SP 2] Phase Angle Firing Mode

[SP 134 - 135] Reserved
Reserved

[SP 136] Analog Input 1 Monitor Full Scale Value	
Units:	N/A
Minimum:	0.0
Maximum:	3200.0
Default:	1000.0

[SP 137] Analog Input 2 Monitor Full Scale Value	
Units:	N/A
Minimum:	0.0
Maximum:	3200.0
Default:	1000.0

[SP 138] IP Shadow HI	
Units:	N/A
Minimum:	0 (.0 . 0)
Maximum:	65535 (255.255)
Default:	65535

[SP 139] IP Shadow LO	
Units:	N/A
Minimum:	0 (.0 . 0)
Maximum:	65535 (255.255)
Default:	65535

[SP 140] Meter 1 Output Type	
Units:	N/A
Minimum:	1
Maximum:	2
Default:	1
Selections:	
1 =	Voltage Output
2 =	Current Output

Meter 1 Output Type sets the type of signal generated by the controller for the Meter 1 Output (P2-1 P2-2). The signal is scaled with [SP 142] through [SP 145].

[SP 141] Meter 1 Signal Select	
Units:	N/A
Minimum:	1
Maximum:	12
Default:	1
Selections:	
1 =	Load Voltage A
2 =	Load Current A
3 =	Load Voltage B
4 =	Load Current B
5 =	Load Voltage C
6 =	Load Current C
7 =	Real Power
8 =	Apparent Power
9 =	Direct Out [SP 146]
10 =	Load Resistance A
11 =	Load Resistance B
12 =	Load Resistance C

[SP 142] Meter 1 Command Lo Value	
Units:	% (Based on Full Scale value for the Signal selected)
Minimum:	0.00
Maximum:	100.00
Default:	0.00

This sets the value, in percent of the Full Scale, corresponding to the selection for [SP 141] Meter 1 Signal Select that generates the output signal set by [SP 143] Meter 1 Signal Lo Output.

[SP 143] Meter 1 Signal Lo Output

Units:	V, mA
Minimum:	0.00
Maximum:	20.00
Default:	0.00

This sets the output signal level generated for Meter 1 out corresponding to the value determined by [SP 142] Meter 1 Command Lo Value.

[SP 144] Meter 1 Command Hi Value

Units:	N/A (Based on Full Scale value)
Minimum:	0.00
Maximum:	100.00
Default:	100.00

This sets the value, in percent of the Full Scale, corresponding to the selection for [SP 141] Meter 1 Signal Select that generates the output signal set by [SP 145] Meter 1 Signal Hi Output.

[SP 145] Meter 1 Signal Hi Output

Units:	V, mA
Minimum:	0.00
Maximum:	20.00
Default:	5.00

This sets the output signal level generated for Meter 1 out corresponding to the value determined by [SP 144] Meter 1 Command Hi Value.

[SP 146] Meter 1 Out Direct

Units:	V, mA
Minimum:	0.00
Maximum:	20.00
Default:	0.00

Use this parameter to set the Meter output signal level when [SP 141] Meter 1 Signal Select is set to 5 = Direct out.

[SP 147] Meter 2 Output Type

Units:	N/A
Minimum:	1
Maximum:	2
Default:	1
Selections:	
1 =	Voltage Output
2 =	Current Output

Meter 2 Output Type sets the type of signal generated by the controller for the Meter 2 Output (P2-3 P2-4). The signal is scaled with [SP 149] through [SP 152].

[SP 148] Meter 2 Signal Select

Units:	N/A
Minimum:	1
Maximum:	12
Default:	2
Selections:	
1 =	Load Voltage A
2 =	Load Current A
3 =	Load Voltage B
4 =	Load Current B
5 =	Load Voltage C
6 =	Load Current C
7 =	Real Power
8 =	Apparent Power
9 =	Direct Out [SP 153]
10 =	Load Resistance A
11 =	Load Resistance B
12 =	Load Resistance C

[SP 149] Meter 2 Command Lo Value

Units:	N/A (Based on Full Scale values)
Minimum:	0.00
Maximum:	100.00
Default:	0.00

This sets the value, in percent of the Full Scale, corresponding to the selection for [SP 148] Meter 2 Signal Select that generates the output signal set by [SP 150] Meter 2 Signal Lo Output.

[SP 150] Meter 2 Signal Lo Output

Units:	V, mA
Minimum:	0.00
Maximum:	20.00
Default:	0.00

This sets the output signal level generated for Meter 3 out corresponding to the value determined by [SP 149] Meter 2 Command Lo Value.

[SP 151] Meter 2 Command HI Value

Units:	N/A (Based on Full Scale values)
Minimum:	0.00
Maximum:	100.00
Default:	100.00

This sets the value, in percent of the Full Scale, corresponding to the selection for [SP 148] Meter 2 Signal Select that generates the output signal set by [SP 152] Meter 2 Signal Hi Output.

[SP 152] Meter 2 Signal HI Output	
Units:	V, mA
Minimum:	0.00
Maximum:	20.00
Default:	5.00

This sets the output signal level generated for Meter 2 out corresponding to the value determined by [SP 151] Meter 2 Command Hi Value.

[SP 153] Meter 2 Out Direct	
Units:	V, mA
Minimum:	0.00
Maximum:	20.00
Default:	0.00

Use this parameter to set the Meter output signal level when [SP 148] Meter 2 Signal Select is set to 5 = Direct out.

[SP 154] Load Resistance Maximum (Retransmit Scaling)	
Units:	Ohm
Minimum:	0.00
Maximum:	650.00
Default:	50.00

Set the value for this parameter to the approximate maximum expected resistance of the load when the selection for one of the Meter outputs [SP 141], [SP 148] is set for Load Resistance. This value equates to the Meter n Signal HI Output value [SP 145], [SP 152].

[SP 155] PWM Input LO Duty Cycle	
Units:	%
Minimum:	0.00
Maximum:	100.00
Default:	0.00

[SP 156] PWM Input LO Command Output	
Units:	%
Minimum:	0.00
Maximum:	100.00
Default:	0.00

[SP 157] PWM Input HI Duty Cycle	
Units:	%
Minimum:	0.00
Maximum:	100.00
Default:	100.00

[SP 158] PWM Input HI Command Output	
Units:	%
Minimum:	0.00
Maximum:	100.00
Default:	100.00

[SP 159] Reserved
Reserved

[SP 160] Transducer MAC ID (CCI Link Server Node)	
Units:	N/A
Minimum:	0
Maximum:	63
Default:	0

[SP 161] Transducer Feedback Select	
Units:	N/A
Minimum:	1
Maximum:	9
Default:	1
Selection:	
1 =	V1
2 =	I1
3 =	V2
4 =	I2
5 =	V3
6 =	I3
7 =	P1
8 =	P2
9 =	P3

[SP 162] Transducer Feedback Timeout Action	
Units:	N/A
Minimum:	0
Maximum:	2
Default:	2
Selections:	
0 =	NONE, continue
1 =	STOP, fault shutdown
2 =	Use Internal Feedback [SP-19 = 1]

[SP 163 - 199] Reserved
Reserved

Monitor Parameters, User List, Range: 200 to 389

[MP 200] Active Setpoint	
Units:	N/A
Minimum:	1
Maximum:	14
Representation:	
1 =	S1 Analog Input 1
2 =	S1 Analog Input 2
3 =	S1 Fieldbus Setpoint
4 =	S1 Keypad Setpoint
5 =	S1 PWM Setpoint
6 =	S1 FBU Setpoint
7 =	S1 EE Setpoint
8 =	S2 Analog Input 1
9 =	S2 Analog Input 2
10 =	S2 Fieldbus Setpoint
11 =	S2 Keypad Setpoint
12 =	S2 PWM Setpoint
13 =	S2 FBU Setpoint
14 =	S2 EE Setpoint

[MP 201] PWM Setpoint	
Units:	%
Minimum:	-100.00
Maximum:	100.00

[MP 202] Analog Input 1	
Units:	% (Based on Full Scale Values)
Minimum:	-100.00
Maximum:	100.00

[MP 203] Analog Input 1 Command Value	
Units:	V, A, W
Format:	±xxxxx.x

[MP 204] Analog Input 1 Signal	
Units:	V, mA
Format:	±xx.xx

[MP 205] Analog Input 2	
Units:	% (Based on Full Scale values)
Minimum:	-100.00
Maximum:	100.00

[MP 206] Analog Input 2 Command Value	
Units:	V, A, W
Format:	±xxxxx.x

[MP 207] Analog Input 2 Signal	
Units:	V, mA
Format:	±xx.xx

[MP 208] Analog Input 1 Monitor Value	
Units:	N/A
Format:	±xxxx.x

[MP 209] Analog Input 2 Monitor Value	
Units:	N/A
Format:	±xxxx.x

[MP 210] Inhibit Alarm Status	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxx
Representation:	
Bit:	
BIT 7 =	Watchdog Timeout
BIT 6 =	Memory Error (Not Active)
BIT 5 =	Network Timeout
BIT 4 =	I / O Power Supply Failure
BIT 3 =	Line Phase Loss
BIT 2 =	PLL Lock Loss
BIT 1 =	Heatsink Over-Temp
BIT 0 =	Current Trip

[MP 211] Controller Status	
Units:	N/A
Minimum:	0
Maximum:	6
Representation:	
0 =	Disabled
1 =	Enabled
2 =	Diagnostic
3 =	Calibration
4 =	Program Mode
5 =	Heater Bakeout
6 =	Load Fault Teach

[MP 212] Feedback Source Control Loop	
Units:	N/A
Minimum:	1
Maximum:	4
Representation:	
1 =	Internal Feedback Signal (V I P)
2 =	Analog Input 1
3 =	Analog Input 2
4 =	Transducer Card

[MP 213] Digital I / O Status	
Units:	N/A
Minimum:	0000_0000 = 0
Maximum:	1111_1111 = 255
Representation:	0 = Open/Not-Active 1 = Closed/Active
Bit:	
BIT 7 =	Not Used
BIT 6 =	Not Used
BIT 5 =	Not Used
BIT 4 =	Relay
BIT 3 =	Not Used
BIT 2 =	Not Used
BIT 1 =	GP I/O
BIT 0 =	Run/Stop - Reset

[MP 214 - 217] Reserved
Reserved

[MP 218] AC Line Phase	
Units:	Coded: AC Line Phasing for Phases C, B
Minimum:	00 = Not Determined
Maximum:	EE

Phase	Positive	Negative
0 Degrees	1	9
30 Degrees	2	A
60 Degrees	3	B
90 Degrees	4	C
120 Degrees	5	D
150 Degrees	6	E

[MP 219] AC Line Frequency	
Units:	Hz
Minimum:	0.00
Maximum:	99.9

[MP 220] Line Voltage A	
Units:	RMS Volts
Minimum:	0.00
Maximum:	999.99

[MP 221] Load Voltage A	
Units:	Volts RMS or AVG
Minimum:	0.00
Maximum:	999.99

[MP 222] Load Current A	
Units:	Amps RMS or AVG
Minimum:	0.00
Maximum:	9999.99

[MP 223] Load Resistance A	
Units:	Ohms
Minimum:	0.00
Maximum:	999.99

[MP 224] Heatsink Temperature	
Units:	°C
Format:	+xxx.xx

[MP 225] Line Voltage B	
Units:	RMS Volts
Minimum:	0.00
Maximum:	999.99

[MP 226] Load Voltage B	
Units:	Volts RMS or AVG
Minimum:	0.00
Maximum:	999.99

[MP 227] Load Current B	
Units:	Amps RMS or AVG
Minimum:	0.00
Maximum:	9999.99

[MP 228] Load Resistance B	
Units:	Ohms
Minimum:	0.00
Maximum:	999.99

[MP 229] Reserved
Reserved

[MP 230] Line Voltage C	
Units:	RMS Volts
Minimum:	0.00
Maximum:	999.99

[MP 231] Load Voltage C	
Units:	Volts RMS or AVG
Minimum:	0.00
Maximum:	999.99

[MP 232] Load Current C	
Units:	Amps RMS or AVG
Minimum:	0.00
Maximum:	9999.99

[MP 233] Load Resistance C	
Units:	Ohms
Minimum:	0.00
Maximum:	999.99

[MP 234] Reserved	
Reserved	

[MP 235] Load Current A	
Units:	Amps RMS or Average
Minimum:	0.00
Maximum:	999.99

[MP 236] Load Current B	
Units:	Amps RMS or Average
Minimum:	0.00
Maximum	999.99

[MP 237] Load Current C	
Units:	Amps RMS or Average
Minimum:	0.00
Maximum:	999.99

[MP 238-244] Reserved	
Reserved	

[MP 245] Load Power HI (MSW)	
Units:	Watts or VA
Minimum:	0
Maximum:	32767

[MP 246] Load Power LO (LSW)	
Units:	Watts or VA
Minimum:	0
Maximum:	65535

[MP 247] Line Power Factor	
Units:	N/A
Minimum:	0.00
Maximum:	9.99

[MP 248] Controller State	
Units:	N/A
Minimum:	0
Maximum:	3
Representation:	
0 =	STOP
1 =	RUN
2 =	FAULT
3 =	FAULT RESET

[MP 249] Output Duty Cycle %	
Units:	% of Full ON
Minimum:	0.0
Maximum:	999.9

[MP 250] Setpoint Reference HI (MSW)	
Units:	Volts, Amps, Watts
Minimum:	-99
Maximum:	99

[MP 251] Setpoint Reference LO (LSW)	
Units:	Volts, Amps, Watts
Minimum:	0
Maximum:	65535

[MP 252] Feedback HI (MSW)	
Units:	Volts, Amps, Watts
Minimum:	-99
Maximum:	99

[MP 253] Feedback LO (LSW)	
Units:	Volts, Amps, Watts
Minimum:	0
Maximum:	65535

[MP 254] Control Loop Error HI (MSW)

Units:	Volts, Amps, Watts
Minimum:	-99
Maximum:	99

[MP 255] Control Loop Error LO (LSW)

Units:	Volts, Amps, Watts
Minimum:	0
Maximum:	65535

[MP 256] Warning Alarm Status

Units:	N/A
Range:	0 to 4095
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 12 =	Partial Load Fault
BIT 11 =	Misfiring Pulse
BIT 10 =	Network Timeout
BIT 9 =	Deviation
BIT 8 =	Output % High or Tap Change Up
BIT 7 =	Output % Low or Tap Change Down
BIT 6 =	Low Output
BIT 5 =	Load Imbalance
BIT 4 =	Shorted SCR
BIT 3 =	Heatsink Temperature
BIT 2 =	Power Limit
BIT 1 =	Current Limit
BIT 0 =	Voltage Limit

[MP 257] Load Power Factor

Units:	N/A
Minimum:	0
Maximum:	9.99

[MP 258 - 259] Reserved

Reserved

[MP 260, 261] Transducer Ch.1 Voltage HI/LO

Units:	Volts
Representation:	xxxx.xxx

These two parameters are concatenated to be the value of the signal connected to the input of channel 1.

[MP 262, 263] Transducer Ch.1 Current HI/LO

Units:	Amps
Representation:	xxxxx.x

These two parameters are concatenated to be the value of the signal connected to the input of channel 2.

[MP 264, 265] Transducer Ch.2 Voltage HI/LO

Units:	Volts
Representation:	xxxx.xxx

These two parameters are concatenated to be the value of the signal connected to the input of channel 3.

[MP 266, 267] Transducer Ch.2 Current HI/LO

Units:	Amps
Representation:	xxxxx.x

These two parameters are concatenated to be the value of the signal connected to the input of channel 4.

[MP 268, 269] Transducer Ch.3 Voltage HI/LO

Units:	Volts
Representation:	xxxx.xxx

These two parameters are concatenated to be the value of the signal connected to the input of channel 5.

[MP 270, 271] Transducer Ch.3 Current HI/LO

Units:	Amps
Representation:	xxxxx.x

These two parameters are concatenated to be the value of the signal connected to the input of channel 6.

[MP 272, 273] Transducer Power Ch.1 HI/LO

Units:	Watts
Representation:	xxxxxxxx

These two parameters are concatenated to be the value for power calculated from the signals connected to channels 1 and 4.

[MP 274, 275] Transducer Power Ch.2 HI/LO

Units:	Watts
Representation:	xxxxxxxx

These two parameters are concatenated to be the value for power calculated from the signals connected to channels 2 and 5.

[MP 276, 277] Transducer Power Ch.3 HI/LO

Units:	Watts
Representation:	xxxxxxxx

These two parameters are concatenated to be the value for power calculated from the signals connected to channels 3 and 6.

[MP 278] Transducer Digital I/O	
Units:	N/A
Minimum:	00000000 = 0
Maximum:	00001111 = 15
Representation:	
Bit:	
BIT 7 =	not used
BIT 6 =	not used
BIT 5 =	not used
BIT 4 =	not used
BIT 3 =	Digital Input 4 state
BIT 2 =	Digital Input 3 state
BIT 1 =	Digital Input 2 state
BIT 0 =	Digital Input 1 state

[MP 279] Transducer Channel Status	
Units:	N/A
Minimum:	00000000 = 0
Maximum:	00111111 = 63
Representation:	
Bit:	
BIT 7 =	not used
BIT 6 =	not used
BIT 5 =	CH 6 overload
BIT 4 =	CH 5 overload
BIT 3 =	CH 4 overload
BIT 2 =	CH 3 overload
BIT 1 =	CH 2 overload
BIT 0 =	CH 1 overload

[MP 280] Transducer AC Line Timing/Status	
Units:	N/A
Minimum:	00000000 = 0
Maximum:	00111111 = 63
Representation:	
Bit:	
BIT 7 =	not used
BIT 6 =	not used
BIT 5 =	Sync signal connection detected
BIT 4 =	Cycle time determined
BIT 3 =	ADC same clock timing = OK
BIT 2 =	Synchronized, Locked-in
BIT 1 =	Synchronization stage 2 pass
BIT 0 =	Synchronization stage 1 pass

[MP 281] Transducer Full Scale Ch.1 Voltage	
Units:	Volts
Representation:	xxx.x

[MP 282] Transducer Full Scale Ch.1 Current	
Units:	Amps
Representation:	xxxx

[MP 283] Transducer Full Scale Ch.2 Voltage	
Units:	Volts
Representation:	xxx.x

[MP 284] Transducer Full Scale Ch.2 Current	
Units:	Amps
Representation:	xxxx

[MP 285] Transducer Full Scale Ch.3 Voltage	
Units:	Volts
Representation:	xxx.x

[MP 286] Transducer Full Scale Ch.3 Current	
Units:	Amps
Representation:	xxxx

[MP 287, 288] Transducer Full Scale Power Ch.1	
Units:	Watts or Volt-Amps
Representation:	xxxxxxx

[MP 289, 290] Transducer Full Scale Power Ch.2	
Units:	Watts or Volt-Amps
Representation:	xxxxxxx

[MP 291, 292] Transducer Full Scale Power Ch.3	
Units:	Watts or Volt-Amps
Representation:	xxxxxxx

[MP 293] Transducer Firmware ID	
Units:	N/A
Representation:	xxxxx

[MP 294, 295] Transducer Serial # HI/LOW	
Units:	N/A
Representation:	xxxxxxxxxx

[MP 296 - 302] Reserved	
Reserved	

[MP 303, 304] kVAh Consumption	
MP 303:	MSW
MP 304:	LSW
Units:	kVAh
Format:	+xxxxxxxxx.x

[MP 305, 306] kWh Consumption	
MP 305:	MSW
MP 306:	LSW
Units:	kWh
Format:	+xxxxxxxxx.x

[MP 307] Power-up Count	
Units:	Counts
Minimum:	0
Maximum:	65535

[MP 308] Low Power Count	
Units:	Counts
Minimum:	0
Maximum:	65535

[MP 309, 310] In Service Time	
MP 309:	MSW
MP 310:	LSW
Units:	Hour
Format:	+xxxxxxxxx.x

[MP 311 - 321] Reserved
Reserved

[MP 322] USB Status	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxxxx
Representation:	
Bit:	
BIT 7 =	CRC Error
BIT 6 =	Not Used
BIT 5 =	Not Used
BIT 4 =	Not Used
BIT 3 =	Parity Error
BIT 2 =	Framing Error
BIT 1 =	Receive Buffer Overrun
BIT 0 =	Address received, Message Error encountered

[MP 323] Network Status (CCI Link)	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxxxx
Representation:	
Bit:	
BIT 7 =	Bus OFF State

[MP 323] Network Status (CCI Link)	
BIT 6 =	Bus Passive State
BIT 5 =	Duplicate MAC ID Detected
BIT 4 =	Connection Timeout
BIT 3 =	Cyclic Connection Established
BIT 2 =	Reserved
BIT 1 =	Explicit Connection Established
BIT 0 =	ON Line

[MP 324] Slave Connection Status (CCI Link)	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxxxx
Representation:	
Bit:	
BIT 7=	Connection 2 Timeout
BIT 6 =	Connection 2 Cyclic or Poll
BIT 5 =	Connection 2 Explicit
BIT 4 =	Connection 2 Allocated/ Connected
BIT 3 =	Connection 1 Timeout
BIT 2 =	Connection 1 Cyclic or Poll
BIT 1 =	Connection 1 Explicit
BIT 0 =	Connection 1 Allocated/ Connected

[MP 325] Master Connection Status (CCI Link)	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxxxx
Representation:	
Bit:	
BIT 7=	Connection 2 Timeout
BIT 6 =	Connection 2 Established/Active
BIT 5 =	Connection 1 Timeout
BIT 4 =	Connection 1 Established/Active
BIT 3 =	Connection Failure
BIT 2 =	Configuration check in progress
BIT 1 =	On-Line, communicating
BIT 0 =	Slave Detection

[MP 326] Comm Status (Comm. Module)	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxxxx
Representation:	
Bit:	
BIT 7=	Heartbeat Timer Timeout
BIT 6 =	Module Not Responding = Timeout

[MP 326] Comm Status (Comm. Module)	
BIT 5 =	Module Reset
BIT 4 =	IP Address Query
BIT 3 =	Configuration Error
BIT 2 =	Configuration Mode
BIT1 =	IP Address is set correctly
BIT 0 =	Communicating (Active)

[MP 327, 328] EE Calibration Bits, Stored	
MP 327:	MSW
MP 328:	LSW
Units:	ADC Bits
Format:	±xxxxxxxxxx

[MP 329, 330] Live Calibration Bits In, Live	
MP 329:	MSW
MP 330:	LSW
Units:	ADC Bits
Format:	±xxxxxxxxxx

[MP 331] Firmware ID	
Units:	N/A
Minimum:	0
Maximum:	65535

[MP 332] Firmware Version	
Units:	N/A
Format:	+xx.xx.xx

[MP 333] Minor Revision (Appended to Firmware Version	
Units:	N/A
Format:	+xx
NOTE: Firmware version [MP 332, 333] format XX.XX.xx (Maximum: 99.99.99)	

[MP 334] Reserved
Reserved

[MP 335] Misc. Status	
Units:	N/A
Range:	0 to 2045
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 15 =	Not Used
BIT 14 =	Not Used
BIT 13 =	Not Used
BIT 12 =	Not Used

[MP 335] Misc. Status	
BIT 11 =	Not Used
BIT 10 =	HiPER, Phase Angle firing
BIT 9 =	HiPER firing
BIT 8 =	Initialization in progress (0 = finished = ready)
BIT 7 =	Load Trace is ON, Collecting Data
BIT6 =	AC Line Trace is ON, Collecting Data
BIT 5 =	Load Trace is Enabled, waiting for Trigger
BIT 4 =	AC Line Trace is Enabled, Waiting for Trigger
BIT 3 =	Waiting for the Enter Key During Initialization
BIT 2 =	USER Unlock, Access Code Successfully Entered
BIT 1 =	Not Used
BIT 0 =	MFG Unlock, Access Code Successfully Entered

[MP 336] EEPROM Status	
Units:	N/A
Range:	0 to 6143
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 15 =	Not Used
BIT 14 =	Not Used
BIT 13 =	EEPROM SP Definition Table Update
BIT 12 =	EEPROM is Write Protected
BIT 11 =	Backup User SP V-Table Checksum Failure
BIT 10 =	Not Used
BIT 9 =	Not Used
BIT 8 =	Repair Record Checksum Failure
BIT 7 =	Error Code Record Checksum Failure
BIT 6 =	MFG Data Table Checksum Failure
BIT 5 =	Calibration Data Table Checksum Failure
BIT 4 =	CAL Parameter V-Table Checksum Failure
BIT 3 =	MFG SP V-Table Checksum Failure
BIT 2 =	User SP V-Table Checksum Failure
BIT 1 =	Blank, Initialization Required
BIT 0 =	Read/Write Failure

[MP 337 - 341] Reserved
Reserved

[MP 342] AC Line Status	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 7 =	Feedback ADC Timing OK
BIT 6 =	Control Loop Timing OK
BIT 5 =	Phase Rotation 3-2-1 (0 = Phase Rotation 1-2-3)
BIT 4 =	Phase Rotation Determined (Three Phase)
BIT 3 =	Not Used
BIT 2 =	Line Voltage C Present
BIT 1 =	Line Voltage B Present
BIT 0 =	Line Voltage A Present

[MP 343] Load Status	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 7 =	Not Used
BIT 6 =	Open Load C
BIT 5 =	Open Load B
BIT 4 =	Open Load A
BIT 3 =	Not Used
BIT 2 =	Shorted SCR C
BIT 1 =	Shorted SCR B
BIT 0 =	Shorted SCR A

[MP 344] Zone Status	
Units:	N/A
Range:	0 to 16
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 15 - 5 =	Not Used
BIT 4 =	Zone 1: (0 = Not at Setpoint, 1 = at Setpoint)
BIT 3 =	Not Used
BIT 2 =	Not Used
BIT 1 =	Not Used
BIT 0 =	Zone 1: (0 = Normal, 1 = FAULT)

[MP 345] Error Latch	
Units:	N/A
Range:	0 to (31 = $001F_h$)
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 15 - 8 =	Reserved
BIT 7 =	SCR firing interrupt failed
BIT 6 =	SCR Fire output failed
BIT 5 =	Missed SCR Firing Pulse detected
BIT 4 =	ADC/DMA Feedback “Re-Sync” performed
BIT 3 =	AC Line “Re-Syn” performed
BIT 2 =	AC Line Frequency check failure
BIT 1 =	Phase Loss or Missing AC Line cycle detected
BIT 0 =	AC Line Phase Lock Loss

[MP 346] Alarms	
Units:	N/A
Range:	0 to 65535 (0000 to $FFFF_h$)
Hex. Format:	xxxx
Representation:	
Bit:	
BIT 15 =	I / O Power Supply failure
BIT 14 =	Watchdog Timeout
BIT 13 =	Output % High or Tap Change Up
BIT 12 =	Output % Low or Tap Change Down
BIT 11 =	Line Phase Loss
BIT 10 =	PLL Lock Loss
BIT 9 =	Heatsink Over Temp
BIT 8 =	Current Trip
BIT 7 =	Deviation
BIT 6 =	Low Output (at MAX Output)
BIT 5 =	Load Imbalance
BIT 4 =	Shorted SCR
BIT 3 =	Heatsink Close to Over Temp
BIT 2 =	Power Limiting
BIT 1 =	Current Limiting
BIT 0 =	Voltage Limiting

[MP 347] Missed SCR Firing Pulse Count	
Units:	Counts
Minimum:	0
Maximum:	65535

[MP 348] Network Message Error Count (CCI Link)	
Units:	Counts
Minimum:	0
Maximum:	65535

[MP 349] Firmware Update Code	
Units:	N/A
Minimum:	0
Maximum:	65535

[MP 350 - 359] Reserved
Reserved

[MP 360] Load Fault Target Resistance A	
Units:	Ohm
Minimum:	0.00
Maximum:	+xxx.xx

[MP 361] Load Fault Target Resistance B	
Units:	Ohm
Minimum:	0.00
Maximum:	+xxx.xx

[MP 362] Load Fault Target Resistance C	
Units:	Ohm
Minimum:	0.00
Maximum:	+xxx.xx

[MP 363] Load Fault Resistance Deviation A	
Units:	%
Minimum:	0.0
Maximum:	100.0

[MP 364] Load Fault Resistance Deviation B	
Units:	%
Minimum:	0.0
Maximum:	100.0

[MP 365] Load Fault Resistance Deviation C	
Units:	%
Minimum:	0.0
Maximum:	100.0

[MP 366] Load Fault Resistance A	
Units:	Ohm
Format:	+xxx.xx

[MP 367] Load Fault Resistance B	
Units:	Ohm
Format:	+xxx.xx

[MP 368] Load Fault Resistance C	
Units:	Ohm
Format:	+xxx.xx

[MP 369] Partial Load Fault Status	
Units:	N/A
Range:	0 to (32767 = $7FFF_h$)
Binary Display Format:	xxxxxxxxxxx
Representation:	
Bit:	
BIT 15 =	Not Used
BIT 14 =	Not Used
BIT 13 =	Not Used
BIT 12 =	Not Used
BIT 11 =	Partial Load Fault C
BIT 10 =	Partial Load Fault B
BIT 9 =	Partial Load Fault A
BIT 8 =	Out of Range C
BIT 7 =	Out of Range B
BIT 6 =	Out of Range A
BIT 5 =	Teach - determining MIN setpoint
BIT 4 =	Teach in progress
BIT 3 =	Teach enabled
BIT 2 =	Ramp Initialized
BIT 1 =	Ramp Mode
BIT 0 =	Enabled

[MP 370] Network Heartbeat Timer	
Units:	Seconds
Minimum:	0
Maximum:	65535

[MP 371, 372] Heater Bakeout Time Remaining	
MP 371:	MSW
MP 372:	LSW
Units:	Minutes
Minimum:	0.00
Maximum:	10000.00

[MP 373 - 377] Reserved
Reserved

[MP 378] EEProm Status 2	
Units:	N/A
Range:	0 to 255
Binary Display Format:	xxxxxxxx
Representation:	
Bit:	
BIT 7 =	User Backup XP Table 2 checksum error
BIT 6 =	User Backup XP Table 1 checksum error
BIT 5 =	MFG XP Table 2 Checksum error
BIT 4 =	MFG XP Table 1 Checksum error
BIT 3 =	XP Table 2 checksum error
BIT 2 =	XP Table 1 checksum error
BIT 1 =	XP Definition table 2 error
BIT 0 =	XP Definition table 1 error

[MP 379] Bootloader Version	
Units:	N/A
Minimum:	1.00
Maximum:	99.99

[MP 380] PGA Gain AC Line	
Units:	N/A
Minimum:	1
Maximum:	32

[MP 381] PGA Gain Load Voltage	
Units:	N/A
Minimum:	1
Maximum:	32

[MP 382] Load Voltage Range	
Units:	N/A
Minimum:	1
Maximum:	3

[MP 383 - 384] Reserved
Reserved

[MP 385] PGA Gain Load Current	
Units:	N/A
Minimum:	1
Maximum:	32

[MP 386 - 388] Reserved
Reserved

[MP 389] PGA Gain Message Count	
Units:	AC Line 1/2 Cycles
Minimum:	0
Maximum:	65535

Special Function Parameter List, (XP)
Range: 3400 - 3412

[XP 3400] Digital RUN/STOP Configuration	
Units:	N/A
Minimum:	0
Maximum:	2
Default:	1
Selections:	
0 =	Never use Digital RUN/Stop, use switch
1 =	Analog use switch only, Digital use Digital RUN/Stop and switch
2 =	Always use Digital RUN/Stop and switch

[XP 3401] Digital RUN/Stop Power-Up Default	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	0
Selections:	
0 =	STOP
1 =	RUN

[XP 3402] Output % High Alarm Threshold	
Units:	%
Minimum:	0.00
Maximum:	100
Default:	100

[XP 3403] Output % Low Alarm Threshold	
Units:	%
Minimum:	0
Maximum:	100
Default:	0

[XP 3404 - 3409] Reserved
Reserved

[XP 3410] High/Low Out % Alarm Display Text Select	
Units:	N/A
Minimum:	1
Maximum:	2
Default:	1
Selections:	
1 =	Out % High / Low
2 =	Tap Change Up / Down

[XP 3411] Reserved
Reserved

[XP 3412] Missed SCR Firing Pulse Detection Enable	
Units:	N/A
Minimum:	0
Maximum:	1
Default:	1
Selections:	
0 =	OFF (Disabled)
1 =	ON (Enabled)

APPENDIX D: FUSING OPTIONS

All touchsafe kits have 600 VAC, Class-T Fusing, and are Branch-Rated.

Single phase controllers require 2-Pole Fuseblocks, while the Three Phase controllers require 3-Pole Fuseblocks.

Touchsafe Kits: Single Phase

CCI PART NUMBER	AMP SIZE	DESCRIPTION
SFKTS62T10	10	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T15	15	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T20	20	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T25	25	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T30	30	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T35	35	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T40	40	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T45	45	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T50	50	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS62T60	60	2 Pole Assy — 2 x Fuse, 1 x Block, 2 x Cover
SFKTS61T70	70	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T80	80	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T90	90	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T100	100	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T110	110	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T125	125	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T150	150	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T175	175	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T200	200	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T225	225	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T250	250	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T300	300	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T350	350	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T400	400	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T450	450	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)
SFKTS61T500	500	1 Pole Assy — 1 x Fuse, 1 x Block, 1 x Cover (2 required)

1.3 Feature Comparison

MicroFUSION is available with one of two circuit boards. SX is a lower-cost alternative, whereas HX is a fully populated board that can be field-upgraded to include retransmits and other features.

● = Included
☐ = Option Available at Manufacturing Time
❍ = Field Upgradeable Option
- = Not available

Feature List	SX	HX
Auto-Ranging Input (24 - 600 VAC for UL/cUL, 24 - 690 VAC for CE)	●	●
Phase Angle and Zero Cross Firing Modes	●	●
LED Bar Graph	●	●
Touchsafe Design	●	●
UL - Listed, CE, 100kA SCCR, and RoHS certifications	●	●
Micro USB Connection (USB Plug-N-Play)	●	●
Free Control Panel Software	●	●
DIN Rail Mountable (Up to 80 A)	●	●
Panel Mount	●	●
RUN / STOP	●	●
Overcurrent Trip	●	●
Analog Input (0 - 10 Vdc, 0/4 - 20 mA or potentiometer)	●	●
CCI Link™ Connectivity	●	●
Fixed Current Limit - 105% of Frame	●	-
Adjustable Current Limit	❍	●
kWh Monitoring	❍	●
Alarm Relay	❍	●
Current Control	❍	●
Load Voltage Control	-	●
Voltage Limit	-	●
Monitor Current	❍	●
Isolated I / O	❍	❍
Analog Channel 2 Input	❍	❍
General Purpose Input	❍	❍
Pulse Width Modulation Input	❍	❍
Accessory Option: Remote Display	❍	❍
SYNC - GUARD™ Connectivity	❍	❍
External Fieldbus Options: DeviceNet, Modbus TCP, EtherNet/IP, PROFINET, EtherCAT	❍	❍
Internal Fieldbus Options: PROFINET, Modbus TCP, and EtherNet/IP	☐	☐
External Panel Mount Heatsink (Up to 50 A)	☐	☐
Water-Cooled Heatsink (Up to 400 A) (Contact factory)	☐	☐
Zero Cross Transformer Firing Mode	-	❍
Retransmit (RTX): 2x High Resolution Analog Retransmits (0 - 10 Vdc or 0/4 - 20 mA)	-	❍
Power Limit	-	❍
True Power Control	-	❍
Monitor True RMS Power	-	❍
High Resolution Control Loop	-	❍
Resistance Calculation	-	❍

DECLARATION OF CONFORMITY

MicroFUSION Series SCR Power Controller

Control Concepts, Inc.
18760 Lake Drive East
Chanhassen, MN 55317 USA

Declares that the following product:

Designation:	MicroFUSION Series Power Controller
Model Numbers:	Model uF, followed by 1 or 3, followed by HX or SX, followed by T or D or 4DY or 6DY or 64Y or 6ID, followed by A through Z, followed by any number or letter, followed by numbers -01 through -400, followed by "-" and numbers and/or letters
Classification:	Solid State Power Controller, Class I, CE Pollution Degree II
Rated Voltage:	24 - 690 VAC
Rated Frequency:	45 - 65 Hz

Meets the essential requirements of the following European Union Directive(s) using the relevant section(s) of the normalized standards and related documents shown:

EN 60947 - 4 - 3: 2014 Low-voltage switchgear and controlgear

IEC 60947- 4 - 1: 2012
- -Clause 9.4.2 Immunity referencing IEC 60947-1: 2007/A1: 2010/A2: 2014, Clause 8.4.1, Table 23
  - -IEC 61000- 4 - 2: 2008
  - -IEC 61000- 4 - 3: 2006/A1: 2007/A2: 2010
  - -IEC 61000- 4 - 4: 2004/A1:2010
  - -IEC 61000- 4 - 5: 2005/AC1:2009
  - -IEC 61000- 4 - 6: 2013
  - -IEC 61000- 4 - 8: 2009
  - -IEC 61000- 4 - 11: 2004

IEC 60947 - 4 - 1: 2012, Clause 9.4.3 Emission
Referencing IEC 60947-1: 2007/A1: 2010/A2: 2014, Clause 7.3.3
EUROPEAN STANDARD EN 55011: 2009 + A1: 2010
FCC Part 15 Subpart B

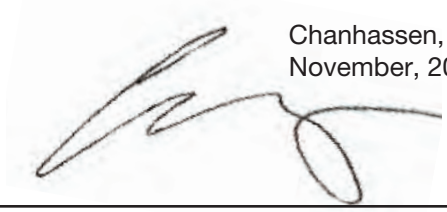
Note 1: All power terminals must be populated as to keep the controller touch safe to comply with EN 60947-4-3.
Note 2: Controller must be mounted in a shielded enclosure to comply with EMC Directive 2014/30/EU.
Note 3: Controller must have appropriate line and control power filter to comply with EN61000-6-2.

Third party conformance testing conducted by TÜV America.

TÜV SÜD America Inc.
Suite 104
1774 Old Highway 8 NW
New Brighton, MN 55112 - 1891

Name of Authorized Representative: Cory Watkins
Title of Authorized Representative: President

Place of Issue: Chanhassen, Minnesota, USA
Date of Issue: November, 2017



Signature of Authorized Representative

11/17/2017
Date

CONTROL CONCEPTS, INC. 2 YEAR LIMITED WARRANTY

CONTROL CONCEPTS, INC. warrants that the products delivered will be as described in the sales order or contract.

CONTROL CONCEPTS, INC. warrants to the original user that CONTROL CONCEPTS, INC. products will be free from defects in materials and workmanship for a period of two (2) years after the date CONTROL CONCEPTS, INC. ships such products.

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By purchasing CONTROL CONCEPTS, INC.'s products, the purchaser agrees to the terms and conditions of this limited warranty.

WARNING: The Control Concepts, Inc. power controllers use power thyristors to switch voltage to the connected load. Line voltage must be assumed at the output terminals at all times, even when the control signal has been removed and the load voltage appears to be off. It has been mandated by the National Electrical Code and the Occupational Safety and Health Act of 1970 that a physical disconnect be opened ahead of all remotely actuated controls before performing any maintenance work on the controller or its connected load.

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