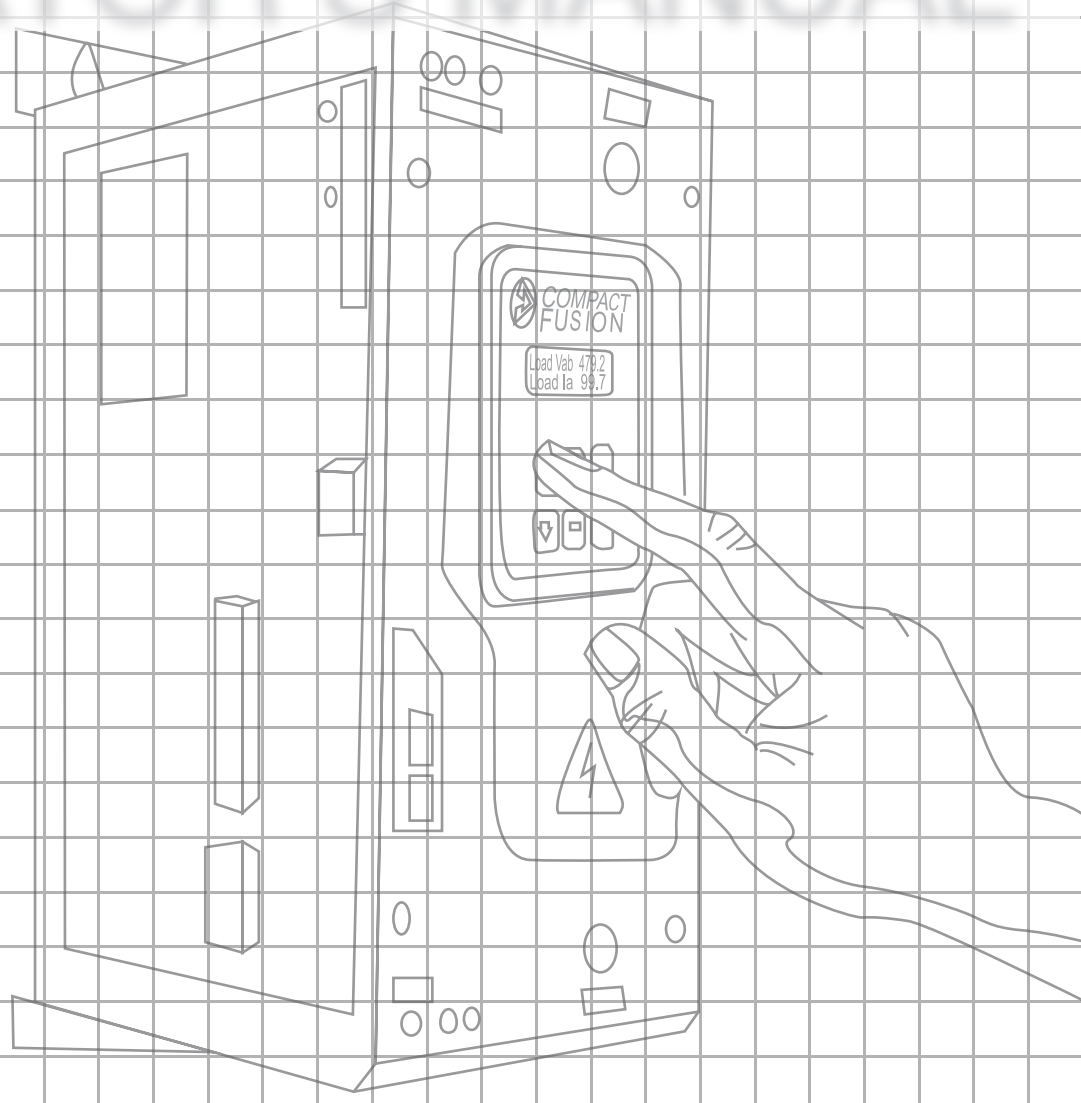
CONTROL CONCEPTS

COMPACT FUSION
SCR POWER CONTROLLERS
OPERATOR'S MANUAL



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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 Heath 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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Listed 3L32 - Industrial Control Equipment
100kA Short Circuit Current Rating
File Number E136219

EN60947-4-3
IP 20
See CE Declaration of Conformity

Part 15 Subpart B
Class A Device

See RoHS Certificate of Compliance

DECLARATION OF CONFORMITY

FUSION CF Series SCR Power Controller

CE

Control Concepts, Inc.
8077 Century Blvd
Chanhassen, MN 55317 USA

Declares that the following product:

Designation:	FUSION CF Series Power Controller
Model Numbers:	Model CF followed by ZC, PA, followed by 1, 2 or 3, followed by 1 through 9 or A through E followed by number or letter, may be followed by numbers and/or letters, may be followed by numbers and/or letters, may be followed by numbers and/or letters.
Classification:	Solid State Power Controller, Class I, Pollution Degree II
Rated Voltage:	24 - 600 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

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

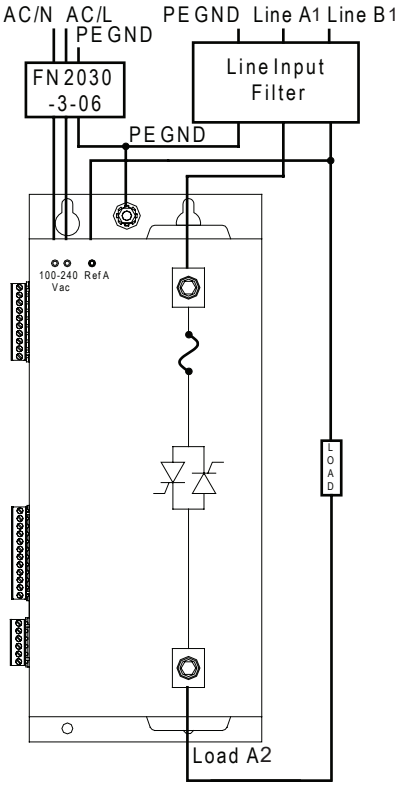
The Schaffner filter for universal input power, or it's equivalent, may be used as listed above. The line input power filter however, will need to be sized accordingly for your load. Please contact Schaffner EMC Inc. for help finding the appropriate filter.

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

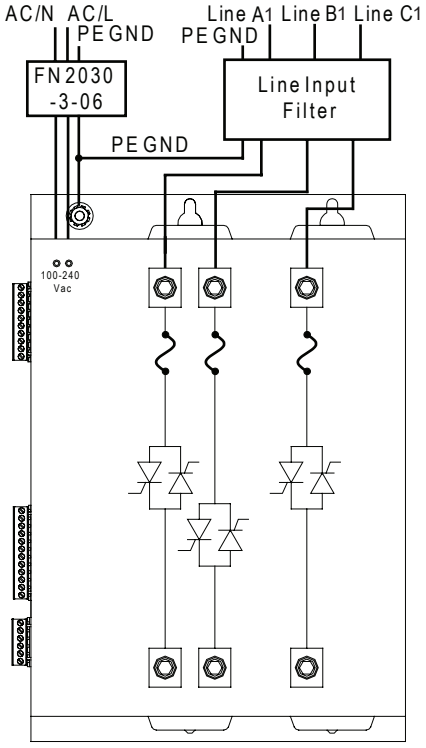
*No filtering is required for emissions.

Wire filters as shown below:

1 Phase Controller



3 Phase Controller



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.

PB-FREE/REDUCTION OF HAZARDOUS SUBSTANCE (RoHS)

CERTIFICATE OF COMPLIANCE

This document certifies that Control Concepts, Inc's products listed in the table are fully RoHS complient as of Nov 17, 2017 in accordance with EU RoHS Directive 2011/65/EU. The products listed in the table have been identified as RoHS compliant do not exceed the maximum limit for the six substances: Lead, Mercury, Cadmium, Hexavalent chromium, Polybrominated biphenyls and Polybrominated diphenyl ether.

PRODUCT FAMILY	PART NUMBERS	DATE ADDED
FUSION	FUSION-□□-□-□□□□-□-□□□□-□□□□	11/13/2009
FUSION CF	CF-□□-□-□□□□-□-□□□□-□□□□	12/20/2010

Authorized Signature
Cory Watkins, President

11/17/2017
Date Last Updated

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1. OVERVIEW

The Compact FUSION series controller is a modular digital controller capable of single phase or three phase operation. The modular design allows up to four independent zones of control within one footprint-saving package.

Compact FUSION is nearly identical to its predecessor FUSION, but with a narrower footprint, onboard branch-rated protection fusing (Class T), and a blown fuse indicator for each line. Optional pass through fusing allows a line to pass through the single phase controller to fuse the return leg of the load.

Loads can be controlled in phase-angle, zero-cross, or burst modes for operation of resistive or transformer connected loads. Output is controlled linearly with respect to command signal and can be set to the average or RMS value of the voltage or current, as well as true instantaneous power or external feedback.

Compact FUSION controllers are available in current ratings from 10 - 160 amps AC. Auto-ranging voltage circuitry enables mains supply voltage from 24-600 VAC, (45-65 Hz) eliminating the need for hardware jumpers or stocking multiple controllers for international voltages. A separate power source supplies the control electronics and maintains critical communications to your control system when the mains are absent.

An integrated display and on-board diagnostics make operation and trouble shooting simple. Limits, set-points, and alarm conditions can be easily viewed and customized. A plug-n-play USB interface and free FUSION Control Panel software for the PC further simplifies installing and configuring the controller to your application. OEMs, for example, can duplicate controller settings by simply loading a configuration file saved from a previous unit.

Parameters can be easily viewed and controlled through the onboard display. For additional convenience, the display can also be remotely mounted on an electrical enclosure door.

Setpoints can be controlled through the standard analog or optional Fieldbus interface. The factory-configured analog setpoint signal ranges are 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 Modbus TCP (Ethernet), DeviceNet™, ProfiNet (Ethernet) and Ethernet/IP. These interface options can be used to communicate with a PLC or factory control system. For multi zone controllers consisting of 3 or 4 zones, a Fieldbus interface is required.

1.1 Certifications / Markings

Controllers meet UL, CE and RoHS standards for safety, emissions and environment.

c UL us

100kA SHORT CIRCUIT CURRENT RATING

CE EN60947-4

FC Part 15 Subpart B Class A Device

RoHS COMPLIANT

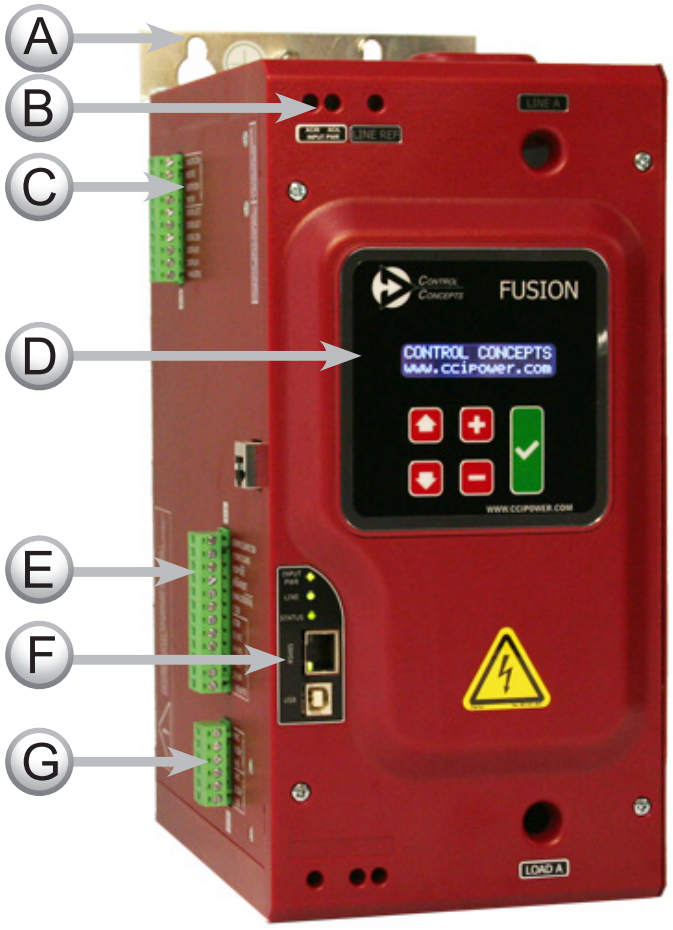
Pb Pb-Free

ODVA

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

- Model Number
- Serial Number
- Voltage Range (24 - 600 Vac)
- Current Size
- 1 Phase or 3 Phase
- Frequency (45 - 65 Hz)
- Control Concepts contact information
- Torque information on Line / Load connections

1.2 Points of Interest



A. BASE PLATE WITH GROUND STUD
Metal mounting plate to ground the controller.

B. UNIVERSAL INPUT POWER
Operates circuitry and on-board fans when present. Allows users to configure controller without line power.

C. OPTIONAL AUX I/O CARD
(P3) Provides additional features. Has two digital inputs, two digital outputs, and two analog outputs (retransmits)

D. DISPLAY, KEYPAD, & OPT. 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, setpoint select, run/reset, SYNC-GUARD™ feature.

F. INDICATOR LEDs, USB PORT, & DIGITAL COMMUNICATIONS
Streamlines controller setup, configuration, diagnostics, and troubleshooting. Digital communication options includ DeviceNet, Modbus RTU or TCP, EtherNet/IP, and PROFINET.

G. RELAY CONNECTIONS
(P2) Alarms can be mapped to two internal relays for external triggering.

1.3 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 SCR's.

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 SCR's.

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 SCR's.

1.4 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 (see Transformers section)
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. INDICATOR LEDs

INPUT PWR LED turns green when the Universal Input has been connected and power is applied. LINE LED turns green when the Lines have been connected and power is applied (input power is also required).

STATUS LED turns green when the controller is in a run state. If the LED is flashing orange, the controller has a Warning Alarm. If the LED is red, there is an Inhibit Alarm. Note: The LED will be off if there are no alarms but the controller is not in a “Run” state.

NOTE: Line reference is required for single phase, three phase 2 leg, and three phase 4 wye controllers only.

Standard

Modbus RTU (RS 485)

Modbus TCP (Ethernet) EtherNet/IP PROFINET

DeviceNet

3. COMMUNICATIONS

3.1 USB Interface

A USB interface is standard on all controllers. Included with each controller is a software package titled 'Control Panel'. This allows the user to connect to the controller using a computer and USB cable. See the Control Panel manual for details on how to use the software.

Control Concepts stocks 15 foot USB cables for customers to purchase (P/N: 0058004-0000-15).

3.2 Control Panel Software

The Control Panel software assists with the installation, parameter setup, operation, and troubleshooting of Control Concepts devices. The installer for the Control Panel software (CCIControlPanelSetup.exe) can be found on the CD packaged with your Control Concepts device or on our website at www.ccipower.com. Refer to the "Control Panel Manual" available on the Control Concepts website for a reference on using the Control Panel application.

The Control Panel 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 such as the example in Figure 3.00. 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 in Figure 3.00 shows that the controller's limit and trip parameters and located in the "Limits" subcategory within the "Control Configuration" main category of the Control Panel application.

FIND IN CONTROL PANEL

LIMIT AND TRIP PARAMETERS
Category: Control Configuration > Limits

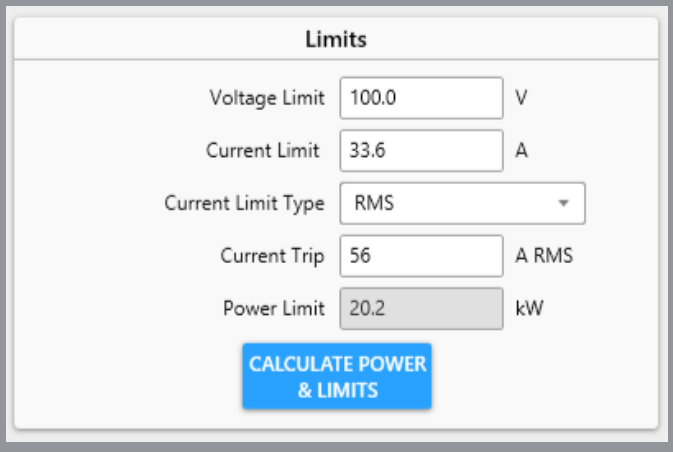


FIGURE 3.00

3.3 Factory Industrial Communications Interface

Modbus communication is one of the most commonly used communication types in an industrial manufacturing environment. It allows communication between many devices (up to 247) on the same network.

Control Concepts offers a Modbus Developers software kit that allows users to write their own protocols. There is a hardware kit available for purchase (P/N: SMAFUSION-MDK) that includes a Modbus converter, splitter and terminating plug. This will allow controllers to be “Daisy Chained” together and controlled from a single interface.

Control Concepts 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 Modbus RTU cannot also have Modbus TCP.

3.3.1 Modbus RTU [RS-485] Interface (Optional)

See Modbus manual for details

3.3.2 Modbus TCP [Ethernet] Interface (Optional)

See Modbus manual for details

3.3.3 DeviceNet Interface (Optional)

See DeviceNet manual for details

3.3.4 PROFINET Interface (Optional)

See ProfiNet manual for details.

3.3.5 EtherNet/IP Interface (Optional)

See EtherNet/IP manual for details.

4. START-UP PROCEDURE

Before applying power to the controller, check that all connections are correct and tightened to the proper torque value. Make sure the controller is in a stop state (not run) via pin 9 of the P1 connector.

1. Apply the universal input power.

   Expected Response:
   - Display will illuminate and scroll initial start-up screen.
   - *Display will read “INHIBIT ALARM” with LINE LOSS and AC LINE SYNC PLL alarms scrolling.

2. Verify proper system and zone settings
   - Control mode set for desired operation (Phase Angle, Zero Cross, etc).
   - Full scale settings are correct.
   - Limit settings are correct.
   - If a 3 phase controller, verify 3 phase load config is set for correct load type (Delta or 3 Wire Wye, Inside Delta or 4 Wire Wye).

3. Apply the line power. Line LED will turn on to indicate power.

4. Place the controller in Run mode by closing Pin 9 of the P1 connector.

   - If the status LED does not change to green when this is closed the Digital Enable check box is not checked.
   - Open the FUSION Control panel software and check the zone “Enable” button in the Dashboard section.

5. When all indicator LEDs are green, apply a command signal. The output of the controller will respond linearly to the command signal.

   * When the line power is applied these two alarms will go away.

NOTE: If the status LED is red or flashing orange the display will read the inhibit or warning alarm that is causing the alarm. See the troubleshooting section in this manual for details on alarms.

5. BASIC OPERATION & SETTINGS

For single phase controllers multiple zones may be present. Each zone of the controller has its own list of parameters to configure. The following parameters will be followed by a list of numbers contained in square brackets. The numbers will correspond to the zone it pertains to. For example Control Mode [SP 3] [SP 23] [SP 43] [SP 63], SP 3 is for Zone 1, SP 23 is for Zone 2, SP 43 is for Zone 3 and SP 63 is for Zone 4.

If your device does not have four zones, ignore the parameters that apply to the unused zones. The parameters for the unused zones will not appear in the Control Panel software.

A separate category appears in Control Panel for the control settings for each zone with the title "Control - Zone X", where X is the zone number. The Setpoint and Run/Stop parameters for all active zones appear in the "Setpoint" category. These categories are shown in Figure 5.00. The parameters that appear in these categories in Control Panel will be explained in this section.

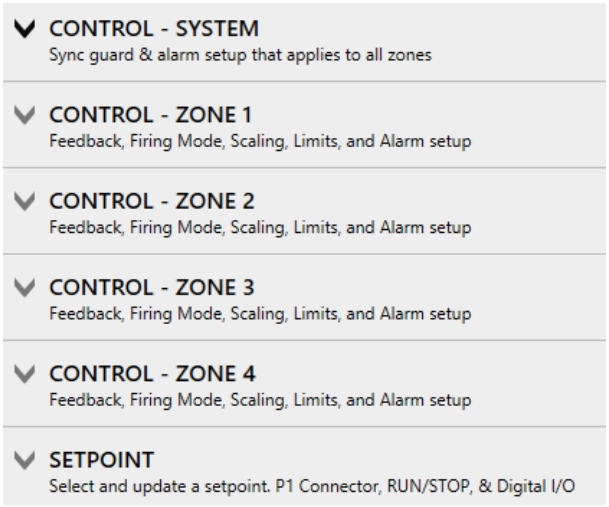


Figure 5.00: The control settings for each zone appears in a separate "Control Configuration" category in Control Panel.

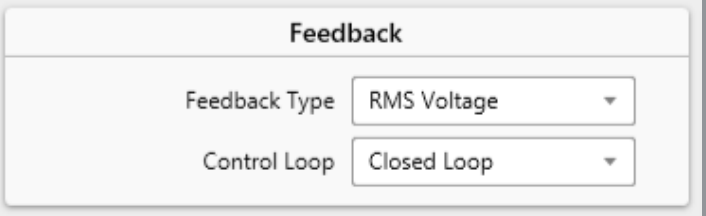
5.1 Feedback Type [SP 1] [SP 21] [SP 41] [SP 61]

The Feedback type determines how the control loop feedback works. By default this is set to *RMS Voltage*.

Setting	Description
RMS Voltage [Default]	Use RMS voltage as the control loop feedback
AVG Voltage	Use average voltage as the control loop feedback
RMS Current	Use RMS current as the control loop feedback
AVG Current	Use average current as the control loop feedback
Power	Use real power as the control loop feedback
External	Use an external transducer that provides the feedback signal into Analog Setpoint 2. Analog SP2 Function (SP 89) must be set to *Normal*.
Apparent Power	Use apparent power as the control loop feedback

FIND IN CONTROL PANEL

FEEDBACK TYPE [SP1][SP 21][SP 41][SP 61]
Category: Control - Zone X



Here are the calculations on how the feedback is measured:

RMS Voltage

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

RMS Current

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

Power

The output is adjusted via the real Power.

$$\text{Real Power} = \frac{\sum_{i=1}^{n} (Vi * Ii)}{n}$$

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

$$\text{Power Factor} = \frac{\text{Real Power}}{\text{Apparent Power}}$$

AVG Voltage

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

AVG Current

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

V_{pk} = Peak Voltage
Vi = Instantaneous Voltage sample
n = number of samples in 1 AC line cycle

I_{pk} = Peak Current
Ii = Instantaneous Current sample

External Feedback

External Feedback uses the Analog Input “SP2” 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.

NOTE: External Feedback is only available on 1 Zone controllers.

NOTE: For instruction about wiring external feedback, see the FUSION Installation and Maintenance manual.

Connect the external feedback signal to analog input 2 “SP2.” Select “External (Use Analog SP2 input)” as the Feedback Type. Scale the external feedback by setting up the analog setpoint as described in Section 5.7.2, “Analog Setpoints.” The Analog Input 2 “Function Select” should be set to “Normal.”

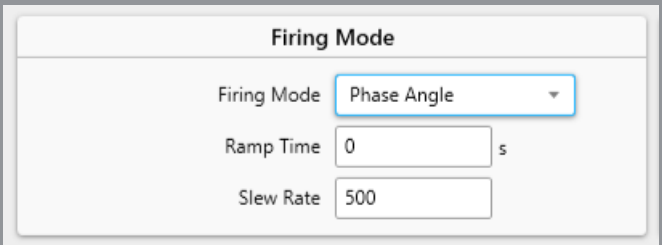
5.2 Firing Mode [SP 2] [SP 22] [SP 42] [SP 62]

Knowing the application and the type of load you are trying to control is critical for choosing the right mode of operation. The Compact FUSION Series power controllers are capable of Phase Angle and Zero Cross operation.

The following sections will describe each type of operation and will show the expected output.

FIND IN CONTROL PANEL

FIRING MODE [SP 2][SP 22][SP 42][SP 62]
Category: Control - Zone X



Ramp Time and Slew Rate are visible in Control Panel when Phase Angle is selected. Phase Angle to Zero Cross Switch Threshold is visible when Zero Cross Transformer is selected. Burst Start Angle is visible when Zero Cross Burst is selected.

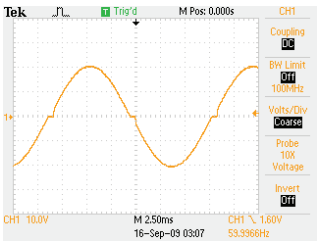
Setting	Description
Zero Cross	The load power is turned ON for a number of complete electrical half-cycles and then turned OFF for a number of complete half-cycles.
Zero Cross Burst	The first half cycle is fired at a user specified angle and then works the same as Zero Cross mode.
Phase Angle	The SCR 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.

5.2.1 Phase Angle

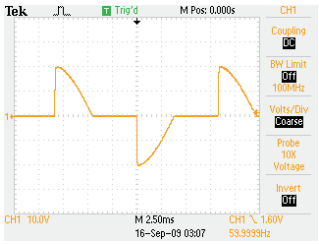
In phase-angle control, each SCR of the back-to-back pair is turned on for a variable portion of the half-cycle that it conducts. Power is regulated by advancing or delaying the point at which the SCR is turned ON within each half cycle. Light dimmers are an example of phase-angle control.

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.
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.

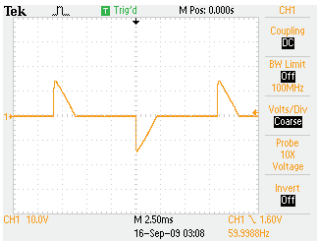
Single Phase Operation



100% Load Power

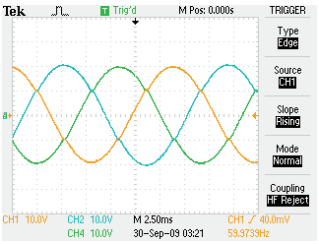


50% Load Power

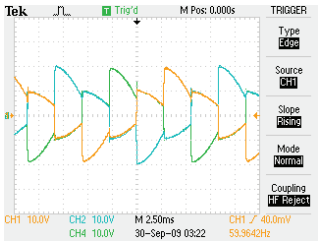


25% Load Power

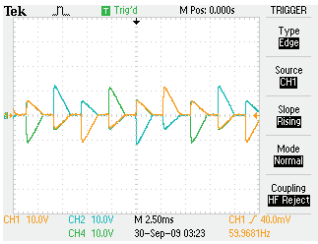
Three Phase Operation



100% Load Power



50% Load Power



25% Load Power

Ramp Time [SP 4] [SP 24] [SP 44] [SP 64]
Default value: 0 seconds.

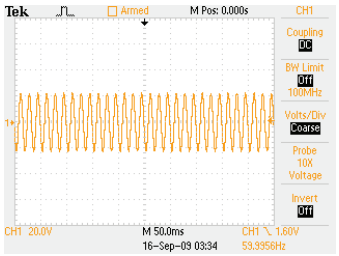
This parameter allows the user to set a maximum ramp time (in seconds) for the controller to reach the full scale value from 0% output. The ramp time is not used if the setpoint is changed from something other than 0% output.

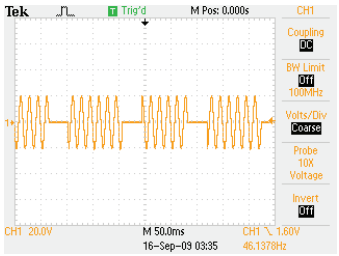
Example: If the controller is set for Voltage Feedback and the Full Scale Voltage is set to 100 Volts and the Ramp Time is set for 10 seconds, when a setpoint is applied the output will rise at 10 volts a second. So if the setpoint is set to 40% the ramp time will be 4 seconds.

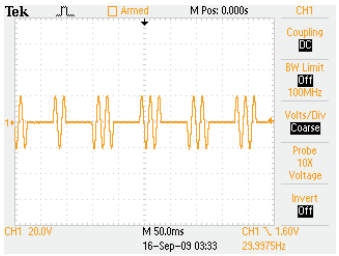
Slew Rate Factor [SP 5] [SP 25] [SP 45] [SP 65]
Default value: 10

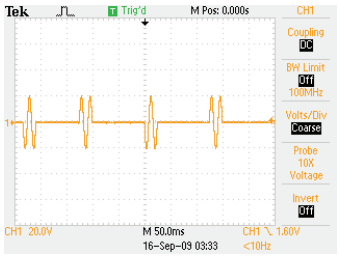
The slew rate controls how aggressively or slowly the system will respond to a change in feedback. A smaller number will make the system respond faster and more aggressively. A larger number will make the system respond slower. It is important that the full scale settings are set appropriately in order for the default value to work correctly.

5.2.2 Zero Cross









In zero-cross control, load power is turned ON and OFF only when instantaneous value of the sinusoidal waveform is zero. Load power is controlled by switching the SCRs "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 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 tabulation on the right 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 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

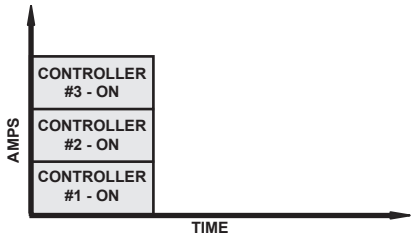
Note: Even though it takes 1.33 seconds to obtain precisely 85% power, the load power during the 23 ON and 4 OFF cycles is 23/27 or 85.185% power and that this cycle is repeated every 0.225 seconds.

TRANS-GUARD™

The TRANS-GUARD™ feature eliminates a DC component that can exist with zero-cross operation. Elimination of this DC component prevents saturation and over heating of the upstream supply transformers. TRANS-GUARD™ is a standard feature on all zero-cross controllers. There is no set-up required.

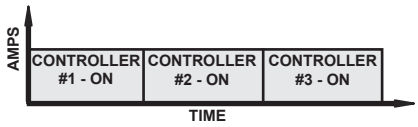
SYNC-GUARD™

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.



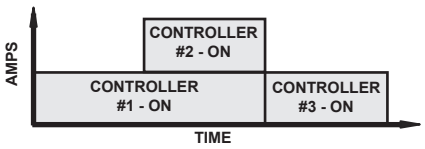
Three controllers providing 33.3% power each, operating synchronously without SYNC-GUARD™

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.



Three controllers providing 33.3% power each, with SYNC-GUARD™

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.



Three controllers with SYNC-GUARD™, two providing 33.3% power & one providing 66.6% power.

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

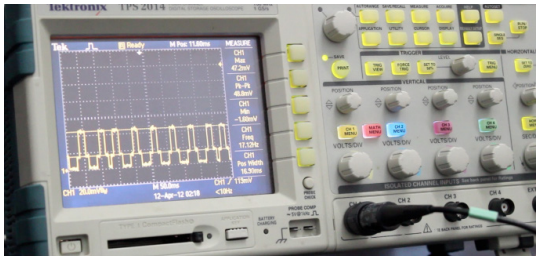
The SYNC-GUARD™ feature works to reduce the peak current draw required from the source for multiple controllers over time. However, each controller cannot predict when another controller is going to fire. Therefore the probability of multiple controllers firing at the same time exists even when using 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™.

The figures below show the total current as a function of time for three controllers, with, and without SYNC-GUARD™ and various load powers. To set up the SYNC-GUARD™ feature, see the Installation manual.

SYNC-GUARD™ Enable [SP 131]

Setting	Description
Disabled [Default]	SYNC-GUARD™ is disabled
Enabled	SYNC-GUARD™ is enabled

FOR MORE INFORMATION:



SYNC-GUARD™

Check our **Youtube channel** (ControlConceptsInc) and watch our SYNC-GUARD™ overview video!

5.2.4 Zero Cross Transformer Mode (ZCT)

This is a Control Concepts 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] [SP 27] [SP 47] [SP 67]
When using the ZCT firing mode, P.A. to Z.C. Switch Threshold is used to specify the desired number of cycles to use to ramp up to full conduction. This parameter is adjustable from 5 to 20 cycles (default is 12 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.

5.2.5 Burst

Burst mode operates very similar to ZCT Mode The difference is the first half cycle is fired at a user specified angle.

This type of hybrid control can consequently be used to control the primary of a transformer with transformer coupled loads by avoiding the excessive inrush currents that can occur with magnetizing inductance of the transformer (prevents transformer saturation). The power factor is improved over standard phase angle operation into a transformer.

Burst Start Angle [SP 6] [SP 26] [SP 46] [SP 66]
Only applies when Zero Cross Burst is selected as the Firing Mode.

Default value: 90 Degrees

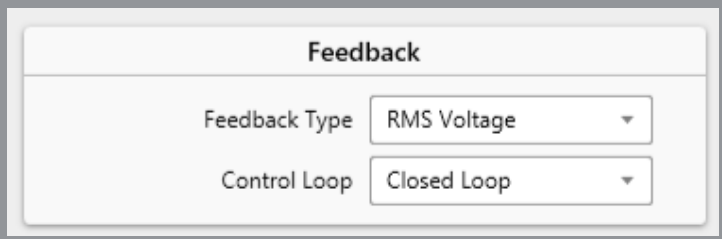
This is the setting in phase angle degrees at which the SCRs are fired during the first half cycle. Adjust this depending on the system design and the downstream transformer characteristics. See the Operator Manual for why to use Burst Start Angle or consult with Control Concepts for more information.

5.3 Control Mode [SP 3] [SP 23] [SP 43] [SP 63]

Setting	Description
Open Loop	The output percentage is directly proportional to the setpoint. Feedback is not used.
Closed Loop [Default]	The output is adjusted so that the feedback equals the setpoint.

FIND IN CONTROL PANEL

CONTROL MODE [SP3][SP 23][SP 43][SP 63]
Category: Control - Zone X



5.4 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).

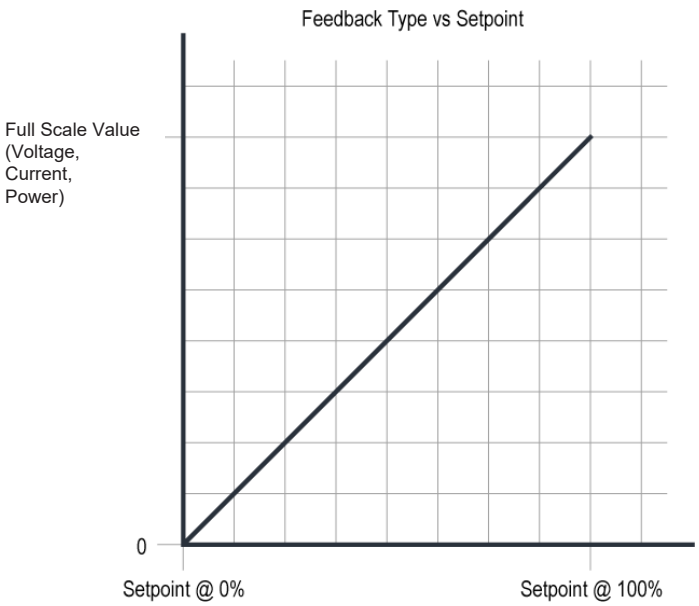
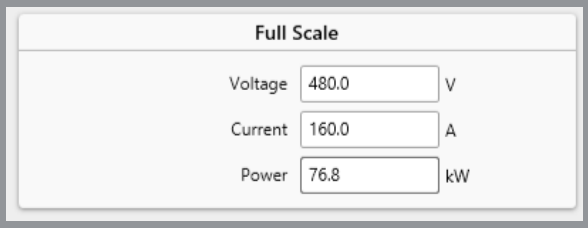


FIGURE 5.01
This figure shows how the setpoint corresponds to the full scale value.

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

FIND IN CONTROL PANEL

FULL SCALE SETTINGS
Category: Category: Control - Zone X > Full Scale



5.4.1 Full Scale Voltage [SP 8] [SP 28] [SP 48] [SP 68]

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 value is set to 480 V.

5.4.2 Full Scale Current [SP 9] [SP 29] [SP 49] [SP 69]

The current 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 actual current is common. This should not be set to more than 2X the actual current. The default value is set to the frame rating of the controller.

5.4.3 Full Scale Power [SP 10] [SP 30] [SP 50] [SP 70]

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

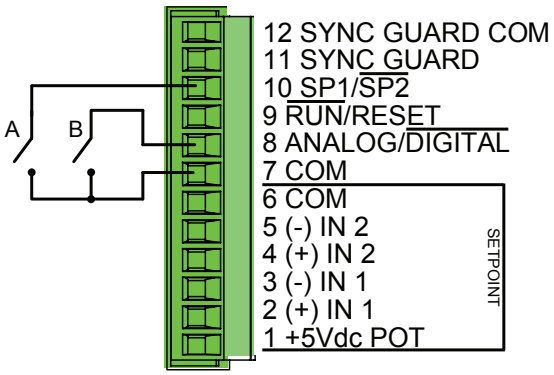
1 Phase AC & DC 3 Phase DC	3 Phase AC	
	Delta, 3 & 4 Wire Wye	Inside Delta
[Full Scale V] x [Full Scale I]	[Full Scale V] x [Full Scale I] x [√3]	[Full Scale V] x [Full Scale I] x [3]

Note: In the Control Panel Software there is a “Calculate” button for these equations. This will automatically fill in the full scale power once pressed. It will also automatically set up the limit settings.

5.5 Setpoints

There are four possible setpoints: two digital, two analog. These can be selected by connecting pins 7, 8, and 10 on the P1 command connector .The diagram on the right shows how to access each setpoint with the use of two switches. The hardware switch setpoint selection can be overrode and a digital selection can be used as described in Section 5.5.3, “Digitally override the P1 and P2 connector.” For wiring analog setpoints see the Installation & Maintenance Manual.

	Switch A	Switch B
Analog Setpoint 1	Open	Open
Analog Setpoint 2	Closed	Open
Digital Setpoint 1	Open	Closed
Digital Setpoint 2	Closed	Closed



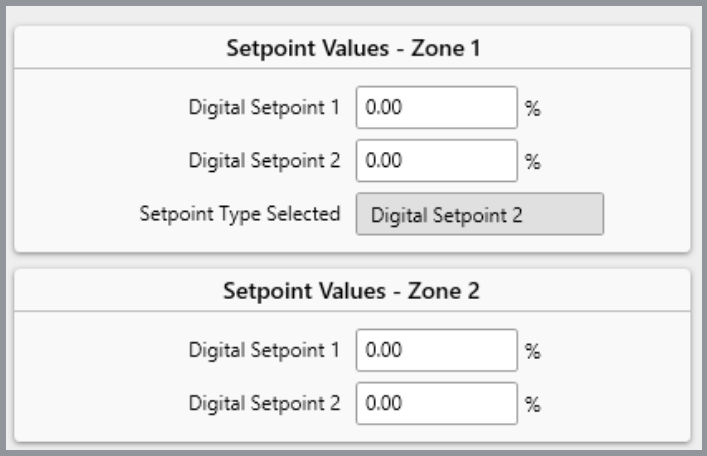
5.5.1 Digital Setpoints

There are two digital setpoints available. The digital setpoint can be entered as a percent (0 - 100%) via the display. The setpoints can also be set via the USB, RS-485 or Ethernet interfaces. The digital setpoint can also be set using Control Panel.

When digital control is selected, pin 10 on the P1 command connector controls whether Digital Setpoint 1 or Digital Setpoint 2 is used. This switch can be overrode and a digital selection can be used as described in Section 5.5.3, “Digitally override the P1 and P2 connector.”

FIND IN CONTROL PANEL

DIGITAL SETPOINTS [SP 100 - 107]
Category: Setpoint > Setpoint Values - Zone X



A group is available with Digital Setpoint 1 and 2 in Control Panel for each active zone.

5.5.2 Analog Setpoints

There are two analog inputs on each controller. A single zone controller can select either setpoint 1 or setpoint 2 using pin 8 on the P1 connector. Single zone controllers have special functionality in that analog setpoint 2 can be used for external feedback as described in section 5.1. For 2 zone controllers, analog setpoint 1 is for zone 1 where setpoint 2 is for zone 2. These configurations can be overrode digitally as described in Section 5.5.3, “Digitally override the P1 and P2 connector.”

The inputs allow a wide array of input scaling for the user. The hardware capabilities are 0 - 10 Vdc for voltage and 0 - 20 mA for current. The factory default setting for SP1 is 4 - 20 mA and SP2 is set for 0 - 5 Vdc. Refer to section 7.2, “Analog Inputs” for information on analog input setup and the parameters used.

Example 1: If a 0 - 5 Vdc command is desired for 0 - 100% output using SP1

Controller Setting
No connection between Pin 7 & 8 on P1 (a connection here would set the setpoint to be in digital mode)
Connection between Pin 7 & 9 on P1 (with closed to run logic, this would put the controller in a Run state)
No connection between Pin 7 & 10 (a connection here makes SP2 the active setpoint)

Software Settings
Analog SP1 Type set to Voltage
Analog SP1 Lo Cmd set to 0.00
Analog SP1 Lo Out set to 0.00%
Analog SP1 Hi Cmd set to 5.00
Analog SP1 Hi Out set to 100.00%

Example 2: If a 4 - 20 mA command is desired for 0 - 100% output using SP2

Controller Setting
No connection between Pin 7 & 8 on P1 (a connection here would set the setpoint to be in digital mode)
Connection between Pin 7 & 9 on P1 (with closed to run logic, this would put the controller in a Run state)
Connection between Pin 7 & 10 (makes SP2 the active setpoint)

Software Settings
Analog SP2 Type set to Current
Analog SP2 Lo Cmd set to 4.00
Analog SP2 Lo Out set to 0.00%
Analog SP2 Hi Cmd set to 20.00
Analog SP2 Hi Out set to 100.00%

Example 3: If a 0 - 20 mA command is desired for 30 - 100% output using SP1

Controller Setting
No connection between Pin 7 & 8 on P1 (a connection here would set the setpoint to be in digital mode)
Connection between Pin 7 & 9 on P1 (with closed to run logic, this would put the controller in a Run state)
No connection between Pin 7 & 10 (a connection here makes SP2 the active setpoint)

Software Settings
Analog SP1 Type set to Current
Analog SP1 Lo Cmd set to 0.00
Analog SP1 Lo Out set to 30.00%
Analog SP1 Hi Cmd set to 20.00
Analog SP1 Hi Out set to 100.00%

Note: For example 3 - with the setpoint at 0 mA the controller would be on at 30%. When a setpoint is applied the controller will immediately respond. Similarly at 20 mA it would be on at 100%.

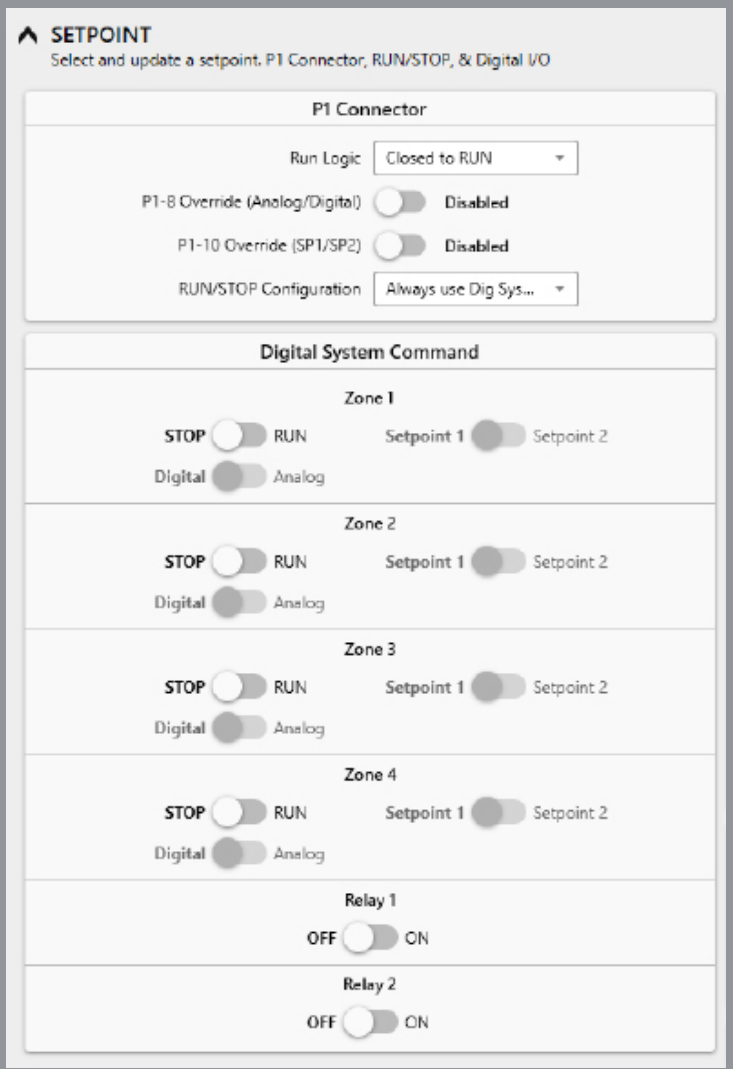
5.5.3 Digitally override the P1 and P2 connector

Device parameters can be used to bypass the functionality of the P1 and P2 connector. It is mainly used when using digital communications.

The Digital System Command is used mainly when using digital communications. It is a 16 bit parameter that contains sections that put the controller into the RUN/Stop state, determines which setpoint to use and to turn the relays On/Off. This section is used to bypass the functionality of the P1 and P2 connector.

FIND IN CONTROL PANEL

DIGITAL OVERRIDE PARAMETERS
Category: Setpoint



Digital System Command - Run/Stop [SP 129, Bits 0:3]
These bits provide digital control for the Run/Stop for each of the zones that can be used along with or as an alternative to the Run/Stop hardware switch. A set bit (1) is Run, and a clear bit (0) is Stop. Use RUN/STOP Configuration [SP 3400] to configure when the hardware switch and digital system command parameter are used for the Run/Stop.

Digital System Command - Setpoint Select [SP 129, Bits 4:7]
These bits provide digital control for whether Setpoint 1 or Setpoint 2 is used for each of the zones as an alternative to the SP1/SP2 hardware switch. A set bit (1) means Setpoint 2 will be used (either analog or digital), and a clear bit (0) means Setpoint 1 will be used (either analog or digital). Use P1 10 Override [SP 134] to enable digital system command for Setpoint 1 / Setpoint 2 selection.

Digital System Command – Relay 1 [SP 129 bit 10]
When the checkbox for Dig Sys Cmd Bit 10 (SP-85, bit 15) under SP085 Relay 1 Alarms has been checked, selecting ON (SP-129, bit 10) will energize Relay 1.

Digital System Command – Relay 2 [SP 129 bit 11]
When the checkbox for Dig Sys Cmd Bit 11 (SP-86, bit 15) under SP086 Relay 2 Alarms has been checked, selecting ON (SP-129, bit 11) will energize Relay 2.

Digital System Command - Setpoint Select [SP 129, Bits 4:7]
These bits provide digital control for whether the analog or digital setpoint is used for each of the zones as an alternative to the ANALOG/DIGITAL hardware switch. A set bit (1) means the Analog Setpoint will be used (either SP1 or SP2), and a clear bit (0) is means the Digital Setpoint will be used (either SP1 or SP2). Use P1 8 Override [SP 134] to enable digital system command for Analog / Digital Setpoint selection.

P1 8 Override [SP 133]

Setting	Description
Disabled [Default]	Use switch setting on P1 connector (pins 7 and 8)
Enabled	Override P1 connector. Use SP 129 bits 12 – 15.

If Enabled the controller will use the Digital System Command to determine setpoint type (Analog/ Digital - SP 129 bits 12 -15.) Each zone is set to Analog (0) by default.

P1 10 Override [SP 134]

Setting	Description
Disabled [Default]	Use switch setting on P1 connector (pins 7 and 10)
Enabled	Override P1 connector. Use SP 129 bits 4 – 7.

If Enabled the controller will use the Digital System Command to determine the setpoint (setpoint 1 / setpoint 2 - SP 129 bits 4 – 7.) Each zone is set to Setpoint 1 (0) by default.

Run/Stop Configuration [SP 3400]
The Run/Stop Configuration parameter controls whether the Digital Run/Stop [SP 129] parameter, the Run/Stop hardware switch, or both are used for setting the controller's Run/ Stop.

Setting	Description
Analog Use Switch Digital Use Both [Default]	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.

Run Logic [SP 82]

Setting	Description
Closed for Run [Default]	Connection on P1 between pin 7 and 9 must be CLOSED before a Run State can be achieved
Open for Run	Connection on P1 between pin 7 and 9 must be OPEN before a Run State can be achieved

Sets the Logic for Run/Reset (pin 9) of the P1 Command I/O (green 12 pin) connector on the side of the controller.

Digital System Command Power-up Default [SP 3401]

The bit definition for this parameter is identical to the bit definition for the Digital System Command parameter [SP 129]. During power-up/reset initialization, the values from this parameter will be used to initialize the values for the Digital System Command parameter.

5.6 Limits & Trip Settings

The Limits and Trips are safety features of the FUSION Power Controller. These protect the device from excessive voltage, current and/or power. These cannot be set higher or lower than what is listed in this manual. If these settings need to be set outside of the available ranges contact the factory.

5.6.1 Voltage Limit [SP 11] [SP 31] [SP 51] [SP 71]

Limits the voltage applied to the load. The recommended setting is 105% of the full scale voltage. The default value is set to 630 Volts which is 105% of a 600 VAC frame voltage.

5.6.2 Current Limit [SP 12] [SP 32] [SP 52] [SP 72]

Limits the current applied to the load. The recommended setting is 105% of the full scale current. The default value is set to 105% of frame rating. Use the Current Limit Type parameter [SP 13, 33, 53, 73] to change between RMS or AVG.

5.6.3 Power Limit [SP 15] [SP 35] [SP 55] [SP 77]

Limits the power applied to the load. The controller will continue to operate but will not exceed the power specified in this field. The recommended setting is 105% of the full scale power. The default value is set to 105% of the full scale power.

5.6.4 Current Trip [SP 14] [SP 34] [SP 54] [SP 74]

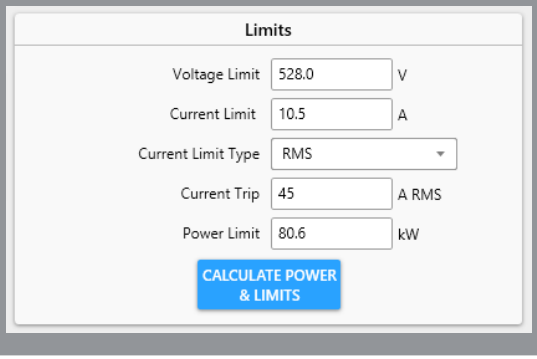
If the current exceeds the setting in this field the controller will shut down. Current Trip responds faster than the current limit setting. This protects the controller from experiencing surge currents that could damage the controller. This will shut the controller down and display an alarm.

For Phase Angle firing mode, the default value is set to 175% of frame rating.

For Zero Cross firing mode, the default value is set to 350% of frame rating.

FIND IN CONTROL PANEL

LIMITS AND TRIP PARAMETERS
Category: Control - Zone X - Limits



5.6.5 Shorted SCR Detection [SP 132]

Setting	Description
Disabled	Shorted SCR Detection is disabled
Enabled [Default]	Shorted SCR Detection is enabled

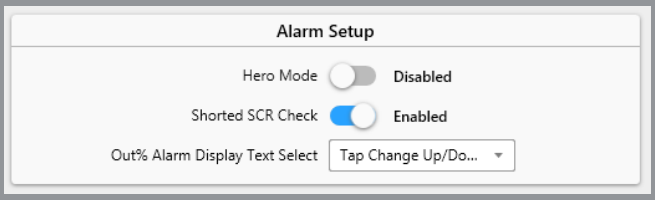
A shorted SCR can occur when excessive voltage and/or current passes through the SCR in a short period of time. The limit and trip features are intended to prevent damage to the controller/SCR but may not respond fast enough in every scenario. To determine if the SCR has a short, make sure that the line and the load has been disconnected from the controller. With a multimeter measure the resistance from the line connection to the load connection. This measurement typically measures greater than 300kΩ. If this measures less, the SCR is likely to have a short and 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.

A false Shorted SCR warning can also happen if the controller does not have the settings in the Zone Tab correctly set up. Check the Full Scale settings (SP 8, SP 9 & SP 10). If nuisance alarms are continuing to happen or if a Shorted SCR is thought to be present, consult with Control Concepts, Inc.

FIND IN CONTROL PANEL

SHORTED SCR DETECTION [SP 132]
Category: Control - System



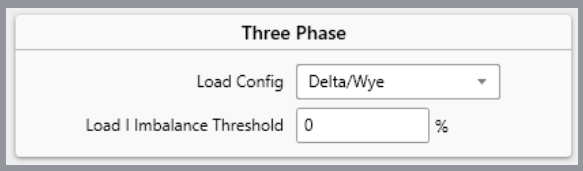
5.6.6 Three Phase Settings

Three Phase Load Configuration [SP 81]

Setting	Description
Delta / Wye [Default]	Load is configured as either a Delta or a 3 Wire Wye
4 Wire Wye	Load is configured as a 4 Wire Wye
Inside Delta	Load is configured as an Inside Delta

FIND IN CONTROL PANEL

THREE PHASE SETTINGS
Category: System > Three Phase

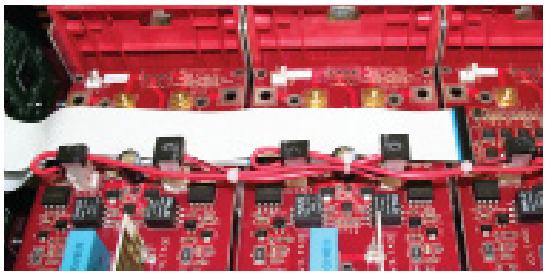


Note: This is for three phase three leg controllers only.

This indicates the load wiring configuration. This is generally determined before the controller is ordered from the factory, but can be changed in the field if a different load type is desired.

Changing this parameter requires an internal wiring change that can only be done with a wire harness from Control Concepts, Inc.

FOR MORE INFORMATION:



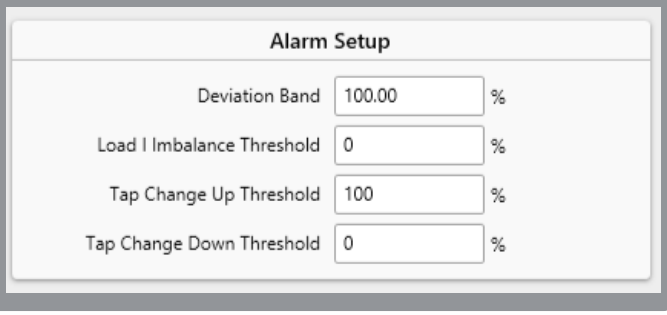
THREE PHASE LOAD CONFIGURATION
Instructions for wiring the controller for each load type can also be found in the **Installation and Maintenance Manual.**

Three Phase Load Balance [SP 87]
Default Value: 0% (Disabled)

This sets the percent difference threshold for the phase currents, used to indicate a load imbalance. If any phase current is different than another phase current by the percentage set in SP 87, then a “Load Imbalance” is indicated.

FIND IN CONTROL PANEL

THREE PHASE LOAD BALANCE [SP87]
Category: Control - Zone 1 > Alarm Setup



5.7 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.

5.7.1 Setting Using Control Panel Software

To enable Tap Change indication set the High/Low Out % Alarm Display Text (SP 3410) selection to “Tap Change Up/Down.” Each active Zone has parameters for the High/Low thresholds. To set the High/Low thresholds, set parameters Tap Change Up Threshold (SP 3402, 3404, 3406, 3408) and Tap Change Down Threshold (SP 3403, 3405, 3407, 3409), also referred to as Output High/Low Alarm Threshold for each zone, as described in Section 6.2.7.

When enabling the Tap Change indicator there are a few visual changes to the Control Panel:

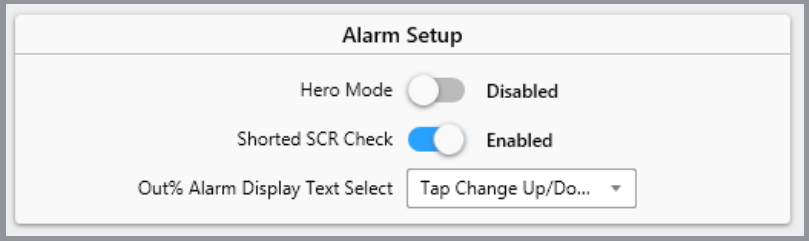
1. Warning alarm text is changed from Out% High/Low change to Tap Change Up/Down.
2. Output High/Low Alarm Threshold parameter title changed to Tap Change Up/Down Threshold.
3. Relay Alarm text changed from Output% High/Low change to Tap Change Up/Down.

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

Setting	Description
Out% High/Low [Default]	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 = “TAP CHANGE UP” and Low = “TAP CHANGE DOWN”

FIND IN CONTROL PANEL

SP 3410
Category: Control - System > Alarm Setup



6. TROUBLESHOOTING

If a problem is thought to exist, first look at the LEDs and the Display on the lid of the controller. Start with the following order:

1. INPUT PWR LED (green)
2. LINE LED (green)
3. STATUS LED (multi-color)
4. Display (backlight)
5. Display (Alarm message)

Problem: INPUT PWR LED is not on

Possible causes:

- Improper connections / wiring issue
- Universal Input Power has not been turned on
- The Universal Input Power is outside of the operating voltage
- The fuse for the Universal Input Power has opened

Things to do:

- Check the wiring from the source to the controller.
- With a multimeter check the voltage at the source and at the controller. Verify that the voltage is within the operating range (100 – 240 Vac)
- Check accessible fuses. If the internal fuse is believed to have opened, contact Control Concepts for further assistance.

Problem: LINE LED is not on

Possible causes:

- Improper connections / wiring issue
- Line fuse has opened
- Line voltage has not been supplied
- Line voltage is outside of the operating voltage
- Line Reference has not been connected (Select models require a line reference)

Things to do:

- Check the wiring from the source to the controller.
- Verify all terminal connections are tightened on the wire and not on the wire insulation.
- Check accessible fuses.
- With a multimeter check the voltage at the source and at the controller. Verify that the voltage is within the operating range (24 – 600 Vac)

Problem: STATUS LED is not on

Possible causes:

- The controller in not in a “Run State”

Things to do:

- Place the controller into a “Run State” with the P1 connector (pins 7 & 9).
- If this does not work, connect the controller to the Control Panel software and check to see if the P1 connector is wired correctly. Look for the Command I/O section in the Dashboard. Check to see the status of the Run/Reset pin: Run/Stop Closed (P1 connector pins 7 & 9 are closed) and Run/Stop Open (P1 connector pins 7 & 9 are open)

Problem: STATUS LED is green / no output

Possible causes:

- No command signal
- Open Load
- Load is not connected

Things to do:

- Check that the P1 connector is wired correctly. Connect the controller to the Control Panel software. Look for the Command I/O section in the Dashboard.
- Check to see what type of setpoint is selected: Analog Set Pt (P1 connector pins 7 & 8 are open) and Digital Set Pt (P1 connector pins 7 & 8 are closed)
- Check to see what which setpoint is selected: Set Point 1 (P1 connector pins 7 & 10 are open) and Set Point 2 (P1 connector pins 7 & 10 are closed)
- Check the wiring from the controller to the load. When applicable check with wiring from the load to the return source.

Problem: STATUS LED is Red or is flashing Orange

Possible causes:

- Alarm is preset

Things to do:

- Check display for what alarm is present.

Problem: Display will not turn on

- Possible causes:
- Display wiring
- Internal fuse

Things to do:

- Check the wiring at the display and at the controller to make sure that the connector is properly seated.
- With a multimeter check the voltage on the P1 connector (pin 1 to pin 6). This should read 5 Vdc +/-0.5 Vdc. Contact Control Concepts for further assistance.

6.1 Processor and Fault Resets

Fault Resets

- Toggle the Run/Reset pin on the P1 controller
- Disable, then re-enable the Digital System command

Processor Resets*

- Using the Control Panel software, press the Processor Reset button
- Cycle the controller power
- Processor Reset Key Sequence
  1. Press and hold the Up and Down arrow keys for three seconds.
  2. Press enter when the "**SYSTEM RESET**" message displays.
  3. If the Arrow keys are released, the controller returns to normal operation.
  4. When the Enter key is preseed, Line 2 changes to "Release Key."
  5. When all keys are released, the Processor resets.

*Processor resets also clear faults.

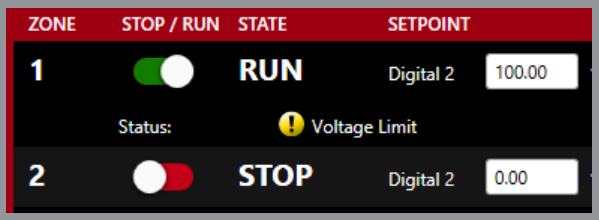
The following table indicates which inhibit alarms require fault resets. Warning alarms never require resets.

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

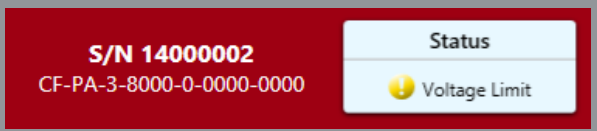
FIND IN CONTROL PANEL

WARNING ALARMS
Device Dashboard

For a multi-zone FUSION, warning alarms appear below each zone in the dashboard table.



For a single-zone FUSION, warning alarms appear in the Status section of the dashboard.



6.2 Warning Alarms

During a warning alarm the STATUS LED will be flashing orange. For all controllers, when a warning alarm is present it is displayed on the display. For multi-zone controllers, to determine which zone has the alarm present, connect to the Control Panel software.

The Warning Alarms may be mapped to Relay 1 and/or Relay 2. Refer to section 7.1, "Alarm Relays," for instructions to setup the relays. See the Installation and Maintenance Manual for relay wiring details.

6.2.1 Voltage Limit

* WARNING ALARM *
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.

6.2.2 Current Limit

* WARNING ALARM *
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.

6.2.3 Power Limit

* WARNING ALARM *
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.

6.2.4 Heat Sink Temp

* WARNING ALARM *
HEAT SINK TEMP

A 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.

6.2.5 Shorted SCR

* WARNING ALARM *
SHORTED SCR

The controller is detecting a shorted SCR.

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

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

	Phase Rotation 123			Phase Rotation 321		
	Zone			Zone		
Type of firing mode	A	B	C	A	B	C
Zero Cross	Yes	No	Yes	No	Yes	Yes
Zero Cross Burst	Yes	No	No	No	Yes	No

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

6.2.6 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 the load is capable of.

* WARNING ALARM *
LOW OUTPUT

6.2.7 Output % Low / Output % High

Each active zone for the Fusion controller has a parameter to set the threshold for the Output % High alarm and a parameter to set the threshold for the Output % Low alarm. The Output % Low alarm occurs when the Fusion zone's output % is at a value lower than the threshold set using the "Output% Low Alarm Threshold" parameter [SP 3402, 3404, 3406, 3408]. 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, 3405, 3407, 3409].

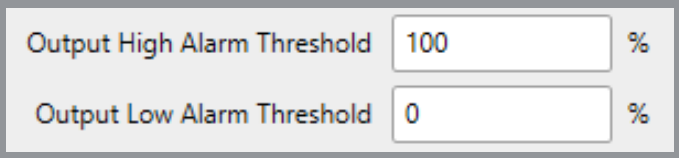
When using the "Tap Change" functionality as described in section 5.7, these alarms change to "Tap Change Up" and "Tap Change Down."

Output% High Alarm Threshold [SP 3402, 3404, 3406, 3408]
Default value: 100%
Sets a threshold in % so that when the controller output % is above this value it will indicate a HIGH OUTPUT % Alarm or TAP CHANGE ALARM Alarm.

Output% Low Alarm Threshold [SP 3403, 3405, 3407, 3409]
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: Control - Zone X > Alarm Setup



FIND IN CONTROL PANEL

INHIBIT ALARMS
Active inhibit alarms are displayed with a red icon in the "Status" section of the device dashboard

6.3 Inhibit Alarms

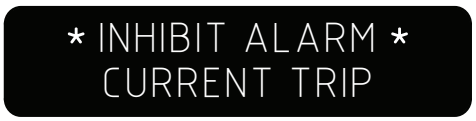
During an inhibit alarm the STATUS LED will be RED. The display will indicate the alarm that is present. The Status LED will also be red.

Reason: The controller is not registering any line voltage. This could mean the line voltage is too low or not present. The Inhibit alarms can be mapped to Relay 1 and/or 2. This is done through the Control Panel Software. See the Installation & Maintenance Manual for more details.

6.3.1 AC Line Sync PLL

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

6.3.2 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: The Run/Reset jumper on P1 (pins 7 & 9). This depends on the run logic selected (Open for Run / Closed for Run). The default is Closed for Run. For this case the Run/Reset jumper has to be opened than closed again.
2. With software: Un-check and check the zone digital “Enable” button. This will be the preferred method when multiple zones are present and only one zone exhibited a Current trip.

6.3.3 Line Loss

An AC line connection has been lost.

6.3.4 Heat Sink Temp

A heat sink 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.

6.3.5 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 universal input power and reapply it. If any of these warnings continue to appear, contact factory.

6.4 Heatsink Warning/Inhibit Alarm Temperatures

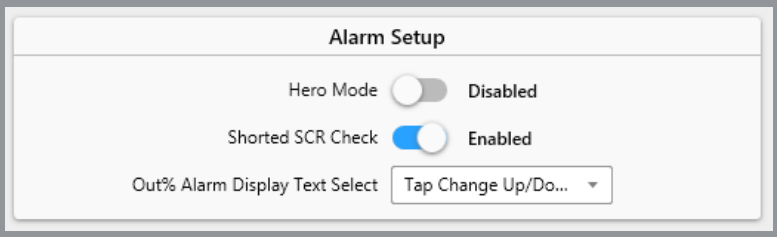
1Ø OR 3Ø AC	1Ø DC	3Ø DC	Warning (°C)	Inhibit (°C)
50A	45A DC	60A DC	95	100
80A	-	-	95	100
100A	90A DC	120A DC	93.8	98.8
130A	-	-	95	100
160A	145A DC	195A DC	95	100
200A	-	-	82.2	87.2
240A	220A DC	290A DC	82.2	87.2
320A	-	-	95	100
400A	360A DC	490A DC	91	96
500A	-	-	95	100
650A	-	-	95	100
800A	720 A DC	975A DC	92.2	97.2
1000A	-	-	95	100
1200A	1080A DC	1400A DC	87.6	92.6

6.4.1 Hero Mode

Note: Controller warranty is voided 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.

FIND IN CONTROL PANEL

HERO MODE [SP84]
Cateogry: Control - System > Alarm Setup



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 is designed in for customers that need to keep their process in operation, even if it may damage the SCR power controller.

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 front lid of the controller will flash orange. The over-temp indications will clear when the temperature drops below the over-temp limit threshold.

6.5 Additional Statuses

The controller has many other statuses to assist with troubleshooting. These statuses appear in the “Diagnostics” category in the Control Panel software. A status will only appear when it is active.

6.5.1 AC Line Status [MP 342]

				Status Color:	
				(Red)	**(Green)**
Bit Definition:	Bit 7	=	ADC Timing	Not OK	OK
	6	=	Control Timing	Not OK	OK
	5	=	Phase Rotation	1-2-3 **(Blue)**	3-2-1
	4	=	Phase Rotation	TBD	OK
	3	=	Module D Line	Absent	Present
	2	=	Module C Line	Absent	Present
	1	=	Module B Line	Absent	Present
	Bit 0	=	Module A Line	Absent	Present

Module A Line [MP 342 bit 0] Present / Absent

Indicates if the AC line is present on module A.

Module B Line [MP 342 bit 1] Present / Absent

Indicates if the AC line is present on module B.

Module C Line [MP 342 bit 2] Present / Absent

Indicates if the AC line is present on module C.

Module D Line [MP 342 bit 3] Present / Absent

Indicates if the AC line is present on module D.

Phase Rotation [MP 342 bit 4] TBD / OK

Indicates if the phase rotation has been determined.

Phase Rotation [MP 342 bit 5] 1-2-3 / 3-2-1

Indicates the phase rotation.

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.

6.5.2 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	Not Protected	Protected
	11 =	User SP Backup	Fail	OK
	10 =	DC Current Backup	Fail	OK
	9 =	DC Current Comp Table	Fail	OK
	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 =	Initialized	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 / Init Required [MP 336 bit 1]

The EEPROM has been initialized.

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.

DC Current Comp Table [MP 336 bit 9] OK/Fail

Status of the DC current compensation table.

DC Current Backup [MP 336 bit 10] OK/Fail

Status of the backup DC current compensation table.

User SP Backup [MP 336 bit 11] OK/Fail

Status of the backup user setup parameter table.

EE Write Protected / EE Not Write Protected [MP 336 bit 12]

The status of the EEPROM write protection.

EE SP Def / EE SP Def Update Req [MP 336 bit 13]

The status of the setup parameter definition table.

6.5.3 Misc Status [MP 335]

Compatible CPLD Present – Incompatible CPLD Present [MP 335 bit 1]
Not Waiting on Enter Key – Waiting on Enter Key [MP 335 bit 3]

6.5.4 Module A EEProm Status [MP 337]

				Status Color: (Red)	(Green)
Bit Definition:	Bit	7	= EE Write Protected	Not Protected	Protected
		6	= TBD		
		5	= Main EE Cal Backup	Fail	OK
		4	= Repair Record Table	Fail	OK
		3	= Cal Table	Fail	OK
		2	= MFG Table	Fail	OK
		1	= Initialized	Init Required	Initialized
	Bit	0	= Read/Write	Fail	OK

Read/Write [MP 337 bit 0] OK/Fail

During power up, checks to see if the EEPROM is functional.

Initialized / Init Required [MP 337 bit 1]

The EEPROM has been initialized.

MFG Table [MP 337 bit 2] OK/Fail

Status of manufacturing data table.

Cal Table [MP 337 bit 3] OK/Fail

Status of the calibration data table.

Repair Record Table [MP 337 bit 4] OK/Fail

Status of the repair record table.

Main EE Cal Backup [MP 337 bit 5] OK/Fail

Status of the backup calibration data table.

EE Write Protected / EE Not Write Protected [MP 337 bit 7]

The status of the EEPROM write protection.

6.5.5 Module B EEProm Status [MP 338]

				Status Color: (Red)	(Green)
Bit Definition:	Bit 7	=	EE Write Protected	Not Protected	Protected
	6	=	TBD		
	5	=	Main EE Cal Backup	Fail	OK
	4	=	Repair Record Table	Fail	OK
	3	=	Cal Table	Fail	OK
	2	=	MFG Table	Fail	OK
	1	=	Initialized	Init Required	Initialized
	Bit 0	=	Read/Write	Fail	OK

Read/Write [MP 338 bit 0] OK/Fail

During power up, checks to see if the EEPROM is functional.

Initialized / Init Required [MP 338 bit 1]

The EEPROM has been initialized.

MFG Table [MP 338 bit 2] OK/Fail

Status of manufacturing data table.

Cal Table [MP 338 bit 3] OK/Fail

Status of the calibration data table.

Repair Record Table [MP 338 bit 4] OK/Fail

Status of the repair record table.

Main EE Cal Backup [MP 338 bit 5] OK/Fail

Status of the backup calibration data table.

EE Write Protected / EE Not Write Protected [MP 338 bit 7]

The status of the EEPROM write protection.

6.5.6 Module C EEProm Status [MP 339]

				Status Color: (Red)	(Green)
Bit Definition:	Bit	7	= EE Write Protected	Not Protected	Protected
		6	= TBD		
		5	= Main EE Cal Backup	Fail	OK
		4	= Repair Record Table	Fail	OK
		3	= Cal Table	Fail	OK
		2	= MFG Table	Fail	OK
		1	= Initialized	Init Required	Initialized
	Bit	0	= Read/Write	Fail	OK

Read/Write [MP 339 bit 0] OK/Fail

During power up, checks to see if the EEPROM is functional.

Initialized / Init Required [MP 339 bit 1]

The EEPROM has been initialized.

MFG Table [MP 339 bit 2] OK/Fail

Status of manufacturing data table.

Cal Table [MP 339 bit 3] OK/Fail

Status of the calibration data table.

Repair Record Table [MP 339 bit 4] OK/Fail

Status of the repair record table.

Main EE Cal Backup [MP 339 bit 5] OK/Fail

Status of the backup calibration data table.

EE Write Protected / EE Not Write Protected [MP 339 bit 7]

The status of the EEPROM write protection.

6.5.7 Module D EEProm Status [MP 340]

				Status Color: (Red)	(Green)
Bit Definition:	Bit	7	= EE Write Protected	Not Protected	Protected
		6	= TBD		
		5	= Main EE Cal Backup	Fail	OK
		4	= Repair Record Table	Fail	OK
		3	= Cal Table	Fail	OK
		2	= MFG Table	Fail	OK
		1	= Initialized	Init Required	Initialized
	Bit	0	= Read/Write	Fail	OK

Read/Write [MP 340 bit 0] OK/Fail

During power up, checks to see if the EEPROM is functional.

Initialized / Init Required [MP 340 bit 1]

The EEPROM has been initialized.

MFG Table [MP 340 bit 2] OK/Fail

Status of manufacturing data table.

Cal Table [MP 340 bit 3] OK/Fail

Status of the calibration data table.

Repair Record Table [MP 340 bit 4] OK/Fail

Status of the repair record table.

Main EE Cal Backup [MP 340 bit 5] OK/Fail

Status of the backup calibration data table.

EE Write Protected / EE Not Write Protected [MP 340 bit 7]

The status of the EEPROM write protection.

6.5.8 Aux I/O EEProm Status [MP 341]

				Status Color: **(Red)**	**(Green)**
Bit Definition:	Bit 7	=	EE Write Protected	Not Protected	Protected
	6	=	TBD		
	5	=	Main EE Cal Backup	Fail	OK
	4	=	Repair Record Table	Fail	OK
	3	=	Cal Table	Fail	OK
	2	=	MFG Table	Fail	OK
	1	=	Initialized	Init Required	Initialized
	Bit 0	=	Read/Write	Fail	OK

Read/Write [MP 341 bit 0] OK/Fail

During power up, checks to see if the EEPROM is functional.

Initialized / Init Required [MP 341 bit 1]

The EEPROM has been initialized.

MFG Table [MP 341 bit 2] OK/Fail

Status of manufacturing data table.

Cal Table [MP 341 bit 3] OK/Fail

Status of the calibration data table.

Repair Record Table [MP 341 bit 4] OK/Fail

Status of the repair record table.

Main EE Cal Backup [MP 341 bit 5] OK/Fail

Status of the backup calibration data table.

EE Write Protected / EE Not Write Protected [MP 341 bit 7]

The status of the EEPROM write protection.

6.6 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 manual for more information on the controller data trace and scope features.

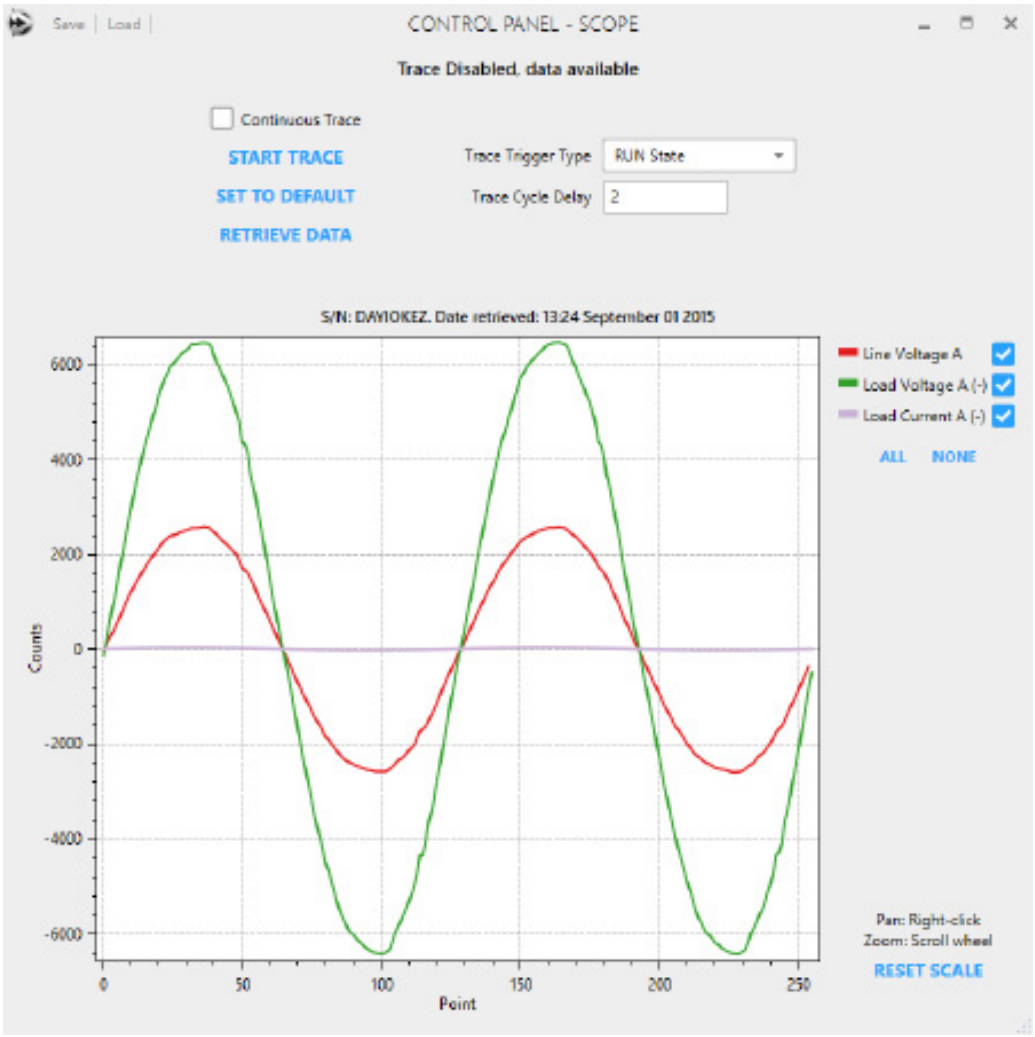


Figure 6.00 Use the Scope window in Control Panel to view the controller's line voltage, load voltage, and load current signals.

6.7 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 manual for more information.

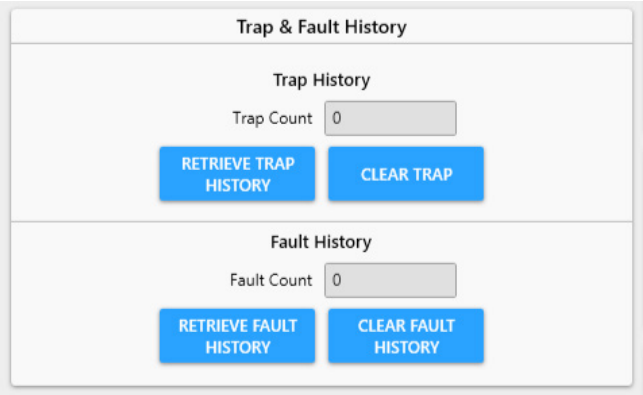


Figure 6.01. Retrieve controller event information using Control Panel

7. I/O

7.1 Alarm Relay

There are two relays available on the Fusion controller. For each relay, a Relay Alarm Mask parameter [SP 16, 17, 36, 37, 56, 57, 76, 77] exists for each active zone. For example, if the controller has only one zone, SP 16 will be used for Relay 1 and SP 17 will be used for Relay 2, and the other Relay Alarm mask parameters will have no effect. Each relay also has a System Relay Mask parameter [SP 85, 86]. All alarms mapped to the relay are OR'ed together to determine the relay state--if one or more alarms are active, the relay will be energized.

The Relay Alarm Mask maps any or all of the following:

Name	Description
Output % Low / Tap Change Down	When the Output % Low warning alarm is active, the relay will energize.
Out High / Tap Change Up	When the Output % High warning alarm is active, the relay will energize.
Deviation	When the Deviation warning alarm is active, the relay will energize.
Low Output	When the Low Output warning alarm is active, the relay will energize.
Load Imbalance	If the Three Phase Load Balance (SP 87) has been enabled, and a load imbalance has been detected, the relay will energize.
Digital Enable	If the bit for the Digital System Command (SP 129) is set to run, the relay will energize.
Voltage Limit	If Voltage Limit is present the relay will energize.
Current Limit	If Current Limit is present the relay will energize.
Power Limit	If Power Limit is present the relay will energize.
Shorted SCR	If a Shorted SCR is present the relay will energize.
Line Phase Loss	If a phase loss is detected the relay will energize.
Heatsink Warning Temp	If the heatsink temperature reaches within 5°C of the over-temperature alarm the relay will energize.
Current Trip	If a Current Trip occurs the relay will energize. This will keep the relay energized until the fault condition is reset. See section 3 on resetting the fault condition.
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. However, the controller will remain in a fault state.

The System Relay Alarm Mask maps any or all of the following:

Name	Description
Processor Error Trap	These are rare types of errors where the controller will not be functioning. Errors that are included are: flash program error, stack over flow error, math error, address error, and DMA conflict. To clear these errors follow the message(s) on the display, or connect to Control Panel software. For further assistance contact Control Concepts, Inc.
Communications Error	A communication problem when using digital communications only.
Memory Error1	EEPROM check failure (MP 210 bit 6). See the Diagnostics 2 tab for errors.
Watchdog Timeout1	Specific processor error trap (MP 210 bit 7).
PLL Lock Loss	Phase Locked Loop lost its lock on the AC line (MP 210 bit 2).
In “Run” State	When the Controller State (MP 248) is in Run.
Run Enable	The Run/Stop switch is set to the run position on the P1 Connector.

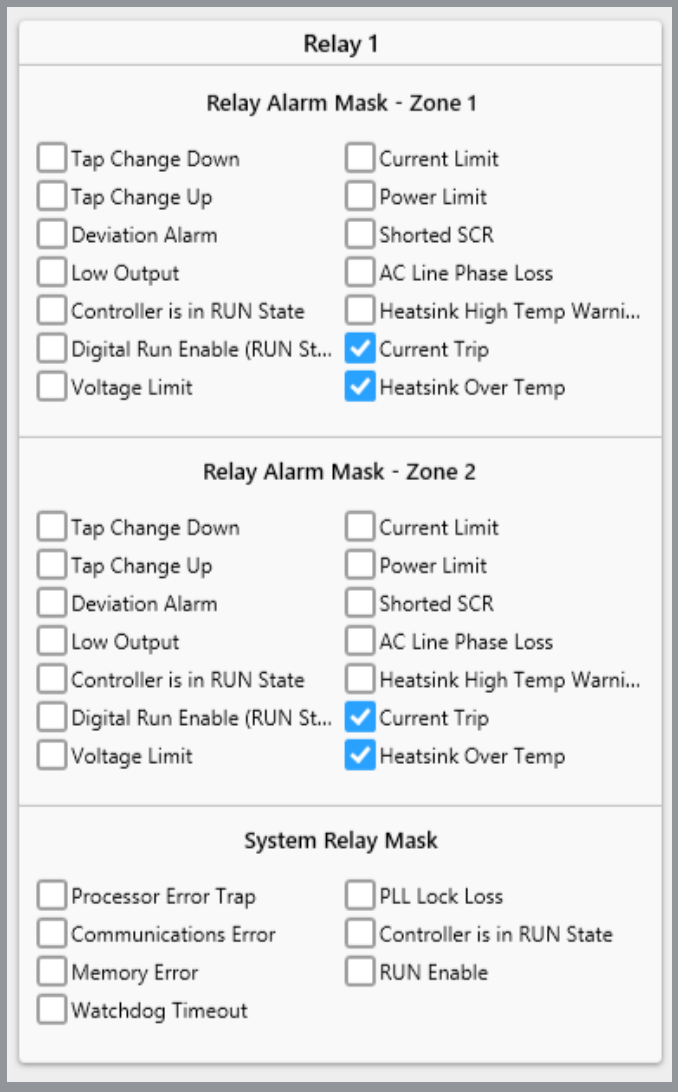
In Control Panel, select the check box next to the alarm/function that you wish to energize the relay if the alarm condition is met. Any number of conditions may be mapped to the relay.

Refer to the Fusion Installation and Maintenance manual for information on relay ratings and wiring.

FIND IN CONTROL PANEL

ALARM RELAY PARAMETERS
Category: Alarm Relays > Relay X

Each relay has options for each active zone and the system.



7.2 Analog Inputs

Compact FUSION analog inputs can be used as the control setpoint or used as an external feedback source. Refer to section 5.5.2, “Analog Setpoints,” for how to enable the analog input for use a setpoint or external feedback source.

7.2.2 Analog Setpoints

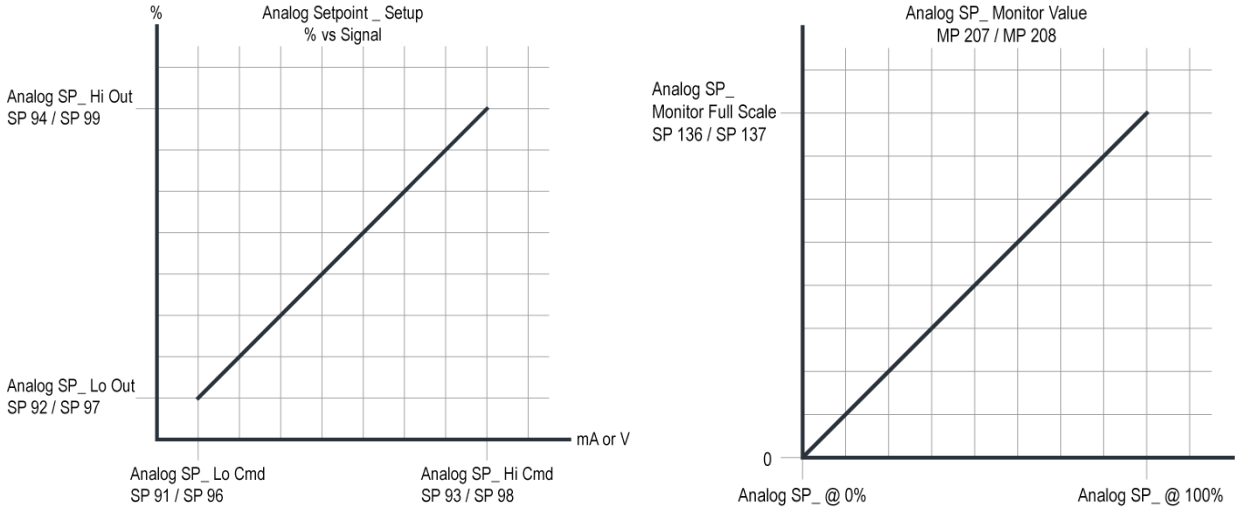


FIGURE 7.00

This is a graphical representation of how the Analog Setpoints and the Monitor Values are configured.

Analog SP1 Type [SP 90]

Setting	Description
Voltage	Voltage input scalable from 0 – 10 Vdc
Current [Default]	Current input scalable from 0 – 20 mA (default 4-20mA)

This 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 SP1 Function [SP 88]

Setting	Description
Normal [Default]	Uses the Analog Setpoint 1 to control the Set Point Reference (MP 250).
Reserved	To Be Determined
Monitor	Uses the Analog Setpoint 1 as a monitor variable that can be scaled for monitoring purposes.

Under *Normal* operation, the setpoint is used for control. When *Monitor* is chosen it can be scaled with a full scale parameter (SP 136). The monitor value is then viewed with parameter (MP 208). When using the Monitor setting the controller will not use Analog Setpoint for control.

Analog SetPt 1 Signal [MP 204]
This gives the value of the setpoint signal.

Analog SP1 Lo Cmd [SP 91]
Default value: **4.00** mA

This is paired with Analog SP1 Lo Out (SP 92). This parameter is the signal value at the percent displayed in (SP 92). This is typically your lowest possible signal value that can be achieved.

Analog SP1 Lo Out [SP 92]
Default value: **0.00** %

This is paired with Analog SP1 Lo Cmd (SP 91). This parameter is the percentage at the signal value displayed in (SP 91).

Analog SP1 Hi Cmd [SP 93]
Default value: **20.00** mA

This is paired with Analog SP1 Hi Out (SP 94). This parameter is the signal value at the percent displayed in (SP 94). This is typically the highest possible signal value that can be achieved.

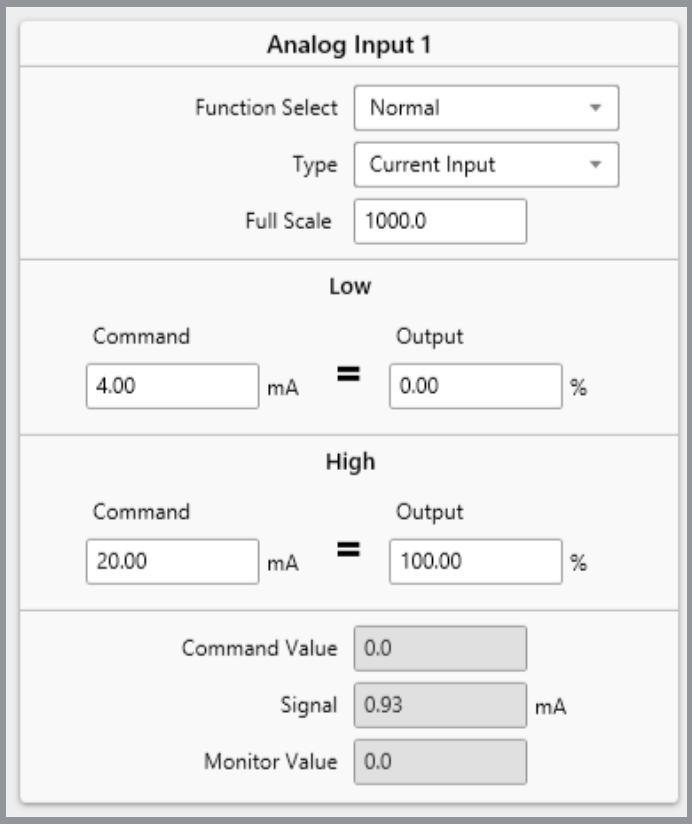
Analog SP1 Hi Out [SP 94]
Default value: **100.00** %

This is paired with Analog SP1 Hi Cmd (SP 93). This parameter is the percentage at the signal value displayed in (SP 93).

FIND IN CONTROL PANEL

ANALOG INPUT PARAMETERS
Category: Analog Inputs > Analog Input X

The parameters for each analog input appear in a group as pictured.



Analog SP1 Monitor Full Scale [SP 136]
Default value: **1000**

This is 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 SP1 Monitor Value [MP 208]
The Analog Setpoint 1 monitor value that is calculated from the analog input signal and scaled by the full scale setting (SP 136).

Analog SP2 Type [SP 95]

Setting	Description
Voltage [Default]	Voltage input scalable from 0 – 10 Vdc (default 0 – 5 Vdc)
Current	Current input scalable from 0 – 20 mA

This 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 SP2 Function [SP 89]

Setting	Description
Normal [Default]	Uses Analog Setpoint 2 to control the Set Point Reference (MP 250).
External CT for Leg C	Use to monitor the third leg current when using a three phase 2 leg controller.
Monitor	Uses Analog Setpoint 2 as a monitor variable that can be scaled for monitoring purposes.

Under *Normal* operation, the setpoint is used for control. When using the *External CT for Leg C* an external current transducer will be measuring the current on the third leg of a three phase 2 leg controller. The scaling for the high and low commands are determined by the ratio of the current transducer with the full scale current (SP 9). When *Monitor* is chosen it can be scaled with a full scale parameter (SP 137). The monitor value is then viewed with parameter (MP 209). When using the Monitor setting the controller will not use Analog Setpoint for control.

Analog SetPt 2 Signal [MP 207]

This gives the value of the setpoint signal.

Analog SP2 Lo Cmd [SP 96]

Default value: **0.00** V

This is paired with Analog SP2 Lo Out (SP 97). This parameter is the signal value at the percent displayed in (SP 97). This is typically your lowest possible signal value that can be achieved.

Analog SP2 Lo Out [SP 97]

Default value: **0.00** %

This is paired with Analog SP2 Lo Cmd (SP 96). This parameter is the percentage at the signal value displayed in (SP 96).

Analog SP2 Hi Cmd [SP 98]
Default value: **5.00** V

This is paired with Analog SP2 Hi Out (SP 99). This parameter is the signal value at the percent displayed in (SP 99). This is typically your highest possible signal value that can be achieved.

Analog SP2 Hi Out [SP 99]
Default value: **100.00** %

This is paired with Analog SP2 Hi Cmd (SP 98). This parameter is the percentage at the signal value displayed in (SP 98).

Analog SP2 Monitor Full Scale [SP 137]
Default value: **1000**

This is 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.

Analog SP2 Monitor Value [MP 209]
The Analog Setpoint 2 monitor value that is calculated from the analog input signal and scaled by the full scale setting (SP 137).

7.3 Analog Outputs (Retransmits)

The outputs 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).

Meter 1 Signal [SP 141] / Meter 2 Signal [SP 148]
Figure 7.01 is a picture of a 4 zone Compact FUSION to help determine the proper *Setting* to use.

A three phase controller would only have Modules A, B and C. A multizone single phase would use Module A for Zone 1, Module B for Zone 2, and so on. The Module letters also represent values that can be seen in the Dashboard section of this manual.

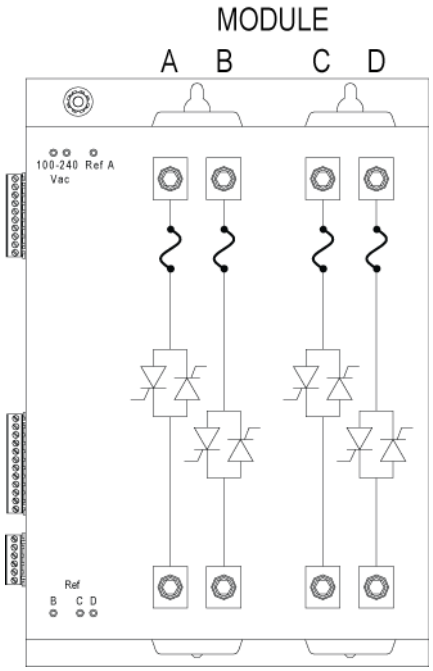


Figure 7.01

Setting	Description
RMS Load Voltage A [Meter 1 Default]	The load voltage for module A
AVG Load Voltage A	The load voltage for module A
RMS Load Current A [Meter 2 Default]	The load current for module A
AVG Load Current A	The load current for module A
Load Power A	The load power for module A
RMS Load Voltage B	The load voltage for module B
AVG Load Voltage B	The load voltage for module B
RMS Load Current B	The load current for module B
AVG Load Current B	The load current for module B
Load Power B	The load power for module B
RMS Load Voltage C	The load voltage for module C
AVG Load Voltage C	The load voltage for module C
RMS Load Current C	The load current for module C
AVG Load Current C	The load current for module C
Load Power C	The load power for module C
RMS Load Voltage D	The load voltage for module D
AVG Load Voltage D	The load voltage for module D
RMS Load Current D	The load current for module D
AVG Load Current D	The load current for module D
Load Power D	The load power for module D
Load Voltage	The controllers load voltage (For single phase only)
Load Current	The controllers load current (For single phase only)
Load Power	The controllers load power
Direct Out	Use Meter 1 Out Direct (SP 146) / Meter 2 Out Direct (SP 153) to set the value of the output.

7.4 Aux Digital I/O

Digital Input 1 FX [SP 154]

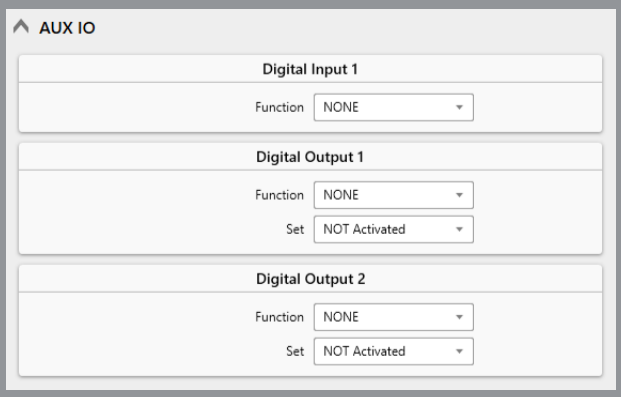
Setting	Description
None [Default]	Digital IN 1 (P3 pin 2 & 4) has no function
Open Closed Loop	Switch Closed = Open Loop Switch Open = Closed Loop

This is for a single zone controller only. When set to Open Closed Loop it will override Control Loop (SP 3). The Digital IN 1 (P3 pin 2 & 4) will work as follows:

- When closed the controller will be in Open Loop mode.
- When open the controller will be in Closed Loop mode.

FIND IN CONTROL PANEL

AUX DIGITAL I/O PARAMETERS
Category: Aux I/O



Digital Out 1 FX [SP 156] / Digital Out 2 FX [SP 157]

Setting	Description
None [Default]	Digital OUT 1 (P3 pin 5) has no function – low output Digital OUT 2 (P3 pin 6) has no function – low output
Direct Out	Sets output according to Digital Out 1 (SP 158) / Digital Out 2 (SP 159)
Voltage Limit	Sets output high if controller is in Voltage Limit
Current Limit	Sets output high if controller is in Current Limit
Power Limit	Sets output high if controller is in Power Limit
Controller Ready	Sets output high if the controller is ready to output (may or may-not be in the Run state).
Controller Output ON	Sets output high if the controller is in a Run state (may or may-not be outputting).

Digital Out 1 Direct [SP 158] / Digital Out 2 Direct [SP 159]

Setting	Description
Low Inactive [Default]	Sets the output of Digital Out 1 (SP 156) / Digital Out 2 (SP 157) low
High Active	Sets the output of Digital Out 1 (SP 156) / Digital Out 2 (SP 157) high

APPENDIX A - SPECIFICATIONS

Line Power	
Line Voltage (auto ranging)	24 - 600 Vac (Nominal) +10% / -15% lower voltages available for special orders
Line Frequency (auto ranging)	45 - 65 Hz
Frame Current Ratings I Continuous RMS for AC	10, 25, 50, 80, 100, 125, 160
Minimum Hold/Latch Current	1 A RMS
SCR Rating (PIV)	1600 V peak forward & reverse
SCR Protection DV/DT	200 Volt / µSec dv/dt protection 1400 V MOV peak voltage protection
SCR Surge Current	Peak 1 cycle surge current is: 10 - 80 Amp rating - 1,750 A 100 - 160 Amp rating - 5,000 A
SCR I^2T Ratings	10 - 80 Amp rating - 15,000 A^2S 100 - 160 Amp rating - 125,000 A^2S
Fusing	Internal compliant with UL, CE or Local Authority
Thermal	Integrated heat sink thermal sensor
Current Limit	20% – 105% of continuous rating of Frame Amp Rating. Factory set to 105%
Current Trip	50% - 450% of continuous rating Factory set to 175% for phase angle Factory set to 350% for zero cross
Power Dissipation	1.3 Watt per amp of load current per phase
Wire Temperature Rating	75°C or higher

Universal Input Power	
Universal Input Power / Operate Internal Control	100 - 240 Vac 50/60 Hz
Power Consumption (max)	1.5 A / 240 V / 360 W

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

Enclosure Protective Rating	
International	IP 20
Removable Display	IP 65, UL Type 1 & 12

Environmental	
Air Operating Temperature	32°F [0°C] - 122°F [50°C] No derating up to 122°F [50°C] at rated current
Humidity	20% to 90% RH Non-Condensing
Rated Operating Altitude	Up to 6000 ft [1750m] at rated current
Contaminates	ROHS Compliant, CE Pollution Degree 2 * see below
Storage Temperature	- 4 to 176°F [- 20 to 80°C]

* Produces only non-conductive pollution

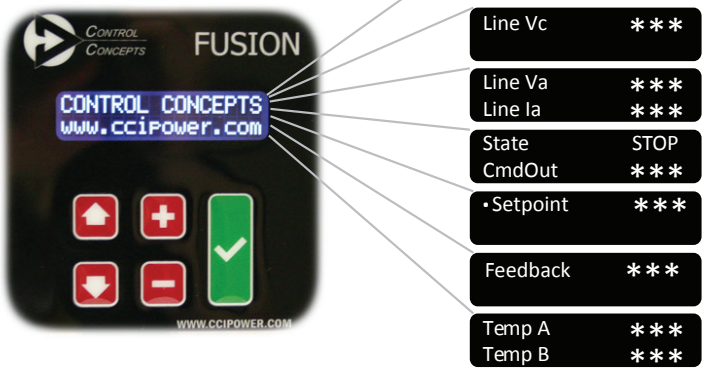
Isolation	
Signal to Line/Load	3750 Vac minimum
Line/Load to Ground	2500 Vac minimum
Signal to Ground	1500 Vac minimum
Line to Load	1400 Vac minimum
Network	1500 Vac minimum
USB	2500 Vac minimum
Signal to Processor	1500 Vac minimum
Remote Display	2500 Vac minimum

Short Circuit Current Rating
All controllers have a 100 KA short circuit current rating when installed in an enclosure, minimum 150% volume of controller size, with at least 2 latches in place.

Cooling	
10 - 25 Amp 1 Zone Single Phase 50 Amp	Natural Convection
50 - 125 Amp	Forced Air with 1 Fan Per Zone (PN 3100KL-05W-B60)
160 Amp	Forced Air with 2 Fans Per Zone (PN 3100KL-05W-B60) Forced Air across fuses with 1 Fan (PN2406KL-05W-B50)

APPENDIX B: REMOTE DISPLAY

After applying universal input power, the user can now edit parameters via the display or Control Panel Software.



Auto Scroll

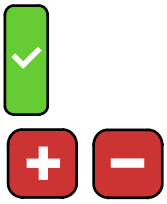
The 5 button display has an auto scroll and manual scroll display list. Pictured right are examples of how screens will appear. Auto Scroll can be enabled or disabled using the "Display Auto Scroll" parameter (SP 116).

Manual Scroll

The controller will automatically start in auto scroll mode. The screen will change every few seconds. Press the arrow keys to access the manual scroll display list.

The up and down buttons will also scroll through different screens . To return to auto scroll, press and hold either button for a minimum of two seconds. If the display idles for ten minutes in manual scroll, it will automatically return to auto scroll.

Changing Value



On setable parameters there will be a dot in front of the parameter name. To adjust the value, press the green button. The dot will change to an arrow. See examples, right. Press the Plus and Minus buttons to adjust the value up or down. After the desired value is reached, press the green button to accept the changes. The screen should appear as before with the adjusted value.

Screen Lists

NOTE

If the parameter entry is left unchanged, or the accept button is not pressed, within 20 seconds the parameter will abort and return to the original value.

Each controller is shipped with a customizable screen list that pertains to the hardware configuration of the controller. The default lists will show things such as line/load voltages, load currents and heatsink temperatures. If the controller is equipped with a communications card the default list will also show specific parameters pertaining to the communications settings.

The screen list can be customized by connecting to Control Panel software. Within the software any combination of screens can be programmed onto the screen (limit 50 screens). Refer to the Control Panel manual for details on customizing the display screen list.

Parameter Lock

A parameter lock can be setup to prevent anyone from changing parameter values using the display keypad. Refer to the Control Panel manual for details on locking parameters on the display.

APPENDIX C: MODEL NUMBER IDENTIFICATION

CF - □□ - □ - □□□□ - □ - □□□□ - □□□□

Type of Controller
- ZC - Zero Cross
- PA - Phase Angle

Number of Legs of Control
- 1 - 1 Leg
- 2 - 2 Leg (ZC only)
- 3 - 3 Leg

Module Amperage Selections

		Single Phase						Three Phase		
	# of Zones	1 Zone	1 Zone	2 Zones	2 Zones	3 Zones	4 Zones	1 Zone 2 Leg	1 Zone 2 Leg	1 Zone 3 Leg
	Lines Fused	L1	L1, L2	L1, L2	L1, L2, L3, L4	L1, L2, L3	L1, L2, L3, L4	L1, L2	L1, L2, L3	L1, L2, L3
Current Size	10 Amps	1000	1F00	1100	1F1F	1110	1111	1100	1F10	1110
	25 Amps	2000	2F00	2200	2F2F	2220	2222	2200	2F20	2220
	50 Amps	3000	3F00	3300	3F3F	3330	3333	3300	3F30	3330
	80 Amps	4000	4F00	4400	4F4F	4440	4444	4400	4F40	4440
	100 Amps	5000	5F00	5500	5F5F	5550	5555	5500	5F50	5550
	125 Amps	6000	6F00	6600	6F6F	6660	6666	6600	6F60	6660
	160 Amps	7000	7F00	7700	7F7F	7770	7777	7700	7F70	7770

NOTE: F = Pass-Through Fuse
Multi-Zone Note: When combining current sizes, the first two and last two numbers must be identical. (Examples: 3311, 6655) Higher numbers precede lower numbers.

Factory Industrial Communications*
- 0 - None
- I - Ethernet/IP
- E - Modbus TCP (Ethernet)
- N - PROFINET

Discontinued
- S - Modbus RTU (RS-485)
- P - PROFIBUS
- D - DeviceNet

*This is in addition to USB, which comes standard on all controllers.

Configuration Data (supplied by Control Concepts, Inc.)

Includes configuration data such as load configurations, firing modes, feedback, limits, setpoints, ramp rates, etc.
- 0000 - Standard
- 0001 - 3 Phase Controller with a Inside Delta Load
- 0002 - 3 Phase Controller with a 4 Wire Wye Load
- XXXX - Custom configuration data such as load configurations, firing modes, feedback, limits, setpoints ramp rates, etc., assigned by factory.

Option Card
- 0000 - No option card
- 1000 - Auxiliary I/O expansion card [Details found in Installation & Maintenance Manual]

Model Number	Controller Description
CF - PA - 1 - 7000 - 0 - 0000 - 1000	Single Phase, Phase Angle, 160 Amps, Aux I/O Card
CF - PA - 1 - 3330 - E - 0000 - 0000	(3x) Single Phase, Phase Angle, 50 Amps, Modbus TCP
CF - PA - 1 - 7F5F - 0 - 0000 - 0000	(2x) Single Phase, Phase Angle, 160 Amps with Pass-Through Fusing, 100 Amps with Pass-Through Fusing

Custom configurations are available. Contact factory with special requirements and for availability.
This may require a "-SP□□" to be appended to the model number which would be supplied by Control Concepts, Inc.

APPENDIX D: QUICK START GUIDE

1. Install the controller in desired location with appropriate keep out areas (see Installation & Maintenance Manual for more details).

Warning: Disconnect all high voltage before attempting to wire. Wire in accordance to local codes.

2. Make all necessary connections.
   a. Line
   b. Load
   c. Ref (single phase, three phase two leg and three phase three leg 4 wire wye controllers only)
   d. Ground
   e. Connect the Universal Input Power (100-240 Vac / 50 - 60 Hz)

3. Make communication connections.
   a. P1 - Command Connector
   b. P2 - Relay Connector (Optional)
   c. P3 - Auxiliary I/O Connector (Optional)

4. Apply Power
   a. Universal Input Power (100 - 240 Vac / 50 - 60 Hz)
   b. Line (24 - 600 Vac)

5. Place the controller in Run mode via pin 9 as shown in the Command Connectors section.

6. Check Indicator Status LEDs and Display.
   a. INPUT PWR - green when control power present
   b. LINE - green when line power present
   c. STATUS - green when operating
   d. Display - Alarms will display if present and status LED will be red or flashing orange

7. Apply command signal to adjust setpoint / output

If alarms are present, check connections and controller settings. Otherwise see Trouble Shooting section of this manual.