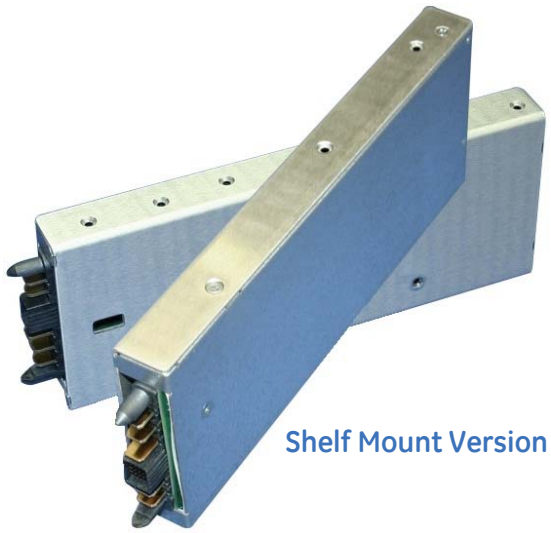
GE

Data Sheet

CCR0512FP Power Supply

90 - 264V_{ac} Input; 12V_{dc}, 500W Output



Shelf Mount Version

Stand Alone Version

Features

- Conduction cooling for fan less operation
- Compact 0.5U Profile
- Overall Dimensions:
  Shelf Mount Version: 0.877 in. x 3.35 in. x 8.790 in.
  Stand Alone Version: 0.888 in. x 4.392 in. x 10.40 in.
- 12V_{dc}, 500W Output
- 10.8 to 13.2V_{dc} Output Voltage Programmability
- Universal AC input with Active PFC
- Hot Pluggable (Shelf Mount Version)
- Redundant Parallel Operation
- Active Load Sharing (Single Wire)
- Analog, I²C or PMBus^ means of control and monitoring
- Remote On/Off
- Remote Sense (up to 0.25V of total compensation)
- No Minimum Load Requirements
- Three visual LED Indicators; Input, Output and Fault status
- 3.3V_{dc} 2A Standby Output
- UL*Recognized to UL60950-1, CAN/CSA† C22.2 No.60950-1, and EN60950-1(VDE‡ 0805-1) Licensed
- CE mark meets 2006/95/EC directive§
- ISO** 9001 and ISO 14001 certified manufacturing facility
- Compliant to RoHS EU Directive 2011/65/EU

Applications

- Test Equipment
- Network Support Equipment
- Storage Area Networks (SAN)
- Network Attached Storage (NAS)
- Servers

Description

The CCR0512FP power supply is a universal ac input, 12V_{dc}, 500W output fan-less conduction cooled, 0.5U thick product designed for environments, where conduction or system airflow is available for cooling. The 0.5U form factor makes locating the supply very flexible and space efficient. The supply includes capability for hot plug and redundant load sharing applications. Standard features include remote sense, output voltage programmability, active load sharing, status LEDs, 3.3V_{dc} standby output, and analog, I²C and PMBus control and communication interfaces.

^PMBus name and logo are registered trademarks of SMIF, Inc.
* *UL* is a registered trademark of Underwriters Laboratories, Inc.
† *CSA* is a registered trademark of Canadian Standards Association.
‡ *VDE* is a trademark of Verband Deutscher Elektrotechniker e.V
§ This product is intended for integration into end-user equipment. All of the required procedures of end-use equipment should be followed.
** ISO is a registered trademark of the International Organization of Standards

CCR0512FP Power Supply

90 - 264V_{ac} Input; 12V_{dc}, 500W Output

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage. These conditions are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the data sheet's specifications sections. Exposure to absolute maximum ratings for extended periods can adversely affect the device reliability.

Parameter	Min	Max	Unit
Input Voltage - Continuous	90	264	V_{ac}
Operating Ambient Temperature (see Thermal Considerations section) Operating Case Temperature (Cold Plate) (*See exceptions for spec variations between -10C to -20C)	-20* -20*	55 85	°C °C
Storage Temperature	-40	90	°C
Humidity (non-condensing)	30	95	%
Altitude		2250	m
Isolation Voltage – Input to Output Input to Chassis Output and Signal/Comm pin to Chassis		3000 1500 100	V_{ac} V_{dc} V_{dc}

Electrical Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions.

Parameter				
Input	**Min**	**Typ**	**Max**	**Unit**
Operating Voltage	90	115/230	264	V_{ac}
Source Frequency	47	50/60	63	Hz
Turn On Voltage (*Turn On Max may increase to 95 V_{ac} at -20C)	78	85	90*	V_{ac}
Turn Off Voltage (*Turn Off Max may increase to 90 V_{ac} at -20C)	73	80	85*	V_{ac}
Turn On/Turn Off Hysteresis	3	4		V_{ac}
Current, V_{IN} = 90V_{ac}			6.8	A_{RMS}
Fuse Rating, 250V_{ac}		15		A
Power Factor, 230V_{ac}, 100% Load		0.96		%
Inrush Transient Current, V_{IN} = 264V_{ac}, T_A = 25°C		50		A_{PEAK}
Efficiency: V_{IN} = 115V_{ac}, 20% load		87.0		%
50% load		90.0		%
100% load		89.0		%
V_{IN} = 230V_{ac}, 20% load		87.8		%
50% load		91.8		%
100% load		91.4		%
Holdup Time, V_{IN} = 90V_{ac} to 264V_{ac} 80% load, C_{OUT} = 2,200 µF, V_{OUT}≥ 10.8V_{dc}		12		ms
Leakage Current to earth ground, V_{IN} = 264V_{ac}			3.5	mA
Output 1 – Main Output	**Min**	**Typ**	**Max**	**Unit**
Voltage Set-point (50% load)	11.98	12.00	12.02	V_{dc}
Voltage Programming Limits	10.8		13.2	V_{dc}
Voltage Tolerance (due to set point, temperature, load, and line regulation)	-2		2	$\%V_{OUT, set}$
Load Regulation	-100		100	mV_{dc}
Line Regulation	-40		+40	mV_{dc}
Ripple and Noise (C_{OUT} = 0.1µF ceramic || with 10µF tantalum capacitor) Peak-to-peak (20MHz Bandwidth)			120	mV_{p-p}
Dynamic Load Response (50% to 100% load transient, 1A/µs slew rate) Voltage deviation Settling Time			5 1.5	$\%V_{OUT, set}$ ms
Current Range	0		42	A_{dc}
Current Limit Inception	110		135	$\%I_{O,max}$
Current Sharing Accuracy, >20% load	-5		5	$\%I_{O,max}$
External Capacitance Range	0		10,000	µF
Turn On Delay Time from AC Input (*Delay Time Max may increase to 3s at -20C)			2*	s
Turn On Delay Time from Remote On, V_{IN} within limits			40	ms
Rise Time (from 10% to 90% of final value)			50	ms
Voltage Overshoot			5	$\%V_{OUT, set}$
Turn Off Delay Time from Remote On, V_{IN} within limits			40	ms
Over Voltage Protection	13.8	14.8	15.8	V_{dc}

Electrical Specifications (continued)

Output 2 – Standby (V_{SB}) Output				
Parameter	**Min**	**Typ**	**Max**	**Unit**
Voltage Set-point (50% load) Model: CCR0512FPHXXZ01A [$V_{OUT,set}$]	3.23	3.3	3.37	V_{dc}
Voltage Tolerance (due to set point, temperature, load, and line regulation)	-5		5	$\%V_{OUT,set}$
Load Regulation	-0.17		+0.17	V_{dc}
Line Regulation	-0.17		+0.17	V_{dc}
Ripple and Noise (C_{OUT} = 0.1µF ceramic || with 10µF tantalum capacitor) Peak-to-peak (20MHz Bandwidth)			100	mV_{p-p}
Dynamic Load Response (50% to 100% load transient, 1A/µs slew rate) Voltage deviation Settling Time			 5 1.5	 $\%V_{OUT,set}$ ms
Current Range	0		2.0	A_{dc}
Current Limit Inception	110		150	$\%I_{O,max}$

General Specifications

Parameter	Symbol	Typ	Unit
Calculated Reliability based on Telcordia SR-332 Issue 2: Method 1 Case 3 (V_{IN}=230V_{ac}, I_{o1} = 42A, I_{o2} = 2.0A, T_A = 30ºC, airflow 200LFM, 90% confidence)	FIT MTBF	602.8 1,659,038	10^9/Hours Hours
Weight		825 29.1	g oz.

Feature Specification

Parameter	Min	Typ	Max	Unit
Remote On Signal, High turns supply on	2.0		12.0	V_{dc}
Remote Off Signal, Low turns supply off	0.0		0.8	V_{dc}
Maximum Remote On/Off Sink Current			4	mA
Output Current Monitoring Signal ±250mV		0.1		V/A

Environmental Specifications

Parameter	Specification
IPC-9592A	Category 1, Class II Product Classification
Radiated Emissions	FCC and CISPR22 (EN55022) Class A with 3dB margin
Conducted Emissions	FCC and CISPR22 (EN55022) Class A with 3dB margin
Shock & Vibration Operational Test	IPC-9592A, section 5.2.8- 5.2.13
Conducted Continuous Wave	IPC-9592A, section 5.3.1
Radiated Immunity	IPC-9592A, section 5.3.2
Conducted Electrical Fast Transient (EFT)	IPC-9592A, section 5.3.3
Conducted Surges	IPC-9592A, section 5.3.4
Ring Waves	IPC-9592A, section 5.3.5
Electrostatic Discharge –Packaged Power	IPC-9592A, section 5.3.6
Power Line Disturbance Immunity	IPC-9592A, section 5.3.8
Input Harmonics	EN61000-3-2

Safety Specifications

Parameter	Specification
Isolation Voltage Input to Output	3000V_{ac} (1 minute)
Isolation Voltage Input to Chassis	1500V_{dc}
Isolation Output/Signal GND to Chassis	100V_{dc}
Insulation Resistance Input to Output	>10MΩ
Safety Certifications	UL, CSA, VDE

Characteristic Curves

The following figures provide typical characteristics for the CCR0515FP (12.0V, 42.0A) at 25ºC (unless otherwise noted).

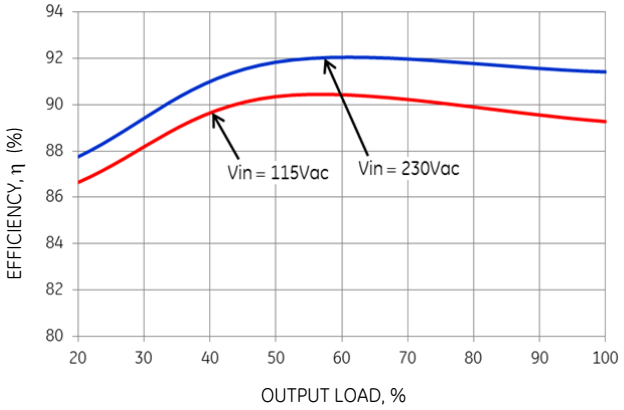


Figure 1. Converter Efficiency versus % Load.

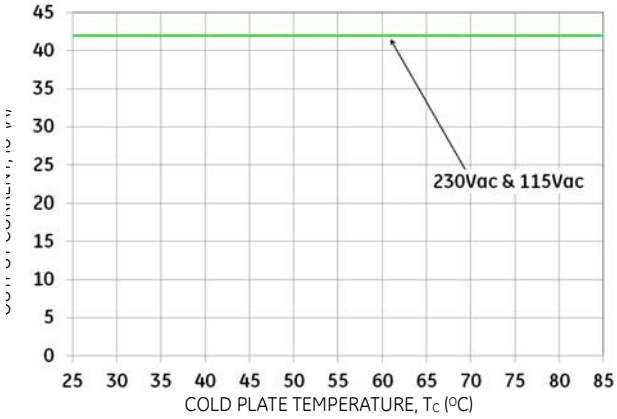


Figure 2. Output Power Derating in Conduction cooling (cold plate) applications; Ta <70ºC adjacent to module.

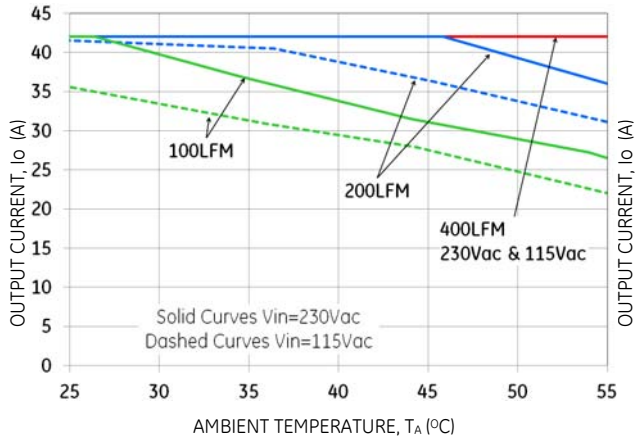


Figure 3. Derating Output Current versus Airflow and Ambient Temperature, 0.6" horizontal heat sink, front to back airflow. See Mechanical Figures for airflow direction.

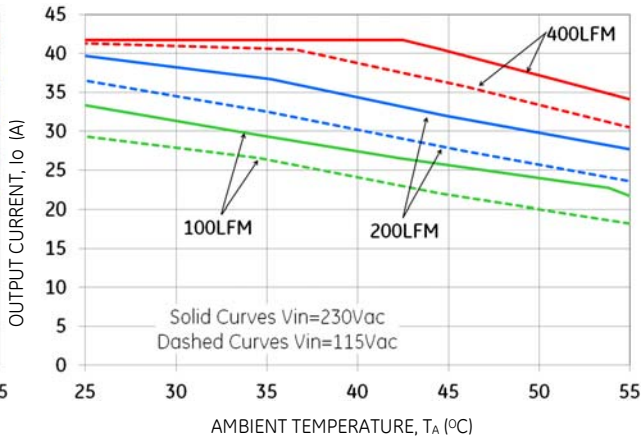


Figure 4. Derating Output Current versus Airflow and Ambient Temperature, no heat sink, front to back airflow. See Mechanical Figures for airflow direction.

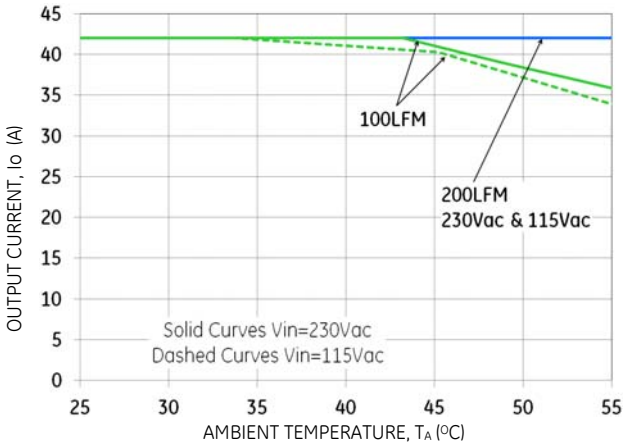


Figure 5. Derating Output Current versus Airflow and Ambient Temperature, 0.6" vertical heat sink, side to side airflow. See Mechanical Figures for airflow direction.

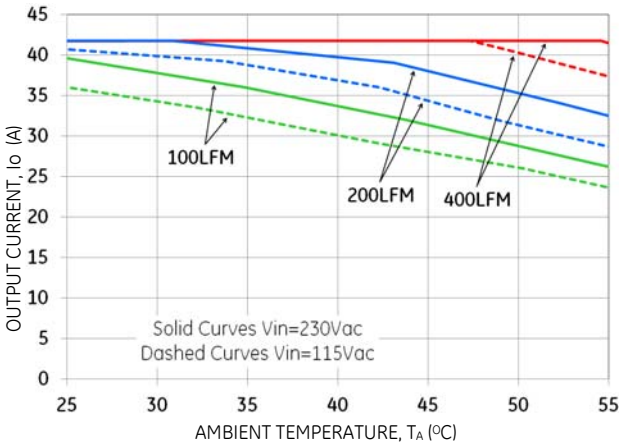


Figure 6. Derating Output Current versus Airflow and Ambient Temperature, no heat sink, side to side airflow. See Mechanical Figures for airflow direction.

Characteristic Curves (continued)

The following figures provide typical characteristics for the CCR0515FP (12.0V, 42.0A) at 25ºC (unless otherwise noted).

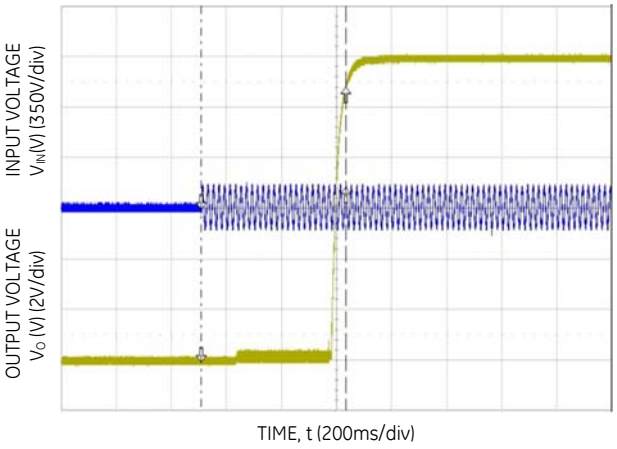


Figure 7. Start-up (V_{IN} = 90V, I_o = $I_{o,max}$).

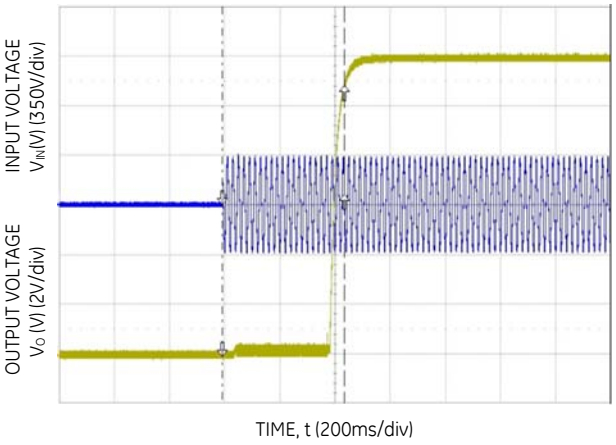


Figure 8. Start-up (V_{IN} = 264V, I_o = $I_{o,max}$).

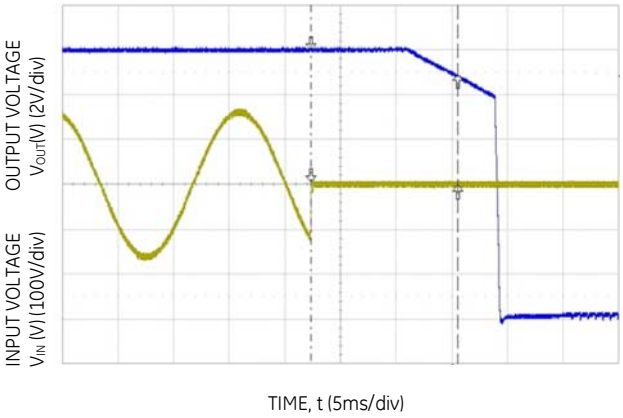


Figure 9. Hold-up (V_{IN} = 115V, I_o = 80% $I_{o,max}$).

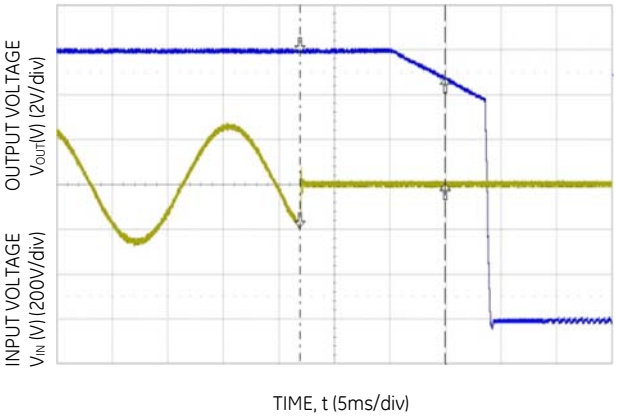


Figure 10. Hold-up (V_{IN} = 230V, I_o = 80% $I_{o,max}$).

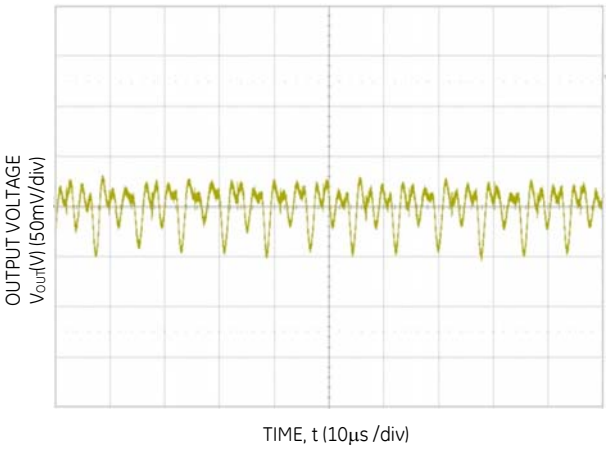


Figure 11. Output ripple and noise (C_O=22µF ceramic, V_{IN} = 230V, I_o = $I_{o,max}$,).

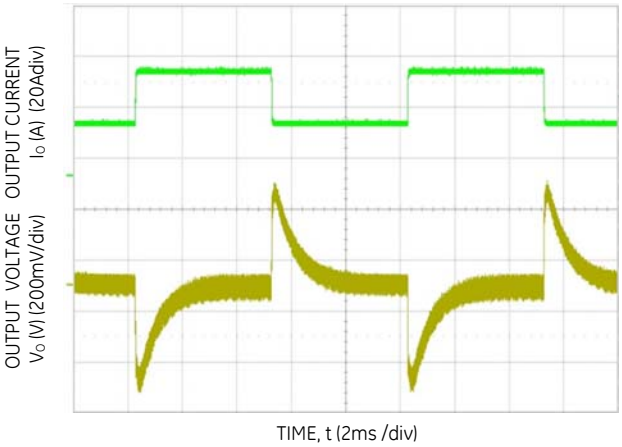


Figure 12. Transient Response to Dynamic Load Change from 50% to 100% $I_{o,max}$ at V_{IN} = 230V.

Safety Considerations

The CCR0512 power supply is intended for inclusion in other equipment and the user must ensure that it is in compliance with all the requirements of the end application.
This product is only for inclusion within other equipment and must not be operated as a stand-alone product.

Thermal Considerations

The power supply can be operated in a variety of thermal environments; however sufficient cooling should be provided to ensure reliable operation.

Considerations include ambient temperature, airflow, power supply dissipation and the need for increased reliability. A reduction in the operating temperature of the power supply will result in increased reliability. The thermal derating presented in Figures 2-6 is based on measurements taken in a wind tunnel.

Feature Descriptions

Standby Power Supply

A standby output, V_{SB}, in the CCR0512 power supply comes on when AC input in the operating range is applied.

Remote Sense

The power supply has both positive and negative remote sense connections that can be connected to the positive and negative rails of the main output near the load. Care should be taken in routing the sense lines to ensure that noise is not picked up or that additional filtering elements that affect the stability of the power supply are not used. The power supply will operate without the remote sense connections being made, however if remote sense near the load is not used it is recommended that the remote sense lines be connected directly to the main output terminals.

Overcurrent Protection

To provide protection in a fault condition (output overload), the power supply is equipped with internal current-limiting circuitry and can endure current limiting continuously. At the point of current-limit inception, the unit enters hiccup mode. The power supply operates normally once the output current is brought back into its specified range.

Overvoltage Protection

Overvoltage protection is a feature of the CCR0512 power supply that protects both the load and the power supply from an output overvoltage condition. When an overvoltage occurs, the power supply shuts down and latches off. It is necessary to recycle the input to restart the power supply when this protection is activated.

Overtemperature Protection

The CCR0512 also features overtemperature protection in order to provide additional protection in a fault condition. The power supply is equipped with a thermal shutdown circuit which detects excessive internal temperatures and shuts the unit down. In the event of an over temperature condition, the unit protects itself by providing a low warning signal for 10 seconds (typical) and then shutting off. Once the power supply goes into overtemperature shutdown, it will cool before attempting to restart.

Input Undervoltage Lockout

At input voltages below the input undervoltage lockout limit, power supply operation is disabled. The power supply will begin to operate at an input voltage above the undervoltage lockout turn-on threshold.

DC OK

The CCR0512 provides a DC OK signal that indicates when the output has come up and is in regulation. This is an open-collector type signal that goes high when the output is available and within regulation.

Paralleling/Load Share

This power supply can be paralleled to provide larger load currents than can be delivered from a single power supply. Up to four power supplies may be paralleled. Paralleling is accomplished by connecting the Current Share signals of multiple power supplies together. At load current levels above 20%, the output currents of multiple power supplies will be within ±5% of the full load value.

If remote sense is used when paralleling is employed, the remote sense connection points should be common to both power supplies.

The supply is equipped with internal Or-ring mosfets in the + V_{OUT} leg and designed for hot swap operation.

Signal Considerations

Signal Return

The signal return is the referenced for all the signals and is internally connected to the output return (+V_{OUT} return).

Fault Signal

TTL compatible. Open collector (High) for normal operation.
Sink current: 4mA. Max collector voltage: 12V_{dc}
This alarm is an opto-isolated open collector signal referenced to +V_{OUT} Return or chassis ground.
The signal indicates that a failure has been detected in the unit (OTP, OVP, AC Fail or No Input).

Output Current Monitoring

Analog output signal. Voltage proportional to the power supply output current (0.1V/AMP) +/- 250mv.

Module Enable

The power supply will turn on when the pin engages to the mating connector and senses it connected to Signal Return. It is required to tie the mating connector pin to the Signal Return pin for the power supply to function.

PSU Present

Binary signal delivered when the rectifier is present (active low, strap to return signal).

Load Share/Paralleling

Analog signal. Single wire connection. Unit will load share within ±5% of full load.

Over Temperature Warning
TTL compatible. Open collector (High) for normal operation. Sink current: 4mA. Max collector voltage: 12V_{dc}. In the event of an over temperature condition, the unit protects itself by providing a low warning signal for 10 seconds (typical) and then shutting off. Auto restart after the condition is cleared.

Output Voltage Programming
Analog input signal - voltage determining the rectifier output voltage.

V_{OUT} = 10.8V+ (V_{prog} X 0.96)V, for V_{prog} from 0V to 2.5V
V_{OUT} = 13.2V, for V_{prog} from 2.5V to 3.0V
V_{OUT} = 12.0V, for V_{prog} higher than 3.0V or left open

Remote ON-OFF
TTL compatible. Open collector (High) for normal operation. Sink current: 4mA. Max collector voltage: 12V_{dc}
Logic 1 (TTL High) or open enables unit (ON); Logic 0 (TTL Low) or short shuts unit down (OFF). Cycling this signal resets the over-voltage protection memory.

DC OK
TTL compatible. Open collector (High) for normal operation. Sink current: 4mA. Max collector voltage: 12V_{dc}

AC OK
TTL compatible. Open collector (High) for normal operation. Sink current: 4mA. Max collector voltage: 12V_{dc}
AC OK indicates that AC is applied within the specified input range for the rectifier.

Serial Bus Communications
All signals are referenced to 'Signal Return'.

Device addressing: The microcontroller (MCU) and the EEPROM have the following addresses:

Device	Address	Address Bit Assignments (Most to Least Significant)							
MCU	0xBx	1	0	1	1	A2	A1	A0	R/W
Broadcast	0x00	0	0	0	0	0	0	0	0
EEPROM	0xAx	1	0	1	0	A2	A1	A0	R/W

Address lines (A2, A1, A0): These signal pins allow up to eight (8) modules to be addressed on a single I²C bus. The pins are pulled HI internally. For logic LO connect to 'Output Return'.

Global broadcast: This is a powerful command because it instruct all power supplies to respond simultaneously. A ***read*** instruction should never be accessed globally. The power supply should issue an 'invalid command' state if a 'read' is attempted globally.

For example, changing the 'system' output voltage requires the global broadcast so that all paralleled power supplies change their output simultaneously. This command can also turn OFF the 'main' output or turn ON the 'main' output of all power supplies simultaneously. Unfortunately, this command does have a side effect. Only a single power supply needs to pull down the ninth *acknowledge* bit. To be certain that each power supply responded to the global instruction, a *READ* instruction should be executed to each power supply to verify that the command properly executed. The GLOBAL BROADCAST command should only be executed for write instructions to slave devices.
The I²C interface facilitates the monitoring and control of various operating parameters within the unit and transmits these on demand over an industry standard I²C Serial bus.

Serial Clock (SCL): Clock pulses are host generated initiating communications across the I²C Serial bus, and are pulled up internally to 3.3V by a 10kΩ resistor. The end user should add additional pull up resistance as necessary to ensure that rise and fall time timing and the maximum sink current is in compliance to the I²C specifications.

Serial Data (SDA): This is a bi-directional data line, pulled up internally to 3.3V by a 10kΩ resistor. The end user should add additional pull up resistance as necessary to ensure that rise and fall time timing and the maximum sink current is in compliance to the I²C specifications.

Basic Operation
PMBus™ compliance: The power supply is fully compliant to the Power Management Bus (PMBus™) rev1.2 requirements.

Manufacturer specific commands located between addresses 0xD0 to 0xEF provide instructions that either do not exist in the general PMBus specification or make the communication interface simpler and more efficient.

Master/Slave: The 'host controller' is always the MASTER. Power supplies are always SLAVES. SLAVES cannot initiate communications or toggle the Clock. SLAVES also must respond expeditiously at the command of the MASTER as required by the clock pulses generated by the MASTER.

Clock stretching: The 'slave' µController inside the power supply may initiate clock stretching if it is busy and it desires to delay the initiation of any further communications. During the clock stretch the 'slave' may keep the clock LO until it is ready to receive further instructions from the host controller. The maximum clock stretch interval is 25ms.

The host controller needs to recognize this clock stretching, and refrain from issuing the next clock signal, until the clock line is released, or it needs to delay the next clock pulse beyond the clock stretch interval of the power supply.

Note that clock stretching can only be performed after completion of transmission of the 9th ACK bit, the exception being the START command.

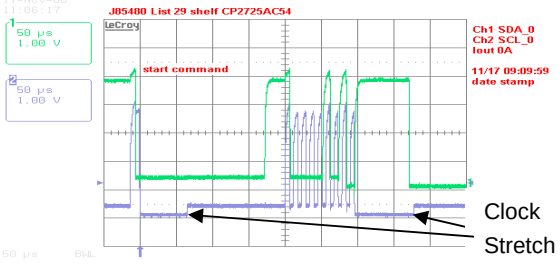


Figure 13. Example waveforms showing clock stretching.

I²C Bus Lock-Up detection: The device will abort any transaction and drop off the bus if it detects the bus being held low for more than 35ms.

Communications speed: Both 100kHz and 400kHz clock rates are supported. The power supplies default to the 100kHz clock rate. The minimum clock speed specified by SMBus is 10 kHz.

Packet Error Checking (PEC): Although the power supply will respond to commands with or without the trailing PEC, it is highly recommended that PEC be used in all communications. The integrity of communications is compromised if packet error correction is not employed. There are many functional features, including turning OFF the main output, which should require validation to ensure that the correct command is executed.

PEC is a CRC-8 error-checking byte, based on the polynomial $C(x) = x^8 + x^2 + x + 1$, in compliance with PMBus™ requirements. The calculation is based in all message bytes, including the originating write address and command bytes preceding read instructions. The PEC is appended to the message by the device that supplied the last byte.

SMBAlert (E4): The µC driven SMBAlert signal informs the 'master/host' controller that either a STATE or ALARM change has occurred. Normally this signal is HI. The signal will change to its LO level if the power supply has changed states and the signal will be latched LO until the power supply receives a 'clear' instruction as outlined below. If the alarm state is still present after the 'clear_faults' command has been received, then the signal will revert back into its LO state again and will latch until a subsequent 'clear_faults' signal is received from the host controller.

The signal will be triggered for any state change, including the following conditions;

- VIN under or over voltage
- Vout under or over voltage
- IOUT over current
- Over Temperature warning or fault
- Communication error
- PEC error
- Invalid command
- Detected internal faults

The power supply will clear the SMBusAlert# signal (release the signal to its HI state) upon the following events:

- the STATUS_BYTE (0x78) or STATUS_WORD (0x79) are read
- Receiving a CLEAR_FAULTS command
- The main output recycled (turned OFF and then ON) via the REMOTE ON/OFF signal pin
- The main output recycled (turned OFF and then ON) by the OPERATION command

Read back delay: The power supply issues the SMBAlert # notification as soon as the first state change occurred. During an event a number of different states can be transitioned to before the final event occurs. If a read back is implemented rapidly by the host a successive SMBAlert# could be triggered by the transitioning state of the power supply. In order to avoid successive SMBAlert# s and read back and also to avoid reading a transitioning state, it is prudent to wait more than 2 seconds after the receipt of an SMBAlert# before executing a read back. This delay will ensure that only the final state of the power supply is captured.

Successive read backs: Successive read backs to the power supply should not be attempted at intervals faster than every one second. This time interval is sufficient for the internal processors to update their data base so that successive reads provide fresh data.

Invalid commands or data: The power supply notifies the MASTER if a non-supported command has been sent or invalid data has been received. Notification is implemented by setting the appropriate STATUS and ALARM registers and setting the SMBAlert# flag.

If a non-supported read is requested the power supply will return all 0x00h.

PMBus™ Commands

Standard instruction: Up to two bytes of data may follow an instruction depending on the required data content. Analog data is always transmitted as LSB followed by MSB. PEC is optional and includes the address and data fields.

1	8	1	8	1
S	Slave address	Wr	A	Command Code	A

8	1	8	1	8	1	1
Low data byte	A	High data byte	A	PEC	A	P

☐ Master to Slave ☐ Slave to Master

SMBUS annotations; S – Start , Wr – Write, Sr – re-Start, Rd – Read,
A – Acknowledge, NA – not-acknowledged, P – Stop

Standard READ: Up to two bytes of data may follow a READ request depending on the required data content. Analog data is always transmitted as LSB followed by MSB. PEC is mandatory and includes the address and data fields. PEC is optional and includes the address and data fields.

1	7	1	1	8	1
S	Slave address	Wr	A	Command Code	A

1	7	1	1	8	1
Sr	Slave Address	Rd	A	LSB	A

8	1	8	1	1
MSB	A	PEC	No-ack	P

Block communications: When writing or reading more than two bytes of data at a time, BLOCK instructions for WRITE and READ commands must be used instead of the Standard Instructions

Block write format:

1	7	1	1		8	1
S	Slave address	Wr	A		Command Code	A

8	1	8	1	8		1
Byte count = N	A	Data 1	A	Data 2		A

8	1	8	1	8	1	1
.....	A	Data 48	A	PEC	A	P

Block read format:

1	7	1	1		8	1
S	Slave address	Wr	A		Command Code	A

1	7	1	1
Sr	Slave Address	Rd	A

8	1	8	1	8		1
Byte count = N	A	Data 1	A	Data 2		A

8	1	8	1	8	1	1
.....	A	Data 48	A	PEC	NoAck	P

Linear Data Format The definition is identical to Part II of the PMBus Specification. All standard PMBus values, with the exception of output voltage related functions, are represented by the linear format described below. Output voltage functions are represented by a 16 bit mantissa. Output voltage has a E=-9 constant exponent.

The Linear Data Format is a two byte value with an 11-bit, two's complement mantissa and a 5-bit, two's complement exponent or scaling factor, its format is shown below.

	Data Byte High								Data Byte Low							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	Exponent (E)					Mantissa (M)										

The relationship between the Mantissa, Exponent, and Actual Value (V) is given by the following equation:

$$V = M * 2^{E}$$

Where: V is the value, M is the 11-bit, two's complement mantissa, *E* is the 5-bit, two's complement exponent

Notes: Settings and read backs above support the 12Vdc main output. There are no adjustments or read backs of the standby output. Failure of the standby output is reported by the STATUS_MFR_SPECIFIC register. The code does not check the validity of, or whether the data being changed is within the expected boundary. The user is responsible to make sure that data placed in the registers is within the monitored range.

Command Descriptions

Operation (01) : By default the Power supply is turned ON at power up as long as *Power ON/OFF* signal pin is active HI. The Operation command is used to turn the Power Supply ON or OFF via the PMBus. The data byte below follows the OPERATION command.

FUNCTION	DATA BYTE
Unit ON	80
Unit OFF	00

To **RESET** the power supply cycle the power supply OFF, wait at least 2 seconds, and then turn back ON. All alarms and shutdowns are cleared during a restart.

Clear_faults (03): This command clears all STATUS and FAULT registers and resets the SMBAlert# line.

If a fault still persists after the issuance of the clear_faults command the specific registers indicating the fault are reset and the SMBAlert# line is activated again.

WRITE_PROTECT register (10): Used to control writing to the PMBus device. The intent of this command is to provide protection against accidental changes. All supported command parameters may have their parameters read, regardless of the write_protect settings. The contents of this register can be stored to non-volatile memory using the Store_default_code command. The default setting of this register is disable_all_writes except write_protect 0x80h.

FUNCTION	DATA BYTE
Enable all writes	00
Disable all writes except write_protect	80
Disable all writes except write_protect and OPERATION	40

Vout_Command (21) : This command is used to change the output voltage of the power supply. Changing the output voltage should be performed simultaneously to all power supplies operating in parallel using the Global Address (Broadcast) feature. If only a single power supply is instructed to change its output, it may attempt to source all the required power which can cause either a power limit or shutdown condition.

Software programming of output voltage permanently overrides the set point voltage configured by the Vprog signal pin. The program no longer looks at the 'Vprog pin' and will not respond to any hardware voltage settings. If power is removed from the µController it will reset itself into its default configuration looking at the Vprog signal for output voltage control. In many applications, the Vprog pin is used for setting initial conditions, if different that the factory setting. Software programming then takes over once I^2C communications are established.

To properly hot-plug a power supply into a live backplane, the system generated voltage should get re-configured into either the factory adjusted firmware level or the voltage level reconfigured by the margin pin. Otherwise, the voltage state of the plugged in power supply could be significantly different than the powered system.

Vout_OV_warn_limit (42): OV_warning is extremely useful because it gives the system controller a heads up that the output voltage is drifting out of regulation and the power supply is close to shutting down. Preemptive action may be taken before the power supply would shut down and potentially disable the system.

OC and OT_fault_ response (47, 50): The default response for both OC and OT is auto_restart (hiccup). Each register, individually, can be reconfigured into a latched state. Latched and hiccup are the only supported states.

Restart after a latch off: Either of four restart possibilities are available. The hardware pin Remote ON/OFF may be turned OFF and then ON**.** The unit may be commanded to restart via i2c through the *Operation* command by first turning OFF then turning ON . The third way to restart is to remove and reinsert the unit. The fourth way is to turn OFF and then turn ON ac power to the unit. Each of these commands must keep the power supply in the OFF state for at least 2 seconds, with the exception of changing to restart.

A power system that is comprised of a number of power supplies could have difficulty restarting after a shutdown event because of the non-synchronized behavior of the individual power supplies. Implementing the latch-off mechanism permits a synchronized restart that guarantees the simultaneous restart of the entire system.

A synchronous restart can be implemented by;

1. Issuing a GLOBAL OFF and then ON command to all power supplies,
2. Toggling Off and then ON the Remote ON/OFF signal
3. Removing and reapplying input commercial power to the entire system.

The power supplies should be turned OFF for at least 20 – 30 seconds in order to discharge all internal bias supplies and

Vin_UV_warn_limit (58): This is another warning flag indicating that the input voltage is decreasing dangerously close to the low input voltage shutdown level.

Status_word (79): returns two bytes of information. The upper byte bit functionality is tabulated in the Status_word section. The lower byte bit functionality is identical to Status_byte.

Status Register Bit Allocation:

Register	Code	Bit	Function
Status_Byte	78	7	N/A
		6	N/A
		5	Output OV Fault detected
		4	Output OC Fault detected
		3	Input UV Fault detected
		2	Temperature Fault/warning detected
		1	CML (communication fault) detected
		0	N/A
Status_word (includes Status_byte)	79	7	OV Fault detected
		6	OC Fault detected
		5	Input Fault detected
		4	N/A
		3	N/A
		2	N/A
		1	N/A
		0	N/A
Status_Vout	7A	7	Vout OV Fault
		6	Vout OV Warning
		5	Vout UV Warning
		4	Vout UV Fault
		3	N/A
		2	N/A
		1	N/A
		0	N/A
Status_Iout	7B	7	IOUT OC Fault
		6	N/A
		5	IOUT OC Warning
		4	N/A
		3	N/A
		2	N/A
		1	N/A
		0	N/A
Status_input	7C	7	Vin OV Fault
		6	Vin OV Warning
		5	Vin UV Warning
		4	Vin UV Fault
		3	N/A
		2	N/A
		1	N/A
		0	N/A
Status_temperature	7D	7	OT Fault
		6	OT Warning
		5	UT Fault
		4	UT Warning
		3	N/A
		2	N/A
		1	N/A
		0	N /A
Status_cml	7E	7	Invalid Command
		6	Invalid Data
		5	ERROR PEC
		4	N/A
		3	N/A
		2	N/A
		1	Other Fault
		0	N/A
Status_mfr_specific	80	7	0 = V_{SB} Fault, 1 = No V_{SB} Fault
		6	0 = OV Fault, 1 = No OV Fault
		5	0 = Interrupt, 1 = No Interrupt
		4	0 = Any Fault, 1 = No Fault
		3	0 = OT Fault; 1 = Temperature OK
		2	0 = DC Fault, 1 = DC OK
		1	0 = Input AC Fault, 1 = Input AC OK
		0	0 = AC high line, 1 = AC low line

Mfr_ID (99): Manufacturer in ASCII – 5 characters maximum, General Electric – Critical Power represented as, 'GECP_'

Mfr_Model (9A): Total 15 bytes: 'CCR0512FPXXZ01A'

Mfr_Location (9C): Total 4 bytes: 'CHN_'

Mfr_Date (9D): Total 6 bytes: yymmdd

Mfr_Serial (9E): Total 15 bytes

Read_mfr_rev (D0): Total 1 bytes

Each byte is partitioned into high and low nibbles.
Example: FF (11111111) is read as 16.16
1A (00011010) is read as 1.10

EEPROM

The microcontroller has 96 bytes of EEPROM memory available for the system host.

PMBus™ Command set:

Hex Code	Command	Data Byte	Read/ Write	Function	Factory Default/Notes
01	OPERATION	1	R/W	Output ON/OFF	0x80/ Only 0x00 and 0x80 allowed
02	ON_OFF_CONFIG	1	R	On/Off Control Configuration	0x09/ Only 0x09 allowed
03	CLEAR_FAULTS	0		Clear Status	
10	WRITE_PROTECT	1	R/W	Write control	0x80
11	STORE_DEFAULT_ALL	0	W	Store permanently	
12	RESTORE_DEFAULT_ALL	0	W	Reset defaults	
19	CAPABILITY	1	R	PEC support (data ≥ 2 byte); 400kHz; SMBAlert	0x30
20	VOUT_MODE	1	R	Vout constants, Exp=-9	0x17
21	VOUT_COMMAND	2	R/W	Set Output Vout	12.0V
40	VOUT_OV_FAULT_LIMIT	2	R/W	Set Output OV fault limit	14.0V
41	VOUT_OV_FAULT_RESPONSE	1	R/W	Set Response to Output OV fault	0xC0
42	VOUT_OV_WARN_LIMIT	2	R/W	Set Output OV warn limit	13.5V
43	VOUT_UV_WARN_LIMIT	2	R/W	Set Output UV warn limit	10.5V
44	VOUT_UV_FAULT_LIMIT	2	R/W	Set Output UV fault limit	10.0V
45	VOUT_UV_FAULT_RESPONSE	1	R/W	Set Response to Output UV fault	0xC0
46	IOUT_OC_FAULT_LIMIT	2	R/W	Set Output OC fault limit	48A
47	VOUT_OC_FAULT_RESPONSE	1	R/W	Set Response to Output OC fault	0xC0
4A	IOUT_OC_WARN_LIMIT	2	R/W	Set Output OC warn limit	45A
4F	OT_FAULT_LIMIT	2	R/W	Set OT fault limit	112C
50	OT_FAULT_RESPONSE	1	R/W	Set Response to OT fault	0xC0
51	OT_WARN_LIMIT	2	R/W	Set OT warn limit	100C
55	VIN_OV_FAULT_LIMIT	2	R/W	Set Input OV fault limit	270V
57	VIN_OV_WARN_LIMIT	2	R/W	Set Input OV warn limit	266V
58	VIN_UV_WARN_LIMIT	2	R/W	Set Input UV warn limit	90V
59	VIN_UV_FAULT_LIMIT	2	R/W	Set Input UV shutdown	83V
78	STATUS_BYTE	1	R		
79	STATUS_WORD	2	R		
7A	STATUS_VOUT	1	R		
7B	STATUS_IOUT	1	R		
7C	STATUS_INPUT	1	R		
7D	STATUS_TEMPERATURE	1	R		
7E	STATUS_CML	1	R		
7F	STATUS_OTHER	1	R		
80	STATUS_MFR_SPECIFIC	1	R		
88	READ_VIN	2	R	Read input voltage	
89	READ IIN	2	R	Read input current	
8B	READ_VOUT	2	R	Read output voltage	
8C	READ_IOUT	2	R	Read output current	
8D	READ_TEMPERATURE	2	R	Read temperature	
96	READ_POUT	2	R	Read output power	
97	READ_PIN	2	R	Read input power	
98	PMBUS REVISION	1	R		0x11
99	MFR_ID	5	R	FRU_ID	ASCII
9A	MFR_MODEL	15	R		ASCII
9C	MFR_LOCATION	4	R		ASCII
9D	MFR_DATE	6	R		ASCII
9E	MFR_SERIAL	15	R		ASCII
B0	USER_DATA_00	48	R/W	User memory space	
B1	USER_DATA_01	48	R/W	User memory space	
D0	READ_FRW_REVISION	1	R		1.10

Visual Indicators (LEDs)

AC OK (Green)
DC OK (Green)
FAULT (Red)

#	Condition	LED Indicators			Monitoring Signals			
		AC OK	DC OK	FAULT	FAULT	DC OK	AC OK	TEMP OK
1	Normal Operation	GREEN	GREEN	OFF	HIGH	HIGH	HIGH	HIGH
2	Input Out of Range	OFF	OFF	OFF	HIGH	LOW	LOW	HIGH
3	Over Voltage Shutdown	GREEN	OFF	RED	LOW	LOW	HIGH	HIGH
4	Over Current Hiccup	GREEN	BLINKING	OFF	HIGH	PULSE	HIGH	HIGH
5	Temperature Warning	GREEN	GREEN	OFF	HIGH	HIGH	HIGH	LOW
6	Over Temperature Shutdown	GREEN	OFF	BLINKING	PULSE	LOW	HIGH	LOW

NOTES:

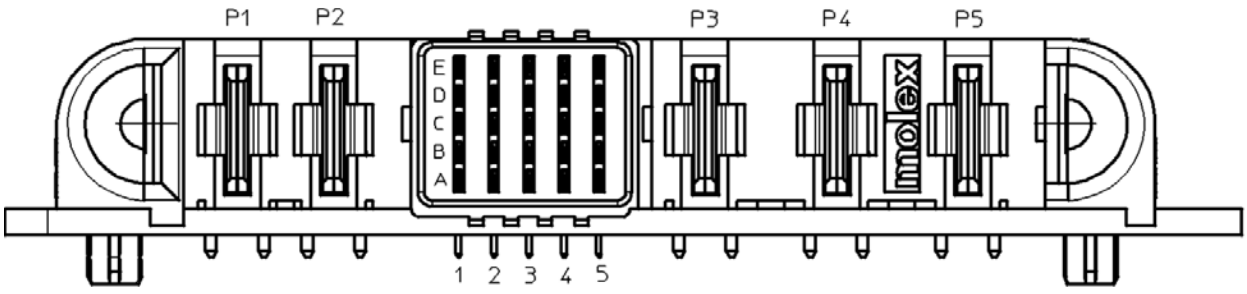
1. Condition # 2 has two modules plugged in. The second module provided back bias to the module with no-input applied.
2. Blinking: 0.5, +/-0.05 seconds ON, and 0.5, +/-0.05 seconds OFF.
3. Pulse: 0.5, +/-0.05 seconds high, and 0.5, +/-0.05 seconds low.

Connector Information –Shelf version

Connector On Power Supply	Mating Connector
Molex part # 46437-1154	Molex part # 46436-1154 (Right Angle Mounting)

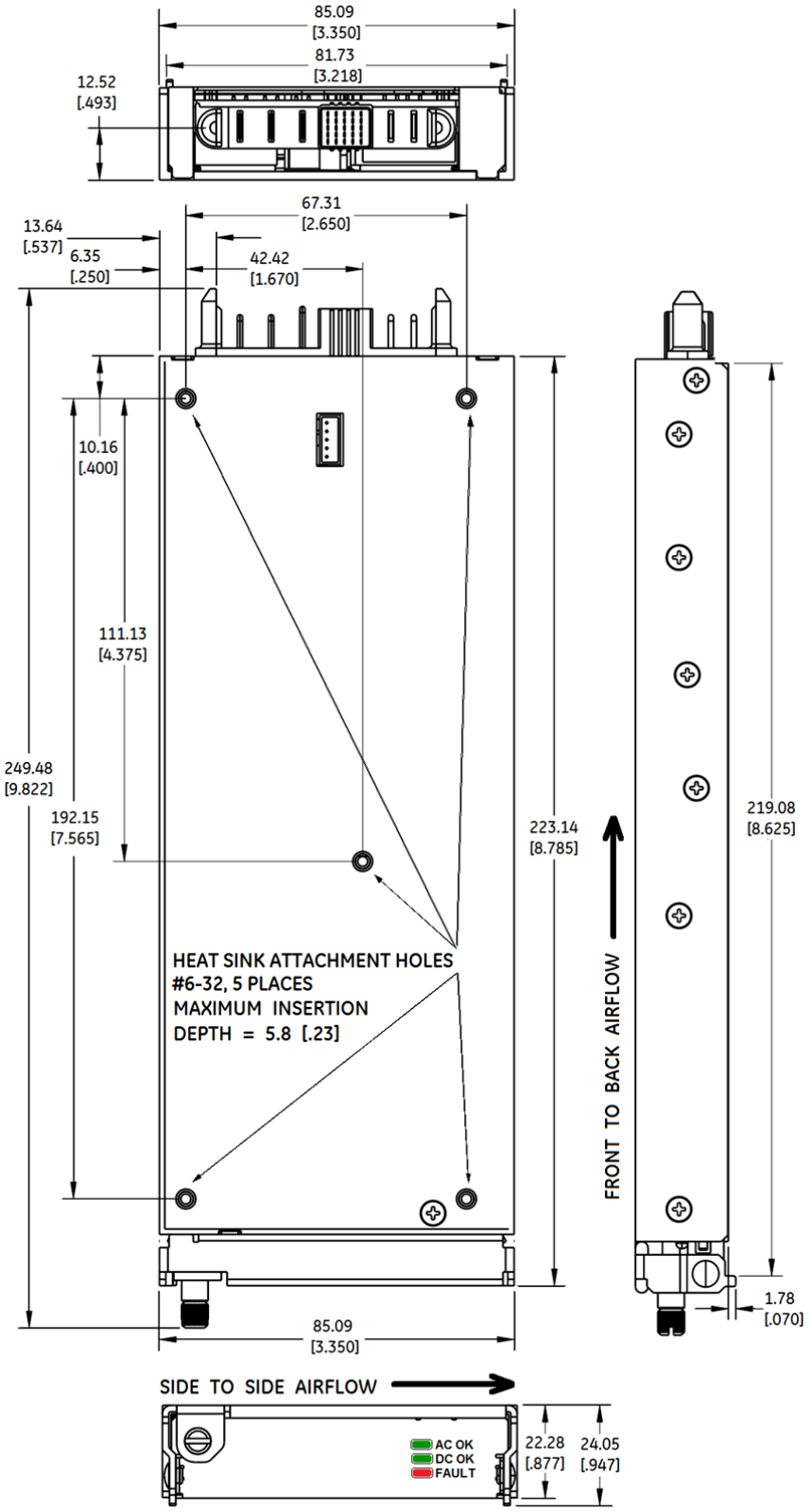
Pin No.	Function	Pin No.	Function	Pin No.	Function
A1	$+V_{SB}$	C1	SDA (I^2C bus)	E1	Remote ON/OFF
A2	$-V_{SB}$ Return	C2	SCL (I^2C bus)	E2	DC OK
A3	Signal Return	C3	I_{share}	E3	AC OK
A4	Reserved (do not connect)	C4	N/C	E4	Interrupt (SMBALERT)
A5	Remote Sense (+)	C5	Over Temperature Warning	E5	Signal Return
B1	Remote Sense (-)	D1	I^2C Address (A0)	P1	$+V_{OUT}$
B2	Fault	D2	I^2C Address (A1)	P2	V_{OUT} RTN
B3	I Monitor (IMON)	D3	I^2C Address (A2)	P3	SAFETY GND
B4	Module Enable	D4	V_{prog}	P4	AC NETURAL
B5	PSU Present	D5	Reserved (do not connect)	P5	AC LINE

Yellow denotes short pins (last to make), Green denotes long pins (first to make).



Mechanical Outline – Shelf Version

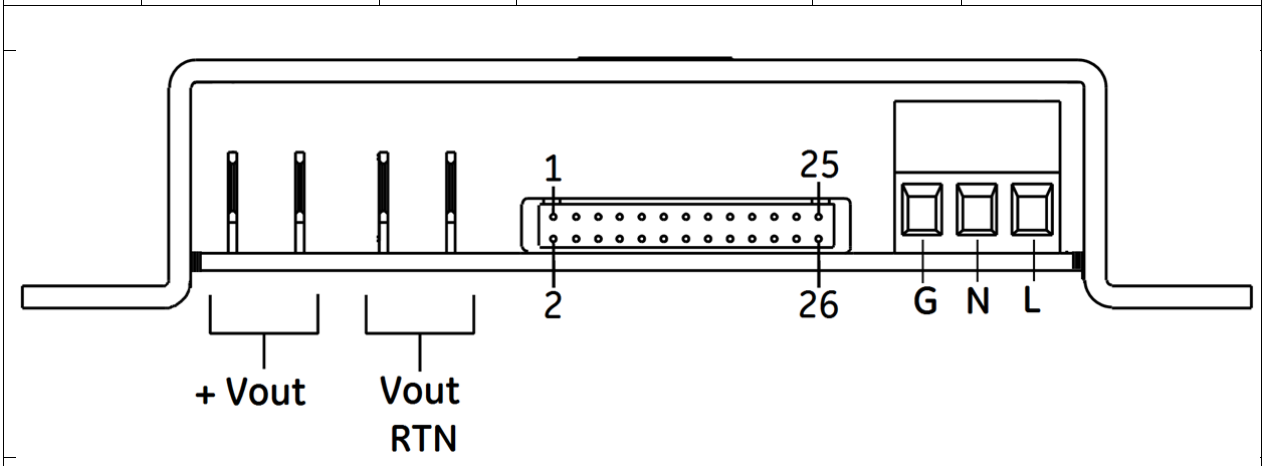
Dimensions are in millimeters and [inches].
Tolerances: x.x mm ± 0.5 mm [x.xx in. ± 0.02 in.] (unless otherwise indicated)
x.xx mm ± 0.25 mm [x.xxx in ± 0.010 in.] (unless otherwise indicated)



Connector Information –Stand Alone version

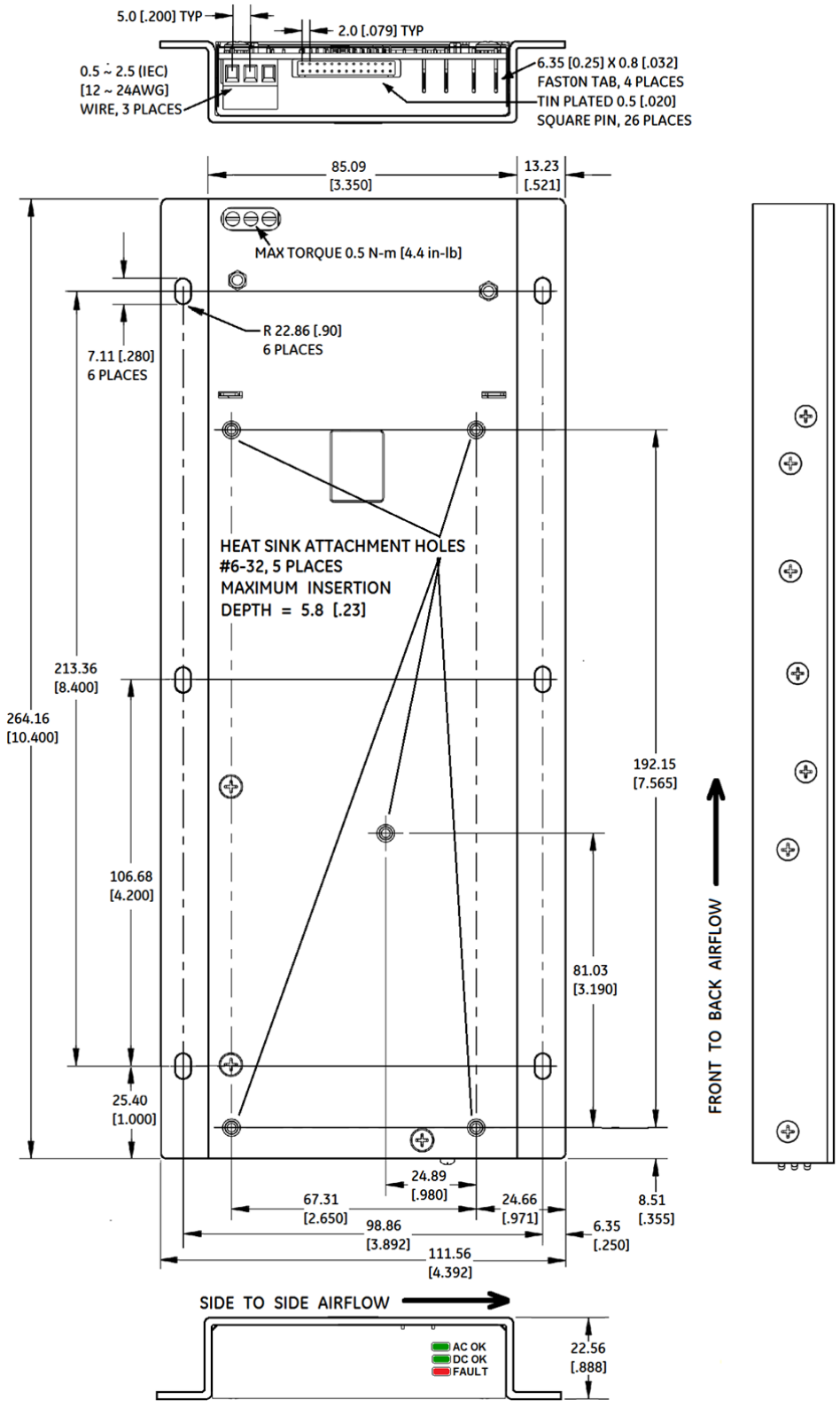
Function	Connector On Power Supply	Mating Connector
AC Input	*EK500V-03P*	*Discrete Wires* 20A 300VAC 24-12AWG
DC Output	*PFC250 FASTON TAB*	250FASTON TERMINAL
Control/Communication	*CI0126P1HDL-LF RA W/LOCKING LATCH 26-CTS 2-ROW*	*CI01 Series 2.00mm(.079") Dual Row Wire to Board Housing & Terminal (or equivalent)*

Pin No.	Function	Pin No.	Function	Pin No.	Function
1	+V_{SB}	11	I^2C Address (A2)	21	Signal Return
2	-V_{SB} Return	12	I^2C Address (A1)	22	Module Enable
3	Remote Sense (-)	13	DC OK	23	PSU Present
4	Remote Sense (+)	14	I_{share}	24	Over Temperature Warning
5	Fault	15	AC OK	25	Reserved (do not connect)
6	I Monitor (IMON)	16	N/C	26	Reserved (do not connect)
7	SCL (I^2C bus)	17	Interrupt (SMBALERT)		
8	SDA (I^2C bus)	18	V_{prog}	G	SAFETY GND
9	Remote ON/OFF	19	Signal Return	N	AC NETURAL
10	I^2C Address (A0)	20	Reserved (do not connect)	L	AC LINE



Mechanical Outline – Stand Alone Version

Dimensions are in millimeters and [inches].
Tolerances: x.x mm ± 0.5 mm [x.xx in. ± 0.02 in.] (unless otherwise indicated)
x.xx mm ± 0.25 mm [x.xxx in ± 0.010 in.] (unless otherwise indicated)



GE

Data Sheet

CCR0512FP Power Supply

90 - 264V_{ac} Input; 12V_{dc}, 500W Output

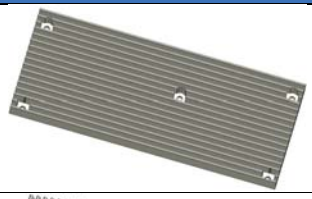
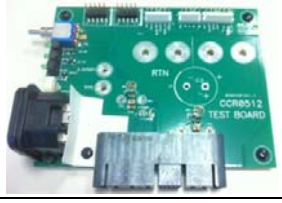
Ordering Information

Please contact your GE Power Electronics' Sales Representative for pricing, availability and optional features.

Device Codes

Product Code	Input Voltage	Output Power	Output Ratings	Mounting	Comcode
CCR0512FPXXXZ01A	90-264V_{ac}	500W	12V_{dc}/42A, 3.3V_{dc}/2.0A	Shelf	CCR0512FPXXXZ01A
CCR0512FPSXXZ01A	90-264V_{ac}	500W	12V_{dc}/42A, 3.3V_{dc}/2.0A	Stand alone	CCR0512FPSXXZ01A

Accessories

Item	Description	Product Code/Comcode	Source
	Horizontal 0.6 in. Heatsink plus screws (5)	CCR0512FPKITZ01A	GE
	Vertical 0.6 in. Heatsink plus screws (5)	CCR0512FPKITZ02A	GE
	Interface Card (for use with shelf mounted version only)	150036347	GE

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