PFC Micro™
Power Factor Corrected AC-DC Switcher

VICOR

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Overview

The PFC Micro is a low-profile switching power supply that combines the advantages of power factor correction (PFC) and high power density. This guide covers both standard and rugged COTS (MI) versions of the supply. A PFC Micro provides up to six isolated outputs (from two slots) and each slot may accommodate the following Vicor DC-DC Converters:

VE-200™/VE-J00™ Series: 1 VE-200 or 2 VE-J00

Maxi/Mini/ Micro Series: 1 Maxi, 2 Minis, or 3 Micros

The use of these converters gives the PFC Micro the inherent power flexibility typical of all Vicor products. Accepting input voltages of $85 - 264V_{AC}$, and $100 - 300V_{DC}$, the PFC Micro can provide up to 800W in a package size of 1.86 x 5.06 x 10.40in [47,3 x 128,5 x 264,1mm]. The PFC Micro is factory-configured to meet user output requirements.

Standard Features

- Power Factor Correction: Typically 0.98 (>75% Load)
- Universal Input: 85 – 264V_{AC}, 47 – 500Hz, or 120 – 300V_{DC}
- Power Output: 800W at 230V_{AC} (200V_{AC} minimum input); 500W at 115V_{AC} (100V_{AC} minimum input)
- Up to six isolated outputs (two slots)
- Fan cooled
- Full power to 45°C; half power at 65°C
- Soft start for limiting inrush current
- Conducted EMI: FCC Class A; EN55022 Class A (consult factory)
- Harmonic Distortion to EN61000-3-2
- AC Power OK status signal
- RoHS compliant available
- Output Sequencing and General Shut Down
- Autosense (Refer to pages 6 and 14 for more information on Autosense)
- Output overcurrent protection on all outputs
- Output overvoltage protection and output overtemperature limiting (not applicable when using VI-J00)
- Ride-through (hold-up) time: >20ms at 500W load
- Size: 1.86 x 5.06 x 10.4in [47,3 x 128,5 x 264,1mm]
- Safety Agency Approvals: CE Marking, TÜV CUE (certain models may not have all listed approvals)
- Uses 300V_{DC} input VI-200™/VI-J00™ modules and/or 375V_{DC} input Maxi/Mini/Micro modules
- Power good status signal when Maxi, Mini, or Micro modules used

Optional Features

- I/T/H-Grade output converters
- Current Share Board for unit to unit power sharing - see pages 22 – 23
- Connector kits (# 19-130044)
    - MI Chassis Specific
    - Mil-STD 810 for Shock and Vibration
    - Mil-STD 704 and 1399 for overvoltage and transients
    - –40°C operation
    - Conformal coating - contact factory

Part Numbering

PFC Micro   **PCx$_1$-x$_2$ x$_3$ (-x$_4$)-xxxx-x$_5$**
ex: PC6-06-5012-G

x$_1$ = number of outputs

x$_2$ = number of VI-200™/VI-J00™ modules

x$_3$ = number of Maxi/Mini/Micro modules

(-x$_4$) = optional Factory assigned

xxxx = sequential number assigned by Vicor

x$_5$ = optional versions

Note: **x$_5$** = MI for rugged chassis, = MC for rugged chassis with conformal coating

Mechanical Considerations

The PFC Micro™ can be mounted on one of three surfaces using standard 8-32 or 4mm screws. Maximum allowable torque is 5in·lbs and the maximum penetration of 0.25in [6mm] on the sides and 0.125in [3mm] on the bottom.

When selecting a mounting location and orientation, the unit should be positioned so air flow is not restricted. Maintain a 2in [5,1cm] minimum clearance at both ends of the PFC Micro and route all cables so air flow is not obstructed. The power supply draws air in at the fan side/AC input side and exhausts air out the load side. If air-flow ducting is used, avoid sharp turns that could create back pressure. The fan moves approximately 10CFM of air.

Avoid excessive bending of output power cables after they are connected to the output terminals. For high-current outputs, use cable ties to support heavy cables and minimize mechanical stress on connectors. Be careful not to short-out to neighboring outputs. The maximum torque recommended on output nuts is 10in·lbs.

Avoid applications in which the unit is exposed to excessive shock or vibration levels as the unit is designed primarily for office type equipment. In such applications, a shock-absorbing mount design is required.

PFC Micro Dos and Don'ts

- Do not restrict airflow to the unit. The cooling fan draws air into the unit and forces it out at the output power terminals. A minimum of two inches in front and behind the supply should be maintained in order to prevent air obstructions.

- Run the output (+/–) power cables next to each other to minimize inductance.

- Do not attempt to repair or modify the power supply in any manner. In the event of problems, contact Customer Service at 1-800-735-6200.

- Insert proper fault protection at power supply input terminals (i.e., a fuse).

- Use proper size wires to avoid overheating and excessive voltage drop.

- Output voltages over 60V$_{DC}$, whether from individual modules or series arrays, are considered as hazardous secondary outputs under UL 60950. Appropriate care must be taken in design implementation of the supply.

Technical Description

The PFC Micro™ consists of an off-line single-phase, power-factor-corrected front end, EMI filter, cooling fan, customer interface, power supply control circuit, associated housekeeping circuits and a selection of Vicor VI-200™/VI-J00™ and/or Maxi DC-DC converters.

Input AC mains voltage is applied to input connector MB1J1. The input current is passed through an EMI filter designed to meet conducted noise limit "A" specifications of FCC Part 15.

At start up, inrush current is limited by a PTC thermistor. The PTC is shunted out shortly after initial power up by a DC bus voltage sense circuit driving a relay. After rectification, the input voltage is put through a boost converter that keeps the AC input current sinusoidal and synchronized with the input AC voltage (in compliance with EN61000). The boost converter delivers a regulated input to the hold-up capacitors and a high-voltage backplane. The backplane supplies power to the DC-DC converters that provide the desired low voltage regulated outputs.

Output voltage conversion is achieved by the Vicor family of Zero-Current Switching (ZCS) DC-DC converters. These are forward converters in which the main switching element switches at zero current. This patented topology has a number of unique attributes: low switching losses; high-frequency operation, resulting in reduced size for magnetics and capacitors; excellent line and load regulation; wide adjustment range for output; low EMI/RFI emission and high efficiencies.

At initial power up, the PFC Micro outputs are disabled to limit the inrush current and to allow the DC bus potential to settle out to the correct operating level. A low-power flyback converter converts the high-voltage DC bus into regulated low voltage to power the internal housekeeping circuits and DC cooling fan.

The internal housekeeping V_{CC} comes up within 1s after the application of input power. Once the high-voltage bus is within operating limits, the AC Power OK signal asserts to a TTL "1," indicating the input power is OK, and the power outputs will come up 250ms later.

An output enable / disable function is provided to control Vicor DC-DC converters. If the Enable/Disable control pin is pulled low, the modules output is disabled. The nominal delay associated for an output to come up when measured from release of the Enable/Disable pin is 9 – 12ms. The General Shut Down function controls all outputs simultaneously and works in a similar manner.

Figure 1
PFC Micro architecture
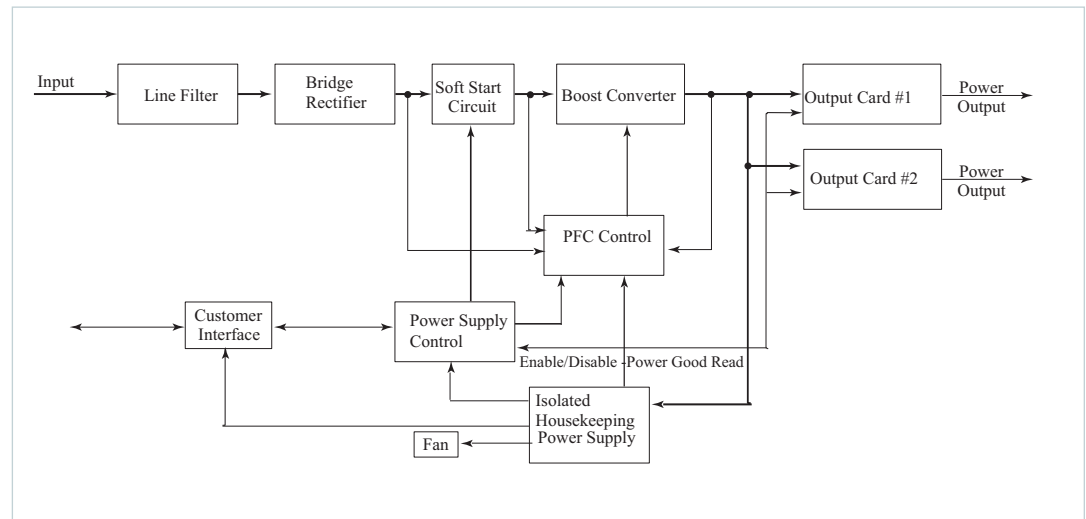
PFC Micro™ Quick Install Instructions

(For Mechanical Drawing, see page 7)

Mounting the PFC Micro

■ The PFC Micro can be mounted on either of three sides.

■ Use #8-32 or 4mm mounting screws. Maximum penetration should not exceed 0.25in [6 mm] on the side and 0.125in [3mm] on the bottom.

■ Maintain 2in [5,1cm] clearance at both ends of power supply for air flow.

Input Connections

MBJ1-5 PIN

L1

Not Connected

L2/N

Not Connected

GND

Input Power MBJ1

■ Apply input AC power connector MBJ1.

■ Maximum torque is 5in·lbs.

■ **A fuse or circuit breaker in the input line is necessary for safety requirements (10A).**

■ Molex mating receptacle 39-01-4051, terminals 39-00-0090, crimp tool Molex # 11-01-0199.

MAXI MODULE
(2 ISOLATED OUTPUTS)

-
S1
+

10-32 STUDS

-
S2
+
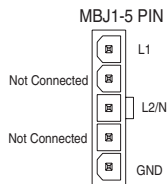
Output Connections

Note: Outputs with current molex connectors are limited to 9A/pin (27A per output).
A PFC Micro with DIFFERENT Molex connectors capable of 40A is available. Contact factory.

Power Connections

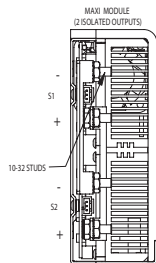### Installing bus bars on output studs (when full-size module is used):

■ The right stud is Positive and the left stud is the Return on single output cards.

■ Remove the nut and place ring lug over output stud.

■ Replace and tighten the nut to a torque of **10 inch pounds.**
Do Not over-tighten nuts.

S1/S2 J1

18	17	16	15	14	13	12	11	10
9	8	7	6	5	4	3	2	1

Installing power connectors with 18-pin Molex connectors (when half-size module used):

■ S1/S2 J1-7, S1/S2 J1-8 and S1/S2 J1-16 are Positive for output #1, while pins
S1/S2 J1-9, S1/S2 J1-17 and S1/S2 J1-18 are the Returns.
S1/S2 J1-1, S1/S2 J1-10 and S1/S2 J1-11 are Positive for output #2, while pins
S1/S2 J1-2, S1/S2 J1-3 and S1/S2 J1-12 are the Returns.

■ For this 18-pin housing, use Molex mating receptacle #39-01-2180 with #39-00-0039 terminals.

■ Attach 18 – 24AWG stranded wire using Molex tool #11-01-0197.

S1/S2 J1 (18 Pin)

-	-	+	-	T	+	-	+	+
-	+	+	T	-	+	-	-	+

Installing power connectors with 16-pin Molex connectors (when quarter-size modules used):

■ S1/S2 J1-7 and S1/S2 J1- 15 are Positive for output #1, while pins
S1/S2 J1-8 and S1/S2 J1- 16 are the Return.
S1/S2 J1-4 and S1/S2 J1-12 are Positive for output #2, while pins
S1/S2 J1-5 and S1/S2 J1- 13 are the Return.
S1/S2 J1-1 and S1/S2 J1-9 are Positive for output # 3, while pins
S1/S2 J1-2, and S1/S2 J1-10 are the Returns.

■ For this 16-pin housing, use Molex mating receptacle #39-01-2160 with #39-00-0039 terminals.

■ Attach 18 – 24AWG stranded wire using Molex tool #11-01-0197.

S1/S2J1

16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1

S1/S2J1 (16 Pin)

-	+	T	-	+	N/C	-	+
-	+	T	-	+	T	-	+

Sense Connections

Sense Connections

Pin
1 **Trim Pin**
2 **+REMOTE SENSE**
3 **–REMOTE SENSE**

S1/S2 J2

Sense connections on output connections with studs:

- The PFC Micro™ is shipped with Autosense installed
  (For more information on Autosense, refer to page 14)

- For remote sense, connect remote-sense wires to remote-sense/trim-pin access connector S1/S2 J2.

- Connector pin S1/S2 J2-2 is the +SENSE and
  S1/S2 J2-3 is the –SENSE.

- Use Molex mating receptacle #50-57-9403 with #16-02-0103 terminals.

- Attach terminals to 24 – 30AWG stranded twisted pair wire using Molex tool #11-01-0208.

- Attach opposite end of sense lines to their respective outputs to point where regulation is desired. **Verify that sense lines are not cross-connected**.

S1/S2 J1

18	17	16	15	14	13	12	11	10
9	8	7	6	5	4	3	2	1

S1/S2 J1 (18 Pin)

-	-	+	-	T	+	-	+	+
-	+	+	T	-	+	-	-	+

Sense connections on output connections with 18-pin Molex connectors:

- The PFC Micro is shipped with Autosense installed
  (For more information on Autosense, refer to page 14)

- If remote sense is desired, connect remote sense wires to sense lines of Connector S1/S2 J1.

- Connector pin S1/S2 J1-13 is the +SENSE and
  S1/S2 J1-15 is the –SENSE for output #1.
  S1/S2 J1-4 is the +SENSE and
  S1/S2 J1-5 is the –SENSE for output #2.

- Use Molex mating receptacle #39-01-2180 with #39-00-0039 terminals.

- Attach 18 – 24AWG stranded twisted pair wire using Molex tool #11-01-0197.

Note: Remote sense is NOT available for triple-output slots.

Trim Connections

Trim Connection with Batmod

Pin
1 **Current Trim Access**
2 **Voltage Trim**
3 **Current Monitor**

S1/S2 J2

Trim connections on output with studs:

- S1/S2 J2-1 provides trim access.

- Use Molex mating receptacle #50-57-9403 with #16-02-0103 terminals.

- Attach 18 – 24AWG stranded wire using Molex tool #11-01-0208.

S1/S2 J1

18	17	16	15	14	13	12	11	10
9	8	7	6	5	4	3	2	1

S1/S2 J1 (18 Pin)

-	-	+	-	T	+	-	+	+
-	+	+	T	-	+	-	-	+

Trim connections on connector with 18-pin molex connectors:

- S1/S2 J1-6 provides trim access for output #1, and
  S1/S2 J1-14 provides trim access for output #2.

- Use Molex mating receptacle #39-01-2180 with #39-00-0039 terminals.

- Attach 18 – 24AWG stranded wire using Molex tool #11-01-0197.

S1/S2J1

16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1

S1/S2J1 (16 Pin)

-	+	T	-	+	N/C	-	+
-	+	T	-	+	T	-	+

Trim connections on connectors with 16-pin Molex connectors:

- S1/S2 J1-14 provides trim access for output #1, and
  S1/S2 J1-6 provides trim access for output #2, and
  S1/S2 J1-3 provides trim access for output #3.

- Use Molex mating receptacle #39-01-2180 with #39-00-0039 terminals.

- Attach 18 – 24AWG stranded wire using Molex tool #11-01-0197.

Interface Connections

- CBJ3-1 is Signal Ground,
  CBJ3-2 is Power Good Read and
  CBJ3-3 is AC-OK.

- CBJ3-4-9 are Enable/Disable,
  CBJ3-10 is General Shut Down,
  CBJ3-11 is Power Good Data Valid (PGDV) and
  CBJ3-12 is +5 VS.

- Use Molex mating receptacle #50-57-9412 with #16-02-0097 cinch pins.

- Attach terminals to 24 – 30AWG stranded wire.
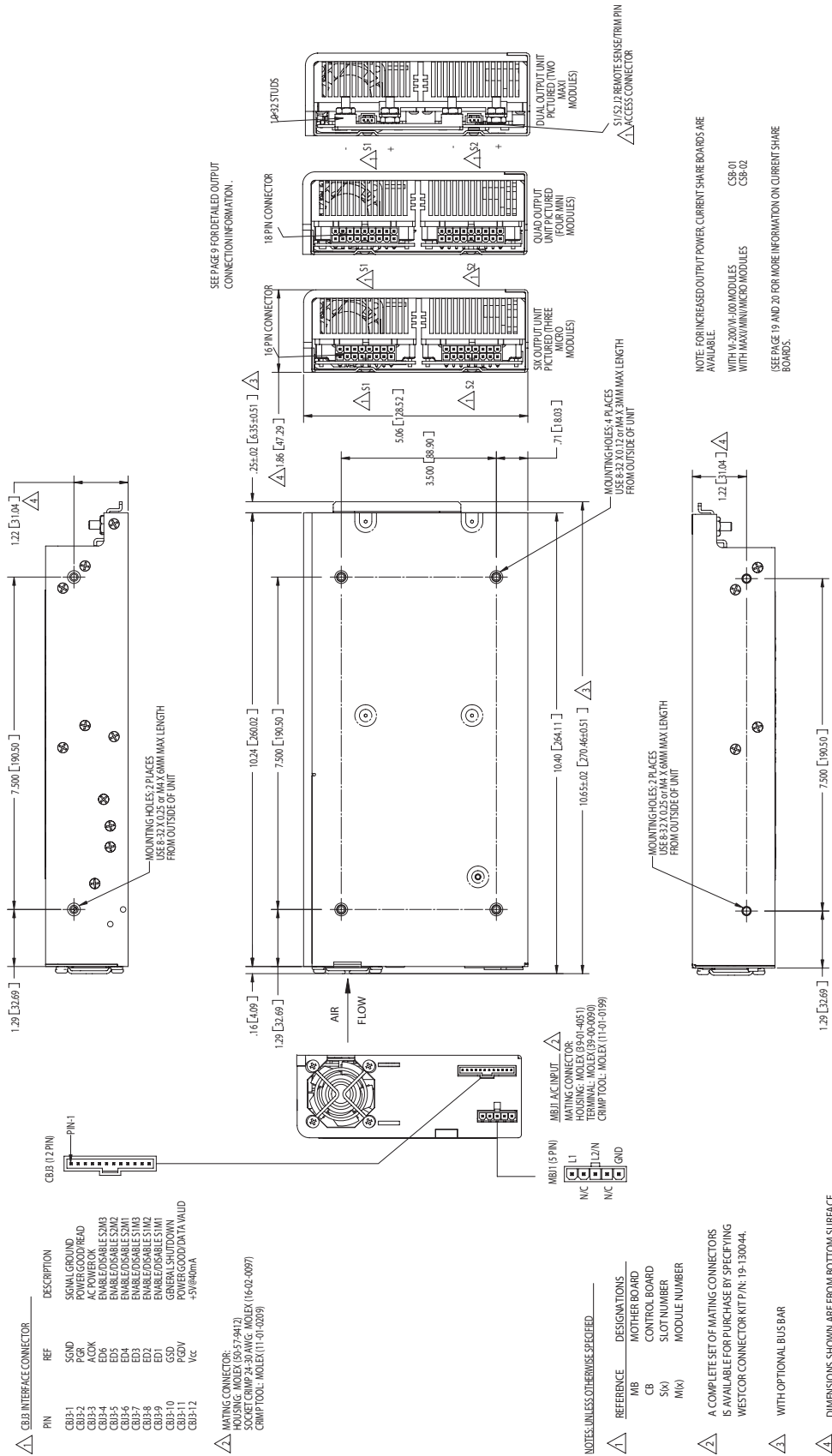
CBJ3 E/D INTERFACE CONNECTOR

MATING CONNECTOR: (WESTCOR KIT P/N: 19-130044)
HOUSING: MOLEX (50-57-9412)
SOCKET CRIMP 24-30 AWG: MOLEX (16-02-0097)
CRIMP TOOL: MOLEX (11-01-0209)

PIN	DESCRIPTION
CBJ3-1	SGND
CBJ3-2	PGR
CBJ3-3	ACOK
CBJ3-4	ED6
CBJ3-5	ED5
CBJ3-6	ED4
CBJ3-7	ED3
CB3-8	ED2
CBJ3-9	ED1
CBJ3-10	GSD
CBJ3-11	PGDV
CBJ3-12	+5 VS

PFC MICRO

CB.3 INTERFACE CONNECTOR

PIN	REF	DESCRIPTION
CB.3-1	SGND	SIGNAL GROUND
CB.3-2	PGR	POWER GOOD/READ
CB.3-3	ACOK	AC POWER OK
CB.3-4	ED6	ENABLE/DISABLE S2M3
CB.3-5	ED5	ENABLE/DISABLE S2M2
CB.3-6	ED4	ENABLE/DISABLE S2M1
CB.3-7	ED3	ENABLE/DISABLE S1M3
CB.3-8	ED2	ENABLE/DISABLE S1M2
CB.3-9	ED1	ENABLE/DISABLE S1M1
CB.3-10	GSD	GENERAL SHUTDOWN
CB.3-11	PGDV	POWER GOOD/DATA VALID
CB.3-12	Vcc	+5V@40mA

MATING CONNECTOR:
HOUSING: MOLEX (50-57-9412)
SOCKET CRIMP 24-30 AWG: MOLEX (16-02-0097)
CRIMP TOOL: MOLEX (11-01-0209)

CB.3 (12 PIN)   PIN-1

NOTES: UNLESS OTHERWISE SPECIFIED

REFERENCE	DESIGNATIONS
MB	MOTHER BOARD
CB	CONTROL BOARD
S(x)	SLOT NUMBER
M(x)	MODULE NUMBER

A COMPLETE SET OF MATING CONNECTORS IS AVAILABLE FOR PURCHASE BY SPECIFYING WESTCOR CONNECTOR KIT P/N: 19-130044.

WITH OPTIONAL BUS BAR

DIMENSIONS SHOWN ARE FROM BOTTOM SURFACE MOUNTING PEMNUTS EXTEND .010 PAST BOTTOM SURFACE.

MB.II AC INPUT
MATING CONNECTOR:
HOUSING: MOLEX (39-01-4051)
TERMINAL: MOLEX (39-00-0090)
CRIMP TOOL: MOLEX (11-01-0199)

MB.II (5 PIN)
N/C   L1
      L2/N
N/C   GND

MOUNTING HOLES; 2 PLACES
USE 8-32 X 0.25 or M4 X 6MM MAX LENGTH
FROM OUTSIDE OF UNIT

AIR FLOW

1.22 [31.04]
7.500 [190.50]
1.29 [32.69]

.16 [4.09]
10.24 [260.02]
7.500 [190.50]
1.29 [32.69]

MOUNTING HOLES; 2 PLACES
USE 8-32 X 0.25 or M4 X 6MM MAX LENGTH
FROM OUTSIDE OF UNIT

10.40 [264.11]
10.65±.02 [270.46±0.51]

1.22 [31.04]
7.500 [190.50]
1.29 [32.69]

.25±.02 [6.35±0.51]
1.86 [47.29]
3.500 [88.90]
5.06 [128.52]
.71 [18.03]

MOUNTING HOLES; 4 PLACES
USE 8-32 X 0.12 or M4 X 3MM MAX LENGTH
FROM OUTSIDE OF UNIT

SEE PAGE 9 FOR DETAILED OUTPUT CONNECTION INFORMATION.

DUAL OUTPUT UNIT PICTURED (TWO MAXI MODULES)
18 PIN CONNECTOR
S1/S2 J2 REMOTE SENSE/TRIM PIN ACCESS CONNECTOR
1/4-32 STUDS
S1   S2

QUAD OUTPUT UNIT PICTURED (FOUR MINI MODULES)
16 PIN CONNECTOR
S1   S2

SIX OUTPUT UNIT PICTURED (THREE MICRO MODULES)
S1   S2

NOTE: FOR INCREASED OUTPUT POWER, CURRENT SHARE BOARDS ARE AVAILABLE.

WITH VI-200/VI-J00 MODULES   CSB-01
WITH MAXI/MINI/MICRO MODULES   CSB-02

(SEE PAGE 19 AND 20 FOR MORE INFORMATION ON CURRENT SHARE BOARDS.)

All Westcor power supplies can now be configured online using VSPOC, the online configurator tool available on vicorpower.com

A. OUTPUT STUDS - SINGLE OUTPUT (when populated with full size module)

–VOUT

10-32 OUTPUT STUDS

+VOUT
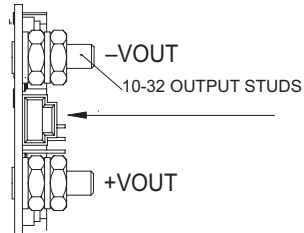
SxJ2 REMOTE SENSE/TRIM
PIN CONNECTOR

3	–SENSE
2	+SENSE
1	TRIM

MATING CONNECTOR:
HOUSING: MOLEX (50-57-9403)
TERMINAL FEM CRIMP 24-30 AWG: MOLEX (16-02-0103)
USE CRIMP TOOL: MOLEX (11-01-0208)

B. 18 PIN MOLEX CONNECTOR - SINGLE OR DUAL OUTPUTS (when populated with half size modules)

9	18
8	17
7	16
6	15
5	14
4	13
3	12
2	11
1	10

SxJ1 (18 PIN OUTPUT, REMOTE SENSE
AND TRIM PIN CONNECTOR)

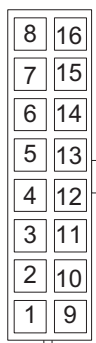| PIN	DESCRIPTION	PIN	DESCRIPTION
1	+VOUT M2	10	+VOUT M2
2	–VOUT M2	11	+VOUT M2
3	–VOUT M2	12	–VOUT M2
4	+SENSE M2	13	+SENSE M1
5	–SENSE M2	14	TRIM M2
6	TRIM M1	15	–SENSE M1
7	+VOUT M1	16	+VOUT M1
8	+VOUT M1	17	–VOUT M1
9	–VOUT M1	18	–VOUT M1

MATING CONNECTOR:
18 PIN HOUSING: MOLEX (39-01-2180)
TERMINAL FEM CRIMP 18-24 AWG: MOLEX (39-00-0039)
USE CRIMP TOOL: MOLEX (11-01-0197)

Note: The current molex connectors are limited to 9A/pin (27A per output). A PFC Micro with DIFFERENT molex connectors that are capable of 40A is available. Contact factory!

C. 16 PIN MOLEX CONNECTOR - SINGLE, DUAL, TRIPLE OUTPUTS (when populated with quarter size modules)

8	16
7	15
6	14
5	13
4	12
3	11
2	10
1	9

*SxJ1 (16 PIN OUTPUT, REMOTE SENSE
AND TRIM PIN CONNECTOR)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	+VOUT M3	9	+VOUT M3
2	–VOUT M3	10	–VOUT M3
3	TRIM M3	11	N/C
4	+VOUT M2	12	+VOUT M2
5	–VOUT M2	13	–VOUT M2
6	TRIM M2	14	TRIM M1
7	+VOUT M1	15	+VOUT M1
8	–VOUT M1	16	–VOUT M1

MATING CONNECTOR:
16 PIN HOUSING: MOLEX (39-01-2160)
TERMINAL FEM CRIMP 18-24 AWG: MOLEX (39-00-0039)
USE CRIMP TOOL: MOLEX (11-01-0197)

Output Connectors for PFC Micro™

(Part #19-130044. Available for purchase from Vicor.)

| Item	Qty	Description	Vendor #1	Part #
1	3	HOUSING 3 POS .100 CTR W/LATCH	MOLEX	50-57-9403
2	8	TERMINAL FEM CRIMP 22-24AWG SEL GOLD	MOLEX	16-02-0103
**		CRIMP TOOL FOR ITEM 2	MOLEX	11-01-0208
3	2	HOUSING 16 POS .165 CTRS W/LATCH	MOLEX	39-01-2160
4	2	HOUSING 18 POS .165 CTRS W/LATCH	MOLEX	39-01-2180
5	40	TERMINAL FEM CRIMP 18-24AWG SEL GOLD	MOLEX	39-00-0039
**		CRIMP TOOL FOR ITEM 5	MOLEX	11-01-0197
6	40	TERMINAL FEM CRIMP 16AWG SEL GOLD	MOLEX	45750-3211
**		CRIMP TOOL FOR ITEM 6	MOLEX	11-01-0199
7	1	HOUSING 5 POS .165 CTRS W/LATCH	MOLEX	39-01-4051
8	5	TERMINAL FEM CRIMP 16AWG SEL GOLD	MOLEX	45750-3211
**		CRIMP TOOL FOR ITEM 8	MOLEX	11-01-0199
9	1	HOUSING 12 POS .10 CTRS W/LATCH	MOLEX	50-57-9412
10	14	TERMINAL FEM CRIMP 24-30AWG SEL GOLD	MOLEX	16-02-0097
**		CRIMP TOOL FOR ITEM 10	MOLEX	11-01-0209
** ITEMS FOR REFERENCE ONLY (NOT INCLUDED IN KIT)				

Power Connections

Chassis Input Power Terminals (MBJ1)

Input AC power is applied through connector MBJ1 using Molex mating connector 39-01-4051. Use 16AWG wire with Molex Socket Pin 39-00-0090 and Crimp Tool 11-01-0199.

A fault-clearing device, such as a fuse or circuit breaker, with a maximum 10A rating at the power supply input is required for safety agency compliance. It should be sized to handle the start-up inrush current of 8.5A peak at $115V_{AC}$ and 17A peak at $230V_{AC}$.

Figure 2
Input power terminal MBJ1
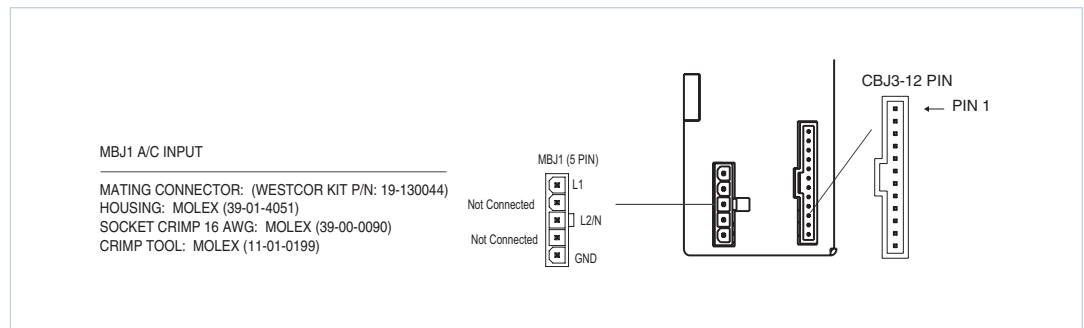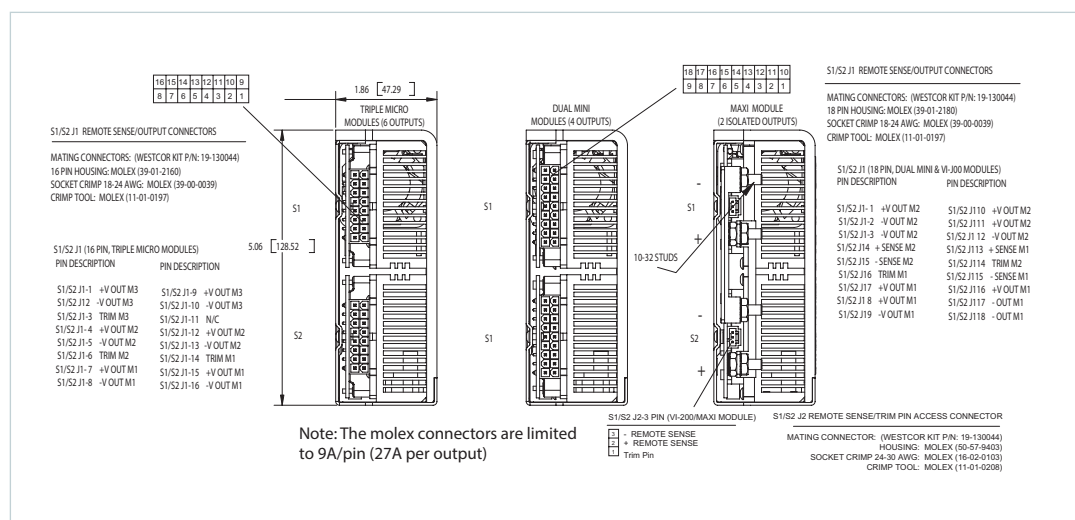
Output Power Connections

There are three types of output power terminals available in the PFC Micro™. Each slot has one of the following configurations: 10-32 plated steel bolts from outputs using full-size converters, an 18-pin Molex connector for outputs using half size converters and a 16-pin Molex connector for outputs using quarter size converters.

Note: The Molex connectors are limited to 9A/pin (27A/output).

The positive polarity of the single-output termination is the right bolt when viewed from the output end. Each power output is isolated, so outputs of positive or negative polarity can be configured through proper selection of the output reference terminal.

In order to minimize parasitic cable inductance and reduce EMI, the output power cables should be routed in close proximity to one another and large current loops should be avoided. To avoid excessive voltage drop, do not undersize power cables, especially for high-current outputs. Do not bulk input AC wires with the output wires because this can couple output noise into the input wires which can increase EMI. Excessive cable inductance coupled with large capacitive loading can introduce instability in switching power supplies. This problem can be avoided with proper system design. Consult the Vicor Applications Engineering Department for assistance with applications that use long cable lengths and excessive load capacitance.

Figure 3
Output power connections

User Interface Connections

Signal Ground (CBJ3-1)

Signal Ground on CBJ3-1 is an isolated secondary ground reference for all CBJ3 interfacing signals. This is not the same as Earth Ground on input power connector MBJ1.

Bidirectional I/O lines (CBJ3-4 to CBJ3-9) (Enable/Disable or Module Power Good Status)

Enable/Disable Mode

Enable/Disable mode is the default condition for these I/O lines. In this mode, the control pins allow the outputs to be sequenced either ON or OFF. To disable a module, the E/D pin should be pulled low to less than 0.7V with respect to signal ground. The E/D lines will typically source 250mA (1mA max.) under this condition. To enable a module, a E/D pin should be open circuited or driven high to a logic-high voltage of 3.5V (40mA typical) or greater not to exceed 5V. (When one has a two module array, use GSD to disable the output instead of using E/D.)

The correspondence between a module and its E/D line as seen from the output end of the power supply goes from left to right. The PFC Micro™ power supply is a two-slot box. Slot 1 is the left slot and Slot 2 is the right slot. See Table 1. E/D1, E/D2, E/D3 correspond with VOUT M1, VOUT M2 and VOUT M3 on slot 1. E/D4, E/D5, E/D6 correspond with VOUT M1, VOUT M2 and VOUT M3 on slot 2.

Table 1
Enable/Disable mode

Module	Slot 1			Slot 2		
	E/D1	E/D2	E/D3	E/D4	E/D5	E/D6
Maxi	X			X		
Mini	X	X		X	X	
Micro	X	X	X	X	X	X
VI-200™	X			X		
VI-J00™	X	X		X	X	

Module Power Good Status Mode

The power supply will enter the Power Good status mode when logic high (50mA typical) is applied to Power Good Read (PGR) pin (CBJ3-2). After transitioning to PGR mode the I/O lines (CBJ3-4 to CBJ3-9) will be outputs and will give a onetime readout of the associated module status. These outputs give an indication of the status of the modules of the power supply at the time of transition to PGR. A TTL "1" (>3.5V) on a line indicates the module is ON and functioning properly and a TTL "0" (<0.7V) indicates the module is either OFF or is not functioning properly. The correspondence between the module and the Power Good status of that module is the same as between a E/D pin and its module. This mode does NOT constantly monitor the module status and must be re-triggered by transitioning the PGR pin from logic-low to logic-high to get current module status.

Procedurally, certain guidelines must be followed when using this feature. Upon application of a logic-high on the Power Good Read (PGR) pin, the user must change its E/D interface (CBJ3-4 to CBJ3-9) from outputs to inputs within 3ms. The Power Good status data will be valid on the E/D lines when the Power Good Data Valid (PGDV) pin (CBJ3-11) asserts to a logic-high. The Power Good status measurement takes typically 200ms. While in the Power Good Read mode (PGR=1) the individual shut-down lines are not functional. However, General Shut Down (GSD) is functional. Leaving the Power Good Read mode is accomplished by removing the logic-high or applying a logic-low (<0.7V) to the Power Good Read (PGR) pin (CBJ3-2). The user must change its E/D interface (CBJ3-4 to CBJ3-9) from inputs to outputs between 1 and 4ms of the time the PGR-low is applied to pin CBJ3-2.

Note: If any model is disabled by the user when a Power Good Read is requested (PGR=1), that module will remain off during the Power Good Read and status of said module will be power not good (<0.7V). Power Good Read status data on open E/D lines are not valid. An open E/D line is a E/D pin where there is no module associated with said E/D line (i.e., A power supply with two Maxi modules, data on E/D2, E/D3 and E/D5 and E/D6 are NOT valid.

The Power Good Status mode feature is only valid when Maxi, Mini and/or Micro modules are used.

The following page shows examples of triggering PGR with a 1Hz square while monitoring PGDV and a selected E/D line with a good module and a defective one.

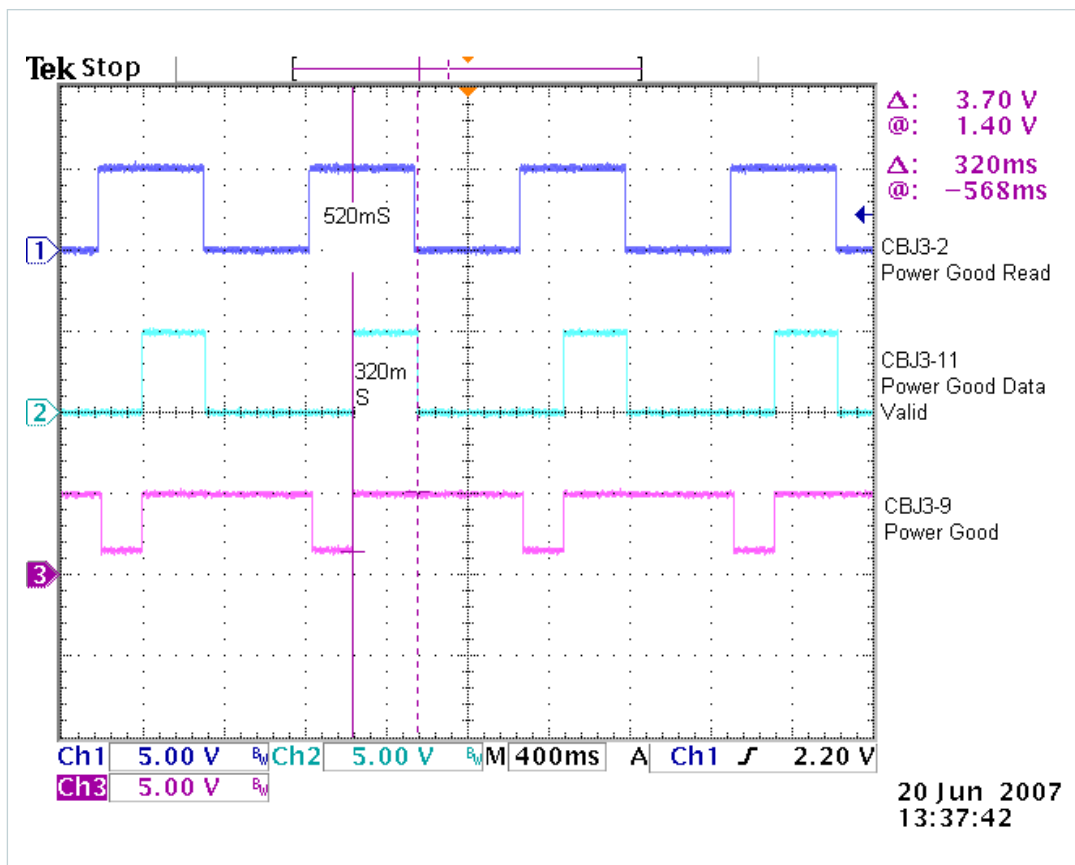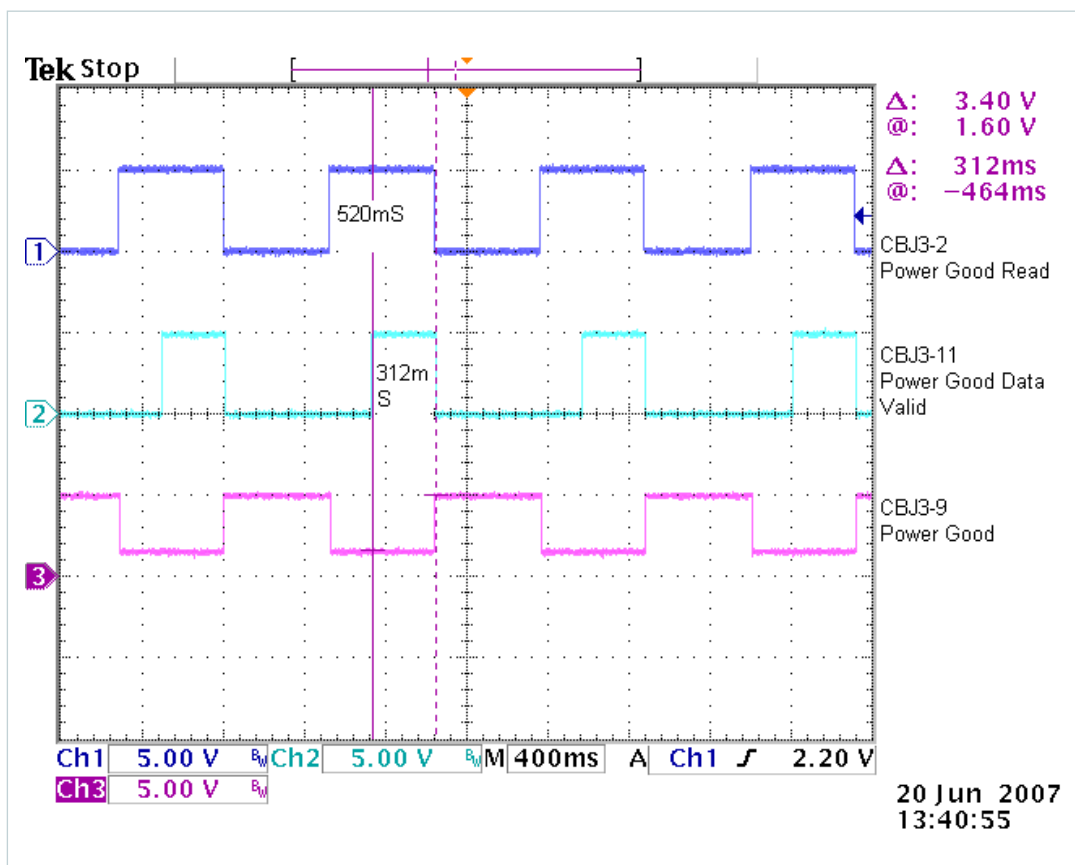**Figure 4**

*Power Good Read
with good module*

Figure 5

*Power Good Read
with defective module*

General Shut Down/GSD (CBJ3-10)

The GSD control pin on CBJ3-10 allows simultaneous shut down of all outputs. This pin must be pulled down to less than 0.7V, and will typically source 250mA (1mA maximum) to shut down all outputs. The GSD pin should be open circuited or driven high to a logic-high voltage of 3.5V or greater when not in use, or when the outputs are to be enabled. Do not apply more than 5V to this input.

AC OK (CBJ3-3)

AC OK is an active high TTL compatible signal and provides a status indication of the AC input power. It is on pin CBJ3-3 and is capable of sinking 5mA maximum. This signal switches to a TTL "1" when the high-voltage bus exceeds low-line condition during turn-on. Upon loss of input power, the bus voltage will drop, causing the AC OK signal to go low. Typically, a 3ms holdup time is provided for a 500W load following the loss of the AC OK signal.

Auxiliary V_{CC} +5V/40mA (CBJ3-12)

The V_{CC} on CBJ3-12 is an auxiliary 5V regulated power source. It is +5V_{DC} ±5% with respect to signal ground and can supply 40mA maximum. It is capable of withstanding a short, but shorted user interface functionality will be lost.

Figure 6
Auxiliary V_{CC}
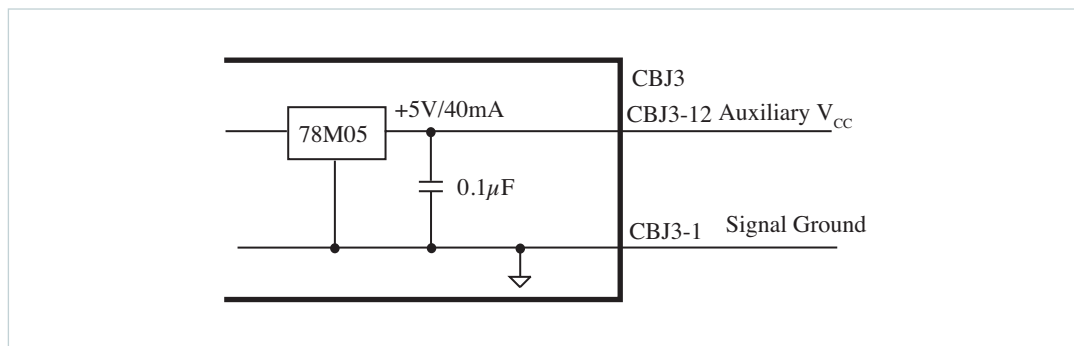
Power Good Read (PGR, CBJ3-2)

This pin initiates the Power Good Read sequence. A logic-high applied to this pin will cause the power supply to enter the Power Good Read status mode. In this mode, the I/O lines (CBJ3-4 to CBJ3-9) will be outputs. These outputs give an indication of the status of the modules of the power supply. A high on an I/O line (CBJ3-4 to CBJ3-9) indicates a module is ON and functioning and a low indicate the module is OFF or in a fault condition. The Power Good status data will be valid on the ED lines (CBJ3-4 to CBJ3-9) when the Power Good Data Valid (PGDV) pin (CBJ3-11) asserts a logic-high. Applying a logic-low or opening the PGR pin puts the power supply back in the enable/disable mode. Instructions for using this function are on page 11 under module Power Good status mode.

Power Good Data Valid (PGDV- CBJ3-11)

Upon entering the Power Good Read status mode (PGR=1, CBJ3-2), the data will not be valid on the I/O lines (CBJ3-4 to CBJ3-9) until the PGDV pin asserts itself logic-high. This pin can source up to 5mA. When this pin is logic-low, Power Good status data is not valid or the power supply is not in the Power Good Read status mode.
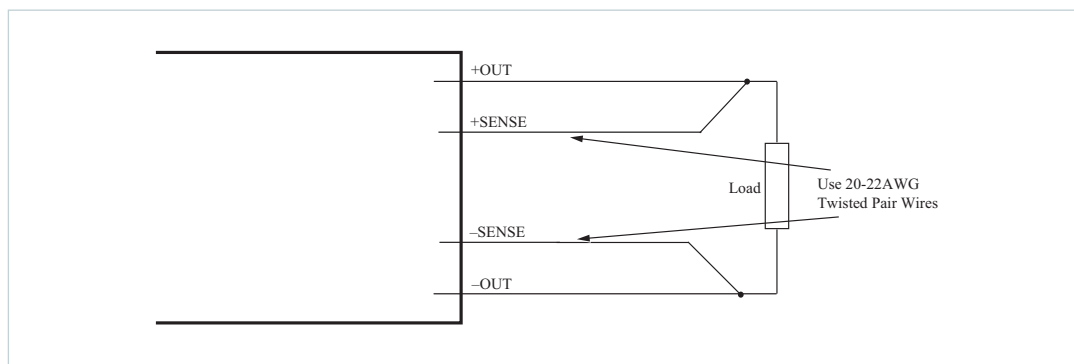
+SENSE/–SENSE (S1/S2 J2)

The sense lines for the outputs are shipped from the factory with Autosense. Autosense provides the user with automatic sensing of the outputs. With Autosense, the PFC Micro™ will automatically operate in a remote-sense mode when the remote-sense connections are made. But in the event that the remote sense is not connected or needed, no local-sense selection is necessary – simply hook up the outputs and the PFC Micro will automatically operate in local-sense mode.

In the local-sense mode (remote-sense lines not connected), the power supply will regulate the output at the output terminals. The voltage appearing at the load may drop slightly due to voltage drop in the power cables. If it is necessary to compensate for voltage drop along the output power cables, the output can be trimmed up or configured for remote sense. Use stranded twisted pair 20 – 22AWG wire for the remote-sense lines. Remote sense can compensate for a voltage drop of up to 0.5V, or 0.25V on each leg.

The sense connector for a single output board is a 3-pin connector providing the +SENSE connection on S1/S2 J2-2 and the –SENSE connection on S1/S2 J2-3. The sense connector for a dual output board is provided on the 18-pin output connector that also provides the output and trim connections. +SENSE and –SENSE for the first output are located on S1/S2 J1-13 and S1/S2 J1-15, respectively. +SENSE and –SENSE for the second output are located on S1/S2 J1-4 and S1/S2 J1-5, respectively. Remote sense is not available for triple-output configurations.
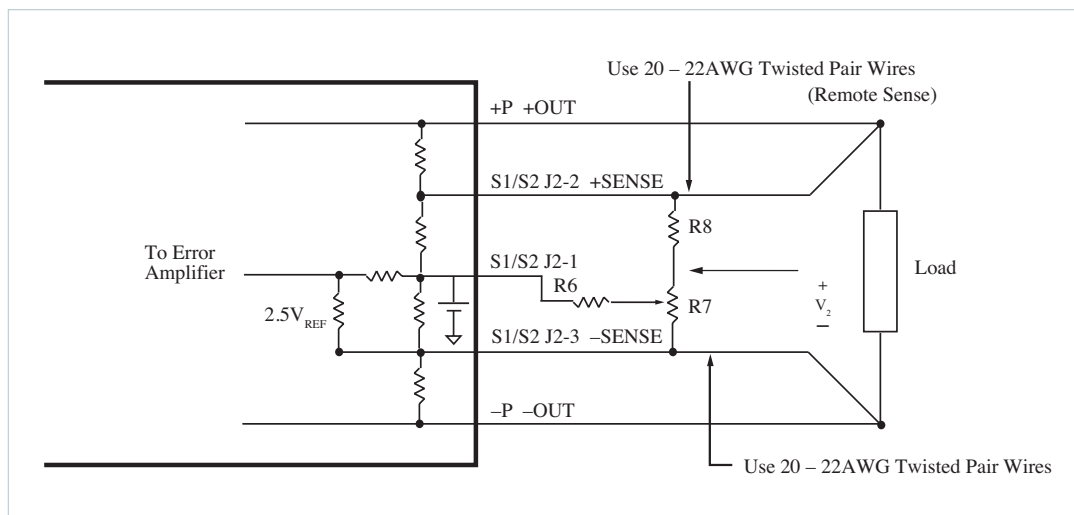
Figure 7
Remote sense

External Trim (S1/S2 J2)

The trim pin at S1/S2 J2 is referenced to the –SENSE pin and can be used for external control of the output voltage. For triple output cards, the Trim pins are available on S1/S2 J2-14, S1/S2 J2-6 and S1/S2 J2-3 for outputs 1, 2 and 3 respectively. For dual-output cards, the trim pins are available at S1/S2 J2-6 and S1/S2 J2-14 for outputs 1 and 2, respectively. For a single-output card, the trim pin is S1/S2 J2-1. A 10% increase to the trim pin voltage will result in a 10% increase in output voltage. Reducing the trim-pin voltage by 10% will result in a 10% decrease in output voltage.

Table 2
Module internal reference voltages and Thevenin resistances

Output Module	V_{REF}	R_{TH}
VI-200™/VI-J00™ ≥ 3.3V	2.50V	10.0kΩ
VI-200/VI-J00 < 3.3V	0.97V	3.88kΩ
Maxi (Predefined)	1.23V	1.0kΩ
Maxi (User Defined)	1.23V	Consult Factory

Figure 8
External pin

Use 20 – 22AWG Twisted Pair Wires
(Remote Sense)

+P +OUT

S1/S2 J2-2 +SENSE

R8

To Error
Amplifier

S1/S2 J2-1

R6

Load

2.5V$_{REF}$

R7

S1/S2 J2-3 –SENSE

+
V$_2$
–

–P –OUT

Use 20 – 22AWG Twisted Pair Wires

Example:

±10% Trim adjust on a 12V nominal output.

Figure 8 shows a typical variable trim circuit. Using a 10kΩ trimpot (R7), the resistor values for R6 and R8 can be calculated as follows:

V$_1$ = V$_{REF}$ + 10% = 2.75V   Given: V$_{REF}$ = 2.5V (see Table 2)

I$_{R5}$ = (2.75V − V$_{REF}$)/R$_{TH}$ = (2.75V − 2.5V)/10kΩ = 25mA   Given: R$_{TH}$ = 10kΩ (see Table 2)

Setting the bottom limit:

V$_{R6}$ = 2.5V − 10% = 2.25V

And since I$_{R5}$ = I$_{R6}$ = 25mA,

R6 = V$_{R6}$/I$_{R6}$ = 2.25V/25mA = 90kΩ

V$_2$ = V$_1$ + V$_{R6}$ = 2.75V + 2.25V = 5V

I$_{R7}$ = V$_2$/R7 = 5V/10kΩ = 500mA

I$_{R8}$ = I$_{R7}$ + I$_{R6}$ = 525mA

V$_{R8}$ = (V$_{NOM}$ + 10%) − V$_2$ = 13.2V − 5V = 8.2V   Given: V$_{NOM}$ = 12V

R8 = V$_{R8}$/I$_{R8}$ = 8.2V/525mA = 15.62kΩ

CONSULT APPLICATIONS ENGINEERING WHEN TRIMMING OUTPUTS BELOW 5V.

Single-Output Power Supplies (Arrays)

Vicor standard configuration for single-output power supplies is to set the left module (as seen from looking at the power supply output) as the controlling module of the array.

Specifications

Typical at 25°C, nominal line and 75% load, unless otherwise specified.

General	
Number of Outputs	1 – 6
Modules	VI/E-200 and VI/E-J00: two VI/E-200s or four VI/E-J00s Maxi: two Maxis, four Minis or six Micros
Efficiency	Typically > 75%
Safety Agency Approvals	cURus – UL 60950-1, CSA 60950-1; cTÜVus – EN 60950-1, UL 60950-1, CSA 60950-1 CE Mark – Low Voltage Directive, 2006/95/EC Note: certain wide temp range MI chassis will not carry all approvals
Maximum Output Power	500W at 115V_{AC}, (100V_{AC} minimum input) [a] 800W at 230V_{AC}, (200V_{AC} minimum input)
Input	
Input	85 – 264V_{AC}, 47 – 500Hz 120 – 300V_{DC} (derated output level)
VI-200™/VI-J00™ Line/Load Regulation	0.2% max from 10% to full load 0.5% max from no load to 10% load
Maxi/Mini/Micro Line Regulation [b]	0.20% max to 0.30%max
Maxi/Mini/Micro Load Regulation [b]	0.20% max to 0.70% max
Inrush Current	8.5A peak @ 115V_{AC} 17A peak @ 230V_{AC}
Ride Through Time	>20ms at 500W load (nominal load)
Conducted EMI	FCC Class A EN 55022 Class A (consult factory) Mil-STD 461 requires external filter
Power Factor	>0.98
Transient Burst Immunity	EN61000-4-4 (consult factory)
Surge Immunity (Common Mode & Normal Mode)	Compliant with IEC 61000-4-5, Level 3, Performance Criteria B (Temporary loss of output power may occur which is self recoverable.)
Dielectric Withstand	Primary to Chassis GND = 2,121V_{DC} Secondary to Chassis GND = 750V_{DC}
MI Chassis Overvoltage and Transients	Compliant to Mil-STD 704 and 1399

[a] Do Not to exceed an input current of 7.5A.
[b] See Vicor module specifications. A preload may be necessary for modules trimmed down below 90% of normal output voltage.

Specifications (Cont.)

Typical at 25°C, nominal line and 75% load, unless otherwise specified.

Output (VI-200™/VI-J00™ Modules)					
Parameter	**Min**	**Typ**	**Max**	**Units**	**Notes**
Set-Point Accuracy [c]		0.5	1	%	of V_{NOM}
Load/Line Regulation		0.05	0.5	%	LL to HL, 10% to Full Load
Load/Line Regulation		0.2	0.5	%	LL to HL, No Load to 10%
Temperature Regulation		0.01	0.02	%/°C	Over rated temperature
Long-Term Drift		0.02		%/K hours	

Output Ripple & Noise:
  ≤10V_{OUT}
  >10V_{OUT}
		100
		1.0
				mV
				% V_{OUT}
					20MHz bandwidth

Voltage Trim Range: VI-200/VI-J00 Slots		50 – 110		% V_{OUT}	±10% on 10 – 15V_{OUT}
Total Remote-Sense Compensation	0.5			Volts	Autosense. See pages 6 & 14
OVP Set Point [d]	115	125	135	%V_{OUT}	Recycle Power
Current Limit	105	115	125	% of I_{MAX}	Auto Recovery
Short Circuit Current	120 (105 [e])		130	%	
Overtemperature Limiting					Not available on VI-J00
Maxi, Mini and Micro Series Modules					
Parameter	**Min**	**Typ**	**Max**	**Units**	**Notes**
Set-Point Accuracy [f]		±0.5	±1	% of V_{NOM}	
Load/Line Regulation		±0.08	±0.45 (±7)	% of V_{NOM}	0 – 100%
Temperature Regulation		0.002	0.005	%/°C	–40 to 100°C
Long-Term Drift		0.02		%/K hours	

Output Ripple and Noise:
  ≤10V_{OUT}
  >10V_{OUT}
		100
		1.0
				mV
				%V_{OUT}
					20MHz bandwidth

Voltage Trim Range: Maxi/Mini/Micro Slots		10 – 110		% V_{OUT}	Preload may be required
Total Remote-Sense Compensation	0.5			Volts	Autosense. See pages 6 & 14 [g]
OVP Set Point	112		135	% of V_{OUT}	Recycle power
Current Limit	102	115	135	% of I_{MAX}	Auto Recovery
Overtemperature Limiting					Not available

[a] Do Not to exceed an input current of 7.5A.
[b] See Vicor module specifications. A preload may be necessary for modules trimmed down below 90% of normal output voltage.
[c] For special and adjustable voltages, maximum set-point accuracy is 2% of V_{NOM}.
[d] 131% nominal for booster modules. No OVP for VI-J00.
[e] VI-J00 modules only.
[f] For special, adjustable voltages and 48V_{DC} outputs, maximum set-point accuracy is 2% of V_{NOM}.
  Note: See individual module data sheets for specific module specifications.
[g] Micro modules do not support remote sense.

Specifications (Cont.)

Typical at 25°C, nominal line and 75% load, unless otherwise specified.

Environmental	
Storage Temperature	–40 to +85°C

Operating Temperature
   Full Power
   Half Power
	
	–20 to +45°C (–40 to +45°C option w/MI chassis)
	–20 to +65°C (–40 to +60°C option w/MI chassis)

Altitude	Derate 2.6% total output power for each 1,000ft to a maximum operating altitude of 15,000ft. Non-operating storage maximum altitude is 40K.
Shock and Vibration	Mil-STD 810 (MI rugged chassis only)
Humidity	0 – 95% non condensing
Product Weight	5.2lbs [2,4kg]
Dimensions	1.86 x 5.06 x 10.40in [47,3 x 128,5 x 264,1mm]
Warranty [h]	2 years limited warranty. See vicorpower.com for complete warranty statement.

[a] Do Not to exceed an input current of 7.5A

[b] See Vicor module specifications. A preload may be necessary for modules trimmed down below 90% of normal output voltage.

[c] For special and adjustable voltages, maximum setpoint accuracy is 2% of V_{NOM}.

[d] 131% nominal for booster modules. No OVP for VI-J00.

[e] VI-J00 modules only.

[f] For special, adjustable voltages and 48V_{DC} outputs, maximum set-point accuracy is 2% of V_{NOM}.
   Note: See individual module data sheets for specific module specifications.

[g] Micro modules do not support remote sense.

[h] Opening, repairing or modifying the unit will void the warranty. If you have any problem with the power supply, please contact Customer Service at 1-800-735-6200. If the unit needs to be returned for inspection/analysis, an RMA number will be issued. All units must have a RMA number prior to return.

Output Power De-Rating
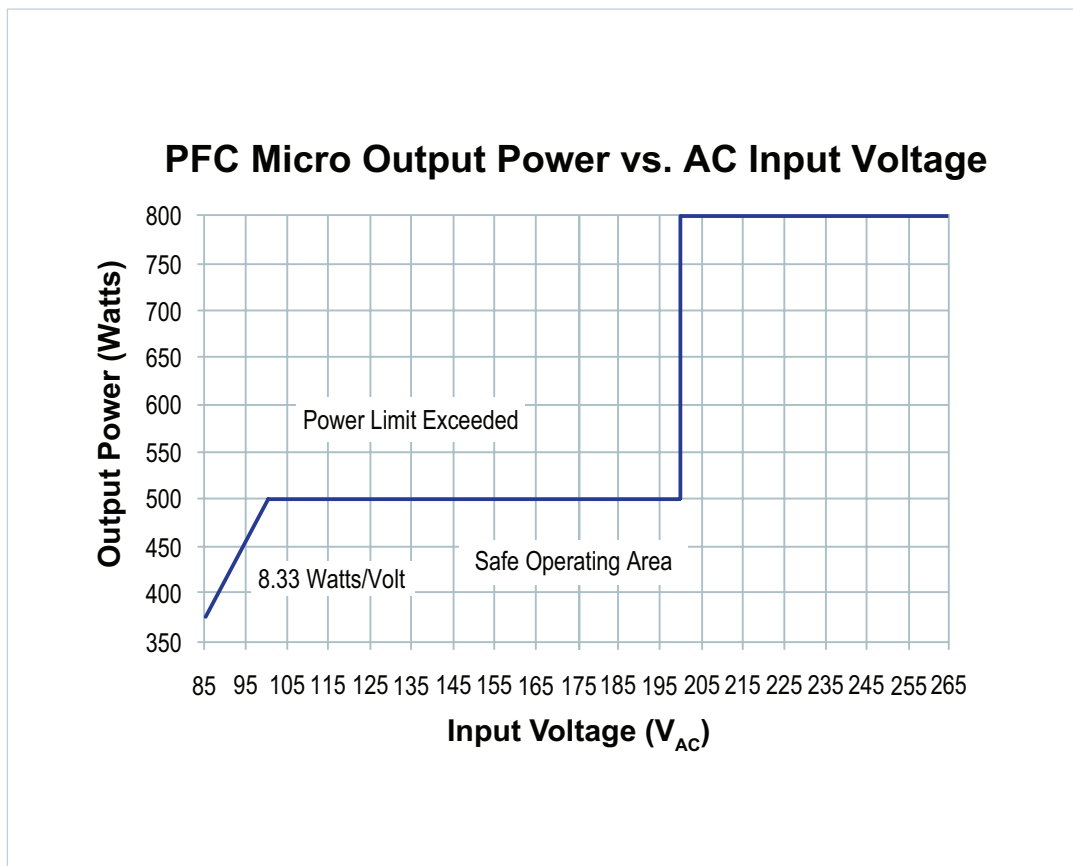
PFC Micro Output Power vs. AC Input Voltage

Output Power (Watts) vs. Input Voltage (V$_{AC}$)

Power Limit Exceeded

8.33 Watts/Volt

Safe Operating Area

PFC Micro Output Power vs. DC Input Voltage

Output Power (Watts) vs. Input Voltage (V$_{DC}$)

Power Limit Exceeded

Safe Operating Area
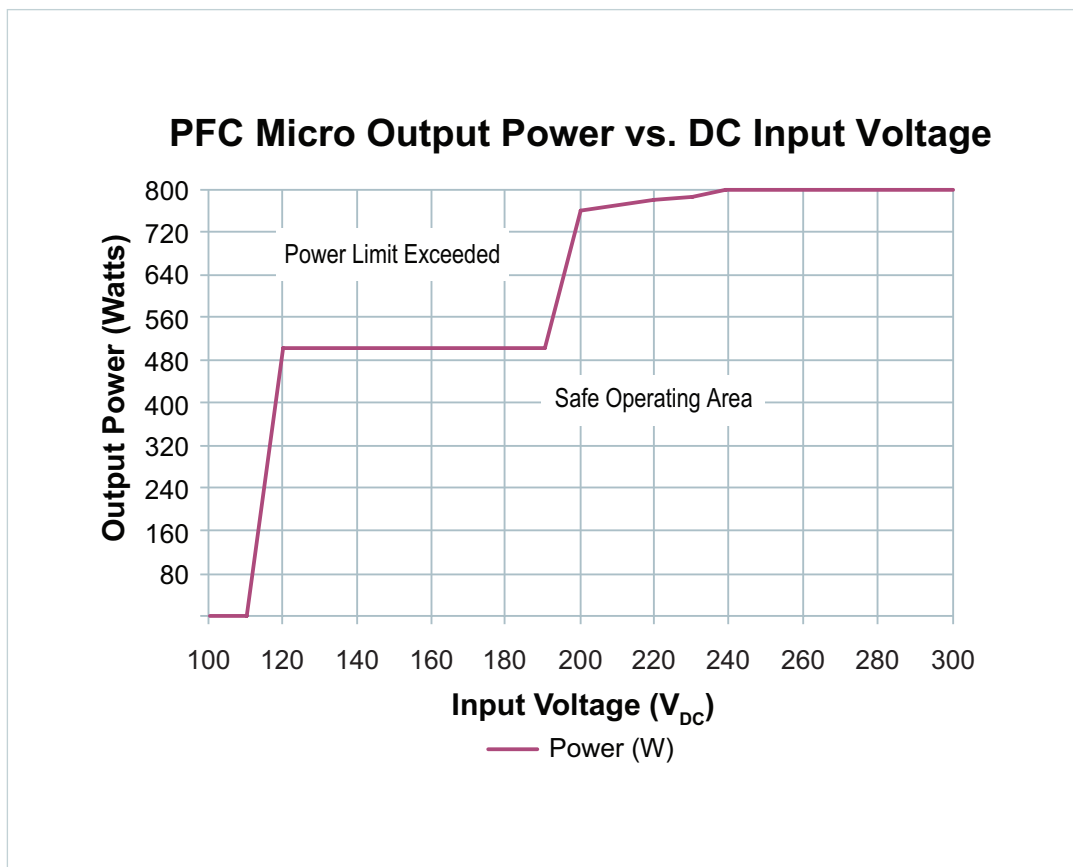
Power (W)

Figure 11

*PFC Micro™ output power
temperature de-rating*

PFC Micro: Output Power Temperature De-Rating
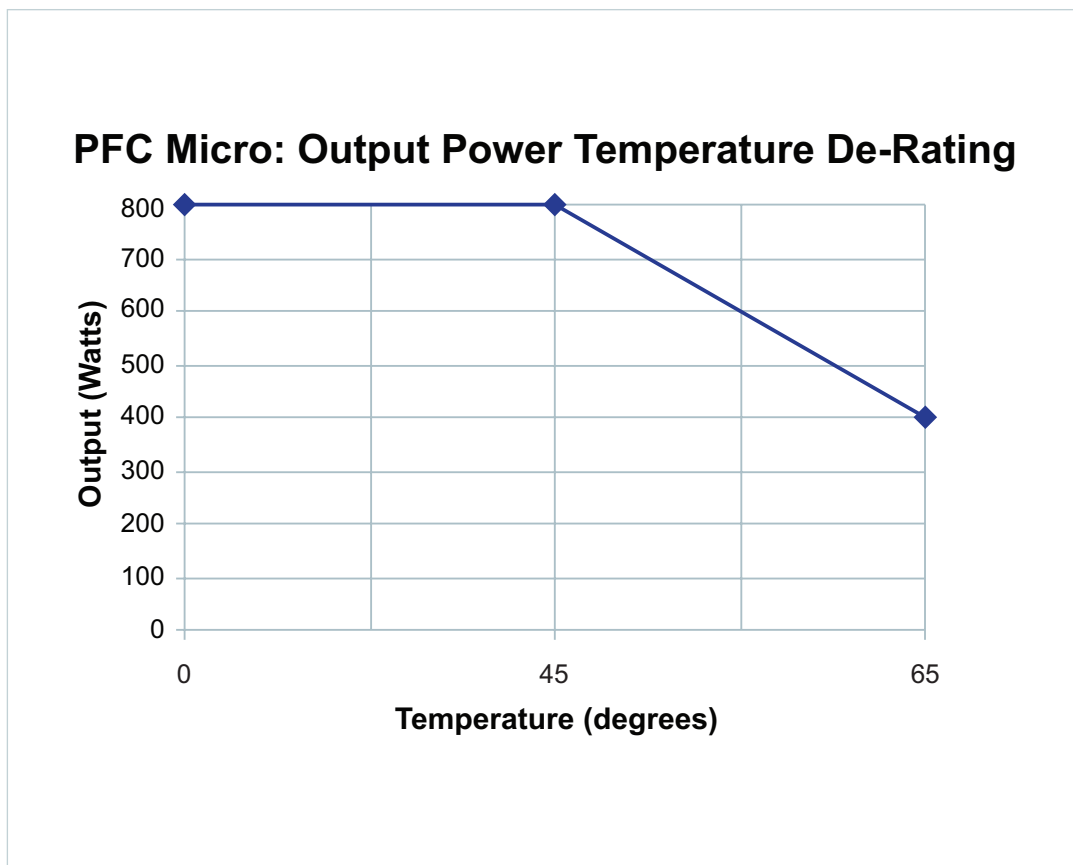
1. For all module configurations. The PFC Micro or an individual output may be limited by module power limitations e.g. 5V Maxi module is 400W maximum. One cannot exceed the output power rating of the PFC Micro regardless of the module capability.

2. Also see output power vs. input voltage charts on page 19.

3. Please note that a PFC Micro configuration that uses a Molex connector is limited to 9A/pin (27A per output). This is a Molex connector limitation, NOT a module power limitation. Please consult Applications Engineering for assistance on requirements that exceed the 27A limitation.
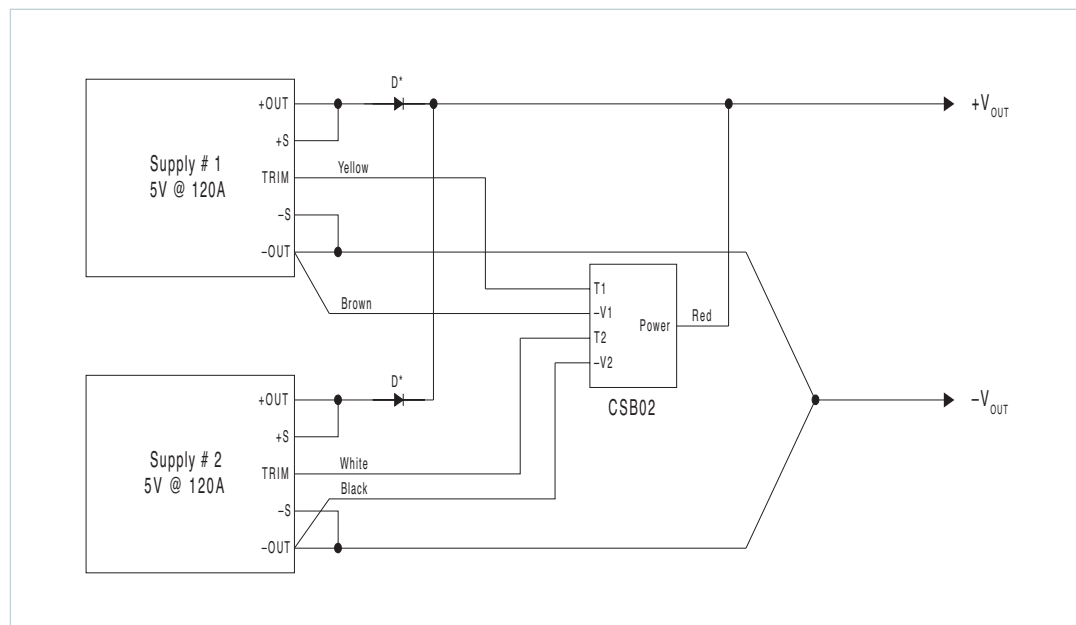
Current Share Boards – Optional Feature

"Current sharing" also known as load sharing, is the ability to divide the output current evenly across all active power supplies. This greatly reduces stresses on each power supply and allows them to run cooler, resulting in higher reliability. Standard "current sharing" techniques typically utilize shunt resistors or Hall-Effect devices to measure the current from each power supply. Power shunt resistors continually dissipate power and require cooling especially when dealing with high output currents of >100A. Hall-Effect devices measure magnetic fields generated by current flowing through a conductor and although they dissipate no power, they tend to be large and expensive.

First developed by Vicor Engineering for paralleling MegaPAC™ supplies, the box-to-box Current Share Board or CSB allows two or more Vicor power supplies to current share by utilizing the inherent voltage drop produced in the negative output return cable. This eliminates the need for additional shunt resistors or expensive Hall-Effect devices and provides a simple five-wire connection method to achieve a ±1mV accuracy between the negative output power rails. This accuracy translates to a 1% current sharing if there is a total of 100mV conductional voltage drop in the negative return path.

Constructed as a current source to drive the trim pin of a Vicor module, the design uses an accurate comparator circuit to monitor the power returns. In addition, the circuit is unidirectional and can only trim an output voltage up. The benefit is that only the supply that is supporting less current is adjusted up. This action balances the currents to the load by matching the output voltages of the supplies. In the case of one supply failing, the circuit will attempt to trim the failed supply only. This will leave the remaining functional supply alone to provide power to the load at its nominal voltage. Thus the circuit also offers simple redundancy. In addition, because CSB functions as a current source, the trim outputs (T1 and T2) of the CSB can be placed in parallel to create a summing node. This allows current sharing between more than two supplies by paralleling the T2 output of one CSB circuit with the T1 output of the next CSB.

Please Note: The CSB is not intended for use in hot-swap applications.

Figure 12
CSB interconnect example

Current Share Boards – Optional Feature (Cont.)

Requirements:

1. For proper operation, the power supplies being paralleled should be enabled at the same time.

2. –OUT conductors must be of equal length and wire gauge. Separate –OUT conductors must be used from each supply to the load, or the use of a "Y" connection to a common point must be used as shown in Figure 12. Each leg of the "Y" must have a minimum of a few millivolts of drop in order for proper operation. 50 – 100mV of drop will provide from 5 – 1% accuracy.

3. –V1 and –V2 for all box-to-box circuits must be connected directly at the negative output power studs or terminals to achieve accurate current sharing.

4. D* can be added if redundancy is needed. If redundancy is not required, D* can be replaced with direct wire connections.

5. When using D*, the power input should be connected on the cathode side of the paralleling diodes as shown above.

6. Terminate sense leads either locally or remotely as shown in Figure 12.

7. For paralleling more than two supplies, consult factory for assistance.

0.13in [3.3mm] Dia Non
Plated thru hole 4
places

2 1
4 3
6 5

Molex CT43045F surface mountable
connector. .390" height above board.

1.74"
[44.2mm]

1.500"
[38.1mm]

0.12"
[3.0mm]

0.12"
[3.0mm]

0.900"
[22.9mm]

1.14"
[29.0mm]

J1 Pinout

Pin	Description
1	Power
2	T1
3	–V1
4	T2
5	–V2
6	No Connection
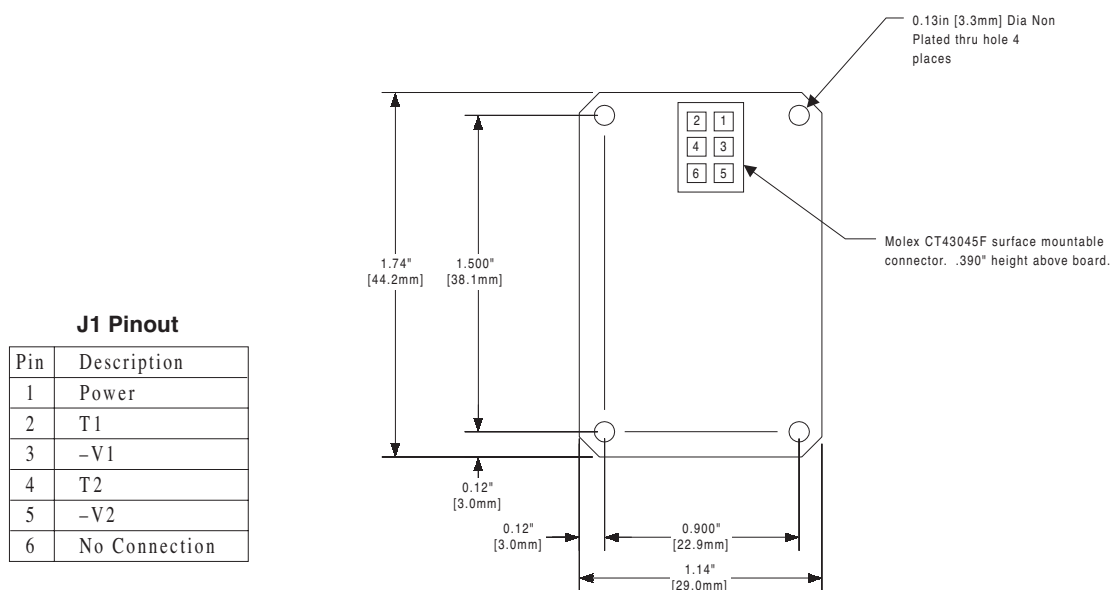
Figure 13. Mechanical Drawing

24.0" +/- 1.0"

P1

Red, 22 AWG — Power

Yellow, 22 AWG — T1

Brown, 22 AWG — –V1

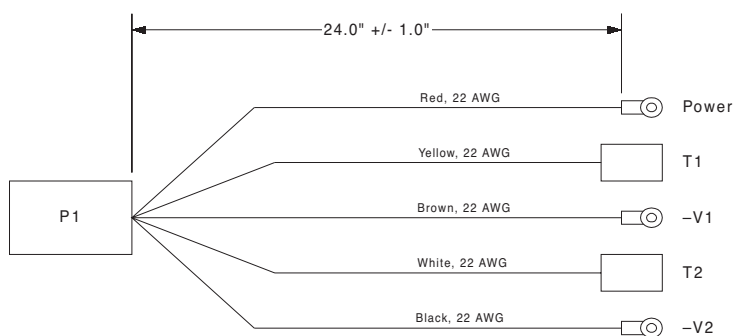White, 22 AWG — T2

Black, 22 AWG — –V2

Figure 14. Cable Drawing

Specifications:

1. Power: 2 – 50V$_{DC}$ at 5mA maximum.

2. Accuracy: ±1mV between –VOUT connections.

3. Output current when not trimming up: ±1µA (VI-200/J00), ±5µA (Maxi).

4. Use four non-plated through holes with standoffs for mounting.

5. CSB01 MUST be used for current sharing VI-200™/VI-J00™ converters.

6. CSB02 MUST be used for current sharing Maxi/Mini/Micro converters.

PLEASE NOTE: THE CSB IS NOT INTENDED FOR HOT-SWAP APPLICATIONS.

Contact your Regional Applications Engineer at 1-800-927-9474 for additional information.

For more information about this or other Vicor products, or for assistance with component-based power system design, contact the Vicor office nearest you. Vicor comprehensive line of power solutions includes modular, high-density DC-DC converters and accessory components, configurable power supplies, and custom power systems. Vicor designs and builds configurable power supplies incorporating Vicor high-density DC-DC converters and accessory components.

This product line includes:

LoPAC™ FAMILY:

- PFC MicroS™
- PFC Micro™
- PFC Mini™

MegaPAC™ FAMILY:

- PFC MegaPAC™
- 4kW MegaPAC™
- PFC MegaPAC™ (High Power)
- PFC MegaPAC-EL™
- Mini MegaPAC™
- ConverterPACs™

Others:

- FlatPAC-EN™

Rugged COTS versions (MI) are available for the PFC Micro, PFC MicroS, PFC Mini, PFC MegaPAC.

Limitation of Warranties

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