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PFC Mini™
Power Factor Corrected AC-DC Switcher

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Overview

The PFC Mini is an extremely low-profile 1RU switching power supply that combines the advantages of power-factor correction and high power density. This guide covers both standard- and rugged-chassis COTS (MI) versions of the product. The PFC Mini can provide up to six isolated outputs (three slots) and each slot accommodates the following Vicor DC-DC Converters.

VI/E-200™ and VI/E-J00™ series: one VI/E-200 or two VI/E-J00 converters

Maxi, Mini Micro series: one Maxi, two Mini converters (Micros cannot be used)

The use of these converters give the PFC Mini the inherent power flexibility typical of all Vicor products. Accepting input voltages of 85 – 264V_{AC}, and 100 – 380V_{DC}, the PFC Mini can provide up to 1,500 Watts in a package size of 1.72 x 6 x 12.2in [43,6 x 152,4 x 309,9mm]. The PFC Mini is factory-configured to meet user requirements.

Note: If you have a PFC Mini that shipped from October 2005 onwards, please see Page 18 for more details.

Standard Features

- Power factor correction: 0.99 at $115V_{AC}$; 0.95 at $230V_{AC}$
- Universal input: 85 – $264V_{AC}$, 47 – 500Hz, or 100 – $380V_{DC}$
- Power output: 1,500W at $230V_{AC}$; 800W at $115V_{AC}$
- Up to six isolated outputs (three slots)
- Fan cooled
- Full power to 45°C; half power at 65°C
- Conducted EMI:

VI-200™/VI-J00™ series:	**Maxi, Mini, Micro series:**
FCC Class B	FCC Class A
EN55022 Class B	EN55022 Class A (certain configurations meet EN55022 Class B)

- Harmonic distortion complies with EN61000-3-2
- AC Power OK status signal
- Autosense (for more information, see Page 8 and Page 13)
- Output overcurrent protection on all outputs
- Output overvoltage protection (not applicable when using VI-J00)
- Output overtemperature limiting (not applicable when using VI-J00)
- Ride-through (hold-up) time: >20ms at 1,200W load (nominal line)
- Size: 1.72 x 6 x 12.2in [43,6 x 152,4 x 309,9mm]
- Safety agency approvals: CE Mark, cTÜVus, UL
  (Note: certain MI chassis may not carry all safety certs.)

Optional Features

- Extended temperature range output converters
- Current share board - see Page 23
- RAM™ modules for low noise applications - see Page 26
- Connector kit available (#19-130047)
- Low leakage available – see Page 26
- Office environment fan – see Page 26
- MI-chassis-specific options:
  - Mil-STD-810 for shock and vibration
  - Mil-STD-704 and -1399 for overvoltage and transients
  - –40°C Operation
  - Conformal coating – contact factory

Mechanical Considerations

The PFC Mini™ can be mounted on either of two surfaces using standard 8-32 (4 mm) size screws. Maximum allowable torque is 4.4in·lbs and the maximum penetration is 0.16in [4mm]. When selecting a mounting location and orientation, the unit should be positioned so airflow is not restricted. Maintain a 2in [5,1cm] minimum clearance at both ends of the PFC Mini and route all cables so airflow is not obstructed. The power supply draws air in at the fan-side/AC-input side and exhausts air out the load side. If airflow ducting is used, avoid sharp turns that could create back pressure. The fans move approximately 20CFM 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. In such applications, a shock-absorbing mount design is required.

PFC Mini Dos and Don'ts

- **If sense jumpers are removed, do not leave sense lines open (especially if unit does not have Autosense). Sense lines must be terminated to their respective outputs. Use twisted pair 20 – 22AWG wire when installing remote sense**
- **NEVER** disconnect the +OUT and –OUT load wires while the supply is operating as disconnecting WILL cause damage to the power supply. Ensure load wires connected before remote sense connected.
- To prevent damage to supply, verify polarity of remote-sense connection before turning supply on.
- Always turn the power supply off before disconnecting input or output wires.
- Do not restrict airflow to the unit. The cooling fan draws air into the unit and forces it out at the output terminals.
- Run the output (+/–) power cables next to each other to minimize inductance.
- Do not repair or modify the power supply in any manner. Doing so will void the warranty. Contact Factory.
- 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 UL60950. Appropriate care must be taken in design implementation of the supply.

Technical Description

The PFC Mini consists of an offline single-phase, power-factor-corrected front end, EMI filter, cooling fan, customer interface, associated housekeeping circuits and a selection of Vicor DC-DC converters.

Input AC mains voltage is applied to a terminal block. The input current is passed through an EMI filter designed to meet conducted noise limit "B" specifications in FCC Part 15 and EN55022, Class B (with VI-200™/VI-J00™ series modules. If Maxi, Mini, Micro series modules are used, it meets FCC Class A and EN55022 Class A. (Certain configurations meet Class B).

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 EN61000-3-2). 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.

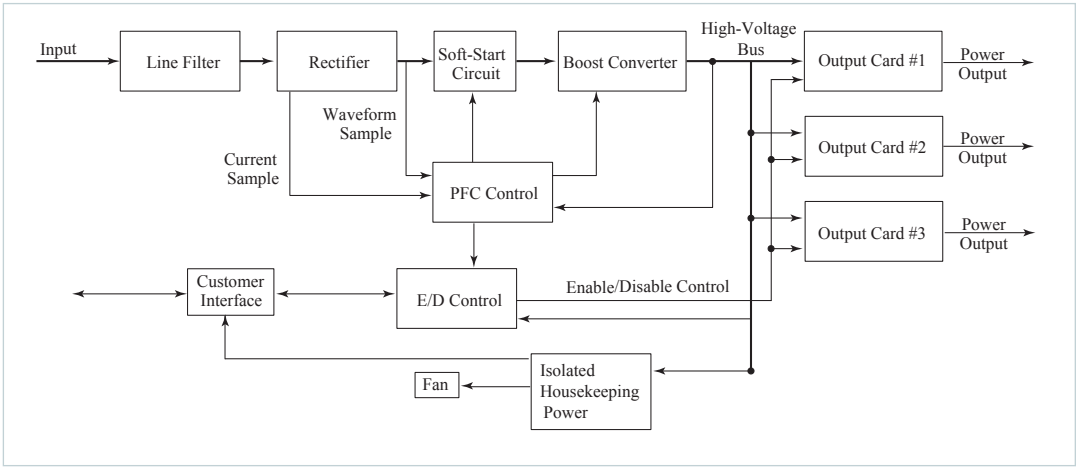
Voltage conversion is achieved by the Vicor family of zero-current switching (ZCS) DC-DC converters. These are forward converters in which the main switching element switches at zero current. This patented topology has a number of unique attributes: low switching losses; high-frequency operation, resulting 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 Mini™ 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 operating with PWM current-mode control converts the high-voltage DC bus into regulated low voltage to power the internal housekeeping circuits and DC cooling fans.

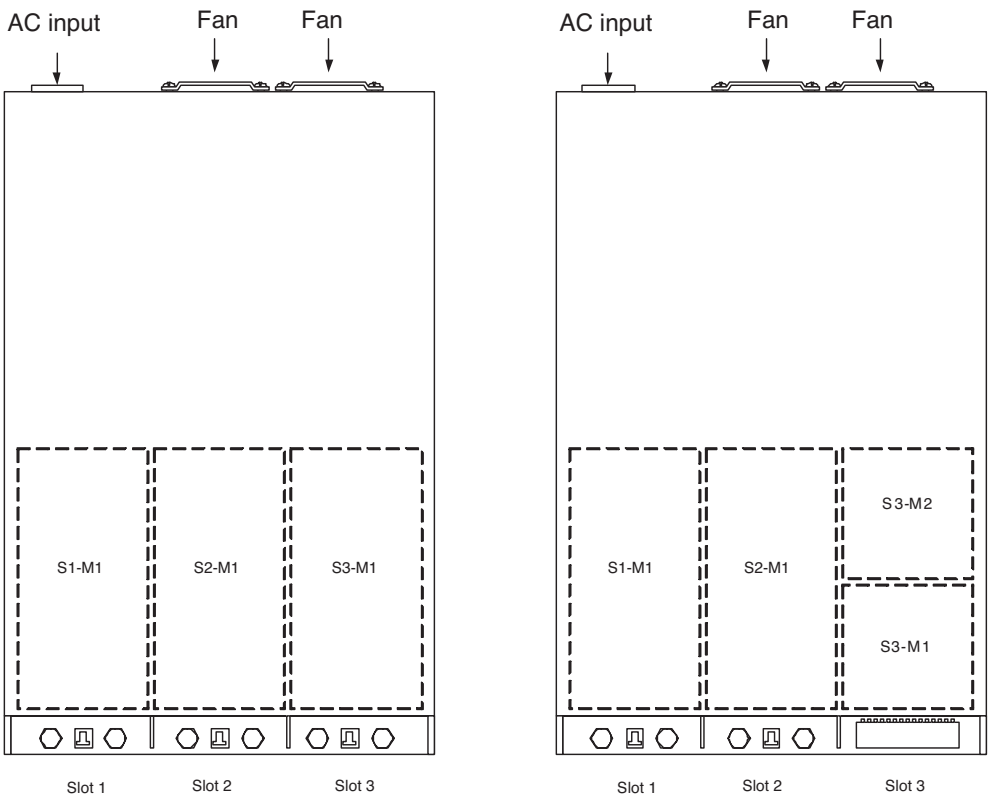
The internal housekeeping V_{CC} comes up within two seconds after the application of input power. Once the high-voltage bus is within operating limits, the AC Power OK signal asserts to a TTL "1," indicating the input power is OK and enables the power outputs. An auxiliary V_{CC} output of $5V_{DC}$ sourcing up to 0.3A is provided for peripheral use.

An output enable / disable function is provided by using an optocoupler to control Vicor DC-DC converters. If the enable / disable control pin is pulled low, the optocoupler turns on and disables the output. The nominal delay associated for an output to come up when measured from release of the enable / disable pin is 5 – 10ms. The General Shut Down function controls all outputs simultaneously and works in a similar manner.

Figure 1



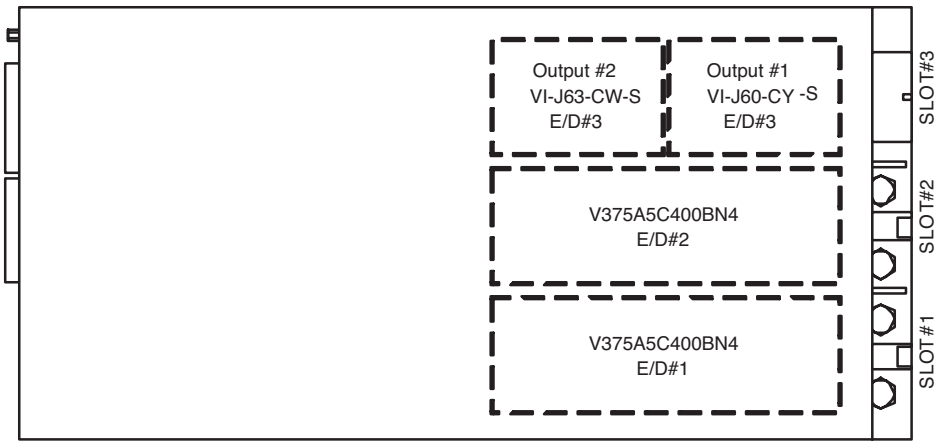
PFC Mini™ Configuration Layout



Shown above are two sample PFC Mini configuration layouts. Due to the configurability nature of the PFC Mini, various output combinations are possible. See Page 11 for more information about your output connections. The PFC Mini has three slots, and each slot accommodates either full- or half-brick modules.

Please note that the maximum output power of the PFC Mini is 1,500W at $230V_{AC}$, 800W at $115V_{AC}$, irrespective of the maximum output power of the modules; e.g., if a PFC Mini is configured with three Maxi modules on the configuration sheet, the maximum output power of the module (600W) is listed. However, irrespective of the maximum output power of the three Maxi modules (1,800W), the maximum output power of the PFC Mini is still 1,500W at $230V_{AC}$ and 800W at $115V_{AC}$.

When populated with 12V modules, the maximum output power per slot is 500W (with other modules it is 600W). Hence, when a 12V Maxi module is used, the maximum output power is limited to 500W. If a 12V Mini module is used, the maximum output power is limited to 250W.



Configuration Example:

SLOT#	VOLTS	AMPS	WATTS	Modules
1	5.0	80	800	V375A5C400BN4*
2				V375A5C400BN4*
3 (M1)	5.0	10	50	VI-J60-CY-S*
3 (M2)	24.0	4.2	100	VI-J63-CW-S*

* Actual module part numbers may vary depending on customer configuration

E/D = Enable/Disable

Part Numbering

PFC Mini™ **PMx_1-x_2 x (x_4)-xxxx(-x_5)(-x_6)**

e.g.: PM4-22-2988
PM1-03B-48
PM3-03-2643-2
PM6-60-2888-2-QF

PM = PM

x_1 = number of outputs

x_2 = number of VI-200™/VI-J00™

x_3 = number of Maxi, Mini

x_4 = optional - standard product designator

xxxx = configuration/customer specific # assigned by Vicor

x_5 = optional factory assigned note

x_6 = additional option codes revised to orginal configuration

MI = rugged chassis + **MC** for conformal coated rugged

QF = quiet fan/office enviornment

LL = low leakage

PFC MegaPAC™ Quick Install Instructions

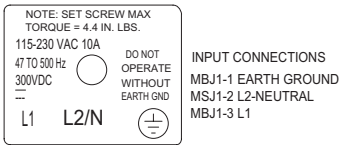
(For mechanical drawing, see Page 9)

Mounting the PFC Mini™

- Mount the PFC Mini on either of two sides.
- Use #8-32 or 4mm mounting screws. Maximum penetration should not exceed 0.16in [4mm].
- Maintain 2in [5,1cm] clearance at both ends of power supply for airflow.

Input Connections

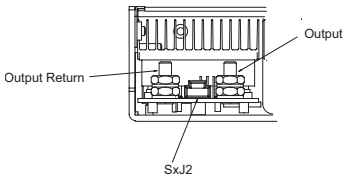
Input Power MBJ1



- Apply input AC power to terminal block MBJ1 using a pressure screw terminal.
- Strip length of AC power conductors to be 0.35 inches.
- Maximum torque is 4.4in·lbs.
- Place a fuse or circuit breaker in the input line for safety requirements.
- The connector manufacturer recommends the wires not be tinned. A ferrule can be used to prevent fraying.

Output Connections (see Page 10 for more details on output connectors)

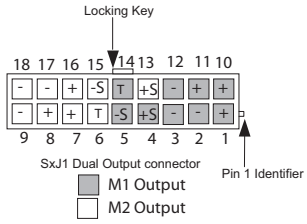
Power Connections



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

- The right stud is Positive and the left stud is the Return.
- Remove the top nut and place ring lug over output stud.
- Do not remove the lower nut next to the PCB.
- Replace and tighten the nut to a torque of **10 inch pounds. Do Not over-tighten nuts.**

Installing power connectors with 18-pin molex connectors [a] (when half size module used):



- SxJ1-1, SxJ1-10, SxJ1-11 are Positive for output #1, while pins SxJ1-2, SxJ1-3, SxJ1-12 are the Return.
  SxJ1-7, S3J1-8 and SxJ1-16 are Positive for output #2, while pins SxJ1-9, SxJ1-17 and SxJ1-18 are the Return. [b]
- Use Molex mating receptacle #39-01-2180 with #44476-3112 terminals.
- Attach 18 – 24AWG stranded wire using Molex tool #11-01-0199.
- Current PFC Minis have 18-pin SxJ1 connectors.

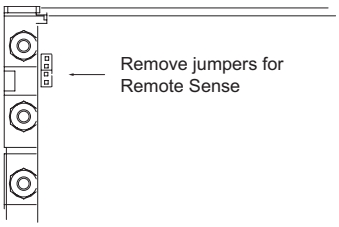
Note: Effective January 2001, all PFC Mini units have 18-pin connectors (Molex PN#39-01-2180) vs. the 14-pin (Molex PN# 39-01-2140). If you already have a 14-pin design in, remove the harness assembly from the 14-pin connector housing and insert the harness connector pins into the 18-pin connector housing. For further information, contact an Applications Engineer.

[a] Outputs with current molex connectors are limited to 9A/pin (27A per output).
[b] Where x refers to the slot number.

Sense Connections

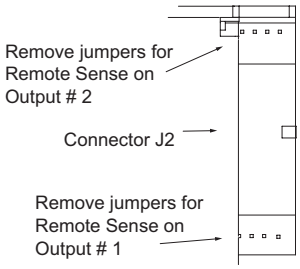
Note: PFC Mini™ units built after 12/2000 have been equipped with a feature called Autosense. If no sense connections are made, the PFC Mini will automatically operate in local-sense mode. If remote-sense connections are made, the PFC Mini will operate in a remote-sense mode.

For units built before 12/2000 (units without Autosense), Sense connections must **ALWAYS** be made. Not connecting Sense Lines to their respective outputs can cause failure to the unit.



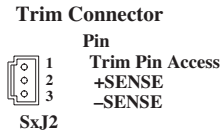
Sense connections on output connections with studs

- PFC Minis are currently shipped with Autosense installed. Those without the Autosense were shipped with local sense installed. (See note on Page 13)
- If remote sense is desired, remove jumpers MBJ1 and J3, located behind the sense connector.
- Connector pin SxJ2-2 is the +SENSE and SxJ2-3 is the –SENSE.
- Use Molex mating receptacle #50-57-9403 with #16-02-0103 terminals.
- Attach terminals to 20 – 22AWG stranded twisted pair wire using Molex tool #11-01-0208.
- Attach opposite end of sense lines to point where regulation is desired.
- Verify that sense lines are not cross-connected.



Sense connections on output connection with Molex connectors

- PFC Minis are currently shipped with Autosense installed. Those without the Autosense were shipped with local sense installed. (See note on Page 13)
- If remote sense is desired, remove jumpers on MBJ1 and J3, located on either side of the output connector.
- Connector pin SxJ1-4 is the +SENSE and SxJ1-5 is the –SENSE for output #1. SxJ1-13 is the +SENSE and SxJ1-15 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.



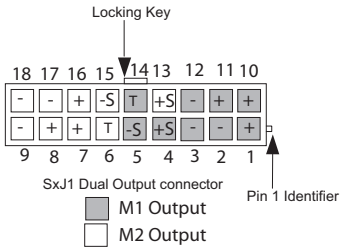
Trim Connections

Trim connections on outputs with studs:

- SxJ2-1 provides trim access.
- Use Molex mating receptacle #50-57-9403 with #16-02-0103 terminals.
- Attach 20 – 22AWG stranded wire using Molex tool #11-01-0208.

Trim connections on outputs with Molex connectors:

- SxJ1-14 provides trim access for output #1, and SxJ1-6 provides trim access for output #2.
- Use Molex mating receptacle #39-01-21 with #39-00-0039 terminals.
- Attach 18 – 24AWG stranded wire using Molex tool #11-01-0197.



Interface Connections

- J3-1 to 3 are Enable/Disable for cards 1-3, respectively.
- J3-4 is Signal Ground, J3-5 is +5V, J3-6 is AC Power OK, and J3-7 is General Shutdown.
- Use mating receptacle AMP P/N 205204-4 with terminals AMP P/N 66506-9.
- Attach terminals to 18 – 24AWG stranded wire.

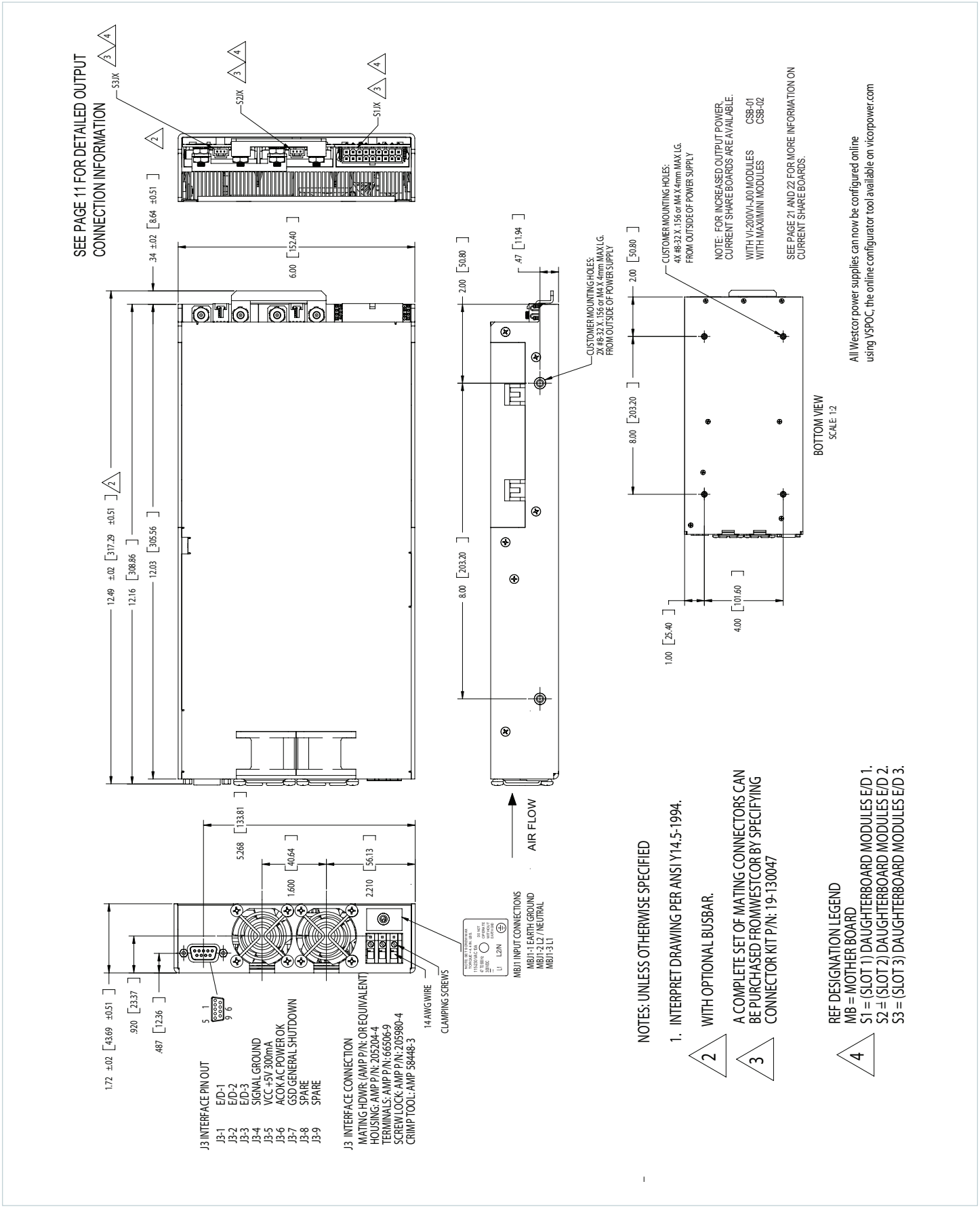
J3 INTERFACE CONNECTION

MATING HDWR:
HOUSING: AMP P/N 205204-4
TERMINALS: AMP P/N 66506-9
SCREW LOCK: AMP P/N 205980-4
CRIMP TOOL: AMP 58448-3

J3 INTERFACE PIN OUT

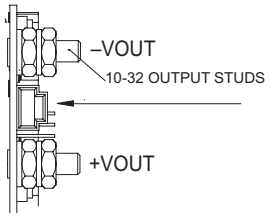
J3-1	E/D-1
J3-2	E/D-2
J3-3	E/D-3
J3-4	SIGNAL GROUND
J3-5	VCC +5V 300mA
J3-6	ACOK AC POWER OK
J3-7	GSD GENERAL SHUTDOWN
J3-8	SPARE
J3-9	SPARE

PFC Mini™ Mechanical Drawing



Output Connectors for PFC Mini™

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



SxJ2 REMOTE SENSE/TRIM PIN CONNECTOR

3	–SENSE
2	+SENSE
1	TRIM

MATING CONNECTOR:
HOUSING: MOLEX P/N 50-57-9403
TERMINALS: MOLEX P/N 16-02-0103
USE CRIMP TOOL: MOLEX P/N 11-01-0208

B. MOLEX CONNECTOR - SINGLE OR DUAL OUTPUT - (when populated with half-size modules)
18-pin Housing



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

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

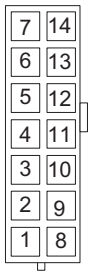
MATING CONNECTOR:
18-PIN HOUSING: MOLEX (39-01-2180)
TERMINAL FEM CRIMP 18 – 24AWG: MOLEX (39-00-0039)
USE CRIMP TOOL: MOLEX (11-01-0197)

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

M1 Output

M2 Output

C. MOLEX CONNECTOR - SINGLE OR DUAL OUTPUT SLOT (14-pin Housing - PFC Minis built prior to 1/2001)



SxJ1 (14-PIN OUTPUT, REMOTE SENSE AND TRIM PIN CONNECTOR)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	+SENSE M1	8	–SENSE M1
2	+OUTPUT M1	9	+OUTPUT M1
3	–OUTPUT M1	10	–OUTPUT M1
4	TRIM M1	11	TRIM M2
5	+OUTPUT M2	12	+OUTPUT M2
6	–OUTPUT M2	13	–OUTPUT M2
7	+SENSE M2	14	–SENSE M2

MATING CONNECTOR:
14 PIN HOUSING: MOLEX (39-01-2140)
TERMINAL FEM CRIMP 18 – 24AWG: MOLEX (39-00-0039)
USE CRIMP TOOL: MOLEX (11-01-0197)

PFC Mini™ Connector Kit (19-130047) Listing

(Available for purchase)

Item	Qty	Description	Vendor #1	Part #
1	3	HOUSING 3 POS .100 CTR W/LATCH	MOLEX	50-57-9403
2	10	TERM FEM CRIMP 22-24AWG SEL GOLD	MOLEX	16-02-0103
**		CRIMP TOOL FOR ITEM 2	MOLEX	11-01-0208
3	1	HOUSING FEMALE D-SUB 09 PIN	AMP	205204-4
3	10	TERM MALE CRIMP 22 – 24 AWG TIN	AMP	66506-9
3	1	SCREW LOCK MALE (1 PAIR)	AMP	205980-4
**		CRIMP TOOL FOR ITEM 3	AMP	58448-3
4	3	HOUSING 18 POS .165 CTR W/LATCH	MOLEX	39-01-2180
5	60	TERM FEM CRIMP 18 – 24AWG SEL GOLD	MOLEX	39-00-0039
**		CRIMP TOOL FOR ITEM 5	MOLEX	11-01-0197
6	60	TERM FEM CRIMP 16AWG SEL GOLD	MOLEX	45750-3211
**		CRIMP TOOL FOR ITEM 6	MOLEX	11-01-0199
** ITEMS FOR REFERENCE ONLY (NOT INCLUDED IN KIT)				

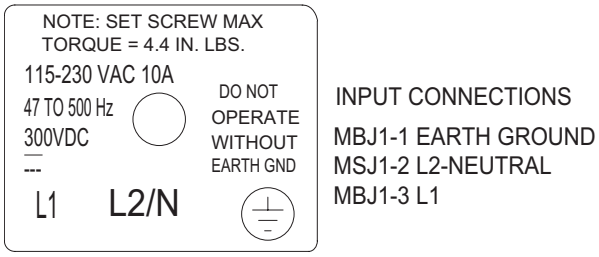
Interface Connections

Chassis Input Power Terminals (MBJ1)

Input AC power is applied to terminal block MBJ1 using a pressure screw terminal that accepts a maximum wire size of 14AWG. The insulation should be stripped 0.35 inches and the maximum torque applied to the screws should not exceed 4.4in·lbs. The connector manufacturer recommends the wires not be tinned. A ferrule (Phoenix P/N 32-00-58-0, provided in optional connector kit) can be used to prevent fraying. MBJ1-1 (GND) is Earth Ground for safety; MBJ1-2 (L2) and MBJ1-3 (L1) are the other "hot" connections.

A fault clearing device, such as a fuse or circuit breaker, with a maximum 15A rating at the power supply input is required for safety agency compliance. It should be sized to handle the start up inrush current of $8.5A_{PK}$ at $115V_{AC}$ and $17A_{PK}$ at $230V_{AC}$.

Figure 2
Input power terminal MBJ1



Output Power Connections

There are two types of output power terminals available in the PFC Mini. Outputs from full-sized converters are terminated in two 10-32 plated steel bolts. The positive polarity of the output is the right bolt when viewed from the output end. Outputs from half-sized converters terminate in a Molex connector.

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

Note: Effective January 2001, PFC Minis using VI-J00 modules on a dualboard (dual output) now require an 18-pin connector (Molex PN# 39-01-2180) vs. a 14-pin (Molex PN# 39-01-2140), making them the same as dualboards with Mini converters. If you already have a 14-pin design in, the change to the 18-pin should not affect your design in. Remove the harness assembly from the 14-pin connector housing and insert the harness connector pins into the 18-pin connector housing. Contact Field Applications for further information.

Figure 3
Power connections for single output

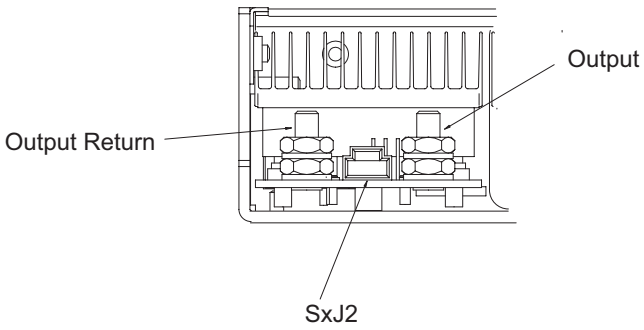
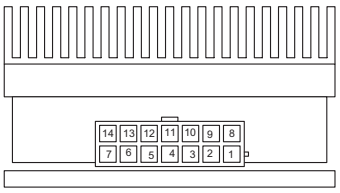
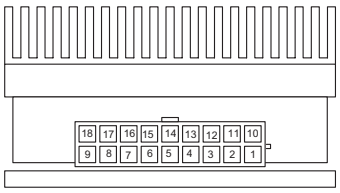


Figure 4
Power connections for dual output



14 PIN DUAL MODULE OUTPUT CONNECTIONS

PIN DESCRIPTION	PIN DESCRIPTION
SxJ1-1 +SENSE M1	SxJ1-8. –SENSE M1
SxJ1-2. +OUTPUT M1	SxJ1-9. +OUTPUT M1
SxJ1-3. –OUTPUT M1	SxJ1-10. –OUTPUT M1
SxJ1-4. TRIM M1	SxJ1-11. TRIM M2
SxJ1-5. +OUTPUT M2	SxJ1-12. +OUTPUT M2
SxJ1-6. –OUTPUT M2	SxJ1-13. –OUTPUT M2
SxJ1-7. +SENSE M2	SxJ1-14. –SENSE M2



18 Pin DUAL MINI AND JR. MODULE OUTPUT CONNECTIONS

PIN DESCRIPTION	PIN DESCRIPTION
SxJ1-1. +OUTPUT M1	SxJ1-10. +OUTPUT M1
SxJ1-2. –OUTPUT M1	SxJ1-11. +OUTPUT M1
SxJ1-3. –OUTPUT M1	SxJ1-12. –OUTPUT M1
SxJ1-4. +SENSE M1	SxJ1-13. +SENSE M2
SxJ1-5. –SENSE M1	SxJ1-14. TRIM M1
SxJ1-6. TRIM M2	SxJ1-15. –SENSE M2
SxJ1-7. +OUTPUT M2	SxJ1-16. +OUTPUT M2
SxJ1-8. +OUTPUT M2	SxJ1-17. –OUTPUT M2
SxJ1-9. –OUTPUT M2	SxJ1-18. –OUTPUT M2

+SENSE/ –SENSE (SxJ2/SxJ1)

Current PFC Mini™ units are shipped with Autosense installed. If the unit does not have Autosense, sense selection is very important. In units without Autosense, the sense lines for the outputs are shipped from the factory with local sense installed. If remote sense is desired the local-sense jumpers can be removed for individual outputs. If the local-sense jumpers are removed, the sense lines must be connected for remote sense. **Leaving the sense lines open will prevent proper output regulation and can result in damage to the unit.**

When local sense is used, 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.

Installing remote sense requires the local-sense jumpers to be removed. On single output cards, the local-sense jumpers are located behind the sense connector on MBJ1 and J3. To remove the jumpers, make certain the power to the supply is off and pull them off the connectors MBJ1 and J3. On dual output cards, the local-sense jumpers are on either side of the output connector at MBJ1 and J3. The jumpers at MBJ1 are for output #1 and the jumpers at J3 are for output #2.

The sense connector for a single output board is a 3-pin connector providing the +SENSE connection on SxJ2-2 and the –SENSE connection on SxJ2-3. The sense connector for a dual output board is an 18-pin connector that also provides the output and trim connections. +SENSE and –SENSE for the first output are located on SxJ1-4 and SxJ1-5, respectively. +SENSE and –SENSE for the second output are located on SxJ1-13 and SxJ1-15, respectively.

Figure 5
Removing local-sense jumpers

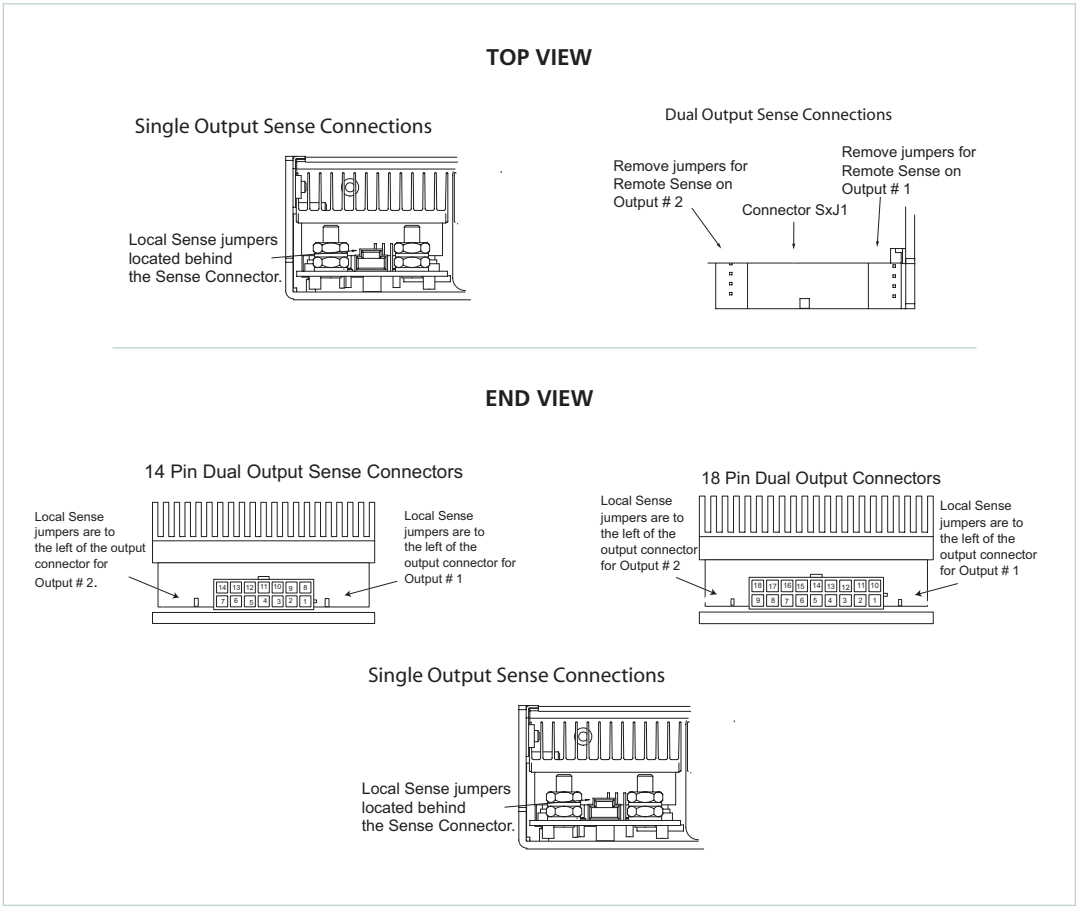


Figure 6
Remote sense

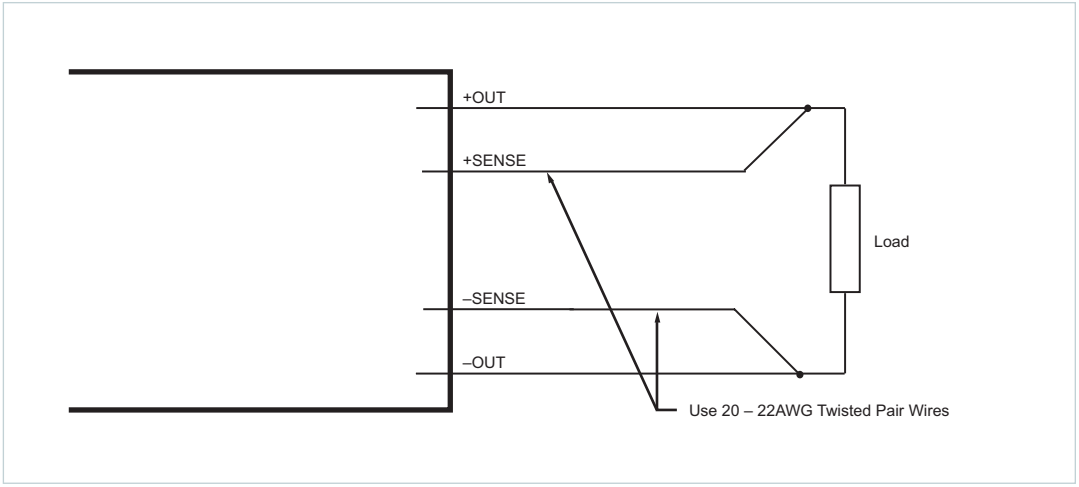


Figure 7
External trim

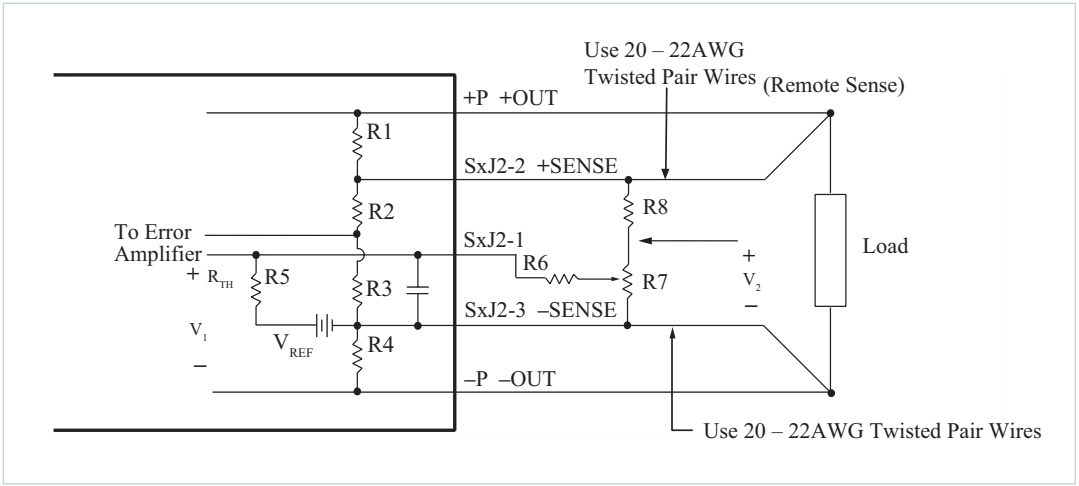


Table 1
Module internal reference voltages and Thevenin resistances

Output Module	V_{REF}	R_{TH}
VI-200™/VI-J00™ ≥3.3V	2.5V	10.0kΩ
VI-200/VI-J00 <3.3V	0.97V	3.88kΩ
Maxi, Mini Micro series (Predefined)	1.23V	1kΩ
Maxi, Mini Micro series (User Defined)	1.23V	Consult Factory

External Trim (SxJ2/SxJ1)

The Trim pin at SxJ2 is referenced to the –SENSE pin and can be used for external control of the output voltage. For dual-output cards, the trim pins are available at SxJ1-14 and SxJ1-6 for outputs 1 and 2, respectively. 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.

Note: Converters are sometimes pre-trimmed at the factory if a non-standard output voltage is requested. If a non-standard voltage is requested, the resistor calculations will differ from those that follow. Consult Vicor Applications Engineering for assistance.

Example:

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

Figure 7 shows a typical variable trim circuit. Using a 10kΩ trimpot (R7), the resistor values for R6 and R8 can be calculated as follows:

$\mathbf{V_1} = V_{REF} + 10\% = 2.75V$ Given: $V_{REF} = 2.5V$ (see Table 1)

$\mathbf{I_{R5}} = (2.75V - V_{REF})/R_{TH} = (2.75V - 2.5V)/10k\Omega = 25\mu A$ Given: $R_{TH} = 10k\Omega$ (see Table 1)

Setting the bottom limit:

$\mathbf{V_{R6}} = 2.5V - 10\% = 2.25V$

And since $I_{R5} = I_{R6} = 25\mu A$,

$\mathbf{R6} = V_{R6}/I_{R6} = 2.25V/25\mu A = 90k\Omega$

$\mathbf{V_2} = V_1 + V_{R6} = 2.75V + 2.25V = 5V$

$\mathbf{I_{R7}} = V_2/R7 = 5V/10k\Omega = 500\mu A$

$\mathbf{I_{R8}} = I_{R7} + I_{R6} = 525\mu A$

$\mathbf{V_{R8}} = (V_{NOM} + 10\%) - V_2 = 13.2 - 5V = 8.2V$ Given: $V_{NOM} = 12V$

$\mathbf{R8} = V_{R8}/I_{R8} = 8.2V/525\mu A = 15.62k\Omega$

CONSULT APPLICATIONS ENGINEERING WHEN TRIMMING OUTPUTS BELOW 5V.

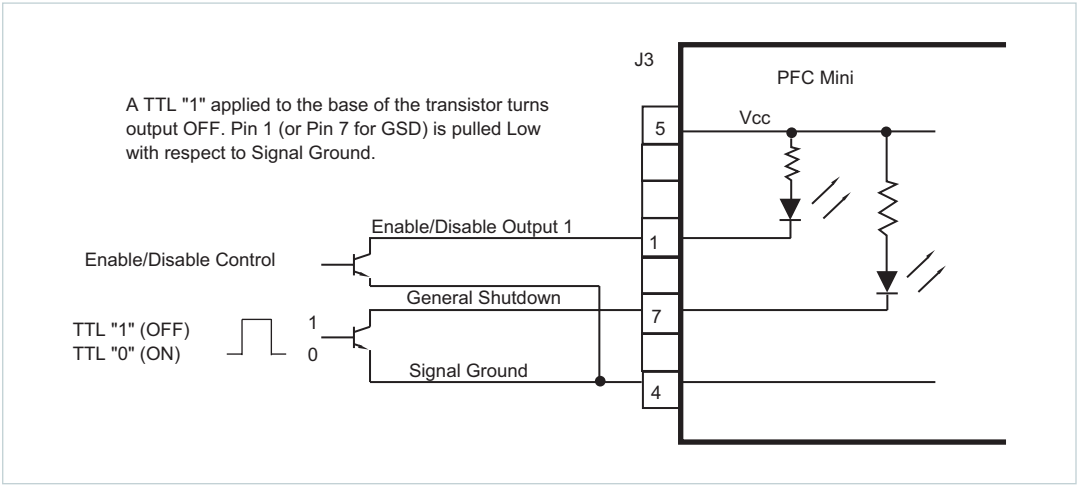
Signal Ground (J3-4)

Signal Ground on J3-4 is an isolated secondary ground reference for all J3 interfacing signals. This is not the same as Earth Ground on input power connector MBJ1.

Enable/Disable (J3-1 to J3-3)

The Enable/Disable control pins allow outputs to be sequenced either on or off. J3-1 through J3-3 are the control pins for output cards 1 through 3, respectively. For 2-output cards, both outputs are enabled or disabled with a single control. The Enable/Disable pins should be pulled low to less than 0.7V with respect to Signal Ground to disable the outputs. They will source 4mA maximum. These pins should be open circuited or allowed to exceed 4.5V when enabled. Do not apply more than 5V to these inputs.

Figure 8
Enable / disable and general shut down



Enable / Disable Control of Maxi, Mini, Micro Series Module Arrays

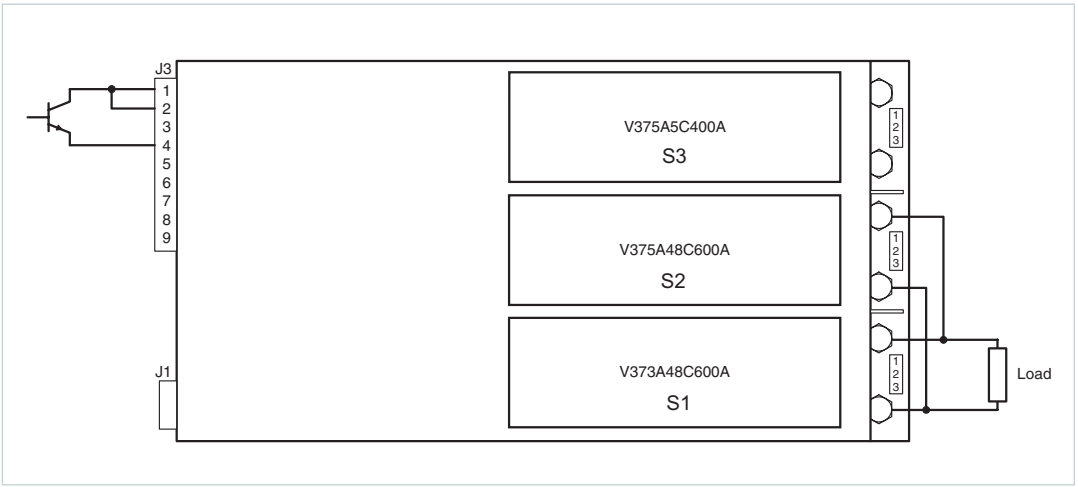
When using the enable / disable function on an output that consists of two or more Maxi/Mini series modules, it is necessary to connect the enable / disable pins of the corresponding module locations together such that both modules are commanded to turn ON or OFF simultaneously.

Example: S1 and S2 has been configured as a single output parallel array (see Figure 9)

In order to disable the 48V output, enable / disable 1 and 2 should be shorted together as shown in Figure 9. With enable / disable 1 and 2 connected together, a single switch can then be used to remotely enable and disable the output.

Note: For single-output Maxi/Mini series power supply configurations, the simplest method of remotely enabling and disabling the output is to use the General Shut Down (GSD) function.

Figure 9
Enable / disable control of Maxi, Mini, Micro series module arrays



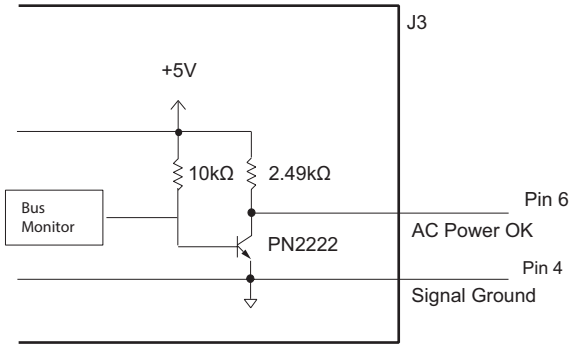
General Shutdown/GSD (J3-7)

The GSD control pin on J3-7 allows simultaneous shut down of all outputs. This pin must be pulled down to less than 0.7V and will source 4mA maximum to shut down all outputs. The GSD pin should be open circuited or allowed to exceed 4.5V when not in use or when the outputs are to be enabled. Do not apply more than 5V to this input at any time. Normal open-circuit voltage is 1.5 – 3V with respect to signal ground.

AC OK (J3-6)

AC OK is an active high TTL-compatible signal and provides a status indication of the AC input power. It is on pin J3-6 and is capable of sinking 16mA 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. A minimum of 3ms hold-up time is provided for a 1,200W load following the loss of the AC OK signal.

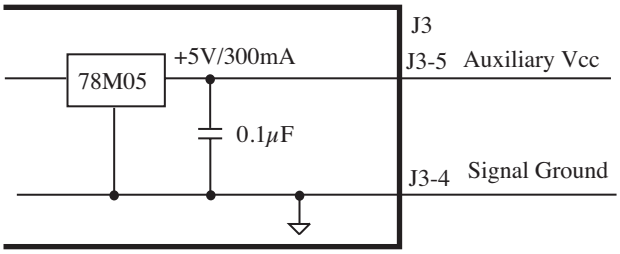
Figure 10
AC OK



Auxiliary V_{CC} +5V/0.3A (J3-5)

The V_{CC} on J3-5 is an auxiliary 5V regulated power source. It is $+5V_{DC}$ ±5% with respect to signal ground and can supply 300mA maximum. It is short-circuit proof, but if shorted all outputs will shut down through the enable / disable circuitry.

Figure 11
Auxiliary V_{CC}



Single-Output Power Supplies (Arrays)

The 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.

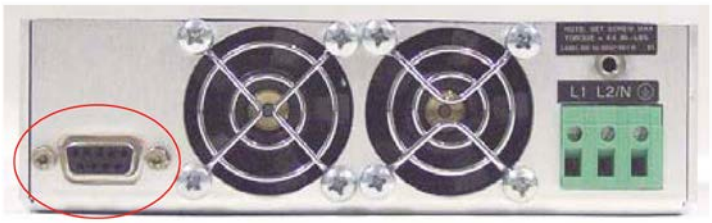
Minor Changes for PFC Mini™ Shipped October 2005 Onwards

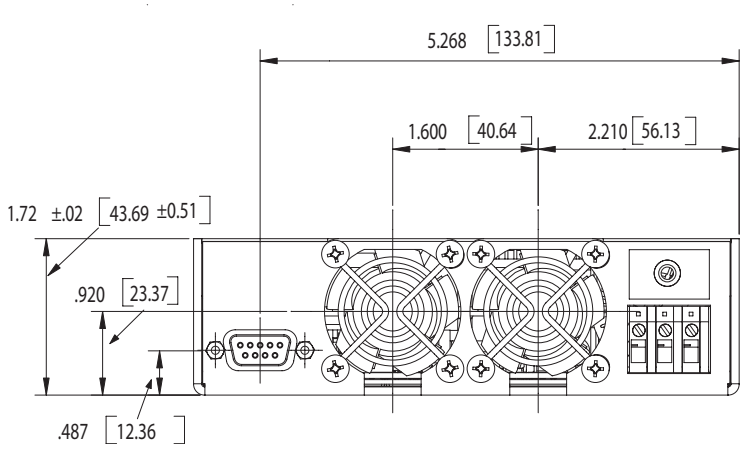
As part of our philosophy of continuous improvement for the PFC Mini, Vicor made a number of changes to the unit. Usually such actions have no impact on form, fit, or function of the supplies. In this instance, the improvements required minor changes in the external appearance of the supply. The fans have been moved 0.62in and are now centered. The D-Sub logic connector has also been rotated 90 degrees. Please see the following photos for a visual comparison. **No other external dimensions, mounting locations, or performance characteristics have been changed.**

PFC Mini - without change



PFC Mini - with change





How to Identify When Your Unit was Manufactured

Serial numbers for Vicor products are determined as follows:

XXXXXXXMMYY

XXXXXXX = Factory assigned

MM = Month of manufacture

Y = Last digit of year of manufacture

PFC Mini™ Output Power vs. Input Voltage

Figure 12
PFC Mini™ output power vs. AC input voltage

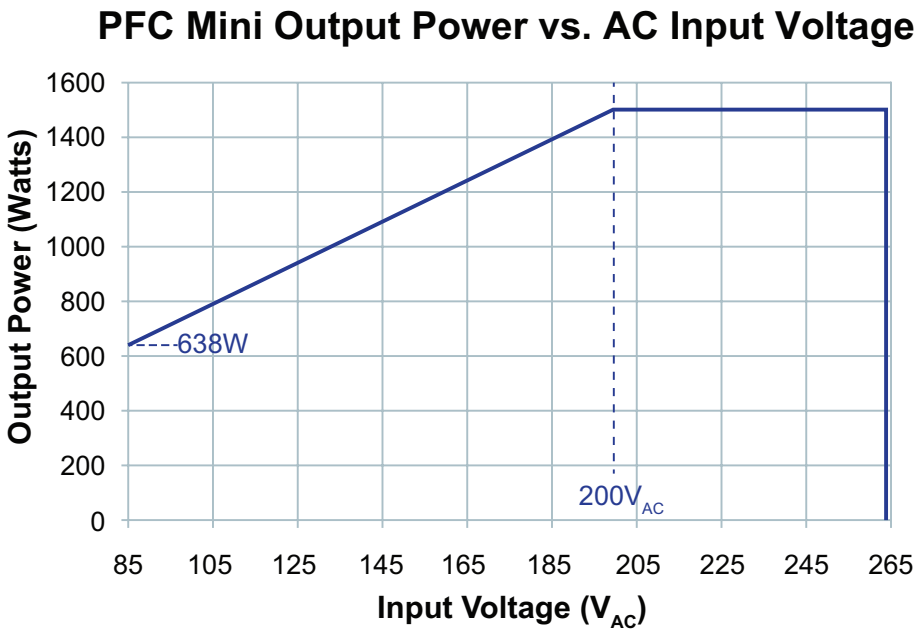
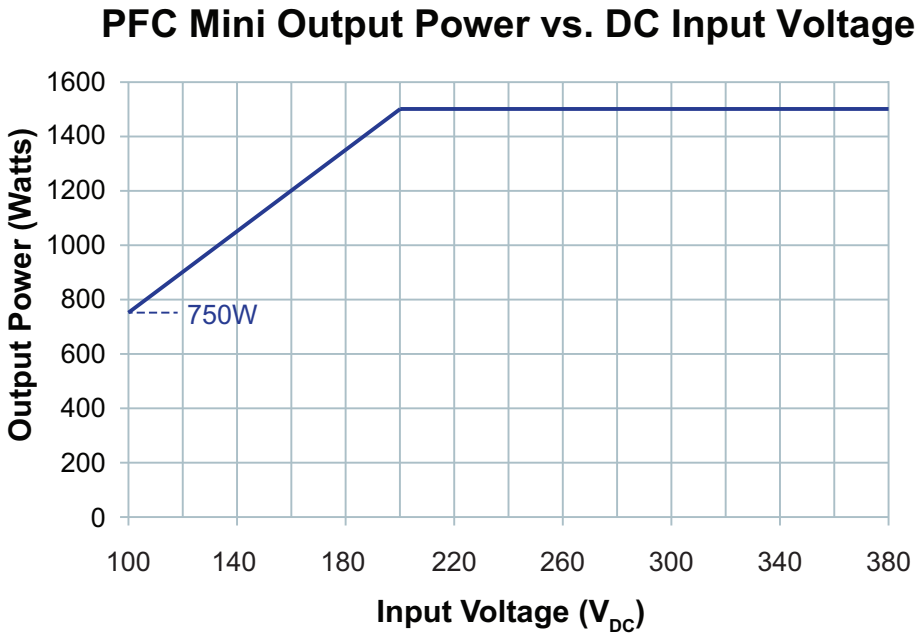


Figure 13
PFC Mini output power vs. DC input voltage



Specifications

General		
Number of Outputs	1 – 6	
Efficiency	>80%	
Safety Approvals	cURus – UL 60950-1, CSA 60950-1; cTÜVus – EN 60950-1, UL 60950-1, CSA 60950-1 CE Mark – Low Voltage Directive, 73/23/EEC amended by 93/68/EEC Note: certain MI chassis may not carry all safety approvals	
Maximum Output Power+ (+Not to exceed an input current of 10A)	>800W at $115V_{AC}$; 1,500W at $230V_{AC}$	
Note: Only PFC Minis™ populated with 12V Maxi modules are limited to 500W max. per slot. With 12V Mini modules, it is limited to 250W.		
Input		
Input	85 – $264V_{AC}$, 47 – 500Hz; 100 – $380V_{DC}$	
Line/Load Regulation	VI-200™/VI-J00™: ±0.2% max, 10% to full load; ±0.5% max, 0 – 10% load	
Line Regulation	Maxi/Mini: ±0.20% max to 0.3% max LL to HL, Full Load	
Inrush Current	$8.5A_{PK}$ at $115V_{AC}$; $17A_{PK}$ at $230V_{AC}$	
Ride Through Time	20ms at 1,200W load	
Conducted EMI	**VI-200/VI-J00 Ss:** EN55022 Class B	**Maxi, Mini** **(some configurations may meet Class B):** EN55022 Class A
	Mil-STD 461 will require external filter	
Power Factor	0.99 at $115V_{AC}$; 0.95 at $230V_{AC}$	
Voltage Fluctuations and Flicker	EN61000-3-3	
ESD Susceptibility	EN61000-4-2, Level 3, Performance Criteria A	
RF Radiated Immunity, 10v/m	EN61000-4-3, Performance Criteria A	
Transient Burst Immunity	EN 61000-4-4, Level 3, Performance Criteria B	
Surge Immunity	EN 61000-4-5 Installation Class 3, Performance Criteria B	
RF Conducted Immunity	EN61000-4-6, Limit Class 3 Performance Criteria A	
Voltage Dips and Interrupts	EN61000-4-11	
Dielectric Withstand	Primary to Chassis GND = $2,121V_{DC}$ Primary to Secondary = $4,242V_{DC}$ Secondary to Chassis GND = $750V_{DC}$	
MI Chassis Overvoltage and Transients	Compliant to Mil-STD 704 and 1399	
Note: See Vicor module specifications. A preload may be necessary for modules trimmed down below 90% of normal output voltage.		

Specifications (Cont.)

Environmental	
Storage Temperature	–40 to +85°C
Operating Temperature Full Power Half Power	 –20 to +45°C [c] (–40 to +45°C optional with MI chassis) –20 to +65°C (–40 to +65°C optional with MI chass)
Specific temperature data on all module configurations can be obtained by contacting Applications Engineering.	
Shock and Vibration (MI Chassis) Altitude	Mil-STD 810 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. 75% maximum load
Humidity	0 – 95% non condensing
Product Weight	5.5lbs (2,5kg)
Dimensions	1.72 x 6.0 x 12.2in [43,6 x 152,4 x 309,9mm]
Warranty [d]	2 years limited warranty. See vicorpower.com for complete warranty statement.

Output

VI-200™/VI-J00™ Modules

Parameter	Min	Typ	Max	Units	Notes
Set-Point Accuracy [e] Load/Line Regulation Load/Line Regulation		0.5	1 ±0.2 ±0.5	% % %	of V_{NOM} 10% to full load No load to 10% load
Temperature Regulation		0.01	0.02	%/°C	Over rated temperature
Long-Term Drift Output Ripple & Noise: ≤10V_{OUT} >10V_{OUT}		 100 1.0		 mV % V_{OUT}	 20MHz bandwidth 20MHz bandwidth
Voltage Trim Range VI-200/VI-J00 series slots		50 – 110		% V_{OUT}	±10% on 10 – 15V_{OUT}
Total Remote Sense Compensation	0.5			Volts	Autosense. See Pages 8 & 14
OVP Set Point [f]	115	125	135	% V_{OUT}	Recycle Power
Current Limit	105	115	125	% of I_{MAX}	Auto Recovery
Short Circuit Current	20 (105 [g])		130	%	
Overtemperature Limiting					Not available on VI-J00

[c] 45°C is the maximum operating temperature. If one is using a Maxi/Mini module less than 24V output and more than 500W, the maximum operating temperature is 40°C.

[d] 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.

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

[f] 131% Nominal for Booster Modules. No OVP for VI-J00

[g] VI-J00 modules only

Specifications (Cont.)

Maxi, Mini, Micro Series Modules (Maxi and Mini Modules Only)					
Parameter	**Min**	**Typ**	**Max**	**Units**	**Notes**
Set-Point Accuracy [e] Load Regulation		±0.5 ±0.1	±1	% of V_{NOM} % of V_{NOM}	See module design guide for exact specifications
Temperature Regulation		0.002	0.005	%/°C	–20 to 100°C
Long-Term Drift Output Ripple & Noise: ≤10V_{OUT} >10V_{OUT}		 100 1.0		 mV % V_{OUT}	 20MHz bandwidth 20MHz bandwidth
Voltage Trim Range Maxi/Mini Slots		 10 – 110		 % V_{OUT}	 Preload may be required
Total Remote-Sense Compensation	0.5			Volts	Autosense. See Pages 8 & 14
OVP Set Point	112		135	% V_{OUT}	Recycle Power
Current Limit		115	135	% of I_{MAX}	Auto Recovery
Overtemperature Limiting	100	115			MMM OTL is non-latching

[c] 45°C is the maximum operating temperature. If one is using a Maxi/Mini module less than 24V output and more than 500W, the maximum operating temperature is 40°C.

[d] 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.

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

[f] 131% Nominal for Booster Modules. No OVP for VI-J00

[g] VI-J00 modules only

Current Share Boards – Optional Feature

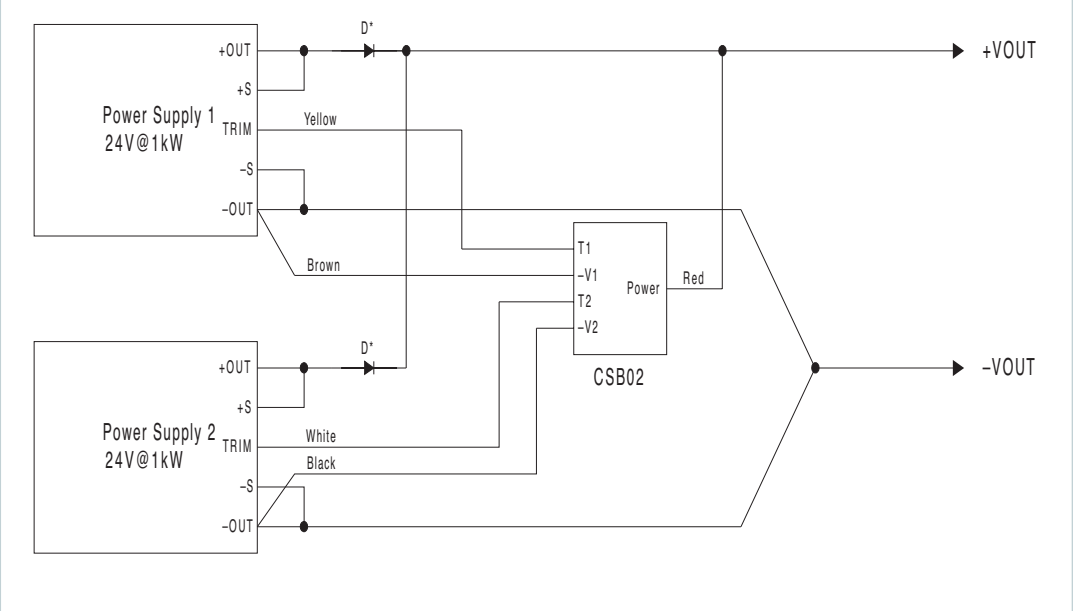
"Current Sharing" also known as load sharing, is the ability to divide the output current evenly across all active power supplies. This greatly reduces stresses on each power supply and allows them to run cooler, resulting in higher reliability. Standard "Current Sharing" techniques typically utilize 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 5-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 14
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 1. 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 to 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 in Figure 14.
6. Terminate Sense Leads either locally or remotely as shown in Figure 1.
7. For paralleling more than two supplies consult Applications Engineering for assistance.

J1 Pinout

Pin	Description
1	Power
2	T1
3	–V1
4	T2
5	–V2
6	No Connection

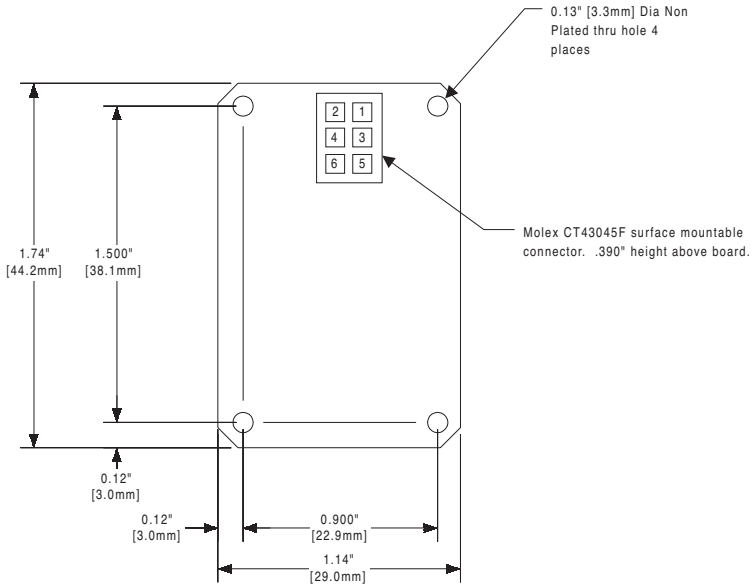


Figure 15. Mechanical Drawing

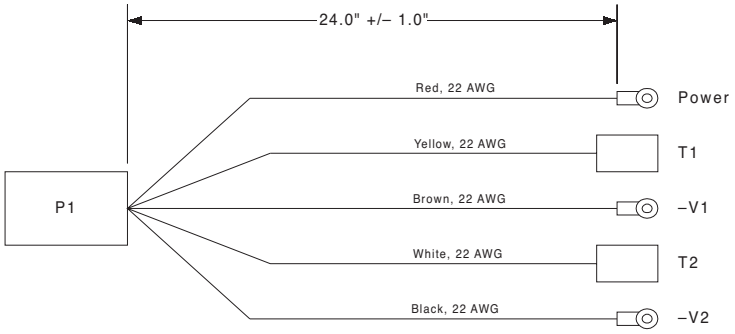


Figure 16. Cable Drawing

Specifications:

1. Power: 2 – 50V_{DC} at 5mA maximum.
2. Accuracy: ±1mV between –V_{OUT} connections.
3. Output current when not trimming up: ±1µA (VI-200/J00), ±5µA (Maxi, Mini, Micro series).
4. Use four non-plated through holes with standoffs for mounting.
5. CSB01 MUST be used for current sharing VI-200™/VI-J00™ series converters (VI-200/J00).
6. CSB02 MUST be used for current sharing Maxi, Mini, Micro series converters (Maxi, Mini and Micros).

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

Low-Leakage Version

(Available upon request)

If low leakage is required, Vicor has a PFC Mini™ model variant (must be requested). This model enables the user to meet various additional specifications. The advantage of the low-leakage PFC Mini power supply is in multiple power supply systems that have one AC input. This option will lower the input leakage current for these products to 500µA or less (may vary if Maxi, Mini, Micro series modules are used. Contact Applications Engineering for more details.) An additional external EMI filter is typically required.

How Low-Leakage is Obtained

Low leakage is obtained with the removal of the "Y" capacitors from within the EMI filter of the PFC Mini. This reduces the leakage current from the AC input to AC ground (chassis) to below 500µA. At the same time, since the "Y" capacitors are a vital component of the EMI filter, without them, the EMI will go up. When this happens, the unit may no longer meet Vicor published specifications for conducted EMI. In order to reduce the EMI to within an acceptable limit, an additional external EMI filter may be required. All safety agency certifications for the PFC Mini remains intact. [h] Contact Applications Engineering for more information.

[h] Please note that the PFC Mini (including low leakage version) is NOT UL2601 compliant.

Low Output Ripple

If output ripple of $10mV_{P-P}$ or 0.15% (whichever is greater) is required, a PFC Mini with RAM™ modules can be configured if the maximum output power per output does not exceed 100W. If this configuration is required, please contact: apps@vicorpower.com to have it configured.

If there are space restrictions, an external RAM™/µRAM™ can also be used.

Office Environment Fan

A PFC Mini using an office environment fan is available. Please note that the maximum output power for this version is 1,200W. The maximum output power per slot is limited to 500W.

Molex Connector Limitation

Please note that those PFC Mini configurations that use Molex connectors are limited to 9A/pin (27A per output). This is a Molex connector limitation, NOT a module power limitation.

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™
- 4kW MegaPAC-EL™ (Low Noise)
- PFC MegaPAC™ (High Power)
- PFC MegaPAC™ (Low Noise/High Power)
- PFC MegaPAC-EL™
- Autoranging MegaPAC™
- Mini MegaPAC™
- ConverterPACs™

Others:

- FlatPAC-EN™
- PFC FrontEnd™
- MicroPAC™
- Conduction Cooled MicroPAC™

Rugged COTS versions (MI) are available for the PFC Micro, PFC MicroS, PFC Mini, PFC MegaPAC, Standard MicroPAC and Conduction Cooled MicroPAC.

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Contact Us: http://www.vicorpower.com/contact-us

Vicor Corporation
25 Frontage Road
Andover, MA, USA 01810
Tel: 800-735-6200
Fax: 978-475-6715
www.vicorpower.com

email
Customer Service: custserv@vicorpower.com
Technical Support: apps@vicorpower.com

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