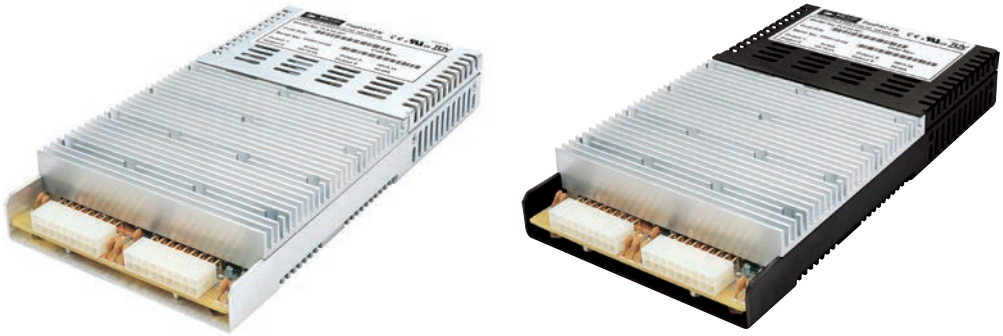
FlatPAC-EN™ and FlatPAC-EN MI EN-Compliant Autoranging Switchers



Overview

The FlatPAC-EN/EN MI is an ultra-low-profile switching power supply that provides up to 500W from up to four isolated outputs. It operates on either 115 or 230V_{AC} nominal (47 – 63Hz), or 250 – 380V_{DC}. It can be populated with either VI-200/VI-J00 or Maxi/Mini/Micro Vicor converters. The use of these converters gives the FlatPAC-EN/EN MI the inherent power flexibility typical of all Vicor products. With dimensions of 1.4in H [35,6mm] x 5.0in W [127mm] x 9.2in L [233,7mm], the FlatPAC-EN/EN MI provides a power density greater than 7W/in^3. It is factory configured to meet user output requirements.

Note: The FlatPAC-EN/EN MI does not have an internal fan.
The MI version is a rugged chassis designed specifically for COTS and harsh environment applications.

Standard Features

- Power Factor Correction (passive): Power Factor (Typical) 0.70 (>75% Load)
- Input Voltage: 90 – 132/180 – 264V_{AC} [a], 47 – 63Hz, or 250 – 380V_{DC}
- Maximum Power Output: 500W (105/190V_{AC} min.)
  425W for EN61000-3-2 compliance
- Up to 4 isolated user specifiable outputs
- Conducted EMI: FCC Class A EN 55022 Class A
  FCC Class B EN 55022 Class B
  Mil-STD 461 may require external filter
- Harmonic Attenuation to EN61000-3-2/A14 [b]
- Compliant to EN61000-4-4
  (Electrical Fast Transient/Burst) and EN61000-4-5 (Surge Immunity)
- MI version meets Mil-STD 810 for Shock and Vibration with extended temp range
- MI version also available with –40°C temp rating
- Efficiency (typical) >70%
- Autosense [c]
- RS-232 microcontroller interface
- Output overcurrent protection on all outputs
- Size: 1.4in H [35,6mm] x 5.0in W [127,0mm] x 9.2in L [233,7mm]
- Safety Agency Approvals: cURus, cTÜVus, CE Mark

[a] De-rates to 260W @ 90V_{AC}, 400W @ 180V_{AC}.
[b] For output power up to 425W, not to exceed an input current of 3.33A_{RMS} at 230V_{AC}, 50Hz.
[c] This feature is implemented in all converter slots (except with Micro modules). Autosense allows automatic local sensing when remote-sense connections are not made. The FlatPAC-EN™/EN MI will operate in remote-sense mode when remote-sense connections are made. Refer to Page 18 for more information on Autosense.

Optional Features

- Current Share Board for unit to unit power sharing – See Pages 28 – 30
- Connector kits (#19-130044)
- Conformal coating available on select MI models – contact factory
- –40°C Operation, Mil-STD 810 Shock and Vibration (MI rugged chassis only)

Part Numbering

FlatPAC-EN/EN MI **FLx_1-x_2 x_3 -xxxx (-x_4)(-x_5)**

ex. FL4-13-6544

x_1 = number of outputs

x_2 = number of VI-200/VI-J00 modules

x_3 = number of Maxi/Mini/Micro modules

xxxx = sequential number assigned by Vicor

(-x_4) = optional Factory assigned: G - RoHS

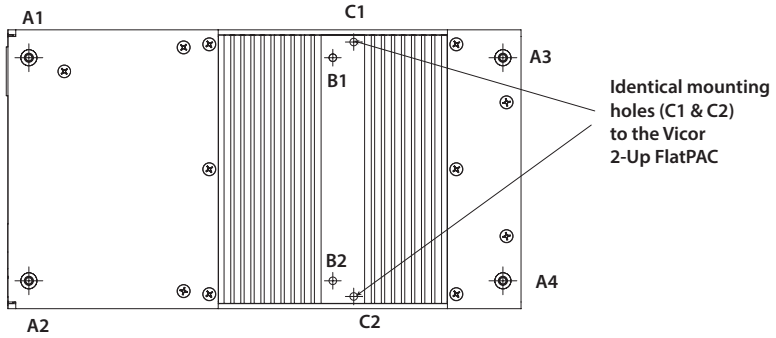
(-x_5) = optional versions

x_B = Number of modules

Note: x_5 = MI for rugged chassis, = MC for rugged chassis with conformal coating

Mechanical Considerations

The FlatPAC-EN™/EN MI is mounted on the bottom surface using standard 8-32 or 4mm screws (cannot be mounted from the front.)



Maximum allowable torque is 5in·lbs. The maximum penetration for mounting holes A1, A2, A3 and A4 is 0.125in [3mm] and for mounting holes B1, B2, C1 and C2 is 0.250in [6mm]. The minimum recommended mounting holes are as follows:

1. For standard mounting (forced air cooling), use A1, A2, A3, A4 mounting holes.
2. For standard mounting (conduction cooling), use A1, A2, A3, A4, B1 and B2 mounting holes.
3. For a Vicor 2-Up FlatPAC™ retrofit replacement, use C1 and C2 as these two are identical to the recommended mounting holes on the FlatPAC.

For increased ruggedness, additional mounting holes can be used to secure the power supply.

The FlatPAC-EN/EN MI does not have an internal fan. It can be either conduction or convection cooled (same model).

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.

For applications that require vibration levels above MIL-STD-810E, minimum integrity test, a shock-absorbing mount design is required.

FlatPAC-EN™/EN MI Dos and Don'ts

- Do not exceed an operating case temperature of 90°C. To prevent an overtemperature condition, an external fan may be required.
- Run the output (+/–) power cables next to each other to minimize inductance.
- Always turn the power supply off before disconnecting input or output wires.
- When using the remote-sense feature, the +OUT and –OUT load wires should never be disconnected while the supply is operating. Failing to do so could damage the power supply.
- Do not attempt to repair or modify the power supply in any manner as this action will void the warranty. In the event of problems, contact Applications Engineering at 1-800-927-9474.
- Insert proper fault protection at power supply input terminals (i.e., a fuse). Refer to Page 13 for more information.
- 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 FlatPAC-EN/EN MI consists of an off-line single-phase autoranging front end, EMI filter, customer interface, power supply control circuit, associated housekeeping circuits, a MiniHAM™ module and a selection of Vicor VI-200™/VI-J00™ and/or Maxi/Mini/Micro DC-DC converters.

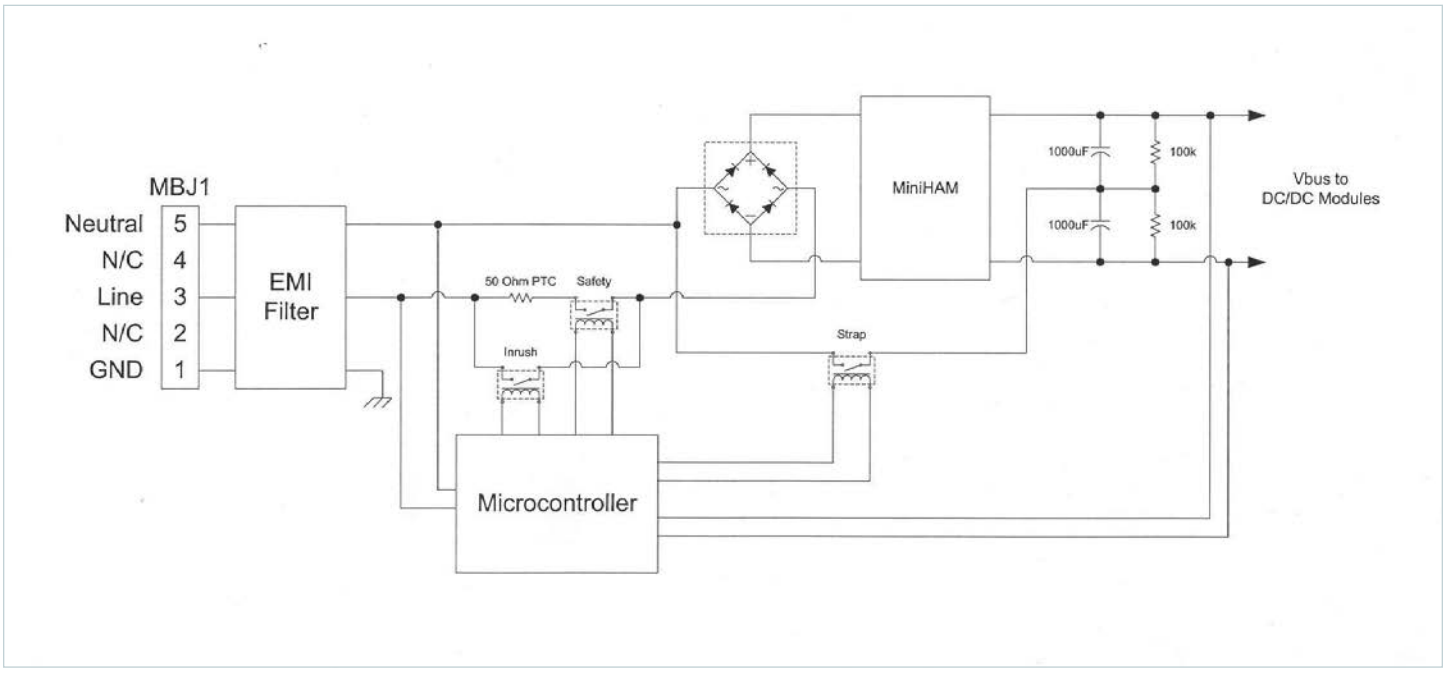
The MiniHAM was specifically designed for EN compliance using passive filtering. Unlike active PFC solutions, the MiniHAM generates no EMI, greatly simplifying and reducing system noise filtering requirements. It is also considerably smaller and more efficient than active alternatives and improves the unit's MTBF. It will provide harmonic current compliance at $230V_{AC}$ input up to 425W of output power. Input AC mains voltage is applied to input connector MBJ1 (see Page 7) and the input current is passed through an EMI filter designed to meet conducted noise limit of EN 55022, Classes A and B specifications (certain configurations meet EN55022 Class B. Consult Factory.)

At start up, the microcontroller verifies that the input voltage is within the specified operating range. Once this occurs, the microcontroller closes the safety relay and puts the autoranging front end in the correct mode (closing or opening the doubler relay). The autoranging front end has two modes, the doubler mode (90 – $132V_{AC}$) or bridge rectifier mode (180 – $264V_{AC}$, 250 – $380V_{DC}$). Inrush current is limited by a PTC thermistor. The PTC is shunted out (by closing the Inrush relay) when the output voltage has charged up the bus capacitors within the specified range (205 – $390V_{DC}$). Approximately one second after the application of the input voltage, the bus voltage is within operating limits and the AC OK signal asserts to a TTL "1", indicating the input power is OK. After AC OK is asserted high, the user can now control the power outputs.

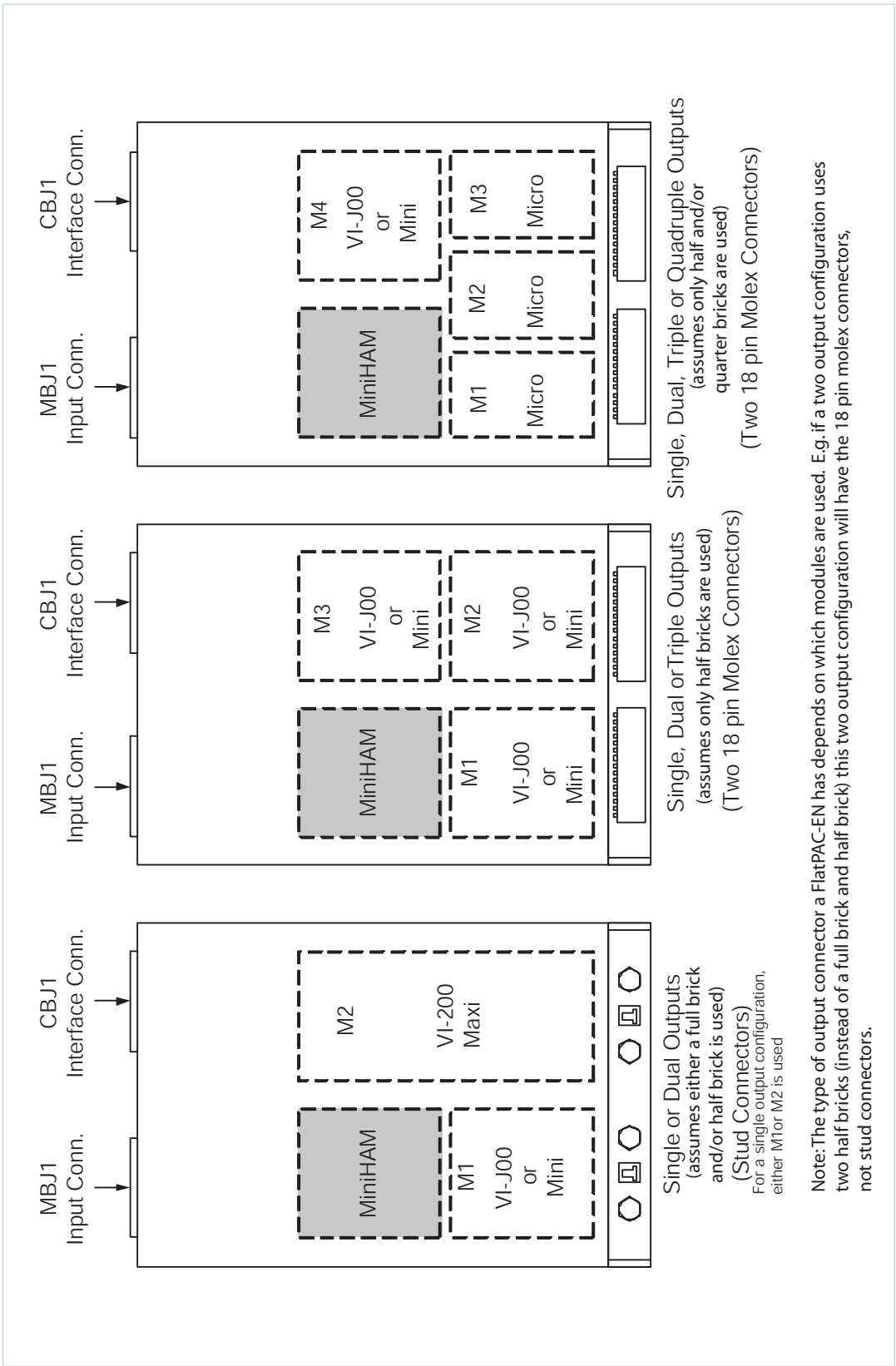
Output voltage conversion is achieved by Vicor $300V_{IN}$ family of Zero-Current Switching (ZCS) DC-DC converters. These are forward converters in which the main switching element switches at zero current. This patented topology has a number of unique attributes: low switching losses; high-frequency 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, all outputs are disabled to limit the inrush current and to allow the DC bus potential to settle to the correct operating level. A low-power transformer flyback circuit converts the high-voltage DC bus into regulated low voltage to power the internal housekeeping circuits as well as the auxiliary +5VS located in the interface connector.

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.

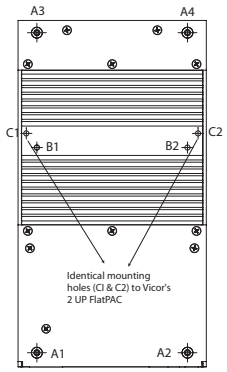


FlatPAC-EN™/EN MI Configuration Layout



FlatPAC-EN™/EN MI "Quick Install" Instructions

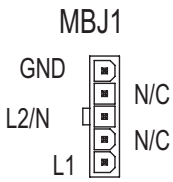
(For Mechanical Drawing, see Page 10)



Mounting the FlatPAC-EN/EN MI

- Mount the FlatPAC-EN on the bottom (cannot be mounted from the front).
- For **standard mounting (forced air cooling)**, use A1, A2, A3, A4 mounting holes.
- For **standard mounting (conduction cooling)**, use A1, A2, A3, A4, B and B2 mounting holes.
- For a **Vicor 2-Up FlatPAC™ retrofit replacement**, use C1 and C2 as these two are identical to the mounting holes on the FlatPAC.
- For increased ruggedness, use additional mounting holes to secure the power supply.
- Use #8-32 or 4mm mounting screws. For mounting holes A1, A2, A3 and A4, the maximum penetration should not exceed 0.125in [3mm]. For mounting holes B1, B2, C1 and C2, do not exceed maximum penetration of 0.250in [6mm].

Note: The maximum allowable torque is 5in·lbs.



Input Connections

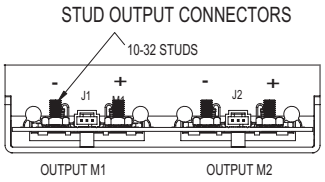
Input Power MBJ1

- Apply input AC power connector MBJ1 using a maximum torque of 5in·lbs.
- **Place a fuse or circuit breaker in the input line for safety requirements (9A).**
- Use Molex mating receptacle 39-01-4051, terminals 39-00-0090 and crimp tool Molex #11-01-0199.

Output Connections

(Refer to Page 6 for more information on configuration layout and output connector type)

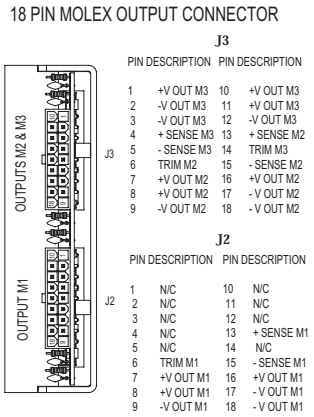
Note: The type of output connector a FlatPAC-EN has depends on which modules are used. Also, outputs with molex connectors are limited to 9A/pin (27A per output).



Power Connections

Installing power connectors on outputs with 10-32 stud connectors (only full and/or half bricks used):

- Install #10 **ring lugs** on output studs
  Note: The right stud is positive and the left stud is the return when viewed from the output end.
- 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.

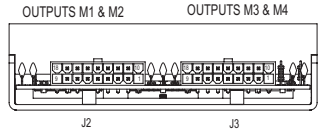


Installing power connectors on outputs with 18-pin Molex connectors (only half bricks used):

- The **output M1** slot accepts either a Mini or a Junior module. J2-7, J2-8, J2-16 are positive, while pins J2-9, J2-17 and J2-18 are the returns.
- J2-1, J2-2, J2-3, J2-4, J2-5, J2-10, J2-11, J2-12 and J2-14 are not connected.
- The **output M2** slot accepts either a Mini or a Junior module. J3-7, J3-8, and J3-16 are positive, while pins J3-9, J3-17 and J3-18 are the returns.
- The **output M3** slot accepts either a Mini or a Junior module. J3-1, J3-10, J11 are positive, while pins J3-2, J3-3, J3-12 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.

Note: The molex connectors are limited to 9A/pin (27A per output)

18 PIN MOLEX OUTPUT CONNECTORS



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

PIN	DESCRIPTION	PIN	DESCRIPTION
1	+V OUT M4	10	+V OUT M4
2	-V OUT M4	11	+V OUT M4
3	-V OUT M4	12	-V OUT M4
4	+ SENSE M4	13	+ VOUT M3
5	- SENSE M4	14	TRIM M4
6	TRIM M3	15	- VOUT M3
7	+V OUT M3	16	+V OUT M3
8	+V OUT M3	17	- V OUT M3
9	-V OUT M3	18	- V OUT M3

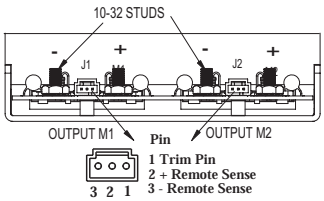
Installing power connectors on outputs with 18-pin Molex connectors (only half and/or quarter bricks used):

- The output M1 slot only accepts a Micro module. J2-7, J2-8, J2-13 and J2-16 are positive, while pins J2-9, J2-15, J2-17 and J2-18 are the returns.
- The output M2 slot only accepts a Micro module. J2-1, J2-4, J2-10, J2-11 are positive, while pins J2-2, J2-3, J2-5 and J2-12 are the returns.
- The output M3 slot only accepts a Micro module. J3-7, J3-8, J3-13 and J3-16 are positive, while pins J3-9, J3-15, J3-17 and J3-18 are the returns.
- The output M4 slot only accepts either a Mini or a Junior module. J3-1, J3-10 and J3-11 are positive, while pins J3-2, J3-3, and J3-12 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

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

See Page 11 for detailed diagrams of output connections.

STUD OUTPUT CONNECTORS



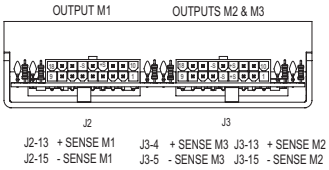
Sense Connections

The FlatPAC-EN™/EN MI is shipped with Autosense installed.
(For more information on Autosense, refer to Page 18.)

Sense Connections for stud outputs (only full and/or half bricks used):

- For Remote Sense, connect remote-sense wires to Remote SENSE/TRIM pin access connector J1 or J2 for single output and J1/J2 for dual outputs.
  Note: Connector pins J1-2 and J2-2 are the +SENSEs and J1-3 and J2-3 are the –SENSEs.
- 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.**

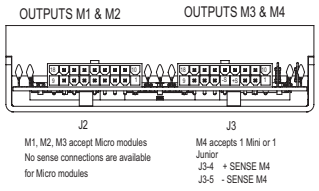
18 PIN MOLEX OUTPUT CONNECTORS



Sense Connections on 18-pin molex output connectors (only half bricks used):

- If Remote Sense is desired, connect remote-sense wires to the sense lines of Connector J2 for output 1 and J3 for outputs 2 and 3.
  - For Output M1, J2-13 is the +SENSE and J2-15 is the –SENSE.
  - For Output M2, J3-13 is the +SENSE andJ3-15 is the –SENSE.
  - For Output M3, J3-4 is the +SENSE and J3-5 is the –SENSE.
- 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.

18 PIN OUTPUT CONNECTORS

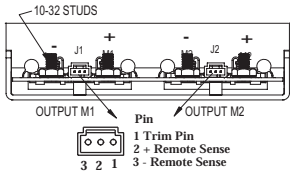


Sense Connections on 18-pin output connectors (only half and/or quarter bricks used):

- If Remote Sense is desired (available only on output M4), connect remote-sense wires to sense lines of Connector J3.
  - Remote Sense is NOT available for Micro modules and hence is not available on outputs M1, M2 and M3.
  - On output M4, J3-4 is the +SENSE and J3-5 is the –SENSE.
- 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

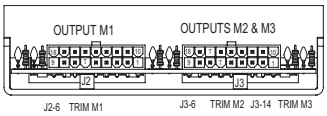
TRIM: STUD OUTPUT CONNECTORS



*TRIM Connections on **stud output connectors** (when full and/or half brick used):*

- For output M1, J1-1 provides TRIM access.
- For output M2, J2-2 provides TRIM access.
- Use Molex mating receptacle #50-57-9403 with #16-02-0103 terminals.
- Attach 24 – 30AWG stranded wire using Molex tool #11-01-0208.

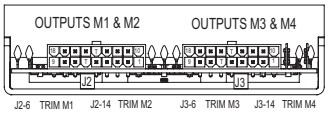
18 PIN MOLEX OUTPUT CONNECTORS



*TRIM Connections for **18-pin Molex output connectors** (when half bricks used):*

- For output M1, J2-6 provides TRIM access.
- For output M2 and M3, J3-6 and J3-14 provides TRIM access respectively.
- Use Molex mating receptacle #39-01-2180 with #39-00-0039 terminals.
- Attach 18 – 24AWG stranded wire using Molex tool #11-01-0197.

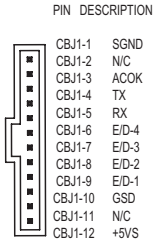
18 PIN MOLEX OUTPUT CONNECTORS



*TRIM Connections for **18-pin Molex output connectors** (when half and/or quarter bricks used):*

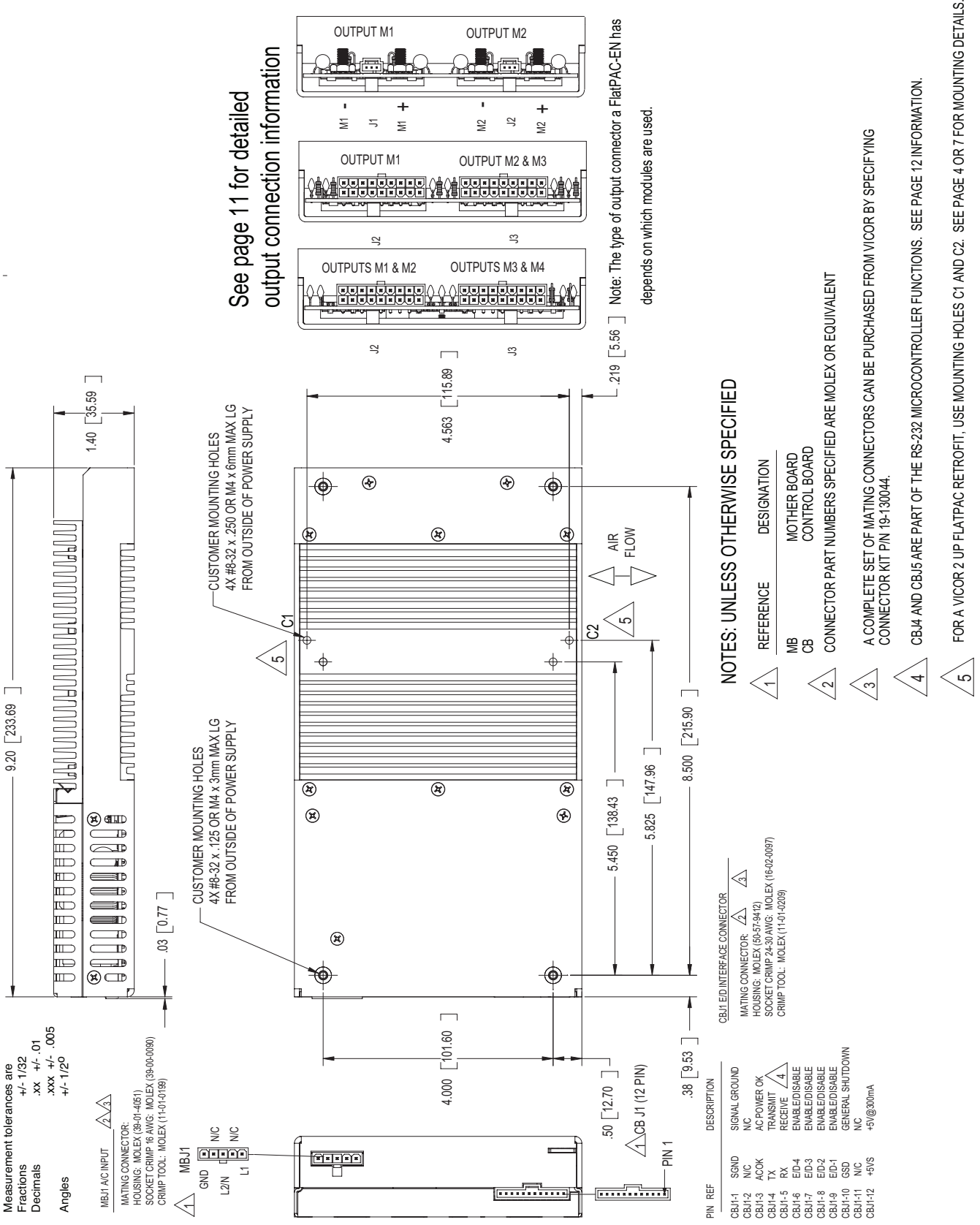
- For outputs M1 and M2, J2-6 and J2-14 provide TRIM access respectively.
- For outputs M3 and M4, J3-6 and J3-14 provide TRIM access respectively.
- Use Molex mating receptacle #39-01-2180 with #39-00-0039 terminals.
- Attach 18 – 24AWG stranded wire using Molex tool #11-01-0197.

Interface Connections



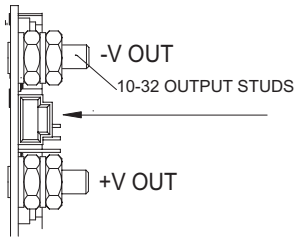
- CBJ1-1 is Signal Ground and CBJ1-3 is AC OK.
- CBJ1-4 is the Transmit and CBJ1-5 is the Receive functions for the RS-232 command protocol. [d]
- CBJ1-4 thru 9 are Enable/Disable,CBJ1-10 is General Shutdown and CBJ3-12 is +5VS.
- For the FlatPAC-EN™, CBJ1-2 and CBJ1-11 are not connected.
- Use Molex mating receptacle #50-57-9412 with #16-02-0097 cinch pins.
- Attach 24 – 30AWG stranded wire using Molex tool #11-01-0209.

[d] These functions are part of the RS-232 Command Protocols. See Page 14 for detailed information.


See page 11 for detailed output connection information
OUTPUT M1
OUTPUT M2
OUTPUT M1
OUTPUT M2 & M3
OUTPUTS M1 & M2
OUTPUTS M3 & M4
Note: The type of output connector a FlatPAC-EN has depends on which modules are used.
NOTES: UNLESS OTHERWISE SPECIFIED
REFERENCE DESIGNATION
MB MOTHER BOARD
CB CONTROL BOARD
CONNECTOR PART NUMBERS SPECIFIED ARE MOLEX OR EQUIVALENT
A COMPLETE SET OF MATING CONNECTORS CAN BE PURCHASED FROM VICOR BY SPECIFYING CONNECTOR KIT P/N 19-130044.
CBJ4 AND CBJ5 ARE PART OF THE RS-232 MICROCONTROLLER FUNCTIONS. SEE PAGE 12 INFORMATION.
FOR A VICOR 2 UP FLATPAC RETROFIT, USE MOUNTING HOLES C1 AND C2. SEE PAGE 4 OR 7 FOR MOUNTING DETAILS.
CUSTOMER MOUNTING HOLES 4X #8-32 x .250 OR M4 x 6mm MAX LG FROM OUTSIDE OF POWER SUPPLY
CUSTOMER MOUNTING HOLES 4X #8-32 x .125 OR M4 x 3mm MAX LG FROM OUTSIDE OF POWER SUPPLY
AIR FLOW
C1
C2
MBJ1
CB J1 (12 PIN)
PIN 1
CBJ1 E/D INTERFACE CONNECTOR
MBJ1 A/C INPUT
Measurement tolerances are
Fractions +/- 1/32
Decimals .xx +/- .01
.xxx +/- .005
Angles +/- 1/2°

Refer to page 6 to review configuration layout of FlatPAC-EN

A. STUD OUTPUT CONNECTOR - when configured with full brick and/or half brick



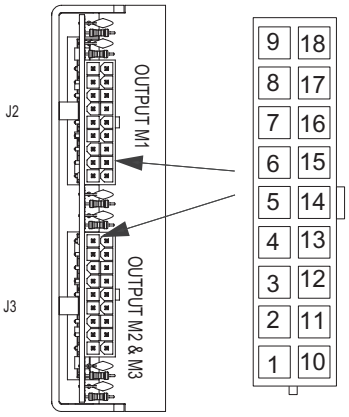
SxJ2 REMOTE SENSE/TRIM PIN CONNECTOR

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 CONNECTORS - when configured only with half bricks

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



Outputs M1

PIN	DESCRIPTION	PIN	DESCRIPTION
1	N/C	10	N/C
2	N/C	11	N/C
3	N/C	12	N/C
4	N/C	13	+ SENSE M1
5	N/C	14	N/C
6	TRIM M1	15	- SENSE M1
7	+V OUT M1	16	+V OUT M1
8	+V OUT M1	17	-V OUT M1
9	-V OUT M1	18	-V OUT M1

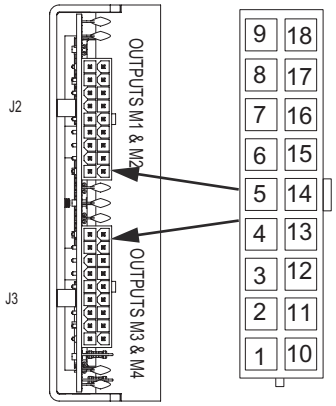
Outputs M2 and M3

PIN	DESCRIPTION	PIN	DESCRIPTION
1	+V OUT M3	10	+V OUT M3
2	-V OUT M3	11	+V OUT M3
3	-V OUT M3	12	-V OUT M3
4	+ SENSE M3	13	+ SENSE M2
5	- SENSE M3	14	TRIM M3
6	TRIM M2	15	- SENSE M2
7	+V OUT M2	16	+V OUT M2
8	+V OUT M2	17	-V OUT M2
9	-V OUT M2	18	-V OUT M2

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)

C. 18 PIN MOLEX CONNECTORS - when configured with half and/or quarter bricks

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



Outputs M1 and M2

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

Outputs M3 and M4

PIN	DESCRIPTION	PIN	DESCRIPTION
1	+V OUT M4	10	+V OUT M4
2	-V OUT M4	11	+V OUT M4
3	-V OUT M4	12	-V OUT M4
4	+SENSE M4	13	+V OUT M3
5	-SENSE M4	14	TRIM M4
6	TRIM M3	15	-V OUT M3
7	+V OUT M3	16	+V OUT M3
8	+V OUT M3	17	- V OUT M3
9	-V OUT M3	18	- V OUT M3

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 type of output connector a FlatPAC-EN has depends on which modules are used. E.g. if a two output configuration uses two half bricks (instead of a full brick and half brick) this two output configuration will have the 18 pin molex connectors, not stud connectors.

Output Connectors for FlatPAC-EN™/EN MI

Item	Qty	Description	Vendor #1	Part Number
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
[e]		CRIMP TOOL FOR ITEM 2	MOLEX	11-01-0208
3				
4	2	HOUSING 16 POS .165 CTRS W/LATCH	MOLEX	39-01-2160
5	2	TERMINAL FEM CRIMP 18 – 24AWG SEL GOLD	MOLEX	39-01-2180
6	40	TERMINAL FEM CRIMP 18 – 24AWG SEL GOLD	MOLEX	39-00-0039
[e]		CRIMP TOOL FOR ITEM 6	MOLEX	11-01-0197
7	1	HOUSING 5 POS .165 CTRS W/LATCH	MOLEX	39-01-4051
8	5	TERMINAL CRIMP 16AWG 9A GOLD	MOLEX	39-00-0090
[e]		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
[e]		CRIMP TOOL FOR ITEM 10	MOLEX	11-01-0209
[e] ITEMS FOR REFERENCE ONLY (NOT INCLUDED IN KIT)				

FlatPAC-EN – Connector Kit listing

Connector Kit 19-130044 – Available for purchase from Vicor

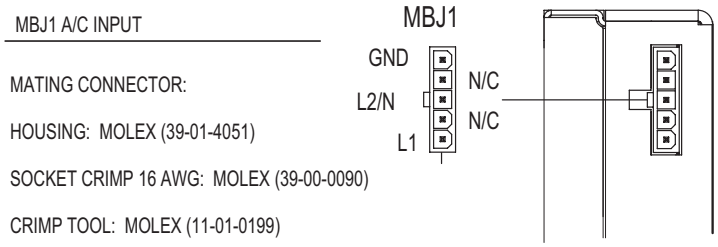
Interface Connections

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 9A 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 $115V_{AC}$ or 17A peak at $230V_{AC}$.

Figure 1
Input power terminal MBJ1



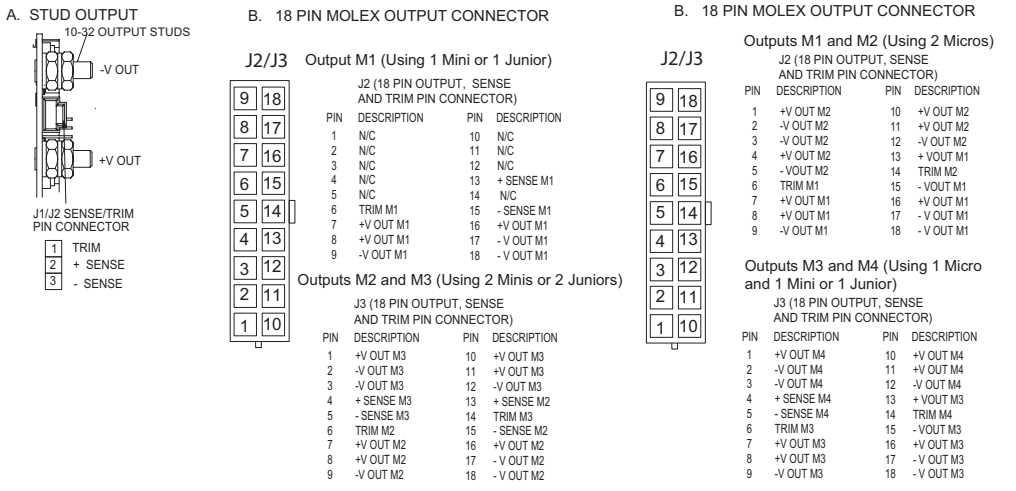
Output Power Connections

There are two types of output power terminals available in the FlatPAC-EN™. Each slot has one of the following configurations: either 10-32 plated steel bolts or an 18-pin Molex connector (The type of output connector a FlatPAC-EN has depends on which modules are used. See Pages 7 and 11. Molex connectors are limited to 9A/pin, 27A per output) The positive polarity of the stud 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 2

Output power connections



User Interface Connections

Signal Ground (CBJ1-1)

Signal Ground on CBJ1-1 is an isolated secondary ground reference for all CBJ1 interfacing signals. This is not the same as earth ground on input power connector MBJ1.

AC OK (CBJ1-3)

AC OK is an active high TTL compatible signal and provides a status indication of the AC input power. It is on pin CBJ1-3 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. Typically, a 2.5ms hold-up time is provided for a 500W load following the loss of the AC OK signal.

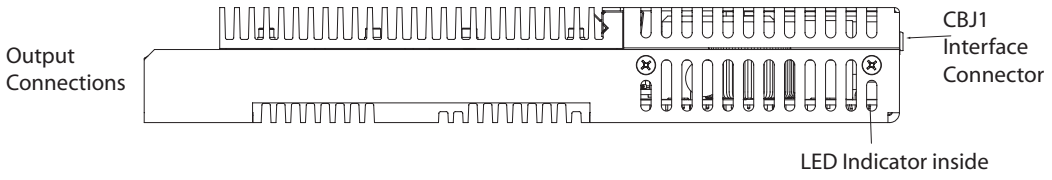
TRANSMIT/RECEIVE RS-232 Command Protocol (CBJ1-4 and CBJ1-5)

The FlatPAC-EN™/EN MI incorporates a microprocessor for communicating status and allowing user control. A suitable Terminal Emulator must be used to communicate with this circuit. Operation in the remote mode requires commanding the Power Supply to be a slave via the RS-232 interface.

Operating Modes

The FlatPAC-EN has two operating modes, remote and manual, which can be set using the RS-232 interface feature. The operating-mode setting is stored in a non-volatile EEPROM and requires an REON or REOFF command in order to switch modes. The default mode setting from the factory is in manual mode. The FlatPAC-EN has an operating mode indicator LED, which is viewable through the left side vent hole nearest the CBJ1 E/D Interface Connector. When this LED is ON, the power supply is operating in remote mode.

Figure 3
LED indicator



Communications Protocol

The protocol is an ASCII character stream that will be sent back and forth between the power supply and the user. The FlatPAC-EN™/EN MI in the remote mode will be considered a slave in that it will only respond to commands and requests and will not initiate conversations. Communications are half-duplex in that only the FlatPAC-EN/EN MI receiver or transmitter may be active at one time. The unit will reply to all commands or requests with a defined response followed by a carriage return and line feed character pair (CR/LF). The user must wait for the reply from the FlatPAC-EN before issuing the next command or request. The data bytes will have a format of 1 start bit, 8 data bits, 1 stop bit and no parity at 9600 Baud.

Commands, Status Requests and Module Replies

All commands and requests will have a reply. The reply will be one of the following character strings followed by a CR/LF character pair. "OK" – Issued when a command has been received and acted upon and the command has no return data associated with it. "Inv Command" – Issued when an unrecognized command has been received or a command cannot be executed at this time. "Inv Range" – Issued when a command argument is not within a valid range.

The following is the list of commands and their definitions. All commands must be followed with a CR/LF character pair.

PUP – Power Up

This command starts the automatic turn on timed sequence for the modules. If a power-down sequence is active at the time this command is received, a reply of "Inv Command" is returned; otherwise "OK" is returned.

PDN – Power Down

This command starts the automatic turn off timed sequence for the modules. This command can be given at any time and will cancel any uncompleted automatic power-up sequences. "OK" is returned.

EMO – Emergency Off

This command turns all modules off. If either a power-up or power-down sequence is active at the time, it will be terminated immediately. A response of "OK" is returned.

TON1, TON2, TON3, TON4

Turn On commands for modules 1, 2, 3, or 4.

These commands turn on the module identified by the trailing digit. If an automatic sequence is in effect at the time this command is received, a reply of "Inv Command" is returned; otherwise "OK" is returned.

TOFF1, TOFF2, TOFF3, TOFF4

Turn Off commands for modules 1, 2, 3, or 4.

These commands turn off the module identified by the trailing digit. If an automatic sequence is in effect at the time this command is received, a reply of "Inv Command" is returned; otherwise "OK" is returned.

SDON1, SDON2, SDON3, SDON4

Set Delay On Time for modules 1, 2, 3 or 4.

These commands set the associated time delays for the DC-DC converters to be activated via "PC" pin release. There is an additional delay of up to 7ms inherent in the DC-DC converters. These commands are entered with a trailing argument. The valid range of the argument is from 1 to 255 and is in 10-millisecond increments. The effective range of delay then becomes 10 – 2550 milliseconds or 0.01 – 2.55 seconds. Out-of-range arguments are replied to with an "Inv Range" message; otherwise "OK" is returned. The delay times are effective and run concurrent from either power up of the unit or from receipt of the power-up command. If these commands are entered without an argument then the unit will report the present settings of these variables.

SDOFF1, SDOFF2, SDOFF3, SDOFF4

Set Delay Off Time for modules 1, 2, 3, or 4.

These commands set the associated time delays for the DC-DC converters to be deactivated via "PC"pin release. These commands are entered with a trailing argument. The valid range of the argument is from 1 – 255 and is in 10-millisecond increments. The effective range of delay then becomes 10 – 2550 milliseconds or 0.01 – 2.55 seconds. Out-of-range arguments are replied to with an "Inv Range" message; otherwise "OK" is returned. The delay times are effective and run concurrent from either receipt of the power-down command or from an error condition with the unit. If these commands are entered without an argument then the unit will report the present settings of these variables.

BV – Bus Voltage Readback

This command returns the current bus voltage reading.

MS – Module Status

This command returns the module status as shown: MS = X1 X2 X3 X4 X5

X1 indicates the status of module output 1.

X2 indicates the status of module output 2.

X3 indicates the status of module output 3.

X4 indicates the status of module output 4.

A "1" indicates the output is up/on and ok and a "0" indicates the output is down/off.

X5 indicates the status of the power supply Bus. A "1" indicates BUS OK and a "0" indicates BUS NOT OK.

SN – Serial Number

This command returns the serial number as set by factory (available only on request.)

REON – Remote Mode ON

This command put the power supply into the slave mode. In this mode the power supply will only respond when commanded.

REOFF – Remote Mode OFF

This command put the power supply into the manual mode. In this mode the power supply will only respond to the following commands via the RS-232 interface: REON, SN, SDON1, SDON2, SDON3, SDON4, BV, MS, HST.

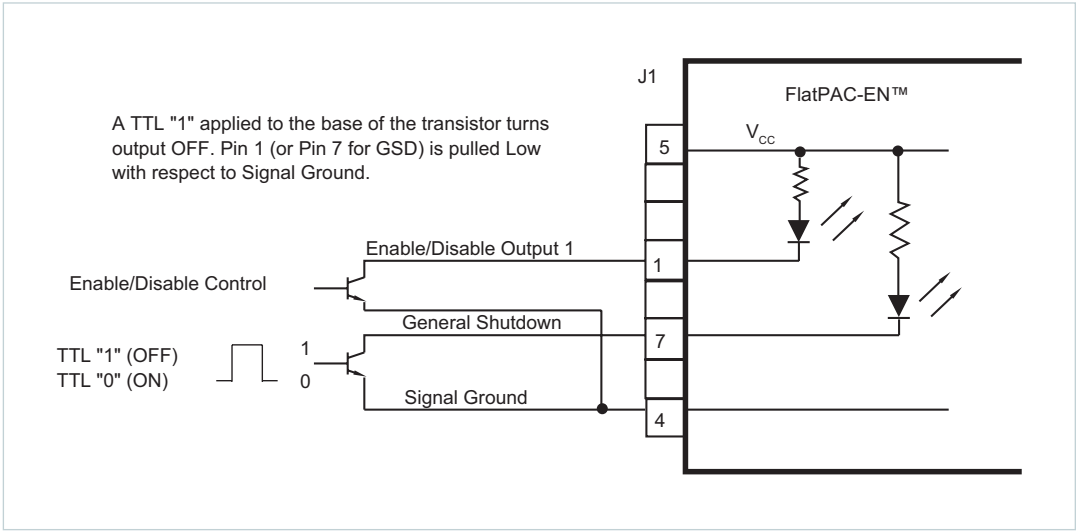
HST – Heat Sink Temperature

This command returns Temperature of the heat sink in degrees Celsius. Heat-sink temperature is measured frequently and stored into EEPROM memory. Upon loss of power last measured value in stored in EEPROM.

Enable/Disable Mode (CBJ1-8 and CBJ1-9)

The Enable/Disable control pins allow outputs to be sequenced either on or off.
CBJ1-4 through CBJ1-9 are the control pins for outputs 1 – 4. 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 9mA 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 4
Enable/Disable mode



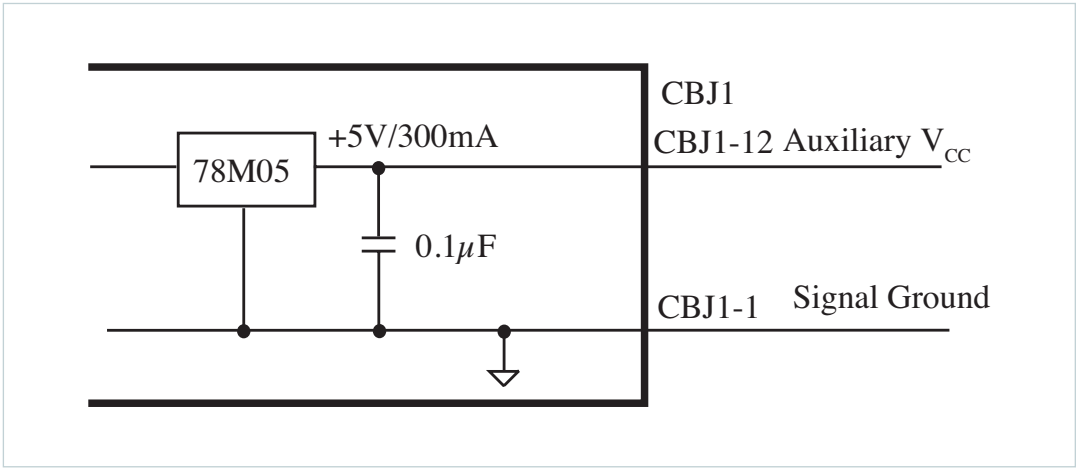
The correspondence between a module and its E/D line as seen from the output end of the power supply goes from left to right.

General Shut Down /GSD (CBJ1-10)

The GSD control pin on CBJ1-10 allows simultaneous shut down of all outputs. This pin must be pulled down to less than 0.7V and will source 9mA 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 – 4V with respect to signal ground.

Auxiliary V_{CC} +5V/300mA (CBJ1-12)

Figure 5
Auxiliary V_{CC}



The V_{CC} on CBJ1-12 is an auxiliary 5V regulated power source. It is $+5V_{DC}$ ±5% with respect to Signal Ground and can supply 300mA maximum. It is capable of withstanding a short, but shorted user interface functionality will be lost.

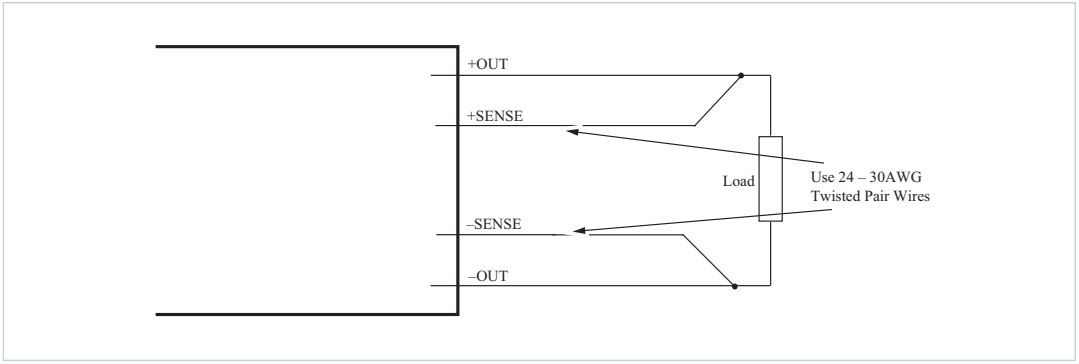
+SENSE/–SENSE (J2) (Not applicable when using BatMod™ current source.)

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 FlatPAC-EN™/EN MI 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 FlatPAC-EN will automatically operate in local-sense mode. To check if an output has the Autosense feature, measure the impedance from the +OUT to +SENSE and –OUT to –SENSE pins. If the impedance is 5Ω, then the output has Autosense and does not require local sense jumpers. When using the remote sense feature, the +OUT and –OUT load wires should never be disconnected while the supply is operating. Failing to do so could damage the power supply.

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 24 – 30AWG 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 outputs with stud connectors is a 3-pin connector providing the +SENSE connection on J1/ J2-2 and the –SENSE connection on J1/J2-3. The sense connector for outputs with 18-pin Molex connectors is provided on the 18-pin output connector that also provides the output and trim connections. See Page 11 for details.

Figure 6
Remote sense



Note: Remote sense is not available for output configurations using the Micro modules.

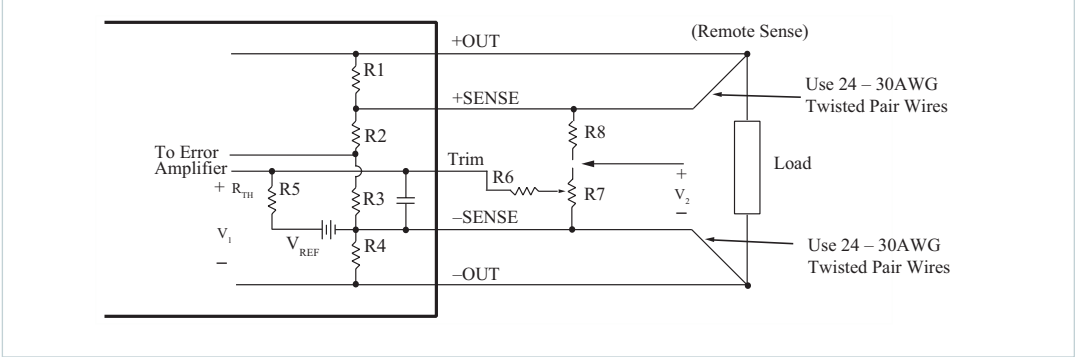
External Trim (Not applicable when using BatMod™ current source)

The TRIM pin can be used for external control of the output voltage. TRIM connections on single- and dual-output connector for output M1 is J1-1 while for output M2 is J2-2. TRIM connections on triple-output connectors for output M1 is J2-6, for output M2 is J3-6 and for output M3 is J3-14. TRIM connections for quadruple-output connectors on outputs M1 and M2 is J2-6 and J2-14 respectively, and for outputs M3 and M4 is J3-6 and J3-14 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.

Table 1
Module internal reference voltages and Thevenin resistances

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

Figure 7
External trim



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:

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

$I_{R5} = (2.75V - V_{REF})/R_{TH} = (2.75V - 2.5V)/10kW = 25mA$ Given: R_{TH} = 10kW (see Table 1)

Setting the bottom limit:

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

And since $I_{R5} = I_{R6} = 25mA$,

$R6 = V_{R6}/I_{R6} = 2.25V/25mA = 90kW$

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

$I_{R7} = V_2/R7 = 5V/10kW = 500mA$

$I_{R8} = I_{R7} + I_{R6} = 525mA$

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

$R8 = V_{R8}/I_{R8} = 8.2V/525mA = 15.62kW$

CONSULT APPLICATIONS ENGINEERING WHEN TRIMMING OUTPUTS BELOW 5V.

Specifications

(Typical at 25ºC, nominal line and 75% load unless otherwise specified.)

General					
Number of Outputs	1 – 4				
Modules	VI-200™/VI-J00™, VE-200/VE-J00: Maxi/Mini/Micro				
Efficiency	Typically >70%				
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, 73/23/EEC amended by 93/68/EEC				
Vibration	Mil-STD 810 Minimum Integrity (MI chassis only)				
Shock	Mil-STD 810 40G Functional Shock (MI chassis only)				
Maximum Output Power (not to exceed input current of 9A)	Up to 500W; 425W for EN 61000-3-2/A14 compliance (105/190V_{AC} minimum input)				
Input					
Input	90 – 132/180 – 264V_{AC} 47 – 63Hz 90 – 132/180 – 264V_{AC} 47 – 63Hz				
Inrush Current	8.5A peak @ 115V_{AC} and 17A peak at 230V_{AC}				
Line/Load Regulation	VI200/VI-J00: ±0.2% max; 10% to full load; ±0.5% max. No load to 10% load				
Line Regulation [f]	Maxi/Mini/Micro: ±0.20% max to 0.3% max LL to HL, full load				
Ride-Through Time: @ 115V_{AC} (typical) @ 230V_{AC} (typical)	**500W** 12ms 16ms	**400W** 15ms 18ms			
Harmonic Distortion	EN61000-3-2 A/14 (For output power up to 425W or input current not in excess of 3.33A_{RMS} at 230V_{AC}, 50Hz.)				
Conducted EMI	FCC and EN 55022 Class A (certain configurations meet EN 55022 Class B) Mil-STD 461 may require external filter – contact factory				
Power Factor	>0.70				
Transient Burst Immunity	EN61000-4-4				
Surge Immunity	EN61000-4-5				
Voltage Dips	EN61000-4-11				
Dielectric Withstand	Primary to Chassis GND = 1,500V_{RMS} Primary to Secondary = 3,000V_{RMS} Secondary to Chassis GND = 500V_{RMS}				
Output (VI-200/VI-J00 Modules)					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Notes**
Setpoint Accuracy [g]		0.5	1	%	of V_{NOM}
Load/line Regulation			±0.2	%	10% to full load
Load/line Regulation			±0.5	%	Load to 10%
Temperature Regulation		0.01	0.02	%/ºC	Over rated temp.
Long Term Drift		0.02		%/K hours	
Output Ripple & Noise: VI/E-200 VI/E-J00		 100 100		mV_{P-P}	See module design guide for exact specifications
Voltage Trim Range: VI-200/VI-J00 Slots		50 – 110		$\%V_{OUT}$	±10% on 10 – 15V_{OUT}
Total Remote-Sense Compensation	0.5			V	Autosense. See Page18
OVP Set Point [h]	115	125		$\%V_{OUT}$	Recycle power
Current Limit	105	115		% of I_{MAX}	Auto recovery

[f] See Vicor module specifications. A preload may be necessary for modules trimmed down below 90% of normal output voltage.
[g] For special and adjustable voltages, maximum setpoint accuracy is 2% of V_{NOM}.
[h] 131% Nominal for Booster Modules. No OVP for VI-J00.

Specifications (Cont.)

(Typical at 25ºC, nominal line and 75% load unless otherwise specified.)

Output (Cont.) (VI-200™/VI-J00™ Modules)					
Parameter	**Min**	**Typ**	**Max**	**Unit**	**Notes**
Short-Circuit Current	20 (105 [j])		130	%	
Overtemperature Limiting					Not available on VI-J00
Setpoint Accuracy [k]		±0.5	±1	% of V_{NOM}	
Load Regulation		±0.01		% of V_{NOM}	See module design guide for exact specifications
Temperature Regulation		0.002	0.005	%/°C	–20 to 100°C
Long-Term Drift		0.02		%/K hours	
Output Ripple and noise: Maxi Mini Micro		 75 100 125		mV_{P-P}	See module design guide for exact specifications
Voltage Trim Range: Maxi/Mini/Micro Slots		 10 – 110		% V_{OUT}	Preload may be required
Total Remote-Sense Compensation	0.5			V	Autosense. See Page18
OVP Set Point	112		135	% of V_{OUT}	Recycle power
Current Limit	102	115	135	% of I_{MAX}	Auto recovery
Overtemperature Limiting					Not available
Environmental					
Storage Temperature [m]	–40°C to +100°C				
Operating Temperature [m] Ambient Air (see de-rating curves) Case Temperature	 –20°C to +70°C (MI –40°C to +70°C) –20°C to +90°C (MI –40°C to +90°C) (75° for full size VI-200 module)				
Altitude	De-rate 2.6% total output power for each 1,000ft to a maximum operating altitude of 15,000ft. Non-operating storage maximum altitude is 40K.				
Humidity	0 – 95% non condensing				
Product Weight	3.4lbs [1,5 kg]				
Dimensions	1.4in H [35,6mm] x 5.0in W [127,0mm] x 9.20in L [233,7mm]				
Warranty [n]	2 years limited warranty. See vicorpower.com for complete warranty statement.				

[j] VI-J00 modules only.

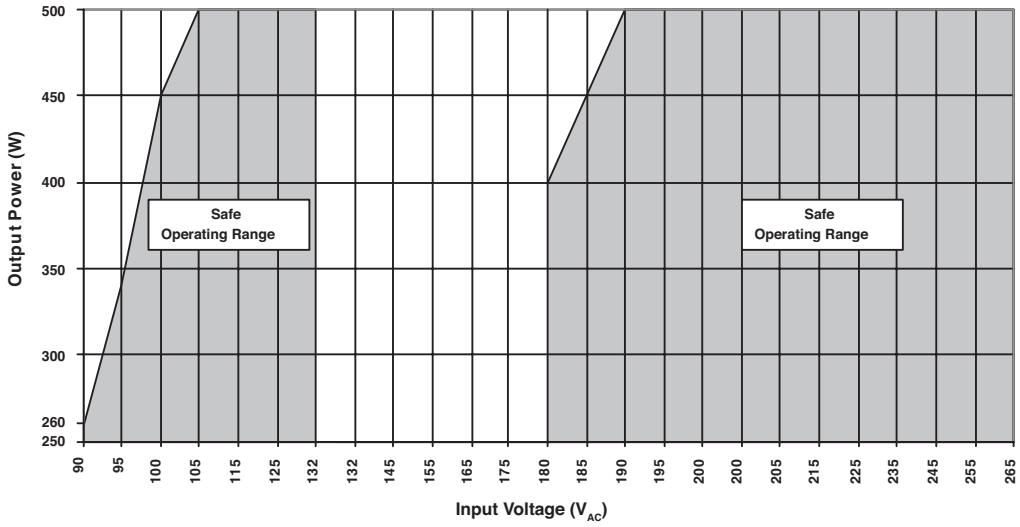
[k] For special, adjustable voltages and 48V_{DC} outputs, maximum setpoint accuracy is 2% of V_{NOM}.
Note: See individual module data sheets for specific module specifications.

[m] Specific temperature data on all module configurations can be obtained by contacting Applications Engineering.

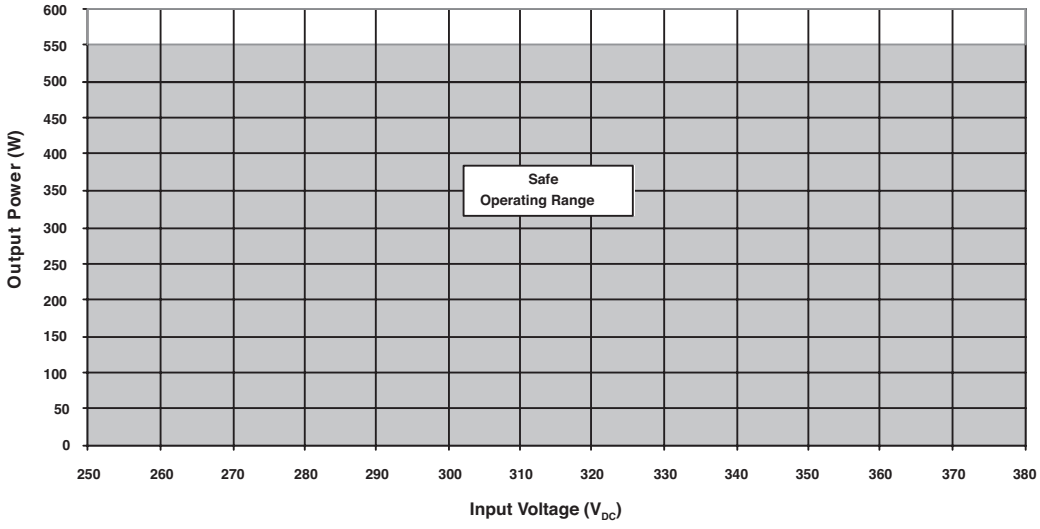
[n] Opening, repairing or modifying the unit will void the warranty. If you have any problem with the power supply, please contact Customer Service at 1-800-735-6200. If the unit needs to be returned or inspection/analysis, an RMA number will be issued. All units must have a RMA number prior to return.

Output Power De-Rating

FlatPAC-EN™
Output Power vs. Input Voltage



FlatPAC-EN
Output Power vs. DC Input Voltage



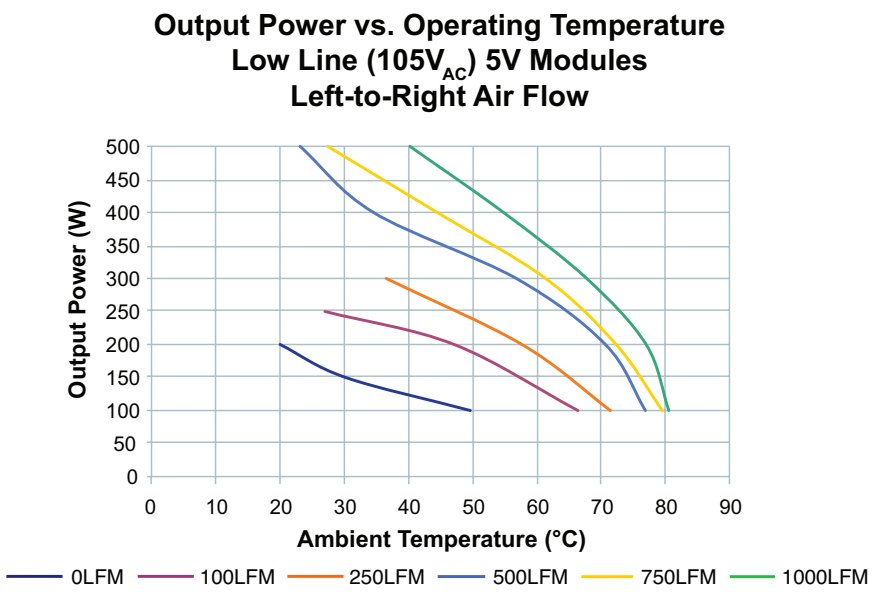
Output Power De-Rating (Cont.)

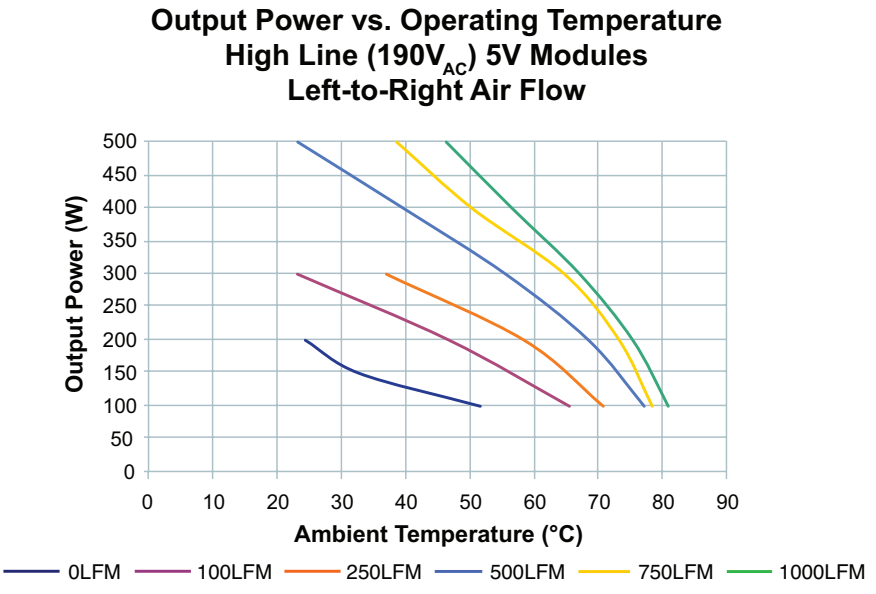
Vicor DC-DC Converters – 300V_{IN} Family Avilable Power (W)					
Output Voltage (V_{DC})	**VI-200™**	**VI-J00™**	**Maxi**	**Mini**	**Micro**
2	80	40	160	100	50
3.3	132	66	264	150	75
5	200	100	400	200	100
12	200	100	500	250	150
15					
24					
28					
48					

All module configurations: The FlatPAC-EN™/EN MI or an individual output may be limited by module power limitations.

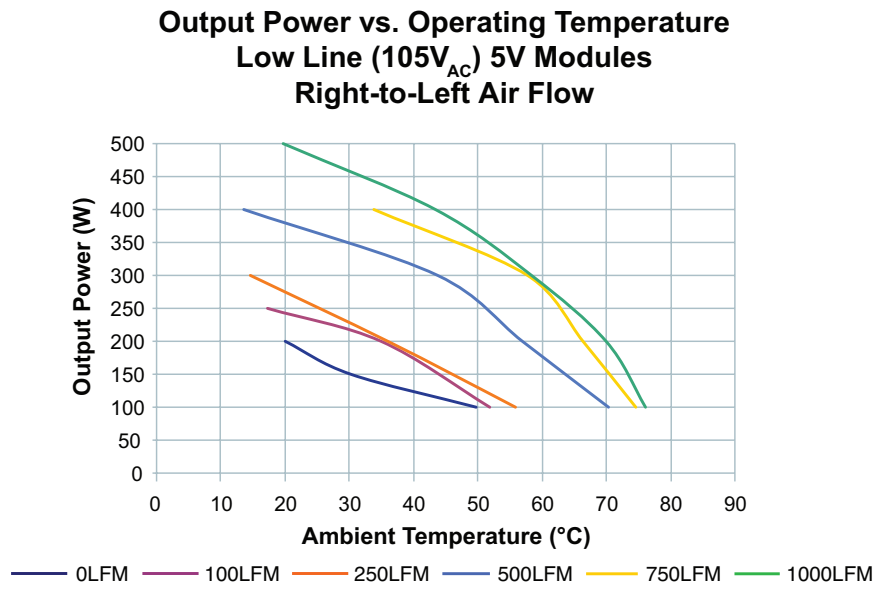
1. One cannot exceed the output power rating of the FlatPAC-EN regardless of the module capability.
2. Also see output power vs. input voltage charts on Page 22.
3. Please note that FlatPAC-EN configurations that uses Molex outputs connectors are limited to 9A/pin (27A per output). This is a Molex connector limitation, NOT a module power limitation.

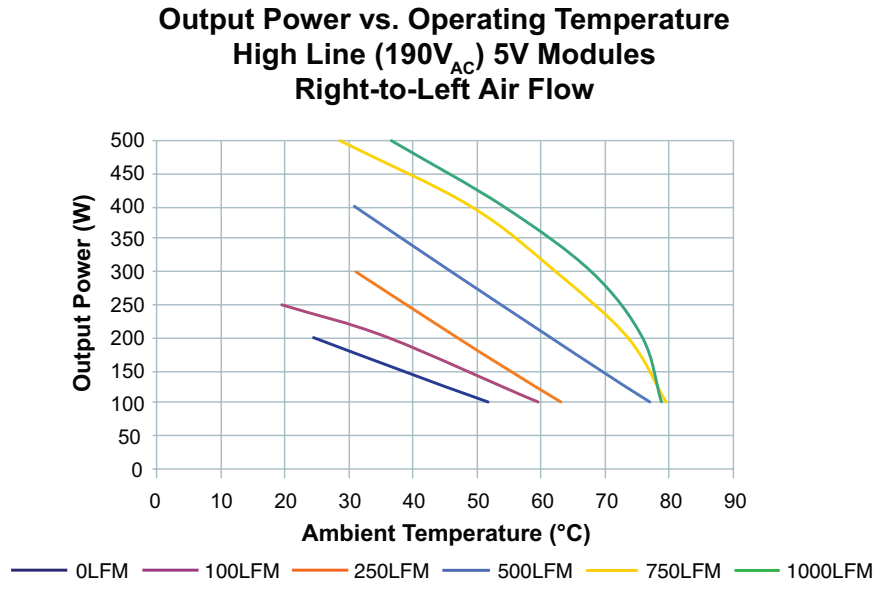
Thermal Curves for FlatPAC-EN™/EN MI



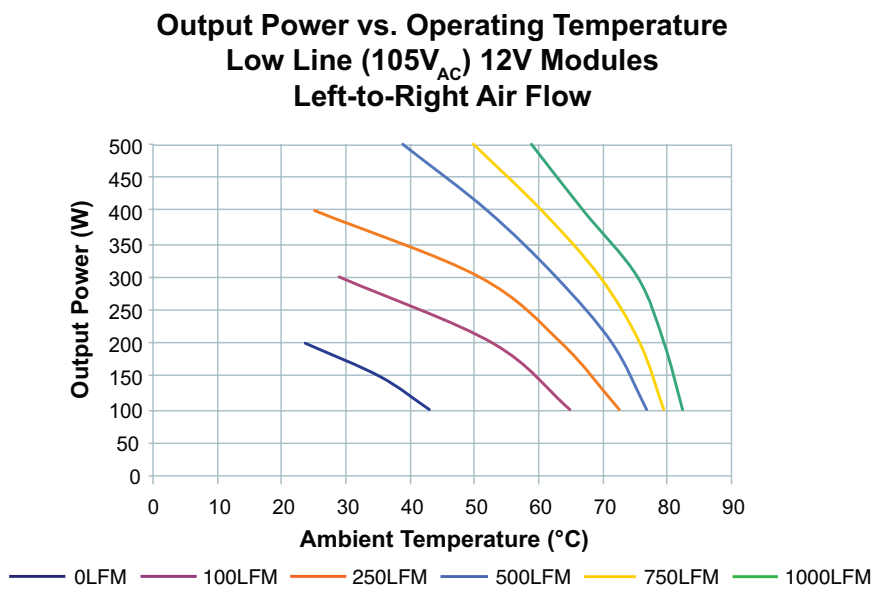


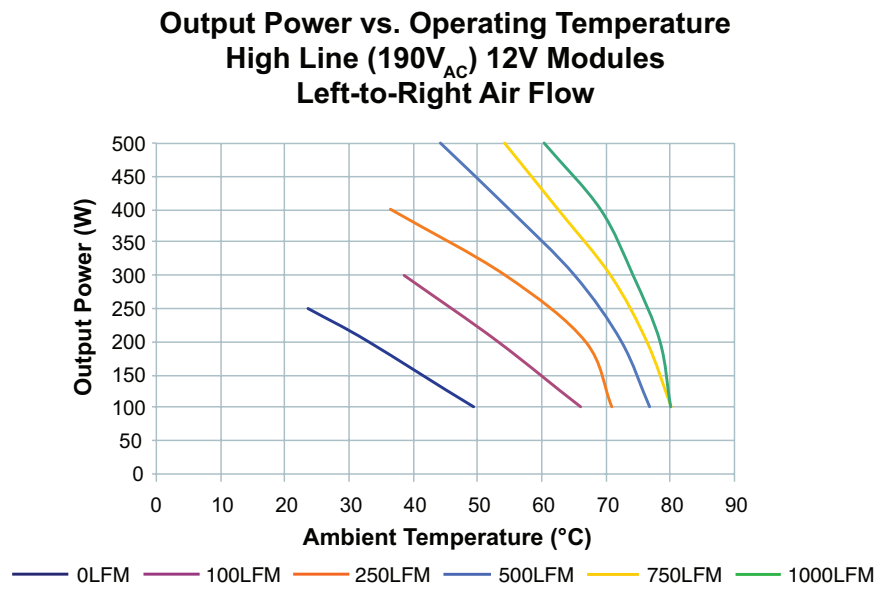
Thermal Curves for FlatPAC-EN™/EN MI (Cont.)



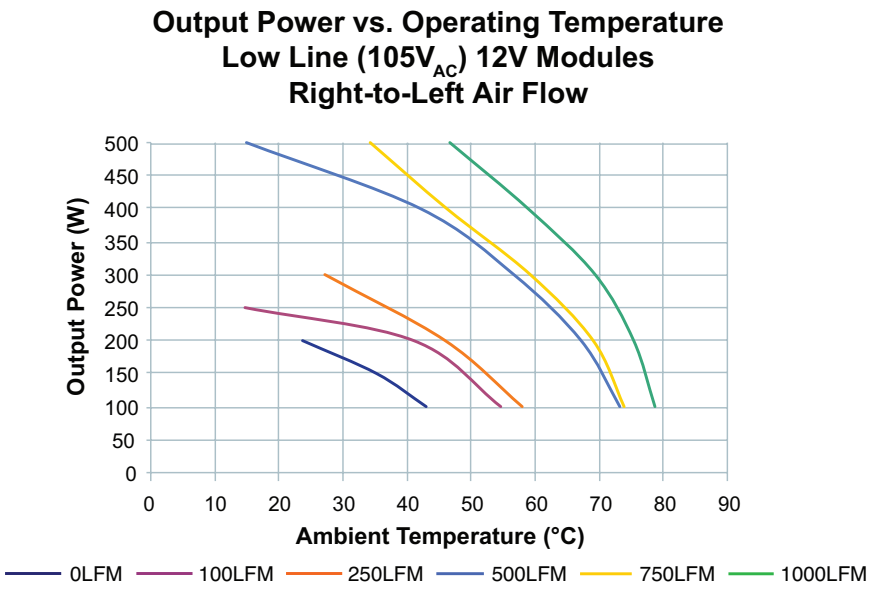


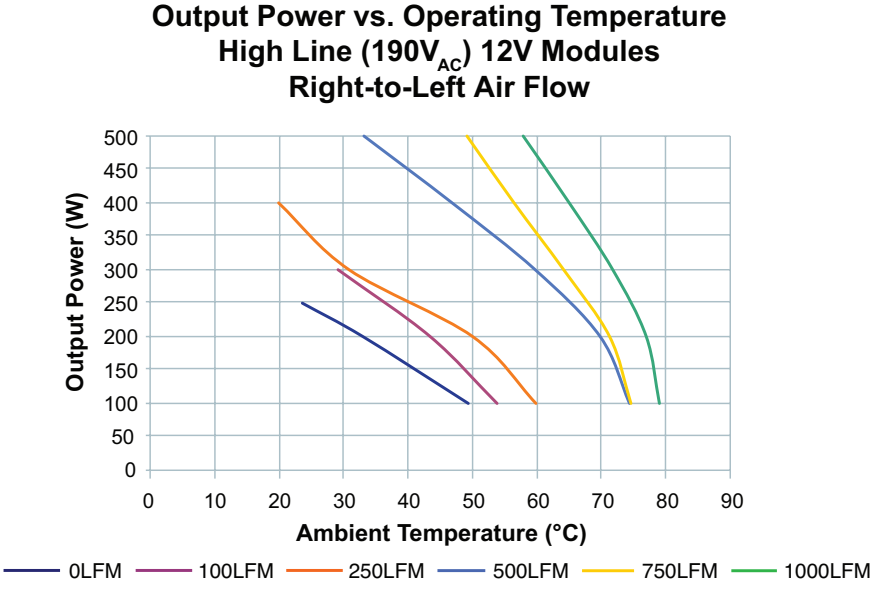
Thermal Curves for FlatPAC-EN™/EN MI (Cont.)





Thermal Curves for FlatPAC-EN™/EN MI (Cont.)





Current Share Boards – Optional Feature

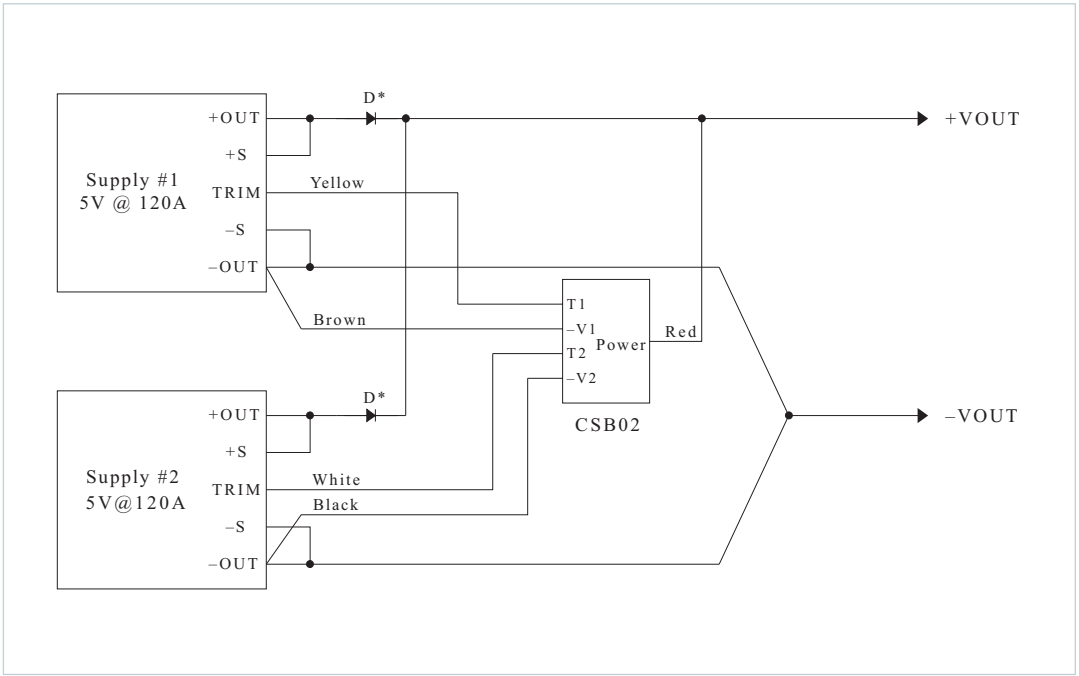
"Current sharing" also known as load sharing, is the ability to divide the output current evenly across all active power supplies. This greatly reduces stresses on each power supply and allows them to run cooler, resulting in higher reliability. Standard "current sharing" techniques typically utilize 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 8
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 8. 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 above.
6. Terminate SENSE leads either locally or remotely as shown in Figure 8.

J1 Pinout

Pin	Description
1	Power
2	1T
3	-V1
4	2T
5	-V2
6	No Connection

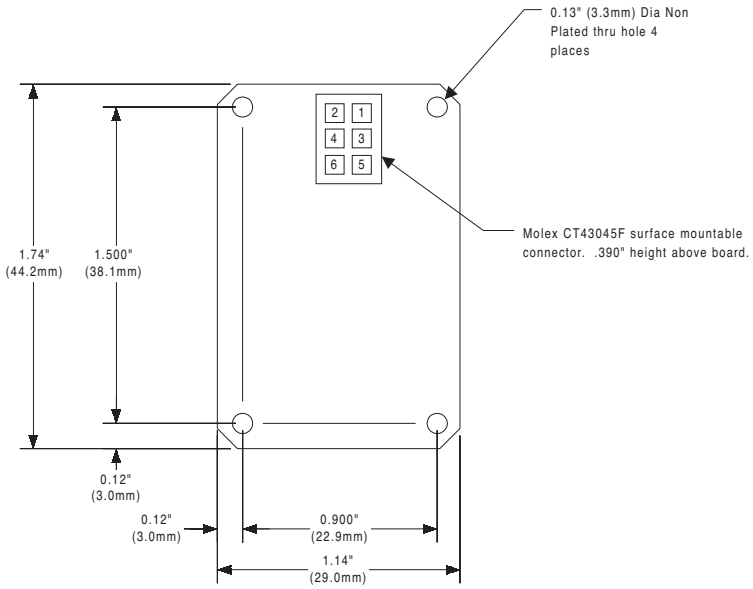


Figure 9. Mechanical Drawing

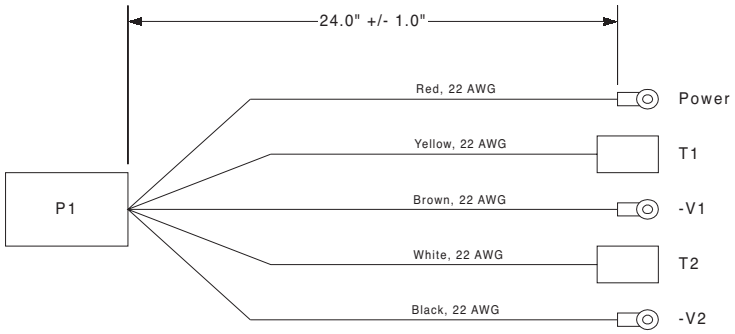


Figure 10. Cable Drawing

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/Mini/Micro).
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 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 and PFC MegaPAC.

Limitation of Warranties

Information in this document is believed to be accurate and reliable. HOWEVER, THIS INFORMATION IS PROVIDED "AS IS" AND WITHOUT ANY WARRANTIES, EXPRESSED OR IMPLIED, AS TO THE ACCURACY OR COMPLETENESS OF SUCH INFORMATION. VICOR SHALL HAVE NO LIABILITY FOR THE CONSEQUENCES OF USE OF SUCH INFORMATION. IN NO EVENT SHALL VICOR BE LIABLE FOR ANY INDIRECT, INCIDENTAL, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES (INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR SAVINGS, BUSINESS INTERRUPTION, COSTS RELATED TO THE REMOVAL OR REPLACEMENT OF ANY PRODUCTS OR REWORK CHARGES).

Vicor reserves the right to make changes to information published in this document, at any time and without notice. You should verify that this document and information is current. This document supersedes and replaces all prior versions of this publication.

All guidance and content herein are for illustrative purposes only. Vicor makes no representation or warranty that the products and/or services described herein will be suitable for the specified use without further testing or modification. You are responsible for the design and operation of your applications and products using Vicor products, and Vicor accepts no liability for any assistance with applications or customer product design. It is your sole responsibility to determine whether the Vicor product is suitable and fit for your applications and products, and to implement adequate design, testing and operating safeguards for your planned application(s) and use(s).

VICOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED FOR USE IN LIFE SUPPORT, LIFE-CRITICAL OR SAFETY-CRITICAL SYSTEMS OR EQUIPMENT. VICOR PRODUCTS ARE NOT CERTIFIED TO MEET ISO 13485 FOR USE IN MEDICAL EQUIPMENT NOR ISO/TS16949 FOR USE IN AUTOMOTIVE APPLICATIONS OR OTHER SIMILAR MEDICAL AND AUTOMOTIVE STANDARDS. VICOR DISCLAIMS ANY AND ALL LIABILITY FOR INCLUSION AND/OR USE OF VICOR PRODUCTS IN SUCH EQUIPMENT OR APPLICATIONS AND THEREFORE SUCH INCLUSION AND/OR USE IS AT YOUR OWN RISK.

Terms of Sale

The purchase and sale of Vicor products is subject to the Vicor Corporation Terms and Conditions of Sale which are available at: (http://www.vicorpower.com/termsconditionswarranty)

Export Control

This document as well as the item(s) described herein may be subject to export control regulations. Export may require a prior authorization from U.S. export authorities.

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