Overview

The Vicor FlatPAC consists of an offline single phase AC front end and one, two or three VI-26x / VI-B6x Family DC-DC converter modules (1-up, 2-up, 3-up), combined in an integrated mechanical assembly. This assembly provides a complete, high-efficiency, offline switching power supply delivering power up to 600W. The offline front end provides rectification and filtering of the AC input, delivering a nominal unregulated $300V_{DC}$ bus as input to the VI-26x / VI-B6x Family converter modules. The front end control circuit will automatically strap the bridge as a voltage doubler for $115V_{AC}$ operation or as a full bridge for $230V_{AC}$ operation.

Circuit Operation

AC line voltage is applied via an agency-approved terminal block providing AC mains (L1, L2/N and GND). Current in the L1 lead is applied to a 15A / 250V fuse for the 3-up FlatPAC, a 12A / 250V fuse for the 2-up FlatPAC and a 8A / 250V fuse for the 1-up FlatPAC. This current is interrupted only in the event of a catastrophic failure of a main power component internal to the FlatPAC.

The input current beyond the fuse is passed through an EMC filter designed to meet conducted noise limits of FCC Part 15 EN55022 Class B for the 2-up and 3-up versions. At start-up, AC inrush current is limited by a PTC thermistor prior to being passed to the main energy storage capacitors. This PTC thermistor serves as both an inrush current limiter on power-up and a current limiting shutdown device in the event of a line overvoltage condition. The PTC is shunted out shortly after initial power-up by a pair of inverse parallel SCRs on the 3-up FlatPAC (TRIAC for the 1-up and 2-up FlatPAC), controlled by an opto-TRIAC coupler driven by a DC bus voltage sense circuit. The main rectifiers and filter capacitors are arranged in a conventional selectable configuration and act as either a full wave bridge or voltage doubler, delivering a nominal $300V_{DC}$ to the converter modules.

At initial power-up, the front end is configured for 230V operation and the PTC inrush limiter permits the main storage capacitors to charge up at a controlled rate toward full operating DC bus potential. If the bus voltage is below the operating threshold for the converter, the unit will autostrap for 115V operation. The autostrapping function is performed by a control circuit and TRIAC (dual SCRs on 3-up unit) which configures the front end from a full wave bridge to a voltage doubler. Once the unit autostraps for 230V operation, it will be necessary to recycle the AC power to allow operation at 115V. If the unit is operating in the 115V mode and a long duration transient is applied to the FlatPAC (>$150V_{AC}$ for 50ms), the unit will autostrap for 230V operation.

The control circuit maintains the converter GATE IN pins low, the PTC shunt inactive and the AC-OK and BUS-OK outputs in FAIL status until the DC bus potential reaches a minimum threshold at which full power and hold-up can be delivered. The GATE IN terminals of all Driver modules internal to the FlatPAC are FET-controlled by a logical replica of the BUS-OK status line, and as such will inhibit converter operation at power-up until the DC bus potential has settled to full operating level. The converters are then enabled and the PTC shunt activated.

The AC-OK and BUS-OK status lines go to their respective active states almost simultaneously on initial power-up. AC-OK will de-assert prior to BUS-OK on loss of AC input, providing advance warning of impending DC failure should the AC line not return prior to the expiration of the ride-through time (a function of both load and line voltage).

The front-end output is bled down automatically after loss of AC input, as the logic circuit operating power is derived from a bleed path across the DC output bus. Wait two minutes before reapplying input after shutdown. Input voltage to the converters is made via fast-acting 3A / 250V Buss PC-Tron fuses in each positive input lead. The fuse will clear rapidly and protect the front-end from damage in the event of a module input short.

Input overvoltage sensing and protection is performed by a voltage sensing circuit connected across the DC bus. In the event of an overvoltage condition, a SCR / PTC combination will simultaneously disable the drive for the TRIAC / SCR PTC shunt, disable the converters and apply a load across the DC bus. Normal operation resumes when the input voltage falls within the normal operating range when operated from a $230V_{AC}$ source.

A Overall Disable function is incorporated in the 2-up and 3-up FlatPAC (MOD DIS+, MOD DIS–). This optically isolated input will disable the output of all converters simultaneously. Applying a current to this input will disable the converters. This disable current should be limited to 30mA maximum by an external control element.

FlatPAC AC-OK and BUS-OK Status Outputs, MOD-DIS Input (2-up and 3-up only)

The BUS-OK and AC-OK outputs provide the user with both an optically isolated status indication of the internal DC bus condition and advance warning of pending DC bus drop-out due to AC line loss. These outputs, in system applications, can provide power supply status, switch in (standby) backup sources or initiate “power-down” sequences to save volatile memory contents in the event of AC line loss. The MOD-DIS input is an optically coupled input and allows for remote disabling of the outputs of 2-up and 3-up FlatPACs.

BUS-OK: An internal replica of BUS-OK is wired to the GATE IN input of all internal Driver modules. The modules will be disabled (no DC output) during initial power-up of the FlatPAC until the internal DC input bus voltage to the DC-DC converters is sufficient to support fully-loaded operation. The BUS-OK status output reflects the status of this inhibit function. This same logic circuit will shut down the converters when the internal DC bus voltage is insufficient to support proper loaded operation. This shut down will occur during normal power down, AC line dropouts of duration exceeding the hold-up time, or internal faults causing the internal DC bus voltage at the input of the converters to collapse.

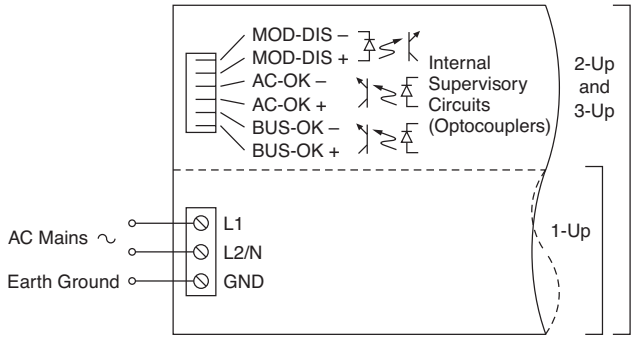
AC-OK: This output is provided primarily as an advance warning of a potential DC BUS-OK shut down due to loss of AC line or an internal fault. A minimum advance warning time of 5ms is provided at $90V_{AC}$ and full load.

MOD-DIS+, MOD-DIS–

The Module Disable function will disable the output(s) of the 2-up and 3-up FlatPACs. The supply is disabled by applying current to the MOD-DIS+ / MOD-DIS– input. The minimum input current for disabling the supplies is 1mA. The maximum allowable current is 30mA.

Electrical Connections

Status output pairs AC-OK+, AC-OK– and BUS-OK+, BUS-OK– are the collectors (+) and emitters (–) of NPN optoisolator output transistors (one optoisolator per status signal). The collector terminals AC-OK+ and BUS-OK+ of the optocouplers, in a typical application, can be connected via current limiting resistors to a source no greater than $70V_{DC}$. These resistors should limit the maximum current to the optocoupler output transistors to 1.5mA. The emitter terminals AC-OK– and BUS-OK– are connected to the return of the external source. The status OK condition will set the optocoupler output transistors in saturation and are capable of sinking up to 1.5mA with a V_{CE} saturation voltage of 0.4V. Users should be cautioned that although the output of the FlatPAC can be used as the pull-up source, shortly after BUS-OK changes from OK (saturated) to NOT OK (high Z), the pull-up voltage will be shut down. It is thus advisable to provide a capacitive reservoir, if the pull-up source is one of the FlatPAC's outputs, in order to maintain the pull-up potential after loss of DC current output. Use edge sensing logic to detect assertion of logic outputs, or a separate source of bias supply voltage (i.e., backup batteries) to provide a safe pull-up voltage source regardless of the AC line status.



Note: Product is internally fused.

Figure 18.1 — *AC mains and supervisory connections*

Mod-Dis Input: Apply a current of 1 – 30mA to disable output. Forward voltage drop of internal opto diode is 1.65V max. at 30mA max.

AC-OK and BUS-OK Status Outputs: Outputs low when OK. V_{CE} sat. = <0.4V at 1.5mA. Maximum external pull up is $70V_{DC}$. AC-OK and BUS-OK signals are isolated and can have different reference levels.

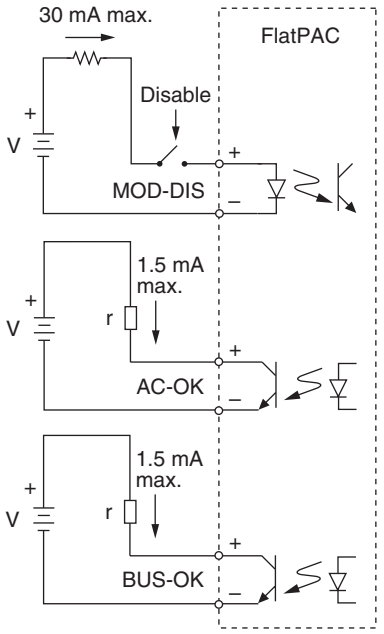
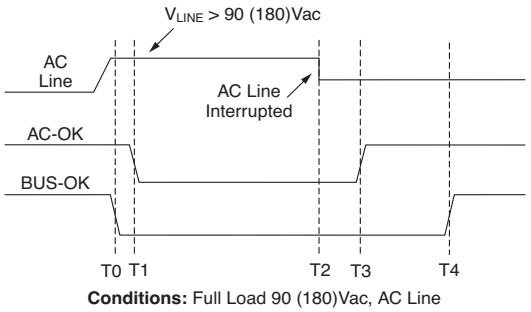


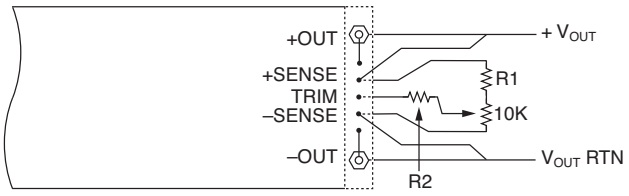
Figure 18.2 — *External supervisory functions (2-up and 3-up models only)*



Conditions: Full Load 90 (180)Vac, AC Line

Time Interval	Min	Typ	Max	Unit	Notes
T1 – T0	0	0.1	1.0	ms	
T3 – T2	0	–	–	ms	Ride-through time
T4 – T2	5	–	–	ms	Hold-up time
T4 – T3	5	–	–	ms	AC fail warning time

Figure 18.3 — *Timing diagram, status signals (2-up and 3-up models only)*



Note: +SENSE and –SENSE must be connected locally or remotely (shown).

Resistor Values for Trimming Standard Output Voltages

Resistor	Nominal Output Voltage						Trim Range
	5V	12V	15V	24V	28V	48V	
R1 (kΩ)	0.953	15.8	22.1	41.2	48.7	90.9	+10%, –10%
R2 (kΩ)	90						

Figure 18.4 — *Output SENSE and TRIM (all models with VI-200s)*

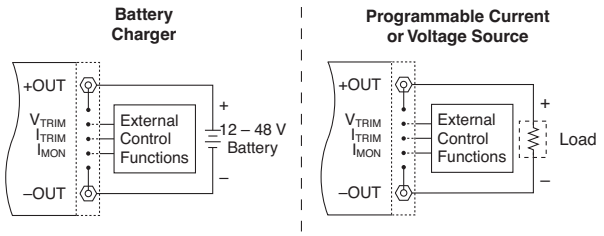


Figure 18.5 — *Typical applications (models with BatMods only)*

Fusing: The FlatPAC's internal fuses are not user-replaceable. Please return the unit to vendor if servicing is necessary.

Grounding: To satisfy IEC950 Class I grounding requirements, connect a ground lead to the terminal marked ⏚ (GND). For 1-up FlatPAC models (max. output 200W), use 1.5mm^2 / #16AWG wire; for 2-up and 3-up models (max. output 400W and 600W), use 2.5mm^2 / #14AWG wire.

Input Voltage Connections: Connect the line voltage to L1 (hot) and L2N (neutral). For 1-up FlatPAC models (max. output 200W), use #16AWG input wire; for 2-up and 3-up models (max. output 400W and 600W), use #14AWG input wire. Recommended connector screw torque is 5 to 7in·lbs (0.5 – 0.8N·m). Recommended strip length is 8mm. Use your FlatPAC model only with the corresponding input voltages and frequencies shown in the table below.

Product Grade	Model	90 – 132V_{AC}	180 – 264V_{AC}
C-Grade	VIxU-Cx	47 – 63Hz	
I-Grade	VI-xU-Ix	47 – 440Hz	

Output Wire Gauge: Use the output wire gauge that corresponds to the output current of your Autoranging FlatPAC unit, below: Do not loosen bottom nut.

Output Current & Corresponding Wiring					
100 – 160A	#2	30 – 50A	#8	10 – 15A	#14
75 – 100A	#4	20 – 30A	#10	6 – 10A	#16
50 – 75A	#6	15 – 20A	#12	0 – 6A	#18

Long cable runs, or wires in large bundles will require heavier cable to avoid excessive voltage drops or overheating.

Output Voltage Trimming: Do not trim the outputs higher than 110% of their nominal output voltage. When an output is trimmed up, do not exceed its maximum rated output power. (refer to Section 5)

Operating Temperature: Do not allow the FlatPAC to exceed its maximum operating temperature, which is reached when the heat sink is 85°C. (Full power can be delivered up to this temperature.) Heat sink temperature is a function of the output power and voltage of the supply, ambient temperature, and airflow across the heat sink. Always use worst-case conditions when calculating operating temperature.

Note 1: To ensure proper heat transfer from the internal module(s) to the heat sink, the mounting holes through the heat sink (two, three, and four holes on 1-up, 2-up and 3-up models, respectively) must contain torqued screws at all times during operation, whether or not the unit is mounted. If the unit is operated unmounted, insert a #6 or M3.5 panhead screw through each hole from below and secure with a nut on top, torqued to 6in·lbs [0.7 N·m].

Note 2: All FlatPAC models are available with a conduction cooled flat plate instead of the top heat sink.
Go to vicorpower.com for outline drawings.

Input / Output Retrofit Connections: A hardware kit, available from Vicor, allows the input and output supervisory terminals to be connected in the same manner as for the earlier style FlatPAC (2-up model only). The retrofit output terminals are sized to accept AMP Faston® insulated receptacle #2-520184-2.