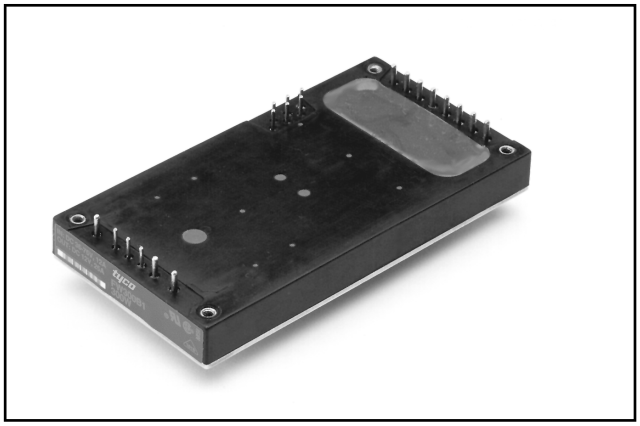
Data Sheet
May 1999

FC250R Power Module:
dc-dc Converter; 18 Vdc to 36 Vdc Input, 28 Vdc Output; 250 W



The FC250R Power Module uses advanced, surface-mount technology and delivers high-quality, compact, dc-dc conversion at an economical price.

Applications

- Redundant and/or distributed power architectures
- Workstations
- EDP equipment
- Telecommunication

Options

- Heat sinks available for extended operation
- Choice of primary remote on/off logic configurations

Features

- Size: 61.0 mm x 116.8 mm x 13.5 mm (2.40 in. x 4.60 in. x 0.53 in.)
- Wide input voltage range
- High efficiency: 88% typical
- Parallel operation with load sharing
- Adjustable output voltage
- Thermal protection
- Synchronization
- Power good signal
- Current monitor
- Output overvoltage and overcurrent protection
- Constant frequency
- Case ground pin
- Input-to-output isolation
- Remote sense
- Remote on/off
- Short-circuit protection
- Output overvoltage clamp
- ISO9001 Certified manufacturing facilities
- *UL** 1950 Recognized, *CSA*† C22.2 No. 950-95 Certified, and VDE 0805 (EN60950, IEC950) Licensed

Description

The FC250R Power Module is a dc-dc converter that operates over an input voltage range of 18 Vdc to 36 Vdc and provides a precisely regulated dc output. The outputs are fully isolated from the inputs, allowing versatile polarity configurations and grounding connections. The module has a maximum power rating of 250 W at a typical full-load efficiency of 88%.

Two or more modules may be paralleled with forced load sharing for redundant or enhanced power applications. The package, which mounts on a printed-circuit board, accommodates a heat sink for high-temperature applications.

* *UL* is a registered trademark of Underwriters Laboratories, Inc.
† *CSA* is a registered trademark of Canadian Standards Association.

Absolute Maximum Ratings

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

Parameter	Symbol	Min	Max	Unit
Input Voltage Continuous	V_I	—	50	Vdc
I/O Isolation Voltage	—	—	1500	V
Operating Case Temperature (See Thermal Considerations section and Figure 18.)	T_C	–40	100	°C
Storage Temperature	T_{stg}	–55	125	°C

Electrical Specifications

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

Table 1. Input Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	V_I	18	28	36	Vdc
Maximum Input Current (V_I = 0 V to 36 V)	$I_{I,\,max}$	—	—	22	A
Inrush Transient	i^2t	—	—	4.0	A^2s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 µH source impedance; see Figure 8.)	—	—	10	—	mAp-p
Input Ripple Rejection (120 Hz)	—	—	60	—	dB

Fusing Considerations

CAUTION: This power module is not internally fused. An input line fuse must always be used.

This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of a sophisticated power architecture. To preserve maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a normal-blow fuse with a maximum rating of 25 A (see Safety Considerations section). Based on the information provided in this data sheet on inrush energy and maximum dc input current, the same type of fuse with a lower rating can be used. Refer to the fuse manufacturer's data for further information.

Electrical Specifications (continued)

Table 2. Output Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point (V_I = 28 V; $I_O = I_{O,\,max}$; T_C = 25 °C)	$V_{O,\,set}$	27.45	28.0	28.55	Vdc
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life; see Figure 9 and Feature Descriptions.)	V_O	27.16	—	28.84	Vdc
Output Regulation:					
Line (V_I = 18 V to 36 V)	—	—	0.01	0.1	%
Load ($I_O = I_{O,\,min}$ to $I_{O,\,max}$)	—	—	0.05	0.2	%
Temperature (T_C = –40 °C to +100 °C)	—	—	100	300	mV
Output Ripple and Noise Voltage (See Figures 4 and 10.):					
RMS	—	—	—	50	mVrms
Peak-to-peak (5 Hz to 20 MHz)	—	—	—	100	mVp-p
Output Current (At $I_O < I_{O,\,min}$, the modules may exceed output ripple specifications.)	I_O	0.3	—	9.0	A
Output Current-limit Inception (V_O = 90% of $V_{O,\,set}$; see Feature Descriptions.)	$I_{O,\,cli}$	103*	—	130*	% $I_{O,\,max}$
Output Short-circuit Current (V_O = 1.0 V; indefinite duration, no hiccup mode; see Figure 2.)	—	—	—	150	% $I_{O,\,max}$
External Load Capacitance (total for one unit or multiple paralleled units)	—	330	—	†	µF
Efficiency (V_I = 28 V; $I_O = I_{O,\,max}$; T_C = 25 °C; see Figures 3 and 9.)	η	—	88	—	%
Switching Frequency	—	—	500	—	kHz
Dynamic Response ($\Delta I_O/\Delta t$ = 1 A/10 µs, V_I = 28 V, T_C = 25 °C (tested with a 330 µF aluminum and a 1.0 µF ceramic capacitor across the load); see Figures 5 and 6.):					
Load Change from I_O = 50% to 75% of $I_{O,\,max}$:					
Peak Deviation	—	—	300	—	mV
Settling Time (V_O < 10% of peak deviation)	—	—	250	—	µs
Load Change from I_O = 50% to 25% of $I_{O,\,max}$:					
Peak Deviation	—	—	400	—	mV
Settling Time (V_O < 10% of peak deviation)	—	—	250	—	µs

* These are manufacturing test limits. In some situations, results may differ.
† Please consult your sales representative or the factory.

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	1700	—	pF
Isolation Resistance	10	—	—	MΩ

General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O,\ max}$; T_C = 40 °C)		1,800,000		hours
Weight	—	—	200 (7)	g (oz.)

Feature Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions. See Feature Descriptions for further information.

Parameter	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal Interface					
(V_I = 0 V to 36 V; open collector or equivalent compatible; signal referenced to V_I(–) terminal; see Figure 11 and Feature Descriptions.):					
Logic Low—Module On					
Logic High—Module Off					
Logic Low:					
At $I_{on/off}$ = 1.0 mA	$V_{on/off}$	0	—	1.2	V
At $V_{on/off}$ = 0.0 V	$I_{on/off}$	—	—	1.0	mA
Logic High:					
At $I_{on/off}$ = 0.0 µA	$V_{on/off}$	—	—	15	V
Leakage Current	$I_{on/off}$	—	—	50	µA
Turn-on Time (I_O = 80% of $I_{O,\ max}$; V_O within ±1% of steady state)	—	—	50	100	ms
Output Voltage Overshoot	—	—	0	5	%$V_{O,\ set}$
Output Voltage Adjustment (See Feature Descriptions.):					
Note: Do not allow the combination of remote-sense and trim to exceed 28.5 V on the output.					
Output Voltage Remote-sense Range	—	—	—	0.5	V
Output Voltage Set-point Adjustment Range (trim)	—	60	—	102	%$V_{O,\ nom}$
Output Overvoltage Protection (shutdown)	—	30.9	—	37.0	V
Output Current Monitor (I_O = $I_{O,\ max}$, T_C = 70 °C)	$I_{O,\ mon}$	0.34*	0.40	0.45*	V/A
Synchronization:					
Clock Amplitude	—	4.00	—	5.00	V
Clock Pulse Width	—	0.4	—	—	µs
Fan-out	—	—	—	1	—
Capture Frequency Range	—	450	—	550	kHz
Overtemperature Shutdown (See Figure 18.)	T_C	—	105	—	°C
Current Share Accuracy	—	—	10	—	%$I_{O,\ rated}$
Power Good Signal Interface (See Feature Descriptions.):					
Low Impedance—Module Operating	$R_{pwr/good}$	—	—	100	Ω
	$I_{pwr/good}$	—	—	1	mA
High Impedance—Module Off	$R_{pwr/good}$	1	—	—	MΩ
	$V_{pwr/good}$	—	—	40	V

* These are manufacturing test limits. In some situations, results may differ.

Characteristic Curves

The following figures provide typical characteristics for the power module.

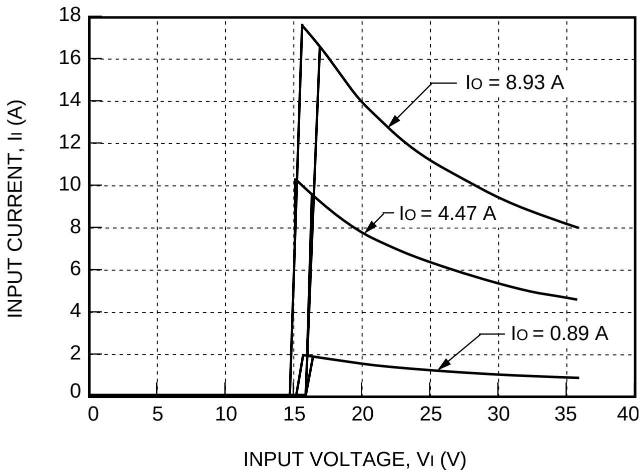


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Figure 1. Typical FC250R Input Characteristics at Room Temperature, I_O = Full Load

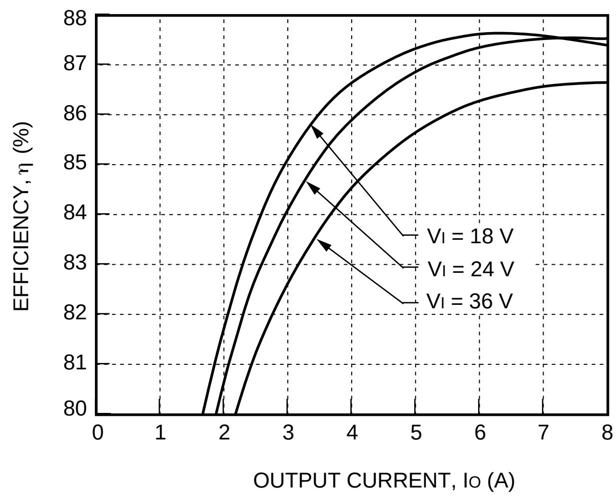

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Figure 3. Typical FC250R Efficiency vs. Output Current at Room Temperature

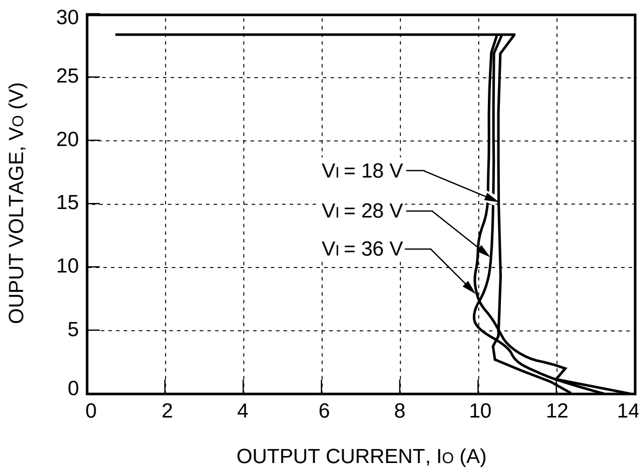

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Figure 2. Typical FC250R Output Characteristics at Room Temperature

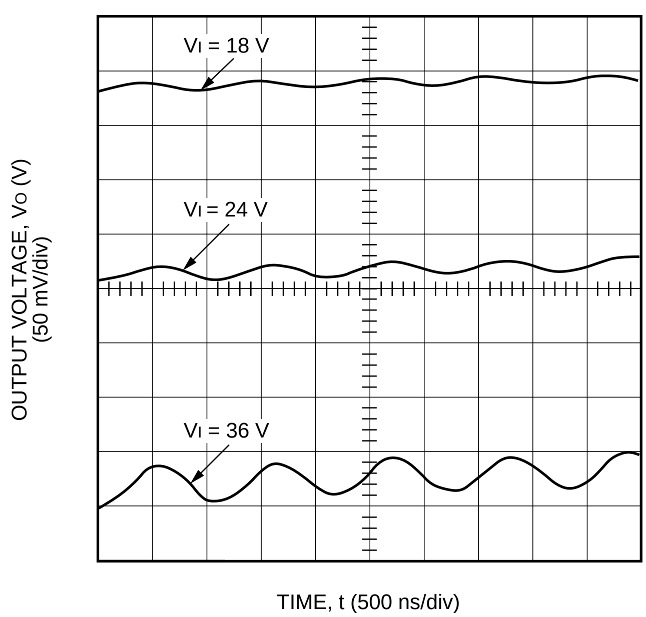

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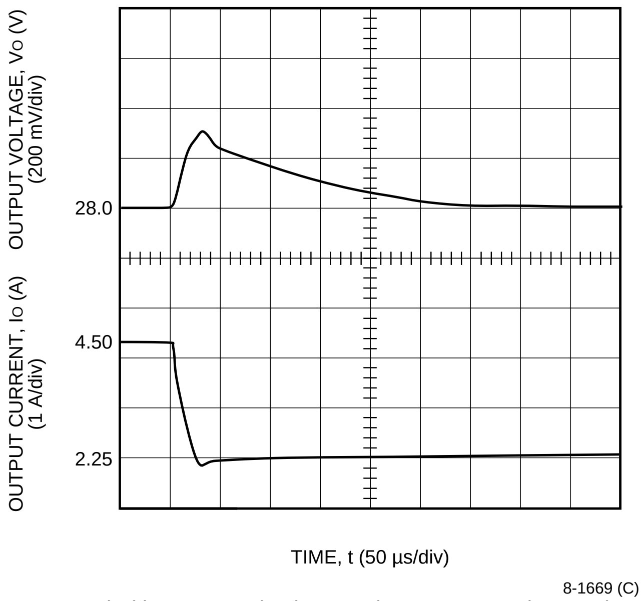
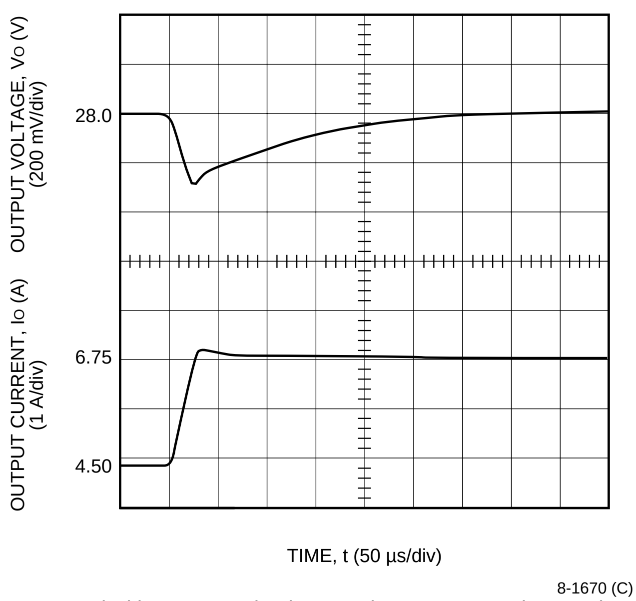
Figure 4. Typical FC250R Output Ripple Voltage at Room Temperature and 9 A Output

Characteristic Curves (continued)



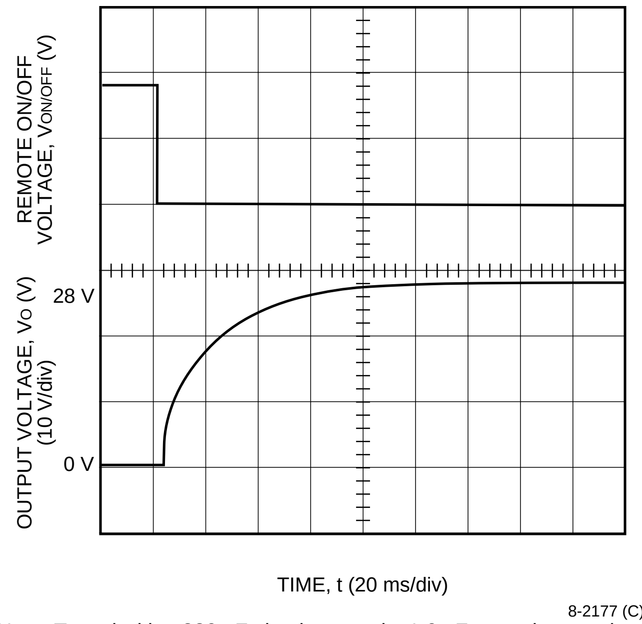
Note: Tested with a 330 µF aluminum and a 1.0 µF ceramic capacitor across the load.

Figure 5. Typical FC250R Transient Response to Step Decrease in Load from 50% to 25% of Full Load at Room Temperature and 28 V Input (Waveform Averaged to Eliminate Ripple Component.)



Note: Tested with a 330 µF aluminum and a 1.0 µF ceramic capacitor across the load.

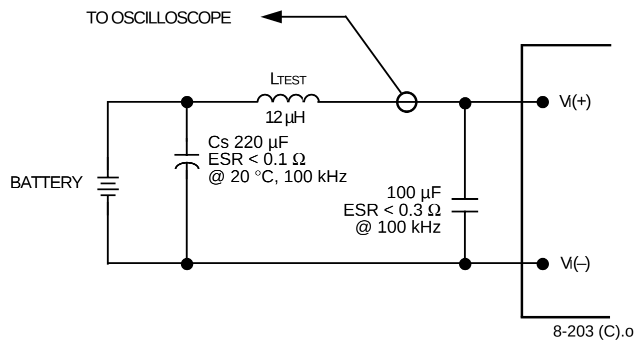
Figure 6. Typical FC250R Transient Response to Step Increase in Load from 50% to 75% of Full Load at Room Temperature and 28 V Input (Waveform Averaged to Eliminate Ripple Component.)



Note: Tested with a 330 µF aluminum and a 1.0 µF ceramic capacitor across the load.

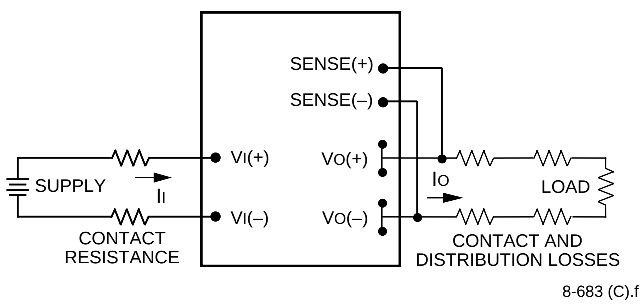
Figure 7. Typical FC250R Start-Up Transient at Room Temperature, 28 V Input, and Full Load

Test Configurations



Note: Measure input reflected-ripple current with a simulated source inductance (L_{TEST}) of 12 µH. Capacitor C_S offsets possible battery impedance. Measure current as shown above.

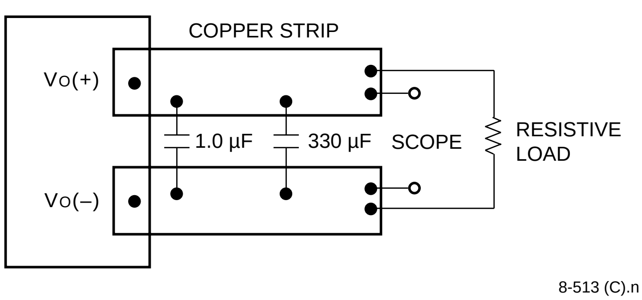
Figure 8. Input Reflected-Ripple Test Setup



Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

$$\eta = \left(\frac{[V_O(+) - V_O(-)]I_O}{[V_I(+) - V_I(-)]I_I}\right) \times 100 \quad \%$$

Figure 9. Output Voltage and Efficiency Measurement Test Setup



Note: Use a 0.1 µF ceramic capacitor and a 330 µF aluminum or tantalum capacitor. The 330 µF capacitor is needed for stability. Scope measurement should be made using a BNC socket. Position the load between 50 mm and 76 mm (2 in. and 3 in.) from the module.

Figure 10. Peak-to-Peak Output Noise Measurement Test Setup

Design Considerations

Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. For the test configuration in Figure 8, a 100 µF electrolytic capacitor (ESR < 0.3 Ω at 100 kHz) mounted close to the power module helps ensure stability of the unit. For other highly inductive source impedances, consult the factory for further application guidelines.

Safety Considerations

For safety-agency approval of the system in which the power module is used, the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standard, i.e., *UL*1950, *CSA* C22.2 No. 950-95, and VDE 0805 (EN60950, IEC950).

For the converter output to be considered meeting the requirements of safety extra-low voltage (SELV), the input must meet SELV requirements.

The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

The input to these units is to be provided with a maximum 25 A normal-blow fuse in the ungrounded lead.

Feature Descriptions

Overcurrent Protection

To provide protection in a fault (output overload) condition, the unit is equipped with internal current-limiting circuitry and can endure current limiting for an unlimited duration. At the point of current-limit inception, the unit shifts from voltage control to current control. If the output voltage is pulled very low during a severe fault, the current-limit circuit can exhibit either foldback or tailout characteristics (output-current decrease or increase). The unit operates normally once the output current is brought back into its specified range.

Feature Descriptions (continued)

Remote On/Off

To turn the power module on and off, the user must supply a switch to control the voltage between the on/off terminal and the V_I(–) terminal ($V_{on/off}$). The switch can be an open collector or equivalent (see Figure 11). A logic low is $V_{on/off}$ = 0 V to 1.2 V, during which the module is on. The maximum $I_{on/off}$ during a logic low is 1 mA. The switch should maintain a logic-low voltage while sinking 1 mA.

During a logic high, the maximum $V_{on/off}$ generated by the power module is 15 V. The maximum allowable leakage current of the switch at $V_{on/off}$ = 15 V is 50 µA.

If not using the remote on/off feature, short the ON/OFF pin to V_I(–).

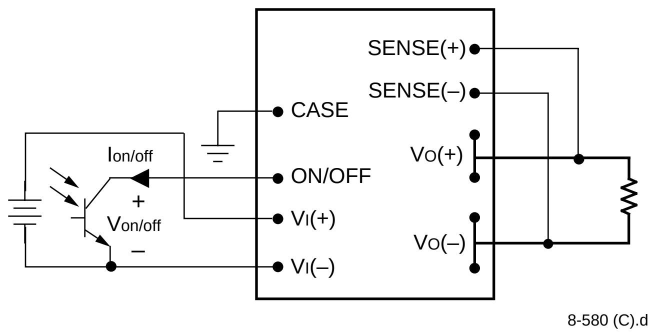


Figure 11. Remote On/Off Implementation

Remote Sense

Remote sense minimizes the effects of distribution losses by regulating the voltage at the remote-sense connections. The voltage between the remote-sense pins and the output terminals must not exceed the output voltage sense range given in the Feature Specifications table, i.e.:

$$[V_O(+) - V_O(-)] - [SENSE(+) - SENSE(-)] \le 0.5\ V$$

The voltage between the V_O(+) and V_O(–) terminals must not exceed the minimum value indicated in the output overvoltage shutdown section of the Feature Specifications table. This limit includes any increase in voltage due to remote-sense compensation and output voltage set-point adjustment (trim), see Figure 12.

If not using the remote-sense feature to regulate the output at the point of load, connect SENSE(+) to V_O(+) and SENSE(–) to V_O(–) at the module.

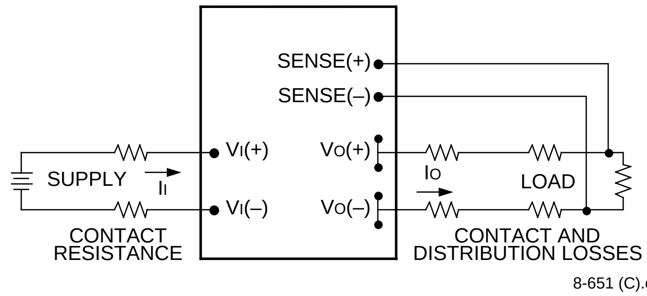


Figure 12. Effective Circuit Configuration for Single-Module Remote-Sense Operation

Output Voltage Set-Point Adjustment (Trim)

Output voltage trim allows the user to increase or decrease the output voltage set point of a module. This is accomplished by connecting an external resistor between the TRIM pin and either the SENSE(+) or SENSE(–) pins. The TRIM resistor should be positioned close to the module.

If not using the trim feature, leave the TRIM pin open.

With an external resistor between the TRIM and SENSE(–) pins ($R_{adj\text{-}down}$), the output voltage set point ($V_{O,\ adj}$) decreases (see Figure 13). The following equation determines the required external-resistor value to obtain a percentage output voltage change of Δ%.

$$R_{adj\text{-}down} = \left(\frac{205}{\Delta\%} - 2.255\right)\ k\Omega$$

The test results for this configuration are displayed in Figure 14. This figure applies to all output voltages.

With an external resistor connected between the TRIM and SENSE(+) pins ($R_{adj\text{-}up}$), the output voltage set point ($V_{O,\ adj}$) increases (see Figure 15).

Note: The output voltage of this module may be increased to a maximum of 0.5 V. The 0.5 V is the combination of both the remote sense and the output voltage set-point adjustment (trim). Do not exceed 28.5 V between the V_O(+) and V_O(–) terminals.

The following equation determines the required external-resistor value to obtain a percentage output voltage change of Δ%.

$$R_{adj\text{-}up} = \left(\frac{V_O(100 + \Delta\%)}{1.225\Delta\%} - \frac{(100 + 2\Delta\%)}{\Delta\%}\right)\ k\Omega$$

Only trim up to 0.5 V maximum; see note above.

Feature Descriptions (continued)

Output Voltage Set-Point Adjustment (Trim) (continued)

The test results for this configuration are displayed in Figure 15.

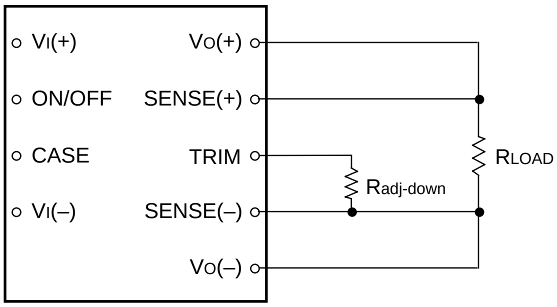


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Figure 13. Circuit Configuration to Decrease Output Voltage

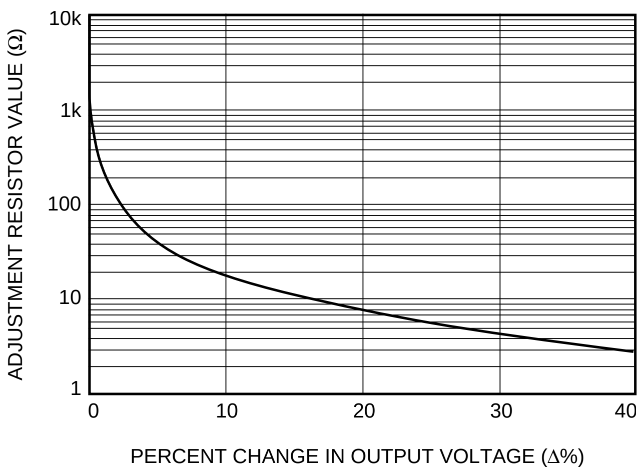

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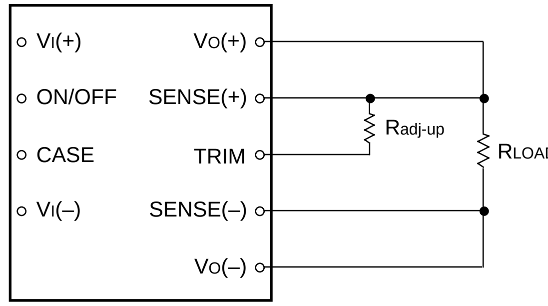
Figure 14. Resistor Selection for Decreased Output Voltage



8-715 (C).b

Figure 15. Circuit Configuration to Increase Output Voltage

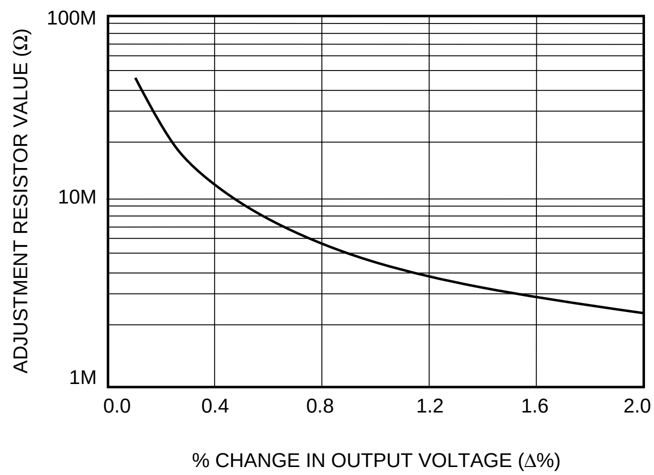


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Figure 16. Resistor Selection for Increased Output Voltage

Output Overvoltage Protection

The output voltage is monitored at the $V_O(+)$ and $V_O(–)$ pins of the module. If the voltage at these pins exceeds the value indicated in the feature specifications table, the module will shut down and latch off. Recovery from latched shutdown is accomplished by cycling the dc input power off for at least 1.0 s or toggling the primary referenced on/off signal for at least 1.0 s.

Feature Descriptions (continued)

Output Current Monitor

The CURRENT MON pin provides a dc voltage proportional to the dc output current of the module given in the Feature Specifications table. For example, on the FC250R, the V/A ratio is set at 370 mV/A ± 10% @ 70 °C case. At a full load current of 9.0 A, the voltage on the CURRENT MON pin is 3.33 V. The current monitor signal is referenced to the SENSE(–) pin on the secondary and is supplied from a source impedance of approximately 2 kΩ. It is recommended that the CURRENT MON pin be left open when not in use, although no damage will result if the CURRENT MON pin is shorted to secondary ground. Directly driving the CURRENT MON pin with an external source will detrimentally affect operation of the module and should be avoided.

Synchronization

Any module can be synchronized to any other module or to an external clock using the SYNC IN or SYNC OUT pins. The modules are not designed to operate in a master/slave configuration; that is, if one module fails, the other modules will continue to operate.

SYNC IN Pin

This pin can be connected either to an external clock or directly to the SYNC OUT pin of another FC250x module.

If an external clock signal is applied to the SYNC IN pin, the signal must be a 500 kHz (±50 kHz) square wave with a 4 Vp-p amplitude. Operation outside this frequency band will detrimentally affect the performance of the module and must be avoided.

If the SYNC IN pin is connected to the SYNC OUT pin of another module, the connection should be as direct as possible, and the V_I(–) pins of the modules must be shorted together.

Unused SYNC IN pins should be tied to V_I(–). If the SYNC IN pin is unused, the module will operate from its own internal clock.

SYNC OUT Pin

This pin contains a clock signal referenced to the V_I(–) pin. The frequency of this signal will equal either the module's internal clock frequency or the frequency established by an external clock applied to the SYNC IN pin.

When synchronizing several modules together, the modules can be connected in a daisy-chain fashion where the SYNC OUT pin of one module is connected to the SYNC IN pin of another module. Each module in the chain will synchronize to the frequency of the first module in the chain.

To avoid loading effects, ensure that the SYNC OUT pin of any one module is connected to the SYNC IN pin of only one module. Any number of modules can be synchronized in this daisy-chain fashion.

Overtemperature Protection

To provide protection in a fault condition, the unit is equipped with an overtemperature shutdown circuit. The shut down circuit will not engage unless the unit is operated above the maximum case temperature. Recovery from overtemperature shutdown is accomplished by cycling the dc input power off for at least 1.0 s or toggling the primary referenced on/off signal for at least 1.0 s.

Forced Load Sharing (Parallel Operation)

For either redundant operation or additional power requirements, the power modules can be configured for parallel operation with forced load sharing (see Figure 17). For a typical redundant configuration, Schottky diodes or an equivalent should be used to protect against short-circuit conditions. Because of the remote sense, the forward-voltage drops across the Schottky diodes do not affect the set point of the voltage applied to the load. For additional power requirements, where multiple units are used to develop combined power in excess of the rated maximum, the Schottky diodes are not needed.

Feature Descriptions (continued)

Forced Load Sharing (Parallel Operation) (continued)

Good layout techniques should be observed for noise immunity. To implement forced load sharing, the following connections must be made:

- The parallel pins of all units must be connected together. The paths of these connections should be as direct as possible.
- All remote-sense pins should be connected to the power bus at the same point, i.e., connect all SENSE(+) pins to the (+) side of the power bus at the same point and all SENSE(–) pins to the (–) side of the power bus at the same point. Close proximity and directness are necessary for good noise immunity.

When not using the parallel feature, leave the PARALLEL pin open.

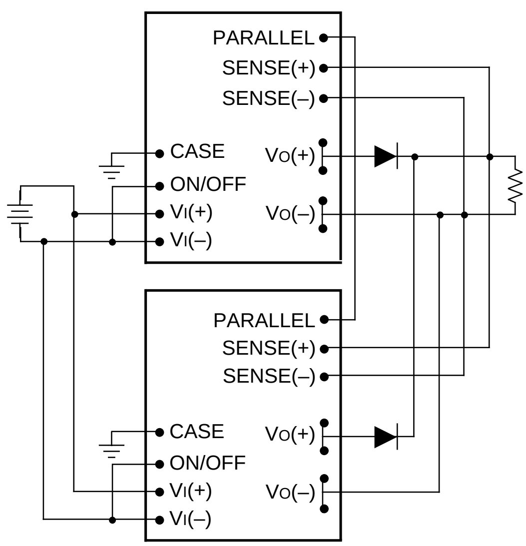

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Figure 17. Wiring Configuration for Redundant Parallel Operation

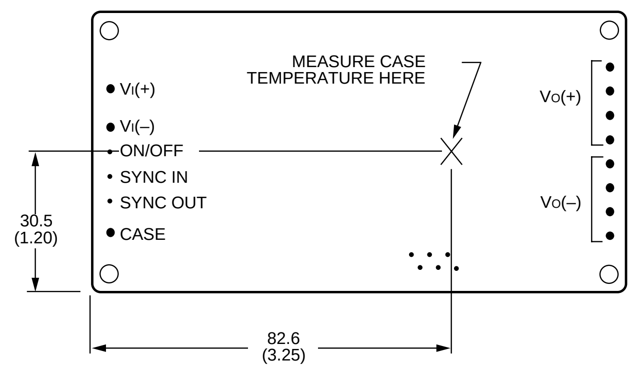
Power Good Signal

The PWR GOOD pin provides an open-drain signal (referenced to the SENSE(–) pin) that indicates the operating state of the module. A low impedance (<100 Ω) between PWR GOOD and SENSE(–) indicates that the module is operating. A high impedance (>1 MΩ) between PWR GOOD and SENSE(–) indicates that the module is off or has failed. The PWR GOOD pin can be pulled up through a resistor to an external voltage to facilitate sensing. This external voltage level must not exceed 40 V, and the current into the PWR GOOD pin during the low-impedance state should be limited to 1 mA maximum.

Thermal Considerations

Introduction

The power modules operate in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat-dissipating components inside the unit are thermally coupled to the case. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the case temperature. Peak temperature occurs at the position indicated in Figure 18.



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Note: Top view, measurements shown in millimeters and (inches). Pin locations are for reference only.

Figure 18. Case Temperature Measurement Location

The temperature at this location should not exceed 100 °C. The maximum case temperature can be limited to a lower value for extremely high reliability. The output power of the module should not exceed the rated power for the module as listed in the Ordering Information table.

For additional information about these modules, refer to the *Thermal Management for FC- and FW-Series 250 W—300 W Board-Mounted Power Modules* Technical Note (TN96-009EPS).

Thermal Considerations (continued)

Heat Transfer Without Heat Sinks

Derating curves for forced-air cooling without a heat sink are shown in Figures 19 and 20. These curves can be used to determine the appropriate airflow for a given set of operating conditions. For example, if the unit with airflow along its length dissipates 20 W of heat, the correct airflow in a 40 °C environment is 1.0 m/s (200 ft./min.).

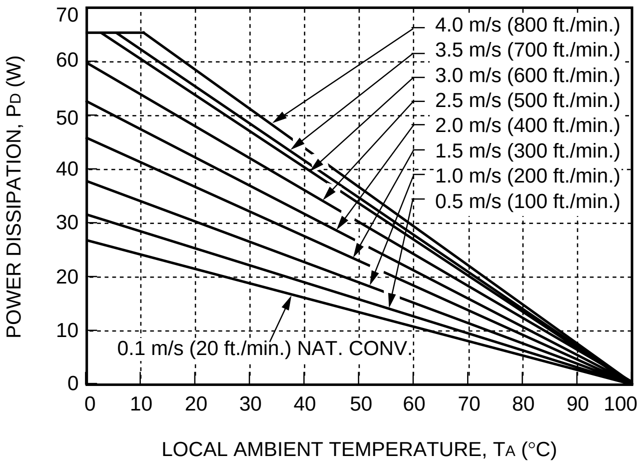


Figure 19. Convection Power Derating with No Heat Sink; Airflow Along Width (Transverse)

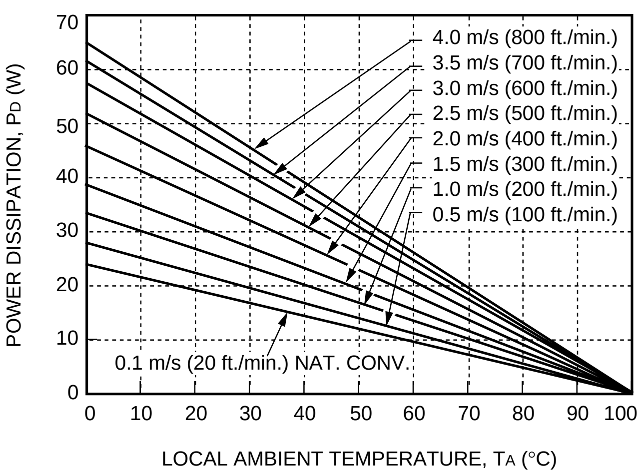


Figure 20. Convection Power Derating with No Heat Sink; Airflow Along Length (Longitudinal)

Heat Transfer With Heat Sinks

The power modules have through-threaded, M3 x 0.5 mounting holes, which enable heat sinks or cold plates to be attached to the module. The mounting torque must not exceed 0.56 N-m (5 in.-lb.). For a screw attachment from the pin side, the recommended hole size on the customer's PWB around the mounting holes is 0.130 ± 0.005 inches. If a larger hole is used, the mounting torque from the pin side must not exceed 0.25 N-m (2.2 in.-lbs.).

Thermal derating with heat sinks is expressed by using the overall thermal resistance of the module. Total module thermal resistance (θca) is defined as the maximum case temperature rise ($\Delta T_{C,\,max}$) divided by the module power dissipation (P_D):

$$\theta ca = \left[\frac{\Delta T_{C,\,max}}{P_D}\right] = \left[\frac{(T_C - T_A)}{P_D}\right]$$

The location to measure case temperature (T_C) is shown in Figure 18. Case-to-ambient thermal resistance vs. airflow for various heat sink configurations is shown in Figure 21 and Figure 22. These curves were obtained by experimental testing of heat sinks, which are offered in the product catalog.

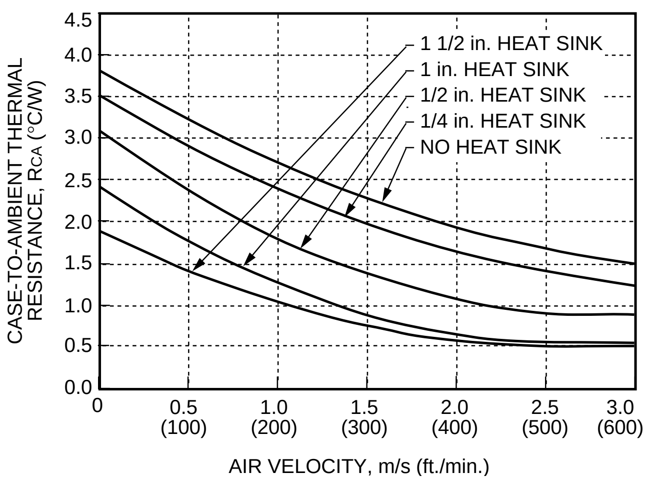


Figure 21. Case-to-Ambient Thermal Resistance Curves; Transverse Orientation

Thermal Considerations (continued)

Heat Transfer With Heat Sinks (continued)

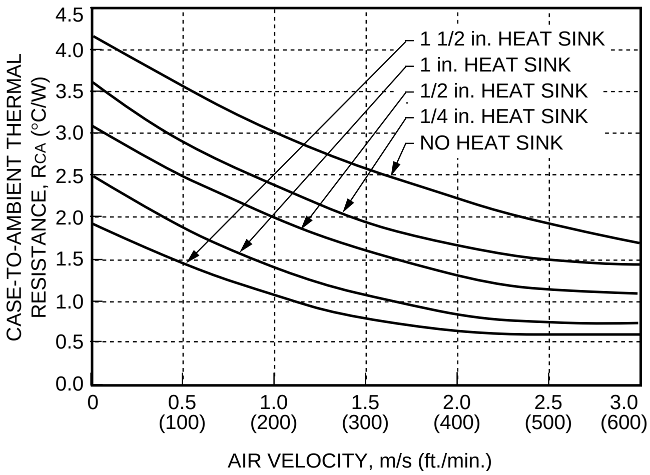


Figure 22. Case-to-Ambient Thermal Resistance Curves; Longitudinal Orientation

These measured resistances are from heat transfer from the sides and bottom of the module as well as the top side with the attached heat sink; therefore, the case-to-ambient thermal resistances shown are generally lower than the resistance of the heat sink by itself. The module used to collect the data in Figures 21 and 22 had a thermal-conductive dry pad between the case and the heat sink to minimize contact resistance.

To choose a heat sink, determine the power dissipated as heat by the unit for the particular application. Figure 23 shows typical heat dissipation for a range of output currents and three voltages for the FC250R.

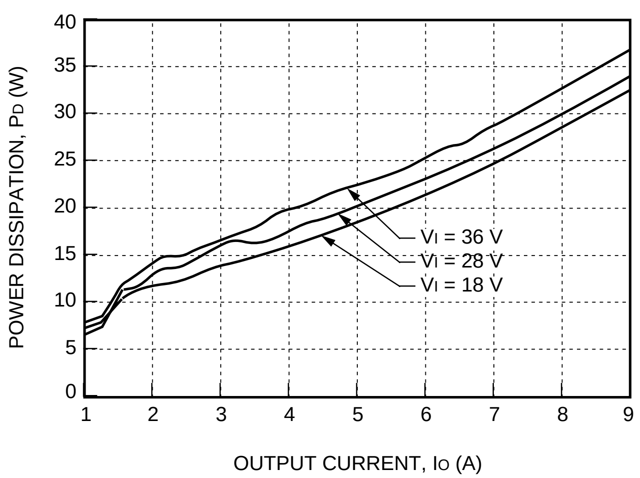


Figure 23. FC250R Power Dissipation vs. Output Current

Example

If an 85 °C case temperature is desired, what is the minimum airflow necessary? Assume the FC250R module is operating at nominal line and an output current of 9.0 A, maximum ambient air temperature of 40 °C, and the heat sink is 0.5 inch.

Solution

Given: $V_I = 28$ V
$I_O = 9.0$ A
$T_A = 40$ °C
$T_C = 85$ °C
Heat sink = 0.5 inch.

Determine P_D by using Figure 23:

$P_D = 34$ W

Then solve the following equation:

$$\theta ca = \left[\frac{(T_C - T_A)}{P_D}\right]$$

$$\theta ca = \left[\frac{(85 - 40)}{34}\right]$$

$$\theta ca = 1.32 \text{ °C/W}$$

Use Figures 21 and 22 to determine air velocity for the 0.5 inch heat sink. The minimum airflow necessary for this module depends on heat sink fin orientation and is shown below:

- 1.6 m/s (320 ft./min.) (oriented along width)
- 2.0 m/s (400 ft./min.) (oriented along length)

Custom Heat Sinks

A more detailed model can be used to determine the required thermal resistance of a heat sink to provide necessary cooling. The total module resistance can be separated into a resistance from case-to-sink (θcs) and sink-to-ambient (θsa) as shown in Figure 24.

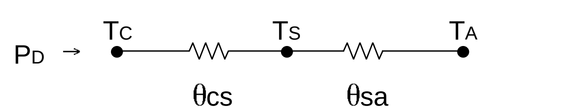


Figure 24. Resistance from Case-to-Sink and Sink-to-Ambient

Thermal Considerations (continued)

Custom Heat Sinks (continued)

For a managed interface using thermal grease or foils, a value of θcs = 0.1 °C/W to 0.3 °C/W is typical. The solution for heat sink resistance is:

$$\theta sa = \left[\frac{(T_C - T_A)}{P_D}\right] - \theta cs$$

This equation assumes that all dissipated power must be shed by the heat sink. Depending on the user-defined application environment, a more accurate model, including heat transfer from the sides and bottom of the module, can be used. This equation provides a conservative estimate for such instances.

Solder, Cleaning, and Drying Considerations

Post solder cleaning is usually the final circuit-board assembly process prior to electrical testing. The result of inadequate circuit-board cleaning and drying can affect both the reliability of a power module and the testability of the finished circuit-board assembly. For guidance on appropriate soldering, cleaning, and drying procedures, refer to the *Board-Mounted Power Modules Soldering and Cleaning* Application Note (AP97-021EPS).

EMC Considerations

For assistance with designing for EMC compliance, please refer to the FLTR100V10 data sheet (DS98-152EPS).

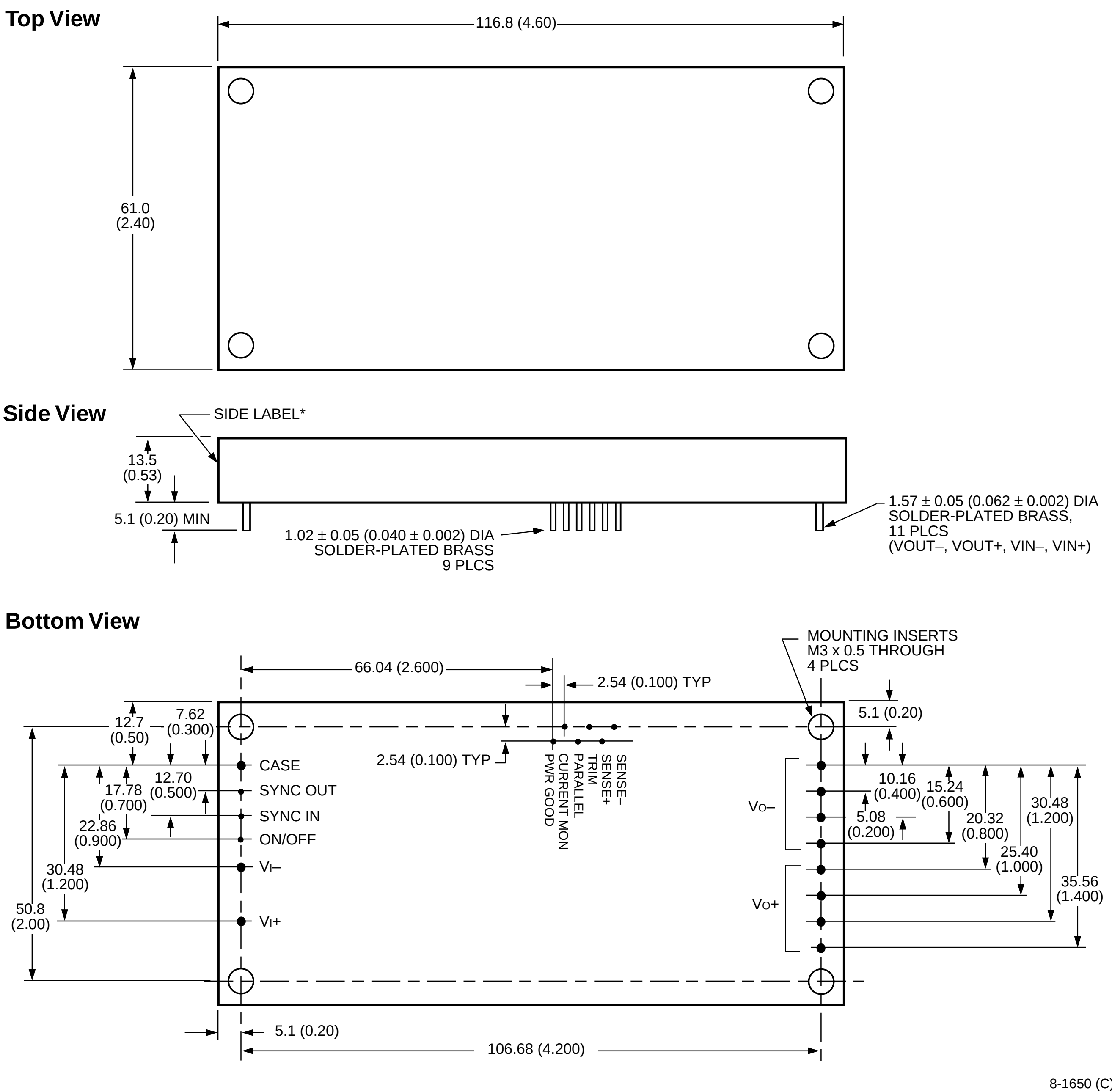
Layout Considerations

Copper paths must not be routed beneath the power module mounting inserts. For additional layout guidelines, refer to the FLTR100V10 data sheet (DS98-152EPS).

Outline Diagram

Dimensions are in millimeters and (inches).

Tolerances: x.x mm ± 0.5 mm (x.xx in. ± 0.02 in.),
x.xx mm ± 0.25 mm (x.xxx in. ± 0.010 in.)

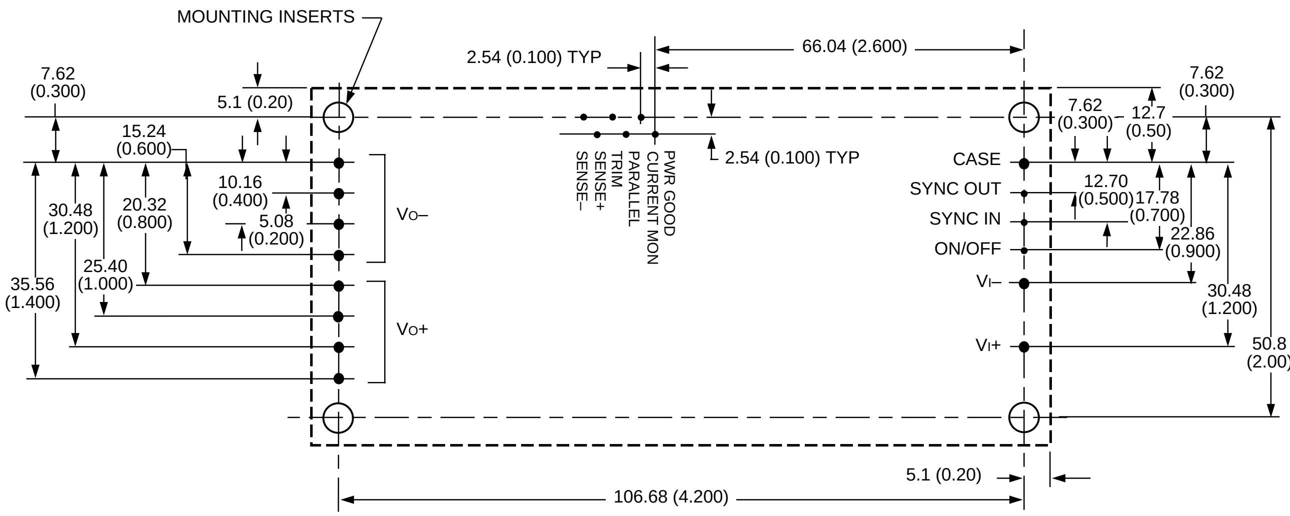


* Side label includes Tyco name, product designation, safety agency markings, input/output voltage and current ratings, and bar code.

Recommended Hole Pattern

Component-side footprint.

Dimensions are in millimeters and (inches).



8-1650 (C).a

Ordering Information

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
28 V	28 V	250 W	FC250R1	107430316

Ordering Information (continued)

Table 4. Device Accessories

Accessory	Comcode
1/4 in. transverse kit (heat sink, thermal pad, and screws)	847308335
1/4 in. longitudinal kit (heat sink, thermal pad, and screws)	847308327
1/2 in. transverse kit (heat sink, thermal pad, and screws)	847308350
1/2 in. longitudinal kit (heat sink, thermal pad, and screws)	847308343
1 in. transverse kit (heat sink, thermal pad, and screws)	847308376
1 in. longitudinal kit (heat sink, thermal pad, and screws)	847308368
1 1/2 in. transverse kit (heat sink, thermal pad, and screws)	847308392
1 1/2 in. longitudinal kit (heat sink, thermal pad, and screws)	847308384

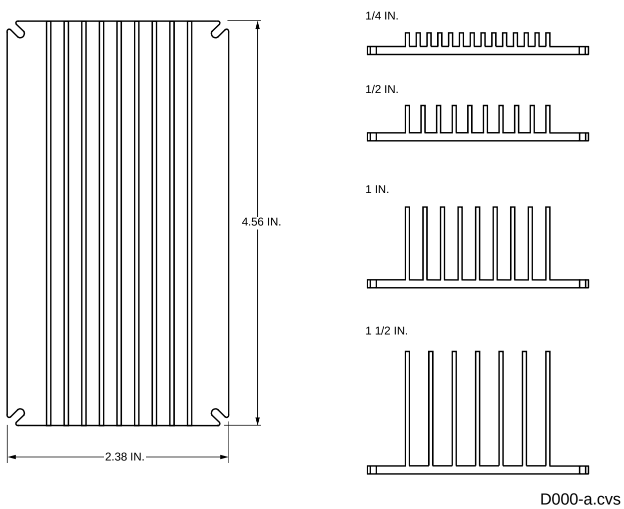


Figure 25. Longitudinal Heat Sink

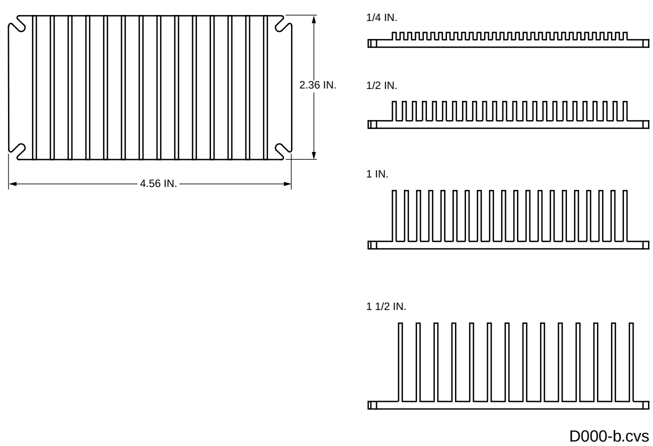


Figure 26. Transverse Heat Sink

Notes

Notes

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http://power.tycoeleectronics.com

May 1999
DS97-544EPS (Replaces DS95-158EPS)