

## JAW050F and JAW075F Power Modules; dc-dc Converters: 36 Vdc to 75 Vdc Input, 3.3 Vdc Output; 33 W to 50 W



The JAW Series Power Modules use surface-mount technology and deliver efficient and compact dc-dc conversion.

### Applications

- Distributed power architectures
- Communications equipment
- Computer equipment

### Options

- Heat sinks available for extended operation
- Choice of remote on/off logic configuration
- Choice of short lead lengths

### Description

The JAW050F and JAW075F Power Modules are dc-dc converters that operate over an input voltage range of 36 Vdc to 75 Vdc and provide a regulated dc output. The outputs are fully isolated from the inputs, allowing versatile polarity configurations and grounding connections. The modules have maximum power ratings from 33 W to 50 W at a typical full-load efficiency of 79.5%.

The sealed modules offer a metal baseplate for improved thermal performance. Threaded-through holes are provided to allow easy mounting or addition of a heat sink for high-temperature applications. The standard feature set includes remote sensing, output trim, and remote on/off for convenient flexibility in distributed power applications.

### Features

- Small size: 61.0 mm x 57.9 mm x 12.7 mm (2.40 in. x 2.28 in. x 0.50 in.)
- High power density
- High efficiency: 79.5% typical
- Low output noise
- Constant frequency
- Industry-standard pinout
- Metal case
- 2:1 input voltage range
- Overtemperature, overvoltage, and overcurrent protection
- Remote on/off and remote sense
- Adjustable output voltage
- Case ground pin
- Manufacturing facilities registered against the ISO\*9000 series standards
- UL† 60950 Recognized, CSA‡ C22.2 No. 60950-00 Certified, and VDE§ 0805 (IEC\*\* 60950, 4th Edition) Licensed
- CE mark meets 73/23/EEC and 93/68/EEC directives††

\* ISO is a registered trademark of the International Organization for Standardization.

† UL is a registered trademark of Underwriters Laboratories, Inc.

‡ CSA is a registered trademark of Canadian Standards Association.

§ VDE is a trademark of Verband Deutscher Elektrotechniker e.V.

\*\* IEC is a trademark of International Elektrotechniker Commission.

†† This product is intended for integration into end-use equipment. All the required procedures for CE marking of end-use equipment should be followed. (The CE mark is placed on selected products.)

## 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                                                          | $V_I$          | —   | 80   | Vdc  |
| Transient (100 ms)                                                  | $V_{I, trans}$ | —   | 100  | V    |
| Operating Case Temperature<br>(See Thermal Considerations section.) | $T_C$          | –40 | 100  | °C   |
| Storage Temperature                                                 | $T_{stg}$      | –55 | 125  | °C   |
| I/O Isolation Voltage                                               | —              | —   | 1500 | Vdc  |

## 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                                                                                          | $V_I$        | 36  | 48  | 75  | Vdc              |
| Maximum Input Current:                                                                                           |              |     |     |     |                  |
| $V_I = 0 \text{ V to } 75 \text{ V}; I_O = I_{O, max}$ :                                                         |              |     |     |     |                  |
| JAW050F (See Figure 1.)                                                                                          | $I_{I, max}$ | —   | —   | 2.0 | A                |
| JAW075F (See Figure 2.)                                                                                          | $I_{I, max}$ | —   | —   | 3.0 | A                |
| $V_I = 36 \text{ V to } 75 \text{ V}; I_O = I_{O, max}$ :                                                        |              |     |     |     |                  |
| JAW050F                                                                                                          | $I_{I, max}$ | —   | —   | 1.2 | A                |
| JAW075F                                                                                                          | $I_{I, max}$ | —   | —   | 2.0 | A                |
| Inrush Transient                                                                                                 | $i^2t$       | —   | —   | 1.0 | A <sup>2</sup> s |
| Input Reflected-ripple Current, Peak-to-peak<br>(5 Hz to 20 MHz, 12 $\mu$ H source impedance;<br>see Figure 11.) | $I_I$        | —   | 5   | —   | 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 6 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                                                                                                                                                                                                                                                                                                                                                                                                                                                | Device                   | Symbol                                     | Min              | Typ                  | Max                                | Unit                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------|------------------|----------------------|------------------------------------|----------------------------------------------------------------------------------|
| Output Voltage Set Point<br>( $V_I = 48\text{ V}$ ; $I_O = I_{O, \max}$ ; $T_C = 25\text{ }^\circ\text{C}$ )                                                                                                                                                                                                                                                                                                                                             | All                      | $V_{O, \text{set}}$                        | 3.25             | 3.3                  | 3.35                               | Vdc                                                                              |
| Output Voltage<br>(Over all operating input voltage, resistive load, and temperature conditions until end of life. See Figure 13.)                                                                                                                                                                                                                                                                                                                       | All                      | $V_O$                                      | 3.2              | —                    | 3.4                                | Vdc                                                                              |
| Output Regulation:<br>Line ( $V_I = 36\text{ V}$ to $75\text{ V}$ )<br>Load ( $I_O = I_{O, \min}$ to $I_{O, \max}$ )<br>Temperature ( $T_C = -40\text{ }^\circ\text{C}$ to $+100\text{ }^\circ\text{C}$ )                                                                                                                                                                                                                                                | All<br>All<br>All        | —<br>—<br>—                                | —<br>—<br>—      | 0.01<br>0.05<br>15   | 0.1<br>0.2<br>50                   | % $V_O$<br>% $V_O$<br>mV                                                         |
| Output Ripple and Noise Voltage<br>(See Figure 12.):<br>RMS<br>Peak-to-peak (5 Hz to 20 MHz)                                                                                                                                                                                                                                                                                                                                                             | All<br>All               | —<br>—                                     | —<br>—           | —<br>—               | 40<br>150                          | mVrms<br>mVp-p                                                                   |
| External Load Capacitance                                                                                                                                                                                                                                                                                                                                                                                                                                | All                      | —                                          | 0                | —                    | *                                  | $\mu\text{F}$                                                                    |
| Output Current<br>(At $I_O < I_{O, \min}$ , the modules may exceed output ripple specifications.)                                                                                                                                                                                                                                                                                                                                                        | JAW050F<br>JAW075F       | $I_O$<br>$I_O$                             | 0.5<br>0.5       | —<br>—               | 10<br>15                           | A<br>A                                                                           |
| Output Current-limit Inception<br>( $V_O = 90\%$ of $V_{O, \text{nom}}$ )                                                                                                                                                                                                                                                                                                                                                                                | JAW050F<br>JAW075F       | $I_{O, \text{cli}}$<br>$I_{O, \text{cli}}$ | —<br>—           | 12.0<br>18.0         | 14 <sup>†</sup><br>21 <sup>†</sup> | A<br>A                                                                           |
| Output Short-circuit Current ( $V_O = 250\text{ mV}$ )                                                                                                                                                                                                                                                                                                                                                                                                   | All                      | —                                          | —                | 170                  | —                                  | % $I_{O, \max}$                                                                  |
| Efficiency ( $V_I = 48\text{ V}$ ; $I_O = I_{O, \max}$ ; $T_C = 70\text{ }^\circ\text{C}$ ; see Figure 13)                                                                                                                                                                                                                                                                                                                                               | JAW050F<br>JAW075F       | $\eta$<br>$\eta$                           | —<br>—           | 79<br>79.5           | —<br>—                             | %<br>%                                                                           |
| Switching Frequency                                                                                                                                                                                                                                                                                                                                                                                                                                      | All                      | —                                          | —                | 320                  | —                                  | kHz                                                                              |
| Dynamic Response<br>( $\Delta I_O / \Delta t = 1\text{ A}/10\text{ }\mu\text{s}$ , $V_I = 48\text{ V}$ , $T_C = 25\text{ }^\circ\text{C}$ ; tested without any load capacitance.):<br>Load Change from $I_O = 50\%$ to $75\%$ of $I_{O, \max}$ :<br>Peak Deviation<br>Settling Time ( $V_O < 10\%$ of peak deviation)<br>Load Change from $I_O = 50\%$ to $25\%$ of $I_{O, \max}$ :<br>Peak Deviation<br>Settling Time ( $V_O < 10\%$ of peak deviation) | All<br>All<br>All<br>All | —<br>—<br>—<br>—                           | —<br>—<br>—<br>— | 5<br>300<br>5<br>300 | —<br>—<br>—<br>—                   | % $V_{O, \text{set}}$<br>$\mu\text{s}$<br>% $V_{O, \text{set}}$<br>$\mu\text{s}$ |

\* Consult your sales representative or the factory.

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

Table 3. Isolation Specifications

| Parameter             | Min | Typ  | Max | Unit       |
|-----------------------|-----|------|-----|------------|
| Isolation Capacitance | —   | 2500 | —   | pF         |
| Isolation Resistance  | 10  | —    | —   | M $\Omega$ |

| Parameter                                                                              | Min       | Typ | Max       | Unit    |
|----------------------------------------------------------------------------------------|-----------|-----|-----------|---------|
| Calculated MTBF ( $I_o = 80\%$ of $I_{o, \max}$ ; $T_C = 40\text{ }^{\circ}\text{C}$ ) | 3,000,000 |     |           | hours   |
| Weight                                                                                 | —         | —   | 100 (3.5) | g (oz.) |

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

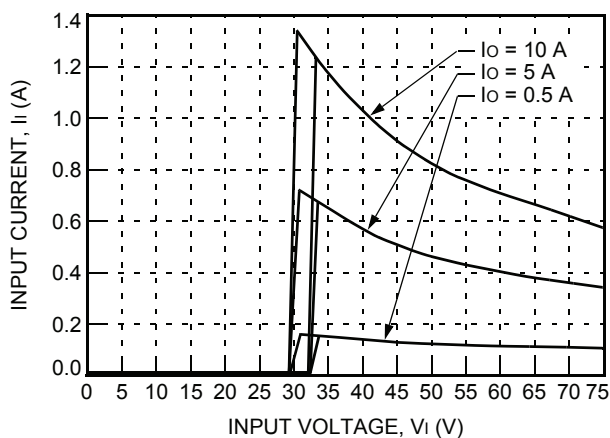
| <b>Parameter</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Symbol</b>                                                     | <b>Min</b>            | <b>Typ</b>             | <b>Max</b>                   | <b>Unit</b>                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------|------------------------|------------------------------|-------------------------------------|
| Remote On/Off Signal Interface<br>( $V_I = 0\text{ V}$ to $75\text{ V}$ ; open collector or equivalent compatible;<br>signal referenced to $V_{I(-)}$ terminal:<br>JAWxxxF Preferred Logic:<br>Logic Low—Module On<br>Logic High—Module Off<br>JAWxxxF Optional Logic:<br>Logic Low—Module Off<br>Logic High—Module On<br>Logic Low:<br>At $I_{on/off} = 1.0\text{ mA}$<br>At $V_{on/off} = 0.0\text{ V}$<br>Logic High:<br>At $I_{on/off} = 0.0\text{ }\mu\text{A}$<br>Leakage Current<br>Turn-on Time (See Figure 10.)<br>( $I_O = 80\%$ of $I_{O,max}$ , $V_O$ within $\pm 1\%$ of steady state) | $V_{on/off}$<br>$I_{on/off}$<br>$V_{on/off}$<br>$I_{on/off}$<br>— | 0<br>—<br>—<br>—<br>— | —<br>—<br>—<br>—<br>40 | 1.2<br>1.0<br>15<br>50<br>80 | V<br>mA<br>V<br>$\mu\text{A}$<br>ms |
| Output Voltage Adjustment:<br>Output Voltage Remote-sense Range<br>Output Voltage Set-point Adjustment Range (trim)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | —<br>—                                                            | —<br>60               | —<br>—                 | 0.5<br>110                   | V<br>% $V_{O,nom}$                  |
| Output Overvoltage Protection                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $V_{O,sd}$                                                        | 3.8*                  | —                      | 5.0*                         | V                                   |
| Overtemperature Protection                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $T_C$                                                             | —                     | 105                    | —                            | $^{\circ}\text{C}$                  |

## Solder, Cleaning, and Drying Considerations

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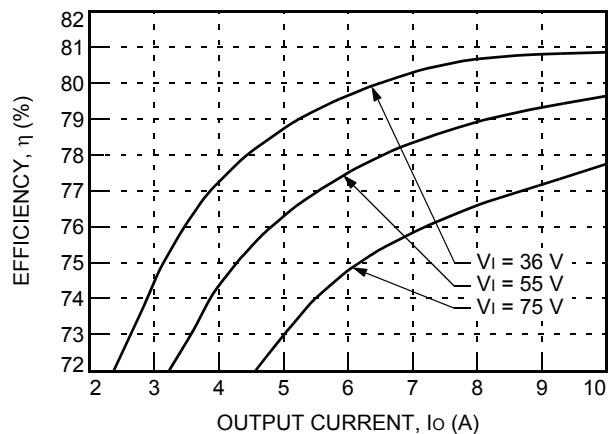
## Characteristic Curves

The following figures provide typical characteristics for the power modules. The figures are identical for both on/off configurations.



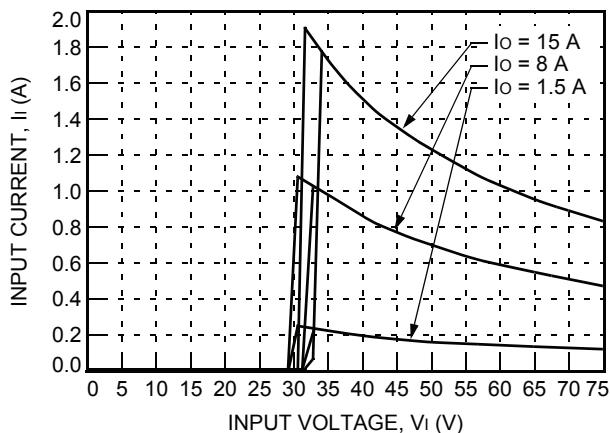
8-3338 (F)

Figure 1. Typical JAW050F Input Characteristics at Room Temperature



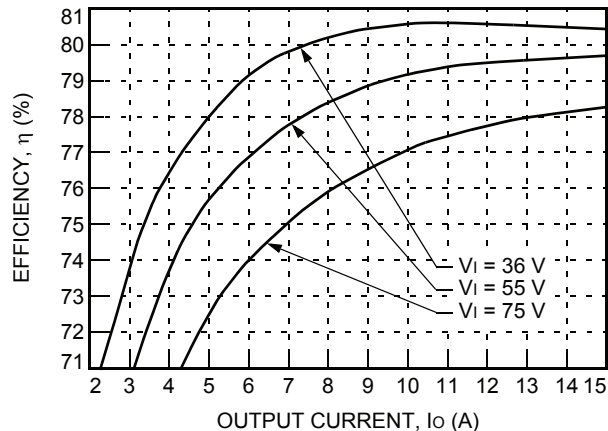
8-3340 (F)

Figure 3. Typical JAW050F Efficiency vs. Output Current at Room Temperature



8-3339 (F)

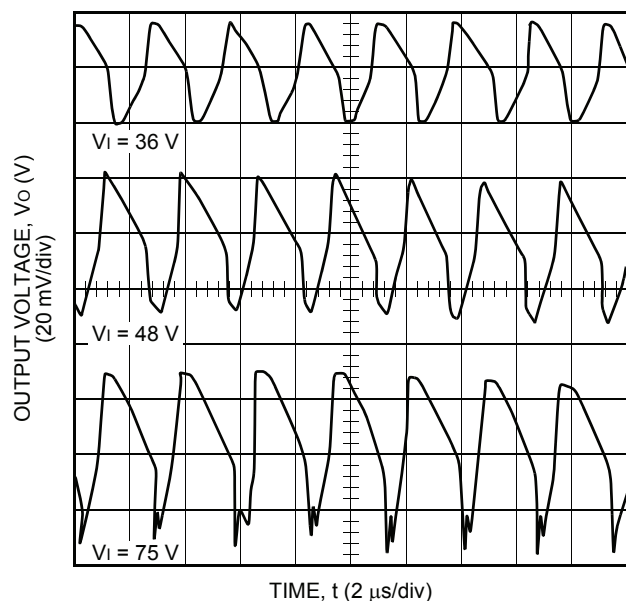
Figure 2. Typical JAW075F Input Characteristics at Room Temperature



8-3341 (F)

Figure 4. Typical JAW075F Efficiency vs. Output Current at Room Temperature

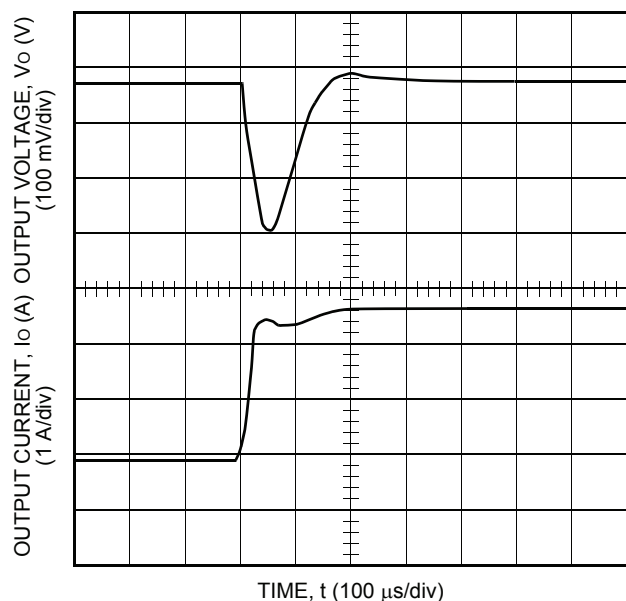
## Characteristic Curves (continued)



8-3342 (F)

Note: See Figure 12 for test conditions.

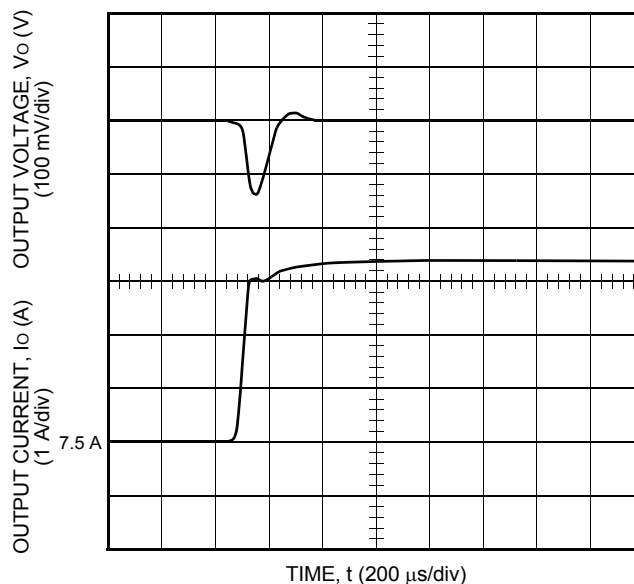
**Figure 5. Typical JAW050F and JAW075F Output Ripple Voltage at Room Temperature**



8-3343 (F)

Note: Tested without any load capacitance.

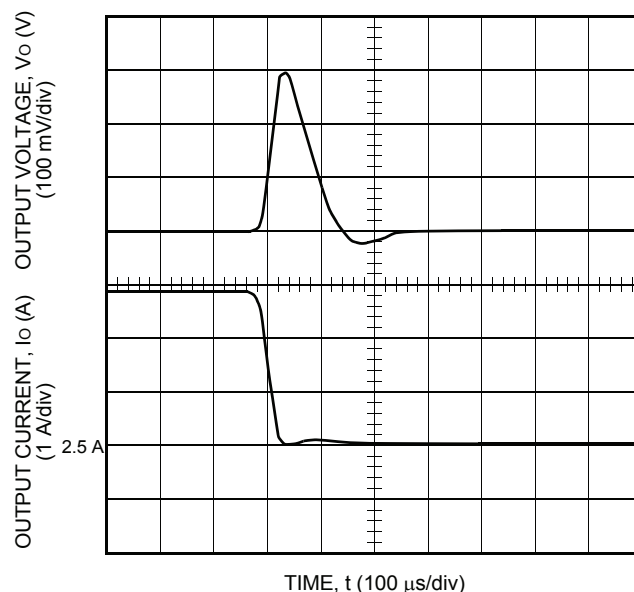
**Figure 6. Typical JAW050F Transient Response to Step Increase in Load from 50% to 75% of Full Load at Room Temperature and 48 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)**



8-3344 (F)

Note: Tested without any load capacitance.

**Figure 7. Typical JAW075F Transient Response to Step Increase in Load from 50% to 75% of Full Load at Room Temperature and 48 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)**

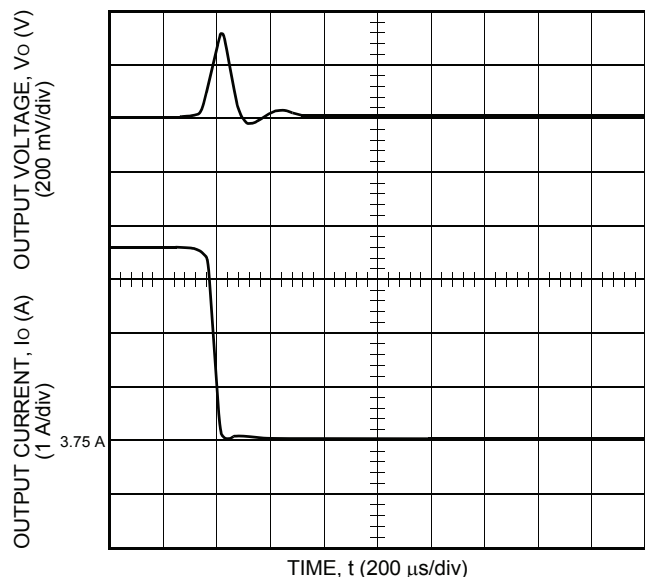


8-3345 (F)

Note: Tested without any load capacitance.

**Figure 8. Typical JAW050F Transient Response to Step Decrease in Load from 50% to 25% of Full Load at Room Temperature and 48 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)**

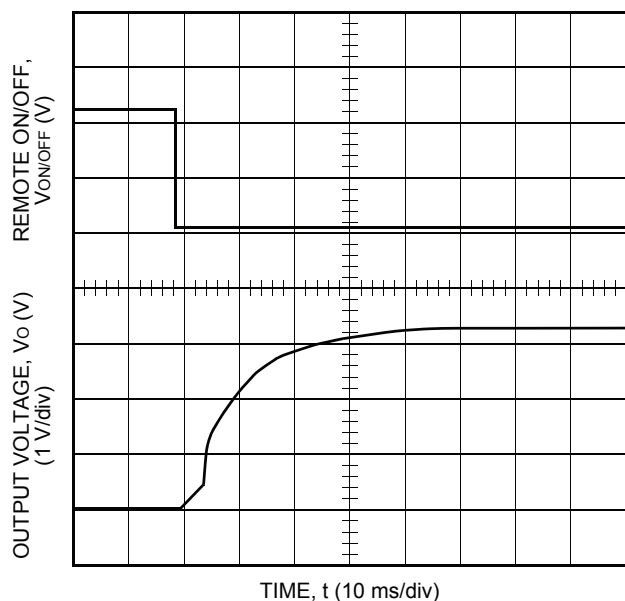
## Characteristic Curves (continued)



8-3346 (F)

Note: Tested without any load capacitance.

**Figure 9. Typical JAW075F Transient Response to Step Decrease in Load from 50% to 25% of Full Load at Room Temperature and 48 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)**

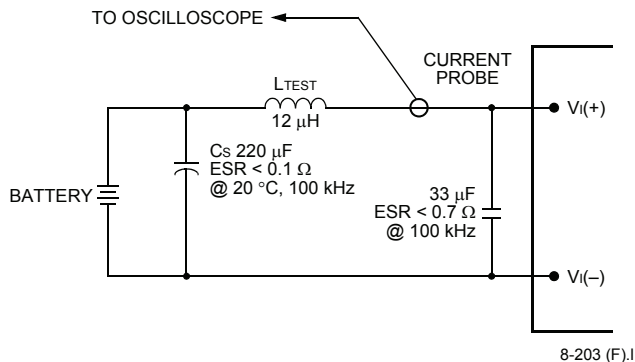


8-3347 (F)

Note: Tested without any load capacitance.

**Figure 10. JAW050F1 Typical Start-Up from Remote On/Off;  $I_o = I_{o, \max}$**

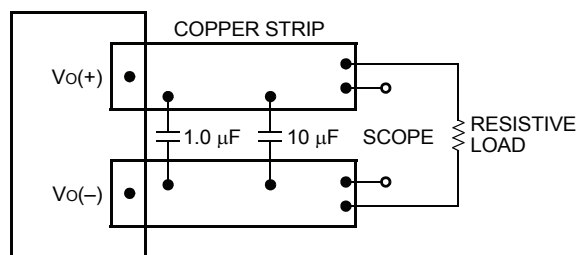
## Test Configurations



8-203 (F),I

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

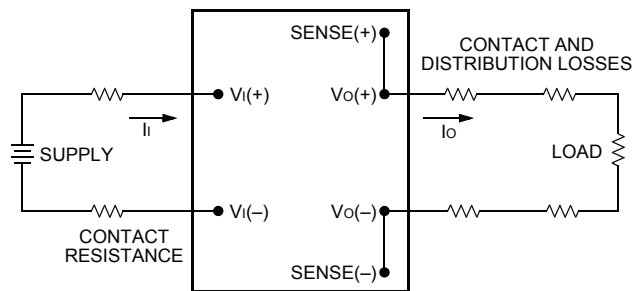
**Figure 11. Input Reflected-Ripple Test Setup**



8-513 (F),d

Note: Use a 1.0  $\mu$ F ceramic capacitor and a 10  $\mu$ F aluminum or tantalum capacitor. Scope measurement should be made using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from the module.

**Figure 12. Peak-to-Peak Output Noise Measurement Test Setup**



8-749 (F)

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 13. Output Voltage and Efficiency 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 14, a 33  $\mu$ F electrolytic capacitor ( $ESR < 0.7 \Omega$  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 60950*, *CSA C22.2 No. 60950-00*, and *VDE 0805 (IEC 60950, 4th Edition)*.

If the input source is non-SELV (ELV or a hazardous voltage greater than 60 Vdc and less than or equal to 75 Vdc), for the module's output to be considered meeting the requirements of safety extra-low voltage (SELV), all of the following must be true:

- The input source is to be provided with reinforced insulation from any other hazardous voltages, including the ac mains.
- One  $V_I$  pin and one  $V_O$  pin are to be grounded, or both the input and output pins are to be kept floating.
- The input pins of the module are not operator accessible.
- Another SELV reliability test is conducted on the whole system, as required by the safety agencies, on the combination of supply source and the subject module to verify that under a single fault, hazardous voltages do not appear at the module's output.

**Note:** Do not ground either of the input pins of the module without grounding one of the output pins. This may allow a non-SELV voltage to appear between the output pins and ground.

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 6 A normal-blow fuse in the ungrounded lead.

## Feature Descriptions

### Overcurrent Protection

To provide protection in an output overload condition, the unit is equipped with an internal shutdown and auto-restart mechanism. At the instance of current-limit inception, the module enters a hiccup mode of operation whereby it shuts down and automatically attempts to restart. As long as the fault persists, the module remains in this mode.

The protection mechanism is such that the unit can continue in this condition until the fault is cleared.

### Remote On/Off

Two remote on/off options are available. Positive logic remote on/off turns the module on during a logic-high voltage on the ON/OFF pin, and off during a logic low. Negative logic remote on/off turns the module off during a logic high and on during a logic low. Negative logic, device code suffix "1," is the factory-preferred configuration.

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 14). A logic low is  $V_{on/off} = 0$  V to 1.2 V. The maximum  $I_{on/off}$  during a logic low is 1 mA. The switch should maintain a logic-low voltage while sinking 1 mA.

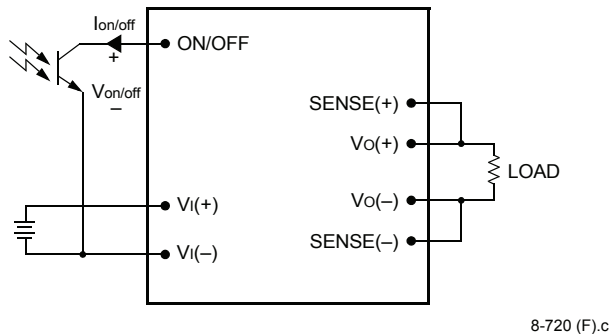
During a logic high, the maximum  $V_{on/off}$  generated by the power module is 15 V. The maximum allowable leakage current of the switch at  $V_{on/off} = 15$  V is 50  $\mu$ A.

If not using the remote on/off feature, do one of the following:

- For negative logic, short the ON/OFF pin to  $V_I(-)$ .
- For positive logic, leave the ON/OFF pin open.

## Feature Descriptions (continued)

### Remote On/Off (continued)



8-720 (F).c

Figure 14. 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.:

$$[V_o(+)-V_o(-)]-[SENSE(+)-SENSE(-)] \leq 0.5\text{ V}$$

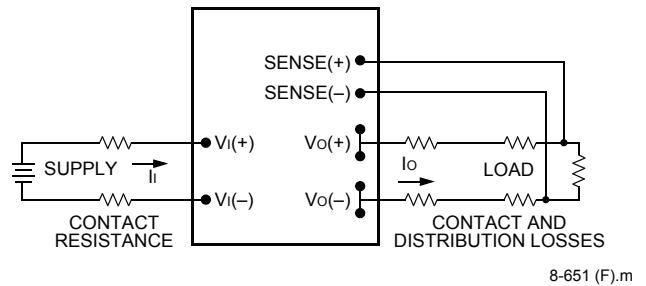
The voltage between the Vo(+) and Vo(-) terminals must not exceed the minimum output overvoltage protection voltage as indicated in the Feature Specifications table. This limit includes any increase in voltage due to remote-sense compensation and output voltage set-point adjustment (trim). See Figure 15.

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

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. Consult the factory if you need to increase the output voltage more than the above limitation.

The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote-sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.

Lineage Power



8-651 (F).m

Figure 15. 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 ( $R_{\text{adj-down}}$ ), the output voltage set point ( $V_{o, \text{adj}}$ ) decreases (see Figure 16). The following equation determines the required external-resistor value to obtain a percentage output voltage change of  $\Delta\%$ .

$$R_{\text{adj-down}} = \left( \frac{1000}{\Delta\%} - 11 \right) \text{ k}\Omega$$

With an external resistor connected between the TRIM and SENSE(+) pins ( $R_{\text{adj-up}}$ ), the output voltage set point ( $V_{o, \text{adj}}$ ) increases (see Figure 17).

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

$$R_{\text{adj-up}} = \left( \frac{(V_{o, \text{nom}}) \left( 1 + \frac{\Delta\%}{100} \right) - 1.225}{1.225 \Delta\%} 1000 - 11 \right) \text{ k}\Omega$$

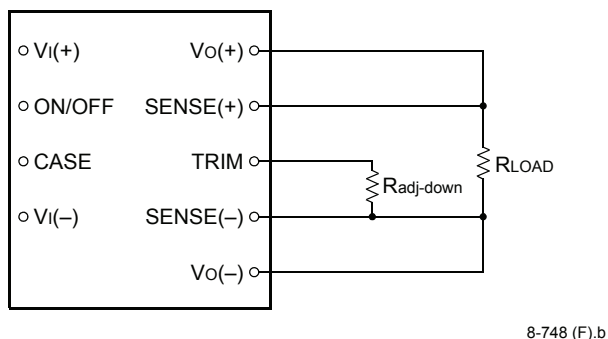
The voltage between the Vo(+) and Vo(-) terminals must not exceed the minimum output overvoltage protection voltage as indicated in the Feature Specifications table. This limit includes any increase in voltage due to remote-sense compensation and output voltage set-point adjustment (trim). See Figure 15.

## Feature Descriptions (continued)

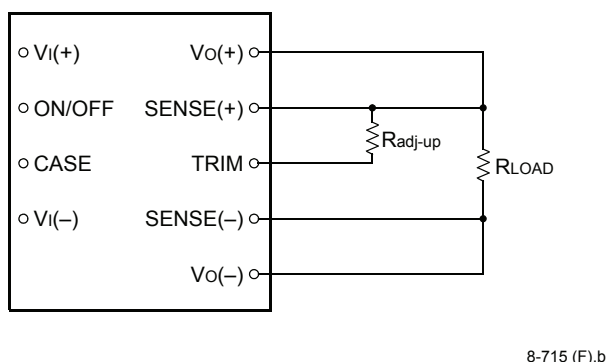
### Output Voltage Set-Point Adjustment (Trim) (continued)

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. Consult the factory if you need to increase the output voltage more than the above limitation.

The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote-sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.



**Figure 16. Circuit Configuration to Decrease Output Voltage**



**Figure 17. Circuit Configuration to Increase Output Voltage**

## Output Overvoltage Protection

To provide protection in an output overvoltage condition, the unit is equipped with circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceed the overvoltage protection threshold, the module enters a hiccup mode of operation whereby it shuts down and automatically attempts to restart. As long as the fault persists, the module remains in this mode.

The protection mechanism is such that the unit can continue in this condition until the fault is cleared.

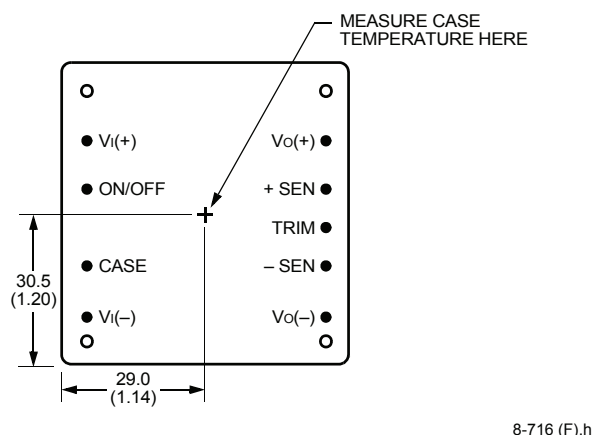
## Overtemperature Protection

These modules feature an overtemperature protection circuit to safeguard against thermal damage. The circuit shuts down when the maximum case temperature is exceeded. The module will automatically restart when the case temperature cools sufficiently.

## 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 ( $T_C$ ) occurs at the position indicated in Figure 18.



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

**Figure 18. Case Temperature Measurement Location**

## Thermal Considerations (continued)

### Heat Transfer with Heat Sinks (continued)

The temperature at this location should not exceed 100 °C. The output power of the module should not exceed the rated power for the module as listed in the Ordering Information table.

Although the maximum case temperature of the power modules is 100 °C, you can limit this temperature to a lower value for extremely high reliability.

### Heat Transfer Without Heat Sinks

Increasing airflow over the module enhances the heat transfer via convection. Figures 21 and 22 show the maximum power that can be dissipated by the module without exceeding the maximum case temperature versus local ambient temperature ( $T_A$ ) for natural convection through 4 m/s (800 ft./min.). Note that the thermal performance is orientation dependent. Longitudinal orientation occurs when the long direction of the module is parallel to the airflow, whereas transverse orientation occurs when the short direction of the module is parallel to the airflow.

Note that the natural convection condition was measured at 0.05 m/s to 0.1 m/s (10 ft./min. to 20 ft./min.); however, systems in which these power modules may be used typically generate natural convection airflow rates of 0.3 m/s (60 ft./min.) due to other heat-dissipating components in the system. The use of Figure 21 is shown in the following example.

#### Example

What is the minimum airflow necessary for a JAW075F operating at  $V_I = 55$  V, an output current of 15 A, longitudinal orientation, and a maximum ambient temperature of 55 °C?

#### Solution

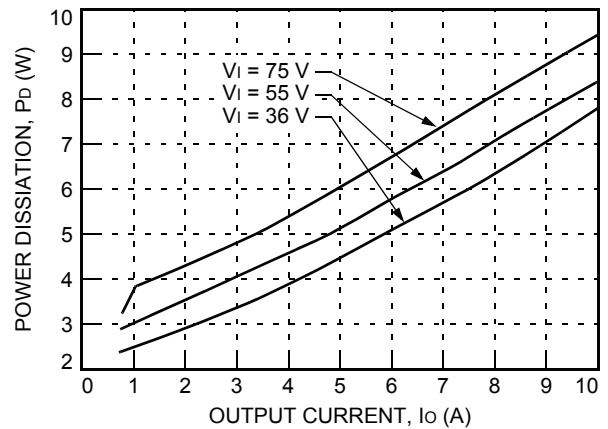
Given:  $V_I = 55$  V  
 $I_O = 15$  A  
 $T_A = 55$  °C

Determine  $P_D$  (Use Figure 20.):

$$P_D = 12.5 \text{ W}$$

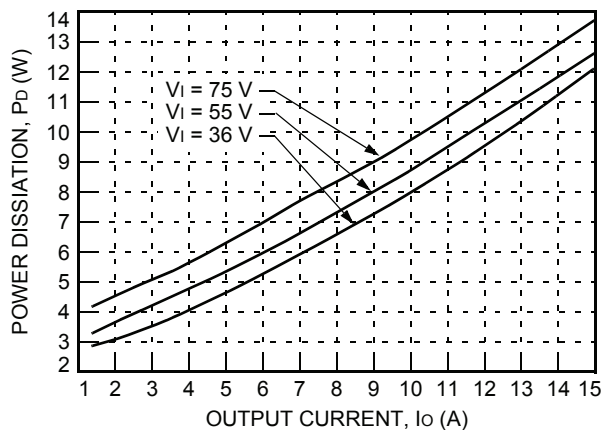
Determine airflow ( $v$ ) (Use Figure 21.):

$$v = 1.6 \text{ m/s (320 ft./min.)}$$



8-3348 (F)

Figure 19. JAW050F Power Dissipation vs. Output Current at 25 °C

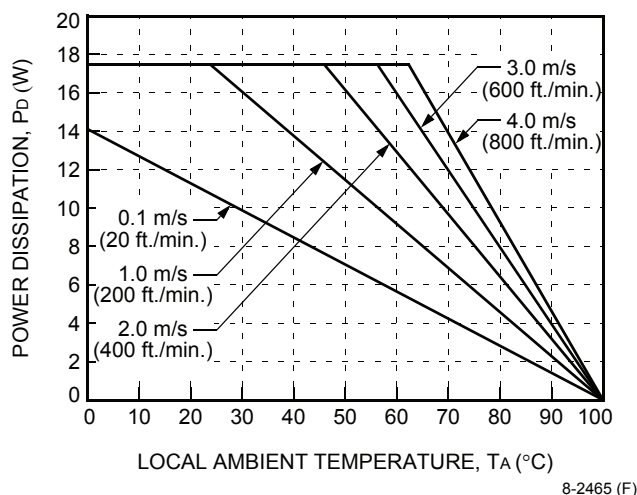


8-3349 (F)

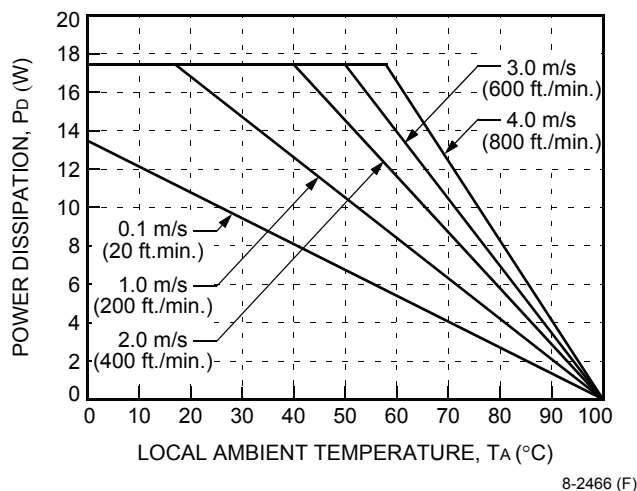
Figure 20. JAW075F Power Dissipation vs. Output Current at 25 °C

## Thermal Considerations (continued)

### Heat Transfer Without Heat Sinks (continued)



**Figure 21. Forced Convection Power Derating with No Heat Sink; Longitudinal Orientation**



**Figure 22. Forced Convection Power Derating with No Heat Sink; Transverse Orientation**

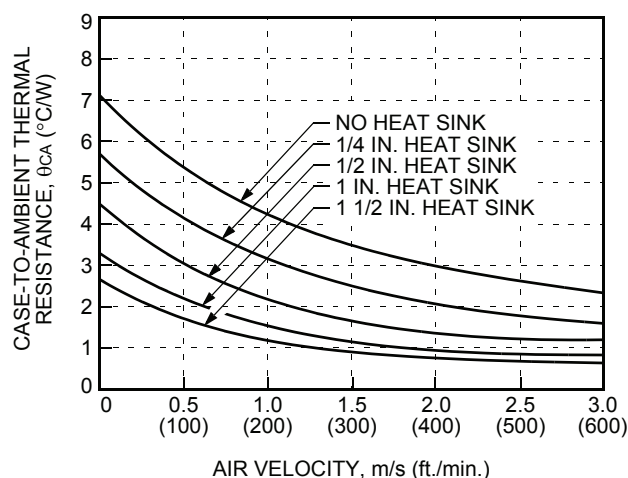
### Heat Transfer with Heat Sinks

The power modules have through-threaded, M3 x 0.5 mounting holes, which enable heat sinks or cold plates to attach to the module. The mounting torque must not exceed 0.56 N-m (5 in.-lb.).

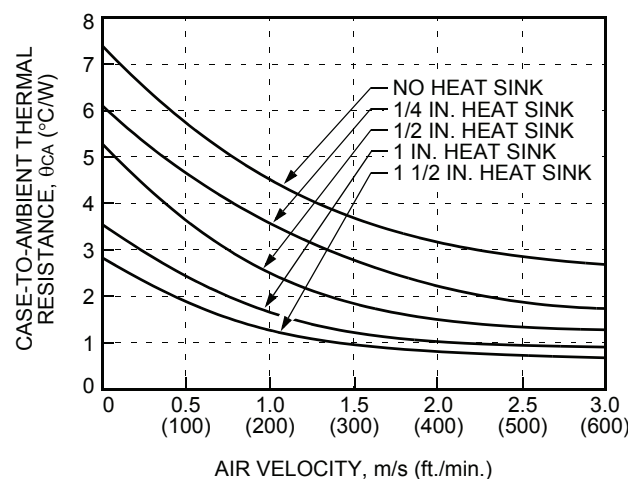
Thermal derating with heat sinks is expressed by using the overall thermal resistance of the module. Total module thermal resistance ( $\theta_{ca}$ ) is defined as the maximum case temperature rise ( $\Delta T_{C, \max}$ ) divided by the module power dissipation ( $P_D$ ):

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

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 and heights is shown in Figures 23 and 24. These curves were obtained by experimental testing of heat sinks, which are offered in the product catalog.



**Figure 23. Case-to-Ambient Thermal Resistance Curves; Longitudinal Orientation**



**Figure 24. Case-to-Ambient Thermal Resistance Curves; Transverse Orientation**

## Thermal Considerations (continued)

### Heat Transfer with Heat Sinks (continued)

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 23 and 24 had a thermal-conductive dry pad between the case and the heat sink to minimize contact resistance. The use of Figure 23 is shown in the following example.

#### Example

If an 82 °C case temperature is desired, what is the minimum airflow necessary? Assume the JAW075F module is operating at  $V_I = 55$  V and an output current of 15 A, longitudinal orientation, maximum ambient air temperature of 40 °C, and the heat sink is 1/4 inch.

#### Solution

Given:  $V_I = 55$  V  
 $I_O = 15$  A  
 $T_A = 40$  °C  
 $T_C = 82$  °C  
Heat sink = 1/4 inch

Determine  $P_D$  by using Figure 20:

$$P_D = 12.5 \text{ W}$$

Then solve the following equation:

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

$$\theta_{ca} = \left[ \frac{(82 - 40)}{12.5} \right]$$

$$\theta_{ca} = 3.4 \text{ °C/W}$$

Use Figure 23 to determine air velocity for the 1/4 inch heat sink.

The minimum airflow necessary for this module is 0.9 m/s (180 ft./min.).

## 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 ( $\theta_{cs}$ ) and sink-to-ambient ( $\theta_{sa}$ ) as shown in Figure 25.



8-1304 (F).e

**Figure 25. Resistance from Case-to-Sink and Sink-to-Ambient**

For a managed interface using thermal grease or foils, a value of  $\theta_{cs} = 0.1$  °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.

## EMC Considerations

For assistance with designing for EMC compliance, refer to the *FLTR100V10 Filter Module Data Sheet* (DS99-294EPS).

## Layout Considerations

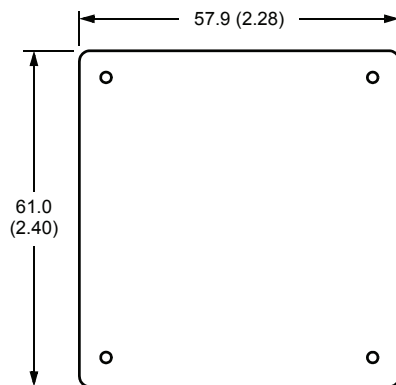
Copper paths must not be routed beneath the power module standoffs. For additional layout guidelines, refer to the *FLTR100V10 Filter Module Data Sheet* (DS99-294EPS).

## Outline Diagram

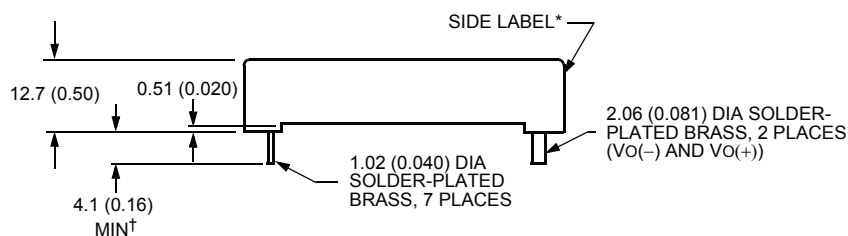
Dimensions are in millimeters and (inches).

Tolerances: x.x mm  $\pm$  0.5 mm (x.xx in.  $\pm$  0.02 in.)  
 x.xx mm  $\pm$  0.25 mm (x.xxx in.  $\pm$  0.010 in.)

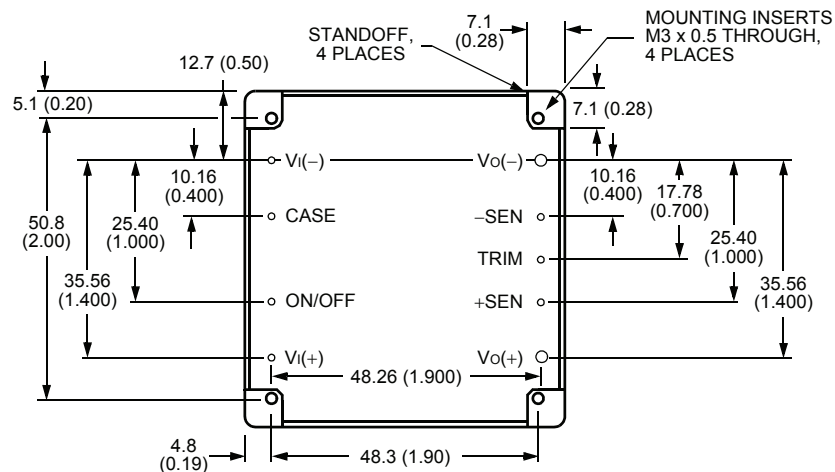
### Top View



### Side View



### Bottom View



8-716(F).j

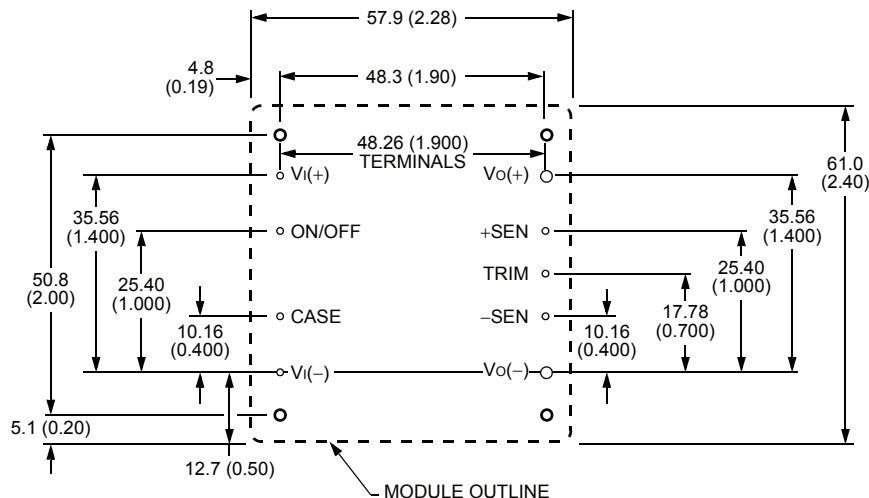
\* Side label includes Lineage name, product designation, safety agency markings, input/output voltage and current ratings, and bar code.

† The case pin length is 5.3 (0.21), i.e., 1.2 (0.05) longer than the other pins.

## Recommended Hole Pattern

Component-side footprint.

Dimensions are in millimeters and (inches).



8-716(F).j

## Ordering Information

Please contact your Lineage Power Account Manager or Field Application Engineer for pricing and availability.

**Table 4. Device Codes**

| Input Voltage | Output Voltage | Output Power | Output Current | Remote On/Off Logic | Device Code | Comcode   |
|---------------|----------------|--------------|----------------|---------------------|-------------|-----------|
| 48 Vdc        | 3.3 Vdc        | 33 W         | 10 A           | Negative            | JAW050F1    | 108209982 |
| 48 Vdc        | 3.3 Vdc        | 50 W         | 15 A           | Negative            | JAW075F1    | 108064361 |
| 48 Vdc        | 3.3 Vdc        | 33 W         | 10 A           | Positive            | JAW050F     | 108449356 |
| 48 Vdc        | 3.3 Vdc        | 50 W         | 15 A           | Positive            | JAW075F     | 108449455 |

Optional features can be ordered using the suffixes shown in Table 5. To order more than one option, list the device codes suffixes in numerically descending order. For example, the device code for a JAW075F module with the following option is shown below:

Short pins: 3.68 mm ± 0.25 mm (0.145 in. ± 0.010 in.)

JAW075F6

**Table 5. Device Options**

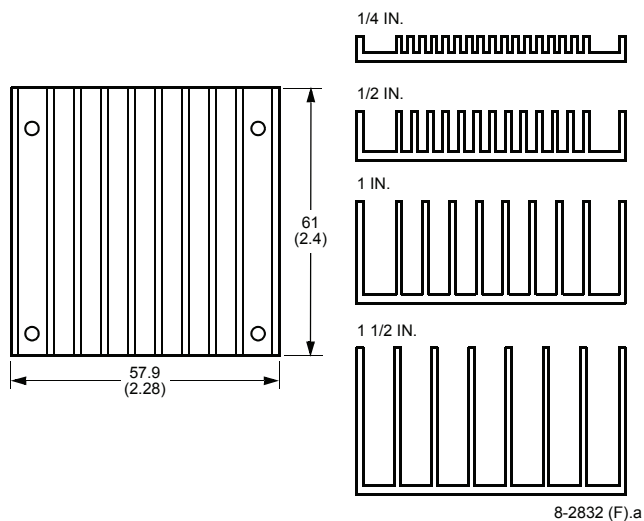
| Option                                                             | Suffix |
|--------------------------------------------------------------------|--------|
| Short pins: 2.79 mm ± 0.25 mm<br>(0.110 in. +0.020 in./-0.010 in.) | 8      |
| Short pins: 3.68 mm ± 0.25 mm<br>(0.145 in. ± 0.010 in.)           | 6      |

## Ordering Information (continued)

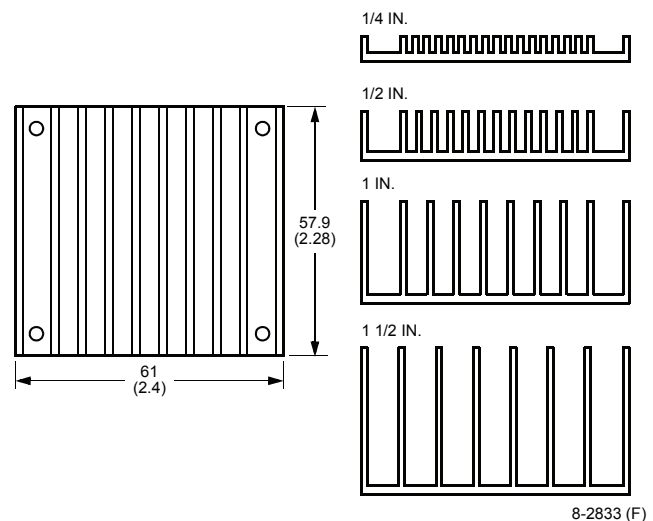
**Table 6. Device Accessories**

| Accessory                                                       | Comcode   |
|-----------------------------------------------------------------|-----------|
| 1/4 in. transverse kit (heat sink, thermal pad, and screws)     | 407243989 |
| 1/4 in. longitudinal kit (heat sink, thermal pad, and screws)   | 407243997 |
| 1/2 in. transverse kit (heat sink, thermal pad, and screws)     | 407244706 |
| 1/2 in. longitudinal kit (heat sink, thermal pad, and screws)   | 407244714 |
| 1 in. transverse kit (heat sink, thermal pad, and screws)       | 407244722 |
| 1 in. longitudinal kit (heat sink, thermal pad, and screws)     | 407244730 |
| 1 1/2 in. transverse kit (heat sink, thermal pad, and screws)   | 407244748 |
| 1 1/2 in. longitudinal kit (heat sink, thermal pad, and screws) | 407244755 |

Dimensions are in millimeters and (inches).



**Figure 26. Longitudinal Heat Sink**



**Figure 27. Transverse Heat Sink**



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