

## JBW030-Series Power Module: dc-dc Converters 36-75 Vdc Input; 3.3 Vdc and 5 Vdc Outputs; 30 W



The JBW030-Series Power Modules use advanced, surface-mount technology and deliver high-quality, compact, dc-dc conversion at an economical price.

### Applications

- Distributed power architectures
- Communications equipment
- Workstations / Computer equipment

### Options

- Heat sinks available for extended operation
- Choice of remote on/off logic configuration
- Short pins: 2.79 mm  $\pm$  0.25 mm (0.110 in.  $\pm$  0.010 in.)
- Short pins: 3.68 mm  $\pm$  0.25 mm (0.145 in.  $\pm$  0.010 in.)

### Description

The JBW030-Series Power Modules are dc-dc converters that operate over an input voltage range of 36 Vdc to 75 Vdc and provide precisely regulated outputs. The outputs are isolated from the inputs, allowing versatile polarity configurations and grounding connections. The modules have maximum power ratings of up to 30 W at a typical full-load efficiency of up to 82% (5 Vout).

These power modules feature remote on/off, remote sense, and output voltage adjustment, (80% to 110% of the nominal output voltage). The modules are PC board-mountable, encapsulated in metal cases, and are rated to full load at 100 °C case temperature. No external filtering is required.

### 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.)
- Low output noise
- Constant frequency
- Industry-standard pinout
- Metal case
- Case ground pin
- 2:1 input voltage range
- Overcurrent protection
- Output overvoltage protection
- Remote on/off
- Remote sense
- Adjustable output voltage: 80% to 110% of  $V_{O, nom}$
- UL\* 60950 Recognized, CSA† C22.2 No. 60950-00 Certified, and EN 60950 (VDE0805):2001-12 Licensed
- CE mark meets 73/23/EEC and 93/68/EEC directives‡
- Within FCC Class A radiated limits

\* UL is a registered trademark of Underwriters Laboratories, Inc.

† CSA is a registered trademark of Canadian Standards Association.

‡ 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
Operating Case Temperature (See Thermal Considerations section.)	$T_C$	–40	100	°C
Storage Temperature	$T_{stg}$	–40	110	°C
I/O Isolation Voltage: Continuous	—	—	500	Vdc
Transient	—	—	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 ( $V_I = 0$ V to 75 V; $I_O = I_{O, max}$ ; see Figure 1.)	$I_{I, max}$	—	—	1.6	A
Inrush Transient	$i^2t$	—	—	0.2	A <sup>2</sup> s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 $\mu$ H source impedance; $T_C = 25$ °C; see Figure 11 and Design Considerations section.)	$I_r$	—	25	—	mAp-p
Input Ripple Rejection (120 Hz)	—	—	50	—	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 fast-acting fuse with a maximum rating of 5 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 Code or Code Suffix	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point ( $V_I = 48\text{ V}$ ; $I_O = I_{O, \text{max}}$ ; $T_C = 25\text{ }^\circ\text{C}$ )	JBW030F JBW030A	$V_{O, \text{set}}$ $V_{O, \text{set}}$	3.25 4.95	3.3 5.0	3.35 5.05	Vdc Vdc
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life. See Figure 13.)	JBW030F JBW030A	$V_O$ $V_O$	3.20 4.85	— —	3.40 5.15	Vdc Vdc
Output Regulation: Line ( $V_I = 36\text{ V}$ to $75\text{ V}$ ) Load ( $I_O = I_{O, \text{min}}$ to $I_{O, \text{max}}$ ) Temperature ( $T_C = -40\text{ }^\circ\text{C}$ to $+100\text{ }^\circ\text{C}$ )	All All JBW030F JBW030A	— — — —	— — — —	0.01 0.05 0.75 0.5	0.1 0.2 1.5 1.5	% $V_O$ % $V_O$ % $V_O$ % $V_O$
Output Ripple and Noise Voltage (See Figure 12.): RMS Peak-to-peak (5 Hz to 20 MHz)	All All	— —	— —	— —	20 150	mVrms mVp-p
Output Current (At $I_O < I_{O, \text{min}}$ , the modules may exceed output ripple specifications; see Figures 2 and 3.)	JBW030F JBW030A	$I_O$ $I_O$	0.6 0.6	— —	6.5 6.0	A A
Output Current-limit Inception ( $V_O = 90\%$ of $V_{O, \text{nom}}$ )	JBW030F JBW030A	$I_O$ $I_O$	— —	8.5 8.0	— —	A A
Output Short-circuit Current ( $V_O = 250\text{ mV}$ )	JBW030F JBW030A	— —	— —	10.0 9.5	13 12.5	A A
Efficiency ( $V_I = 48\text{ V}$ ; $I_O = I_{O, \text{max}}$ ; $T_C = 25\text{ }^\circ\text{C}$ ; see Figures 4, 5 and 13.)	JBW030F JBW030A	$\eta$ $\eta$	75 79	78 82	— —	% %
Switching Frequency	All	—	—	300	—	kHz
Dynamic Response ( $\Delta I_O / \Delta t = 1\text{ A}/10\text{ }\mu\text{s}$ , $V_I = 48\text{ V}$ , $T_C = 25\text{ }^\circ\text{C}$ ; see Figures 6 — 9.): Load Change from $I_O = 50\%$ to $75\%$ of $I_{O, \text{max}}$ : Peak Deviation Settling Time ( $V_O < 10\%$ peak deviation) Load Change from $I_O = 50\%$ to $25\%$ of $I_{O, \text{max}}$ : Peak Deviation Settling Time ( $V_O < 10\%$ of peak deviation)	JBW030F JBW030A All  JBW030F JBW030A All	— — —  — — —	— — —  — — —	5 2 0.5  5 2 0.5	— — —  — — —	% $V_{O, \text{set}}$ % $V_{O, \text{set}}$ ms  % $V_{O, \text{set}}$ % $V_{O, \text{set}}$ ms

## Electrical Specifications (continued)

**Table 3. Isolation Specifications**

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	2500	—	pF
Isolation Resistance	10	—	—	MΩ

## General Specifications

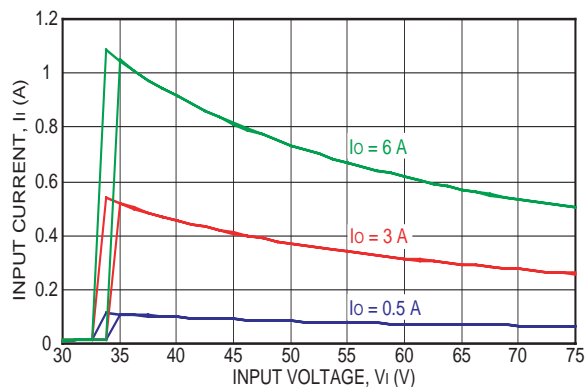
Parameter	Min	Typ	Max	Unit
Calculated MTBF ( $I_o = 80\%$ of $I_{o, max}$ ; $T_c = 40\text{ }^{\circ}\text{C}$ )	4,370,000			hours
Weight	—	—	113 (4.0)	g (oz.)

## Feature Specifications

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

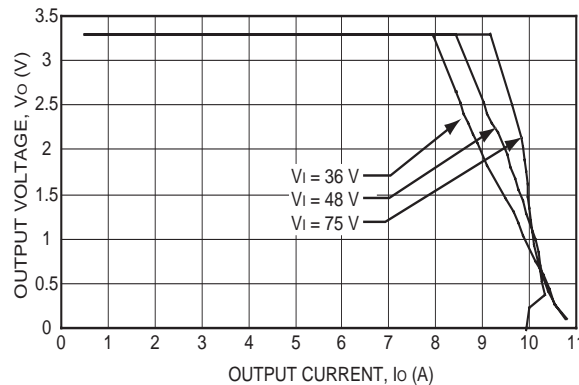
Parameter	Device Code or Code Suffix	Symbol	Min	Typ	Max	Unit
Remote On/Off ( $V_I = 36\text{ V}$ to $75\text{ V}$ ; open collector or equivalent compatible; signal referenced to $V_I(-)$ terminal. See Figure 14 and Feature Descriptions.): JW030x1-M Negative Logic: Logic Low—Module On Logic High—Module Off JW030x-M Positive Logic: Logic Low—Module Off Logic High—Module On Module Specifications: On/Off Current—Logic Low On/Off Voltage: Logic Low Logic High ( $I_{on/off} = 0$ ) Open Collector Switch Specifications: Leakage Current During Logic High ( $V_{on/off} = 10\text{ V}$ ) Output Low Voltage During Logic Low ( $I_{on/off} = 1\text{ mA}$ ) Turn-on Time (@ $80\%$ of $I_{o, max}$ ; $T_A = 25\text{ }^{\circ}\text{C}$ ; $V_O$ within $\pm 1\%$ of steady state; see Figure 10.) Output Voltage Overshoot	All	$I_{on/off}$	—	—	1.0	mA
	All	$V_{on/off}$	−0.7	—	1.2	V
	All	$V_{on/off}$	—	—	15	V
	All	$I_{on/off}$	—	—	50	μA
	All	$V_{on/off}$	—	—	1.2	V
	All	—	—	80	150	ms
	All	—	—	0	5	%
Output Voltage Sense Range	All	—	—	—	10	% $V_{O, nom}$
Output Voltage Set-point Adjustment Range (See Feature Descriptions.)	All	—	80	—	110	% $V_{O, nom}$
Output Overvoltage Protection (clamp)	JBW030F	$V_{O, clamp}$	4.0	—	5.7	V
	JBW030A	$V_{O, clamp}$	5.6	—	7.0	V

## Characteristic Curves



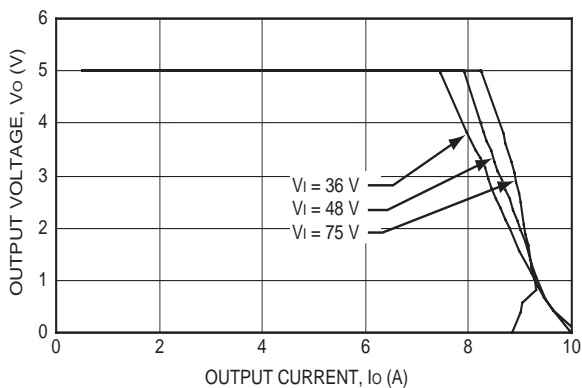
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Figure 1. Typical Input Characteristics



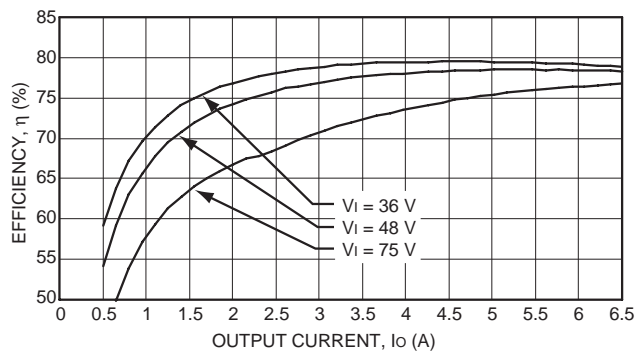
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Figure 3. JBW030F Typical Output Characteristics



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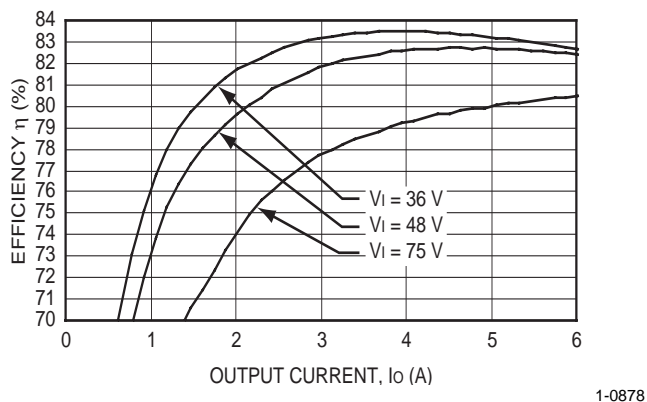
Figure 2. JBW030A Typical Output Characteristics



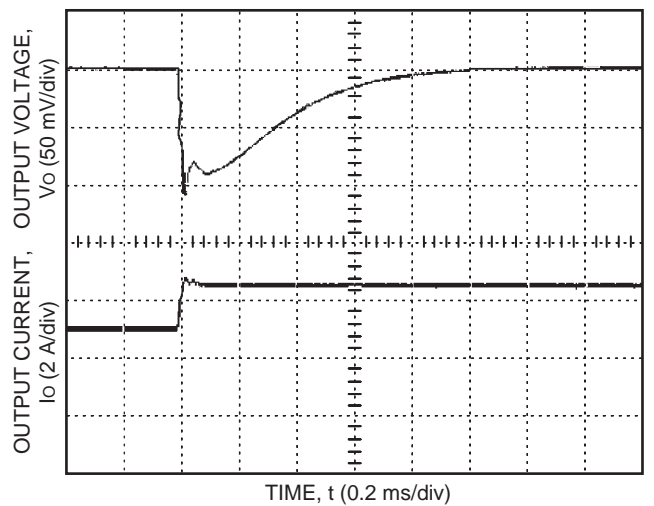
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Figure 4. JBW030F Typical Converter Efficiency vs. Output Current

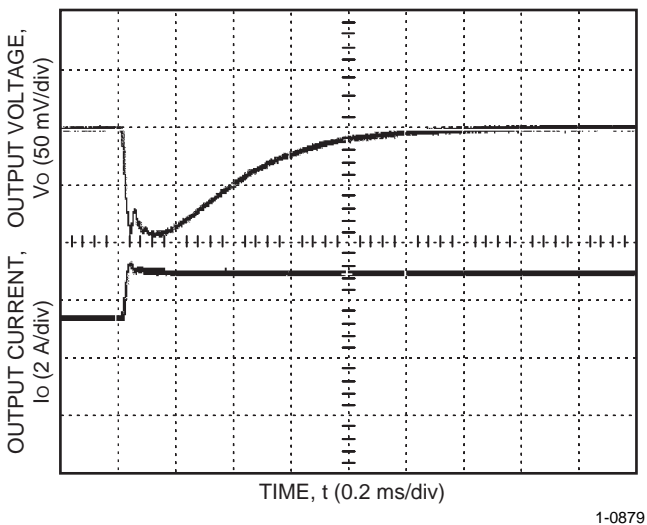
## Characteristic Curves (continued)



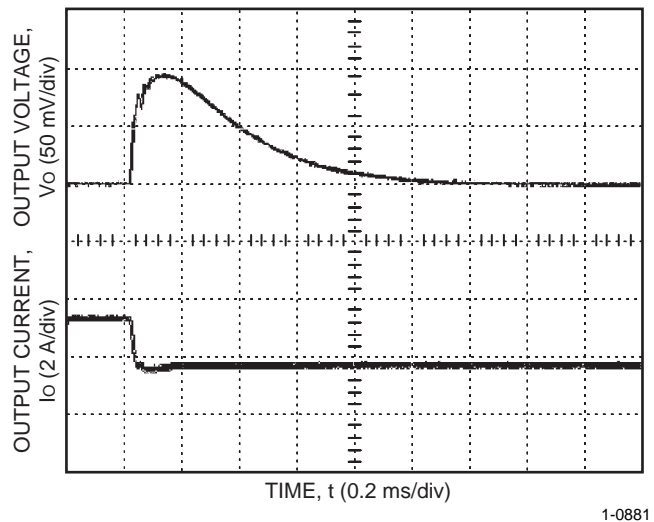
**Figure 5. JBW030A Typical Converter Efficiency vs. Output Current**



**Figure 7. JBW030A Typical Output Voltage for a Step Load Change from 50% to 75%**

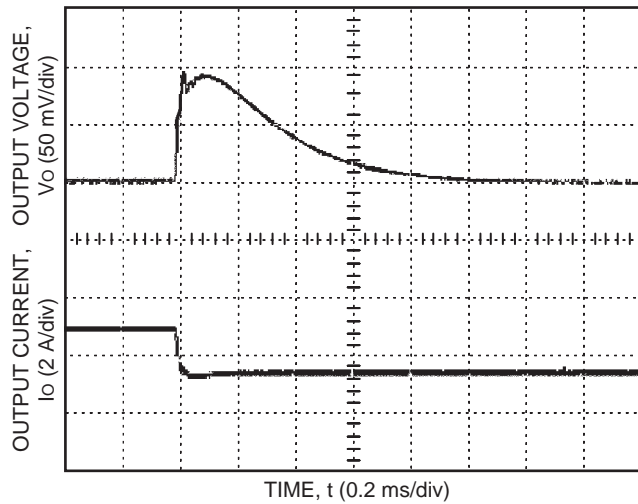


**Figure 6. JBW030F Typical Output Voltage for a Step Load Change from 50% to 75%**



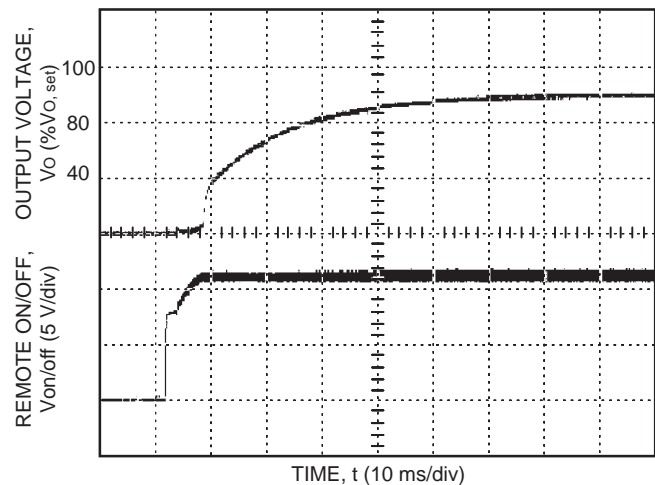
**Figure 8. JBW030F Typical Output Voltage for a Step Load Change from 50% to 25%**

## Characteristic Curves (continued)



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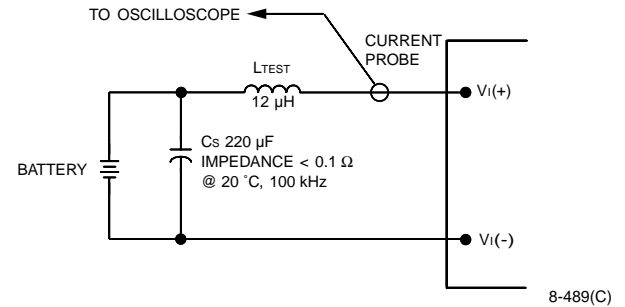
**Figure 9. JBW030A Typical Output Voltage for a Step Load Change from 50% to 25%**



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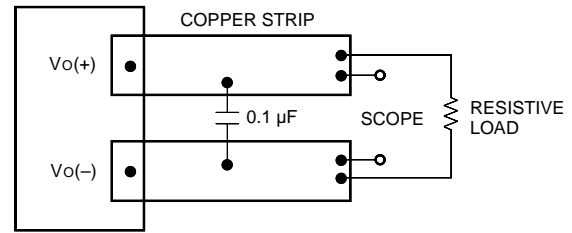
**Figure 10. Typical Output Voltage Start-Up when Signal Applied to Remote On/Off**

## Test Configurations



Note: Input reflected-ripple current is measured with a simulated source impedance of 12 μH. Capacitor Cs offsets possible battery impedance. Current is measured at the input of the module.

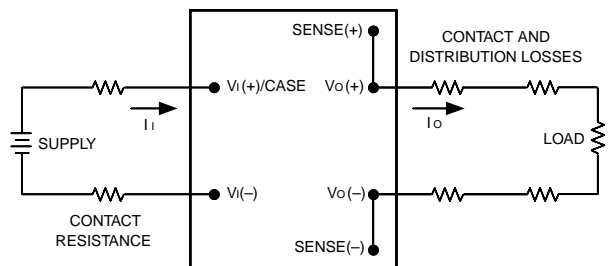
**Figure 11. Input Reflected-Ripple Test Setup**



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Note: Use a 0.1 μF ceramic capacitor. Scope measurement should be made using a BNC socket. Position the load between 50 mm and 75 mm (2 in. and 3 in.) from the module.

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



8-749(C).a

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

### Grounding Considerations

The case is not connected internally to allow the user flexibility in grounding.

### 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. 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. (See Figure 11.)

## 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 EN 60950 (VDE0805):2001-12.

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 5 A fast-acting 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.

### 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 REMOTE 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  $V_{on/off} = -0.7$  V to 1.2 V, during which the module is off. 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.

The module has internal capacitance to reduce noise at the ON/OFF pin. Additional capacitance is not generally needed and may degrade the start-up characteristics of the module.

**CAUTION:** To avoid damaging the power module or external on/off circuit, the connection between the  $V_I(-)$  pin and the input source must be made before or simultaneously to making a connection between the ON/OFF pin and the input source (either directly or through the external on/off circuit.)



## Feature Descriptions (continued)

### Remote On/Off (continued)

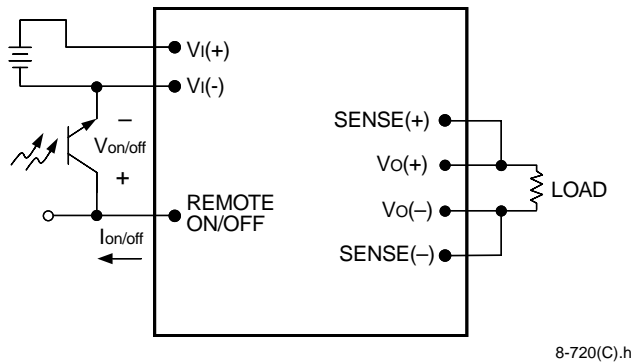


Figure 14. Remote On/Off Implementation

### 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.:

$$[Vo(+)-Vo(-)]-[SENSE(+)-SENSE(-)] \leq 0.2 \text{ V}$$

The voltage between the Vo(+) and Vo(-) terminals must not exceed the minimum output overvoltage shutdown 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.

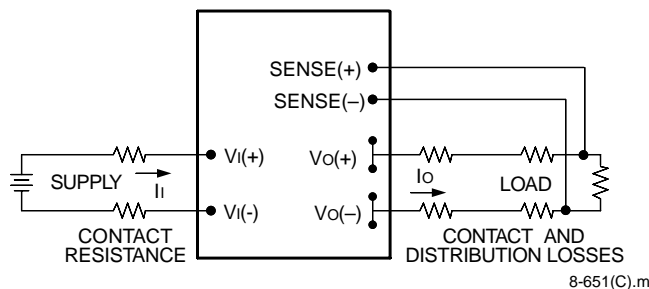


Figure 15. Effective Circuit Configuration for Single-Module Remote-Sense Operation

## 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. 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 an output voltage change of %  $\Delta$ .

$$R_{\text{adj-down}} = \left( \frac{1 - \% \Delta}{\% \Delta} \right) 10 \text{ k}\Omega$$

For example, to lower the output voltage by 20%, the external resistor value must be:

$$R_{\text{adj-down}} = \left( \frac{1 - 0.2}{0.2} \right) 10 \text{ k}\Omega = 40.00 \text{ k}\Omega$$

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 equations determine the required external-resistor value to obtain an output voltage change of %  $\Delta$ .

#### JBW030A:

$$R_{\text{adj-up}} = \left( \frac{V_{O, \text{nom}}}{2.5} - 1 \right) \left( \frac{1 + \% \Delta}{\% \Delta} \right) 10 \text{ k}\Omega$$

For example, to increase the output voltage of the JBW030A by 5%, the external resistor value must be:

$$R_{\text{adj-up}} = \left( \frac{5.0}{2.5} - 1 \right) \left( \frac{1 + 0.05}{0.05} \right) 10 \text{ k}\Omega = 210 \text{ k}\Omega$$

#### JBW030F:

$$R_{\text{adj-up}} = \left( \frac{V_{O, \text{nom}}}{1.235} - 1 \right) \left( \frac{1 + \% \Delta}{\% \Delta} \right) 10 \text{ k}\Omega$$

For example, to increase the output voltage of the JBW030F by 5%, the external resistor must be:

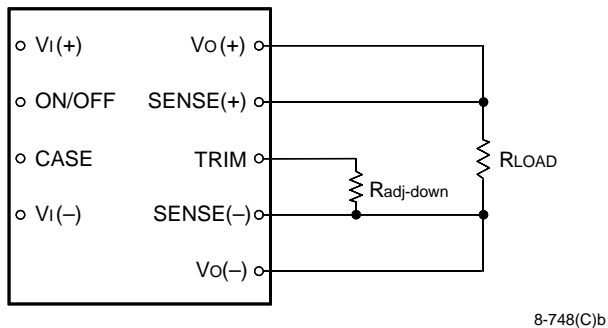
$$R_{\text{adj-up}} = \left( \frac{3.3}{1.235} - 1 \right) \left( \frac{1 + 0.05}{0.05} \right) 10 \text{ k}\Omega = 351.1 \text{ k}\Omega$$

## Feature Descriptions (continued)

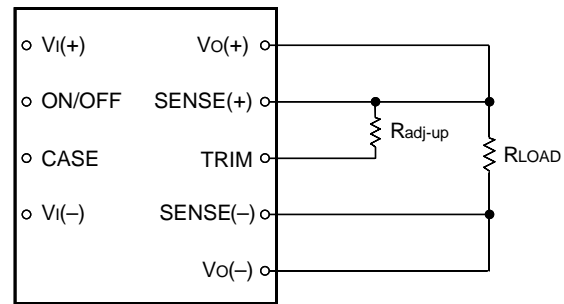
### Output Voltage Set-Point Adjustment (Trim) (continued)

The combination of the output voltage adjustment and sense range and the output voltage given in the Feature Specifications table cannot exceed 110% of the nominal output voltage between the Vo(+) and Vo(−) terminals.

The JBW030-Series Power Modules have a fixed current-limit set point. Therefore, as the output voltage is adjusted down, the available output power is reduced. In addition, the minimum output current is a function of the output voltage. As the output voltage is adjusted down, the minimum required output current can increase.



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



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

### Output Overvoltage Protection

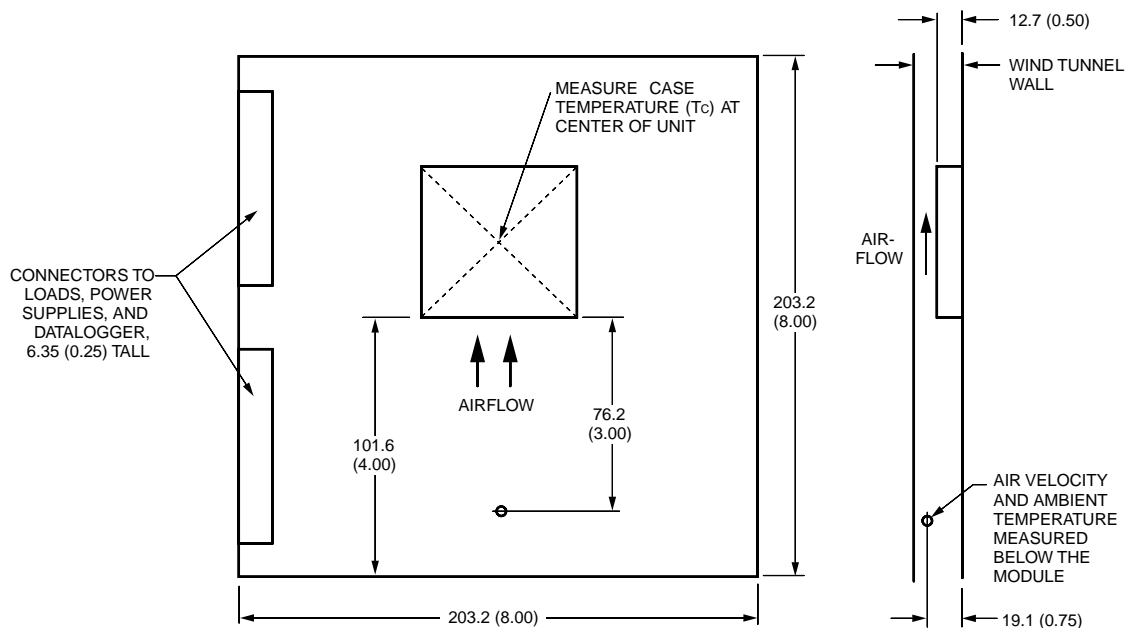
The output overvoltage clamp consists of control circuitry, independent of the primary regulation loop, that monitors the voltage on the output terminals. The control loop of the clamp has a higher voltage set point than the primary loop (see Feature Specifications table). This provides a redundant voltage-control that reduces the risk of output overvoltage.

## Thermal Considerations

The JBW030-Series Power Modules are designed to operate in a variety of thermal environments. As with any electronic component, sufficient cooling must be provided to help ensure reliable operation. Heat-dissipating components inside the module are thermally coupled to the case to enable heat removal by conduction, convection, and radiation to the surrounding environment.

The thermal data presented is based on measurements taken in a wind tunnel. The test setup shown in Figure 18 was used to collect data for Figure 21.

The graphs in Figures 19 and 20 provide general guidelines for use. Actual performance can vary depending on the particular application environment. The maximum case temperature of 100 °C must not be exceeded.



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Note: Dimensions are in millimeters and (inches).

Figure 18. Thermal Test Setup

## Basic Thermal Performance

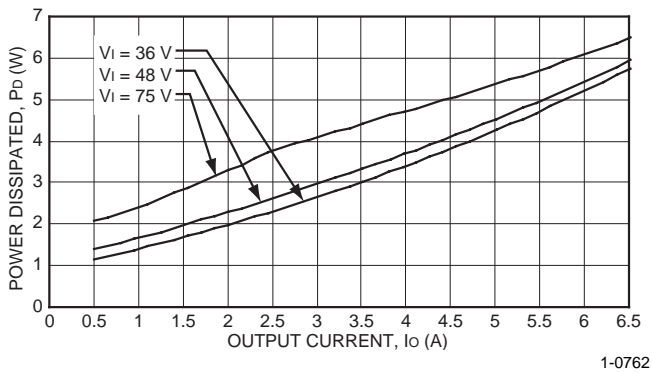
The JBW030-Series Power Modules are constructed with a specially designed, heat spreading enclosure. As a result, full-load operation in natural convection at 50 °C can be achieved without the use of an external heat sink.

Higher ambient temperatures can be sustained by increasing the airflow or by adding a heat sink. As stated, this data is based on a maximum case temperature of 100 °C and measured in the test configuration shown in Figure 18.

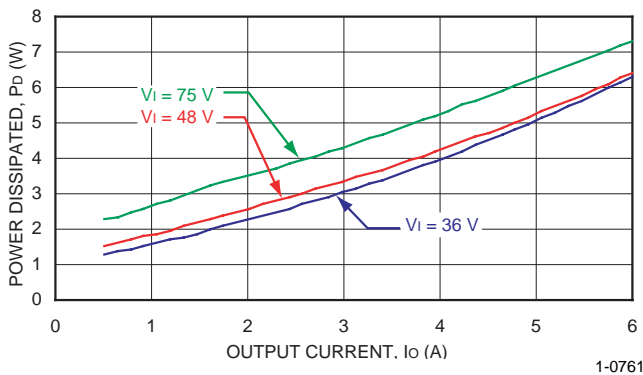
## Thermal Considerations (continued)

### Forced Convection Cooling

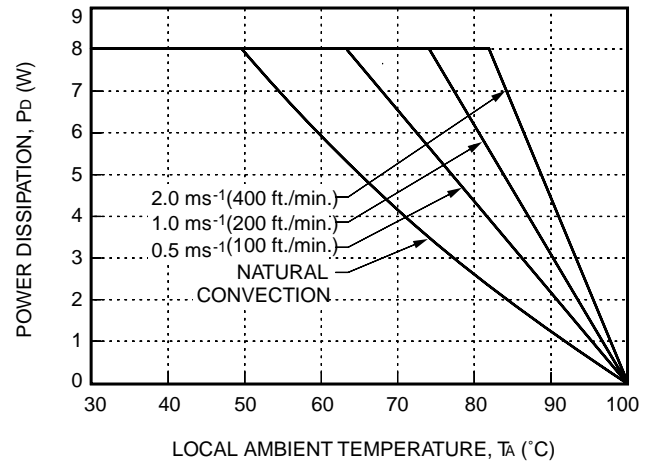
To determine the necessary airflow, determine the power dissipated by the unit for the particular application. Figures 19 and 20 show typical power dissipation for these power modules over a range of output currents. With the known power dissipation and a given local ambient temperature, the appropriate airflow can be chosen from the derating curves in Figure 21. For example, if the JBW030A dissipates 6.2 W, the minimum airflow in a 80 °C environment is 1 ms<sup>-1</sup> (200 ft./min.).



**Figure 19. JBW030F Power Dissipation vs. Output Current**



**Figure 20. JBW030A Power Dissipation vs. Output Current**



8-1051(C)

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

### Heat Sink Selection

Several heat sinks are available for these modules. The case includes through-threaded mounting holes allowing attachment of heat sinks or cold plates from either side of the module. The mounting torque must not exceed 0.56 N-m (5 in./lb.).

Figure 22 shows the case-to-ambient thermal resistance,  $\theta$  (°C/W), for these modules. These curves can be used to predict which heat sink will be needed for a particular environment. For example, if the JBW030A dissipates 7 W of heat in an 80 °C environment with an airflow of 0.7 ms<sup>-1</sup> (130 ft./min.), the minimum heat sink required can be determined as follows:

$$\theta \leq (T_{C, \max} - T_A) / P_D$$

where:

- $\theta$  = module's total thermal resistance
- $T_{C, \max}$  = case temperature (See Figure 18.)
- $T_A$  = inlet ambient temperature (See Figure 18.)
- $P_D$  = power dissipation

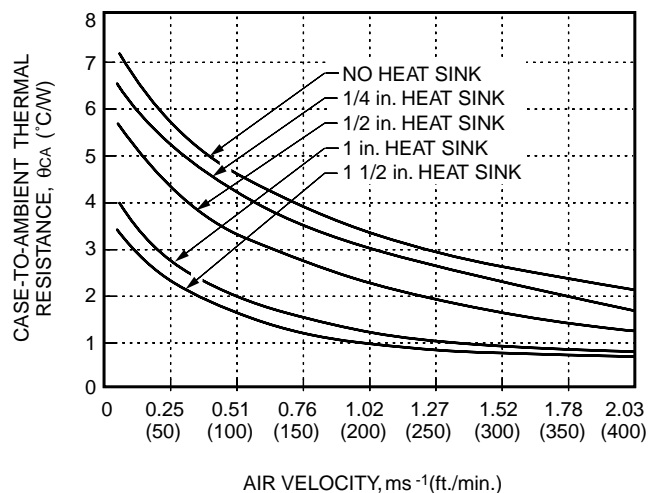
$$\theta \leq (100 - 80) / 7$$

$$\theta \leq 2.9 \text{ °C/W}$$

From Figure 22, the 1/2 in. high heat sink or greater is required.

## Thermal Considerations (continued)

### Heat Sink Selection (continued)



8-1052(C).a

**Figure 22. Case-to-Ambient Thermal Resistance vs. Air Velocity Curves; Either Orientation**

Although the previous example uses 100 °C as the maximum case temperature, for extremely high reliability applications, one can use a lower temperature for  $T_{C, max}$ .

It is important to point out that the thermal resistances shown in Figure 22 are for 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 will generally be lower than the resistance of the heat sink by itself. The data in Figure 22 was taken with a thermally conductive dry pad between the case and the heat sink to minimize contact resistance (typically 0.1 °C/W to 0.3 °C/W).

For a more detailed explanation of thermal energy management for this series of power modules as well as more details on available heat sinks, please request the following technical note: *Thermal Energy Management for JC- and JW-Series 30 Watt Board-Mounted Power Modules* (TN97-016EPS).

## Layout Considerations

Copper paths must not be routed beneath the power module standoffs.



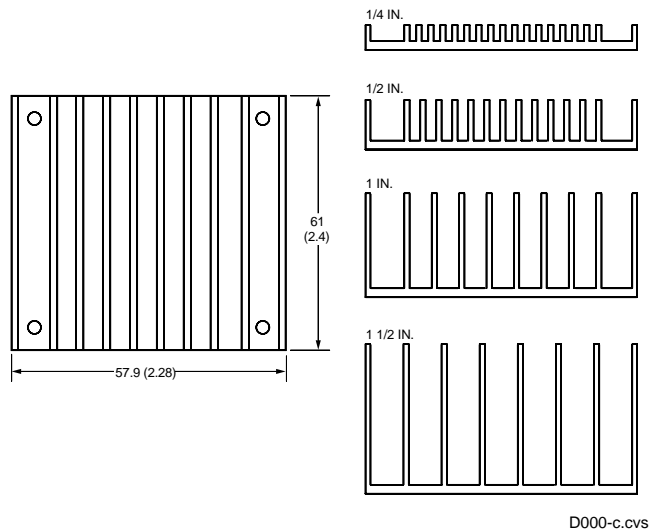


## Ordering Information (continued)

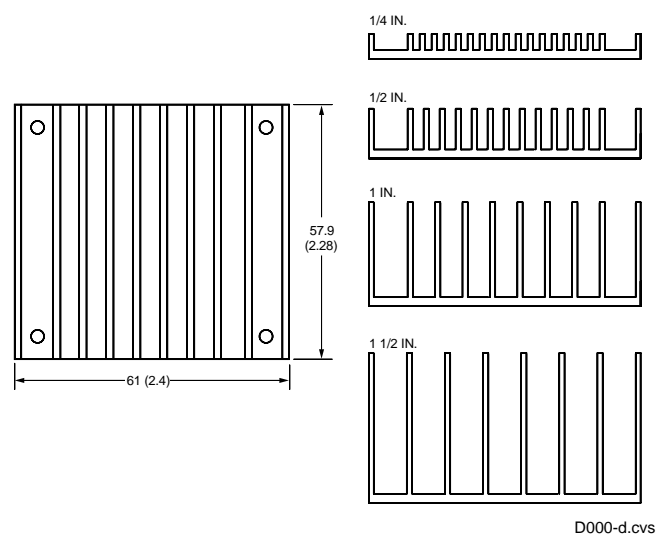
**Table 6. Device Accessories**

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

Note: Dimensions are in millimeters and (inches).



**Figure 23. Longitudinal Heat Sink**



**Figure 24. Transverse Heat Sink**



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