Lucent Technologies
Bell Labs Innovations

JW060 Triple-Output-Series Power Modules: dc-dc Converters; 36 to 75 Vdc Input, 5 and ±12 Vdc, or 5 and ±15 Vdc Outputs; 60 W

The JW060 Triple-Output-Series Power Modules use advanced, surface-mount technology and deliver high-quality, efficient, and compact dc-dc conversion.

Applications

- Distributed power architectures
- Telecommunications

Options

- Choice of remote on/off logic configuration
- Heat sink available for extended operation

Features

- Small size: 61.0 mm x 57.9 mm x 13.3 mm (2.40 in. x 2.28 in. x 0.52 in.)
- High power density
- High efficiency: 86% typical
- Low output noise
- Constant frequency
- Wide operating temperature range
- Metal baseplate
- 2:1 input voltage range
- Overvoltage and overcurrent protection
- Overtemperature protection
- Remote on/off
- Adjustable output voltage
- *UL* Recognized, *CSA*[†] Certified, VDE Licensed
- CE mark meets 73/23/EEC and 93/68/EEC directives[‡]

[*] *UL* is a registered trademark of Underwriters Laboratories, Inc.
[†] *CSA* is a registered trademark of Canadian Standards Assn.
[‡] 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.)

Description

The JW060 Triple-Output-Series Power Modules are dc-dc converters that operate over an input voltage range of 36 Vdc to 75 Vdc and provide three dc outputs. The outputs are fully isolated from the inputs, allowing versatile grounding connections. Built-in shielding provides improved EMI performance. The modules have a maximum power rating of 60 W at a typical full-load efficiency of 86%.

The total output power of the JW060 Triple-Output-Series Power Modules is limited to 60 W. The main output (V_{O1}) is tightly regulated and designed to deliver up to 45 W. The auxiliary outputs (V_{O2} and V_{O3}) are cross-regulated and can provide a total of 58 W with the main output loaded at its minimum of 2 W.

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

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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
  Transient (100 ms)
	V_I
	$V_{I, trans}$
		—
		—
			80
			100
				V
				Vdc

I/O Isolation Voltage	—	—	1500	Vdc
Operating Baseplate Temperature	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	36	48	75	Vdc
Maximum Input Current (V_I = 0 V to 75 V)	$I_{I, max}$	—	—	3.0	A
Inrush Transient Energy ($i^2t = W_{fuse}/R_{fuse}$; J/Ω = A^2s)	W_{fuse}	—	—	4.0	mJ

Input Reflected-ripple Current, Peak-to-peak
  (5 Hz to 20 MHz, 12 µH source impedance;
  see Figure 13.)
	—	—	50	—	mAp-p

Input Ripple Rejection (120 Hz)	—	—	57	—	dB

Fusing Considerations

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

This 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, dc fuse with a maximum rating of 20 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.

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Electrical Specifications (continued)

Table 2. Output Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point (V_I = 48 V; T_C = 25 °C, I_{O1} = 5.00 A; for JW060ABK, I_{O2} = I_{O3} = 1.45 A; for JW060ACL, I_{O2} = I_{O3} = 1.12 A)	JW060ABK	$V_{O1, set}$	4.90	5.00	5.10	Vdc
		$V_{O2, set}$	11.70	12.05	12.35	Vdc
		$V_{O3, set}$	−11.70	−12.05	−12.35	Vdc
	JW060ACL	$V_{O1, set}$	4.90	5.00	5.10	Vdc
		$V_{O2, set}$	15.30	15.60	15.90	Vdc
		$V_{O3, set}$	−15.25	−15.60	−15.90	Vdc
Output Voltage with Typical Loads (Over all operating input voltage and temperature conditions until end of life with resistive loads greater than the following minimums: I_{O1} > 2.0 A; I_{O2} & I_{O3} > 1.0 A)	JW060ABK	V_{O1}	4.83	—	5.17	Vdc
		V_{O2}	11.25	—	12.85	Vdc
		V_{O3}	−11.25	—	−12.85	Vdc
	JW060ACL	V_{O1}	4.83	—	5.17	Vdc
		V_{O2}	14.60	—	16.60	Vdc
		V_{O3}	−14.60	—	−16.60	Vdc
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life; see Figures 2—5 and Figures 9—12.)	JW060ABK	V_{O1}	4.83	—	5.17	Vdc
		V_{O2}	10.55	—	13.65	Vdc
		V_{O3}	−10.45	—	−13.65	Vdc
	JW060ACL	V_{O1}	4.83	—	5.17	Vdc
		V_{O2}	14.00	—	17.25	Vdc
		V_{O3}	−13.90	—	−17.25	Vdc
Output Regulation: Line (V_I = 36 V to 75 V)	All	V_{O1}	−0.1	0.01	0.1	%
	JW060ABK	V_{O2}, V_{O3}	−0.5	0.05	0.6	%
	JW060ACL	V_{O2}, V_{O3}	−0.35	−0.03	0.3	%
Load (I_{O1} = 1.67 A to 5.00 A; for JW060ABK, I_{O2} = I_{O3} = 0.48 A to 1.45 A; for JW060ACL, I_{O2} = I_{O3} = 0.37 A to 1.12 A)	All	V_{O1}	−0.2	0.0	0.1	%
	JW060ABK	V_{O2}, V_{O3}	−2.0	0.2	2.0	%
	JW060ACL	V_{O2}, V_{O3}	0.4	1.4	2.5	%
Temperature (T_C = −40 °C to +100 °C)	All	V_{O1}	—	15	—	mV
	JW060ABK	V_{O2}, V_{O3}	—	−220	—	mV
	JW060ACL	V_{O2}, V_{O3}	—	−230	—	mV
Output Ripple and Noise Voltage (5 Hz to 20 MHz; see Figure 14.): RMS	JW060ABK	V_{O1}	—	—	25	mVrms
		V_{O2}	—	—	35	mVrms
		V_{O3}	—	—	30	mVrms
	JW060ACL	V_{O1}	—	—	30	mVrms
		V_{O2}	—	—	50	mVrms
		V_{O3}	—	—	40	mVrms
Peak-to-peak	JW060ABK	V_{O1}	—	—	80	mVp-p
		V_{O2}	—	—	120	mVp-p
		V_{O3}	—	—	90	mVp-p
	JW060ACL	V_{O1}	—	—	100	mVp-p
		V_{O2}	—	—	160	mVp-p
		V_{O3}	—	—	120	mVp-p
Total External Load Capacitance Referred to Output 1 (electrolytic; multiply output 2 & 3 load capacitances by 5.44 for JW060ABK or 9 for JW060ACL)	All	—	0	—	18,000	µF

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Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Currents	JW060ABK	I_{o1}	0.5	—	9.0	A
(At $I_o < I_{o, min}$, the modules may		I_{o2}, I_{o3}	0.3	—	3.0	A
exceed output ripple and output 2 and	JW060ACL	I_{o1}	0.5	—	9.0	A
3 voltage specifications. Operation is		I_{o2}, I_{o3}	0.2	—	2.2	A
not recommended at $I_{o1} < 200$ mA or						
$I_{o2} < 100$ mA due to possible control						
malfunction. No load is necessary on						
output 3, but at no load, its voltage						
may rise to the Output Overvoltage						
Clamp specified on page 7.)						
Output Current-limit Inception:						
Typical ($V_I = 48$ V, $T_C = 40$ °C):						
For JW060ABK: $I_{o1} = 3.33$ A,	JW060ABK	I_{o1}	—	12.5	—	A
$I_{o2} = I_{o3} = 0.97$ A		I_{o2}, I_{o3}	—	5.0	—	A
For JW060ACL: $I_{o1} = 3.33$ A,	JW060ACL	I_{o1}	—	12.5	—	A
$I_{o2} = I_{o3} = 0.75$ A		I_{o2}, I_{o3}	—	3.9	—	A
Worst Case (minimum loads on other	JW060ABK	I_{o1}	14.0*	—	18.0*	A
outputs)		I_{o2}, I_{o3}	4.0*	—	8.5*	A
	JW060ACL	I_{o1}	14.0*	—	18.0*	A
		I_{o2}, I_{o3}	3.0*	—	7.0*	A
Output Short-circuit Current	JW060ABK	I_{o1}	—	5.5	7.5	Adc
(foldback current limit;		I_{o2}, I_{o3}	—	4.5	6.5	Adc
output voltage = 0.5 V)	JW060ACL	I_{o1}	—	6.0	7.5	Adc
		I_{o2}, I_{o3}	—	3.0	4.5	Adc

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

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Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Efficiency (V_I = 48 V; T_C = 25 °C, I_{O1} = 5.0 A, I_{O2} = I_{O3} = 1.45 A for JW060ABK, 1.12 A for JW060ACL)	JW060ABK JW060ACL	η η	— —	86 87	— —	% %
Switching Frequency	All	—	—	320	—	kHz

Dynamic Response
($\Delta I_O/\Delta t$ = 1 A/µs, V_I = 48 V, T_C = 25 °C,
load capacitance per Figure 14):
V_{O1} for a Step Load Change:
  I_{O1} Step from 3.0 A to 6.0 A
    for JW060ABK, I_{O2} = I_{O3} = 0.62 A;
    for JW060ACL, I_{O2} = I_{O3} = 0.48 A:
      Peak Deviation
	
	JW060ABK
	JW060ACL
		
		—
		—
			
			—
			—
				
				4.0
				4.4
					
					—
					—
						
						%$V_{O,\,set}$
						%$V_{O,\,set}$

Settling Time (V_O < 10% of peak
      deviation)
  I_{O1} Step from 0.5 A to 9.0 A, Other
  Loads at Their Minimum:
      Peak Deviation
	JW060ABK
	JW060ACL
	
	JW060ABK
	JW060ACL
		—
		—
		
		—
		—
			—
			—
			
			—
			—
				680
				850
				
				11.6
				13.0
					—
					—
					
					—
					—
						µs
						µs
						
						%$V_{O,\,set}$
						%$V_{O,\,set}$

Settling Time (V_O < 10% of peak
      deviation)
V_{O2} for a Step Load Change:
  for JW060ABK, I_{O2} Step from 0.62 A
    to 1.87 A, I_{O1} = 3.0 A, I_{O3} = 0.62 A;
  for JW060ACL, I_{O2} Step from 0.48 A
    to 1.44 A, I_{O1} = 3.0 A, I_{O3} = 0.48 A:
      Peak Deviation
	JW060ABK
	JW060ACL
	
	JW060ABK
	JW060ACL
		—
		—
		
		—
		—
			—
			—
			
			—
			—
				700
				800
				
				4.5
				4.5
					—
					—
					
					—
					—
						µs
						µs
						
						%$V_{O,\,set}$
						%$V_{O,\,set}$

Settling Time (V_O < 10% of peak deviation)	JW060ABK JW060ACL	— —	— —	580 780	— —	µs µs

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Electrical Specifications (continued)

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance:				
Baseplate to I/O Pins	—	1100	—	pF
Input to Output Pins	—	300	—	pF
Isolation Resistance:				
Baseplate to I/O Pins	10	—	—	MΩ
Input to Output Pins	10	—	—	MΩ

General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O, max}$; T_C = 40 °C)		5,500,000		hr.
Failure Rate in the First 2 Years of Operation*	—	—	500	ppm
Useful Life at 55 °C Ambient, 80% Full Load*	15	—	—	years
Weight	—	51 (1.8)	55 (2)	g (oz.)

* Based on other similar products.

Cleanliness Requirements

The open frame (no case or potting) power module will meet requirements per J-STD-001B. These requirements state that solder balls must be attached and their size should not compromise minimum electrical spacing of the power module.

The cleanliness designator of the open frame power module is C00 (per J specification).

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Feature Specifications

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

Parameter	Device	Symbol	Min	Typ	Max	Unit

Remote On/Off Signal Interface
(V_I = 0 V to 75 V; open collector or equivalent compatible; signal referenced to $V_I(-)$ terminal; see Figure 16 and Feature Descriptions.):
    JW060xxx Preferred Logic:
        Logic Low—Module Off
        Logic High—Module On
    JW060xxx1 Optional Logic:
        Logic Low—Module On
        Logic High—Module Off						

Logic Low (ON/OFF pin tied to V_I (−)): At $V_{on/off}$ = 0.0 V	— —	$V_{on/off}$ $I_{on/off}$	0 —	— —	— —	V mA

Logic High (ON/OFF pin open):
    At $I_{on/off}$ = 0.0 µA
    Leakage Current
	—
	—
		$V_{on/off}$
		$I_{on/off}$
			—
			—
				—
				—
					—
					—
						V
						µA

Turn-on Time (See Figure 8.) (I_O = 80% of $I_{O, max}$; V_O within ±1% of steady state)	—	—	20	—	60*	ms
Output Voltage Overshoot	All	—	—	0	5	%
Output Voltage Adjustment (See Feature Descriptions.): Output Voltage Set-point Adjustment Range (trim)	—	—	70	—	110	%$V_{O, nom}$
Set-point Accuracy with Trim	All	—	−2.5	—	3.0	%
Output Overvoltage Shutdown for V_{O1}	All	V_{O1}	5.55*	6.00	6.15*	V
Output Overvoltage Clamp for V_{O2} and V_{O3}	JW060ABK JW060ACL	V_{O2}, V_{O3} V_{O2}, V_{O3}	— —	— —	17.0* 20.0*	V V
Overtemperature Threshold	All	T_C	100	105	—	°C

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

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Characteristic Curves

The following figures provide typical characteristics for the JW060ABK and JW060ACL power modules. The figures are identical for both on/off configurations.
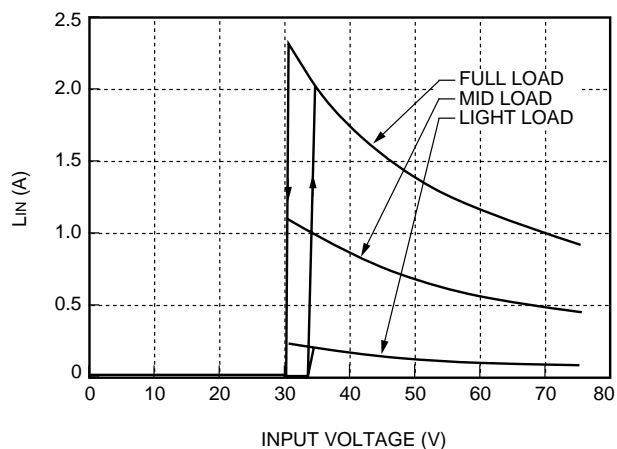
Figure 1. Typical JW060xxx Input Characteristics at Room Temperature, I_O = Full Load
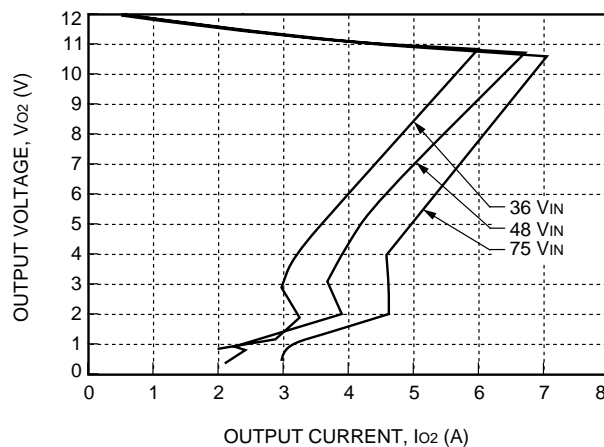
Figure 3. Typical JW060ABK V_{O2} Characteristics at Room Temperature, V_{IN} = 48 V, I_{O1} = 0.5 A, I_{O3} = 0.3 A
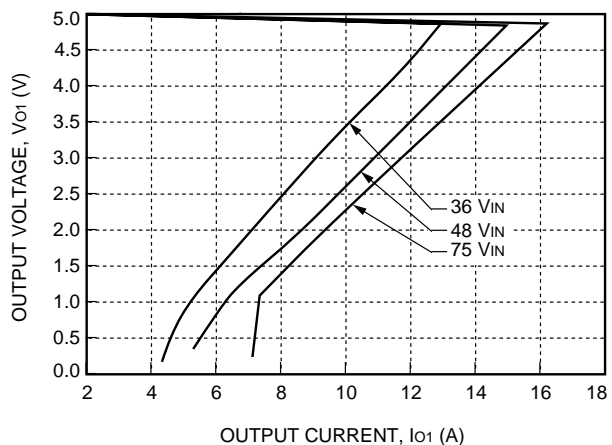
Figure 2. Typical JW060ABK V_{O1} Characteristics at Room Temperature, V_{IN} = 48 V, I_{O2} = I_{O3} = 0.3 A
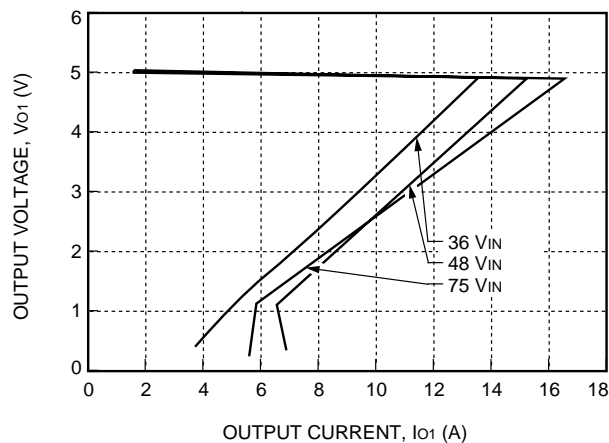
Figure 4. Typical JW060ACL V_{O1} Characteristics at Room Temperature, V_{IN} = 48 V, I_{O2} = I_{O3} = 0.2 A

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Characteristic Curves (continued)
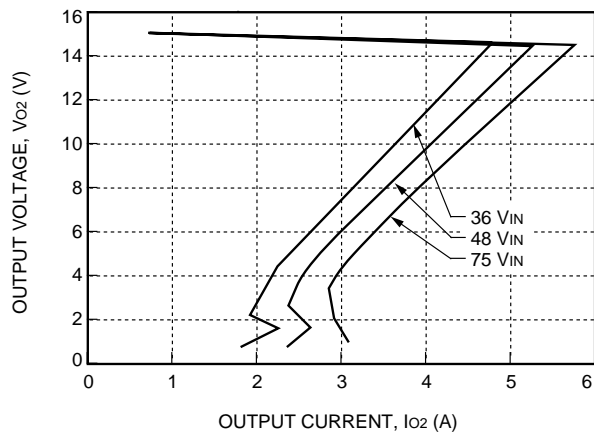
8-1532 (C)

Figure 5. Typical JW060ACL V_{O2} Characteristics at Room Temperature, V_{IN} = 48 V, I_{O1} = 0.5 A, I_{O3} = 0.2 A
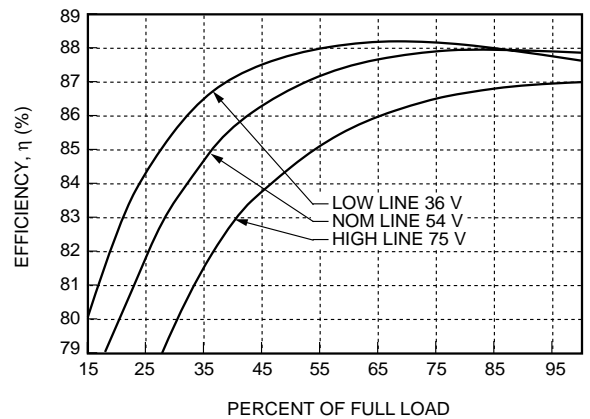
8-1514 (C)

Figure 7. Typical JW060ACL Converter Efficiency vs. Output Current at Room Temperature
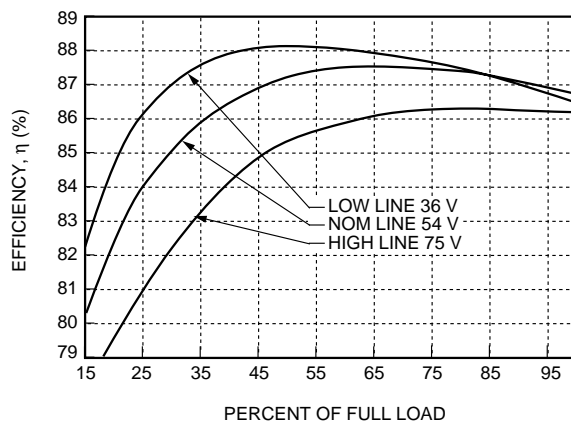
8-1513 (C)

Figure 6. Typical JW060ABK Converter Efficiency vs. Output Current at Room Temperature
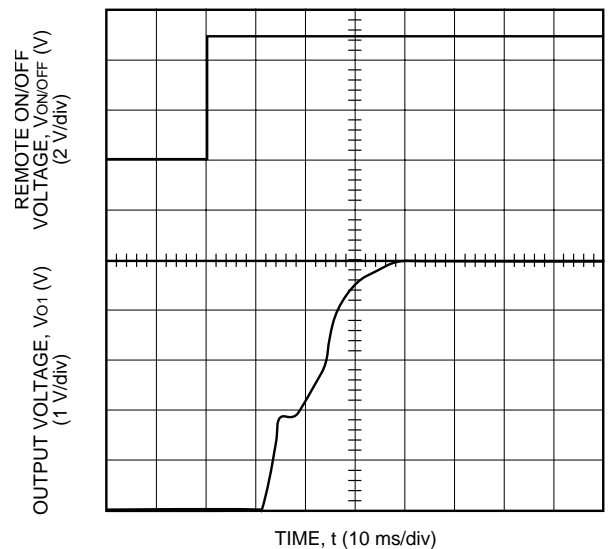
8-1515 (C)

Figure 8. Typical Start-Up from Remote On/Off JW060xxx; Full Load

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Characteristic Curves (continued)
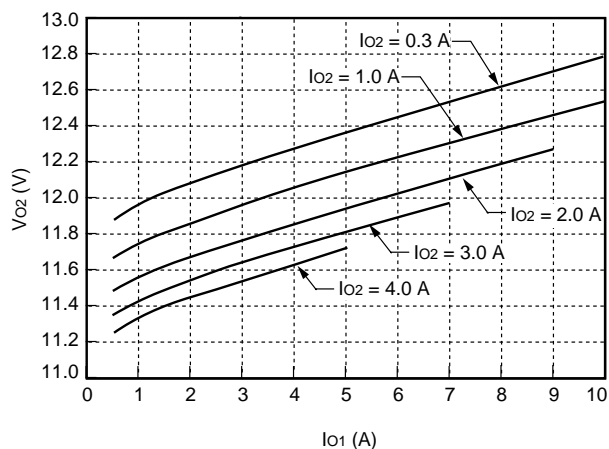
8-1516 (C)

Figure 9. Typical JW060ABK V_{O2} Load Regulation for $I_{O3, min} \leq I_{O3} \leq I_{O3, max}$
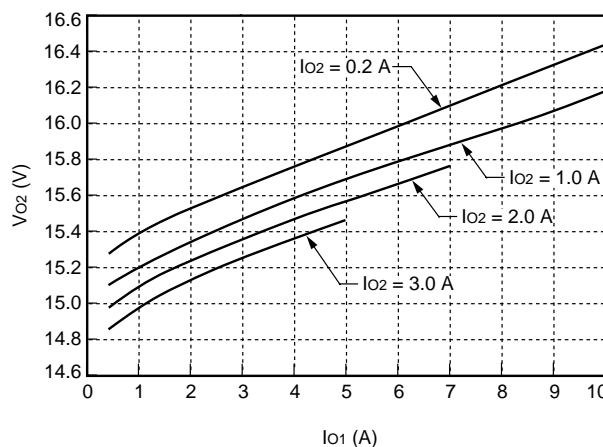
8-1533 (C)

Figure 11. Typical JW060ACL V_{O2} Load Regulation for $I_{O3, min} \leq I_{O3} \leq I_{O3, max}$
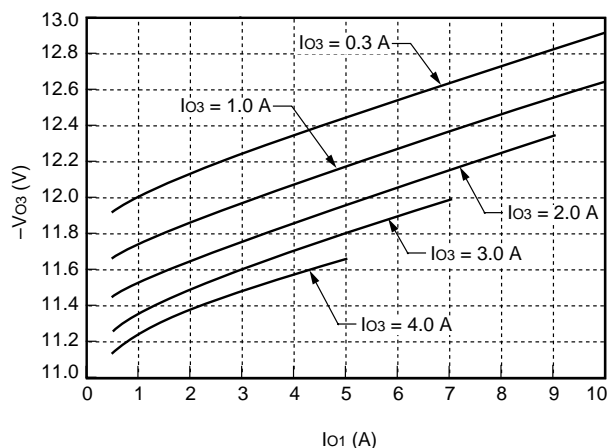
8-1517 (C)

Figure 10. Typical JW060ABK V_{O3} Load Regulation for $I_{O2, min} \leq I_{O2} \leq I_{O2, max}$
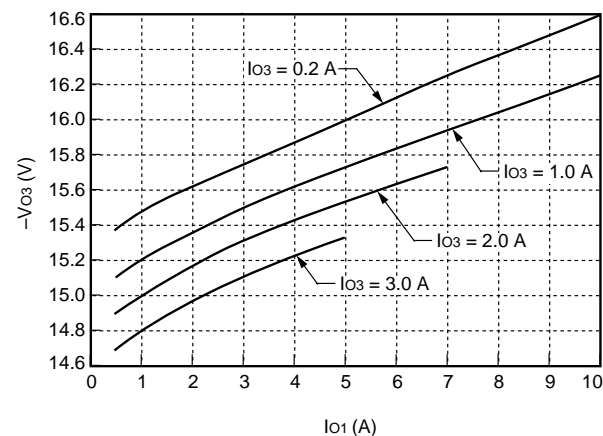
8-1534 (C)

Figure 12. Typical JW060ACL V_{O3} Load Regulation for $I_{O2, min} \leq I_{O2} \leq I_{O2, max}$

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Test Configurations

8-203 (C).l
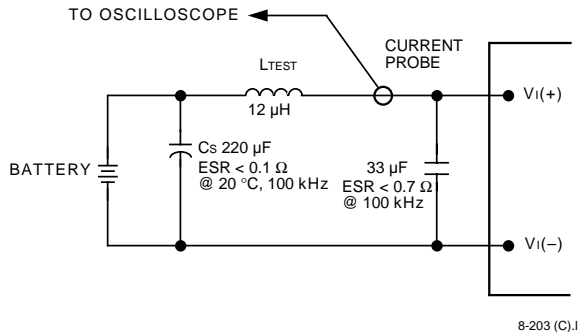
Note: Input reflected-ripple current is measured with a simulated source inductance (LTEST) of 12 µH. Capacitor CS offsets possible battery impedance. Current is measured at the input of the module.

Figure 13. Input Reflected-Ripple Test Setup

8-811.b (C)
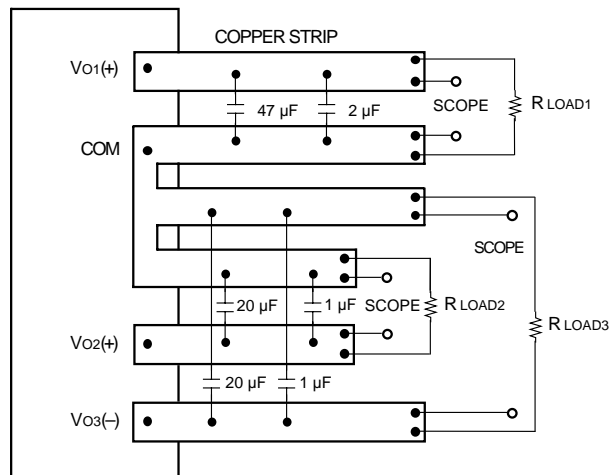
Note: Use the specified tantalum (larger value) and ceramic capacitors across each output. Scope measurement should be made by using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from the module.

Figure 14. Output Noise Measurement Test Setup

8-749 (C).e
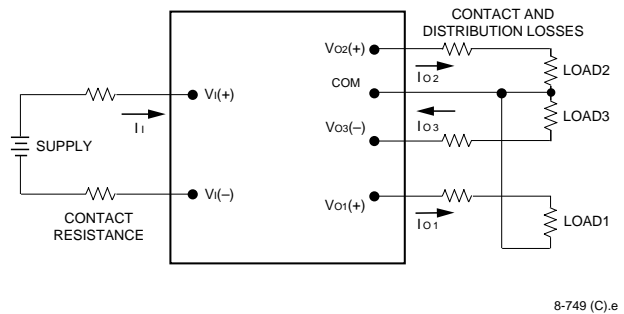
Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

$$\eta = \left(\frac{[V_{O1}(+) - V_{COM}]I_{O1} + [V_{O2}(+) - V_{COM}]I_{O2} - [V_{O3}(-) - V_{COM}]I_{O3}}{[V_I(+) - V_I(-)]I_I} \right) \times 100$$

Figure 15. Triple-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 13, a 33 µF electrolytic capacitor (ESR < 0.7 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.

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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* 22.2-950, and EN60950.

For the converter output to be considered meeting the requirements of safety extra-low voltage (SELV), one of the following must be true:

■ All inputs are SELV and floating, with the output also floating.

■ All inputs are SELV and grounded, with the output also grounded.

■ Any non-SELV input must be provided with reinforced insulation from any other hazardous voltages, including the ac mains, and must have a SELV reliability test performed on it in combination with the converters. Inputs must meet SELV requirements.

If the input meets extra-low voltage (ELV) requirements, then the converter's output is considered ELV.

The input to these units is to be provided with a maximum 20 A normal-blow fuse in the ungrounded lead.

Assembly Considerations

The power module is not encapsulated. It is designed to be mounted to the printed-wiring board (PWB) after the assembly cleaning process.

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 exhibits foldback characteristics (output current decrease). The unit operates normally once the overload condition is removed.

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.

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 16). 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 is 50 µA. It is not recommended to drive the ON/OFF pin with an external source; however, if one is used, current into the pin must not exceed 1 mA.

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

■ For negative logic, short ON/OFF pin to $V_I(-)$.

■ For positive logic, leave ON/OFF pin open.
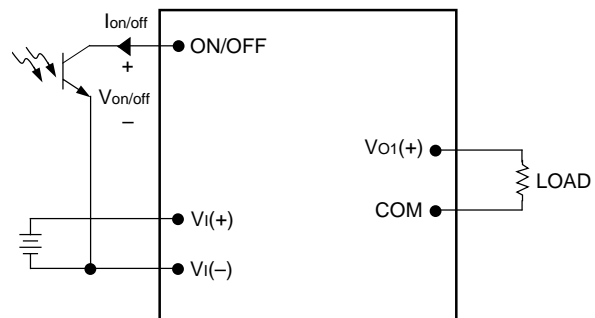
8-720 (C).g

Figure 16. Remote On/Off Implementation

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**JW060 Triple-Output Series Power Modules: dc-dc Converters;
36 to 75 Vdc Input, 5 and ±12 Vdc, or 5 and ±15 Vdc Outputs; 60 W**

Feature Descriptions (continued)

Output Voltage Set-Point Adjustment (Trim)

Output voltage trim allows the user to increase or decrease the output voltage set points of all outputs simultaneously. This is accomplished by connecting an external resistor between the TRIM pin and either the $V_{O1}(+)$ or COM pins. With an external resistor between the TRIM and COM pins ($R_{adj-down}$), the output voltage set points decrease (see Figure 17). The following equation, plotted in Figure 18, gives the required external-resistor value to lower the output voltages by a percentage ($\Delta\%$).

$$R_{adj-down} = 10,000\left(\frac{100}{\Delta\%} - 2\right)\ \Omega$$

With an external resistor connected between the TRIM and $V_{O1}(+)$ pins (R_{adj-up}), the output voltage set points increase (see Figure 19).

The following equation, plotted in Figure 20, gives the required external-resistor value to raise the output voltages by a percentage ($\Delta\%$).

$$R_{adj-up} = 10,000\left[\left(\frac{V_{O1, nom}}{1.225} - 1\right)\left(\frac{100}{\Delta\%} + 1\right) - 1\right]\ \Omega$$

The voltage between the $V_{O1}(+)$ and COM terminals must not exceed the minimum output overvoltage shutdown voltage as indicated in the Feature Specifications table.

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

8-1536 (C)

Figure 18. Resistor Selection for Decreased Output Voltage
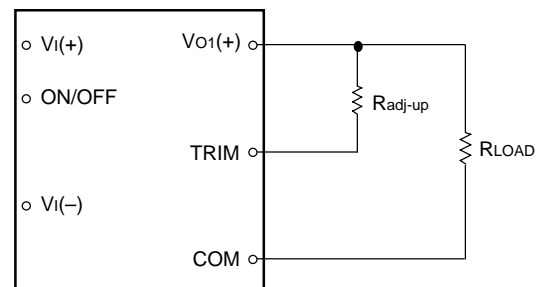
8-715 (C).f

Figure 19. Circuit Configuration to Increase Output Voltage

8-748 (C).d

Figure 17. Circuit Configuration to Decrease Output Voltage

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Feature Descriptions (continued)

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

8-1535 (C)
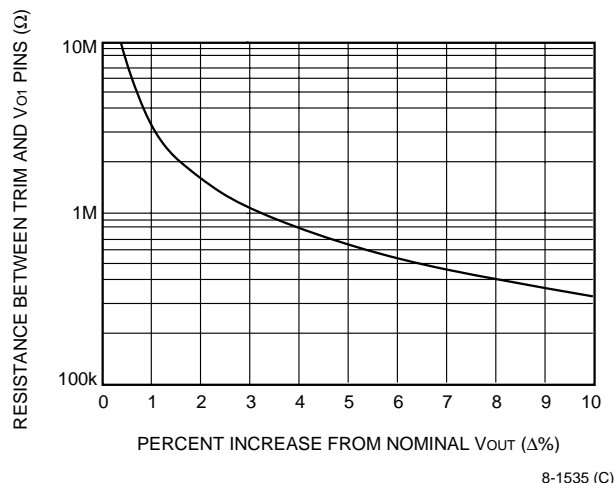
Figure 20. Resistor Selection for Increased Output Voltage

Output Overvoltage Protection

The output overvoltage clamp consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the overvoltage protection threshold, then the module will shut down and attempt to restart periodically.

Overtemperature Protection

To provide protection in a fault condition, the unit is equipped with a temperature limiting circuit. This circuit will not engage unless the unit is operated above the absolute maximum temperature limit. When active, the overtemperature circuit lowers all output voltages sufficiently to prevent exceeding the overtemperature threshold. Recovery from the temperature limit is automatic after the unit cools below the overtemperature threshold.

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 metal baseplate. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the metal baseplate temperature. Peak temperature (T_C) occurs at the position indicated in Figure 21.
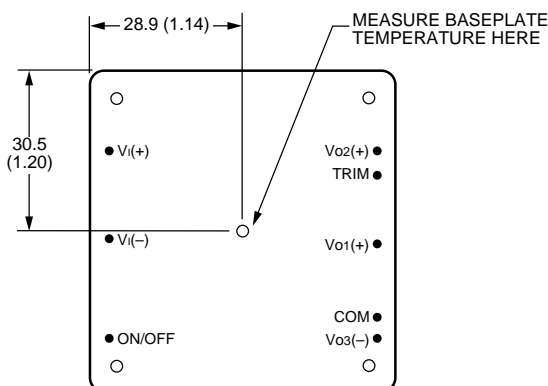
8-716 (C).g

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

Figure 21. Case Temperature Measurement Location

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.

Thermal performance of the module varies with the direction of airflow, assumed to be parallel to one edge of the baseplate. The best orientation has air entering the side with input pins, and the second best orientation has air entering the side closest to the ON/OFF and $V_{O3}(-)$ pins.

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Thermal Considerations (continued)

Introduction (continued)

Total power dissipation for the modules at 48 V input is given by Figure 24 and Figure 25. Power dissipation at 36 V input is approximately 0.3 W higher than shown for 48 V input, and power dissipation at 75 V input is approximately 0.6 W higher than shown for 48 V input.

Heat Transfer Without Heat Sinks

Increasing airflow over the module enhances the heat transfer via convection. Figure 22 shows the maximum power that can be dissipated by the module without exceeding the maximum base plate temperature versus local ambient temperature (T_A), for natural convection through 4 m/s (800 ft./min.) in transverse (better) orientation, where the air flows parallel to the shorter side.

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 22 and Figure 23 is shown in the following example.

Example

What is the minimum airflow necessary for a JW060ABK operating at nominal line, an output current of 9 A on 5 V, 1.25 A on +12 V, and 0 A on −12 V, and a maximum ambient temperature of 50 °C?

Solution

Given: V_I = 54 V
       I_{O1} @5 V = 9 A
       I_{O2} @ +12 V = 1.25 A
       I_{O3} @ −12 V = 0 A
      T_A = 50 °C

Determine P_D (Use Figure 24.):

    P_D = 11.5 W

Determine airflow 1 (v) (Use Figure 22.):

    v = 0.75 m/s (150 ft./min.)

Determine airflow 2 (v) (Use Figure 23.):

    v = 0.9 m/s (180 ft./min.)
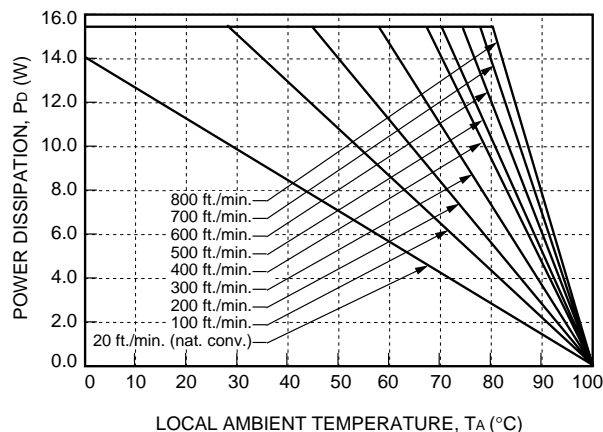
8-1509 (C)

Figure 22. Forced Convection Power Derating with No Heat Sink; Transverse Orientation
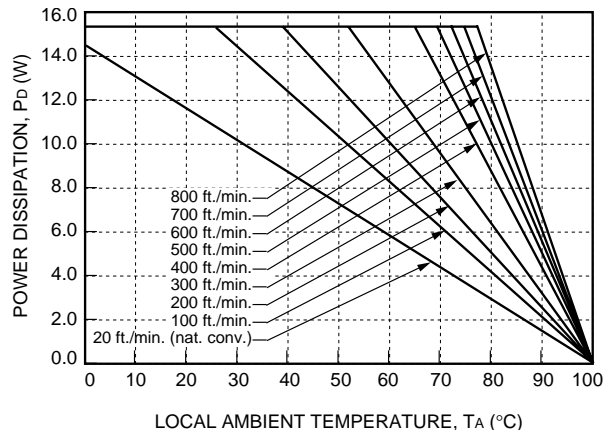
8-1510 (C)

Figure 23. Forced Convection Power Derating with No Heat Sink; Longitudinal Orientation

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Thermal Considerations (continued)

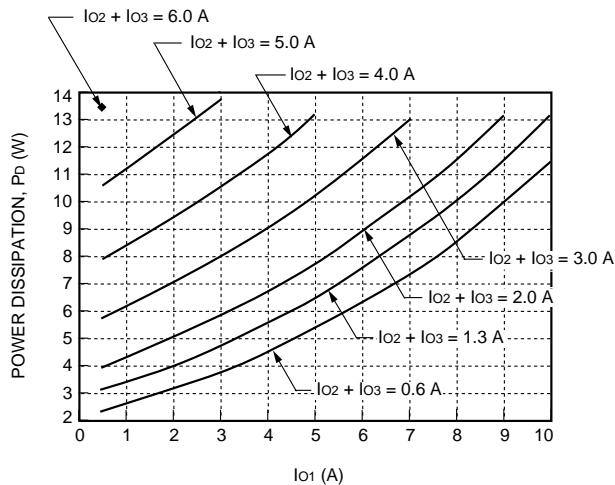### Heat Transfer Without Heat Sinks (continued)

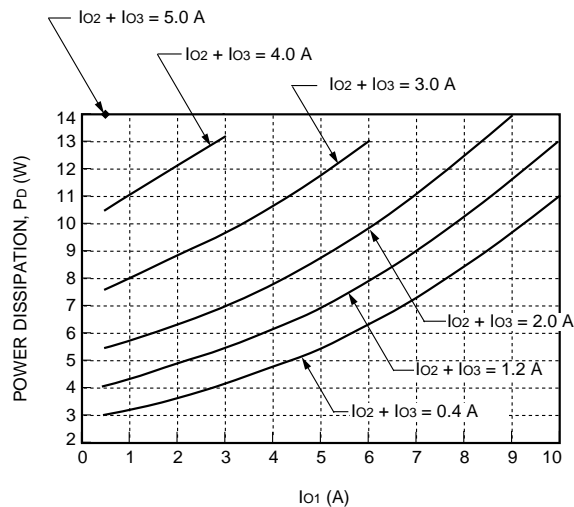**Figure 24. JW060ABK Power Dissipation vs. Output Current for V_I = 48 V**

Figure 25. JW060ACL Power Dissipation vs. Output Current for V_I = 48 V

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.). 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.-lb.).

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 21. Case-to-ambient thermal resistance vs. airflow is shown, for various heat sink configurations and heights, in Figure 26. These curves were obtained by experimental testing of heat sinks, which are offered in the product catalog.
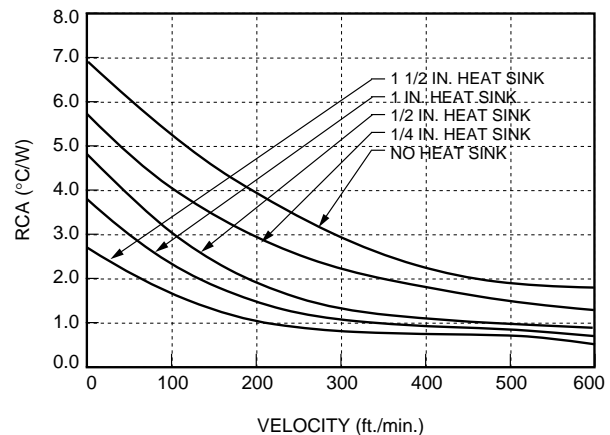
Figure 26. Case-to-Ambient Thermal Resistance Curves; Either Orientation

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 Figure 26 had a thermal-conductive dry pad between the case and the heat sink to minimize contact resistance. The use of Figure 26 is shown in the following example.

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Thermal Considerations (continued)

Heat Transfer with Heat Sinks (continued)

Example

If an 85 °C case temperature is desired, what is the minimum airflow necessary? Assume the JW060ABK module is operating at nominal line and an output current of 9 A on 5 V, 1.25 A on +12 V, and 0 A on −12 V, maximum ambient air temperature of 40 °C, and a heat sink that is 0.25 inches.

Solution

Given: V_I = 54 V
I_{O1} @ 5 V = 9 A
I_{O2} @ +12 V = 1.25 A
I_{O3} @ −12 V = 0 A
T_A = 40 °C
T_C = 85 °C
Heat sink = 0.25 in.

Determine P_D by using Figure 24:

P_D = 11.5 W

Then solve the following equation:

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

$$\theta ca = \left[\frac{(85 - 40)}{11.5}\right]$$

$$\theta ca = 3.9 \text{ °C/W}$$

Use Figure 26 to determine air velocity for the 0.25 inch heat sink.

The minimum airflow necessary for the JW060ABK module is 0.6 m/s (110 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 (θcs) and sink-to-ambient (θsa) shown below (Figure 27).
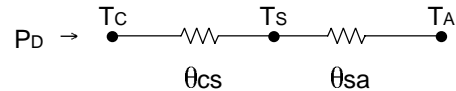
8-1304 (C)

Figure 27. Resistance from Case-to-Sink and Sink-to-Ambient

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.

Layout Considerations

Copper paths must not be routed beneath the power module mounting inserts, which are conductive and connected together electrically. Furthermore, it is not recommended that any copper paths be routed underneath or near the power module because they are likely to pick up noise from the module.
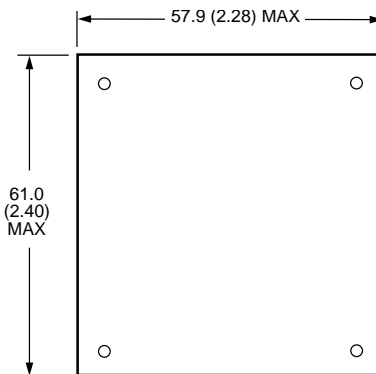
For improved EMI performance, follow the layout guidelines given in data sheet DS97-053EPS for the FLTR100V10 filter module, or data sheet DS96-215EPS for the FLTR100V20 filter module. For best EMI performance, use either of these filter modules at the input of one or more power modules.

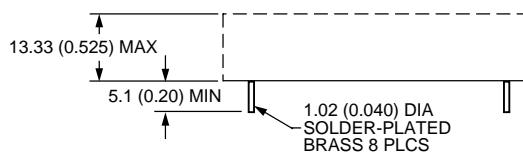**JW060 Triple-Output Series Power Modules: dc-dc Converters;**
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Outline Diagram

Dimensions are in millimeters and (inches).

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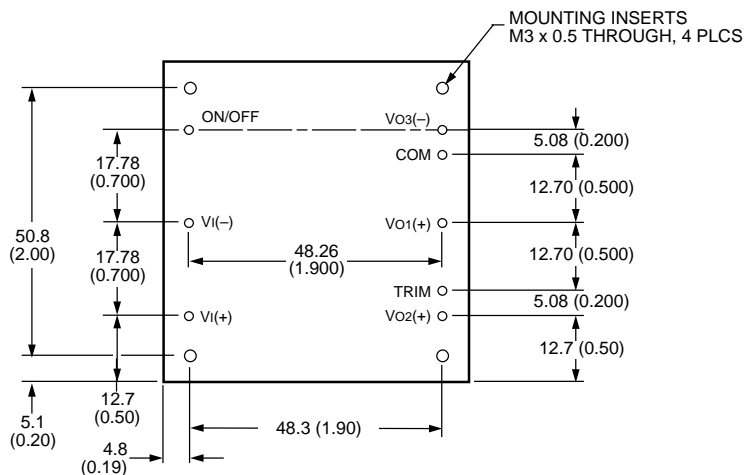   x.xx mm ± 0.25 mm (x.xxx in. ± 0.010 in.)

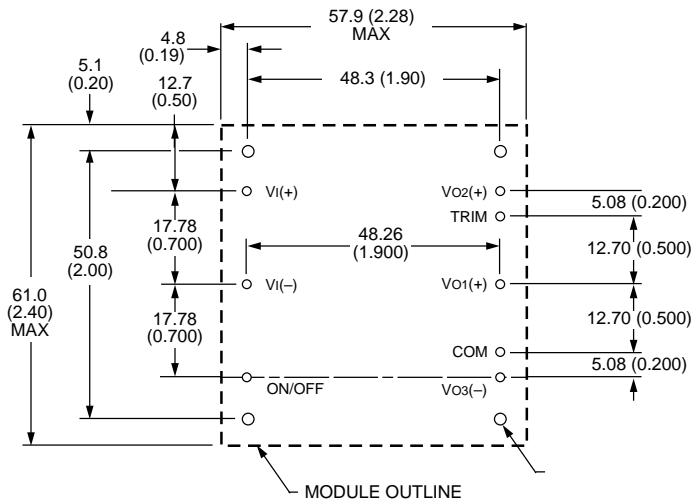**Top View**

Side View

Bottom View

8-1190 (C).d

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JW060 Triple-Output Series Power Modules: dc-dc Converters;
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Recommended Hole Pattern

Component-side footprint.

Dimensions are in millimeters and (inches).

MODULE OUTLINE

8-1190 (C).d

Ordering Information

Input Voltage	Output Voltage	Output Power	Remote On/Off Logic	Device Code	Comcode
36 V—75 V	+5 V, ±12 V	60 W	positive	JW060ABK	107880296
36 V—75 V	+5 V, ±15 V	60 W	positive	JW060ACL	107880312
36 V—75 V	+5 V, ±12 V	60 W	negative	JW060ABK1	108237124
36 V—75 V	+5 V, ±15 V	60 W	negative	JW060ACL1	108237108

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