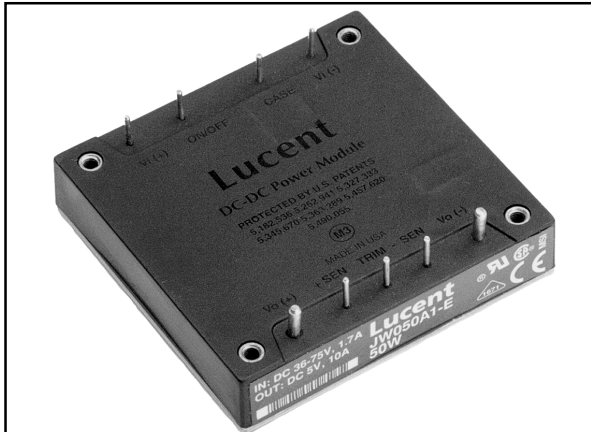**Lucent Technologies**
Bell Labs Innovations

JW050A1-E and JW075A1-E Power Modules:
dc-dc Converters; 36 to 75 Vdc Input, 5 Vdc Output; 50 W to 75 W

The JW050A1-E and JW075A1-E Power Modules use advanced, surface-mount technology and deliver high-quality, efficient, and compact dc-dc conversion.

Applications

- Distributed power architectures
- Workstations
- EDP equipment
- 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 12.7 mm (2.40 in. x 2.28 in. x 0.50 in.)
- High power density
- High efficiency: 83% typical
- Low output noise
- Constant frequency
- Industry-standard pinout
- Metal baseplate
- 2:1 input voltage range
- Remote sense
- Remote on/off
- Adjustable output voltage
- Case ground pin
- *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 JW050A1-E and JW075A1-E Power Modules are dc-dc converters that operate over an input voltage range of 36 Vdc to 75 Vdc and provide a precisely 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 50 W to 75 W at a typical full-load efficiency of 83%.

The modules offer a metal baseplate for excellent 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.

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	V_I	—	75	Vdc
I/O Isolation Voltage	—	—	1500	Vdc
Operating Case Temperature (See Thermal Considerations section.)	T_C	0	85	°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_O = $I_{O, max}$): JW050Ax-E (See Figure 1.) JW075Ax-E (See Figure 2.)	$I_{I, max}$ $I_{I, max}$	— —	— —	2.0 3.0	A A
Inrush Transient	i^2t	—	—	1.0	A^2s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 µH source impedance; see Figure 10.)	—	—	10	—	mAp-p
Input Ripple Rejection (120 Hz)	—	—	60	—	dB

Fusing Considerations

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

This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of a sophisticated power architecture. To preserve maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a normal-blow, 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 (Over all operating input voltage, resistive load, and temperature conditions until end of life. See Figure 12.)	All	V_O	4.85	—	5.15	Vdc
Output Voltage Set Point ($V_I = 48$ V; $I_O = I_{O, max}$; $T_C = 25$ °C)	All	$V_{O, set}$	4.92	5.0	5.08	Vdc

Output Regulation:
  Line ($V_I = 36$ V to 75 V)
  Load ($I_O = I_{O, min}$ to $I_{O, max}$)
  Temperature ($T_C = -40$ °C to +100 °C)
	All
	All
	All
		—
		—
		—
			—
			—
			—
				0.01
				0.05
				15
					0.1
					0.2
					50
						%
						%
						mV

Output Ripple and Noise Voltage
(See Figure 10.):
  RMS
  Peak-to-peak (5 Hz to 20 MHz)
	
	All
	All
		
		—
		—
			
			—
			—
				
				—
				—
					
					100
					150
						
						mVrms
						mVp-p

External Load Capacitance (electrolytic)	All	—	0	—	10,000	µF
Output Current (At $I_O < I_{O, min}$, the modules may exceed output ripple specifications.)	JW050Ax-E JW075Ax-E	I_O I_O	0.5 0.5	— —	10 15	A A
Output Current-limit Inception ($V_O = 90$% of $V_{O, nom}$)	JW050Ax-E JW075Ax-E	$I_{O, cli}$ $I_{O, cli}$	— —	12.0 18.0	14 21	A A
Output Short-circuit Current ($V_O = 250$ mV)	All	—	—	170	—	%$I_{O, max}$
Efficiency ($V_I = 48$ V; $I_O = I_{O, max}$; $T_C = 70$ °C)	JW050Ax-E JW075Ax-E	η η	— —	83 83	— —	% %

Dynamic Response
($\Delta I_O/\Delta t = 1$ A/10 µs, $V_I = 48$ V, $T_C = 25$ °C):
  Load Change from $I_O = 50$% to 75% of $I_{O, max}$:
    Peak Deviation
    Settling Time ($V_O < 10$% of peak deviation)
  Load Change from $I_O = 50$% to 25% of $I_{O, max}$:
    Peak Deviation
    Settling Time ($V_O < 10$% of peak deviation)
	
	All
	All
	
	All
	All
		
		—
		—
		
		—
		—
			
			—
			—
			
			—
			—
				
				3
				300
				
				3
				300
					
					—
					—
					
					—
					—
						
						%$V_{O, set}$
						µs
						
						%$V_{O, set}$
						µs

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 °C)	1,000,000	—	—	hr.
Weight	—	—	67 (2.3)	g (oz.)

Feature Specifications

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

Parameter	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 13 and Feature Descriptions.): JWxxxA1-E Preferred Logic: Logic Low—Module On Logic High—Module Off JWxxxA-E Optional Logic: Logic Low—Module Off Logic High—Module On Logic Low:					
At $I_{on/off}$ = 1.0 mA	$V_{on/off}$	0	—	1.2	V
At $V_{on/off}$ = 0.0 V	$I_{on/off}$	—	—	1.0	mA
Logic High:					
At $I_{on/off}$ = 0.0 μA	$V_{on/off}$	—	—	15	V
Leakage Current	$I_{on/off}$	—	—	50	μA
Turn-on Time (See Figure 9.) (I_O = 80% of $I_{O, max}$; V_O within ±1% of steady state)	—	—	20	35	ms
Output Voltage Adjustment (See Feature Descriptions.): Output Voltage Remote-sense Range	—	—	—	0.5	V
Output Voltage Set-point Adjustment Range (trim)	—	90	—	110	%$V_{O, nom}$
Output Overvoltage Clamp	$V_{O, clamp}$	5.6	—	7.0	V

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Characteristic Curves

The following figures provide typical characteristics for the JW050Ax-E and JW075Ax-E power modules. The figures are identical for both on/off configurations.
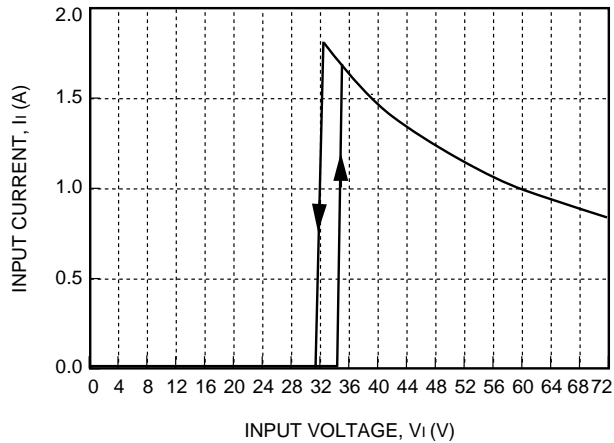
8-1159 (C)

Figure 1. Typical JW050Ax-E Input Characteristics at Room Temperature, I$_O$ = 10 A
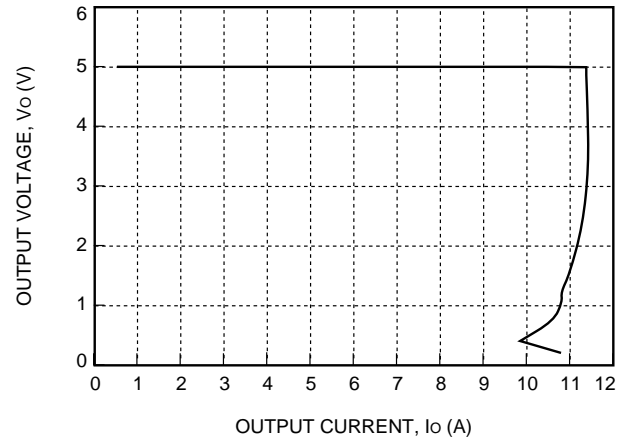
8-1165 (C)

Figure 3. Typical JW050Ax-E Output Characteristics at Room Temperature, V$_{IN}$ = 48 V
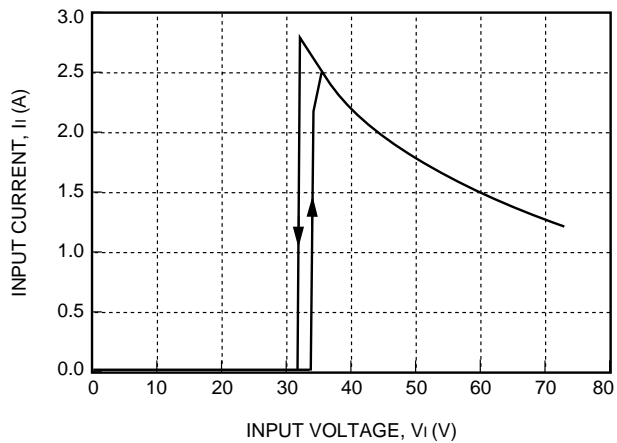
8-1131 (C)

Figure 2. Typical JW075Ax-E Input Characteristics at Room Temperature, I$_O$ = 15 A
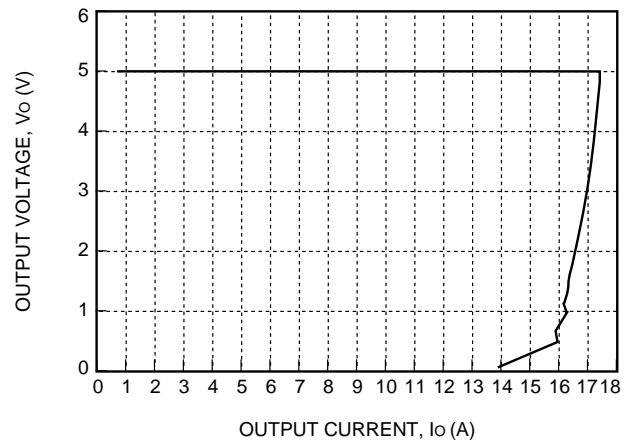
8-1134 (C)

Figure 4. Typical JW075Ax-E Output Characteristics at Room Temperature, V$_{IN}$ = 48 V

Characteristic Curves (continued)
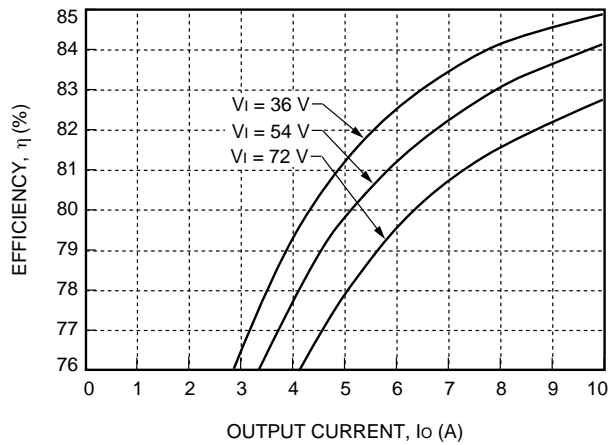
8-1161 (C)

Figure 5. Typical JW050Ax-E Converter Efficiency vs. Output Current at Room Temperature
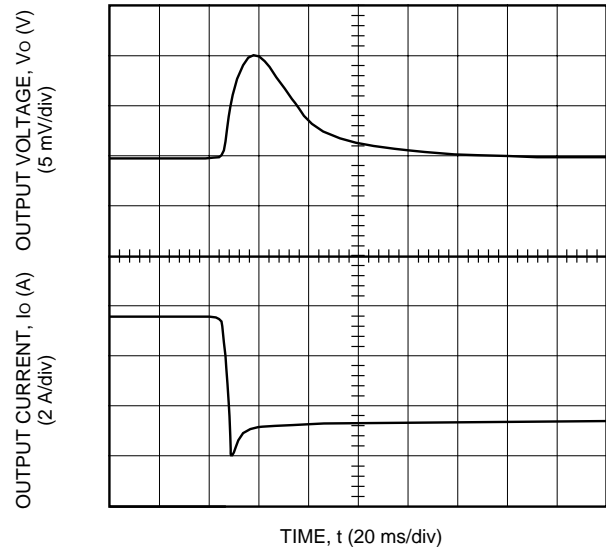
8-1963 (C)

Figure 7. Typical JW075Ax-E Transient Response to Step Decrease in Load from 50% to 25% of Full Load at Room Temperature and 48 V Input (Waveform Averaged to Eliminate Ripple Component.)
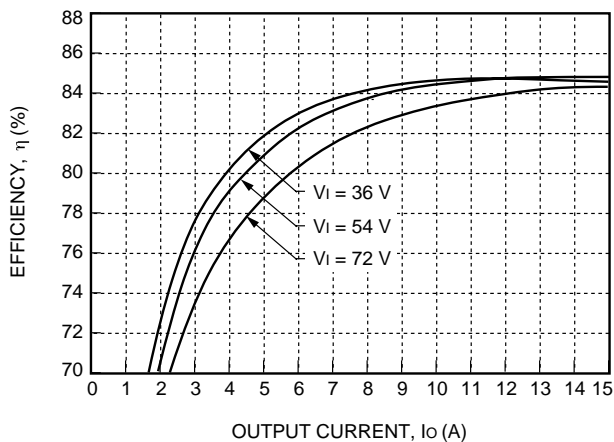
8-1132 (C)

Figure 6. Typical JW075Ax-E Converter Efficiency vs. Output Current at Room Temperature

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Characteristic Curves (continued)

TIME, t (20 ms/div)

8-1964 (C)
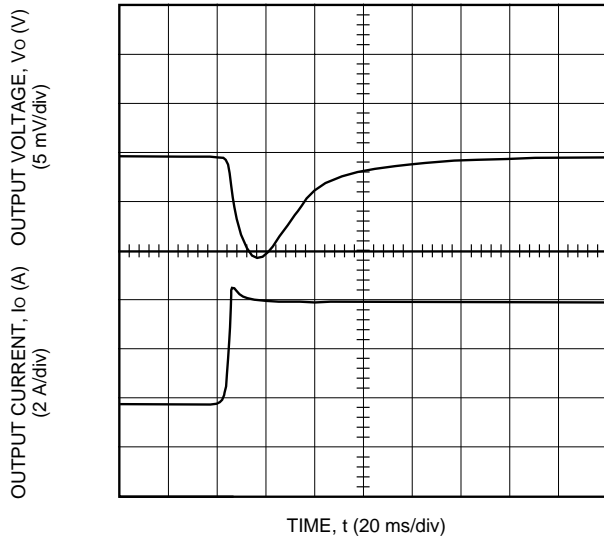
Figure 8. Typical JW075Ax-E Transient Response to Step Increase in Load from 50% to 75% of Full Load at Room Temperature and 48 V Input (Waveform Averaged to Eliminate Ripple Component.)

TIME, t (2 ms/div)

8-1143 (C)
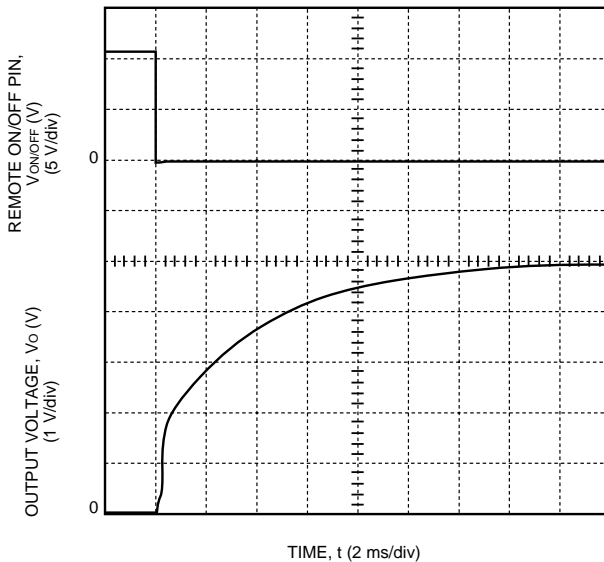
Figure 9. Typical Start-Up from Remote On/Off JW075A1-E; I_O = Full Load

Test Configurations

8-203 (C).l
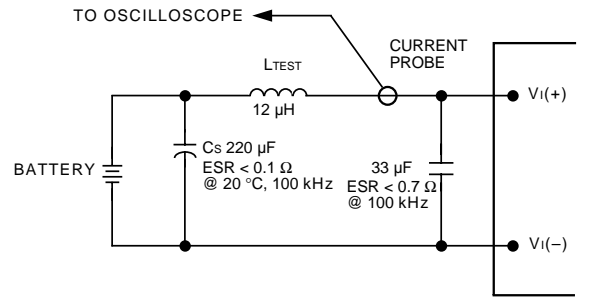
Note: Measure input reflected-ripple current with a simulated source inductance (L_{TEST}) of 12 μH. Capacitor C_S offsets possible battery impedance. Measure current as shown above.

Figure 10. Input Reflected-Ripple Test Setup

8-513 (C).d
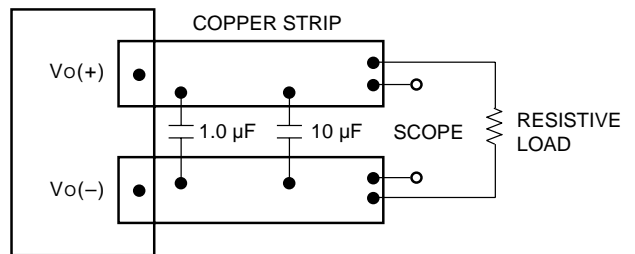
Note: Use a 1.0 μF ceramic capacitor and a 10 μF aluminum or tantalum capacitor. Scope measurement should be made using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from the module.

Figure 11. Peak-to-Peak Output Noise Measurement Test Setup

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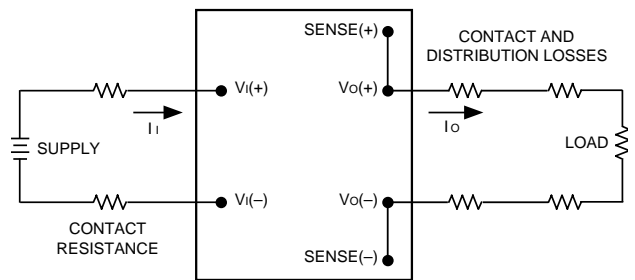
Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

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

Figure 12. 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 10, 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.

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.

Electrical Descriptions

Current Limit

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

Feature Descriptions

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 (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 13). 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.
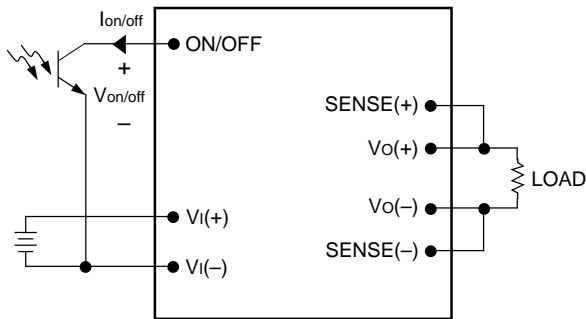
During a logic high, the maximum $V_{on/off}$ generated by the power module is 15 V. The maximum allowable leakage current of the switch at $V_{on/off}$ = 15 V is 50 µA.

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.

Feature Descriptions (continued)

Remote On/Off (continued)

8-720 (C).c

**Figure 13. Remote On/Off Implementation**

Remote Sense

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

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

The voltage between the $V_O(+)$ and $V_O(-)$ terminals must not exceed 5.6 V. This limit includes any increase in voltage due to remote-sense compensation and output voltage set-point adjustment (trim). See Figure 14.

If not using the remote-sense feature to regulate the output at the point of load, then connect SENSE(+) to $V_O(+)$ and SENSE(−) to $V_O(-)$ at the module.
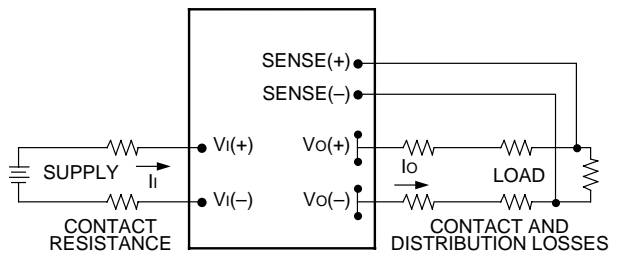
8-651 (C).m

Figure 14. 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 ($R_{adj-down}$), the output voltage set point ($V_{O, adj}$) decreases (see Figure 15). The following equation determines the required external-resistor value to obtain a percentage output voltage change of $\Delta\%$.

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

The test results for this configuration are displayed in Figure 16. This figure applies to all output voltages.

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

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

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

The test results for this configuration are displayed in Figure 18.

The voltage between the $V_O(+)$ and $V_O(-)$ terminals must not exceed 5.6 V. This limit includes any increase in voltage due to remote-sense compensation and output voltage set-point adjustment (trim). See Figure 14.

If not using the trim feature, leave the TRIM pin open.
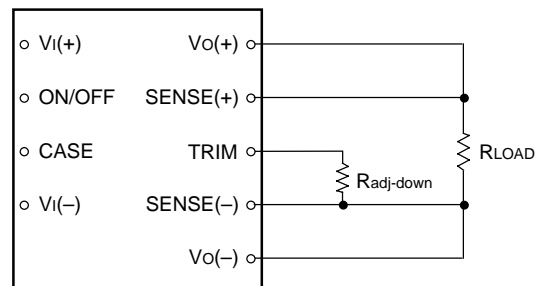
8-748 (C).b

Figure 15. Circuit Configuration to Decrease
Output Voltage

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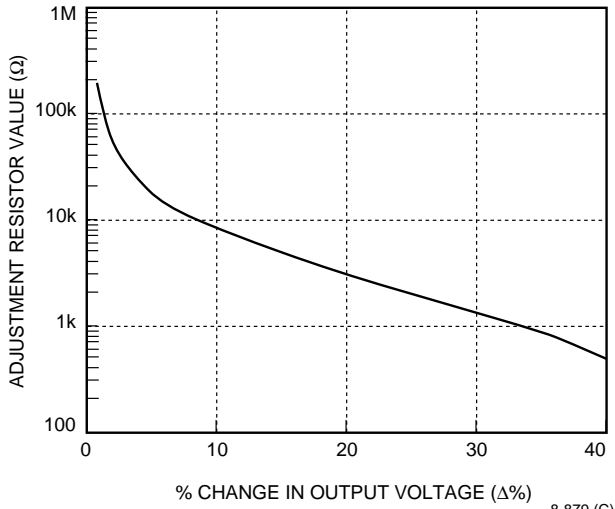
Output Voltage Set-Point Adjustment (Trim)
(continued)

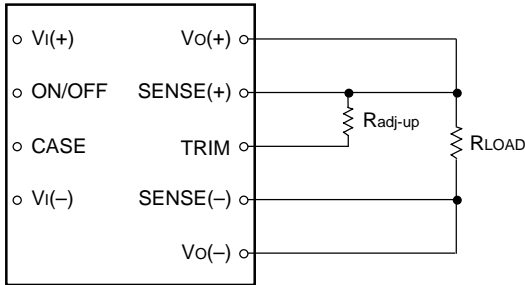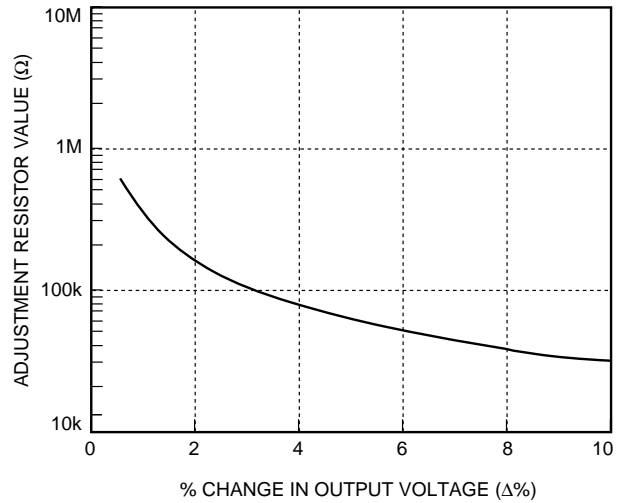**Figure 16. Resistor Selection for Decreased Output Voltage**

Figure 17. Circuit Configuration to Increase Output Voltage

Figure 18. Resistor Selection for Increased Output Voltage

Output Overvoltage Clamp

The output overvoltage clamp consists of control cir-
cuitry, independent of the primary regulation loop, that
monitors the voltage on the output terminals. The con-
trol 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

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 ther-
mally coupled to the case. Heat is removed by conduc-
tion, convection, and radiation to the surrounding
environment. Proper cooling can be verified by mea-
suring the case temperature. Peak temperature (T_C)
occurs at the position indicated in Figure 19.

Thermal Considerations (continued)

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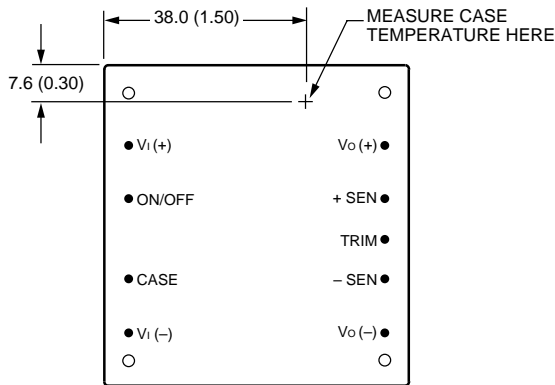
Note: Top view, pin locations are for reference.
Measurements shown in millimeters and (inches).

Figure 19. Case Temperature Measurement Location

The temperature at this location should not exceed 85 °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 85 °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. Figure 20 shows 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 3 m/s (600 ft./min.).

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 20 is shown in the following example.

Example

What is the minimum airflow necessary for a JW075A1-E operating at nominal line, an output current of 15 A, and a maximum ambient temperature of 40 °C?
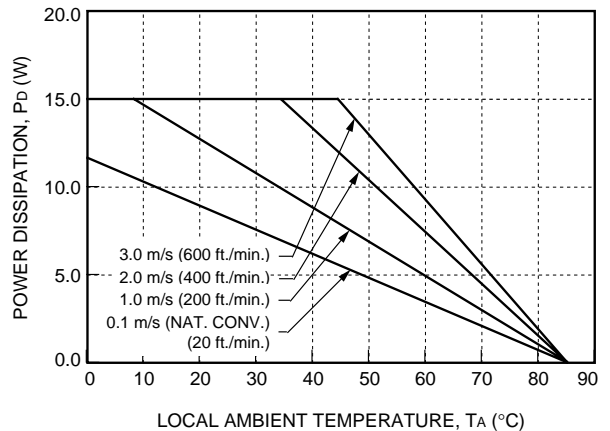
Solution

Given: V_I = 54 V
I_O = 15 A
T_A = 40 °C

Determine P_D (Use Figure 22.):

P_D = 13 W

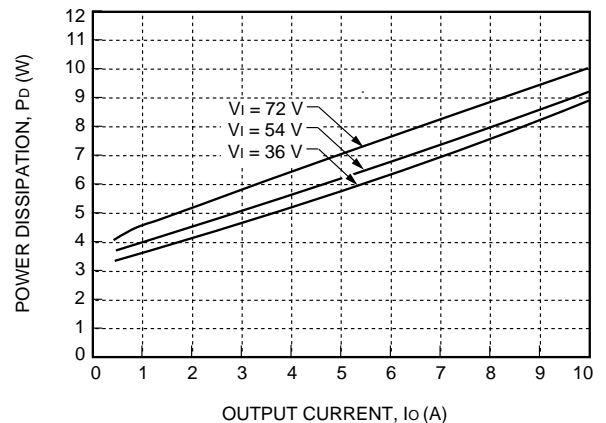Determine airflow (v) (Use Figure 20.):

v = 2.3 m/s (450 ft./min.)

Figure 20. Forced Convection Power Derating with No Heat Sink; Either Orientation

Figure 21. JW050A1-E Power Dissipation vs. Output Current

Thermal Considerations (continued)
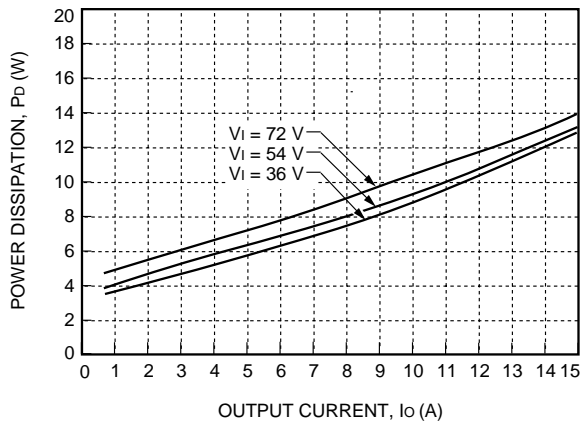
Heat Transfer Without Heat Sinks (continued)

**Figure 22. JW075Ax-E Power Dissipation vs. Output Current**

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 (θ_{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 19. Case-to-ambient thermal resistance vs. airflow is shown, for various heat sink configurations and heights, in Figure 23. These curves were obtained by experimental testing of heat sinks, which are offered in the product catalog.

AIR VELOCITY MEASURED IN m/s (ft./min.)
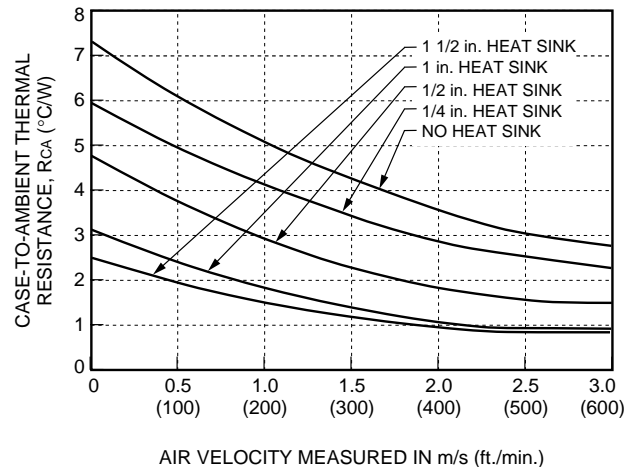
8-1761 (C)

Figure 23. 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 23 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.

Thermal Considerations (continued)

Heat Transfer with Heat Sinks (continued)

Example

If an 70 °C case temperature is desired, what is the minimum airflow necessary? Assume the JW075A1-E module is operating at nominal line and an output current of 15 A, maximum ambient air temperature of 40 °C, and the heat sink is 0.5 in.

Solution

Given: $V_I = 54$ V
$I_O = 15$ A
$T_A = 40$ °C
$T_C = 70$ °C
Heat sink = 0.5 in.

Determine P_D by using Figure 22:

$P_D = 13$ W

Then solve the following equation:

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

$$\theta ca = \left[\frac{(70 - 40)}{13} \right]$$

$$\theta ca = 2.3 \text{ °C/W}$$

Use Figure 23 to determine air velocity for the 0.5 inch heat sink.

The minimum airflow necessary for the JW075A1-E module is 1.5 m/s (300 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 24).

$$P_D \rightarrow \overset{T_C}{\bullet} \text{---}\Lambda\Lambda\Lambda\text{---} \overset{T_S}{\bullet} \text{---}\Lambda\Lambda\Lambda\text{---} \overset{T_A}{\bullet}$$
$$\theta cs \qquad \theta sa$$
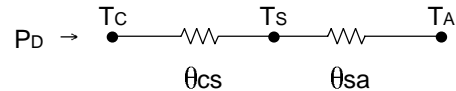
8-1304 (C)

Figure 24. 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.
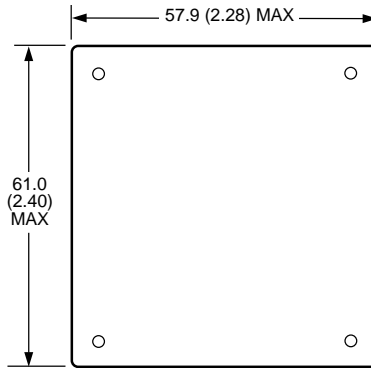
Layout Considerations

Copper paths must not be routed beneath the power module mounting inserts.
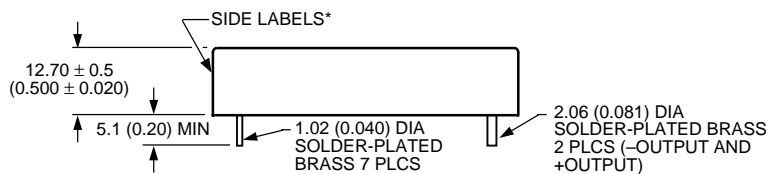
Outline Diagram

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

57.9 (2.28) MAX

61.0
(2.40)
MAX

Side View

SIDE LABELS*

12.70 ± 0.5
(0.500 ± 0.020)

5.1 (0.20) MIN

1.02 (0.040) DIA
SOLDER-PLATED
BRASS 7 PLCS

2.06 (0.081) DIA
SOLDER-PLATED BRASS
2 PLCS (–OUTPUT AND
+OUTPUT)

Bottom View

12.7 (0.50)

5.1 (0.20)

MOUNTING INSERTS
M3 x 0.5 THROUGH
4 PLCS

V_I (–)

V_O (–)

10.16
(0.400)

10.16
(0.400)

17.78
(0.700)

50.8
(2.00)

25.40
(1.000)

CASE

– SEN

25.40
(1.000)

35.56
(1.400)

TRIM

ON/OFF

+ SEN

35.56
(1.400)

V_I (+)

48.26
(1.900)

V_O (+)

4.8
(0.19)

48.3 (1.90)
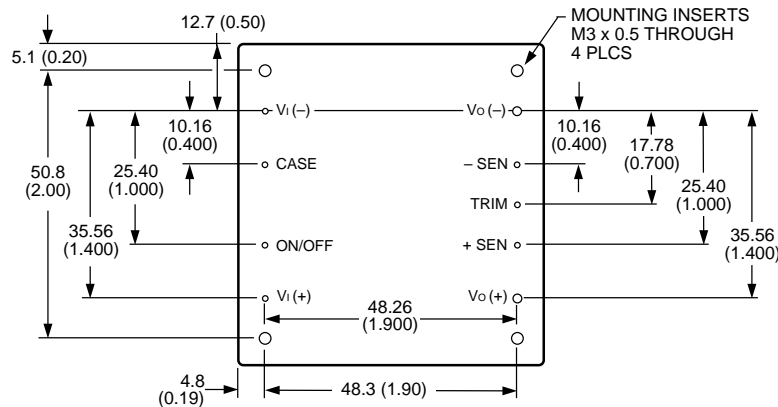
8-1945 (C).a

* Side labels include Lucent logo, product designation, safety agency markings, input/output voltage and current ratings, and bar code.

Recommended Hole Pattern

Component-side footprint.

Dimensions are in millimeters and (inches).
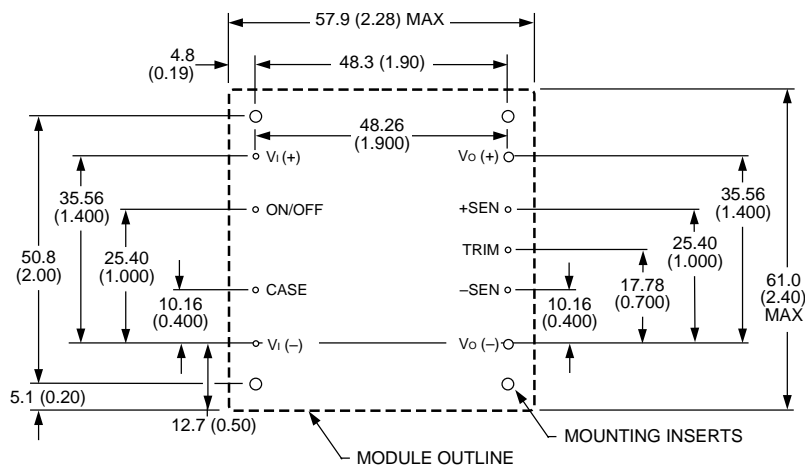
8-1945 (C).a

Ordering Information

This family of modules is not recommended for new designs. For new designs, we recommend the JAW family of power modules. Please refer to the Lucent Technologies Power Systems Selection Guide or to individual data sheets. For further assistance, call the Lucent Technologies Power Systems Technical Hotline (1-800-526-7819 or 972-284-2626).

Input Voltage	Output Voltage	Output Power	Remote On/Off Logic	Device Code	Comcode
48 V	5.0 V	50 W	negative	JW050A1-E	107332462
48 V	5.0 V	75 W	negative	JW075A1-E	107332520
48 V	5.0 V	50 W	positive	JW050A-E	107332371
48 V	5.0 V	75 W	positive	JW075A-E	107332413

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