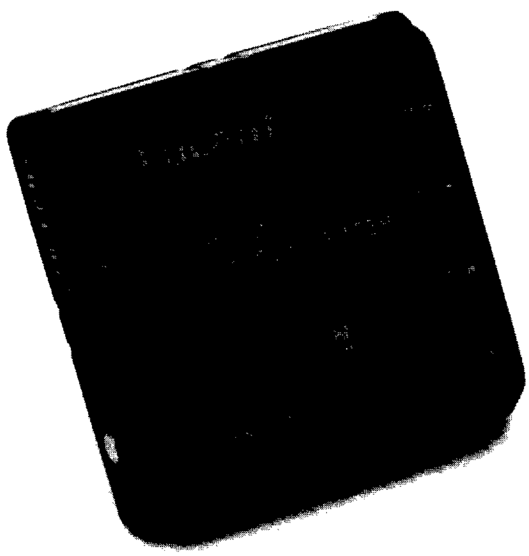
LW016 Dual Output-Series Power Modules: 36 Vdc to 75 Vdc Inputs; 16 W



The LW016 Dual Output-Series Power Modules use advanced, surface-mount technology and deliver high-quality, compact, dc-dc conversion at an economical price.

Features

- Low profile: 0.390 in. with 15 mil standoffs (0.375 in. with standoffs recessed)
- Wide input voltage range: 36 Vdc to 75 Vdc
- Output current limiting, unlimited duration
- Short circuit protection
- Output overvoltage clamp
- Input-to-output isolation
- Operating case temperature range: –40 °C to +100 °C
- Remote on/off
- Output voltage adjust: 90% to 110% of $V_{O,\,nom}$
- *UL** 1950 recognized, *CSA*† 22.2-234, IEC 950 and VDE 0805 certified
- CE mark meets 73/23/EEC and 93/68/EEC directives‡
- Within FCC and VDE Class A radiated limits

Options

- Choice of on/off configuration
- Case ground pin
- Synchronization
- Short pin (0.110 in. ± 0.010 in.)

Description

The LW016 Dual Output-Series Power Modules are low-profile dc-dc converters that operate over an input voltage range of 36 Vdc to 75 Vdc and provide two precisely regulated outputs. The output is isolated from the input, allowing versatile polarity configurations and grounding connections. The modules have a maximum power rating of 16 W at a typical full-load efficiency of >80%.

The power modules feature remote on/off and output voltage adjustment of 90% to 110% of the nominal output voltages. Built-in filtering for both input and output minimizes the need for external filtering.

* *UL* is a registered trademark of Underwriters Laboratories, Inc.
† *CSA* is a registered trademark of the 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 devices. These are absolute stress ratings only. Functional operation of the devices are 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	0	80	Vdc
100 ms Transient	V_I	0	100	V
Operating Case Temperature	T_C	–40	100	°C
Storage Temperature	T_{stg}	–40	120	°C
I/O Isolation Voltage	—	—	1500	Vdc

Electrical Specifications

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

Table 1. Input Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	V_I	36	48	75	Vdc
Maximum Input Current (See Figure 1.) (V_I = 0 V to $V_{I,\,max}$; $I_O = I_{O,\,max}$)	$I_{I,\,max}$	—	—	0.9	A
Inrush Transient	i^2t	—	—	0.1	A^2s
Input Reflected-ripple Current (50 Hz to 20 MHz; 12 µH source impedance; T_A = 25 °C; see Figure 7.)	I_I	—	3	—	mAp-p
Input Ripple Rejection (100 Hz to 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 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	Symbol	Min	Typ	Max	Unit
Output Voltage (Over all line, load, and temperature conditions until end of life; see Figure 9.)	LW016AJ	V_{O1}	4.575	—	5.425	Vdc
		V_{O2}	–4.575	—	–5.425	Vdc
	LW016BK	V_{O1}	10.98	—	13.02	Vdc
		V_{O2}	–10.98	—	–13.02	Vdc
	LW016CL	V_{O1}	13.72	—	16.28	Vdc
		V_{O2}	–13.72	—	–16.28	Vdc
Output Voltage Set Point (V_I = 48 V; $I_O = I_{O,\,max}$; T_C = 25 °C)	LW016AJ	$V_{O1,\,set}$	4.905	5	5.095	Vdc
		$V_{O2,\,set}$	–4.905	–5	–5.095	Vdc
	LW016BK	$V_{O1,\,set}$	11.76	12	12.24	Vdc
		$V_{O2,\,set}$	–11.76	–12	–12.24	Vdc
	LW016CL	$V_{O1,\,set}$	14.70	15	15.30	Vdc
		$V_{O2,\,set}$	–14.70	–15	–15.30	Vdc
Output Regulation:						
Line (V_I = 36 V to 75 V)	All	—	—	0.2	0.5	%V_O
Load ($I_{O1} = I_{O2} = I_{O,\,min}$ to $I_{O,\,max}$)	All	—	—	0.5	1.0	%V_O
Cross ($I_{O2} = I_{O,\,min}$ to $I_{O,\,max}$, $I_{O1} = I_{O,\,max}$)	All	—	—	4.0	—	%V_O
Temperature (T_C = –40 °C to +100 °C)	All	—	—	0.5	1.0	%V_O
Output Ripple and Noise (See Figure 8.):						
RMS	LW016AJ	—	—	—	20	mVrms
	LW016BK, CL	—	—	—	50	mVrms
Peak-to-peak (5 Hz to 20 MHz)	LW016AJ	—	—	50	100	mVp-p
	LW016BK, CL	—	—	75	150	mVp-p
Output Current (At $I_O < I_{O,\,min}$, the modules may exceed output ripple and regulation specifications.)	LW016AJ	I_{O1}	0.16	—	1.6	A
		I_{O2}	–0.16	—	–1.6	A
	LW016BK	I_{O1}	0.07	—	0.67	A
		I_{O2}	–0.07	—	–0.67	A
	LW016CL	I_{O1}	0.05	—	0.53	A
		I_{O2}	–0.05	—	–0.53	A
Output Current-limit Inception (See Figure 2.) ($V_{O1,\,2}$ = 0.9 x $V_{O,\,set}$)	All	$I_{O1,\,2}$	103	130	160	%$I_{O,\,max}$
Output Short-circuit Current ($V_{O1,\,2}$ = 250 mV)	All	$I_{O1,\,2}$	—	135	220	%$I_{O,\,max}$
Efficiency ($V_I = V_{I,\,nom}$; $I_{O1,\,2} = I_{O,\,max}$; T_C = 25 °C; see Figures 3 and 9.)	LW016AJ	η	77	80	—	%
	LW016BK	η	78	81	—	%
	LW016CL	η	78	81	—	%

Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Dynamic Response (I_{O1} or I_{O2} = $I_{O,\ max}$, $\Delta I_O/\Delta t$ = 1 A/10 µs, V_I = $V_{I,\ nom}$, T_C = 25 °C; see Figures 4 and 5.)						
Load Change from I_O = 50% to 75% of $I_{O,\ max}$:						
Peak Deviation	All	—	—	1	—	%$V_{O,\ set}$
Settling Time (V_O < 10% peak deviation)	All	—	—	0.5	—	ms
Load Change from I_O = 50% to 25% of $I_{O,\ max}$:						
Peak Deviation	All	—	—	1	—	%$V_{O,\ set}$
Settling Time (V_O < 10% peak deviation)	All	—	—	0.5	—	ms

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	0.002	—	µF
Isolation Resistance	10	—	—	MΩ

General Specifications

Parameter	Device	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O,\ max}$; T_C = 40 °C)			4,800,000		hours
Weight	—	—	—	1.9 (54)	oz. (g)

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	Symbol	Min	Typ	Max	Unit
Remote On/Off						
(V_I = 0 V to 75 V; open collector or equivalent compatible; signal referenced to $V_I(-)$ terminal. See Figure 10 and Feature Descriptions.):						
LW016xx Positive Logic						
Logic Low—Module Off						
Logic High—Module On						
LW016xx1 Negative Logic						
Logic Low—Module On						
Logic High—Module Off						
Module Specifications:						
On/Off Current—Logic Low	All	$I_{on/off}$	—	—	1.0	mA
On/Off Voltage:						
Logic Low	All	$V_{on/off}$	0	—	1.2	V
Logic High ($I_{on/off}$ = 0)	All	$V_{on/off}$	—	—	6	V
Open Collector Switch Specifications:						
Leakage Current During Logic High ($V_{on/off}$ = 6 V)	All	$I_{on/off}$	—	—	50	µA
Output Low Voltage During Logic Low ($I_{on/off}$ = 1 mA)	All	$V_{on/off}$	—	—	1.2	V
Turn-on Time (I_O = 80% of $I_{O,\,max}$; T_C = 40 °C V_O within ±1% of steady state)	All	—	—	—	5.0	ms
Output Voltage Overshoot	All	—	—	0	5.0	%
Output Voltage Set Point Adjustment Range	All	—	90	—	110	$\%V_{O,\,nom}$
Output Overvoltage Clamp	LW016AJ	$V_{O1,\,clamp}$	5.6	—	7.0	V
		$V_{O2,\,clamp}$	−5.6	—	−7.0	V
	LW016BK	$V_{O1,\,clamp}$	13.2	—	16.5	V
		$V_{O2,\,clamp}$	−13.2	—	−16.5	V
	LW016CL	$V_{O1,\,clamp}$	16.5	—	19.0	V
		$V_{O2,\,clamp}$	−16.5	—	−19.0	V

Characteristic Curves

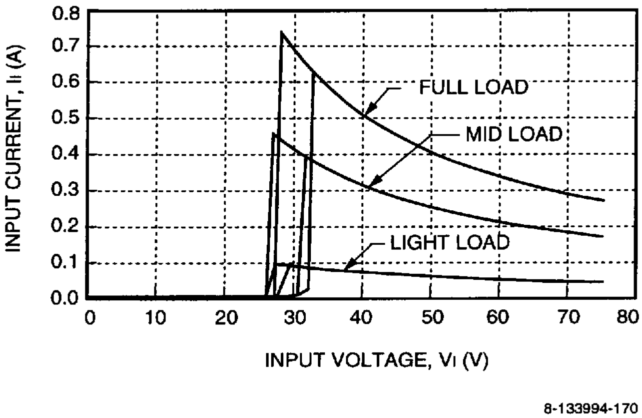


Figure 1. LW016AJ Typical Input Characteristics

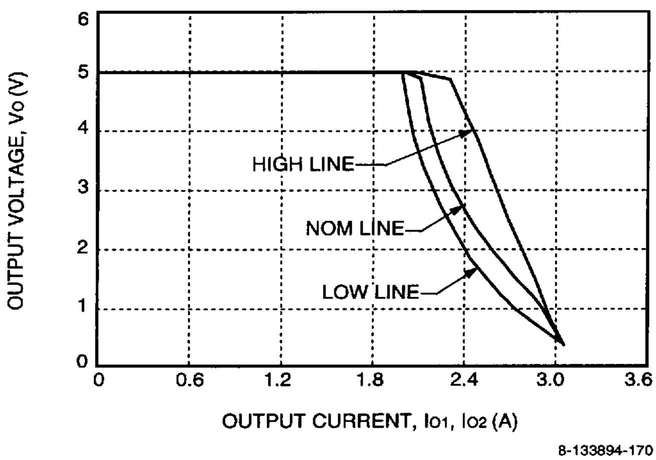


Figure 2. LW016AJ Typical Output Characteristics (Io1 = Io2)

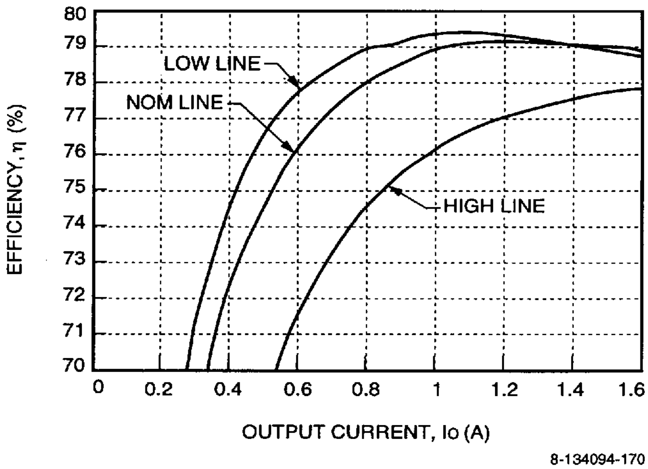


Figure 3. LW016AJ Typical Converter Efficiency vs. Output Current

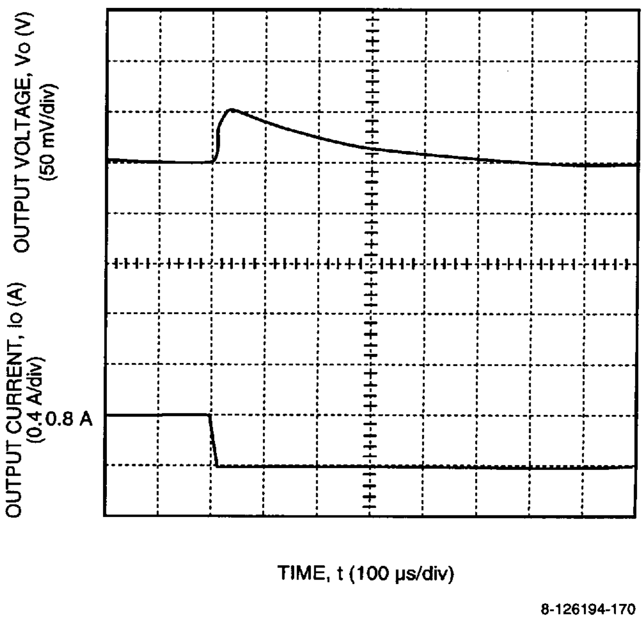
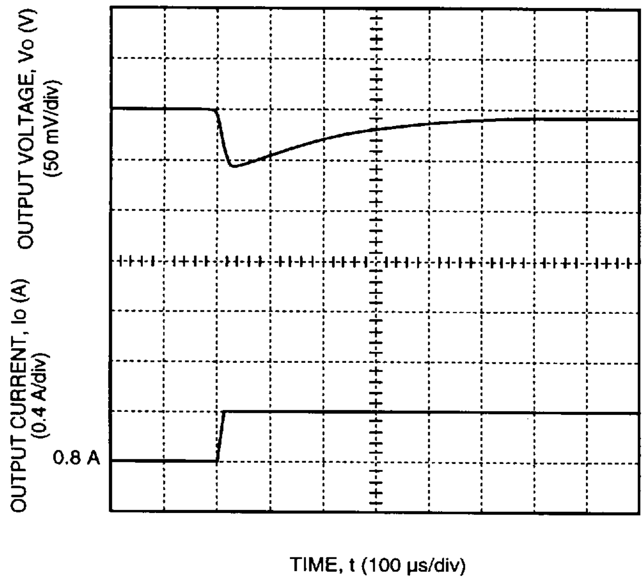


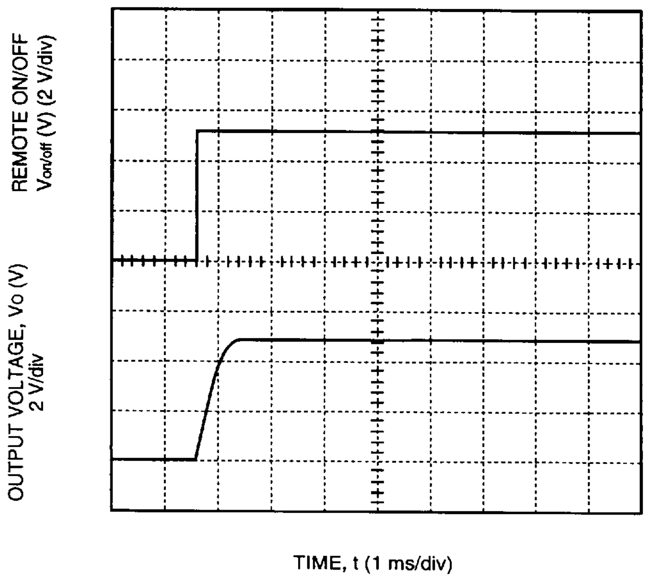
Figure 4. LW016AJ Typical Output Voltage for a Step Load Change from 50% to 25%

Characteristic Curves (continued)



8-126294-170

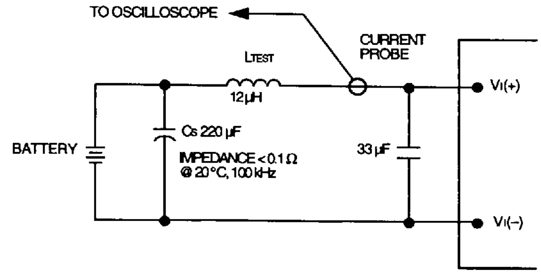
Figure 5. LW016AJ Typical Output Voltage for a Step Load Change from 50% to 75%



8-126394-170

Figure 6. LW016AJ Typical Output Voltage Start-Up when Signal Applied to Remote On/Off

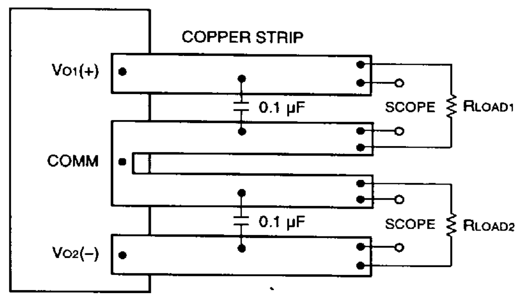
Test Configurations



8-203 (C)

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.

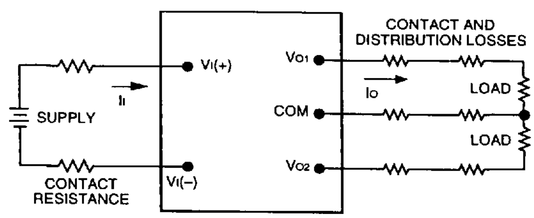
Figure 7. Input Reflected-Ripple Test Setup



8-808 (C)

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

Figure 8. Peak-to-Peak Output Noise Measurement Test Setup



8-863.a (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.

$$\eta = \frac{\sum_{J=1}^{2} |[V_{OJ} - COM] I_{OJ}|}{[V_I(+) - V_I(-)] I_I} \times 100$$

Figure 9. Output Voltage and Efficiency Measurement Test Setup

Design Considerations

Input Source Impedance

The power modules should be connected to low ac-impedance input sources. Highly inductive source impedances can affect the stability of the power modules. For the test configuration in Figure 7, 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 modules are used, the power modules 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, EN60950.

For the converter output to meet the requirements of safety extra low voltage (SELV), one of the following must be true of the dc input:

- 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 an SELV reliability test performed on it in combination with the converters.

The power modules have extra low voltage (ELV) outputs when all inputs are ELV.

The input to these units is to be provided with a maximum 5 A normal blown fuse in the ungrounded lead.

Feature Descriptions

Output Overvoltage Clamp

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 shutdown has a higher voltage set point than the primary loop (see Feature Specifications table).

In a fault condition, the overvoltage clamp ensures that the output voltage does not exceed $V_{O,\,clamp,\,max}$. This provides a redundant voltage-control that reduces the risk of output overvoltage.

Current Limit

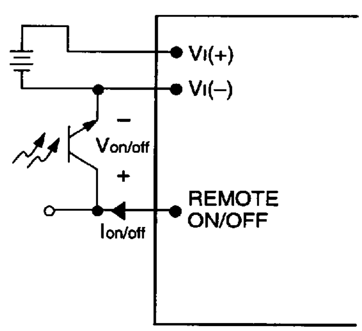
To provide protection in a fault (output overload) condition, the units are equipped with internal current-limiting circuitry and can endure current limiting for an unlimited duration. At the point of current-limit inception, the units shift from voltage control to current control. If the output voltage 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 units operate 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 (code suffix of 1) 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 10). A logic low is $V_{on/off}$ = 0 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 6 V. The maximum allowable leakage current of the switch at $V_{on/off}$ = 6 V is 50 µA.



8-758.a (C)

Figure 10. Remote on/off Implementation

Feature Descriptions (continued)

Output Voltage Adjustment

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 Vo(+) or Vo(–) pins. With an external resistor between the TRIM and Vo(+) pins ($R_{adj\text{-}down}$), the output voltage set point ($V_{O,\,adj}$) decreases. With an external resistor between the TRIM and Vo(–) pins ($R_{adj\text{-}up}$), $V_{O,\,adj}$ increases.

The following equation determines the required external resistor value to obtain an output voltage change of Δ%:

$$R_{adj\text{-}down} = \left[\frac{a}{\Delta\%} - b\right] k\Omega$$

$$R_{adj\text{-}up} = \left[\frac{c}{\Delta\%} - d\right] k\Omega$$

Device	a	b	c	d	–5% Vo $R_{adj\text{-}down}$	+5% Vo $R_{adj\text{-}up}$
LW016AJ	3.56	8.4	1.19	3.65	62.8 kΩ	20.1 kΩ
LW016BK	13.8	30.1	1.60	14.7	246 kΩ	17.3 kΩ
LW016CL	15.5	31.6	1.41	14.7	278 kΩ	13.5 kΩ

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 modules have fixed current-limit set points. 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.

Synchronization (Optional)

The unit is capable of external synchronization from an independent time base with a switching rate of 256 kHz. The amplitude of the synchronizing pulse train is TTL compatible and the duty cycle ranges between 40% and 60%. Synchronization is referenced to $V_{IN}(+)$.

Thermal Considerations

Introduction

The LW016A power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat-dissipating components inside the unit are thermally coupled to the case. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the case temperature. Peak case temperature (T_C) occurs at the position indicated in Figure 11.

Thermal Considerations (continued)

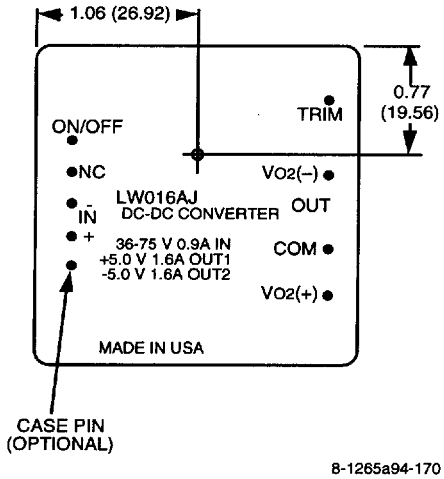


Figure 11. Case Temperature Measurement Location

Note that the view in Figure 11 is of the metal surface of the module—the pin locations shown are for reference. 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.

Heat Transfer Without Heat Sinks

Increasing airflow over the module enhances the heat transfer via convection. Figure 12 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 600 ft./min. (3.0 ms^{-1}).

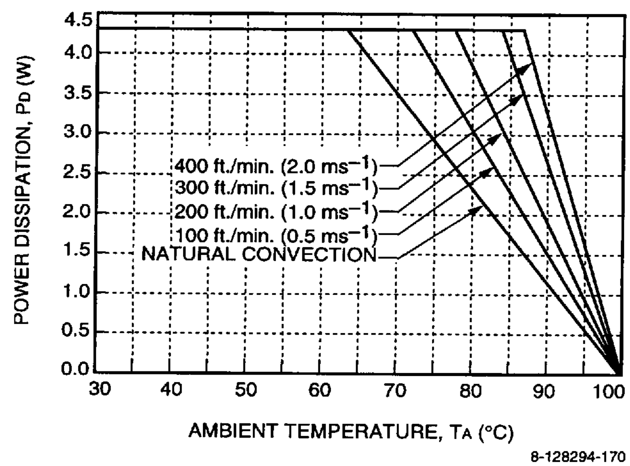
Note that the natural convection condition was measured at 10 ft./min. (0.05 ms^{-1}) to 20 ft./min. (0.1 ms^{-1}); however, systems in which these power modules may be used typically generate natural convection airflow rates of 60 ft./min. (0.3 ms^{-1}) due to other heat dissipating components in the system. Use of Figure 12 is shown in the following example.

Example

What is the minimum airflow necessary for a LW016AJ operating at high line, an output current of 0.8 A on each output, and a maximum ambient temperature of 82 °C?

Solution:

Given: V_I = 75 V, I_{O1} = I_{O2} = 0.8 A, T_A = 82 °C
Determine P_D (Figure 12): P_D = 2.75 W
Determine Airflow (Figure 11): v = 100 ft./min. (0.5 ms^{-1})



Note: Conversion factor for linear feet per minute to meters per second: 200 ft./min. = 1 ms^{-1}.

Figure 12. Forced Convection Power Derating with No Heat Sink; Either Orientation

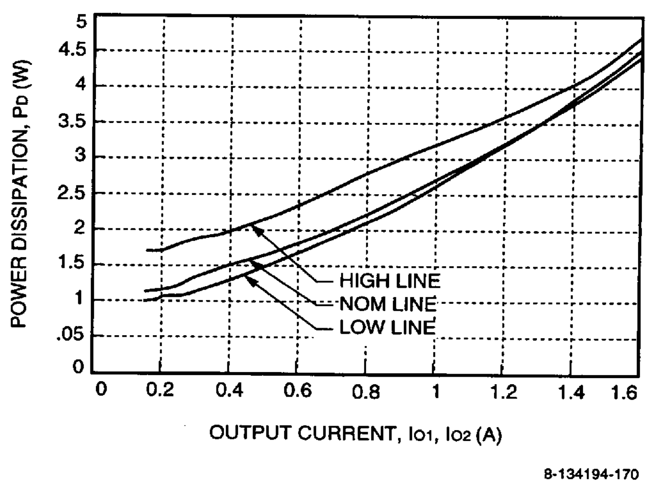
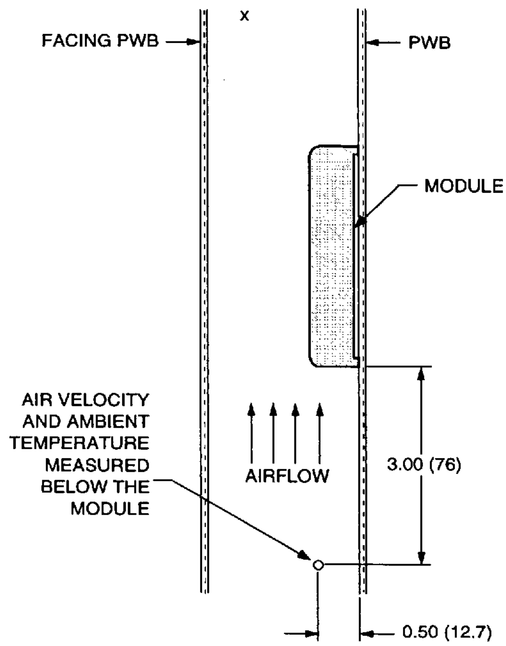


Figure 13. LW016AJ Power Dissipation vs. Output Current (I_{O1} = I_{O2})

Thermal Considerations (continued)

Module Derating

The derating curves in Figure 12 were obtained from measurements obtained in an experimental apparatus shown in Figure 14. Note that the module and the printed-wiring board (PWB) that it is mounted on are vertically oriented. The passage has a rectangular cross-section.



8-1126.a (C)

Note: Dimensions are in inches and (millimeters).

Figure 14. Experimental Test Setup

Outline Diagram

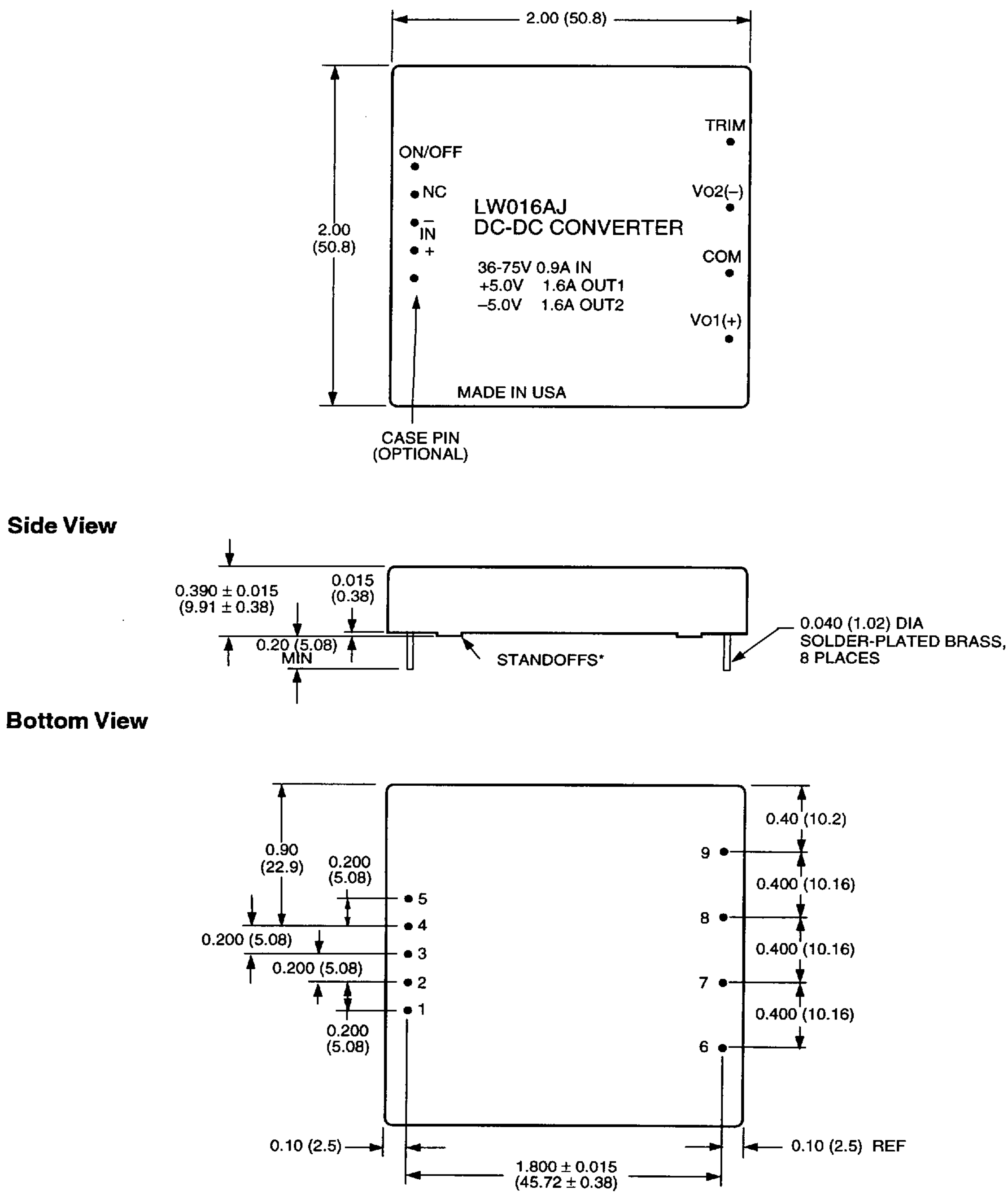
Dimensions are in inches and (millimeters). Copper paths must not be routed beneath the power module standoffs.

Tolerances: x.xx ± 0.02 in. (0.5 mm), x.xxx ± 0.010 in. (0.25 mm) (pin-to-pin tolerances are not cumulative).

Note: For standard modules, V_I(+) is internally connected to the case.

Top View

Pin	Function
1	Remote On/Off
2	No Connection (sync feature optional)
3	V_I(–)
4	V_I(+)
5	Case Pin (Pin Optional)
6	Trim
7	– Output
8	Common
9	+ Output



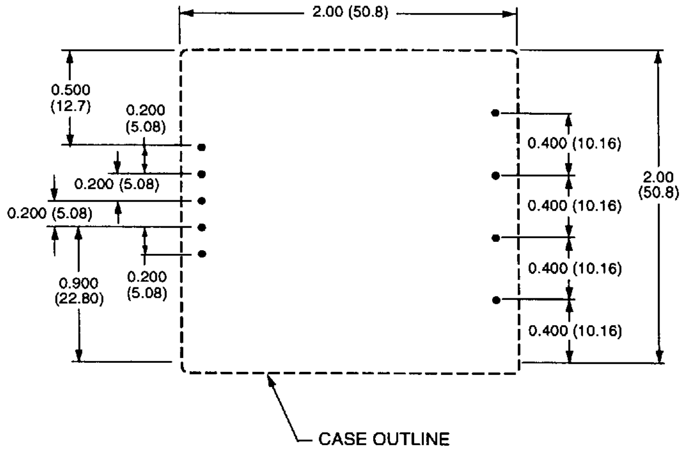
8-1198a94-170

* At the time this document was printed standoffs were being added to the case.

Recommended Hole Pattern

Component-side footprint.

Dimensions are in inches and (millimeters).



8-1198.a (C)

Ordering Information

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
48 V	±5 V	16 W	LW016AJ	107314312
48 V	±12 V	16 W	LW016BK	107383614
48 V	±15 V	16 W	LW016CL	107640781

Optional features maybe ordered using the device code suffixes shown below. To order more than one option, list suffixes in numerically descending ordering.

Option	Device Code Suffix
Short pin (0.110 in. ± 0.010 in.)	8
Case pin	7
Synchronization	3
Negative on/off logic	1

Please contact your Microelectronics Group Account Manager or Application Engineer for pricing and availability of options.

0050026 0026382 T03