Data Sheet
January 1997

microelectronics group

Lucent Technologies
Bell Labs Innovations

CW030-Series Power Modules: 36 Vdc to 75 Vdc Inputs; 30 W

The CW030-Series Power Modules use advanced, surface-mount technology and deliver high-quality, compact, dc-dc conversion at an economical price.

Applications

- Distributed power architectures
- Telecommunications

Features

- Small size: 2.40 in. x 2.80 in. x 0.50 in.
- Low output noise
- Constant frequency
- Industry-standard pinout
- Metal case
- 2:1 input voltage range
- Remote sense
- Remote on/off (positive logic)
- High efficiency: 83% typical
- Adjustable output voltage: 90% to 110% of $V_{O,\,nom}$
- *UL** Recognized, *CSA*† Certified and VDE Licensed
- Within FCC and VDE Class A Radiated Limits
- CE mark meets 73/23/EEC and 93/68/EEC directives‡

Options

- Choice of on/off configuration
- Case ground pin
- Short pin (0.110 in. ± 0.010 in.)
- Heat sink available for extended operation

Description

The CW030A, B, and C Power Modules are dc-dc converters that operate over an input voltage range of 36 Vdc to 75 Vdc and provide precisely regulated 5 V, 12 V, and 15 V outputs respectively. These outputs are isolated from the inputs, allowing versatile polarity configurations and grounding connections. The modules have maximum power ratings of 30 W at a typical full-load efficiency of 83% (81% for the CW030A).

The power modules feature remote on/off, output sense (both negative and positive leads), and output voltage adjustment, which allows output voltage adjustment from 90% to 110% of the nominal output voltage. For disk-drive applications, the CW030B Power Module provides a motor-start surge current of 3 A.

The modules are PC board mountable and encapsulated in metal cases. The modules are rated to full load at 100 °C case temperature.

* *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 markina 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	V
I/O Isolation Voltage dc Transient (1 min)	 — —	 — —	 500 850	 V V
Operating Case Temperature	T_C	–40	100	°C
Storage Temperature	T_{stg}	–40	110	°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; $I_O = I_{O,\,max}$; see Figure 1.)	$I_{I,\,max}$	—	—	1.6	A
Inrush Transient	i^2t	—	—	0.2	A^2s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 µH source impedance; T_C = 25 °C; see Figure 14 and Design Considerations section.)	—	—	25	—	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 5 A in series with the ungrounded input lead. 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 (Overall operating input voltage, resistive load, and temperature conditions until end of life.)	CW030A-M CW030B-M CW030C-M	V_O V_O V_O	4.80 11.52 14.40	— — —	5.20 12.48 15.60	Vdc Vdc Vdc
Output Voltage Set Point V_I = 48 V; $I_O = I_{O,\,max}$; T_C = 25 °C	CW030A-M CW030B-M CW030C-M	$V_{O,\,set}$ $V_{O,\,set}$ $V_{O,\,set}$	4.90 11.76 14.70	5.0 12.0 15.0	5.10 12.24 15.30	Vdc Vdc Vdc
Output Regulation:						
Line (V_I = 36 V to 75 V)	All	—	—	0.01	0.1	%
Load ($I_O = I_{O,\,min}$ to $I_{O,\,max}$)	All	—	—	0.05	0.2	%
Temperature (T_C = –40 °C to +100 °C)	All	—	—	0.5	1.5	%
Output Ripple and Noise (See Figure 14.):						
RMS	CW030A-M	—	—	—	20	mVrms
	CW030B-M, C-M	—	—	—	25	mVrms
Peak-to-peak (5 Hz to 20 MHz)	CW030A-M	—	—	—	150	mVp-p
	CW030B-M, C-M	—	—	—	200	mVp-p
Output Current (At $I_O < I_{O,\,min}$, the modules may exceed output ripple specifications.)	CW030A-M CW030B-M CW030B-M CW030C-M	I_O I_O $I_{O,\,trans}$ I_O	0.6 0.3 — 0.2	— — — —	6.0 2.5 3.0 2.0	A A A A
Output Current-limit Inception (V_O = 90% of $V_{O,\,nom}$; see Figures 5—7.)	CW030A-M CW030B-M CW030C-M	— — —	— — —	6.9 3.6 2.5	— — —	A A A
Output Short-circuit Current (V_O = 250 mV)	CW030A-M CW030B-M CW030C-M	— — —	— — —	8.0 4.0 3.0	— — —	A A A
Efficiency (V_I = 48 V; $I_O = I_{O,\,max}$; T_C = 25 °C; see Figures 8—10 and 16.)	CW030A-M CW030B-M, C-M	η η	79 80	81 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 $I_{O,\,max}$: (See Figure 11.)						
Peak Deviation	All	—	—	2	—	%$V_{O,\,set}$
Setting Time (V_O < 10% of peak deviation)	All	—	—	0.5	—	ms
Load Change from I_O = 50% to 25% of $I_{O,\,max}$: (See Figure 12.)						
Peak Deviation	All	—	—	2	—	%$V_{O,\,set}$
Setting Time (V_O < 10% of peak deviation)	All	—	—	0.5	—	ms

Electrical Specifications (continued)

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	0.02	—	µF
Isolation Resistance	10	—	—	MΩ

General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O,\,max}$; T_C = 40 °C)		4,300,000		hours
Weight	—	—	4.0 (113)	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 = 36 V to 75 V; open collector or equivalent compatible; signal referenced to $V_I(-)$ terminal. See Figure 17 and Feature Descriptions.):						
CW030x Positive Logic						
Logic Low—Module Off						
Logic High—Module On						
CW030x 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
Low Logic High ($I_{on/off}$ = 0)	All	$V_{on/off}$	—	—	6	V
Open Collector Switch Specifications:						
Leakage Current During Logic High ($V_{on/off}$ = 10 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 (See Figure 13.) (@ 80% of $I_{O,\,max}$; T_A = 25 °C; V_O within ±1% of steady state)	All	—	—	—	5	ms
Output Voltage Overshoot	All	—	—	0	5	%
Output Voltage Sense Range	All	—	—	—	0.5	V
Output Voltage Set Point Adjustment Range (See Feature Descriptions.)	All	—	90	—	110	$\%V_{O,\,nom}$
Output Overvoltage Clamp	CW030A-M	$V_{O,\,clamp}$	5.6	—	7.0	V
	CW030B-M	$V_{O,\,clamp}$	13.0	—	16.0	V
	CW030C-M	$V_{O,\,clamp}$	17.0	—	20.0	V

Characteristic Curves

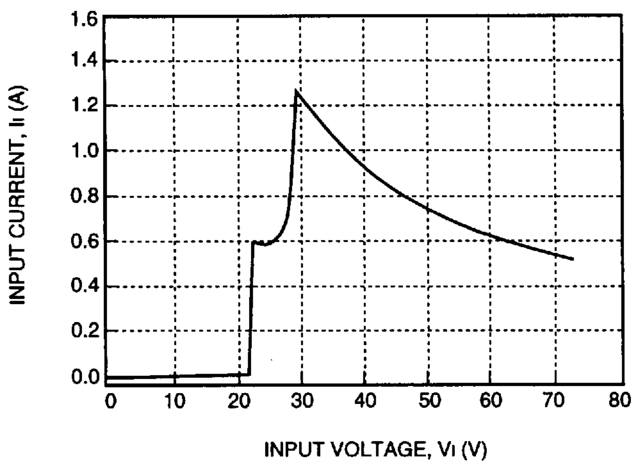

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Figure 1. CW030-Series Typical Input Characteristics

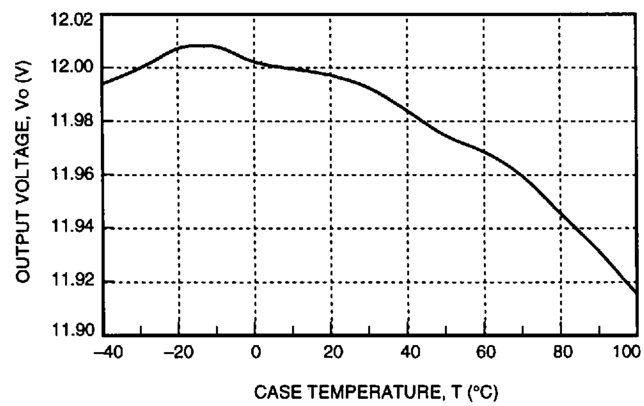

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Figure 3. CW030B-M Typical Output Voltage Variation Over Ambient Temperature Range

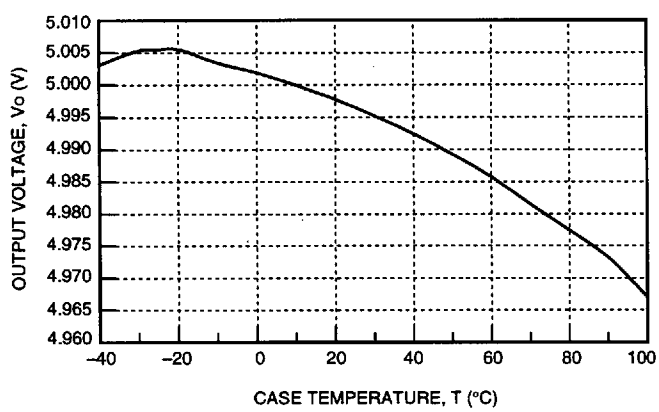

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Figure 2. CW030A-M, A7-M Typical Output Voltage Variation Over Ambient Temperature Range

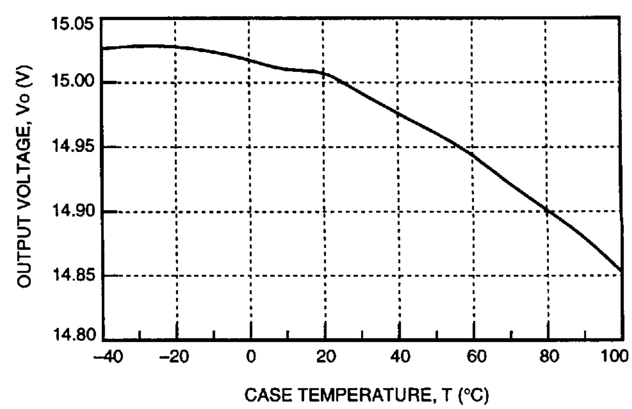

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Figure 4. CW030C-M Typical Output Voltage Variation Over Ambient Temperature Range

Characteristic Curves (continued)

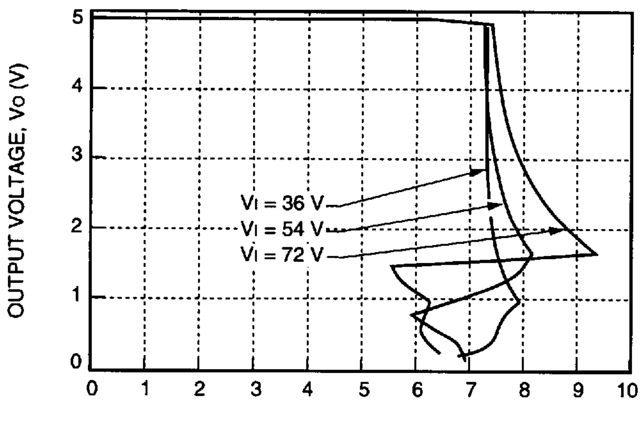

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Figure 5. CW030A-M, A7-M Typical Output Characteristics

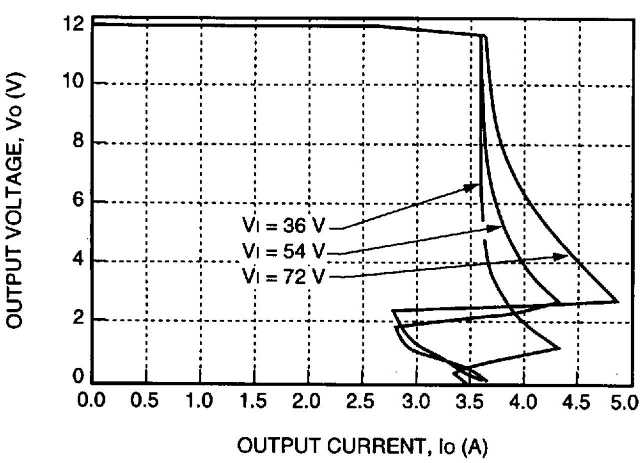

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Figure 6. CW030B-M Typical Output Characteristics

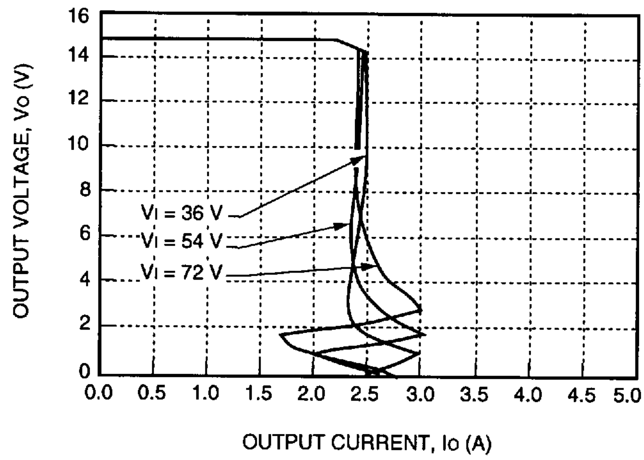

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Figure 7. CW030C-M Typical Output Characteristics

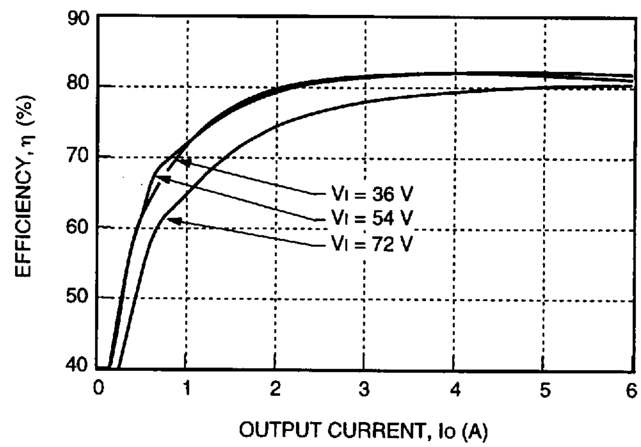

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Figure 8. CW030A-M, A7-M Typical Converter Efficiency vs. Output Current

Characteristic Curves (continued)

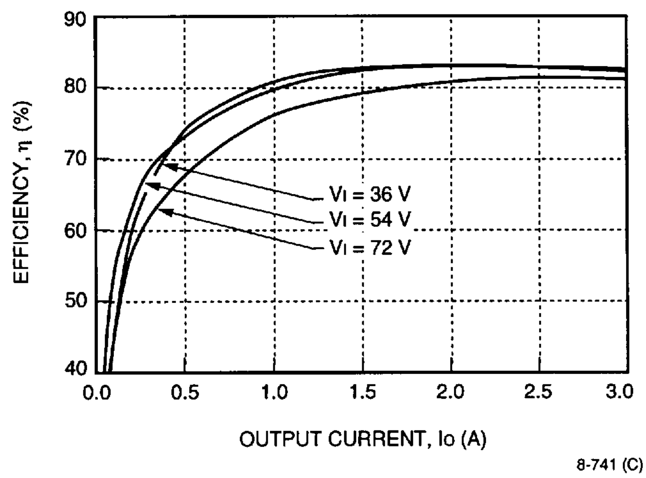

Figure 9. CW030B-M Typical Converter Efficiency vs. Output Current

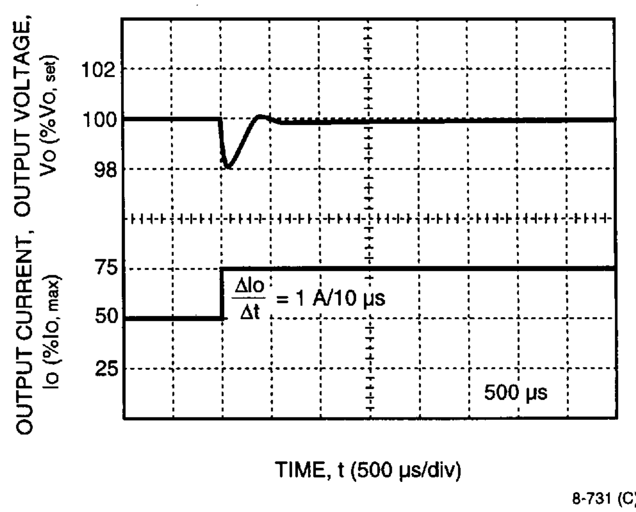

Figure 11. Typical Output Voltage for a Step Load Change from 50% to 75%

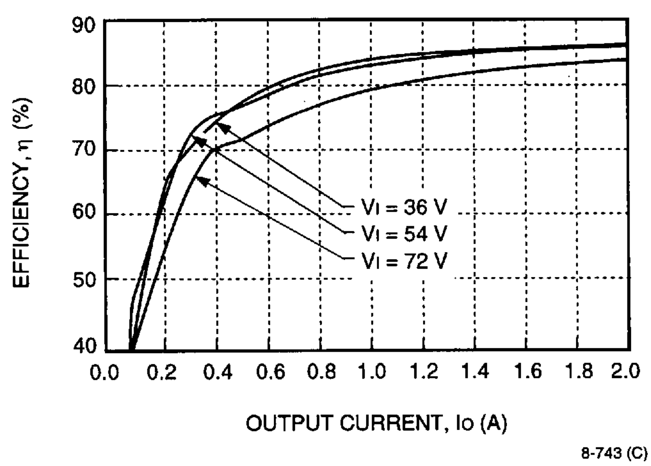

Figure 10. CW030C-M Typical Converter Efficiency vs. Output Current

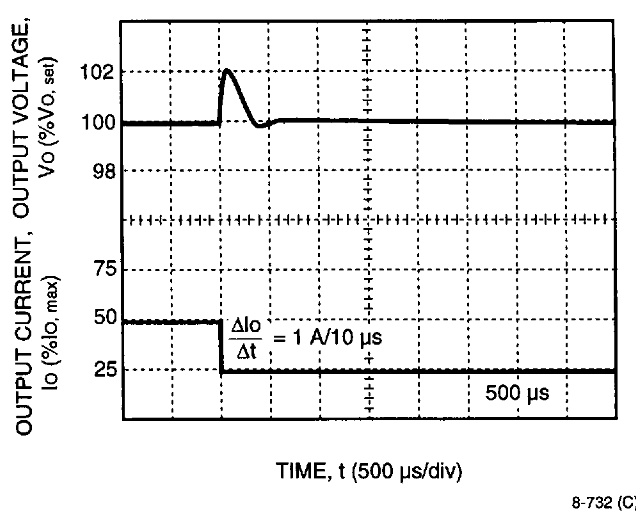

Figure 12. Typical Output Voltage for a Step Load Change from 50% to 25%

Characteristic Curves (continued)

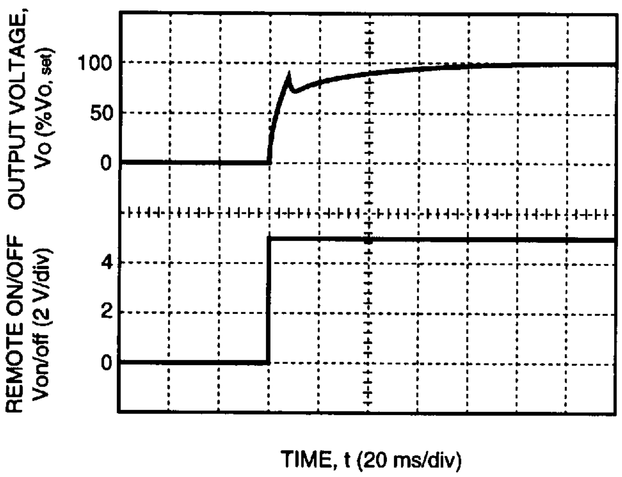

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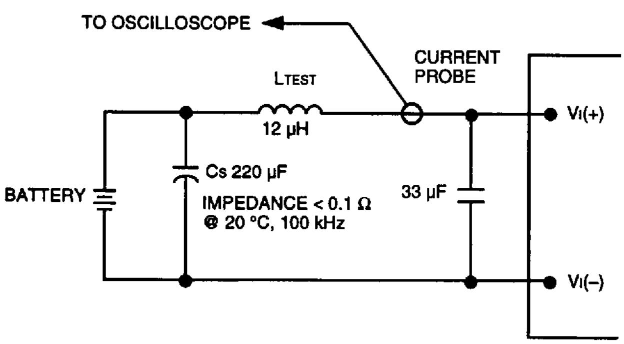
Figure 13. Typical Output Voltage Start-Up when Signal Applied to Remote On/Off

Test Configurations



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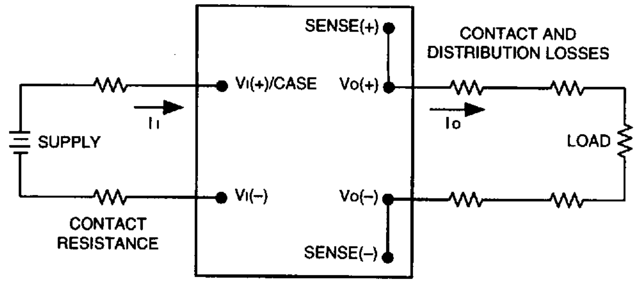
Note: Input reflected-ripple current is measured with a simulated source impedance of 12 µH. Capacitor Cs offsets possible battery impedance. Current is measured at the input of the module.

Figure 14. Input Reflected-Ripple Test Setup



8-749.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.

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

Note: VI(+) is internally connected to base.

Figure 15. 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. Source inductance greater than 12 µH can affect the stability of the power module. 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.

Design Considerations (continued)

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, EN 60950.

For the converter output to be considered to be meeting 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 module has extra low voltage (ELV) when all inputs are ELV.

Feature Descriptions

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, for example, for the CW030Bs:

$[V_O(+) - V_O(-)] - [SENSE(+) - SENSE(-)] \leq 0.5$ V

The voltage between the $V_O(+)$ and $V_O(-)$ terminals must not exceed 13.2 V. This limit includes any increase in voltage due to remote-sense compensation, set-point adjustment, and trim (see Figure 16).

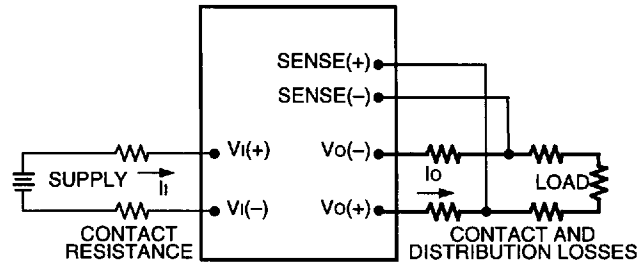


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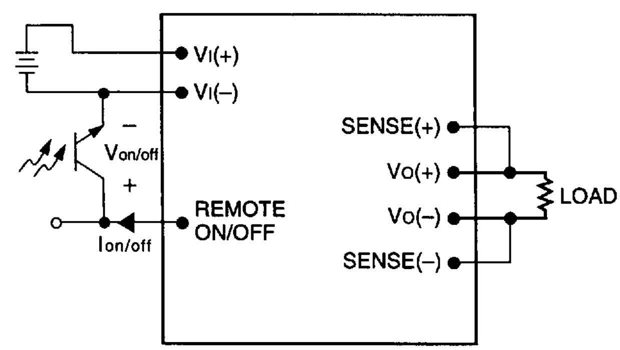
Figure 16. Effective Circuit Configuration for Single-Module Remote-Sense Operation

Remote On/Off

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 17). 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 6 V. The maximum allowable leakage current of the switch at $V_{on/off}$ = 6 V is 50 µA.



8-720.a (C)

Figure 17. Remote On/Off Implementation

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 is specified by a "1" suffix in the device code.

Feature Descriptions (continued)

Output Overvoltage Clamp

The output overvoltage clamp consists of control circuitry, which is 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.

Output Voltage Adjustment

Output voltage adjustment 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 (see Figures 18 and 19). With an external resistor between the TRIM and SENSE(–) pins ($R_{adj\text{-}up}$), the output voltage set point ($V_{O,\,adj}$) increases.

$$R_{adj\text{-}up} = \left(\frac{2.5 \times R_1}{V_{O,\,adj} - V_{O,\,nom}}\right) k\Omega$$

The value of the internal resistor R_1 is shown in Table 4.

Table 4. Internal Resistor Values

BMPM Code	R_1
CW030A-M, A7-M	16.940
CW030B-M	15.732
CW030C-M	16.670

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

$$R_{adj\text{-}down} = \left(\frac{(V_{O,\,adj} - 2.5) \times R_1}{V_{O,\,nom} - V_{O,\,adj}}\right) k\Omega$$

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

The CW030 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.

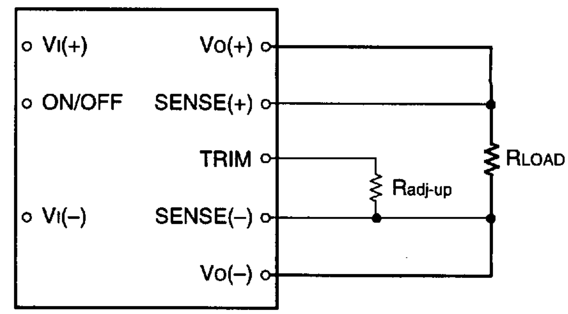


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Figure 18. Circuit Configuration to Increase Output Voltage

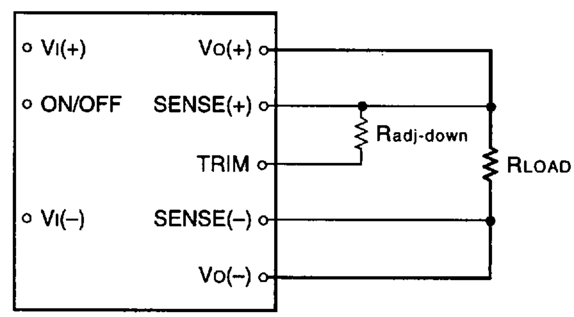

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Figure 19. Circuit Configuration to Decrease Output Voltage

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.

Thermal Considerations

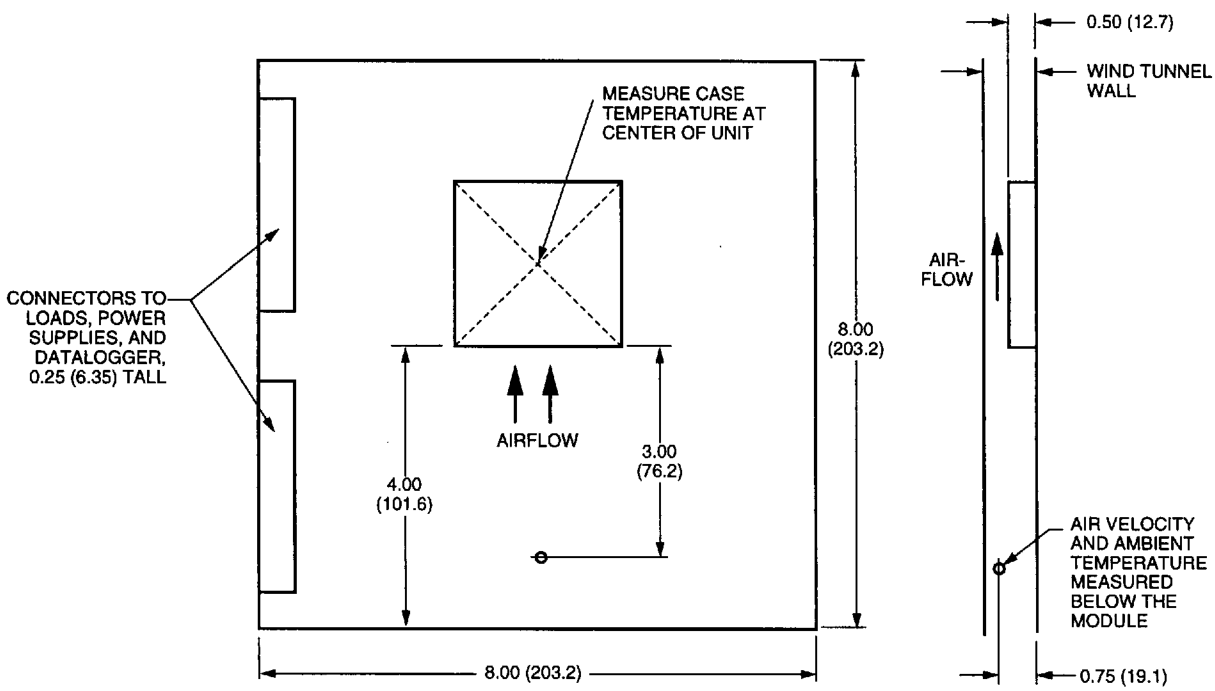


Figure 20. Thermal Test Setup

The CW030-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 20 was used to collect data for Figures 24 and 25.

The graphs in Figures 21 and 23 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.

Basic Thermal Performance

The CW030-series is 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 of Figure 20.

Thermal Considerations (continued)

Forced Convection Cooling

To determine the necessary airflow, determine the power dissipated by the unit for the particular application. Figures 21 through 23 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 Figures 24. For example, if the unit dissipates 6.2 W, the minimum airflow in a 80 °C environment is 200 ft./min.

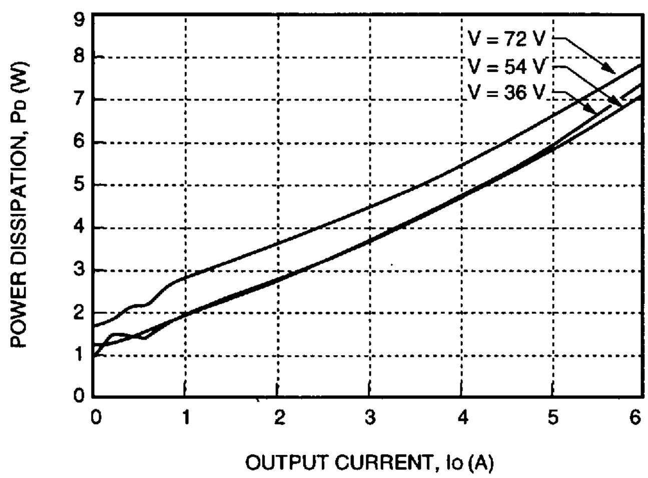


Figure 21. CW030A Power Dissipation vs. Output Current

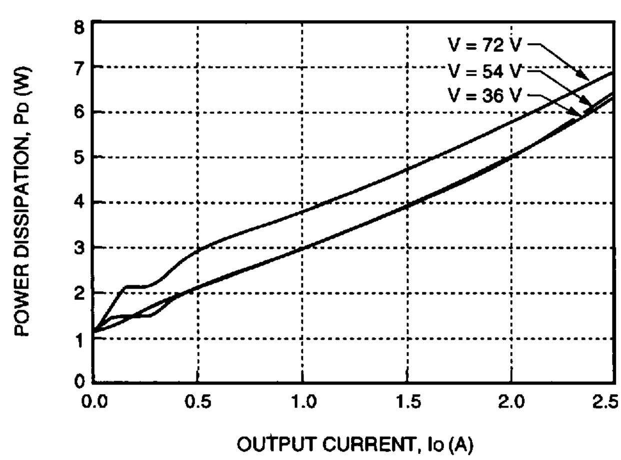


Figure 22. CW030B Power Dissipation vs. Output Current

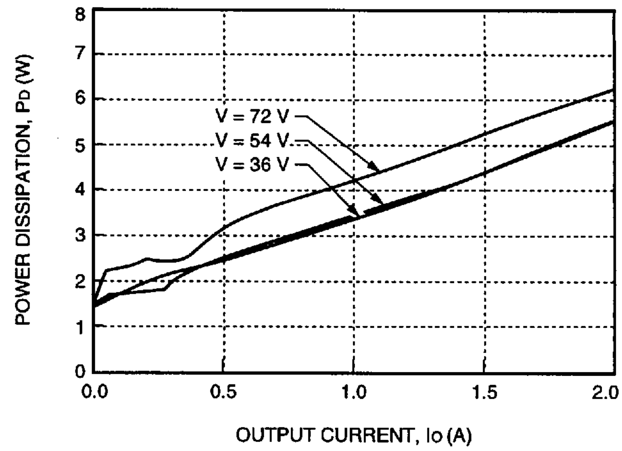


Figure 23. CW030C Power Dissipation vs. Output Current

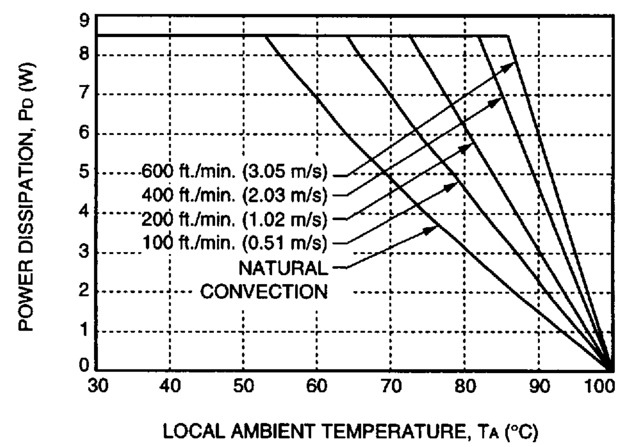


Figure 24. Forced Convection Power Derating with No Heat Sink; Either Orientation

Heat Sink Selection

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

Thermal Considerations (continued)

Heat Sink Selection (continued)

Figure 25 shows the case-to-ambient thermal resistant, θ (°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 unit dissipates 7.1 W of heat in an 80 °C environment with an airflow of 100 ft./min., the minimum heat sink required can be determined as follows:

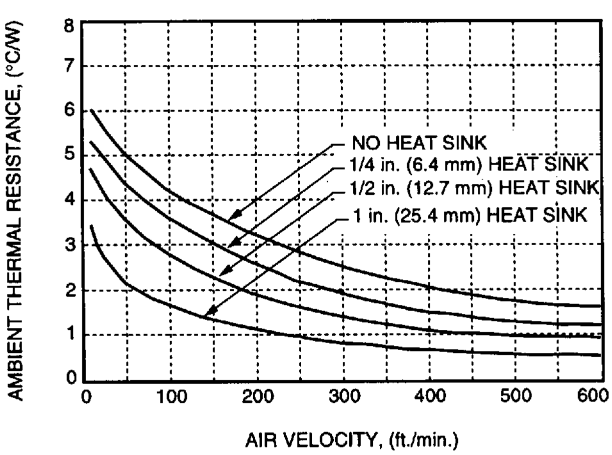
$$\theta \leq (T_{C,max} - T_A)/P_D$$

where:

- θ = module's total thermal resistance
- $T_{C,max}$ = case temperature (See Figure 20.)
- T_A = inlet ambient temperature (See Figure 20.)
- P_D = power dissipation

$$\theta \leq (100 - 80)/7.1$$
$$\theta \leq 2.8\ °C/W$$

From Figure 25, the 1/2 in. high heat sink or greater is required.



8-1157(C).a

Figure 25. 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 $T_{C,\,max}$.

The thermal resistances shown in Figure 25 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 25 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 CC-, CW-, DC-, and DW-Series 25 W to 30 W Board-Mounted Power Modules.*

Outline Diagram

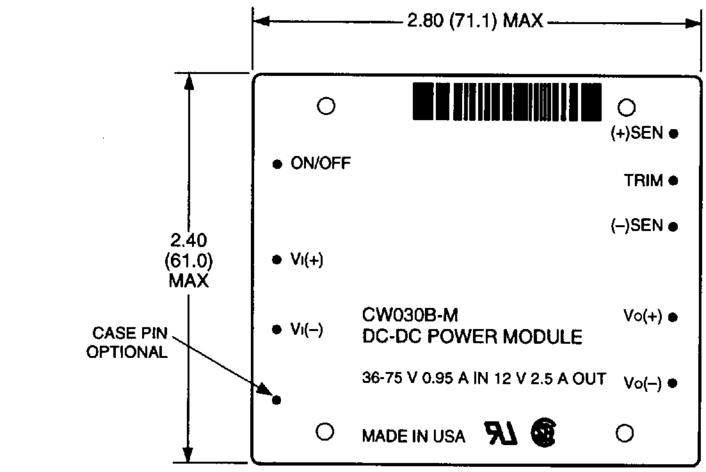
Dimensions are in inches and (millimeters).

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

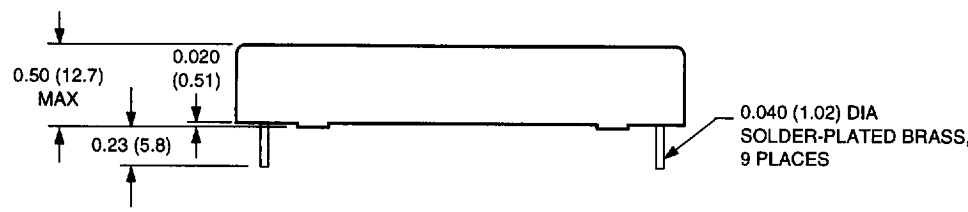
Tolerances: x.xx in. ± 0.02 in. (0.5 mm), x.xxx in. ± 0.010 in. (0.25 mm)

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

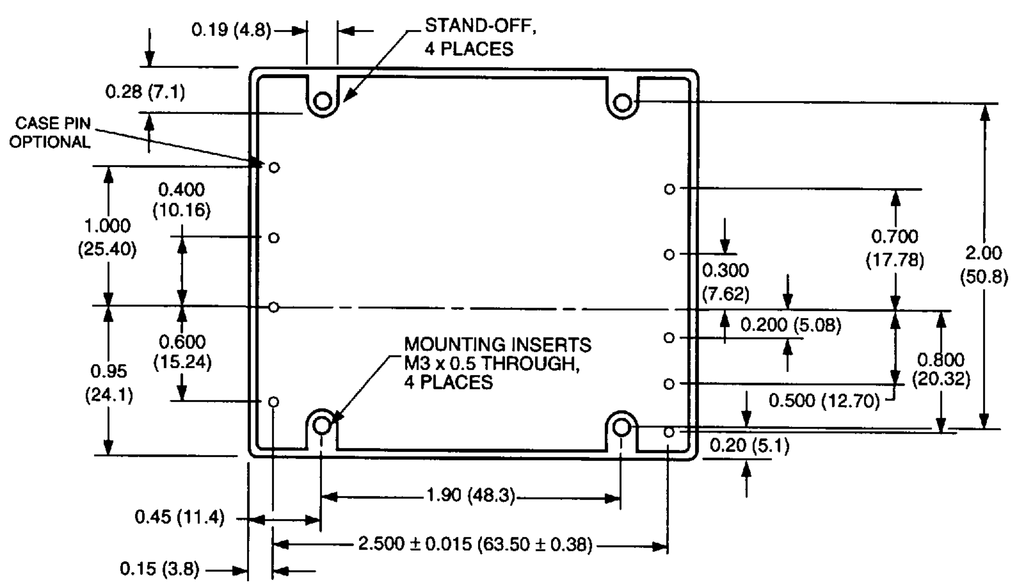
Top View



Side View



Bottom View



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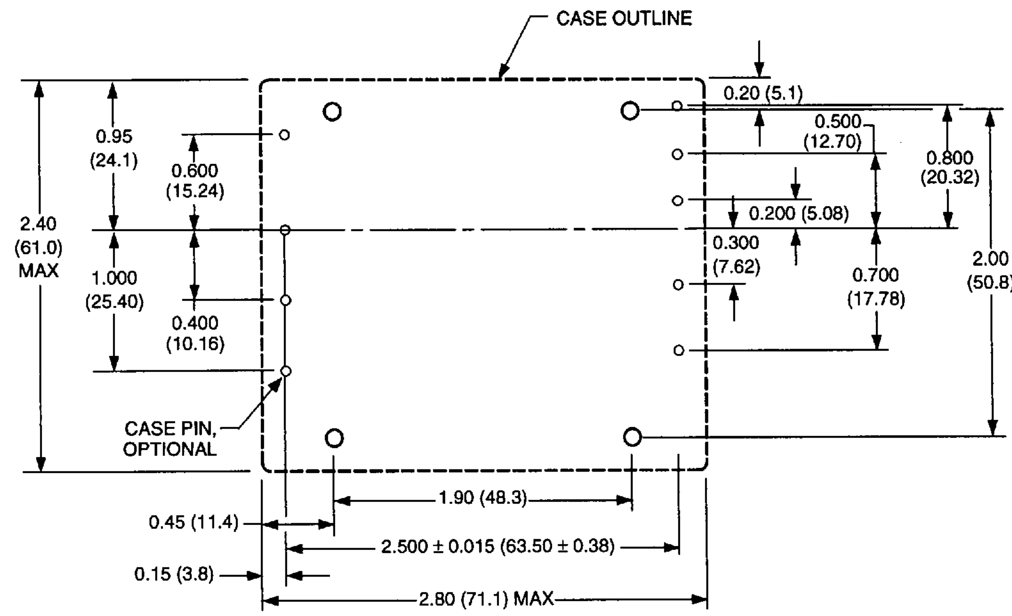
Recommended Hole Pattern

Component-side footprint.

Dimensions are in inches and (millimeters).



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Ordering Information

An **-M** suffix denotes M3x0.5 heat sink hardware. The heat sinks designed for this package have an **M** prefix, i.e., MHST05045 (see *Thermal Energy Management CC-, CW-, DC-, and DW-Series 25 W to 30 W Board-Mounted Power Modules* Technical Note [TN94-018EPS]).

For assistance in ordering, please contact your Microelectronics Group Account Manager.

Device Code	Input Voltage	Output Voltage	Output Power	Case Ground Pin	Comcode
CW030A-M	48 V	5 V	30 W	No	107587263
CW030B-M	48 V	12 V	30 W	No	107584237
CW030C-M	48 V	15 V	30 W	No	107587271

Optional features may be ordered using the device code suffixes shown below. The feature suffixes are shown in numerically descending order.

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

For additional information, contact your Microelectronics Group Account Manager or the following:
INTERNET: **http://www.lucent.com/micro**
U.S.A.: Microelectronics Group, Lucent Technologies Inc., 555 Union Boulevard, Room 30L-15P-BA, Allentown, PA 18103,
1-800-372-2447, FAX 610-712-4106 (In CANADA: **1-800-553-2448**, FAX 610-712-4106)
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FRANCE: **(33) 1 47 67 47 67** (Paris), SOUTHERN EUROPE: **(39) 2 6601 1800** (Milan) or **(34) 1 807 1700** (Madrid)

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