Data Sheet
June 1993

AT&T Microelectronics

CW030-Series Power Modules: 36 Vdc to 72 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.

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
- High efficiency: 83% typical
- Adjustable output voltage: 90% to 110% of $V_{O,\,nom}$
- UL and CSA recognized
- Within FCC and VDE Class A Radiated Limits

Options

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

Applications

- Distributed power architectures
- Telecommunications

Description

The CW030A, B, and C Power Modules are dc-dc converters that operate over an input voltage range of 36 Vdc to 72 Vdc and provide precisely regulated 5 V, 12 V, and 15 V outputs respectively. The 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.

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	—	—	500	V
Transient (1 min)	—	—	800	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	72	Vdc
Maximum Input Current (V_I = 0 V to 72 V; $I_O = I_{O,\,max}$)	$I_{I,\,max}$	—	—	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.)	—	—	25	—	mA p-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 *Underwriters Laboratories Conditions of Acceptability* requires a normal-blow, dc fuse with a maximum rating of 5 A in series with the input. 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 operating input voltage, resistive load, and temperature conditions until end of life.)	CW030A CW030B CW030C	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 CW030B CW030C	$V_{O,\,set}$ $V_{O,\,set}$ $V_{O,\,set}$	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 72 V) Load ($I_O = I_{O,\,min}$ to $I_{O,\,max}$) Temperature (T_C = –40 °C to +100 °C)	 all all CW030A,B,C	 — — —	 — — —	 0.01 0.05 0.5	 0.1 0.2 1.5	 % % %
Output Ripple and Noise (See Figure 14.): RMS Peak-to-peak (5 Hz to 20 MHz) 	 CW030A CW030B, C CW030A CW030B, C	 — — — —	 — — — —	 — — — —	 20 25 150 200	 mV rms mV rms mV p-p mV p-p
Output Current (At $I_O < I_{O,\,min}$, the modules may exceed output ripple specifications.)	CW030A CW030B CW030B CW030C	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 $V_{O,\,NOM}$	 CW030A CW030B CW030C	 — — —	 — — —	 6.9 3.6 2.5	 — — —	 A A A
Output Short-circuit Current (V_O = 250 mV)	CW030A CW030B CW030C	— — —	— — —	8.0 4.0 3.0	— — —	A A A
Efficiency (V_I = 48 V; $I_O = I_{O,\,max}$; T_C = 25 °C; see Figure 14.)	CW030A CW030B, C	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 $I_{O,\,max}$: Peak Deviation Settling Time (V_O < 10% 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	 — — — —	 — — — —	 2 0.5 2 0.5	 — — — —	 $\%V_{O,\,set}$ ms $\%V_{O,\,set}$ 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)		TBD		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 72 V; open collector or equivalent compatible; signal referenced to V_I(–) terminal. See Figure 16 and Feature Descriptions.):						
Logic Low—Module Off						
Logic High—Module On						
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 ($V_{on/off}$ =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 (@ 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	$V_{O,\,clamp}$	5.6	—	7.0	V
	CW030B	$V_{O,\,clamp}$	13.0	—	16.0	V
	CW030C	$V_{O,\,clamp}$	17.0	—	20.0	V

Characteristic Curves

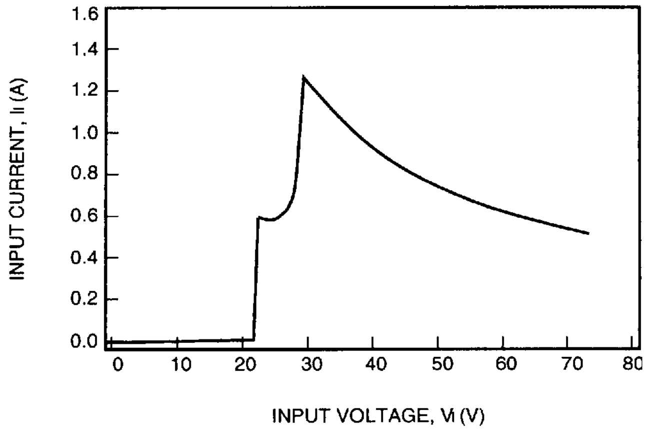


Figure 1. CW030-Series Typical Input Characteristic

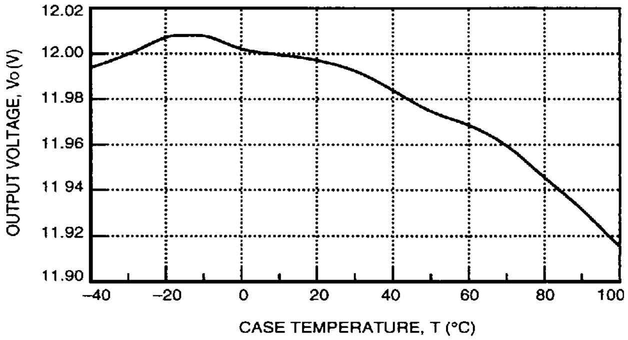


Figure 3. CW030B Typical Output Voltage Variation over Ambient Temperature Range

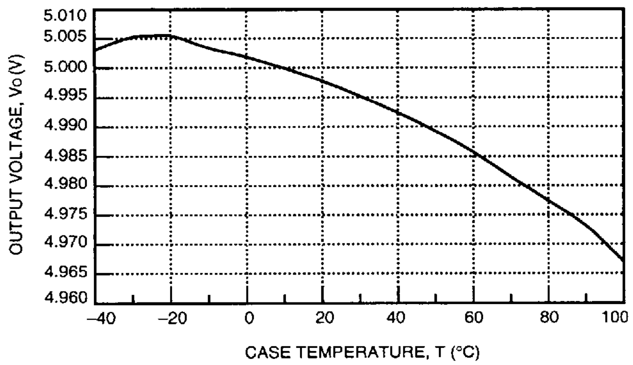


Figure 2. CW030A Typical Output Voltage Variation Over Ambient Temperature Range

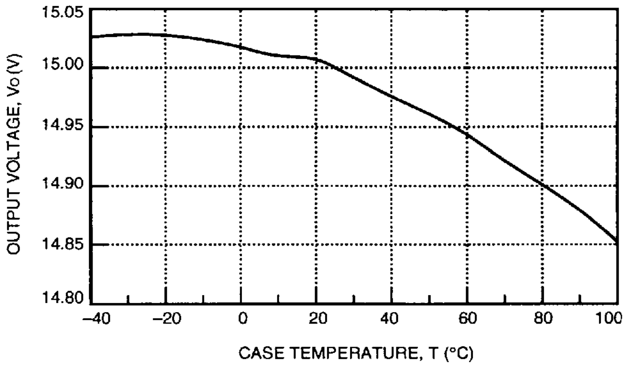


Figure 4. CW030C Typical Output Voltage Variation over Ambient Temperature Range

Characteristic Curves (continued)

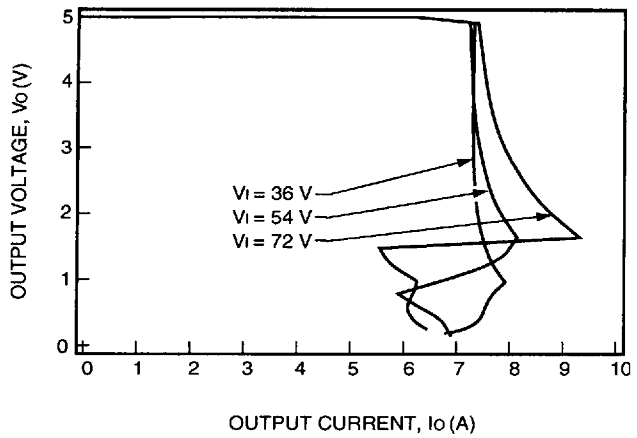


Figure 5. CW030A Typical Output Characteristics

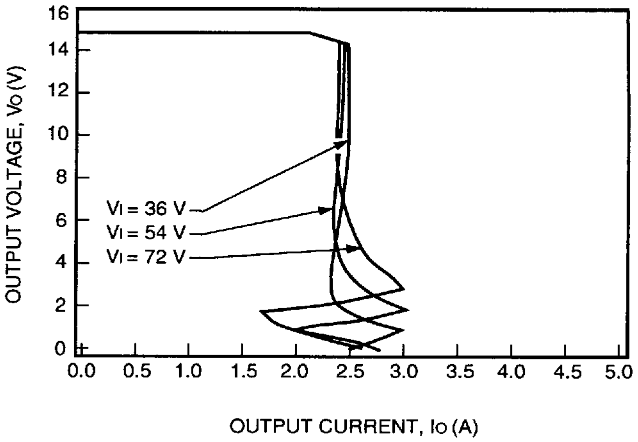


Figure 7. CW030C Typical Output Characteristics

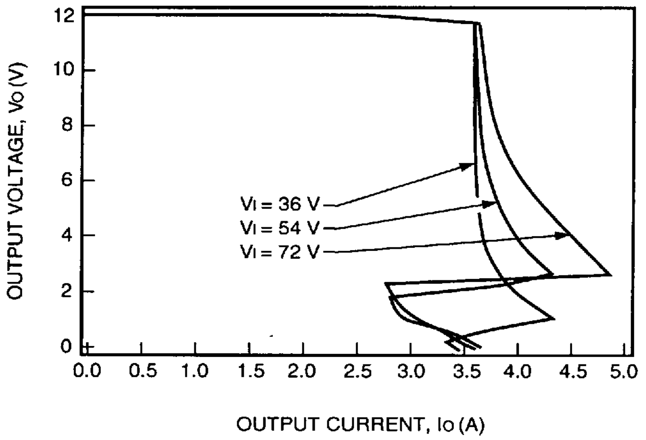


Figure 6. CW030B Typical Output Characteristics

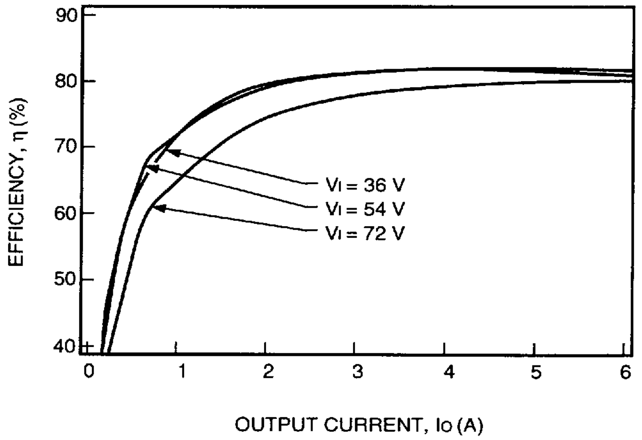


Figure 8. CW030A Typical Converter Efficiency vs. Output Current

Characteristic Curves (continued)

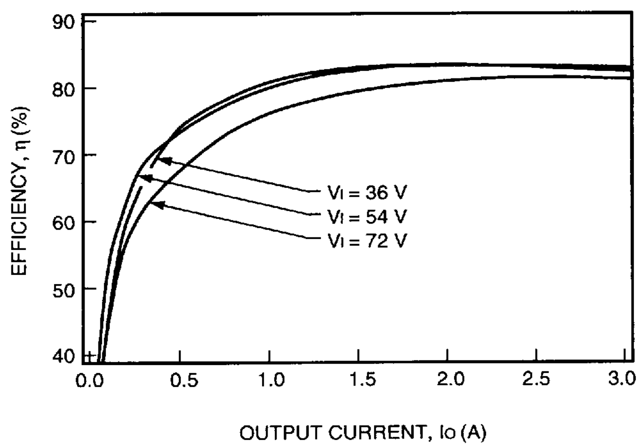


Figure 9. CW030B Typical Converter Efficiency vs. Output Current

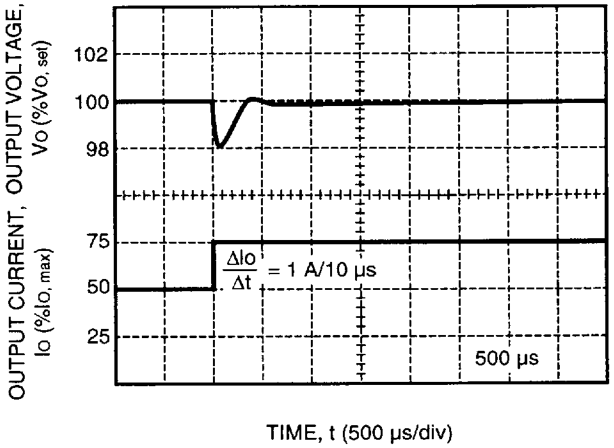


Figure 11. Typical Output Voltage for a Step Load Change from 50% to 75%

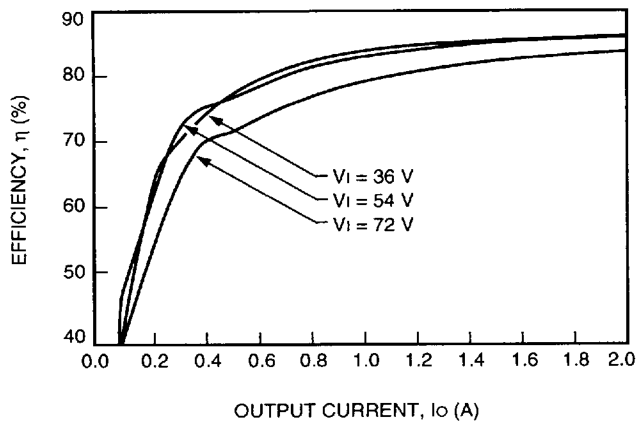


Figure 10. CW030C Typical Converter Efficiency vs. Output Current

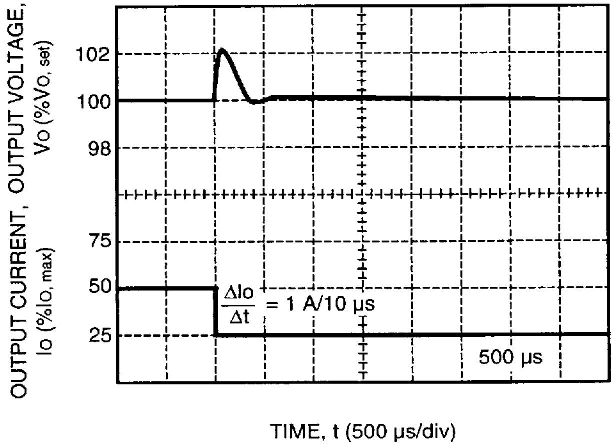


Figure 12. Typical Output Voltage for a Step Load Change from 50% to 25%

Characteristic Curves (continued)

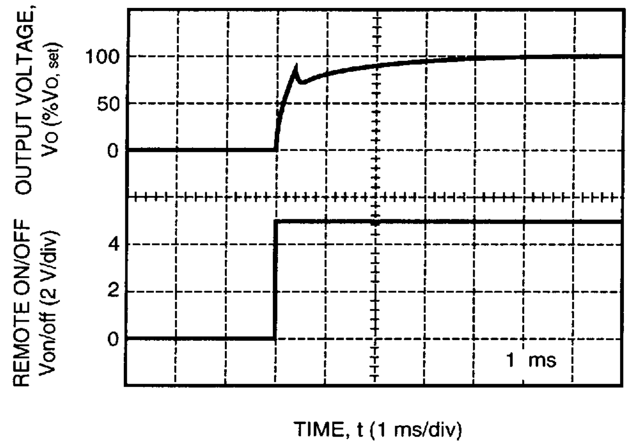
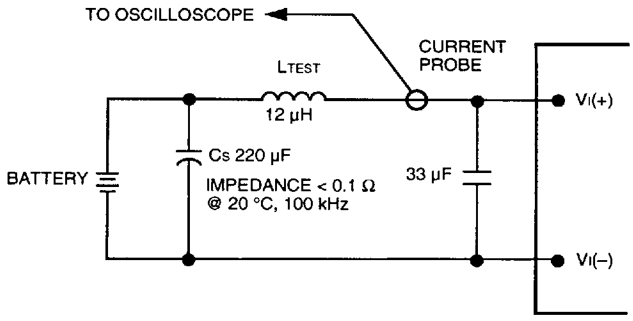


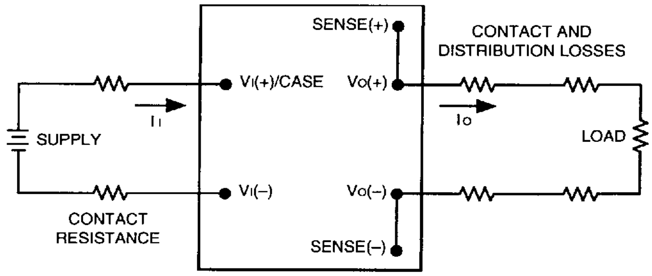
Figure 13. Typical Output Voltage Start-up when Signal Applied to Remote On/Off

Test Configurations



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

Figure 14. Input Reflected-Ripple Test Setup



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: $V_{I(+)}$ is internally connected to case.

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.

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 60 950.

For the converter output to be considered 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 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 16). 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.

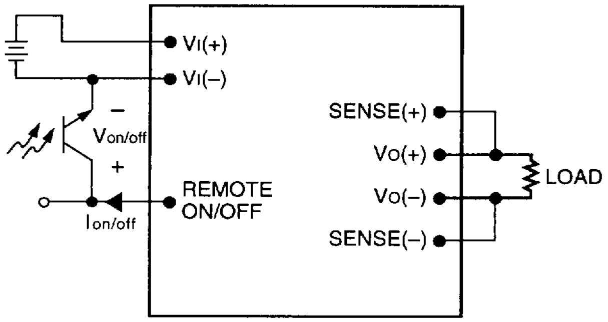


Figure 16. Remote On/Off Implementation

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.

Feature Descriptions (continued)

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 17 and 18). 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	16.940
CW030B	15.732
CW030C	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.

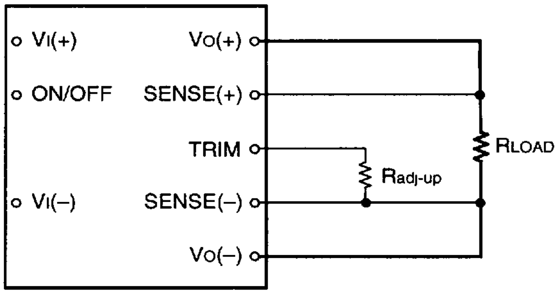


Figure 17. Circuit Configuration to Increase Output Voltage

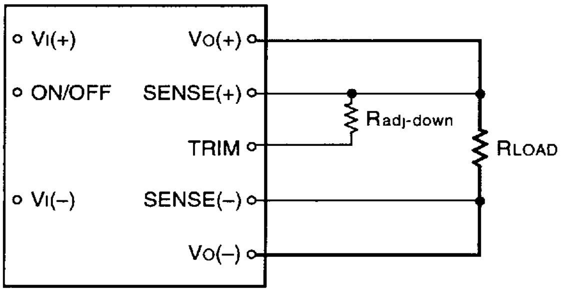


Figure 18. Circuit Configuration to Decrease Output Voltage

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

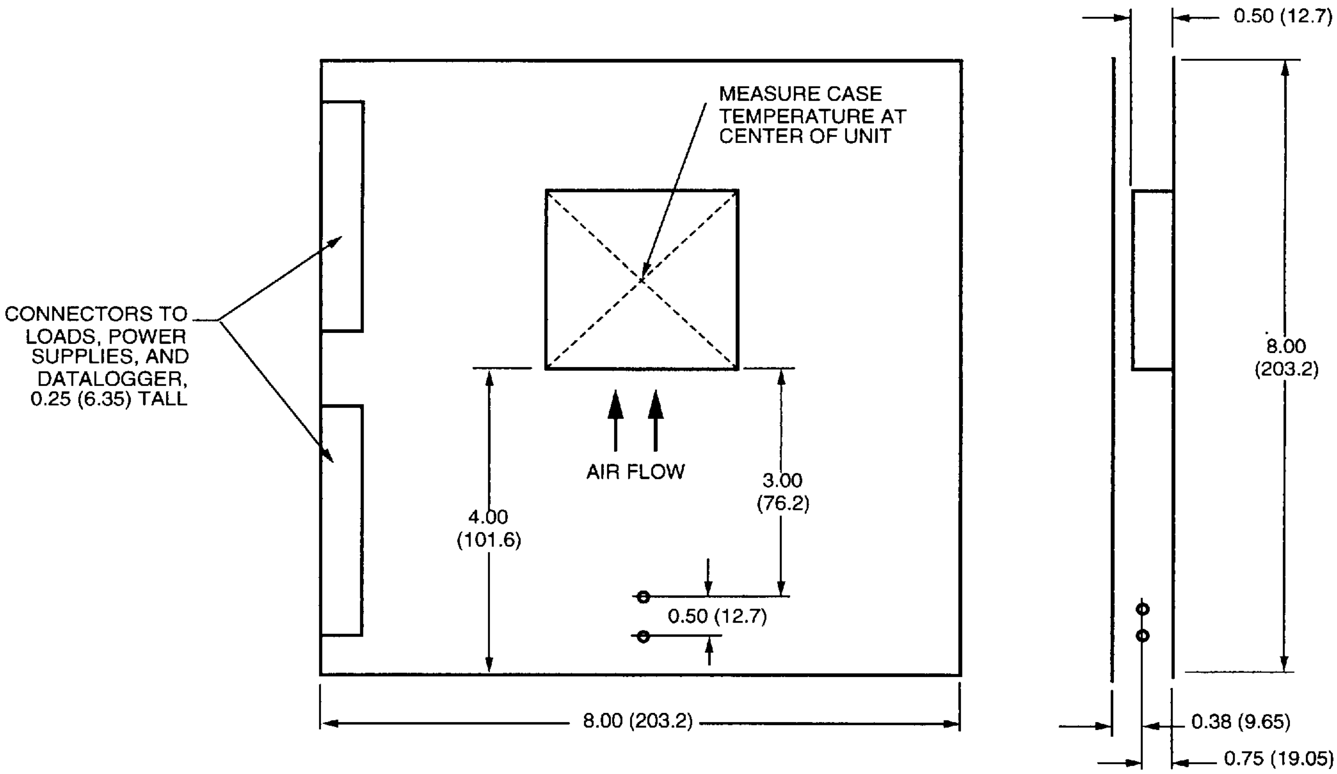


Figure 19. Thermal Test Setup

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 19 was used to collect data for Figures 20 and 21.

The graphs in Figures 20 and 21 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.

Thermal Considerations (continued)

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 55 °C can be achieved without the use of an external heat sink (see Figure 20).

Higher ambient temperatures can be sustained by increasing the airflow or by adding a heat sink (see Use of Heat Sinks and Cold Plates section). As stated, this data is based on a maximum case temperature of 100 °C and measured in the test configuration of Figure 19.

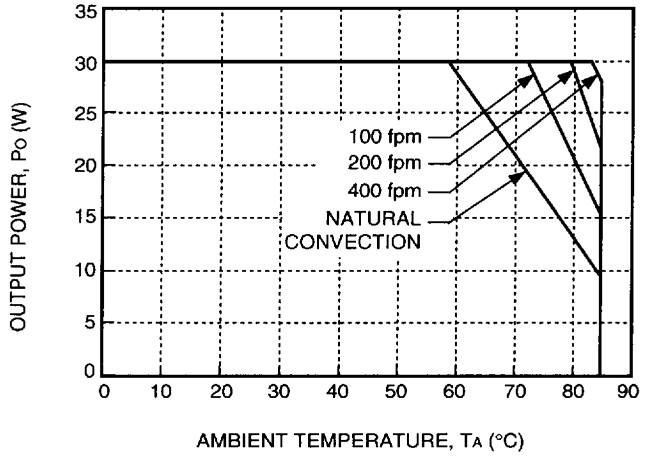


Figure 20. CW030A/B/C Derating Curve

Case-to-Ambient Thermal Impedance

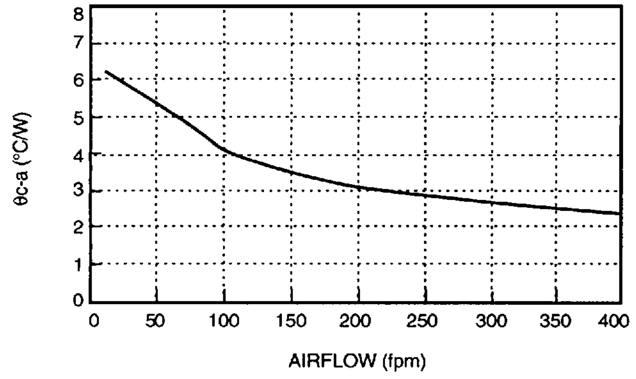


Figure 21. CW030A/B/C Case to Ambient Thermal Impedance

Figure 21 shows the case-to-ambient thermal impedance, θ_{ca} (°C/W) for the CW030 modules. This information is used to predict the case temperature for a given operating point and airflow using the equation:

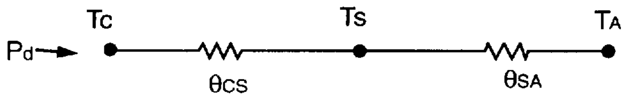
$$T_C = P_O\left(\frac{1-\eta}{\eta}\right)\theta_{ca} + T_A$$

where T_C is the case temperature (°C), P_O is the output power (W), η is the efficiency for the desired voltage and load (see Characteristics Curves section), and T_A is the ambient inlet temperature (°C).

Use of Heat Sinks and Cold Plates

The CW030 case includes through-threaded 4-40 mounting holes allowing attachment of heat sinks or cold plates from either side of the module. The mounting torque must not exceed 5 in.-lb.

The following thermal model can be used to determine the required thermal resistance of the sink to provide the necessary cooling:



where P_d is the power dissipated by the module, θ_{cs} represents the interfacial contact resistance between the module and the sink, and θ_{SA} is the sink-to-ambient thermal impedance (°C/W). For thermal greases or foils, a value of θ_{cs} = 0.1 °C/W to 0.3 °C/W is typical. Substituting for:

$$P_d = \frac{P_O(1-\eta)}{\eta}$$

the required θ_{SA} is calculated from the following equation:

$$\theta_{SA} = \frac{(T_C - T_A)\times\eta}{(1-\eta)P_O} - \theta_{CS}$$

Note that this equation assumes that all dissipated power must be shed by the sink. Depending on the user-defined application environment, a more accurate model including heat transfer from the sides and rear of the module can be used. This equation provides a conservative estimate in such instances.

Outline Diagram

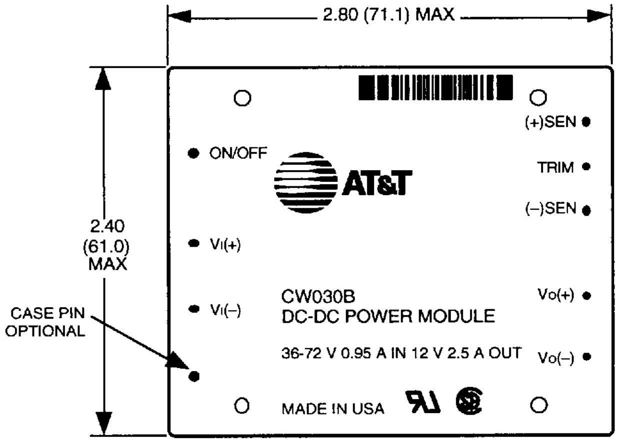
Dimensions are in inches and (millimeters).

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

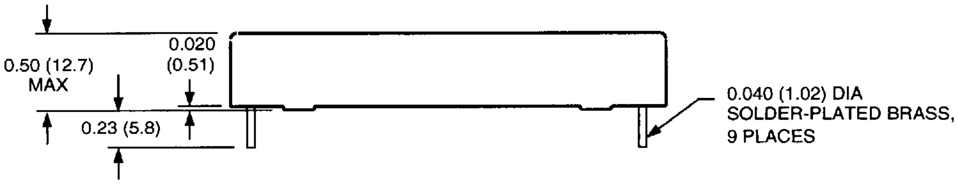
Tolerances: x.xx in. ± 0.02 in. (0.5 mm), x.xxx in. ± 0.010 in. (0.25 mm)

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

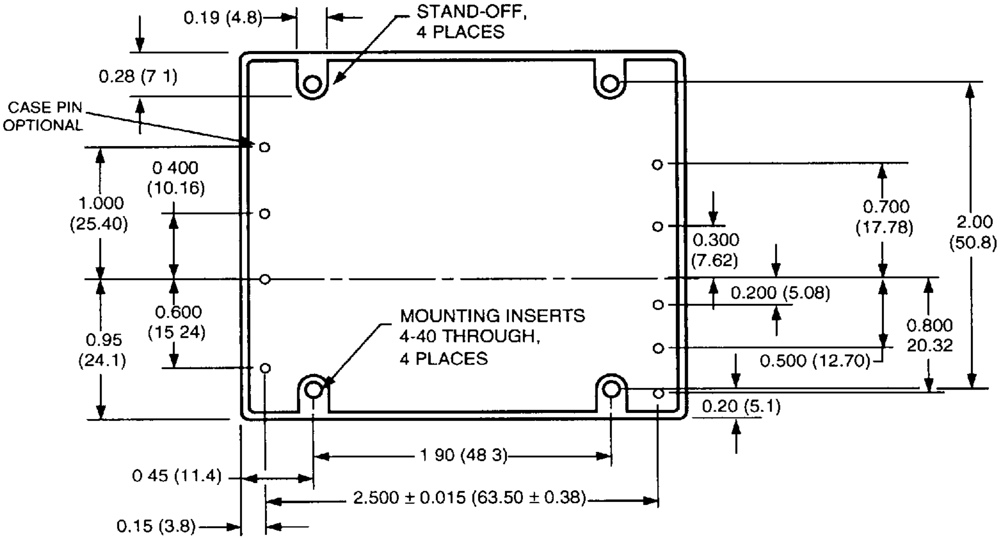
Top View



Side View



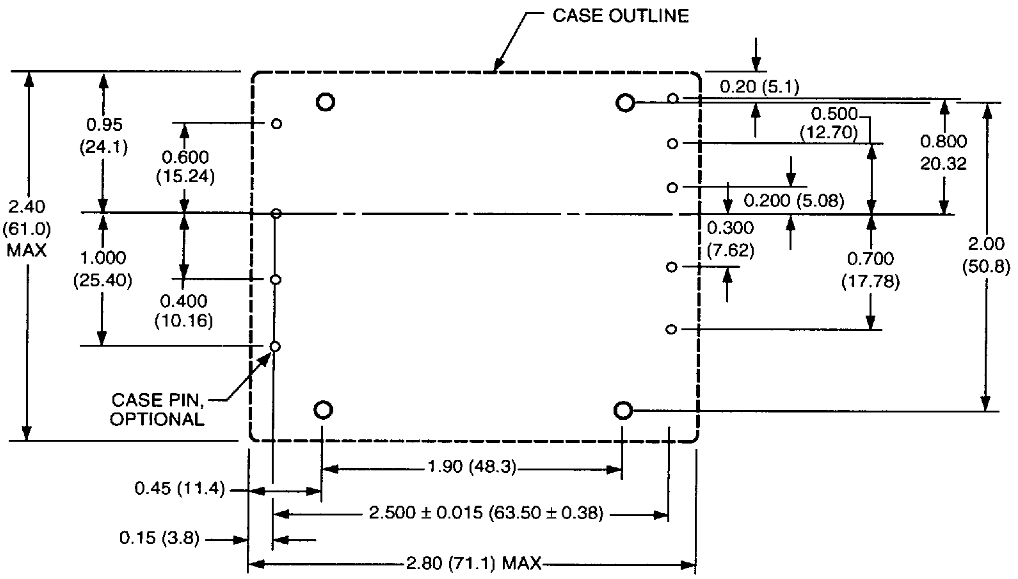
Bottom View



Recommended Hole Pattern

Component-side footprint.

Dimensions are in inches and (millimeters).



Ordering Information

For assistance with ordering options, please contact your AT&T Account Manager or Application Engineer.

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
48 V	5 V	30 W	CW030A	106745029
48 V	12 V	30 W	CW030B	106745045
48 V	15 V	30 W	CW030C	106745052