

## Preliminary Data Sheet



## 984-Series Power Modules; 48 Vdc Input, 5 Vdc or 12 Vdc Output, 30 W



The 984-Series Power Modules feature input-to-output isolation, allowing versatile polarity configurations and grounding connections.

### Features

- High reliability: MTBF > 1,000,000 hours at 40°C
- Complete input and output filtering
- Small size: 2.0 in. × 3.6 in. × 0.75 in.
- Input-to-output isolation
- No minimum load
- UL recognized: Standard 1012
- CSA certified
- Output current limiting: unlimited duration
- Remote on/off
- Meets FCC EMI Class A requirements
- Motor start-up surge-current capacity: 3 A for 1 s (984D only)

### Applications

- Telecommunications
- Digital circuits
- Private branch exchange (PBX)
- Distributed power architecture
- Disk drives

### Description

The 984A and 984D Power Modules are designed for high reliability and ease of application. The fully encapsulated units mount directly on printed circuit boards, where each device provides 30 W of output power from nominal 48 V inputs in only 7.2 square inches of footprint area. The devices include complete input and output filtering so no additional circuitry is necessary. Total input-to-output isolation allows the user to select any polarity configuration desired.

The TTL-compatible remote on/off feature enables the user to control the turn-on of the units, which is especially useful for sequenced circuit power-up. For airflows of 200 fpm or more, the 984A can be operated at full load over the temperature range  $-40^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  without derating or heat sink. Using only natural convection, the 984D can also be operated over the same temperature range at full load without derating or heat sink.

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**Absolute Ratings**

Exceeding these values can damage the module.

Parameter	Device	Symbol	Min	Max	Unit
Input Voltage	all	$V_I$	—	60	V
I/O Isolation Voltage	all		—	500	V
Operating Ambient Temperature (air velocity = 200 fpm)	984A	$T_A$	-40	+70	°C
	984D	$T_A$	-40	+80	°C
Storage Temperature	all		-50	+105	°C

**Electrical Specifications**

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

Parameter	Device	Symbol	Min	Typ	Max	Unit
<b>Input</b>						
Operating Input Voltage	all	$V_I$	40	48	60	V
Max. Input Current ( $V_I = 0$ to 60 V)(see Figure 1)	all	$I_{I, max}$	—	—	1.1	A
Inrush Transient	all	$i^2t$	—	—	0.7	A <sup>2</sup> s
Input Reflected Ripple Current, Peak-to-Peak (5 Hz to 20 MHz, 12 $\mu$ H source impedance) (see Figure 12)	all		—	30	—	mA p-p
Input Ripple Rejection (120 Hz)	all		—	60	—	dB

**Fusing Considerations**

These encapsulated power modules 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 comply with UL Conditions of Acceptability and to achieve maximum safety and system protection, an input line fuse should always be used. This data sheet provides information on inrush energy, maximum dc input current, and the fuse type and rating specified in the UL report. The same type of fuse with a lower rating may be used, but under no circumstances should the dc rating of the fuse exceed the maximum value stated in the Conditions of Acceptability for UL recognition. Refer to the fuse manufacturer's data for further information.

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## Electrical Specifications (Continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit	
<b>Output</b>							
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life)	984A	$V_O$	4.75	—	5.25	Vdc	
	984D	$V_O$	11.40	—	12.60	Vdc	
Output Voltage Set Point ( $V_I = 48$ V, $I_O$ at full load, $T_A = 25$ °C)	984A	$V_{O\ set}$	4.92	5.00	5.08	Vdc	
	984D	$V_{O\ set}$	11.80	12.00	12.20	Vdc	
Output Regulation (see Figures 2 and 3): Line ( $V_I = 40$ V to 60 V) Load ( $I_O$ at min. to max. load) Temperature ( $T_A = -40$ °C to +70 °C)	all		—	0.02	0.15	%	
	all		—	0.5	0.8	%	
	all		—	25	60	mV	
Output Ripple and Noise: RMS  Peak-to-Peak (5 Hz to 20 MHz)	984A		—	10	20	mV rms	
	984D		—	15	30	mV rms	
	984A		—	120	200	mV p-p	
	984D		—	150	250	mV p-p	
Output Current	984A	$I_O$	0	—	6	A	
	984D	$I_O$	0	—	2.5	A	
Output Current Limit Inception: ( $V_O = 0.9 \times 5.0$ V)(see Figure 4) ( $V_O = 0.9 \times 12.0$ V)(see Figure 4)	984A		—	6.5	—	A	
	984D		—	3.3	—	A	
Output Current Limit ( $V_O = 1.0$ V) (see Figure 4)	984A		6.5	—	8	A	
	984D		3.5	—	7	A	
Output Short-Circuit Current ( $V_O = 250$ mV)(see Figure 4)	all		—	9	—	A	
Efficiency (see Figure 5) ( $V_I = 48$ V, $I_O$ at full load, $T_A = 25$ °C)	984A	$\eta$	78	82	—	%	
	984D	$\eta$	82	86	—	%	
Dynamic Response ( $\Delta I_O / \Delta t = 1$ A/ 10 $\mu$ s, $V_I = 48$ V, $T_A = 25$ °C): Load Change from $I_O = 50\%$ to 75% Full Load: Peak Deviation Settling Time ( $V_O < 10\%$ peak deviation)(see Figures 6 and 7) Load Change from $I_O = 50\%$ to 25% Full Load: Peak Deviation Settling Time ( $V_O < 10\%$ peak deviation)(see Figure 8)	all		—	50	—	mV	
	all		—	350	—	$\mu$ s	
	all		—	60	—	mV	
	all		—	300	—	$\mu$ s	
	<b>Isolation</b>						
	Isolation Capacitance	all		—	1000	—	pF
Isolation Resistance	all		10	—	—	M $\Omega$	

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**General Specifications**

Parameter	Device	Min	Typ	Max	Unit
Calculated MTBF (80% full load and case temperature = 40 °C)	all	1,020,000			hours
Weight	all	—	—	5.8	oz.

**Feature Specifications**

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

Parameter	Symbol	Min	Typ	Max	Unit
Remote On/Off (40 V < V <sub>I</sub> < 60 V): Level Controlled:					
Voltage Level High — Unit Off:	all	2	—	8	V
Source Current	all	25	—	160	μA
Voltage Level Low — Unit On:	all	—	—	1.25	V
Sink Current	all	—	—	10	μA
Turn-On Time	984A	—	2.5	3	ms
(80% full load and V <sub>O</sub> within ±1% of steady state)	984D	—	4	5	ms
Output Voltage Overshoot (see Figures 10 and 11)	all	—	—	5	%
Output Overvoltage Clamp	984A	5.3	—	7	V
	984D	12.7	—	16.0	V
ΔV <sub>O</sub> During Output Current Surge (I <sub>O</sub> = 1.8 to 3 A for 1 s)	984D	—	100	500	mV

**Characteristics**

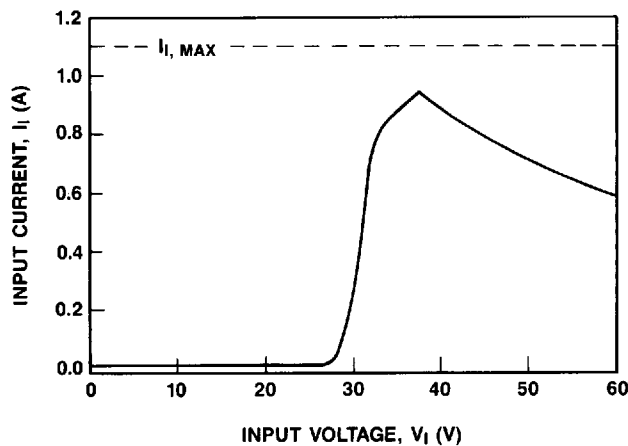


Figure 1. 984-Series Typical Input Characteristic with a Resistive Load of I<sub>O</sub> = I<sub>O,max</sub> and T<sub>A</sub> = 25 °C

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Characteristics (Continued)

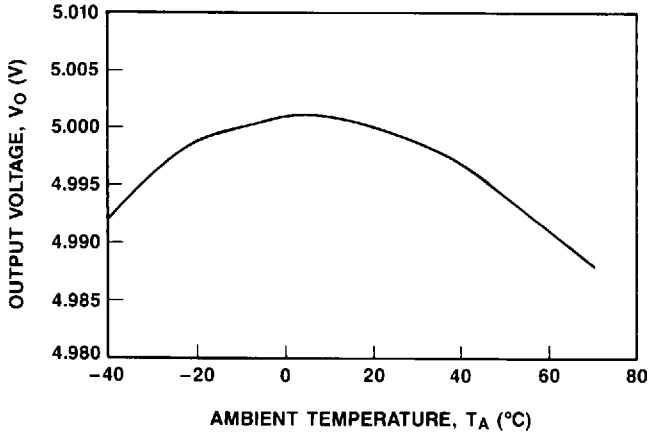


Figure 2. 984A Typical Output Voltage Variation Over Operating Ambient Temperature Range at Full Load and with  $V_i = 48$  V

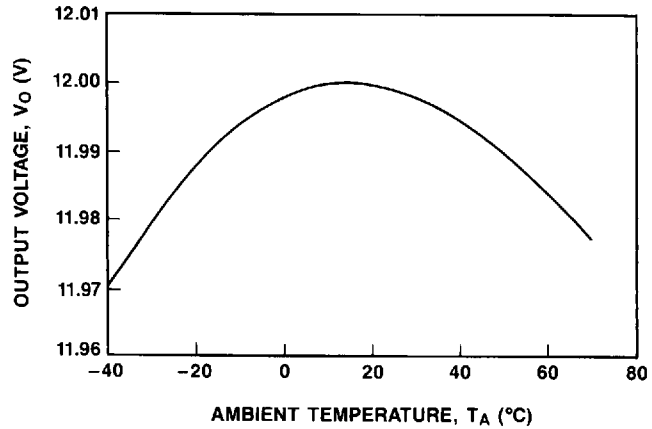


Figure 3. 984D Typical Output Voltage Variation Over Operating Ambient Temperature Range at Full Load and with  $V_i = 48$  V

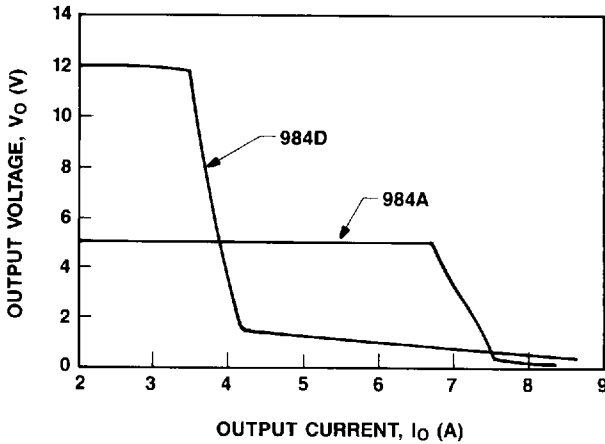


Figure 4. 984-Series Typical Output Characteristics with  $V_i = 48$  V and  $T_A = 25^\circ\text{C}$

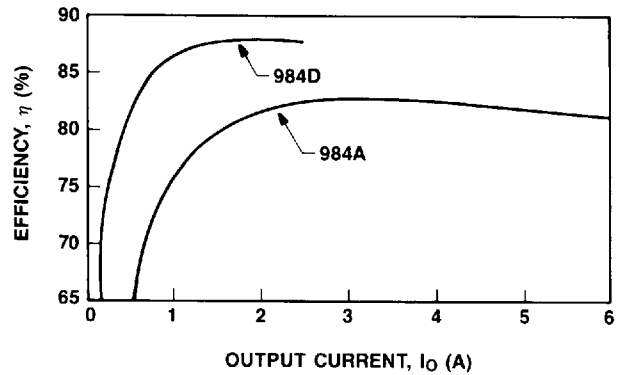


Figure 5. 984-Series Typical Converter Efficiencies as a Function of Output Current with  $V_i = 48$  V and  $T_A = 25^\circ\text{C}$

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Characteristics (Continued)

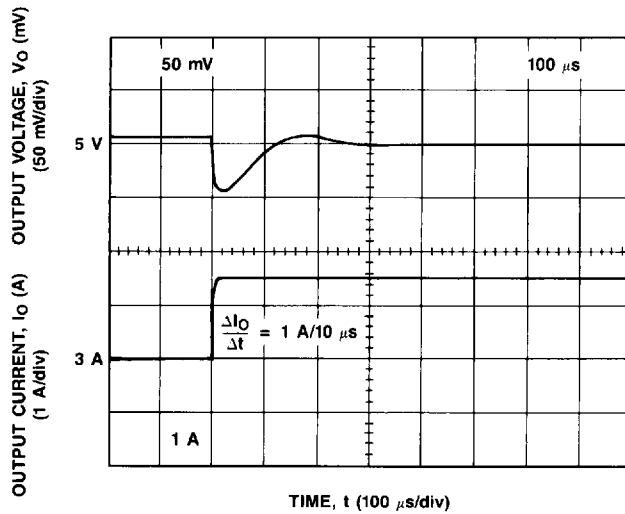


Figure 6. 984A Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of Full Output Power,  $V_I = 48$  V, and  $T_A = 25^\circ\text{C}$

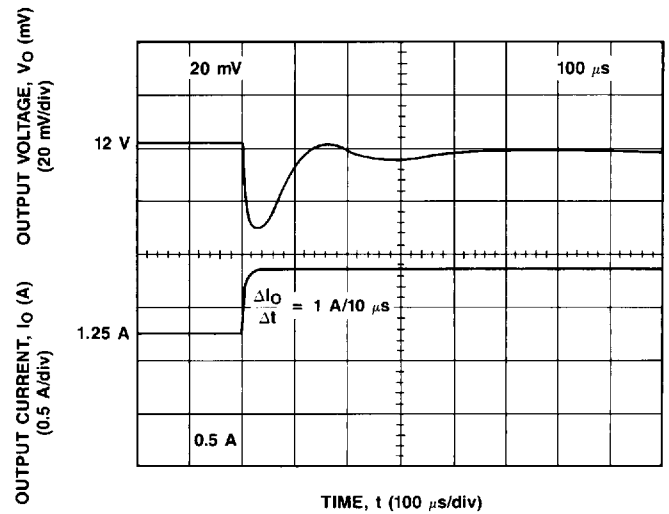


Figure 7. 984D Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of Full Output Power,  $V_I = 48$  V, and  $T_A = 25^\circ\text{C}$

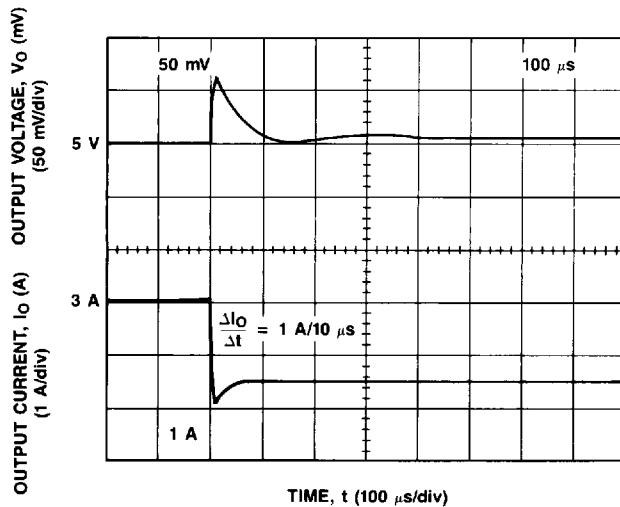


Figure 8. 984A Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of Full Output Power,  $V_I = 48$  V, and  $T_A = 25^\circ\text{C}$

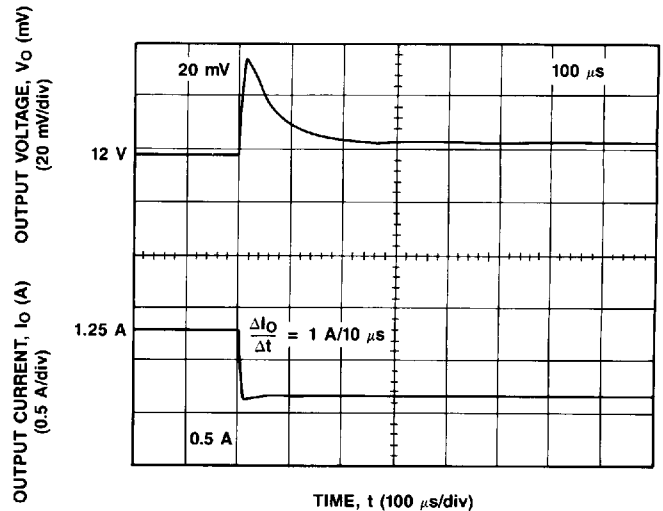


Figure 9. 984D Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of Full Output Power,  $V_I = 48$  V, and  $T_A = 25^\circ\text{C}$

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Characteristics (Continued)

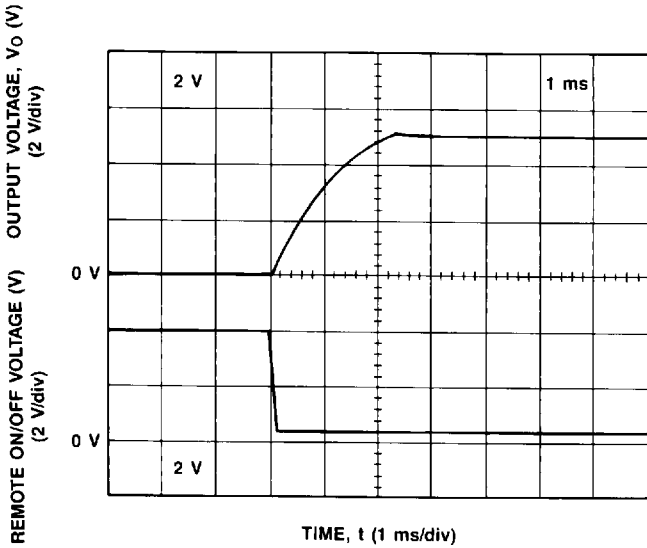


Figure 10. 984A Typical Output Voltage Start-Up Waveform Once Remote On/Off Is Removed at  $V_i = 48 \text{ V}$ ,  $I_o = 80\%$  of Full Load, and  $T_A = 25^\circ \text{C}$

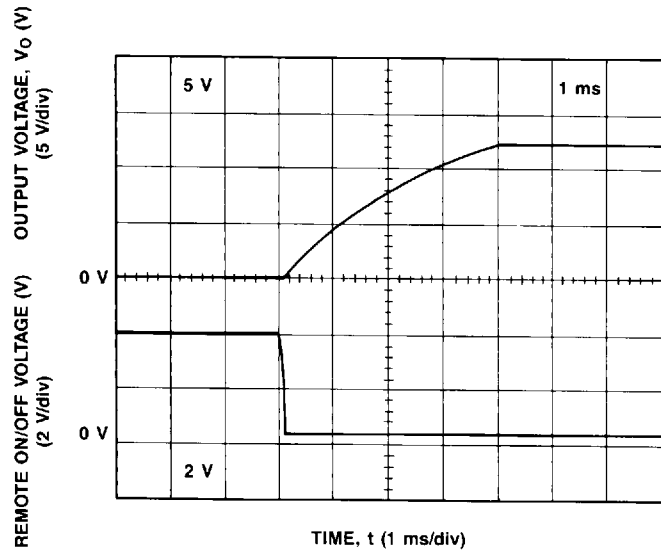
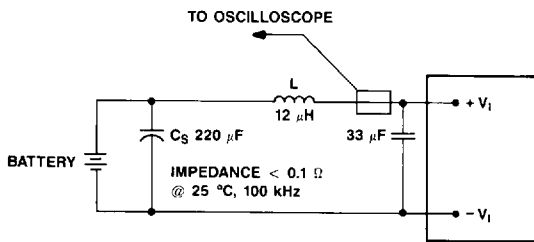


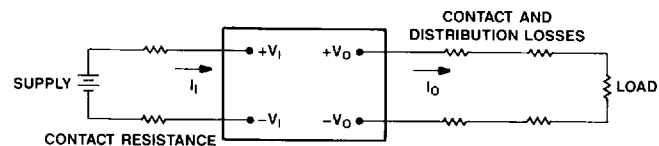
Figure 11. 984D Typical Output Voltage Start-Up Waveform Once Remote On/Off Is Removed at  $v_i = 48 \text{ V}$ ,  $I_o = 80\%$  of Full Load, and  $T_A = 25^\circ \text{C}$

Test Configurations



Note: Input-reflected ripple current is measured with a simulated source impedance of  $12 \mu\text{H}$ . Capacitor  $C_s$  will offset possible battery impedance. Current is measured at the input of the module.

Figure 12. Input Reflected Ripple Test Set-Up



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.

$$\eta = \frac{[+V_o - (-V_o)] I_o}{[+V_i - (-V_i)] I_i}$$

Figure 13. Output Voltage and Efficiency Measurement Test Set-Up

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## Feature Descriptions

### Remote On/Off

The remote on/off feature enables the user to control the turn-on of the unit. This is especially useful for sequenced circuit power-up. A TTL-compatible voltage potential between terminals ON/OFF and IN (-) turns the power unit on and off. The user must furnish a supply with two voltage levels. An applied voltage between 2 V and 8 V with a source current between 25  $\mu$ A and 160  $\mu$ A will turn the power module off. A voltage less than 1.25 V will keep the power module on (see Figure 14). If this feature is not used, the power module will remain on when the ON/OFF and IN (-) terminals are shorted together or when the ON/OFF terminal is allowed to float.

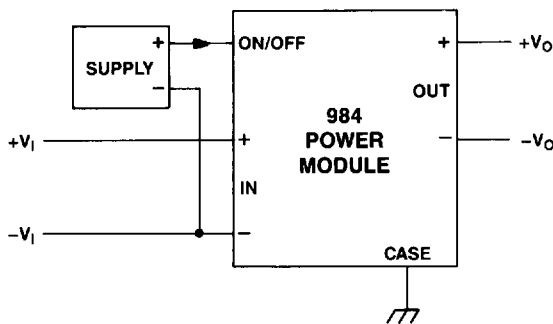


Figure 14. Remote On/Off Implementation

### Output Overvoltage Clamp

The output overvoltage clamp consists of control circuitry that monitors the voltage on the output terminals, independent of the primary regulation loop. The control loop for the clamp has a higher set point of nominally 120% of the typical  $V_{Oset}$ . This feature provides a redundant voltage-control capability that reduces the risk of damage due to output overvoltage.

### Current Limit

Each unit is equipped with internal current limiting that will operate for an unlimited duration. The module will operate normally once the output current is brought into the specified range.

### Output Current Surge (984D)

For disk drive and other motor applications where start-up current exceeds the steady-state operating current, the 984D Power Module can provide a 3 A surge of current of 1 s with no more than 500 mV deviation in output voltage. This load surge may be repeated once every 30 s.



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**Note for UL Application**

The Underwriters Laboratories Conditions of Acceptability for using the 984A and 984D Power Modules as UL-recognized components require a 5 A, normal blow, dc fuse in series with the input of the module.

**Thermal Management**

Figures 15 and 16 show the output power derating curves for units mounted horizontally on one-inch board spacing under either natural convection or 200 fpm forced air conditions. Air velocity is measured with a hot-wire anemometer placed two inches above the unit in the center of the channel formed by the front of the unit and the adjacent board. To ensure proper operation in other environments, the user must not allow the case temperature to exceed 100°C. Refer to the Outline Diagram for the location of the case temperature measurement.

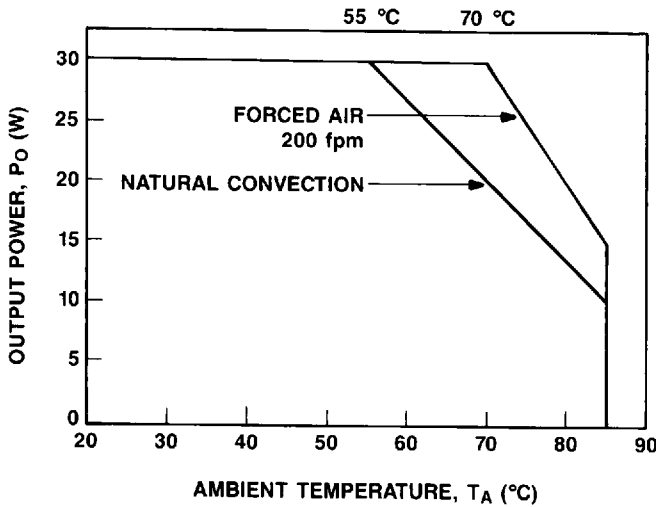


Figure 15. 984A Output Power Derating Curves

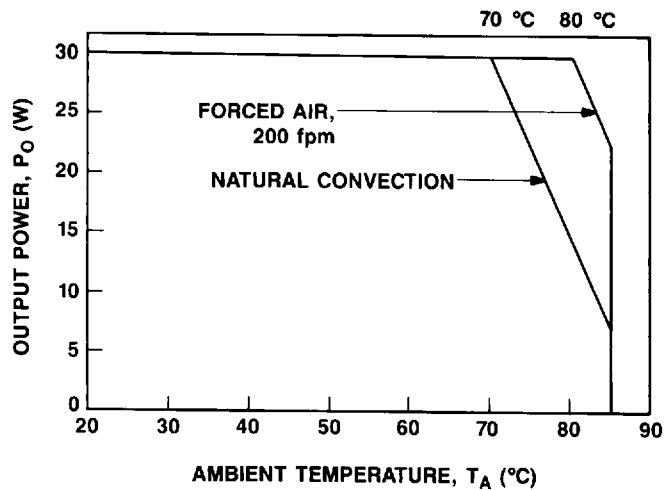


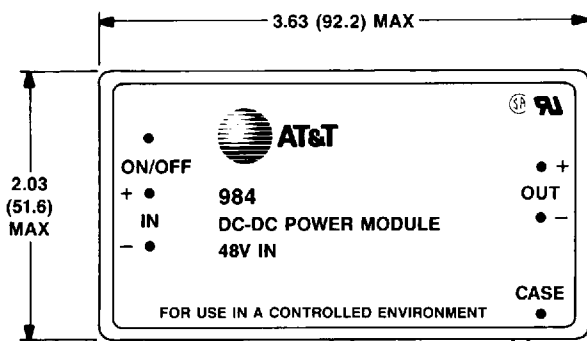
Figure 16. 984D Output Power Derating Curves

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**Module Dimensions**

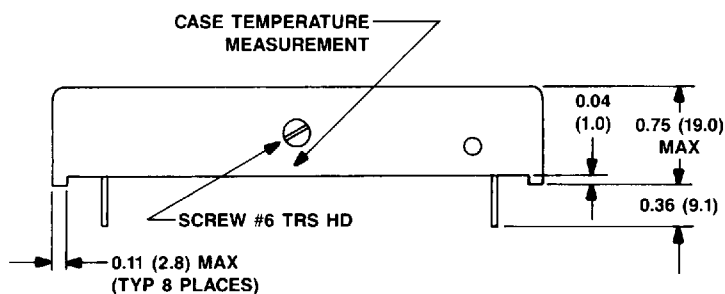
Dimensions are in inches and (millimeters).

**Top View**

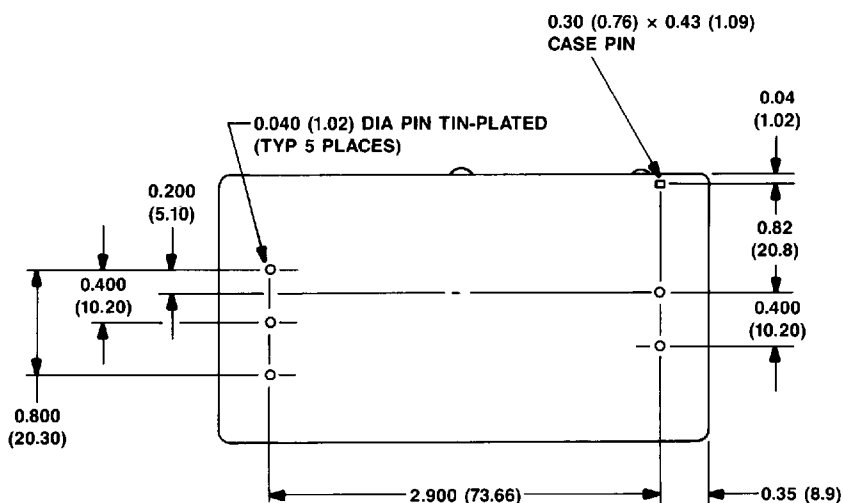


**Side View**

Drawing 8-230



**Bottom View**



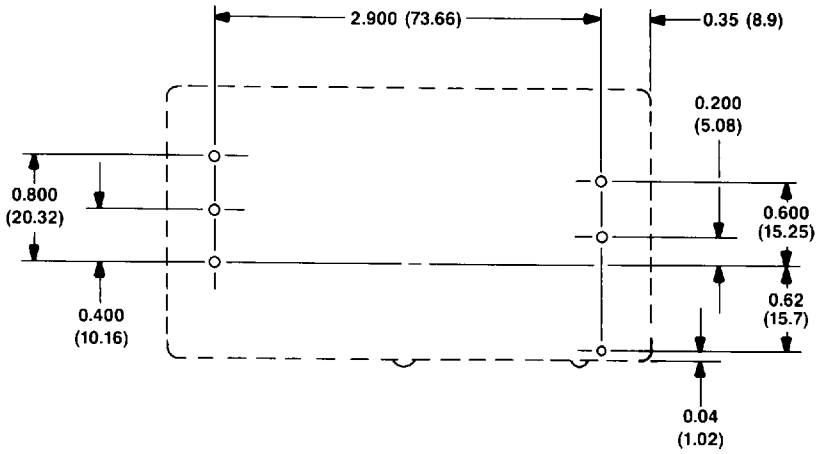
Tolerances: x.xx ± 0.02 inch (0.5 mm), x.xxx ± 0.015 inch (0.38 mm)

A T & T MELEC (CMPNT/PWR) 25E D

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**Recommended Hole Pattern** (Component-Side Footprint)

Dimensions are in inches and (millimeters).



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Module Code	AT&T Comcode
984A	104055033
984D	104199666