Preliminary Data Sheet

AT&T

T-57-11

990-Series Power Modules; 48 Vdc Input, 5 Vdc or 12 Vdc Output, 100 W

The 990-Series Power Modules feature input-to-output isolation, allowing versatile polarity configurations and grounding connections.

Features

- High efficiency: η = 84%, typ (990A1)
  η = 88%, typ (990B1)
- Parallel operation with load sharing
- Low profile: 0.6 in.
- Meets FCC Class A requirements for telecommunications
- Complete input and output filtering
- Input-to-output isolation
- Remote sense
- Remote on/off
- Short-circuit protection
- Output overvoltage clamp:
  V_O < 6.3 V (990A1)
  V_O < 13.5 V (990B1)

Applications

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

Description

The 990A1 and 990B1 Power Modules are high-efficiency dc-dc converters mounted on printed circuit boards. The devices operate from standard 48 Vdc inputs and provide precisely regulated dc outputs that are fully isolated.

Built-in filtering for both the inputs and outputs eliminates the need for external filters. Two or more 990-Series Power Modules may be paralleled with forced load sharing for redundant or enhanced power applications. The packages are designed to easily accommodate a heat sink for high-temperature applications. The devices are available with two styles of heat sinks (see Figures 22 and 23).

Absolute Ratings

Exceeding these values can damage the module.

Parameter	Device	Symbol	Min	Max	Unit
Input Voltage	all	V_I	—	60	Vdc
I/O Isolation Voltage	all		—	500	Vdc
Operating Ambient Temperature (see Thermal Management section)	all	T_A	0	70	°C
Storage Temperature	all		−40	+100	°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
Input						
Operating Input Voltage	all	V_I	40	48	60	Vdc
Maximum Input Current (V_I = 0 V to 60 V) (see Figures 1 and 2)	990A1	$I_{I,\,max}$	—	—	4.1	A
	990B1	$I_{I,\,max}$	—	—	3.9	A
Inrush Transient	all	I^2t	—	—	1.8	A^2s
Input Reflected Ripple Current, Peak-to-Peak (5 Hz to 20 MHz, 12 μH source impedance) (see Figure 15)	all		—	10	—	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
Output						
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life)	990A1	V_O	4.750	—	5.250	Vdc
	990B1	V_O	11.40	—	12.60	Vdc
Output Voltage Set Point (V_I = 48 V, I_O at full load, T_A = 25 °C)	990A1	$V_{O\,set}$	4.900	5.000	5.100	Vdc
	990B1	$V_{O\,set}$	11.76	12.00	12.24	Vdc
Output Regulation:						
Line (V_I = 40 Vdc to 60 Vdc)	all		—	—	0.2	%
Load (I_O = 2 A to 20 A)	all		—	—	0.2	%
Temperature (T_A = 0 °C to 70 °C)	990A1		—	—	50	mV
(see Figures 3 and 4)	990B1		—	—	120	mV
Output Ripple and Noise Voltage						
RMS	990A1		—	—	35	mV rms
	990B1		—	—	40	mV rms
Peak-to-Peak (5 Hz to 20 MHz)	990A1		—	—	100	mV p-p
	990B1		—	—	120	mV p-p
Output Current	990A1	I_O	0.5	—	20	A
	990B1	I_O	0.5	—	8.5	A
Output Current Limit Inception:						
(V_O = 4.5 V)(see Figure 5)	990A1		21	—	25	A
(V_O = 10.8 V)(see Figure 6)	990B1		9.0	—	11.0	A
Output Short-Circuit Current (V_O = 250 mV)(see Figures 5 and 6)	990A1		—	30	—	A
	990B1		—	13.0	—	A
Efficiency (V_I = 48 V, I_O at full load, T_A = 25 °C) (see Figures 7 and 8)	990A1	η	80	84	—	%
	990B1	η	85	88	—	%
Dynamic Response ($\Delta I_O/\Delta t$ = 1 A/10 μs, V_I = 48 V, T_A = 25 °C):						
Load Change from I_O = 50% to 75% Full Load:						
Peak Deviation	990A1		—	150	—	mV
	990B1		—	90	—	mV
Settling Time	990A1		—	400	—	μs
(V_O < 10% of peak deviation) (see Figures 9 and 10)	990B1		—	120	—	μs
Load Change from I_O = 50% to 25% Full Load:						
Peak Deviation	990A1		—	150	—	mV
	990B1		—	90	—	mV
Settling Time	990A1		—	400	—	μs
(V_O < 10% of peak deviation) (see Figures 11 and 12)	990B1		—	120	—	μs

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Electrical Specifications (Continued)

Parameter	Device	Min	Typ	Max	Unit
Isolation					
Isolation Capacitance	all	—	300	—	pF
Isolation Resistance	all	10	—	—	MΩ

General Specifications

Parameter	Device	Min	Typ	Max	Unit
Calculated MTBF (80% full load and case temperature = 40 °C)	all		550,000		hours
Weight	all	—	—	14	oz.

Feature Specifications

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

Parameter	Device	Min	Typ	Max	Unit
Remote On/Off Switch Specifications ($40\ V < V_I < 60\ V$):					
Switch Open — Unit Off					
Withstand Voltage	all	—	—	5	V
Leakage Current	all	—	—	100	μA
Switch Closed — Unit On					
Contact Voltage	all	—	—	0.25	V
Current Sink	all	—	—	2	mA
Turn-On Time (V_I = 48 V, I_O at 80% full load, T_A = 25 °C, V_O within 1% of steady state)(see Figures 13 and 14)	all	—	5	10	ms
Output Voltage Sense Range	all	—	—	0.5	V
Output Voltage Set Point Adjustment Range	990A1	—	—	10	%
	990B1	—	—	5	%
Parallel Operation Load Sharing	990A1	—	—	3.0	A
	990B1	—	—	1.3	A
Output Overvoltage Clamp	990A1	5.7	—	7.0	V
	990B1	12.6	—	15.4	V

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Characteristics

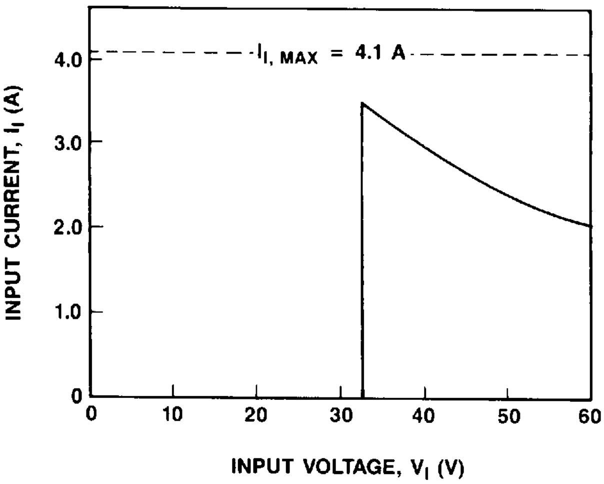

Figure 1. 990A1 Typical Input Characteristic with a Resistive Load of I_O = 20 A and T_A = 25°C

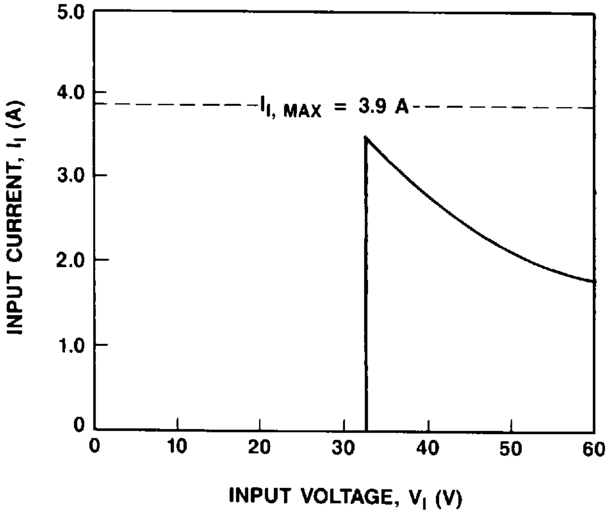

Figure 2. 990B1 Typical Input Characteristic with a Resistive Load of I_O = 8.5 A and T_A = 25°C

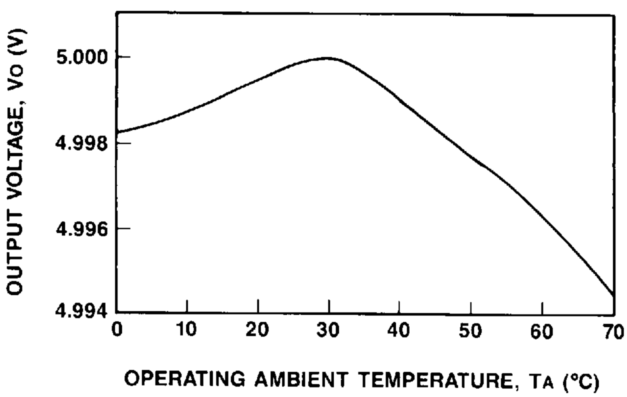

Figure 3. 990A1 Typical Output Voltage Variation Over Operating Ambient Temperature Range at 80% Load and with V_I = 48 V

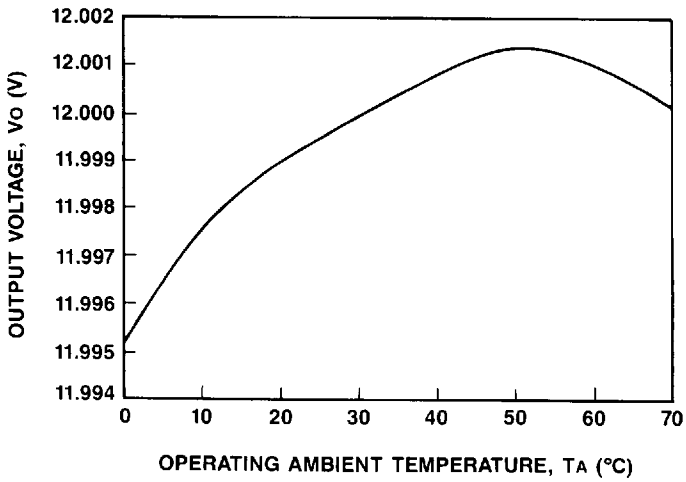

Figure 4. 990B1 Typical Output Voltage Variation Over Operating Ambient Temperature Range at Full Load and with V_I = 48 V

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Characteristics (Continued)

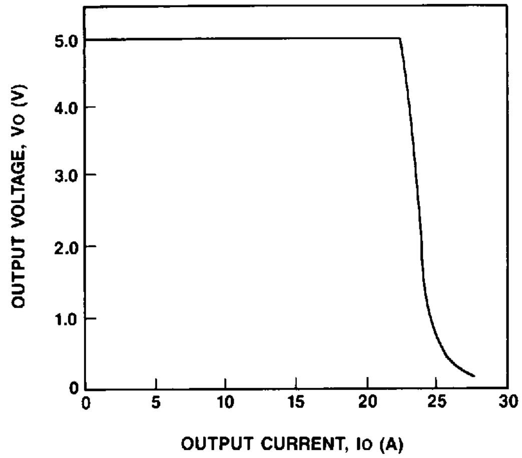

Figure 5. 990A1 Typical Output Characteristic with V_I = 48 V and T_A = 25°C

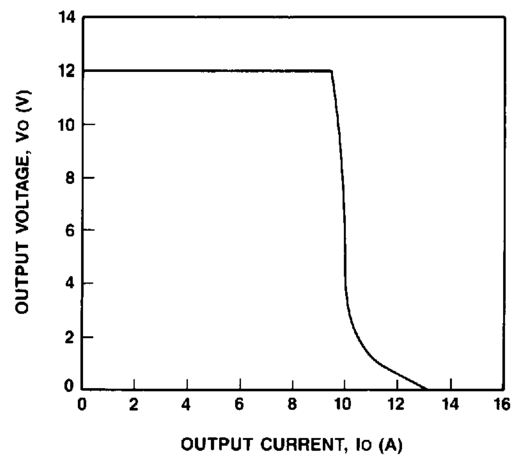

Figure 6. 990B1 Typical Output Characteristic with V_I = 48 V and T_A = 25°C

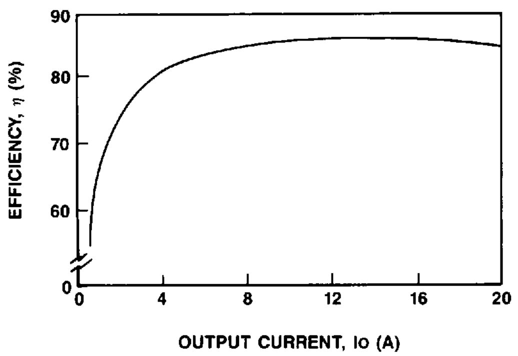

Figure 7. 990A1 Typical Converter Efficiency as a Function of Output Current with V_I = 48 V and T_A = 25°C

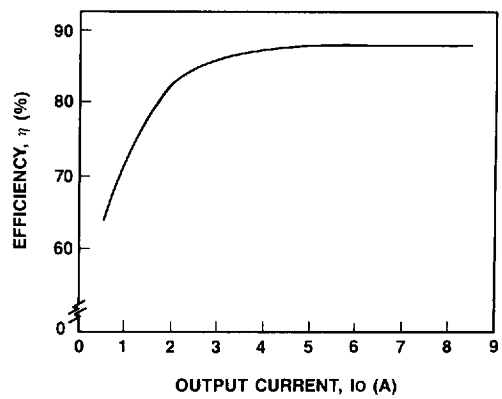

Figure 8. 990B1 Typical Converter Efficiency as a Function of Output Current with V_I = 48 V and T_A = 25°C

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Characteristics (Continued)

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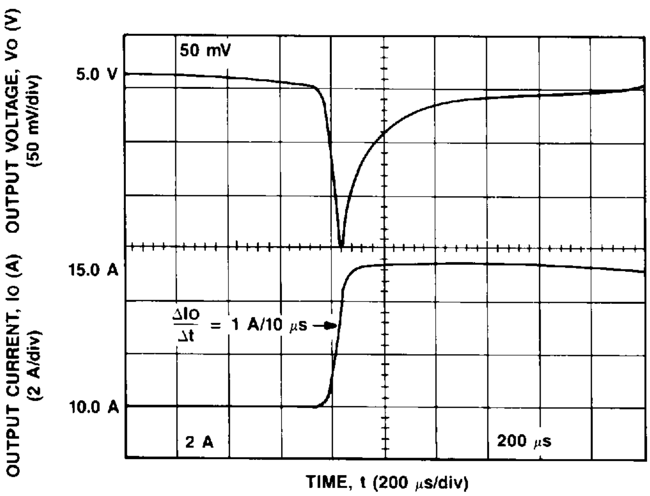

Figure 9. 990A1 Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of Full Output Power with V_I = 48 V and T_A = 25°C

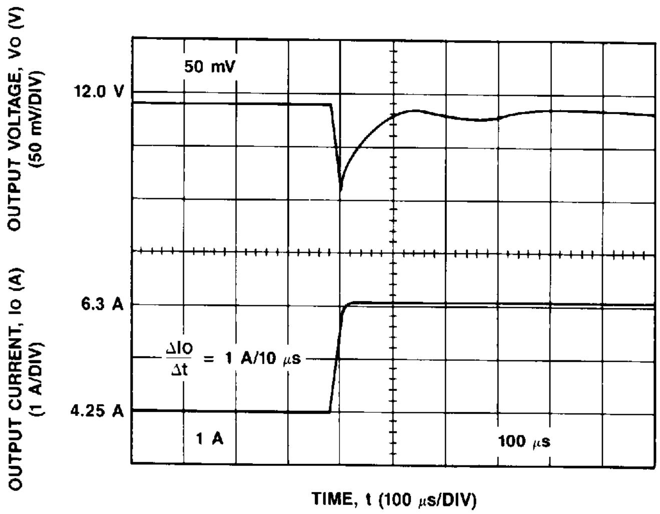

Figure 10. 990B1 Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of Full Output Power with V_I = 48 V and T_A = 25°C

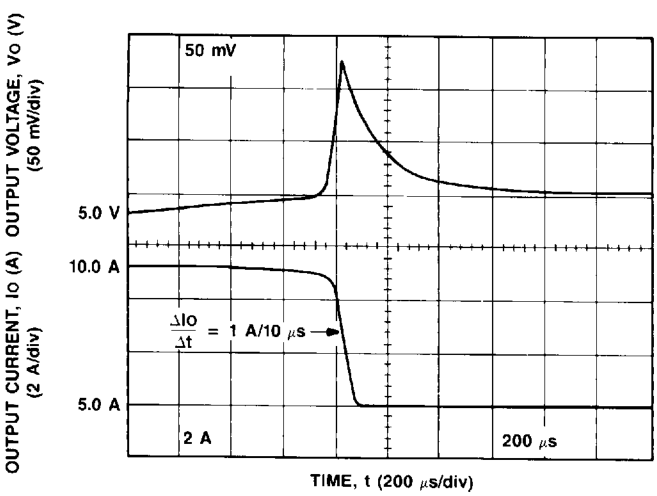

Figure 11. 990A1 Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of Full Output Power with V_I = 48 V and T_A = 25°C

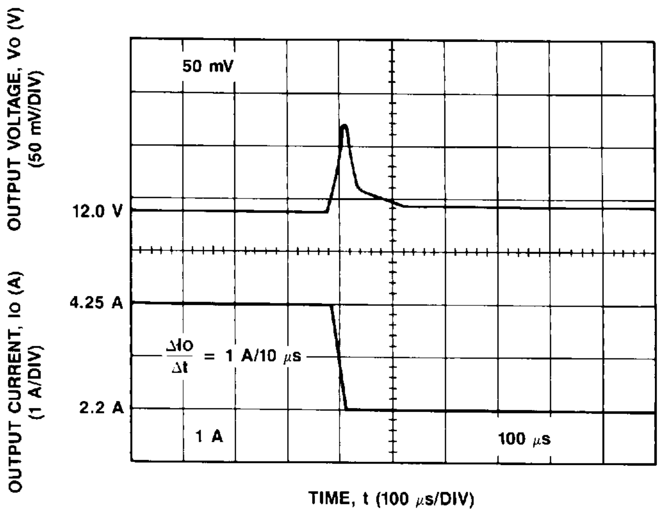

Figure 12. 990B1 Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of Full Output Power with V_I = 48 V and T_A = 25°C

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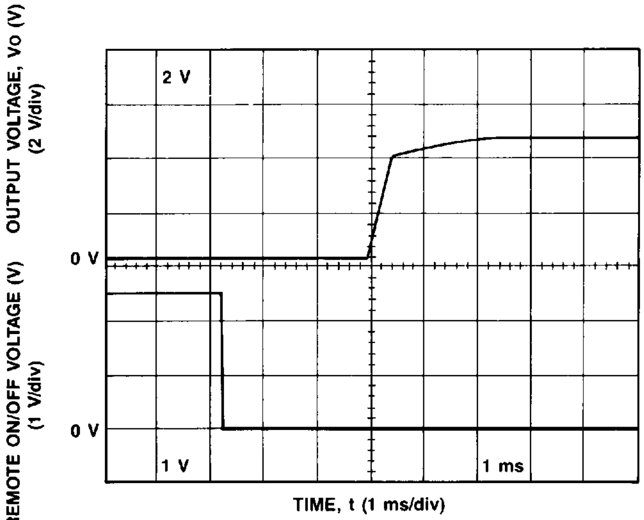


Figure 13. 990A1 Typical Output Voltage Start-Up Waveform Once Remote On/Off Is Applied and the Output Current Is at 80% of the Maximum Rated Value and with T_A = 25°C

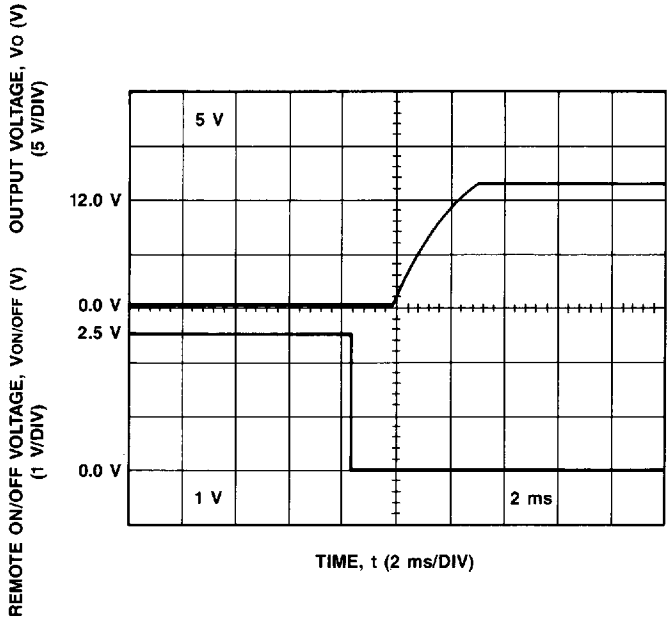
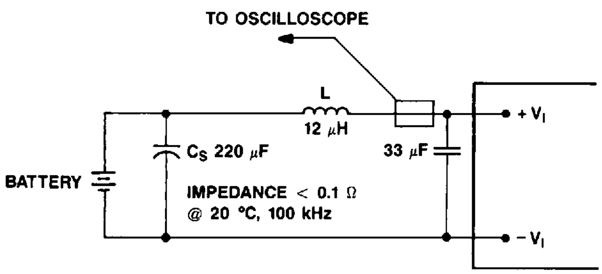


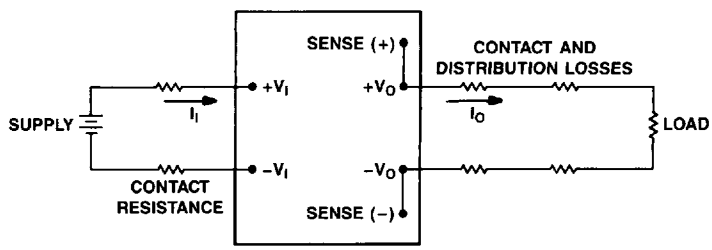
Figure 14. 990B1 Typical Output Voltage Start-Up Waveform Once Remote On/Off Is Applied and the Output Current Is at 80% of the Maximum Rated Value and with T_A = 25°C

Test Configurations



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

Figure 15. Input Reflected Ripple Test Set-Up



Note: All measurements are taken at the module terminals with sense pins connected directly to the module output pins. 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 16. Output Voltage and Efficiency Measurement Test Set-Up

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Feature Descriptions

Remote On/Off

The voltage potential between terminals 17 and 18 turns the power unit on and off. A switch must be supplied by the user to control this voltage. This function requires a switch with both high-impedance and low-impedance states. The switch must be optically or mechanically isolated. When the switch is in the high state, between 2.2 V and 5 V will appear at the terminals and the unit will be off. In the low state, the switch must maintain 0.25 V or less while sinking a maximum of 2 mA. This will turn the unit on.

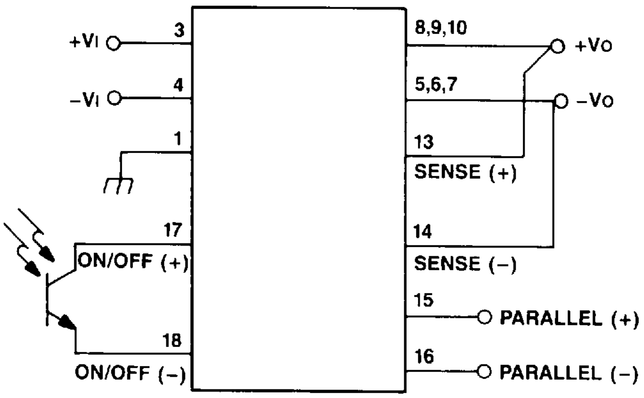

Figure 17. Remote On/Off Implementation

Output Overvoltage Clamp

The output overvoltage clamp consists of control circuitry that monitors the voltage on the output terminals. The circuit consists of a second totally independent control loop with a higher voltage set point. This 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. The module is designed to endure current limiting for an unlimited time duration. The module will operate normally once the output current is brought into its specified range.

Remote Sense

Remote sense is used to minimize the effects of distribution losses by regulating the voltage at the sense connections. The output voltage specifications actually refer to measurements taken at the sense connections. Take care to maintain the voltage between the sense terminals and the output voltage terminals at less than the specified maximum.

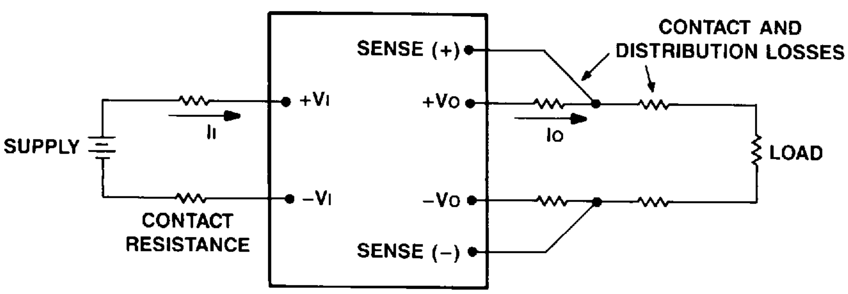

Figure 18. Effective Circuit Configuration for Remote Sense Operation

Parallel Operation

The 990-Series Power Modules can be configured for parallel operation with forced load sharing. Either redundant operation or additional power requirements can be accommodated with this feature. For a typical redundant configuration, Schottky diodes or an equivalent can be used to protect against short-circuit conditions. Because of the remote sense, the forward voltage drops across the Schottky diodes do not affect the set point of the voltage applied to the load. For additional power requirements where multiple units are used to develop combined power in excess of the rated single-unit maximum, the Schottky diodes are not necessary.

To implement forced load sharing, the proper connections must be made and good layout techniques should be observed for noise immunity. The two critical areas of concern are:

— The parallel pins of each unit must be connected; i.e., pin 15 to pin 15, pin 16 to pin 16, etc. The paths of these connections should be as close to each other and as direct as possible.

— The remote sense pins of all units should be connected to the same point on the power bus; i.e., all pin 13s should be connected to the same point on the positive (+) side of the power bus, and all pin 14s should be connected to the same point on the negative (–) side of the power bus. Again, close proximity and directness are necessary for good noise immunity.

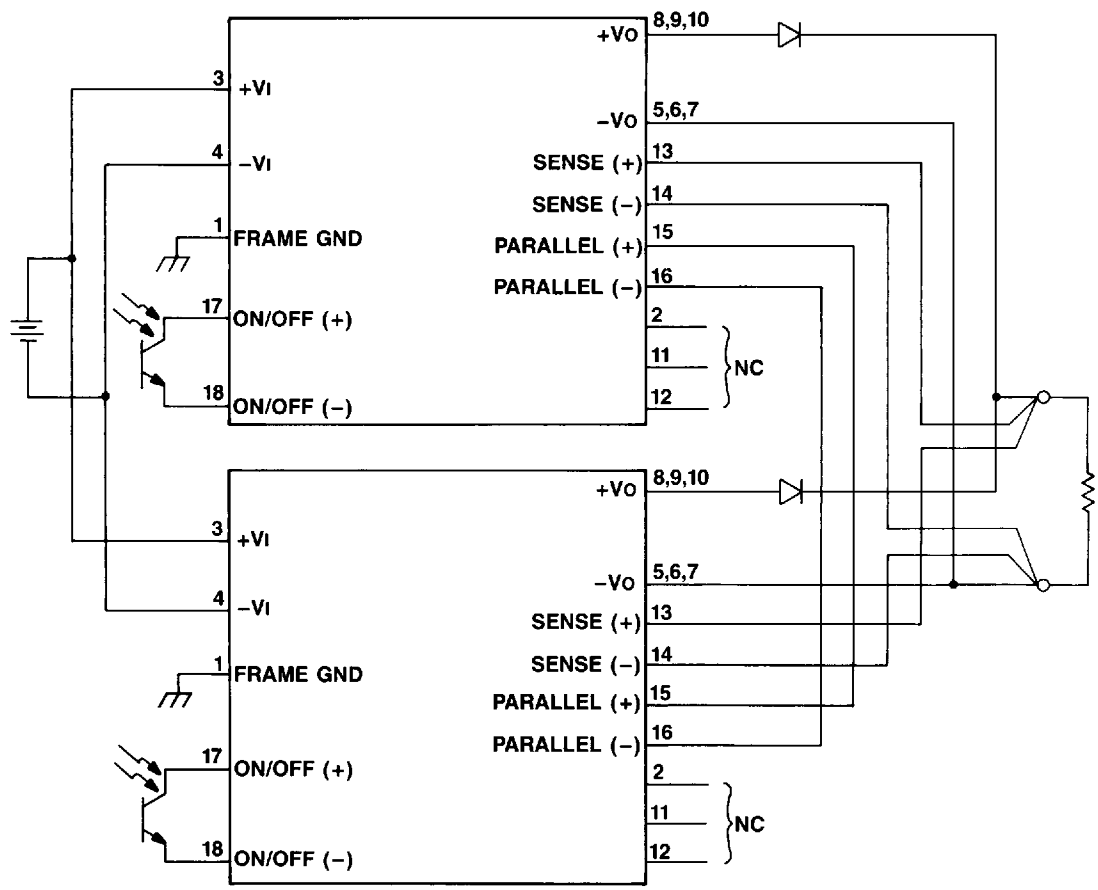

Figure 19. Typical Redundant Paralleling Application

Note for UL Application

The Underwriters Laboratories Conditions of Acceptability for using the 990A1 and 990B1 Power Modules as UL-recognized components require a 5 A, normal blow, dc fuse in series with the input of the module.

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Thermal Management

The 990-Series Power Modules are designed for natural convection cooling. Four mounting holes are provided for heat sink attachment, if necessary, as shown in the Outline Diagram. The 990A2 and 990B2 are equipped with the heat sink shown in Figure 22. The 990A3 and 990B3 are equipped with the heat sink shown in Figure 23.

Figure 20 shows power derating curves for operation in a natural convection environment; mounted vertically on 1.5 in. board spacings, with and without heat sinks. The heat sink thermal resistance is 2.5°C/W for the 990A2/990B2 and 2.7 °C/W for the 990A3/990B3.

To ensure proper operation in other environments, the case temperature should be monitored at the point indicated in the Outline Diagram. The temperature at this point must not be allowed to exceed 100°C.

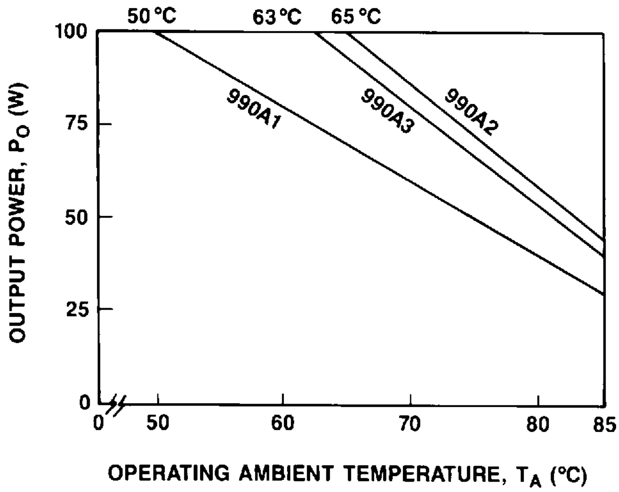

Figure 20. 990A1, 990A2, 990A3 Thermal Derating Curves

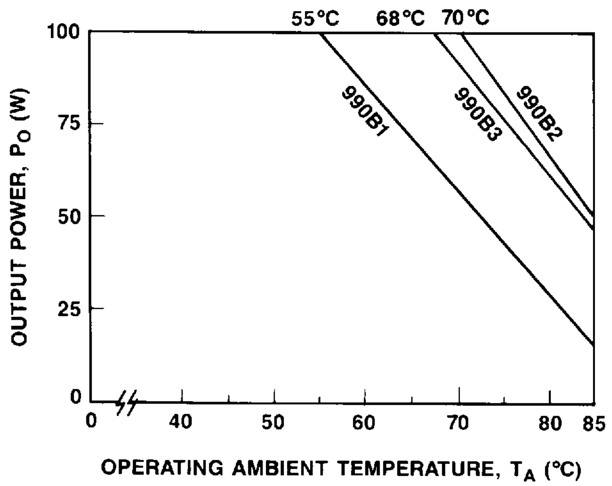

Figure 21. 990B1, 990B2, 990B3 Thermal Derating Curves

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Thermal Management (Continued)

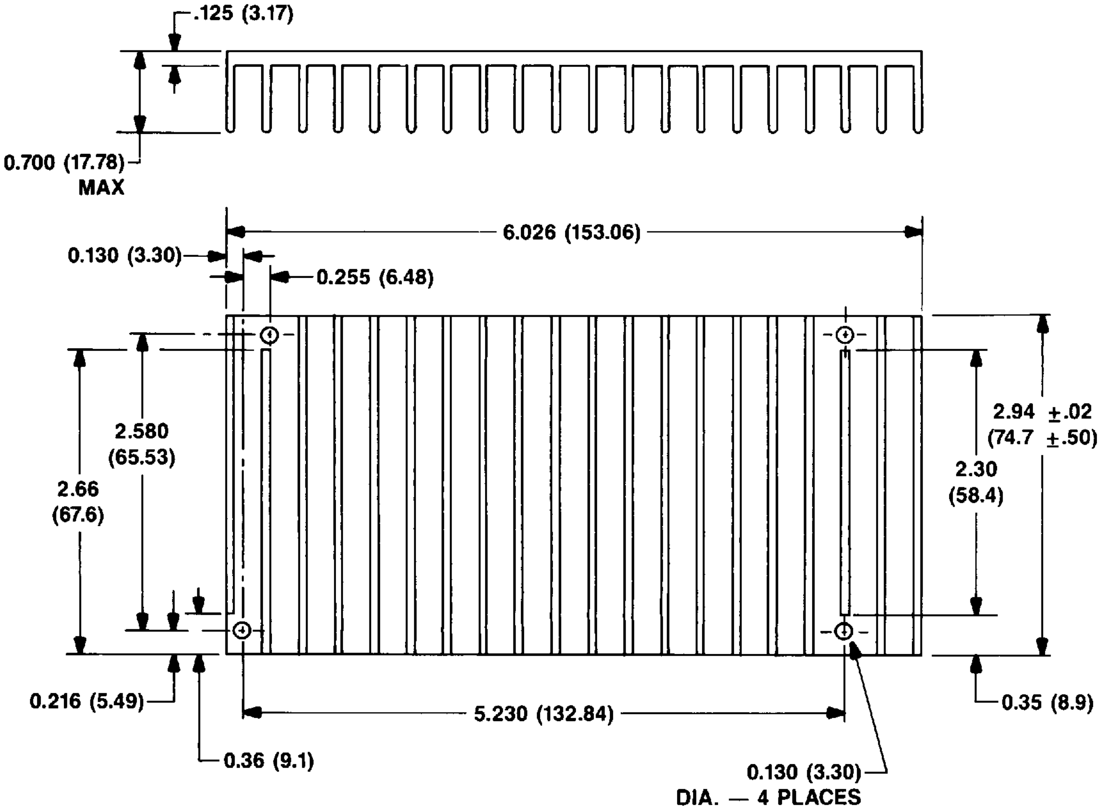


Figure 22. 990A2/990B2 Heat Sink

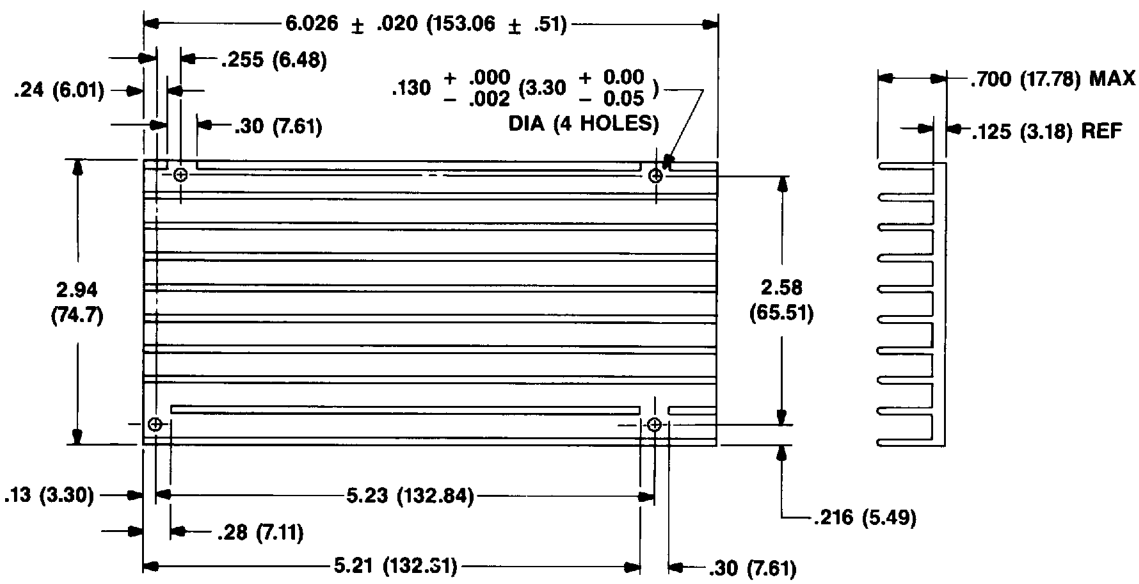
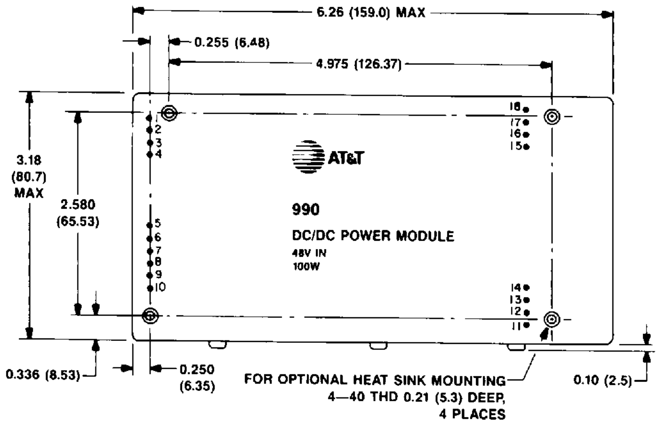


Figure 23. 990A3/990B3 Heat Sink

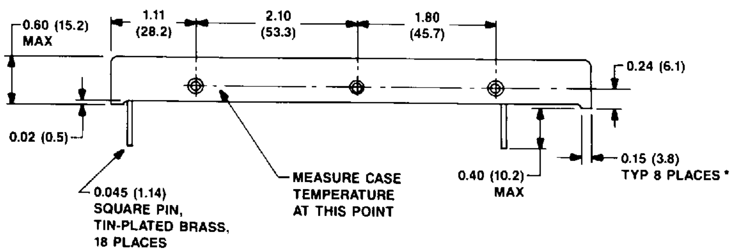
Module Dimensions

Dimensions are in inches and (millimeters).

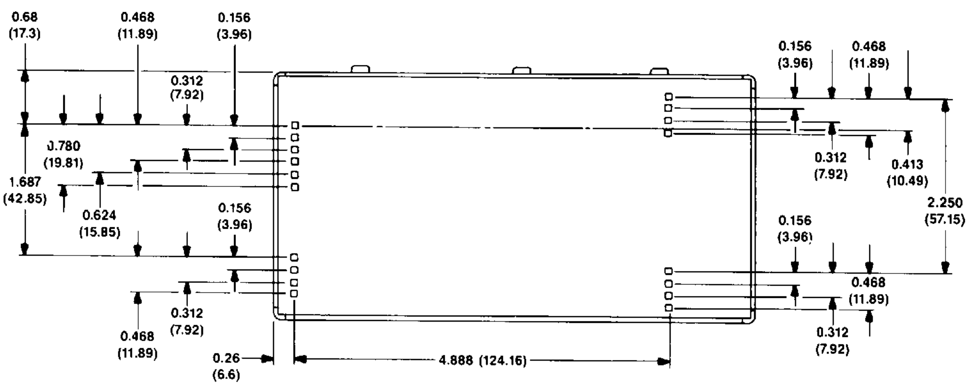
Top View



Side View



Bottom View



Pin	Description
1	Frame Ground
2	NC
3	+48 V In
4	-48 V In
5	-V Out
6	-V Out
7	-V Out
8	+V Out
9	+V Out
10	+V Out
11	NC
12	NC
13	Remote Sense (+)
14	Remote Sense (-)
15	Parallel (+)
16	Parallel (-)
17	Remote On/Off (+)
18	Remote On/Off (-)

Module tolerances, unless otherwise indicated: x.xx ± 0.020 in. (0.5 mm), x.xxx ± 0.010 in. (0.025 mm)

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

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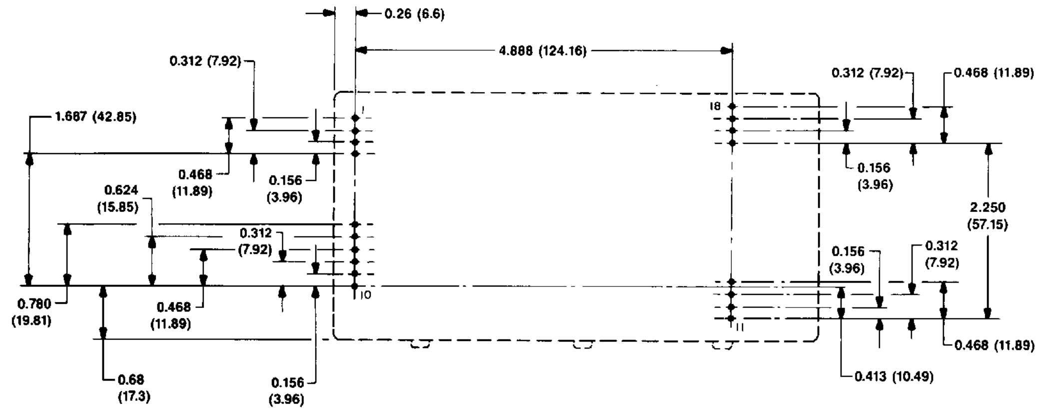
Recommended PCB Hole Pattern (Component-Side Footprint)

Dimensions are in inches and (millimeters).



Module Code	AT&T Comcode
990A1	104428024
990B1	104428032
990A2	104450168
990A3	105566640
990B2	105550370
990B3	105566673