Preliminary Data Sheet

AT&T

T-57-11

950-Series Power Modules; 48 Vdc Input

The 950-Series Power Modules feature input-to-output isolation, allowing versatile polarity configurations and grounding connections.

Features

- High efficiency: η = 85%, typ. (950A)
  η = 88%, typ. (950B)
- Parallel operation with load sharing
- Low profile: 0.6 in.
- Complete input and output filtering
- Input-to-output isolation
- Remote sense
- Short-circuit protection
- Remote on/off
- Meets FCC Class A EMI requirements
- Output overvoltage clamp:
  Vo ≤ 6.3 V (950A)
  Vo ≤ 13.5 V (950B)

Applications

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

Description

The 950A and 950B Power Modules are high-efficiency, board-mounted power modules that operate from standard 48 Vdc inputs. The units provide precisely regulated dc outputs that are fully isolated.

Internal input and output filtering is provided, as well as output overload and overvoltage protection. Both power modules operate in a natural convection environment at full load up to 70°C and require no heat sinks.

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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	Vdc
I/O Isolation Voltage	all		—	500	Vdc
Operating Ambient Temperature (natural convection) (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 Vdc to 60 Vdc) (see Figures 1 and 2)	950A 950B	$I_{I,max}$ $I_{I,max}$	— —	— —	2.0 2.3	A 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.

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)	950A	V_O	4.75	—	5.25	Vdc
	950B	V_O	11.40	—	12.60	Vdc
Output Voltage Set Point (V_I = 48 V, I_O at full load, and T_A = 25°C)	950A	$V_{O\,set}$	4.90	5.00	5.10	Vdc
	950B	$V_{O\,set}$	11.76	12.00	12.24	Vdc
Output Regulation:						
Line (V_I = 40 Vdc to 60 Vdc)	all		—	—	0.2	%
Load (I_O = min. to max. load)	all		—	—	0.2	%
Temperature (T_A = 0°C to 70°C)	950A		—	—	50	mV
(see Figures 3 and 4)	950B		—	—	120	mV
Output Ripple and Noise Voltage:						
RMS	950A		—	—	35	mV rms
	950B		—	—	40	mV rms
Peak-to-Peak (5 Hz to 20 MHz)	950A		—	—	100	mV p-p
	950B		—	—	120	mV p-p
Output Current	950A	I_O	0.25	—	10	A
	950B	I_O	0.25	—	5	A
Output Current Limit Inception:						
(V_O = 4.5 V)(see Figure 5)	950A		10.5	11.6	13.5	A
(V_O = 4.5 V)(see Figure 6)	950B		5.3	6.0	6.8	A
Output Short-Circuit Current	950A		—	14	—	A
(V_O = 250 mV)(see Figures 5 and 6)	950B		—	8.0	—	A
Efficiency (V_I = 48 V, I_O at full load,	950A	η	81	85	—	%
T_A = 25 °C)(see Figures 7 and 8)	950B	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	950A		—	150	—	mV
	950B		—	60	—	mV
Settling Time	950A		—	180	—	μs
(V_O < 10% peak deviation)(see Figures 9, 10)	950B		—	150	—	μs
Load Change from I_O = 50% to 25% Full Load:						
Peak Deviation	950A		—	150	—	mV
	950B		—	60	—	mV
Settling Time	950A		—	100	—	μs
(V_O < 10% peak deviation)(see Figures 11, 12)	950B		—	150	—	μs

Electrical Specifications (Continued)

Parameter	Device	Symbol	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)	950A 950B		670,000 697,000		hours hours
Weight	all	—	—	12	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 = 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	950A 950B	— —	— —	10 5	% %
Parallel Operation Load Sharing	950A 950B	— —	— —	1.5 0.75	A A
Output Overvoltage Clamp	950A 950B	5.7 12.6	— —	7.0 15.4	V V

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Characteristics

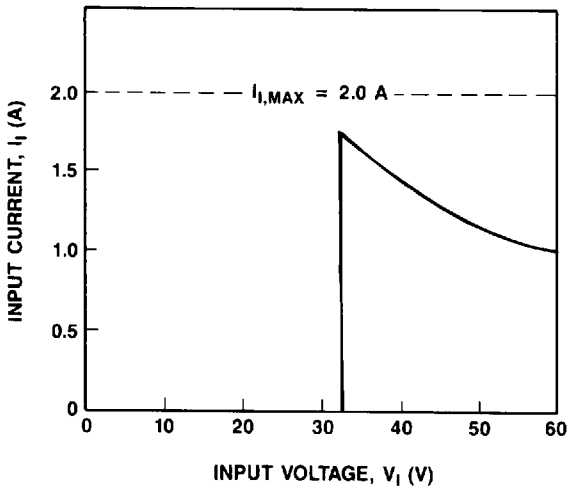

Figure 1. 950A Typical Input Characteristic with a Resistive Load of Io = 10 A and TA = 25°C

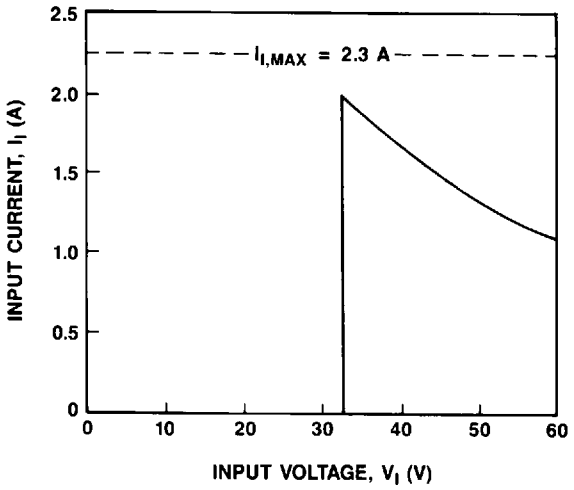

Figure 2. 950B Typical Input Characteristic with a Resistive Load of Io = 5 A and TA = 25°C

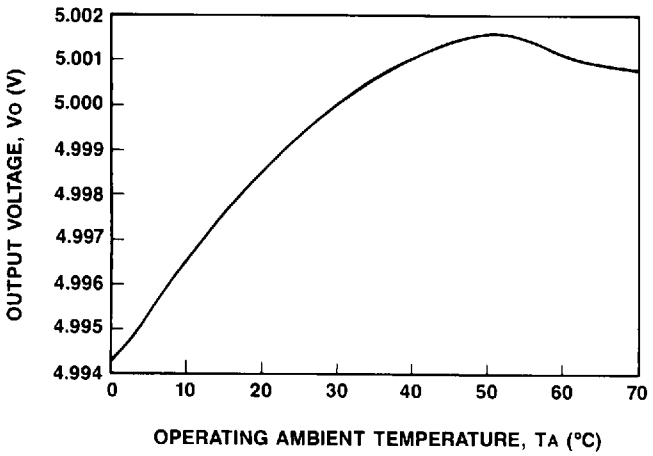

Figure 3. 950A Typical Output Voltage Variation Over Operating Ambient Temperature Range at Full Load with VI = 48 V

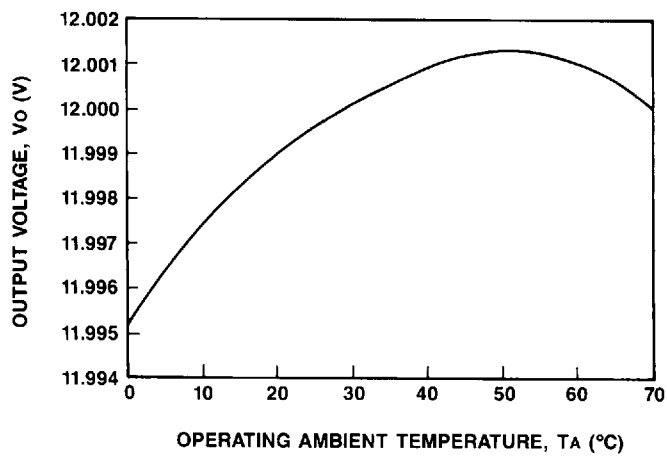

Figure 4. 950B Typical Output Voltage Variation Over Operating Ambient Temperature Range at Full Load with VI = 48 V

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Characteristics (Continued)

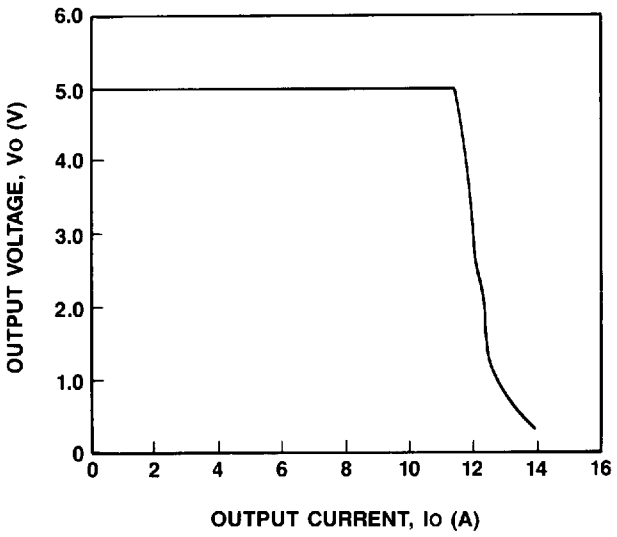


Figure 5. 950A Typical Output Characteristic with V_I = 48 V and T_A = 25 °C

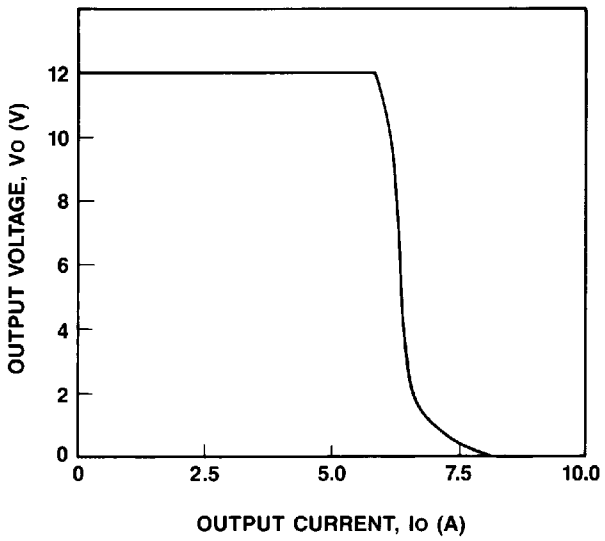


Figure 6. 950B Typical Output Characteristic with V_I = 48 V and T_A = 25 °C

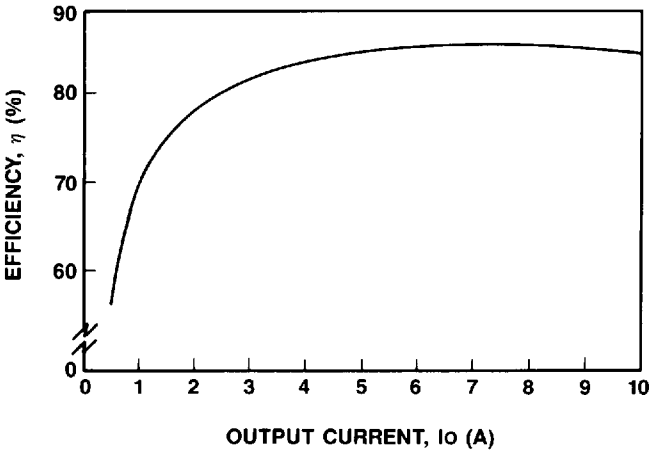


Figure 7. 950A Typical Converter Efficiency as a Function of Output Current with V_I = 48 V and T_A = 25 °C

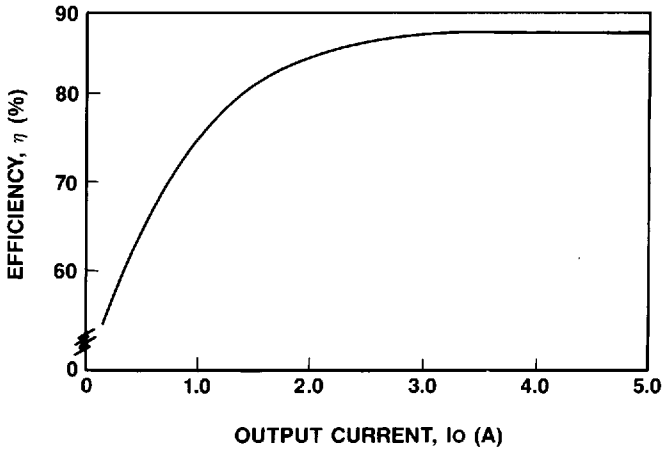


Figure 8. 950B Typical Converter Efficiency as a Function of Output Current with V_I = 48 V and T_A = 25 °C

Characteristics (Continued)

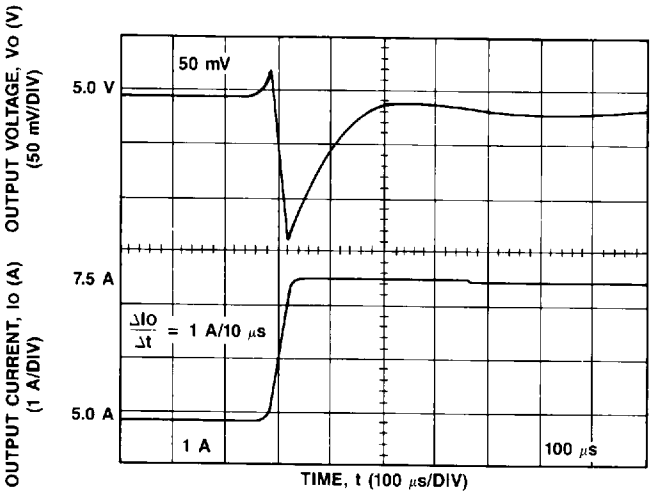


Figure 9. 950A Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of Full Output Power with V_I = 48 V and T_A = 25°C

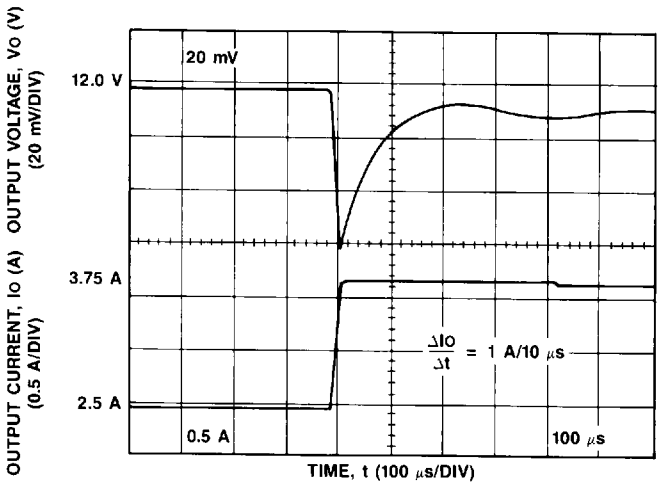


Figure 10. 950B Typical Output Voltage Waveform for a Step Load Change from 50% to 75% of Full Output Power with V_I = 48 V and T_A = 25°C

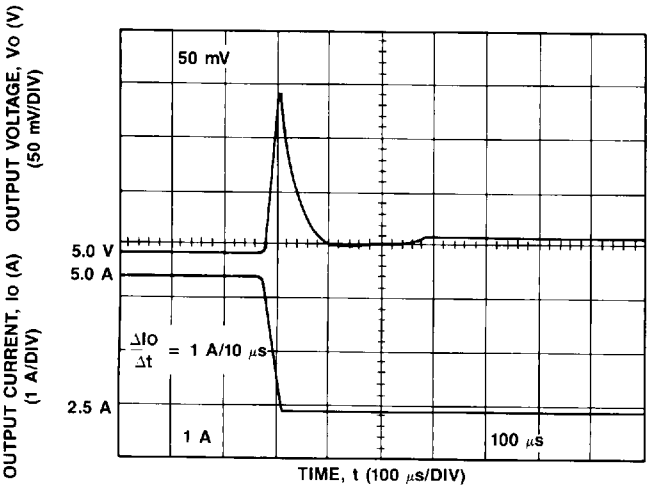


Figure 11. 950A Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of Full Output Power with V_I = 48 V and T_A = 25°C

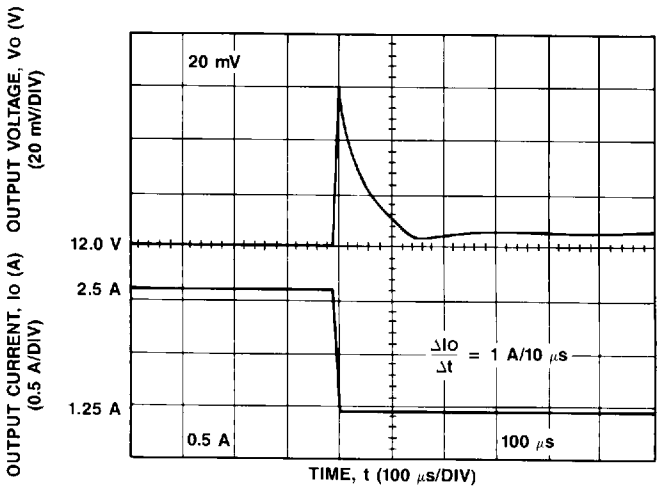


Figure 12. 950B Typical Output Voltage Waveform for a Step Load Change from 50% to 25% of Full Output Power with V_I = 48 V and T_A = 25°C

Characteristics (Continued)

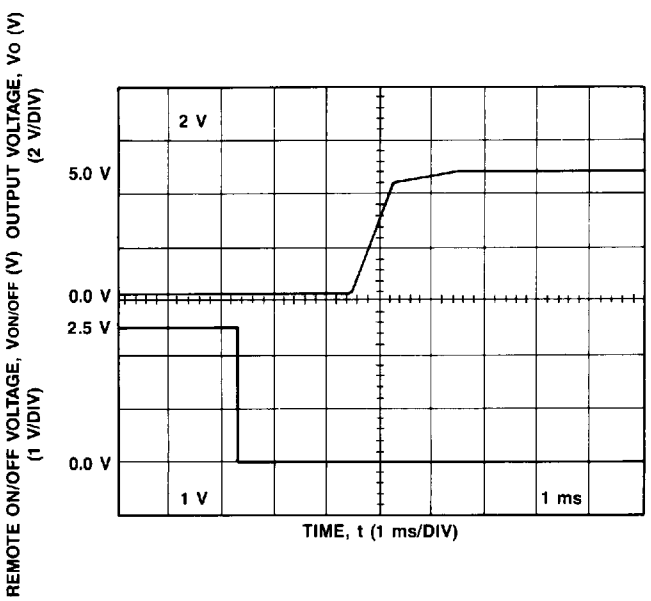


Figure 13. 950A Typical Output Voltage Start-Up Waveform Once Remote On/Off Is Applied and I_O Is at 80% of Full Load with V_I = 48 V and T_A = 25°C

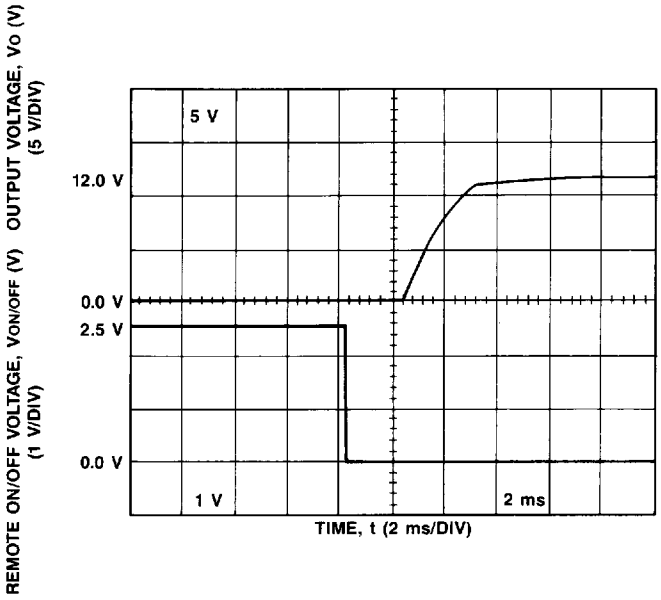
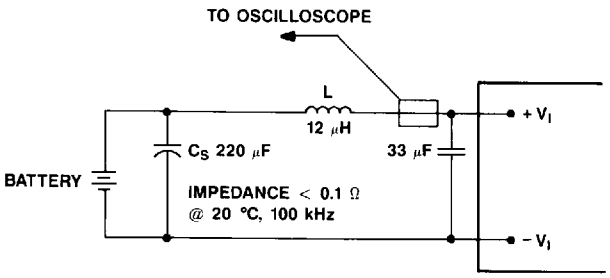


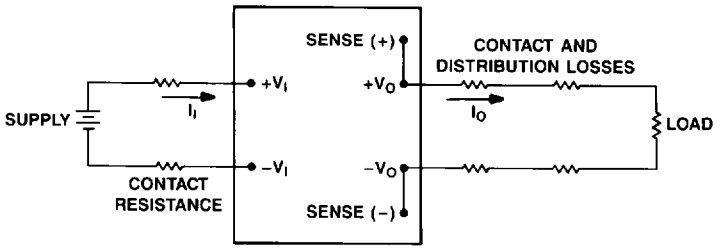
Figure 14. 950B Typical Output Voltage Start-Up Waveform Once Remote On/Off Is Applied and I_O Is at 80% of Full Load with V_I = 48 V and T_A = 25°C

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.

$$\eta = \frac{[+Vo - (-Vo)]\ Io}{[+Vi - (-Vi)]\ Ii}$$

Figure 16. Output Voltage and Efficiency Measurement Test Set-Up

Feature Descriptions

Remote On/Off

The voltage potential between terminals 17 and 18 turns the power module on and off. A switch must be supplied by the user to control this voltage. This function requires a switch with both a high-impedance and a low-impedance state. The switch must be optically or mechanically isolated. Failure to provide this isolation may compromise noise immunity.

When the switch is in the high-impedance state, 2.2 V to 5 V should appear at the terminals, causing the unit to turn off. When the switch is in the low-impedance state, 0.25 V or less must be maintained while sinking a maximum current of 2 mA, causing the unit to turn on.

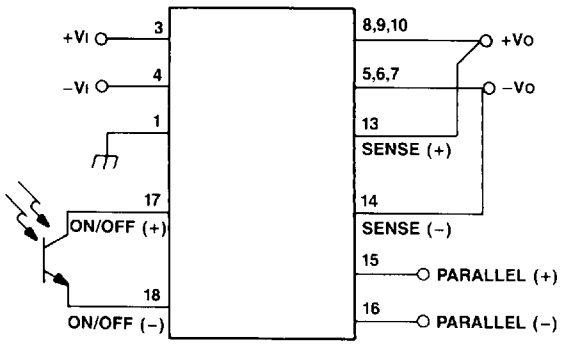


Figure 17. Remote On/Off Implementation

Output Overvoltage Clamp

The output overvoltage clamp consists of control circuitry that monitors the voltage on the output terminals, independent of the primary regulation loop. The control loop for the clamp has a higher set point of nominally 6.3 V for the 950A or 13.5 V for the 950B. 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.

Remote Sense

Remote sense is used to minimize the effects of distribution losses by regulating the voltage at the sense connections. The output specifications actually refer to measurements taken at the sense connections. The difference between the voltage at the output terminals and the voltage at the sense terminals must not exceed the maximum output voltage sense range, as specified in the Feature Specifications.

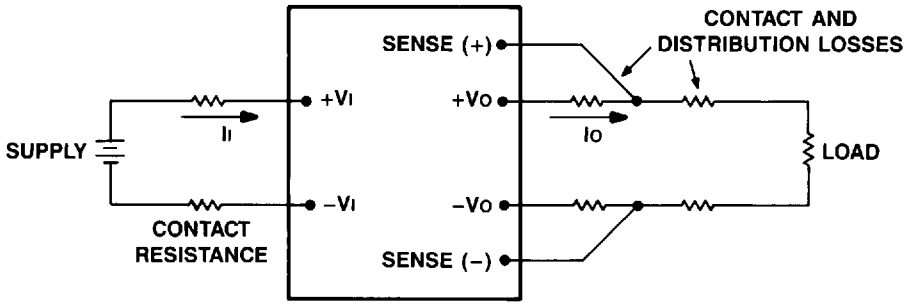


Figure 18. Effective Circuit Configuration for Remote Sense Operation

Parallel Operation

The 950-Series Power Modules can be configured for parallel operation with forced load sharing. Either redundant operation or additional power requirements are accommodated with this feature. For a typical redundant configuration, such as shown in Figure 19, Schottky diodes or an equivalent can be used to protect against short-circuit conditions. Because of the remote sense, 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.

The following connections must be made to implement forced load sharing, and good layout techniques should be observed for noise immunity:

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

— The remote sense pins of each unit should be connected to the same point on the power bus, respectively; i.e., Sense (+) to the same point on the (+) side of the power bus, and Sense (–) to the same point on the (–) side of the power bus. Again, close proximity and directness are necessary for good noise immunity.

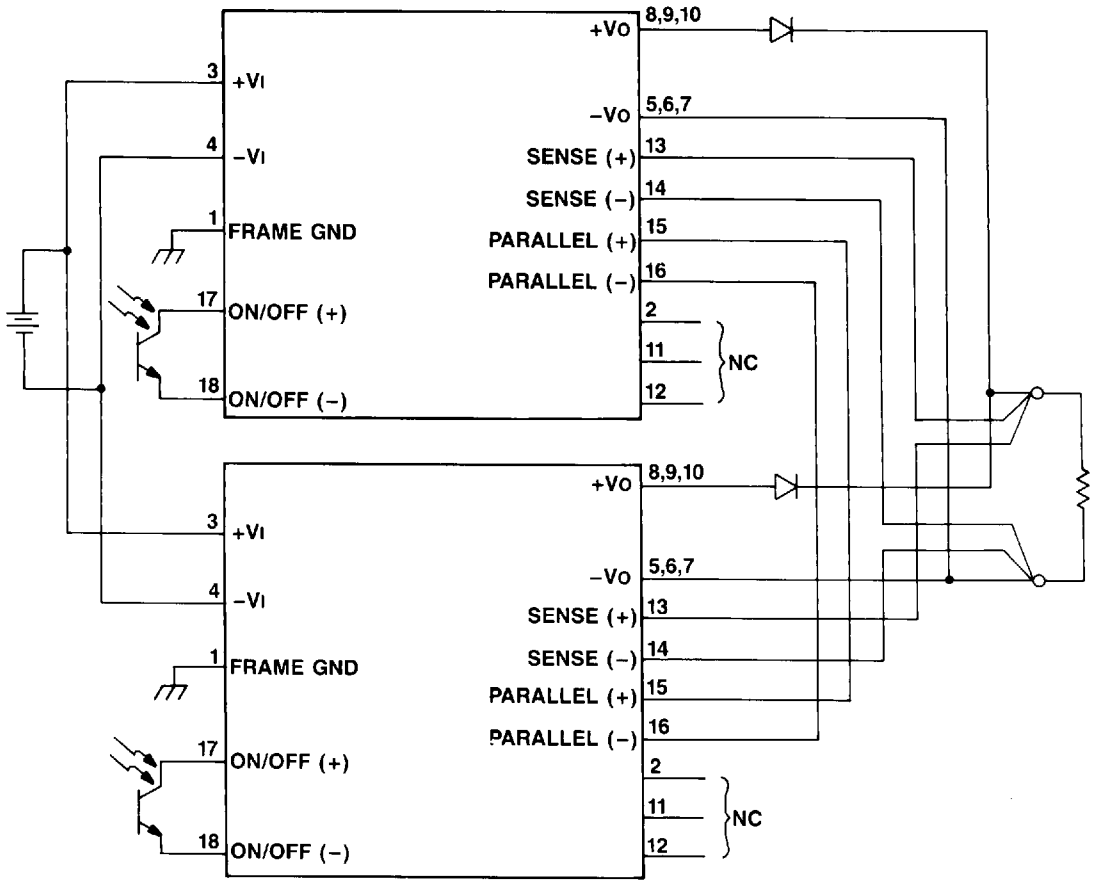


Figure 19. Typical Redundant Paralleling Application

Note for UL Application

The Underwriters Laboratories Conditions of Acceptability for using the 950A and 950B Power Modules as UL-recognized components require a 5 A, normal blow, dc fuse in series with the input of the module.

Thermal Management

The 950-Series Power Modules are designed for natural convection cooling in a 70°C environment at full load. Figure 20 shows the power derating curve for operation above 70°C.

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

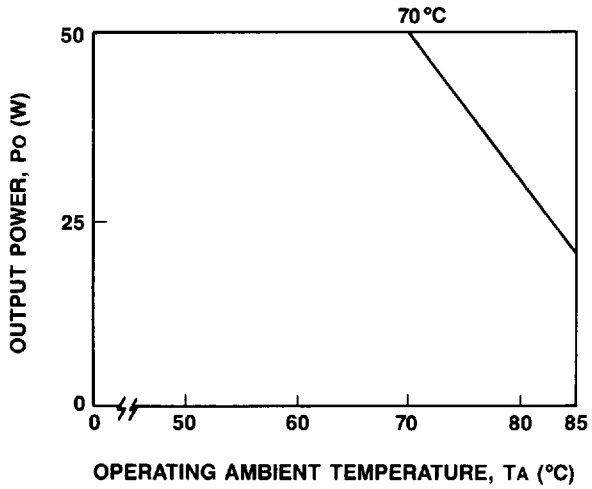


Figure 20. 950A Thermal Derating Curve

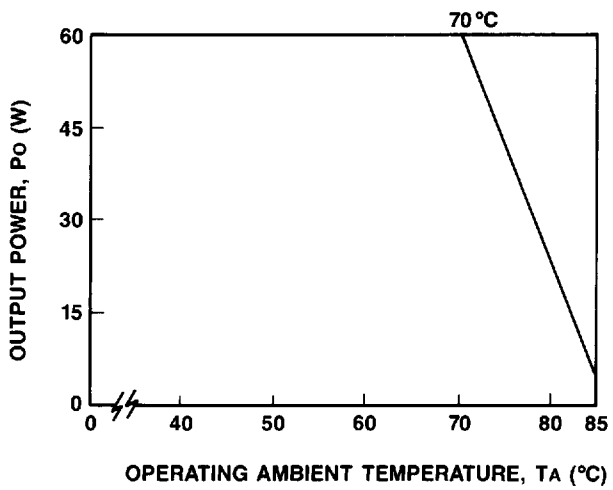
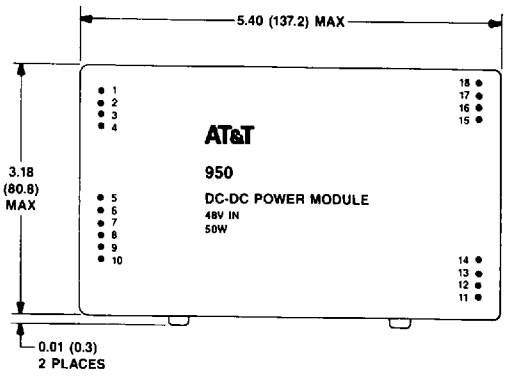


Figure 21. 950B Thermal Derating Curve

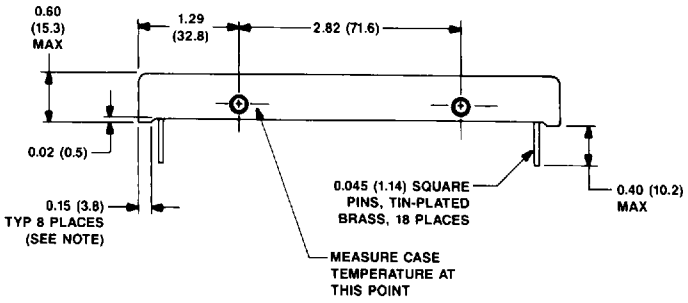
Module Dimensions

Dimensions are in inches and (millimeters).

Top View

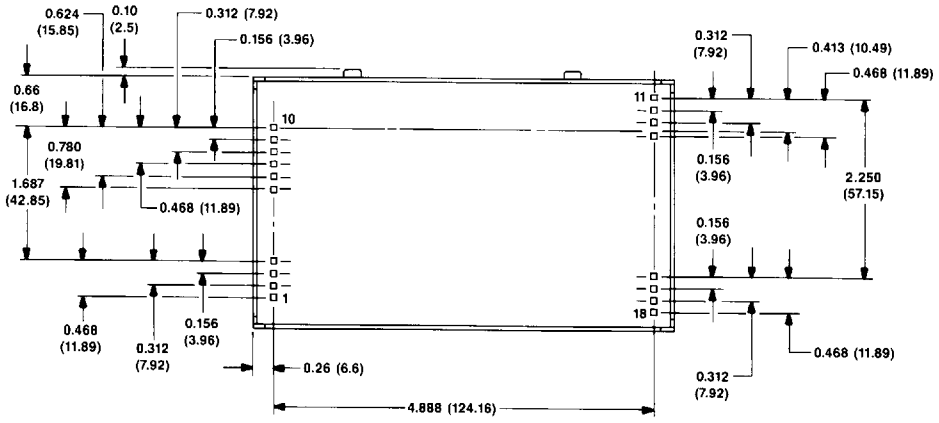


Side View



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 (–)

Bottom View



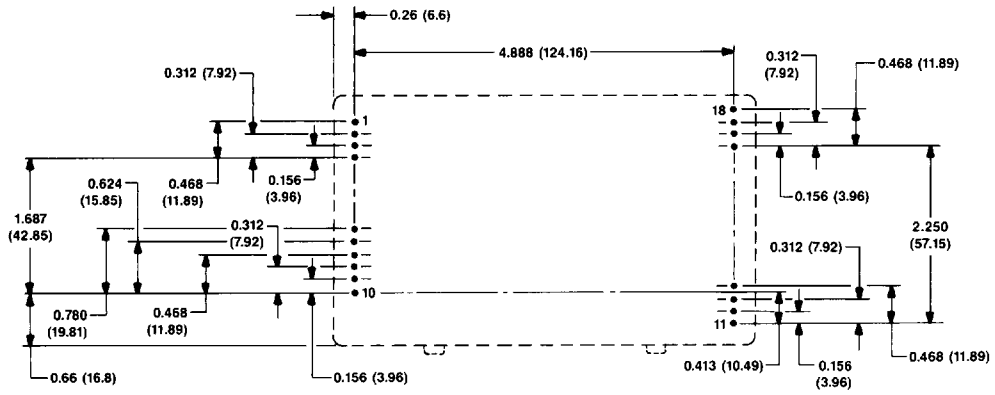
Module tolerances, unless otherwise indicated: x.xx ± 0.02 inch (0.5 mm), x.xxx ± 0.010 inch (0.025 mm)

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

50-60 WATTS

Recommended PCB Hole Pattern (Component-Side Footprint)

Dimensions are in inches and (millimeters).



Module Code	AT&T Comcode
950A	104409339
950B	104409347