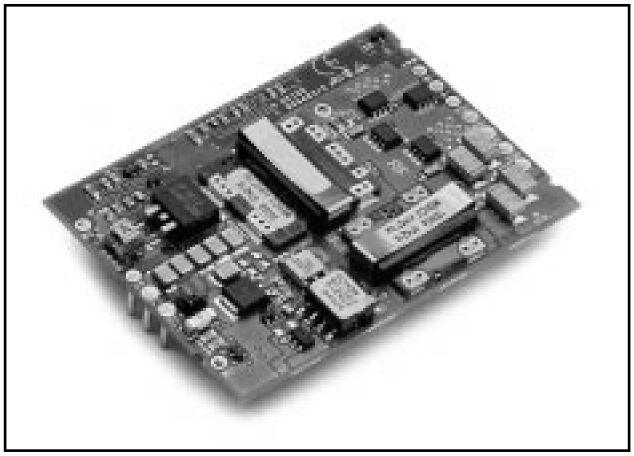
Data Sheet
August 2000

Lucent Technologies
Bell Labs Innovations

HW125F Power Modules; dc-dc Converters: 36 Vdc to 75 Vdc Input, 3.3 Vdc Output; 83.5 W



The HW125F Power Modules use advanced surface-mount technology and deliver high-quality, efficient, and compact dc-dc conversion.

Applications

- Distributed power architectures
- Communications equipment
- Computer equipment

Options

- Choice of remote on/off logic configuration
- Short pins: 3.68 mm ± 0.25 mm (0.145 in. ± 0.010 in.)

Features

- Low profile: 10.7 mm (0.42 in.)
- Small size: 83.8 mm x 59.7 mm x 10.7 mm (3.30 in. x 2.35 in. x 0.42 in.)
- High power density
- High efficiency: 87% typical
- Low noise, low EMI
- Constant frequency
- Open frame design; no case or potting
- 2:1 input voltage range
- Overvoltage and overcurrent protection
- Overtemperature protection
- Remote sense
- Remote on/off
- Adjustable output voltage
- *UL** 1950 Recognized, *CSA*† C22.2 No. 950-95 Certified, *VDE*‡ 0805 (EN60950, IEC950) Licensed
- CE mark meets 73/23/EEC and 93/68/EEC directives§

Description

The HW125F Power Modules are open frame (no case, no potting) dc-dc converters that operate over an input voltage range of 36 Vdc to 75 Vdc and provide a precisely regulated 3.3 Vdc output. The outputs are fully isolated from the inputs, allowing versatile polarity configurations and grounding connections. The modules have a maximum power rating of 83.5 W at a typical full-load efficiency of 87%.

* *UL* is a registered trademark of Underwriters Laboratories, Inc.
† *CSA* is a registered trademark of Canadian Standards Association.
‡ *VDE* is a trademark of Verband Deutscher Elektrotechniker e.V.
§ This product is intended for integration into end-use equipment. All the required procedures for CE marking 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	—	75	Vdc
Transient	$V_{I, trans}$	—	100	V
Operating Ambient Temperature (See Thermal Considerations section.)	T_A	–40	85*	°C
Storage Temperature	T_{stg}	–55	125	°C
I/O Isolation Voltage (for 1 minute)	—	—	1500	Vdc

* With derated output power. See Thermal Considerations section.

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; $I_O = I_{O, max}$	$I_{I, max}$	—	—	4.0	A
V_I = 36 V to 75 V; $I_O = I_{O, max}$	$I_{I, max}$	—	—	4.0	A
Inrush Transient	i^2t	—	—	2.5	A^2s
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 µH source impedance; see Figure 9.)	—	—	—	100	mAp-p
Input Ripple Rejection (120 Hz)	—	—	60	—	dB

Fusing Considerations

This power module is internally fused in the V_I(+) leg.

Electrical Specifications (continued)

Table 2. Output Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point (V_I = 48 V; $I_O = I_{O,\ max}$; T_A = 25 °C)	$V_{O,\ set}$	3.25	3.3	3.35	Vdc
Output Voltage (Over all operating input voltage, resistive load, and temperature conditions until end of life. See Figure 11.)	V_O	3.20	—	3.40	Vdc
Output Regulation: Line (V_I = 36 V to 75 V) Load ($I_O = I_{O,\ min}$ to $I_{O,\ max}$) Temperature (T_A = –40 °C to +50 °C)	 — — —	 — — —	 0.01 0.05 15	 0.2 0.2 50	 %V_O %V_O mV
Output Ripple and Noise Voltage (See Figures 3 and 10.): RMS Peak-to-peak (5 Hz to 20 MHz)	 — —	 — —	 — —	 50 200	 mVrms mVp-p
External Load Capacitance	—	0	—	*	µF
Output Current (At $I_O < I_{O,\ min}$, the modules may exceed output ripple specifications.)	I_O	0.5	—	25	A
Output Current-limit Inception (Shutdown threshold; see Electrical Descriptions section.)	$I_{O,\ cli}$	—	—	35†	A
Efficiency (V_I = 48 V; $I_O = I_{O,\ max}$; T_A = 25 °C)	η	—	87	—	%
Switching Frequency	—	—	300	—	kHz
Dynamic Response ($\Delta I_O/\Delta t$ = 1 A/10 µs, V_I = 48 V, T_A = 25 °C; tested with a 10 µF tantalum and a 1.0 µF ceramic capacitor across the load.): Load Change from I_O = 50% to 75% of $I_{O,\ max}$: Peak Deviation Settling Time (V_O < 10% of peak deviation) Load Change from I_O = 50% to 25% of $I_{O,\ max}$: Peak Deviation Settling Time (V_O < 10% of peak deviation)	 — — — —	 — — — —	 8 600 8 600	 — — — —	 %$V_{O,\ set}$ µs %$V_{O,\ set}$ µs

* Consult your sales representative or the factory.
† These are manufacturing test limits. In some situations, results may differ.

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	2000	—	pF
Isolation Resistance	10	—	—	MΩ

General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O, max}$; T_A = 20 °C)		3,266,000		hours
Weight	—	—	50 (1.8)	g (oz.)

Feature Specifications

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

Parameter	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal Interface					
(V_I = 0 V to 75 V; open collector or equivalent compatible; signal referenced to V_I(–) terminal; see Figure 12 and Feature Descriptions.):					
HW125x1 Preferred Logic:					
Logic Low—Module On					
Logic High—Module Off					
HW125x Optional Logic:					
Logic Low—Module Off					
Logic High—Module On					
Logic Low:					
At $I_{on/off}$ = 1.0 mA	$V_{on/off}$	0	—	1.2	V
At $V_{on/off}$ = 0.0 V	$I_{on/off}$	—	—	1.0	mA
Logic High:					
At $I_{on/off}$ = 0.0 µA	$V_{on/off}$	—	—	15	V
Leakage Current	$I_{on/off}$	—	—	50	µA
Turn-on Time (I_O = 80% of $I_{O, max}$; V_O within ±1% of steady state; see Figure 8.)	—	10	30	50*	ms
Output Voltage Adjustment (See Feature Descriptions.):					
Output Voltage Remote-sense Range	—	—	—	0.5	V
Output Voltage Set-point Adjustment Range (trim)	—	90	—	110	$\%V_{O, nom}$
Output Overvoltage Protection	$V_{O, sd}$	4.0*	—	5.5*	V

* These are manufacturing test limits. In some situations, results may differ.

Solder Ball and Cleanliness Requirements

The open frame (no case or potting) power module will meet the solder ball requirements per J-STD-001B. These requirements state that solder balls must neither be loose nor violate the power module minimum electrical spacing.

The cleanliness designator of the open frame power module is C00 (per J specification).

For cleaning process, refer to Lucent Technologies *Board-Mounted Power Modules: Soldering and Cleaning* Application Note (AP97-021EPS).

Characteristic Curves

The following figures provide typical characteristics for the power modules. The figures are identical for both on/off configurations.

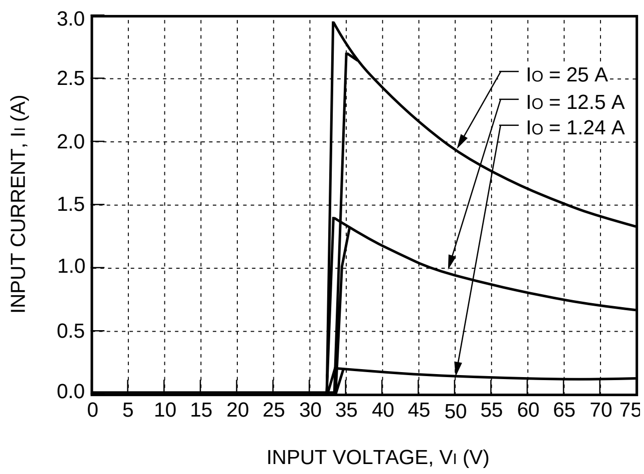
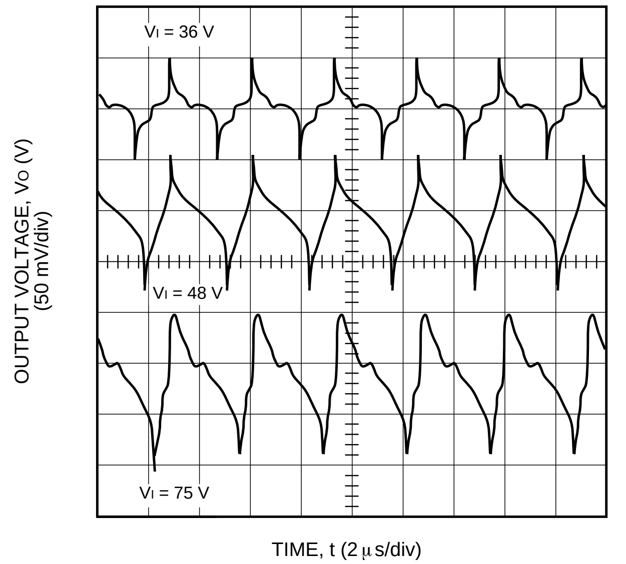


Figure 1. Typical HW125F1 Input Characteristics at Room Temperature



Note: See Figure 10 for test conditions.

Figure 3. Typical HW125F1 Output Ripple Voltage at Room Temperature and $I_O = I_{O, max}$

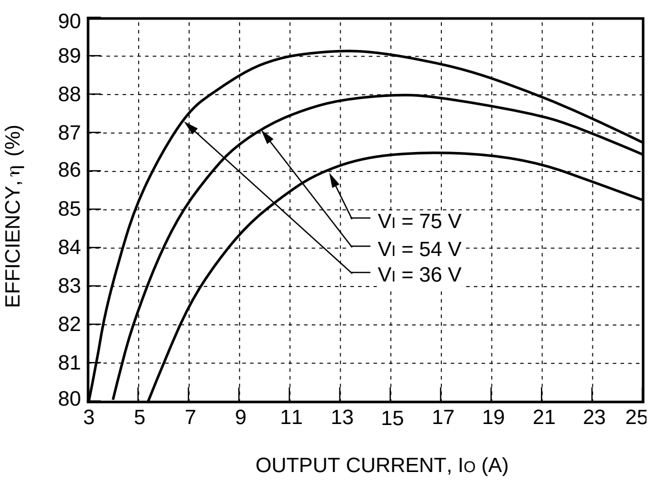
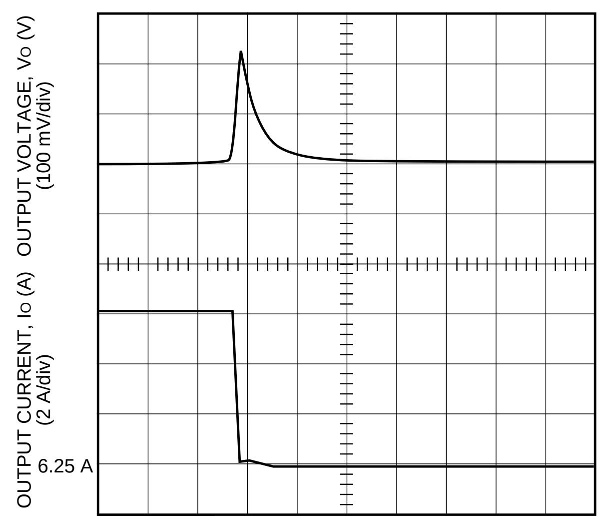


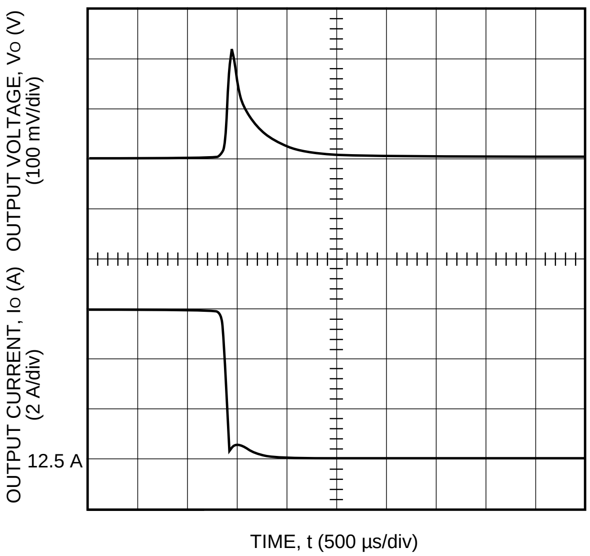
Figure 2. Typical HW125F1 Converter Efficiency vs. Output Current at Room Temperature



Note: Tested with a 10 µF tantalum and a 1.0 µF ceramic capacitor across the load.

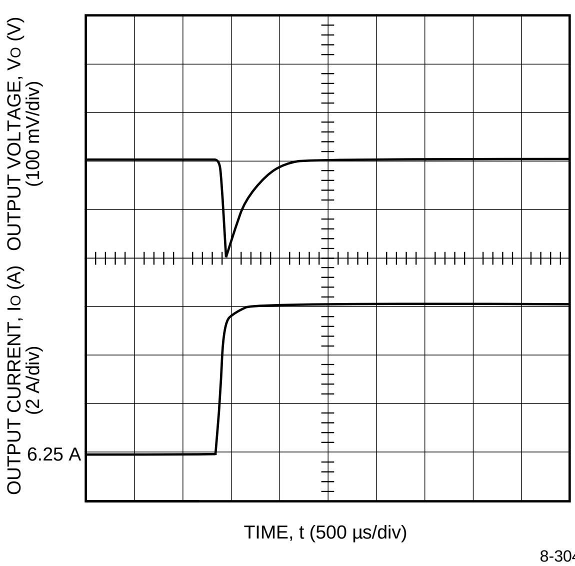
Figure 4. Typical HW125F1 Transient Response to Step Decrease in Load from 50% to 25% of Full Load at Room Temperature and 36 Vdc to 75 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)

Characteristic Curves (continued)



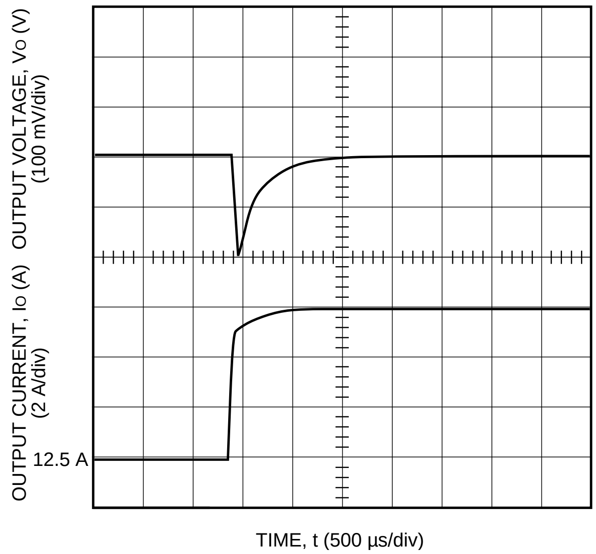
Note: Tested with a 10 µF tantalum and a 1.0 µF ceramic capacitor across the load.

Figure 5. Typical HW125F1 Transient Response to Step Decrease in Load from 75% to 50% of Full Load at Room Temperature and 36 Vdc to 75 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)



Note: Tested with a 10 µF tantalum and a 1.0 µF ceramic capacitor across the load.

Figure 6. Typical HW125F1 Transient Response to Step Increase in Load from 25% to 50% of Full Load at Room Temperature and 36 Vdc to 75 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)



Note: Tested with a 10 µF tantalum and a 1.0 µF ceramic capacitor across the load.

Figure 7. Typical HW125F1 Transient Response to Step Increase in Load from 50% to 75% of Full Load at Room Temperature and 36 Vdc to 75 Vdc Input (Waveform Averaged to Eliminate Ripple Component.)

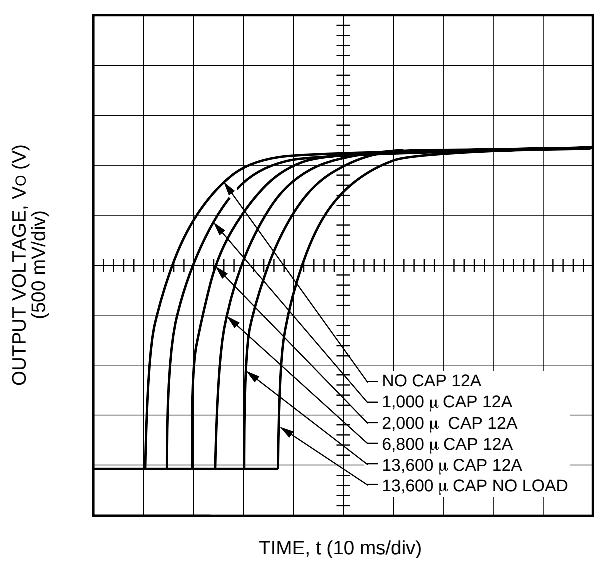
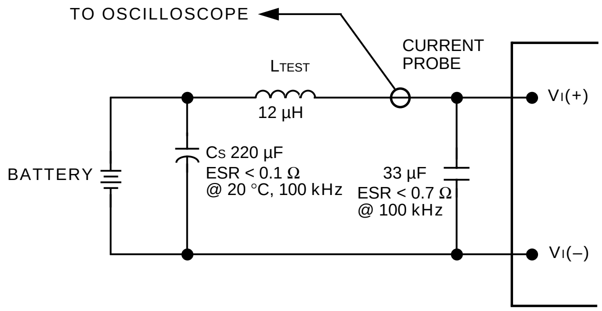


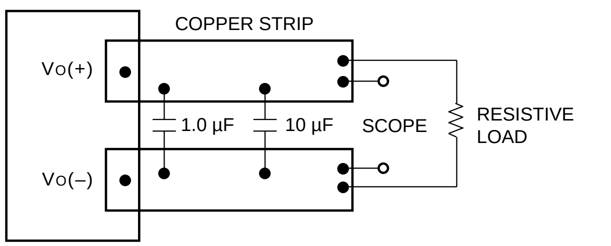
Figure 8. Typical Start-Up from Remote On/Off HW125F1; $I_O = I_{O,\,max}$

Test Configurations



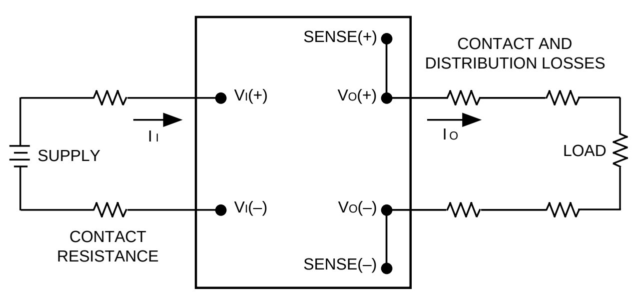
Note: Measure input reflected-ripple current with a simulated source inductance (L_{TEST}) of 12 µH. Capacitor C_S offsets possible battery impedance. Measure current as shown above.

Figure 9. Input Reflected-Ripple Test Setup



Note: Use a 1.0 µF ceramic capacitor and a 10 µF aluminum or tantalum capacitor. Scope measurement should be made using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from the module.

Figure 10. Peak-to-Peak Output Noise Measurement 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.

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

Figure 11. 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. Highly inductive source impedances can affect the stability of the power module. For the test configuration in Figure 9, 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* C22.2 No. 950-95, and *VDE* 0805 (EN60950, IEC950).

If the input source is non-SELV (ELV or a hazardous voltage greater than 60 Vdc and less than or equal to 75 Vdc), for the module's output to be considered meeting the requirements of safety extra-low voltage (SELV), all of the following must be true:

- The input source is to be provided with reinforced insulation from any other hazardous voltages, including the ac mains.
- One V_I pin and one V_O pin are to be grounded, or both the input and output pins are to be kept floating.
- The input pins of the module are not operator accessible.
- Another SELV reliability test is conducted on the whole system, as required by the safety agencies, on the combination of supply source and the subject module to verify that under a single fault, hazardous voltages do not appear at the module's output.

Note: Do not ground either of the input pins of the module without grounding one of the output pins. This may allow a non-SELV voltage to appear between the output pins and ground.

The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

Feature Descriptions

Overcurrent Protection

To provide protection in a fault (output overload) condition, the unit is equipped with internal current-limiting circuitry and can endure current limiting for up to one second. If overcurrent exists for more than one second, the unit will latch in an off condition. The overcurrent latch is reset by either cycling the input power or by toggling the ON/OFF pin for one second. 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).

Remote On/Off

Two remote on/off options are available. Positive logic remote on/off turns the module on during a logic-high voltage on the 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, device code suffix “1,” is the factory-preferred configuration.

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 12). 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 15 V. The maximum allowable leakage current of the switch at $V_{on/off}$ = 15 V is 50 µA.

If not using the remote on/off feature, do one of the following:

- For negative logic, short ON/OFF pin to $V_I(–)$.
- For positive logic, leave ON/OFF pin open.

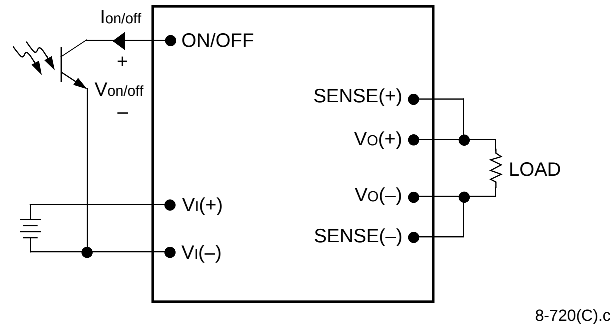


Figure 12. Remote On/Off Implementation

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, i.e.:

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

The voltage between the $V_O(+)$ and $V_O(–)$ terminals must not exceed the minimum output overvoltage shutdown voltage as indicated in the Feature Specifications table. This limit includes any increase in voltage due to remote-sense compensation and output voltage setpoint adjustment (trim). See Figure 13.

If not using the remote-sense feature to regulate the output at the point of load, then connect SENSE(+) to $V_O(+)$ and SENSE(–) to $V_O(–)$ at the module.

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. Consult the factory if you need to increase the output voltage more than the above limitation.

The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote-sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.

Feature Descriptions (continued)

Remote Sense (continued)

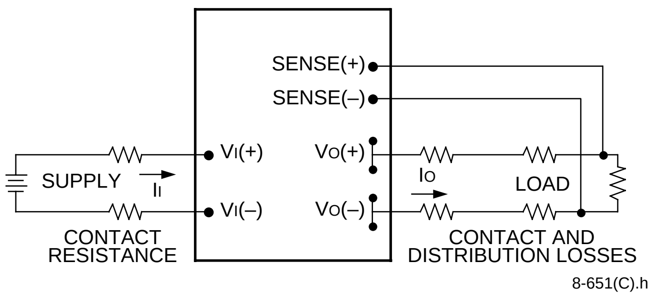


Figure 13. Effective Circuit Configuration for Single-Module Remote-Sense Operation

The voltage between the $V_O(+)$ and $V_O(–)$ terminals must not exceed the minimum output overvoltage shutdown voltage as indicated in the Feature Specifications table. This limit includes any increase in voltage due to remote-sense compensation and output voltage set-point adjustment (trim). See Figure 13.

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. Consult the factory if you need to increase the output voltage more than the above limitation.

The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote-sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.

Output Voltage Set-Point Adjustment (Trim)

Output voltage trim 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. The trim resistor should be positioned close to the module.

If not using the trim feature, leave the TRIM pin open.

With an external resistor between the TRIM and SENSE(–) pins ($R_{adj\text{-}down}$), the output voltage set point ($V_{O,\ adj}$) decreases (see Figure 14). The following equation determines the required external-resistor value to obtain a percentage output voltage change of Δ%.

$$R_{adj\text{-}down} = \left(\frac{510}{\Delta\%} - 10.2\right)\ \text{k}\Omega$$

With an external resistor connected between the TRIM and SENSE(+) pins ($R_{adj\text{-}up}$), the output voltage set point ($V_{O,\ adj}$) increases (see Figure 15).

The following equation determines the required external-resistor value to obtain a percentage output voltage change of Δ%.

$$R_{adj\text{-}up} = \left(\frac{5.1V_O(100 + \Delta\%)}{1.225\Delta\%} - \frac{510}{\Delta\%} - 10.2\right)\ \text{k}\Omega$$

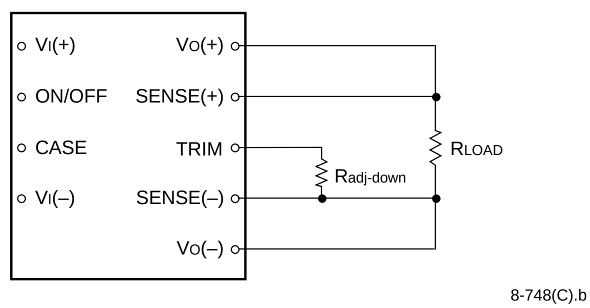


Figure 14. Circuit Configuration to Decrease Output Voltage

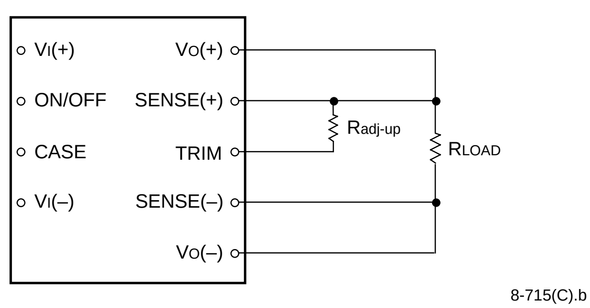


Figure 15. Circuit Configuration to Increase Output Voltage

Feature Descriptions (continued)

Output Overvoltage Protection

The output overvoltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the overvoltage protection threshold, then the module will shut down and latch off. The overvoltage latch is reset by either cycling the input power for one second or by toggling the ON/OFF pin for one second.

Overtemperature Protection

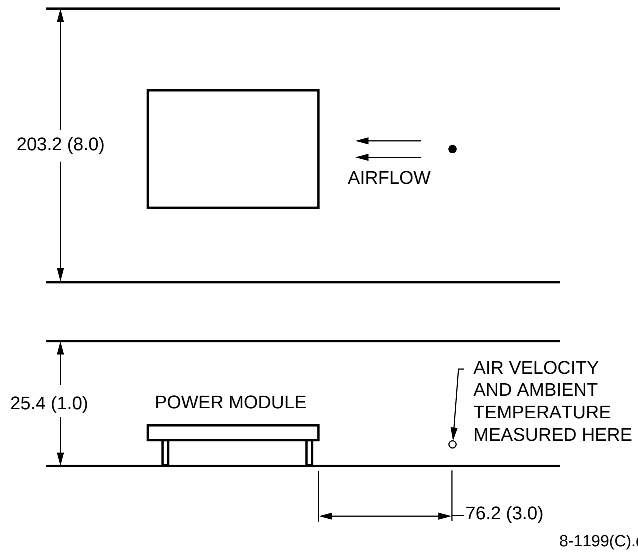
To provide protection in a fault condition, the unit is equipped with a thermal shutdown circuit. The shutdown circuit will not engage unless the unit is operated above the maximum device temperature. Recovery for the thermal shutdown is accomplished by cycling the dc input power off for at least one second or toggling the primary referenced on/off signal for at least one second.

Thermal Considerations

Introduction

The power modules operate in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by 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 16 was used to collect data for Figures 22 and 23. Note that the orientation of the module with respect to airflow affects thermal performance. Two orientations are shown in Figures 17 and 18.



Note: Dimensions are in millimeters and (inches).

Figure 16. Thermal Test Setup

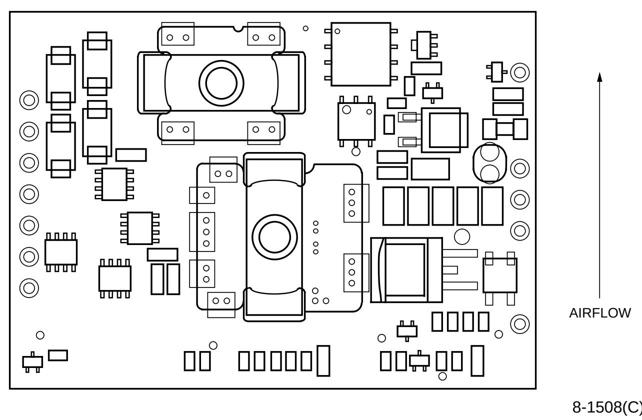
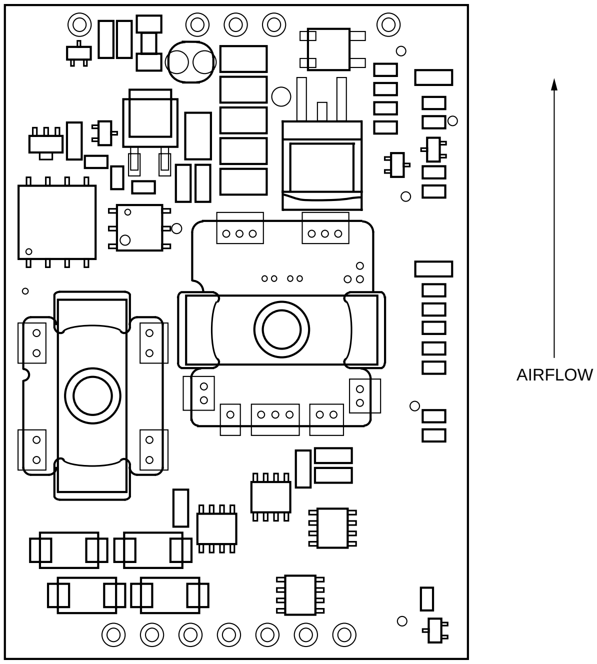


Figure 17. Best Orientation (Top View)

Thermal Considerations (continued)

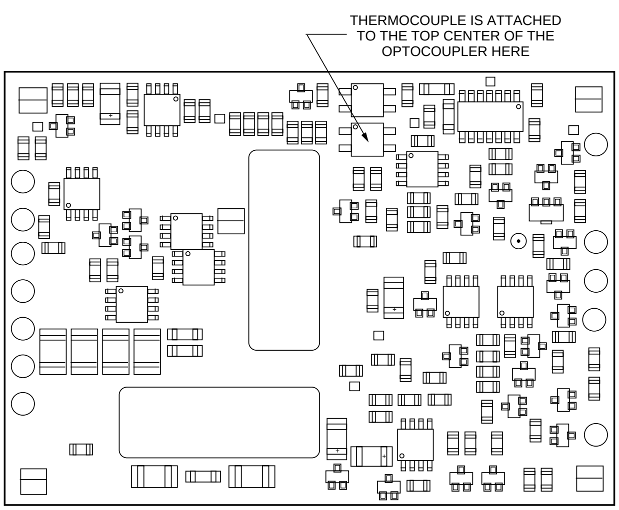
Introduction (continued)



8-1508(C)

Figure 18. Worst Orientation (Top View)

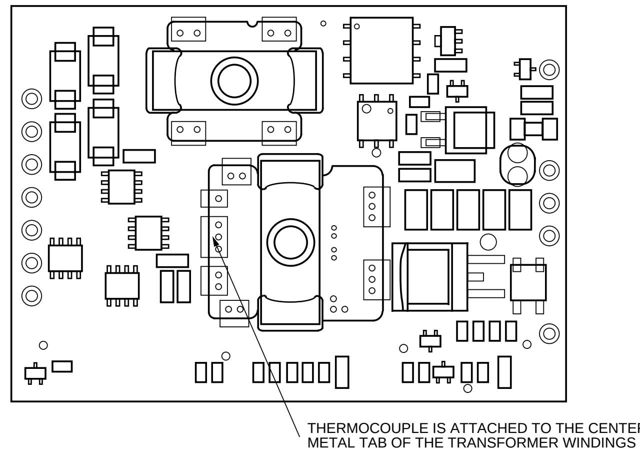
Proper cooling can be verified by measuring the power module's temperature at the top center of the case of the optocoupler as shown in Figure 19 and the power transformer winding as shown in Figure 20.



8-1645(C).a

Figure 19. Temperature Measurement Location (Bottom View)

The temperature at the top center of the optocoupler case should not exceed 100 °C. The output power of the module should not exceed the rated power.



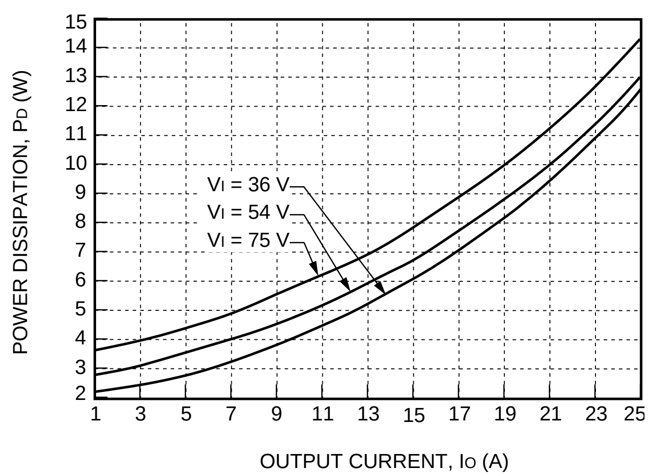
8-1508(C).b

Figure 20. Temperature Measurement Location (Top View)

The temperature at the center metal tab of the transformer windings should not exceed 120 °C.

Convection Requirements for Cooling

To predict the approximate cooling needed for the module, determine the power dissipated as heat by the unit for the particular application. Figure 21 shows typical heat dissipation for the module over a range of output currents.



8-3007(C)

Figure 21. HW125F1 Power Dissipation vs. Output Current, T_A = 25 °C

Thermal Considerations (continued)

Convection Requirements for Cooling (continued)

With the known heat dissipation, module orientation with respect to airflow, and the local ambient temperature, the minimum airflow can be chosen from the derating curves in Figures 22 and 23.

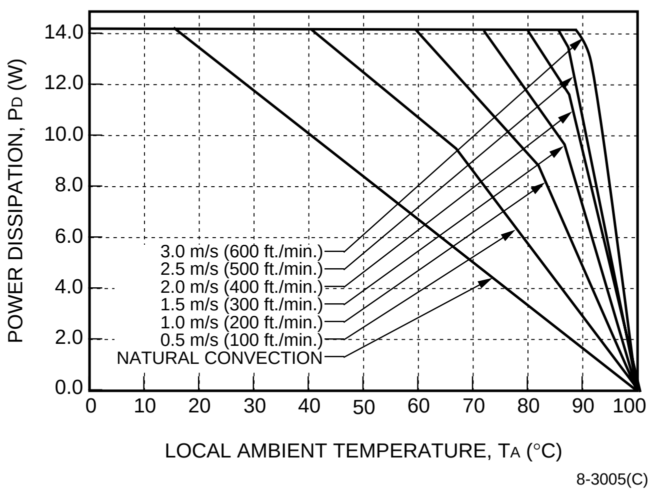


Figure 22. HW125F1 Power Derating vs. Local Ambient Temperature and Air Velocity; Best Orientation

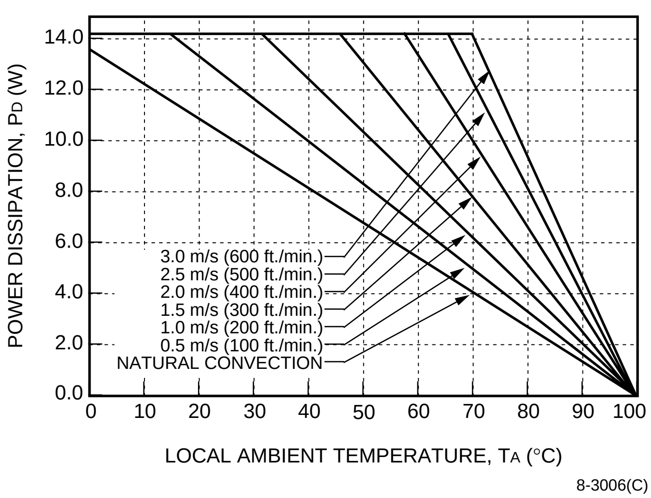


Figure 23. HW125F1 Power Derating vs. Local Ambient Temperature and Air Velocity; Worst Orientation

For example, if the HW125F1 dissipates 13 W of heat at 25 A full load and nominal line voltage, the minimum airflow for best module orientation in a 50 °C environment is 0.6 m/s (120 ft./min.).

Keep in mind that these derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be checked as shown in Figures 19 and 20 to ensure it does not exceed the critical temperatures at those locations.

Solder, Cleaning, and Drying Considerations

Post solder cleaning is usually the final circuit-board assembly process prior to electrical board testing. The result of inadequate circuit-board cleaning and drying can affect both the reliability of a power module and the testability of the finished circuit-board assembly. For guidance on appropriate soldering, cleaning, and drying procedures, refer to Lucent Technologies *Board-Mounted Power Modules: Soldering and Cleaning* Application Note (AP97-021EPS).

EMC Considerations

For assistance with designing for EMC compliance, refer to the *FLTR100V10 Filter Module* Data Sheet (DS99-294EPS).

Layout Considerations

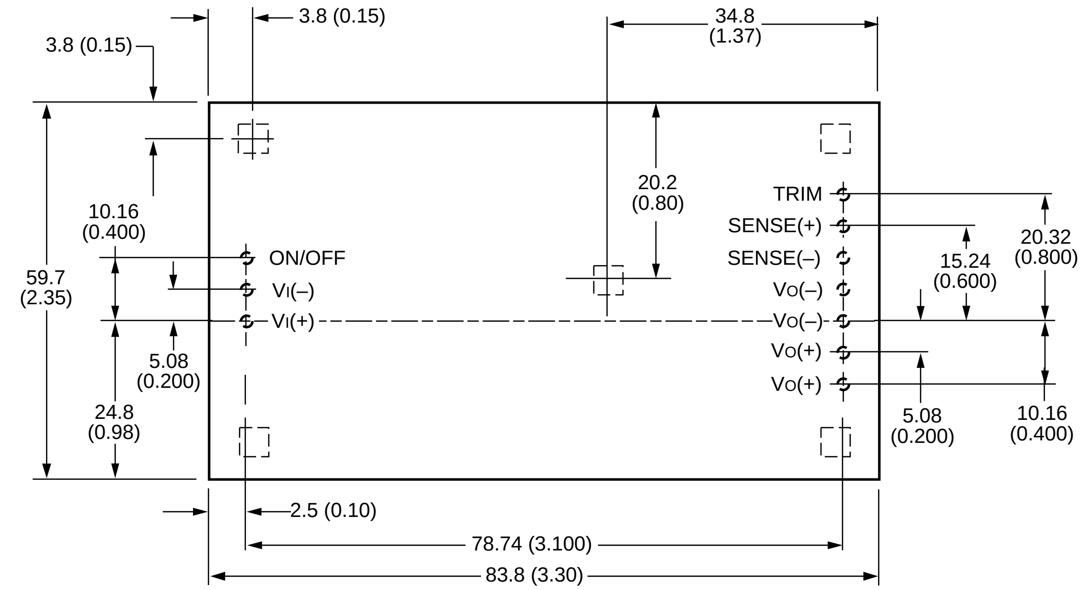
Copper paths must not be routed beneath the power module standoffs. For additional layout guidelines, refer to the *FLTR100V10 Filter Module* Data Sheet (DS99-294EPS).

Outline Diagram

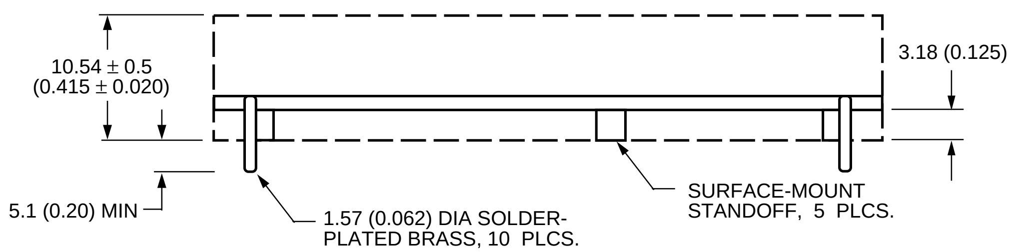
Dimensions are in millimeters and (inches).

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

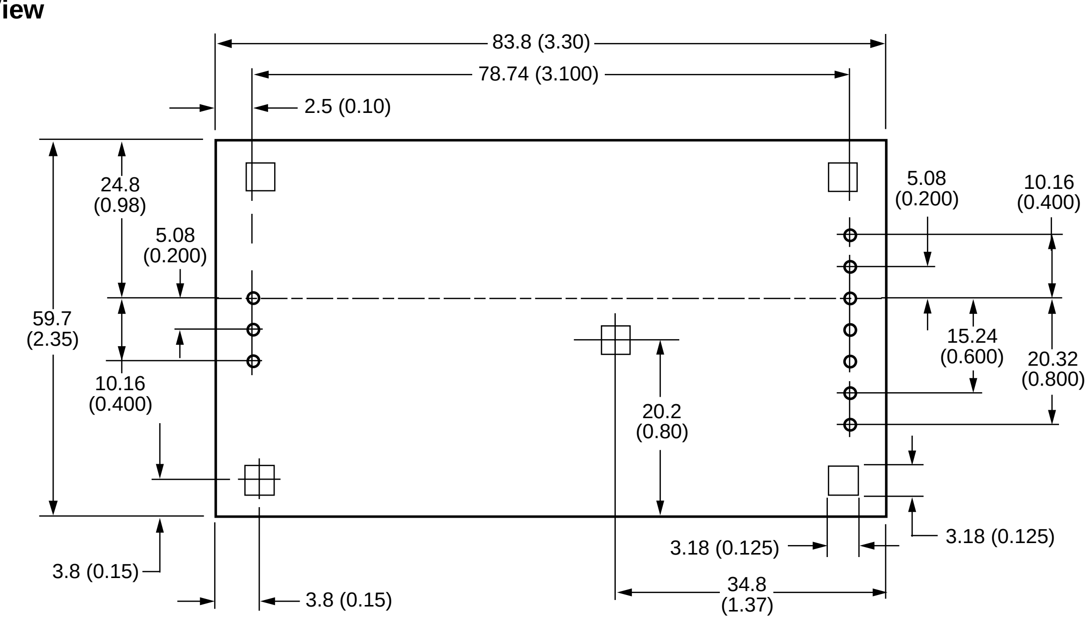
Top View



Side View



Bottom View

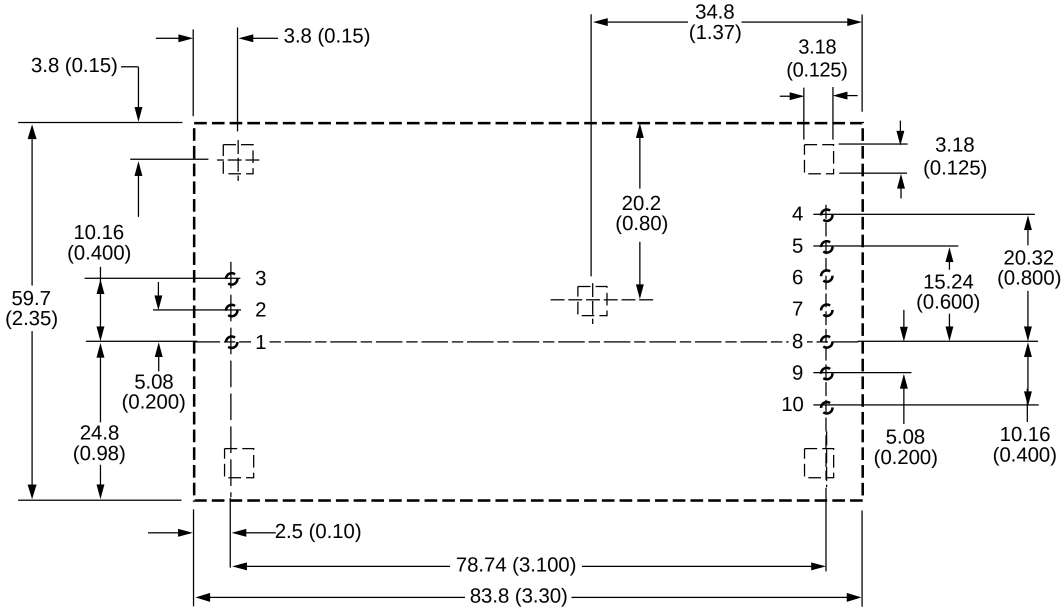


8-1301(C).b

Recommended Hole Pattern

Component-side footprint.

Dimensions are in millimeters and (inches).



8-1301(C).b

Table 4. Pin Functions

Pin	Function	Pin	Function
1	V_I(+)	6	SENSE(–)
2	V_I(–)	7	V_O(–)
3	ON/OFF	8	V_O(–)
4	TRIM	9	V_O(+)
5	SENSE(+)	10	V_O(+)

Ordering Information

Table 5. Device Codes

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
48 Vdc	3.3 Vdc	83.5 W	HW125F	TBD

Optional features may be ordered using the device code suffixes shown below. To order more than one option, list suffixes in numerically descending order. Please contact your Lucent Technologies Account Manager or Application Engineer for pricing and availability of options.

Table 6. Device Options

Option	Device Code Suffix
Short pins: 3.68 mm ± 0.25 mm (0.145 in. ± 0.010 in.)	6
Negative remote on/off logic	1
Positive remote on/off logic	—

For additional information, contact your Lucent Technologies Account Manager or the following:

POWER SYSTEMS UNIT: Network Products Group, Lucent Technologies Inc., 3000 Skyline Drive, Mesquite, TX 75149, USA
+1-800-526-7819 (Outside U.S.A.: **+1-972-284-2626**, FAX +1-888-315-5182) (product-related questions or technical assistance)

INTERNET: **http://www.lucent.com/networks/power**

E-MAIL: **techsupport@lucent.com**

ASIA PACIFIC: Lucent Technologies Singapore Pte. Ltd., 750D Chai Chee Road #07-06, Chai Chee Industrial Park, Singapore 469004
Tel. (65) 240 8041, FAX (65) 240 8438

CHINA: Lucent Technologies (China) Co. Ltd., SCITECH Place No. 22, Jian Guo Men Wai Avenue, Beijing 100004, PRC
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FRANCE: **(33) 1 40 83 68 00** (Paris), SWEDEN: **(46) 8 594 607 00** (Stockholm), FINLAND: **(358) 9 4354 2800** (Helsinki),
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