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Data Sheet
April 2008

LC/LW005-Series Power Modules: 18 Vdc to 36 Vdc or 36 Vdc to 75 Vdc Inputs, 5 W

The LC/LW005-Series Power Modules use advanced, surface-mount technology and deliver high-quality, compact, dc-dc conversion at an economical price.

Applications

- Computer equipment
- Communications equipment
- Distributed power architectures

Options

- Positive remote on-off logic
- Short pins: 2.8 mm ± 0.25 mm (0.110 in. ± 0.010 in.)
- Synchronization
- Tight output voltage tolerance

Features

- Low profile: 10.2 mm x 25.4 mm x 32 mm (0.400 in. x 1 in. x 1.26 in.) with standoffs (9.78 mm (0.385 in.) with standoffs recessed)
- Wide input voltage range: 18 Vdc to 36 Vdc or 36 Vdc to 75 Vdc
- Input-to-output isolation up to 1500 V
- Operating case temperature range: –40 °C to +105 °C
- Overcurrent protection, unlimited duration
- Output overvoltage protection
- Undervoltage lockout
- *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‡
- Within FCC Class A radiated limits

* *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.)

Description

The LC/LW005-Series Power Modules are low-profile, dc-dc converters that operate over an input voltage range of 18 Vdc to 36 Vdc or 36 Vdc to 75 Vdc and provide a precisely regulated output. The output is isolated from the input, allowing versatile polarity configurations and grounding connections. The modules have a maximum power rating of 5 W and efficiencies greater than 75%. Built-in filtering for both input and output minimizes the need for external filtering.

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	Device	Symbol	Min	Typ	Max	Unit
Input Voltage:						
Continuous	LC	V_I	0	—	50	Vdc
	LW	V_I	0	—	80	Vdc
Transient (100 ms)	LW	$V_{I, trans}$	0	—	100	V
Operating Case Temperature	All	T_C	–40	—	105	°C
Operating Ambient Temperature in Natural Convection (See Thermal Considerations section.)	All	T_A	–40	—	85	°C
Storage Temperature	All	T_{stg}	–55	—	125	°C
I/O Isolation Voltage (1 minute)	All	—	—	—	1500	Vdc

Electrical Specifications

Table 1. Input Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	LC	V_I	18	24	36	Vdc
	LW	V_I	36	48	75	Vdc
Maximum Input Current (V_I = 0 to $V_{I, max}$; I_O = $I_{O, max}$; see Figures 1 and 2.)	LC	$I_{I, max}$	—	—	0.6	A
	LW	$I_{I, max}$	—	—	0.3	A
Inrush Transient	All	I^2t	—	—	0.2	A^2s
Input Reflected-ripple Current (5 Hz to 20 MHz; 12 µH source impedance; T_C = 25 °C; see Figure 16.)	All	I_I	—	5	—	mAp-p
Input Ripple Rejection (100 Hz—120 Hz)	All	—	—	45	—	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 safety agencies require a normal-blow fuse with a maximum rating of 5 A (see Safety Considerations section). 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 Code or Suffix	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point ($V_I = V_{I,\,nom}$; $I_O = I_{O,\,max}$; T_C = 25 °C)	F	$V_{O,\,set}$	3.17	—	3.43	Vdc
	A	$V_{O,\,set}$	4.85	—	5.20	Vdc
	B	$V_{O,\,set}$	11.52	—	12.48	Vdc
	C	$V_{O,\,set}$	14.40	—	15.60	Vdc
Output Voltage (Over all line, load, and temperature conditions until end of life; see Figure 18.)	F	V_O	3.13	—	3.47	Vdc
	A	V_O	4.80	—	5.25	Vdc
	B	V_O	11.40	—	12.60	Vdc
	C	V_O	14.25	—	15.75	Vdc
Output Regulation:						
Line ($V_I = V_{I,\,min}$ to $V_{I,\,max}$)	A, F	—	—	2	5	mV
	B, C	—	—	0.03	0.1	%V_O
Load ($I_O = I_{O,\,min}$ to $I_{O,\,max}$; see Figure 3.)	A, F	—	—	2	10	mV
	B, C	—	—	0.1	0.2	%V_O
Temperature (T_C = –40 °C to +85 °C)	A, F	—	—	25	100	mV
	B, C	—	—	0.5	2.0	%V_O
Output Ripple and Noise Voltage:						
With an External 0.1 µF Ceramic Output Capacitor (See Figure 17.):						
RMS	All	—	—	—	35	mVrms
Peak-to-peak (5 Hz to 20 MHz)	All	—	—	—	150	mVp-p
With an External 3.3 µF Ceramic Output Capacitor:						
RMS	A, F	—	—	—	30	mVrms
Peak-to-peak (5 Hz to 20 MHz)	A, F	—	—	—	100	mVp-p
External Load Capacitance	A, F	—	0	—	470	µF
	B, C	—	0	—	100	µF
Output Current (At $I_O < I_{O,\,min}$, the modules may exceed output ripple specifications, but operation is guaranteed.)	F	I_O	0.12	—	1.21	A
	A	I_O	0.1	—	1.0	A
	B	I_O	0.08	—	0.42	A
	C	I_O	0.06	—	0.33	A
Output Current-limit Inception (V_O = 90% $V_{O,\,set}$; see Figure 4.)	F	I_O	—	1.7	3.0	A
	A	I_O	—	1.4	2	A
	B, C	I_O	—	0.6	0.9	A
Output Short-circuit Current (V_O = 0.25 V)	F	I_O	—	2.4	4.5	A
	A	I_O	—	2.2	4.0	A
	B, C	I_O	—	1.0	2.5	A
Efficiency ($V_I = V_{I,\,nom}$; $I_O = I_{O,\,max}$; T_C = 25 °C; see Figures 6 through 8.)	LC005F	η	69	72	—	%
	LC005A	η	73	76	—	%
	LC005B, C	η	71	74	—	%
	LW005F	η	71	74	—	%
	LW005A, B, C	η	75	78	—	%
Switching Frequency	All	—	—	300	—	kHz

Electrical Specifications (continued)

Table 2. Output Specifications (continued)

Parameter	Device Code or Suffix	Symbol	Min	Typ	Max	Unit
Dynamic Response ($\Delta I_O/\Delta t$ = 1 A/10 µs; $V_I = V_{I,\,nom}$; T_C = 25 °C; see Figures 12 and 13.):						
Load Change from I_O = 50% to 75% of $I_{O,\,max}$:						
Peak Deviation	All	—	—	1.5	—	$\%V_{O,\,set}$
Settling Time (V_O < 10% of peak deviation)	All	—	—	0.8	—	ms
Load Change from I_O = 50% to 25% of $I_{O,\,max}$:						
Peak Deviation	All	—	—	1.5	—	$\%V_{O,\,set}$
Settling Time (V_O < 10% of peak deviation)	All	—	—	0.8	—	ms

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	2300	—	pF
Isolation Resistance	10	—	—	M¾

Table 4. General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (I_O = 80% of $I_{O,\,max}$; T_C = 40 °C)	—	8,400,000	—	hours
Weight	—	—	17 (0.6)	g (oz.)
Hand Soldering (soldering iron 3 mm (0.125 in.) tip, 425 °C)	—	—	12	s

Electrical Specifications (continued)

Table 5. Feature Specifications

Parameter	Device Code Suffix	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal Interface (optional) (V_I = 0 V to $V_{I, max}$; open collector or equivalent compatible; signal referenced to V_I(–) terminal. See Feature Descriptions section and Figure 19.):						
Positive Logic—Device Code Suffix “4:”						
Logic Low—Module Off						
Logic High—Module On						
Module Specifications:						
On/Off Current—Logic Low	All	$I_{on/off}$	—	5.0	10	mA
On/Off Voltage:						
Logic Low	All	$V_{on/off}$	–0.7	—	1.2	V
Logic High ($I_{on/off}$ = 0)	All	$V_{on/off}$	—	—	15	V
Open Collector Switch Specifications:						
Leakage Current During Logic High ($V_{on/off}$ = 15 V)	All	$I_{on/off}$	—	—	50	µA
Output Low Voltage During Logic Low ($I_{on/off}$ = 10 mA)	All	$V_{on/off}$	—	—	1.2	V
Turn-on Delay and Rise Times (at 80% of $I_{O, max}$; T_C = 25 °C; see Figures 14 and 15.):						
Case 1: On/Off Input Is Set for Unit On and then Input Power Is Applied (delay from point at which $V_I = V_{I, min}$ until V_O = 10% of $V_{O, nom}$).	All	T_{delay}	—	5	20	ms
Case 2: Input Power Is Applied for at Least One Second, and then the On/Off Input Is Set to Turn the Module On (delay from point at which on/off input is toggled until V_O = 10% of $V_{O, nom}$).	All	T_{delay}	—	4	10	ms
Output Voltage Rise Time (time for V_O to rise from 10% of $V_{O, nom}$ to 90% of $V_{O, nom}$)	All	T_{rise}	—	0.3	5	ms
Output Voltage Overshoot (at 80% of $I_{O, max}$; T_C = 25 °C)	All	—	—	0	5	%
Output Overvoltage Protection (clamp)	F	$V_{O, clamp}$	3.5	—	6.2	V
	A	$V_{O, clamp}$	5.4	—	7.0	V
	B	$V_{O, clamp}$	12.7	—	16.0	V
	C	$V_{O, clamp}$	15.8	—	21.0	V
Undervoltage Lockout	LCxxx	V_{uvlo}	11	14	—	V
	LWxxx	V_{uvlo}	20	27	—	V

Characteristic Curves

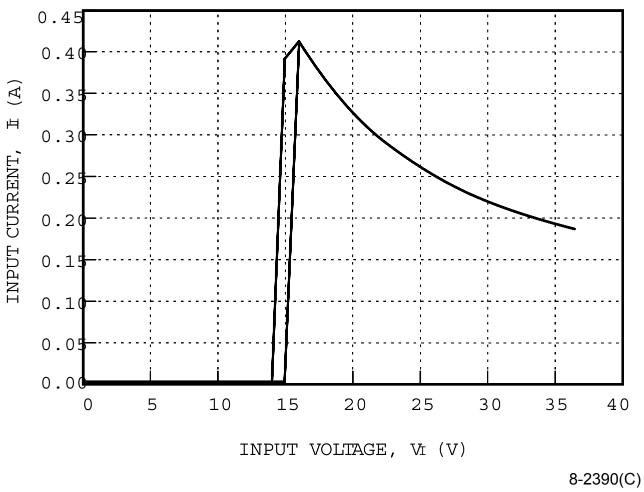

Figure 1. LC005x Input Current vs. Input Voltage at $I_O = I_{O, max}$ and T_C = 25 °C

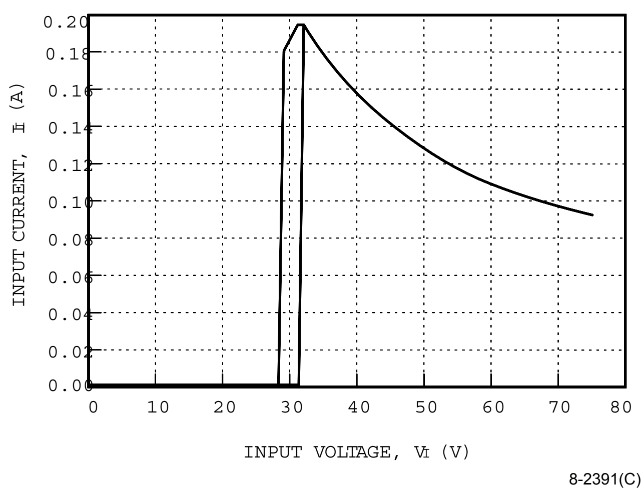

Figure 2. LW005x Input Current vs. Input Voltage at $I_O = I_{O, max}$ and T_C = 25 °C

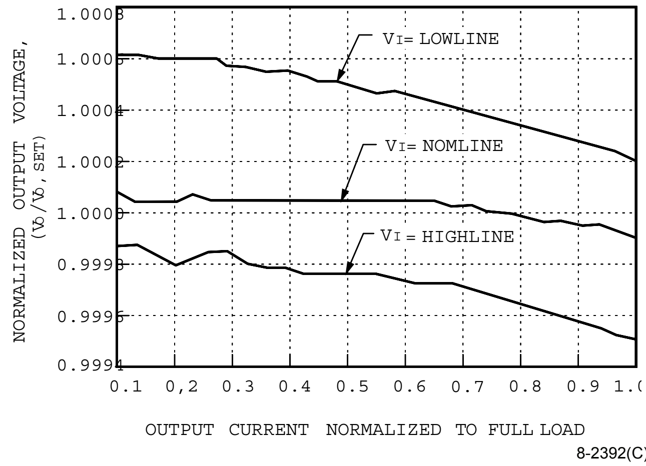

Figure 3. LW005x Load Regulation, Normalized Output Voltage vs. Normalized Output Current at T_C = 25 °C

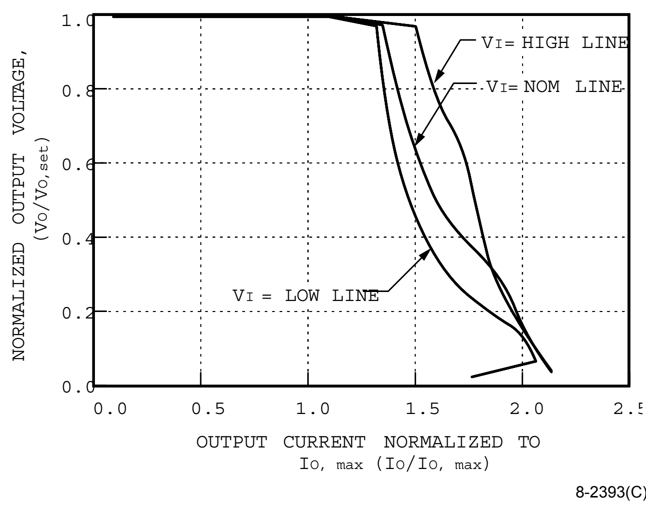

Figure 4. Lx005x Normalized Output Current vs. Normalized Output Voltage at T_C = 25 °C

Characteristics Curves (continued)

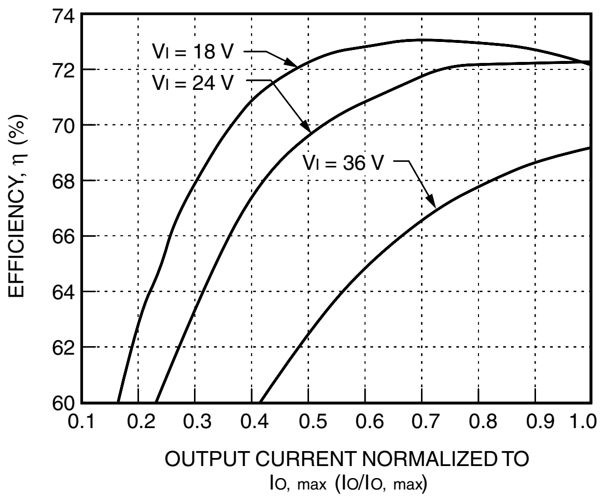

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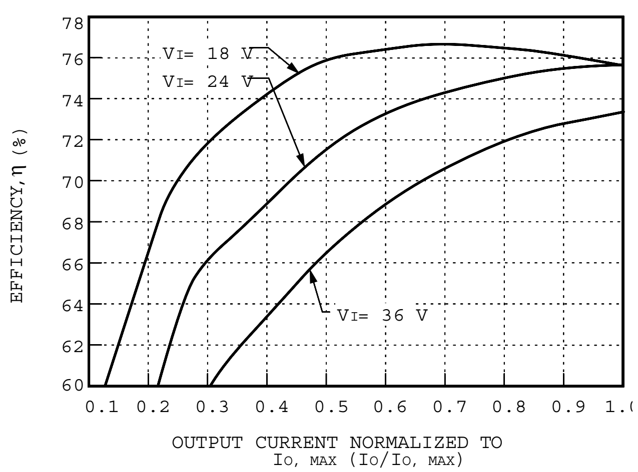
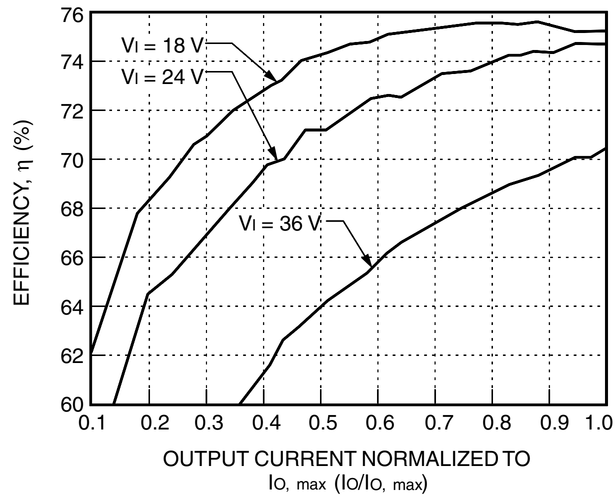
Figure 5. LC005F Typical Efficiency vs. Normalized Output Current at Tc = 25 °C



8-2394(C)

Figure 6. LC005A Typical Efficiency vs. Normalized Output Current at Tc = 25 °C



8-2395(C)

Figure 7. LC005B Typical Efficiency vs. Normalized Output Current at Tc = 25 °C

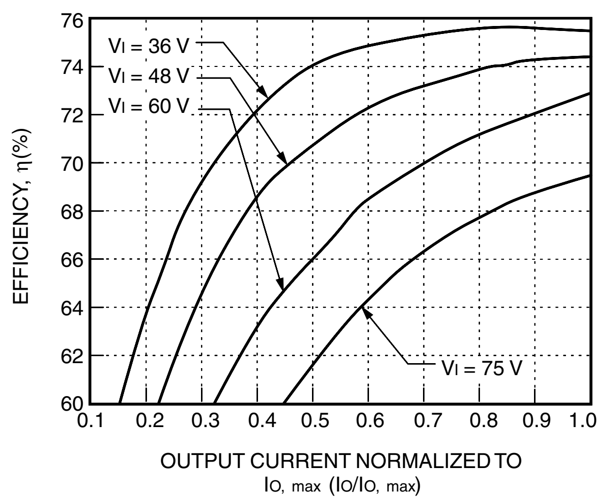


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Figure 8. LW005F Typical Efficiency vs. Normalized Output Current at Tc = 25 °C

Characteristics Curves (continued)

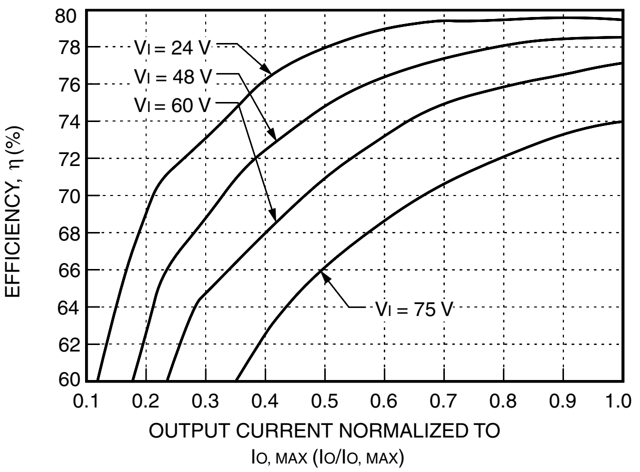


Figure 9. LW005A Typical Efficiency vs. Normalized Output Current at T_C = 25 °C

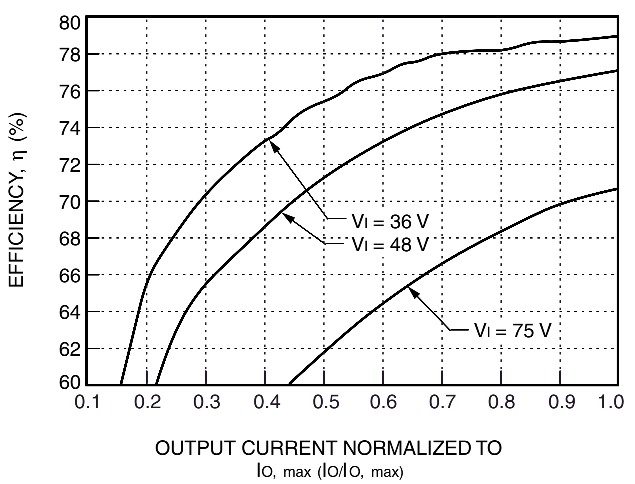


Figure 10. LW005B Typical Efficiency vs. Normalized Output Current at T_C = 25 °C

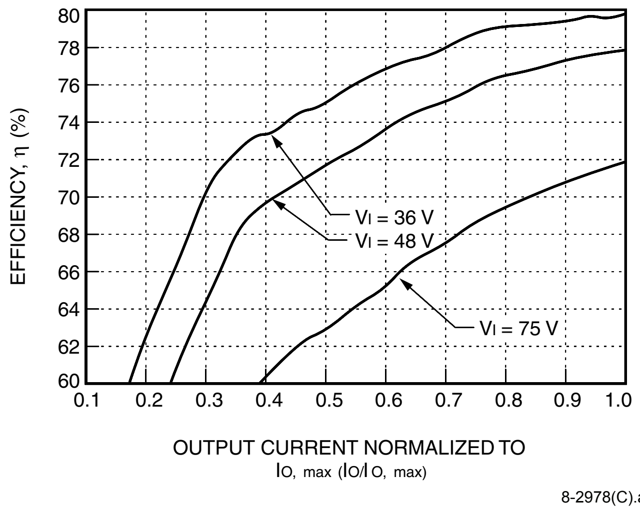


Figure 11. LW005C Typical Efficiency vs. Normalized Output Current at T_C = 25 °C

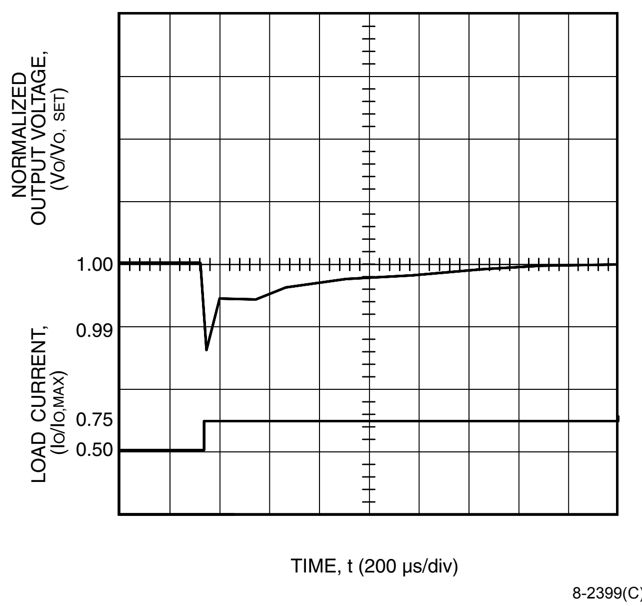
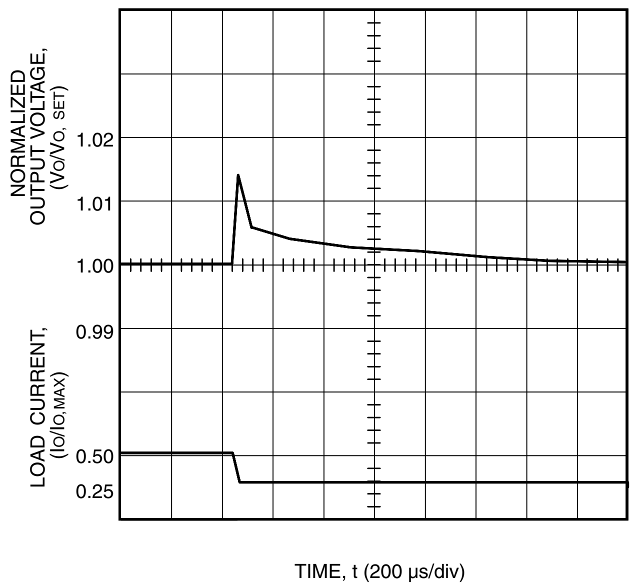


Figure 12. Typical Output Voltage for Step Load Change from 50% to 75% of $I_O = I_{O,\,max}$ at T_C = 25 °C

Characteristics Curves (continued)



8-2400(C)

Figure 13. Typical Output Voltage for Step Load Change from 50% to 25% of $I_O = I_{O, max}$ at T_C = 25 °C

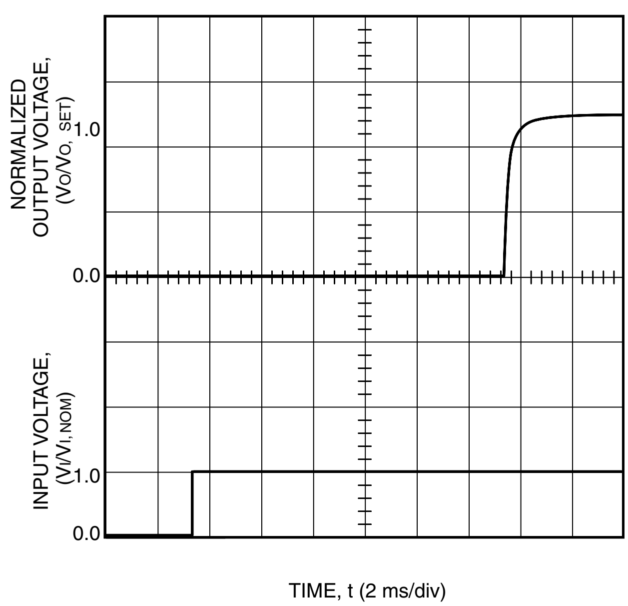


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Figure 14. Typical Output Start-Up when Input Voltage Is Applied; $I_O = I_{O, max}$, V_I = Nominal Line at T_C = 25 °C

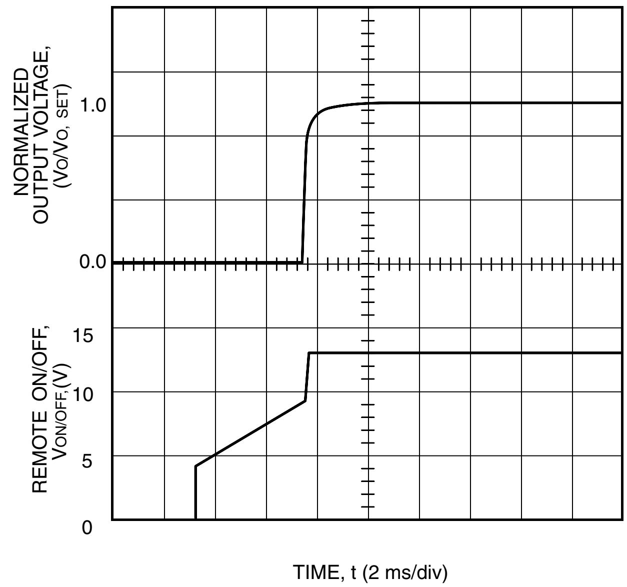

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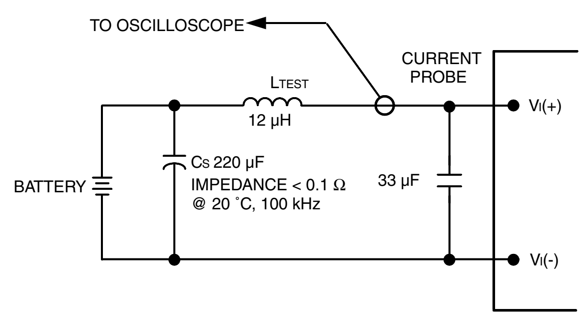
Figure 15. Typical Output Voltage Start-Up when Signal Is Applied to Remote On/Off; $I_O = I_{O, max}$ V_I = Nominal Line at T_C = 25 °C

Test Configurations

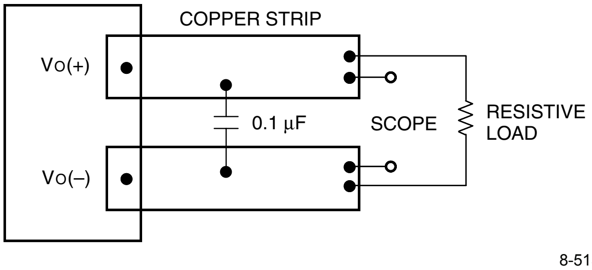


8-203(C)

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.

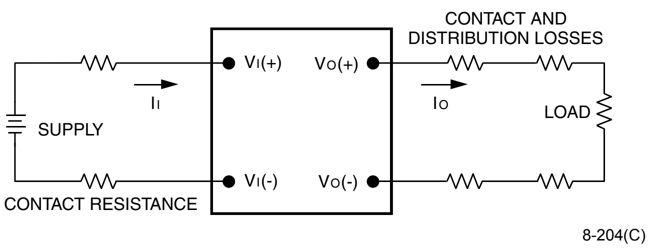
Figure 16. Input Reflected-Ripple Test Setup

Test Configurations (continued)



Note: Use one external 0.1 µF ceramic capacitor. Scope measurement should be made using a BNC socket. Position the load between 50 mm and 75 mm (2 in. and 3 in.) from the module.

Figure 17. 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 18. 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 (see Figure 16). Highly inductive source impedances can affect the stability of the power module. If the source inductance exceeds 5 µH, a 33 µF electrolytic capacitor (ESR < 0.7 ¾ at 100 kHz) mounted close to the power module helps ensure stability of the unit.

Safety Considerations (LC Modules)

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).

For the converter output to be considered meeting the requirements of safety extra-low voltage (SELV), the input must meet SELV requirements.

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

The input to these units is to be provided with a maximum 5 A normal-blow fuse in the ungrounded lead.

Safety Considerations (LW Modules)

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.

The input to these units is to be provided with a maximum 5 A normal-blow fuse in the ungrounded lead.

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 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.

Output Overvoltage Protection

The output overvoltage clamp consists of control circuitry, almost entirely independent of the secondary regulation circuitry, that monitors the voltage on the output terminals. This control loop has a higher voltage set point than the primary loop (see Feature Specifications table). In a fault condition, the overvoltage clamp ensures that the output voltage does not exceed $V_{O,\ clamp,\ max}$. This provides a redundant voltage-control that reduces the risk of output overvoltage.

If totally redundant overvoltage protection is needed in the user application, it is recommended that an external overvoltage protection circuitry be used on the user application board assembly for additional protection. For external overvoltage protection circuit suggestions, contact technical support.

Input Undervoltage Lockout

At input voltages below the input undervoltage lockout limit, the module operation is disabled. The module will begin to operate at an input voltage between the undervoltage lockout limit and the minimum operating input voltage.

Remote On/Off (Optional)

Positive logic, device code suffix “4,” remote on/off turns the module on during a logic-high voltage on the REMOTE ON/OFF pin, and off during a logic low.

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 may be an open collector or equivalent (see Figure 19). A logic low is $V_{on/off}$ = –0.7 V to 1.2 V. The maximum $I_{on/off}$ during a logic low is 10 mA. The switch should maintain a logic-low voltage while sinking 10 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.

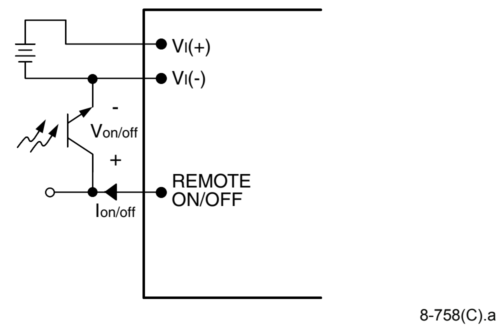


Figure 19. Remote On/Off Implementation

Synchronization (Optional)

With external circuitry, the unit is capable of synchronization at 300 kHz from an independent time base with a switching rate of 600 kHz. The synchronization signal should be applied when the unit is operating to ensure the unit functions properly.

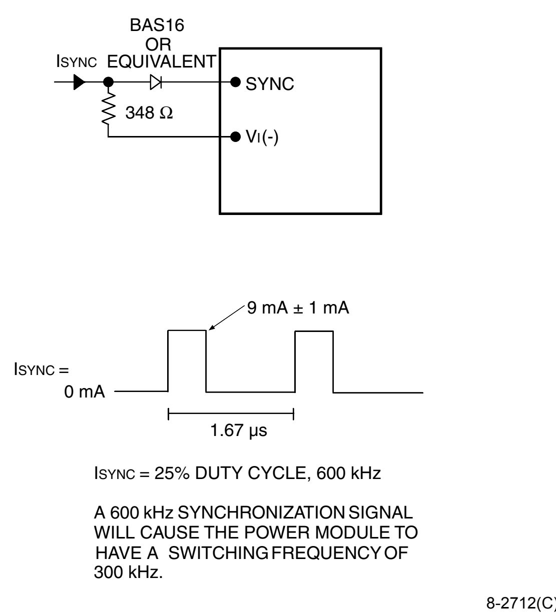
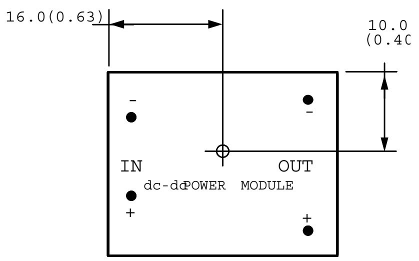


Figure 20. Synchronization Information

Thermal Considerations

Sufficient cooling should be provided to help ensure reliable operation of the power module. Heat-dissipating components inside the unit are thermally coupled to the case. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the case temperature. The case temperature (T_C) should be measured at the position indicated in Figure 21.



8-1363(C).a

Note: Dimensions are in millimeters and (inches). Pin locations are for reference only.

Figure 21. Case Temperature Measurement Location

Note that the view in Figure 21 is of the surface of the module—the pin locations shown are for reference. The temperature at this location should not exceed a maximum case temperature of 105 °C. The output power of the module should not exceed the rated power for the module as listed in the Ordering Information table.

The LC/LW005-Series Power Modules operate at $I_O = I_{O,\,max}$ in an 85 °C ambient temperature with 0.25 ms^{-1} (50 ft./min.) airflow. This airflow is present in a typical circuit pack environment in a natural cooled equipment rack, with other components causing airflow through the chimney effect. In very low airflow environments, such as small enclosures, the module should be derated approximately 10 °C at full load. Note that these are approximations and that actual case temperature measurements in the equipment rack should be taken to verify the case temperature does not exceed 105 °C.

Heat Transfer Characteristics

Increasing airflow over the module enhances the heat transfer via convection. Figure 22 shows the maximum power that can be dissipated by the module without exceeding the maximum case temperature versus local ambient temperature (T_A) for natural convection through 3.0 ms^{-1} (600 ft./min.).

Systems in which these power modules are used typically generate natural convection airflow rates of 0.25 ms^{-1} (50 ft./min.) due to other heat dissipating components in the system. Therefore, the natural convection condition represents airflow rates of approximately 0.25 ms^{-1} (50 ft./min.). Use of Figure 22 is shown in the following example.

Example

What is the minimum airflow necessary for an LW005A operating at 75 V, an output current of 1 A, and a maximum ambient temperature of 90 °C?

Solution:

Given: V_I = 75 V, I_O = 1 A ($I_{O,\,max}$), T_A = 90 °C
Determine P_D (Figure 27): P_D = 1.75 W
Determine airflow (Figure 22): v = 1.0 ms^{-1} (200 ft./min.)

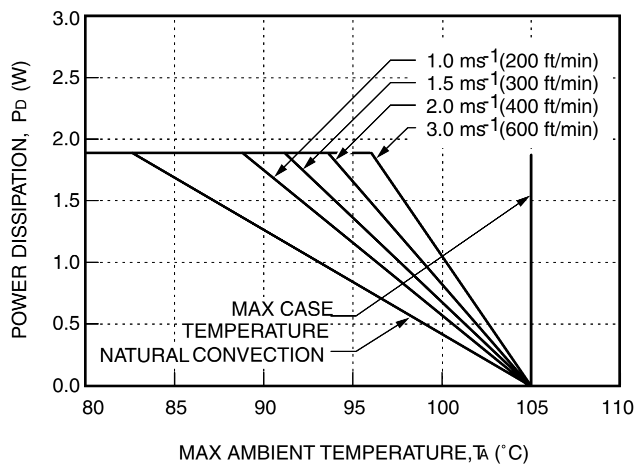


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Figure 22. LC/LW005-Series Forced Convection Power Derating

Thermal Considerations (continued)

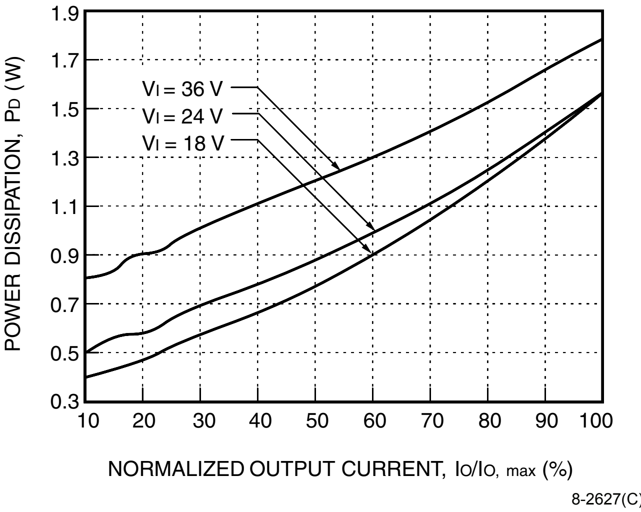


Figure 23. LC005F Power Dissipation vs. Output Current

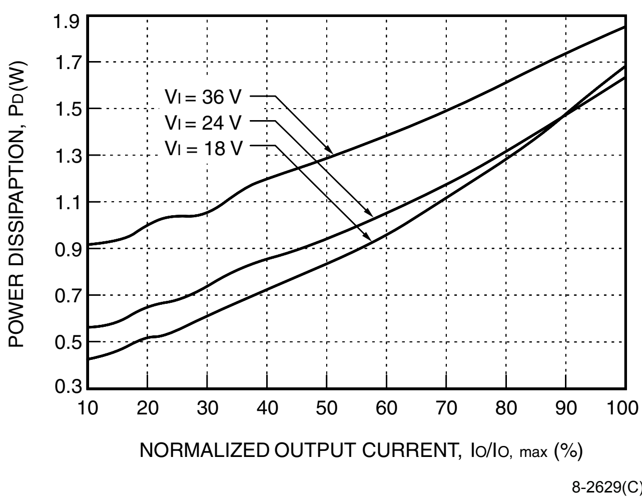


Figure 24. LC005A Power Dissipation vs. Output Current

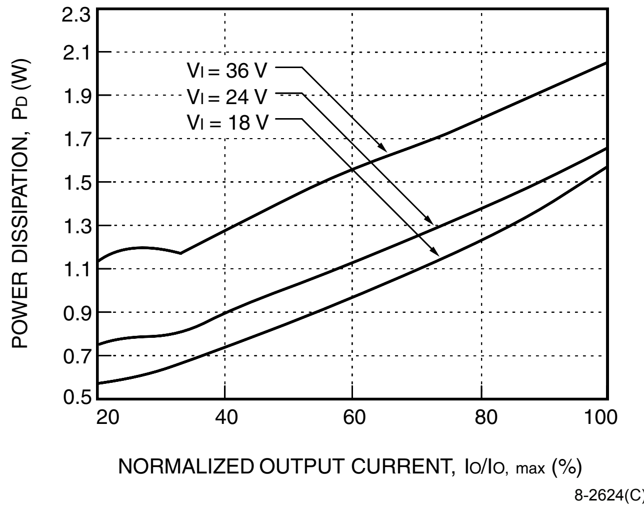


Figure 25. LC005B Power Dissipation vs. Output Current

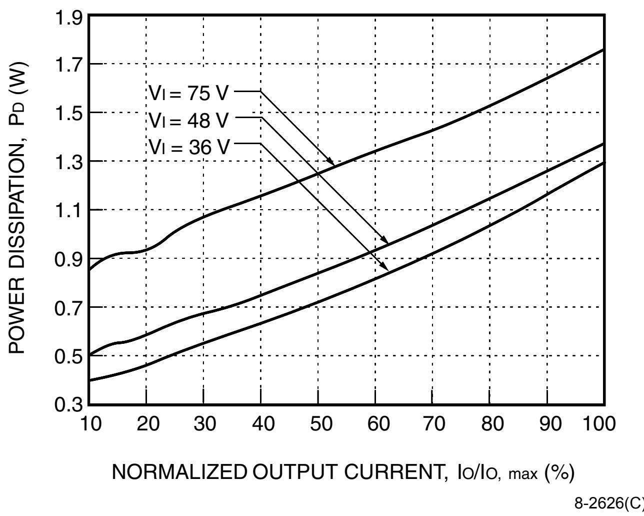


Figure 26. LW005F Power Dissipation vs. Output Current

Thermal Considerations (continued)

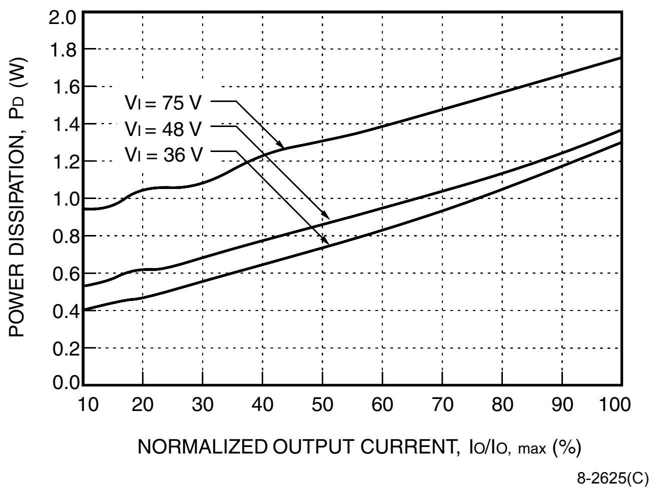


Figure 27. LW005A Power Dissipation vs. Output Current

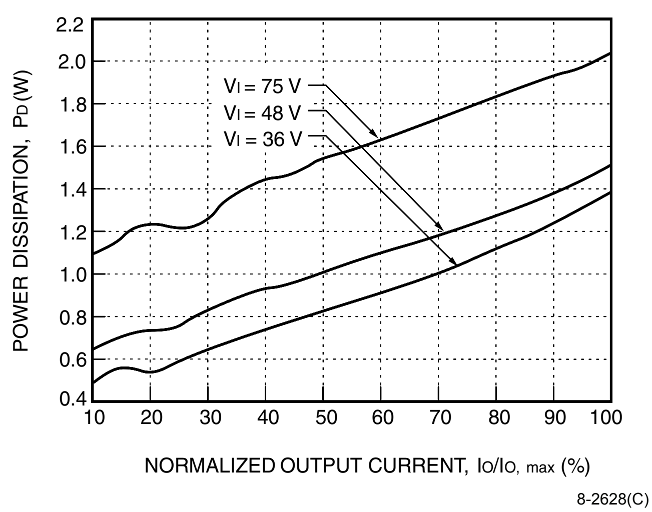


Figure 28. LW005B Power Dissipation vs. Output Current

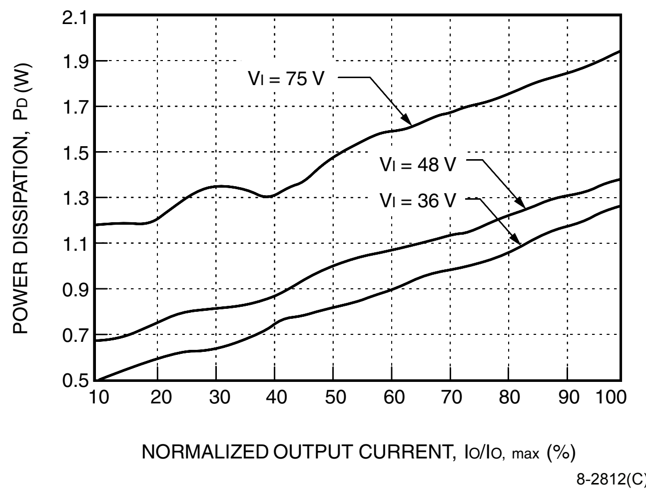
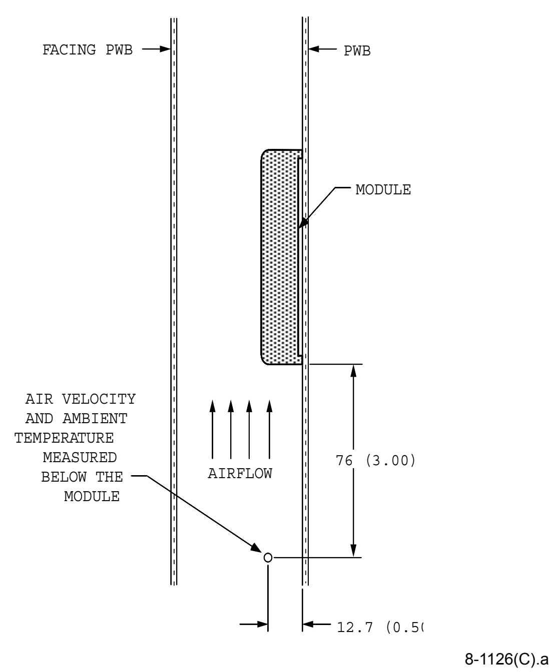


Figure 29. LW005C Power Dissipation vs. Output Current

Module Derating

The derating curves in Figure 22 were derived by measurements obtained in an experimental apparatus shown in Figure 30. Note that the module and the printed-wiring board (PWB) that it is mounted on are both vertically oriented. The passage has a rectangular cross section.



Note: Dimensions are in millimeters and (inches).

Figure 30. Experimental Test Setup

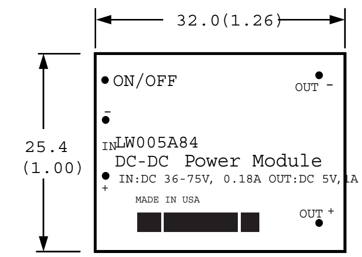
Outline Diagram

Dimensions are in millimeters and (inches).

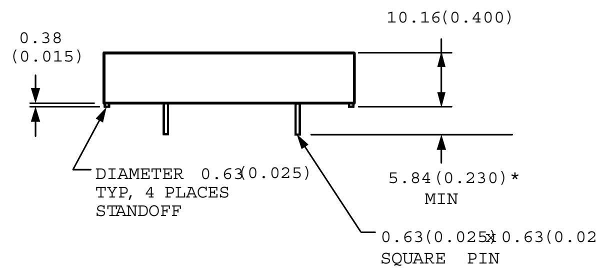
Tolerance: x.x ± 0.5 mm (0.020 in.); x.xx ± 0.38 mm (0.015 in.).

If slightly lower height is needed, the four standoffs can be dropped through holes on the user's PWB. By dropping the standoffs through the PWB, the module height will be decreased to 9.8 mm (0.385 in.) typical height.

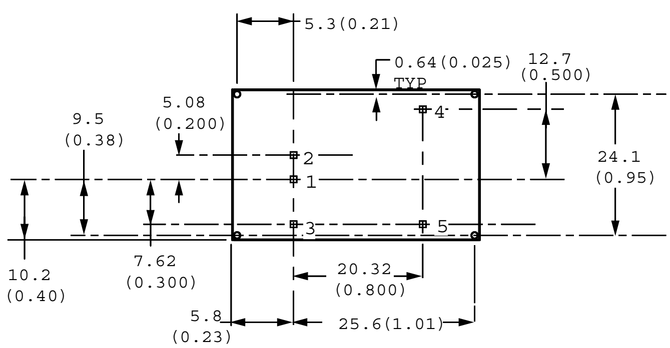
Top View



Side View



Bottom View



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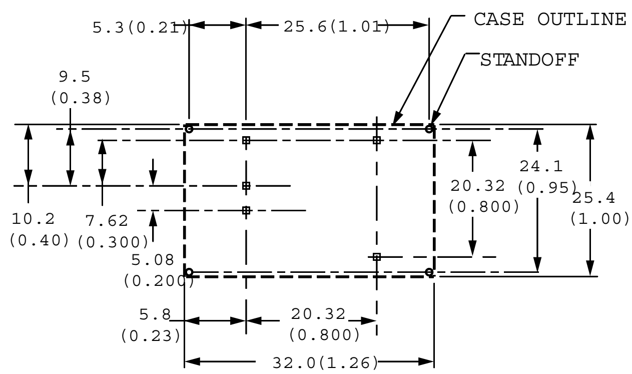
* An optional short pin dimension is 2.8 mm ± 0.25 mm (0.110 in. ± 0.010 in.).

Pin	Function
1	$V_I(-)$
2	$V_I(+)$
3	ON/OFF or SYNC (optional) Pin is not present unless one of these options is specified.
4	$V_O(+)$
5	$V_O(-)$

Recommended Hole Pattern

Component-side footprint.

Dimensions are in millimeters and (inches).



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Ordering Information

Table 6. Device Codes

Input Voltage	Output Voltage	Output Power	Device Code	Comcode
24 V	3.3 V	4 W	LC005F	108122201
24 V	5 V	5 W	LC005A	108122185
24 V	12 V	5 W	LC005B	108122193
24 V	15 V	5 W	LC005C	TBD*
48 V	3.3 V	4 W	LW005F	108122177
48 V	5 V	5 W	LW005A	108122136
48 V	12 V	5 W	LW005B	108122169
48 V	15 V	5 W	LW005C	108407024

* Please contact your Lineage Power Account Manager or Field Application Engineer for pricing and availability.

Optional features may be ordered using the device code suffixes shown below. The feature suffixes are listed numerically in descending order. Please contact your Lineage Power Account Manager or Field Application Engineer for pricing and availability.

Table 7. Device Options

Option	Device Code Suffix
Short pins: 2.8 mm ± 0.25 mm (0.110 in. ± 0.010 in.)	8
Positive logic remote on/off (cannot be ordered on units with the synchronization option)	4
Synchronization* (cannot be ordered on units with the remote on/off option)	3

* Customized option. May not be available on all codes.

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