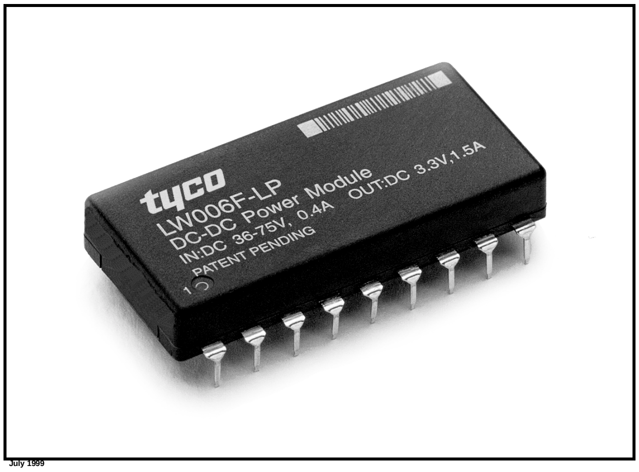
Advance Data Sheet
July 1999

tyco / Electronics

LW006-Series Power Modules: 36 Vdc to 75 Vdc Inputs, 6 W



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The LW006-Series Power Modules use advanced, surface-mount technology and deliver high-quality, compact, dc-dc conversion at an economical price.

Applications

- Communications equipment
- Computer equipment
- Private branch exchange (PBX)
- Voice and data multiplexing

Features

- Low profile: 8.3 mm (0.327 in.) maximum
- Wide input voltage range: 36 Vdc to 75 Vdc
- Input-to-output isolation: 1500 V
- Operating case temperature range: –40 °C to +110 °C
- Overcurrent protection, unlimited duration
- Output overvoltage protection
- Parallel capability (–LP suffix)
- Undervoltage protection
- *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

Options

- Positive remote on-off logic
- Synchronization
- Output voltage adjustment: 85% to 115% of $V_{O,\ nom}$
- Tight tolerance output voltage (nonparallellable) (–L suffix)

Description

The LW006-Series Power Modules are low-profile, dc-dc converters that operate over an input voltage range of 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 6 W to and efficiencies of up to 80% for a 5 V output. Built-in filtering for both input and output minimizes the need for external filtering. The LW006-Series Power Modules are low-profile with a DIP-style package which allows for automatic insertion operation.

* *UL* is a registered trademark of Underwriters Laboratories, Inc.
† *CSA* is a registered trademark of Canadian Standards Association.
‡ 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 Transient (100 ms)	 V_I $V_{I, trans}$	 0 0	 80 100	 Vdc V
Operating Case Temperature (See Thermal Considerations section.)	T_C	–40	110*	°C
Storage Temperature	T_{stg}	–55	125	°C
I/O Isolation Voltage	—	—	1500	Vdc

* Maximum case temperature varies based on power dissipation. See derating curve, Figure 8, for details.

Electrical Specifications

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 to $V_{I, max}$; I_O = $I_{O, max}$)	$I_{I, max}$	—	—	400	mA
Inrush Transient	I^2t	—	—	0.2	A^2s
Input Reflected-ripple Current (5 Hz to 20 MHz; 12 µH source impedance; T_A = 25 °C; see Figure 1.)	I_I	—	1	—	mAp-p
Input Ripple Rejection (100 Hz—120 Hz)	—	—	55	—	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 ($V_I = V_{I, nom}$; $I_O = I_{O, min}$; T_A = 25 °C)	F–LP A–LP	$V_{O, set}$ $V_{O, set}$	3.29 4.95	3.4 5.1	3.45 5.20	Vdc Vdc
Output Voltage (Over all line, load, and temperature conditions until end of life; see Figure 3.)	F–LP A–LP	V_O V_O	3.15 4.80	— —	3.48 5.25	Vdc Vdc
Output Voltage (20% to 100% load; over all line and temperature conditions until end of life)	F–LP	V_O	3.15	—	3.465	Vdc
Output Regulation:						
Line ($V_I = V_{I, min}$ to $V_{I, max}$)	All	—	—	2	10	mV
Load ($I_O = I_{O, min}$ to $I_{O, max}$)	F–LP A–LP	— —	— —	115 135	— —	mV mV
Temperature (T_C = –40 °C to +85 °C)	All	—	—	25	100	mV
Output Ripple and Noise Voltage (Across 1 x 0.1 µF ceramic capacitors; see Figure 2.):						
RMS	All	—	—	—	15	mVrms
Peak-to-peak (5 Hz to 20 MHz)	All	—	—	—	50	mVp-p
External Load Capacitance	All	—	—	—	220	µF
Output Current (At $I_O < I_{O, min}$, the modules may exceed output ripple specifications, but operation is guaranteed. See Parallel Module Operation section.) **Note:** The output voltage may exceed specifications when $I_O < I_{O, min}$.	F–LP A–LP	I_O I_O	0.15 0.12	— —	1.5 1.2	A A
Output Current-limit Inception (V_O = 90% $V_{O, set}$)	F–LP A–LP	I_O I_O	— —	1.72 1.45	2.0 1.65	A A
Output Short-circuit Current (V_O = 0.25 V)	All	I_O	—	2.2	5	A
Efficiency ($V_I = V_{I, nom}$; $I_O = I_{O, max}$; T_A = 25 °C; see Figure 3.)	F–LP A–LP	η η	74* 77	77 80	— —	% %
Switching Frequency	All	—	—	365	—	kHz
Dynamic Response ($\Delta I_O/\Delta t$ = 1A/10 µs; $V_I = V_{I, nom}$; T_A = 25 °C):						
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	—	—	0.1	—	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	—	—	0.1	—	ms

* Engineering estimate.

Electrical Specifications (continued)

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	—	1100	—	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)		6,800,000		hours
Weight	—	—	17 (0.6)	g (oz.)

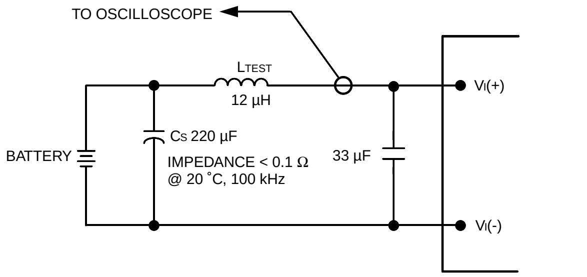
Electrical Specifications (continued)

Table 5. Feature Specifications

Parameter	Device	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 Figure 4 and Feature Descriptions.):						
Positive Logic— Device Code Suffix "4":						
Logic Low—Module Off						
Logic High—Module On						
Module Specifications:						
On/Off Current—Logic Low	All	$I_{on/off}$	—	—	1.0	mA
On/Off Voltage:						
Logic Low	All	$V_{on/off}$	–0.7	—	1.2	V
Logic High ($I_{on/off}$ = 0)	All	$V_{on/off}$	—	—	10	V
Open Collector Switch Specifications:						
Leakage Current During Logic High ($V_{on/off}$ = 10 V)	All	$I_{on/off}$	—	—	50	µA
Output Low Voltage During Logic Low ($I_{on/off}$ = 1 mA)	All	$V_{on/off}$	—	—	1.2	V
Turn-on Delay and Rise Times (At 80% of $I_{O, max}$; T_A = 25 °C):						
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}	—	30	60	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}	—	3	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}	—	1	5	ms
Output Voltage Overshoot (at 80% of $I_{O, max}$; T_A = 25 °C)	All	—	—	—	5	%
Output Voltage Set-point Adjustment Range (optional) (See Feature Descriptions section.)	All	—	85	—	115	%$V_{O, nom}$
Output Overvoltage Protection (clamp) ($V_{O, clamp}$ may be set higher on units with output voltage set-point adjustment option.)	F–LP	$V_{O, clamp}$	—	6.6	—	V
	A–LP	$V_{O, clamp}$	—	6.6	—	V
Undervoltage Protection (lockout):						
Module On	All	$V_{I, on}$	—	32	34.5	V
Module Off	All	$V_{I, off}$	—	27	—	V
Hysteresis	All	—	1.5	5	—	V

† Engineering estimate.

Test Configurations



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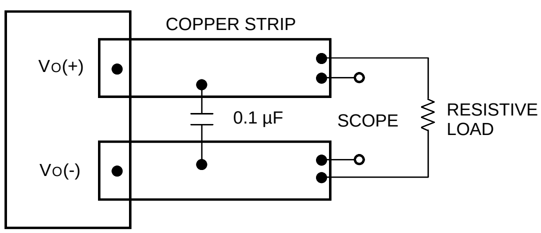
Note: Input reflected-ripple current is measured with a simulated source impedance of 12 µH. Capacitor Cs offsets possible battery impedance. Current is measured at the input of the module.

Figure 1. Input Reflected-Ripple Test Setup



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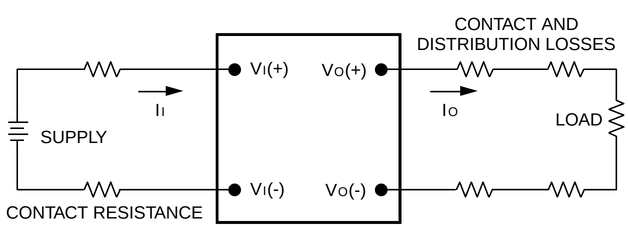
Note: Use one 0.1 µF ceramic capacitor. Scope measurement should be made using a BNC socket. Position the load between 50 mm and 75 mm (2 in. and 3 in.) from the module.

Figure 2. Peak-to-Peak Output Noise Measurement Test Setup for Single Outputs



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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.

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

Figure 3. Output Voltage and Efficiency Measurement Test Setup for Single Outputs

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. If the source inductance exceeds 10 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

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.

Remote On/Off (optional)

The positive logic option, 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 4). A logic low is $V_{on/off}$ = –0.7 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 10 V. The maximum allowable leakage current of the switch at $V_{on/off}$ = 10 V is 50 µA.

The module has internal capacitance to reduce noise at the ON/OFF pin. Additional capacitance is not generally needed and may degrade the start-up characteristics of the module.

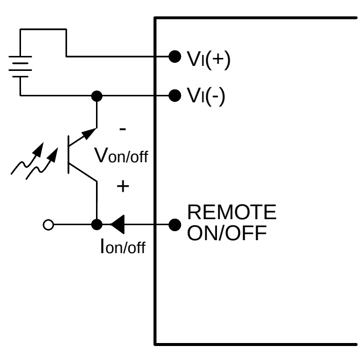

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Figure 4. Remote On/Off Implementation

Output Voltage Adjustment (optional)

Output voltage set-point adjustment 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 V_O(+) or V_O(–) pins. With an external resistor between the TRIM and V_O(+) pins ($R_{adj\text{-}down}$), the output voltage set point ($V_{O,\,adj}$) decreases (see Figure 5). The following equation determines the required external resistor value to obtain an output voltage change from $V_{O,\,set,\,typ}$ to $V_{O,\,adj}$:

$$R_{adj\text{-}down} = \left[\frac{(V_{O,\,adj} - 1.225)6490}{(V_{O,\,set,\,typ} - V_{O,\,adj})} - 2490\right]\Omega$$

where $R_{adj\text{-}down}$ is the resistance value connected between TRIM and V_O(+), and the values for $V_{O,\,set,\,typ}$ and $V_{O,\,adj}$ are shown in the following table.

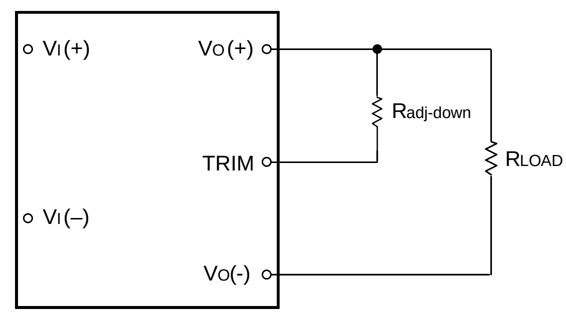

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Figure 5. Circuit Configuration to Decrease Output Voltage

With an external resistor connected between the TRIM and V_O(–) pins ($R_{adj\text{-}up}$), the output voltage set point ($V_{O,\,adj}$) increases (see Figure 6). The following equation determines the required external resistor value to obtain an output voltage from $V_{O,\,set,\,typ}$ to $V_{O,\,adj}$:

$$R_{adj\text{-}up} = \left[\frac{7950}{(V_{O,\,adj} - V_{O,\,set,\,typ})} - 2490\right]\Omega$$

where $R_{adj\text{-}up}$ is the resistance value connected between TRIM and V_O(–), and the values for $V_{O,\,set,\,typ}$ and $V_{O,\,adj}$ are shown in the following table:

	LW006F–LP	LW006A–LP
$V_{O,\,set,\,typ}$	3.4 V	5.1 V
$V_{O,\,adj}$	Desired voltage at minimum load	

Feature Descriptions (continued)

Output Voltage Adjustment (optional) (continued)

The combination of the output voltage adjustment and the output voltage tolerance cannot exceed 115% of the nominal output voltage between the $V_O(+)$ and $V_O(–)$ terminals where $V_{O,\,nom}$ is the typical voltage (e.g., 5.0 V for the LW006A–LP.)

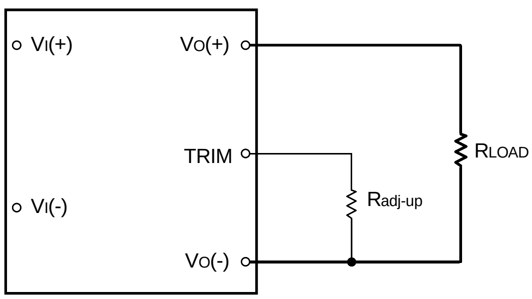


Figure 6. Circuit Configuration to Increase Output Voltage

The LW006-Series Power Modules have a fixed current-limit set point. Therefore, as the output voltage is adjusted down, the available output power is reduced. In addition, the minimum output current is a function of the output voltage. As the output voltage is adjusted down, the minimum required output current can increase (i.e., minimum power is constant).

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 is not excessive. This provides a redundant voltage-control that reduces the risk of output overvoltage.

Parallel Module Operation

Units with the –LP option can be operated in parallel by directly connecting the output voltage pins (pin 1 and pin 2). The load regulation of the parallel units provides the load sharing capability. When paralleling modules, the output power should not exceed:

$$P_{OUT} = 0.9 \times P_{O,\,max} \times n$$

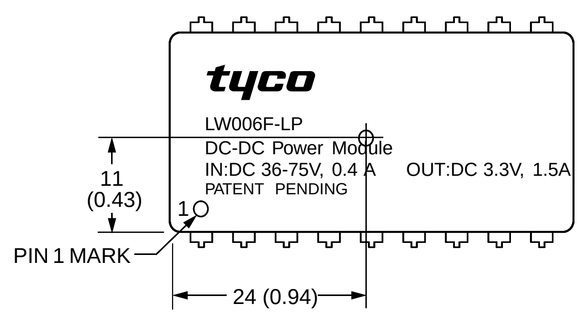
where:

n = number of paralleled converters
$P_{O,\,max}$ = output power of a single converter

Note: Units without the parallel capability option have improved load regulation which results in a better voltage tolerance. The modules with parallel capability have a "–LP" suffix. The modules without parallel capability have tight tolerance and a "–L" suffix. Call technical support for details.

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 7.



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

Figure 7. Case Temperature Measurement Location

Thermal Considerations (continued)

Note that the view in Figure 7 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 110 °C. The output power of the module should not exceed the rated power for the module as listed in the Ordering Information table.

The LW006-Series Power Modules operates 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 naturally 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 110 °C.

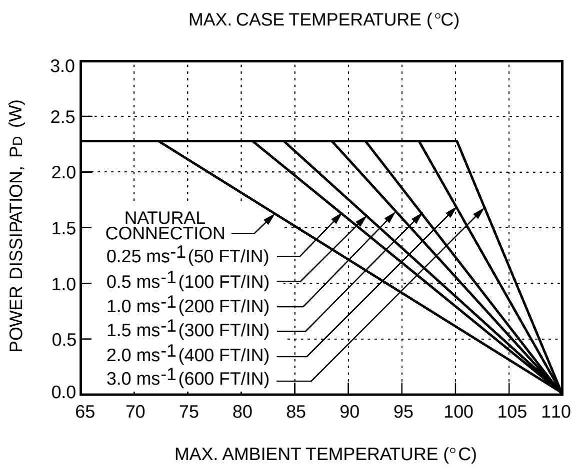


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Figure 8. LW006F–LP, A–LP Forced Convection Power Derating; Either Orientation

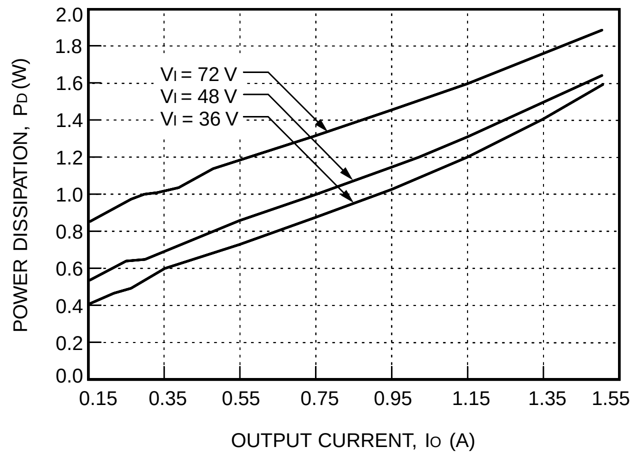

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Figure 9. LW006F–LP Typical Power Dissipation vs. Output Current at T_A = 25 °C

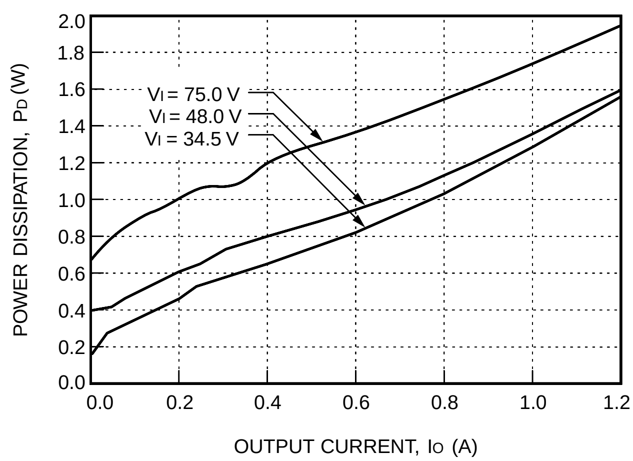

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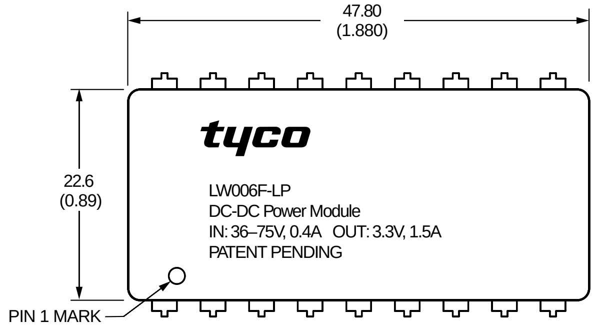
Figure 10. LW006A–LP Typical Power Dissipation vs. Output Current at T_A = 25 °C

Outline Diagram

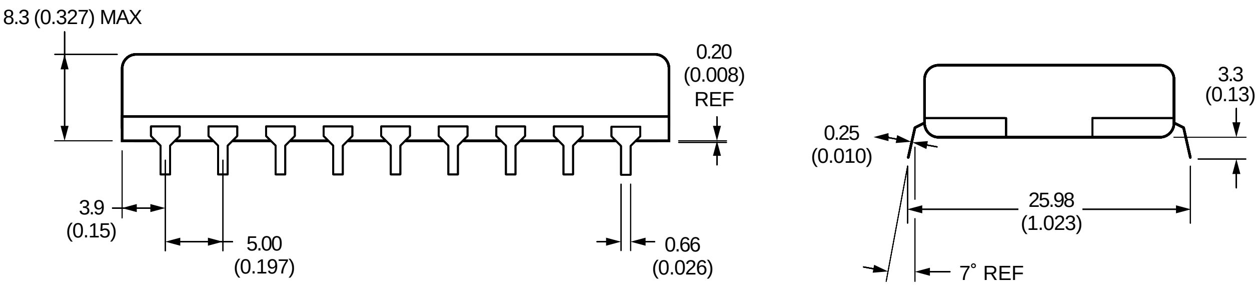
Dimensions are in millimeters and (inches).

Tolerance: x.x ± 0.5 mm (0.02 in.); x.xx ± 0.38 mm (0.015 in.).

Top View



Side Views



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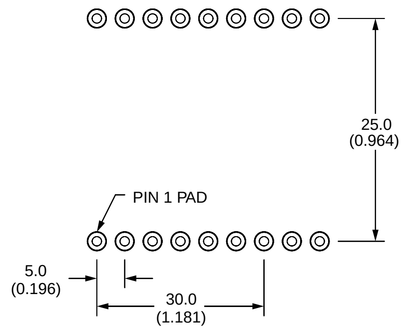
Pin	Function	Pin	Function
1	$V_O(+)$	10	NC
2	$V_O(–)$	11	NC (optional: Remote ON/OFF)
3	NC (optional: V_O adjustment)	12	NC
4	NC	13	NC
5	NC	14	NC
6	NC	15	NC
7	NC	16	NC
8	NC	17	$V_I(–)$
9	NC	18	$V_I(+)$

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
36 V—75 V	3.3 V	6 W	LW006F–LP	108458282
36 V—75 V	5 V	6 W	LW006A–LP	108458274

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

Table 7. Device Options

Option	Device Code Suffix
Output voltage adjustment	9
Positive logic remote on/off	4
Parallel operation	–LP
Tight tolerance output voltage (nonparallellable)	–L

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