



### Features

- Triple Logic Voltage Outputs (*Independently Regulated!*)
- Input Voltage Range: 36V to 75V
- 1500VDC Isolation
- Over-Current Protection
- Over-Voltage Protection
- Over-Temperature Shutdown
- Under-Voltage Lockout
- Independently Adjustable Outputs

- Dual Logic On/Off Control
- Fixed Frequency Operation
- Solderable Space Saving Package: 1.97 sq. in. PCB Area (suffix N)
- IPC Lead Free 2
- Safety Approvals Pending:  
UL60950  
CSA 22.2 950  
VDE EN60950

### Description

The PT4850 Excalibur™ power modules are a series of isolated triple-output DC/DC converters that operate from a standard (-48V) central office supply. These modules are rated for a combined output of up to 25A, and were designed for powering mixed logic applications. The triple-output voltage provides a compact multiple-output power supply in a single DC/DC module.

Output voltage options include a low-voltage output for a DSP or ASIC core, and two additional supply voltages for the I/O, and other functions.

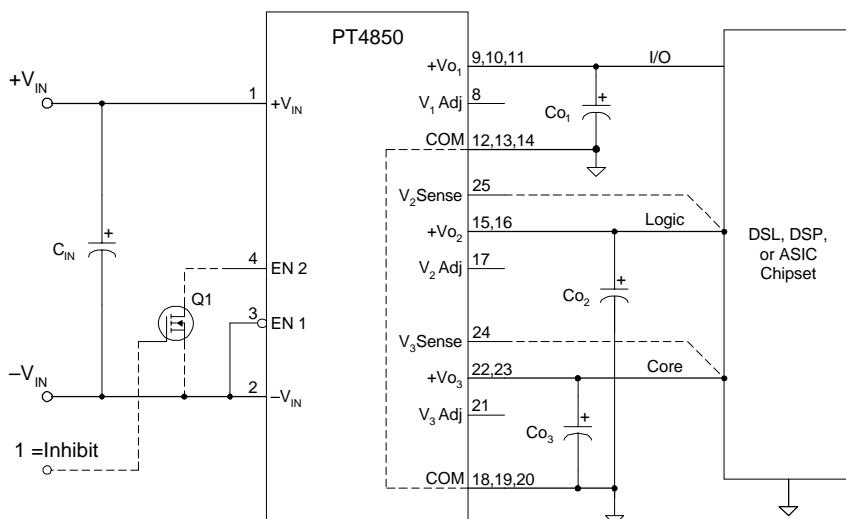
The PT4850 series incorporates many features to simplify system integration. These include a flexible On/Off enable control, input undervoltage lockout and over-temperature protection. All outputs are current limited and short-circuit protected, and are internally sequenced to meet the power-up and power-down requirements of popular DSP ICs.

The PT4850 series is housed in a space-saving solderable case. The module requires no external heat sink. Both vertical and horizontal pin configurations are available, including surface mount.

### Ordering Information

**PT4851** = +3.3/+2.5/+1.5V  
**PT4852** = +3.3/+1.8/+1.5V  
**PT4853** = +3.3/+2.5/+1.2V  
**PT4854** = +3.3/+1.8/+1.2V  
**PT4855** = +3.3/+1.5/+1.2V  
**PT4856** = +5.0/+3.3/+1.5V

### Standard Application



(Reference the applicable package code drawing for the dimensions and PC layout)

### PT Series Suffix (PT1234x)

Case/Pin Configuration	Order Suffix	Package Code
Vertical	<b>N</b>	(EKD)
Horizontal	<b>A</b>	(EKA)
SMD	<b>C</b>	(EKC)

$C_{in}$  =Optional  
 $C_{o1}, C_{o2}, C_{o3}$  =Optional. See specifications  
 EN1 & EN2 operation: See application notes

## Environmental Specifications

Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Operating Temperature Range	T <sub>a</sub>	Over V <sub>in</sub> Range	-40	—	+85 (i)	°C
Case Temperature	T <sub>c</sub>	—	—	—	105	°C
Storage Temperature	T <sub>s</sub>	—	-40	—	+125	°C
Over Temperature Protection	OTP	Case temperature	—	110	125	°C
Mechanical Shock	—	Per Mil-STD-883D, Method 2002.3 1 msec, ½ Sine, mounted	—	500	—	G's
Mechanical Vibration	—	Mil-STD-883D, Method 2007.2 20-2000 Hz	Suffix N Suffix A, C	10 (ii) 20 (ii)	—	G's
Weight	—	Vertical/Horizontal	—	90	—	grams
Flammability	—	Meets UL 94V-O	—	—	—	—

**Notes:** (i) See SOA curves or consult factory for appropriate derating.

(ii) The case pins on through-hole pin configurations (N & A) must be soldered. For more information see the applicable package outline drawing.

## Pin Configuration

Pin Function	Pin Function	Pin Function
1 +Vin	10 +Vo <sub>1</sub>	19 COM
2 -Vin	11 +Vo <sub>1</sub>	20 COM
3 EN 1	12 COM	21 Vo <sub>3</sub> Adjust
4 EN 2	13 COM	22 +Vo <sub>3</sub>
5 TEMP	14 COM	23 +Vo <sub>3</sub>
6 Pin Not Present	15 +Vo <sub>2</sub>	24 Vo <sub>3</sub> Rem Sense
7 Do Not Connect	16 +Vo <sub>2</sub>	25 Vo <sub>2</sub> Rem Sense
8 Vo <sub>1</sub> Adjust	17 Vo <sub>2</sub> Adjust	26 Do Not Connect
9 +Vo <sub>1</sub>	18 COM	—

*Note: Shaded functions indicate those pins that are at primary-side potential.*

## Pin Descriptions

**+Vin:** The positive input supply for the module with respect to -Vin. When powering the module from a -48V telecom central office supply, this input is connected to the primary system ground.

**-Vin:** The negative input supply for the module, and the 0VDC reference for the EN 1, and EN 2 inputs. When powering the module from a +48V supply, this input is connected to the 48V(Return).

**EN 1:** The negative logic input that activates the module output. This pin must be connected to -Vin to enable the module's outputs. A high impedance disables the module's outputs.

**EN 2:** The positive logic input that activates the module output. If not used, this pin should be left open circuit. Connecting this input to -Vin disables the module's outputs.

**TEMP:** This pin produces an output signal that tracks a temperature that is approximately the module's metal case. The output voltage is referenced to -Vin and rises approximately 10mV/°C from an initial value of 0.1VDC at -40°C. The signal is available whenever the module is supplied with a valid input voltage, and is independant of the enable logic status. (Note: A load impedance of less than 1MΩ will adversely

affect the module's over-temperature shutdown threshold. Use a high-impedance input when monitoring this signal.)

**Vo 1:** The highest regulated output voltage, which is referenced to the COM node.

**Vo 2:** The regulated output that is designed to power logic circuitry. It is referenced to the COM node.

**Vo 3:** The low-voltage regulated output that provides power for a µ-processor or DSP core, and is referenced to the COM node.

**COM:** The secondary return reference for the module's three regulated output voltages. It is DC isolated from the input supply pins.

**Vo<sub>(n)</sub> Adjust:** Using a single resistor, this pin allows the associated output Vo<sub>(n)</sub> to be adjusted higher or lower than the preset value. If not used, this pin should be left open circuit.

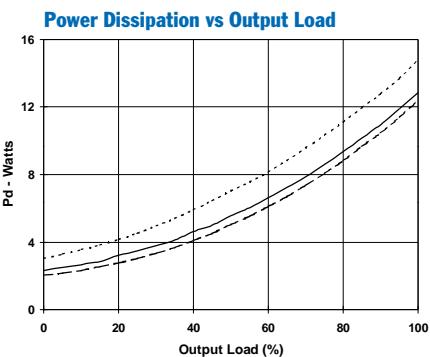
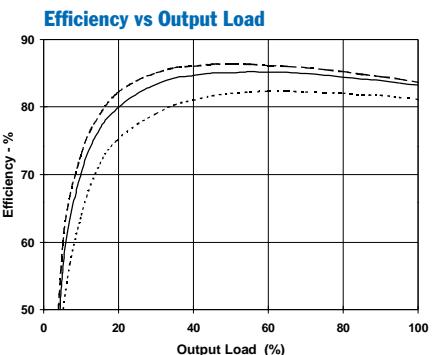
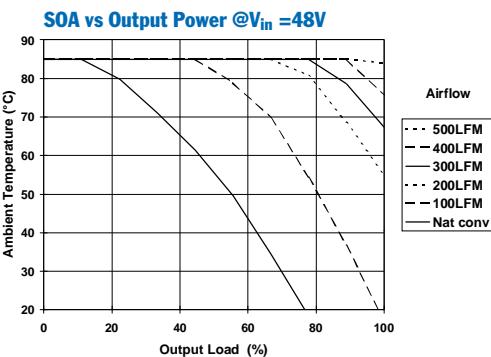
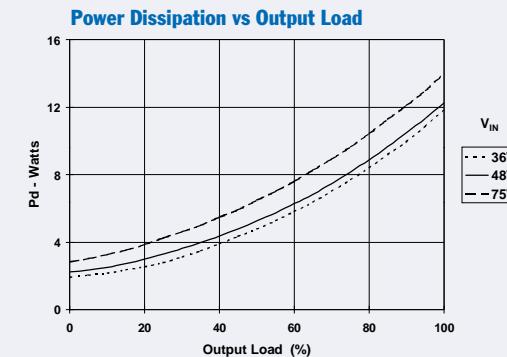
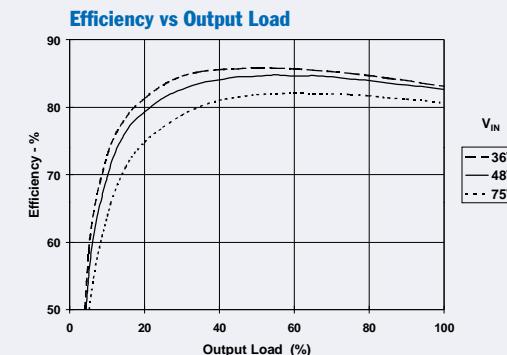
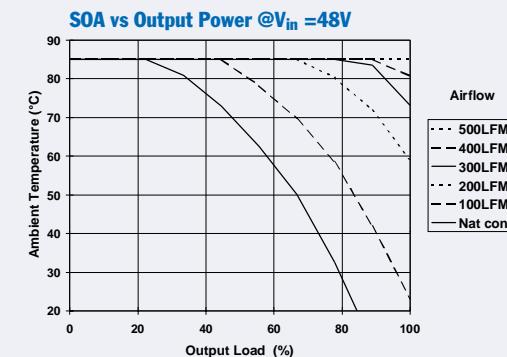
**Vo<sub>(n)</sub> Rem Sense:** An external remote sense input is provided for the two lowest voltage outputs, +Vo<sub>2</sub> and +Vo<sub>3</sub>. Connecting the remote sense pins improves the load regulation of the applicable output by allowing the regulation circuit to compensate for voltage drop between the converter and load. If desired these inputs may be left disconnected.

## Electrical Specifications

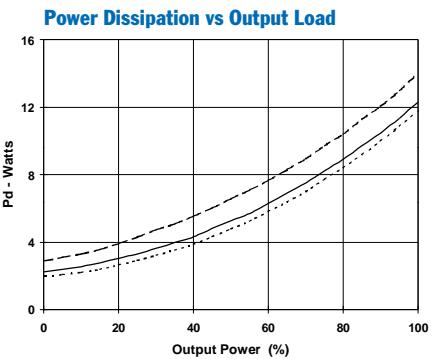
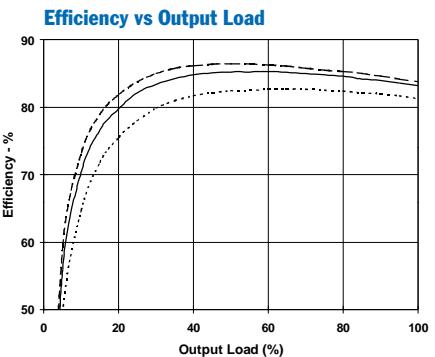
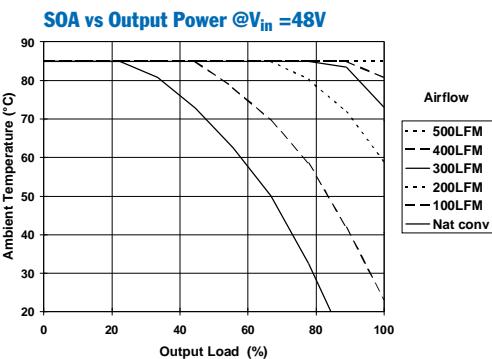
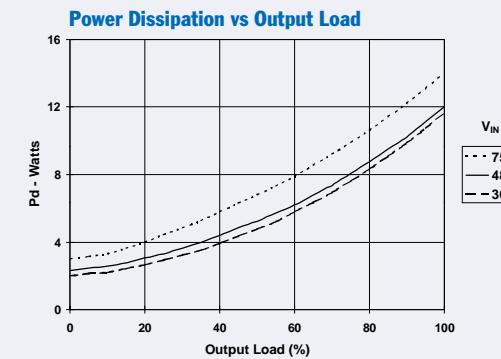
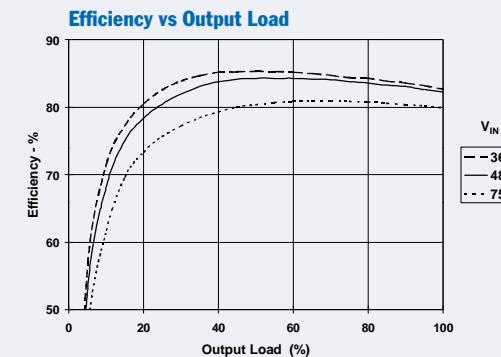
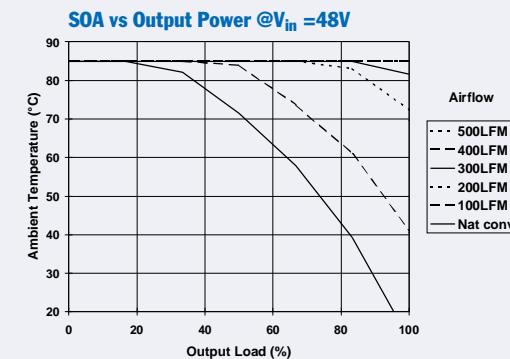
(Unless otherwise stated, the operating conditions are:-  $T_a = 25^\circ\text{C}$ ,  $V_{in} = 48\text{V}$ , and  $I_o = 0.5I_{o\max}$ )

Characteristics	Symbols	Conditions	PT4850 Series (Except PT4856)			Units
			Min	Typ	Max	
Output Current	$I_o$	Each output	$I_{o1}$ 0	—	15	A
			$I_{o2}$ 0	—	10	
			$I_{o3}$ 0	—	10	
	$I_{tot}$	Total (all three outputs)	—	—	25	A
Input Voltage Range	$V_{in}$	Continuous Surge (1 minute)	36 —	—	75 80	V
Set-Point Voltage Tolerance	$V_{tol}$		—	—	1.5	% $V_o$
Temperature Variation	$\Delta V_{temp}$	$-40^\circ\text{C} \leq T_a \leq 85^\circ\text{C}$ , $I_{o1} = I_{o2} = I_{o3} = I_{o\min}$	—	$\pm 0.5$	—	% $V_o$
Line Regulation	$\Delta V_{line}$	All outputs, Over $V_{in}$ range	—	$\pm 0.2$	$\pm 0.5$	% $V_o$
Load Regulation	$\Delta V_{load}$	Each output, $0 \leq I_o \leq I_{o\max}$	—	$\pm 5$	$\pm 10$	mV
Cross Regulation	$\Delta V_{cross}$	Any output vs. another	—	—	$\pm 10$	mV
Total Output Voltage Variation	$\Delta V_{tol}$	Includes set-point, line, load, $-40^\circ\text{C} \leq T_a \leq 85^\circ\text{C}$	—	$\pm 2$	$\pm 3$ (1)	% $V_o$
Efficiency	$\eta$	$I_{o1} = 10\text{A}$ , $I_{o2} = 5\text{A}$ , $I_{o3} = 5\text{A}$	—	85	—	%
$V_o$ Ripple (pk-pk)	$V_r$	20MHz bandwidth, $I_{o1} = I_{o2} = I_{o3} = 5\text{A}$	$V_o = 5.0\text{V}$ $V_o = 3.3\text{V}$ $V_o = 1.8\text{V}/2.5\text{V}$ $V_o \leq 1.5\text{V}$	50 20 20 15	75 50 30 25	mV <sub>pp</sub>
Transient Response	$t_{tr}$ $V_{os}$	0.1A/μs load step, 50% to 75% $I_{o\max}$ $V_o$ over/undershoot	— —	200 5	— —	μSec % $V_o$
Output Adjust Range	$V_{adj}$		$V_{o1}/V_{o2}/V_{o3}$	—	$\pm 10$	% $V_o$
Current Limit Threshold	$I_{LIM}$	$\Delta V_o = -1\%$	$V_{o1}$ $V_{o2}$ $V_{o3}$	20 15 15	— — —	A
Output Over-Voltage Protection	OVP	All outputs; module shutdown and latch off	—	125 (2)	—	% $V_o$
Switching Frequency	$f_s$	Over $V_{in}$ and $I_o$ ranges	280	320	340	kHz
Under Voltage Lockout	$V_{on}$ $V_{off}$	$V_{in}$ increasing $V_{in}$ decreasing	— 30	34 32	36 —	V
Enable Control (pins 3 & 4)		Referenced to $-V_{in}$ (pin 2)				
High-Level Input Voltage	$V_{IH}$		3.5	—	Open (3)	V
Low-Level Input Voltage	$V_{IL}$		-0.2	—	0.8 (3)	
Low-Level Input Current	$I_{IL}$		—	0.5	—	mA
Standby Input Current	$I_{in\ standby}$	pins 3 & 4 open circuit	—	2.5	4 (1)	mA
Internal Input Capacitance	$C_{int}$		—	2	—	μF
External Output Capacitance	$C_{out}$	Per each output	0	—	5,000	μF
Primary/Secondary Isolation	$V_{iso}$ $C_{iso}$ $R_{iso}$		1500 — 10	— 2,200 —	— — —	V pF MΩ
Temperature Sense	$V_{temp}$	Output voltage at temperatures:- $-40^\circ\text{C}$ $100^\circ\text{C}$	— —	0.1 (4) 1.5 (4)	— —	V

**Notes:** (1) Limits are specified by design.(2) This is a fixed parameter. Adjusting  $V_{o1}$  or  $V_{o2}$  higher will increase the module's sensitivity to over-voltage detection. For more information, see the application note on output voltage adjustment.(3) The Enable inputs (pins 3 & 4) have internal pull-ups. Leaving pin 4 open-circuit and connecting pin 3 to  $-V_{in}$  (pin 2) allows the the converter to operate when input power is applied. The maximum open-circuit voltage for the Enable inputs is 5.4V.(4) Voltage output at "TEMP" pin is defined by the equation:-  $V_{TEMP} = 0.5 + 0.01 \cdot T$ , where  $T$  is in  $^\circ\text{C}$ . See pin descriptions for more information.

**PT4851 Performance Characteristics** (See Note A)  
*(Io<sub>1</sub> = 10A, Io<sub>2</sub> = 7.5A, Io<sub>3</sub> = 7.5A represents 100% Load)***PT4851 Safe operating Area Curves** (See Note B)  
*(Io<sub>1</sub> + Io<sub>2</sub> + Io<sub>3</sub> = 25A, represents 100% load)***PT4852 Performance Characteristics** (See Note A)  
*(Io<sub>1</sub> = 10A, Io<sub>2</sub> = 7.5A, Io<sub>3</sub> = 7.5A represents 100% Load)***PT4852 Safe operating Area Curves** (See Note B)  
*(Io<sub>1</sub> + Io<sub>2</sub> + Io<sub>3</sub> = 25A, represents 100% load)*

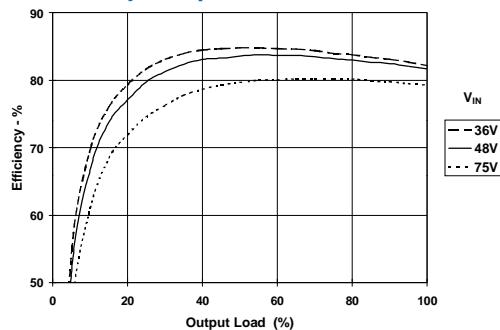
**Note A:** All Characteristic data in the above graphs has been developed from actual products tested at 25°C. This data is considered typical data for the ISR.  
**Note B:** SOA curves represent operating conditions at which the internal components are at or below the manufacturer's maximum rated operating temperatures.

**PT4853 Performance Characteristics** (See Note A)  
*(Io<sub>1</sub> = 10A, Io<sub>2</sub> = 7.5A, Io<sub>3</sub> = 7.5A represents 100% Load)*

**PT4853 Safe operating Area Curves** (See Note B)  
*(Io<sub>1</sub> + Io<sub>2</sub> + Io<sub>3</sub> = 25A, represents 100% load)*

**PT4854 Performance Characteristics** (See Note A)  
*(Io<sub>1</sub> = 10A, Io<sub>2</sub> = 7.5A, Io<sub>3</sub> = 7.5A represents 100% Load)*

**PT4854 Safe operating Area Curves** (See Note B)  
*(Io<sub>1</sub> + Io<sub>2</sub> + Io<sub>3</sub> = 25A, represents 100% load)*


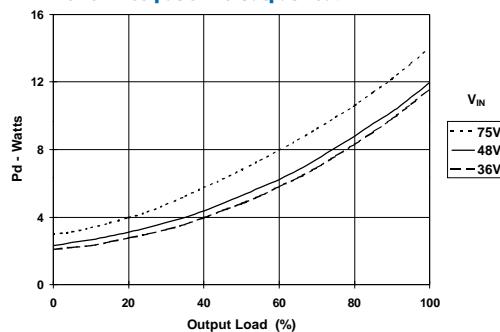
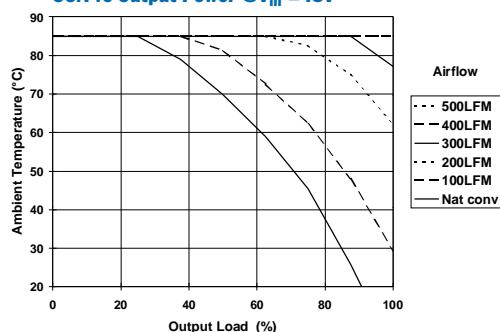
**Note A:** All Characteristic data in the above graphs has been developed from actual products tested at 25°C. This data is considered typical data for the ISR.  
**Note B:** SOA curves represent operating conditions at which the internal components are at or below the manufacturer's maximum rated operating temperatures.

**PT4855 Performance Characteristics** (See Note A)  
*(Io1 = 10A, Io2 = 7.5A, Io3 = 7.5A represents 100% Load)*

Efficiency vs Output Load



Power Dissipation vs Output Load


**PT4855 Safe operating Area Curves** (See Note B)  
*(Io1 + Io2 + Io3 = 25A, represents 100% load)*
SOA vs Output Power @V<sub>in</sub> = 48V

**Note A:** All Characteristic data in the above graphs has been developed from actual products tested at 25°C. This data is considered typical data for the ISR.  
**Note B:** SOA curves represent operating conditions at which the internal components are at or below the manufacturer's maximum rated operating temperatures.

## PT4856 Electrical Specifications

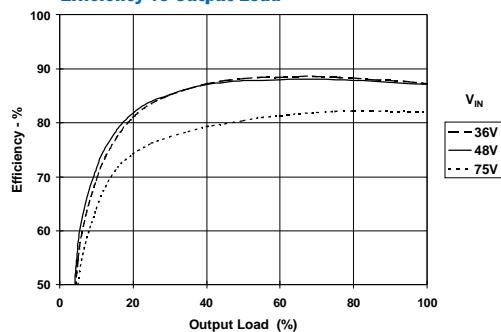
(Unless otherwise stated, the operating conditions are:-  $T_a = 25^\circ\text{C}$ ,  $V_{in} = 48\text{V}$ , and  $I_o = 0.5I_{o\text{max}}$ )

Characteristics	Symbols	Conditions	PT4856 (Only)			Units
			Min	Typ	Max	
Output Current	$I_o$	Each output	$I_{o1}$ 0	—	10	A
			$I_{o2}$ 0	—	10	
			$I_{o3}$ 0	—	10	
	$I_{tot}$	Total (all three outputs)	—	—	25	A
Input Voltage Range	$V_{in}$	Continuous Surge (1 minute)	36 —	—	75 80	V
Set-Point Voltage Tolerance	$V_{tol}$		—	—	1.5	% $V_o$
Temperature Variation	$\Delta V_{temp}$	$-40^\circ\text{C} \leq T_a \leq 85^\circ\text{C}$ , $I_{o1} = I_{o2} = I_{o3} = I_{o\text{min}}$	—	$\pm 0.5$	—	% $V_o$
Line Regulation	$\Delta V_{line}$	All outputs, Over $V_{in}$ range	—	$\pm 0.2$	$\pm 0.5$	% $V_o$
Load Regulation	$\Delta V_{load}$	Each output, $0 \leq I_o \leq I_{o\text{max}}$	—	$\pm 5$	$\pm 10$	mV
Cross Regulation	$\Delta V_{cross}$	Any output vs. another	—	—	$\pm 10$	mV
Total Output Voltage Variation	$\Delta V_o$ tol	Includes set-point, line, load, $-40^\circ\text{C} \leq T_a \leq 85^\circ\text{C}$	—	$\pm 2$	$\pm 3$ (1)	% $V_o$
Efficiency	$\eta$	$I_{o1} = 7\text{A}$ , $I_{o2} = 5\text{A}$ , $I_{o3} = 5\text{A}$	—	88	—	%
$V_o$ Ripple (pk-pk)	$V_r$	20MHz bandwidth, $I_{o1} = I_{o2} = I_{o3} = 5\text{A}$	$V_o = 5.0\text{V}$ $V_o = 3.3\text{V}$ $V_o = 1.5\text{V}$	50 20 15	75 50 25	mV <sub>pp</sub>
Transient Response	$t_{tr}$ $V_{os}$	0.1A/ $\mu\text{s}$ load step, 50% to 75% $I_{o\text{max}}$ $V_o$ over/undershoot	— —	200 5	— —	$\mu\text{Sec}$ % $V_o$
Output Adjust Range	$V_{adj}$		$V_{o1}/V_{o2}/V_{o3}$	—	$\pm 10$	% $V_o$
Current Limit Threshold	$I_{LIM}$	$\Delta V_o = -1\%$	$V_{o1}$ $V_{o2}$ $V_{o3}$	20 15 15	— — —	A
Output Over-Voltage Protection	OVP	All outputs; module shutdown and latch off	—	125 (2)	—	% $V_o$
Switching Frequency	$f_s$	Over $V_{in}$ and $I_o$ ranges	280	320	340	kHz
Under Voltage Lockout	$V_{on}$ $V_{off}$	$V_{in}$ increasing $V_{in}$ decreasing	— 30	34 32	36 —	V
Enable Control (pins 3 & 4)	$V_{IH}$ $V_{IL}$ IIL	Referenced to $-V_{in}$ (pin 2)	3.5 — —	— — 0.5	Open (3) 0.8 (3)	V
High-Level Input Voltage						
Low-Level Input Voltage						
Low-Level Input Current						
Standby Input Current	$I_{in}$ standby	pins 3 & 4 open circuit	—	2.5	4 (1)	mA
Internal Input Capacitance	$C_{int}$		—	2	—	$\mu\text{F}$
External Output Capacitance	$C_{out}$	Per each output	0	—	5,000	$\mu\text{F}$
Primary/Secondary Isolation	$V_{iso}$ $C_{iso}$ $R_{iso}$		1500 — 10	— 2,200 —	— — —	V pF $M\Omega$
Temperature Sense	$V_{temp}$	Output voltage at temperatures:- $-40^\circ\text{C}$ $100^\circ\text{C}$	— —	0.1 (4) 1.5 (4)	— —	V

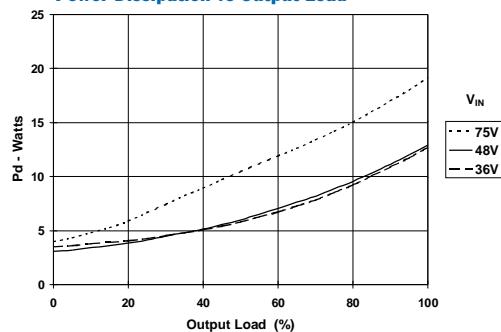
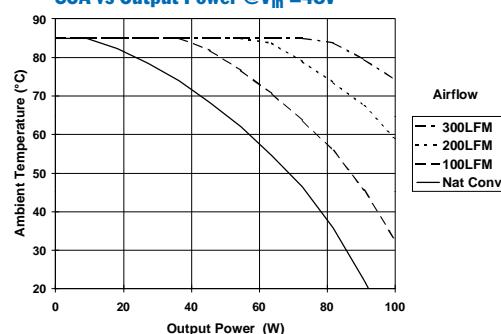
**Notes:** (1) Limits are specified by design.(2) This is a fixed parameter. Adjusting  $V_{o1}$  or  $V_{o2}$  higher will increase the module's sensitivity to over-voltage detection. For more information, see the application note on output voltage adjustment.(3) The Enable inputs (pins 3 & 4) have internal pull-ups. Leaving pin 4 open-circuit and connecting pin 3 to  $-V_{in}$  (pin 2) allows the the converter to operate when input power is applied. The maximum open-circuit voltage for the Enable inputs is 5.4V.(4) Voltage output at "TEMP" pin is defined by the equation:-  $V_{TEMP} = 0.5 + 0.01 \cdot T$ , where  $T$  is in  $^\circ\text{C}$ . See pin descriptions for more information.

**PT4856 Performance Characteristics** (See Note A)  
*(Io1 = 10A, Io2 = 7.5A, Io3 = 7.5A represents 100% Load)*

Efficiency vs Output Load



Power Dissipation vs Output Load


**PT4856 Safe operating Area Curves** (See Note B)  
*(Io1 + Io2 + Io3 = 24A, represents 100% load)*
SOA vs Output Power @V<sub>in</sub> = 48V

**Note A:** All Characteristic data in the above graphs has been developed from actual products tested at 25°C. This data is considered typical data for the ISR.  
**Note B:** SOA curves represent operating conditions at which the internal components are at or below the manufacturer's maximum rated operating temperatures.

### Operating Features of the PT4850 Triple-Output DC/DC Converters

#### Over-Current Protection

The PT4850 series of DC/DC converters provide three independently regulated logic output voltages,  $V_{O1}$ ,  $V_{O2}$ , and  $V_{O3}$ . Each output is current limited to protect against load faults. The module will not be damaged by a continuous load fault applied to any output. Current will continue to flow into the fault but is reduced as the voltage across the fault decreases towards zero.

Applying a load fault above the current limit threshold to any output causes the affected output to significantly drop. Also load faults applied to  $V_{O1}$  will affect  $V_{O2}$  and  $V_{O3}$ , once  $V_{O1}$  drops to within 0.2V of either of these voltages. However, load faults applied to  $V_{O2}$  or  $V_{O3}$  will not affect the other outputs.

#### Over-Temperature Protection

The PT4850 DC/DC converter series have an internal temperature sensor, which monitors the temperature of the module's metal case. If the case temperature exceeds the specified limit the converter will shut down. The converter will automatically restart when the sensed temperature returns to within the normal operating range. The analog voltage generated by the sensor is also made available at the 'TEMP' output (pin 5), and can be monitored by the host system for diagnostic purposes. Consult the 'Pin Descriptions' section of the data sheet for more information on this feature.

#### Under-Voltage Lock-Out

The Under-Voltage Lock-Out (UVLO) circuit prevents operation of the converter whenever the input voltage to the module is insufficient to maintain output regulation. The UVLO has approximately 2V of hysteresis. This is to prevent oscillation with a slowly changing input voltage. Below the UVLO threshold the module is off and the enable control inputs, EN1 and EN2 are inoperative.

#### Primary-Secondary Isolation

The PT4850 series of DC/DC converters incorporate electrical isolation between the input terminals (primary) and the output terminals (secondary). All converters are production tested to a withstand voltage of 1500VDC. The isolation complies with UL60950 and EN60950, and the requirements for operational isolation. This allows the converter to be configured for either a positive or negative input voltage source.

The regulation control circuitry for these modules is located on the secondary (output) side of the isolation barrier. Control signals are passed between the primary and secondary sides of the converter via a proprietary magnetic coupling scheme. This eliminates the use of opto-couplers. The data sheet 'Pin Descriptions' and 'Pin-Out Information' provides guidance as to which reference (primary or secondary) that must be used for each of the external control signals.

#### Fuse Recommendations

If desired an input fuse may be added to protect against the application of a reverse input voltage.

## Using the On/Off Enable Controls on the PT4850 Series of Triple Output DC/DC Converters

The PT4850 (48V input) series of 25-A, triple-output DC/DC converters incorporate two output enable controls. EN1 (pin 3) is the *Negative Enable* input, and EN2 (pin 4) is the *Positive Enable* input. Both inputs are electrically referenced to  $-V_{in}$  (pin 2) on the primary or input side of the converter. A pull-up resistor is not required, but may be added if desired. Voltages of up to 70V can be safely applied to the either of the *Enable* pins.

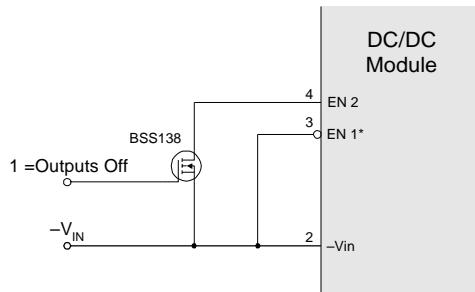
### Automatic (UVLO) Power-Up

Connecting EN1 (pin 3) to  $-V_{in}$  (pin 2) and leaving EN2 (pin 4) open-circuit configures the converter for automatic power up. (See data sheet "Typical Application"). The converter control circuitry incorporates an "Under Voltage Lockout" (UVLO) function, which disables the converter until the minimum specified input voltage is present at  $\pm V_{in}$ . (See data sheet Specifications). The UVLO circuitry ensures a clean transition during power-up and power-down, allowing the converter to tolerate a slow-rising input voltage. For most applications EN1 and EN2, can be configured for automatic power-up.

## Positive Output Enable (Negative Inhibit)

To configure the converter for a positive enable function, connect EN1 (pin 3) to  $-V_{in}$  (pin 2), and apply the system On/Off control signal to EN2 (pin 4). In this configuration, a low-level input voltage ( $-V_{in}$  potential) applied to pin 4 disables the converter outputs. Figure 1 is an example of this configuration.

**Figure 1; Positive Enable Configuration**

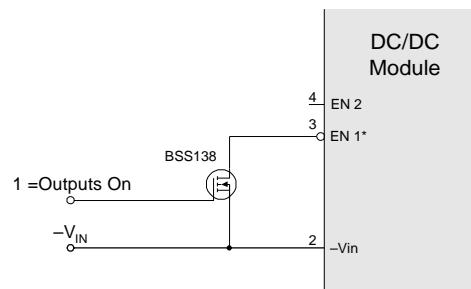


## **Negative Output Enable (Positive Inhibit)**

To configure the converter for a negative enable function, EN2 (pin 4) is left open circuit, and the system On/Off control signal is applied to EN1 (pin 3). A low-level input voltage ( $-V_{in}$  potential) must then be applied to

pin 3 in order to enable the outputs of the converter. An example of this configuration is detailed in Figure 2. Note: The converter will only produce and output voltage if a valid input voltage is applied to  $\pm V_{in}$ .

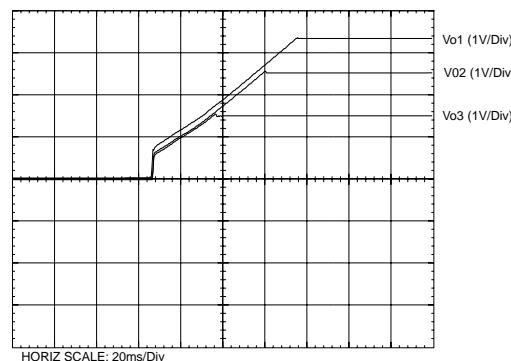
**Figure 2: Negative Enable Configuration**



## On/Off Output Voltage Sequencing

The power-up characteristic of the PT4850 series of DC/DC converters meets the requirements of micro-processor and DSP chipsets. All three outputs from the converter are internally sequenced to power up in unison. Figure 3 shows the waveforms from a PT4851 after power is applied to the input of the converter. During power-up, all three output voltages rise together until each reaches their respective output voltage. The waveforms of Figure 3 were measured with loads of approximately 50% on each output, with an input source of 48VDC. The converter typically produces a fully regulated output within 150ms.

**Figure 3:  $Vo_1$ ,  $Vo_2$ ,  $Vo_3$  Power-Up Sequence**



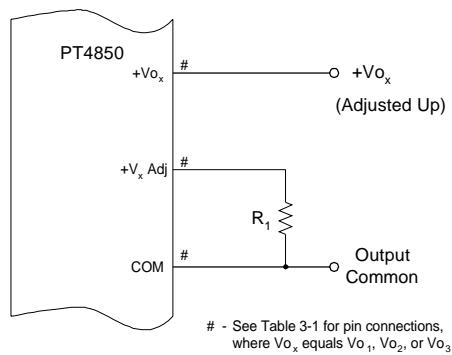
During turn-off, all outputs drop rapidly due to the discharging effect of actively switched rectifiers. The voltage at  $V_{O2}$  remains higher than  $V_{O3}$  during this period. The discharge time is typically 100 $\mu$ s, but will vary with the amount of external load capacitance.

### Adjusting the Output Voltages of the PT4850 Triple-Output DC/DC Converters

The output voltages of the PT4850 series of triple-output DC/DC converters,  $V_{o1}$ ,  $V_{o2}$  and  $V_{o3}$ , are independently adjustable. The adjustment method uses a single external resistor, <sup>1</sup> which may be used to adjust a selected output by up to  $\pm 10\%$  from the factory preset value. The value of the resistor determines the magnitude of adjustment, and the placement of the resistor determines the direction of adjustment (up or down). The resistor values can be calculated using the appropriate formula (see below), using the constants provided in Table 3-2. Alternatively the resistor value may be selected directly from Table 3-3 and Table 3-4, for  $V_{o1}$  and  $V_{o2}/V_{o3}$  respectively. The placement of each resistor is as follows.

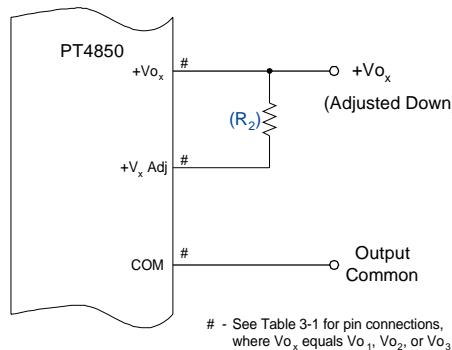
**Adjust Up:** To increase a specific output, add a resistor  $R_1$  between the appropriate  $V_x$  Adj ( $V_1$  Adj,  $V_2$  Adj, or  $V_3$  Adj) and the output common (COM). See Figure 3-1(a) and Table 3-1 for the resistor placement and pin connections.

**Figure 3-1a**



**Adjust Down:** Add a resistor ( $R_2$ ), between the appropriate  $V_x$  Adj ( $V_1$  Adj,  $V_2$  Adj, or  $V_3$  Adj) and the output being adjusted,  $+V_{ox}$ . See Figure 3-1(b) and Table 3-1 for the resistor placement and pin connections.

**Figure 3-1b**



**Table 3-1; Adjust Resistor Pin Connections**

	To Adjust Up Connect $R_1$		To Adjust Down Connect ( $R_2$ )	
	from	to	from	to
	$V_{ox}$ Adj	COM	$V_{ox}$ Adj	$V_{ox}$
$V_{o1}$	8	12	8	9
$V_{o2}$	17	18	17	16
$V_{o3}$	21	18	21	22

### Calculation of Adjust Values

The adjust resistor value may also be calculated using an equation. In each case, the equation for  $R_1$  [Adjust Up] is different to that for ( $R_2$ ) [Adjust Down]. For the PT4850 series, the following points should be noted.

- $V_{o1}$  uses different equations to  $V_{o2}$  and  $V_{o3}$ . The equations are defined for the desired output voltage.
- The equations for  $V_{o2}$  and  $V_{o3}$  are based on the percentage of desired adjustment. Both  $V_{o2}$  and  $V_{o3}$  use the same constants, which are common for all output voltages.

#### **$V_{o1}$ Adjust:**

$$R_1 \text{ [Adjust Up]}^3 = \frac{2.5 R_o}{V_a - V_o} - R_s \text{ k}\Omega$$

$$(\mathbf{R}_2) \text{ [Adjust Down]}^3 = \frac{R_o (V_a - 2.5)}{V_o - V_a} - R_s \text{ k}\Omega$$

Where:  $V_o$  = Original output voltage

$V_a$  = Adjusted output voltage

$R_o$  = The resistance value in Table 3-2

$R_s$  = The series resistance from Table 3-2

#### **$V_{o2} / V_{o3}$ Adjust:**

$$R_1 \text{ [Adjust Up]}^3 = \frac{50 \cdot R_o}{n\%} - R_s \text{ k}\Omega$$

$$(\mathbf{R}_2) \text{ [Adjust Down]}^3 = R_o \cdot \frac{(50 - n\%)}{n\%} - R_s \text{ k}\Omega$$

Where:  $R_o$  = The resistance value in Table 3-2

$R_s$  = The series resistance from Table 3-2

$n\%$  = The desired adjustment from the nominal (in percent)

**Notes:**

1. Use only a single 1% (or better) tolerance resistor in either the  $R_1$  or  $(R_2)$  location to adjust a specific output. Place the resistor as close to the ISR as possible.
2. Never connect capacitors to any of the 'Vo<sub>x</sub> Adj' pins. Any capacitance added to these control pins will affect the stability of the respective regulated output.
3. Adjustments made to any output must also comply with the following limitations.

$$\begin{aligned} V_{o1} &\geq (V_{o2} + 0.5V), \text{ and} \\ V_{o1} &\geq (V_{o3} + 0.5V) \end{aligned}$$

**Table 3-2****ADJUSTMENT RANGE AND FORMULA PARAMETERS**

	<b>V<sub>o1</sub> Bus</b>	<b>V<sub>o2</sub> / V<sub>o3</sub> Bus</b>
<b>V<sub>o</sub>(nom)</b>	5.0V	3.3V
<b>V<sub>a</sub>(min)</b>	4.5V	2.97V
<b>V<sub>a</sub>(max)</b>	5.5V	3.63V
<b>R<sub>o</sub> (kΩ)</b>	4.99	4.42
<b>R<sub>s</sub> (kΩ)</b>	4.99	4.99

**Table 3-3****ADJUSTMENT RESISTOR VALUES FOR V<sub>o1</sub> Bus**

<b>Adj. Resistors</b>	<b>R<sub>1</sub>/(R<sub>2</sub>)</b>
<b>V<sub>o</sub>(nom)</b>	3.3V
<b>V<sub>a</sub>(req'd)</b>	5.0V
3.0	(2.4)kΩ
3.05	(4.7)kΩ
3.1	(8.3)kΩ
3.15	(14.2)kΩ
3.2	(26.0)kΩ
3.25	(61.3)kΩ
3.3	
3.35	216.0kΩ
3.4	106.0kΩ
3.45	68.7kΩ
3.5	50.3kΩ
3.55	39.2kΩ
3.6	31.8kΩ
•	
4.5	(15.0)kΩ
4.6	(21.2)kΩ
4.7	(31.6)kΩ
4.8	(52.4)kΩ
4.9	(115.0)kΩ
5.0	
5.1	120.0kΩ
5.2	57.4kΩ
5.3	36.6kΩ
5.4	26.2kΩ
5.5	20.0kΩ

R<sub>1</sub> = Black, R<sub>2</sub> = (Blue)**Table 3-4****ADJUSTMENT RESISTOR VALUES FOR V<sub>o2</sub> / V<sub>o3</sub> Buses**

<b>V<sub>o</sub> (nom)</b>	3.3V	2.5V	1.8V	1.5V	1.2V	<b>R<sub>1</sub>/(R<sub>2</sub>)</b>
<b>% Adjust</b>	<b>Adjusted Output Voltage</b>					
-10	2.97	2.25	1.62	1.35	1.08	(3.4)kΩ
-9	3.003	2.275	1.638	1.365	1.092	(4.6)kΩ
-8	3.036	2.3	1.656	1.38	1.104	(6.0)kΩ
-7	3.069	2.325	1.674	1.395	1.116	(7.9)kΩ
-6	3.102	2.35	1.692	1.41	1.128	(10.4)kΩ
-5	3.135	2.375	1.71	1.425	1.14	(13.9)kΩ
-4	3.168	2.4	1.728	1.44	1.152	(19.2)kΩ
-3	3.201	2.425	1.746	1.455	1.164	(27.9)kΩ
-2	3.234	2.45	1.764	1.47	1.176	(45.4)kΩ
-1	3.267	2.475	1.782	1.485	1.188	(97.9)kΩ
0	3.3	2.5	1.8	1.5	1.2	
+1	3.333	2.525	1.818	1.515	1.212	100.0kΩ
+2	3.366	2.55	1.836	1.53	1.224	47.5kΩ
+3	3.399	2.575	1.854	1.545	1.236	30.0kΩ
+4	3.432	2.6	1.872	1.56	1.248	21.3kΩ
+5	3.465	2.625	1.89	1.575	1.26	16.0kΩ
+6	3.498	2.65	1.908	1.58	1.272	12.5kΩ
+7	3.531	2.675	1.926	1.605	1.284	10.0kΩ
+8	3.564	2.7	1.944	1.62	1.296	8.1kΩ
+9	3.597	2.725	1.962	1.635	1.308	6.7kΩ
+10	3.630	2.75	1.98	1.65	1.32	5.5kΩ

R<sub>1</sub> = Black, R<sub>2</sub> = (Blue)

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**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
PT4851A	NRND	SIP MODULE	EKA	26	6	TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4851C	NRND	SIP MODULE	EKC	26	6	TBD	Call TI	Level-3-215C-168HRS	Samples Not Available
PT4851N	NRND	SIP MODULE	EKD	26	6	TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4852A	NRND	SIP MODULE	EKA	26	6	TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4852C	NRND	SIP MODULE	EKC	26		TBD	Call TI	Level-3-215C-168HRS	Samples Not Available
PT4852N	NRND	SIP MODULE	EKD	26		TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4853A	NRND	SIP MODULE	EKA	26		TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4853C	NRND	SIP MODULE	EKC	26	6	TBD	Call TI	Level-3-215C-168HRS	Samples Not Available
PT4853N	NRND	SIP MODULE	EKD	26	6	TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4854A	NRND	SIP MODULE	EKA	26	6	TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4854C	NRND	SIP MODULE	EKC	26	6	TBD	Call TI	Level-3-215C-168HRS	Samples Not Available
PT4854N	NRND	SIP MODULE	EKD	26	6	TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4855A	NRND	SIP MODULE	EKA	26		TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4855C	NRND	SIP MODULE	EKC	26	6	TBD	Call TI	Level-3-215C-168HRS	Samples Not Available
PT4855N	NRND	SIP MODULE	EKD	26		TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4856A	NRND	SIP MODULE	EKA	26		TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available
PT4856C	NRND	SIP MODULE	EKC	26	6	TBD	Call TI	Level-3-215C-168HRS	Samples Not Available
PT4856N	NRND	SIP MODULE	EKD	26	6	TBD	Call TI	Level-1-215C-UNLIM	Samples Not Available

<sup>(1)</sup> The marketing status values are defined as follows:

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**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

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**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

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(<sup>3</sup>) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
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		Wireless	<a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>