PT4220 Series

10-W Low-Profile 48V-Input
Isolated DC/DC Converter

EXCALIBUR

SLTS127A

(Revised 1/14/2002)

Features

- 10W Output Power
- Input Voltage: 36V to 75V
- Output Voltages: 1.2V to 13.2V
- 1500 VDC Isolation
- Temp Range: –40°C to +85°C
- Remote On/Off Control
- Undervoltage Lockout
- Output Current Limit
- Short-Circuit Protection
- Low-Profile Package (8mm)
- Space Saving Package
- Solderable Copper Case
- Safety Agency Approvals:
  UL 60950
  CSA 22.2 60950

Description

The PT4220 power modules are a series of DC/DC converters housed in an ultra-low profile (8mm) solderable copper case. The series includes a number of preset output voltages ranging from 1.3V† up to 12V, all fully approved for Telecom use. They may also be used in many other applications that require input-output isolation over an extended temperature range. The modules are an ideal choice for low-power digital and analog circuits, including DSPs and microcontrollers. The flexibility of input-output isolation also allows the output to be configured for negative voltage operation.

The PT4220 series is made available in both horizontal and vertical pin configurations, including surface mount.

Ordering Information

	PT4221☐ =1.8V/3A	(5.4W)
	PT4222☐ =3.3V/3A	
	PT4223☐ =5.0V/2A	
	PT4224☐ =12.0V/0.85A	
	PT4225☐ =2.5V/3A	(7.5W)
	PT4226☐ =1.5V/3A	(4.5W)
†	PT4227☐ =1.3V/3A	(3.9W)

† *Adjustable to 1.2V*

PT Series Suffix (PT1234x)

Case/Pin Configuration	Order Suffix	Package Code
Vertical	**N**	(EPE)
Horizontal	**A**	(EPF)
SMD	**C**	(EPG)

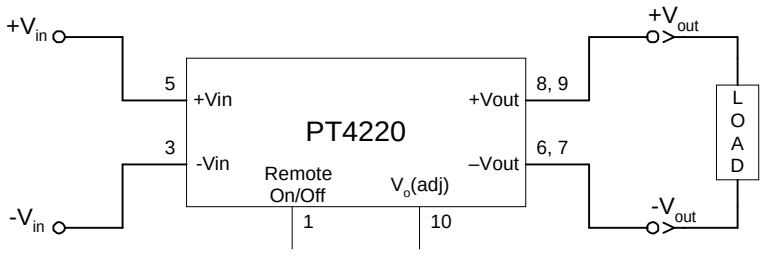
(Reference the applicable package code drawing for the dimensions and PC board layout)

Pin-Out Information

Pin	Function
1	Remote On/Off *
2	Do not connect
3	$-V_{in}$
4	Do not connect
5	$+V_{in}$
6	$-V_{out}$
7	$-V_{out}$
8	$+V_{out}$
9	$+V_{out}$
10	V_{out} Adj *

* *For further information, see application notes.*

Standard Application



PT4220 Series

10-W Low-Profile 48V-Input Isolated DC/DC Converter

Specifications (Unless otherwise stated, T_a =25°C, V_{in} =48V, C_{in} =0µF, C_{out} =0µF, and I_o =$I_o$max)

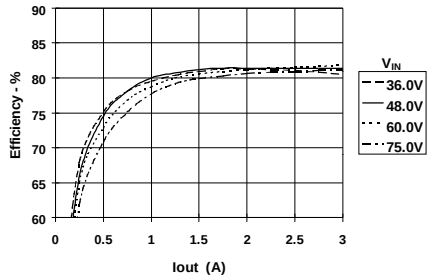
Characteristic	Symbol	Conditions		PT4220 SERIES Min	Typ	Max	Units
Output Current	I_o	Over V_{in} range	$V_o \le 3.3V$ V_o =5.0V V_o = 12V	0.1 (1) 0.1 (1) 0.1 (1)	— — —	3 2 0.85	
Input Voltage Range	V_{in}	Over I_o Range		36.0	48.0	75.0	VDC
Set Point Voltage Tolerance	V_o tol			—	±1	±2	%V_o
Temperature Variation	Reg_{temp}	–40° ≤T_a ≤ +85°C, I_o =$I_o$min		—	±0.2	—	%V_o
Line Regulation	Reg_{line}	Over V_{in} range		—	±1	—	mV
Load Regulation	Reg_{load}	Over I_o range		—	±5	—	mV
Total Output Voltage Variation	ΔV_otot	Includes set-point, line, load, –40° ≤T_a ≤ +85°C		—	±1.5	±3	%V_o
Efficiency	η		V_o = 12V V_o = 5.0V V_o = 3.3V V_o = 2.5V V_o = 1.8V V_o = 1.5V V_o = 1.3V	— — — — — — —	87 85 81 78 73 71 65	— — — — — — —	%
V_o Ripple (pk-pk)	V_r	20MHz bandwidth	$V_o \le 5.0V$ V_o = 12V	— —	50 100	— —	mV_{pp}
Transient Response	t_{tr}	1A/µs load step, 50% to 100% $I_o$max		—	75	—	µs
	ΔV_{tr}	V_o over/undershoot	$V_o \le 5.0V$ V_o = 12V	— —	±150 ±350	— —	mV
Output Voltage Adjust	V_{adj}		$V_o \ge 2.5V$	±10	—	—	%V_o
Current Limit Threshold	I_{lim}	V_{in} =36V, ΔV_o = –1%		—	150	—	%$I_o$max
Switching Frequency	f_s	Over V_{in} range		250	300	350	kHz
Under-Voltage Lockout	UVLO			—	32	—	V
Remote On/Off (Pin 1) Input High Voltage Input Low Voltage	 V_{IH} V_{IL}	Referenced to –Vin (pin 3)		 4.5 –0.2	 — —	 Open (3) +0.8	V
Input Low Current	I_{IL}			—	–0.5	—	mA
Standby Input Current	I_{in} standby	pins 1 & 3 connected		—	1	—	mA
Internal Input Capacitance	C_{in}			—	0.66	—	µF
External Output Capacitance	C_{out}		$V_o \le 5.0V$ V_o = 12V	0 (5) 0 (5)	— —	1000 330	µF
Isolation Voltage Capacitance Resistance		Input–output/input–case Input to output Input to output		1500 — 10	— 1,100 —	— — —	V pF MΩ
Operating Temperature Range	T_a	Over V_{in} range		-40	—	+85 (4)	°C
Storage Temperature	T_s	—		-40	—	+125	°C
Reliability	MTBF	Per Bellcore TR-332 50% stress, T_a =40°C, ground benign		4.7	—	—	10^6 Hrs
Mechanical Shock	—	Per Mil-Std-883D, method 2002.3, 1mS, half-sine, mounted to a fixture		—	500	—	G's
Mechanical Vibration	—	Mil-Std-883D, Method 2007.2 20-2000Hz, all case styles soldered to PC		—	20 (6)	—	G's
Weight	—	—		—	20	—	grams
Flammability	—	Materials meet UL 94V-0					

Notes: *(1) The DC/DC converter will operate at no load with reduced specifications.*
(2) The maximum output current reduces the output power of the following devices to less than 10W:- PT4225 =7.5W; PT4221 =5.4W; PT4226 =4.5W; PT4227 =3.9W.
(3) The Remote On/Off (pin 1) has an internal pull-up, and if it is left open circuit the converter will operate when input power is applied. The open-circuit voltage is typically 5V. Refer to the application notes for interface considerations.
(4) See Safe Operating Area curves or contact the factory for the appropriate derating.
(5) An output capacitor is not required for proper operation.
(6) The case pins on through-hole pin configurations (N & A) must be soldered. For more information see the applicable package outline drawing.

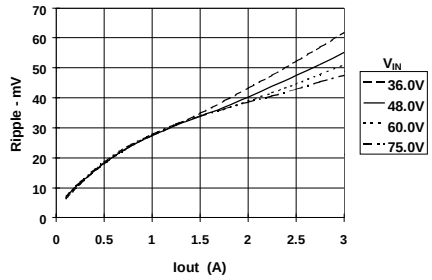
Typical Characteristics

PT4222, V_o =3.3VDC (See Note A)

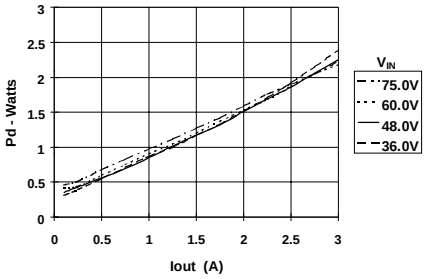
Efficiency vs Output Current



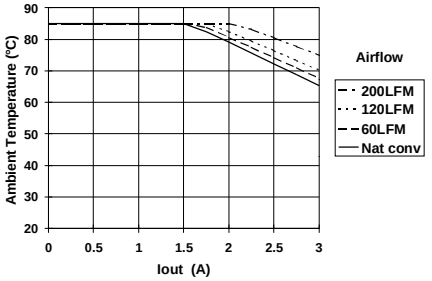
Output Ripple vs Output Current



Power Dissipation vs Output Current

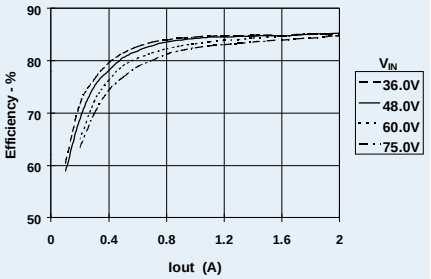


Safe Operating Area @Vin =48V (Note B)

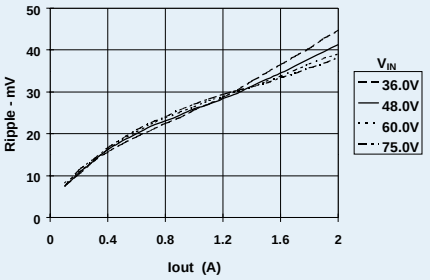


PT4223, V_o =5.0VDC (See Note A)

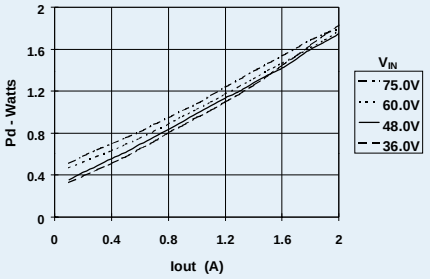
Efficiency vs Output Current



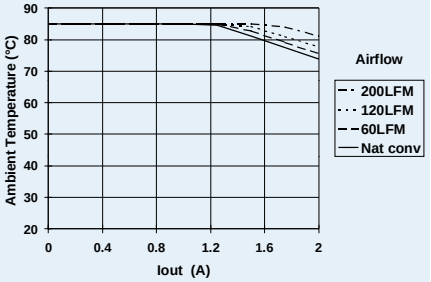
Output Ripple vs Output Current



Power Dissipation vs Output Current

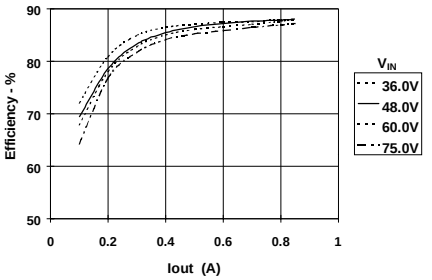


Safe Operating Area @Vin =48V (Note B)

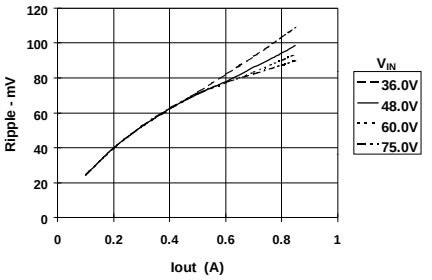


PT4224, V_o =12.0VDC (See Note A)

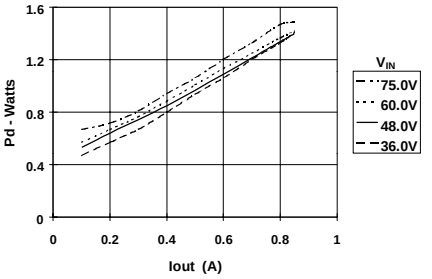
Efficiency vs Output Current



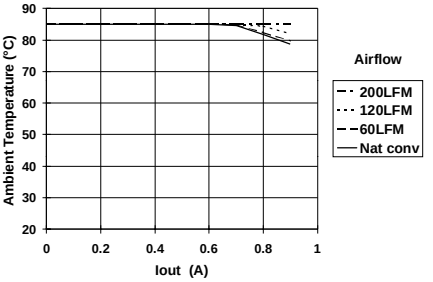
Output Ripple vs Output Current



Power Dissipation vs Output Current



Safe Operating Area @Vin =48V (Note B)



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

Using the Remote On/Off with the PT4220/4240 Isolated 10W Excalibur™ DC/DC Converters

For applications requiring output voltage On/Off control, the PT4220/4240 DC/DC converter series incorporates a "*Remote On/Off*" control (pin 1). This feature can be used to switch the module off without removing the applied input source voltage.

The converter functions normally with Pin 1 open-circuit, providing a regulated output voltage when a valid source voltage is applied to $+V_{in}$ (pin 5), with respect to $-V_{in}$ (pin 3). When a low-level [1] ground signal is applied to pin 1, the converter output will be turned off.

Figure 1 shows an application schematic, which details the typical use of the *Remote On/Off* function. Note the discrete transistor (Q1). The pin has its own internal pull-up, allowing it to be controlled with an open-collector or open-drain device (See notes 2 & 3). Table 1 gives the threshold requirements.

When placed in the "Off" state, the standby current drawn from the input source is typically reduced to less than 1mA.

Table 1; Pin 1 Remote On/Off Control Parameters [1]

Parameter	Min	Typ	Max
Enable (V_{IH})	4.5V	—	—
Disable (V_{IL})	—	—	0.8V
$V_{o/c}$ [Open-Circuit]		5.0V	
I_{in} [pin 1 at $-V_{in}$]	—	—	–0.5mA

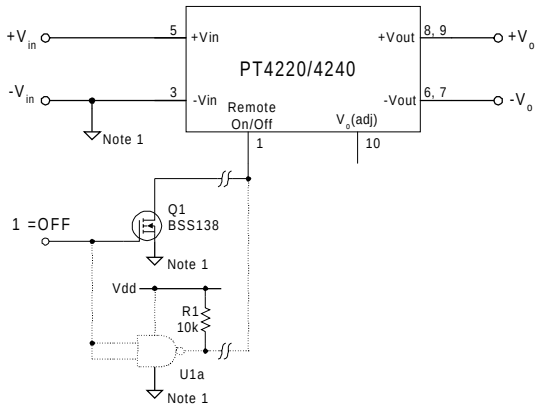
Notes:

1. The *Remote On/Off* control uses $-V_{in}$ (pin 3) as its ground reference. All voltages specified are with respect to $-V_{in}$.
2. Use an open-collector device (preferably a discrete transistor) for the *Remote On/Off* input. A pull-up resistor is not necessary. To disable the output voltage, the control pin should be pulled low to less than +0.8VDC.
3. The *Remote On/Off* pin may be controlled with devices that have a totem-pole output. This is provided the drive voltage meets the threshold requirements in Table 1. *Do not* apply more than +20V. If a TTL gate is used, a pull-up resistor may be required to the logic supply voltage.
4. The PT4220/4240 converters incorporate an "Under-Voltage Lockout" (UVLO). The UVLO will keep the module off when the input voltage to the converter is low, regardless of the state of the *Remote On/Off* control. Table 2 gives the UVLO input voltage thresholds.

Table 2; UVLO Thresholds [4]

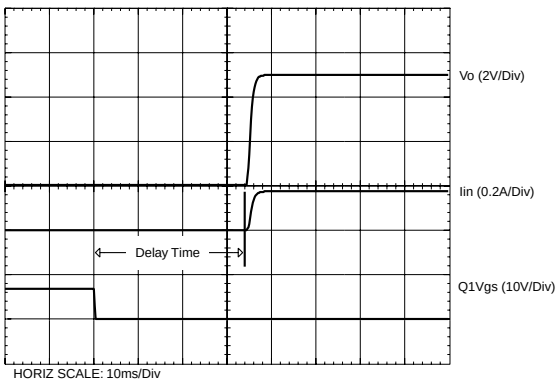
Series	V_{in} Range	UVLO Threshold
PT4220	36 – 75V	32V ±2V
PT4240	18 – 36V	15.8V ±2V

Figure 1



Turn-On Time: In the circuit of Figure 1, turning Q_1 on applies a low-voltage to pin 1 and disables the converter output. Correspondingly, turning Q_1 off allows pin 1 to be pulled high by an internal pull-up resistor. The converter produces a regulated output voltage within 60ms. Figure 2 shows shows the output response of a PT4223 (5.0V) following the turn-off of Q_1. The turn off of Q_1 corresponds to the drop in Q_1 Vgs. Although the rise-time of the output voltage is short (<5ms), the indicated delay time will vary depending upon the input voltage and the module's internal timing. The waveform was measured with a 48Vdc input voltage, and a 1.4A resistive load.

Figure 2



Adjusting the Output Voltage of the 10W-Rated Excalibur™ Series of Isolated DC/DC Converters

The factory pre-set output voltage of Power Trends' 10W Excalibur series of isolated DC-DC converters may be adjusted over a narrow range. This is accomplished with the addition of a single external resistor. For the input voltage range specified in the data sheet, Table 1 gives the allowable adjustment range for each model as V_o (min) and V_o (max).

Adjust Up: An increase in the output voltage is obtained by adding a resistor, R_2 between pin 10 (V_o adjust), and pins 6 & 7 ($-V_{out}$).

Adjust Down: Add a resistor (R_1), between pin 10 (V_o adjust) and pins 8 & 9 ($+V_{out}$).

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor, (R_1) or R_2.

The values of (R_1) [adjust down], and R_2 [adjust up], can also be calculated using the following formulas.

$$(R_1) = \frac{56.2\ (V_a - 1.225)}{V_o - V_a} - R_s \quad k\Omega$$

$$R_2 = \frac{68.845}{V_a - V_o} - R_s \quad k\Omega$$

Where, V_o = Original output voltage
V_a = Adjusted output voltage
R_s = Internal resistance (Table 1)

Notes:

1. Use only a single 1% resistor in either the (R_1) or R_2 location. Place the resistor as close to the ISR as possible.
2. Never connect capacitors to V_o adjust. Any capacitance added to the V_o adjust control pin will affect the stability of the ISR.
3. The output power is limited to 10W. If the output voltage is increased, the maximum load current must be derated according to the following equation.

$$I_o(max) = \frac{10}{V_a}$$

In any instance, the load current must not exceed the converter's rated current (See Table 1).

Table 1

DC/DC CONVERTER ADJUSTMENT RANGE AND FORMULA PARAMETERS

Series Pt #							
24V Bus	**PT4247**	**PT4246**	**PT4241**	**PT4245**	**PT4242**	**PT4243**	**PT4244**
48V Bus	**PT4227**	**PT4226**	**PT4221**	**PT4225**	**PT4222**	**PT4223**	**PT4224**
Rated Current [3]	**3A**	**3A**	**3A**	**3A**	**3A**	**2A**	**0.85A**
V_o(nom)	1.3V	1.5V	1.8V	2.5V	3.3V	5.0V	12.0V
Vo(min)	1.2V	1.45V	1.7V	2.25V	2.95V	4.5V	10.8V
Vo(max)	1.4V	1.65V	1.98V	2.75V	3.65V	5.5V	13.2V
R_s (kΩ)	340.0	243.0	243.0	187.0	187.0	110.0	49.9

Figure 1

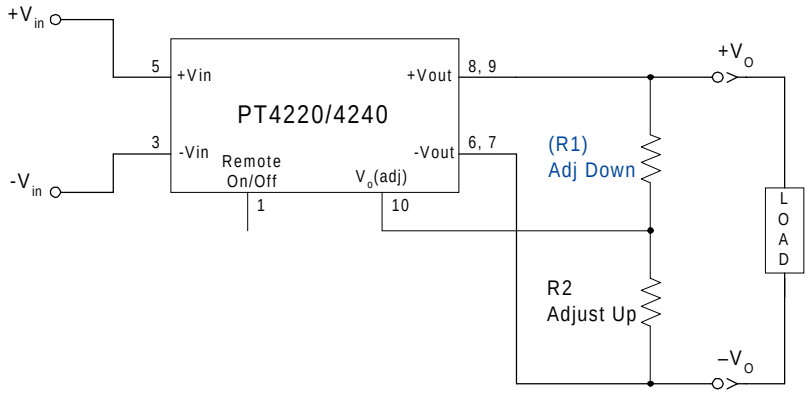


Table 2

DC/DC CONVERTER ADJUSTMENT RESISTOR VALUES

Series Pt #							
24V Bus	**PT4247**	**PT4246**	**PT4241**	**PT4245**	**PT4242**	**PT4243**	**PT4244**
48V Bus	**PT4227**	**PT4226**	**PT4221**	**PT4225**	**PT4222**	**PT4223**	**PT4224**
V_o(nom)	1.3V	1.5V	1.8V	2.5V	3.3V	5.0V	12.0V
V_a(req'd)						**V_a(req'd)**	
1.2	(0.0)kΩ					4.5	(258.0)kΩ	
1.25	(340.0)kΩ					4.6	(364.0)kΩ	
1.3						4.7	(541.0)kΩ	
1.35	340.0kΩ					4.8	(895.0)kΩ	
1.4	0.0.0kΩ					4.9	(1960.0)kΩ	
1.45		(9.9)kΩ				5.0		
1.5						5.1	578.0kΩ	
1.55		1130.0kΩ				5.2	234.0kΩ	
1.6		445.0kΩ				5.3	119.0kΩ	
1.65		216.0kΩ				5.4	62.1kΩ	
1.7			(23.9)kΩ			5.5	27.7kΩ	
1.75			(347.0)kΩ			10.8		(399.0)kΩ
1.8						11.0		(499.0)kΩ
1.85			1130.0kΩ			11.5		(1110.0)kΩ
1.9			445.0kΩ			12.0		
1.95			216.0kΩ			12.5		87.8kΩ
2.25				(43.4)kΩ		13.0		18.9kΩ
2.3				(115.0)kΩ		13.2		7.5kΩ
2.35				(235.0)kΩ				
2.4				(473.0)kΩ				
2.45				(1190.0)kΩ				
2.5								
2.55				1190.0kΩ				
2.6				501.0kΩ				
2.65				272.0kΩ				
2.7				157.0kΩ				
2.75				88.4kΩ				
2.95					(90.0)kΩ			
3.0					(146.0)kΩ			
3.05					(223.0)kΩ			
3.1					(340.0)kΩ			
3.15					(534.0)kΩ			
3.2					(923.0)kΩ			
3.25					(2090.0)kΩ			
3.3								
3.35					1190.0kΩ			
3.4					501.0kΩ			
3.45					272.0kΩ			
3.5					157.0kΩ			
3.55					88.4kΩ			
3.6					42.5kΩ			
3.65					9.7kΩ			

R_1 = (Blue) R_2 = Black

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PT4222C	OBSOLETE	SIP MODULE	EPG	10		TBD	Call TI	Call TI	-40 to 85		

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
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.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) 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.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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