

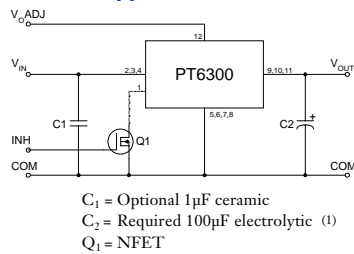
- 90% Efficiency
- Adjustable Output Voltage
- Internal Short Circuit Protection
- Over-Temperature Protection
- On/Off Control (Ground Off)
- Small SIP Footprint
- Wide Input Range

Switching Regulators (ISRs) designed to meet the on-board power conversion needs of battery powered or other equipment requiring high efficiency and small size. This high performance ISR family offers a unique combination of features combining 90% typical efficiency with open-collector on/off control and adjustable output voltage.

The PT6300 Series is a line of High-Performance 3 Amp, 12-Pin SIP (Single In-line Package) Integrated

Quiescent current in the shutdown mode is typically less than 100µA.

### Standard Application



### Pin-Out Information

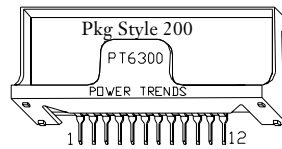
Pin	Function
1	Inhibit (30V max)
2	$V_{in}$
3	$V_{in}$
4	$V_{in}$
5	GND
6	GND
7	GND
8	GND
9	$V_{out}$
10	$V_{out}$
11	$V_{out}$
12	$V_{out-Adj}$ (5)

### Ordering Information

- PT6302□ = +5 Volts
- PT6303□ = +3.3 Volts
- PT6304□ = +12 Volts
- PT6314□ = +1.5 Volts

### PT Series Suffix (PT1234X)

Case/Pin Configuration	Suffix
Vertical Through-Hole	N
Horizontal Through-Hole	A
Horizontal Surface Mount	C



### Specifications

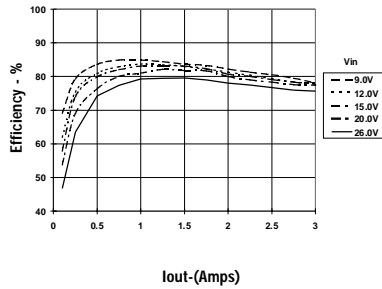
Characteristics ( $T_a=25^\circ\text{C}$ unless noted)	Symbols	Conditions	PT6300 SERIES			Units
			Min	Typ	Max	
Output Current	$I_o$	Over $V_{in}$ range	0.1 (2)	—	3.0	A
Short Circuit Current	$I_{sc}$	$V_{in} = V_o + 5V$	—	5.0	—	Apk
Input Voltage Range (Note: inhibit function cannot be used above 30V.)	$V_{in}$	$0.1 \leq I_o \leq 3.0 \text{ A}$	$V_o = 12V$ 16 $V_o = 5.0V$ 9 $V_o = 3.3V$ 9 $V_o = 1.5V$ 9.0	—	30/38 (3) 30/38 (3) 26 17	V
Output Voltage Tolerance	$\Delta V_o$	Over $V_{in}$ Range, $I_o = 3.0 \text{ A}$ $T_a = 0^\circ\text{C}$ to $+60^\circ\text{C}$	—	$\pm 1.0$	$\pm 2.0$	% $V_o$
Line Regulation	$Reg_{line}$	Over $V_{in}$ range	—	$\pm 0.25$	$\pm 0.5$	% $V_o$
Load Regulation	$Reg_{load}$	$0.1 \leq I_o \leq 3.0 \text{ A}$	—	$\pm 0.25$	$\pm 0.5$	% $V_o$
$V_o$ Ripple/Noise	$V_n$	$V_{in} = V_{in \text{ min}}, I_o = 3.0 \text{ A}$	—	$\pm 2$	—	% $V_o$
Transient Response with $C_o = 100\mu\text{F}$	$t_{tr}$ $V_{os}$	50% load change $V_o$ over/undershoot	—	100 5.0	200 —	$\mu\text{Sec}$ % $V_o$
Efficiency	$\eta$	$V_{in}=16V, I_o = 0.5 \text{ A},$ $V_{in}=9V, I_o = 0.5 \text{ A},$ $V_{in}=9V, I_o = 0.5 \text{ A},$ $V_{in}=9V, I_o = 0.5 \text{ A},$	$V_o = 12V$ — $V_o = 5.0V$ — $V_o = 3.3V$ — $V_o = 1.5V$ —	—	91 89 84 72	%
Switching Frequency	$f_o$	Over $V_{in}$ and $I_o$ ranges,	$V_o = 12V$ 600 $V_o = 3.3V/5V$ 400 $V_o = 1.5V$ 350	750 500 450	900 600 550	kHz
Shutdown Current	$I_{sc}$	$V_{in} = 15V$	—	100	—	$\mu\text{A}$
Quiescent Current	$I_{nl}$	$I_o = 0A, V_{in}=10V$	—	10	—	mA
Absolute Maximum Operating Temperature Range	$T_a$	Over $V_{in}$ range	-40	—	+85 (4)	$^\circ\text{C}$
Thermal Resistance	$\theta_{ja}$	Free Air Convection (40-60LFM)	—	30	—	$^\circ\text{C}/\text{W}$
Storage Temperature	$T_s$	—	-40	—	+125	$^\circ\text{C}$
Mechanical Shock		Per Mil-STD-883D, Method 2002.3, 1 msec, Half Sine, mounted to a fixture	—	500	—	G's
Mechanical Vibration		Per Mil-STD-883D, Method 2007.2, 20-2000 Hz, Soldered in a PC board	—	10	—	G's
Weight	—	—	—	6.5	—	grams

- Notes:**
- (1) The PT6300 Series requires a 100µF electrolytic or tantalum output capacitor for proper operation in all applications.
  - (2) The ISR will operate to no load with reduced specifications.
  - (3) Input voltage cannot exceed 30V when the inhibit function is used.
  - (4) See Thermal Derating charts.
  - (5) Consult the related application note for guidance on adjusting the output voltage.

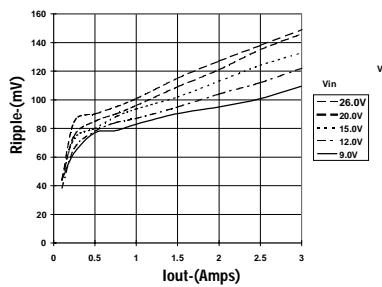
3 Amp Adjustable Positive Step-down Integrated Switching Regulators

PT6303, 3.3 VDC (See Note A)

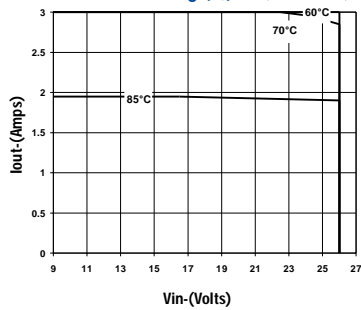
Efficiency vs Output Current



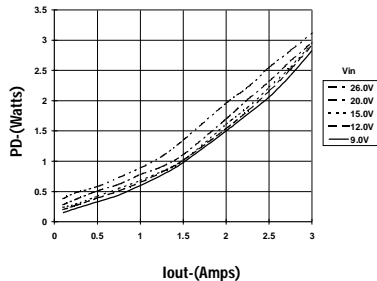
Ripple vs Output Current



Thermal Derating (Ta) (See Note B)

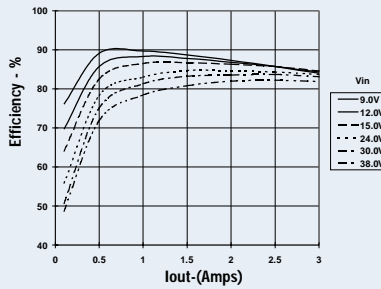


Power Dissipation vs Output Current

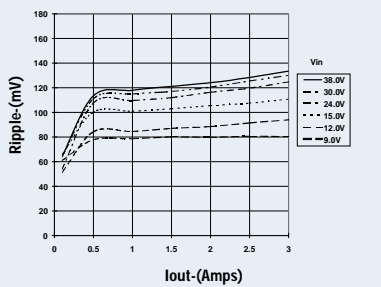


PT6302, 5.0 VDC (See Note A)

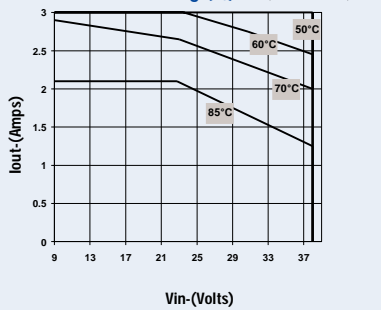
Efficiency vs Output Current



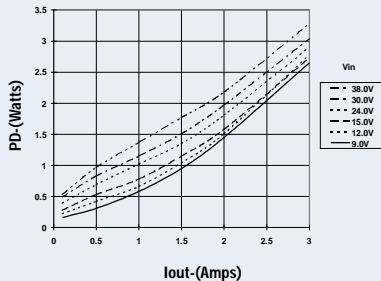
Ripple vs Output Current



Thermal Derating (Ta) (See Note B)

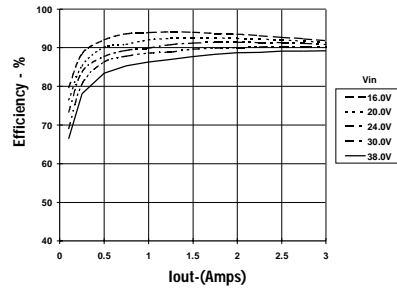


Power Dissipation vs Output Current

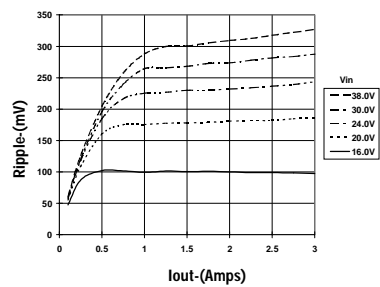


PT6304, 12.0 VDC (See Note A)

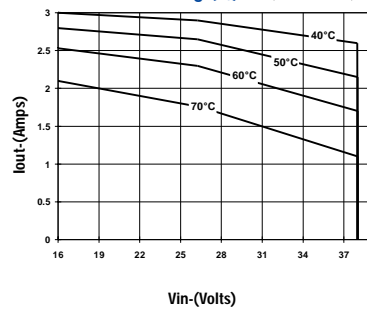
Efficiency vs Output Current



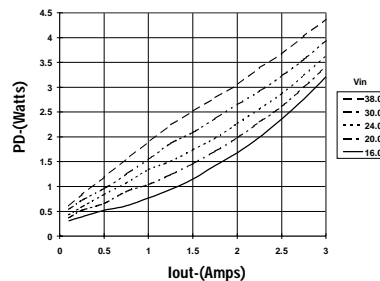
Ripple vs Output Current



Thermal Derating (Ta) (See Note B)



Power Dissipation vs Output Current



Note A: Characteristic data listed 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: Thermal derating graphs are developed in free air convection cooling of 40-60 LFM. (See Thermal Application note.)

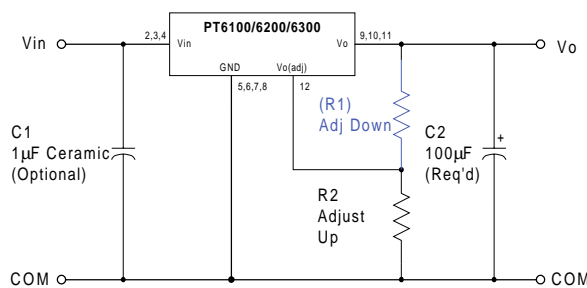
## Adjusting the Output Voltage of Power Trends' Wide Input Range Bus ISRs

The output voltage of the Power Trends' Wide Input Range Series ISRs may be adjusted higher or lower than the factory trimmed pre-set voltage with the addition of a single external resistor. Table 1 accordingly gives the allowable adjustment range for each model for either series as  $V_a$  (min) and  $V_a$  (max).

**Adjust Up:** An increase in the output voltage is obtained by adding a resistor R2, between pin 12 ( $V_o$  adjust) and pins 5-8 (GND).

**Adjust Down:** Add a resistor (R1), between pin 12 ( $V_o$  adjust) and pins 9-11( $V_{out}$ ).

Figure 1



The values of (R1) [adjust down], and R2 [adjust up], can also be calculated using the following formulas. Refer to Figure 1 and Table 2 for both the placement and value of the required resistor; either (R1) or R2 as appropriate.

$$(R1) = \frac{R_o (V_a - 1.25)}{V_o - V_a} \quad k\Omega$$

$$R2 = \frac{1.25 R_o}{V_a - V_o} \quad k\Omega$$

Where:  $V_o$  = Original output voltage  
 $V_a$  = Adjusted output voltage  
 $R_o$  = The resistance value from Table 1

Table 1

ISR ADJUSTMENT RANGE AND FORMULA PARAMETERS					
1A dc Rated		PT6102	PT6101		PT6103
2A dc Rated	PT6216	PT6213		PT6212	PT6214
3A dc Rated	PT6314	PT6303		PT6302	PT6304
$V_o$ (nom)	1.5	3.3	5.0	5.0	12.0
$V_a$ (min)	1.3	1.8	1.88	2.18	2.43
$V_a$ (max)	1.9	6.07	11.25	8.5	22.12
$R_o$ (k $\Omega$ )	8.25	66.5	150.0	90.9	243.0

### Notes:

1. Use only a single 1% resistor in either the (R1) or R2 location. Place the resistor as close to the ISR as possible.
2. Never connect capacitors from  $V_o$  adjust to either GND or  $V_{out}$ . Any capacitance added to the  $V_o$  adjust pin will affect the stability of the ISR.
3. Adjustments to the output voltage may place additional limits on the maximum and minimum input voltage for the part. The revised maximum and minimum input voltage limits must comply with the following requirements. The limits are model dependant.

### PT6216/PT6314:

$V_{in} (max) = (10 \times V_a)V$  or 17V, whichever is less.

$V_{in} (min) = 9.0V$

### All other models:

$V_{in} (max) = (8 \times V_a)V$  or as specified.

$V_{in} (min) = (V_a + 4)V$  or 9V, whichever is greater.

PT6100/6210/6300 Series

Table 2

ISR ADJUSTMENT RESISTOR VALUES

1Adc Rated		PT6102	PT6101		PT6103
2Adc Rated	PT6216	PT6213		PT6212	PT6214
3Adc Rated	PT6314	PT6303		PT6302	PT6304
V <sub>0</sub> (nom)	1.5	3.3	5.0	5.0	12.0
V <sub>a</sub> (req.d)					
1.3	(2.1kΩ)				
1.4	(12.4kΩ)				
1.5					
1.6	103.0kΩ				
1.7	51.6kΩ				
1.8	34.4kΩ	(24.4)kΩ			
1.9	25.8kΩ	(30.9)kΩ	(31.5)kΩ		
2.0		(38.4)kΩ	(37.5)kΩ		
2.1		(47.1)kΩ	(44.0)kΩ		
2.2		(57.4)kΩ	(50.9)kΩ	(30.8)kΩ	
2.3		(69.8)kΩ	(58.3)kΩ	(35.4)kΩ	
2.4		(85.0)kΩ	(66.3)kΩ	(40.2)kΩ	
2.5		(104.0)kΩ	(75.0)kΩ	(45.5)kΩ	(32.0)kΩ
2.6		(128.0)kΩ	(84.4)kΩ	(51.1)kΩ	(34.9)kΩ
2.7		(161.0)kΩ	(94.6)kΩ	(57.3)kΩ	(37.9)kΩ
2.8		(206.0)kΩ	(106.0)kΩ	(64.0)kΩ	(40.9)kΩ
2.9		(274.0)kΩ	(118.0)kΩ	(71.4)kΩ	(44.1)kΩ
3.0		(388.0)kΩ	(131.0)kΩ	(79.5)kΩ	(47.3)kΩ
3.1		(615.0)kΩ	(146.0)kΩ	(88.5)kΩ	(50.5)kΩ
3.2		(1300.0)kΩ	(163.0)kΩ	(98.5)kΩ	(53.8)kΩ
3.3		(181.0)kΩ	(110.0)kΩ	(57.3)kΩ	
3.4		831.0kΩ	(202.0)kΩ	(122.0)kΩ	(60.8)kΩ
3.5		416.0kΩ	(225.0)kΩ	(136.0)kΩ	(64.3)kΩ
3.6		227.0kΩ	(252.0)kΩ	(153.0)kΩ	(68.0)kΩ
3.7		208.0kΩ	(283.0)kΩ	(171.0)kΩ	(71.7)kΩ
3.8		166.0kΩ	(319.0)kΩ	(193.0)kΩ	(75.6)kΩ
3.9		139.0kΩ	(361.0)kΩ	(219.0)kΩ	(79.5)kΩ
4.0		119.0kΩ	(413.0)kΩ	(250.0)kΩ	(83.5)kΩ
4.1		104.0kΩ	(475.0)kΩ	(288.0)kΩ	(87.7)kΩ
4.2		92.4kΩ	(533.0)kΩ	(335.0)kΩ	(91.9)kΩ
4.3		83.1kΩ	(654.0)kΩ	(396.0)kΩ	(96.3)kΩ
4.4		75.6kΩ	(788.0)kΩ	(477.0)kΩ	(101.0)kΩ
4.5		69.3kΩ	(975.0)kΩ	(591.0)kΩ	(105.0)kΩ
4.6		63.9kΩ	(1260.0)kΩ	(761.0)kΩ	(110.0)kΩ
4.7		59.4kΩ	(1730.0)kΩ	(1050.0)kΩ	(115.0)kΩ
4.8		55.4kΩ		(1610.0)kΩ	(120.0)kΩ
4.9		52.0kΩ			(125.0)kΩ
5.0		48.9kΩ			(130.0)kΩ
5.1		46.2kΩ	1880.0kΩ	1140.0kΩ	(136.0)kΩ
5.2		43.8kΩ	937.0kΩ	568.0kΩ	(141.0)kΩ
5.3		41.6kΩ	625.0kΩ	379.0kΩ	(147.0)kΩ
5.4		39.6kΩ	469.0kΩ	284.0kΩ	(153.0)kΩ
5.5		37.8kΩ	375.0kΩ	227.0kΩ	(159.0)kΩ
5.6		36.1kΩ	313.0kΩ	189.0kΩ	(165.0)kΩ
5.7		34.6kΩ	268.0kΩ	162.0kΩ	(172.0)kΩ
5.8		33.3kΩ	234.0kΩ	142.0kΩ	(178.0)kΩ
5.9		32.0kΩ	208.0kΩ	126.0kΩ	(185.0)kΩ
6.0		30.8kΩ	188.0kΩ	114.0kΩ	(192.0)kΩ

ISR ADJUSTMENT RESISTOR VALUES (Cont)

1Adc Rated	PT6101		PT6103
2Adc Rated		PT6212	PT6214
3Adc Rated		PT6302	PT6304
V <sub>0</sub> (nom)	5.0	5.0	12.0
V <sub>a</sub> (req.d)			
6.2	156.0kΩ	94.7kΩ	(207.0)kΩ
6.4	134.0kΩ	81.2kΩ	(223.0)kΩ
6.6	117.0kΩ	71.0kΩ	(241.0)kΩ
6.8	104.0kΩ	63.1kΩ	(259.0)kΩ
7.0	93.8kΩ	56.8kΩ	(279.0)kΩ
7.2	85.2kΩ	51.6kΩ	(301.0)kΩ
7.4	78.1kΩ	47.3kΩ	(325.0)kΩ
7.6	72.1kΩ	43.7kΩ	(351.0)kΩ
7.8	67.0kΩ	40.6kΩ	(379.0)kΩ
8.0	62.5kΩ	37.9kΩ	(410.0)kΩ
8.2	58.6kΩ	35.5kΩ	(444.0)kΩ
8.4	55.1kΩ	33.4kΩ	(483.0)kΩ
8.6	52.1kΩ		(525.0)kΩ
8.8	49.3kΩ		(573.0)kΩ
9.0	46.9kΩ		(628.0)kΩ
9.5	41.7kΩ		(802.0)kΩ
10.0	37.5kΩ		(1060.0)kΩ
10.5	34.1kΩ		(1500.0)kΩ
11.0	31.3kΩ		
11.5			
12.0			
12.5			608.0kΩ
13.0			304.0kΩ
13.5			203.0kΩ
14.0			152.0kΩ
14.5			122.0kΩ
15.0			101.0kΩ
15.5			86.8kΩ
16.0			75.9kΩ
16.5			67.5kΩ
17.0			60.8kΩ
17.5			55.2kΩ
18.0			50.6kΩ
18.5			46.7kΩ
19.0			43.4kΩ
19.5			40.5kΩ
20.0			38.0kΩ
20.5			35.7kΩ
21.5			33.8kΩ
21.5			32.0kΩ
22.0			30.4kΩ

R1 = (Blue) R2 = Black

## Using the Inhibit Function on Power Trends' Wide Input Range Bus ISRs

For applications requiring output voltage On/Off control, the 12pin ISR products incorporate an inhibit function. The function has uses in areas such as battery conservation, power-up sequencing, or any other application where the regulated output from the module is required to be switched off. The On/Off function is provided by the Pin 1 (*Inhibit*) control.

The ISR functions normally with Pin 1 open-circuit, providing a regulated output whenever a valid source voltage is applied to  $V_{in}$ , (pins 2, 3, & 4). When a low-level<sup>2</sup> ground signal is applied to Pin 1, the regulator output will be disabled.

Figure 1 shows an application schematic, which details the typical use of the Inhibit function. Note the discrete transistor (Q1). The Inhibit control has its own internal pull-up with a maximum open-circuit voltage of 8.3VDC. Only devices with a true open-collector or open-drain output can be used to control this pin. A discrete bipolar transistor or MOSFET is recommended.

Equation 1 may be used to determine the approximate current drawn by Q1 when the inhibit is active.

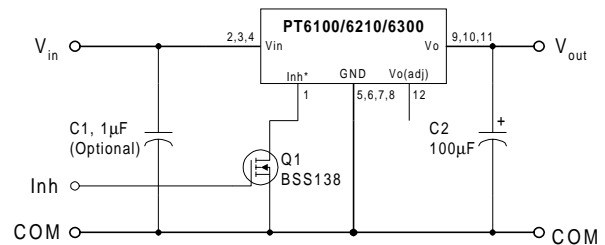
### Equation 1

$$I_{stby} = V_{in} \div 155k\Omega \pm 20\%$$

### Notes:

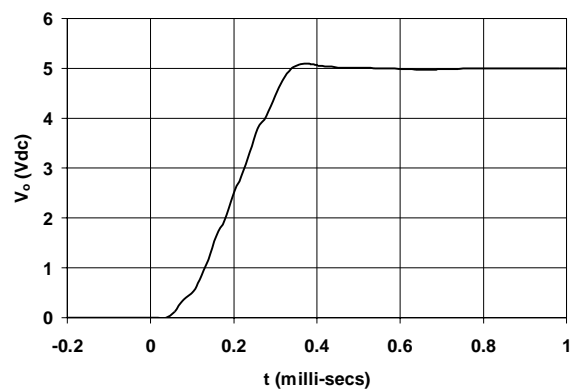
1. The Inhibit control logic is similar for all Power Trends' modules, but the flexibility and threshold tolerances will be different. For specific information on the inhibit function of other ISR models, consult the applicable application note.
2. Use only a true open-collector device (preferably a discrete transistor) for the Inhibit input. Do Not use a pull-up resistor, or drive the input directly from the output of a TTL or other logic gate. To disable the output voltage, the control pin should be pulled low to less than +1.5VDC.
3. When the Inhibit control pin is active, i.e. pulled low, the maximum allowed input voltage is limited to +30Vdc.
4. Do not control the Inhibit input with an external DC voltage. This will lead to erratic operation of the ISR and may over-stress the regulator.
5. Avoid capacitance greater than 500pF at the Inhibit control pin. Excessive capacitance at this pin will cause the ISR to produce a pulse on the output voltage bus at turn-on.
6. Keep the On/Off transition to less than 10 $\mu$ s. This prevents erratic operation of the ISR, which can cause a momentary high output voltage.

Figure 1



**Turn-On Time:** The output of the ISR is enabled automatically when external power is applied to the input. The *Inhibit* control pin is pulled high by its internal pull-up resistor. The ISR produces a fully regulated output voltage within 1-msec of either the release of the Inhibit control pin, or the application of power. The actual turn-on time will vary with the input voltage, output load, and the total amount of capacitance connected to the output. Using the circuit of Figure 1, Figure 2 shows the typical rise in output voltage for the PT6101 following the turn-off of Q1 at time  $t=0$ . The waveform was measured with a 9Vdc input voltage, and 5-Ohm resistive load.

Figure 2



**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
PT6302H	OBSOLETE	SIP MODULE	EBH	12		TBD	Call TI	Call TI			
PT6302J	OBSOLETE	SIP MODULE	EBJ	12		TBD	Call TI	Call TI			
PT6303S	OBSOLETE	SIP MODULE	EBF	12		TBD	Call TI	Call TI			
PT6304H	OBSOLETE	SIP MODULE	EBH	12		TBD	Call TI	Call TI			
PT6304J	OBSOLETE	SIP MODULE	EBJ	12		TBD	Call TI	Call TI			

(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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