

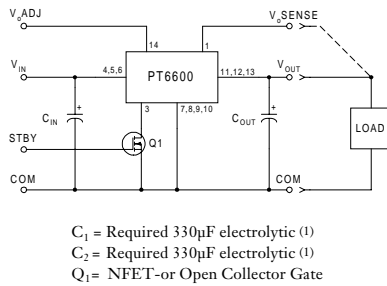
- Single Device 9A Output
- Input Voltage Range: 3.1V to 6.0V
- Adjustable Output Voltage
- 90% Efficiency
- Remote Sense Capability
- Standby Function
- Over-Temperature Protection

In-line Package) Integrated Switching Regulators (ISRs), designed for stand-alone operation in applications requiring as much as 9A of output current.

The PT6600 series will operate off either a 3.3V or 5V input bus and requires only two external capacitors for proper operation. Please note that this product does not include short circuit protection.

The PT6600 series is a high performance family of 14-Pin SIP (Single

Standard Application



Pin-Out Information

Pin	Function
1	Remote Sense
2	Do not connect
3	STBY*-Standby
4	V _{in}
5	V _{in}
6	V _{in}
7	GND
8	GND
9	GND
10	GND
11	V _{out}
12	V _{out}
13	V _{out}
14	V _{out} Adjust

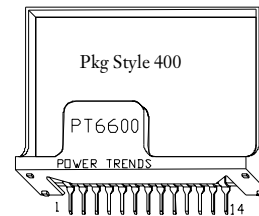
Ordering Information

PT6601!	= +3.3 Volts
†PT6602!	= +1.5 Volts
PT6603!	= +2.5 Volts
PT6604!	= +3.6 Volts
†PT6605!	= +1.2 Volts
†PT6606!	= +1.8 Volts

†3.3V Input Bus Capable

PT Series Suffix (PT1234X)

Case/Pin Configuration	Heat Spreader	Heat Spreader with Side Tabs
Vertical Through-Hole	P	R
Horizontal Through-Hole	D	G
Horizontal Surface Mount	E	B



Note: Back surface of product is conducting metal.

Specifications

Characteristics (T _a = 25°C unless noted)	Symbols	Conditions	PT6600 SERIES			Units
			Min	Typ	Max	
Output Current	I _o	T _a = 60°C, 200 LFM, pkg P T _a = 25°C, natural convection	0.1 (2) 0.1 (2)	—	9.0 (4) 7.0 (4)	A
Input Voltage Range	V _{in}	0.1A ≤ I _o ≤ 8.0A	V _o = +2.5/3.3V 4.5 3.1 4.8	—	6.0 6.0 6.0	V
Output Voltage Tolerance	ΔV _o	V _{in} = +5V, I _o = 8.0A T _a = 0°C to 65°C	V _o -0.1	—	V _o +0.1	V
Output Voltage Adjust Range	V _{oadj}	Pin 14 to V _o or ground V _{in} min = +3.1V or V _o +1.2V (whichever is greater)	V _o = +3.3V 2.25 V _o = +1.5V 1.27 V _o = +2.5V 1.80 V _o = +3.6V 2.50	—	4.20 2.65 3.50 4.30	V
Line Regulation	Reg _{line}	4.5V ≤ V _{in} ≤ 6.0V, I _o = 8.0A 3.1V ≤ V _{in} ≤ 6.0V, I _o = 8.0A 4.5V ≤ V _{in} ≤ 6.0V, I _o = 8.0A	V _o = +3.3V — V _o = +1.5V — V _o = +2.5V —	±7 ±3 ±7	±17 ±8 ±13	mV
Load Regulation	Reg _{load}	V _{in} = +5V, 0.1 ≤ I _o ≤ 8.0A	V _o = +3.3V — V _o = +1.5V — V _o = +2.5V —	±17 ±12 ±13	±33 ±23 ±25	mV
V _o Ripple/Noise	V _n	V _{in} = 5V, I _o = 8.0A	—	50	—	mV _{pp}
Transient Response with C ₂ = 330 μ F	t _{tr} V _{os}	I _o step between 4.0A and 8.0A V _o over/undershoot	—	100 150	—	μ Sec mV
Efficiency	η	V _{in} = +5V, I _o = 3.0A V _{in} = +5V, I _o = 8.0A	V _o = +3.3/3.6V — V _o = +1.5V — V _o = +2.5V —	90 76 85	—	%
Switching Frequency	f _o	3.1V ≤ V _{in} ≤ 6.0V 0.1A ≤ I _o ≤ 8.0A	—	475 600 725	—	kHz
Absolute Maximum Operating Temperature Range	T _a	Over V _{in} range	-40 (3)	—	+85 (4)	°C
Thermal Resistance	θ _{ja}	Free Air Convection (40-60 LFM)	—	25	—	°C/W

Continued

PT6600 Series

9 Amp 5V/3.3V Input Adjustable Integrated Switching Regulator

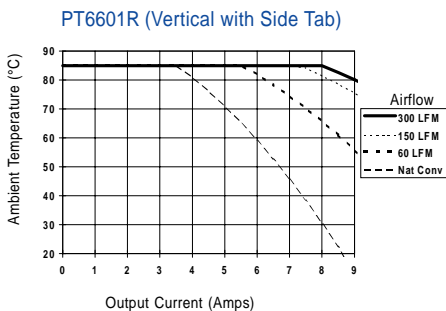
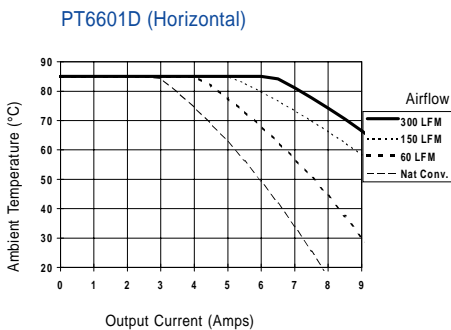
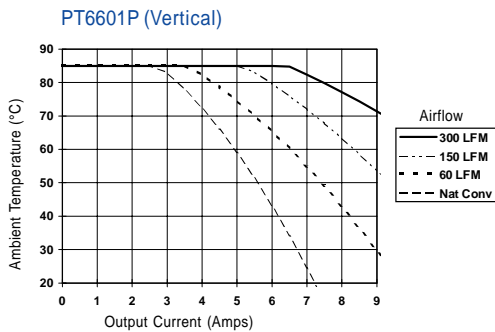
Specifications (continued)

Characteristics (T _a = 25°C unless noted)	Symbols	Conditions	PT6600 SERIES			Units
			Min	Typ	Max	
Storage Temperature	T _s	—	-40	—	+125	°C
Mechanical Shock	—	Per Mil-STD-883D, Method 2002.3	—	500	—	G's
Mechanical Vibration	—	Per Mil-STD-883D, Method 2007.2, 20-2000 Hz, soldered in a PC board	—	7.5	—	G's
Weight	—	—	—	14	—	grams

- Notes: (1) The PT6600 series requires two 330µF electrolytic capacitors (input and output) for proper operation in all applications. The input capacitance must be rated for a minimum of 1.1Arms of ripple current. See the application note, PT6500/6600 Series Capacitor Recommendations.
 (2) ISR will operate down to no load with reduced specifications.
 (3) For operation below 0°C, use tantalum capacitors for C_{IN} and C_{OUT}. For more information, contact an Application Specialist.
 (4) See Safe Operating Curves, or contact the factory for the appropriate derating.

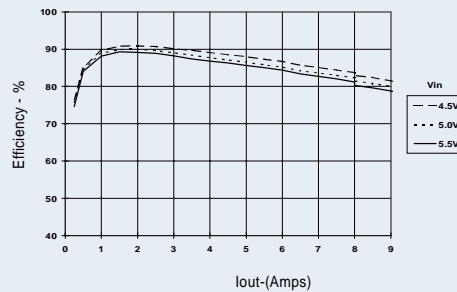
TYPICAL CHARACTERISTICS

Safe Operating Area Curves (@ V_{in}=+5.0V) (See Note B)

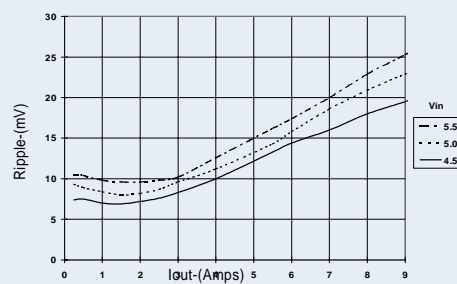


PT6601, 3.3 VDC (See Note A)

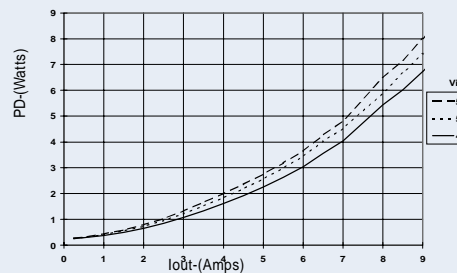
Efficiency vs Output Current



Ripple vs Output Current



Power Dissipation vs Output Current



Note A: All 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: SOA curves represent operating conditions at which internal components are at or below manufacturer's maximum rated operating temperatures.

PT6600 Series

Table 2

PT6600 ADJUSTMENT RESISTOR VALUES								
Series Pt #	PT6605	PT6607	PT6602	PT6608	PT6606	PT6603	PT6601	PT6604
V_O (nom)	1.2	1.3	1.5	1.7	1.8	2.5	3.3	3.6
V_a (req'd)								
1.15	(5.5)k Ω							
1.2		(3.0)k Ω						
1.25	47.8k Ω	(10.5)k Ω						
1.3	22.9k Ω		(1.7)k Ω					
1.35	14.6k Ω	47.8k Ω	(3.8)k Ω					
1.4	10.5k Ω	22.9k Ω	(8.0)k Ω	(1.3)k Ω	(0.5)k Ω			
1.45	8.0k Ω	14.6k Ω	(20.4)k Ω	(2.5)k Ω	(1.2)k Ω			
1.5	6.3k Ω	10.5k Ω		(4.2)k Ω	(2.2)k Ω			
1.55	5.1k Ω	8.0k Ω	47.8k Ω	(7.1)k Ω	(3.5)k Ω			
1.6	4.2k Ω	6.3k Ω	22.9k Ω	(12.9)k Ω	(5.5)k Ω			
1.65	3.5k Ω	4.1k Ω	14.6k Ω	(30.4)k Ω	(8.8)k Ω			
1.7	3.0k Ω	4.2k Ω	10.5k Ω		(15.4)k Ω			
1.75	2.5k Ω	3.5k Ω	8.0k Ω	47.8k Ω	(35.4)k Ω			
1.8	2.2k Ω	3.0k Ω	6.3k Ω	22.9k Ω		(1.5)k Ω		
1.85	1.8k Ω	2.5k Ω	5.1k Ω	14.6k Ω	47.8k Ω	(2.3)k Ω		
1.9	1.6k Ω	2.2k Ω	4.2k Ω	10.5k Ω	22.9k Ω	(3.3)k Ω		
1.95	1.3k Ω	1.8k Ω	3.5k Ω	8.0k Ω	14.6k Ω	(4.4)k Ω		
2.0	1.1k Ω	1.6k Ω	3.0k Ω	6.3k Ω	10.5k Ω	(5.8)k Ω		
2.05	0.9k Ω	1.3k Ω	2.5k Ω	5.1k Ω	8.0k Ω	(7.4)k Ω		
2.1	0.8k Ω	1.1k Ω	2.2k Ω	4.2k Ω	6.3k Ω	(9.5)k Ω		
2.15	0.6k Ω	0.9k Ω	1.8k Ω	3.5k Ω	5.1k Ω	(12.2)k Ω		
2.2	0.5k Ω	0.8k Ω	1.6k Ω	3.0k Ω	4.2k Ω	(15.7)k Ω		
2.25	0.4k Ω	0.6k Ω	1.3k Ω	2.5k Ω	3.5k Ω	(20.7)k Ω	(2.3)k Ω	
2.3	0.3k Ω	0.5k Ω	1.1k Ω	2.2k Ω	3.0k Ω	(28.2)k Ω	(3.6)k Ω	
2.35	0.2k Ω	0.4k Ω	0.9k Ω	1.8k Ω	2.5k Ω	(40.7)k Ω	(5.1)k Ω	
2.4		0.3k Ω	0.8k Ω	1.6k Ω	2.2k Ω	(65.6)k Ω	(6.7)k Ω	
2.45		0.2k Ω	0.6k Ω	1.3k Ω	1.8k Ω	(140.0)k Ω	(8.5)k Ω	
2.5			0.5k Ω	1.1k Ω	1.6k Ω		(10.6)k Ω	(1.5)k Ω
2.55			0.4k Ω	0.9k Ω	1.3k Ω	95.6k Ω	(12.9)k Ω	(2.7)k Ω
2.6			0.3k Ω	0.8k Ω	1.1k Ω	45.7k Ω	(15.6)k Ω	(3.9)k Ω
2.65			0.2k Ω	0.6k Ω	6.9k Ω	29.0k Ω	(18.6)k Ω	(5.3)k Ω
2.7				0.5k Ω	0.8k Ω	20.7k Ω	(22.2)k Ω	(6.8)k Ω
2.75				0.4k Ω	0.6k Ω	15.7k Ω	(26.4)k Ω	(8.5)k Ω
2.8				0.3k Ω	0.5k Ω	12.4k Ω	(31.5)k Ω	(10.4)k Ω
2.85				0.2k Ω	0.4k Ω	10.0k Ω	(37.6)k Ω	(12.6)k Ω
2.9					0.3k Ω	8.3k Ω	(45.4)k Ω	(15.0)k Ω
2.95					0.2k Ω	0.9k Ω	(55.3)k Ω	(17.9)k Ω
3.0						5.8k Ω	(68.6)k Ω	(21.2)k Ω
3.1						4.1k Ω	(115.0)k Ω	(29.9)k Ω
3.2						2.9k Ω	(254.0)k Ω	(42.9)k Ω
3.3						2.0k Ω		(64.6)k Ω
3.4						1.3k Ω	109.0k Ω	(108.0)k Ω
3.5						0.8k Ω	48.4k Ω	(238.0)k Ω
3.6							28.2k Ω	
3.7							18.2k Ω	87.9k Ω
3.8							12.1k Ω	37.9k Ω
3.9	4/. $V_{OUT} > 3.8V_{dc}$ requires $V_{IN} > 5.0V_{dc}$!						8.1k Ω	21.2k Ω
4.0							5.2k Ω	12.9k Ω
4.1							3.0k Ω	7.9k Ω
4.2							1.3k Ω	4.6k Ω
4.3								2.2k Ω

R1 = (Blue) R2 = Black

PT6600 Series

Using the Standby Function on the PT6600 5V Bus Converters

For applications requiring output voltage On/Off control, the 14-pin PT6600 ISR series incorporates a standby function. This function may be used in applications that require power-up/shutdown sequencing, and wherever there is a requirement for the output status of the module to be controlled by external circuitry.

The standby function is provided by the *STBY** control, pin 3. If pin 3 is left open-circuit the regulator operates normally, and provides a regulated output when a valid supply voltage is applied to V_{in} (pins 4, 5, & 6) with respect to GND (pins 7-10). If a low voltage² is then applied to pin-3 the regulator output will be disabled and the input current drawn by the ISR will drop to less than 50mA⁴. The standby control may also be used to hold-off the regulator output during the period that input power is applied.

The standby control pin is ideally controlled using an open-collector (or open-drain) discrete transistor (See Figure 1). It may also be driven directly from a dedicated TTL³ compatible gate. Table 1 provides details of the threshold requirements.

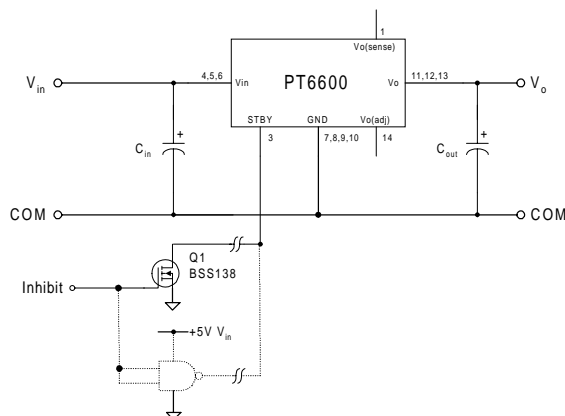
Table 1 Inhibit Control Thresholds ^(2,3)

Parameter	Min	Max
Enable (V_{IH})	1V	5V
Disable (V_{IL})	-0.1V	0.35V

Notes:

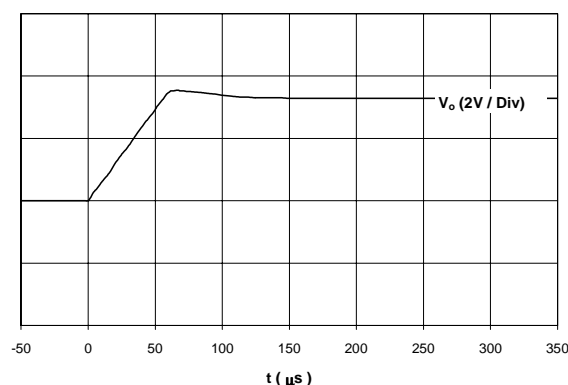
- The Standby/Inhibit control logic is similar for all Power Trends' modules, but the flexibility and threshold tolerances will be different. For specific information on this function for other regulator models, consult the applicable application note.
- The Standby control pin is ideally controlled using an open-collector (or open-drain) discrete transistor and requires no external pull-up resistor. The control input has an open-circuit voltage of about 1Vdc. To disable the regulator output, the control pin must be pulled to less than 0.35Vdc with a low-level 0.5mA sink to ground.
- The Standby input on the PT6600 series may be driven by a differential output device, making it compatible with TTL logic. A standard TTL logic gate will meet the 0.35V $V_{IL(max)}$ requirement (Table 1) at 0.5mA I_{OL} . *Do not* use devices that can drive the Standby control input above 5Vdc.
- When the regulator output is disabled the current drawn from the input source is reduced to approximately 30–40mA (50mA maximum).

Figure 1



Turn-On Time: In the circuit of Figure 1, turning Q_1 on applies a low voltage to the Standby control (pin 3) and disables the regulator output. Correspondingly, turning Q_1 off releases the low-voltage signal and enables the output. The PT6600 ISR series regulators have a fast response and will provide a fully regulated output voltage within 250 μ sec. The actual turn-on time will vary with load and the total amount of output capacitance. The waveform of Figure 2 shows the typical output voltage response of a PT6601 (3.3V) following the turn-off of Q_1 at time $t = 0.0$ secs. The waveform was measured with a 5Vdc input voltage, and 0.6 Ω load.

Figure 2



PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
PT6601B	NRND	SIP MOD ULE	EEK	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6601D	NRND	SIP MOD ULE	EEA	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6601E	NRND	SIP MOD ULE	EEC	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6601ET	NRND	SIP MOD ULE	EEC	14		TBD	Call TI	Call TI
PT6601F	NRND	SIP MOD ULE	EEF	14		TBD	Call TI	Call TI
PT6601G	NRND	SIP MOD ULE	EEG	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6601L	NRND	SIP MOD ULE	EEL	14		TBD	Call TI	Call TI
PT6601M	NRND	SIP MOD ULE	EEM	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6601P	NRND	SIP MOD ULE	EED	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6601Q	NRND	SIP MOD ULE	EEQ	14		TBD	Call TI	Call TI
PT6601R	NRND	SIP MOD ULE	EEE	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6601S	NRND	SIP MOD ULE	EES	14		TBD	Call TI	Call TI
PT6602B	NRND	SIP MOD ULE	EEK	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6602D	NRND	SIP MOD ULE	EEA	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6602E	NRND	SIP MOD ULE	EEC	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6602F	NRND	SIP MOD ULE	EEF	14		TBD	Call TI	Call TI
PT6602G	NRND	SIP MOD ULE	EEG	14		TBD	Call TI	Call TI
PT6602L	NRND	SIP MOD ULE	EEL	14		TBD	Call TI	Call TI
PT6602M	NRND	SIP MOD ULE	EEM	14		TBD	Call TI	Call TI
PT6602P	NRND	SIP MOD ULE	EED	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6602Q	NRND	SIP MOD ULE	EEQ	14		TBD	Call TI	Call TI
PT6602R	NRND	SIP MOD ULE	EEE	14		TBD	Call TI	Call TI
PT6603B	NRND	SIP MOD ULE	EEK	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6603D	NRND	SIP MOD ULE	EEA	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6603E	NRND	SIP MOD ULE	EEC	14	12	TBD	Call TI	Level-1-215C-UNLIM

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
PT6603F	NRND	SIP MOD ULE	EEF	14		TBD	Call TI	Call TI
PT6603G	NRND	SIP MOD ULE	EEG	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6603L	NRND	SIP MOD ULE	EEL	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6603M	NRND	SIP MOD ULE	EEM	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6603P	NRND	SIP MOD ULE	EED	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6603Q	NRND	SIP MOD ULE	EEQ	14		TBD	Call TI	Call TI
PT6603R	NRND	SIP MOD ULE	EEE	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6603S	NRND	SIP MOD ULE	EES	14		TBD	Call TI	Call TI
PT6604B	NRND	SIP MOD ULE	EEK	14		TBD	Call TI	Call TI
PT6604D	NRND	SIP MOD ULE	EEA	14		TBD	Call TI	Call TI
PT6604E	NRND	SIP MOD ULE	EEC	14		TBD	Call TI	Call TI
PT6604F	NRND	SIP MOD ULE	EEF	14		TBD	Call TI	Call TI
PT6604G	NRND	SIP MOD ULE	EEG	14		TBD	Call TI	Call TI
PT6604L	NRND	SIP MOD ULE	EEL	14		TBD	Call TI	Call TI
PT6604M	NRND	SIP MOD ULE	EEM	14		TBD	Call TI	Call TI
PT6604P	NRND	SIP MOD ULE	EED	14		TBD	Call TI	Call TI
PT6604Q	NRND	SIP MOD ULE	EEQ	14		TBD	Call TI	Call TI
PT6604R	NRND	SIP MOD ULE	EEE	14		TBD	Call TI	Call TI
PT6605B	NRND	SIP MOD ULE	EEK	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6605D	NRND	SIP MOD ULE	EEA	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6605E	NRND	SIP MOD ULE	EEC	14		TBD	Call TI	Call TI
PT6605ET	OBSOLETE	SIP MOD ULE	EEC	14		TBD	Call TI	Call TI
PT6605F	NRND	SIP MOD ULE	EEF	14		TBD	Call TI	Call TI
PT6605G	NRND	SIP MOD ULE	EEG	14		TBD	Call TI	Call TI
PT6605L	NRND	SIP MOD ULE	EEL	14		TBD	Call TI	Call TI
PT6605M	NRND	SIP MOD ULE	EEM	14		TBD	Call TI	Call TI

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
PT6605P	NRND	SIP MOD ULE	EED	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6605Q	NRND	SIP MOD ULE	EEQ	14		TBD	Call TI	Call TI
PT6605R	NRND	SIP MOD ULE	EEE	14		TBD	Call TI	Call TI
PT6606B	NRND	SIP MOD ULE	EEK	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6606D	NRND	SIP MOD ULE	EEA	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6606E	NRND	SIP MOD ULE	EEC	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6606F	NRND	SIP MOD ULE	EEF	14		TBD	Call TI	Call TI
PT6606G	NRND	SIP MOD ULE	EEG	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6606L	NRND	SIP MOD ULE	EEL	14		TBD	Call TI	Call TI
PT6606M	NRND	SIP MOD ULE	EEM	14		TBD	Call TI	Call TI
PT6606P	NRND	SIP MOD ULE	EED	14	12	TBD	Call TI	Level-1-215C-UNLIM
PT6606Q	NRND	SIP MOD ULE	EEQ	14		TBD	Call TI	Call TI
PT6606R	NRND	SIP MOD ULE	EEE	14	12	TBD	Call TI	Level-1-215C-UNLIM

⁽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.

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