

## Features

- +12V Bus Input
- 5-bit Programmable:  
1.3V to 3.5V or  
4.5V to 7.6V
- High Efficiency
- Differential Remote Sense
- 27-pin SIP Package
- Parallelable with PT7748  
17A current booster

## Description

The PT7720 series is a +12-V input, 17-A output, high-performance Integrated Switching Regulator (ISR), housed in a 27-pin SIP package. The 17A capability allows easy integration of the latest high-speed, low-voltage microprocessors and bus drivers into +12V power systems.

The output voltage is programmable using a 5-bit code. The output voltage range and code for the PT7721 is compatible with Intel's Pentium® II processor.

The PT7720 series has been designed to work in parallel with one or more of the PT7748 current boosters, allowing the output load current capacity to be increased in increments of 17A.

A differential remote sense is provided to compensate for voltage drop between the ISR to the load. A 1200µF of output capacitance is required for proper operation.

## Ordering Information

<b>PT7721□</b>	= 1.3 to 3.5 Volts
<b>PT7722□</b>	= 4.5 to 7.6 Volts
<b>PT7748□</b>	= 17-A Booster

## PT Series Suffix (PT1234 x)

Case/Pin Configuration	Order Suffix	Package Code *
Vertical	<b>N</b>	(EJE)
Horizontal	<b>A</b>	(EJF)
SMD	<b>C</b>	(EJG)

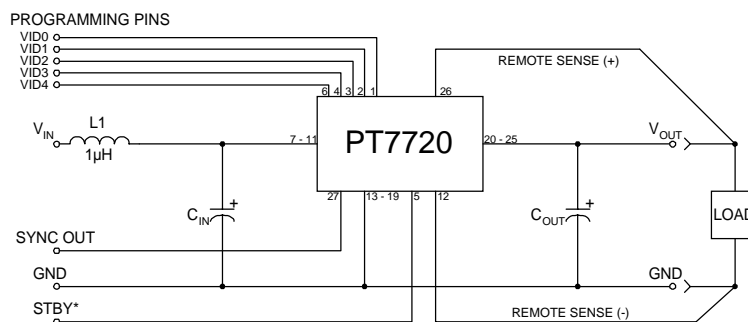
\* Previously known as package styles 1000/1010. (Reference the applicable package code drawing for the dimensions and PC board layout)

## Pin-Out Information

Pin	Function	Pin	Function
1	VID0	15	GND
2	VID1	16	GND
3	VID2	17	GND
4	VID3	18	GND
5	STBY #	19	GND
6	VID4	20	Vout
7	Vin	21	Vout
8	Vin	22	Vout
9	Vin	23	Vout
10	Vin	24	Vout
11	Vin	25	Vout
12	Sense Gnd	26	Sense Vout
13	GND	27	Sync Out
14	GND		

# For further information, see application notes.

## Standard Application



$C_{in}$  = Required 560µF electrolytic  
(See input filter note)  
 $C_{out}$  = Required 1200µF electrolytic  
 $L_1$  = Optional 1µH input choke

# PT7720 Series

17 A, 12-V Input "Big-Hammer II"  
Programmable ISR

## Programming Information

				PT7721		PT7722	
VID3	VID2	VID1	VID0	VID4=1 Vout	VID4=0 Vout	VID4=1 Vout	VID4=0 Vout
1	1	1	1	2.0V	1.30V	4.5V	6.1V
1	1	1	0	2.1V	1.35V	4.6V	6.2V
1	1	0	1	2.2V	1.40V	4.7V	6.3V
1	1	0	0	2.3V	1.45V	4.8V	6.4V
1	0	1	1	2.4V	1.50V	4.9V	6.5V
1	0	1	0	2.5V	1.55V	5.0V	6.6V
1	0	0	1	2.6V	1.60V	5.1V	6.7V
1	0	0	0	2.7V	1.65V	5.2V	6.8V
0	1	1	1	2.8V	1.70V	5.3V	6.9V
0	1	1	0	2.9V	1.75V	5.4V	7.0V
0	1	0	1	3.0V	1.80V	5.5V	7.1V
0	1	0	0	3.1V	1.85V	5.6V	7.2V
0	0	1	1	3.2V	1.90V	5.7V	7.3V
0	0	1	0	3.3V	1.95V	5.8V	7.4V
0	0	0	1	3.4V	2.00V	5.9V	7.5V
0	0	0	0	3.5V	2.05V	6.0V	7.6V

Logic 0 = Pin 12 potential (remote sense gnd)

Logic 1 = Open circuit (no pull-up resistors)

VID3 and VID4 may not be changed while the unit is operating.

## Specifications (Unless otherwise stated, $T_a = 25^\circ\text{C}$ , $V_{in} = 12\text{V}$ , $C_{in} = 560\mu\text{F}$ , $C_{out} = 1200\mu\text{F}$ , and $I_o = I_{o,max}$ )

PT7720 SERIES							
Characteristics	Symbols	Conditions	Min	Typ	Max	Units	
Output Current	$I_o$	$T_a = +60^\circ\text{C}$ , 200 LFM, pkg N, $T_a = +25^\circ\text{C}$ , natural convection, $V_o \leq 5\text{V}$ $V_o \leq 5\text{V}$	0.1 (1) 0.1 (1)	—	17 (2) 17 (2)	A	
Output Power	$P_o$	$T_a = +60^\circ\text{C}$ , 200 LFM, pkg N, $T_a = +25^\circ\text{C}$ , natural convection, $V_o \leq 5\text{V}$ $V_o \geq 5\text{V}$	—	—	85 85	W	
Input Voltage Range	$V_{in}$	$0.1\text{A} \leq I_o \leq 17\text{A}$	11.0	—	14.0	V	
Output Voltage Tolerance	$\Delta V_o$	$0^\circ\text{C} \leq T_a \leq +60^\circ\text{C}$ (PT7721) (PT7722)	$V_o - 0.03$ —	— $\pm 1$	$V_o + 0.03$ $\pm 2$	V % $V_o$	
Line Regulation	$\text{Reg}_{line}$	$11\text{V} \leq V_{in} \leq 14\text{V}$ (with remote sense)	—	$\pm 5$	$\pm 10$	mV	
Load Regulation	$\text{Reg}_{load}$	$0.1 \leq I_o \leq 17\text{A}$ (with remote sense)	—	$\pm 5$	$\pm 10$	mV	
$V_o$ Ripple/Noise	$V_n$	(PT7721) (PT7722)	— —	50 100	—	mVpp	
Transient Response with $C_{out} = 1200\mu\text{F}$	$t_{tr}$ $V_{os}$	$I_o$ step between 7.5A and 15A $V_o$ over/undershoot	— —	100 200	—	$\mu\text{Sec}$ mV	
Efficiency	$\eta$	$I_o = 10\text{A}$ $V_o = 5.0\text{V}$ $V_o = 3.3\text{V}$ $V_o = 2.5\text{V}$ $V_o = 1.5\text{V}$	— — — —	90 88 85 78	—	%	
Switching Frequency	$f_s$	$11\text{V} \leq V_{in} \leq 14\text{V}$ $0.1\text{A} \leq I_o \leq 17\text{A}$	300	350	400	kHz	
Operating Temperature Range	$T_a$	—	0	—	+85 (3)	$^\circ\text{C}$	
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	—	TBD	—	G's	
Mechanical Vibration		Per Mil-STD-883D, Method 2007.2, 20-2000 Hz, Soldered in a PC board	—	TBD	—	G's	
Weight	—	Vertical Horizontal	— —	53 66	—	grams	

**Notes:** (1) The ISR will operate down to no load with reduced specifications. Please note that this product is not short-circuit protected.

(2) The PT7720 series can be easily paralleled with one or more of the PT7748 Current Boosters to provide increased output current in increments of 17A.

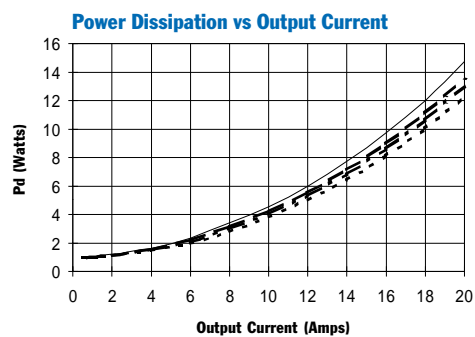
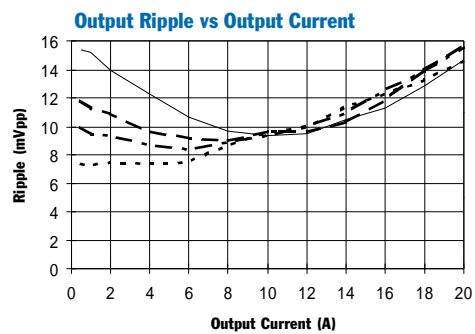
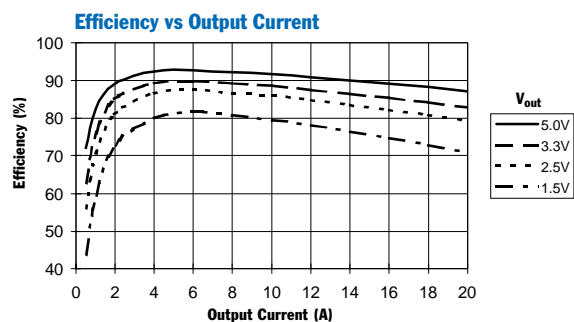
(3) See Safe Operating Area curves or contact the factory for the appropriate derating.

**Output Capacitors:** The PT7720 series requires a minimum output capacitance of 1200 $\mu\text{F}$  for proper operation. Do not use Oscon type capacitors. The maximum allowable output capacitance is  $(57,000 \div V_{out})\mu\text{F}$ , or 15,000 $\mu\text{F}$ , whichever is less.

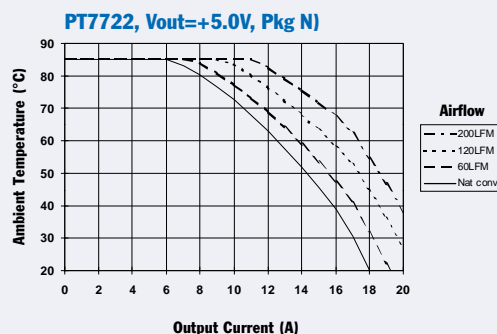
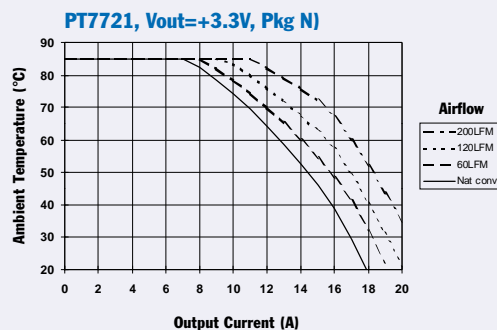
**Input Filter:** An input inductor is optional for most applications. The input inductor must be sized to handle 7ADC with a typical value of 1 $\mu\text{H}$ . The input capacitance must be rated for a minimum of 4 Arms of ripple current when operated at maximum output current and maximum output voltage. Contact an applications specialist for input capacitor selection for applications at other output voltages and output currents.

17 A, 12-V Input "Big-Hammer II"  
Programmable ISR

PT7721/PT7722 @  $V_{in}=12V$  (See Note A)



Safe Operating Area,  $V_{in}=+12V$  (See 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 PT7748 17-A Current Booster with the PT7720 Series Programmable ISRs

The PT7748 is a 17-A “Current Booster” module for the PT7720 series of regulators. The booster is controlled directly by the regulator, and effectively adds a parallel output stage. This allows the system to run synchronously, providing a low noise solution. Up to four booster modules can be connected to a single regulator. Each booster increases the available output current by 17A. Combinations of a regulator and booster modules can supply power for virtually any multi-processor application.

A current booster is not a stand-alone product, and can only operate with a regulator. It is housed in the same package as its compatible regulator, and shares the same mechanical outline. Except for an increase in output current, the overall performance of a PT7720 regulator/booster combination is identical to that of a stand-alone regulator. Refer to the appropriate data sheet for the performance specifications.

**Notes:**

1. Each booster requires the same amount of input and output capacitance as recommended for a stand-alone regulator. See the Standard Application schematic and

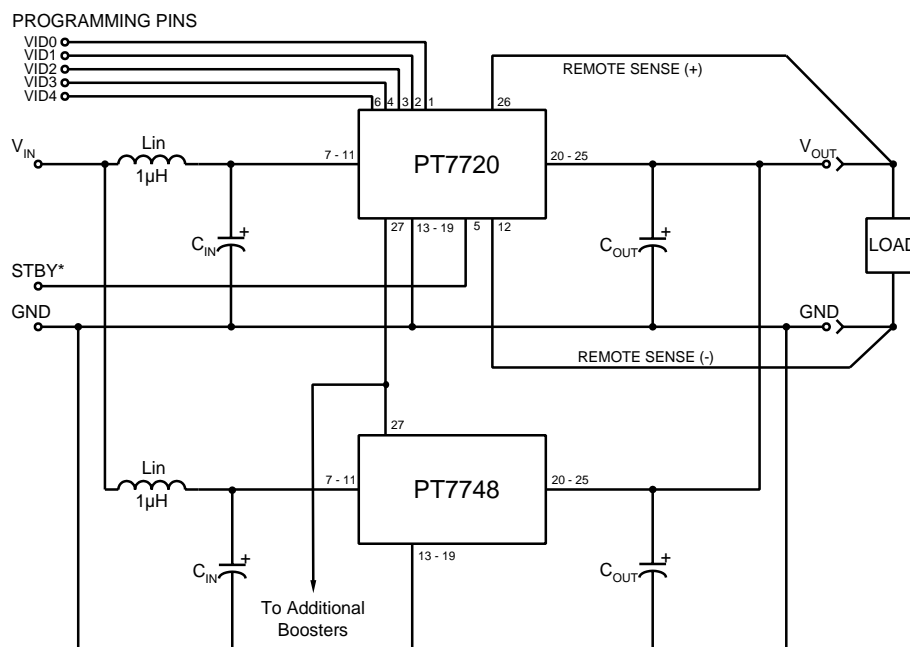
the respective input/output filter notes in the PT7720 product data sheet.

2. The 1- $\mu$ H filter choke located at the input of each regulator and booster module ( $L_{in}$ ) is optional for most applications. If specified, each inductor must be sized to handle 7ADC at full output load.
3. The pin-out of the current booster modules include a number pins identified, “No Connect” (see Table 1). These pins are not connected internally to the module but must be soldered to a pad to preserve the unit’s mechanical integrity.
4. A similar PCB footprint and trace layout between the regulator and each booster will facilitate current sharing between all modules.

**Table 1-1; PT7748 Pin-Out Information**

Pin	Function	Pin	Function	Pin	Function
1	No Connect	10	$V_{in}$	19	GND
2	No Connect	11	$V_{in}$	20	$V_{out}$
3	No Connect	12	No Connect	21	$V_{out}$
4	No Connect	13	GND	22	$V_{out}$
5	No Connect	14	GND	23	$V_{out}$
6	No Connect	15	GND	24	$V_{out}$
7	$V_{in}$	16	GND	25	$V_{out}$
8	$V_{in}$	17	GND	26	No Connect
9	$V_{in}$	18	GND	27	Sync In

**Figure 1-1: Current Booster Application Schematic**



### Pin-Coded Output Voltage Adjustment on the “Big Hammer II” Series ISRs

Power Trends PT7720 series ISRs incorporate pin-coded voltage control to adjust the output voltage. The control pins are identified VID0 - VID4 (pins 1, 2, 3, 4, & 6) respectively. When the control pins are left open-circuit, the ISR will regulate at its factory trimmed output voltage. Each pin is internally connected to a precision resistor, which when grounded changes the output voltage by a set amount. By selectively grounding VID0-VID4, the output voltage of each ISR in the PT7720 series ISRs can be programmed in incremental steps over its specified output voltage range. The output voltage ranges offered by these regulators provide a convenient method of voltage selection for many applications. In addition, the program code and output voltage range of the PT7721 model is compatible with the voltage ID specification defined by Intel Corporation for voltage regulator modules (VRMs) used to power Pentium® II microprocessors. Refer to Figure 2-1 below for the connection schematic, and the PT7720 Data Sheet for the appropriate programming code information.

#### Notes:

1. The programming convention is as follows:-  
 Logic 0: Connect to pin12 (Remote Sense Ground).  
 Logic 1: Open circuit/open drain (See notes 2, & 4)
2. Do not connect pull-up resistors to the voltage programming pins.
3. To minimize output voltage error, always use pin 12 (Sense Ground) as the logic “0” reference. While the regular

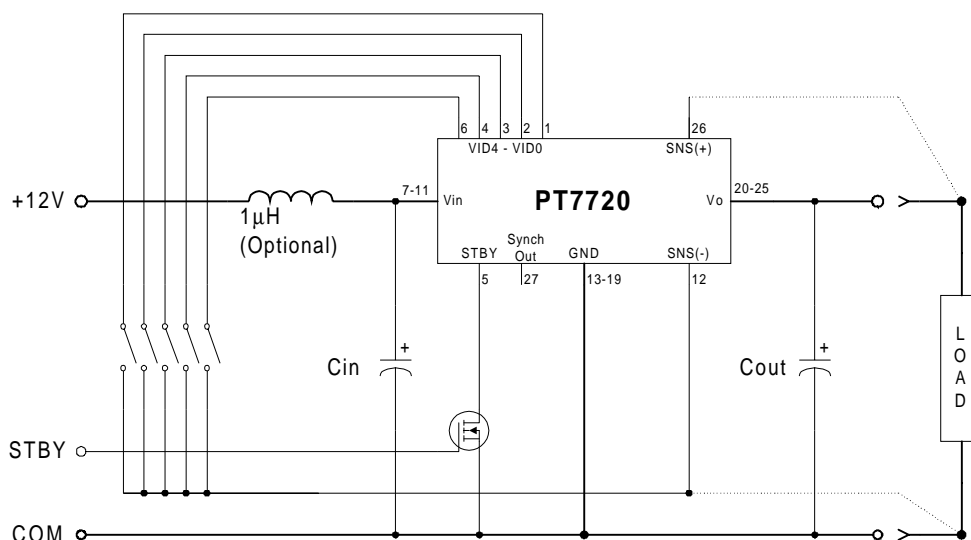
ground (pins 13-19) can also be used for programming, doing so will degrade the load regulation of the product.

4. If active devices are used to ground the voltage control pins, low-level open drain MOSFET devices should be used over bipolar transistors. The inherent  $V_{ce(sat)}$  in bipolar devices introduces errors in the device's internal divider network. Discrete transistors such as the BSS138, 2N7002, or the IRLML2402 are examples of appropriate devices.

#### Active Voltage Programming:

Special precautions should be taken when making changes to the voltage control program code while the unit is powered. It is highly recommended that the ISR be either powered down or held in standby. Changes made to the program code while  $V_{out}$  is enabled induces high current transients through the device. This is the result of the electrolytic output capacitors being either charged or discharged to the new output voltage set-point. The transient current can be minimized by making only incremental changes to the binary code, i.e. one LSB at a time. A minimum of 100 $\mu$ s settling time between each program state is also recommended. Making non-incremental changes to VID3 and VID4 with the output enabled is discouraged. If they are changed, the transients induced can overstress the device resulting in a permanent drop in efficiency. If the use of active devices prevents the program code being asserted prior to power-up, pull pin 5 (STBY) to the device GND during the period that the input voltage is applied to  $V_{in}$ . Releasing pin 5 will then allow the device output to execute a soft-start power-up to the programmed voltage.

Figure 2-1



## Using the Standby Function on the PT7720 “Big Hammer II” Programmable ISRs

For applications requiring output voltage On/Off control, the PT7720 “Big Hammer” ISRs incorporate a standby function. This feature may be used for power-up/shut-down 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 5. If pin 5 is left open-circuit the regulator operates normally, providing a regulated output whenever a valid supply voltage is applied to  $V_{in}$  (pins 7-11) with respect to GND (pins 13-19). Connecting pin 5 to ground<sup>1</sup> will set the regulator output to zero volts<sup>2</sup>. This places the regulator in standby mode, and reduces the input current to typically 30mA (50mA max). If a ground signal is applied to pin 5 prior to power-up, the regulator output will be held at zero volts during the period that input power is applied.

The standby input must be controlled with an open-collector (or open-drain) discrete transistor (See Figure 3-1). Table 3-1 gives the threshold requirements.

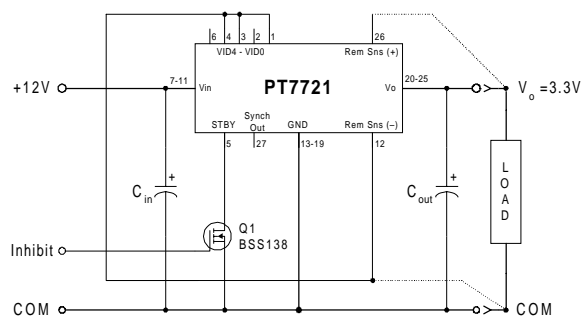
**Table 3-1 Inhibit Control Threshold<sup>1</sup>**

Parameter	Min	Max
Disable ( $V_{IL}$ )	-0.1V	0.3V

### Notes:

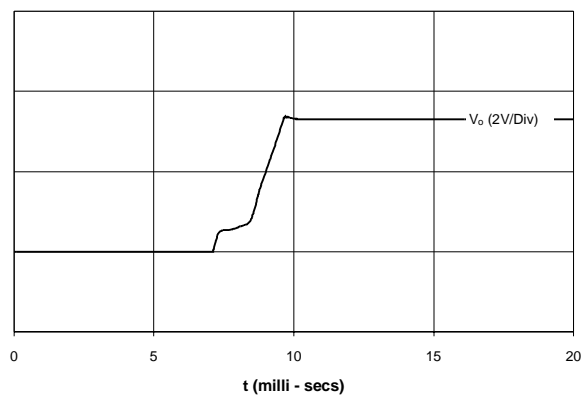
1. The Standby input on the PT7720 regulator series must be controlled using an open-collector (or open-drain) discrete transistor. *Do Not* use a pull-up resistor. The control input has an open-circuit voltage of about 1.5Vdc. To set the regulator output to zero, the control pin must be “pulled” to less than 0.3Vdc with a low-level 0.1mA sink to ground.
2. When placed in the standby mode, the regulator output discharges the output capacitance with a low impedance to ground. If an external voltage is applied to the output, it will sink current and possibly over-stress the part.
3. The turn-off time of  $Q_1$ , or rise time of the standby input is not critical on the PT7720 series. Turning  $Q_1$  off slowly, over periods up to 100ms, will not affect regulator operation. However, a slow turn-off time will increase both the initial delay and rise-time of the output voltage.

**Figure 3-1**



**Turn-On Time:** Turning  $Q_1$  in Figure 3-1 off, removes the low-voltage signal at pin 5 and enables the output. Following a brief delay of 5-15ms, the output voltage of the PT7720 series regulators rise to full regulation within 20ms<sup>3</sup>. Figure 3-2 shows the typical output voltage waveform of a PT7721, following the prompt turn-off of  $Q_1$  at time  $t=0$  secs. The output voltage in Figure 3-1 is set to 3.3V by connecting VID0 (pin 1), VID2 (pin 3), and VID3 (pin 4) to the Sense Gnd (pin 12)\*. The waveform in Figure 3-2 was measured with a 12-V input source voltage, and 15-A resistive load.

**Figure 3-2**



\* Consult the data sheet for details on other VID codes.

## 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>
PT7721A	NRND	SIP MOD ULE	EJF	27	6	TBD	Call TI	Level-1-215C-UNLIM
PT7721C	NRND	SIP MOD ULE	EJG	27	6	TBD	Call TI	Level-1-215C-UNLIM
PT7721N	NRND	SIP MOD ULE	EJE	27	8	TBD	Call TI	Level-1-215C-UNLIM
PT7722A	NRND	SIP MOD ULE	EJF	27	6	TBD	Call TI	Level-1-215C-UNLIM
PT7722C	NRND	SIP MOD ULE	EJG	27	6	TBD	Call TI	Level-1-215C-UNLIM
PT7722N	NRND	SIP MOD ULE	EJE	27	8	TBD	Call TI	Level-1-215C-UNLIM
PT7748N	NRND	SIP MOD ULE	EJE	27	8	TBD	Call TI	Level-1-215C-UNLIM

<sup>(1)</sup> 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.

<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.

**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)

<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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DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Low Power Wireless	<a href="http://www.ti.com/lpw">www.ti.com/lpw</a>	Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
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