



Features

- Single-Device: 5V/3.3V Input
- DSP Compatible
- 89% Efficiency
- Small Footprint
- Space-Saving package
- Adjustable Output Voltage
- Output Inhibit Function
- Short Circuit Protection
- Solderable Copper Case

Description

The PT5520 Excalibur™ power modules are a series of high-performance Integrated Switching Regulators (ISRs). Rated 1.5A, these modules operate from input voltages as low as 3.1V to provide a local step-down power source. They are an ideal complement to the industry's latest high-performance DSPs and microprocessors. The series includes output voltage options as low as 1.0VDC.

The PT5520 series is packaged in a 5-pin thermally efficient copper case. The case is solderable, has a small footprint, and can accommodate both through-hole and surface mount pin configurations.

The product features external output voltage adjustment, an inhibit function, and short circuit protection. A 100µF capacitor is required for proper operation.

Ordering Information

PT5521□	= 3.3 Volts
PT5522□	= 2.5 Volts
PT5523□	= 2.0 Volts
PT5524□	= 1.8 Volts
PT5525□	= 1.5 Volts
PT5526□	= 1.2 Volts
PT5527□	= 1.0 Volts

PT Series Suffix (PT1234x)

Case/Pin Configuration	Order Suffix	Package Code
Vertical	N	(EFK)
Horizontal	A	(EFL)
SMD	C	(EFM)

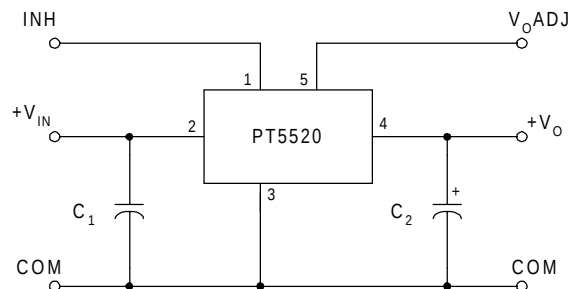
(Reference the applicable package code drawing for the dimensions and PC board layout)

Pin-Out Information

Pin	Function
1	Inhibit *
2	V _{IN}
3	GND
4	V _O
5	V _O Adjust

* For Inhibit pin:
Open = output enabled
Ground = output disabled

Standard Application



C1 = Optional 1µF ceramic
C2 = Required 100µF (See Notes)

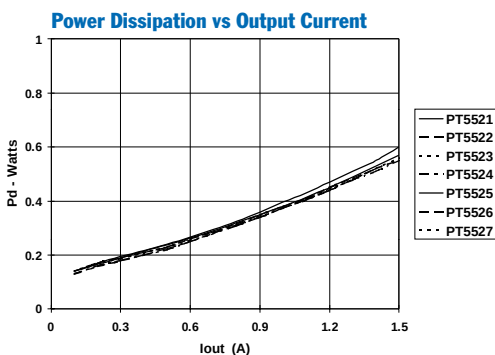
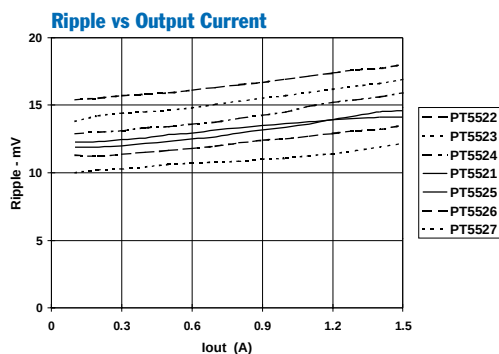
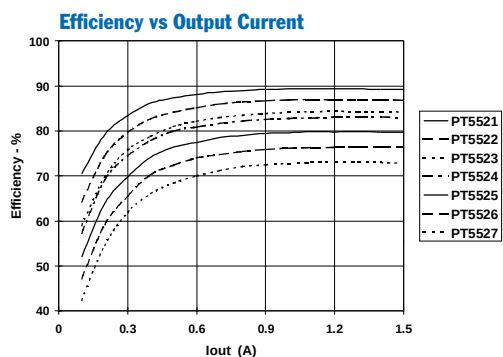
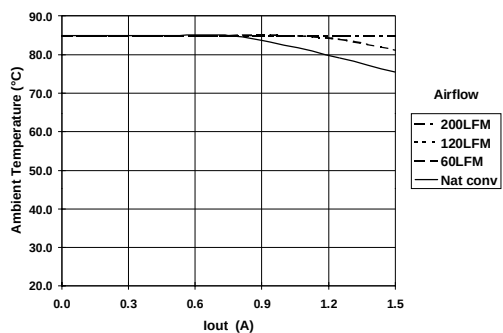
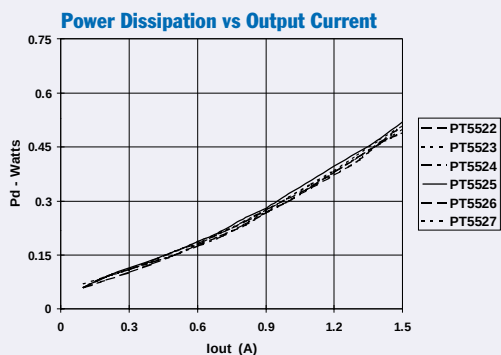
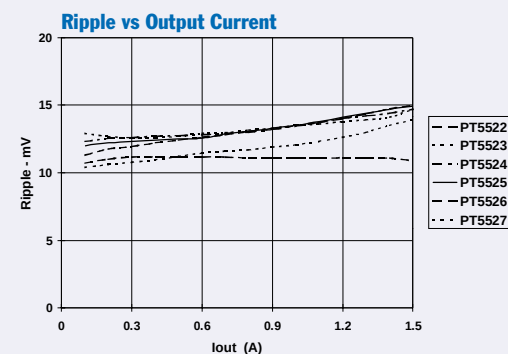
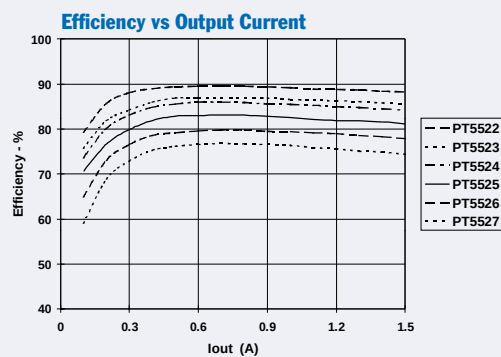
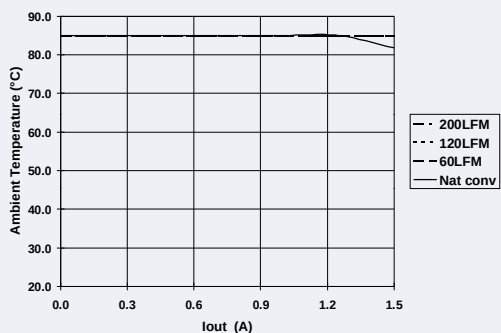
PT5520 Series

1.5-A 5-V/3.3-V Input Adjustable Integrated Switching Regulator

Specifications (Unless otherwise stated, $T_a = 25^\circ\text{C}$, $V_{in} = 5\text{V}$, $C_{out} = 100\mu\text{F}$, and $I_o = I_{o,max}$)

Characteristics	Symbols	Conditions	PT5520 SERIES			Units
			Min	Typ	Max	
Output Current	I_o	Over V_{in} range	0.1 ⁽¹⁾	—	1.5	A
Input Voltage Range	V_{in}	Over I_o range $V_o = 3.3\text{V}$ $V_o \leq 2.5\text{V}$	4.5 3.1	—	5.5 5.5	V
Set-Point Voltage Tolerance	$V_o \text{ tol}$		—	—	± 2	$\%V_o$
Temperature Variation	$\Delta\text{Reg}_{\text{temp}}$	$-40^\circ\text{C} < T_a < +85^\circ\text{C}$	—	± 0.5	—	$\%V_o$
Line Regulation	$\Delta\text{Reg}_{\text{line}}$	Over V_{in} range	—	—	± 6	mV
Load Regulation	$\Delta\text{Reg}_{\text{load}}$	Over I_o range	—	—	± 10	mV
Total Output Variation	$\Delta\text{Reg}_{\text{tot}}$	Includes set-point, line, load, $-40^\circ\text{C} \leq T_a \leq +85^\circ\text{C}$	—	—	± 3	$\%V_o$
Efficiency	η	PT5521 PT5522 PT5523 PT5524 PT5525 PT5526 PT5527	— — — — — — —	89 86 84 83 81 79 76	— — — — — — —	%
V_o Ripple (pk-pk)	V_r	20MHz bandwidth	—	15	30	mV
Transient Response	t_{tr} ΔV_{tr}	1A/ μs load step from 50% to 100% $I_{o,max}$ V_o over/undershoot	— —	50 50	— 100	μSec mV
Current Limit	I_{lim}		—	4	—	A
Switching Frequency	f_o	Over V_{in} and I_o ranges	—	600 ⁽²⁾	—	kHz
Inhibit Control (pin1) Input High Voltage Input Low Voltage Input Low Current	V_{IH} V_{IL} I_{IL}	Referenced to GND (pin3) Pin 1 to GND	$V_{in} - 0.5$ -0.2 —	— — -0.5	Open ⁽³⁾ 0.5 —	V mA
External Capacitance	C_{out}		100 ⁽⁴⁾	—	—	μF
Absolute Maximum Operating Temperature Range	T_a	Over V_{in} range	-40 ⁽⁵⁾	—	+85 ⁽⁶⁾	$^\circ\text{C}$
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	—	500	—	G's
Mechanical Vibration		Per Mil-STD-883D, Method 2007.2, 20-2000 Hz, Soldered in a PC board	—	15 ⁽⁷⁾	—	G's
Weight	—	—	—	6.5	—	grams
Flammability	—	Materials meet UL 94V-0	—	—	—	—

- Notes:** (1) The ISR will operate down to no load with reduced specifications.
(2) This is a typical value only. The switching frequency will vary with input voltage.
(3) The Inhibit control (pin 1) has an internal pull-up, and if left open-circuit the module will operate when input power is applied. A small low-leakage (<100nA) MOSFET is recommended to control this input. Ensure an On/Off transition time of $\leq 10\mu\text{s}$. See application notes for more information.
(4) The PT5520 Series requires a 100 μF electrolytic or tantalum output capacitor for proper operation in all applications.
(5) For operation below 0°C , the output capacitor C_2 must have stable characteristics. Use either a low ESR tantalum or Oscon® capacitor.
(6) See SOA curves or consult factory for the appropriate derating.
(7) The case pins on the through-hole package types (suffixes N & A) must be soldered. For more information see the applicable package outline drawing.

1.5-A 5-V/3.3-V Input Adjustable
Integrated Switching RegulatorPerformance Data; $V_{in} = 5.0V$ (See Note A)Safe Operating Area; $V_{in} = 5.0V$ (See Note B)Performance Data; $V_{in} = 3.3V$ (See Note A)Safe Operating Area; $V_{in} = 3.3V$ (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 ISR.

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

Adjusting the Output Voltage of the PT5500/20 Series of Excalibur™ Step-Down ISRs

The output voltage of both the PT5500 and PT5520 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 R_2 , between pin 5 (V_o adj) and pin 3 (GND).

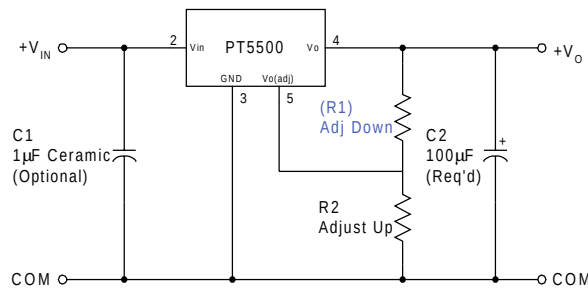
Adjust Down: Add a resistor (R_1), between pin 5 (V_o adj) and pin 4 (V_{out}).

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 from V_o adj to either GND or V_{out} . Any capacitance added to the V_o adjust pin will affect the stability of the ISR.
3. For each model, adjustments to the output voltage may place additional limits on the minimum input voltage. The revised minimum input voltage must comply with the following requirement.

$$V_{in(min)} = (V_a + 0.5)V \text{ or as specified in the data sheet, whichever is greater.}$$

Figure 1



The values of (R_1) [adjust down], and R_2 [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 (R_1) or R_2 as appropriate.

$$(R_1) = \frac{R_o (V_a - 0.9)}{V_o - V_a} - R_s \quad k\Omega$$

$$R_2 = \frac{0.9 R_o}{V_a - V_o} - R_s \quad k\Omega$$

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

Table 1

ISR ADJUSTMENT RANGE AND FORMULA PARAMETERS

3.0 A dc Rated	PT5501	PT5502	PT5503	PT5504	PT5505	PT5506	PT5507
1.5 A dc Rated	PT5521	PT5522	PT5523	PT5524	PT5525	PT5526	PT5527
V_o (nom)	3.3	2.5	2.0	1.8	1.5	1.2	1.0
V_a (min)	2.88	1.97	1.64	1.5	1.3	1.08	0.97
V_a (max)	3.5	2.95	2.45	2.25	1.95	1.65	1.45
R_o (kΩ)	10.0	10.0	10.0	10.0	10.0	10.0	10.2
R_s (kΩ)	49.9	20.0	20.0	20.0	20.0	20.0	20.0

PT5500/5520 Series

Table 2

ISR ADJUSTMENT RESISTOR VALUES

3.0 Adc Rated	PT5501	PT5502	PT5503	PT5504	PT5505	PT5506	PT5507
1.5 Adc Rated	PT5521	PT5522	PT5523	PT5524	PT5525	PT5526	PT5527
V ₀ (nom)	3.3	2.5	2.0	1.8	1.5	1.2	1.0
V _a (req.d)							
0.97							(0.0)kΩ
1.0							
1.05							164.0kΩ
1.1						(0.0)kΩ	72.8kΩ
1.15						(30.0)kΩ	41.2kΩ
1.2							25.9kΩ
1.25						160.0kΩ	16.7kΩ
1.3					(0.0)kΩ	70.0kΩ	10.6kΩ
1.35					(10.0)kΩ	40.0kΩ	6.2kΩ
1.4					(30.0)kΩ	25.0kΩ	3.0kΩ
1.45					(90.0)kΩ	16.0kΩ	0.4kΩ
1.5				(0.0)kΩ		10.0kΩ	
1.55				(6.0)kΩ	160.0kΩ	5.7kΩ	
1.6				(15.0)kΩ	70.0kΩ	2.5kΩ	
1.65			(1.4)kΩ	(30.0)kΩ	40.0kΩ	0.0kΩ	
1.7			(6.7)kΩ	(60.0)kΩ	25.0kΩ		
1.75			(14.0)kΩ	(150.0)kΩ	16.0kΩ		
1.8			(25.0)kΩ		10.0kΩ		
1.85			(43.3)kΩ	160.0kΩ	5.7kΩ		
1.9			(80.0)kΩ	70.0kΩ	2.5kΩ		
1.95			(190.0)kΩ	40.0kΩ	0.0kΩ		
2.0		(2.0)kΩ		25.0kΩ			
2.05		(5.6)kΩ	160.0kΩ	16.0kΩ			
2.1		(10.0)kΩ	70.0kΩ	10.0kΩ			
2.15		(15.7)kΩ	0.0kΩ	5.7kΩ			
2.2		(23.3)kΩ	25.0kΩ	2.5kΩ			
2.25		(34.0)kΩ	16.0kΩ	0.0kΩ			
2.3		(50.0)kΩ	10.0kΩ				
2.35		(76.7)kΩ	5.7kΩ				
2.4		(130.0)kΩ	2.5kΩ				
2.45		(284.0)kΩ	0.0kΩ				
2.5							
2.55		160.0kΩ					
2.6		70.0kΩ					
2.65		40.0kΩ					
2.7		25.0kΩ					
2.75		16.0kΩ					
2.8		10.0kΩ					
2.85		5.7kΩ					
2.9	(0.0)kΩ	2.5kΩ					
2.95	(8.5)kΩ	0.0kΩ					
3.0	(20.1)kΩ						
3.05	(36.1)kΩ						
3.1	(60.1)kΩ						
3.15	(100.0)kΩ						
3.2	(180.0)kΩ						
3.25	(420.0)kΩ						
3.3							
3.35	130.0kΩ						
3.4	40.1kΩ						
3.45	10.1kΩ						
3.48	0.0kΩ						

R1 = (Blue) R2 = Black

Using the Inhibit Control on the PT5500/PT5520 Series of Excalibur™ Step-Down ISRs

For applications requiring output voltage On/Off control, both the PT5500 and PT5520 series of power modules incorporate an inhibit function. This function can be used for power-up sequencing or wherever there is a requirement for the module to be switched off. The On/Off function is provided by the *Inhibit* (pin 1) control.

The ISR functions normally with Pin 1 open-circuit, providing a regulated output whenever a valid source voltage is applied to V_{in} , (pin 2). When a low-level² 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 to $+V_{in}$ potential. An open-collector or open-drain device is required to control this pin.

The Inhibit pin control thresholds are given in Table 1. Equation 1 may be used to determine the approximate current drawn from the input source, and by Q1 when the regulator is in the inhibit state.

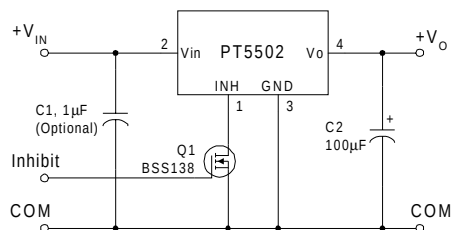
Table 1; Inhibit Control Requirements

Parameter	Min	Max
Enable (VIH)	$V_{in} - 0.5$	Open
Disable (VIL)	-0.2V	+0.5V

Equation 1

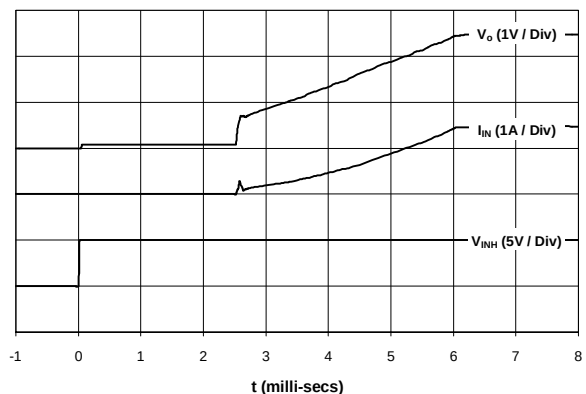
$$I_{inh} = V_{in} / 10k\Omega \pm 20\%$$

Figure 1



Turn-On Time: In the circuit of Figure 1, turning Q1 on applies a low-voltage to the Inhibit control (pin 1) and disables the regulator output. Correspondingly, turning Q1 off allows the *Inhibit* control pin to be pulled high by its internal pull-up resistor. The ISR produces a fully regulated output voltage within 10-msec of the release of the Inhibit control pin. The actual turn-on time will vary with input voltage, output load, and the total amount of load capacitance. Figure 2 shows the typical rise in both output voltage and input current for a PT5502 (2.5V) following the turn-off of Q1 at time $t = 0$. The waveform was measured with a 5Vdc input voltage, and 2.5A resistive load.

Figure 2



Notes:

1. Use an open-collector device (preferably a discrete transistor) for the Inhibit input. A pull-up resistor is not necessary. To disable the output voltage, the control pin should be pulled low to less than +0.5VDC.
2. 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 10μs. This prevents erratic operation of the ISR, which could cause a momentary high output voltage.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
PT5521A	NRND	SIP MOD ULE	EFL	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5521C	NRND	SIP MOD ULE	EFM	5	30	Pb-Free (RoHS)	Call TI	Level-3-215C-168HRS
PT5522A	NRND	SIP MOD ULE	EFL	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5522C	NRND	SIP MOD ULE	EFM	5	30	Pb-Free (RoHS)	Call TI	Level-3-215C-168HRS
PT5523A	NRND	SIP MOD ULE	EFL	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5523C	NRND	SIP MOD ULE	EFM	5	30	Pb-Free (RoHS)	Call TI	Level-3-215C-168HRS
PT5523N	NRND	SIP MOD ULE	EFK	5		TBD	Call TI	Call TI
PT5524A	NRND	SIP MOD ULE	EFL	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5524C	NRND	SIP MOD ULE	EFM	5	30	Pb-Free (RoHS)	Call TI	Level-3-215C-168HRS
PT5525A	NRND	SIP MOD ULE	EFL	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5525C	NRND	SIP MOD ULE	EFM	5	30	Pb-Free (RoHS)	Call TI	Level-3-215C-168HRS
PT5525N	NRND	SIP MOD ULE	EFK	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5526A	NRND	SIP MOD ULE	EFL	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5526C	NRND	SIP MOD ULE	EFM	5	30	Pb-Free (RoHS)	Call TI	Level-3-215C-168HRS
PT5527A	NRND	SIP MOD ULE	EFL	5	30	Pb-Free (RoHS)	Call TI	N / A for Pkg Type
PT5527C	NRND	SIP MOD ULE	EFM	5		TBD	Call TI	Call TI
PT5527N	NRND	SIP MOD ULE	EFK	5		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.

OBSELETE: 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.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2009, Texas Instruments Incorporated