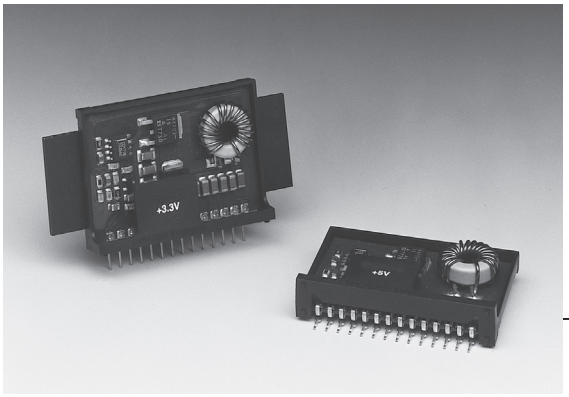
24W 12V Input Positive to Negative Voltage Converter

SLTS037A

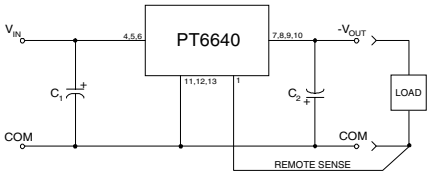
(Revised 6/30/2000)



- Wide Input Voltage Range: +8V to +25V
- Negative Output: –2.5V/4A to –15V/1.5A
- Adjustable Output Voltage
- 85% Efficiency
- Remote Sense Capability

The PT6640 series is a positive input to negative output line of Integrated Switching Regulators (ISRs). Designed for general purpose applications, the PT6640 series delivers a negative output voltage at up to 24W. The PT6640 is packaged in a 14-Pin SIP (Single In-line Package) and is available in a surface-mount configuration.

Standard Application



C_1 = Required 560µF electrolytic
C_2 = Required 330µF electrolytic

Pin-Out Information

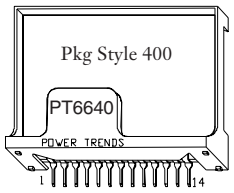
1	Remote Sense
2	Do Not Connect
3	Do Not Connect
4	$+V_{in}$
5	$+V_{in}$
6	$+V_{in}$
7	$-V_{out}$
8	$-V_{out}$
9	$-V_{out}$
10	$-V_{out}$
11	GND
12	GND
13	GND
14	V_{out} Adjust

Ordering Information

PT6641☐ = –3.3 Volts
PT6642☐ = –5.0 Volts
PT6643☐ = –12.0 Volts
PT6644☐ = –9.0 Volts
PT6645☐ = –15.0 Volts
PT6646☐ = –2.5 Volts

PT Series Suffix (PT1234X)

Case/Pin Configuration	*Heat Spreader*
Vertical Through-Hole	**P**
Horizontal Through-Hole	**D**
Horizontal Surface Mount	**E**



Note: Back surface of product is conducting metal

Specifications

Characteristics (T_a = 25°C unless noted)	Symbols	Conditions	PT6640 SERIES Min	Typ	Max	Units
Output Current	I_o	T_a = 60°C, 200 LFM, pkg P	0.1	—	(See Note 2)	A
		T_a = 25°C, natural convection $V_o \leq -$ 5.0V	0.1	—	4.0	
		$V_o = -$ 9.0V	0.1	—	2.5	
		$V_o = -$ 12.0V	0.1	—	2.0	
		$V_o = -$ 15.0V	0.1	—	1.5	
Input Voltage Range	V_{in}	0.1A ≤ I_o ≤ I_o max V_o = –2.5V/3.3V	+8	—	+27	V
		$V_o = -$ 5.0V	+8	—	+25	
		$V_o = -$ 9.0V	+8	—	+21	
		$V_o = -$ 12.0V	+8	—	+18	
		$V_o = -$ 15.0V	+8	—	+15	
Output Voltage Tolerance	ΔV_o	Over V_{in} range, T_a = -40°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 $V_o = -$ 2.5V	–1.8	—	–4.3	V
		$V_o = -$ 3.3V	–2.2	—	–4.7	
		$V_o = -$ 5.0V	–3.0	—	–6.5	
		$V_o = -$ 9.0V	–6.0	—	–10.2	
		V_o = –12.0V	–9.0	—	–13.6	
		V_o = –15.0V	–10.0	—	–17.0	
Line Regulation	Reg_{line}	+9V≤V_{in}≤+V_{in}max, I_o = $I_o$max	—	±0.5	±1.0	%V_o
Load Regulation	Reg_{load}	V_{in} = +12V, 0.1≤ I_o≤$I_o$max	—	±0.5	±1.0	%V_o
V_o Ripple/Noise	V_n	V_{in} = +12V, I_o = $I_o$max	—	3.0	—	%V_o
Transient Response	t_{tr}	I_o step between 0.5x$I_o$max and $I_o$max	—	200	—	µSec
with C_2 = 330µF	V_{os}	V_o over/undershoot	—	100	—	mV
Efficiency	η	V_{in} = +12V, I_o = 0.5x $I_o$max $V_o = -$ 2.5V	—	75	—	%
		$V_o = -$ 3.3V	—	79	—	
		$V_o = -$ 5.0V	—	83	—	
		V_o = –9.0/12.0V	—	85	—	
		V_o = –15.0V	—	84	—	
		V_{in} = +12V, I_o = $I_o$max $V_o = -$ 2.5V	—	74	—	%
		$V_o = -$ 3.3V	—	77	—	
		$V_o = -$ 5.0V	—	80	—	
		V_o = –9.0/12.0/15.0V	—	84	—	

Continued

Specifications *(continued)*

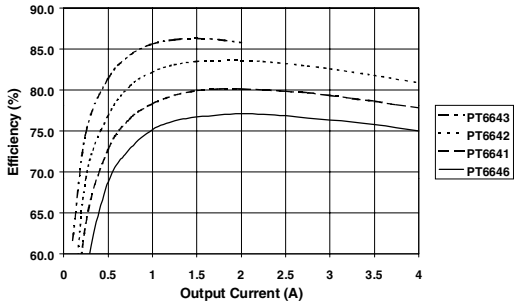
Characteristics (T_a = 25°C unless noted)	Symbols	Conditions	PT6640 SERIES Min	Typ	Max	Units
Switching Frequency	f_o	+9V ≤ V_{in} ≤ V_{in}max Over I_o range	500	550	600	kHz
Absolute Maximum Operating Temperature Range	T_a	Over V_{in} range	-40	—	+85 (2)	°C
Storage Temperature	T_s	—	-40	—	+125	°C
Mechanical 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 PT6640 Series requires a 330µF(output) and 560µF(input) electrolytic capacitors for proper operation in all applications.*
(2) See Safe Operating Area curves or call the factory for guidance on thermal derating.

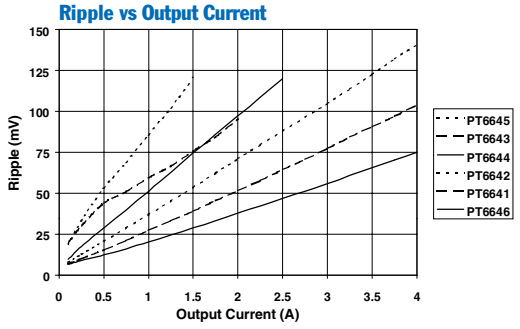
TYPICAL CHARACTERISTICS

Characteristic Curves @12.0V V_{in} (See Note A)

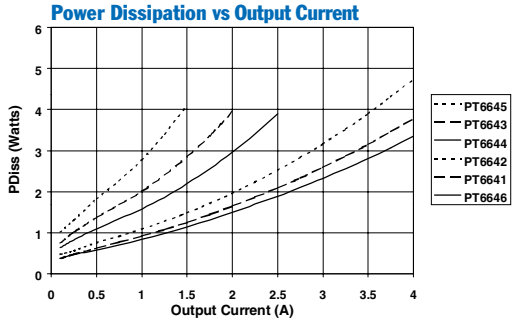
Efficiency vs Output Current



Ripple vs Output Current

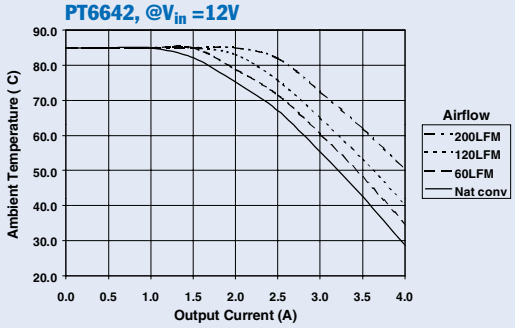


Power Dissipation vs Output Current



Safe Operating Area Curves (See Note B)

PT6642, @V_{in} =12V



Note A: *Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the DC-DC Converter.*
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 PT6640 24W Positive to Negative ISR Series

The negative output voltage of the Power Trends PT6640 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 gives the allowable adjustment range for each model in the series as V_a (min) and V_a (max).

Adjust Up: An increase in the negative output voltage is obtained by adding a resistor R2, between pin 14 (V_o adjust) and pins 7-10 ($-V_{out}$).

Adjust Down: Adding a resistor (R1), between pin 14 (V_o adjust) and pins 11-13 (GND), decreases the output voltage magnitude.

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor, either (R1) or R2 as appropriate.

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, V_{out}, or the Remote Sense pin. Any capacitance added to the V_o adjust pin will affect the stability of the ISR.
3. If the Remote Sense feature is being used, connecting the resistor (R1) between pin 14 (V_o adjust) and pin 1 (Remote Sense) can benefit load regulation.
4. The maximum allowed input voltage (V_{in}) will change as V_{out} is adjusted. The difference between the input voltage (V_{in}) and the output voltage (V_{out}) must not exceed 30V or $10 \times V_{out}$, whichever is less. Use one of the following formulas to determine the maximum allowed input voltage for the PT6640.

$|V_{out}|$ greater than 2.73V,

$$V_{in}(max) = 30 - |V_{out}| \quad Vdc$$

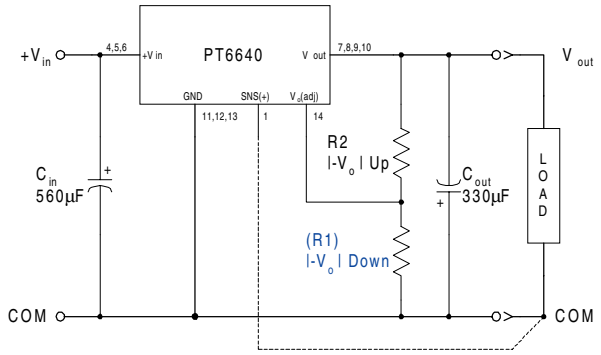
For example, if $V_{out} = -12V$,

$$V_{in}(max) = 30 - |-12| = 18Vdc$$

$|V_{out}|$ less than 2.73V,

$$V_{in}(max) = 10 \times |V_{out}| \quad Vdc$$

Figure 1



The values of (R1) [adjust down], and R2 [adjust up], can also be calculated using the following formulas.

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

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

Where: V_o = Original V_{out} (magnitude)
V_a = Adjusted V_{out} (magnitude)
R_o = The resistance value in Table 1
R_s = The series resistance from Table 1

Table 1

PT6640 ADJUSTMENT AND FORMULA PARAMETERS

Series Pt #	PT6646	PT6641	PT6642	PT6644	PT6643	PT6645
V_o (nom)	–2.5V	–3.3V	–5.0V	–9.0V	–12.0V	–15.0V
V_a (min)	–1.8V	–2.2V	–3.0V	–6.0V	–9.0V	–10.0V
V_a (max)	–4.3V	–4.7V	–6.5V	–10.2V	–13.6V	–17.0V
R_o (kΩ)	4.99	4.22	2.49	2.0	2.0	2.0
R_s (kΩ)	2.49	4.99	4.99	12.7	12.7	12.7

Table 2

PT6640 ADJUSTMENT RESISTOR VALUES

Series Pt #	PT6646	PT6641	PT6642	Series Pt #	PT6644	PT6643	PT6645
Current	4Adc	4Adc	4Adc	Current	2.5Adc	2Adc	1.5Adc
V_o (nom)	–2.5Vdc	–3.3Vdc	–5.0Vdc	V_o (nom)	–9.0Vdc	–12.0Vdc	–15.0Vdc
V_a (req'd)				V_a (req'd)			
–1.8	(1.4)kΩ			–6.0	(6.9)kΩ		
–1.9	(2.9)kΩ			–6.2	(9.2)kΩ		
–2.0	(5.0)kΩ			–6.4	(11.9)kΩ		
–2.1	(8.1)kΩ			–6.6	(14.0)kΩ		
–2.2	(13.3)kΩ	(1.0)kΩ		–6.8	(18.6)kΩ		
–2.3	(23.7)kΩ	(2.3)kΩ		–7.0	(23.0)kΩ		
–2.4	(54.9)kΩ	(3.9)kΩ		–7.2	(28.3)kΩ		
–2.5		(5.8)kΩ		–7.4	(35.0)kΩ		
–2.6	59.9kΩ	(8.4)kΩ		–7.6	(43.5)kΩ		
–2.7	28.7kΩ	(11.7)kΩ		–7.8	(55.0)kΩ		
–2.8	18.3kΩ	(16.5)kΩ		–8.0	(71.0)kΩ		
–2.9	13.1kΩ	(23.6)kΩ		–8.2	(95.0)kΩ		
–3.0	10.0kΩ	(35.4)kΩ	(1.6)kΩ	–8.4	(135.0)kΩ		
–3.1	7.9kΩ	(59.0)kΩ	(2.3)kΩ	–8.6	(215.0)kΩ		
–3.2	6.4kΩ	(130.0)kΩ	(3.1)kΩ	–8.8	(455.0)kΩ		
–3.3	5.3kΩ		(4.0)kΩ	–9.0		(31.7)kΩ	
–3.4	4.4kΩ	81.5kΩ	(5.1)kΩ	–9.2	64.8kΩ	(36.1)kΩ	
–3.5	3.8kΩ	38.3kΩ	(6.2)kΩ	–9.4	26.1kΩ	(41.2)kΩ	
–3.6	3.2kΩ	23.8kΩ	(7.6)kΩ	–9.6	13.1kΩ	(47.1)kΩ	
–3.7	2.7kΩ	16.6kΩ	(9.1)kΩ	–9.8	6.7kΩ	(54.1)kΩ	
–3.8	2.3kΩ	12.3kΩ	(10.9)kΩ	–10.0	2.8kΩ	(62.6)kΩ	(25.8)kΩ
–3.9	2.0kΩ	9.4kΩ	(13.0)kΩ	–10.2	0.2kΩ	(72.8)kΩ	(28.3)kΩ
–4.0	1.7kΩ	7.4kΩ	(15.6)kΩ	–10.4		(85.7)kΩ	(31.1)kΩ
–4.1	1.4kΩ	5.8kΩ	(18.7)kΩ	–10.6		(102.0)kΩ	(34.1)kΩ
–4.2	1.2kΩ	4.6kΩ	(22.6)kΩ	–10.8		(124.0)kΩ	(37.3)kΩ
–4.3	1.0kΩ	3.7kΩ	(27.6)kΩ	–11.0		(155.0)kΩ	(40.9)kΩ
–4.4		2.9kΩ	(34.2)kΩ	–11.2		(201.0)kΩ	(44.9)kΩ
–4.5		2.2kΩ	(43.6)kΩ	–11.4		(278.0)kΩ	(49.3)kΩ
–4.6		1.7kΩ	(57.6)kΩ	–11.6		(432.0)kΩ	(54.3)kΩ
–4.7		1.2kΩ	(80.9)kΩ	–11.8		(895.0)kΩ	(59.8)kΩ
–4.8			(128.0)kΩ	–12.0			(66.1)kΩ
–4.9			(268.0)kΩ	–12.2		94.8kΩ	(73.3)kΩ
–5.0				–12.4		41.1kΩ	(81.6)kΩ
–5.1			88.4kΩ	–12.6		23.1kΩ	(91.3)kΩ
–5.2			41.7kΩ	–12.8		14.2kΩ	(103.0)kΩ
–5.3			26.1kΩ	–13.0		8.8kΩ	(117.0)kΩ
–5.4			18.4kΩ	–13.2		5.2kΩ	(133.0)kΩ
–5.5			13.7kΩ	–13.4		2.7kΩ	(154.0)kΩ
–5.6			10.6kΩ	–13.6		0.7kΩ	(181.0)kΩ
–5.7			8.4kΩ	–13.8			(217.0)kΩ
–5.8			6.7kΩ	–14.0			(268.0)kΩ
–5.9			5.4kΩ	–14.2			(343.0)kΩ
–6.0			4.4kΩ	–14.5			(570.0)kΩ
–6.1			3.5kΩ	–15.0			
–6.2			2.8kΩ	–15.5			42.3kΩ
–6.3			2.2kΩ	–16.0			14.8kΩ
–6.4			1.7kΩ	–16.5			5.6kΩ
–6.5			1.2kΩ	–17.0			1.1kΩ

R1 = (Blue) R2 = Black

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
PT6641P	LIFEBUY	SIP MODULE	EED	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6642D	LIFEBUY	SIP MODULE	EEA	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6642E	LIFEBUY	SIP MODULE	EEC	14	12	Pb-Free (RoHS)	Call TI	Level-1-215C-UNLIM	
PT6642G	LIFEBUY	SIP MODULE	EEG	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6642P	LIFEBUY	SIP MODULE	EED	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6643D	LIFEBUY	SIP MODULE	EEA	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6643E	LIFEBUY	SIP MODULE	EEC	14	12	Pb-Free (RoHS)	Call TI	Level-1-215C-UNLIM	
PT6643M	LIFEBUY	SIP MODULE	EEM	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6643P	LIFEBUY	SIP MODULE	EED	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6644D	LIFEBUY	SIP MODULE	EEA	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6644E	LIFEBUY	SIP MODULE	EEC	14	12	Pb-Free (RoHS)	Call TI	Level-1-215C-UNLIM	
PT6645D	LIFEBUY	SIP MODULE	EEA	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6645E	LIFEBUY	SIP MODULE	EEC	14	12	Pb-Free (RoHS)	Call TI	Level-1-215C-UNLIM	
PT6645F	LIFEBUY	SIP MODULE	EEF	14	12	Pb-Free (RoHS)	Call TI	Level-1-215C-UNLIM	
PT6645G	LIFEBUY	SIP MODULE	EEG	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6645P	LIFEBUY	SIP MODULE	EED	14	12	Pb-Free (RoHS)	Call TI	N / A for Pkg Type	
PT6646E	LIFEBUY	SIP MODULE	EEC	14	12	Pb-Free (RoHS)	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.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265