

## DS96F173M/DS96F175C/DS96F175M EIA-485/EIA-422 Quad Differential Receivers

 Check for Samples: [DS96F173M/DS96F175C/DS96F175M](#)

### FEATURES

- Meets EIA-485, EIA-422A, EIA-423A standards
- Designed for multipoint bus applications
- TRI-STATE outputs
- Common mode input voltage range:  $-7V$  to  $+12V$
- Operates from single  $+5.0V$  supply
- Reduced power consumption ( $I_{CC} = 50$  mA max)
- Input sensitivity of  $\pm 200$  mV over common mode range
- Input hysteresis of 50 mV typical
- High input impedance
- Military temperature range available
- Qualified for MIL STD 883C
- Available to standard military drawings (SMD)
- Available in DIP(J), LCC(E), and FlatPak (W) packages
- DS96F173 and DS96F175 are lead and function compatible with SN75173/175 or the AM26LS32/MC3486

### DESCRIPTION

The DS96F173 and the DS96F175 are high speed quad differential line receivers designed to meet the EIA-485 standard. The DS96F173 and the DS96F175 offer improved performance due to the use of L-FAST bipolar technology. The use of LFAST technology allows the DS96F173 and DS96F175 to operate at higher speeds while minimizing power consumption.

The DS96F173 and the DS96F175 have TRI-STATE outputs and are optimized for balanced multipoint data bus transmission at rates up to 15 Mbps. The receivers feature high input impedance, input hysteresis for increased noise immunity, and input sensitivity of 200 mV over a common mode input voltage range of  $-7V$  to  $+12V$ . The receivers are therefore suitable for multipoint applications in noisy environments. The DS96F173 features an active high and active low Enable, common to all four receivers. The DS96F175 features separate active high Enables for each receiver pair.

### Logic Diagram

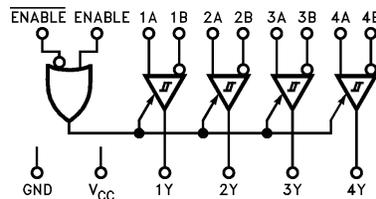


Figure 1. DS96F173

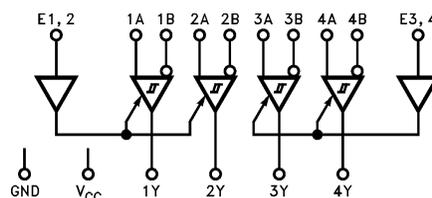


Figure 2. DS96F175



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

## Function Tables

**Table 1. (Each Receiver) DS96F173<sup>(1)</sup>**

Differential Inputs	Enable		Output
	E	$\bar{E}$	
A–B			Y
$V_{ID} \geq 0.2V$	H	X	H
	X	L	H
$V_{ID} \leq -0.2V$	H	X	L
	X	L	L
X	L	X	Z
X	X	H	Z

**Table 2. (Each Receiver) DS96F175<sup>(1)</sup>**

Differential Inputs	Enable	Output
A–B	E	Y
$V_{ID} \geq 0.2V$	H	H
$V_{ID} \leq -0.2V$	H	L
X	L	Z

- (1) H = High Level  
 L = Low Level  
 Z = High Impedance (off)  
 X = Don't Care



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings **COMMERCIAL** <sup>(1)</sup>

Specifications for the 883 version of this product are listed separately.

Storage Temperature Range ( $T_{STG}$ )	–65°C to +175°C
Lead Temperature	
(Soldering, 60 sec.)	300°C
Max. Package Power Dissipation <sup>(2)</sup> at 25°C	
Ceramic DIP (J)	1500 mW
Supply Voltage	7.0V
Input Voltage, A or B Inputs	±25V
Differential Input Voltage	±25V
Enable Input Voltage	7.0V
Low Level Output Current	50 mA

- (1) "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.  
 (2) Derate package 10 mW/°C above 25°C.

## Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage ( $V_{CC}$ )				
DS96F175C	4.75	5.0	5.25	V
Common Mode Input Voltage ( $V_{CM}$ )	-7		+12	V
Differential Input Voltage ( $V_{ID}$ )			12	V
Output Current HIGH ( $I_{OH}$ )			-400	$\mu$ A
Output Current LOW ( $I_{OL}$ )			11	mA
Operating Temperature ( $T_A$ )				
DS96F175C	0	25	70	$^{\circ}$ C

## Electrical Characteristics <sup>(1)</sup> <sup>(2)</sup>

Over recommended supply voltage and operating temperature ranges, unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
$V_{TH}$	Differential-Input High Threshold Voltage	$V_O = V_{OH}$				0.2	V
$V_{TL}$	Differential-Input <sup>(3)</sup> Low Threshold Voltage	$V_O = V_{OL}$		-0.2			V
$V_{TH} - V_{TL}$	Hysteresis <sup>(4)</sup>	$V_{CM} = 0V$			50		mV
$V_{IH}$	Enable Input Voltage HIGH			2.0			V
$V_{IL}$	Enable Input Voltage LOW					0.8	V
$V_{IC}$	Enable Input Clamp Voltage	$I_I = -18$ mA				-1.5	V
$V_{OH}$	Output Voltage HIGH	$V_{ID} = 200$ mV	$0^{\circ}$ C to $+70^{\circ}$ C	2.8			V
		$I_{OH} = -400$ $\mu$ A	$-55^{\circ}$ C to $+125^{\circ}$ C	2.5			V
$V_{OL}$	Output Voltage LOW	$V_{ID} = -200$ mV	$I_{OL} = 8.0$ mA			0.45	V
			$I_{OL} = 11$ mA			0.50	V
$I_{OZ}$	High-Impedance State Output	$V_O = 0.4V$ to $2.4V$				$\pm 20$	$\mu$ A
$I_I$	Line Input Current <sup>(5)</sup>	Other Input = $0V$	$V_I = 12V$			1.0	mA
			$V_I = -7.0V$			-0.8	mA
$I_{IH}$	Enable Input Current HIGH	$V_{IH} = 2.7V$				20	$\mu$ A
$I_{IL}$	Enable Input Current LOW	$V_{IL} = 0.4V$				-100	$\mu$ A
$R_I$	Input Resistance			14	18	22	k $\Omega$
$I_{OS}$	Short Circuit Output Current	<sup>(6)</sup>		-15		-85	mA
$I_{CC}$	Supply Current	No Load	Outputs Enabled			50	mA
$I_{CCX}$			Outputs Disabled			50	mA

- (1) Unless otherwise specified min/max limits apply across the  $0^{\circ}$ C to  $+70^{\circ}$ C range for the DS96F175C. All typicals are given for  $V_{CC} = 5V$  and  $T_A = 25^{\circ}$ C.
- (2) All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are reference to ground unless otherwise specified.
- (3) The algebraic convention, when the less positive (more negative) limit is designated minimum, is used in this data sheet for common mode input voltage and threshold voltage levels only.
- (4) Hysteresis is the difference between the positive-going input threshold voltage,  $V_{TH}$ , and the negative going input threshold voltage,  $V_{TL}$ .
- (5) Refer to EIA-485 Standard for exact conditions.
- (6) Only one output at a time should be shorted.

## COMMERCIAL Switching Characteristics

 $V_{CC} = 5.0V$ ,  $T_A = 25^\circ C$ 

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{PLH}$	Propagation Delay Time, Low to High Level Output	$V_{ID} = -2.5V$ to $+2.5V$ , $C_L = 15$ pF, <a href="#">Figure 9</a>	5.0	15	22	ns
$t_{PHL}$	Propagation Delay Time, High to Low Level Output	$V_{CM} = 0V$	5.0	15	22	ns
$t_{ZH}$	Output Enable Time to High Level	$C_L = 15$ pF, <a href="#">Figure 10</a>		12	16	ns
$t_{ZL}$	Output Enable Time to Low Level	$C_L = 15$ pF, <a href="#">Figure 11</a>		13	18	ns
$t_{HZ}$	Output Disable Time from High Level	$C_L = 5.0$ pF, <a href="#">Figure 10</a>		14	20	ns
$t_{LZ}$	Output Disable Time from Low Level	$C_L = 5.0$ pF, <a href="#">Figure 11</a>		14	18	ns
$ t_{PLH} - t_{PHL} $	Pulse Width Distortion (SKEW)	<a href="#">Figure 9</a>		1.0	3.0	ns

## Absolute Maximum Ratings MIL-STD-883C <sup>(1)</sup>

For complete Military Specifications, refer to the appropriate SMD or MDS.

Storage Temperature Range ( $T_{STG}$ )	-65°C to +175°C
Lead Temperature (Soldering, 60 sec.)	300°C
Max. Package Power Dissipation <sup>(2)</sup> at 25°C	
Ceramic DIP (J)	1500 mW
Ceramic Flatpak (W)	1034 mW
Ceramic LCC (E)	1500 mW
Supply Voltage	7.0V
Input Voltage, A or B Inputs	±25V
Differential Input Voltage	±25V
Enable Input Voltage	7.0V
Low Level Output Current	50 mA

- (1) "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.
- (2) Above  $T_A = 25^\circ C$  derate J package 10 mW/°C, W package 6.90 mW/°C, E package 11.11 mW/°C.

## Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage ( $V_{CC}$ )				
DS96F173M/DS96F175M	4.50	5.0	5.50	V
Common Mode Input Voltage ( $V_{CM}$ )	-7		+12	V
Differential Input Voltage ( $V_{ID}$ )			12	V
Output Current HIGH ( $I_{OH}$ )			-400	µA
Output Current LOW ( $I_{OL}$ )			11	mA
Operating Temperature ( $T_A$ )				
DS96F173M/DS96F175M	-55	25	125	°C

**Electrical Characteristics** <sup>(1)</sup> <sup>(2)</sup>

Over recommended supply voltage and operating temperature ranges, unless otherwise specified

Symbol	Parameter	Conditions		Min	Max	Units
$V_{TH}$	Differential-Input High Threshold Voltage	$V_{CC} = 4.5V, 5.5V$ $V_{CM} = 0V, 12V, -12V$			0.2	V
$V_{TL}$	Differential-Input Low Threshold Voltage <sup>(3)</sup>	$V_{CC} = 4.5V, 5.5V$ $V_{CM} = 0V, 12V, -12V$		-0.2		V
$V_{IH}$	Enable Input Voltage HIGH			2.0		V
$V_{IL}$	Enable Input Voltage LOW				0.8	V
$V_{IC}$	Enable Input Clamp Voltage	$I_I = -18\text{ mA}, V_{CC} = 4.5V$			-1.5	V
$V_{OH}$	Output Voltage HIGH	$V_{ID} = 200\text{ mV}$ $I_{OH} = -400\text{ }\mu\text{A}$	$-55^\circ\text{C to }+125^\circ\text{C}$	2.5		V
$V_{OL}$	Output Voltage LOW	$V_{ID} = -200\text{ mV}$	$I_{OL} = 8.0\text{ mA}$		0.45	V
$I_{OZ}$	High-Impedance State Output	$V_O = 0.4V, 2.4V, V_{CC} = 5.5V$			$\pm 20$	$\mu\text{A}$
$I_I$	Line Input Current <sup>(4)</sup>	Other Input = 0V	$V_I = 12V$ $V_I = -7.0V$		1.0 -0.8	mA
$I_{IH}$	Enable Input Current HIGH	$V_{IH} = 2.7V, V_{CC} = 5.5V$			20	$\mu\text{A}$
$I_{IL}$	Enable Input Current LOW	$V_{IL} = 0.4V, V_{CC} = 5.5V$			-100	$\mu\text{A}$
$R_I$	Input Resistance			10		k $\Omega$
$I_{OS}$	Short Circuit Output Current	<sup>(5)</sup>		-15	-85	mA
$I_{CC}$	Supply Current	No Load	Outputs Enabled or Disabled		50	mA
$I_{CCX}$						

- (1) Unless otherwise specified min/max limits apply across the  $0^\circ\text{C}$  to  $+70^\circ\text{C}$  range for the DS96F175C. All typicals are given for  $V_{CC} = 5V$  and  $T_A = 25^\circ\text{C}$ .
- (2) All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are reference to ground unless otherwise specified.
- (3) The algebraic convention, when the less positive (more negative) limit is designated minimum, is used in this data sheet for common mode input voltage and threshold voltage levels only.
- (4) Refer to EIA-485 Standard for exact conditions.
- (5) Only one output at a time should be shorted.

### MIL-STD-883C Switching Characteristics

V<sub>CC</sub> = 5.0V

Symbol	Parameter	Conditions	T <sub>A</sub> = 25°C		T <sub>A</sub> = -55°C	T <sub>A</sub> = 125°C	Units
			Typ	Max	Max	Max	
t <sub>PLH</sub>	Propagation Delay Time, Low to High Level Output	V <sub>ID</sub> = -2.5V to +2.5V, C <sub>L</sub> = 15 pF, <a href="#">Figure 9</a>	15	22	30	30	ns
t <sub>PHL</sub>	Propagation Delay Time, High to Low Level Output	V <sub>CM</sub> = 0V	15	22	30	30	ns
t <sub>ZH</sub>	Output Enable Time to High Level	C <sub>L</sub> = 15 pF, <a href="#">Figure 10</a>	12	16	27	27	ns
t <sub>ZL</sub>	Output Enable Time to Low Level	C <sub>L</sub> = 15 pF, <a href="#">Figure 11</a>	13	18	27	27	ns
t <sub>HZ</sub>	Output Disable Time from High Level	C <sub>L</sub> = 5.0 pF, <a href="#">Figure 10</a> <sup>(1)</sup>	14	20	27	27	ns
		C <sub>L</sub> = 20 pF, <a href="#">Figure 10</a> <sup>(1)</sup>	14	30	37	37	ns
t <sub>LZ</sub>	Output Disable Time from Low Level	C <sub>L</sub> = 5.0 pF, <a href="#">Figure 11</a>	14	18	30	30	ns
t <sub>PLH</sub> -t <sub>PHL</sub>	Pulse Width Distortion (SKEW)	<a href="#">Figure 9</a>	1	3	5.0	5.0	ns

(1) Testing at 20 pF assures conformance to 5 pF specification.

### Connection Diagrams

#### 16-Lead Ceramic Dual-In-Line Package

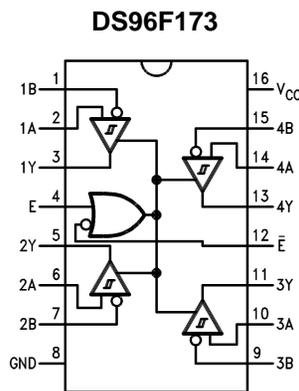


Figure 3. Top View

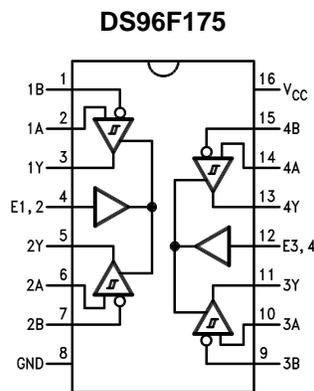
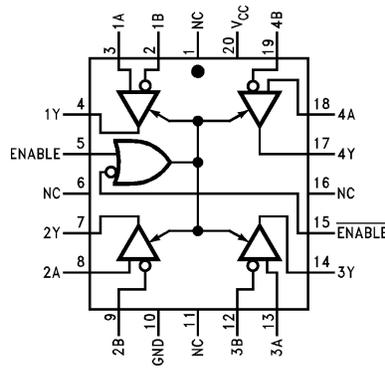


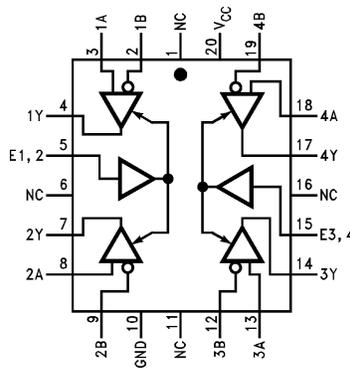
Figure 4. Top View

**20-Lead Ceramic Leadless Chip Carrier**



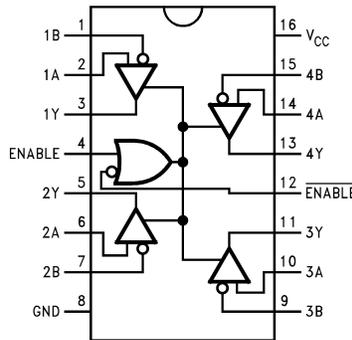
\*NC—No Connection

**Figure 5. Top View**

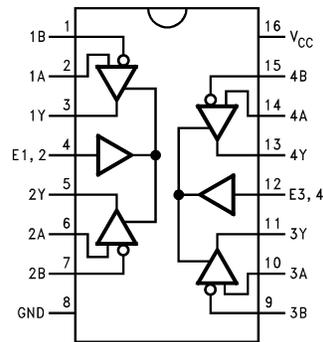


**Figure 6. Top View**

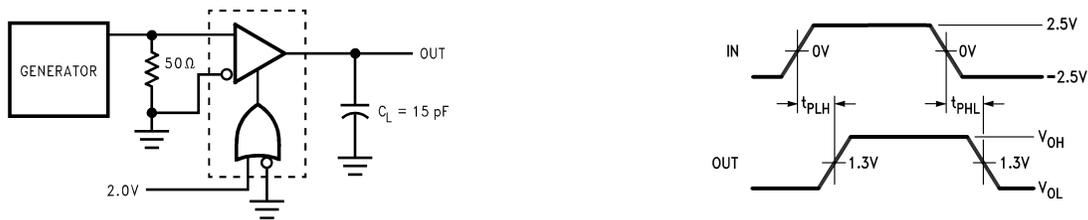
**16-Lead Ceramic Flatpack**



**Figure 7. Top View**

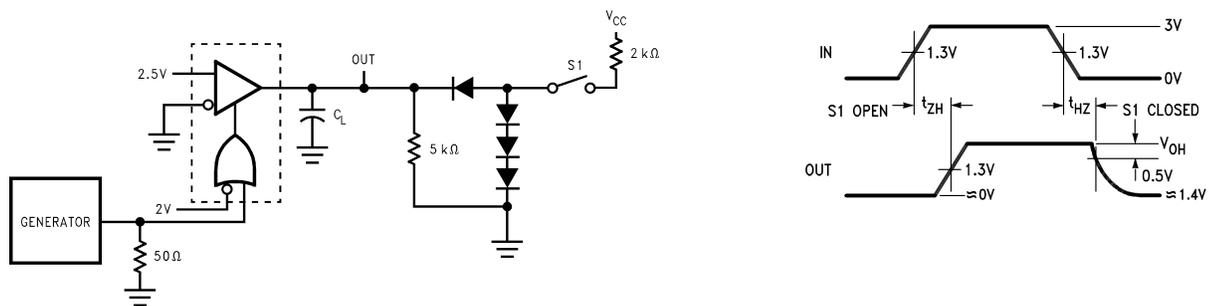


**Figure 8. Top View**

**Parameter Measurement Information**


(10) The input pulse is supplied by a generator having the following characteristics:  $f = 1.0$  MHz, 50% duty cycle,  $t_r \leq 6.0$  ns,  $t_f \leq 6.0$  ns,  $Z_O = 50\Omega$ .

(11)  $C_L$  includes probe and stray capacitance.

**Figure 9.  $t_{PLH}$ ,  $t_{PHL}$  (see Notes)**


(10) The input pulse is supplied by a generator having the following characteristics:  $f = 1.0$  MHz, 50% duty cycle,  $t_r \leq 6.0$  ns,  $t_f \leq 6.0$  ns,  $Z_O = 50\Omega$ .

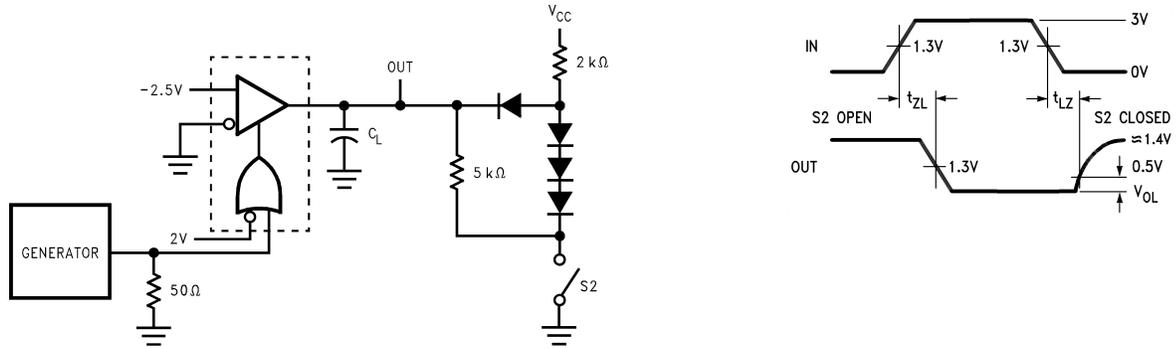
(11)  $C_L$  includes probe and stray capacitance.

(12) DS96F173 with active high and active low Enables are shown. DS96F175 has active high Enable only.

(13) All diodes are 1N916 or equivalent.

(14) To test the active low Enable  $\bar{E}$  of DS96F173, ground E and apply an inverted input waveform to  $\bar{E}$ . DS96F175 has active high enable only.

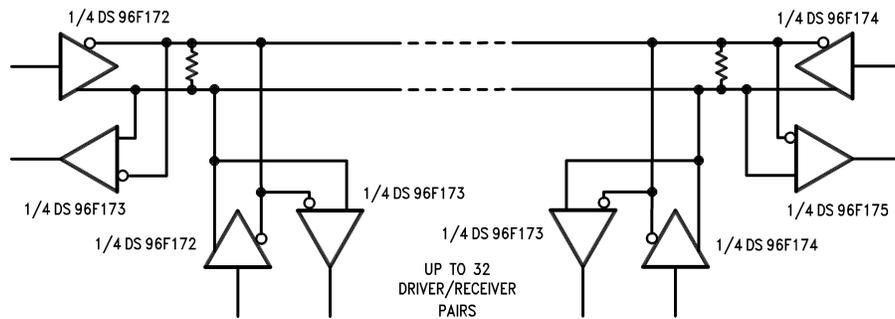
**Figure 10.  $t_{HZ}$ ,  $t_{ZH}$  (see Notes)**



- (10) The input pulse is supplied by a generator having the following characteristics:  $f = 1.0 \text{ MHz}$ , 50% duty cycle,  $t_r \leq 6.0 \text{ ns}$ ,  $t_f \leq 6.0 \text{ ns}$ ,  $Z_0 = 50\Omega$ .
- (11)  $C_L$  includes probe and stray capacitance.
- (12) DS96F173 with active high and active low Enables are shown. DS96F175 has active high Enable only.
- (13) All diodes are 1N916 or equivalent.
- (14) To test the active low Enable  $\bar{E}$  of DS96F173, ground E and apply an inverted input waveform to  $\bar{E}$ . DS96F175 has active high enable only.

Figure 11.  $t_{ZL}$ ,  $t_{LZ}$  (see Notes)

Typical Application



NOTE

The line length should be terminated at both ends in its characteristic impedance. Stub lengths off the main line should be kept as short as possible.

## 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 which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)