

## DS89C21 Differential CMOS Line Driver and Receiver Pair

Check for Samples: [DS89C21](#)

### FEATURES

- Meets TIA/EIA-422-A (RS-422) and CCITT V.11 Recommendation
- **LOW POWER** Design—15 mW Typical
- **Guaranteed AC Parameters:**
  - Maximum Driver Skew 2.0 ns
  - Maximum Receiver Skew 4.0 ns
- **Extended Temperature Range:** –40°C to +85°C
- Available in SOIC Packaging
- Operates over 20 Mbps
- Receiver OPEN Input Failsafe Feature

### DESCRIPTION

The DS89C21 is a differential CMOS line driver and receiver pair, designed to meet the requirements of TIA/EIA-422-A (RS-422) electrical characteristics interface standard. The DS89C21 provides one driver and one receiver in a minimum footprint. The device is offered in an 8-pin SOIC package.

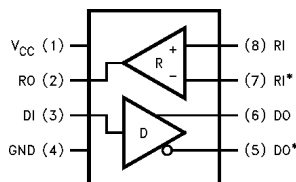
The CMOS design minimizes the supply current to 6 mA, making the device ideal for use in battery powered or power conscious applications.

The driver features a fast transition time specified at 2.2 ns, and a maximum differential skew of 2 ns making the driver ideal for use in high speed applications operating above 10 MHz.

The receiver can detect signals as low as 200 mV, and also incorporates hysteresis for noise rejection. Skew is specified at 4 ns maximum.

The DS89C21 is compatible with TTL and CMOS levels (DI and RO).

### Connection Diagram



See Package Number D (R-PDSO-G8)

### Truth Table Driver

Input	Outputs	
DI	DO	DO*
H	H	L
L	L	H

### Truth Table Receiver

Inputs	Output
RI–RI*	RO
$V_{DIFF} \geq +200$ mV	H
$V_{DIFF} \leq -200$ mV	L
OPEN <sup>(1)</sup>	H

(1) Non-terminated



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.



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 <sup>(1)(2)(3)</sup>

Supply Voltage ( $V_{CC}$ )	7V
Driver Input Voltage (DI)	-1.5V to $V_{CC} + 1.5V$
Driver Output Voltage (DO, $\overline{DO}$ )	-0.5V to +7V
Receiver Input Voltage— $V_{CM}$ (RI, $\overline{RI}$ )	$\pm 14V$
Differential Receiver Input Voltage— $V_{DIFF}$ (RI, $\overline{RI}$ )	$\pm 14V$
Receiver Output Voltage (RO)	-0.5V to $V_{CC} + 0.5V$
Receiver Output Current (RO)	$\pm 25$ mA
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150°C
Lead Temperature ( $T_L$ ) (Soldering 4 sec.)	+260°C
Maximum Junction Temperature	150°C
Maximum Package Power Dissipation @+25°C	
D Package	714 mW
Derate D Package	5.7 mW/°C above +25°C

- (1) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. They are not meant to imply that the devices should be operated at these limits. The tables of [Electrical Characteristics](#) specify conditions for device operation.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (3) ESD Rating: HBM (1.5 k $\Omega$ , 100 pF) all pins  $\geq 2000V$ . EIAJ (0 $\Omega$ , 200 pF)  $\geq 250V$

### Recommended Operating Conditions

	Min	Max	Units
Supply Voltage ( $V_{CC}$ )	4.50	5.50	V
Operating Temperature ( $T_A$ )	-40	+85	°C
Input Rise or Fall Time (DI)		500	ns

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

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

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units	
<b>DRIVER CHARACTERISTICS</b>								
$V_{IH}$	Input Voltage HIGH		DI	2.0		$V_{CC}$	V	
$V_{IL}$	Input Voltage LOW			GND		0.8	V	
$I_{IH}, I_{IL}$	Input Current	$V_{IN} = V_{CC}, GND, 2.0V, 0.8V$			0.05	$\pm 10$	$\mu A$	
$V_{CL}$	Input Clamp Voltage	$I_{IN} = -18\text{ mA}$				-1.5	V	
$V_{OD1}$	Unloaded Output Voltage	No Load	DO, DO*		4.2	6.0	V	
$V_{OD2}$	Differential Output Voltage	$R_L = 100\Omega$		2.0	3.0		V	
$\Delta V_{OD2}$	Change in Magnitude of $V_{OD2}$ for Complementary Output States				5.0	400	mV	
$V_{OD3}$	Differential Output Voltage	$R_L = 150\Omega$		2.1	3.1		V	
$V_{OD4}$	Differential Output Voltage	$R_L = 3.9\text{ k}\Omega$			4.0	6.0	V	
$V_{OC}$	Common Mode Voltage	$R_L = 100\Omega$			2.0	3.0	V	
$\Delta V_{OC}$	Change in Magnitude of $V_{OC}$ for Complementary Output States				2.0	400	mV	
$I_{OSD}$	Output Short Circuit Current	$V_{OUT} = 0V$			-30	-115	-150	mA
$I_{OFF}$	Output Leakage Current	$V_{CC} = 0V$				0.03	+100	$\mu A$
						-0.08	-100	$\mu A$
<b>RECEIVER CHARACTERISTICS</b>								
$V_{TL}, V_{TH}$	Differential Thresholds	$V_{IN} = +7V, 0V, -7V$	RI, RI*	-200	$\pm 25$	+200	mV	
$V_{HYS}$	Hysteresis	$V_{CM} = 0V$		20	50		mV	
$R_{IN}$	Input Impedance	$V_{IN} = -7V, +7V, \text{Other} = 0V$		5.0	9.5		k $\Omega$	
$I_{IN}$	Input Current	Other Input = 0V, $V_{CC} = 5.5V$ and $V_{CC} = 0V$		$V_{IN} = +10V$		+1.0	+1.5	mA
				$V_{IN} = +3.0V$	0	+0.22		mA
				$V_{IN} = +0.5V$		-0.04		mA
				$V_{IN} = -3V$	0	-0.41		mA
				$V_{IN} = -10V$		-1.25	-2.5	mA
$V_{OH}$	Output HIGH Voltage	$I_{OH} = -6\text{ mA}$		$V_{DIFF} = +1V$	3.8	4.9	V	
				$V_{DIFF} = \text{OPEN}$	3.8	4.9	V	
$V_{OL}$	Output LOW Voltage	$I_{OL} = +6\text{ mA}, V_{DIFF} = -1V$			0.08	0.3	V	
$I_{OSR}$	Output Short Circuit Current	$V_{OUT} = 0V$		-25	-85	-150	mA	
<b>DRIVER AND RECEIVER CHARACTERISTICS</b>								
$I_{CC}$	Supply Current	No Load		$V_{CC}$		3.0	6	mA
						3.8	12	mA

- (1) Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground unless otherwise specified.
- (2) All typicals are given for  $V_{CC} = 5.0V$  and  $T_A = 25^\circ C$ .

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

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
<b>DIFFERENTIAL DRIVER CHARACTERISTICS</b>							
$t_{PLHD}$	Propagation Delay LOW to HIGH	$R_L = 100\Omega$	2	4.9	10	ns	
$t_{PHLD}$	Propagation Delay HIGH to LOW	$C_L = 50\text{ pF}$					
$t_{SKD}$	Skew, $ t_{PLHD} - t_{PHLD} $						
$t_{TLH}$	Transition Time LOW to HIGH		(Figure 2 Figure 4)		2.2	9	ns
$t_{THL}$	Transition Time HIGH to LOW			2.1	9	ns	
<b>RECEIVER CHARACTERISTICS</b>							
$t_{PLH}$	Propagation Delay LOW to HIGH	$C_L = 50\text{ pF}$	6	18	30	ns	
$t_{PHL}$	Propagation Delay HIGH to LOW	$V_{DIFF} = 2.5\text{V}$					
$t_{SK}$	Skew, $ t_{PLH} - t_{PHL} $	$V_{CM} = 0\text{V}$					
$t_r$	Rise Time		(Figure 7)		2.5	9	ns
$t_f$	Fall Time			2.1	9	ns	

- (1) All typicals are given for  $V_{CC} = 5.0\text{V}$  and  $T_A = 25^\circ\text{C}$ .
- (2)  $f = 1\text{ MHz}$ ,  $t_r$  and  $t_f \leq 6\text{ ns}$ .

#### Parameter Measurement Information

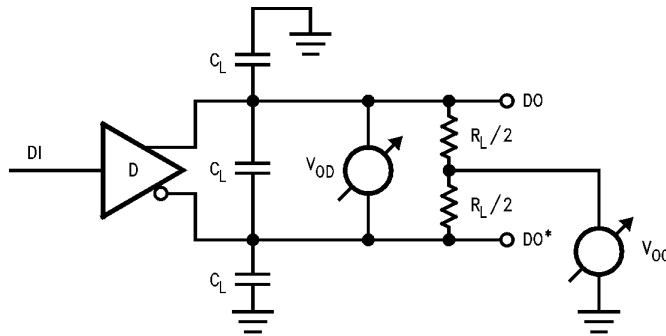
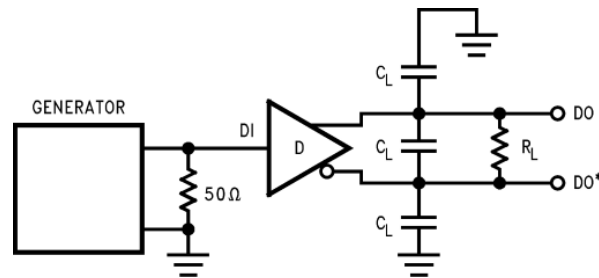


Figure 1.  $V_{OD}$  and  $V_{OC}$  Test Circuit



$f = 1\text{ MHz}$ ,  $t_r$  and  $t_f \leq 6\text{ ns}$ .

Figure 2. Driver Propagation Delay Test Circuit

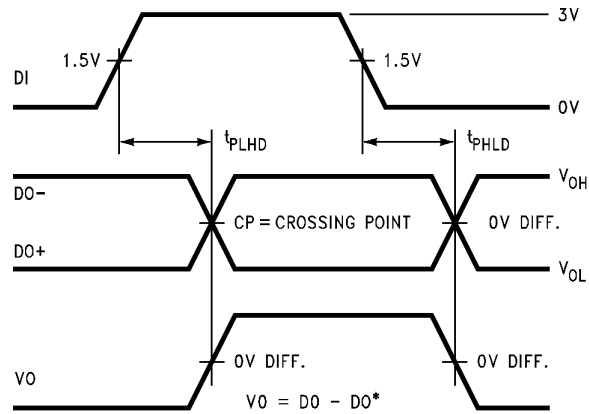


Figure 3. Driver Differential Propagation Delay Timing

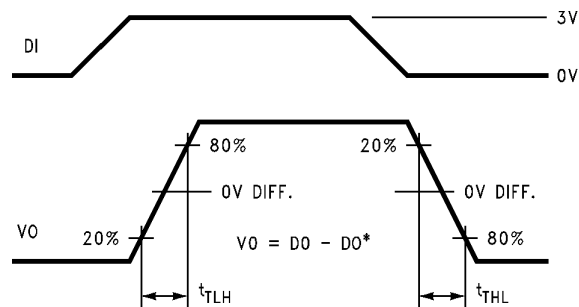
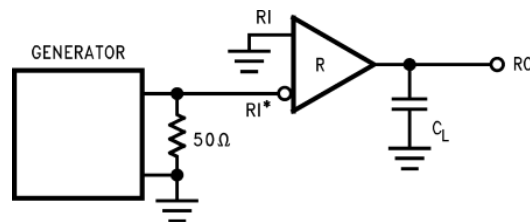


Figure 4. Driver Differential Transition Timing



f = 1 MHz, tr and tf ≤ 6 ns.

Figure 5. Receiver Propagation Delay Test Circuit

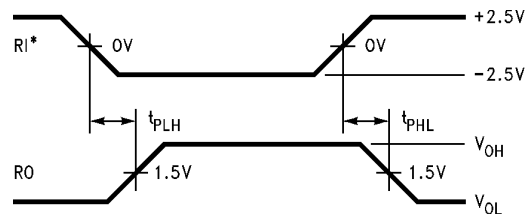
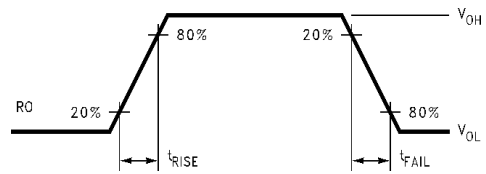


Figure 6. Receiver Propagation Delay Timing

**Figure 7. Receiver Rise and Fall Times**

---

**REVISION HISTORY**

<b>Changes from Revision B (April 2013) to Revision C</b>	<b>Page</b>
<hr/> <ul style="list-style-type: none"><li>• Changed layout of National Data Sheet to TI format .....</li></ul>	<hr/> <b>6</b>

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DS89C21TM	LIFEBUY	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	DS89C21TM	
DS89C21TM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS89C21TM	Samples
DS89C21TMX	LIFEBUY	SOIC	D	8	2500	TBD	Call TI	Call TI	-40 to 85	DS89C21TM	
DS89C21TMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS89C21TM	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**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.

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS89C21TMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

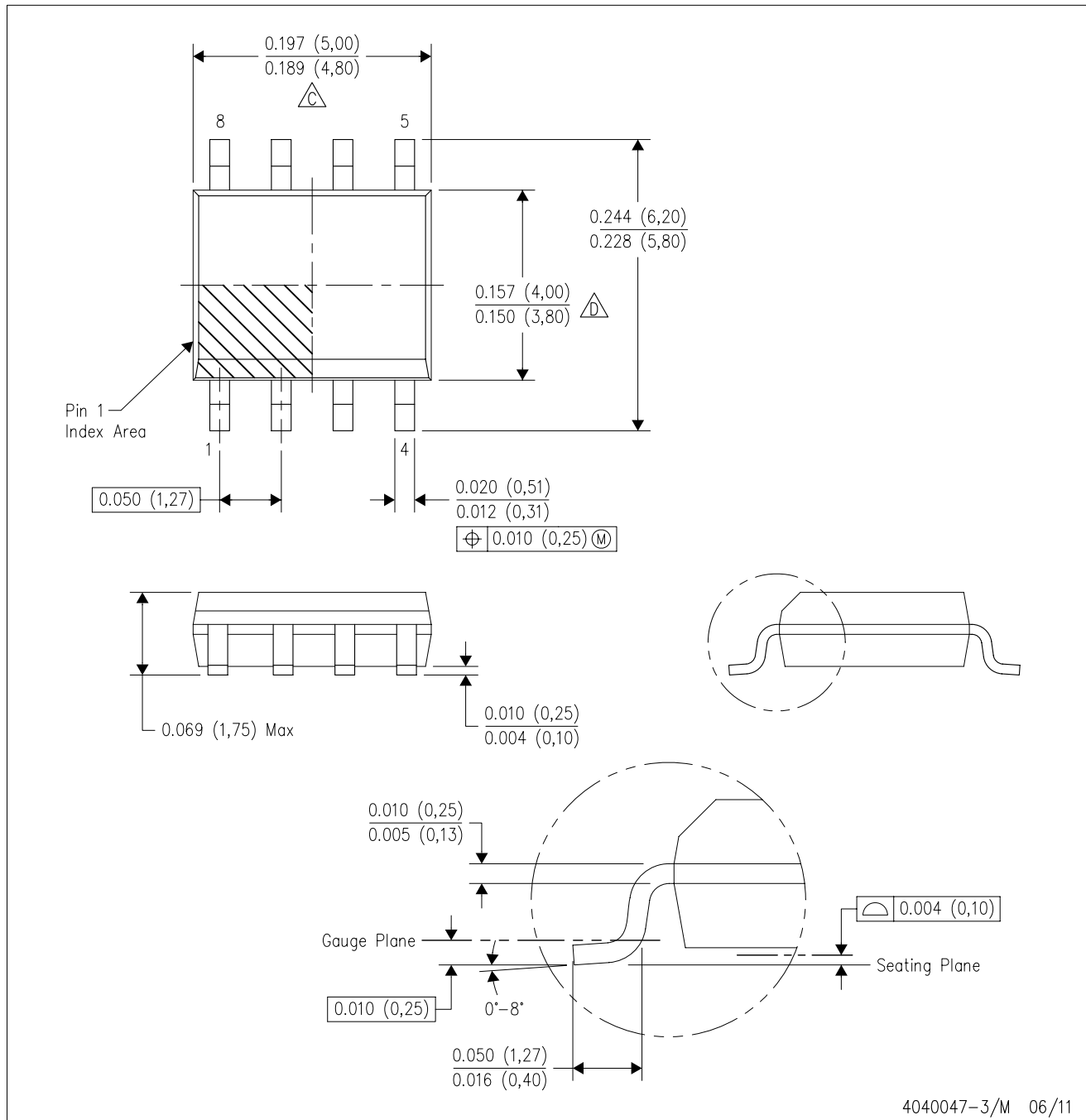


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS89C21TMX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.  
 D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.  
 E. Reference JEDEC MS-012 variation AA.

## IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves 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.

TI's published terms of sale for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI 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 reproduced 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.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources 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.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.