

5-V ECL Differential Receiver

FEATURES

- Differential PECL/NECL Receiver
- Operating Range
 - PECL: $V_{CC} = 4.2\text{ V to } 5.7\text{ V}$ With $V_{EE} = 0\text{ V}$
 - NECL: $V_{CC} = 0\text{ V}$ With $V_{EE} = -4.2\text{ V to } -5.7\text{ V}$
- 250-ps Propagation Delay
- Support for Clock Frequencies >2 GHz
- Deterministic Output Value for Open Input Conditions
- Built-In Temperature Compensation
- Drop-In Compatible With MC10EL16, MC100EL16
- Built-In Input Pulldown Resistors

APPLICATIONS

- Data and Clock Transmission Over Backplane

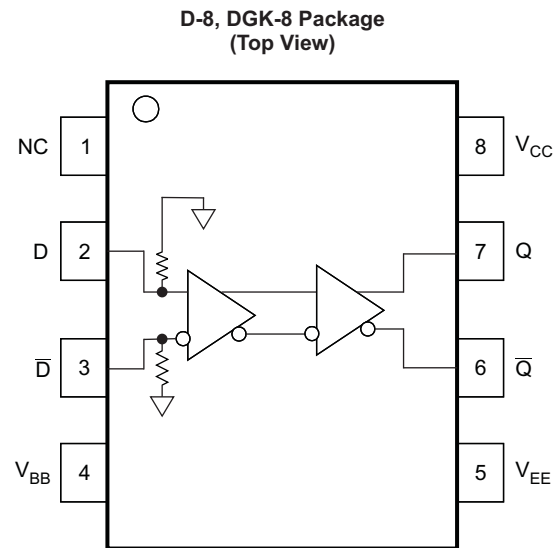
DESCRIPTION

The SN65EL16 is a differential PECL/ECL receiver with PECL/ECL output. The device includes circuitry to hold Q to a low logic level when the inputs are in an open condition.

The V_{BB} pin is a reference voltage output for the device. When the device is used in the single-ended mode, the unused input should be tied to V_{BB} . This reference voltage can also be used to bias the input when it is ac coupled. When the V_{BB} pin is used, place a 0.01- μF decoupling capacitor between V_{CC} and V_{BB} . Also, limit the sink/source current to <0.5 mA to V_{BB} . Leave V_{BB} open when it is not used.

The SN65EL11 is housed in an industry-standard SOIC-8 package and is also available in a TSSOP-8 package.

PINOUT ASSIGNMENT



P0065-03

Table 1. Pin Description

PIN	FUNCTION
D, \bar{D}	PECL/ECL data inputs
Q, \bar{Q}	PECL/ECL outputs
V_{CC}	Positive supply
V_{EE}	Negative supply
V_{BB}	Reference voltage output

ORDERING INFORMATION⁽¹⁾

PART NUMBER	PART MARKING	PACKAGE	LEAD FINISH
SN65EL16D	SN65EL16	SOIC	NiPdAu
SN65EL16DGK	SN65EL16	SOIC-TSSOP	NiPdAu

(1) Leaded device options not initially available; contact a sales representative for further details.



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.



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⁽¹⁾

PARAMETER	CONDITIONS	VALUE	UNIT
Absolute PECL-mode supply voltage, V_{CC}	$V_{EE} = 0\text{ V}$	6	V
Absolute NECL-mode supply voltage, V_{EE}	$V_{CC} = 0\text{ V}$	–6	V
Sink/source current, V_{BB}		± 0.5	mA
PECL-mode input voltage	$V_{EE} = 0\text{ V}; V_I \leq V_{CC}$	6	V
NECL-mode input voltage	$V_{CC} = 0\text{ V}; V_I \geq V_{EE}$	–6	V
Output current	Continuous	50	mA
	Surge	100	mA
Operating temperature range		–40 to 85	°C
Storage temperature range		–65 to 150	°C

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

POWER DISSIPATION RATINGS

PACKAGE	CIRCUIT-BOARD MODEL	POWER RATING $T_A < 25^\circ\text{C}$ (mW)	THERMAL RESISTANCE, JUNCTION-TO-AMBIENT, NO AIRFLOW	DERATING FACTOR $T_A > 25^\circ\text{C}$ (mW/°C)	POWER RATING $T_A = 85^\circ\text{C}$ (mW)
SOIC	Low-K	719	139	7	288
	High-K	840	119	8	336
SOIC-TSSOP	Low-K	469	213	5	188
	High-K	527	189	5	211

THERMAL CHARACTERISTICS

PARAMETER		PACKAGE	VALUE	UNIT
θ_{JB}	Junction-to-board thermal resistance	SOIC	79	°C/W
		SOIC-TSSOP	120	
θ_{JC}	Junction-to-case thermal resistance	SOIC	98	°C/W
		SOIC-TSSOP	74	

KEY ATTRIBUTES

CHARACTERISTICS	VALUE
Internal input pulldown resistor	75 k Ω
Moisture sensitivity level	Level 1
Flammability rating (oxygen index: 28 to 34)	UL 94 V-0 at 0.125 in
ESD—human-body model	4 kV
ESD—machine model	200 V
ESD—charged-device model	2 kV
Meets or exceeds JEDEC Spec EIA/JESD78 latchup test	

PECL DC CHARACTERISTICS⁽¹⁾ ($V_{CC} = 5\text{ V}$; $V_{EE} = 0\text{ V}$)⁽²⁾

PARAMETER	–40°C			25°C			85°C			UNIT
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
I_{EE} Power-supply current		15	20		15	20		19	23	mA
V_{OH} Output HIGH voltage ⁽³⁾	3915		4120	3915	4011	4120	3915		4120	mV
V_{OL} Output LOW voltage ⁽³⁾	3170		3380	3170	3252	3380	3170		3380	mV
V_{IH} Input HIGH voltage (single-ended)	3835		4120	3835		4120	3835		4120	mV
V_{IL} Input LOW voltage (single-ended)	3190		3525	3190		3525	3190		3525	mV
V_{BB} Output reference voltage	3.62		3.74	3.62		3.74	3.62		3.74	V
V_{IHCMR} Input HIGH voltage, common-mode range (differential) ⁽⁴⁾	2.5		4.6	2.5		4.6	2.5		4.6	V
I_{IH} Input HIGH current			150		60	150			150	μA
I_{IL} Input LOW current	0.5			0.5	64		0.5			μA

- (1) The device meets the specifications after thermal balance has been established when mounted in a socket or printed-circuit board with maintained transverse airflow greater than 500 lfm (2.54 m/s). Electrical parameters are assured only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and are not valid simultaneously.
- (2) Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.8 V /–0.5 V.
- (3) Outputs are terminated through a 50-Ω resistor to $V_{CC} - 2\text{ V}$.
- (4) V_{IHCMR} min varies 1:1 with V_{EE} ; V_{IHCMR} max varies 1:1 with V_{CC} . The V_{IHCMR} range is referenced to the more-positive side of the differential input signal. Normal operation is obtained if the HIGH level falls within the specified range and the peak-to-peak voltage lies between V_{PP} min and 1 V.

NECL DC CHARACTERISTICS⁽¹⁾ ($V_{CC} = 0\text{ V}$; $V_{EE} = 5\text{ V}$)⁽²⁾

PARAMETER	–40°C			25°C			85°C			UNIT
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
I_{EE} Power-supply current		15	20		15	20		19	23	mA
V_{OH} Output HIGH voltage ⁽³⁾	–1085		–880	–1085	–988	–880	–1085		–880	mV
V_{OL} Output LOW voltage ⁽³⁾	–1830		–1620	–1830	–1747	–1620	–1830		–1620	mV
V_{IH} Input HIGH voltage (single-ended)	–1165		–880	–1165		–880	–1165		–880	mV
V_{IL} Input LOW voltage (single-ended)	–1810		–1475	–1810		–1475	–1810		–1475	mV
V_{BB} Output reference voltage	–1.38		–1.26	–1.38		–1.26	–1.38		–1.26	V
V_{IHCMR} Input HIGH voltage, common-mode range (differential) ⁽⁴⁾	–2.5		–0.4	–2.5		–0.4	–2.5		–0.4	V
I_{IH} Input HIGH current			150			150			150	μA
I_{IL} Input LOW current	0.5			0.5			0.5			μA

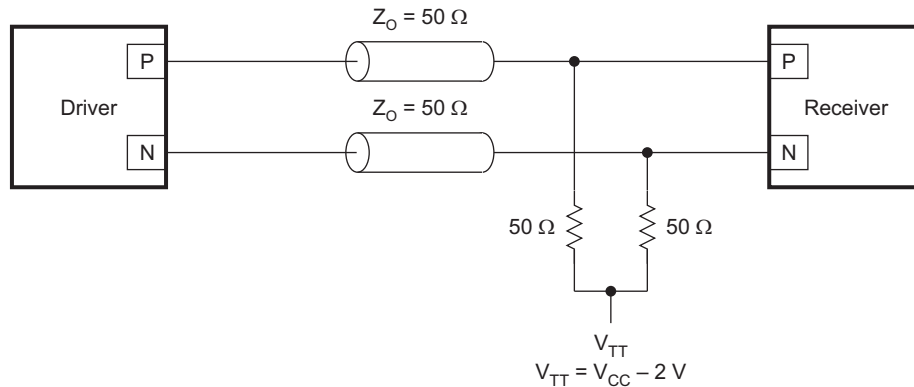
- (1) The device meets the specifications after thermal balance has been established when mounted in a socket or printed-circuit board with maintained transverse airflow greater than 500 lfm (2.54 m/s). Electrical parameters are assured only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and are not valid simultaneously.
- (2) Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.8 V /–0.5 V.
- (3) Outputs are terminated through a 50-Ω resistor to $V_{CC} - 2\text{ V}$.
- (4) V_{IHCMR} min varies 1:1 with V_{EE} ; V_{IHCMR} max varies 1:1 with V_{CC} . The V_{IHCMR} range is referenced to the more-positive side of the differential input signal. Normal operation is obtained if the HIGH level falls within the specified range and the peak-to-peak voltage lies between V_{PP} min and 1 V.

AC CHARACTERISTICS⁽¹⁾ ($V_{CC} = 5\text{ V}$; $V_{EE} = 0\text{ V}$ or $V_{CC} = 0\text{ V}$; $V_{EE} = -5\text{ V}$)⁽²⁾

PARAMETER		-40°C			25°C			85°C			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
f_{MAX}	Maximum switching frequency ⁽³⁾ (see Figure 6)	3.5			3.5			3.4			GHz
t_{PLH}/t_{PHL}	Propagation delay to output	Diff mode (see Figure 3)		200	300	200	300	200	300	ps	
		SE mode (see Figure 2)		75				405			
t_{SKEW}	Duty cycle skew ⁽⁴⁾	5 20			5 20			5 20			ps
t_{JITTER}	Random clock jitter (RMS)	0.2			0.2			0.2			ps
V_{PP}	Input swing ⁽⁵⁾ (see Figure 4)	150	1000	150	1000	150	1000	150	1000	mV	
t_r/t_f	Output rise/fall times Q (20%–80%) (see Figure 5)	100	250	100	250	100	250	100	250	ps	

- (1) The device meets these specifications after thermal equilibrium has been established when mounted in a test socket or printed-circuit board with maintained transverse airflow greater than 500 lfpm (2.54 m/s). Electrical parameters are assured only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and are not valid simultaneously.
- (2) Input and output parameters vary 1:1 with V_{CC} . V_{EE} can vary +0.8 V / -0.5 V.
- (3) Maximum switching frequency is measured at an output amplitude of 300 mV.
- (4) Duty-cycle skew is the difference between a t_{PLH} and t_{PHL} propagation delay through a device.
- (5) $V_{PP(min)}$ is the minimum input swing for which ac parameters assured.

Typical Termination for Output Driver



S0078-02

Figure 1. Typical Termination for Output Driver

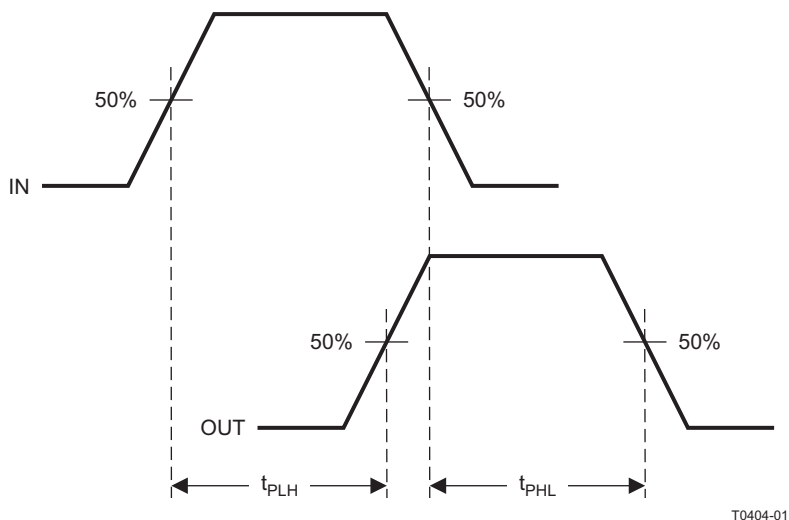


Figure 2. Single-Ended Propagation Delay

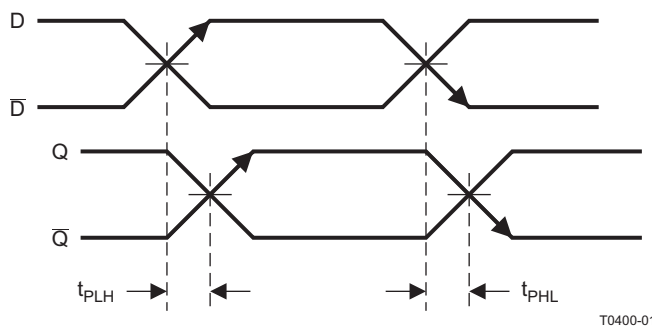


Figure 3. Differential Propagation Delay

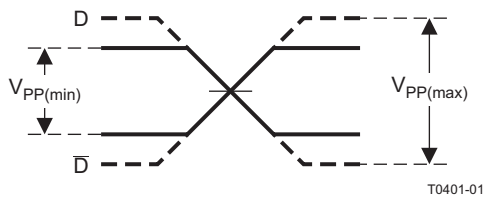


Figure 4. Input Voltage Swing

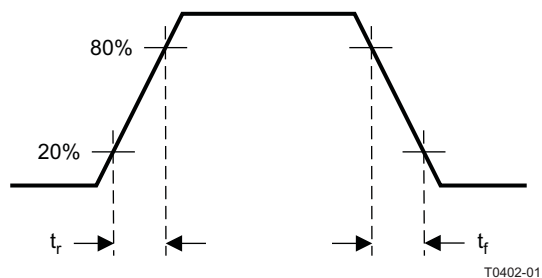


Figure 5. Output Rise and Fall Times

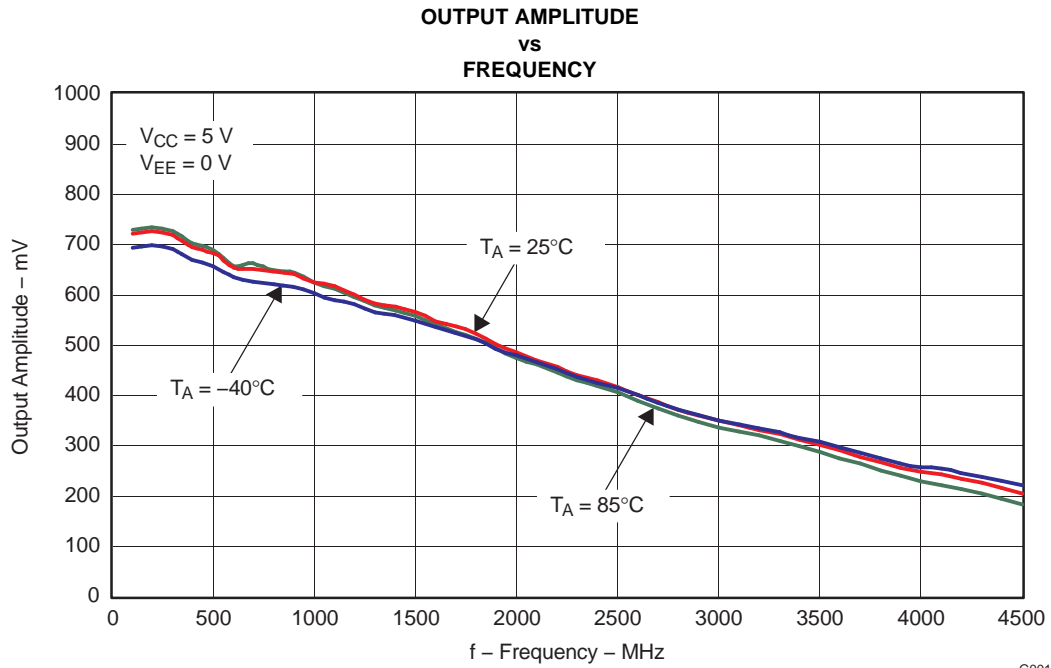


Figure 6.

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)
SN65EL16D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN65EL16DGK	ACTIVE	VSSOP	DGK	8	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN65EL16DGKR	ACTIVE	VSSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN65EL16DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-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 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
REEL DIMENSIONS

TAPE DIMENSIONS


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*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
SN65EL16DGKR	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
SN65EL16DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	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)
SN65EL16DGKR	VSSOP	DGK	8	2500	367.0	367.0	35.0
SN65EL16DR	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.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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 JESD46C and to discontinue any product or service per JESD48B. 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	www.ti.com/audio
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
OMAP Mobile Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

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

TI E2E Community e2e.ti.com