

LMx85-1.2, LM385B-1.2 Micropower Voltage References

1 Features

- Operating Current Range
 - LM285-1.2: 10 μ A to 20 mA
 - LM385-1.2: 15 μ A to 20 mA
 - LM385B-1.2: 15 μ A to 20 mA
- 1% and 2% Initial Voltage Tolerance
- Reference Impedance
 - LM385-1.2: 1 Ω MAX at 25°C
 - All devices: 1.5 Ω MAX over Full Temperature Range
- Very Low Power Consumption
- Interchangeable with Industry Standard LM285-1.2 and LM385-1.2

2 Applications

- Portable Meter References
- Portable Test Instruments
- Battery-Operated Systems
- Current-Loop Instrumentation
- Panel Meters

3 Description

These micropower, two-terminal, band-gap voltage references operate over a 10- μ A to 20-mA current range and feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming provides tight voltage tolerance. The band-gap reference for these devices has low noise and long-term stability.

The design makes these devices exceptionally tolerant of capacitive loading and, thus, easier to use in most reference applications. The wide dynamic operating temperature range accommodates varying current supplies, with excellent regulation.

The extremely low power drain of this series makes them useful for micropower circuitry. These voltage references can be used to make portable meters, regulators, or general-purpose analog circuitry, with battery life approaching shelf life. The wide operating current range allows them to replace older references with tighter-tolerance parts.

Device Information⁽¹⁾

PART NUMBER	PACKAGE (PIN)	BODY SIZE (NOM)
LMx85-1.2	SOIC (8)	4.90 mm x 3.91 mm
	SOP (8)	6.20 mm x 5.30 mm
	TSSOP (8)	3.00 mm x 4.40 mm
	TO-226 (3)	4.30 mm x 4.30 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

4 Simplified Schematic



Table of Contents

1 Features	1	8.3 Feature Description	7
2 Applications	1	8.4 Device Functional Modes	7
3 Description	1	9 Application and Implementation	8
4 Simplified Schematic	1	9.1 Application Information	8
5 Revision History	2	9.2 Typical Application	8
6 Pin Configuration and Functions	3	9.3 System Examples	10
7 Specifications	4	10 Power Supply Recommendations	11
7.1 Absolute Maximum Ratings	4	11 Layout	11
7.2 ESD Ratings	4	11.1 Layout Guidelines	11
7.3 Recommended Operating Conditions	4	11.2 Layout Example	11
7.4 Thermal Information	4	12 Device and Documentation Support	12
7.5 Electrical Characteristics	5	12.1 Related Links	12
7.6 Typical Characteristics	5	12.2 Trademarks	12
8 Detailed Description	7	12.3 Electrostatic Discharge Caution	12
8.1 Overview	7	12.4 Glossary	12
8.2 Functional Block Diagram	7	13 Mechanical, Packaging, and Orderable Information	12

5 Revision History

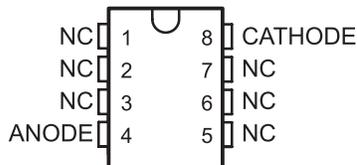
Changes from Revision I (December 2005) to Revision J

Page

- Added *Applications*, *Device Information* table, *Pin Functions* table, *ESD Ratings* table, *Thermal Information* table, *Typical Characteristics*, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. **1**
- Deleted *Ordering Information* table. **1**

6 Pin Configuration and Functions

**LM285-1.2 . . . D PACKAGE
LM385-1.2 . . . D, PS, OR PW PACKAGE
LM385B-1.2 . . . D OR PW PACKAGE
(TOP VIEW)**



NC – No internal connection

**LM285-1.2, LM385-1.2, LM385B-1.2 . . . LP PACKAGE
(TOP VIEW)**



NC – No internal connection

Pin Functions

NAME	PIN		TYPE	DESCRIPTION
	LP	D, PS or PW		
ANODE	1	4	I	Shunt Current/Voltage input
CATHODE	2	8	O	Common pin, normally connected to ground
NC	3	1, 2, 3, 5, 6, 7	—	No internal connection

7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT
I_R	Reverse Current		30	mA
I_F	Forward Current		10	mA
T_J	Operating virtual junction temperature		150	°C
T_{stg}	Storage temperature	–65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	±1000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
 (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
I_{ZZ}	Reference current		0.01	20	mA
T_A	Operating free-air temperature	LM285-1.2	–40	85	°C
		LM385-1.2, LM385B-1.2	0	70	

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾	LMx85-1.2				UNIT	
	D	LP	PS	PW		
	8 PINS	3 PINS	8 PINS	8 PINS		
$R_{\theta JA}$	Junction-to-ambient thermal resistance	97	140	95	149	°C/W

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](http://www.ti.com/lit/zip/Spra953).

7.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

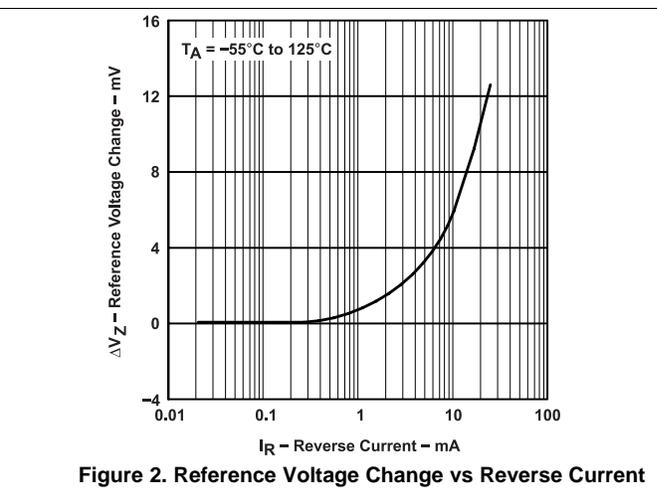
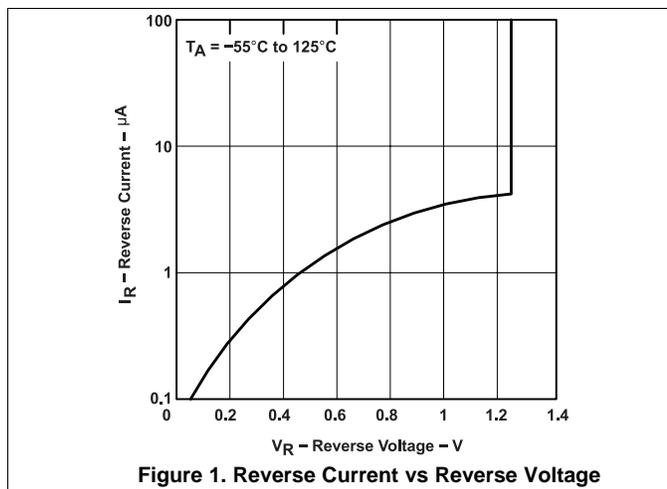
PARAMETER	TEST CONDITIONS	T _A ⁽¹⁾	LM285-1.2			LM385-1.2			LM385B-1.2			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
V _Z	Reference voltage	I _Z = I(min) to 20 mA ⁽²⁾	25°C	1.223	1.235	1.247	1.21	1.235	1.26	1.223	1.235	1.247	V
α _{VZ}	Average temperature coefficient of reference voltage ⁽³⁾	I _Z = I(min) to 20 mA ⁽²⁾	Full Range	±20			±20			±20			ppm/°C
ΔV _Z	Change in reference voltage with current	I _Z = I(min) to 1 mA ⁽²⁾	25°C	1			1			1			mV
			Full Range	1.5			1.5			1.5			
		I _Z = I(min) to 20 mA	25°C	12			20			20			
			Full Range	30			30			30			
ΔV _Z /Δt	Long-term change in reference voltage	I _Z = 100 μA	25°C	±20			±20			±20			ppm/khr
I _Z (min)	Minimum reference current		Full Range	8 10			8 15			8 15			μA
Z _Z	Reference impedance	I _Z = 100 μA, f = 25 Hz	25°C	0.2 0.6			0.4 1			0.4 1			Ω
			Full Range	1.5			1.5			1.5			
V _n	Broadband noise voltage	I _Z = 100 μA, f = 10 Hz to 10 kHz	25°C	60			60			60			μV

(1) Full range is –40°C to 85°C for the LM285-1.2 and 0°C to 70°C for the LM385-1.2 and LM385B-1.2.

(2) I(min) = 10 μA for the LM285-1.2 and 15 μA for the LM385-1.2 and LM385B-1.2

(3) The average temperature coefficient of reference voltage is defined as the total change in reference voltage divided by the specified temperature range.

7.6 Typical Characteristics



Typical Characteristics (continued)

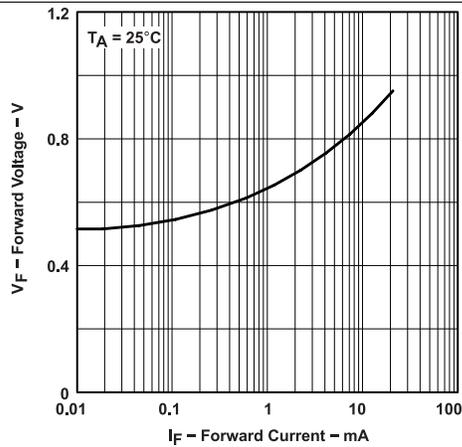


Figure 3. Forward Voltage vs Forward Current

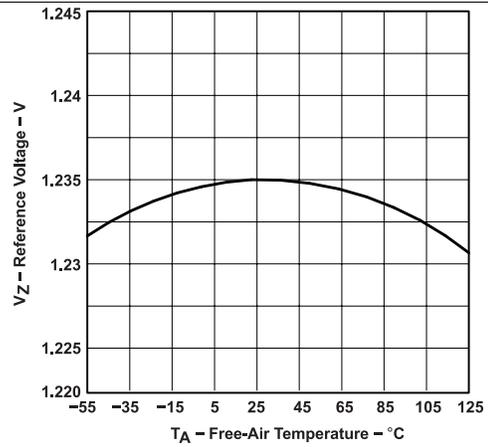


Figure 4. Reference Voltage vs Free-Air Temperature

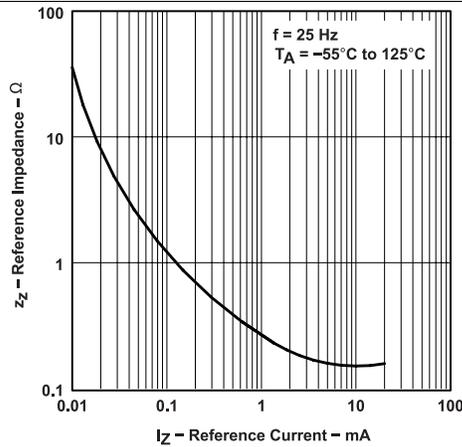


Figure 5. Reference Impedance vs Reference Current

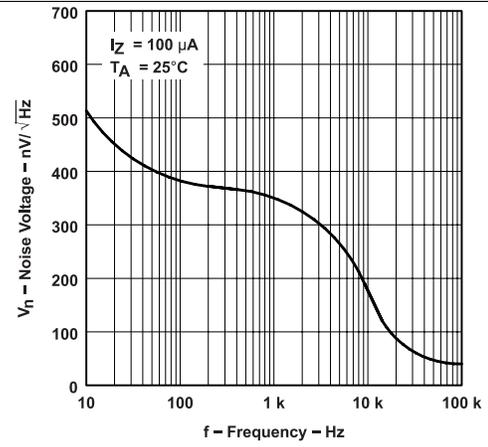


Figure 6. Noise Voltage vs Frequency

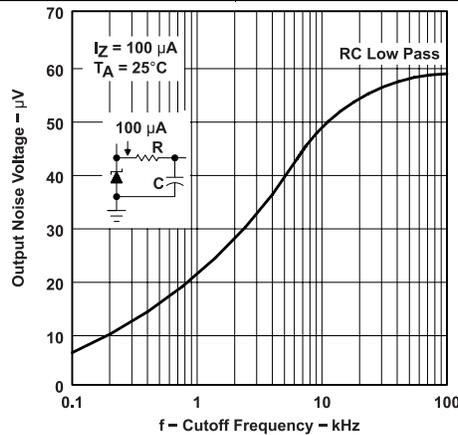


Figure 7. Output Noise Voltage vs Cutoff Frequency

8 Detailed Description

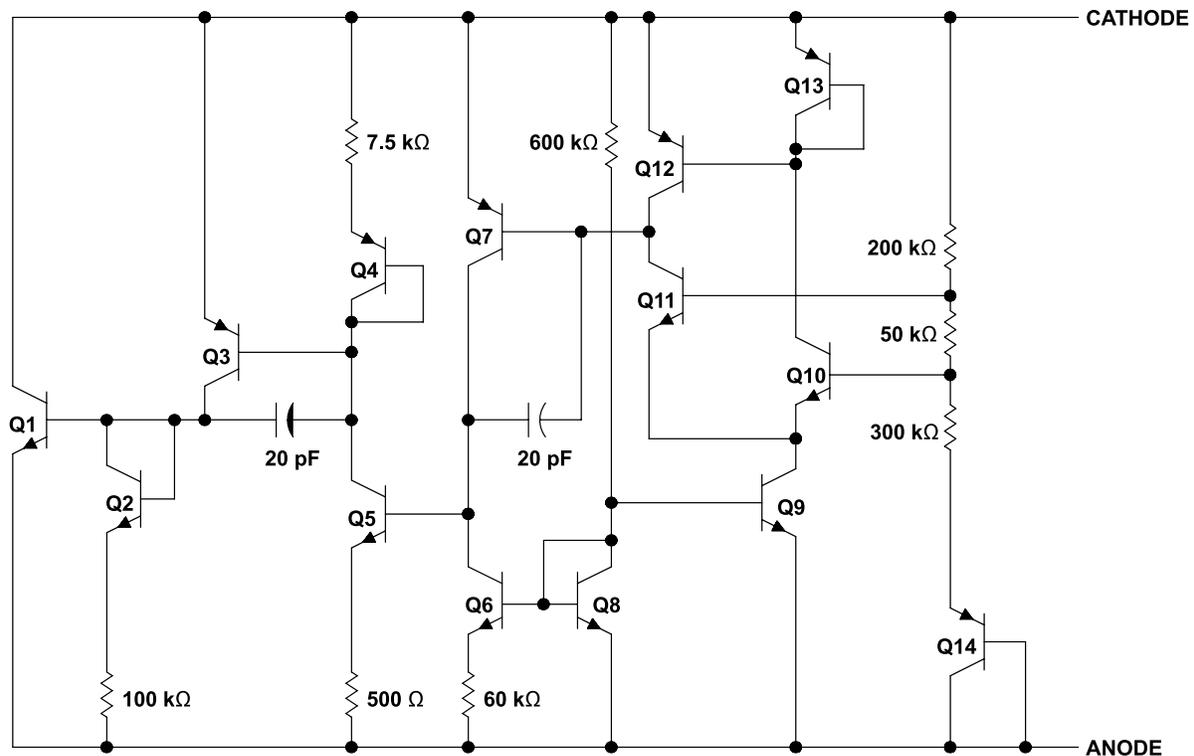
8.1 Overview

The LM285-1.2, LM385-1.2, and LM385B-1.2 devices are micropower, two-terminal, band-gap voltage references which operate over a 10- μ A to 20-mA current range. On-chip trimming provides tight voltage tolerance. The band-gap reference for these devices has low noise and long-term stability.

The design makes these devices exceptionally tolerant of capacitive loading and, thus, easier to use in most reference applications. The wide dynamic operating temperature range accommodates varying current supplies, with excellent regulation.

The extremely low power drain of this series makes them useful for micropower circuitry. These voltage references can be used to make portable meters, regulators, or general-purpose analog circuitry, with battery life approaching shelf life.

8.2 Functional Block Diagram



A. Component values shown are nominal.

8.3 Feature Description

A band gap voltage reference controls high gain amplifier and shunt pass element to maintain a nearly constant voltage between cathode and anode. Regulation occurs after a minimum current is provided to power the voltage divider and amplifier. Internal frequency compensation provides a stable loop for all capacitor loads. Floating shunt design is useful for both positive and negative regulation applications.

8.4 Device Functional Modes

LM285-1.2, LM385-1.2, and LM385B-1.2 devices will operate in one mode, which is as a fixed voltage reference that cannot be adjusted.

In order for a proper Reverse Voltage to be developed, current must be sourced into the cathode of LM285. The minimum current needed for proper regulation is denoted in *Electrical Characteristics* as $I_{Z,min}$.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The The LM285-1.2, LM385-1.2, and LM385-1.2 devices create a voltage reference for to be used for a variety of applications including amplifiers, power supplies, and current-sensing circuits. The following application shows how to use these devices to establish a voltage reference.

9.2 Typical Application

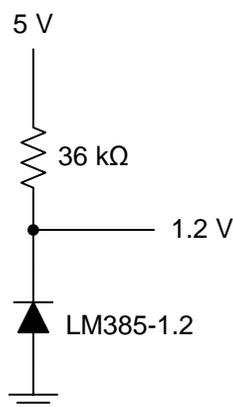


Figure 8. Generating Reference Voltage with a Resistive Current Source

9.2.1 Design Requirements

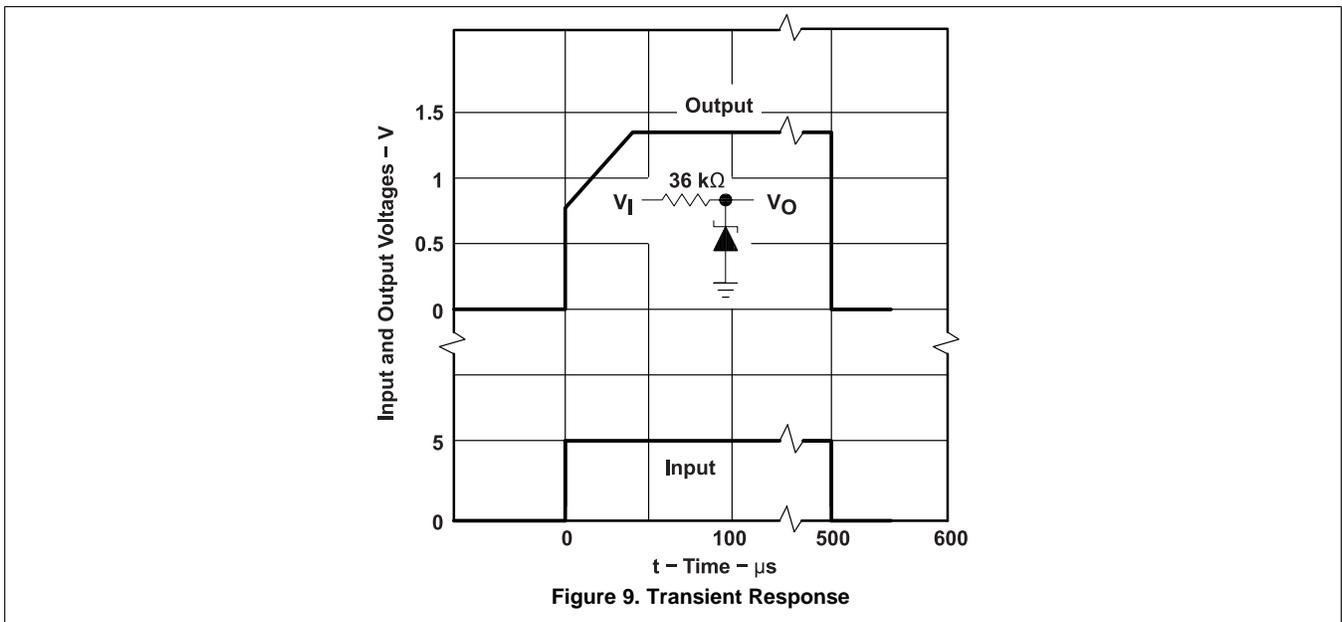
The key design requirement when using this device as a voltage reference is to supply the LM385 with a minimum Cathode Current (I_Z), as indicated in [Electrical Characteristics](#).

9.2.2 Detailed Design Procedure

In order to generate a constant and stable reference voltage, a current greater than $I_{Z(MIN)}$ must be sourced into the cathode of this device. This can be accomplished using a current regulating device such as LM334 or a simple resistor. For a resistor, its value should be equal to or greater than $(V_{supply} - V_{reference}) \div I_{Z(MIN)}$.

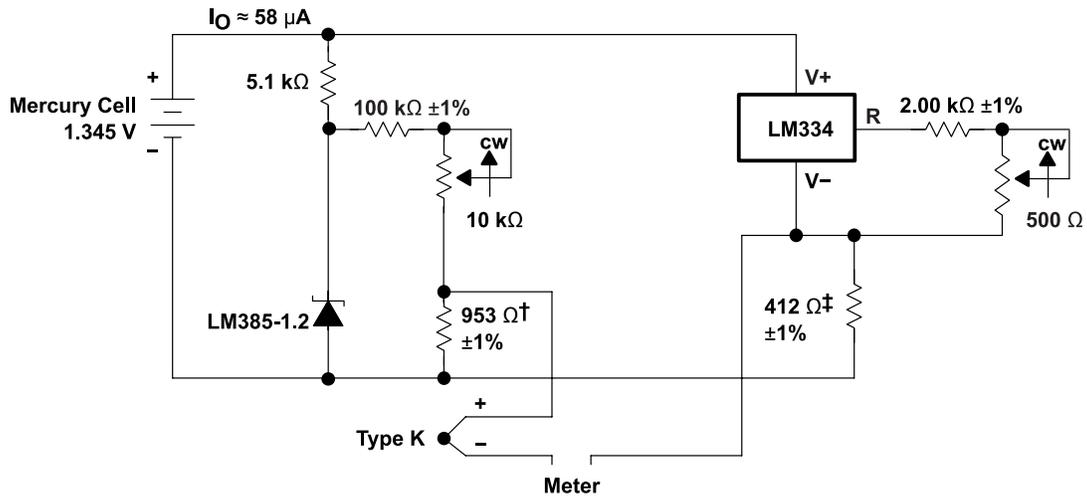
Typical Application (continued)

9.2.3 Application Curves



9.3 System Examples

9.3.1 Thermocouple Cold-Junction Compensator



† Adjust for 11.15 mV at 25°C across 953 Ω

‡ Adjust for 12.17 mV at 25°C across 412 Ω

Figure 10. Thermocouple Cold-Junction Compensator

9.3.2 Generating Reference Voltage with a Constant Current Source

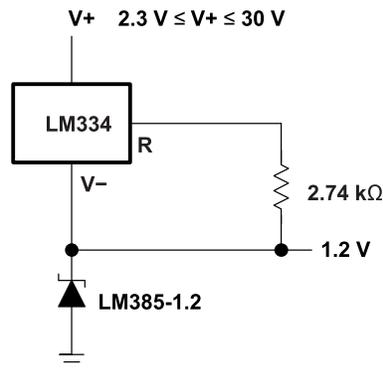


Figure 11. Generating Reference Voltage with a Constant Current Source Device

10 Power Supply Recommendations

In order to not exceed the maximum cathode current, be sure that the supply voltage is current limited.

For applications shunting high currents (30 mA max), pay attention to the cathode and anode trace lengths, adjusting the width of the traces to have the proper current density.

11 Layout

11.1 Layout Guidelines

Figure 12 shows an example of a PCB layout of LMx85x-1.2. Some key V_{ref} noise considerations are:

- Connect a low-ESR, 0.1- μ F (C_L) ceramic bypass capacitor on the cathode pin node.
- Decouple other active devices in the system per the device specifications.
- Using a solid ground plane helps distribute heat and reduces electromagnetic interference (EMI) noise pickup.
- Place the external components as close to the device as possible. This configuration prevents parasitic errors (such as the Seebeck effect) from occurring.
- Do not run sensitive analog traces in parallel with digital traces. Avoid crossing digital and analog traces if possible and only make perpendicular crossings when absolutely necessary.

11.2 Layout Example

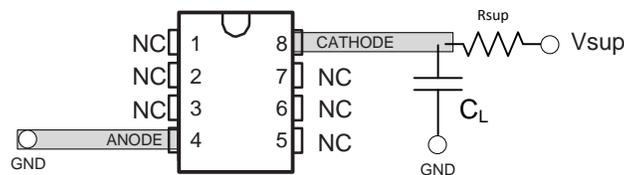


Figure 12. Layout Diagram

12 Device and Documentation Support

12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
LM285-1.2	Click here				
LM385-1.2	Click here				
LM385B-1.2	Click here				

12.2 Trademarks

All trademarks are the property of their respective owners.

12.3 Electrostatic Discharge Caution



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.

12.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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
LM285D-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	285-12	Samples
LM285DE4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	285-12	Samples
LM285DG4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	285-12	Samples
LM285DR-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	285-12	Samples
LM285DRE4-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	285-12	Samples
LM285DRG4-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	285-12	Samples
LM285LP-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	-40 to 85	285-12	Samples
LM285LPE3-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	-40 to 85	285-12	Samples
LM285LPRE3-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	-40 to 85	285-12	Samples
LM385BD-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385B12	Samples
LM385BDE4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385B12	Samples
LM385BDG4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385B12	Samples
LM385BDR-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385B12	Samples
LM385BDRG4-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385B12	Samples
LM385BLP-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385B12	Samples
LM385BLPE3-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385B12	Samples
LM385BLPR-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385B12	Samples

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
LM385BLPRE3-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385B12	Samples
LM385BPW-1-2	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385B12	Samples
LM385BPWR-1-2	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385B12	Samples
LM385D-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	Samples
LM385DG4-1-2	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	Samples
LM385DR-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	Samples
LM385DRG4-1-2	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	Samples
LM385LP-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385-12	Samples
LM385LPE3-1-2	ACTIVE	TO-92	LP	3	1000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385-12	Samples
LM385LPR-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385-12	Samples
LM385LPRE3-1-2	ACTIVE	TO-92	LP	3	2000	Pb-Free (RoHS)	CU SN	N / A for Pkg Type	0 to 70	385-12	Samples
LM385PW-1-2	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	Samples
LM385PWE4-1-2	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	Samples
LM385PWR-1-2	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	Samples
LM385PWRE4-1-2	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	385-12	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.

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.

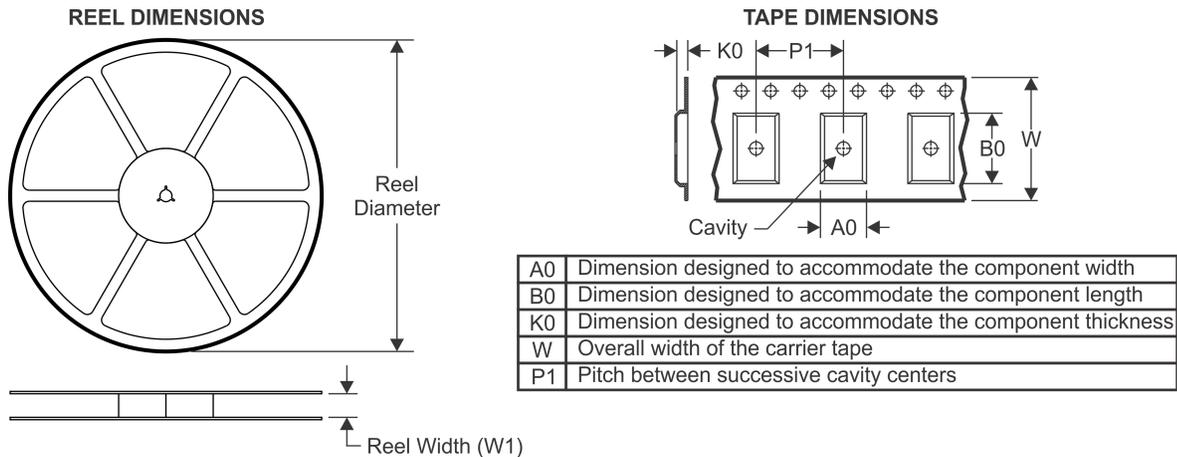
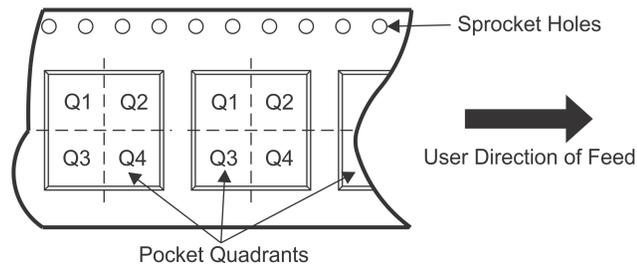
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

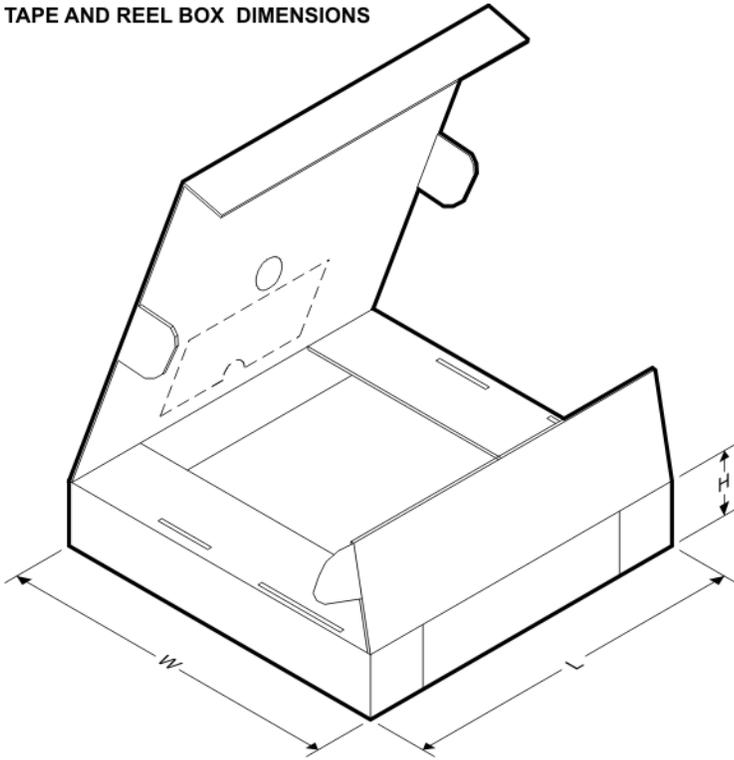
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

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
LM285DR-1-2	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM385BDR-1-2	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM385DR-1-2	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

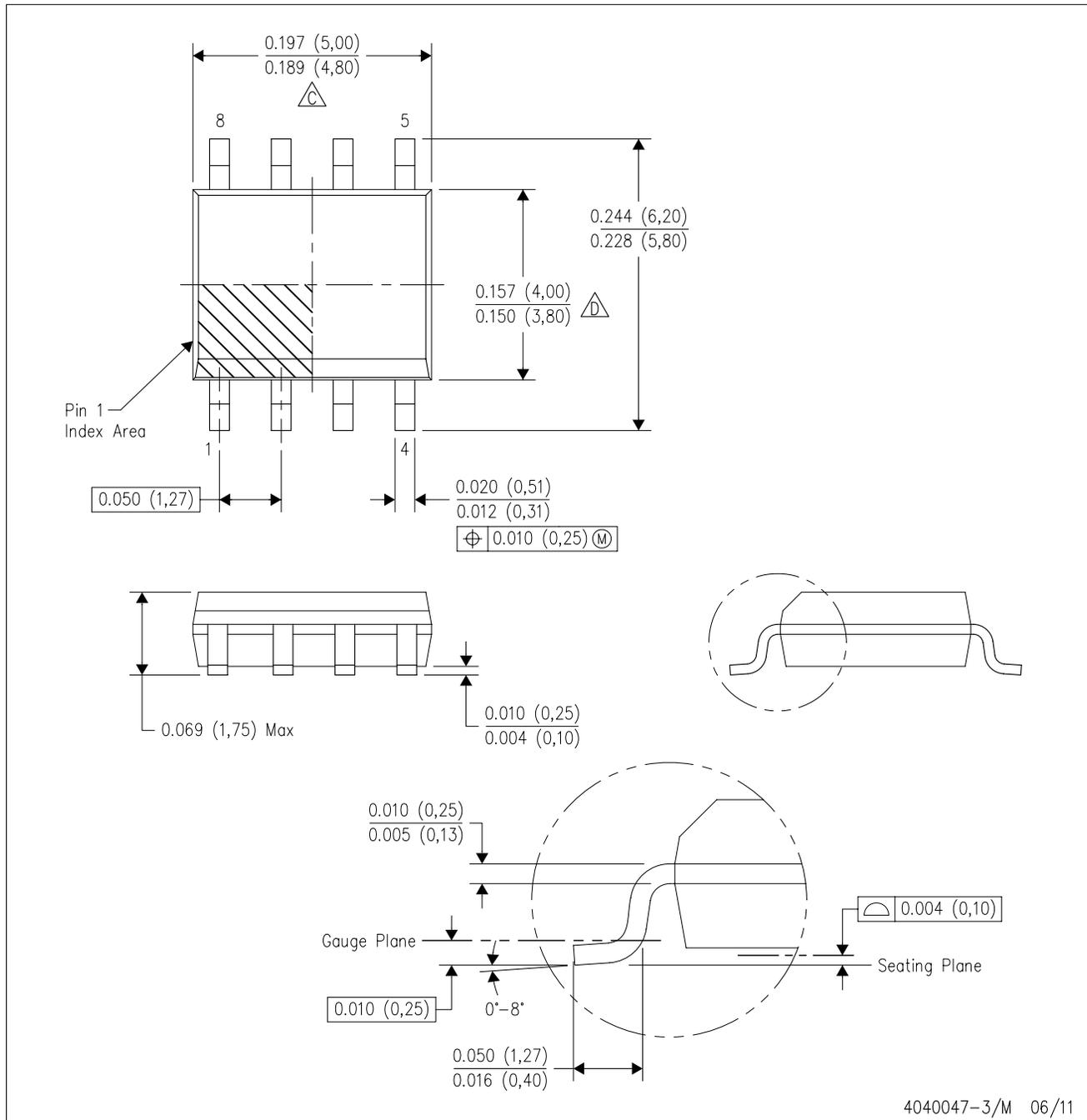


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM285DR-1-2	SOIC	D	8	2500	340.5	338.1	20.6
LM385BDR-1-2	SOIC	D	8	2500	340.5	338.1	20.6
LM385DR-1-2	SOIC	D	8	2500	340.5	338.1	20.6

D (R-PDSO-G8)

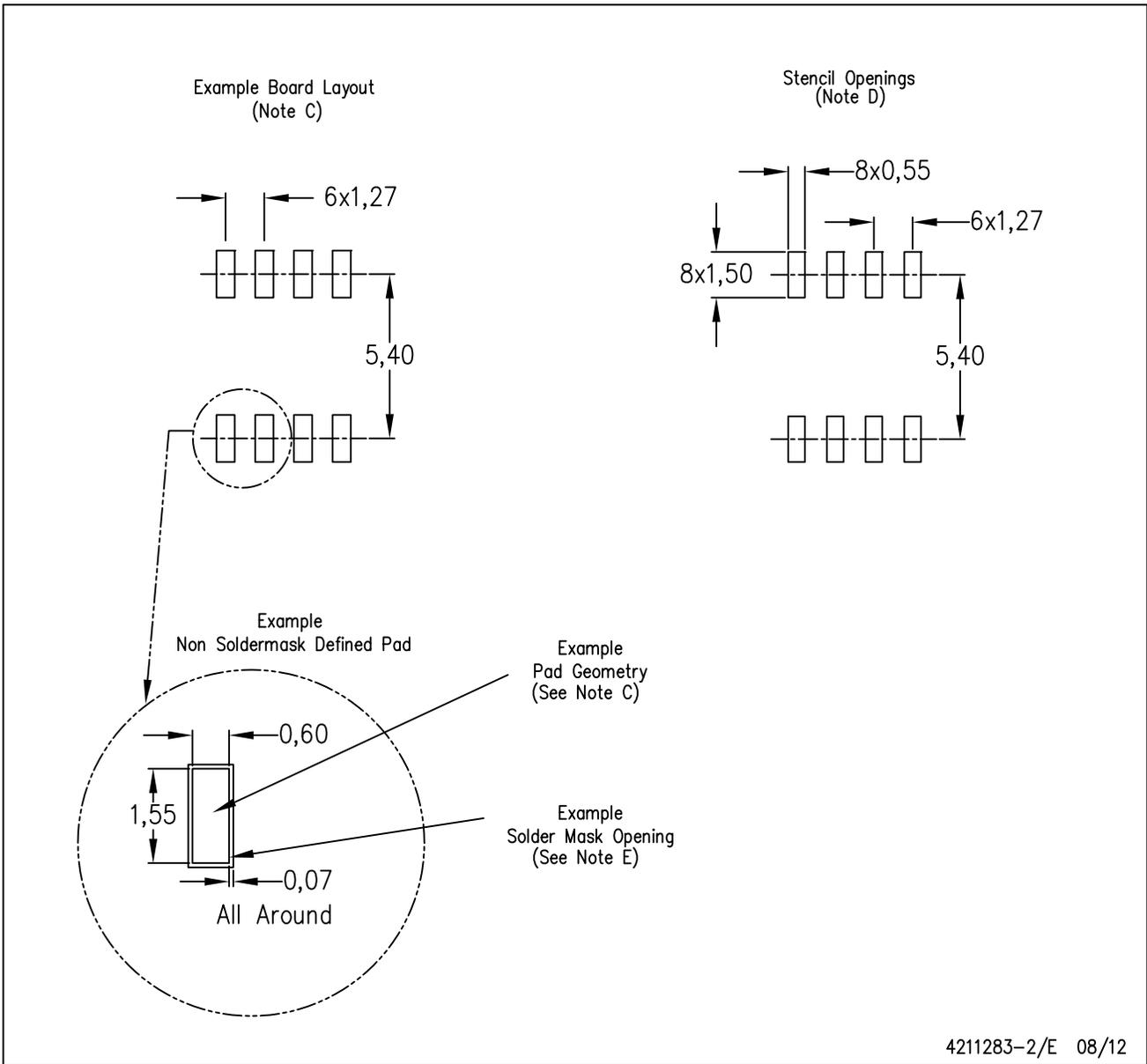
PLASTIC SMALL OUTLINE



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

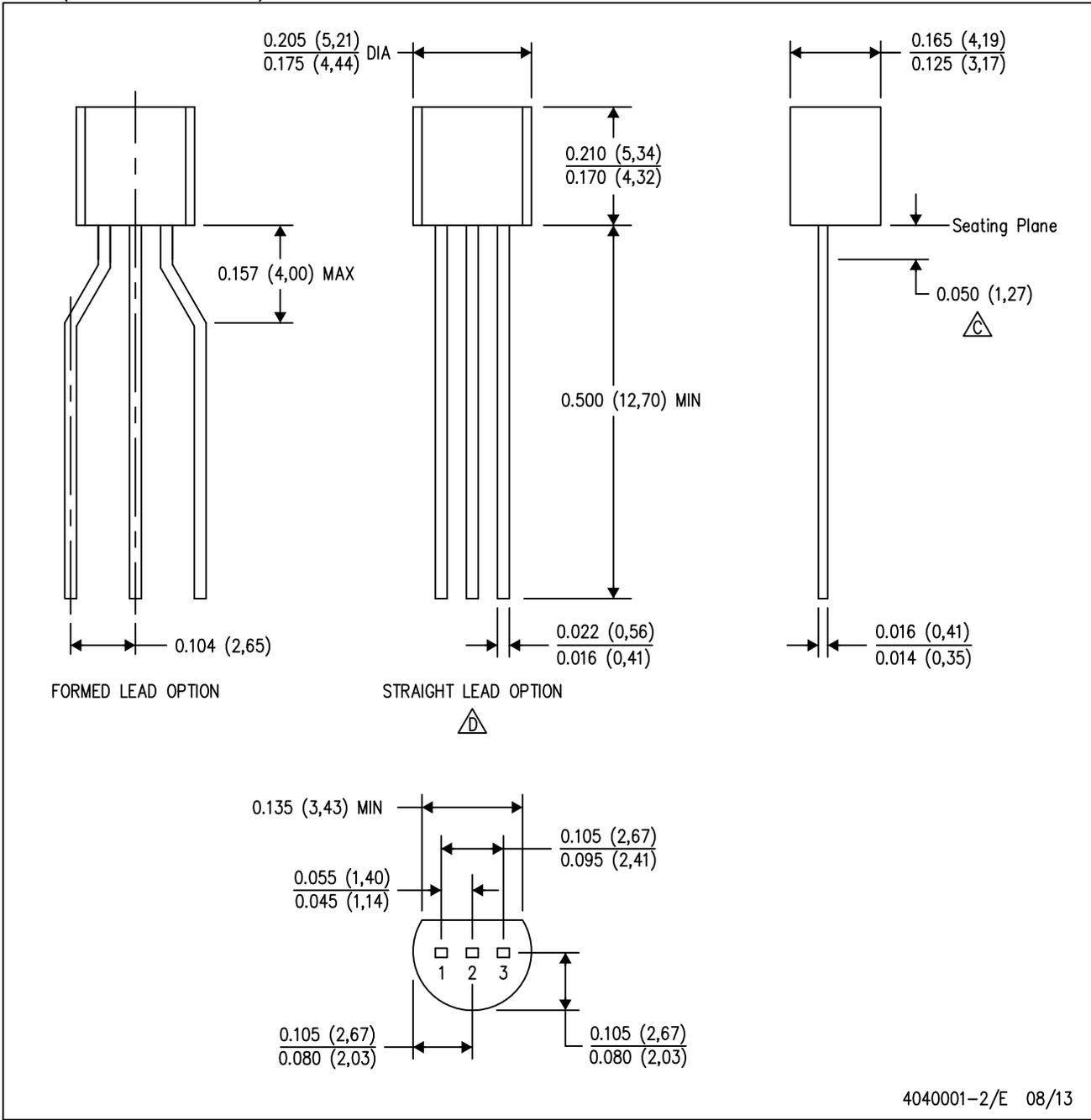


- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should 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.

MECHANICAL DATA

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



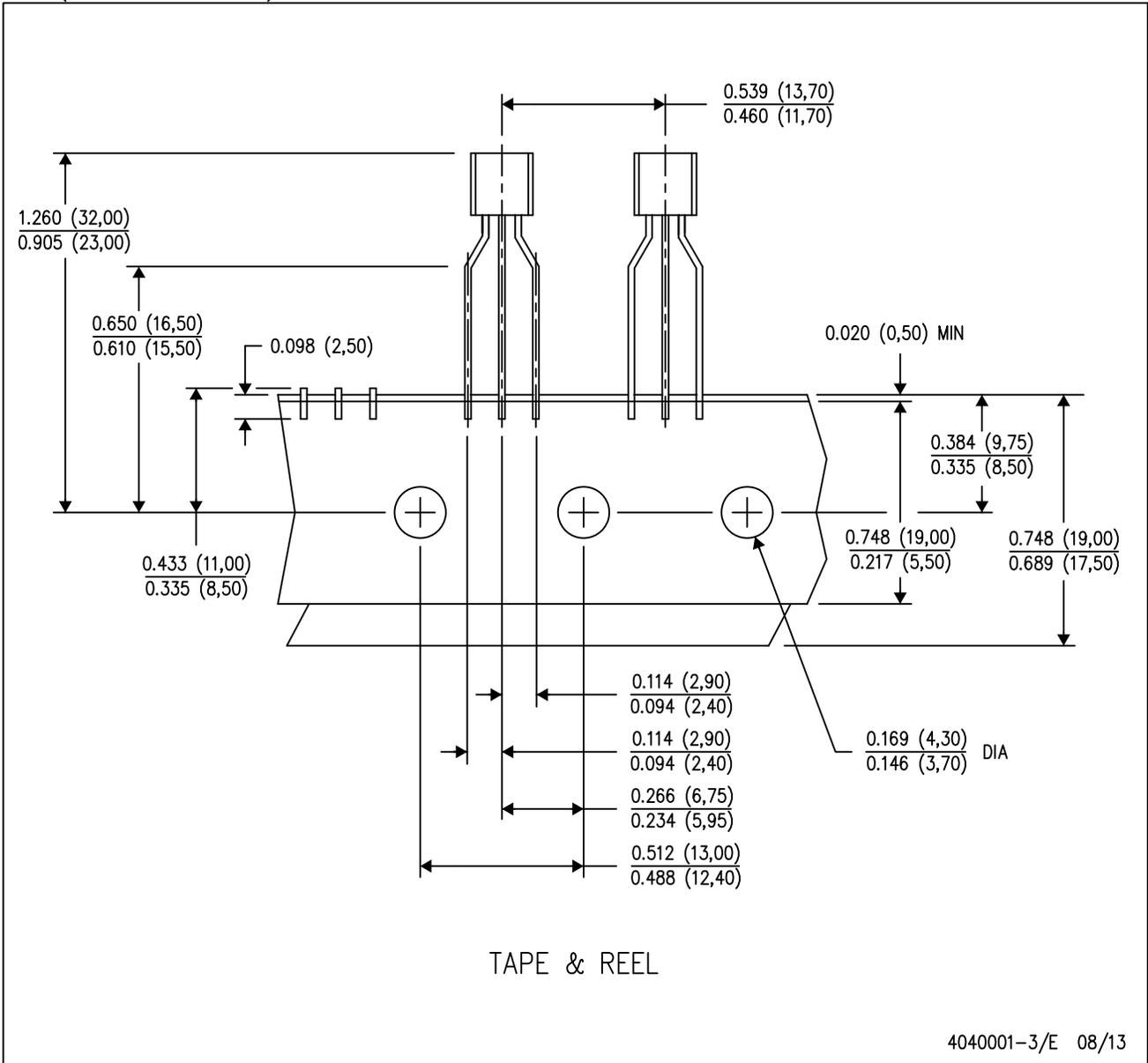
4040001-2/E 08/13

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 -  Lead dimensions are not controlled within this area.
 -  Falls within JEDEC TO-226 Variation AA (TO-226 replaces TO-92).
 - E. Shipping Method:
 - Straight lead option available in bulk pack only.
 - Formed lead option available in tape & reel or ammo pack.
 - Specific products can be offered in limited combinations of shipping mediums and lead options.
 - Consult product folder for more information on available options.

MECHANICAL DATA

LP (O-PBCY-W3)

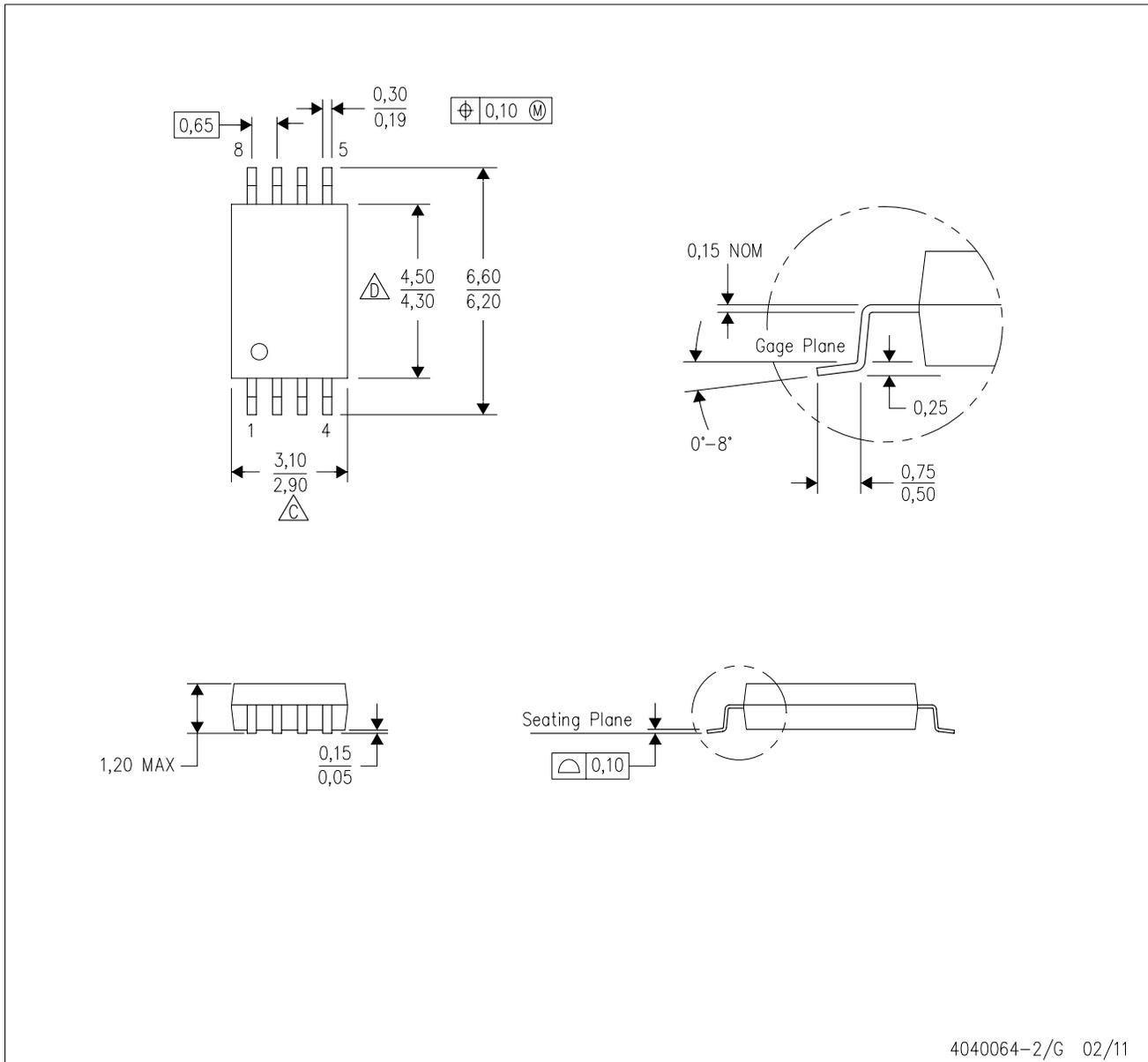
PLASTIC CYLINDRICAL PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Tape and Reel information for the Formed Lead Option package.

PW (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - 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 0,15 each side.
 -  D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

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

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 Applications 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