

DUAL OPERATIONAL AMPLIFIERS WITH INTERNAL REFERENCE

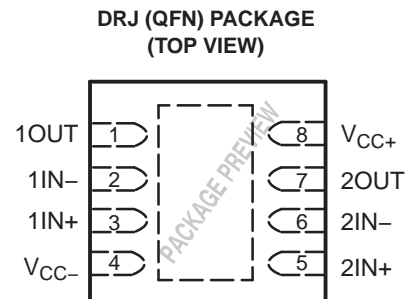
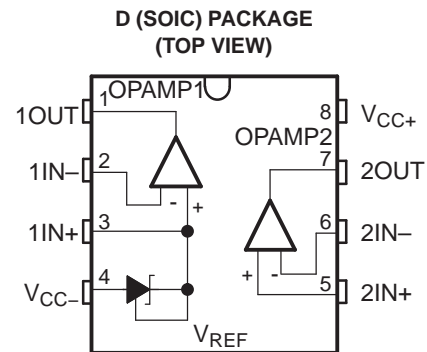
Check for Samples: [TL103W](#), [TL103WA](#)

FEATURES

- **OPERATIONAL AMPLIFIER**
 - Low Offset Voltage Max of:
 - TL103WA...3 mV (25°C) and 5 mV (Full Temperature)
 - TL103W...4 mV (25°C) and 5 mV (Full Temperature)
 - Low Supply Current...350 μ A/Channel (Typ)
 - Unity Gain Bandwidth...0.9 MHz (Typ)
 - Input Common-Mode Range Includes GND
 - Large Output-Voltage Swing... 0 V to $V_{CC} - 1.5$ V
 - Wide Supply-Voltage Range...3 V to 32 V
 - 2-kV ESD Protection (HBM)
- **VOLTAGE REFERENCE**
 - Fixed 2.5-V Reference
 - Tight Tolerance Max of:
 - TL103WA...0.4% (25°C) and 0.8% (Full Temperature)
 - TL103W . . . 0.7% (25°C) and 1.4% (Full Temperature)
 - Low Temperature Drift...7 mV (Typ) Over Operating Temperature Range
 - Wide Sink-Current Range . . . 0.5 mA (Typ) to 100 mA
 - Output Impedance...0.2 Ω (Typ)

TYPICAL APPLICATIONS

- Battery Chargers
- Switch-Mode Power Supplies
- Linear Voltage Regulation
- Data-Acquisition Systems



NOTE: Exposed thermal pad is connected internally to V_{CC-} via die attach.

DESCRIPTION/ORDERING INFORMATION

The TL103W and TL103WA combine the building blocks of a dual operational amplifier and a fixed voltage reference – both of which often are used in the control circuitry of both switch-mode and linear power supplies. OPAMP1 has its noninverting input internally tied to a fixed 2.5-V reference, while OPAMP2 is independent, with both inputs uncommitted.

For the A grade, especially tight voltage regulation can be achieved through low offset voltages for both operational amplifiers (typically 0.5 mV) and tight tolerances for the voltage reference (0.4% at 25°C and 0.8% over operating temperature range).

The TL103W and TL103WA are characterized for operation from -40°C to 105°C .



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.

ORDERING INFORMATION

T _A	MAX V _{IO} AND V _{REF} TOLERANCE (25°C)	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 105°C	A grade 3 mV, 0.4%	QFN (DRJ)	Reel of 1000	TL103WAIDRJR	PREVIEW
		SOIC (D)	Tube of 75	TL103WAID	Z103WA
			Reel of 2500	TL103WAIDR	
	Standard grade 4 mV, 0.7%	QFN (DRJ)	Reel of 1000	TL103WIDRJR	PREVIEW
		SOIC (D)	Tube of 75	TL103WID	Z103W
			Reel of 2500	TL103WIDR	

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

Typical Application Circuit

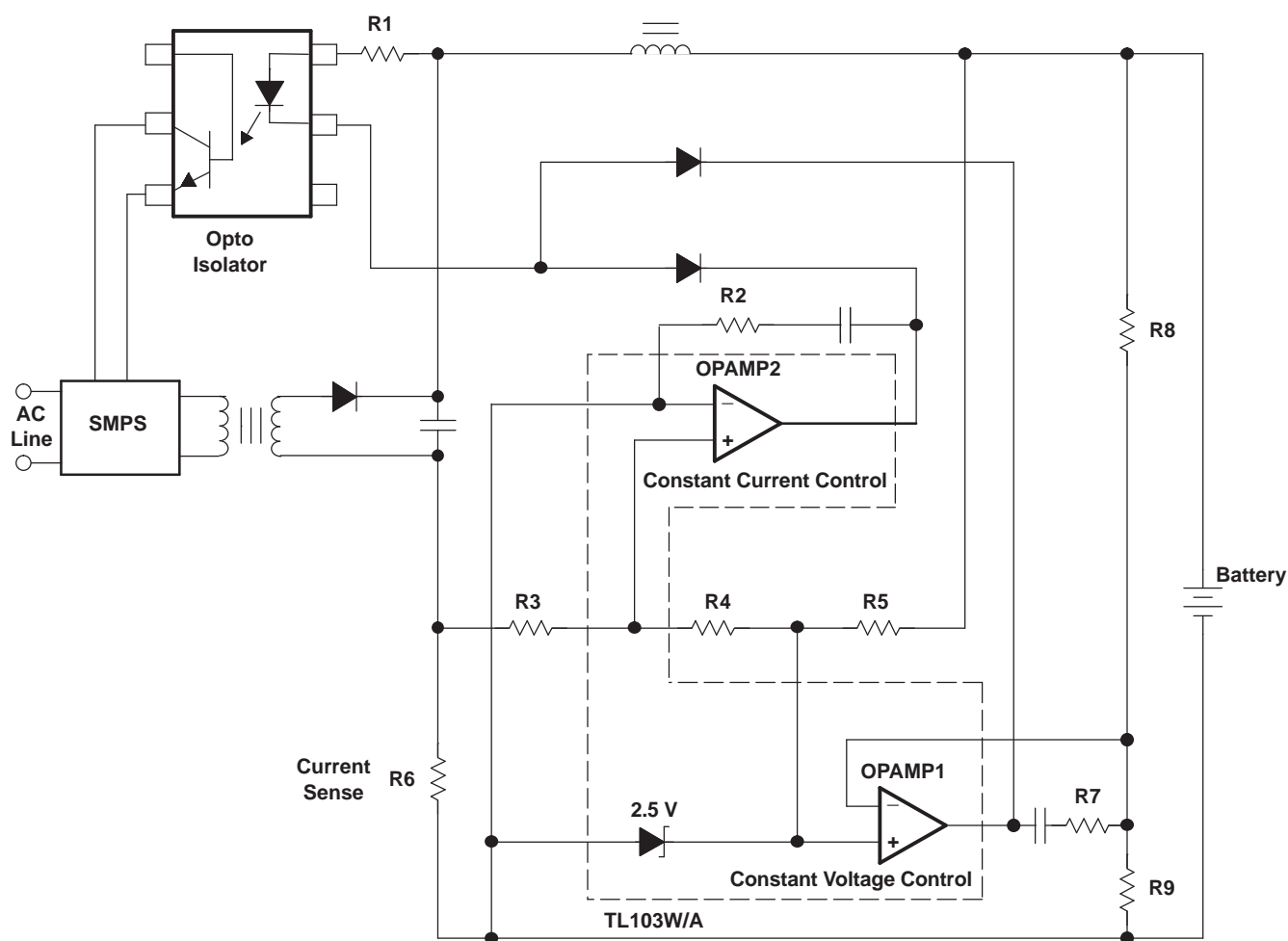


Figure 1. TL103W/A in a Constant-Current and Constant-Voltage Battery Charger

Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT
V _{CC}	Supply voltage		36	V
V _{ID}	Operational amplifier input differential voltage		36	V
V _I	Operational amplifier input voltage range	–0.3	36	V
I _{KA}	Voltage reference cathode current		100	mA
θ _{JA}	Package thermal impedance	D package ^{(2) (3)}		97
		DRJ package ^{(2) (4)}		TBD
T _J	Maximum junction temperature		150	°C
T _{stg}	Storage temperature range	–65	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 other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} – T_A)/θ_{JA}. Selecting the maximum of 150°C can affect reliability.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.
- (4) The package thermal impedance is calculated in accordance with JESD 51-5.

Recommended Operating Conditions

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

		MIN	MAX	UNIT
V _{IN}	Supply voltage	3	32	V
I _K	Cathode current	1	100	mA
T _A	Operating free-air temperature	–40	105	°C

OPAMP1, Operational Amplifier With Noninverting Input Connected to the Internal V_{REF} Electrical Characteristics

$V_{CC+} = 5\text{ V}$, $V_{CC} = \text{GND}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_{icm} = 0\text{ V}$	25°C		1	4	mV
			Full range			5	
	TL103WA	$V_{icm} = 0\text{ V}$	25°C		0.5	3	
			Full range			5	
αV_{IO}	Input offset-voltage drift		25°C		7		$\mu\text{V}/^\circ\text{C}$
I_{IB}	Input bias current (negative input)		25°C		20		nA
A_{VD}	Large-signal voltage gain	$V_{CC+} = 15\text{ V}$, $R_L = 2\text{ k}\Omega$, $V_{icm} = 0\text{ V}$	25°C		100		V/mV
k_{SVR}	Supply-voltage rejection ratio	$V_{CC+} = 5\text{ V}$ to 30 V , $V_{icm} = 0\text{ V}$	25°C	65	100		dB
$I_{O(\text{source})}$	Output source current	$V_{CC+} = 15\text{ V}$, $V_O = 2\text{ V}$, $V_{id} = 1\text{ V}$	25°C	20	40		mA
I_{SC}	Short circuit to GND	$V_{CC+} = 15\text{ V}$	25°C		40	60	mA
$I_{O(\text{sink})}$	Output sink current	$V_{CC+} = 15\text{ V}$, $V_O = 2\text{ V}$, $V_{id} = -1\text{ V}$	25°C	10	12		mA
		$V_{CC+} = 15\text{ V}$, $V_O = 0.2\text{ V}$, $V_{id} = -1\text{ V}$		12	50		μA
V_{OH}	High-level output voltage	$V_{CC} = 30\text{ V}$, $R_L = 2\text{ k}\Omega$	25°C	26	27		V
			Full range	26			
		$V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$	25°C	27	28		
			Full range	27			
V_{OL}	Low-level output voltage	$R_L = 10\text{ k}\Omega$	25°C		5	20	mV
			Full range			20	
SR	Slew rate at unity gain	$V_{CC+} = 15\text{ V}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, $V_I = 0.5\text{ V}$ to 2 V , unity gain	25°C	0.2	0.4		V/ μs
GBW	Gain bandwidth product	$V_{CC+} = 30\text{ V}$, $V_I = 10\text{ mV}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, $f = 100\text{ kHz}$	25°C	0.5	0.9		MHz
THD	Total harmonic distortion	$V_{CC+} = 30\text{ V}$, $V_O = 2\text{ V}_{pp}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, $f = 1\text{ kHz}$, $A_V = 20\text{ dB}$	25°C		0.02		%

OPAMP2, Independent Operational Amplifier Electrical Characteristics

 $V_{CC+} = 5\text{ V}$, $V_{CC} = \text{GND}$, $V_O = 1.4\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	TL103W	$V_{icm} = 0\text{ V}$	25°C	1	4	mV
			Full range		5		
		TL103WA	$V_{icm} = 0\text{ V}$	25°C	0.5	3	
			Full range		5		
αV_{IO}	Input offset voltage drift		25°C	7		$\mu\text{V}/^\circ\text{C}$	
I_{IO}	Input offset current		25°C	2	75	nA	
		Full range		150			
I_{IB}	Input bias current		25°C	20	150	nA	
		Full range		200			
A_{VD}	Large-signal voltage gain	$V_{CC+} = 15\text{ V}$, $R_L = 2\text{ k}\Omega$, $V_O = 1.4\text{ V}$ to 11.4 V	25°C	50	100	V/mV	
			Full range	25			
k_{SVR}	Supply-voltage rejection ratio	$V_{CC+} = 5\text{ V}$ to 30 V	25°C	65	100	dB	
V_{ICR}	Input common-mode voltage range	$V_{CC+} = 30\text{ V}^{(1)}$	25°C	0	$V_{CC+} - 1.5$	V	
			Full range	0	$V_{CC+} - 2$		
CMRR	Common-mode rejection ratio		25°C	70	85	dB	
		Full range	60				
$I_{O(\text{source})}$	Output source current	$V_{CC+} = 15\text{ V}$, $V_O = 2\text{ V}$, $V_{id} = 1\text{ V}$	25°C	20	40	mA	
I_{SC}	Short circuit to GND	$V_{CC+} = 15\text{ V}$	25°C	40	60	mA	
$I_{O(\text{sink})}$	Output sink current	$V_{CC+} = 15\text{ V}$, $V_O = 2\text{ V}$, $V_{id} = -1\text{ V}$	25°C	10	12	mA	
		$V_{CC+} = 15\text{ V}$, $V_O = 0.2\text{ V}$, $V_{id} = -1\text{ V}$		12	50	μA	
V_{OH}	High-level output voltage	$V_{CC} = 30\text{ V}$, $R_L = 2\text{ k}\Omega$	25°C	26	27	V	
			Full range	26			
		$V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$	25°C	27	28		
			Full range	27			
V_{OL}	Low-level output voltage	$R_L = 10\text{ k}\Omega$	25°C	5	20	mV	
			Full range	20			
SR	Slew rate at unity gain	$V_{CC+} = 15\text{ V}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, $V_I = 0.5\text{ V}$ to 3 V , unity gain	25°C	0.2	0.4	$\text{V}/\mu\text{s}$	
GBW	Gain bandwidth product	$V_{CC+} = 30\text{ V}$, $V_I = 10\text{ mV}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, $f = 100\text{ kHz}$	25°C	0.5	0.9	MHz	
THD	Total harmonic distortion	$V_{CC+} = 30\text{ V}$, $V_O = 2\text{ V}_{pp}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$, $f = 1\text{ kHz}$, $A_V = 20\text{ dB}$	25°C	0.02		%	
V_n	Equivalent input noise voltage	$V_{CC} = 30\text{ V}$, $R_S = 100\ \Omega$, $f = 1\text{ kHz}$	25°C	50		$\text{nV}/\sqrt{\text{Hz}}$	

(1) The input common-mode voltage of either input should not be allowed to go below -0.3 V . The upper end of the common-mode voltage range is $V_{CC+} - 1.5\text{ V}$, but either input can go to $V_{CC+} + 0.3\text{ V}$ (but $\leq 36\text{ V}$) without damage.

**Voltage Reference
Electrical Characteristics**

PARAMETER		TEST CONDITIONS	T _A	MIN	TYP	MAX	UNIT
V _{REF}	Reference voltage	I _K = 10 mA	25°C	2.482	2.5	2.518	V
			Full range	2.465		2.535	
		I _K = 10 mA	25°C	2.49	2.5	2.51	
			Full range	2.48		2.52	
ΔV _{REF}	Reference input voltage deviation over temperature range	V _{KA} = V _{REF} , I _K = 10 mA	Full range		7	30	mV
I _{min}	Minimum cathode current for regulation	V _{KA} = V _{REF}	25°C		0.5	1	mA
z _{ka}	Dynamic impedance ⁽¹⁾	V _{KA} = V _{REF} , ΔI _K = 1 mA to 100 mA, f < 1 kHz	25°C		0.2	0.5	Ω

(1) The dynamic impedance is defined as $|z_{ka}| = \frac{\Delta V_{KA}}{\Delta I_K}$.

**Total Device
Electrical Characteristics**

PARAMETER		TEST CONDITIONS	T _A	MIN	TYP	MAX	UNIT
I _{CC}	Total supply current, excluding cathode-current reference	V _{CC+} = 5 V, No load	Full range		0.7	1.2	mA
		V _{CC+} = 30 V, No load				2	

REVISION HISTORY

Changes from Revision J (September 2010) to Revision K	Page
• Changed topside marking to fix typo Z103WQ to Z103WA	2

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)
TL103WAID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Contact TI Distributor or Sales Office
TL103WAIDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Contact TI Distributor or Sales Office
TL103WAIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Contact TI Distributor or Sales Office
TL103WAIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free Samples
TL103WAIDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free Samples
TL103WAIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free Samples
TL103WID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Purchase Samples
TL103WIDE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Purchase Samples
TL103WIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Purchase Samples
TL103WIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free Samples
TL103WIDRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free Samples
TL103WIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Request Free 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⁾ 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



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
TL103WAIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TL103WIDR	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)
TL103WAIDR	SOIC	D	8	2500	340.5	338.1	20.6
TL103WIDR	SOIC	D	8	2500	340.5	338.1	20.6

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