

Dual 12-/10-/8-Bit I²C
V_{OUT} DACs with
10ppm/°C Reference

FEATURES

- **Integrated Precision Reference**
2.5V Full-Scale 10ppm/°C (LTC2633-L)
4.096V Full-Scale 10ppm/°C (LTC2633-H)
- **Maximum INL Error: ±1LSB (LTC2633A-12) ±1.5**
- **Low Noise: 0.75mV_{p-p} 0.1Hz to 200kHz**
- **Guaranteed Monotonic Over -40°C to 125°C Temperature Range**
- **Selectable Internal or External Reference**
- **2.7V to 5.5V Supply Range (LTC2633-L)**
- **Low Power: 0.4mA at 3V**
- **Power-on-Reset to Zero-Scale/Mid-Scale/Hi-Z**
- **Double-Buffered Data Latches**
- **8-Lead ThinSOT™ Package**

APPLICATIONS

- Mobile Communications
- Process Control and Industrial Automation
- Power Supply Margining
- Portable Equipment
- Automotive

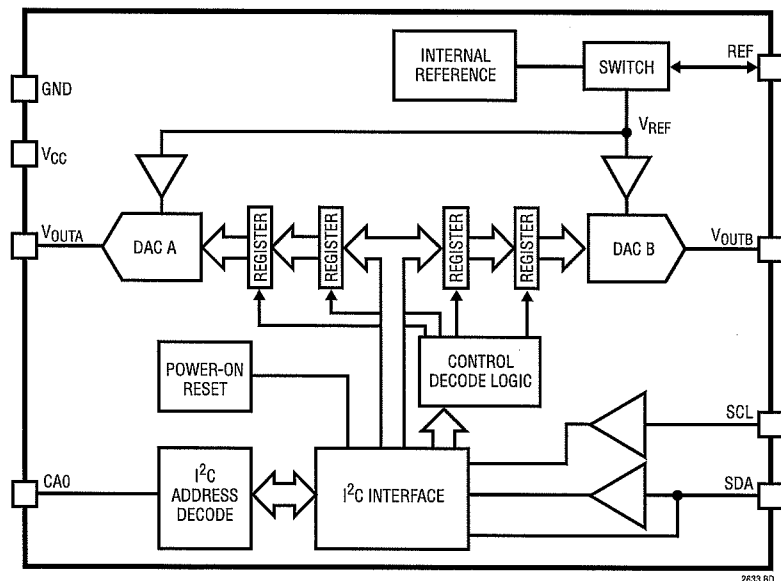
DESCRIPTION

The LTC®2633 is a family of dual 12-, 10-, and 8-bit voltage-output DACs with an integrated, high accuracy, low drift reference in an 8-lead TSOT-23 package. It has rail-to-rail output buffers and is guaranteed monotonic. The LTC2633-L has a full-scale output of 2.5V, and operates from a single 2.7V to 5.5V supply. The LTC2633-H has a full-scale output of 4.096V, and operates from a 4.5V to 5.5V supply. Each DAC can also operate with an external reference, which sets the full-scale output to the external reference voltage.

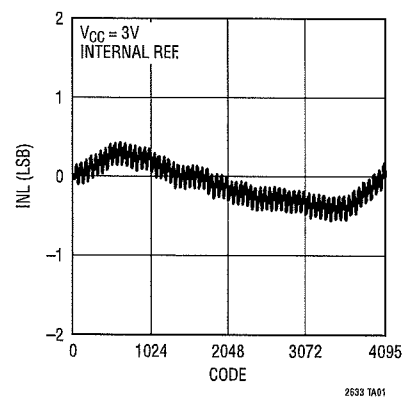
These DACs communicate via a 2-wire I²C-compatible serial interface. The LTC2633 operates in both the standard mode (clock rate of 100kHz) and the fast mode (clock rate of 400kHz). The LTC2633 incorporates a power-on reset circuit. Options are available for reset to zero-scale, reset to mid-scale in internal reference mode, reset to mid-scale in external reference mode, or reset with all DAC outputs in a high impedance state after power-up.

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BLOCK DIAGRAM



Integral Nonlinearity (LTC2633A-LZ12)
INL Curve



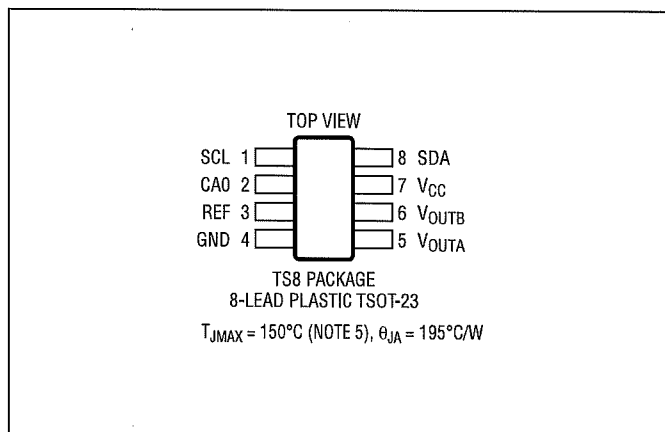
LTC2633

ABSOLUTE MAXIMUM RATINGS

(Notes 1, 2)

Supply Voltage (V_{CC})	.....	-0.3V to 6V
SCL, SDA	.....	-0.3V to 6V
V_{OUTA} , V_{OUTB}	.....	-0.3V to $\text{Min}(V_{CC} + 0.3V, 6V)$
CA0	.....	-0.3V to $\text{Min}(V_{CC} + 0.3V, 6V)$
REF	.....	-0.3V to $\text{Min}(V_{CC} + 0.3V, 6V)$
Operating Temperature Range		
LTC2633C	.....	0°C to 70°C
LTC2633H	.....	-40°C to 125°C
Maximum Junction Temperature	.....	150°C
Storage Temperature Range	.....	-65°C to 150°C
Lead Temperature (Soldering, 10 sec)	.....	300°C

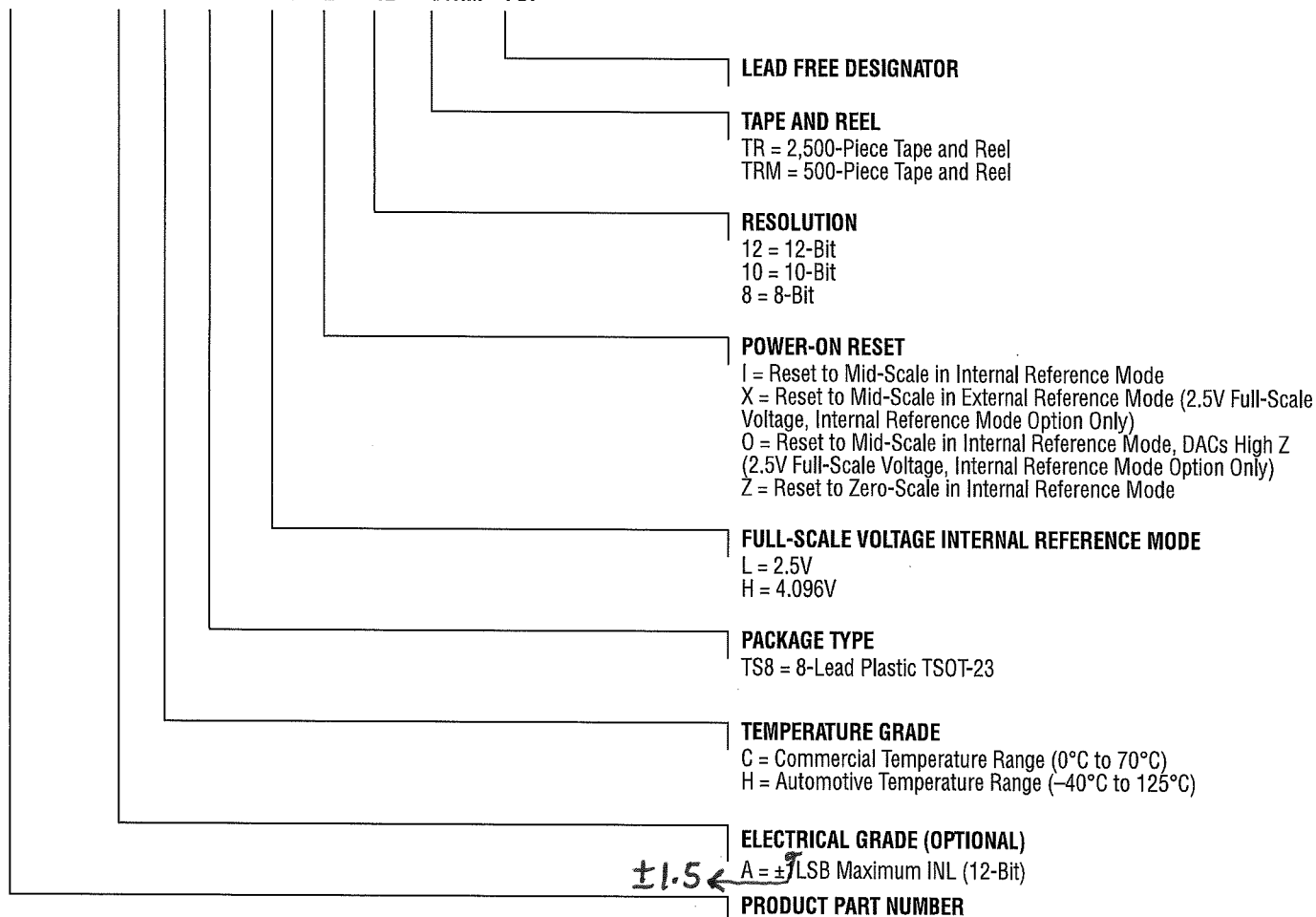
PIN CONFIGURATION



ORDER INFORMATION

<http://www.linear.com/product/LTC2633#orderinfo>

LTC2633 A C TS8 -L Z 12 #TRM PBF



Consult LTC Marketing for parts specified with wider operating temperature ranges.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeandree/>. Some packages are available in 500 unit reels through designated sales channels with #TRMPBF suffix.

2633fc

PRODUCT SELECTION GUIDE

PART NUMBER	PART MARKING**	VFS WITH INTERNAL REFERENCE	POWER-ON RESET TO CODE	POWER-ON REFERENCE MODE	RESOLUTION	V _{CC}	MAXIMUM INL
LTC2633A-LI12	LTFTC	2.5V • (4095/4096)	Mid-Scale	Internal	12-Bit	2.7V to 5.5V	±1.5 ±1LSB
LTC2633A-LX12	LTFTB	2.5V • (4095/4096)	Mid-Scale	External	12-Bit	2.7V to 5.5V	±1.5 ±1LSB
LTC2633A-LZ12	LTFSZ	2.5V • (4095/4096)	Zero-Scale	Internal	12-Bit	2.7V to 5.5V	±1.5 ±1LSB
LTC2633A-LO12*	LTFTV	2.5V • (4095/4096)	High Impedance	Internal	12-Bit	2.7V to 5.5V	±1.5 ±1LSB
LTC2633A-HI12	LTFTF	4.096V • (4095/4096)	Mid-Scale	Internal	12-Bit	4.5V to 5.5V	±1.5 ±1LSB
LTC2633A-HZ12	LTFTD	4.096V • (4095/4096)	Zero-Scale	Internal	12-Bit	4.5V to 5.5V	±1.5 ±1LSB
LTC2633-LI12	LTFTC	2.5V • (4095/4096)	Mid-Scale	Internal	12-Bit	2.7V to 5.5V	±2.5LSB
LTC2633-LI10	LTFTJ	2.5V • (1023/1024)	Mid-Scale	Internal	10-Bit	2.7V to 5.5V	±1LSB
LTC2633-LI8	LTFTQ	2.5V • (255/256)	Mid-Scale	Internal	8-Bit	2.7V to 5.5V	±0.5LSB
LTC2633-LX12	LTFTB	2.5V • (4095/4096)	Mid-Scale	External	12-Bit	2.7V to 5.5V	±2.5LSB
LTC2633-LX10	LTFTH	2.5V • (1023/1024)	Mid-Scale	External	10-Bit	2.7V to 5.5V	±1LSB
LTC2633-LX8	LTFTP	2.5V • (255/256)	Mid-Scale	External	8-Bit	2.7V to 5.5V	±0.5LSB
LTC2633-LZ12	LTFSZ	2.5V • (4095/4096)	Zero-Scale	Internal	12-Bit	2.7V to 5.5V	±2.5LSB
LTC2633-LZ10	LTFTG	2.5V • (1023/1024)	Zero-Scale	Internal	10-Bit	2.7V to 5.5V	±1LSB
LTC2633-LZ8	LTFTN	2.5V • (255/256)	Zero-Scale	Internal	8-Bit	2.7V to 5.5V	±0.5LSB
LTC2633-LO12*	LTFTV	2.5V • (4095/4096)	High Impedance	Internal	12-Bit	2.7V to 5.5V	±2.5LSB
LTC2633-LO10*	LTFTW	2.5V • (1023/1024)	High Impedance	Internal	10-Bit	2.7V to 5.5V	±1LSB
LTC2633-LO8*	LTFTX	2.5V • (255/256)	High Impedance	Internal	8-Bit	2.7V to 5.5V	±0.5LSB
LTC2633-HI12	LTFTF	4.096V • (4095/4096)	Mid-Scale	Internal	12-Bit	4.5V to 5.5V	±2.5LSB
LTC2633-HI10	LTFTM	4.096V • (1023/1024)	Mid-Scale	Internal	10-Bit	4.5V to 5.5V	±1LSB
LTC2633-HI8	LTFTS	4.096V • (255/256)	Mid-Scale	Internal	8-Bit	4.5V to 5.5V	±0.5LSB
LTC2633-HZ12	LTFTD	4.096V • (4095/4096)	Zero-Scale	Internal	12-Bit	4.5V to 5.5V	±2.5LSB
LTC2633-HZ10	LTFTK	4.096V • (1023/1024)	Zero-Scale	Internal	10-Bit	4.5V to 5.5V	±1LSB
LTC2633-HZ8	LTFTR	4.096V • (255/256)	Zero-Scale	Internal	8-Bit	4.5V to 5.5V	±0.5LSB

* Contact Linear Technology for other Hi-Z options.

**The temperature grade is identified by a label on the shipping container.

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V_{CC} = 2.7V to 5.5V, V_{OUT} unloaded unless otherwise specified.

LTC2633-LI12/-LI10/-LI8/-LX12/-LX10/-LX8/-LZ12/-LZ10/-LZ8/-LO12/-LO10/-LO8/LTC2633A-LI12/-LX12/-LZ12/-LO12 (V_{FS} = 2.5V)

SYMBOL	PARAMETER	CONDITIONS	LTC2633-8			LTC2633-10			LTC2633-12			LTC2633A-12			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
	Resolution		●	8		10		12		12				Bits	
	Monotonicity	V _{CC} = 3V, Internal Ref. (Note 3)	●	8		10		12		12				Bits	
DNL	Differential Nonlinearity	V _{CC} = 3V, Internal Ref. (Note 3)	●		±0.5		±0.5		±1		±1			LSB	
INL	Integral Nonlinearity	V _{CC} = 3V, Internal Ref. (Note 3)	●	±0.05	±0.5	±0.2	±1	±1	±2.5	±0.5	±1.5			LSB	
ZSE	Zero Scale Error	V _{CC} = 3V, Internal Ref., Code = 0	●	0.5	5	0.5	5	0.5	5	0.5	5			mV	
V _{OS}	Offset Error	V _{CC} = 3V, Internal Ref. (Note 4)	●	±0.5	±5	±0.5	±5	±0.5	±5	±0.5	±5			mV	
V _{OSTC}	V _{OS} Temperature Coefficient	V _{CC} = 3V, Internal Ref.		±10		±10		±10		±10				µV/°C	
GE	Gain Error	V _{CC} = 3V, Internal Ref.	●	±0.2	±0.8	±0.2	±0.8	±0.2	±0.8	±0.2	±0.8			%FSR	

LTC2633

TIMING CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_{CC} = 2.7\text{V}$ to 5.5V . (See Figure 1) (Note 12)

LTC2633-LI12/-LI10/-LI8/-LX12/-LX10/-LX8/-LZ12/-LZ10/-LZ8/-LO12/-LO10/-LO8/LTC2633A-LI12/-LX12/-LZ12/-LO12 ($V_{FS} = 2.5\text{V}$)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
f_{SCL}	SCL Clock Frequency	●	0		400	kHz
$t_{HD(STA)}$	Hold Time (Repeated) Start Condition	●	0.6			μs
t_{LOW}	Low Period of the SCL Clock Pin	●	1.3			μs
t_{HIGH}	High Period of the SCL Clock Pin	●	0.6			μs
$t_{SU(STA)}$	Set-Up Time for a Repeated Start Condition	●	0.6			μs
$t_{HD(DAT)}$	Data Hold Time	●	0		0.9	μs
$t_{SU(DAT)}$	Data Set-Up Time	●	100			ns
t_r	Rise Time of Both SDA and SCL Signals	(Note 11)	●	$20 + 0.1C_B$	300	ns
t_f	Fall Time of Both SDA and SCL Signals	(Note 11)	●	$20 + 0.1C_B$	300	ns
$t_{SU(STO)}$	Set-Up Time for Stop Condition	●	0.6			μs
t_{BUF}	Bus Free Time Between a Stop and Start Condition	●	1.3			μs

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V_{CC} = 4.5\text{V}$ to 5.5V , V_{OUT} unloaded unless otherwise specified.

LTC2633-HI12/-HI10/-HI8/-HZ12/-HZ10/-HZ8/LTC2633A-HI12/-HZ12 ($V_{FS} = 4.096\text{V}$)

SYMBOL	PARAMETER	CONDITIONS	LTC2633-8			LTC2633-10			LTC2633-12			LTC2633A-12			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
DC Performance															
	Resolution	●	8			10			12			12			Bits
	Monotonicity	$V_{CC} = 5\text{V}$, Internal Ref. (Note 3)	●	8		10			12			12			Bits
DNL	Differential Nonlinearity	$V_{CC} = 5\text{V}$, Internal Ref. (Note 3)	●		± 0.5			± 0.5			± 1			± 1	LSB
INL	Integral Nonlinearity	$V_{CC} = 5\text{V}$, Internal Ref. (Note 3)	●	± 0.05	± 0.5	± 0.2	± 1	± 1	± 2.5	± 0.5	± 1.5	± 0.5	± 1.5	LSB	
ZSE	Zero Scale Error	$V_{CC} = 5\text{V}$, Internal Ref., Code = 0	●	0.5	5	0.5	5	0.5	5	0.5	5	0.5	5	mV	
VOS	Offset Error	$V_{CC} = 5\text{V}$, Internal Ref. (Note 4)	●	± 0.5	± 5	± 0.5	± 5	± 0.5	± 5	± 0.5	± 5	± 0.5	± 5	mV	
VOSTC	V_{OS} Temperature Coefficient	$V_{CC} = 5\text{V}$, Internal Ref.		± 10		± 10		± 10		± 10		± 10		$\mu\text{V}/^\circ\text{C}$	
GE	Gain Error	$V_{CC} = 5\text{V}$, Internal Ref.	●	± 0.2	± 0.8	± 0.2	± 0.8	± 0.2	± 0.8	± 0.2	± 0.8	± 0.2	± 0.8	%FSR	
GE _{TC}	Gain Temperature Coefficient	$V_{CC} = 5\text{V}$, Internal Ref. (Note 9) C-Grade H-Grade		10 10		10 10		10 10		10 10		10 10		ppm/ $^\circ\text{C}$ ppm/ $^\circ\text{C}$	
	Load Regulation	$V_{CC} = 5\text{V} \pm 10\%$, Internal Ref. Mid-Scale, $-10\text{mA} \leq I_{OUT} \leq 10\text{mA}$	●	0.006	0.01	0.022	0.04	0.09	0.16	0.09	0.16	0.09	0.16	LSB/mA	
R _{OUT}	DC Output Impedance	$V_{CC} = 5\text{V} \pm 10\%$, Internal Ref. Mid-Scale, $-10\text{mA} \leq I_{OUT} \leq 10\text{mA}$	●	0.09	0.156	0.09	0.156	0.09	0.156	0.09	0.156	0.09	0.156	Ω	