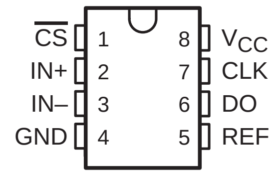
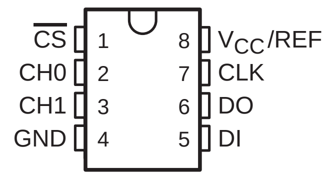
- **8-Bit Resolution**
- **2.7 V to 3.6 V V_{CC}**
- **Easy Microprocessor Interface or Standalone Operation**
- **Operates Ratiometrically or With V_{CC} Reference**
- **Single Channel or Multiplexed Twin Channels With Single-Ended or Differential Input Options**
- **Input Range 0 V to V_{CC} With V_{CC} Reference**
- **Inputs and Outputs Are Compatible With TTL and MOS**
- **Conversion Time of 32 µs at $f_{(CLK)}$ = 250 kHz**
- **Designed to Be Functionally Equivalent to the National Semiconductor ADC0831 and ADC0832 at 3 V Supply**
- **Total Unadjusted Error . . . ± 1 LSB**

TLV0831 . . . D OR P PACKAGE
(TOP VIEW)



TLV0832 . . . D OR P PACKAGE
(TOP VIEW)



description

These devices are 8-bit successive-approximation analog-to-digital converters. The TLV0831 has single input channels; the TLV0832 has multiplexed twin input channels. The serial output is configured to interface with standard shift registers or microprocessors.

The TLV0832 multiplexer is software configured for single-ended or differential inputs. The differential analog voltage input allows for common-mode rejection or offset of the analog zero input voltage value. In addition, the voltage reference input can be adjusted to allow encoding any smaller analog voltage span to the full 8 bits of resolution.

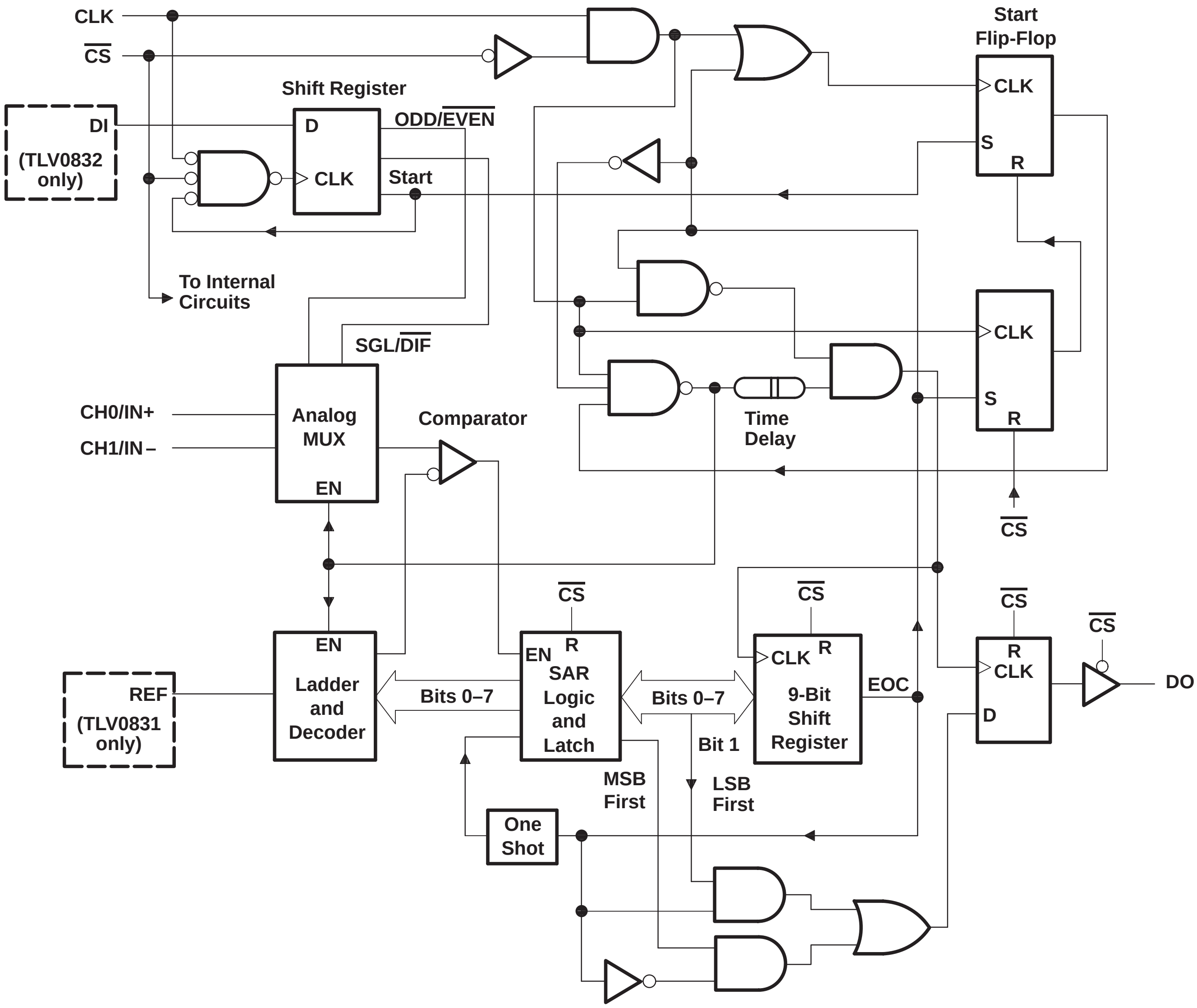
The operation of the TLV0831 and TLV0832 devices is very similar to the more complex TLV0834 and TLV0838 devices. Ratiometric conversion can be attained by setting the REF input equal to the maximum analog input signal value, which gives the highest possible conversion resolution. Typically, REF is set equal to V_{CC} (done internally on the TLV0832).

The TLV0831C and TLV0832C are characterized for operation from 0°C to 70°C. The TLV0831I and TLV0832I are characterized for operation from –40°C to 85°C.

AVAILABLE OPTIONS

T_A	PACKAGE			
	SMALL OUTLINE (D)		PLASTIC DIP (P)	
0°C to 70°C	TLV0831CD	TLV0832CD	TLV0831CP	TLV0832CP
–40°C to 85°C	TLV0831ID	TLV0832ID	TLV0831IP	TLV0832IP

functional block diagram



TEXAS INSTRUMENTS
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functional description

The TLV0831 and TLV0832 use a sample-data-comparator structure that converts differential analog inputs by a successive-approximation routine. The input voltage to be converted is applied to an input terminal and is compared to ground (single ended), or to an adjacent input (differential). The TLV0832 input terminals can be assigned a positive (+) or negative (–) polarity. The TLV0831 contains only one differential input channel with fixed polarity assignment; therefore it does not require addressing. The signal can be applied differentially, between IN+ and IN–, to the TLV0831 or can be applied to IN+ with IN– grounded as a single ended input. When the signal input applied to the assigned positive terminal is less than the signal on the negative terminal, the converter output is all zeros.

Channel selection and input configuration are under software control using a serial-data link from the controlling processor. A serial-communication format allows more functions to be included in a converter package with no increase in size. In addition, it eliminates the transmission of low-level analog signals by locating the converter at the analog sensor and communicating serially with the controlling processor. This process returns noise-free digital data to the processor.

A conversion is initiated by setting $\overline{CS}$ low, which enables all logic circuits. $\overline{CS}$ must be held low for the complete conversion process. A clock input is then received from the processor. An interval of one clock period is automatically inserted to allow the selected multiplexed channel to settle. DO comes out of the high-impedance state and provides a leading low for one clock period of multiplexer settling time. The SAR comparator compares successive outputs from the resistive ladder with the incoming analog signal. The comparator output indicates whether the analog input is greater than or less than the resistive-ladder output. As the conversion proceeds, conversion data is simultaneously output from DO, with the most significant bit (MSB) first. After eight clock periods, the conversion is complete. When $\overline{CS}$ goes high, all internal registers are cleared. At this time, the output circuits go to the high-impedance state. If another conversion is desired, $\overline{CS}$ must make a high-to-low transition followed by address information.

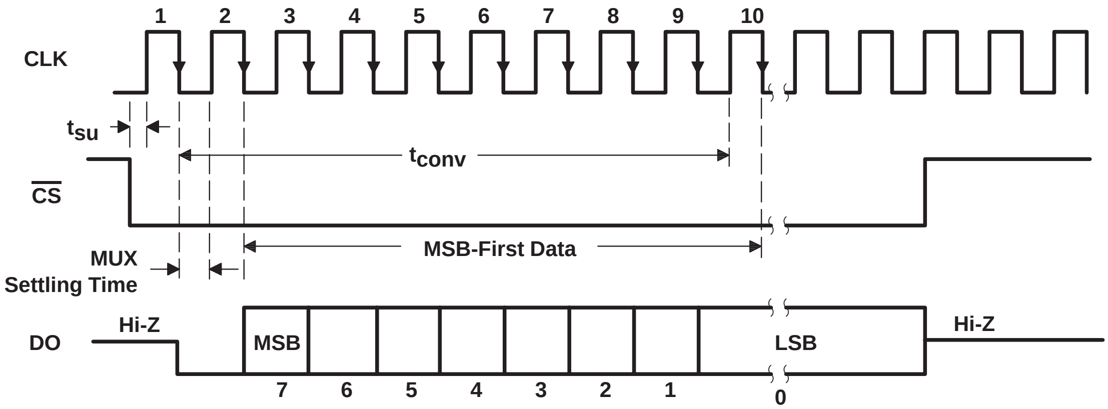
A TLV0832 input configuration is assigned during the multiplexer-addressing sequence. The multiplexer address shifts into the converter through the data input (DI) line. The multiplexer address selects the analog inputs to be enabled and determines whether the input is single ended or differential. When the input is differential, the polarity of the channel input is assigned. In addition to selecting the differential mode, the polarity may also be selected. Either channel of the channel pair may be designated as the negative or positive input.

On each low-to-high transition of the clock input, the data on DI is clocked into the multiplexer-address shift register. The first logic high on the input is the start bit. A 2-bit assignment word follows the start bit on the TLV0832. On each successive low-to-high transition of the clock input, the start bit and assignment word are shifted through the shift register. When the start bit is shifted into the start location of the multiplexer register, the input channel is selected and conversion starts. The TLV0832 DI terminal to the multiplexer shift register is disabled for the duration of the conversion.

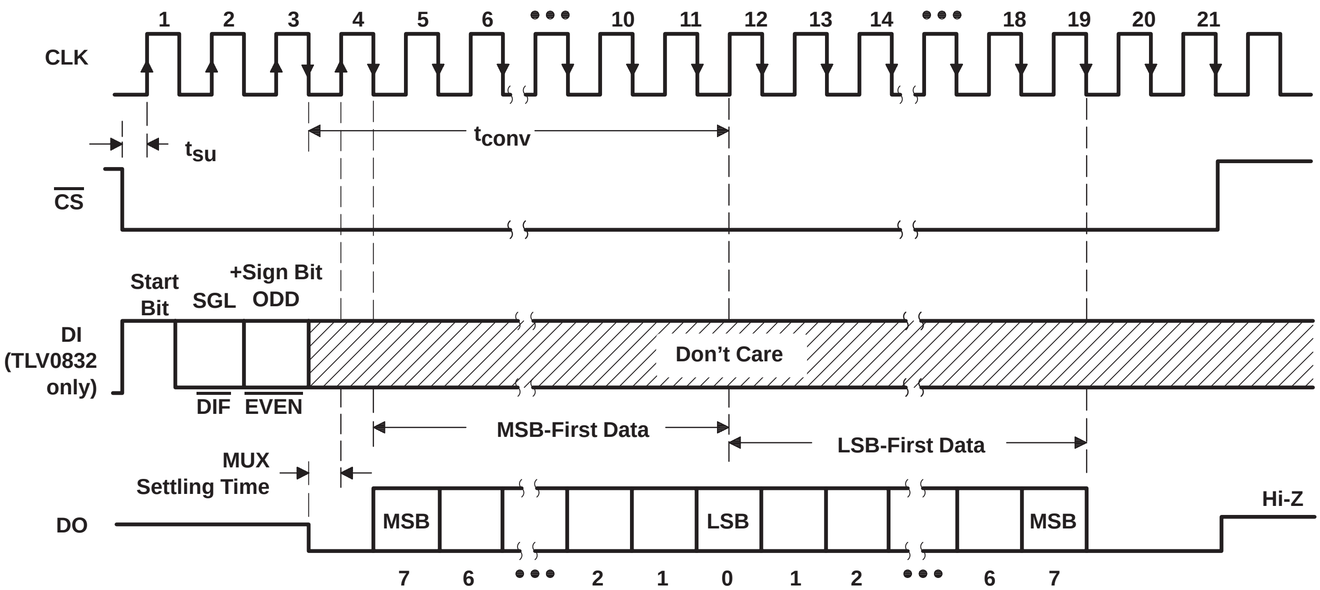
The TLV0832 outputs the least-significant-bit (LSB) first data after the MSB-first data stream. The DI and DO terminals can be tied together and controlled by a bidirectional processor I/O bit received on a single wire. This is possible because DI is only examined during the multiplexer-addressing interval and DO is still in the high-impedance state.

sequence of operation

TLV0831



TLV0832



TLV0832 MUX-ADDRESS CONTROL LOGIC TABLE

MUX ADDRESS		CHANNEL NUMBER	
SGL/$\overline{\text{DIF}}$	ODD/$\overline{\text{EVEN}}$	CH0	CH1
L	L	+	–
L	H	–	+
H	L	+	
H	H		+

H = high level, L = low level,
– or + = terminal polarity for the selected input channel

absolute maximum ratings over recommended operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} (see Note 1) . . . . 6.5 V
Input voltage range, V_I: Logic . . . . –0.3 V to V_{CC} + 0.3 V
Analog . . . . –0.3 V to V_{CC} + 0.3 V
Input current, I_I . . . . ±5 mA
Total input current . . . . ±20 mA
Operating free-air temperature range, T_A: C suffix . . . . 0°C to 70°C
I suffix . . . . –40°C to 85°C
Storage temperature range, T_{stg} . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: P package . . . . 260°C

† 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.

NOTE 1: All voltage values, except differential voltages, are with respect to the network ground terminal.

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC} (see clock operating conditions)		2.7	3.3	3.6	V
High-level input voltage, V_{IH}		2			V
Low-level input voltage, V_{IL}				0.8	V
Clock frequency, $f_{(CLK)}$	V_{CC} = 2.7 V			250	kHz
	V_{CC} = 3.3 V	10		600	kHz
Clock duty cycle (see Note 2)		40%		60%	
Pulse duration, $\overline{CS}$ high, $t_{wH(CS)}$		220			ns
Setup time, $\overline{CS}$ low or TLV0832 data valid before CLK↑, t_{su}		350			ns
Hold time, TLV0832 data valid after CLK↑, t_h		90			ns
Operating free-air temperature, T_A	C suffix	0		70	°C
	I suffix	–40		85	°C

NOTE 2: The clock-duty-cycle range ensures proper operation at all clock frequencies. When a clock frequency is used outside the recommended duty-cycle range, the minimum pulse duration (high or low) is 1 µs.

electrical characteristics over recommended range of operating free-air temperature, V_{CC} = 3.3 V, $f_{(CLK)}$ = 250 kHz (unless otherwise noted)

digital section

PARAMETER		TEST CONDITIONS†		C SUFFIX			I SUFFIX			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{OH}	High-level output voltage	V_{CC} = 3 V,	I_{OH} = –360 µA	2.8			2.4			V
		V_{CC} = 3 V,	I_{OH} = –10 µA	2.9			2.8			
V_{OL}	Low-level output voltage	V_{CC} = 3 V,	I_{OL} = 1.6 mA			0.34			0.4	V
I_{IH}	High-level input current	V_{IH} = 3.6 V			0.005	1		0.005	1	µA
I_{IL}	Low-level input current	V_{IL} = 0			–0.005	–1		–0.005	–1	µA
I_{OH}	High-level output (source) current	At V_{OH}, DO= 0 V,	T_A = 25°C	–6.5	–15		–6.5	–15		mA
I_{OL}	Low-level output (sink) current	At V_{OL}, DO= 0 V,	T_A = 25°C	8	–16		8	–16		mA
I_{OZ}	High-impedance-state output current (DO)	V_O = 3.3 V,	T_A = 25°C		0.01	3		0.01	3	µA
		V_O = 0,	T_A = 25°C		–0.01	–3		–0.01	–3	
C_i	Input capacitance				5			5		pF
C_o	Output capacitance				5			5		pF

† All parameters are measured under open-loop conditions with zero common-mode input voltage.
‡ All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

analog and converter section

PARAMETER			TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
V_{IC}	Common-mode input voltage		See Note 3	–0.05 to V_{CC}+0.05			V
$I_{I(stdby)}$	Standby input current (see Note 4)	On channel	V_I = 3.3 V			1	µA
		Off channel	V_I = 0			–1	
		On channel	V_I = 0			–1	
		Off channel	V_I = 3.3 V			1	
$r_{i(REF)}$	Input resistance to REF			1.3	2.4	5.9	kΩ

† All parameters are measured under open-loop conditions with zero common-mode input voltage.
‡ All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

NOTES: 3. When channel IN– is more positive than channel IN+, the digital output code is 0000 0000. Connected to each analog input are two on-chip diodes that conduct forward current for analog input voltages one diode drop above V_{CC}. Care must be taken during testing at low V_{CC} levels (3 V) because high-level analog input voltage (3.6 V) can, especially at high temperatures, cause the input diode to conduct and cause errors for analog inputs that are near full scale. As long as the analog voltage does not exceed the supply voltage by more than 50 mV, the output code is correct. To achieve an absolute 0- to 3.3-V input range requires a minimum V_{CC} of 3.25 V for all variations of temperature and load.

4. Standby input currents go in or out of the on or off channels when the A/D converter is not performing conversion and the clock is in a high or low steady-state conditions.

total device

PARAMETER			MIN	TYP‡	MAX	UNIT
I_{CC}	Supply current	TLV0831		0.2	0.75	mA
		TLV0832		1.5	2.5	

‡ All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

operating characteristics $V_{CC} = V_{ref} = 3.3$ V, $f_{(CLK)} = 250$ kHz, $t_r = t_f = 20$ ns, $T_A = 25°C$ (unless otherwise noted)

PARAMETER			TEST CONDITIONS†	MIN	TYP	MAX	UNIT
	Supply-voltage variation error		V_{CC} = 3 V to 3.6 V		±1/16	±1/4	LSB
	Total unadjusted error (see Note 5)		V_{ref} = 3.3 V, T_A = MIN to MAX			±1	LSB
	Common-mode error		Differential mode		±1/16	±1/4	LSB
t_{pd}	Propagation delay time, output data after CLK↑ (see Note 6)	MSB-first data	C_L = 100 pF		200	500	ns
		LSB-first data			80	200	
t_{dis}	Output disable time, DO after $\overline{CS}$↑		C_L = 10 pF, R_L = 10 kΩ		80	125	ns
			C_L = 100 pF, R_L = 2 kΩ			250	
t_{conv}	Conversion time (multiplexer-addressing time not included)					8	clock periods

† All parameters are measured under open-loop conditions with zero common-mode input voltage. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

NOTES: 5. Total unadjusted error includes offset, full-scale, linearity, and multiplexer errors.
6. The MSB-first data is output directly from the comparator and, therefore, requires additional delay to allow for comparator response time. LSB-first data applies only to TLV0832.

PARAMETER MEASUREMENT INFORMATION

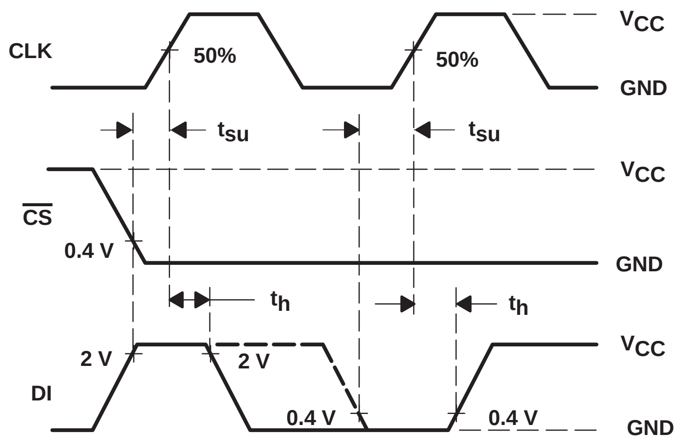


Figure 1. TLV0832 Data-Input Timing

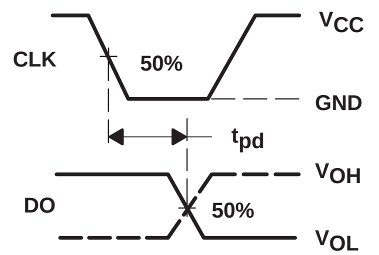
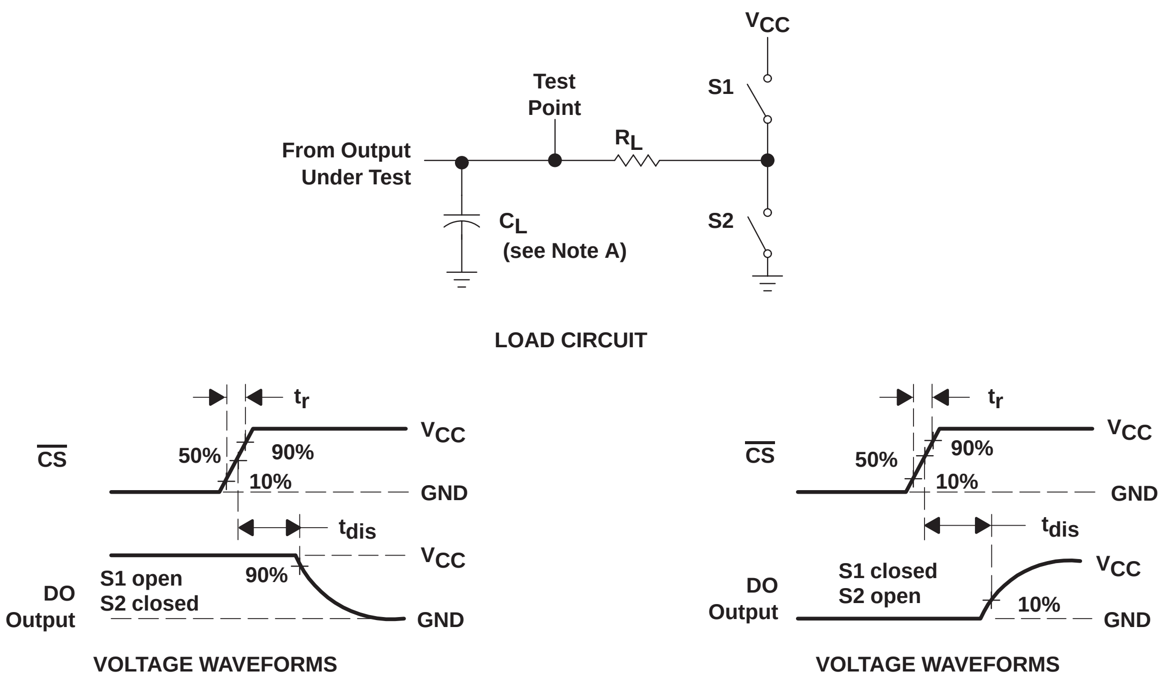


Figure 2. Data-Output Timing



NOTE A: C_L includes probe and jig capacitance.

Figure 3. Output Disable Time Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

UNADJUSTED OFFSET ERROR vs REFERENCE VOLTAGE

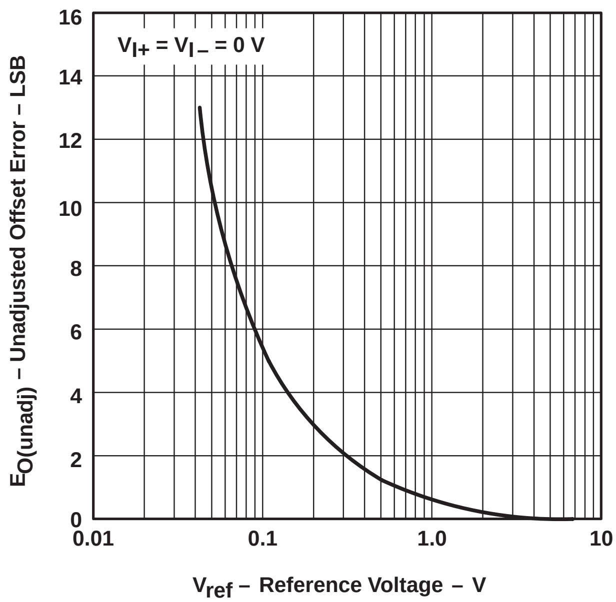


Figure 4

LINEARITY ERROR vs REFERENCE VOLTAGE

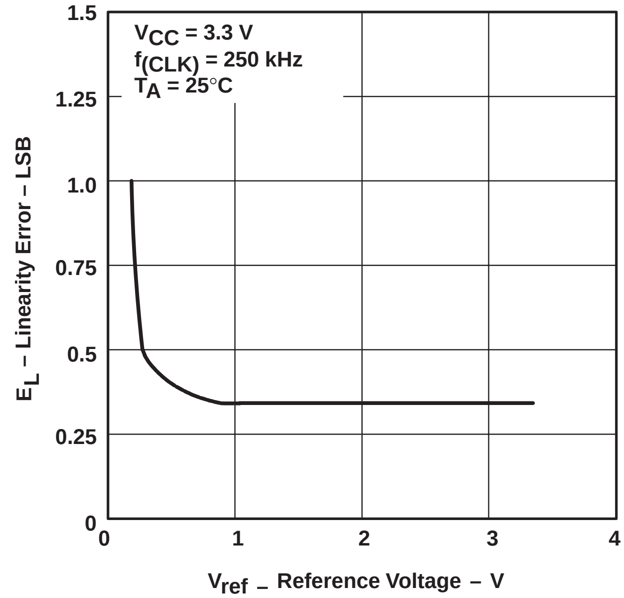


Figure 5

LINEARITY ERROR vs FREE-AIR TEMPERATURE

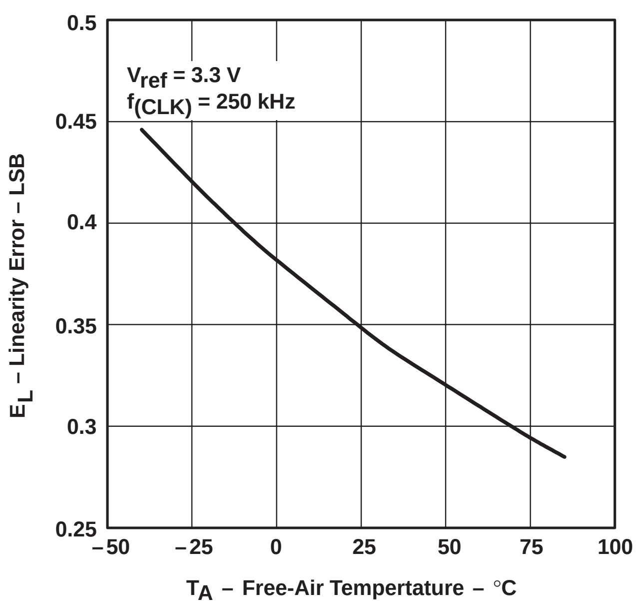


Figure 6

LINEARITY ERROR vs CLOCK FREQUENCY

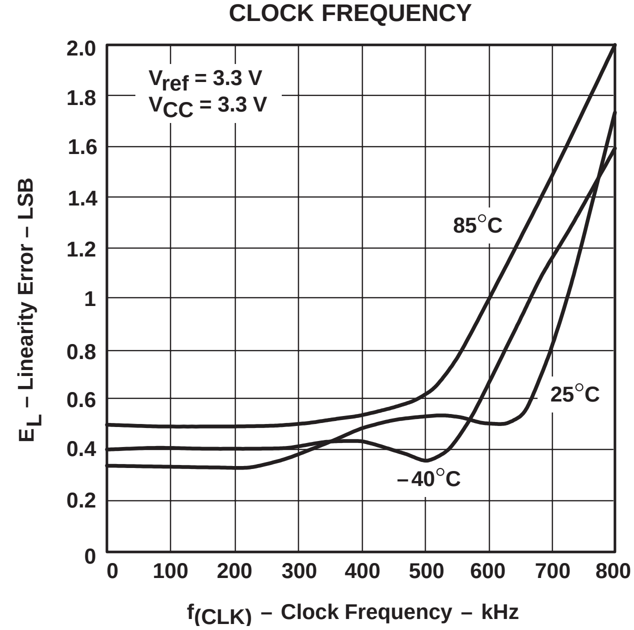


Figure 7

TYPICAL CHARACTERISTICS

TLV0831
SUPPLY CURRENT
vs
FREE-AIR TEMPERATURE

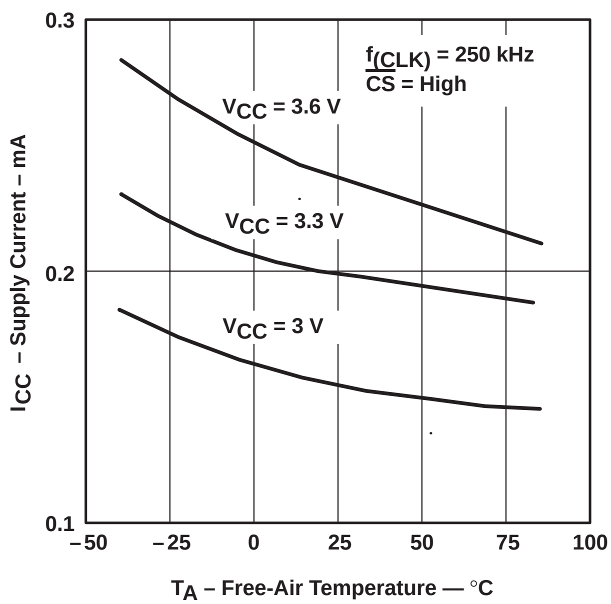


Figure 8

TLV0831
SUPPLY CURRENT
vs
CLOCK FREQUENCY

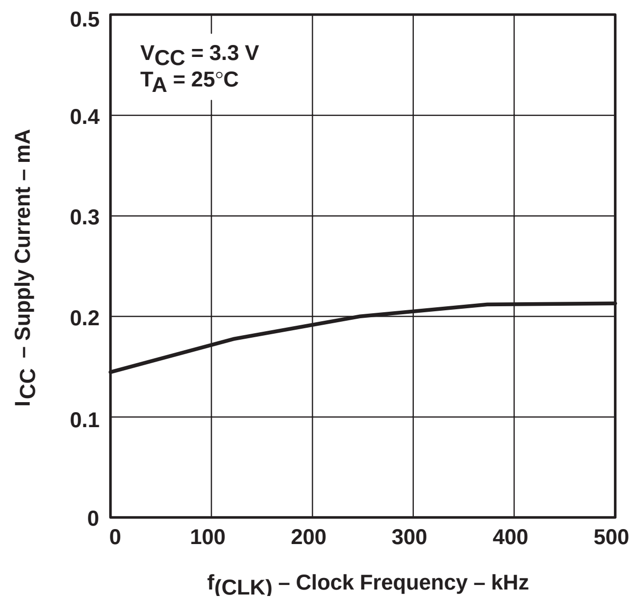


Figure 9

OUTPUT CURRENT
vs
FREE-AIR TEMPERATURE

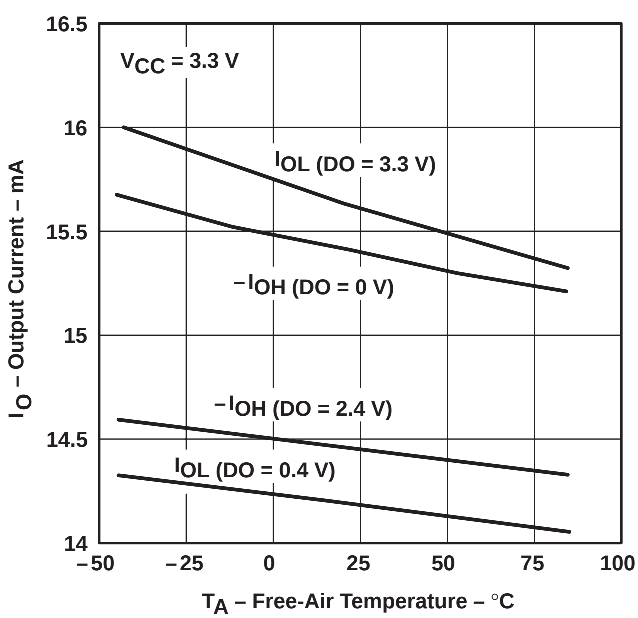


Figure 10

TYPICAL CHARACTERISTICS

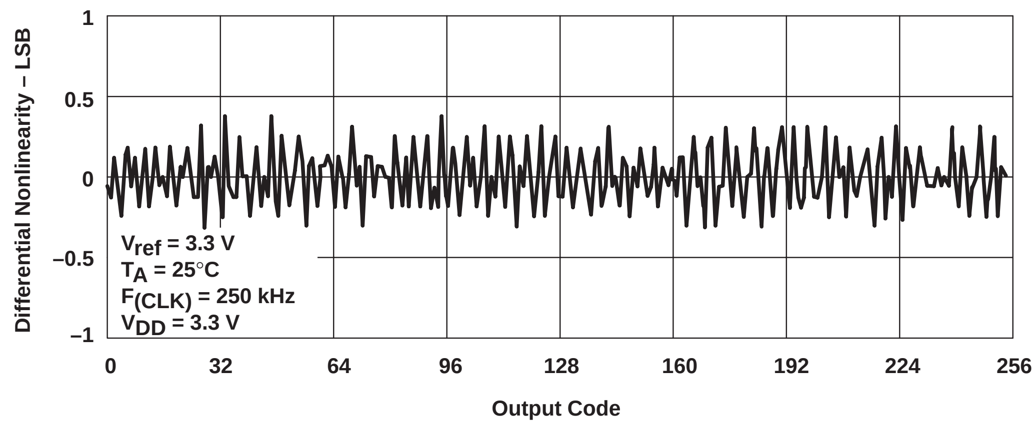


Figure 11. Differential Nonlinearity With Output Code

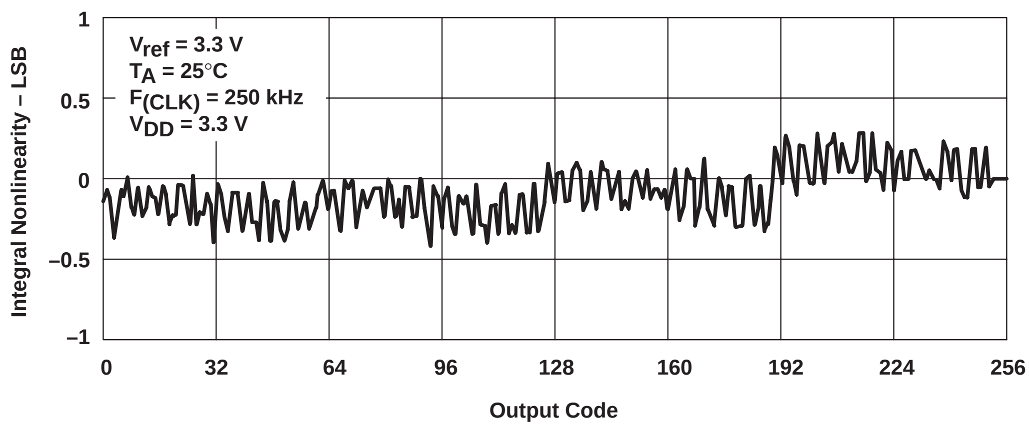


Figure 12. Integral Nonlinearity With Output Code

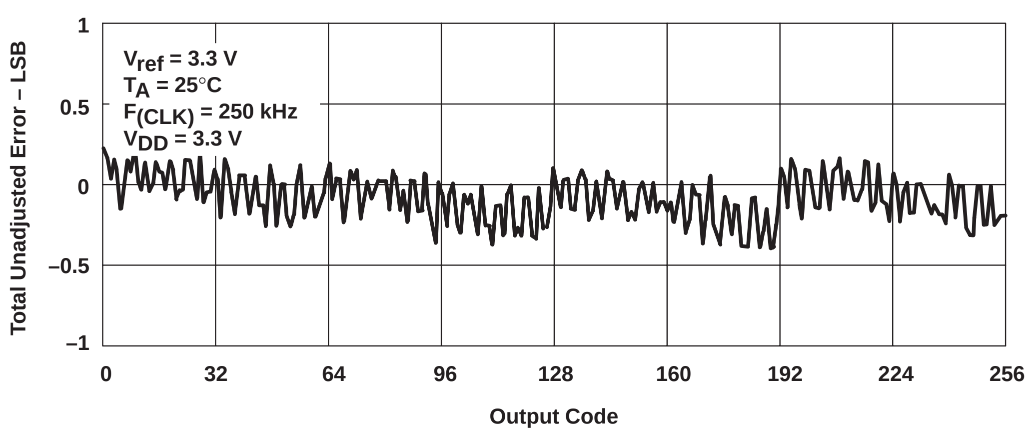


Figure 13. Total Unadjusted Error With Output Code

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
TLV0831CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV0831CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV0831ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0831IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV0831IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV0832CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV0832CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV0832ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV0832IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV0832IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type

[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.

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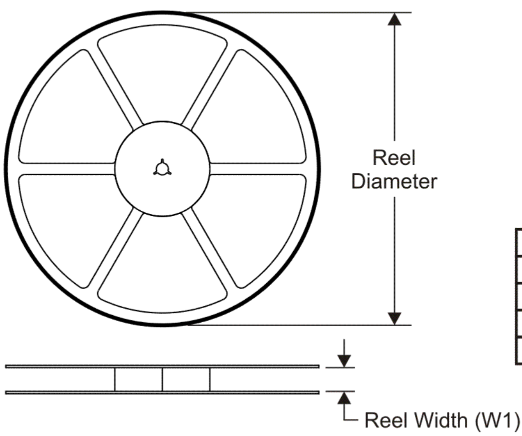
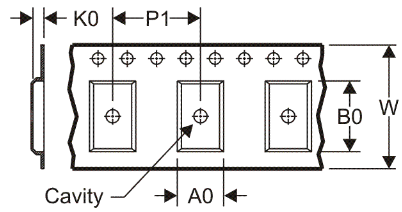
TAPE AND REEL INFORMATION

REEL DIMENSIONS

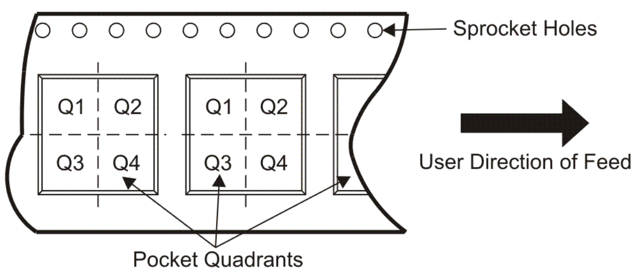


TAPE DIMENSIONS



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

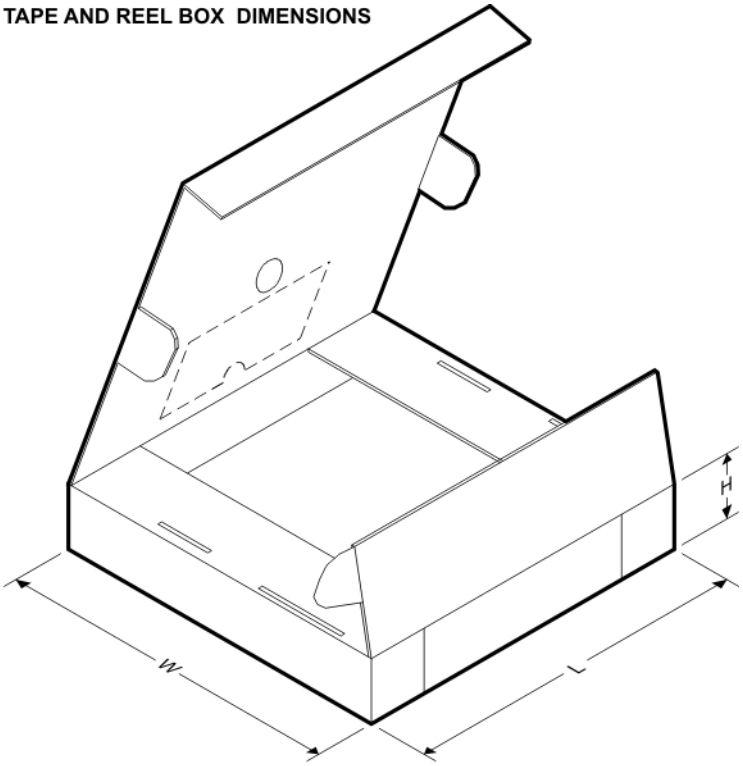
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TLV0831CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV0831IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV0832CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV0832IDR	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)
TLV0831CDR	SOIC	D	8	2500	346.0	346.0	29.0
TLV0831IDR	SOIC	D	8	2500	346.0	346.0	29.0
TLV0832CDR	SOIC	D	8	2500	346.0	346.0	29.0
TLV0832IDR	SOIC	D	8	2500	346.0	346.0	29.0

IMPORTANT NOTICE

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
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RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
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