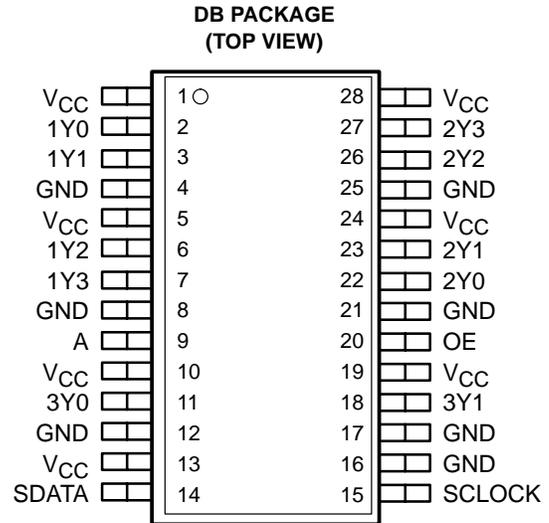


# CDC319

## 1-LINE TO 10-LINE CLOCK DRIVER WITH I<sup>2</sup>C CONTROL INTERFACE

SCAS590A – DECEMBER 1997 – REVISED OCTOBER 2001

- **High-Speed, Low-Skew 1-to-10 Clock Buffer for SDRAM (Synchronous DRAM) Clock Buffering Applications**
- **Output Skew,  $t_{sk(o)}$ , Less Than 250 ps**
- **Pulse Skew,  $t_{sk(p)}$ , Less Than 500 ps**
- **Supports up to Two Unbuffered SDRAM DIMMs (Dual Inline Memory Modules)**
- **I<sup>2</sup>C Serial Interface Provides Individual Enable Control for Each Output**
- **Operates at 3.3 V**
- **Distributed V<sub>CC</sub> and Ground Pins Reduce Switching Noise**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015**
- **Packaged in 28-Pin Shrink Small Outline (DB) Package**



### description

The CDC319 is a high-performance clock buffer that distributes one input (A) to 10 outputs (Y) with minimum skew for clock distribution. The CDC319 operates from a 3.3-V power supply, and is characterized for operation from 0°C to 70°C.

The device provides a standard mode (100K-bits/s) I<sup>2</sup>C serial interface for device control. The implementation is as a slave/receiver. The device address is specified in the I<sup>2</sup>C device address table. Both of the I<sup>2</sup>C inputs (SDATA and SCLOCK) provide integrated pullup resistors (typically 140 kΩ) and are 5-V tolerant.

Three 8-bit I<sup>2</sup>C registers provide individual enable control for each of the outputs. All outputs default to enabled at powerup. Each output can be placed in a disabled mode with a low-level output when a low-level control bit is written to the control register. The registers are write only and must be accessed in sequential order (i.e., random access of the registers is not supported).

The CDC319 provides 3-state outputs for testing and debugging purposes. The outputs can be placed in a high-impedance state via the output-enable (OE) input. When OE is high, all outputs are in the operational state. When OE is low, the outputs are placed in a high-impedance state. OE provides an integrated pullup resistor.



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
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# CDC319

## 1-LINE TO 10-LINE CLOCK DRIVER WITH I<sup>2</sup>C CONTROL INTERFACE

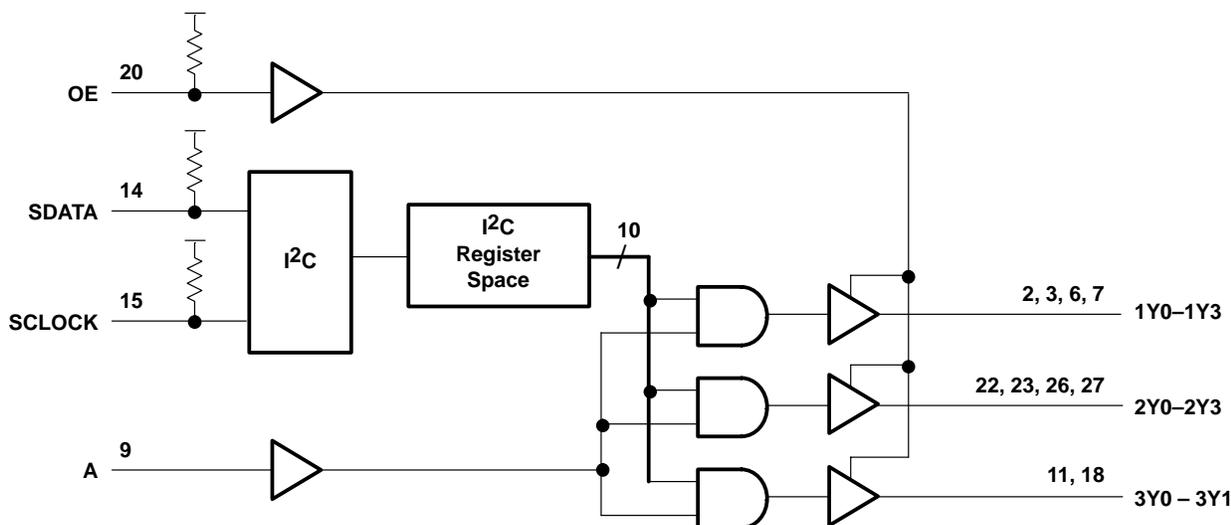
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FUNCTION TABLE

INPUTS		OUTPUTS		
OE	A	1Y0–1Y3	2Y0–2Y3	3Y0–3Y1
L	X	Hi-Z	Hi-Z	Hi-Z
H	L	L	L	L
H	H	H <sup>†</sup>	H <sup>†</sup>	H <sup>†</sup>

<sup>†</sup>The function table assumes that all outputs are enabled via the appropriate I<sup>2</sup>C configuration register bit. If the output is disabled via the appropriate configuration bit, then the output is driven to a low state, regardless of the state of the A input.

### logic diagram (positive logic)



### Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
1Y0–1Y3	2, 3, 6, 7	O	3.3-V SDRAM byte 0 clock outputs
2Y0–2Y3	22, 23, 26, 27	O	3.3-V SDRAM byte 1 clock outputs
3Y0–3Y1	11, 18	O	3.3-V clock outputs provided for feedback control of external PLLs (phase-locked loops)
A	9	I	Clock input
OE	20	I	Output enable. When asserted, OE puts all outputs in a high-impedance state. A nominal 140-k $\Omega$ pullup resistor is internally integrated.
SCLOCK	15	I	I <sup>2</sup> C serial clock input. A nominal 140-k $\Omega$ pullup resistor is internally integrated.
SDATA	14	I/O	Bidirectional I <sup>2</sup> C serial data input/output. A nominal 140-k $\Omega$ pullup resistor is internally integrated.
GND	4, 8, 12, 16, 17, 21, 25		Ground
V <sub>CC</sub>	1, 5, 10, 13, 19, 24, 28		3.3-V power supply

**I<sup>2</sup>C DEVICE ADDRESS**

A7	A6	A5	A4	A3	A2	A1	A0 (R/W)
H	H	L	H	L	L	H	—

**I<sup>2</sup>C BYTE 0-BIT DEFINITION†**

BIT	DEFINITION	DEFAULT VALUE
7	Reserved	H
6	Reserved	H
5	Reserved	H
4	Reserved	H
3	1Y3 enable (pin 7)	H
2	1Y2 enable (pin 6)	H
1	1Y1 enable (pin 3)	H
0	1Y0 enable (pin 2)	H

† When the value of the bit is high, the output is enabled.  
 When the value of the bit is low, the output is forced to a low state. The default value of all bits is high.

**I<sup>2</sup>C BYTE 1-BIT DEFINITION†**

BIT	DEFINITION	DEFAULT VALUE
7	2Y3 enable (pin 27)	H
6	2Y2 enable (pin 26)	H
5	2Y1 enable (pin 23)	H
4	2Y0 enable (pin 22)	H
3	Reserved	H
2	Reserved	H
1	Reserved	H
0	Reserved	H

† When the value of the bit is high, the output is enabled.  
 When the value of the bit is low, the output is forced to a low state. The default value of all bits is high.

**I<sup>2</sup>C BYTE 2-BIT DEFINITION†**

BIT	DEFINITION	DEFAULT VALUE
7	3Y1 enable (pin 18)	H
6	3Y0 enable (pin 11)	H
5	Reserved	H
4	Reserved	H
3	Reserved	H
2	Reserved	H
1	Reserved	H
0	Reserved	H

† When the value of the bit is high, the output is enabled.  
 When the value of the bit is low, the output is forced to a low state. The default value of all bits is high.

# CDC319

## 1-LINE TO 10-LINE CLOCK DRIVER WITH I<sup>2</sup>C CONTROL INTERFACE

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

Supply voltage range, $V_{CC}$	–0.5 V to 4.6 V
Input voltage range, $V_I$ (see Note 1)	–0.5 V to 4.6 V
Input voltage range, $V_I$ (SCLOCK, SDATA) (see Note 1)	–0.5 V to 6.5 V
Output voltage range, $V_O$ (SDATA) (see Note 1)	–0.5 V to 6.5 V
Voltage range applied to any output in the high-impedance or power-off state, $V_O$	–0.5 V to $V_{CC} + 0.5$ V
Current into any output in the low state (except SDATA), $I_O$	48 mA
Current into SDATA in the low state, $I_O$	12 mA
Input clamp current, $I_{IK}$ ( $V_I < 0$ ) (SCLOCK)	–50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ ) (SDATA)	–50 mA
Package thermal impedance, $\theta_{JA}$ (see Note 2)	120 °C/W
Storage temperature range, $T_{stg}$	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	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.

- NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.  
2. The package thermal impedance is calculated in accordance with EIA/JEDEC Std JESD51, except for through-hole packages, which use a trace length of zero.

### recommended operating conditions (see Note 3)

		MIN	TYP	MAX	UNIT
$V_{CC}$	3.3-V core supply voltage	3.135		3.465	V
$V_{IH}$	High-level input voltage	A, OE	2	$V_{CC}+0.3$	V
		SDATA, SCLOCK (see Note 3)	2.2	5.5	V
$V_{IL}$	Low-level input voltage	A, OE	–0.3	0.8	V
		SDATA, SCLOCK (see Note 3)	0	1.04	V
$I_{OH}$	High-level output current			–24	mA
$I_{OL}$	Low-level output current			24	mA
$R_I$	Input resistance to $V_{CC}$		140		k $\Omega$
$f(SCL)$	SCLOCK frequency			100	kHz
$t(BUS)$	Bus free time	4.7			$\mu$ s
$t_{su}(START)$	START setup time	4.7			$\mu$ s
$t_h(START)$	START hold time	4			$\mu$ s
$t_w(SCLL)$	SCLOCK low pulse duration	4.7			$\mu$ s
$t_w(SCLH)$	SCLOCK high pulse duration	4			$\mu$ s
$t_r(SDATA)$	SDATA input rise time			1000	ns
$t_f(SDATA)$	SDATA input fall time			300	ns
$t_{su}(SDATA)$	SDATA setup time	250			ns
$t_h(SDATA)$	SDATA hold time	0			ns
$t_{su}(STOP)$	STOP setup time	4			$\mu$ s
$T_A$	Operating free-air temperature	0		70	°C

NOTE 3: The CMOS-level inputs fall within these limits:  $V_{IH} \text{ min} = 0.7 \times V_{CC}$  and  $V_{IL} \text{ max} = 0.3 \times V_{CC}$ .



**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)**

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT	
V <sub>IK</sub>	Input clamp voltage		V <sub>CC</sub> = 3.135 V, I <sub>I</sub> = -18 mA			-1.2	V	
V <sub>OH</sub>	High-level output voltage	Y outputs	V <sub>CC</sub> = 3.135 V, I <sub>OH</sub> = -1 mA	2.4			V	
V <sub>OL</sub>	Low-level output voltage	Y outputs	V <sub>CC</sub> = 3.135 V, I <sub>OL</sub> = 1 mA			0.4	V	
		SDATA	V <sub>CC</sub> = 3.135 V	I <sub>OL</sub> = 3 mA	0.1	0.4		
				I <sub>OL</sub> = 6 mA	0.2	0.6		
I <sub>OH</sub>	High-level output current	SDATA	V <sub>CC</sub> = 3.135 V, V <sub>O</sub> = V <sub>CC</sub> MAX			20	μA	
		Y outputs	V <sub>CC</sub> = 3.135 V, V <sub>O</sub> = 2 V		-54	-126		
				V <sub>CC</sub> = 3.3 V, V <sub>O</sub> = 2.6 V		-60		
I <sub>OL</sub>	Low-level output current	Y outputs	V <sub>CC</sub> = 3.465 V, V <sub>O</sub> = 3.135 V	-21		-46	mA	
			V <sub>CC</sub> = 3.135 V, V <sub>O</sub> = 1 V	49		118		
			V <sub>CC</sub> = 3.3 V, V <sub>O</sub> = 0.7 V		58			
I <sub>IL</sub>	Low-level input current	A	V <sub>CC</sub> = 3.465 V, V <sub>I</sub> = GND			-5	μA	
		OE				-10		-50
		SCLOCK, SDATA				-10		-50
I <sub>OZ</sub>	High-impedance-state output current		V <sub>CC</sub> = 3.465 V, V <sub>O</sub> = 3.465 V or 0			±10	μA	
I <sub>off</sub>	Off-state current	SCLOCK, SDATA	V <sub>CC</sub> = 0 V, V <sub>I</sub> = 0 V to 5.5 V			50	μA	
I <sub>CC</sub>	Supply current		V <sub>CC</sub> = 3.465 V, I <sub>O</sub> = 0		0.2	0.5	mA	
ΔI <sub>CC</sub>	Change in supply current		V <sub>CC</sub> = 3.135 V to 3.465 V, One input at V <sub>CC</sub> - 0.6 V, All other inputs at V <sub>CC</sub> or GND			500	μA	
C <sub>i</sub>	Input capacitance		V <sub>I</sub> = V <sub>CC</sub> or GND, V <sub>CC</sub> = 3.3 V		4		pF	
C <sub>o</sub>	Output capacitance		V <sub>O</sub> = V <sub>CC</sub> or GND, V <sub>CC</sub> = 3.3 V		6		pF	
C <sub>I/O</sub>	SDATA I/O capacitance		V <sub>I/O</sub> = V <sub>CC</sub> or GND, V <sub>CC</sub> = 3.3 V		7		pF	

# CDC319

## 1-LINE TO 10-LINE CLOCK DRIVER WITH I<sup>2</sup>C CONTROL INTERFACE

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### switching characteristics over recommended operating conditions

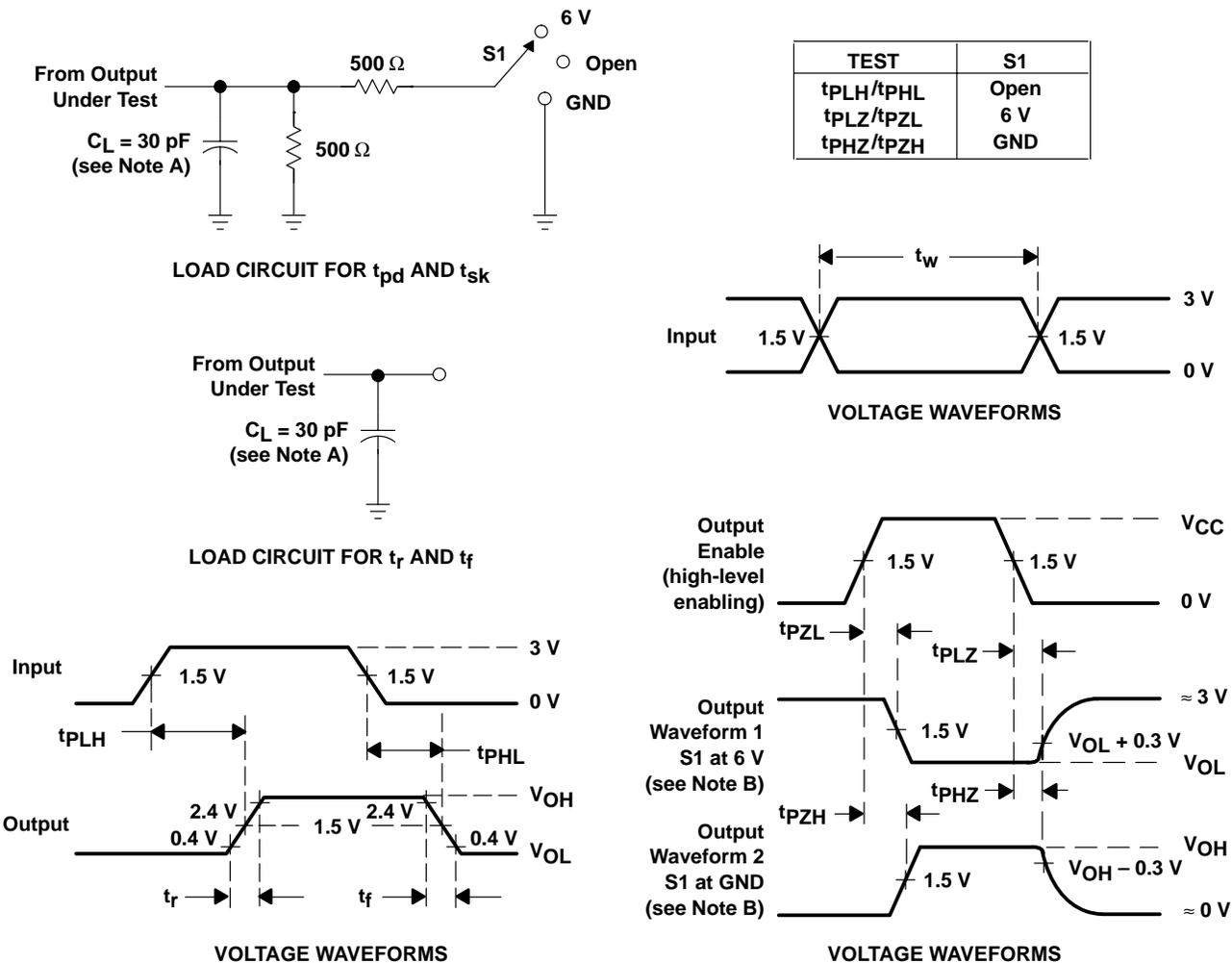
PARAMETER		FROM	TO	TEST CONDITIONS	MIN	MAX	UNIT
t <sub>PLH</sub>	Low-to-high level propagation delay time	A	Y		1.2	3.6	ns
		SCLOCK↓	SDATA valid	V <sub>CC</sub> = 3.3 V ±0.185 V, See Figure 3		2	μs
t <sub>PLH</sub>	Low-to-high level propagation delay time	SDATA↑	Y	V <sub>CC</sub> = 3.3 V ±0.185 V, See Figure 3		150	ns
t <sub>PHL</sub>	High-to-low level propagation delay time	A	Y		1.2	3.6	ns
		SCLOCK↓	SDATA valid	V <sub>CC</sub> = 3.3 V ±0.185 V, See Figure 3		2	μs
t <sub>PHL</sub>	High-to-low level propagation delay time	SDATA↑	Y	V <sub>CC</sub> = 3.3 V ±0.185 V, See Figure 3		150	ns
t <sub>PZH</sub>	Enable time to the high level	OE	Y		1	4.7	ns
t <sub>PZL</sub>	Enable time to the low level						
t <sub>PHZ</sub>	Disable time from the high level						
t <sub>PLZ</sub>	Disable time from the low level						
t <sub>sk(o)</sub>	Skew time	A	Y			250	ps
t <sub>sk(p)</sub>	Skew time	A	Y			500	ps
t <sub>sk(pr)</sub>	Skew time	A	Y			1	ns
t <sub>r</sub>	Rise time		Y		0.5	1.3	ns
t <sub>r</sub>	Rise time (see Note 4 and Figure 3)	SDATA		C <sub>L</sub> = 10 pF	6		ns
				C <sub>L</sub> = 400 pF		250	
t <sub>f</sub>	Fall time		Y		0.5	1.3	ns
t <sub>f</sub>	Fall time (see Note 4 and Figure 3)	SDATA		C <sub>L</sub> = 10 pF	20		ns
				C <sub>L</sub> = 400 pF		250	
f	Operating frequency (see Note 5)			C <sub>L</sub> = 30 pF, T <sub>A</sub> = 70°C		100	MHz
				C <sub>L</sub> = 20 pF, T <sub>A</sub> = 70°C		125	
				C <sub>L</sub> = 15 pF, T <sub>A</sub> = 70°C		140	

NOTES: 4. This parameter has a lower limit than BUS specification. This allows use of series resistors for current spike protection.

5. See Figure 4 (Frequency versus Capacitive Load).



**PARAMETER MEASUREMENT INFORMATION**



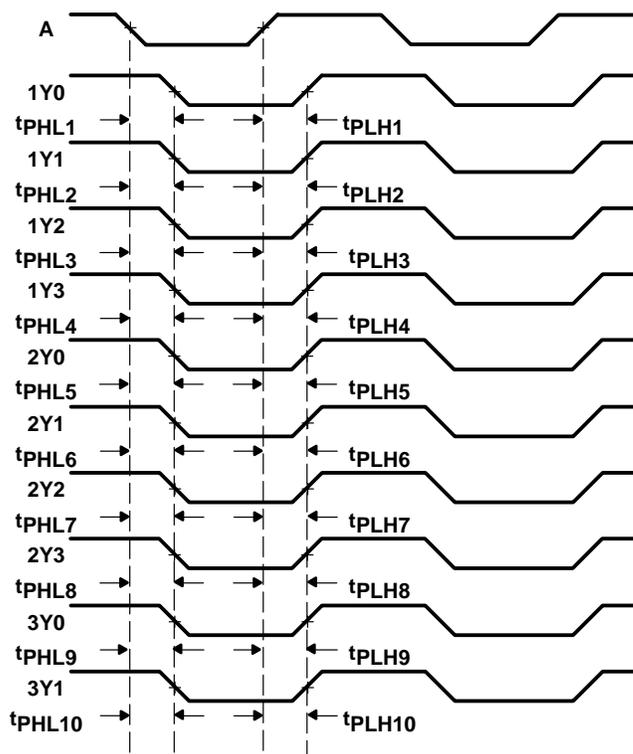
- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.  
 C. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .  
 D. The outputs are measured one at a time with one transition per measurement.

**Figure 1. Load Circuit and Voltage Waveforms**

**CDC319**  
**1-LINE TO 10-LINE CLOCK DRIVER**  
**WITH I<sup>2</sup>C CONTROL INTERFACE**

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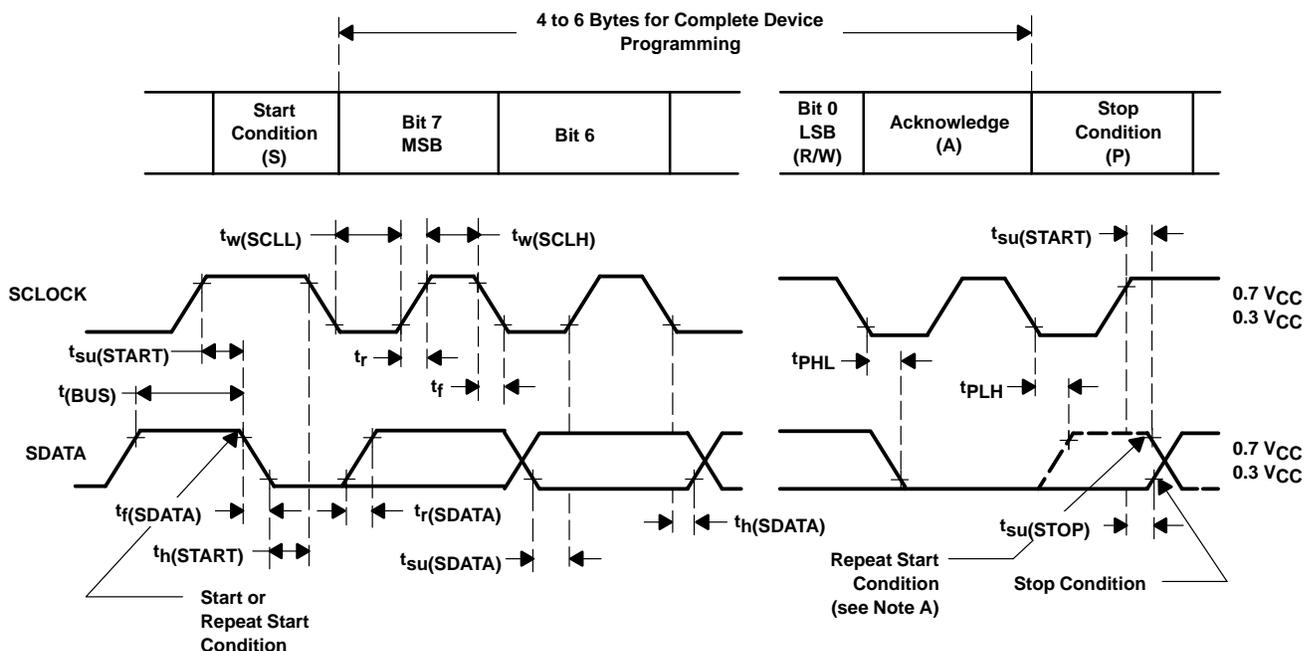
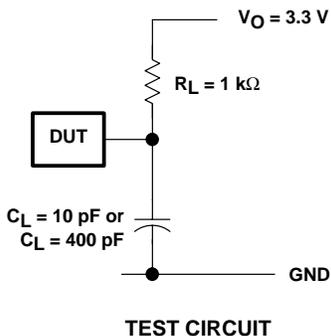
**PARAMETER MEASUREMENT INFORMATION**



- NOTES: A. Output skew,  $t_{sk(o)}$ , is calculated as the greater of:
- The difference between the fastest and slowest of  $t_{PLHn}$  ( $n = 1:10$ )
  - The difference between the fastest and slowest of  $t_{PHLn}$  ( $n = 1:10$ )
- B. Pulse skew,  $t_{sk(p)}$ , is calculated as the greater of  $|t_{PLHn} - t_{PHLn}|$  ( $n = 1:10$ ).
- C. Process skew,  $t_{sk(pr)}$ , is calculated as the greater of:
- The difference between the fastest and slowest of  $t_{PLHn}$  ( $n = 1:10$ ) across multiple devices under identical operating conditions
  - The difference between the fastest and slowest of  $t_{PHLn}$  ( $n = 1:10$ ) across multiple devices under identical operating conditions

**Figure 2. Waveforms for Calculation of  $t_{sk(o)}$ ,  $t_{sk(p)}$ ,  $t_{sk(pr)}$**

**PARAMETER MEASUREMENT INFORMATION**



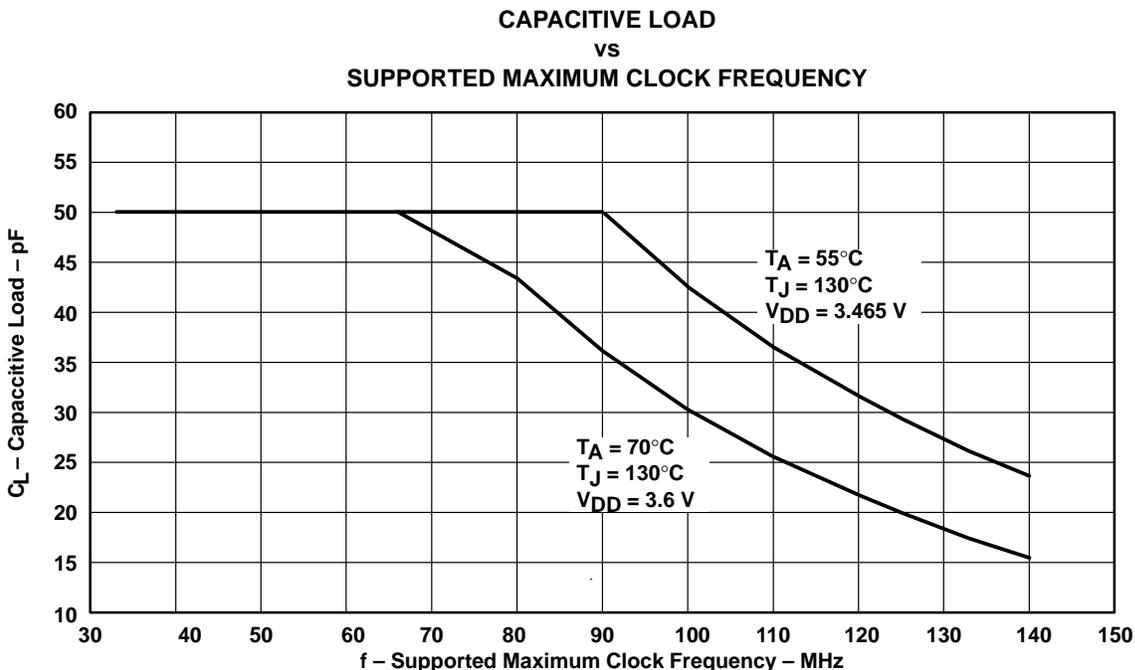
BYTE	DESCRIPTION
1	I <sup>2</sup> C address
2	Command (dummy value, ignored)
3	Byte count (dummy value, ignored)
4	I <sup>2</sup> C data byte 0
5	I <sup>2</sup> C data byte 1
6	I <sup>2</sup> C data byte 2

NOTES: A. The repeat start condition is not supported.  
 B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 100 kHz, Z<sub>O</sub> = 50 Ω, t<sub>r</sub> ≥ 10 ns, t<sub>f</sub> ≥ 10 ns.

**Figure 3. Propagation Delay Times, t<sub>r</sub> and t<sub>f</sub>**

**CDC319**  
**1-LINE TO 10-LINE CLOCK DRIVER**  
**WITH I<sup>2</sup>C CONTROL INTERFACE**

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NOTES: A. With a total capacitive load of 20 pF for each output, the CDC319 is capable of running up to about 125 MHz. A lower capacitive load will allow higher application frequencies, up to 133 MHz (140 MHz).

B. CPD for the CDC319 is about 25 pF per output (21 pF if  $C_L < 20$  pF)  
 $P(\text{total}) = V_{DD}^2 \times CPD \times F_O \times N + (V_{OH} - V_{OL})^2 \times C_L \times F_O \times N + \text{DC load}$

where:

N = number of switching outputs

$F_O$  = clock frequency

Package thermal impedance (junction-to-ambient) = 92.4°C/W

Maximum junction temperature = 150°C (<125°C recommended)

**Figure 4**

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">CDC319DB</a>	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	CDC319
CDC319DB.B	Active	Production	SSOP (DB)   28	50   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	CDC319
<a href="#">CDC319DBR</a>	Active	Production	SSOP (DB)   28	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	CDC319
CDC319DBR.B	Active	Production	SSOP (DB)   28	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	CDC319

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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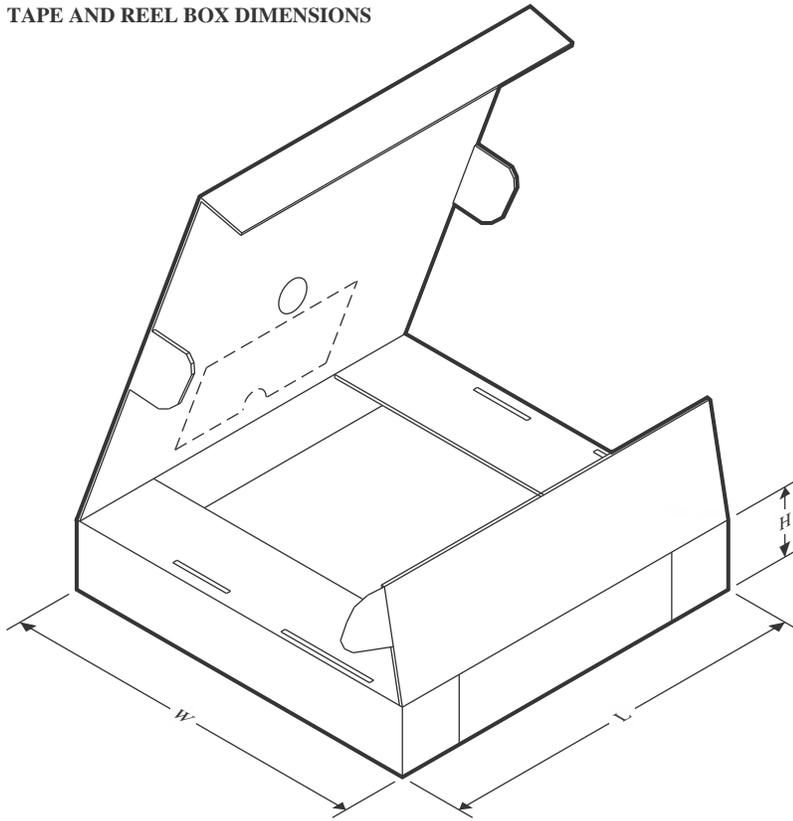
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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**

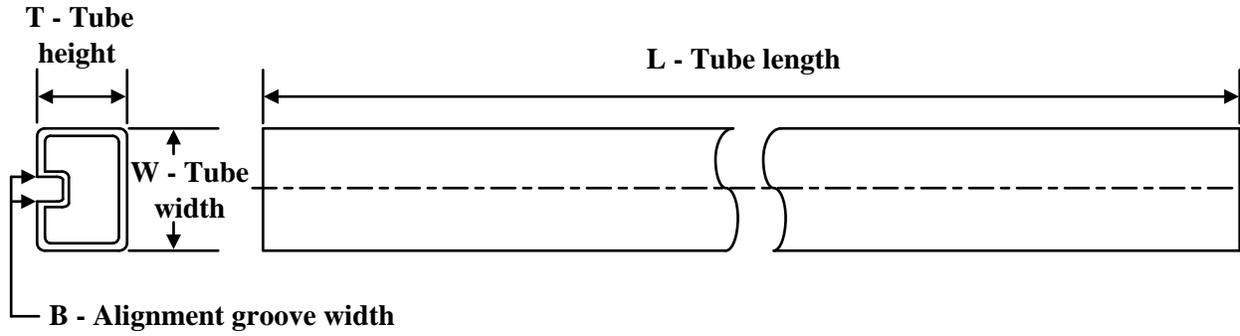

\*All dimensions are nominal

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
CDC319DBR	SSOP	DB	28	2000	330.0	16.4	8.45	10.55	2.5	12.0	16.2	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CDC319DBR	SSOP	DB	28	2000	353.0	353.0	32.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
CDC319DB	DB	SSOP	28	50	530	10.5	4000	4.1
CDC319DB.B	DB	SSOP	28	50	530	10.5	4000	4.1

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