

- Qualification in Accordance With AEC-Q100†
- Qualified for Automotive Applications
- Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval
- Designed for High-Speed Multipoint Data Transmission Over Long Cables
- Operate With Pulse Durations as Low as 30 ns
- Low Supply Current . . . 5 mA Max
- Meet or Exceed the Requirements of ANSI Standard RS-485 and ISO 8482:1987(E)
- 3-State Outputs for Party-Line Buses
- Common-Mode Voltage Range of -7 V to 12 V
- Thermal Shutdown Protection Prevents Driver Damage From Bus Contention
- Positive and Negative Output Current Limiting
- Pin Compatible With the SN75ALS180

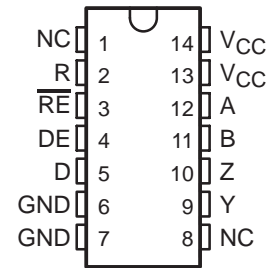
† Contact factory for details. Q100 qualification data available on request.

description

The SN65LBC180 differential driver and receiver pair is a monolithic integrated circuit designed for bidirectional data communication over long cables that take on the characteristics of transmission lines. It is a balanced, or differential, voltage mode device that meets or exceeds the requirements of industry standards ANSI RS-485 and ISO 8482:1987(E). The device is designed using TI's proprietary LinBiCMOS™ with the low power consumption of CMOS and the precision and robustness of bipolar transistors in the same circuit.

The SN65LBC180 combines a differential line driver and receiver with 3-state outputs and operates from a single 5-V supply. The driver and receiver have active-high and active-low enables, respectively, which can be externally connected to function as a direction control. The driver differential outputs and the receiver differential inputs are connected to separate terminals for full-duplex operation and are designed to present minimum loading to the bus whether disabled or powered off ($V_{CC} = 0$). This part features a wide common-mode voltage range making it suitable for point-to-point or multipoint data-bus applications.

D PACKAGE
(TOP VIEW)



NC—No internal connection

Function Tables

DRIVER

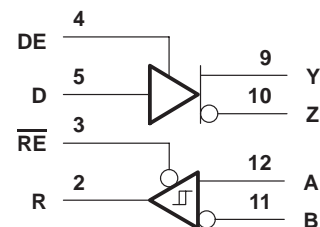
INPUT D	ENABLE DE	OUTPUTS	
		Y	Z
H	H	H	L
L	H	L	H
X	L	Z	Z

RECEIVER

DIFFERENTIAL INPUTS A-B	ENABLE \overline{RE}	OUTPUT R
$V_{ID} \geq 0.2$ V	L	H
-0.2 V < $V_{ID} < 0.2$ V	L	?
$V_{ID} \leq -0.2$ V	L	L
X	H	Z
Open circuit	L	H

H = high level, L = low level, ? = indeterminate, X = irrelevant, Z = high impedance (off)

logic diagram (positive logic)



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LinBiCMOS is a trademark of Texas Instruments Incorporated.

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
INSTRUMENTS**

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SN65LBC180-Q1

LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIR

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description/ordering information (continued)

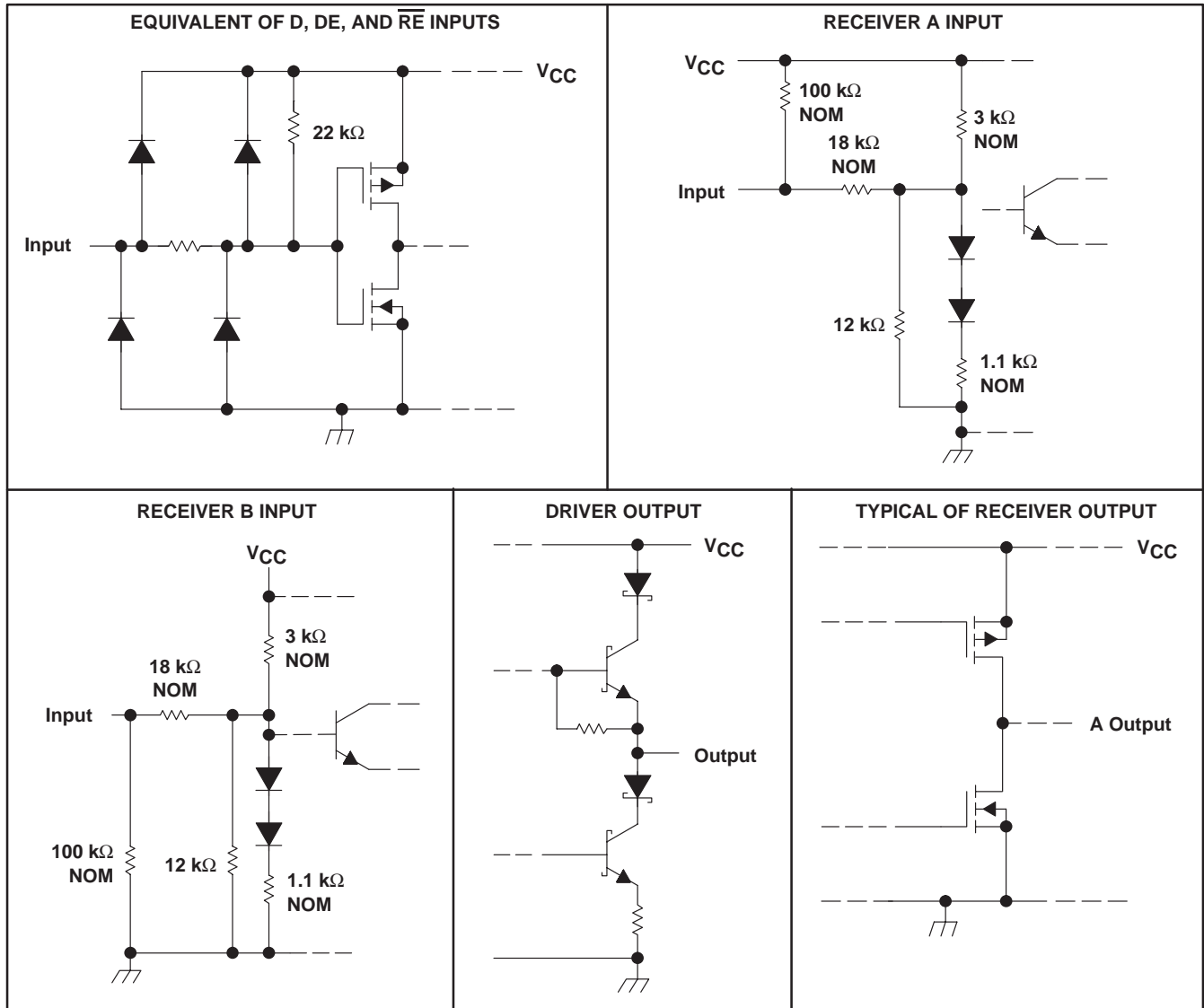
ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SOIC – D	Tape and reel	SN65LBC180IDRQ1	LBC180Q1

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

The devices also provide positive and negative output-current limiting and thermal shutdown for protection from line fault conditions. The line driver shuts down at a junction temperature of approximately 172°C.

schematics of inputs and outputs



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LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIR

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

Supply voltage range, V_{CC} (see Note 1)	–0.3 V to 7 V
Input voltage range, V_I (A, B)(see Note 1)	–10 V to 15 V
Voltage range at D, R, DE, \overline{RE} (see Note 1)	–0.3 V to $V_{CC} + 0.5$ V
Continuous total power dissipation (see Note 2)	Internally limited
Total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A	–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	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. All voltage values are with respect to GND.

2. The maximum operating junction temperature is internally limited. Use the dissipation rating table to operate below this temperature.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/°C	608 mW	494 mW

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.75	5	5.25	V
High-level input voltage, V_{IH}	D, DE, and \overline{RE}	2			V
Low-level input voltage, V_{IL}	D, DE, and \overline{RE}	0.8			V
Differential input voltage, V_{ID}		–6 [‡]		6	V
Voltage at any bus terminal (separately or common mode), V_O , V_I , or V_{IC}	A, B, Y, or Z	–7 [‡]		12	V
High-level output current, I_{OH}	Y or Z	–60			mA
	R	–8			
Low-level output current, I_{OL}	Y or Z	60			mA
	R	8			
Operating free-air temperature, T_A		–40		85	°C

[‡] The algebraic convention where the least positive (more negative) limit is designated minimum, is used in this data sheet for the differential input voltage, voltage at any bus terminal, operating temperature, input threshold voltage, and common-mode output voltage.



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LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIR

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DRIVER SECTION

electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V _{IK}	Input clamp voltage	I _I = -18 mA				-1.5	V
V _{OD}	Differential output voltage magnitude (see Note 3)	R _L = 54 Ω,	See Figure 1	1.1	2.5	5	V
		R _L = 60 Ω,	See Figure 2	1.1	2	5	
Δ V _{OD}	Change in magnitude of differential output voltage (see Note 4)	See Figures 1 and 2				±0.2	V
V _{OC}	Common-mode output voltage			1	2.5	3	V
Δ V _{OC}	Change in magnitude of common-mode output voltage (see Note 4)	R _L = 54 Ω,	See Figure 1			±0.2	V
I _O	Output current with power off	V _{CC} = 0,	V _O = -7 V to 12 V			±100	μA
I _{OZ}	High-impedance-state output current	V _O = -7 V to 12 V				±100	μA
I _{IH}	High-level input current	V _I = 2.4 V				-100	μA
I _{IL}	Low-level input current	V _I = 0.4 V				-100	μA
I _{OS}	Short-circuit output current	-7 V ≤ V _O ≤ 12 V				±250	mA
I _{CC}	Supply current	Receiver disabled	Outputs enabled			5	mA
			Outputs disabled			3	

† All typical values are at V_{CC} = 5 V and T_A = 25°C.

NOTES: 3. The minimum V_{OD} specification of the SN65LBC180 may not fully comply with ANSI RS-485 at operating temperatures below 0°C. System designers should take the possibly lower output signal into account in determining the maximum signal-transmission distance.

4. Δ|V_{OD}| and Δ|V_{OC}| are the changes in the steady-state magnitude of V_{OD} and V_{OC}, respectively, that occur when the input is changed from a high level to a low level.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t _{d(OD)}	Differential output delay time	R _L = 54 Ω,	See Figure 3	7	12	18	ns
t _{t(OD)}	Differential output transition time			5	10	20	ns
t _{PZH}	Output enable time to high level	R _L = 110 Ω,	See Figure 4			35	ns
t _{PZL}	Output enable time to low level	R _L = 110 Ω,	See Figure 5			35	ns
t _{PHZ}	Output disable time from high level	R _L = 110 Ω,	See Figure 4			50	ns
t _{PLZ}	Output disable time from low level	R _L = 110 Ω,	See Figure 5			35	ns



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RECEIVER SECTION

electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IT+}	Positive-going input threshold voltage	$I_O = -8 \text{ mA}$			0.2	V
V_{IT-}	Negative-going input threshold voltage	$I_O = 8 \text{ mA}$	-0.2			V
V_{hys}	Hysteresis voltage ($V_{IT+} - V_{IT-}$)			45		mV
V_{IK}	Enable-input clamp voltage	$I_I = -18 \text{ mA}$			-1.5	V
V_{OH}	High-level output voltage	$V_{ID} = 200 \text{ mV}$, $I_{OH} = -8 \text{ mA}$	3.5	4.5		V
V_{OL}	Low-level output voltage	$V_{ID} = -200 \text{ mV}$, $I_{OL} = 8 \text{ mA}$		0.3	0.5	V
I_{OZ}	High-impedance-state output current	$V_O = 0 \text{ V to } V_{CC}$			± 20	μA
I_{IH}	High-level enable-input current	$V_{IH} = 2.4 \text{ V}$			-50	μA
I_{IL}	Low-level enable-input current	$V_{IL} = 0.4 \text{ V}$			-100	μA
I_I	Bus input current	$V_I = 12 \text{ V}$, $V_{CC} = 5 \text{ V}$, Other input at 0 V		0.7	1	mA
		$V_I = 12 \text{ V}$, $V_{CC} = 0 \text{ V}$, Other input at 0 V		0.8	1	
		$V_I = -7 \text{ V}$, $V_{CC} = 5 \text{ V}$, Other input at 0 V		-0.5	-0.8	
		$V_I = -7 \text{ V}$, $V_{CC} = 0 \text{ V}$, Other input at 0 V		-0.5	-0.8	
I_{CC}	Supply current	Driver disabled	Outputs enabled		5	mA
			Outputs disabled		3	

switching characteristics, $V_{CC} = 5 \text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high- to low-level output	$V_{ID} = -1.5 \text{ V to } 1.5 \text{ V}$, See Figure 6	11	22	33	ns
t_{PLH}	Propagation delay time, low- to high-level output		11	22	33	ns
$t_{sk(p)}$	Pulse skew ($ t_{PHL} - t_{PLH} $)		3	6		ns
t_t	Transition time		5	8		ns
t_{PZH}	Output enable time to high level	See Figure 7			35	ns
t_{PZL}	Output enable time to low level				30	ns
t_{PHZ}	Output disable time from high level				35	ns
t_{PLZ}	Output disable time from low level				30	ns

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PARAMETER MEASUREMENT INFORMATION

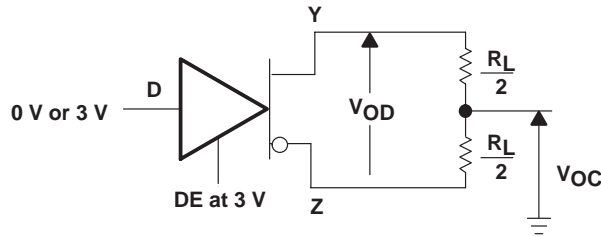


Figure 1. Differential and Common-Mode Output Voltages

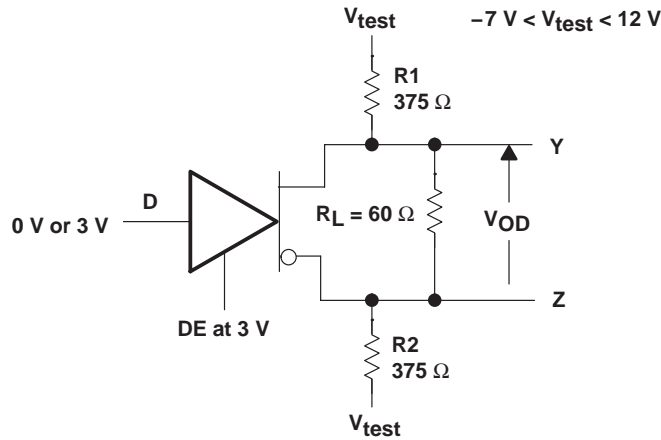
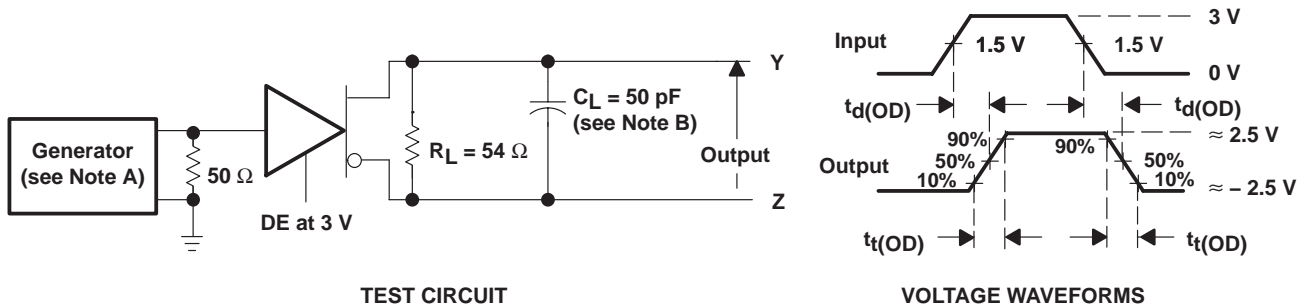


Figure 2. Driver V_{OD} Test Circuit



- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR > 1 MHz, 50% duty cycle, $t_r \leq 6$ ns, $t_f \leq 6$ ns, $Z_O = 50 \Omega$.
B. C_L includes probe and jig capacitance.

Figure 3. Driver Test Circuit and Differential Output Delay and Transition Time Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

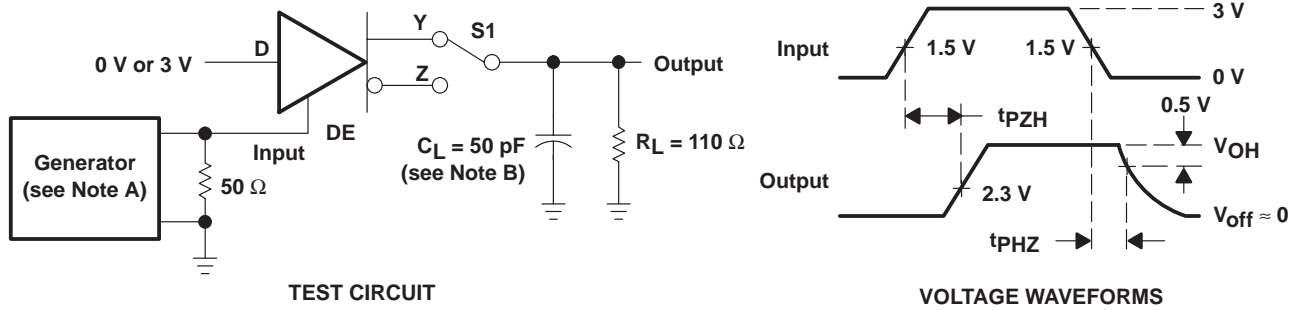


Figure 4. Driver Test Circuit and Enable and Disable Time Waveforms

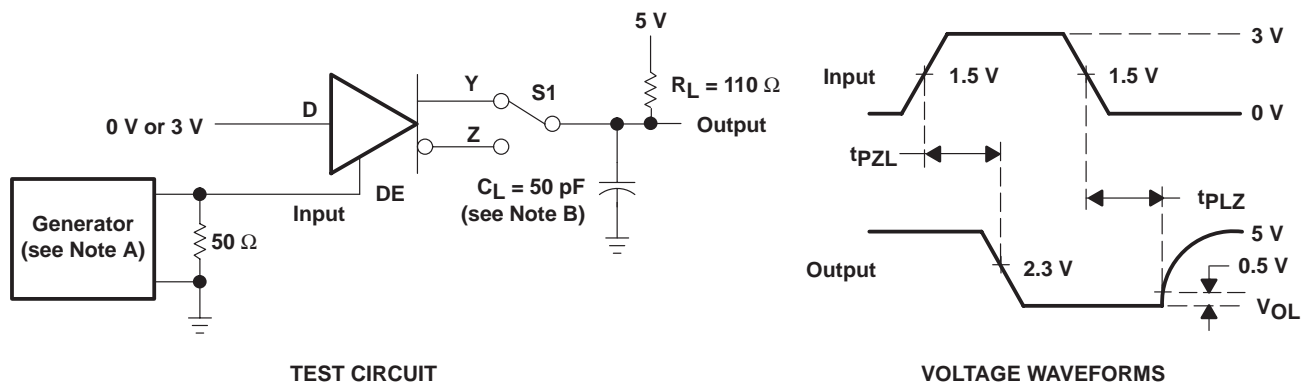
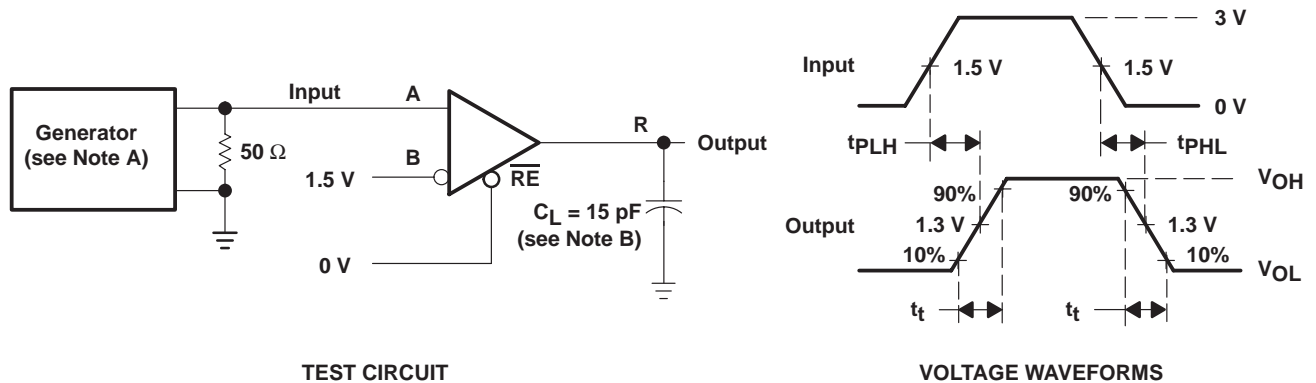


Figure 5. Driver Test Circuit and Enable and Disable Time Voltage Waveforms



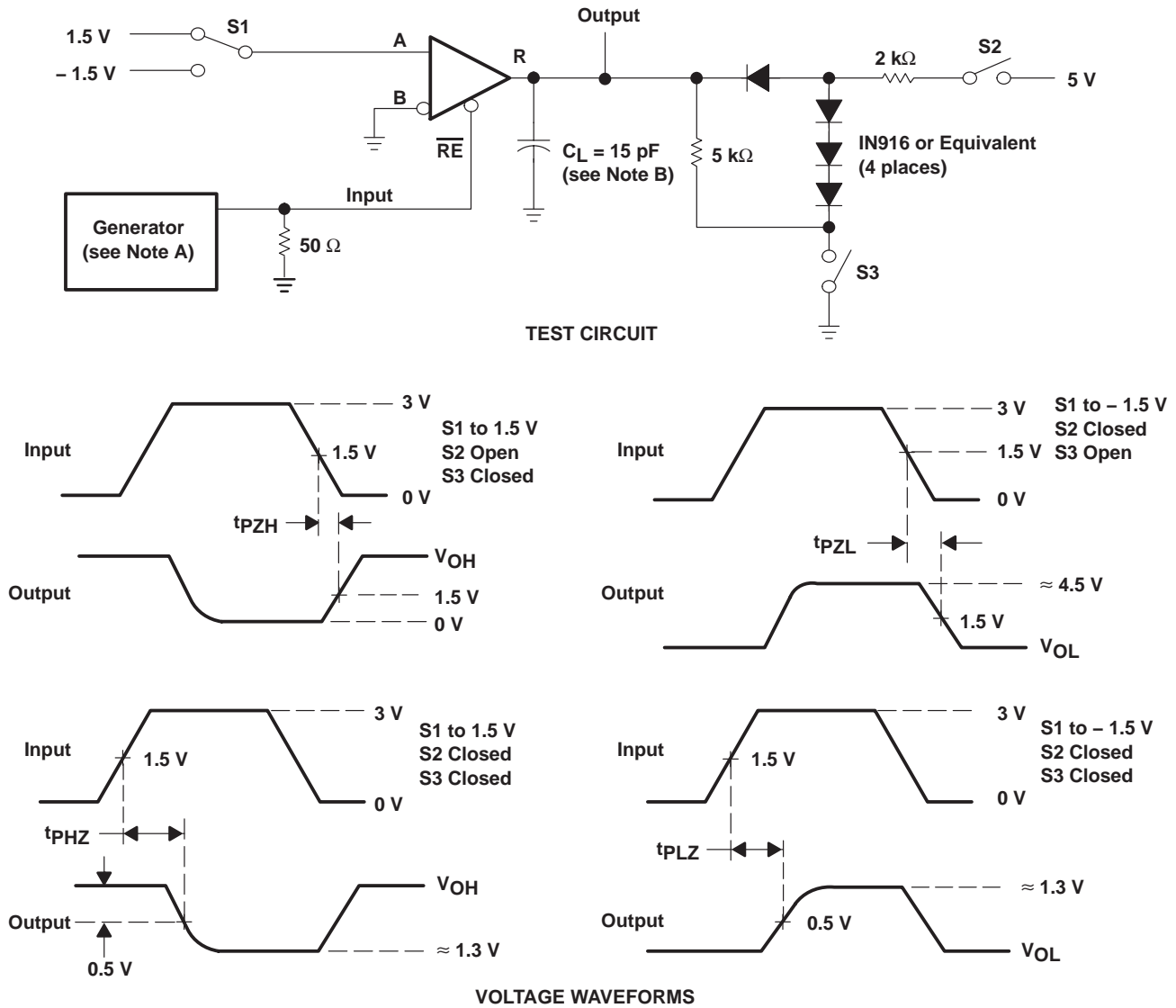
- NOTES: A. The input pulse is supplied by a generator having the following characteristics: $PRR \leq 1 \text{ MHz}$, 50% duty cycle, $t_r \leq 6 \text{ ns}$, $t_f \leq 6 \text{ ns}$, $Z_O = 50 \Omega$.
 B. C_L includes probe and jig capacitance.

Figure 6. Receiver Test Circuit and Propagation Delay Time Voltage Waveforms

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PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics: $PRR \leq 1$ MHz, 50% duty cycle, $t_r \leq 6$ ns, $t_f \leq 6$ ns, $Z_O = 50 \Omega$.
 B. C_L includes probe and jig capacitance.

Figure 7. Receiver Output Enable and Disable Times

TYPICAL CHARACTERISTICS

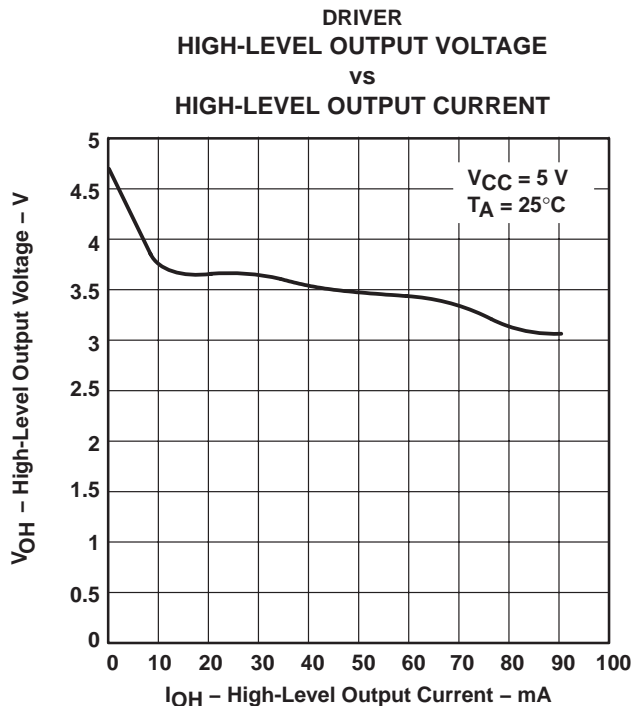


Figure 8

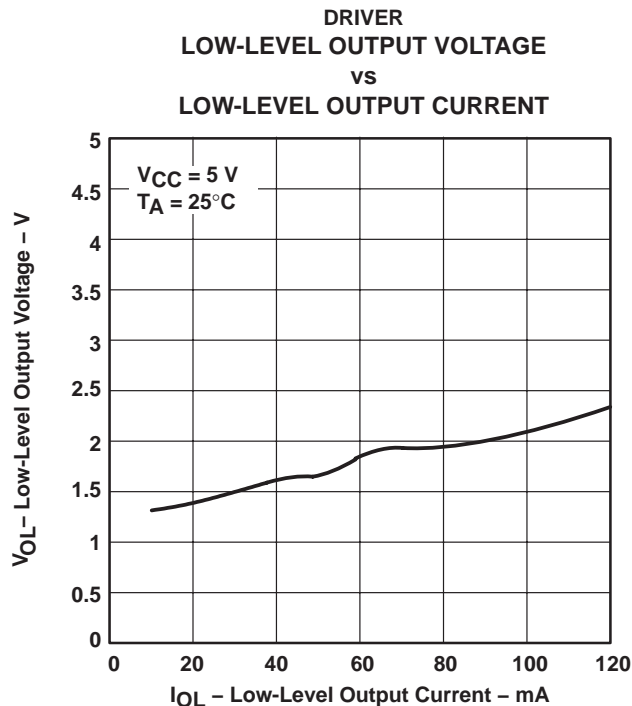


Figure 9

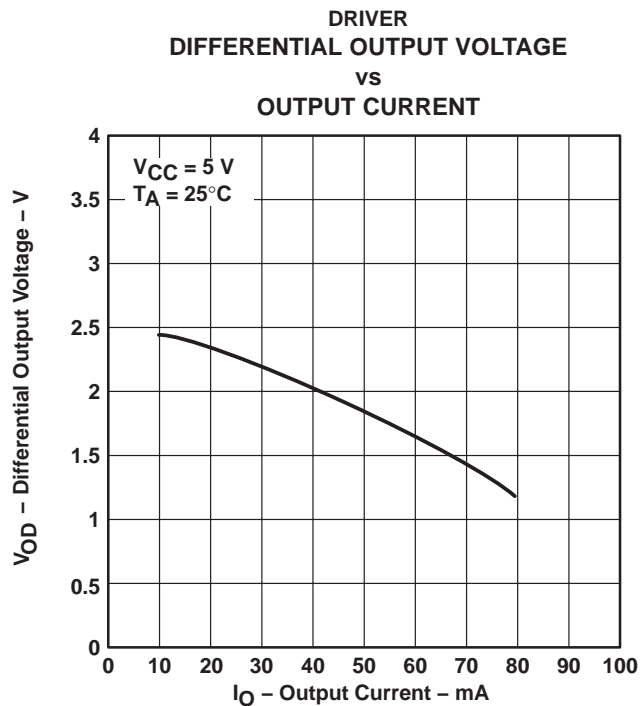


Figure 10

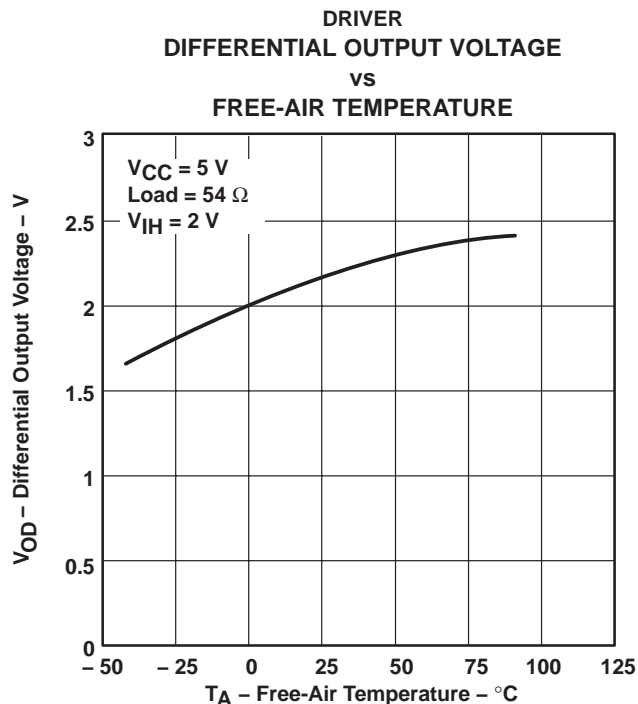


Figure 11

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LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIR

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TYPICAL CHARACTERISTICS

DRIVER
DIFFERENTIAL DELAY TIMES
vs
FREE-AIR TEMPERATURE

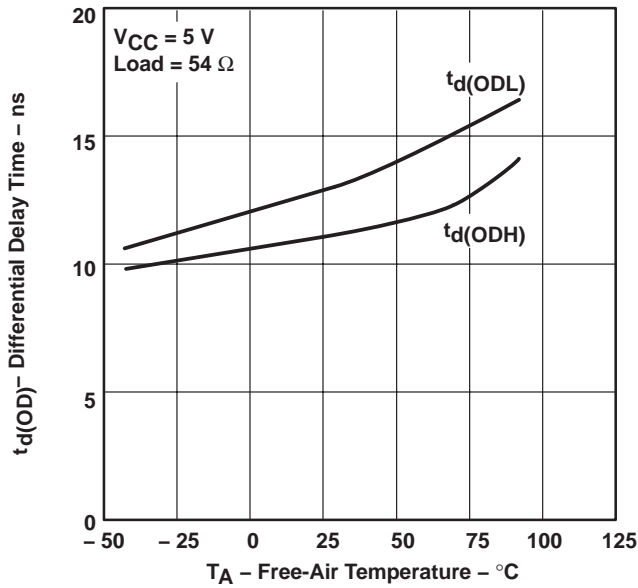


Figure 12

DRIVER
OUTPUT CURRENT
vs
SUPPLY VOLTAGE

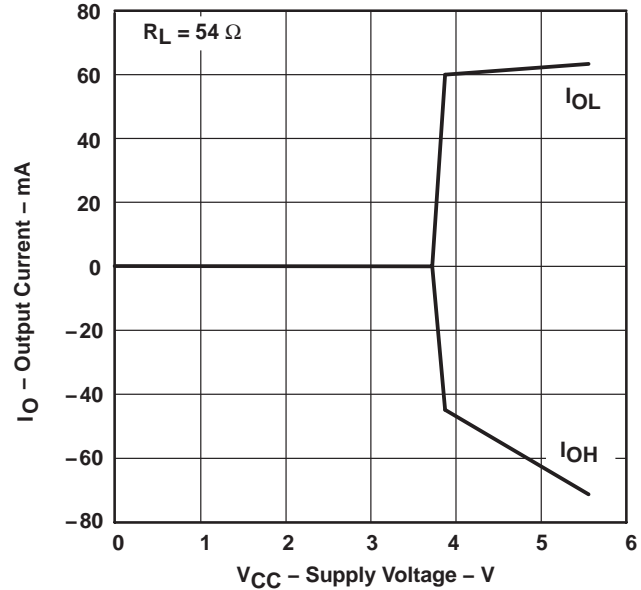


Figure 13

RECEIVER
HIGH-LEVEL OUTPUT VOLTAGE
vs
HIGH-LEVEL OUTPUT CURRENT

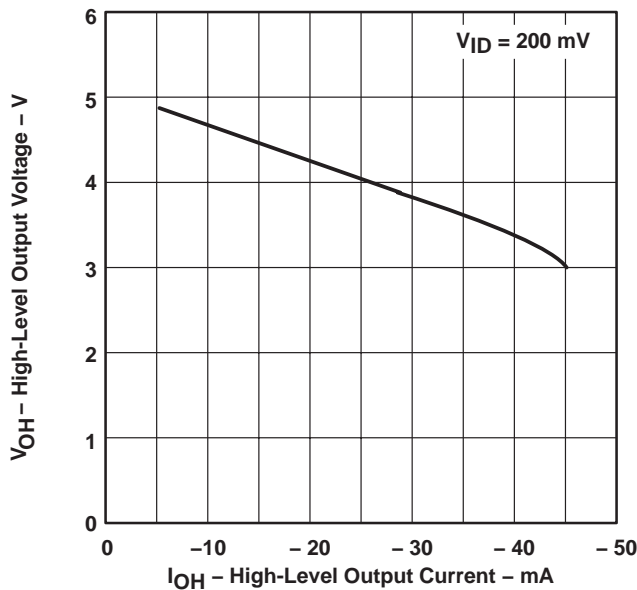


Figure 14

RECEIVER
LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT

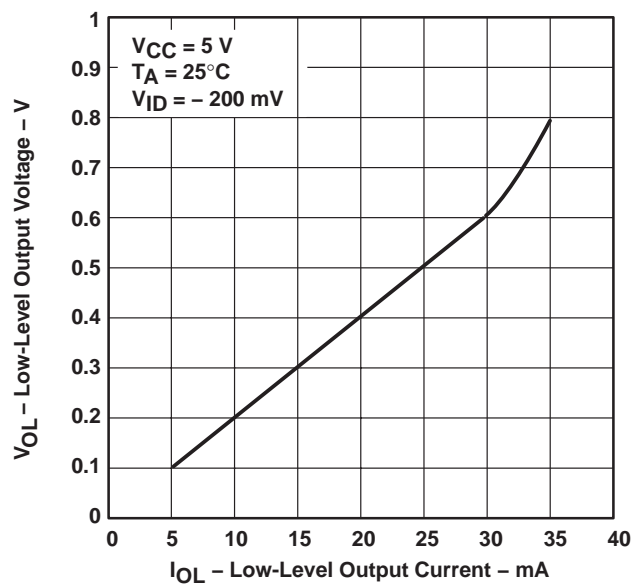
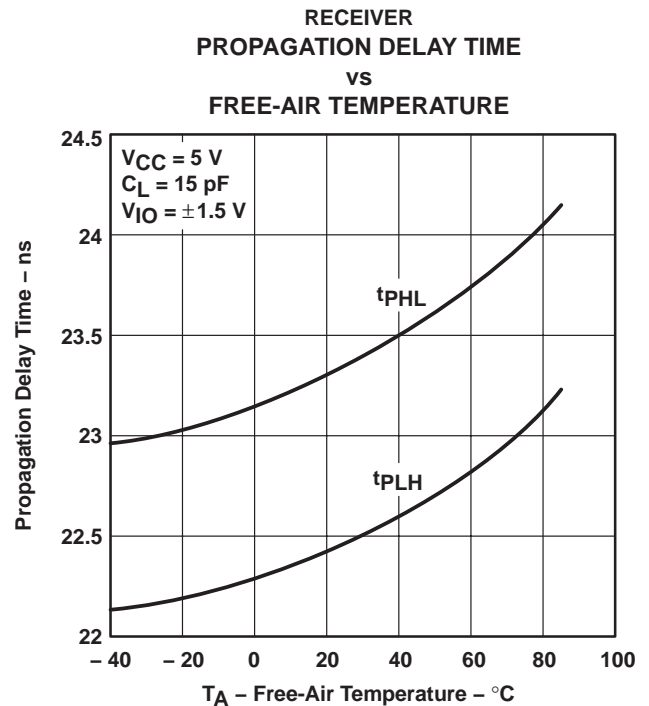
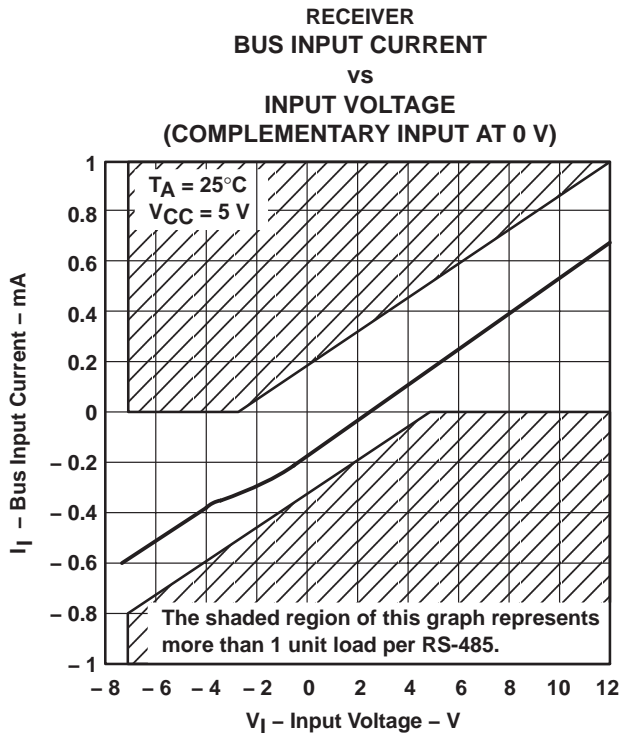
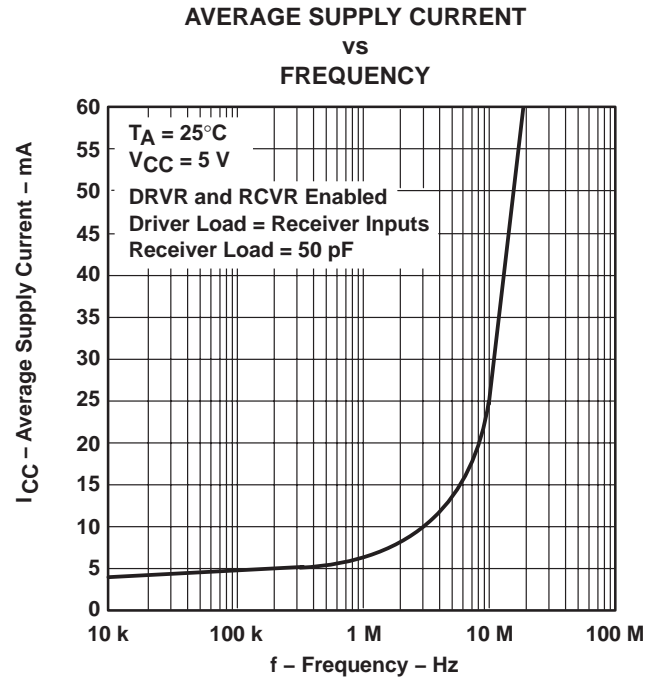
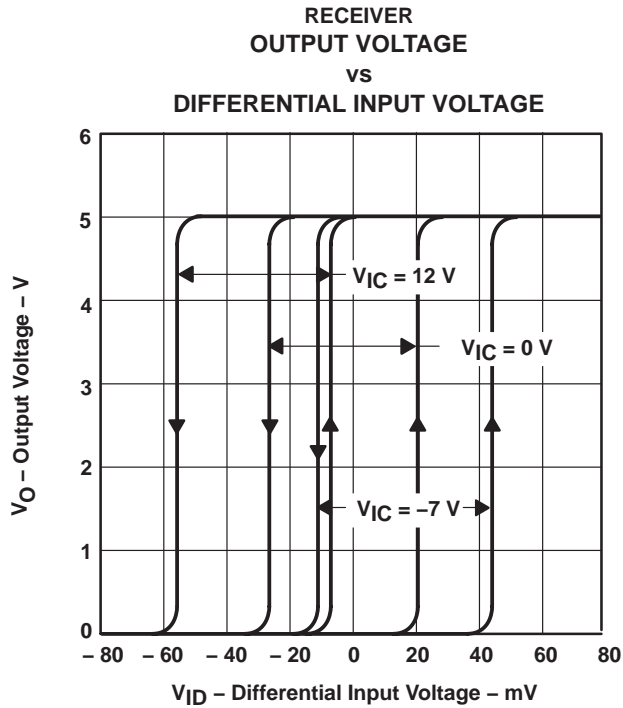


Figure 15

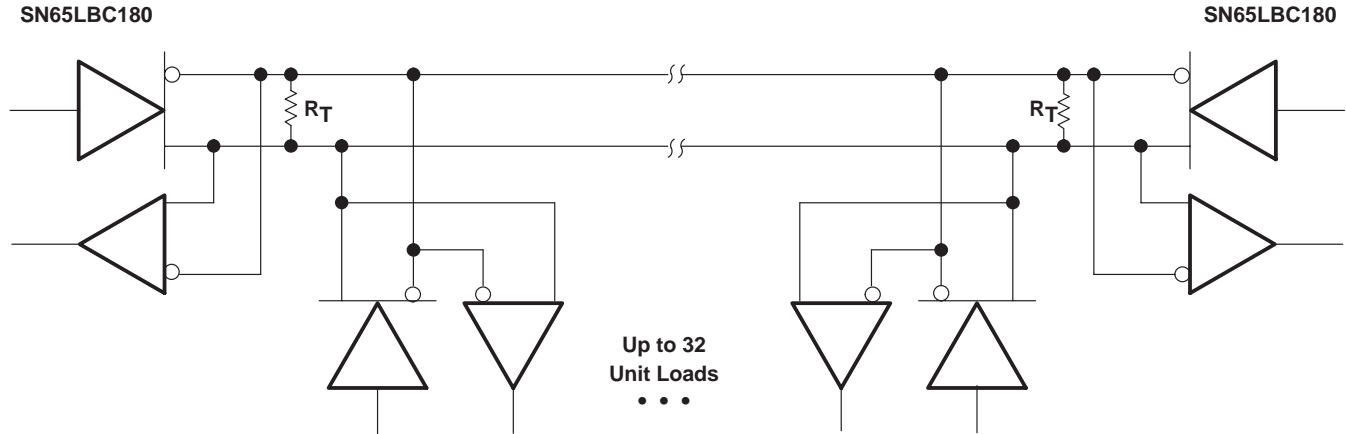
TYPICAL CHARACTERISTICS



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APPLICATION INFORMATION



NOTE A: The line should be terminated at both ends in its characteristic impedance ($R_T = Z_0$). Stub lengths off the main line should be kept as short as possible. One SN65LBC180 typically represents less than one unit load.

Figure 20. Typical Application Circuit

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MS-012 variation AB.

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