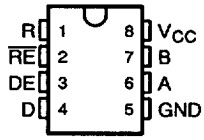
- **Meets EIA Standards RS-422A and RS-485 and CCITT Recommendations V.11 and X.27**
- **Designed and Tested for Data Rates up to 35 MBaud**
- **SN65ALS176 Operating Temperature −40°C to 85°C**
- **Three Skew Limits Available:**
  'ALS176 . . . 10 ns
  'ALS176A . . . 7.5 ns
  'ALS176B . . . 5 ns
- **Designed for Multipoint Transmission on Long Bus Lines in Noisy Environments**
- **Low Supply Current Requirements 30 mA Max**
- **Wide Positive and Negative Input/Output Bus Voltage Ranges**
- **Thermal Shutdown Protection**
- **Driver Positive and Negative Current Limiting**
- **Receiver Input Hysteresis**
- **Glitch-Free Power-Up and Power-Down Protection**
- **Receiver Open-Circuit Fail-Safe Design**

D OR P PACKAGE
(TOP VIEW)



Function Tables

DRIVER

INPUT D	ENABLE DE	OUTPUTS A	OUTPUTS B
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
Inputs open	L	H

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

AVAILABLE OPTIONS

T_A	$t_{sk(LIM)}$‡	PACKAGE	
		SMALL OUTLINE (D)†	PLASTIC DIP (P)
0°C to 70°C	10	SN75ALS176D	SN75ALS176P
	7.5	SN75ALS176AD	SN75ALS176AP
	5	SN75ALS176BD	SN75ALS176BP
−40°C to 85°C	10	SN65ALS176D	SN65ALS176P

† The D package is available taped and reeled. Add the suffix R to the device type, (e.g., SN75ALS176DR).

‡ $t_{sk(LIM)}$ is the greater of 1) the difference between the maximum and minimum specified values of t_{PLH} (or t_{dDH}), and 2) the difference between the maximum and minimum specified values of t_{PHL} (or t_{dDL}). This is the maximum range that the driver or receiver delay time will vary over temperature, V_{CC}, and device to device.

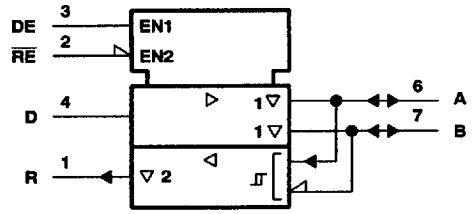
description

The SN65ALS176 and SN75ALS176 series differential bus transceivers are monolithic integrated circuits designed for bidirectional data communication on multipoint bus transmission lines. They are designed for balanced transmission lines and meet EIA Standards RS-422-A and RS-485 and CCITT recommendations V.11 and X.27.

The SN65ALS176 and SN75ALS176 series combine a 3-state differential line driver and a differential input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can be externally connected together to function as a direction control. The driver differential outputs and the receiver differential inputs are connected internally to form a differential input/output (I/O bus port that is designed to offer minimum loading to the bus whenever the driver is disabled or $V_{CC} = 0$. This port features wide positive and negative common-mode voltage ranges making the device suitable for party-line applications.

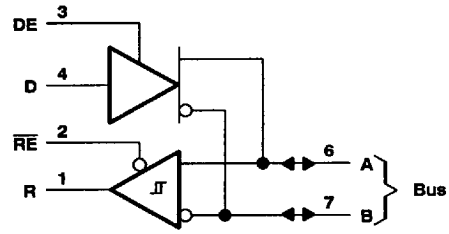
The SN65ALS176 is characterized for operation from −40°C to 85°C, and the SN75ALS176 series is characterized for operation from 0°C to 70°C.

logic symbol†

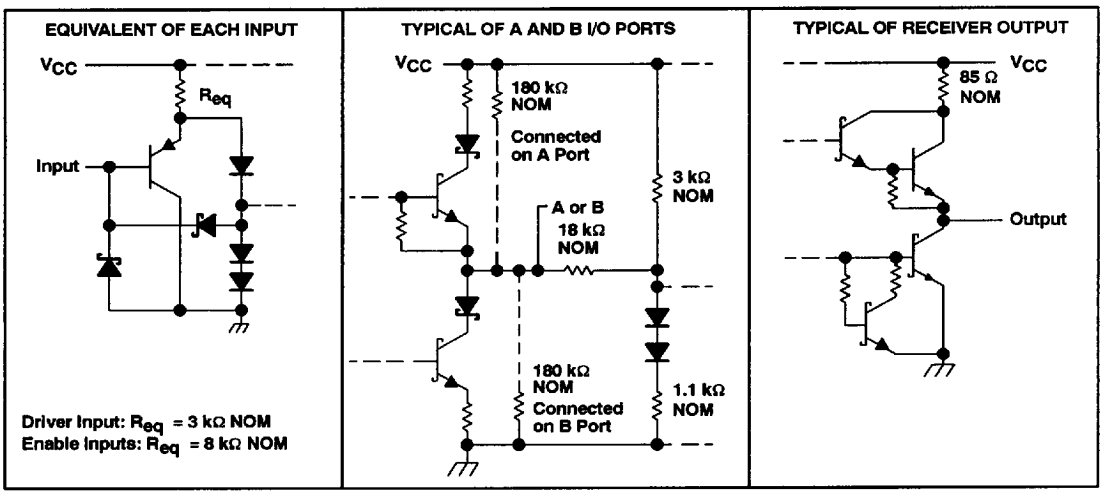


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic diagram (positive logic)



schematics of inputs and outputs



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

Supply voltage, V_{CC} (see Note 1) ..... 7 V
Voltage range at any bus terminal ..... −7 V to 12 V
Enable input voltage ..... 5.5 V
Continuous total power dissipation ..... See Dissipation Rating Table
Operating free-air temperature range, T_A: SN65ALS176 ..... −40°C to 85°C
SN75ALS176 series ..... 0°C to 70°C
Storage temperature range ..... −65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ..... 260°C

NOTE 1: All voltage values, except differential I/O bus voltage, are with respect to network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.75	5	5.25	V
Input voltage at any bus terminal (separately or common mode), V_I or V_{IC}				12	V
				−7	
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} (see Note 2)				±12	V
High-level output current, I_{OH}	Driver			−60	mA
	Receiver			−400	µA
Low-level output current, I_{OL}	Driver			60	mA
	Receiver			8	
Operating free-air temperature, T_A	SN65ALS176	−40		85	°C
	SN75ALS176	0		70	

NOTE 2: Differential-input/output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.

DRIVER SECTION

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
V_{IK}	Input clamp voltage	$I_I = -18$ mA				−1.5	V
V_O	Output voltage	$I_O = 0$		0		6	V
$\lvert V_{OD1} \rvert$	Differential output voltage	$I_O = 0$		1.5		6	V
$\lvert V_{OD2} \rvert$	Differential output voltage	R_L = 100 Ω,	See Figure 1	1/2 V_{OD1} or 2¶			V
		R_L = 54 Ω,	See Figure 1	1.5	2.5	5	V
V_{OD3}	Differential output voltage	V_{test} = −7 V to 12 V,	See Figure 2	1.5		5	V
$\Delta\lvert V_{OD} \rvert$	Change in magnitude of differential output voltage§	R_L = 54 Ω or 100 Ω,	See Figure 1			±0.2	V
V_{OC}	Common-mode output voltage					3 −1	V
$\Delta\lvert V_{OC} \rvert$	Change in magnitude of common-mode output voltage§					±0.2	V
I_O	Output current	Outputs disabled, See Note 3	V_O = 12 V			1	mA
			V_O = −7 V			−0.8	
I_{IH}	High-level input current	V_I = 2.4 V				20	μA
I_{IL}	Low-level input current	V_I = 0.4 V				−400	μA
I_{OS}	Short-circuit output current	V_O = −4 V	SN65ALS176			−250	mA
		V_O = −6 V	SN75ALS176				
		V_O = 0				−150	
		$V_O = V_{CC}$				250	
		V_O = 8 V					
I_{CC}	Supply current	No load	Outputs enabled		23	30	mA
			Outputs disabled		19	26	

† The power-off measurement in EIA Standard RS-422-A applies to disabled outputs only and is not applied to combined inputs and outputs.
‡ All typical values are at V_{CC} = 5 V and T_A = 25°C.
§ $\Delta\lvert V_{OD} \rvert$ and $\Delta\lvert V_{OC} \rvert$ are the changes in magnitude of V_{OD} and V_{OC}, respectively, that occur when the input is changed from one logic state to the other.
¶ The minimum V_{OD2} with a 100-Ω load is either 1/2 V_{OD1} or 2 V, whichever is greater.
NOTE 3: This applies for both power on and power off; refer to EIA standard RS-485 for exact conditions. The RS-422-A limit does not apply for a combined driver and receiver terminal.

switching characteristics over recommended ranges of supply voltage and operating free-air temperature

SN65ALS176

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t_{dD}	Differential output delay time	R_L = 54 Ω, C_L = 50 pF, See Figure 3			15	ns
$t_{sk(p)}$	Pulse skew ($\lvert t_{dDL} - t_{dDH} \rvert$)			0	2	ns
t_{tD}	Differential output transition time			8		ns
t_{PZH}	Output enable time to high level	R_L = 110 Ω, C_L = 50 pF, See Figure 4			80	ns
t_{PZL}	Output enable time to low level	R_L = 110 Ω, C_L = 50 pF, See Figure 5			30	ns
t_{PHZ}	Output disable time from high level	R_L = 110 Ω, C_L = 50 pF, See Figure 4			50	ns
t_{PLZ}	Output disable time from low level	R_L = 110 Ω, C_L = 50 pF, See Figure 5			30	ns

SN75ALS176, SN75ALS176A, SN75ALS176B

PARAMETER			TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t_{dD}	Differential output delay time	'ALS176	R_L = 54 Ω, C_L = 50 pF, See Figure 3	3	8	13	ns
		'ALS176A		4	7	11.5	
		'ALS176B		5	8	10	
$t_{sk(p)}$	Pulse skew ($\lvert t_{dDL} - t_{dDH} \rvert$)				0	2	ns
t_{TD}	Differential output transition time				8		ns
t_{PZH}	Output enable time to high level		R_L = 110 Ω, C_L = 50 pF, See Figure 4		23	50	ns
t_{PZL}	Output enable time to low level		R_L = 110 Ω, C_L = 50 pF, See Figure 5		14	20	ns
t_{PHZ}	Output disable time from high level		R_L = 110 Ω, C_L = 50 pF, See Figure 4		20	35	ns
t_{PLZ}	Output disable time from low level		R_L = 110 Ω, C_L = 50 pF, See Figure 5		8	17	ns

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

SYMBOL EQUIVALENTS

DATA SHEET PARAMETER	RS-422-A	RS-485
V_O	V_{oa}, V_{ob}	V_{oa}, V_{ob}
$\lvert V_{OD1} \rvert$	V_o	V_o
$\lvert V_{OD2} \rvert$	V_t (R_L = 100 Ω)	V_t (R_L = 54 Ω)
$\lvert V_{OD3} \rvert$		V_t (Test Termination Measurement 2)
$\Delta \lvert V_{OD} \rvert$	$\lvert\lvert V_t \rvert - \lvert \overline{V}_t \rvert\rvert$	$\lvert\lvert V_t \rvert - \lvert \overline{V}_t \rvert\rvert$
V_{OC}	$\lvert V_{os} \rvert$	$\lvert V_{os} \rvert$
$\Delta \lvert V_{OC} \rvert$	$\lvert V_{os} - \overline{V}_{os} \rvert$	$\lvert V_{os} - \overline{V}_{os} \rvert$
I_{OS}	$\lvert I_{sa} \rvert$, $\lvert I_{sb} \rvert$	
I_O	$\lvert I_{xa} \rvert$, $\lvert I_{xb} \rvert$	I_{ia}, I_{ib}

RECEIVER SECTION

electrical characteristics over recommended ranges of common-mode input voltage, supply voltage, and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{T+}	Positive-going threshold voltage	V_O = 2.7 V,	I_O = −0.4 mA			0.2	V
V_{T-}	Negative-going threshold voltage	V_O = 0.5 V,	I_O = 8 mA	−0.2‡			V
V_{hys}	Hysteresis ($V_{T+} - V_{T-}$)				60		mV
V_{IK}	Enable-input clamp voltage	I_I = −18 mA				−1.5	V
V_{OH}	High-level output voltage	V_{ID} = 200 mV, See Figure 6	I_{OH} = −400 μA,	2.7			V
V_{OL}	Low-level output voltage	V_{ID} = −200 mV, See Figure 6	I_{OL} = 8 mA,			0.45	V
I_{OZ}	High-impedance-state output current	V_O = 0.4 V to 2.4 V				±20	μA
V_I	Line input current	Other input = 0 V, See Note 4	V_I = 12 V			1	mA
			V_I = −7 V			−0.8	
I_{IH}	High-level-enable input current	V_{IH} = 2.7 V				20	μA
I_{IL}	Low-level-enable input current	V_{IL} = 0.4 V				−100	μA
r_i	Input resistance			12	20		kΩ
I_{OS}	Short-circuit output current	V_{ID} = 200 mV,	V_O = 0	−15		−85	mA
I_{CC}	Supply current	No load	Outputs enabled		23	30	mA
			Outputs disabled		19	26	

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ The algebraic convention, in which the less-positive (more negative) limit is designated minimum, is used in this data sheet for common-mode input voltage and threshold voltage levels only.
NOTE 4: This applies for both power on and power off. Refer to EIA Standard RS-485 for exact conditions.

switching characteristics over recommended ranges of supply voltage and operating free-air temperature

SN65ALS176

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t_{pd}	Propagation time	V_{ID} = −1.5 V to 1.5 V, C_L = 15 pF, See Figure 7			25	ns
$t_{sk(p)}$	Pulse skew ($\lvert t_{PHL} - t_{PLH} \rvert$)			0	2	ns
t_{PZH}	Output enable time to high level	C_L = 15 pF, See Figure 8		11	18	ns
t_{PZL}	Output enable time to low level			11	18	ns
t_{PHZ}	Output disable time from high level				50	ns
t_{PLZ}	Output disable time from low level				30	ns

SN75ALS176, SN75ALS176A, SN75ALS176B

PARAMETER			TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t_{pd}	Propagation time	'ALS176	V_{ID} = −1.5 V to 1.5 V, C_L = 15 pF, See Figure 7	9	14	19	ns
		'ALS176A		10.5	14	18	
		'ALS176B		11.5	13	16.5	
$t_{sk(p)}$	Pulse skew ($\lvert t_{PHL} - t_{PLH} \rvert$)				0	2	ns
t_{PZH}	Output enable time to high level		C_L = 15 pF, See Figure 8		7	14	ns
t_{PZL}	Output enable time to low level				20	35	ns
t_{PHZ}	Output disable time from high level				20	35	ns
t_{PLZ}	Output disable time from low level				8	17	ns

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

PARAMETER MEASUREMENT INFORMATION

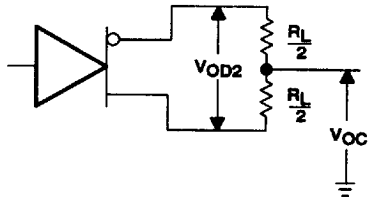


Figure 1. Driver V_{OD2} and V_{OC}

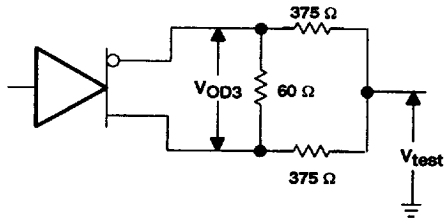
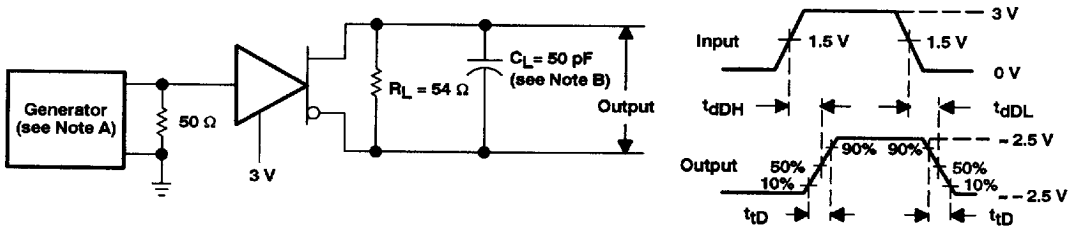


Figure 2. Driver V_{OD3}



TEST CIRCUIT

VOLTAGE WAVEFORMS

NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1 MHz, 50% duty cycle, t_r ≤ 6 ns, t_f ≤ 6 ns, Z_O = 50 Ω.
B. C_L includes probe and jig capacitance.
C. $t_{dD} = t_{dDH}$ or t_{dDL}

Figure 3. Driver Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

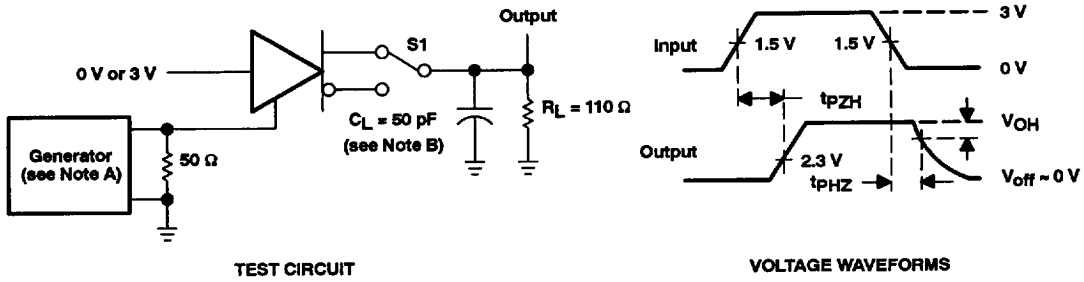


Figure 4. Driver Test Circuit and Voltage Waeforms

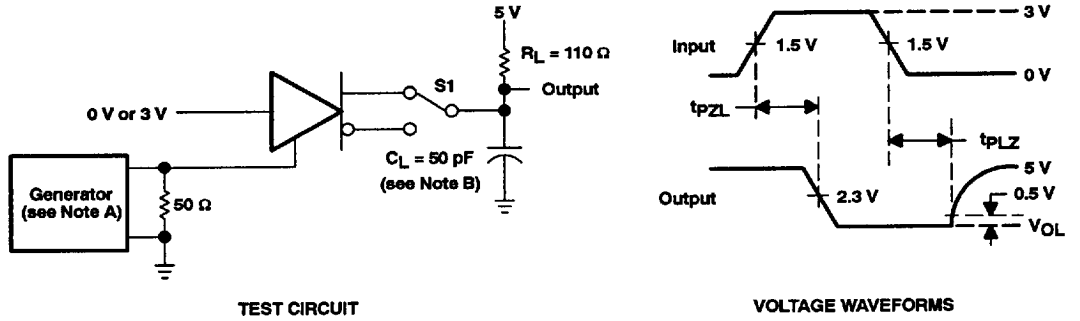


Figure 5. Driver Test Circuit and Voltage Waveforms

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

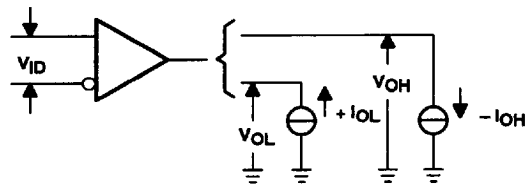


Figure 6. Receiver V_{OH} and V_{OL} Test Circuit

PARAMETER MEASUREMENT INFORMATION

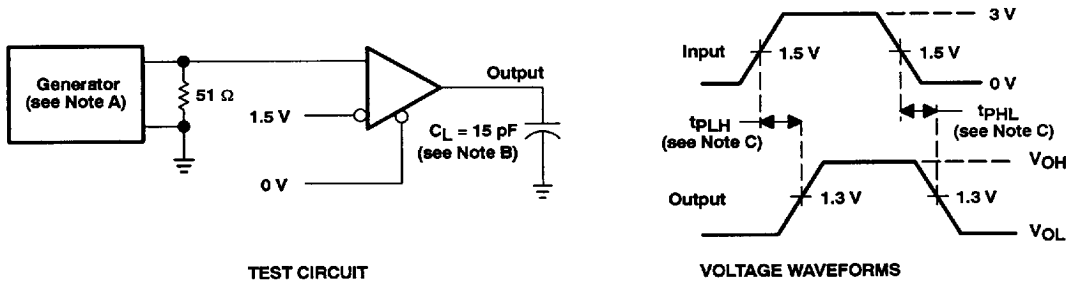


Figure 7. Receiver Test Circuit and Voltage Waveforms

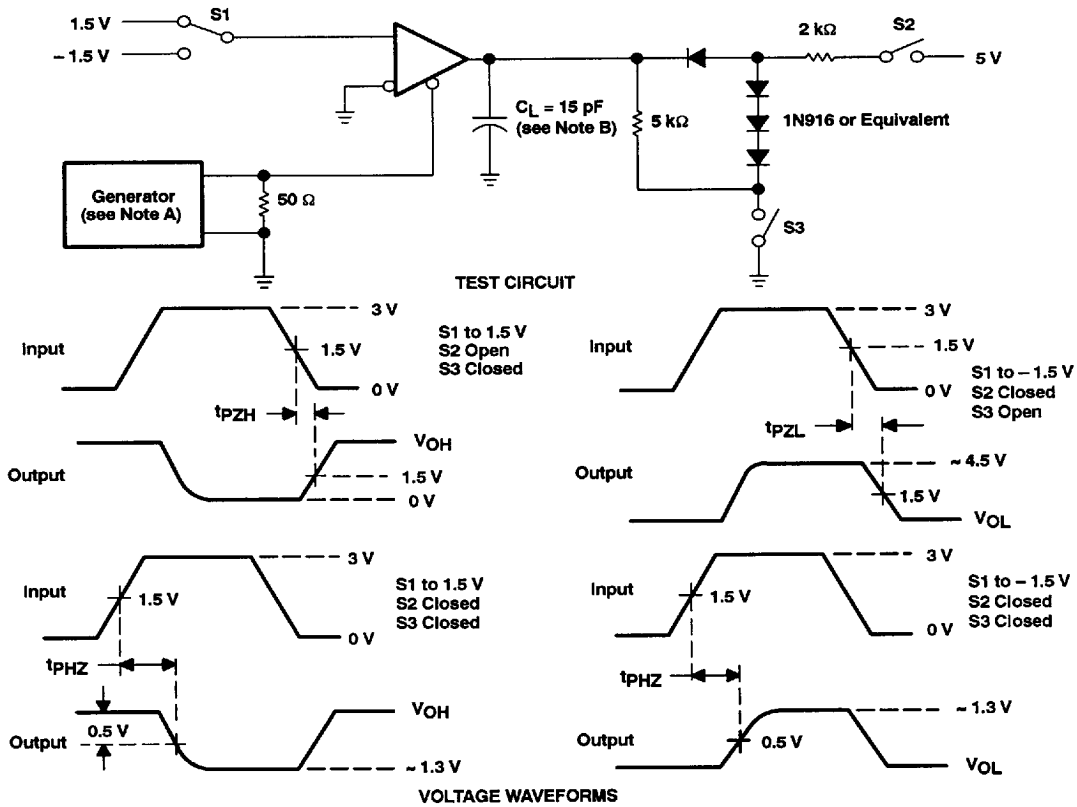


Figure 8. Receiver Test Circuit and Voltage Waveforms

NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1 MHz, 50% duty cycle, t_r ≤ 6 ns, t_f ≤ 6 ns, Z_O = 50 Ω.
B. C_L includes probe and jig capacitance.
C. t_{pd} = t_{PLH} or t_{PHL}

TYPICAL CHARACTERISTICS

DRIVER HIGH-LEVEL OUTPUT VOLTAGE
vs
DRIVER HIGH-LEVEL OUTPUT CURRENT

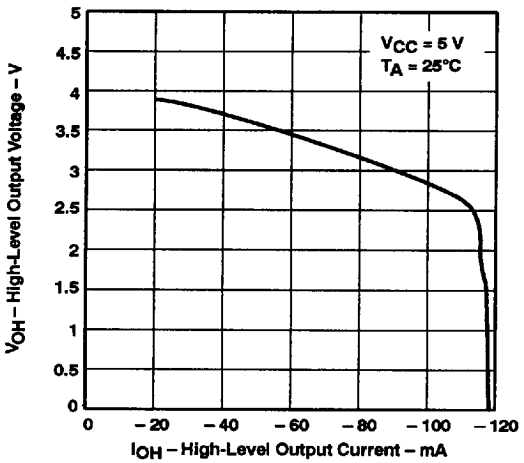


Figure 9

DRIVER LOW-LEVEL OUTPUT VOLTAGE
vs
DRIVER LOW-LEVEL OUTPUT CURRENT

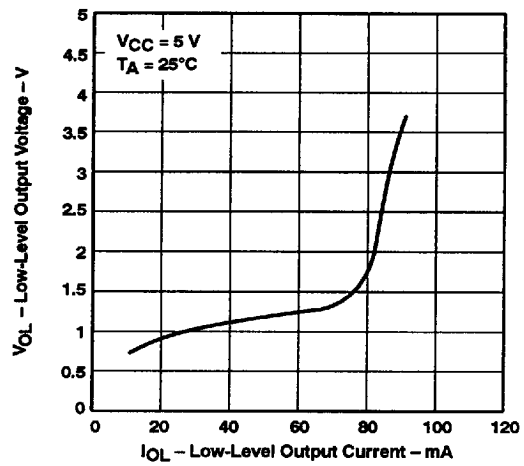


Figure 10

DRIVER DIFFERENTIAL OUTPUT VOLTAGE
vs
DRIVER OUTPUT CURRENT

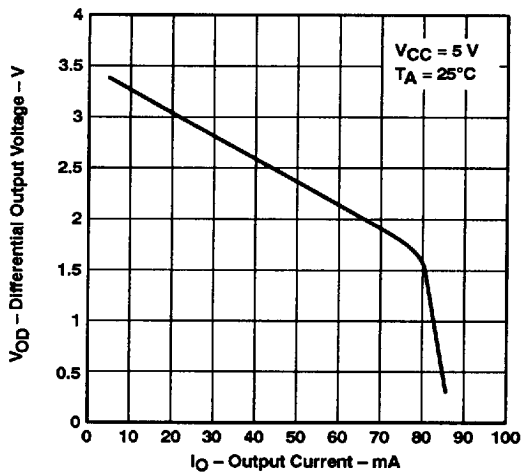


Figure 11

TYPICAL CHARACTERISTICS

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

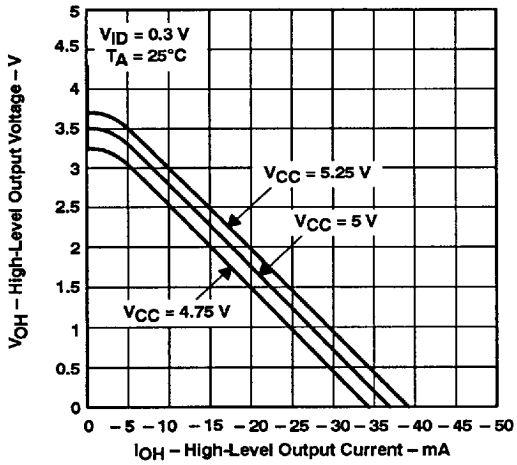


Figure 12

RECEIVER HIGH-LEVEL OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE

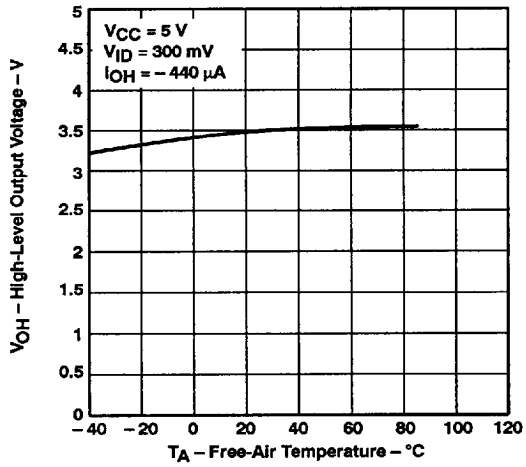


Figure 13

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

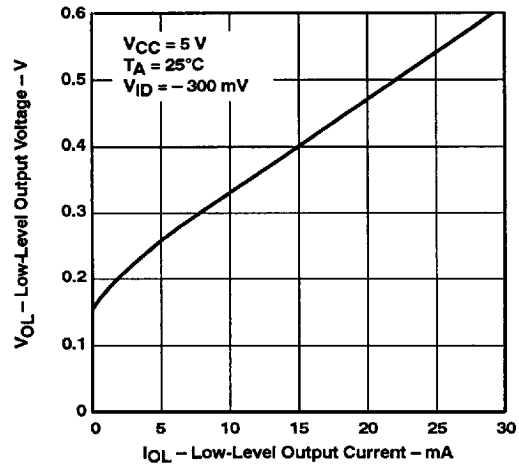


Figure 14

RECEIVER LOW-LEVEL OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE

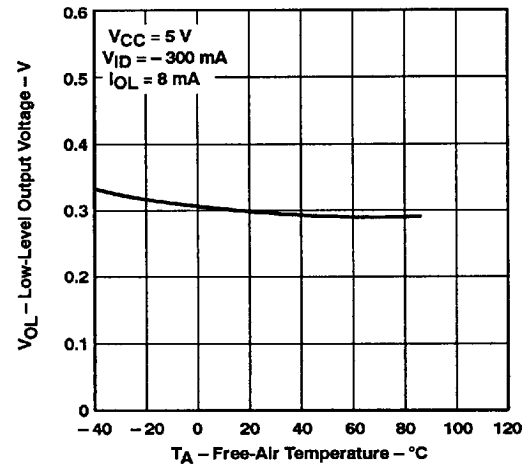


Figure 15

TYPICAL CHARACTERISTICS

RECEIVER OUTPUT VOLTAGE
vs
ENABLE VOLTAGE

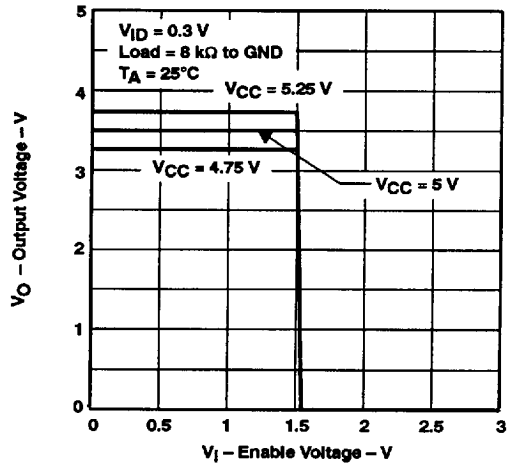


Figure 16

RECEIVER OUTPUT VOLTAGE
vs
ENABLE VOLTAGE

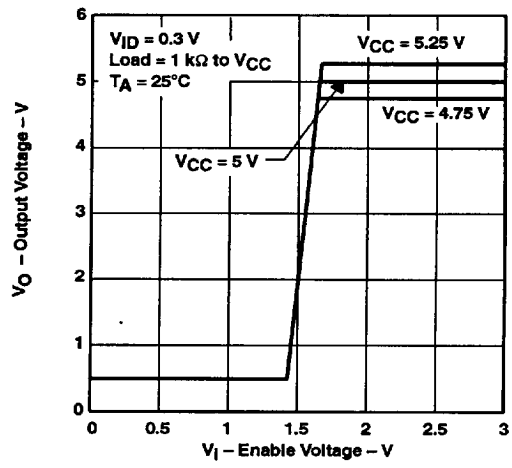
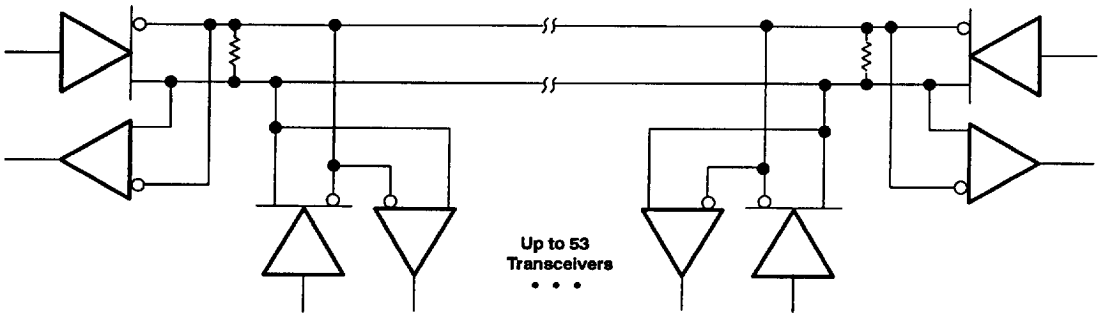


Figure 17

APPLICATION INFORMATION



NOTE: The line should be terminated at both ends in its characteristic impedance. Stub lengths off the main line should be kept as short as possible.

Figure 18. Typical Application Circuit

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265