

HIGH OUTPUT RS-485 TRANSCEIVERS

FEATURES

- Minimum Differential Output Voltage of 2.5 V Into a 54-Ω Load
- Open-Circuit, Short-Circuit, and Idle-Bus Failsafe Receiver
- 1/8th Unit-Load Option Available (Up to 256 Nodes on the Bus)
- Bus-Pin ESD Protection Exceeds 16 kV HBM
- Driver Output Slew Rate Control Options
- Electrically Compatible With ANSI TIA/EIA-485-A Standard
- Low-Current Standby Mode . . . 1 μA Typical
- Glitch-Free Power-Up and Power-Down Protection for Hot-Plugging Applications
- Pin Compatible With Industry Standard SN75176

APPLICATIONS

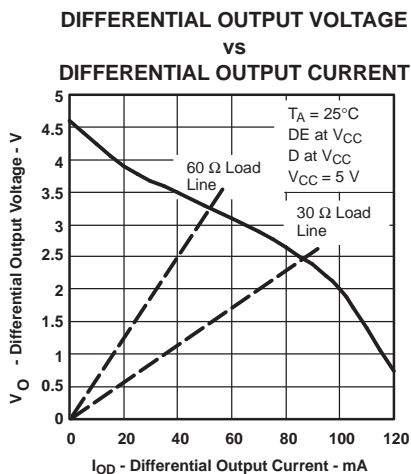
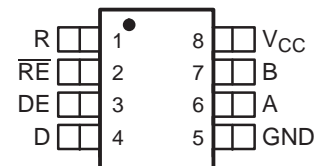
- Data Transmission Over Long or Lossy Lines or Electrically Noisy Environments
- Profibus Line Interface
- Industrial Process Control Networks
- Point-of-Sale (POS) Networks
- Electric Utility Metering
- Building Automation
- Digital Motor Control

DESCRIPTION

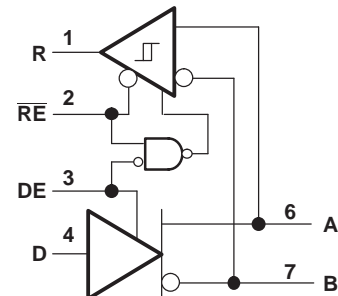
The SN65HVD05, SN75HVD05, SN65HVD06, SN75HVD06, SN65HVD07, and SN75HVD07 combine a 3-state differential line driver and differential line receiver. They are designed for balanced data transmission and interoperate with ANSI TIA/EIA-485-A and ISO 8482E standard-compliant devices. The driver is designed to provide a differential output voltage greater than that required by these standards for increased noise margin. The drivers and receivers have active-high and active-low enables respectively, which can be externally connected together to function as direction control.

The driver differential outputs and receiver differential inputs connect 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 not powered. These devices feature wide positive and negative common-mode voltage ranges, making them suitable for party-line applications.

N OR M PACKAGE
(TOP VIEW)



LOGIC DIAGRAM
(POSITIVE LOGIC)



ORDERING INFORMATION

DEVICE	Package Type	MARKING	Packing	Packing Qty
SN65HVD05EIN	DIP8L	65HVD05	TUBE	2000pcs/box
SN65HVD06EIN	DIP8L	65HVD06	TUBE	2000pcs/box
SN65HVD07EIN	DIP8L	65HVD07	TUBE	2000pcs/box
SN75HVD05ECN	DIP8L	65HVD05	TUBE	2000pcs/box
SN75HVD06ECN	DIP8L	65HVD06	TUBE	2000pcs/box
SN75HVD07ECN	DIP8L	65HVD07	TUBE	2000pcs/box
SN65HVD05EIM/TR	SOP8L	65HVD05	REEL	2500pcs/reel
SN65HVD06EIM/TR	SOP8L	65HVD06	REEL	2500pcs/reel
SN65HVD07EIM/TR	SOP8L	65HVD07	REEL	2500pcs/reel
SN75HVD05ECM/TR	SOP8L	65HVD05	REEL	2500pcs/reel
SN75HVD06ECM/TR	SOP8L	65HVD06	REEL	2500pcs/reel
SN75HVD07ECM/TR	SOP8L	65HVD07	REEL	2500pcs/reel

PACKAGE DISSIPATION RATINGS

(See [Figure 12](#) and [Figure 13](#))

PACKAGE	T _A ≤ 25°C POWER RATING	DERATING FACTOR ⁽¹⁾ ABOVE T _A = 25°C	T _A = 70°C POWER RATING	T _A = 85°C POWER RATING
D ⁽²⁾	710 mW	5.7 mW/°C	455 mW	369 mW
D ⁽³⁾	1282 mW	10.3 mW/°C	821 mW	667 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW

(1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.

(2) Tested in accordance with the Low-K thermal metric definitions of EIA/JESD51-3

(3) Tested in accordance with the High-K thermal metric definitions of EIA/JESD51-7

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range unless otherwise noted⁽¹⁾⁽²⁾

		SN65HVD05, SN65HVD06, SN65HVD07 SN75HVD05, SN75HVD06, SN75HVD07	
Supply voltage range, V _{CC}		-0.3 V to 6 V	
Voltage range at A or B		-9 V to 14 V	
Input voltage range at D, DE, R or \overline{RE}		-0.5 V to V _{CC} + 0.5 V	
Voltage input range, transient pulse, A and B, through 100 Ω (see Figure 11)		-50 V to 50 V	
Receiver output current, I _O		-11 mA to 11mA	
Electrostatic discharge	Human body model ⁽³⁾	A, B, and GND	16 kV
		All pins	4 kV
	Charged-device model ⁽⁴⁾	All pins	1 kV
Continuous total power dissipation		See Dissipation Rating Table	

(1) 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.

(2) All voltage values, except differential I/O bus voltages, are with respect to network ground terminal.

(3) Tested in accordance with JEDEC Standard 22, Test Method A114-A.

(4) Tested in accordance with JEDEC Standard 22, Test Method C101.

RECOMMENDED OPERATING CONDITIONS

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.5		5.5	V
Voltage at any bus terminal (separately or common mode) V_I or V_{IC}		-7 ⁽¹⁾		12	V
High-level input voltage, V_{IH}	D, DE, \overline{RE}	2			V
Low-level input voltage, V_{IL}	D, DE, \overline{RE}			0.8	V
Differential input voltage, V_{ID} (see Figure 7)		-12		12	V
High-level output current, I_{OH}	Driver	-100			mA
	Receiver	-8			
Low-level output current, I_{OL}	Driver			100	mA
	Receiver			8	
Operating free-air temperature, T_A	SN65HVD05	-40		85	°C
	SN65HVD06				
	SN65HVD07				
	SN75HVD05	0		70	°C
	SN75HVD06				
	SN75HVD07				

(1) The algebraic convention, in which the least positive (most negative) limit is designated as minimum is used in this data sheet.

DRIVER ELECTRICAL CHARACTERISTICS

over operating free-air temperature range unless otherwise noted

PARAMETER		TEST CONDITIONS		MIN	TYP ⁽¹⁾	MAX	UNIT
V_{IK}	Input clamp voltage	$I_I = -18$ mA		-1.5			V
$ V_{OD} $	Differential output voltage	No Load				V_{CC}	V
		$R_L = 54 \Omega$, See Figure 4		2.5			
		$V_{test} = -7$ V to 12 V, See Figure 2		2.2			
$\Delta V_{OD} $	Change in magnitude of differential output voltage	See Figure 4 and Figure 2		-0.2		0.2	V
$V_{OC(SS)}$	Steady-state common-mode output voltage	See Figure 3		2.2		3.3	V
$\Delta V_{OC(SS)}$	Change in steady-state common-mode output voltage	See Figure 3		-0.1		0.1	V
$V_{OC(PP)}$	Peak-to-peak common-mode output voltage	HVD05	See Figure 3		600		mV
		HVD06		500			
		HVD07		900			
I_{OZ}	High-impedance output current	See receiver input currents					
I_I	Input current	D		-100		0	μ A
		DE		0		100	
I_{OS}	Short-circuit output current	-7 V $\leq V_O \leq 12$ V		-250		250	mA
$C_{(diff)}$	Differential output capacitance	$V_{ID} = 0.4 \sin(4E6\pi t) + 0.5$ V, DE at 0 V			16		pF
I_{CC}	Supply current	\overline{RE} at V_{CC} , D & DE at V_{CC} , No load	Receiver disabled and driver enabled		9	15	mA
		\overline{RE} at V_{CC} , D at V_{CC} DE at 0 V, No load	Receiver disabled and driver disabled (standby)		1	5	μ A
		\overline{RE} at 0 V, D & DE at V_{CC} , No load	Receiver enabled and driver enabled		9	15	mA

(1) All typical values are at 25°C and with a 5-V supply.

DRIVER SWITCHING CHARACTERISTICS

over operating free-air temperature range unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT		
t_{PLH}	Propagation delay time, low-to-high-level output	$R_L = 54 \Omega, C_L = 50 \text{ pF}$, See Figure 4	HVD05	6.5	11	ns		
			HVD06	27	40			
			HVD07	250	400			
t_{PHL}	Propagation delay time, high-to-low-level output		HVD05	6.5	11	ns		
			HVD06	27	40			
			HVD07	250	400			
t_r	Differential output signal rise time		HVD05	2.7	3.6	6	ns	
			HVD06	18	28	55		
			HVD07	150	300	450		
t_f	Differential output signal fall time	HVD05	2.7	3.6	6	ns		
		HVD06	18	28	55			
		HVD07	150	300	450			
$t_{sk(p)}$	Pulse skew ($t_{PHL} - t_{PLH}$)	HVD05			2	ns		
		HVD06			2.5			
		HVD07			10			
$t_{sk(pp)}^{(2)}$	Part-to-part skew	HVD05			3.5	ns		
		HVD06			14			
		HVD07			100			
t_{PZH1}	Propagation delay time, high-impedance-to-high-level output	\overline{RE} at 0 V, $R_L = 110 \Omega$, See Figure 5	HVD05			25	ns	
			HVD06			45		
			HVD07			250		
t_{PHZ}	Propagation delay time, high-level-to-high-impedance output		HVD05			25	ns	
			HVD06			60		
			HVD07			250		
t_{PZL1}	Propagation delay time, high-impedance-to-low-level output		\overline{RE} at 0 V, $R_L = 110 \Omega$, See Figure 6	HVD05			15	ns
				HVD06			45	
				HVD07			200	
t_{PLZ}	Propagation delay time, low-level-to-high-impedance output	HVD05				14	ns	
		HVD06				90		
		HVD07				550		
t_{PZH2}	Propagation delay time, standby-to-high-level output	$R_L = 110 \Omega, \overline{RE}$ at 3 V, See Figure 5				6	μs	
t_{PZL2}	Propagation delay time, standby-to-low-level output	$R_L = 110 \Omega, \overline{RE}$ at 3 V, See Figure 6				6	μs	

(1) All typical values are at 25°C and with a 5-V supply.

(2) $t_{sk(pp)}$ is the magnitude of the difference in propagation delay times between any specified terminals of two devices when both devices operate with the same supply voltages, at the same temperature, and have identical packages and test circuits.

RECEIVER ELECTRICAL CHARACTERISTICS

over operating free-air temperature range unless otherwise noted

PARAMETER		TEST CONDITIONS		MIN	TYP ⁽¹⁾	MAX	UNIT	
V_{IT+}	Positive-going input threshold voltage	$I_O = -8 \text{ mA}$				0.01	V	
V_{IT-}	Negative-going input threshold voltage	$I_O = 8 \text{ mA}$		-0.2				
V_{hys}	Hysteresis voltage ($V_{IT+} - V_{IT-}$)				35		mV	
V_{IK}	Enable-input clamp voltage	$I_I = -18 \text{ mA}$		-1.5			V	
V_{OH}	High-level output voltage	$V_{ID} = 200 \text{ mV}$,	$I_{OH} = -8 \text{ mA}$,	See Figure 7		4	V	
V_{OL}	Low-level output voltage	$V_{ID} = -200 \text{ mV}$,	$I_{OL} = 8 \text{ mA}$,	See Figure 7		0.4	V	
I_{OZ}	High-impedance-state output current	$V_O = 0$ or V_{CC}	\overline{RE} at V_{CC}	-1		1	μA	
I_I	Bus input current	HVD05	Other input at 0 V	V_A or $V_B = 12 \text{ V}$		0.23	0.5	mA
				V_A or $V_B = 12 \text{ V}$, $V_{CC} = 0 \text{ V}$		0.3	0.5	
				V_A or $V_B = -7 \text{ V}$		-0.4	0.13	
				V_A or $V_B = -7 \text{ V}$, $V_{CC} = 0 \text{ V}$		-0.4	0.15	
		HVD06 HVD07	Other input at 0 V	V_A or $V_B = 12 \text{ V}$		0.06	0.1	mA
				V_A or $V_B = 12 \text{ V}$, $V_{CC} = 0 \text{ V}$		0.08	0.13	
V_A or $V_B = -7 \text{ V}$				-0.1	0.05			
		V_A or $V_B = -7 \text{ V}$, $V_{CC} = 0 \text{ V}$		-0.05	0.03			
I_{IH}	High-level input current, \overline{RE}	$V_{IH} = 2 \text{ V}$		-60	26.4		μA	
I_{IL}	Low-level input current, \overline{RE}	$V_{IL} = 0.8 \text{ V}$		-60	27.4		μA	
$C_{(diff)}$	Differential input capacitance	$V_I = 0.4 \sin(4E6\pi t) + 0.5 \text{ V}$, DE at 0 V			16		pF	
I_{CC}	Supply current	\overline{RE} at 0 V, D & DE at 0 V, No load		Receiver enabled and driver disabled		5	10	mA
		\overline{RE} at V_{CC} , DE at 0 V, D at V_{CC} , No load		Receiver disabled and driver disabled (standby)		1	5	μA
		\overline{RE} at 0 V, D & DE at V_{CC} , No load		Receiver enabled and driver enabled		9	15	mA

(1) All typical values are at 25°C and with a 5-V supply.

RECEIVER SWITCHING CHARACTERISTICS

over operating free-air temperature range unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP ⁽¹⁾	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output 1/2 UL	HVD05		14.6	25	ns
t_{PHL}	Propagation delay time, high-to-low-level output 1/2 UL	HVD05		14.6	25	ns
t_{PLH}	Propagation delay time, low-to-high-level output 1/8 UL	HVD06		55	70	ns
		HVD07		55	70	
t_{PHL}	Propagation delay time, high-to-low-level output 1/8 UL	HVD06		55	70	ns
		HVD07		55	70	
$t_{sk(p)}$	Pulse skew ($ t_{PHL} - t_{PLH} $)	HVD05			2	ns
		HVD06			4.5	
		HVD07			4.5	
$t_{sk(pp)}^{(2)}$	Part-to-part skew	HVD05			6.5	ns
		HVD06			14	
		HVD07			14	
t_r	Output signal rise time	$C_L = 15 \text{ pF}$, See Figure 8		2	3	ns
t_f	Output signal fall time			2	3	
t_{PZH1}	Output enable time to high level	$C_L = 15 \text{ pF}$, DE at 3 V, See Figure 9			10	ns
t_{PZL1}	Output enable time to low level				10	
t_{PHZ}	Output disable time from high level				15	
t_{PLZ}	Output disable time from low level				15	
t_{PZH2}	Propagation delay time, standby-to-high-level output	$C_L = 15 \text{ pF}$, DE at 0, See Figure 10			6	μs
t_{PZL2}	Propagation delay time, standby-to-low-level output				6	

(1) All typical values are at 25°C and with a 5-V supply.

(2) $t_{sk(pp)}$ is the magnitude of the difference in propagation delay times between any specified terminals of two devices when both devices operate with the same supply voltages, at the same temperature, and have identical packages and test circuits.

PARAMETER MEASUREMENT INFORMATION

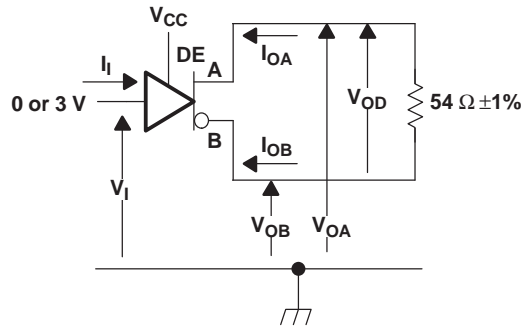


Figure 1. Driver V_{OD} Test Circuit and Voltage and Current Definitions

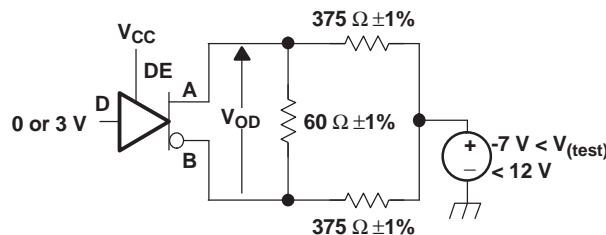
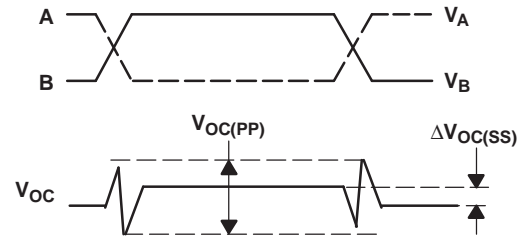
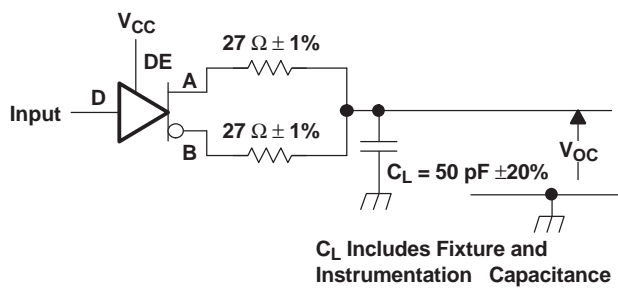


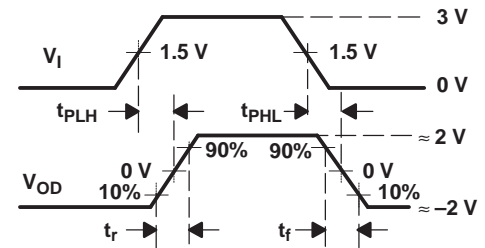
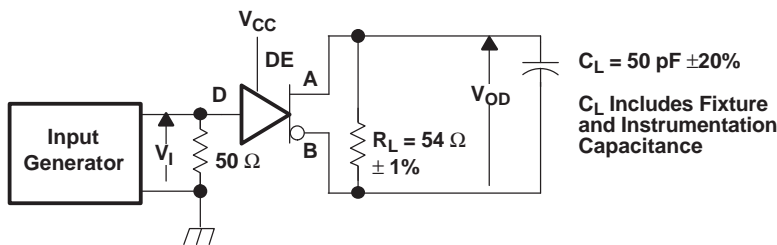
Figure 2. Driver V_{OD} With Common-Mode Loading Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)



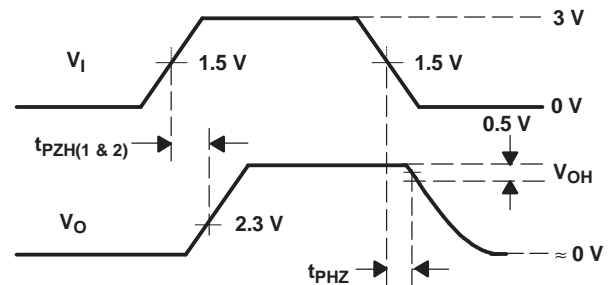
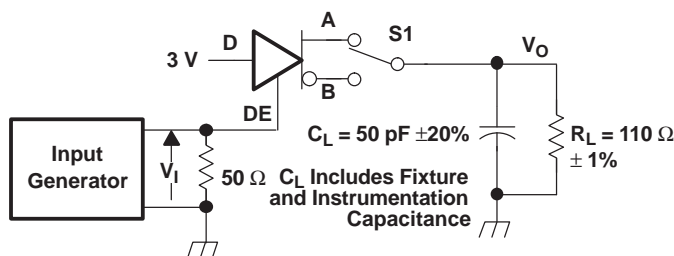
Input: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6$ ns, $t_f < 6$ ns, $Z_o = 50 \Omega$

Figure 3. Test Circuit and Definitions for the Driver Common-Mode Output Voltage



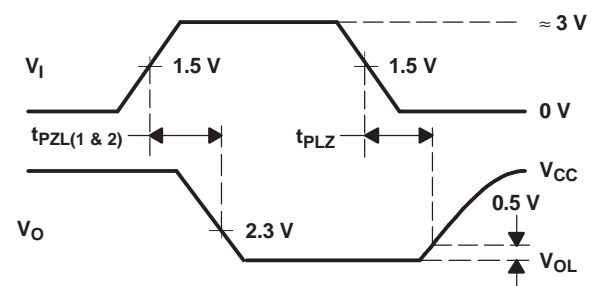
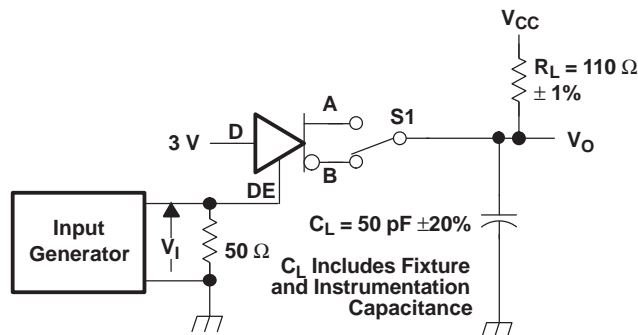
Generator: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6$ ns, $t_f < 6$ ns, $Z_o = 50 \Omega$

Figure 4. Driver Switching Test Circuit and Voltage Waveforms



Generator: PRR = 100 kHz, 50% Duty Cycle, $t_r < 6$ ns, $t_f < 6$ ns, $Z_o = 50 \Omega$

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



Generator: PRR = 100 kHz, 50% Duty Cycle, $t_r < 6$ ns, $t_f < 6$ ns, $Z_o = 50 \Omega$

Figure 6. Driver Low-Level Output Enable and Disable Time Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

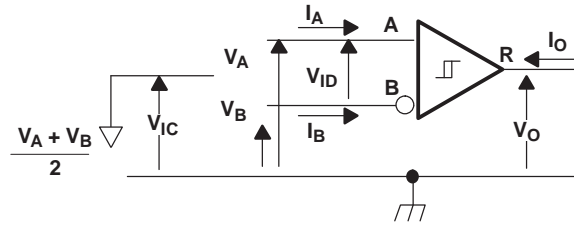


Figure 7. Receiver Voltage and Current Definitions

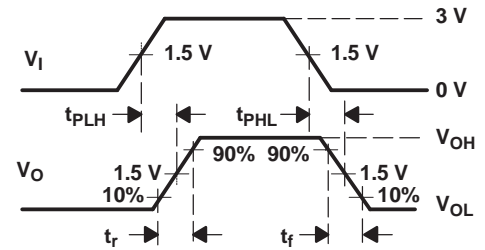
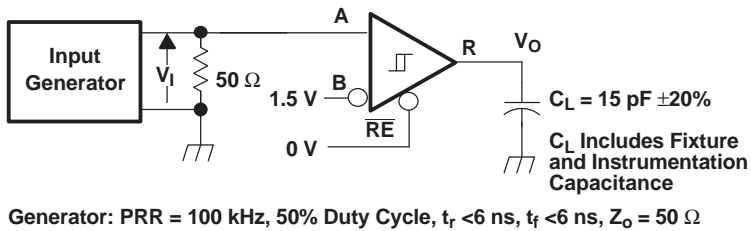


Figure 8. Receiver Switching Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

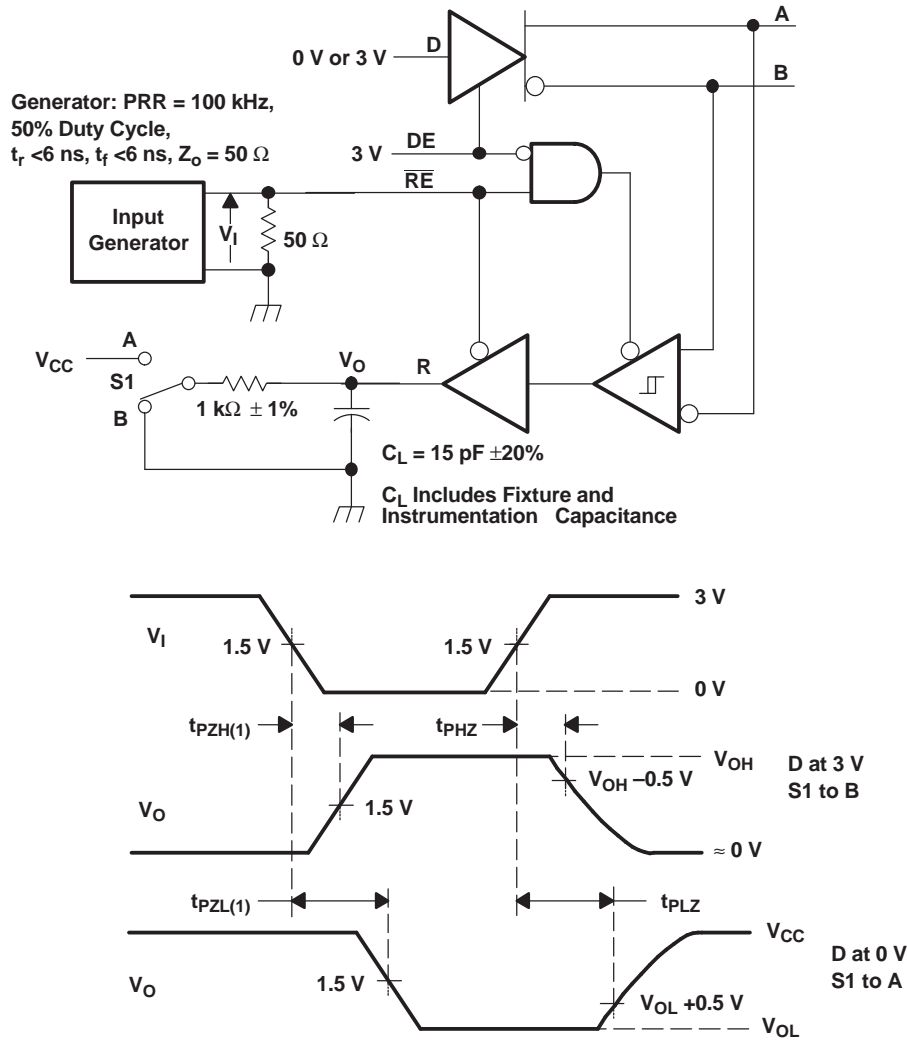


Figure 9. Receiver Enable and Disable Time Test Circuit and Voltage Waveforms With Drivers Enabled

PARAMETER MEASUREMENT INFORMATION (continued)

Generator: PRR = 100 kHz,
50% Duty Cycle,
 $t_r < 6$ ns, $t_f < 6$ ns, $Z_o = 50 \Omega$

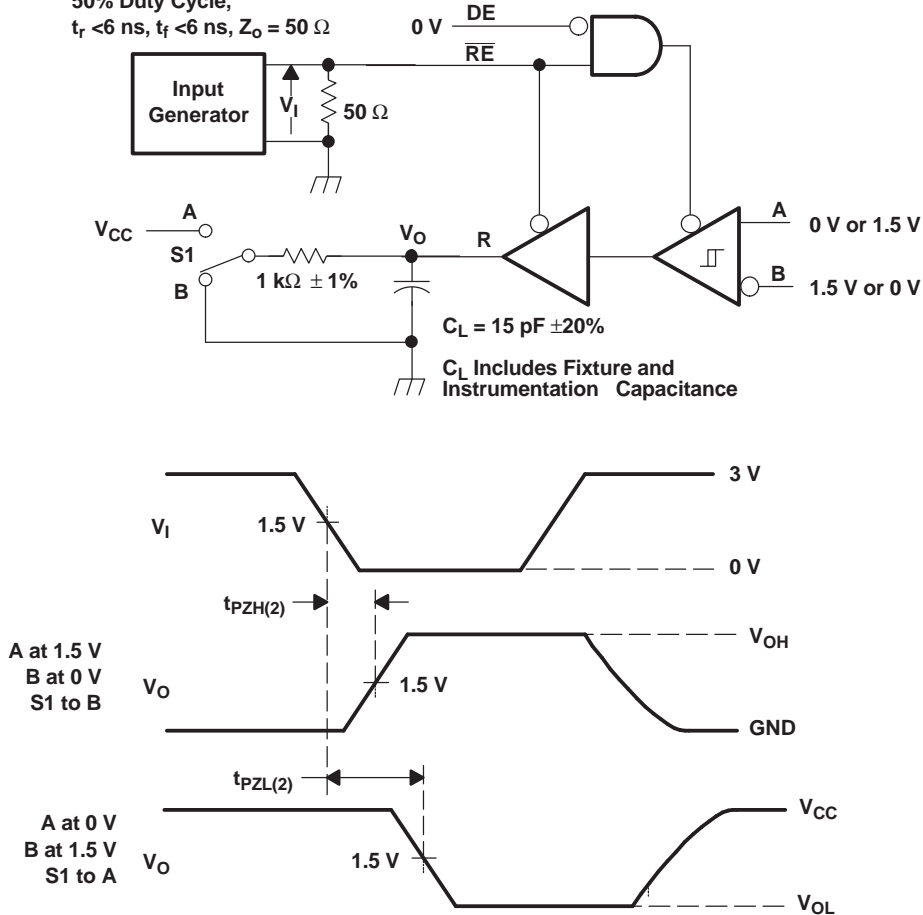
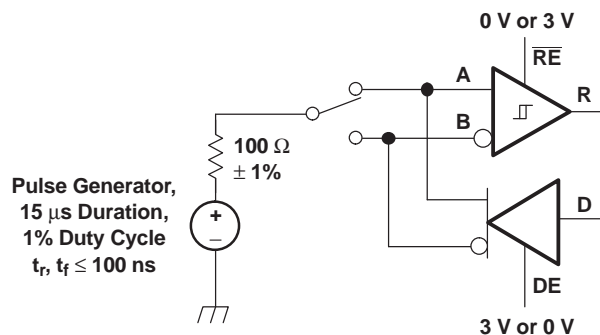


Figure 10. Receiver Enable Time From Standby (Driver Disabled)



NOTE: This test is conducted to test survivability only. Data stability at the R output is not specified.

Figure 11. Test Circuit, Transient Over Voltage Test

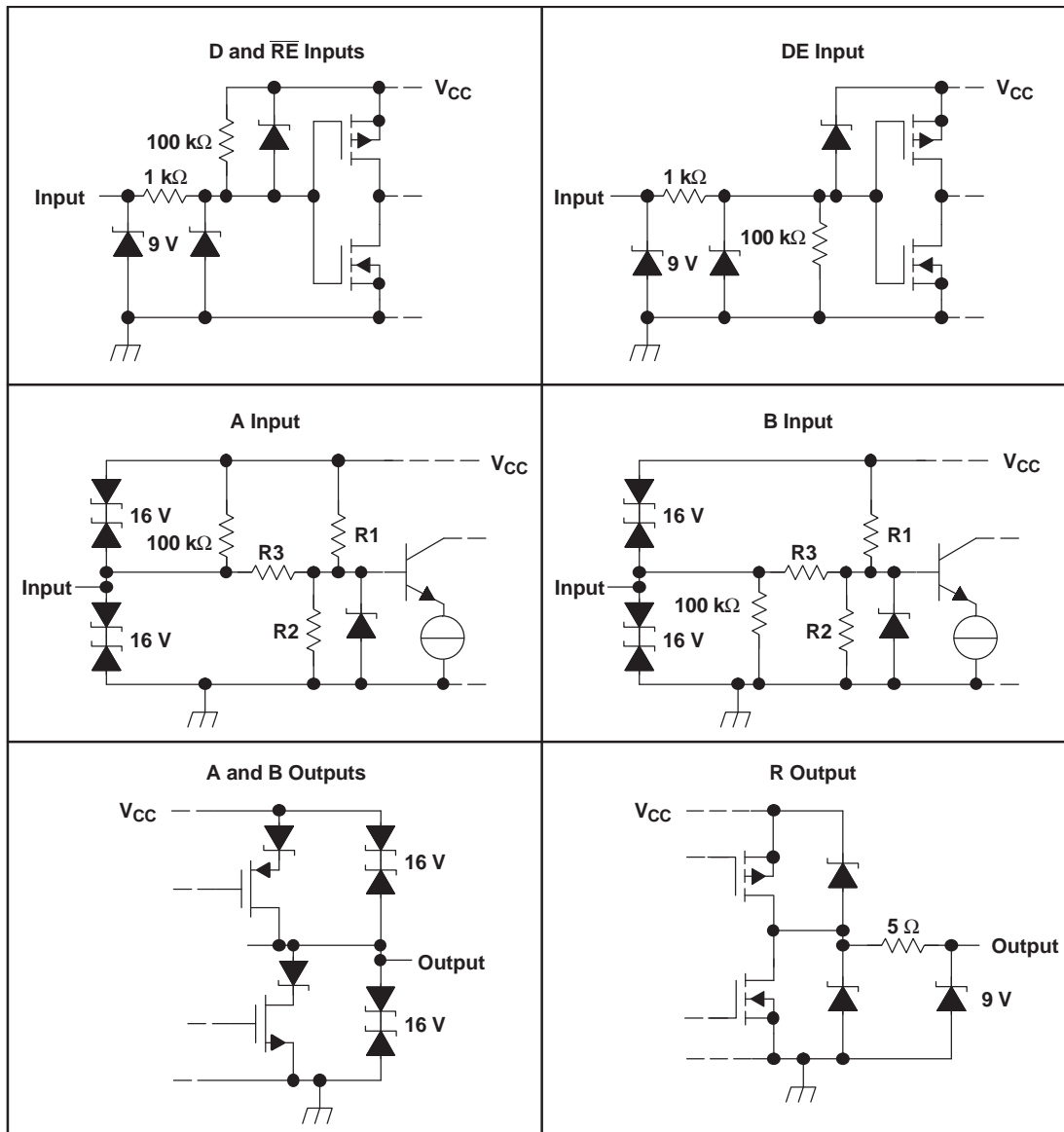
FUNCTION TABLES
DRIVER

INPUT D	ENABLE	OUTPUTS	
	DE	A	B
H	H	H	L
L	H	L	H
X	L	Z	Z
Open	H	H	L
X	Open	Z	Z

RECEIVER⁽¹⁾

DIFFERENTIAL INPUTS $V_{ID} = V_A - V_B$	ENABLE RE	OUTPUT R
$V_{ID} \leq -0.2$ V	L	L
-0.2 V < $V_{ID} < -0.01$ V	L	?
-0.01 V $\leq V_{ID}$	L	H
X	H	Z
Open Circuit	L	H
Short Circuit	L	H
X	Open	Z

(1) H = high level; L = low level; Z = high impedance; X = irrelevant;
 ? = indeterminate

EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS


	R1/R2	R3
SN65HVD05	9 kΩ	45 kΩ
SN65HVD06	36 kΩ	180 kΩ
SN65HVD07	36 kΩ	180 kΩ

TYPICAL CHARACTERISTICS

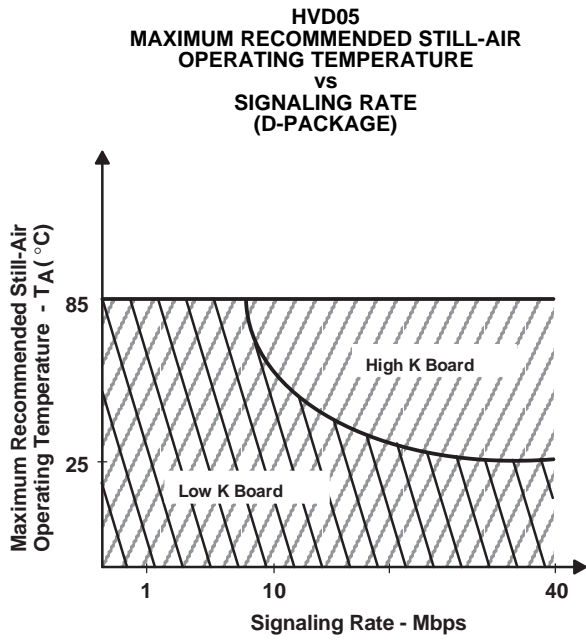


Figure 12.

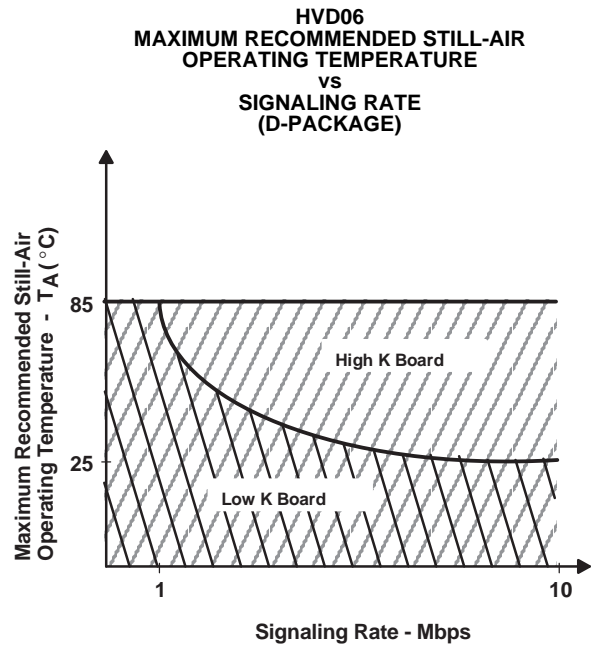


Figure 13.

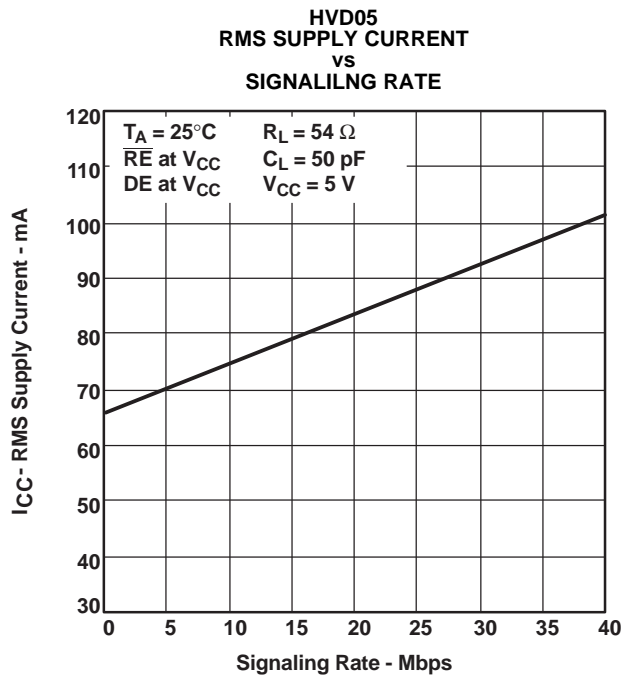


Figure 14.

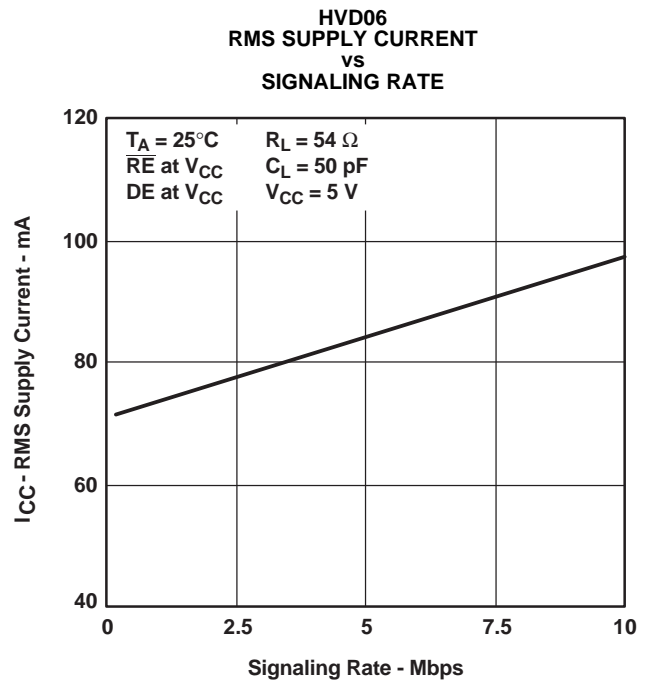


Figure 15.

TYPICAL CHARACTERISTICS (continued)

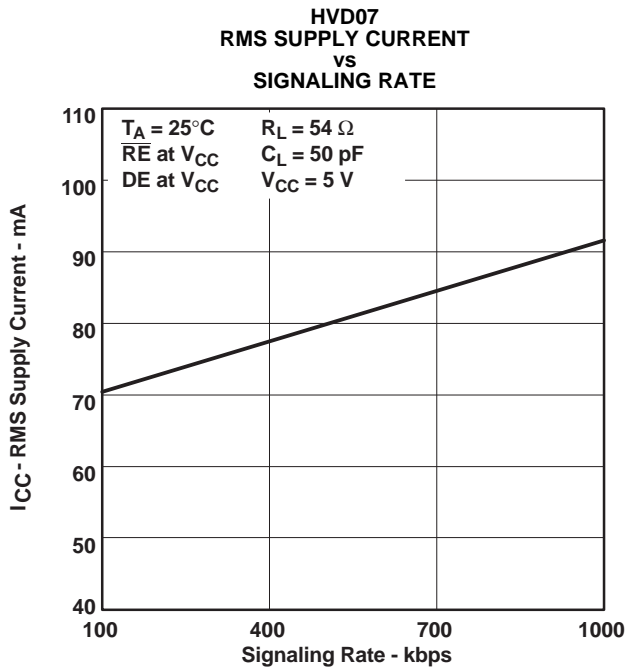


Figure 16.

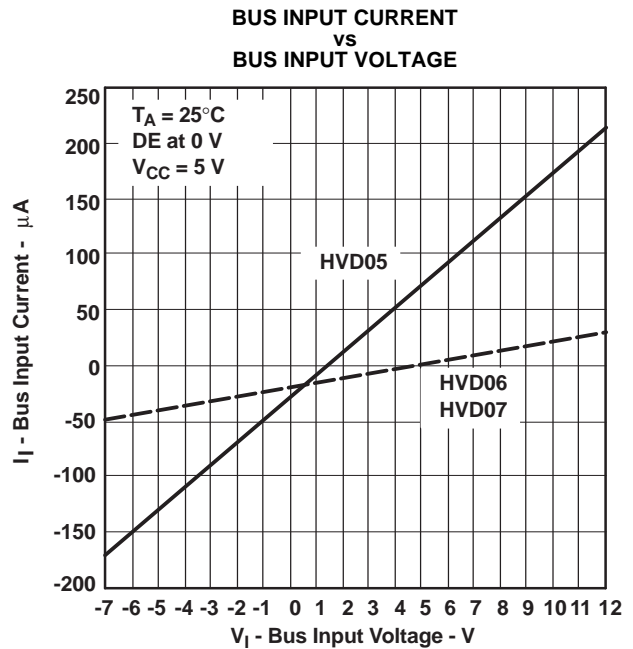


Figure 17.

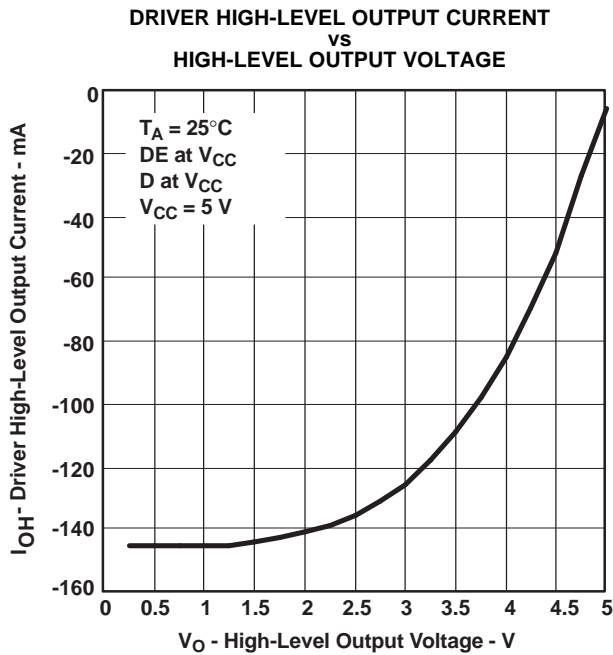


Figure 18.

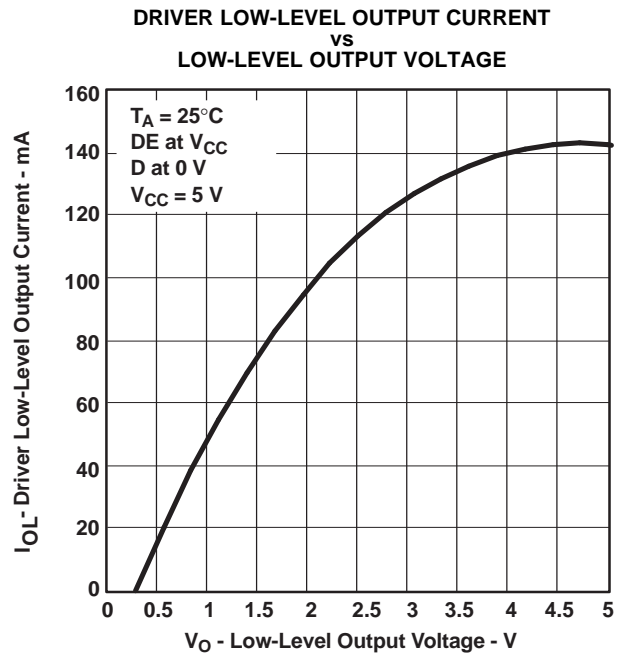


Figure 19.

TYPICAL CHARACTERISTICS (continued)

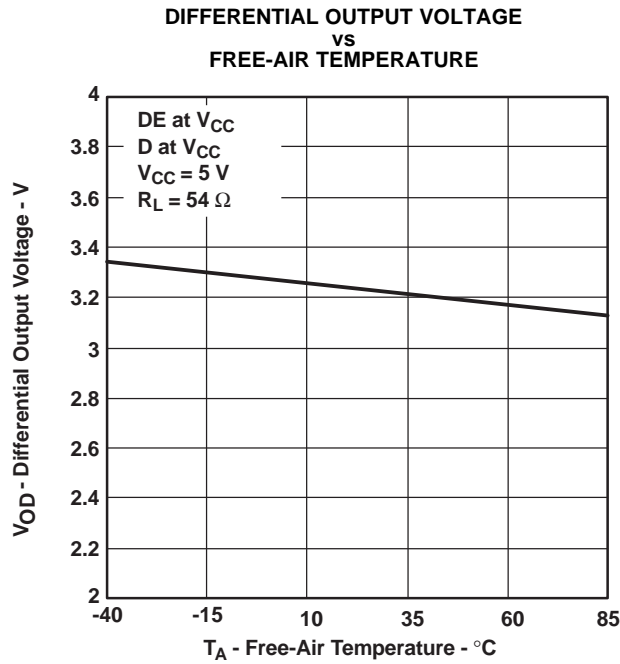


Figure 20.

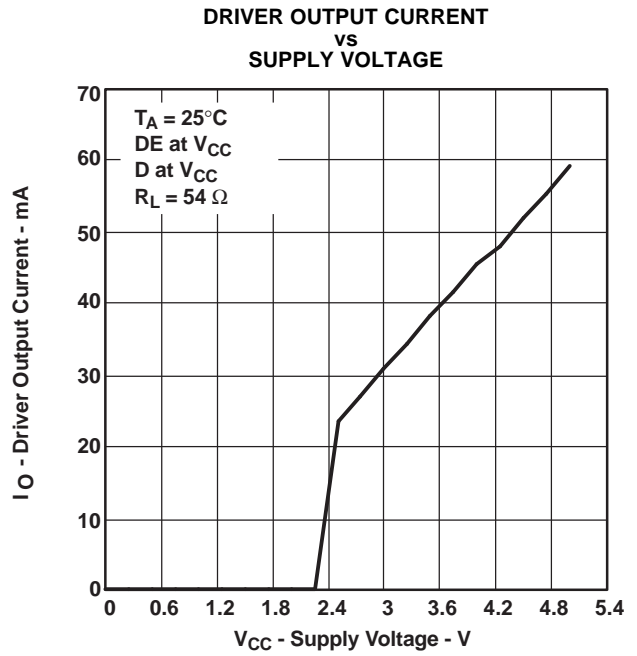


Figure 21.

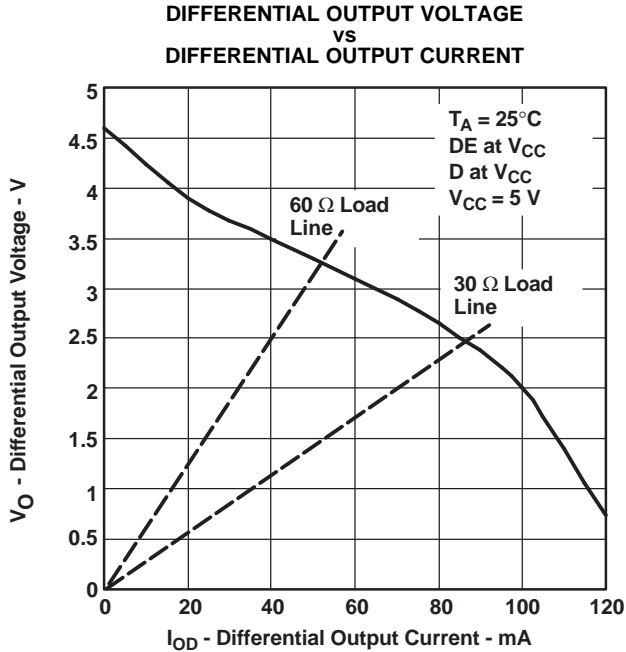


Figure 22.

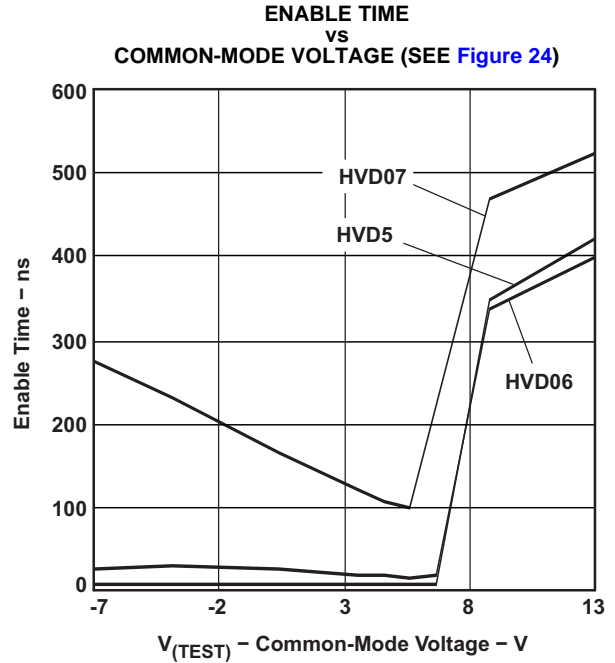


Figure 23.

TYPICAL CHARACTERISTICS (continued)

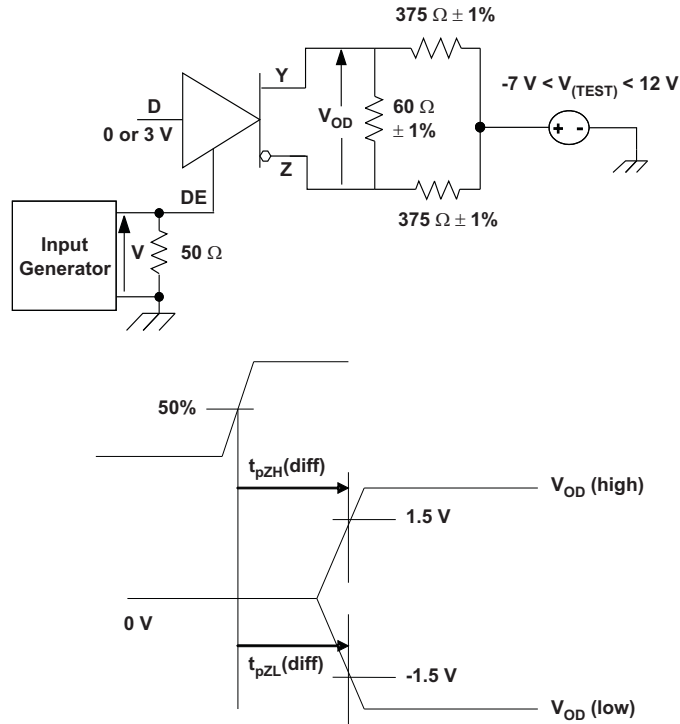
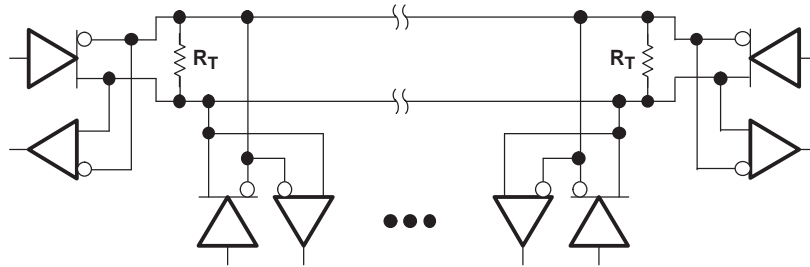


Figure 24. Driver Enable Time From DE to V_{OD}

The time $t_{pZL}(x)$ is the measure from DE to $V_{OD}(x)$. V_{OD} is valid when it is greater than 1.5 V.

APPLICATION INFORMATION



Device	Number of Devices on Bus
HVD05	64
HVD06	256
HVD07	256

NOTE: The line should be terminated at both ends with its characteristic impedance ($R_T = Z_0$). Stub lengths off the main line should be kept as short as possible.

Figure 25. Typical Application Circuit

PACKAGE

SOP8

Dimensions In Millimeters

Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	1.225	1.570	D	0.400	0.950
A1	0.100	0.250	Q	0°	8°
B	4.800	5.100	a	0.420 TYP	
C	5.800	6.250	b	1.270 TYP	
C1	3.800	4.000			

DIP8

Dimensions In Millimeters

Symbol :	Min :	Max :	Symbol :	Min :	Max :
A	6.100	6.680	L1	3.000	3.600
B	9.000	9.500	a	1.524 TYP	
D	8.400	9.000	b	0.889 TYP	
D1	7.420	7.820	c	0.457 TYP	
E	3.100	3.550	d	2.540 TYP	
L	0.500	0.700			

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