

3.3-V RS-485 TRANSCEIVERS

DESCRIPTION

The HX65HVD10, HX65HVD11, and HX65HVD12, combine a 3-state differential line driver and differential input line receiver that operate with a single 3.3-V power supply. They are designed for balanced transmission lines and meet or exceed ANSI standard TIA/EIA-485-A and ISO 8482:1993. These differential bus transceivers are monolithic integrated circuits designed for bidirectional data communication on multipoint bus-transmission lines. The drivers and receivers have active-high and active-low enables respectively, that can be externally connected together to function as direction control. Very low device standby supply current can be achieved by disabling the driver and the receiver.

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 VCC = 0. These parts feature wide positive and negative common-mode voltage ranges, making them suitable for party-line applications.

FEATURES

- Operates With a 3.3-V Supply
- Bus-Pin ESD Protection Exceeds 16 kV HBM
- 1/8 Unit-Load Option Available (Up to 256 Nodes on the Bus)
- Optional Driver Output Transition Times for Signaling Rates (1) of 1 Mbps, 10 Mbps, and 32 Mbps
- Meets or Exceeds the Requirements of ANSI TIA/EIA-485-A
- Bus-Pin Short Circuit Protection From -7 V to 12 V
- Low-Current Standby Mode . . . 1 μ A Typical
- Open-Circuit, Idle-Bus, and Shorted-Bus Failsafe Receiver
- Thermal Shutdown Protection
- Glitch-Free Power-Up and Power-Down Protection for Hot-Plugging Applications

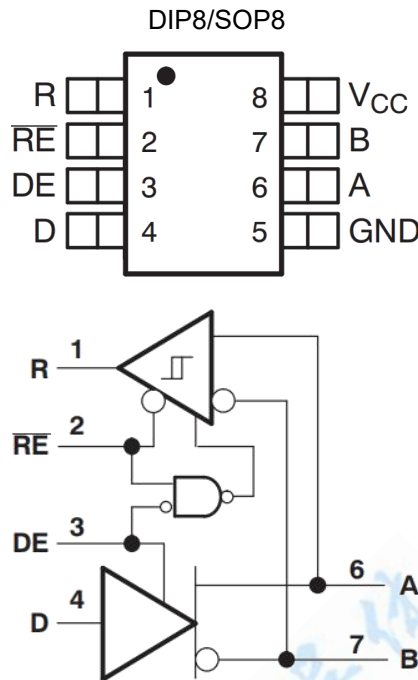
APPLICATIONS

- Digital Motor Control
- Utility Meters
- Chassis-to-Chassis Interconnects
- Electronic Security Stations
- Industrial Process Control
- Building Automation
- Point-of-Sale (POS) Terminals and Networks

ORDERING INFORMATION

DEVICE	Package Type	MARKING	Packing	Packing Qty
HX65HVD10EIPG	DIP8L	65HVD10	TUBE	2000pcs/box
HX65HVD11EIPG	DIP8L	65HVD11	TUBE	2000pcs/box
HX65HVD12EIPG	DIP8L	65HVD12	TUBE	2000pcs/box
HX65HVD10EIDRG	SOP8L	65HVD10	REEL	2500pcs/reel
HX65HVD11EIDRG	SOP8L	65HVD11	REEL	2500pcs/reel
HX65HVD12EIDRG	SOP8L	65HVD12	REEL	2500pcs/reel

Pin Connection



(1) The signaling rate of a line is the number of voltage transitions that are made per second expressed in the units bps (bits per second).

ABSOLUTE MAXIMUM RATINGS

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

		UNIT	
V _{CC} Supply voltage range		-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 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	
I _o Receiver output current		-11 mA to 11 mA	
Electrostatic discharge	Human body model ⁽³⁾	A, B, and GND	±16 kV
		All pins	±4 kV
	Charged-device model ⁽⁴⁾	All pins charge	±1 kV
Continuous total power dissipation		See Dissipation Rating Table	
Electrical Fast Transient/Burst ⁽⁵⁾		A, B, and GND	±4 kV
T _J Junction temperature		170°C	

- (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 and IEC 60749-26.
- (4) Tested in accordance with JEDEC Standard 22, Test Method C101.
- (5) Tested in accordance with IEC 61000-4-4.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range unless otherwise noted

		MIN	NOM	MAX	UNIT
V _{CC}	Supply voltage	3		3.6	V
V _I or V _{IC}	Voltage at any bus terminal (separately or common mode)	-7(1)		12	
V _{IH}	High-level input voltage	2		V _{CC}	
V _{IL}	Low-level input voltage	0		0.8	
V _{ID}	Differential input voltage	-12		12	mA
I _{OH}	High-level output current	Driver		-60	
		Receiver		-8	
I _{OL}	Low-level output current	Driver		60	mA
		Receiver		8	
R _L	Differential load resistance	54	60		Ω
C _L	Differential load capacitance		50		pF
Signaling rate	HVD10		32		Mbps
	HVD11		10		
	HVD12		1		
T _J	Junction temperature		145		°C

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

(2) See thermal characteristics table for information regarding this specification.

DRIVER ELECTRICAL CHARACTERISTICS

over recommended operating conditions 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 ⁽²⁾	I _O = 0		2		V _{CC}	V
		R _L = 54 Ω, See Figure 1		1.5			
		V _{test} = -7 V to 12 V, See Figure 2		1.5			
Δ V _{OD}	Change in magnitude of differential output voltage	See Figure 1 and Figure 2		-0.2		0.2	V
V _{OC(PP)}	Peak-to-peak common-mode output voltage	See Figure 3		400			mV
V _{OC(SS)}	Steady-state common-mode output voltage			1.4		2.5	V
ΔV _{OC(SS)}	Change in steady-state common-mode output voltage			-0.05		0.05	V
I _{OZ}	High-impedance output current	See receiver input currents					
I _I	Input current	D		-100		0	μA
		DE		0		100	
I _{OS}	Short-circuit output current	-7 V ≤ V _O ≤ 12 V		-250		250	mA
C _(OD)	Differential output capacitance	V _{OD} = 0.4 sin(4E6πt) + 0.5 V, DE at 0 V		16			pF
I _{CC}	Supply current	R _E at V _{CC} , D & DE at V _{CC} , No load	Receiver disabled and driver enabled	9		15.5	mA
		R _E at V _{CC} , D at V _{CC} , DE at 0 V, No load	Receiver disabled and driver disabled (standby)	1		5	μA
		R _E at 0 V, D & DE at V _{CC} , No load	Receiver enabled and driver enabled	9		15.5	mA

(1) All typical values are at 25°C and with a 3.3-V supply.

(2) For TA > 85°C, V_{CC} is ±5%.

DRIVER SWITCHING CHARACTERISTICS

over recommended operating conditions unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
t _{PLH}	Propagation delay time, low-to-high-level output	HVD10	5	8.5	16	ns
		HVD11	18	25	40	
		HVD12	135	200	300	
t _{PHL}	Propagation delay time, high-to-low-level output	HVD10	5	8.5	16	ns
		HVD11	18	25	40	
		HVD12	135	200	300	
t _r	Differential output signal rise time	HVD10	3	4.5	10	ns
		HVD11	10	20	30	
		HVD12	100	170	300	
t _f	Differential output signal fall time	HVD10	3	4.5	10	ns
		HVD11	10	20	30	
		HVD12	100	170	300	
t _{sk(pp)}	Pulse skew (t _{PHL} - t _{PLH})	HVD10		1.5		ns
		HVD11		2.5		
		HVD12		7		
t _{sk(pp)} (2)	Part-to-part skew	HVD10		6		ns
		HVD11		11		
		HVD12		100		
t _{PZH}	Propagation delay time, high-impedance-to-high-level output	HVD10		31		ns
		HVD11		55		
		HVD12		300		
t _{PHZ}	Propagation delay time, high-level-to-high-impedance output	HVD10		25		ns
		HVD11		55		
		HVD12		300		
t _{PZL}	Propagation delay time, high-impedance-to-low-level output	HVD10		26		ns
		HVD11		55		
		HVD12		300		
t _{PLZ}	Propagation delay time, low-level-to-high-impedance output	HVD10		26		ns
		HVD11		75		
		HVD12		400		
t _{PZH}	Propagation delay time, standby-to-high-level output	R _L = 110 Ω, RE at 3 V, See Figure 5		6		μs
t _{PZL}	Propagation delay time, standby-to-low-level output	R _L = 110 Ω, RE at 3 V, See Figure 6		6		μs

(1) All typical values are at 25°C and with a 3.3-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 recommended operating conditions unless otherwise noted

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
V _{IT+} Positive-going input threshold voltage	I _O = -8 mA			-0.06 5	-0.01	V
V _{IT-} Negative-going input threshold voltage	I _O = 8 mA		-0.2	-0.1		V
V _{hys} Hysteresis voltage (V _{IT+} - V _{IT-})				35		mV
V _{IK} Enable-input clamp voltage	I _I = -18 mA			-1.5		V
V _{OH} High-level output voltage	V _{ID} = 200 mV, I _{OH} = -8 mA, See Figure 7			2.4		V
V _{OL} Low-level output voltage	V _{ID} = -200 mV, I _{OL} = 8 mA, See Figure 7			0.4		V
I _{OZ} High-impedance-state output current	V _O = 0 or V _{CC}	RE at V _{CC}	-1		1	μA
I _I Bus input current	V _A or V _B = 12 V	HVD11, HVD12, Other input at 0 V		0.05	0.11	mA
	V _A or V _B = 12 V, V _{CC} = 0 V			0.06	0.13	
	V _A or V _B = -7 V			-0.1	-0.05	
	V _A or V _B = -7 V, V _{CC} = 0 V			-0.05	-0.04	
	V _A or V _B = 12 V	HVD10, Other input at 0 V		0.2	0.5	mA
	V _A or V _B = 12 V, V _{CC} = 0 V			0.25	0.5	
	V _A or V _B = -7 V			-0.4	-0.2	
	V _A or V _B = -7 V, V _{CC} = 0 V			-0.4	-0.15	
I _{IH} High-level input current, \overline{RE}	V _{IH} = 2 V		-30		0	μA
I _{IL} Low-level input current, \overline{RE}	V _{IL} = 0.8 V		-30		0	μA
C _{ID} Differential input capacitance	V _{ID} = 0.4 sin (4E6πt) + 0.5 V, DE at 0 V			15		pF
I _{CC} Supply current	\overline{RE} at 0 V, D & DE at 0 V, No load	Receiver enabled and driver disabled		4		mA
				8		
	\overline{RE} at V _{CC} , D at V _{CC} , DE at 0 V, 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	15.5	mA

(1) All typical values are at 25°C and with a 3.3-V supply.

RECEIVER SWITCHING CHARACTERISTICS

over recommended operating conditions unless otherwise noted

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	HVD10	12.5	20	25	ns
t_{PHL}	Propagation delay time, high-to-low-level output	HVD10	12.5	20	25	
t_{PLH}	Propagation delay time, low-to-high-level output	HVD11 HVD12	30	55	70	ns
t_{PHL}	Propagation delay time, high-to-low-level output	HVD11 HVD12	30	55	70	
$t_{sk(p)}$	Pulse skew ($ t_{PHL} - t_{PLH} $)	HVD10		1.5		ns
		HVD11		4		
		HVD12		4		
$t_{sk(pp)}$ ⁽²⁾	Part-to-part skew	HVD10		8		ns
		HVD11		15		
		HVD12		15		
t_r	Output signal rise time	$C_L = 15\text{ pF}$, See Figure 8	1	2	5	ns
t_f	Output signal fall time		1	2	5	
t_{PZH} ⁽¹⁾	Output enable time to high level	$C_L = 15\text{ pF}$, DE at 3 V, See Figure 9		15		ns
t_{PZL} ⁽¹⁾	Output enable time to low level			15		
t_{PHZ}	Output disable time from high level			20		
t_{PLZ}	Output disable time from low level			15		
t_{PZH} ⁽²⁾	Propagation delay time, standby-to-high-level output	$C_L = 15\text{ pF}$, DE at 0, See Figure 10		6		μs
t_{PZL} ⁽²⁾	Propagation delay time, standby-to-low-level output			6		

(1) All typical values are at 25°C and with a 3.3-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

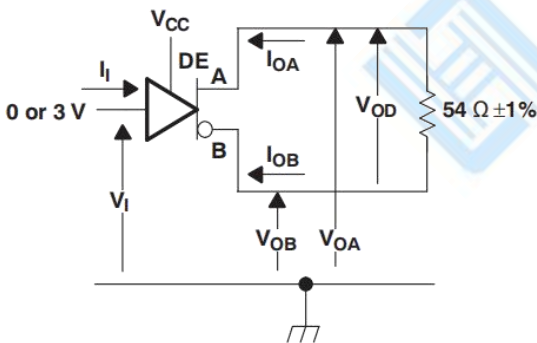


Figure 1. Driver VOD Test Circuit and Voltage and Current Definitions

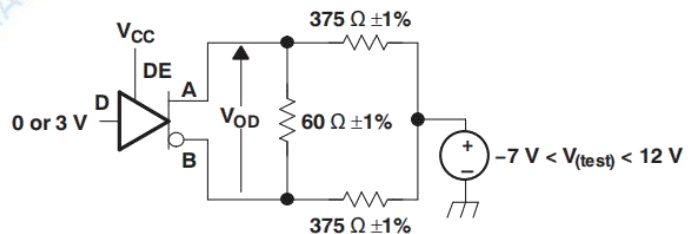
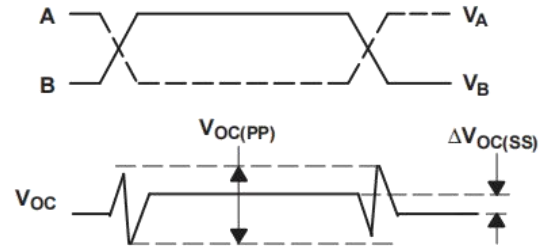
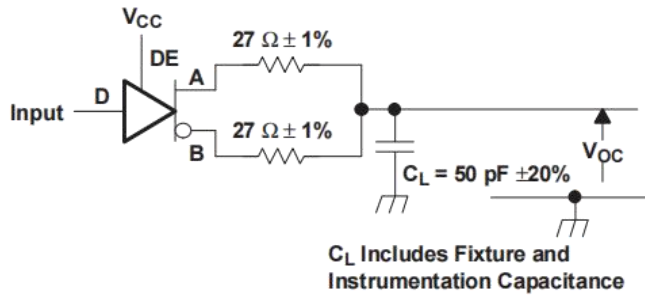
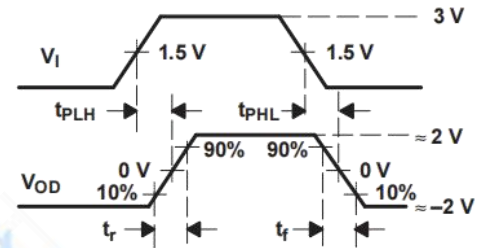
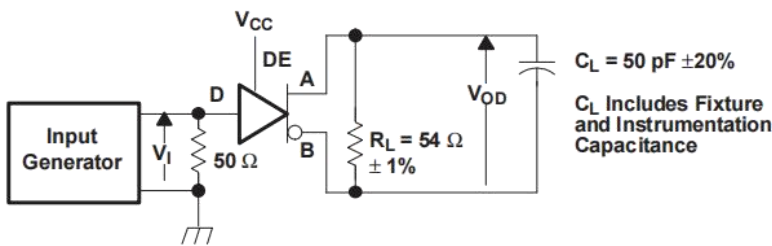


Figure 2. Driver VOD With Common-Mode Loading Test Circuit



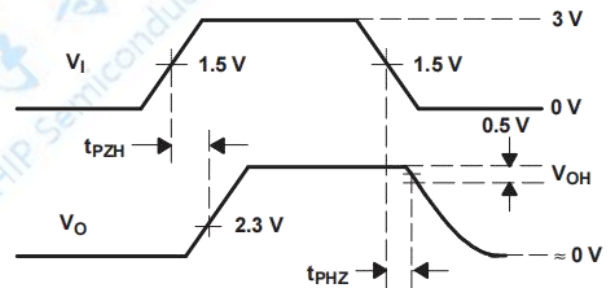
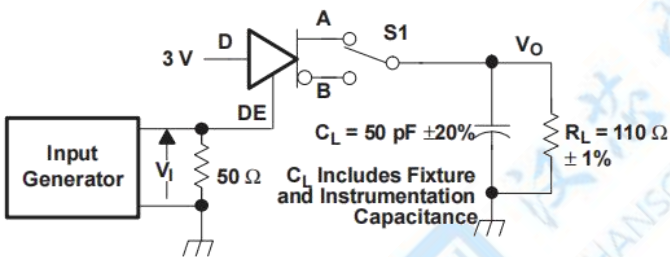
Input: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6\text{ns}$, $t_f < 6\text{ns}$, $Z_o = 50 \Omega$

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



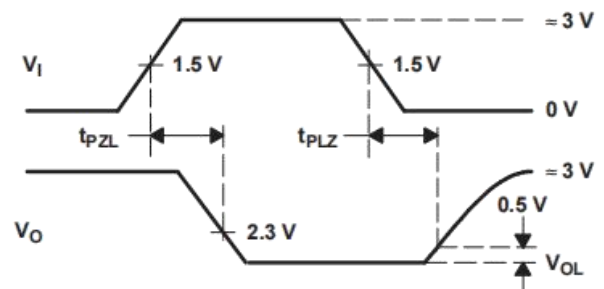
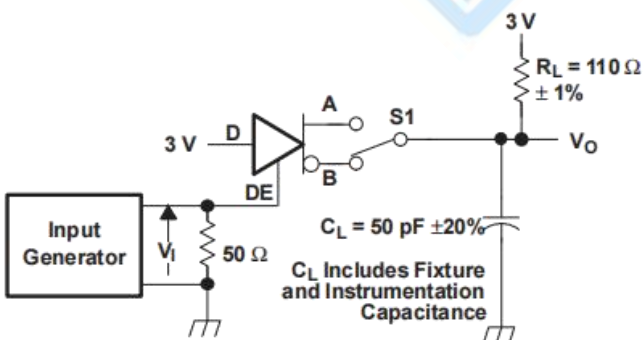
Generator: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6\text{ ns}$, $t_f < 6\text{ ns}$, $Z_o = 50 \Omega$

Figure 4. Driver Switching Test Circuit and Voltage Waveforms



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

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



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

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

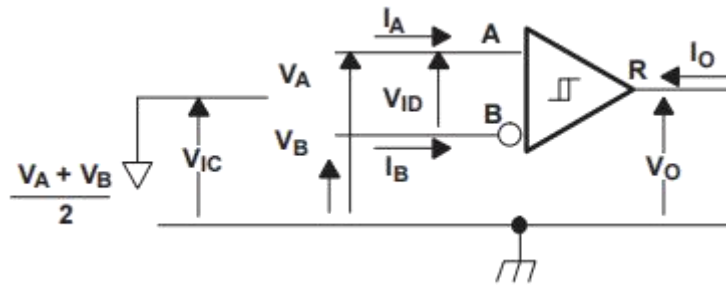


Figure 7. Receiver Voltage and Current Definitions

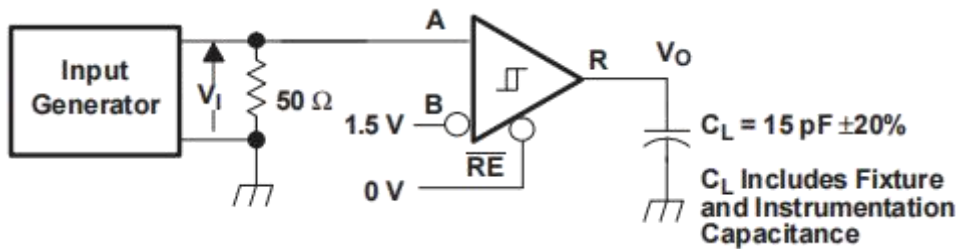
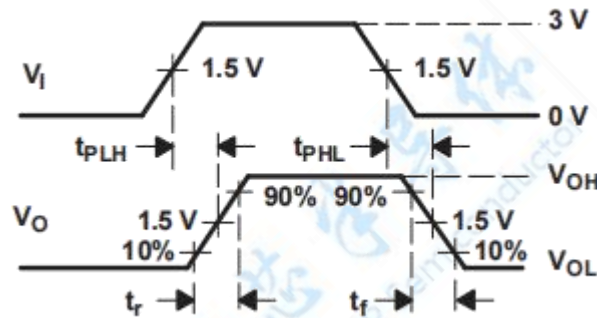

 Generator: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6$ ns, $t_f < 6$ ns, $Z_o = 50 \Omega$


Figure 8. Receiver Switching Test Circuit and Voltage Waveforms

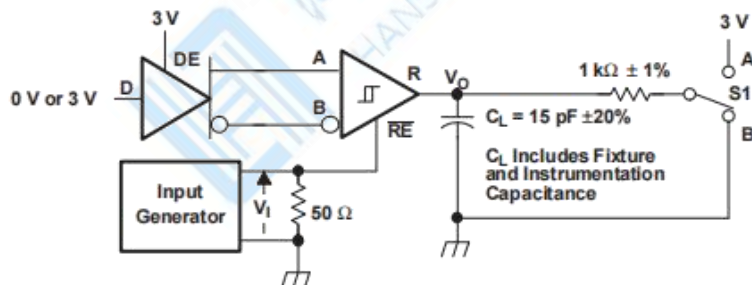
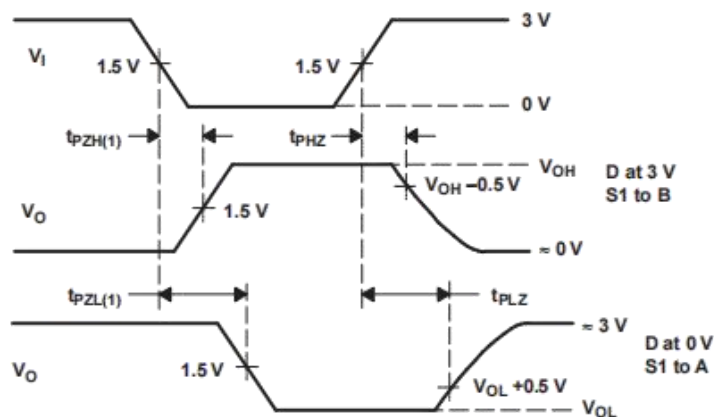

 Generator: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6$ ns, $t_f < 6$ ns, $Z_o = 50 \Omega$


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

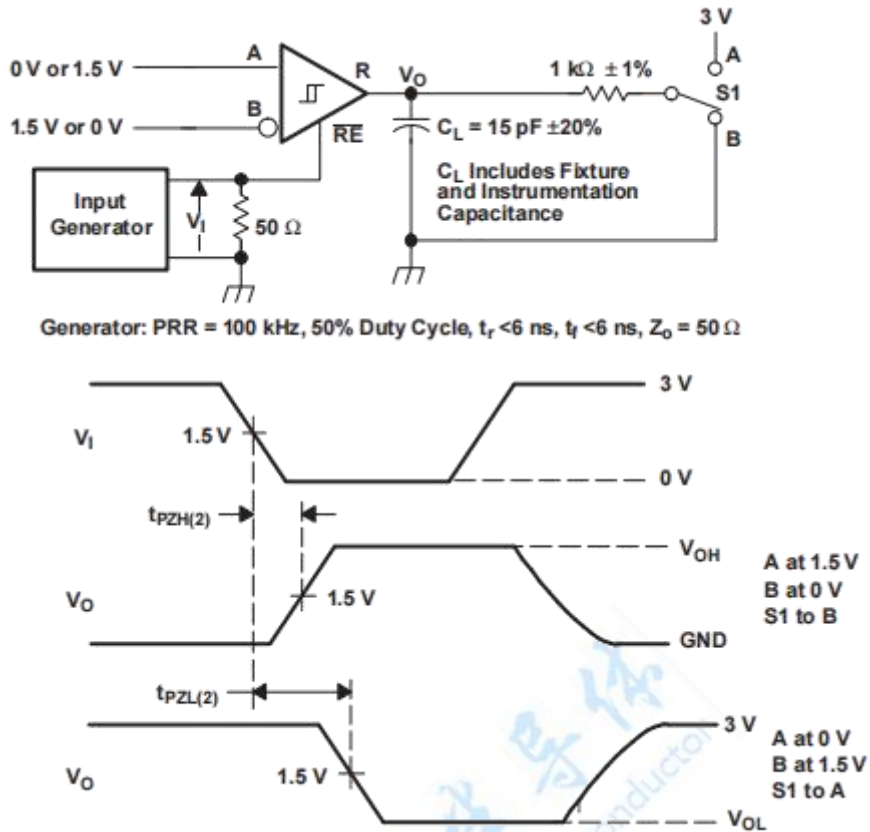
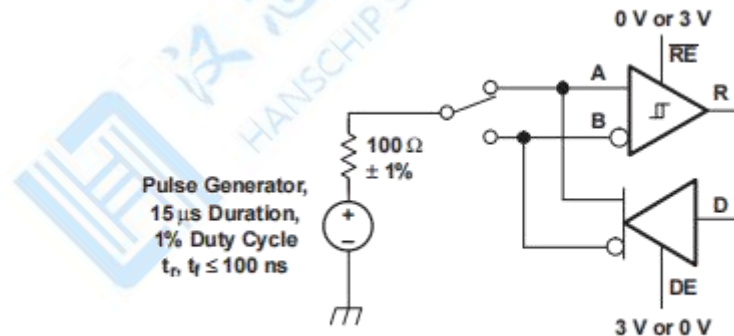


Figure 10. Receiver Enable Time From Standby (Driver Disabled)



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

PARAMETER MEASUREMENT INFORMATION (continued)
FUNCTION TABLES

Table 1. DRIVER(1)

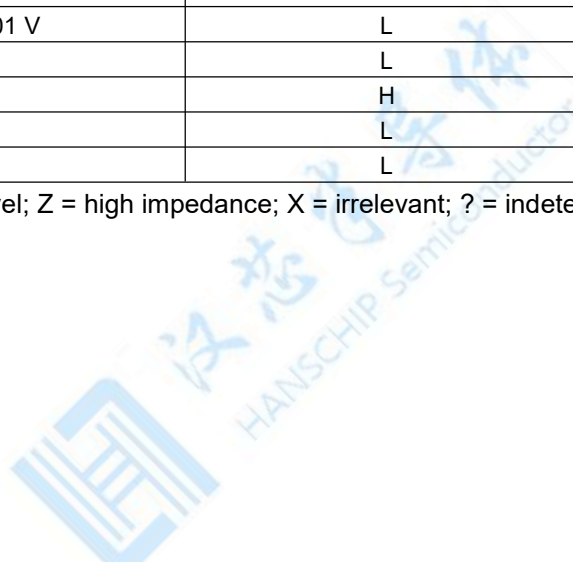
INPUT TD	ENABLE DE	OUTPUTS	
		A	B
H	H	H	L
L	H	L	H
X	L	Z	Z
Open	H	H	L

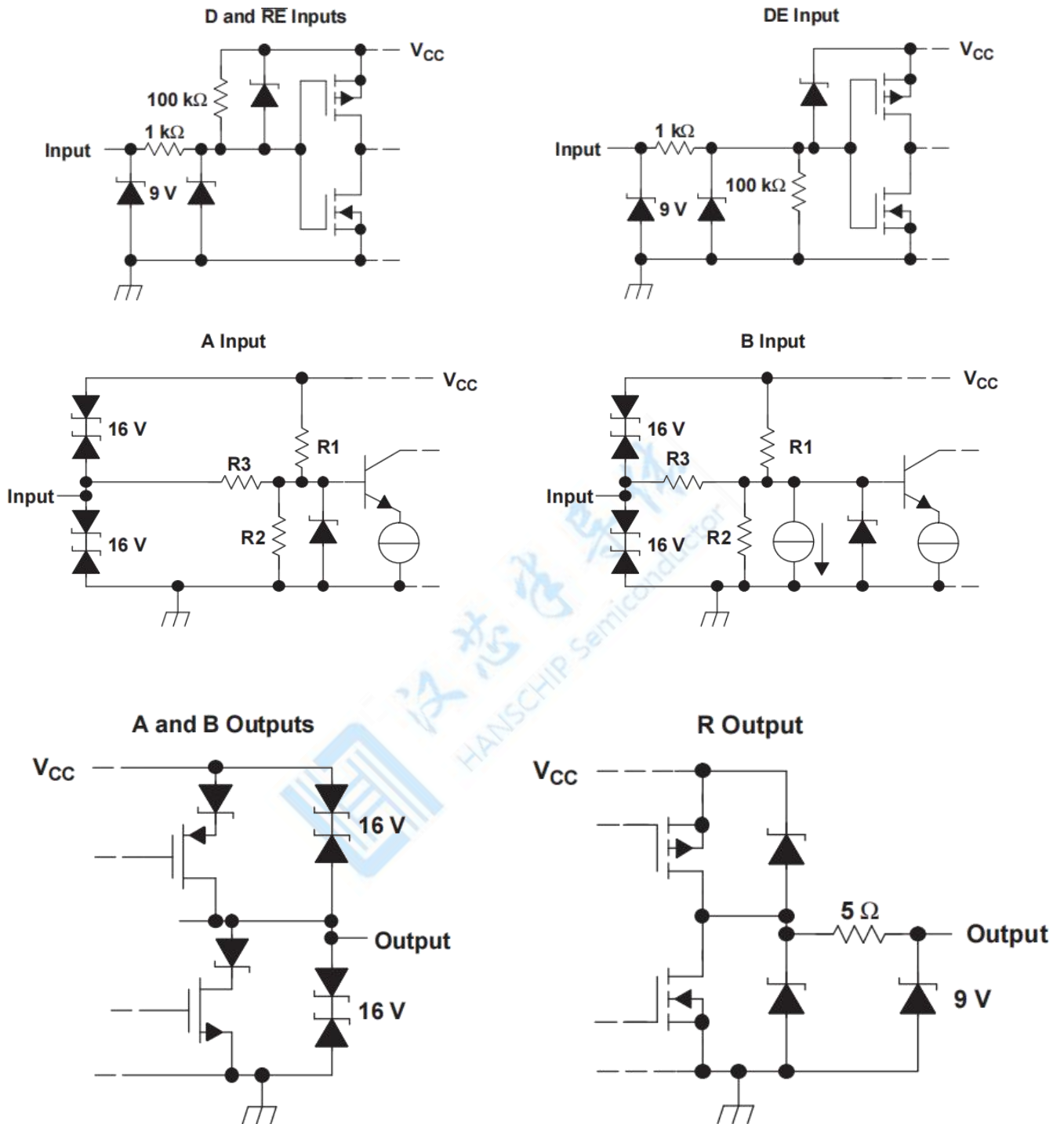
(1) H = high level; L = low level; Z = high impedance; X = irrelevant; ? = indeterminate

Table 2. RECEIVER(1)

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

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



EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS


	R1/R2	R3
HX65HVD10	9 kΩ	45 kΩ
HX65HVD11	36 kΩ	180 kΩ
HX65HVD12	36 kΩ	180 kΩ

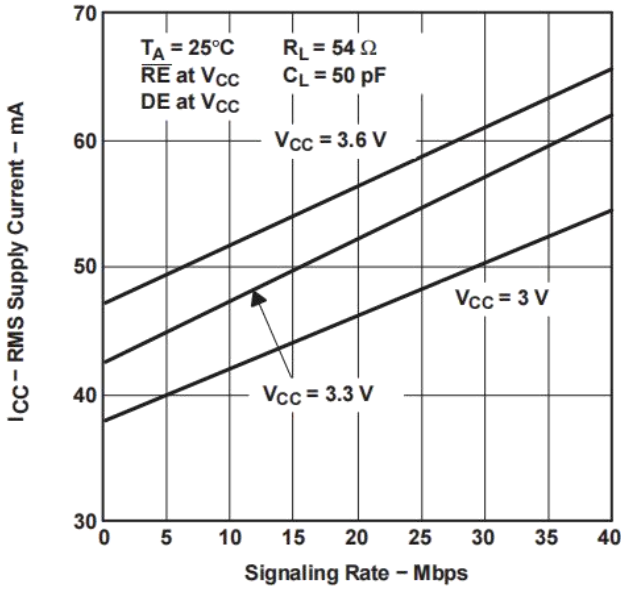
TYPICAL CHARACTERISTICS
**HVD10
RMS SUPPLY CURRENT
vs
SIGNALING RATE**


Figure 12.

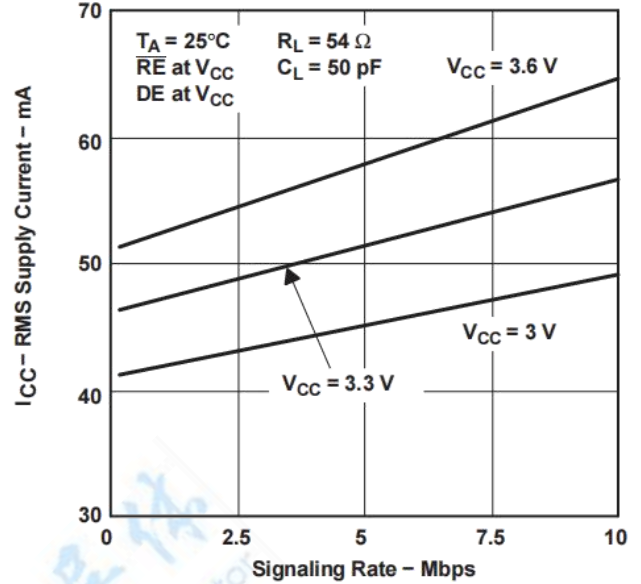
**HVD11
RMS SUPPLY CURRENT
vs
SIGNALING RATE**


Figure 13.

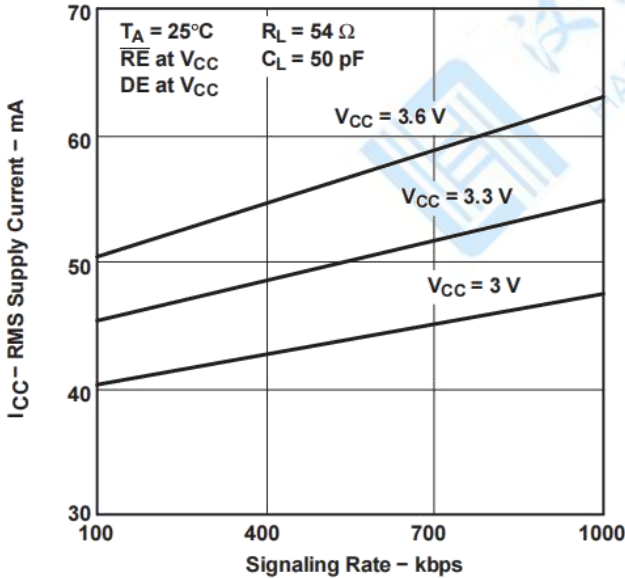
**HVD12
RMS SUPPLY CURRENT
vs
SIGNALING RATE**


Figure 14.

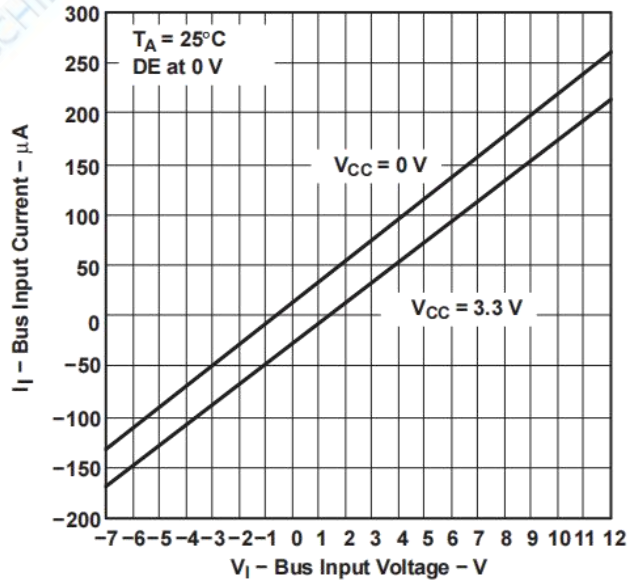
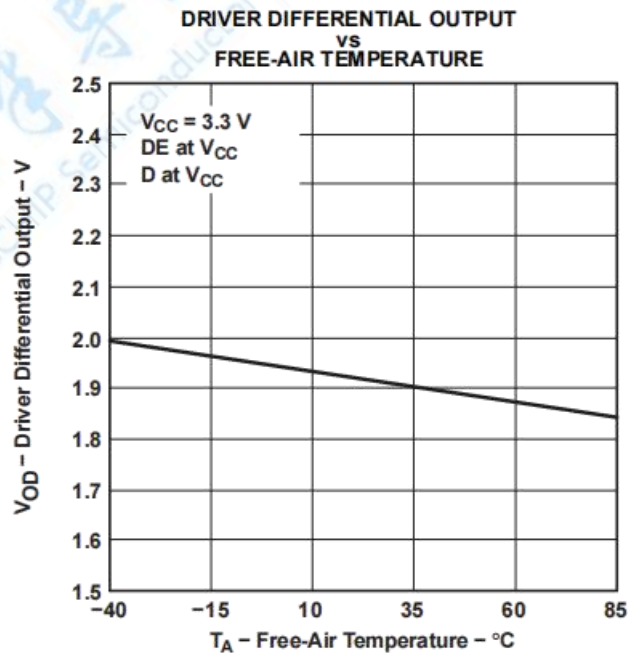
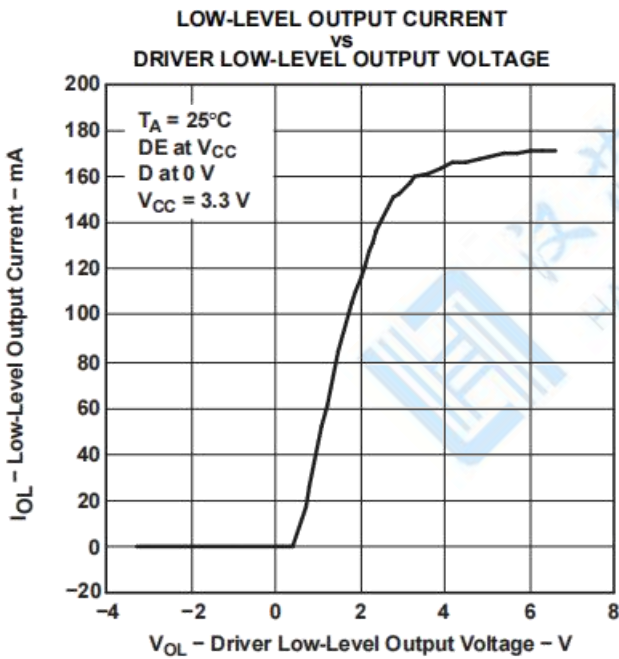
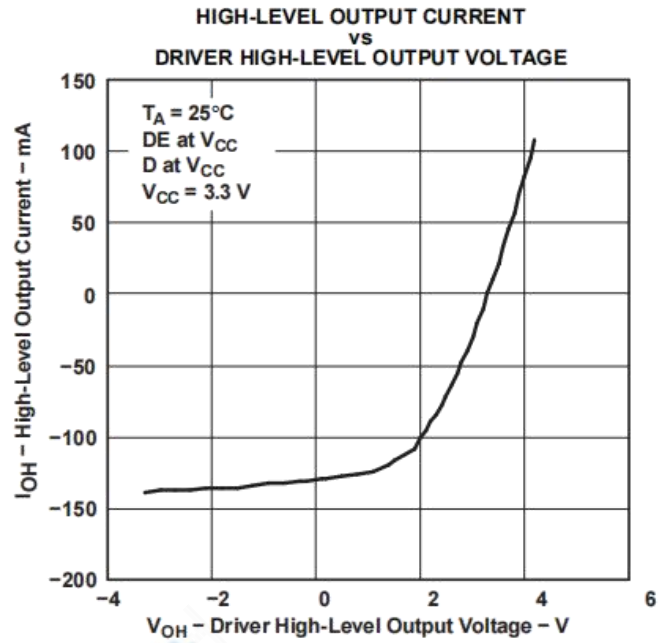
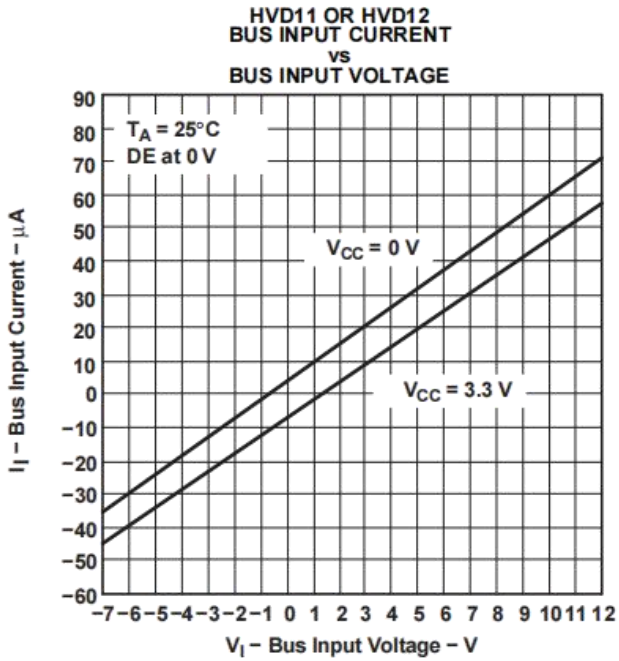
**HVD10
BUS INPUT CURRENT
vs
BUS INPUT VOLTAGE**


Figure 15.



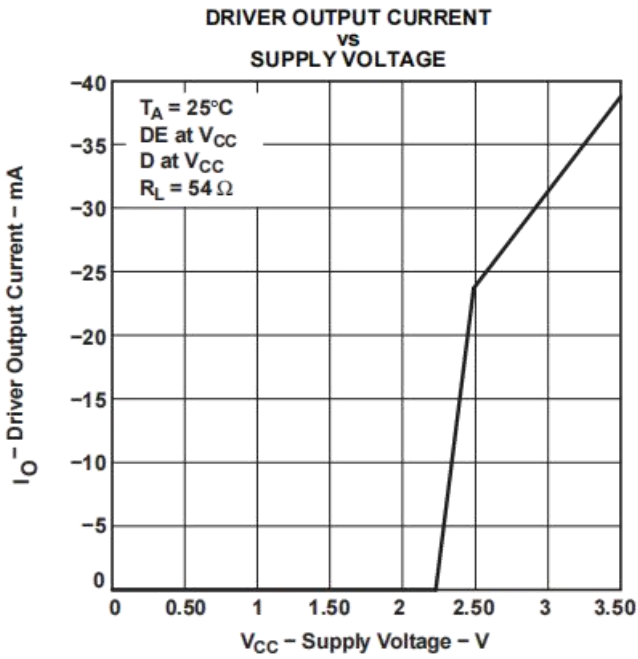


Figure 20.

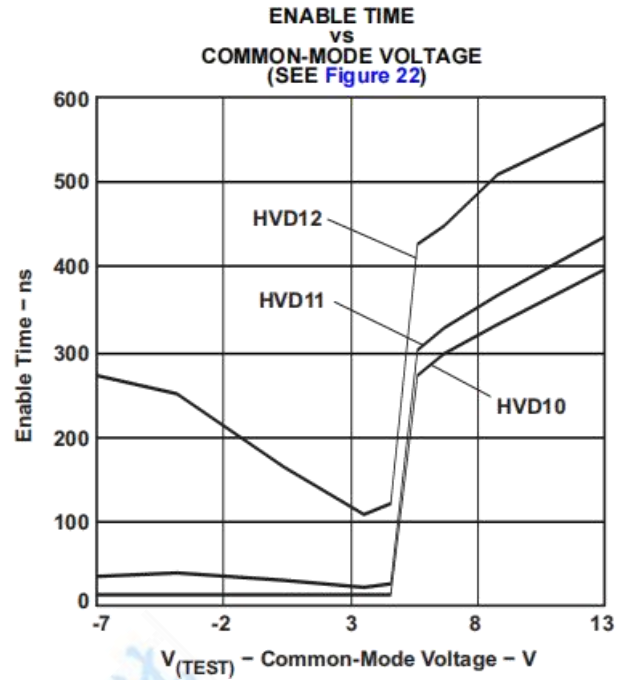


Figure 21.

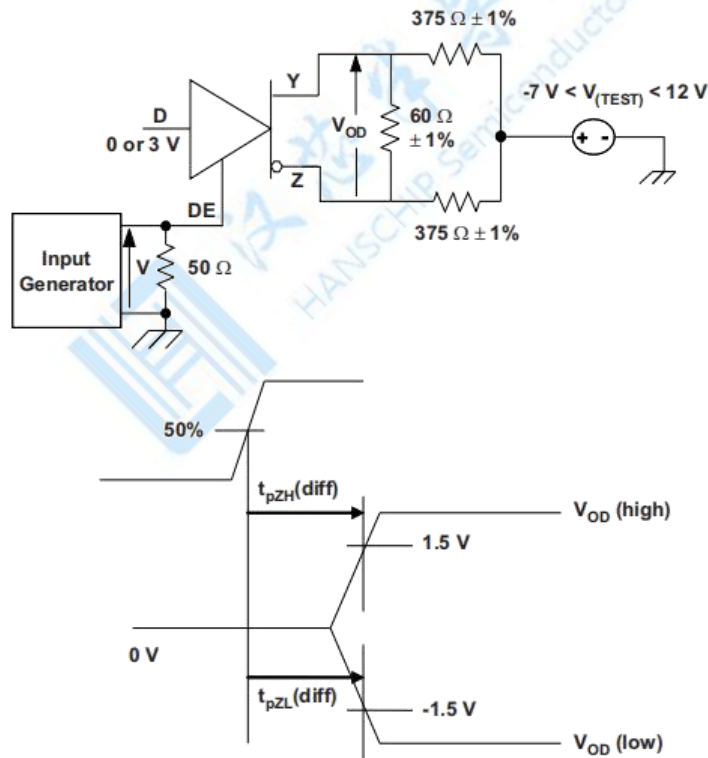
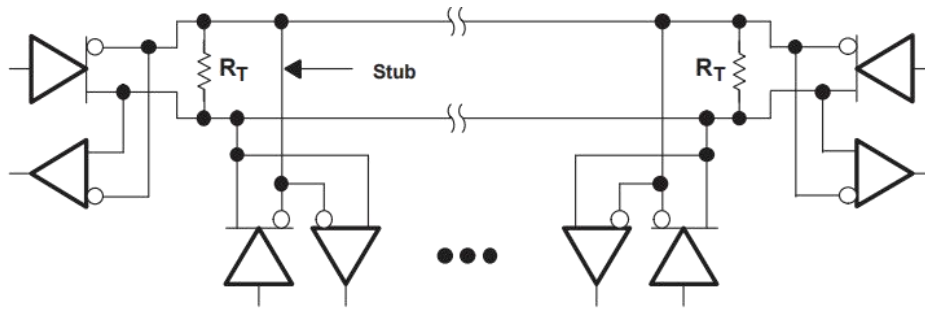


Figure 22. Driver Enable Time From DE to VOD

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
HVD10	64
HVD11	256
HVD12	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.

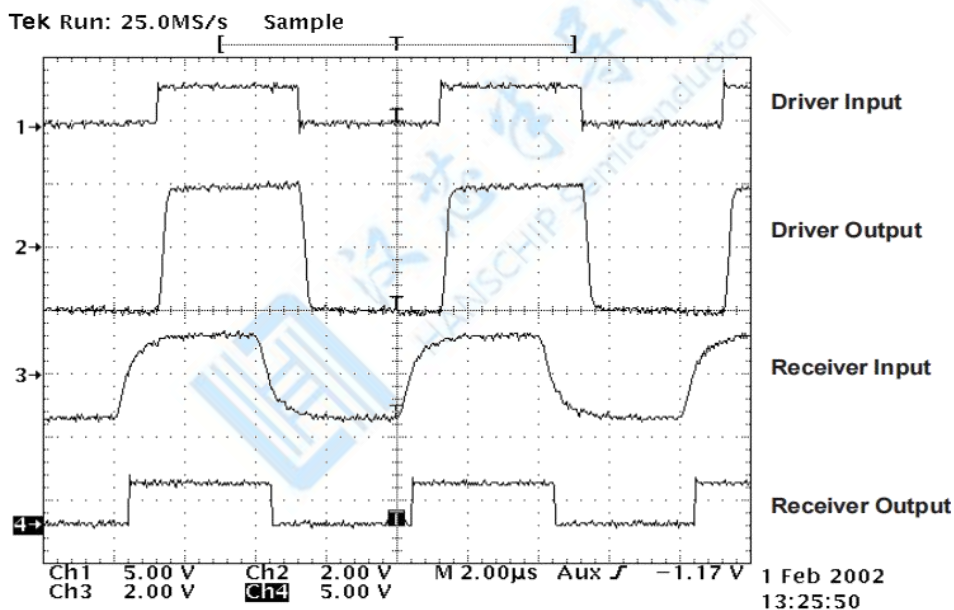
Figure 23. Typical Application Circuit


Figure 24. HVD12 Input and Output Through 2000 Feet of Cable

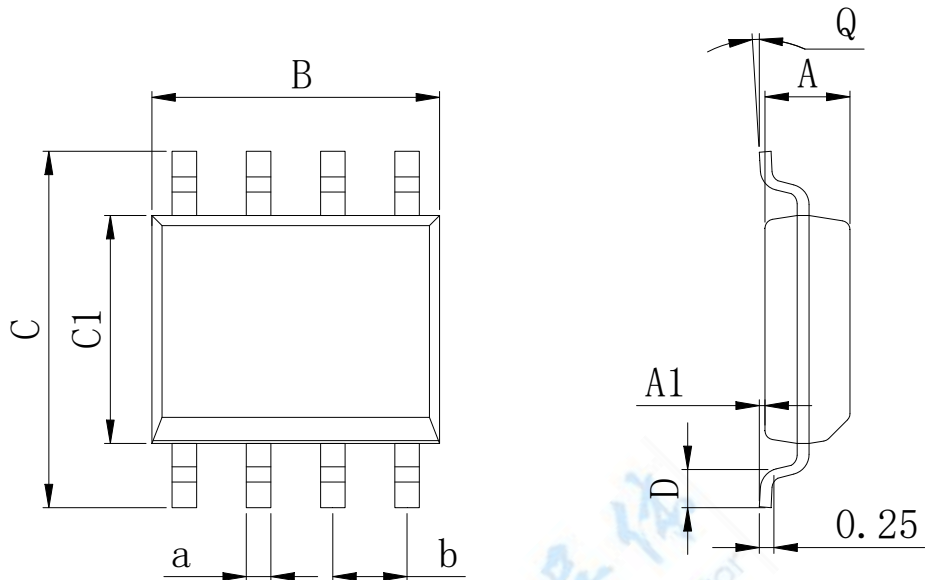
An example application for the HVD12 is illustrated in Figure 23. Two HVD12 transceivers are used to communicate data through a 2000 foot (600 m) length of Commscope 5524 category 5e+ twisted pair cable. The bus is terminated at each end by a 100-Ω resistor, matching the cable characteristic impedance. Figure 24 illustrates operation at a signaling rate of 250 kbps.

LOW-POWER STANDBY MODE

When both the driver and receiver are disabled (DE low and RE high) the device is in standby mode. If the enable inputs are in this state for less than 60 ns, the device does not enter standby mode. This guards against inadvertently entering standby mode during driver/receiver enabling. Only when the enable inputs are held in this state for 300 ns or more, the device is assured to be in standby mode. In this low-power standby mode, most internal circuitry is powered down, and the supply current is typically less than 1 nA. When either the driver or the receiver is re-enabled, the internal circuitry becomes active.

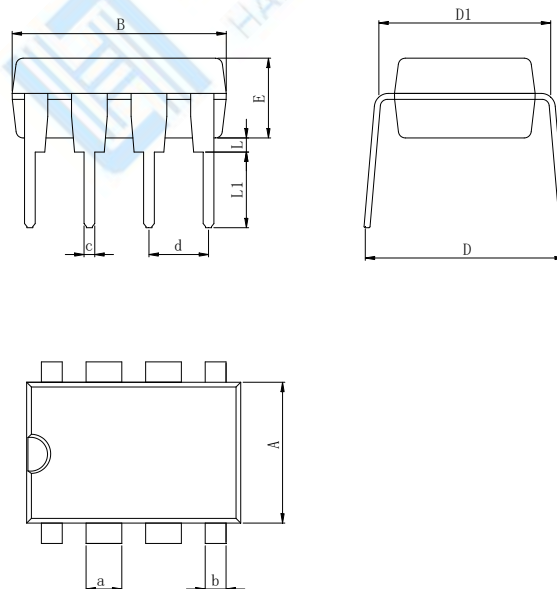
Physical Dimensions

SOP8 (150mil)


Dimensions In Millimeters(SOP8)

Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

DIP8


Dimensions In Millimeters(DIP8)

Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	9.00	8.40	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	9.50	9.00	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

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