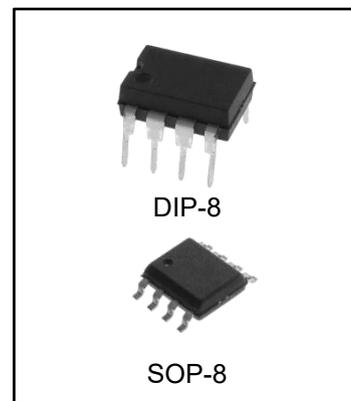


HIGH OUTPUT RS-485 TRANSCEIVERS

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



ORDERING INFORMATION

DEVICE	Package Type	MARKING	Packing	Packing Qty
HX65HVD05EIPG	DIP-8	HVD05EI	TUBE	2000pcs/box
HX65HVD06EIPG	DIP-8	HVD06EI	TUBE	2000pcs/box
HX65HVD07EIPG	DIP-8	HVD07EI	TUBE	2000pcs/box
HX75HVD05ECPG	DIP-8	HVD05EC	TUBE	2000pcs/box
HX75HVD06ECPG	DIP-8	HVD06EC	TUBE	2000pcs/box
HX75HVD07ECPG	DIP-8	HVD07EC	TUBE	2000pcs/box
HX65HVD05EIDRG	SOP-8	HVD05EI	REEL	2500pcs/reel
HX65HVD06EIDRG	SOP-8	HVD06EI	REEL	2500pcs/reel
HX65HVD07EIDRG	SOP-8	HVD07EI	REEL	2500pcs/reel
HX75HVD05ECDRG	SOP-8	HVD05EC	REEL	2500pcs/reel
HX75HVD06ECDRG	SOP-8	HVD06EC	REEL	2500pcs/reel
HX75HVD07ECDRG	SOP-8	HVD07EC	REEL	2500pcs/reel
HX65HVD05EIDRG4	SOP-8	HVD05EI	REEL	4000pcs/reel
HX65HVD06EIDRG4	SOP-8	HVD06EI	REEL	4000pcs/reel
HX65HVD07EIDRG4	SOP-8	HVD07EI	REEL	4000pcs/reel
HX75HVD05ECDRG4	SOP-8	HVD05EC	REEL	4000pcs/reel
HX75HVD06ECDRG4	SOP-8	HVD06EC	REEL	4000pcs/reel
HX75HVD07ECDRG4	SOP-8	HVD07EC	REEL	4000pcs/reel

DESCRIPTION

The HX65HVD05, HX75HVD05, HX65HVD06, HX75HVD06, HX65HVD07, and HX75HVD07 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.

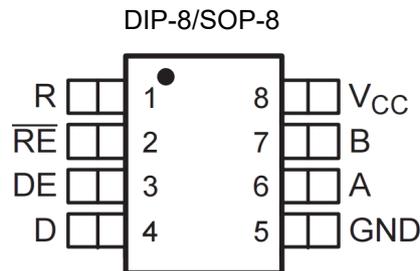
The driver differential outputs and receiver differential inputs connect internally to form a differential input/output (I/O) bus port that is designed to offer minimum loading to the bus whenever the driver is disabled or not powered.

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

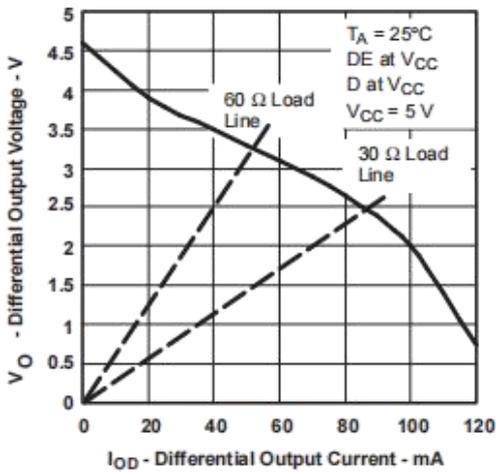
APPLICATIONS

- 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

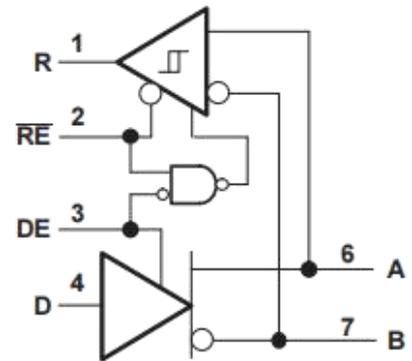
PIN CONNECTION



DIFFERENTIAL OUTPUT VOLTAGE
vs
DIFFERENTIAL OUTPUT CURRENT



LOGIC DIAGRAM
(POSITIVE LOGIC)



PACKAGE DISSIPATION RATINGS

(See Figure 12 and Figure 13)

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ⁽¹⁾ ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING
SOP(2)	710 mW	5.7 mW/ $^\circ\text{C}$	455 mW	369 mW
SOP(3)	1282 mW	10.3 mW/ $^\circ\text{C}$	821 mW	667 mW
DIP	1000 mW	8.0 mW/ $^\circ\text{C}$	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

		HX65HVD05, HX65HVD06, HX65HVD07 HX75HVD05, HX75HVD06, HX75HVD07
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 RE		-0.5 V to $V_{CC} + 0.5\text{V}$
Voltage input range, transient pulse, A and B, through 100 (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
Lead Temperature (Soldering, 10 seconds)		245 $^\circ\text{C}$

- (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.
- (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, RE	2			V
Low-level input voltage, V _{IL}	D, DE, 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	HX65HVD05	-40		85	°C
	HX65HVD06				
	HX65HVD07				
	HX75HVD05	0		70	°C
	HX75HVD06				
	HX75HVD07				

(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 Ω, See Figure 4	2.5			
		V _{test} = -7 V to 12 V, See Figure 2	2.2			
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
V _{OC(SS)}	Change in steady-state common-mode output voltage		-0.1		0.1	V
V _{OC(PP)}	Peak-to-peak common-mode output voltage	HVD05		600		mV
		HVD06	See Figure 3	500		
		HVD07		900		
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 _(diff)	Differential output capacitance	V _{ID} = 0.4 sin(4E6πt) + 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	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.

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 = 54Ω, C _L = 50 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	R _E at 0 V, R _L = 110 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	R _E at 0 V, R _L = 110 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 = 110Ω, R _E at 3 V See Figure 5		6	μs		
t _{PZL2}	Propagation delay time, standby-to-low-level output	R _L = 110Ω, R _E 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 clampvoltage	$I_I = -18 \text{ mA}$			-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	$V_O = 0 \text{ or } V_{CC}$	\overline{RE} at V_{CC}		-1		1	μA
I_I	Bus input current	HVD05	Other input at 0 V	$V_A \text{ or } V_B = 12 \text{ V}$		0.23	0.5	mA
				$V_A \text{ or } V_B = 12 \text{ V}, V_{CC} = 0 \text{ V}$		0.3	0.5	
				$V_A \text{ or } V_B = -7 \text{ V}$		-0.4	0.13	
				$V_A \text{ or } V_B = -7 \text{ V}, V_{CC} = 0 \text{ V}$		-0.4	0.15	
		HVD06 HVD07	Other input at 0 V	$V_A \text{ or } V_B = 12 \text{ V}$		0.06	0.1	mA
				$V_A \text{ or } V_B = 12 \text{ V}, V_{CC} = 0 \text{ V}$		0.08	0.13	
				$V_A \text{ or } V_B = -7 \text{ V}$		-0.1	0.05	
				$V_A \text{ or } V_B = -7 \text{ V}, V_{CC} = 0 \text{ V}$		-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	$V_I = 0.4 \sin(4E6\pi t) + 0.5 \text{ V}, DE \text{ at } 0 \text{ V}$				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	$V_{ID} = -1.5\text{ V to }1.5\text{ V},$ $C_L = 15\text{ pF},$ See Figure 8		14.6	25	ns	
t_{PHL}	Propagation delay time, high-to-low-level output 1/2 UL			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	$C_L = 15\text{ pF}, DE\text{ at }3\text{ V},$ 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	$C_L = 15\text{ pF}, DE\text{ at }0,$ 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

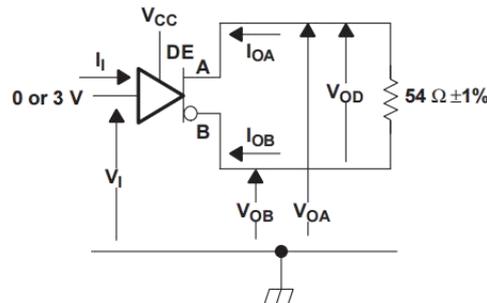


Figure 1. Driver VOD Test Circuit and Voltage and Current Definitions

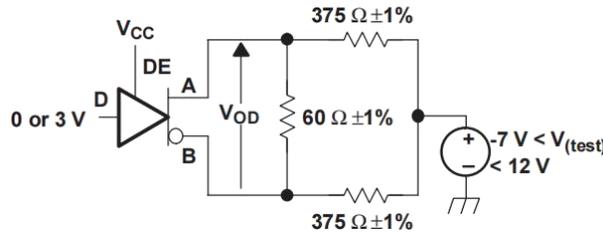
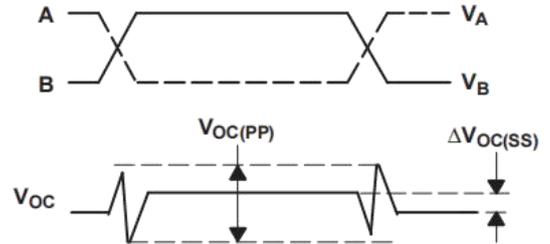
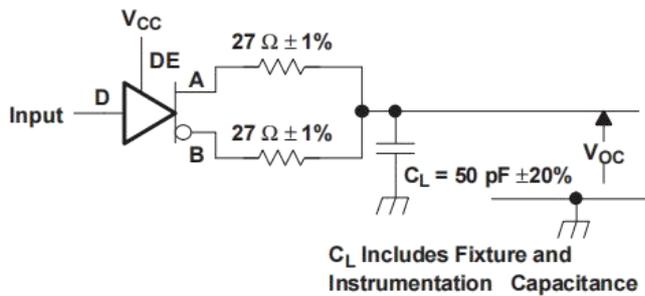
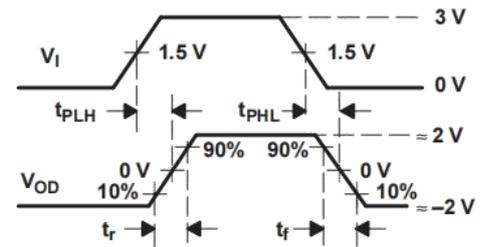
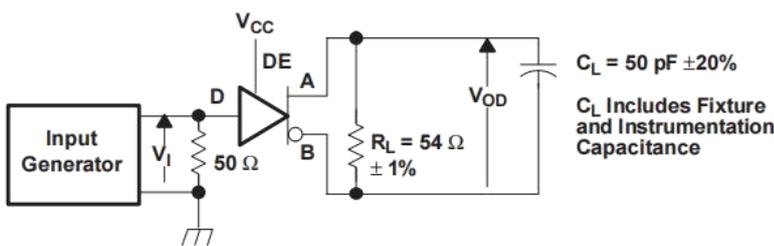


Figure 2. Driver VOD With Common-Mode Loading Test Circuit



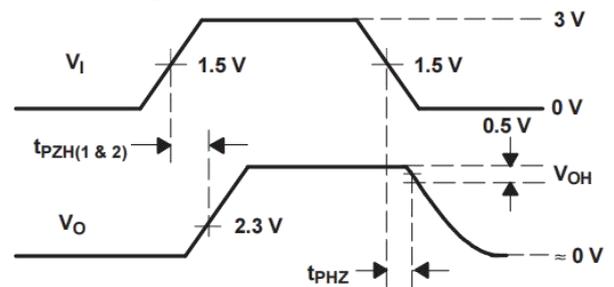
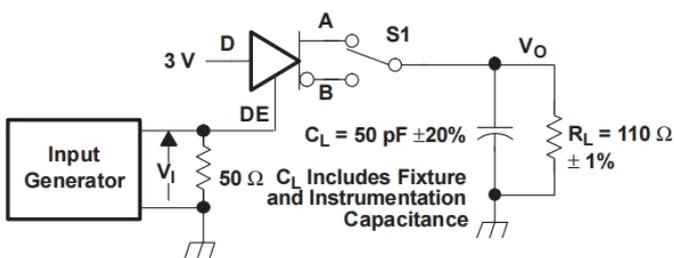
Input: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6\text{ ns}$, $t_f < 6\text{ ns}$, $Z_0 = 50\ \Omega$

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



Generator: PRR = 500 kHz, 50% Duty Cycle, $t_r < 6\text{ ns}$, $t_f < 6\text{ ns}$, $Z_0 = 50\ \Omega$

Figure 4. Driver Switching Test Circuit and Voltage Waveforms



Generator: PRR = 100 kHz, 50% Duty Cycle, $t_r < 6\text{ ns}$, $t_f < 6\text{ ns}$, $Z_0 = 50\ \Omega$

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

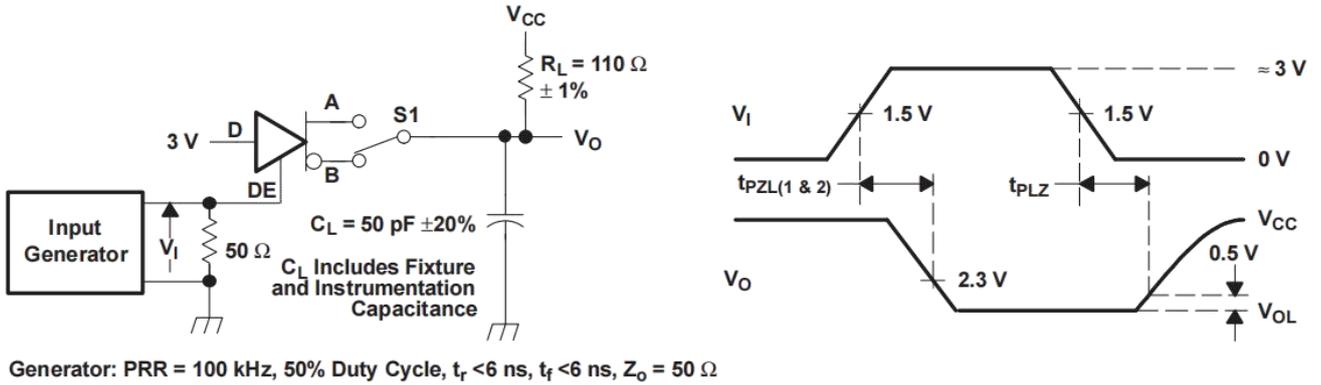


Figure 6. Driver Low-Level Output Enable and Disable Time Test Circuit and Voltage Waveforms

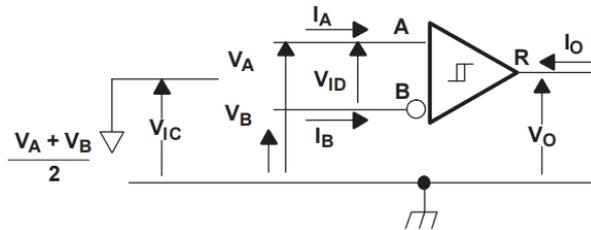


Figure 7. Receiver Voltage and Current Definitions

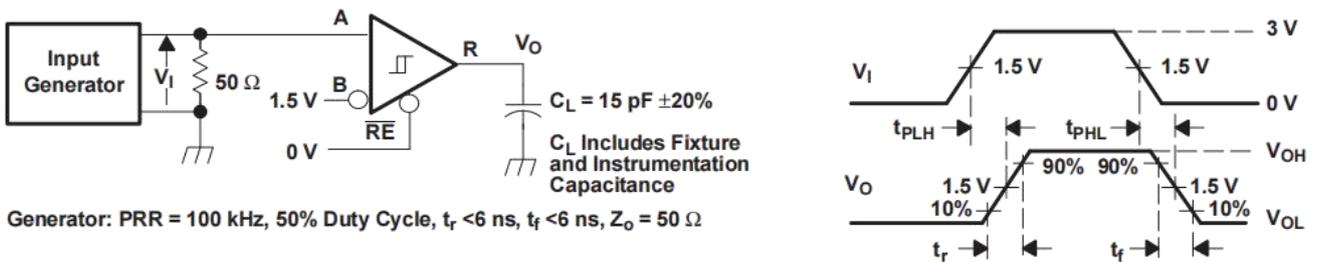


Figure 8. Receiver Switching Test Circuit and Voltage Waveforms

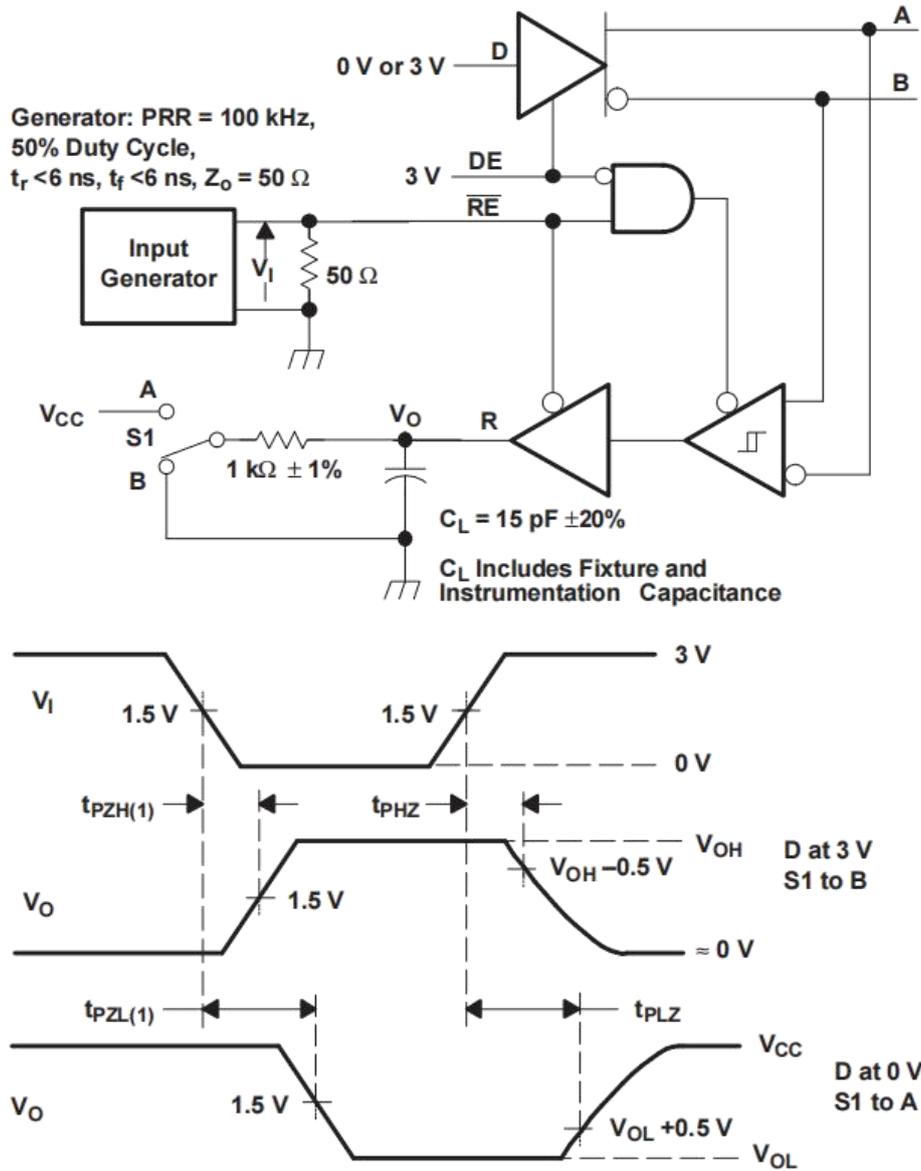


Figure 9. Receiver Enable and Disable Time Test Circuit and Voltage Waveforms With Drivers Enabled

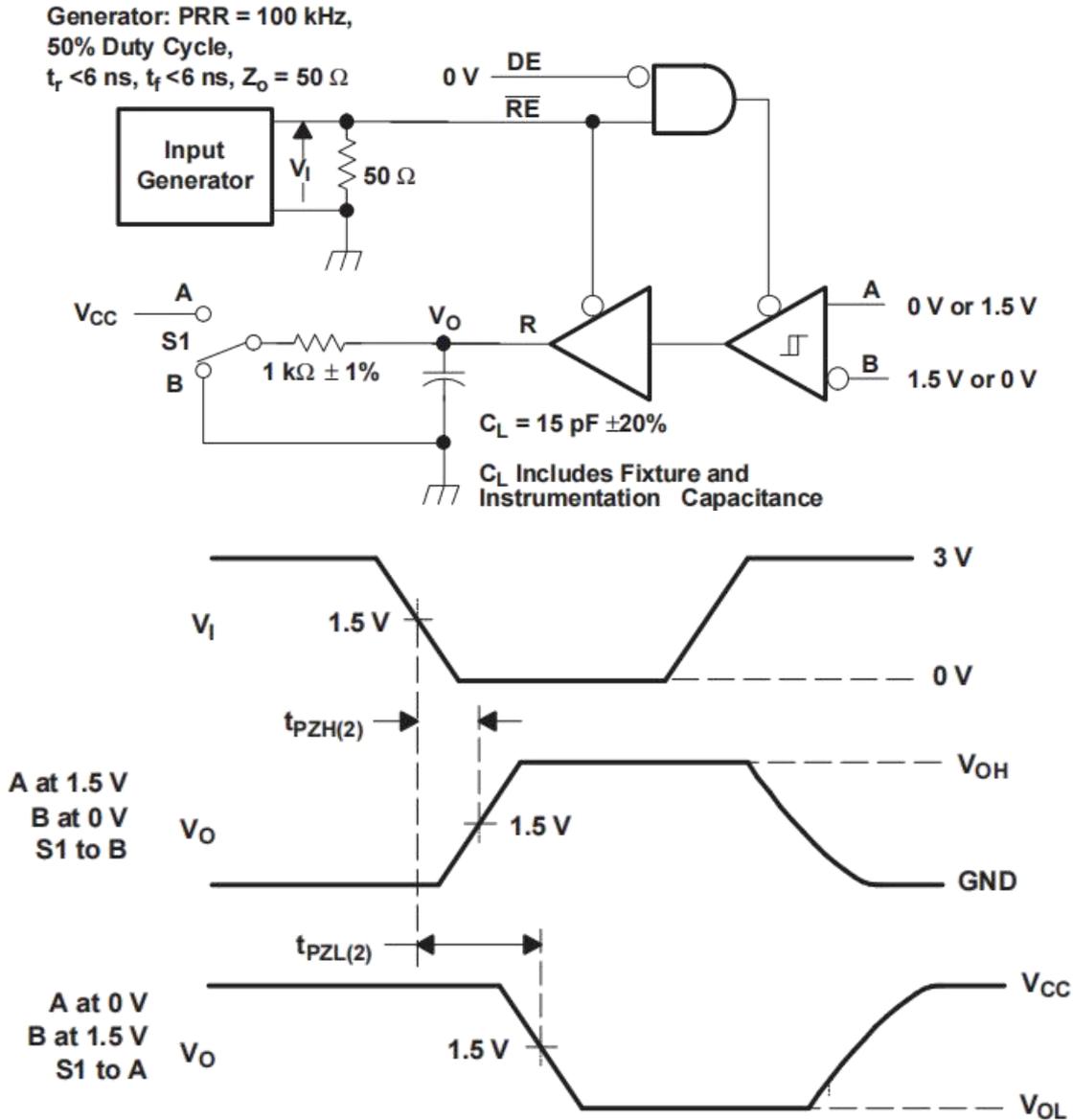
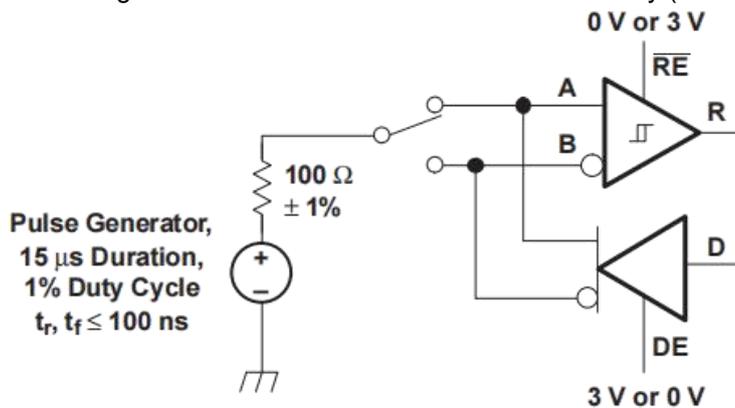


Figure 10. Receiver Enable Time From Standby (Driver Disabled)



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

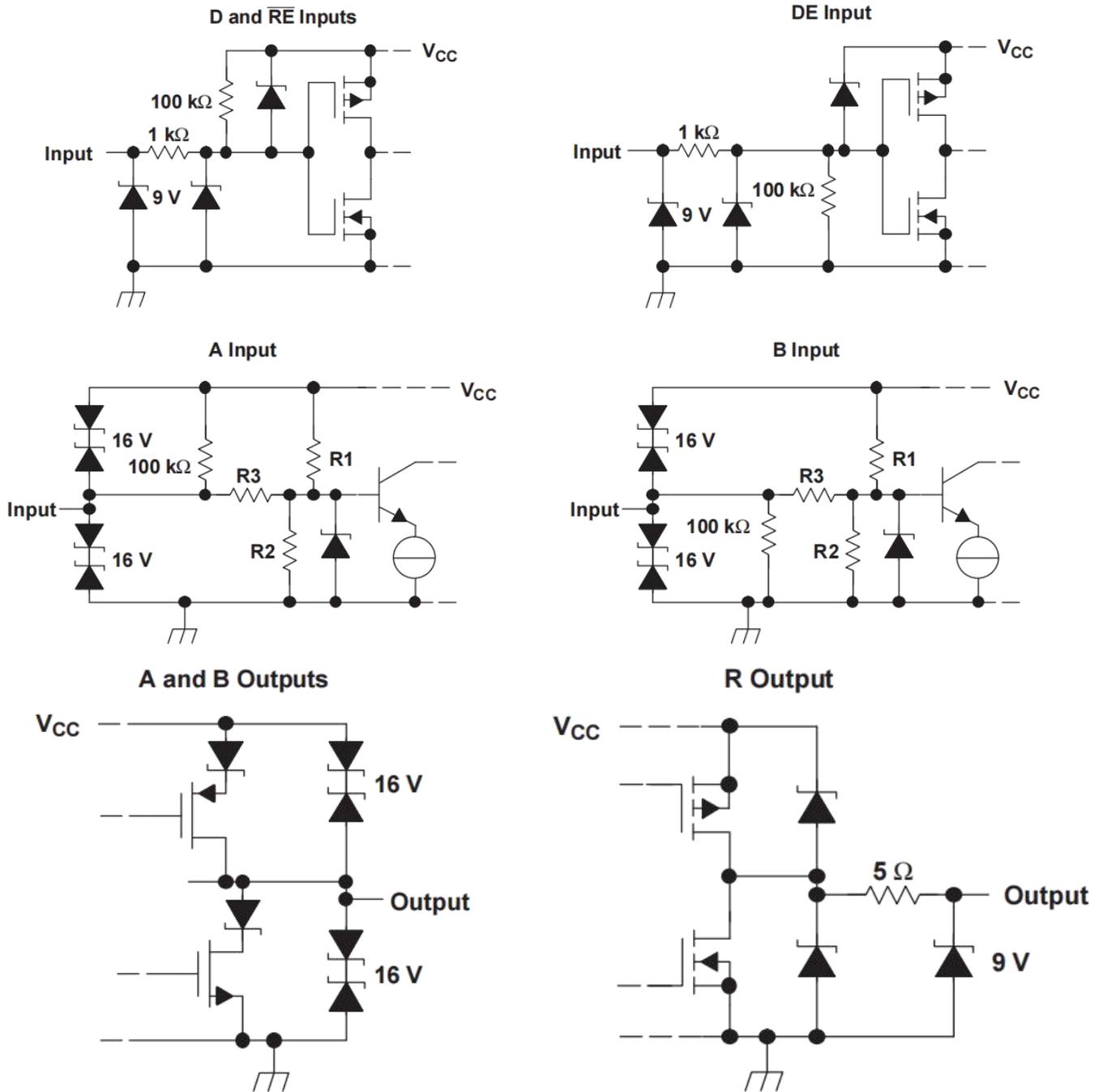
FUNCTION TABLES

INPUT D	ENABLE DE	OUTPUTS	
		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
$V_{ID} \leq -0.2 \text{ V}$	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
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
HX65HVD05	9 k Ω	45 k Ω
HX65HVD06	36 k Ω	180 k Ω
HX65HVD07	36 k Ω	180 k Ω

TYPICAL CHARACTERISTICS

HVD05
MAXIMUM RECOMMENDED STILL-AIR
OPERATING TEMPERATURE
VS
SIGNALING RATE
(D-PACKAGE)

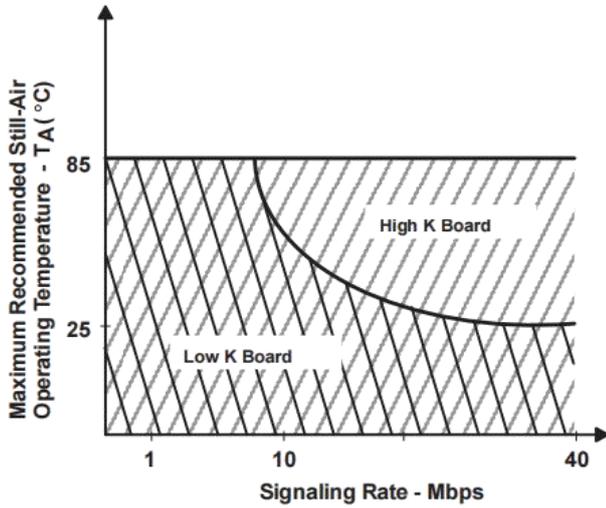


Figure 12.

HVD06
MAXIMUM RECOMMENDED STILL-AIR
OPERATING TEMPERATURE
VS
SIGNALING RATE
(D-PACKAGE)

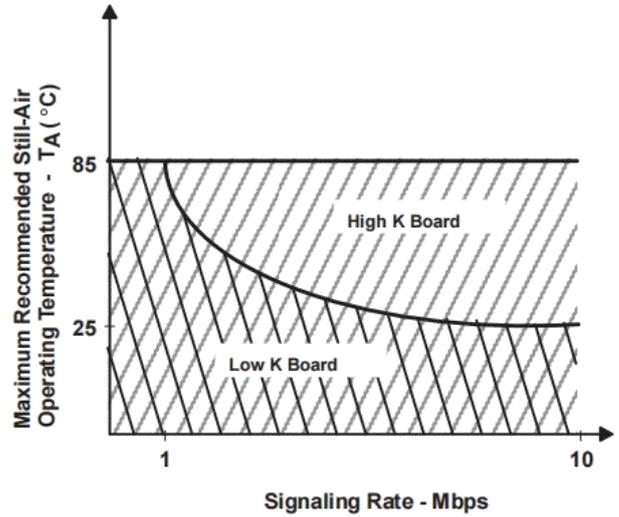


Figure 13.

HVD05
RMS SUPPLY CURRENT
VS
SIGNALING RATE

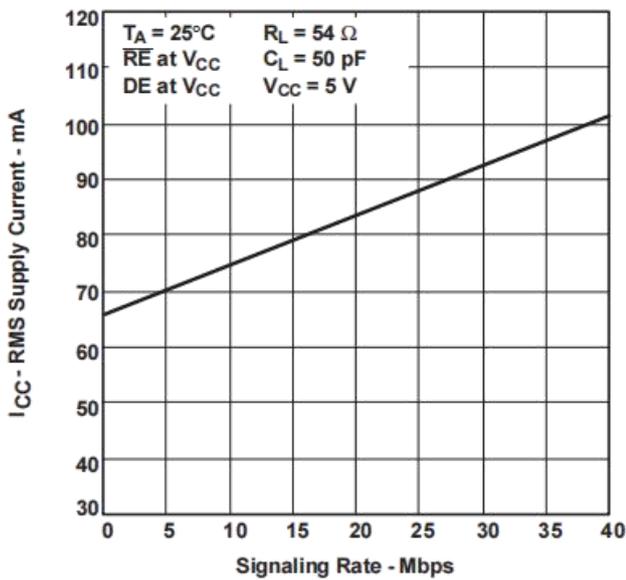


Figure 14.

HVD06
RMS SUPPLY CURRENT
VS
SIGNALING RATE

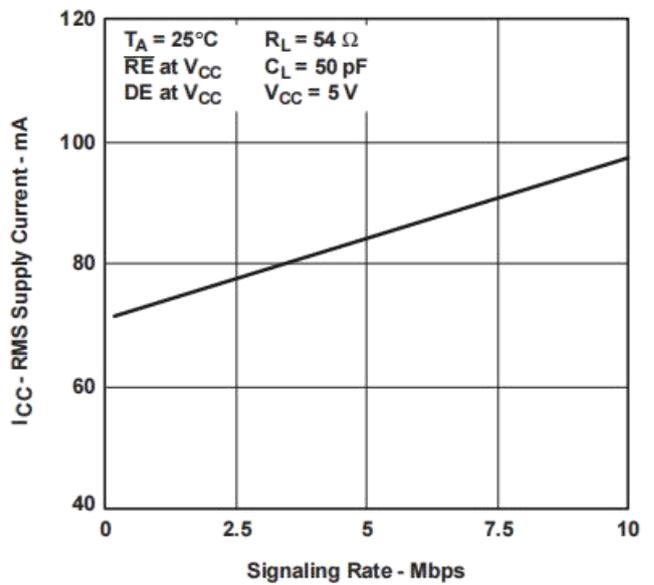


Figure 15.

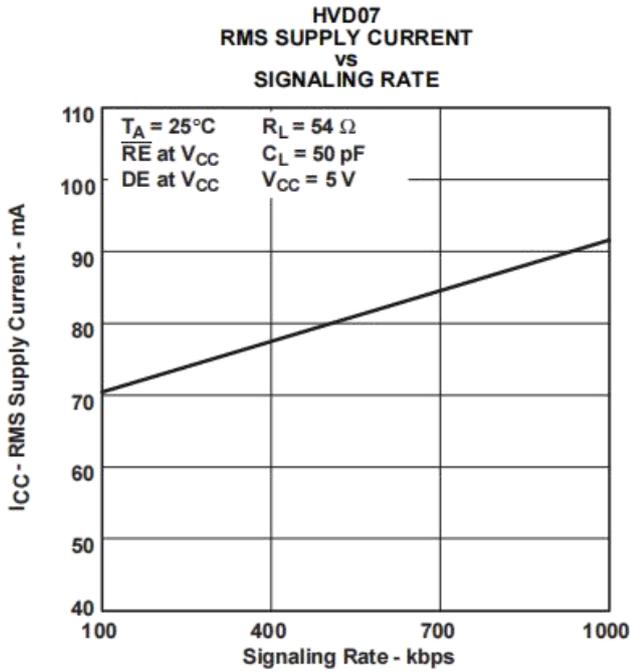


Figure 16.

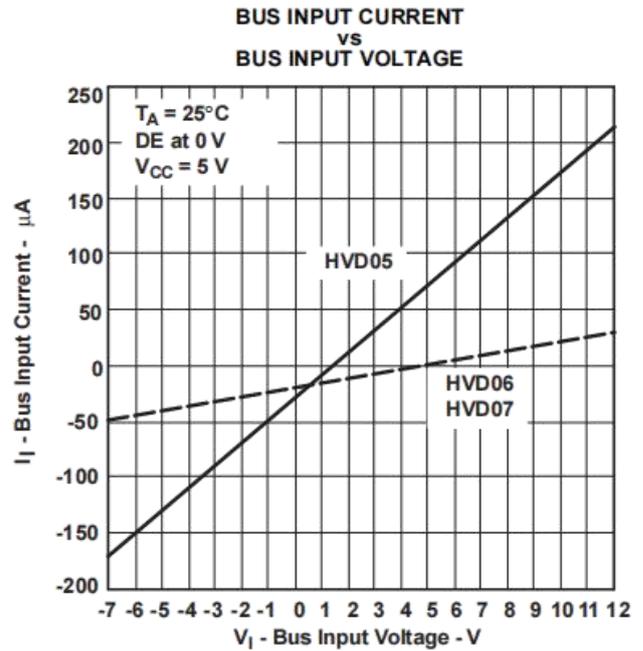


Figure 17.

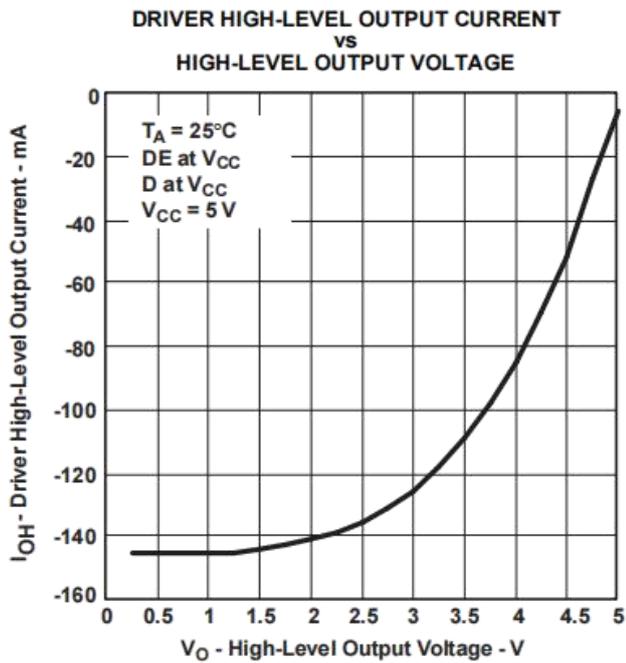


Figure 18.

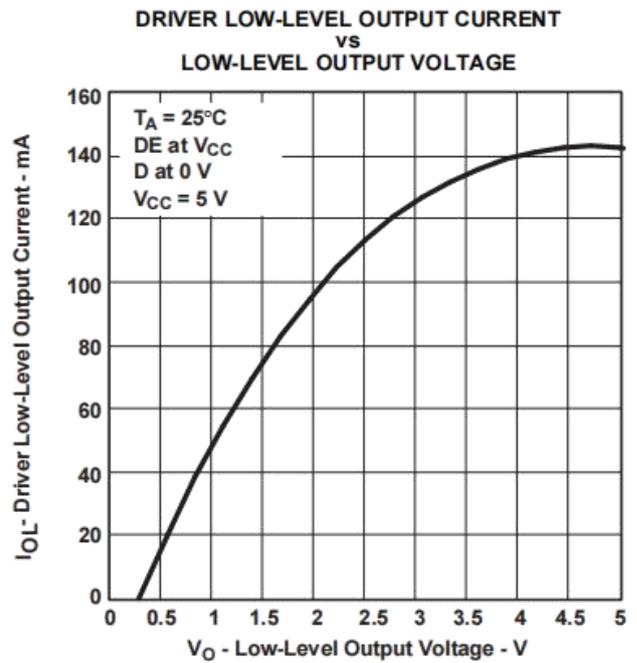


Figure 19.

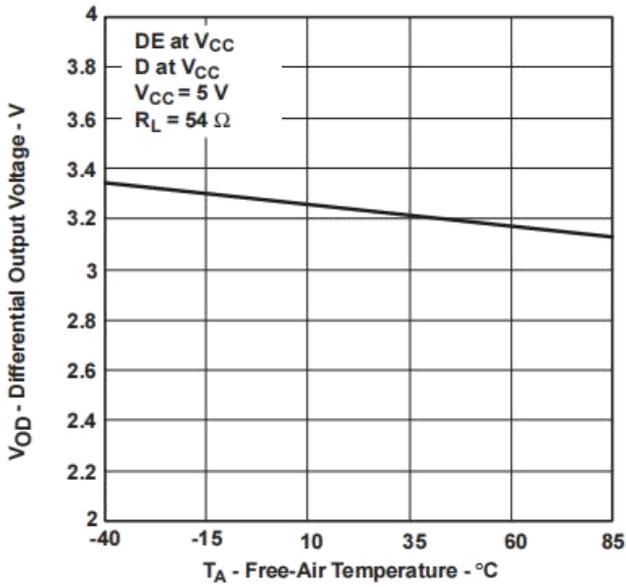
**DIFFERENTIAL OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE**


Figure 20.

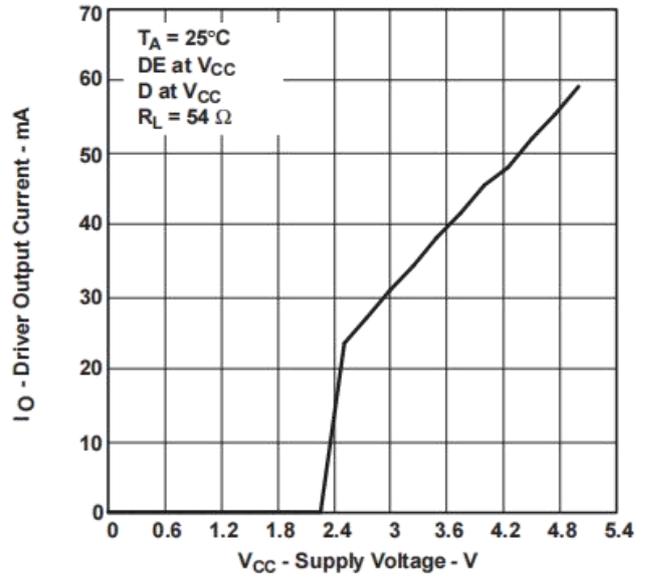
**DRIVER OUTPUT CURRENT
vs
SUPPLY VOLTAGE**


Figure 21.

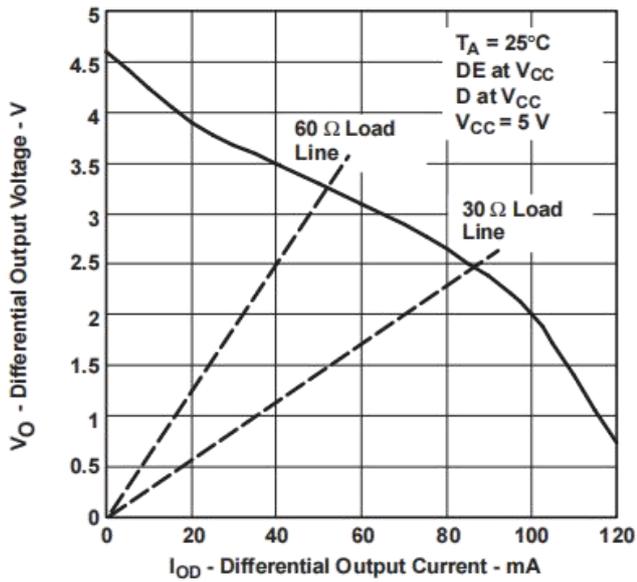
**DIFFERENTIAL OUTPUT VOLTAGE
vs
DIFFERENTIAL OUTPUT CURRENT**


Figure 22.

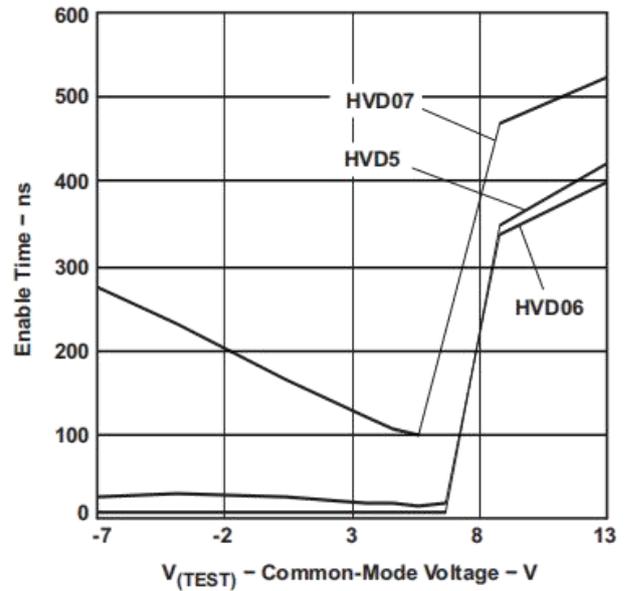
**ENABLE TIME
vs
COMMON-MODE VOLTAGE (SEE Figure 24)**


Figure 23.

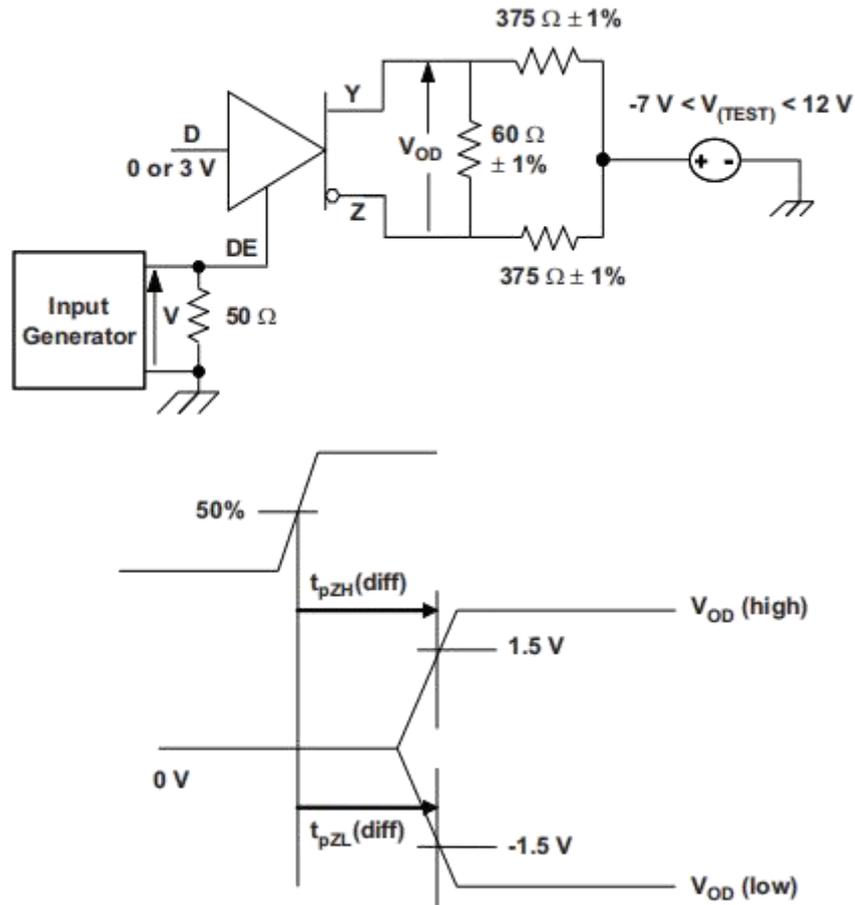
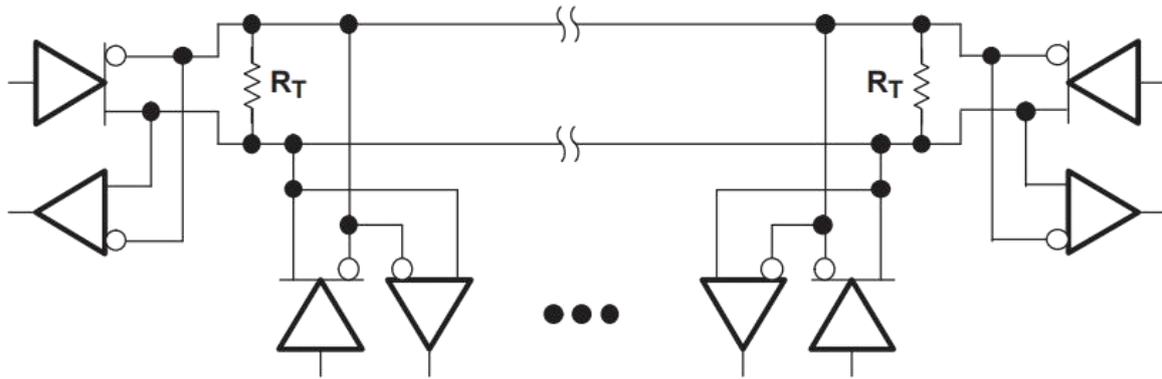


Figure 24. Driver Enable Time From DE to VOD

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


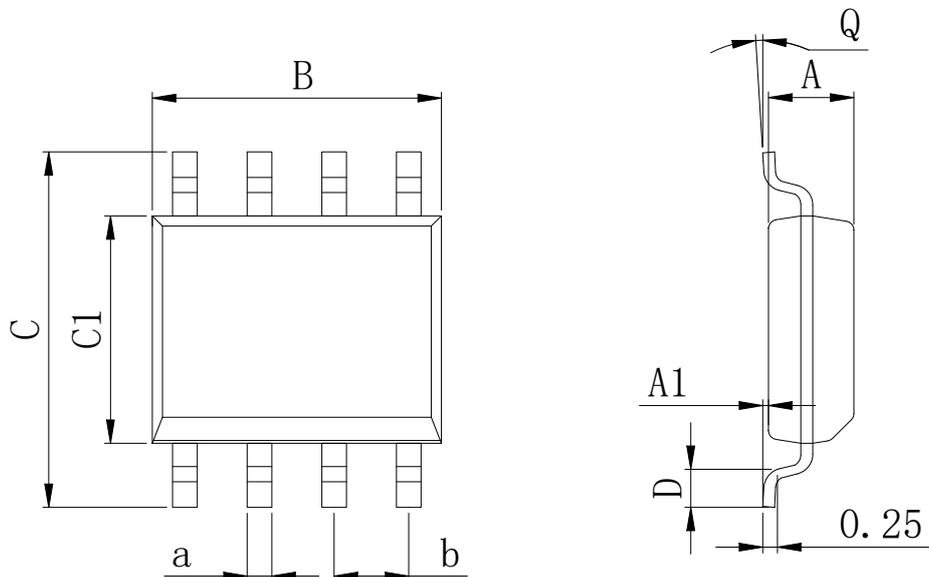
Device	Number of Devices on Bus
HVD05	64
HVD06	256
HVD07	256

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

Physical Dimensions

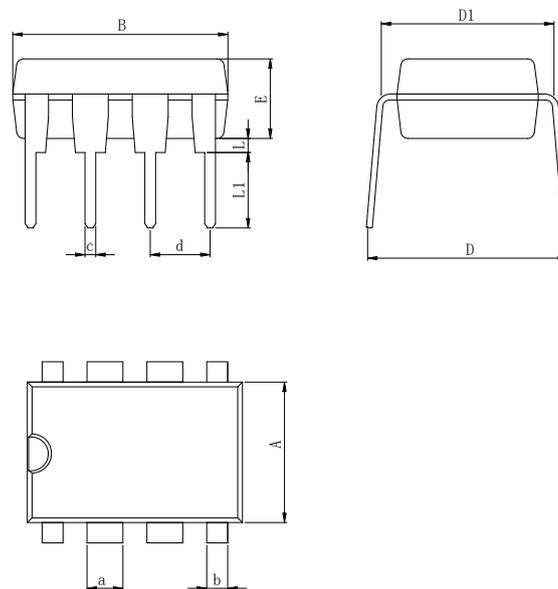
SOP-8



Dimensions In Millimeters(SOP-8)

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	

DIP-8



Dimensions In Millimeters(DIP-8)

Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	9.00	8.10	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	9.50	10.9	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

Revision History

REVISION NUMBER	DATE	REVISION	PAGE
V1.0	2016-6	New	1-21
V1.1	2023-8	Update encapsulation type、 Update Lead Temperature	1、 3

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