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

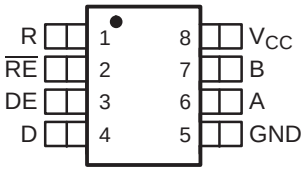
- **Data Transmission Over Long or Lossy Lines or Electrically Noisy Environments**
- **Profibus Line Interface**
- **Industrial Process Control Networks**
- **Point-of-Sale (POS) Networks**
- **Electric Utility Metering**
- **Building Automation**
- **Digital Motor Control**

DESCRIPTION

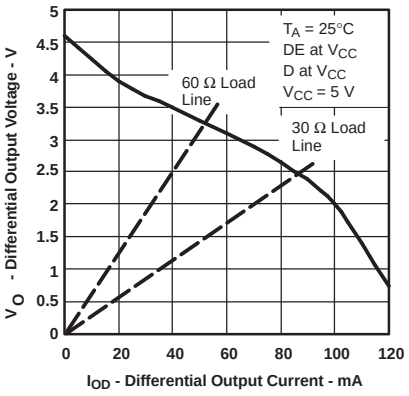
The SN65HVD05, SN75HVD05, SN65HVD06, SN75HVD06, SN65HVD07, and SN75HVD07 combine a 3-state differential line driver and differential line receiver. They are designed for balanced data transmission and interoperate with ANSI TIA/EIA-485-A and ISO 8482E standard-compliant devices. The driver is designed 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.

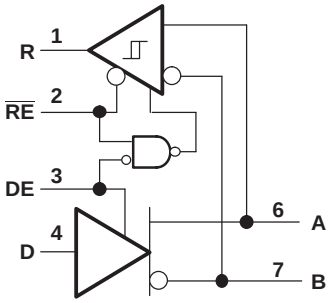
N OR M PACKAGE
(TOP VIEW)



DIFFERENTIAL OUTPUT VOLTAGE
vs
DIFFERENTIAL OUTPUT CURRENT



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	$T_A \leq 25°C$ 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
$\lvert V_{OD}\rvert$	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			
$\Delta\lvert V_{OD}\rvert$	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				-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	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	HVD05	R_L = 54 Ω, C_L = 50 pF, See Figure 4		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	HVD05	$\overline{RE}$ at 0 V, R_L = 110 Ω, See Figure 5			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	HVD05	$\overline{RE}$ at 0 V, R_L = 110 Ω, See Figure 6			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 , $\overline{RE}$ at 3 V, See Figure 5			6	µs
t_{PZL2}	Propagation delay time, standby-to-low-level output		R_L = 110 Ω, $\overline{RE}$ 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 mA					0.01	V
V_{IT-}	Negative-going input threshold voltage		I_O = 8 mA			-0.2			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	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}	$\overline{RE}$ at V_{CC}		-1		1	µA
I_I	Bus input current	HVD05	Other inputat 0 V	V_A or V_B = 12 V			0.23	0.5	mA
				V_A or V_B = 12 V,	V_{CC} = 0 V		0.3	0.5	
				V_A or V_B = -7 V		-0.4	0.13		
				V_A or V_B = -7 V,	V_{CC} = 0 V	-0.4	0.15		
		HVD06 HVD07	Other inputat 0 V	V_A or V_B = 12 V			0.06	0.1	mA
				V_A or V_B = 12 V,	V_{CC} = 0 V		0.08	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	0.03		
I_{IH}	High-level input current, $\overline{RE}$		V_{IH} = 2 V			-60	26.4		µA
I_{IL}	Low-level input current, $\overline{RE}$		V_{IL} = 0.8 V			-60	27.4		µA
$C_{(diff)}$	Differential input capacitance		V_I = 0.4 sin (4E6πt) + 0.5 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	V_{ID} = -1.5 V to 1.5 V, C_L = 15 pF, See Figure 8		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 ($\lvert t_{PHL} - t_{PLH} \rvert$)	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 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 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 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

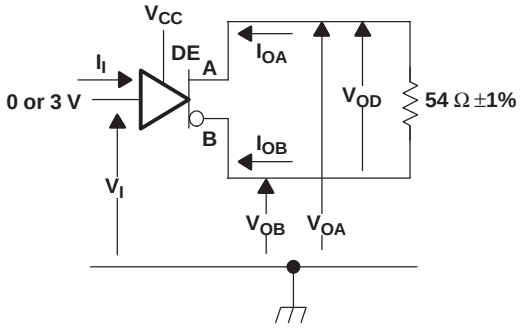


Figure 1. Driver V_{OD} Test Circuit and Voltage and Current Definitions

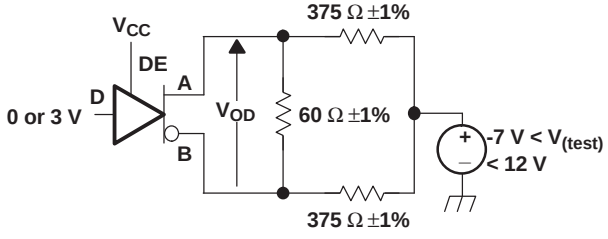
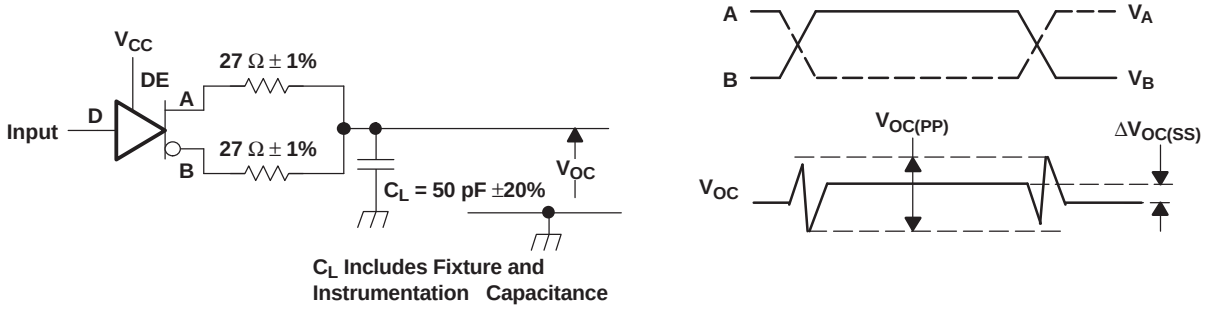


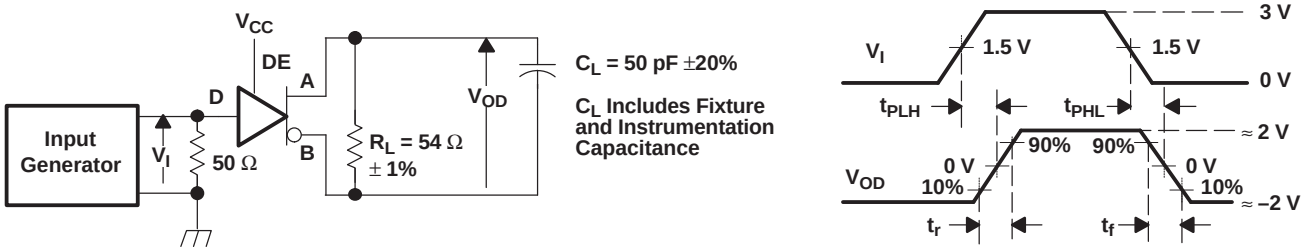
Figure 2. Driver V_{OD} With Common-Mode Loading Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)



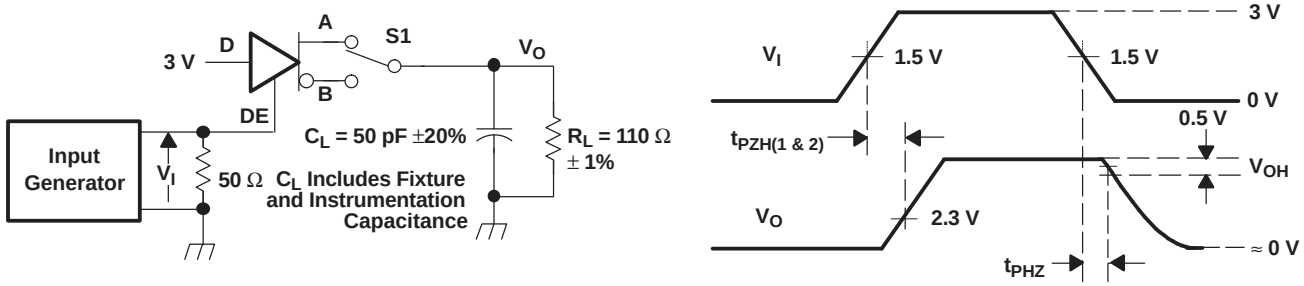
Input: PRR = 500 kHz, 50% Duty Cycle, t_r<6ns, t_f<6ns, Z_O = 50 Ω

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



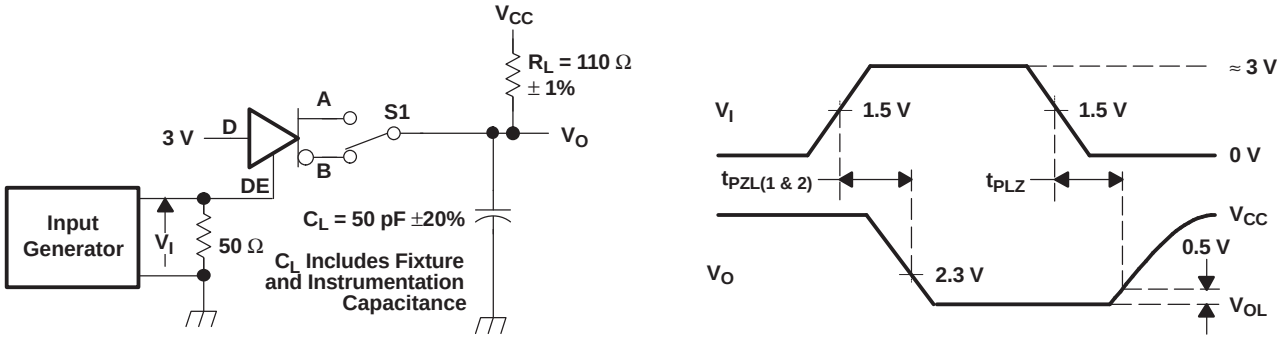
Generator: PRR = 500 kHz, 50% Duty Cycle, t_r <6 ns, t_f <6 ns, Z_o = 50 Ω

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 Ω

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 Ω

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

PARAMETER MEASUREMENT INFORMATION (continued)

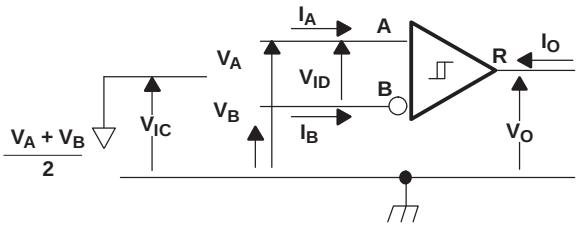
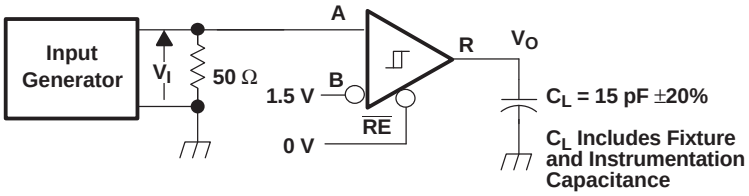


Figure 7. Receiver Voltage and Current Definitions



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

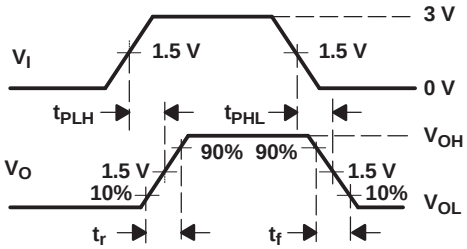


Figure 8. Receiver Switching Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

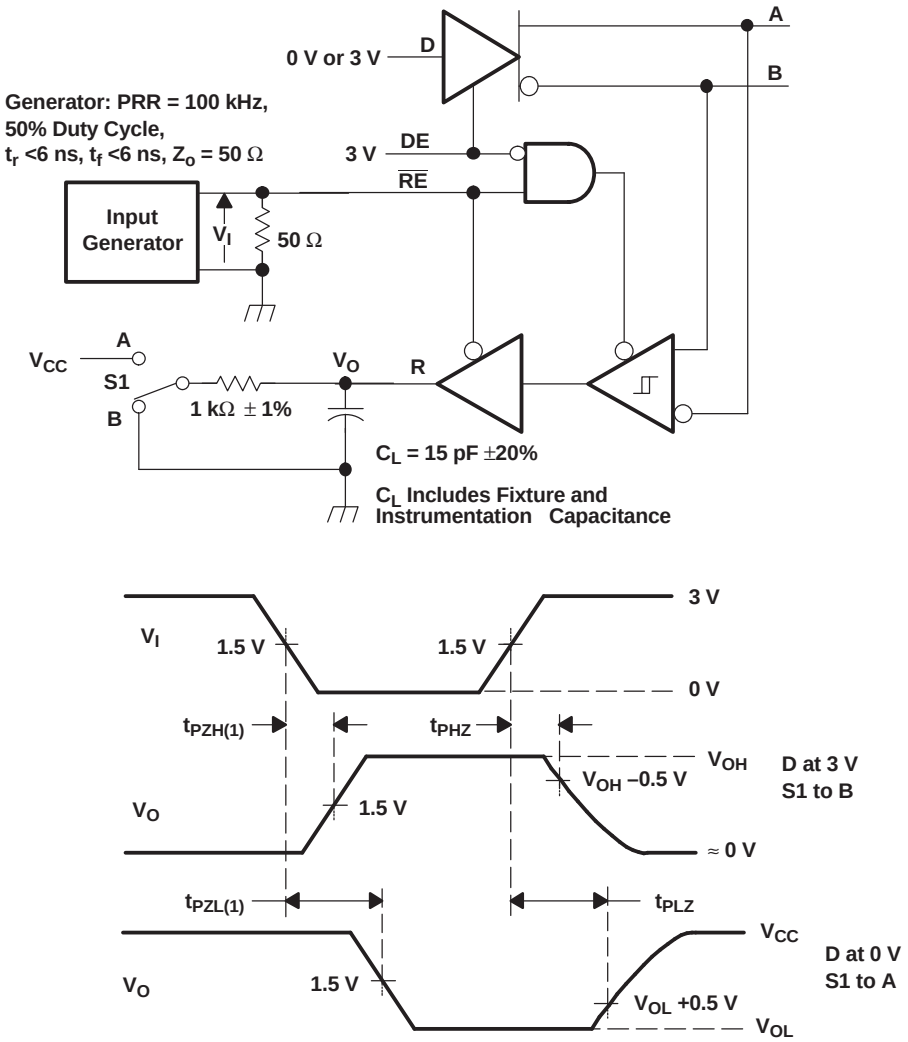


Figure 9. Receiver Enable and Disable Time Test Circuit and Voltage Waveforms With Drivers Enabled

PARAMETER MEASUREMENT INFORMATION (continued)

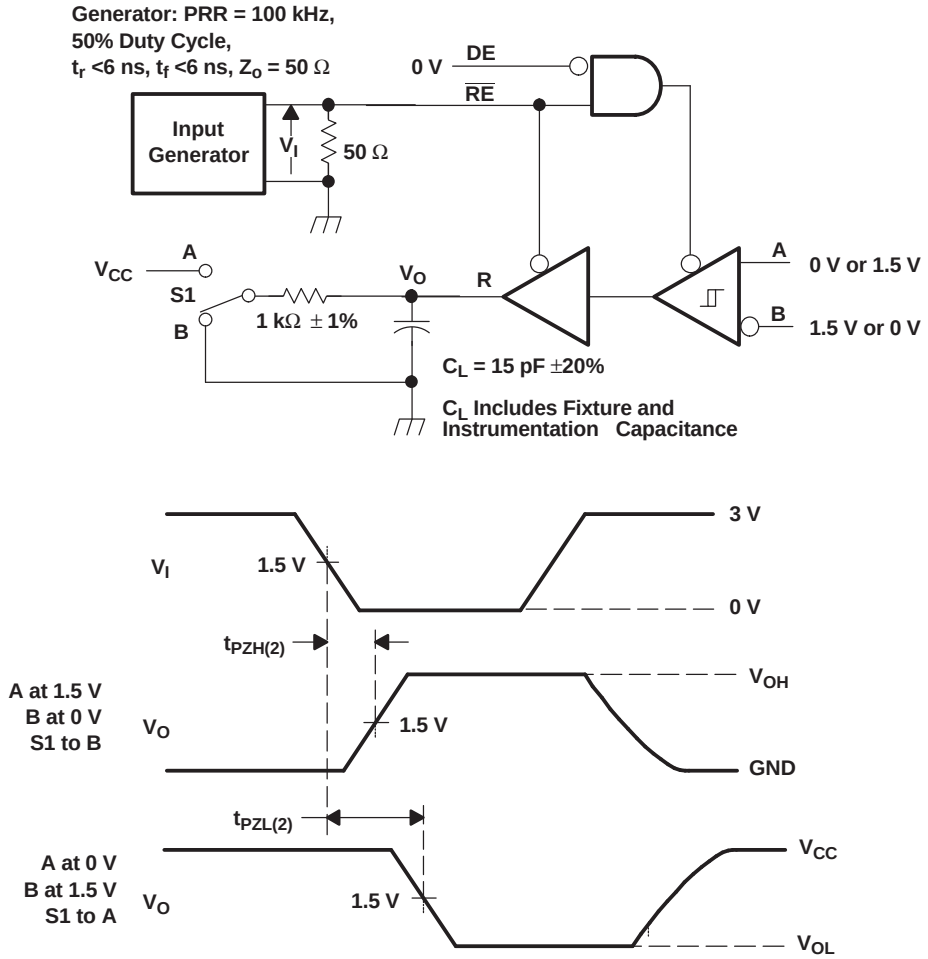
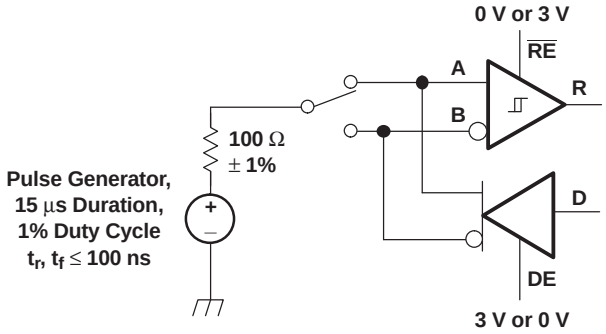


Figure 10. Receiver Enable Time From Standby (Driver Disabled)



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

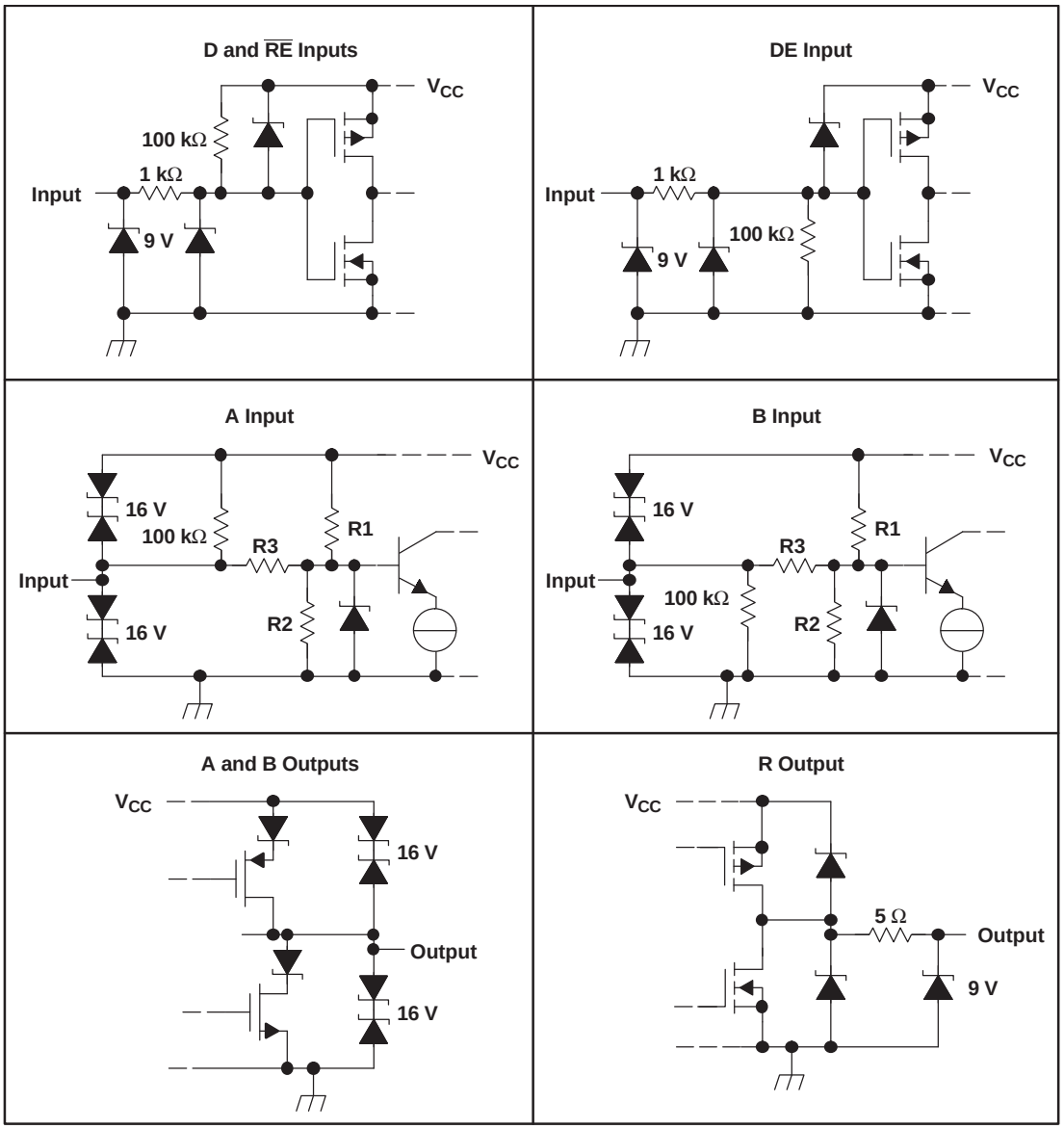
INPUT	ENABLE	OUTPUTS	
D	DE	A	B
H	H	H	L
L	H	L	H
X	L	Z	Z
Open	H	H	L
X	Open	Z	Z

RECEIVER(1)

DIFFERENTIAL INPUTS	ENABLE	OUTPUT
$V_{ID} = V_A - V_B$	$\overline{RE}$	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

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

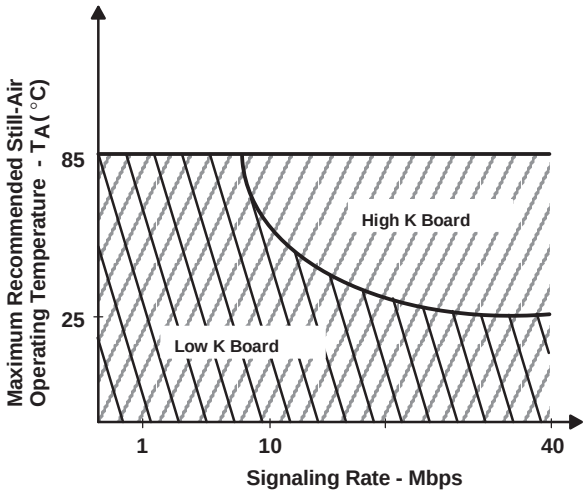


Figure 12.

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

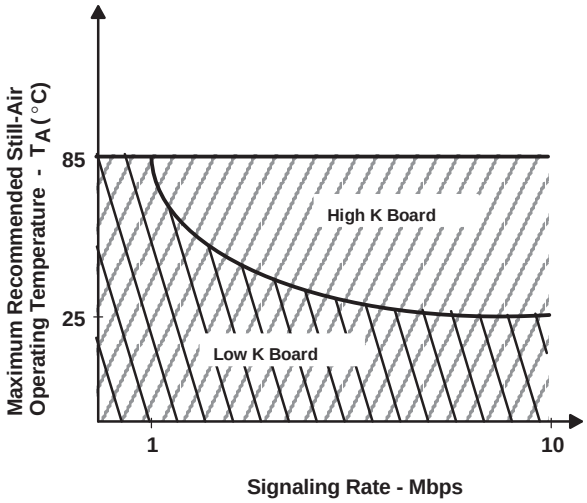


Figure 13.

HVD05
RMS SUPPLY CURRENT
vs
SIGNALILNG RATE

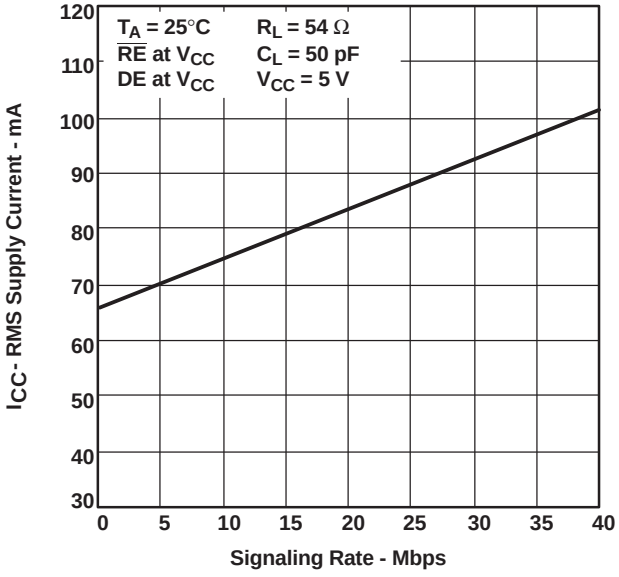


Figure 14.

HVD06
RMS SUPPLY CURRENT
vs
SIGNALING RATE

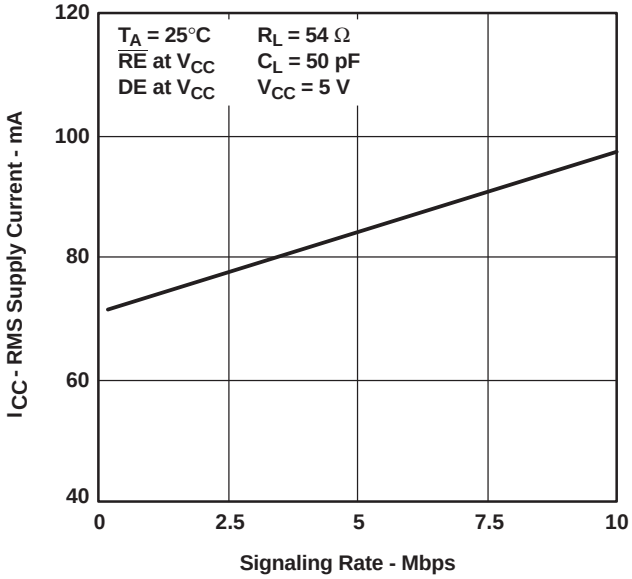


Figure 15.

TYPICAL CHARACTERISTICS (continued)

HVD07
RMS SUPPLY CURRENT
vs
SIGNALING RATE

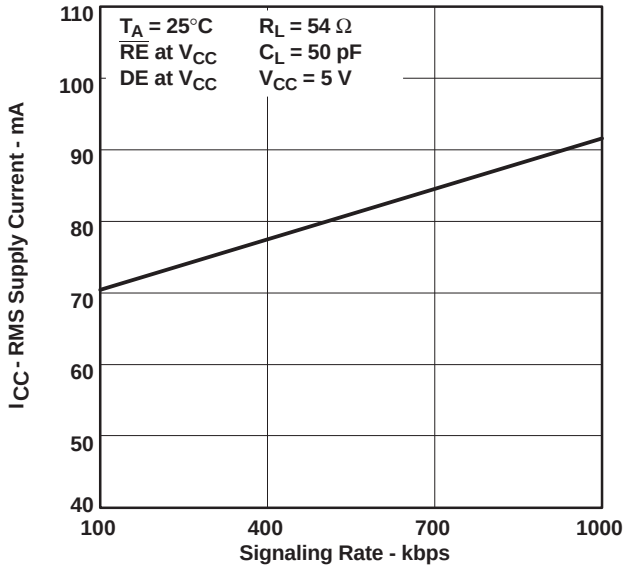


Figure 16.

BUS INPUT CURRENT
vs
BUS INPUT VOLTAGE

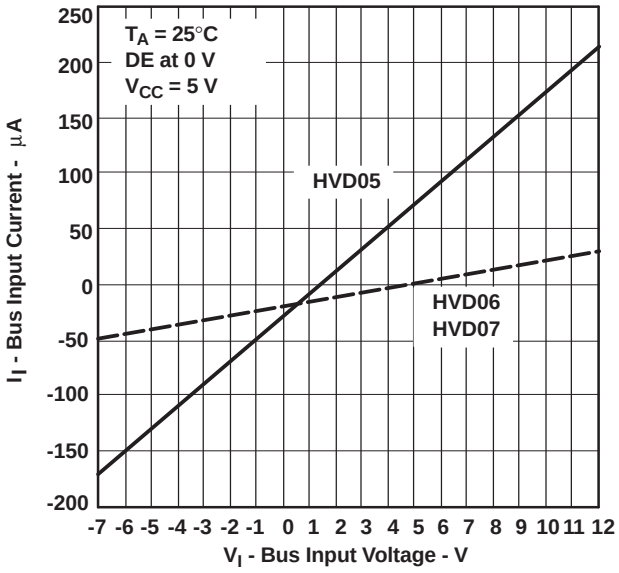


Figure 17.

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

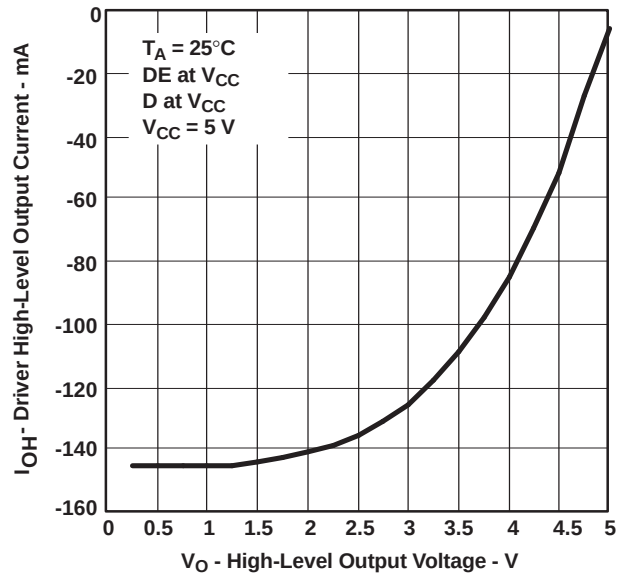


Figure 18.

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

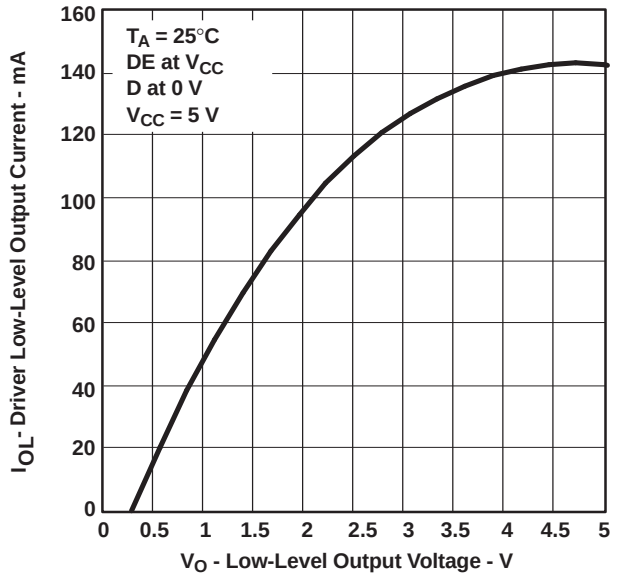


Figure 19.

TYPICAL CHARACTERISTICS (continued)

DIFFERENTIAL OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE

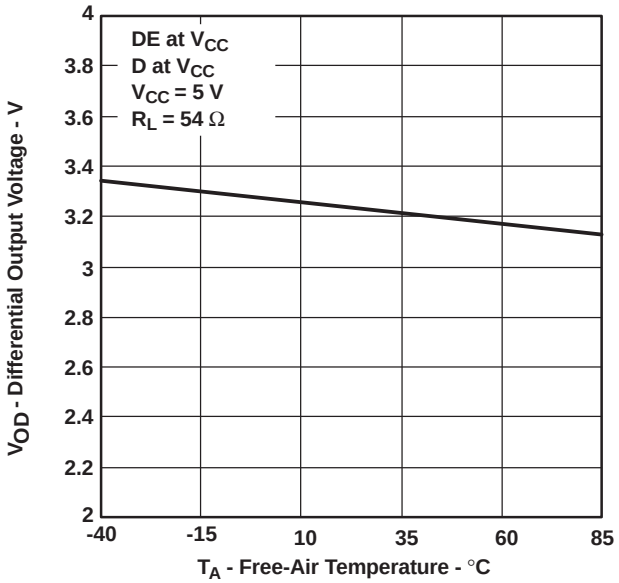


Figure 20.

DRIVER OUTPUT CURRENT
vs
SUPPLY VOLTAGE

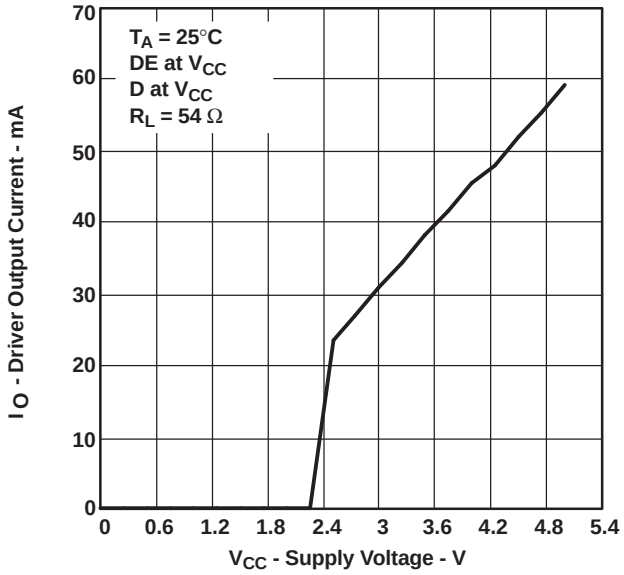


Figure 21.

DIFFERENTIAL OUTPUT VOLTAGE
vs
DIFFERENTIAL OUTPUT CURRENT

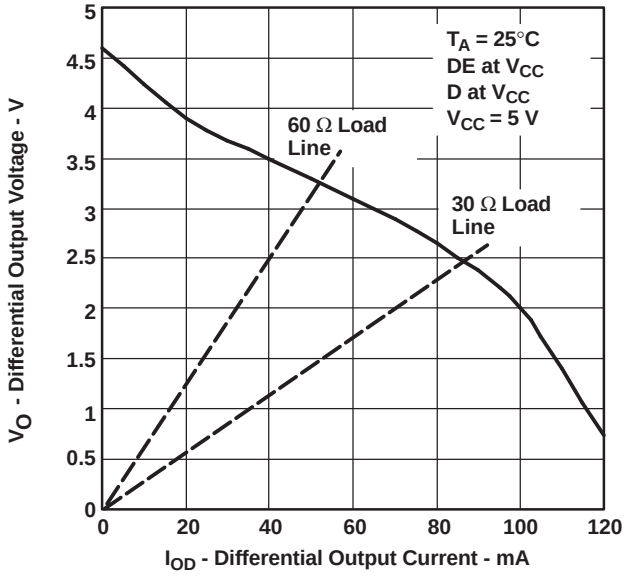


Figure 22.

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

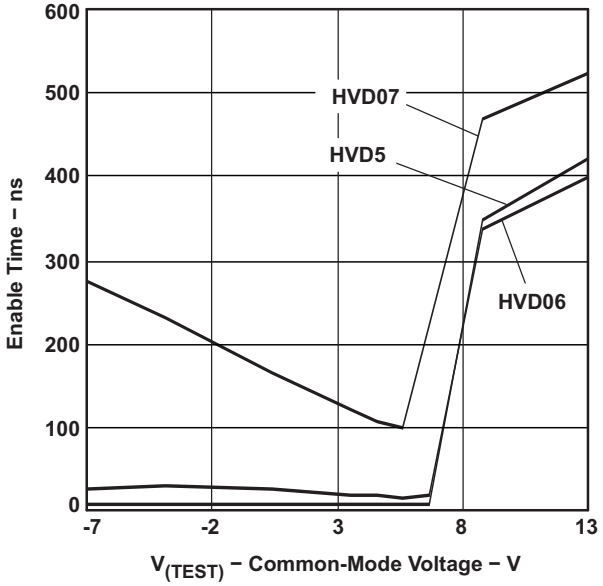


Figure 23.

TYPICAL CHARACTERISTICS (continued)

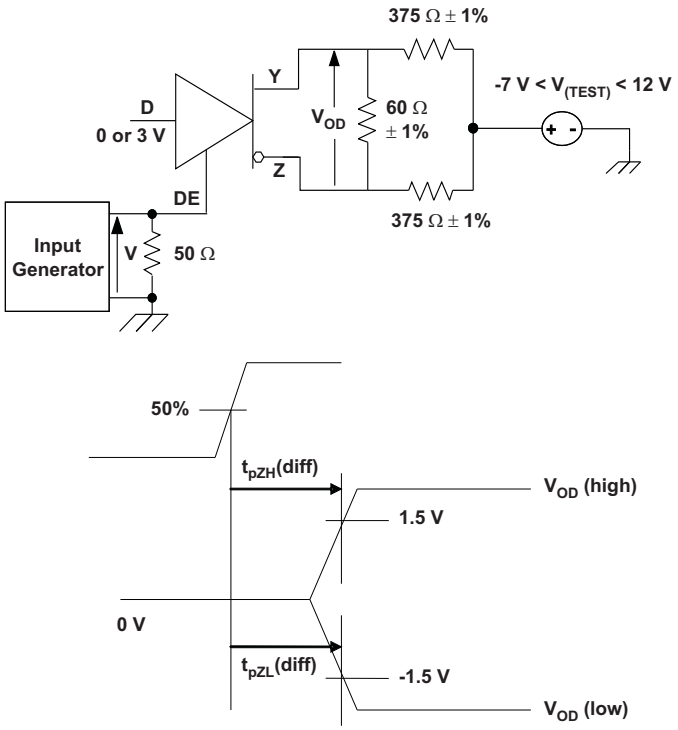
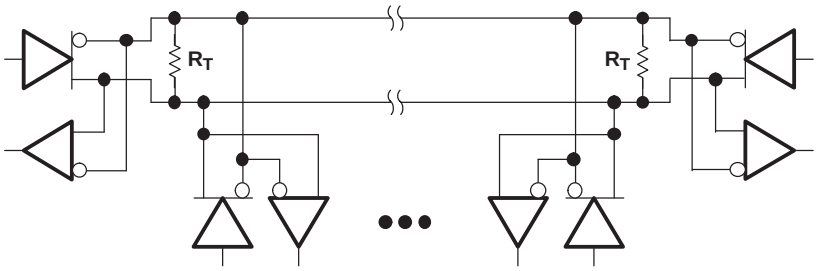


Figure 24. Driver Enable Time From DE to V_{OD}

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



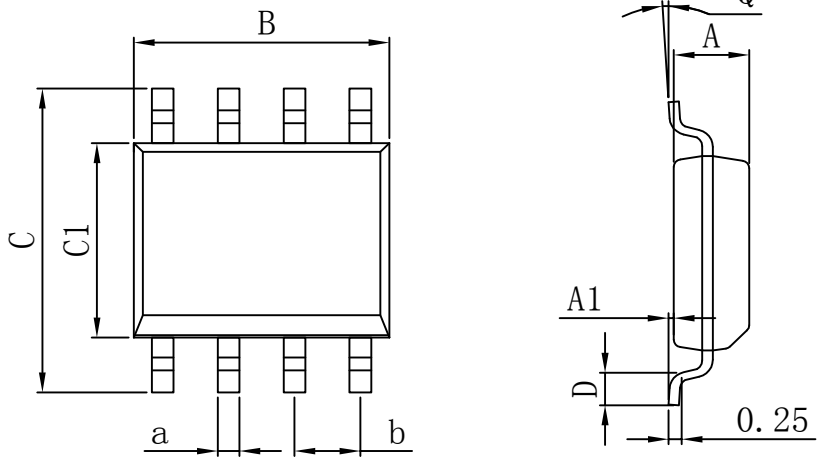
Device	Number of Devices on Bus
HVD05	64
HVD06	256
HVD07	256

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

Figure 25. Typical Application Circuit

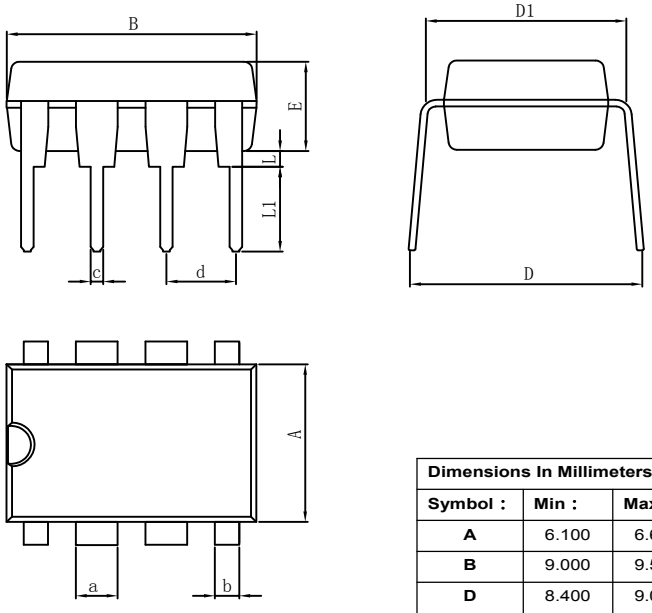
PACKAGE

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			

Important statement:

Huaguan Semiconductor Co,Ltd. reserves the right to change the products and services provided without notice. Customers should obtain the latest relevant information before ordering, and verify the timeliness and accuracy of this information.

Customers are responsible for complying with safety standards and taking safety measures when using our products for system design and machine manufacturing to avoid potential risks that may result in personal injury or property damage.

Our products are not licensed for applications in life support, military, aerospace, etc., so we do not bear the consequences of the application of these products in these fields.

Our documentation is only permitted to be copied without any tampering with the content, so we do not accept any responsibility or liability for the altered documents.