



钜地半导体
Tudi Semiconductor

Product Specification

TUDI-SN65HVD72/SN65HVD75/
SN65HVD78

3.3V RS-485 with IEC ESD protection

网址 www.sztdbdt.com 🔍

用芯智造 · 卓越品质

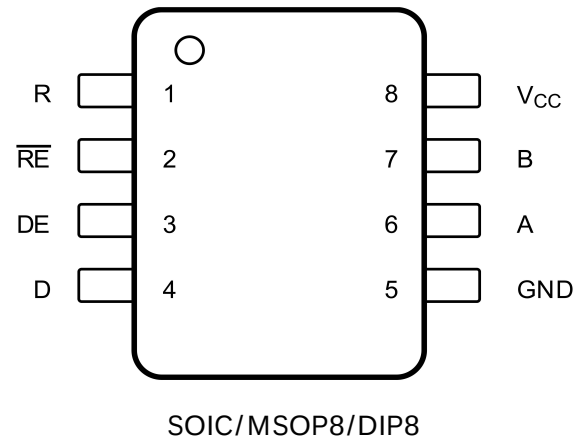
**semiconductor device
manufacturer**

- Design
- research and development
- production
- and sales



FEATURES

- Available in space-saving VSSOP and widely compatible SOIC packages
- Bus I/O protection:
 - >±15-kV Human Body Model (HBM) ESD protection
 - >±12-kV IEC 61000-4-2 contact discharge
 - >±4-kV IEC 61000-4-4 fast transient burst
- Extended industrial temperature range:
 - 40°C to 125°C
- High receiver hysteresis (80 mV) for noise rejection
- Low unit load allows connection of up to 200 nodes
- Low power consumption:
 - Low standby supply current: < 2 μ A
 - I_{CC} supply current during operation: < 1 mA
- 5-V tolerant logic inputs compatible with 3.3-V or 5-V controllers
- Optimized for signal transmission rates of 250 kbps, 20 Mbps, and 50 Mbps
- Glitch-free power-up and power-down bus inputs and outputs



DESCRIPTION

These devices feature robust 3.3-V drivers and receivers, and are available in small packages to meet industrial applications. The bus pins are tolerant to ESD events, providing high-level protection against both the Human Body Model (HBM) and IEC contact discharge specifications. Each of these devices includes a differential driver and a differential receiver. The devices are powered by a single 3.3-V supply. The differential driver output and the differential receiver input are internally connected to form a bus port suitable for half-duplex (two-wire bus) communication. These devices offer a wide common-mode voltage range, making them ideal for applications over long cables. They are rated to operate over a temperature range of –40°C to 125°C.

APPLICATIONS

- Factory Automation
- Telecom Infrastructure
- Motion Control



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NUMBER		
A	6	Bus I/O	Driver output or receiver input(complementary to B)
B	7	Bus I/O	Driver output or receiver input(complementary to A)
D	4	Digital input	Driver data input
DE	3	Digital input	Active-high driver enable
GND	5	Reference potential	Local device ground
R	1	Digital output	Receive data output
RE	2	Digital input	Active-low receiver enable
V _{CC}	8	Supply	3-V to 3.6-V supply

Specifications

Absolute Maximum Ratings

over recommended operating range (unless otherwise specified)(1)

	MIN	MAX	UNIT
Supply voltage,V _{CC}	-0.5	5	V
Voltage at A or B inputs	-13	16.5	
Voltage at D,DE,or RE	-0.3	5.7	
Voltage input,transient pulse,A and B,through 100 Ω	-100	100	
Receiver output current	-24	24	mA
Junction temperature,T _J		170	°C
Continuous total power dissipation	See Power Dissipation		
Storage temperature,T _{stg}	-65	150	°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



ESD Ratings

		VALUE	UNIT
V _(ESD) Electrostatic discharge	Human body model(HBM),per ANSIESDAJEDEC JS-001,all pins(1)	± 8000	V
	Charged device model (CDM),per JEDEC specification JESD22-C101 or ANSIESDAJEDEC JS-002,all pins(2)	±1500	
	JEDEC Standard 22,Test Method A115(Machine Model),all pins	±300	
	IEC 61000-4-2 ESD(Air-Gap Discharge),bus pins and GND(3)	± 12000	
	IEC 61000-4-2 ESD(Contact Discharge),bus pins and GND	±12000	
	IEC 61000-4-4 EFT(Fast transient or burst)bus pins and GND	±4000	
	IEC 60749-26 ESD (Human Body Model),bus pins and GND	±15000	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
V _{CC} (1)	Supply voltage	3	3.3	3.6	V
V _I	Input voltage at any bus terminal (separately or common mode)(2)	-7		12	V
V _{IH}	High-level input voltage(driver,driver enable,and receiver enable inputs)	2		V _{CC}	V
V _{IL}	Low-level input voltage(driver,driver enable,and receiver enable inputs)	0		0.8	V
V _{ID}	Differential input voltage	-12		12	V
I _O	Output current,driver	-60		60	mA
I _O	Output current,receiver	-8		8	mA
R _L	Differential load resistance	54	60		Ω
C _L	Differential load capacitance		50		pF
1/t _{UI}	Signaling rate	SN65HVD72		250	kbps
		SN65HVD75		20	Mbps
		SN65HVD78		50	Mbps

Recommended Operating Conditions(continued)

	MIN	NOM	MAX	UNIT
T _A (3) Operating free-air temperature (See Thermal Information)	-40		125	°C
T _J Junction temperature	-40		150	°C

- (1) Exposure to conditions beyond the recommended operation maximum for extended periods may affect device reliability.
 (2) The algebraic convention, in which the least positive (most negative) limit is designated as minimum, is used in this data sheet.
 (3) Operation is specified for internal (junction) temperatures up to 150°C. Self-heating due to internal power dissipation should be considered for each application. Maximum junction temperature is internally limited by the thermal shutdown (TSD) circuit which disables the driver outputs when the junction temperature reaches 170°C.

Thermal Information

THERMAL METRIC(1)		SN65HVD72,SN65HVD75, SN65HVD78			UNIT
		D (SOIC)	DGK (VSSOP)	DRB (VSON)	
		8 PINS			
R _{θJA}	Junction-to-ambient thermal resistance	110.7	168.7	40	°C/W
R _{θJC(top)}	Junction-to-case (top)thermal resistance	54.7	62.2	49.6	°C/W
R _{θJC(bot)}	Junction-to-case (bottom)thermal resistance	—	—	3.9	°C/W
R _{θJB}	Junction-to-board thermal resistance	51.3	89.5	15.5	°C/W
ψ _{JT}	Junction-to-top characterization parameter	9.2	7.4	0.6	°C/W
ψ _{JB}	Junction-to-board characterization parameter	50.7	87.9	15.7	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.



Electrical Characteristics

over recommended operating range (unless otherwise specified)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V _{OD}	Driver differential output voltage magnitude	R _L =60 Ω, 375Ω on each output to -7V to 12V	See Figure 1	1.5	2		V
		R _L =54Ω(RS-485)	See Figure 2	1.5	2		
		R _L =100 Ω(RS-422), T _J ≥0°C V _{CC} ≥3.2V		2	2.5		
Δ V _{OD}	Change in magnitude of driver differential output voltage	R _L =54Ω, C _L =50 pF		-50	0	50	mV
V _{OC(SS)}	Steady-state common-mode output voltage	Center of two 27- Ω load resistors		1	V _{CC} /2	3	V
ΔV _{OC}	Change in differential driver output common-mode voltage	Center of two 27-Ω load resistors		-50	0	50	mV
V _{OC(PP)}	Peak-to-peak driver common-mode output voltage	Center of two 27- Ω load resistors			200		mV
C _{OD}	Differential output capacitance				15		pF
V _{IT+}	Positive-going receiver differential input voltage threshold			See(1)	-70	-20	mV
V _{IT-}	Negative-going receiver differential input voltage threshold			-200	-150	See(1)	mV
V _{HYS}	Receiver differential input voltage threshold hysteresis(V _{IT+} -V _{IT-})			50	80		mV



Electrical Characteristics(continued)

over recommended operating range (unless otherwise specified)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V _{OH}	Receiver high-level output voltage	I _{OH} = -8 mA			2.4	V _{CC} -0.3		V
V _{OL}	Receiver low-level output voltage	I _{OL} =8 mA				0.2	0.4	V
I _I	Driver input,driver renable,and receiver enable input current				-2		2	μA
I _{OZ}	Receiver output high-impedance current	V _O =0V or V _{CC} ,RE at V _{CC}			-1		1	μA
I _{OS}	Driver short-circuit output current				-160		160	mA
I _I	Bus input current (disabled driver)	V _{CC} =3 to 3.6V or V _{CC} =0V DE at 0V	SN65HVD72	V _I = 12V		75	150	μA
			SN65HVD75	V _I =- 7V	-100	-40		
			SN65HVD78	V _I =12V		240	333	
				V _I =- 7V	-267	-180		
I _{CC}	Supply current (quiescent)	Driver and receiver enabled	DE=V _{CC} ,RE=GND No load			750	950	μA
		Driver enabled, receiver disabled	DE=V _{CC} ,RE=V _{CC} No load			300	500	
		Driver disabled ,receiver enabled	DE=GND,RE=GND No load			600	800	
		Driver and receiver disabled	DE=GND,D=open RE=V _{CC} ,No load			0.1	2	
T _{TSD}	Thermal shutdown junction temperature					170		°C

(1) Under any specific conditions, V_{IT+} is assured to be at least V_{HYS} higher than V_{IT-} .



Power Dissipation

PARAMETER			TEST CONDITIONS		VALUE	UNIT
PD	Power Dissipation driver and receiver enabled, $V_{CC}=3.6\text{ V}$, $T_J=150^{\circ}\text{C}$ 50% duty cycle square-wave signal at signaling rate: SN65HVD72 at 250 kbps SN65HVD75 at 20 Mbps SN65HVD78 at 50 Mbps	Unterminated	$R_L=300\Omega$ $C_L=50\text{ pF}$ (driver)	SN65HVD72	120	mW
				SN65HVD75	160	
				SN65HVD78	200	
		RS-422 load	$R_L=100\Omega$ $C_L=50\text{ pF}$ (driver)	SN65HVD72	155	mW
				SN65HVD75	195	
				SN65HVD78	230	
		RS-485 load	$R_L=54\Omega$ $C_L=50\text{ pF}$ (driver)	SN65HVD72	190	mW
				SN65HVD75	230	
				SN65HVD78	260	

Switching Characteristics: 250 kbps Device (SN65HVD72) Bit Time 4 μs

over recommended operating conditions

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
DRIVER							
t _r ,t _f	Driver differential output rise or fall time	R _L =54Ω C _L =50pF	See Figure 3	0.3	0.7	1.2	μs
t _{PHL} ,t _{PLH}	Driver propagation delay				0.7	1	μ s
t _{SK(P)}	Driver pulse skew,t _{PHL} -t _{PLH}					0.2	μs
t _{PHZ} ,t _{PLZ}	Driver disable time		See Figure 4 and Figure 5		0.1	0.4	μs
t _{PZH} ,t _{PZL}	Driver enable time	Receiver enabled			0.5	1	μs
		Receiver disabled			3	9	
RECEIVER							
t _r ,t	Receiver output rise or fall time	C _L =15 pF	See Figure 6		12	30	ns
t _{PHL} ,t _{PLH}	Receiver propagation delay time				75	100	ns
t _{sK(P)}	Receiver pulse skew,t _{PHL} -t _{PLH}				3	15	ns



Switching Characteristics: 250 kbps Device (SN65HVD72) Bit Time 4 μ s (continued)

over recommended operating conditions

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{PLZ}, t_{PHZ}	Receiver disable time				40	100	ns
$t_{PZL}(1), t_{PZH}(1),$ $t_{PZL}(2), t_{PZH}(2)$	Receiver enable time	Driver enabled	See Figure 7		20	50	ns
		Driver disabled	See Figure 8		3	8	μ s

Switching Characteristics: 20 Mbps Device (SN65HVD75) Bit Time ≥ 50 ns

over recommended operating conditions

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
DRIVER							
t _r ,t _f	Driver differential output rise or fall time	R _L =54Ω C _L =50pF	See Figure 3	2	7	14	ns
t _{PHL} ,t _{PLH}	Driver propagation delay			7	11	17	ns
t _{SK(P)}	Driver pulse skew, t _{PHL} -t _{PLH}				0	2	ns
t _{PHZ} ,t _{PLZ}	Driver disable time		See Figure 4 and Figure 5		12	50	ns
t _{PZH} ,t _{PZL}	Driver enable time	Receiver enabled			10	20	ns
		Receiver disabled			3	7	μ s
RECEIVER							
t _t	Receiver output rise or fall time	C _L =15pF	See Figure 6		5	10	ns
t _{PHL} ,t _{PLH}	Receiver propagation delay time				60	70	ns
t _{SK(P)}	Receiver pulse skew, t _{PHL} -t _{PLH}				0	6	ns
t _{PLZ} ,t _{PHZ}	Receiver disable time				15	30	ns
t _{PZL} (1),t _{PZH} (1), t _{PZL} (2),t _{PZH} (2)	Receiver enable time	Driver enabled	See Figure 7		10	50	ns
		Driver disabled	See Figure 8		3	8	μs



Switching Characteristics: 50 Mbps Device (SN65HVD78) Bit Time ≥ 20 ns

over recommended operating conditions

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
DRIVER							
t _r ,t _f	Driver differential output rise or fall time	R _L =54Ω C _L =50 pF	See Figure 3	1	3	6	ns
t _{PHL} ,t _{PLH}	Driver propagation delay				9	15	ns
t _{SK(P)}	Driver pulse skew,t _{PHL} -t _{PLH}				0	1	ns
t _{PHZ} ,t _{PLZ}	Driver disable time		See Figure 4 and Figure 5		10	30	ns
t _{PZH} ,t _{PZL}	Driver enable time	Receiver enabled			10	30	ns
		Receiver disabled				8	μs
RECEIVER							
t _r ,t _f	Receiver output rise or fall time	C _L =15 pF	See Figure 6	1	3	6	ns
t _{PHL} ,t _{PLH}	Receiver propagation delay time					35	ns
t _{SK(P)}	Receiver pulse skew,t _{PHL} -t _{PLH}					2.5	ns
t _{PLZ} ,t _{PHZ}	Receiver disable time				8	30	ns
t _{PZL} (1),t _{PZH} (1), t _{PZL} (2),t _{PZH} (2)	Receiver enable time	Driver enabled	See Figure 7		10	30	ns
		Driver disabled	See Figure 8		3	8	μs



Parameter Measurement Information

Input generator rate is 100 kbps, 50% duty cycle, rise or fall time is less than 6 ns, output impedance is 50 Ω .

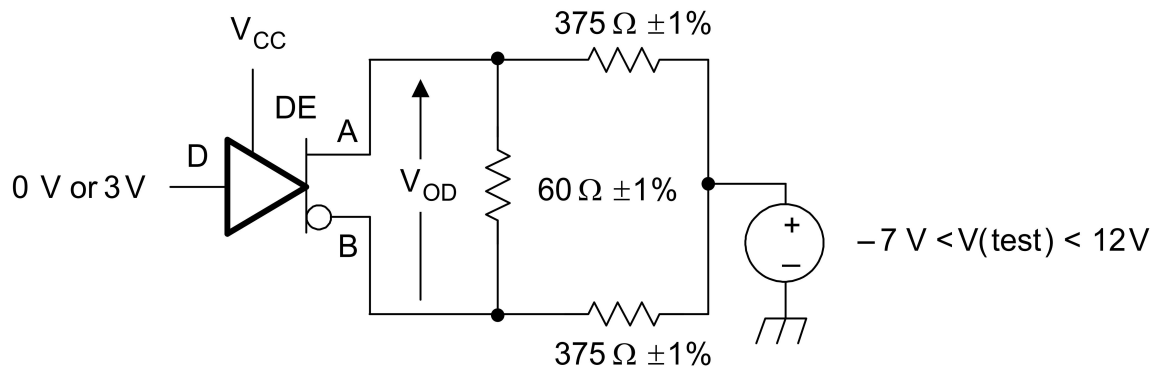


Figure 1. Measurement of Driver Differential Output Voltage With Common-Mode Load

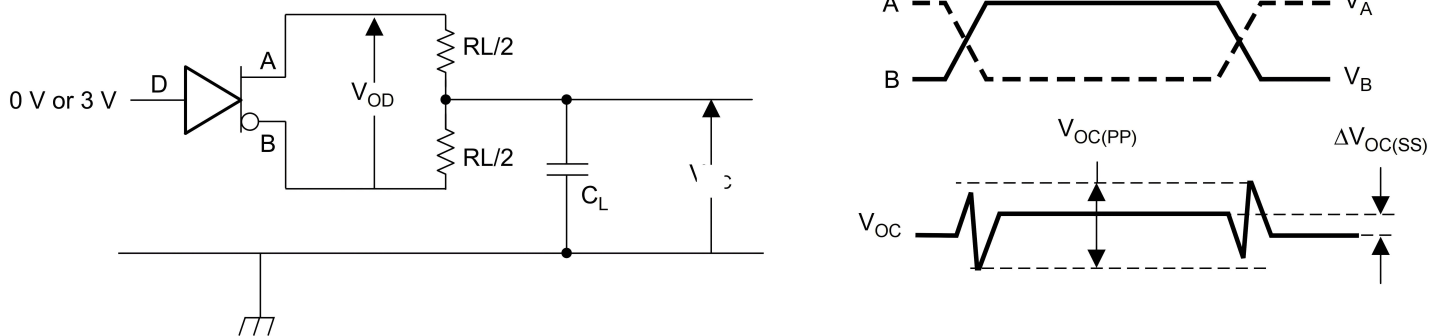


Figure 2. Measurement of Driver Differential and Common-Mode Output With RS-485 Load

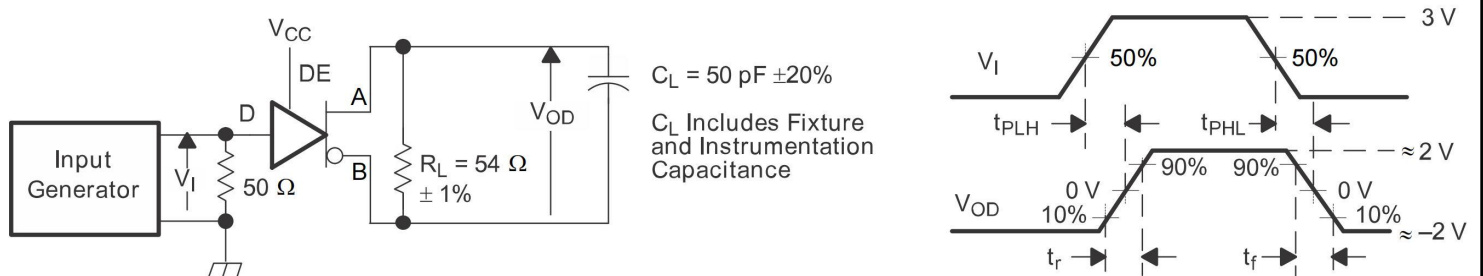


Figure 3. Measurement of Driver Differential Output Rise and Fall Times and Propagation Delays

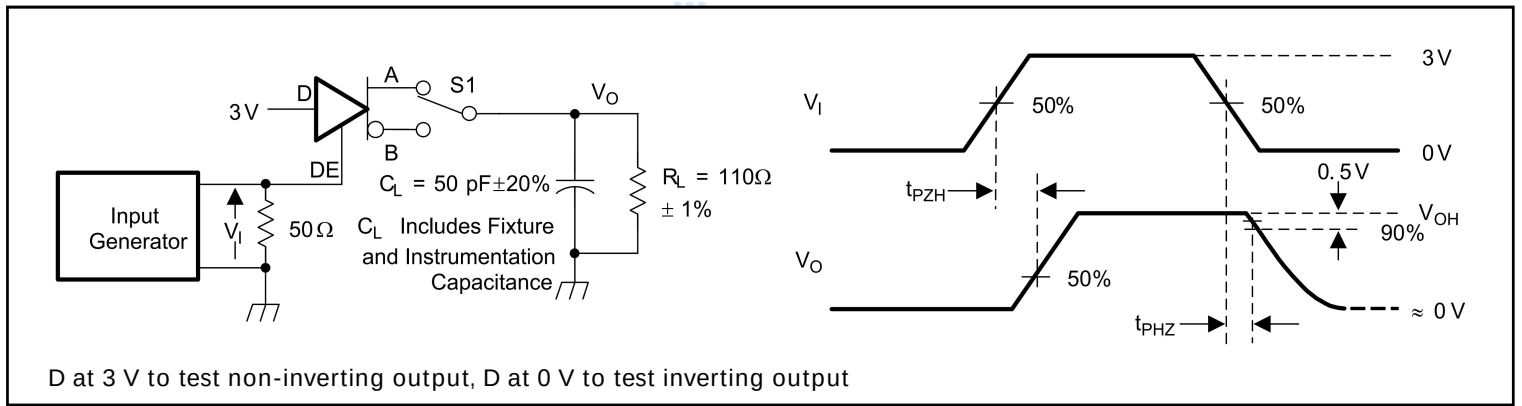


Figure 4. Measurement of Driver Enable and Disable Times With Active High Output and Pulldown Load

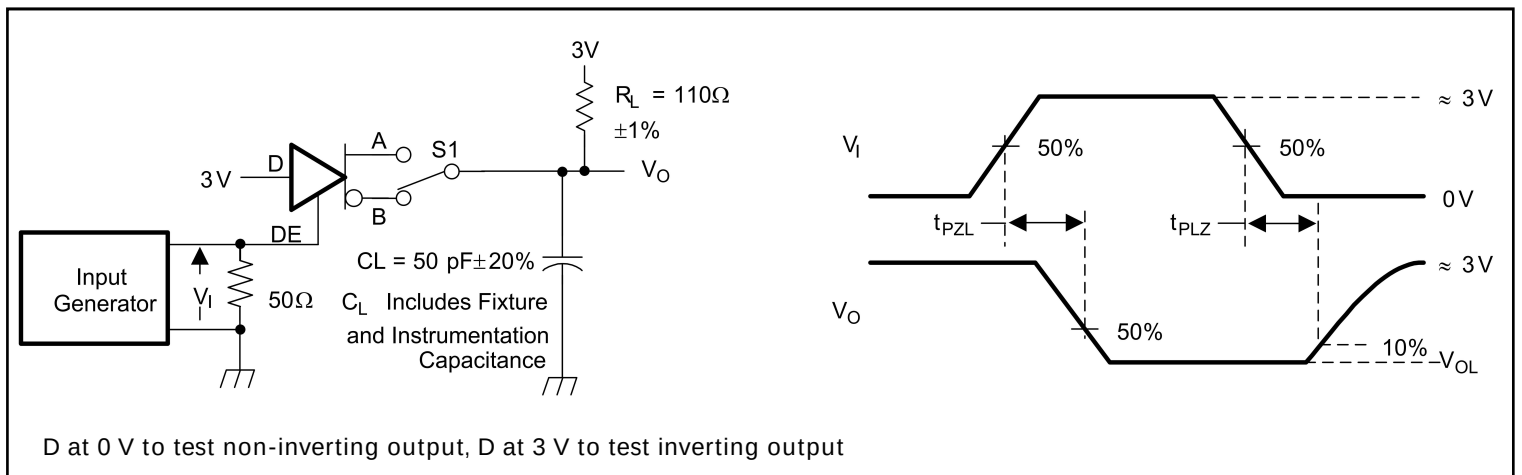


Figure 5. Measurement of Driver Enable and Disable Times With Active Low Output and Pullup Load

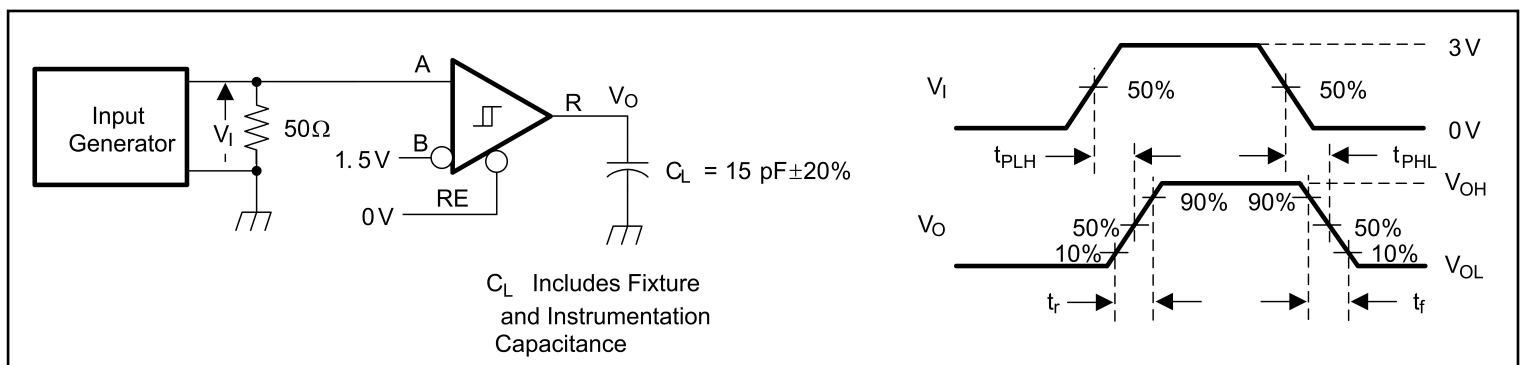


Figure 6. Measurement of Receiver Output Rise and Fall Times and Propagation Delays

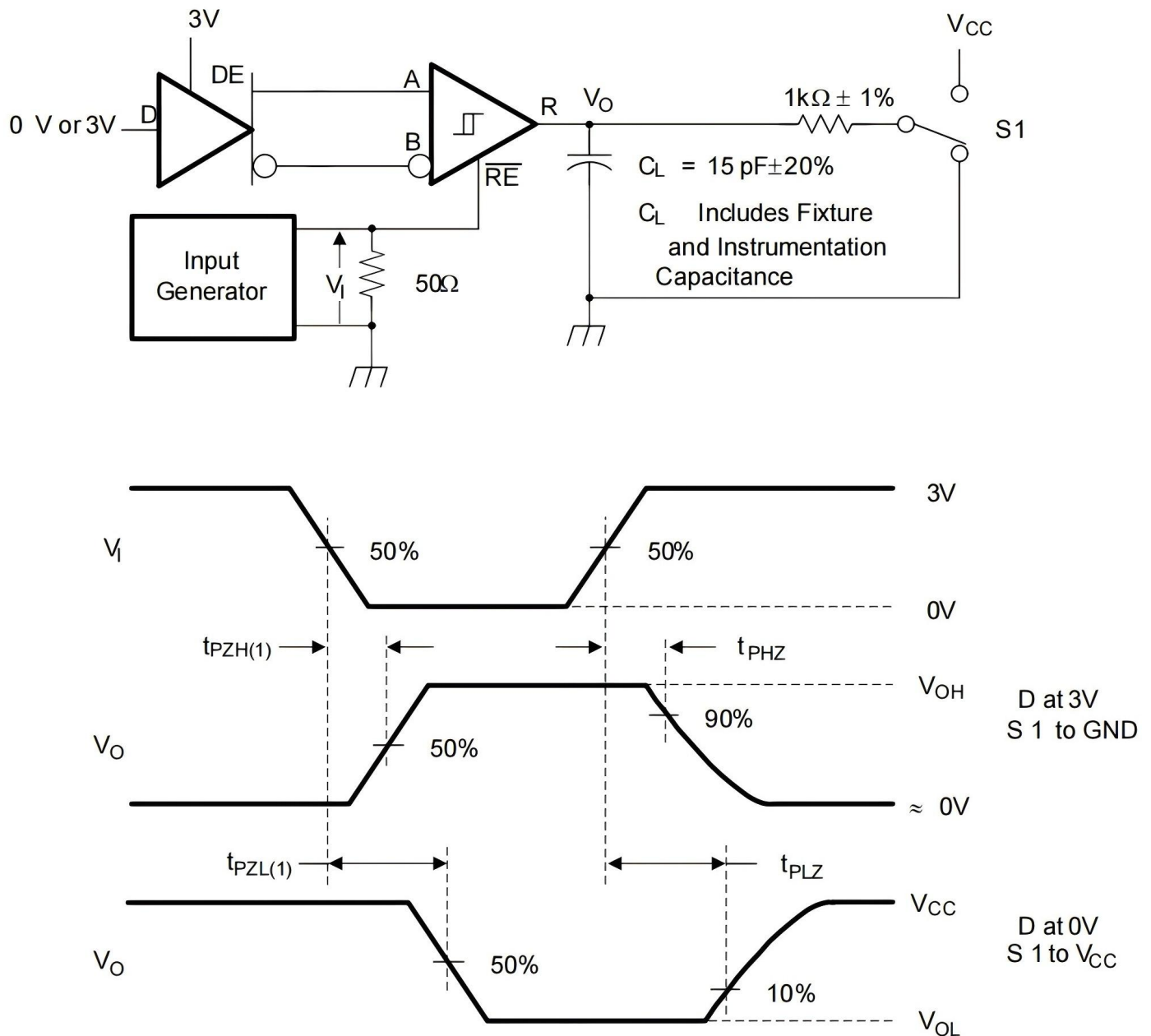


Figure 7. Measurement of Receiver Enable and Disable Times With Driver Enabled

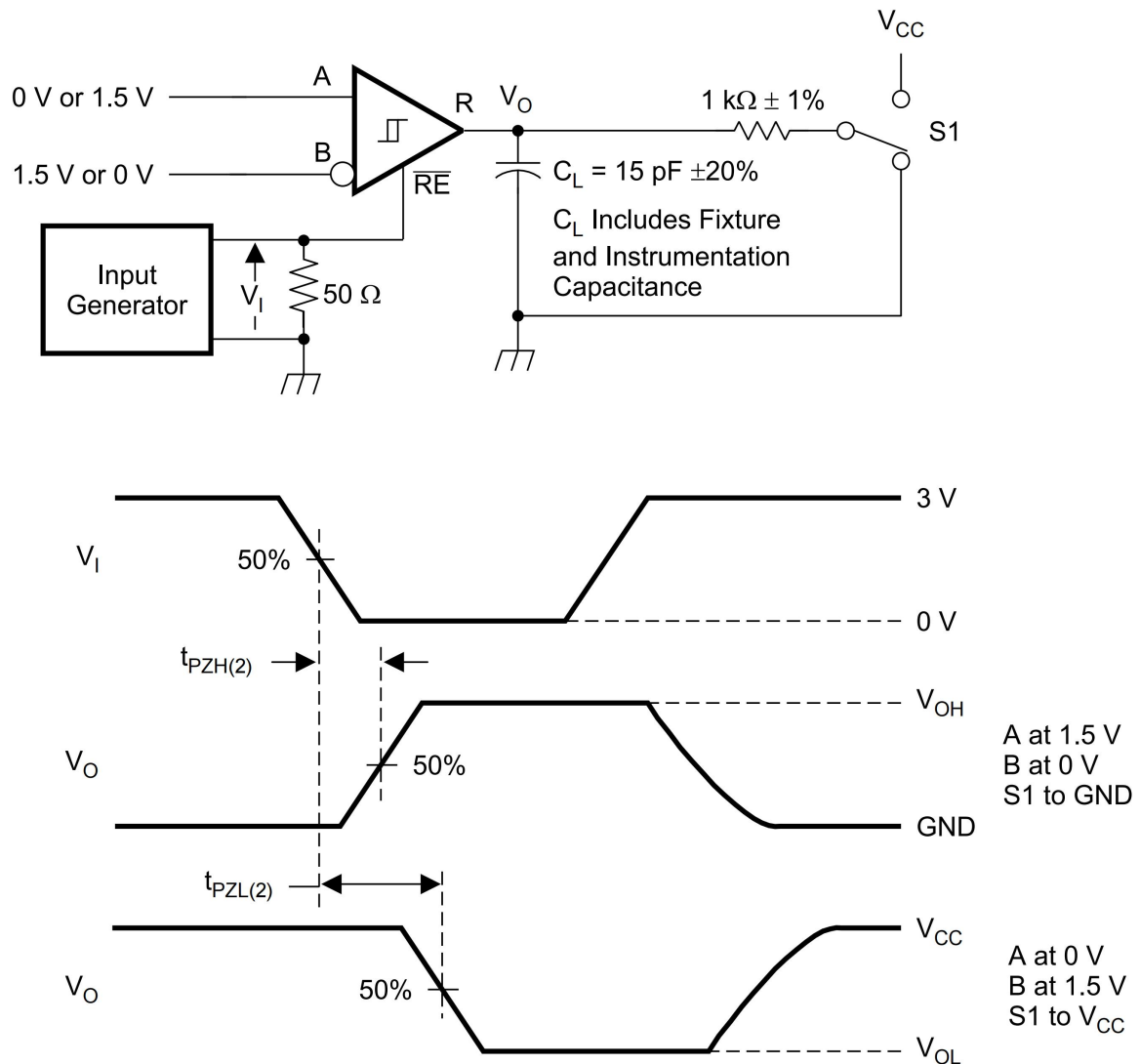


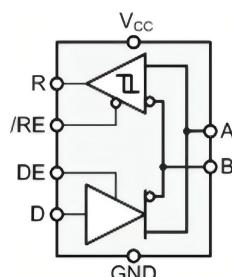
Figure 8. Measurement of Receiver Enable Times With Driver Disabled

Detailed Description

Overview

The SN65HVD72, SN65HVD75, and SN65HVD78 are low-power, half-duplex RS-485 transceivers available in 3 speed grades suitable for data transmission up to 250 kbps, 20 Mbps, and 50 Mbps. These devices have active-high driver enables and active-low receiver enables. A standby current of less than $2\ \mu\text{A}$ can be achieved by disabling both driver and receiver.

Functional Block Diagram



Feature Description

Internal ESD protection circuits protect the transceiver against electrostatic discharges (ESD) according to IEC 61000-4-2 of up to ± 12 kV, and against electrical fast transients (EFT) according to IEC 61000-4-4 of up to ± 4 kV.

The SN65HVD7x half-duplex family provides internal biasing of the receiver input thresholds in combination with large input threshold hysteresis. At a positive input threshold of $V_{IT+} = -20$ mV and an input hysteresis of $V_{HYS} = 50$ mV, the receiver output remains logic high under a bus-idle or bus-short condition even in the presence of 140-mV_{PP} differential noise without the need for external failsafe biasing resistors.

Device operation is specified over a wide ambient temperature range from -40°C to 125°C .

Device Functional Modes

When the driver enable pin, DE, is logic high, the differential outputs A and B follow the logic states at data input D. A logic high at D causes A to turn high and B to turn low. In this case the differential output voltage defined as $V_{OD} = V_A - V_B$ is positive. When D is low, the output states reverse, B turns high, A becomes low, and V_{OD} is negative.

When DE is low, both outputs turn high-impedance. In this condition the logic state at D is irrelevant. The DE pin has an internal pulldown resistor to ground; thus, when left open, the driver is disabled (high-impedance) by default. The D pin has an internal pullup resistor to V_{CC} ; thus, when left open while the driver is enabled, output A turns high and B turns low.

Table 1. Driver Function Table

INPUT	ENABLE	OUTPUTS		DESCRIPTION
		A	B	
H	H	H	L	Actively drive bus high
L	H	L	H	Actively drive bus low
X	L	Z	Z	Driver disabled
X	OPEN	Z	Z	Driver disabled by default
OPEN	H	H	L	Actively drive bus high by default



When the receiver enable pin, RE, is logic low, the receiver is enabled. When the differential input voltage defined as $V_{ID} = V_A - V_B$ is positive and higher than the positive input threshold, V_{IT+} , the receiver output, R, turns high. When V_{ID} is negative and lower than the negative input threshold, V_{IT-} , the receiver output turns low. If V_{ID} is between V_{IT+} and V_{IT-} , the output is indeterminate. When RE is logic high or left open, the receiver output is high-impedance and the magnitude and polarity of V_{ID} are irrelevant. Internal biasing of the receiver inputs causes the output to go failsafe -high when the transceiver is disconnected from the bus (open-circuit), the bus lines are shorted (short-circuit), or the bus is not actively driven (idle bus).

Table 2. Receiver Function Table

DIFFERENTIAL INPUT	ENABLE	OUTPUT	DESCRIPTION
$V_{ID} = V_A - V_B$	RE	R	
$V_{IT+} < V_{ID}$	L	H	Receive valid bus high
$V_{IT-} < V_{ID} < V_{IT+}$	L	?	Indeterminate bus state
$V_{ID} < V_{IT-}$	L	L	Receive valid bus low
X	H	Z	Receiver disabled
X	OPEN	Z	Receiver disabled by default
Open-circuit bus	L	H	Failsafe high output
Short-circuit bus	L	H	Failsafe high output
Idle (terminated) bus	L	H	Failsafe high output

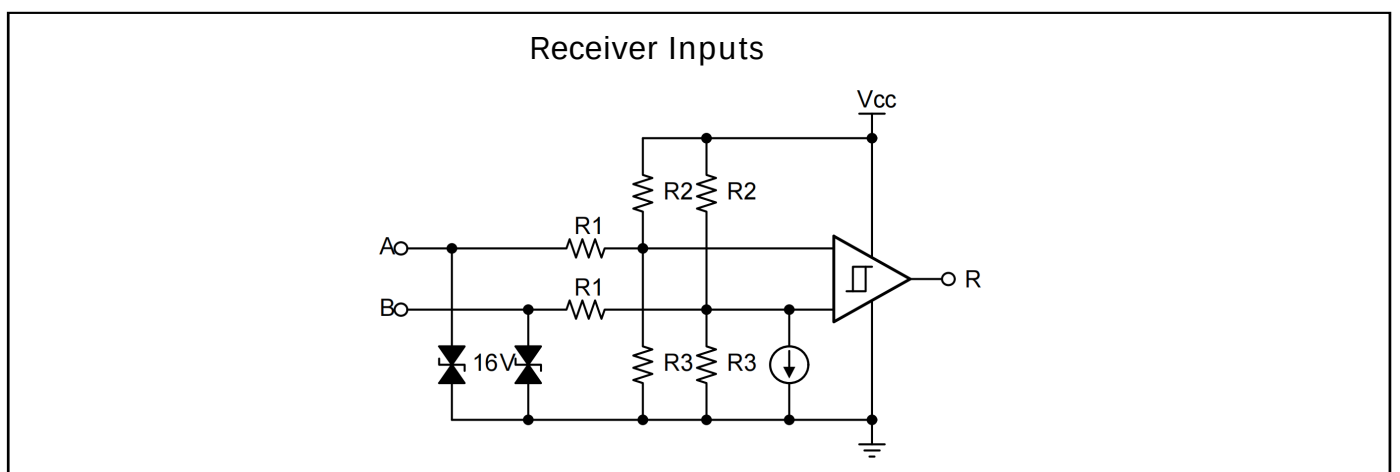
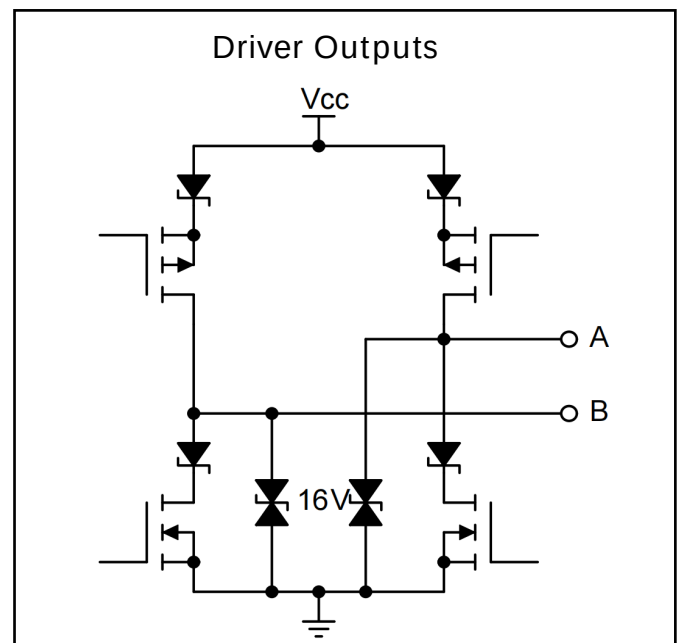
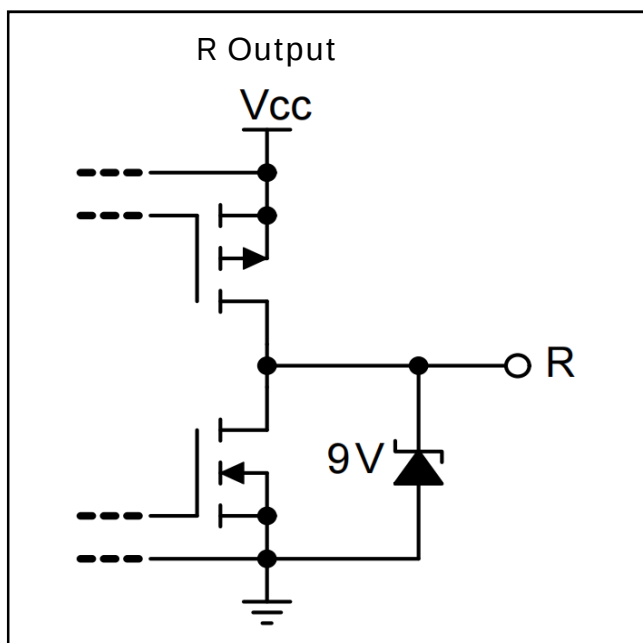
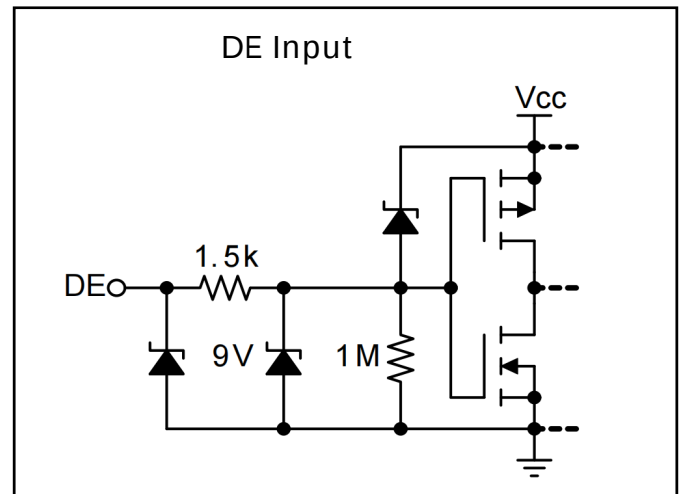
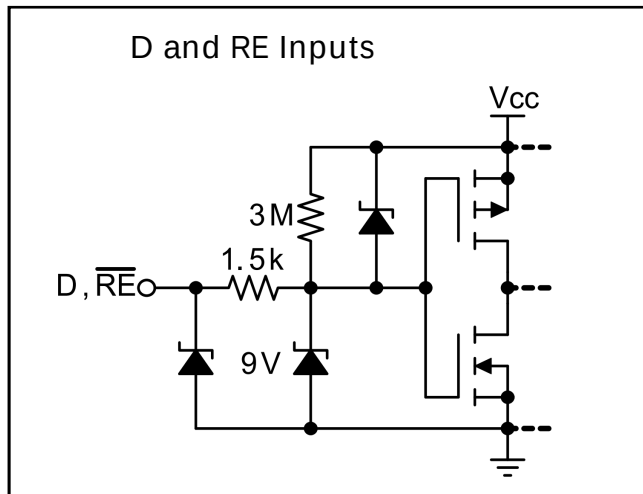


Figure 9. Equivalent Input and Output Circuit Diagrams

Order information

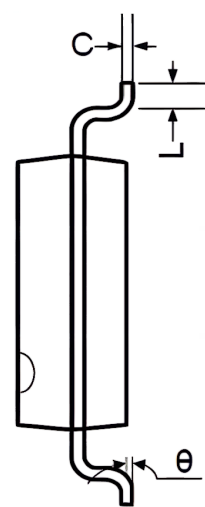
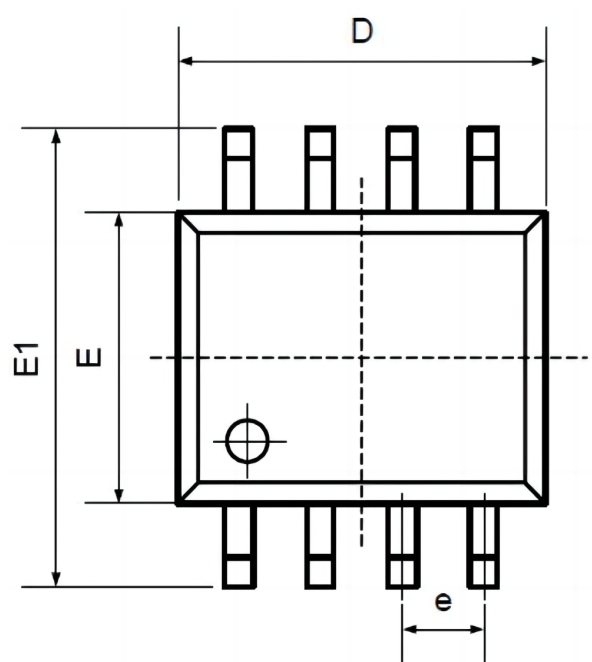
Order Number	Package	Package Quantity	Marking On The park	Temperature
SN65HVD72DGKR-TUDI	MSOP8	Tape,Reel,4000	HVD72	-40°C to 125°C
SN65HVD72DR-TUDI	SOP8	Tape,Reel,4000	HVD72	
SN65HVD75DGKR-TUDI	MSOP8	Tape,Reel,4000	HVD75	
SN65HVD75DR-TUDI	SOP8	Tape,Reel,4000	HVD75	
SN65HVD78DGKR-TUDI	MSOP8	Tape,Reel,4000	HVD78	
SN65HVD78DR-TUDI	SOP8	Tape,Reel,4000	HVD78	

Revision history

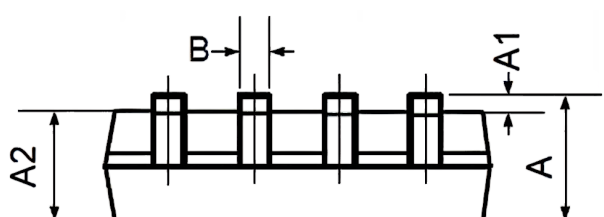
	Date	Revision	Page
V1.0	2020/6	New	1-10
V1.1	2024/2	Update model and PDF template	1-21



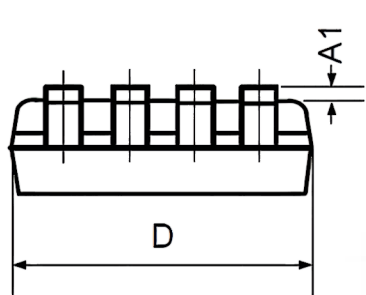
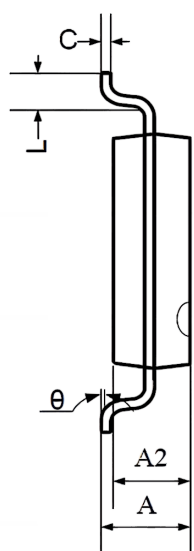
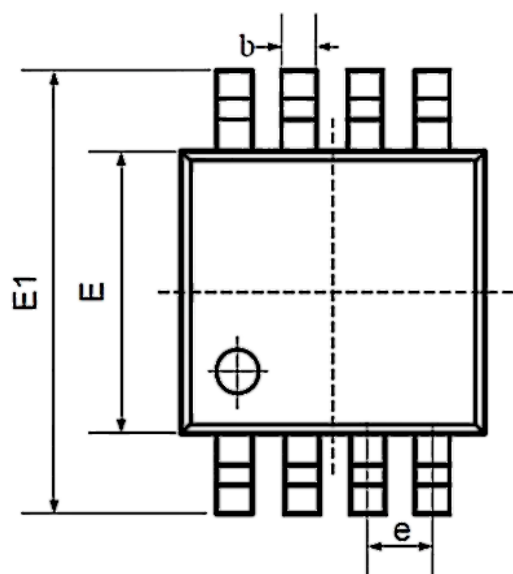
Package SOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°



Package MSOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°



Important statement:

- TUDI Semiconductor reserves the right to modify the product manual without prior notice! Before placing an order, customers need to confirm whether the obtained information is the latest version and verify the completeness of the relevant information.
- Any semi-guide product is subject to failure or malfunction under specified conditions. It is the buyer's responsibility to comply with safety standards when using TUDI Semiconductor products for system design and whole machine manufacturing. And take the appropriate safety measures to avoid the potential in the risk of loss of personal injury or loss of property situation!
- TUDI Semiconductor products have not been licensed for life support, military, and aerospace applications, and therefore TUDI Semiconductor is not responsible for any consequences arising from the use of this product in these areas.
- If any or all TUDI Semiconductor products (including technical data, services) described or contained in this document are subject to any applicable local export control laws and regulations, they may not be exported without an export license from the relevant authorities in accordance with such laws.
- The specifications of any and all TUDI Semiconductor products described or contained in this document specify the performance, characteristics, and functionality of said products in their standalone state, but do not guarantee the performance, characteristics, and functionality of said products installed in Customer's products or equipment. In order to verify symptoms and conditions that cannot be evaluated in a standalone device, the Customer should ultimately evaluate and test the device installed in the Customer's product device.
- TUDI Semiconductor documentation is only allowed to be copied without any alteration of the content and with the relevant authorization. TUDI Semiconductor assumes no responsibility or liability for altered documents.
- TUDI Semiconductor is committed to becoming the preferred semiconductor brand for customers, and TUDI Semiconductor will strive to provide customers with better performance and better quality products.