

**FEATURES**

- Operates with a single 3.3 V Supply
- Compatible With ISO 11898-2 Standard
- Bus Pin ESD Protection Exceeds  $\pm 15$  kV HBM
- High Input Impedance Allows for Up to 120 Nodes
- Adjustable Driver Transition Times for Improved Emissions Performance
- Low Current Standby Mode 650 $\mu$ A typical
- Designed for Data Rates up to 1 Mbps
- Thermal Shutdown Protection
- Open Circuit Fail-Safe Design
- Glitch Free Power Up and Power Down Protection for Hot Plugging Applications

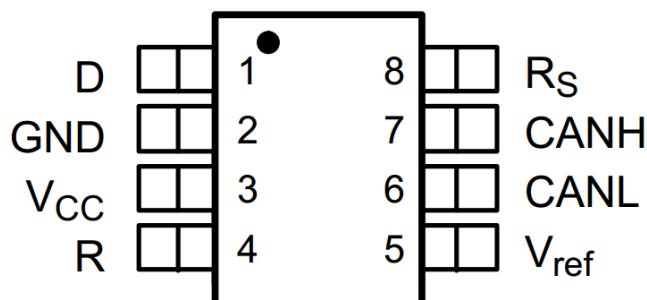
**OUTLINE**


Provide green and environmentally friendly lead-free package

**DESCRIPTION**

The SIT65HVD230 is the interface between the Controller Area Network (CAN) protocol controller and the physical bus. It is designed for use with the 3.3V  $\mu$ Ps, MCUs and DSPs with CAN controllers, or with equivalent protocol controller devices. It is used in Industrial Automation, Control, Sensors and Drive Systems, Motor and Robotic Control, Building and Climate Control (HVAC), Telecom and Basestation Control and Status. The devices are intended for use in applications employing the CAN serial communication physical layer in accordance with the ISO 11898 standard.

PARAMETER	SYMBOL	CONDITION	MIN.	MAX.	UNIT
Supply voltage	$V_{cc}$		3	3.6	V
Maximum transmission rate	1/t <sub>bit</sub>	Non-return to zero code	1		Mbaud
CANH/CANL input or output voltage	$V_{can}$		-16	+16	V
Bus differential voltage	$V_{diff}$		1.5	3.0	V
Virtual junction temperature	$T_{amb}$		-40	125	°C

**PIN CONFIGURATION**

**LIMITING VALUES**

PARAMETER	SYMBOL	VALUE	UNIT
Supply voltage	$V_{CC}$	-0.3~+6	V
DC voltage on D/R pins	D, R	-0.5~ $V_{CC}+0.5$	V
Voltage range at any bus terminal (CANH, CANL)	CANL, CANH	-18~18	V
Transient voltage on pins CANH, CANL	$V_{tr}$	-25~+25	V
Receiver output current, $I_O$		-11~11	mA
Storage temperature		-40~150	°C
Virtual junction temperature		-40~125	°C
Welding temperature range		300	°C
Continuous total power dissipation	SOP8	400	mW
	DIP8	700	mW

The maximum limit parameters means that exceeding these values may cause irreversible damage to the device. Under these conditions, it is not conducive to the normal operation of the device. The continuous operation of the device at the maximum allowable rating may affect the reliability of the device. The reference point for all voltages is ground.

**PINNING**

PIN	SYMBOL	DESCRIPTION
1	D	CAN transmit data input(LOW for dominant and HIGH for recessive bus states), also called TXD, driver input
2	GND	Ground connection
3	VCC	Transceiver 3.3V supply voltage
4	R	CAN receive data output(LOW for dominant and HIGH for recessive bus states), also called RXD, receiver output
5	Vref	Vcc/2 reference output pin
6	CANL	Low level CAN bus line
7	CANH	High level CAN bus line
8	Rs	Mode select pin: strong pull down to GND=high speed mode, strong pull up to Vcc =low power mode,10kQ to 100kQ pull down to GND=slope control mode

**DRIVER ELECTRICAL DC CHARACTERISTICS**

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$V_{O(D)}$	output voltage (Dominant)	CANH	$V_I=0V, R_S=0V, R_L=60\Omega$ (Figure 1、 Figure 2)	2.45	VCC	V
		CANL		0.5		
$V_{OD(D)}$	Differential output voltage (Dominant)	$V_I=0V, R_S=0V, R_L=60\Omega$ (Figure 1)	1.5	2	3	V
		$V_I=0V, R_L=60\Omega, R_S=0V$ (Figure 3)	1.2	2	3	V
$V_{O(R)}$	output voltage (Recessive)	CANH	$V_I=3V, R_S=0V, R_L=60\Omega$ (Figure 1)		2.3	V
		CANL			2.3	
$V_{OD(R)}$	Differential output voltage (Recessive)	$V_I=3V, R_S=0V$	-0.12		0.012	V
		$V_I=3V, R_S=0V, NO$ LOAD	-0.5		0.05	V
$I_{IH}$	High-level input current	$V_I=2V$	-30			$\mu A$
$I_{IL}$	Low-level input current	$V_I=0.8V$	-30			$\mu A$
$I_{OS}$	Short-circuit output current	CANH=-2V	-250			mA
		CANH=7V			1	

		CANL=-2V	-1			
		CANL=7V			250	
<b>Co</b>	Output capacitance	See receiver				
<b>I<sub>CC</sub></b>	Supply current	Standby		650	950	μA
		V <sub>I</sub> =0V (Dominant) , No load		10	17	mA
		V <sub>I</sub> =VCC (Recessive) , No load		10	17	mA

(If not otherwise specified, V<sub>CC</sub>=3.3V±10% ,Temp=T<sub>MIN</sub>~T<sub>MAX</sub>, Typical :VCC=+3.3V, Temp=25°C)

### DRIVER SWITCHING CHARACTERISTICS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
<b>t<sub>PLH</sub></b>	Propagation delay time (low-to-high-level)	R=0, Short circuit (Figure 4)		35	85	ns
		R=10 kΩ		70	125	
		R=100 kΩ		500	870	
<b>t<sub>PHL</sub></b>	Propagation delay time (high-to-low-level)	R=0, Short circuit (Figure 4)		70	120	
		R=10 kΩ		130	180	
		R=100 kΩ		870	1200	
<b>t<sub>sk(p)</sub></b>	Pulse skew (  t <sub>PLH</sub> - t <sub>PHL</sub>  )	R=0, Short circuit (Figure 4)		35		
		R=10 kΩ		60		
		R=100 kΩ		370		
<b>tr</b>	Differential output signal rise time	R=0, Short circuit (Figure 4)	25	50	100	
		R=10 kΩ	80	120	160	
		R=100 kΩ	600	800	1200	
<b>tf</b>	Differential output signal fall time	R=0, Short circuit (Figure 4)	40	55	80	
		R=10 kΩ	80	125	150	
		R=100 kΩ	600	825	1000	

(If not otherwise specified, V<sub>CC</sub>=3.3V±10% ,Temp=T<sub>MIN</sub>~T<sub>MAX</sub>, Typical : VCC=+3.3V, Temp=25°C)

**RECEIVER ELECTRICAL CHARACTERISTICS**

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$V_{IT+}$	Positive-going input threshold voltage	Table 1		750	900	mV
$V_{IT-}$	Negative-going input threshold voltage	Table 1	500	650		mV
$V_{hys}$	Hysteresis voltage	$V_{IT+} - V_{IT-}$		100		mV
$V_{OH}$	High-level output voltage	$-6V < V_{ID} < 500mV$ $I_O = -8mA$ (Figure5)	2.4			V
$V_{OL}$	Low-level output voltage	$900mV < V_{ID} < 6V$ $I_O = 8mA$ (Figure5)			0.4	V
$I_i$	Bus input current	$V_{IH} = 7V, V_{CC} = 0V$	100		350	$\mu A$
$I_i$		$V_{IH} = 7V, V_{CC} = 3.3V$	100		250	$\mu A$
$I_i$		$V_{IH} = -2V, V_{CC} = 0V$	-100		-20	$\mu A$
$I_i$		$V_{IH} = -2V, V_{CC} = 3.3V$	-200		-30	$\mu A$
$R_i$	Bus input resistance	Corresponding standards of ISO 11898-2	20	35	50	K $\Omega$
$R_{diff}$	Differential input resistance	Corresponding standards of ISO 11898-2	40		100	K $\Omega$
$C_i$	Bus input capacitance	Corresponding standards of ISO 11898-2		40		pF
$C_{diff}$	Diferential input capacitance	Corresponding standards of ISO 11898-2		20		pF
$I_{CC}$	Supply current	See driver				

(If not otherwise specified,  $V_{CC} = 3.3V \pm 10\%$ ,  $Temp = T_{MIN} \sim T_{MAX}$ , Typical :  $V_{CC} = +3.3V$ ,  $Temp = 25^\circ C$ )

**RECEIVER SWITCHING CHARACTERISTICS**

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$t_{PLH}$	Propagation delay time (low-to-high-level)	Figure 6		35	50	ns

$t_{PHL}$	Propagation delay time (high-to-low-level)	Figure 6		35	50	ns
$t_{sk}$	Pulse skew	$ t_{PHL} - t_{PLH} $			10	ns
$t_r$	output signal rise time	Figure 6		1.5		ns
$t_f$	output signal fall time	Figure 6		1.5		ns

(If not otherwise specified,  $V_{CC}=3.3V\pm 10\%$ ,  $Temp=T_{MIN}\sim T_{MAX}$ , Typical :  $V_{CC}=+3.3V$ ,  $Temp=25^{\circ}C$ )

## DEVICE SWITCHING CHARACTERISTICS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$t_{(LOOP1)}$	Total loop delay,driver input to receiver output,recessive to dominant	R=0, Short circuit (Figure 8)		70	115	ns
		R=10 k $\Omega$		105	175	
		R=100 k $\Omega$		535	920	
$t_{(LOOP2)}$	Total loop delay,driver input to receiver output,dominant to recessive	R=0, Short circuit (Figure 8)		100	135	ns
		R=10 k $\Omega$		155	185	
		R=100 k $\Omega$		830	990	

(If not otherwise specified,  $V_{CC}=3.3V\pm 10\%$ ,  $Temp=T_{MIN}\sim T_{MAX}$ , Typical :  $V_{CC}=+3.3V$ ,  $Temp=25^{\circ}C$ )

## OVER TEMPERATURE PROTECTION

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Thermal shutdown temperature	$T_j(sd)$		155	165	180	$^{\circ}C$

(If not otherwise specified,  $V_{CC}=3.3V\pm 10\%$ ,  $Temp=T_{MIN}\sim T_{MAX}$ , Typical :  $V_{CC}=+3.3V$ ,  $Temp=25^{\circ}C$ )

## CONTROL-PIN CHARACTERISTICS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$T_{WAKE}$	wake-up time from standby mode	$R_s$ adds square wave (Figure7)		0.55	1.5	us

$V_{ref}$	Reference output voltage	$-5\mu A < I_{ref} < 5\mu A$	$0.45V_{CC}$		$0.55V_{CC}$	V
		$-50\mu A < I_{ref} < 50\mu A$	$0.4V_{CC}$		$0.6V_{CC}$	V
$I_{RS}$	Input current for high-speed	$V_{RS} < 1V$	-450		0	$\mu A$
$V_{RS}$	Input voltage for standby/sleep	$0 < V_{RS} < V_{CC}$	$0.75V_{CC}$		$V_{CC}$	V
$I_{off}$	Power-off leakage current	$V_{CC} = 0V$	-250		250	$\mu A$
		$V_{CANH} = V_{CANL} = 5V$				

(If not otherwise specified,  $V_{CC} = 3.3V \pm 10\%$ ,  $Temp = T_{MIN} \sim T_{MAX}$ , Typical :  $V_{CC} = +3.3V$ ,  $Temp = 25^\circ C$ )

### SUPPLY CURRENT

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$I_{CC}$	Power consumption in standby mode	$R_S = V_{CC}$ , $V_I = V_{CC}$		650	950	$\mu A$
	Dominant power consumption	$V_I = 0V$ , $R_S = 0V$ , LOAD = $60\Omega$		50	70	mA
	Recessive power consumption	$V_I = V_{CC}$ , $R_S = 0V$ , NO LOAD		6	10	mA

(If not otherwise specified,  $V_{CC} = 3.3V \pm 10\%$ ,  $Temp = T_{MIN} \sim T_{MAX}$ , Typical :  $V_{CC} = +3.3V$ ,  $Temp = 25^\circ C$ )

### FUNCTION TABLE

Table 1 Receiver characteristics in common mode ( $V(RS) = 1.2V$ )

$V_{IC}$	$V_{ID}$	$V_{CANH}$	$V_{CANL}$	R OUTPUT	
-2 V	900mV	-1.55V	-2.45V	L	VOL
7 V	900mV	8.45V	6.55V	L	
1 V	6V	4V	-2V	L	
4 V	6V	7V	1V	L	
-2 V	500mV	-1.75V	-2.25V	H	VOH
7 V	500mV	7.25V	6.75V	H	
1 V	-6V	-2V	4V	H	
4 V	-6V	1V	7V	H	
X	X	Open	Open	H	

(1) H=High voltage; L=Low voltage; X=Irrelevant

**Table2.Operating Mode**

<b>R<sub>S</sub> Pin</b>	<b>MODE</b>	<b>DRIVER</b>	<b>RECEIVER</b>	<b>RXD Pin</b>
LOW、V <sub>(RS)</sub> < 1.2V、strong pull down to GND	High Speed Mode	Enabled(ON) High Speed	Enabled(ON)	Mirrors Bus State
LOW、V <sub>(RS)</sub> < 1.2V、10kΩ to 100kΩ pull down to GND	Slope Control Mode	Enabled(ON) With Slope Control	Enabled(ON)	Mirrors Bus State
High、V <sub>(RS)</sub> > 0.75 V <sub>CC</sub>	Standby Mode	Disabled (OFF)	Enabled(ON)	Mirrors Bus State

**Table3.Driver Function**

<b>INPUT D</b>	<b>R<sub>S</sub></b>	<b>OUTPUTS</b>		<b>BUS STATE</b>
		<b>CANH</b>	<b>CANL</b>	
L	V <sub>(RS)</sub> < 1.2V (including 10kΩ to 100kΩ pull down to GND)	H	L	Dominant
H		Z	Z	Recessive
Open	Standby Mode	Z	Z	Recessive
X	V <sub>(RS)</sub> > 0.75V <sub>CC</sub>	Z	Z	Recessive

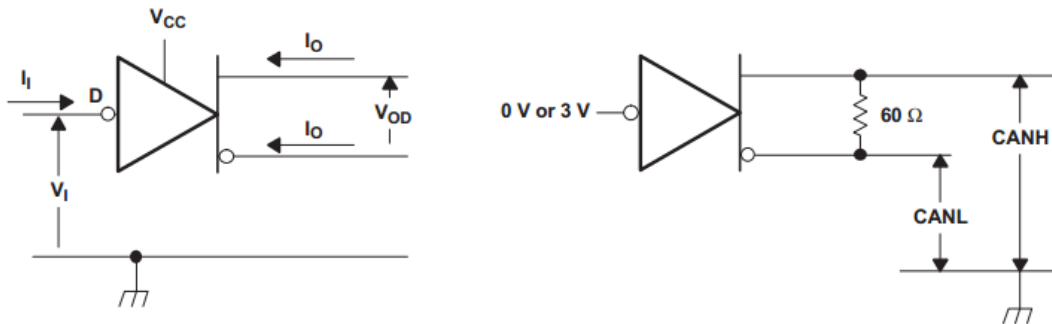
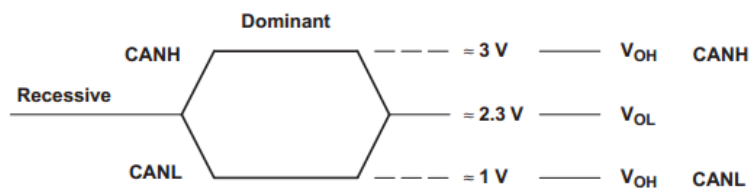
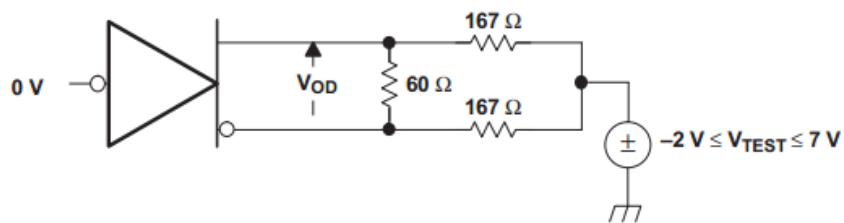
(1) H= High voltage; L= Low voltage; Z=High impedance

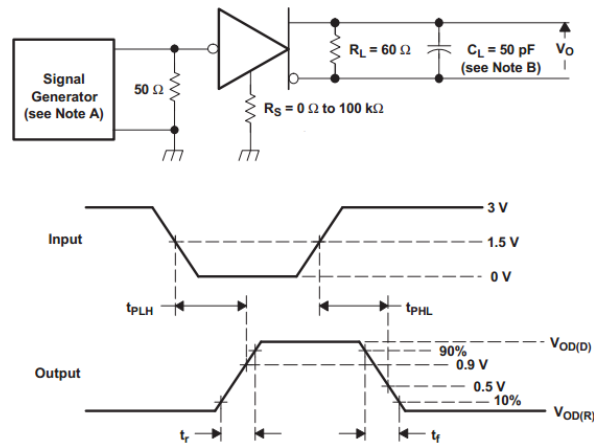
**Table4. Receiver Function**

<b>V<sub>ID</sub>=CANH-CANL</b>	<b>R<sub>S</sub></b>	<b>OUTPUT R</b>
V <sub>ID</sub> ≥ 0.9V	X	L
0.5 < V <sub>ID</sub> < 0.9V	X	?
V <sub>ID</sub> ≤ 0.5V	X	H
Open	X	H

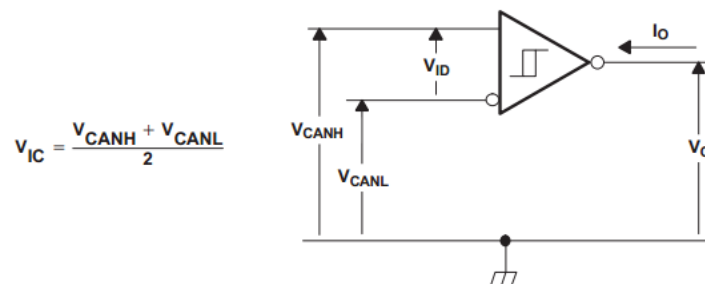
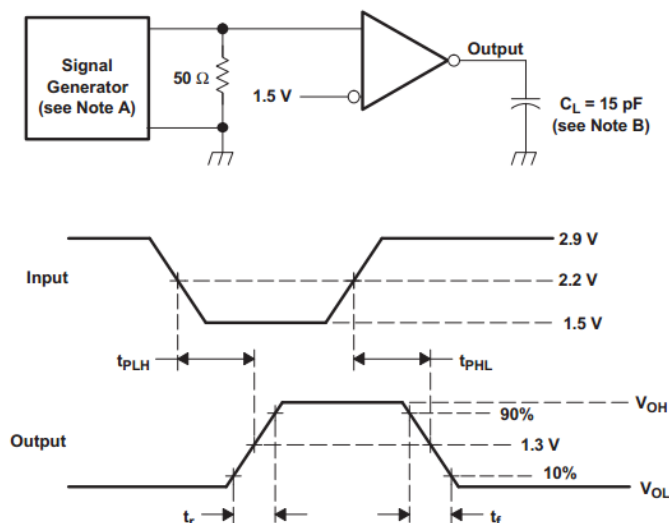
(1) H= High voltage; L= Low voltage; ? =Indeterminate; X=Irrelevant



**TEST CIRCUIT**

**Fig.1 Driver Voltage And Current Definition**

**Fig.2 Bus Logic State Voltage Definition**

**Fig.3 Driver Vod Test Circuit**

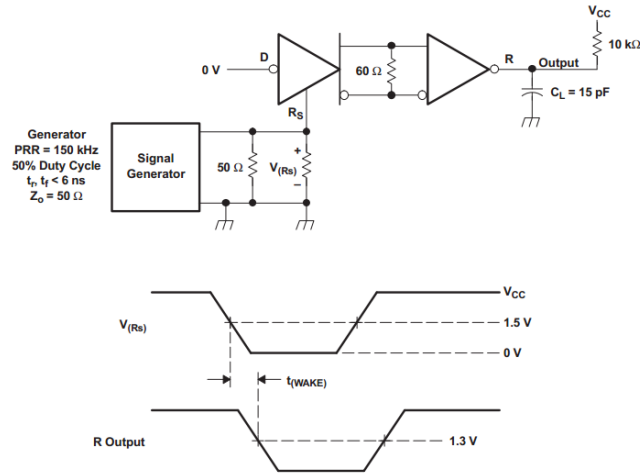
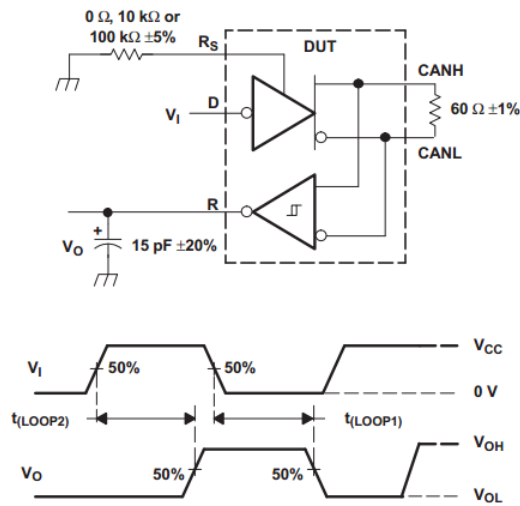


- A、 The input pulse is supplied by a generator having the following characteristics: PRR ≤ 500KHz, 50% duty cycle,  $t_r < 6\text{ns}$ ,  $t_f < 6\text{ns}$ ,  $Z_o = 50\Omega$ .
- B、  $C_L$  includes probe and jig capacitance, the error is within 20%.

**Fig.4 Driver Test Circuit and Waveform**

**Fig.5 Receiver Voltage and Current Definition**


- A、 The input pulse is supplied by a generator having the following characteristics: PRR ≤ 500KHz, 50% duty cycle,  $t_r < 6\text{ns}$ ,  $t_f < 6\text{ns}$ ,  $Z_o = 50\Omega$
- B、  $C_L$  includes probe and jig capacitance, the error is within 20%.

**Fig.6 Receiver Test Circuit and Waveform**


**Fig.7  $t_{(WAKE)}$  Test Circuit and Waveform**


A、 The input pulse is supplied by a generator having the following characteristics: PRR $\leq$ 125KHz, 50% duty cycle,  $t_r < 6$ ns,  $t_f < 6$ ns,  $Z_o = 50 \Omega$

**Fig.8  $t_{(LOOP)}$  Test Circuit and Waveform**

**ADDITIONAL DESCRIPTION****1 Sketch**

The SIT65HVD230 is the interface between the Controller Area Network (CAN) protocol controller and the physical bus. It is designed for use with the 3.3V  $\mu$ Ps, MCUs and DSPs with CAN controllers, or with equivalent protocol controller devices. It is used in Industrial Automation, Control, Sensors and Drive Systems, Motor and Robotic Control, Building and Climate Control (HVAC), Telecom and Basestation Control and Status. It supports programmable data rates up to 1 Mbps. The devices are intended for use in applications employing the CAN serial communication physical layer in accordance with the ISO 11898 standard.

**2 Current protection**

A current-limiting circuit protects the transmitter output stage from damage caused by accidental short-circuit to either positive or negative supply voltage, although power dissipation increases during this fault condition.

**3 Over temperature protection**

SIT65HVD230 has the function of over temperature protection. After the over temperature protection is triggered, the current of the driving stage will be reduced, because the driving tube is the main energy consuming part. The current reduction can reduce the power consumption and thus reduce the chip temperature. At the same time, other parts of the chip still work normally.

**4 Transient Protection**

Electrical transients often occur in automotive application environment, CANH、CANL of SIT65HVD230 have the function of preventing electrical transient damage.

**5 Operating modes**

The RS pin mode, slop (Pin 8) of the SIT65HVD230 provides three different modes of operation: high-speed mode, slope-control mode, and low-power mode.

**5.1 High-Speed Mode**

The high-speed mode can be selected by applying a logic low to the RS pin (pin 8). The high-speed mode of operation is commonly employed in industrial applications. High-speed allows the output to switch as fast as possible with no internal limitation on the output rise and fall slopes. If the high speed transitions are a concern for emissions performance slope control mode can be used.

If both high speed mode and the low-power standby mode is to be used in the application, direct connection to a  $\mu$ P, MCU or DSP general purpose output pin can be used to switch between a logic-low level ( $< 1.2$  V) for high speed operation, and the logic-high level ( $> 0.75$  VCC) for standby.

### 5.2 Slope Control Mode

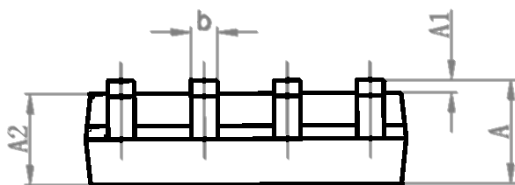
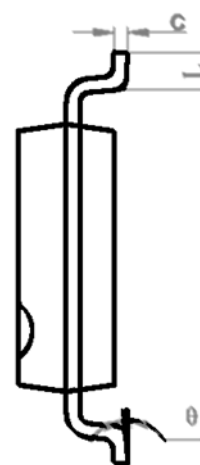
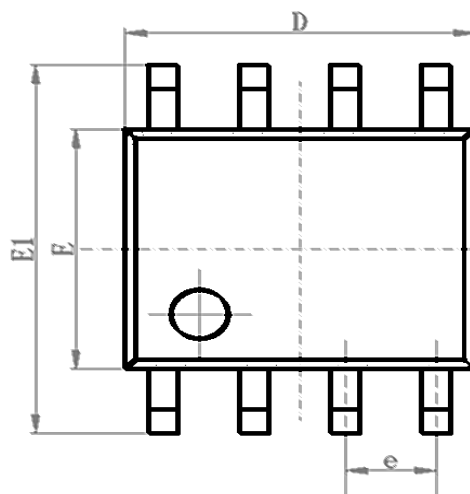
Electromagnetic compatibility is essential in many applications while still making use of unshielded twisted pair bus cable to reduce system cost. Slope control mode was added to the SIT65HVD230 devices to reduce the electromagnetic interference produced by the rise and fall times of the driver and resulting harmonics. These rise and fall slopes of the driver outputs can be adjusted by connecting a resistor from RS (pin 8) to ground or to a logic low voltage. The slope of the driver output signal is proportional to the pin's output current. This slope control is implemented with an external resistor value of 10 k $\Omega$  to 100 k $\Omega$  to achieve slew rate.

### 5.3 Standby Mode (Listen Only Mode)

If a logic high ( $> 0.75 V_{CC}$ ) is applied to RS (pin 8), the circuit of the SIT65HVD230 enters a low-current, listen only standby mode, during which the driver is switched off and the receiver remains active. In this listen only state, the transceiver is completely passive to the bus. It makes no difference if a slope control resistor is in place. The  $\mu P$  can reverse this low-power standby mode when the rising edge of a dominant state (bus differential voltage  $> 900$  mV typical) occurs on the bus. The  $\mu P$ , sensing bus activity, reactivates the driver circuit by placing a logic low ( $< 1.2$  V) on RS (pin 8).

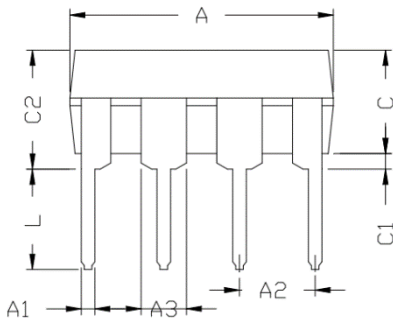
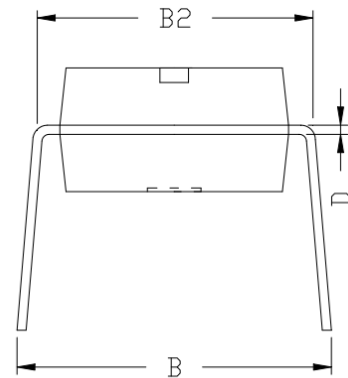
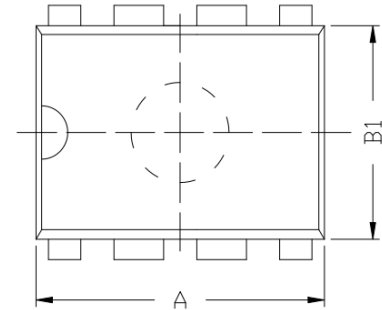
**SOP8 DIMENSIONS**
**PACKAGE SIZE**

SYMBOL	MIN./mm	TYP./mm	MAX./mm
A	1.50	1.60	1.70
A1	0.1	0.15	0.2
A2	1.35	1.45	1.55
b	0.355	0.400	0.455
D	4.800	4.900	5.00
E	3.780	3.880	3.980
E1	5.800	6.000	6.200
e		1.270BSC	
L	0.40	0.60	0.80
c	0.153	0.203	0.253
$\theta$	-2°	-4°	-6°



**DIP8 DIMENSIONS**
**PACKAGE SIZE**

SYMBOL	MIN./mm	TYP./mm	MAX./mm
A	9.00	9.20	9.40
A1	0.33	0.45	0.51
A2	2.54TYP		
A3	1.525TYP		
B	8.40	8.70	9.10
B1	6.20	6.40	6.60
B2	7.32	7.62	7.92
C	3.20	3.40	3.60
C1	0.50	0.60	0.80
C2	3.71	4.00	4.31
D	0.20	0.28	0.36
L	3.00	3.30	3.60


**ORDERING INFORMATION**

TYPE NUMBER	TEMPERATURE	PACKAGE
SIT65HVD230DR	-40°C~125°C	SOP8
SIT65HVD230P	-40°C~125°C	DIP8

It is packed with 2500 pieces/disc in braided packaging.