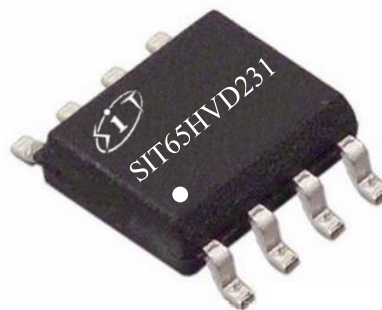


**FEATURES**

- Operates with a single 3.3V supply;
- Compatible with ISO 11898-2 standard;
- Bus pin ESD protection exceeds  $\pm 16$  kV HBM;
- At least 120 nodes can be connected;
- Adjustable drive conversion time can improve radiation performance;
- Ultra-low current sleep mode: 40nA (typical value)
- 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

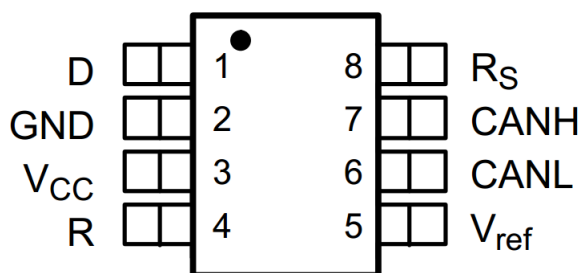
**OUTLINE**


Provide Green and Environmentally  
 Friendly Lead-free package

**DESCRIPTION**

The SIT65HVD231 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	$1/t_{bit}$	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	$^{\circ}$ 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 6, 7	$V_{tr}$	-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 selection pin: strong pull-down to GND = high-speed mode; strong pull-up to VCC = low power.Power consumption sleep mode; pull down to GND = slope control mode through a 10k $\Omega$ to 100k $\Omega$ resistorformula.

**DRIVER ELECTRICAL CHARACTERISTICS**

SYMBOL	PARAMETER		CONDITION	MIN.	TYP.	MAX.	UNIT
$V_{O(D)}$	Output voltage (Dominant)	CANH	$V_I=0V, R_L=60\Omega$ (Figure 1, Figure 2)	2.45		VCC	V
		CANL		0.5		1.25	
$V_{OD(D)}$	Differential output voltage (Dominant)		$V_I=0V, R_L=60\Omega$ (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	$V_I=3V, R_L=60\Omega$ (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	
$C_O$	Output capacitance		See receiver				
$I_{CC}$	Supply current		休眠		0.04	1	$\mu A$
			$V_I=0V$ (Dominant), NO LOAD		10	17	mA
			$V_I=V_{CC}$ (Recessive), NO LOAD		10	17	mA

( $V_{CC}=3.3V\pm 10\%$  and  $Temp=T_{MIN}\sim T_{MAX}$  unless specified otherwise; typical in  $V_{CC}=+5V$  and  $Temp=25^\circ C$ )

**DRIVER SWITCHING CHARACTERISTICS**

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$t_{PLH}$	Propagation delay	$R=0$ , short circuit (Fig. 4)		35	85	ns

	time (low-to-high level)	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 (Fig. 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 (Fig. 4)		35	
		R=10 kΩ		60	
		R=100 kΩ		370	
<b>t<sub>r</sub></b>	Differential output signal rise time	R=0, short circuit (Fig. 4)	25	50	100
		R=10 kΩ	80	120	160
		R=100 kΩ	600	800	1200
<b>t<sub>f</sub></b>	Differential output signal fall time	R=0, short circuit (Fig. 4)	40	55	80
		R=10 kΩ	80	125	150
		R=100 kΩ	600	825	1000

(V<sub>CC</sub>=3.3V±10% and Temp=T<sub>MIN</sub>~T<sub>MAX</sub> unless specified otherwise; typical in V<sub>CC</sub>=+5V and Temp=25°C)

## RECEIVER ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
<b>V<sub>IT+</sub></b>	Positive-going input threshold voltage	See Table 1		750	900	mV
<b>V<sub>IT-</sub></b>	Negative-going input threshold voltage	See Table 1	500	650		mV
<b>V<sub>hys</sub></b>	Hysteresis voltage	V <sub>IT+</sub> - V <sub>IT-</sub>		100		mV
<b>V<sub>OH</sub></b>	High-level output voltage	-6V < V <sub>ID</sub> < 500mV I <sub>O</sub> =-8mA (see Fig. 5)	2.4			V
<b>V<sub>OL</sub></b>	Low-level output voltage	900mV < V <sub>ID</sub> < 6V I <sub>O</sub> =8mA (see Fig. 5)			0.4	V
<b>I<sub>i</sub></b>	Bus input current	V <sub>IH</sub> =7V, V <sub>CC</sub> =0V	100		350	μA
<b>I<sub>i</sub></b>		V <sub>IH</sub> =7V, V <sub>CC</sub> =3.3V	100		250	μA

$I_i$		$V_{IH}=-2V, V_{CC}=0V$	-100		-20	$\mu A$
$I_i$		$V_{IH}=-2V, V_{CC}=3.3V$	-200		-30	$\mu A$
$R_i$	Input resistance	ISO 11898-2 standard	20	35	50	$K\Omega$
$R_{diff}$	Differential input resistance	ISO 11898-2 standard	40		100	$K\Omega$
$C_i$	Input capacitance	ISO 11898-2 standard		40		pF
$C_{diff}$	Differential input capacitance	ISO 11898-2 standard		20		pF
$I_{CC}$	Supply current	See driver				

( $V_{CC}=3.3V\pm 10\%$  and  $Temp=T_{MIN}\sim T_{MAX}$  unless specified otherwise; typical in  $V_{CC}=+5V$  and  $Temp=25^\circ C$ )

### 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

( $V_{CC}=3.3V\pm 10\%$  and  $Temp=T_{MIN}\sim T_{MAX}$  unless specified otherwise; typical in  $V_{CC}=+5V$  and  $Temp=25^\circ C$ )

### DEVICE SWITCHING CHARACTERISTICS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
$t_{(LOOP1)}$	Loop delay 1, driver input to receiver	$R=0$ , short circuit (Figure 8)		70	115	ns
		$R=10\ k\Omega$		105	175	

	output, Recessive to Dominant	R=100 kΩ		535	920	
<b>t<sub>(LOOP2)</sub></b>	Loop delay 2, driver input to receiver output, Dominant to Recessive	R=0, short circuit (Figure 8)		100	135	ns
		R=10 kΩ		155	185	
		R=100 kΩ		830	990	

(V<sub>CC</sub>=3.3V±10% and Temp=T<sub>MIN</sub>~T<sub>MAX</sub> unless specified otherwise; typical in V<sub>CC</sub>=+5V and Temp=25°C)

### OVER TEMPERATURE PROTECTION

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Shutdown junction temperature	T <sub>j(sd)</sub>		155	165	180	°C

(V<sub>CC</sub>=3.3V±10% and Temp=T<sub>MIN</sub>~T<sub>MAX</sub> unless specified otherwise; typical in V<sub>CC</sub>=+5V and Temp=25°C)

### CONTROL PIN CHARACTERISTIC

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
<b>T<sub>WAKE</sub></b>	Sleep to wake time	RS connected to square wave (see Figure 7)		3	5	us
<b>V<sub>ref</sub></b>	Reference output voltage	-5uA<I <sub>ref</sub> <5uA	0.45V <sub>CC</sub>		0.55V <sub>CC</sub>	V
		-50uA<I <sub>ref</sub> <50uA	0.4V <sub>CC</sub>		0.6V <sub>CC</sub>	V
<b>I<sub>RS</sub></b>	High-speed mode input current	V <sub>RS</sub> <1V	-450		0	μA
<b>V<sub>RS</sub></b>	Sleep input voltage	0<V <sub>RS</sub> <V <sub>CC</sub>	0.75V <sub>CC</sub>		V <sub>CC</sub>	V
<b>I<sub>off</sub></b>	Power-down leakage current	V <sub>CC</sub> =0V, V <sub>CANH</sub> =V <sub>CANL</sub> =5V	-250		250	μA

(V<sub>CC</sub>=3.3V±10% and Temp=T<sub>MIN</sub>~T<sub>MAX</sub> unless specified otherwise; typical in V<sub>CC</sub>=+5V and Temp=25°C)

### SUPPLY CURRENT

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Sleep mode	I <sub>CC</sub>	RS=V <sub>CC</sub> , VI=V <sub>CC</sub>		0.04	1	μA
Dominant		V <sub>I</sub> =0V, LOAD=60Ω		50	70	mA

Recessive		$V_I=V_{CC}$ , NO LOAD		6	10	mA
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( $V_{CC}=3.3V\pm 10\%$  and  $Temp=T_{MIN}\sim T_{MAX}$  unless specified otherwise; typical in  $V_{CC}=+5V$  and  $Temp=25^{\circ}C$ )

**FUNCTION TABLE**

 Table 1. Receiver characteristics over 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 level; L=low level; X=irrelevant

Table 2 Working Mode

$R_s$	Mode	driver	receiver	RXD
Low level, $V(R_s) < 1.2V$ , strong pull-down to GND	High speed mode	Enable (open) high	Enable (open)	Reflect bus status
Low level, $V(R_s) < 1.2V$ , pull down to GND through a resistance in the range of 10k $\Omega$ to 100k $\Omega$	Slope control mode	Enable (open) high, with slope control	Enable (open)	Reflect bus status
High level, $V(R_s) > 0.75 V_{CC}$	Sleep mode	Disable (closed)	Disable (closed)	High level

Table 3 Drive function

Input D	$R_s$	Output		bus status
		CANH	CANL	
L	$V(R_s) < 1.2V$ (including pulling down to GND through a resistor in the range of 10k $\Omega$ to 100k $\Omega$ )	H	L	Dominant
H		Z	Z	Recessive
open circuit	Sleep mode	Z	Z	Recessive
X	$V(R_s) > 0.75V_{CC}$	Z	Z	Recessive

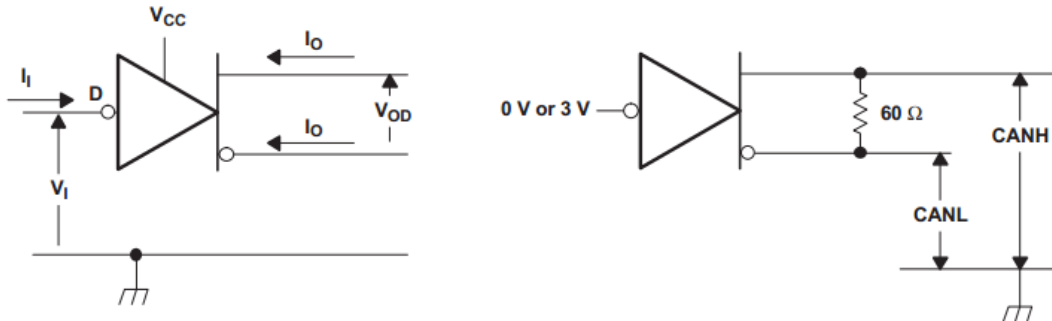
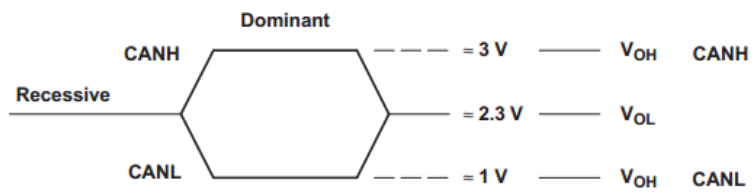
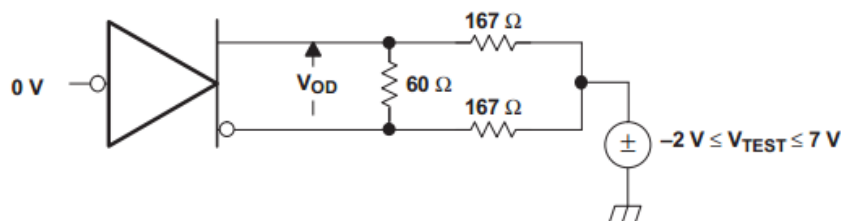
(1) H=high level; L=low level; Z=high impedance state

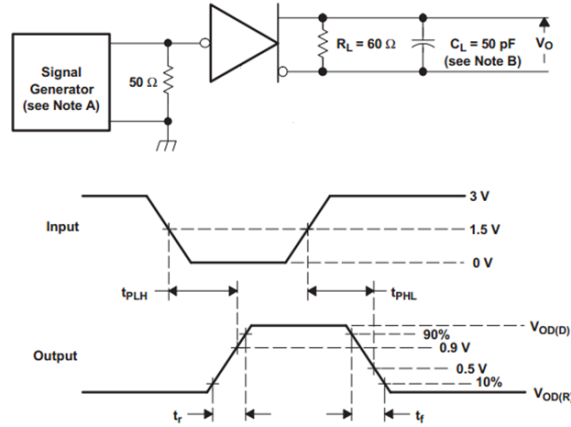


Table 4 Receiver functions

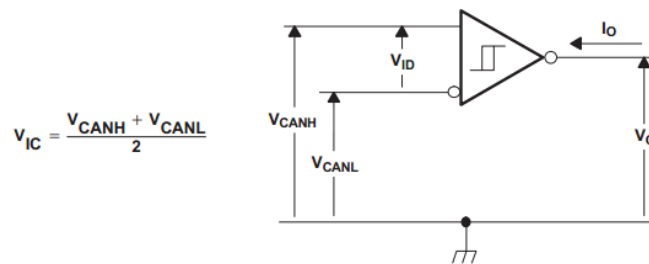
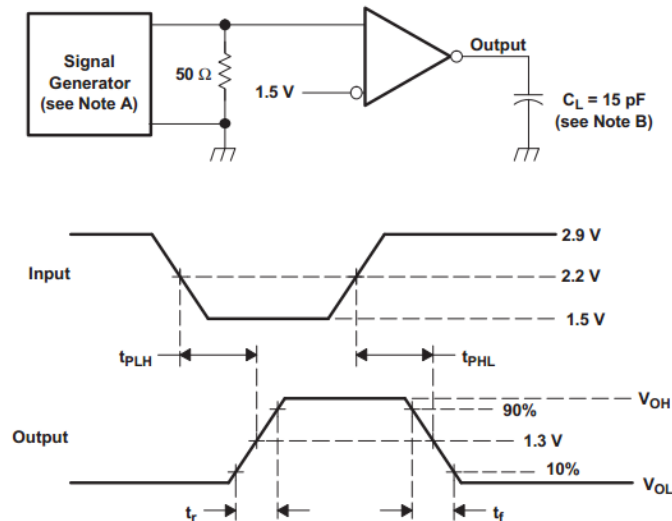
$V_{ID}=CANH-CANL$	$R_s$	输出 R
$V_{ID} \geq 0.9V$	X	L
$0.5 < V_{ID} < 0.9V$	X	?
$V_{ID} \leq 0.5V$	X	H
Open	X	H

(1)H=high level; L=low level;? = Not sure; X = not relevant

**TEST CIRCUIT**

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

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

**图 3 驱动器 VOD 测试电路**



- A. The input pulse is supplied by a generator having the following characteristics  
 $PRR \leq 500 \text{ kHz}$ , 50% duty cycle,  $t_r < 6 \text{ ns}$ ,  $t_f < 6 \text{ ns}$ ,  $Z_o = 50 \Omega$
- B. CL includes instrumentation and fixture capacitance within  $\pm 20\%$ .

**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  
 $PRR \leq 500 \text{ kHz}$ , 50% duty cycle,  $t_r < 6 \text{ ns}$ ,  $t_f < 6 \text{ ns}$ ,  $Z_o = 50 \Omega$
- B. CL includes instrumentation and fixture capacitance within  $\pm 20\%$ .

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

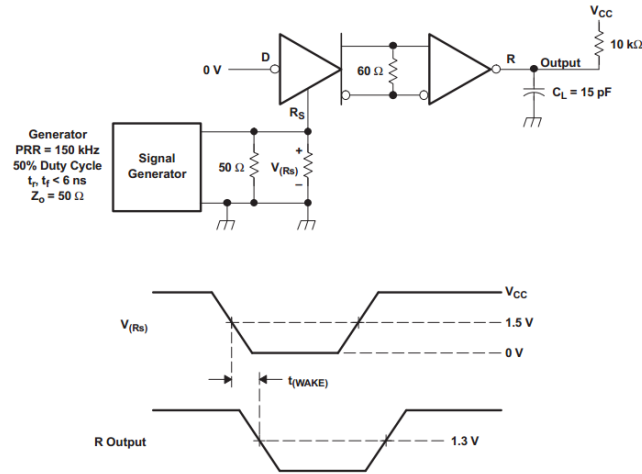
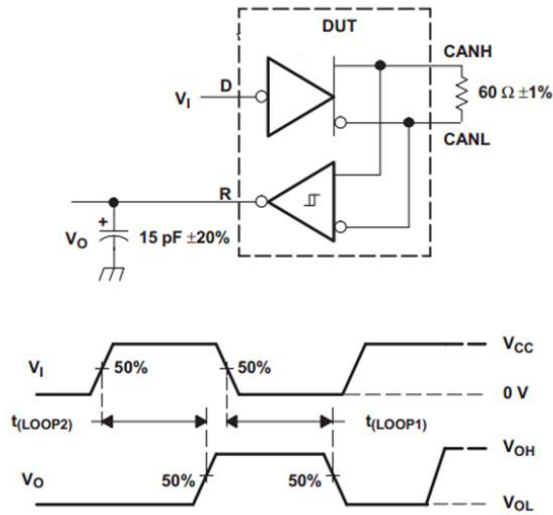


Figure 7  $t_{(WAKE)}$  test circuit and voltage waveform



A. The input pulse is supplied by a generator having the following characteristics,  $PRR \leq 500 \text{ kHz}$ , 50% duty cycle,  $t_r < 6 \text{ ns}$ ,  $t_f < 6 \text{ ns}$ ,  $Z_o = 50 \Omega$

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

**ADDITIONAL DESCRIPTION****1 Brief description**

SIT65HVD231 is an interface chip used between the CAN protocol controller and the physical bus. It has a low power supply within 1 $\mu$ A. Stream sleep mode, and 3.3V microprocessor with CAN controller, microcontroller (MCU) and digital signal processor (DSP) or The equivalent protocol controller can be used in combination with industrial automation, control, sensor and drive system, motor and robot control, In the fields of building and temperature control, telecommunications and base station control and status, the rate can reach 1Mbps and is fully compatible with the "ISO 11898" standard.

**2 Short-circuit protection**

A current-limiting circuit protects the driver output stage of the SIT65HVD231 against short-circuits to positive and negative supply voltage. When short-circuit occurs the power dissipation increases but the short-circuit protection function will prevent destruction of the driver output stage.

**3 Over-temperature protection**

The SIT65HVD231 has an integrated over-temperature protection circuit. If the junction temperature exceeds approximately 160°C, the current in the driver stage will decrease. Because the driver stage dissipates most of the power, the power dissipation and temperature of the IC is reduced. All other parts of the chip remain operational.

**4 Electrical transient protection**

Electrical transients often occur in automotive applications. The CANH and CANL of the SIT65HVD231 are also protected against electrical transients.

**5 Control mode**

Three different operating modes are provided through the RS pin (pin 8): high-speed mode, slope control mode and low-power mode.

**(1) High-speed mode:**

High-speed mode can be selected by applying logic low level to RS pin (pin 8). High-speed working mode is usually used in industrial applications. The high-speed mode allows the output to switch as fast as possible, and there are no internal restrictions on the output rise and fall slopes. If the high-speed conversion will affect the radiation performance, you can use the slope control mode.

If the application requires the use of high-speed and low-power sleep modes, the mode selection pins can be directly connected to the general-purpose output pins of the microprocessor, MCU or DSP. When the controller outputs a logic low level (< 1.2 V), the device enters high-speed mode; when the controller outputs a logic high level (> 0.75 VCC), the device enters sleep mode.

**(2) Slope control mode**

For many applications that are still using unshielded twisted pair bus cables to reduce system costs, electromagnetic compatibility is critical. The device has a new slope control mode, which can reduce the electromagnetic interference generated by the rise and fall time of the driver and the harmonics generated

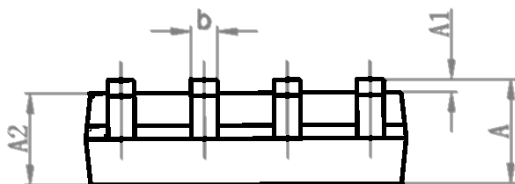
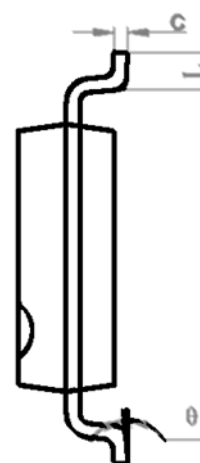
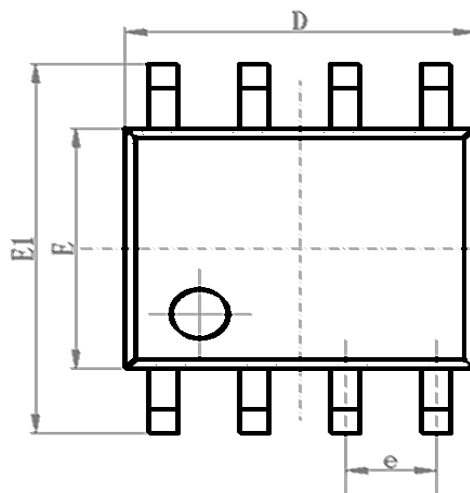
thereby. By connecting a resistor between RS (pin 8) and ground or logic low voltage, the rising and falling slopes of the driver output can be adjusted. The slope of the output signal of the driver is proportional to the output current of the pin, and the slope control is achieved through an external resistor (typically  $10\text{k}\Omega\sim 100\text{k}\Omega$ ).

(3) Sleep mode

If a logic high level ( $> 0.75\text{ VCC}$ ) is applied to RS (pin 8), the device circuit will enter an ultra-low current sleep mode. During this mode, both the driver and receiver are turned off. In this sleep mode, communication between the device and the bus will not be possible. The device will always remain in sleep mode until the device is reactivated by applying a logic low level to the RS pin.

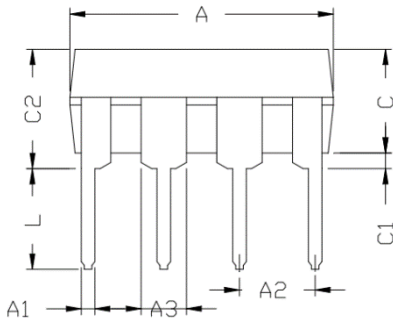
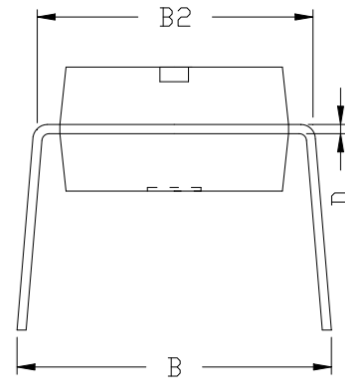
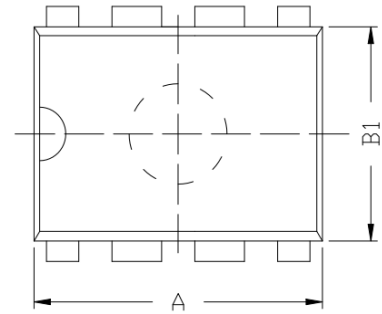
**SOP8 DIMENSIONS**
**PACKAGE SIZE**

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
SIT65HVD231DR	-40°C~125°C	SOP8
SIT65HVD231P	-40°C~125°C	DIP8

SOP8 package is 2500 pieces/disc.