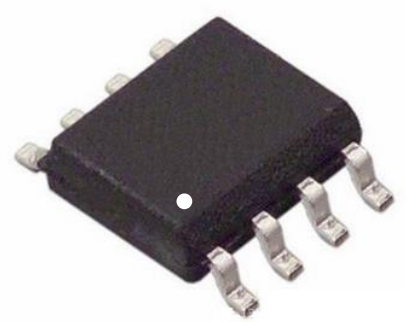
3.3V, High ESD Protected ,1Mbps High Speed CAN Transceiver

FEATURES

- Operates with a single 3.3 V Supply
- Compatible With ISO 11898-2 Standard
- Bus Pin ESD Protection Exceeds ±15 kV HBM
- High Input Impedance Allows for Up to 120 Nodes
- Adjustable Driver Transition Times for Improved Emissions Performance
- Low Current Standby Mode 650μA 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



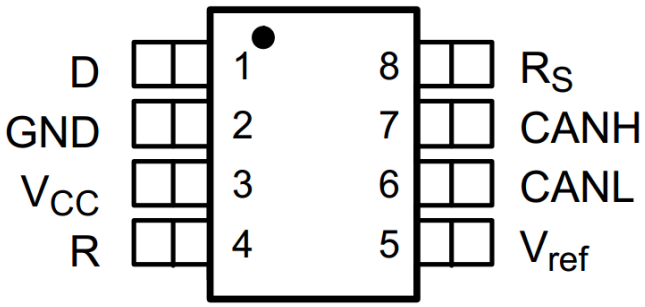
Provide green and environmentally friendly lead-free package

DESCRIPTION

The SL65HVD230 is the interface between the Controller Area Network (CAN) protocol controller and the physical bus. It is designed for use with the 3.3V μPs, 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	℃

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~VCC+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	℃
Virtual junction temperature		-40~125	℃
Welding temperature range		300	℃
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 opration 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	R_S	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	VI=0V,R_S=0V,R_L=60Ω （Figure1、Figure 2）	2.45		VCC	V
		CANL		0.5		1.25	
$V_{OD(D)}$	Differential output voltage （Dominant）		VI=0V,R_S=0V,R_L=60Ω （Figure 1）	1.5	2	3	V
			VI=0V,R_L=60Ω,R_S =0V （Figure 3）	1.2	2	3	V
$V_{O(R)}$	output voltage （Recessive）	CANH	VI=3V,R_S=0V,R_L=60Ω （Figure 1）		2.3		V
		CANL			2.3		
$V_{OD(R)}$	Differential output voltage （Recessive）		VI=3V, R_S=0V	-0.12		0.012	V
			VI=3V, R_S=0V,NO LOAD	-0.5		0.05	V
I_{IH}	High-level input current		VI=2V	-30			μA
I_{IL}	Low-level input current		VI=0.8V	-30			μA
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	Standby		650	950	μA
		V_I=0V（Dominant）, No load		10	17	mA
		V_I=VCC（Recessive）, No load		10	17	mA

（If not otherwise specified，V_{CC}=3.3V±10% ,Temp=T_{MIN}~T_{MAX}，Typical :VCC=+3.3V，Temp＝25℃）

DRIVER SWITCHING CHARACTERISTICS

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

（If not otherwise specified，V_{CC}=3.3V±10% ,Temp=T_{MIN}~T_{MAX}，Typical : VCC=+3.3V，Temp＝25℃）

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	VIT+- VIT-		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	VIH=7V，VCC=0V	100		350	μA
I_i		VIH=7V，VCC=3.3V	100		250	μA
I_i		VIH=-2V，VCC=0V	-100		-20	μA
I_i		VIH=-2V，VCC=3.3V	-200		-30	μA
R_i	Bus input resistance	Corresponding standards of ISO 11898-2	20	35	50	KΩ
R_{diff}	Differential input resistance	Corresponding standards of ISO 11898-2	40		100	KΩ
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±10% ,Temp=T_{MIN}~T_{MAX}，Typical : VCC=+3.3V，Temp＝25℃）

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， VCC=3.3V±10% ,Temp=TMIN~TMAX， Typical : VCC=+3.3V， Temp＝25℃）

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 circurt（Figure 8）		70	115	ns
		R=10 kΩ		105	175	
		R=100 kΩ		535	920	
$t_{(LOOP2)}$	Total loop delay,driver input to receiver output,dominant to recessive	R=0，Short circurt（Figure 8）		100	135	ns
		R=10 kΩ		155	185	
		R=100 kΩ		830	990	

（If not otherwise specified， VCC=3.3V±10% ,Temp=TMIN~TMAX， Typical : VCC=+3.3V， Temp＝25℃）

OVER TEMPERATURE PROTECTION

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
Thermal shutdown temperature	Tj(sd)		155	165	180	℃

（If not otherwise specified， VCC=3.3V±10% ,Temp=TMIN~TMAX， Typical : VCC=+3.3V， Temp＝25℃）

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

（If not otherwise specified， VCC=3.3V±10% ,Temp=TMIN~TMAX， Typical : VCC=+3.3V， Temp＝25℃）

SUPPLY CURRENT

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

（If not otherwise specified， VCC=3.3V±10% ,Temp=TMIN~TMAX， Typical :VCC=+3.3V， Temp＝25℃）

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

R_S Pin	MODE	DRIVER	RECEIVER	RXD Pin
LOW、$V_{(Rs)}$ < 1.2V、strong pull down to GND	High Speed Mode	Enabled(ON) High Speed	Enabled(ON)	Mirrors Bus State
LOW、$V_{(Rs)}$ < 1.2V、10kΩ to 100kΩ pull down to GND	Slope Control Mode	Enabled(ON) With Slope Control	Enabled(ON)	Mirrors Bus State
High、$V_{(Rs)}$> 0.75 V_{CC}	Standby Mode	Disabled（OFF）	Enabled(ON)	Mirrors Bus State

Table3.Driver Function

INPUT D	R_S	OUTPUTS		BUS STATE
		CANH	CANL	
L	$V_{(Rs)}$ < 1.2V（including 10kΩ to 100kΩ pull down to GND）	H	L	Dominant
H		Z	Z	Recessive
Open	Standby Mode	Z	Z	Recessive
X	$V_{(Rs)}$ >0.75V_{CC}	Z	Z	Recessive

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

Table4. Receiver Function

V_{ID}=CANH-CANL	R_S	OUTPUT R
V_{ID}≥0.9V	X	L
0.5< V_{ID}<0.9V	X	?
V_{ID}≤0.5V	X	H
Open	X	H

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

TEST CIRCUIT

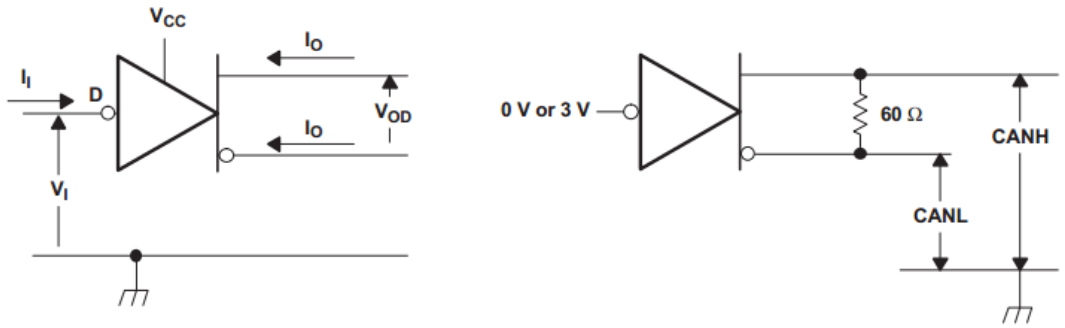


Fig.1 Driver Voltage And Current Definition

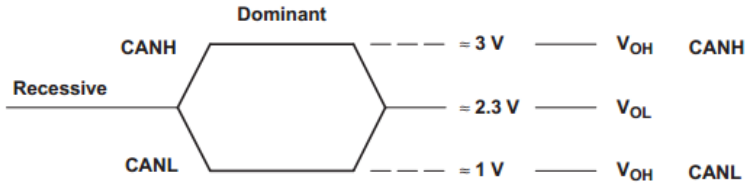


Fig.2 Bus Logic State Voltage Definition

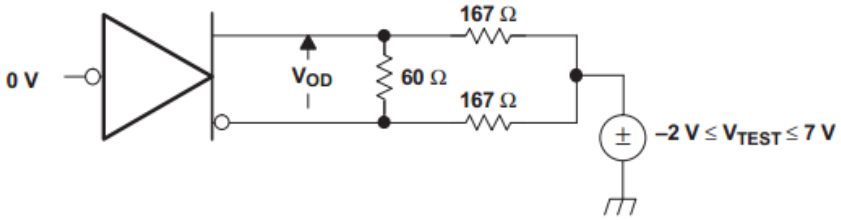
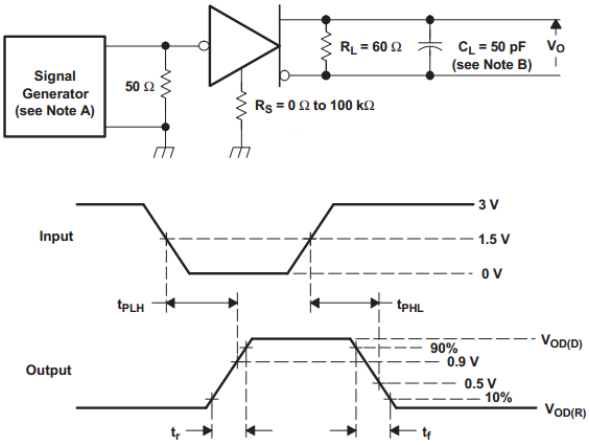


Fig.3 Driver V_{OD} Test Circuit



A、 The input pulse is supplied by a generator having the following characteristics: PRR≤500KHz，50% duty cycle，tr<6ns，tf<6ns，Zo=50Ω.

B、C_L includes probe and jig capacitance，the error is within 20%.

Fig.4 Driver Test Circuit and Waveform

$$V_{IC} = \frac{V_{CANH} + V_{CANL}}{2}$$

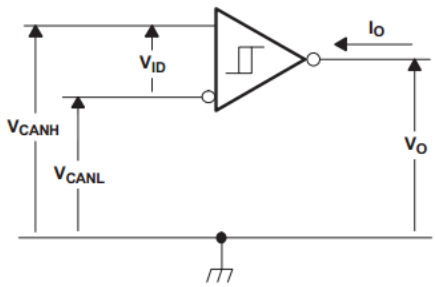
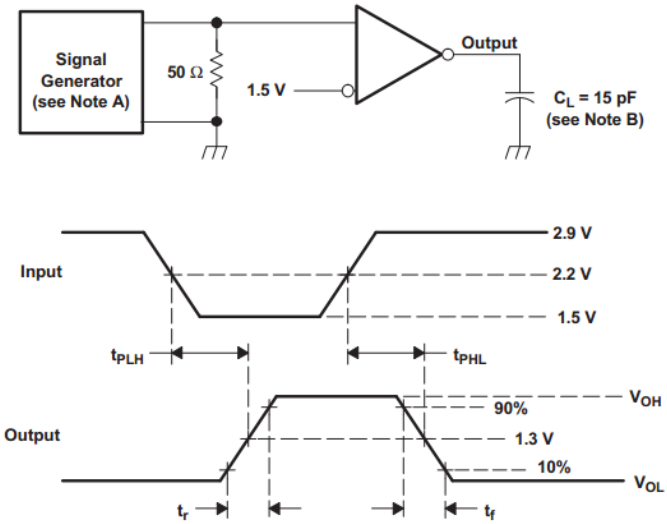


Fig.5 Receiver Voltage and Current Definition



A、 The input pulse is supplied by a generator having the following characteristics: PRR≤500KHz，50% duty cycle，tr<6ns，tf<6ns，Zo=50Ω

B、C_L includes probe and jig capacitance，the error is within 20%.

Fig.6 Receiver Test Circuit and Waveform

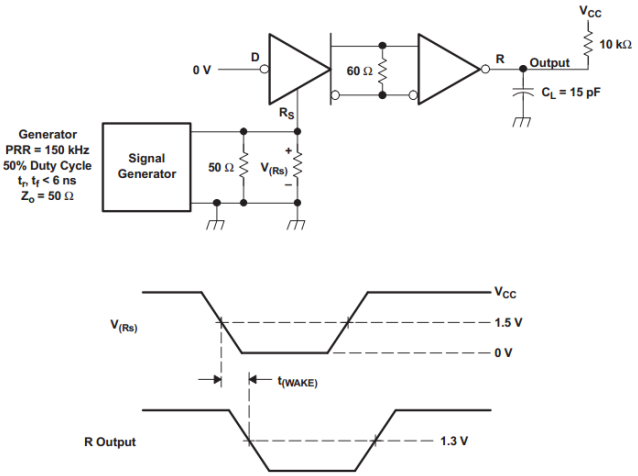
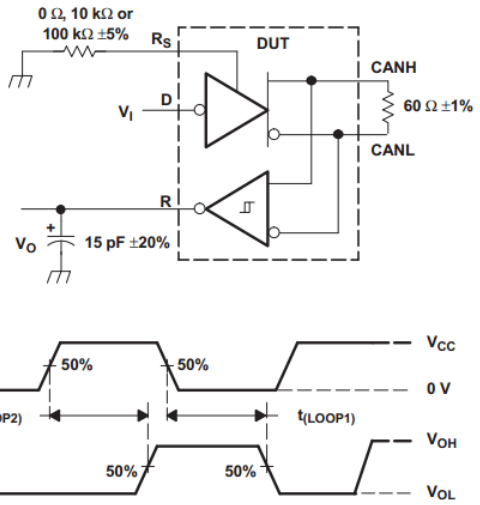


Fig.7 $t_{(WAKE)}$Test Circuit and Waveform



A、 The input pulse is supplied by a generator having the following characteristics:PRR≤125KHz，50% duty cycle，tr<6ns，tf<6ns，Zo=50Ω

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

ADDITIONAL DESCRIPTION

1 Sketch

The SL65HVD230 is the interface between the Controller Area Network (CAN) protocol controller and the physical bus. It is designed for use with the 3.3V µPs, 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

SL65HVD230 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 SL65HVD230 have the function of preventing electrical transient damage.

5 Operating modes

The RS pin mode, slop (Pin 8) of the SL65HVD230 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 µP, 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 SL65HVD230 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 kΩ to 100 kΩ to achieve slew rate.

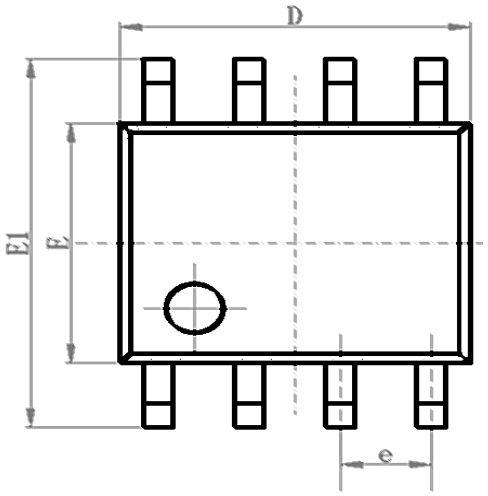
5.3 Standby Mode (Listen Only Mode)

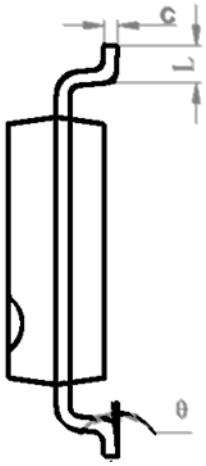
If a logic high (> 0.75 VCC) is applied to RS (pin 8), the circuit of the SL65HVD230 enters a low- current, listen only standby mode, during which the driver is switched off and the receiver remains active. In this listen only state, the transceiver is completely passive to the bus. It makes no difference if a slope control resistor is in place. The µP 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 µP, sensing bus activity, reactivates the driver circuit by placing a logic low (< 1.2 V) on RS (pin 8).

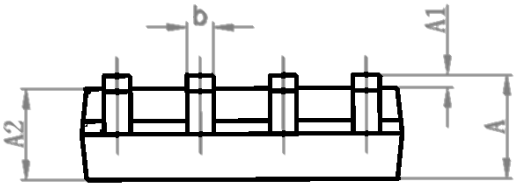
SOP8 DIMENSIONS

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
θ	-2°	-4°	-6°



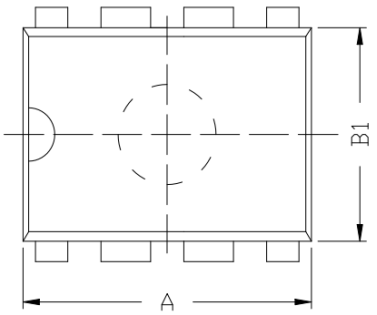


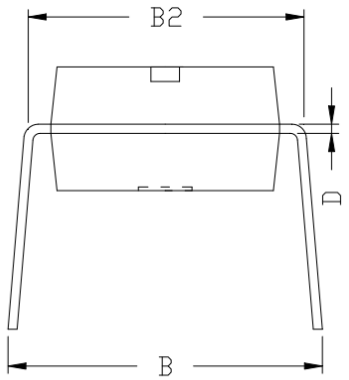


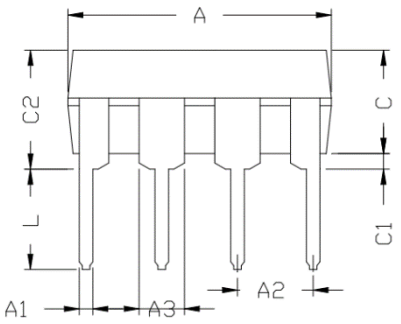
DIP8 DIMENSIONS

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
SL65HVD230DR	-40℃~125℃	SOP8
SL65HVD230P	-40℃~125℃	DIP8

SOP8 is packed with 2500 pieces/disc in braided packing. DIP8 is packed with 50 pieces/disc in tubed packing.