FEATURES

- Operates with a single 3.3V supply;
- Compatible with ISO 11898-2 standard;
- Bus pin ESD protection exceeds ±16kV Human Body Model (HBM);
- Allows up to 120 nodes to be connected on a bus;
- Adjustable driver transition times for improved emissions performance;
- Low current standby mode: 360μA (typical value);
- Designed for data rates up to 1Mbps;
- Thermal shutdown protection;
- Open circuit fail-safe design;
- Glitch-free power-up and power-down protection for hot plugging applications

OUTLINE

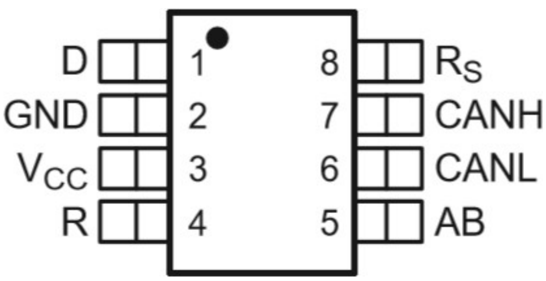
Provide green and environmentally friendly lead-free packaging

DESCRIPTION

The SIT65HVD235 is an interface chip used between the CAN protocol controller and the physical bus. It is designed for use with the 3.3V microprocessors, microcontrollers and digital signal processors 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 temperature control (HVAC), telecom and base station control and status and other fields. It is suitable for use in applications employing the CAN serial communication physical layer in accordance with the ISO 11898 standard.

Parameter	Symbol	Test Conditions	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}		-36	+36	V
Bus differential voltage	V_{diff}		1.5	3.0	V
Ambient temperature	T_{amb}		-40	125	°C

PIN CONFIGURATION



LIMITING VALUES

Parameter	Symbol	Size	Unit
Supply voltage	V_{CC}	-0.3~+6	V
DC voltage on D/R pins	D, R	-0.5~VCC+0.5	V
Bus side input voltage	CANL, CANH	-36~36	V
Transient voltage on pins 6, 7	V_{tr}	-100~+100	V
Receiver output current, I_O		-11~11	mA
Storage temperature range		-40~150	°C
Ambient temperature range		-40~125	°C
Welding temperature range		300	°C
Continuous power consumption	SOP8	400	mW
	DIP8	700	mW

The maximum limit parameter value 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. Continuous operation of the device under the maximum allowable rating may affect the reliability of the device. The reference point of all voltages is ground.

PINNING

Pin number	Pin name	Pin function
1	D	CAN transmit data input (low level in the dominant bus state; high level in the recessive bus state), also known as TXD, driver input
2	GND	Ground connection
3	VCC	Transceiver 3.3V supply voltage
4	R	CAN receive data output (low level in the dominant bus state; high level in the recessive bus state), also known as RXD, driver output
5	AB	Automatic loopback mode input control pin
6	CANL	Low level CAN bus line
7	CANH	High level CAN bus line
8	R_S	Mode selection pin: - strong pull-down to GND = high-speed mode; - strong pull-up to VCC = low power consumption mode; - pull down to GND through a 10kΩ to 100kΩ resistor = slope control mode.

BUS TRANSMITTER DC CHARACTERISTICS

Symbol	Parameter		Test Conditions	Min	Typ	Max	Unit
$V_{O(D)}$	Output voltage (dominant)	CANH	VI=0V, R_S=0V, R_L=60Ω (See Figure 1, 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 (See Figure 1)	1.5	2	3	V
			VI=0V, R_L=60Ω, R_S =0V (See Figure 3)	1.2	2	3	V
$V_{O(R)}$	Output voltage (recessive)	CANH	VI=3V, R_S=0V, R_L=60Ω (See 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 voltage input current		VI=2V	-30		30	μA
I_{IL}	Low voltage input current		VI=0.8V	-30		30	μA
I_{OS}	Short circuit output current		CANH=-7V	-250			mA
			CANH=12V			1	
			CANL=-7V	-1			
			CANL=12V			250	
C_O	Output capacitance		See receiver				
I_{CC}	Supply current		Standby		360	600	μA
			V_I=0V (dominant), no load			6	mA
			V_I=VCC (recessive), no load			6	mA

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

BUS TRANSMITTER SWITCHING CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time (low-to-high level)	R=0, short circuit (see 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 circuit (see Figure 4)		70	120	
		R=10 kΩ		130	180	
		R=100 kΩ		870	1200	

$t_{sk(p)}$	Pulse skew (| t_{PLH} - t_{PHL} |)	R=0, short circuit (see Figure 4)		35		
		R=10 kΩ		60		
		R=100 kΩ		370		
tr	Output signal rise time	R=0, short circuit (see Figure 4)	20		80	
		R=10 kΩ	30		160	
		R=100 kΩ	300		1400	
tf	Output signal fall time	R=0, short circuit (see Figure 4)	20		80	
		R=10 kΩ	30		160	
		R=100 kΩ	300		1400	

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

BUS RECEIVER DC CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IT+}	Positive-going input threshold voltage	See Table 1		750	900	mV
V_{IT-}	Negative-going input threshold voltage	See 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 (See Figure 5)	2.4			V
V_{OL}	Low level output voltage	900mV< V_{ID}< 6V I_O=8mA (See Figure 5)			0.4	V
I_i	Bus input current	VIH=12V, VCC=0V	100		600	uA
I_i		VIH=12V, VCC=3.3V	100		500	µA
I_i		VIH=-7V, VCC=0V	-450		-20	µA
I_i		VIH=-7V, VCC=3.3V	-610		-30	µA
R_i	Input resistance	ISO 11898-2 standard	20	35	50	KΩ
R_{diff}	Differential input resistance	ISO 11898-2 standard	40		100	KΩ
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				

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

BUS RECEIVER SWITCHING CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation delay time (low-to-high level)	See Figure 6		35	60	ns
t_{PHL}	Propagation delay time (high-to-low level)	See Figure 6		35	60	ns
t_{sk}	Pulse skew	$\|t_{PHL} - t_{PLH}\|$			10	ns
t_r	Output signal rise time	See Figure 6		1.5		ns
t_f	Output signal fall time	See Figure 6		1.5		ns

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

DEVICE SWITCHING CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{(LOOP1)}$	Loop delay 1, driver input to receiver output, recessive to dominant	R=0, short circuit (see Figure 8)		70	135	ns
		R=10 kΩ		105	190	ns
		R=100 kΩ		535	1000	ns
$t_{(LOOP2)}$	Loop delay 2, driver input to receiver output, dominant to recessive	R=0, short circuit (see Figure 8)		70	165	ns
		R=10 kΩ		105	190	ns
		R=100 kΩ		535	1000	ns
$t_{(AB1)}$	Loopback delay, driver input to receiver output	(See Figure 9)		10	20	ns
$t_{(AB2)}$	Loopback delay, driver input to receiver output	(See Figure10)		35	60	ns

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

OVER TEMPERATURE PROTECTION

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Over temperature shutdown	Tj(sd)		155	165	180	°C

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

CONTROL PIN CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
T_{WAKE}	Standby to wake up time	R_S connected to square wave (see Figure 7)		0.55	1.5	µs
I_{RS}	High-speed mode input current	V_{RS}<1V	-450		0	µA
V_{RS}	Standby/sleep input voltage	0<V_{RS}<V_{CC}	0.75V_{CC}		V_{CC}	V
I_{off}	Power-down leakage current	Vcc=0V V_{CANH}=V_{CANL}=5V	-250		250	µA

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

SUPPLY CURRENT

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Standby mode power consumption	I_{CC}	R_S=VCC, V_I=VCC		360	600	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	mA

(If not otherwise stated, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, the typical value is V_{CC}=+3.3V, Temp=25°C)

FUNCTION TABLE

Table 1 Receiver characteristics over common mode ($V_{(RS)}$=1.2V)

V_{ID}	V_{CANH}	V_{CANL}	R OUTPUT	
900mV	-6.1V	-7V	L	VOL
900mV	12V	11.1V	L	
6V	-1V	-7V	L	
6V	12V	6V	L	
500mV	-6.5V	-7V	H	VOH
500mV	12V	11.5V	H	
-6V	-7V	-1V	H	
-6V	6V	12V	H	
X	Open	Open	H	

(1) H=high level; L=low level; X=irrelevant

Table 2 Driver functions

INPUTS			OUTPUTS		
D	**LBK**	**R_S**	**CANH**	**CANL**	**Bus state**
X	X	>0.75V_{CC}	Z	Z	Recessive
L	L or open	<0.33V_{CC}	H	L	Dominant
H or open	X	<0.33V_{CC}	Z	Z	Recessive
X	H	0.33V_{CC}	Z	Z	Recessive

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

Table 3 Receiver functions

INPUTS				OUTPUT
Bus state	**V_{ID}=CANH-CANL**	**LBK**	**D**	**R**
Dominant	$V_{ID} \geq 0.9V$	L or open	X	L
Recessive	$V_{ID} \leq 0.5V$ or open	L or open	H or open	H
?	$0.5 < V_{ID} < 0.9V$	L or open	H or open	?
Dominant	$V_{ID} \geq 0.9V$	H	X	L
Recessive	$V_{ID} \leq 0.5V$ or open	H	H	H
Recessive	$V_{ID} \leq 0.5V$ or open	H	L	L
?	$0.5 < V_{ID} < 0.9V$	H	L	L

(1) H=high level; L=low level; ?=uncertain; X=irrelevant

TEST CIRCUIT

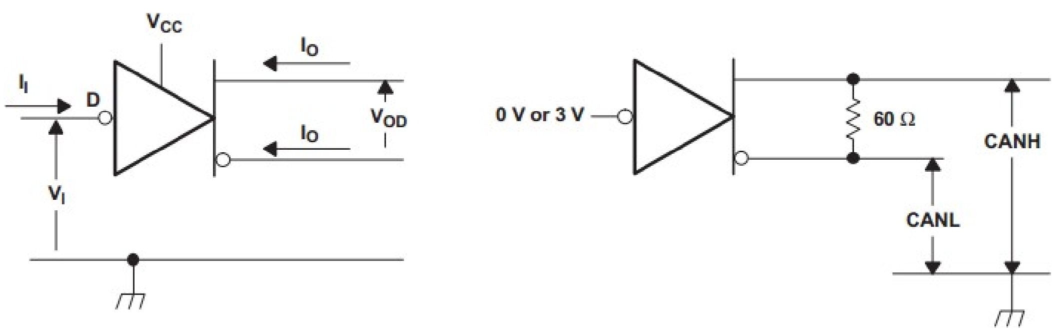


Figure 1 Driver Voltage And Current Definition

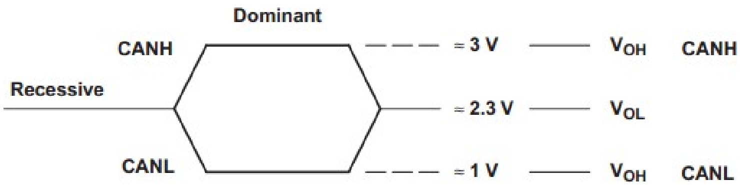


Figure 2 Bus Logic State Voltage Definition

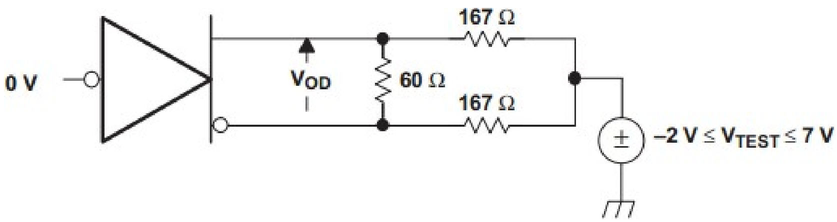
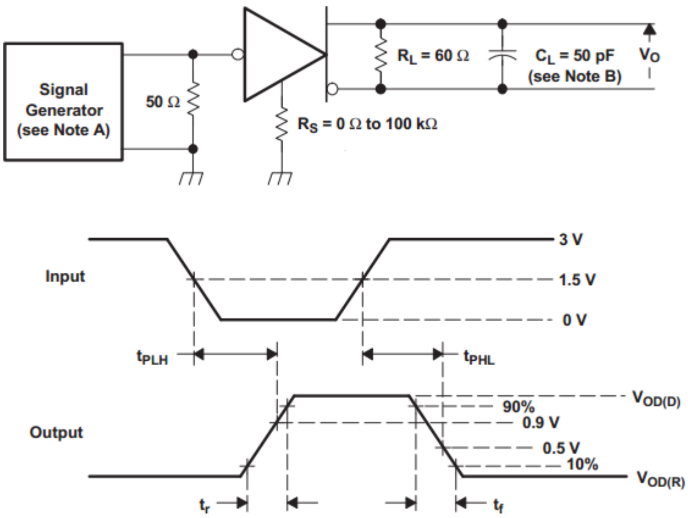


Figure 3 Driver V_{OD} Test Circuit



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. CL includes instrumentation and fixture capacitance within ±20%.

Figure 4 Driver Test Circuit and Waveform

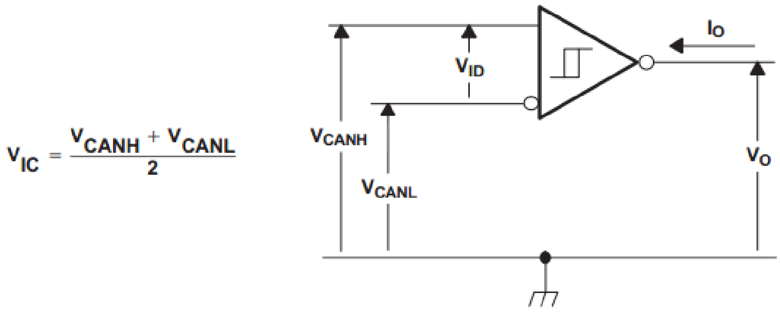
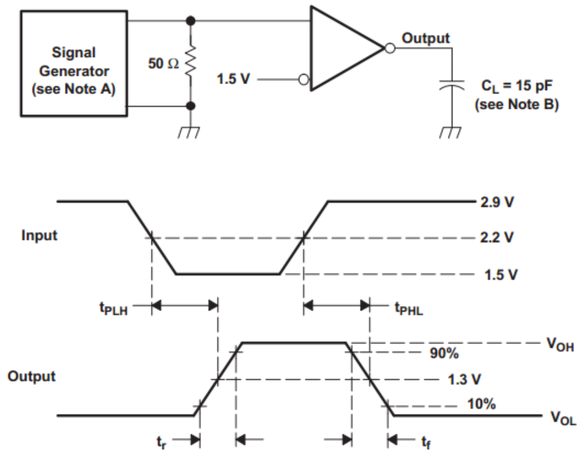


Figure 5 Receiver Voltage and Current Definition



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. CL includes instrumentation and fixture capacitance within ±20%.

Figure 6 Receiver Test Circuit and Waveform

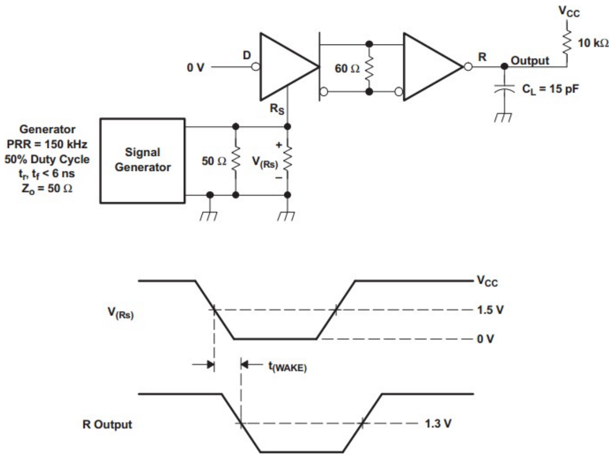
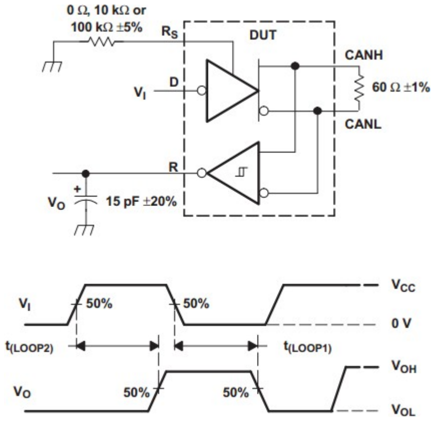
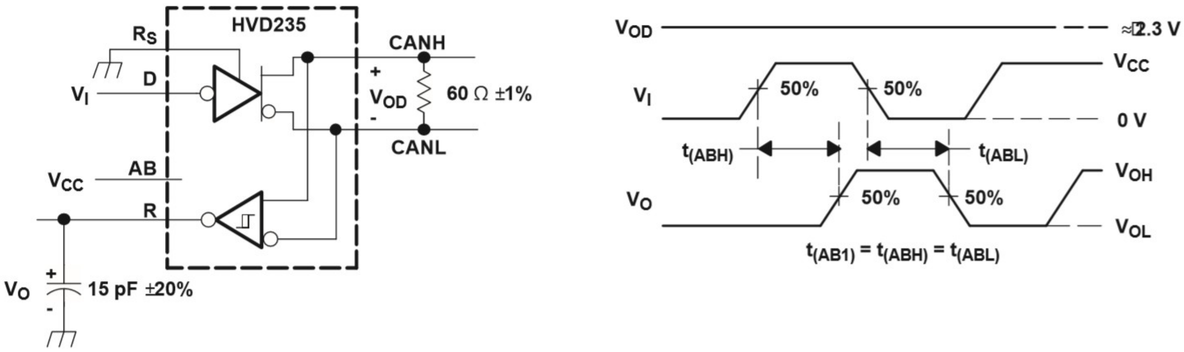


Figure 7 $t_{(WAKE)}$ Test Circuit and Waveform



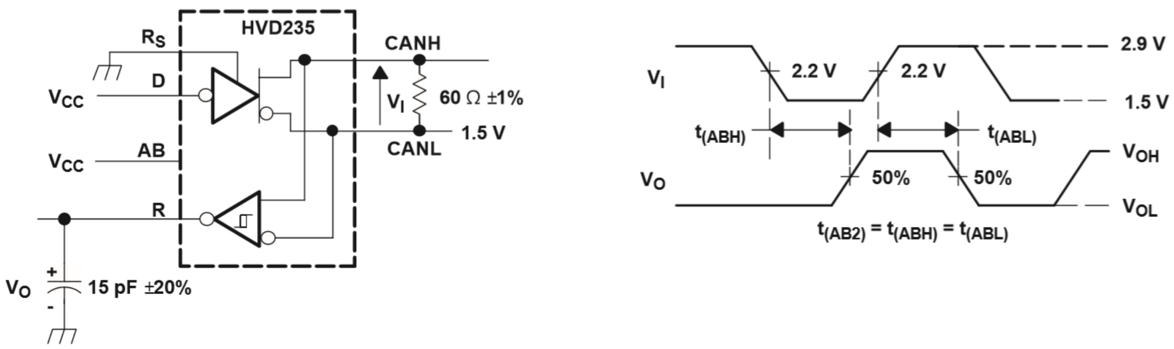
A. The input pulse is supplied by a generator having the following characteristics
PRR ≤ 125kHz, 50% duty cycle, tr < 6ns, tf < 6ns, Zo=50Ω

Figure 8 $t_{(LOOP)}$ 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

Figure 9 $t_{(AB1)}$ 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

Figure 10 $t_{(AB2)}$ Test Circuit and Waveform

DESCRIPTION

1 Brief description

The SIT65HVD235 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 is designed for data rates up to 1 Mbps and intended for use in applications employing the CAN serial communication physical layer in accordance with the ISO 11898 standard.

2 Short circuit protection

A current-limiting circuit protects the driver output stage of the SIT65HVD235 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 SIT65HVD235 has an integrated over-temperature protection circuit. If the junction temperature exceeds 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 SIT65HVD235 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 mode affects radiation performance, you can use the slope control mode.

If the application requires the use of high-speed and low-power standby modes, the mode selection pin can be directly connected to the general-purpose output pin 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 standby 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 10kΩ~100kΩ).

(3) Standby mode

If a logic high level (> 0.75 VCC) is applied to RS (pin 8), the device will enter a low current, listen only standby mode. During this mode, the driver will be turned off and the receiver will remain working. In this listen-only state, the transceiver is completely passive to the bus. It makes no difference if a slope control resistor is placed or not. When the rising edge of the dominant state (bus differential voltage > 900mV typical value) occurs on the bus, the microprocessor can reverse this low-power standby mode. The microprocessor senses bus activity and reactivates the driver circuit by applying a logic low (< 1.2V) to RS (pin 8).

6 Autobaud loopback

The autobaud loopback mode of the SIT65HVD235 is enabled by placing a high level input on pin 5, AB. In this mode, the driver output is disabled, thus blocking the D pin to bus path and the bus transmit function of the transceiver, and the bus pins are set to recessive. The receiver to R pin path or the bus receive function of the device remains operational, allowing bus activity to be monitored.

In addition, the automatic baud rate loopback mode adds an internal logic loopback path from pin D to pin R, so that the local node can transmit to itself synchronously without disturbing messages on the bus. Therefore, if the local node's CAN controller generates an error frame, it is not transmitted to the bus, but only detected by the local CAN controller. This is especially helpful to determine if the local node is set to the same baud rate as the network, and whether to adjust it to the network baud rate.

Automatic baud rate detection is best suited to applications with a known selection of baud rates. For example, the popular settngs in industrial applications are 125kbps, 250kbps, or 500kbps. Once the SIT65HVD235 enters autobaud loopback mode the first baud rate that the application software can assume is 125kbps. It then waits for another node on the bus to transmit a message. If the wrong baud rate has been selected, the local CAN controller generates an error message because the sample times will not be at the correct time. However, because the bus-transmit function of the device has been disabled, no other nodes receive the error frame generated by the CAN controller of this node.

The application will then use the status register indications of the local CAN controller to determine the received message and error warning status to confirm whether the set baud rate is correct. The warning status indicates that the error count of the CAN controller has been incremented. The status of the received message indicates that a correct message has been received. If an error occurs, the application will then set the CAN controller with the next possible baud rate, and wait to receive another message. This pattern is repeated until an error free message has been received, thus the correct baud rate has been selected.

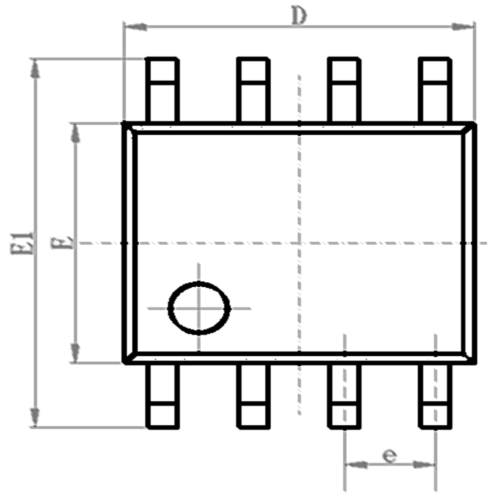
At this point the application will place the SIT65HVD235 in a normal transmitting mode by setting pin 5 to a low level, so that the bus-transmit and bus-receive functions of the transceiver are enabled to normal operating states.

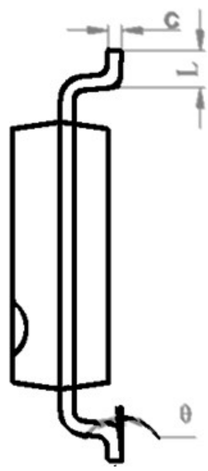
If the AB pin is not used, it may be grounded (GND). However, it is pulled low internally (defaults to a low level input) and may be left open if not used.

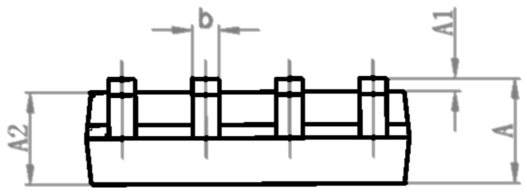
SOP8 DIMENSIONS

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°



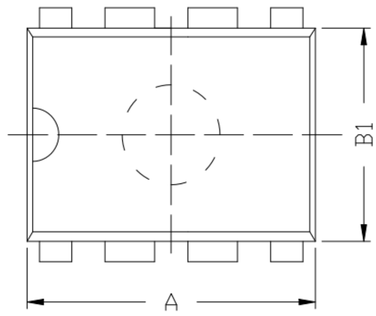


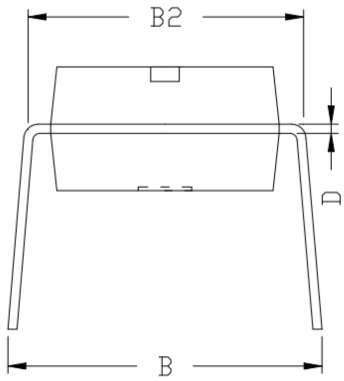


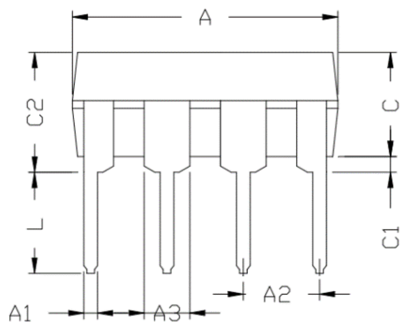
DIP8 DIMENSIONS

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

PART NUMBER	TEMPERATURE	PACKAGE
SIT65HVD235DR	-40°C~125°C	SOP8
SIT65HVD235P	-40°C~125°C	DIP8

Tape/reel package is 2500 pieces