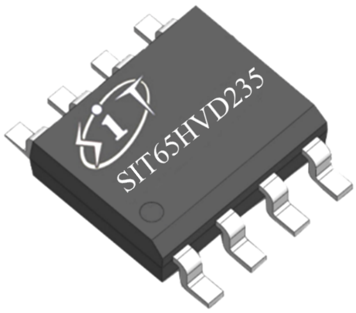
FEATURES

- Operates with a single 3.3V supply
- Compatible with ISO 11898-2 standard
- Bus pin ESD protection exceeds ±12kV (HBM)
- High input impedance allows for up to 120 nodes
- Adjustable driver transition times for improved emissions performance
- Low current standby mode: 360µA typical
- 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

PRODUCT APPEARANCE



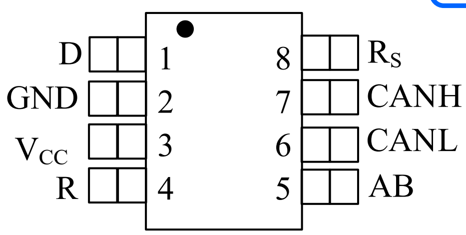
Provide environmentally friendly lead-free package

DESCRIPTION

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 base station 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}		-36	+36	V
Bus differential voltage	V_{diff}		1.5	3.0	V
Virtual junction temperature	T_{amb}		-40	125	℃

PIN CONFIGURATION



PIN DESCRIPTION

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.
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	AB	Automatic baud rate loop mode input control 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 V_{CC}=low power mode,10kΩ to 100kΩ pull down to GND=slope control mode.

LIMIT VALUES

PARAMETER	SYMBOL	VALUE	UNIT
Supply voltage	V_{CC}	-0.3~+6	V
MCU side voltage	D, R	-0.5~VCC+0.5	V
Bus side input voltage	CANL, CANH	-36~36	V
Transient voltage on pins CANH, CANL (test with 100Ω) See Fig 11	V_{tr}	-40~+40	V
Receiver output current	I_O	-11~11	mA
Storage temperature	T_{stg}	-40~150	℃
Virtual junction temperature	T_j	-40~125	℃
Welding temperature range		300	℃

The maximum limit parameters mean 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.

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 Fig 1, Fig 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 Fig 1	1.5	2	3	V
			VI=0V, R_L=60Ω, R_S =0V Fig 3	1.2	2	3	V
$V_{O(R)}$	output voltage (Recessive)	CANH	VI=3V, R_S=0V, R_L=60Ω Fig 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		30	µA
I_{IL}	Low-level input current		VI=0.8V	-30		30	µA
I_{OS}	Short-circuit output current		CANH=-7V	-250			mA
			CANH=12V			1	
			CANL=-7V	-1			mA
			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 specified, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, Typical: VCC=+3.3V, Temp=25°C)

DRIVER SWITCHING CHARACTERISTICS

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation delay time (low-to-high-level)	t_{PLH}	R=0, Short circuit (Fig 4)		35	85	ns
		R=10kΩ		70	125	ns
		R=100kΩ		500	870	ns
Propagation delay time (high-to-low-level)	t_{PHL}	R=0, Short circuit (Fig 4)		70	120	ns
		R=10kΩ		130	180	ns
		R=100kΩ		870	1200	ns

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation delay symmetry (| t_{PLH} - t_{PHL} |)	$t_{sk(p)}$	R=0, Short circuit (Fig 4)		35		ns
		R=10kΩ		60		ns
		R=100kΩ		370		ns
Differential output signal rise time	t_r	R=0, Short circuit (Fig 4)	20		80	ns
		R=10kΩ	30		160	ns
		R=100kΩ	300		1400	ns
Differential output signal fall time	t_f	R=0, Short circuit (Fig 4)	20		80	ns
		R=10kΩ	30		160	ns
		R=100kΩ	300		1400	ns

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

RECEIVER ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Positive-going input threshold voltage	V_{IT+}	Table 1		750	900	mV
Negative-going input threshold voltage	V_{IT-}	Table 1	500	650		mV
Hysteresis voltage	V_{hys}	VIT+- VIT-		100		mV
High-level output voltage	V_{OH}	$-6V<V_{ID}<00mV$ I_O=-8mA (Fig 5)	2.4			V
Low-level output voltage	V_{OL}	$900mV<V_{ID}<6V$ I_O=8mA (Fig 5)			0.4	V
Bus input current	I_i	VIH=12V, VCC=0V	100		600	μA
Bus input current	I_i	VIH=12V, VCC=3.3V	100		500	μA
Bus input current	I_i	VIH=-7V, VCC=0V	-450		-20	μA
Bus input current	I_i	VIH=-7V, VCC=3.3V	-610		-30	μA
Bus input resistance	R_i	Corresponding standards of ISO 11898-2	20	35	50	kΩ
Differential input resistance	R_{diff}		40		100	kΩ
Bus input capacitance	C_i			40		pF
Differential input capacitance	C_{diff}			20		pF
Supply current	I_{CC}	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

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation delay time (low-to-high-level)	t_{PLH}	Fig 6		35	60	ns
Propagation delay time (high-to-low-level)	t_{PHL}	Fig 6		35	60	ns
Pulse skew	t_{sk}	$\mid t_{PHL}- t_{PLH} \mid$			10	ns
Output signal rise time	t_r	Fig 6		1.5		ns
Output signal fall time	t_f	Fig 6		1.5		ns

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

DEVICE SWITCHING CHARACTERISTICS

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
loop delay 1, driver input to receiver output, recessive to dominant	$t_{(LOOP1)}$	R=0, short circuit, Fig 8		70	135	ns
		R=10kΩ		105	190	ns
		R=100kΩ		535	1000	ns
loop delay 2, driver input to receiver output, dominant to recessive	$t_{(LOOP2)}$	R=0, short circuit, Fig 8		70	165	ns
		R=10kΩ		105	190	ns
		R=100kΩ		535	1000	ns
Loop back delay, driver input to receiver output	$t_{(AB1)}$	Fig 9		10	20	ns
Loop back delay, driver input to receiver output	$t_{(AB2)}$	Fig 10		35	60	ns

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

OVER TEMPERATURE PROTECTION

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Thermal shutdown temperature	$T_{j(sd)}$		155	165	180	°C

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

CONTROL PIN CHARACTERISTICS

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
wake-up time from standby mode	t_{WAKE}	R_S adds square wave Fig 7		0.55	1.5	µs
Input current for high-speed	I_{RS}	V_{RS}<1V	-450		0	µA
Input voltage for standby/sleep	V_{RS}	0<V_{RS}<V_{CC}	0.75V_{CC}		V_{CC}	V
Power-off leakage current	I_{off}	Vcc=0V， V_{CANH}=V_{CANL}=5V	-250		250	µA

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

SUPPLY CURRENT

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Power consumption in sleep mode	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 specified, V_{CC}=3.3V±10%, Temp=T_{MIN}~T_{MAX}, Typical: VCC=+3.3V, Temp=25°C).

FUNCTION TABLE

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

V_{ID}	V_{CANH}	V_{CANL}	R OUTPUT	
900mV	-6.1V	-7V	L	V_{OL}
900mV	12V	11.1V	L	
6V	-1V	-7V	L	
6V	12V	6V	L	
500mV	-6.5V	-7V	H	V_{OH}
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 Function

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		Z	Z	Recessive
X	H	0.33V_{CC}	Z	Z	Recessive

(1) H= High level; L=Low level; Z=High impedance.

Table 3 Receiver Function

INPUTS				OUTPUT
BUS STATE	**V_{ID}=CANH-CANL**	**LBK**	**D**	**R**
Dominant	V_{ID}≥0.9V	L or open	X	L
Recessive	V_{ID}≤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}≥0.9V	H	X	L
Recessive	V_{ID}≤0.5V or open	H	H	H
Recessive	V_{ID}≤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

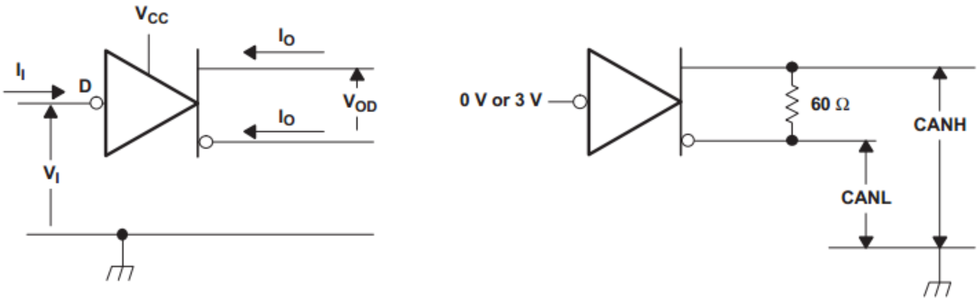


Fig 1 Driver voltage, current and test definition

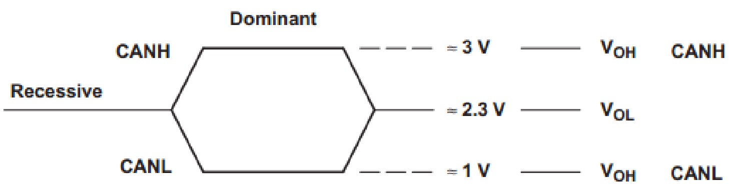


Fig 2 Bus logic state voltage definition

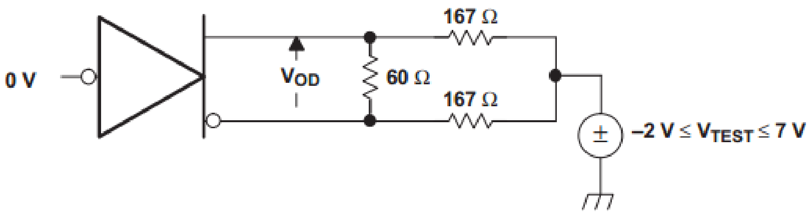
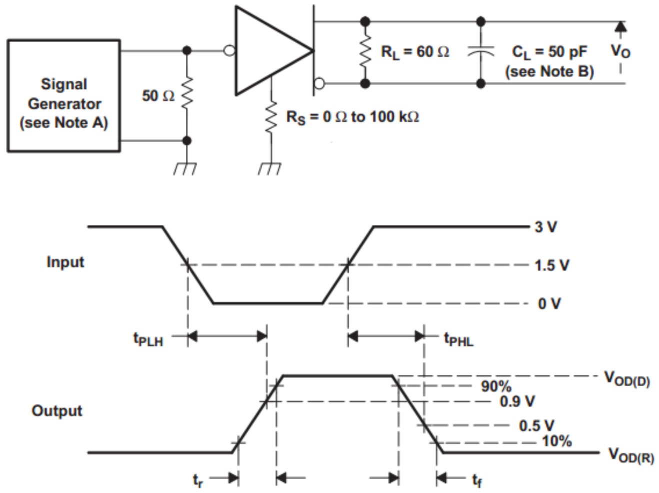


Fig 3 Driver V_{OD} test circuit



A、 The input pulse is supplied by a generator having the following characteristics: PRR≤125kHz, 50% duty cycle, t_r<6ns, t_f<6ns, Z_O=50Ω.

B、 C_L includes fixture and instrumentation capacitance, the error is within 20%.

Fig 4 Driver test circuit and waveforms

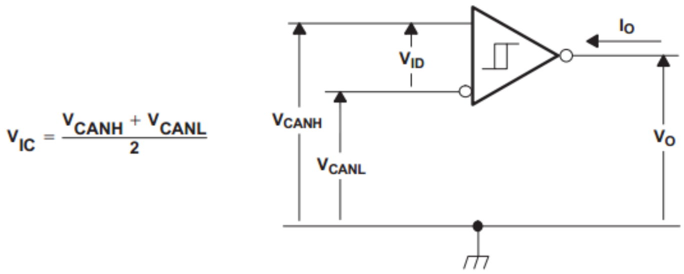
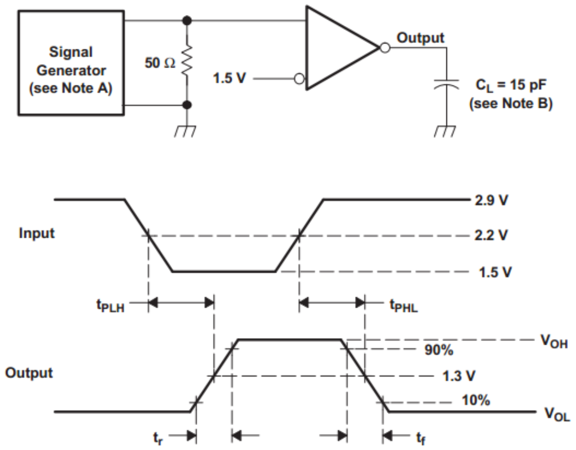


Fig 5 Receiver voltage and current definitions



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

B、 C_L includes fixture and instrumentation capacitance, the error is within 20%.

Fig 6 Receiver test circuit and waveform

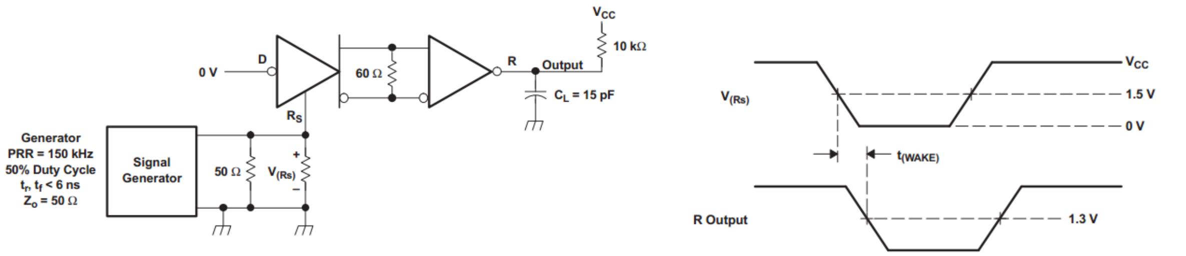
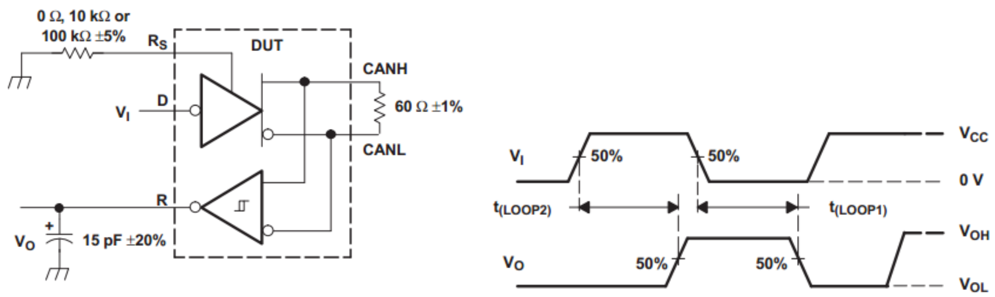
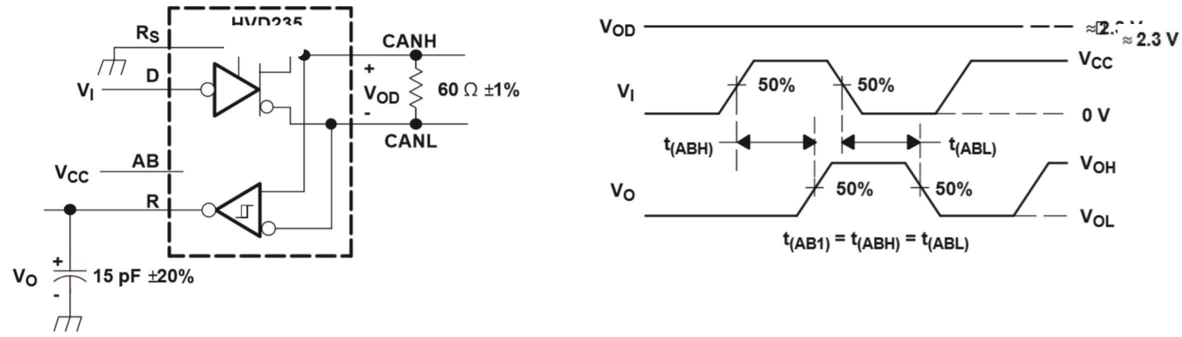


Fig 7 $t_{(WAKE)}$ test circuit and waveform



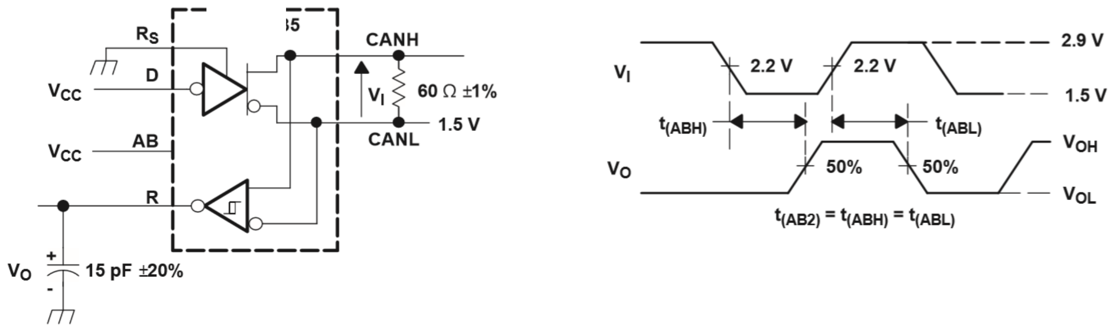
The input pulse is supplied by a generator having the following characteristics: PRR≤125kHz, 50% duty cycle, t_r<6ns, t_f<6ns, Zo=50Ω.

Fig 8 $t_{(LOOP)}$ test circuit and waveform



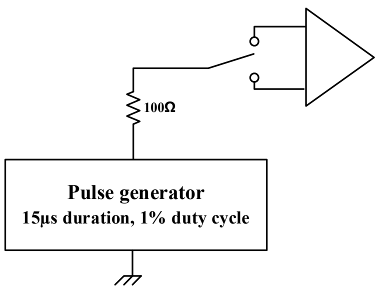
The input pulse is supplied by a generator having the following characteristics: PRR≤125kHz, 50% duty cycle, t_r<6ns, t_f<6ns.

Fig 9 $t_{(AB1)}$ test circuit and waveform



The input pulse is supplied by a generator having the following characteristics: PRR≤125kHz, 50% duty cycle, t_r<6ns, t_f<6ns.

Fig 10 $t_{(AB2)}$ test circuit and waveform



D, RS, and AB input status is 0 or VCC.

Fig 11 Overvoltage protection

ADDITIONAL DESCRIPTION

1 Sketch

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 base station 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

SIT65HVD235 has the function of over temperature protection. When the junction temperature exceeds 160°C, the current of the driver stage will be reduced. Because the driver tube is the main energy consuming component, the reduced current can reduce the power consumption and thus reduce the chip temperature. Meanwhile, the rest of the chip remains functional.

4 Transient protection

Electrical transients often occur in automotive application environment, CANH, CANL of SIT65HVD235 have the function of preventing electrical transient damage.

5 Operating modes

The R_S pin mode, slop (pin 8) of the SIT65HVD235 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 R_S 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. When the controller output logic level is low (<1.2V), the device enters high speed mode can be used to switch between a logic-low level (<1.2V) for high-speed operation, and the logic-high level (>0.75VCC) 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 SIT65HVD235 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 R_S (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 10kΩ to 100kΩ to achieve slew rate.

5.3 Standby Mode

If a logic high (>0.75VCC) is applied to R_S (pin 8), the circuit of the SIT65HVD235 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 (<1.2V) on RS (pin 8).

6 Automatic baud rate loop function

SIT65HVD235 can enter automatic baud rate loop mode by setting input pin 5 (AB) to high. In this mode, the driver output is disabled, blocking the transmission path of pin D to the bus and the transmission function of the bus, and the bus pin is set to recessive. In addition, the automatic baud rate loopback mode adds an internal logical loopback path from pin D to pin R, so that the local node can transmit to itself synchronously without causing interference to the information on the bus. Therefore, if the CAN controller of the local node generates an error frame, it is not transmitted to the bus, but only detected by the local CAN controller. This is particularly helpful for whether the local node is set to the same baud rate as the network, and whether it is adjusted to the network baud rate. Automatic baud rate detection is most appropriate for an application with a known selected baud rate. For example, popular communication frequencies in industrial devices are 125kbps, 250kbps, or 500kbps. Once the SIT65HVD235 enters the automatic baud rate loop mode, the application software can undertake the first baud rate of 125kbps. Then it will wait for another node on the bus to transmit the information. If a wrong baud rate is chosen, an error message is generated by the local CAN controller due to the wrong message sampling time. However, since the transmission function of the bus has been disabled, no other node will receive the error frame generated due to the CAN controller of this node.

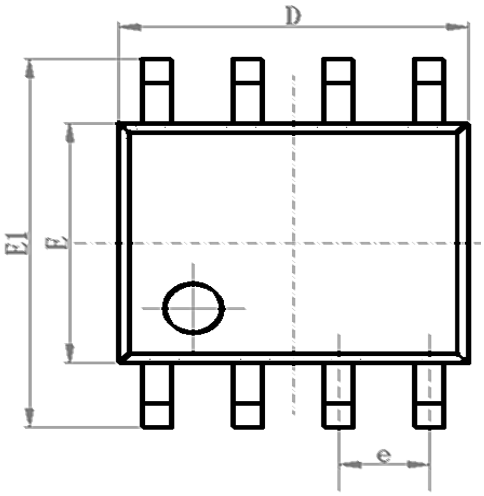
The application will then use the status register indication of the local CAN controller to determine the received message and the error warning status to confirm whether the baud rate set is correct. The warning state indicates that the error count of the CAN controller has been increased. The received message status indicates that a correct message has been received. If an error is generated, the application sets the CAN controller with the next possible baud rate and waits to receive another message. This pattern is repeated until an error-free message is received. Thus, the correct baud rate has been selected. At this time, the application program sets the pin 5 of the SIT65HVD235 to low, so that the SIT65HVD235 enters the normal receiving mode, so that the bus sending and bus receiving functions of the transceiver reach the normal working state.

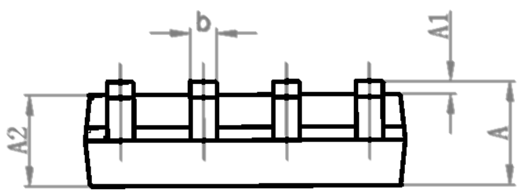
If the pin AB is not used, it can be either grounded (GND) or floated(open) because it is pulled down internally by the chip in the open state (the default is low input).

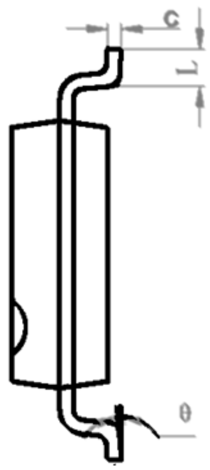
SOP8 DIMENSIONS

PACKAGE SIZE

SYMBOL	MIN./mm	TYP./mm	MAX./mm
A	1.40	-	1.80
A1	0.10	-	0.25
A2	1.30	1.40	1.50
b	0.38	-	0.51
D	4.80	4.90	5.00
E	3.80	3.90	4.00
E1	5.80	6.00	6.20
e		1.27BSC	
L	0.40	0.60	0.80
c	0.20	-	0.25
θ	0°	-	8°



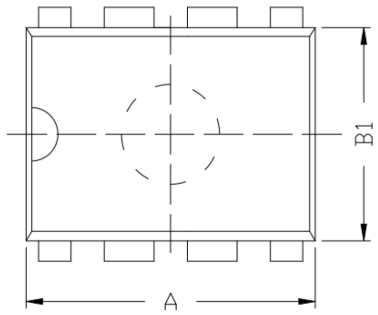


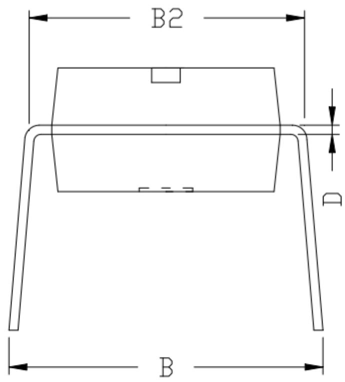


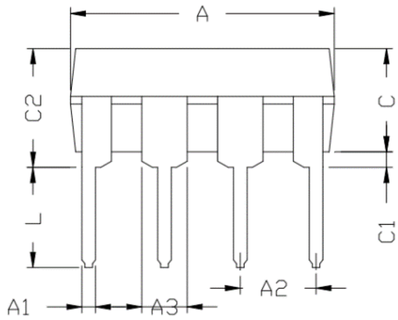
DIP8 DIMENSIONS

PACKAGE SIZE

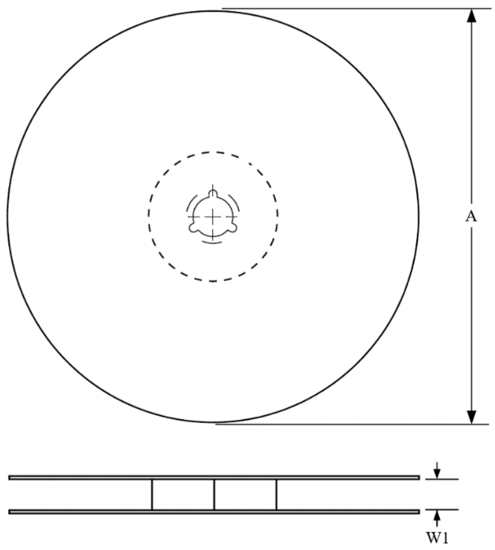
SYMBOL	MIN./mm	TYP./mm	MAX./mm
A	9.00	9.20	9.40
A1	0.33	0.45	0.51
A2		2.54TYP	
A3		1.525TYP	
B	8.40	8.70	9.10
B1	6.20	6.40	6.60
B2	7.32	7.62	7.92
C	3.20	3.40	3.60
C1	0.50	0.60	0.80
C2	3.71	4.00	4.31
D	0.20	0.28	0.36
L	3.00	3.30	3.60



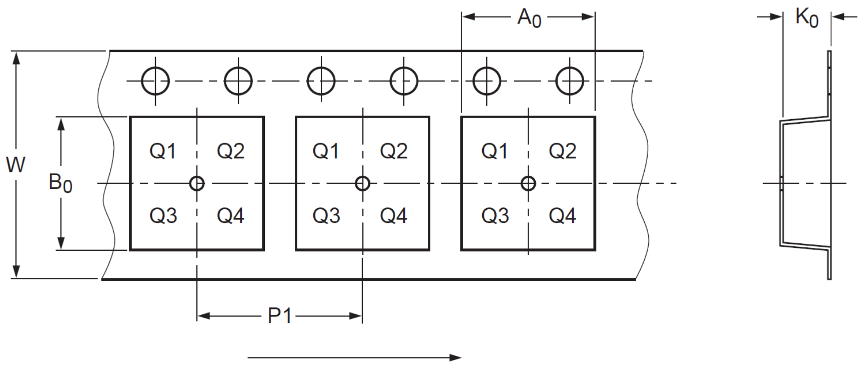




TAPE AND REEL INFORMATION



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers



Direction of Feed

PIN1 is in quadrant 1

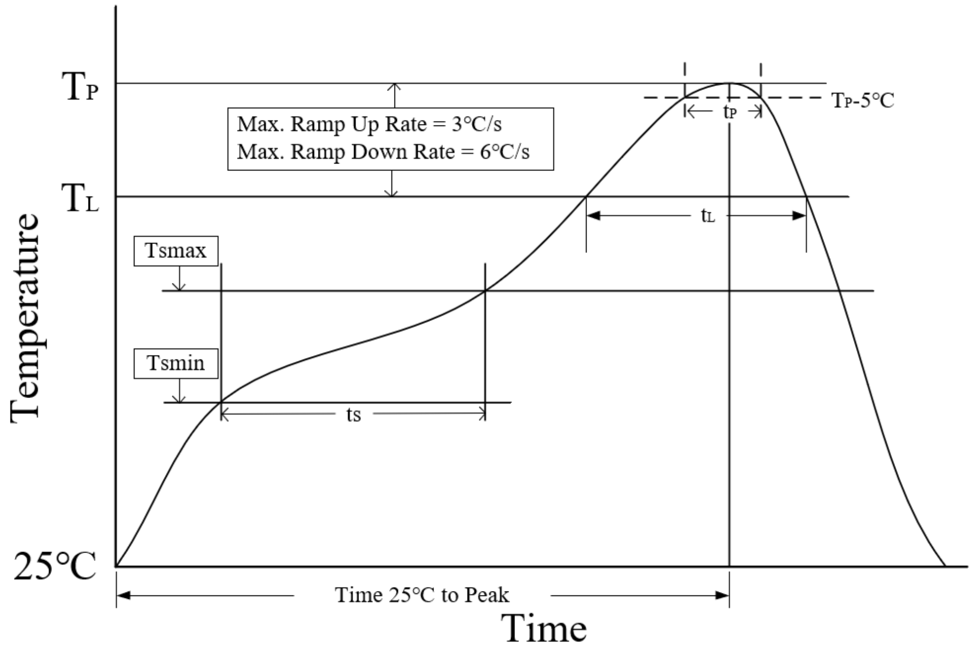
Package Type	Reel Diameter A (mm)	Tape width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)
SOP8	330±2	12.4±0.40	6.50±0.1	5.30±0.10	2.05±0.1	8.00±0.1	12.00±0.1

ORDERING INFORMATION

TYPE NUMBER	PACKAGE	PACKING
SIT65HVD235DR	SOP8	Tape and reel
SIT65HVD235P	DIP8	Tube

SOP8 is packed with 2500 pieces/disc in braided packaging. DIP8 is packed with 50 pieces/tube in tube packaging.

REFLOW SOLDERING



Parameter	Lead-free soldering conditions
Ave ramp up rate (T_L to T_P)	3°C/second max
Preheat time ts (T_{smin}=150°C to T_{smax}=200°C)	60-120 seconds
Melting time t_L (T_L=217°C)	60-150 seconds
Peak temp T_P	260-265°C
5°C below peak temperature t_P	30 seconds
Ave cooling rate (T_P to T_L)	6°C/second max
Normal temperature 25°C to peak temperature T_P time	8 minutes max

Important statement

SIT reserves the right to change the above-mentioned information without prior notice.

VERSION HISTORY

Version number	Data sheet status	Revision Date
V1.0	Initial version.	February 2023