1. DESCRIPTION

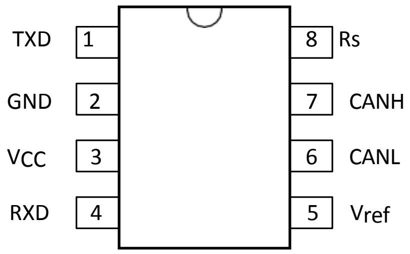
The XL/XD82C251 is the interface between a CAN protocol controller and the physical bus. The device provides differential transmit capability to the bus and differential receive capability to the CAN controller.

2. FEATURES

- Fully compatible with the “ISO 11898-24 V” standard
- Slope control to reduce Radio Frequency Interference (RFI)
- Thermally protected
- Short-circuit proof to battery and ground in 24 V powered systems
- Low-current Standby mode
- An unpowered node does not disturb the bus lines
- High speed (up to 1 MBd)
- High immunity against electromagnetic interference

3. PIN CONFIGURATIONS AND FUNCTIONS

XL/XD82C251



(TOP VIEW)

Pin Functions

Symbol	Pin	Description
TXD	1	transmit data input
GND	2	ground
V_{CC}	3	supply voltage
RXD	4	receive data output
V_{ref}	5	reference voltage output
CANL	6	LOW-level CAN voltage input/output
CANH	7	HIGH-level CAN voltage input/output
Rs	8	slope resistor input

3.1. Functional description

The XL/XD82C251 is the interface between a CAN protocol controller and the physical bus. It is primarily intended for applications up to 1 MBd in trucks and buses. The device provides differential transmit capability to the bus and differential receive capability to the CAN controller. It is fully compatible with the “ISO 11898-24 V” standard.

A current-limiting circuit protects the transmitter output stage against short-circuits to positive and negative battery voltage. Although power dissipation will increase as a result of a short circuit fault condition, this feature will prevent destruction of the transmitter output stage.

If the junction temperature exceeds approximately 150 °C, the limiting current of both transmitter outputs is decreased. Because the transmitter is responsible for most of the power dissipated, this will result in reduced power dissipation and hence a lower chip temperature. All other parts of the IC will remain operational. The thermal protection is needed, in particular, when a bus line is short-circuited.

The CANH and CANL lines are also protected against electrical transients which may occur in an automotive environment.

Pin 8 (Rs) allows three different modes of operation to be selected: High-speed, Slope control and Standby.

For high-speed operation, the transmitter output transistors are simply switched on and off as fast as possible. In this mode, no measures are taken to limit the rise and fall slopes. A shielded cable is recommended to avoid RFI problems. High-speed mode is selected by connecting pin 8 to ground.

Slope control mode allows the use of an unshielded twisted pair or a parallel pair of wires as bus lines. To reduce RFI, the rise and fall slopes should be limited. The rise and fall slopes can be programmed with a resistor connected from pin 8 to ground. The slope is proportional to the current output at pin 8.

If a HIGH level is applied to pin 8, the circuit enters a low-current Standby mode. In this mode, the transmitter is switched off and the receiver is switched to a low current. If dominant bits are detected (differential bus voltage >0.9 V), RXD will be switched to a LOW level. The microcontroller should react to this condition by switching the transceiver back to normal operation (via pin 8). Because the receiver is slower in Standby mode, the first message will be lost at higher bit rates.

Table 3-1. Truth table of the CAN transceiver

Supply	TXD	CANH	CANL	Bus state	RXD
4.5 V to 5.5 V	0	HIGH	LOW	dominant	0
4.5 V to 5.5 V	1 (or floating)	floating	floating	recessive	[1]
4.5 V < Vcc < 5.5 V	[2]	floating if $V_{Rs} > 0.75V_{CC}$	floating if $V_{Rs} > 0.75V_{CC}$	floating	[1]
0 V < Vcc < 5.5 V	floating	floating	floating	floating	[2]

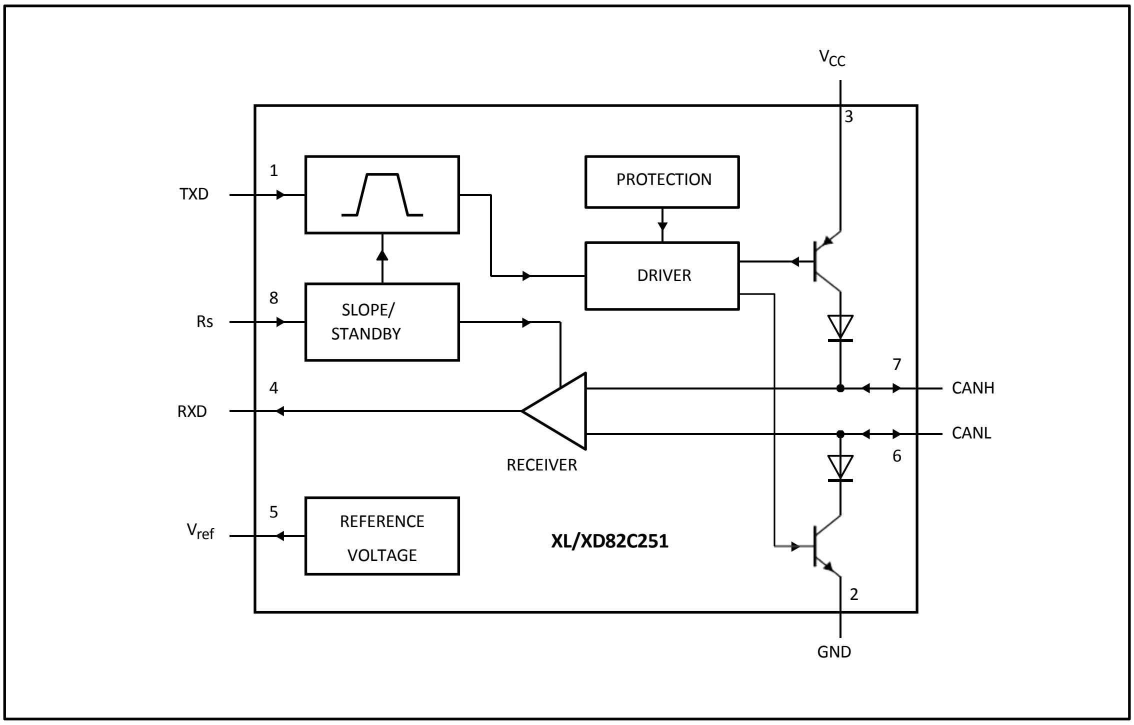
[1] If another bus node is transmitting a dominant bit, then RXD is logic 0.

[2] X = don't care.

Table 3-2. Pin Rs summary

Condition forced at pin Rs	Mode	Resulting voltage or current at pin Rs
$V_{Rs} > 0.75V_{CC}$	Standby	$I_{Rs} < 10$ µA
10 µA< $-I_{Rs} < 200$ µA	Slope control	$0.4V_{CC} < V_{Rs} < 0.6V_{CC}$
$V_{Rs} < 0.3V_{CC}$	High-speed	$I_{Rs} < 500$ µA

4. BLOCK DIAGRAM



Block Diagram

5. SPECIFICATIONS

5.1. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are referenced to pin 2; positive input current.

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		- 0.3	+7.0	V
V_n	DC voltage at pins 1, 4, 5 and 8		- 0.3	V_{CC} + 0.3	V
V_6	DC voltage at pin 6 (CANL)	0 V < V_{CC} < 5.5 V; TXD HIGH or floating	- 36	+36	V
		0 V < V_{CC} < 5.5 V; no time limit [1]	- 36	+36	V
		0 V < V_{CC} < 5.5 V; no time limit [2]	- 36	+36	V
V_7	DC voltage at pins 7 (CANH)	0 V < V_{CC} < 5.5 V; no time limit	- 36	+36	V
V_{trt}	transient voltage at pins 6 and 7	see Figure 5-6	- 150	+150	V
T_{stg}	storage temperature		- 45	+125	℃
T_{amb}	ambient temperature		- 40	+85	℃
T_{vj}	virtual junction temperature	[3]	- 40	+150	℃
V_{ESD}	electrostatic discharge voltage	[4]	- 2000	+2000	V
		[5]	- 250	+250	V

[1] TXD is LOW. Short-circuit protection provided for slew rates up to 5 V/μs for voltages above +30 V.

[2] Short-circuit applied when TXD is HIGH, followed by TXD switched to LOW.

[3] An alternative definition of virtual junction temperature is: Tvj = Tamb + Pd × Rth(vj-a), where Rth(j-a) is a fixed value to be used for the calculation of Tvj. The rating for Tvj limits the allowable combinations of power dissipation (Pd) and ambient temperature (Tamb).

[4] Classification A: human body model; C = 100 pF; R = 1500Ω; V = ±2000 V.

[5] Classification B: machine model; C = 200 pF; R = 25 Ω; V = ±150 V.

5.2. Quick reference data

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		4.5	5.5	V
I_{CC}	supply current	Standby mode	-	300	μA
$1/t_{bit}$	maximum transmission speed	non-return-to-zero	-	1	MBd
V_{CAN}	CANH, CANL input/output voltage		-30	+30	V
V_{diff}	differential bus voltage		1.5	3.0	V
t_{PD}	propagation delay	High-speed mode	-	50	ns
T_{amb}	ambient temperature		-40	+85	C

5.3. Thermal Data

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	160	K/W

5.4. Characteristics

VCC = 4.5 V to 5.5 V; Tamb = -40° C to +85° C; RL = 60 Ω; I8 > -10 µA; unless otherwise specified; all voltages referenced to ground (pin 2); positive input current; all parameters are guaranteed over the ambient temperature range by design, but only 100 % tested at +25 ° C.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply						
I_3	supply current	dominant; V_1 = 1 V; V_{CC} = 5.1 V	-	-	85	mA
		dominant; V_1 = 1 V; V_{CC} = 5.25V	-	-	90	mA
		dominant; V_1 = 1 V; V_{CC} = 5.5 V	-	-	95	mA
		recessive; V_1 = 4 V; R_8 = 47 k	-	-	20	mA
		Standby	[1] -	-	300	µA
DC bus transmitter						
V_{IH}	HIGH-level input voltage	output recessive	0.7V_{CC}	-	V_{CC} + 0.3	V
V_{IL}	LOW-level input voltage	output dominant	0.3	-	0.3V_{CC}	V
I_{IH}	HIGH-level input current	V_1 = 4 V	200	-	+30	µA
I_{IL}	LOW-level input current	V_1 = 1 V	-100	-	600	µA
$V_{6,7}$	recessive bus voltage	V_1 = 4 V; no load	2.0	-	3.0	V
I_{LO}	off-state output leakage current	2 V < (V_6, V_7) < 7 V	2	-	+2	mA
		5 V < (V_6, V_7) < 30V	-10	-	+10	mA
V_7	CANH output voltage	V_1 = 1 V; V_{CC} = 4.75V to 5.5V	3.0	-	4.5	V
		V_1 = 1 V; V_{CC} = 4.5 V to 4.75 V	2.75		4.5	V
V_6	CANL output voltage	V_1 = 1 V	0.5	-	2.0	V
$V_{6,7}$	difference between output	V_1 = 1 V	1.5	-	3.0	V
	voltage at pins 6 and 7	V_1 = 1 V; R_L = 45	1.5	-	-	V
		V_1 = 4 V; no load	-500	-	+50	mV
I_{sc7}	short-circuit CANH current	V_7 = -5V	-	-	200	mA
		V_7 = -30V	-	-100	-	mA
I_{sc6}	short-circuit CANL current	V_6 = 30 V	-	-	200	mA
DC bus receiver: V1 = 4 V; pins 6 and 7 externally driven; - 2V< (V6, V7) < 7 V; unless otherwise specified						
$V_{diff(d)}$	differential input voltage (recessive)		-1.0	-	+0.5	V
		7 V < (V_6, V_7) < 12 V	-1.0	-	+0.4	V
$V_{diff(d)}$	differential input voltage (dominant)		0.9	-	5.0	V
		7 V < (V_6, V_7) < 12 V; not Standby mode	1.0	-	5.0	V
		Standby mode	0.97	-	5.0	V
		Standby mode; V_{CC} = 4.5 V to 5.10 V	0.91	-	5.0	V
Vdiff(hys)	differential input hysteresis	see Figure 5-3	-	150	-	mV
VOH	HIGH-level output voltage	pin 4; I4 = -100 µA	0.8VCC	-	VCC	V
VOL	LOW-level output voltage	pin 4; I4 = 1 mA	0	-	0.2VCC	V
		I4 = 10 mA	0	-	1.5	V
Ri	input resistance	CANH, CANL	5	-	25	kΩ
Rdiff	differential input resistance		20	-	100	kΩ
Reference output						
Vref	reference output voltage	V8 =1 V; |I5| < 50 µA	0.45VCC	-	0.55VCC	V
		V8 =4 V; |I5| <5 µA	0.4VCC	-	0.6VCC	V
Timing (CL = 100 pF; see Figure 5-1, Figure 5-2, Figure 5-4 and Figure 5-5)						
tbit	minimum bit time	Rext =0 Ω	-	-	1	µs
tonTXD	delay TXD to bus active	Rext =0Ω	-	-	50	ns

Characteristics (continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
toffTXD	delay TXD to bus inactive	Rext =0 Ω	-	40	80	ns
tonRXD	delay TXD to receiver active	Rext =0 Ω	-	55	120	ns
toffRXD	delay TXD to receiver inactive	Rext =0 ; Tamb < +85 C VCC = 4.5 V to 5.1 V	-	80	150	ns
		Rext = 0 ; VCC = 4.5 V to 5.1 V	-	80	170	ns
		Rext = 0 ; Tamb < +85 C	-	90	170	ns
		Rext =0 kΩ	-	90	190	ns
		Rext = 47 kΩ	-	290	400	ns
tonRXD	delay TXD to receiver active	Rext = 47 kΩ	-	440	550	ns
SR	CANH, CANL slew rate	Rext = 47 kΩ	-	7	-	V / s
tWAKE	wake-up time from Standby (via pin 8)	see Figure 5-4	-	-	20	μs
tdRXDL	bus dominant to RXD LOW	V8 = 4 V; see Figure 5-5	-	-	3	μs
Standby/Slope control (pin 8)						
Vstb	input voltage for Standby mode	0.75VCC		-	-	V
Islope	Slope control mode current	10		-	200	μA
Vslope	Slope control mode voltage	0.4VCC		-	0.6VCC	V

[1] I1 = I4 = I5 = 0 mA; 0 V < V6 < VCC; 0 V < V7 < VCC; V8 = VCC; Tamb < 80 °C.

[2] This is valid for the receiver in all modes: High-speed, Slope control and Standby.

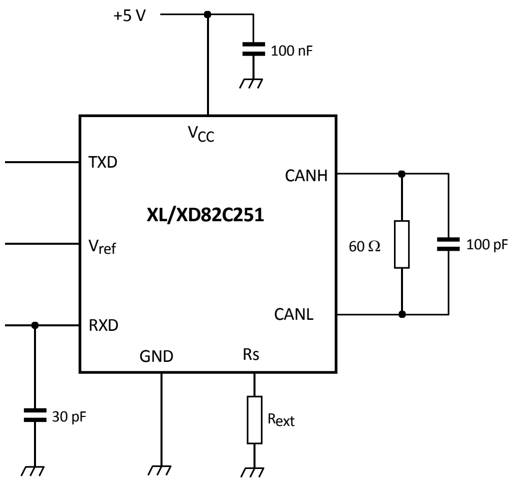


Figure 5-1 : Test circuit for dynamic characteristics.

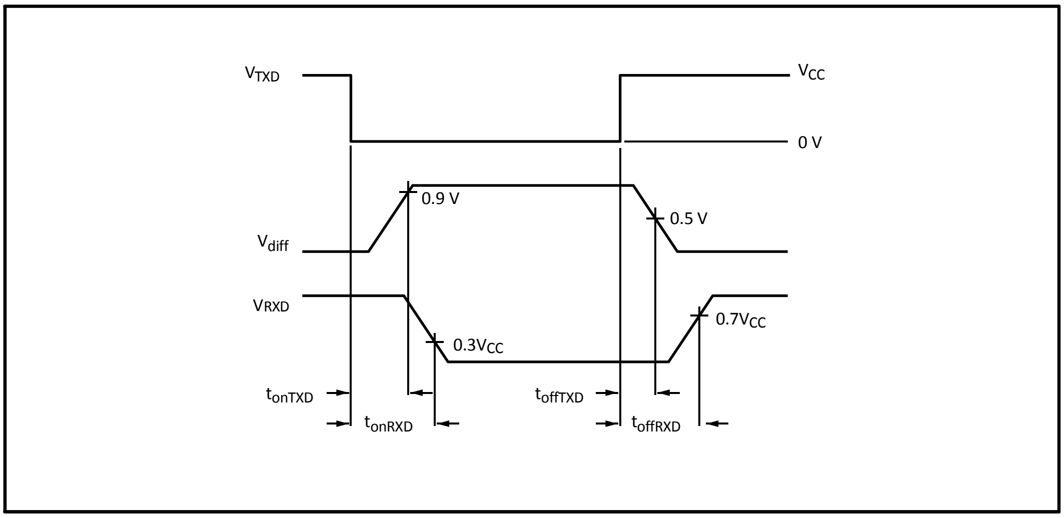


Figure 5-2 : Switching Times Test Circuits.

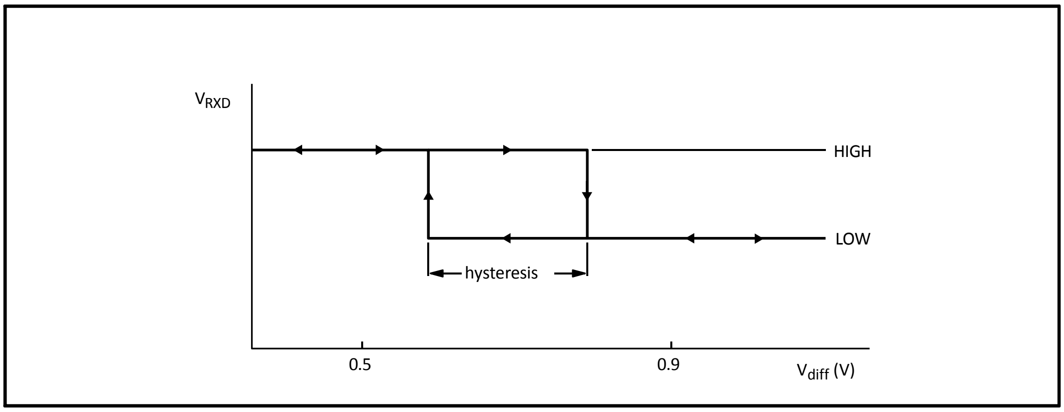


Figure 5-3 : Sink Current Delay Times vs. Input 0 V Enable Switching.

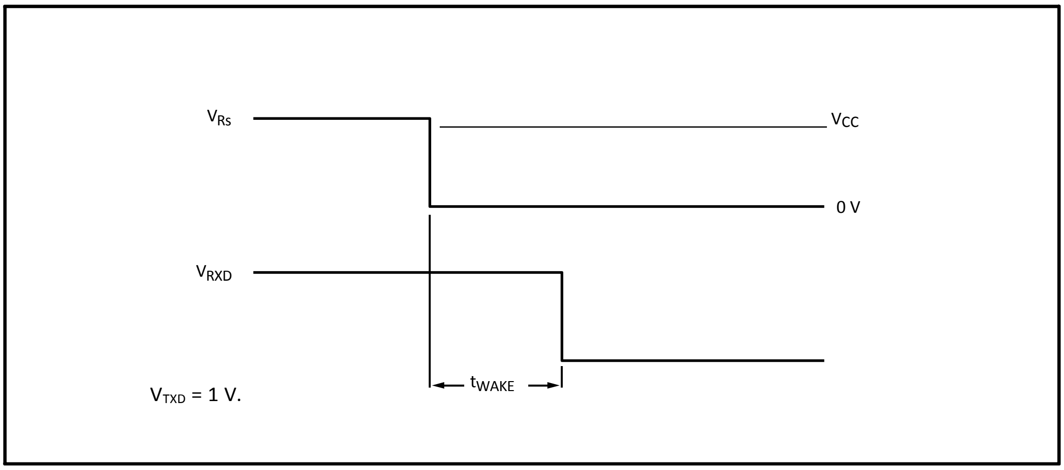


Figure 5-4 : Bidirectional DC Motor Control.

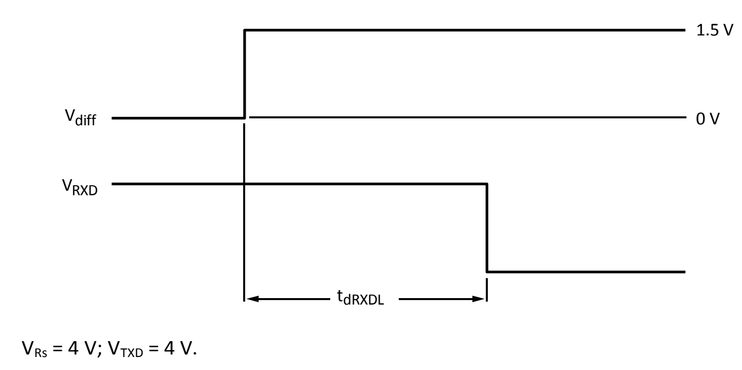
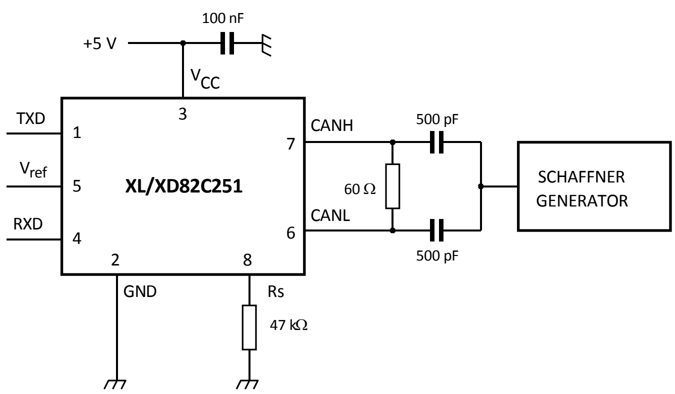


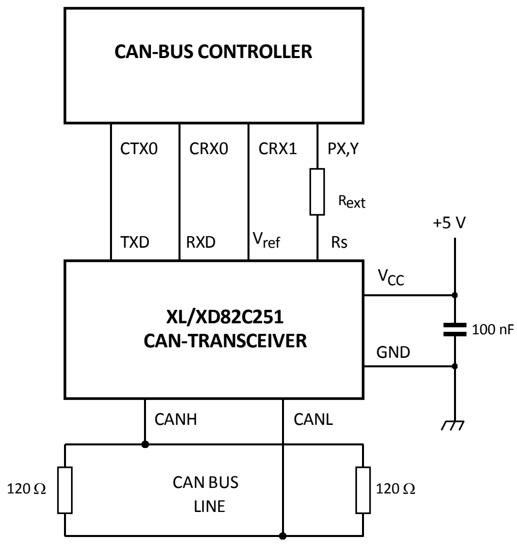
Figure 5-5. Timing diagram for bus dominant to RXD LOW



The waveforms of the applied transients shall be in accordance with *"ISO 7637 part 1"*, test pulses 1, 2, 3a and 3b.

Figure 5-6. Test circuit for transients.

6. Application Information



(1) The output pin is push-pull mode, dominant = LOW.

(2) If no slope control is desired: R_{ext} = 0.

Figure 6-1. XL/XD82C251 CAN transceiver application diagram

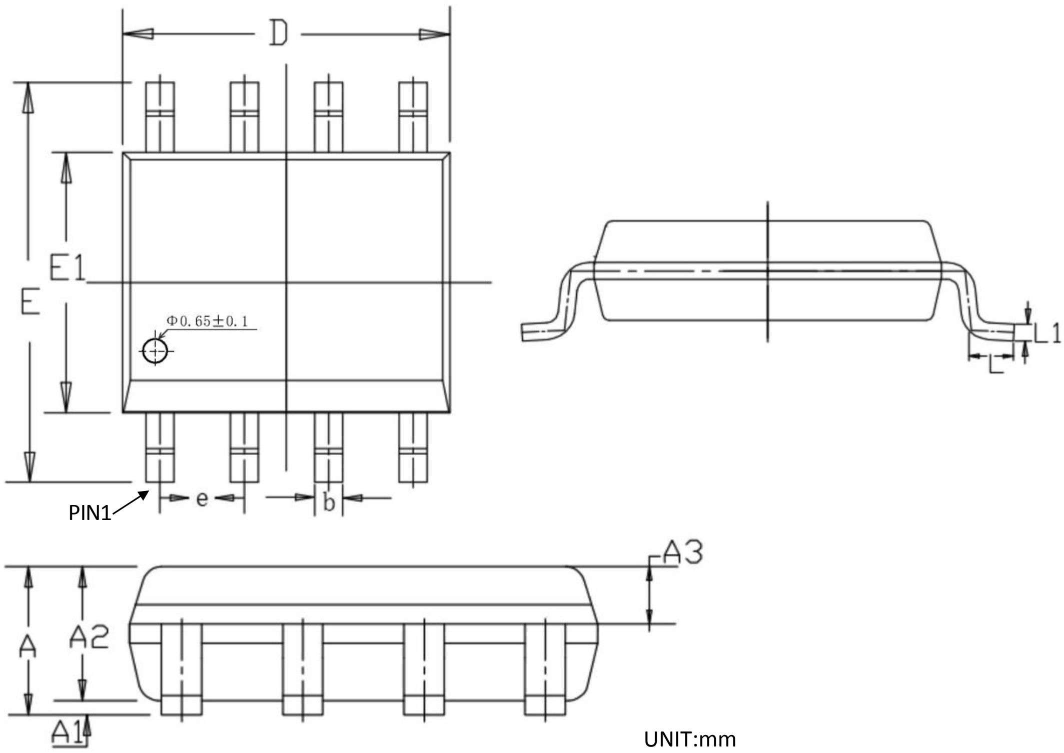
7. ORDERING INFORMATION

Ordering Information

Part Number	Device Marking	Package Type	Body size (mm)	Temperature (°C)	MSL	Transport Media	Package Quantity
XL82C251	XL82C251	SOP8	4.90 * 3.90	- 40 to 85	MSL3	T&R	2500
XD82C251	XD82C251	DIP8	9.25 * 6.38	- 40 to 85	MSL3	Tube 50	2000

8. DIMENSIONAL DRAWINGS

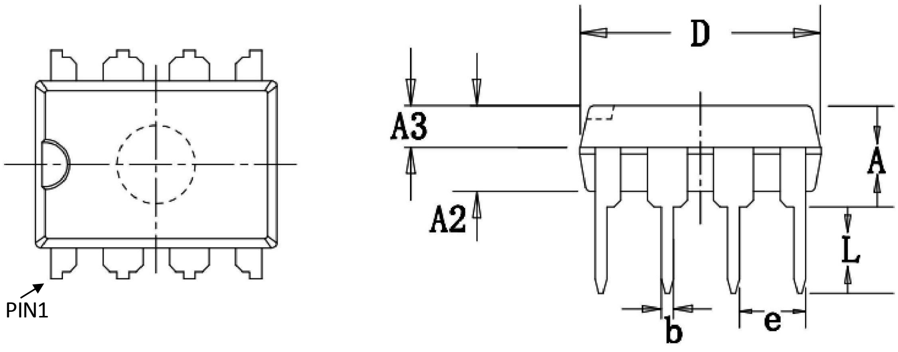
SOP8

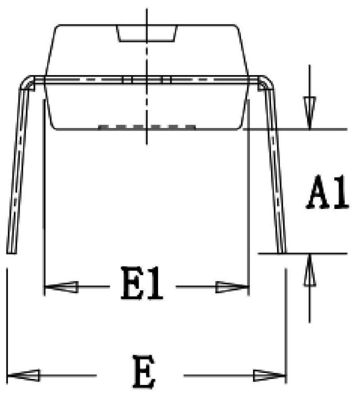


UNIT:mm

	MIN	NOM	MAX
A	1.450	1.550	1.650
A1	0.100	0.150	0.200
A2	1.300	1.400	1.500
A3	0.600	0.650	0.700
b	0.380	–	0.510
e	1.240	1.270	1.300
D	4.800	4.900	5.000
E	5.800	6.000	6.200
E1	3.800	3.900	4.000
L	0.450	0.600	0.750
L1	–	0.25BSC	–

DIP8





UNIT:mm

	MIN	NOM	MAX
A	3.600	3.800	4.000
A1	3.786	3.886	3.986
A2	3.200	3.300	3.400
A3	1.550	1.600	1.650
b	0.440	–	0.490
e	2.510	2.540	2.570
D	9.150	9.250	9.350
E	7.800	8.500	9.200
E1	6.280	6.380	6.480
L	3.000	–	–