FEATURES

- Operates with a single 3.3V supply
- Common mode voltage is better than ISO 11898 standard, up to -7V~+12V;
- Bus pin ESD protection exceeds ±12kV HBM
- Adjustable driver transition times for improved emissions performance
- Support four operating modes: high-speed, slope-control, standby and low current off. The low current off mode is as low as 1μA.
- 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

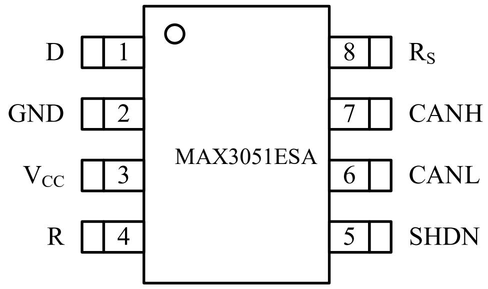
SOP-8

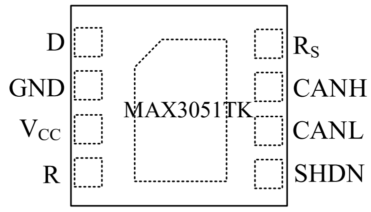
DESCRIPTION

The MAX3051 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 supports four operation modes: high-speed, slope-control, standby and low current off and common model can reach up to -7V~+12V. 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.

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
Ambient 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. Internal has pull-up resistor to VCC.
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, driver output.
5	SHDN	Shutdown input, CMOS/TTL compatible. When the SHDN is driven to HIGH, it is turned off in low current mode. Inside there is a pull-down resistor to GND.
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,10kΩ to 100kΩ pull down to GND=slope control mode.

LIMITING VALUES

PARAMETER	SYMBOL	VALUE	UNIT
Supply voltage	V_{CC}	-0.3~+6	V
MCU side port voltage	D, R	-0.5~VCC+0.5	V
Bus side input voltage	CANL, CANH	-36~36	V
Transient voltage on pin 6, 7	V_{tr}	-100~+100	V
Receiver output current	I_O	-11~11	mA
Ambient temperature	T_{amb}	-40~125	℃
Storage temperature	T_{stg}	-55~150	℃
Continuous power consumption	SOP8	400	mW
	DIP8	700	mW

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, V_{SHDN}=0V	-250			mA
			CANH=12V, V_{SHDN}=0V			1	
			CANL=-7V, V_{SHDN}=0V	-1			
			CANL=12V, V_{SHDN}=0V			250	
C_O	Output capacitance		See receiver				
I_{CC}	Supply current		V_I=0V (dominant), 60Ω load		35	70	mA
			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

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

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

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

RECEIVER ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT
V_{IT+}	Positive-going input threshold voltage	High-speed mode, Fig 1		750	900	mV
		VRS=3V (Standby mode)			1100	mV
V_{IT-}	Negative-going input threshold voltage	High-speed mode, Fig 1	500	650		mV
		VRS=3V (Standby mode)	500			mV
V_{hys}	Hysteresis voltage	VIT+- VIT-		100		mV
V_{OH}	High-level output voltage	-6V< V_{ID} <500mV I_o =-8mA (Fig 5)	2.4			V
V_{OL}	Low-level output voltage	900mV< V_{ID} <6V I_o =8mA (Fig 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	Bus input resistance		20	35	50	kΩ
R_{diff}	Differential input resistance		40		100	kΩ
C_i	Bus input capacitance			40		pF
C_{diff}	Differential input capacitance			20		pF

(If not otherwise specified, VCC=3.3V±10%, Temp=TMIN~TMAX, 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)	Fig 6		35	60	ns
t_{PHL}	Propagation delay time (high-to-low-level)	Fig 6		35	60	ns
t_{sk}	Pulse skew	$\|t_{PHL}- t_{PLH}\|$			10	ns
t_r	Output signal rise time	Fig 6		1.5		ns
t_f	Output signal fall time	Fig 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
$t_{(LOOP1)}$	Loop delay 1, driver input to receiver output, recessive to dominant	R=0, Short circuit (Fig 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 (Fig 8)		70	165	ns
		R=10 kΩ		105	190	ns
		R=100 kΩ		535	1000	ns

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

OVER TEMPERATURE PROTECTION

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

(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 (Fig7)		0.55	1.5	µs

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
V_{IH}	Lower limit input high level		2		VCC+0.3	V
V_{IL}	Upper limit of input low level		-0.3		0.8	V

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

SUPPLY CURRENT

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Power consumption in shutdown mode	I_{SHDN}	V_{SHDN}=3V			1	μA
Power consumption in standby mode	$I_{standby}$	R_S=VCC, V_I=VCC		8	15	μA
Dominant power consumption	I_{CC}	V_I=0V, R_S=0V, LOAD=60Ω		35	70	mA
Recessive power consumption	I_{CC}	V_I=VCC, R_S=0V, NO LOAD			6	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_{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 Function

INPUTS			OUTPUTS		
D	**SHDN**	**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**	**SHDN**	**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	?
X	X	H	X	H

(1) H=High level; L=Low level; ?=uncertain; X=Irrelevant.

TEST CIRCUIT

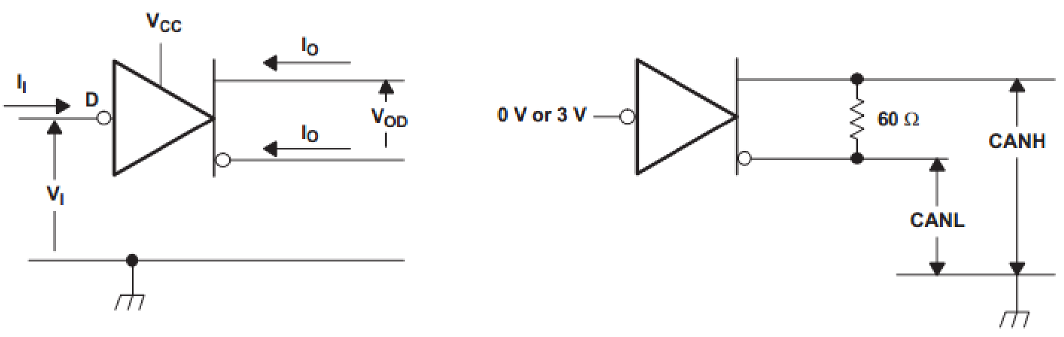


Fig 1 Driver voltage, current and test definition

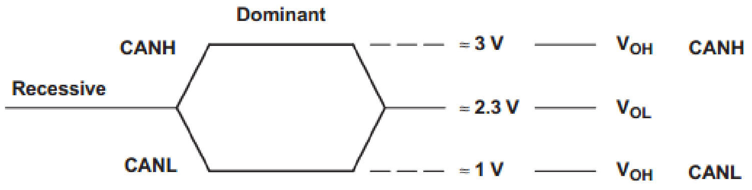


Fig 2 Bus logic state voltage definitions

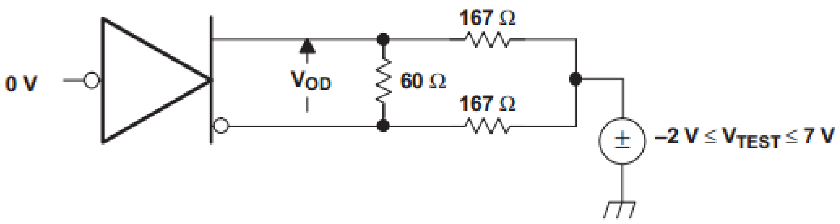
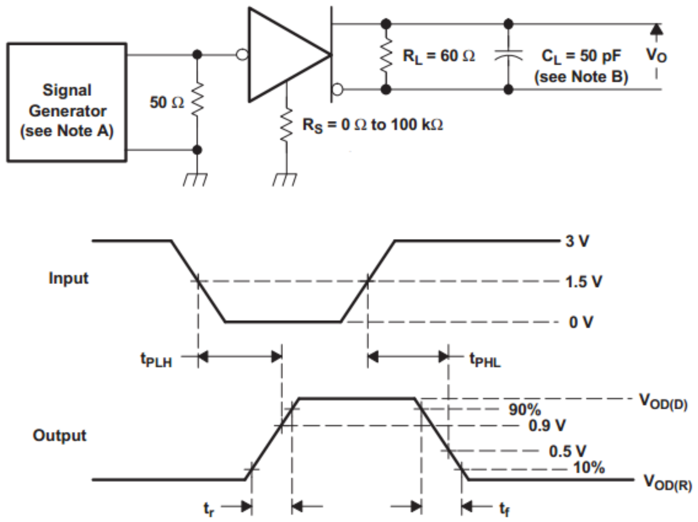


Fig 3 Driver V_{OD} test circuit



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

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

Fig 4 Driver test circuit and waveforms

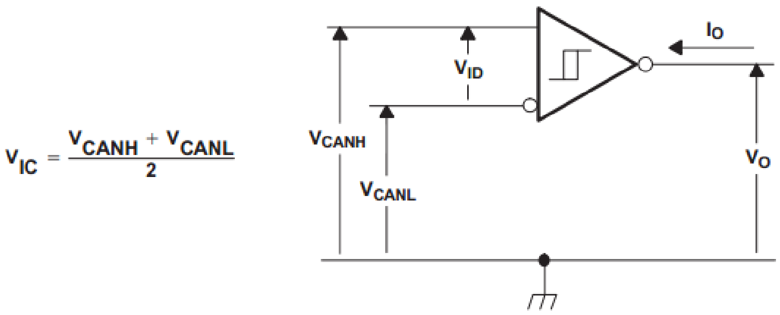
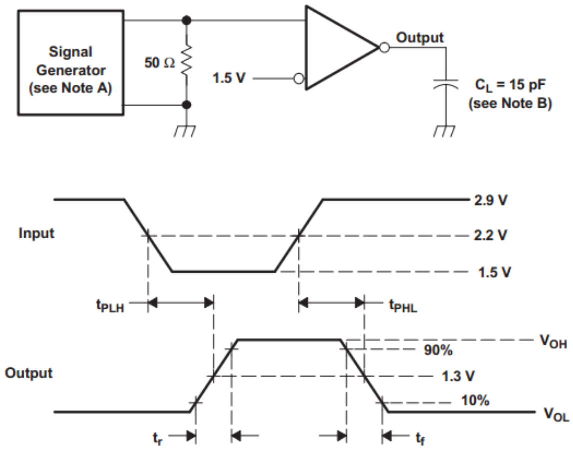


Fig 5 Receiver voltage and current definitions



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

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

Fig 6 Receiver test circuit and waveform

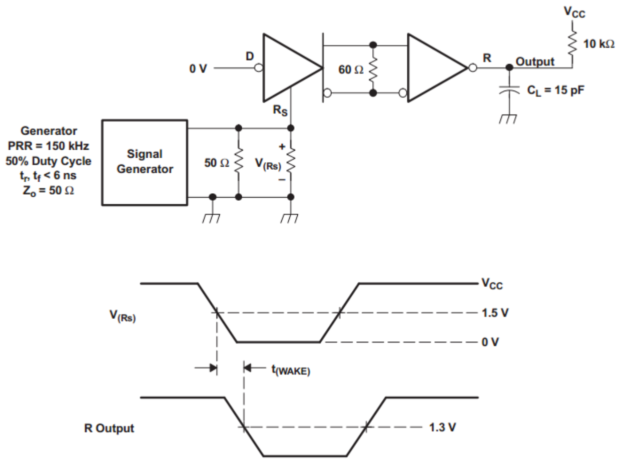
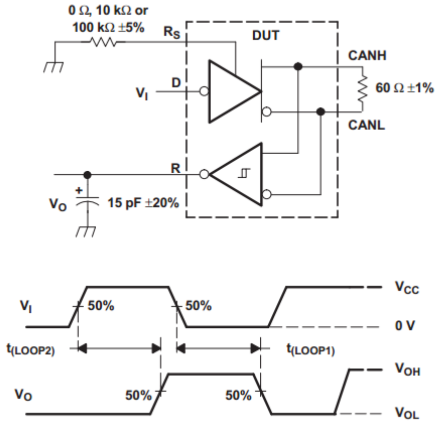


Fig 7 $t_{(WAKE)}$ test circuit and waveform



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

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

ADDITIONAL DESCRIPTION

1 Sketch

The MAX3051 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 data rates up to 1Mbps, and it is compatible 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

The MAX3051 has overtemperature protection function. When the junction temperature exceeds 165℃, the current of the driver stage will decrease. Because the driver tube is the main power consuming component, the current reduction can reduce the power consumption and thus the chip temperature. Meanwhile, the rest of the chip remains normal operating mode.

4 Transient protection

Electrical transients often occur in automotive application environment, CANH, CANL of MAX 3051 have the function of preventing electrical transient damage.

5 Control mode

The pin SHDN (pin 5) and pin R_S (pin 8) provide four different modes of operation: high-speed mode, slope-control mode, standby mode and low-power off mode.

High-speed mode

The high-speed mode can be selected by applying a logic low to the RS pin (pin 8), when the pin SHDN (pin 5) is low. 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.

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 MAX3051 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 when pin SHDN is low. 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.

Standby mode

When pin SHDN is low, if a logic high (> 0.75VCC) is applied to R_S (pin 8), the device circuit enters a low-current, listen only standby mode, during which the driver is switched off and the receiver remains low current/low speed operation. 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. Whether or not a slope control resistor is placed makes no difference. 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 can sense bus activity and reactivate the driver circuit by placing a logic low (< 1.2 V) on R_S (pin 8).

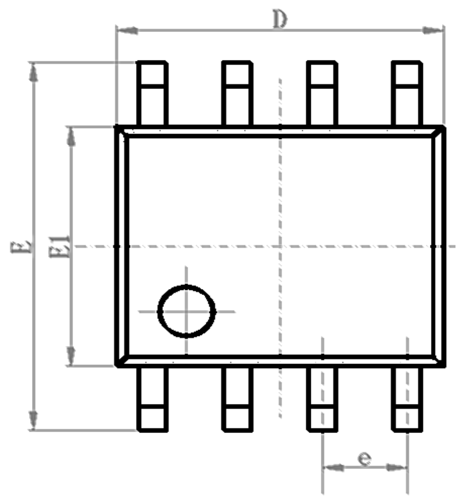
Low-power off mode

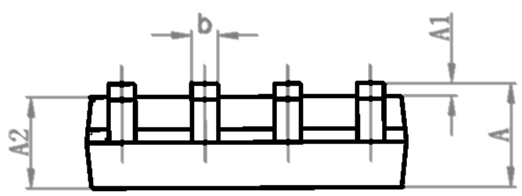
Enter standby mode while driving the pin SHDN to high and enter standby mode. When the pin SHDN is grounded or float, it is in normal operating mode.

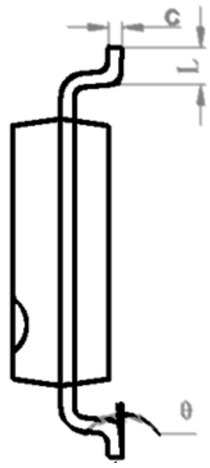
SOP8 DIMENSIONS

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	5.80	6.00	6.20
E1	3.80	3.90	4.00
e		1.27BSC	
L	0.40	0.60	0.80
c	0.20	-	0.25
θ	0°	-	8°



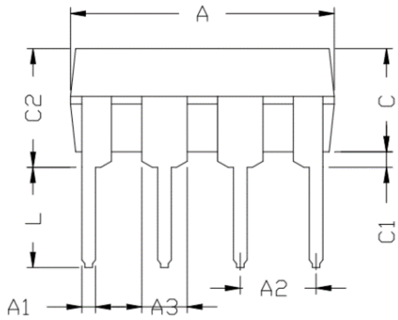


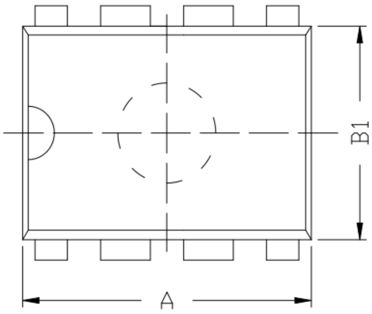


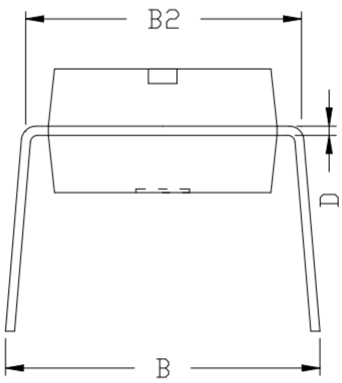
DIP8 DIMENSIONS

PACKAGE SIZE

SYMBOL	MIN./mm	TYP./mm	MIN./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



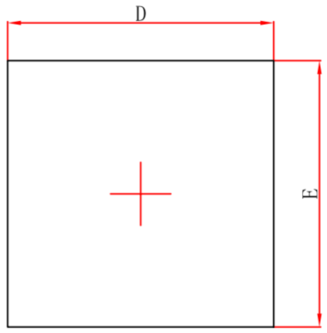


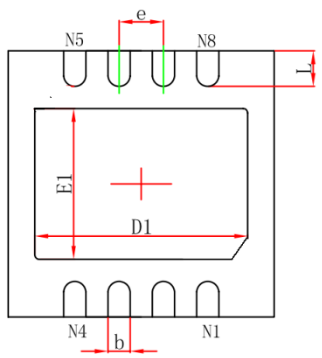


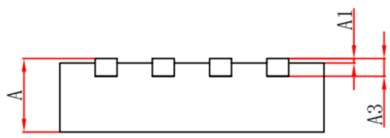
DFN3*3-8 DIMENSIONS

PACKAGE SIZE

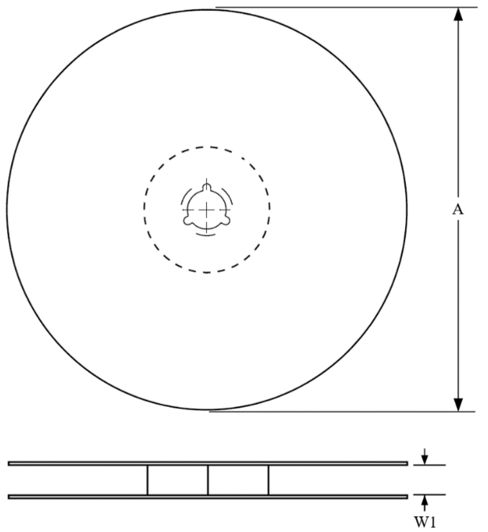
SYMBOL	MIN./mm	TYP./mm	MAX./mm
A	0.70		0.80
A1	0.00	0.02	0.05
A3	0.203 REF		
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D1	2.35	2.3	2.55
E1	1.55	1.65	1.75
b	0.2	0.25	0.33
e	0.65 TYP		
L	0.35		0.45



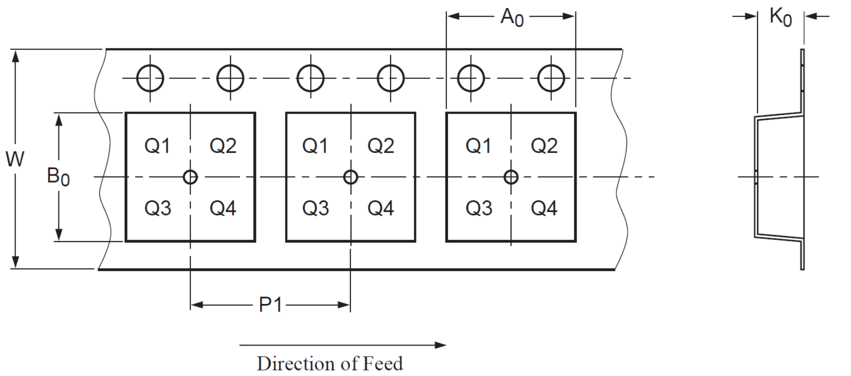




TAPE AND REEL INFORMATION



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



PIN1 is in quadrant 1

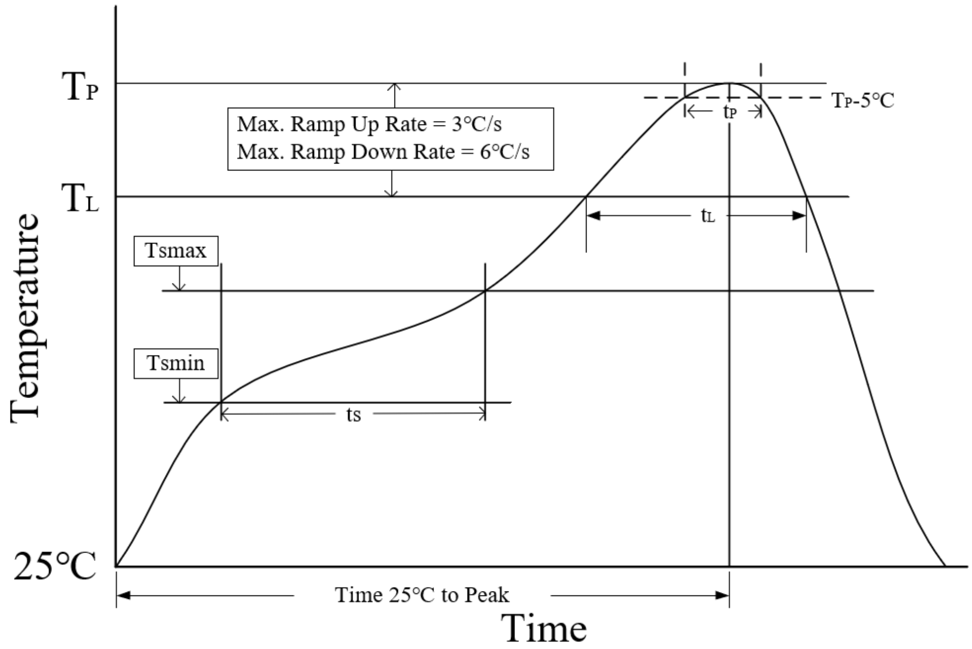
Package Type	Reel Diameter A (mm)	Tape width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)
SOP8	330±2	12.4±0.40	6.50±0.1	5.30±0.10	2.05±0.1	8.00±0.1	12.00±0.1
DFN3*3-8	330	12.5±0.20	3.23±0.10	3.23±0.10	1.05±0.10	4.00±0.10	12.00±0.30

ORDERING INFORMATION

TYPE NUMBER	PACKAGE	PACKING
MAX3051ESA	SOP8	Tape and reel
MAX3051EPA	DIP8	Tube
MAX3051TK	DFN3*3-8, Small outline, no leads	Tape and reel

SOP8 is packed with 2500 pieces/disc. Leadless DFN3*3-8 is packed with 5000 pieces/disc. DIP8 is packed with 50 pieces/tube in tubed 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