

Single-Phase Full-Wave Motor Driver for Silent Fan Motor

Features

- **Single Phase Full Wave Fan Driver**
- **Silent Driver**
- **Low Supply Current**
- **Built-in Lock Protection and Auto Restart Function (External Capacitor Unnecessary)**
- **FG Output**
- **Include Hall Bias Circuit**
- **Built-in Thermal Protection Circuit**
- **Lead Free and Green Devices Available (RoHS Compliant)**

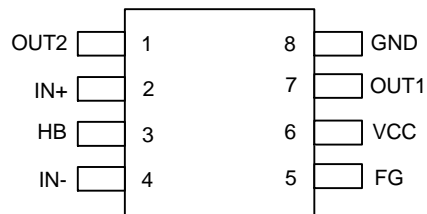
General Description

The APX9268 is a single phase full wave motor driver for DC fan motor. The output signal of this IC is the amplified hall input signal. It is suitable for both game machine and CPU cooler that need silent drivers. The device is built-in lock protection. When fan is locked, the device will enter the lockup protection mode. It is also with thermal shutdown function. In normal operation, the supply current is less than 5mA. The APX9268 is available in MSOP-8 package.

Applications

- **Motor Drivers For Silent Fan Motors**

Pin Configuration



MSOP-8

Ordering and Marking Information

<p>APX9268 □□-□□□</p> <div style="margin-left: 20px;"> <p>└─ Assembly Material</p> <p>└─ Handling Code</p> <p>└─ Temperature Range</p> <p>└─ Package Code</p> </div>	<p>Package Code X : MSOP - 8</p> <p>Temperature Range I : -40 to 105 °C</p> <p>Handling Code TR : Tape & Reel</p> <p>Assembly Material L : Lead Free Device G : Halogen and Lead Free Device</p>
<p>APX9268 X : A9268 XXX XX</p>	<p>XXXXX - Date Code</p>

Note: ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020C for MSL classification at lead-free peak reflow temperature. ANPEC defines "Green" to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

ANPEC reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

Absolute Maximum Ratings (Note 2)

Symbol	Parameter	Rating	Unit
V _{CC}	VCC Pin Maximum Supply Voltage	7	V
I _{OUT}	Output Pin Maximum Output Current	1	A
V _{OUT}	Output Pin Output Supply Voltage	7	V
I _{HB}	HB Pin Maximum Output Current	10	mA
V _{FG}	FG Pin Maximum Output Voltage	7	V
I _{FG}	FG Pin Maximum Output Current	10	mA
R _{TH,JA}	Thermal Resistance-Junction to Ambient MSOP8	225	°C/W
P _D	Power Dissipation ^(Note1)	0.585	W
T _J	Junction Temperature	-40 to 150	°C
T _{STG}	Storage Temperature	-65 to 150	°C
T _{SDR}	Maximum Lead Soldering Temperature, 10 Seconds	260	°C

Note1: Mounted on a board (60x38x1.6t mm, Glass epoxy)

Note2: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Ratings	Unit
V _{CC}	VCC Pin Supply Voltage	2 to 5.5	V
V _{Hall}	Hall Input Voltage Range	0.4 to V _{CC} -1.1	V
T _A	Ambient Temperature	-40 to 105	°C

Electrical Characteristics (V_{CC}=5V, T_A=25°C)

Symbol	Parameter	Test Conditions	APX9268			Unit
			Min.	Typ.	Max.	
V _{HB}	Hall Bias Voltage	I _{HB} = 0 ~ 5mA	1.1	1.3	1.5	V
I _{CC1}	Supply Current	Rotation Mode	-	3.5	5	mA
I _{CC2}		Lock Protection Mode	-	3.5	5	mA
V _{HOFs}	Input Offset Voltage		-	-	±6	mV
G _{IO}	Input – Output Gain		45	48	51	dB
T _{ON}	Lock Detection On Time		0.35	0.5	0.65	sec
T _{OFF}	Lock Detection Off Time		3.5	5	6.5	sec
V _{OL}	Output Lower Side Voltage	I _{OUT} = 250mA	-	0.15	0.22	V
V _{OH}	Output Upper Side Voltage	I _{OUT} = 250mA	-	0.15	0.22	V
V _{FG}	FG Pin Low Voltage	I _{FG} = 3mA	-	0.2	0.3	V
I _{FG}	FG Pin Leak Current	V _{FG} = 5V	-	-	1	μA

Electrical Characteristics (Cont.) (V_{CC}=5V, T_A=25°C)

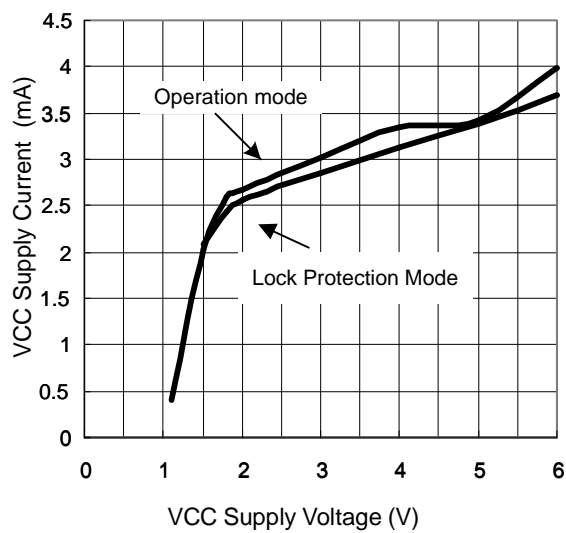
Symbol	Parameter	Test Conditions	APX9268			Unit
			Min.	Typ.	Max.	
V _{HYS}	Input Hysteresis Voltage		±5	±10	±15	mV
	Over Temperature Shutdown		-	175	-	°C
	Over Temperature Shutdown Hysteresis		-	25	-	

Truth Table

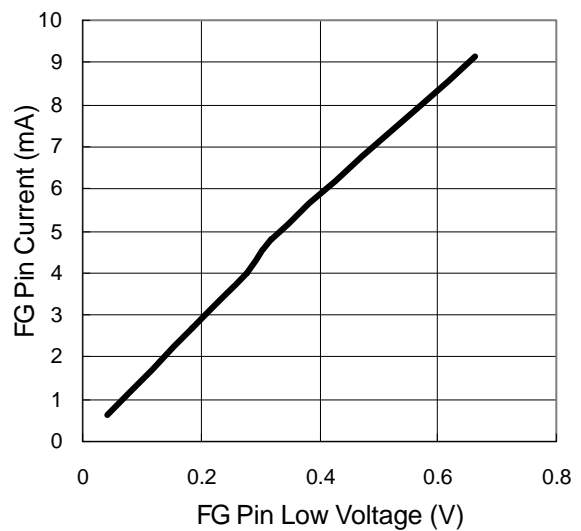
Input		Output			Mode
IN-	IN+	OUT1	OUT2	FG	
L	H	H	L	L	Operation Mode
H	L	L	H	OFF	
H	L	L	L	OFF	Lock Protection Mode
L	H	L	L	L	

Typical Operating Characteristics

VCC Supply Current vs. VCC Supply Voltage

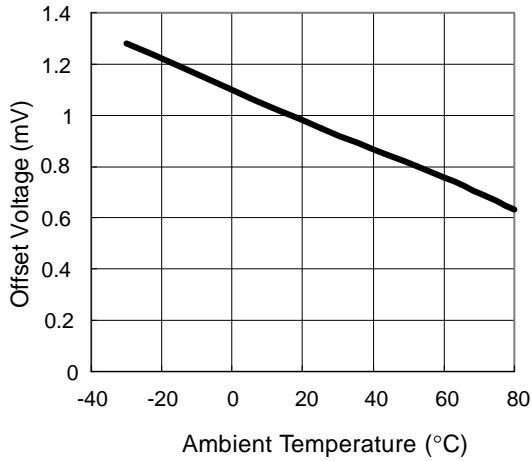


FG Pin Current vs. Low Voltage

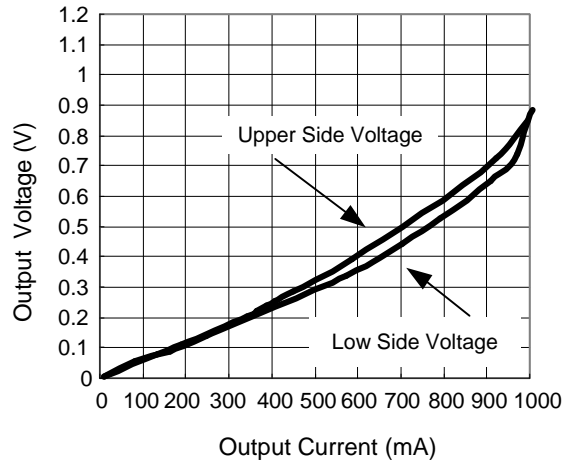


Typical Operating Characteristics (Cont.)

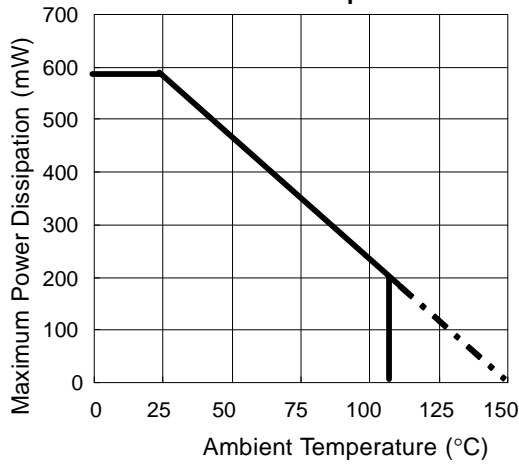
Offset Voltage vs. Ambient Temperature



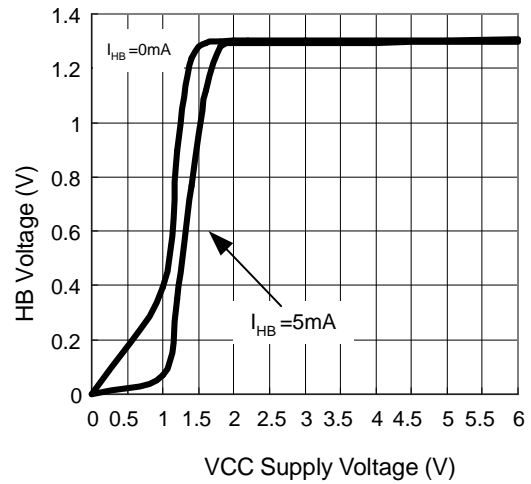
Output Voltage vs. Output Current



Maximum Power Dissipation vs. Ambient Temperature

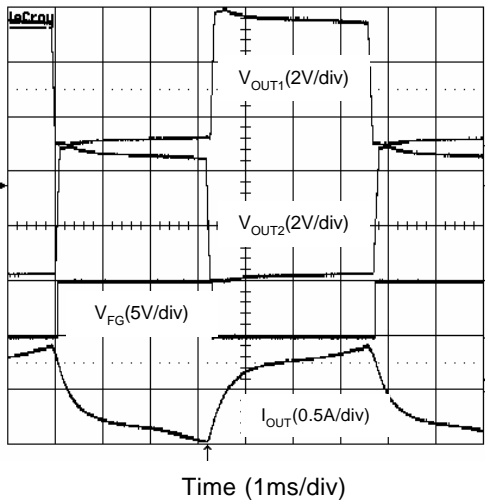


HB Voltage vs. VCC Supply Voltage

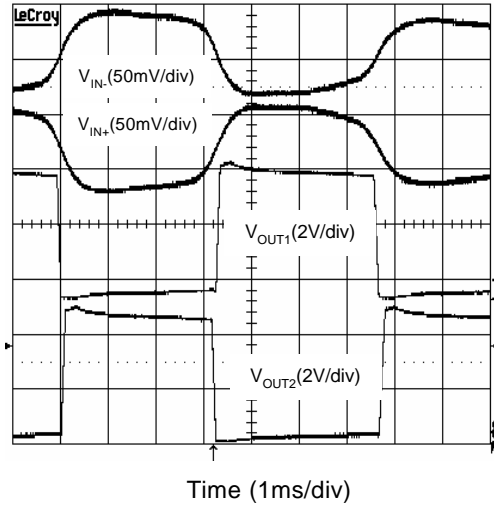


Operating Waveforms

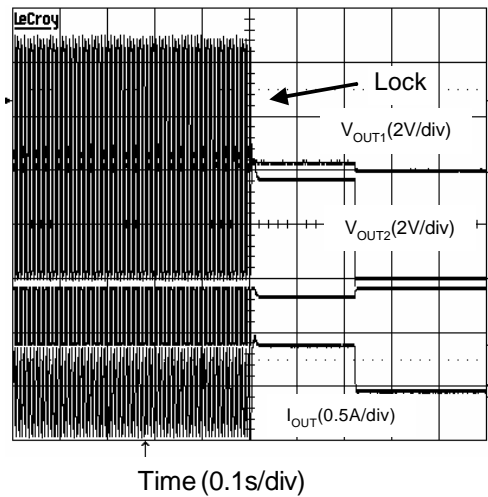
Rotation Mode Waveform1



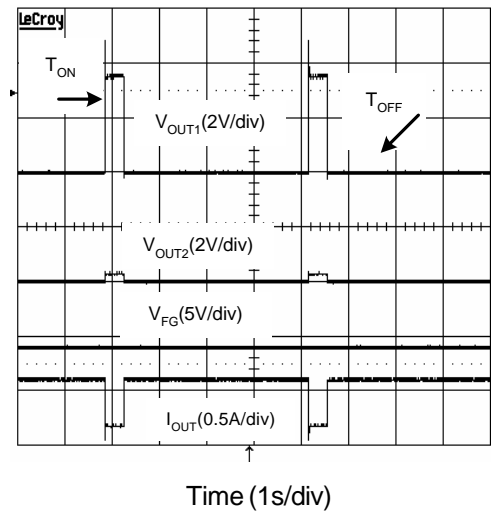
Rotation Mode Waveform2



Lock Protection Waveform1

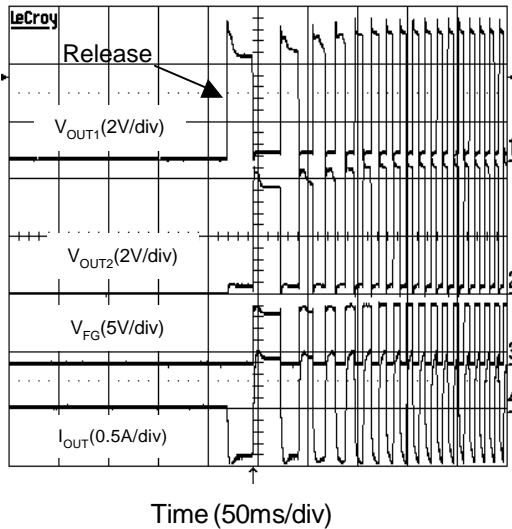


Lock Protection Waveform2



Operating Waveforms (Cont.)

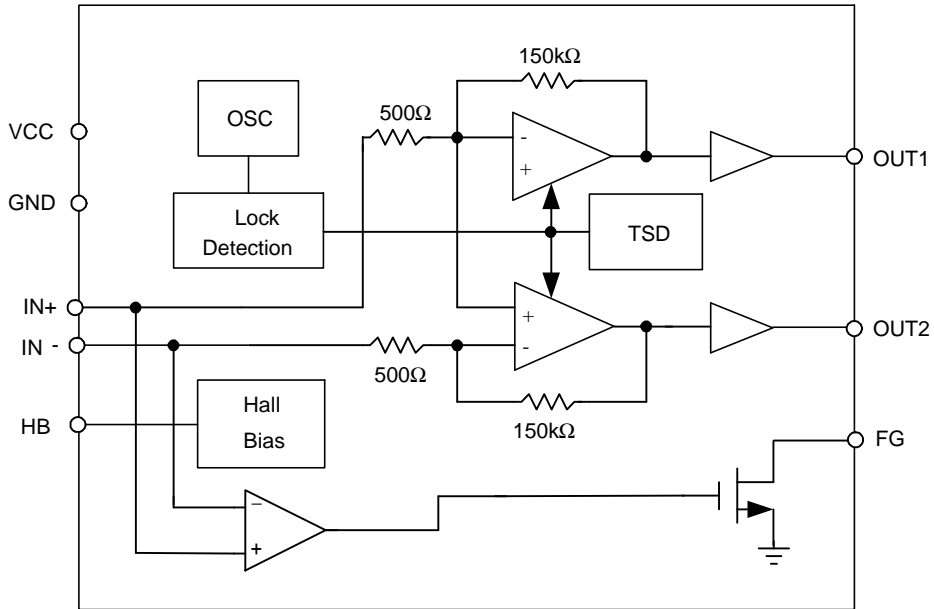
Lock Protection Waveform3



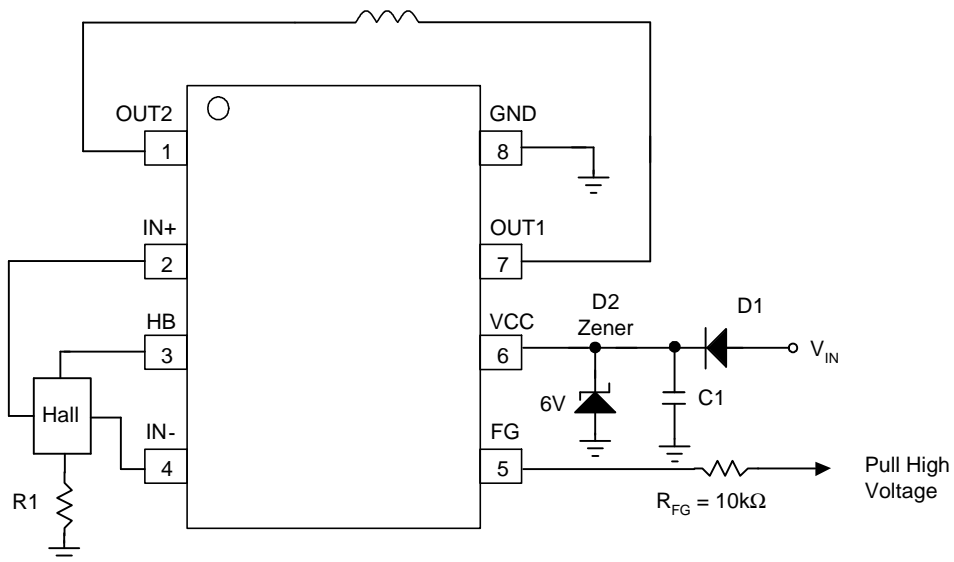
Pin Description

PIN		Description
No.	Name	
1	OUT2	H-bridge output connection. The output stage is a H-bridge formed by four transistors and four-protection diode for switching applications.
2	IN+	Hall Input +
3	HB	Hall Bias
4	IN-	Hall Input -
5	FG	FG signal output terminal
6	VCC	Supply Voltage
7	OUT1	H-bridge output connection. The output stage is a H-bridge formed by four transistors and four-protection diode for switching applications.
8	GND	Power GND.

Block Diagram



Typical Application Circuit



Note 3: In hot plug application, it's necessary to protect against a hot plug input voltage overshoot by adding an input zener diode between the VCC and GND to clamp the overshoot. In normal operation, the zener diode isn't stressed because output current doesn't reverse to VCC.

Function Description

Lockup Protection and Automatic Restart

The APX9268 provides the lockup protection and automatic restart functions for preventing the coil burn-out in the fan is locked. This IC has an internal counter to determine the shutdown time (T_{OFF}) and restart time (T_{ON}). During shutdown time, the output drivers keep turning off for 5 seconds and then enter the restart time. During the restart time, one output is high and the other is low, which makes a torque for fan rotation. The restart time has 0.5 second.

If the locked condition is not removed, the shutdown/restart process will be recurred until the locked condition is released (See Figure 1 Lockup/Auto Restart Waveform).

Output Drivers

All four drivers in the bridge output are designed for single phase full wave motor driver for fan motor.

The linear output architecture is used as output driver.

Frequency Generator Function

The FG pin is an open collector output, connecting a pull up resistor to a high level voltage for the frequency generator function.

When IN- is larger than IN+, FG is high (switch off); when IN- is smaller than IN+, FG is low (switch on). Open the terminal when not in using.

Thermal Protection

The APX9268 has thermal protection. When internal junction temperature reaches 175°C, the output devices will be switched off. When the IC's junction temperature cools by 25°C, the thermal sensor will turn the output devices on again, resulting in a pulsed output during continuous thermal protection.

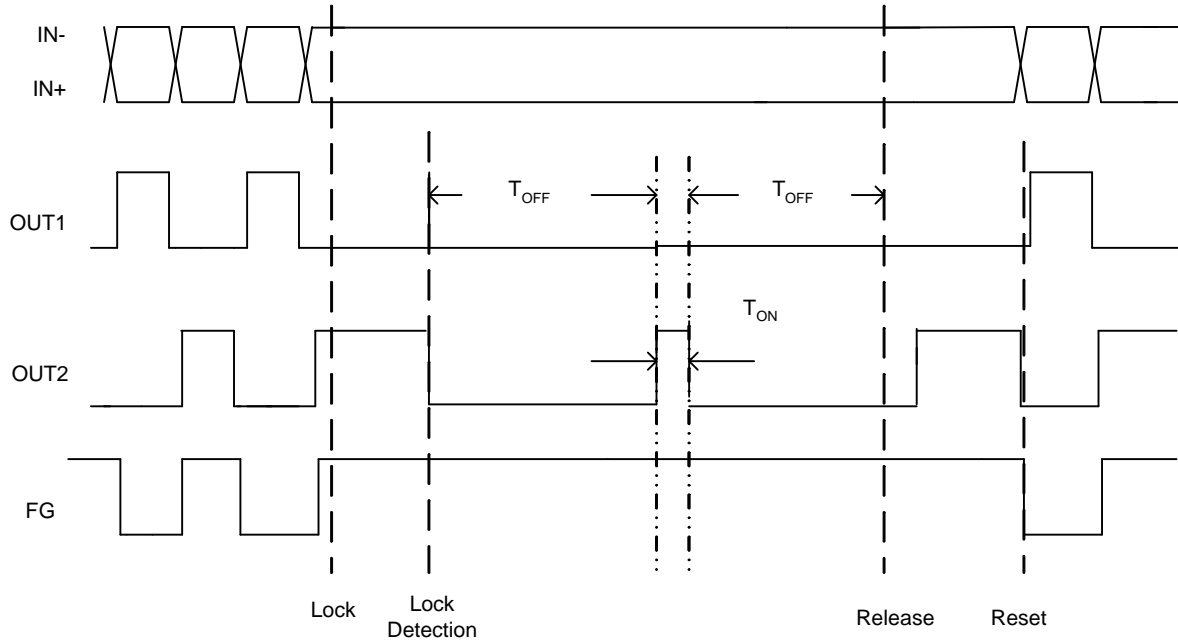


Figure 1 Lockup /Auto Restart Waveform

Application Information

Input Protection Diode & Zener Diode & Capacitor

It should be added a protection diode (D1) to protect the damage from the power reverse connection. However, the protection diode will cause a voltage drop on the supply voltage. The current rating of the diode must be larger than the maximum output current. Connecting VCC and GND with a Zener diode (D2) can avoid exceeding the absolute maximum rating voltage. For the noise reduction purpose, there is a capacitor (C1) 1μF (recommended) connecting VCC and GND (See Typical Application Circuit).

Hall input

The output signal of this IC is the amplified hall input signal, therefore, the output signal depends on hall input. When the hall input is small, the output signal becomes gentle. Oppositely, the input signal is large, the output signal becomes steep (See Figure 2 Different of output signal depending on the shape of hall input signal). The input/output gain is 48dB(typ.). Thus, please adjust the amplitude of hall input to meet the adequate output voltage.

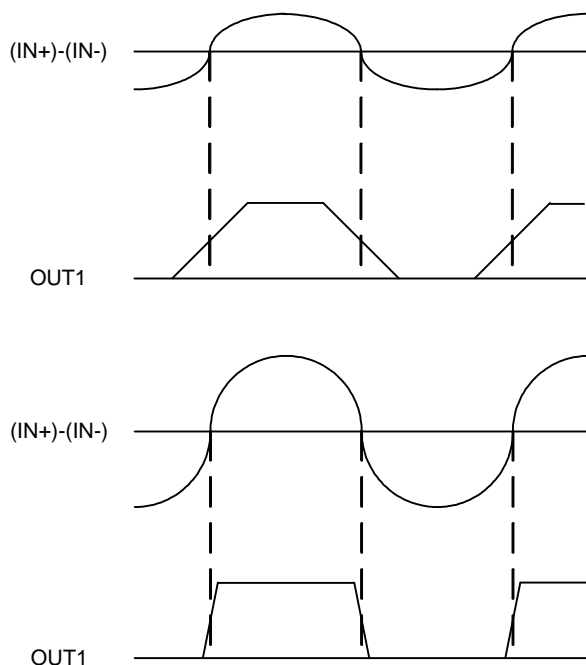


Figure 2 Different of output signal depending on the shape

FG Resistor

The value of the FG resistor could be decided by the following equation:

$$R_{FG} = \frac{V_{CC} - V_{FG}}{I_{FG}}$$

For example:

$$V_{CC} = 5V, I_{FG} = 3mA, V_{FG} = 0.2V, R_{FG} = 1.6K\Omega$$

The value of resistor in the range of 1kΩ to 10kΩ is recommended.

Thermal Consideration

The IC is safe to operate below the line and it will cause the thermal protection if the operating area is above the line. For example, $T_A = 75^\circ C$, the maximum power dissipation is about 0.35W (See Power Dissipation vs. Ambient Temperature). Mounted on a board, there is 60x38x1.6t mm, Glass epoxy. The power dissipation can be calculated by the following equation:

$$P_D = (V_{CC} - V_{OH} + V_{OL}) \times I_{OUT} + V_{CC} \times I_{CC}$$

For example:

If

$$V_{CC} = 5V, I_{CC} = 4mA, I_{OUT} = 270mA, V_{OH} = 4.83V,$$

$$V_{OL} = 0.17V,$$

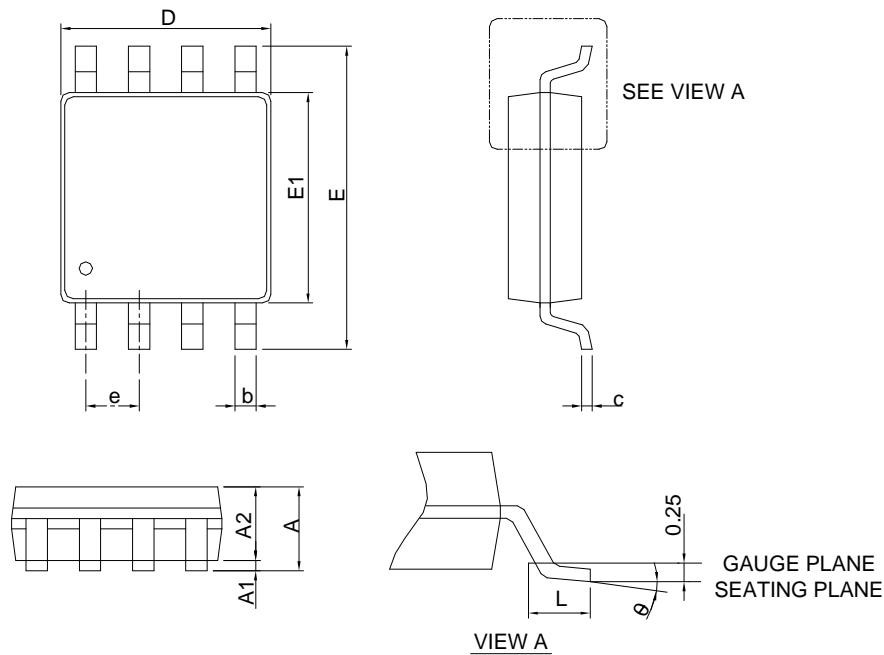
then

$$P_D = 0.111W$$

The GND pin provides an electrical connection to ground and channeling heat away. The printed circuit board (PCB) forms a heat sink and dissipates most of the heat into ambient air.

Package Information

MSOP-8

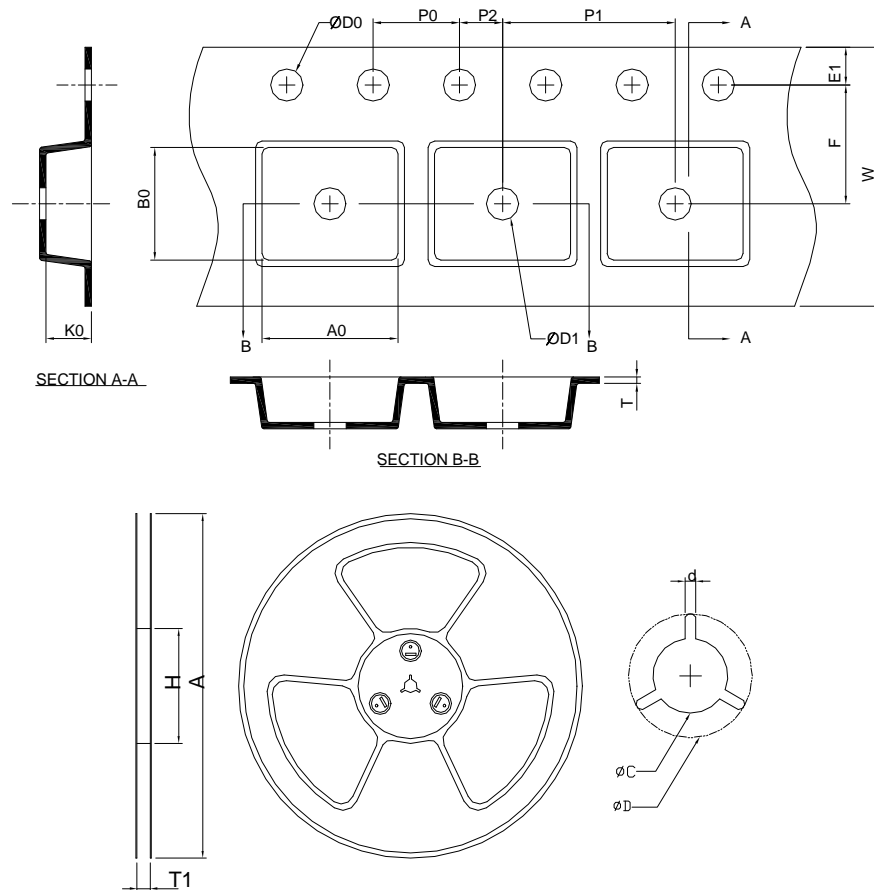


DIMENSIONS	MSOP-8			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.10	0.043	
A1	0.00	0.15	0.000	0.006
A2	0.75	0.95	0.030	0.037
b	0.22	0.38	0.009	0.015
c	0.08	0.23	0.003	0.009
D	2.90	3.10	0.114	0.122
E	4.70	5.10	0.185	0.201
E1	2.90	3.10	0.114	0.122
e	0.65 BSC		0.026 BSC	
L	0.40	0.80	0.016	0.031
θ	0°	8°	0°	8°

Note: 1. Follow JEDEC MO-187 AA.

2. Dimension " D " does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
3. Dimension " E1 " does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 5 mil per side.

Carrier Tape & Reel Dimensions



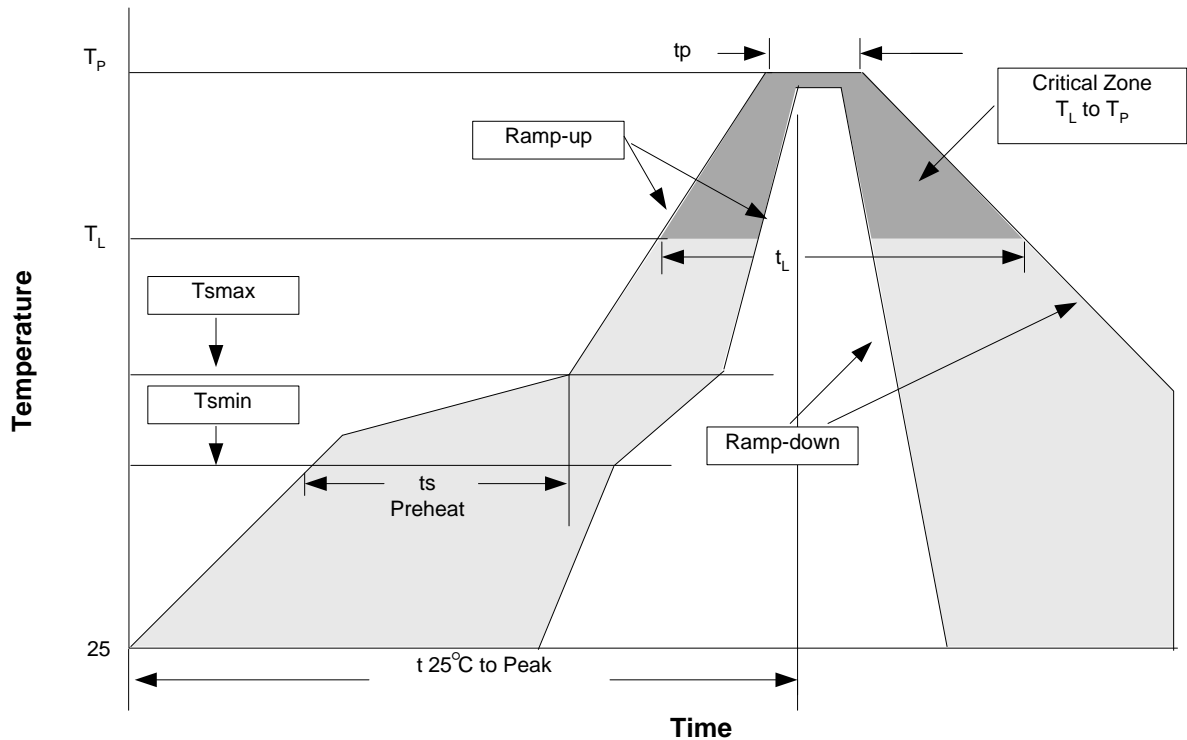
Application	A	H	T1	C	d	D	W	E1	F
MSOP- 8	330.0 ±2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0 ±0.30	1.75 ±0.10	5.5 ±0.10
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.00 ±0.10	8.00 ±0.10	2.00 ±0.10	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.70 ±0.20	3.30 ±0.20	1.40 ±0.20

(mm)

Devices Per Unit

Package Type	Unit	Quantity
MSOP- 8	Tape & Reel	3000

Reflow Condition (IR/Convection or VPR Reflow)



Reliability Test Program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C, 5 sec
HOLT	MIL-STD-883D-1005.7	1000 Hrs Bias @ 125°C
PCT	JESD-22-B,A102	168 Hrs, 100%RH, 121°C
TST	MIL-STD-883D-1011.9	-65°C~150°C, 200 Cycles
ESD	MIL-STD-883D-3015.7	VHBM > 2KV, VMM > 200V
Latch-Up	JESD 78	10ms, 1 _{tr} > 100mA

Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T _L to T _P)	3°C/second max.	3°C/second max.
Preheat		
- Temperature Min (T _{min})	100°C	150°C
- Temperature Max (T _{max})	150°C	200°C
- Time (min to max) (t _s)	60-120 seconds	60-180 seconds
Time maintained above:		
- Temperature (T _L)	183°C	217°C
- Time (t _L)	60-150 seconds	60-150 seconds
Peak/Classification Temperature (T _p)	See table 1	See table 2
Time within 5°C of actual Peak Temperature (t _p)	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max.	6°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

Note: All temperatures refer to topside of the package. Measured on the body surface.

Classification Reflow Profiles (Cont.)

Table 1. SnPb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	240 +0/-5°C	225 +0/-5°C
≥2.5 mm	225 +0/-5°C	225 +0/-5°C

Table 2. Pb-free Process – Package Classification Reflow Temperatures

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ >2000
<1.6 mm	260 +0°C*	260 +0°C*	260 +0°C*
1.6 mm – 2.5 mm	260 +0°C*	250 +0°C*	245 +0°C*
≥2.5 mm	250 +0°C*	245 +0°C*	245 +0°C*

* Tolerance: The device manufacturer/supplier **shall** assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.

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