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

Features

- **Single Phase Full Wave Fan Driver**
- **Silent Driver (45dB Gian for Low Noise)**
- **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)**
- **Design Reference for AEC-Q100 Grade3 Compliant**

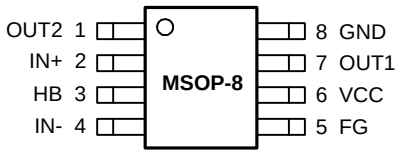
Applications

- **Motor Drivers For Silent Fan Motors**

General Description

The APX9268A 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 APX9268A is available in MSOP-8 package.

Pin Configuration



Ordering and Marking Information

APX9268A □□-□□□

- Assembly Material
- Handling Code
- Temperature Range
- Package Code

Package Code
X : MSOP-8
Temperature Range
I : -40 to 105 °C
Handling Code
TR : Tape & Reel
Assembly Material
G : Halogen and Lead Free Device

APX9268A X :

XXXXX - Date Code

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).

Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Rating	Unit
V_{CC}	VCC Pin Supply Voltage (VCC to GND)	-0.3 to 10	V
I_{OUT}	Output Pin Maximum Output Current	1	A
V_{OUT}	Output Pin Output Voltage	-0.3 to 10	V
I_{HB}	HB Pin Maximum Output Current	10	mA
	FG Pin Maximum Output Voltage	-0.3 to 10	V
I_{FG}	FG Pin Maximum Output Sink Current	10	mA
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

Note 1 : 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.

Thermal Characteristics

Symbol	Parameter	Typical Value	Unit
θ_{JA}	Thermal Resistance-Junction to Ambient (Note 2) MSOP-8	215	°C/W
P_D	Power Dissipation, T_A=25 °C	0.585	W

Note 2: θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air.

Recommended Operating Conditions

Symbol	Parameter	Range	Unit
V_{CC}	VCC Pin Supply Voltage	2 to 6	V
V_{Hall}	Hall Input Voltage Range	0.4 to Vcc-1.1	V
T_A	Ambient Temperature	-40 to 105	°C
T_J	Junction Temperature	-40 to 125	°C

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

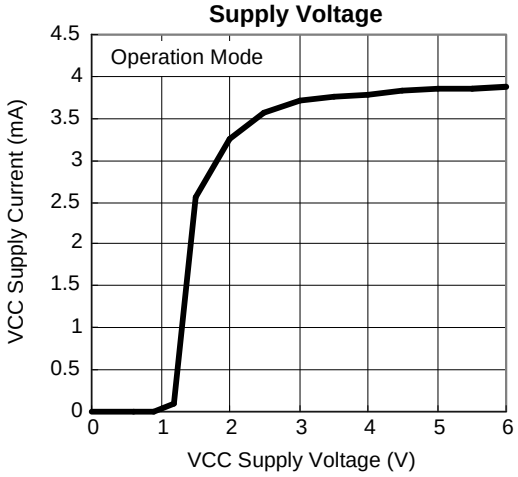
Symbol	Parameter	Test Conditions	APX9268A			Unit
			Min.	Typ.	Max.	
SUPPLY CURRENT						
V_{HB}	HB Pin Output Voltage	I_{HB} = 5mA	1.1	1.3	1.5	V
I_{CC1}	Supply Current	Rotation Mode	-	4	5	mA
I_{CC2}		Lock Protection Mode	-	4	5	mA
LOCK PROTECTION						
T_{ON}	Lock Detection On Time		0.35	0.5	0.65	sec
T_{OFF}	Lock Detection Off Time		3.5	5	6.5	sec

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

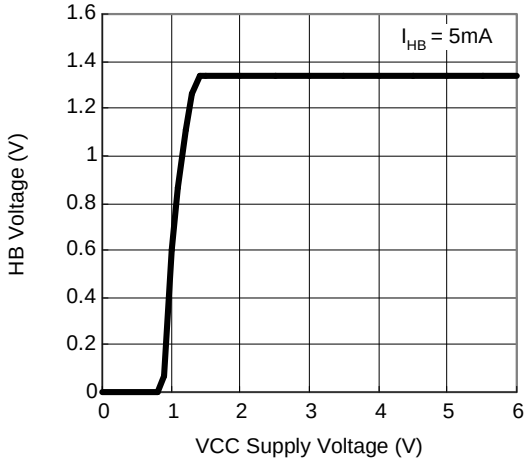
Symbol	Parameter	Test Conditions	APX9268A			Unit
			Min.	Typ.	Max.	
OUTPUT DRIVERS						
V_O	Output Driver Saturation Voltage	I_{OUT} = 250mA, Upper and Lower total	-	0.3	0.44	V
V_{FG}	FG Pin Low Voltage	I_{FG} = 5mA	-	0.1	0.2	V
I_{FGL}	FG Pin Leakage Current	V_{FG} = 5V	-	0.1	1	μA
G_{ID}	Input - Output Gain	V_{OUT}/V_{IN+}-V_{IN-}	44	45	46	dB
HALL SENSITIVITY						
V_{HOFS}	Hall Input Offset Voltage		-	-	±6	mV
V_{HYS}	Input Hysteresis Voltage		±5	±10	±15	mV
THERMAL SHUTDOWN						
OTS	Over Temperature Shutdown Threshold		-	165	-	°C
	Over Temperature Shutdown Hysteresis		-	30	-	°C

Typical Operating Characteristics

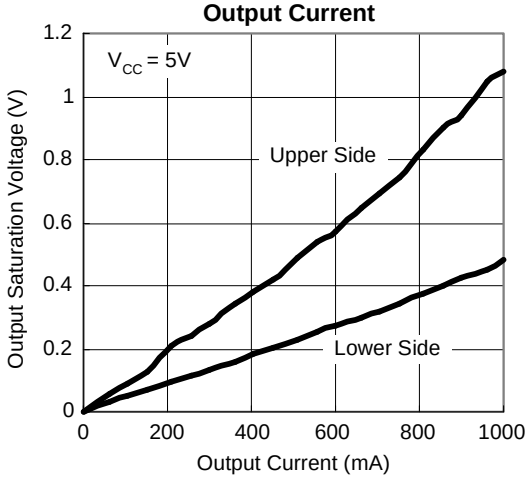
VCC Supply Current vs. VCC Supply Voltage



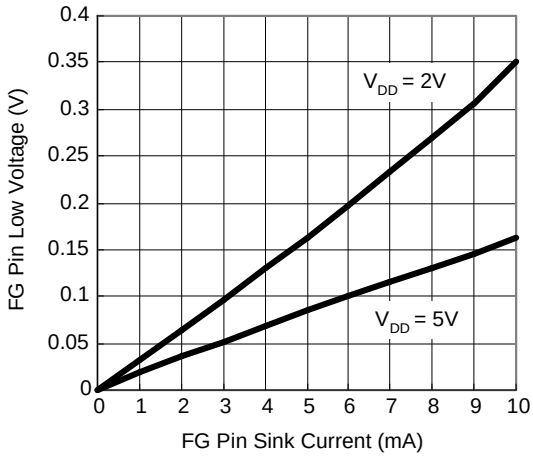
HB Voltage vs. VCC Supply Voltage



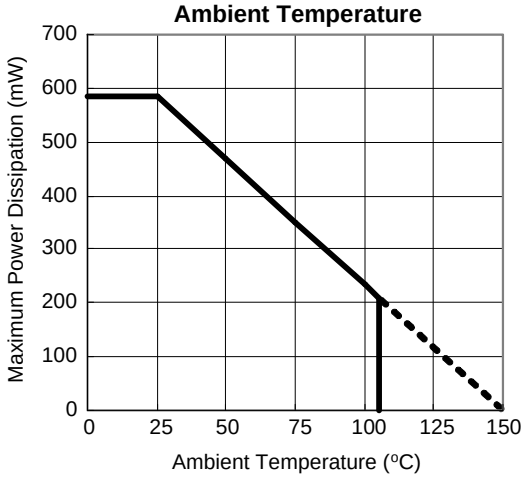
Output Saturation Voltage vs. Output Current



FG Pin Low Voltage vs. Sink Current

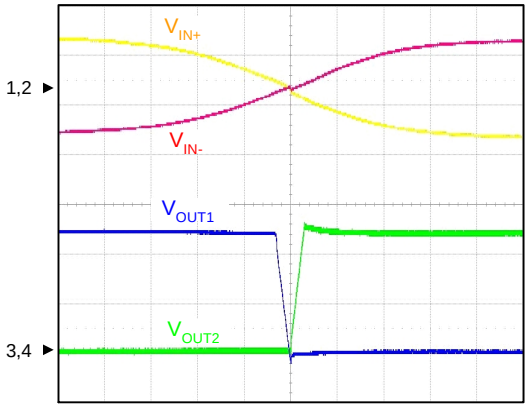


Maximum Power Dissipation vs. Ambient Temperature



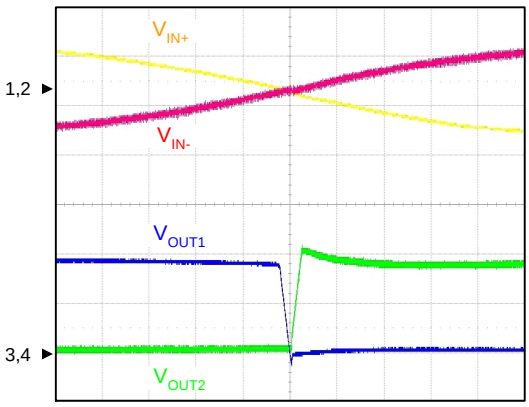
Operating Waveforms

Rotation Mode Waveform1 (VCC=5V)



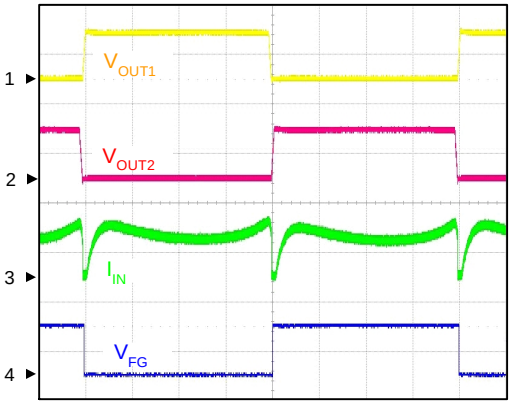
CH1:V_{IN+},100mV/div,AC
CH2:V_{IN-},100mV/div,AC
CH3:V_{OUT1},2V/div,DC
CH4:V_{OUT2},2V/div,DC
Time:200µs/div

Rotation Mode Waveform1 (VCC=2V)



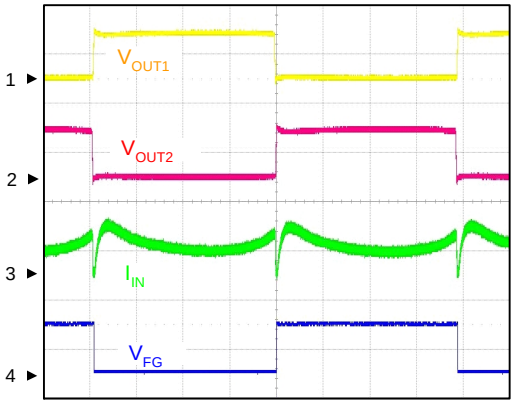
CH1:V_{IN+},100mV/div,AC
CH2:V_{IN-},100mV/div,AC
CH3:V_{OUT1},1V/div,DC
CH4:V_{OUT2},1V/div,DC
Time:200µs/div

Rotation Mode Waveform2 (VCC=5V)



CH1:V_{OUT1},5V/div,DC
CH2:V_{OUT2},5V/div,DC
CH3:I_{IN},200mA/div,DC
CH4:V_{FG},5V/div,DC
Time:1ms/div

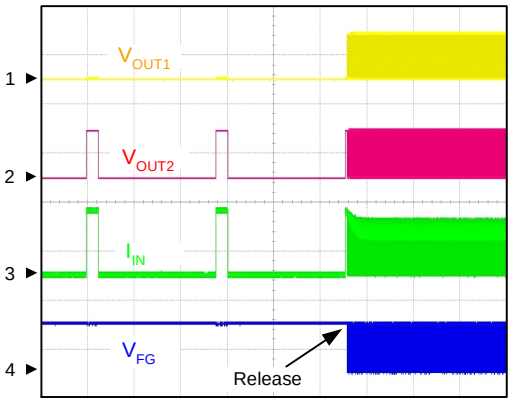
Rotation Mode Waveform2 (VCC=2V)



CH1:V_{OUT1},2V/div,DC
CH2:V_{OUT2},2V/div,DC
CH3:I_{IN},100mA/div,DC
CH4:V_{FG},2V/div,DC
Time:2ms/div

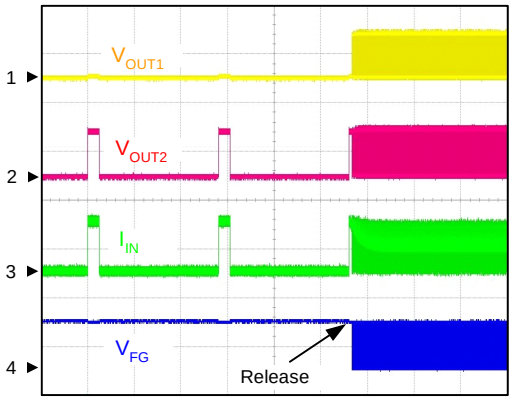
Operating Waveforms (Cont.)

Lock Protection Waveform (VCC=2V)



CH1:V_{OUT1},5V/div,DC
CH2:V_{OUT2},5V/div,DC
CH3:I_{IN},200mA/div,DC
CH4:V_{FG},5V/div,DC
Time:2s/div

Lock Protection Waveform (VCC=2V)

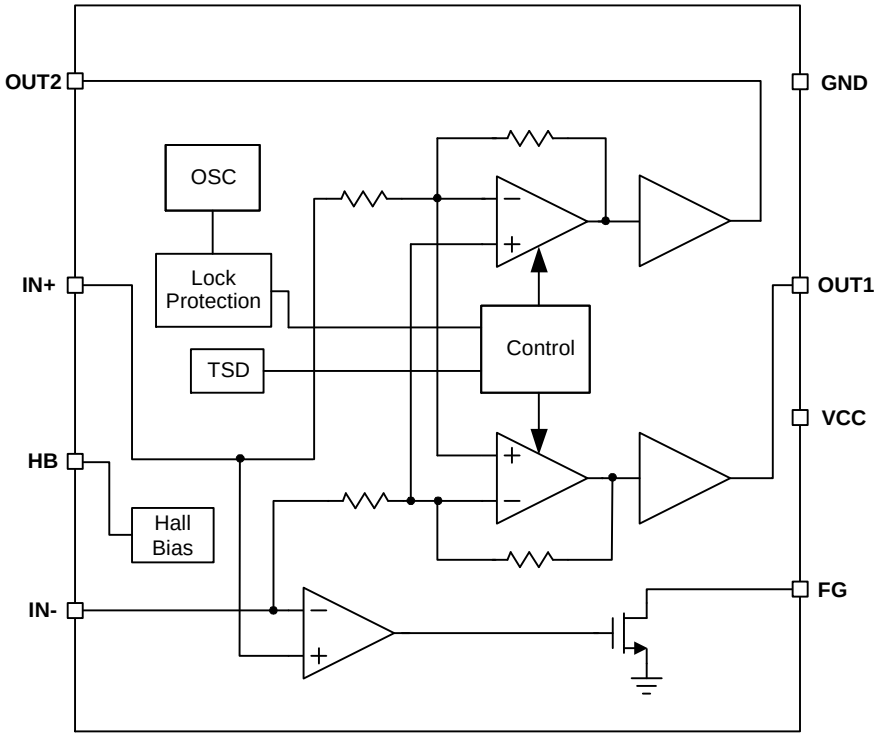


CH1:V_{OUT1},2V/div,DC
CH2:V_{OUT2},2V/div,DC
CH3:I_{IN},100mA/div,DC
CH4:V_{FG},2V/div,DC
Time:2s/div

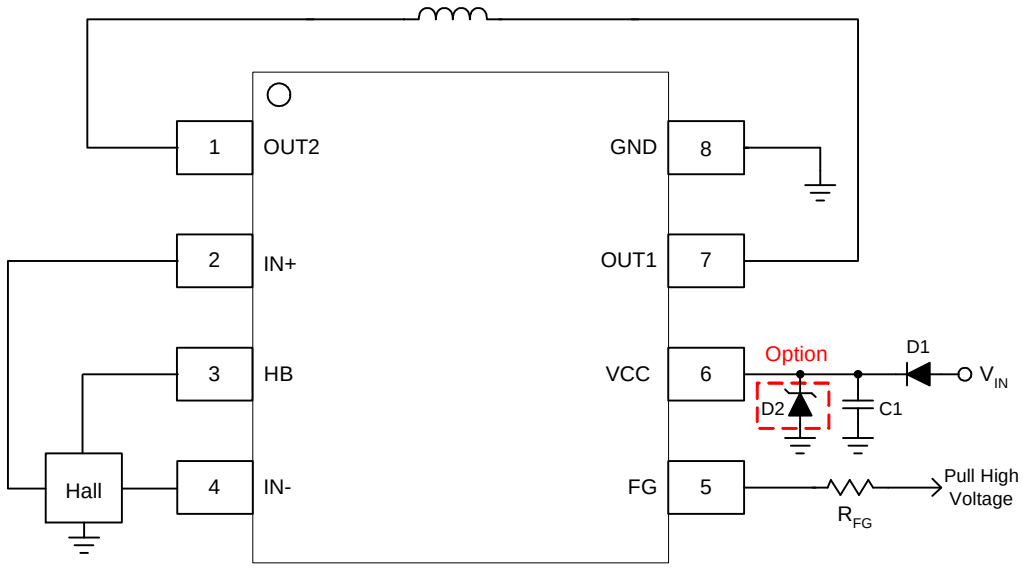
Pin Description

PIN		FUNCTION
NO.	NAME	
1	OUT2	H-bridge output connection.
2	IN+	Hall Input +. Connect to hall element positive output.
3	HB	Hall Bias. This is a 1.3V constant-voltage output for hall element bias.
4	IN-	Hall Input -. Connect to hall element negative output.
5	FG	Rotation Speed Output. This is an open-collector output.
6	VCC	Supply Voltage.
7	OUT1	H-bridge output connection.
8	GND	Power GND.

Block Diagram



Typical Application Circuit



Note : For zener diode (D2) is optional choice.

Function Description

Lockup Protection and Automatic Restart

The APX9268A provides the lockup protection and automatic restart functions for preventing the coil burnout 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).

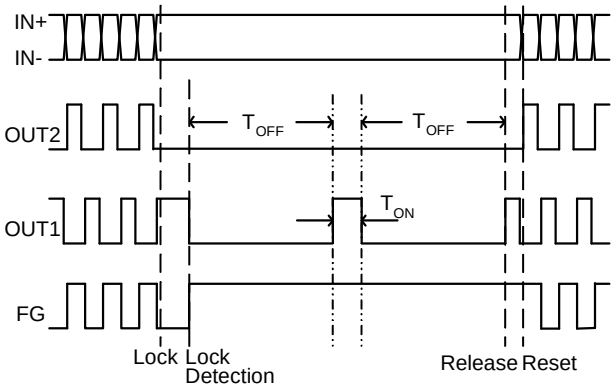


Figure 1. Lockup /Auto Restart Waveform

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

Thermal Protection

The APX9268A has thermal protection. When internal junction temperature reaches 165°C, the output devices will be switched off. When the IC's junction temperature cools by 30°C, the thermal sensor will turn the output devices on again, resulting in a pulsed output during continuous thermal protection.

Truth Table

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

Application Information

Input Protection Diode & Zener Diode & Capacito

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 when power on or system power transients. 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 becomes steep (See Figure 2 Different of output signal depending on the shape of hall input signal). The input/output gain is 45dB(typ.). Thus, please adjust the amplitude of hall input to meet the adequate output voltage.

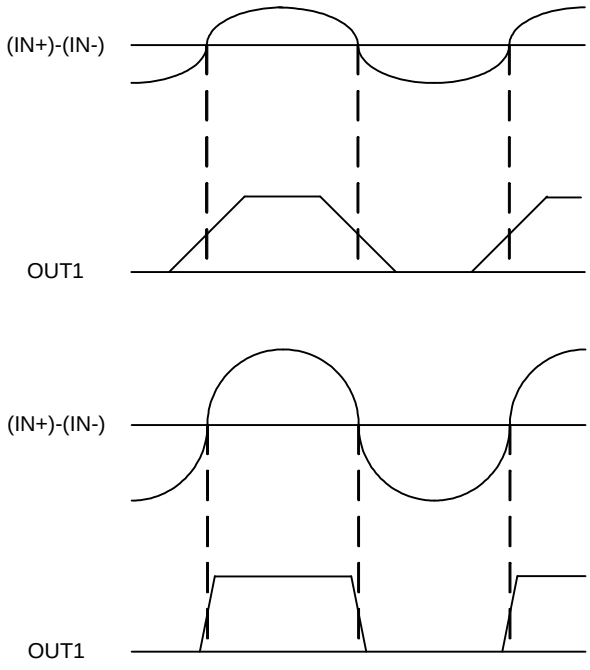


Figure 2. Different of Output Signal Depending on the Shape of Hall Input Signal

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} = 5mA, V_{FG} = 0.2V, R_{FG} = 0.96kΩ

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°C, the maximum power dissipation is about 0.35W (See Power Dissipation vs. Ambient Temperature). Mounted on a board, there is 60x38x 1.6t 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} = 250mA, V_{OH} = 4.76V, V_{OL} = 0.11V,

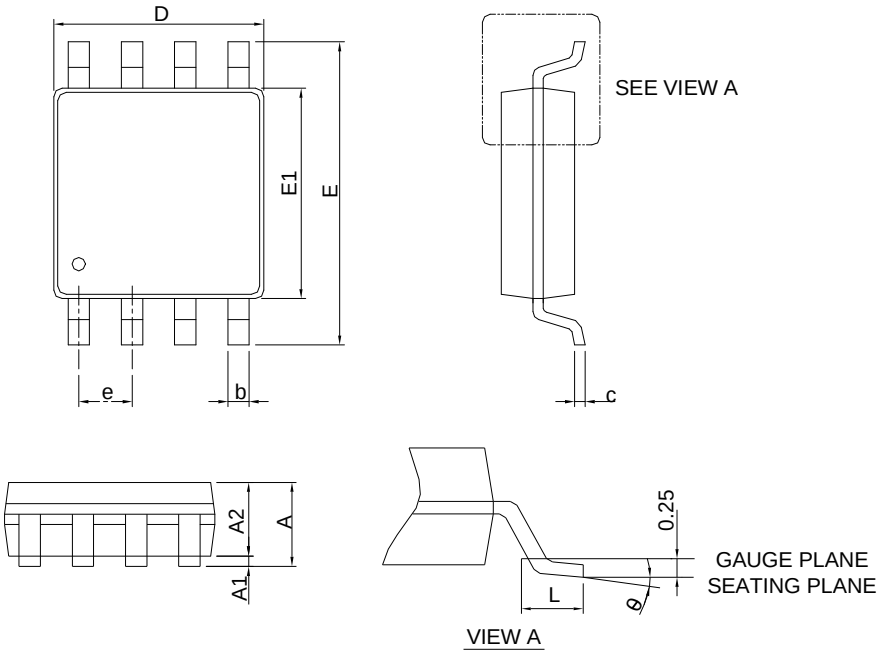
then

P_D = 0.108W

The GND pin provides an electrical connection to the 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

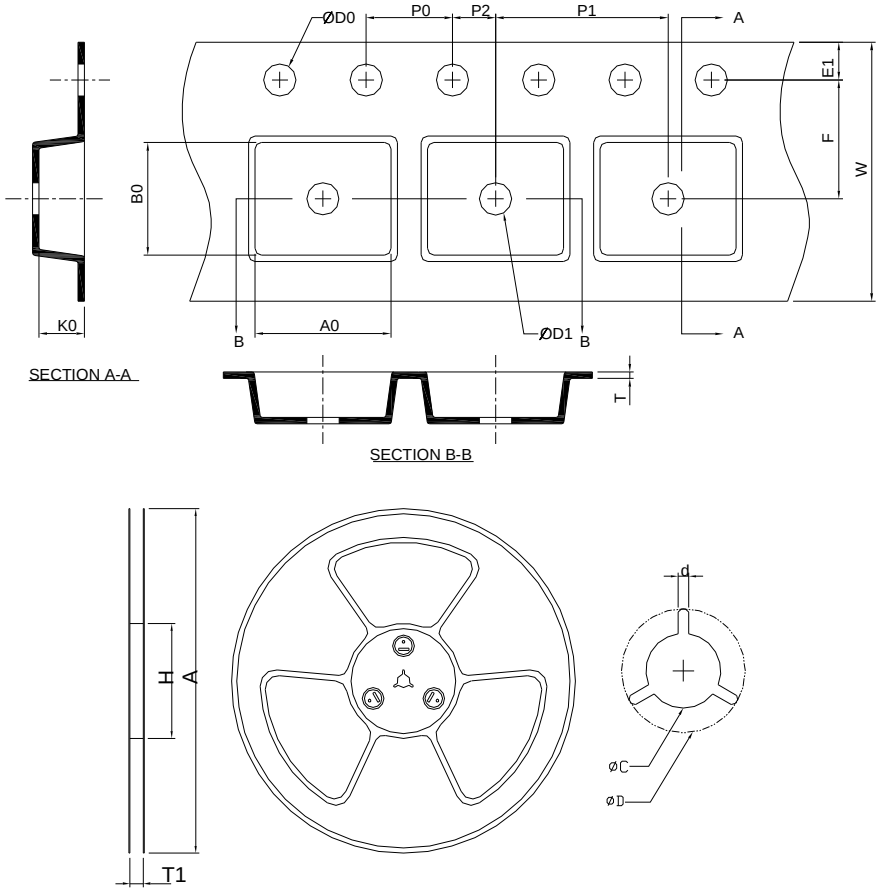
MSOP-8



SYMBOL	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±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.00±0.10	8.00±0.10	2.00±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	5.30±0.20	3.30±0.20	1.40±0.20

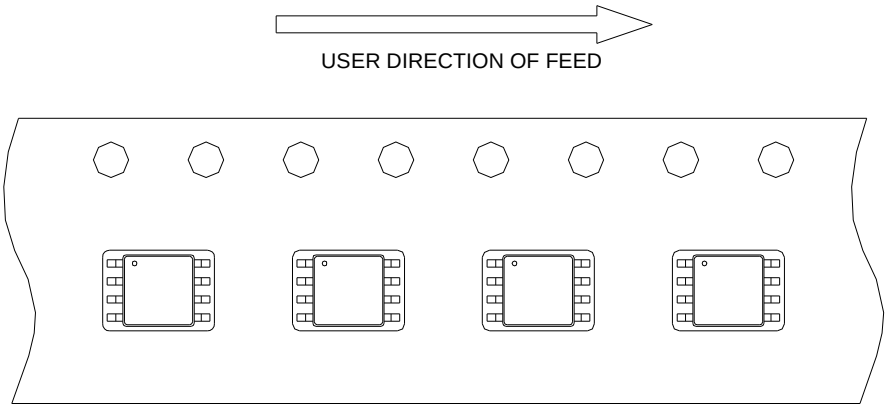
(mm)

Devices Per Unit

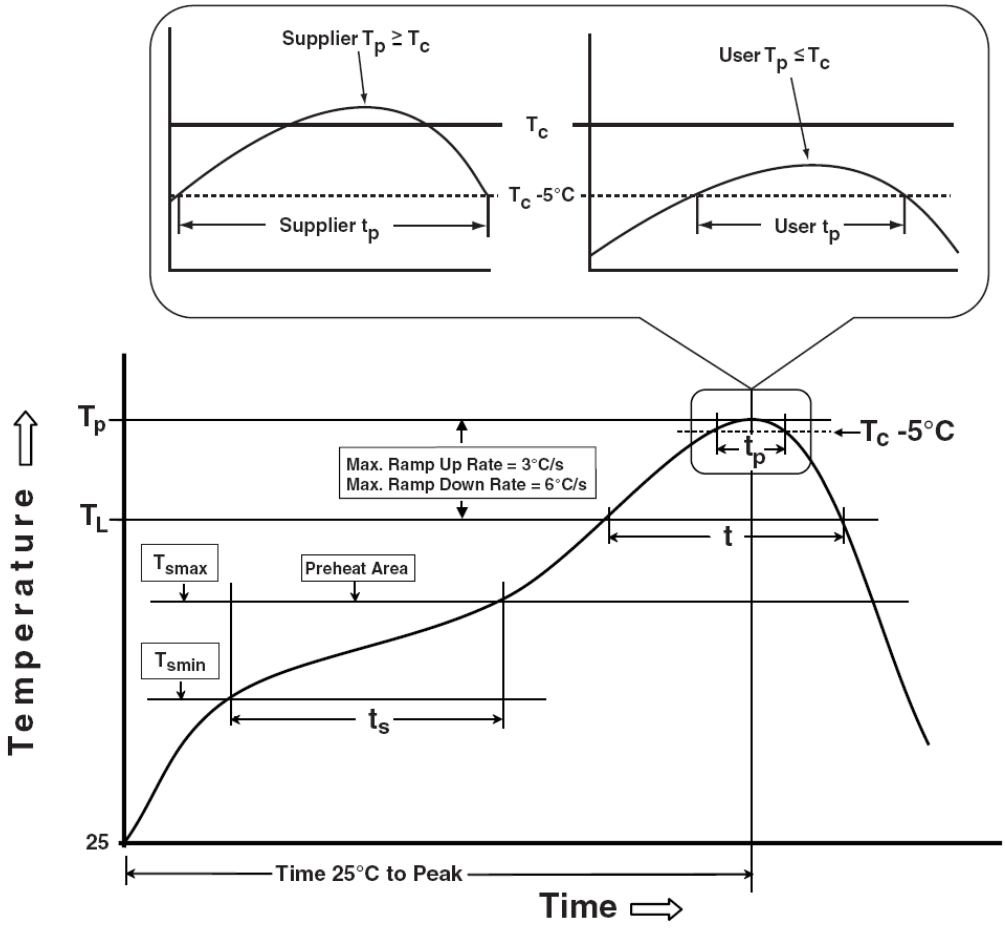
Package Type	Unit	Quantity
MSOP- 8	Tape & Reel	3000

Taping Direction Information

MSOP-8



Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_P)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (t_P)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum. ** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (Tc)

Package Thickness	Volume mm^3 <350	Volume mm^3 ³350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (Tc)

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

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	JESD-22, B102	5 Sec, 245°C
HOLT	JESD-22, A108	1000 Hrs, Bias @ 125°C
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C
ESD	JESD-22, A114; A115	VHBM≧2KV, VMM≧200V
Latch-Up	JESD 78	10ms, 1_{tr}≧100mA

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