Single-Phase Full-Wave Motor Driver for Fan Motor

Features

- **Single Phase Full Wave Fan Driver**
- **Low Quiescent Current**
- **Built-in Variable Speed Function**
- **OTP Setting Minimum Input and Output Duty**
- **OTP Setting Enable Soft Start Function**
- **Current Limit Circuit**
- **Built-in Lock Protection and Auto Restart Function**
- **FG Output (SEL floating) or RD Output (SEL GND)**
- **Built-in Thermal Protection Circuit**
- **Lead Free and Green Device Available (RoHS Compliant)**

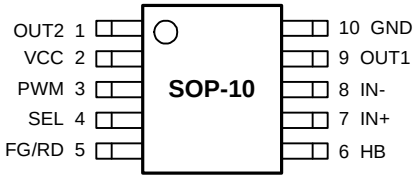
Applications

- **CPU Cooler Fans**
- **Variable Speed Control Fans**

General Description

The APX9766 is a single phase full wave DC brushless motor driver with PWM variable speed control and current limit features suitable for the fan of personal computer's power supply and CPU cooler. The PWM control system fixed the minimum input and output duty through internal OTP block setting. The device is equipped with a built-in lock protection, which protects the fan when it is locked. It also has rotation speed detection output and thermal protection function. The APX9766 is available in SOP-10 package (see Pin Configuration).

Pin Configuration



Ordering and Marking Information

APX9766 □□-□□□ Assembly Material Handling Code Temperature Range Package Code	Package Code K:SOP-10 Operating Ambient Temperature Range I : -40 to 90 °C Handling Code TR : Tape & Reel Assembly Material G: Halogen and Lead Free Device
APX9766 K : APX9766 XXXXX	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-020D 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.

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Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Ratings	Unit
V_{CC}	VCC Pin Supply Voltage (VCC to GND)	-0.3 to 18	V
I_{OUT}	OUT1, OUT2 Pin Maximum Output Current	1	A
$V_{OUT1, OUT2}$	OUT1, OUT2 Pin Output Voltage	VGND-0.3 to VCC	V
V_{PWM}	PWM Pin Input Voltage (PWM to GND)	-0.3 to 18	V
	FG Pin Output Voltage	-0.3 to 18	V
I_{FG}	FG Pin Maximum Output Sink Current	10	mA
I_{HB}	HB Pin Output Source Current	10	mA
T_J	Maximum Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 to 150	°C
T_{SDR}	Maximum Lead Soldering Temperature, 10 Seconds	260	°C

Note1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability

Thermal Characteristics

Symbol	Parameter	Typical Value	Unit
$R_{TH,JA}$	Thermal Resistance-Junction to Ambient (Note 2) SOP-10	147	°C/W
P_D	Power Dissipation, T_A=25°C SOP-10	0.85	W

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

Recommended Operation Conditions (Note 3)

Symbol	Parameter	Range	Unit
V_{CC}	VCC Pin Supply Voltage Range	3.5 to 15	V
V_{ICM}	Hall Input (IN+, IN-) Common-Phase Input Voltage Range	0.2 to 3	V
T_A	Ambient Temperature	-40 to 90	°C
T_J	Junction Temperature	-40 to 125	°C

Note 3: Refer to the typical application circuit.

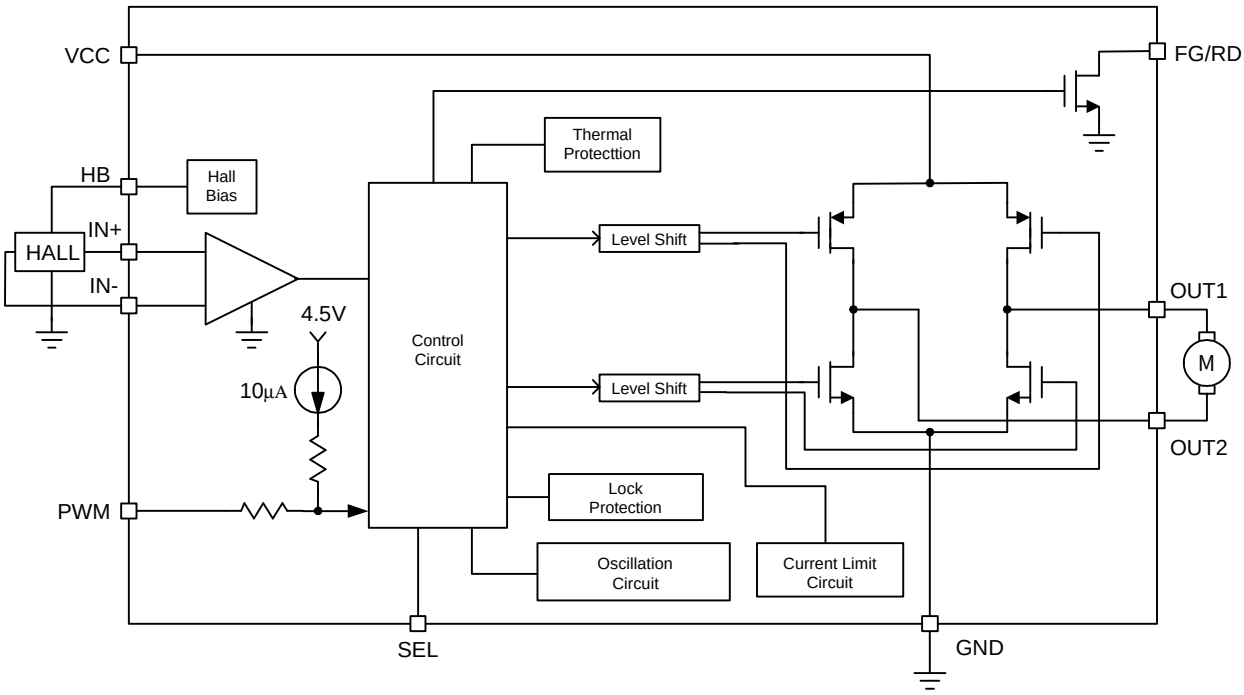
Electrical Characteristics (V_{CC}=12V, T_A= 25 °C. unless otherwise specified)

Symbol	Parameter	Test Conditions	APX9766			Unit
			Min	Typ	Max	
SUPPLY CURRENT						
V_{HB}	HB Pin Output Voltage	I_{HB} = 5mA	1.06	1.1	1.14	V
I_{CC1}	Operating Current	Rotation Mode	-	5	8	mA
I_{CC2}		Lock Protection Mode	-	5	8	
I_{CC3}		PWM=0% (OUTPUT=0%)	-	1	1.5	
LOCK PROTECTION						
T_{ON}	Lock Detection On Time	User define by OTP programming	0.5	-	1	sec
T_{OFF}	Lock Detection Off Time	User define by OTP programming	3.5	-	7	sec
R_{LOCK}	T_{OFF}/T_{ON} Ratio	$R_{LOCK} = T_{OFF}/T_{ON}$	-	7	-	-
SOFT START						
T_{SS}	Soft Start Time	User enable by OTP programming	-	13*T_{ON}	-	sec
OUTPUT DRIVERS						
V_O	Output Driver Saturation Voltage	I_{OUT} = 200mA, Upper and Lower total	-	0.25	0.5	V
V_{FG}	FG Pin Low Voltage	I_{FG} = 5mA	-	0.1	0.2	V
I_{FGL}	FG Pin Leakage Current	V_{FG} = 12V	-	<0.1	1	µA
PWM CONTROL						
V_{PWMH}	PWM Pin Input High Level Voltage		2	-	V_{CC}+0.3	V
V_{PWML}	PWM Pin Input Low Level Voltage		-0.3	-	0.8	V
I_{PWMH}	PWM Pin High Level Input Current	V_{PWM} = 5V	-	10	20	µA
I_{PWML}	PWM Pin Low Level Input Current	V_{PWM} = 0V	-	-10	-20	µA
F_{PWM}	PWM Pin Input Frequency		20	-	50	KHz
INPUT-OUTPUT DUTY						
DI_{MIN}	Minimum Input Duty for DO_{MIN} setting	User define by OTP programming	0	-	90	%
DO_{MIN}	Minimum Output Duty for DI_{MIN} setting	User define by OTP programming	9	-	90	%
R_{OI}	Ratio of DO_{MIN} and DI_{MIN} setting	(100-DO_{MIN})/(100-DI_{MIN})	0	-	2	
HALL SENSITIVITY						
V_{HN}	Hall Input Sensitivity	Zero to peak including offset and hysteresis	-	10	20	mV
CURRENT LIMIT						
I_{LIM}	Internal Current Limit		-	1000	-	mA
THERMAL PROTECTION						
T_{OTS}	Over Temperature Shutdown Threshold		-	165	-	°C
	Over Temperature Shutdown Hysteresis		-	30	-	

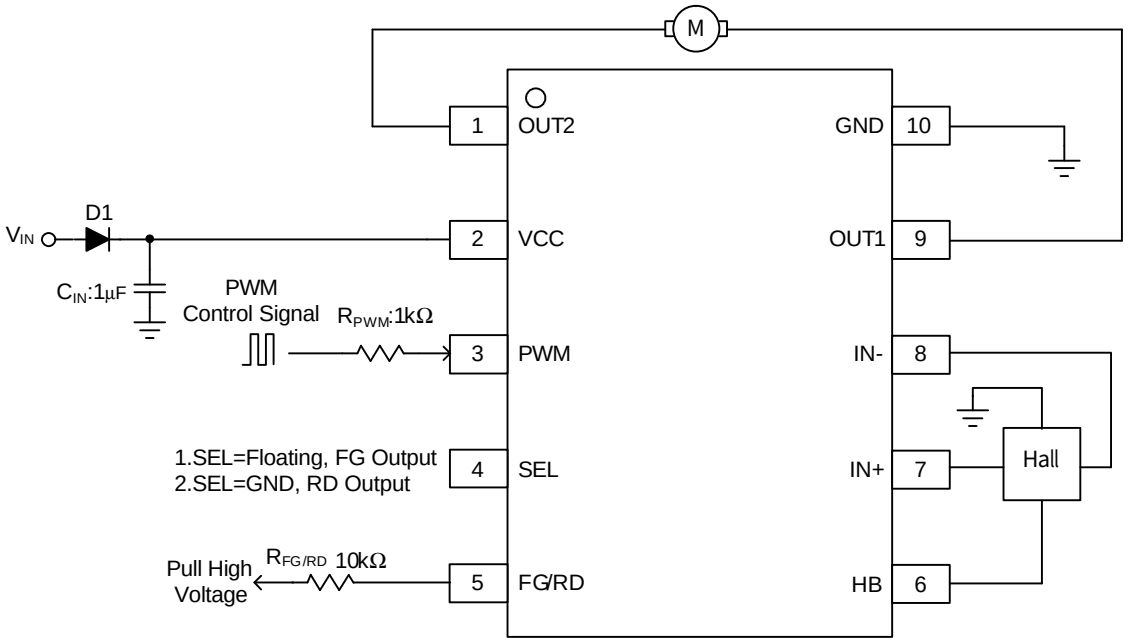
Pin Description

PIN		FUNCTION
NO.	NAME	
1	OUT2	H-bridge Output Connection.
2	VCC	Supply Voltage Input Pin.
3	PWM	PWM Signal Input Terminal.
4	SEL	FG/RD Function Select Pin.
5	FG/RD	Rotation Speed or Detection Output. This is an open-drain output.
6	HB	Hall Bias. This is a 1.1V constant-voltage output for hall element bias.
7	IN+	Hall Input +. Connect to hell element positive output.
8	IN-	Hall Input -. Connect to hell element negative output.
9	OUT1	H-bridge Output Connection.
10	GND	Power GND.

Block Diagram



Typical Application Circuit



Note: R_{PWM} is optional to protect internal circuit for high voltage stress

Function Description

External PWM Speed Control

For the simply speed control curve of cooler fans, the APX9766 embedded OTP (One Time Programming) block to set two types input and output duties. (See Figure1: Output Duty Control Curve).

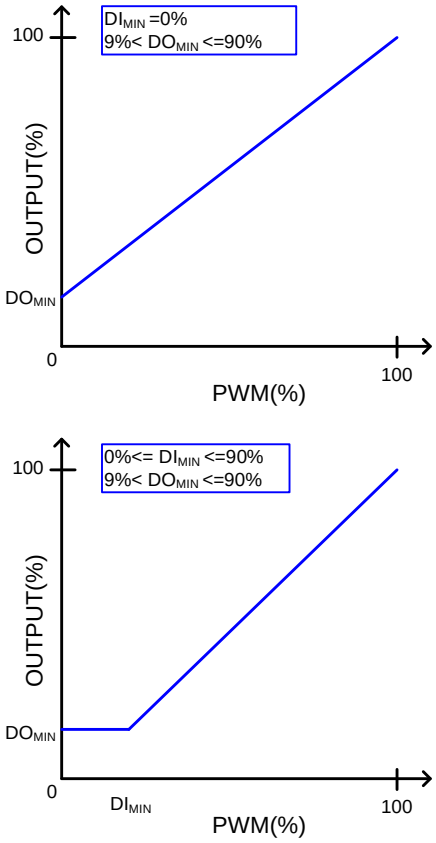


Figure1: Output Duty Control Curve

Lockup Protection and Automatic Restart

This IC detects the rotation of the motor by the hall signal, and adjusts lock detection ON time (T_{ON}) and lock detection OFF time (T_{OFF}) by the internal counter. These times (T_{ON}, T_{OFF}) are shown below (see Figure 2: Lock/Auto Restart Waveform).

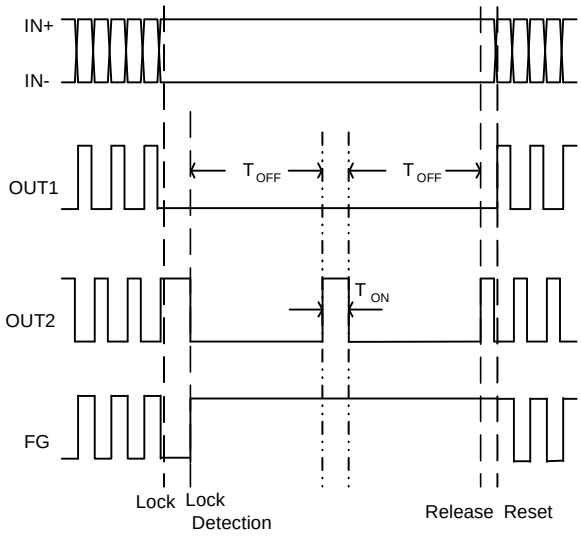


Figure2: Lock/Auto Restart Waveform

FG Output

The FG pin is an open drain output connecting a pull up resistor to a high level voltage for the speed detection function. When V_{IN-} is larger than V_{IN+}, the V_{FG} is high (switch off); when VIN- is smaller than V_{IN+}, the V_{FG} is low (switch on). Leave it open when not in using.

Thermal Protection

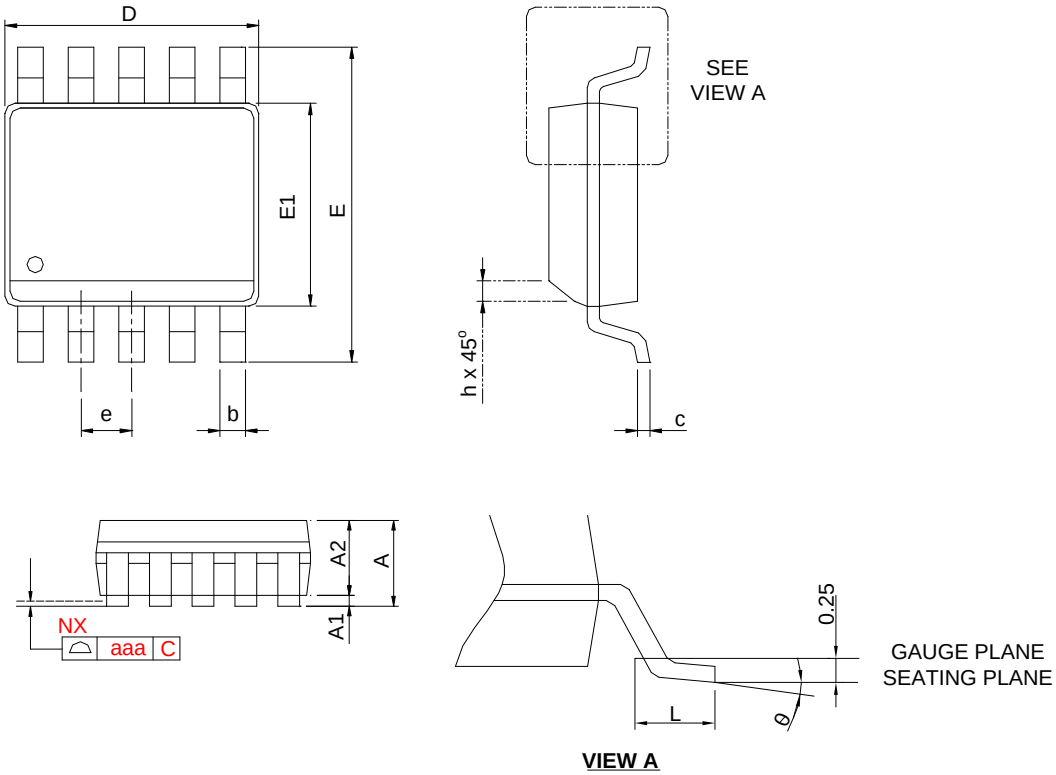
The APX9766 is designed with a thermal protection to protect the IC from the damage of over temperature. When internal junction temperature reaches 165°C, the output devices will be switched off. When the IC's junction temperature cools by 30°C, the thermal sensor will turn the output devices on again resulting in a pulsed output during continuous thermal overload.

Pin Description

Input		Output				
IN-	IN+	OUT1	OUT2	FG	RD	Mode
H	L	H	L	OFF	L	Rotation (Drive)
L	H	L	H	L	L	
H	L	OFF	L	OFF	L	Rotation (Regeneration)
L	H	L	OFF	L	L	
H	L	OFF	L	OFF	OFF	Lock Mode
L	H	L	OFF	OFF	OFF	

Package Information

SOP-10

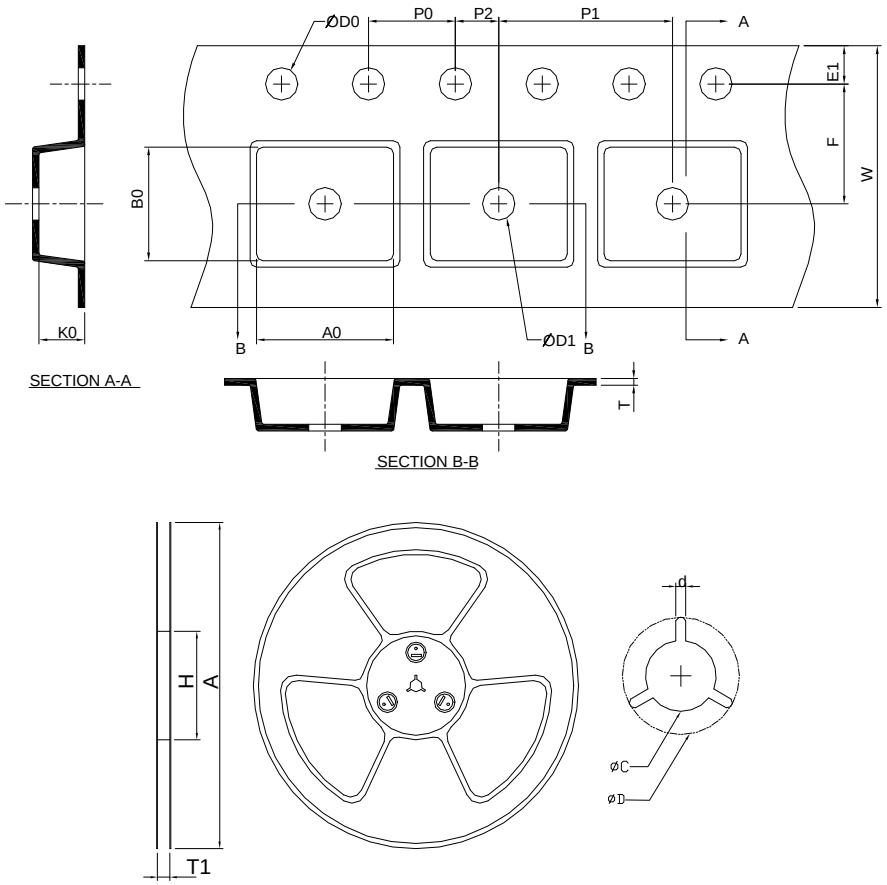


VIEW A

SYMBOL	SOP-10			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.75		0.069
A1	0.10	0.25	0.004	0.010
A2	1.25		0.049	
b	0.30	0.45	0.012	0.018
c	0.17	0.25	0.007	0.010
D	4.80	5.00	0.189	0.197
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.00 BSC		0.039 BSC	
h	0.25	0.50	0.010	0.020
L	0.40	1.27	0.016	0.050
θ	0°	8°	0°	8°
aaa	0.10		0.004	

Note:1. Dimension “D” does not include mold flash, protrusions or gate burrs.
Mold flash, protrusion or gate burrs shall not flash or protrusions.
2. Dimension “E” does not include inter-lead flash or protrusions.
Inter-lead flash and protrusions shall not exceed 10 mil per side.

Carrier Tape & Reel Dimensions



Application	A	H	T1	C	d	D	W	E1	F
SOP-10	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**
	4.0±0.10	8.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.40±0.20	5.20±0.20	2.10±0.20

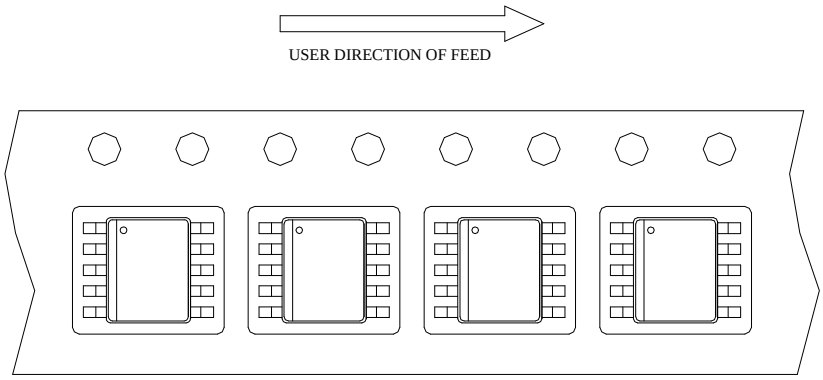
(mm)

Devices Per Unit

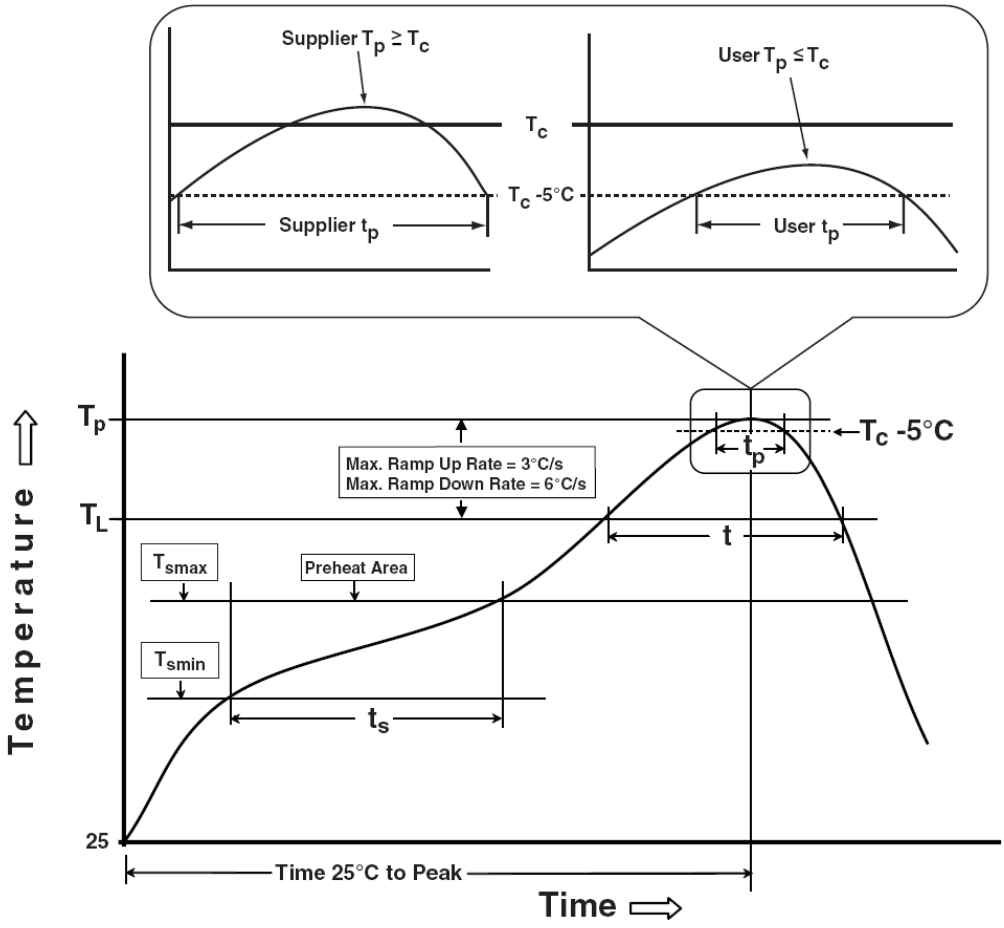
Package Type	Unit	Quantity
SOP-10	Tape & Reel	2500

Taping Direction Information

SOP-10



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^3 350
<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 @ Tj=125°C
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C
HBM	MIL-STD-883-3015.7	VHBM≧2KV
MM	JESD-22, A115	VMM≧200V
Latch-Up	JESD 78	10ms, 1_{tr}≧100mA

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