

## High Sensitivity Hall IC for FAN Driver

### Features

- **On-Chip Hall Sensor**
- **Low Operating Supply Voltage: 2.5V**
- **Lower Speed Under 7.5V (Typ.) VDD Supply Voltage**
- **High Sensitivity Hall Effect Sensor IC:  $\pm 20G$  (Type.)**
- **Soft-Switch to Reduce Phase-Switching Noise**
- **Built-In Output Protection Clamping Circuit**
- **Lock Protection and Auto Restart Function**
- **Built-In Thermal Protection Circuit**
- **4 Pin TO-92M4 Package**
- **Lead Free and Green Devices Available (RoHS Compliant)**

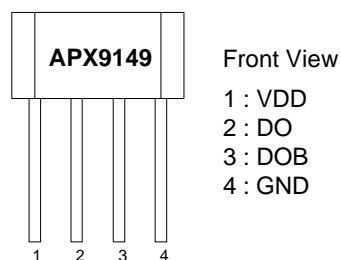
### Applications

- **Brushless DC Fans**
- **Brushless DC Motors**

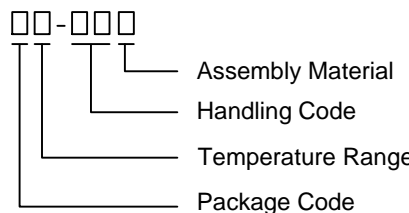
### General Description

The APX9149 is an integrated Hall Effect Sensor IC designed for electric commutation of two-phase DC brushless motor applications. In DC fan applications, the APX9149 provides lower driving current under 7.5V (typ.) VDD supply voltage for low noise applications. The device is built-in lock protection. When the fan is locked, the device will enter the lock protection mode. The APX9149 is available in a low cost TO-92M4 package.

### Pin Description



### Ordering and Marking Information

APX9149		<b>Package Code</b> E : TO-92M4 <b>Temperature Range</b> I : -40 to 105 °C <b>Handling Code</b> PB : Plastic Bag <b>Assembly Material</b> G : Halogen and Lead Free Device
APX9149 E :	<div style="border: 1px solid black; padding: 2px; display: inline-block;">                     APX 9149 XXXXX                 </div>	XXXXXX - 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.

## Absolute Maximum Ratings ( $T_A = 25^\circ\text{C}$ unless otherwise noted) (Note 1)

Symbol	Parameter	Rating	Unit
$V_{DD}$	VDD Pin Supply Voltage	-0.3 to 20	V
$V_{DO, DOB}$	Output Pin (DO, DOB) Output Voltage	-0.3 to $V_{OUT-CLAMP}$	V
$I_{OUT}$	Maximum Output Pin (DO, DOB) Sink Current - Continuous <sup>(Note 2)</sup> Hold Peak (<100 $\mu\text{s}$ )	600 900 1200	mA
$T_J$	Maximum Junction Temperature	150	$^\circ\text{C}$
$T_{STG}$	Storage Temperature	-65 to 150	$^\circ\text{C}$
$T_{SOR}$	Maximum Lead Soldering Temperature, 10 Seconds	260	$^\circ\text{C}$

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.

Note 2: The maximum continuous current rating should refer recommend operating conditions ( $V_{DD}$ ,  $T_A$ ,  $T_J$ ) to guarantee reliability.

## Thermal Characteristics

Symbol	Parameter	Typical Value	Unit
$\theta_{JA}$	Thermal Resistance-Junction to Ambient <sup>(Note 3)</sup> TO-92M4	131	$^\circ\text{C}/\text{W}$
$P_D$	Power Dissipation, $T_A = 25^\circ\text{C}$	950	mW

Note 3: The maximum allowable power dissipation at any  $T_A$  (ambient temperature) is calculated using:  $P_D(\text{max}) = (T_J - T_A) / \theta_{JA}$ ;  $T_J = 150^\circ\text{C}$ . Exceeding the maximum allowable power dissipation will result in excessive die temperature.

## Recommended Operating Conditions

Symbol	Parameter	Range	Unit
$V_{DD}$	VDD Supply Voltage	2.5 to 16	V
$T_A$	Operating Ambient Temperature	-40 to 105	$^\circ\text{C}$
$T_J$	Junction Temperature	-40 to 125	$^\circ\text{C}$

## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ , $V_{DD} = 12\text{V}$ unless otherwise noted)

Symbol	Parameter	Test Conditions	APX9149			Unit
			Min.	Typ.	Max.	
$I_{DD1}$	VDD Supply Current	$V_{DD}=3\text{V}$ , Output Open	-	2	4	mA
$I_{DD2}$		$V_{DD}=20\text{V}$ , Output Open	-	2	4	mA
$V_{SAT1}$	High Power Output Saturation Voltage	$V_{DD}=12\text{V}$ , $I_{OUT}=300\text{mA}$	-	210	300	mV
$V_{SAT2}$	Low Power Output Saturation Voltage	$V_{DD}=4\text{V}$ , $I_{OUT}=100\text{mA}$	1500	1700	1900	mV
$V_{SAT3}$	Start Up Output Saturation Voltage	$V_{DD}=3\text{V}$ , $I_{OUT}=100\text{mA}$	-	100	200	mV
$V_{TH1}$	High Side VDD Threshold Voltage	$V_{DD}$ falling	7	7.5	8	V
$V_{hys}$	$V_{TH1}$ Hysteresis		-	-	0.5	V
$V_{TH2}$	Low Side VDD Threshold Voltage	$V_{DD}$ rising	3.2	3.4	3.6	V
$V_{OUT-CLAMP}$	DO, DOB Output Clamp Voltage	DO, DOB Pin Off	20	24	28	V
$I_{DOH}$	DO Pin High Input Current	$V_{DO}=12\text{V}$ , $B < Brp$	-	120	200	$\mu\text{A}$
$I_{DOBH}$	DOB Pin High Input Current	$V_{DOB}=12\text{V}$ , $B > Bop$	-	120	200	$\mu\text{A}$

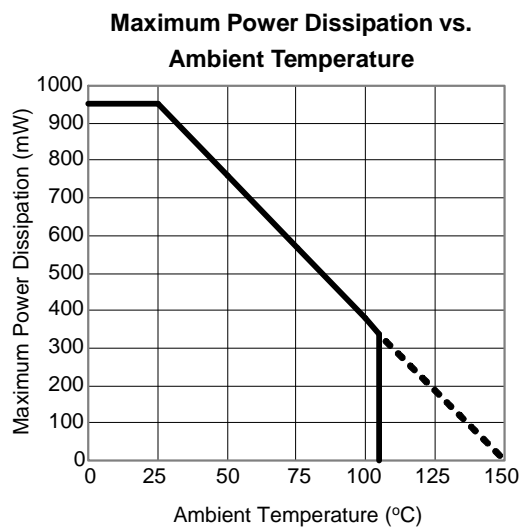
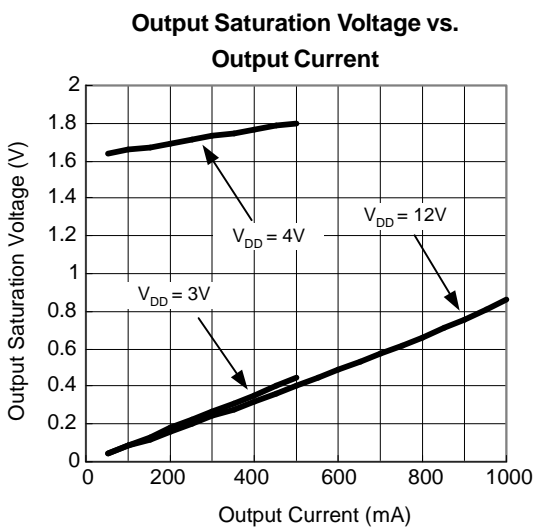
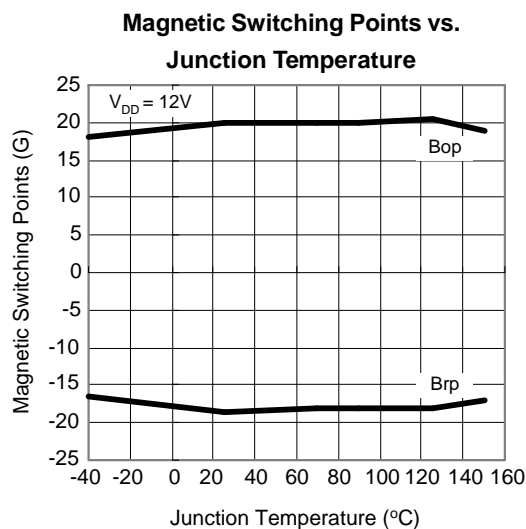
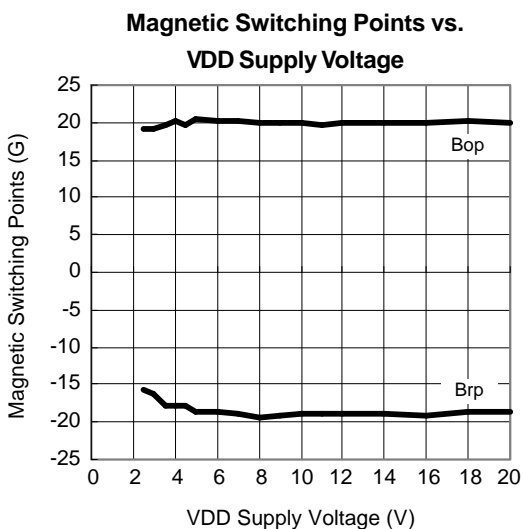
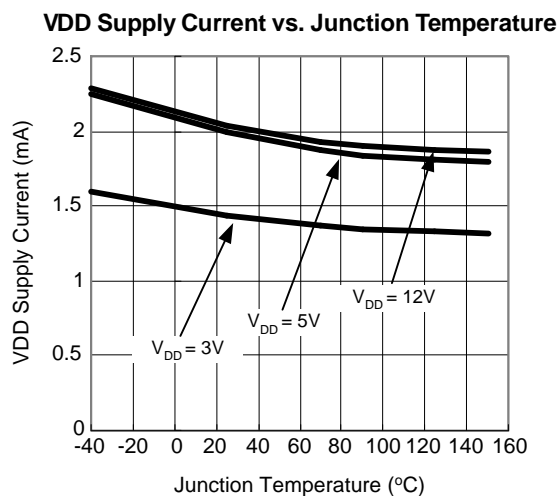
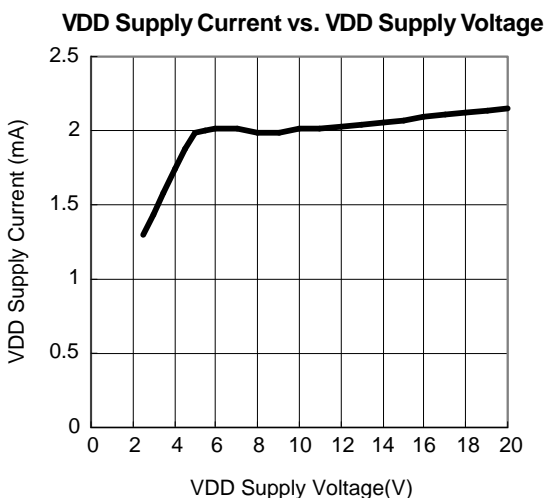
**Electrical Characteristics (Cont.)** ( $T_A=25^\circ\text{C}$ ,  $V_{DD}=12\text{V}$  unless otherwise noted)

Symbol	Parameter	Test Conditions	APX9149			Unit
			Min.	Typ.	Max.	
$T_{ON}$	Lock Detection On Time		-	0.4	-	sec
$T_{OFF}$	Lock Detection Off Time		-	2.8	-	sec
$T_{OTS}$	Over-Temperature Shutdown Threshold		-	165	-	$^\circ\text{C}$
	Over-Temperature Shutdown Hysteresis		-	30	-	$^\circ\text{C}$

**Magnetic Characteristics** ( $T_A=25^\circ\text{C}$ ,  $V_{DD}=12\text{V}$  unless otherwise noted)

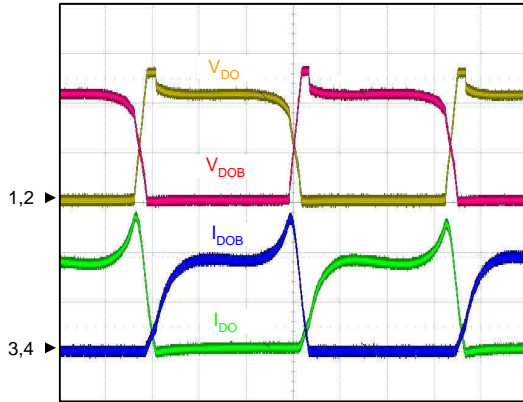
Symbol	Parameter	Test Conditions	APX9149			Unit
			Min.	Typ.	Max.	
Bop	Magnetic Operation Point		5	20	40	Gauss
Brp	Magnetic Release Point		-40	-20	-5	Gauss
Bhys	Magnetic Hysteresis		30	40	50	Gauss

## Typical Operating Characteristics



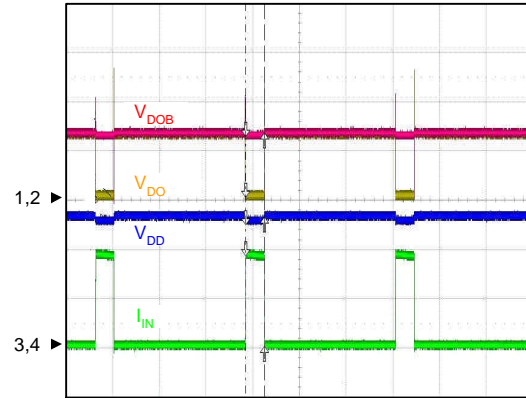
## Operating Waveforms

Rotation Mode Waveform (VIN=14V)



CH1:  $V_{DO}$ , 10V/div, DC  
 CH2:  $V_{DOB}$ , 10V/div, DC  
 CH3:  $I_{DOB}$ , 200mA/div, DC  
 CH4:  $I_{DO}$ , 200mA/div, DC  
 Time: 1ms/div

Lock Mode Waveform (VIN=14V)

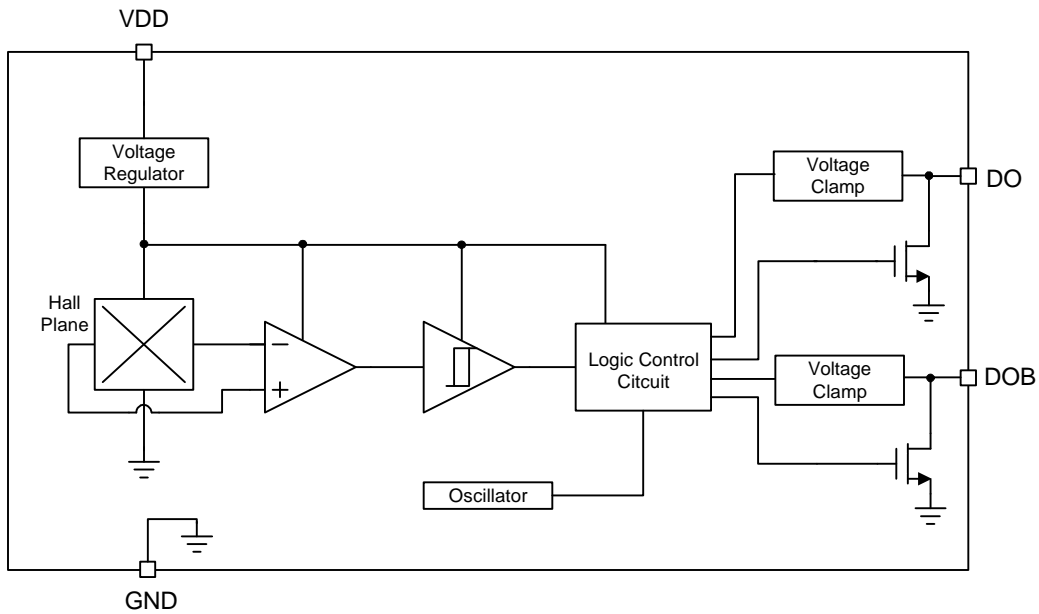


CH1:  $V_{DO}$ , 10V/div, DC  
 CH2:  $V_{DOB}$ , 10V/div, DC  
 CH3:  $V_{DD}$ , 5V/div, DC  
 CH4:  $I_{IN}$ , 500mA/div, DC  
 Time: 1s/div

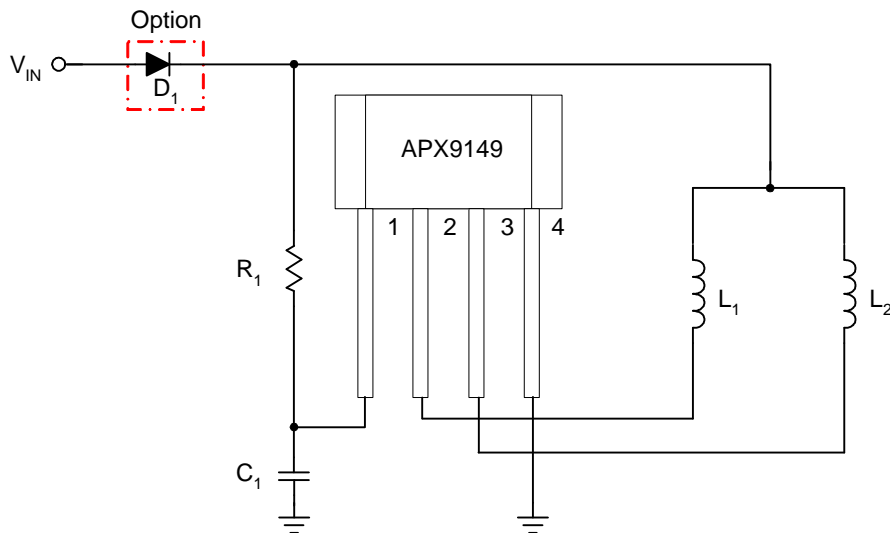
## Pin Description

PIN		FUNCTION
NO.	NAME	
1	VDD	Supply Voltage Input.
2	DO	Open Drain Output. Controlled by magnetic field input.
3	DOB	Open Drain Output. Controlled by magnetic field input.
4	GND	Ground of the IC.

### Block Diagram



### Typical Application Circuit

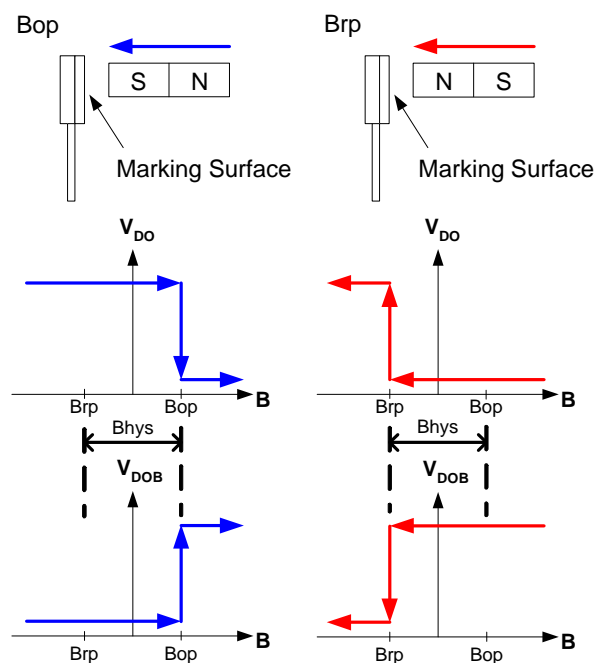


Notes:  $D_1$  is to protect IC and coils when reverse power input.  
 $C_1$ : typical 1 $\mu$ F/25V capacitor recommended.  
 $R_1$ : typical 5.1 $\Omega$  resistor recommended.  
 The  $R_1$  and  $C_1$  are to avoid inrush current to damage IC at hot plug ON/OFF moments and the  $R_1$  and  $C_1$  values need to be selected base on coils design.

## Function Description

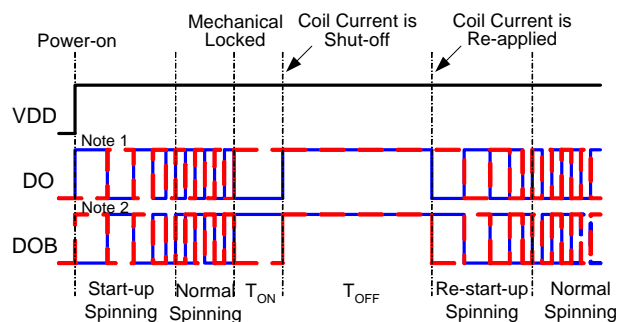
### Output Switch Principle

The APX9149 built in a Hall-effect sensor plane to sense the vertical magnetic flux density (B). There are two output drivers in APX9149 to drive two-phase DC brushless motor. When the South pole magnetic field is close to the IC marking surface and the magnetic flux density higher than operate point (Bop), the DO pin output will turn ON and the DOB pin output will turn OFF. When the South pole magnetic field far away the IC marking surface and North pole magnetic field close to the IC marking surface until the magnetic flux density higher than release point (Brp), the DO pin output will turn OFF and the DOB pin output will turn ON.



### Lockup Protection and Automatic Restart

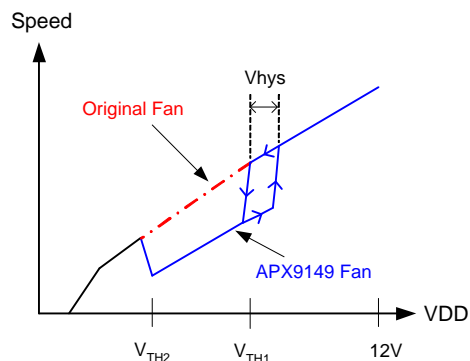
The APX9149 detects the rotation of the motor by internal hall sensor signal, and adjusts lock detection ON time ( $T_{ON}$ ) and lock detection OFF time ( $T_{OFF}$ ) by internal counter.



Note 1: — North pole face to the hall IC marking surface at power on.  
 Note 2: - - South pole face to the hall IC marking surface at power on.

### Voltage Speed Control Function

In some DC fan applications, the system adjusts the input power voltage to control fan speed. The APX9149 internal circuit controls the lower fan speed in the low voltage region between  $V_{TH2}$  and  $V_{TH1}$ . When adjusts the VDD pin voltage from 12V to  $V_{TH1}$  (7.5V typical), the APX9149 will apply lower current to coils and the fan speed will be lower than original fan. A slower fan speed will have a smaller fan noise.

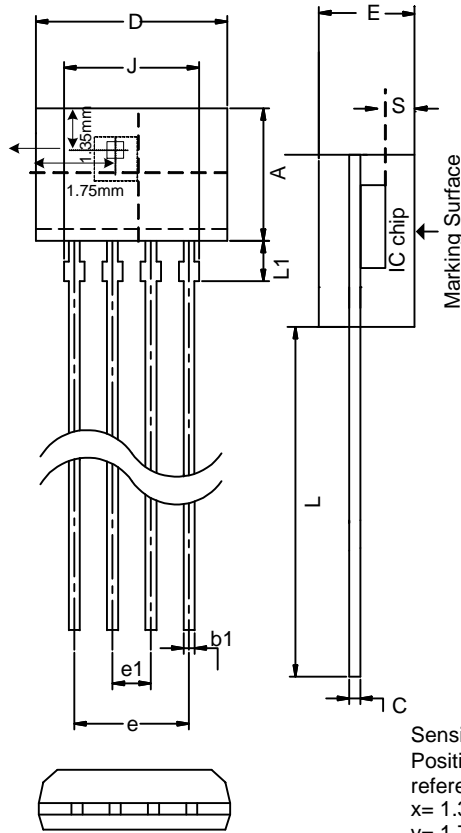


### Thermal Protection

The APX9149 has a thermal protection. When the 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.

Package Information

TO-92M4

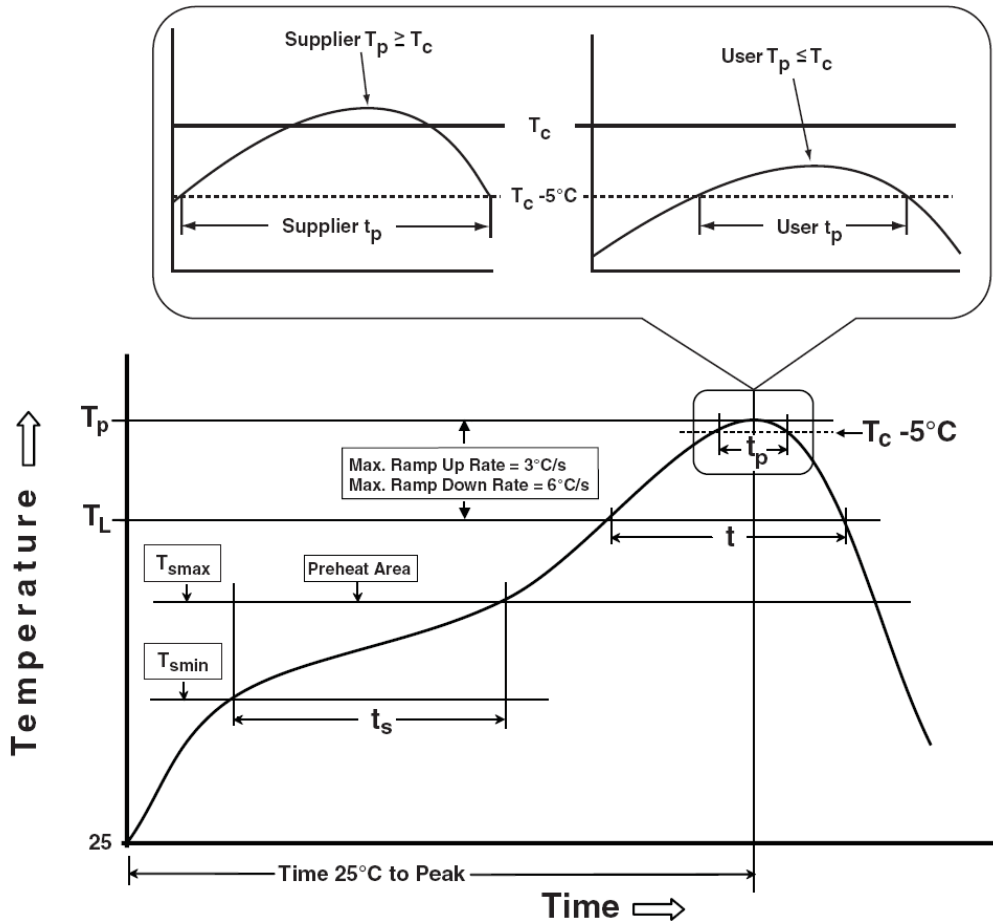


Sensitive Area (0.286x0.286mm<sup>2</sup>)  
 Position of Hall Sensor  
 reference to the top-left of package  
 x= 1.35±0.1mm  
 y= 1.75±0.1mm

SYMBOL	TO-92M4			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	3.60	3.70	0.142	0.146
b	0.35	0.41	0.014	0.016
c	0.35	0.41	0.014	0.016
D	5.17	5.27	0.204	0.208
e	1.27 BSC		0.050 BSC	
E	1.50	1.60	0.059	0.063
l	4.04	4.34	0.159	0.171
L	13.80	14.80	0.543	0.583
L2	1.34	1.54	0.053	0.061
s	0.70	0.76	0.028	0.030



### Classification Profile



### Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
<b>Preheat &amp; Soak</b>		
Temperature min ( $T_{smin}$ )	100 °C	150 °C
Temperature max ( $T_{smax}$ )	150 °C	200 °C
Time ( $T_{smin}$ to $T_{smax}$ ) ( $t_s$ )	60-120 seconds	60-120 seconds
Average ramp-up rate ( $T_{smax}$ to $T_p$ )	3 °C/second max.	3°C/second max.
Liquidous temperature ( $T_L$ )	183 °C	217 °C
Time at liquidous ( $t_L$ )	60-150 seconds	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.		

## Classification Reflow Profiles (Cont.)

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

Package Thickness	Volume mm <sup>3</sup> <350	Volume mm <sup>3</sup> ≥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 <sup>3</sup> <350	Volume mm <sup>3</sup> 350-2000	Volume mm <sup>3</sup> >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 @ T <sub>j</sub> =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 <sub>tr</sub> 100mA

## Customer Service

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