

## Hall Effect Micro Switch IC

### Features

- **Micro Power Operation for Battery Applications**
- **Chopper Stabilized Amplifier**
- **Independent of North or South Pole Magnet, Easy for Manufacture**
- **Small Size Package**
- **Lead Free and Green Devices Available (RoHS Compliant)**

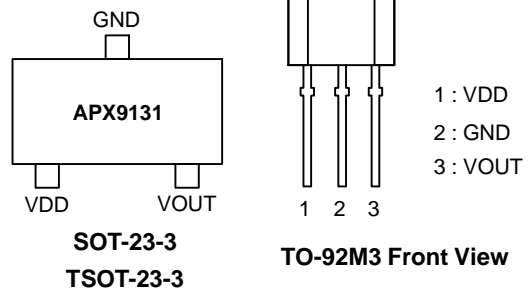
### Applications

- **Micro Switch**
- **Handheld Wireless Application Wake Up Switch**
- **Clamp Shell Type Application Switch**
- **Magnet Switch in Low Duty Cycle Applications**

### General Description

The APX9131, integrated circuit, is an ultra-sensitive, pole independent Hall-effect switch with a latched digital output. A 2.5 volt to 3.5 volt operation and an unique clocking scheme reduce the average operating power requirements, either a north or south pole of sufficient flux will turn the output on; in the absence of a magnetic field, the output is off. The polarity independence and minimal power requirement allow this device to be easily replaced reed switch for superior for signal conditioning. Advanced CMOS processing is used to take advantage of low-voltage and low-power requirements, SOT-23-3, TSOT-23-3, and TO-92M3 packages provided an optimized package for most applications.

### Pin Configuration



### Ordering and Marking Information

<p>APX9131    □□□-□□□</p> <p style="margin-left: 40px;">└─ Assembly Material</p> <p style="margin-left: 40px;">└─ Handling Code</p> <p style="margin-left: 40px;">└─ Temperature Range</p> <p style="margin-left: 40px;">└─ Package Code</p>	<p>Package Code                  A : SOT-23-3    AT : TSOT-23-3    E : TO-92M3</p> <p>Operating Ambient Temperature Range                  I : -40 to 85 °C</p> <p>Handling Code                  TR : Tape &amp; Reel    PB : Plastic Bag</p> <p>Assembly Material                  G : Halogen and Lead Free Device</p>
<p>APX9131 A/AT:    <span style="border: 1px solid black; padding: 2px;">X31X</span></p>	<p>X - Date Code</p>
<p>APX9131 E:    <span style="border: 1px solid black; padding: 2px;">APX9131 XXXXX</span></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-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)

Symbol	Parameter	Rating	Unit
$V_{DD}$	Supply Voltage	5	V
$V_{OUT}$	Output Voltage	5	V
$T_J$	Junction Temperature Range	150	°C
$T_{STG}$	Storage Temperature Range	-65 to +150	

## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ , $V_{DD} = 3\text{V}$ unless otherwise noted)

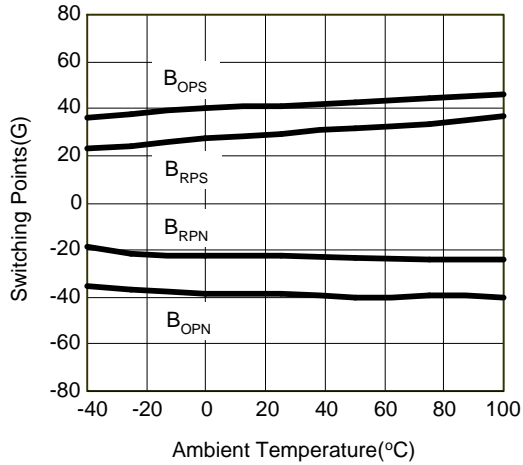
Symbol	Characteristic	Test Conditions	APX9131			Unit
			Min.	Typ.	Max.	
$V_{DD}$	Supply Voltage Range	Operating	2.5	-	3.5	V
$I_{DD}$	Supply Current	Average	-	5	10	$\mu\text{A}$
		Awake	-	1.2	2	mA
		Sleep	-	2	8	$\mu\text{A}$
$I_{OFF}$	Output Leakage Current	$V_{OUT} = 3.5\text{V}$ , $B_{RPN} < B < B_{RPS}$	-	-	1.0	$\mu\text{A}$
$V_{OL}$	Output Low Voltage	$I_{SINK} = 1\text{mA}$	-	20	40	mV
$t_{wake}$	Wake Up Time		-	180	-	$\mu\text{s}$
$t_{period}$	Period		-	60	120	ms
d.c.	Duty Cycle		-	0.3	-	%
$f_c$	Chopping Frequency		-	11	-	kHz

## Magnetic Characteristics ( $T_A = 25^\circ\text{C}$ , $V_{DD} = 3\text{V}$ unless otherwise noted)

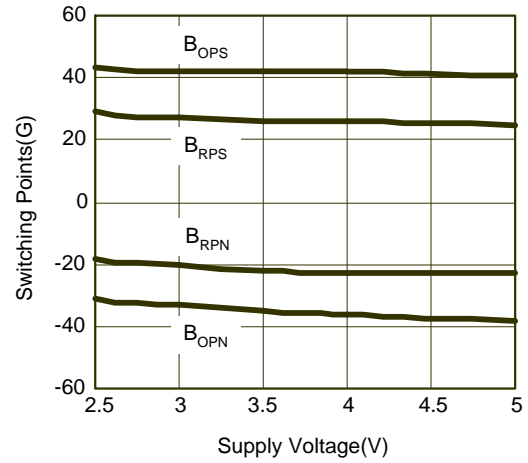
Symbol	Characteristic	Test Conditions	APX9131			Unit
			Min.	Typ.	Max.	
$B_{OPS}$	Operate Points		20	40	60	G
$B_{OPN}$			-60	-40	-20	G
$B_{RPS}$	Release Points		10	25	50	G
$B_{RPN}$			-50	-25	-10	G
$B_{hys}$	Hysteresis		-	15	-	G

## Typical Operating Characteristics

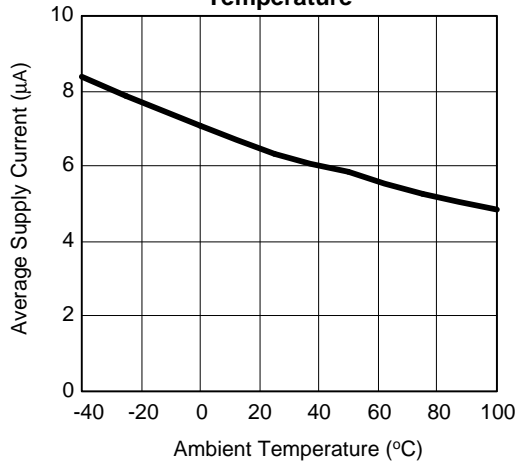
**Switching Points vs. Ambient Temperature**



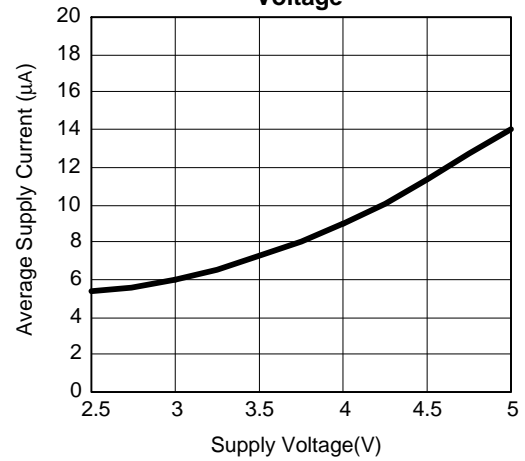
**Switching Points vs. Supply Voltage**



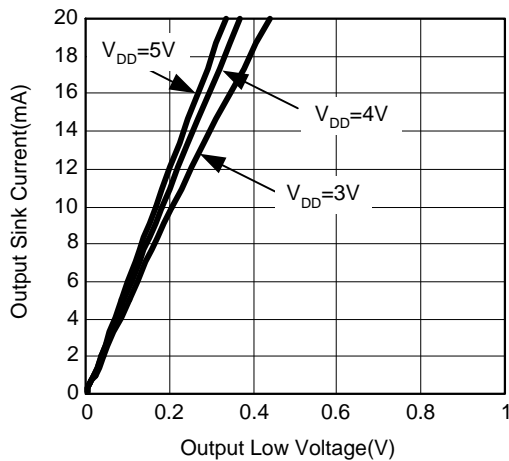
**Average Supply Current vs. Ambient Temperature**



**Average Supply Current vs. Supply Voltage**

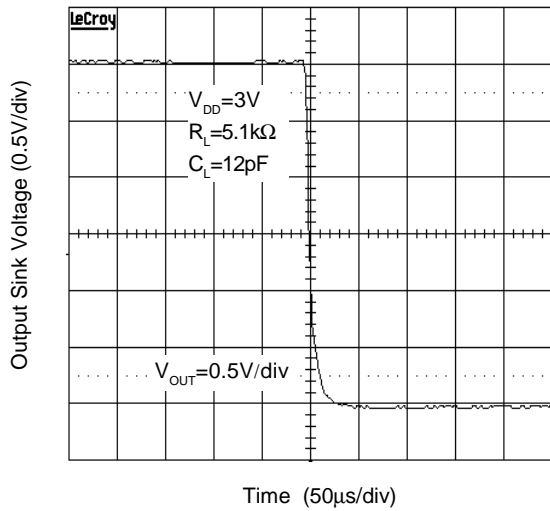


**Output Sink Current vs. Output Low Voltage**

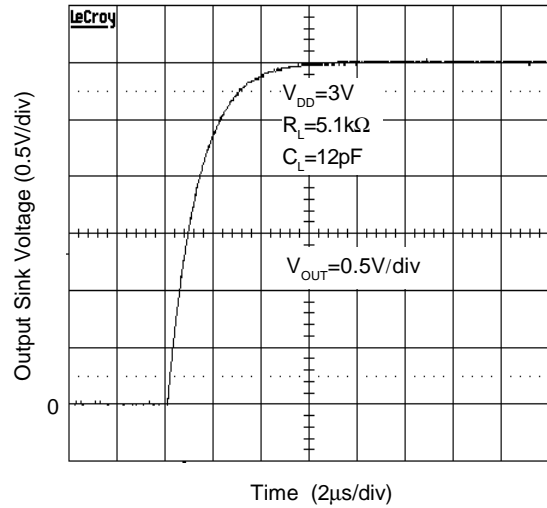


Operating Waveforms

Output Switch Waveform



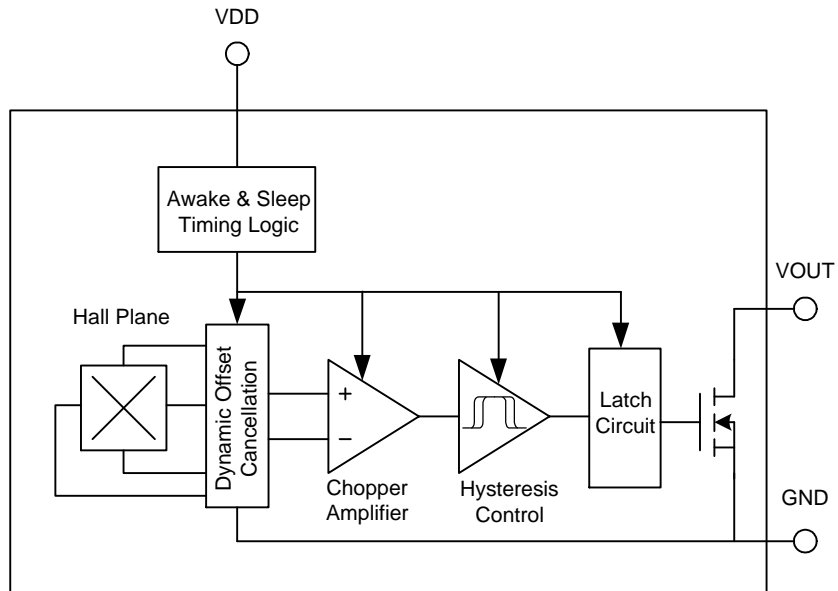
Output Switch Waveform



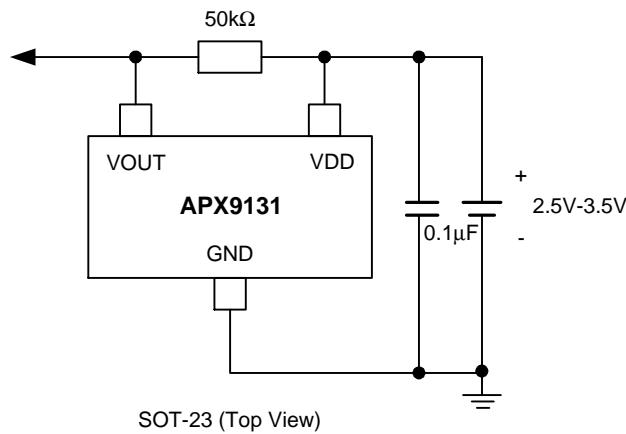
Pin Description

PIN		FUNCTION
NO.	NAME	
1	VDD	Power Input
2	VOUT	When a magnetic field enters the hall element and exceeds the operate point BOPS (or less than BOPN), the output turns on (output is low). When the magnetic field is below the release point BRPS (or above BRPN), the output turns off (output is high). It is designed with open drain configuration and connecting a pull up resistor from VOUT to VDD is necessary. It cannot be floating.
3	GND	Ground Connection.

Block Diagram



Typical Application Circuit



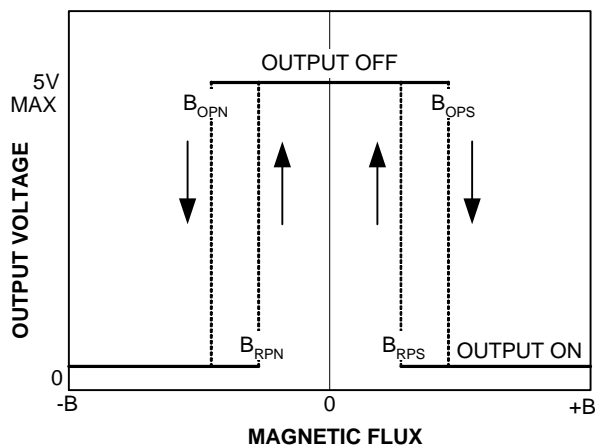
## Function Description

### Operation

The output of APX9131 switches low (turns on) when in presence of strong flux density facing the marked side of package exceeds the operate point  $B_{OPS}$  (or is less than  $B_{OPN}$ ). After turn-on, the output is capable of sinking up to 1mA and the output voltage is low (turns on). In absence of flux density below the release point  $B_{RPS}$  (or increased above  $B_{RPN}$ ), the APX9131 output switches high (turns off). The difference in the magnetic operated and released point is the hysteresis ( $B_{hys}$ ) of the device. This built-in hysteresis allows clean switching of the output even in the presence of external mechanical bouncing vibration and electrical noise.

### Chopper Stabilized Technique

The chopper stabilized technique cancels the mismatching of the hall element, the amplifier offset voltage and temperature sensitive drift by the dynamic offset cancellation and switched capacitor technique. This technique produces devices have an extremely stable Hall output voltage, therefore, the magnetic switch points are stable.



### Pole-Independent

The pole-independent sensing technique allows for operation with either a north or south pole magnet orientation, enhancing the manufacturability of the device. The state-of-the-art technology provides the same output polarity for either pole in presence.

### Awake & Sleep

Internal awake & sleep timing block circuit activates the sensor for 180µs and deactivates it for the remainder of the period (60ms). A short “awake” time allows for stabilization prior to the sensor sampling and data latching on the falling edge of the timing pulse. When in sleep cycle, the output is latched in its previous state.

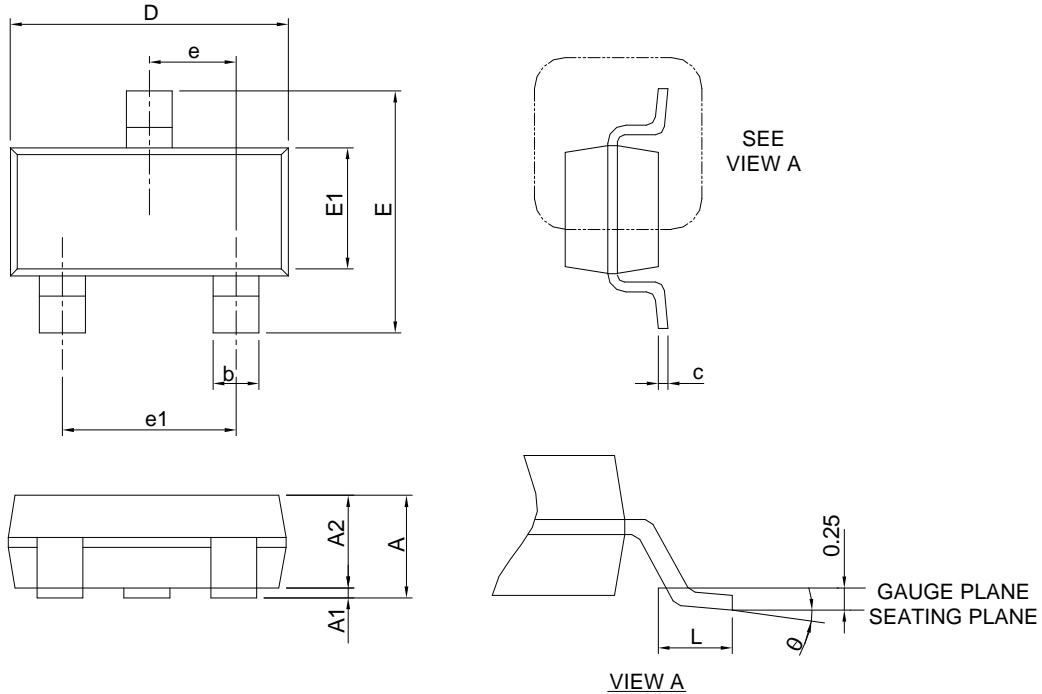
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## Application Information

It is strongly recommended that an external bypass capacitor be connected (in close to the Hall sensor) between the supply and the ground of the device to reduce both external noise and noise generated by the chopper-stabilization technique. This is especially true due to the relatively high impedance of battery supplies. The output is an open drain output, it must be connected a pull-up resistor to a supply voltage which is lower than 5V, connect a 50k $\Omega$  resistor to VDD in common use.

Package Information

SOT-23-3



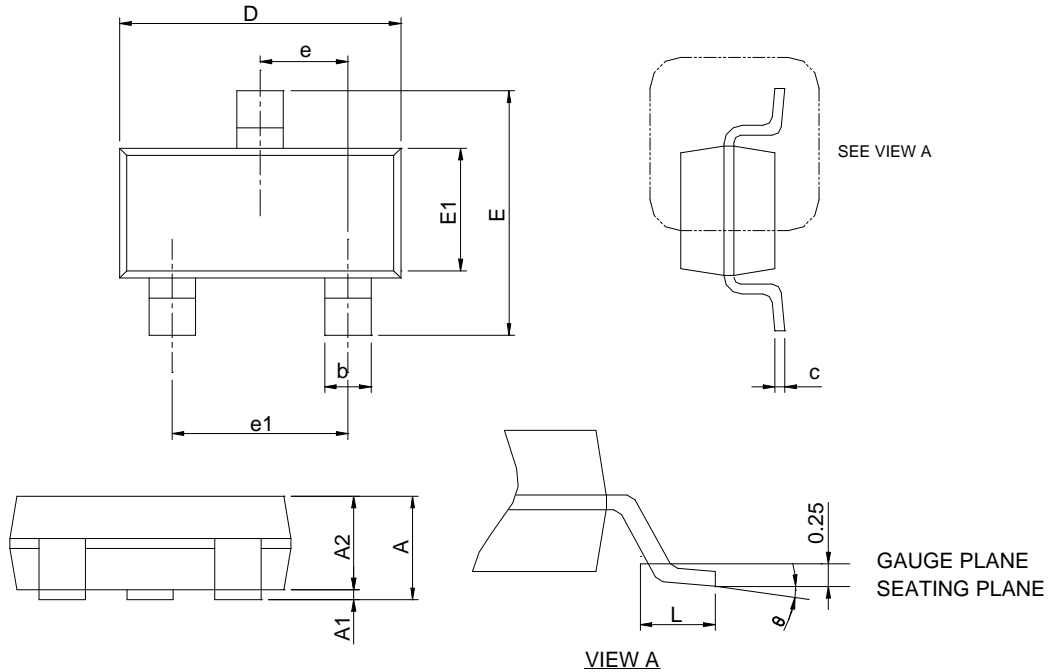
SYMBOL	SOT-23-3			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.45		0.057
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

Note : Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.



## Package Information

TSOT-23-3

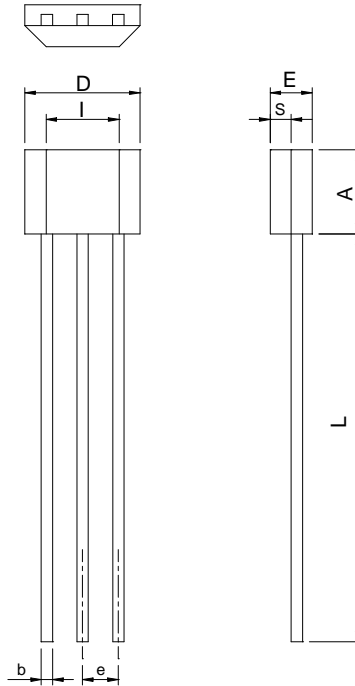


SYMBOL	TSOT-23-3			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.75	0.80	0.030	0.031
A1	0.03	0.05	0.001	0.002
A2	0.70	0.75	0.028	0.030
b	0.30	0.50	0.012	0.020
c	0.08	0.20	0.003	0.008
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90BSC		0.075 BSC	
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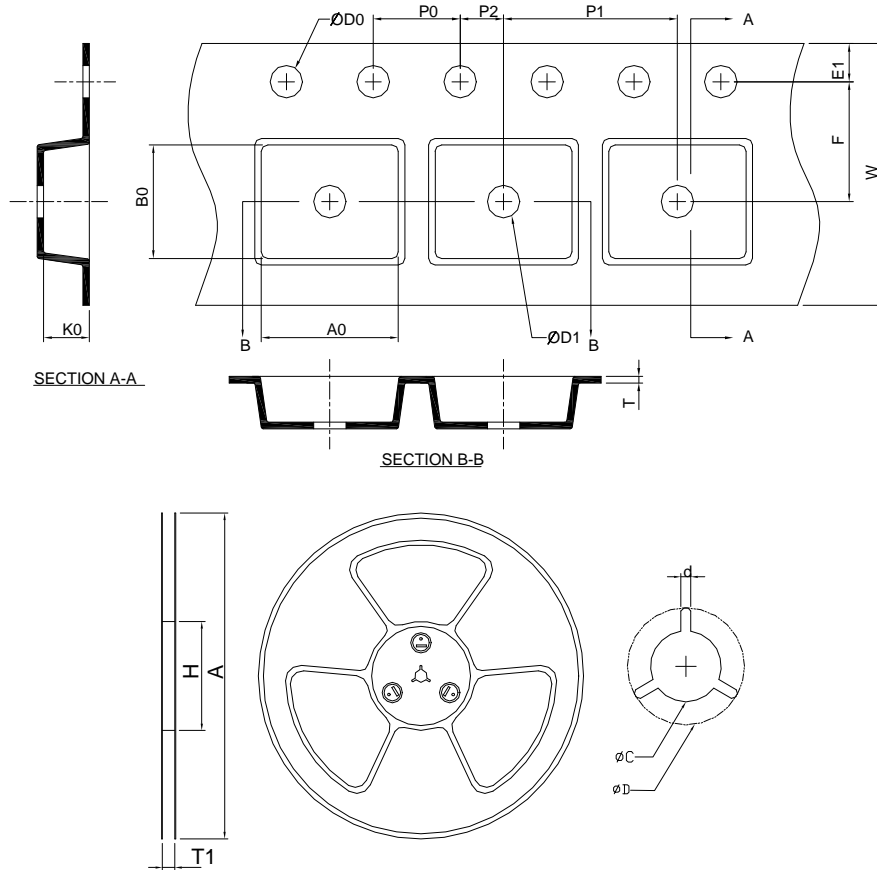
## Package Information

TO-92M3



SYMBOL	TO-92M3			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	2.80	3.20	0.110	0.126
b	0.33	0.43	0.013	0.017
D	3.90	4.30	0.154	0.169
e	1.27 BSC		0.050 BSC	
E	1.40	1.60	0.055	0.063
I	2.40	2.80	0.094	0.110
L	13.60	15.60	0.535	0.614
s	0.63	0.81	0.025	0.032

Carrier Tape & Reel Dimensions



Application	A	H	T1	C	d	D	W	E1	F
SOT-23-3	178.0 ±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0 ±0.30	1.75 ±0.10	3.5 ±0.05
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.0 ±0.10	4.0 ±0.10	2.0 ±0.05	1.5+0.10 -0.00	1.0 MIN.	0.6+0.00 -0.40	3.20 ±0.20	3.10 ±0.20	1.50 ±0.20
Application	A	H	T1	C	d	D	W	E1	F
TSOT-23-3	178.0 ±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0 ±0.30	1.75 ±0.10	3.5 ±0.05
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.0 ±0.10	4.0 ±0.10	2.0 ±0.10	1.5+0.10 -0.00	1.0 MIN.	0.6+0.00 -0.40	3.20 ±0.20	3.10 ±0.20	1.50 ±0.20

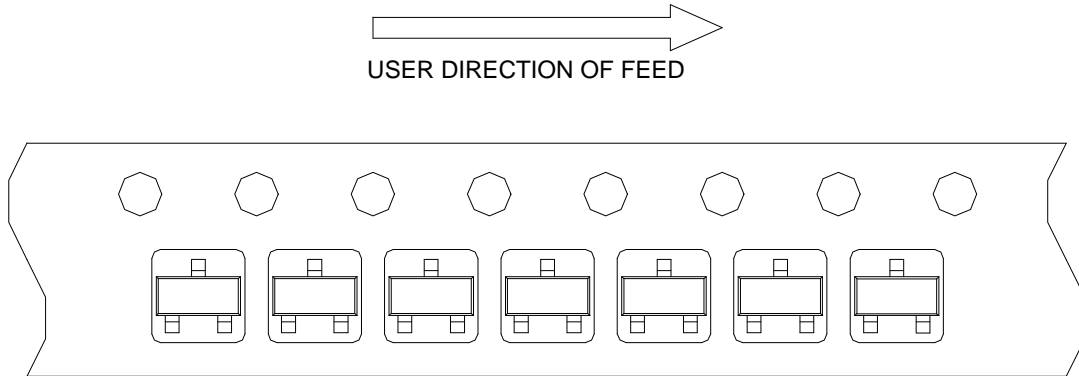
(mm)

Devices Per Unit

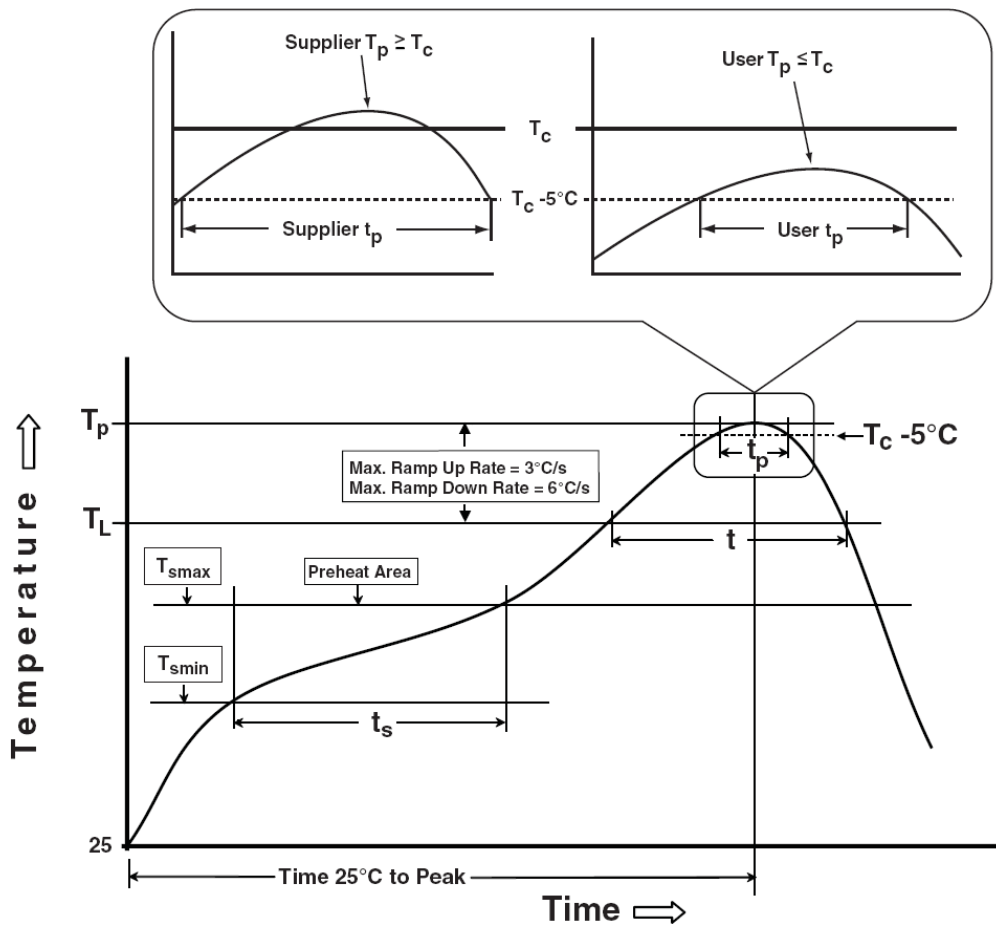
Package Type	Unit	Quantity
SOT-23	Tape & Reel	3000
TSOT-23	Tape & Reel	3000
TO-92M3	Plastic Bag	1000

### Taping Direction Information

SOT-23-3/TSOT-23-3



### 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.		

Table 1. SnPb Eutectic Process – Classification Temperatures ( $T_c$ )

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 ( $T_c$ )

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 @ 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

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## Customer Service

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