Single-Phase Full-Wave Motor Driver with Built-in Hall Sensor

Features

- On-chip Hall Sensor
- High Sensitivity Hall Effect Sensor IC: ±15G(Typ.)
- Built-in Lock Protection and Auto Restart Function
- Speed Controllable by DC Input Signal
- FG Output (for APX9170)
- 1/2FG Output (for APX9170A)
- RD Output (for APX9170B)
- Built-in Thermal Protection Circuit
- 6 Pin TSOT23-6F and TSOT23-6 Packages
- Lead Free and Green Devices Available (RoHS Compliant)

General Description

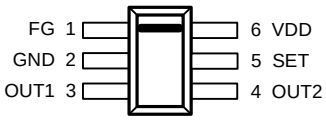
The APX9170 is an integrated Hall Effect Sensor IC designed for electric commutation of single-phase DC brushless motor applications. The device is built-in lock protection. When fan is locked, the device will enter the lock protection mode. It is also with thermal shutdown function. The APX9170 is available in a low cost TSOT23-6F and TSOT23-6 packages.

Applications

- Brushless DC Fans
- Brushless DC Motors

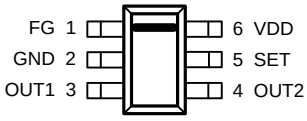
Pin Configuration

APX9170



TSOT-23-6F
(TOP VIEW)

APX9170



TSOT-23-6
(TOP VIEW)

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.

Ordering and Marking Information

APX9170 □□□-□□□ Assembly Material Handling Code Temperature Range Package Code	Package Code CE : TSOT-23-6F CT : TSOT-23-6 Operating Ambient Temperature Range I : -40 to 105 °C Handling Code TR : Tape & Reel Assembly Material G : Halogen and Lead Free Device
APX9170 CE/CT : X70X	The last X is referred as Date Code
APX9170A CE/CT : A70X	The last X is referred as Date Code
APX9170B CE/CT : B70X	The last X is referred as 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).

Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Rating	Unit
V_{DD}	VDD Pin Supply Voltage (VDD to GND)	-0.3 to 20	V
V_{OUT}	Output Pin (OUT1, OUT2) Output Voltage	-0.3 to 20	V
I_{OUT}	Output Pin (OUT1, OUT2) Maximum Output Current – Continuous Hold	250 500	mA
V_{SET}	SET Pin Input Voltage	-0.3 to 20	V
I_{FG}	FG Pin Output Sink Current	20	mA
	FG Pin Output Voltage	-0.3 to 20	V
T_J	Maximum Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 to 150	°C
T_{SOR}	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
θ_{JA}	Thermal Resistance-Junction to Ambient (Note 2) TSOT-23-6F TSOT-23-6	240	°C/W
P_D	Power Dissipation, T_A = 25°C TSOT-23-6F TSOT-23-6	520	mW

Note 2 : The maximum allowable power dissipation at any T_A (ambient temperature) is calculated using: $P_D = (T_J - T_A) / \theta_{JA}$; T_J = 150°C. Exceeding the maximum allowable power dissipation will result in excessive die temperature.

Recommended Operation Conditions

Symbol	Parameter	Range	Unit
V_{DD}	VDD Supply Voltage	2.2 to 16	V
V_{SET}	SET Pin Input Voltage	0 to V_{CC}	V
T_A	Operating Ambient Temperature	-40 to 105	°C
T_J	Junction Temperature	-40 to 125	°C

Electrical Characteristics (T_A=25°C, V_{DD}=12V, unless otherwise noted)

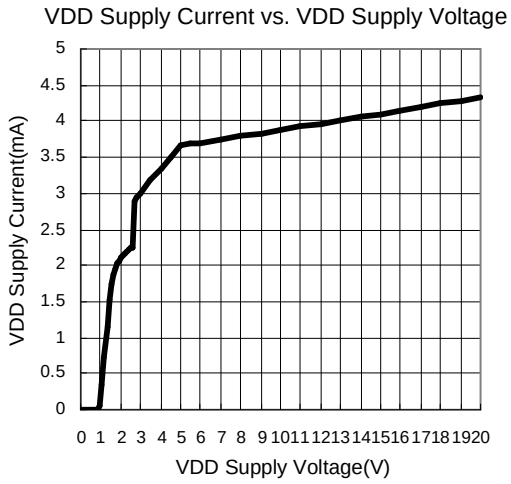
Symbol	Parameter	Test Condition	APX9170			Unit
			Min.	Typ.	Max.	
I_{DD}	VDD Supply Current	V_{DD}=12V, no load	-	4.5	7	mA
V_O	Output Driver Saturation Voltage	I_{OUT}=200mA, Upper and Lower total	-	0.8	1.2	V
V_{FG}	FG Pin Low Voltage	I_{FG} =5mA	-	0.1	0.3	V
I_{FGL}	FG Pin Off Leakage Current	V_{FG} =12V	-	<0.1	1	µA
V_{OSCH}	Internal OSC oscillation High Level Voltage	Guarantee by D1 and D2 test	-	10/32*V_{DD}	-	V
V_{OSCL}	Internal OSC oscillation Low Level Voltage	Guarantee by D1 and D2 test	-	1/32*V_{DD}	-	V
F_{OSC}	Internal OSC oscillation Frequency		20		50	kHz
D1	SET Mode Output Duty 1	V_{DD}=12V, V_{SET}=3.075V, no load	70	80	90	%
D2	SET Mode Output Duty 2	V_{DD}=12V, V_{SET}=1.05V, no load	10	20	30	%
T_{ON}	Lock Detection On Time		-	0.4	-	sec
T_{OFF}	Lock Detection Off Time		-	4	-	sec
OTS	Over Temperature Shutdown Threshold		-	165	-	°C
	Over Temperature Shutdown Hysteresis		-	30	-	°C

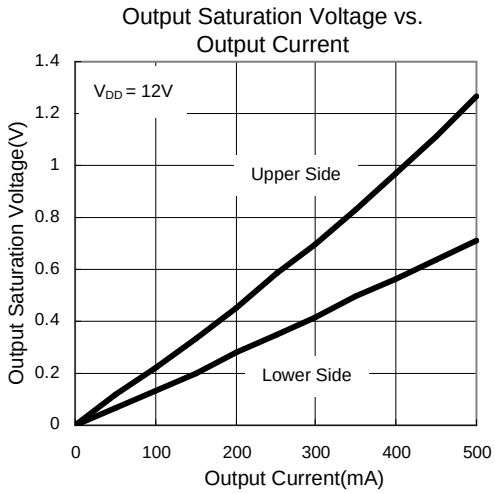
Copyright © ANPEC Electronics Corp.

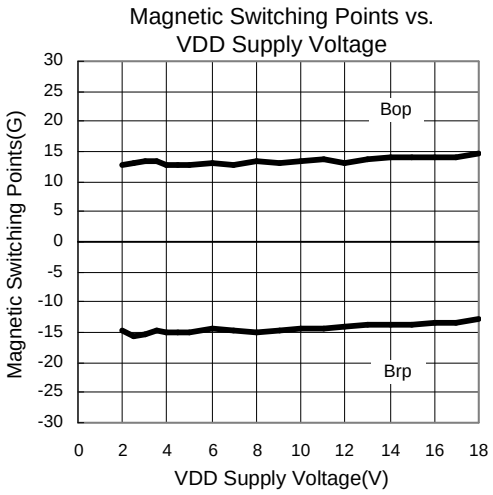
Magnetic Characteristics (T_A=25°C, V_{DD}=12V, unless otherwise noted)

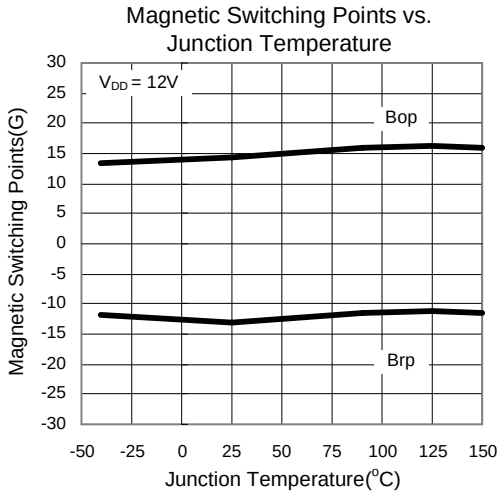
Symbol	Parameter	Test Condition	APX9170			Unit
			Min.	Typ.	Max.	
Bop	Magnetic Operation Point		5	15	30	Gauss
Brp	Magnetic Release Point		-30	-15	-5	Gauss
Bhys	Magnetic Hysteresis			30		Gauss

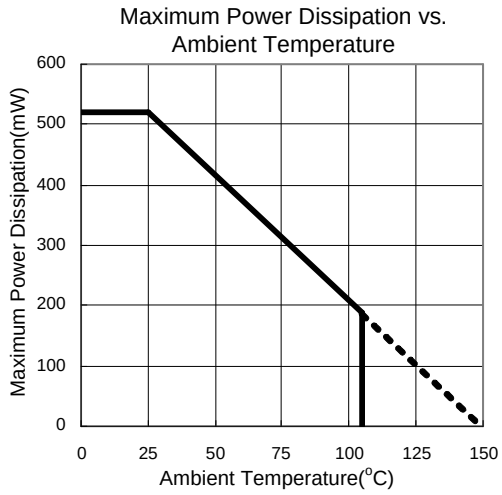
Typical Operating Characteristics









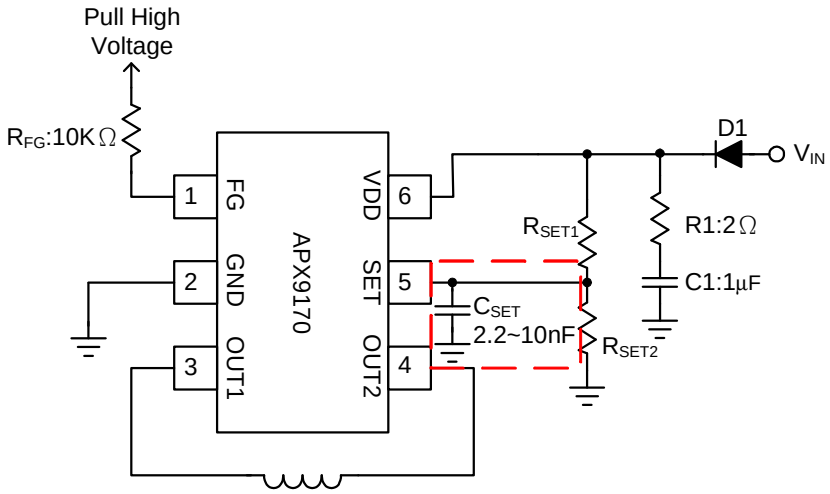


Pin Description

PIN		Function
NO.	NAME	
1	FG (APX9170)	Rotation Speed or Detection Output. This is an open-drain output.
	1/2FG (APX9170A)	
	RD (APX9170B)	
2	GND	Ground of the IC.
3	OUT1	H-bridge output connection.
4	OUT2	H-bridge output connection.
5	SET	Speed Setting. Input an external voltage to SET pin to set fan speed.
6	VDD	Supply Voltage Input.

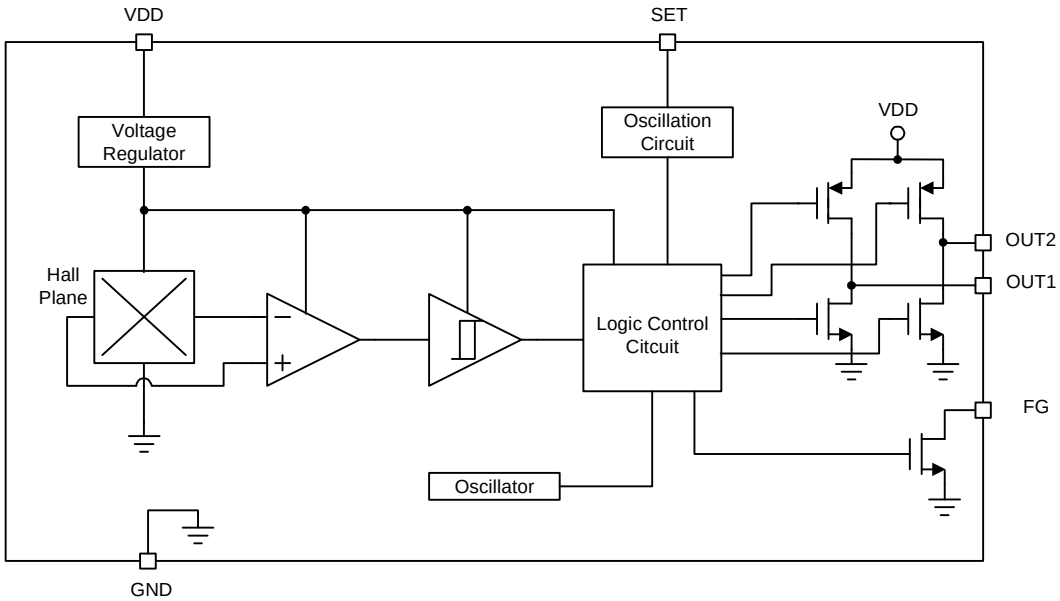
Copyright © ANPEC Electronics Corp.

Typical Application Circuit



Note: C_{SET} is optional to prevent noise coupling for stability of output duty setting.

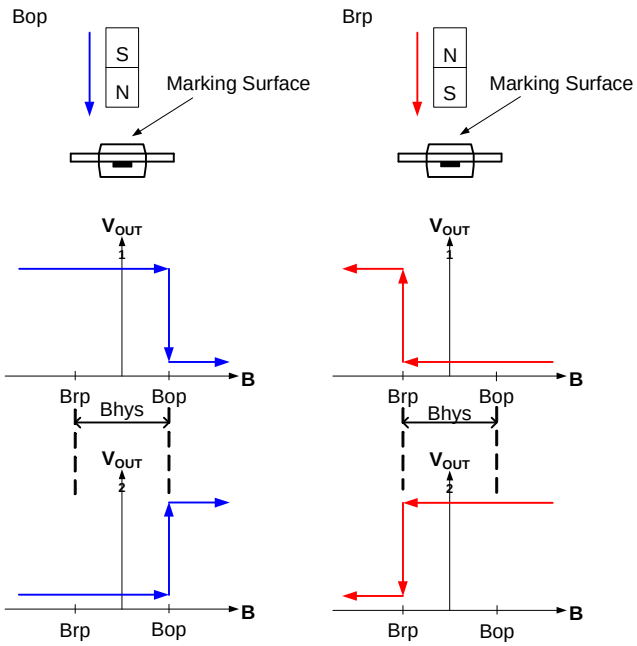
Block Diagram



Function Description

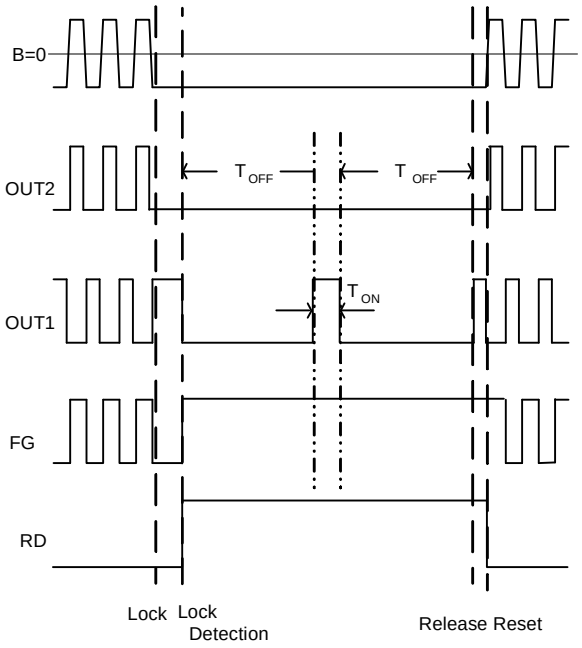
Output Switch Principle

The APX9170 built in a Hall-effect sensor plane to sense the vertical magnetic flux density (B). There are two output drivers in APX9170 to drive single-phase DC brushless motor. When the N pole magnetic field close to the IC marking surface and the magnetic flux density higher than operate point (Bop), the OUT1 pin output will turn to LOW and the OUT2 pin output will turn to HIGH. When the N pole magnetic field far away the IC marking surface and S pole magnetic field close to the IC marking surface until the magnetic flux density higher than release point (Brp), the OUT1 pin output will turn HIGH and the OUT2 pin output will turn LOW.



Lockup Protection and Automatic Restart

The APX9170 detects the rotation of the motor by internal hall sensor signal, and adjusts lock detection ON time (TON) and lock detection OFF time (TOFF) by internal counter.

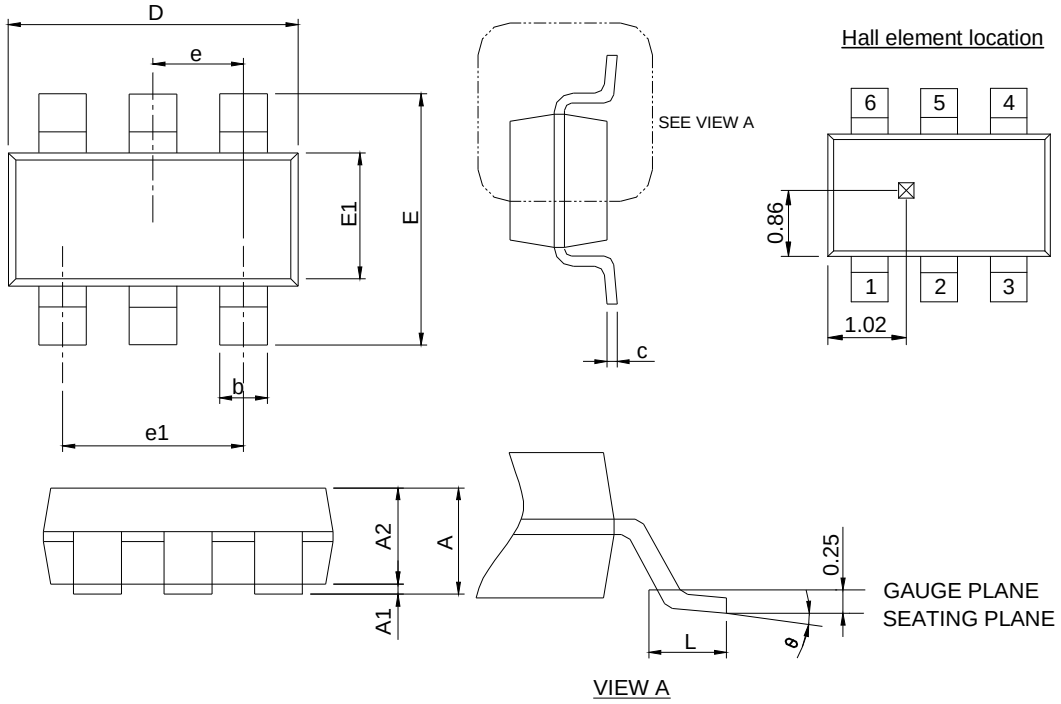


VDD Speed Control with duty setting

Using resistor divider on VDD to set a dc voltage to SET pin for output duty setting. The dc voltage of SET pin compares with internal osc triangle wave to determine the output duty.

Package Information

TSOT-23-6



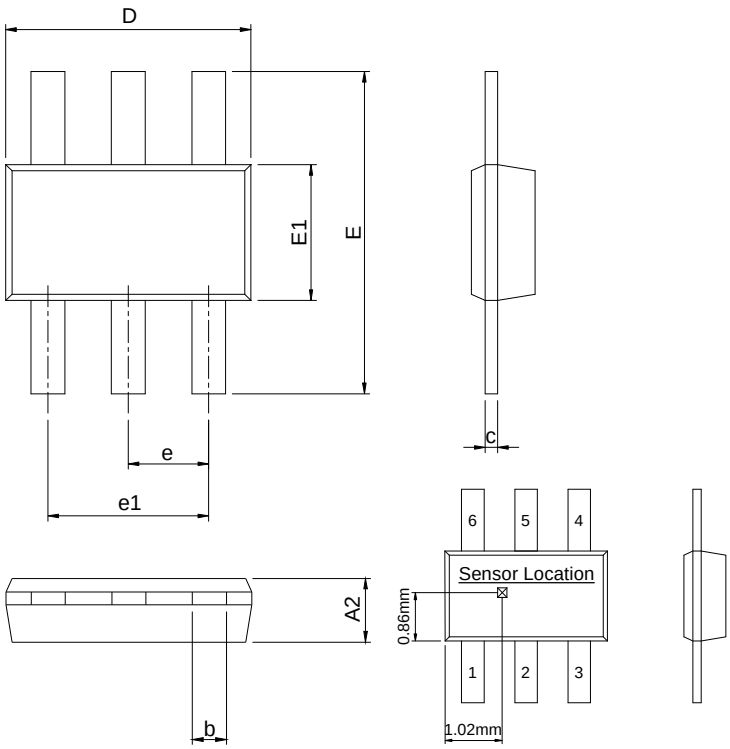
SYMBOL	TSOT-23-6			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.70	1.00	0.028	0.039
A1	0.01	0.10	0.000	0.004
A2	0.70	0.90	0.028	0.035
b	0.30	0.50	0.012	0.020
c	0.08	0.20	0.003	0.008
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
θ	0^o	8^o	0^o	8^o

Note : 1. Followed from JEDEC TO-178 AB.
2. 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.

Copyright © ANPEC Electronics Corp.

Package Information

TSOT-23-6F

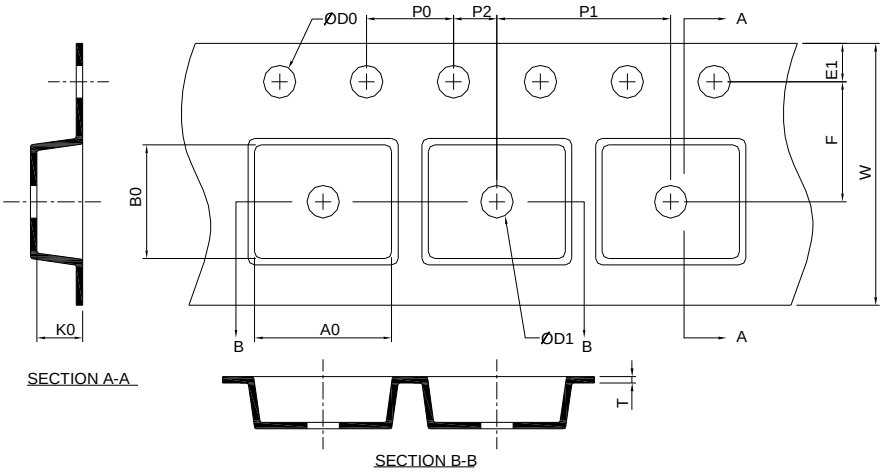


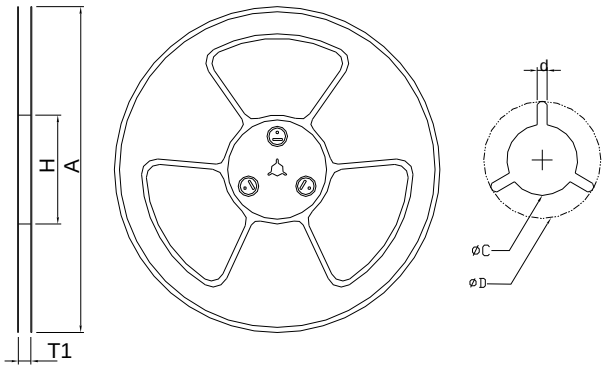
Top view : Marking side

SYMBOL	TSOT-23-6F			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A2	0.70	0.775	0.028	0.031
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.80	3.00	0.110	0.118
E	3.70	3.90	0.146	0.154
E1	1.50	1.70	0.059	0.067
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	

Note : 1. 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.

Carrier Tape & Reel Dimensions





Application	A	H	T1	C	d	D	W	E1	F
TSOT-23-6	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	1.20±0.20
Application	**A**	**H**	**T1**	**C**	**d**	**D**	**W**	**E1**	**F**
TSOT-23-6F	178.0±2.00	50 MIN.	16.4+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**
	4.0±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	3.10±0.20	4.00±0.20	1.15±0.20

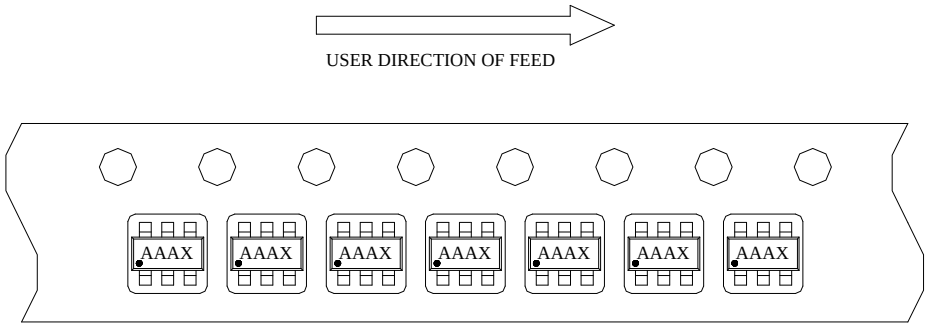
(mm)

Devices Per Unit

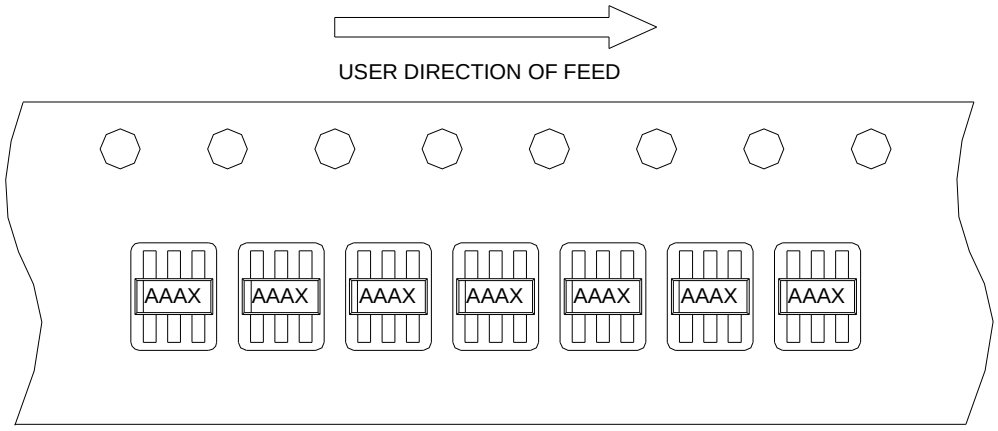
Package Type	Unit	Quantity
TSOT-23-6	Tape & Reel	3000
TSOT-23-6F	Tape & Reel	3000

Taping Direction Information

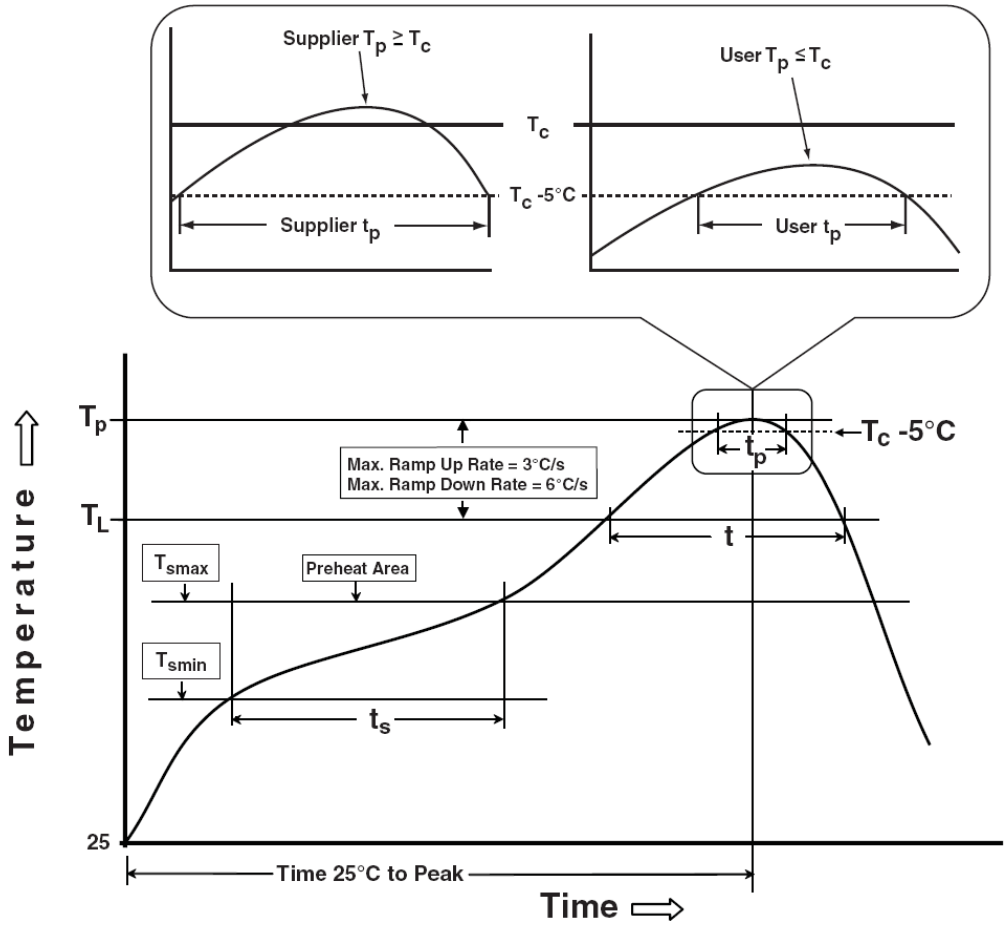
TSOT-23-6



TSOT-23-6F



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.		

Classification Reflow Profiles (Cont.)

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 @ T_j=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

Customer Service

Anpec Electronics Corp.
Head Office :
No.6, Dusing 1st Road, SBIP,
Hsin-Chu, Taiwan
Tel : 886-3-5642000
Fax : 886-3-5642050

Taipei Branch :
2F, No. 11, Lane 218, Sec 2 Jhongsing Rd.,
Sindian City, Taipei County 23146, Taiwan
Tel : 886-2-2910-3838
Fax : 886-2-2917-3838