High Sensitivity Hall IC for FAN Driver

Features

- **On-Chip Hall Sensor**
- **Low Operating Supply Voltage: 2.7V**
- **High Sensitivity Hall Effect Sensor IC: ±20G (Type.)**
- **Soft-Switch to Reduce Phase-Switching Noise**
- **Built-In Output Protection Clamping Circuit**
- **Lock Protection and Auto Restart Function**
- **FG Output**
- **Built-In Thermal Protection Circuit**
- **Pin TSOT-23-5F Package**
- **Lead Free and Green Devices Available (RoHS Compliant)**

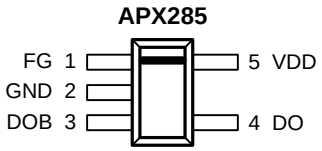
Applications

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

General Description

The APX285 is an integrated Hall Effect Sensor IC designed for electric commutation of two-phase DC brushless motor applications. The device is built-in lock protection. When the fan is locked, the device will enter the lock protection mode. The APX285 is available in a low cost TSOT-23-5F package.

Pin Description



TSOT-23-5F
(TOP VIEW)

Ordering and Marking Information

APX285 □□□-□□□

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

Package Code
BE : TSOT-23-5F
Temperature Range
I : -40 to 105 °C
Handling Code
PB : Plastic Bag TR : Tape & Reel
Assembly Material
G : Halogen and Lead Free Device

APX285 BE : 285X — The last X is referred to 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 (T_A=25°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 (Note 2) Hold Peak (<100μs)	300 600 1000	mA
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

Note 1: 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
θ_{JA}	Thermal Resistance-Junction to Ambient (Note 3) TSOT-23-5F	 250	°C/W
P_D	Power Dissipation, T_A = 25°C TSOT-23-5F	 500	mW

Note 3: The maximum allowable power dissipation at any T_A (ambient temperature) is calculated using: $P_D(max)=(T_J - T_A) / \theta_{JA}$; T_J=150°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	2.7 to 16	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)

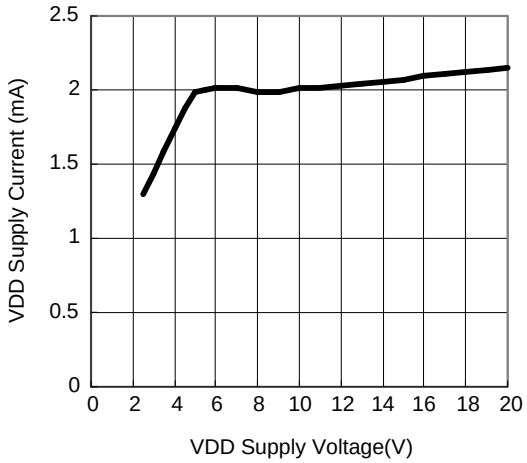
Symbol	Parameter	Test Conditions	APX285			Unit
			Min.	Typ.	Max.	
I_{DD1}	VDD Supply Current	V_{DD} = 3V, Output Open	-	2	4	mA
I_{DD2}		V_{DD} = 20V, Output Open	-	2	4	mA
V_{SAT}	Output Saturation Voltage	V_{DD} = 12V, I_{OUT} = 300mA	-	210	300	mV
$V_{OUT-CLAMP}$	DO, DOB Output Clamp Voltage	DO, DOB Pin Off	20	24	28	V
I_{DOH}	DO Pin High Input Current	V_{DO} = 12V, B<Brp	-	120	200	μA
I_{DOBH}	DOB Pin High Input Current	V_{DOB} = 12V, B>Bop	-	120	200	μA
V_{FG}	FG Pin Low Voltage	I_{FG} = 5mA	-	0.2	0.4	V
I_{FGL}	FG Pin Leakage Current	FG Off, V_{FG} = 12V	-	<0.1	1	μA
T_{ON}	Lock Detection On Time		-	0.4	-	sec
T_{OFF}	Lock Detection Off Time		-	2.8	-	sec

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

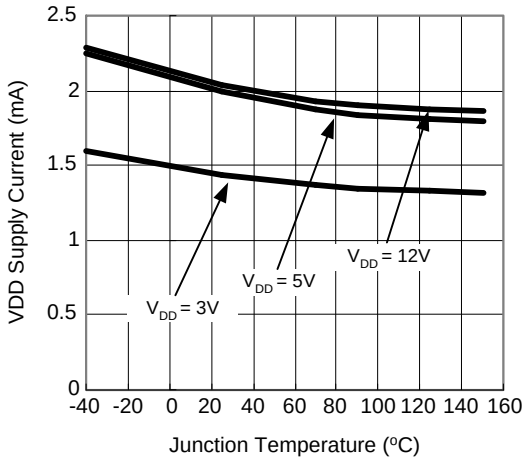
Symbol	Parameter	Test Conditions	APX285			Unit
			Min.	Typ.	Max.	
T_{OTS}	Over-Temperature Shutdown Threshold		-	165	-	°C
	Over-Temperature Shutdown Hysteresis		-	30	-	°C
Bop	Magnetic Operation Point		5	20	40	Gauss
Brp	Magnetic Release Point		-40	-20	-5	Gauss
Bhys	Magnetic Hysteresis		30	40	50	Gauss

Typical Operating Characteristics

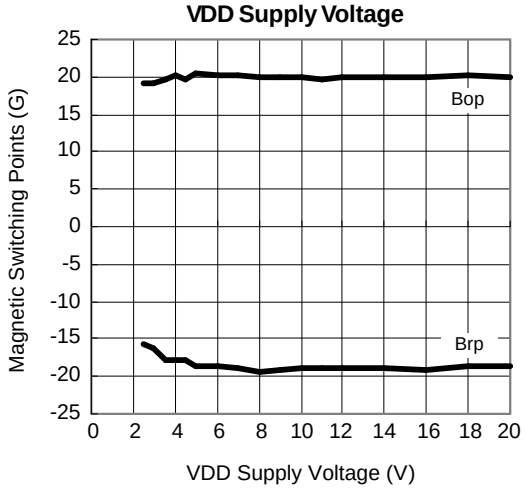
VDD Supply Current vs. VDD Supply Voltage



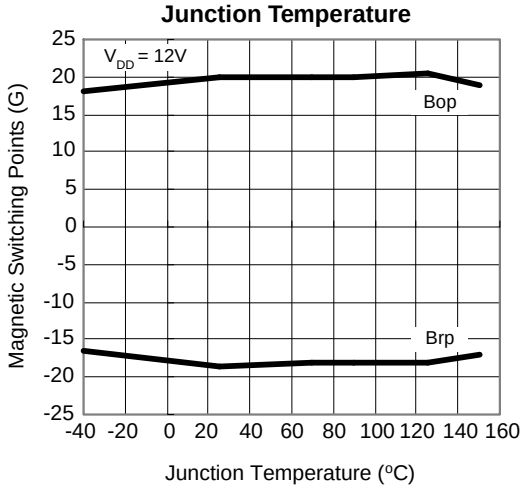
VDD Supply Current vs. Junction Temperature



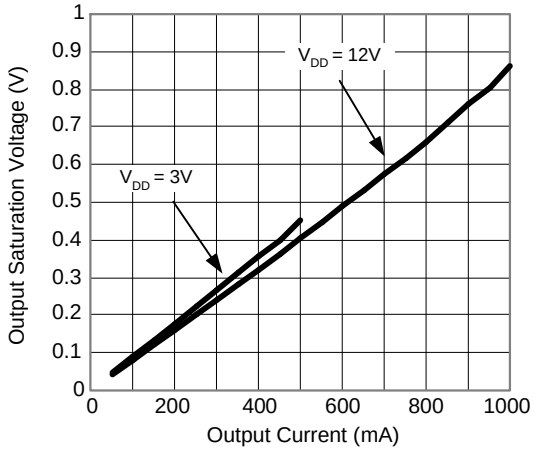
Magnetic Switching Points vs. VDD Supply Voltage



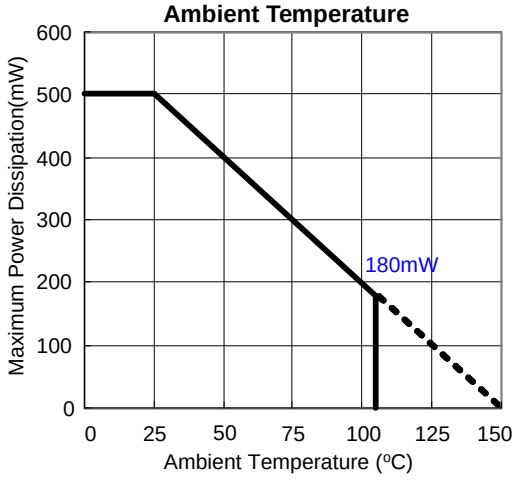
Magnetic Switching Points vs. Junction Temperature



Output Saturation Voltage vs. Output Current

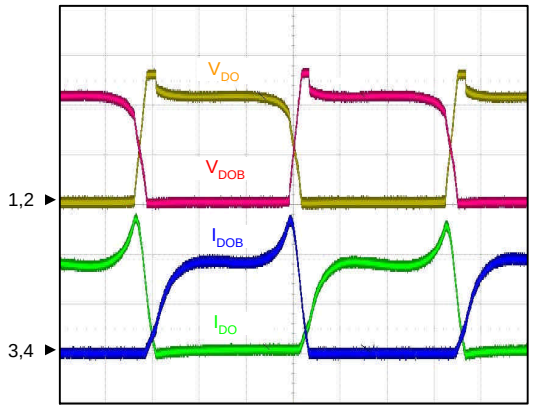


Maximum Power Dissipation vs. Ambient Temperature



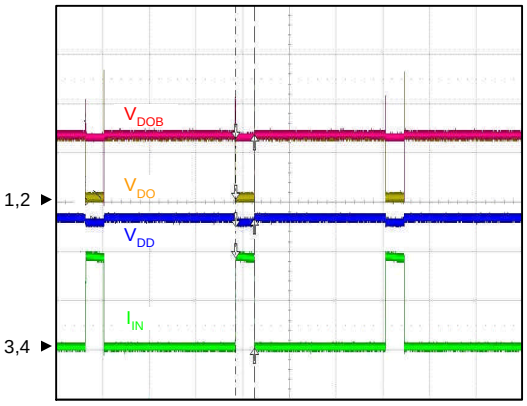
Operating Waveforms

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)



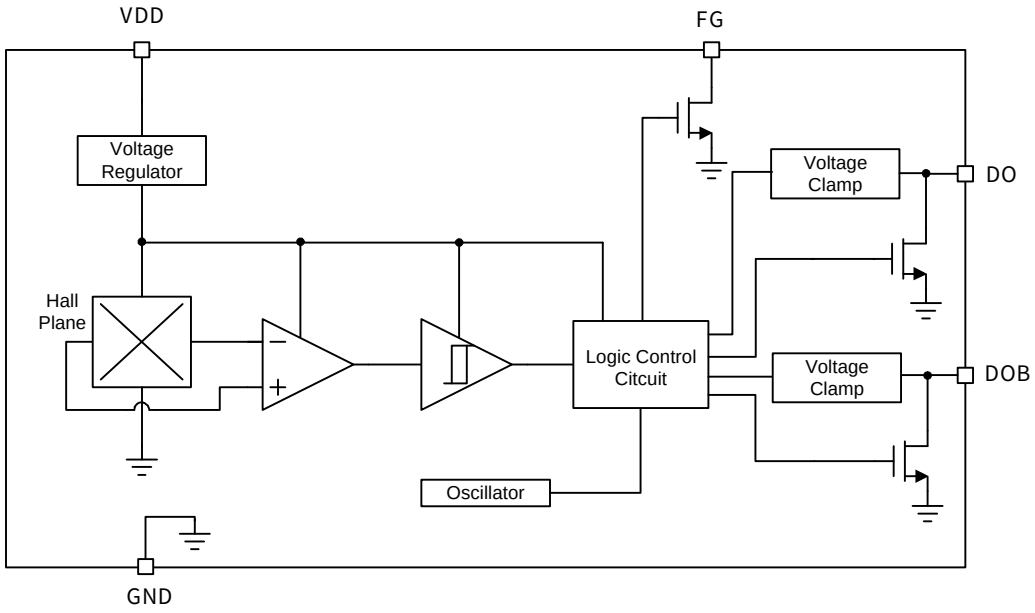
CH1:V_{DO},10V/div,DC
CH2:V_{DOB},10V/div,DC
CH3:V_{DD},5V/div,DC
CH4:I_{IN},500mA/div,DC
Time:1s/div

Pin Description

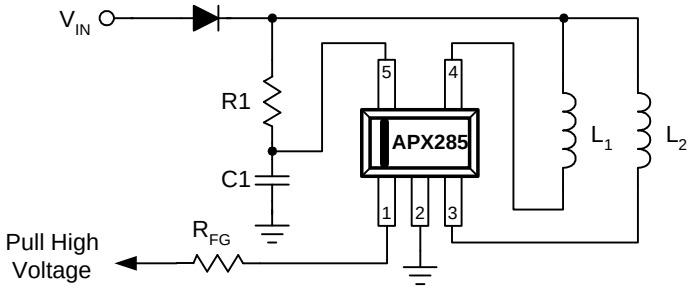
TSOT-23-5F

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

Block Diagram



Typical Application Circuit

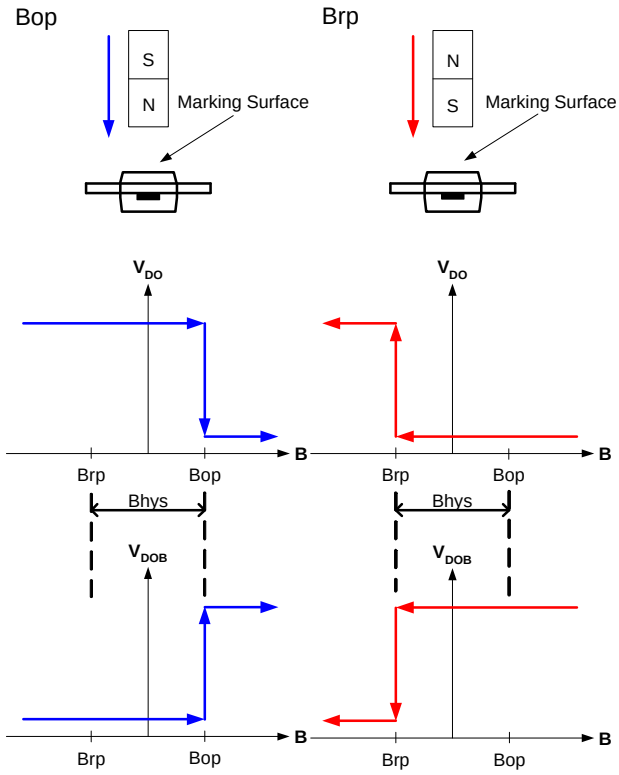


Notes: D_1 is to protect IC and coils when reverse power input.
C_1: typical 1μF/25V capacitor recommended.
R_1: typical 20Ω resistor recommended.
The R_1 and C_1 are to avoid inrush current to damage IC at hot plug ON/OFF moments and the R_1 and C_1 values need to be selected base on coils design.

Function Description

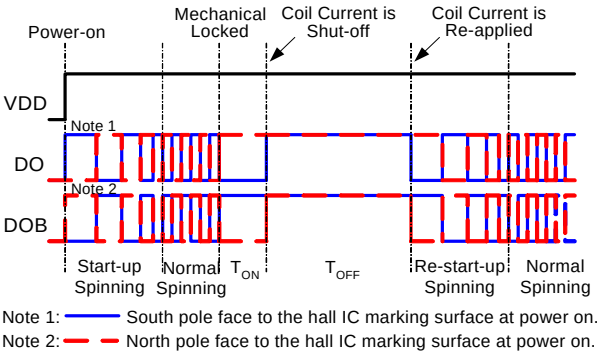
Output Switch Principle

The APX285 builts in a Hall-effect sensor plane to sense the vertical magnetic flux density (B). There are two output drivers in APX284 to drive two-phase DC brushless motor. When the North 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 North pole magnetic field far away the IC marking surface and South 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 APX285 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.

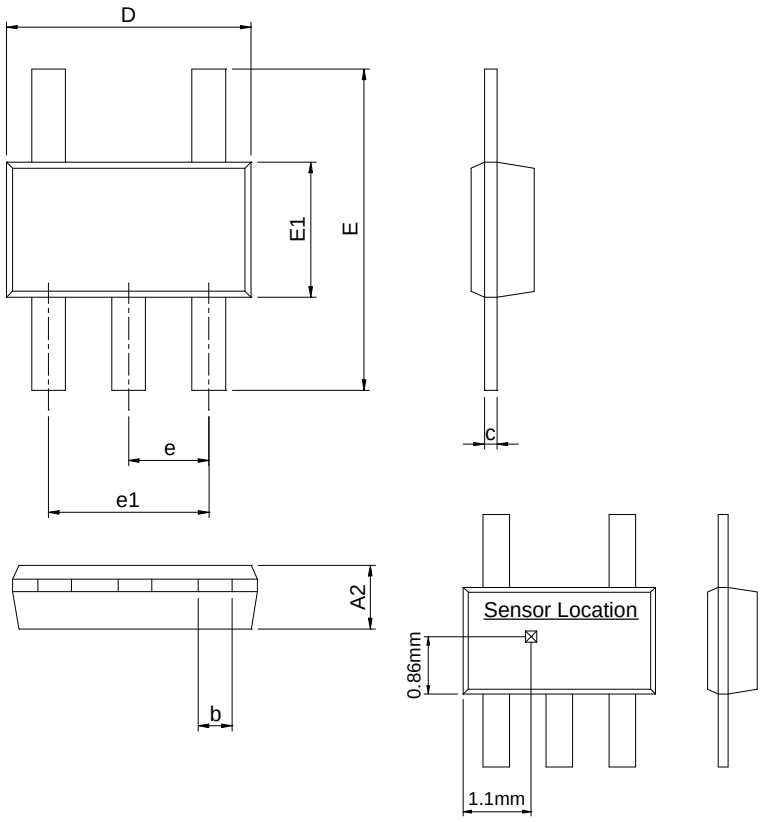


Thermal Protection

The APX285 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

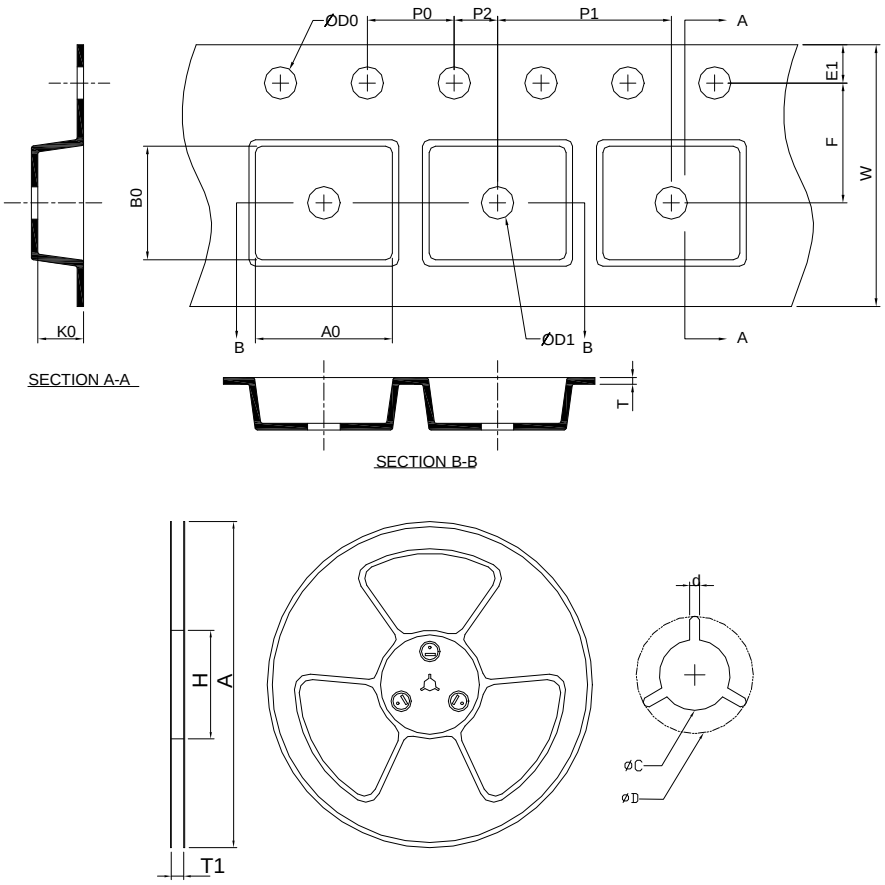
TSOT-23-5F



SYMBOL	TSOT-23-5F			
	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-23-5F	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	5.50±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	1.30±0.20

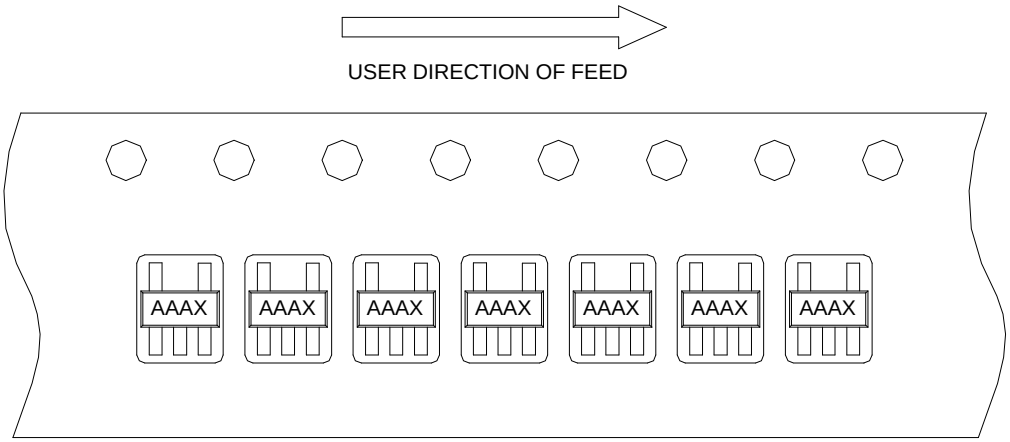
(mm)

Devices Per Unit

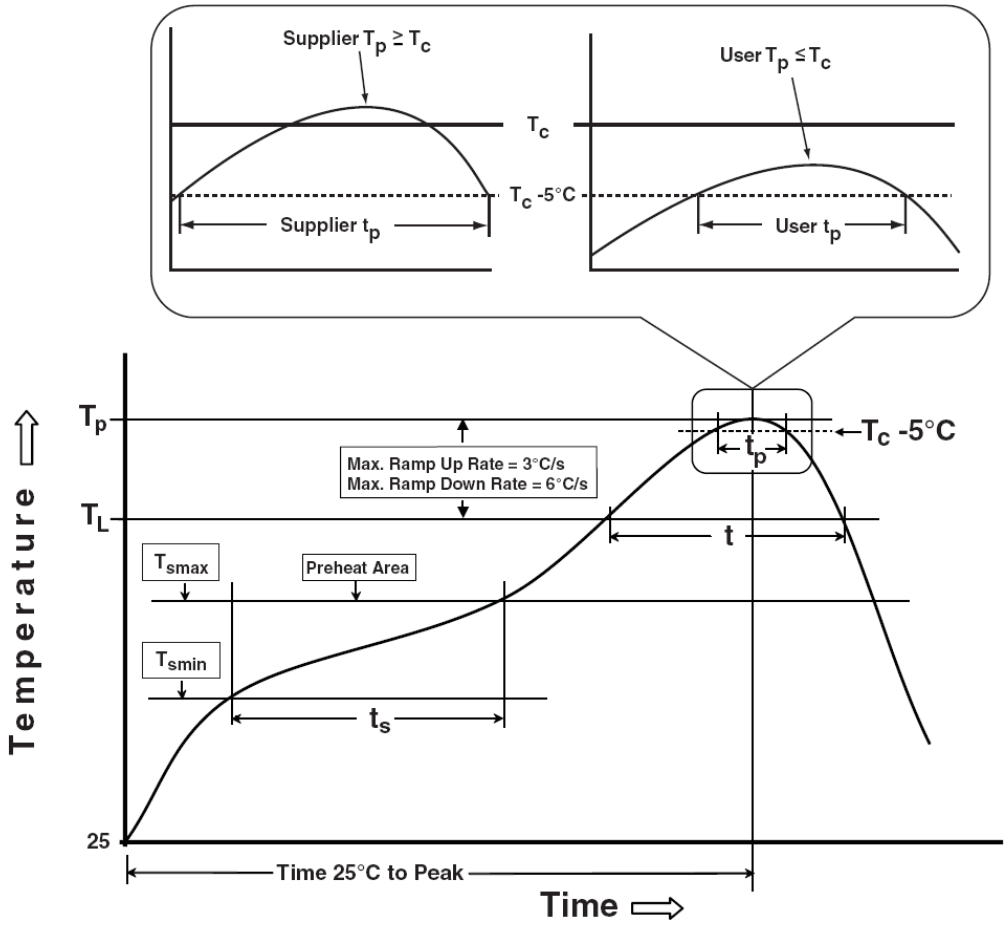
Package Type	Unit	Quantity
TSOT-23-5F	Tape & Reel	3000

Taping Direction Information

TSOT-23-5F



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 @ 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

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