Single-Phase digital calibration Motor Pre-Driver for Fan Motor

Features

- **Single Phase Fan Pre-Driver**
- **Easy digital programming (EDP.)**
- **Built-in direct PWM input terminal**
- **Built-in soft start function**
- **Multi Signal Output for SOUT (FG,RD,FG+RD,Low RPM Alarm)**
- **Built-in Current Limit**
- **LDO 5V output**
- **Low Quiescent Current**
- **Built-in Lock Protection and Auto Restart Function**
- **Thermal shut down circuit**
- **Lead Free and Green Device Available (RoHS Compliant)**

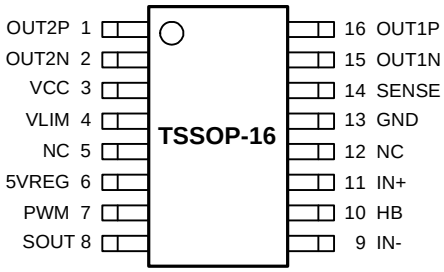
Applications

- **CPU And Server Cooling Fans**
- **Variable Speed Control Fans**

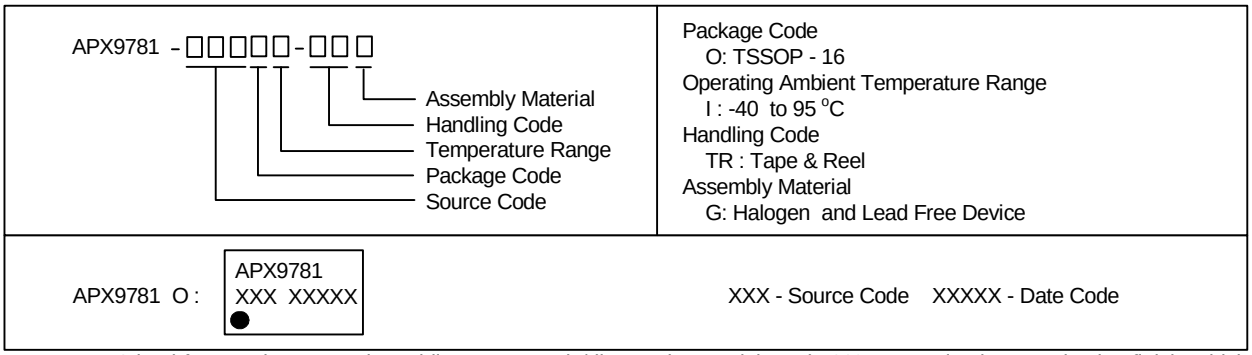
General Description

The APX9781 is a single phase full wave DC brushless motor driver with variable speed control that works with a speed feedback signal and current limit features suitable for the fan of server system and high power cooling fan.APX9781 currect protection can be set via digital programming. Multi PWM curve, soft start, output signal, the lock protection.The APX9781 is available in TSSOP-16 package (see Pin Configuration).Using digital calibration (OTP), the design speed curve for more easily.

Pin Configuration



Ordering and Marking Information



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	Ratings	Unit
V_{CC}	VCC Pin Supply Voltage (VCC to GND)	-0.3 to 18	V
$V_{OUTP, OUTN}$	Output Pin Voltage	-0.3 to 18	V
I_{OUTP}	Output Pin Sink and Source Current	50	mA
I_{OUTN}	Output Pin Sink and Source Current	50	mA
V_{PWM}	PWM Pin Input Voltage (PWM to GND)	-0.3 to 7	V
$V_{SENSE/VLIM}$	SENSE/VLIM Pin Withstand Voltage (SENSE/VLIM to SGND)	-0.3 to 7	V
V_{SOUT}	SOUT Pin Output Voltage	-0.3 to 18	V
I_{SOUT}	SOUT Pin Maximum Output Sink Current	10	mA
I_{HB}	HB Pin Output Current	10	mA
I_{5VREG}	5VREG Pin Output Source Current	20	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) TSSOP-16	156	°C/W
P_D	Power Dissipation, T_A=25°C	0.8	W

Note 2: Mounted on a board (60x38x1.6t mm, Glass epoxy).

Recommended Operating Conditions (Note4)

Symbol	Parameter	Range	Unit
V_{CC}	VCC Pin Supply Voltage Range	4 to 15	V
V_{PWM}	PWM Pin Input Voltage Range	0 to V_{5VREG}	V
V_{VLIM}	VLIM Pin Input Voltage Range	0 to V_{5VREG}	V
V_{ICM}	Hall Input (IN+, IN-) Common-Phase Input Voltage Range	0.2 to 3	V
T_A	Ambient Temperature	-40 to 105	°C
T_J	Junction Temperature	-40 to 125	°C

Note 4: Mounted on a board (60x38x1.6t mm, Glass epoxy).

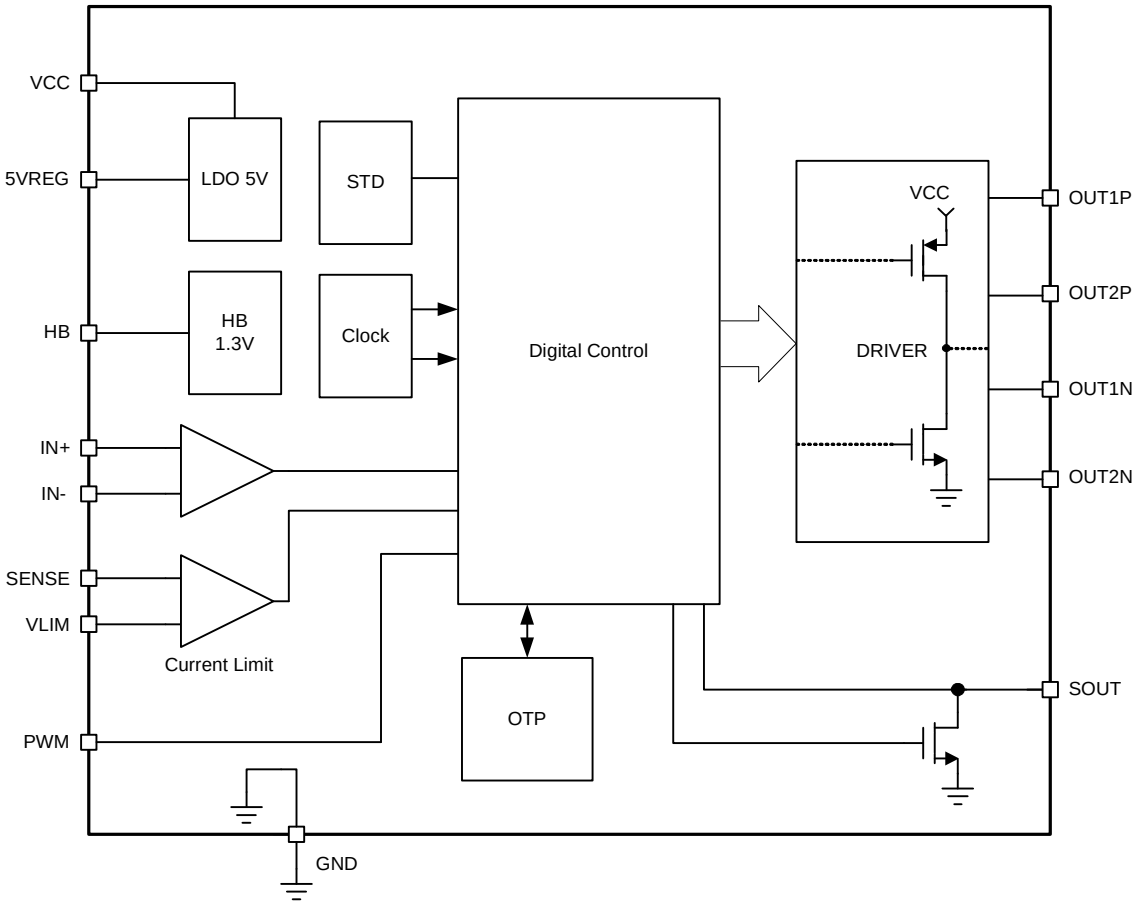
Electrical Characteristics (V_{CC} = 12V, T_A = 25°C, unless otherwise specified)

Symbol	Parameter	Test Conditions	APX9781			Unit
			Min	Typ	Max	
SUPPLY CURRENT						
V_{5VREG}	5VREG Pin Output Voltage	I_{5VREG} = 5mA	4.85	5	5.15	V
V_{HB}	HB Pin Output Voltage	I_{HB} = 5mA	1.15	1.3	1.45	V
I_{CC1}	Operating Current	Rotation Mode	-	9	15	mA
I_{CC2}		Lock Protection Mode	-	9	15	
LOCK PROTECTION						
T_{ON}	Lock Detection On Time		0.1	-	2	s
T_{OFF}	Lock Detection Off Time		3	-	18	s
OUTPUT DRIVERS						
V_{OUTPH}	OUT_P Output Low Voltage	I_{OUTP} = 20mA	V_{CC}-2	V_{CC}-1.5	-	V
V_{OUTPL}	OUT_P Output Low Voltage	I_{OUTN} = 20mA	-	0.5	1	V
V_{OUTNH}	OUT_N Output High Voltage	I_{OUTN} = -20mA	V_{CC}-2	V_{CC}-1.5	-	V
V_{OUTNL}	OUT_N Output Low Voltage	I_{OUTN} = 20mA	-	0.5	1	V
V_{SOUT}	SOUT Pin Low Voltage	I_{SOUT} = 5mA	-	0.2	0.3	V
I_{SOUTL}	SOUT Pin Leakage Current	V_{SOUT} = 12V	-	<0.1	1	μA
PWM CONTROL						
V_{PWMH}	PWM Input High Level Voltage		2.5	-	V_{CC}+0.3	V
V_{PWML}	PWM Input Low Level Voltage		-0.3	-	0.8	V
I_{PWMH}	PWM High Input Current	PWM=5V	-	0	-	μA
I_{PWML}	PWM Low Input Current	PWM=GND	-	-10	-20	μA
F_{PWM}	PWM Input Frequency		1	-	50	kHz
HALL SENSITIVITY						
V_{HN}	Hall Input Sensitivity	Zero to peak including offset and hysteresis	-	10	20	mV
THERMAL PROTECTION						
OTS	Over Thermal Protection Temperature		-	165	-	°C
	Over Thermal Protection Hysteresis		-	30	-	

Pin Descriptions

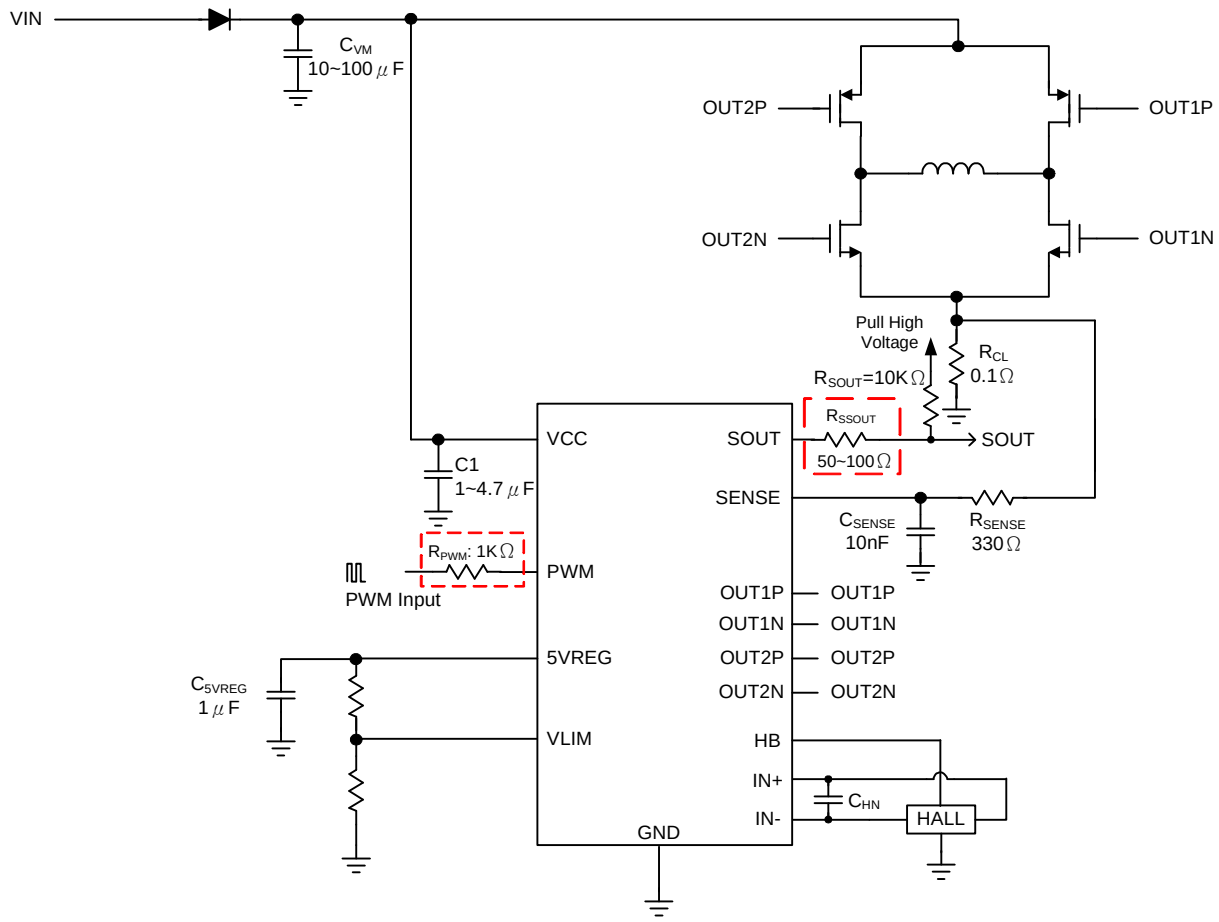
PIN		FUNCTION
NO.	NAME	
1	OUT2P	High side external H-bridge Driver. Connect this pin to the upper P-MOSFET gate of OUT2.
2	OUT2N	Low side external H-bridge Driver. Connect this pin to the lower N-MOSFET gate of OUT2.
3	VCC	Supply Voltage Input.
4	VLIM	Current-Limit Setting. Use a voltage divider from 5VREG to set VLIM pin voltage to set current limit value.
5	NC	
6	5VREG	5V Regulator Output. This is a 5V constant-voltage output for application circuit biases.
7	PWM	PWM Signal Input Terminal. Please let it be floating when not be used.
8	SOUT	Multi Signal Output (FG, RD, FG+RD, Low RPM Alarm). This pin is an open-collector output.
9	IN-	Hall Input -. Connect to hall element negative output.
10	HB	Hall Bias. This is a 1.3V constant–voltage output for hall element bias.
11	IN+	Hall Input +. Connect to hall element positive output.
12	NC	
13	GND	Control stage GND.
14	SENSE	Current-Limit Input. Connect to external N-MOSFET source pins and connect a resistor SENSE to GND to sense coil current
15	OUT1N	Low side external H-bridge Driver. Connect this pin to the lower N-MOSFET gate of OUT1.
16	OUT1P	High side external H-bridge Driver. Connect this pin to the upper P-MOSFET gate of OUT1.

Block Diagram



Typical Application Circuit

Circuit 1: Direct PWM Input Speed Control

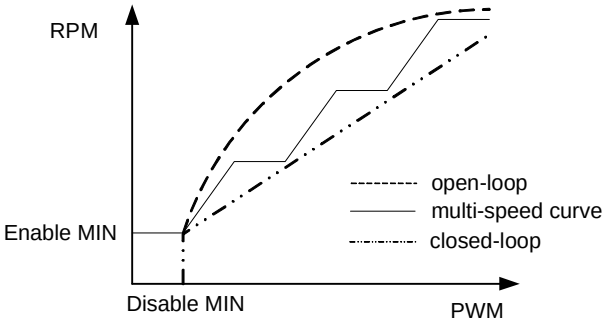


Note: Insert the capacitor C_{HN} to avoid noise coupling at power switch
R_{PWM} and R_{SSOUT} are optional to protect internal circuit for abnormal voltage stress.

Functional Descriptions

Variable multi-speed Control

The APX9781 can be selected open or closed loop and multi-speed curve.



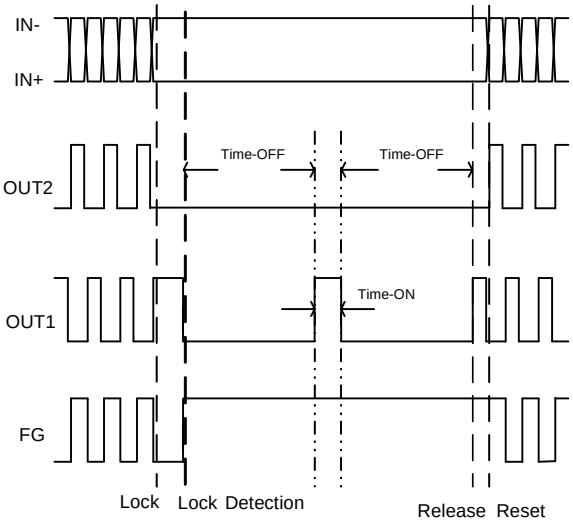
Lockup Protection and Automatic Restart

The APX9781 provides the lockup protection and automatic restart functions for preventing the coil burn-out when the fan is locked. This IC has an internal counter to determine the shutdown time (Time-OFF) and restart time (Time-ON). During shutdown time, the output drivers keep turning off for Time-OFF and then enter the restart time. During the restart time, one output is high and the other is low, which makes a torque for fan rotation. The restart time has Time-ON. If the locked condition is not removed, the shutdown/restart process will be recurred until the locked condition is released.

Time-OFF = 3S ~ 18S

Time-ON = 0.1S ~ 2S

APX9781 can set TON and TOFF values.



Signal Output (SOUT) PIN

The SOUT pin is an open drain output connecting a pull up resistor to a high level voltage for the detection function. This detection feature includes four modes (FG,RD, FG+RD,Low RPM Alarm) can be selected.

Easy digital programming (EDP.)

The Easy Digital Program is called "EDP.". Help engineers design a suitable speed curve, without changing the hardware. Achieve Low-cost, high-value design, just new parameters can be quickly downloaded to the IC. EDP. including I2C hardware and applications. Use method please contact ANPEC service personnel.

PWM Speed Control (fixed-frequency output)

It is possible to change rotation speed of the motor by switching output transistor. The on-duty of switching depends on the signal from input to PWM terminal. The output PWM frequency is fixed frequency.(25KHZ)

Soft Start Function

The APX9781 provides an internal programmable soft-start circuitry to control the current rise rate and limit the inrush current during startup. Soft-start when the power is turned on and restart. The typical soft-start control range of 1 to 30 seconds.

Current Limit Function

The APX9781 is equipped with external current limit circuit. The external current limit circuit works when SENSE pin voltage is higher than VLIM. VLIM is defined in APX9781 internal circuit and its typical value is 200mV.

Limit Current = V_{LIM} / R_F

Where:

V_{LIM} = internal reference voltage for current limit

RCL = SENSE pin resistor

For example:

V_{LIM} = 0.2V, RF = 0.1Ω

Limit Current = 2A

PCB layout wiring of RCL between N-MOSFET source pins, SENSE pin and GND must to be short to set an accurate limit current value.

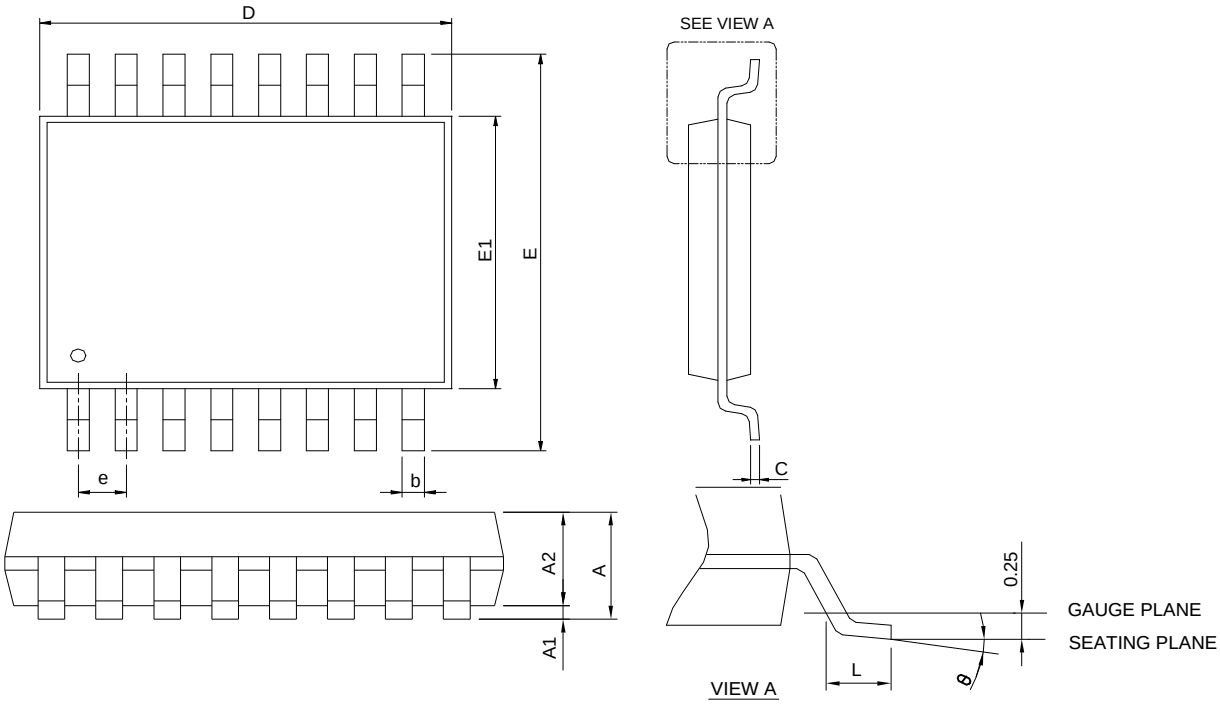
Functional Descriptions (Cont.)

Thermal Protection

The APX9781 is designed with a thermal protection to protect the IC from the damage of over temperature. When internal junction temperature reaches 175°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.

Package Information

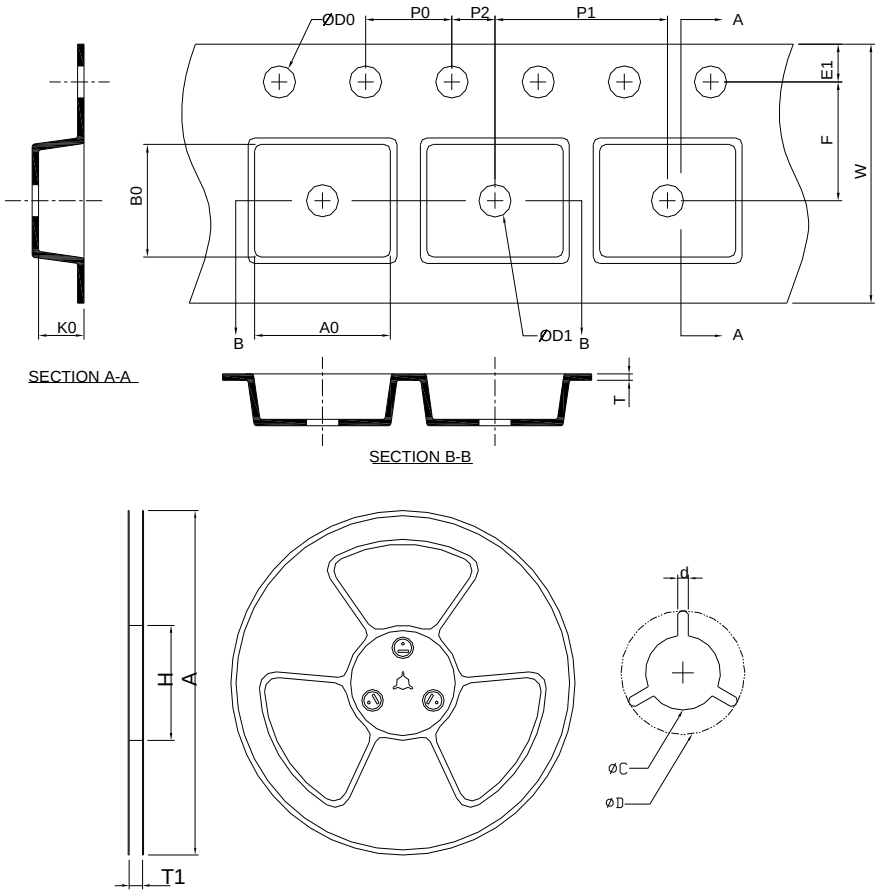
TSSOP-16



SYMBOL	TSSOP-16			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.20		0.047
A1	0.05	0.15	0.002	0.006
A2	0.80	1.05	0.031	0.041
b	0.19	0.30	0.007	0.012
c	0.09	0.20	0.004	0.008
D	4.90	5.10	0.193	0.201
E	6.20	6.60	0.244	0.260
E1	4.30	4.50	0.169	0.177
e	0.65 BSC		0.026 BSC	
L	0.45	0.75	0.018	0.030
θ	0°	8°	0°	8°

Note : 1. Follow from JEDEC MO-153 AB.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
3. Dimension "E1" 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
TSSOP-16	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	5.50±0.05
	4.00±0.10	8.00±0.10	2.00±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.80±0.20	5.40±0.20	1.60±0.20

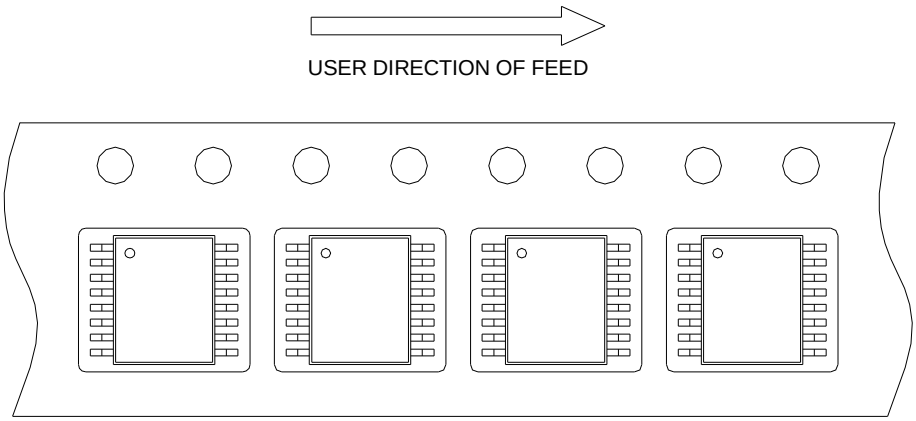
(mm)

Devices Per Unit

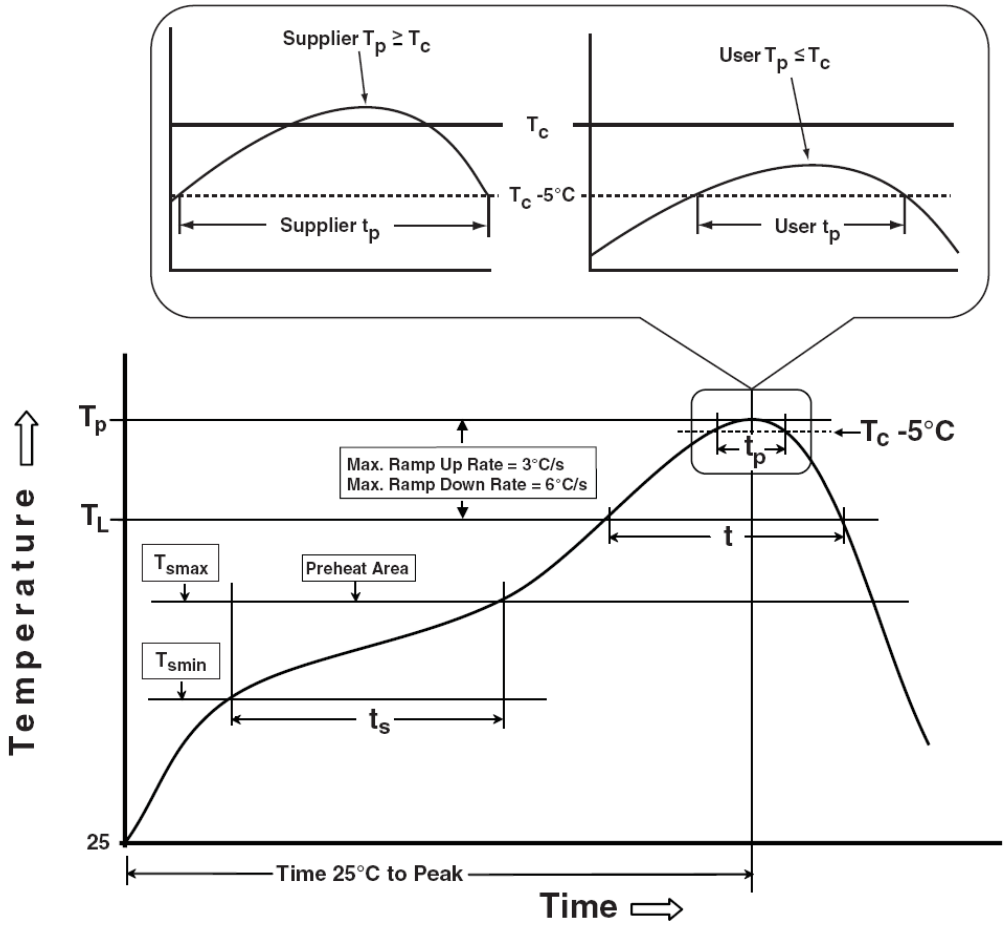
Package Type	Unit	Quantity
TSSOP- 16	Tape & Reel	2500

Taping Direction Information

TSSOP-16



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 @ 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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