

## P-Channel Enhancement Mode MOSFET

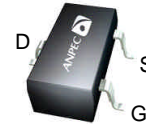
### Features

- 30V/-2.2A,  
 $R_{DS(ON)} = 105m\Omega(\text{typ.}) @ V_{GS} = -10V$   
 $R_{DS(ON)} = 165m\Omega(\text{typ.}) @ V_{GS} = -4.5V$
- Super High Dense Cell Design
- Reliable and Rugged
- Lead Free and Green Devices Available (RoHS Compliant)

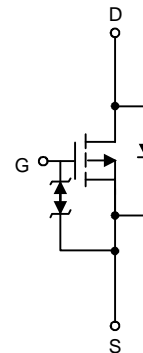
### Applications

- Power Management in Notebook Computer, Portable Equipment and Battery Powered Systems

### Pin Description



Top View of SOT-23-3



P-Channel MOSFET

### Ordering and Marking Information

<p>APM2309 <span style="font-family: monospace;">□□-□□□</span></p> <p> <span style="font-family: monospace;">□□</span> - Assembly Material  <span style="font-family: monospace;">□□</span> - Handling Code  <span style="font-family: monospace;">□</span> - Temperature Range  <span style="font-family: monospace;">□□□</span> - Package Code         </p>	<p>Package Code              A : SOT-23-3              Operating Junction Temperature Range              C : -55 to 150 °C              Handling Code              TR : Tape &amp; Reel              Assembly Material              G : Halogen and Lead Free Device</p>
<p>APM2309 A : <span style="border: 1px solid black; padding: 2px;">M09X</span></p>	<p>X - 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	
$V_{DSS}$	Drain-Source Voltage	-30	V	
$V_{GSS}$	Gate-Source Voltage	$\pm 20$		
$I_D^*$	Continuous Drain Current	-2.2	A	
$I_{DM}^*$	Pulsed Drain Current			
$I_S^*$	Diode Continuous Forward Current	-1	A	
$T_J$	Maximum Junction Temperature	150	$^\circ\text{C}$	
$T_{STG}$	Storage Temperature Range	-55 to 150		
$P_D^*$	Maximum Power Dissipation	$T_A=25^\circ\text{C}$	0.83	W
		$T_A=100^\circ\text{C}$	0.3	
$R_{\theta JA}^*$	Thermal Resistance-Junction to Ambient	150	$^\circ\text{C}/\text{W}$	

Note : \*Surface Mounted on 1in<sup>2</sup> pad area, t ≤ 10sec.

**Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Symbol	Parameter	Test Conditions	APM2309			Unit
			Min.	Typ.	Max.	
<b>STATIC CHARACTERISTICS</b>						
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS}=0\text{V}, I_{DS}=-250\mu\text{A}$	-30	-	-	V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS}=-24\text{V}, V_{GS}=0\text{V}$	-	-	-1	$\mu\text{A}$
		$T_J=85^\circ\text{C}$	-	-	-30	
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}, I_{DS}=-250\mu\text{A}$	-1.3	-1.8	-2.5	V
$I_{GSS}$	Gate Leakage Current	$V_{GS}=\pm 16\text{V}, V_{DS}=0\text{V}$	-	-	$\pm 10$	$\mu\text{A}$
$R_{DS(ON)}^a$	Drain-Source On-State Resistance	$V_{GS}=-10\text{V}, I_{DS}=-2.2\text{A}$	-	105	130	m $\Omega$
		$V_{GS}=-4.5\text{V}, I_{DS}=-1.7\text{A}$	-	165	220	
<b>DIODE CHARACTERISTICS</b>						
$V_{SD}^a$	Diode Forward Voltage	$I_{SD}=-1\text{A}, V_{GS}=0\text{V}$	-	-0.8	-1.1	V
$t_{rr}$	Reverse Recovery Time	$I_{SD}=-2.2\text{A},$ $di_{SD}/dt=100\text{A}/\mu\text{s}$	-	13	-	ns
$Q_{rr}$	Reverse Recovery Charge		-	6	-	nC

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

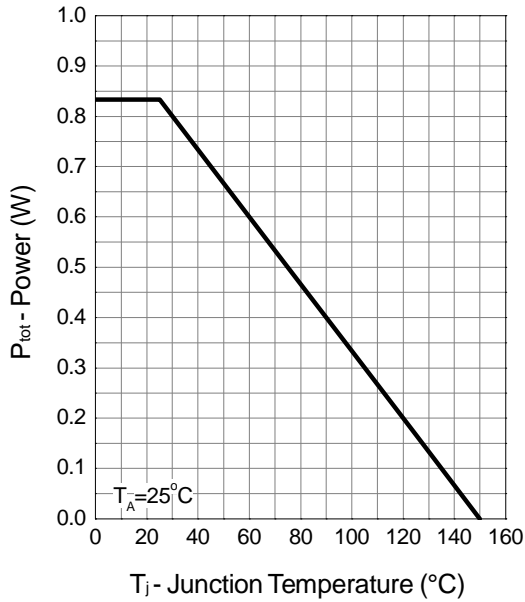
Symbol	Parameter	Test Conditions	APM2309			Unit
			Min.	Typ.	Max.	
<b>DYNAMIC CHARACTERISTICS<sup>b</sup></b>						
$R_G$	Gate Resistance	$V_{GS}=0V, V_{DS}=0V, F=1\text{MHz}$	-	11	-	$\Omega$
$C_{iss}$	Input Capacitance	$V_{GS}=0V,$ $V_{DS}=-15V,$ Frequency=1.0MHz	-	310	-	pF
$C_{oss}$	Output Capacitance		-	40	-	
$C_{rss}$	Reverse Transfer Capacitance		-	25	-	
$t_{d(ON)}$	Turn-on Delay Time	$V_{DD}=-15V, R_L=15\Omega,$ $I_{DS}=-1A, V_{GEN}=-10V,$ $R_G=6\Omega$	-	8	15	ns
$t_r$	Turn-on Rise Time		-	12	23	
$t_{d(OFF)}$	Turn-off Delay Time		-	18	33	
$t_f$	Turn-off Fall Time		-	3	6	
<b>GATE CHARGE CHARACTERISTICS<sup>b</sup></b>						
$Q_g$	Total Gate Charge	$V_{DS}=-15V, V_{GS}=-10V,$ $I_{DS}=-2.2A$	-	6.4	9	nC
$Q_{gs}$	Gate-Source Charge		-	1.4	-	
$Q_{gd}$	Gate-Drain Charge		-	1.3	-	

Note a : Pulse test ; pulse width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$ .

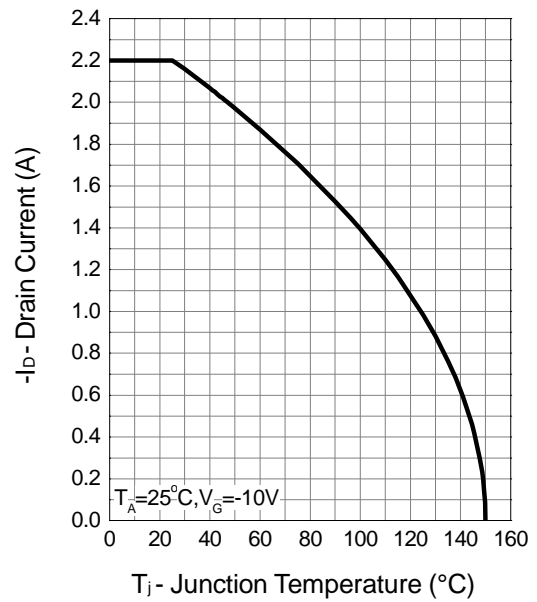
Note b : Guaranteed by design, not subject to production testing.

## Typical Operating Characteristics

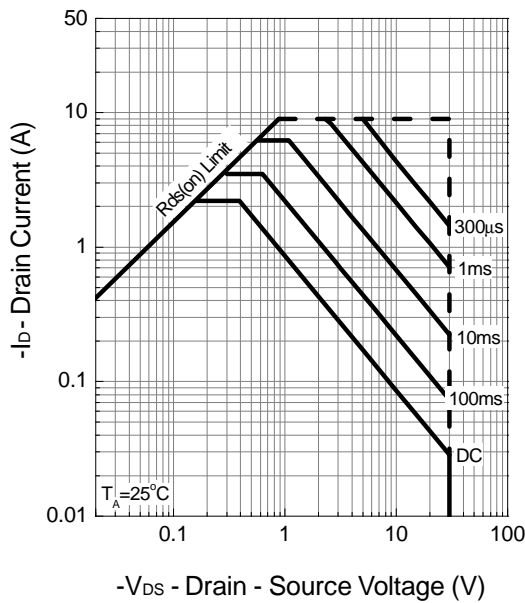
Power Dissipation



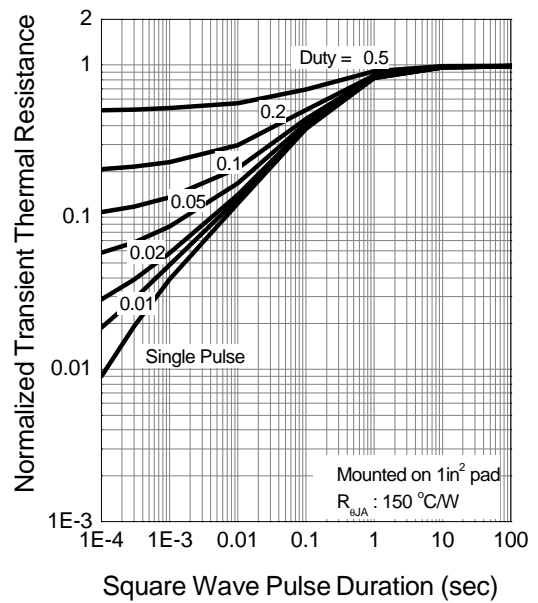
Drain Current



Safe Operation Area

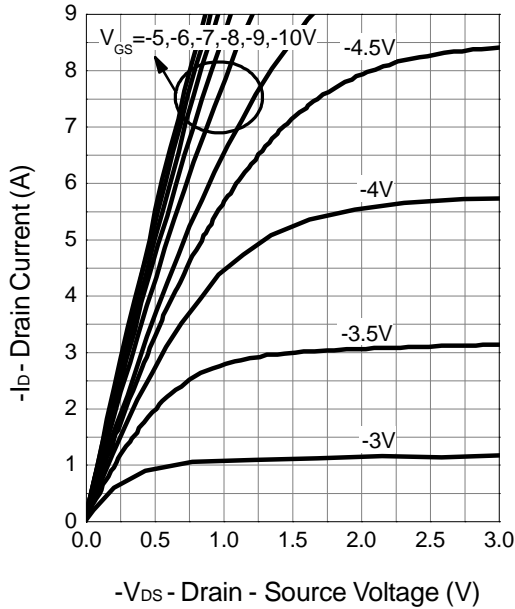


Thermal Transient Impedance

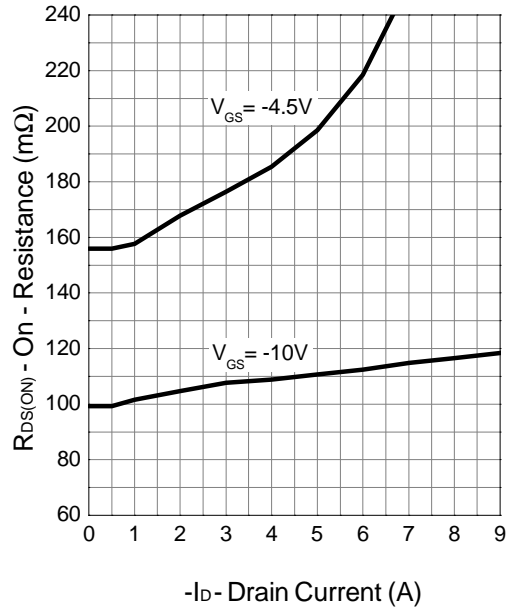


Typical Operating Characteristics (Cont.)

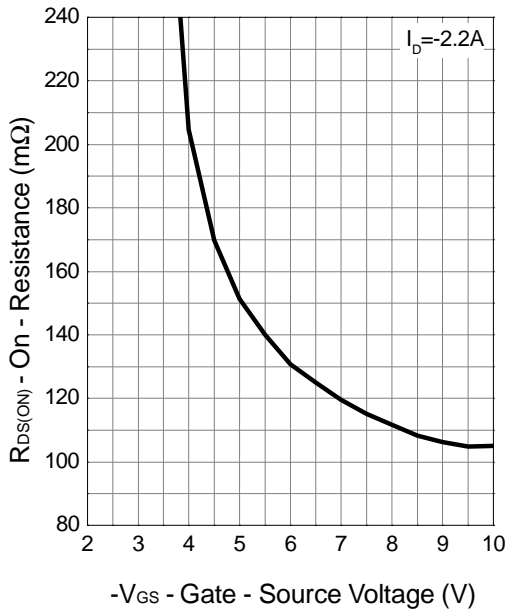
Output Characteristics



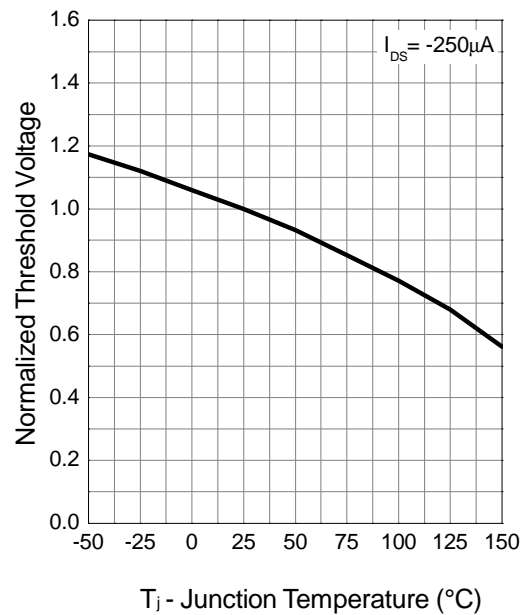
Drain-Source On Resistance



Gate-Source On Resistance

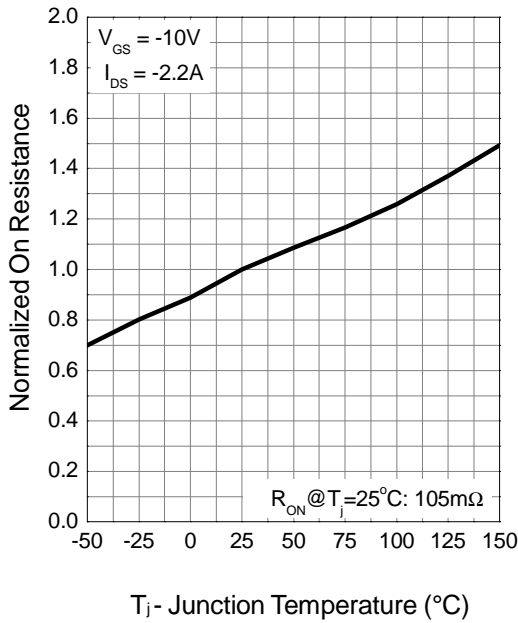


Gate Threshold Voltage

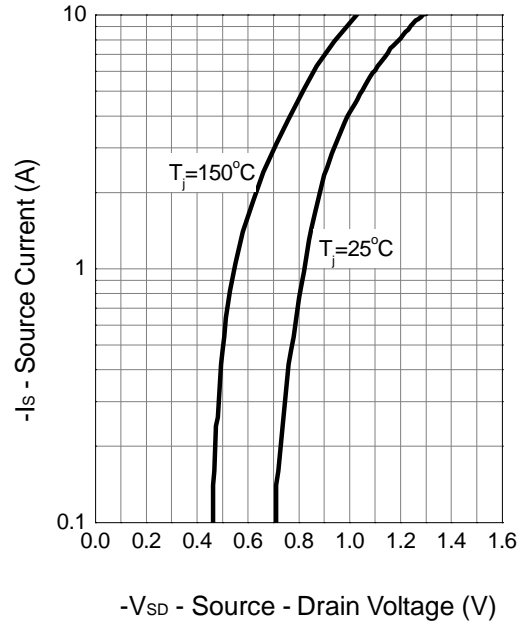


Typical Operating Characteristics (Cont.)

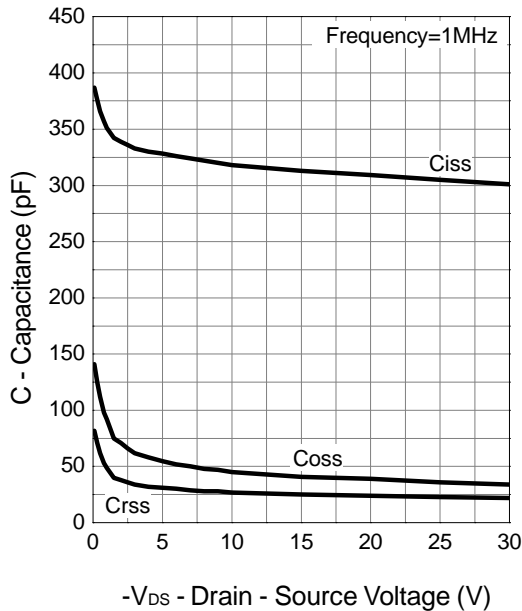
Drain-Source On Resistance



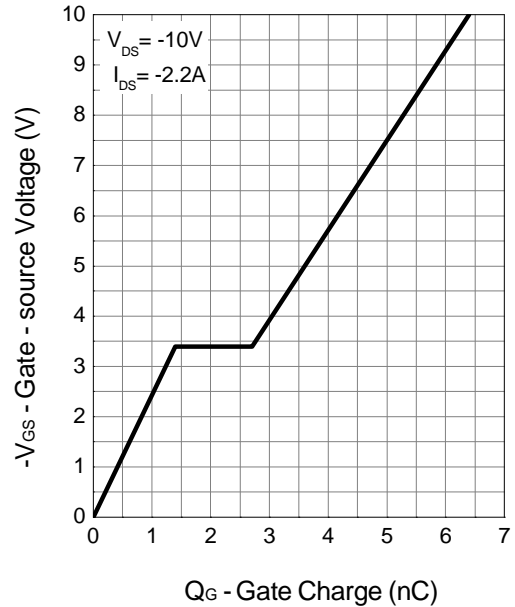
Source-Drain Diode Forward



Capacitance

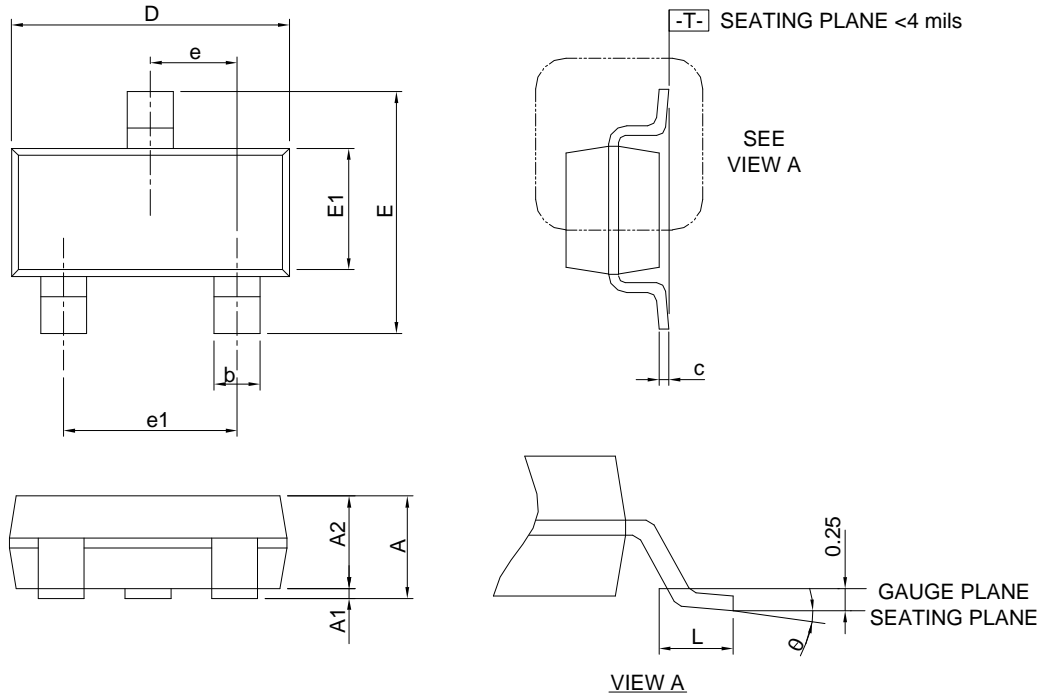


Gate Charge



Package Information

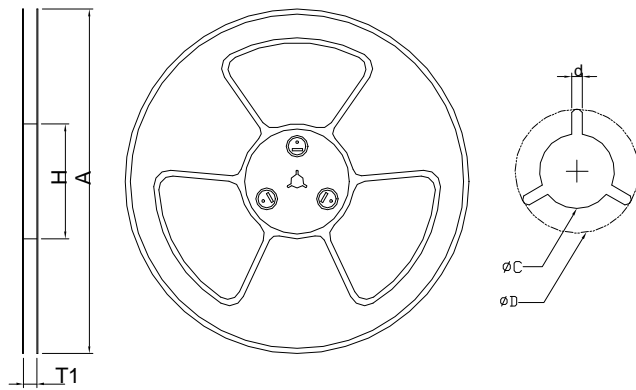
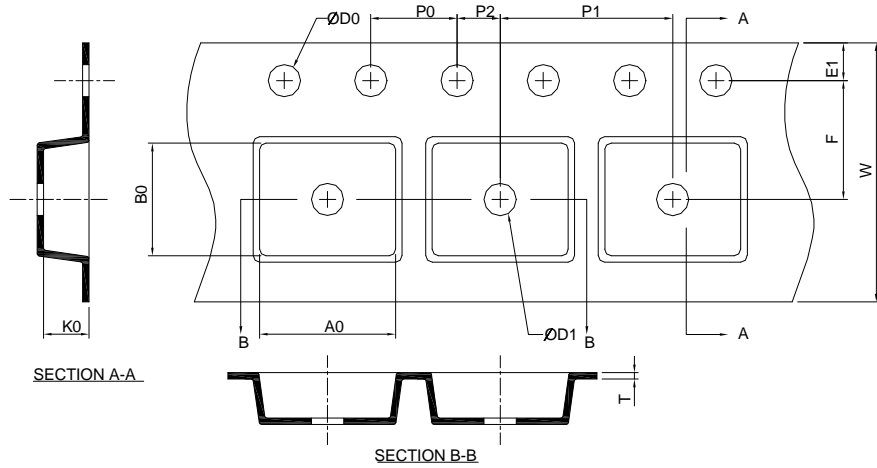
SOT-23-3



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.

### 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
	<b>P0</b>	<b>P1</b>	<b>P2</b>	<b>D0</b>	<b>D1</b>	<b>T</b>	<b>A0</b>	<b>B0</b>	<b>K0</b>
	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

(mm)

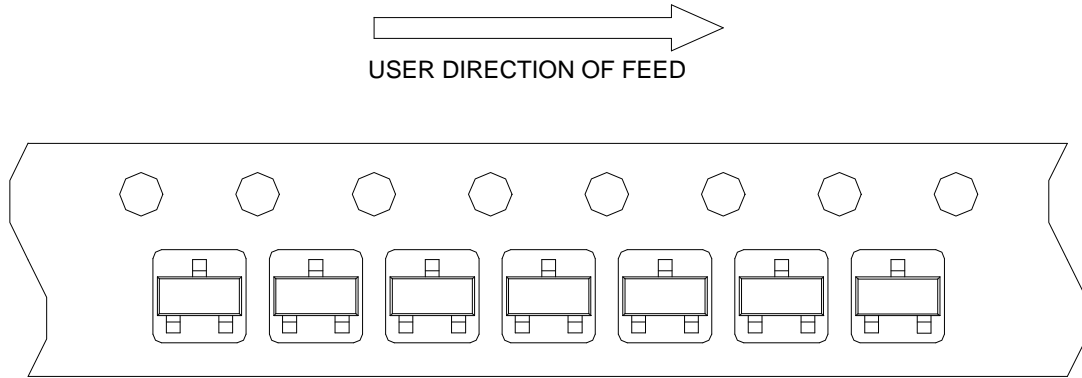
### Devices Per Unit

Package Type	Unit	Quantity
SOT-23-3	Tape & Reel	3000

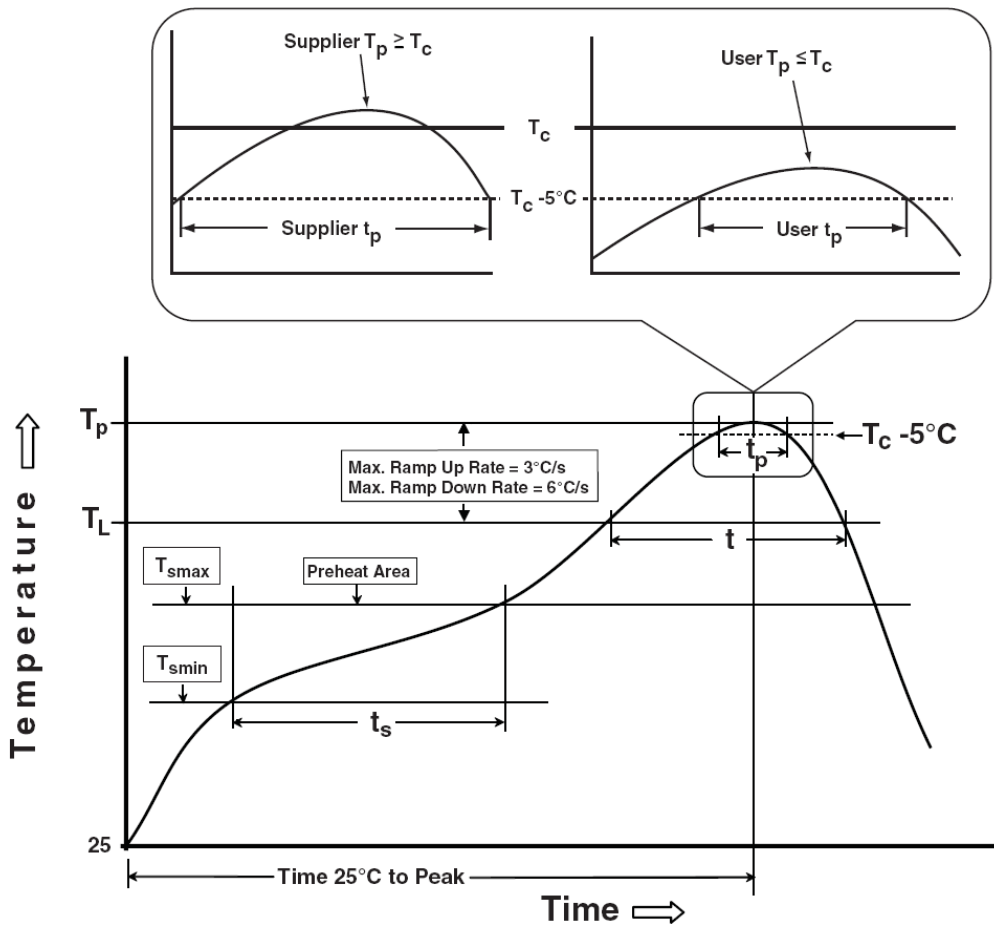


## Taping Direction Information

SOT-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

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## Customer Service

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