

2N7002E-Q1

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2N7002E-Q1

60V N-Channel Enhancement Mode MOSFET ESD Protection

Features

- ESD protected 2kV HBM
- Low $R_{DS(on)}$
- Surface mount package
- Lead-free parts meet RoHS requirements
- Qualified to AEC-Q101 standards for high reliability
- Suffix "-H" indicates Halogen-free part, ex. 2N7002E-Q1-H

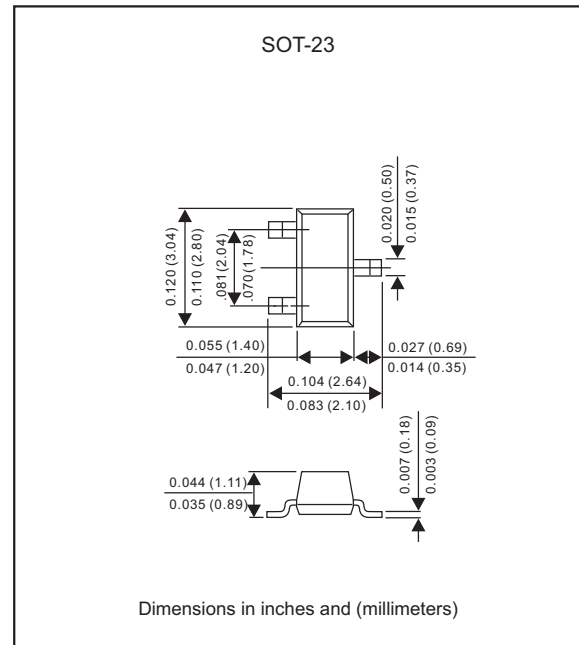
Applications

- Low side load switch
- Level shift circuits
- DC-DC converter
- Portable applications i.e. DSC, PDA, Cell phone, etc

Mechanical data

- Epoxy:UL94-V0 rated flame retardant
- Case : Molded plastic, SOT-23
- Terminals : Solder plated, solderable per MIL-STD-750, Method 2026
- Mounting Position : Any
- Weight : Approximated 0.008 gram

Package outline



Maximum ratings (AT $T_A=25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Limits	Unit
Drain-source voltage	V_{DS}	60	V
Drain current	I_D	320	mA
Steady state $T_A=25^\circ\text{C}$		230	
$T_A=85^\circ\text{C}$		380	
$t < 5\text{s}$ $T_A=25^\circ\text{C}$		270	
$T_A=85^\circ\text{C}$			
Pulsed drain current $t_p=10\mu\text{s}$	I_{DM}	1.5	A
Gate-source voltage	V_{GS}	± 20	V
Power dissipation (Note 1)	P_D	300	mW
Steady state		420	
$t < 5\text{s}$			
Source current (body diode)	I_S	300	mA
Lead temperature for soldering purposes (1/8" from case for 10s)	T_L	260	$^\circ\text{C}$
Gate-source ESD rating (HBM, Method)	ESD	2000	V
Thermal resistance junction to ambient steady (Note 1)	$R_{\theta JA}$	417	$^\circ\text{C/W}$
Thermal resistance junction to ambient $t \leq 5\text{s}$ (Note 1)		300	
Operation junction temperature range	T_J	-55 to +150	$^\circ\text{C}$
Storage temperature range	T_{STG}	-55 to +150	$^\circ\text{C}$

Note 1: FR-4 = $1.0 \times 0.75 \times 0.062$ in

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

Parameter	Conditions	Symbol	MIN.	TYP.	MAX.	Unit
OFF CHARACTERISTICS						
Drain-source breakdown voltage	$V_{GS}=0V, I_D=250\mu A$	$V_{(BR)DSS}$	60			V
Drain-to-source breakdown voltage temperature coefficient		$V_{(BR)DSS}/T_J$		71		mV/ $^{\circ}\text{C}$
Zero gate voltage drain current	$V_{DS}=60V, V_{GS}=0V, T_J=25^{\circ}\text{C}$	I_{DSS}			1.0	μA
	$V_{DS}=60V, V_{GS}=0V, T_J=125^{\circ}\text{C}$				500	μA
	$V_{DS}=50V, V_{GS}=0V, T_J=25^{\circ}\text{C}$				100	nA
Gate-body leakage current	$V_{GS}=\pm 20V, V_{DS}=0V$	I_{GSS}			± 10	μA

ON CHARACTERISTICS (Note 2)

Gate threshold voltage	$V_{DS}=V_{GS}, I_D=250\mu A$	$V_{GS(th)}$	1.0		2.0	V
Negative threshold temperature coefficient		$V_{GS(th)}/T_J$		4.0		mV/ $^{\circ}\text{C}$
Drain-source on-resistance	$V_{GS}=10V, I_D=500mA$	$R_{DS(on)}$			2.8	Ω
	$V_{GS}=4.5V, I_D=200mA$				3.2	
Forward transconductance	$V_{DS}=5.0V, I_D=200mA$	g_{fs}	80			mS

DYNAMIC CHARACTERISTICS

Input capacitance	$V_{DS}=25V, V_{GS}=0V, f=1MHz$	C_{iss}		21		pF
Output capacitance		C_{oss}		12		
Reverse transfer capacitance		C_{rss}		0.35		
Total gate charge	$V_{DS}=10V, V_{GS}=4.5V, I_D=500mA$	$Q_{g(tot)}$		0.44		nC
Gate-to-source charge		Q_{gs}		0.20		
Gate-to-drain charge		Q_{gd}		0.10		

SWITCHING CHARACTERISTICS

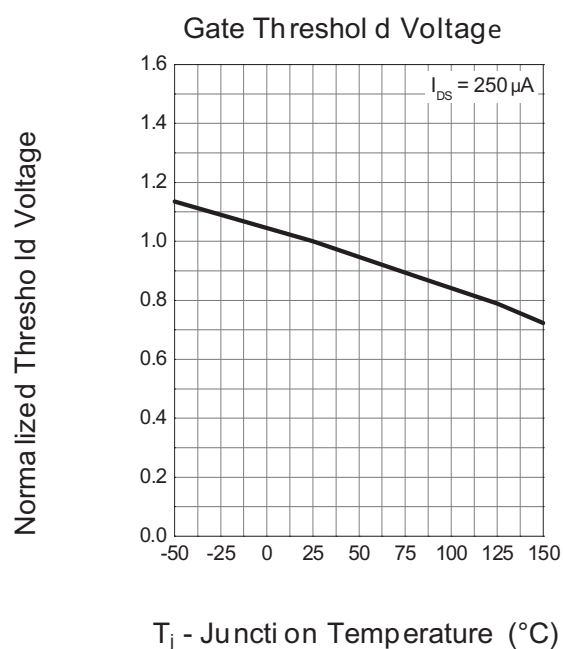
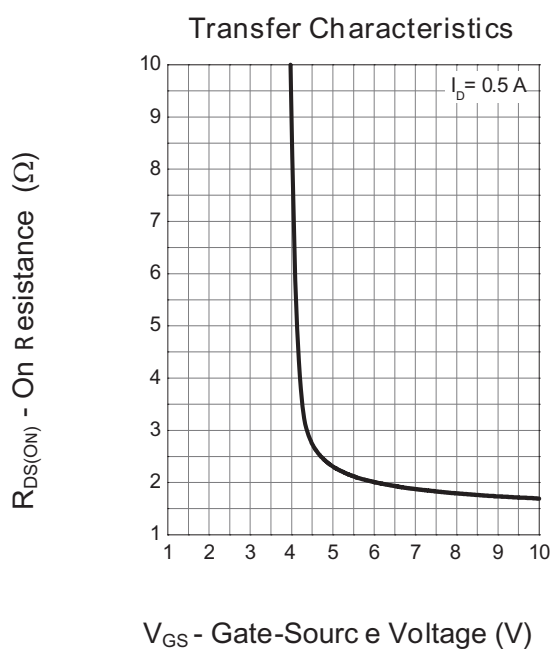
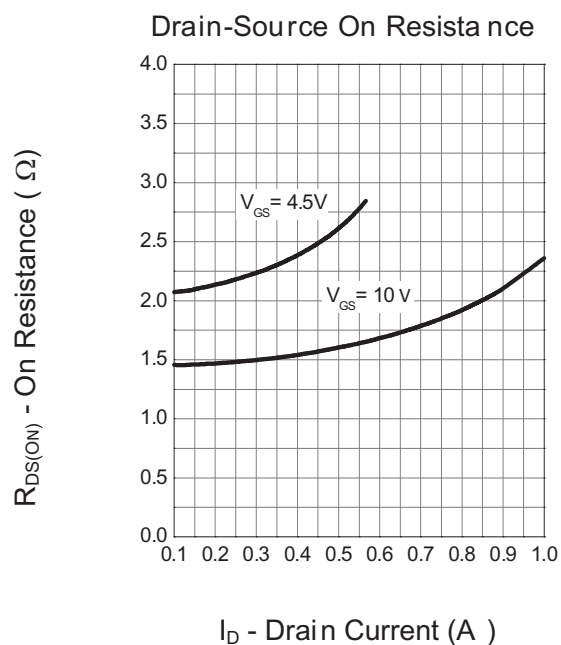
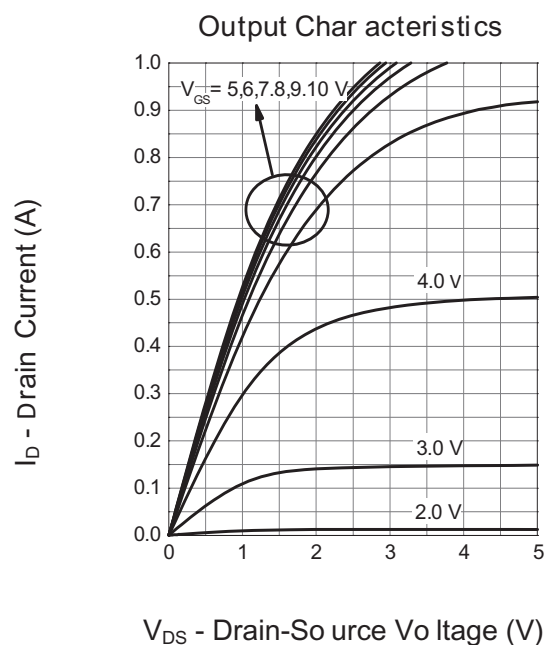
Turn-on delay time	$V_{DS}=30V, V_{GEN}=10V, I_D=500mA, R_G=25\Omega, R_L=60\Omega$	$t_{d(on)}$		2.7		ns
Turn-on rise time		t_r		2.5		
Turn-off delay time		$t_{d(off)}$		13		
Turn-off fall time		t_f		8		

BODY-DRAIN DIODE RATINGS

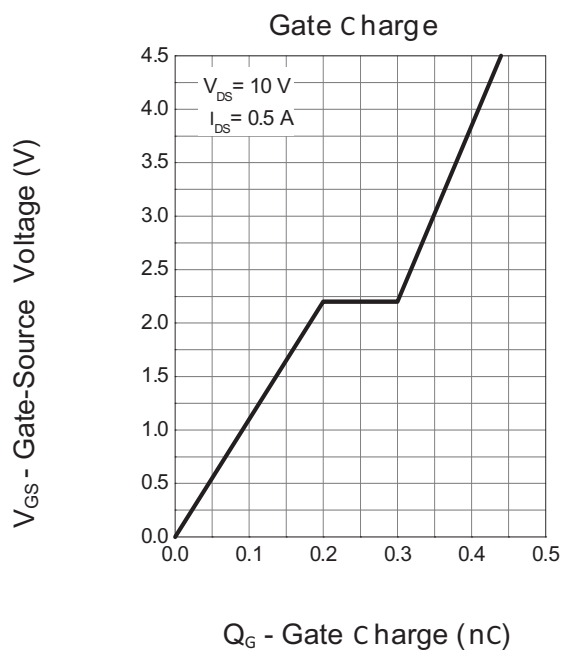
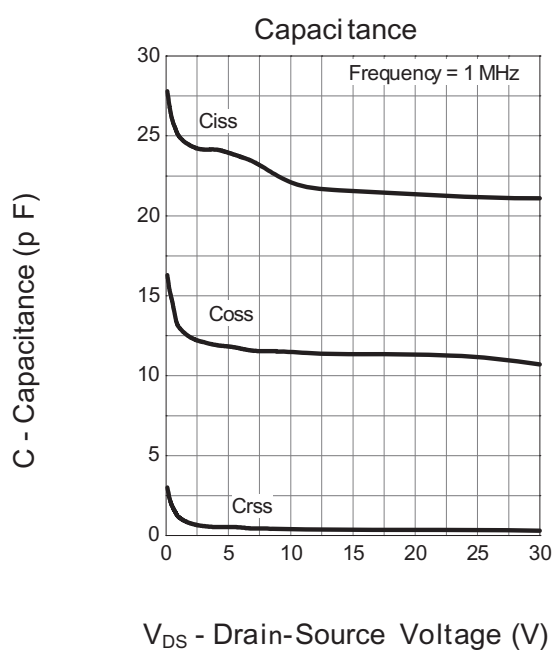
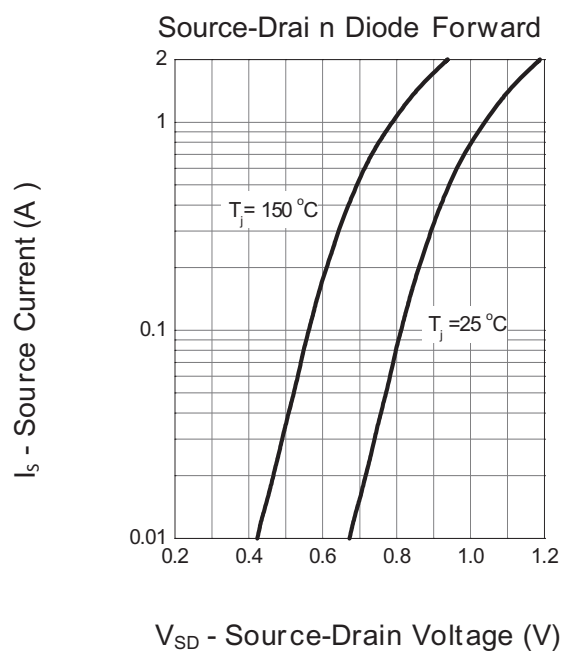
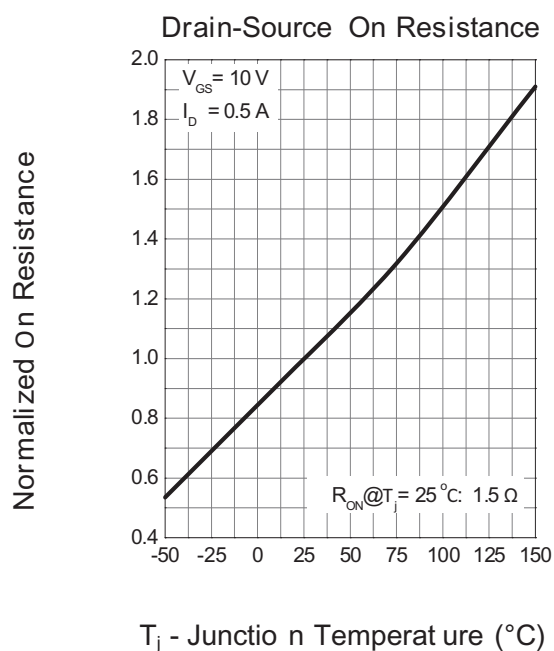
Diode forward on-voltage	$I_S=0.5A, V_{GS}=0V$	V_{SD}		0.85		V
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Note 2: Pulse Test: pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$

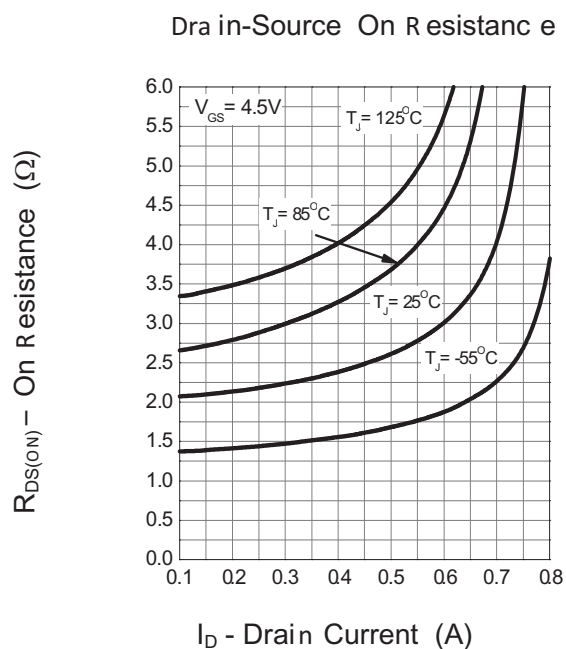
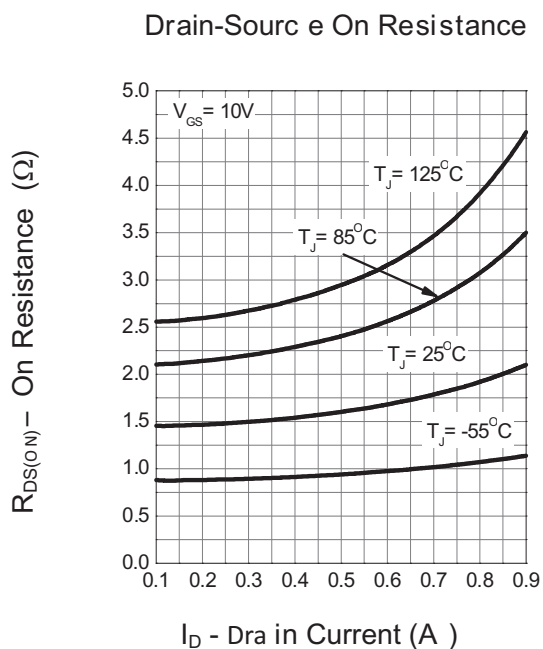
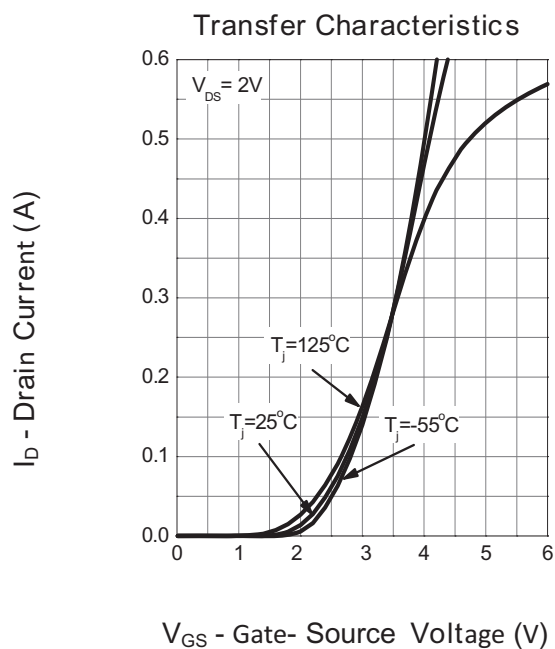
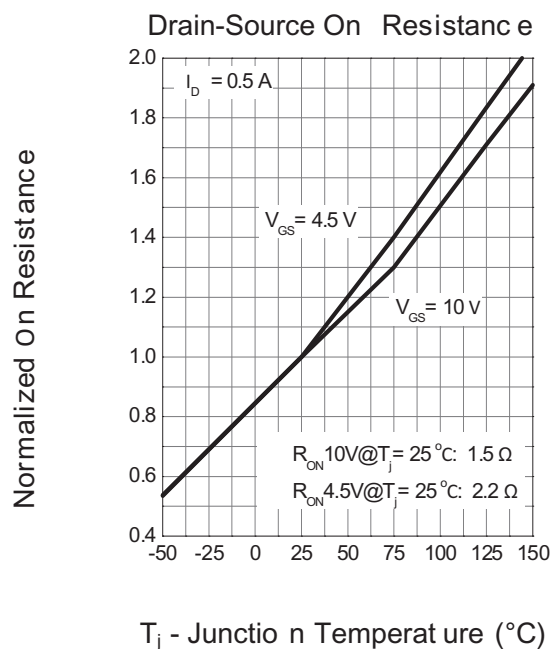
Rating and characteristic curves (2N7002E-Q1)



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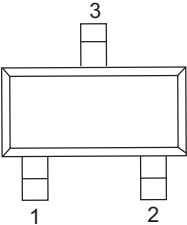
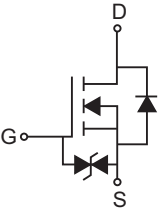


Rating and characteristic curves (2N7002E-Q1)



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Pinning information

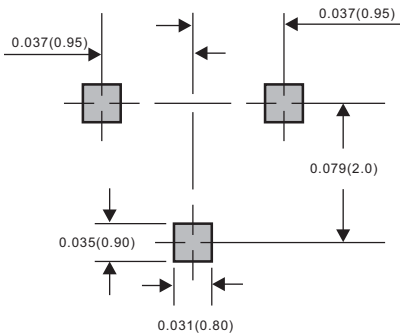
Pin	Simplified outline	Symbol
Pin1 Gate Pin2 Source Pin3 Drain		

Marking

Type number	Marking code
2N7002E-Q1	72K

Suggested solder pad layout

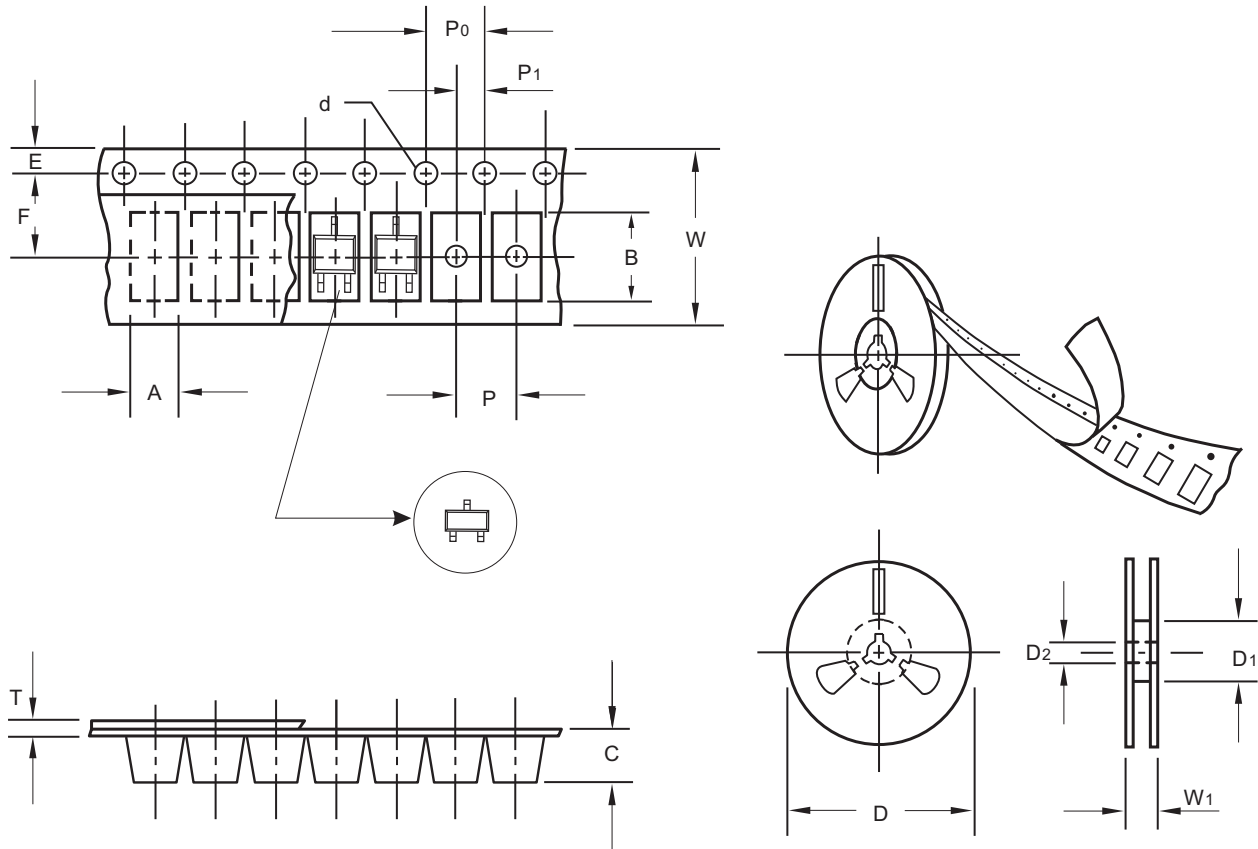
SOT-23



Dimensions in inches and (millimeters)

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Packing information



unit:mm

Item	Symbol	Tolerance	SOT-23
Carrier width	A	0.1	3.15
Carrier length	B	0.1	2.77
Carrier depth	C	0.1	1.22
Sprocket hole	d	0.1	1.50
13" Reel outside diameter	D	2.0	-
13" Reel inner diameter	D1	min	-
7" Reel outside diameter	D	2.0	178.00
7" Reel inner diameter	D1	min	54.40
Feed hole diameter	D2	0.5	13.00
Sprocket hole position	E	0.1	1.75
Punch hole position	F	0.1	3.50
Punch hole pitch	P	0.1	4.00
Sprocket hole pitch	P0	0.1	4.00
Embossment center	P1	0.1	2.00
Overall tape thickness	T	0.1	0.23
Tape width	W	0.3	8.00
Reel width	W1	1.0	11.40

Note: Devices are packed in accordance with EIA standard RS-481-A and specifications listed above.

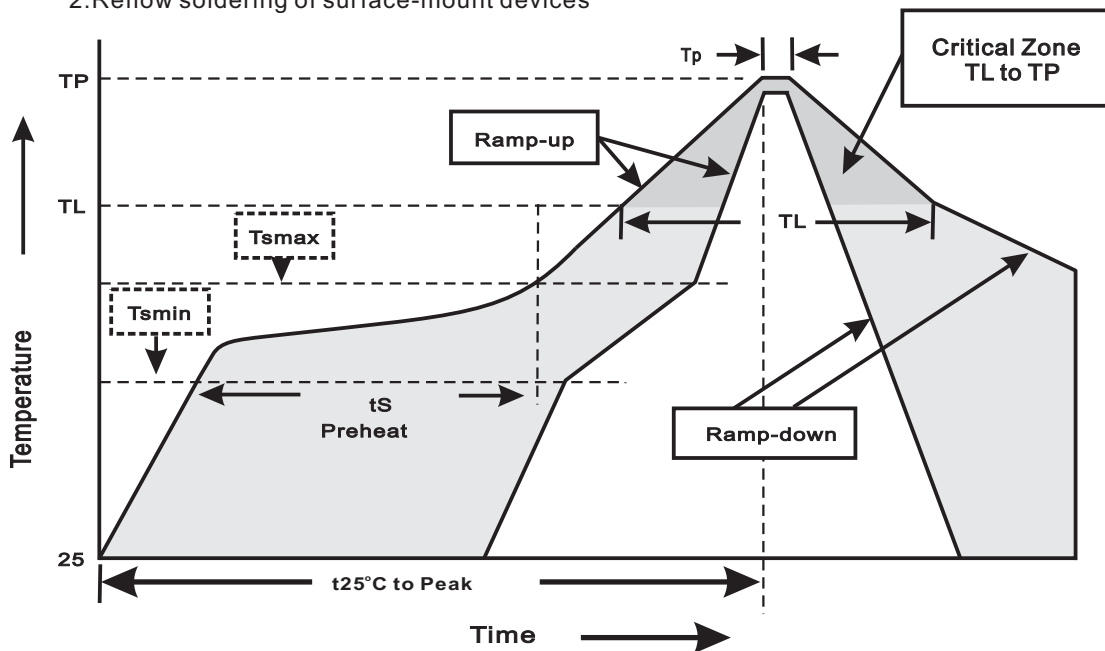
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Reel packing

PACKAGE	REEL SIZE	REEL (pcs)	COMPONENT SPACING (m/m)	BOX (pcs)	INNER BOX (m/m)	REEL DIA, (m/m)	CARTON SIZE (m/m)	CARTON (pcs)	APPROX. GROSS WEIGHT (kg)
SOT-23	7"	3,000	4.0	30,000	183*123*183	178	382*257*387	240,000	11.6

Suggested thermal profiles for soldering processes

- 1.Storage environment: Temperature=5°C~40°C Humidity=55%±25%
- 2.Reflow soldering of surface-mount devices



3.Reflow soldering

Profile Feature	Soldering Condition
Average ramp-up rate(T _L to T _P)	<3°C/sec
Preheat -Temperature Min(T _{smmin}) -Temperature Max(T _{smmax}) -Time(min to max)(t _s)	150°C 200°C 60~120sec
T _{smmax} to T _L -Ramp-upRate	<3°C/sec
Time maintained above: -Temperature(T _L) -Time(t _L)	217°C 60~260sec
Peak Temperature(T _P)	255°C-0/+5°C
Time within 5°C of actual Peak Temperature(t _P)	10~30sec
Ramp-down Rate	<6°C/sec
Time 25°C to Peak Temperature	<6minutes

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High reliability test capabilities

Item Test	Conditions	Reference
1. MSL Preconditioning	24hr bake@125°C+168hrs@85°C /85%RH+3xIR@260°C+1flux immersion+alcohol+DI H2O rinse	JESD22-A113
2. High Temperature Reverse Bias	$V_{DS}=V_{DS}^*100\%$ (T_J max=150°C) Test Duration:1000hrs	JESD22-A108
3. High Temperature Storage Life	T_a =Storage temperature range device specified maximum temperature) Test Duration:1000hrs	JESD22 A-103
4. Temperature Cycle	-55°C(15min) to 150°C(15min) Test Cycles:1000cycles	JESD22 A-104
5. Autoclave	$P=2atm$ $T_a=121^\circ C$ $RH=100\%$ Test Duration:96hrs	JESD22 A-102
6. Solderability	245+0/-5°C for 5sec	J-STD-002
7. Moisture Resistance	$T_a=85^\circ C$ /85% Relative humidity Test Duration:1000hrs	MIL-STD-750E METHOD 1021.2
8. Resistance To Solder Heat	260+0/-5°C for 10sec	JESD22 B-106
9. High Temperature High Humidity Reverse Bias	$T_a=85^\circ C$, 85%RH, $V_{DS}=80\%$ rated V_{DS} Test Duration:1000hrs	JESD22-A101