

FMBT4401

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FMBT4401

600mA Silicon NPN Epitaxial Planar Transistor

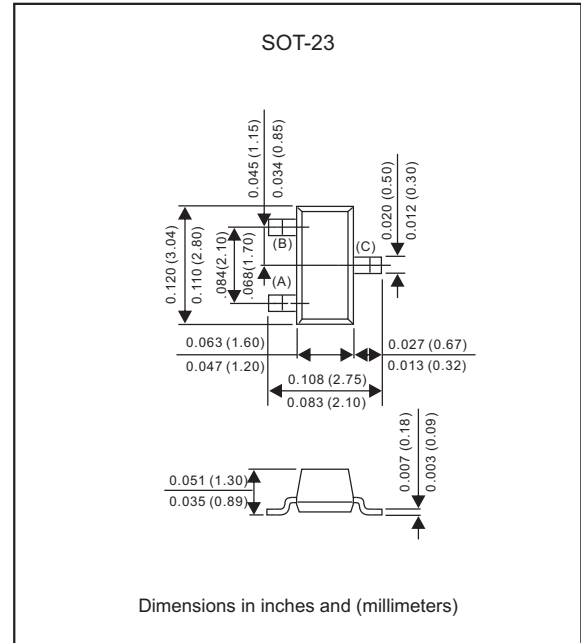
Features

- Epitaxial plana chip construction
- Ideal for medium power application and switching
- Capable of 225mW power dissipation.
- Lead-free parts for green partner, exceeds environmental standards of MIL-STD-19500 /228
- Suffix "-H" dinicates Halogen-free part, ex.FMBT4401-H.

Mechanical data

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

Package outline



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

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
Collector-Base voltage		V_{CBO}			60	V
Collector-Emitter voltage		V_{CEO}			40	V
Emitter-Base voltage		V_{EBO}			6.0	V
Collector current		I_C			600	mA
Total device dissipation FR-5 board (1)	$T_A = 25^{\circ}\text{C}$	P_D			225	mW
	Derate above 25°C	P_D			1.8	mW/ $^{\circ}\text{C}$
Thermal resistance	Junction to ambient	R_{BJA}			556	$^{\circ}\text{C}/\text{W}$
Total device dissipation alumina substrate(2)	$T_A = 25^{\circ}\text{C}$	P_D			300	mW
	Derate above 25°C	P_D			2.4	mW/ $^{\circ}\text{C}$
Thermal resistance	Junction to ambient	R_{BJA}			417	$^{\circ}\text{C}/\text{W}$
Operating temperature		T_J	-55		+150	$^{\circ}\text{C}$
Storage temperature		T_{STG}	-65		+150	

1.FR-5 = 1.0 X 0.75 X0.062 in.

2.Alumina = 0.4 X 0.3 X 0.024 in. 99.5% alumina.

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

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
Collector-Base breakdown voltage	$I_C = 0.1\text{mA}, I_E = 0$	$V_{(BR)CBO}$	60			V
Collector-Emitter breakdown voltage(3)	$I_C = 1.0\text{mA}, I_B = 0$	$V_{(BR)CEO}$	40			V
Emitter-Base breakdown voltage	$I_E = 0.1\text{mA}, I_C = 0$	$V_{(BR)EBO}$	6.0			V
Base cutoff current	$V_{CE} = 35\text{Vdc}, V_{EB} = 0.4\text{Vdc}$	I_{BL}			0.1	μA
Collector cutoff current	$V_{CE} = 35\text{Vdc}, V_{EB} = 0.4\text{Vdc}$	I_{CEX}			0.1	

On characteristics(3)

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
DC current gain	$I_C = 0.1\text{mA}, V_{CE} = 1.0\text{V}$	h_{FE}	20			-
	$I_C = 1.0\text{mA}, V_{CE} = 1.0\text{V}$		40			
	$I_C = 10\text{mA}, V_{CE} = 1.0\text{V}$		80		300	
	$I_C = 150\text{mA}, V_{CE} = 1.0\text{V}$		100			
	$I_C = 500\text{mA}, V_{CE} = 2.0\text{V}$		40			
Collector-Emitter saturation voltage(3)	$I_C = 150\text{mA}, I_B = 15\text{mA}$	$V_{CE(sat)}$			0.4	Vdc
	$I_C = 500\text{mA}, I_B = 50\text{mA}$				0.75	
Base-Emitter saturation voltage(3)	$I_C = 150\text{mA}, I_B = 15\text{mA}$	$V_{BE(sat)}$	0.75		0.95	Vdc
	$I_C = 500\text{mA}, I_B = 50\text{mA}$				1.20	

3. Pulse test : pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2.0\%$.

Small-signal characteristics

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
Current-gain-bandwidth product(4)	$I_C = 20\text{mA}, V_{CE} = 10\text{V}, f = 100\text{MHz}$	f_T	250			MHz
Output capacitance	$V_{CB} = 5.0\text{V}, I_E = 0, f = 1.0\text{MHz}$	C_{obo}			6.5	pF
Input capacitance	$V_{EB} = 0.5\text{V}, I_C = 0, f = 1.0\text{MHz}$	C_{ibo}			30	pF
Input impedance	$V_{CE} = 10\text{mA}, I_C = 1.0\text{mA}, f = 1.0\text{KHz}$	h_{ie}	1.0		15	k
Voltage feedback ratio	$V_{CE} = 10\text{V}, I_C = 1.0\text{mA}, f = 1.0\text{KHz}$	h_{fe}	0.1		8.0	$\times 10^{-4}$
Small-signal current gain	$V_{CE} = 10\text{V}, I_C = 1.0\text{mA}, f = 1.0\text{KHz}$	h_{fe}	40		500	-
Output admittance	$V_{CE} = 10\text{V}, I_C = 1.0\text{mA}, f = 1.0\text{KHz}$	h_{oe}	1.0		30	μmhos

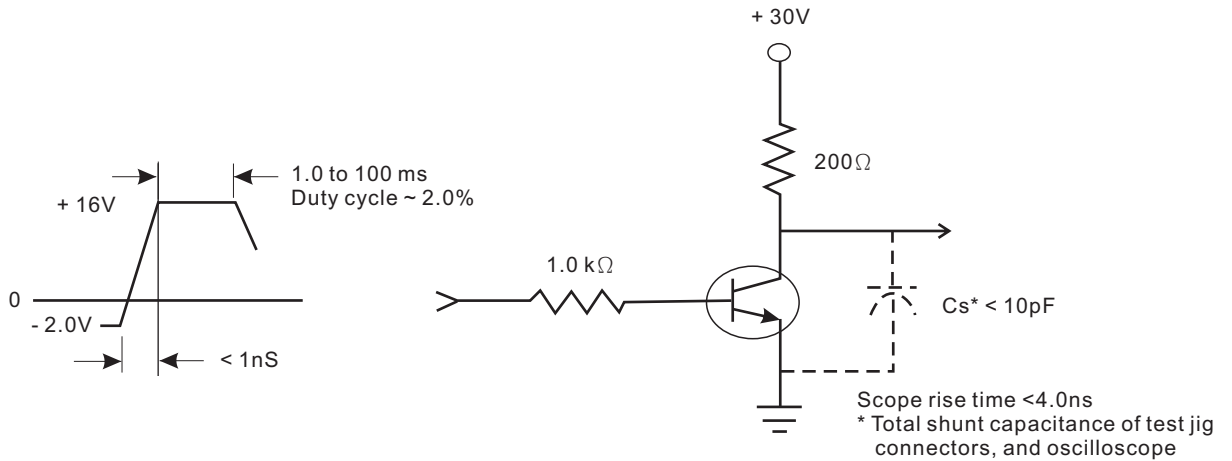
4. f_T is defined as the frequency at which h_{fe} extrapolates to unity.

Switching characteristics

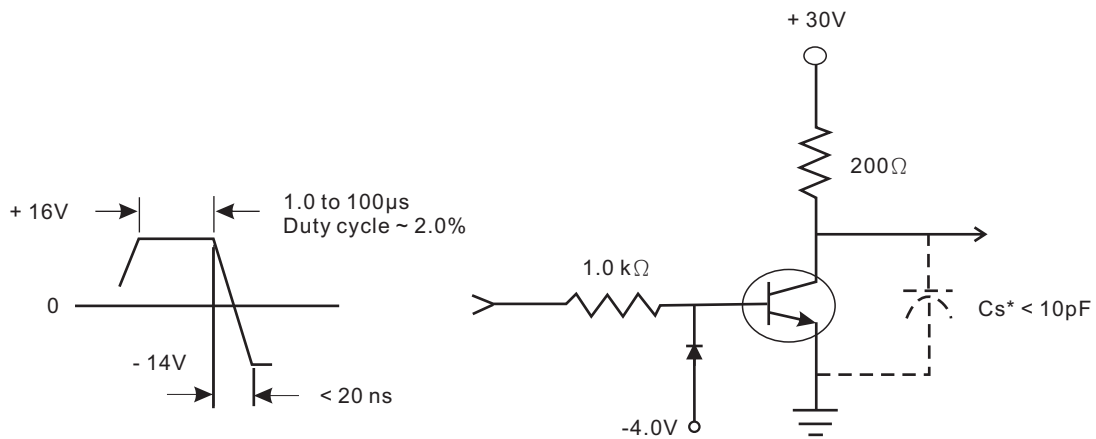
PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
Delay time	$V_{CC} = 30\text{V}, V_{BE} = 2.0\text{Vdc}, I_C = 150\text{mA}, I_{B1} = 15\text{mA}$	t_d			35	ns
Rise time		t_r			35	
Storage time	$V_{CC} = 30\text{V}, I_C = 150\text{mA}, I_{B1} = I_{B2} = 15\text{mA}$	t_s			200	
Fall time		t_f			50	

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Switching time equivalent test circuits



Delay and rise time equivalent test circuit



Storage and fall time equivalent test circuit

Rating and characteristic curves (FMBT4401)

TRANSIENT CHARACTERISTICS

Fig.1- Capacitances

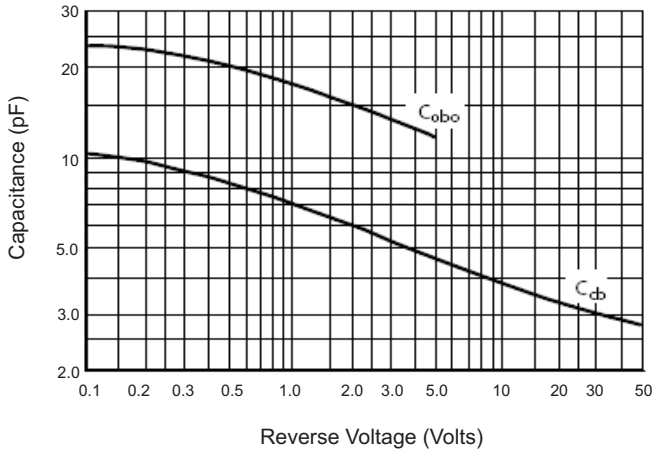


Fig. 2-Charge Data

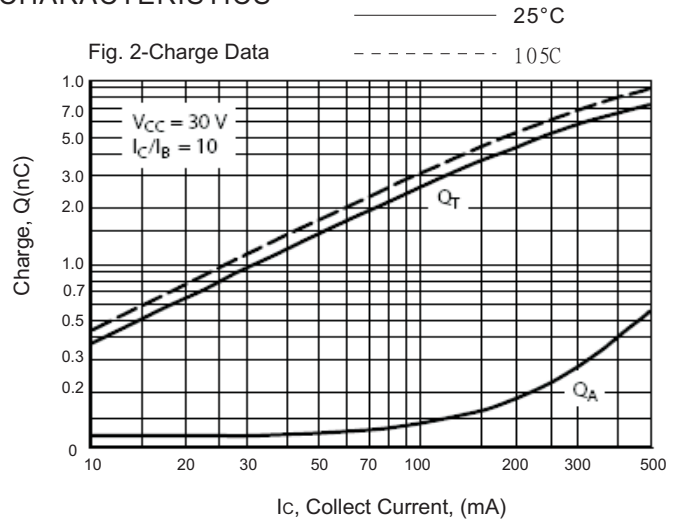


FIG.3- Turn-On Time

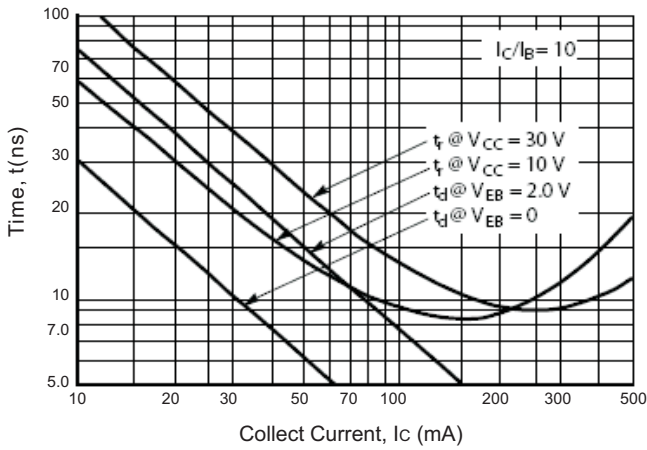


Fig. 4-Rise and Fall Time

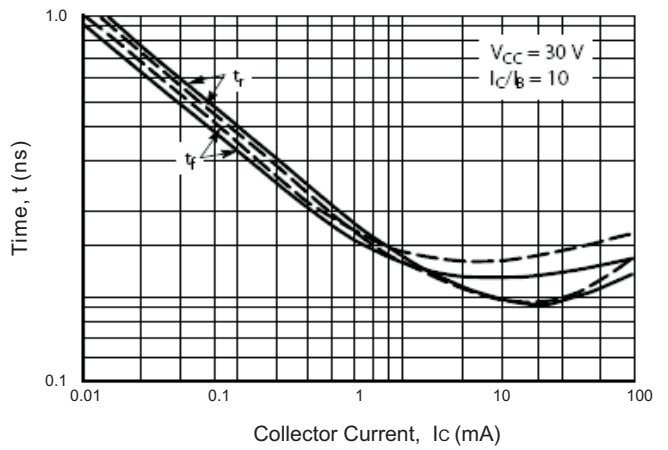


Fig. 5.-Storage T time

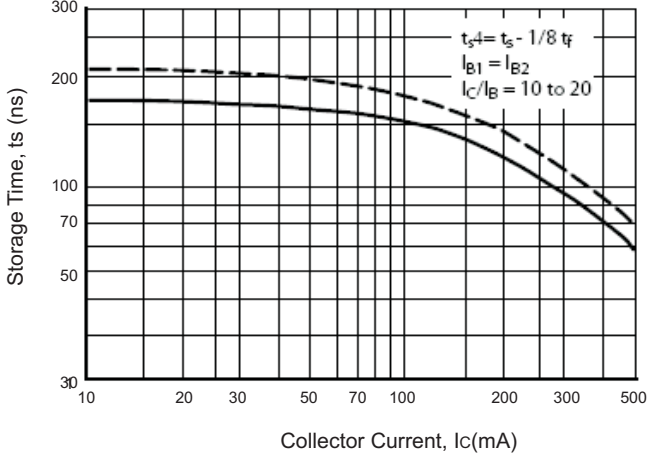
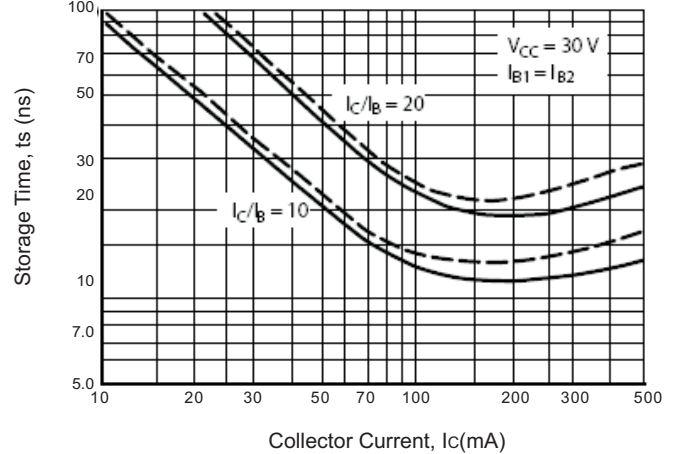


Fig. 6- Fall Time



Rating and characteristic curves (FMBT4401)

STATIC CHARACTERISTICS

Fig.7- DC Current Gain

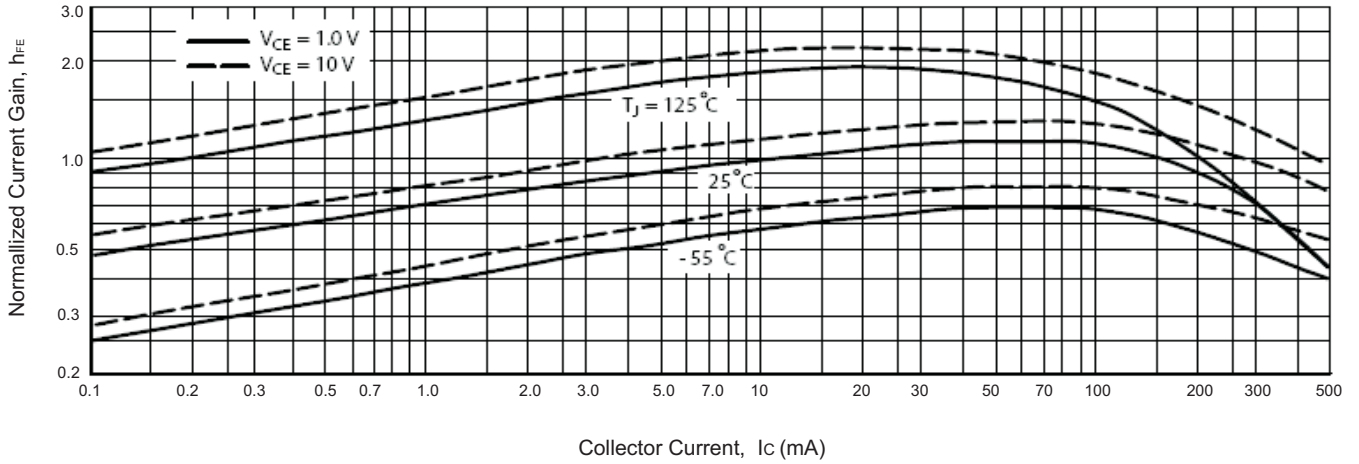


FIG.8- Collector Saturation Region

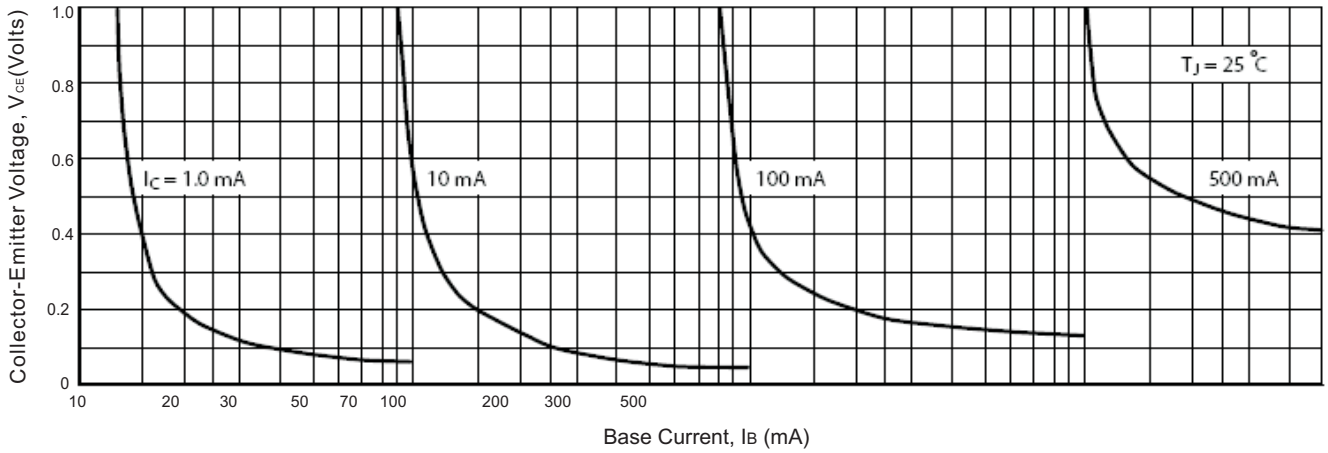


Fig. 9- "On" Voltage

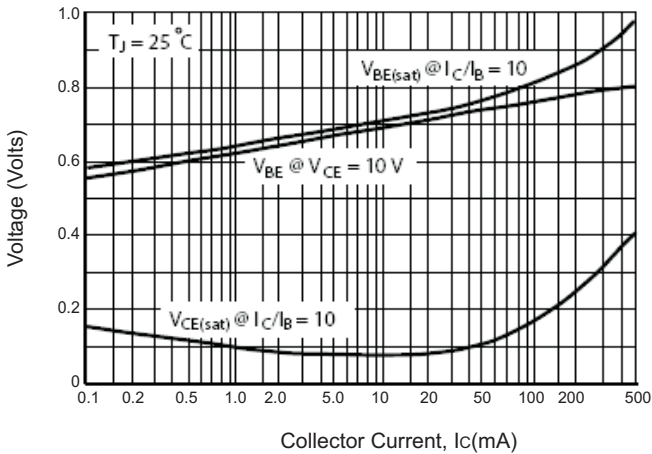
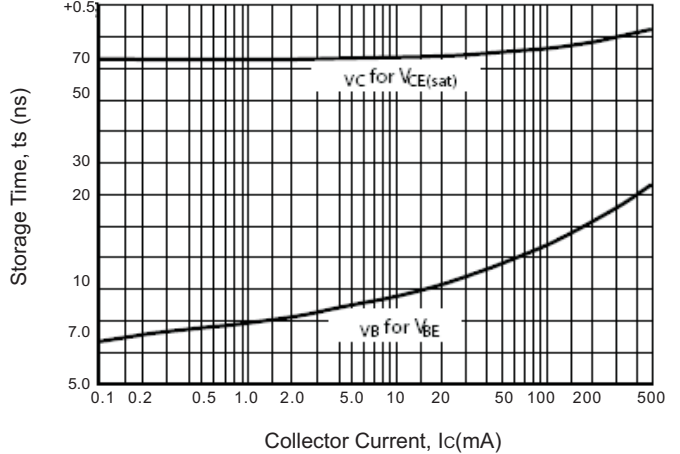


Fig. 10- Temperature Coefficients



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Pinning information

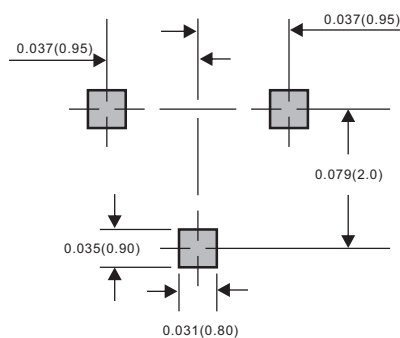
Pin	Simplified outline	Symbol
PinB Base PinC Collector PinE Emitter		

Marking

Type number	Marking code
FMBT4401	2X

Suggested solder pad layout

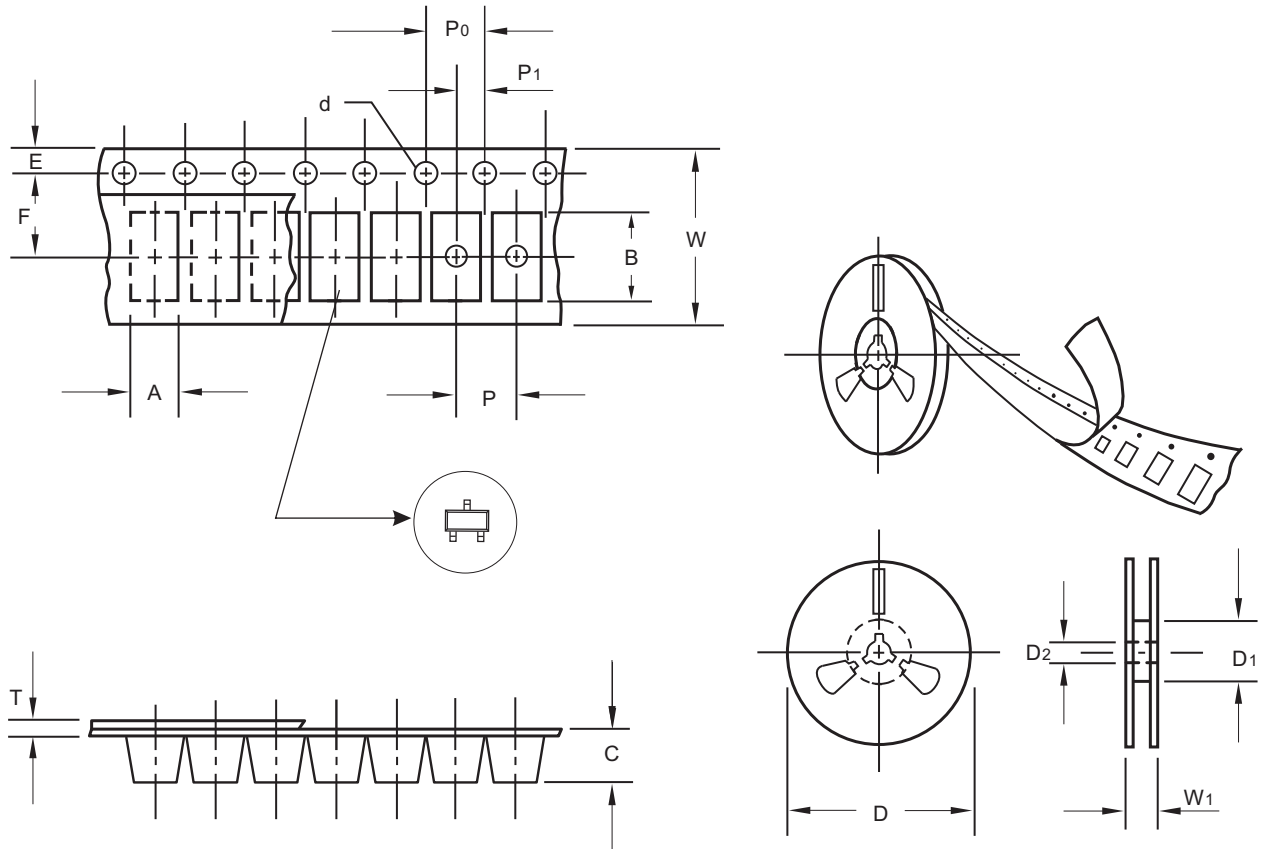
SOT-23



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	55.00
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	12.0

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

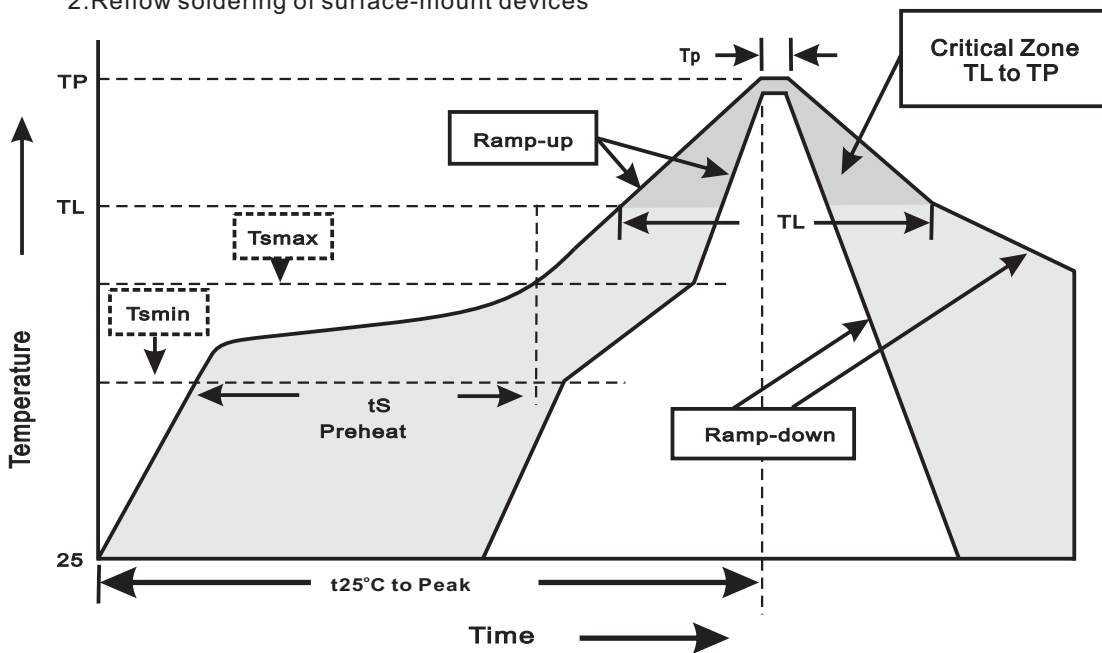
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Reel packing

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*183*123	178	382*262*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
1. Steady State Operating Life	$P_o=225\text{mW}$ Test Duration:1000hrs
2. High Temperature Reverse Bias	$T_j=150^\circ\text{C}$, $V_{ce}=80\%$ related volage, 1000hrs
3. Temperature Cycle	$-55^\circ\text{C}(15\text{min})$ to $150^\circ\text{C}(15\text{min})$ Air to Air Transition Time<20sec Test Cycles: 1000cycle
4. Autoclave	$P=2\text{atm}$ $T_a=121^\circ\text{C}$ $\text{RH}=100\%$ Test Duration: 96hrs
5. High Temperature Storage Life	$T_a=150^\circ\text{C}$ Test Duration: 1000hrs
6. Solderability	245°C ,5sec
7. High Temperature High Humidity Reverse Bias	$T_a=85^\circ\text{C}$, 85%RH, $V_{ce}=80\%$ related volage, 1000hrs
8. Resistance to Soldering Heat	260°C ,10sec