

FMBT3904

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FMBT3904

200mA Silicon NPN Epitaxial Planar Transistor

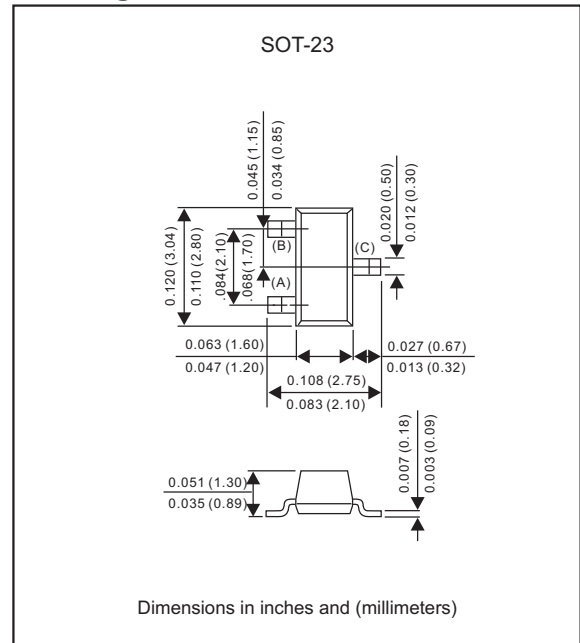
Features

- High collector-emitter breakdown voltage.
(V_{CE0} 40V Min. @ $I_C=1mA$)
- Small load switch transistor with high gain and low saturation voltage, is designed for general purpose amplifier and switching applications at collector current.
- Capable of 225mW power dissipation.
- Lead-free parts for green partner, exceeds environmental standards of MIL-STD-19500 /228
- Suffix "-H" indicates Halogen free part, ex. FMBT3904-H.

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 $T_A=25^{\circ}C$ 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			200	mA
Total device dissipation FR-5 board (Note 1)	$T_A = 25^{\circ}C$ Derate above $25^{\circ}C$	P_D			225	mW
Thermal resistance(Note 1)	Junction to ambient	$R_{\theta JA}$			1.8	$mW/^{\circ}C$
Thermal resistance(Note 1)	Junction to case	$R_{\theta JC}$			556	$^{\circ}C/W$
Total device dissipation alumina substrate(Note 2)	$T_A = 25^{\circ}C$ Derate above $25^{\circ}C$	P_D			300	mW
Thermal resistance(Note 2)	Junction to ambient	$R_{\theta JA}$			2.4	$mW/^{\circ}C$
Thermal resistance(Note 2)	Junction to case	$R_{\theta JC}$			417	$^{\circ}C/W$
Operating junction temperature range		T_J	-55		+150	$^{\circ}C$
Storage temperature range		T_{STG}	-55		+150	$^{\circ}C$

Note 1: FR-5 = 1.0 X 0.75 X 0.062 in.

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

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

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
Collector-Base breakdown voltage	$I_C = 10\mu\text{A}, I_E = 0$	$V_{(BR)CBO}$	60			V
Collector-Emitter breakdown voltage(3)	$I_C = 1\text{mA}, I_B = 0$	$V_{(BR)CEO}$	40			V
Emitter-Base breakdown voltage	$I_E = 10\mu\text{A}, I_C = 0$	$V_{(BR)EBO}$	6.0			V
Base cutoff current	$V_{CE} = 30\text{V}, V_{EB} = 3.0\text{V}$	I_{BL}			50	nA
Collector cutoff current	$V_{CE} = 30\text{V}, V_{EB} = 3.0\text{V}$	I_{CEX}			50	nA

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}	40			-
	$I_C = 1.0\text{mA}, V_{CE} = 1.0\text{V}$		70			
	$I_C = 10\text{mA}, V_{CE} = 1.0\text{V}$		100		300	
	$I_C = 50\text{mA}, V_{CE} = 1.0\text{V}$		60			
	$I_C = 100\text{mA}, V_{CE} = 1.0\text{V}$		30			
Collector-Emitter saturation voltage(3)	$I_C = 10\text{mA}, I_B = 1.0\text{mA}$	$V_{CE(sat)}$			0.2	V
	$I_C = 50\text{mA}, I_B = 5.0\text{mA}$				0.3	
Base-Emitter saturation voltage(3)	$I_C = 10\text{mA}, I_B = 1.0\text{mA}$	$V_{BE(sat)}$	0.65		0.85	V
	$I_C = 50\text{mA}, I_B = 5.0\text{mA}$				0.95	

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	$I_C = 10\text{mA}, V_{CE} = 20\text{V}, f = 100\text{MHz}$	f_T	300			MHz
Output capacitance	$V_{CB} = 5.0\text{V}, I_E = 0, f = 1.0\text{MHz}$	C_{obo}			4.0	pF
Input capacitance	$V_{EB} = 0.5\text{V}, I_C = 0, f = 1.0\text{MHz}$	C_{ibo}			8.0	pF
Input impedance	$V_{CE} = 10\text{V}, I_C = 1.0\text{mA}, f = 1.0\text{KHz}$	h_{ie}	1.0		10	kohms
Voltage feedback ratio	$V_{CE} = 10\text{V}, I_C = 1.0\text{mA}, f = 1.0\text{KHz}$	h_{fe}	0.5		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}	100		400	-
Output admittance	$V_{CE} = 10\text{V}, I_C = 1.0\text{mA}, f = 1.0\text{KHz}$	h_{oe}	1.0		40	umhos
Noise figure	$V_{CE} = 5.0\text{V}, I_C = 100\mu\text{A}, R_s = 1.0\text{K ohms}, f = 1.0\text{KHz}$	NF			5.0	dB

Switching characteristics

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
Delay time	$V_{CC} = 3.0\text{V}, V_{BE} = -0.5\text{V}, I_C = 10\text{mA}, I_{B1} = 1.0\text{mA}$	td			35	ns
Rise time		tr			35	
Storage time	$V_{CC} = 3.0\text{V}, I_C = 10\text{mA}, I_{B1} = I_{B2} = 1.0\text{mA}$	ts			200	
Fall time		tf			50	

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Switching time equivalent test circuits

Figure 1. Delay and Rise Time Equivalent Test Circuit

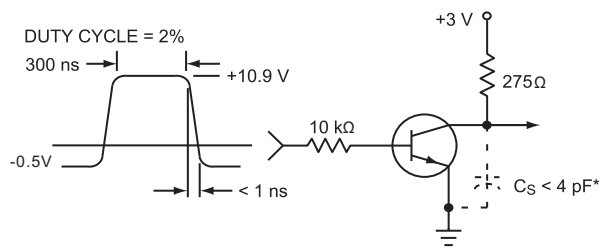
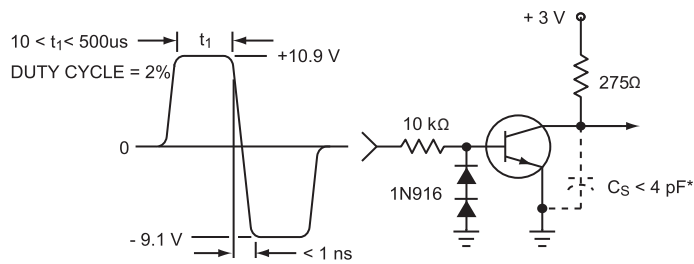


Figure 2. Storage and Fall Time Equivalent Test Circuit



* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

Figure 3. Capacitance

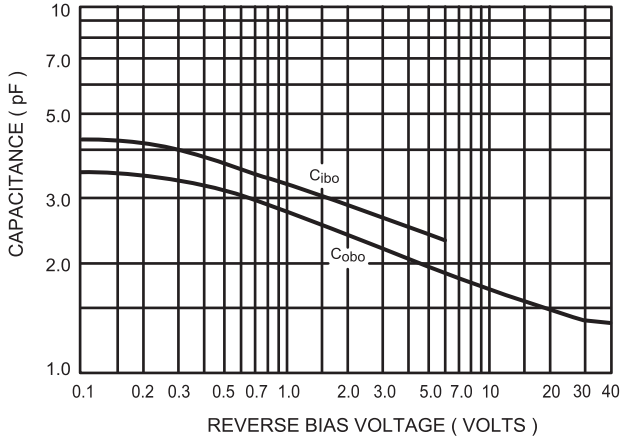


Figure 4. Charge Data

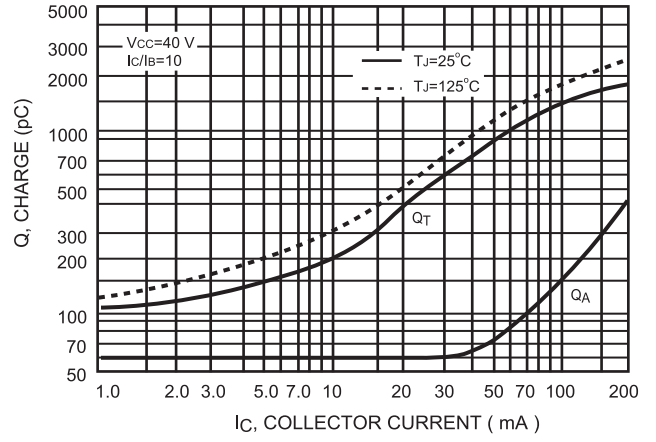


Figure 5. Turn-On Time

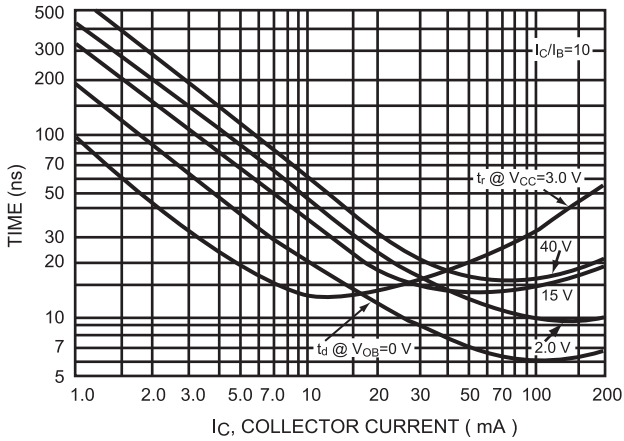


Figure 6. Rise Time

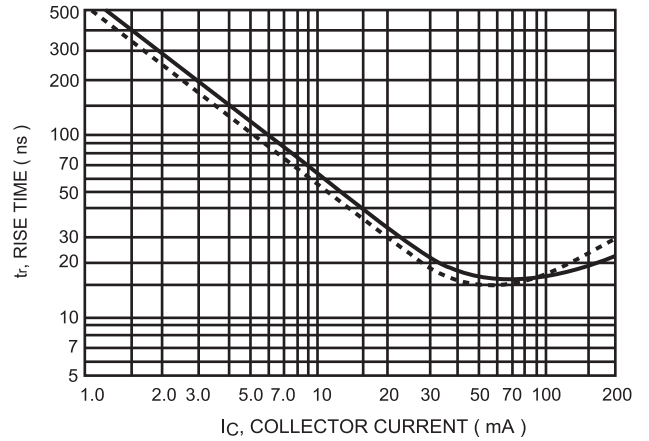


Figure 7. Storage Time

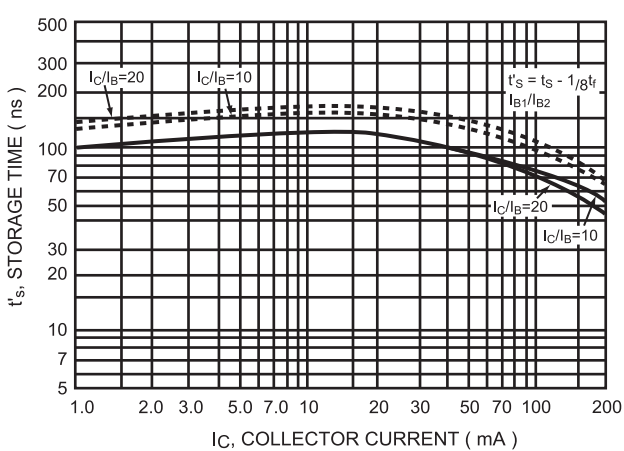
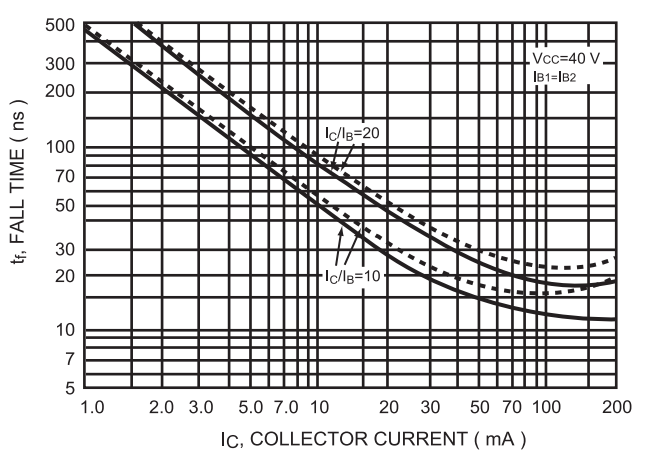


Figure 8. Fall Time



TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

(VCE=5.0 V, TA=25 °C, Bandwidth=1.0Hz)

Figure 9.

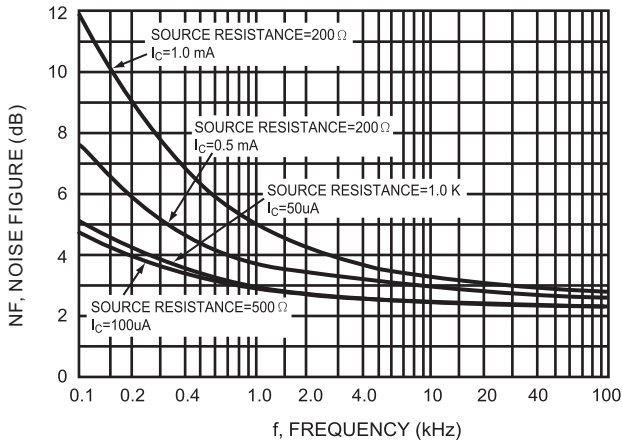
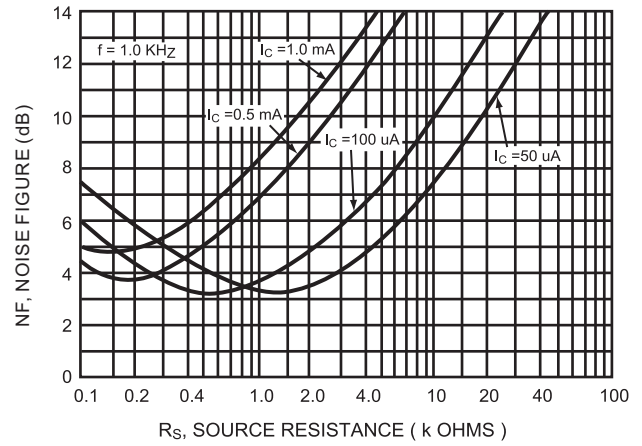


Figure 10.



h PARAMETERS

(VCE=10 V, f=1.0 kHz, TA=25 °C)

Figure 11. Current Gain

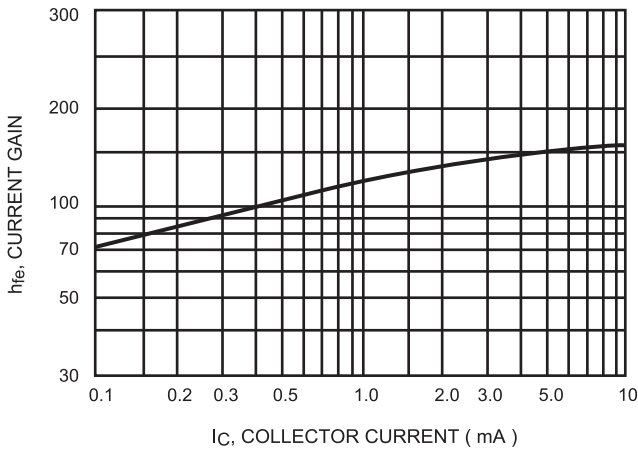


Figure 12. Output Admittance

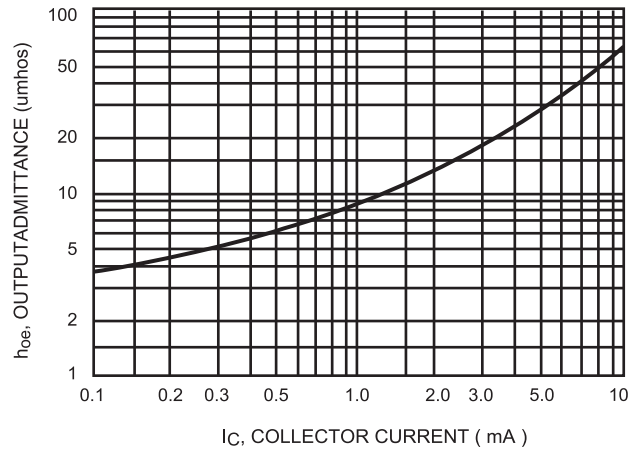


Figure 13. Input Impedance

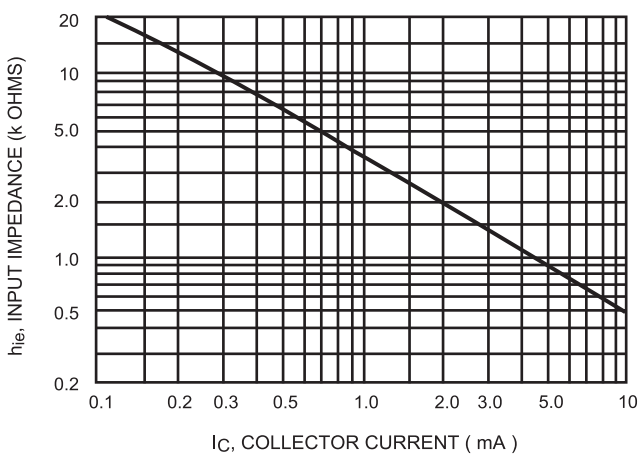
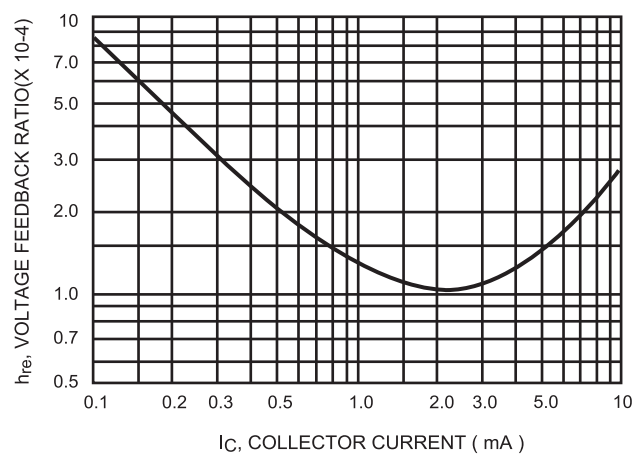


Figure 14. Voltage Feedback Ratio



TYPICAL STATIC CHARACTERISTICS

Figure 15. DC Current Gain

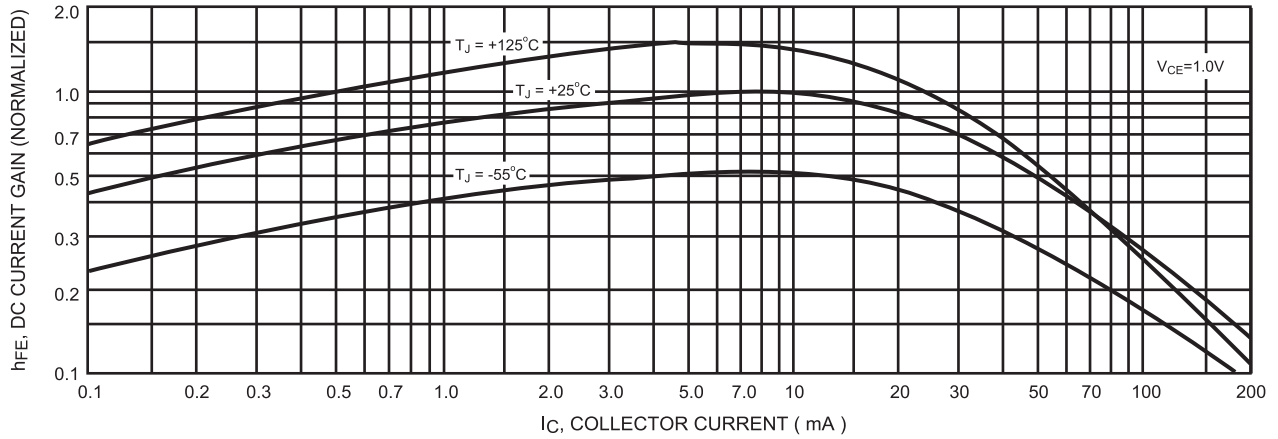


Figure 16. Collector Saturation Region

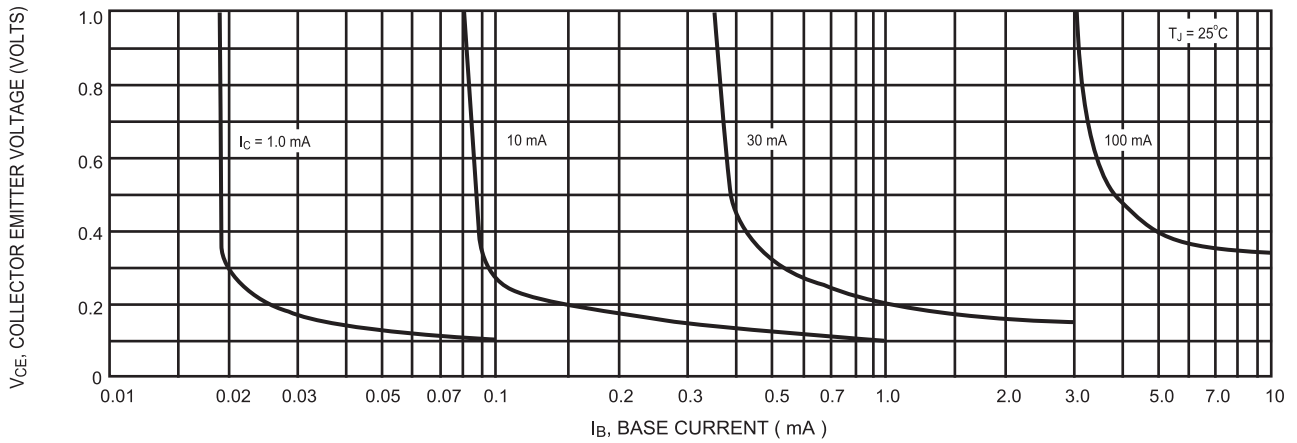


Figure 17. " ON " Voltage

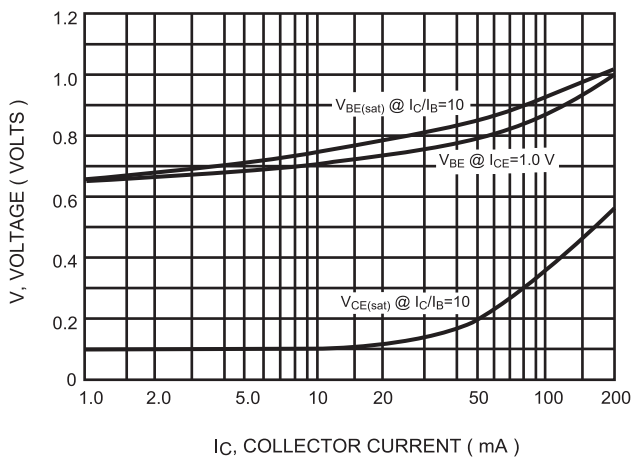
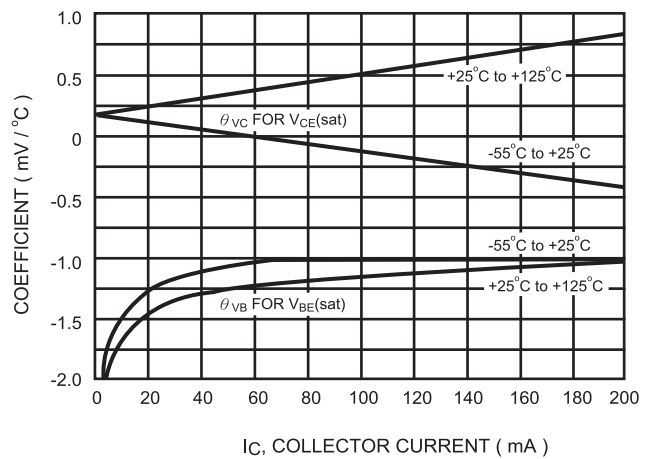
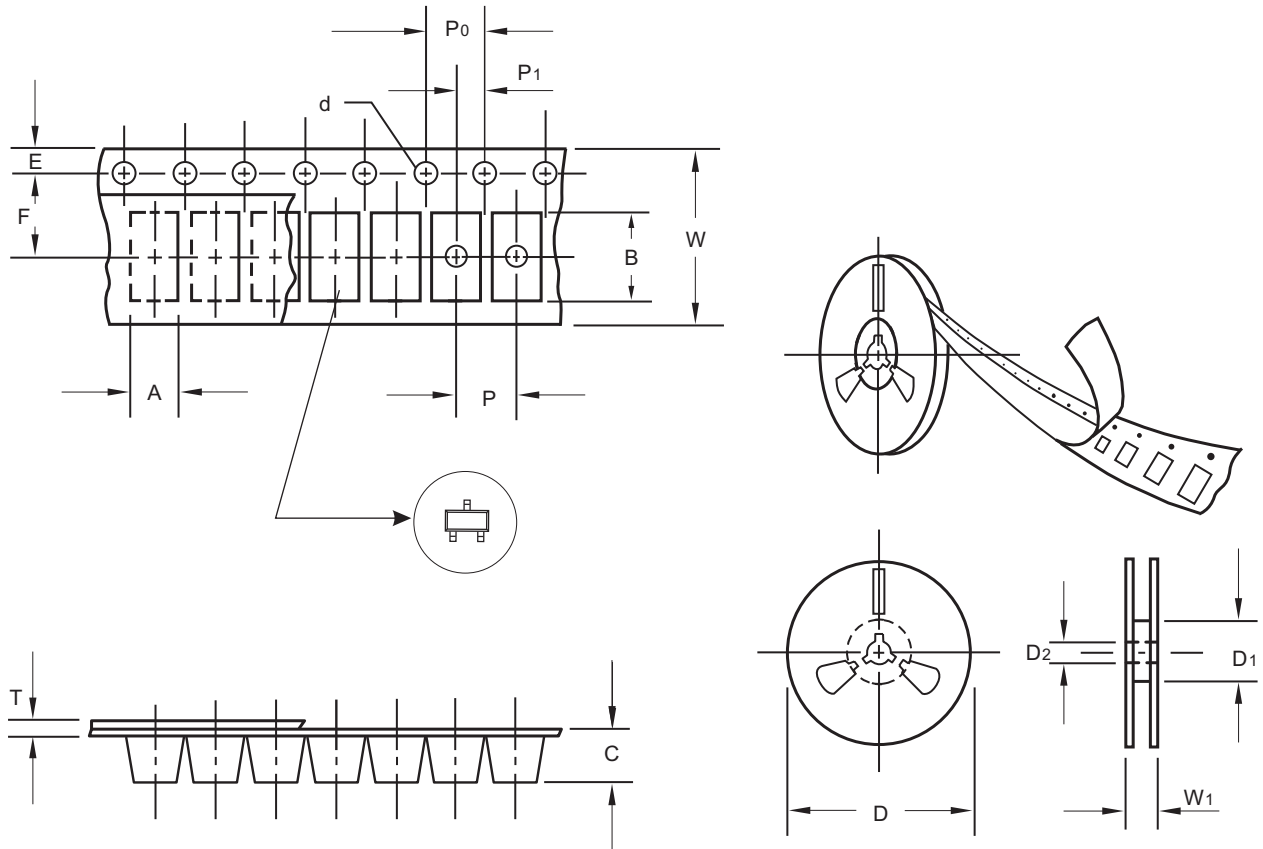


Figure 18. Temperature Coefficients



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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.

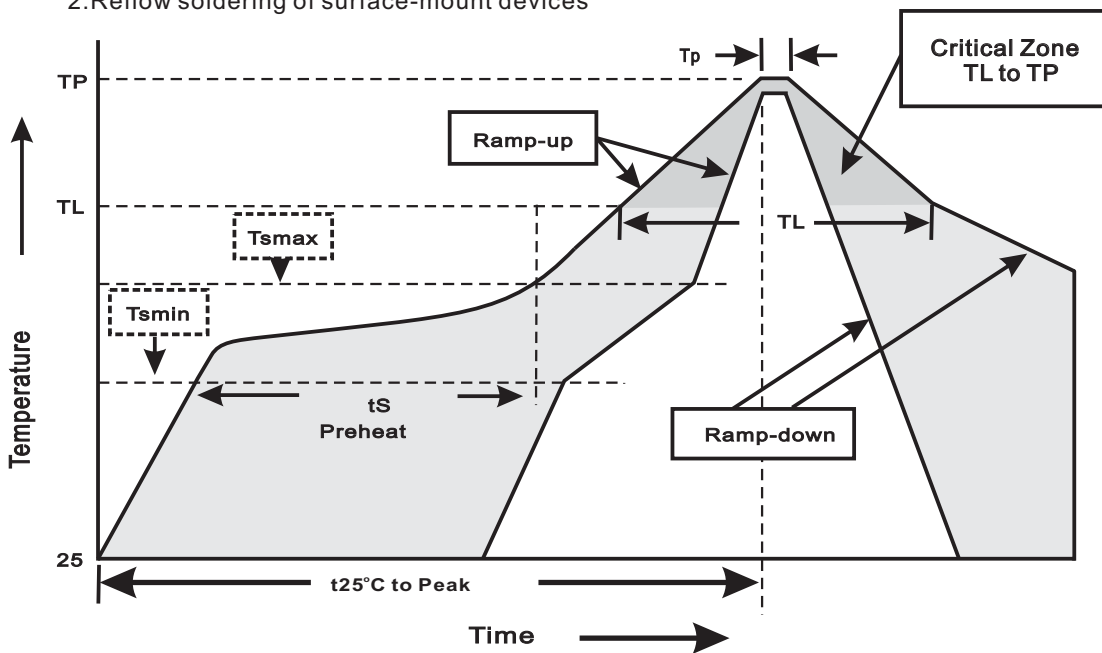
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Reel packing

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 _{smín}) -Temperature Max(T _{smáx}) -Time(min to max)(t _s)	150°C 200°C 60~120sec
T _{smáx} 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

FMBT3904**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