

FMBT3946DW**List**

List.....	1
Package outline.....	2
Features.....	2
Mechanical data.....	2
Maximum ratings	2
Electrical characteristics.....	3~4
Switching time equivalent test circuits.....	4
Rating and characteristic curves.....	5~10
Pinning information.....	11
Marking.....	11
Suggested solder pad layout.....	11
Packing information.....	12
Reel packing.....	13
Suggested thermal profiles for soldering processes.....	13
High reliability test capabilities.....	14

FMBT3946DW

Dual General Purpose Transistors NPN/PNP Silicon

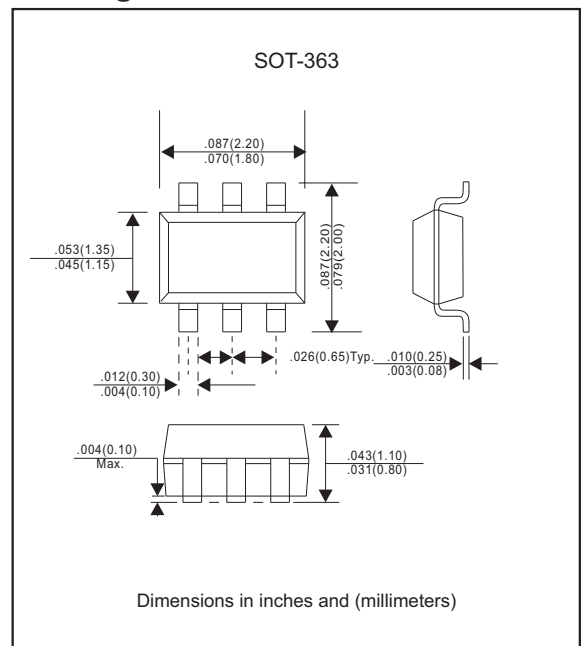
Features

- High collector-emitter breakdown voltage ($BV_{CEO} \pm 40V \text{ MIN. @ } I_C = \pm 1mA$)
- Small load switch transistor with high gain and low Saturation voltage, is designed for general purpose amplifier and switching applications at collector current
- Offer NPN+PNP in one package
- Capable of 150mW power dissipation
- Lead-free parts meet RoHS requirements
- Suffix "-H" indicates Halogen free part, ex. FMBT3946DW-H

Mechanical data

- Epoxy: UL94-V0 rated flame retardant
- Case : Molded plastic, SOT-363
- Terminals : Solder plated, solderable per MIL-STD-750, Method 2026
- Polarity : See Diagram
- Mounting Position : Any
- Weight : Approximated 0.006 gram

Package outline



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

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNIT
Collector-base voltage	NPN PNP	V_{CBO}			60 -40	V
Collector-emitter voltage	NPN PNP	V_{CEO}			40 -40	V
Emitter-base voltage	NPN PNP	V_{EBO}			6.0 -5.0	V
Collector current -continuous	NPN PNP	I_C			200 -200	mA
Total device dissipation (1)	$T_A = 25^\circ C$	P_D			150	mW
Thermal resistance	Junction to ambient	$R_{\theta JA}$			833	$^\circ C/W$
Operating junction temperature range		T_J	-55		+150	$^\circ C$
Storage temperature range		T_{STG}	-55		+150	$^\circ C$

1. Device mounted on FR-4 glass epoxy printed circuit board using the minimum recommended footprint

FMBT3946DW**Electrical characteristics** (AT $T_A=25^{\circ}\text{C}$ unless otherwise noted)**Off characteristics**

PARAMETER (NPN)	CONDITIONS (NPN)	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	
PARAMETER (PNP)	CONDITIONS (PNP)	Symbol	MIN.	TYP.	MAX.	UNIT
Collector-base breakdown voltage	$I_C = -10\mu\text{A}$, $I_E = 0$	$V_{(BR)CBO}$	-40			V
Collector-emitter breakdown voltage(3)	$I_C = -1\text{mA}$, $I_B = 0$	$V_{(BR)CEO}$	-40			V
Emitter-base breakdown voltage	$I_E = -10\mu\text{A}$, $I_C = 0$	$V_{(BR)EBO}$	-5.0			V
Base cutoff current	$V_{CE} = -30\text{V}$, $V_{EB} = -3.0\text{V}$	I_{BL}			-50	nA
Collector cutoff current	$V_{CE} = -30\text{Vdc}$, $V_{EB} = -3.0\text{Vdc}$	I_{CEX}			-50	

On characteristics(2)

PARAMETER (NPN)	CONDITIONS (NPN)	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(2)	$I_C = 10\text{mA}$, $I_B = 1.0\text{mA}$	$V_{CE(sat)}$			0.2	V
	$I_C = 50\text{mA}$, $I_B = 5.0\text{mA}$				0.3	
Base-emitter saturation voltage(2)	$I_C = 10\text{mA}$, $I_B = 1.0\text{mA}$	$V_{BE(sat)}$	0.65		0.85	V
	$I_C = 50\text{mA}$, $I_B = 5.0\text{mA}$				0.95	
PARAMETER (PNP)	CONDITIONS (PNP)	Symbol	MIN.	TYP.	MAX.	UNIT
DC current gain	$I_C = -0.1\text{mA}$, $V_{CE} = -1.0\text{V}$	h_{FE}	60			
	$I_C = -1.0\text{mA}$, $V_{CE} = -1.0\text{V}$		80			
	$I_C = -10\text{mA}$, $V_{CE} = -1.0\text{V}$		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(2)	$I_C = -10\text{mA}$, $I_B = -1.0\text{mA}$	$V_{CE(sat)}$			-0.25	V
	$I_C = -50\text{mA}$, $I_B = -5.0\text{mA}$				-0.40	
Base-emitter saturation voltage(2)	$I_C = -10\text{mA}$, $I_B = -1.0\text{mA}$	$V_{BE(sat)}$	-0.65		-0.85	V
	$I_C = -50\text{mA}$, $I_B = -5.0\text{mA}$				-0.95	

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

FMBT3946DW

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

Small-signal characteristics

PARAMETER (NPN)	CONDITIONS (NPN)	Symbol	MIN.	TYP.	MAX.	UNIT
Current-gain-bandwidth product(3)	$I_C = 10\text{mA}$, $V_{CE} = 20\text{V}$, $f = 100\text{MHz}$	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	k Ω
Voltage feedback ratio	$V_{CE} = 10\text{V}$, $I_C = 1.0\text{mA}$, $f = 1.0\text{KHz}$	h_{re}	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	μmhos
Noise figure	$V_{CE} = 5.0\text{V}$, $I_C = 100\mu\text{A}$, $R_S = 1.0\text{K}\Omega$, $f = 1.0\text{KHz}$	NF			5.0	dB
PARAMETER (PNP)	CONDITIONS (PNP)	Symbol	MIN.	TYP.	MAX.	UNIT
Current-gain-bandwidth product(3)	$I_C = -10\text{mA}$, $V_{CE} = -20\text{V}$, $f = 100\text{MHz}$	f_T	250			MHz
Output capacitance	$V_{CB} = -5.0\text{V}$, $I_E = 0$, $f = 1.0\text{MHz}$	C_{obo}			4.5	pF
Input capacitance	$V_{EB} = -0.5\text{V}$, $I_C = 0$, $f = 1.0\text{MHz}$	C_{ibo}			10.0	pF
Input impedance	$V_{CE} = -10\text{V}$, $I_C = -1.0\text{mA}$, $f = 1.0\text{KHz}$	h_{ie}	2.0		12	k Ω
Voltage feedback ratio	$V_{CE} = -10\text{V}$, $I_C = -1.0\text{mA}$, $f = 1.0\text{KHz}$	h_{re}	0.1		10.0	$\times 10^{-4}$
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}	3.0		60	μmhos
Noise figure	$V_{CE} = -5.0\text{V}$, $I_C = -100\mu\text{A}$, $R_S = 1.0\text{K}\Omega$, $f = 1.0\text{KHz}$	NF			4.0	dB

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

Switching characteristics

PARAMETER (NPN)	CONDITIONS (NPN)	Symbol	MIN.	TYP.	MAX.	UNIT
Delay time	$V_{CC} = 3.0\text{V}$, $V_{BE} = -0.5\text{V}$, $I_C = 10\text{mA}$, $I_{B1} = 1.0\text{mA}$	t_d			35	ns
Rise time		t_r			35	
Storage time	$V_{CC} = 3.0\text{V}$, $I_C = 10\text{mA}$, $I_{B1} = I_{B2} = 1.0\text{mA}$	t_s			200	
Fall time		t_f			50	
PARAMETER (PNP)	CONDITIONS (PNP)	Symbol	MIN.	TYP.	MAX.	UNIT
Delay time	$V_{CC} = -3.0\text{V}$, $V_{BE} = 0.5\text{V}$, $I_C = -10\text{mA}$, $I_{B1} = -1.0\text{mA}$	t_d			35	ns
Rise time		t_r			35	
Storage time	$V_{CC} = -3.0\text{V}$, $I_C = -10\text{mA}$, $I_{B1} = I_{B2} = -1.0\text{mA}$	t_s			225	
Fall time		t_f			75	

4. Pulse Test: Pulse width $\leq 300\mu\text{s}$, Duty cycle $\leq 2.0\%$

(NPN)

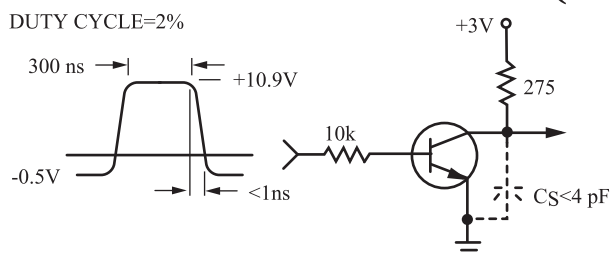


Figure 1. Delay and Rise Time
Equivalent Test Circuit

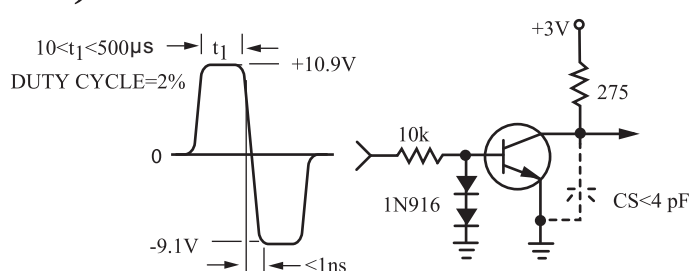


Figure 2. Storage and Fall Time
Equivalent Test Circuit

Rating and characteristic curves (NPN)

TYPICAL TRANSIENT CHARACTERISTIC

$T_J=25^{\circ}\text{C}$, ----- $T_J=125^{\circ}\text{C}$

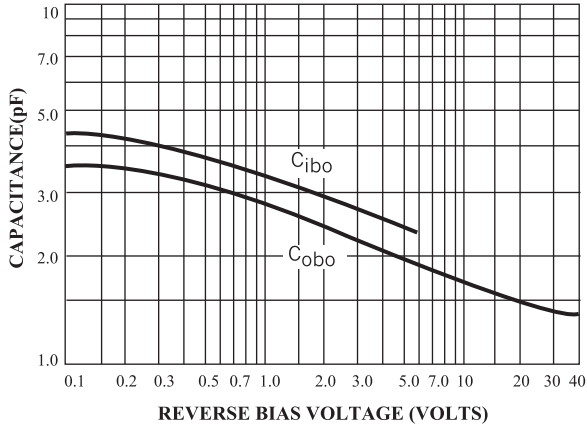


Figure 3. Capacitance

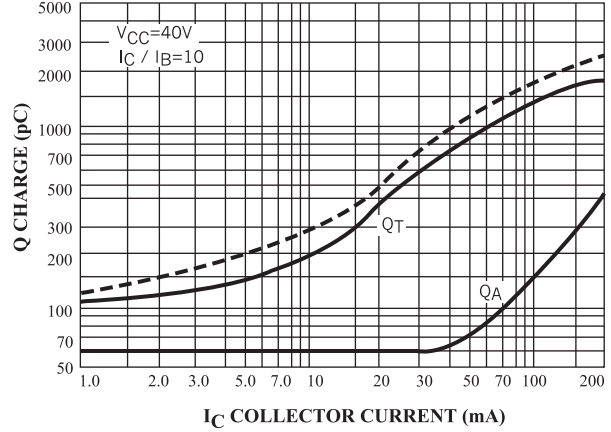


Figure 4. Charge Data

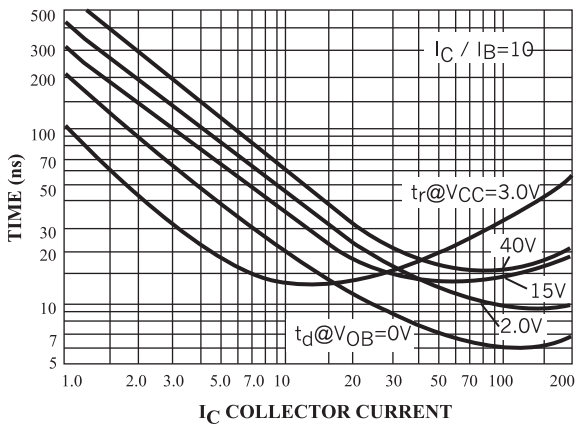


Figure 5. Turn-On Time

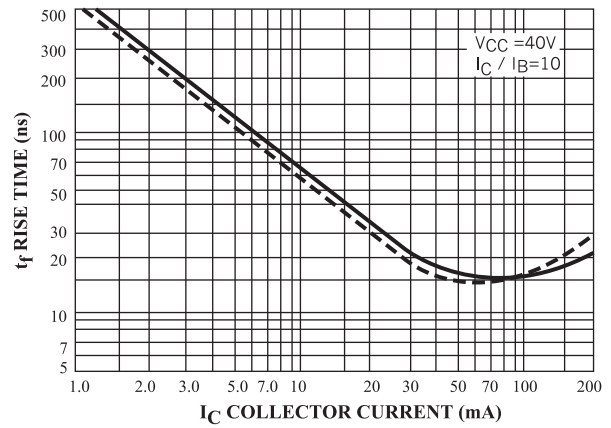


Figure 6. Rise Time

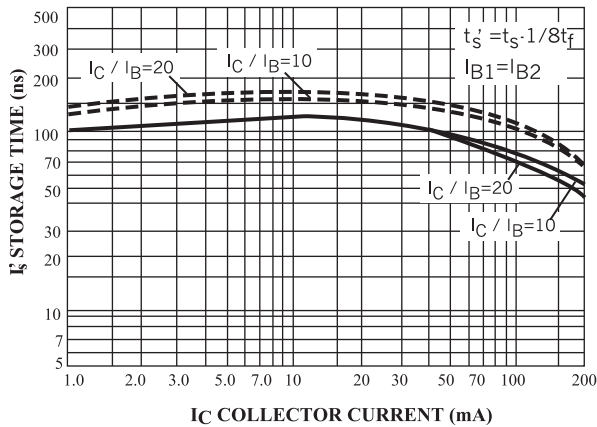


Figure 7. Storage Time

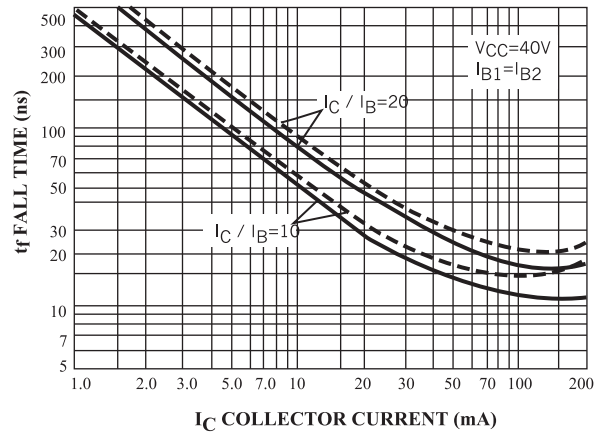


Figure 8. Fall Time

Rating and characteristic curves (NPN)

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS ($V_{CE}=-5.0V_{dc}$, $T_A=25^{\circ}C$, Bandwidth=1.0Hz)

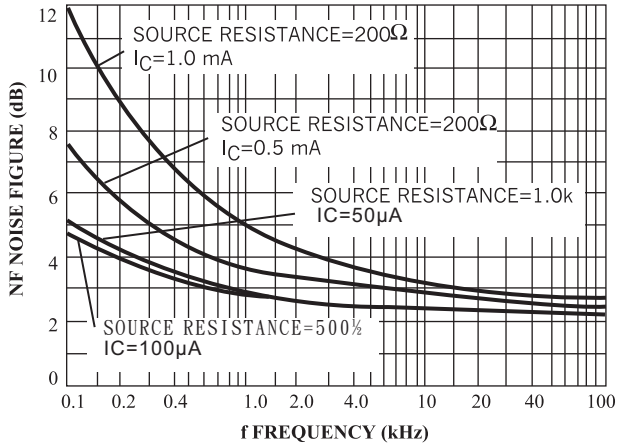


Figure 9.

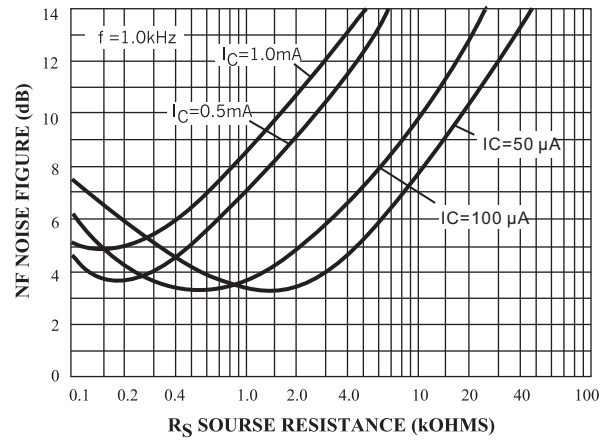


Figure 10.

h PARAMETER ($V_{CE}=10V_{dc}$, $T_A=25^{\circ}C$, $f=1.0\text{ kHz}$)

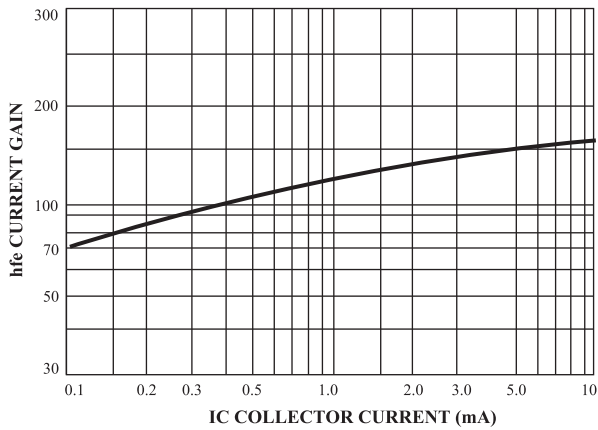


Figure 11. Current Gain

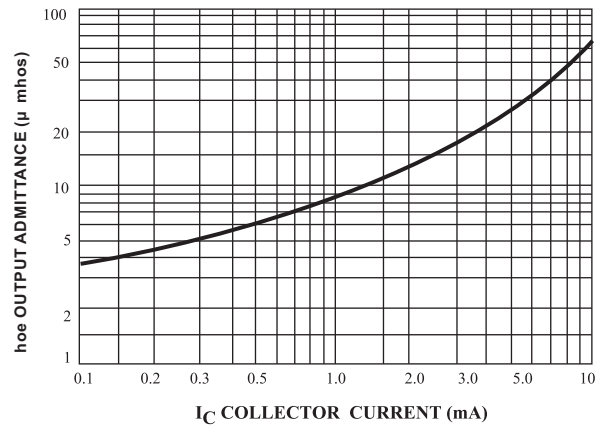


Figure 12. Output Admittance

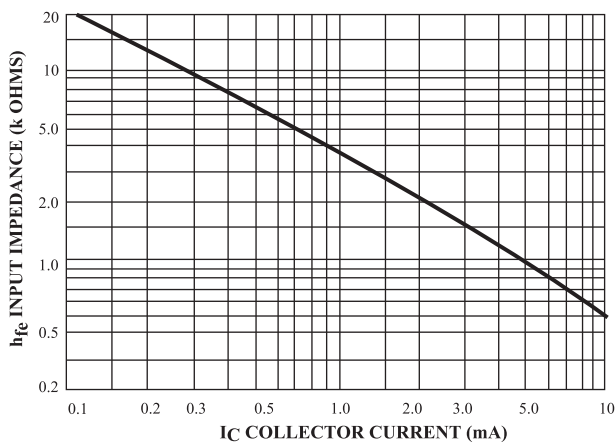


Figure 13. Input Impedance

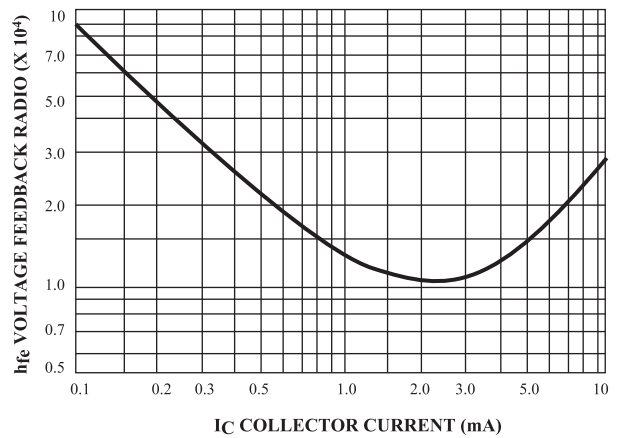


Figure 14. Voltage Feedback Ratio

Rating and characteristic curves (NPN)

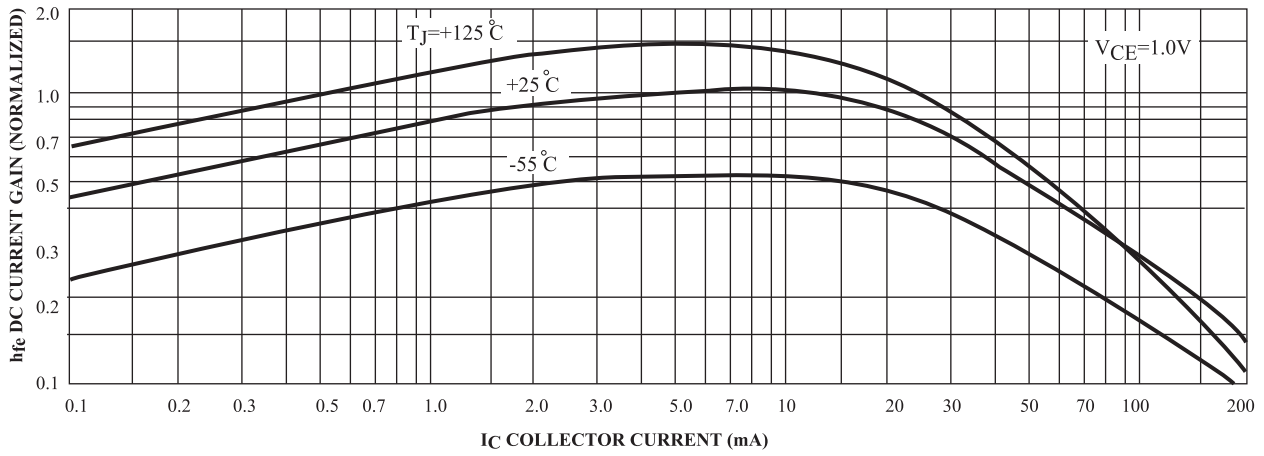


Figure 15. DC Current Gain

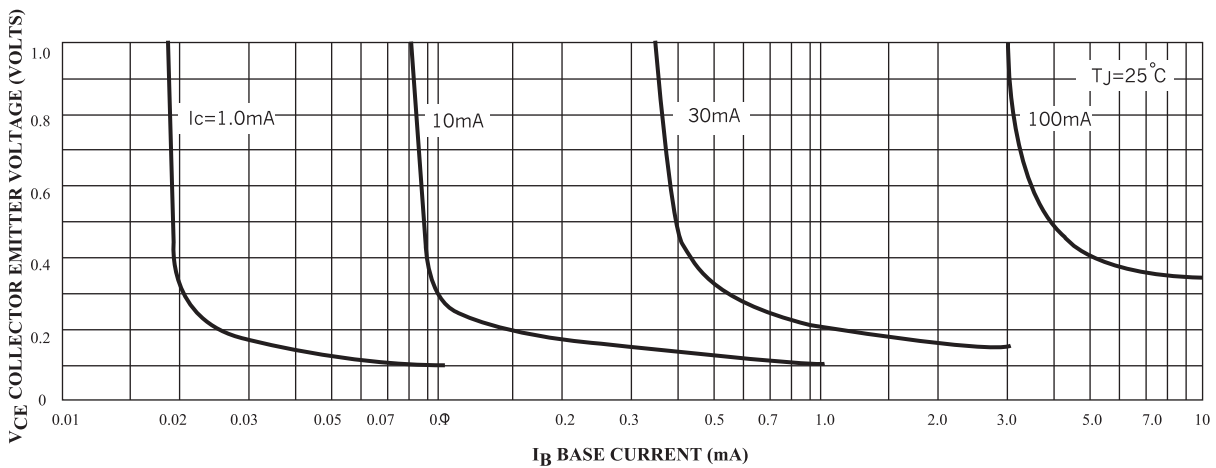


Figure 16. Collector Saturation Region

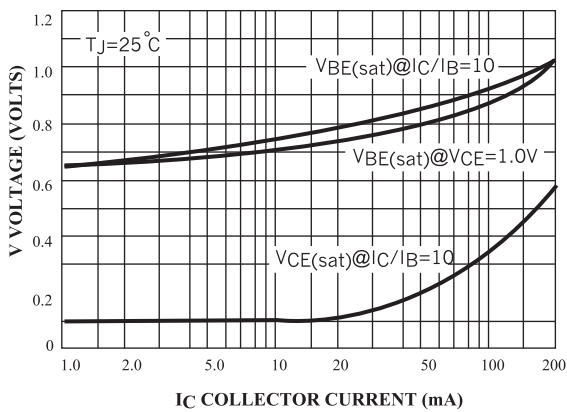


Figure 17. "ON" Voltage

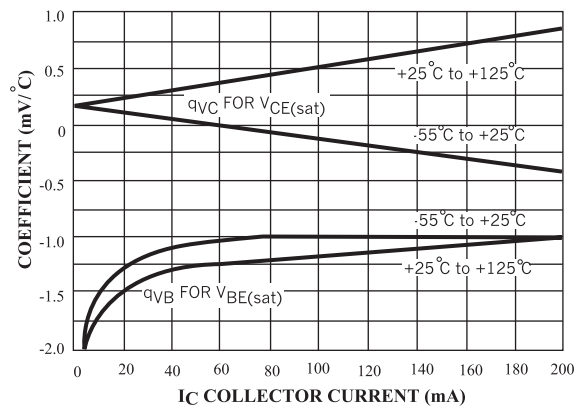


Figure 18. Temperature Coefficients

Switching time equivalent test circuits (PNP)

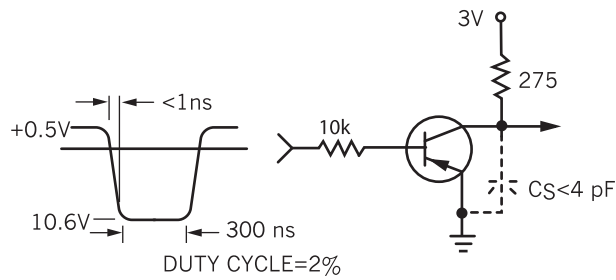


Figure 19. Delay and Rise Time
Equivalent Test Circuit

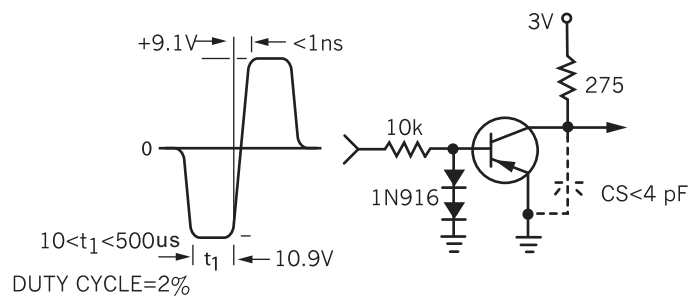


Figure 20 . Storage and Fall Time
Equivalent Test Circuit

*Total shunt capacitance of test jig and connectors

Rating and characteristic curves (PNP)

TYPICAL TRANSIENT CHARACTERISTIC $T_J=25^{\circ}\text{C}$, ----- $T_J=125^{\circ}\text{C}$

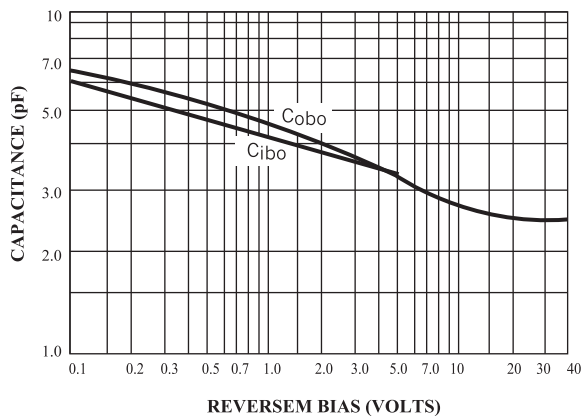


Figure 21. Capacitance

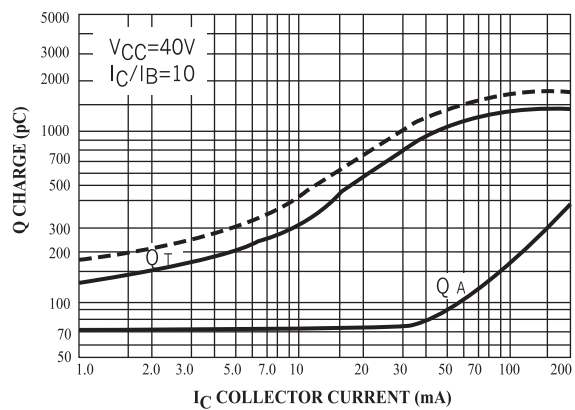


Figure 22. Charge Data

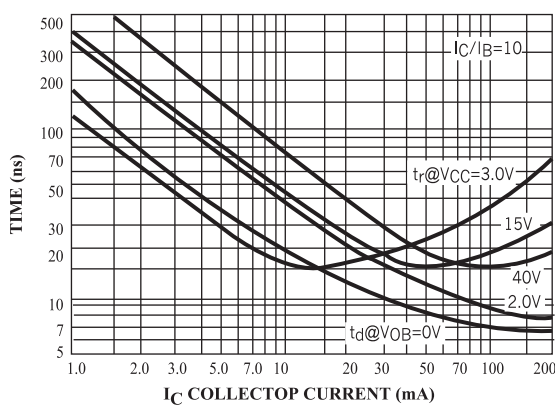


Figure 23. Turn-On Time

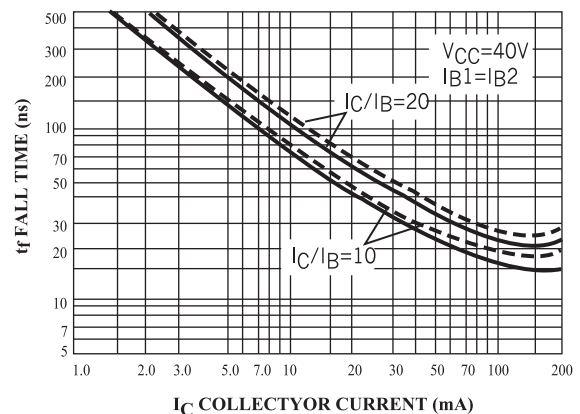


Figure 24. Fall Time

Rating and characteristic curves (PNP)

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS ($V_{CE} = -5.0V_{dc}$, $T_A = 25^\circ C$, Bandwidth = 1.0Hz)

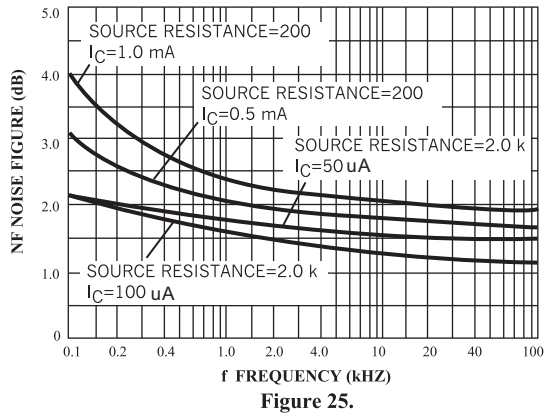


Figure 25.

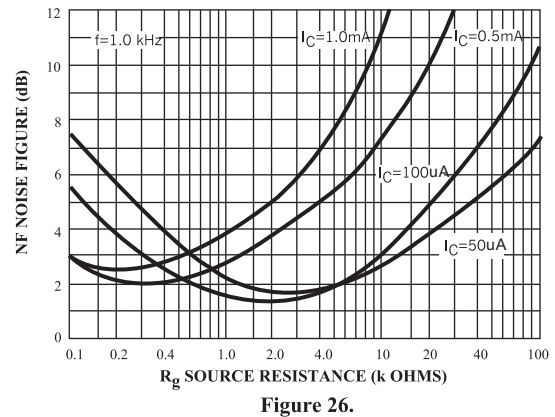


Figure 26.

h PARAMETERS ($V_{CE} = -10 V_{dc}$, $f = 1.0\text{ kHz}$, $T_A = 25^\circ C$)

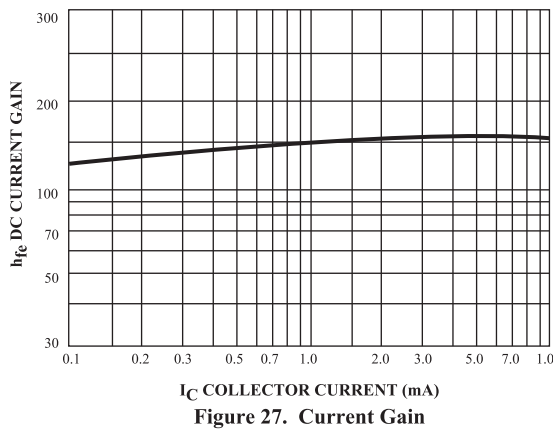


Figure 27. Current Gain

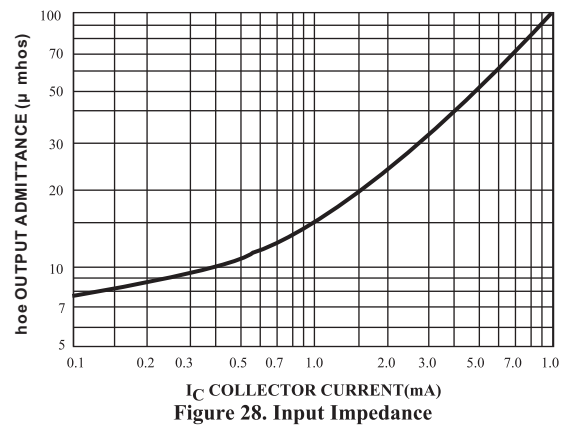


Figure 28. Input Impedance

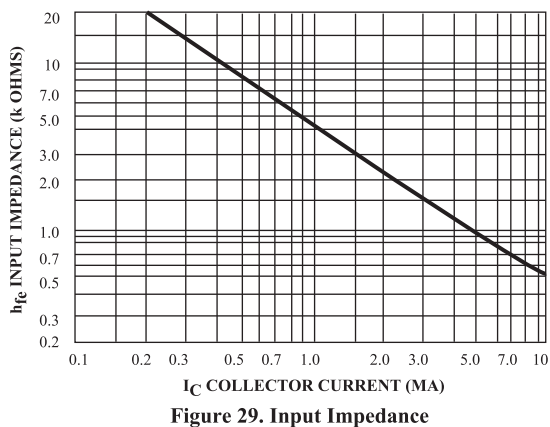


Figure 29. Input Impedance

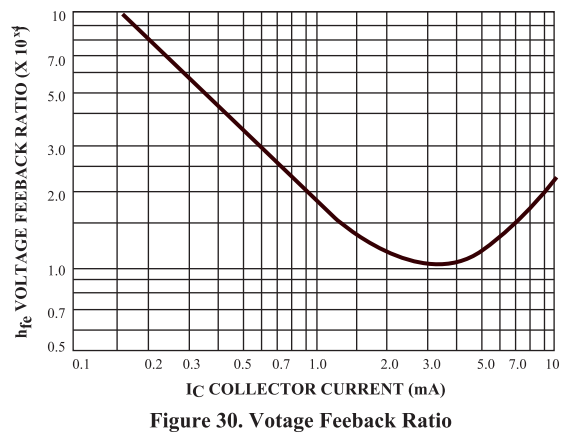


Figure 30. Votage Feedback Ratio

Rating and characteristic curves (PNP) TYPICAL STATIC CHARACTERISTICS

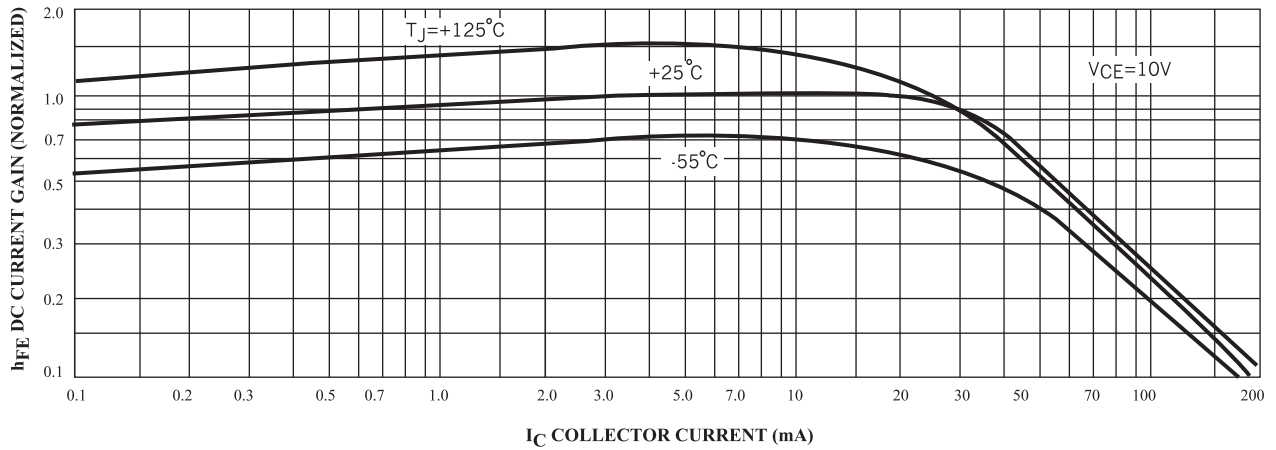


Figure 31. DC Current Gain

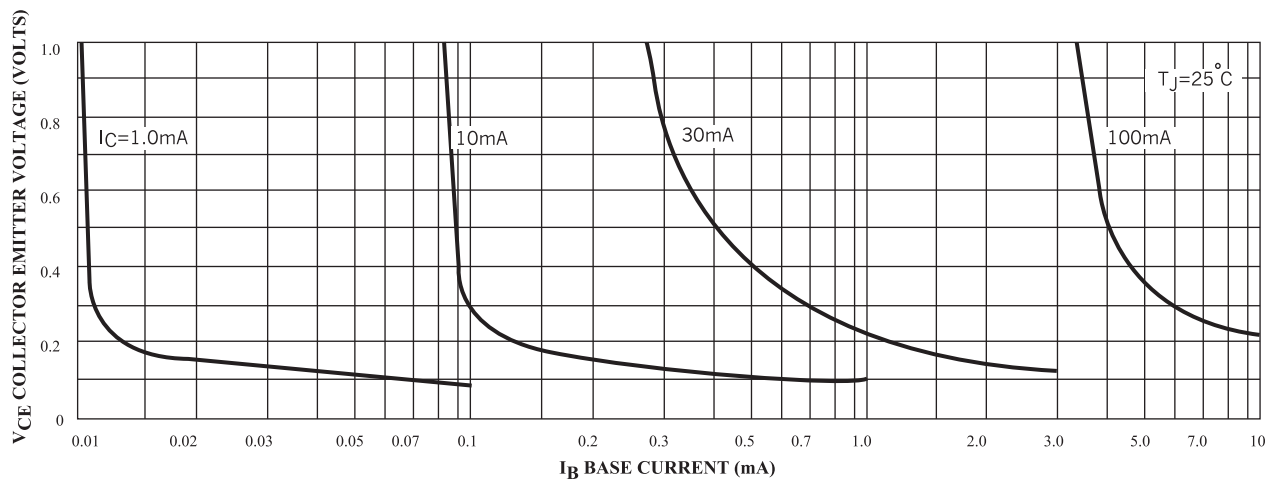


Figure 32. Collector Saturation Region

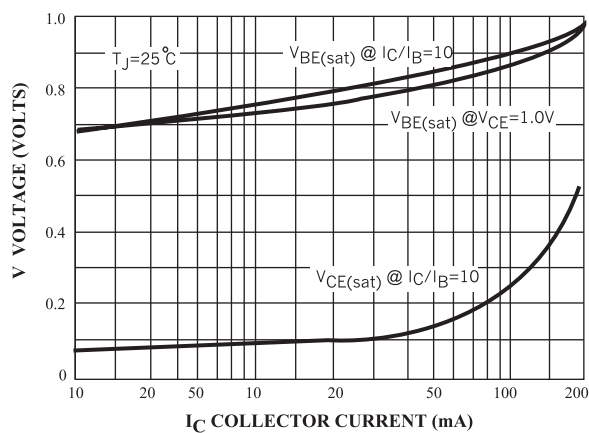


Figure 33. "ON" Voltages

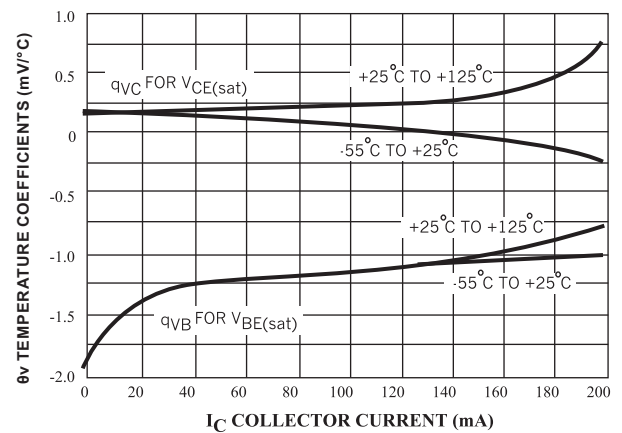
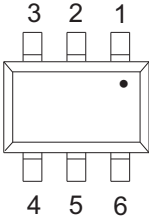
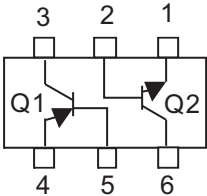


Figure 34. Temperature Coefficients

FMBT3946DW

Pinning information

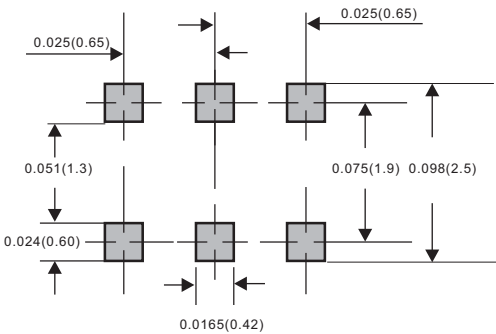
Pin	Simplified outline	Symbol
PIN 1. EMITTER 2 PIN 2. BASE 2 PIN 3. COLLECTOR 1 PIN 4. EMITTER 1 PIN 5. BASE 1 PIN 6. COLLECTOR 2		 *Q1 PNP Q2 NPN

Marking

Type number	Marking code
FMBT3946DW	46

Suggested solder pad layout

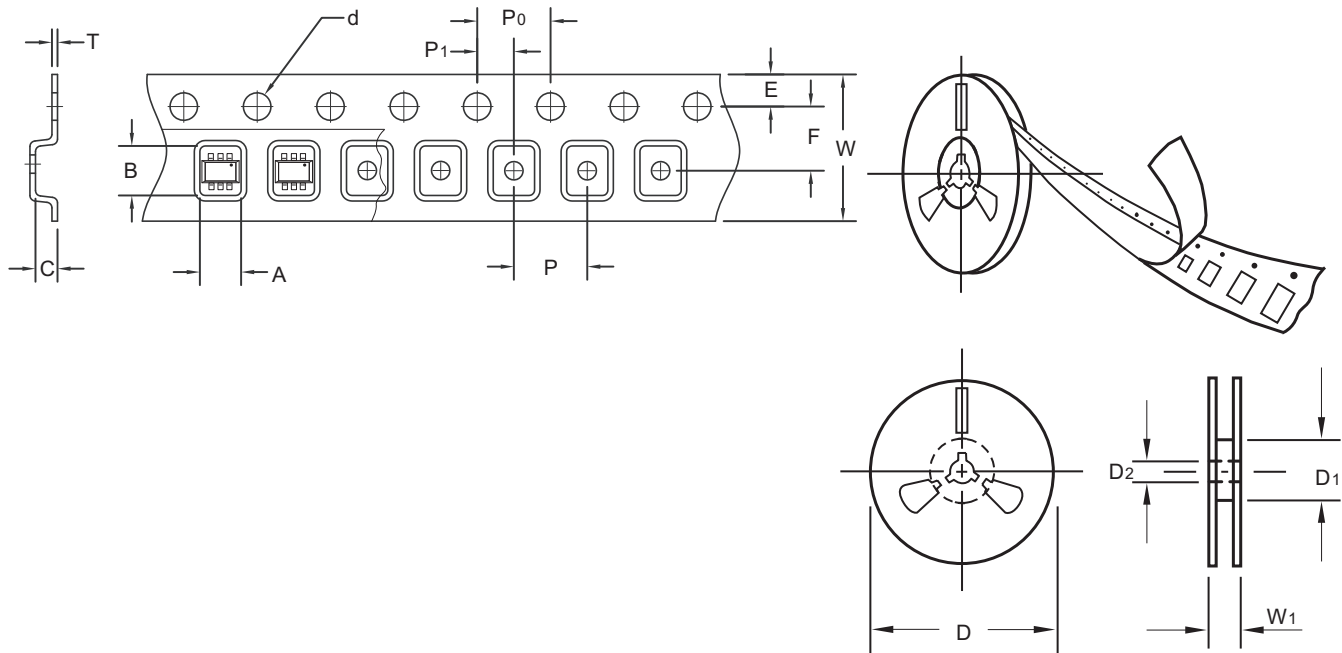
SOT-363



Dimensions in inches and (millimeters)

FMBT3946DW

Packing information



unit:mm

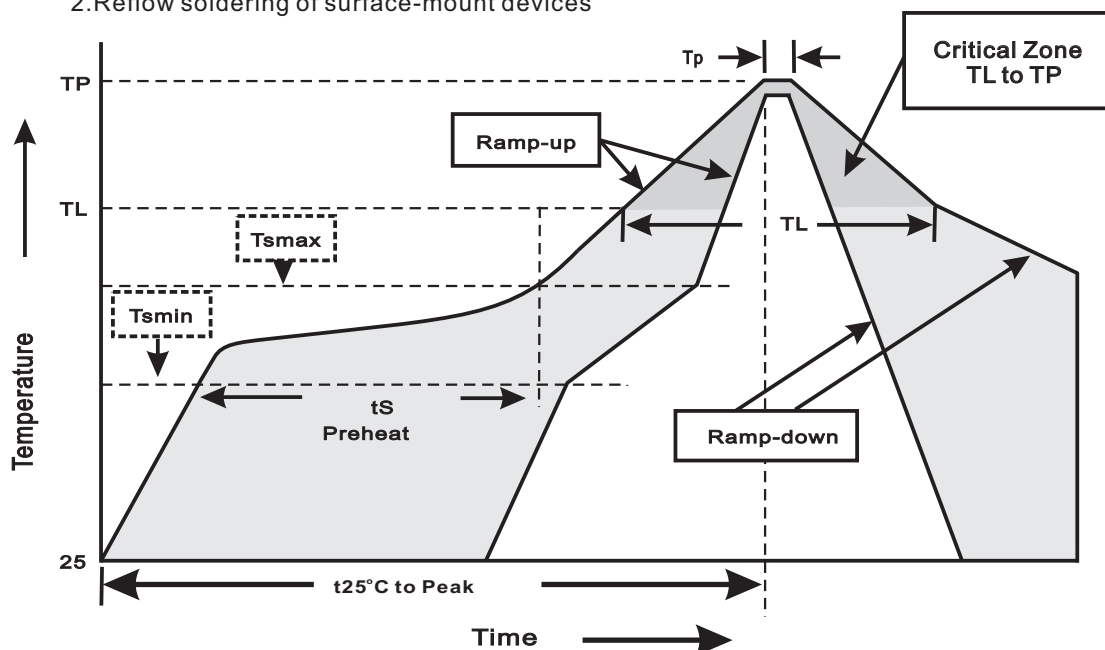
Item	Symbol	Tolerance	SOT-363
Carrier width	A	0.1	2.36
Carrier length	B	0.1	2.40
Carrier depth	C	0.1	1.20
Sprocket hole	d	0.1	1.50
13" Reel outside diameter	D	2.0	-
13" Reel inner diameter	D ₁	min	-
7" Reel outside diameter	D	2.0	178.00
7" Reel inner diameter	D ₁	min	62.00
Feed hole diameter	D ₂	0.5	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	P ₀	0.1	4.00
Embossment center	P ₁	0.1	2.00
Overall tape thickness	T	0.1	0.23
Tape width	W	0.3	8.00
Reel width	W ₁	1.0	11.40

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

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-363	7"	3,000	4.0	30,000	183*123*183	178	382*257*387	240,000	9.5

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



Profile Feature	Soldering Condition
Average ramp-up rate(T_L to T_P)	$<3^{\circ}\text{C}/\text{sec}$
Preheat -Temperature Min(T_{min}) -Temperature Max(T_{max}) -Time(min to max)(t_s)	150°C 200°C $60\sim 120\text{sec}$
T_{max} to T_L -Ramp-upRate	$<3^{\circ}\text{C}/\text{sec}$
Time maintained above: -Temperature(T_L) -Time(t_L)	217°C $60\sim 260\text{sec}$
Peak Temperature(T_P)	$255^{\circ}\text{C}-0/+5^{\circ}\text{C}$
Time within 5°C of actual Peak Temperature(t_P)	$10\sim 30\text{sec}$
Ramp-down Rate	$<6^{\circ}\text{C}/\text{sec}$
Time 25°C to Peak Temperature	$<6\text{minutes}$

FMBT3946DW

High reliability test capabilities

Item Test	Conditions
1. Steady State Operating Life	TA=25°C P _o =150mW Test Duration:1000hrs
2. High Temperature Reverse Bias	T _j =150°C, V _{ce} =80% related volage, Test Duration:1000hrs
3. Temperature Cycle	-55°C(15min) to 150°C(15min) Air to Air Transition Time<20sec Test Cycles: 1000cycle
4. Autoclave	P=2atm Ta=121°C RH=100% Test Duration:96hrs
5. High Temperature Storage Life	Ta=150°C Test Duration: 1000hrs
6. Solderability	245°C,Test Duration: 5sec
7. High Temperature High Humidity Reverse Bias	Ta=85°C, 85%RH, V _{ce} =80% related volage, Test Duration: 1000hrs
8. Resistance to Soldering Heat	260°C,Test Duration: 10sec