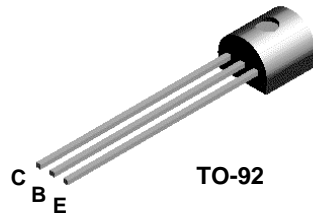
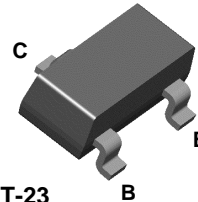


2N4401



TO-92

MMBT4401



SOT-23
Mark: 2X

NPN General Purpose Amplifier

This device is designed for use as a medium power amplifier and switch requiring collector currents up to 500 mA.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	600	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:

- 1) These ratings are based on a maximum junction temperature of 150 degrees C.
- 2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics

TA = 25°C unless otherwise noted

Symbol	Characteristic	Max		Units
		2N4401	*MMBT4401	
P_D	Total Device Dissipation	625	350	mW
	Derate above 25°C	5.0	2.8	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

NPN General Purpose Amplifier

(continued)

2N4401 / MMBT4401

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
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OFF CHARACTERISTICS

$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0 \text{ mA}, I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 0.1 \text{ mA}, I_E = 0$	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 0.1 \text{ mA}, I_C = 0$	6.0		V
I_{BL}	Base Cutoff Current	$V_{CE} = 35 \text{ V}, V_{EB} = 0.4 \text{ V}$		0.1	μA
I_{CEX}	Collector Cutoff Current	$V_{CE} = 35 \text{ V}, V_{EB} = 0.4 \text{ V}$		0.1	μA

ON CHARACTERISTICS*

h_{FE}	DC Current Gain	$I_C = 0.1 \text{ mA}, V_{CE} = 1.0 \text{ V}$ $I_C = 1.0 \text{ mA}, V_{CE} = 1.0 \text{ V}$ $I_C = 10 \text{ mA}, V_{CE} = 1.0 \text{ V}$ $I_C = 150 \text{ mA}, V_{CE} = 1.0 \text{ V}$ $I_C = 500 \text{ mA}, V_{CE} = 2.0 \text{ V}$	20 40 80 100 40	300	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$ $I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$		0.4 0.75	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 150 \text{ mA}, I_B = 15 \text{ mA}$ $I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$	0.75	0.95 1.2	V V

SMALL SIGNAL CHARACTERISTICS

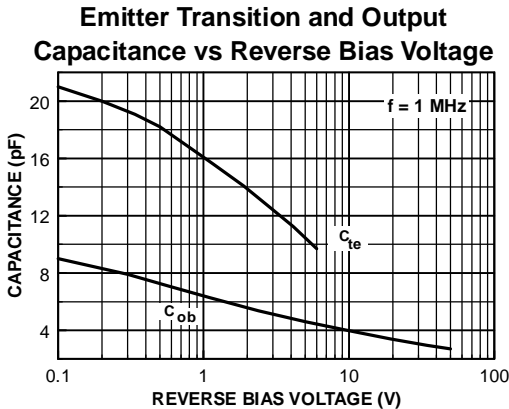
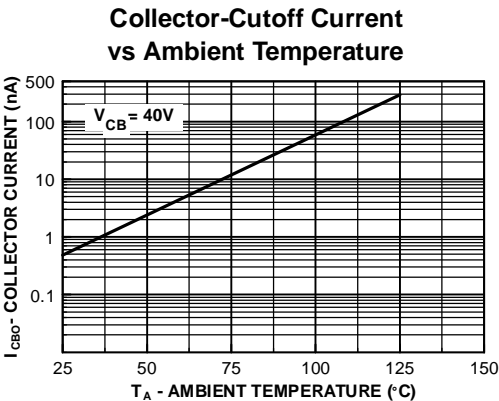
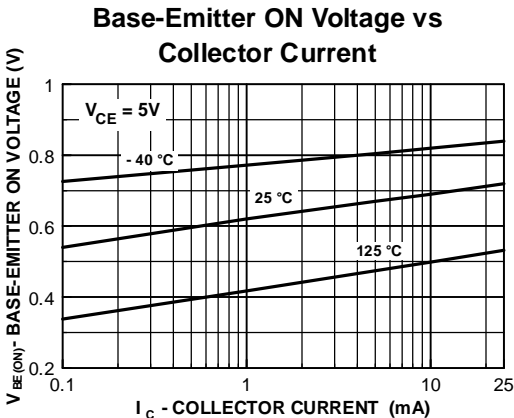
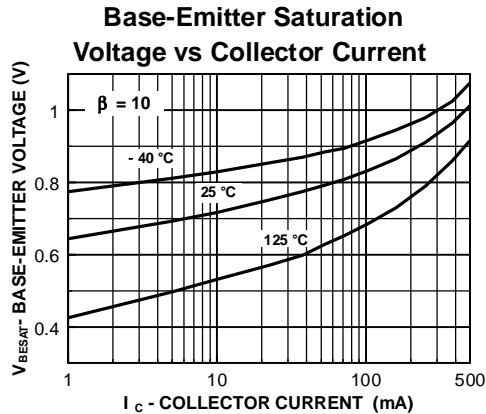
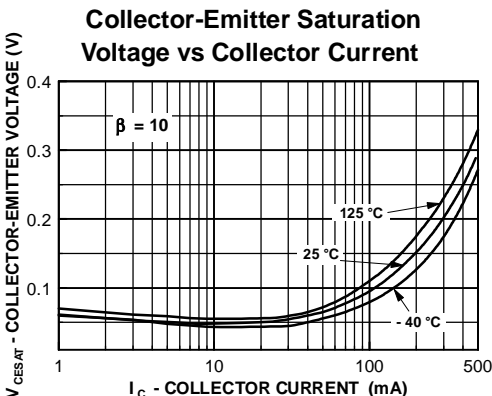
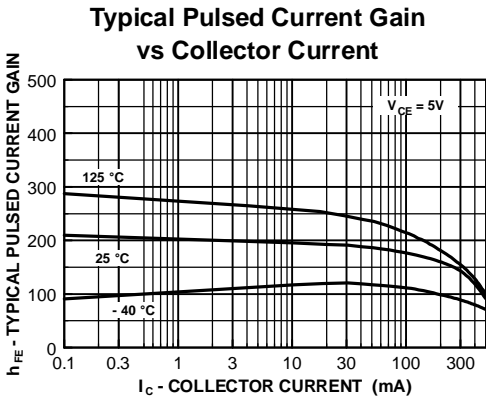
f_T	Current Gain - Bandwidth Product	$I_C = 20 \text{ mA}, V_{CE} = 10 \text{ V}, f = 100 \text{ MHz}$	250		MHz
C_{cb}	Collector-Base Capacitance	$V_{CB} = 5.0 \text{ V}, I_E = 0, f = 140 \text{ kHz}$		6.5	pF
C_{eb}	Emitter-Base Capacitance	$V_{BE} = 0.5 \text{ V}, I_C = 0, f = 140 \text{ kHz}$		30	pF
h_{ie}	Input Impedance	$I_C = 1.0 \text{ mA}, V_{CE} = 10 \text{ V}, f = 1.0 \text{ kHz}$	1.0	15	$k\Omega$
h_{re}	Voltage Feedback Ratio	$I_C = 1.0 \text{ mA}, V_{CE} = 10 \text{ V}, f = 1.0 \text{ kHz}$	0.1	8.0	$\times 10^{-4}$
h_{fe}	Small-Signal Current Gain	$I_C = 1.0 \text{ mA}, V_{CE} = 10 \text{ V}, f = 1.0 \text{ kHz}$	40	500	
h_{oe}	Output Admittance	$I_C = 1.0 \text{ mA}, V_{CE} = 10 \text{ V}, f = 1.0 \text{ kHz}$	1.0	30	μmhos

SWITCHING CHARACTERISTICS

t_d	Delay Time	$V_{CC} = 30 \text{ V}, V_{EB} = 2 \text{ V},$		15	ns
t_r	Rise Time	$I_C = 150 \text{ mA}, I_{B1} = 15 \text{ mA}$		20	ns
t_s	Storage Time	$V_{CC} = 30 \text{ V}, I_C = 150 \text{ mA}$		225	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 15 \text{ mA}$		30	ns

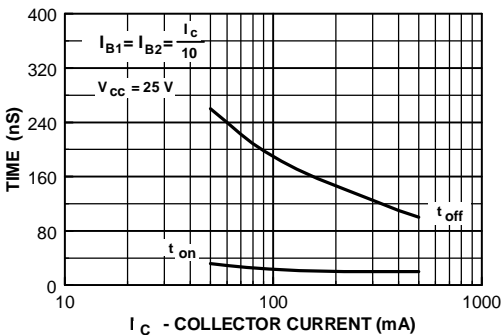
*Pulse Test: Pulse Width $\leq 300 \mu\text{s}$, Duty Cycle $\leq 2.0\%$

Typical Characteristics

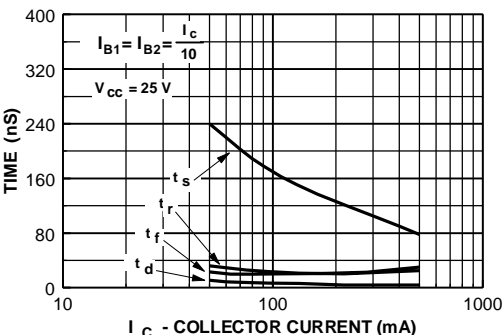


Typical Characteristics (continued)

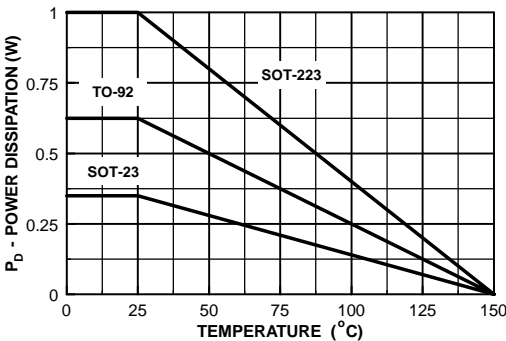
Turn On and Turn Off Times
vs Collector Current



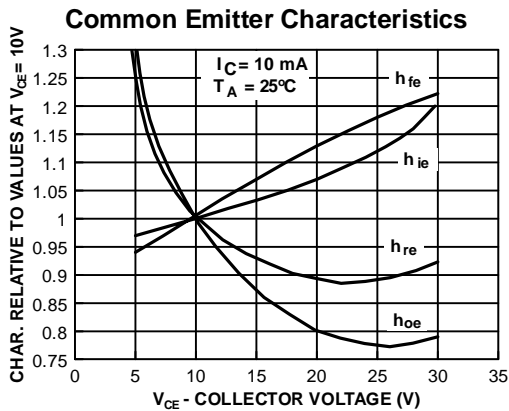
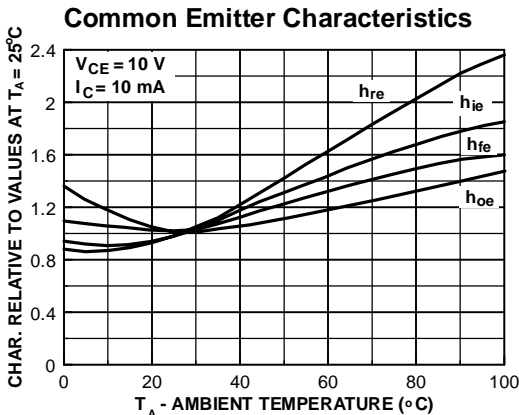
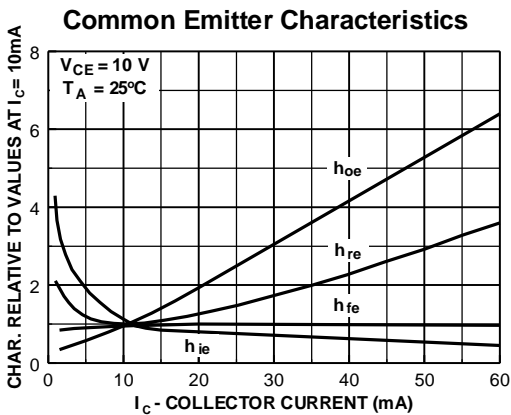
Switching Times
vs Collector Current



Power Dissipation vs
Ambient Temperature



Typical Common Emitter Characteristics (f = 1.0kHz)



Test Circuits

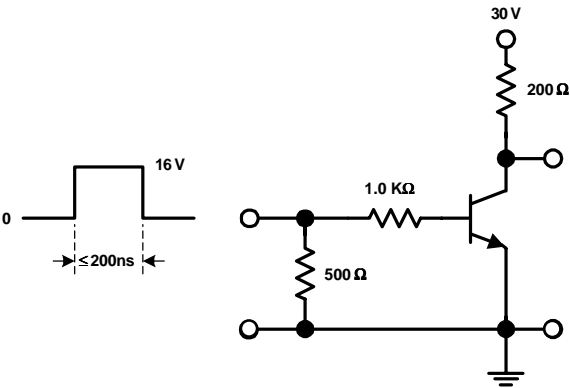


FIGURE 1: Saturated Turn-On Switching Timer

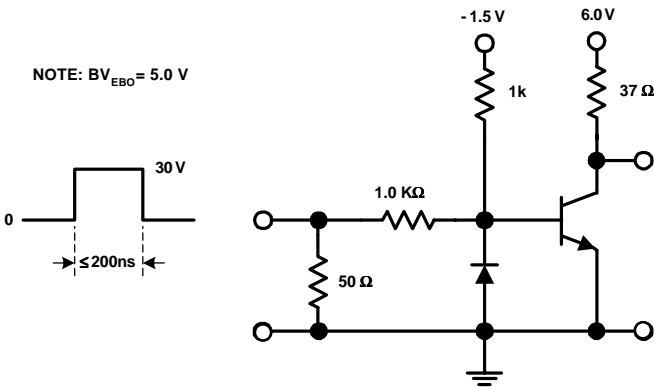


FIGURE 2: Saturated Turn-Off Switching Time

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