MOTOROLA
SEMICONDUCTOR TECHNICAL DATA

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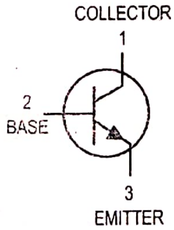
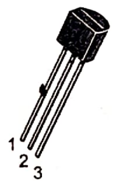
by BC546/D

Amplifier Transistors
NPN Silicon

BC546, B
BC547, A, B, C
BC548, A, B, C





CASE 29–04, STYLE 17
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	BC 546	BC 547	BC 548	Unit
Collector–Emitter Voltage	V_{CEO}	65	45	30	Vdc
Collector–Base Voltage	V_{CBO}	80	50	30	Vdc
Emitter–Base Voltage	V_{EBO}	6.0			Vdc
Collector Current — Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	BC546 BC547 BC548	$V_{(BR)CEO}$	65 45 30	— — —	— — —	V
Collector–Base Breakdown Voltage (I_C = 100 µAdc)	BC546 BC547 BC548	$V_{(BR)CBO}$	80 50 30	— — —	— — —	V
Emitter–Base Breakdown Voltage (I_E = 10 µA, I_C = 0)	BC546 BC547 BC548	$V_{(BR)EBO}$	6.0 6.0 6.0	— — —	— — —	V
Collector Cutoff Current (V_{CE} = 70 V, V_{BE} = 0) (V_{CE} = 50 V, V_{BE} = 0) (V_{CE} = 35 V, V_{BE} = 0) (V_{CE} = 30 V, T_A = 125°C)	 BC546 BC547 BC548 BC546/547/548	I_{CES}	 — — — —	 0.2 0.2 0.2 —	 15 15 15 4.0	 nA µA

REV 1

MOTOROLA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 µA, V_{CE} = 5.0 V)	BC547A/548A		—	90	—	
	BC546B/547B/548B		—	150	—	
	BC548C		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC546		110	—	450	
	BC547		110	—	800	
	BC548		110	—	800	
	BC547A/548A		110	180	220	
	BC546B/547B/548B		200	290	450	
	BC547C/BC548C		420	520	800	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC547A/548A		—	120	—	
	BC546B/547B/548B		—	180	—	
	BC548C		—	300	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.09	0.25	
(I_C = 100 mA, I_B = 5.0 mA)			—	0.2	0.6	
(I_C = 10 mA, I_B = See Note 1)			—	0.3	0.6	
Base–Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	—	0.7	—	V
Base–Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	—	0.7	
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	0.77	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product		f_T				MHz
(I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	BC546		150	300	—	
	BC547		150	300	—	
	BC548		150	300	—	
Output Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{obo}	—	1.7	4.5	pF
Input Capacitance (V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	10	—	pF
Small–Signal Current Gain		h_{fe}				—
(I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC546		125	—	500	
	BC547/548		125	—	900	
	BC547A/548A		125	220	260	
	BC546B/547B/548B		240	330	500	
	BC547C/548C		450	600	900	
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2 kΩ, f = 1.0 kHz, Δf = 200 Hz)	BC546		—	2.0	10	
	BC547		—	2.0	10	
	BC548		—	2.0	10	

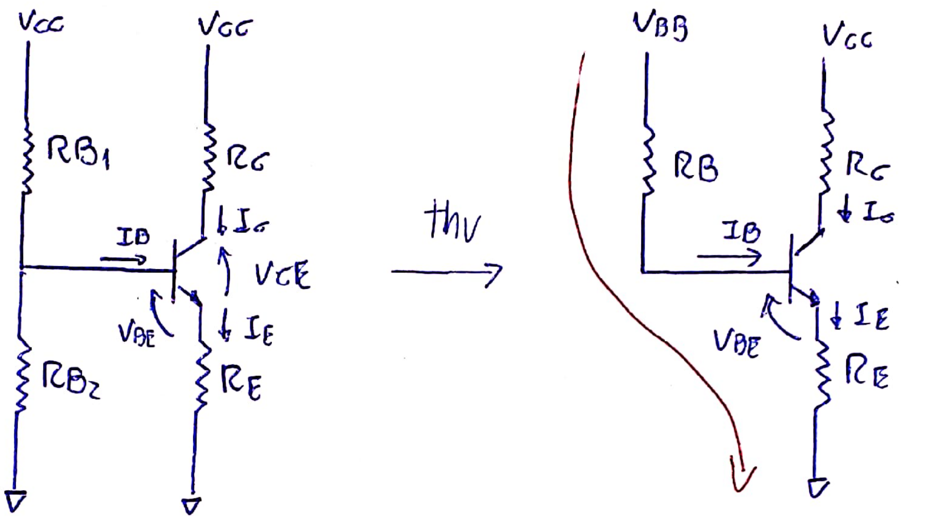
Note 1: I_B is value for which I_C = 11 mA at V_{CE} = 1.0 V.

BC548B NJBJ

$\beta : [200, 450]$ Tipico 290

V_{be} [0,55 ; 0,7]

$V_{CE_{SAT}} = 0{,}2$ Typ $\cdot V_{Early} = 63$ segun modelo LTspic



$$V_{BB} = V_{CC} \cdot \frac{R_{B2}}{R_{B1} + R_{B2}} \qquad R_B = \frac{R_{B1} \cdot R_{B2}}{R_{B1} + R_{B2}} \qquad I_C = \beta I_B$$

$$I_E = I_C + I_B$$

$$V_{BB} - I_E \cdot R_E - I_B \cdot R_B - V_{BE} = 0$$

$$V_{BB} - V_{BE} = (I_B + \beta I_B) R_E + I_B \cdot R_B$$

$$V_{BB} - V_{BE} = I_B \left(\underbrace{(1+\beta)}_{\approx \beta} R_E + R_B \right)$$

$$V_{BB} - V_{BE} = \underbrace{I_B \beta}_{I_C} \left(R_E + \frac{R_B}{\beta} \right)$$

$$\frac{V_{BB} - V_{BE}}{R_E + \frac{R_B}{\beta}} = I_C$$

Defino $I_C \sim 5mA$

• $RE = 470$

↳ LA necesito en señal para aumentar rib pero afecta ganancia ⇒ utilizo la más chica

$$V_{BB} = I_C \left(\frac{R_B}{\beta} + R_E \right) + V_{BE}$$

• Si $R_{B1} = 820K$ y $R_{B2} = 100k \Rightarrow R_B = 89K$ ✗

$V_{BB} = 4{,}6V$

$$V_{CC} = V_{BB} \cdot \left(\frac{R_{B2} + R_{B1}}{R_{B2}} \right) = 42V$$ ✗

• Si $R_{B1} = 82k$ y $R_{B2} = 100K \Rightarrow R_B = 45K$ ✓

$V_{BB} = 3{,}82V$

$$V_{CC} = V_{BB} \cdot \left(\frac{R_{B2} + R_{B1}}{R_{B2}} \right) = 7V$$

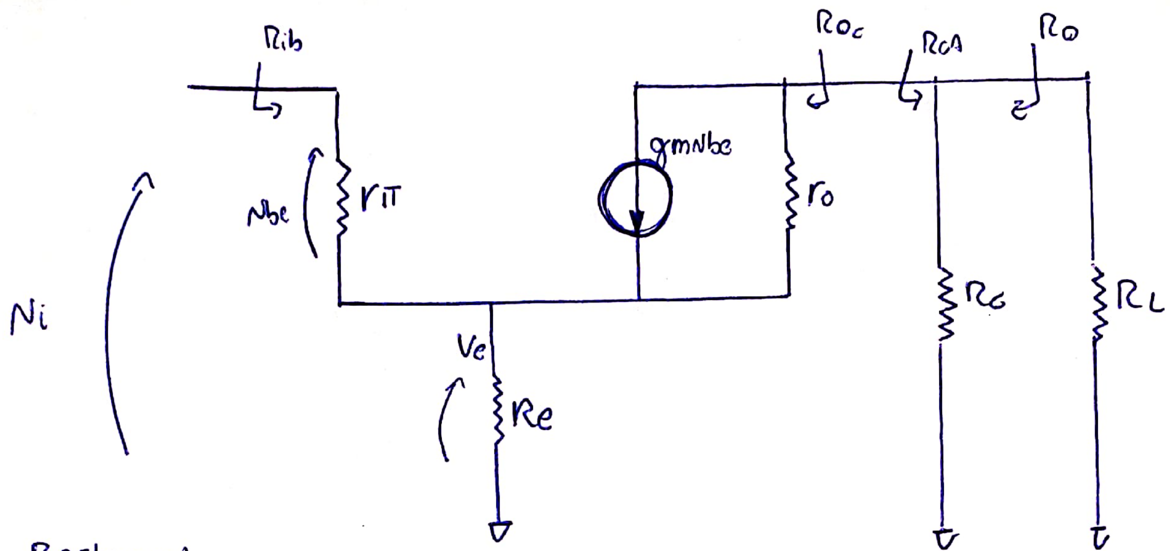
↙ 6V ↘ 9V

$V_{CC} = 6V$	$V_{CC} = 9V$
$V_{BB} = 6V \cdot \frac{100K}{82K + 100K} = 3{,}3V$	$V_{BB} = 9V \cdot \frac{100K}{82K + 100K} = 5V$

$\boxed{R_B = 45K}$

$$\boxed{I_C = \frac{V_{BB} - V_{BE}}{\frac{R_B}{\beta} + R_E}}$$

$V_{CC} = 6V$	$V_{CC} = 9V$
$I_C = 4{,}2m$	$I_C = 7m$
$g_m = \frac{I_{CQ}}{V_{Th}} = 162m$	$g_m = 270m$
$r_\pi = \frac{\beta}{g_m} = 1800\Omega$	$r_\pi = \frac{\beta}{g_m} = 1074\Omega$
$r_o \to \infty$	$r_o \to \infty$



Reflejando LA Re A la entrada $\qquad r_o \to \infty \Rightarrow i_c = g_m v_{be}$

$$V_e = \Big(\underbrace{g_m \cdot v_{be}}_{i_c} + \underbrace{\frac{v_{be}}{r_\pi}}_{i_B}\Big) \cdot R_e = \Big(v_{be} \cdot \big(g_m + \frac{g_m}{\beta}\big) R_e\Big) =$$

$$V_e = R_e^* \cdot \underbrace{\frac{v_{be}}{r_\pi}}_{i_b}$$

$$R_e^* \frac{\cancel{v_{be}}}{r_\pi} = \cancel{v_{be}} \cdot \frac{g_m}{\beta} \cdot (\beta+1) R_e$$

$$R_e^* = \cancel{\frac{g_m}{\beta}} (\beta+1) R_e \cdot \cancel{\frac{\beta}{g_m}}$$

$$R_e^* = R_e \underbrace{(\beta+1)}_{\approx \beta}$$

$$R_E^* = \beta R_E$$

Reflejando R_E a la salida. $\qquad r_o \to \infty \Rightarrow i_c = g_m \cdot v_{be}$

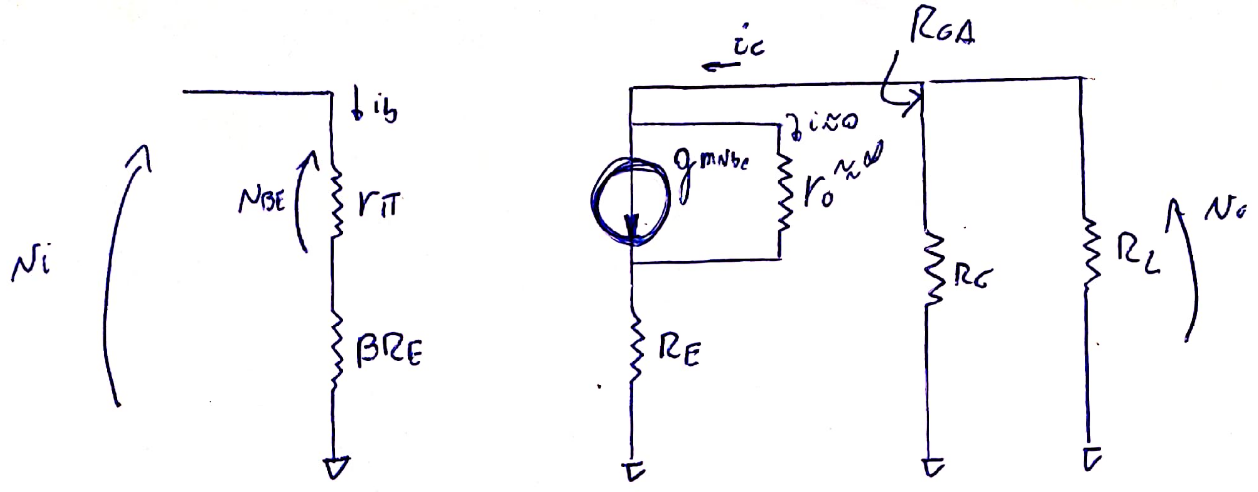
$$V_e = \Big(g_m v_{be} + \frac{v_{be}}{r_\pi}\Big) R_E =$$

$$V_e = R_E^{**} \cdot g_m v_{be}$$

$$R_E^{**} \cancel{g_m v_{be}} = \Big(\cancel{g_m v_{be}} + \frac{\cancel{v_{be} g_m}}{\beta}\Big) R_E$$

$$R_E^{**} = \underbrace{\Big(1 + \frac{1}{\beta}\Big)}_{\approx 1} R_E$$

$$R_E^{**} = R_E$$



$$r_{ib} = r_\pi + \beta R_E$$

$$R_i = R_B // R_{ib}$$

$$A_v = \frac{v_o}{v_i} = -\frac{g_m \cdot \cancel{v_i} \cdot \frac{r_\pi}{\beta R_E + r_\pi} \cdot R_{CA}}{\cancel{v_i}} = -\frac{\cancel{g_m} \cdot \beta / \cancel{g_m}}{\beta R_E + r_\pi}$$

$$A_v = -\frac{\cancel{\beta}}{\cancel{\beta} R_E + \frac{\cancel{\beta}}{g_m}} R_{CA} = -\frac{R_{CA}}{R_E + \frac{1}{g_m}}$$

$R_C = 1K$ $\quad R_L = 10K \Rightarrow R_{CA} = 909\Omega$

$V_{CC} = 6V$	$V_{CC} = 9V$
$g_m = 162m$	$g_m = 270m$
$r_\pi = 1800\Omega$	$r_\pi = 1074$
$R_{ib} = 138K\Omega$	$r_{ib} = 137K\Omega$
$A_v = -1{,}9$	$A_v = -1{,}91$