

PNP Germanium RF Transistor

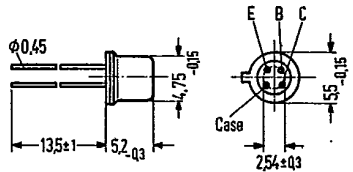
AF 139

- SIEMENS AKTIENGESELLSCHAFT ——— T-31-07

for input stages, mixer and oscillator stages up to 860 MHz

AF 139 is a germanium PNP mesa transistor in TO 92 case (18 A 4 DIN 41876). The leads are electrically insulated from the case.

Type	Ordering code
AF 139	Q60106-X139



Approx. weight 0.4 g Dimensions in mm

Maximum ratings

Collector-emitter voltage	$-V_{CEO}$	15	V
Collector-base voltage	$-V_{CBO}$	20	V
Emitter-base voltage	$-V_{EBO}$	0.3	V
Collector current	$-I_C$	10	mA
Emitter current	I_E	11	mA
Base current	$-I_B$	1	mA
Junction temperature	T_J	90	°C
Storage temperature range	T_{stg}	-30 to +75	°C
Total power dissipation ($T_{amb} = 45^\circ\text{C}$)	P_{tot}	60	mW

Thermal resistance

Junction to ambient air	R_{thJA}	≤ 750	K/W
Junction to case	R_{thJC}	≤ 400	K/W

Static characteristics ($T_{amb} = 25^{\circ}\text{C}$)

$-V_{CE}$ V	$-I_C$ mA	$-I_B$ μA	h_{FE} I_C/I_B	$-V_{BE}$ mV
12	1.5	30	50 (>10)	380 (320 to 430)
6	2	36	55	380 (320 to 430)
6	5	66	75	405 (360 to 450)

Collector cutoff current ($-V_{CBO} = 20\text{ V}$)	$-I_{CBO}$	0.5 (<8)	μA
Emitter cutoff current ($-V_{EBO} = 0.3\text{ V}$)	$-I_{EBO}$	2 (<100)	μA
Collector cutoff current ($-V_{CEO} = 15\text{ V}$)	$-I_{CEO}$	<500	μA

Dynamic characteristics ($T_{amb} = 25^{\circ}\text{C}$)

Operating point: $-I_C = 1.5\text{ mA}$; $-V_{CE} = 12\text{ V}$.

Transition frequency ($f = 100\text{ MHz}$)

Feedback time constant ($f = 2.5\text{ MHz}$)

Max. frequency of oscillation $f_{max} = \sqrt{\frac{f_T}{8\pi \cdot r_{bb'} \cdot C_{b'c}}}$	f_T	550	MHz
	$r_{bb'} \cdot C_{b'c}$	3	ps
	f_{max}	2.7	GHz
Reverse transfer capacitance ($f = 450\text{ kHz}$)	$-C_{12e}$	0.25	pF
Power gain ($f = 800\text{ MHz}$; $R_L = 1.4\text{ k}\Omega$)	$G_{pb}^{1)}$	11 (>9)	dB
Power gain ($f = 900\text{ MHz}$)	G_{pb}	9 (>6.5)	dB
Feedback damping ($f = 800\text{ MHz}$)	$-G_{pb}^{binv}^{1)}$	23	dB
Noise figure ($f = 800\text{ MHz}$; $R_g = 60\text{ }\Omega$)	$NF^{1)}$	7 (<8.2)	dB
Noise figure ($f = 900\text{ MHz}$; $R_L = 0.5\text{ k}\Omega$; $-V_{CE} = 10\text{ V}$; $I_E = 2\text{ mA}$)	NF	7.5 (≤ 9)	dB

Four-pole characteristics:

$-I_C = 1.5\text{ mA}$; $-V_{CE} = 12\text{ V}$; $f = 200\text{ MHz}$

$g_{11b} = 28\text{ mS}$	$-g_{12b} = 0.06\text{ mS}$	$-g_{21b} = 22\text{ mS}$	$g_{22b} = 0.09\text{ mS}$
$-b_{11b} = 24\text{ mS}$	$-b_{12b} = 0.16\text{ mS}$	$b_{21b} = 30\text{ mS}$	$b_{22b} = 1.9\text{ mS}$

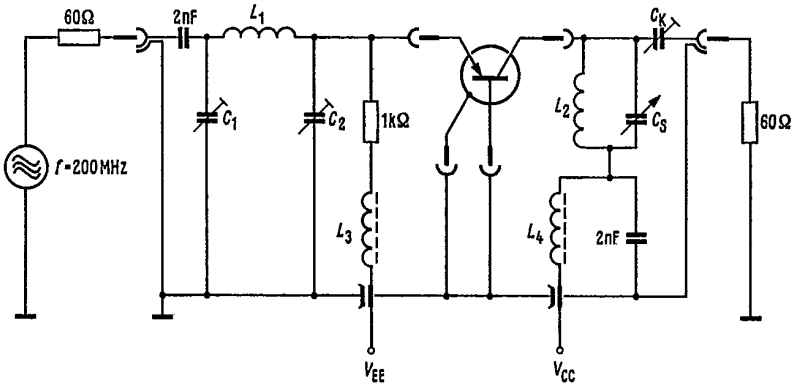
$-I_C = 1.5\text{ mA}$; $-V_{CE} = 12\text{ V}$; $f = 800\text{ MHz}$

$g_{11b} = 7\text{ mS}$	$y_{12b} = 0.4\text{ mS}$	$ y_{21b} = 14\text{ mS}$	$g_{22b} = 0.5\text{ mS}$
$-b_{11b} = 11\text{ mS}$	$\varphi_{12b} = -120^{\circ}$	$\varphi_{21b} = 35^{\circ}$	$b_{22b} = 7.5\text{ mS}$

1) measured in circuit shown on page 108

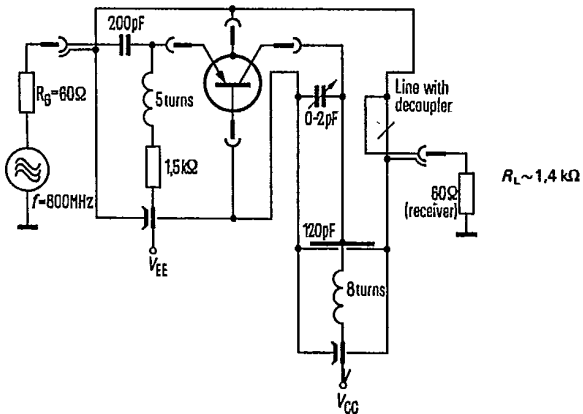
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Test circuit for power gain and noise figure at $f = 200$ MHz



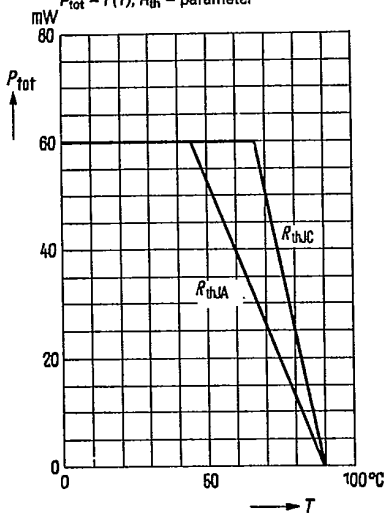
- $L_1 = 3$ turns; $d = 1$ mm; dia = 6.5 mm
- $L_2 = 2$ turns; $d = 1$ mm; dia = 6.5 mm
- $L_3 = L_4 = 20$ turns 0.5 CuLs on core B63310-K1-A12.3
- $C_K = 1.5$ to 5 pF so that $R_L = 920 \Omega$
- $C_1 = 6.5$ to 18 pF
- $C_2 = 9.5$ to 20 pF
- $C_3 = 3$ to 10 pF

Test circuit for power gain and noise figure at $f = 800$ MHz

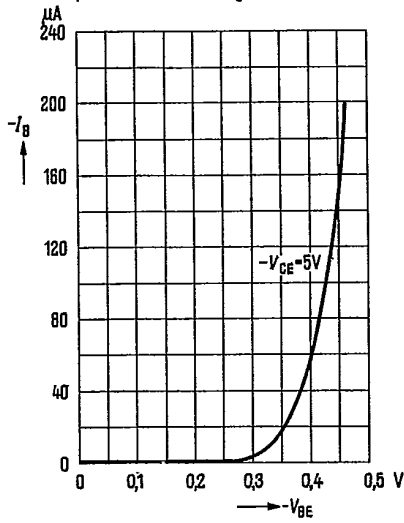


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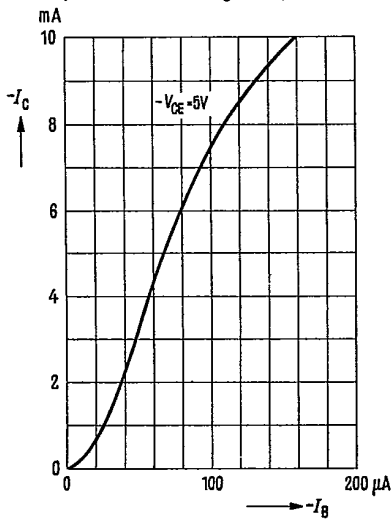
Total perm. power dissipation versus temperature
 $P_{tot} = f(T)$; R_{th} = parameter



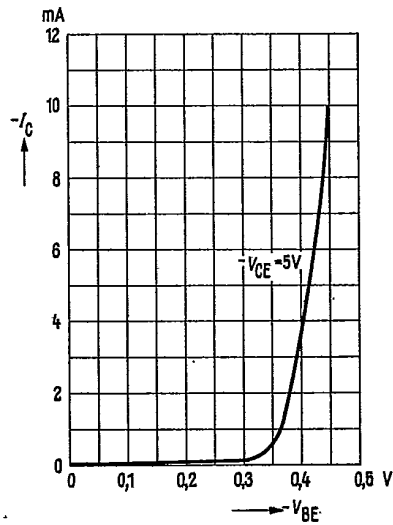
Input characteristic $I_B = f(V_{BE})$;
 $-V_{CE} = 5V$
 (common emitter configuration)



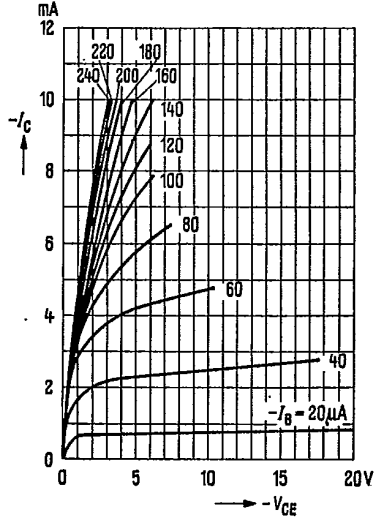
Collector current $I_C = f(I_B)$;
 $-V_{CE} = 5V$
 (common emitter configuration)



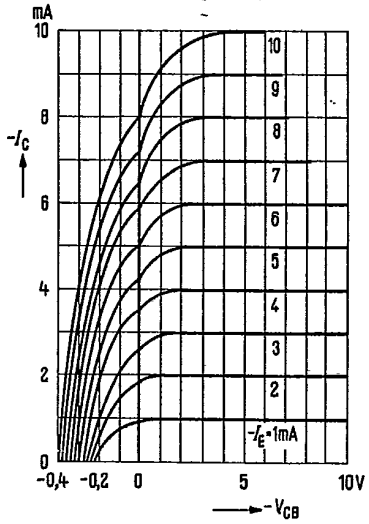
Collector current $I_C = f(V_{BE})$;
 $-V_{CE} = 5V$
 (common emitter configuration)



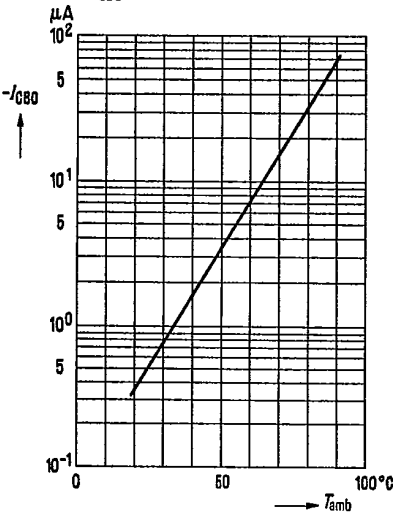
Output characteristics $I_C = f(V_{CE})$;
 I_B = parameter
 (common emitter configuration)



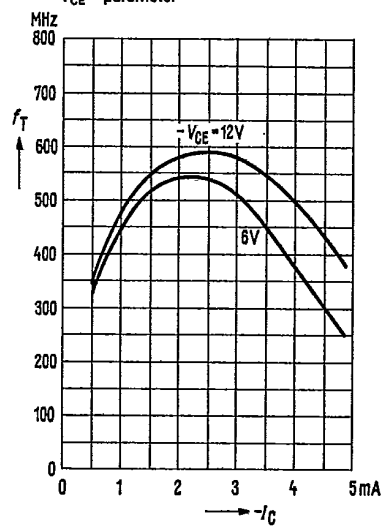
Output characteristics $I_C = f(V_{CB})$;
 I_E = parameter
 (common base configuration)



Collector cutoff current $I_{CBO} = f(T_{amb})$;
 versus temperature
 $-V_{CBO} = 20V$

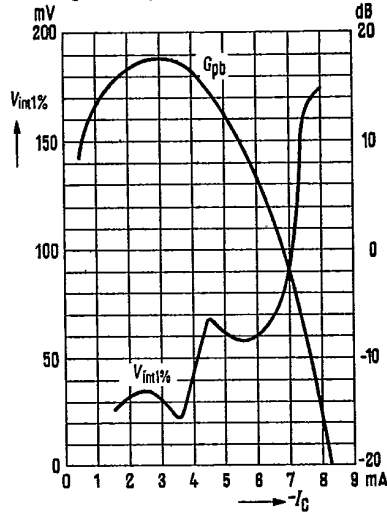


Transition frequency $f_T = f(I_C)$;
 V_{CE} = parameter

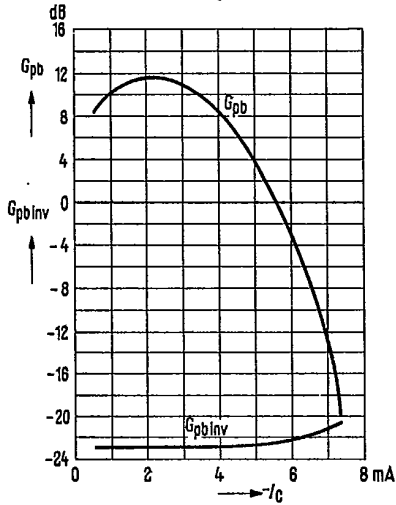


1) $V_{int 1\%}$ is the rms value of half the EMF (terminal voltage under matching condition) of a 100% sine wave modulated TV-carrier at a generator impedance of 240Ω which causes a 1% amplitude modulation on the signal carrier.

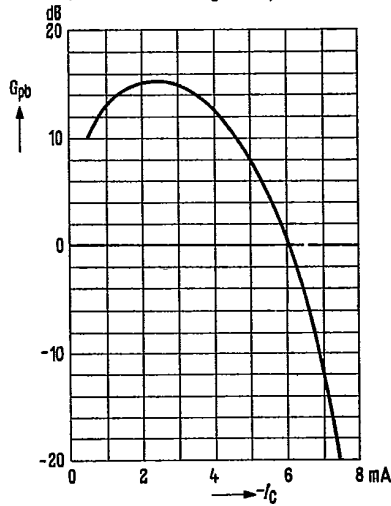
Interference voltage $V_{int 1\%} = f(I_C)$
 Power gain $G_{pb} = f(I_C)$
 $f = 200 \text{ MHz}; -V_{batt} = 12 \text{ V}; R_V = 1 \text{ k}\Omega;$
 $R_L = 0.9 \text{ k}\Omega$ (common base configuration)



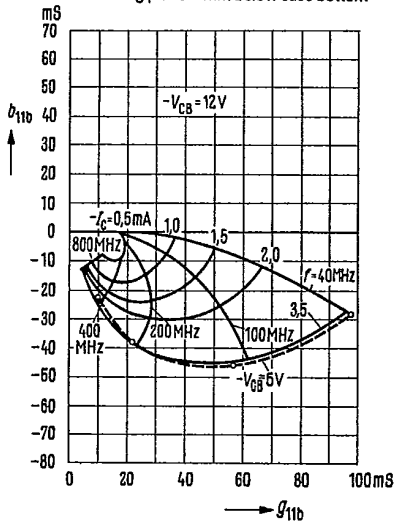
Power gain $G_{pb} = f(I_C)$
 $f = 800 \text{ MHz}; -V_{batt} = 12 \text{ V}; R_V = 1 \text{ k}\Omega$
 $R_L = 1.4 \text{ k}\Omega$
 (common base configuration)



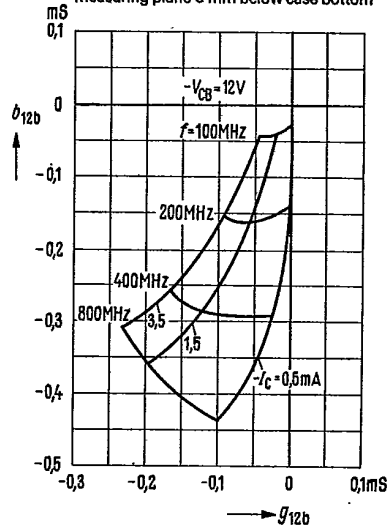
Power gain $G_{pb} = f(I_C)$
 $f = 500 \text{ MHz}; -V_{batt} = 12 \text{ V}; R_V = 1 \text{ k}\Omega$
 $R_L = 1.4 \text{ k}\Omega$
 (common base configuration)



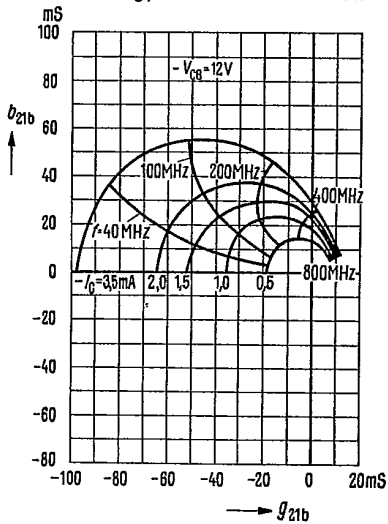
Small signal short circuit input admittance y_{11b} ; $-V_{CB} = 12V$
(common base configuration)
measuring plane 5 mm below case bottom



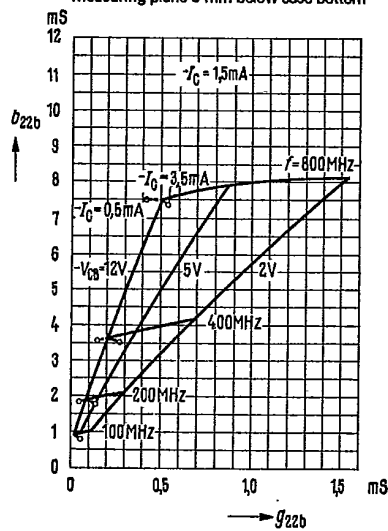
Small signal circuit reverse transfer admittance y_{12b} ; $-V_{CB} = 12V$
(common base configuration)
measuring plane 5 mm below case bottom



Small signal short circuit forward transfer admittance y_{21b} ; $-V_{CB} = 12V$
(common base configuration)
measuring plane 5 mm below case bottom

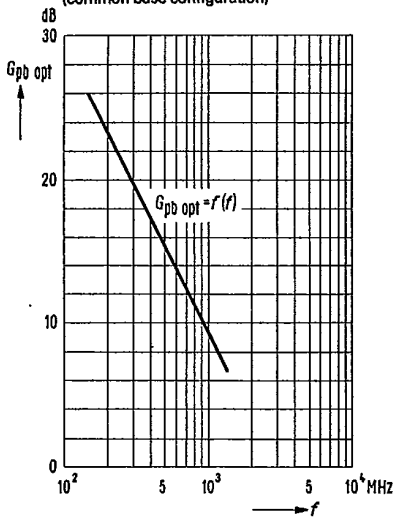


Small signal short circuit output admittance y_{22} ; $I_E = 1.5 mA$
(common emitter, base configuration)
measuring plane 5 mm below case bottom



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Power gain versus frequency
 $G_{pb\text{opt}} = f(f)$; $-I_C = 1.5 \text{ mA}$; $-V_{CE} = 12 \text{ V}$
 (common base configuration)



Noise figure versus frequency $NF = f(f)$
 $-V_{CE} = 12 \text{ V}$
 $-I_C = 1.5 \text{ mA}$; $R_G = 60 \Omega$

