

PNP Germanium RF Transistor

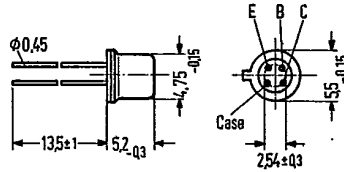
AF 139

- 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:

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

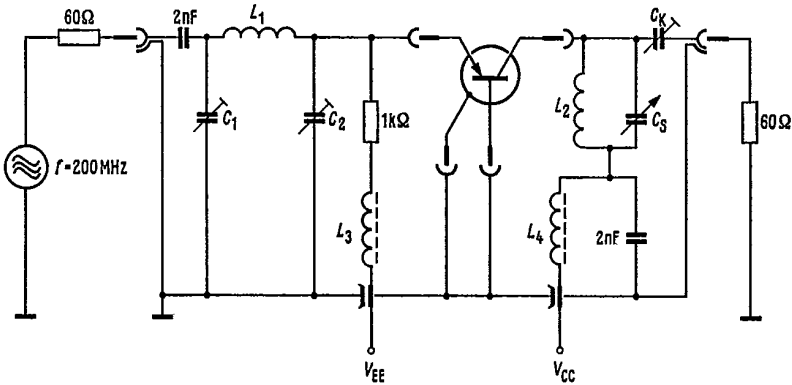
| | | | |
|---------------------------|-----------------------------|---------------------------|----------------------------|
| $g_{11b} = 28\text{ mS}$ | $-g_{12b} = 0.06\text{ mS}$ | $-g_{21b} = 22\text{ mS}$ | $g_{22b} = 0.09\text{ mS}$ |
| $-b_{11b} = 24\text{ mS}$ | $-b_{12b} = 0.16\text{ mS}$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

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

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

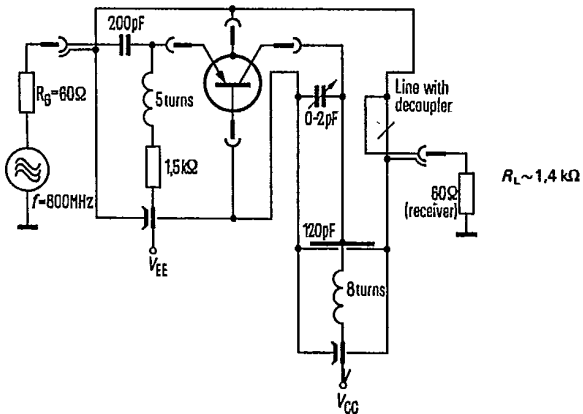
1) measured in circuit shown on page 108

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



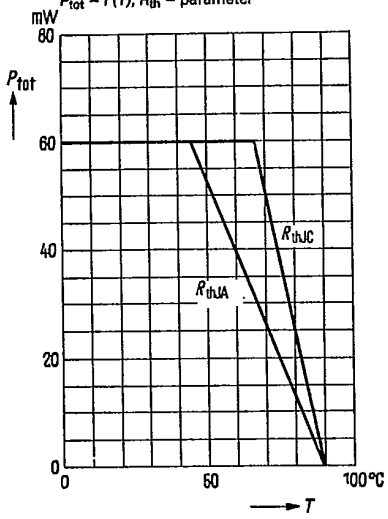
- $L_1 = 3$ turns; $d = 1$ mm; dia = 6.5 mm
- $L_2 = 2$ turns; $d = 1$ mm; dia = 6.5 mm
- $L_3 = L_4 = 20$ turns 0.5 CuLs on core B63310-K1-A12.3
- $C_K = 1.5$ to 5 pF so that $R_L = 920 \Omega$
- $C_1 = 6.5$ to 18 pF
- $C_2 = 9.5$ to 20 pF
- $C_3 = 3$ to 10 pF

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

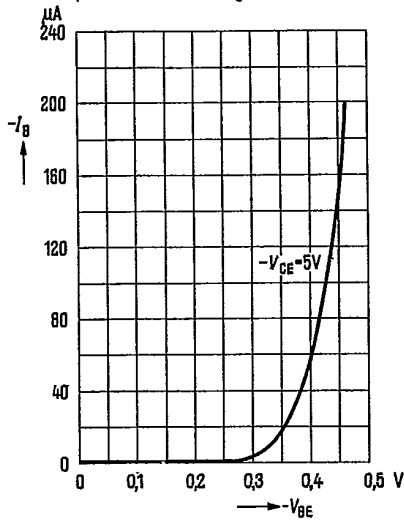


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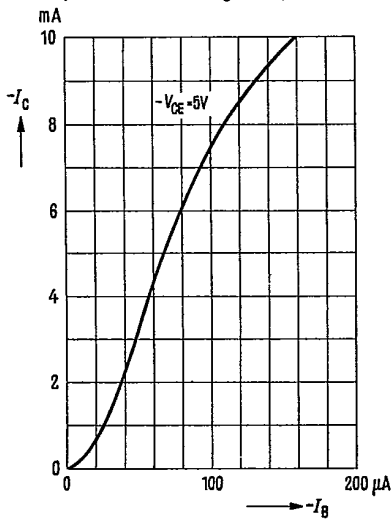
Total perm. power dissipation versus temperature
 $P_{tot} = f(T)$; R_{th} = parameter



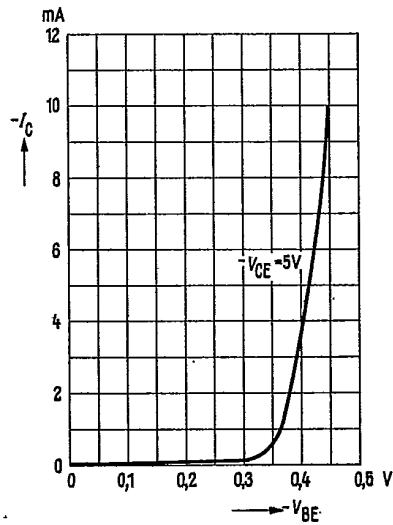
Input characteristic $I_B = f(V_{BE})$;
 $-V_{CE} = 5V$
 (common emitter configuration)



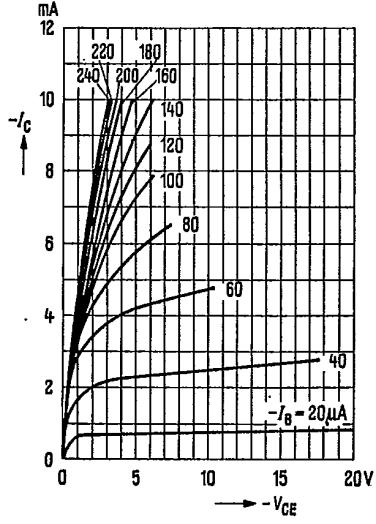
Collector current $I_C = f(I_B)$;
 $-V_{CE} = 5V$
 (common emitter configuration)



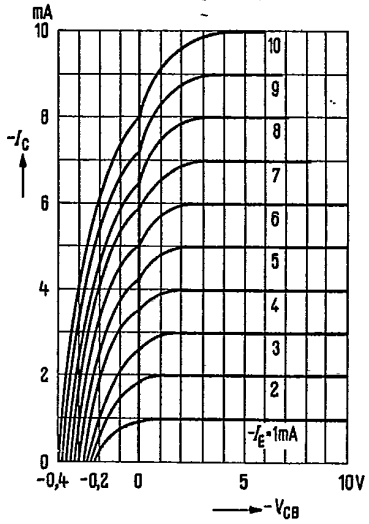
Collector current $I_C = f(V_{BE})$;
 $-V_{CE} = 5V$
 (common emitter configuration)



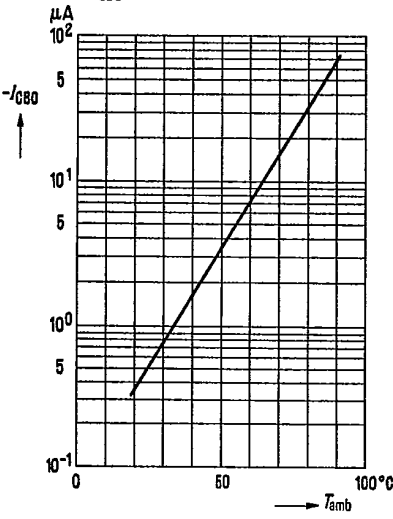
Output characteristics $I_C = f(V_{CE})$;
 I_B = parameter
 (common emitter configuration)



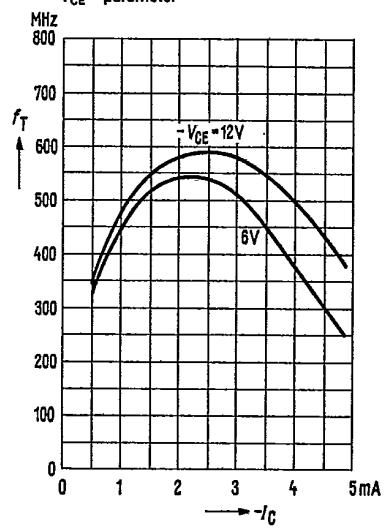
Output characteristics $I_C = f(V_{CB})$;
 I_E = parameter
 (common base configuration)



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

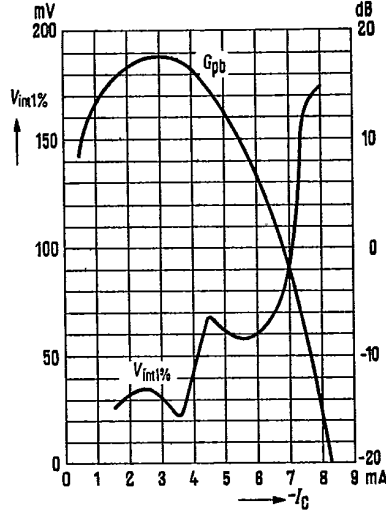


Transition frequency $f_T = f(I_C)$;
 V_{CE} = parameter

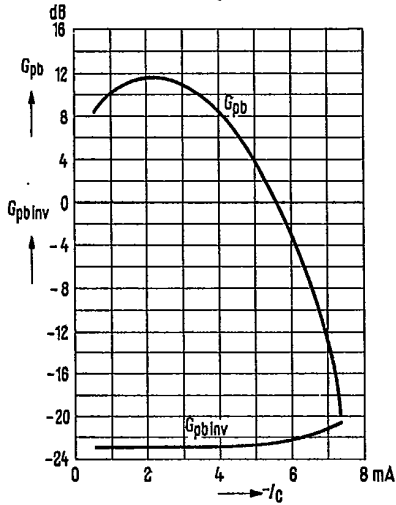


1) $V_{int 1\%}$ is the rms value of half the EMF (terminal voltage under matching condition) of a 100% sine wave modulated TV-carrier at a generator impedance of 240Ω which causes a 1% amplitude modulation on the signal carrier.

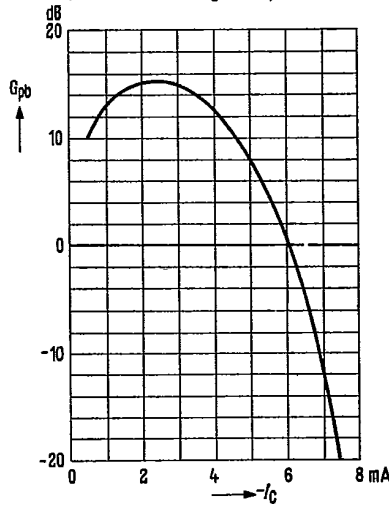
Interference voltage $V_{int 1\%} = f(I_C)$
 Power gain $G_{pb} = f(I_C)$
 $f = 200 \text{ MHz}; -V_{batt} = 12 \text{ V}; R_V = 1 \text{ k}\Omega;$
 $R_L = 0.9 \text{ k}\Omega$ (common base configuration)



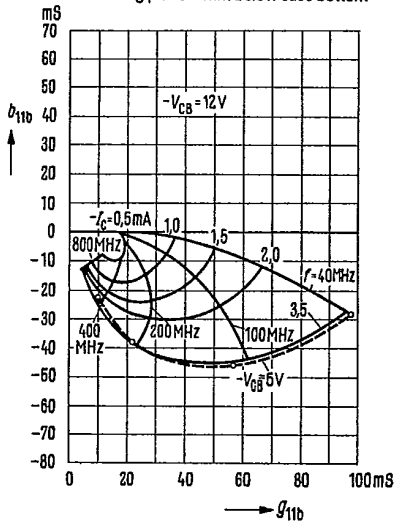
Power gain $G_{pb} = f(I_C)$
 $f = 800 \text{ MHz}; -V_{batt} = 12 \text{ V}; R_V = 1 \text{ k}\Omega$
 $R_L = 1.4 \text{ k}\Omega$
 (common base configuration)



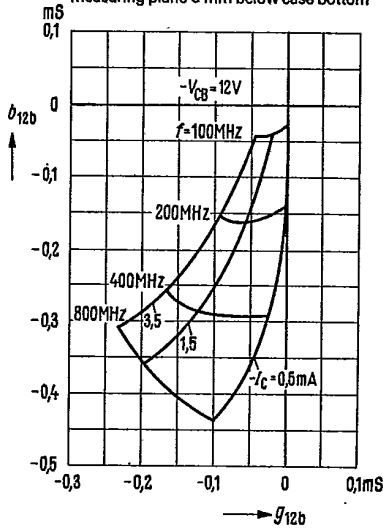
Power gain $G_{pb} = f(I_C)$
 $f = 500 \text{ MHz}; -V_{batt} = 12 \text{ V}; R_V = 1 \text{ k}\Omega$
 $R_L = 1.4 \text{ k}\Omega$
 (common base configuration)



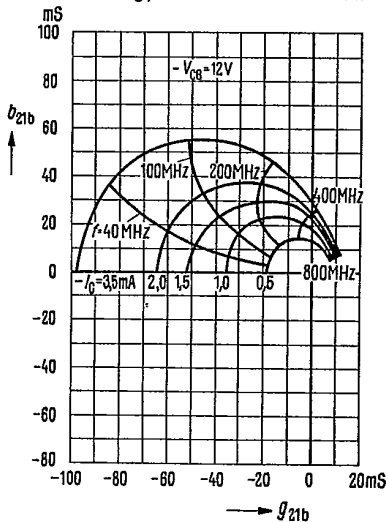
Small signal short circuit input admittance y_{11b} ; $-V_{CB} = 12V$
 (common base configuration)
 measuring plane 5 mm below case bottom



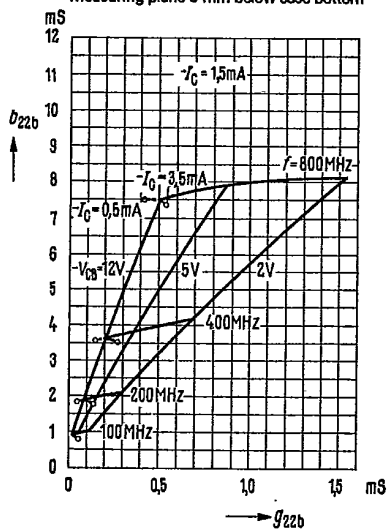
Small signal circuit reverse transfer admittance y_{12b} ; $-V_{CB} = 12V$
 (common base configuration)
 measuring plane 5 mm below case bottom



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

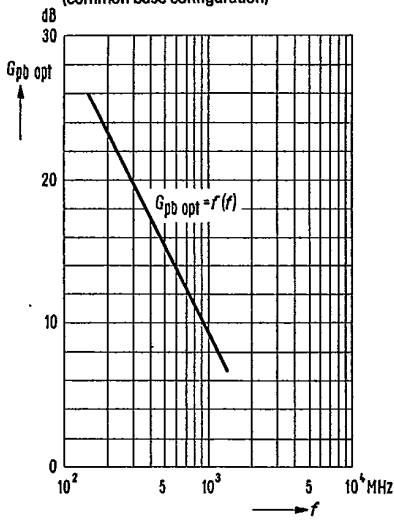


Small signal short circuit output admittance y_{22b} ; $I_E = 1.5 mA$
 (common emitter, base configuration)
 measuring plane 5 mm below case bottom

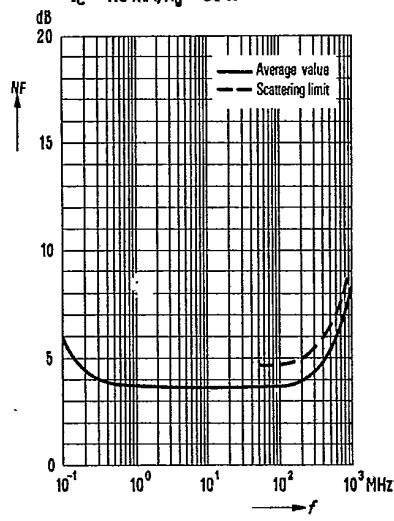


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Power gain versus frequency
 $G_{pb\text{opt}} = f(f)$; $-I_C = 1.5 \text{ mA}$; $-V_{CE} = 12 \text{ V}$
 (common base configuration)



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





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