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V.H.F. POWER TRANSISTOR

N-P-N silicon planar epitaxial transistor intended for use in class-A, B and C operated mobile, industrial and military transmitters with a nominal supply voltage of 12,5 V. The transistor is resistance stabilized and is guaranteed to withstand severe load mismatch conditions with a supply over-voltage to 16,5 V. Matched h_{FE} groups are available on request.

It has a 3/8" capstan envelope with a ceramic cap. All leads are isolated from the stud.

QUICK REFERENCE DATA

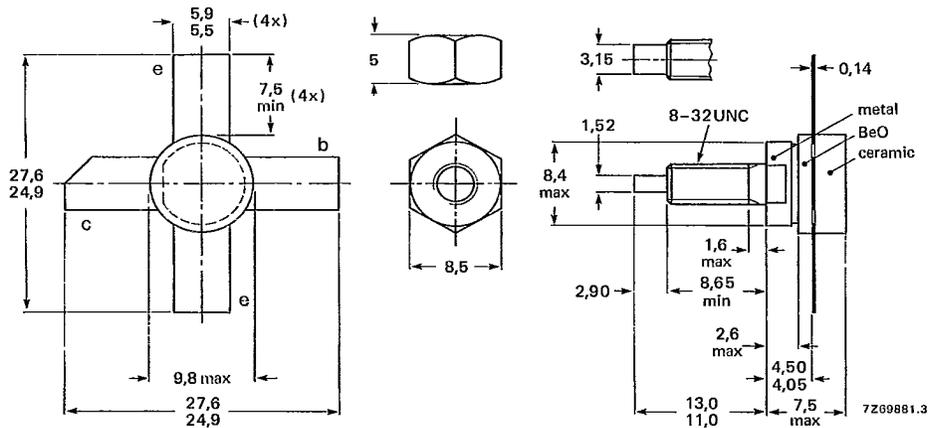
R.F. performance up to $T_h = 25\text{ }^\circ\text{C}$

| mode of operation | V_{CC} V | f MHz | P_L W | G_p dB | η % | \bar{Z}_i Ω | \bar{Z}_L Ω | d_3 dB |
|-------------------|---------------|----------|---------------|-------------|-------------|-------------------------|-------------------------|-------------|
| c.w. (class-B) | 12,5 | 175 | 45 | > 5,0 | > 75 | 1,2 + j1,4 | 2,6 - j1,2 | — |
| s.s.b. (class-AB) | 12,5 | 1,6-28 | 3-30 (P.E.P.) | typ. 19,5 | typ. 35 | — | — | typ. -33 |

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-120.



Torque on nut: min. 0,75 Nm
(7,5 kg cm)
max. 0,85 Nm
(8,5 kg cm)

Diameter of clearance hole in heatsink: max. 4,2 mm.
Mounting hole to have no burrs at either end.
De-burring must leave surface flat; do not chamfer or countersink either end of hole.

When locking is required an adhesive is preferred instead of a lock washer.

PRODUCT SAFETY This device incorporates beryllium oxide, the dust of which is toxic. The device is entirely safe provided that the BeO disc is not damaged.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-emitter voltage ($V_{BE} = 0$)
peak value

V_{CESM} max. 36 V

Collector-emitter voltage (open base)

V_{CEO} max. 16 V

Emitter-base voltage (open-collector)

V_{EBO} max. 4 V

Collector current (average)

$I_{C(AV)}$ max. 9 A

Collector current (peak value); $f > 1$ MHz

I_{CM} max. 22 A

R.F. power dissipation ($f > 1$ MHz); $T_{mb} = 25$ °C

P_{rf} max. 100 W

Storage temperature

T_{stg} -65 to + 150 °C

Operating junction temperature

T_j max. 200 °C

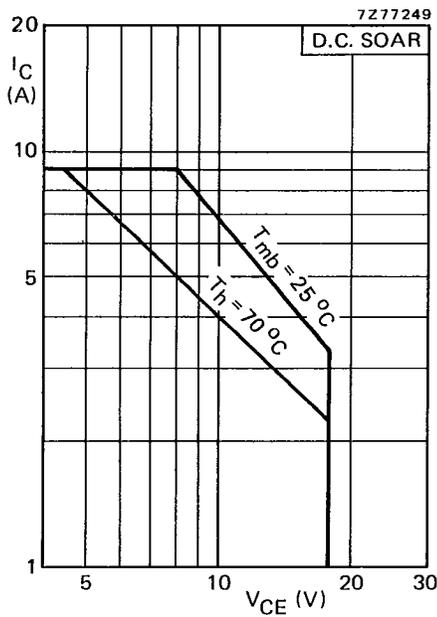


Fig. 2 D.C. SOAR.

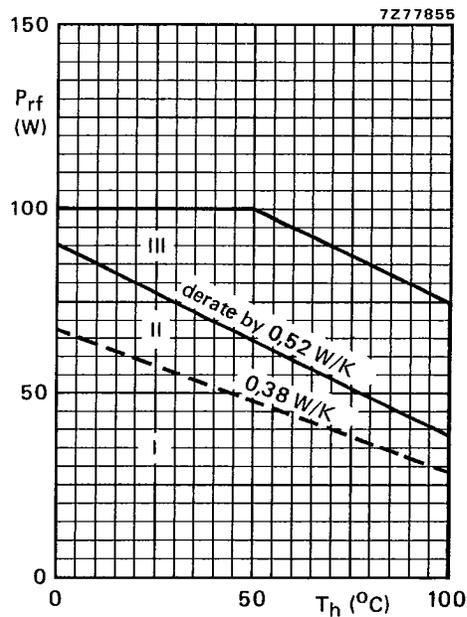


Fig. 3 R.F. power dissipation; $V_{CE} \leq 16,5$ V; $f > 1$ MHz.

- I Continuous d.c. operation
- II Continuous r.f. operation
- III Short-time operation during mismatch

THERMAL RESISTANCE (dissipation = 40 W; $T_{mb} = 88$ °C, i.e. $T_h = 70$ °C)

From junction to mounting base (d.c. dissipation)

$R_{th j-mb(dc)}$ = 2,8 K/W

From junction to mounting base (r.f. dissipation)

$R_{th j-mb(rf)}$ = 2,05 K/W

From mounting base to heatsink

$R_{th mb-h}$ = 0,45 K/W

CHARACTERISTICS $T_j = 25\text{ }^\circ\text{C}$ **Breakdown voltage**

Collector-emitter voltage

 $V_{BE} = 0; I_C = 50\text{ mA}$ $V_{(BR)CES} > 36\text{ V}$

Collector-emitter voltage

open base; $I_C = 100\text{ mA}$ $V_{(BR)CEO} > 16\text{ V}$

Emitter-base voltage

open collector; $I_E = 25\text{ mA}$ $V_{(BR)EBO} > 4\text{ V}$ **Collector cut-off current** $V_{BE} = 0; V_{CE} = 15\text{ V}$ $I_{CES} < 25\text{ mA}$ **Transient energy** $L = 25\text{ mH}; f = 50\text{ Hz}$

open base

 $-V_{BE} = 1,5\text{ V}; R_{BE} = 33\text{ }\Omega$ $E > 8\text{ ms}$ $E > 8\text{ ms}$ **D.C. current gain *** $I_C = 4\text{ A}; V_{CE} = 5\text{ V}$ h_{FE} typ 50
10 to 80**D.C. current gain ratio of matched devices *** $I_C = 4\text{ A}; V_{CE} = 5\text{ V}$ $h_{FE1}/h_{FE2} < 1,2$ **Collector-emitter saturation voltage *** $I_C = 12,5\text{ A}; I_B = 2,5\text{ A}$ V_{CEsat} typ 1,5 V**Transition frequency at $f = 100\text{ MHz}$ *** $I_C = 4\text{ A}; V_{CE} = 12,5\text{ V}$ $I_C = 12,5\text{ A}; V_{CE} = 12,5\text{ V}$ f_T typ 650 MHz f_T typ 600 MHz**Collector capacitance at $f = 1\text{ MHz}$** $I_E = I_e = 0; V_{CB} = 15\text{ V}$ C_c typ 120 pF
< 160 pF**Feedback capacitance at $f = 1\text{ MHz}$** $I_C = 200\text{ mA}; V_{CE} = 15\text{ V}$ C_{re} typ 80 pF**Collector-stud capacitance** C_{cs} typ 2 pF* Measured under pulse conditions: $t_p \leq 200\text{ }\mu\text{s}; \delta \leq 0,02$.

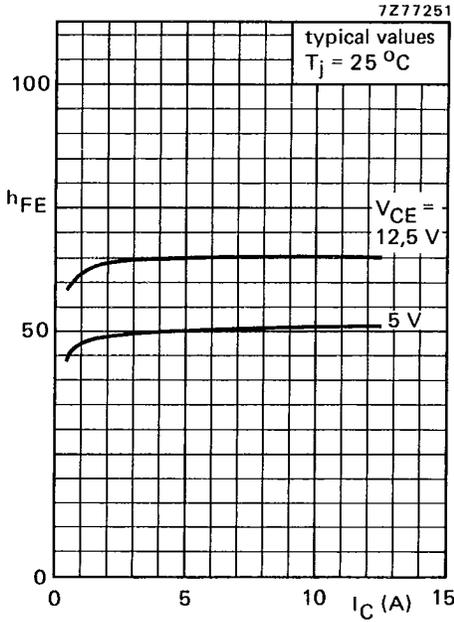


Fig.4 DC current gain as a function of collector current.

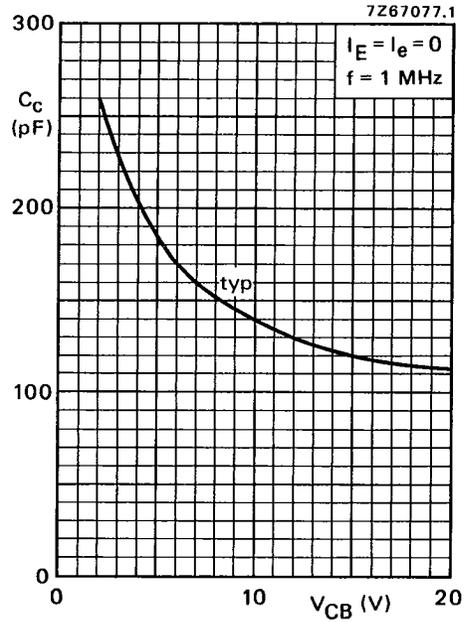


Fig.5 Collector capacitance as a function of collector-base voltage.

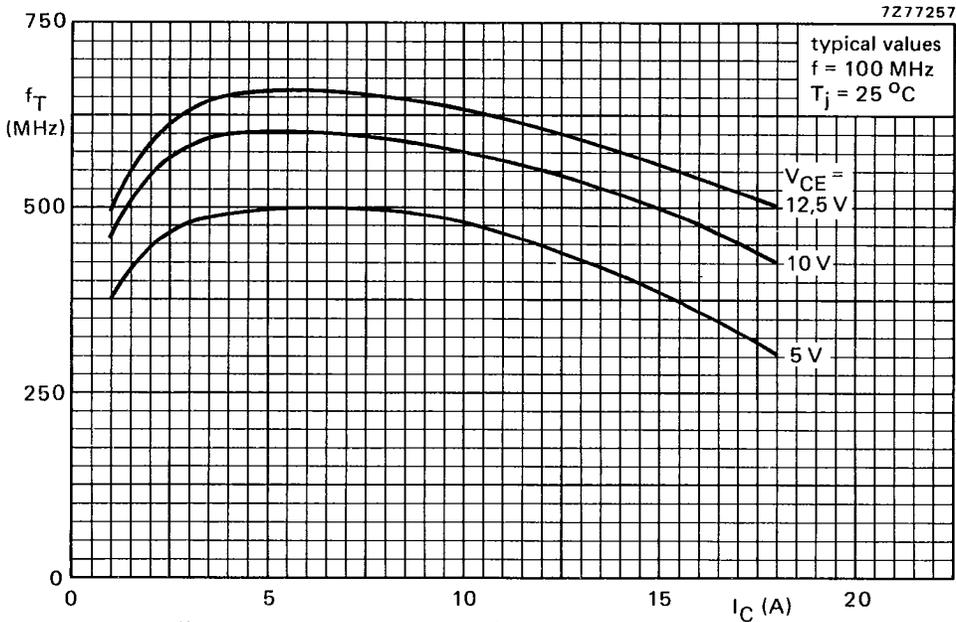


Fig.6 Transition frequency as a function of collector current.

APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralized common-emitter class-B circuit)

 $T_h = 25\text{ }^\circ\text{C}$

| f (MHz) | V _{CC} (V) | P _L (W) | P _S (W) | G _p (dB) | I _C (A) | η (%) | \bar{Z}_i (Ω) | \bar{Z}_L (Ω) |
|---------|---------------------|--------------------|--------------------|---------------------|--------------------|---------|-----------------|-----------------|
| 175 | 12,5 | 45 | < 14,2 > | 5,0 | < 4,8 > | > 75 | 1,2 + j1,4 | 2,6 - j1,2 |
| 175 | 13,5 | 45 | — | typ. 6,0 | — | typ. 75 | — | — |

Test circuit for 175 MHz

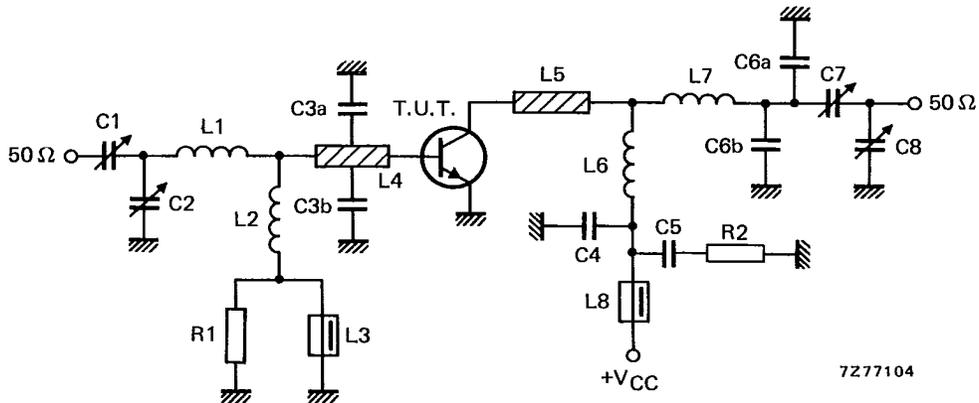


Fig. 7 Class-B test circuit at f = 175 MHz.

List of components:

C1 = 2,5 to 20 pF film dielectric trimmer (cat. no. 2222 809 07004)

C2 = C8 = 4 to 40 pF film dielectric trimmer (cat. no. 2222 809 07008)

C3a = C3b = 47 pF ceramic capacitor (500 V)

C4 = 120 pF ceramic capacitor

C5 = 100 nF polyester capacitor

C6a = C6b = 8,2 pF ceramic capacitor (500 V)

C7 = 5 to 60 pF film dielectric trimmer (cat. no. 2222 809 07011)

L1 = 1 turn Cu wire (1,6 mm); int. dia. 9,0 mm; leads 2 x 5 mm

L2 = 100 nH; 7 turns closely wound enamelled Cu wire (0,5 mm); int. dia. 3 mm; leads 2 x 5 mm

L3 = L8 = Ferroxcube wide-band h.f. choke, grade 3B (cat. no. 4312 020 36640)

L4 = L5 = strip (12 mm x 6 mm); taps for C3a and C3b at 5 mm from transistor

L6 = 2 turns enamelled Cu wire (1,6 mm); int. dia. 5,0 mm; length 6,0 mm; leads 2 x 5 mm

L7 = 2 turns enamelled Cu wire (1,6 mm); int. dia. 4,5 mm; length 6,0 mm; leads 2 x 5 mm

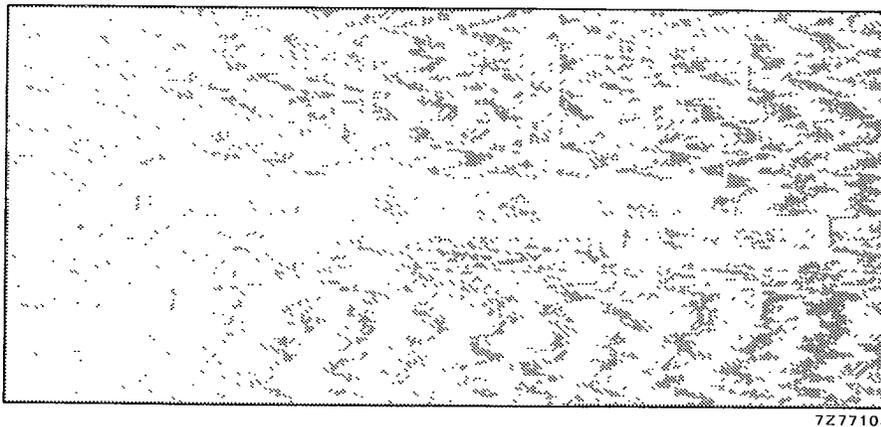
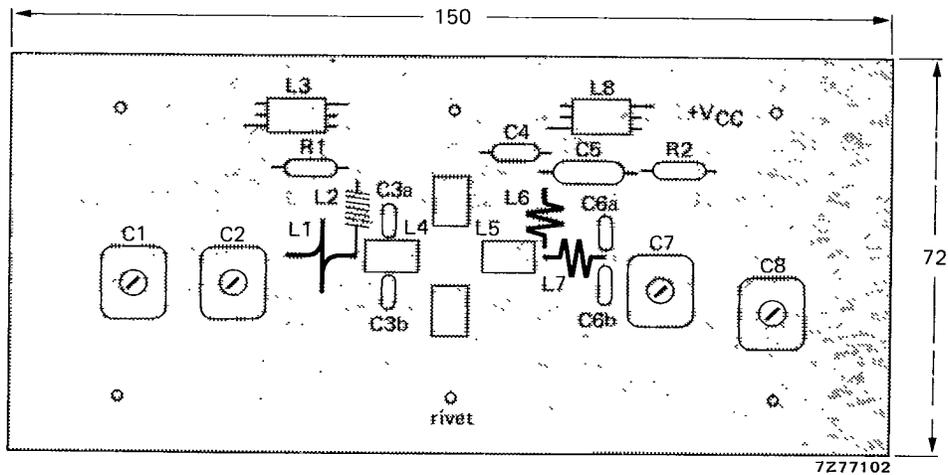
L4 and L5 are strips on a double Cu-clad printed-circuit board with epoxy fibre-glass dielectric, thickness 1/16".

R1 = 10 Ω (±10%) carbon resistor

R2 = 4,7 Ω (±5%) carbon resistor

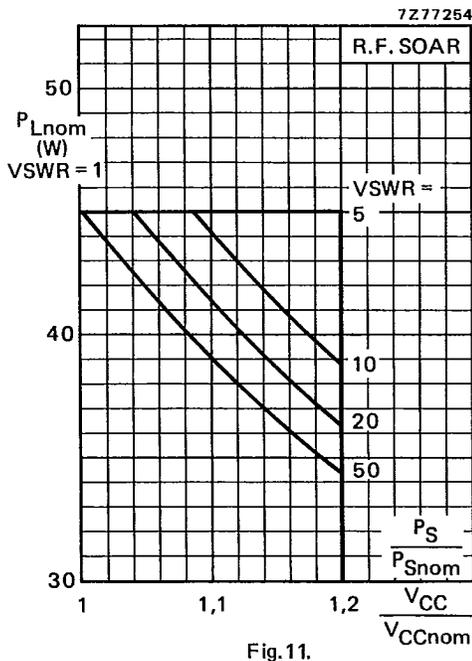
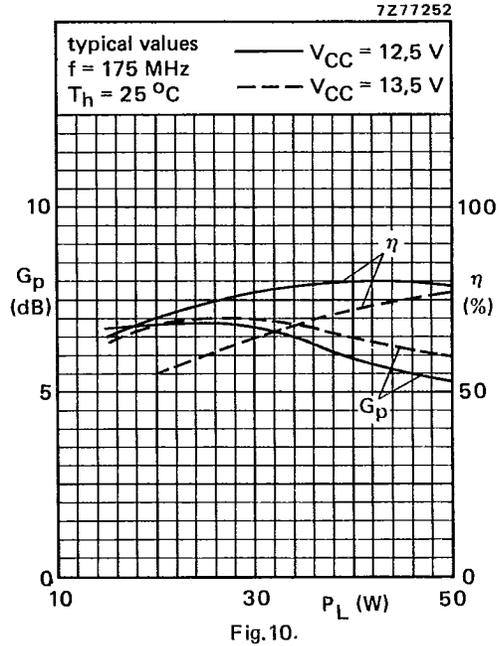
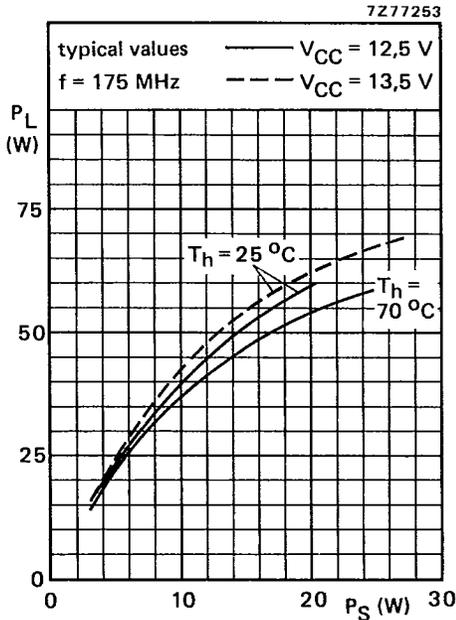
Component layout and printed-circuit board for 175 MHz test circuit on

APPLICATION INFORMATION (continued)



The circuit and the components are situated on one side of the epoxy fibre-glass board, the other side being fully metallized to serve as earth. Earth connections are made by means of hollow rivets, whilst under the emitter leads Cu straps are used for a direct contact between upper and lower sheets.

Fig.8 Component layout and printed-circuit board for 175 MHz class-B test circuit.



Conditions for R.F. SOAR

$f = 175 \text{ MHz}$
 $T_h = 70 \text{ }^\circ\text{C}$
 $R_{th \text{ mb-h}} = 0,45 \text{ K/W}$
 $V_{CCnom} = 12,5 \text{ V or } 13,5 \text{ V}$
 $P_S = P_{Snom}$ at V_{CCnom} and $V_{SWR} = 1$
 measured in circuit of Fig.7.

The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graph for safe operation at supply voltages other than the nominal. The graph shows the permissible output power under nominal conditions ($V_{SWR} = 1$), as a function of the expected supply over-voltage ratio with V_{SWR} as parameter.

The graph applies to the situation in which the drive (P_S/P_{Snom}) increases linearly with supply over-voltage ratio.

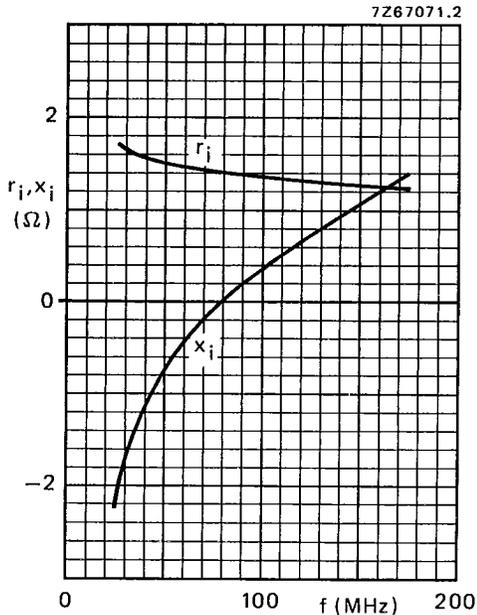


Fig. 12 Input impedance (series components).

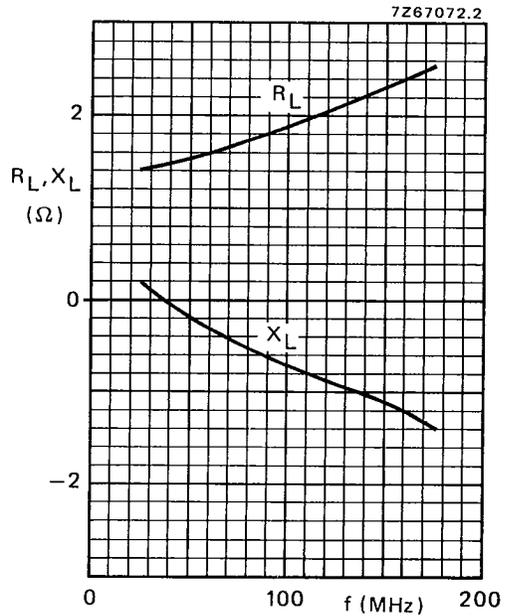


Fig. 13 Load impedance (series components).

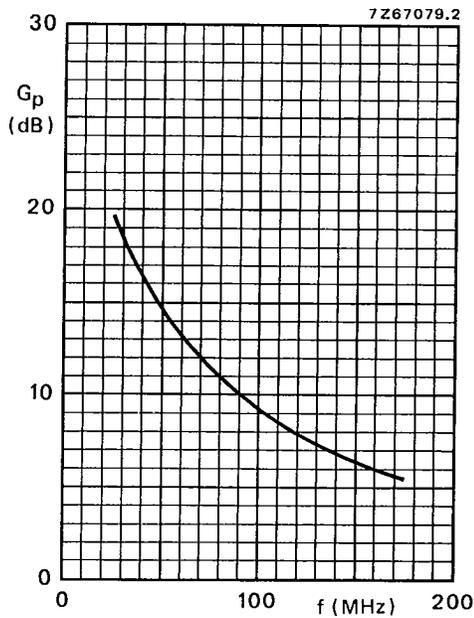


Fig. 14.

Conditions for Figs 12, 13 and 14:
Typical values; $V_{CE} = 12,5$ V; $P_L = 45$ W;
class-B operation; $T_h = 25$ °C.

APPLICATION INFORMATION (continued)

R.F. performance in s.s.b. class-AB operation

$V_{CE} = 12,5 \text{ V}$; T_h up to $25 \text{ }^\circ\text{C}$; $R_{th \text{ mb-h}} \leq 0,45 \text{ K/W}$
 $f_1 = 28,000 \text{ MHz}$; $f_2 = 28,001 \text{ MHz}$

| output power W | G_p dB | η_{dt} % | d_3 dB * | d_5 dB * | $I_{C(ZS)}$ mA |
|-------------------|-------------|------------------|---------------|---------------|-------------------|
| 3 to 30 (P.E.P.) | typ 19,5 | typ 35 | typ -33 | typ -36 | 25 |

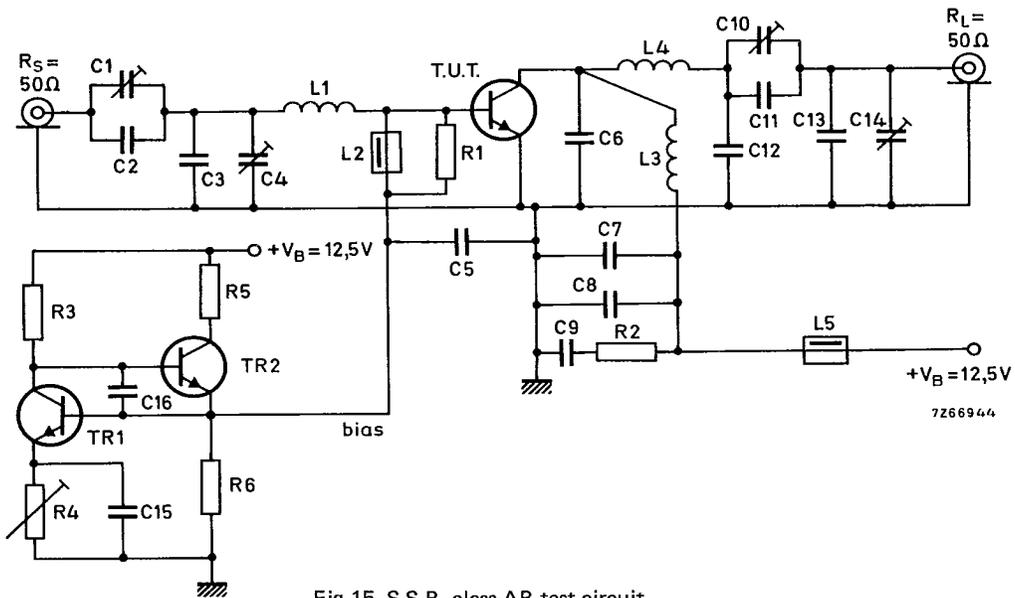


Fig.15 S.S.B. class-AB test circuit.

List of components:

TR1 = TR2 = BD137

C1 = 100 pF air dielectric trimmer (single insulated rotor type)

C2 = 27 pF ceramic capacitor

C3 = 180 pF ceramic capacitor

C4 = 100 pF air dielectric trimmer (single non-insulated rotor type)

C5 = C7 = 3,9 nF polyester capacitor

C6 = 2 x 270 pF polystyrene capacitors in parallel

C8 = C15 = C16 = 100 nF polyester capacitor

C9 = 2,2 μF moulded metallized polyester capacitor

C10 = 2 x 385 pF film dielectric trimmer

C11 = 68 pF ceramic capacitor

* Stated intermodulation distortion figures are referred to the according level of either of the equal amplified tones. Relative to the according peak envelope powers these figures should be increased by 6 dB.

APPLICATION INFORMATION (continued)

List of components (continued)

C12 = 2 x 82 pF ceramic capacitors in parallel

C13 = 47 pF ceramic capacitor

C14 = 385 pF film dielectric trimmer

L1 = 88 nH; 3 turns Cu wire (1,0 mm); int. dia. 9 mm; length 6,1 mm; leads 2 x 5 mm

L2 = L5 = Ferroxcube choke coil (cat. no. 4312 020 36640)

L3 = 68 nH; 3 turns enamelled Cu wire (1,6 mm); int. dia. 8 mm; length 8,3 mm; leads 2 x 5 mm

L4 = 96 nH; 3 turns enamelled Cu wire (1,6 mm); int. dia. 10 mm; length 7,6 mm; leads 2 x 5 mm

R1 = 27 Ω ($\pm 5\%$) carbon resistor

R2 = 4,7 Ω ($\pm 5\%$) carbon resistor

R3 = 1,5 k Ω ($\pm 5\%$) carbon resistor

R4 = 10 Ω wirewound potentiometer (3 W)

R5 = 47 Ω wirewound resistor (5,5 W)

R6 = 150 Ω ($\pm 5\%$) carbon resistor

Measuring conditions for Figs 16 and 17:

$V_{CC} = 12,5$ V

$f_1 = 28,000$ MHz

$f_2 = 28,001$ MHz

$T_h = 25$ °C

$R_{th\ mb-h} \leq 0,45$ °K/W

$I_{C(ZS)} = 25$ mA

typical values

Measuring conditions for Figs 18 and 19:

$V_{CC} = 13,5$ V

$f_1 = 28,000$ MHz

$f_2 = 28,001$ MHz

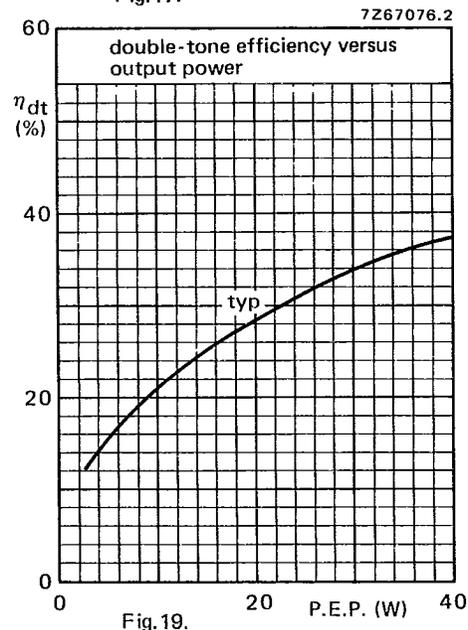
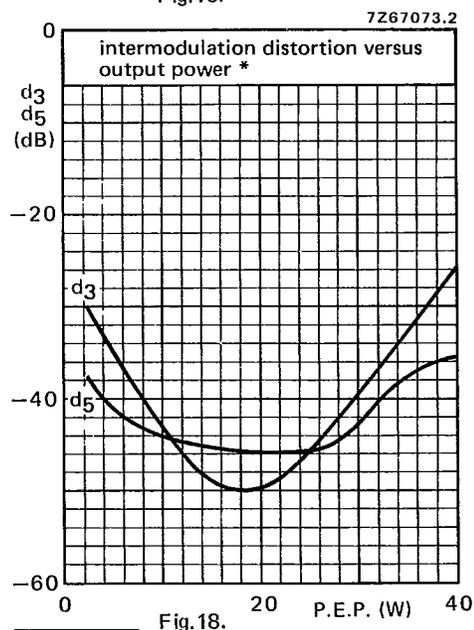
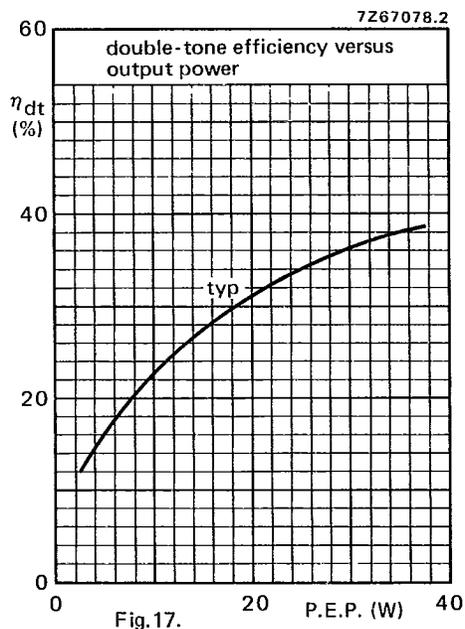
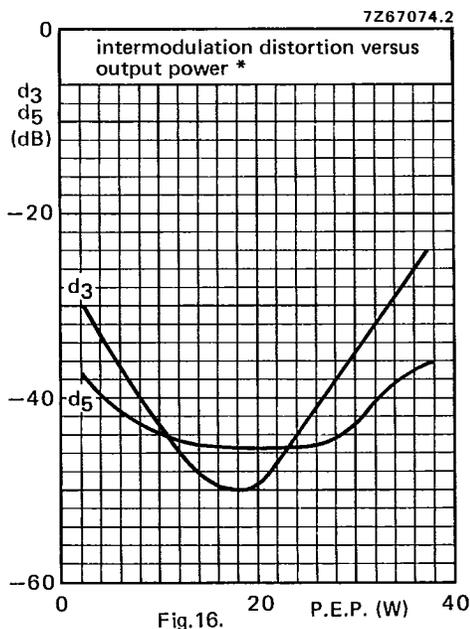
$T_h = 25$ °C

$R_{th\ mb-h} \leq 0,45$ °K/W

$I_{C(ZS)} = 25$ mA

typical values

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* Stated intermodulation distortion figures are referred to the according level of either of the equal amplified tones. Relative to the according peak envelope powers these figures should be increased by 6 dB.

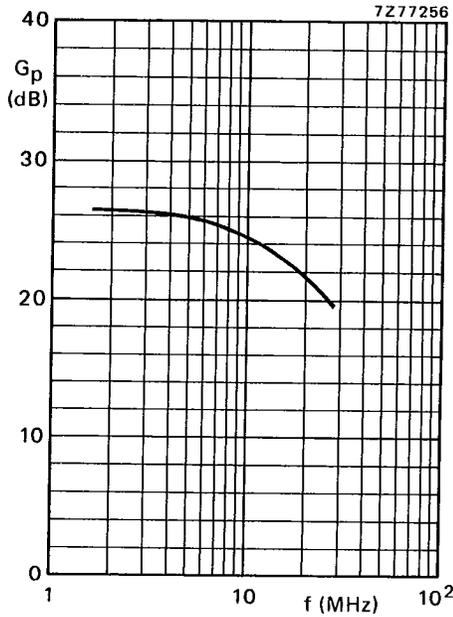


Fig.20.

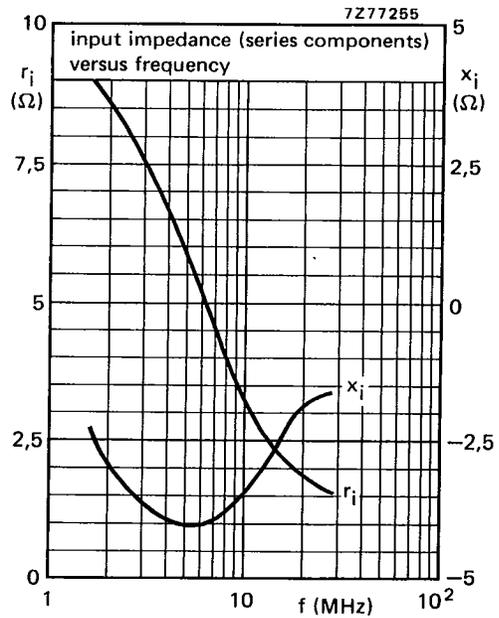


Fig.21.

S.S.B. class-AB operation

Conditions for Figs 20 and 21:

$V_{CC} = 12,5 \text{ V}$

$P_L = 30 \text{ W (P.E.P.)}$

$T_h = 25 \text{ }^\circ\text{C}$

$R_{th \text{ mb-h}} \leq 0,45 \text{ K/W}$

$I_{C(ZS)} = 25 \text{ mA}$

$Z_L = 1,9 \text{ } \Omega$

$V_{CC} = 13,5 \text{ V}$

$P_L = 35 \text{ W (P.E.P.)}$

$T_h = 25 \text{ }^\circ\text{C}$

$R_{th \text{ mb-h}} \leq 0,45 \text{ K/W}$

$I_{C(ZS)} = 25 \text{ mA}$

$Z_L = 1,9 \text{ } \Omega$

The typical curves (both conditions) hold for an unneutralized amplifier.