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H.F./V.H.F. POWER TRANSISTOR

N-P-N silicon planar epitaxial transistor intended for use in class-A, AB and B operated h.f. and v.h.f. transmitters with a nominal supply voltage of 28 V. The transistor is resistance stabilized and is guaranteed to withstand severe load mismatch conditions. Matched h_{FE} groups are available on request. It has a 3/8" flange envelope with a ceramic cap. All leads are isolated from the flange.

QUICK REFERENCE DATA

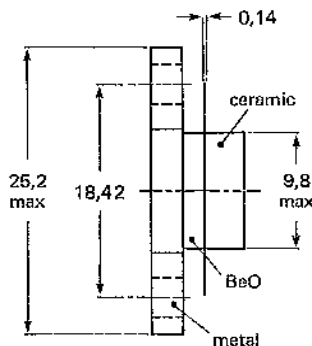
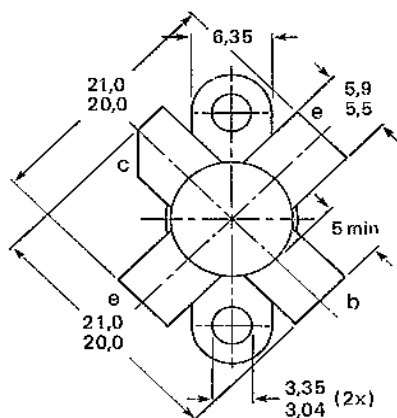
R.F. performance up to $T_H = 25^\circ\text{C}$

mode of operation	V_{CE} V	f MHz	P_L W	G_p dB	η %	Z_i Ω	$\bar{Y}_L$ mS	d_3 dB
c.w. (class-B)	28	175	45	$> 7,5$	> 70	$0,7 + j1,3$	$110 - j62$	—
s.s.b. (class-AB)	28	1,6 – 28	5–47,5 (P.E.P.)	typ. 19	typ. 45	—	—	typ. –30
s.s.b. (class-A)	26	1,6 – 28	17 (P.E.P.)	typ. 22	—	—	—	typ. –42

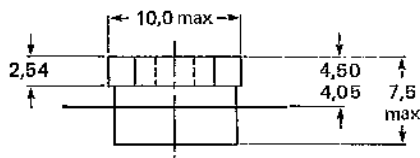
MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-123.



7277388.2



Torque on screw: min. 0,6 Nm (6 kg cm)
max. 0,75 Nm (7,5 kg cm)

Recommended screw: cheese-head
4-40 UNC/2A

Heatsink compound must be applied sparingly
and evenly distributed.

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. 65 V

Collector-emitter voltage (open base)

 V_{CEO} max. 36 V

Emitter-base voltage (open-collector)

 V_{EBO} max. 4 V

Collector current (average)

 $I_{C(AV)}$ max. 4 ACollector current (peak value); $f > 1$ MHz I_{CM} max. 12 AR.F. power dissipation ($f > 1$ MHz); $T_{mb} = 25$ °C P_{rf} max. 105 W

Storage temperature

 T_{stg} -65 to +150 °C

Operating junction temperature

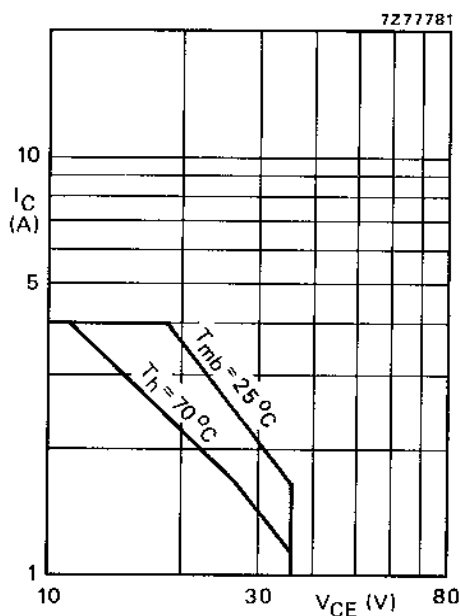
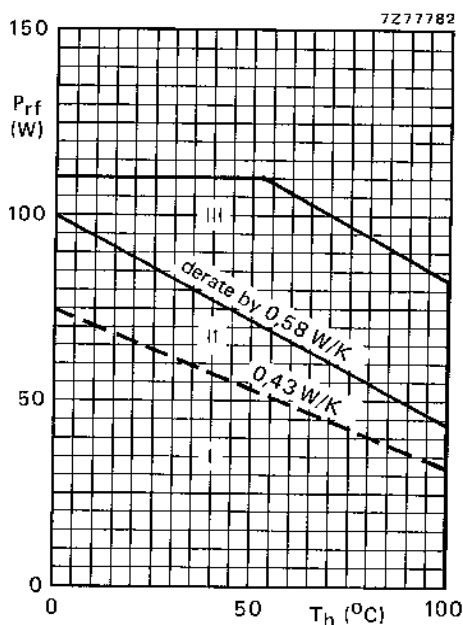
 T_j max. 200 °C

Fig. 2 D.C. SOAR.

Fig. 3 R.F. power dissipation; $V_{CE} \leq 28$ V;
 $f > 1$ MHz.

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

THERMAL RESISTANCE (dissipation = 46 W; $T_{mb} = 83,5$ °C, i.e. $T_h = 70$ °C)

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

 $R_{th j-mb(dc)}$ = 2,65 K/W

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

 $R_{th j-mb(rf)}$ = 1,95 K/W

From mounting base to heatsink

 $R_{th mb-h}$ = 0,3 K/W

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CHARACTERISTICS

 $T_j = 25^\circ\text{C}$ unless otherwise specified

Collector-emitter breakdown voltage

 $V_{BE} = 0; I_C = 25\text{ mA}$ $V_{(BR)CES} > 65\text{ V}$

Collector-emitter breakdown voltage

open base; $I_C = 100\text{ mA}$ $V_{(BR)CEO} > 36\text{ V}$

Emitter-base breakdown voltage

open collector; $I_E = 10\text{ mA}$ $V_{(BR)EBO} > 4\text{ V}$

Collector cut-off current

 $V_{BE} = 0; V_{CE} = 36\text{ V}$ $I_{CES} < 10\text{ mA}$ Second breakdown energy; $L = 25\text{ mH}; f = 50\text{ Hz}$

open base

 $ESBO > 8\text{ mJ}$ $R_{BE} = 10\ \Omega$ $ESBR > 8\text{ mJ}$

D.C. current gain*

 $I_C = 2,5\text{ A}; V_{CE} = 5\text{ V}$ h_{FE} typ. 45
10 to 80

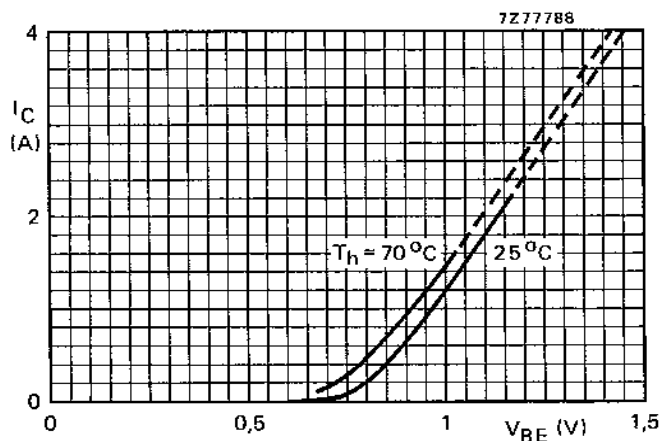
D.C. current gain ratio of matched devices*

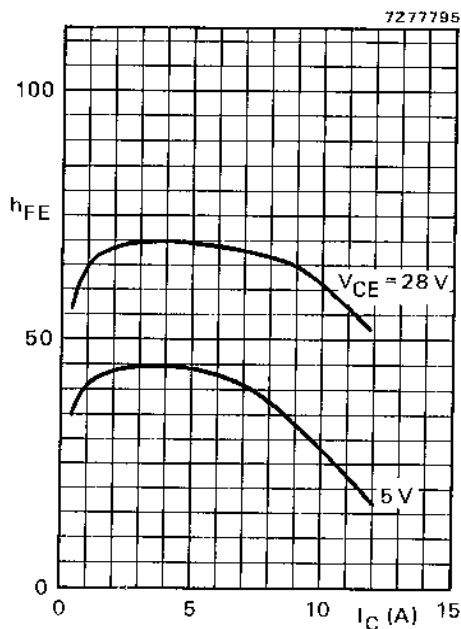
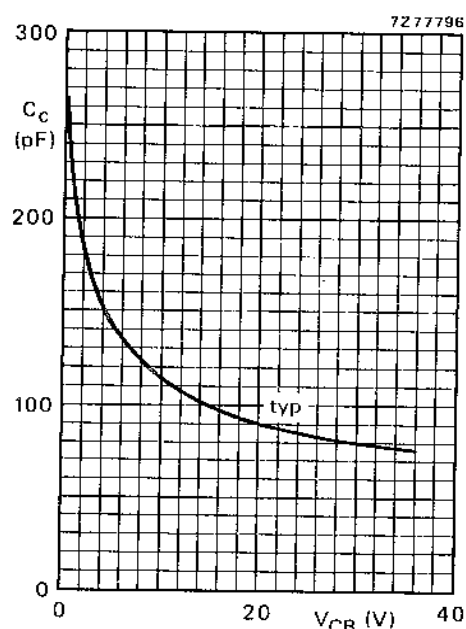
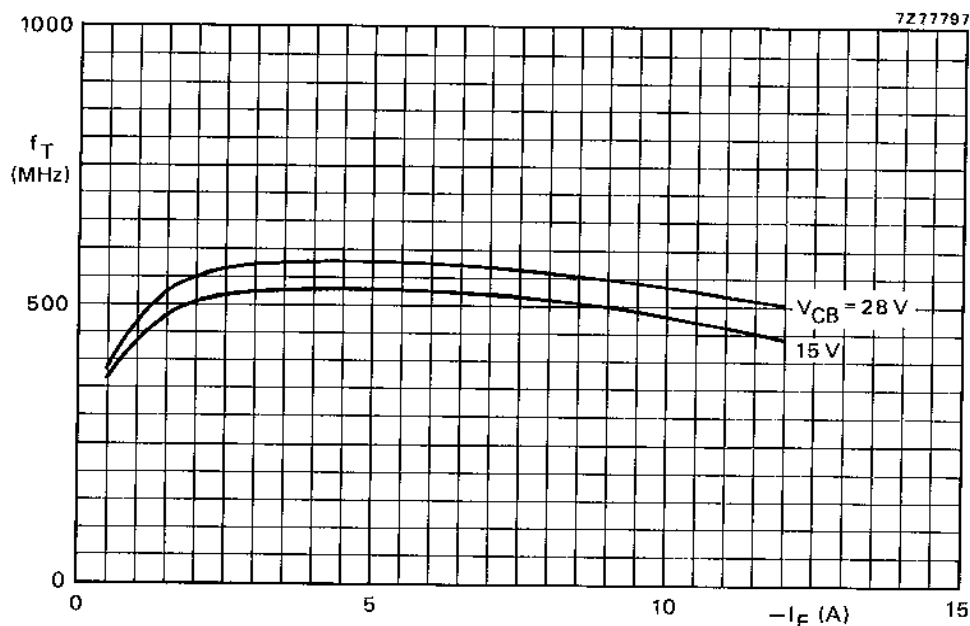
 $I_C = 2,5\text{ A}; V_{CE} = 5\text{ V}$ $h_{FE1}/h_{FE2} < 1,2$

Collector-emitter saturation voltage*

 $I_C = 7,5\text{ A}; I_B = 1,5\text{ A}$ V_{CEsat} typ. 1,5 VTransition frequency at $f = 100\text{ MHz}$ * $-I_E = 2,5\text{ A}; V_{CB} = 28\text{ V}$ f_T typ. 570 MHz $-I_E = 7,5\text{ A}; V_{CB} = 28\text{ V}$ f_T typ. 570 MHzCollector capacitance at $f = 1\text{ MHz}$ $I_E = I_C = 0; V_{CB} = 28\text{ V}$ C_c typ. 82 pFFeedback capacitance at $f = 1\text{ MHz}$ $I_C = 100\text{ mA}; V_{CE} = 28\text{ V}$ C_{re} typ. 54 pF

Collector-flange capacitance

 C_{cf} typ. 2 pFFig. 4 Typical values; $V_{CE} = 28\text{ V}$.* Measured under pulse conditions: $t_p \leq 200\ \mu\text{s}; \delta \leq 0,02$.

Fig. 5 Typical values; $T_J = 25^\circ\text{C}$.Fig. 6 $I_E = I_e = 0$; $f = 1\text{ MHz}$; $T_J = 25^\circ\text{C}$.Fig. 7 Typical values; $f = 100\text{ MHz}$; $T_J = 25^\circ\text{C}$.

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APPLICATION INFORMATION

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

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

f (MHz)	V_{CE} (V)	P_L (W)	P_S (W)	G_p (dB)	I_C (A)	η (%)	$\bar{Z}_i$ (Ω)	$\bar{Y}_L$ (mS)
175	28	45	< 8	> 7,5	< 2,47	> 70	$0,7 + j1,3$	$110 - j62$

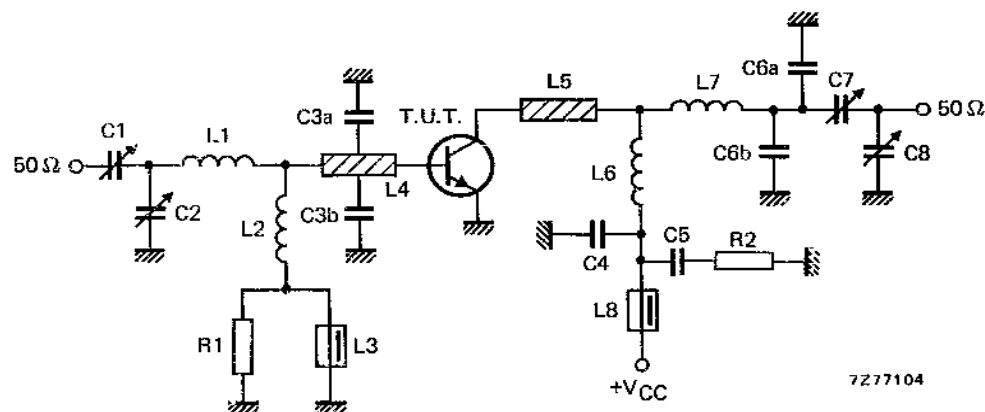


Fig. 8 Test circuit; c.w. class-B.

List of components:

C1 = C7 = 2,5 to 20 pF film dielectric trimmer (cat. no. 2222 809 07004)

C2 = 5 to 60 pF film dielectric trimmer (cat. no. 2222 809 07011)

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

C4 = 120 pF ceramic capacitor

C5 = 100 nF polyester capacitor

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

C6b = 1,8 pF ceramic capacitor (500 V)

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

L1 = 14 nH; 1 turn Cu wire (1,6 mm); int. dia. 7,7 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 = 80 nH; 3 turns Cu wire (1,6 mm); int. dia. 9,0 mm; length 8,0 mm; leads 2 x 5 mm

L7 = 62 nH; 3 turns Cu wire (1,6 mm); int. dia. 7,5 mm; length 8,1 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 = R2 = 10 Ω carbon resistor

Component layout and printed-circuit board for 175 MHz test circuit see Fig. 9.

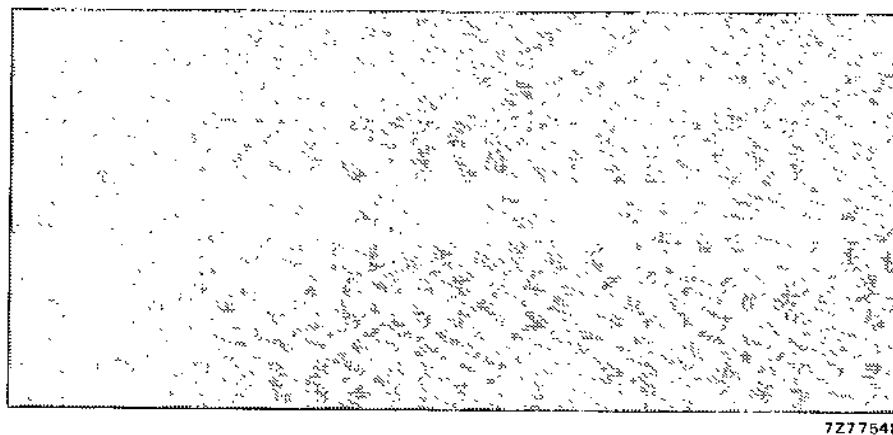
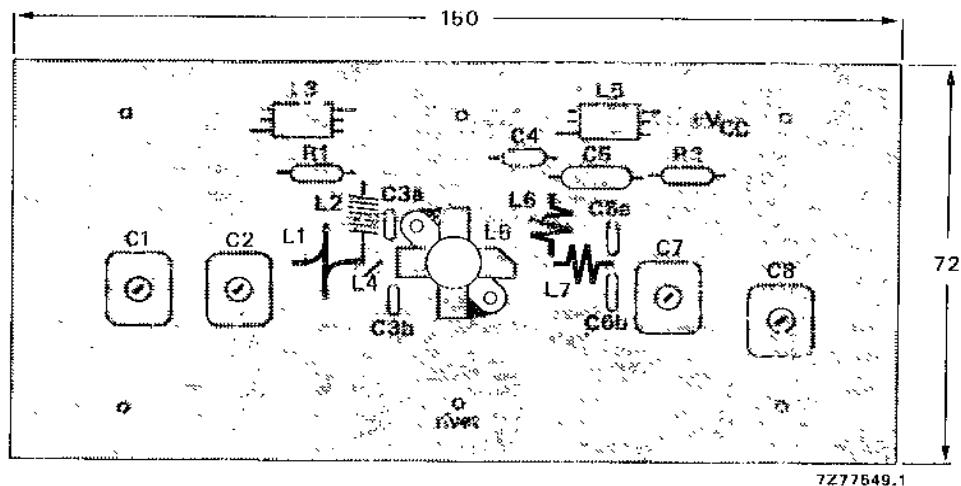


Fig. 9 Component layout and printed-circuit board for 175 MHz test circuit.

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.

To minimize the dielectric losses, the ground plane under the interconnection of L7 and C7 has been removed.

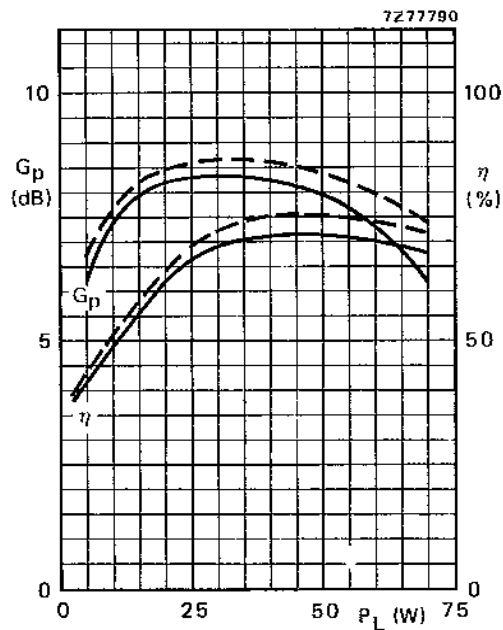
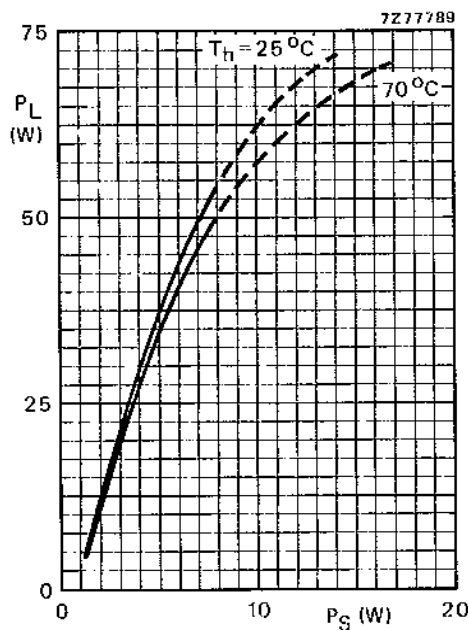


Fig. 10 Typical values; $V_{CE} = 28$ V; $f = 175$ MHz. Fig. 11 Typical values; $V_{CE} = 28$ V; $f = 175$ MHz; --- $T_h = 25^\circ\text{C}$; — $T_h = 70^\circ\text{C}$.

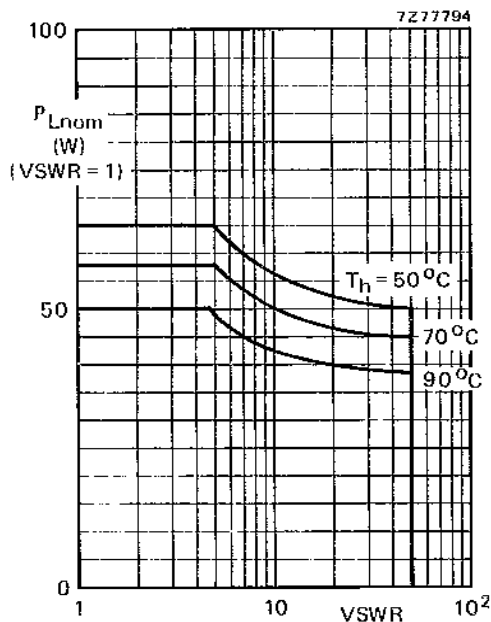


Fig. 12 R.F. SOAR; c.w. class-B operation; $f = 175$ MHz; $V_{CE} = 28$ V; $R_{th mb-h} = 0,3$ K/W. The graph shows the permissible output power under nominal conditions (VSWR = 1) as a function of the expected VSWR during short-time mismatch conditions with heatsink temperatures as parameter.

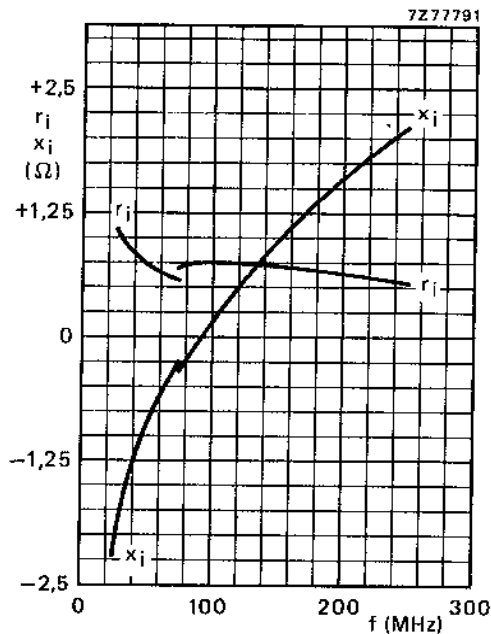


Fig. 13 Input impedance (series components).

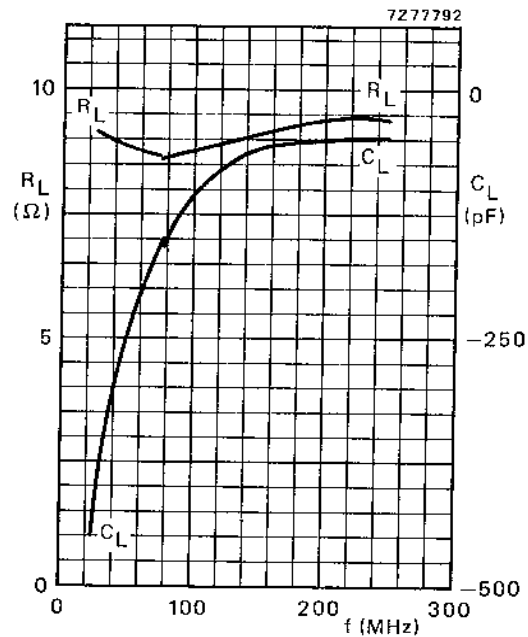


Fig. 14 Load impedance (parallel components).

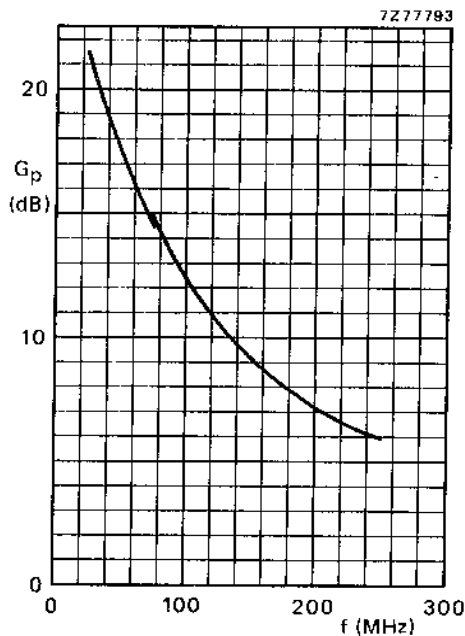


Fig. 15 Power gain versus frequency.

OPERATING NOTE

Below 75 MHz a base-emitter resistor of 10 Ω is recommended to avoid oscillation. This resistor must be effective for r.f. only.

Conditions for Figs 13; 14 and 15.

Typical values; $V_{CE} = 28$ V; $P_L = 45$ W; $T_h = 25$ °C.

R.F. performance in s.s.b. class-AB operation (linear power amplifier)

$V_{CE} = 28 \text{ V}$; $f_1 = 28,000 \text{ MHz}$; $f_2 = 28,001 \text{ MHz}$

output power W	G_p dB	η_{dt} (%) at 47,5 W (P.E.P.)	I_C (A) at 47,5 W (P.E.P.)	d_3 dB*	d_5 dB*	$I_{C(ZS)}$ mA	T_h °C
5 to 47,5 (P.E.P.)	typ. 19	typ. 45	typ. 1,9	typ. -30	< -30	50	25
5 to 42,5 (P.E.P.)	typ. 19	—	—	typ. -30	< -30	50	70

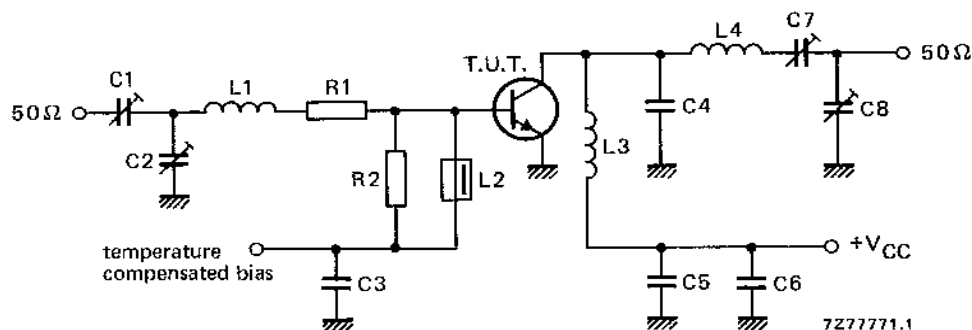


Fig. 16 Test circuit; s.s.b. class-AB.

List of components:

$C1 = C2 = 10$ to 780 pF film dielectric trimmer

$C3 = C5 = C6 = 220 \text{ nF}$ polyester capacitor

$C4 = 56 \text{ pF}$ ceramic capacitor (500 V)

$C7 = C8 = 15$ to 575 pF film dielectric trimmer

$L1 = 4$ turns closely wound enamelled Cu wire (1,6 mm); int. dia. 7,0 mm; leads $2 \times 5 \text{ mm}$

$L2 =$ Ferroxcube wide-band h.f. choke, grade 3B (cat. no. 4312 020 36640)

$L3 = 4$ turns enamelled Cu wire (1,6 mm); int. dia. 10 mm; length 9,4 mm; leads $2 \times 5 \text{ mm}$

$L4 = 7$ turns enamelled Cu wire (1,6 mm); int. dia. 12 mm; length 17,2 mm; leads $2 \times 5 \text{ mm}$

$R1 = 1,2 \Omega$; parallel connection of $4 \times 4,7 \Omega$ carbon resistors

$R2 = 39 \Omega$ carbon resistor

* 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.

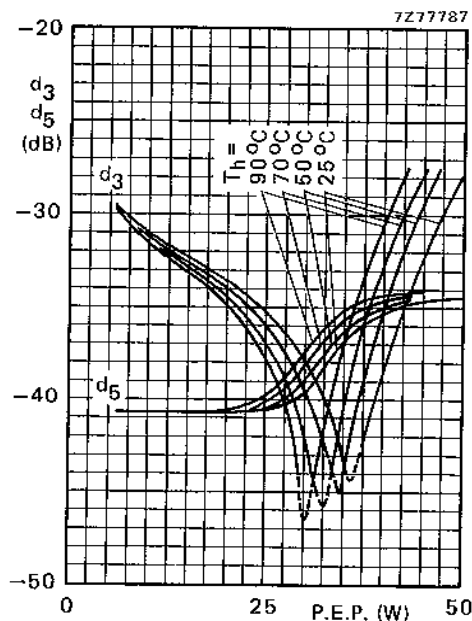


Fig. 17 Intermodulation distortion as a function of output power.*

Conditions for Fig. 17:

$V_{CE} = 28 \text{ V}$; $I_{C(ZS)} = 50 \text{ mA}$; $f_1 = 28,000 \text{ MHz}$; $f_2 = 28,001 \text{ MHz}$; typical values.

Conditions for Fig. 18:

$V_{CE} = 28 \text{ V}$; $I_{C(ZS)} = 50 \text{ mA}$; $f_1 = 28,000 \text{ MHz}$; $f_2 = 28,001 \text{ MHz}$; $T_h = 25^\circ\text{C}$; typical values.

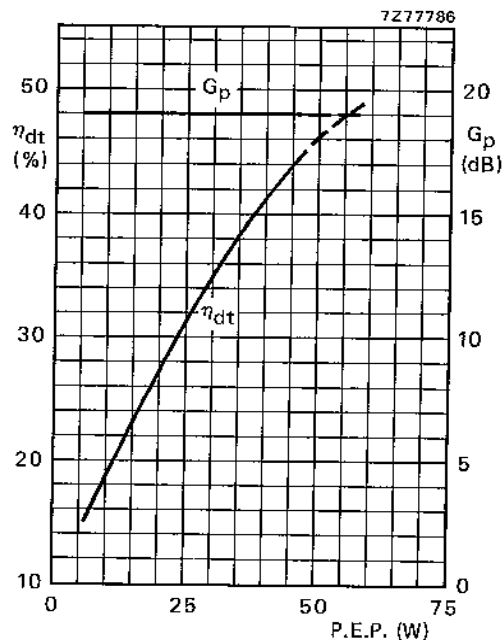


Fig. 18 Double-tone efficiency and power gain as a function of output power.

* See note on previous page.

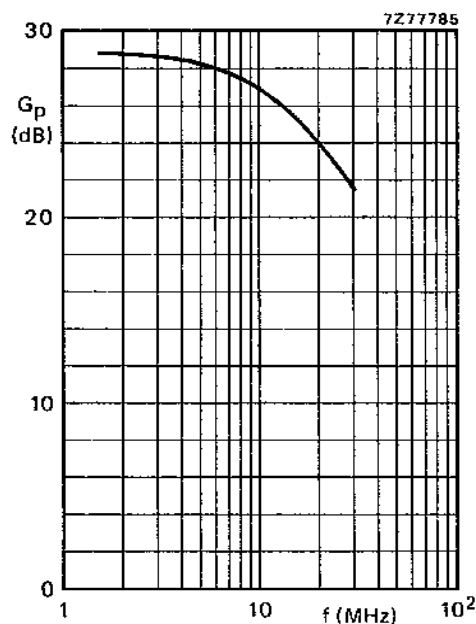


Fig. 19 Power gain as a function of frequency.

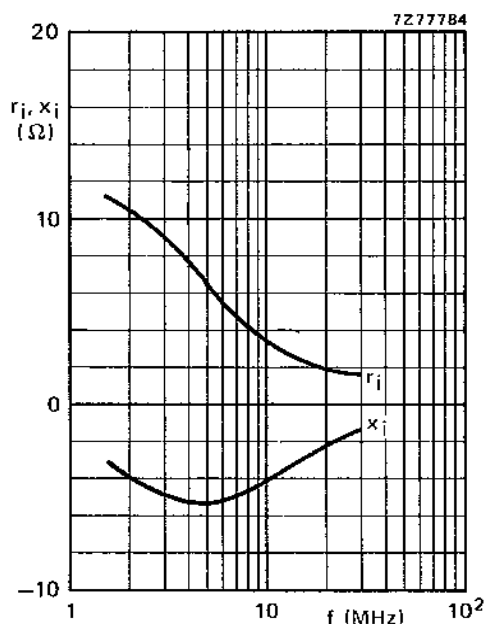


Fig. 20 Input impedance (series components) as a function of frequency.

Figs 19 and 20 are typical curves and hold for an unneutralized amplifier in s.s.b. class-AB operation.

Conditions:

$V_{CE} = 28 \text{ V}$; $I_{C(ZS)} = 50 \text{ mA}$; $P_L = 47,6 \text{ W}$; $T_h = 25 \text{ }^\circ\text{C}$; $Z_L = 6,4 \text{ } \Omega$.

Ruggedness in s.s.b. operation

The BLW86 is capable of withstanding a load mismatch ($V_{SWR} = 50$) under the following conditions: class-AB operation; $f_1 = 28,000 \text{ MHz}$; $f_2 = 28,001 \text{ MHz}$; $V_{CE} = 28 \text{ V}$; $T_h = 70 \text{ }^\circ\text{C}$ and $P_{Lnom} = 50 \text{ W P.E.P.}$

R.F. performance in s.s.b. class-A operation (linear power amplifier)

$V_{CE} = 26 \text{ V}$; $f_1 = 28,000 \text{ MHz}$; $f_2 = 28,001 \text{ MHz}$

output power W	G_p dB	I_C A	d_3 dB*	d_5 dB*	T_h °C
17 (P.E.P.)	typ. 22	1,7	typ. -40	< -40	70
17 (P.E.P.)	typ. 22	1,7	typ. -42	< -40	25

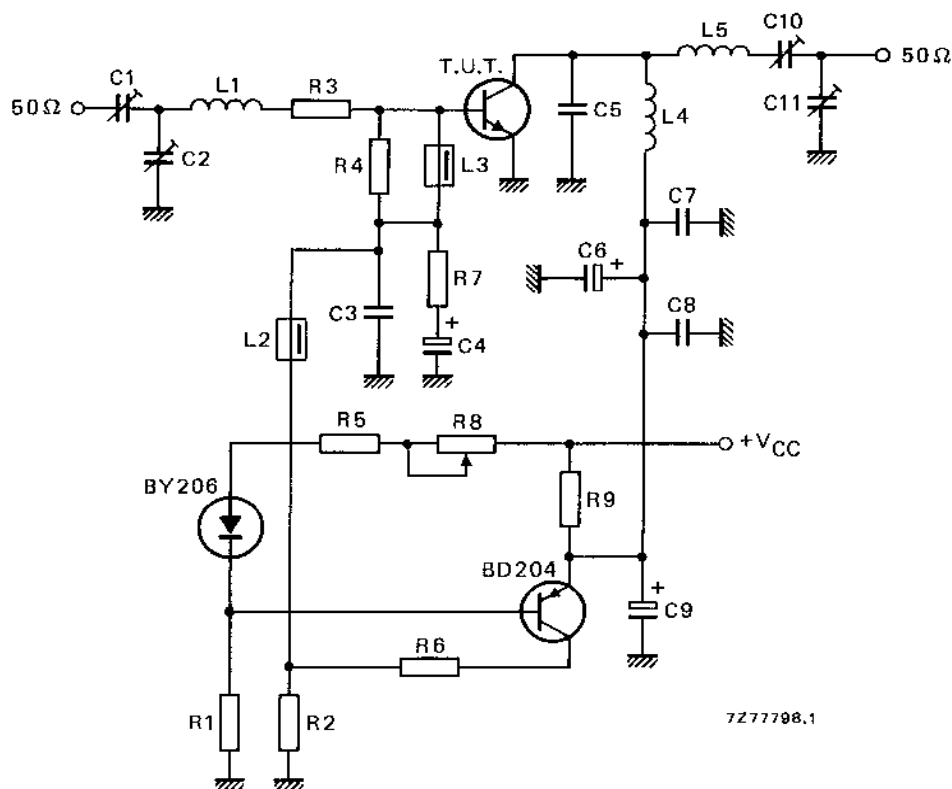


Fig. 21 Test circuit; s.s.b. class-A.

* 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.

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List of components in Fig. 21:

- C1 = C2 = 10 to 780 pF film dielectric trimmer
- C3 = 22 nF ceramic capacitor (63 V)
- C4 = 47 μ F/10 V electrolytic capacitor
- C5 = 56 pF ceramic capacitor (500 V)
- C6 = 47 μ F/35 V electrolytic capacitor
- C7 = C8 = 220 nF polyester capacitor
- C9 = 10 μ F/35 V electrolytic capacitor
- C10 = 10 to 210 pF film dielectric trimmer
- C11 = 15 to 575 pF film dielectric trimmer

L1 = 3 turns closely wound enamelled Cu wire (1,6 mm); int. dia. 9,0 mm; leads 2 x 5 mm

L2 = L3 = Ferroxcube wide-band h.f. choke, grade 3B (cat. no. 4312 020 36640)

L4 = 11 turns closely wound enamelled Cu wire (1,6 mm); int. dia. 11,0 mm

L5 = 14 turns closely wound enamelled Cu wire (1,6 mm); int. dia. 11,0 mm

R1 = 600 Ω ; parallel connection of 2 x 1,2 k Ω carbon resistors ($\pm 5\%$; 0,5 W each)

R2 = 15 Ω carbon resistor ($\pm 5\%$; 0,25 W)

R3 = 1,2 Ω ; parallel connection of 4 x 4,7 Ω carbon resistors ($\pm 5\%$; 0,125 W each)

R4 = 33 Ω carbon resistor ($\pm 5\%$; 0,25 W)

R5 = 18 Ω carbon resistor ($\pm 5\%$; 0,25 W)

R6 = 120 Ω wirewound resistor ($\pm 5\%$; 5,5 W)

R7 = 1 Ω carbon resistor ($\pm 5\%$; 0,125 W)

R8 = 47 Ω wirewound potentiometer (3 W)

R9 = 1,57 Ω ; parallel connection of 3 x 4,7 Ω wirewound resistors ($\pm 5\%$; 5,5 W each)

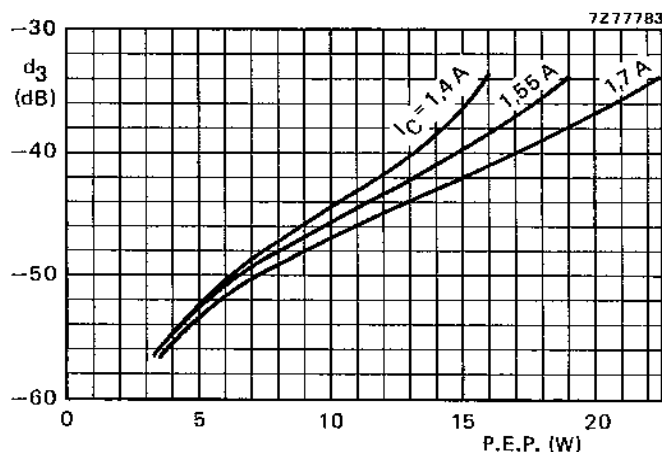


Fig. 22 Intermodulation distortion as a function of output power.
Typical values; $V_{CE} = 26$ V; $T_h = 70$ °C; $f_1 = 28,000$ MHz; $f_2 = 28,001$ MHz.