## HF/VHF power transistor

## BLW78

### DESCRIPTION

N-P-N silicon planar epitaxial transistor intended for use in class-A, AB or B operated mobile, industrial and military transmitters in the h.f. and v.h.f. bands. It is resistance stabilized and is guaranteed to withstand severe load mismatch conditions.

It has a ½" flange envelope with a ceramic cap. All leads are isolated from the flange.

### QUICK REFERENCE DATA

R.F. performance up to $T_h$ = 25 °C

| MODE OF OPERATION | $V_{CE}$ V | $I_C$ $I_{C(ZS)}$ A | f MHz | $P_L$ W | $G_p$ dB | η % | $d_3$(1) dB |
|---|---|---|---|---|---|---|---|
| **c.w. (class-B)** | **28** | – | **150** | **100** | > **6** | > **70** | – |
| s.s.b. (class-A) | 26 | 3 | 28 | 35 (P.E.P.) | typ. 19,5 | – | typ. –40 |
| s.s.b. (class-AB) | 28 | 0,05 | 28 | 100 (P.E.P.) | typ. 19,0 | typ. 42 | typ. –30 |

**Note**

1. 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.

### PIN CONFIGURATION

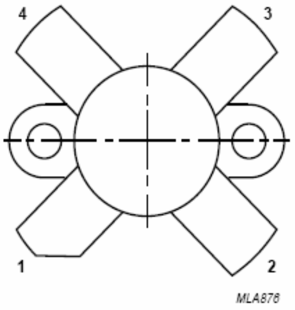


Fig.1 Simplified outline. SOT121B.

### PINNING - SOT121B.

| PIN | DESCRIPTION |
|---|---|
| 1 | collector |
| 2 | emitter |
| 3 | base |
| 4 | emitter |

**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. | 70 | V |
| Collector-emitter voltage (open base) | $V_{CEO}$ | max. | 35 | V |
| Emitter-base voltage (open collector) | $V_{EBO}$ | max. | 4 | V |
| Collector current (average) | $I_{C(AV)}$ | max. | 10 | A |
| Collector current (peak value); f > 1 MHz | $I_{CM}$ | max. | 25 | A |
| R.F. power dissipation (f > 1 MHz); $T_{mb}$ = 25 °C | $P_{rf}$ | max. | 160 | W |
| Storage temperature | $T_{stg}$ | | –65 to +150 | °C |
| Operating junction temperature | $T_j$ | max. | 200 | °C |

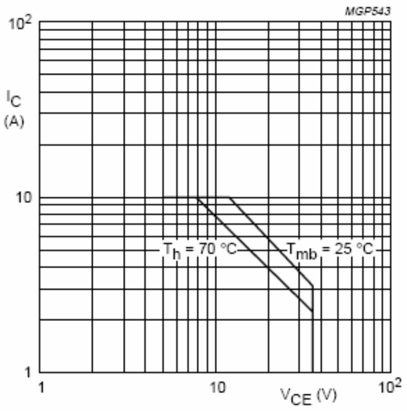
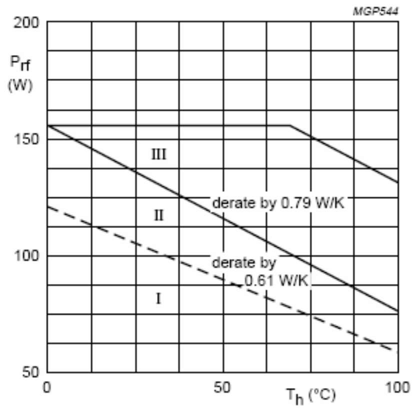


Fig.2 D.C. SOAR.



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

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

## THERMAL RESISTANCE

(dissipation = 80 W; $T_{mb}$ = 86 °C; i.e. $T_h$ = 70 °C)

| | | | | |
|---|---|---|---|---|
| From junction to mounting base (d.c. dissipation) | $R_{th\ j\text{-}mb(dc)}$ | = | 1,45 | K/W |
| From junction to mounting base (r.f. dissipation) | $R_{th\ j\text{-}mb(rf)}$ | = | 1,06 | K/W |
| From mounting base to heatsink | $R_{th\ mb\text{-}h}$ | = | 0,2 | K/W |

## CHARACTERISTICS

$T_j = 25\ °C$

| | | | | |
|---|---|---|---|---|
| Collector-emitter breakdown voltage | | | | |
| $V_{BE} = 0$; $I_C = 50$ mA | $V_{(BR)CES}$ | > | 70 | V |
| Collector-emitter breakdown voltage | | | | |
| open base; $I_C = 100$ mA | $V_{(BR)CEO}$ | > | 35 | V |
| Emitter-base breakdown voltage | | | | |
| open collector; $I_E = 5$ mA | $V_{(BR)EBO}$ | > | 4 | V |
| Collector cut-off current | | | | |
| $V_{BE} = 0$; $V_{CE} = 35$ V | $I_{CES}$ | < | 5 | mA |
| D.C. current gain(1) | | | | |
| $I_C = 5$ A; $V_{CE} = 5$ V | $h_{FE}$ | 20 to 85 | | |
| Collector-emitter saturation voltage | | | | |
| $I_C = 15$ A; $I_B = 3$ A | $V_{CEsat}$ | typ. | 2 | V |
| Transition frequency at f = 100 MHz(2) | | | | |
| $-I_E = 5$ A; $V_{CB} = 28$ V | $f_T$ | typ. | 370 | MHz |
| $-I_E = 15$ A; $V_{CB} = 28$ V | $f_T$ | typ. | 350 | MHz |
| Collector capacitance at f = 1 MHz | | | | |
| $I_E = I_e = 0$; $V_{CB} = 28$ V | $C_c$ | typ. | 155 | pF |
| Feedback capacitance at f = 1 MHz | | | | |
| $I_C = 100$ mA; $V_{CE} = 28$ V | $C_{re}$ | typ. | 102 | pF |
| Collector-flange capacitance | $C_{cf}$ | typ. | 3 | pF |

**Notes**

1. Measured under pulse conditions: $t_p \leq 300\ \mu s$; $\delta \leq 0{,}02$.
2. Measured under pulse conditions: $t_p \leq 50\ \mu s$; $\delta \leq 0{,}01$.

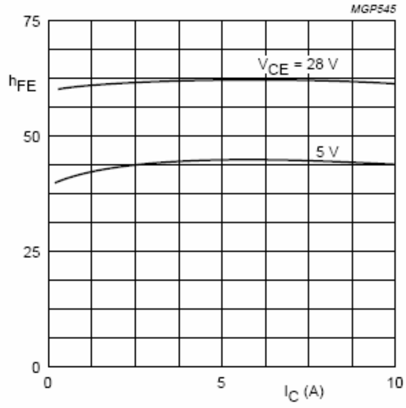


Fig.4 Typical values; $T_j$ = 25 °C.

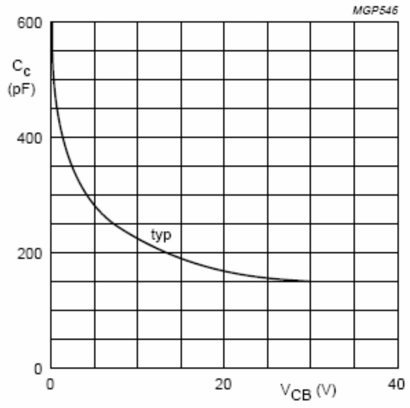


Fig.5 $I_E$ = $I_e$ = 0; f = 1 MHz; $T_j$ = 25 °C.

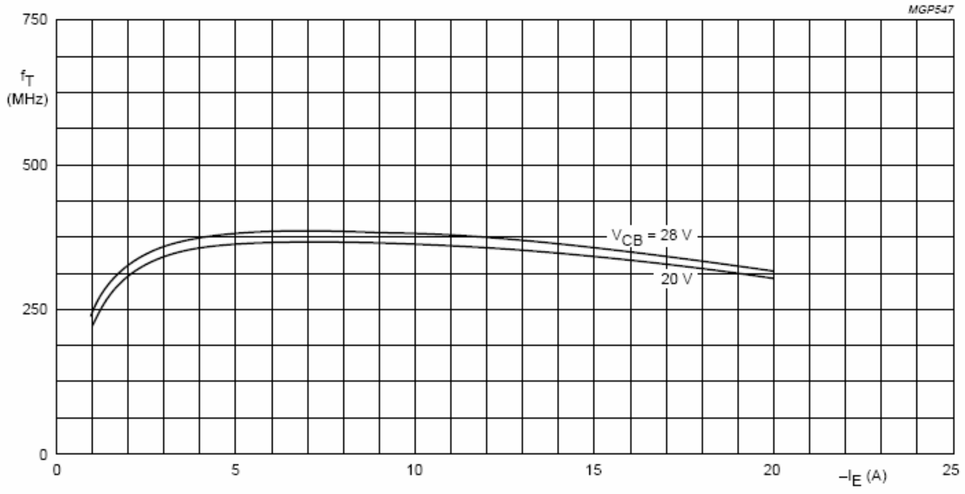


Fig.6 Typical values; f = 100 MHz; $T_j$ = 25 °C.

## APPLICATION INFORMATION

R.F. performance in c.w. operation (unneutralized common-emitter class-B circuit); $T_h$ = 25 °C

| f (MHz) | $V_{CE}$ (V) | $P_L$ (W) | $P_D$ (W) | η (%) | $\overline{Z}_i$ (Ω) | $\overline{Z}_L$ (Ω) |
|---|---|---|---|---|---|---|
| 150 | 28 | 100 | ≤ 25 | ≥ 70 | 0,74 + j1,35 | 4,30 + j0,60 |

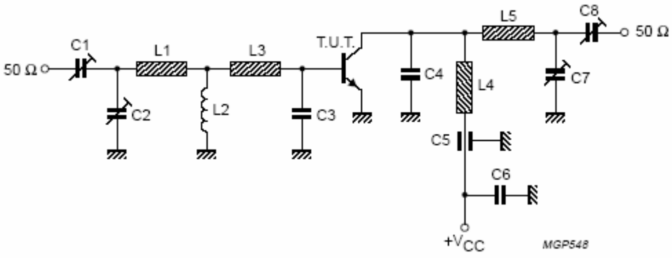


Fig.7 Test circuit; c.w. class-B; f = 150 MHz.

List of components:

C1 = C2 = C7 = C8 = 5 to 100 pF film dielectric trimmer

C3 = 203 pF; 2 × 82 pF and 39 pF multilayer ceramic chip capacitors (500 V, ATC[1]) in parallel

C4 = 39 pF multilayer ceramic chip capacitor (500 V, ATC[1])

C5 = 1 nF feed-through capacitor

C6 = 100 nF polyester capacitor

L1 = strip (30 mm × 8 mm); bent to form inverted ‘U’ shape with top 15 mm above heatsink, and bottom 5 mm above heatsink

L2 = 1 µH r.f. choke

L3 = strip; shape as shown in Fig.8; 5 mm above heatsink

L4 = strip (40 mm × 8 mm); bent in form _|‾‾ , 25 mm at 15 mm above heatsink, 5 mm at 5 mm above heatsink

L5 = strip (75 mm long; width 8 mm); 5 mm above base

L1, L3, L4, and L5 are copper strips with a thickness of 0,6 mm.

Heatsink: aluminium; 0,9 K/W

At $P_L$ = 100 W and $V_{CE}$ = 28 V, the output power at heatsink temperatures between 25 °C and 90 °C relative to that at 25 °C is diminished by typ. 0,12 W/K.

Component layout on an aluminium heatsink for 150 MHz test circuit is shown in Fig.8.

**Note**

1. ATC means American Technical Ceramics.

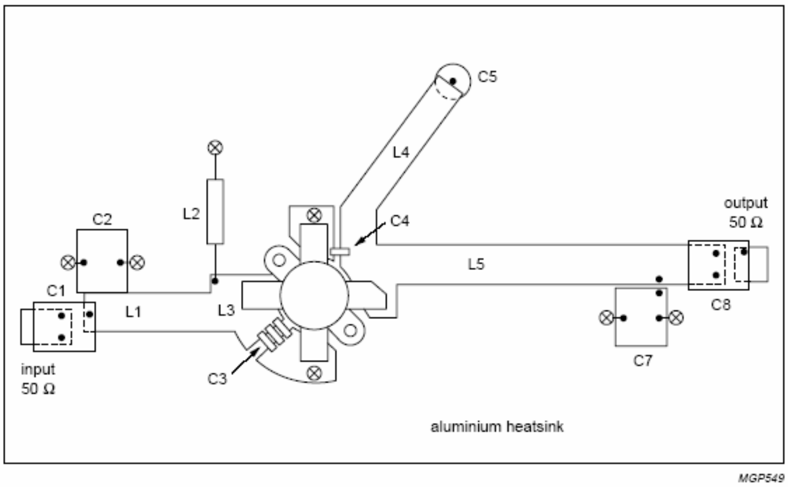


Fig.8 Component layout on an aluminium heatsink for 150 MHz test circuit. ⊗ Earthing bolts.

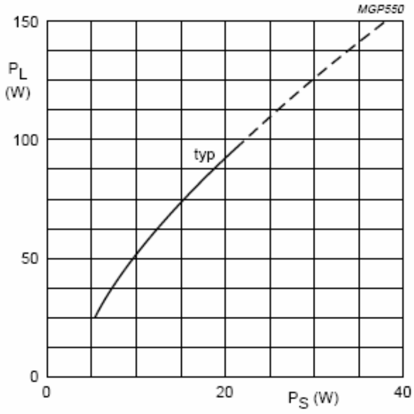


Fig.9 $V_{CE}$ = 28 V; f = 150 MHz; $T_h$ = 25 °C.

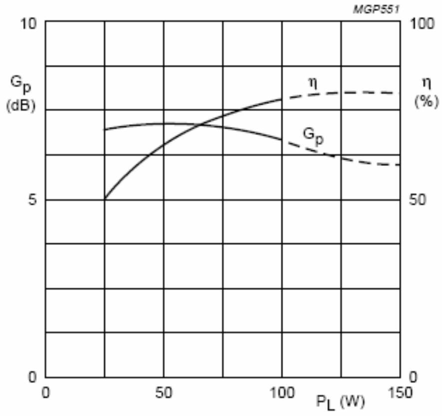
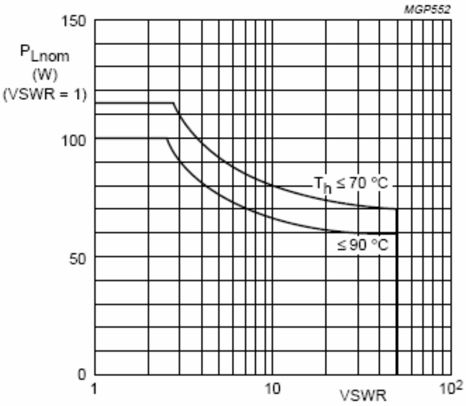


Fig.10 $V_{CE}$ = 28 V; f = 150 MHz; $T_h$ = 25 °C; typical values.

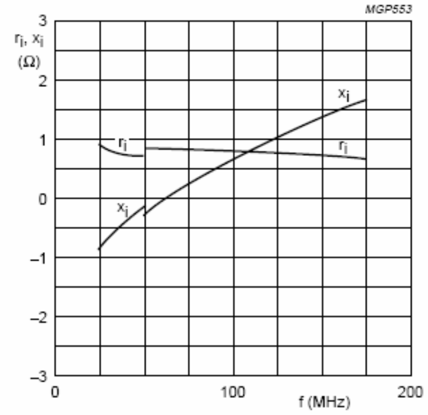


The graph shows the permissible output power under nominal conditions (VSWR = 1) as a function of the expected VSWR during short-time mismatch conditions with heatsink temperatures as parameter.

Fig.11 R.F. SOAR; c.w. class-B operation; f = 150 MHz; $V_{CE}$ = 28 V; $R_{th\ mb\text{-}h}$ = 0,2 K/W.

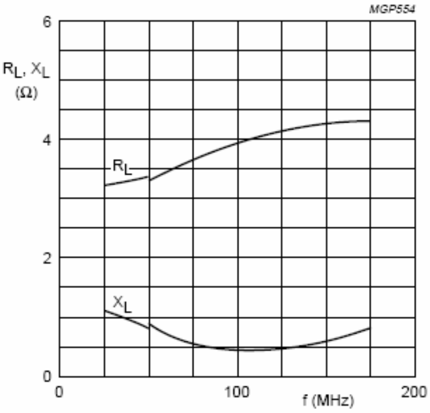
## OPERATING NOTE

Below 50 MHz a base-emitter resistor of 4,7 Ω is recommended to avoid oscillation. This resistor must be effective for r.f. only.



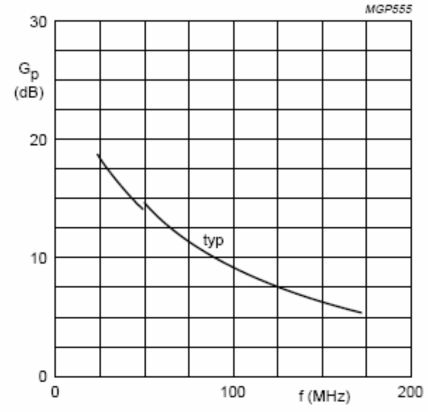
$V_{CE}$ = 28 V; $P_L$ = 100 W; $T_h$ = 25 °C;
typical values; class-B operation.

Fig.12 Input impedance (series components).



$V_{CE}$ = 28 V; $P_L$ = 100 W; $T_h$ = 25 °C;
typical values; class-B operation.

Fig.13 Load impedance (series components).



$V_{CE}$ = 28 V; $P_L$ = 100 W; $T_h$ = 25 °C;
typical values; class-B operation.

Fig.14

R.F. performance in s.s.b. class-A operation
$V_{CE}$ = 26 V; $T_h$ = 40 °C; $f_1$ = 28,000 MHz; $f_2$ = 28,001 MHz

| OUTPUT POWER W | $G_p$ dB | $I_C$ A | $d_3$ dB |
|---|---|---|---|
| 35 (P.E.P.) | typ. 19,5 | 3 | typ. –40 |

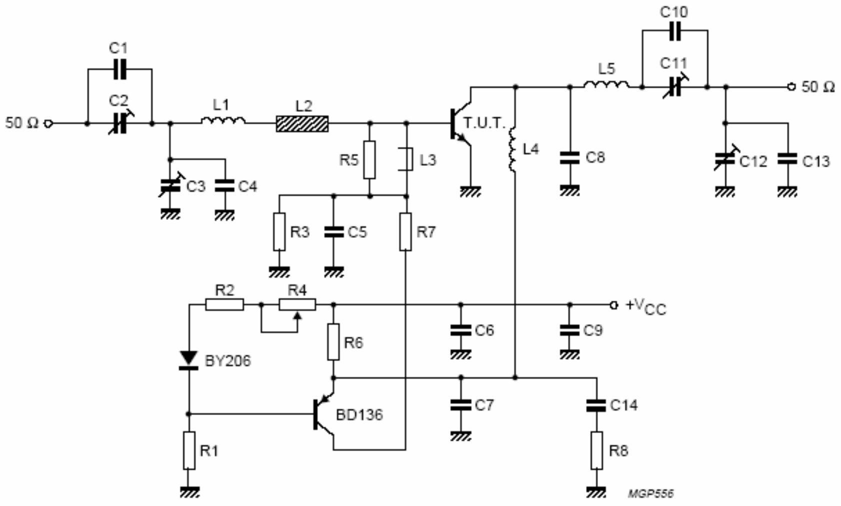


Fig.15 Test circuit; s.s.b. class-A; f = 28 MHz.

List of components:

C1 = 33 pF ceramic capacitor (500 V)
C2 = 100 pF air dielectric trimmer (single insulated rotor type)
C3 = 280 pF air dielectric trimmer (single non-insulated rotor type)
C4 = 180 pF polystyrene capacitor
C5 = C6 = C7 = 3,9 nF ceramic capacitor
C8 = 2 × 33 pF ceramic capacitors in parallel (500 V)
C9 = 330 nF polyester capacitor
C10 = 82 pF ceramic capacitor (500 V)
C11 = 100 pF air dielectric trimmer (single insulated rotor type)
C12 = 180 pF air dielectric trimmer (single non-insulated rotor type)
C13 = 150 pF polystyrene capacitor
C14 = 390 nF polyester capacitor
L1 = 72 nH; 3 turns Cu wire (1,0 mm); int. dia. 7 mm; length 4,8 mm; leads 2 × 5 mm
L2 = Cu strip (28 mm × 5 mm × 0,2 mm); 18 mm at 3 mm above printed-circuit board
L3 = Ferroxcube choke coil (cat. no. 4312 020 36640)
L4 = 300 nH; 6 turns Cu wire (1,5 mm); int. dia. 12 mm; length 16 mm; leads 2 × 5 mm
L5 = 330 nH; 7 turns Cu wire (1,5 mm); int. dia. 12 mm; length 20,8 mm; leads 2 × 5 mm
R1 = 1,5 kΩ (± 5%) carbon resistor (0,5 W)
R2 = 100 Ω (± 5%) carbon resistor (0,5 W)
R3 = 68 Ω (± 5%) carbon resistor (0,5 W)
R4 = 100 Ω wirewound potentiometer
R5 = 33 Ω (± 5%) carbon resistor (0,5 W)
R6 = 0,68 Ω (± 10%) wirewound resistor (7 W)
R7 = 120 Ω wirewound resistor (8 W)
R8 = 10 Ω (± 10%) carbon resistor (0,5 W)

R.F. performance in s.s.b. class-AB operation (linear power amplifier)
$V_{CE}$ = 28 V; $T_h$ = 25 °C; $f_1$ = 28,000 MHz; $f_2$ = 28,001 MHz

| OUTPUT POWER W | $G_p$ dB | $\eta_{dt}$ % | $I_C$ A | $d_3$(1) dB | $d_5$(1) dB | $I_{C(ZS)}$ mA |
|---|---|---|---|---|---|---|
| 100 (P.E.P.) | typ. 19 | typ. 42 | typ. 4,3 | typ. –30 | typ. –37 | 50 |

**Note**

1. 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.

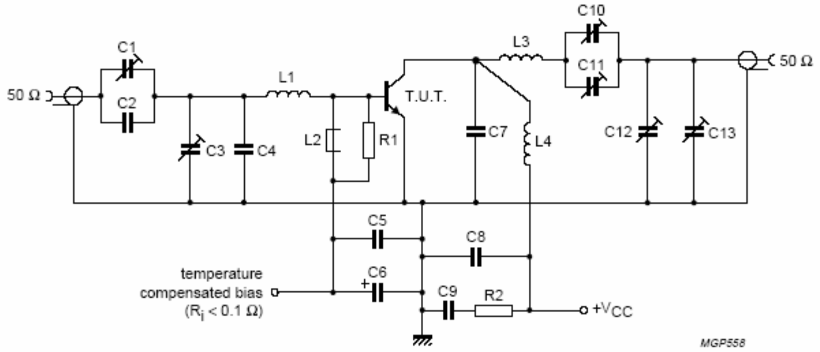
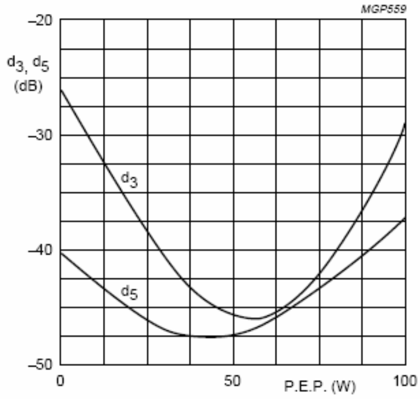


Fig.17 Test circuit; s.s.b. class-AB; f = 28 MHz.

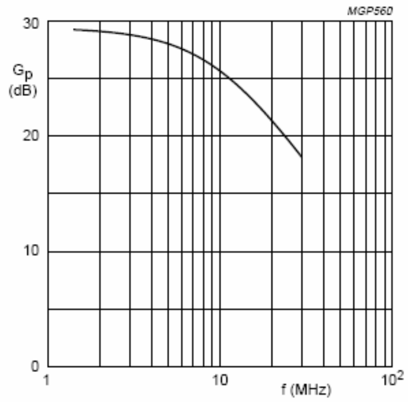
List of components:

C1 = C11 = 150 pF air dielectric trimmer (single insulated rotor type)
C2 = 27 pF ceramic capacitor (500 V)
C3 = C12 = 150 pF air dielectric trimmer (single non-insulated rotor type)
C4 = 180 pF ceramic capacitor (500 V)
C5 = C8 = 3,9 nF ceramic capacitor
C6 = 150 μF/6 V solid tantalum capacitor
C7 = 150 pF ceramic capacitor (500 V)
C9 = 100 nF polyester capacitor
C10 = 750 pF mica dielectric trimmer (single insulated rotor type)
C13 = 750 pF mica dielectric trimmer (single non-insulated rotor type)
L1 = 3 turns enamelled Cu wire (1,0 mm); int. dia. 12 mm; length 12 mm
L2 = Ferroxcube wide-band h.f. choke, grade 3B (cat. no. 4312 020 36640)
L3 = 3 turns enamelled Cu wire (2,0 mm); int. dia. 12 mm; length 12 mm
L4 = 2 turns enamelled Cu wire (2,0 mm); int. dia. 12 mm; length 8 mm
R1 = 27 Ω (± 10%) carbon resistor (0,5 W)
R2 = 4,7 Ω (± 10%) carbon resistor (0,5 W)



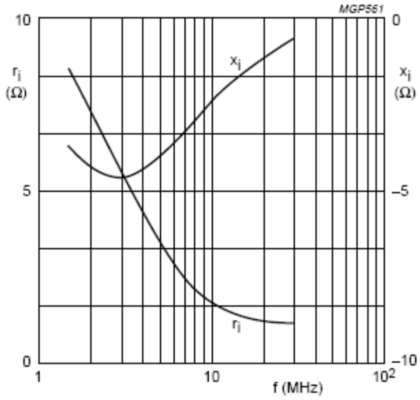
Typical values; $V_{CE}$ = 28 V; $I_{C(ZS)}$ = 50 mA;
$f_1$ = 28,000 MHz; $f_2$ = 28,001 MHz;
$T_h$ = 25 °C.

Fig.18 Intermodulation distortion(1) as a function of output power.



$V_{CE}$ = 28 V; $I_{C(ZS)}$ = 50 mA; $P_L$ = 100 W (P.E.P.);
$T_h$ = 25 °C; $Z_L$ = 2,7 Ω.

Fig.19 Power gain as a function of frequency.



$V_{CE}$ = 28 V; $I_{C(ZS)}$ = 50 mA; $P_L$ = 100 W (P.E.P.);
$T_h$ = 25 °C; $Z_L$ = 2,7 Ω.

Fig.20 Input impedance (series components).

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

ELEFLOW OFFICES

| CHINA | R & D CENTER |
|---|---|
| ELEFLOW TECHNOLOGIES(HQ)<br>Suite1-603, HuaKang Plaza<br>109 ZhenXing Road, Futian District<br>ShenZhen518031, P.R. China<br>Phone: 86-755-83204665/83204663<br>Fax: 86-755-8320 4659<br>Email: eleflow@163.com | ELEFLOW TECHNOLOGIES(R&D CENTER)<br>Overseas Chinese High-Tech Venture Park<br>No. 12 South, Hi-tech Park, NanShan Dist.<br>ShenZhen518057, China |
| USA | CHENGDU, CHINA |
| ELEFLOW TECHNOLOGIES(USA)<br>Mr. Ted Seymore (Manager)<br>3291 NE 4th Ave., Boca Raton<br>Florida 33431-6011, USA<br>Phone: 408-716-8509<br>Fax: 561-852-0505<br>Email: tedseymour@adelphia.net | Eleflow Technologies (Chengdu Office)<br>Mr. Ou, Lin ( Manager)<br>Suite A401, Qunyi Business Centre<br>13 ErHuanLu NanYiDuan, Chengdu<br>Sichuan610041, China<br>Phone: 86-28-8521 3480<br>Fax: 86-28-8521 3480<br>Email: eleflow@163.com |