DATA SHEET

BLW78
HF/VHF power transistor

Product specification

August 1986

Philips
Semiconductors

PHILIPS

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

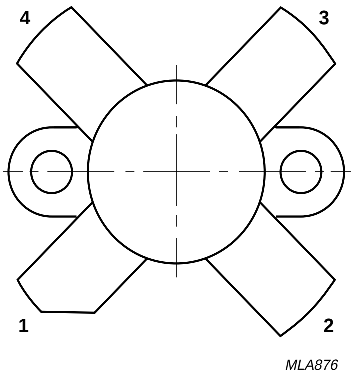


Fig.1 Simplified outline. SOT121B.

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

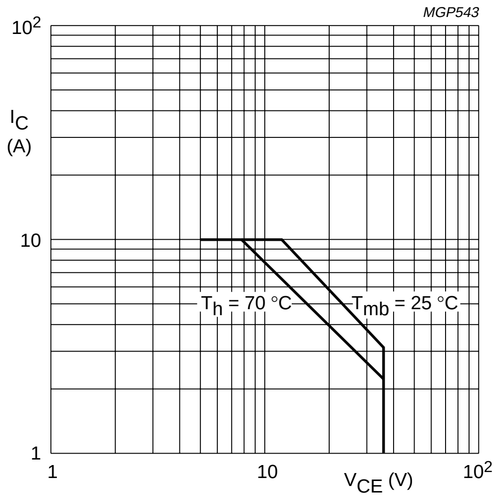


Fig.2 D.C. SOAR.

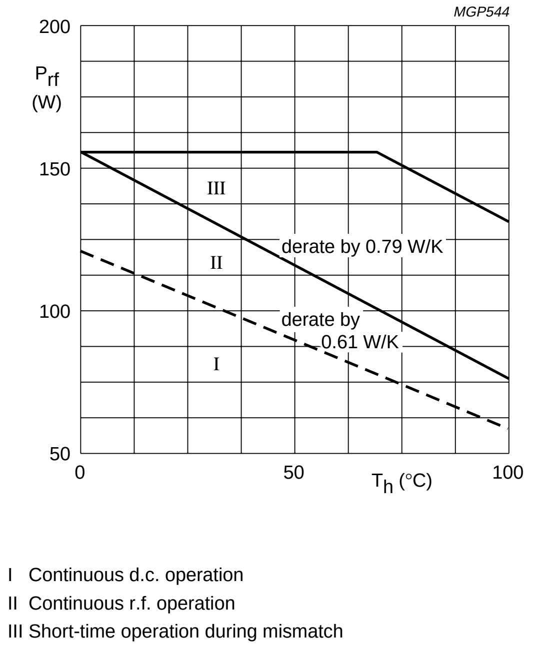


Fig.3 R.F. power dissipation; V_{CE} ≤ 28 V; f > 1 MHz.

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: $t_p \leq 50\ \mu s$; $\delta \leq 0{,}01$.

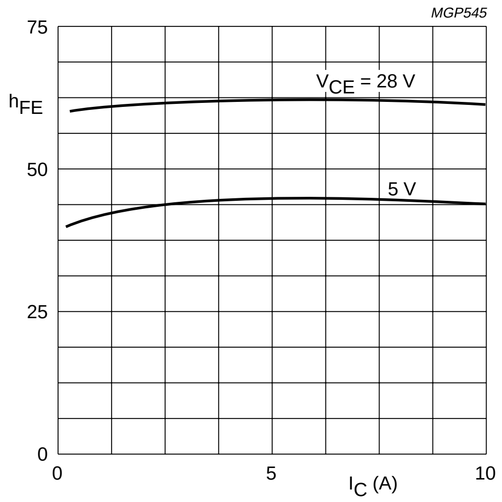


Fig.4 Typical values; T_j = 25 °C.

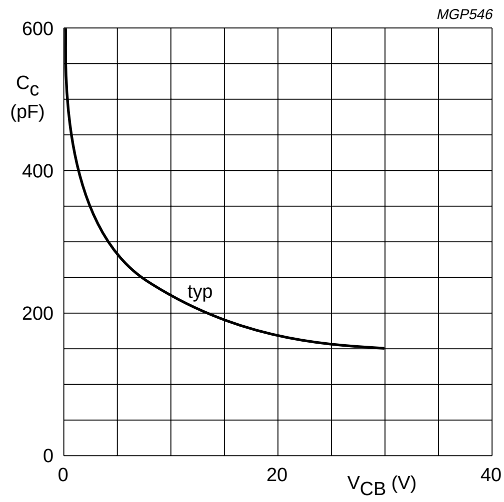


Fig.5 I_E = I_e = 0; f = 1 MHz; T_j = 25 °C.

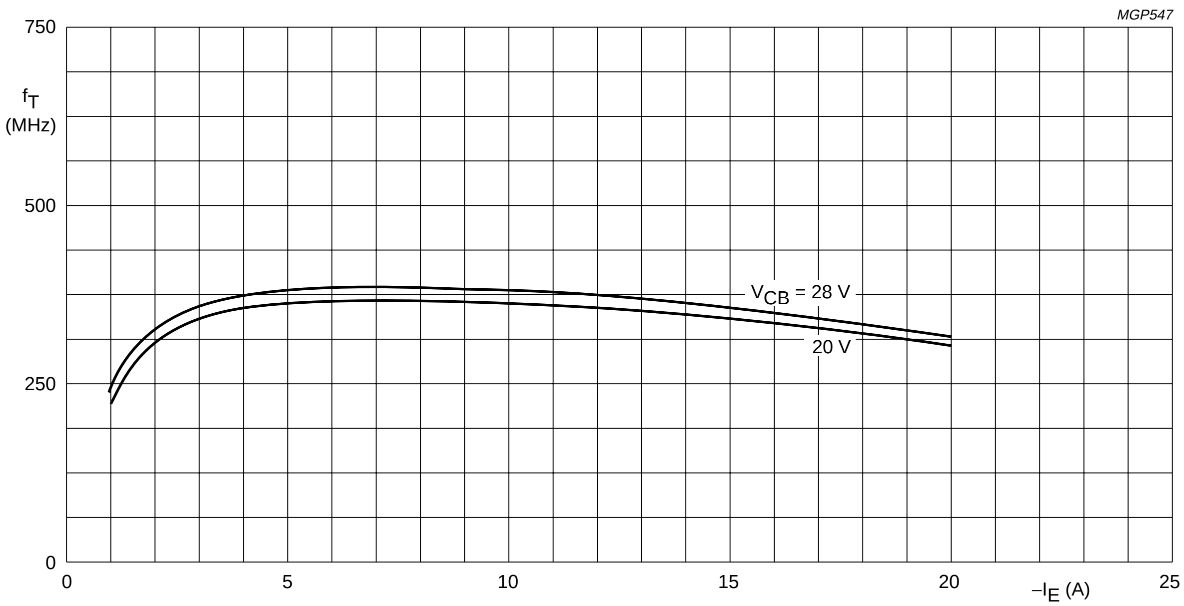


Fig.6 Typical values; f = 100 MHz; T_j = 25 °C.

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

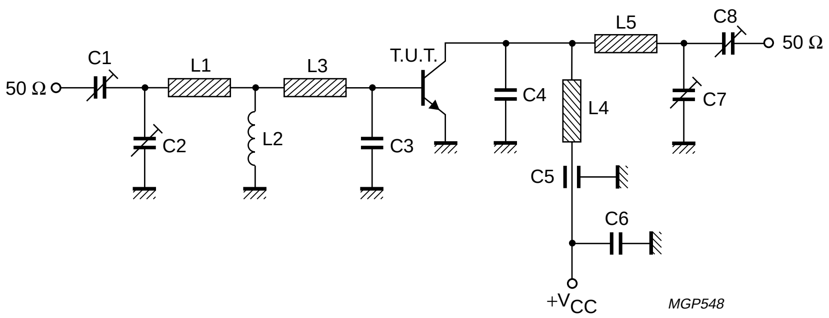


Fig.7 Test circuit; c.w. class-B; f = 150 MHz.

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.

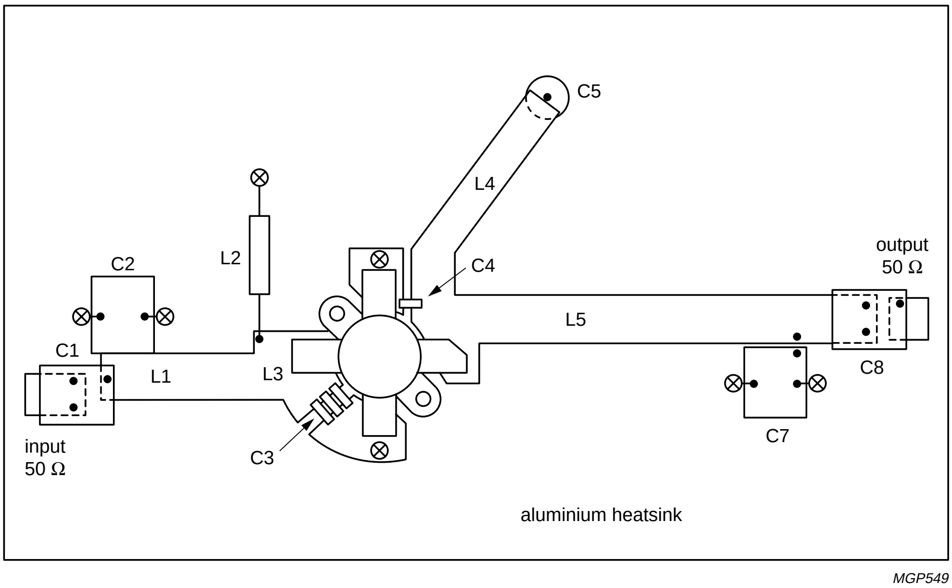


Fig.8 Component layout on an aluminium heatsink for 150 MHz test circuit. ⊗ Earthing bolts.

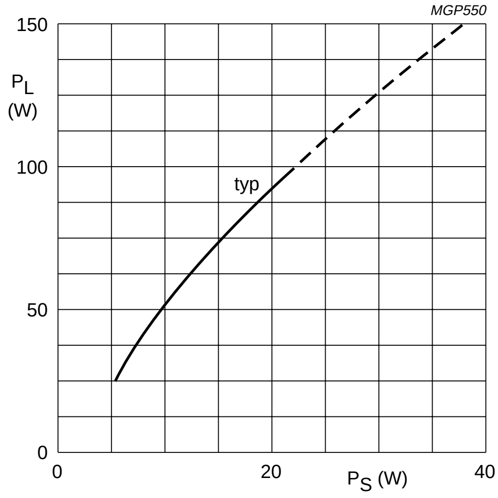


Fig.9 V_{CE} = 28 V; f = 150 MHz; T_h = 25 °C.

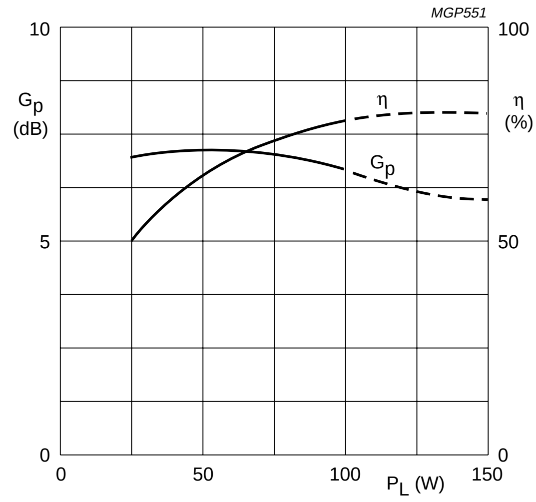
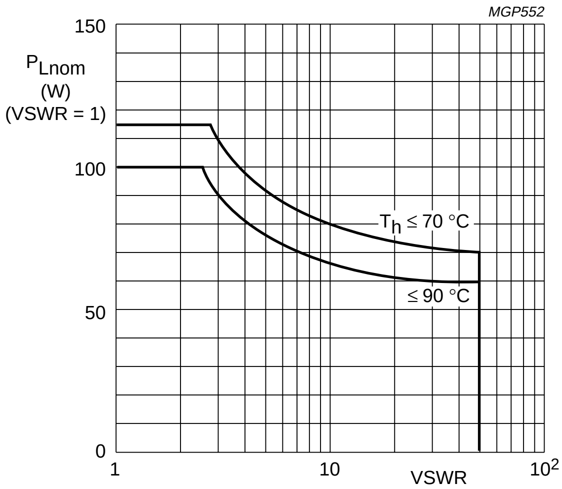


Fig.10 V_{CE} = 28 V; f = 150 MHz; T_h = 25 °C; typical values.

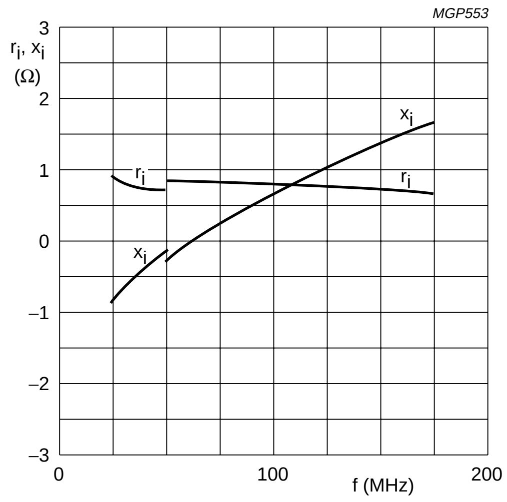


The graph shows the permissible output power under nominal conditions (VSWR = 1) as a function of the expected VSWR during short-time mismatch conditions with heatsink temperatures as parameter.

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

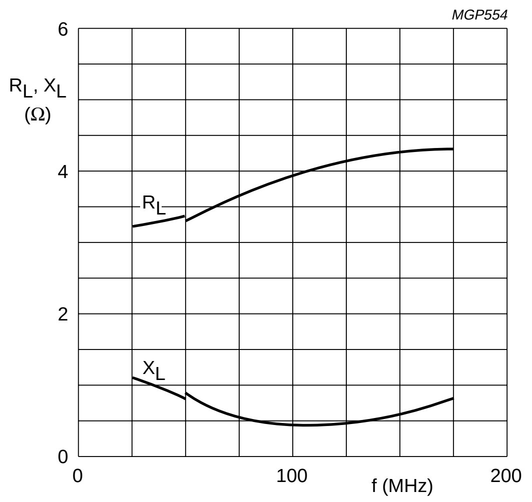
OPERATING NOTE

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.



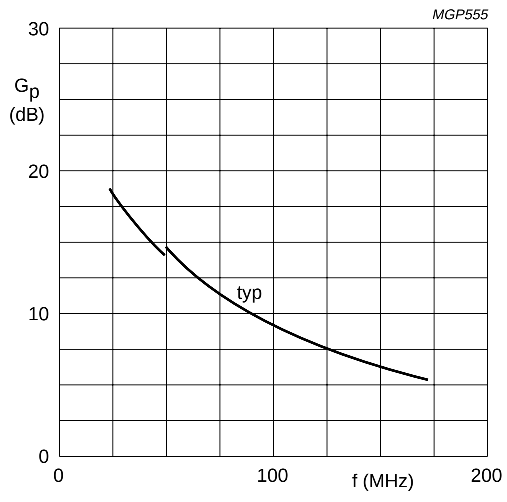
V_{CE} = 28 V; P_L = 100 W; T_h = 25 °C; typical values; class-B operation.

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

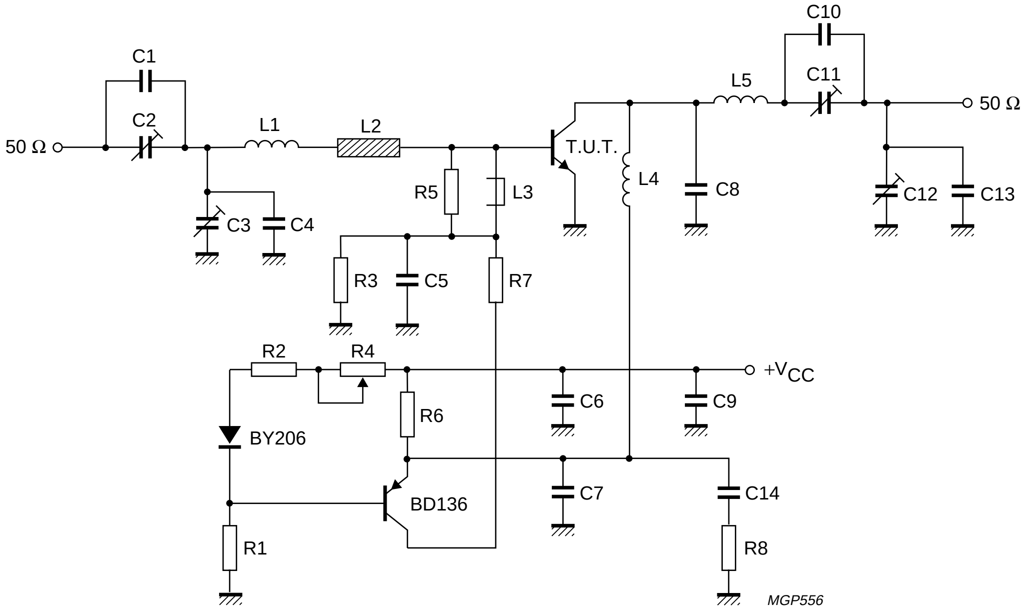


Fig.15 Test circuit; s.s.b. class-A; f = 28 MHz.

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)

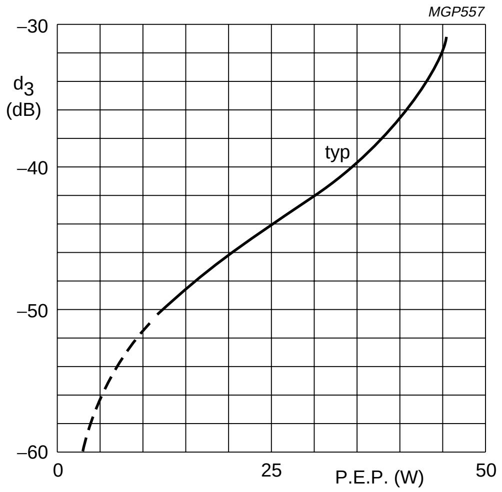


Fig.16 Intermodulation distortion as a function of output power; V_{CE} = 26 V; I_C = 3 A; f_1 = 28,000 MHz; f_2 = 28,001 MHz; T_h = 40 °C.

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	η_{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.

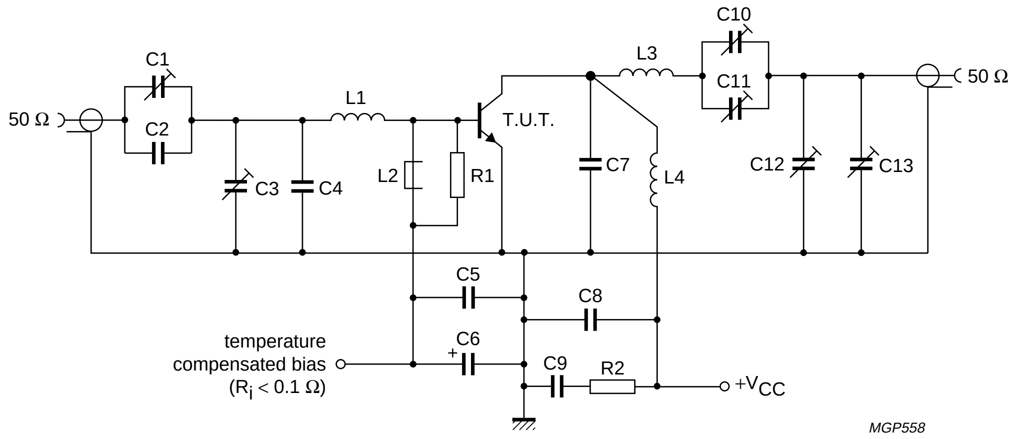
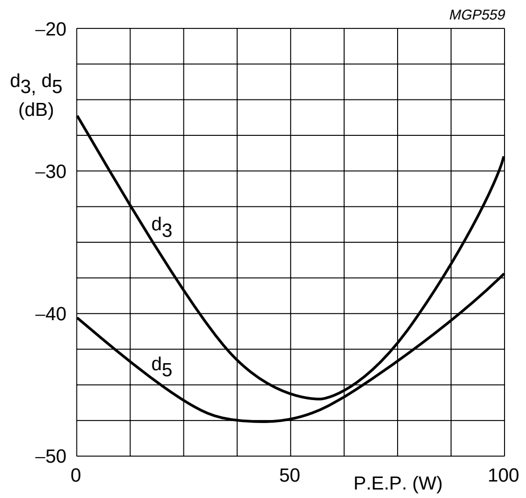


Fig.17 Test circuit; s.s.b. class-AB; f = 28 MHz.

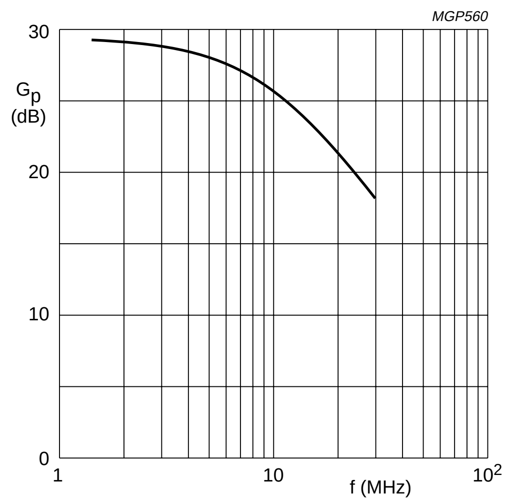
List of components:

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)



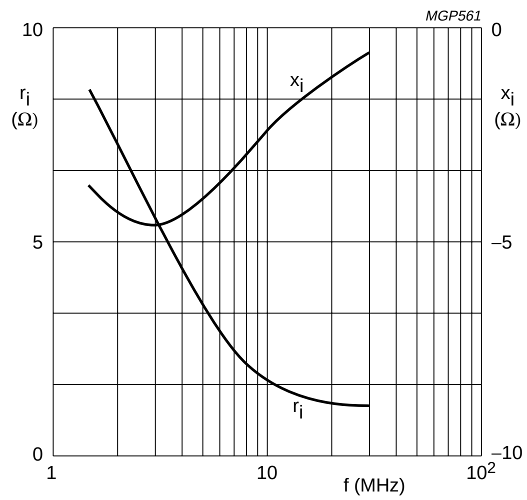
Typical values; V_{CE} = 28 V; $I_{C(ZS)}$ = 50 mA;
f_1 = 28,000 MHz; f_2 = 28,001 MHz;
T_h = 25 °C.

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.



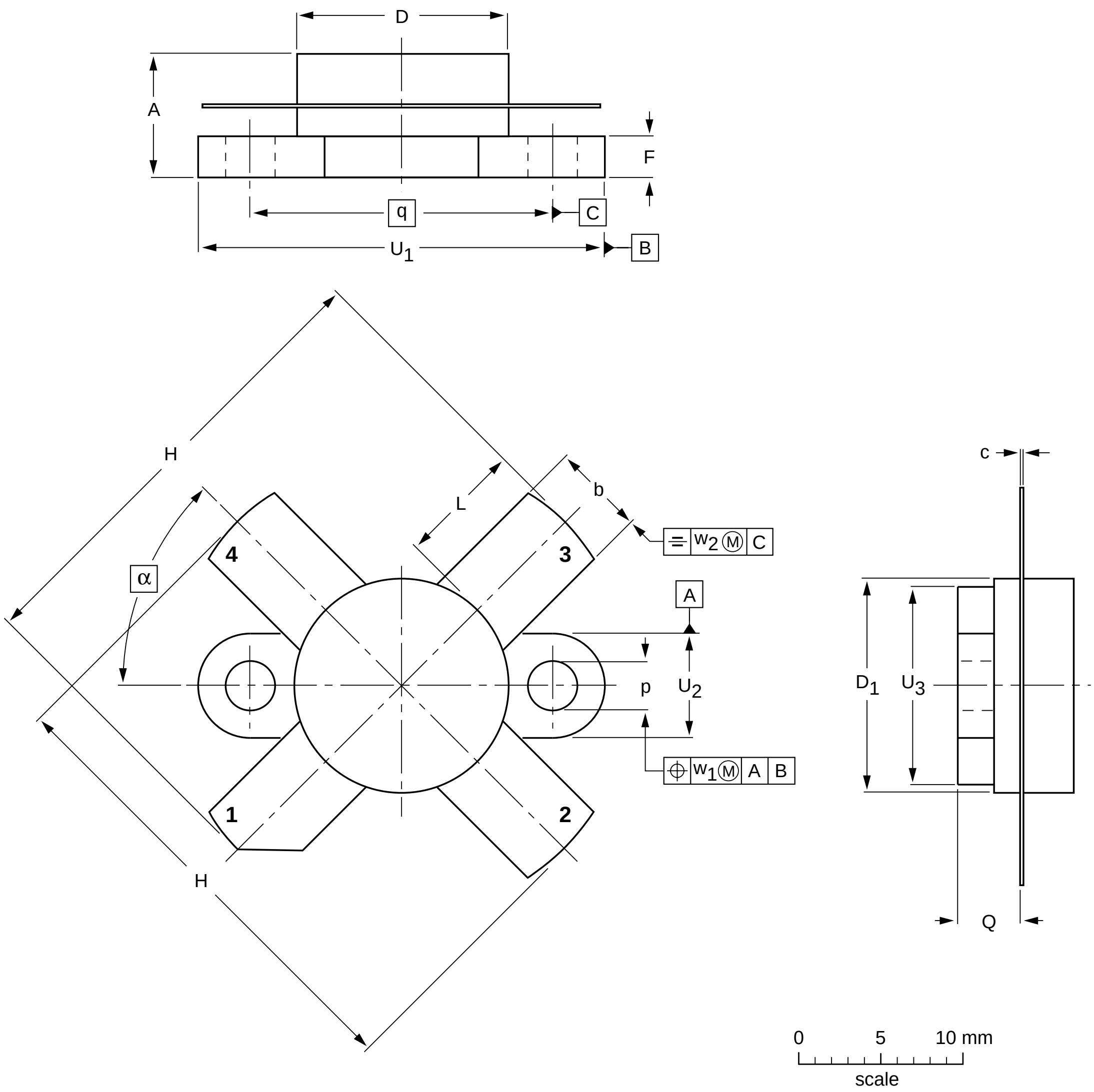
V_{CE} = 28 V; $I_{C(ZS)}$ = 50 mA; P_L = 100 W (P.E.P.);
T_h = 25 °C; Z_L = 2,7 Ω.

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.

PACKAGE OUTLINE

Flanged ceramic package; 2 mounting holes; 4 leads **SOT121B**



DIMENSIONS (millimetre dimensions are derived from the original inch dimensions)

UNIT	A	b	c	D	D_1	F	H	L	p	Q	q	U_1	U_2	U_3	w_1	w_2	α
mm	7.27 6.17	5.82 5.56	0.16 0.10	12.86 12.59	12.83 12.57	2.67 2.41	28.45 25.52	7.93 6.32	3.30 3.05	4.45 3.91	18.42	24.90 24.63	6.48 6.22	12.32 12.06	0.51	1.02	45°
inches	0.286 0.243	0.229 0.219	0.006 0.004	0.506 0.496	0.505 0.495	0.105 0.095	1.120 1.005	0.312 0.249	0.130 0.120	0.175 0.154	0.725	0.98 0.97	0.255 0.245	0.485 0.475	0.02	0.04	

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT121B						97-06-28

DEFINITIONS

Data Sheet Status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

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