DATA SHEET

BLW60C
VHF power transistor

Product specification

March 1993

Philips Semiconductors

PHILIPS

VHF power transistor BLW60C

DESCRIPTION

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 °C

MODE OF OPERATION	V_{CC} V	f MHz	P_L W	G_L 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

PIN CONFIGURATION

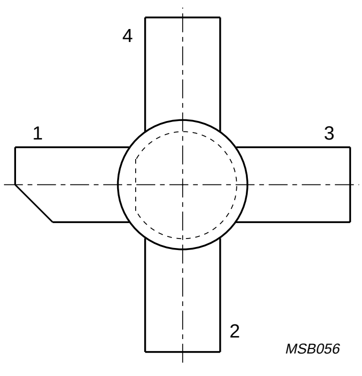


Fig.1 Simplified outline. SOT120A.

PINNING - SOT120A.

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.		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

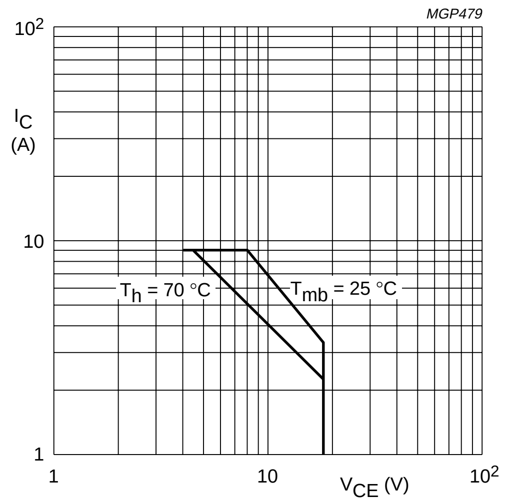
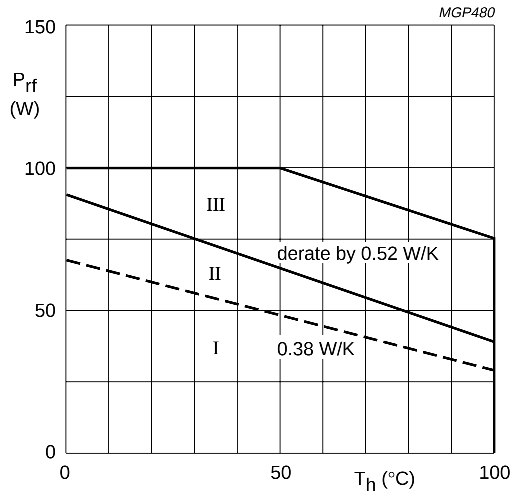


Fig.2 D.C. SOAR.



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

Fig.3 R.F. power dissipation; V_{CE} ≤ 16,5 V; f > MHz.

THERMAL RESISTANCE

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

From junction to mounting base (d.c. dissipation)	$R_{th\ j\text{-}mb(dc)}$	=	2,8	K/W
From junction to mounting base (r.f. dissipation)	$R_{th\ j\text{-}mb(rf)}$	=	2,05	K/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,45	K/W

CHARACTERISTICS

T_j = 25 °C

Breakdown voltage				
Collector-emitter voltage				
V_{BE} = 0; I_C = 50 mA	$V_{(BR)CES}$	>	36	V
Collector-emitter voltage				
open base; I_C = 100 mA	$V_{(BR)CEO}$	>	16	V
Emitter-base voltage				
open collector; I_E = 25 mA	$V_{(BR)EBO}$	>	4	V
Collector cut-off current				
V_{BE} = 0; V_{CE} = 15 V	I_{CES}	<	25	mA
Transient energy				
L = 25 mH; f = 50 Hz				
open base	E	>	8	ms
$-V_{BE}$ = 1,5 V; R_{BE} = 33 Ω	E	>	8	ms
D.C. current gain (1)				
I_C = 4 A; V_{CE} = 5 V	h_{FE}	typ	50	
		10 to	80	
D.C. current gain ratio of matched devices (1)				
I_C = 4 A; V_{CE} = 5 V	h_{FE1}/h_{FE2}	<	1,2	
Collector-emitter saturation voltage (1)				
I_C = 12,5 A; I_B = 2,5 A	V_{CEsat}	typ	1,5	V
Transition frequency at f = 100 MHz (1)				
I_C = 4 A; V_{CE} = 12,5 V	f_T	typ	650	MHz
I_C = 12,5 A; V_{CE} = 12,5 V	f_T	typ	600	MHz
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 15 V	C_c	typ	120	pF
		<	160	pF
Feedback capacitance at f = 1 MHz				
I_C = 200 mA; V_{CE} = 15 V	C_{re}	typ	80	pF
Collector-stud capacitance	C_{cs}	typ	2	pF

Note

1. Measured under pulse conditions: $t_p \leq 200$ µs; $\delta \leq 0,02$.

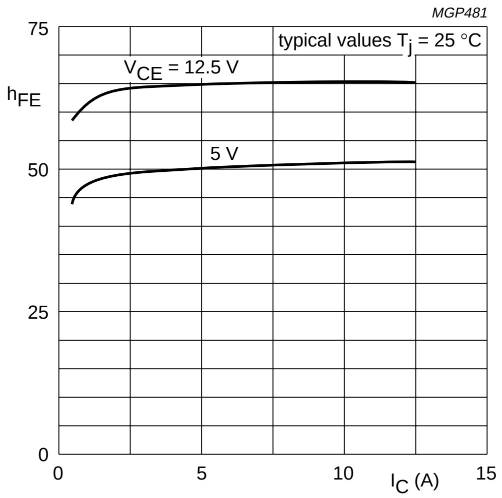


Fig.4 DC current gain as a function of collector current.

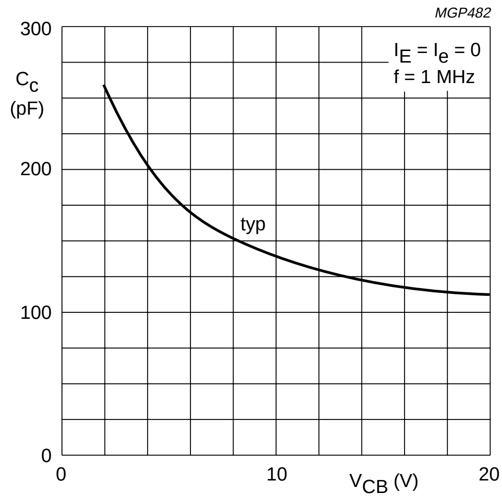


Fig.5 Collector capacitance as a function of collector-base voltage.

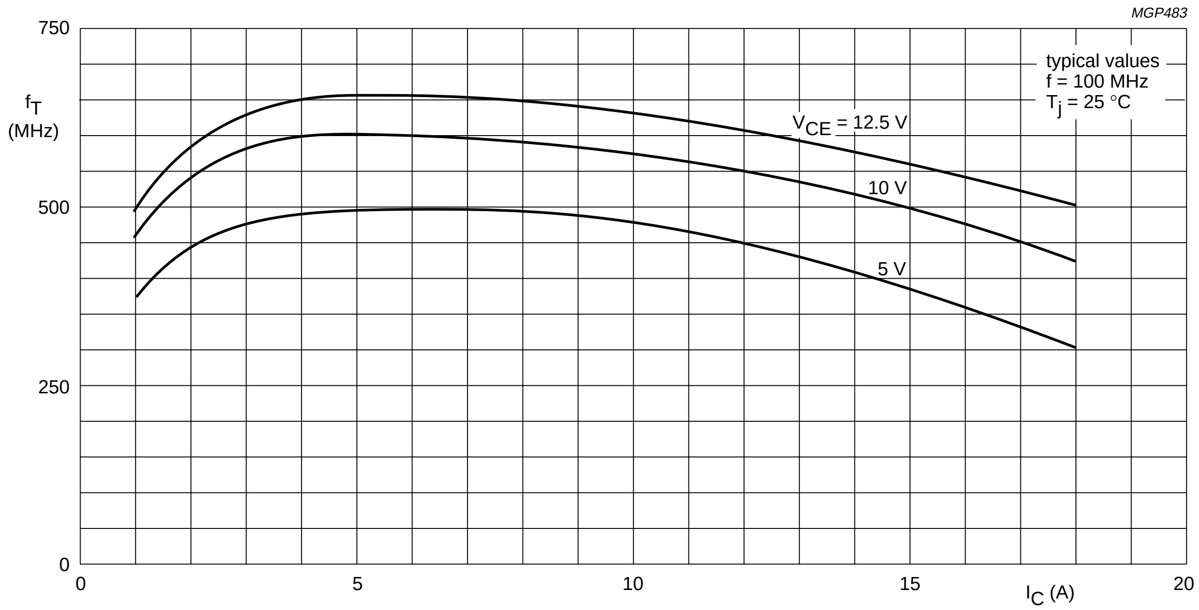


Fig.6 Transition frequency as a function of collector current.

APPLICATION INFORMATION

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

f (MHz)	V_{CC} (V)	P_L (W)	P_S (W)	G_p (dB)	I_C (A)	η (%)	$\overline{z_i}$ (Ω)	$\overline{Z_L}$ (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

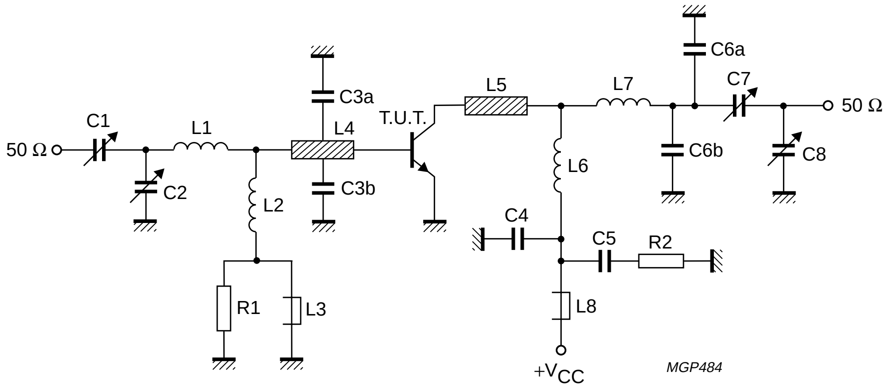


Fig.7 Class-B test circuit at f = 175 MHz.

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 × 5 mm

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

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

L4 = L5 = strip (12 mm × 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 × 5 mm

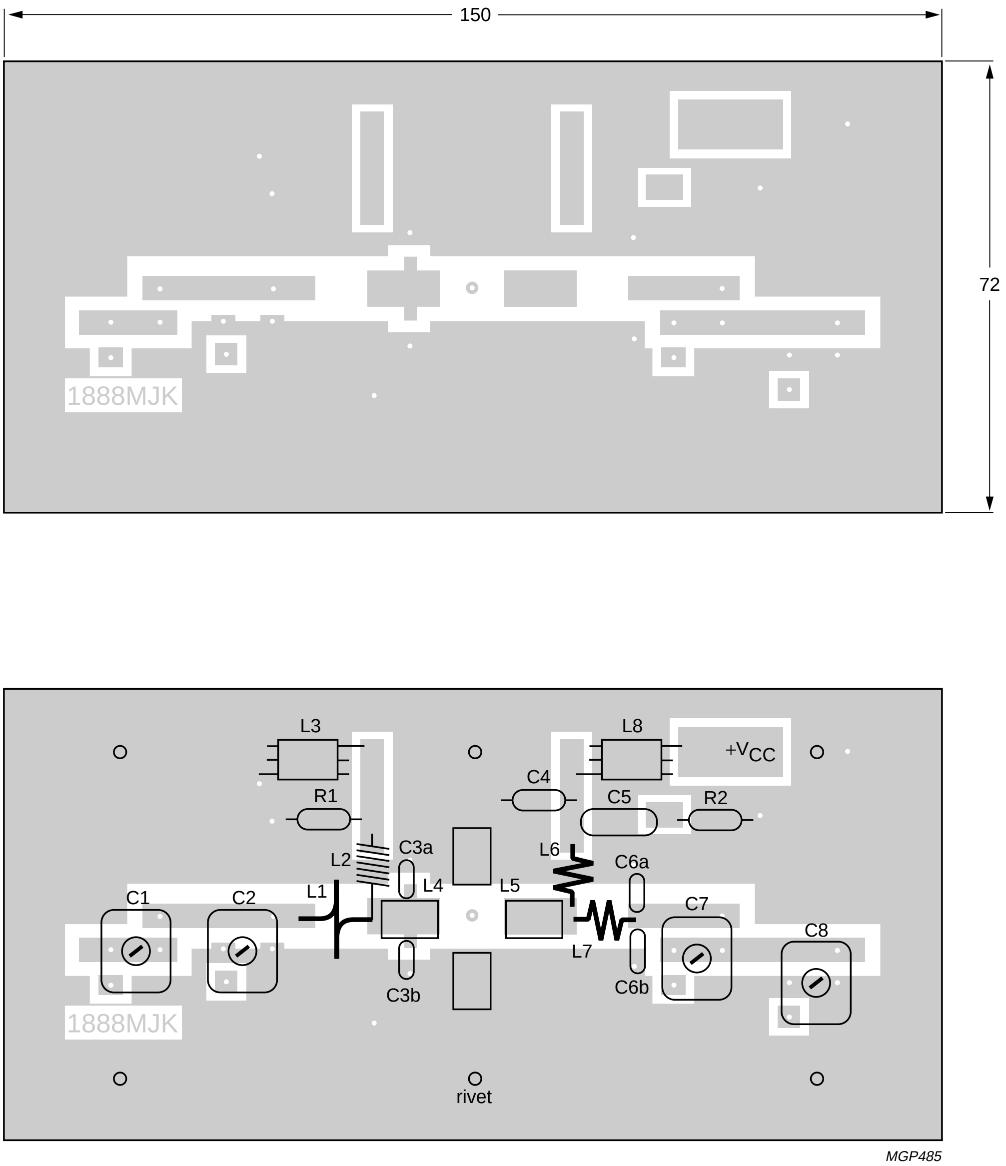
L7 = 2 turns enamelled Cu wire (1,6 mm); int. dia. 4,5 mm; length 6,0 mm; leads 2 × 5 mm

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: Fig.8.



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.

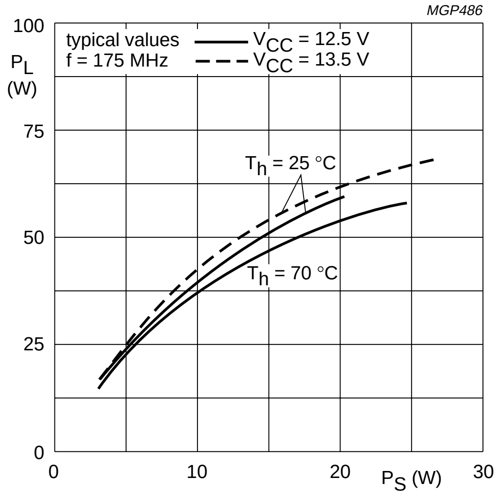


Fig.9

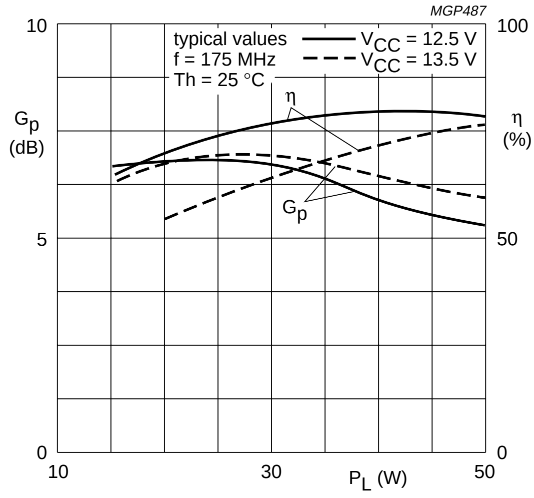


Fig.10

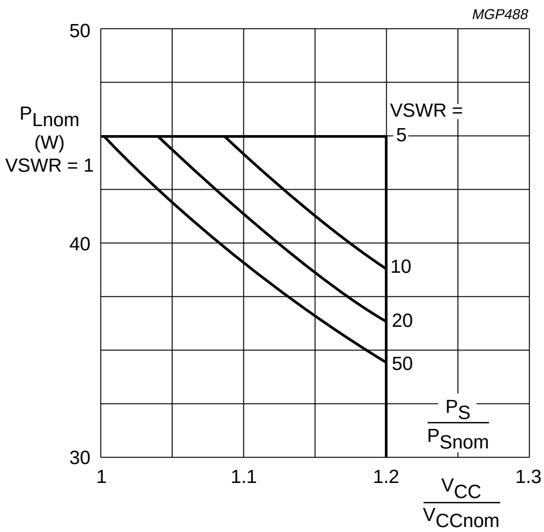


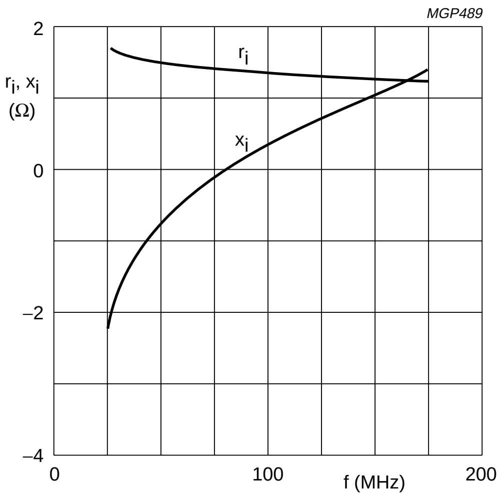
Fig.11

Conditions for R.F. SOAR

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

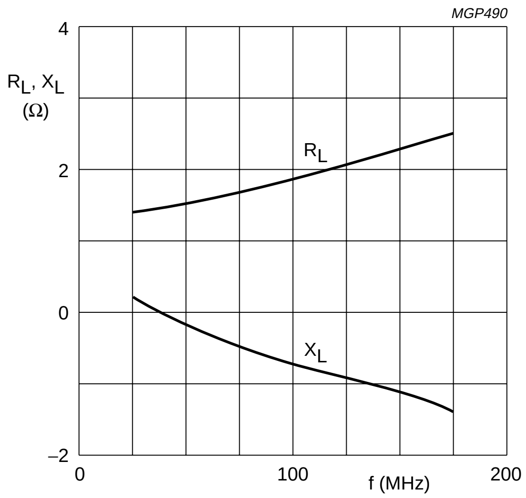
The transistor has been developed for use with unstabilized supply voltages. As the output power and drive power increase with the supply voltage, the nominal output power must be derated in accordance with the graph for safe operation at supply voltages other than the nominal. The graph shows the permissible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

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



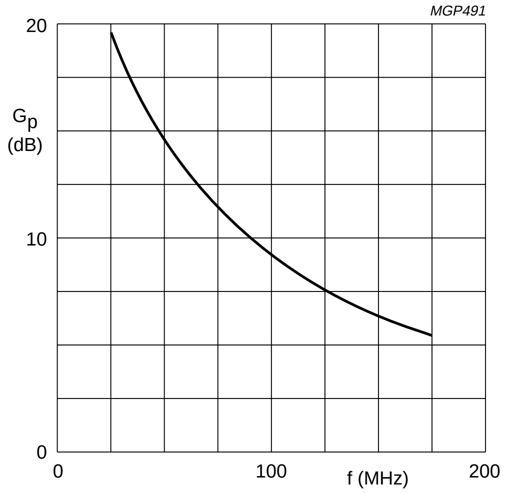
Typical values; V_{CE} = 12,5 V; P_L = 45 W;
class-B operation; T_h = 25 °C.

Fig.12 Input impedance (series components).



Typical values; V_{CE} = 12,5 V; P_L = 45 W;
class-B operation; T_h = 25 °C.

Fig.13 Load impedance (series components).



Typical values; V_{CE} = 12,5 V; P_L = 45 W;
class-B operation; T_h = 25 °C.

Fig.14

R.F. performance in s.s.b. class-AB operation
V_{CE} = 12,5 V; T_h up to 25 °C; $R_{th\ mb\text{-}h}$ ≤ 0,45 K/W
f_1 = 28,000 MHz; f_2 = 28,001 MHz

OUTPUT POWER W	G_p dB	η_{dt} %	d_3 dB [(1)]	d_5 dB [(1)]	$I_{C(ZS)}$ mA
3 to 30 (P.E.P.)	typ 19,5	typ 35	typ –33	typ –36	25

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.

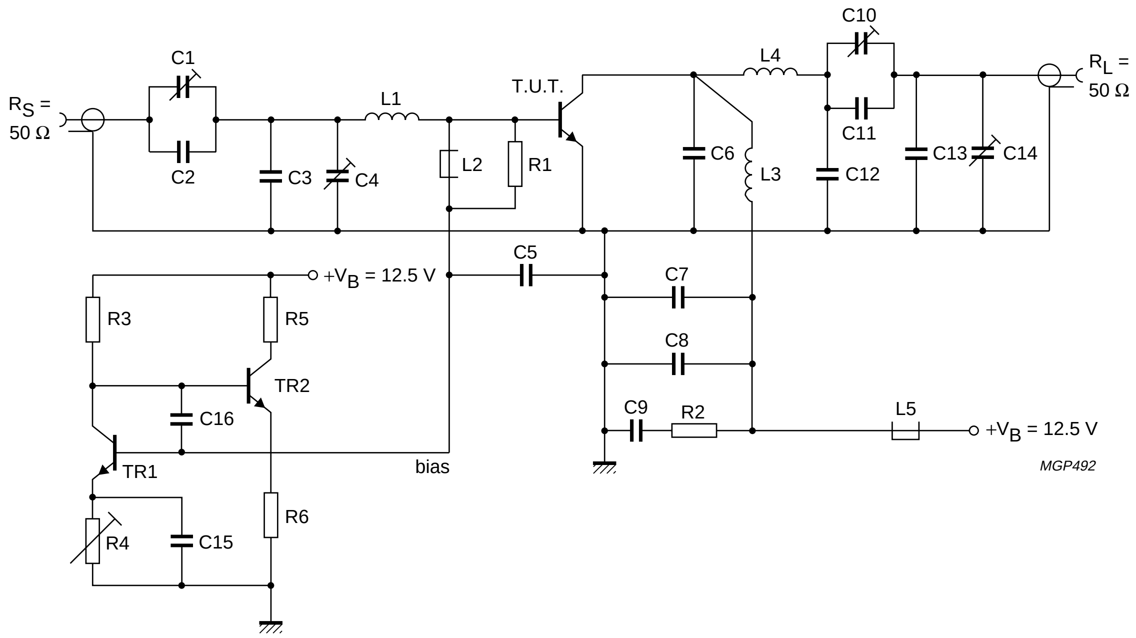


Fig.15 S.S.B. class-AB test circuit.

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 × 270 pF polystyrene capacitors in parallel
- C8 = C15 = C16 = 100 nF polyester capacitor
- C9 = 2,2 μF moulded metallized polyester capacitor
- C10 = 2 × 385 pF film dielectric trimmer
- C11 = 68 pF ceramic capacitor
- 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 × 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 × 5 mm
- L4 = 96 nH; 3 turns enamelled Cu wire (1,6 mm); int. dia. 10 mm; length 7,6 mm; leads 2 × 5 mm
- R1 = 27 Ω (± 5%) carbon resistor
- R2 = 4,7 Ω (±5%) carbon resistor
- R3 = 1,5 kΩ (±5%) carbon resistor
- R4 = 10 Ω wirewound potentiometer (3 W)
- R5 = 47 Ω wirewound resistor (5,5 W)
- R6 = 150 Ω (±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
$R_{th\ mb\text{-}h}$ ≤ 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
$R_{th\ mb\text{-}h}$ ≤ 0,45 ° K/W
$I_{C(ZS)}$ = 25 mA
typical values

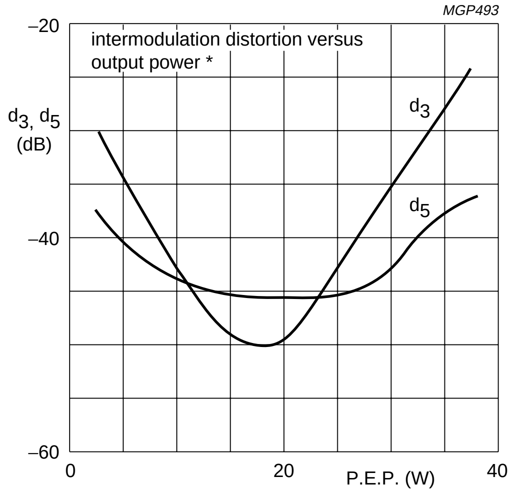


Fig.16

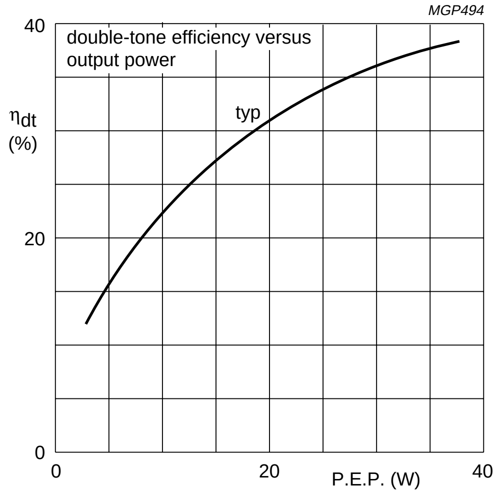


Fig.17

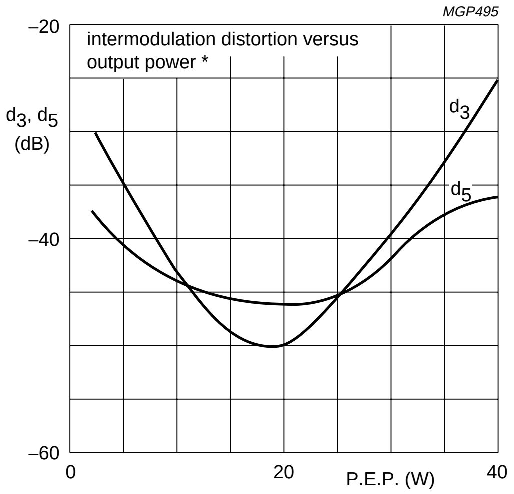


Fig.18

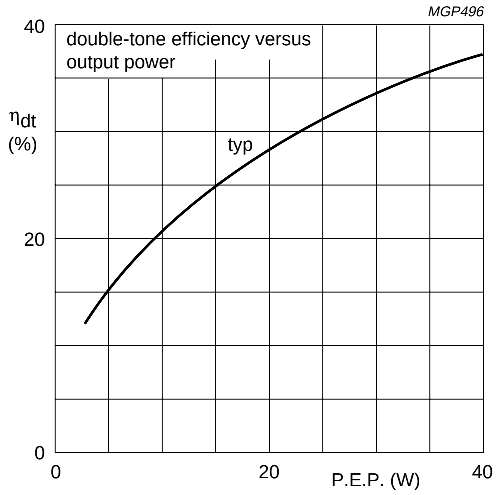


Fig.19

* 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.

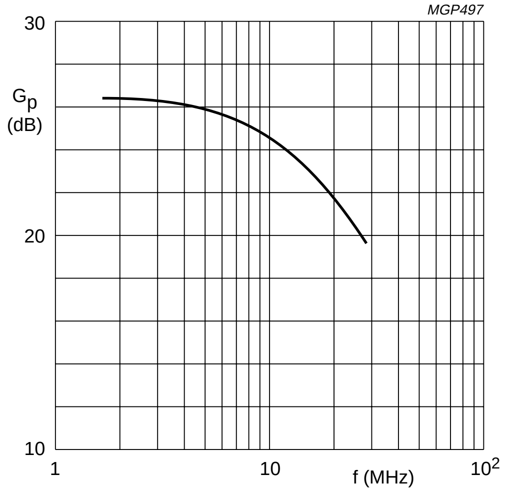


Fig.20

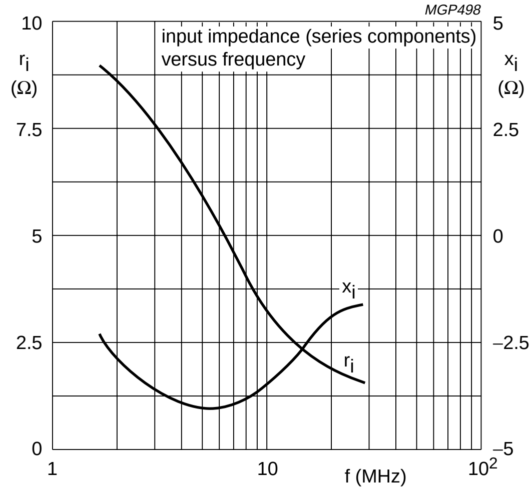


Fig.21

S.S.B. class-AB operation

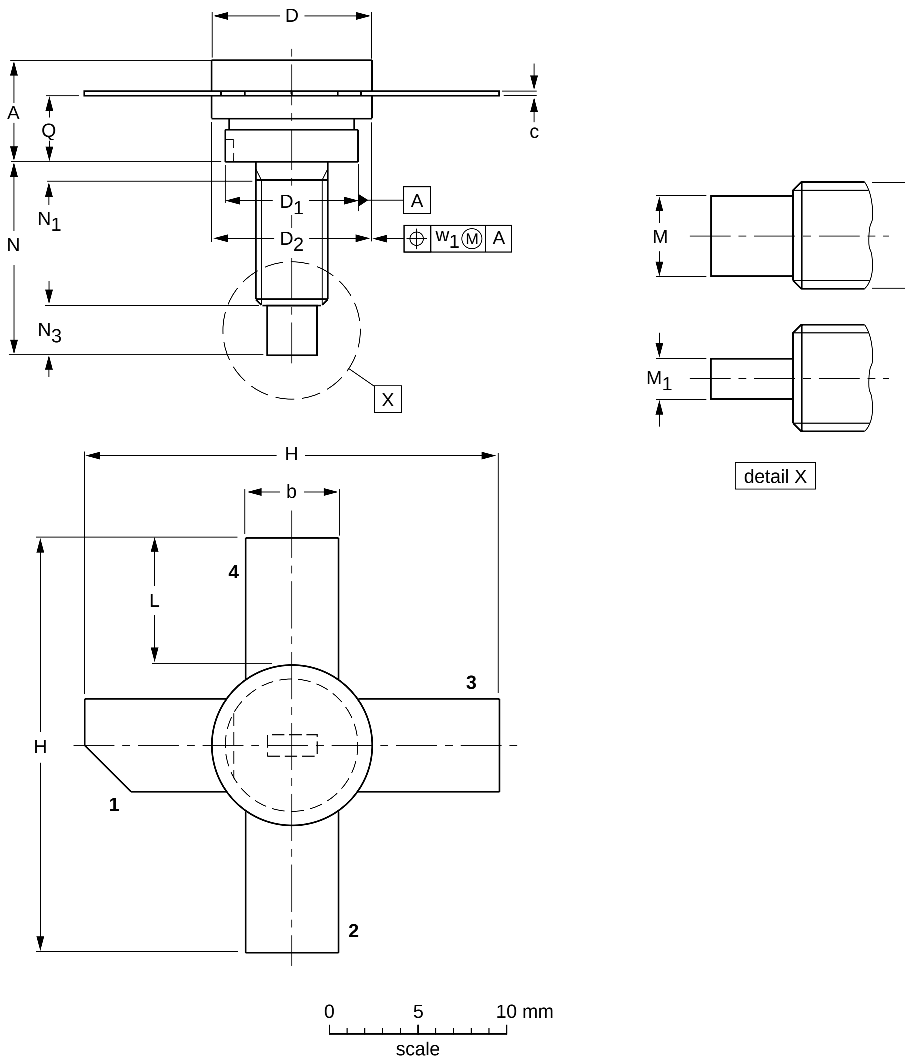
Conditions for Figs 20 and 21:

V_{CC} = 12,5 V	V_{CC} = 13,5 V
P_L = 30 W (P.E.P.)	P_L = 35 W (P.E.P.)
T_h = 25 °C	T_h = 25 °C
$R_{th\ mb\text{-}h}$ ≤ 0,45 K/W	$R_{th\ mb\text{-}h}$ ≤ 0,45 K/W
$I_{C(ZS)}$ = 25 mA	$I_{C(ZS)}$ = 25 mA
Z_L = 1,9 Ω	Z_L = 1,9 Ω

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

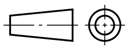
PACKAGE OUTLINE

Studded ceramic package; 4 leads **SOT120A**



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

UNIT	A	b	c	D	D_1	D_2	H	L	M	M_1	N	N_1	N_3	Q	W	w_1
mm	5.97 4.74	5.90 5.48	0.18 0.14	9.73 9.47	8.39 8.12	9.66 9.39	27.44 25.78	9.00 8.00	3.41 2.92	1.66 1.39	12.83 11.17	1.60 0.00	3.31 2.54	4.35 3.98	8-32 UNC	0.38
inches	0.283 0.248	0.232 0.216	0.007 0.004	0.383 0.373	0.330 0.320	0.380 0.370	1.080 1.015	0.354 0.315	0.134 0.115	0.065 0.055	0.505 0.440	0.063 0.000	0.130 0.100	0.171 0.157		0.015

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT120A						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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