APPLICATION NOTE

A wide-band class-A linear power amplifier (174 – 230 MHz) with 2 transistors BLV33F

ECO8005

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CONTENTS

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1 ABSTRACT

For application in driver or final stages of TV-transposers in Band III (174-230 MHz) a linear wideband power amplifier has been designed with 2 transistors BLV33F, coupled by means of 3 dB – 90° hybrids.
Each transistor is adjusted in Class-A at V_{CE} = 25 V and I_C = 3.25 A. A demonstration model showed a peak sync. output power of 40 W at a 3-tone I.M. distortion between –52 and –53 dB. At this power level the cross-modulation varied from 15 to 18%. The power gain is between 13.3 and 13.6 dB. For natural convection cooling the heatsink temperature is 40 °C above ambient temperature.

2 INTRODUCTION

For application in T.V. transposers and transmitters for Band III a wideband linear power amplifier has been designed with 2 transistors BLV33F, coupled by means of 3 dB –90° hybrids. Each transistor is adjusted in Class-A at V_{CE} = 25 V and I_C = 3.25 A.

Note: The BLV33F is a high gain, internally matched, 1/2 inch 6 leads flange version of the BLV33.

3 DESIGN OF THE AMPLIFIER

For class-A operation the BLV33F is specified at V_{CE} = 25 V, I_C = 3.25 A. The corresponding typical gain, input and load impedance are given in Table 1:

Table 1

FREQ. (MHz)	GAIN (dB)	INPUT IMPEDANCE (Ω)	LOAD IMPEDANCE (Ω)
174	12.94	0.85 + j0.59	2.68 + j1.24
202	12.88	1.02 + j0.47	2.23 + j0.90
230	13.91	0.93 + j0.02	1.84 + j0.51

To obtain a high linear output and at the same time good input and output matching (V.S.W.R. ≤1.2) 3 dB –90° hybrids are used. The reflected input power will be absorbed in the 50 Ω resistor, matching the isolated port (see Fig.1). For detailed information on computer-aided design (carried out by Mr. Hilbers Central Application Laboratory) see Refs 1, 2 and 3. The transistors used in this particular amplifier are typical products, measured in a narrow band test amplifier and specified as follows:

V_{CE} = 25 V – I_C = 3.25 A – Th = 70°

Table 2

Transistor type	BLV33F	
Batch no.	MD 8-16 no.7	MD 8-16 no. 10
Vision frequency	224.25 MHz	
Output power (peak sync)	17.7 W	18 W
Intermod. product	–55 dB	–55 dB
Gain	14.2 dB	14.2 dB

4 ADJUSTMENTS OF THE AMPLIFIER

The amplifier consists of two equal BLV33F branches (see Fig.1) and both transistors are separately biased at V_{CE} = 25 V – I_C = 3.25 A. The printed circuit board of the 2× BLV33F wideband amplifier is given in Fig.2 and schematic diagram + lay-out of the bias unit is given in Fig.3. Figure 9 at the end of the report shows the lay-out of the amplifier with

the situation of the components. Each branch was adjusted for maximum and flat gain by means of a high power sweep with a frequency range from 170 – 230 MHz. The output of the amplifier was levelled at 40 W which means about 50% of the D.C. input power. After that, both branches are coupled by means of 3 dB –90° hybrids.

5 ASSEMBLING OF THE AMPLIFIER AND MECHANICAL DATA

Due to the dimensions of the printed circuit board (220 × 210 mm) 2 extruded blackened aluminium heat sinks (cat.no. 56293) are screwed on an aluminium plate (thickness 12 mm) which on its turn is screwed on the heat sink. Special attention has been paid to the surface finishing to keep the thermal resistance as low as possible.

Dimensions of the amplifier: l = 224 mm – w = 223 mm – h = 113 mm. Weight: 7.5 kg.

6 MEASURED RESULTS

In Fig.4 the typical results of crossmodulation and 3-tone intermod. product (from 170 – 230 MHz) have been given for peak sync output powers of 30 W and 40 W. Figure 5 shows peak sync output power as function of 3-tone intermod. products (measured on channel 12: Vision freq. 224.25 MHz – Sound freq. 229.75 MHz). In Figs 6 and 7 the forward and reverse transducer gain as well as input and output voltage standing wave ratio are given. The measuring test set-up is depicted in Fig.8.

Note:
Signal levels 3-tone measurements:
Vision carrier –8 dB; Sound carrier –7 dB;
Sideband –16 dB; 0 dB corresponds to peak sync.

Signals levels crossmodulation:
Vision carrier switched from –20 dB to 0 dB;
Sound carrier –7 dB; 0 dB = peak sync level
Crossmodulation is defined as the voltage variation (%) of the sound carrier.

7 CONCLUSION

Two transistors BLV33F, coupled by means of 3 dB –90° hybrids, can deliver an output power (peak sync) of typ. 40 W for –52 dB 3-tone intermodulation. At 40 W output the crossmodulation varied from 15% to 18% in Band III (170 – 230 MHz). The gain of the amplifier is typically 13.3 + 0.3 dB. The required D.C. input is approx. 165 W. Using a high power sweep with adjustable transistor output levelling provides a suitable method to adjust a linear wideband power amplifier.

8 REFERENCES

Ref.1:
G.L. Matthaei – Tables of Chebyshev
Impedance Transforming Network of Low-Pass Filter Form. Proceedings of the IEEE August 1964, pp 939 – 963.

Ref.2:
A.H. Hilbers and M.J. Köppen – A wideband linear power amplifier (470 – 860 MHz) with two transistors BLW34. C.A.B. report ECO7901.

Ref.3:
R.F.F. Zwanen – A wideband Class-A linear power amplifier (170 – 230 MHz) with two transistors BLV33. C.A.B. report ECO7904.

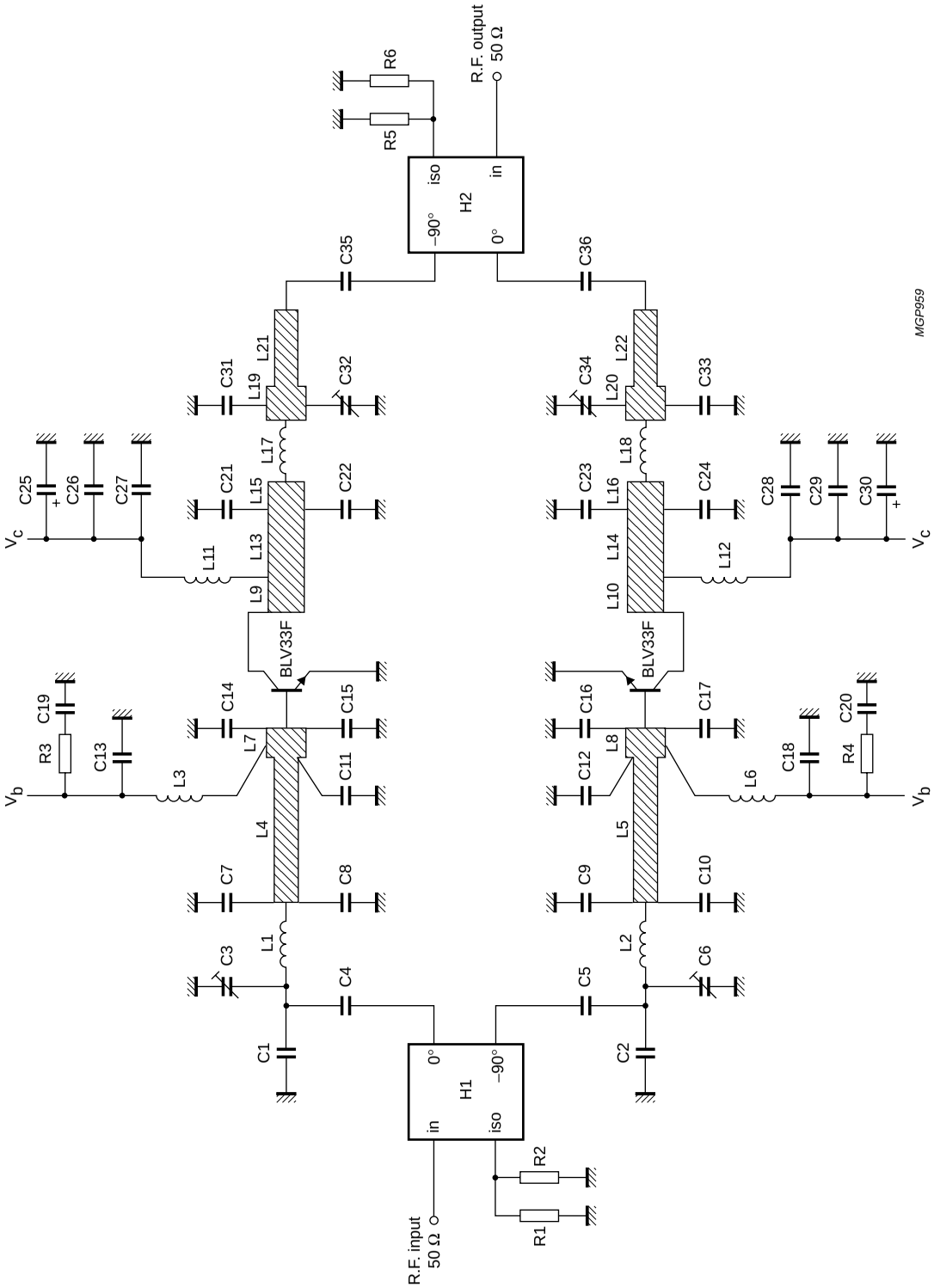


Fig.1 2× BLV33F Band III Class A linear power amplifier.

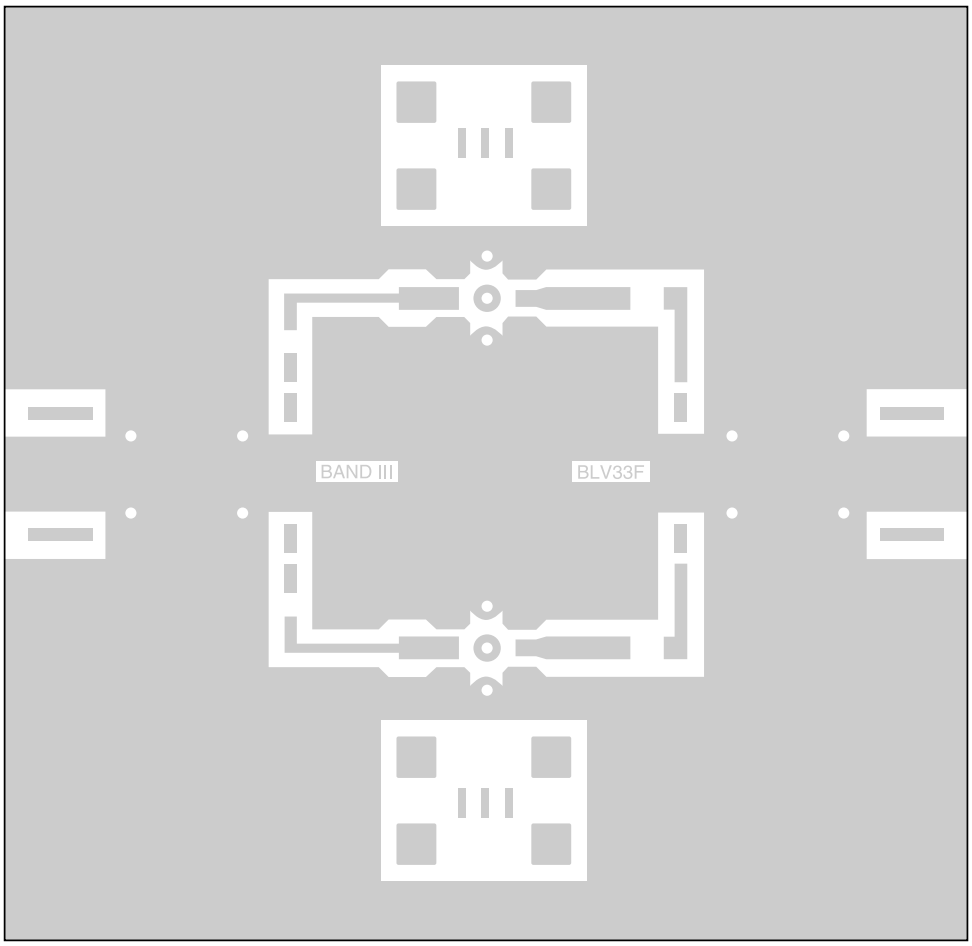


Fig.2 Printed circuit board 2× BLV33F wideband power amplifier.

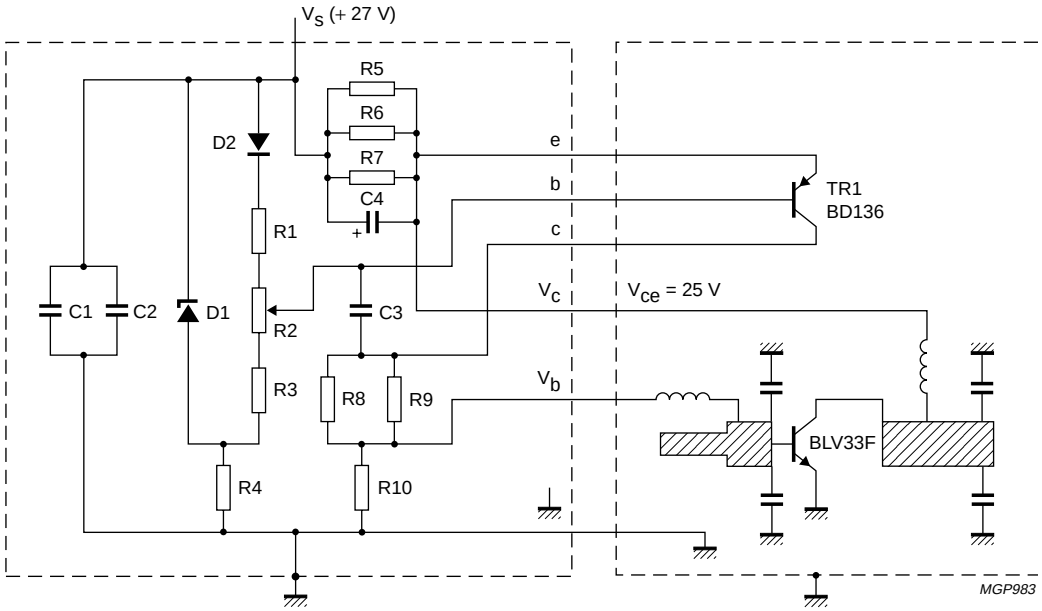
Table 3 Parts list: BLV33F Band III Class A linear power amplifier (170 – 230 MHz)

C1 = C2 = C7 = C9	10 pF	chip capacitor
C3 = C6 = C32 = C34	1.8 to 10 pF	film dielectric trimmer (cat. no. 222280905002)
C4 = C5 = C35 = C36	220 pF	chip capacitor
C8 = C10	39 pF	chip capacitor
C11 = C12	68 pF	chip capacitor
C13 = C18 = C27 = C28	1000 pF	chip capacitor
C14 = C15 = C16 = C17	120 pF	chip capacitor
C19 = C20 = C26 = C29	300 nF	metallized film capacitor (cat. no. 222235225334)
C21 = C22 = C23 = C24	56 pF	chip capacitor
C25 = C30	10 μF (40 V)	electrolytic capacitor (cat. no. 222212117109)
C31 = C33	18 pF	chip capacitor (chip capacitors: ATC type 100B – C – MSX – 500)
R1 = R2 = R5 = R6	100 Ω	power metal film resistor PR52 type (cat. no. 232219231001)
R3 = R4	10 Ω	carbon resistor CR68 type
H1 = H2	3 dB –90°	coupler, model no. 10262 – 3, range 125 to 250 MHz, ANAREN MICROWAVE INC.
L1 = L2	25 nH	2 turns enamelled Cu wire (1 mm); int. diam. 5 mm; leads 2 × 3 mm
L3 = L6	90 nH	5 turns closely wound enamelled Cu wire (1.5 mm) int. diam. 6.5 mm; length 5 mm; leads 2 × 9 mm
L4 = L5		60 Ω stripline; w = 2 mm; length = 30 mm
L7 = L8		30 Ω stripline; w = 6 mm; length = 11 mm
L9 = L10		40 Ω stripline; w = 4 mm; length = 5 mm
L11 = L12	20 nH	Cu strip (1 mm); length = 17 mm; h = 5 mm; w = 4 mm
L13 = L14		30 Ω stripline; w = 6 mm; length = 17 mm
L15 = L16		30 Ω stripline; w = 6 mm; length = 4 mm
L17 = L18	28 nH	2 turns enamelled Cu wire (1.5 mm); int. diam. 6.5 mm; length 9 mm; leads 2 × 3 mm
L19 = L20		30 Ω stripline; w = 6 mm; length = 6 mm
L21 = L22		50 Ω stripline; w = 3 mm; length = 15 mm

The striplines are printed on double Cu-clad printed circuit board with epoxy fibre-glass dielectric (ε_r = 4.5); thickness 1/16 inch.

Table 4 Parts list: Class A bias circuit for a single transistor BLV33F

R1	150 Ω	carbon resistor CR25 type
R2	100 Ω	preset potentiometer CTP10 type
R3	10 Ω	carbon resistor CR25 type
R4	1000 Ω	carbon resistor CR25 type
R5 = R6 = R7	1.8 Ω	rectangular wirewound resistor EH707 type
R8 = R9	180 Ω	carbon resistor CR25 type
R10	33 Ω	carbon resistor CR25 type
C1 = C3	100 nF	metallized film capacitor
C2	100 pF	ceramic capacitor
C4	10 μF	electrolytic capacitor
D1		BZY 88 (3V3)
D2		BY 206
T1		BD 136



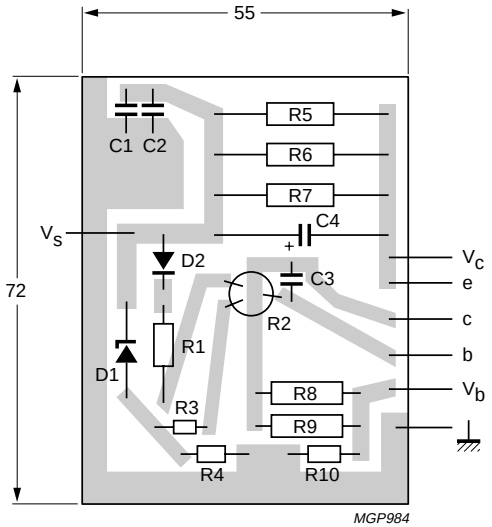
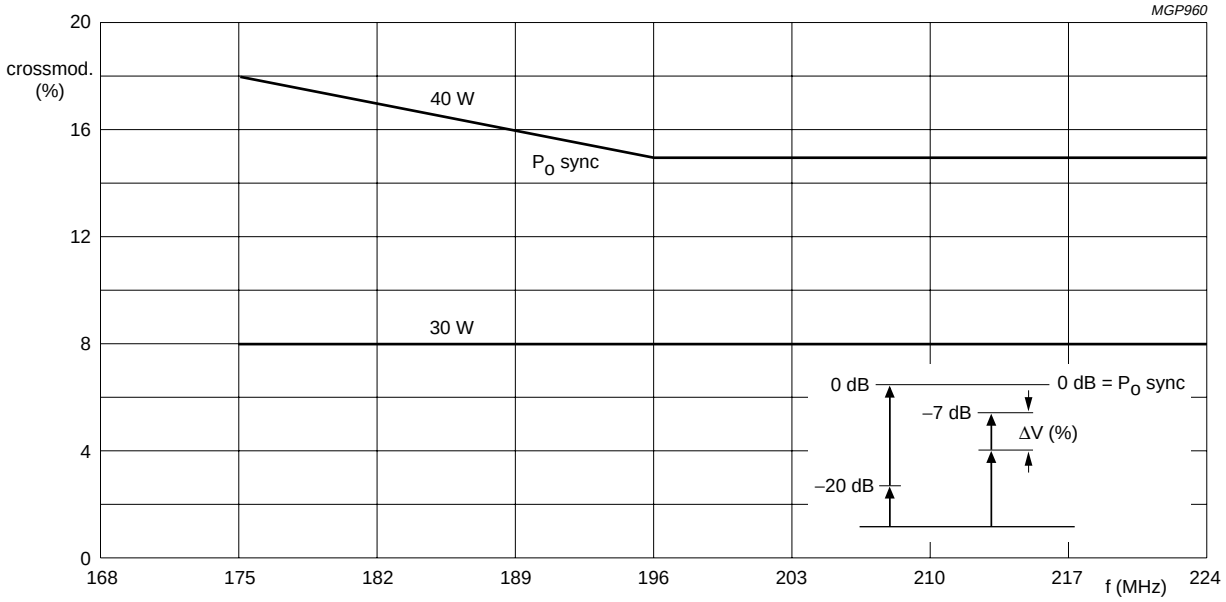
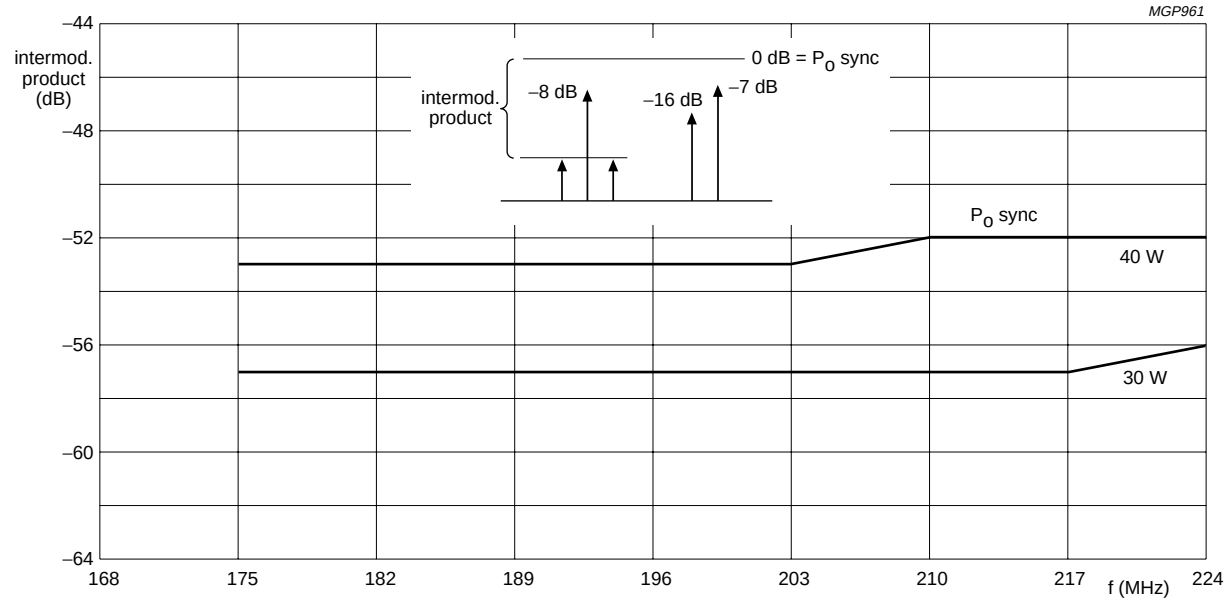


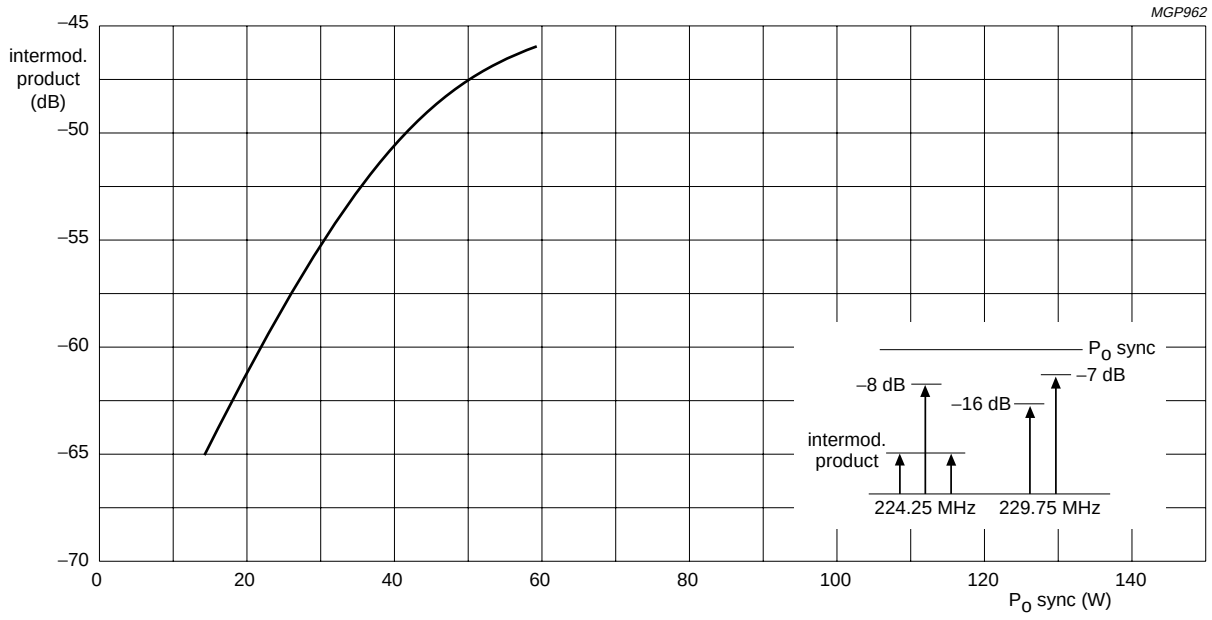
Fig.3 Class A bias circuit for a single transistor BLV33F.





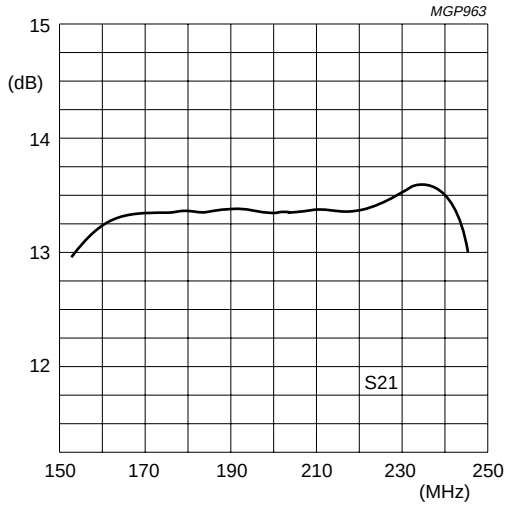
2× BLV33F Class A linear power amplifier.
V_{CE} – 25 V – I_C = 2 × 3.25 A – T_{amb} – 23 °C – Th = 65 °C.

Fig.4 Crossmodulation and intermodulation products of the 2× BLV33F wideband Band III linear power amplifier.

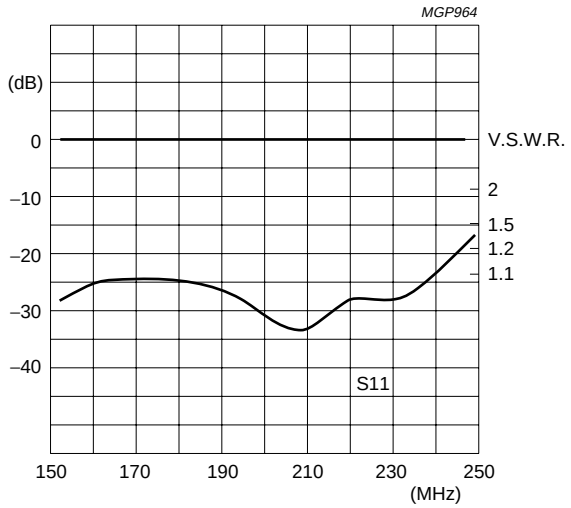


2× BLV33F Band III amplifier.
V_{CE} = 25 V; I_C = 2 × 3.25 A; T_{amb} = 23 °C; Th = 65 °C.

Fig.5 3-tone intermodulation product as function of Po sync. Vision freq. 224 MHz; sound freq 229.5 MHz.

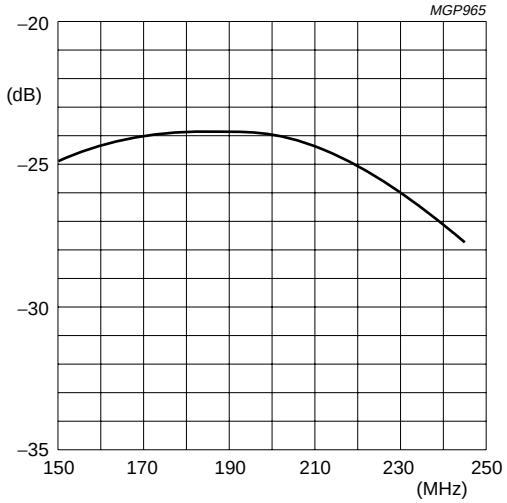


a. Forward transducer gain.

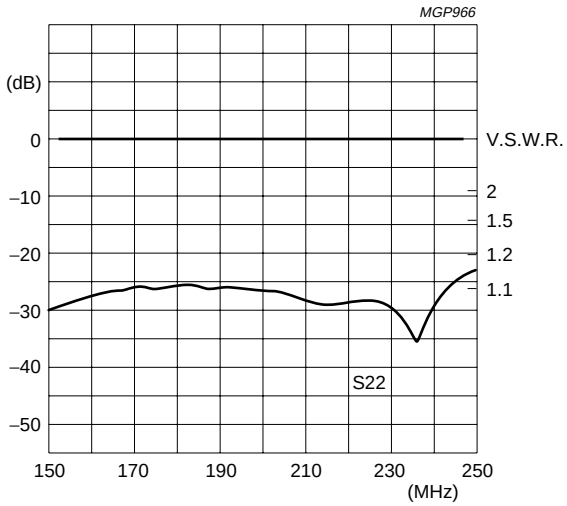


b. Input voltage standing wave ratio.

Fig.6 2× BLV33F wideband Band III power amplifier.



a. Reverse transducer gain.



b. Output voltage standing wave ratio.

Fig.7 2× BLV33F wideband power amplifier.

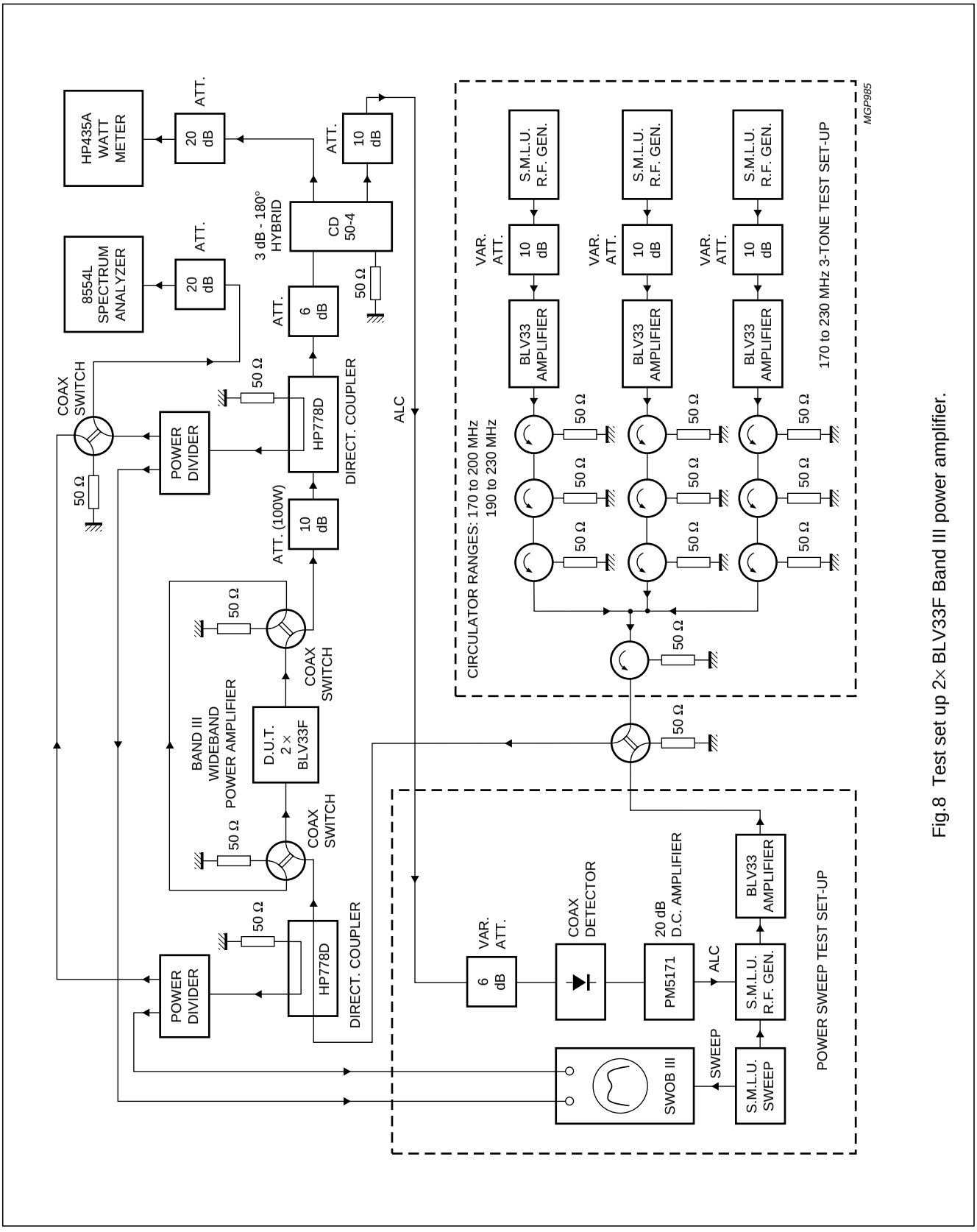


Fig.8 Test set up 2× BLV33F Band III power amplifier.

Unfortunately the numbers in the lay-out of Fig.9 do not correspond with those of the schematic diagram of Fig.1. The reader is referred to the translation Table 5.

Table 5

NUMBER IN LAY-OUT (see Fig.9)	**NUMBER OF SCHEMATIC DIAGRAM** (see Fig.1)
R1	R3
R2	R5
R3	R6
C2	C1
C3	C3
C4	C4
C5	C7
C6	C8
C7	C11
C8	C14
C9	C15
C10	C19
C11	C13
C12	C21
C13	C22
C14	C25
C15	C26
C16	C27
C17	C31
C18	C32
C19	C35
L1	L1
L3	L3
L6	L11
L9	L17

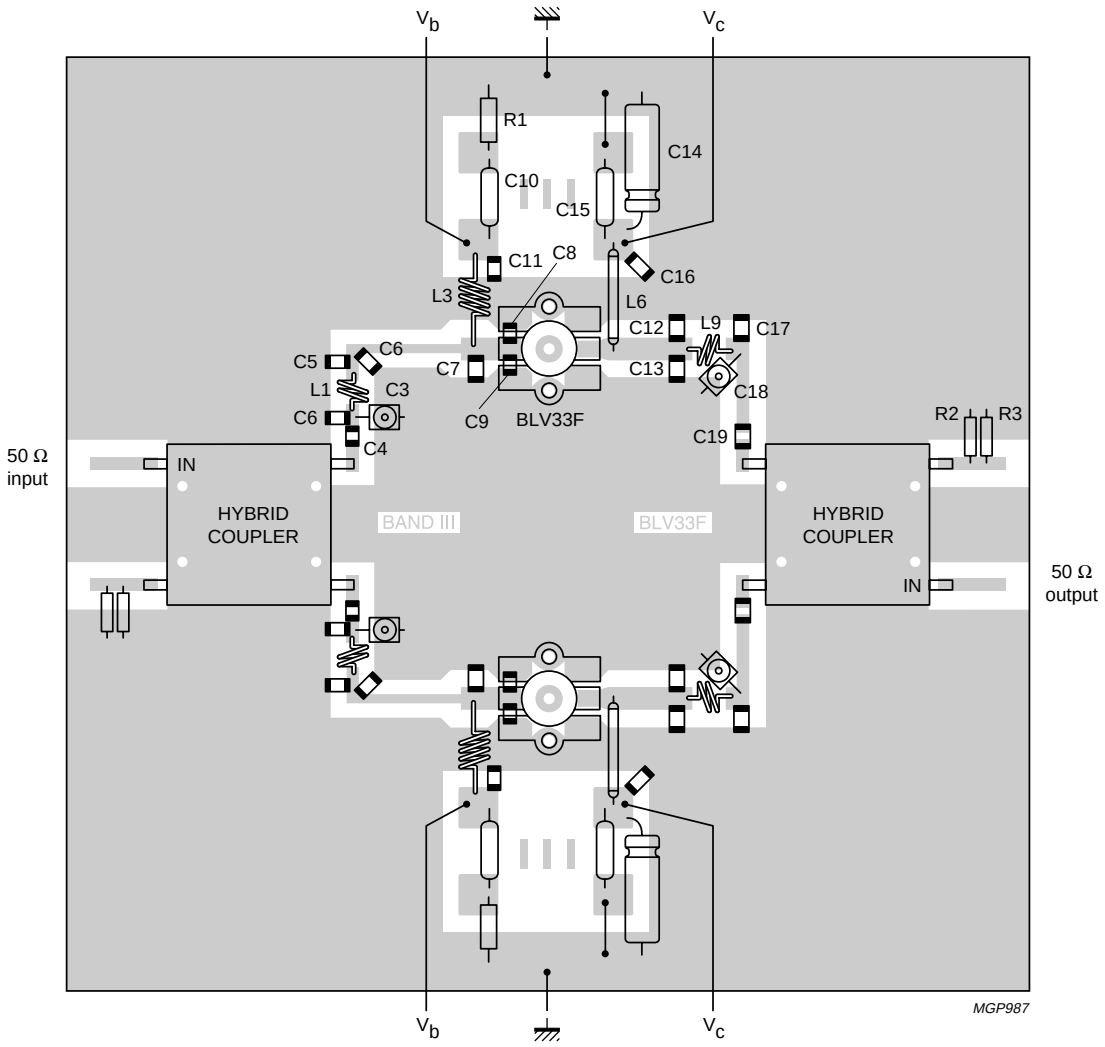


Fig.9 Lay-out of amplifier with situation of components.

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