APPLICATION NOTE

15 W class-AB amplifier with the BLV2044 for 1930 – 1990 MHz (PCS)

AN98022

Philips
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CONTENTS

1 INTRODUCTION

In this application note a 15 W linear base station amplifier for the 1930 – 1990 MHz PCS band is given.
The amplifier is equipped with the Philips BLV2044, a NPN silicon planar transistor in a 2-lead SOT437 flange package. The BLV2044 features internal input- and output matching to achieve high power gain and collector efficiency, and to ease the design of wideband circuits. Other features of the BLV2044 are gold top metallization for excellent reliability and emitter ballasting resistors for optimum temperature profile. When operated from a 26 V supply in class-AB mode the transistor has a minimum power gain of 8 dB and a minimum collector efficiency of 40% at 15 W CW output power level. Two-tone IMD performance is typically –30 dBc

2 CIRCUIT DESCRIPTION

The circuit diagram of the amplifier is given in Fig.1. Substrate material used in double copper-clad Rogers 6006, with a dielectrical constant of 6.15 and a substrate thickness of 0.635 mm (0.025”). Low Q matching networks at input- and outputside of the transistor are designed for an optimum gain flatness and efficiency over the PCS band. Bypass capacitors C5 and C7 resonate at approximately 2 GHz. Capacitors C2, C3 and C8 are added to improve intermodulation distortion. A list of components and stripline dimensions is given in Table 1. Figure 2 includes printed-circuit board and component layout for PCS applications.

3 DC BIAS CIRCUIT

Figure 3 does include an example for a temperature compensated DC bias circuit, which operates from a 15 V supply voltage and ensures a constant bias voltage. R5 is added in series for a flat response of the intermodulation distortion over the amplifier’s total dynamic range. See application note AN98026 for more background information.

4 RF MEASUREMENT RESULTS

All measurements were taken at 26 V supply voltage at a frequency of 1950 MHz and a heatsink temperature of 25 °C. Both input and output were fixed tuned.

- Gp and ηc = f(PL), PL = f(Pin)
- Gp = f(Pd), IMD = f(PL), d3 = f(PL).

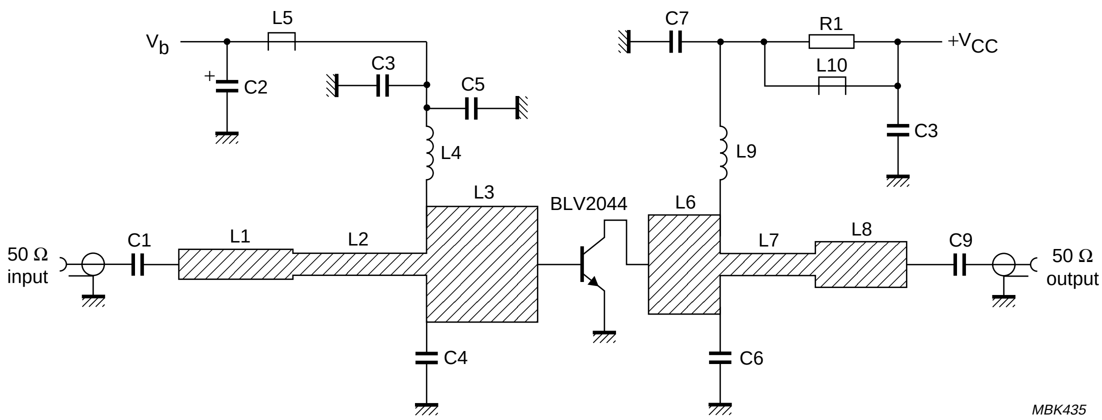
Important: demoboard must be placed on a heatsink in order to get a proper cooling.

Single-tone performance curves are presented in, Figs 4 to 7 at an I_{cq} of 40 mA. Figure 8 presents the gain expansion versus drive level at serval I_{cq} settings. Two-tone intermodulation behaviour of the amplifier is presented in Figs 9 and 10.

5 CONCLUSIONS

The amplifier described can be used in PCS applications and is able to deliver 15 W CW power with a gain of 9 dB and an efficiency of 47%. For two-tone operation IMD-3 is below –32 dBc for optimum I_{cq} setting.

The matching networks applied also allow operation in the DCS 1800 band.



See Table 1: List of components.

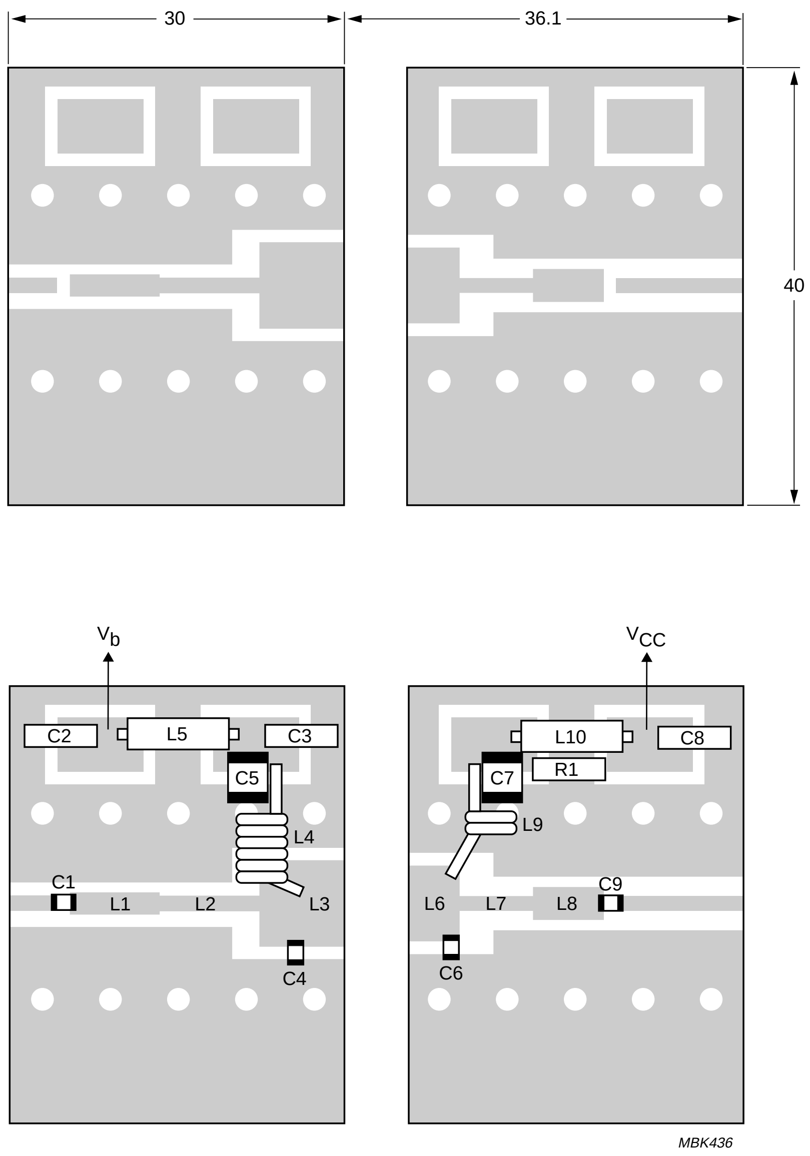
Fig.1 Class-AB testcircuit for 1.8 to 2 GHz.

Table 1 List of components

COMPONENT	DESCRIPTION	VALUE	DIMENSIONS	CATALOGUE NO.
C1, C9	multilayer ceramic chip capacitor; note 1	30 pF		
C2	tantal SMD capacitor	35 V; 10 μF		
C3	multilayer ceramic chip capacitor	22 nF		2222 629 08223
C4	multilayer ceramic chip capacitor; note 1	1.1 pF		
C5, C7	multilayer ceramic chip capacitor; note 2	20 pF		
C6	multilayer ceramic chip capacitor; note 1	1.2 pF		
C3	multilayer ceramic chip capacitor	100 nF		2222 852 47104
L1	stripline; note 3	31 Ω	7.8 × 2 mm	
L2	stripline; note 3	40 Ω	8.8 × 1.4 mm	
L3	stripline; note 3	10 Ω	8 × 8 mm	
L4	5 turns enamelled 1 mm copper wire	38 nH	int. dia = 3 mm; length = 8 mm	
L5, L10	grade 4S2 ferroxcube chip-bead			4330 030 36301
L6	stripline; note 3	12 Ω	5 × 7 mm	
L7	stripline; note 3	40 Ω	6.7 × 1.4 mm	
L8	stripline; note 3	23 Ω	6.4 × 3 mm	
L9	2 turns enamelled 1 mm copper wire	9 nH	int. dia = 3 mm; length = 4 mm	
R1	metal film resistor	10 Ω; 0.4 W		2311 153 51009

Notes

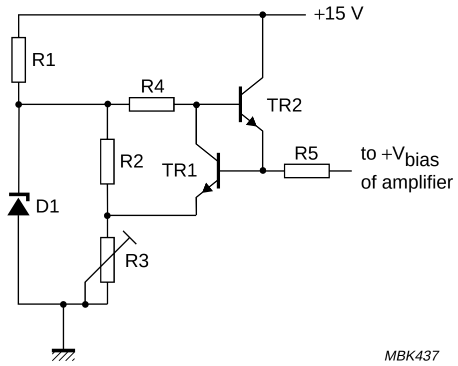
1. American Technical Ceramics type 100A or capacitor of same quality.
2. American Technical Ceramics type 100B or capacitor of same quality.
3. The striplines are on a double copper-clad Printed-circuit board with epoxy fibre-glass dielectric (ε_r = 6.15); thickness 0.64 mm.



Dimensions in mm.

The components are situated on one side of the copper-clad epoxy fibre-glass board, the other side is unetched and serves as a ground plane. Earth connections from the component side to the ground plane are made by through metallization.

Fig.2 printed-circuit board and component layout for 1.8 to 2 GHz class-AB testcircuit.

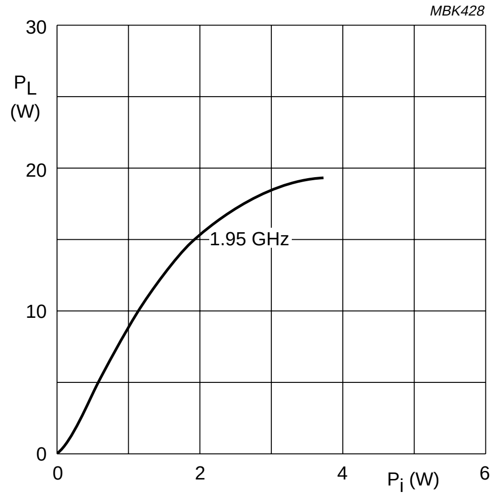


See Table 2.

Fig.3 Class AB bias network.

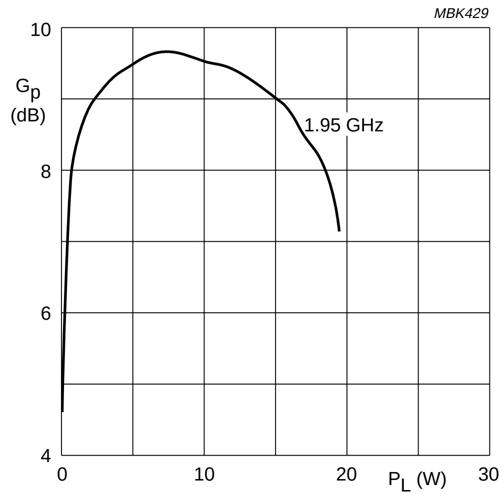
Table 2

COMPONENTS	TYPE NUMBER	DESCRIPTION
Semiconductors		
D1	BZX84, C6V2	SMD Zener Diode
T1	MJD31C	SMD NPN Transistor
T2	BC846C	SMC NPN Transistor
Resistors		
R1	1.1 kΩ	SMD resistor Philips 1206
R2	4.3 kΩ	SMD resistor Philips 1206
R3	500 Ω	Bourns 10 turn
R4	3 kΩ	SMD resistor Philips 1206
R5	3.3 Ω	SMD resistor Philips 1206
R6	11 Ω	SMD resistor Philips 1206



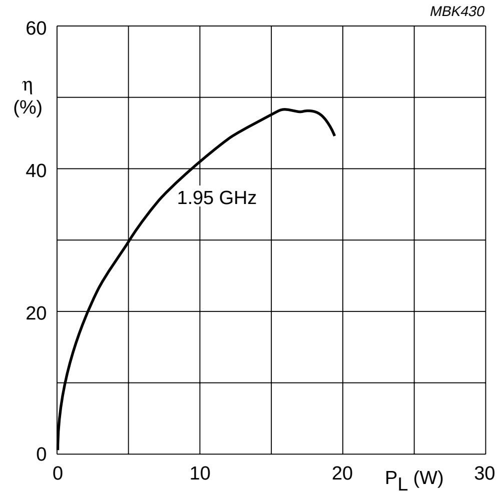
V_{CE} = 26 V; I_{cq} = 40 mA.

Fig.4 Output power versus input power; typical value.



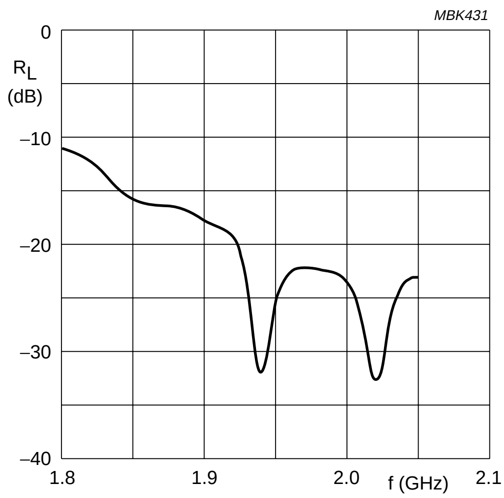
V_{CE} = 26 V; I_{cq} = 40 mA.

Fig.5 Power gain versus output power; typical level.



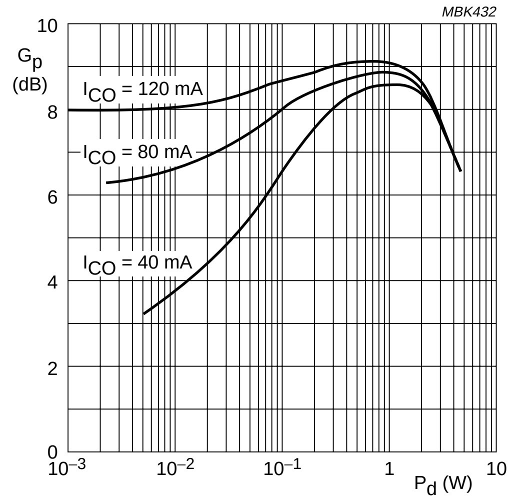
V_{CE} = 26 V; I_{cq} = 40 mA.

Fig.6 Efficiency versus output power; typical level.



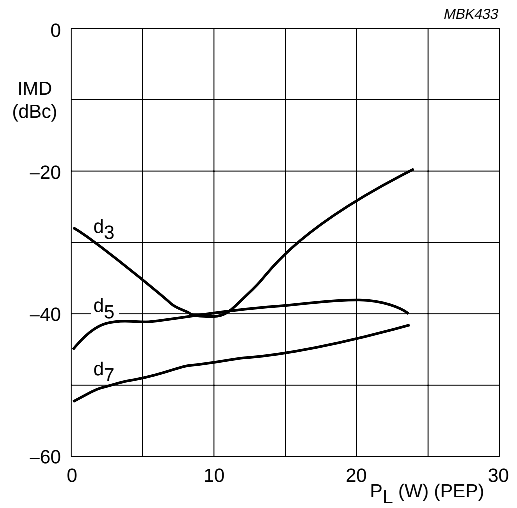
V_{CE} = 26 V; I_{cq} = 40 mA.

Fig.7 Input return loss versus frequency.



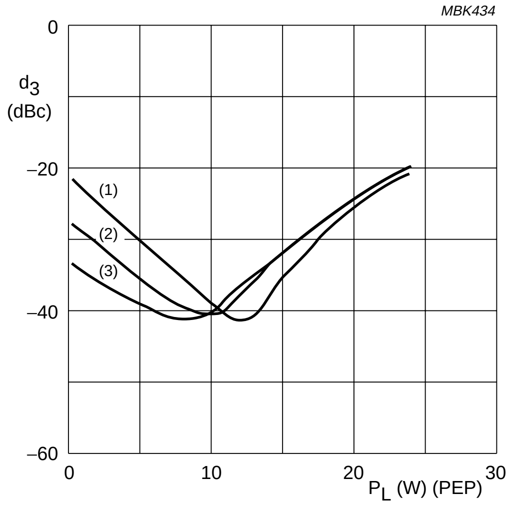
V_{CE} = 26 V; f = 1950 MHz.

Fig.8 Power gain expansion as a function of the drive power: typical values.



V_{CE} = 26 V; I_{cq} = 40 mA; f_2 = 1950 MHz; f_1 = 1950.1 MHz.

Fig.9 Intermodulation distortion as a function of the load power: typical values.



V_{CE} = 26 V; f_1 = 1950 MHz; f_2 = 1950.1 MHz.
(1) I_{cq} = 20 mA.
(2) I_{cq} = 40 mA.
(3) I_{cq} = 60 mA.

Fig.10 Intermodulation distortion as a function of the load power: typical values.

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