

APPLICATION NOTE

**9 W Linear Class-AB Amplifier
with the BLV909 for
935 – 960 MHz**

AN98020

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1 INTRODUCTION

This application note contains information on a 9 W class-AB amplifier based on the SMD transistor BLV909. The amplifier described can be used for driver stages in cellular radio base stations in GSM band 935 – 960 MHz. The next sections contain information on the transistor, the amplifier construction and the typical RF performance obtained.

2 TRANSISTOR BACKGROUND

The BLV909 is an NPN bipolar RF power transistor in an 8-lead SMD package called SOT409. The package contains an Aluminium Nitride (AlN) substrate to enhance its thermal performance. The bottom surface is fully metallized to enable reflow soldering of the transistor to the PCB. All leads are isolated from the bottom surface and a ceramic lid is used to cover the transistor. The BLV909 features internal input matching for easy wide band matching over the 935 – 960 MHz frequency band. When operated from a 26 V supply in class-AB mode the transistor has a minimum power gain of 9.5 dB and a minimum collector efficiency of 50%. Two tone IMD performance is typically –30 dBc.

3 AMPLIFIER BACKGROUND

Figure 1 shows the schematic diagram of the amplifier. The matching circuits applied are fixed tuned two-stage lowpass networks using striplines and multilayer chip capacitors. Conventional bias decoupling networks are applied with improved decoupling for two-tone operation. The list of components and stripline dimensions is given in Tabel 2. Figure 2 contains the printed-circuit board lay-out and components topology of the amplifier. The printed-circuit board contains a footprint of solder pads for collector and base lead interconnect and a thermal pad with vias to provide a low thermal resistance path to the package. Pads with vias for RF grounding of the emitter leads are intergrated with the thermal pad. All SMD components were reflow soldered to the printed-circuit board. The printed-circuit board was soldered to a heatsink in the same process step. More details on the mounting considerations for the SOT409B can be found in application note AN98017. The printed-circuit board material used is Rogers RT/Duroid 6010 with a dielectric constant of 10.2 and thickness of 0.64 mm.

4 AMPLIFIER PERFORMANCE

The amplifiers performance was measured at $V_{ce} = 26$ V and $I_{cq} = 25$ mA. The heatsink temperature was held at 25 °C during the measurement. A summary of the performance is given in Table 1.

Table 1

	UNIT	SINGLE-TONE	TWO-TONE
Frequency band	MHz	935 – 960	935 – 960
Load power	W	9	9 (PEP)
Power gain	dB	11	11.5
Power gain flatness	dB	<0.5	–
Collector efficiency	%	50	40
Intermodulation distortion	dBc	–	–32 @ 9 W PEP

Single-tone performance curves are presented in:

Figure 3; Load power (P1) versus drive power (Pd).

Figure 4; Power gain (Gp) and collector efficiency (Eff) versus load power (P1).

2-tone performance curves are presented in:

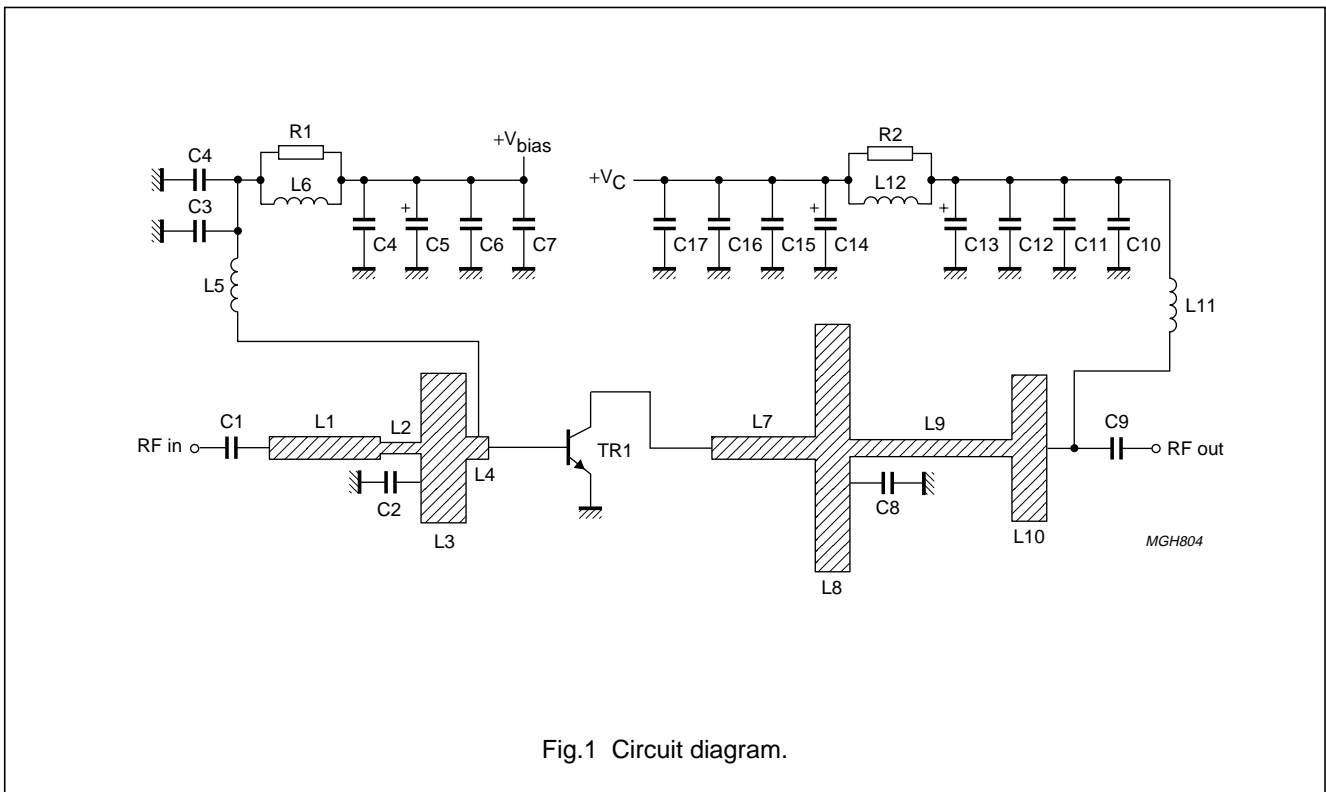
Figure 5; Load power (P1-PEP) versus drive power (Pd-PEP)

Figure 6; Power gain (Gp) and collector efficiency (Eff) versus load power (P1-PEP)

Figure 7; Intermodulation distortion (d3) as function of load power (P1-PEP).

5 CONCLUSIONS

An AlN based surface mountable transistor BLV909 has been used to develop an amplifier for driver application in GSM base stations. Biased at 26 V and 25 mA this amplifier has shown a 9 W CW power output capability with a gain of 11 dB and a collector efficiency 50%. For 2-tone operation the IMD performance is better than -32 dBc at 9 W PEP. In addition the IMD over a wide dynamic range can be further optimized by adding a base series resistor of a few ohms combined with a good selection of Icq as described in application note AN98026.



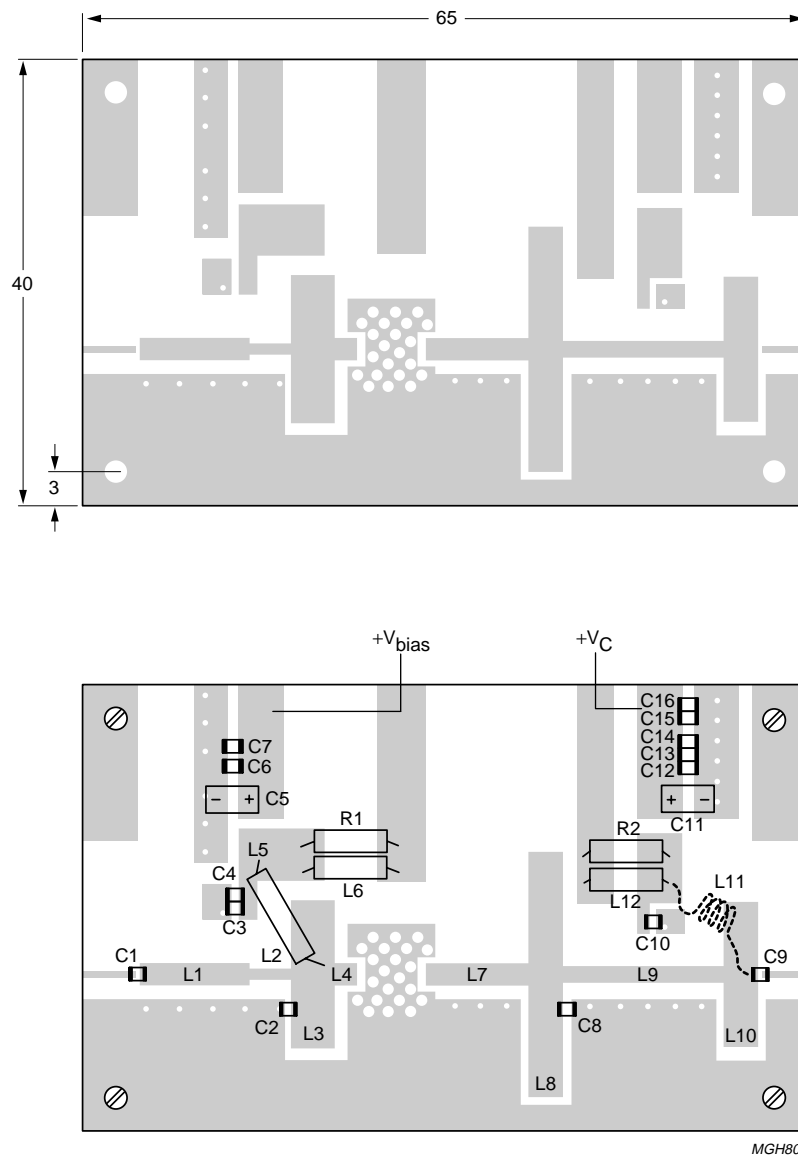


Fig.2 Printed-circuit board and lay-out amplifier.

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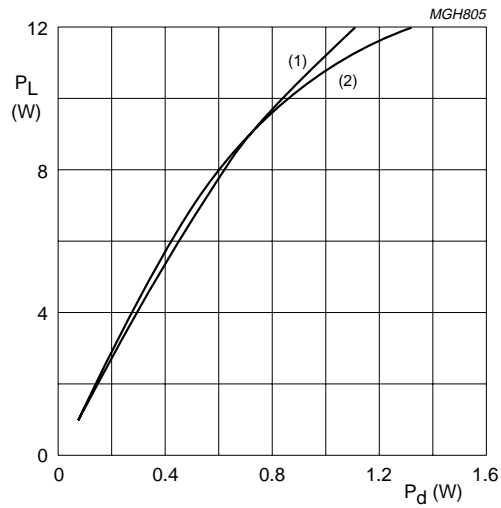
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Table 2

COMPONENT	DESCRIPTION	VALUE	DIMENSIONS	CATALOGUE NO.
C1 and C9	multilayer ceramic chip capacitor; note 1	24 pF		
C2	multilayer ceramic chip capacitor; notes 1 and 2	5.6 pF		
C3, C7, C10 and C16	multilayer ceramic chip capacitor; note 3	110 pF		
C4 and C15	multilayer ceramic chip capacitor; note 3	200 pF		
C5 and C11	tantal SMD capacitor	35 V; 10 μ F		
C6, C12, C13 and C14	ceramic chip capacitor	100 nF		2222 852 47104
C8	multilayer ceramic chip capacitor; note 1	8.2 pF		
L1	stripline	24.3 Ω	9.85 \times 2 mm	
L2	stripline	37.5 Ω	3.63 \times 1 mm	
L3	stripline	5.11 Ω	4.1 \times 13.3 mm	
L4	stripline	24.3 Ω	2 \times 2 mm	
L5	RF choke	0.22 μ H		
L6, L12	grade 4S2 ferroxcube chip-bead			4330 030 36301
L7	stripline	24.3 Ω	9.2 \times 2 mm	
L8	stripline	3.2 Ω	3.1 \times 22 mm	
L9	stripline	29.4 Ω	14.4 \times 1.5 mm	
L10	stripline	5.22 Ω	3.2 \times 13 mm	
L11	5 turns enamelled 1 mm copper wire	35 nH	int. dia. = 3.2 mm pitch = 1.23 mm	
R1 and R2	metal film resistor	100 Ω ; 0.4 W		
T1	RF transistor	BLV909		

Notes

1. American Technical Ceramics type 100A or capacitor of same quality.
2. For operation 820 – 900 MHz: $C_2 = 6.2$ pF.
3. American Technical Ceramics type 100B or capacitor of same quality.



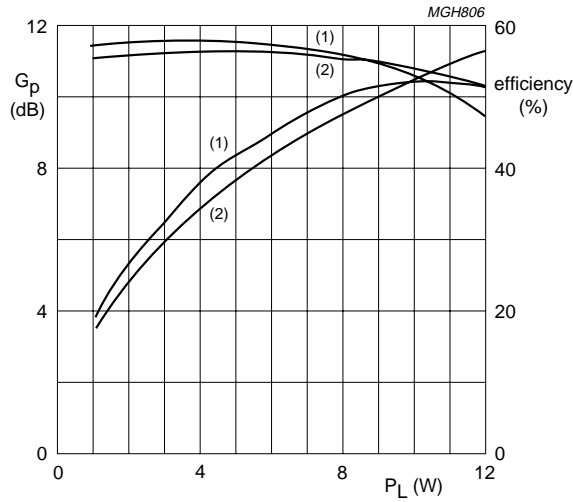
- (1) f = 960 MHz.
- (2) f = 935 MHz.

Class AB: $V_{ce} = 26\text{ V}$, $I_{cq} = 25\text{ mA}$, 9 W loadline, f = 960 MHz.

Fig.3 BLV909 PL = f (Pd).

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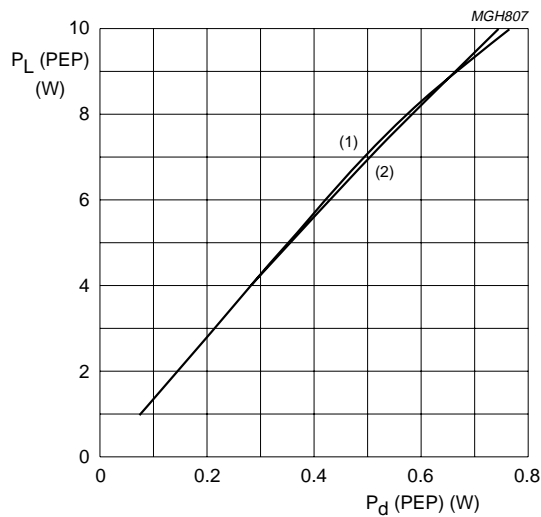
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- (1) f = 935 MHz.
- (2) f = 960 MHz.

Class AB: $V_{ce} = 26\text{ V}$, $I_{cq} = 25\text{ mA}$, 9 W loadline, $f_1 = 960\text{ MHz}$.

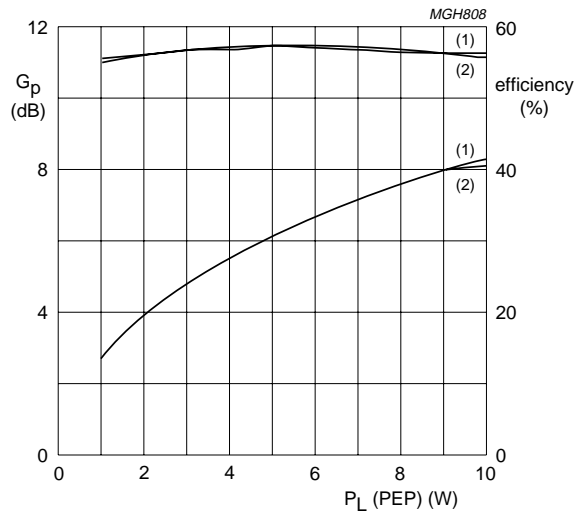
Fig.4 BLV909 Gp and Eff. = f (PL).



- (1) f = 960 MHz.
- (2) f = 935 MHz.

Class AB: $V_{ce} = 26\text{ V}$, $I_{cq} = 25\text{ mA}$, 9 W PEP loadline $\Delta f = 0.1\text{ MHz}$, $f_1 = 960.1\text{ MHz}$.

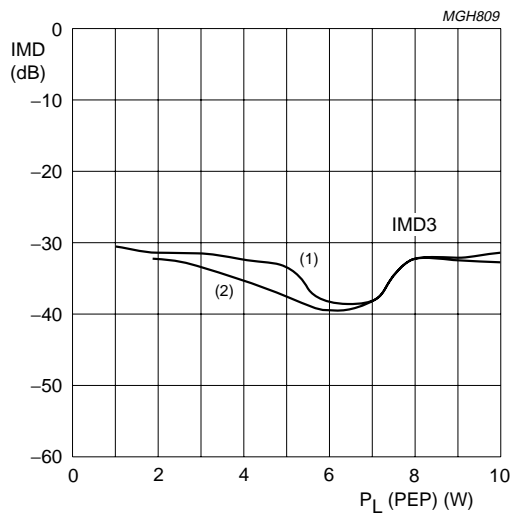
Fig.5 BLV909 PL-PEP = f (Pd).



- (1) f = 960 MHz.
- (2) f = 935 MHz.

Class AB: $V_{ce} = 26$ V, $I_{cq} = 25$ mA, 9 W PEP loadline, $\Delta f = 0.1$ MHz, $f_1 = 960$ MHz, $f_2 = 960$ MHz.

Fig.6 BLV909 G_p and Eff. = f (PL-PEP).



- (1) f = 960 MHz.
- (2) f = 935 MHz.

Class AB: $V_{ce} = 26$ V, $I_{cq} = 25$ mA, 9 W PEP loadline, $\Delta f = 0.1$ MHz, $f_1 = 960$ MHz, $f_2 = 960.1$ MHz.

Fig.7 BLV909 IMD = f (PL PEP).

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