APPLICATION NOTE

5 W Class-AB Amplifier with the BLV904 for 935 – 960 MHz

AN98019

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INTRODUCTION

This application note contains information on a 5 W class-AB amplifier based on the SMD transistor BLV904. The amplifier described can be used for driver stages in cellular radio base stations in the GSM band 935 – 960 MHz. The next chapters contain information on the transistor, the amplifier construction and the typical RF performance obtained.

TRANSISTOR BACKGROUND

The BLV904 is an NPN bipolar RF power transistor in an 8-lead SMD package called SOT409. The package contains an Aluminium Nitride (AIN) substrate to enhance its thermal performance. The bottom surface is fully metallized to enable reflow soldering of the transistor to the printed-circuit board. All leads are isolatad from the bottom surface and a ceramic lid is used to cover the transistor. The BLV904 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 13 dB and a minimum collector efficiency of 50%. Two tone IMD performance is typically below –30 dBc.

AMPLIFIER DESCRIPTION

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 inTable 2.
Figure 2 contains the printed-circuit board layout 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 integrated 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 pc-board material used is Rogers RT/Duroid 6010 with a dielectric constant of 10.2 and a thickness of 0.64 mm.

AMPLIFIER PERFORMANCE

The amplifiers performance was measured at V_{CE} = 26 V and I_{cq} = 15 mA. The heatsink temperature was held at 25 °C during the measurement. A summary of the performance is given in the Table 1.

Table 1

	UNIT	SINGLE-TONE	TWO-TONE
Frequency band	MHz	935 – 960	935 – 960
Load power	W	5	5 (PEP)
Power gain	dB	15.5	15.5
Power gain flatness	dB	1.9	–
Collector efficiency	%	53	40
Intermodulation distortion	dBc	–	–30 up to 5 W PEP

Single-tone performance curves are presented in:
Figure 3; Load power (Pl) versus drive power (Pd);
Figure 4; Power gain (Gp) and collector efficiency (Eff) versus load power (Pl).

Two-tone performance curves are presented in:
Figure 5; Load power (Pl-PEP) versus drive power (Pd-PEP)
Figure 6; Power gain (Gp) and collector efficiency (Eff) versus load power (Pl-PEP)
Figure 7; Intermodulation distortion (d3) as function of load power (Pl-PEP)

CONCLUSION

An AIN based surface mountable transistor BLV904 has been used to develop an amplifier for driver application in GSM base stations. Biased at 26 V and 15 mA this amplifier has shown a 5 W CW power output capability with a gain of 15 dB and a collector efficiency 53%. For two-tone operation the IMD performance is better than –31 dBc up to 5 W PEP. In addition the IMD over a wide dynamic range can be further optimized by adding a base series resistor of a few Ω combined with a good selection of I_{cq} as described in application note AN98026.

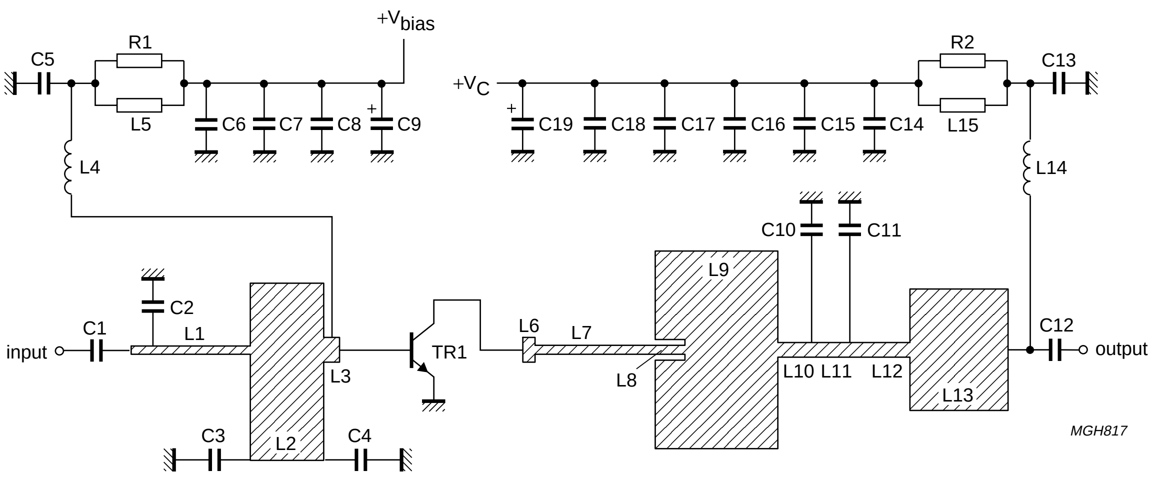


Fig.1 Schematic diagram.

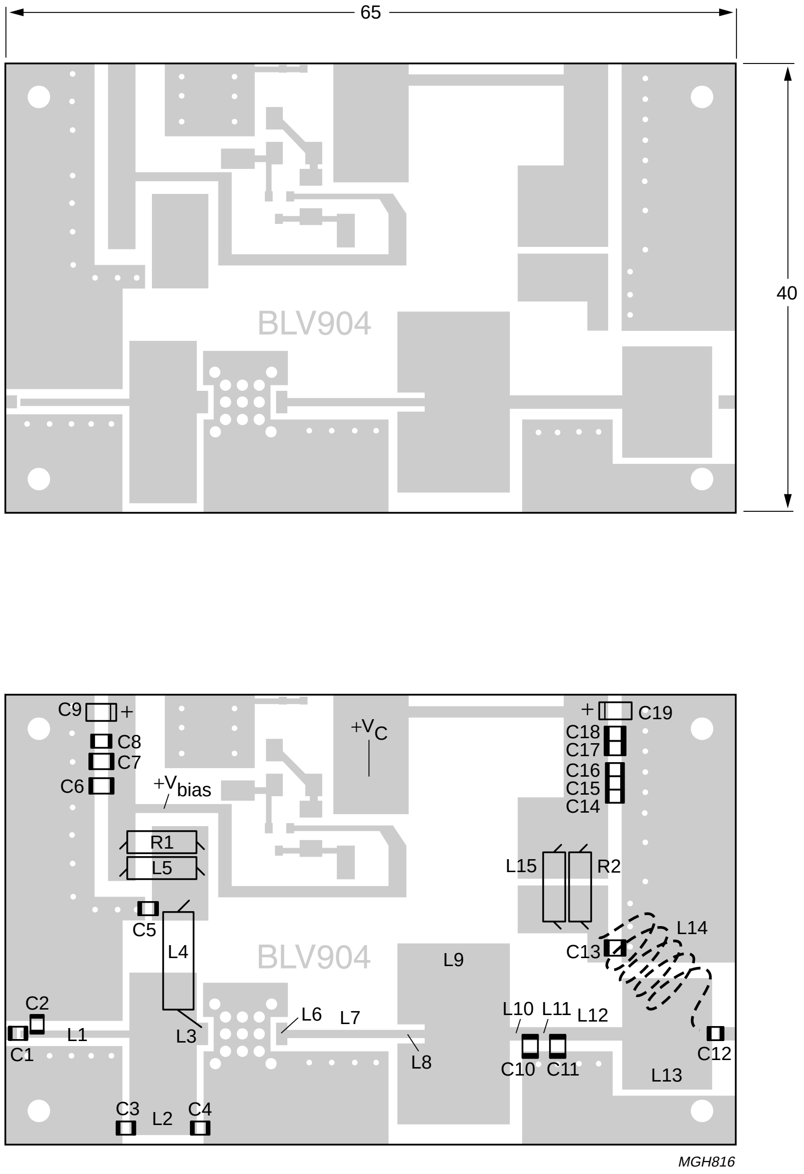


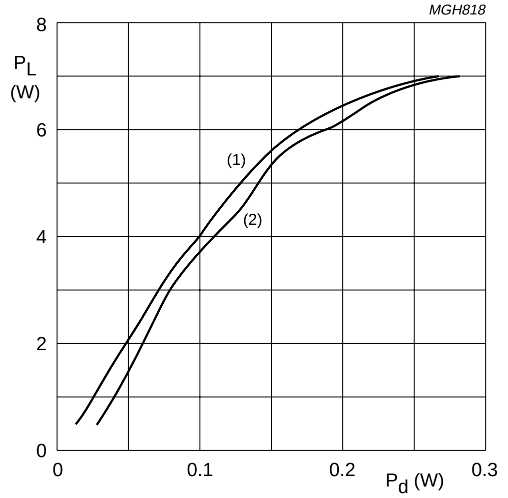
Fig.2 Printed-Circuit board and layout amplifier.

Table 2

COMPONENT	DESCRIPTION	VALUE	DIMENSIONS	CATALOGUE NO.
C1, C12	multilayer ceramic chip capacitor; note 1	24 pF		
C2	multilayer ceramic chip capacitor; note 1	3.3 pF		
C3	multilayer ceramic chip capacitor; note 1	2.2 pF		
C4	multilayter ceramic chip capacitor; note 1	1.6 pF		
C5, C6, C13, C18	multilayer ceramic chip capacitor; note 2	200 pF		
C7, C17	multilayer ceramic chip capacitor; note 2	100 pF		
C8, C14, C15, C16	multilayer ceramic chip capacitor	100 nF		2222 581 16641
C9, C19	tantal SMD capacitor	35 V, 10 μF		
C10	multilayer ceramic chip capacitor; note 1	1.8 pF		
C11	multilayer ceramic chip capacitor; note 1	13 pF		
L1	stripline; note 3	50 Ω	8.2 × 0.65 mm	
L2	stripline; note 3	4.9 Ω	6 × 14 mm	
L3, L6	stripline; note 3	24.5 Ω	1.5 × 2 mm	
L4	RF-choke	0.22 μH		
L5, L15	grade 4S2 ferroxcube chip-bead			4330 030 36301
L7	stripline; note 3	46.3 Ω	12.22 × 0.7 mm	
L8	stripline: L8 not connected over total length, only 7.58 mm. connected; note 3	4.3 Ω	7.58 × 16.1 mm	
L9	stripline; note 3	4.3 Ω	10 × 16.1 mm	
L10	stripline; note 3	34.3 Ω	1.9 × 1.2 mm	
L11	stripline; note 3	34.3 Ω	3.2 × 1.2 mm	
L12	stripline; note 3	34.3 Ω	4.8 × 1.2 mm	
L13	stripline; note 3	6.7 Ω	8 × 9.9 mm	
L14	5 turns enamelled 1 mm copper wire			
R1	metal film resistor	100 Ω; 0.4 W		
T1	RF transistor	BLV904		

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 double copper-clad printed-circuit board RT/Duroid 6010 (ε_r = 10.2); thickness 0.64 mm.

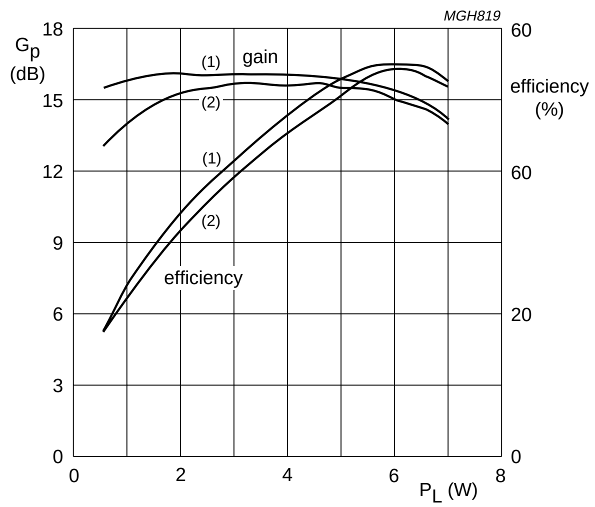


(1) f = 960 MHz.

(2) f = 935 MHz.

Pd(W); Class AB: V_{ce} = 26 V; I_{cq} = 15 mA; 5 W loadline, f = 960 MHz.

Fig.3 PL = f (Pd).

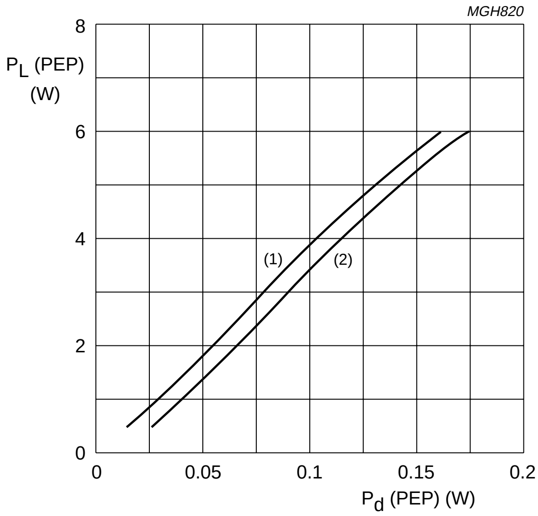


(1) f = 960 MHz.

(2) f = 935 MHz.

PL(W); Class AB: V_{ce} = 26 V; I_{cq} = 15 mA; 5 W loadline, f = 960 MHz.

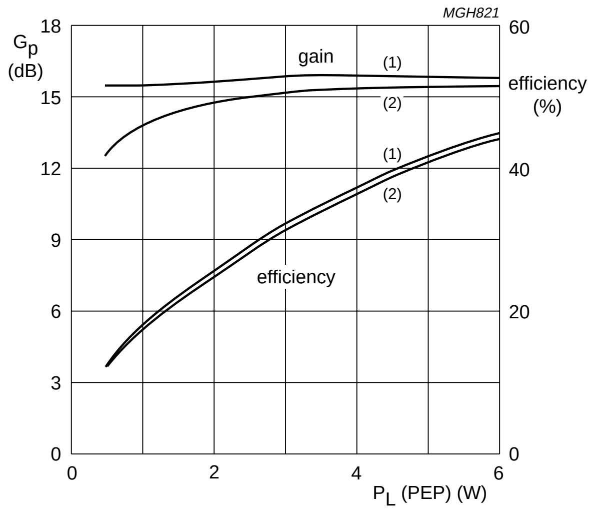
Fig.4 Gp and Eff. = f(PL).



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

Pd-PEP(W); Class AB: V_{ce} = 26 V; I_{cq} = 15 mA; 5 W PEP loadline; delta-f = 0.1 MHz, f1 = 960 MHz, f2 = 960.1 MHz.

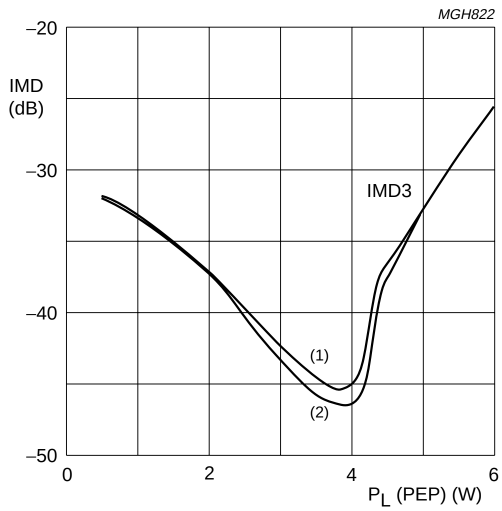
Fig.5 PL-PEP = f (Pd).



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

PL-PEP(W); Class AB: V_{ce} = 26 V; I_{cq} = 15 mA; 5 W PEP loadline; delta-f = 0.1 MHz, f2 = 960.1 MHz.

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



(1) f = 960 MHz.

(2) f = 935 MHz.

PL-PEP(W); Class AB: V_{ce} = 26 V; I_{cq} = 15 mA; 5 W PEP loadline; delta-f = 0.1 MHz, f1 = 960 MHz, f2 = 960.1 MHz.

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

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