

APPLICATION NOTE

The BLF246 as an H.F.-S.S.B. amplifier

NCO8801

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Application Note
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CONTENTS

- 1 SUMMARY
- 2 INTRODUCTION
- 3 NARROW BAND TEST AT 28 MHz
- 4 WIDEBAND OPERATION
- 5 ACKNOWLEDGEMENT

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Application Note
NCO8801

1 SUMMARY

This report gives information on the BLF246 as a linear amplifier at 28 MHz for S.S.B. signals.

Typically the device produces an output power of 80 W P.E.P. at an I.M. distortion of -34 dB.

At a supply voltage of 28 V the power gain is 20 dB and the 2-tone efficiency 40%.

For the design of wideband amplifiers in the range of 1.5 – 30 MHz additional information is presented showing that the power gain drops to appr. 19 dB with a variation of ± 0.4 dB.

2 INTRODUCTION

The BLF246 is an R.F. power MOS-transistor in SOT121 package specified at a frequency of 108 MHz and a supply voltage of 28 V for an output power of 80 W C.W.

During the development period this device has also been tested in a class-AB amplifier at 28 MHz to investigate its behaviour as a linear amplifier for possible application in the H.F. band (1.5 – 30 MHz) with S.S.B. modulation.

In that case the 3rd and 5th order intermodulation products are of special interest.

3 NARROW BAND TEST AT 28 MHz

The R.F. circuit used for this purpose is depicted in Fig.1. The optimum drain quiescent current for linear operation of this device in class-AB is 0.6 A.

This is achieved with a V_{gs} which is appr. 0.48 V higher than the specified $V_{gs(th)}$.

The output circuit has been aligned with a dummy load consisting of the parallel connection of a 3.5 Ω resistor and a 400 pF capacitor. This results in a load seen by the transistor of appr. 3.3 Ω with a negligible reactive part.

The capacitors C9 and C10 are used to reduce the second harmonic voltage at the drain.

In a wideband amplifier this is not necessary because the same effect is obtained by other means like a centre-tapped drain choke in a push-pull amplifier.

The input circuit is aligned for minimum reflection at 50% of the maximum output power.

The gate-source damping resistors R1 and R2 are needed for 2 reasons:

1. Stability i.e. to prevent oscillation when the output circuit is detuned
2. Low intermodulation distortion. In general it can be said that I.M. distortion is improved by lowering the value of these resistors. Of course they will influence the power gain of the amplifier.

The average performance of the BLF246 in this amplifier is shown in Figs 2, 3, 4 and 5.

At an output power of 80 W P.E.P. the average performance is:

$G_p = 20$ dB

Eff. = 40% (2-tone)

$d_3 = -34$ dB

$d_5 = -42$ dB.

The distortion products have been measured with respect to one tone.

It must be mentioned that the information given here is typical i.e. it is not guaranteed by measurements on individual transistors.

4 WIDEBAND OPERATION

For operation in the H.F. range (1.5 – 30 MHz) it will be necessary to reduce the value of R_{gs} from 18 Ω as used in the narrow band amplifier down to 12 Ω to obtain a more constant power gain over the band and to achieve a smaller variation in the input impedance to allow an easier matching to a driver stage or a 50 Ω source.

The BLF246 as an H.F.-S.S.B. amplifier

Application Note NCO8801

Table 2 shows the results of a computer calculation on this basis. It appears that the power gain is reduced by appr. 1 dB while the gain variation is then ± 0.4 dB.

The optimum load impedance is still appr. 3.3Ω with a negligible reactive part.

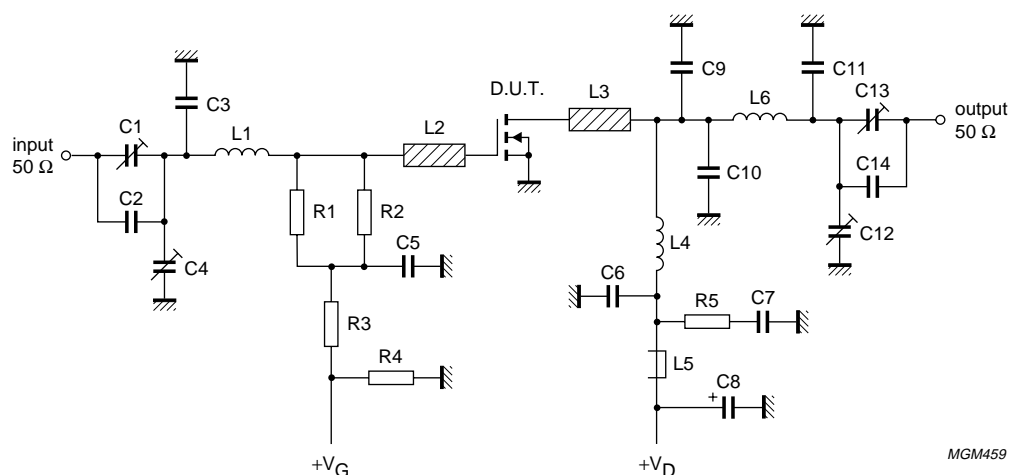
It must be mentioned that the figures given for power gain and input impedance include already the effects of an R_{gs} of 12Ω .

As mentioned earlier the lowering of R_{gs} has a positive effect on the intermodulation behaviour.

For the design of a suitable wideband input matching network one is referred to application report nr. NCO8703.

5 ACKNOWLEDGEMENT

The 28 MHz amplifier described in this report was designed and constructed by Mr. G. Lukkassen of our laboratory. He also made the various measurements.



MGM459

Fig.1 BLF246 Testcircuit at 28 MHz.

The BLF246 as an H.F.-S.S.B. amplifier

Application Note
NCO8801**Table 1** PC-board: double Cu-clad, 1.6 mm PTFE fibre-glas dielectric ($\epsilon_r = 2.2$)

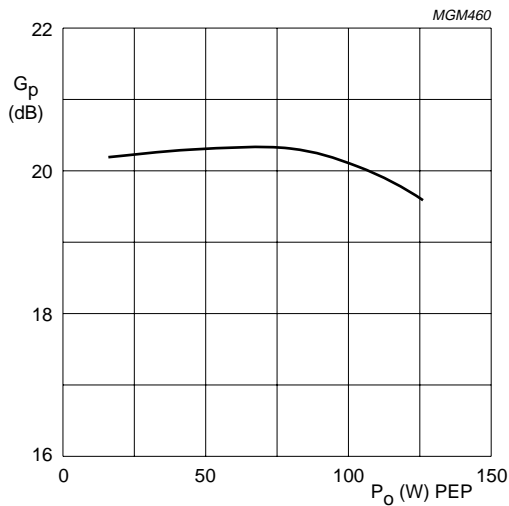
| | | |
|----------------|-------------------|--|
| C1 = C4 | 6 to 80 pF | film dielectric trimmer (cat.nr. 2222 809 07013) |
| C2 | 62 pF | multilayer ceramic chip capacitor; note 1 |
| C3 | 150 pF | multilayer ceramic chip capacitor; note 1 |
| C5 = C6 | 100 nF | multilayer ceramic chip capacitor (cat.nr. 2222 852 47104) |
| C7 | 3×100 nF | multilayer ceramic chip capacitor (cat.nr. 2222 852 47104) |
| C8 | 2.2 μ F | electrolytic capacitor |
| C9 = C10 = C14 | 75 pF | multilayer ceramic chip capacitor; note 1 |
| C11 | 100 pF | multilayer ceramic chip capacitor; note 1 |
| C12 = C13 | 7 to 100 pF | film dielectric trimmer (cat.nr. 2222 809 07015) |
| L1 | 184 nH | 6 turns enamelled Cu-wire (0.7 mm), int.dia: 6 mm |
| L2 = L3 | 41.1 Ω | stripline (10×6 mm) |
| L4 | 278 nH | 7 turns enamelled Cu-wire (1.5 mm), int.dia: 8 mm |
| L5 | | Ferroxcube h.f. core, grade 3B (cat.nr. 4312 020 36642) |
| L6 | 131 nH | 4 turns enamelled Cu-wire (1.5 mm), int.dia: 8 mm |
| R1 = R2 | 34.8 Ω | metal film resistor (cat.nr. 2322 153 53489) |
| R3 | 1 k Ω | metal film resistor (cat.nr. 2322 151 71002) |
| R4 | 1 M Ω | metal film resistor (cat.nr. 2322 151 71005) |
| R5 | 10 Ω | metal film resistor (cat.nr. 2322 153 51009) |

Note

1. American Technical Ceramics type 100B or capacitor of same quality.

The BLF246 as an H.F.-S.S.B. amplifier

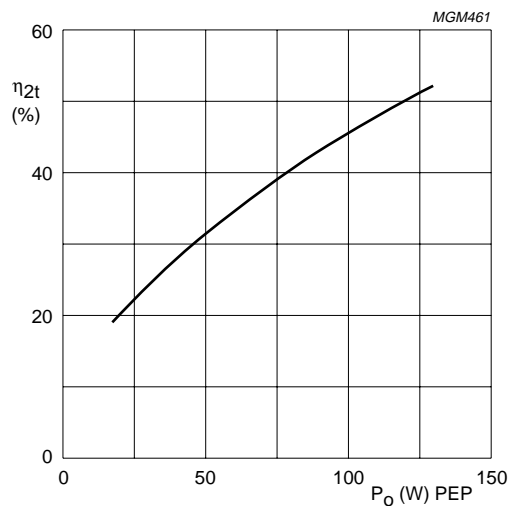
Application Note
NCO8801



Conditions

$f = 28 \text{ MHz}$ $I_{dq} = 0.6 \text{ A}$ $T_h = 25 \text{ }^\circ\text{C}$
 $V_{ds} = 28 \text{ V}$ $R_{gs} = 18 \text{ }\Omega$ $R_{th \text{ mb-h}} = 0.2 \text{ K/W}$

Fig.2 Power gain versus output power.

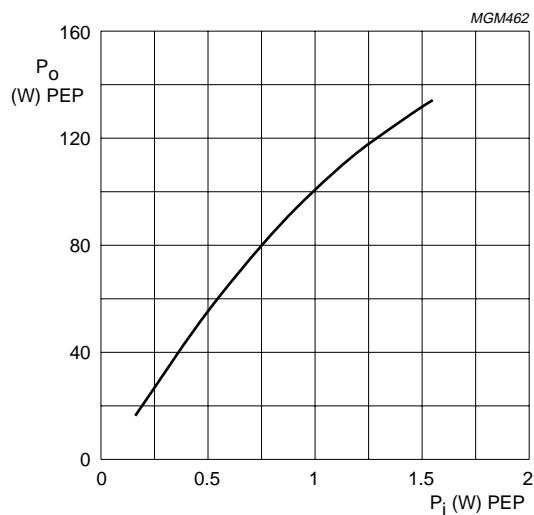


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Fig.3 2-tone efficiency versus output power.

The BLF246 as an H.F.-S.S.B. amplifier

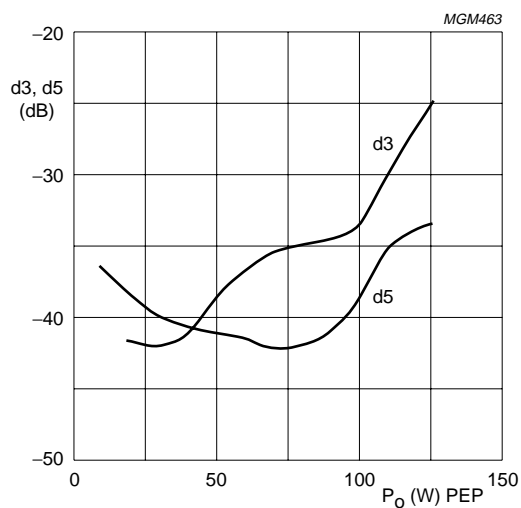
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 $R_{gs} = 18 \Omega$

$T_h = 25^\circ \text{C}$
 $R_{th \text{ mb-h}} = 0.2 \text{ K/W}$

Fig.4 Output power versus drive power.

**Conditions**

$f = 28 \text{ MHz}$
 $V_{ds} = 28 \text{ V}$

$I_{dq} = 0.6 \text{ A}$
 $R_{gs} = 18 \Omega$

$T_h = 25^\circ \text{C}$
 $R_{th \text{ mb-h}} = 0.2 \text{ K/W}$

Fig.5 Intermodulation distortion versus output power.

The BLF246 as an H.F.-S.S.B. amplifier

Application Note
NCO8801**Table 2** Power gain, input and load impedance versus frequency; $I_{dQ} = 0.6$ A; $R_{gs} = 12 \Omega$

| BLF246 | $V_{DS} = 28$ V | $P_O = 80$ W P.E.P. | Class-AB |
|---------------|-----------------------------------|---------------------------------------|------------------|
| f | G | Inp.Imp. | Load Imp. |
| MHz | dB | Ω | Ω |
| 1.5 | 19.57 | $11.97 - j0.51$ | $3.34 + j0.01$ |
| 5.0 | 19.54 | $11.71 - j1.67$ | $3.34 + j0.02$ |
| 10.0 | 19.47 | $10.92 - j3.06$ | $3.33 + j0.04$ |
| 15.0 | 19.35 | $9.86 - j4.03$ | $3.32 + j0.07$ |
| 20.0 | 19.20 | $8.75 - j4.59$ | $3.31 + j0.09$ |
| 25.0 | 19.00 | $7.72 - j4.84$ | $3.30 + j0.11$ |
| 30.0 | 18.77 | $6.83 - j4.86$ | $3.28 + j0.13$ |

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Printed in The Netherlands

Date of release: 1998 Mar 23

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