APPLICATION NOTE

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

NCO8801

Philips
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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 in 0.6 A.
This is achieved with a Vgs which is appr. 0.48 V higher than the specified Vgs(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:

Gp = 20 dB

Eff. = 40% (2-tone)

d3 = –34 dB

d5 = –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 Rgs 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.

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. 3.3 Ω 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 Rgs of 12 Ω.

As mentioned earlier the lowering of Rgs 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.

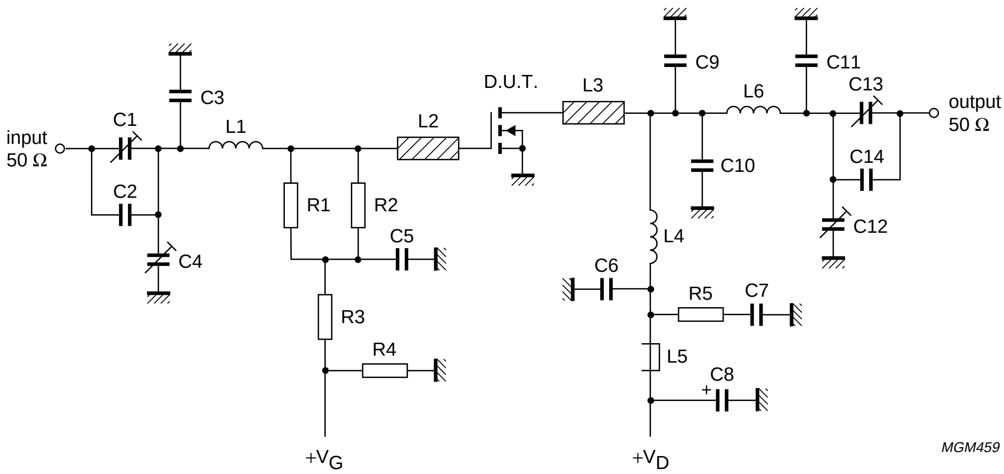


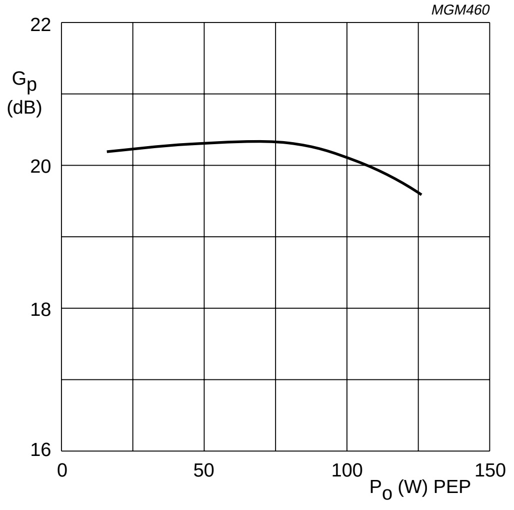
Fig.1 BLF246 Testcircuit at 28 MHz.

Table 1 PC-board: double Cu-clad, 1.6 mm PTFE fibre-glas dielectric (ε_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 μF	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. coke, 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 kΩ	metal film resistor (cat.nr. 2322 151 71002)
R4	1 MΩ	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.



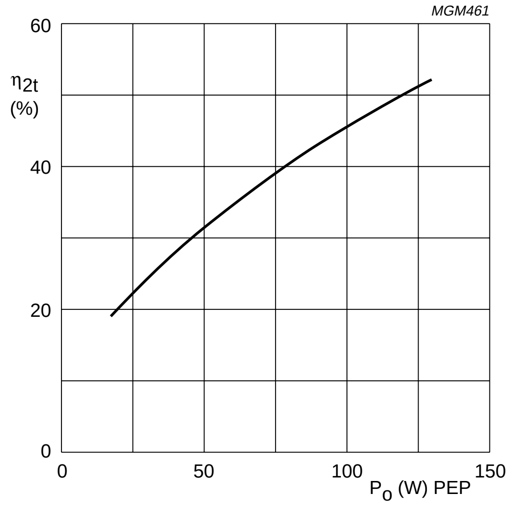
Conditions

f = 28 MHz
Vds = 28 V

Idq = 0.6 A
Rgs = 18 Ω

Th = 25 °C
Rth mb-h = 0.2 K/W

Fig.2 Power gain versus output power.



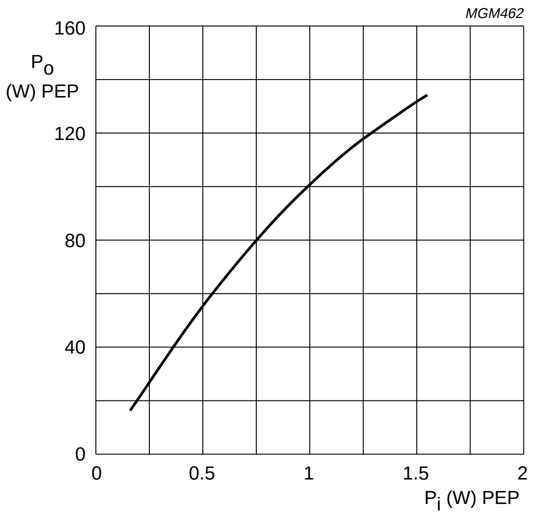
Conditions

f = 28 MHz
Vds = 28 V

Idq = 0.6 A
Rgs = 18 Ω

Th = 25 °C
Rth mb-h = 0.2 K/W

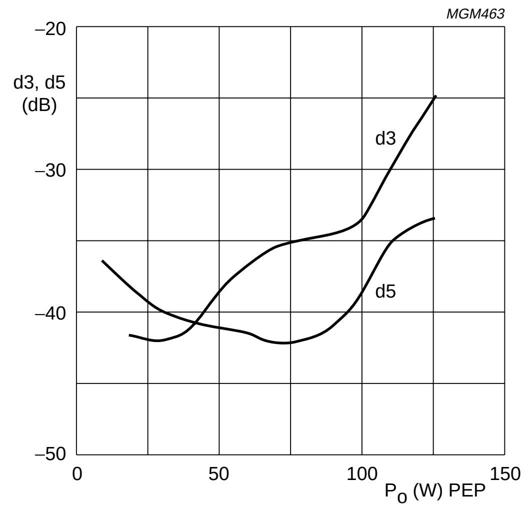
Fig.3 2-tone efficiency versus output power.



Conditions

f = 28 MHz	Idq = 0.6 A	Th = 25 °C
Vds = 28 V	Rgs = 18 Ω	Rth mb-h = 0.2 K/W

Fig.4 Output power versus drive power.



Conditions

f = 28 MHz	Idq = 0.6 A	Th = 25 °C
Vds = 28 V	Rgs = 18 Ω	Rth mb-h = 0.2 K/W

Fig.5 Intermodulation distortion versus output power.

Table 2 Power gain, input and load impedance versus frequency; Idq = 0.6 A; Rgs = 12 Ω

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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