



### SD2932 RF MOSFET for 300 W FM amplifier

#### Introduction

This application note gives a description of a broadband power amplifier operating over the frequency range 88 - 108 MHz using the new STMicroelectronics RF MOSFET transistor SD2932.

**Table 1. Typical achievable performances**

Parameter	Performance
Device	1 X SD2932
Frequency	88-108 MHz
Vdd	50 V
Idq	200 mA
Pout	300 W
Gain	>19 dB
Input return loss	< -11 dB
Drain efficiency	>70%

# 1 Amplifier design

## 1.1 Input matching network

Typical input gate-to-gate impedance of SD2932 at 100 MHz is  $Z_{in} = R_s + jX_s = 2 - 2.6 j$ , and can also be expressed as the combination of parallel resistance and reactance using the following formulas:

**Equation 1**

$$R_p = R_s \cdot \left[ 1 + \left( \frac{X_s}{R_s} \right)^2 \right] = 5.38 \Omega$$

**Equation 2**

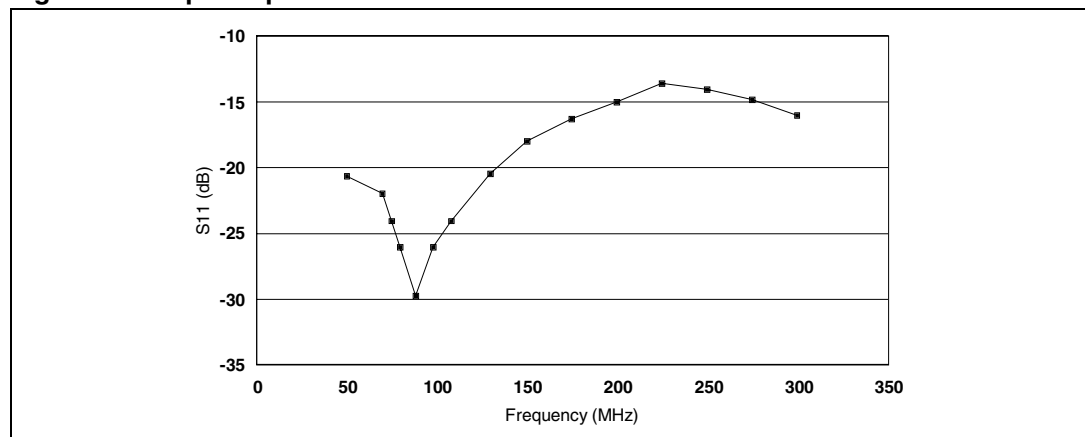
$$X_p = R_p / \left( \frac{X_s}{R_s} \right) = -4.14 j \Omega$$

Therefore, in order to achieve good input matching performances over the frequency range 88-108 MHz the unbalanced 50 Ω is to be transformed into an impedance with a value as close as possible to  $R_p$  of 5.38 Ω

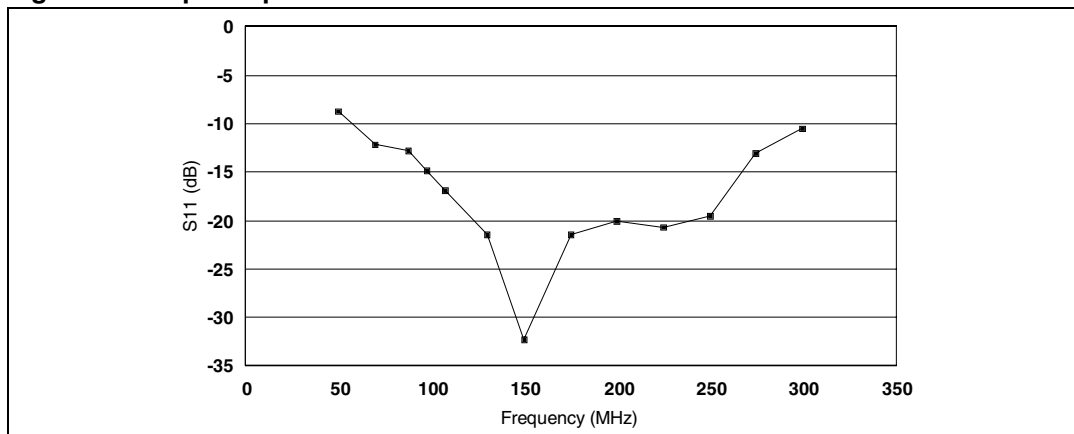
From the circuit schematic given in *Figure 6*, we can see that the input matching network is based on a two section balun (1:1 balun in cascade with a 9:1 balun transformer) which transforms the unbalanced 50 Ω to a balanced 5.56 Ω (2 x 2.78 Ω / 9:1 ratio). The first section, a 5" long - 50 Ω coaxial cable and the second section, a two 3.9" long - 25 Ω flexible coaxial cables with ferrite core NEOSIDE, are connected as described: a 10 nH inductor (L1) is connected between the two gates to compensate SD2932 input parallel reactance  $X_p$ .

## 1.2 Input matching network tuning

**Figure 1. Input Impedance of 1:1 balun in cascade with 4:1 balun**



**Figure 2. Input Impedance of 1:1 balun in cascade with 9:1 balun**



SD2932 input matching network was tuned in order to achieve the best compromise in terms of power gain (Gp) and input return loss (Rtl) over the frequency range 88 - 108 MHz. Best results were achieved by adding a 10 pF chip capacitor (C1) between RFIN and the 1 nF blocking capacitor (C2).

### 1.3 Output matching network

The output impedance of each side is a combination of the output capacitance Coss ( 195 pF) and the optimum load resistance which can be determined as follows:

**Equation 3**

$$R_p = \frac{(0.85 \cdot V_{dd})^2}{2 \cdot P_{out}} = \frac{0.85 \cdot 2500}{2 \cdot 150W} = 6.02\Omega$$

The total optimum load, seen by SD2932 (drain to drain), is  $2 \times 6.02 = 12.04 \Omega$ . Therefore, a simple two section balun (1:1 balun in cascade with a 4:1 balun transformer) is used to transform the unbalanced  $50 \Omega$  to a balanced  $12.5 \Omega$  ( $2 \times 6.25 \Omega$ ) which is very near to the total optimum load resistance.

The first section, a 5" long -  $50 \Omega$  flexible coaxial cable, and the second section, two 5" long -  $25 \Omega$  flexible coaxial cables, are connected as described in [Figure 6](#).

To compensate for the output capacitance Coss of SD2932 , a 40 nH inductor (L2) is connected between the two drains. This LC network (L2 & Coss) is a high pass filter with a resonance frequency calculated at 10 % below the minimum operating frequency:

**Equation 4**

$$C_{OSS} = \frac{C_{OSS(per\ side)}}{2} = \frac{180pF}{2} = 90pF$$

**Equation 5**

$$\text{Frequency of resonance} = 0.9 \cdot 88MHz = 80MHz$$

**Equation 6**

$$L2 \cdot Coss \cdot (2 \cdot \pi \cdot F)^2 = 1 \rightarrow L2 = 44nH$$

Figure 3. Power gain vs. frequency

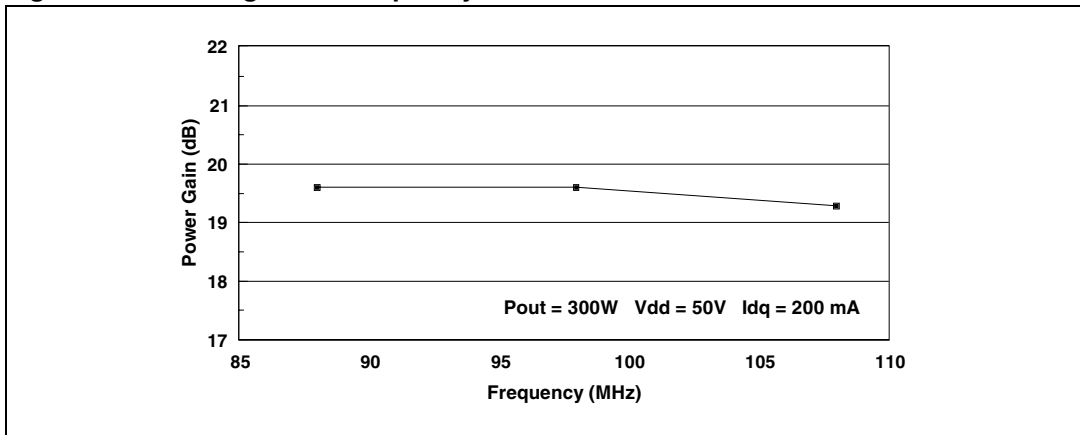


Figure 4. Drain efficiency vs. frequency

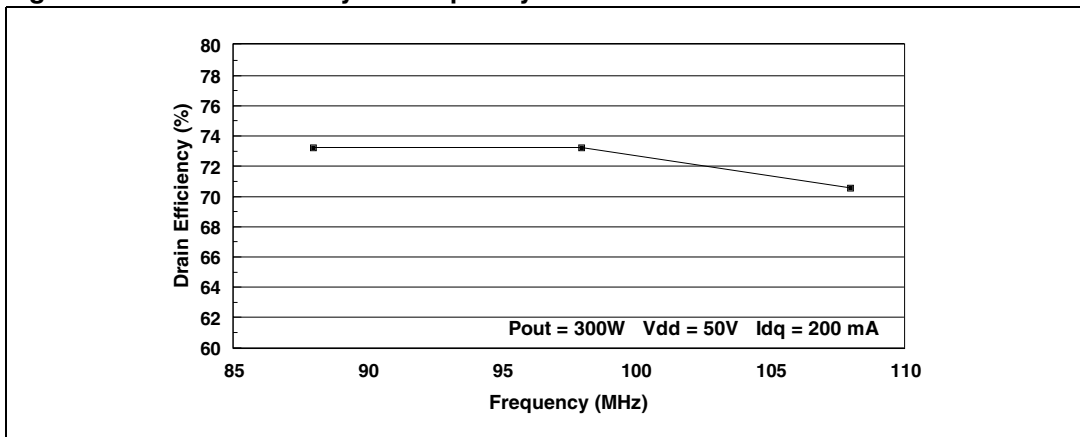
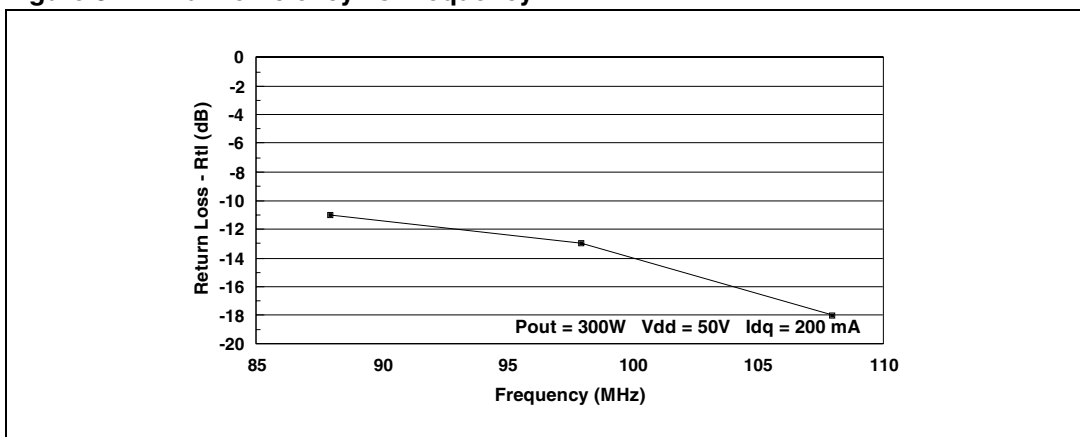


Figure 5. Drain efficiency vs. frequency



## 2 SD2932 typical performances and conclusion

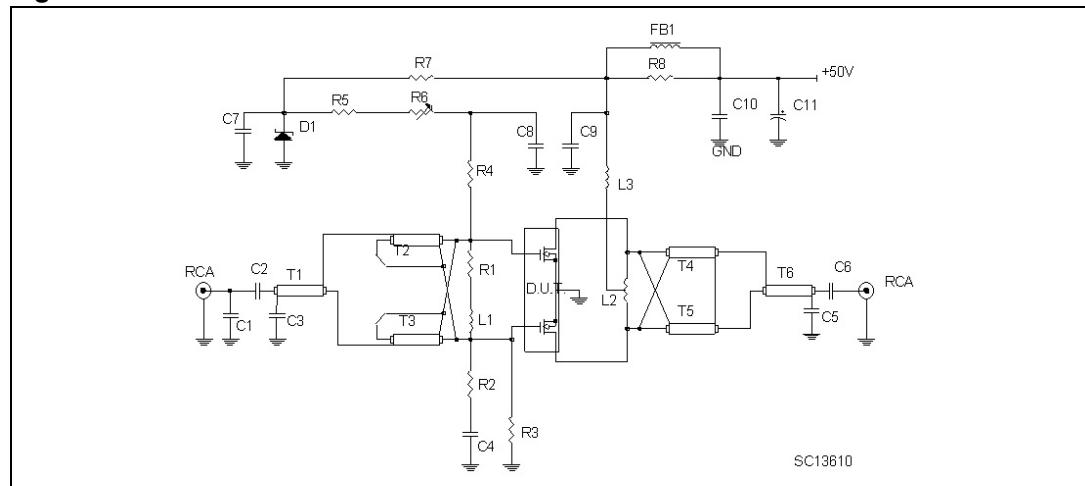
Figure 3, Figure 4 and Figure 5 show power gain, efficiency and input return loss over the frequency range 88 - 108 MHz at a constant output power of 300 W and a drain supply voltage of 50 V and a quiescent current of 200 mA. Typical performances are as follows:

**Table 2. Typical performances**

Parameters	Min	Max
Gp	19.3 dB	19.6 dB
R <sub>TL</sub>	-18 dB	-11 dB
Eff	71%	73%

Finally, in this report we have demonstrated ST's SD2932 MOSFET transistor excellent performance as a wideband 300 W - 50 V push-pull amplifier for FM applications.

**Figure 6. 88-108 MHz circuit schematic**



**Table 3. 88-108 MHz circuit components list**

Symbol	Description
PCB	1/32" Woven fiberglass 0.0030 Cu, 2 side, er
T1	50 Ω Flexible coax cable OD 0.006", 5" long
T2/ T3	9:1 Transformer, 25 Ω flexible coax cable OD 0.1" 3.9". ferrite core NEOSIDE
T4 / T5	4:1 Transformer, 25 Ω flexible coax cable OD 0.1" 5.0" long.
T6	50 Ω flexible coax cable OD 0.1" 5.0" long.
FB1	VK200
C1	10 pf Ceramic capacitor
C2/C3/C4/C7/C8	1 nF Chip capacitor
C5/C6	1 nF ATC chip capacitor

**Table 3. 88-108 MHz circuit components list (continued)**

Symbol	Description
C9	470 pF ATC chip capacitor
C10	100 nF chip capacitor
R1	56 $\Omega$ Resistor
R2/R4	10 $\Omega$ Chip resistor
R3	10 K $\Omega$ Resistor
R5	5.6 K $\Omega$ Resistor
R6	10K $\Omega$ 10 Turn trim resistor
R7	3.3 K $\Omega$ 1 W Resistor
R8	15 $\Omega$ 1 W Resistor
D1	6.8 V Zener diode
L1	10 nH inductor
L2	40 nH inductor
L3	70 nH inductor

### 3 Revision history

**Table 4. Revision history**

Date	Revision	Changes
21-Jun-2006	2	Minor text changes
30-Jul-2007	3	The document has been reformatted

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