AN1229
APPLICATION NOTE

SD2932 RF MOSFET FOR 300W FM AMPLIFIER

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1. ABSTRACT

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

Table 1: Typical Acheivable Performances

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%

2. AMPLIFIER DESIGN.

2.1. Input Matching Network.

Typical input gate to gate impedance of SD2932 at 100 MHz is Zin = Rs + jXs = 2 - 2.6 j, and can also be expressed as the combination of parallel resistance and reactance using the following formulae :

$$Rp = Rs \times [1 + (Xs / Rs)^2] = 5.38 \text{ ohms}$$

$$Xp = Rp / (Xs / Rs) = -4.14 \text{ j ohms}$$

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

From the circuit schematic given in Fig. 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 will transform the unbalanced 50 ohms to a balanced 5.56 ohms (2 x 2.78 ohms / 9:1 ratio). The first section, a 5" long - 50 ohms coaxial cable and the second section, a two 3.9" long - 25 ohms 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 Xp. quasi-neutral region of the junction. The breakdown-voltage regime is the avalanching of carriers due to the electric field being greater than the critical electric field (approximately 1×10^5 V/cm). Under these conditions an electron can be accelerated by the electric field.

Due to elastic and inelastic scattering this electron acceleration can generate more than one carrier and thus a multiplication scheme transpires.

2.2. Input Matching Network Tuning.

Figure 1: Input Impedance of 1:1 Balun in Cascade with 4:1 Balun

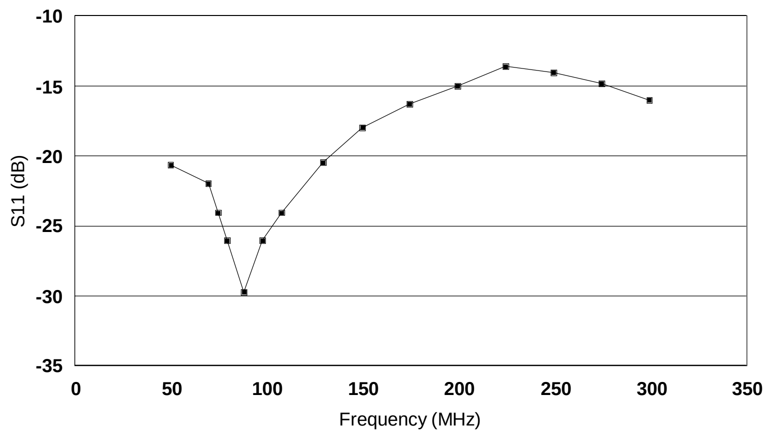
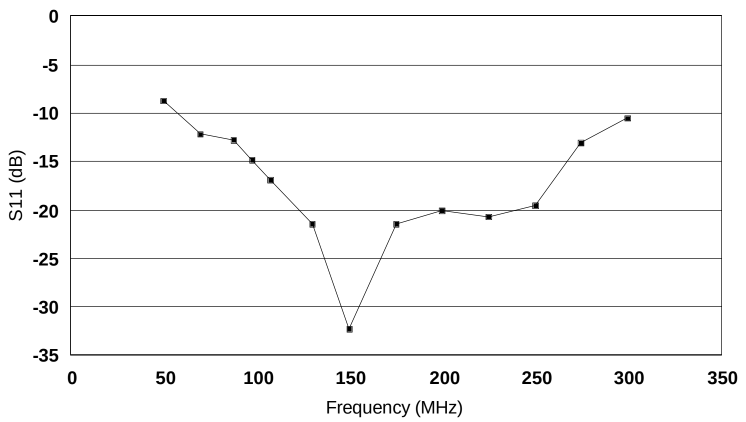


Figure 2: Input Impedance of 1:1 Balun in Cascade with 9:1 Balun



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 1nF blocking capacitor (C2).

2.3. Output Matching Network.

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

$$Rp = (0.85 \times Vdd)^2 / (2 \times Pout) = (0.85 \times 50V) / (2 \times 150W) = 6.02 \text{ ohms}$$

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

The first section, a 5" long - 50 ohms flexible coaxial cable, and the second section, two 5" long - 25 ohms flexible coaxial cables, are connected as described in figure 6.
To compensate for the output capacitance C_{oss} of SD2932 , a 40nH inductor (L2) is connected between the two drains. This LC network (L2 & C_{oss}) is a high pass filter with a resonance frequency calculated at 10 % below the minimum operating frequency :

C_{oss}=C_{oss} (per side)/2 = 180 pF/2 = 90 pF
Frequency of resonance = 0.9x88MHz=80MHz
L2 x Coss (2pf)^2 = 1---->L2 = 44nH.

Figure 3: Power Gain vs. Frequency

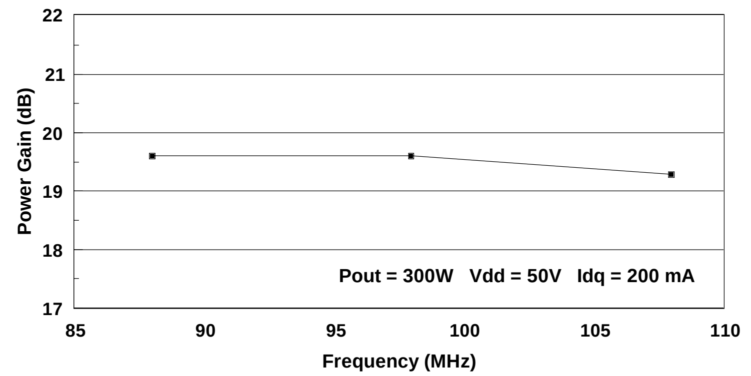


Figure 4: Drain Efficiency vs. Frequency

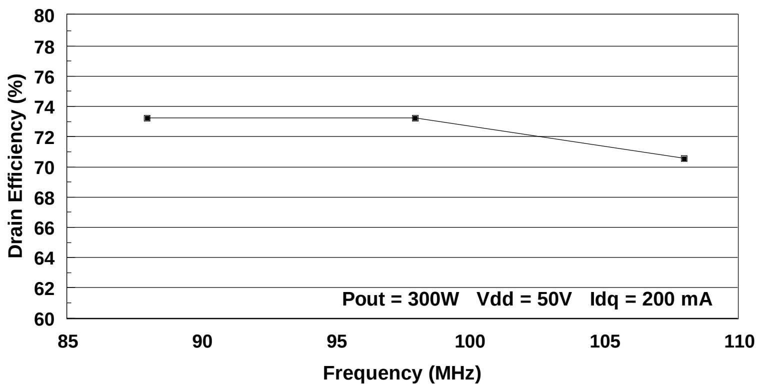
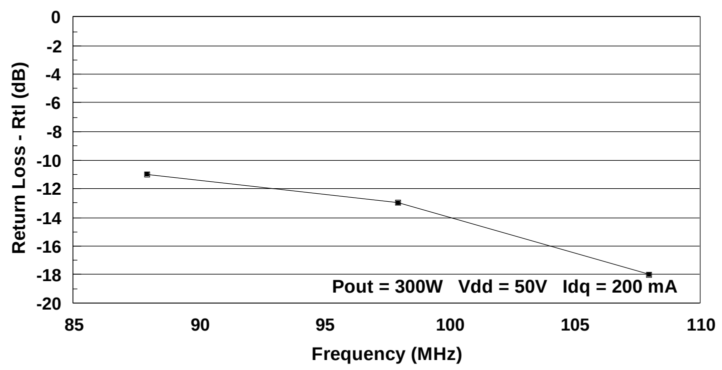


Figure 5: Input Return Loss vs. Frequency



3. MEASURED SD2932 TYPICAL PERFORMANCES AND CONCLUSION.

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

Table 2.

	MIN	MAX
Gp	19.3dB	19.6dB
R_{TL}	-18dB	-11dB
Eff	71%	73%

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

Figure 6: 88-108MHz Circuit Schematic

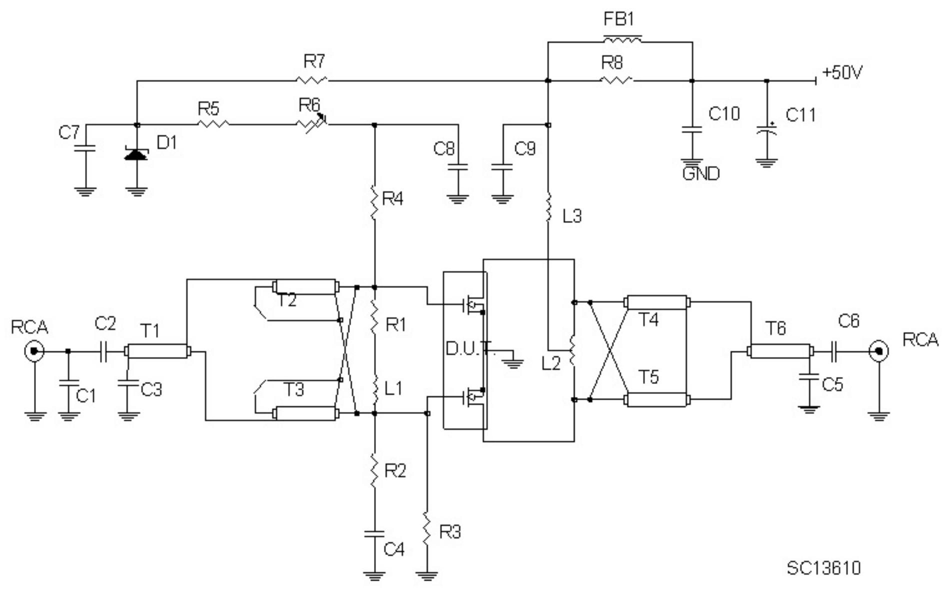


Table 3: 88-108MHz Circuit Components List

PCB	1/32” Woven Fiberglass 0.0030 Cu, 2 side, ε_r = 4.8
T1	50 Ohm Flexible Coax Cable OD 0.006”, 5” Long
T2/ T3	9:1 Transformer, 25 Ohm Flexible Coax Cable OD 0.1” 3.9”. Ferrite Core NEOSIDE
T4 / T5	4:1 Transformer, 25 Ohm Flexible Coax Cable OD 0.1” 5.0” Long.
T6	50 Ohm Flexible Coax Cable OD 0.1” 5.0” Long.
FB1	VK200
C1	10pf Ceramic Capacitor
C2/C3/C4/C7/C8	1 nF Chip Capacitor
C5/C6	1 nF ATC chip Capacitor
C9	470 pF ATC Chip Capacitor
C10	100 nF Chip Capacitor
R1	56 Ohm Resistor
R2/R4	10 Ohm Chip Resistor
R3	10K Ohm Resistor
R5	5.6K Ohm Resistor
R6	10K Ohm. 10 Turn Trim Resistor
R7	3.3K Ohm/ 1 W Resistor
R8	15 Ohm/ 1 W Resistor
D1	6.8 V Zener Diode
L1	10 nH Inductor
L2	40 nH Inductor
L3	70 nH Inductor

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