# 7T Current-Mode Class-D (CMCD) RF Power Amplifier

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## Introduction

Today there is an intensive research effort in high-field MRI, mainly motivated by the higher SNR, and consequently higher spatial and temporal resolution attainable by higher magnetic fields. Counteracting these advantages are dielectric resonance effects when increasing sample size -as in the case of human imaging-, intravoxel dephasing due to increased susceptibility and increased SAR [1,2]. B1 shimming [3] and lower imaging acquisition time through the use of multichannel imaging can potentially overcome the mentioned drawbacks. In this work we present preliminary results of the first, to our knowledge, on-coil class D, current mode (CDCM) amplifier [4-6] for 7T applications. High efficiency, intrinsic decoupling and the elimination of high power RF cables make this configuration promising for 7T parallel RF transmission.

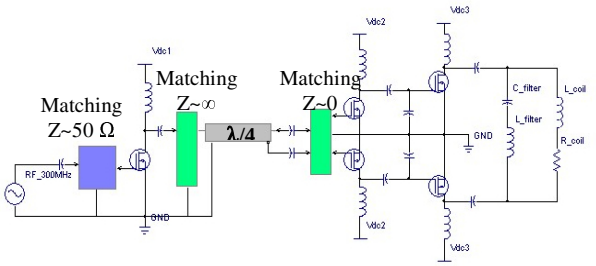


**Fig.1** 7T CMCD amplifier simplified circuit diagram

## Materials and Methods

The amplifier circuit diagram is shown in Fig. 1. The first stage is composed of a class-A amplifier with a 50Ω matching network. The output of this stage is converted to balanced 180 degree dephased signals through a quarter wave (17.5cm) semi-rigid coaxial cable and matching networks. This signal is further amplified in a second stage composed of a push-pull class B amplifier to finally give a high peak voltage at the gate of the switching MOSFET in the class D stage. A capacitor is connected between gate and source of the MRF275 power transistor to match the input impedance to higher values and therefore avoid a dramatic loss of gain from the previous stage. The LC filter in the output of the last stage resonates with the MOSFETs output parasitic impedance at the fundamental frequency (300MHz) attenuating harmonics, always present in switch mode amplifiers, and providing decoupling from transmitting neighboring coils due to the high impedance seen from the coil. The amplifier and a transmit RF coil tuned to 300Mhz were tested in a 7T Bruker Biospec scanner. A FLASH sequence was used for readout, with hard RF excitation pulse. A phantom was made from a 500ml tube filled with water and a separate 30mm diameter receive-only coil was used for signal reception. For this preliminary experiment, the amplifier was located at the edge of the scanner bore at 80 cm from isocenter due to the slightly magnetic MOSFETs.

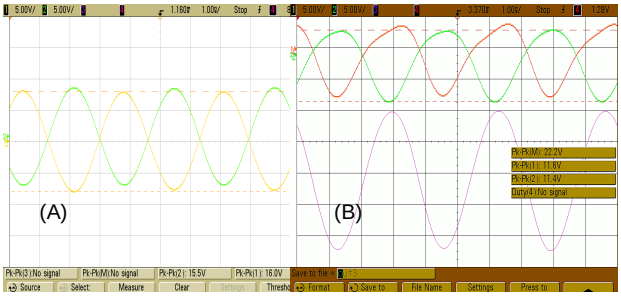


**Fig. 2** (A) Class-B preamplifier output: 180º dephased gate-control signals. (B) RF Voltage at the output of the amplifier with a 1Ω load resistor

## Results and Discussions

The gate signal that switches the MOSFETs of the class-D configuration is shown in Fig. 2A. We can see that the signals are perfectly 180 dephased and the amplitude is high enough to bring the MOSFET to a conduction state with relatively low on-resistance. In Fig. 2B we see (one-third) of the differential output voltage (purple wave) across the middle of three 1Ω resistors placed in series. Indirect measurement from this graph gives approximately 12 A RF peak current and 70 W RF power. Fig.3 A shows an axial image of the phantom obtained with a multislice FLASH sequence with 15ms TR, 3.4 ms TE, 2mm slice thickness, 4x4mm FOV no averaging and 90µs RF pulse length. The projected coronal and sagital images are shown in Fig 3B and C. We can observe there is a good signal intensity across the FOV except for the signal drop closer to the anterior region that is repeated all along the z direction, which is likely due to too high of a flip angle in these regions.

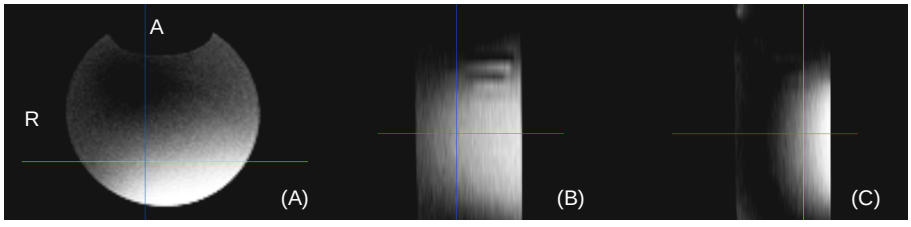


**Fig.3** (A) axial Image obtained with a multislice FLASH sequence, with 15ms TR, 3.4 ms TE, 2mm slice thickness, 4x4mm FOV, NA=1, 90µs RF pulse length. (B) and (C) projected coronal and sagital plane respectively using MedINRIA image viewer software.

## Conclusion

We have successfully demonstrated a current mode class-D amplifier for 7T. This represents a promising advance for high field multichannel transmit arrays.

## References

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