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Projektarbeit

Power Meter for 7-Tesla MRI Power Amplifier

In a research project, the department develops a high pulse-power amplifier for a 7-Tesla Magnetic Resonance Imaging (MRI) system. The power amplifier employs a high pulse-power final stage with a maximum of 1 kW output power into a 50 Ohm load at an operating frequency of 298 MHz. Measurement of the power level and the amplitude envelope of the pulses is required during the assembly and matching optimization of the amplifier units.

The task is to design, build and test a power meter circuit on the basis of an envelope detector (integrated circuit log-amplifier AD8307) which provides a dc output voltage proportional to the logarithm of the input power level with a slope of 25mV per dB of RF input power. The input signal must be in the order of milliwatts so that only a sample of the 1 kW –pulse is to be fed to the IC. The main part of the power has to be absorbed in a 50 Ohm-load resistor which sits on a heat sink while a resistor-probe is used to take a sample of the high-power signal. The detector output voltage for our MRI power amplifier signals will show a pulsed dc level which is shifted by a bias voltage. In order to allow correct measurement of the pulse power level, the offset voltage has to be stripped off before applying the measurement. Measurement can be afforded by buffering the detector voltage and connecting itthrough a coaxial cable to an oscilloscope which will show the pulse envelope. As a built-in meter, an LCD voltage display module (e.g., Voltcraft DVM210) is to be included.This will require a sample & hold circuit (e.g., LF198) which is triggered by the TTL-pulse from the power amplifier control circuit (the so-called “Unblank” signal). When the sampling of the detector voltage is performed from shortly after the start of the power pulse to the end of the pulse duration, the voltage display can indicate correctly the instantaneous power level of the pulse.

In particular, the task entails the following steps:

- Design a circuit for the RF load, probe and the AD8307 plus the operational amplifiers required to cancel offset and as S/H-amplifier, buffer and scaling circuits for the output voltages.Examples for various parts of the circuit are available from other projects and from manufacturer data sheets. Design a circuit to provide variable delay to the trigger voltage allowing to move the sampling instance along the pulse duration of up to 5 msec.
- Design a PCB using EAGLE software .
- Assemble the circuit after production of the PCB at our workshop.
- Test the circuit regarding impedance match, insertion loss of the probe and the output voltage of the IC; the circuit should function over 10 MHz to 500MHz but should be optimum at 298 MHz.
- Adjust the output voltage of the circuit and set the LCD voltage display module such that at 1kW pulse power the display shows a numerical value of 60.0, representing 60 dBmpower. This can be adjusted using low-power signals from a test generator with precise output levels in the mW-range.
- Compare the results of the power meter display with measurements using an oscilloscope.
- Verify the proper functioning of the circuits using a signal from a high-power amplifier with CW- and pulsed excitation.
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  At the end of the work, a public presentation of results is to be given