Design of a Fast, High Power RF Switch for a HF/VHF Direct Antenna Modulation System

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This investigation explores the design of a fast, high power RF switch that operates at HF/VHF frequencies. Specifically, this switch is designed to change its state within ten nanoseconds and handle one watt of power. This switch will enable a direct antenna modulation (DAM) system to be constructed that transmits wideband on-off-keyed (OOK) signals from a handheld system. OOK signals communicate a '0' by transmitting nothing during that symbol period and a '1' by transmitting a RF signal during that symbol period. Due to size constraints on handheld HF/VHF systems, the antenna is necessarily electrically small, which means that any linear time invariant (LTI) antenna system may only efficiently transmit within a narrow band. To transmit a wideband OOK signal, the antenna is modulated directly using a switch that connects and disconnects the antenna from the transmitter based on the current symbol being transmitted. The benefit of directly modulating the signal with a switch is that energy may be stored on the antenna during the "off" symbol periods. This decreases the transients typically associated with the energy leaving the antenna when the signal generator is turned off as well as the transients typically associated with energy entering the antenna once the generator is turned back on. Theoretically, a DAM OOK system is capable of efficiently transmitting an OOK symbol with a significantly wider bandwidth than a statically-tuned antenna could efficiently transmit.

An off-the-shelf switch that met the requirements of a one-watt HF/VHS DAM OOK transmitter was not available, so a fast one-watt HF/VHF switch was developed in-house using metal oxide semiconductor field effect transistors (MOSFET). MOSFET devices provide high switching speeds and low on resistance, coming as close as possible to an ideal switch with today's technology. Because an electrically small antenna needs to match to a 50 Ω system, a large voltage is developed across the antenna. As typical MOSFET devices can only tolerate a potential of 20 V between the gate and the source, the gate driver must be isolated from the rest of the circuit. Strategies for implementing a gate driver while maintaining the ability for the switch to hold a charge on the antenna will be presented.