NOTES

BRIEF contributions in any field of instrumentation or technique within the scope of the journal should be submitted for this section. Contributions should in general not exceed 500 words.

A compact general-purpose fast high-power pulser for inductive load

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We present the design principles of a compact general-purpose fast high-power (and low-cost) pulser for inductive load, using an isolate gate bipolar transistor, a dedicated smart driver unit and digital control designed in very high speed integrated circuit hardware description language. We demonstrate the performance of this pulser as a driver for a high-pressure supersonic pulsed valve. [DOI: 10.1063/1.1469673]

High power switching, especially under inductive loads, causes undesirable side effects such as high voltage transients and overheating of the switching elements. These high voltage transients may reach the control circuits and other electrical devices in their vicinity, thus causing a malfunction and consequently damages.

The pulser presented here was originally developed for use with a pulsed valve[1] operating under characteristic values of 300 A, 150 V, and 20 Hz rate. Previously, the valve was driven by an analog pulser, which often caused objectionable noise and other undesirable side effects. We show, that by integrating digital control, switching by an isolate gate bipolar transistor (IGBT) with a dedicated smart driver, optical coupling to external devices and proper protection mechanisms, one can implement a compact, reliable, accurate, and safe system at relatively low cost. Our pulser is capable of controlling a current of 500 A, at voltages of up to 200 V, rates of up to 200 Hz, pulses width of 1–100 μs, and a resolution of 0.1 μs, using small, desktop PC CPU-size cooling elements.

Our initial consideration in the design was to choose the switching element. We chose to use an IGBT[2] that combines the advantages of Power metal–oxide–semiconductor field effect transistor (MOSFET) and Power bipolar junction transistor (BJT). Like the power MOSFET, the IGBT is a voltage-controlled switch, which allows fast switching. Like the Power BJT, the ON state voltage drop is very low and allows for high efficiency. There are IGBT elements that can operate with currents of thousands of amperes and thousands of volts. Our element, however, GA200SA60S[3] is in the middle power scale, for reasons of size and cost.

The secret of successfully using IGBT elements is controlling the gate that drives the IGBT between the saturation (ON) and the cutoff (OFF) states. A typical drive for an ON state is around 15 V. This drive must charge the 1000 nC gate capacitance with a current of approximately 1–2 A to achieve a rise time shorter than 1 μs. At a gate bias of 0 V, the IGBT is at an OFF state. It is recommended to have a negative bias of about 3–8 V to enable a faster transition from the ON to the OFF state.

Figure 1 is a block diagram of the circuit. The circuit is composed of three blocks: a digital control, a smart analog driver, and a power-switching unit. In order to eliminate mutual interference between the three blocks, each one has its own power supply. Figure 2 describes the smart driver unit and the power-switching unit. The smart driver L6353[4] is the heart of the system that controls all the required parameters for the IGBT, and also provides the necessary protection. At terminal IN, the device gets a digital pulse at a transistor–transistor logic (TTL) or complementary metal–oxide–semiconductor level through an optocoupler that accomplishes isolation from the control line. At OUT1 and OUT2, the device supplies a positive drive, for the ON state, and a negative bias for the OFF state of the IGBT. This drive is set

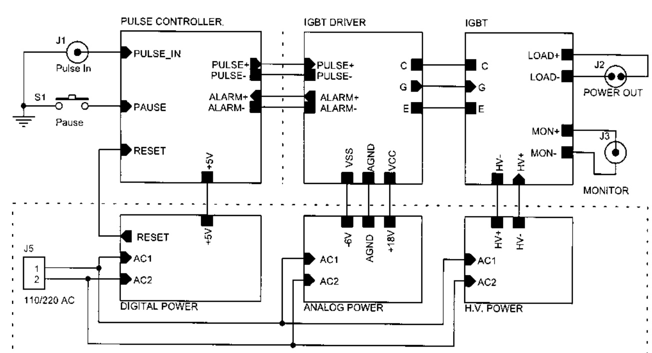

FIG. 1. A block diagram of the circuit. The circuit is composed of three blocks: a digital control, a smart analog driver, and a power-switching unit. Each one has its own power supply.

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