REAL TIME MONITORING OF THE POWER LIMIT RESISTOR IN THE BOOST INJECTION KICKER POWER SUPPLY *

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Abstract

After many years of troubleshooting the transistor bank-driver regulator for the Booster Injection Kicker, we developed and tested a real time monitoring system. It consists of a simple floating circuit that can monitor, in real time, the status of the driver's regulator power limit resistor and warn operators of changes in the value of the resistor. Our paper discusses the power supply and introduces the newly designed monitoring system.

INTRODUCTION

The booster injection kicker system consists of four magnets, each of which is energised by one pulsed power supply encompassing a capacitor bank and a transistor bank. Figure 1 is a diagram of the power supply, illustrating its operational principle.

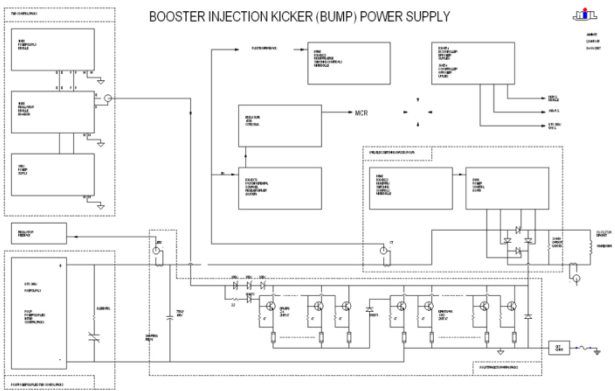

Figure 1: Diagram of the power supply to the booster injection kicker.

The kicker magnet's inductance is approximately 10uH. A 0V to 300V DC power supply charges the capacitor bank to an operating voltage that depends on the energy of the injection beam. The capacitance of the capacitor is 75mF and its voltage rating is 400V. A transistor bank, connected in between the capacitor bank and the magnet load controls the load current. The current's waveform is similar to that of the reference voltage. A current-polarity switch bridge alters the polarity of the load current according to the different kinds of injection beams employed.

A regulator circuit drives the transistor bank, which consists of hundreds of transistors. To protect the transistor bank from excess current or power, a 10-ohm, low-power resistor limits the regulator board's output power to the transistor bank. During past years of operation, this scheme has functioned satisfactorily. . However, the 10-ohm resistor fails slowly over time, without giving any noticeable indication. Its gradual failure has entailed many hours of downtime in the booster's operation. Hence, a real-time monitor of the resistor's status was required. We fabricated a new status monitor specifically to meet this need, and installed it in the booster injection system's power supply; it can monitor the resistor's status from pulse to pulse. We verified the long-term success of the new monitor.

REAL-TIME RESISTOR MONITOR

The real-time resistor monitor measures the 10-ohm resistance from pulse to pulse. Normally, resistance changes slowly. A setting resistor, installed in the circuit, detects when the measured resistance is higher than the setting resistance; then, the circuit sends out a status signal to PLC controller that, in turn, generates a warning signal to the machine's pet page and warns the operator. The circuit is described as follows:

Monitor Resistor's Bridge Circuit and Comparator Circuit

Figure 2 illustrates the layout of the resistor's bridge circuit, comprising three10 ohm resistors, a 12 ohm

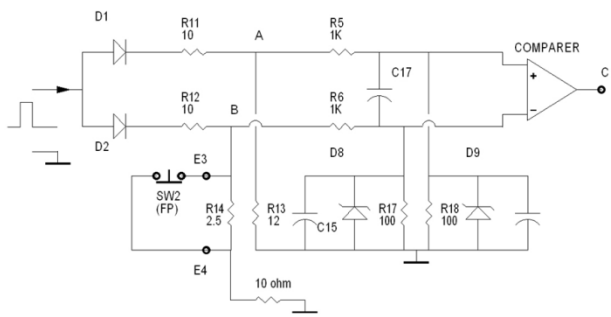

Figure 2: Resistor bridge circuit.

resistor, and two diodes. When a voltage pulse arrives at the resistor bridge, its centre connections, points A and B, transmit a different voltage to the voltage comparator. If the resistance in the monitor resistor is lower than 12 ohm, the comparator's output maintains the needed high level. However, if the resistance in the resistor increases so that its value is higher than 12 ohm, the output of the comparator circuit output declines to a low level and drives the optical coupler to send out a signal.

Pulse Amplifier and Floating Power Supply

The 10-ohm resistor is located at the input side of the transistor bank driver; the resistor's voltage potential

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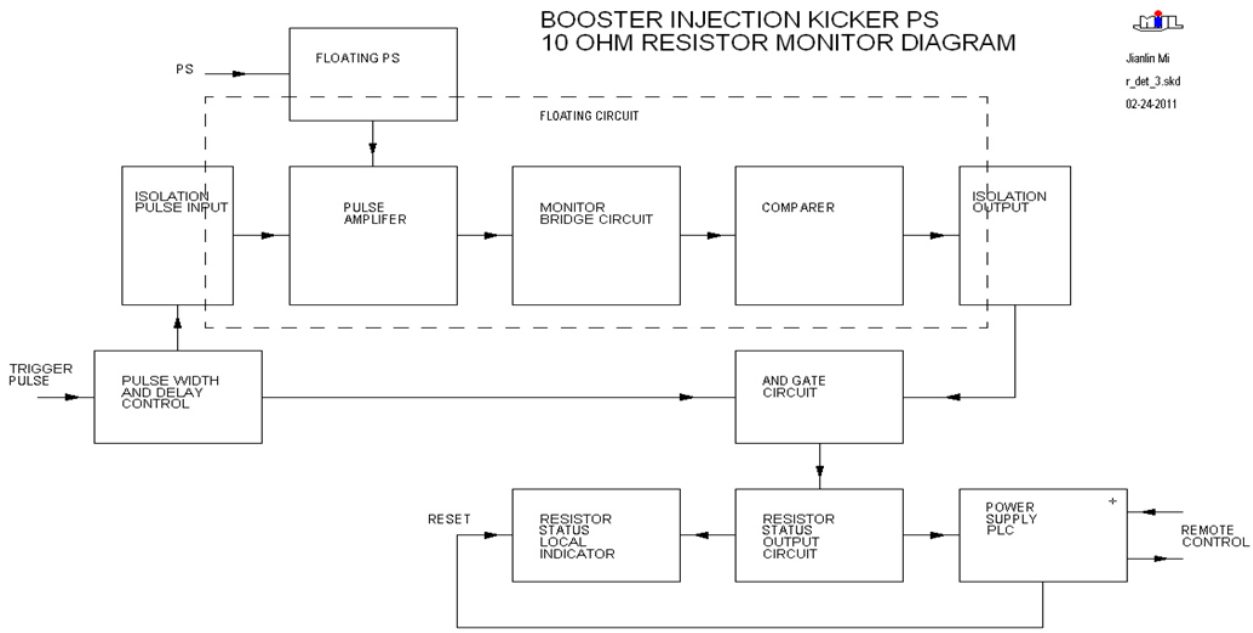

Figure 3: Block diagram of the booster injection kicker's power supply 10 ohm resistor monitor.

changes continuously whilst the driver is operational. The monitor's voltage pulse added to the bridge should be floating on the driver's input side, as shown in figure 3. A DC/DC floating power supply, from TDK-Lambda Americas Inc., is used as the source of the pulse amplifier's voltage. This is a CC E Series Ultra Compact single DC to DC converter power-supply. The isolation voltage is 500VAC. The output power is 1.5W. The input DC voltage is 12V, and the output voltage is 5VDC. An optically coupled isolation pulse-input unit isolates the amplifier's input.

Trigger Delay and Resistor Error Signal Pickup

A 1mS width trigger pulse was added to the resistor bridge through an isolation circuit. As this is a real-time detecting circuit, the monitoring function should not operate during the power supply's pulsing time. The pulse's width and a delay-control circuit can postpone the trigger pulse by about 4mS. The resistor's error-signal pickup incorporates a NAND circuit to pick up the resistor's monitored error signal. A test pushbutton was installed for checking the monitor, while a reset switch is present to clear faults.

Output Circuit

The output circuit includes a remote and a local-status indicator. The latter shows the resistor's status; a button switch allows us to test the monitor's circuit. The remote indication will appear in the pet page via the power-supply PLC controller unit. Normally, it sends an error signal to the pet page to warn the operator. Both local- and remote-controls can reset the resistor's monitor.

Figure 5 is a very detailed schematic of the monitor.

ASSEMBLY AND INSTALLATION

All parts are installed in a 3U euro-card standard format PCB with a board size of 100mm×220mm. Because the booster injection kicker's power supply has operated for more than 20 years, all control chassis are of the NIM style. We are planning to replace them s with new euro-card standard chassis; therefore, the new PCB will adopt the euro card standard format. The assembled PCB temporarily is in a NIM chassis. Figure 6 is a PLC and control monitor chassis in a rack.

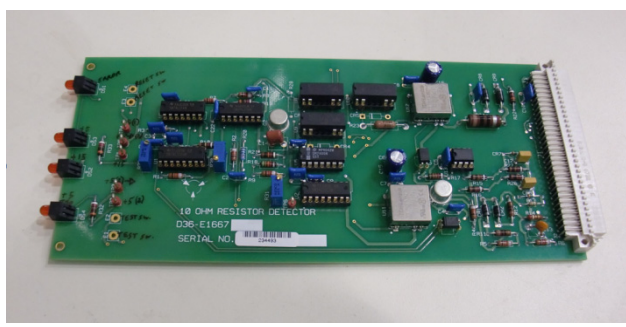

Figure 4: Assembled PCB.

OPERATION

There are four pulse-power supplies for the booster injection kicker system, each installed with four resistor-monitor chasses. When the system is operating, the monitor's status will be displayed on the machine's pet control page. A warning informs operators if the resistance of the 10 ohm resistor is out of the monitoring range. We plant to replace the resistor by a new one soon.

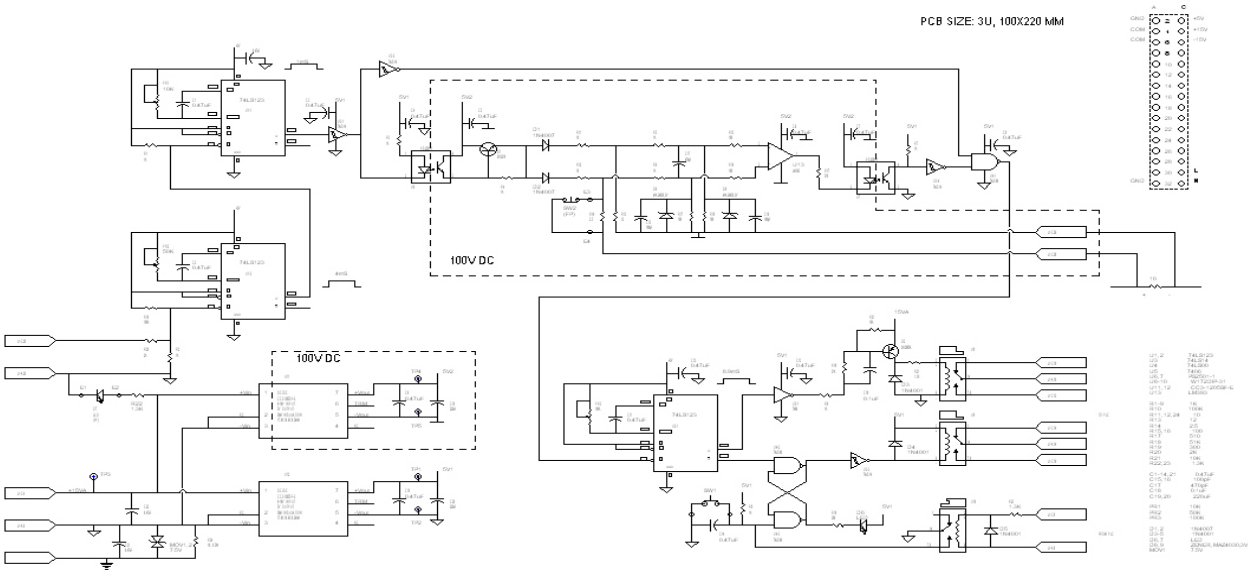

Figure 5: Schematic of the booster injection kicker's 10-ohm resistor monitor's PCB.

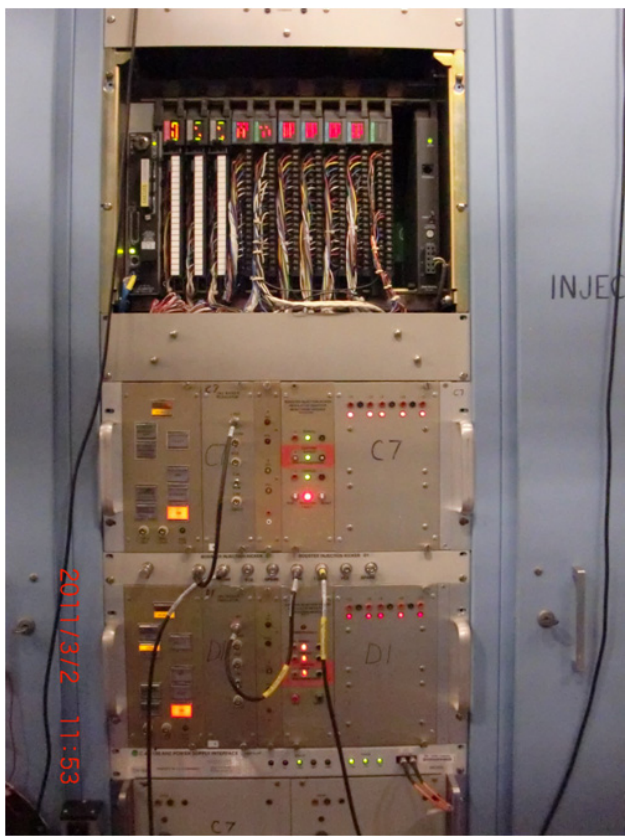

Figure 6: PLC and control monitor chassis.

CONCLUSION

Our real-time resistor-monitor circuit is proving to be a useful approach to monitoring some critical parts in the booster pulse's power supply. This monitor has worked well throughout two years of accelerator operation. It has proved invaluable in saving us, much time that previously was lost in troubleshooting the operation of the booster machine. . We will reinstall all four PCBs into Euro Card Standard Chasses when the power supply system is updated.

ACKNOWLEDGMENTS

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REFERENCES

[1] "Booster design manual", BNL, C-A Department tech note.