New design of timing-controller circuit board for accelerators in the SCRIT facility

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A timing-controller circuit board installed in the electron injection system at the SCRIT facility[1] has been designed for electron beam injection from a racetrack microtron (RTM) into the storage ring (SR2). However, it is used to inject the electrons into the electron-beam driven RI separator[2] (ERIS) at the SCRIT facility. For electron injection into the SR2, the frequency of the beam pulse frequency is 2.0 Hz. On the other hand, a higher frequency is desired to have a high intensity beam of RIs of ERIS.

The SR2 was developed as the electron storage ring in order to provide synchrotron radiation for basic research and/or application for industries as the lithography light source. Consequently, the timing controller system for the electron injection does not have the function to inject the beam into another facility such as ERIS. In order to satisfy both injection conditions into SR2 and ERIS, the timing-controller should have a function to switch the beam between the storage ring SR2 and ERIS and to change the injection conditions. In this report, we detail the new design for the timing-controller circuit board. The circuit board has functions for processing internal pulse triggers and external triggers to utilize various injection parameters for ERIS. Therefore, we added a switching function onto the new board.

We used the 74HC logic IC family to construct the circuit as the original circuit is designed using the 74HC logic IC family and it is relatively easy to buy this from the vendors. In addition, almost all of the 74HC family is provided in DIP packages. The speed of 74HC is high enough for more than 1 kHz frequency. The final goal of the frequency is 100 Hz for this new board.

Figure 1 shows a simplified circuit diagram for one channel. Each channel has two trigger inputs (Ext. TRG and TRG), interlock signal inputs (Ext. I/L and I/L), and one trigger selector input. One board has five channels inside.

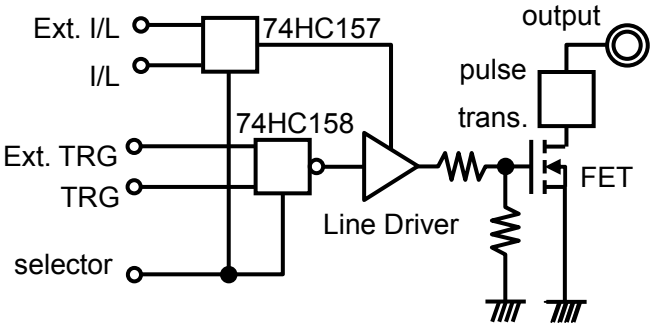

Fig. 1. Simplified schematic of the circuit.

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Figure 2 is the photo of the developed circuit board. The white connector at the right side is for the connection to the mother board of the timing-controller system. In the connector, there are 5 coaxial connectors for internal trigger input, 5 interlock signal pins (24 V), and DC 15 V power line. The 15 V is converted into 5 V by a regulator IC to provide electric power for the logic ICs. On the left side, there are 5 coaxial connectors for external trigger inputs, 5 external interlock pins, and int./ext. selector pins. The selector pins can be used by either short/open or 5 V / 0 V states. To use the 5 V / 0 V states as selectors, IC 62003 has to be installed into the IC socket next to the input pins.

Other than the input connectors, there are a few DIP switches on the board. One of them is a selector switch that select the terminator for the external trigger input. It is possible to choose either 50 ohm or 1M ohm. Other switches are “interlock ON” switch and “interlock flip” switches.

Output trigger lines are insulated from the logic system of this circuit board by pulse transformers. Input signals into the pulse transformers are supplied by the series of driver ICs and FETs to provide sufficient voltage and power for 50 ohm impedance lines. The pulse peak heights from the FETs are close to the 15 V power line. The outputs from the pulse transformers should be similar to the input signals, since the ratio of the transformer is 1:1. In order to modify the pulse shape of the output, zener diodes are used to control the output pulse heights. All output pulse except for the output for the RF driver is set at 5 V heights. The widths of the pulses depends on the input trigger widths.

The newly designed circuit boards have been already installed, and they are confirmed to work at the frequency of 100 Hz.

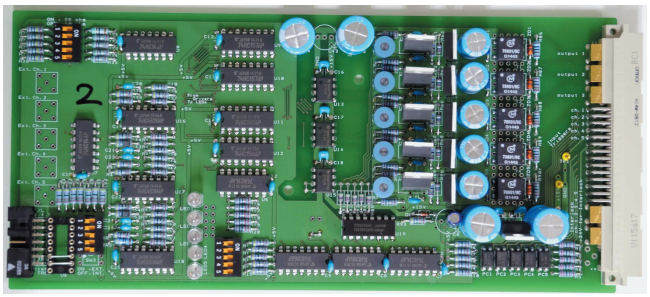

Fig. 2. Photo of the timing-controller circuit board. The left side is for the external trigger input area, and the right internal. The black connector at the left bottom is selector pins for the int./ext. input switches.

References

1) M. Wakasugi et al.: Nucl. Instr. And Meth. B**317**, 668 (2013)
2) T. Ohnishi et al.: Phys. Scr. T**166**, 014071 (2015)