Common trigger firmware for GTO

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The data acquisition (DAQ) system at RIKEN RIBF[1)] utilizes the field programmable gate array (FPGA)-based logic modules of LUPO[2)] and GTO[3)]. A common trigger firmware for the GTO has been introduced for experiments in BigRIPS, SHARAQ, EURICA, MINOS, and SAMURAI[4)]. There are two versions of the common trigger firmware: 8-trigger/16-end-of-busy inputs version and 4-trigger/20-end-of-busy inputs version. Both versions provide the same functionality, and the only difference between them is the number of the trigger and busy inputs. Here, we report on the functionality and timing performance of the 8-trigger/16-end-of-busy inputs version of the common trigger firmware.

This firmware was developed to provide acceptable triggers, i.e., the common trigger, for all CAMAC and VME front-end systems. Previously, three logic fan-in/out, three latch and one coincidence NIM modules were used to generate the common trigger. However, the developed firmware can generate the common trigger using only one GTO module. In addition, the remote control capabilities via Ethernet of the GTO allow us to change the trigger configuration without inserting and removing cables. Common trigger firmware consists of trigger multiplexer, multi-channel latch, and trigger veto circuits. Figure 1 shows the functional schematic of the firmware. The trigger multiplexer circuit has 8 inputs, and these input signals are enabled by the remote control function. The multi-channel latch circuit produces the veto signal for the trigger when CAMAC/VME front-end systems are busy. There are 16 end-of-busy inputs; therefore, this firmware can accept up to 16 CAMAC/VME front-end systems. Each latch signal is triggered by the leading edge of the accepted trigger, and it is cleared by the trailing edge of the end-of-busy signal from the front-end system. The trigger veto circuit inhibits trigger signals when either DAQ is not started or at least one of the front-end systems is busy. Using these circuits, the GTO can provide the complete common trigger. The dead time of the DAQ system is determined by the slowest front-end system.

To evaluate the timing performance of the common trigger firmware, the propagation delay and time jitter are measured. The propagation delay is the time between the trigger input and the accepted-trigger output. These parameters are measured by an Agilent Technologies U1060A-002 TDC, which has a timing resolution of 5 ps; the results are shown in Tab. 1.

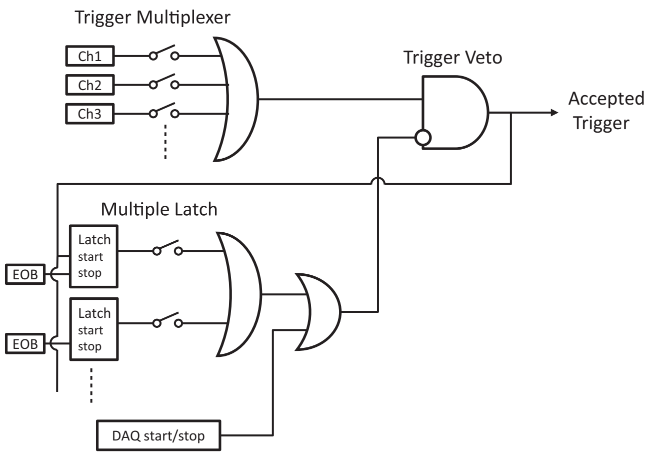

Fig. 1. Circuit schematic of the common trigger firmware. EOB is end-of-busy signal from the front-end system.

Table 1. Propagation delay and time jitter.

Channel	delay (ns)	jitter (ps)
1	15.7	6
2	15.9	6
3	15.5	7
4	15.9	4
5	16.2	7
6	16.1	6
7	16.5	8
8	15.8	5

According to these results, the skew, that is, the maximum difference between the propagation delay of all channels, is 1.0 ns. This 1.0-ns skew is not small but does not present any difficulty to the function of the trigger multiplexer. The maximum time jitter is 8 ps, which is normal for a NIM logic module.

In summary, the common trigger firmware for the GTO has been successfully developed. It allow us to reduce the number of logic NIM modules and change the configuration remotely. Further, the timing performance of the firmware is sufficient for use as a trigger circuit.

References
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