Special Trigger Algorithm

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Change Log:

Version	Date	Comment
2010_a	December 7, 2009	First version for 2010. Removed the old special trigger logic and replaced it with the new laser logic.
2010_b	January 6, 2010	Moved the laser_fire output bit from bit 1 to bit 13 in the output list.
2010_c	January 7, 2010	Moved the laser_fire bit back to its original location. Moved the input bits from bits 0 and 1 of channel 0 to bits 4 and 5. Also added a copy of the unmodified input bits to the output list.
2010_c	July 24, 2018	No algorithm changes. The documentation has been significantly updated to clarify how the laser trigger works.

The ST201 DSM board produces 3 special-trigger bits that can be used for tests, calibrations and normalizations. There is a **zero-bias bit**, which is just a pre-scaled RHIC clock, a **pseudo-random bit** and a **laser trigger**. The pseudo-random bit is generated by comparing the current value of an exponentially decaying 32-bit number to a threshold value chosen from a linear feedback shift register. When the decaying value drops below the threshold the pseudo-random bit is set and the decaying register is reinitialized to its maximum value. The user can control the rate of exponential decay. The laser trigger is based on signals received from the TPC's laser calibration system. Please see https://www.star.bnl.gov/public/trg/TSL/Software/tpc_laser_to_dsm_diagram.pdf for a diagram showing how those signals are created and distributed.

The 3 sets of logic are independent of each other so they are described in separate "Actions" sections.

RBT File: l1_st201_2010_c.rbt

Users: ST201

Inputs: Ch0 = TPC Laser system
Ch. 1:7 = Unused

From the TPC Laser system:
Bits 0:3 = Unused
Bit 4 = Laser lamp
Bit 5 = Laser diode
Bits 6:15 = Unused

LUTS: 1:1

Registers:
R0: XPERT_LSB_ZB_PreScale (16 bits)
R1: XPERT_MSB_ZB_PreScale (16 bits)
R2: XPERT_LSB_12bit_Random_Rate (12 bits)
R3: XPERT_MSB_12bit_Random_Rate (12 bits)
R4: XPERT_Laser_Protection_Length (16 bits)

Zero-Bias Logic Action:

1st Latch board mode. NOTE: The board mode signal has a dedicated input port that is completely separate from the data input channels (Ch. 0:7)

2nd Compare the previous and current values of the board mode signal to see if it has changed from STOPPED to RUNNING

3rd If the board mode signal has just changed to the RUNNING state OR the zero-bias counter equals 1 then

 (Re)Initialize the 32-bit zero-bias counter to the value specified by combining R0 and R1

 Else

 Decrement the zero-bias counter by 1

 If the zero-bias counter equals 1 then

 Turn on the Zero-bias bit (1)

 Else

 Turn off the Zero-bias bit (0)

4th Latch Outputs

Pseudo-Random Logic Actions:

1st Latch board mode. NOTE: The board mode signal has a dedicated input port that is completely separate from the data input channels (Ch. 0:7)

2nd Compare the previous and current values of the board mode signal to see if it has changed from STOPPED to RUNNING

3rd If the board mode signal has just changed to the RUNNING state OR the 24-bit rate counter equals 1 then

 (Re)Initialize the rate counter to the value specified by combining R2 and R3

 Else

 Decrement the rate counter by 1

 Shift the 128-bit linear feedback shift register so that

 New bits 1:127 = Old bits 0:126

 New bit 0 = Old bit 127 xor old bit 0

 If the rate counter equals 1 then

 If the current value of the exponentially decaying register is less than the current test value, then:

 Re-initialize the exponentially decaying register to 32 bits, all 1's

 Set the new test value to bits 32:63 of the linear feedback shift register

 Turn on the Random output bit (1)

 Else

 Right-shift the exponentially decaying register

 If the Random output bit is on (1) then turn it off (0)

4th Latch Outputs

Laser Logic Actions:

1st Latch inputs.

2nd Compare the previous and current values of the laser lamp signal to see if it has changed. Compare the previous and current values of the laser diode signal to see if it has changed.

3rd If the laser lamp signal has just turned on AND R4 is set to a non-zero value then

 Turn on the Laser-protection bit (1)

 If the Laser-protection bit is already on AND the laser logic counter is non-zero, then

Decrement the laser logic counter by 1

If the Laser-protection bit is already on AND the laser logic counter equals zero, then

Turn off the Laser-protection bit (0)

Re-initialize the laser logic counter to R4

If the laser diode signal has just turned on then:

Turn on the Laser-fire bit (1)

If the Laser-fire bit is already on then:

Turn off the Laser-fire bit (0)

4th Latch Outputs

Output to TCU:

Bit	Name	Description
Bit 0	Laser-protection	Laser is about to fire so no physics triggers should be issued
Bit 1	Laser-fire	Laser firing
Bit 2	Laser-lamp	Copy of the original Laser lamp input signal
Bit 3	Laser-diode	Copy of the original Laser diode input signal
Bits 4:13	Unused	Unused
Bit 14	Zero-bias	Zero-bias
Bit 15	Random	Random

Output to Scalers:

Bit	Description
Bit 0	Laser is about to fire so no physics triggers should be issued
Bit 1	Laser firing
Bit 2	Copy of the original Laser lamp input signal
Bit 3	Copy of the original Laser diode input signal
Bits 4:13	Unused
Bit 14	Zero-bias
Bit 15	Random