Requirements for a multi event dead time locker and trigger type priority encoder

**General:**
The aim is to develop a dead time locker and trigger type priority encoder, in order to utilize the multi event storage capability of front end systems like the CAEN V7xx and others. As for the running single event version, this new functionality shall be based on the VME module VULOM3 (or its successor).

**Input parameters:**
The only input parameter, to be set before enabling the module is the maximal number of triggers N_TRIG, which will be accepted before a readout trigger shall be send to the GSI trigger module. N_TRIG is set to 32 as default at power up.

**Input - / output signals:**
The VULOM3 has 16 ECL inputs; 16 ECL in-/outputs selectable in groups of 8 for in or out; 16 ECL outputs; 2 LEMO / NIM inputs and 2 LEMO / NIM outputs. All ECL in-/outputs are grouped in sockets of 8 x 2 signals. They will be used as follows (ECL in-outputs are numbered logically, i.e. signal pair 1, 2 is named 1, 15-16 is named 8, etc):

**16 ECL inputs** (two upper most VULOM3 sockets):
1-13: trigger inputs for 13 different hardware trigger types
14-16: free

**16 ECL outputs** (two lowest VULOM3 sockets):
1-13: dead time locked output for 13 different trigger types (see ECL inputs). To be used for gates, starts stops, etc. will be send immediately for each hardware trigger input, if dead time was off at arrival of the trigger input signal.
14: OR of ECL outputs 1-10.
15: OR of ECL outputs 1-13
16: Dead time: Logically high, whenever no trigger can be accepted, regardless of reason for dead time.

**8 ECL inputs** (third socket from VULOM3 top):
These 8 signals are the connection to the 8 ECL outputs of the trigger module TRIVA3/5 and therefore fixed as follows:
1: Master trigger
2: Fast clear
3: Start of readout
4: TRIVA3/5 dead time
5: Go
6: Halt (Inverted Go)
7-8: Reserved
8 ECL outputs (fourth socket from VULOM3 top):
These 8 signals are the connection to the 8 ECL inputs of the trigger module TRIVA3/5 and therefore fixed as follows:
1-4: Encoded trigger (types). These 4 bits encode the 13 dead time locked outputs (see above) in the following way: Only the numbers 1, 11, 12 and 13 will occur and shall be encoded (see functional description below).
5-7: Not used.

2 LEMO inputs:
1: dead time in. This will be an OR of the dead time of all modules or sub systems (see below).
2: free (other ideas?)

2 LEMO outputs:
1: pulse (~50ns), sent whenever a trigger type 1-13 was accepted.
2: to be set logically high and low by VME register access of a VME processor. This signal set to high is equivalent with dead time on. It can be used to enable and disable the trigger generation in the external trigger logic.

Memory:
For each multi event trigger, 4 bits shall be reserved for storing the trigger type consecutively for the maximal number of triggers N_TRIG.

Registers:
1) Trigger counter register. Will be reset by VME processor
2) Register to set and clear level on LEMO 2 output
3) Status and error register?

Functional description:
Multi event readout refers to the capability of modern digitizers to store locally many events, before a read is needed. If a large chunk of data can be readout from modules at once, fast (VME, PCI Express) Block readout modes can be used efficiently and improve the performance substantially. The module with the least event storage capability defines the maximum number of triggers/events in the complete system to be stored locally in the modules. This maximum number of triggers/events shall be set with the N_TRIG input parameter. Lower, but not higher numbers are possible.

General: The trigger (type) inputs are grouped logically in two groups. Trigger type 1-10 are used for multi event storage, trigger type 11-13 force always the complete readout of the multi event buffers of all modules. Trigger type 11-13 can be used as pure multi event readout trigger, or as physics trigger, where a last event is stored in the modules and afterwards the readout of the modules starts.
Before the acquisition is started the N_TRIG parameter needs to be set from the VME processor only if a value differing from the default shall be set. Writing any number to VME to set N_TRIG forces the module to be reset and enabled to accept triggers. This must also be the case if the value of N_TRIG is identical to the previous setting.
**Trigger inputs:** If the internal dead time of the dead time locker is off, the module accepts new triggers. For each trigger type 1-13 accepted, the trigger counter register is incremented by 1 and the trigger type is stored as 4 bit value in the trigger type memory. After accepting the trigger a pulse with a length of ~ 50 ns is sent to the corresponding trigger type ECL output. This will be used for gates, starts, etc.

**Dead time:** The module raises its internal dead time with the arrival of a trigger type 1-13. This and the priority detection of concurrent triggers shall be the same as with the current single event dead time locker.

The internal dead time of this dead time locker is released by the module in the following scheme:

1) If the trigger counter is less than N_TRIG and the current trigger type is between 1 and 10, the dead time is released with the falling edge of the signal on LEMO input 1. The signal on LEMO input 1 is the ORed dead time of the digitizer modules and indicates, that a further trigger/event can now be stored in their multi event buffers.
2) If the trigger counter is equal to N_TRIG, or the current trigger type is between 11 and 13, the dead time is released by the falling edge of the dead time signal from the trigger module TRIVA3/5.

A trigger is only accepted if the internal dead time is off.

**Single trigger ECL outputs:** For each accepted trigger a pulse, as described above, is sent to its corresponding ECL output. This is done regardless of the trigger type.

**Encoded trigger outputs to TRIVA3/5:** 1) If the trigger counter is equal to N_TRIG, a trigger type 1 shall be send as encoded trigger. This signals the VME readout processor to read all event buffers, because the buffers are filled to the predefined stage.
2) If a trigger type in the range of 11-13 occurs, the actual trigger type shall be sent encoded to the TRIVA3/5. These trigger types signal the VME readout processor that the multi event buffers shall be read regardless of the filling state.

**Trigger type memory and trigger counter clear:** After a trigger type 1, 11, 12 or 13 has been sent to the TRIVA3/5 the VME readout processor reads the trigger type memory - , clears the trigger counter on the dead time locker, reads the multi event buffers and releases then the TRIVA3/5 dead time. This enables the dead time locker again to accept at maximum further N_TRIG triggers/events. Before accepting the first trigger after TRIVA3/5 dead time release, it may be checked that the trigger counter is really set to zero. If not, an error bit may be set.