

# LTP Proposal

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**Draft description of a module interfacing a TTC partition to the central trigger processor and containing all the necessary ingredients to run a partition in stand-alone mode.**

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**Revision 1.** July 2002. First draft based on the DCTPI and the liquid argon LTP specs.

**Revision 2.** September 2002. Add all functionality to be able to run several LTP in a separate partition. Add block diagrams. Rename the module LTP.

**Revision 3 & 4.** December 2002 and January 2003. Clarifications and including comments.

**Revision 5.** February 2003. Comments from Guy Perrot.

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## **1.0 Introduction**

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ATLAS is divided in 36 partitions, each of them having its own TTC network, controlled by its own TTCvi. Each partition can run in two modes:

- Global mode, when the TTC signals are coming from the Central Trigger Processor and when the data are read-out through the main ATLAS central DAQ system;
- Local mode, when the partition is run stand-alone with “private” TTC signals and when the data are kept separate from the main ATLAS central DAQ system (the data can be stopped at the RODs level or further).

In both cases, the TTCvi must receive all the TTC signals and a way of handling the dead-time has to be foreseen. In addition, some mechanisms allowing special calibration sequences must be allowed.

This note describe a module which will interface the TTCvi with the trigger source which can be either the CTP when running in global mode or some local electronics when running in local mode. The module allows also to combine several TTC partitions in local mode.

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## **2.0 TTC partition root**

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A TTC partition is driven by a set of 4 modules as shown in Figure 2:

- The LTP;
- The TTCvi;
- The TTCxx (ex, mx or tx);
- The ROD-Busy module.

The LTP interfaces the partition to the Central Trigger Processor when running in Global mode (i.e under control of the CTP) and to the local trigger logic when running in Local mode.

The interface to the CTP is done through a differential link (CTP-Link) and each sub-detector has got its own link. It means that one CTP-Link connect the CTP to all the LTPs of a given sub-detector and only to these LTPs.

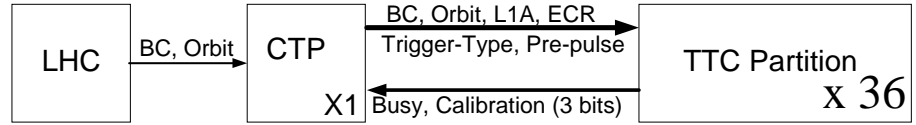
The TTCvi provides the A- and B-Channel signals to the TTCxx module which contains the encoder and the electrical-to-optical converter. The ROD-Busy module gathers the Busy signals from the RODs attached to this partition to form an overall BUSY signal which will throttle the trigger source (either the CTP or some local trigger logic).

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## **3.0 Partition in a Global run**

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In normal running an ATLAS partition receives the Timing, Trigger and Control (TTC) signals from the ATLAS Central Trigger Processor (CTP) through a set of interfaces as shown in Figure 1 and detailed in Table 1.



**FIGURE 1.** Interface between the CTP and a partition

**TABLE 1.** Signals exchanged between the CTP and a TTC partition when the partition is in the central data acquisition system (global mode)

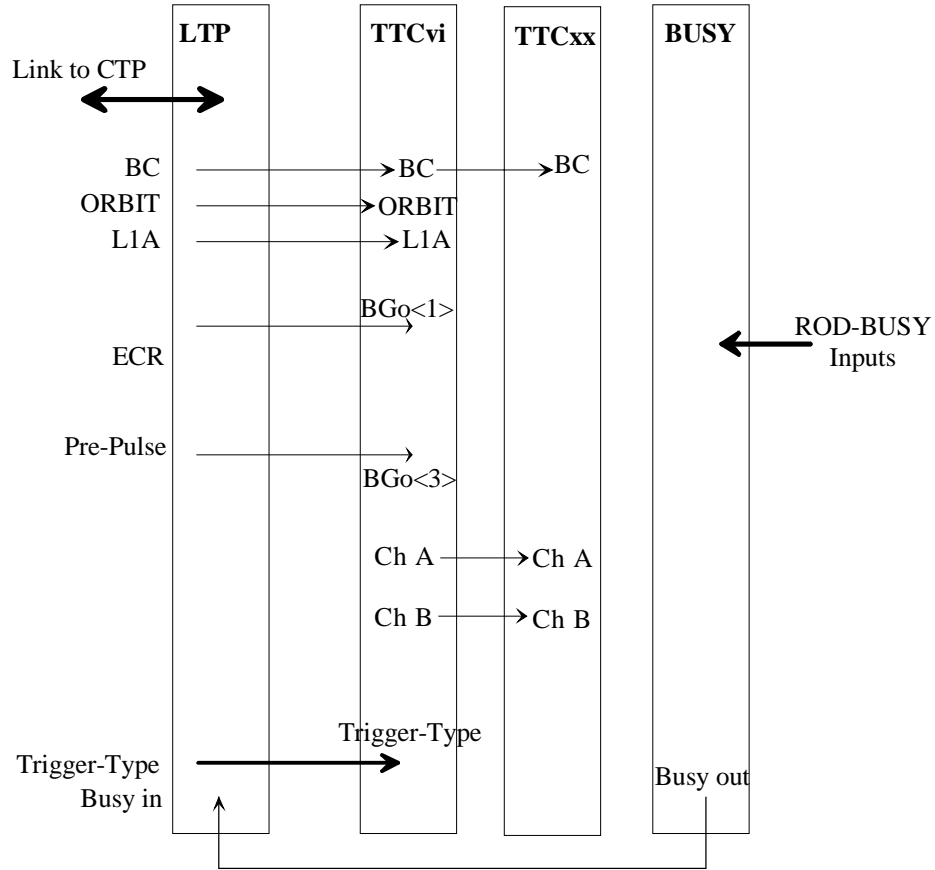
Name	Function
BC	LHC clock
ORBIT	LHC ORBIT signal used for instance to issue the BCR signal
L1A	L1 Accept signal
Trigger-Type	8-bit trigger-type word issued by the CTP with each L1A
ECR	Event Counter Reset signal. Signal used to reset the 24 low-order bits and to increment the 8 high-order bits of the L1ID
Pre-Pulse	A signal issued by the CTP indicating that in N BC a L1A will be issued. This signal can be used, for instance, to fire a calibration or test electronics at the right time during data taking
BUSY	The BUSY signal generated by the RODs of the partition when their buffers are almost full. Used by the CTP to introduce dead-time
Calibration	3-bit word issued by the partition and used by the CTP to generate calibration triggers

The CTP gets the BC and the ORBIT signals from the LHC machine. These signals should always be available even if the machine is down (it may still be useful to foresee a local generation). For each partition included in the central acquisition system (global mode) the CTP delivers the BC, ORBIT, L1A, Trigger-Type, ECR and pre-Pulse. It will receive from each partition a BUSY signal and a 3-bit calibration trigger request.

For calibration during physics runs the Pre-Pulse signal could be used to generate a calibration command at the right time so that the associated L1A signal captures the calibration data. It has to be noted that there may be a Pre-Pulse signal without an associated L1A as it could be masked because of the dead-time algorithms running in the CTP (complex dead-time algorithm or external BUSY signal asserted).

In addition, a partition can request a calibration trigger by asserting a 3-bit calibration request to the CTP. This possibility is mainly used during the long LHC gap; these gaps are shared among the different sub-detectors. Only the CTP is able to handle these calibration requests; i.e this functionality does not exist when in local mode. Several LTPs from the same sub-detectors are connected to the same CTP Link, but only one LTP is able to issue the calibration requests.

Figure 2 shows a view of the different modules and their connection when in global mode.



**FIGURE 2.** View of the TTC root modules in global mode

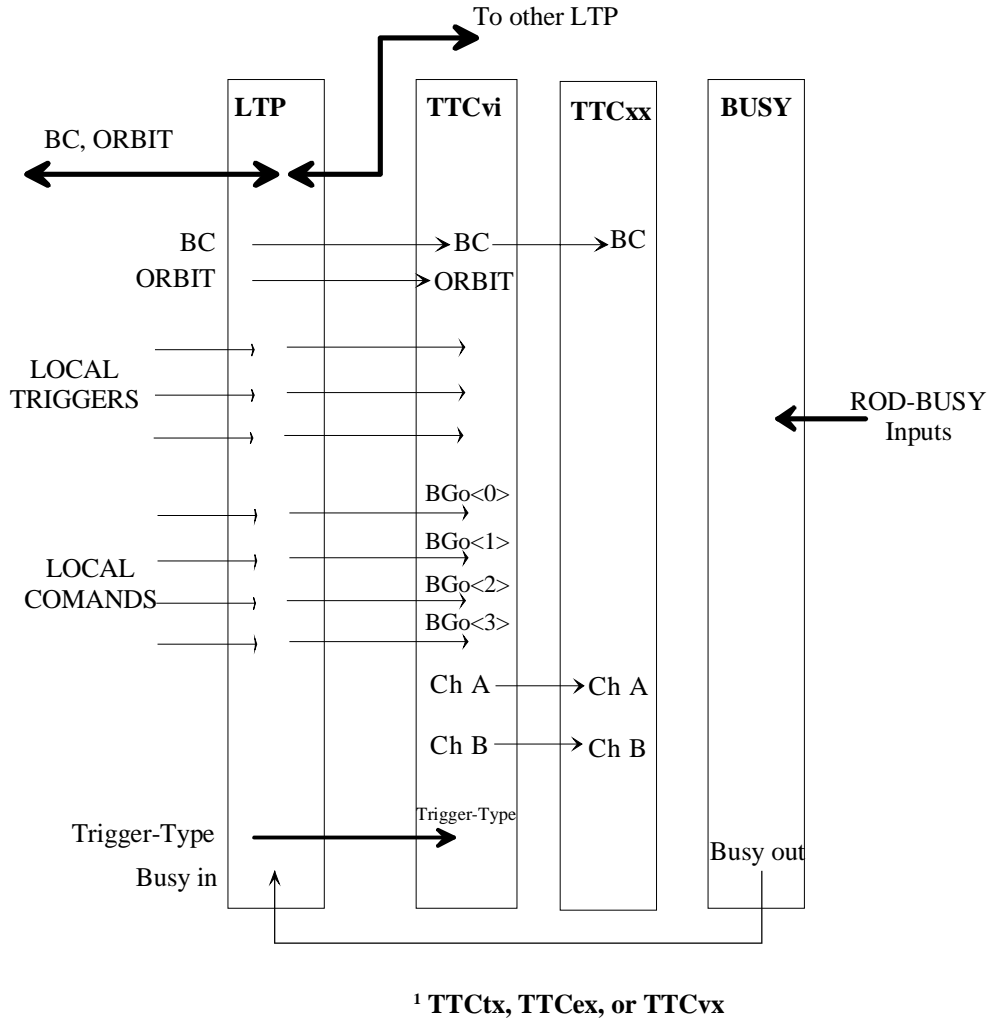
## 4.0 Partition in local mode

It is assumed that the BC and ORBIT signals are always available from the LHC machine. Still, for debug purpose an internal crystal oscillator (40 MHz) can provide the BC clock. Similarly, the ORBIT signal can be internally generated.

In local mode all the signals are locally generated and handled. Local trigger inputs are made available and output towards the trigger inputs of the TTCvi after having been vetoed by the BUSY signal which is now locally handled (i.e it is not transmitted to the CTP). Similarly, the Trigger-Type has to be locally generated.

The local triggers and the local commands can either be issued externally (with a generator for instance) or internally.

Figure 3 shows a view of the TTC root modules when in local mode.



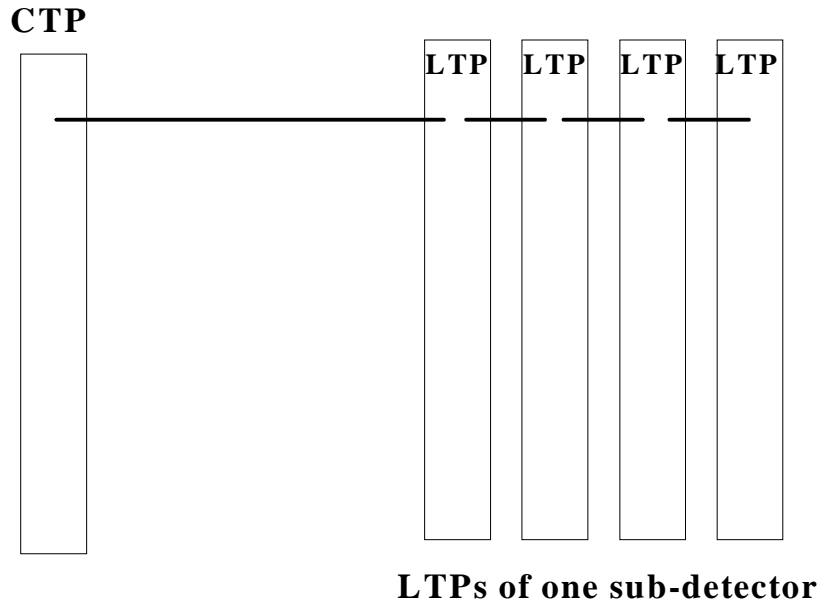
**FIGURE 3.**

View of the TTC root modules when in local mode

It must be possible to have several LTPs connected together when running in local mode. For instance it is necessary to be able to run the calorimeter level-1 trigger partition together with the calorimeters partitions. The LTP provides all the functionality required to do so and different cases must be considered.

#### 4.1 Combining several partitions of one sub-detector in local mode

In this case the LTPs of the different partitions are connected to the same CTP link as shown in Figure 4. The first LTP of the chain will act as a master of the others (referred as local master), i.e it will transmit on the link all the trigger and timing signals used locally and will receive the BUSY from the others LTP. The BUSY signal used by the master LTP is the OR of the BUSY signals of the partition (see Section 5.2.9). As already mentioned, the calibration request signals are not handled in this mode.

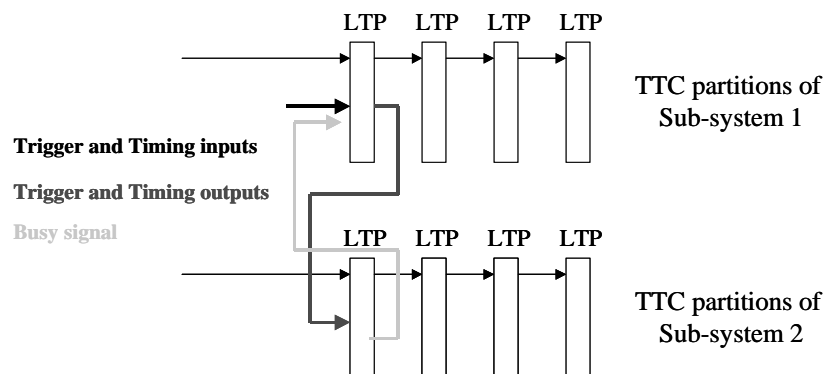


**FIGURE 4.**

Combining partitions from the same sub-detector

#### 4.2 Combining two partitions from 2 different sub-detectors

In this case the LTP of one of the sub-detectors has to act as a master and a few extra cables transmitting the trigger and timing signals (from the master to the slave) and the BUSY signal (from the slave to the master) have to be provided as shown in Figure 5. The BUSY used by the master LTP is the OR of all the BUSY signals of the partition. This OR is done in the LTP (the local master LTP of sub-system 2 delivers the OR of all the BUSY of sub-system 2; the local master LTP from sub-system 1 makes the OR of the sub-system 1 BUSY signals and of the BUSY delivered by the local master LTP of sub-system 2). Here also the calibration request signals are not handled.

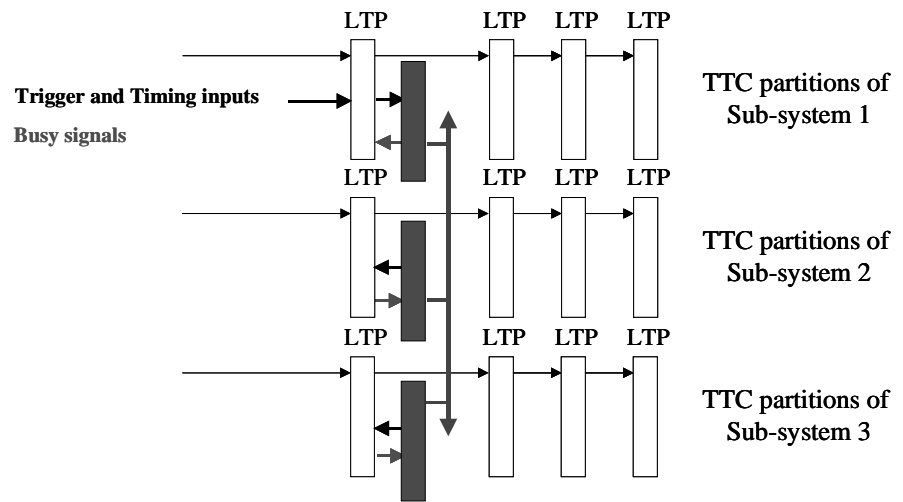


**FIGURE 5.**

Combining partitions from two sub-detectors

#### 4.3 Combining several partitions from several different sub-detectors

Similarly to the previous mode, one LTP has to act as a master, but there is now a need for transmitting timing and trigger signals to several places and to receive BUSY signals from several places. This can be done using standard NIM-ECL converters as shown in Figure 6. As in the previous case, the local master LTPs of sub-system 2 and 3 deliver the global BUSY signal of each sub-system. The OR of BUSY signals from sub-systems 2 and 3 can either be done as wired OR on the link between the NIM-ECL converters or in the BUSY module of sub-system 1; this last possibility has the advantage of providing all the tools for monitoring the BUSY signals. The final OR of all the BUSY signals is done by the local master LTP of sub-system 1.



**FIGURE 6.**

Combining partitions from several sub-detectors

## 5.0 LTP module description

As a first approximation the LTP consists of a programmable switch allowing to interconnect any Input to any Output and a pattern generator, as shown in Figure 7.

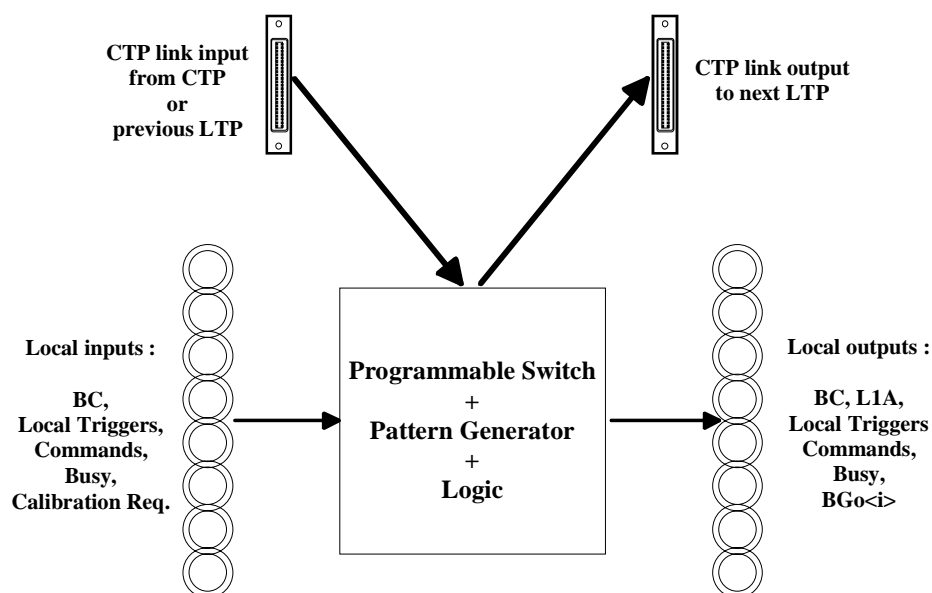


FIGURE 7.

Simplified block diagram of the LTP

### 5.1 Inputs - Outputs

The inputs and outputs are:

- The input CTP link;
- The output CTP link;
- The outputs to the TTCvi;
- The local inputs;
- The Busy input-output;
- The calibration request inputs.

#### 5.1.1 The input CTP link

This input is either connected to the CTPDI of the CTP or to the output CTP link of another LTP. It is using LVDS standard and carries the following signals:

- Inputs
  - BC
  - ORBIT
  - L1A
  - Trigger-Type<7..0>
  - ECR

- Local Command<1..0> (see Section 5.2.7)
- Local Trigger<2..0> (see Section 5.2.5)
- Pre-Pulse
- Outputs
  - BUSY
  - Calibration<2..0>

#### **5.1.2 The output CTP link**

This output can be connected to another LTP input CTP link and carries the following LVDS signals:

- Outputs
  - BC
  - ORBIT
  - L1A
  - Trigger-Type
  - ECR
  - Local Command<1..0> (see Section 5.2.7)
  - Local Trigger<2..0> (see Section 5.2.5)
  - Pre-Pulse
- Inputs
  - BUSY
  - Calibration<2..0>

#### **5.1.3 The outputs to the TTCvi**

The LTP delivers to the TTCvi (Lemo00 connectors):

- L1A, ECL
- Test-Trigger <2..0>, NIM
- BC, ECL
- ORBIT, ECL
- BGo<3..0>, NIM

and the 8-bit Trigger-Type word through a 16-pin 3M connector (differential ECL level).

#### **5.1.4 The local inputs**

The LTP accepts the following local inputs (Lemo00 connectors):

- L1A, NIM
- Test-Trigger <2..0>, NIM
- BC, NIM
- ORBIT, NIM
- BGo<3..0>, NIM

### **5.1.5 The Busy input-output**

The LTP accepts two external BUSY input and delivers a local BUSY output (Lemo00 connectors):

- BUSY-in1, Open Collector TTL
- BUSY-in2, NIM
- Local BUSY-out, NIM

### **5.1.6 The calibration request input**

The 3-bit calibration request (Calibration<2..0>) can be input through a 10-pin 3M connector. LVDS or ECL levels are used.

### **5.1.7 The monitoring outputs**

A copy of the signals sent to the TTCvi are available (Lemo00 connectors):

- L1A, NIM
- Test-Trigger<2..0>, NIM
- BC, NIM
- ORBIT, NIM
- B-Go<3..0>, NIM

## **5.2 Description of the different logical blocks**

This section gives some details of all the different logical blocks:

- Pattern generator
- BC block
- ORBIT block
- L1A block
- Test-trigger block
- Trigger-Type block
- B-Go block
- Calibration request block
- BUSY block

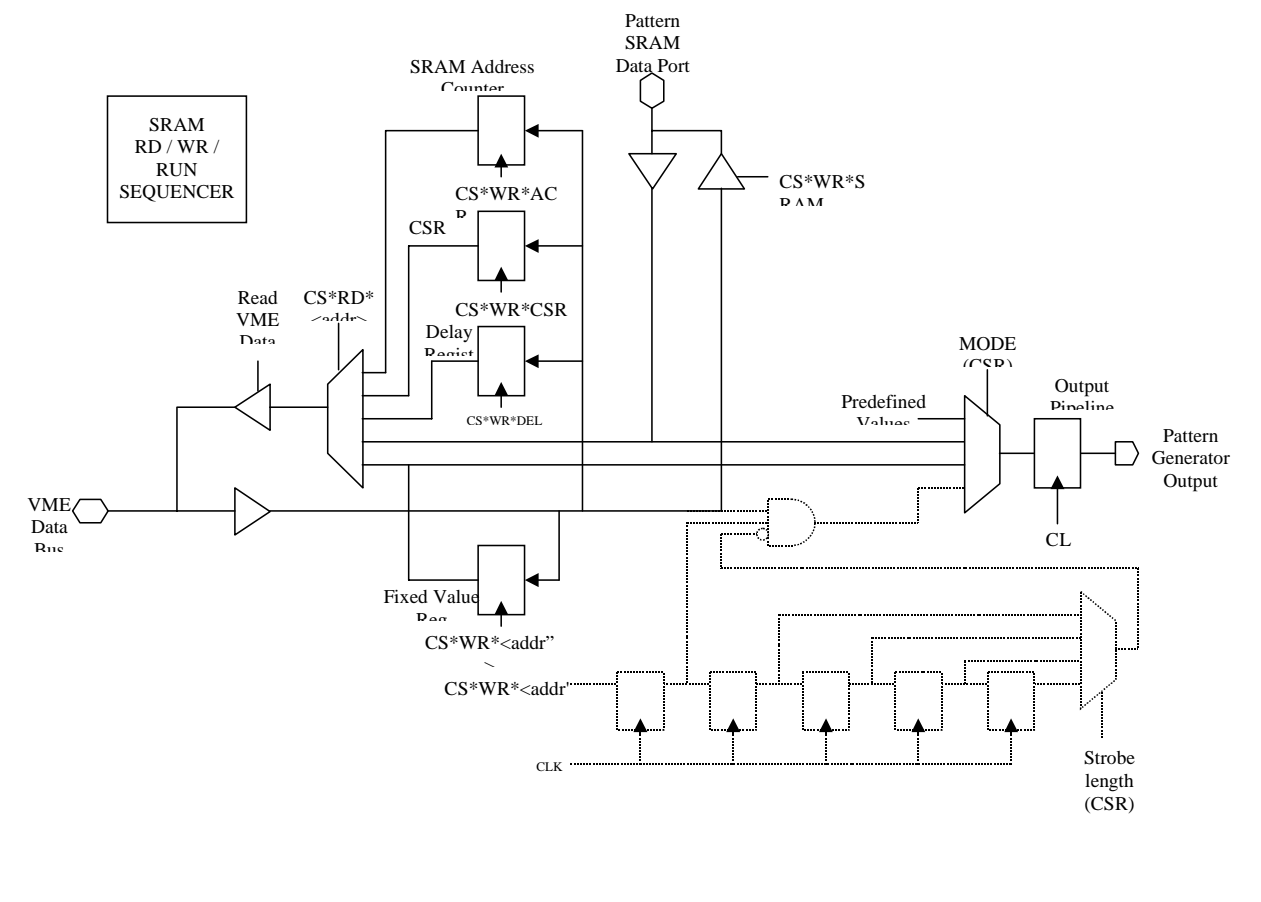
### **5.2.1 Pattern Generator**

The pattern generator allows to generate internal signals at a given time with respect to the LHC cycle. It is realised with a 1 MWord RAM which can be written (and read for control) through VME and which is then read-out at 40 MHz. The content of the RAM (data-out bits) is then used internally to generate signals.

The size of the RAM allows to cover a time window of 26.2 ms. The sequencer can either continuously loops or just stops after a first read path.

The start of the sequence can be started when the ORBIT signal occurs or a VME access, either instantaneously or a programmable time after this signal occurred; the maximum delay is an LHC turn time and it is programmable in steps of 25 ns.

A block diagram of the pattern generator is given in Figure 8.



**FIGURE 8.**

Pattern Generator Block diagram

There are four modes of operation:

- Outputs are disabled and in non-active states. Used to write and read-back the memory through VME. The address counter points at the address to be accessed.
- Outputs are driven by the memory in single shot (triggered by External signal or VME access) or in continuous mode.
- Outputs are levels which are controlled by a VME register, with read-back facility. Sequencer is idle.
- Outputs can be pulsed with a pre-set duration. A VME data word defines which bits must be pulsed and the generation takes place on the VME access. Sequencer is idle.

All the signals can be generated from the pattern generator except the trigger-type word.

### 5.2.2 BC block

Figure 9 shows the block diagram of the BC block. The local BC used can be one of the following sources:

- Internal oscillator
- Local Input
- BC from the CTPlink input

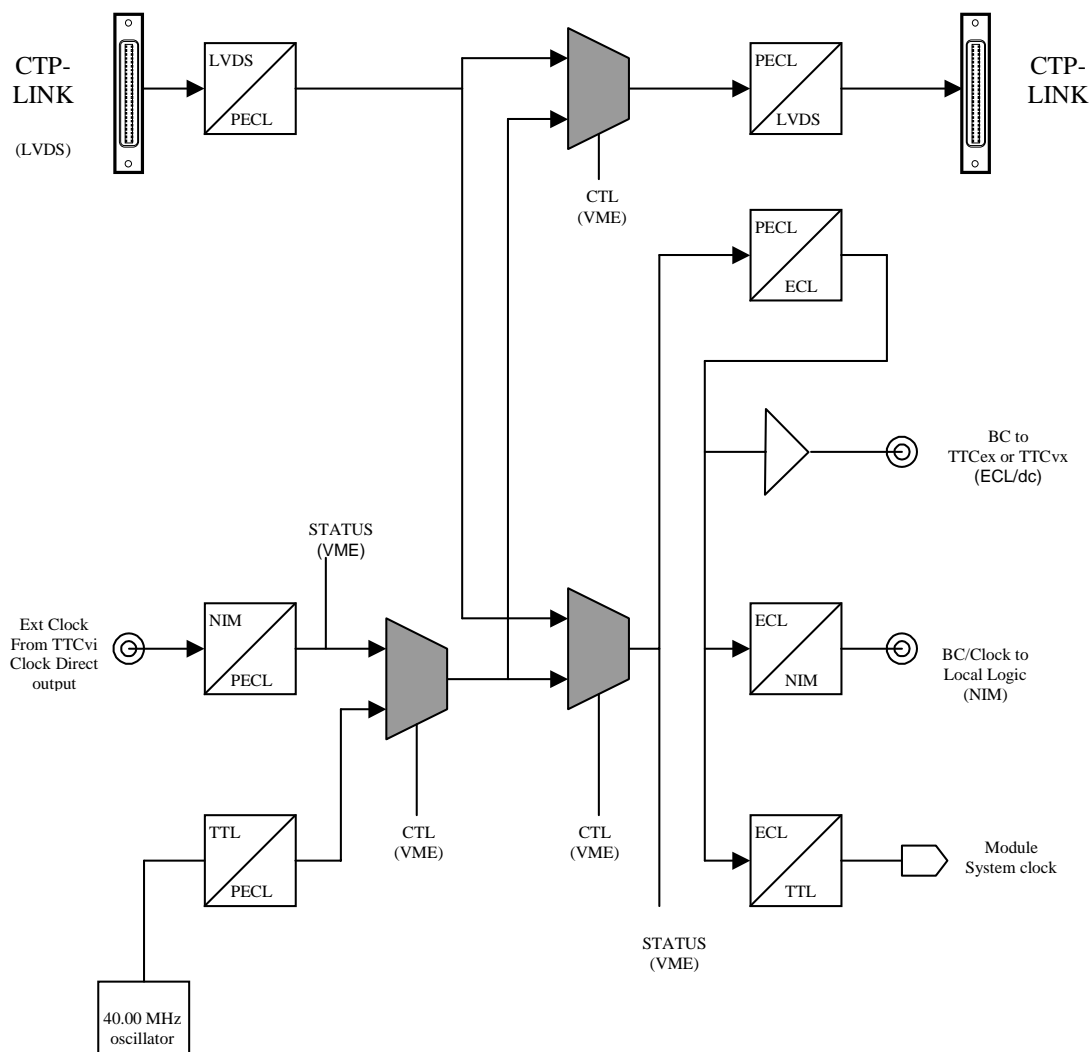


FIGURE 9.

Block diagram of the BC block

The BC transmitted on the CTPLink output can either be the local BC or the one coming from the CTPLink input.

### 5.2.3 ORBIT block

Figure 10 shows the block diagram of the Orbit path. The Orbit signal can either come from the CTP or be locally generated.

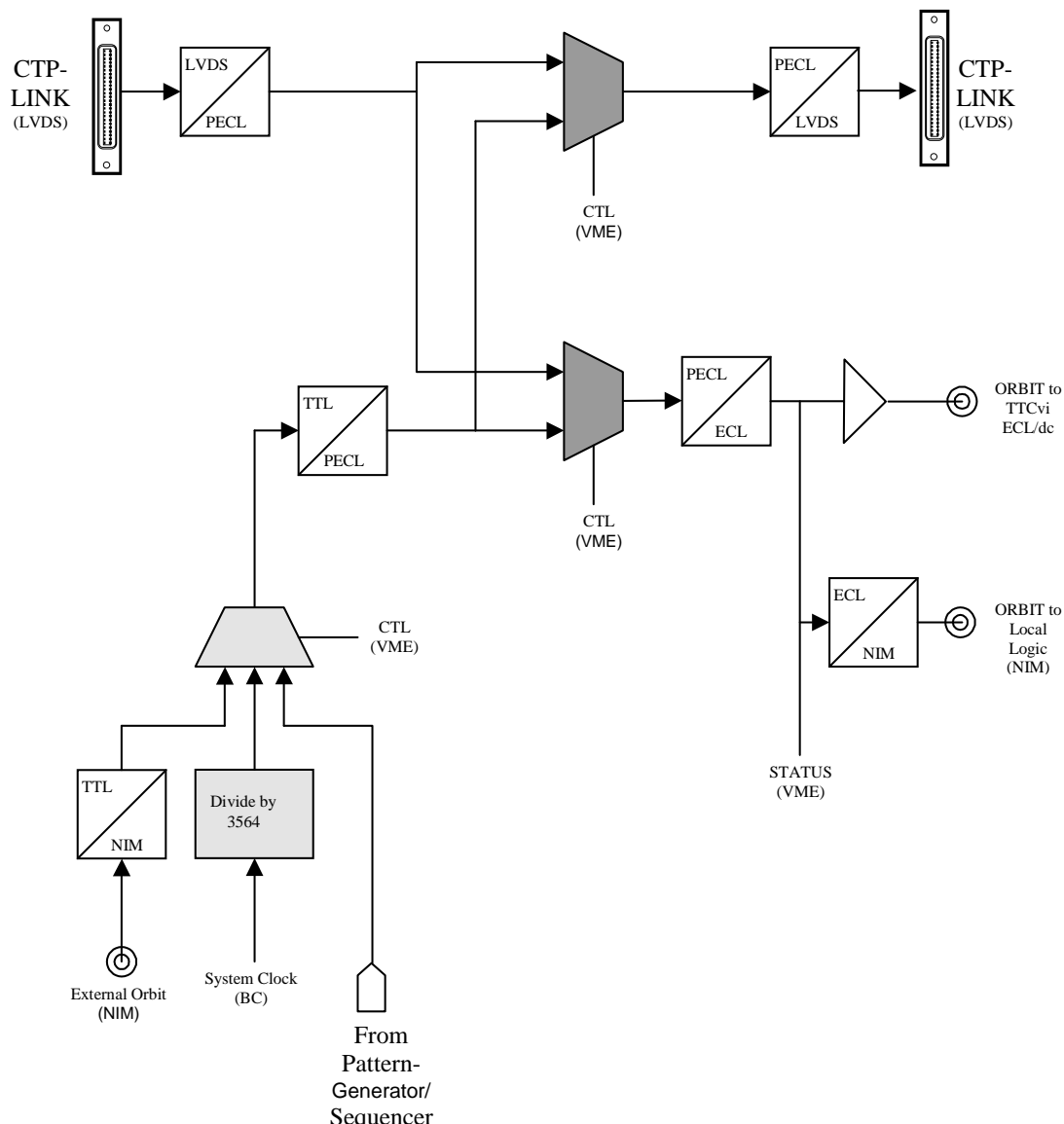


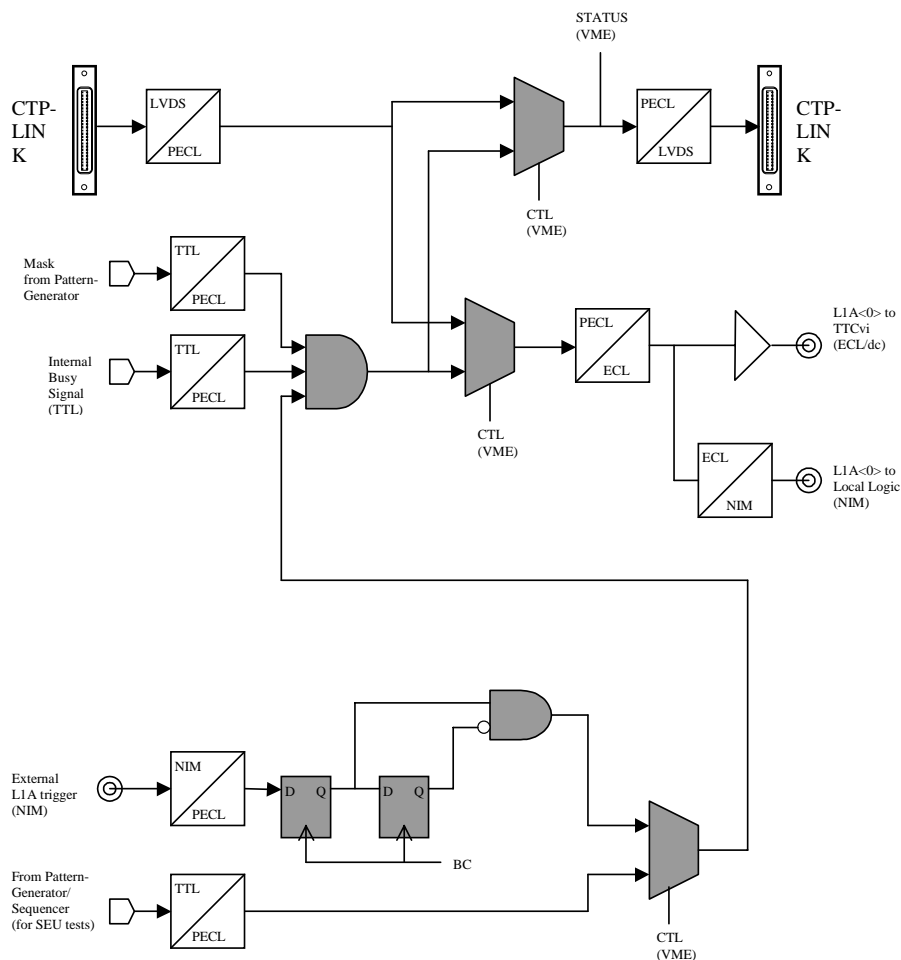
FIGURE 10.

Block diagram of the Orbit block

#### 5.2.4 L1A block

Figure 11 shows the block diagram of the L1A block. This block includes the dead-time handling when L1A is locally generated. It has to be noted that no complex dead-time algorithm is implemented when using an external L1A input (i.e only the BUSY is being looked at and there is no dead-time protection after a L1A). When using the pattern generator, complex dead-time algorithm can be implemented in programming properly the pattern generator.

A dead-time is introduced when BCR is issued.



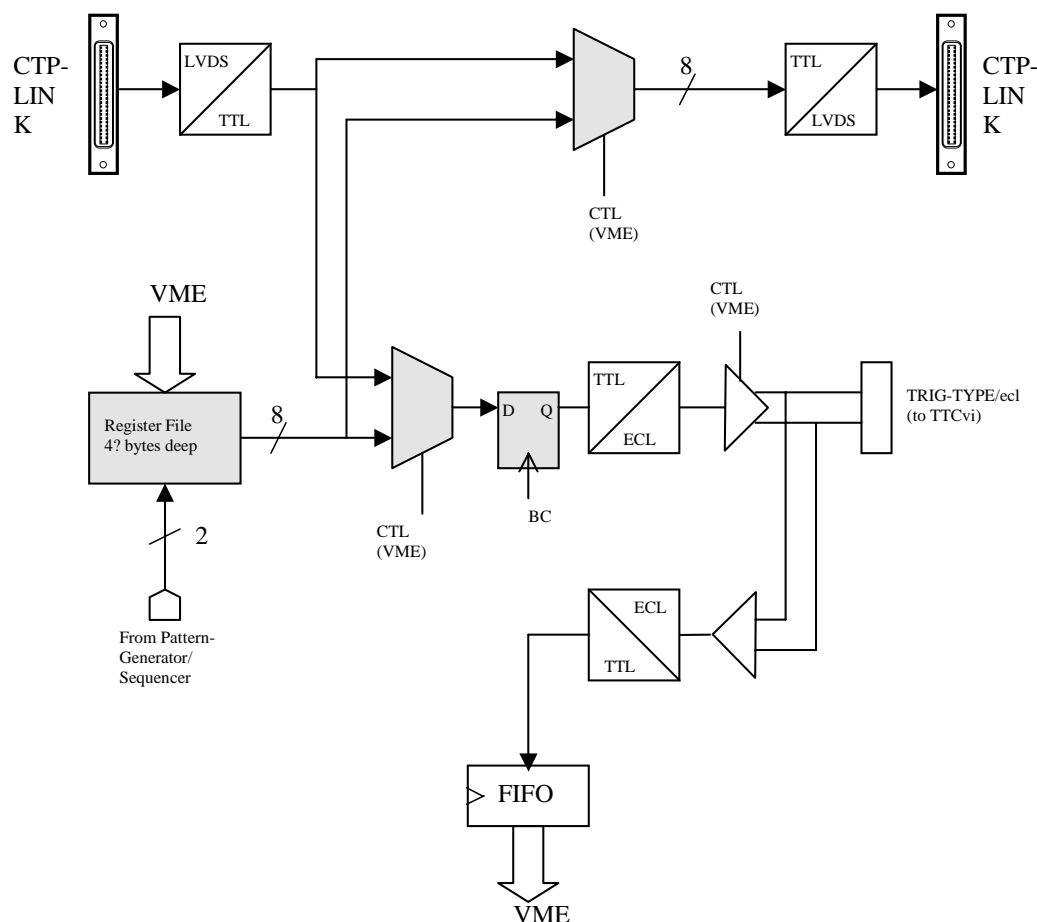
**FIGURE 11.** Block diagram of the L1A block

### 5.2.5 Local Triggers block

The local triggers are the triggers locally generated by each sub-systems. Figure 12 shows the block diagram of the local triggers block. The selected local triggers are available as front-panel outputs (to be connected to the TTCvi) and can also be transmitted on the CTPLink output to allow several LTPs running with the same local triggers.

As for the L1A, no complex dead-time is implemented when using external inputs.




**FIGURE 13.**

Block diagram of the Trigger-Type block

### 5.2.7 Local commands block

Figure 14 shows the block diagram of the local commands (connected to the TTCvi B-Go inputs) block. Two of them are used for the global commands BCR and ECR. The other ones are left to the sub-systems for special purpose uses (e.g test pulse generation, calibration signals, ...). The local commands sources can be external signals or VME registers or pattern generator.

The CTP is delivering only BCR and ECR but the four commands signals are available on the CTP link.

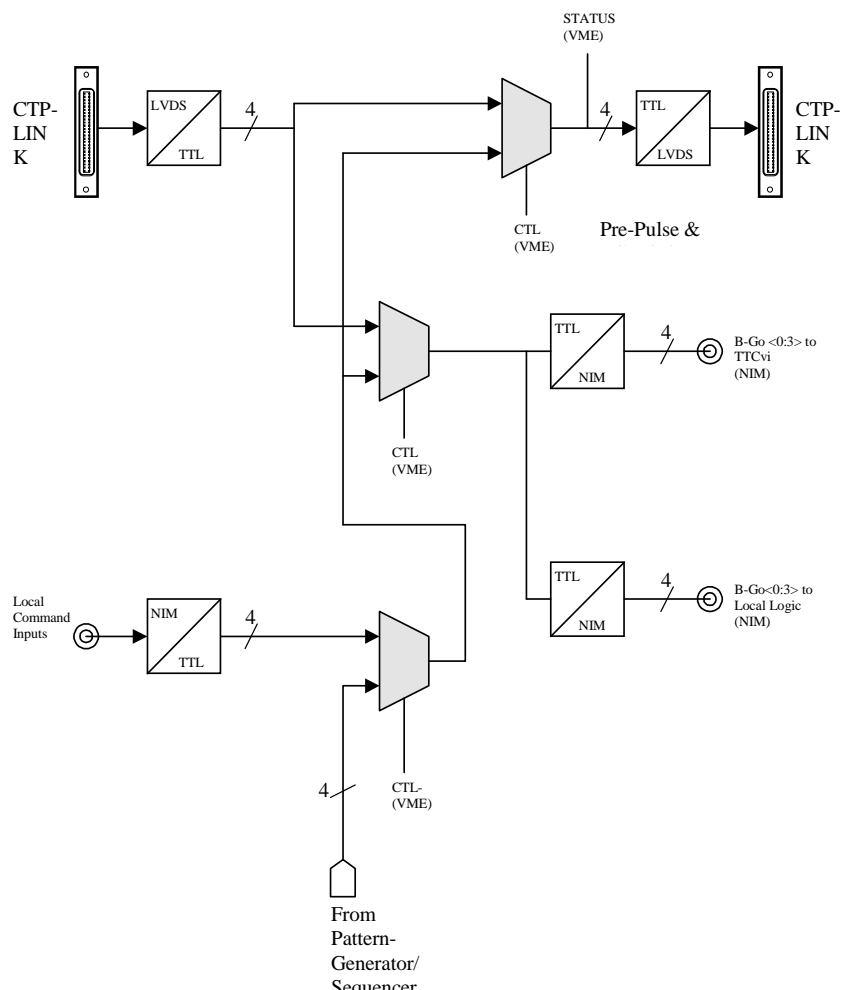


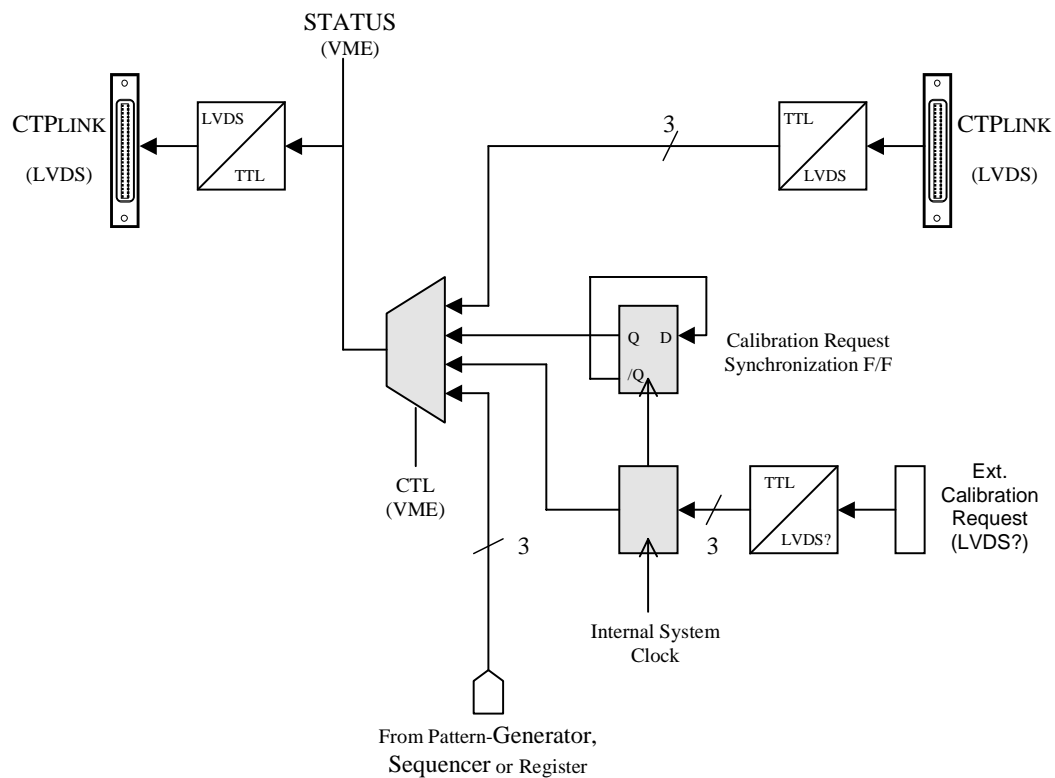
FIGURE 14.

Block diagram of the Local Commands block

### 5.2.8 Calibration request block

Figure 15 shows the block diagram of the calibration request block. The 3-bit calibration request can come from the internal sequencer or from external signals. When several LTPs are connected on a CTPLink only one is allowed to send the calibration request signals. This is deemed not being a limitation as only one sub-system can be connected to a specific CTPLink (the CTP has 20 CTPLinks allowing to have one link per sub-system).

The calibration request can either be levels or pulses. In the later case, there is a need for resynchronisation with the internal clock.

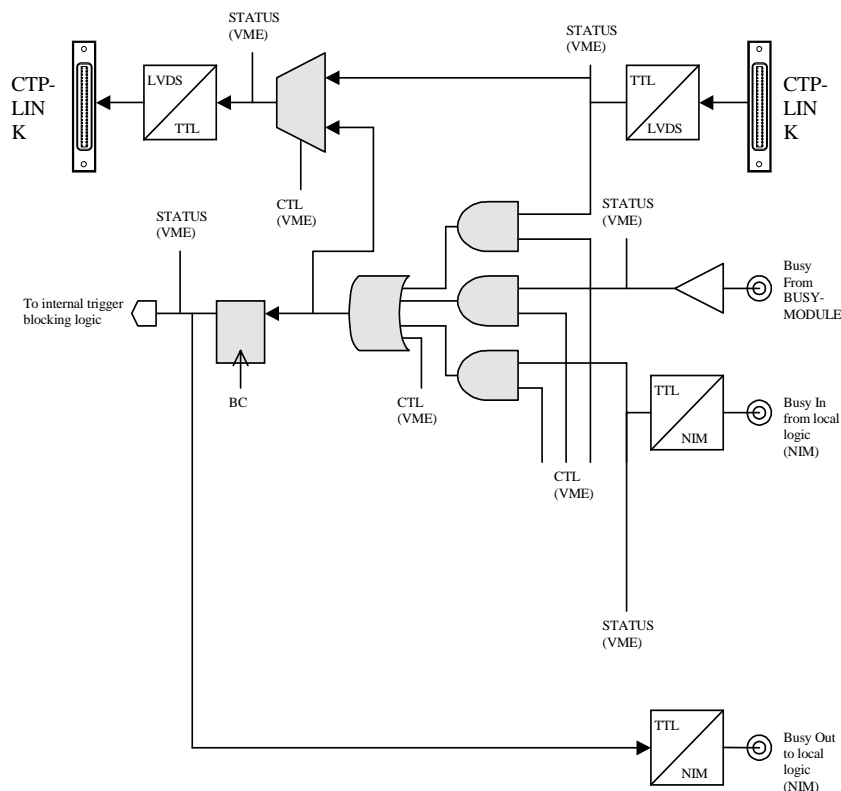


**FIGURE 15.**

Block diagram of the calibration request block

### 5.2.9 BUSY block

Figure 16 shows the block diagram of the BUSY block. Several sources of BUSY signal can be selected. When in global mode, the BUSY signal is sent back to the CTP. When in local mode it is used to generate a local dead-time.




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**FIGURE 16.**

Block diagram of the BUSY block

When in global mode, the last LTP directly connected to the CTP makes the OR of the local BUSY input with the BUSY signal coming from the other LTP connected to this link.

When in local mode the BUSY signal is not sent to the CTP.

It is also possible to have some of the LTPs of a particular CTPLink in local modes with others in global mode as there is a full control of what is transmitted on the CTPLink.

### 5.3 Reset conditions

After a RESET signal (VME SYSRESET) the module is set in local mode and does not transmit anything to the CTP.

### 5.4 Front-panel

A view of the front panel of the LTP is shown in Figure 17.

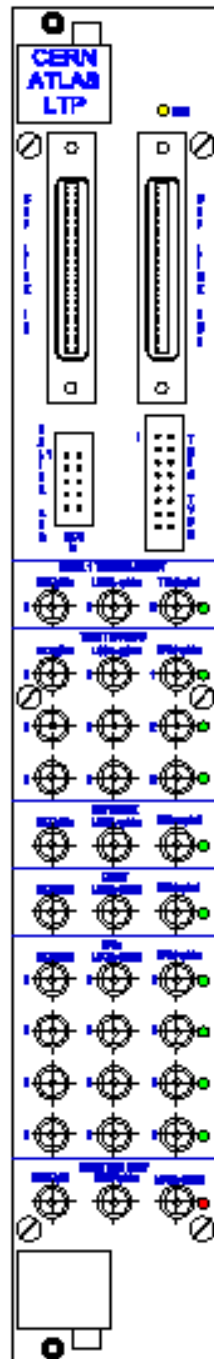


FIGURE 17.

LTP front panel