Summary of Timing and Control Signals

Working document

Version 2.2.2001

1 Fast Control Signals

List of Fast Control signals distributed centrally (the list does not include Test and Calibration signals discussed latter).

Fast Control Signals	TTC command type	TTC Code	Comments
L1 Accept (L1A)	Channel A		High priority signal transmitted by Channel A
Trigger Type	Broadcast Word		Word specifying the trigger type. Optionally, it is broadcast over the TTC Channel B with 1 μs latency relative to L1A.
Bunch Crossing Zero (BC0)	Broadcast Synchronous with Orbit		Command synchronous with the LHC Orbit.
Bunch Counter Reset (BCR)	Broadcast Synchronous with Orbit		Special TTC command that clears the TTCrx internal Bunch Counter.
L1 Reset	Broadcast		Command that initiates a reset of the L1 readout buffers.
Hard Reset	Broadcast		Command used for a partial reset of the front-end electronics
Event Counter Reset (ECR)	Broadcast		Special TTC command that clears the TTCrx internal Event Counter.
Event Number	Broadcast Long Word		24-bit word Event Number. Optionally, it is broadcasted over the TTC Channel B.
Start/Stop Trigger	Broadcast		Broadcast command used to start/stop synchronously trigger system components.

Distribution Scheme:

- L1 Accept and Trigger Type:

  direct cable connection between Trigger Control System (TCS) and TTCvi

- Channel B commands:

  TTC code is stored in TTCvi's FIFO and is distributed synchronously with B-Go from TCS (direct cable connection between TCS and TTCvi)

Open questions:

Present TTCvi is limited to 4 B-Go signals. Need to review TTCvi specifications.

Bunch Crossing Zero

- Periodic command synchronous to LHC Orbit signal (~ 11 kHz)
- Phase adjustments:

  Global phase adjustments in the TTCvi (per sub-system partition)

  Local phase adjustments at the TTCrx receiving ends

- Two phases are needed in some cases:

  BC0: synchronization of trigger data and/or private actions during the gap (test, reset)

  BCR: Bunch Counter Reset in TTCrx

Open questions:

Understand details of BC0 timing.

Sub-detectors may need BC0 at different levels (front-end, front-end driver, in time with data at pipeline input, in time with data at pipeline output, etc.). Are the foreseen phase adjustments enough?

Reset

Two fast reset commands are foreseen:

1. *L1 Reset:*

- Intended to recover from synchronization losses.
- A request for L1 Reset may be generated by a subsystem on detection of a synchronization loss condition (fast monitoring signal Out of Sync)

2. *Hard Reset:*

- Intended to recover from some electronics problems. Reset of readout state machines or fast reconfiguration of FPGA's. Programmable parameters downloaded by software should not be affected by this reset.
- A request for Hard Reset may be generated by a subsystem on detection of an error condition (fast monitoring signal Error)

General Reset Procedure:

1. Trigger Control inhibits L1A and sends Reset command
2. Sub-systems:

   assert Busy signal

   read pending data in readout buffers (or discard data)

   reset pipelines and readout buffers

   reset state machines or other (in case of Hard Reset)

   assert Ready signal
3. Trigger Control:

   sends Event Counter Reset

   checks Ready signals

   sends BC0 at the beginning of a new orbit and resumes L1As

Local Resets

1. As a general policy, sub-systems are not allowed to issue local resets during data taking.
2. Special resets of the front-end electronics can be initiated by the sub-systems during the main gap provided no events are lost and the sub-system preserves the ability to respond to central TTC commands:

– the main orbit gap can be made artificially larger than the trigger latency so that the reset can be issued at the end of the gap after the readout of the events of the previous orbit.

– the front-end electronics reset should not affect the TTCrx chips, and in particular the local Event Number and Bunch Number.

– during the reset the sub-system is able to respond to central TTC commands

Open questions:

Should the Reset procedure include the reset of TTCrx (INIT command)?

What are the consequences (inefficiency) of discarding data?

During the reset procedure should the BC0/BCR be inhibited?

Start/Stop Trigger Command

The Start/Stop Trigger fast command is intended to guarantee controlled and synchronous procedures at run start and stop

Open questions:

Work out detailed start/stop run procedures.

2 Fast Monitoring Signals

The Sub-detector partitions send to the TCS information on their status using the Fast Monitoring network:

a) *Ready:* the partition is ready to receive triggers.

   TCS action: allow L1As

b) *Busy:* the partition is temporary busy and can't yet receive triggers.

   TCS action: inhibit L1As

c) *Warning Overflow:* the partition buffers are close to overflow.

   TCS action: inhibit L1As

d) *Out of Sync:* event fragments collected in the partition doesn't correspond to the same front-end pipeline position or have different Event IDs.

   TCS action: send L1 Reset.

e) *Error:* the partition is in error state and need a reset.

   TCS action: send Hard Reset

Open questions:

How to obtain the partition status from the state of individual components (boards, crates)? Need to specify the 'nodes' of the Fast Monitoring Network and hardware signals.

Which signals are hardware signals and which are fast messages?

3 Calibration and Test Signals

Calibration and Test modes

1. *Sub-detectors in stand-alone mode:*

   Test and calibration sequences are generated locally

   Data is captured with the sub-detector DAQ

2. *Sub-detectors in DAQ partition mode:*

   TCS generates test and calibration triggers at the rate required by the sub-detector partition

   Data is collected by the central DAQ

3. *Periodic test and calibration triggers during a Physics Run:*

   Test triggers sequences (see below) are issued centrally and distributed to all partitions

   Event Number is incremented in local TTCrx

   Sub-systems deliver an event data block (the event block can be empty)

   Calibration/test triggers are issued at pre-programmed cycles in the LHC orbit

   Data is collected by the central DAQ

4. *Local test and calibration triggers during a Physics Run:*

   Test and calibration triggers handled at the sub-system level during a Physics Run: the sub-systems perform test, calibration or monitoring activities during Private Gaps or Private Orbits.

Calibration Control Signals

Fast Control Signals	TTC command type	TTC Code	Comments
Test Enable	Broadcast		Broadcast command sent a fixed time before a test or calibration trigger.
Private Gap	Broadcast		Broadcast command marking the next gap for private use by the sub-detectors
Private Orbit	Broadcast		Broadcast command marking the next orbit for private use by the sub-detectors

Calibration Request Signal

The sub-detector partitions may use the Fast Monitoring Network to send a calibration Request signal. The TCS responds with a calibration trigger sequence (Prepare Test+L1A).

Central Test/Calibration Triggers

1. With programmable periodicity the Trigger Control:

– sends a Test Enable command instructing the sub-detectors to generate a test pulse

– inhibits the normal triggers

– after a fixed delay (~ 150 bx) sends a L1A to capture the test data

2. Test and calibration triggers can be issued anywhere in the LHC orbit at a pre-defined BC number
3. All sub-systems should deliver an event data block (can be empty), in order to keep synchronization
4. Data is collected by the central DAQ

Local Test/Calibration Triggers during a Physics Run

1. Are generated at the top of the Sub-system TTC
2. Should occur during the pre-defined orbit gaps (Private Gaps) reserved for sub-detector use (e.g. every 250 orbits)
3. Trigger Control doesn't issue any command in these gaps other than BC0
4. Data is collected by the Sub-system DAQ partition

Open questions:

Do we really need all the test and calibration modes defined?

Do we need more than one test/calibration trigger per orbit?