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COMPUTER OF THE AGILE MINICALORIMETER  
*CsI Bars* TESRE TEST EQUIPMENT

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**TABLE OF CONTENTS**

**1 Introduction ..... 1**  
    1.1 Purpose and Scope ..... 1  
    1.2 Reference Documents ..... 1  
**2 Test Scenario ..... 3**  
    2.1 Operational Environment ..... 3  
    2.2 External Interfaces..... 3  
**3 System Requirements ..... 7**  
    3.1 Functional Requirements ..... 7  
        3.1.1 CsI Bars Photo Diodes data management ..... 7  
    3.2 Performance Requirements ..... 10  
        3.2.1 CsI Bars Photo Diodes data ..... 10  
    3.3 Interface Requirements ..... 10  
        3.3.1 CsI Bars Photo Diodes data ..... 10  
    3.4 Operational Requirements ..... 11  
        3.4.1 CsI Bars Photo Diodes data ..... 11  
    3.5 Resource Requirements ..... 14  
    3.6 Quality Requirements..... 15  
    3.7 Maintainability Requirements ..... 15  
    3.8 Safety Requirements ..... 15  
    3.9 Verification Requirements ..... 15  
        3.9.1 CsI Bars Photo Diodes data ..... 15  
**ANNEX A Data Formats..... 16**  
    A.1 CsI Bar Photo Diodes data format ..... 16  
    A.2 Trigger data block format ..... 16  
    A.3 Pseudo TM Packet Format..... 17  
        A.3.1 TM Packet header ..... 18  
        A.3.2 TM Packet Data Field..... 19  
    A.4 Pseudo TC Packet Format ..... 20  
        A.4.1 TC Packet header ..... 20  
        A.4.2 TC Packet Data Field..... 21

## 1 Introduction

### 1.1 Purpose and Scope

The CsI Bars TESRE Test Equipment (CsI Bars TESRE TE) will be procured in order to support the test activities to be carried out during the development and calibration of the CsI bars of the AGILE Minicalorimeter subsystem [1].

The scope of the CsI Bars TESRE TE is limited to the test activities to be carried out on the CsI bars before integration with the CAL CsI TE and before integration with the CsI Bars Minicalorimeter front end and read-out electronics [2,3,4].

Within this scope, two different test scenarios are foreseen:

- CERN beam tests: a first prototype made of 6 or 8 (TBC) bars will be tested in November 2000 at CERN.
- Characterisation tests: these are the tests which evaluate the bars characteristics; these tests will be carried out on a maximum of 8 bars at a time.

The purpose of the present document is to define the users software requirements of the Host Computer included in the CsI Bars TESRE TE.

To this purpose, Chapter 2 gives an overview of the operational environment and the external interfaces of the Host Computer, namely *a)* its interface with the CsI Bars read out and front end electronics, *b)* its interface with the Science Console, which is in charge of performing in near real time the complete archive and the Quick Look analysis on the acquired data.

Chapter 3 presents the user software requirements with reference to the functionality to be provided by the Host Computer. The detailed format of the data at the different level of processing is provided in Annex A.

### 1.2 Reference Documents

- [1] C. Labanti *et al*, “Calorimeter Specification and Requirements”, AGILE-ITE-SS-001, Issue 2.3, April 2000, CNR/ITESRE
- [2] M.Trifoglio, F.Gianotti, J.B.Stephen, “AGILE Payload GSE Design Concept, Utilisation Plan and System Requirements, AGILE-ITE-SG-002, Rev. 1.1, Nov. 1999, CNR/ITESRE.
- [3] M.Trifoglio *et al*, “User requirements and design guidelines for the test equipments of the Agile Minicalorimeter CsI”, AGILE-ITE-SS-002, Rev. 1, October 2000.

Ref: AGILE-ITE-SR-002  
Page: 2  
Issue: 01  
Date: October 2000

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[4] LABEN, “AGILE Payload TE & EGSE Design Concept”, TL 16369, Issue 2.0.

## 2 Test Scenario

### 2.1 Operational Environment

It shall be possible to operate the Host Computer in two modalities:

Standalone mode: in this mode the Science Console is not required (e.g. during the integration and test of the CsI Bars Front End and Read Out electronics);

Client Mode: this is the nominal mode of operation during Characterisation tests and CERN beam tests; in this mode the Host Computer, through a TCP/IP connection, forwards in near real time all the CsI data to the Science Console in order to perform additional archiving and Quick Look functions.

Both the Characterisation tests and the CERN beam tests will consist of *Measurements*, each identified by a progressive number (measurement *Run ID*).

A set of consecutive measurements will be identified as *Test Session*.

Before starting a Test Session, the operator shall decide how to operate the measurements:

- in *manual mode*: the operator intervention shall be required in order to start/stop each measurement;
- in *automatic mode*: an automatism shall be used in order to provide automatically the start/stop measurement commands and the operator shall be required only in order to terminate this mode.

For each measurement, the following sequence of operations will be performed:

- any positioning operations shall be completed (in manual mode only);
- the *start acquisition* will be commanded, and a new measurement will begin;
- the Host Computer software will acquire and perform all the required functions on the forthcoming data;
- the *stop acquisition* will be commanded, and all the required functions on the current measurement will be completed.

### 2.2 External Interfaces

The CsI Bars TESRE TE electronics shall include one discriminator logic chain for each PD.

Two different trigger configurations are foreseen for the *peak and hold* of the PDs signals:

- **Internal trigger** configuration, where the trigger is generated by the CsI Bars TESRE TE electronics as logical OR of the discriminator logic of all the PDs.
- **External trigger** configuration, where the trigger is generated by the CsI Bars TESRE TE electronics as logical AND of:
  - the logical OR of the discriminator logic of all the PDs;
  - the signal (external trigger) generated by a source which is external to the CsI Bars TESRE TE.

Using a DAQ I/F card (NI PCI-MIO16E-1) connected to a BNC rack-mount analogue breakout accessory (NI BNC-2090), the Host Computer shall interface the CsI Bars front end and read out electronics in order to acquire the analogue signals gathered from all the Photo Diodes (PDs) and perform on them the analogue to digital conversion.

The following **input** lines shall be connected to the NI BNC-2090:

- up to 16 BNC analogue lines for the PDs signals;
- one Trigger line (TTL):
  - 1  $\mu$ s strobe;
- one Trigger Type line (TTL):
  - 0V the CsI Bars TESRE TE Electronics is set to external trigger;
  - 5V theCsI Bars TESRE TE Electronics is set to internal trigger.
- one Measurement Control line:
  - 0V Measurement disabled;
  - 5V Measurement enabled.

The DAQ I/F shall be programmed in order to react to each strobe received in the trigger line by:

- starting a conversion scan of the  $2*Nbars$  analogue input lines ( where  $Nbars$  is the total number of bars defined by the used at start up);
- producing a *start IRQ*.



The corresponding digital words shall be stored in the DAQ I/F FIFO from where they shall be acquired by the Interrupt Service Routine (ISR) once the *stop IRQ* shall be generated by the DAQ I/F at completion of the conversion scan.

As sketched in figure 2-1, one **output** line on the NI BNC-2090 shall be connected to the CsI Bars TESRE TE electronics, and shall be kept at 0V as long as a conversion scan is in progress.

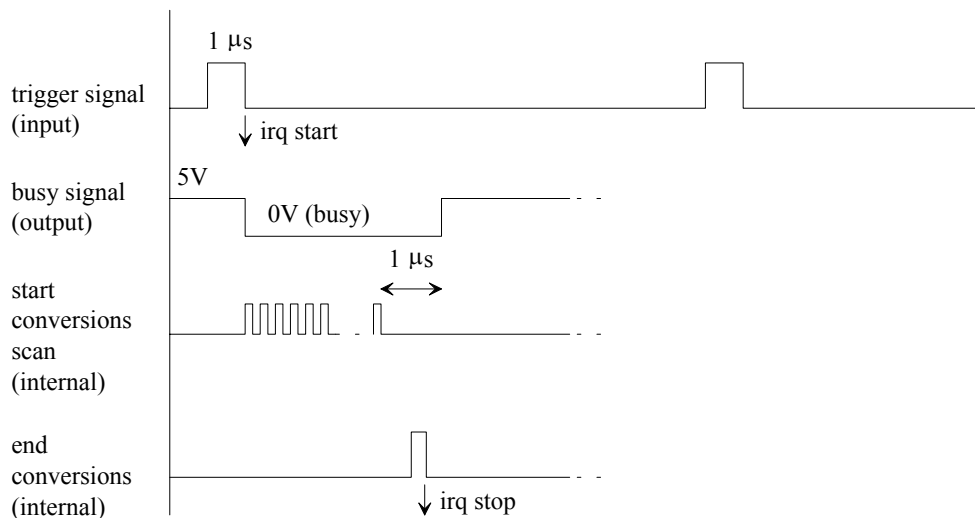


Fig. 2- Handshake and controls for the acquisition and conversion of the PDs signals.

The scan conversion rate is programmable (default value 100 KHz, i.e. one start conversion every 16 µs).

For each conversion, the Host Computer will produce one 16 bit word having the format given in section A.1 of Annex A.

For each trigger the Host Computer shall create a trigger data block having the format given in section A.2 of Annex A.

The maximum expected trigger rate is:

- 1000 (TBC) internal trigger/s, during characterisation tests with gamma ray sources (background + source, as given by  $2 \times [150 \text{ cm}^3 \times 3 \text{ counts/s}]$  per bar);
- 120 external trigger/s, during beam test at CERN (as given by about 60 trigger per spill, with each spill lasting 500 ms);

Consequently, the maximum word rates to be acquired by the Host Computer are:

- 1000 x 16 (16 bit) word /s , i.e. about 16000 (16 bit) word/s (i.e. one 16 bit word every 62.5 µs) during characterisation tests with gamma ray sources;

- 120 x 16 (16 bit) word /s , i.e. about 2000 (16 bit) word/s (i.e. one 16 bit word every 500  $\mu$ s), during beam test at CERN.

In Client mode, the Host Computer shall interface through the LAN to the Science Console in order:

- to notify (by sending pseudo Tele Command Packets, having the format specified in section A.4 of Annex A) when a measurement is starting/stopping;
- to forward in near real time the CsI Bar PDs data included in the pseudo TM Packets having the format detailed in section A.3 and A.4 of Annex A.

To this purpose, in Client mode the Host Computer shall establish (as Client) a TCP/IP link with the Science Console (Server). In case the Data Link drops, automatically the Server restarts waiting for a new connection request from the Client.

### 3 System Requirements

#### 3.1 Functional Requirements

##### 3.1.1 CsI Bars Photo Diodes data management

###### Data acquisition and processing

- F.10 Each measurement shall be identified by the measurement Run Id, which:
- shall be represented with 5 digits in the form *nnnnn* ( i.e. shall range from 00000 to 99999);
  - shall be incremented automatically at every new measurement.
- F.20 If the archiving is selected, upon receiving the *start measurement* command, the Host Computer shall open a new local file (*measurement file*) where to archive all the TC and TM packets related to the measurement.
- F.30 Each measurement file:
- shall contain all the TC/TM packets pertaining to a given measurement;
  - shall be named *nnnnn.raw*;
  - cannot be rewritten, hence:
    - in case the file *nnnnn.raw* already exists, before continuing the user shall be requested to provide a Run Id grater than the Run Ids of all the measurement files currently archived;
  - shall be located in the *archive/raw* subdirectory;
  - shall archive the TM/TC packets (included their prefix) in binary format (big-endian) as a continuous set of bytes (*stream* file).
- F.40 Upon receiving the *start measurement* command, the Host Computer:
- if the archiving is selected, shall save the “start measurement” TC packet (included its prefix) in the measurement file;
  - if the Client mode is selected, shall send on the Data Link a “start measurement” TC packet.
- F.50 For each forthcoming trigger, the Host Computer:
- shall acquire the Trigger Type signal and the Measurement Control signal;
  - shall acquire and convert all the PDs signals ( $2*Nbar$ ) associated to the trigger;
  - shall create a data block (*trigger data block*) with the above acquired data;

F.55 The Host Computer shall inspect each trigger data block, and:

- shall discard the trigger data blocks having the Measurement Control flag disabled.
- shall discard the trigger data blocks having the Trigger Type changed with respect to the value read at the first trigger of the current measurement;
- shall extract the NPD data words found in the data fields of the trigger data block having the Measurement Control flag enabled, and
- shall store them, in the Data Field of a ESA Packet Telemetry (TM) capable of containing some of them;

When the TM Data Field is full or the time-out is expired, the Host Computer:

- shall store in the header of the TM Data Field:
  - the CPU system time corresponding to the creation of the TM packet;
  - the Trigger Type flag
  - the actual number of bars under test;
  - the total number of Trigger data fields contained in the Data Field;
- shall complete the TM Packet Header, i.e. by updating the Source Sequence Counter;
- shall add the prefix to the TM packet;
- if the archiving is selected: shall save the TM packet (included its prefix) in the measurement file;
- if the Client mode is selected: shall send the TM packet (included its prefix) on the Data Link.

F.60 Upon receiving the *stop measurement* command, the Host Computer:

- shall complete the processing of all the Trigger data block already acquired;
- if the archiving is selected, shall save the “stop measurement” TC packet (included its prefix) in the measurement file;
- if the Client mode is selected, shall send on the Data Link a “stop measurement” TC packet.

F.70 In the Client mode, in case the Data Link drops during a measurement, the Host Computer software:

- shall terminate the current measurement by:
  - terminating the data acquisition;

- saving a TC stop measurement command (included its prefix) on the measurement file and closing the measurement file (if the archiving is enable);

F.80 The Host Computer software:

- shall be able to detect whether the data acquisition rate is too high with respect to the processing performances;
- shall be able to evaluate the number of words which have been acquired by the ISR but have not been processed (lost words).

#### **Data Monitoring**

F.100 The Host Computer shall provide on the screen a window with the basic information which allow the user to monitor the data acquisition, i.e.:

- the current Measurement mode (manual/automatic);
- the current Run ID;
- the current Trigger Type (external/internal);
- the current total number of words:
  - acquired;
  - processed;
  - discarded;
  - lost.
- the current acquired words rate per second;

F.110 If the Client mode is selected, the Host Computer shall provide on the same window of the data acquisition monitoring, the basic information which allows the user to monitor the interfacing with the Science Console, i.e.:

- the status of the TCP connection with the Science Console;
- the current total number of TM packet forwarded to the Science Console.

#### **Data Quick Look**

F.200 The Quick Look shall include a graphics window providing a multiple plots of the temporal profiles of the PDs data, identifying the different PDs by using different colours.

F.210 The Quick Look shall include a graphics window providing a multiple plots of the spectrum seen by each PD, identifying the different PDs by using different colours.

#### **Data Retrieval**

F.300 It shall be possible to access an archived measurement in order to:

- inspect the measurement file data in hexadecimal format;

F.310 It shall be possible to retrieve the archived data through ftp.

## 3.2 Performance Requirements

### 3.2.1 CsI Bars Photo Diodes data

#### Data acquisition and processing

- P.10 At input rates up to the maximum rates presented in Section 2.2.1, the Host Computer shall be able to perform all the *Data Acquisition and Processing* functions continuously, without any loss of data.
- P.20 The Host Computer shall include a local disk of at least 10 Gbytes for the local archiving of the PDs data.
- P.30 At input rates up to the maximum rates presented in Section 2.2.1, the Host Computer shall be able to perform all the *Data Monitoring* functions, updating the screen every about 1 s.
- P.40 At input rates up to the maximum rates presented in Section 2.2.1, the Host Computer shall be able to perform the *Data Quick Look* functions with the following performances:
- in Standalone mode:
    - the accumulation will be performed on at least 50% of the acquired data;
    - the screen shall be update automatically every at least 10s (user configurable);
  - in Client mode:
    - the accumulation will be performed on at least 20% of the acquired data;
    - the screen shall be update on user request.

## 3.3 Interface Requirements

### 3.3.1 CsI Bars Photo Diodes data

- I.10 The TCP/IP connection for the Data Link (TC and TM packets) shall be established on the IP address and the TCP port configured by the user.
- I.20 The TC and TM packets shall comply with the data format given in Annex A.
- I.30 The minimum distance among the Digital Interface and the Host Computer shall be 5 m.

### 3.4 Operational Requirements

- O.10 All the Host Computer operations shall be conducted from the Host Computer console.
- O.20 The Host Computer software shall allow to automate the execution of the positioning and start/stop measurements to be performed during the Characterisation tests.
- O.30 The Host Computer design shall take into account the transportability of the equipment.
- O.40 The Host Computer procurement shall include suitable reusable transportation container for the Host Computer itself.

#### 3.4.1 CsI Bars Photo Diodes data

- O.100 The user shall be able to access:
  - the Test Session Configuration;
  - the Test Session Control;
  - the Measurement Control.
- O.110 The Test Session Configuration shall be accessible only in case no measurement is running.
- O.120 In the Test Session Configuration, the user shall be able to select the Operative Mode.
  - *Client mode*; once this mode is selected:
    - the user shall be able to re-configure the following parameters:
      - the IP address of the host which the Host Computer shall connect to for the Data Link ( initial default value = 127.0.0.1).
      - the port to be used for the TCP/IP connection for the Data Link (initial default value = 9001).
      - the *time out* in *ms* (initial default value = 1000) to be used for the TM packets to be forwarded on the Data Link;
    - the Host Computer shall try to establish the Data Link;
    - if the connection succeeded within a time out, the Client Mode is activated, otherwise, the user shall be notified that the required mode cannot be selected.
  - *Standalone mode*; once this mode is selected, no Data Link is required.

- O.130 In the Test Session Configuration, the user shall be able to re-configure the following parameter:
- the next Run Id to be used (initial default value=1);  
before continuing the Host Computer software shall verify automatically that the selected Run Id is greater than the Run Ids of all the measurement files currently archived; in the negative case, the user shall be notified and requested to provide a new Run Id;
  - the total number of CsI Bars under test ( $1 \leq Nbar \leq 8$ , initial default value = 1).
  - the Measurement Mode (initial default value = manual mode):
    - in *manual mode*: the operator intervention shall be required in order to start/stop the measurement;
    - in *automatic mode*: an automatism shall be used in order to generate a sequence of measurements until the operator shall require manually to exit the automatic mode.
  - the archive on/off option (initial default value = no);
  - the Quick Look display update rate for the Standalone mode (initial default value = 10s).
- O.140 The default values for all the configurable parameters shall be set to the last used values.
- O.150 The Test Session Control shall be accessible:
- only in case no measurement is running.
- O.160 In the Test Session Control, the user shall be able:
- to initialise a Test Session;  
once this option is selected:
    - in Client Mode:
      - the Host Computer shall try to establish the Data Link;
      - if the connection succeeded within a time out, the Client Mode is activated, otherwise, the user shall be notified that the required mode cannot be selected.
  - the Host Computer software shall verify automatically that the current Run Id is greater than the Run Ids of all the measurement files currently archived; in the negative case, the user shall be notified and requested to provide a new Run Id.
  - to exit a Test Session.



once this option is selected, the Host Computer:

- shall close the TCP/IP connection of the Data Link (if any).

O.170 The Measurement Control shall be accessible:

- only after a Test Session has been initialised.

O.180 In the Measurement Control, the user shall be able:

- to start a new measurement (only in case no measurement is running);
- to stop the current measurement (only in case a measurement is running);  
in case the measurement was running in automatic mode, the mode shall be changed automatically to manual mode and the user shall be notified.

O.190 For the CERN beam tests, the automatic mode shall be implemented by using the Measurement Control flag included in the acquired data.

Once this mode is entered, the Host Computer shall start reading from the digital interface and:

- shall start a new measurement in case one of the following conditions occurs:
  - the first word read has the flag enabled;
  - between two consecutive words, the flag changed from "disabled" to "enabled";
- shall stop the current measurement in case:
  - between two consecutive words, the flag changed from "enabled" to "disabled";

O.200 For the Characterisation Test, the automatic mode shall be implemented by using a TBD mechanism.

O.210 In the Client mode, the Data Link will be kept along the whole Test Session.

O.220 In the Client mode, in case the Data Link drops during a measurement, the Host Computer software:

- shall terminate the current measurement;
- shall ask the user whether:
  - to re-establish the Data Link
  - or to change the mode to Standalone.

O.230 For the basic operations (e.g.: to start/stop the measurement, to establish/close the Data Link), the Host Computer shall provide to the operator a straight and easy accessible MMI (e.g. widget buttons).

O.250 Well in advance, the user shall be advised when the local disk devoted to the local archiving is getting full.

#### **Data Quick Look**

O.300 In both Standalone and Client mode:

- the minimum and maximum values for the vertical axes of the time profiles (Pulse Height Amplitude) to be displayed shall be adjusted automatically at each refresh according to the minimum and maximum values of the data (initial values: 0, 1).
- the minimum and maximum values for the vertical axes of the spectra (number of counts) to be displayed shall be adjusted automatically at each refresh according to the minimum and maximum values of the data (initial values: 0, 1).

O.310 In both Standalone and Client mode, at each time, the user shall be able:

- to zoom and pan through the vertical axes of the time profiles display;
- to zoom and pan through the horizontal axes of the spectra display.

O.330 In Standalone mode:

- the graphics display shall be updating automatically at the rate specified by the user (initial value = 10s).

In Client mode:

- the graphics display shall be updating on user request.

O.340 In both Standalone and Client mode:

- upon receiving the stop measurement command, all the accumulated spectrum shall remain available to the user until a new measurement shall be started;
- in the meanwhile, the user shall be able:
  - to change the minimum and maximum value for the horizontal and vertical of the spectrum to be displayed;
  - to command the contemporarily reset of the accumulated spectra;

### **3.5 Resource Requirements**

R.10 The use of commercial available hardware which has world-wide service support is recommended.

R.20 The procurement of the harness required to connect the Digital Interface and the Host Computer shall be included in the Host Computer procurement.

R.30 The Host Computer shall be equipped with a colour printer.

R.40 The Host Computer shall be equipped with an Ethernet 10/100 BaseT interface.

### **3.6 Quality Requirements**

- Q.10 The Host Computer software design shall be performed following structured methodologies. During the design phase, CAD tools shall be used to develop the software.

### **3.7 Maintainability Requirements**

- M.10 The Host Computer shall be designed in such a way to allow maintenance, assembly/disassembly, inspection and replacement/substitution of its components.

### **3.8 Safety Requirements**

- S.10 The Host Computer shall be designed in such a way that a failure in the Host Computer shall not propagate to the item under test.
- S.20 The Host Computer design shall be such that any failure occurring during any test configuration or maintenance operation shall not result in hazards for the users of the Host Computer itself.

### **3.9 Verification Requirements**

- V.10 The Host Computer software shall be verified against the requirements contained in the present document.

#### **3.9.1 CsI Bars Photo Diodes data**

- V.100 During the Acceptance Tests, suitable test gigs shall be provided in order to simulate/stimulate the Digital Interface at the maximum rates.
- V.110 The Host Computer software shall include a TCP/IP Server simulator which shall allow to verify the interfacing with the Science Console, namely:
- the simulator shall run on the Host Computer;
  - at start up, the simulator shall wait (as Server) for the TCP/IP connection on the localhost IP address (127.0.0.1), to be requested by the Host Computer (as Client);
  - once the connection is established, the simulator shows to the user the current number of packets received on the TCP/IP socket;
  - in case the TCP/IP connection drops, the simulator waits for a new connection request.

**ANNEX A Data Formats**

**A.1 CsI Bar Photo Diodes data format**

For each conversion, the Host Computer ISR will create one 16 bit word having the following format:

**Photo Diode data (1 x 16-bit word)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
PD ID (4 bits)								Pulse Height Amplitude(12 bits)																							

Where:

- PD ID: Photo Diode identification number, specified in binary format (with MSB first);
- PD PHA: Photo Diode Pulse Height, specified in binary format (with MSB first);

**A.2 Trigger data block format**

For each trigger (either internal or external), the Host Computer ISR routine shall create a trigger data block having a fixed length format: 1 word header plus 16 words data field.

**Trigger data block format (17x 16 bit word)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
TT	MC			spare				NPD																							
0				PD0 Pulse Height Amplitude																											
1				PD1 Pulse Height Amplitude																											
2				PD2 Pulse Height Amplitude																											
.....				.....																											
NPD-1				PD(NPD-1) Pulse Height Amplitude																											
0				0																											
0				0																											
0				0																											

In the **Trigger data header**:

- NPD:  $2 * Nbars$  ( where  $Nbars$  is the total number of bars defined by the user at start up), it corresponds to the number of PD analogue lines converted in the conversion scan;

- TT: Trigger Type flag, which value depends on the value read by the ISR from the Trigger Type line at detection of the start IRQ:
  - 0 0V;
  - 1 5V.
  
- MC: Measurement Control flag, which value depends on the value read by the ISR from the Measurement Control line at detection of the start IRQ:
  - 0 0V (Measurement disabled);
  - 1 5V (Measurement enabled).

**In the Trigger data field:**

- the first NPD words contains the PDs data, each having the format given in section A.1 above;
- the remaining words (if any) shall be filled with 0x00.

### **A.3 Pseudo TM Packet Format**

With the trigger data blocks, the Host Computer shall generate packets having the same basic structure of the ESA Packet TM.

Each packet is of fixed length of 526 bytes and consists of a Packet Header (6 bytes) followed by a Packet Data field (520 bytes).

Each packet is sent on the Data Link in one TCP/IP message containing an additional prefix of two bytes which contain the total number of bytes contained in the packet, specified in binary format (big-endian). I.e. 0x020E (526 decimal).

Data words belonging to the same trigger data block cannot be split into two different packets.

The part of the Source Data Field which does not contain event data is filled with dummy bytes.

The value of the dummy byte is configurable; by default it will be set to 0xFF.

**A.3.1 TM Packet header**

The Packet Header will have the following format:

**Packet Header (3x16-bit word)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MSB															LSB
Version Number			Type	DHFFH	APID										
SF		Source Sequence Counter													
Packet Length															

Where:

**First word:**

- Version number: must be set to '100' binary
- Type: must be set to '0' binary
- DFHF: Data Field Header Flag, must be set to '1' binary
- APID: Application Process Identifier, must be set to 0x50D (decimal 1293)

**Hence: this word must be set to the fixed value: 0x8D0D**

**Second word:**

- SF: Sequence Flag, must be set to '11' bin
- Source Sequence Counter: counts the packets of the above APID; to be reset at the begin of each Test Session.

**Third word:**

- Packet Length: [number of octets in Packet Data Field] – 1;
- Hence: this word must be set to the fixed value: 0x0207 (519 decimal).**

**A.3.2 TM Packet Data Field**

The Packet Data Field will consists of the Data Field Header (8 bytes) and the Source Data Field (512 bytes).

The former will have the following format:

**Data Field Header (4 x 16-bit word)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
Time Tag second (32 bits integer signed MSB)																															
Time Tag second (32 bits integer signed LSB)																															
Time Tag millisecond (16 bit unsigned)																															
TT				Spare				NBars								Nblocks															

Where:

- Time Tag: CPU System Time expressed as second and millisecond since 00:00 UTC January 1,1970 (i.e. as given by the C routine *ftime*) corresponding to the creation of the packet.
- TT: Trigger Type flag as read from the Trigger data block header;
- NBars: Number of CsI Bars under test, as given by NPD/2, where NPD is read from the Trigger data block header;
- Nblocks: number of Trigger data block data fields contained in the Data Field.

The Source Data Field will have the following format:

**Source Data Field (256 x 16-bit word record)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
Source Data Field ( word 1)																															
...																															
Source Data Field (word 256)																															

- E.g.: with 1 Csi Bar under test, each Source Data Field will be capable of containing up to 128 Trigger data fields, each having the format detailed in section A.2 above.
- with 8 Csi Bar under test, each Source Data Field will be capable of containing up to 16 Trigger data fields, each having the format detailed in section A.2 above.

**A.4 Pseudo TC Packet Format**

In order to notify to the Science Console when a new measurement is starting/stopping, the Host Computer shall generate and send on the Data link, packets having the same basic structure of the ESA Packet TC.

Each packet is of fixed length of 10 bytes and consists of a Packet Header (6 bytes) followed by a Packet Data field (4 bytes).

Through the same socket connection established for the TM Packets, each packet is sent on the Data Link in one TCP/IP message containing an additional prefix of two bytes which contain the total number of bytes contained in the packet, specified in binary format (big-endian). I.e. 0x000A (10 decimal).

Further details on the TC Packet format are given below.

**A.4.1 TC Packet header**

The Packet Header will have the following format:

**Packet Header (3x16-bit word)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MSB															LSB
Version Number			Type	DHFH	APID										
SF		Source Sequence Counter													
Packet Length															

Where:

**First word:**

- Version number: must be set to '0001' binary
- Type: must be set to '1' binary
- DFHF: Data Field Header Flag, must be set to '1' binary
- APID: Application Process Identifier, must be set to 0x101 (decimal 257)

**Hence: this word must be set to the fixed value: 0x1D01**

**Second word:**

- SF: Sequence Flag, must be set to '11' bin
- Source Sequence Counter: counts the packets of the above APID; to be reset at the begin of each Test Session.

**Third word:**



Packet Length: [number of octets in Packet Data Field] – 1;  
**Hence: this word must be set to the fixed value: 0x0003 (3 decimal).**

**A.4.2 TC Packet Data Field**

The Packet Data Field will consists of the Data Field Header (2 bytes) and the Source Data Field (2 bytes).

The former will have the following format:

**Data Field Header (1 x 16-bit word)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MSB															LSB
Spare		Checksum type		ACK				Packet Type				Packet subtype			

Where:

- Spare: must be set to '00' binary.
- Checksum type: must be set to '00' binary
- ACK: must be set to '00' binary.
- Packet type: must be set to 0x5.
- Packet subtype: must be set to 0x5.

**Hence: this word must be set to the fixed value: 0x0055**

The Source Data Field will be have the following format:

**Source Data Field (1 x 16-bit word record)**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MSB															LSB
TC Application Data															

Where:

- TC Appication Data: **must be set to the fixed values:**
- **0x0200**, for the "Start measurement" command;
  - **0x0000**, for the "Stop measurement" command.