

ITESRE

AGILE

DOCUMENT TYPE: SOFTWARE REQUIREMENT DOCUMENT

TITLE: USER SOFTWARE REQUIREMENTS FOR THE
HOST COMPUTER OF THE AGILE
MINICALORIMETER CAL-DFE TEST
EQUIPMENT

DOCUMENT No. AGILE-ITE-SR-003 **PAGE:** I of v,30

PROJECT Ref.: AGILE GSE

ISSUE No.: 01/A **DATE:** August 2001
Te.S.R.E. Report 315/01

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CHANGE RECORD

Issue Draft 00/A	First draft circulated via e-mail within Tesre on 20 July 2001.
Issue 01	First issue, circulated to the distribution list on 24 July 2001; presented to LABEN at the "MCAL DFE TE - Preliminary Design Review" meeting held at LABEN on 25 July 2001.
Issue 01/A	Revised after the PDR meeting (MOM LA-A3-DT-TF-0020/01): (a) detailed the performance requirements, (b) modified the usage of the Measurement Control signal, (c) added the CDROM read/writer unit, (d) plus other minor modifications. Circulated to the distribution list on 03 August 2001, as for A.I.1 ITE/AST 03/08/01.

Note: After the first issue, text modifications respect to the previous version are identified by a vertical bar on the right side

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..... 5
3 System Requirements 10
 3.1 Functional Requirements 10
 3.1.1 Instrument data management 10
 3.2 Performance Requirements 14
 3.2.1 Instrument data 14
 3.3 Interface Requirements 15
 3.3.1 Instrument data 15
 3.4 Operational Requirements 16
 3.4.1 Instrument data 16
 3.5 Resource Requirements 21
 3.6 Quality Requirements 21
 3.7 Maintainability Requirements 21
 3.8 Safety Requirements 21
 3.9 Verification Requirements 21
 3.9.1 Instrument data 22
ANNEX A Data Formats..... 23
 A.1 The MCAL Pseudo ESA TM Packets 23
 A.2 GRID events data 25
 A.3 BURST events data 27
 A.4 Housekeeping data 29
 A.5 The MCAL Pseudo ESA TC Packet..... 30

1 Introduction

1.1 Purpose and Scope

The purpose of the document is to detail the user software requirements related to the Host Computer included in the CAL-DFE Test Equipment (CAL-DFE TE), as specified in the Agile Payload TE & EGSE Subsystem Specification document [5] and in [6].

The Host Computer shall interface the Minicalorimeter Detector Front End & Readout Electronics (MCAL DFE) in order to configure and command the detector, acquire and archive both the scientific and the housekeeping data, including the ADC conversion of the analogue housekeepings.

The Host Computer shall allow the operator to monitor the data acquisition and to inspect the acquired scientific and housekeeping data through basic alphanumeric and graphical quick look display tasks.

In order to allow additional processing, archiving and analysis tasks, in near real time the Host Computer shall forward to the Science Console, provided by the Agile Team, the acquired raw data and the echo of the start/stop measurement commands sent to the instrument. These data shall be exchanged using a Pseudo ESA TM/TC packet format defined by the user in the present document. The start/stop measurement commands shall allow the Science Console to create for each measurement period a set of files identified by the unique number, the Run ID, assigned to the measurement.

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 MCAL-DFE, *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 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.
- [4] LABEN, "AGILE Payload TE & EGSE Design Concept", TL 16369, Issue 2.0.
- [5] M.Trifoglio, F.Gianotti, J.B.Stephen, "AGILE Payload TE & EGSE Subsystem Specification, AGILE-ITE-SS-003, Issue 01, January 2001, CNR/ITESRE.
- [6] LABEN, "AGILE MCAL DFE TE Requirements", TL 17865, Issue 1, 05/06/2001.
- [7] LABEN, "PDHU Preliminary Report", TL 17708, Issue 2, 26/06/2001.
- [8] LABEN, "AGILE MCAL DFE TE Preliminary Design Report", TBW.
- [9] AGILE-DWG-SS-002, "Agile Data Handling Requirement Sepcification", Issue 5, 16/02/2001.

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 MCAL DFE);

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

The Host Computer shall allow the user to configure and operate the instrument, by means of suitable commands sent to the MCAL DFE, and to acquire the various instrument data, namely:

- The Digital and Analogue Housekeeping (HK), which shall be made available to the TE once the instrument is powered on;
- The Scientific data (e.g.: the GRID event data and BURST event data), which shall be made available to the TE after that the instrument has entered an observation mode.

~~Each~~ Hence, after having powered on the instrument, a *Test Session* can be carried out as a set of consecutive ~~test will consist of~~ *Measurements*, each consisting of:

- an *Idle* period, during which the instrument can be configured and only the HK data are produced (*Idle* mode);
- an *Observation* period, during which the instrument produces both the scientific and the HK data (*Observation* mode).

For each Measurement:

- a *start Observation* command is sent by the TE to the instrument in order to switch from the Idle mode to the Observation mode;
- a *stop Observation* command is sent by the TE to the instrument in order to terminate the current measurement by switching the instrument to the Idle mode of the next measurement.

~~E~~, each measurement is 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~~observation;
- in *automatic mode*: an automatism shall be used in order to provide automatically the start/stop ~~measurement~~observation commands and the operator shall be required only in order to terminate the Test Session.

Once a Test Session is entered, the Idle Period of the first Measurement begins, and on user request the Host Computer:

- shall perform the operations required to initialise the TE Electronics and the interfacing with the instrument;
- shall send to the CAL-DFE the commands required to configure the instrument;
- shall start the acquisition of the instrument Housekeeping (HK) data (digital and analogue).

Either in manual or in automatic mode, the Host Computer:

- shall send to the CAL-DFE the commands required to start/stop an observation;

As long as the instrument data are produced, in near real time the Host Computer:

- shall encapsulate them in Pseudo TM packets;
- shall generate the Pseudo Start/Stop Observation TC packets in correspondence to the start/stop Observation commands sent to the instrument;
- shall be able to forward the Pseudo TC/TM packets to the Science Console;
- shall be able to archive the Pseudo TC/TM packets locally in the file containing the data (Idle period and Observation period) of the current Measurement;
- shall be able to perform the Quick Look functions on a percentage of the Pseudo TM packets.

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

~~-any positioning operations shall be completed;~~

~~-on the Host Computer, 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;~~

~~-on the Host computer, the stop acquisition will be commanded, and all the required functions on the current measurement will be completed.~~

2.2 External Interfaces

The MCAL DFE TE shall interface the MCAL DFE, on one side, and the Science Console on the other side.

As detailed in [6], through a suitable electronics included in the MCAL DFE TE, the Host computer shall interface to the MCAL DFE as specified in [7] for the AGILE PDHU, and it shall be able:

- to send the configuration commands;
- to acquire the digital housekeeping;
- to acquire the analogue housekeepings;
- to provide the Fast Trigger signal, which commands the GRID event data conversion;
- to acquire the GRID event data;
- to time tag the acquired GRID data with a suitable TE 32 bit internal counter;
- to interface the BURST_TIMING line;
- to acquire the BURST event data;
- to time tag the acquired BURST data with a suitable TE 32 bit internal counter;
- to interface the SUBms_BTR line (TBC);

Details on the internal interfaces among the Host Computer and the MCAL TE Electronics shall be given in [8].

The Host Computer shall encapsulate the instrument data in the corresponding pseudo ESA TM packets, as listed in the table 2.2-1 below:

Instrument data	Pseudo TM Packet
BURST event data	MCAL BURST event
GRID event data	MCAL GRID event
Digital HK, Analogue HK	MCAL Periodic Housekeeping TM report
TBD	TBD

Table 2.2-1 [List of the MCAL Pseudo TM packets](#)

In addition, the following pseudo Tele Command (TC) packets shall be generated by the Host Computer:

Purpose	Pseudo TC Packet
Notify the Science Console that a new measurement Observation period has been started	MCAL start measurement Observation
Notify the Science Console that the current measurement Observation period has been terminated	MCAL stop measurement Observation
TBD	TBD

Table 2.2-2 [List of the MCAL Pseudo TC packets](#)

The above TM/TC pseudo packets shall have the format detailed in Annex A.

In near real time the Host Computer shall be able to prepare and archive locally all the pseudo TM/TC packets.

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

- to send the start/stop ~~measurement~~ [Observation Pseudo](#) TC packets whenever an ~~measurement~~ [Observation](#) has been started/terminated;
- to forward in near real time the instrument data included in the pseudo TM Packets.

To this purpose, in Client mode the Host Computer shall establish (as Client) a TCP/IP link (Data 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.

In addition, it is assumed that an input connector shall be available on the MCAL DFE TE electronic panel for the Measurement Control (TTL) signal which is used to **condition the start/stop Observation in automatic mode**, as specified in chapter 3.

~~set/reset the Measurement Control flag (MC), acquired by the Host Computer, with the following aims:~~

~~-in both the manual acquisition mode and in automatic acquisition mode, only the event data having this flag set shall be processed by the Host Computer;~~

~~-in automatic acquisition mode, the flag changes shall be used to automate the start/stop measurement actions to be taken by the Host Computer without any intervention of the operator.~~

It is noted that:

- the Measurement Control (TTL) signal shall be unique for both the BURST and the GRID events **(TBC)**;

;

~~-the acquisition and processing of the HK data shall always be active, irrespective of the MC flag contained in the event data.~~

The maximum expected acquisition rates are:

- + During characterisation tests with gamma ray sources

- **BURST chain:**

- **Nominal case:**

- - 1000 events/s (background + source, as given by $2 \times [150 \text{ cm}^3 \times 3 \text{ counts/s}]$), distributed as follows:
 - 60% on 1 Bar, which contributes a total of 19200 x (34 bit) word/s;
 - 30% on 2 Bar, which contributes a total of 19200 x (34 bit) word /s;
 - 10% on 3Bar, which contributes a total of 9600 x (34 bit) word /s;
- which lead to a total of 48000 x (34 bit) word /s (i.e. one 34 bit word every 20 μs);

- **Non nominal case:**
 - a maximum of 100000 x (34 bit) word/s (i.e. one 34 bit word every 10 μ s);
- **GRID chain:** no data;
- + During characterisation tests with beam sources (e.g. at CERN beam):
 - **BURST chain:**
 - **Nominal case:**
 - 48000 x (34 bit) word /s, as given above;
 - **Non nominal case:**
 - a maximum of 100000 x (34 bit) word/s, as given above;
 - **GRID chain:**
 - **Nominal case:**
 - 120 external trigger/s, during beam test at CERN (as given by about 60 trigger per spill, with each spill lasting 500 ms), which leads to a total of 120 x 64 (12 bit) word/s, hence 8000 (12 bit) word/s, (i.e. one 12 bit word every 125 μ s);
 - **Non nominal case:**
 - at CERN, when the beam flux could rise up to 500 trigger per spill, this leads to foresee a maximum of 1000 events/s, i.e. 1000 x 64 x (12 bit) word/s, hence 64000 x (12 bit) word/s, (i.e. one 12 bit word every 15 μ s);

~~In the nominal case, the maximum expected trigger rate is:~~

~~- TBD GRID events;~~

~~- TBD BURST events;~~

~~Consequently, in the nominal case the maximum word rates to be acquired by the Host Computer are:~~

~~- TBD (16 bit) word/s for the GRID events;~~

~~- TBD (16 bit) word/s for the BURST events;~~

~~- The non-nominal case is given when the beam flux could rise up to TBD events/s.~~

Suitable handshake among the MCAL DFE TE electronics and the Host Computer and suitable resources (e.g. FIFO) shall be implemented in order to allow the Host Computer:

- ⊞- in the nominal case, to acquire continuously at the above rates, without any loss of data and while performing the required functions, as detailed in section 3.
- ⊞- in the non-nominal case, to acquire as much as possible data ([at least the 20%](#)) while performing the required functions, as detailed in section 3.

3 System Requirements

It is noted that, unless explicitly stated, the following requirements apply to both the Standalone and the Client Mode.

~~1.13.1~~ Functional Requirements

3.1.1 Instrument 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 the Test Session is started, the Host Computer shall open a new local file (*measurement file*) where to archive all the TC and TM packets related to the forthcoming measurement data.
- ~~F.20 If the archiving is selected, upon receiving the *start measurement* command and after having incremented the Run Id, 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 *the Idle period and the Observation period of* 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 a~~ *the start measurement-Observation* command *is sent to the instrument*, the Host Computer:

- if the archiving is selected, shall save the “start ~~measurement~~Observation Pseudo” TC packet (included its prefix) in the measurement file;
- if the Client mode is selected, shall send to the Data Link the start Observation Pseudo TC packet (included its prefix) ~~a “start measurement” TC packet.~~

F.50 For each forthcoming data made available by the instrument, the Host Computer:

- shall acquire the related data words;
- ~~– shall discard the data words having the Measurement Control flag disabled;~~
- with the acquired data words ~~having the Measurement Control flag enabled~~, shall create the data blocks using the specific format given in Annex A;
- using the format specific to the given APID/Type/Subtype (see Annex A), shall store the data blocks in the Data Field of a ESA ~~Packet~~ Telemetry (TM) packets capable of containing some of them.

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

- shall store in the header of the Data Field the information required by the format specific to the given APID/Type/Subtype (see Annex A);
- shall complete the TM Packet Header, i.e. by updating the Source Sequence Counter (see Annex A);
- shall add the prefix to the TM packet (see Annex A);
- 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 a stop Observation command is sent to the instrument ~~Upon receiving the stop measurement command~~, the Host Computer:

- shall acquire from the CAL-DFE the instrument scientific data until the FIFO are empty;
- shall complete the processing of all the data words already acquired;
- if the archiving is selected, shall save the “stop ~~measurement~~Observation” Pseudo TC packet (included its prefix) in the measurement file;
- if the archiving is selected, shall close the current measurement file;
- if the Client mode is selected, shall send on the Data Link a “stop measurement” TC packet;
- shall increment the measurement Run Id;

- if the archiving is selected, shall open the new current measurement file.

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

- shall ask the operator to terminate the current measurement;
- upon a *stop Observation* command is sent to the instrument, the Host Computer:
 - shall complete the processing of all the data words already acquired;
 - if the archiving is selected, shall save the stop Observation Pseudo TC packet (included its prefix) in the measurement file;
 - if the archiving is selected, shall close the current measurement file;
 - shall increment the measurement Run Id;
- shall ask the operator whether to try to re-establish the link with the Science Console or to start a new Test Session in Standalone mode.

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

F.75 In the Client mode, the Host Computer shall buffer the data in order to reduce the possibility that the ~~in case the~~ socket with the SC gets full;

In case the socket gets full, the Host Computer:

- shall empty the socket and the contained packets shall not be sent to the SC (but they shall be archived, if the archive option is selected).

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;

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 measurement status (~~running/not running~~Idle/Observation);
- other information, e.g.:
- the current total number of words or TM packets:
 - acquired;
 - processed;

- discarded;
- whether the acquisition rate is too high;
- 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 (connected/not connected);
- the current total number of TM packet forwarded to the Science Console;
- the total number of times that the socket (or the buffer) has been cleared because was getting full, and the number of Pseudo TM packets discarded;

Data Quick Look

F.200 Upon starting a new **Observation measurement**, the Quick Look shall start to accumulate in parallel two separated spectra (one for the GRID data and one for the BURST data) of 4096 channels each (channel number ranging from 0 to 4095) for each of the 64 possible PDs. Each channel shall count the number of acquired words having the Pulse Height Amplitude value equal to the channel number.

F.210 The Quick Look shall include a graphics window providing a separated plot of the GRID data and the BURST data accumulated spectra; each GRID and BURST display shall consist of the overplot of the spectra seen by the two PD of the Bar selected by the user (note: only one Bar at a time), using specific widget buttons (*spectra display selection widget buttons*).

F.215 The spectra display selection widgets buttons will be identified by a fixed label of 5 characters (e.g. Barxx, where xx=01,...,32) and by an additional label of 5 characters which shall be configurable by the user (e.g.: Barxx, Barxx, where xx are assigned in the order defined by the user).

F.220 It shall be possible to archive on the local disk the accumulated spectra (*spectra file*).

F.230 Each spectra file:

- shall be a stream file containing the current values, in ASCII format, of the 64 GRID spectra and the 64 BURST spectra accumulated by the Quick Look;
- shall be named with the name *name.extension*, where *name* is proposed set to the current RUNID *nnnnn* (e.g. 00030) and can be modified by the user, and *extension* is set to "spectra";
- cannot already exist, in case it already exists, the user shall be required to provide a different name;

- shall be located in the *archive/spectra* subdirectory;
- the 4096 channels of the 64 GRID spectra and the 64 BURST spectra shall be saved as follows:
channel 0 PD0 ; channel 0 PD1 ; ... channel 0 PD 63; <CR><LF>
channel 1 PD0 ; channel 1 PD1 ; ... channel 1 PD 63; <CR><LF>
channel 2 PD0 ; channel 2 PD1 ; ... channel 2 PD 63; <CR><LF>
channel 4095 PD0 ; channel 4095 PD1 ; ... channel 4095 PD 63; <CR><LF>
idem for the BURST spectra

F.240 The Quick Look shall display the digital and analogue housekeeping data acquired by the instrument, namely:

- for each digital ratemeter, alphanumeric display of:
 - the current value,
 - the average value calculated on the last n (configurable by the user) values;
- for each digital meter, alphanumeric display of:
 - the current value,
- for each analogue HK, alphanumeric display of:
 - the current value in **raw and** engineering units,
 - the nominal range values (configurable by the user) in engineering units.

Data Retrieval

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

- inspect the measurement file data in hexadecimal format;
- inspect the spectra file in ASCII format;

F.310 Reload Spectra: it shall be possible to load in memory an archived spectra file in order to perform on it the same operations (Bar selection, spectrum visualisation and zoom) allowed by the Quick Look.

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

3.2 Performance Requirements

3.2.1 Instrument data

Data acquisition and processing

- P.10 At input rates up to the ~~maximum~~-nominal rates presented in Section 2.2, the Host Computer shall be able to perform all the *Data Acquisition and Processing* functions continuously, without any loss of data.
- P.15 Concerning the priorities:
- In Standalone mode, the highest priority shall be given to local archiving;
 - In Client mode, the highest priority shall be given to the delivery of the Pseudo TC/TM packets to the Science Console.
- 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, the Host Computer shall be able to perform all the *Data Monitoring* functions, updating the screen every about 1 s (TBC).
- P.40 At input rates up to the maximum rates presented in Section 2.2, the Host Computer shall be able to perform the *Data Quick Look* functions with the following performances:
- in Standalone mode:
 - the spectra accumulation will be performed on at least 50% (TBC) of the acquired data;
 - the spectra screen shall be update automatically every at least 10s (TBC) (user configurable);
 - the HK screen shall be update automatically every at least 16s (user configurable);
 - in Client mode:
 - the spectra accumulation will be performed on at least 20% (TBC) of the acquired data;
 - the spectra screen shall be updated on user request.
 - the HK screen shall be update on user request.

3.3 Interface Requirements

3.3.1 Instrument data

- I.10 The TCP/IP connection for the Data Link (TC and TM packets) shall be established by the Host Computer (as Client) with the Science Console (Server) on the IP address and the TCP port configured by the user.

I.15 In case the Data Link drops, automatically the Server restarts waiting for a new connection request from the Client.

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 observation~~ 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 Instrument data

O.100 The user shall be able to access:

- the Test Session Configuration;
- the Test Session Control;
- the Measurement Configuration;
- 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 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~~ Observation (only in case no ~~measurement~~ Observation is running):
 - to stop the current ~~measurement~~ Observation (only in case an ~~measurement~~ Observation is running);
in case the ~~M~~measurement was running in automatic mode, the mode shall be changed automatically to manual mode and the user shall be notified.
- O.190 The automatic mode shall be implemented by using the Measurement Control ~~flag~~ signal to condition the start/stop Observation in automatic mode, i.e.: ~~included in the acquired data.~~
- once the signal goes high, the TE:
 - sends a start Observation command to the CAL-DFE;
 - sends a start Observation Pseudo TC packets to the Science Console (if connected);
 - once the signal goes low, the TE:
 - sends a stop Observation command to the CAL-DFE;
 - until the FIFO is empty, acquires the scientific data the CAL-DFE and process them (i.e. encapsulate them in the Pseudo TM packets, and send the packets to the Science Console);
 - sends a stop Observation Pseudo TC packets to the Science Console (if connected);
- ~~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";~~

~~-stop the current measurement in case:~~

~~□between two consecutive words, the flag changed from "enabled" to "disabled";~~

- 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~~Observation, 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, and independently for the GRID spectra and the BURST spectra:
- the minimum and maximum values for the vertical axes (named "number of counts") of the spectrum to be displayed shall be adjusted automatically at each refresh to the minimum and maximum values contained in the current visualised (e.g. zoomed) part of the spectra (initial values: 0, 1);
- O.305 In the Test Session Configuration, the user shall be able to modify:
- the additional labels assigned to the spectra display selection widget buttons (initial values Bar01, Bar02, ..., Bar03);
 - the nominal range values of the analogue HK (in engineering units).
- O.310 In the Measurement Configuration, the user shall be able:
- to change the minimum and maximum value which define the "pulse height" range of the spectra to be accumulated (initial default values: 0, 4095);
- it is noted that the selected limits shall be applied only to the display operations, i.e.: the accumulation shall always be performed on the whole [0-4095] range.

O.320 In both Standalone and Client mode: at any time during the measurement the user shall be able:

- to change the selection of the Bar which PDs spectra shall be displayed;
- to freeze/resume the spectra accumulation and window refresh (note: the accumulation of all the spectra shall be frozen/resumed);
- to obtain the hardcopy of a frozen spectra window;
- to archive on the local disk the frozen spectra;
- to command the contemporarily reset of all the accumulated spectra;
- to change the minimum and maximum value for the horizontal axes (named "pulse height") of the spectra to be displayed (initial default values: 0, 4095);

O.330 In Standalone mode:

- the spectra display shall be updated automatically at the rate specified by the user (initial value = 10s).
- the HK display shall be updated automatically at the rate specified by the user (initial value = 16s).

- In Client mode:

- the spectra display shall be updated on user request;
- the HK display shall be updated automatically.

O.340 In both Standalone and Client mode:

- upon receiving the stop ~~measurement~~ **Observation** command, all the accumulated spectrum shall remain available to the user until a new ~~measurement~~ **Observation** shall be started;
- in the meanwhile, the user shall be able:
 - to change the selection of the Bar which PDs spectra shall be displayed;
 - to change the minimum and maximum value for the horizontal and vertical of the spectra to be displayed;
 - to obtain the hardcopy of the spectra window;
 - to command the contemporarily reset of all the accumulated spectra;

Data Retrieval

O.400 The Reload Spectra function shall be accessible only in case no ~~measurement~~ **Observation** is running.

- O.410 The Reload Spectra function shall allow the user to browse the archive in order to select the file to be loaded.
- O.415 Once a spectra have been reloaded, the GUI shall be the same provided by the Quick Look in order:
- to select the Bar which PDs spectra shall be displayed;
 - to operate on the selected spectra (e.g. zoom);

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;
- R.50 The Host Computer shall be equipped with a CDROM read/writer unit.-

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 Instrument data

- V.100 During the Acceptance Tests, suitable test gigs shall be provided in order to simulate/stimulate the Digital Interfaces 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 The MCAL Pseudo ESA TM Packets

The Pseudo TM/TC packets created by the Host Computer shall have the same basic structure of the AGILE TM.

Actually the main constrain is that:

- the packet header must have the same structure of the packet header of the AGILE TM;

The format presented hereafter is based on the AGILE TM defined in [9].

As shown in A.1-1 below, the various MCAL Pseudo TM packets shall be identified by different Type/SubType, and shall have fixed length.

MCAL Pseudo TM Packet	APID	Type	Sub Type	Packet Header length (bytes)	Data Field header length (bytes)	Source Data Field length (bytes)	Data Field length (bytes) -1 [packet length]	Total Packet length (bytes) [prefix]
MCAL GRID event	TBD	TBD	TBD	6	5x2=10	396x2=792	801 (0x0321)	808 (0x0328)
MCAL BURST event	TBD	TBD	TBD	6	5x2=10	396x2=792	801 (0x0321)	808 (0x0328)
MCAL Periodic Housekeeping TM report	TBD	TBD	TBD	6	4x2=8	TBD	TBD	TBD
TBD	TBD	TBD	TBD	6	TBD	TBD	TBD	TBD

Table A.1-1 **Main parameters of the** MCAL Pseudo TM packets

Each Pseudo TM packet consists of a Packet Header followed by a Packet Data field.

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 (the "total packet

length" specified in table A.1-1), specified in binary format (big-endian). E.g.: 0x0328 (808 decimal).

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

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

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

The Packet Header shall 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	DHFF	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

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 (note: each APID has its own counter).

Third word:

- Packet Length: [number of octets in Packet Data Field] – 1, as specified in table A.1-1;

The Packet Data Field shall consists of the Header and the Source Data.

The first 3 (16 bit) words of the Packet Data Field header shall have the following format:

Data Field Header - first 4 (16-bit) words

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

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 *fime*) corresponding to the creation of the packet.

The format of the remaining Packet Data Field header words (if any) shall depend on the various packet, and is detailed hereafter in the section specific to each packet.

A.2 GRID events data

As specified in [6] and [7], for each GRID event, the CAL DFE TE electronics will make available to the Host Computer:

- 64 (12 bit) word containing the Pulse Height Amplitudes (PHA) of the 64 Photo Diodes, specified in binary format (with MSB first), i.e.:

0	1	2	3	4	5	6	7	8	9	10	11
MSB						LSB					
PD PHA (12 bits)											

- 32 bit stream containing the TE internal counter associated to the event, with the following format:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MSB												LSB			
TE Internal Counter (MSB)															
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MSB												LSB			
TE Internal Counter (LSB)															

~~-1 bit for the Measurement Control (MC) flag.:~~

~~□ the Measurement Control signal is set to 0 V (Measurement disabled);~~

~~- the Measurement Control signal is set to 5 V (Measurement enabled);~~

For each GRID event ~~having the MC flag enabled~~, the Host Computer shall create a GRID event data block having the following format:

GRID event data block format (66 x 16 bit word)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
TE Internal Counter (MSB)																															
TE Internal Counter (LSB)																															
'0'		spare				Bar 01 PDA PHA (12 bits)																									
'0'		spare				Bar 01 PDB PHA (12 bits)																									
...																										
...																										
'0'		spare				Bar 32 PDA PHA (12 bits)																									
'0'		spare				Bar 32 PDB PHA (12 bits)																									

Where:

PDA PHA: Pulse Height Amplitude of PD A

PDB PHA: Pulse Height Amplitude of PD B

The Packet Data Field of the MCAL GRID event Pseudo TM packets shall consists of the Data Field Header having the format detailed below.

Data Field Header (5 x 16-bit word)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
See A.1																															
See A.1																															
See A.1																															
See A.1																															
Spare																								Nevents							

Where:

Nevents: Number of events contained in the packet.

The Source Data Field will be capable of containing up to 6 GRID event data blocks, hence it shall consists of $6 \times 6 = 36$ (16 bits) word.

Source Data Field (396 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 396)																															

A.3 BURST events data

As specified in [6] and [7], for each BURST event, the CAL DFE TE electronics will make available to the Host Computer:

- a variable number n of 34 bit stream related to the Pulse Height Amplitude (PHA) of both the Photo Diodes of the n Bars involved in the event; each bit stream shall have the following format:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16															
MSB																LSB															
Bar Counter (5 bit)																PDA PHA (12 bit)															
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33															
MSB																LSB															
Bar Address (5 bit)																PDB PHA (12 bit)															

See [6] and [7] for the description of the various fields.

- 32 bit stream containing the TE internal counter associated to the event, with the following format:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
TE Internal Counter (MSB)																															
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31																
MSB																LSB															
TE Internal Counter (LSB)																															

- 1 bit for the Measurement Control (MC) flag:
 - the Measurement Control signal is set to 0 V (Measurement disabled);
 - the Measurement Control signal is set to 5 V (Measurement enabled);

For each BURST event ~~having the MC flag enabled~~, the Host Computer shall create a BURST event data block having the following format:

BURST event data block format (variable number 3+2*n of 16 bit word)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																																
MSB																LSB																															
'1'																spare																Number of bars -1															
																TE Internal Counter (MSB)																															
																TE Internal Counter (LSB)																															
'0'																1 st Bar ID (2 MSB)																PDA PHA (12 bits)															
'0'																1 st Bar ID (3 LSB)																PDB PHA (12 bits)															
...																														
...																														
'0'																n-th Bar ID (2 MSB)																PDA PHA (12 bits)															
'0'																n-th Bar ID (3 LSB)																PDB PHA (12 bits)															

Where:

- Bar ID: Bar identification: range [1,32]
- PDA PHA: Pulse Height Amplitude of PD A
- PDB PHA: Pulse Height Amplitude of PD B

The Packet Data Field of the MCAL BURST event Pseudo TM packets shall include a Data Field Header having the format detailed below.

Data Field Header (5 x 16-bit word)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																																
MSB																LSB																															
																See A.1																															
																See A.1																															
																See A.1																															
																See A.1																															
																Spare																Nevents															

Where:

- Nevents: Number of events contained in the packet.

The Source Data Field will be capable of containing a number of BURST event data blocks, and it shall consist of 396 (16 bits) words.

Source Data Field (396 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 396)																															

A.4 Housekeeping data

As specified in [6] and [7], the CAL DFE TE electronics cyclically, every 16 s (configurable), will make available to the Host Computer:

- 97 (16 bit) words containing instrument digital ratemeters
- 4 (16 bit) words containing digital meters
- TBD (16 bit) words containing digital ADC housekeeping.

Each of the above words shall be specified in binary format (with MSB first), i.e.:

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

For each cycle, the Host Computer shall create an Housekeeping (HK) data block containing the values of the above *m* (TBD) data for the current cycle; hence the data block shall have the following format:

HK data block format (n x 16 bit word)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15																
MSB																LSB															
Value 1																															
Value 2																															
...																															
Value <i>m</i>																															

The Packet Data Field of the Periodic Housekeeping TM report packets shall include a Data Field Header having the format detailed below.

Data Field Header (5 x 16-bit word)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15														
MSB															LSB														
See A.1																													
See A.1																													
See A.1																													
See A.1																													

The Source Data Field will be capable of containing one HK data block, and it shall consists of *m* TBD (16 bits) word.

Source Data Field (m 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 m)																													

A.5 The MCAL Pseudo ESA TC Packet

In order to notify to the Science Console when a new ~~measurement~~ **observation** 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.

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).

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 Application Data: **must be set to the fixed values:**

- **0x0200**, for the "Start ~~measurement~~Observation" command;
- **0x0000**, for the "Stop ~~measurement~~Observation" command.