



SUBJECT: User's Manual — SPIRE — TFTS User Interface

PREPARED BY: Trevor Fulton

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Glossary

AD	Applicable Document
CQM	Cryogenic Qualification Model
DPU	Data processing unit
EGSE	Electrical Ground Support Equipment
GUI	Graphical User Interface
HCSS	Herschel Common Science System
ICD	Interface Control Document
IDL	Interactive Data Language
ILT	Instrument Level Test
NRT-QLA	Near Real Time Quick Look Analysis
RAL	Rutherford Appleton Laboratory
RD	Reference Document
SCOS	Spacecraft Operating System
SPIRE	Spectral and Photometric Imaging Receiver
TBD	To Be Determined
TBW	To Be Written
TC	Telecommand Packet
TFTS	UofL Test Facility Fourier Transform Spectrometer
TFTS-UI	UofL Test Facility Fourier Transform Spectrometer User Interface
TM	Telemetry Packet
U500	Unidex 500
UofL	University of Lethbridge
USR	User
UU	Unidex units (10 nm units)
ZPD	Zero path difference

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1 Introduction

This document is a user's manual for the *SPIRE TFTS User Interface (TFTS-UI)*. The TFTS-UI is an IDL application that serves as the front end to the TFTS System, where the TFTS System is comprised of the TFTS Communications Server as well as the TFTS hardware. The TFTS-UI is to be used to initialise, verify and operate the TFTS System in preparation for the SPIRE Cryogenic Qualification Model Instrument Level Test (CQM-ILT) at RAL.

In order to ensure that the TFTS System is reliable before the CQM-ILT, it is necessary for it to be tested in an environment similar to that that will be present during the CQM-ILT. The TFTS-UI was designed with this principle in mind. The TFTS-UI does not issue commands directly to the TFTS System rather, the EGSE Router (AD04§1.4.4.1) serves as an intermediary as shown in Figure 1. Furthermore, the format of the commands issued by the TFTS-UI is identical to that that SCOS (AD05) will issue during the CQM-ILT.

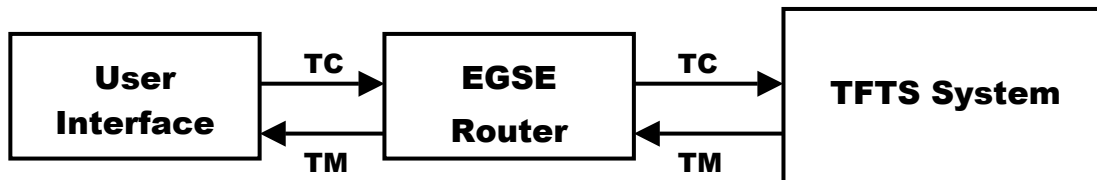


Figure 1 TFTS Software components

1.1 Scope

This purpose of this document is to serve as a guide to the TFTS-UI and how it may be used to test, verify and operate the TFTS System. This document does not describe the details of the communication between the TFTS-UI and the TFTS System. For those details refer to **AD01**.

1.2 Structure of the Document

Section 1.4 of this document presents the requirements for the TFTS User Interface. The procedure on how to load and run the TFTS-UI application as well as the steps necessary to initialise the TFTS-UI is presented in Section 2. Section 3 describes the procedure for verification of the TFTS System. Section 4 describes how to use the TFTS User Interface to control the TFTS System during normal operation. The various exceptions and how one may recover from them are presented in Section 5. Finally, Section 6 describes in detail the elements of the TFTS User Interface GUI and their functionality.

1.3 Documents

1.3.1 Applicable Documents

- AD01 SPIRE Technical Note – Canadian Contribution -- Software (SPIRE-UoL-NOT-001554), Version 1.0
- AD02 SPIRE TFTS Communications Server, User Guide (To be Written)
- AD03 SPIRE Test Facility FTS Data ICD
SPIRE-UoL-PRJ-001452
- AD04 HCSS Test Report
HSC/REP/0314, Issue 1.3
- AD05 EGSE BASED ON SCOS 2000
TOS-EMG/01-1029/bm/sv

1.3.2 Reference Documents

- RD01 HCSS Software Verification and Validation Plan (HERSCHEL/HSC/DOC/0284), Issue 1, Revision 1
- RD02 Unidex 500 User's Manual

1.4 System Requirements

In order to test, verify and operate the TFTS system with the TFTS User interface, the following components are required:

- IDL 5.6 or higher
- TFTS Communications Server (**AD02**)
- EGSE Router (**AD04**)
- A Signal Detection and Display System

The SPIRE TFTS User Interface is a software application written in the IDL programming language. Thus, the host machine on which the TFTS-UI is to be run must have an IDL license. Additionally, the TFTS-UI will only run properly on a system with IDL version 5.6 or later. Instructions on how to initialise and execute the TFTS User Interface are presented in the next section.

The set-up and execution procedure for the TFTS System may be found in **AD02** while that for the EGSE Router may be found in **AD04**. Note that one must start the EGSE Router before initialising either the User Interface or the TFTS System.

The signal detection and display system should consist of an infrared detector (Cryo-cooled $\Delta\Sigma$ detector or a Golay Cell) and an instrument to display the electrical signal from the detector in real-time (e.g. an oscilloscope).

2 Initialisation

The following sections describe how to load, start and initialise the SPIRE TFTS User Interface. The initialisation procedure assumes that the EGSE Router is running and listening for new connections on a host machine to which the TFTS-UI has access.

The procedure to load the SPIRE TFTS User Interface is as follows.

1. **Start an IDL session.** On Windows systems double-click the IDL icon on the desktop or select Start→Programs→Research Systems IDL 5.6→IDL. For a Unix system, load the IDL Development Environment by typing the command ``idlde``.

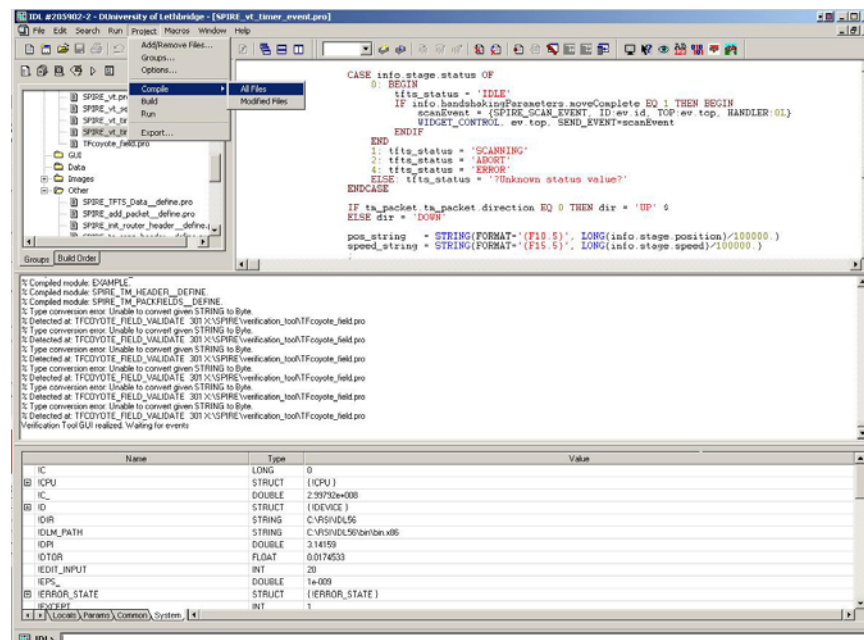


Figure 2 The User Interface Project

2. **Load the User Interface source code into IDL.** Load the source files, definition files and bitmaps required by the User Interface application into IDL by selecting `SPIRE_vt.prj` project file via File→Open Project... You may need to contact your local system administrator to find the location of the `SPIRE_vt.prj` project file on your local system.
3. **Compile the User Interface source code.** Select Project→Compile→All Files to compile the TFTS-UI source code (see Figure 2).

4. **Start the User Interface application.** Select Project→Run to start the TFTS-UI application.

At start-up, the user should see the TFTS User Interface GUI as shown in Figure 3.

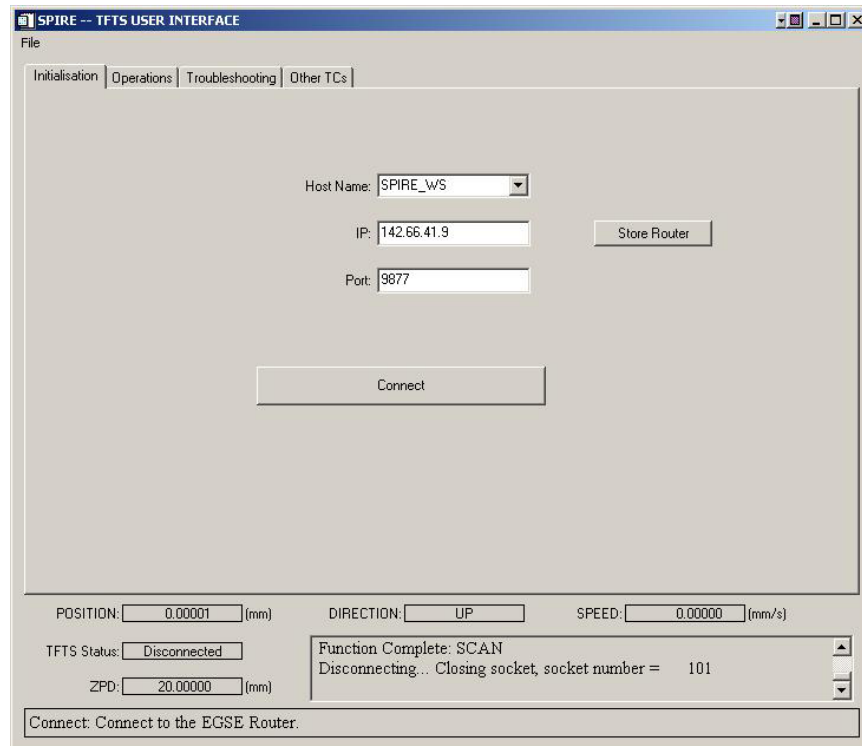


Figure 3 Initialisation Tab

5. **Connect to the Router.** A connection between the User Interface and the EGSE Router must be established in order to send commands to the TFTS System. The Initialisation Tab on the User Interface contains data entry fields that allow the user to select the host on which the EGSE Router is running (see Figure 3).

Select the host machine on which the EGSE Router is running by choosing a host name from the drop-down menu. This will update the IP and Port data fields with values linked to that host name. If the desired host does not appear in the drop-down list, edit the Host Name, IP and Port parameters so that they contain appropriate values. These parameters may then be stored for future use by selecting the **Store Router** button.

Once the appropriate IP and Port values are displayed, select the **Connect** button to try to establish a connection with the EGSE Router. If this attempt is successful, the focus of the User Interface will switch to the Troubleshooting and Verification Tab (§Figure 4) and the elements of the Initialisation Tab will be de-sensitised. If the attempt to establish a connection is unsuccessful, the User Interface will generate an exception message (§5.1.6).

3 Verification

As mentioned in §2, once the connection the EGSE Router has been established, the focus of the User Interface will automatically switch to the Troubleshooting and Verification Tab (see Figure 4). The elements on this tab allow the user to find and/or verify the position of zero path difference of the TFTS stage. The elements on this tab are also useful for sending commands to the TFTS System that enable it to recover from errors.

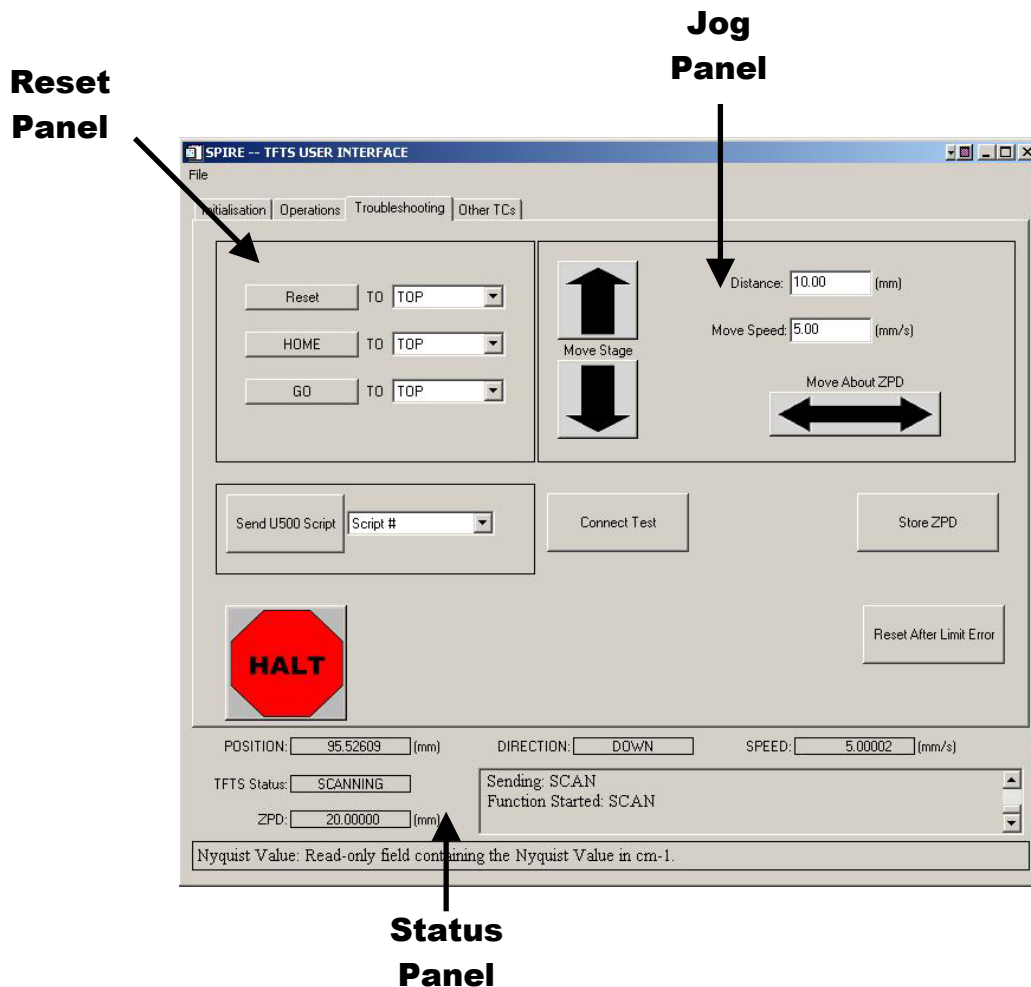


Figure 4 Troubleshooting and Verification Tab

1. **Connect Test.** Select the **Connect Test** button on the Troubleshooting and Verification Tab to test whether there is a valid connection between the TFTS

User Interface and the TFTS System (via the EGSE Router). If the TFTS User Interface does not receive a response from the TFTS System within three (3) seconds, a 'Handshake TIMEOUT' message will appear in the TFTS Status field (§5.1.3). This situation may be remedied by re-starting the TFTS Communications Server. If this problem persists, contact your system administrator

2. **Reset the TFTS.** The next step in the verification process is to reset the TFTS Software and Hardware by choosing the **Reset** button (see Figure 4). *This is recommended not only at start-up but should also be performed whenever the TFTS System reconnects with the EGSE Router or when the TFTS System is in and ERROR or ABORT state (§6.2).*

The TFTS may be reset by choosing one of the three options in the Reset Panel of the Troubleshooting and Verification Tab (see Figure 4). The three TFTS reset options and their effect on the TFTS System is presented in Table 1.

Reset Panel Button	Reset Functions Executed
Reset	1, 2, 3
Home	2, 3
Go	3

Table 1 TFTS Reset Levels

1. Reset the Unidex 500 card
2. Find the stage to the calibration position
3. Move the stage to a specific position

Use the associated drop-down menu in the Reset panel to specify the position to where the stage is to be moved (see Figure 4).

NB Currently, only the TOP of the table may be selected as a final destination of a reset function.

3. **Locate the Position of Zero Path Difference.** In order to locate the position of zero path difference, there must be a mechanism in place to detect and display the output of the TFTS System (i.e. a detector).

Move the Stage to the ZPD position

Use the unidirectional Jog buttons (see Figure 4, Jog panel) to move the stage to the ZPD position. The stage position where ZPD is expected to be is displayed in the status panel of the TFTS-UI.

Scan about the ZPD position

To command the stage to move continuously back and forth (up and down), select the bi-directional arrow button in the Jog panel of the Troubleshooting tab (see Figure 4). For this mode, the distance data field in the Jog panel represents the amplitude of the movement about the starting stage position. Observe the detector signal as the stage moves about the ZPD position.

Once bi-directional stage movement has begun, the TFTS stage will continue moving in this manner indefinitely. The user must select the HALT button to discontinue bi-directional stage movement.

4. **Save the ZPD Value.** When the ZPD position of the TFTS System has been located, move the TFTS stage to that position. Once the stage is at the ZPD position, store the ZPD value by selecting the **Store ZPD** button.

4 Normal Operation

To execute a scan with the TFTS System, select the Operations Tab. Scan parameters may be specified using the data entry fields in Operations Panel as shown in Figure 5. To initiate a scan, select the SCAN button. Note that a scan should only be initiated after the ZPD position has been verified (§3) and only if the TFTS System is in the IDLE state (see Table 4).

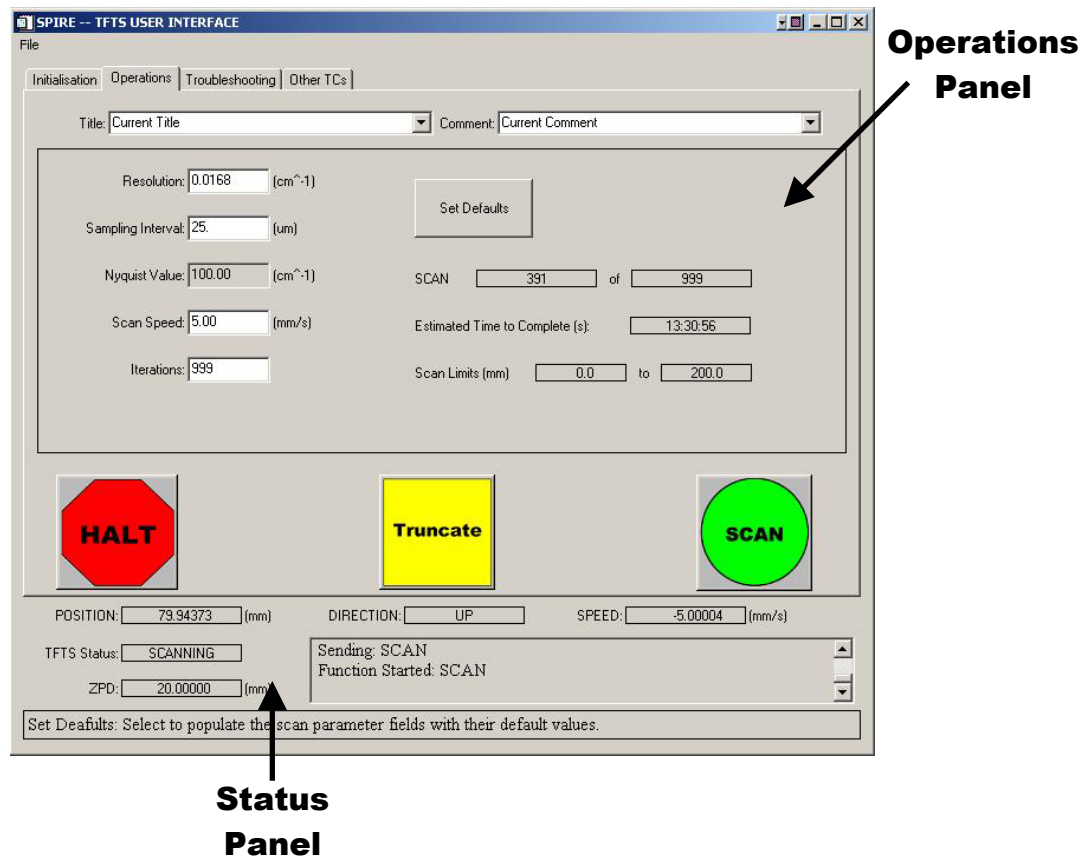


Figure 5 Operations Tab

During a scan, additional status information is provided in the Operations panel (see Figure 5). This additional information consists of the current scan iteration, the total number of scans requested, the estimated time to complete the scan sequence and the absolute positions of the scan endpoints. These parameters are updated once per second from the information provided by the TFTS Housekeeping telemetry.

To terminate a scan sequence prematurely, one may select either the **Halt** button or the **Truncate** button (see Figure 5). The Halt function terminates the scan sequence immediately, and causes the TFTS System to enter the ABORT state. The Truncate function terminates the scan sequence at the end of the current scan, then returns the TFTS to the IDLE state. Issuing the Truncate command when the stage is not scanning has no effect on the TFTS System.

5 Exceptions

5.1.1 Bad Parameter

The User Interface contains many different data entry fields. These fields allow the user to specify values for various TFTS parameters. Each of these parameters has a range of acceptable values (see **AD03** for details). If the operator attempts to submit a value for a parameter outside its range, the User Interface will display one of the error messages shown in Figure 6.

NB Selecting 'OK' acknowledges the exception, but does not correct it.

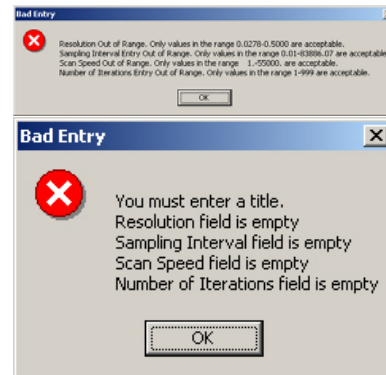


Figure 6 Bad Parameter Exceptions

5.1.2 TFTS Busy

If the user attempts to send a telecommand while the TFTS System is executing a function, a TFTS Busy exception message is generated (see Figure 7). This message indicates that the TFTS System could not execute the most recent command and that the command should be re-sent. Choosing 'OK' acknowledges the exception.

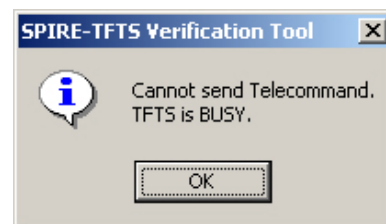


Figure 7 TFTS Busy Exception

5.1.3 Timeout Exceptions

The User Interface maintains two software timers that are used to monitor the status of the TFTS System automatically. These are the Heartbeat timer and the Handshaking timer.

Heartbeat Exception

The TFTS-UI Heartbeat timer checks whether housekeeping telemetry is still being received from the TFTS System. The TFTS-UI is supposed to receive housekeeping telemetry from the TFTS once per second. If the TFTS-UI does not receive telemetry for ten (10) consecutive seconds, the message "Heartbeat TIMEOUT" will appear in the TFTS Status field.

Handshaking Exception

The TFTS-UI Handshaking timer monitors the receipt of Telecommand Execution reports from the TFTS System. The TFTS Communications server must respond to each telecommand from with a series of Telecommand Execution Reports (TER). The Handshaking timer is used to ensure that the TFTS-UI has received this TER telemetry within three (3) seconds. If the User Interface does not receive a timely response, the message “Handshake TIMEOUT” will appear in the TFTS Status field.

The occurrence of either of these timeout exceptions indicates that either the connection between TFTS System and the Router has been lost. Upon notification of a timeout exception, these systems should be checked to ensure that they are operating normally.

5.1.4 TFTS System Exceptions

There are three types of TFTS System exceptions, each of which indicates a serious problem with the TFTS System. When the User Interface receives notification that one of these TFTS System exceptions has occurred, an exception message like the one shown in Figure 8 is generated. This error message contains a short description of the TFTS System exception

as well as TFTS hardware and software status information in the form of two hexadecimal 32-bit words. The TFTS Data ICD (**AD03**) contains detailed explanations of the component bits of the hardware and software status 32-bit words. Table 2 lists the possible TFTS Exceptions and the action(s) that the user should take to correct the exception.

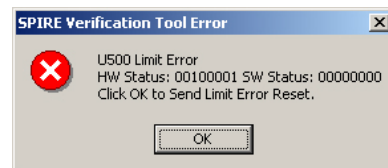


Figure 8 Limit Error Exception

TFTS Exception	Action
DPU Counter Error	Abort the current scan
U500 Feedback Error	Abort the current scan
U500 Limit Error	1. Reset Limit; 2. Reset

Table 2 TFTS Exceptions

5.1.5 Socket Exceptions

Unable to connect to Router

This type of socket exception indicates that the connection between the TFTS-UI and the EGSE Router cannot be established. The user should check that the correct IP/PORT Numbers were chosen (§2.5) and that the EGSE Router is operating normally.



**Figure 9 Socket Exception:
Unable to connect to Router**

Router drops connection

If the EGSE Router drops the connection to the User Interface an exception message as shown in Figure 10 will appear. Select OK to disable the socket locally. The focus of the TFTS-UI will then switch to the Initialisation Tab.



**Figure 10 Socket Exception:
Router drops connection**

5.1.6 Other Exceptions

Bad Telecommand

If the TFTS System receives a poorly formatted command, it will send a Telecommand Execution Exception report to the TFTS-UI. The TFTS-UI will notify the user of such an exception by way of an error message as. The possible Telecommand Execution Exception reports and the action(s) that the user should take to correct the exception are listed in Table 3.

Telecommand Execution Exception	Action
Illegal APID	Resend the telecommand. If the problem persists, disconnect from the EGSE Router and re-initialise the TFTS-UI.
Incomplete Packet/Invalid Length	
Incorrect CRC	
Illegal Packet Type	
Illegal Packet Subtype	
Illegal/Inconsistent Application Data	

Table 3 Telecommand Execution Exceptions

6 TFTS User Interface GUI Layout and Description

The GUI elements that issue the commands to the TFTS System are divided according to their function. The functions that allow the user to disconnect the TFTS-UI and/or exit the program are found under the File menu. The functions that are relevant for normal operations are found on the Operations tab while those that concern troubleshooting are located on the Troubleshooting tab. The following sections describe each of these elements in detail.

6.1 File menu

- **Disconnect:** This menu item closes the socket connection with the EGSE Router. This function only controls the connection between the TFTS User Interface and the EGSE Router and does not affect the status of the TFTS System.
- **Quit:** Choose this menu item to terminate the TFTS-UI application. If there is an open socket connection, it is closed before the application is terminated.

6.2 Status Panel

Diagnostic information from the TFTS System is constantly displayed in the lower panel of the TFTS User Interface (see Figure 4). This diagnostic information comes from the TFTS housekeeping data and is updated once per second. These parameters are:

- **Position:** The current absolute position of the TFTS stage. Measured from the top of the table in units of mm.
- **Direction:** The current direction of stage movement.
- **Speed:** The current speed of the stage in units of mm/s
- **ZPD:** The stage position of zero path difference. Expressed in units of mm, measured from the top of the stage.
- **Message Window:** The scrollable window contains additional detailed status information regarding the TFTS System
- **Help Window:** The lowermost message field in the Status Panel contains a description of the TFTS-UI GUI element to which the mouse pointer is currently pointing.
- **TFTS Status:** See Table 4 for descriptions of the possible TFTS Status values.

TFTS Status	Description
IDLE	The TFTS stage is not currently executing a command and is ready to accept a command.
SCANNING	The TFTS stage is currently executing a command. Note that this command is not necessarily a Scan but could also be a Reset, Home, Move or a Reset Limit command.
ABORT	The TFTS System has executed the Abort function. A Reset command should be issued before issuing any other commands.
ERROR	The TFTS System is in an error state. The user should investigate the error. When the error is resolved, a Reset command should be issued before issuing any other commands.
BUSY	The user has attempted to issue a command while the TFTS System is executing another command. A BUSY status indicates that the second command was disregarded by the TFTS System.
N/A	The status of the TFTS System is unknown. This status condition occurs when either the TFTS User Interface or the TFTS System (or both) has not connected to the EGSE Router.
Disconnected	The User Interface has severed its connection to the router. The TFTS System may or may not be connected to the Router.
Handshake TIMEOUT	The TFTS User Interface issued a command to the TFTS System but did not receive the expected response within the appropriate period (see §5.1.3).
Heartbeat TIMEOUT	The TFTS User Interface has stopped receiving Housekeeping information from the TFTS System (see §5.1.3).

Table 4 TFTS Status States

6.3 Initialisation

The Initialisation Tab of the TFTS User Interface item is used to open a socket connection with the EGSE Router. Both at start-up and after the connection to the EGSE Router has been disabled, the Initialisation Tab is the only TFTS-UI tab that is active. When a connection between the TFTS-UI the EGSE Router is established, the Initialisation tab is de-activated and the other TFTS-UI tabs become active.

Data Entry Fields

- **Host Name:** This drop down menu contains a list of pre-defined hosts on which the EGSE Router has run. Selecting one of the items in this menu will populate the IP and Port fields associated with that host name. This field may be edited to allow the user to store a new EGSE Router host name.
- **IP:** The IP address of the host on which the EGSE Router is running.
- **Port:** The port number on which the EGSE Router is listening for new connections.

Buttons

- **Store Router:** If the host on which the EGSE Router is running is not listed in the Host Name menu, select this button to store its name, IP address and Port number for future use.

- **Connect:** Select this button to attempt to establish a connection with an EGSE Router running on a host whose IP address and Port numbers are given by the values in those data entry fields.

6.4 Operations

The elements on the Operations Tab are those that are used when operating the TFTS System in scan mode.

Data Entry Fields

- **Title:** The user-specified title of the current scan. The user may enter a title or may choose from a list of the five most recent titles.
- **Comments:** The Comment field stores additional information about the current scan. The user may enter a comment or may choose from a list of the five most recent comments.
- **Resolution:** The desired resolution for the current scan in units of cm^{-1} . The value in this field is limited to four decimal places and must be in the range given by:

$$\text{Resolution Range} = [\text{Highest Resolution}, \text{Lowest Resolution}].$$

where:

$$\text{Highest Resolution} = \left[\frac{1.21}{(4 \times (20\text{cm} - \text{ZPD}))} \right]$$

$$\text{Lowest Resolution} = \left[\frac{1.21}{(4 \times \text{ZPD})} \right]$$

- **Sampling Interval:** The desired sampling interval for the current scan in units of μm . This is a floating-point parameter with no decimal places.
- **Nyquist Value:** This is a read-only parameter whose value is calculated based on the value in the Sampling Interval field. The Nyquist Value is evaluated as:

$$\text{Nyquist Value} = \frac{1 \times 10^5}{(4 \times \text{Sampling Interval})}$$

The Nyquist Value is presented in units of cm^{-1} and is limited to two decimal places.

- **Scan Speed:** The desired speed for the current scan. This value is presented to two decimal places in units of mm/s .
- **Iterations:** The number of iterations desired for the upcoming scan.

Parameter	Default Value	Range	Units
Title	N/A	< 20 characters	N/A
Comment	N/A	< 60 characters	N/A
Resolution	0.0168	0.0168 — 0.1513	cm ⁻¹
Sampling Interval	25	10 — 100	µm
Scan Speed	5	1 — 55	mm/s
Iterations	10	1 — 999	N/A
Acceleration	1000	10 — 2500	mm/s ²

Resolution values shown are based on a ZPD = 2.0mm

Buttons

- **Set Defaults:** Press this button to populate the scan parameter fields with default values.
- **Halt:** Abort the current scan sequence immediately. Press this button to issue an Abort command to the TFTS. The result is that the current scan terminates immediately and all science data for the current scan is sent to the EGSE Router. Furthermore, the TFTS System will enter the ABORT state. Note that the Abort command may be issued even if the TFTS is not scanning.
- **Truncate:** Stop the current scan sequence gracefully. Press this button to issue a Truncate command to the TFTS System. The scan sequence will terminate after the current scan is complete. Issuing the Truncate command when there is only one scan remaining in the sequence has no effect on the TFTS System.
- **Scan:** Begin a scan sequence. Press this button to issue a Scan command to the TFTS System. The parameters of the Scan command are determined from the values entered in the scan parameter fields (see Figure 5). If the values in any of the fields are outside their accepted range, the SPIRE User Interface will issue an error message to the user informing the user of the out-of-limit condition (§5.1.1).

Diagnostic Parameters

- **Current scan:** The current scan information from the housekeeping data. Here, current scan number and the total number of iterations are displayed.
- **Estimated Time to Complete:** This read-only parameter is calculated based on the TFTS housekeeping data. The estimated time to complete is calculated as follows:

$$\text{Estimated time to complete} = \frac{\#HalfScans \times d + d_{rem}}{v}$$

where

- #HalfScans is the number of up scans and down scans remaining in the requested scan sequence
- d is stage displacement required for a HalfScan

- d_{rem} is the distance required to complete the current HalfScan
- v is the current stage speed
- **Scan Limits:** The values in these two fields represent the absolute stage positions of the limits of the currents scan in units of mm.

6.5 Troubleshooting

The purpose of the elements of the Troubleshooting Tab is primarily to issue commands to the TFTS System to allow it to recover from an error condition. In addition, the elements on the Troubleshooting Tab are used for verification of the position of zero path difference for the TFTS System.

6.5.1 Reset Panel

The reset panel contains three buttons representing three reset levels for the TFTS System. These reset levels are:

1. Reset Unidex 500 card
2. Move stage to calibration position
3. Move stage to a specific position

The buttons in the reset panel perform the following actions:

Button	Action
Go	3
Home	2, 3
Reset	1, 2, 3

6.5.2 Jog Panel

The elements in the Jog panel allow the user to move the stage a specified distance and direction at a specified speed.

Buttons

- **Move Stage:** The two arrows (pointed up and down) are used to specify the direction of the desired stage movement. The distance and speed for the requested move are given by the values in the data entry fields.
- **Move About ZPD:** Press this button to cause the TFTS stage to move in a periodic fashion from its current position. The stage will move about the initial stage position with an amplitude given by the value in the Distance data entry field (see below). This periodic motion continues until a **Halt** is issued.

Data Entry Fields

- **Distance:** Enter the desired move distance in mm in this field. This field is also used to specify the length of the loop when scanning about ZPD.
- **Speed:** Enter the desired speed for the move commands in this field.

6.5.3 Remaining Troubleshooting Elements

- **Connect Test:** Select this button to issue a Connect Test command to the TFTS System. This type of command is useful for determining whether the TFTS System is still active and able to respond.
- **Reset After Limit Error:** The user should only press this button if one of the stage limits has been breached. The user will be notified of such a condition via a TFTS User Interface exception report (§5.1.4).
- **Halt:** See above (§6.4).
- **Store ZPD:** During verification, it is necessary to locate the stage position corresponding to zero optical path difference (ZPD). When one is confident that the stage is at the ZPD position, press this button to generate a pop-up window that will ask if the user wishes to store the position of the stage. Answering in the affirmative stores the ZPD value as a permanent variable.

6.6 Other TCs

This TFTS-UI tab contains buttons that issue those commands to the TFTS System that are not critical to Initialisation, Operations or Troubleshooting.

Buttons

- **Set OBSID:** Enter an Observation ID in the associated data entry field and select this button to command the TFTS System to set the Observation ID to this value. The Observation ID value is restricted to integers in the range 0 – 65535.
- **Set BBID:** Enter a Building Block ID in the associated data entry field and select this button to command the TFTS System to set the Building Block ID to this value. The Building Block ID value is restricted to integers in the range 0 – 65535.
- **Set Parameter:** Select this button to write the value as displayed in the associated data entry field to the U500 parameter as selected with the associated drop down menu. Refer to **RD02** for a list of the available parameters and their ranges.
- **View Parameter:** Select this button to read the value of the U500 parameter given by the value in the associated drop down menu. Refer to **RD02** for a list of the available parameters. The value of the chosen U500 parameter is displayed in the associated data entry field.

Data Entry Field

Acceleration: Edit this field to select the acceleration of the TFTS Stage in units of mm/s^2 . This field is used to select the desired acceleration for both the Scanning (§6.4) and Moving (§6.5.2) commands.

NOTE: It is recommended that the value in the acceleration field not be changed.