SPIRE

SUBJECT: **Test Facility Control System Data ICD**

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Glossary

APID	Application ID
EGSE	Electronic Ground Support Equipment
SID	Structure ID
SPIRE	Spectral and Photometric Imaging REceiver
TFCS	Test Facility Control System

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1. INTRODUCTION

The Test Facility Control System (TFCS) controls the equipment in the SPIRE Test Facility that is used to simulate the environment in which the instrument will operate and to stimulate the instrument. Although able to operate in a stand-alone manner during testing of the Test Facility itself, it is also used as part of the SPIRE EGSE during instrument-level tests, and in this role it has to conform to the data communication interfaces of the EGSE.

All telemetry data produced by the EGSE systems will follow the same standards as is used in the Herschel Spacecraft and Ground Segment systems (this allows easier transition from the testing to the operational environments). The data is generated in the form of TM Source Packets conforming to the ESA Packet Utilisation Standard (RD1), but the set of supported packet types within the Herschel project is restricted. This restricted set is defined in the Herschel Packet Structure ICD (AD1).

The TFCS utilises a reduced set of telemetry packet types and this document details the contents of each of these.

1.1 Scope

Telemetry packets are passed between the components of the EGSE by sending them as messages, through the Packet Router. The Packet Router ICD (AD2) defines the format of these messages, whereas this document defines the content of the data component of them.

2. DOCUMENTS

2.1 Applicable Documents

AD1   Herschel Packet Structure ICD
AD2   Herschel Packet Router ICD
AD3   SPIRE EGSE Configuration Plan

2.2 Reference Documents

RD1   ESA Packet Utilisation Standard

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3. PACKET STRUCTURES

3.1 Telecommand Packets

The following table gives the general structure of a TFCS TC Packet (after AD1)

Packet Header	Packet ID	0	0	0	1	1		APID							
	Sequence Control	1	1	Src		Count									
	Length			Length											
Data Field	Data Field Header	0	0	0	0	Ack		Type							
		Sub-Type			0	0	0	0	0	0	0	0			
	Source Data					DATA									
	Error Control			Checksum											

- Src, Count, Length and Checksum are defined in AD1
- Ack is defined in AD1. Only bit 3 of the Ack field (TC Acceptance Verification) is used, other bits are assumed to be zero.
- Type and Sub-Type define the packet type and are also defined in AD1.

3.2 Telemetry Packets

The following table gives the general structure of a TFCS TM Packet (after AD1)

Packet Header	Packet ID	0	0	0	0	1		APID							
	Sequence Control	1	1		Count										
	Length			Length											
Data Field	Data Field Header	0	0	0	0	0	0	0	Type						
		Sub-Type			0	0	0	0	0	0	0				
		TIME													
	Source Data					DATA									
	Error Control			Checksum											

Count, Length, TIME and Checksum are defined in AD1
Type and Sub-Type define the packet type and are also defined in AD1

3.3 APIDs

The Application ID is used to identify the source or destination of a telemetry packet. Herschel uses different APIDs for different types of packet (see AD1). The TFCS will follow this convention. The APIDS to be used by the TFCS are defined in the EGSE Configuration Plan (AD3) and are given in the following table:

Telemetry types	APID (hex)
All TFCS Data	7F4

4. TELECOMMAND PACKETS

This section defines all the telecommand packets accepted by the TFCS.

It is the default that all telecomands received by the TFCS will be acknowledged with a TC Acceptance Report (Service1,1 or 1,2 depending on outcome).

There are currently no telecommands that generate command execution reports (Services 1,3; 1,5 or 1,7).

4.1 Telecommand Packet Types

The Packet Structure ICD (AD1) defines many types of service that can be provided by an application. The following table shows the telecommand packet types that will be accepted by the SPIRE TFCS

Description	Service Type	Service Sub-Type	Comments
Function Management Perform Activity of Function	8	4	
Time Management Enable Time Verification	9	7	
Test Service Perform Connection Test	17	1	

Table 4-1 Telecommand Packet Types

4.2 Telecommand Packet Definition

4.2.1.1 Perform Activity of Function (Service 8,4)

All commands of this type and subtype may give rise to the following errors:

Error	TM Service	Error Code	Description
Illegal_Activity_ID	(1,2)	0x0802	Activity_ID_Not_Known

4.2.1.1.1 Function 0xC1 Observations, Activity 0x01: <u>Set Observation ID</u>

This command sets the value for the Observation ID, which is included in all telemetry packets to allow them to be ingested into the HCSS database. The current BBID value is unaffected.

APID1
Count
Length = 11
0 0 0 0 1 0 0 0
0 0 0 0 0 1 0 0
FUNCTIONID ACTIVITYID
OBSID
Checksum

Parameter	Value	Description
FUNCTIONID	0xC1	
ACTIVITYID	0x01	Set Observation ID (8bit)
OBSID		Observation ID (32bit)

4.2.1.1.2 Function 0xC1 Observations, Activity 0x02: <u>Set Building Block ID</u>

This command sets the value for the Building Block ID which is included in all telemetry packets to allow them to be ingested into the HCSS database

APID1
Count
Length = 11
0 0 0 0 1 0 0 0
0 0 0 0 0 1 0 0
FUNCTIONID ACTIVITYID
BBID
Checksum

Parameter	Value	Description
FUNCTIONID	0xC1	
ACTIVITYID	0x02	Set BBID (8bit)
BBID		Building Block ID (32bits)

4.2.1.1.3 Function 0xCC TFCS, Logging Control.

These commands control the activation and deactivation of the logging subsystems of the Temperature, Cryogen Level, and Pressure monitoring systems.

APID1
Count
Length = 7
0 0 0 0 1 0 0 0
0 0 0 0 0 1 0 0
FUNCTIONID ACTIVITYID
Checksum

Parameter	Value	Description
FUNCTIONID	0xCC	
	0x01	Activate Temp. Logging
	0x02	Deactivate Temp. Logging
ACTIVITYID	0x03	Activate Cryogen Logging
	0x04	Deactivate Cryogen Logging
	0x05	Activate Pressure Logging
	0x06	Deactivate Pressure Logging

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4.2.1.1.4 Function 0xCC TFCS, Activity 0x07: <u>Set Interface Temperature</u>

This command sets the temperature of an interface.

				APID1	
				Count	
Length = 13					
				0 0 0 0 1 0 0 0	
0 0 0 0 0 1 0 0					
FUNCTIONID			ACTIVITYID		
				INTERF	
TEMP					
Checksum					

Parameter	Value	Description
FUNCTIONID	0xCC	
ACTIVITYID	0x07	Set Interface Temperature.
INTERF		Interface Number:
	0	Level 0 Heater 1
	1	Level 0 Heater 2
	2	Level 0 Heater 3
	3	Level 1
	4	10K Shield
TEMP		Target Temperature. (32 bits)

4.2.1.1.5 Function 0xCC TFCS, Flip Mirror.

These commands set various attributes of the Cold Black Body.

				APID1	
				Count	
Length = 7					
				0 0 0 0 1 0 0 0	
0 0 0 0 0 1 0 0					
FUNCTIONID			ACTIVITYID		
Checksum					

Parameter	Value	Description
FUNCTIONID	0xCC	
ACTIVITYID	0x08	Activate Logging
	0x09	Deactivate Logging
	0x0A	Open Flip Mirror
	0x0B	Close Flip Mirror
	0x0C	Open Heat Shunt
	0x0D	Close Heat Shunt

4.2.1.1.6 Function 0xCC TFCS, Activity 0x0E. <u>Set Cold Black Body Power</u>

This command sets the Cold Black Body to a specific power level.

				APID1	
				Count	
Length = 11					
				0 0 0 0 1 0 0 0	
0 0 0 0 0 1 0 0					
FUNCTIONID			ACTIVITYID		
POWER					
Checksum					

Parameter	Value	Description
FUNCTIONID	0xCC	
ACTIVITYID	0x0E	Set CBB Power.
POWER		Power Setting. (32 bit)

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4.2.1.1.7 Function 0xCC TFCS, Telescope Simulator MM4006.

These commands control various attributes of the Telescope Simulator System

							APID1								
							Count								
						Length = 7									
								0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0								
		FUNCTIONID								ACTIVITYID					
						Checksum									

Parameter	Value	Description
FUNCTIONID	0xCC	
ACTIVITYID	0x0F	Activate MM4006
	0x10	Deactivate MM4006
	0x11	Center Actuators

4.2.1.1.8 Function 0xCC TFCS, Activity 0x12. <u>Set Actuator Position</u>

This command sets a specific actuator to a specific position.

							APID1								
							Count								
						Length = 13									
								0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0								
		FUNCTIONID								ACTIVITYID					
								ACTUATORID							
						POSITION									
						Checksum									

Parameter	Value	Description
FUNCTIONID	0xCC	
ACTIVITYID	0x12	Set Actuator Position.
ACTUATORID		Actuator Number.
POSITION		Position (mm, 32 bit)

4.2.1.1.9 Function 0xCC TFCS, Activity 0x13. <u>Move To Detector Position</u>

This command moves the telescope beam to a specific location on the detector. The coordinates refer to an absolute position.

							APID1								
							Count								
						Length = 19									
								0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0								
		FUNCTIONID								ACTIVITYID					
						POSITIONX									
						POSITIONY									
						POSITIONZ									
						Checksum									

Parameter	Value	Description
FUNCTIONID	0xCC	
ACTIVITYID	0x13	Move to Detector Position.
POSITIONX		Detector X Coordinate.
POSITIONY		Detector Y Coordinate.
POSITIONZ		Detector Z Coordinate.

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4.2.1.1.10 Function 0xCC TFCS, Activity 0x14. <u>Move from Detector X1,Y1, Z1 to X2,Y2, Z2</u>

This command moves the Telescope beam across the detector from position X1, Y1, Z1 to X2,Y2, Z2.

					APID1										
					Count										
				Length = 31											
								0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0								
	FUNCTIONID							ACTIVITYID							
				POSITIONX1											
				POSITIONY1											
				POSITIONZ1											
				POSITIONX2											
				POSITIONY2											
				POSITIONZ2											
				Checksum											

Parameter	Value	Description
FUNCTIONID	0xCC	
ACTIVITYID	0x14	Move from X1,Y1, Z1 to X2,Y2, Z2.
POSITIONX1		Detector X1 Coordinate.
POSITIONY1		Detector Y1 Coordinate.
POSITIONZ1		Detector Z1 Coordinate.
POSITIONX2		Detector X1 Coordinate.
POSITIONY2		Detector Y2 Coordinate.
POSITIONZ2		Detector Z2 Coordinate.

4.2.2 Time Management

4.2.2.1 Enable Time Verification (Service 9,7)

On receipt of this TC, The TFCS responds with a Time Verification Report (Service 9,9)

					APID1										
					Count										
				Length = 5											
								0	0	0	0	1	0	0	1
0	0	0	0	0	1	1	1								
				Checksum											

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4.2.3 Test Service

4.2.3.1 Perform Connection Test (Service 17,1)

On successful receipt of this command the TFCS shall respond with a nominal Successful Command Acceptance Report (Service 1,1) followed by a Link Connection Report (Service 17,2).

						APID1									
						Count									
						Length = 5									
							0	0	0	1	0	0	0	1	
0	0	0	0	0	0	0	1								
						Checksum									

5. TFCS TELEMETRY PACKETS

This section defines all the TM packets that will be produced by the TFCS.

5.1 Telemetry Packet Types

The Packet Structure ICD (AD1) defines many types of service that can be provided by an Application. The following table shows the telemetry packet types that will be produced by the TFCS:

Description	Service Type	Service Sub-Type	Comments
Telecommand Verification Service			
Telecommand Acceptance Report - Success	1	1	
Telecommand Acceptance Report - Failure	1	2	
Telecommand Execution Report - Failure	1	8	
Housekeeping and Diagnostic Data Reporting			
Housekeeping Parameter Report	3	25	
Event Reporting			
Event Report	5	1	
Error/Alarm Report	5	4	
Time Management			
Time Verification Report	9	9	
Test Service			
Link Connection Report	17	2	

5.2 TC Verification Packets

5.2.1 Telecommand Acceptance Report - Success

```
0 0 0 0 0 1 1 1 1 1 1 0 1 0 0
1 1         Count
0 0 0 0 0 0 0 0 0 0 0 1 1 1 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

         TIME

0 0 0 0 1 1 1 1 1 1 1 1 0 0 0
1 1    TC Packet Count
     Checksum
```

5.2.2 Telecommand Acceptance Report - Failure

The structure of this packet depends on the type of error found.

```
0 0 0 0 0 1 1 1 1 1 1 0 1 0 0
1 1         Count
0 0 0 0 0 0 0 0 0 0 1 0 0 0 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

         TIME

0 0 0 0 1 1 1 1 1 1 1 1 0 0 0
1 1    TC Packet Count
     Failure Code
   Params (n*16bits)
     Checksum
```

Error	Code	Parameter
Illegal Packet Type	3	Type
Illegal Packet Sub-Type	4	Sub-Type

```
0 0 0 0 0 1 1 1 1 1 1 0 1 0 0
1 1         Count
0 0 0 0 0 0 0 0 0 0 1 0 0 1 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

         TIME

0 0 0 0 1 1 1 1 1 1 1 1 0 0 0
1 1    TC Packet Count
0 0 0 0 0 0 0    Code
```

Error	Code	Parameter
Illegal APID	0	APID
Incomplete Packet or invalid Length	1	Length
Incorrect Checksum	2	Checksum

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Parameter
Checksum

```
0 0 0 0 0 1 1 1 1 1 1 0 1 0 0
1 1        Count
         Length
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

         TIME

0 0 0 0 1 1 1 1 1 1 1 1 0 0 0
1 1    TC Packet Count
0 0 0 0 0 0 0      Code

       Parameters

        Checksum
```

Error	Code	Parameters
Illegal or inconsistant Application Data	16	See Note
Illegal TFCS Subsystem	17	See Note
Other TBD TFCS errors	18-255	See Note

Note: The parameters for each TBD error are TBD, but as a suggestion this field should contain the first 20 words from the 'source data' field of the received telecommand packet, unless this field is less than 20 words in length, in which case all words from the 'source data' field will be included.

5.2.3 Telecommand Execution Report - Failure

The structure of this packet depends on the type of error found and are currently TBD, but the Telemetry packet will take the following form.

```
0 0 0 0 0 1 1 1 1 1 1 0 1 0 0
1 1        Count
         Length
0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

         TIME

0 0 0 0 1 1 1 1 1 1 1 1 0 0 0
1 1    TC Packet Count
0 0 0 0 0 0 0      Code

       Parameters

        Checksum
```

5.3 Housekeeping Packets

5.3.1 Housekeeping Parameter Report

Each TFCS packet type is allocated a single Structure ID (SID) which is used to identify the source and contents of the housekeeping packet. The number of parameters, and hence the length of the packet depends on the SID.
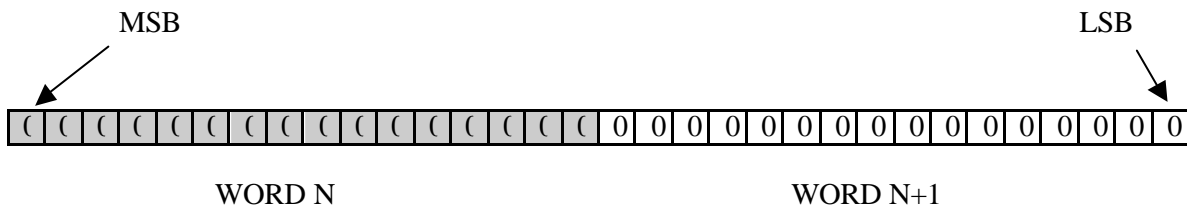
5.3.1.1 TFCS Telemetry Packets

0	0	0	0	0	1	1	1	1	1	1	0	1	0	0
1	1				Count									
					Length									
0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	1	1	0	0	1	0	0	0	0	0	0	0

TIME

SID

Parameters

Checksum
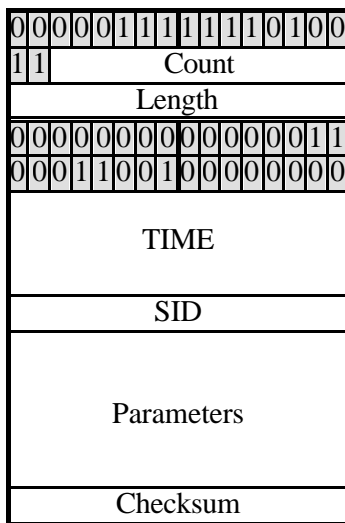
Subsystem	**SID**
TFCS	0x100

The data field in the cryostat telemetry packet is broken down in the following way. The dat atypes are indicated in the table. REAL values are converted to a 32 bit binary (Packet Type Code 5, Packet Format Code 1) in accordance with AD1 Section A6.3.5.

The data field is a fixed length of 300 words. All parameters are always sent. If data is not available for a particular parameter, the data field will be set to the value of the data word count to indicate invalid data.

The parameters are broken down into 2 consecutive 16 bit words:

MSB   LSB

| C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

WORD N   WORD N+1

Data field definition:

Location (Octet)	Parameter Description	Parameter type

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0	SID	Integer (U32)
2	OBSID	Integer (U32)
6	BBID	Integer (U32)
10	Temperature Logging Enabled/Disabled	Boolean (True = Enabled)
11	Pressure Logging Enabled/Disabled	Boolean (True = Enabled)
12	Cryogen level logging Enabled/Disabled	Boolean (True = Enabled)
13	Cold Blackbody Logging Enabled/Disabled	Boolean (True = Enabled)
14	Pirani Gauge Pressure	Real
18	Full Range Gauge Pressure	Real
22	N2 Level	Real
26	He Level	Real
30	77K Shield Endcap 1 Temperature	Real
34	77K Shield Endcap 2 Temperature	Real
38	77K Shield Filter Flange Temperature	Real
42	10K Shield Inlet Pipe Temperature	Real
46	10K Shield Outlet Pipe Temperature	Real
50	10K Shield Endcap 1 Temperature	Real
54	10K Shield Endcap 2 Temperature	Real
58	10K Shield Cylinder End 1Temperature	Real
62	10K Shield Cylinder Centre Temperature	Real
66	10K Shield Cylinder End 2 Temperature	Real
70	10K Shield Filter Flange Temperature	Real
74	Vacuum Vessel Standoff 1 Temperature	Real
78	Vacuum Vessel Standoff 2 Temperature	Real
82	Vacuum Vessel Standoff 3 Temperature	Real
86	Vacuum Vessel Standoff 4 Temperature	Real
90	HOB Sim Phot JFET Enclosure Temperature	Real
94	HOB Sim Spec JFET Enclosure Temperature	Real
98	HOB Sim FPU Foot 1Interface Temperature	Real
102	HOB Sim FPU Foot 2 Interface Temperature	Real
106	HOB Sim FPU Foot 3 Interface Temperature	Real
110	HOB Sim Harness Sink - RF Filters Temperature	Real
114	HOB Sim Harness Sink - Phot JFET Temperature	Real
120	HOB Sim Harness Sink - Spec JFET Temperature	Real
122	4K Vessel Top Temperature	Real
126	4K Vessel Bottom Temperature	Real
130	4K FPU Level 1 Strap interface Temperature	Real
134	1.7K Vessel - Bottom Temperature	Real
138	1.7K FPU Box Strap interface Temperature	Real
142	1.7K FPU Pump Strap interface Temperature	Real
146	1.7K FPU Evap Strap interface Temperature	Real

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150	1.7K Vessel – Top Temperature	Real
154	Level 0 Interface 1 Set Point Temperature	Real
158	Level 0 Interface 1 Set Point Temperature	Real
162	Level 0 Interface 2 Set Point Temperature	Real
166	Level 0 Interface 2 Set Point Temperature	Real
170	10K Shield Set Point Temperature	Real
174	HOB Simulator Heater Temperature	Real
178	Level 0 Heater 1 Power	Real
182	Level 0 Heater 2 Power	Real
186	Level 0 Heater 3 Power	Real
190	Level 1 Heater Power	Real
194	10K Shield Heater Power	Real
198	HOB Simulator Heater Power	Real
202	Fold Mirror 2 Commanded Azimuth	Integer (U32)
206	Fold Mirror 2 Measured Azimuth	Integer (U32)
210	Fold Mirror 2 Commanded Elevation	Integer (U32)
214	Fold Mirror 2 Measured Elevation	Integer (U32)
218	Fold Mirror 3 Commanded Azimuth	Integer (U32)
222	Fold Mirror 3 Measured Azimuth	Integer (U32)
226	Fold Mirror 3 Commanded Elevation	Integer (U32)
230	Fold Mirror 3 Measured Elevation	Integer (U32)
234	Translation Stage Commanded Position	Integer (U32)
238	Translation Stage Measured Position	Integer (U32)
242	Flip Mirror Status	Boolean (True = Closed)
246	Heat Shunt Status	Boolean (True = Active?)
250	Cold Blackbody Temperature 1	Real
254	Cold Blackbody Temperature 2	Real
258	Cold Blackbody Temperature 3	Real
262	Cold Blackbody Heater Power	Real
266 - 299	Spare	

5.3.2 Error/Alarm Report

Each subsystem within the TFCS is allocated a single Structure ID (SID) which is used to identify the source of the alarm. The number of parameters, and hence the length of the packet depends on the subsystem.

0	0	0	0	1	1	1	1	1	1	1	0	1	0	0
1	1		Count											
			Length											
0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Subsystem	SID
TFCS	0
Telescope Simulator	1
FTS	2
Beam Monitor	3
FIR Laser	4
Cold BB	5
Cryostat	6

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TIME
SID
Parameters
Checksum

5.4 Time Management Packets

5.4.1 Time Verification Report

0	0	0	0	1	1	1	1	1	1	1	1	0	1	0	0			
1	1			Count														
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1			
0	0	0	0	0	0	0	0	0	0	0	1	0	0	1				
0	0	0	1	0	0	1	0	0	0	0	0	0	0					

TIME
Local Time
Checksum

5.5 Link Connection Report (17,2)

0	0	0	0	1	1	1	1	1	1	1	1	0	1	0	0		
1	1			Count													
0	0	0	0	0	0	0	0	0	0	0	1	0	1	1			
0	0	0	0	0	0	0	0	0	1	0	0	0	1				
0	0	0	0	0	1	0	0	0	0	0	0	0					

TIME
Checksum

5.6 Supplementary Temperature Monitoring System.

In addition to the TFCS Temperature Monitoring system, there is another temperature monitoring program on the TFCS PC to monitor the 24 extra sensors required during CQM testing. It takes data from 3 additional LakeShore units and displays and logs it in the same way as the TFCS system. Data

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logged by the supplementary temperature monitoring system may be viewed through the TFCS 'Playback' facility.
The data log files created by the TFCS system have names derived from the time and date that the file was created, i.e.:

yymmdd_hhmm.tfc (e.g: 030712_0900.tfc)

Log files created by the supplementary temperature system are named in a slightly different way:

yymmdd_hhmm_T2.tfc (e.g: 030712_0900_T2.tfc)

As with the TFCS system, these extra files log data for 60 minutes before a new file is created.

5.6.1 Supplementary Temperature Monitoring System Logfile structure.

Every 15 seconds the system logs the temperature values to a binary data file of the format:

No. of records
Time stamp
Sensor 1 value
Sensor 2 value
…
Sensor 24 value
Timestamp
Sensor 1 value
Sensor 2 value
…
Sensor 24 value

5.7 Telescope Simulator Global Variables.

Name	Description	Data type
Control	Assign control of Telescope Sim to Local or Remote Panel	Boolean
Motor On/Off	Turn motor on or off	Boolean
Home	Move actuators to HOME position	Boolean
EngYZ	Engage YZ Move button	Boolean
YPos	Y Position Input Box	Integer (U32)
ZPos	Z Position Input Box	Integer (U32)
AxisNum	Axis Number selection	Integer (U8)
InclAxis?	Include Axis? button	Boolean
CommInput	Command Input	String
EngComm	Engage Command button	Boolean
DispInp	Displacement input box	Integer (U32)
InclDisp?	Include Displacement? button	Boolean
ReqAxPos	Requested axes positions	Integer (U32)
ActAxPos	Actual axes positions	Integer (U32)
CodRet	Coding Returned (If command has requested a return)	String

Indicator	Indicator button to show which mode control is in (Local/Remote)	Boolean