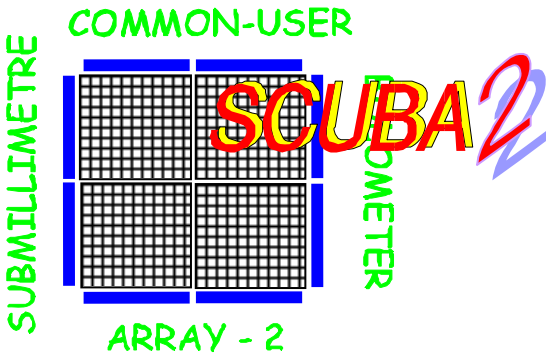

SCUBA-2 FTS Project Office
University of Lethbridge
Physics Department
4401 University Drive
Lethbridge, Alberta
CANADA
T1K 3M4

Tel: 1-403-329-2771
Fax: 1-403-329-2057
Email: brad.gom@uleth.ca
WWW: http://research.uleth.ca/scuba2/

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Document Prepared By:	Baoshe Zhang FTS-2 Software Engineer	Signature and Date:	02/11/06
Document Approved By:	D. A. Naylor FTS-2 Project Lead	Signature and Date:	02/11/06
Document Released By:	J. Molnar Canadian Project Manager	Signature and Date:	02/11/06

Change Record

Issue	Date	Section(s) Affected	Description of Change / Change Request Reference / Remarks
0.1	04/10/04	All	First draft
0.2	13/05/05	All	Revision after restaffing
1.0	20/06/05	All	PDR version
2.0	1/11/06	All	CDR version. No major changes
2.1	2/11/06	5	Updated CONFIGURE XML file

Contents

1. Introduction

1.1. Interface definition

This document defines the interfaces between the JAC Observatory Control System (OCS) and the Fourier Transform Spectrometer (FTS-2) for the SCUBA-2 instrument. The FTS-2 task is a JIT task and conforms to http://www.jach.hawaii.edu/JACdocs/JCMT/OCS/ICD/009/jit.pdf. FTS-2 will also be an RTS DRAMA client. These actions are discussed in detail in the following sections.

1.2. Acronyms and Abbreviations

CFI	-	Canadian Foundation for Innovation
EMI	-	Electromagnetic Interference
FTS	-	Fourier Transform Spectrometer
ICD	-	Interface Control Document
JAC	-	Joint Astronomy Centre
JCMT	-	James Clerk Maxwell Telescope
JOS	-	JCMT Observation Sequencer
OPD	-	Optical Path Difference
OT	-	Observation Template
PC	-	Personal Computer
RTS	-	Real Time Sequencer
SCUBA	-	Submillimetre Common User Bolometer Array
U of L	-	University of Lethbridge
UBC	-	University of British Columbia
UKATC	-	UK Astronomy Technology Centre
ZPD	-	Zero Path Difference

1.3. Applicable and Referenced Documents

Document Number	***Title***	***Number & Issue***
SC2/FTS/SRE/001	FTS-2 Requirements Document	Version 3.0
SCS/FTS/SYS/005	FTS-2 to RTS ICD	Version 2.0
OCS/ICD/009	JAC Instrumentation Task (JIT) Library	

2. Overview

2.1. JOS to FTS-2

The JOS will command FTS-2 with DRAMA obeys. This breaks up into observing actions and housekeeping actions.

Observing Actions

- INITIALIZE - Power up; Connect and initialise Aerotech motor controller
- CONFIGURE - Set scan mode type, scan velocity and scan length or step size and # of steps
- SETUP_SEQUENCE - Start mirror motion or move to first position depending on scan mode
- SEQUENCE - Run an RTS sequence
- EXIT - Exit the FTS-2 task
- END_OBSERVATION - Stop everything and get ready to accept further command

Housekeeping Actions

- LOAD_AEROTECH - Load any macros into the Aerotech motor controllers flash memory.
- INIT_AEROTECH - Load any constants such as motor acceleration, etc., into the Aerotech volatile memory.
- DATUM - Bring the FTS-2 mirror to DATUM.
- HELP - Print DRAMA task help information.
- DEBUG - Set/Clear DEBUG mode.
- REPORT - Take a snap-shot of the current state.
- TEST - Perform a system self test.

Other DRAMA commands

- "kick" of SEQUENCE - Abort the RTS sequence and prepare for a new SEQUENCE

2.2. Translator to FTS-2

The translator prepares an XML file supplying the static parameters for the CONFIGURE action at the start of an observation, based on the description of the observation prepared in the OT.

2.3. RTS to FTS-2

The RTS synchronizes high-speed operations amongst the subsystems participating in a data collecting sequence. FTS-2 is a fully compatible RTS client.

2.4. FTS-2 to SCUBA-2 DR

At every step in an RTS sequence, FTS-2 updates a DRAMA SDS STATE structure which contains configuration information and a sequence step number.

2.5. FTS-2 to JOS

FTS-2 sends error and warning messages to the JOS. This is tagged with a sequence step number that is to be included in the data header for the observation.

3. JOS to FTS-2 – Observing Actions

3.1. INITIALISE

Arguments:

- INITIALISE → Name of INITIALISE XML file.
- SIMULATE → NONE=0, MIRROR=1 default=NONE

Purpose:

Bring FTS-2 into a known passive state. This will establish any paths with other tasks and hardware. The FTS-2 task will call INIT_AEROTECH. This sets any constants for use during observing. Additionally, this will close and open the Aerotech communications port. FTS-2 will be left in a state waiting for commands.

Comments:

- Normally run once after the power is turned on to the Aerotech motor controller.
- This action will not be used during observing but will be used in the observatory start-up scripts.
- If the argument of SIMULATE is not passed to this action a value of 0 (NONE) will be used.
- In the INITIALIZE action the FTS-2 task will read in any initial constants and values from an initialization XML file. This file name is defined in the start-up script.

3.2. CONFIGURE

Arguments:

- CONFIGURE → The name of the configure XML file

Purpose:

Configure FTS-2 for the appropriate observing mode.

Comments:

- CONFIGURE is run at the start of every observing recipe to configure FTS-2
- See CONFIGURE XML section for various configurations.
- There are 2 possible observing modes for FTS-2. The specific mode used depends on the XML received in the CONFIGURE action. These modes are defined in an XML element called FTS_MODE and is either RAPID_SCAN (mode 0) or STEP_AND_INTEGRATE (mode 1).
    (a) RAPID_SCAN mode configures FTS-2 to use a given scan rate in millimetres/second and scan length in millimetres.

(b) STEP_AND_INTEGRATE mode configures FTS-2 to use a given step size and number of steps per scan.

- There is an attribute called MOTION to describe how the mirror is moved in STEP_AND_INTEGRATE mode.
  (a) CONTINUOUS - Position is updated continuously. RTS will hold off integrations while the mirror is moving.
  (b) DISCRETE - Position is updated only between SEQUENCE actions.
  (c) GROUP – (TBD) Position is updated only when the GROUP number changes.
  (d) ONCE - Position updated in the CONFIGURE action.
- For mode 0, or RAPID_SCAN mode, start the mirror motion at FTS_SPD millimetres per second.
- For mode 1, or STEP_AND_INTEGRATE mode, move the mirror to the home location.

3.3. SETUP_SEQUENCE

Arguments:

- GROUP → (TBD) The GROUP number is given and used for STEP_AND_INTEGRATE mode with MOTION set to GROUP. Otherwise, this value is ignored.

Purpose:

For mode 1, or STEP_AND_INTEGRATE mode, move the mirror STEPS_PER_SCAN steps from the home position to the starting position. The completion of all the SETUP_SEQUENCE actions is a major synchronization point just before handing control to the RTS for data taking.

Return Values:

The return value of MULT depends on the FTS-2 mode. (The return value of MULT should be STEPS_PER_INTEGRATION,
See also: http://docs.jach.hawaii.edu/JCMT/OCS/ICD/009/jit.pdf.)

- Mode 0 (RAPID_SCAN): Nothing returned.
- Mode 1 (STEP_AND_INTEGRATE): If MOTION set to CONTINUOUS then return the number of integrations N = STEPS_PER_SCAN in a complete scan. If MOTION set to anything other than CONTINUOUS, return 0.

Comments:

- The mirror always starts from the home position.

3.4. SEQUENCE

Arguments:

- START
- END
- DWELL (not used in SCUBA-2, see SC2/SOF/S200/033)

Purpose:

If mode is STEP_AND_INTEGRATE and MOTION is CONTINUOUS, runs the RTS sequence starting at the START sequence number and ending at the END sequence number. The RTS will handshake with FTS-2 hardware which will allow it to move the mirror to position before the next integration.

Comments:

- A SEQUENCE action can be ended with a kick that will cause it to exit immediately with a failure code.
- During a sequence the following flags are used to keep track of the mirror state:
  1. POS_INDEX An index that counts from 0 to N in a complete scan. After one scan it starts at 0 again.
  2. LAST_SCAN A last scan flag: this gets set to 1 at the start of the last scan prior to the telescope beam moving.

3.5. END_OBSERVATION

Purpose:

Place FTS-2 in a safe mode. Stop the mirror, move to home location, download the position values of the mirror from Soloist, and wait for further commands.

Comments:

- Stops mirror motion and returns to the home location.
- Invalidates CONFIGURE, but not INITIALISE.

3.6. EXIT

Purpose:

Place FTS-2 in safe mode and exit.

Comments:

Similar to the END_OBSERVATION only this completely exits the FTS-2 task, hence the control crate will need to be rebooted. This is usually called when there is a severe OCS system error and all subsystems have to be power-cycled.

4. JOS to FTS-2 – Houskeeping Actions

4.1. LOAD_Aerotech

Purpose:

Load any macros into the Aerotech motor controllers flash memory.

4.2. INIT_Aerotech

Purpose:

Load any constants such as motor acceleration, velocity, etc., into the Aerotech volatile memory.

Comments:

The port to the Aerotech controller will always be closed first and then opened. This is to ensure the port is always reset even if the port is currently in an open state. If the port is in a closed state an attempt to close the port will not return a fatal error.

4.3. Home

Purpose:

Bring the FTS-2 mirror to the HOME position.

4.4. HELP

Purpose:

Print DRAMA task help information

Comments:

Returns the preformatted block of text containing help on the DRAMA actions and the arguments that are defined for the task.

4.5. DEBUG

Purpose:

Set/clear debug mode.

Comments:

1. The single DRAMA argument of type integer must have one of the values:
    - 0: Set debug mode OFF
    - N: Set the bit mask of the debug mode. Only prints debug messages with levels that when AND-ed with N equals 0.
2. Sets an SDS parameter with the name “DEBUG” to the input value N.

4.6. REPORT

Purpose:

Generate a simple report on the current state of the program. Report goes to standard output.

Arguments:

- Level → The level of the report to produce.
    1. Monitor information

2. Include SDS parameter information.
3. Include SDS parameter information in (XML format).

4.7. TEST

Purpose:

Perform simple system tests.

Arguments:

- Mode → SCAN test or just a discrete MOVE test.
  1. SCAN will be given a scan speed (mm/sec) and distance (mm).
  2. MOVE will be given a OPD position in mm.

5. FTS-2 CONFIGURE XML

```
<?xml version="1.0" standalone="no"?>
<!--
This is the definition of FTS-2 configuration that is used for defining the FTS motion
during an observation. Converted from the ROVER configuration written by Mathew Rippa.

Author: Baoshe Zhang
-->

<!--=================================================================-->
<!-- The FTS_CONFIG element is for controlling the position and scanning rate
       of the FTS-2 moving mirror(s).  -->
<!-- The MOTION attribute reflects how it is scanned in STEP_AND_INTEGRATE mode
       and it has the following meanings:

       CONTINUOUS - Position is updated continuously at each step of the sequence.

       DISCRETE - Position is updated only in SETUP_SEQUENCE action.

       GROUP - Position updated when the GROUP SETUP_SEQUENCE parameter changes.

       ONCE - Position is set to zero and left there.

       NONE - FTS-2 position is never updated. -->

<!-- ELEMENT FTS_CONFIG (SCAN_MODE FTS_SCAN) -->

<!-- ATTLIST VALUE (RAPID_SCAN | STEP_AND_INTEGRATE) -->
<!-- ELEMENT FTS_SCAN ( FTS_SCAN_DELAY?, SCAN_ORIGIN?, FTS_SPD?, FTS_SCAN_LENGTH?,
       STEPS_PER_SCAN?, FTS_STEP_SIZE?, INTEGRATE_TIME? ) -->

<!-- ATTLIST FTS_SCAN NAME (RAPID_SCAN | STEP_AND_INTEGRATE ) "RAPID_SCAN"
       MOTION ( CONTINUOUS | DISCRETE | GROUP | ONCE | NONE ) "DISCRETE" -->
<!-- ELEMENT FTS_SCAN_DELAY  (#PCDATA) -->
<!-- SCAN_ORIGIN (#PCDATA) -->
<!-- ELEMENT FTS_SPD (#PCDATA) -->
<!-- ELEMENT FTS_SCAN_LENGTH (#PCDATA) -->
<!-- ELEMENT STEPS_PER_SCAN (#PCDATA) -->
<!-- ELEMENT FTS_STEP_SIZE (#PCDATA) -->
<!-- ELEMENT INTEGRATE_TIME (#PCDATA) -->

<!-- The FTS_SCAN mode can have the attribute of either "RAPID_SCAN",
     where FTS-2 will SCAN at FTS_SPD millimetres/second for FTS_SCAN_LENGTH
     millimetres, or "STEP_AND_INTEGRATE" where FTS-2 will start at a position of
     zero and then step FTS_STEP_SIZE millimetres FTS_STEPS_PER_SCAN times
```

```
     in the positive each time motion is required by the MOTION attribute -->

<!--Here is some example XML: Test file for proposed JCMT FTS-2 control. -->

<FTS_CONFIG>
        <!-- Set the scanning mode.
             When VALUE="RAPID_SCAN", choose the scanning parameters from FTS_SCAN
             with NAME="RAPID_SCAN".
             When VALUE="STEP_AND_INTEGRATE", choose scanning parameters from
             FTS_SCAN with NAME="STEP_AND_INTEGRATE". -->

        <SCAN_MODE VALUE="RAPID_SCAN" />

       <!-- Set up for RAPID_SCAN scanning at 10 millimetres per second
              for 200 millimetres starting from the position of 30 millimeters -->
        <!-- In order to make the stage motion stable, start RTS sequence 3
             milliseconds after the stage starts to move.  -->
        <!-- Do not change the value of attributes 'unit' and 'type' -->
       <FTS_SCAN NAME="RAPID_SCAN" MOTION="ONCE">
                <FTS_SCAN_DELAY unit="millisecond" type="int">3</FTS_SCAN_DELAY>
                <SCAN_ORIGIN unit="mm" type="float">30</SCAN_ORIGIN>
             <FTS_SPD unit="mm/sec" type="float">10</FTS_SPD>
             <FTS_SCAN_LENGTH unit="mm" type="float">200.0</FTS_SCAN_LENGTH>
       </FTS_SCAN>

        <!-- Set up an SI scanning with 100 0.1mm-long steps starting from the
             position of 100mm. The integration time is 0.2 second. The scanning
             speed is 10mm/second. -->
       <FTS_SCAN NAME="STEP_AND_INTEGRATE" MOTION="CONTINUOUS">
                <SCAN_ORIGIN unit="mm" type="float">100</SCAN_ORIGIN>
             <STEPS_PER_SCAN type="int">100</STEPS_PER_SCAN>
                <FTS_SPD unit="mm/sec" type="float">10</FTS_SPD>
             <FTS_STEP_SIZE unit="mm" type="float">0.1</FTS_STEP_SIZE>
                <INTEGRATE_TIME unit="second" type="float">0.2</INTEGRATE_TIME>
       </FTS_SCAN>
</FTS_CONFIG>
```

6. FTS-2 STATE Structure

Parameter Name	Description	Type
NUMBER	The RTS step number	int
OPD	The optical path difference position of the interferometer.	float
POS_INDEX	An index that counts from 0 to N-1 in a complete scan. After the scan it starts at 0 again.	int
SCAN_DIR	The direction of the current scan for the rapid-scan mode. 0 = up, 1 = down.	int
LAST_SCAN	A last scan flag. This gets set to 1 at the start of the last scan prior to the telescope beam moving.	int