

**TEST FACILITY FTS
END ITEM DATA PACK**

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	2	Transportation, Packing, Handling & Integration Procedures	✓	
	3	Certificate of Conformance / Delivery Review Board MoM	✓	
	4	List of Waivers	n/a	There was no DDR.
	5	Copies of Waivers	n/a	There was no DDR.
	6	List of Non-Conformance Reports	n/a	There was no DDR.
	7	Copies of Non-Conformance Reports	n/a	There was no DDR.
	8	Open Work, Deferred Work, Open Tests	✓	
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	24	Software Requirements Document (SRD) & Architectural Design Document (ADD)	✓	
	25	Calibration Data	n/a	Not necessary.
	26	Algorithms (Tech Note)	n/a	No complex algorithms involved.
	27	Timing Budget	n/a	This is a NRT system.
PA	28	Reference List of EIDP's (Associated / Lower Level)	n/a	It's all in here.
	29	Other Useful Information	✓	
	Indicates documentation supplied	✓	All sections should be accounted for.	
	Indicates documentation Not supplied	x		
	Indicates section Not Applicable.	N/A		

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PRODUCT ASSURANCE

1 Shipping Documents

Not yet available.

2 Transportation, Packing, Handling & Integration Procedures

The optical instrument is shipped in a sturdy, custom-made crate with protective foam padding. The crate should be handled with care adequate for a sensitive optical instrument. As indicated by signs on the crate, it should always be standing up. Beamsplitter and mirrors are not in position during travel and will have to be inserted after arrival¹.

The lid of the crate can be lifted after the two latches have been opened. The latches are not locked even though keys exist. The instrument can be lifted from the crate using the supplied nylon straps that support the instrument from below the optical breadboard. The instrument should **never** be lifted from the steel frame that supports the plastic glass housing. The shipping crate will also contain all the electronics necessary to operate the FTS: clock counter board, break-out box, and the weather station.

The optical system must be aligned, the electronics initialized, and the software installed before the instrument can be used. These steps need to be done by trained personnel. The installation procedure for the software is detailed in the user manual. Other components of the system - a DELL PC and the Unidex 500 controller - will be shipped separately.

3 Certificate of Conformance / Delivery Review Board MoM

On arrival, the Test Facility FTS should be inspected to check for

- damage of the plastic housing (dents or cracks).
- upright placement of the mirror mounts on the optical breadboard.
- completeness of optical parts. There should be four flat mirrors, one parabolic mirror, one beamsplitter, and two irises.

It is recommended that personnel from the University of Lethbridge perform the initial inspection.

4 List of Waivers

n/a

5 Copies of Waivers

n/a

¹ Even though a black body (type Pegasus R, Model 970 from Isothermal Technology) will be supplied by RAL for long-term operation of the FTS, the equivalent black body will be shipped from Canada to RAL for the verification. A 1kW transformer will be supplied by RAL for the verification.

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6 *List of Non-Conformance Reports*

n/a

7 *Copies of Non-Conformance Reports*

n/a

8 *Open Work, Deferred Work, Open Tests*

After delivery to RAL, the functionality and performance of the Test Facility FTS needs to be verified. The verification should be performed by trained staff, preferably from the University of Lethbridge.

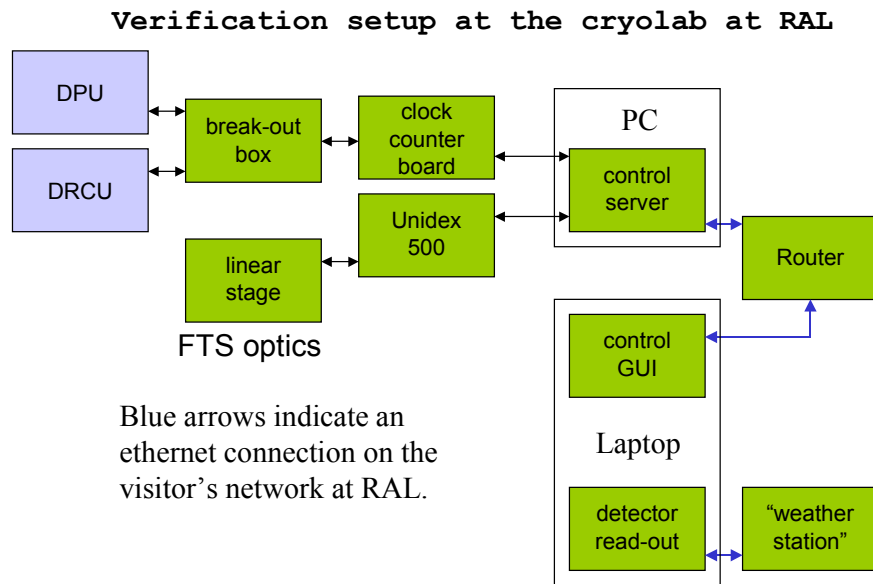


Figure 1: Overview of the setup for the verification procedure

The verification procedure consists of the assembly of the test system, the alignment of the optical components, and eventually verification measurements with the integrated system.

Items that will be located in the clean area need to be cleaned before assembly. RAL will provide support for the cleaning. The following items will go into the clean area:

- FTS (includes cabling to control room)
- Break-out box (includes cabling to control room)
- Weather station (includes cabling to control room)
- IR-detector (includes cabling)
- Transfer tube
- Black body (and transformer as necessary)

The following items will go into the control room:

- A DELL Optiplex GX260 which serves as control server

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the UoL and RAL. The break-out box runs on 9V batteries. Connect the break-out box with the clock counter board in the control room.

- Place the weather station inside the clean room so that the humidity and temperature can be measured inside the FTS encasing. Connect the weather station to an ethernet connection on the visitor's network (MAC = 13 CF 95 7E 5F 1B). It operates on 220 VAC supplied by a UK style socket.

Prepare the **computer systems** necessary for the verification:

- Connect the control server (MAC = 00 08 74 20 D6 6C) to the visitor's network. All necessary software is already installed.
- Connect the verification laptop to the visitor's network (MAC =). All necessary software is already installed. The EGSE router will run on this laptop as well as the control GUI and the detector read-out software.
- Place a DOS box, supplied by RAL², into the control room and connect it to the clock counter via the parallel port.

Alignment procedure for the optical system

1. Adjust height tool at the height of the axis of the beam splitter (~122 mm)
2. With the height tool, adjust the height of the 5 mirrors mounts (mark on the side of each mount)
3. With the height tool, adjust also the beam of the alignment laser (height and horizontality)
4. Use the BS with the pinhole in the middle. Place the laser between BD and M2. Align it on the axis of the translation stage (red mark and the bench + pinhole in the BS). Adjust MM in tilt to have the reflected beam going back on itself.
5. Place the other BS (no hole in the middle) and repeat step 4 for MF.
Assumption: the BS mount has already been adjusted (vertical and at 45°)
Put an object before the BS (source point) and look at its two images given by FM and MM (remove M2 for that). They should overlap properly.
6. Send the laser beam from the focus of M1 to its centre
7. Replace M2, centred it on the axis of the translation stage (red mark on the bench).
8. Tilt M1 to reflect the beam in the centre of M2. Tilt M2 to have the laser reflected back on itself.
9. Put the parabola (M3) in the path of the beam. Make sure it reflects the light at 90°.
10. Place an object at the focus of M1 (white light point source) and look at its image at the focus of the parabola. Place the black body at the location of this image.

Verification of the integrated system

Electronics:

² As agreed in the teleconference of May 6, 2003 or page one of SPIRE-RAL-MOM-001640.

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- Read data from the weather station and compare to reference data of the atmosphere.
- Issue reset commands from the verification laptop to test the reset functionality of the clock counter while taking a 'dry' scan with the FTS, i.e. without the detector. Check the position and time data from the FTS for linearity and the execution of the reset.

Optics:

- The detector cooled with liquid helium is placed at the output of the system (no chopper). The signal is optimized by adjusting the detector laterally. The MM scan from the top to 5 cm (ZPD is at ~ 3.5 cm), speed = $1\text{mm}\cdot\text{s}^{-1}$ – $5\text{mm}\cdot\text{s}^{-1}$; temperature of the black body: $500\text{ }^{\circ}\text{C}$ and $750\text{ }^{\circ}\text{C}$. A symmetrical interferogram (approximately six fringes on either side) should be visible on an oscilloscope.
- Adjustment: the black body can be moved closer to the parabola in order to find the optimal focus point inside the cavity.

HARDWARE

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9 *Historical Record*

DESCRIPTION OF ACTIVITY / EVENT	REMARKS/ REF. DOC.	DATE
Optical components are assembled under a plastic housing	Off-axis parabola is last item to arrive.	4 Apr 03
Prototype of the clock counter electronics is in use		25 Apr 03
The system yields an interferogram on a scope		9 May 03
Alignment of the optical components		5 Jun 03
The system yields an interferogram through the control software		5 Jun 03
Prototype of the break-out box is in use		11 Jun 03
SCOS-controlled tests of the Test Facility FTS at the University of Lethbridge from RAL	Basic tests to see whether remote testing is feasible.	13 Jun 03
Alignment of the black body and improvements of plastic housing		17 Jun 03
SCOS-controlled tests of the Test Facility FTS at the University of Lethbridge from RAL	Tests are mainly successful; a problem with telecommands that use free text is identified	26 Jun 03
The SPIRE beamsplitter from the Cardiff University is inserted into the Test Facility FTS.		27 Jun 03
SCOS-controlled tests of the Test Facility FTS at the University of Lethbridge from RAL.		7 Jul 03
The final clock counter board and break-out box are inserted into the test setup.		1 Aug 03
The complete system is operated while measurements are taken with a Helium-cooled detector.	With or without a 8" long cell of HCl gas.	6 Aug 03 - 15 Aug 03

13 Functional, Block & Mechanical Drawings

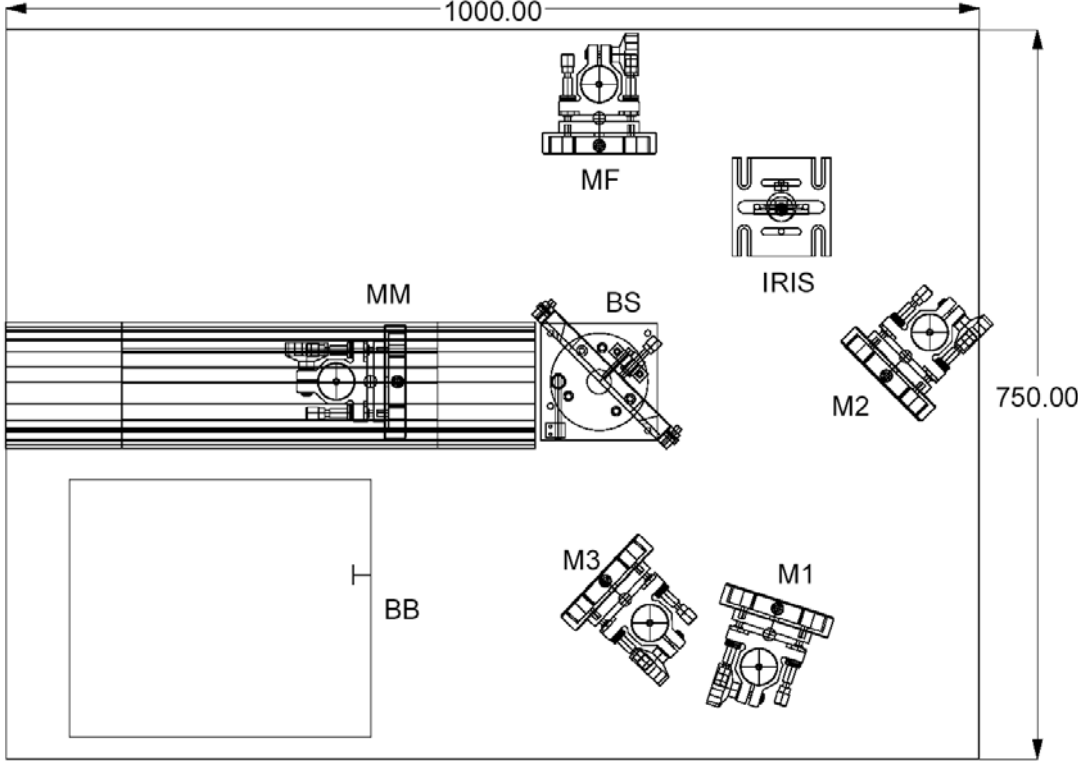


Figure 4: Layout of the optical system

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14 Electrical Circuit Drawings

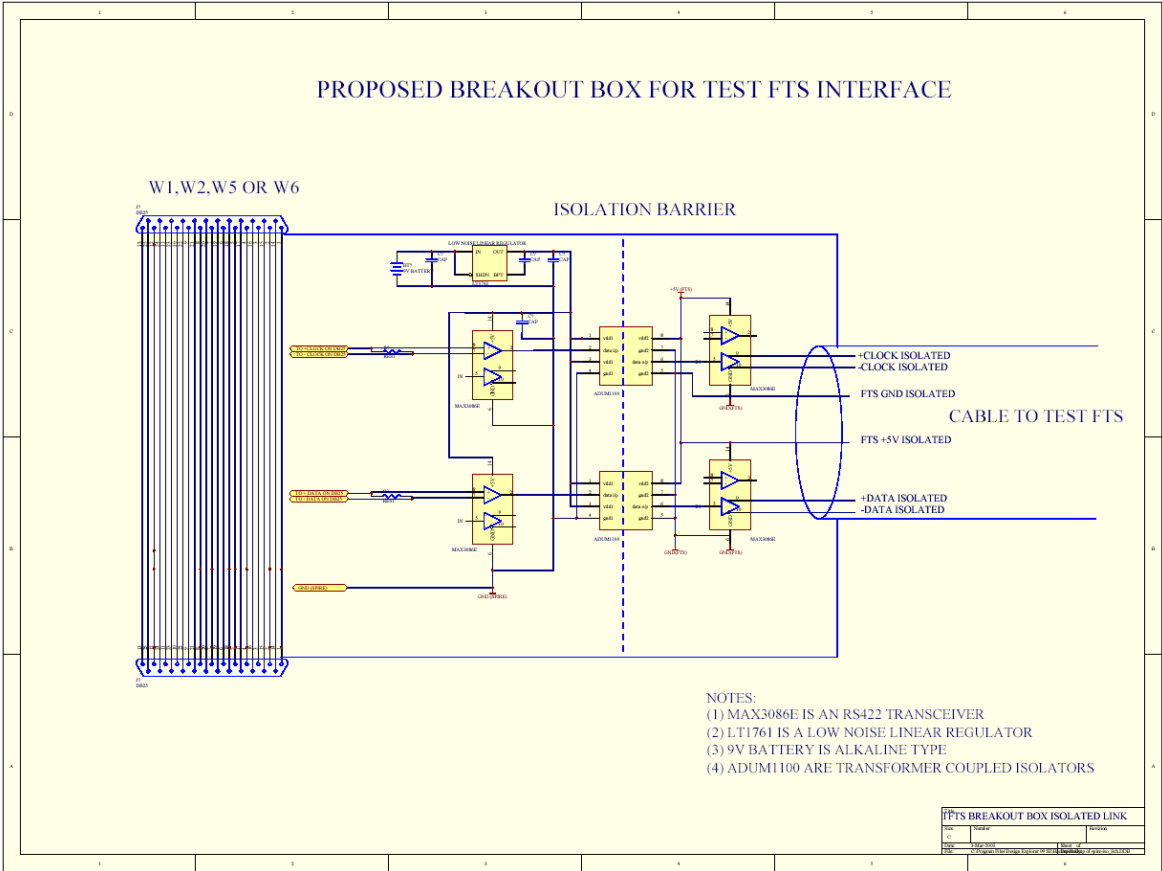


Figure 5: Break-out box

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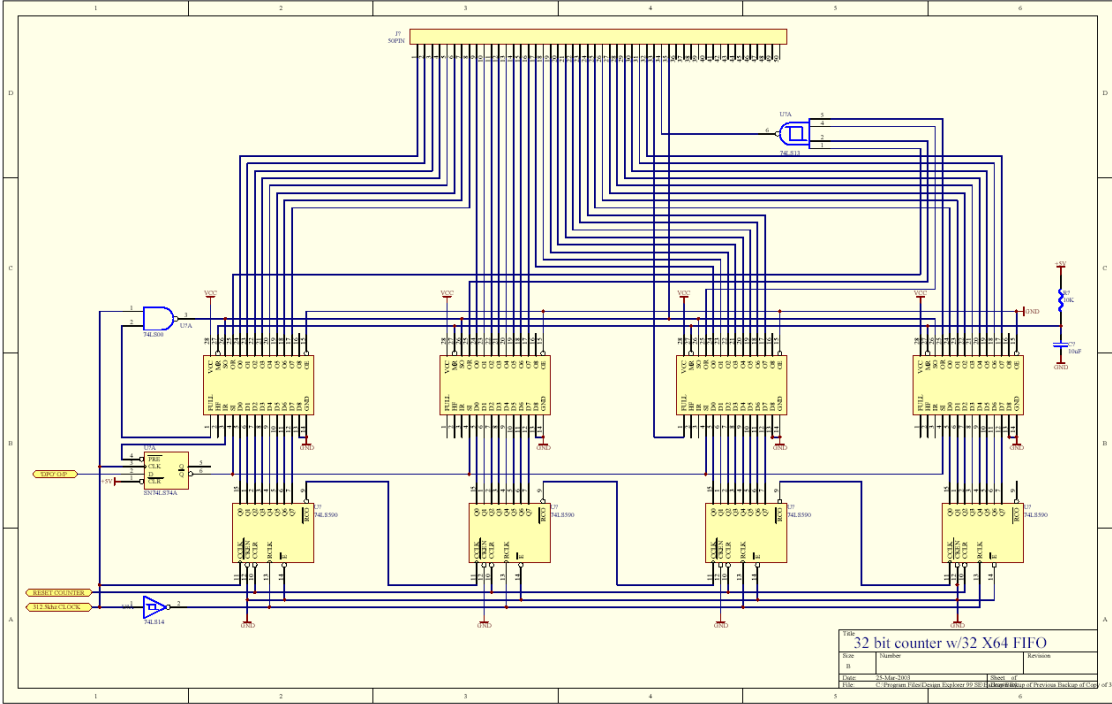


Figure 6: Clock signal counter

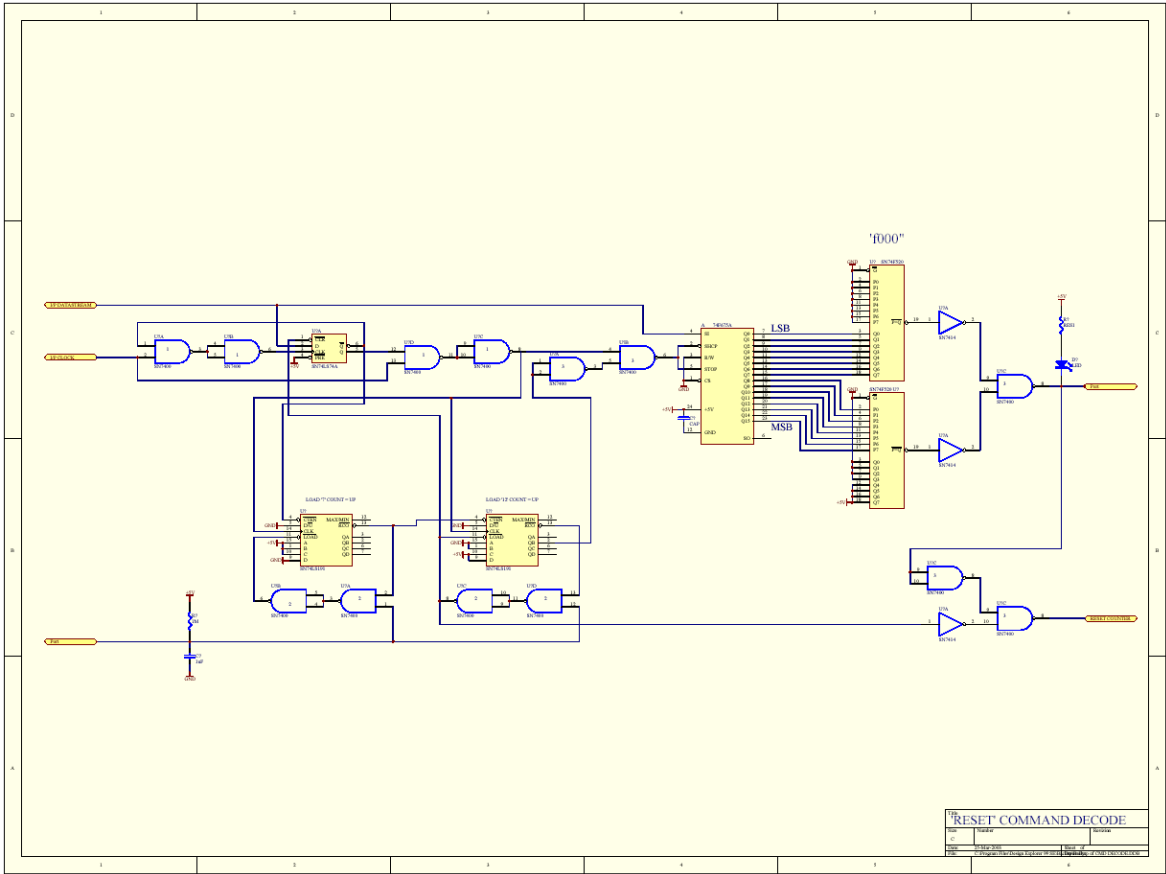


Figure 7: Reset command decoder

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15 Test Reports

Optics

In order to proof the performance of the FTS, a spectrum of HCl has been taken. Its absorption spectrum contains double lines as two stable isotopes of Chlorine (Chlorine-35 and Chlorine-37) can be responsible for the absorption. Two doublets can be observed with the Test Facility FTS. They are located at 20.8470 and 20.8784 cm^{-1} and 41.68125 and 41.74394 cm^{-1} , which translates into a difference of 0.0314 and 0.0627 cm^{-1} respectively. The FTS could resolve these doublets as the following data show:

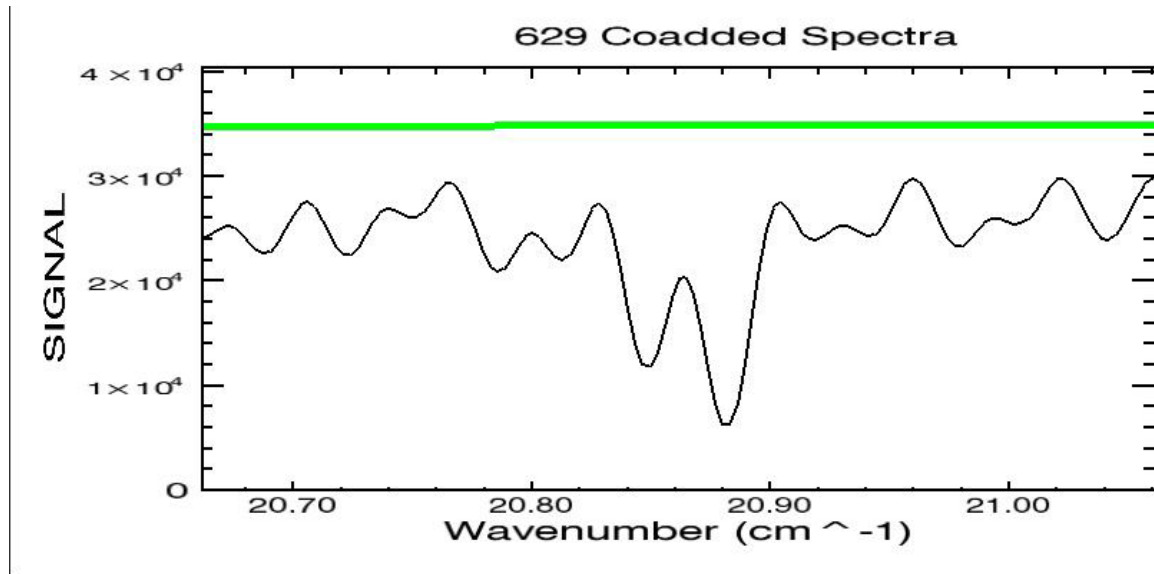


Figure 8: An HCl doublet at 20.85 cm^{-1}
measured spectrum in black, modelled spectrum of the atmosphere without HCl in green

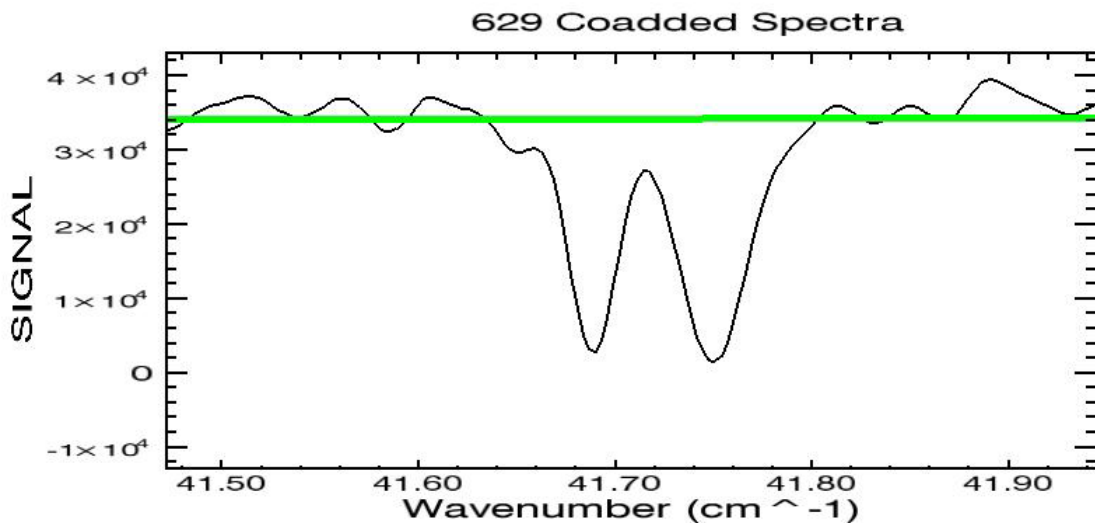


Figure 9: An HCl doublet at 41.71 cm^{-1}
measured spectrum in black, modelled spectrum of the atmosphere without HCl in green

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The full width at half maximum of the resolved lines corresponds to a resolving power of the FTS of 1043 and 1192 at 20.8 cm⁻¹ and 41.7 cm⁻¹ respectively. This matches the design requirement of a resolving power of at least 1000³.

For the following section please note that electronics tests are still under way and will be reported on delivery. The below sections defines what test results we will report.

Clock counter

The performance of the clock counter has been tested against increasing read-out frequency. It has been proven to be functional at a read-out rate of 750Hz (tbc), which is well above the required operating range of 100Hz, i.e. a stage speed of 1 mm/s at a sampling rate of 10 μ m.

The long-term stability of the clock counter has been monitored over a period of weeks. It has shown on average XXX glitches per hour of operation.

The execution of the reset command within one clock pulse or approximately 3 μ s has been tested and could be confirmed.

The reliability of the reset has been monitored over a period of 8 hours. YY% of all reset commands have been shown to be faulty.

Break-out box

The circuitry feeding the break-out box was simulated in order to verify its functionality. The circuitry was connected and verified to match the drawings. No unexpected short or open circuits were observed. Current and voltage measurements were done as indicated in Figure 10:

- A - Current drawn from 9 V source when fully loaded was measured to be 1.6 mA
- B - Positive clock output maximum current was measured to be $12.7 \pm 0.6 \mu$ A
- C - Negative clock output maximum current was measured to be $12.3 \pm 0.6 \mu$ A
- D - Positive Data output maximum current was measured to be $13 \pm 0.6 \mu$ A
- E - Negative Data output maximum current was measured to be $10 \pm 0.6 \mu$ A
- Maximum phase difference between input and output signals was measured to be 100 ns
- 30 mV drop upon loading was observed between no load and loaded conditions

³ Design requirement R6-1 on page 23 of SPIRE-RAL-PRJ-000463, v1.3.

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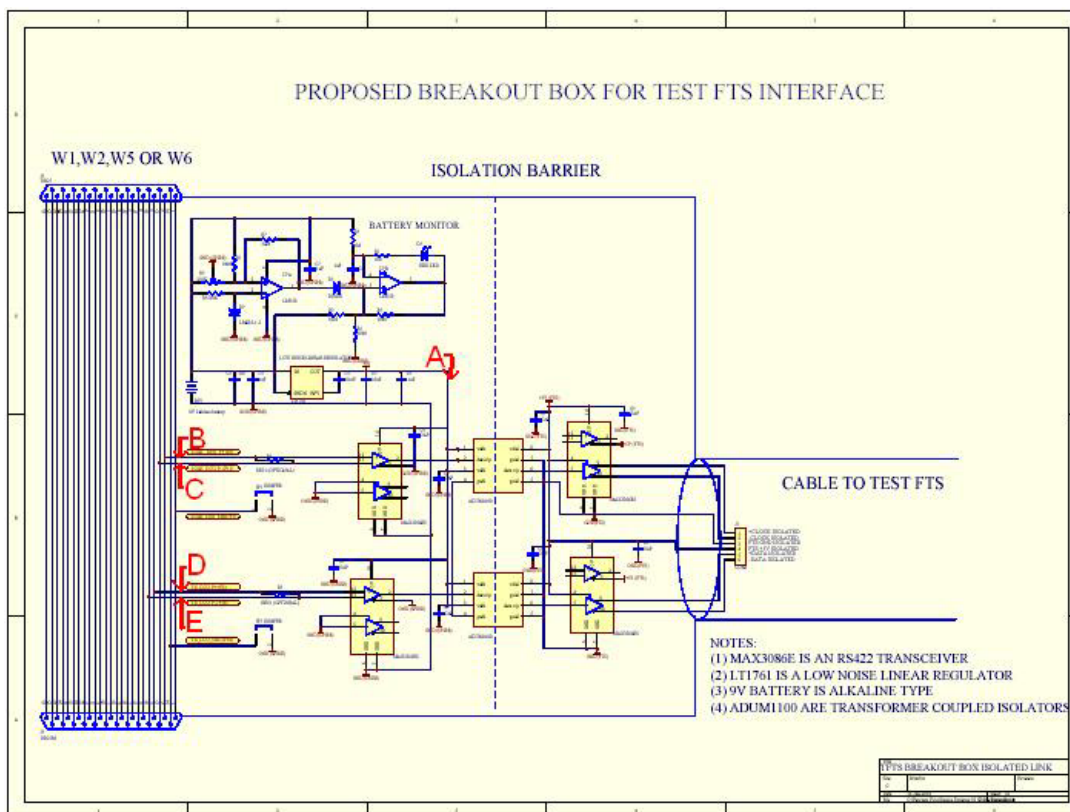


Figure 10: Test measurements for the break-out box

Over a period of ~ 40 hours, no clock pulses were missed on passing through the break-out box. The risk for the connection between the DPU and the DRCU can therefore be considered to be limited.

SOFTWARE

16 Historical Records and Software Inspection

All versions of the control server are available from the UoL upon request.

All versions of the control GUI are available from the UoL upon request.

17 Identification and Handling Procedures for Software Carriers

n/a

18 Software Configuration Status List

The control server is an application written in C. It has been developed under MS Visual C++ 6.0.

The control GUI is implemented in IDL[®]. It requires version 5.6 or higher.

The connection between the control server and the control GUI is established by the EGSE router which has been developed by the Herschel software development team.

The weather station is driven by an embedded processor and the software is stored on flash ROM. The TCP/IP protocol provides the interface to the weather station.

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19 Software User Manual

A user manual has been written for the control GUI. It is available as a separate document.

20 Software Development Plan (containing Test, Verification and Validation Planning)

See section 1.5 of document SPIRE-UOL-NOT-001554.

21 Software Test Procedures and Reports

Unit Testing

A variety of low level tests have been performed on both, the control server, and the control GUI. Problems have been identified and resolved by the respective developers and a summer student.

Integration Testing

The control server and the control GUI have been used over several months to operate the FTS at the UoL. All relevant operational procedures for the FTS have been performed during that time. Problems that occurred have been resolved and a reliable control system was available for several weeks at the end of the development period.

User Acceptance Tests

David Naylor has performed two formal User Acceptance Tests of the integrated control system. Suggested changes have been implemented.

Operational Readiness Tests

The software control system has been successfully integrated with the electronics and the optical system. This setup has been used to collect valid data (as reported in section 15).

22 Source Listings

All listings for the control server will be compressed and made available as a separate document. **Hardcopy?**

All listings for the control GUI will be compressed and made available as a separate document. **Hardcopy?**

23 Index of Directories and Files

Overview of 22

24 Software Requirements Document (SRD) & Architectural Design Document (ADD)

- See the SPIRE Test Facility Requirements Specification document SPIRE-RAL-PRJ-000463, section 4.7.1, R6-6 through R6-10 for basic requirements on the software.
- See the Test Facility FTS Data ICD (SPIRE-UoL-PRJ-001452) for the requirements for the control server.

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- See section 2 of the Technical Note on the Canadian contribution to software SPIRE development (SPIRE-UOL-NOT-001554) for requirements for the control GUI.

25 Calibration Data

n/a

26 Algorithms (Tech Note)

n/a

27 Timing Budget

n/a

PRODUCT ASSURANCE

28 Reference List of EIDP's (Associated / Lower Level)

n/a

29 Other Useful Information

Cleanliness

The instrument was assembled and kept in a regular university room with no further cleanliness precautions over a period of months. The temperature of this laboratory is controlled by a standard university air conditioning system. No special precautions concerning small particles were taken. The laboratory has no windows that can be opened. Dust has been accumulating visibly in the laboratory.