SRON HIFI	**HIFI System** **Interface Control Document**	**HIFI no.:** SRON-G/HIFI/SP/1999-001 **Inst. no.:** HIFI-Instrument **Issue:** 4.2 **Date:** 07-05-04 **Category:** 2

Subject: Interface Control Document

Prepared by:	A. Naber		date: 07-05-04
Checked by:	W. van Leeuwen	date:	07-05-04
Checked by:	H. Aarts		date:
Checked by:	A. Naber		date:
Agreed PA:	H. Jacobs		date:
Authorised by:	C.K. Wafelbakker		date:

Remark

All Sub-System managers are asked to check the contents of the sections that are applicable to them (see section 1.3 for overview). The applicable sign-off page is to be sent to HIFI project office by Facsimile or as a PDF file attached to an Email.

Distribution:

Project Team

DOCUMENT CHANGE RECORD

Revision Status			Section affected
Issue/Rev	**Date**	**Approval**	
Issue 1	Febr. 2000		New
Issue 2	May 2000		1-2, 1-3, 3-2, 4-2 to 4-26, 5-1, 5-2, 5-3, 5-4, 6-1, 7-1, 8-1 to 8-8
Issue 2a	June 2000		4.1.4, 4.1.7, 4.2, 4.4, 4.4.1, 4.4.2, 4.4.3, 4.6.1, 8.1.4, 8.1.5, 8.3.2
Issue 2b	July 2001		4.1.1, 4.1.2, 4.1.3, 4.1.7, 4.2, 4.3.1.2, 4.3.1.3, 4.4, 4.4.1, 4.4.3, 5.1, 5.1.2, 5.1.3, 5.1.4, 6.1, 8
Issue 3	Sept 2001		2.2, 4.1.6, 4.1.11, 4.4, 4.4.3, 4.6, 4.6.1, 5.1.1, 5.1.2, 6.1
Issue 4	Sept 2002		Refer to next page
Issue 4.1	Sept 2003		Refer to next pages
Issue 4.2	May 2004		Refer to next page

Changes between issue 3 and 4	
Section	**Change**
1.3	Update of Applicability Matrix
3.1	LSU-ICU I/F in blockdiagram deleted
3.2	Update of Interface Matrix
4.1	Harness now specified in IID-B
4.2 – 4.7	3dB Coupler included in block diagrams
4.3	FCU Secondary power requirements
4.4	LSU excluded from serial data interface diagram
4.4	Clockrate science data and HL from WBS to 250 kHz
4.6	10 MHz reference signal to both spectrometers IF interface changed from FCU into 3dB coupler Load reflection coefficient between 3dB couplers and Spectrometers from <-15 to <-11dB TBC on Nominal power level of Spectrometer Reference signal
5	Update of optical interface diagram
5	Remark on operational temperature LOU and FPU
6	Update of waveguide interface diagram
8	LSU excluded from ICU communication

Changes between issue 4 and 4.1	
Section	**Change**
1.3	CN/2002-005: Included IFH and IFV in applicability matrix
3.1	CN/2002-005: Replaced figure 3.1-1 to include IFH/V
3.2	CN/2002-005: Included IFH and IFV in interface matrix
4.1	CN/2002-005: Rerplaced 3dB-Couplers by IF Up-Converters.
4.2	CN/2002-005: Replaced figure 4.2-1 to include FHIFH and FHIFV
4.3	CN/2002-005: Added section 4.3.2 Secundary Power IFH/V
4.4	CN/2002-005: Changed mnemonics FH3DH/V into FHIFH/V in figures 4.4-1 and 4.4-2
4.4.1	CN/2003-001: Replaced figure 4.4.1-1 to reflect that both sides of the harness shield should be connected to the unit structure.
4.4.3	CN/2003-001: Replaced figure 4.4.3-1 to reflect that both sides of the harness shield should be connected to the unit structure.
4.6.1	CN/2002-005: Replaed table 4.6.1-1 and 4.6.1-2 to include FHIFH/V
4.6.2	CN/2002-007: Replaced tables 4.6.2-1 to modify nominal power levels for the 10 MHz signal at output of the LSU and input at spectrometers as well as to adjust the cable attenuation.
4.7	CN/2002-005: Changed mnemonics FH3DH/V into FHIFH/V in figure 4.7-1
5	CN/2002-005: Changed mnemonics FH3DH/V into FHIFH/V in figure 5-1
6	CN/2002-005: Changed mnemonics FH3DH/V into FHIFH/V in figure 6-1

Changes between issue 4.1 and 4.2	
Section	**Change**
Table 4.3.1.2	CN/2004-002: FCU secondary power increase
Table 4.3.1.3	CN/2004-002: FCU secondary power increase

Sign off pages:

Sub-System: **ICU**

Sub-System manager: **R. Orfei**

Signature:

Sign off date:

(for applicable sections see section 1.3)

Sub-System: **FP**

Sub-System manager: **C.K. Wafelbakker**

Signature:

Sign off date:

(for applicable sections see section 1.3)

Sub-System: **WBS**

Sub-System manager: **R. Bieber**

Signature:

Sign off date:

(for applicable sections see section 1.3)

Sub-System: **LO**

Sub-System manager: **R. Güsten**

Signature:

Sign off date:

(for applicable sections see section 1.3)

Sub-System: **HRS**

Sub-System manager: **A. Cros**

Signature:

Sign off date:

(for applicable sections see section 1.3)

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to define and specify:
1. all interfaces between the subsystems of the instrument, concerning:

- Electrical,
- Optical,
- Mechanical,
- Waveguide,

Communication.
2. any electrical or optical interfaces between units within a subsystem that involve the FIRST spacecraft.

All external interfaces, that is interfaces between the instrument and the spacecraft, are defined and partially specified in the HIFI IID-B (AD-01). Where there is a conflict the IID-B takes precedence over this document.

All other internal interfaces will be described in the relevant unit specifications.

1.2 Scope

This document, the Interface Control Document,

1. contains an overview of the instrument,
2. identifies the interfaces which will be described,
3. specifies the relevant interfaces.

1.3 Applicability Matrix for Sections/Subsystems

The table below shows what sections of this document are applicable to which sub-systems. In addition, chapters 1, 2 and 3 are applicable to all sub-systems.

	ICU s/s	FP s/s			LO s/s			WBS s/s		HRS s/s
Section	ICU	FCU	FPU	IFH/ IFV	LCU	LSU	LOU	WEH/ WEV	WOH/ WOV	HRH/ HRV
4.1	x	x	x		x	x	x	x	x	x
4.2	x				x			x		x
4.3	x	x			x	x	x	x	x	
4.3.1	x	x								
4.3.1.1	x	x								
4.3.1.2	x	x								
4.3.1.3	x	x								
4.3.2		x		x						
4.4	x	x			x	x		x		x
4.4.1	x	x			x			x		x
4.4.2	x	x			x					
4.4.3	x							x		x
4.6			x	x		x		x	x	x
4.6.1		x	x	x				x		x
4.6.2						x		x		x
4.7		x	x		x	x	x	x	x	
5.1			x				x			
5.1.1			x				x			
5.1.2			x				x			
5.1.3			x				x			
5.1.4			x				x			
6.1						x	x			
8.1	x	x			x			x		x
8.2	x	x			x					
8.3	x							x		x

2 Document References

2.1 Applicable Documents

AD-01	Instrument Interface Document, part B	PT-HIFI-02125
AD-02	Instrument Interface Document, part A	PT-IID-A-04624
AD-03	HIFI Internal Databusses ICD	SRON-U/HIFI-SP-2001-010

2.2 Reference Documents

RD-01	HIFI Instrument Specification.	SRON-G/HIFI/SP/1998-001
RD-02	HIFI OBS URD	IFSI/OBS/SP/2000-001
RD-03	HIFI Acronyms List	SRON-U/HIFI/LI/2001-001
RD-04	HIFI Quasi-Optical Alignment Budget	SRON-G/HIFI/TN/2000-004

3 System Overview

3.1 System Block Diagram

3.1-1 is a block diagram of the instrument showing the interconnection between the various subsystems and units.

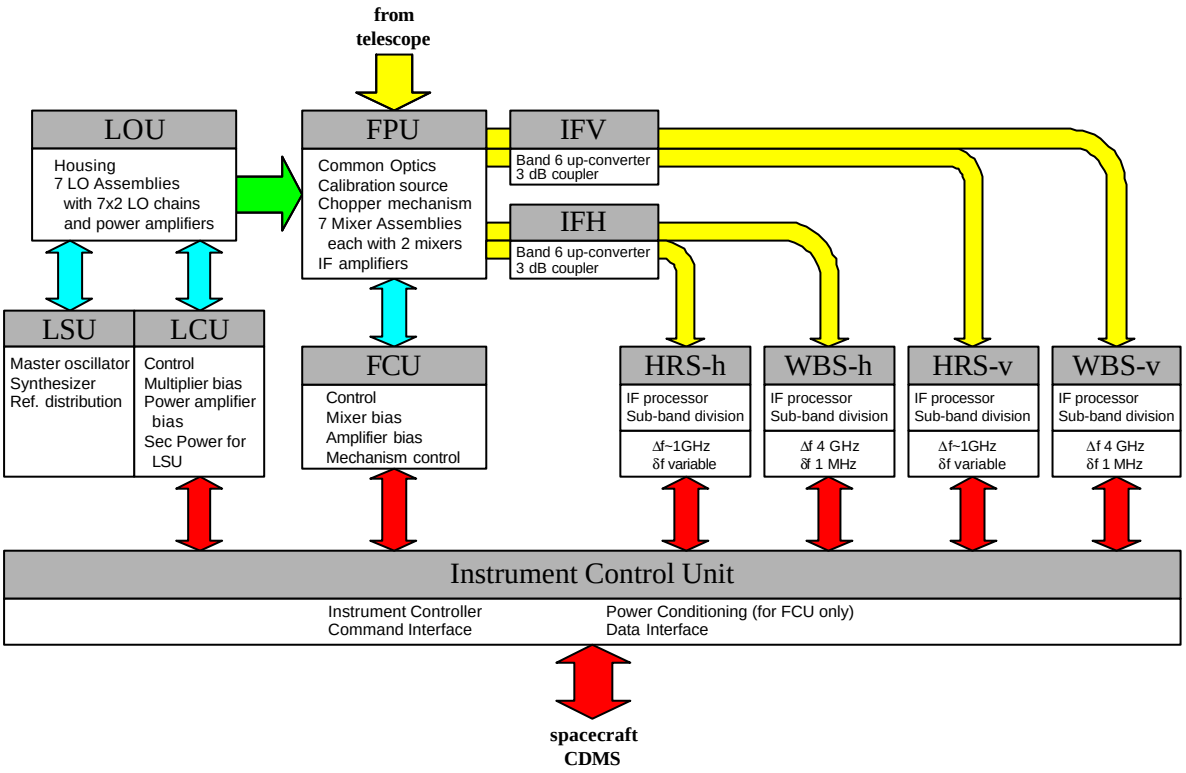


Figure 3.1-1 Block diagram of the HIFI Instrument.

3.2 Interface Matrix

An overview of the internal interfaces in the HIFI instrument is given in the Interface Matrix:

		FP Subsystem				LO Subsystem			HRS Subsystem		WBS Subsystem				ICU	S/C
		FPU	FCU	IFH	IFV	LOU	LSU	LCU	HRH	HRV	WEH	WEV	WOH	WOV	-	-
FP Sub-system	FPU		E*	E*	E*	O*										OMT
	FCU			E	E										EC	MT
	IFH								E		E					MT
	IFV									E		E				MT
LO Sub-system	LOU						W*	E*								OMT
	LSU							EC	E	E	E	E				MT
	LCU														C	EMT
HRS Sub-system	HRH														C	EMT
	HRV														C	EMT
WBS Sub-system	WEH												E		C	EMT
	WEV													E	C	EMT
	WOH															MT
	WOV															MT
ICU	–															ECMT

E: Electrical Interface

O: Optical Interface

C: Communication Interface

M: Mechanical

W: Wave-guide Interface

T: Thermal

*: Harness, wave-guides and windows provided by ESA

Interfaces with the spacecraft are defined in AD-01. Interfaces within the HIFI instrument are described in this document.

4 ELECTRICAL INTERFACES

4.1 Harness

The HIFI harness is specified in IID-B (AD-01).

AD-01, section 5.10.2.1 defines the S/C interface:

- Primary power
- CDMS signals to FHICU

AD-01, section 5.10.2.2 defines the instrument warm harness and is split-up into sub-sections according to EMC harness classes:

- Primary and secondary power
- Digital and high level analog signals
- Low level sensitive analog signals
- RF signals

AD01, section 5.10.2.3 defines the cryo-harnesses:

- Between FHFCU and FHFPU
- Between FHFPU and IF Up-Converters
- Between FHLCU and FHLOU

4.2 Primary power

The figure below shows the Power distribution diagram.

The power consumption of the different units is specified in AD-01.

The specification of the primary voltage can be found in AD-02.

Figure 4.2-1 shows, the primary power interface from the S/C PDU and the secondary power interfaces internal in HIFI. The Primary Power harness is defined in section 4.1.1. The Secondary power interfaces are defined in section 4.3 or in the sub-system documentation.

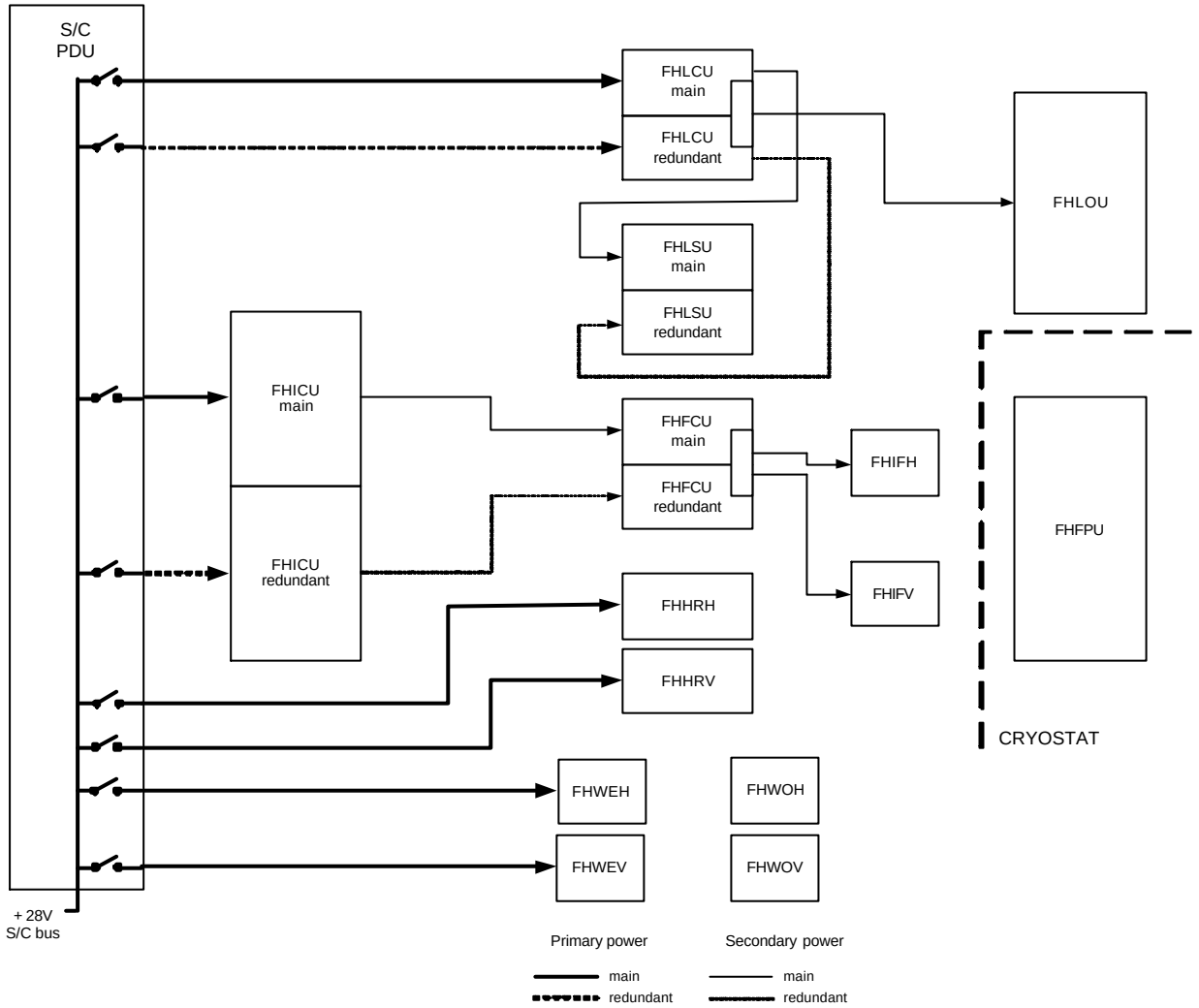


Figure 4.2-1 Power distribution diagram

4.3 Secondary power

Figure 4.2-1 shows the secondary power lines in the HIFI instrument.

The Focal Plane subsystem receives its secondary power from the ICU. The requirements for this interface are specified in section 4.3.1.

Units within the subsystem supply secondary power for those subsystems itself . Therefore they are not specified in this document, but in the subsystem documentation.

4.3.1 Secondary power FCU

4.3.1.1 Functional description

There will be two cold redundant sets of power lines from ICU to FCU. Each set will consist of 6 power lines: regulated +5V, +15V, –15V and unregulated +8V, +18V, -18V.

The +5V and +8V each shall have its own power return line. The + /–15V shall have one common return line. The same applies for the +/-18V outputs.

All 4 power returns with corresponding outputs shall be isolated from each other.

All FCU supply connections shall be isolated from ICU electrical ground and structure ground.

The +5V, + and -15V power returns will be connected to the FCU electrical ground in a star-point and this star-point will be connected to the FCU structure via a low-impedance connection.

The +8V and +/-18V power returns will connected to the HFPU electrical ground in a star-point and this star-point will be connected to the HFPU structure.

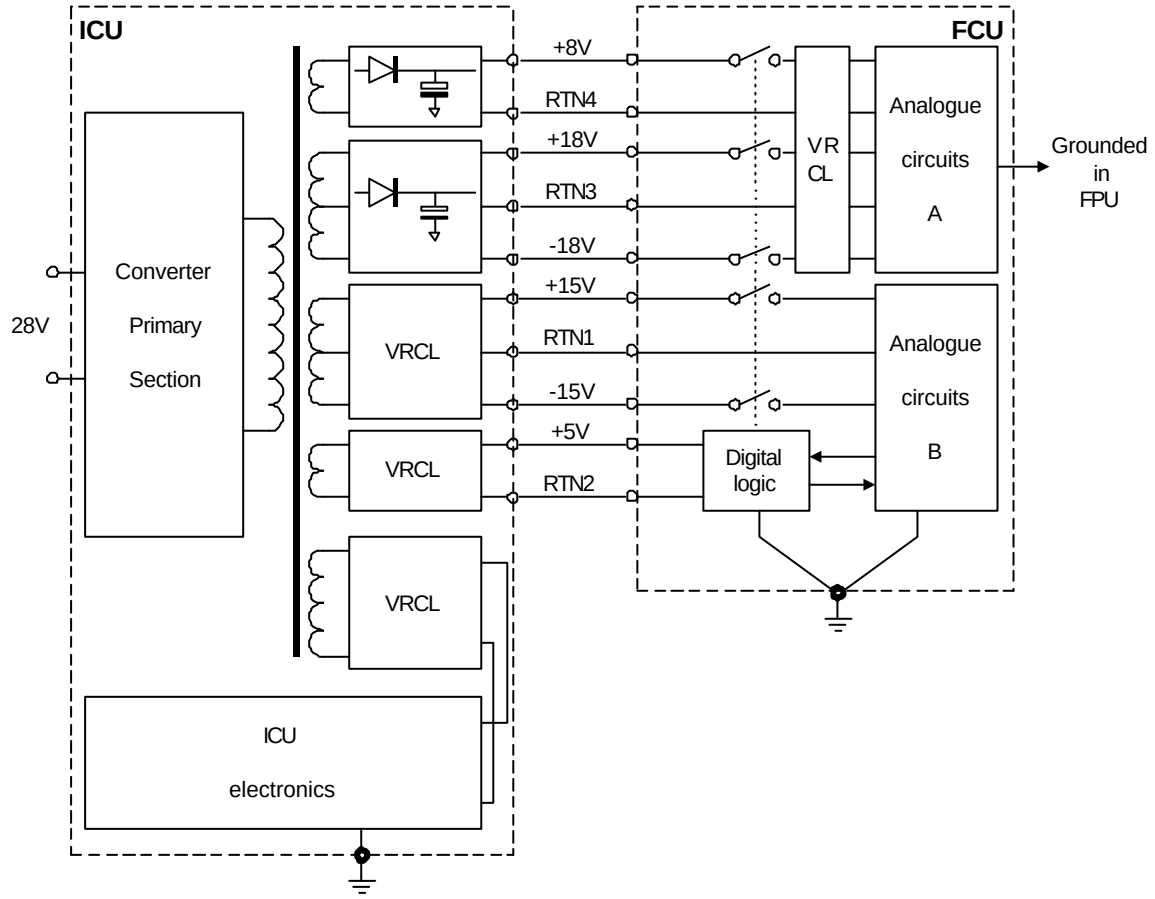


Figure 4.3.1.1-1, overview of power supply interfaces and grounding.
(applicable for as well main as redundant)

There shall be current limiters for the +5V and +/-15V outputs from the ICU such that:

- the maximum steady state current does not exceed a given maximum over a given output voltage range
- the peak output current, including inrush currents, does not exceed a given maximum over a given output voltage range.

There shall be over-voltage protection such that the output voltage is limited to a given range when the output is short circuited to other active supplies.

No power switching in the ICU for the FCU power supply lines is foreseen, but in the FCU there may be switches, switching the power to certain parts of the electronics.

The ICU may include common-mode filters at the power supply outputs, such filtering is foreseen in the FCU.

4.3.1.2 Performance requirements for the regulated outputs

The table below lists the main requirements on the regulated power supply lines.

Output name	V_{min} [V]	V_{max} [V]	V_{lim} [V]	I_{min} [mA]	I_{max} [mA]	I_{lim} [mA]	Ripple [mV_{rms}]	Spikes [mV_p]
+5V	+5.8	+6.0	-0.7…+ 6.5	50	450	600	50	100
+15V	+15.4	+16.2	-0.7…+ 17.3	50	300	500	50	100
-15V	-16.2	-15.4	-17.3…+0.7	40	250	500	50	100

Table 4.3.1.2-1, FCU power supply requirements, regulated outputs

V_{min} is the minimal output voltage delivered when loaded with a current in the range as indicated by I_{min} and I_{max}.

V_{max} is the maximal output voltage delivered when loaded with a current in the range as indicated by I_{min} and I_{max}.

V_{lim} is the absolute maximum output voltage, including a (single component) failure or short circuit to another active supply delivering currents over the I_{clamp} range.

I_{min} is the minimum continuous load current for which the output voltage shall be in the range from V_{min} to V_{max}.

I_{max} is the maximum continuous load current for which the output voltage shall be in the range from V_{min} to V_{max}.

I_{lim} is the maximum output current from the supply line for any output voltage in the OVR.

Ripple is the level of repetetive signals in a 10Hz … 20MHz bandwidth.

Spikes is the level of non-repetetive signals, measured with a 100Hz … 20MHz bandwidth in a 1sec period.

Ripple and spikes shall be measured when the ICU is loaded with a representative dummy load. Such a dummy load will provide a dc. load current of I_{max}, in parallel with a 20µF capacitance in series with a 10 Ohm resistance.

The voltage levels at the load currents as required above shall be delivered over the entire mission life time, for any combination of environmental conditions including ageing, radiation and EMI.

The maximum common-mode output current from any output shall be $100\mu A_{rms}$, over a 10Hz to 10KHz frequency range, increasing 20dB/decade until $10mA_{rms}$ at 1Mhz. Between 1MHz and 10MHz the common mode current shall be less than $10mA_{rms}$.
The common mode load for this requirement is a short circuit.

I_{lim} is also the maximum output current for inrush currents. This requirement means that the ICU supply shall limit the inrush current (transients) to I_{lim}, at times when the power to the FCU is switched ON or OFF. A suitable description of the FCU load on the supply lines is TBD, but for a start one may assume this load to be a 100µF capacitance with no significant series impedance.

The FCU may also perform internal ON/OFF switching of a (large) part of its circuitry. However, the switching will be performed such that I_{lim} will not be exceeded at any time. It is therefore not required that the ICU supply provides additional current limiting in this case.

Further EMC requirements and EMC environment are defined in the AD-02.

4.3.1.3 Performance requirements for the unregulated outputs

The table below lists the main requirements on the unregulated power supply lines.

Output name	V_{min} [V]	V_{max} [V]	I_{min} [mA]	I_{max} [mA]	Ripple [mV_{rms}]	Spikes [mV_p]
+8V	+7.0	+9.0	40	150	300	200
+18V	+17	+20	50	280	500	200
-18V	-17	-20	40	230	500	200

Table 4.3.1.3-1, FCU power supply requirements, unregulated outputs

V_{min} is the minimal output voltage delivered on that supply line when loaded with a current in the range as indicated by I_{min} and I_{max}.
V_{max} is the maximal output voltage delivered on that supply line when loaded with a current in the range as indicated by I_{min} and I_{max}.
Ripple is the level of repetitive signals in a 10Hz … 20MHz bandwidth.
Spikes is the level of non-repetitive signals, measured with a 100Hz … 20MHz bandwidth in a 1sec period.

Ripple and spikes shall be measured when the ICU is loaded with a representative dummy load. Such a dummy load will provide a dc. load current of I_{max}, in parallel with a 20µF capacitance in series with a 10 Ohm resistance.

The maximum common-mode output current from any output shall be $10\mu A_{rms}$, over a 10Hz to 10KHz frequency range, increasing 20dB/decade until $1mA_{rms}$ at 1Mhz. Between 1MHz and 10MHz the common mode current shall be less than $1mA_{rms}$.

The common mode load for this requirement is a short circuit.

4.3.2 Secundary Power IFH/V

The IF Up-converters are power by the DC/DC converter in the ICU, via the secondary power interface with the FCU. The requirements on the power line to the IF Up-converters are:

Supply voltage	5 +/- 0.1 V	TBC (alternative 10.5 V @ 125 mA)
Supply current	50 mA (max.)	TBC (alternative 10.5 V @ 125 mA)
Stability	10 mV / hour	Maximum rate of change of voltage.
Ripple level	5 mV rms	

4.4 Command, Housekeeping and Science Data interface

The HIFI instrument interfaces with the Spacecraft Command and Data Management System via the 1553-bus.
The 1553-bus consist of an A and B bus, as shown in figure 4.4-1.
The FHICU translates the received tele-commands into commands to the other sub-systems.
Housekeeping and Science data are packetized and send over the 1553-bus to the CDMU. The

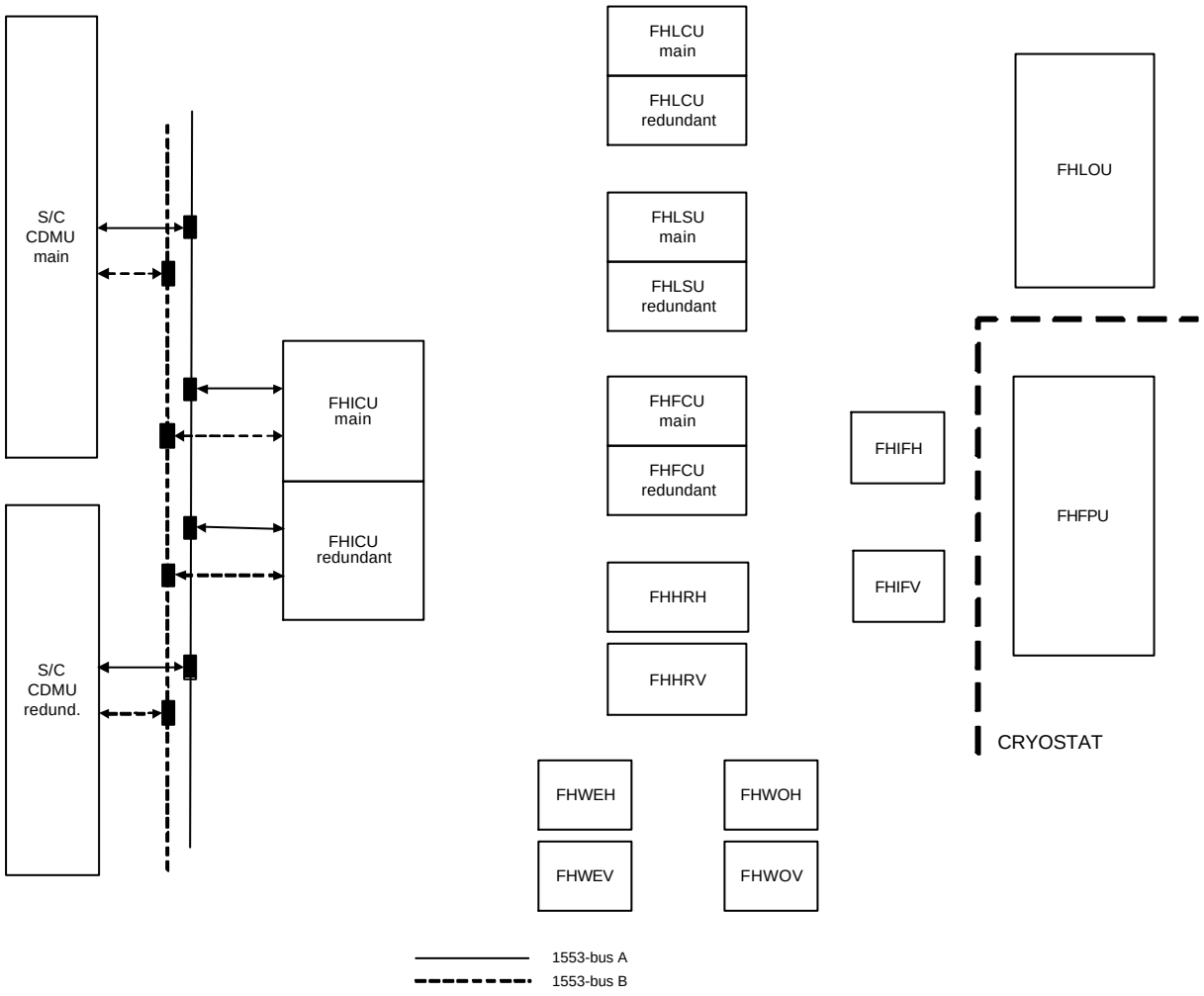


Figure 4.4-1 CDMS Data Interface diagram

requirements for the CDMS interface and tele-command and telemetry packet types are in the Packet Structure ICD (AD-03).

The Serial Data interfaces between the FHICU and the other sub-systems is split-up into three types:

- Commands: to all units as identified in figure 4.4-2
- Housekeeping: from the FHLCU and FHFCU

- Science Data and Housekeeping: from the FHHRH, FHHRV, FHWEH and FHWEV.

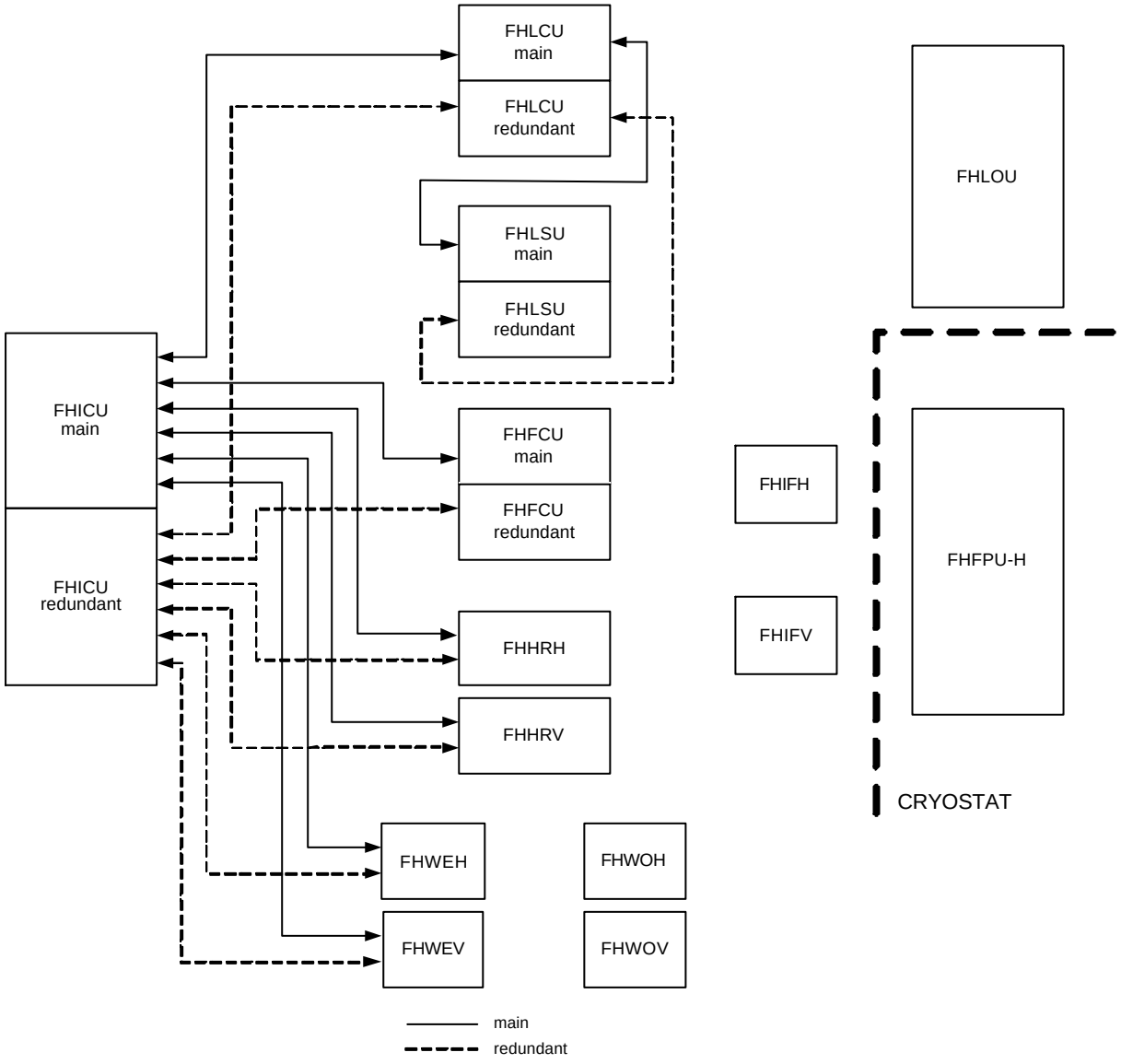


Figure 4.4-2 Serial Data Interface diagram

The interfaces to each of the sub systems are cold redundant, one interface from/to the ICU main and one from/to the ICU redundant. Cross strapping of the cold redundant interfaces to warm redundant electronic subsystem chains must be performed by the warm redundant electronics.

The general requirements for the interface circuits are:

- Clock rate:
  - Command to all subsystems: 312.5 kHz
  - Housekeeping from LCU and FCU: 312.5 kHz
  - Science Data and HK from WBS: 250 kHz
  - Science Data and HK from HRS: 2.5 MHz
- Cable length: ≤5m

The interfaces employ balanced differential line drivers and receivers, type 26C31 and 26C32, to provide good common mode rejection and reasonable isolation characteristics.

The circuit diagram for the Command and Housekeeping interface is shown in figure 4.4.1-1 and for the combined Science Data and Housekeeping in figure 4.4.2-1.

The parasitic capacitance of the 26C32 inputs lines (to ground) shall be < 20pF, this restricts the length of the PCB traces between the input resistors and the 26C32 inputs.

The interface cable shall have the characteristics according to the ESA specification:

SCC 3901/013/42.

All signals are active high and use NRZ-coding. All data has to be transferred with the MSB first.

The voltage levels and timing requirements are given in the table below. These values are measured on the unit connector pins of the receiver circuit.

Parameter	**Value**
Differential voltage:	
High level (‘1’)	V_h>+2.0V
Low level (‘0’)	V_l<-2.0V
Rise and fall time	t_r,t_f < 100ns

Table 4.4-1 Voltage levels and timing requirements

4.4.1 Command interface

The command interface is applicable to the interfaces from the ICU to the LCU, FCU, HRH, HRV, WEH and WEV.

The Interface circuit is presented in figure 4.4.1-1. It also includes the Housekeeping line (CHKDAT), which only applies to the interface with the units LCU and FCU.

Each Command interface consists of the following signal lines:

- Clock signal (CHKCLK), from the ICU to each subsystem
- Command data (CHKCMD), from the ICU to each subsystem

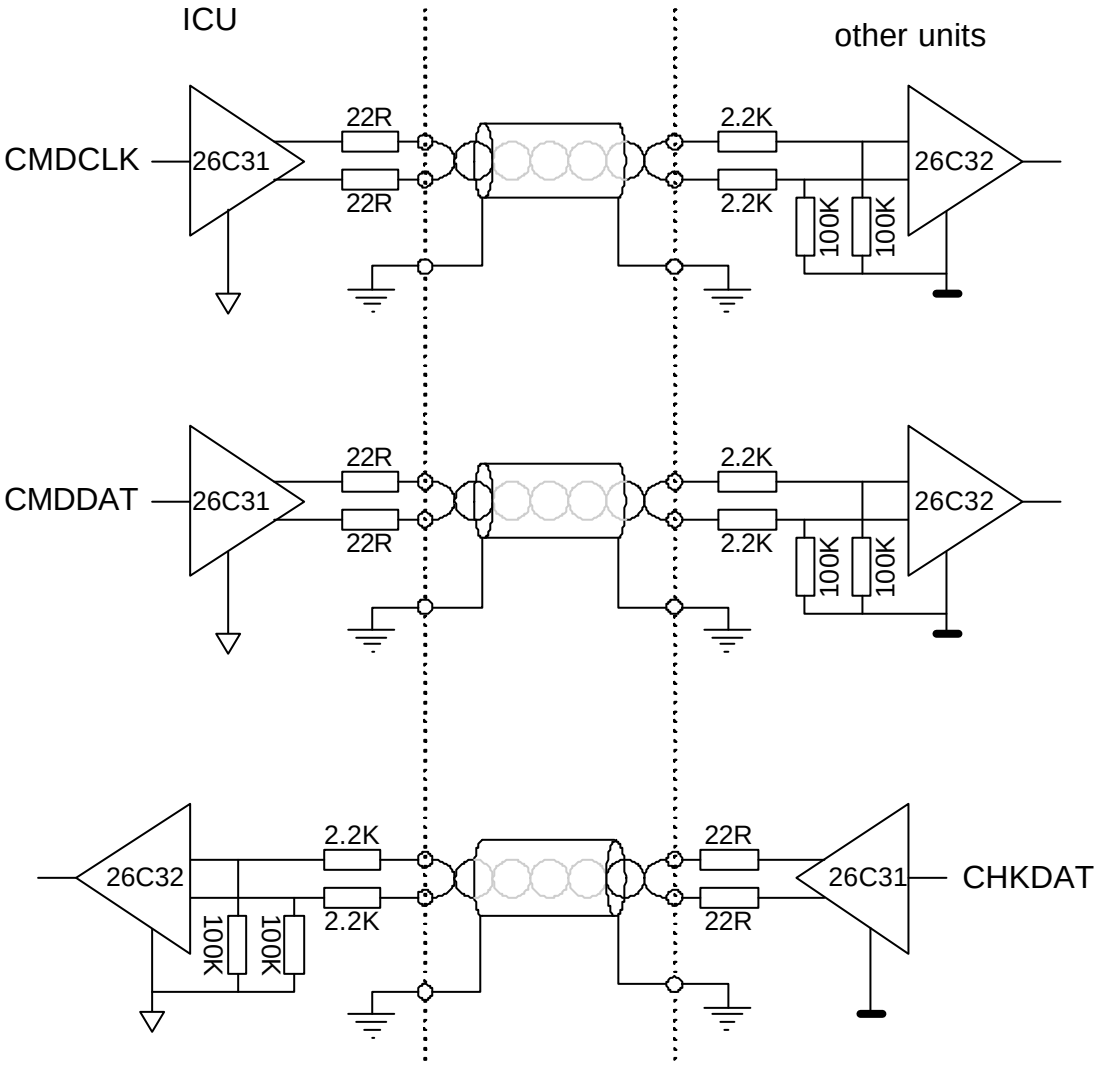


Figure 4.4.1-1 Circuit diagram Command and Housekeeping interface

Note: The CHKDAT does not apply to the interface with FHHRH, FHHRV, FHWEH and FHWEV.

The Command protocol and timing diagram is shown in figure 4.4.1-2. The Command data signal (CHKCMD) change state on the falling edge of the clock signal (CHKCLK).

Each command consists of: one start bit (high), one mode bit (high), four subsystem address bits (SSA0 to SA3) and 26 data bits (D0 to D25).

The subsystem addresses are hamming coded according to table 4.4.1-1. The data bits are defined by the subsystem for which the command is meant.

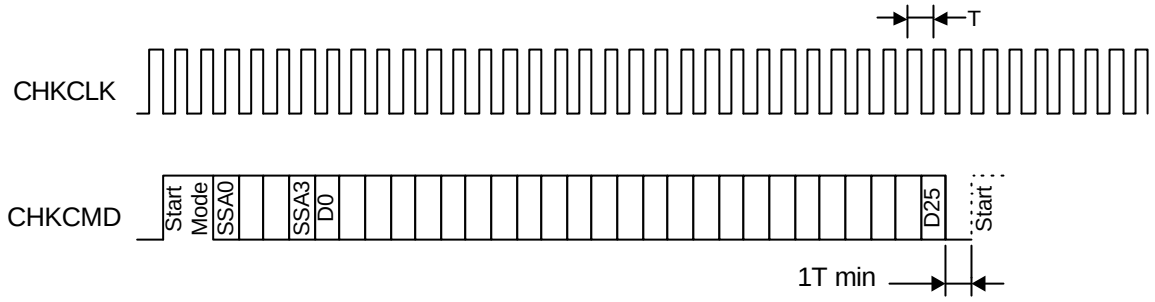


Figure 4.4.1-2 Command protocol

Each unit shall respond to commands that contain its sub system address, according to table 4.4.1-1.

The two units of the HRS subsystem (FHHRH and FHHRV) shall also respond to broadcast commands from which the databits D0 and D1 are set to '11'.

The two units of the WBS subsystem (FHWEH and FHWEV) shall also respond to broadcast commands from which the databits D0 and D1 are set to '00'.

If the subsystem detects a transmission that does not meet the protocol format and/or timing requirements, it will ignore that command.

A command shall not start within one clock-cycle after the previous command has terminated or the housekeeping envelope (see section 4.4.2) has gone to the inactive state.

SSA-bit 0 1 2 3	Unit
0 0 1 1	FHFCU
0 1 0 1	FHHRH
0 1 1 0	FHHRV
1 0 0 1	FHWEH
1 0 1 0	FHWEV
1 1 0 0	FHLCU
1 1 1 1	Broadcast command (WBS and HRS only)

Table 4.4.1-1 Subsystem addresses

4.4.2 Housekeeping interface

This type of Housekeeping interface is applicable to the interfaces from the FHICU to the FHLCU and FHFCU. The Interface circuit, which is a combination with the Command interface, is presented in figure 4.4.1-1.

The Housekeeping interface consists of the following signal lines:

- Clock signal (CHKCLK), from the ICU to each subsystem
- Command/ HK request data (CHKCMD), from the ICU to each subsystem
- Housekeeping data (CHKDAT), from the LCU and FCU to the ICU

The Housekeeping protocol and timing diagram is shown in figure 4.4.2-1. The data signals (CHKCMD, and CHKDAT) change state on the falling edge of the clock signal (CHKCLK).

A housekeeping request consists of: one start bit (high), one mode bit (low), four subsystem address bits (SSA0 to SSA3), ten address bits (A0 to A9) and an envelope. The subsystems have the same subsystem address codes as used for the commands, see table 4.4.2-1. The address bits identify the requested housekeeping parameter(s).

The envelope shall be active (high) until the full housekeeping response has been received, in any case it goes inactive (low) after 625 clock-cycles. If the ICU has to transmit a command, when the housekeeping envelope is still active, than the housekeeping request shall be aborted by setting the envelope into the inactive state.

A command or housekeeping request shall not start within one clock-cycle after the previous command has terminated or the housekeeping envelope has gone to the inactive state.

A housekeeping data word consists of: one start bit (high), one mode bit (low), four subsystem address bits, ten address bits and 16 data bits. The start bit, mode bit, subsystem address bits and address bits are a copy from the request.

The subsystem shall provide the requested housekeeping data when the envelope is active. It shall terminate sending housekeeping data within one clock-cycle after the envelope has gone to the inactive state, even if the data has not been sent completely.

The subsystem shall only respond with housekeeping data to requests, which contain its own subsystem address. If the subsystem detects a transmission that does not meet the protocol format and/or timing requirements, it will ignore that housekeeping request.

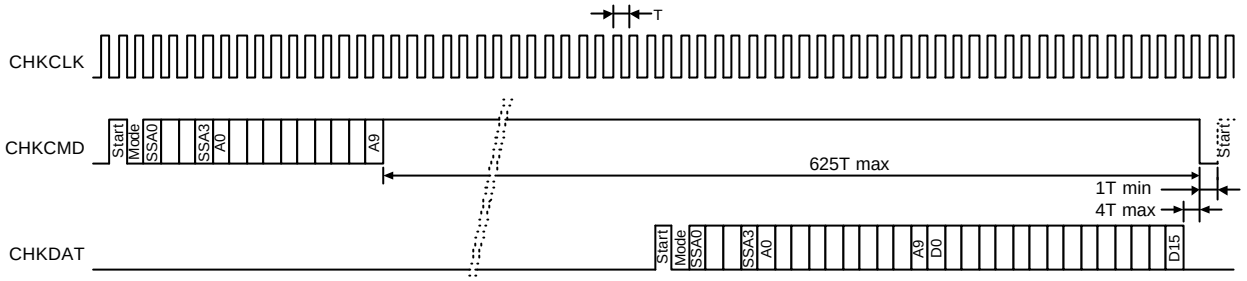


Figure 4.4.2-1 Housekeeping protocol.

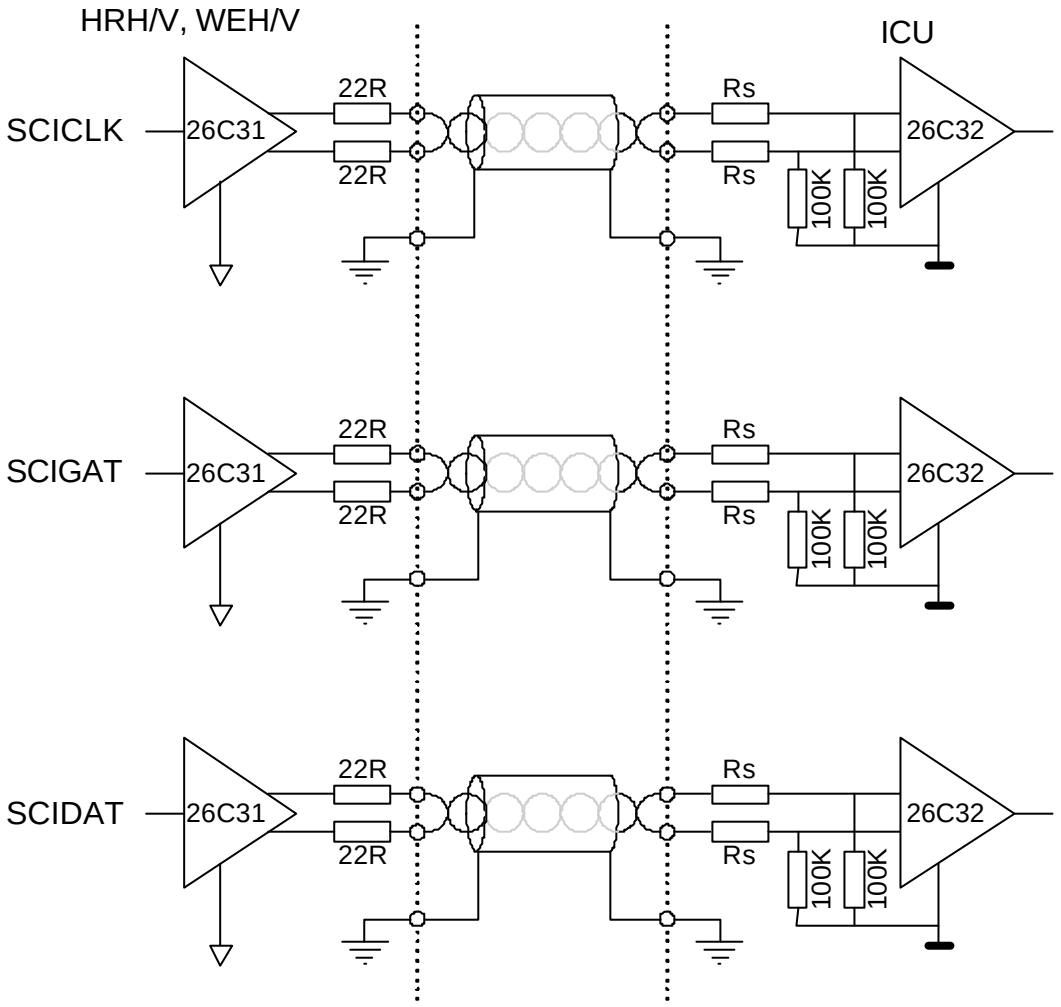
4.4.3 Science Data and Housekeeping interface

The Science Data and Housekeeping interfaces are single direction interfaces, transferring data from one of the spectrometers to the ICU. A total of four interfaces are foreseen for the WEH, WEV, HRH and HRV.

The circuit diagram is presented in figure 4.4.3-1.

Each interface consist of the following lines:

- Clock signal (SCICLK)
- Gate signal (SCIGAT)
- Data signal (SCIDAT)



note: for WBS: Rs = 2.2 kohm
for HRS: Rs = 220 ohm

Figure 4.4.3-1 Circuit diagram Science Data and Housekeeping interface

The protocol and timing diagram is shown in figure 4.4.3-2.
The WBS and HRS send data words over the data line (SCIDAT) within the envelope of the gate signal (SCIGAT). The Gate signal (SCIGAT) and Data signal (SCIDAT) change state on the falling edge of the clock signal (SCICLK).

For the HRS and the WBS each data word (D0 to D23) consists of 24 bits. The gate signal is active (high) during the transmission of the data word. The gate signal shall be inactive (low) for at least one clock cycle between successive data word transfers.

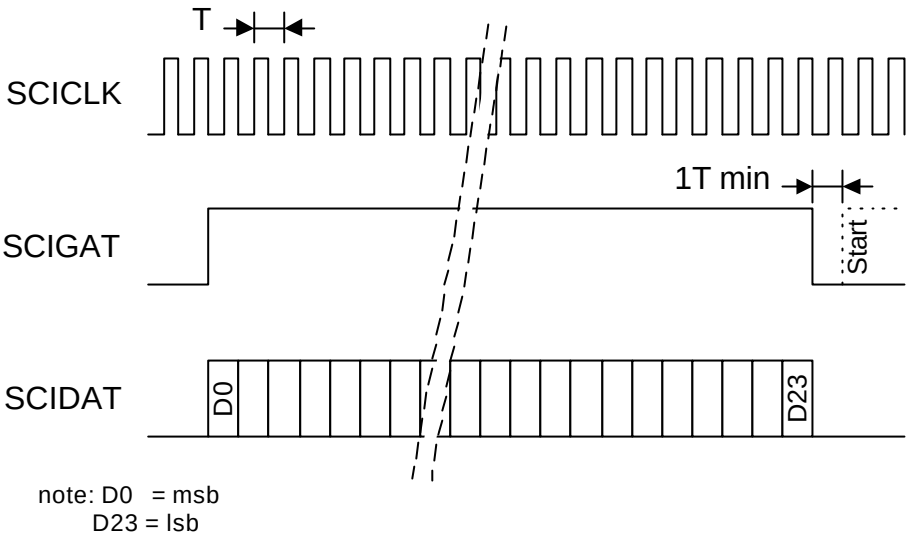


Figure 4.4.3-2 Science Data and Housekeeping protocol

4.5 deleted

4.6 Radio Frequencies

The figure below shows the interface diagram for the Radio Frequencies.

Two types of RF interfaces exist between the HIFI subsystems:

- The Intermediate Frequency interface, between the FPU and the spectrometers
- A 10MHz reference signal from the LSU to the spectrometers

RF interfaces within subsystems are not defined in this document.

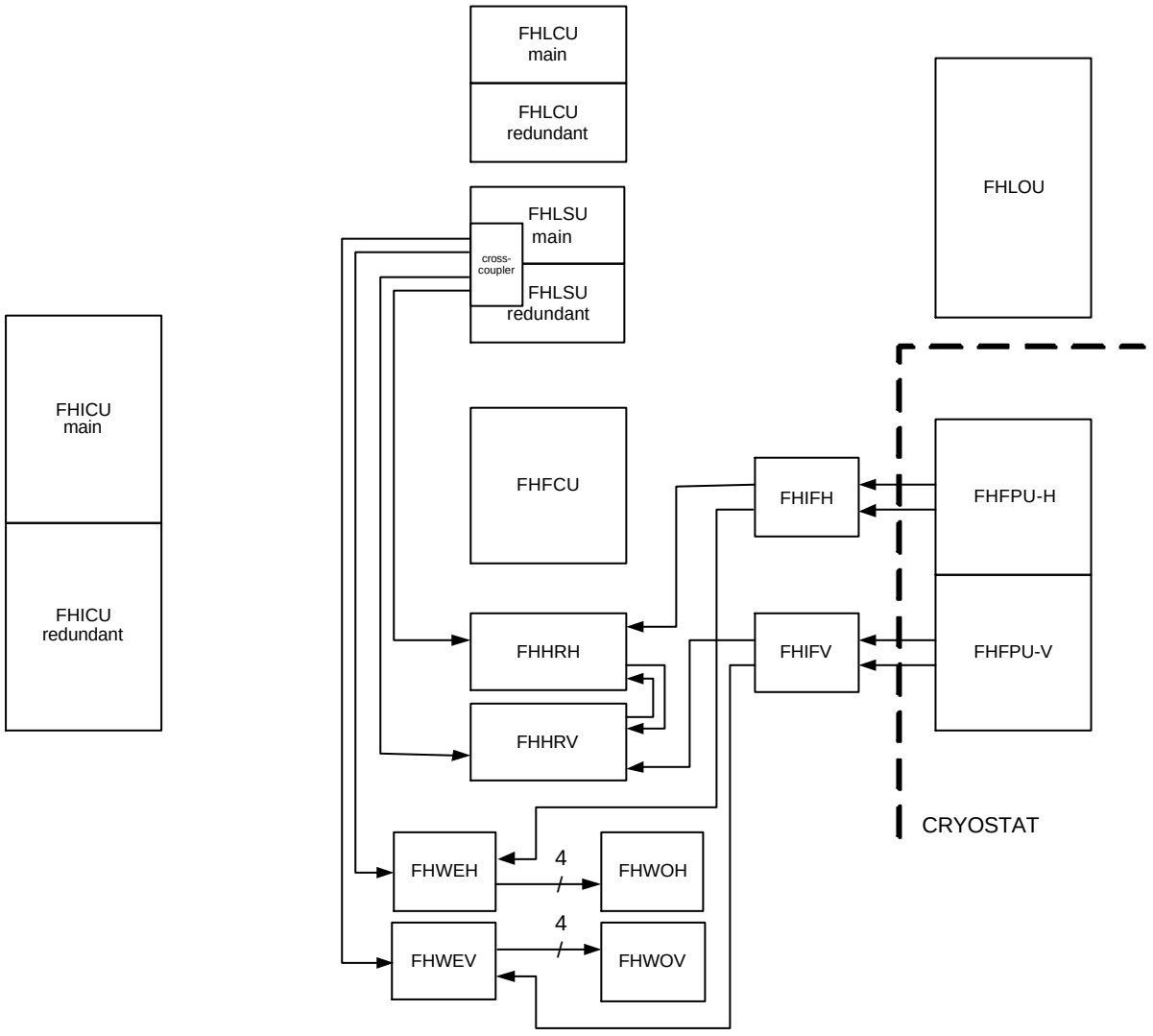


Figure 4.6-1: Electrical interface diagram Radio frequencies

4.6.1 Intermediate Frequency signals

The characteristics of the interface between FHFPU, FHIFH/V and the Spectrometers are listed in the tables below.

parameter	Band 1 – 5 IF	Band 6L & 6H IF	remarks
Frequency range	4 – 8GHz	2.4 – 4.8GHz	
Nominal power level	-82 ±5dBm/MHz	-68 ±5dBm/MHz	at FPU output
Nominal power level	-90 ±5dBm/MHz	-74 ±5dBm/MHz	at FHIFH/V input
Nominal impedance	50 ohm	50 ohm	
Source reflection coefficient	< -15dB	< -15dB	at FPU output
Load reflection coefficient	< -19dB	< -19dB	at FHIFH/V input
Cable attenuation	8dB {+0/-3}	6dB {+0/-2}	mid band
Cable attenuation slope	+0.6dB/GHz {+0/-0.2} **(TBC)**	+0.7dB/GHz {+0/-0.2} **(TBC)**	mid band

Table 4.6.1-1 Interface specification between the FPU and the FHIFH/V.

parameter	Band 1 – 5 IF	Band 6L & 6H IF	remarks
Frequency range	4 – 8GHz	5.6 – 8GHz	
Nominal power level	-93 ±5dBm/MHz **(TBC)**	-93 ±5dBm/MHz **(TBC)**	at FHIFH/V output
Nominal power level	-95 ±5dBm/MHz	-95 ±5dBm/MHz	at Spectrometer input
Power variation	< 3dB	< 3dB	during integration
Ripple (any 250 MHz sub-band)	< 1.5dB	< 1.5dB	instantaneous
Ripple (any 1GHz sub-band)	< 3dB	< 3dB	instantaneous
Nominal impedance	50 ohm	50 ohm	
Source reflection coefficient	**< -19dB**	**< -19dB**	at FHIFH/V output
Load reflection coefficient	< -11dB	< -11dB	at Spectrometer input (goal –17dB)
Cable attenuation	2dB {+0/-1} **(TBC)**	2dB {+0/-1} **(TBC)**	mid band
Cable attenuation slope	+0.2dB/GHz {+0/-0.1} **(TBC)**	+0.2dB/GHz {+0/-0.1} **(TBC)**	mid band
IF noise temperature	< 300K (NF= 3dB)	< 300K (NF= 3dB)	at Spectrometer input

Table 4.6.1-2 Interface specification between the FHIFH/V and the Spectrometers

4.6.2 Spectrometers reference signal

The Spectrometers receives a 10MHz reference signals from the LSU. Within the LSU only one of the two redundant systems is operating at any time, whereas the two halves (i.e. the two polarisation channels) of the HRS and WBS normally operate simultaneous.

The figure below gives the diagram of this interface and also indicates a possible implementation for the distribution of the main and redundant 10MHz signals within the LSU.

The characteristics of the interface are defined in table 4.6.2-1.

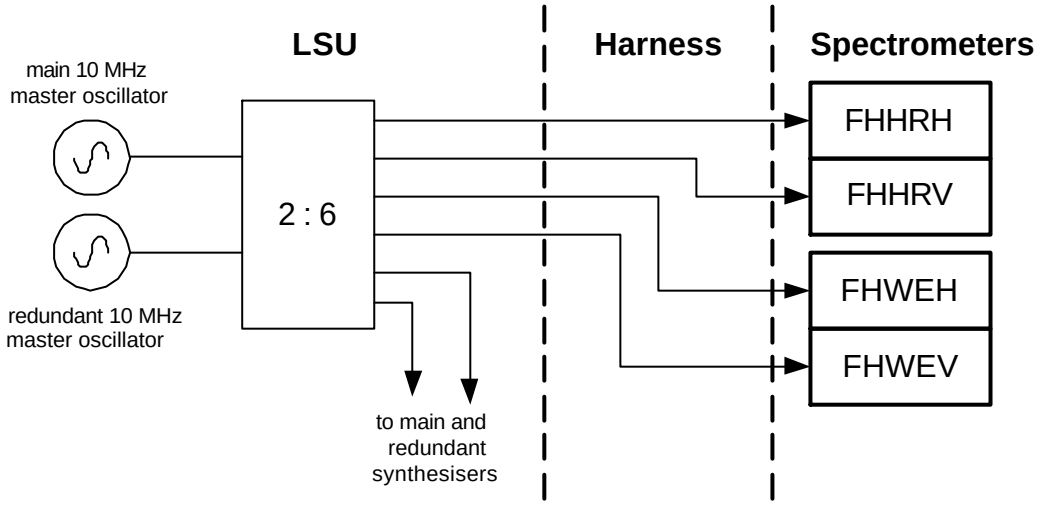


Figure 4.6.2-1 Spectrometers reference signal

Parameter	WBS	HRS
Nominal frequency	10MHz ±0.1Hz	**10MHz ± 0.1Hz**
Nominal power level at LSU output	+2±2dBm	+2±2dBm
Nominal power level at spectrometer input	+2(+2, -2.3)dBm	+2(+2, -2.3)dBm
Nominal impedance	50ohm	50ohm
Source reflection coefficient	< -15dB	< -15dB
Load reflection coefficient	< -15dB	< -15dB
Cable attenuation	< 0.3dB	< 0.3dB

Table 4.6.2-1 Spectrometers reference interface specification

4.7 Low Frequencies

There are no specific LF interfaces between the different subsystems. LF interfaces between units within subsystems are not defined in this document. For completeness the interface diagram is show in the figure below.

The harnesses between the FHLCU and FHLOU and the harness between the FHFCU and FHFPU are part of the cryo-harness and described in AD-01

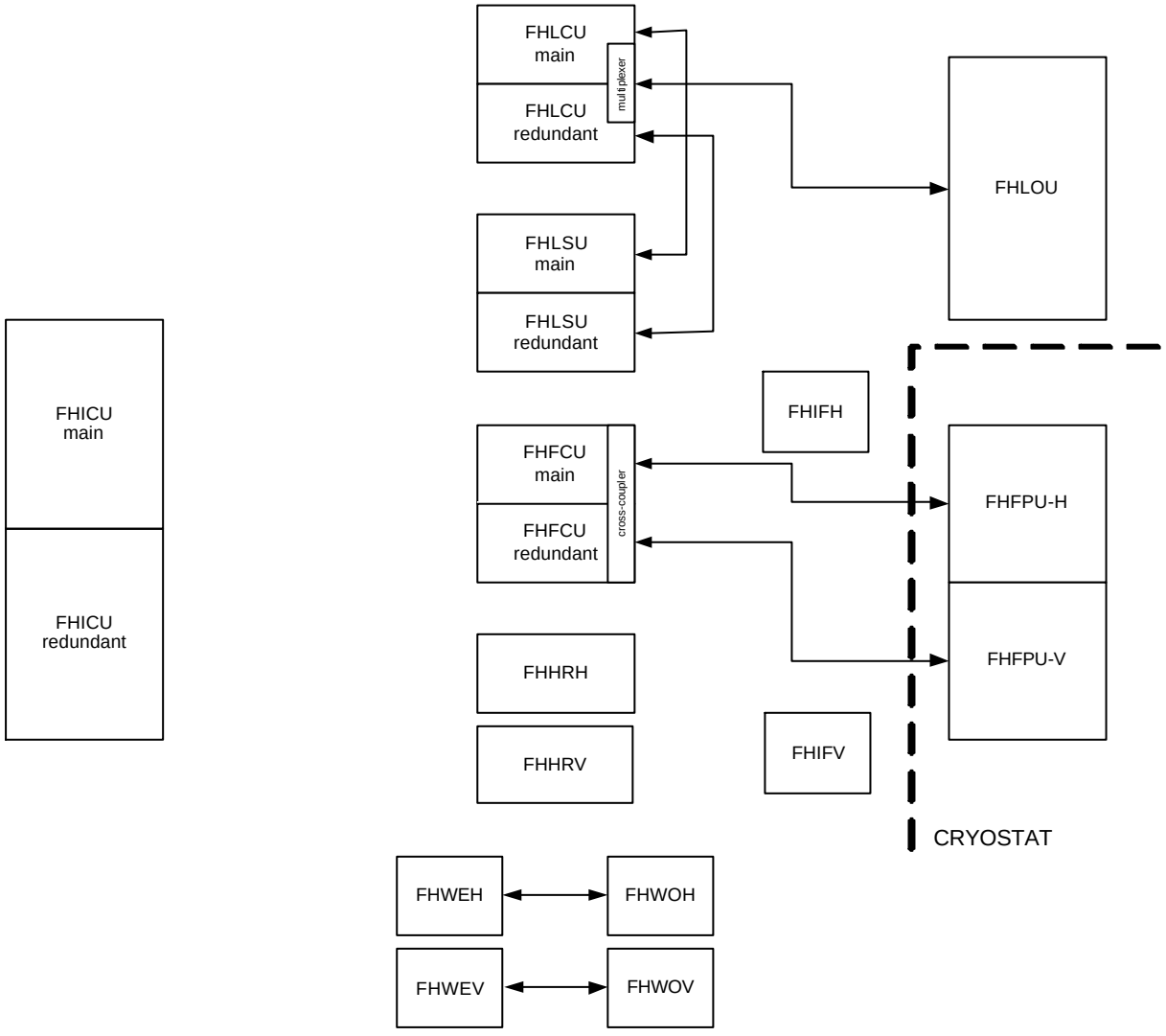


Figure 4.7-1 Electrical interface diagram Low Frequencies.

5 OPTICAL INTERFACES

The optical interface diagram is presented in figure 5-1.

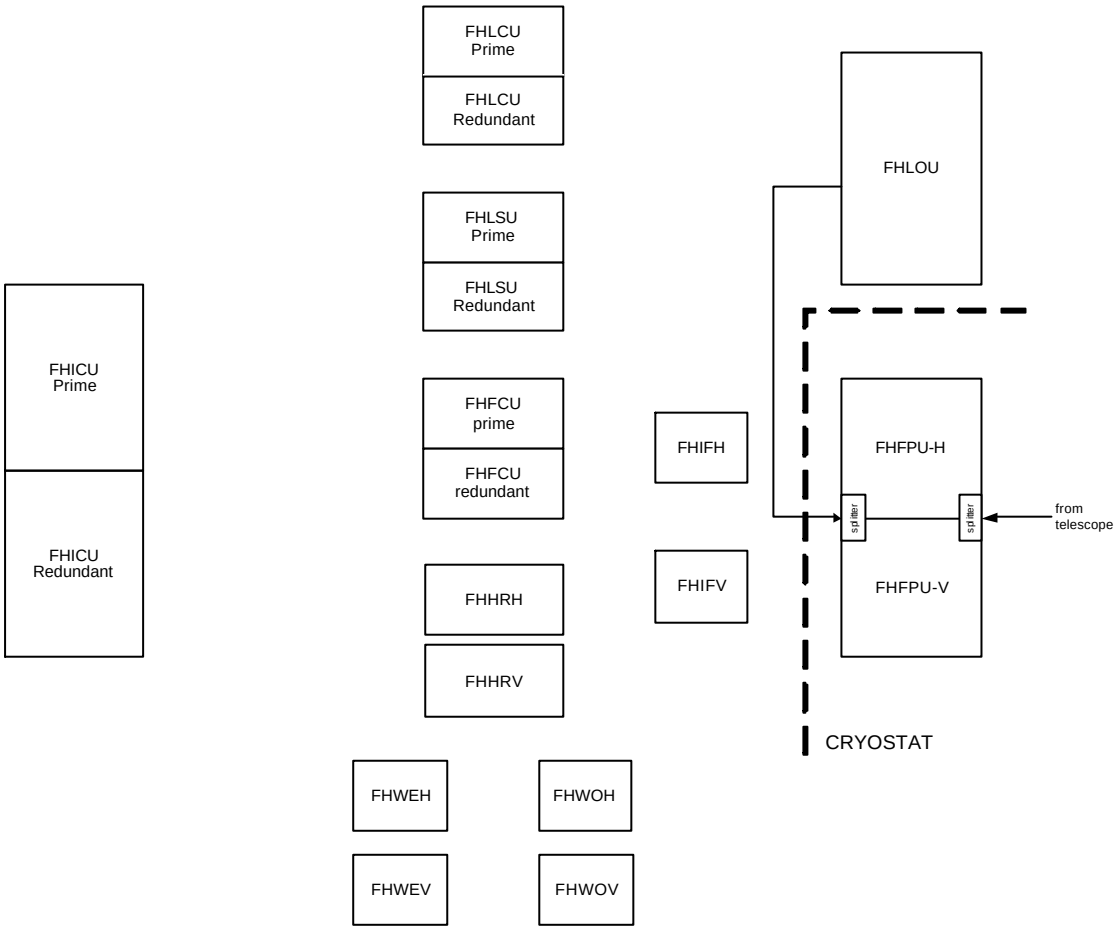


Figure 5-1: The optical interface diagram

5.1 LOU to FPU

The optical interface is defined at a plane between the LOU and FPU. The nominal positions of the Gaussian beam waists are defined to lie in this plane and to have beams propagating normal to the plane. See also Sections 5.3 and 5.8.2.2 in the HIFI-IID-B (AD-01). This interface definition applies at the normal operating temperatures of the concerned units, these being approximately 120K for the LOU and approximately 10K for the FPU.

5.1.1 Nominal LO Beam Definition

The 7 pairs of L.O. beams enter the cryostat outer vessel along 7 parallel paths from the –Y side.

The Gaussian beam waist positions and directions are given with respect to a co-ordinate system aligned with the spacecraft co-ordinate system but with its origin at the intersection of the telescope axis with the optical bench. Note that the origin of this system has the spacecraft co-ordinates (x = –202 mm, y = 0 mm, z = 0 mm).

LO Band	Beam Waist Co-ordinates			Waist Radius (mm)
	X (mm)	Y (mm)	Z (mm)	
1a,b	63	-950	+150	7.5
2a,b	63	-950	+100	7.5
3a,b	63	-950	+50	7.5
4a,b	63	-950	0	7.5
5a,b	63	-950	-50	7.5
6La,b	63	-950	-100	7.5
6Ha,b	63	-950	-150	7.5

Table 5.1.1-1 Nominal LO Beam Waist Definition

The propagation direction of the 7 LO beams is applicable to both the FPU and LOU as given in Table 5.1.1-2 in terms of unit vectors.

Mixer Band	Beam propagation unit vectors (arbitrary units)		
	X	Y	Z
1	0	+1	0
2	0	+1	0
3	0	+1	0
4	0	+1	0
5	0	+1	0
6L	0	+1	0
6H	0	+1	0

Table 5.1.1-2 Nominal LO Beam Propagation Direction

5.1.2 LO Beam Tolerances

With the incoming L.O. beams parallel, the output beams to the mixers shall also be parallel within 2 arcminutes. This will ensure that the LOU and the FPU can be mutually aligned without adjusting the internal alignment of either Unit.

An analysis of the coupling losses as a function of misalignment can be found in RD-04. The following tables summarise the maximum allowed deviations from the nominal LO beam parameters defined in 5.1.1 above and are applicable to both the LO beam launched by the LOU and the LO accepted by the FPU

Mixer Band	Beam propagation unit vectors (arbitrary units)		
	X	Y	Z
1	0 ± 2.0E-3	+1	0 ± 2.0E-3
2	0 ± 1.6E-3	+1	0 ± 1.6E-3
3	0 ± 1.3E-3	+1	0 ± 1.3E-3
4	0 ± 1.1E-3	+1	0 ± 1.1E-3
5	0 ± 1.0E-4	+1	0 ± 1.0E-4
6L	0 ± 0.75E-4	+1	0 ± 0.75E-4
6H	0 ± 0.67E-4	+1	0 ± 0.67E-4

Table 5.1.2-1: Nominal LO Beam Tolerances

The angular beam misalignment tolerances are

Mixer Band	angular alignment tolerances in degrees		
	q_X	q_Y	q_Z
1	± 0.114		± 0.114
2	± 0.091		± 0.091
3	± 0.076		± 0.076
4	± 0.065		± 0.065
5	± 0.058		± 0.058
6L	± 0.043		± 0.043
6H	± 0.038		± 0.038

Table 5.1.2-2: Angular Beam Misalignment Tolerances

The lateral beam tolerances are:

Mixer band	Lateral alignment tolerances in mm	
	D_y	D_z
1	0.75	0.75
2	0.75	0.75
3	0.75	0.75
4	0.75	0.75
5	0.75	0.75
6L	0.75	0.75
6H	0.75	0.75

Table 5.1.2-3: Lateral beam tolerances

5.1.3 FPU to LOU Coupling

The signal coupling efficiency between the LOU and FPU is described in detail in section 4.5.10 of the HIFI Instrument Specification [RD-01]

5.1.4 LO Beam Polarisation Interface

The LO shall provide linearly polarised beams. The polarisation planes will be rotated 45° from the FPU input polarisation planes, to achieve good coupling between each of the two LO channels with each of the two FPU polarisations.

In bands 1 and 2 all polarisations are offset by 18° to allow 10% LO injection without using diplexers.

This offset shall be implemented so that it can easily be adjusted for a different signal-LO split.

The angles are listed in table 5.1.4-1.

Mixer Band	FPU input polarisation planes		LOU polarisation planes	
	V-channel	H-channel	Sub-band A	Sub-band B
1	18°	18°+90°	18°-45°	18°+45°
2	18°	18°+90°	18°-45°	18°+45°
3	0°	90°	-45°	45°
4	0°	90°	-45°	45°
5	0°	90°	-45°	45°
6L	0°	90°	-45°	45°
6H	0°	90°	-45°	45°

Table 5.1.4-1: Polarisation angles

The polarisation angles are defined as in figure 5.1.4-1. +Z and +X denote the directions of the satellite Z and X axes. θ is the angle between the Z axis and the E vector.

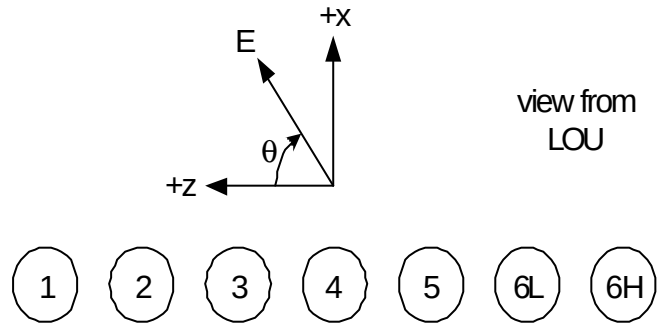
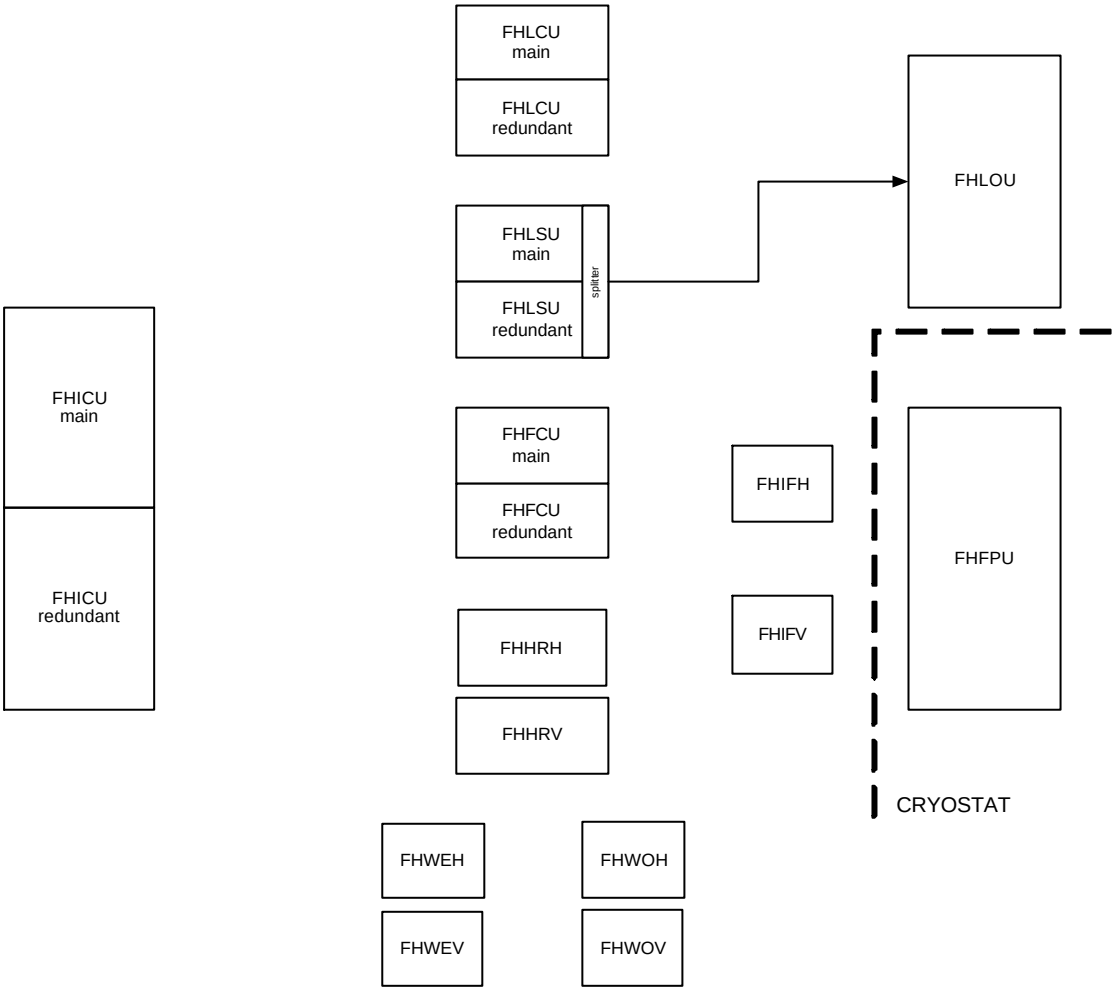


Figure 5.1.4-1: Polarisation angle definition.

6 WAVEGUIDE INTERFACES

The waveguide interface diagram is shown in figure 6-1

Figure 6-1: The waveguide interface diagram



6.1 LSU to LOU

The fourteen waveguides between the FHLSU and the FHLOU are considered as a separate unit the FHLWU. They conduct the Local Oscillator source signal (23.7 to 35.3GHz) from the Local Oscillator Source Unit to the Local Oscillator Unit (figure 1.8-1). The specification of the waveguides can be found in AD-01.

7 MECHANICAL INTERFACES

Not Applicable.

8 COMMUNICATION INTERFACES

8.1 Commands

Commands can be sent from the ICU to the:

- Focal Plain Control Unit
- Local Oscillator Control Unit
- Wide Band Spectrometer (per polarisation direction)
- High Resolution Spectrometer (per polarisation direction)

The interface circuits and transfer protocol are described in the sections 4.4 and 4.4.1.

Commands that can be sent from the ICU to the units are defined in AD-03.

8.2 Housekeeping

The ICU receives housekeeping, based on a request from the ICU, from the:

- Focal Plain Control Unit
- Local Oscillator Control Unit

The interface circuits and transfer protocol are described in the sections 4.4 and 4.4.2.

The Housekeeping data from the two spectrometers are combined with the Science data transfer, see section 8.3.

Housekeeping data that can be returned from the units to the ICU are defined in AD-03.

8.3 Housekeeping and Science data

The ICU receives combined blocks of Housekeeping and Science Data from the:

- Wide Band Spectrometer (per polarisation direction)
- High Resolution Spectrometer (per polarisation direction)

The interface circuits and transfer protocol are described in the sections 4.4 and 4.4.3.

Combined blocks of Housekeeping and Science Data that can be returned from the spectrometers to the ICU are defined in AD-03.