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Title

HIGH RESOLUTION INFRA-RED RADIATION SOUNDER /4 INSTRUMENT INTERFACE CONTROL DOCUMENT

HIRS/4 ICD

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TBC / TBD LISTS

This document includes several TBD (to be defined) and TBC (to be confirmed) on the following pages.

TBD$_{HIRS}$ on Pages	TBC$_{HIRS}$ on Pages
-	
2.14 2.18 2.28 2.30 2.32	
3.54 3.55 3.56 3.60 3.85	3.85
4.2 4.4	-
5.25.35.85.95.105.135.165.20	5.15.9
6.2 6.3	-

TBD$_{MET}$ on Pages	TBC$_{MET}$ on Pages
1.2	1.18 1.19 1.20 1.21 1.22
2.1 2.12 2.13 2.23 2.24 2.25 2.26 2.27 2.28 2.35	2.12
3.80	3.16 3.85
	4.2 4.3 4.12 4.13
5.3 5.5 5.17	5.2 5.12 5.19
6.3	

TABLE OF CONTENTS

This document has been elaborated by MATRA MARCONI SPACE along with DORNIER.

1. GENERAL INFORMATION

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1.1. GENERAL

1.1.1. Purpose of the Document

This document is the HIRS/4 Instrument Interface Control Document. It deals with the interface definition between the instrument and the METOP satellite.

The ICD document forms the unique formal definition on engineering, ground and flight operations for the METOP programme, specifying the binding requirements between ESA and the Instrument Supplier. It is configuration controlled by the METOP project team and formally signed off by ESA, the Instrument Supplier and the METOP prime contractor. *The instrument supplier is NOAA/NA.*

As a single point control of the technical interfaces, the ICD :

- Defines the technical resources allocated to the instrument.
- Defines the detailed mechanical, thermal and electrical interfaces between the instrument and the satellite.
- Defines the design verification programme which shall be implemented to demonstrate compliance with the METOP / HIRS/4 interface requirements.
- Defines the detailed mechanical, electrical and protocol interfaces between the instrument ground support equipment and the METOP PLM ground support equipment.
- Defines the operational interface applicable during ground launch and flight phases.

The objective of the ICD is to ensure that :

- The instrument is designed, built and verified within the constraints imposed by the overall payload complement satellite and launch vehicle,
- The satellite Prime Contractor is able to design, build and verify the satellite in such a manner that all instruments can be successfully integrated into the system,
- The spacecraft system can be successfully launched and operated to achieve the mission objectives of the METOP programme.

1.13. Documentation

In cases of conflict between the following applicable docuinents and the present ICD, the agreement or definition in this HIRS/4 ICD shall govern.

1.1.2.1. Applicable Documentation

AD 1. METOP Product Assurance Requirements for NOM Instruments
Ref. MO-RS-ESA-PA-0065

AD2. METOP Finite Element Model Requirement Specification For Structural Analyses
Ref. MO-RS-MMT-SY -0008

AD3. Satellite Thermal Model Requirement Specification, Ref. MO-RS-MMT-SY-0009

AD4. Electromagnetic Interference Characteristics, Measurement of, MIL-STD-462C.

AD5. NOAA Instrument GSE-to-METOP Interface Requirements, Ref. GSFC S-480-91.

AD6. HIRS/3 Instrument Thermal Interface Mathematical Model Report, Ref. SAI-RPT-085

AD7. HIRS/3 Instrument Thermal Interface Mathematical Model (Ref. LTS/0200/BB)

AD8. Reduced Model of HIRS Baseplate for ESA Thermal Elastic Analysis,
Ref. S-TIROS-SRH-96-0072 (included in LTS/0312/BB)

AD9. HIRS Thermo-Elastic Model (Ref. TBD_{MET})

AD10. PLM EGSE Internal Interface Control Document, Ref. MO-ID-DOR-PM-0018.

AD11. Void

AD12. Cryo Assy HIRS (= Bench Cooler). Ref. 8170792

AD13. Handling Fixture, Ref. 8129933

1.133. Reference Documentation

RD1. Performance Assurance Requirements for the NOAA-K, L & M AVHRR/3 and HIRS/3
Ref. S-480-29.1, Rev. G, dated March 1990

RD2. Performance Specification for the NOAA-N, N' and METOP-1 HIRS/3
Ref. S-480-28.2, Rev. C dated March 1993

RD3. ATN-K,L,M General Instrument Interface Specification
Ref. IS-3267415, Rev. C, dated October 1991

RD4. Unique Interface Specification for HIRS/2 (applicable to HIRS/3 and HIRS/4)
Ref. IS-2285780, Rev. J, dated February 1995

RD5. HIRS/3 Incoming Inspection and Test - Pre-Installation on Satellite Tests
Ref. FPR-2285780, Rev. H, dated April 1992

RD6. Void

RD7. Void

RD8. HIRS/3 Structural Dynamic Analysis Report. Ref. TBD

RD9. METOP GSE Requirements, ITT Technical Note. Dated May 15th, 1996 (M. WEBB)

RD10. Outline Drawing Cooler Target, Ref. 8160346

RD11. Requirements for the Data Acquisition Block for NOM Instruments,
Ref. MO-RS-DOR-PM-0025.

RD12. Final Report far TIROS Instruments Dynamic Analysis (Opening of Radiant Cooler Door),
Ref. S.DRC 19150

1.13. Acronym List

AD	Applicable Document
A-DCS	Advanced Data collection system
AIT	Assembly, Integration & Test
AIV	Assembly, Integration & Verification
AMSU-Al	Advanced Microwave Sounding Unit 1
AMSU-A2	Advanced Microwave Sounding Unit 2
ARGOS	Meteorological Data Collection and Location System
ASCAT	Advanced Wind Scatterometer
AVHRR/3	Advanced Very High Resolution Radiometer
BOL	Beginning of Life
C&C	command & Control
CAM	Coarse Acquisition Mode
CCU	Central Computer Unit (SVM)
CR	Customer Furnished Instrument
CRA	Combined Receive Antenna (A-DCS. SARR, SARP-3)
DBU	Digital Bus Unit
DC	Direct Current
DSPG	Distributed Single Point Grounding
DTA	DCS Transmit Antenna
ECT	Earth Calibration Target
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOL	End of Life
FAM	Fine Acquisition Mode
FEM	Finite Element Model
FMECA	Failure Modes, Effects and Criticality Analysis
FMU	Formatting and Multiplexing Unit
FOV	Field of View
FPM	Fine Pointing Mode
Gbit	Gigabits
GNSS	Global Navigation Satellite System
GOME-2	Global Ozone Monitoring Experiment
GRAS	GNSS Receiver for Atmospheric Sounding
GSE	Ground Support Equipment
H/W	Hardware

HIRS/4	High Resolution Infra-Red Radiation Sounder
HK	House Keeping
HRPT	High Resolution Picture Transmission
ICT	Internal Cold Target
I/F	Interface.
IASI	Infra-red Atmospheric Sounding Interferometer
ICD	Interface Control Document
ICU	Instrument Control Unit
IR	Infrared
IST	Integration System Test
IWT	Internal Warm Target
kbps	kilobits per second
KLM	NOM K, L, M series of satellites
LEOP	Launch and Early Orbit Phase
LRPT	Low Resolution Picture Transmission
Mbps	Megabits per Second
MCMD	Macro Command
MGSE	Mechanical Ground support Equipment
MHS	Microwave Humidity Sounder
MIL	Military (standard)
N/A	Not Applicable
NEdN	Noise Equivalent Spectral Radiance
NIU	NOM Instrument Interface Unit
OBDH	Onboard Data Handling System
OCM	Orbit Control Mode
OCOE	Over Check-Out Equipment
OMI	Ozone Monitoring Instrument
P/F	Platform
P/L	Payload
PA	Product Assurance
PCU	Power Conversion Unit
PLM	Payload Module
PMC	Payload Madule Computer
RD	Reference Document
RF	Radio Frequency
RFC	Radio Frequency Compatibility

rms	root mean square
rpm	round revolutions per minute
RRM	Rate Reduction Mode
Rx	Receive ; Receiver
S&R	Search and Rescue
S/C	Spacecraft
S/L	Satellite
s / s	Subsystem
S/W	Software
SARP-3	Search and Rescue Processor
SARR	Search and Rescue Repeater
SEM-2	Space Environmental Monitor
SLA	S&R L-band Tx Antenna
SVM	Service Module
TB/TV	Thermal Balance / Thermal Vacuum
TBC	To be confirmed
TBCU	Transportable Bench Check Unit
TBD	To be defined
TC	Telecommand
TCU	Thermal Control unit
TM	Telemeuy
TT&C	Tracking, Telemetry, and Telecommand (LEOP, Emergency. and Stand-by)
Tx	Transmit, Transmitter
YSM	Yaw Steering Mode
TCU (GSE)	Temperature Control Unit
NDAPB	....

1.2. INSTRUMENT PRESENTATION

12.1. General

(For information only)

Instrument Name	**HIRS/4** High Resolution **Infra-Red** Radiation **Sounder / 4**
Classification	**Passive optical instrument**

The **HIRS/4** is a **20-channel** scanning **radiometric** sounder.

Multi-spectral data from twenty channels are obtained from a single telescope and a rotating filter wheel containing twenty individual **filters.** An elliptical scan mirror **provides** cross-track **scanning** of 56 steps **in increments of 1.8 deg. The filter wheel makes one revolution for each step of the scan mirror. The** mirror rapidly steps (≈ 32 msec.), then holds at each position **while the** twenty **filter segments** are sampled during the wheel revolution This action (step & dwell) **takes** place each 0.1 sec. As a **result,** an Earth scan line lasts 6.4 sec. (steps & dwells + retrace back).

The **HIRS/4** optics are designed to operate within its **specifications under** any Sun angle condition between 0 and 80 **deg.** The radiant cooler is designed to operate from 0 to 68 deg. Sun angle and, with spacecraft supplied shading, can operate from 0 to 80 deg. Sun angle. The Sun angle is **defined** as the angle between the satellite to **Sun** line and the **normal** to the orbital plane.

1.2.2. Scientific Objectives

(For information only)

The High Resolution **Infra-Red** Sounder **HIRS/4,** scans **the** Earth surface in twenty spectral bands in the range of 0.69 - 14.95 microns : **one** visible channel at 0.69 micron, seven short-wave **IR** channels (3.7 to 4.6 microns) and twelve long-wave **IR** channels (6.5 to 15 microns). It **provides** data for temperature - **altitude** profiles. moisture content. cloud height and **surface** albedo.

Infra-red calibration of the **HIRS/4** is provided by programmed views of two **radiometric** targets : **the** warm target mounted on the instrument base **and** a view of space. Data from these views provides **sensitivity** calibrations for each **IR** channel at 256 second intervals, when commanded.

The instrument sensitivity (noise equivalent spectral radiance, **NEdN)** are illustrated in Table **1.2.2/1.**

Channel	Wavelength (µm)	Specified Sensitivity (NEΔN) ($\frac{mW}{m^2 sr\ cm^{-1}}$)	
1	14.95	3.00	LW
2	14.71	0.67	
3	14.49	0.50	
4	14.22	0.31	
5	13.97	0.21	
6	13.64	0.24	
7	13.35	0.20	
8	11.11	0.10	
9	9.71	0.15	
10	12.47	0.15	
11	7.33	0.20	
12	6.52	0.20	
13	4.57	0.006	SW
14	4.52	0.003	
15	4.47	0.004	
16	4.45	0.004	
17	4.13	0.002	
18	4.00	0.002	
19	3.76	0.001	
20	0.69	0.10% albedo	VIS

Table 1.2.2/1 : HIRS/4** Channel Allocation and **Sensitivity

133. **Functional Description**

The HIRSN **instrument** is a single package which mounts directly onto **the** satellite A **HIRS/4** system **block** diagram is illustrated in Figure **1.2.3/2.** An **exploded** view showing the **major** sub-assemblies is given in **Figure 1.2.3/1. These are described below.**

133.1. Scan subsystem

The scan subsystem includes power, control and **motor** drive electronics. **the** scan drive **motor,** the Beryllium scan mirror, a shaft angle optical **encoder, a tachometer and a torque motor. The subsystem provides** a digitally positioned direct drive **mechanism** far **moving** the scan **mirror through** Earth scanning and **radiometric** calibration. The scan cycle **and** timing are **described** in Table **1.2.3.1/1** and Figure **1.2.3.1/2.**

The scan mirror is driven by a permanent magnet rotor type stepper motor with two stator windings. It is used in a basic four step cycle with 50 cycles per **rotation, giving 200 incremental 1.8 deg. steps per rotation.**

The resulting Earth swath is ± 49.5 deg. with respect to the nadir direction.

The DC torque motor has a permanent magnet bar type rotor. This motor is used to aid in stopping the scanner rotation at any selected position.

1.233. Filter Wheel Sub-Assembly

The separation of infra-red channel information is done by sequentially sampling the energy passing through individual spectral filters in the rotating filter wheel.

The filter wheel is directly mounted on the rotor of a two-phase 40-pole hysteresis synchronous motor driven at precisely 600 revolutions per minute.

1333. Detectors

There are three detectors in the instrument. A Silicon photodiode at the instrument ambient temperature (nominally 15 deg. C) is used for the visible channel, whereas the long-wave and short-wave IR channels respectively use a HgCdTe detector and a InSb detector that are mounted on the patch of the instrument radiant cooler.

1.23.4. Radiant Cooler Assembly

The short-wave and long-wave infra-red detectors are mounted on a two-stage passive radiant cooler and operate at a stabilized 95 K temperature.

An Earth shield door on the cooler assembly shadows the radiator from Earth direct thermal input. The door is released after the initial orbital outgas period. During the outgas / decontamination period, the cooler temperature rises to approximately 300 K.

The door deployment is performed by spring loaded hinges with a redundant solenoid actuated cam. The cooler door opening mechanism is automatically de-energized within 2 seconds after the Door Deploy Command is executed within the instrument. The door, once deployed, cannot be closed without manual intervention.

1335. Optical Assembly

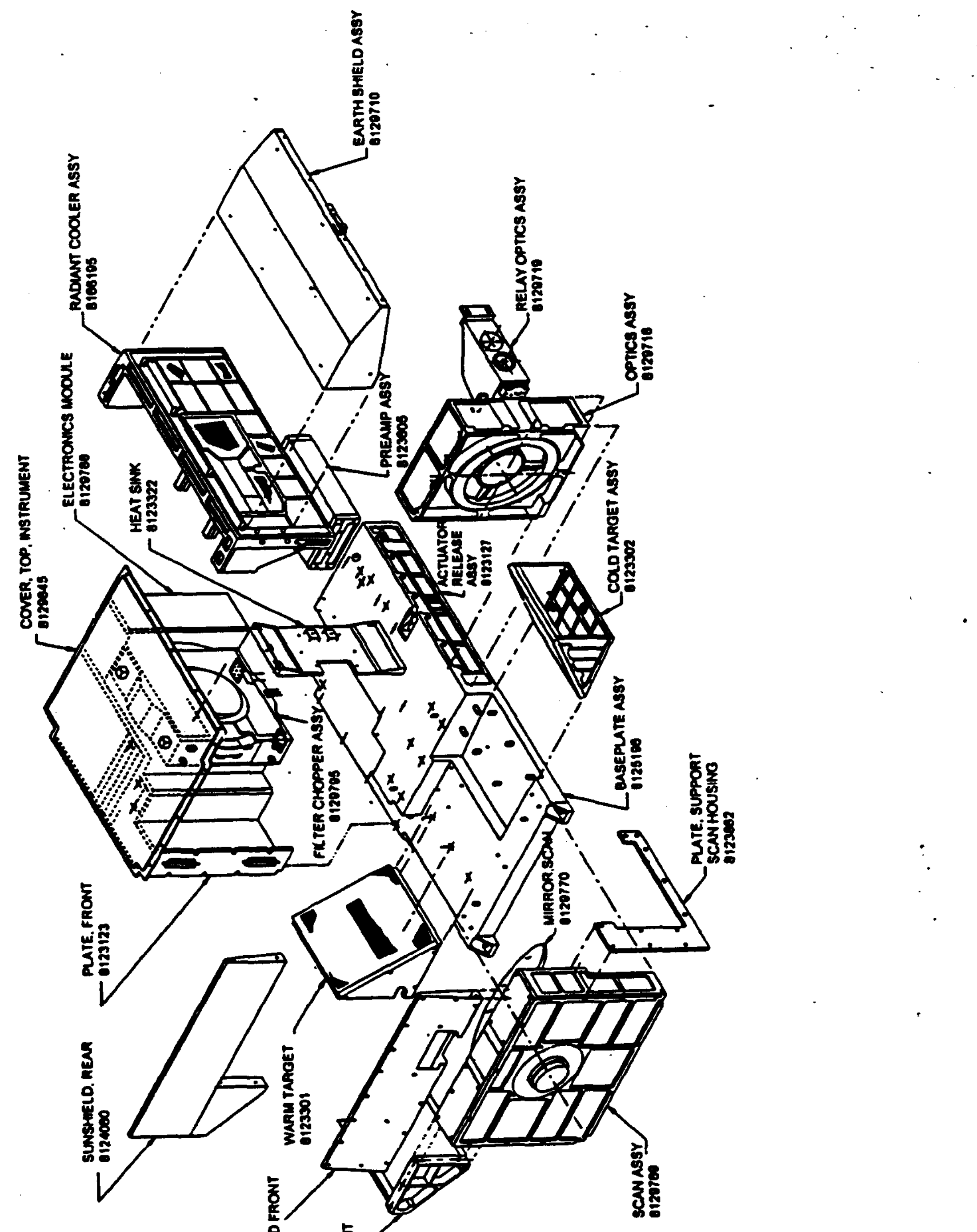
The HIRS/4 scene energy collection optic is a 15-cm Cassegrain telescope. The collected energy is separated by two subsequent beam splitters into long-wave IR components, short-wave IR components and the visible channel.

Its characteristics are summarized as follows :

- Instantaneous scene field of view : 0.69 ± 0.04 deg. (circular, ≈ 10 km at 833 km orbit altitude)
- Total telescope field of view : 1.8 deg. nominal

133.6. Baseplate

The baseplate unit is the common structure on which all other modules are mounted. It is the physical interface to the satellite. It is also the major interface for the radiative thermal control Of the instrument.



[redacted]

Figure [redacted] View

[redacted]

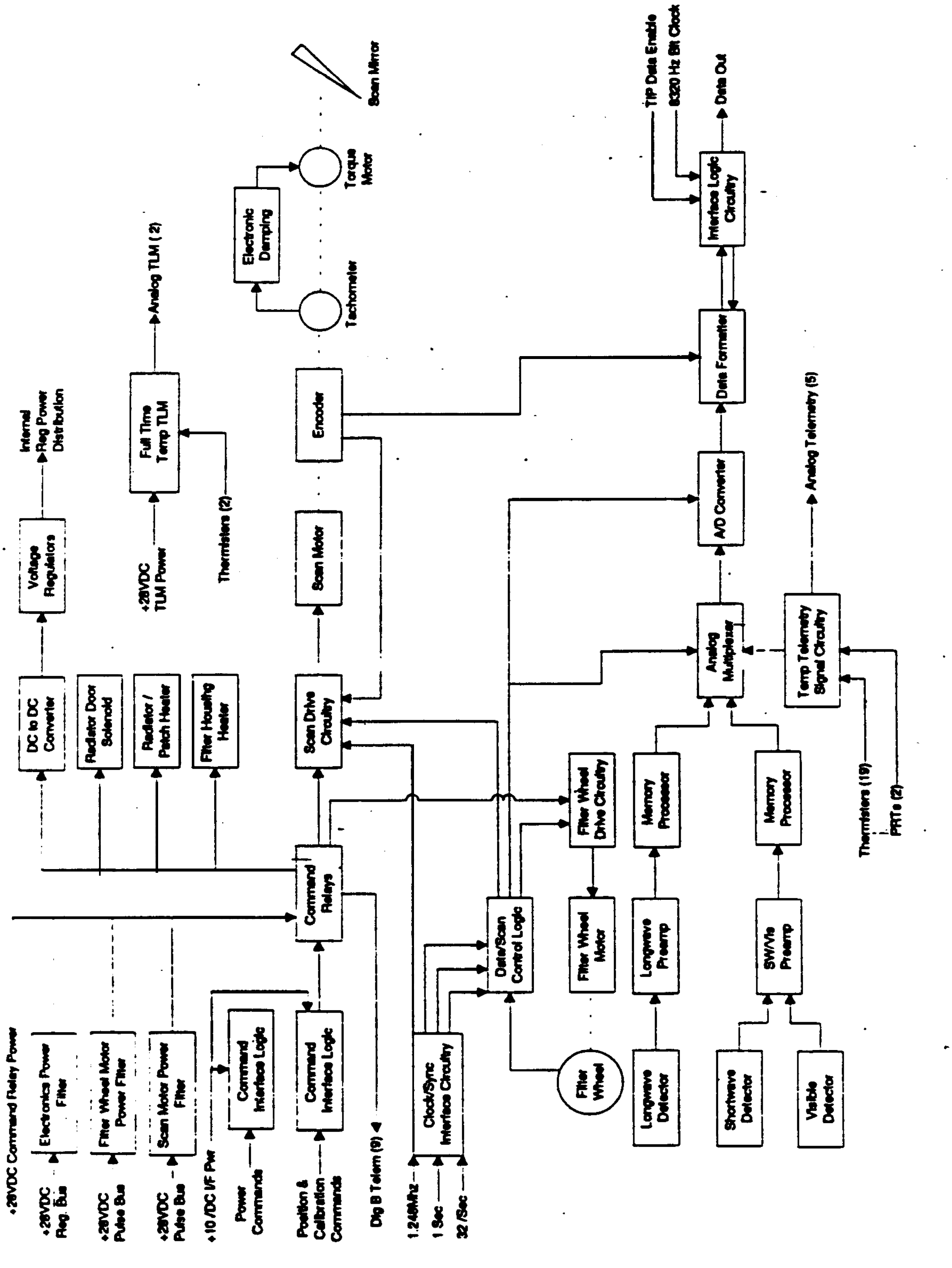


Figure ***1.2.3/2 : HIRS/4 System*** *Block* ***Diagram***

Scan Cycle	Description	Sequence Duration	Total
Part1: Calibration Cycle	Slew	0.8 s	000.8 s
	Space View Dwell	4.8 s	005.6 s
	Slew	0.8 s	006.4 s
	Warm Target Dwell	5.6 s	012.0 s
	Slew	0.8 s	012.8 s
Part2: Earth Scan	**Earth scan #1** 56 steps & dwells of 0.1 s Retrace back of 0.8 s	6.4 s	019.2 s
	Earth scan #2 56 steps & dwells of 0.1 s Retrace back of 0.8 s	6.4 s	025.6 s
	...		...
	Earth scan #38 56 steps & dwells of 0.1 s Retrace back of 0.8 s	6.4 s	256.0 s

Table *1.2.3.1/1* : *HIRS/4* Scan *Cycle Description*

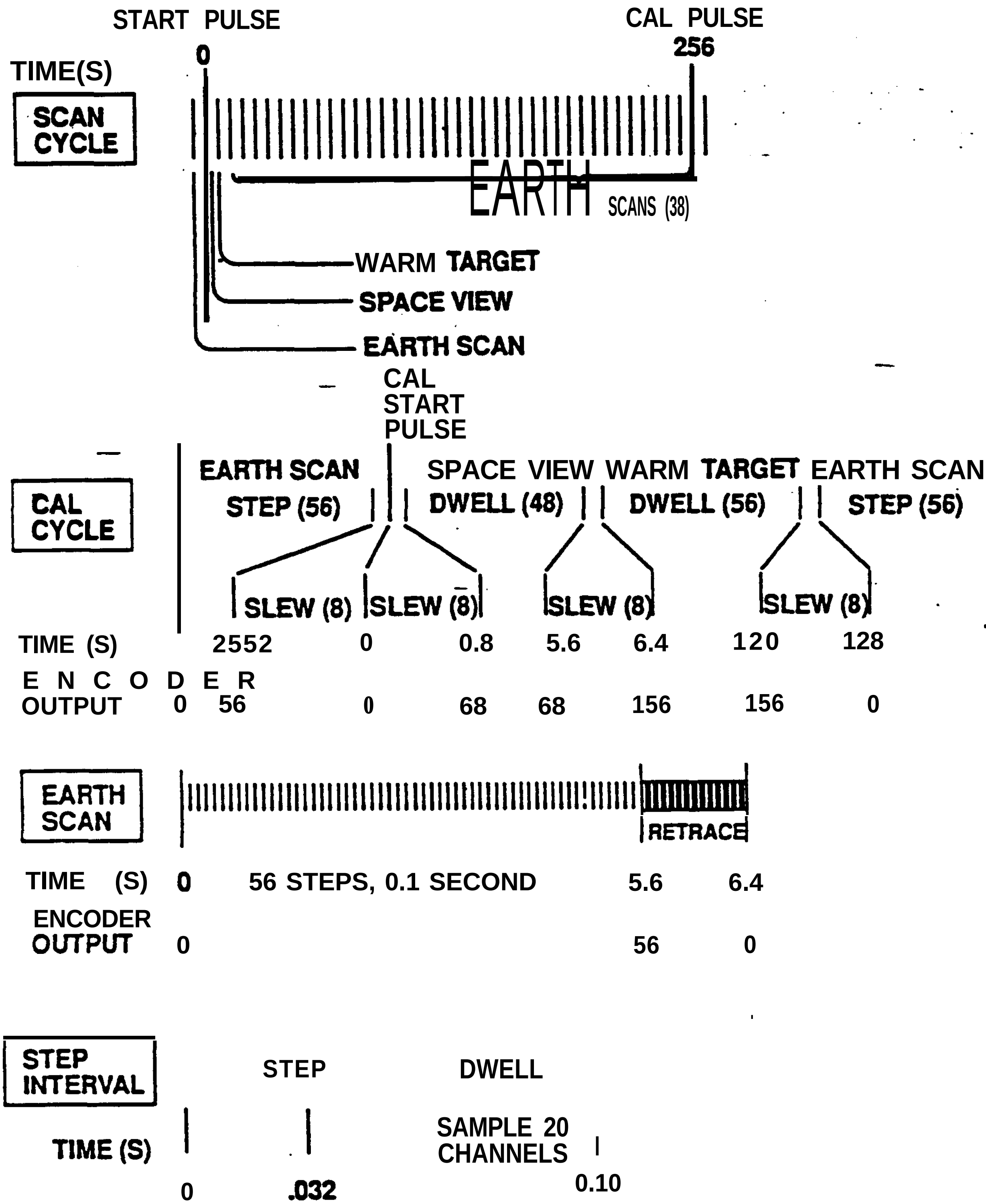


Figure 1.2.3.1/2 : HIRS/4 Scan Timing

1.3. METOP SYSTEM OVERVIEW

13.1. Spacecraft Architecture Concept

(For information only)

The METOP mission consists of a geocentric, three-axis stabilized spacecraft placed into a Sun-synchronous orbit around the Earth. It is built around a primary structure consisting of :

- a service module (SVM), which provides all standard service elements
- an upper payload module (PLM) that accommodates the different instruments and corresponding electronic equipments.

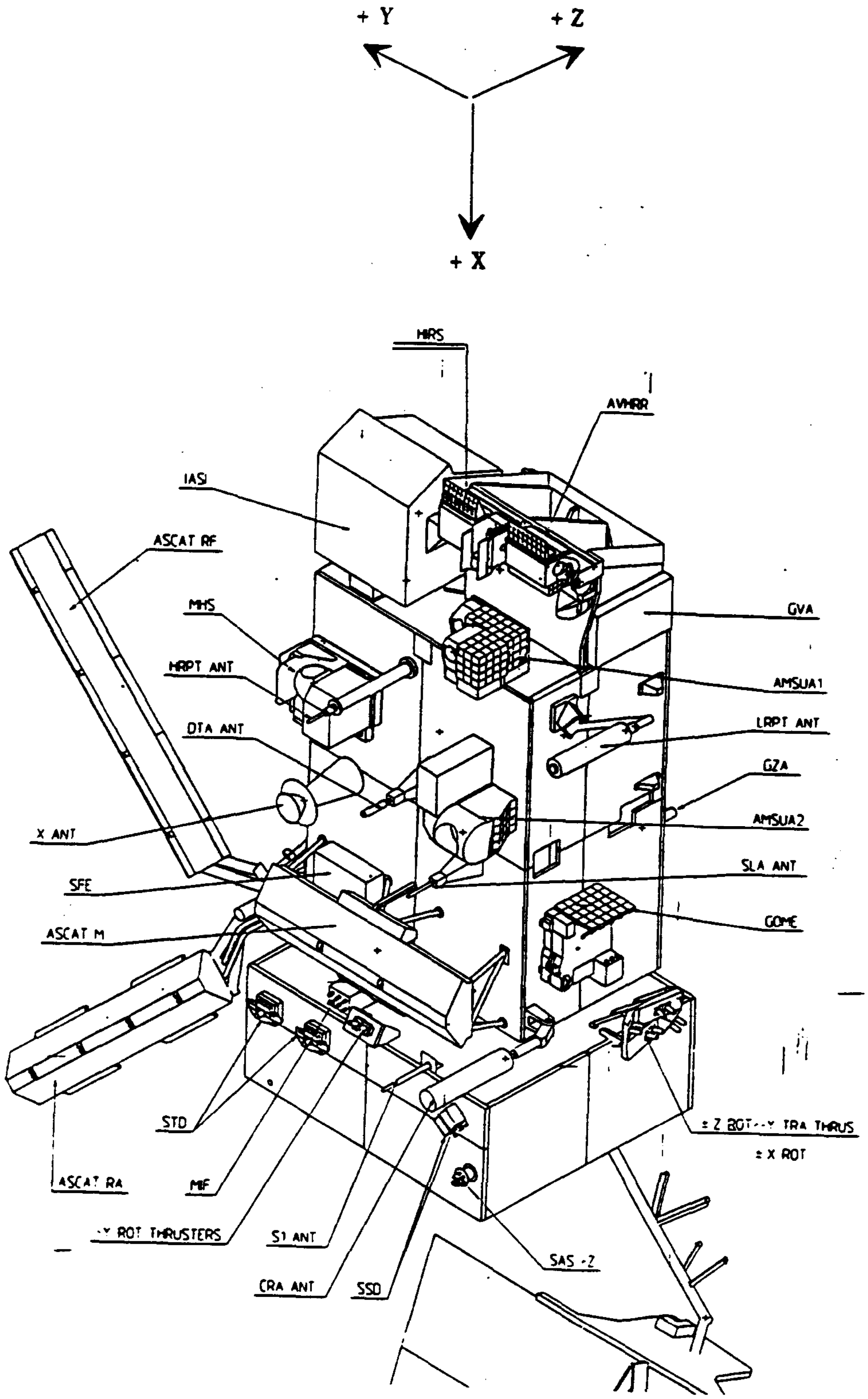
The service module is a box-shaped structure, that interfaces with the launch vehicle at the bottom and with the payload module at the top.

The payload module provides the main supporting structure and external panels on which are mounted the payload instruments. It also provides internal accommodation for both the payload support systems and the instrument electronic units.

The METOP satellite in-orbit configuration is illustrated in Figures 1.3.1/1 and 1.3.1/2.

The HIRS/4 interfaces with the following PLM units :

- the NOAA Instrument Interface Unit (NIU) provides all command and control interfaces to the HIRS/4, i.e. configuration and mode switching (commands), command verification, housekeeping telemetry acquisition, and clock and time management. The NIU also acquires the measurement data from the instrument.
- the Power Conversion Unit (PCU) provides the HIRS/4 with the regulated buses.
- the Thermal Control Unit (TCU) provides heater power supply and acquires the corresponding thermistor outputs.



WARNING : MAY BE SUBJECT TO CHANGE

Figure 1.3.1/1 : METOP Satellite Overall Configuration (For Information Only)

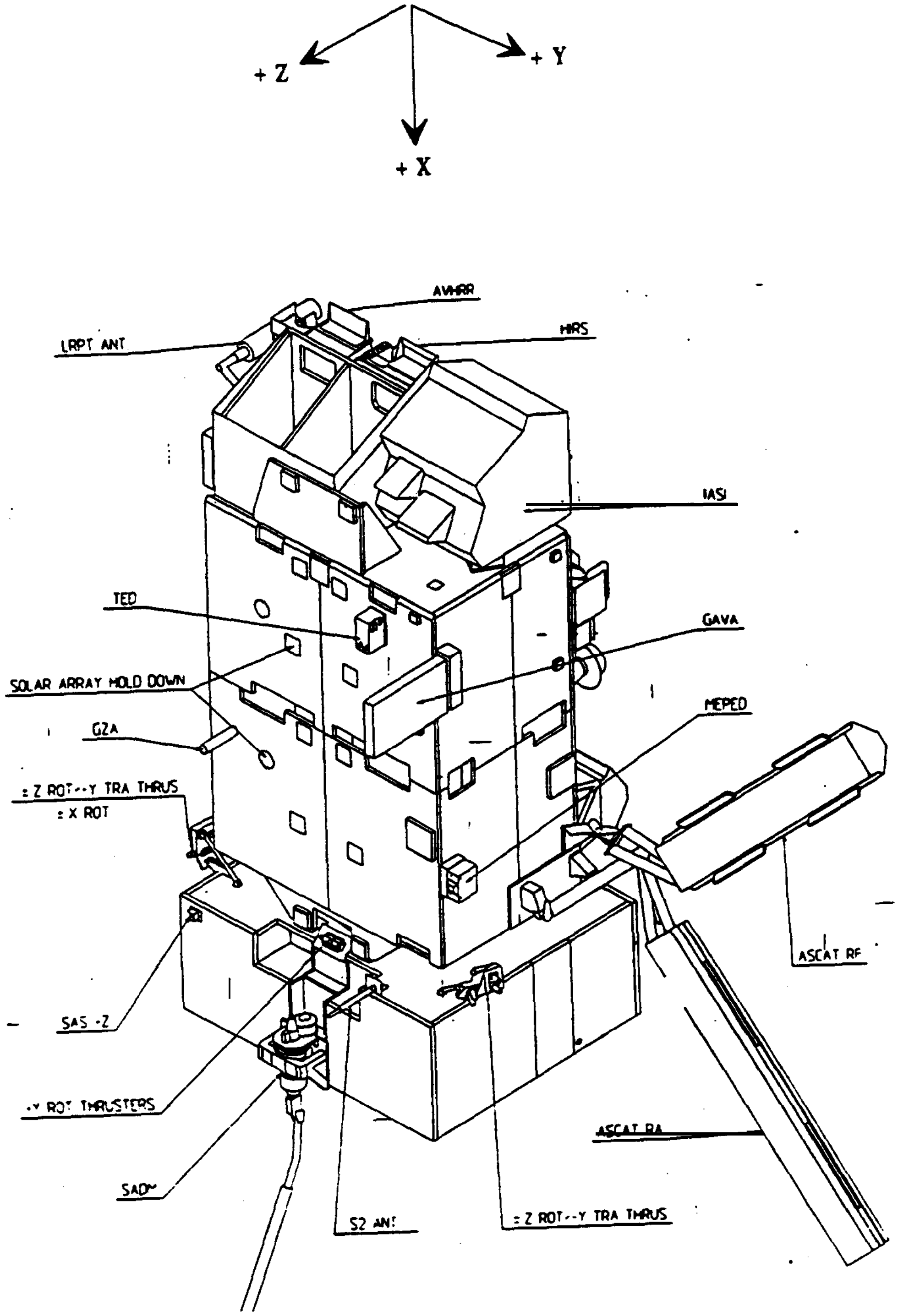


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***Figure 1.3.1/2 : Back View of the Satellite** (For **Information Only**)*

13.2. METOP Reference Frames

1.3.2.1. Satellite Reference Frame

The METOP satellite co-ordinate system is defined as follows (Spacecraft Absolute Reference Frame $(O, X_s, Y_s, Z_s) F_s$) :

- 0 is located within the spacecraft to launcher separation plane, at the centre of the attachment ring,
- **The Xs-axis is perpendicular to this separation plane and oriented from the spacecraft towards the launch vehicle,**
- The Zs-axis is the normal-out of the surface that carries the stowed solar array,
- The Ys-axis completes the right-handed orthogonal reference frame.

This reference is illusuated in Figure 1.3.2/1.

During normal payload operations, the (+X)-axis will be closely aligned to the orbit positive normal direction, the (-Y)-axis will be closely aligned to the METOP velocity vector and the (-Z)-axis will be closely aligned to the local downward direction (nadir)[1].

13.22. Instrument Reference Frame

The following is a requirement for the defmition of the instrument reference frame. The frame specific to the HIRS/4 is defined in § 2.1.3.2

The instrument shall have a right handed orthogonal co-ordinate reference system $(X_{HIRS}, Y_{HIRS}, Z_{HIRS}) F_{HIRS}$ **and it shall be defined such that :**

- the origin shall be physically located on an accessible, identifiable instrument exterior feature (e.g. the centre of one mounting hole, at the instrument baseplate level)
- the axes being ideally aligned with the X_S, Y_S, Z_S spacecraft axes. e.g. for instruments mountedonthe platform nadir side, the datum plane which shall contain the X_{HIRS}, Y_{HIRS} axes. is the plane containing the unit mounting lugs, and the Z_{HIRS} axis is perpendicular to this datum plane in the direction from the unit to the datum plane.

Thesc axes shall be referred to on all drawings and any finite element description.

---

[1] For information, the correspondence between the METOP reference axes and TIROS reference axes is :
Xs METOP = Z TIROS **Ys METOP = Y TIROS** **Zs METOP = - X TIROS**

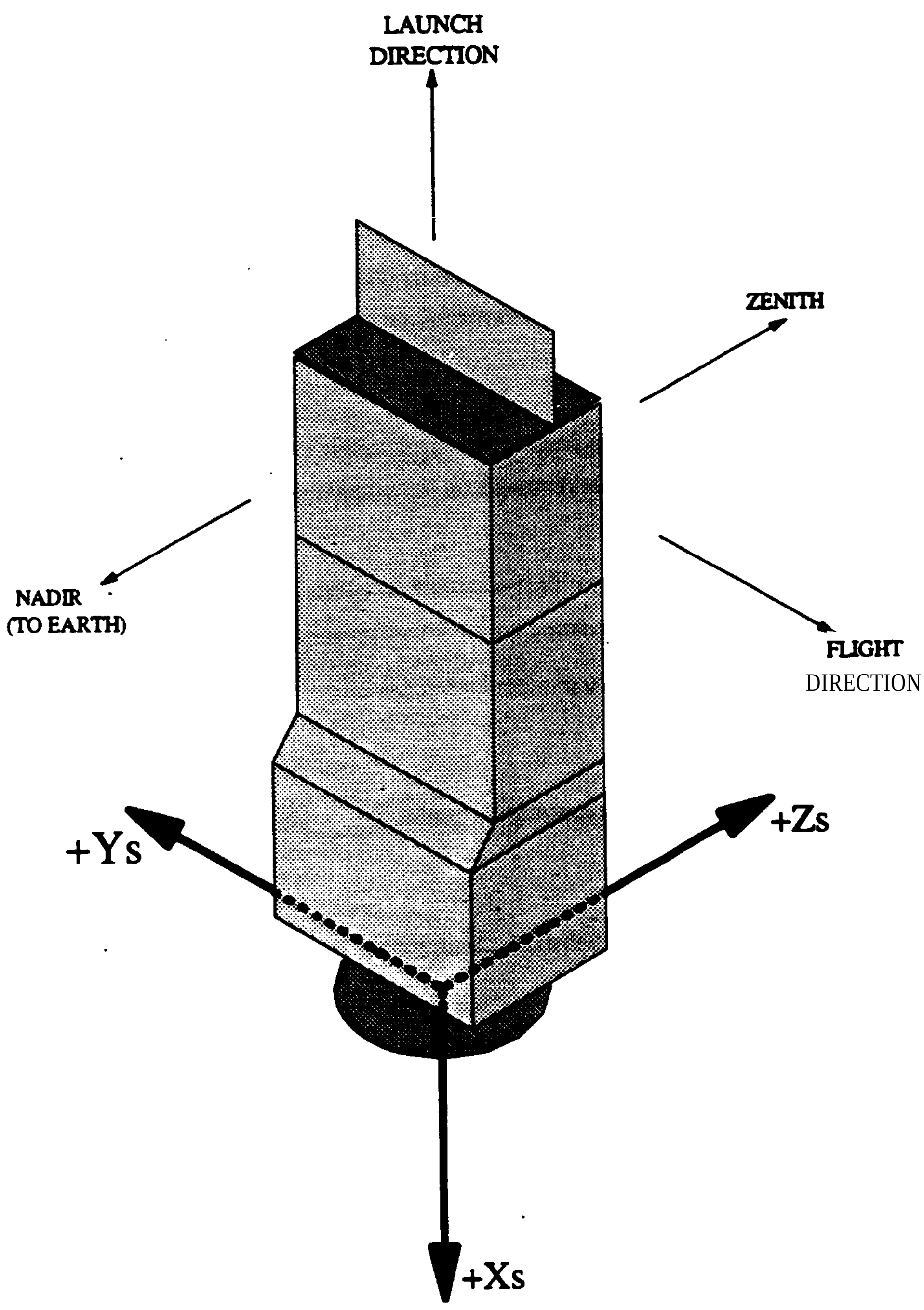


Figure 1.3.2/1 : Satellite Reference Frame

133. Orbital Parameters

133.1. Reference Orbit

METOP will be placed into the following reference orbit :

-Type:	Sun-synchronous
- Semi-major axis :	7197.939 km
- Repeat Cycle :	5 days (14 + 1/5 orbits per day)
- Local Solar Time :	09:30 A.M. descending node

The maximum solar aspect angle for this orbit is 60.5 deg. (the solar aspect angle is defined as the angle between the satellite to Sun line and the normal to the orbital plane).

133.2. Drift Orbit

For METOP-1, the previous orbit will be reached after a 6-month (TBC_{MET}) drifting phase (dual launch), from an initial polar orbit (close to the Sun-synchronous one) with a local solar time around 10:00 AM. descending node.

The maximum solar aspect angle for this orbit is 67.0 deg. (the solar aspect angle is defined as the angle between the satellite to Sun line and the normal to the orbital plane).

METOP-2 will be launched directly into the reference orbit.

13.4. Satellite Mission Phases and operations

13.4.1. Mission Phases

During its lifetime, the satellite is operated through the following mission phases :

- **Launch Phase**

  The proper launch phase begins at the instant of switching the power subsystem to on-board batteries before lift-off and ends at satellite/launch vehicle separation.

- **Acquisition Phase**

  This phase starts at the end of the launch phase and ends once the satellite has acquired its operational attitude and orbit with its appendages deployed. An initial acquisition sequence leading to a system secured state. is followed by a final acquisition period.

- **Commissioning Phase**

  This phase starts once the attitude and orbit have been acquired and covers the time that subsystems and instruments are checked out. It ends when the payload is operational for the nominal orbit.

For **METOP-1**, it starts when the satellite is still drifting to achieve the nominal local solar time of 09:30.

- **Routine /** Operational Phase

This phase starts at the end of the commissioning phase and covers the time when the instruments are operational and the times when orbit maintenance manoeuvres are performed.

1 3 . 4 3 . Satellite Operational Modes

This section describes the satellite operational modes and the corresponding pointing performances.
Note : the **HIRS/4** provides no compensation for satellite pointing errors.

1.3.4.2.1. Nominal Operational Mode

The nominal operational mode for METOP SVM is the Yaw Steering Mode (YSM[2]). During this mode, the PLM is in its Operable Mode : the instruments can be nominally operated through their measurement, heater, calibration... modes, and measurement data are transmitted to the ground.

'The characteristics of the satellite nominal operational mode are the following :

Nominal Mode **(YSM)**			
Commanded Pointing	**-Zs**	**Pointing towards nadir**	
	-Ys	Pointingtowardsthevelocity	
Pointing **Performances (According** to **ESA** Summation Rules)			
Absolute Pointing Error **AVHRR/3** Line of Sight **(TBC$_{MET}$)**	**X axis** f0.17 deg.	**Yaxis** **± 0.17** deg.	**Z axis** f0.22 deg.
Pointing Knowledge All **Instrument** Interface Reference Frames	xaxis ± 0.17 deg.	Yaxis ± 0.17 deg.	zaxis. ± 0.22 deg.
Absolute Rate Error **(Max, 0-4 Hz)**	**X, Y, Z axes** **± 0.005 deg./s TBC$_{MET}$**		

Note : The AVHRR/3 is the reference sensor for **METOP** pointing.

1.3.4.2.2. Orbit Control Modes

The previous performances are not guaranteed during large amplitude orbit control manoeuvres for altitude maintenance or inclination maintenance. Those are performed in SVM Orbit Control Mode (OCM) or Fine Control Mode (FCM).

During those modes, the PLM is still operable and the instrument nominal operations are not stopped even if the generated measurement data may be corrupted. This is not true for the initial orbit

2 During tbe Yaw Steering Mode (YSM), the satellite Z axis (yaw) is steered according to sinusoidal function over the orbit with an amplitude of about 4 deg.

corrections, for which the PLM and the instrument status are in LEOP / Off Modes (see specific provision for HIRS/4 in § 1.4.2).

Altitude Maintenance

For altitude maintenance during the routine phase (in-plane manoeuvres), the commanded attitude is similar to the one in the nominal operating modes (YSM or local orbital reference frame), but with different pointing performances :

Orbit Control Mode : Altitude Maintenance		
Commanded Pointing	-Zs	Pointing towards nadir
	-Ys	Pointing towards the velocity
Pointing Performances		
Absolute Pointing Error All Instrument Interface Reference Frames	X, Y, Z axes ± 2 deg. TBC_{MET}	

Inclination Maintenance

For inclination maintenance during the routine phase (out-of-plane manoeuvres), the satellite body is rotated by 90 deg. ± 20 deg. around the yaw axis (Z-axis), and by ± 20 deg. around the X-axis (local orbital reference frame), and a thrust normal to the orbit plane is performed. The rotation direction can be both clockwise and anti-clockwise and occurs around a node of the orbit.

The overall manoeuvre (rotation, thrust and back rotation) is performed during the eclipse phase of the orbit.

During these manoeuvres, the nominal mode is stopped for typ. 4 orbits, but the duration from the beginning of first rotation to the end of back rotation is less than 1800 sec.

The pointing performances are then :

Orbit Control Mode : Inclination Maintenance Pointing Performances	
Absolute Pointing Error All Instrument Interface Reference Frames	X. Y, Z axes ± 2 den. TBC_{MET}

1.3.4.2.3. Acquisition Modes

The acquisition modes encompass all actions leading to a stabilized Earth attitude, including deployment of all major appendages.

The corresponding SVM modes are the Rate Reduction Mode (RRM), the Coarse Acquisition Mode (CAM), the Fine Acquisition Modes (FAM1, FAM2 and FAM3) and the Fine Pointing Mode (FPM).

During these modes, the PLM is in the Lift-Off Mode and then LEOP Mode. ~~In general, all instruments are switched off.~~

Once the satellite attitude is stabilized, the pointing performances are the following (local orbital reference frame):

Acquisition Modes			
Commanded Pointing	-Zs	Pointing towards nadir	
	-Ys	Pointing towards the velocity	
Pointing Performances			
Absolute Pointing Error All Instrument Interface Reference Frames	xaxis ± 5.0 deg TBC_{MET}	Y axis ± 5.0 deg. TBC_{MET}	zaxis ± 7.5 deg. TBC_{MET}
Absolute Rate Error (Max, 0-4 Hz)	X, Y, Z axes ± 0.05 deg./s TBC_{MET}		

Note : The mode sequence up to a stabilized satellite attitude may last up to 3500 sec.

1.3.4.2.4. Contingency Cases

In the event of detection of a satellite failure, several back up modes exist at PLM and / or SVM levels.

PLM Failure Cases

For failure at PLM level only, the corresponding PLM modes are the PLM Stand-By Mode, the PLM Fix Mode and the PLM Safe Mode, depending on the failure. All instruments are switched ~~off~~ to OFF MODE (see specific provision for HIRS/4 in § 1.4.2).

The SVM is not affected and the nominal attitude is maintained (see § 1.3.4.2.1.)

SVM Failure Cases

For failure at SVM level, the PLM is forced to PLM Stand-By Mode, PLM Fix Mode or PLM Safe Mode, depending on the failure. and all instruments are switched ~~off~~ OFF MODE (see specific provision for HIRS/4 in § 1.4.2).

The SVM enters several modes that lead to a stabilized Earth pointing attitude. Ftom an operational point of view. those modes are similar to the very first attitude acquisition that follows the separation from the launch vehicle. but with deployed appendages..

Once the satellite attitude is stabilized, the pointing performances are the same as those described in § 1.3.4.2.3. with similar delay performances up to a stabilized satellite attitude.

1.3.4.2.5. Safe Mode (Sun Pointing)

In addition to the previous back-up modes, an ultimate safety level is implemented on METOP. This so-called Safe Mode performs the minimal functions for satellite survival by maintaining a Sun-pointed attitude. During the Safe Mode, the PLM is in the PLM Safe Mode and all instruments are switched off (see specific provision for HIRS/4 in § 1.4.2).

The characteristics of such a mode are:

Safe Mode			
Commanded Pointing	+Zs Pointing towards the Sun		
	The attitude is not controlled but remains within the limits specified below		
Pointing Performances			
Absolute Pointing Error	sun-lit phases	xaxis ± 15 deg.	Yaxis ± 15 deg.
All Instrument Interface Reference Frames	Shadowed	xaxis ± 20 deg.	Yaxis ± 20 deg.
	Delay between eclipse and sun-lit performances : 500 s		
Absolute Rate Error (Max, 0-4 Hz)	The rate about any axis is controlled between 0 andfo.l deg./s. TBC_{MET} There is no commanded spin.[3]		

The transients to reach this final attitude may last up to one orbit. Transitions to this final attitude are undetermined.

3 As a consequence, the (-Xs) side of the satellite. that nominally faces the cold space, may continuously face the Earth albedo during the safe mode.

1.4. INSTRUMENT OPERATIONAL MODES

1.4.1. operational Constraints

To assure proper in-orbit operations of the HIRS/4, certain practices are to be observed during the mission phases (see § 1.3.4.1.). These are :

a) ... is to be launched. in the Off Mode (see § 1.4.2.1.), in order to prevent damage to the

b) One the door is opened the cool phase starts. ... me during the drift
Commanding of "Electronics On" shall be

c) performed only if patch temperature has ... reaters. The heaters
reached 95K or patch control is active. ... he [redacted] to be

d

e ... ɔening of the radiant ... iitiated from ground) ... .c time constraint for executing this ...

f) Once the door is opened, the cool down phase starts ~~and the nominal Measurement Mode can be entered.~~ [However IR data are not valid as long as the patch power analog telemetry point is equal to zero (about 48 hours).] move to h)

g) Once the cooler door is opened, all orbit control manoeuvres (inclination manoeuvres) shall be performed in eclipse, to guarantee the instrument mission performances.

h) The nominal operating mode for HIRS/4 is the Measurement Mode. During this mode, the only operational requirement is for the satellite to ensure that the 256 sec. calibration is enabled (see § 1.4.2.3.). replace by text in 1.4.1h of NASA comments.

i) Because of the potential damage to the scanner and filter wheel drive motor bearings (the motors may not re-start). the instrument operations shall avoid to trigger the Inert Mode. All actions leading to HIRS/4 Inert Mode (see § 1.4.2.5) are considered as critical.

j) In case of PLM failure, the clock and power (10 & 28 V) may not be available at the instrument interfaces for a maximum duration of 36 hours.

k) The measurement data acquisition of Digital A Data from HIRS/4 may be corrupted in case of spacecraft failure (i.e. Data Enable and Clock interrupted and Sync. pulses present). In this case, the instrument shall be reset by ground command i.e. by powering down to Off Mode and following powering up the instrument to Measurement Mode.

1.42. Instrument Mode Overview

1.4.2.1. HIRS/4 Off Mode

During the HIRS/4 Off Mode, the HIRS/4 is unpowered except for the scan motor, the filter wheel motor and the required power buses (+28 V Main Bus and +28 V Pulse Load Bus), and the satellite provides the HIRS/4 with a 1 MHz clock for the operation of these motors and the related +10 V Interface Bus. No other service (telemetry, monitoring...) will be performed. In this mode, the scan mirror continuously rotates at 78 steps per second in a low power mode.

This Off Mode for HIRS/4 is used :

- during the METOP launch and acquisition phases, with the cooler cover door in the closed position.
- during the METOP contingency cases, with the cooler door either in the closed or open position (see § 1.3.4.2.4).
- during the METOP safe mode, with the cooler either in the closed or open position (see § 1.3.4.2.5.).

The Switched TLM bus is available at the instrument interfaces only during the PLM Stand-By and Operable Modes. The temperatures will be monitored only during these PLM modes.

1.4.2.2. HIRS/4 Heater Mode

This mode is used for the decontamination / outgassing of the instrument. During this mode, the HIRS/4 does not generate measurement /digital A data

1.4.2.2.1. initial Heater Mode

After launch, the radiant cooler heat shall be turned on and remain on with the radiator door closed to allow the instrument to be outgassed

This configuration, with the scanner and filter wheel motors running and the decontamination heater on, define-s the HIRS/4 Heater Mode.

There is no time constraint for triggering this first Heater Mode.

Duration for the initial decontamination / outgassing : see § 1.4.1.c.

After the end of the initial heater mode. the cooler is opened : see § 1.4.1.e.

1.4.2.2.2. Subsequent Heater Modes

Open-door decontaminations are done on demand They last approximately 10 days.

1.4.2.3. HIRS/4 Measurement Mode

This mode is defined as the normal operating mode of the HIRS/4, with the instrument generating measurement data. Patch temperature must be [illegible] at 95K or patch control must be active.

In this mode, the scan subsystem shall be commanded to perform a calibration sequence every 256 seconds (40 scan line intervals). In that sequence, the scan mirror scans the Earth and retraces for 38 lines, and then performs a calibrate sequence for two scan line intervals, and then repeats (see § 1.2.3.1).

The HIRS/4 Measurement Mode shall not be triggered if the instrument radiant cooler door is closed.

In the event that reference signals for start of scan position are lost, the HIRS/4 enters a *Continuous Step Mode* : a continuous stepping mode at a rate of 0.1 seconds per step or 20 seconds per rotation is initiated, in the place of the nominal 6.4 second per rotation rate. This mode is automatically left as soon as the reference signal is recovered.

1.4.2.4. HIRS/4 Commanded Position Mode

A fixed position can be commanded to accumulate long-tam data at a particular position Those positions are :

- nadir,
- space
- Internal War&Target (IWT)
- Internal Cold Target (ICT)

Upon receipt of one of the position commands, the scanner moves to the corresponding position after completion of the current scan line and retrace to step zero, or after completion of the calibration sequence (see exceptions in § 3.2.2.2). The scanner maintains the position until the command is disabled.

It is possible to go from a commanded position to another commanded position as soon as the first fixed position has been disabled.
The instrument must have been ~~commanded~~ verified to be in calibration enable
There is no constraint on the duration of this mode. Note: (to be formulated in command terms)

1.4.2.5. HIRS/4 Inert Mode

This mode is considered as a contingency mode for the instrument.

In the Inert Mode, the instrument is off, i.e. no power supply (but survival thermal control).

The Inert Mode can only be triggered by a ground command, Note : the HIRS/4 Inert Mode can also be triggered as a result of on-board failure (e.g. converter, LCL...).

Prior the removal of the main power supply, the HIRS/4 shall be faced to a protected configuration. So the' Inert Mode shall follow a Commanded Position Mode at e.g. Internal Warm Target (see § 1.5.6) :

the position of the scan mirror is then known at ± 0.9 deg. (half step) from the commanded fixed position.

During METOP Safe Mode, the Inert Mode is used for emergency shut-down of the instrument (see § 1.5.6.2), but the commanded position is not triggered.

1.43. Cross Reference Between Instrument and PLM Modes

Phases	PLM	HIRS/4	Comments
Launch and Acquisition Phases	Lift-Off Mode LEOP Mode	Off Mode	Stowed cooler door
Re-Operational Phase	Stand-By	Off Mode	Stowed cooler door
Operational Phase	operable	Off Mode Heater Mode Measurement Mode Comm. Position Mode (Inert Mode)	The door is opened after completion of the first Heater Mode
Orbit Control	Operable	Any	During Inclination Manoeuvres, the HIRS/4 is placed in Off Mode or Internal Warm Target Commanded Position Mode
Manoeuvres	Stand-By	Off Mode	
Contingency Cases	Stand-By Fix Safe	Off Mode (Inert Mode)	

1.5. INSTRUMENT LAUNCH AND IN-ORBIT OPERATIONS

The HIRS/4 operational sequences, as used on METOP, are illustrated in Figure 1.5/1.

15.1. General

Instrument operational constraints are presented in § 1.4.1.

The minimum time between two consecutive commands is specified in § 3.2.2., except as noted below..

HIRS/4 telecommands are described in § 3.2.2.

The acknowledgement of the commands by the instrument is done as described in § 3.2.3. and 3.2.4.

Instrument operations during tests axe described in § 5.

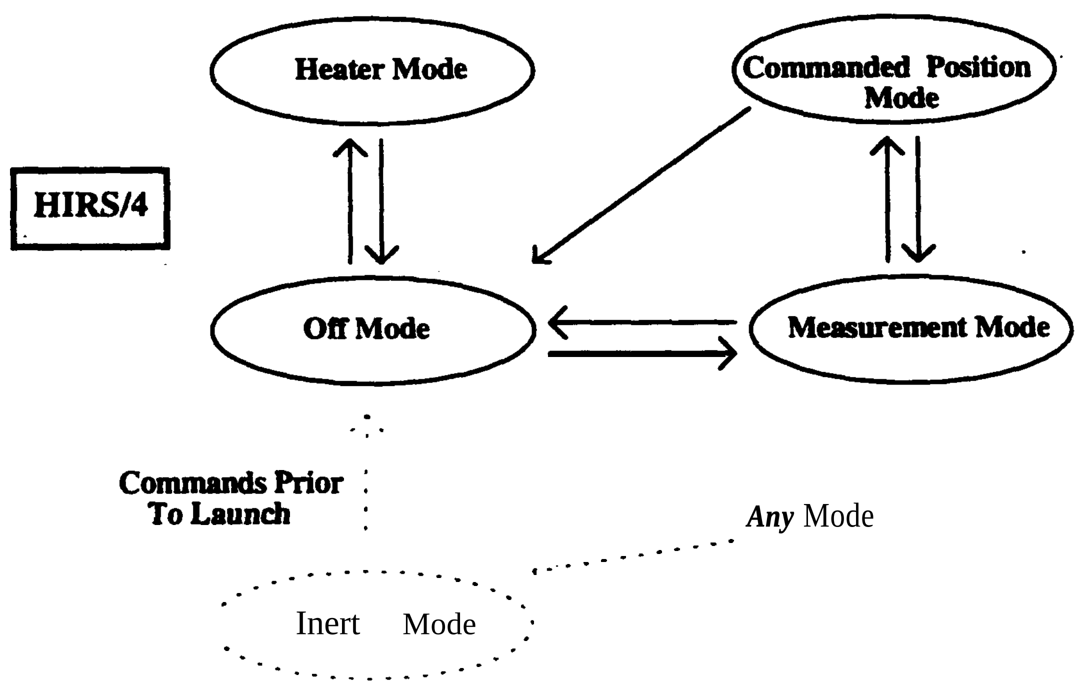


Figure 1.5/1 : HIRS/4 Mode Operation Sequence Used on METOP

15.2. Instrument Sequences to HIRS/4 Off Mode

1.5.2.1. Nominal Sequence to Off Mode

The instrument switch-off sequence from any mode except Inert Mode, into Off Mode (with motors running) shall be as following :

1) Cooler Heater OFF
2) Position Disable
3) Calibration Disable
4) Filter Housing Heater OFF
5) Patch Temp. Controller OFF
6) Electronics OFF

Remark : *The command Cooler Heater OFF will initiate the cooling down* of the instrument. Triggering of the Measurement Mode can go on at any time during this cooling phase.

1.5.2.2. Sequence from Inert Mode to Off Mode

1.5.2.2.1. Nominal Sequence from Inert Mode to Off Mode

HIRS/4 Instrument Initialization

1) Instrument OFF
2) Filter Housing Heater OFF
3) Patch Temp. Controller OFF
4) Filter Motor Power Normal

To HIRS/4 Off Mode

5) Instrument ON
6) Scan Motor ON
7) Filter Wheel Motor ON

The previous command sequences shall be executed prior to the launch.

1.5.2.2.2. Specific Sequence Prom Inert Mode to Off Mode

If the HIRS/4 Inert Mode has been triggered by a removal of the power buses, the following sequence shall be applied to trigger the Off Mode :

1) Apply the 10 V interface Bus
2) Apply the 28V Main Power Bus (to power the command relays)
3) Instrument OFF command
4) Apply all remaining power buses to HIRS/4
5) Execute the sequence described in § 1.5.2.2.1.

1.533. Emergency Sequence to HIRS/4 Off Mode

In case of emergency (including depointing), the NIU shall issue the following command sequence to the instrument, to switch down the HIRS/4 to Off Mode :

1) Cooler Heater OFF
2) Position Disable
3) Calibration Disable
4) Filter Housing Heater OFF
5) Patch Temp. Controller OFF
6) Electronics OFF

This emergency switch-off sequence shall be completed within 50 s.

To keep the motor running, the PCU (28 V) shall not interrupt the power supply to the instrument and the 10 V Interface Bus provided by the NIU will not be switched off. The clock shall not be removed from the interface.

Note : Handling of measurement data may be switched-off immediately after emergency signal reception by the NIU.

1.5.3. Instrument Sequence To HIRS/4 Heater Mode

The instrument sequence from Off Mode or Measurement Mode to Heater Mode shall be as following.

~~This sequence is also valid for the initial Heater Mode.~~

B) For sub-sequence heater modes.

1) Patch Temperature Controller OFF
2) Calibration Disable
3) Electronics OFF
4) Cooler Heater ON

A) For initial heater mode.

1) ~~Patch Temp Control~~ Cooler heater on, wait 2 weeks
2) Cooler Door Release Enable
3) Cooler Door Deploy
4) Cooler Door Release Disable

15.4. Iustrument Sequence to HIRS/4 Measurement Mode

1.5.4.1. Sequence From Off Mode to Measurement Mode

Constraints to trigger Command Measurement Mode : see § 1.4.2.3.

Command to Heater Mode has been executed (see § 1.5.3) in case of decontamination or initial door opening.

The following command sequence is divided into several steps, that can be executed at separate times.

1.5.4.1.1. Beginning of Transition Sequence

~~1) Electronics ON~~

After this command, a delay of 64 s. is necessary to allow the filter wheel to achieve synchronization. Valid visible channel data are generated.

1.5.4.1.2. Instrument Check

The following sequence is mandatory only for the first in-orbit transition from ~~Heater Mode~~ to Measurement Mode :

1) Calibration Enable
2) Nadir Position
3) Wait 13.6 seconds as a minimum
4) Position Disable
5) Space Position
6) Wait 8 seconds as a minimum
7) Position Disable
8) Internal Warm Target Position
9) Wait 7.2 seconds as a minimum
10) Position Disable
11) Internal Cold Target Position
12) Wait 13.6 seconds as a minimum
13) Position Disable
~~14) Filter Motor High Power~~
~~15) Filter Motor Normal Power~~

1.5.4.1.3. Opening of the Cooler Door

This sequence shall be applied only for ~~triggering~~ commanding the firs Measurement Mode.

~~1) Cooler Door Release Enable~~
~~2) Cooler Door Deploy~~
3) ~~Cooler Door Release Disable~~

~~1.5.4.1.4. End of Sequence~~

1) Patch Temperature Controller ON
2) Calibration Enable
3) Electronics On

Verify patch temp @ 95 K or under patch control

. Step

~~There is no time constraint to enter Measurement Mode from Heater Mode~~. The PATCH TEMPERATURE CONTROL may be turned ON at any time during cool down.

15.43. Sequence From Commanded Position Mode to Measurement Mode

The HIRS/4 Commanded Position Mode can be disabled at any time-with the following command :

1) Position Disable
2) Calibration Enable

1.5.5. Instrument Sequence to HIRS/4 Commanded Position Mode

The HIRS/4 Commanded Position Mode can be triggered at any time during the nominal Measurement Mode, with the following sequence :

1) Calibration Enable
2) Nadir Position or
space Position or
Internal Warm Target Position or
Internal Cold Target Position

The commanded position is effective within :

- 13.8 s for the nadir position command.
- 8sforthespacepositioncommand.
- 7.2 s for the IWT position command.
- 13.6 s for the ICT position command.

15.6. Contingency Operations : Instrument Sequences to HIRS/4 Inert Mode

The following switch-off sequence to Inert Mode is executed after ground confirmation.

1.5.6.1. Nominal Sequence to Inert Mode

The following sequence is valid from any mode to Inert Mode. It is divided into two steps, that can be executed at two separate times.

1.5.6.1.1. Protection of the Instrument

1) Position Disable
2) Cooler Heater OFF
3) Electronics ON
4) Calibration Enable
5) Internal Warm Target Position

The protected configuration (commanded position) is effective within 6.4 s after the last command.

1.5.6.1.2. Complete De-Activation of the Instrument

1) Patch Temp. Controller OFF
2) Instrument OFF

1.5.6.2. Emergency Sequence to Inert Mode

This sequence is only valid from HIRS/4 Off Mode to Inert Mode.

In case of emergency, the command fixed position is not triggered.

The sequence is limited to :

Instrument OFF

Or

Removal of power bus

2. MECHANICAL AND THERMAL INTERFACE DESCRIPTION

BLANK

2.1. GENERAL

2.1.1. Interface Definition

The interface definition for the instrument is the following :

Instrument	Satellite
Mechanical	
Instrument unit Alignment device in the form of two orthogonal mirrors permanently mounted on the instrument and aligned by the Instrument Supplier All insuument non flight covers (including aperture cover, radiator dust cover and connector covers)	Attachment bolts Head Bold Washers Adjustment shims Ground strap
Thermal	
Unit thermal control hardware : - Blankets, - Operational mode internal heaters, - Operational mode internal temp. sensors. Mounting of operational and survival heaters, supplied by spacecraft, to baseplate prior to painting with pig-tails for connection to the spacecraft harness.	Thermal washers 1 & 2 Additional thermal isolation stand-off (TBD_{MET}) Baseplate radiator shield : to provide a view to space for the baseplate radiator and shielding from direct solar radiation onto the deployed radiant cooler door. Additional Sun shields : to ensure that there is no solar illumination of the deployed radiant cooler door. Thermal blankets attached to the METOP structure . Main and redundant operational METOP specific heaters and related thermistor sensors for the control of the temperature at the instrument baseplate, as defined in this ICD. survival thermostat-controlled heaters and related hemostats for the conuol of the temperature at the instrument baseplate, as defined in this ICD.

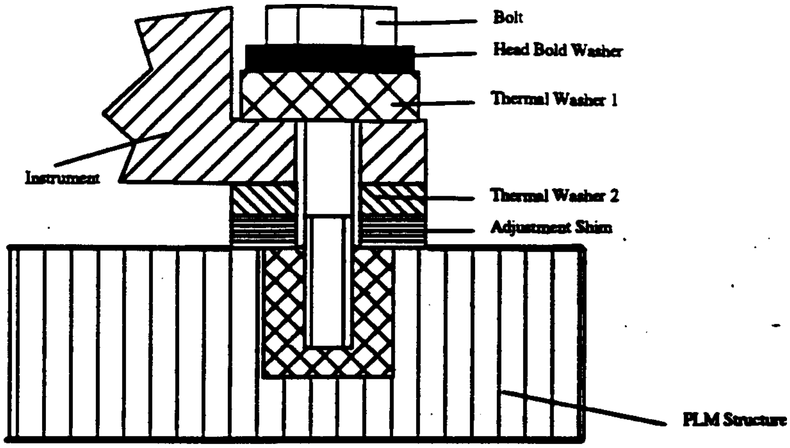


*Figure **2.1.1/1 : Definition** of Attachment **Hardware** (Generic **Schematics**)*

2.13. Module / Unit **Identification**

The Part Number and **Identification** Code of **the HIRS/4 instrument** are :

1) Equipment Name :	High Resolution **Infra-Red** Radiation **Sounder**
2) **Purchase Order** Or Contract Number :	**NAS5-30384**
3) Manufacturer Name :	**ITT Aerospace and Communications Division**
4) **Part No :**	EM **: N/A** **FM1** : 812970665 [1] FM2: 812970667
5) **ID Code :**	**Cage** Code 3 **1550**
6) **METOP ID Code**	**N/A**

The location of the labels giving **these** Part Numbers and **Identification** Codes are **defined** in the Mechanical Interface Control Drawing (See § 2.1.4.).

[1] Part number given assumes that the **FM1 will be H304 and the FM2 will be H306**. NASA / NOM may **deliver any ~~identical~~ equivalent unit to METOP.**

2.13. Reference Frames

2.13.1. Satellite Reference Frame

See § 1.3.2.1.

2.133. Instrument Reference Frame

The reference point for all mechanical and thermal data is the centre of the attachment point number 1 as shown in the Interface Control Drawings (at the interface to the PLM structure, see § 2.1.4).

The HIRS/4 Instrument Interface Reference Frame, F_{HIRS}, with the origin being at the reference point, is as defined in the Mechanical Interface Control Drawing (see § 2.1.4.). The directions Of the F_{HIRS} axes are the same as the Spacecraft Reference Frame F_S.

2.1.4. Interface Drawings

2.1.4.1. Mechanical Interface Drawings

The HIRS/4 instrument configuration and mechanical interfaces are illustrated in the following interface drawings :

- HIRS/4 Instrument Deployed Interfaces, Ref. MMS-106604-S-DD-1/4-03

- HIRS/4 Instrument Stowed Interfaces, Ref. MMS-106604-S-DD-3/4-03

- HIRS/4 Instrument Connector Panel, Ref. MMS-106604-S-DD-4/4-02

- HIRS/4 Instrument Accessibility. Ref. MMS-110216W-DD-1/1-01

2.1.4.2. Thermal Interface Drawing

'The HIRS/4 instrument thermal interfaces are illustrated in the following interface drawing :

- HIRS/4 Instrument Thermal Interfaces, Ref. MMS-106612-D-DD-1/1-03

2.1.43. Reid of View Interface Drawing

The HIRS/4 instrument field of view is illustrated in the following interface drawing :

- HIRS/4 instrument Field of View, Ref. MMS-106604-S-DD-2/4-03

2.2. MECHANICAL INTERFACE DESCRIPTION

22.1. Physical Envelope

HIRS/4 is fully integrated into a single instrument unit.

The external unit dimensions in both launch and in-orbit modes, including thermal blankets, studs, mounting lug and connector envelopes. shall be to a tolerance of ±1 mm. These are :

HIRS/4 Configuration	Y axis (Velocity)	X axis	Z axis (Nadir)
Stowed Envelope	676.9 mm	463.8 mm	403.4 mm
Deployed Configuration (Cooler Door Open)	676.9 mm	620.0 mm	403.4 mm

The overall dimensions are defined without thermal stand-off, which are METOP specific. and without the connector saver.

2.2.2. Field of View Definition

The accommodation on METOP provides HIRS/4 with the following unobstructed Field of View (FoV, see also interface drawing § 2.1.4).

The HIRS/4 boresight is defined as the nadir direction The instrument field of view definition is :

- vertex: The origin of the field of view is a circle dia. 158.8 mm, as quoted in the interface drawing (§ 2.1.4.)

- spacecraft provision :

  - Cross-track scan plane : from 72.6 deg. anti-Sunwards to 5 1 deg. Sunwards.

    This is the general envelope for :

    1.5 deg. margin + 21.6 deg. anti-Sun calibration + 49.5 deg. anti-Sun-wards
    49.5 deg. Sunwards + 1.5 deg. margin

  - Along-track plane : ± 2.0 deg.

The requirements for the instrument thermal radiators and the cryogenic radiator are specified'in the Thermal Interface Description sections of this document (§ 2.3).

2.23. Mass Properties

The mass properties of the HIRS/4 instrument are given in the following table. The co-ordinate system used is the Instrument Interface Reference Frame, F_{HIRS} .

233.1. Mass and Centre of Mass Location

The HIRS/4 centre of gravity location has been measured without the attachment bolts / washers or thermal stand-offs. Instrument to METOP PLM interface connectors and thermal blankets are included.

Module /Unit	Specified Mass	Centre of Mass Location with Respect to the Reference Point (± 0.5 mm) TBC		
		X_{HIRS} (Sun)	Y_{HIRS} (Anti-velocity)	Z_{HIRS} (Zenith)
HIRS/4 stowed	35 kg	133.9 mm	314.2 mm	- 143.0 mm
HIRS/4 Deployed	35 kg	131.8 mm	314.5 mm	-144.5 mm

HIRS/4* Mass *Properties

The HIRS/4 instrument shall not exceed the above specified mass for the METOP mission.

The HIRS/4 mass shall be measured at ± 0.5 %.

The HIRS/4 basic (best estimate) mass is : 33.6 kg (for information *only).*

2333. Moments of Inertia

The HIRSN moments of inertia about the centre of mass of the instrument are as follows :

Module /Unit	Moments of Inertia ($kg.m^2$)					
	I_{XX}	I_{YY}	I_{ZZ}	I_{XY}	I_{XZ}	I_{YZ}
HIRS/4 Stowed	1.232	0.433	1.163	0.009	0.016	0.045
HIRS/4 Deployed	1.259	0.463	1.167	0.0009	0.0001	0.05 2

HIRS/4 Moments of Inertia

Note : The moments of inertia are defined as follows :

$$\begin{bmatrix} I_{xx} & -I_{xy} & -I_{xz} \\ -I_{xy} & I_{yy} & -I_{yz} \\ -I_{xz} & -I_{yz} & I_{zz} \end{bmatrix} \quad \text{with : } \begin{matrix} I_{xx} = \int (y^2+z^2)dm \\ I_{yy} = \int (x^2+z^2)dm \\ I_{zz} = \int (x^2+y^2)dm \end{matrix} \quad \text{and} \quad \begin{matrix} I_{xy} = \int xydm \\ I_{xz} = \int xzdm \\ I_{yz} = \int yzdm \end{matrix}$$

2.2.4. Instrument Mounting Attachments

2.2.4.1. Mounting Description

The HIRS/4 is mounted using the satellite-supplied thermal washers and bolts through the instrument mounting feet Where required METOP will provide additional thamal stand-offs.

The following table describes the instrument mounting hardware :

Module /Unit HIRS/4	Bolt Size	Instr. Mounting Hole Diameter (mm) (+ 0.10 / - 0.0)	Length (mm)	Torque (Nm)	Quantity
Instrument Unit	M5	5.61	TBD_{MET}	TBD_{MET}	6
Alignment Pins	N/A	N/A	N/A	N/A	N/A

Tolerances are specified in the interface drawings (see § 21.4.).

2.2.4.2. Mounting Hole Position and Reference Point (Hole)

The definition of the mounting holes and the instrument Reference Point / Hole for HIRS/4 is given in the Mechanical Interface Control Drawing (see § 2.1.4.).

2.2.4.3. Mounting Surface Characteristics

Instrument Side	Surface Coplanarity	Within 0.127 mm
	Surface roughness of attachment face	0.8 µm rms
	Total area of the mounting surface	3713 mm'
. METOP Side	Surface Flatness	Less~thanO.1 mmin 100 mm
	Surface roughness of attachment face	≤ 1.6 microns R.A
	Shimming Accuracy for Flatness	Within 0.0254 mm

2.2.4.4. Instrument Location

The mounting surface is on the -Z (nadir) face of the balcony structure of the satellite.

2.2.4.5. Materials at Interfaces

Instrument Side	HIRS/4 Baseplate	Aluminium alloy 6061-T651
	Mounting Area Finish	Alodyne 600
METOP Side	Balcony Structure	Aluminium skin with a honeycomb core (TBC_{MET})
	Attachment Bolts and Washers	Titanium bolts with stainless steel washers
	Thermal isolation stand-off material	TBD_{MET}

2.2.4.6. Thermo-Elastic Interface

The thermo-elastic characteristics shall be defined in a reduced mechanical interface model as defined in § 2.2.8.5.

2.2.4.7. Grounding Provisions

Grounding to the spacecraft structure is achieved by a METOP provided grounding strap.

The location (TBD_{MET}) of the grounding point on the instrument is defined in the Mechanical Interface Control Drawing (see § 2.1.4.).

2.2.5. Accessibility

Accessibility to specific parts of the instrument shall be guaranteed, when accommodated on METOP. The faces on which specific parts are accommodated are defined in the following :

	HIRS/4 This *table indicates the viewing direction from the instrument.*		
	Item	Instrument side	Access Required
1	Electrical Connectors	+x	During AIT activities
2	Connector Savers	+x	During AIT activities
3	connector dust caps	+x	When the instrument is not in use
4	Test connector cover	+x	During all AIT activities
5	Alignment Mirror 1	-Z	During AIT alignment activities
6	Alignment Mirror 2	+Y	During AIT alignment activities
7	Dust cover for the scan cavity	-Z	During all AIT activities. except TB/TV andvibration
8	Dust cover for the radiant cooler	-X	During all AIT activities. except TB/TV and vibration
9	Purging interface	None	

The detailed position of these items are indicated on the Mechanical Interface Control Drawings (§ 2.1.4.).

2.2.6. On-Ground Alignment

2.2.6.1. Alignment Method

The primary co-registration of HIRS/4 interface is with respect to AVHRR/3 interface. The instrument provides no means of alignment adjustment. HIRS/4 is attached to the METOP PLM structure with a placement accuracy of ± 0.3 degrees. No mechanical means of adjustment for rotation is foreseen about any axis for initial ground co-registration. The instrument is accommodated accepting the X, Y and Z axis positions. Measurement of the alignment of HIRS/4, with respect to the spacecraft reference axis, is by use of the instrument provided optical reference mirrors mounted on the instrument and is measured to an accuracy of ± 0.006 degrees. The co-alignment between HIRS/4 and AVHRR/3 is measured to an accuracy off 0.009 degrees.

The cross references between the instrument boresight axis and its optical alignment surface and between the optical alignment surface and the instrument mounting surface are established at instrument level and reported in the Acceptance Data Package.

2.2.6.2. Alignment Hardware

The position of the instrument optical reference mirrors is given in the Mechanical Interface Control Drawing (§ 2.1.4).

HIRS/4 Alignment Mirrors	
Description	Two orthogonal alignment surfaces
Alignment Surface Viewing Direction	Satellite -Z and +Y sides.
Surface Size (for one surface)	> 507 mm^2
Surface Characteristics	Polished flat to within $\lambda/4$ where λ = Sodium Yellow (632.8 nm)
Surface Orthogonality	The two alignment surfaces are approximately orthogonal, with a known angular displacement that will be documented in the Acceptance Data Package. The mirror angular measurement accuracy is ± 0.00975 deg. (0.17 mrad.)

Protection of the alignment surfaces for all periods when not in use : tape TBD_{HIR}.

These mirrors are not removable.

Compatibility with METOP alignment plan is TBC_{MET}.

2.2.63. Alignment Tolerances for Instrument Interfaces

The following table gives the alignment tolerances of HIRS/4 : TBC H193, TBC H197, TBC H11

METOP Axes (2 Sigma Values)	X (Deg.)	Y (Deg.)	Z (Deg.)	Respon-sible
Absolute alignment tolerance *between* the instrument line of sight. *and* *the optical* alignment surface.	±0.25 *	±0.25 *	±0.25 *	HIRS/4
Change of alignment tolerance after environmental teat *between* *the* instrument *line* of sight *and* the optical alignment surface	± 0.05	±0.05 *	± 0.05	HIRS/4
Absolute alignment tolerance *between* the instrument line of slght *and* its mounting surface	±0.25 *	±0.25 *	-	HIRS/4
Change of alignment tolerance after environmental test *between* the instrument line of sight *and* its mounting surface	± 0.05	±0.05 *	-	HIRS/4
Absolute alignment tolerance *between* *the* instrument *line* of sight *and* *the* mounting surface hole pattern.	-	-	±0.25 *	HIRS/4

* Budget inputs for METOP ~~(no value provided by NASA)~~.

2.2.7. Deployment Mechanisms and Pyros

2.2.7.1. Deployment Mechanisms

The door for the HIRS/4 radiant cooler is deployable :

Cooler Door Deployment	
Sequence	Single event
Mechanism	Spring driven
Release	Solenoid release or manual release for testing
Reverse Operation	Manual only

2.2.7.2. Pyros

Not applicable for HIRS/4.

23.8. Interface Structural Design

Flight Limits Loads are enveloping the loads, including launch, manufacnuing, handling, transportation and ground testing (excluding qualification testing).

Qualification Limit Loads add a qualification factor (1.25 for METOP) on top of the Flight Limit Loads.

2.2.8.1. HIRS/4 Limit Loads

The HIRS/4 is tested to the following limit loads applied at the instrument interface attachment points :

	Load Axis		
	X	Y	Z
Maximum Flight Limit Load	15.64 g	15.64 g	15.64 g
Qualification Limit Loads	19.44 g	19.44 g	19.44 g

22.8.2. METOP Induced Limit Loads

Preliminary analysis indicate the following maximum predicted limit loads applied to the HIRS/4 during the METOP mission :

Maximum Flight Limit Load	21.6 g	Applied at unit centre of gravity in any spatial direction
Qualification Limit Loads	27.0 g	

Figure 2.2.8.2/1 : METOP Induced Loads for HIRS/4

These levels will be revisited following future structural analysis and the METOP structural model test campaign.

2.2.83. l-g Interface Loads

The HIRS/4 l-g interface loads, calculated at each interface point (zero preload). with the instrument hard-mounted configuration are presented in the following table :

HIRS/4 Hard Mounted Interface Loads Based on 1 g Applied in X			
Attachment Id.	Shear Force (N)	Axial Force (N)	Moment (N.mm)
1	56.96	-160.53	38590
2	23.29	-293.36	7258
3	83.55	-309.62	19087
4	44.89	-204.18	30866
5	89.51	-340.59	36790
6	70.01	-129.53	19432
Alignment Pin	N/A	N/A	N/A

HIRS/4 Hard Mounted Interface Loads Based on 1 g Applied in Y			
Attachment Id.	**Shear Force (N)**	**Axial Force (N)**	**Moment (N.mm)**
1	160.72	-42.47	84859
2	276.77	-224.14	57421
3	332.67	261.15	55984
4	181.17	207.67	45821
5	338.78	-12.75	43516
6	155.41	-189.47	36522
Alignment Pin	N/A	N/A	N/A

HIRS/4 Hard Mounted Interface Loads Based on 1 g Applied in Z			
Attachment Id.	Shear Force (N)	Axial Force (N)	Moment (N.mm)
1	192.03	-174.06	26404
2	88.32	-214.59	67395
3	268.83	-284.82	72982
4	310.70	294.12	68356
5	388.87	221.31	116663
6	214.46	158.05	33358
Alignment Fin	N/A	N/A	N/A

2.2.8.4. Structural Frequency Characteristics

2.2.8.4.1. Launch Configuration Frequency Characteristics

The following gives the dynamic frequency characteristics of the HIRS/4 sensor unit in the launch configuration.

HIRS/4 Sensor Unit - In-Orbit Configuration Stowed							
Freq.	Mode	Effective Mass (kg)			Effective Inertia (kg.m²)		
(Hz, ± TBD$_{HIR}$ %)		Mx	My	Mz	Ix	Iy	Iz
68.4	1. Earth shield rotation Z	0.001	0.024	0.003	0.000	0.000	0.011
121.4'	2. Rear sunshield motion in Y	0.001	0.309	0.026	0.005	0.000	0.000
147.5	3. Patch on radiator motion in X	0.021	0.030	2.160	0.000	0.003	0.010
168.0	4. Scan housing/front sunshield motion in Y	0.283	3.480	0.077	0.000	0.000	0.000
183.8	5. Scan housing/front sunshield motion in Y	0.012	1.720	0.050	0.005	0.000	0.000
189.6	6. Patch on radiator rotation Z	0.039	0.157	4.310	0.000	0.010	0.005
196.6	7. Patch/scan mirror/shaft rotation Z	0.005	0.002	0.809	0.000	0.002	0.003

HIRS/4 Eigen Frequencies and Associated Effective Masses and Inertiae

for the Launch Configuration

2.2.8.4.2. In-Orbit Configuration Frequency Characteristics

The following gives the dynamic frequency characteristics of the HIRS/4 sensor unit in the deployed configuration.

HIRS/4 Sensor Unit - In-Orbit Configuration Deployed							
Freq.	Mode	Effective Mass (kg)			Effective Inertia (kg.m²)		
(Hz, ± TBD$_{HIR}$ %)		Mx	My	Mz	Ix	Iy	Iz
27.5	1. Earth shield rotation Z	0.003	0.001	0.001	0.006	0.000	0.000
121.4	2. Rear sunshield motion in Y	0.001	0.310	0.032	0.005	0.000	0.000
146.6	3. Patch on radiator motion in X	0.045	0.049	2.610	0.000	0.007	0.015
162.2	4. Radiator/patch/shield, rotation about Y	0.362	0.023	3.540	0.002	0.065	0.015
168.1	5. Scan housing/front sunshield motion in Y	0.236	3.640	0.011	0.000	0.000	0.000
183.8	6. Scan housing/front sunshield motion in Y	0.013	1.880	0.031	0.006	0.000	0.000
189.4	7. Patch on radiator rotation Z	0.016	0.113	1.810	0.002	0.002	0.009
196.5	8. Patch/scan mirror/shaft rotation Z	0.018	0.338	0.871	0.003	0.002	0.022

HIRS/4 Eigen Frequencies and Associated Effective Masses and Inertiae

for the In-Orbit Configuration.

2.2.8.5. Structural Mathematical Models - Applicability for HIRS/4

The requirements for delivery and format of instrument structural mathematical models are provided in AD2. This section &fines the applicability of deliverable mathematical models for HIRS/4.

2.2.8.5.1. Full Static Model

Not applicable for HIRS/4.

2.2.8.5.2. Reduced Dynamic Model - Launch Configuration

Not applicable for HIRS/4.

2.2.8.5.3. Reduced Dynamic Model - Deployed (In-Orbit) Configuration

Required Model for HIRS/4 : Yes.

2.2.8.5.4. Simplified Thermo-Elastic Model

Required Model for HIRS/4 : Yes

2.3. THERMAL INTERFACE DESCRIPTION

23.1. Thermal Control Concept

The Instrument Supplier is responsible for the thermal design and the thermal analysis of the instrument within the METOP defined thermal interface constraints.

For the TIROS implementation, the HIRS/4 supplies the following internal hardware' :

- Internal baseplate heaters
- Internal baseplate Platinum Resistance Thermometer (PRT)

All connections of the active thermal control of the instrument are done to the J08 connector.

For the METOP implementation, the use of-this hardware is as follows :

- the HIRS/4 internal baseplate heaters and internal baseplate thermistor are not used (TBC_{MET}).
- the J08 connector is not used , test con will be provided (if needed)

Instead main and redundant operational METOP-specific heaters and related thermistor sensors for control of the instrument baseplate. and survival heaters are used for thermal control.

23.1.1. Thermal Control During Nominal Operations

The nominal operations correspond to the HIRS/4 Measurement Mode, Decontamination Mode (= Heater Mode) and Commanded Position Mode.

The instrument thermal control concept during Measurement Mode and Commanded Position Mode can be summarized as follows :

a) The detector temperature is controlled by means of a radiant cooler to deep space.

b) The instrument unit temperature is controlled by passive design (blankets and small radiating surfaces).

c) The baseplate temperature is actively controlled by the spacecraft Thermal Control Unit (TCU). METOP specific heaters are externally mounted on the baseplate and METOP specific temperature sensors for the baseplate are used for the thermal control by the spacecraft TCU.

For Decontamination Mode, the instrument decontamination heater and thermistor are monitored under the responsibility of the HIRS/4. The power is provided by the +28 V regulated bus and does not exceed the values allocated in § 3.4.2. These heater and thermistor do not require a specific interface with METOP.

23.1.2. Thermal **Control During Non Nominal /Contingency Operations**

2.3.1.2.1. General

The non nominal / contingency modes correspond to the HIRS/4 Off Mode and Inert Mode.

The baseplate temperature is controlled using thermostat-controlled heaters and related temperature thermostats.

2.3.1.2.2. Transient Attitudes

When the scanner motor is running, exposure of the HIRS/4 optical aperture to the Sun will not cause damage to the instrument .

This statement is also valid when the **HIRS/4** is in Intemal Warm Target **Commanded Position Mode.**

The radiant cooler can be exposed to full Sun light for a maximum period of 14 minutes. This assumes that the patch starts at its nominal control temperature, **i.e.** 95 **deg. K** (= Measurement Mode configuration).

2.3.1.2.3. **METOP** Orbit **Control** Modes

The HIRSN is compatible with **the METOP** orbit control modes (See **§ 1:3.4.2.),** provided the inclination **manoeuvres** are **performed** in eclipse.

This statement is also valid when **the HIRS/4** is in Intemal Warm Target **Commanded** Position Mode.

2.3.1.2.4. **METOP** Safe Mode

The HIRS/4 in the Off mode is compatible with the M&TOP safe mode as defined in **§** 1.3.4.2.

23.2. Instrument Thermal Requirements

2 3 2 . 1 . Instrument Temperature Range

2.3.2.1.1. On-Orbit Temperature Range

The following are the on-orbit temperature limits (far reference only, see § 23.22) :

Deg. C	Operational (Measurement and Comm. Position Modes)		Non Operational(Other Modes)		Switch-On
	Min.	Max.	Min.	Max.	Min.
Temperature	+10	+20	-5	+30	0
Ref. Point Location	Baseplate		Baseplate		Baseplate

2.3.2.1.2. Ground Testing Temperature limits

The following temperatures will not be exceeded during all ground tests:

Deg. C	Operational (Measurement and Comm. Position Modes)		Non Operational (Other Modes)		Switch-On
	Min.	Max.	Min.	Max.	Min.
Temperature’	0	+30	-5	+30	0
Ref. Point Location	Baseplate		Baseplate		Baseplate

Under these extreme temperatures, the instrument may not meet its radiometric specification.

2.3.2.1.3. Ground Storage and Transportation Temperature Range

During ground storage, with the instrument installed on the PLM or satellite, and during transportation of the complete PLM or spacecraft, the temperatures of the instrument will be maintained in the range :

~~-20 to + 50 deg. C~~ +5 — +30 +5 / +30 deg C (tbc)

The instrument in its dedicated transport container will be exposed to ~~-20 / +50~~ deg. C. ~~If needed (TBC~~IRR~~). cooling / heating beyond these limits within the unit transport container are under the responsibility of the Instrument Supplier.~~ by adopting the transportation procedure from NOAA/NASA.

233.2. Temperatures at the Interface

The operating, non-operating and switch-on temperatures for the **HIRS/4 instrument** at the **instrument /** satellite interface are **defined hereafter**.

Deg. C	**Operational** **(Measurement** and **Comm. Position Modes)**		Non **Operational** **(Other Modes)**		**Switch-On**
	Min.	**Max.**	'Min.	**Max.**	**Min.**
Temperature	**+5**	+~~25~~ 20	-5	**+30**	**+5**
Ref. Point **Location**	Baseplate		Baseplate		Baseplate

The Temperature Reference Point(s) on the instrument baseplate at which **these** temperatures apply is (are) defined in **the** Thermal Interface **Drawing** (TBD_{MET}).

There is no thermal gradient requirement across the baseplate. However thermal gradients shall be minimised by optimal positioning on **the** baseplate **heaters**.

Stability Requirements

There is a stability requirement for the baseplate only during the Measurement Mode.

Within one orbit, the maximum allowable temperature variation of **the** baseplate shall be 5 deg. peak to **peak**.

A short term stability is defined as 0.3 deg. K within a period of 256 **seconds**.

The long **term** mean **temperature** will fall within the defined **operating temperature** range.

23.23. Radiative **Requirements**

The following sunshields are provided :

Instrument Level

A Sun shield is included in the **HIRS/4** design to protect direct Sun **entering** within the optical **aperture** during nominal operations. and is compatible with the **METOP** local solar time, including drift.

Satellite Level

A satellite-provided Sun shield, dedicated to the instrument, is used to :

- **Prevent** solar illumination of the baseplate radiator area ;
- Give a view to space for the baseplate radiator in the -X direction ;
- Prevent solar illumination of the deployed door during nominal **operations**.

  The **HIRS/4** instrument performances are compatible with an exposure to Sun light of its door in the open position, to an equivalent surface normal to the Sun of up to 20.6 **cm^2**. This statement is valid at **both** beginning and end of life.

  This is a pre-requisite to get valid **radiometric** data from the **instrument**.

2.33. Thermal Control Budgets

233.1. Heater Power Budgets

The heater power budgets for the HIRS/4 insuument are :

Module HIRS/4	Heater Power Budget (Watts)			
	Meas. & Com. Position Modes Hot Case (EOL)	Meas. & Com. Position Modes Cold Case (BOL)	Inert Mode * Cold Case (BOL)	Inert Mode * Safe Mode (BOL)
Baseplate Operational Heaters	15 TBC_{MET}	15 TBC_{MET}	N/A	N/A
Baseplate Survival Heaters	N/A	N/A	TBD_{MET}	TBD_{MET}

* As far as survival heater power budget is concerned, HIRS/4 Inert Mode case covers the HIRS/4 Off mode case

Note : the patch heater power consumption in Heater/ Decontamination Mode is acanmted for at insuument level (see § 3.4.2).

2333. Instrument Thermal Dissipation

The dissipation of the HIRS/4 instrument is constant throughout the orbit and is (see § 3.4.2) :

HIRS/4 Thermal Dissipation (Watts)				
Satellite Nominal Operating Modes				Safe Mode
Minimum Dissipation		Maximum Dissipation		min / Max
Meas. & Corn. Position Modes BOL	Other	Meas. & Corn. Position Modes EOL	Heater Mode EOL	Inert / OFF EOL
17.31	0	27.00	44.06	0 / 17.43

2333. Heat Exchange Budgets

2.3.3.3.1. Conductive Heat Transfer

The averaged calculated conductive heat transfer between the Payload Module balcony structure and the HIRS/4 baseplate for different cases are :

Conductive Heat Transfer (Orbit Average, Watts) Between the METOP Structure and the HIRS/4 Baseplate				
Satellite Nominal Operating Modes				Safe Mode
Minimum		Maximum		min / Max
Meas. & Corn. Position Modes	Other	Meas. & Corn. Position Modes	Heater Mode	
TBD_{MET}	TBD_{MET}	TBD_{MET}	TBD_{MET}	TBD_{MET}

2.3.3.3.2. Joint Characteristics

N/A.

2.3.3.3.3. Radiative Heat Transfer

The ‘averaged calculated radiative beat transfer between the Payload Module structure and the HIRS/4 for different cases, as determined from the coupled analysis, are :

Radiative Heat Transfer (Orbit Average, Watts)					
HIRS/4 Radiators	Satellite Nominal Operating Modes				Safe Mode
	Minimum Dissipation		Maximum Dissipation		min / Max
	Meas. & Corn. Pos. Modes	Other	Meas. & Corn. Pos. Modes	Heater Mode	
TBD_{MET}	TBD_{MET}	TBD_{MET}	TBD_{MET}	TBD_{MET}	TBD_{MET}

23.4. Thermal Interface5

The conductive and radiative characteristics are represented by the Reduced Thermal Model delivered and integrated into the overall METOP Thermal Model as specified in § 2.3.4.6.

2.3.4.1. Conductive Interfaces

The total thermal conductance between HIRS/4 and the Payload Module is TBD_{MET} W/K.

2.3.4.1.1. Description

The conductive interfaces are the mounting feet which are defined in the Mechanical Interface Control Drawing § 21.4.).

1) The mounting foot area is : 618.8 mm* / foot
2) Number of feet : 6
3) Thermal filler : Not required

2.3.4.1.2. Bolts

The bolts are defined in § 22.4.

2.3.4.1.3. Thermal Stand-Offs

Thermal stand-offs will be used between the HIRS/4 mounting feet and the spacecraft balcony. The definition of these stand-offs is contained in the Thermal Interface Control drawing (TBD_{MET}).

23.42. Radiative Interfaces

2.3.4.2.1. Radiator Characteristics

The HIRS/4 radiator areas are :

Unit	Viewing Direction	Radiator Area		Thermal FOV Achieved
		Available (m²)	Used (m²)	
Radiative Cooler *	-x	0.0562	0.0562	TBD_{MET}
Baseplate	-Z	0.1039	TBD_{MET}	TBD_{MET}

• Not used for the instrument thermal control.

Thermal Fieid of View Occlusion

The interactions within the cryogenic radiator field of view, are illustrated in the following table.

Interaction With	View Factor	Sink Temperature (Tsink)
AVHRR/3 Earth Shield	TBD_{MET}	TBD_{MET}
HIRS/4 Patch to AVHRR/3 Sun Shield	TBD_{MET}	TBD_{MET}
HIRS/4 Radiator to AVHRR/3 Sun Shield	TBD_{MET}	TBD_{MET}
IASI Earth Shield	TBD_{MET}	TBD_{MET}

2.3.4.2.2.' **Thermo-Optical Properties**

The external surfaces of the HIRS/4 instrument, and the finishes used are given in the Thermal Interface Drawing (§ 2.1.4.). The baseplate mechanical characteristics (planarity, materials...) is described in the Mechanical Interface Description Sections (§ 2.2.4.).

The thermo-optical properties of the finishes are given in the following table : (TBC) HIRS

#	Acronym	Surface / Material	Solar Absorptance			IR
			BOL	EOL 5yr.	EOL 6yr. *	Emittance
1 6	BLKHNYTTT	- Calibration targets, Baseplate radiant cooler / Black Honeycomb (Cal. Targets) - Radiator / Black Honeycomb	0.98	0.98	0.98	0.98
2	HIOPTCTTT	Optics Housing	0.92	0.92	0.92	0.90
3	CHM306TTT	Cavity radiating area, Inside cavity housing. outside scanner Sun shield / Black Paint Lord Co. 2306	0.95	0.95	0.95	0.90
4	MIRRBKTTT	Mirror Back/Nickel Plate	0.43	0.43	0.43	0.19
5	MIRRFRTTT	Mirror Front / Vapour Aluminium Deposit Over Nickel Plate	0.12	0.16	0.16	0.055
7	*Void*					
8	AGTEFL5MO	Outside radiator door, ±Y face of the scanner Sun shield / 5 mil Silverized Teflon (FSSM)	0.09	0.15	0.16	0.80
9	KAPTON5MO	ITO Aluminized Kapton (5 mil)	0.59	0.72	0.74	0.80
10	EXTVDATTT	Aluminized Kapton Tape (External Surface)	0.12	0.13	0.13	0.05
11	MS74WPTTT	White Paint MS 74	0.17	0.24	0.24	0.90
12	GOLDALTTT	Edges around cooler, Inside of cooler door / Gold Coated Aluminium (Electro-Deposit)	0.24	0.30	0.30	0.03
13	VACDALTTT	Inside of cooler door /vacuum Deposit Aluminium	0.12	0.12	0.13	0.05

* : Extrapolated from 3 year data

HIRS/4 Material Thermo-Optical Properties

2.3.4.3. Thermal Heat Capacity

The thermal heat capacity of **HIRS/4** is **TBD_{HIR} J/K**.

2.3.4.4. Instrument Temperature Measurement

For the thermal control of **the** instrument baseplate radiator, **the temperature sensors are mounted on the baseplate itself. These are used for control of the baseplate temperatures in all instrument modes.**

Location: , **on the HIRS/4** baseplate **and** shown on the **interface** drawing **(TBD_{MET})**.

23.45. Heater **Definition**

The following heaters are implemented on **the HIRS/4 :**

Location	**Number**	**Total Resistance (Ω at 25 deg. C) ± 5%**	Resistance **Variation ΔR/R**	**Remark**
Baseplate, Operational Heaters	**TBD_{MET}**	**TBD_{MET}**	**TBD_{MET} / deg.** c	**METOP** specific
Baseplate, Survival Heaters	**TBD_{MET}**	**TBD_{MET}**	**TBD_{MET} / deg. C**	**METOP specific**

Note : **the** outgassing heaters, filter wheel housing heaters and window heaters are to be considered **as instrument internal heater (the related heater power is accounted for in the instrument power** consumption budget). so are not used for **thermal** control from the satellite point of view.

23.4.6. Thermal Interface Models

A reduced model is required for HIRS/4 for the system thermal analysis, as specified in AD3 :

- Deployed **configuration**
- Stowed configuration (radiative)
- Stowed configuration (convective)

See **AD6**, AD7.

2.4. INSTRUMENT AND DISTURBANCE INTERFACES

Definitions

The co-ordinate system used is the Instrument Interface Reference Frame, $F_{HIRS/4}$. The directions of the F_{HIRS} axes are the same as the METOP Spacecraft Reference Frame Fs.

Static Imbalances

When the centre of mass of the rotating assembly is not aligned on the rotation axis, forces are generated in the plane normal to the rotation axis and time varying with the angular profile. The static imbalance is the product of the rotating assembly mass with the distance between the centre of mass and the rotation axis (unit : kg.m).

Dynamic Imbalances

If the products of inertia of the rotating assembly with respect to the rotation axis are non zero, the rotation along this rotation axis generates torques along the axis normal to the rotation axis. Assuming that the rotation axis is the X axis, the dynamic imbalances are the cross products of inertia Ixz and Ixy (unit : $kg.m^2$).

2.4.L Instrument Induced Disturbances and Shocks

2.4.1.1. Non-Recurring Transient Events

The HIRS/4 non-recurring transients events are :

- Deployment of the radiant cooler door, to reach the in-orbit configuration of the instrument.
- Filter wheel drive motor ramp-up and ramp-down *: those are* to be considered as contingency cases (transition from Inert Mode to Off Mode and from Off Mode to Inert Mode).

They are described with the following tables.

2.4.1.1.1. Cooler Door Deployment

Cooler Door Deployment - Single Event Shock	
Rotation about	-Y axis
Deployment Duration	< 0.1 s.
Impact Duration (impact of door on door stop)	Nominal : 0.00192 s. (See RD12) < 0.002 s.
Total moment of inertia of the moving part	TBD_{HIR}
Compensation	None
Maximum uncompensated kinetic momentum	0.02 Nms (TBC_{HIR}) on the X axis 0.14 Nms (TBC_{HIR}) on the Y axis 0.02 Nms (TBC_{HIR}) on the Z axis
Maximum residual force and torque at the instr. interface [2]	Fx < 96 N Fy < 59 N Fz < 153N Cx < 0.61 Nm Cy < 1.10 Nm Cz < 0.01 Nm

2.4.1.1.2. Filter Wheel Drive Motor Ramp-Up

Filter Wheel Drive Mechanism - Ramp-Up (Contingency Case)	
Rotation about	+x axis
Rotation rate	From 0 to 600 rpm (10 Hz) over 30 ± 1 s, Profile : with constant acceleration
Total moment of inertia of the rotating mirror	3.53 $g.m^2$ wrt rotational axis (nominal inertia)
Compensation	None
Maximum uncompensated kinetic momentum	0.226 Nms on the X axis < 0.0071 Nms on the Y axis < 0.0071 Nms on the Z axis
Maximum residual force at the instr. interface without the effects of static imbalances	0.01 N on all three axes
Maximum residual torque including the effects of dynamic imbalances	< 0.0247 Nm on all three axes
Static imbalances (see definition § 2.4.)	Max : $1.44\ 10^{-5}$ kg.m
Dynamic imbalances (see definition § 2.4.)	Included in maximum residual torque

[2] Those values are max values over a 10 ms period from cooler door release and are mainly due to high frequency (< 300 Hz) components. They include uncertainties (see RD12)

2.4.1.1.3. Filter Wheel Drive Motor Ramp-Down

Filter Wheel Drive Mechanism - Ramp-Down (Contingency Case)	
Rotation about	+X axis
Rotation rate	From 600 (10 Hz) to 0 rpm over 50 ± 15 s, Profile : with constant acceleration
Total moment of inertia of the rotating mirror	3.53 $g.m^2$ wrt rotational axis (nominal inertia)
compensation	None
Maximum uncompensated kinetic momentum	0.226 Nms on the X axis < 0.0071 Nms on the Y axis < 0.0071 Nms on the Z axis
Maximum residual force at the instr. interface without the effects of static imbalances	0.01 N on all three axis
Maximum residual torque including the effects of dynamic imbalances	< 0.0247 Nm on all three axis
Static imbalances (see definition § 2.4.)	Max : $1.44\ 10^{-5}$ kg.m
Dvnamic imbalances (see definition § 2.4.)	Included in maximum residual toraue

2.4.11. Continuous / Recurring Transient Events

The HIRS/4 continuous / recurring transients events are :

- *Scanning* motor continuous rotation (steps) and filter wheel continuous rotation : configuration used in launch phase (Off Mode).
- Scanning step motor and filter wheel continuous rotation : configuration used in operational phase.

Those modes are described with the following table :

Scanning Step Motor & Filter Wheel Continuous Rotation		
Rotation about	+X axis for the filter wheel +Y axis for the scanner (Note 1)	
Rotation rate	Filter wheel : 600 rpm (10 Hz) Scanner : step motor, scan cycle in § 1.2.3.1.	
Total moment of inertia of the rotating item	Filter wheel : 3.53 $g.m^2$ wrt rotational axis (nominal value) Scanner : 0.664 $g.m^2$ wrt rotational axis (See Note 2)	
Compensation	None	
Maximum uncompensated kinetic momentum (See Note 3)	Total for Filter Wheel and Scanner : 0.226 Nms on the X axis 0.0071 Nms on the Y axis 0.0071 Nms on the Z axis	
Maximum residual force at the instr. interface without the effects of static imbalances	Total for Filter Wheel and Scanner : 0.01 N on all three axis	
Maximum residual torque including the effects of dynamic imbalances	Filter Wheel : 0.007 Nm ± 0.002 on X < 0.0001 Nm on Y & Z (TBC_{HIR}) Scanner : < 0.007 Nm ± 0.002 on Y < 0.0001 Nm on X & Z (TBC_{HIR})	
Residual torque vs. time	TBD_{HIR}	
Residual torque numeric description [3]	To be supplied by HIRS/4	
Residual torque spectral decomposition	*Frequency (Hz)*	*Amplitude (Nm)*
	10.0	. 0.005 on X (TBC_{HIR})
	TBD_{HIR}	TBD_{HIR} on Y
Static imbalances (see definition § 2.4.)	Filter wheel : Max : 1.44 10^{-5} kg.m Scanner : TBD_{HIR}	
Dynamic imbalances (see definition § 2.4.)	Included in maximum residual torque	

Note 1 : The scanner continuously rotates (78 steps persecond each step is 1.8 deg.) about +Y during the launch phase. However, during the instrument operational phase, the scan mirror is

[3] This description (effective residual torque for each axis, including transitories, noise... and representative from 0 to 150 Hz.) shall be provided on a numeric tape with a sampling frequency greater than 1000 Hz and an output format compatible witb FORTRAN (double precision if possible).

stepped across the scene (rotation about +Y), then reverse direction to return to the starting position.

Note2: The inertia tensor (±15%) of the rotating scan mirror assembly in the instrument coordinate system is :

$$\begin{bmatrix} I_{xx} & -I_{xy} & -I_{xz} \\ -I_{xy} & I_{yy} & -I_{yz} \\ -I_{xz} & -I_{yz} & I_{zz} \end{bmatrix} = \begin{bmatrix} 0.2454 & -0.2923 & +3.337.E-6 \\ AI.2921 & -0.6290. & 0.000 \\ +3.337.E-6 & 0.000 & 2385 \end{bmatrix} g.m^2$$

Note 3 : The calculated, nominal values for uncompensated kinetic momentum are (for information only) :

	Filter Wheel		Scanner		
H_x =	0.2218	+	0.001835	=	0.224 Nms
H_y =	0	+	0.004	=	0.004 Nms
H_z =	0	+	0	=	0 Nms

2.4.13. Flexible Modes

The HIRS/4 does not have flexible mode on the X, Y, Z *axes.* in the range [0 . 10] Hz.

2.4.1.4. Induced High Frequency Disturbances (Micro-Vibrations)

METOP assumes compatibility of HIRS/4 with the following METOP specific requirement.

The HIRS/4 does not induce disturbances on any axis above 10^{-2} N (force) and 10^{-2} Nm (torque) above 10 Hz.

2.4.2. Compatibility With Satellite Dynamic Environment

2.4.2.1. General Mission Environment

The HIRS/4, in any operation mode, will be exposed to the following in-orbit dynamic environment (frequency range : 0 - 10 Hz) :

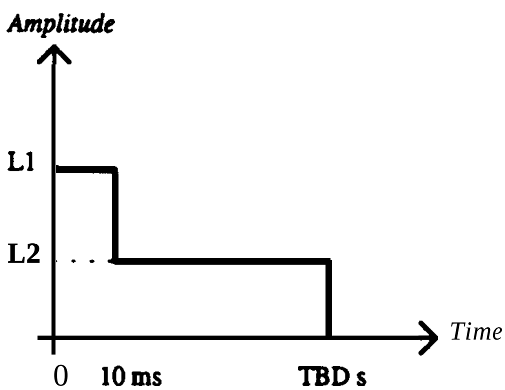
Linear acceleration on X, Y, Z axes at METOP satellite centre of mass *	$0.02\ m/s^2$
Angular rate about X, Y, Z axes	7 deg / s
Angular acceleration about X, Y, Z axes	$0.5\ deg/s^2$

* : With respect to the METOP satellite centre of mass, the HIRS/4 reference point (see § 2.1.4.1) is locatedat:

$$\vec{G}_{SL}\vec{O}_{HIRS} = \begin{bmatrix} -4.5 \\ -0.6 \\ -0.3 \end{bmatrix} \text{(metres)} \qquad (TBC_{MET})$$

2.4.2.2. Environment During Satellite Deployment Sequence

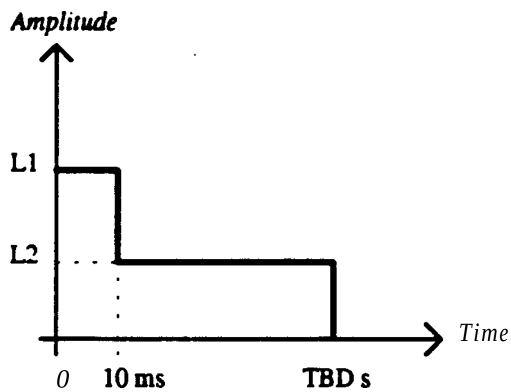
The instrument, in any operation mode, will be exposed to the following in-orbit linear and angular acceleration levels at the instrument interface reference point :



L1: X = 0.3 m/s², Y = 1.0 m/s², Z = 1 .o Ids'.

L2: X = 0.025 m/s², Y = 0.100 m/s², Z = 0.100 m/s²

Maximum Linear Acceleration **Amplitude** Versus ***Time***



L1: X = 1.3 deg./s², Y = 1.3 deg./s², Z = 1.3 deg./s²

L2: X = 0.65 deg./s², Y = 0.50 deg./s', Z = 0.50 deg./s²

Maximum *Angular* ***Acceleration Amplitude*** *Versus* ***Time***

2.4.23. Micro-Vibration Environment

HIRS/4 will be exposed to in-orbit TBD_{MET} disturbances with a frequency greater than 10 Hz.

3. COMMAND AND CONTROL, MEASUREMENT DATA, ELECTRICAL, EMC AND RFC INTERFACE DESCRIPTION

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3.1. ELECTRICAL INTERFACE OVERVIEW

The avionics interface between the METOP Payload Module (PLM) and the HIRS/4 instrument is mainly handled via the Power Conditioning Unit (PCU) and the NOM Interface Unit (NIU).

Figure 3.1-1 gives an overview on the electrical interfaces between the PLM and the HIRS/4.

For adaptation of the single ended interfaces of the HIRS/4, a special grounding concept is described in § 3.8 (EMC).

The command and housekeeping budget for the instrument is as follows :

- 26 pulse discrete commands
- 14 digital B parameters, each 1 bit
- 16 analog parameters, each to be converted to 8 bits within NIU.

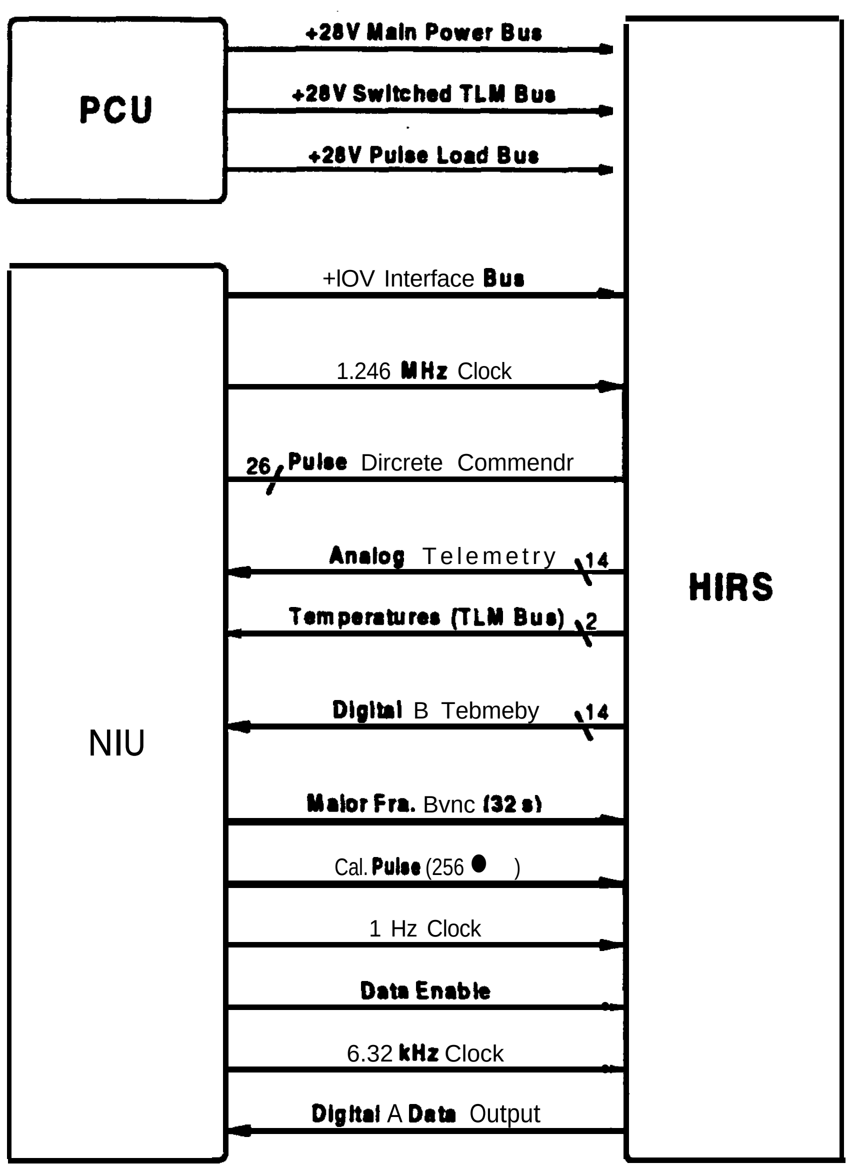


Fig. 3.1-1 ***PLM to HIRS/4 Electrical Interface Overview***

3.2. COMMAND AND CONTROL FUNCTIONAL DESCRIPTION

This section describes the command and control concept for the HIRS/4 Instrument.

'Command and Control' comprises the activities resp. data flows for commanding of the instrument as well as for the acquisition of instrument housekeeping data.

Additionally, the instrument provides an interface of measurement data which is described in § 3.3.

These two data sets are treated separately in the METOP satellite.

Commanding of the instrument and acquisition of instrument housekeeping telemetry is performed under the control of the Payload Module Controller (PMC). Commands are distributed from the PMC via the PLM OBDH Bus to the NOAA Interface Unit (NIU) which translates or converts the functional and electrical interfaces to NOAA instruments. Vice versa housekeeping data are transferred from an instrument to the PMC.

Threedatasetsaremadeavailablebytheinstrument:

- Digital A data
- Digital B data
- Analog data

Digital A data are in the above sense 'measurement data' and are handled by NIU. They are not routed via the PLM OBDH Bus to the PMC and not used for housekeeping by the satellite.

Digital B and analog data are housekeeping data and only the Digital B data are amtrolled by the NIU. Both are reported to the ground via S-band telemetry.

3.2.1. Protocol

Not applicable for HIRS/4.

3.2.2. Telecommands

Telecommands to the instrument shall be provided by the NIU.

Thc minimum time between two consecutive commands is 100 ms.

Thc instrument shall be commanded by Pulse Discrete Commands[1].

Pulse Discrete Commands shall be issued to the instrument one command at a time.

Any pulse ON condition may last for considerable time in case of a spacecraft anomaly. The instrument shall not be damaged by such an occurrence.

---

1 *Pulse Discrete Command Definition*
The pulse discrete command is normally used to change the state of a latching relay in the instrument. An ON or TRUE condition is issued in the form of a pulse to the instrument over a single line.

The **METOP** satellite will provide capabilities for pre-programming of the **HIRS/4** of up to 36 hours. The instrument shall Cope with this pre-programming **period**, and not require any **intermediate** command and control process **(except thermal** control).

The commands to operate the instrument shall be as listed in Table 3.2.2-1.

Note : The operational modes and sequences of commanding are defined in § 1.4 and 1.5.

3.2.2.1. Telecommand Definition.

The satellite shall provide to the **instrument** all commands which are listed in Table 3.2.2-l.

Nr.	**Telecommand**	**Mnemo**	**Type**	**Remarks**
1	**Instrument On**		**Pulse**	
'2	**Instrument** Off		**Pulse**	**Critical Command**
3	Scan Motor On		**Pulse**	
4	Scan Motor Off		**Pulse**	**Critical** Command
5	**Filter Wheel Motor On**		**Pulse**	
6	Filter Wheel Motor Off		**Pulse**	**Critical Command**
7.	**Electronics On**		**Pulse**	**Time**/Patch **Constraints** : see § 15.4.1.2. /1.1.2.2.1
8	**Electronics Off**		**Pulse**	
9	Cooler Heater On		**Pulse**	
10	Cooler Heater Off		**Pulse**	
11	internal **Warm** Target **(IWT)** Position		**Pulse**	
12	Internal Cold Target **(ICT)** Position		**Pulse**	
13	**Space** Position		**Pulse**	
14	**Nadir** Position		**Pulse**	
15	Position Disable		Pulse	
16	Calibration Enable		Pulse	
17	**Calibration** Disable		**Pulse**	
18	Cooler Door Release Enable		Pulse	
19	**Cooler** Door Disable		**Pulse**	
20	**Cooler** Door Deploy		Pulse	
21	Filter Housing Heater **On**		**Pulse**	Not used in flight, Critical Command
22	Filter Housing Heater Off		**Pulse**	
23	**Patch** Temp. Controller On		Pulse	
24	Patch Temp. Controller Off		Pulse	
25	Filter Motor Normal Power		**Pulse**	
26	**Filter** Motor **High** Power		**Pulse**	

Table 3.2.2-1 : Telecommand Definition

3.2.2.2. Telecommand Functional Description

1. Instrument On

This command connects the +28 VDC Main Bus and Pulse Load Bus to HIRS/4 and energizes the telemetry DC/DC converter, permitting temperature monitoring in the absence of all other power. If all power interfaces are enabled, this command causes all analog housekeeping and Digital B telemetry points to be available for monitoring.

2. Instrument Off

Disconnects all +28 V busses from the HIRS/4 except the +28V bus for commands and the analog telemetry bus. This command also resets commands number 1 to 19 to OFF or disabled condition.

3. Scan Motor On

Function 1 (with "Electronics OFF" executed) :

Provides power to the scan motor and drives the scan motor in a continuous stepping mode. This feature is used during launch to prevent damage to the motor bearings.

Function 2 (With *'Electronics ON" executed) :

Provides power to the scan motor and the motor will step and retrace in the normal mode at synchronous speed.

Note : Prerequisite for this command is "Instrument ON".

4. Scan Motor Off

Commands Scan Motor OFF.

5. Filter Wheel Motor On

Function 1 (with "Electronics OFF' executed) :

Provides power to the filter wheel motor and drives the motor in near synchronous speed. This feature is used during launch to prevent damage to the motor bearings.

Function 2 (With "Electronics ON" executed) :

Provides power to the filter wheel motor and the motor will ~~step~~ spin at normal synchronous speed.

Note : Prerequisite for this command is "Instrument OK'.

6. Filter Wheel Motor Off

Commands the filter wheel motor OFF.

7. Electronics On

Provides power to all electronic and data handling systems not provided by the "Instrument ON" command

move to *7

Note : Prerequisite for this command is "Instrument ON".

8. Electronics Off

Commands Electronics Power OFF.

9. Cooler Heater On

*) and Electronics Off

Provides power to first and second stage cooler heaters. Used during orbital decontamination.

Note: Prerequisite for this command is "Instrument ON".* [and under patch control.
[In ambient, either patch control or duration limit (tbd) is used.]

10. Cooler Heater Off

commands cooler heater OFF.

11. Internal Warm Target (IWT) Position

When the instrument is in the calibration enable mode, this command causes the scan mirror to move to the internal warm target (IWT) after completion of the current scan line and retrace to step zero, or after completion of the calibration sequence, except in the following circumstance : if the IWT position is commanded during a calibration sequence and if that position has not yet ~~been watched~~ reached, the calibration sequence will be suspended when the scanner reaches the IWT position. The scan mirror will remain at the IWT until disabled by the ***Position Disable*** command.

12. Internal Cold Target (ICT) Position

When the instrument is in the calibration enable mode, this command causes the scan mirror to move to the internal cold target (ICT) after completion of the current scan line and retrace to step zero, or after completion of the calibration sequence. The scan mirror will remain at the ICT until disabled by the ***Position Disable*** command.

13. Space Position

When the instrument is in the calibration enable mode, this command causes the scan mirror to move to the space after completion of the current scan line and retrace to step zero, or after completion of the calibration sequence, except in the following circumstances : if the space position is commanded during a calibration sequence and if that position has not yet ~~been watched~~ reached, the calibration sequence will be suspended when the scanner reaches the space position.. The scan mirror will remain at space until disabled by the *Position Disable* command.

14. Nadir Position

When the instrument is in the calibration enable mode, this command causes the scan mirror to move to nadir after completion of the current scan line and retrace to step zero, or after completion of the calibration sequence. The scan mirror will remain at nadir until disabled by the *Position Disable* command

15. Position Disable

Disables the IWT, ICT, Space and Nadir position commands and returns scan mirror to scan step zero. Regular scan (i.e. with 256 second calibration, if the Calibration Sequence is enabled) will resume upon receipt of next line synchronization (first element) pulse.

16. Calibration Enable

Enables the radiomeuic calibration control logic. When sent, the scanner will continue line scanning until the next major frame sync pulse. It will then execute a normal calibration sequence. Subsequent calibration sequence will be executed upon receipt of a Calibration Start Pulse coincident with major frame sync.

17. Calibration Disable

Disable the instrument calibration mode. In this mode the instrument will ignore the spacecraft calibration start pulse.

18. Cooler Door Release Enable

Provides power to the Earth shield release solenoid drive circuit only after *Instrument ON has been executed.*

19. Cooler Door Disable

Resets the Cooler Door Release relay to the OFF position.

20. Cooler Door Deploy

Commands opening of cooler door by applying a two-second pulse to the release solenoid Operates only if *Instrument ON and Door Release Enable* commands *have been sent.*

21. **Filter** Housing Heater On

Provides power to filter housing heaters and automatic temperature control circuitry.

Note: **This command is never used in flight. It is used at instrument level for ground-based, short** form, electrical **function test** and possibly for some extreme **troubleshooting** exercise. As a **consequence,** it is considered as a **critical command**[2].

Note : **Prerequisite for this command is "Instrument ON".**

22. **Filter** Housing Heater Off

Commands **filter housing** heater OFF.

23. Patch Temp. Controller On

Provides power to patch temperature control heater to control patch at the nominal operating temperature (see § 1.2.3.4.).

Prerequisite : *Instrument ON* and *Electronics ON* must be enabled for the patch controller to operate.

24. Patch Temp. Controller **Off**

Commands patch temperature heater off permitting patch to seek equilibrium temperature.

25. Filter Motor Normal Power

Applies pre-set power level to filter wheel motor for normal operation.

26. **Filter** Motor High Power

Applies maximum power to filter wheel motor for cold aperation and end-of-life conditions.

2 The switch-off command sequences as defined in § 1.5 consider that this command might have been triggered during the satellite ground and in-orbit lifetime.

3.2.3. Housekeeping Telemetry

This section describes the HIRS/4 Digital B and Analog Telemetry.

333.1. **General Requirements**

The NIU shall only acquire the instrument-provided digital-B and analog HK data at any time when the instrument is in Heater / Decontamination Mode or Measurement Mode or Commanded Position Mode.

The NIU will read out the following housekeeping telemetry formats from the instrument :

- Analog HK
- Digital HK ("Digital B").

The NIU *will sample bath analog* and digital B housekeeping telemetry. with periods of :

- 16 seconds nominally
- up to 1/8 s for any selected parameter on request.

Analog data shall be acquired and converted within the NIU to 8 bit digital information with a 5.12 V full scale resolution (LSB = 20 mV).

No instrument housekeeping data shall be monitored by the METOP satellite Nevertheless the Digital B data will he checked on-board for verification of command execution.

Note: for those commands that do not result in a change of a Digital B point, the verification of the command receipt by the instrument will be done by the Growl System with the instrument provided Analog Telemetry points and / or Digital A telemetry.

3.2.3.2. Digital B Telemetry

The instrument shall provide the Digital B telemetry as listed in Table 3.2.3-l.

Each of the 14 Digital B telemetry points shall indicate the status of one pair of commands according to § 3.2.2.

The Digital B telemetry points aim at monitoring the state of bi-stable magnetic latching command relays. As soon as all power interfaces are enabled the following 9 Digital B telemetry outputs are available regardless of the mode state of the instrument :

- *Instrument Power*
- *Electronics Power*
- *Filter Motor Power*
- *Scan Motor Power*
- *Cooler Heater*
- *Filter Housing Heater*
- *Cooler Door Release*
- *Filter Motor Power Level*
- *Patch Temp. Controller*

The remaining ones are available only after *Instrument On* command *has been executed.*

Nr.	**Telemetry** Point *Name*	**State**		Remark
		Logic "1" (Low Voltage)	**Logic "0" (High Voltage)**	
1	Instrument Power	ON	OFF	
2	Electronics Power	ON	OFF	-
3	Filter Motor Power	ON	OFF	
4	Scan Motor Power	ON	OFF	
5	Cooler Heater	ON	OFF	
6	Filter Housing Heater	ON	OFF	
7	Cooler Door Release	Enabled	Disabled	
8	Cooler Window Heater	OFF	ON	
9	Go to Nadir Position	Yes (initiated)	No	
10	Calibration Sequence	Enabled	Disabled	
11	Cooler Door Closed	No	Yes	
12	Cooler Door Fully Open	No	Yes	
13	Filter Motor Power Level	High	Normal	
14	Patch Temp. Controller	ON	OFF	

Table 3.2.3-l : ***HIRS/4 Digital*** *B Telemetry*

3.2.3.3. *Analog* Telemetry

The HIRS/4 provides analog telemetry channels as listed in Table 3.2.3-2 to monitor on ground the health of the instrument. It shall be considered that telemetry of analog temperature, voltage and current (analog telemetry) will be valid by 6.3 s after switching-on of instrument telemetry, i.e. after *Instrument* ON command has been sent.

Two (2) Analog Temperature Telemetry points shall be available whenever the 28 V Analog Temperature Telemetry Bus is powered and be valid within 1 s after Analog Temperature Telemetry Bus has been commanded ON (independent of HIRS/4 mode). Those points are defined in Table 3.2.3-3.

Typical valid data ranges and values are shown in Table 3.2.3-2.

The telemetry points shall be defined as following :

1) Radiator Temperature

This telemetry point measures the output of a platinum resistance thermometer (PRT) located on the radiant cooler first stage (radiator).

2) *Baseplate Temperature*

This telemetry point measures the output of the thermistor located on the baseplate. It is *powered by* +28 V *Analog* Bus

3) *Electronics Temperature*

This telemetry point measures the output of the thermistor located inside the electronic box.

4) *Patch Temperature*

This telemetry point measures the resistance of a PRT located on the second stage (patch) of the radiant cooler. It also signifies the IR detectors temperatures.

5) *Filter Housing Controller Current*

This telemetry point measures the proportional DC current in the filter wheel housing resistance *heaters.* It generally reports zero current (i.e. heaters OFF during normal operation).

6) *Scan Motor Temperature*

This telemetry point measures the output of a thermistor mounted on the scan motor housing. It is designated as a "Full Time Telemetry Point", since powered by the +28 V Analog Bus.

7) *Filter Wheel Motor Temperature*

This telemetry point measures the output of a thermistor mounted on the filter wheel motor housing.

8) + 5 *VDC Monitor*

This telemetry point measures a DC voltage directly proportional to the + 5 V in the electronics.

9) *+ 10 VDC TLM/DC/DC Converter*

This telemetry point measures a DC voltage directly proportional to the +lOV in the electronics.

10) *+ 7.5 VDC TLM/DC/DC Convener*

This telemetry point measures a DC voltage directly proportional to the +7.5 V in the electronics.

11) *- 7.5 VDC TLM/DC/DC Convener*

This telemetry point measures a DC voltage directly proportional to the -7.5V in the electronics.

12) *+ 15 VDC Monitor*

This telemetry point measures a DC voltage directly proportional to the +15V in the electronics.

13) *- 15 VDC Monitor*

This telemetry point measures a DC voltage directly proportional to the -15 V in the electronics.

14) Filter Wheel Motor Current

This telemetry point measures the current flow in the filter wheel motor by sampling the voltage developed across a 0.5 Ohm resistor in the load return line. The sensed voltage, read by the telemetry point, is passed through a low pass filter. The -3 dB point of this filter is approximately 1 Hz.

15) Scan Motor Current

This telemetry point measures the current flow in the scan motor by sampling the voltage developed across a 0.1 Ohm resistor in the load return line. The sensed voltage, read by the telemetry point, is passed through a low pass filter. The -3 dB point of this filter is approximately 1 Hz.

16) Patch Controller Power

This telemetry point measures the power in the patch temperature control heaters by sampling the voltage applied across the heaters.

The analog telemetry shall have the performance as defined in Table 3.23-2. The transfer function between physical range and voltage range is part of the deliverables / as-built data.

Nr.	Telemetry Point Name	Physical Range	Remarks'
1	Radiator Temperature	150-320 deg. K	
2	Baseplate Temperature	260-320 deg. K	Powered by the Analog Temp. TLM Bus
3	Electronics Temperature	260-320 deg. K	
4	Patch Temperature	90-320 deg. K	
5	Filter Housing Controller Current	0 to 330 mA	
6	Scan Motor Temperature	260-320 deg. K	Powered by the Analog Temp. TLM Bus
7	Filter Wheel Motor Temp.	260-320 deg. K	
8	+5 VDC Monitor	5 ± 0.2 V	
9	+10 VDC TLM/DC/DC Conv.	10 ± 0.2 V	
10	+7.5 VDC TLM/DC/DC Conv.	7.5 ± 0.05 v	
11	-7.5 VDC TLM/DC/DC Conv.	-7.5 ± 0.05 v	
12	+I5 VDC Monitor	15 ± 0.2 V	
13	-15 VDC Monitor	-15 ± 0.2 v	
14	Filter Wheel Motor Current	100 to 300 mA	
15	Scan Motor Current	0.65 to 1.0 A	
16	Patch Controller Power	0 to 80 mW	

Table 3.2.3-2 : Analog Telemetry

Following are the Analog Telemetry status as function of the different telecommands:

	Command	Analog Telemetry Status	Timing
1	Instrument On	Relevant data for : *Radiawr Temperature, Baseplate Temperature, Electronics Temperature, Patch Temperature, Filter Housing- Control Current, Scan Motor Temp., Filter Motor Temperature, +5 VDC Monitor, +10 VDC TLM/DC/DC Convener, +7.5 VDC TLM/DC/DC Convener, -7.5 VDC TLM/DC/DC Converter, +15 VDC Monitor, -15 VDC Monitor, Patch Controller Power,*	< 60 ms
2	instrument Off	The functions given under *Instrument ON* will *be* invalid except fa the *Baseplate Temperature and* the *Scan Motor Temperature.*	< 60 ms
3	Scan Motor On	With either *Electronic ON or OFF* : *Scan Motor Current* will *be* a valid indicator	< 60 ms
4	Scan Motor Off	Scan *Motor Current* should be zero.	< 60 ms
5	Filter Wheel Motor On	*Filter Wheel Motor Current* will be a valid indicator.	< 60 ms
6	Filter Wheel Motor Off	*Filter Wheel Motor Current* will *be* zero	< 60 ms
7	Electronics On	Valid analog telemetry will be either : 1.) Same as under command # 1 *Instrument ON executed* *or* 2.) *Limited* to the following two only if command *# 2 Instrument OFF condition exists* : *Baseplate Temperature* and Scan *Motor Temperature*	< 60 ms
8	Electronics *Off*	1.) *Same* as under command #1 *Instrument* ON executed or 2.) *None* if command #2 *Instrument OFF* condition exists.	< 60 ms
9	Cooler Heater On	*Radiator Temperature* will be a valid indicator. The *Patch Temperature* will also change but at a much slower rate.	< 60 ms
10	Cooler Heater Off	No relevant analog indicator	N/A

Table 3.2.3-3 : Instrument Analog Telemetry vs. Commands (1/2)

	Command	Analog Telemetry Status	Timing
11	Internal Warm Target (IWT) Position	No relevant analog indicator	N/A
12	Internal Cold Target (ICT) Position	No relevant analog indicator	N/A
13	space Position	No relevant analog indicator	N/A
14	NADIR Position	No relevant analog indicator	N/A
15	Position Disable	No relevant analog indicator	N/A
16	Calibration Enable	Nqrelevantanalogindicator	N/A
17	Calibration Disable	No relevant analog indicator	N/A
18	Cooler Door Enable	Norelevantanalogindicator	N/A
19	Cooler Door Disable	No relevant analog indicator	N/A
20	Cooler Door Deploy	No relevant analog indicator	N/A
21	Filter Housing Heater On	No relevant analog indicator	N/A
22	Filter Housing Heater Off	***Filter Housing Controller Current*** should be off	< 60 ms
23	Patch Temp. Controller On	1.) Valid indicator of the controlled ***Patch Temperature*** ***2.)*** Valid indicator of the ***Patch Controller Power.*** ***Note*** : Power level will indicate whether actually appliedtopatchornot.	< 60 ms
24	Patch Temp. Controller Off	1.) Valid indicator of the non-controlled ***Patch Temperature*** ***2.) Patch Controller Power will*** be a valid indication of the patch power if previous command was ON. Note : ***As above*** for command # 23.	< 60 ms
25	Filter Motor Normal Power	Valid indicator of the ***Filter Wheel Motor Current.***	< 60 ms
26	Filter Motor High Power	Valid indicator of the ***Filter Wheel Motor Current.***	< 60 ms

Table 3.2.3-3 : Instrument Analog Telemetry vs. Commands (2/2)

33.4. Telecommand Verification

No check shall be performed by the spacecraft to verify whether the command is consistent with the active instrument mode.

The execution of each co- shall be verified by the spacecraft. The interrelationship between commanding and the verification of a command in the Digital B telemetry is defined in Table 3.2.4-l. The column "Timing" specifies the maximum time delay between the arrival of a command in the instrument and change of the corresponding Digital B parameter.

In case a command does not induce a change in the instrument Digital B data, no execution verification of this command will be performed by the satellite.

The parameter value acquired apart from the routine HK cycle will be discarded after verification and not transmitted to ground. Execution failure will be reported in the history area.

In case of a command execution error by the HIRS/4, the PLM NIU shall report this error to the ground and no autonomous corrective action, including HIRS/4 switch-off, shall be performed by the spacecraft.

	Command	Constraint	Command Verification Digital B	Timing
1	Instrument On		Instrument Power "ON"	< 60 ms
2	Instrument Off		Instrument Power "OFF"	< 60 ms
3	Scan Motor On		Scan Motor Power "ON"	< 60 ms
4	Scan Motor Off		Scan Motor Power "OFF"	< 60 ms
5	Filter Wheel Motor On		Filter Motor Power "ON"	< 60 ms
6	Filter Wheel Motor Off		Filter Motor Power "OFF"	< 60 ms
7	Electronics On	1)	Electronics Power "ON"	< 60 ms
8	Electronics Off		Electronics Power "OFF"	< 60 ms
9	Cooler Heater On	2)	Cooler Heater "ON"	< 60 ms
10	Cooler Heater Off		Cooler Heater "OFF"	< 60 ms
11	Internal Warm Target (IWT) Position	3/ 5)	not available on-board	N/A
12	Internal Cold Target (ICT) Position	3/ 5)	not available on-board	N/A
13	Space Position	3/ 5)	not available on-board	N/A
14	NADIR Position	3/ 5)	Go to NADIR Position "YES"	< 60 ms
15	Position Disable	5)	not available on-board	N/A
16	Calibration Enable	5)	Calibration Sequence "Enabled"	< 60 ms
17	Calibration Disable	5)	Calibration Sequence "Disabled"	< 60 ms
18	Cooler Door Enable		Cooler Door Release "Enabled"	< 60 ms
19	Cooler Door Disable		Cooler Door Release "Disabled"	< 60 ms
20	Cooler Door Deploy	4)	Cooler Door Closed "No" (Cooler Door Fully Open "Yes"	< 60 ms
21	Filter Housing Heater On		Filter Housing Heater "ON"	< 60 ms
22	Filter Housing Heater Off		Filter Housing Heater "OFF"	< 60 ms
23	Patch Temp. Controller On		Patch Temp. Controller "ON"	< 60 ms
24	Patch Temp. Controller Off		Patch Temp. Controller "OFF"	< 60 ms
25	Filter Motor Normal Power		Filter Motor Power Level "Normal"	< 60 ms
26	Filter Motor High Power		Filter Motor Power Level "High"	< 60 ms

Table 3.2.4-1 : Telecommand Verification

1) Patch control
2) Electronic off
3) CAL ENABLE
4) Cooler heater off / Cooler Door Enable "Yes"
5 Electronics must be on.

} refer to corresponding chapter in ICD

335. METOP Specific Thermal Control Electrical Interfaces

The thermal concept for the HIRS/4 on METOP is described in § 2.3.1.

The nominal and survival thermal control of the HIRS/4 baseplate is under the responsibility of the satellite through the PLM Thermal Control unit (TCU).

METOP specific thermistor, heater and thermostat-controlled survival hardware is used for this purpose, but none realises an electrical interface with the HIRS/4 (TBC_{MET} for the nominal heaters and thermistors).

As a conclusion, there is no electrical interface between the HIRS/4 and the PLM for the instrument thermal control.

3.2.6. Satellite Services / **Synchronization**

Note : Satellite Services are defined as all Command and Control and Measurement Data Acquisition tasks which will be performed by the PLM or the SVM to support instrument operations.

Note : the synchronization of measurement data read-out is defined in § 3.3.2.

Synchronization signals :

- **1 Hz (1 second) sync. signal**

  The 1 Hz synch. signal synchronizes an instrument internal 10 Hz clock which is used for scan stepping.

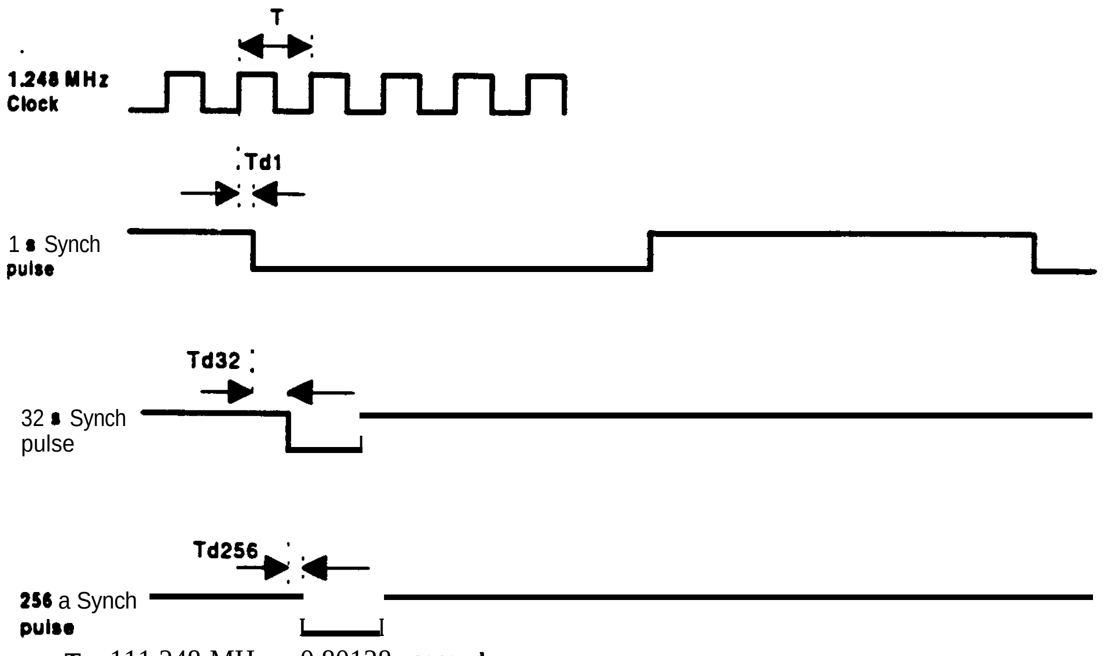
- **32-second** sync. pulse

  The occurrence of the 32 s synchronization pulse synchronizes the internal instrument cycle.

- **256-second** sync. **pulse**

  The 256 **s** synchronization pulse is **used to initiate calibration** when ***Calibration Enable*** is **effective.**

The synchronisation signals are phase correlated to each **other** and to the 1.248 MHz clock as shown in **Figure** 3.2.6-l.



- **T** = 111.248 MHz = 0.80128 **µseconds**
- . Tdl IT
- **Td32 < 4 µseconds** Td32 + Td256 < 4.5 **µseconds**
- Td265 < 1 **µsecond**

*Figure 3.2.6-l : Time **Correlation** Between **Synchronisation** Signals and I.248 **MHz** Clock*

The **NIU** shall provide to the **instrument a clock signal of 1.248 MHz clock (master clock). This signal shall also be** supplied in HIRSH OFF mode, but in this mode the frequency of **the** signal may deviate **from** the above value by **±** 10 **%.**

3.3. MEASUREMENT DATA TRANSFER FUNCTIONAL DESCRIPTION

The measurement data of the HIRS/4 are provided -at the Digital-A interface and are acquired and packetized by the NIU prior to storage and transmission to the ground. Measurement data are not routed via the OBDH bus to the PMC and are not used for instrument housekeeping.

33.1. General - Data Rate

Data rate and data transfer are identical in HIRS/4 Measurement Mode and in Commanded Position Mode.

A full set of HIRS/4 operational data, including command status monitors, housekeeping information and radiance data of the 20 channels, is contained in the Digital A output.

The data from the HIRS/4 are provided to the NIU from a toggle buffer. The NIU calls out groups of 8-bit words. However, the HIRS/4 does not format data into neat 8-bit segments, but in 13-bit words. During any minor frame period (0.1 sec), 288 bits of data are generated by the HIRS/4, i.e. 36 8-bit words or 22 13-bit words plus 2 additional bits (corresponding data rate : 2880 bits per second).

Note : These data are not packetized within the instrument.

Three synchronisation signals are provided to the —ent as described in § 3.2.6.1. The occurrence of the 32 second synchronisation pulse will synchronise the internal instrument cycle. The 256 second synchronisation pulse is used to initiate calibration in auto-calibration mode.

A HIRS/4 6.4 second data period contains 64 acquired elements of 288 bits each. The data of one element correspond to one scan ~~step~~, ~~a slew~~ or a calibration dwell. The HIRS/4 data will repeat every 6.4 seconds.

The 1 Hz synchronisation signal also synchronises the NIU internal 6.4 sec sync. and 0.1 sec sync pulses once per second.

33.2. Measurement Data Acquisition

The measurement data shall be acquired via the digital A data interface.

The measurement data interface consists of the :

- Data Enable pulse line
- Data Clock line
- Data line

The HIRS/4 serial data are clocked into the NIU at a bit rate of 8.32 kHz by means of the data clock, whenever the data enable pulse is presented to the instrument

Both clock and enable pulse shall be delivered by the NIU.

The transfer shall be organised in words of 8 bits.

The transfer shall comply with Figure 3.3.2-1a and -1b.

The HIRS/4 data are stored internally of the instrument within toggle buffers. which are toggled every 0.1 sec. Thus, the first data word of a 256 second cycle, a 6.4 second period or a 0.1 second element will be available for read-out 0.1 seconds + Td_{HIRS} after start of the respective cycle, period or element (refer to Figure 3.3.2-1a).

Td_{HIRS} defines the start of the first Data Enable pulse relative to the start of the 6.4 second (NIU internal) cycle, resp. the start of the 0.1 second (NIU internal) cycle. Nominally the NIU internal and HIRS internal 0.1 cycle are phase correlated to the 1 s Sync.

Td_{HIRS} shall be $(28 * 8 * T_{8.32k} + 2 * T_{8.32k} /5)$. $T_{8.32k}$ is the time period of the 8.32 kHz Clock (CLU).
Note: Td_{HIRS} is approximately 26.97 ms $\pm 10^{-4}$.

During the (continuous) data acquisition, the Data Enable pulse shall repeat every Ts_{HIRS}. Ts_{HIRS} shall be $8 * T_{8.32k}$.
Note: Ts_{HIRS} is approximately 961.5 µs $\pm 10^{-4}$.

The words shall be separated by a gap in the Data Enable pulse according to Figure 3.3.2-1b.

The.1.248 MHz Clock and the 8.32 kHz are derived from a free running oscillator in the NIU. The 1 Hz Clock, the Major Frame Sync.(32 s), and the Cal. Pulse (256 s) are derived in the NIU from the OBDH Bus Broadcast Pulse. The OBDH Bus Broadcast Pulse is generated by the oscillator in the CCU on the Service Module. The leading edge of these pulses will be phase correlated to the 1.248 MHz Clock.

Each of these two oscillators has its own initial setting failure, temperature drift and ageing. This will result in a tolerance of the number of clocks per Sync. Pulse period as depicted in Table 3.3.2.-1. The specified tolerances are the maximum tolerances during mission lifetime and over nominal temperature range conditions.

	Sync 0.1s	sync. 1 sec	Sync. 32 sec	Sync. 256 sec
No. of 1.248 MHz cycles	124800 ± 150 *)	$1.248 \cdot 10^6$ ± 150	$39.936 \cdot 10^6$ ± 4793	$319.488 \cdot 10^6$ ± 38339
No. of 8.32 kHz cycles	832 ± 1 *)	8320 ± 1	$266.24 \cdot 10^3$ ± 32	$266.24 \cdot 10^3$ ± 256

*) Tolerance figure for last (10th) 0.1 s period of a 1 s cycle only. For the 9 first cycles the tolerance figure is ± 0. The tolerance range does not affect METOP specified data transfer.

Table *3.3.2.-1 : Sync. Period Tolerances in Numbers of* 1.248 *MHz and* 8.32 *kHz Cycles*

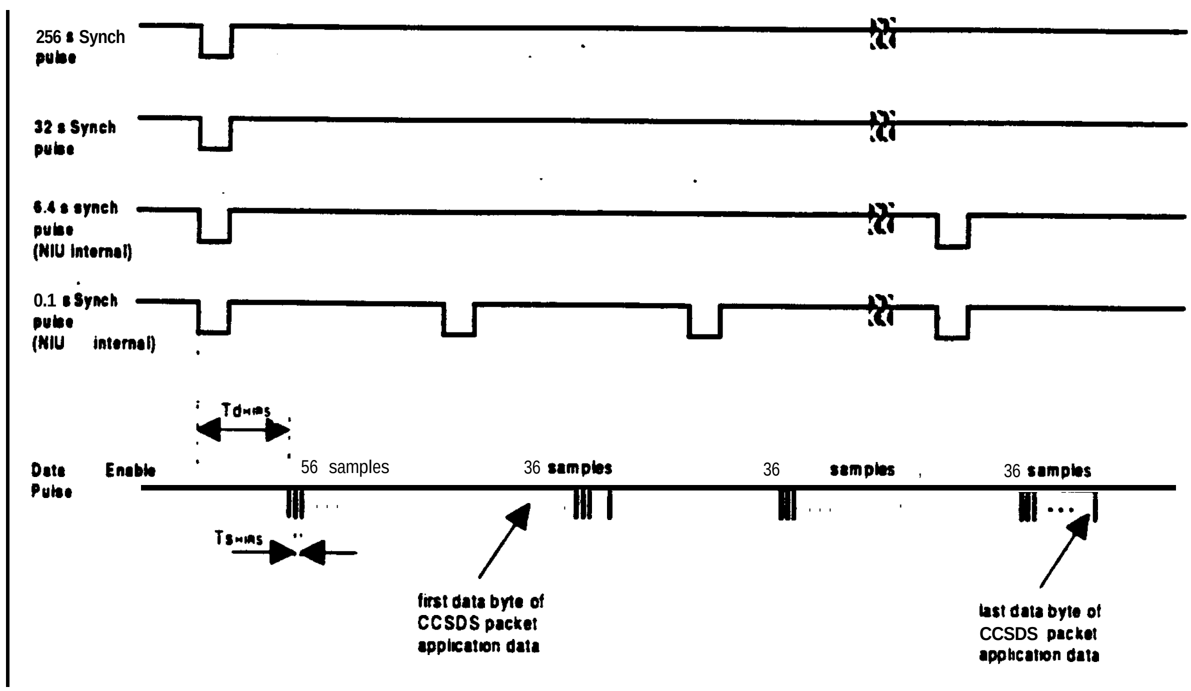


*Figure 3.3.2-1a : **HIRS/4** Measurement **Data** Acquisition **Sampling** Timing*

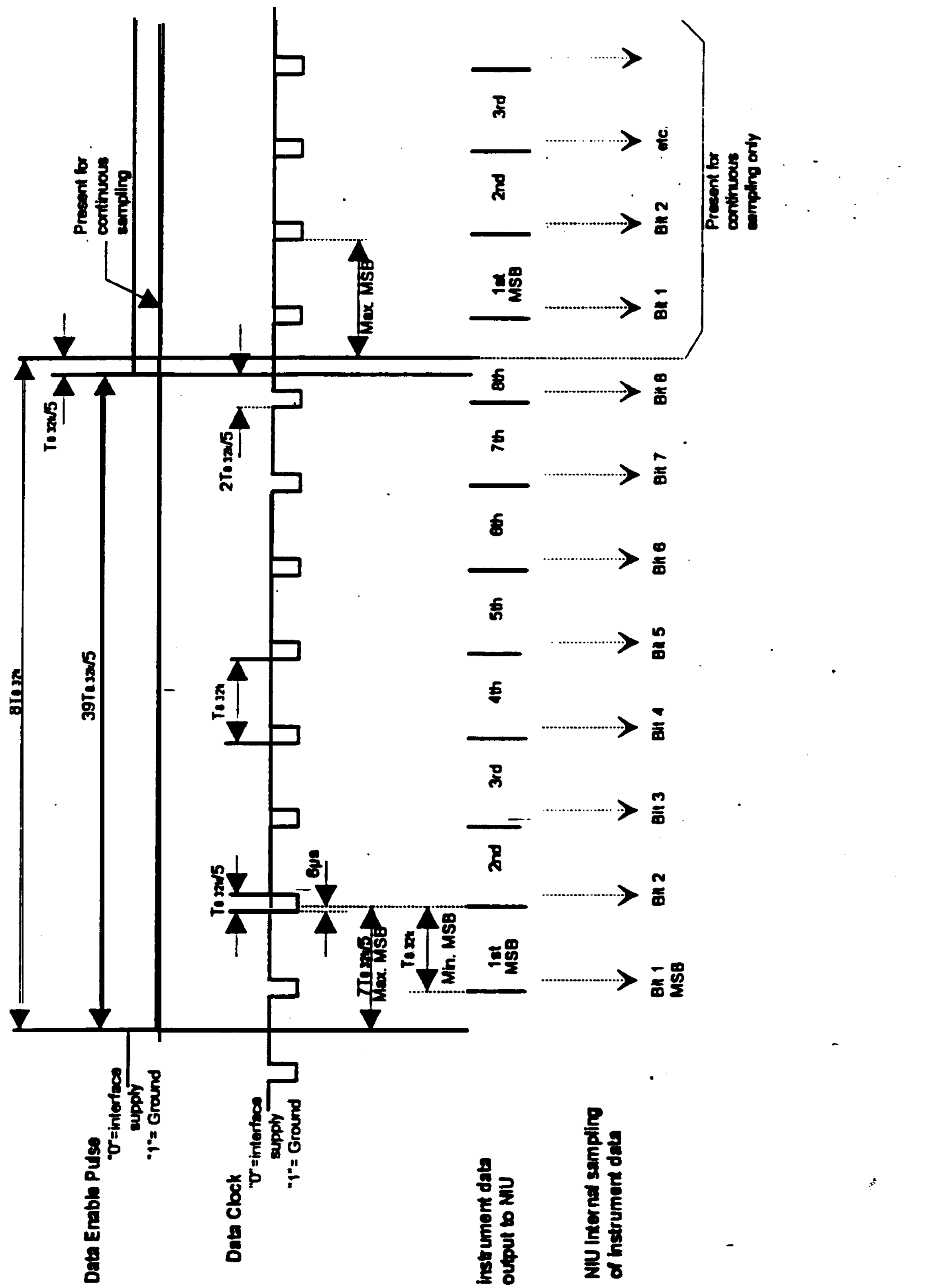


*Figure **3.3.2-1b : HIRS/4 Measurement Data** Acquisition **Detailed** Timing*

333. Measurement (Digital A) Data Format

333.1. General

'The HIRS/4 operation is based on a 256 s. cycle that consists of 40 6.4 s periods, as follows (the auto-calibration mode is assumed enabled) :

- Period #1 : Calibration Cycle - Space View
- Period #2 : Calibration Cycle - Warm Target
- Period #3 : Earth Scan #1
- Period #4 : Earth Scan #2

...

- Period #40 : Earth Scan #38

For each period (6.4 s.), the HIRS/4 data format is the same, with 64 elements of 288 bits each The data of one element correspond to one Earth ~~scan-step or one slew or one of the~~ calibration dwell (space view or warm target), as follows (see also Table 1.23.1-2) :

Element numbers	Calibration Cycle Space View (Period #1)	Calibration Cycle Warm Target (Period #2)	During Earth Scan (Periods #3 to #40)
0-7	Scan mirror motion to the space view position	Warm target dwell	Earth view dwell for each of the 56 Earth scan positions. Element 55 designates the last Earth scan position
8-55	Space view dwell		
56-63	Scan mirror motion to the warm calibration target for next period	Scan mirror motion (retrace) to the first scan position for next period	Scan mirror motion (retrace) to the first scan position for next period

333.2. 288-Bi t Element Format Description

Independent of the period, the 288-bit ele nent format is the same and consists of :

(a) Bit **1-26**

Two 13-bit words have the same function in all elements. The function assembled in these words are as follows :

	Function	Range (Decimal)
Word 1		
1-8	Scan Encoder Position	o t o 1 9 9
9 -13	Electronic Cal Level Indicator	oto31
Word 2		
14 - 19	Channel 1 Period Monitor	0t063
20 - 25	Element Number	Oto63
26	Filter Sync Designator	0 or 1

Scan Encoder Position

The scan encoder position is the sensed position of the scan mirror in 1.8 deg. increments. The encoder position "1" occurs at the first Earth scan position, hence will be the encoder position noted during element "0".

Electronic Cal Level indicator

The electronic calibration level advances by one per period from 0 to 31. defining the step level measured in each radiometric channel during elements 56 and 57. Since both a positive and negative calibration is made at the end of each scan line, the level applies to both. The step level starts at 0 on the first scan after a calibration start pulse and continues repetitively after that and even when calibration is disabled.

Channel I Period Monitor

The channels 1 period monitor measures the variation in time interval of a segment of the filter wheel on each rotation. The reading measures 1.248 MHz clock intervals of that segment, hence defines velocity variations to a granularity of *0.8* microseconds. *This is* a diagnostic output and is not used in system data processing or evaluation,

Element Number

This is ~~three~~ the number of the data group (see § 3.3.3.1). It advances from 0 to 63. The element number repeats regardless of scan position or mode.

Filter Sync Designator

Filter Sync is a "1" when the filter wheel is in synchronism with the timing system. This is diagnostic data not used in data collection or processing.

(b) Bits 27-286

This group of bits is divided into 20 13-bit words (20 channels x 13 Bits), generally correspond@ to the radiant signal outputs of the instrument. The word functions are dependent on the element number. as illustrated in Table 3.3.3.2/1.

Generally, all words are quantity, where bit 1 is the sign bit ("1" positive.; "0" negative) and bits 2 through 13 are amplitude (binary code ; 0 to 4095). Bit 2 is the most significant bit (MSB) and bit 13 is the least significant bit (LSB) of the quantity.

(c) Bits 287-288

These two bits have the same function in all 64 elements.

Bit 287 : Valid Data Bit

In order to aid determination of times when data should not be used, a Valid Data Bit into the data stream have been included. This bit is a "1" when all conditions are normal and data may be considered good. It will be a "0" when the scan system is in a slew mode or when the filter wheel is not synchronised to the timing system.

Bit 287 : Valid Data Bit	
Logic "1"	Valid Data
Logic "0"	Ignore Radiometric Data

Bit 288 Odd Bit Parity.

Minor Word Parity Check is a bit inserted to make the total word odd. This permits automatic checking for data losses in the tra~~mission of the data from the HIRS/4.

Element No	Bit No	Function	Remarks
0-55	27 - 39	Radiometric Channel No 1 (669 cm^{-1})	~~Zero counts radiance from scene equal radiance from filter wheel as viewed through the filter~~. Larger negative values indicate warmer scene temperatures.
	40 - 52	Radiometric Channel No 17 (2360 cm^{-1})	Larger negative values indicate warmer scene temperatures.
	53 - 65	Radiometric Channel No 2 (680 cm^{-1})	No offset
	66 - 78	Radiometric Channel No 3 (690 cm^{-1})	No offset
	79 - 91	Radiometric Channel No 13 (2190cm^{-1})	Offset
	92 - 104	Radiometric Channel No 4 (703 cm^{-1})	No offset
	105 - 117	Radiometric Channel No 18 (2515cm^{-1})	Offset
	118 - 130	Radiometric Channel No 11 (1365cm^{-1})	No offset
	131 - 143	Radiometric Channel No 19 (2660cm^{-1})	Offset
	144 - 156	Radiometric Channel No 7 (749 cm^{-1})	No offset
	157 - 169	Radiometric Channel No 8 (900 cm^{-1})	No offset
	170 - 182	Radiometric Channel No 20 visible (14500 cm^{-1} / 690 nm)	Black is minus White is plus
	183 - 195	Radiometric Channel No 10 (1225cm^{-1})	No offset
	196 - 208	Radiometric Channel No 14 (2210cm^{-1})	Offset
	209 - 221	Radiometric Channel No 6 (733 cm^{-1})	No offset
	222 - 234	Radiometric Channel No 5 (716 cm^{-1})	No offset
	235 - 247	Radiometric Channel No 15 (2240cm^{-1})	Offset
	248 - 260	Radiometric Channel No 12 (1488cm^{-1})	No offset
	261 - 273	Radiometric Channel No 16 (2270cm^{-1})	Offset
	274 - 286	Radiomeuic Channel No 9 (1030 cm^{-1})	Offset

offset offset offset offset

*Figure 3.3.3.2/1 : Digital A Status **Telemetry (1/4)***

Element No	Bit No	Function	Remarks
56	27 - 286	Positive Electronics Calibration. Applied to the 20 radiometric channels	Signal output for all channels as a result of the electronic calibration level, described in bits 9 through 13 of the same element. *)
57	27 - 286	Negative Electronics Calibration Applied to 20 radiometric channels	Signal output for all channels as a result of the electronic calibration level, described in bits 9 through 13 of the same element. *
58	27-91	Internal Warm Target Temperature Sensor # 1	13-bit value, repeated 5 times. Range 273 to 333 K.
	92 - 156	Internal Warm Target Temperamre Sensor # 2	13-bit value, repeated 5 times. Range 273 to 333 K.
	157 - 221	Internal Warm Target Temperature Sensor # 3	13-bit value. repeated 5 times. Range 273 to 333 K.
	222 - 286	Internal Warm Target Temperature Sensor # 4	13-bit value, repeated 5 times. Range 273 to 333 K.
59	27-91	Internal Cold Target Temperamre Sensor # 1	13-bit value, repeated 5 times. Range : 243 to 303 K.
	92 - 156	Ground	13-bit value, repeated 5 times. Range: N/A (approximately 0 count)
	157 - 221	Internal Warm Target Temperature Sensor # 5	13-bit value, repeated 5 times. Range : 273 to 333 K.
	222 - 286	Telescope Temperature Sensor # 3	13-bit value, repeated 5 times. Range : 260 to 300 K.
60	27-91	Filter Wheel Housing Temperamre Sensor # 1	13-bit value, repeated 5 times. Range 273 to 333 K.
	92 - 156	Filter Wheel Housing Temperature Sensor # 2	13-bit value, repeated 5 times. Range 273 to 333 K.
	157 - 221	Filter Wheel Housing Temperature Sensor # 3	13-bit value. repeated 5 times. Range 273 to 333 K.
	222 - 286	Filter Wheel Housing Temperature Sensor # 4	13-bit value, repeated 5 times. Range 273 to 333 K.

Figure 3.3.3.2/1 : Digital A Status Telemetry (2/4)

*) In same order as radiometric data.

Element No	Bit No	Function	Remarks
61	27 - 91	Patch Temperature Expanded Scale	13-bit value, repeated 5 times. Range 90 to 150 K.
	92 - 156	First Stage Radiator Temperature Sensor	13-bit value, repeated 5 times. Range 150 to 320 K.
	157 - 221	Filter Wheel Housing Heater Current	13-bit value, repeated 5 times. Range 0 to 500 mA
	222 - 286	Electronic Calibration Digital to Analog Converter	13-bit value, repeated 5 times. Range 0 to 4 V
62	27 - 39	Scan Mirror Temperature	Range 260 to 320 K
	40 - 52	Primary Telescope Temperature	Range 260 to 320 K
	53 - 65	Secondary Telescope Temperature	Range 260 to 320 K
	66 - 78	Baseplate Temperature	Range 260 to 320 K
	79 - 91	Electronics Temperature	Range 260 to 320 K
	92 - 104	Patch Temperature-Full Range	Range 90 to 320 K
	105 - 117	Scan Motor Temperature	Range 260 to 320 K
	118 - 130	Filter Wheel Motor Temperature	Range 260 to 320 K
	131 - 143	Cooler Housing Temperature	Range 260 to 320 K
	144 - 156	Patch Control Power	Range 0 to 80 mW
	157 - 169	Scan Motor Current	Range 0.65 to 1.0 A
	170 - 182	Filter Motor Current	Range 100 to 300 mA
	183 - 195	+15 VDC	Range +15 ± 0.2 V
	196 - 208	-15 VDC	Range -15 ± 0.2 V
	209 - 221	+7.5 VDC	Range +7.5 ± 0.05 V
	222 - 234	-7.5 VDC	Range -7.5 ± 0.05 V
	235 - 247	+10 VDC	Range +10 ± 0.2 V
	248 - 260	+5 VDC	Range +5 ± 0.2 V
	261 - 273	Analog Ground	Range ± 1 count
	274 - 286	Analog Ground	Range ± 1 count

*Figure **3.3.3.2/1** : Digital A Status Telemetry **(3/4)***

Element No	Bit No	Function	Remarks
63	27 - 39	Line Counter (Gives the number of lines from the last auto-calibration sequence)	0 to 8191. There is no sign bit used in the line counter. Reset to 0 count is only when counter overflows.
	40-52	First Status Word	See Figure 3.3.3.2/2
	53 - 65	2nd Status Word	See Figure 3.3.3.2/2
	66-78	Data Verification This a fixed word pattern used to establish data stream synchronism with the data clock	i.e. Binary Coded (1,1,1,1,1,0,0,1,0,0,0,1,1) equates to +3875 (Base 10). The binary code is MSB to LSB with the leading "1" indicating a "+"
	79-91	Data Verification	Base 10 equivalent +1443
	92 - 104	Data Verification	-1522
	105 - 117	Data verification	-1882
	118 - 130	Data Verification	-1631
	131 - 143	Data Verification	-1141
	144 - 156	Data Verification	+1125
	157 - 169	Data Verification	+3655
	170 - 182	Data Verification	-2886
	183 - 195	Data Verification	-3044
	196 - 208	Data Verification	-3764
	209 - 221	Data Verification	-3262
	222 - 234	Data Verification	-2283
	235 - 247	Data Verification	-2251
	248 - 260	Data Verification	+3214
	261 - 273	Data Verification	+1676
	274 - 286	Data Verification	+1992

*Figure **3.3.3.2/1 : Digital** A **Status Telemetry (4/4)***

Bit No.	Function	
First Status Word		
40	None - Fill Zero	Fill Zero
41-44	Instrument Serial Number	No sign bit
45	Command status bit : Instrument ON/OFF	ON = 1
46	Command status bit : Scan Motor ON/OFF	ON = 0
47	Command status bit : Filter Wheel ON/OFF	ON = 0
48	Command status bit : Electronics ON/OFF	ON = 1
49	Command status bit : Cooler Heat ON/OFF	ON = 0
50	Command status bit : Internal Warm Target Position	True = 0
51	Command status bit : Internal Cold Target Position	True.= 0
52	Command status bit : Space Position	True = 0
Second Status Word		
53	0	
54	0	
55	0	
56	0	
57	0	
58	Command status bit : NADIR Position	True = 0
59	Command status bit : Calibration Enable/Disable	Enabled=0
60	Command status bit : Cooler Door Release Enable/Disable	Enabled=0
61	Command status bit : Cooler Door Open	YES = 1
62	Command status bit : Cooler Door Closed	YES = 1
63	Command status bit : Filter Housing Heater ON/OFF	ON = 0
64	Command status bit : Patch Temperature Control ON/OFF	ON = 0
65	Command status bit : Fllter Motor Power HIGH	Normal = 1

Figure 3.3.3.2/2 : Status Words (Element 63, Bits 40-52 & 53-65)

3.3.3.3. Data Format During HIRS/4 Commaoded Position Mode

For the HIRS/4 Commanded Position Mode, the scan mirror moves and stops at the desired position (nadir, space, internal warm target, internal cold target).

The data format from the HIRS/4 is the same as during the measurement data, with the 64 288-bit element pattern.

This pattern is repeated till the Commanded Position Mode is disabled.

3.4. POWER ELECTRICAL INTERFACES

3.4.1. Overview

The HIRS/4 instrument requires the following power interfaces :

- A regulated *+28 Volt Main Power Bus with high* quality power *as* primary source for the instrument.
- A regulated *+28 Volt Switched TLM Bus* for powering temperature telemetry.
- A regulated *+28 Volt Pulse Loud Bus* for steppers. heaters... which do not comply with the Main Bus ripple specification.
- A regulated *+10 Volt Interface Bus* for the command, clock, part of Digital B telemetry and measurement data interface circuits.

The +28 V Main Power Bus, the +28 V Switched TLM Bus, and the +28 V Pulse Load Bus are conditioned by the internally redundant Power Conversion Unit (PCU). The +28 V Main Power Bus and the +28 V Pulse Load Bus are individually switched and protected. The +28 V Switched TLM Bus is powered whenever the PCU is on. The +10 V Interface Bus is provided by the NIU. This illustrated in Figure 3.4.1-1.

Figure 3.4.1-2 details tbe HIRS/4 internal power distribution.

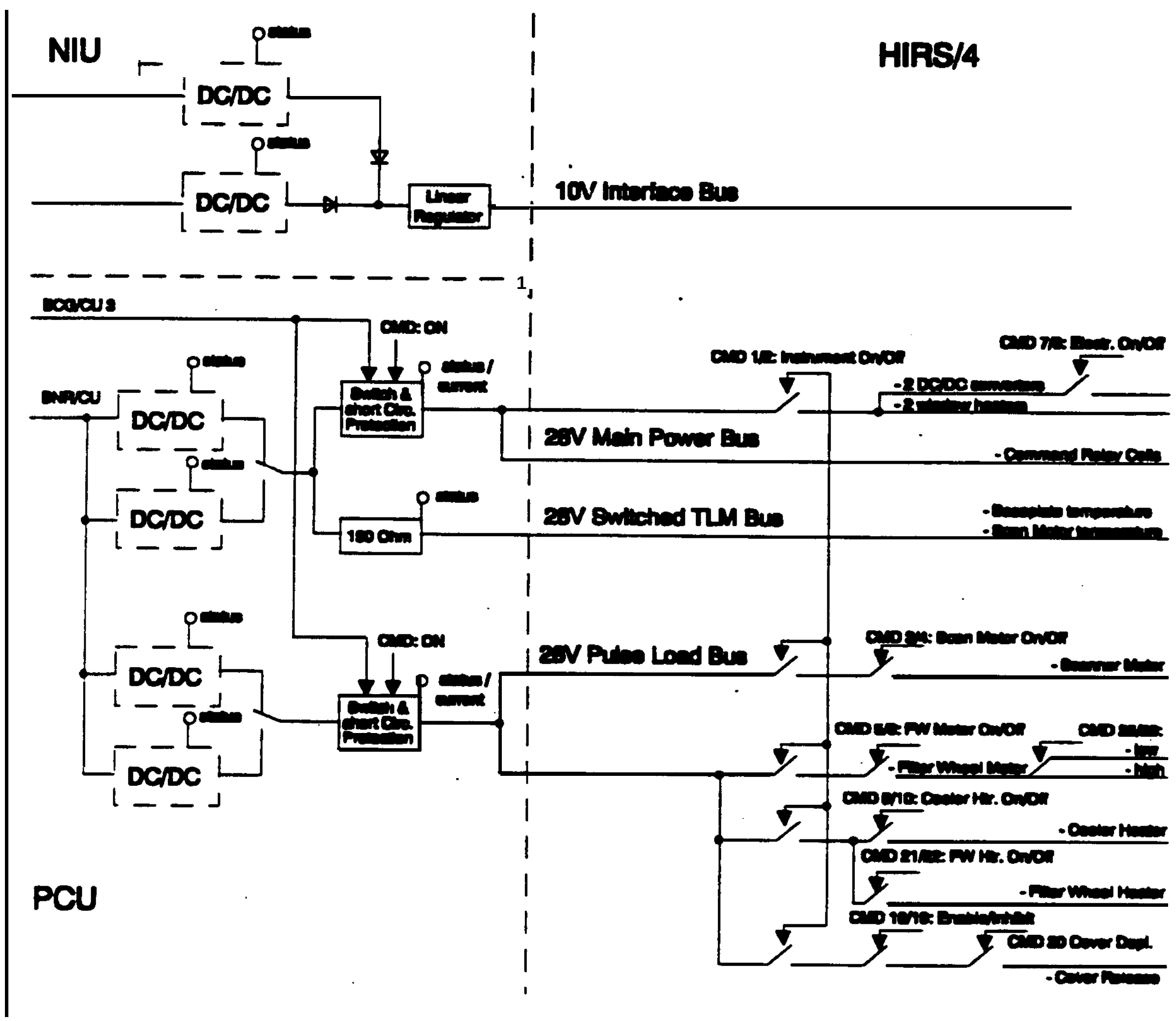


Figure 3.4.1-I : ***HIRS/4*** *Power Distribution* ***Diagram***

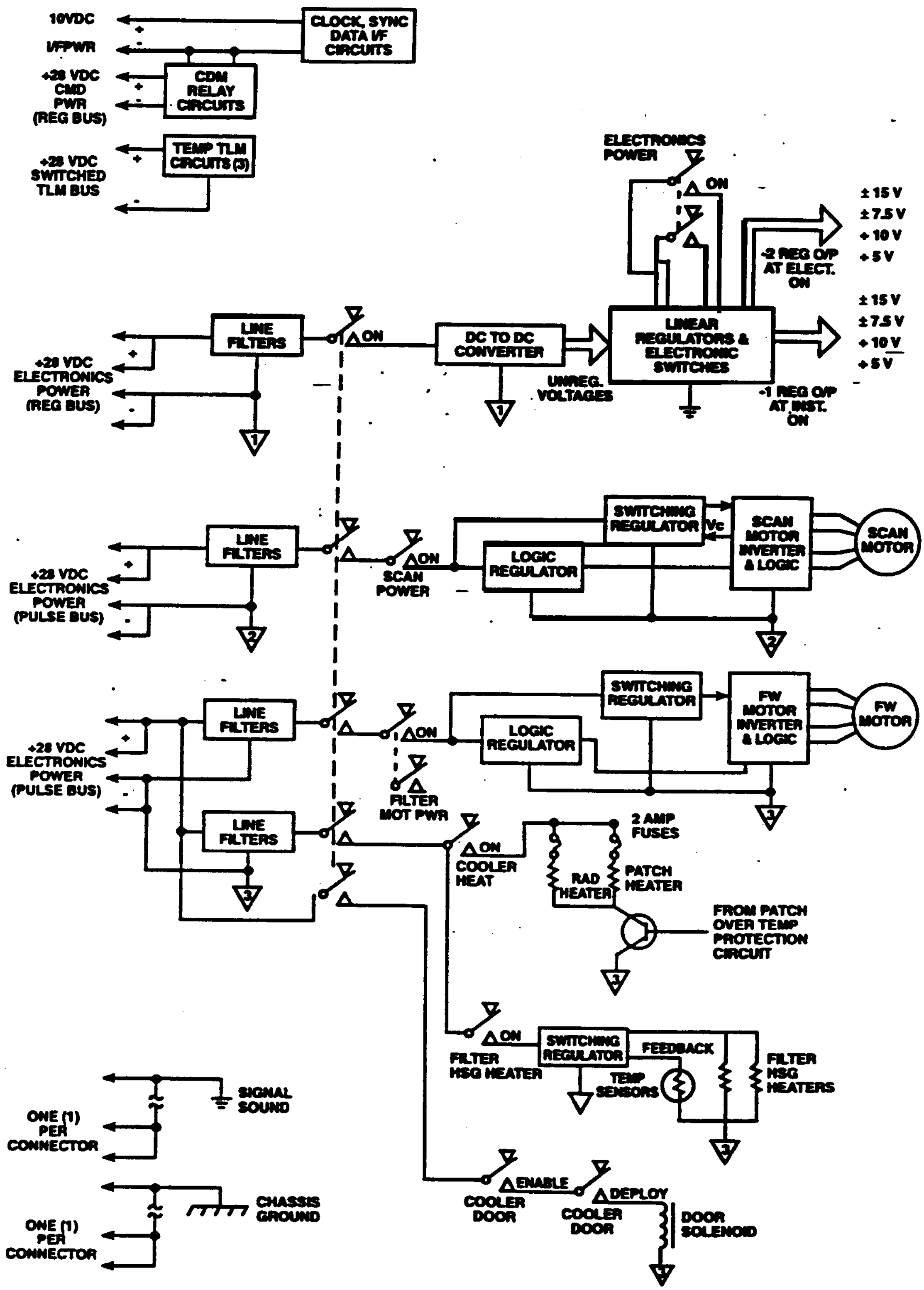


*Fig. 3.4.1-2 : **HIRS/4 Internal** Power **Distribution Diagram***

3.43. Power Demand

The actual power demands for **HIRS/4** on the individual power busses for BOL & EOL during all modes and **required** outlet dimensions are defined in Table 3.4.2-l **Power** Consumption Data Sheet.

The power budget for the thermal control of the baseplate is not part of the instrument power budget (see § 2.3.3.1.).

Parameter Definitions

Typical Beginning of Life Power

Power expected to be **measured during instrument acceptance test,** = basic power.

Worst Case End of Life Power

Specified power the **instrument** *shall never* **exceed (except** in case of failure).

Mean Power

Steady state power consumed when the power bus is set at its mean voltage and with a 25 deg. C temperature.

Min. /Max Power

Min. / max. steady state **power consumed as a function of power bus input voltage and instrument** temperature.

Peak Power

Total power consumed during a peak i.e. corresponding to an **event** of finite duration during **the** considered functional mode. The peak **power** is given at **mean** power bus voltage and with a 25 deg. **C** temperature. The peak power is **characterized** by a peak duration and / or a peak repetition duty **cycle**.

Failure Power Consumption

Maximum permanent power That will be consumed without **triggering** an **internal protection or** without leading to a fuse blowing.

dP/dV @ 25 deg. C

Mean variation of the consumed power with respect to the input voltage.

Table 3.4.2-1 : Power Consumption Data Sheet (1/2)

HIRS/4 — dP/dV @ 25 deg. C

Instr. Mode	Power Bus	Typical Beginning of Life (W) Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Worst Case End of Life (W) Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Failure Power
Off Mode	28 V Main Bus	3.64	3.27	4.19	None	None		3.83	3.44	4.40	None	None		
	28 V Pulse Load	10.60	9.54	12.19				11.13	10.02	12.80				
	28 V Sw. TM Bus (a)	0 / 0.03	0	0 / 0.03				0 / 0.03	0	0 / 0.03				
	10 V Interface Bus	0.10	0.09	0.115				0.10	0.09	0.115				
	TOTAL	14.341 14.37	*12.90*	16.495 16.525	None	*None*		*15.06 /* 15.09	*13.55*	17.315 *17.345*	None	None		
Heater Mode (Elect. Off)	28 V Main Bus	3.64	3.27	4.19				3.83	3.44	4.40				
	28 V Pulse Load	10.60	9.54	12.19	38.60	-	20 % (b)	11.13	10.02	12.80	40.03		95 % (b)	
	28 V Switched TM Bus	0.03	0	0.03				0.03	0	0.03				
	10 V Interface Bus	0.10	0.09	0.115				0.10	0.09	0.115				
	TOTAL	*14.37*	*12.90*	*16.525*	42.37			*15.09*	13.55	*17.345*	43.99			

(a) In Off Mode, the power consumption on the +28 V Switched TLM Bus is 0.03 W, when this bus is available at the instrument interface.

(b) The cooler outgas heater power with the door closed (first Heater Mode) cycles at about 10-20 % duty cycle, whereas, with the door open (subsequent Heater Modes), it cycles at 95% duty cycle.

Table 3.4.2-I : Power Consumption Data Sheet (2/2)

HIRS/4		Typical Beginning of Life (W)						Worst Case End of Life (W)						
Instr. Mode	Power Bus	Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Failure Power
Meas. & Comm. Position Modes	28 V Main Bus	6.44	5.79	7.41				6.80	6.09	7.80				
	28 V Pulse Load	12.60	11.34	14.49	19.0	0.8 sec.	Every 6.4s	13.25	11.90	15.25	20.0	0.8 sec.	Every 6.4s	
	See Note (c)				56.0	2 sec.	Once				-	-		
	28 V Switched TM Bus	0.03	0	0.03				0.03	0	0.03				
	10 V Interface Bus	0.10	0.09	0.115				0.10	0.09	0.115				
	TOTAL	*19.17*	17.22	*22.045*	25.57 62.57			20.18	*18.08*	23.195	26.93			

(c) In Measurement Mode, two peak powers can be observed :

- the first one is due to the retrace part of the scan cycle.
- the second one refers to the radiant cooler door deployment, that occurs at the beginning of the mission.

3.4.3. Power Electrical Interface Requirements

In order to structure the electrical interfaces, all signals to be controlled by this document will be identified and classified into a certain number of signal types. For each signal type a three character identifier code is given as defined in the corresponding tables. In most cases the power-signal code is identical to the code of the Data Sheet by which the signal is specified.

Table 3.4.3-1 shows the power interfaces used by the HIRS/4 and the corresponding data sheet identifiers.

	Data Sheet Code	Interface circuit
+28 V Main Power Bus	FPB	Fig. 3.4.3.2-l
+28 V Switched TLM Bus	BPB	Fig. 3.4.3.2-2
+28 V Pulse Load Bus	WPB	Fig. 3.4.3.2-3
+10 V Interface Bus	DPB	Fig. 3.4.3.2-4

Table 3.4.3-I : Powtr Interfaces to HIRS/4

Within the Power Interface Data Sheets, the electrical characteristics of the power interfaces are defined.

3.43.1. Power Interface Data Sheets

On the following pages the electrical characteristics of the power interfaces are defined with one Data Sheet per signal. In Table 3.4.3-l: 'HIRS/4 Power interfaces' and § 3.4.5 'Power Pin Allocation' is referenced to these Data Sheets.

The performances specified in the Data Sheets are maintained during the mission lifetime and under nominal load and temperature range conditions. Source specifications have to be measured at the connector of the source and load specifications have to be measured at the connector of the load unless specified otherwise.

Parameter Dtjinitions

Small Signal Impedance

Output impedance of the power supply tested with, compared to 28V, small AC signals.

Output impedance

Linear output impedance of the power supply.

Voltage Ripple

Sinusoidal voltage ripple, including repetitive spikes and voltage drop caused by the instruments current ripple.

Under-Voltage (incl. ripple & trans.)

The *specified* voltage range will be considered as under-voltage.

Over-Voltage (incl. ripple & trans.)

The *specified* voltage range will be considered as over-voltage.

Transients

Positive or negative going, non repetitive spikes caused by load current changes.

Max. Steady&ate Current

Maximum power as defined in the Power Consumption Data Sheet divided by the minimum specified nominal voltage.

Current Ripple

Ripple caused by the load pulsed currents (DC/DC converter, stepper motors...).

Inrush Current

Maximum allowed input current for a restricted time, when the load is switched on.

Inrush Current Rate

Rate-of-change of the input current over time when the load is switched 'on'.

Signal Nomenclature	**28 V Main Power Bus**	
Code	FPB	
EMC Class	**Power**	
Power **Source** Specification		
Parameter	**Requirement**	**Remarks**
Voltage	27.44 . . . 28.56 V	**at HIRS/4 input**
Small Signal Impedance	< 0.3 Ω	**f < 100 kHz, short circuit protection & line < 0.1Ω**
Voltage Ripple	See § 4.3.1.2.	
Under-Voltage (incl. ripple & trans.)	**> 16.00 V ; < 27.44 V**	**for < 3 s**
Over-Voltage (incl. ripple & trans.)	> 28.56 V ; < 38.00 V	**for < 50 ms**
Transients	**See §** 4.3.1.2.	
Max. Current	**< 5.0 A**	Limited by short circuit **protection**
Leakage **Current**	**< 6 mA**	Short circuit **protection 'Off'**
Load **Specification**		
Parameter	**Requirement**	**Remarks**
Max. Steady-State Current	0.19 A	
Current Ripple	**<2% of Max. Stdy-State Curr.**	**f < 100 kHz**
Inrush Current	**<150%** of Max. **Stdy-State** cur.	Steady- State after 1 s
Inrush Current Rate	< 30 **mA/µs**	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 20, T4	

Signal Nomenclature	+28 V Switched TLM Bus	
Code	BPB	
EMC Class	Power	
Power Source Specification		
Parameter	**Requirement**	**Remarks**
Voltage	**27.44 ... 28.56 V**	**at HIRS/4** input [3] (tbc) Mel
Small Signal Impedance	**< 160 Ω**	**f < 100 kHz**
Voltage Ripple	See § 4.3.1.2.	
Under-Voltage (incl. ripple & trans.):	> 16.00 ; < 27.44 V	**for < 3 s**
Over-Voltage (incl. ripple & trans.) :	> 28.56 ; < 38.00 V	**for < 50 ms**
Transients	See § 4.3.1.2.	
had **Specification**		
Parameter	**Requirement**	**Remarks**
Max. Steady-State Current	**8 mA**	
Current Ripple	**< 1 mA_{pp}**	**f < 100 kHz**
Inrush Current	c 150% Max stdy-state **Curr.**	steady-state after 30 **ms**
Harness Design		
Parameter	Requirement	**Remarks**
Wiring Type	**AWG 24. TP**	

[3] Measured **under no load condition.**

Signal Nomenclature	28 V Pulse Load Bus	
Code	WPB	
EMC Class	Power	
Power Source Specification		
Parameter	**Requirement**	**Remarks**
Voltage	27.44 . . 28.56 V	at HIRS/4 input
Small Signal Impedance	< 0.3 Ω	f < 100 kHz, short circuit protection & line < 0.1Ω
Voltage Ripple	See § 4.3.1.2.	
Under-Voltage (incl. ripple & trans.)	> 16 ; < 27.44 V	for < 3 s
Over-Voltage (incl. ripple & trans.)	> 28.56 ; < 38 V	for < 50 ms
Transients	See § 4.3.1.2.	
Max. Current	< 5.0 A	Limited by short circuit protection
Leakage Current	< 6 mA	Short circuit protection 'Off'
Load Specification		
Parameter	**Requirement**	**Remarks**
Max. Steady-State Current	1.5 A	
Current Ripple	600 mA_{pp}	f < 100 kHz
Inrush Current	<150% of Max. Stdy-State Curr.	Steady-State after 6 ms
Inrush Current Rate	< 1 A/µs	
Harness Design		
Parameter	Requirement	**Remarks**
Wiring Type	AWG 20, T4	

Signal Nomenclature	**+10 V Interface Bus**	
Code	DPB	
EMC Class	Power	
Power Source specification		
Parameter	**Requirement**	**Remarks**
Voltage	9.5 . . . 10.5 v	at HIRS/4 input
Source Current	< 100 mA	
Small Signal Impedance	< 1 Ω	f < 10 MHz
Voltage Ripple	See § 4.3.1.2.	
Under-Voltage (incl. ripple & trans.)	> 9.0 v ; < 9.5 v	
Over-Voltage (incl. ripple & trans.)	> 10.5 v ; < 15.0 v	
Voltage Transients	See § 4.3.1.2.	
Load Specification		
Parameter	**Requirement**	**Remarks**
Max. steady-state Current	8 mA	
Current Ripple	< 3 mA_{pp}	f < 2.5 MHz
Inrush Current	< 125% Max Stdy-State Cur.	for < 60 ms
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24. TP	

3.432. Power Interface Circuits

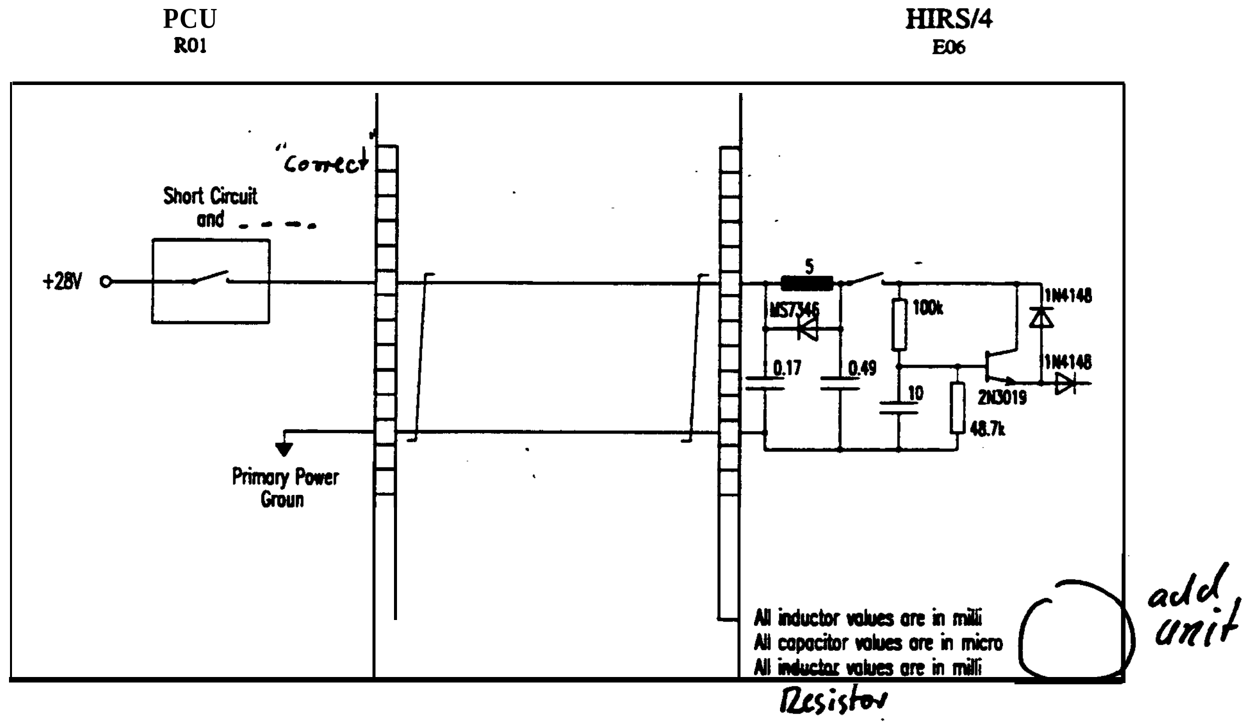


*Figure 3.4.3.2-I : **+28** V Main Power Bus **Interface** Circuit*

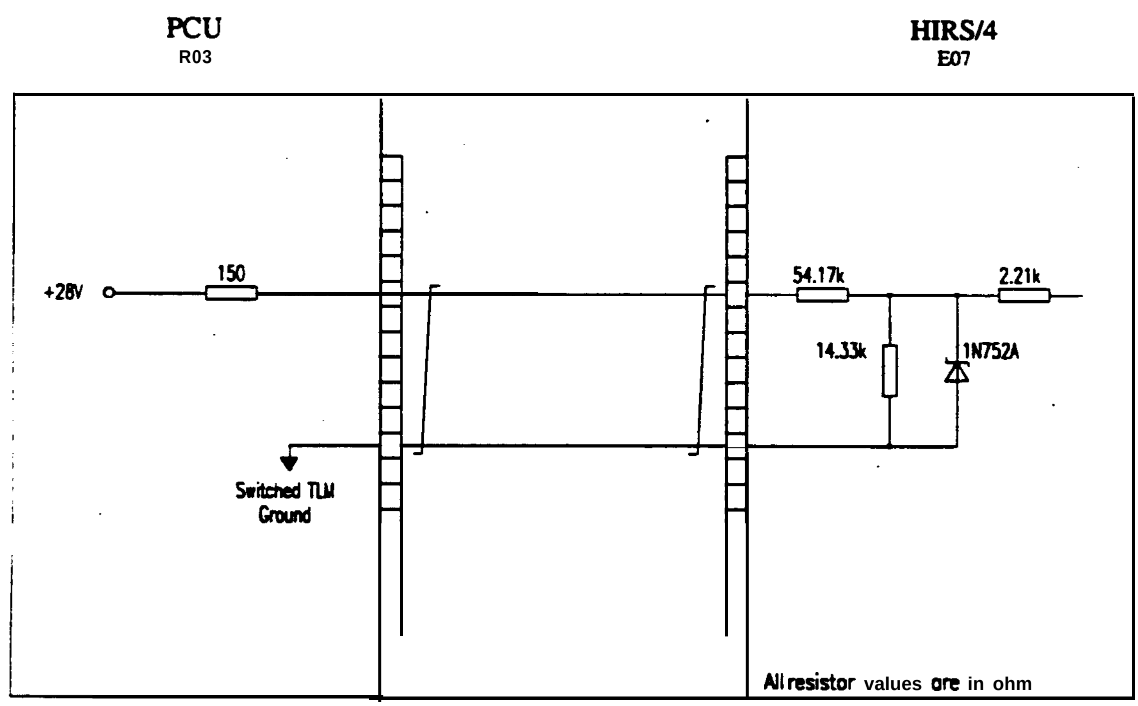


*Figure J-4.3.2-2 : **+28** V Switched **Telemetry** Bus **Interface** Circuit*

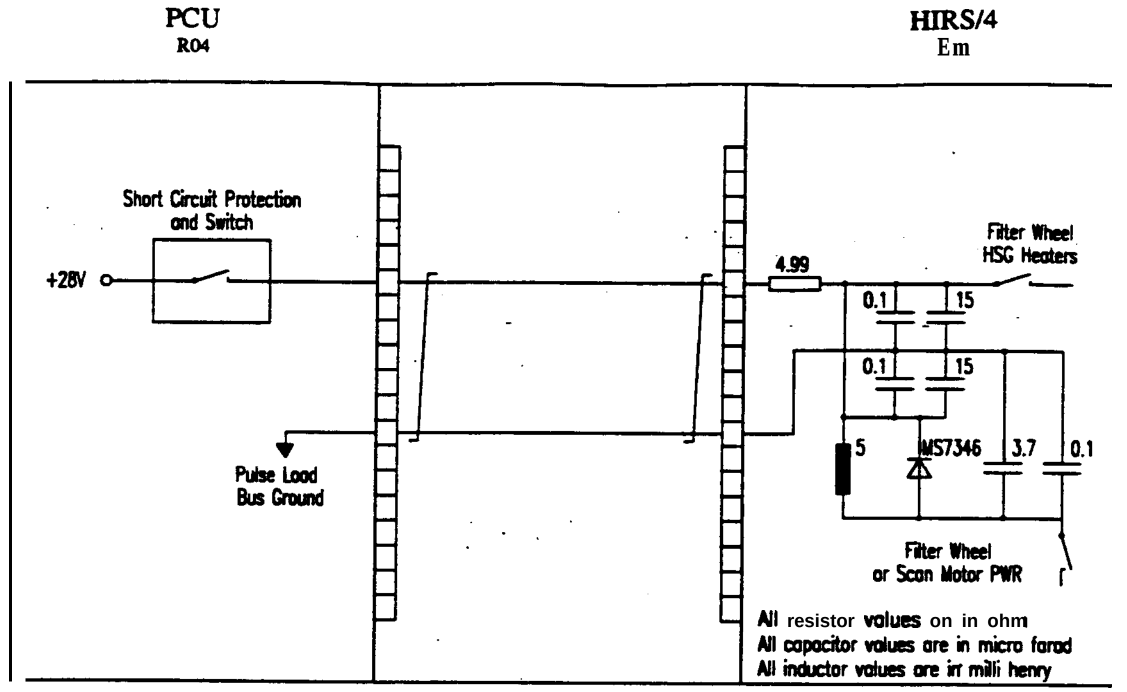


*Figure 3.4.3.2-3 : **+28** V **Pulse** Load Bus **Interface** Circuit*

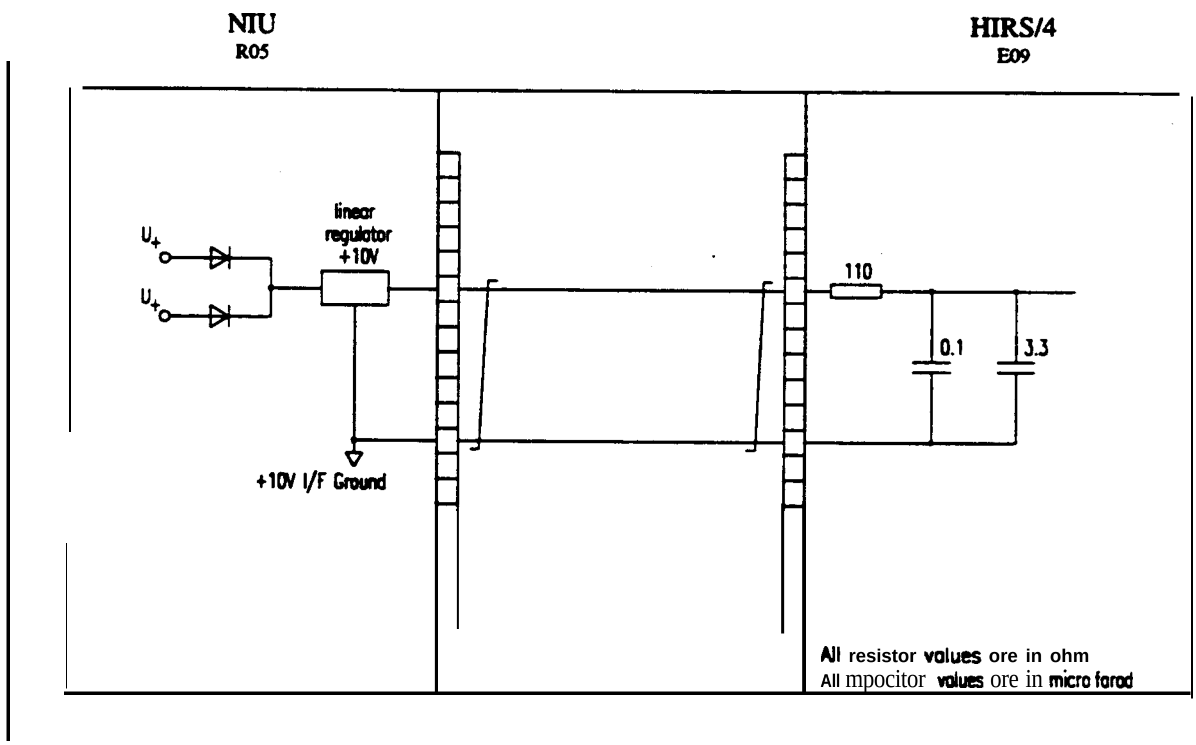


*Figure 3.4.3.24 : **+10** V **Interface** Bus **Interface** Circuit*

3.4.4. Power Connectors

Table 3.4.4-l identifies the power connector types at the HIRS/4 boxes ad Table 3.4.4-2 identifies the power connector types at the HIRS/4 harness.

There is no dedicated connector on the instrument used on METOP for the thermal control of the baseplate.

Connector	Connector-Type	Function
J02	DBMA-25P-NMB	Power
J08	DEMA-9S-NMB	Heater TCU I/F (TIROS specific)

Table 3.4.4-l: Power Connector Types at HIRS/4 Boxes

Connector	Connector-Type	Function
P02	DBMA-25S-NMB	Power
P08	DEMA-9P-NMB	Not used at METOP level

Table 3.4.4-2: Power Connector Types at HIRS/4 Harness

3.45. Power Pin *Allocation* Lists

In these lists, the cross reference between connector pin, signal designation, Interface Data Sheet, target connector and target connector pin is defined and recorded as data base. Per connector one list is prepared.

Interface Data Sheets can be found in § 3.4.3.1.

The individual pin allocation lists are specified by 9 characters of a alpha numerical connector number. For the HIRS/4 the first 3 characters are HIR. The 7th character is J for a box connector or P for a harness connector. The last two characters define the. connector number.

Since these lists also specify wiring and shielding, they will form the basis for harness manufacturing.

The power connector pin allocations at instrument level are &scribed in Tables 3.4.5/1 and /2. The power connector harness are described in Tables 3.4.5/3 and /4.

Connector : 1HIR305J02 Item : HIR305 Function : Power Backshell : N/A
EMC-Category : 1 Conn.-Type : DBMA-25P

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Shd	Cable	Twist	Comment	New
01	+28V Main PwrBus HIR	.SUP1	E06	FPB-	- D	AB01				Pin 1, 2 and 8 are	
14	+28V Main PwrBus HIR	.RTN1	E06	FPB-	- 7	AB01				shorted at P-Conn.	
02	+28V Main PwrBus HIR	.SUP2	E06	FPB-	- D	AB01					
15	+28V Main PwrBus HIR	RTN2	E06	FPB-	-7	AB01				Pin 14, 15 and 21 are	
08	+28V Main PwrBus HIR	.SUP3	E06		- D					shorted at P-Conn.	
21	+28V Main PwrBus HIR	.RTN3	E06		- 7						
03	+28V Pul LoadBus HIR	.SUP1	E08	WPB-	- D	CB00				Pin 3 and 4	
16	+28V Pul LoadBus HIR	.RTN1	E08	WPB-	- 7	CB00				Pin 16 and 17	
04	+28V Pul LoadBus HIR	SUP2	E08		- D					are shorted each	
17	+28V Pul LoadBus HIR	.RTN2	E08		-7					at the P-Conn.	
05	+28V Pul LoadBus HIR	SUP3	E08	WPB-	- D	CB00				Pin 5, 6 and 9	
18	+28V Pul LoadBus HIR	.RTN3	E08	WPB-	- 7	CB00				Pin 18, 19 and 22	
06	+28V Pul LoadBus HIR	SUP4	E08		- D					are shorted each	
19	+28V Pul LoadBus HIR	.RTN4	E08		- 7					at the P-Conn.	
09	+28V Pul LoadBus HIR	SUP5	E08		- D						
22	+28V Pul LoadBus HIR	.RTN5	E08		- 7						
07	+28V Swt TLM BUS HIR	SUP	E07	BPB-	- D	BB00					
20	+28V Swt TLM BUS HIR	.RTN	E07	BPB-	- 7	BB00					
11	+10V I/F Bus HIR	.SUP	E09	DPB-	- D	DB01					
24	+10V I/F Bus HIR	.RTN	E09	DPB-	- 7	DB01					
25	Signal Gnd P02 HIR	.GND		GND-	-	GD01					
1?	Chassis Gnd HIR	.-									
10	SC	.-									
12	NC	.-									
23	NC	.-									

Table 3.4.5/1 : Pin Allocation List of Connector JO2

Not used at METOP level

Table 3.4.5/2 : Pin Allocation List of Connect& J08

Connector : 1HIR305P02 **Item :** HIR305 Function : Power **Conn.-Type :** DBMA-25S-NMB
EMC-Category : 1 **Location :** 305 **Backshell :** TBD

			Interface-Code				Grouping											
Pin	**Signal Designation**		**Circ**	**Signal**	.	**Pos.**	**Ch.**	ID	**Wiring**	**Shd**	**Cable**	**Twist**	**Comment**	**End-It.**	**Loc.**	**Connector**	**Pin**	**New**
01	+28V Main PwrBus HIR	.SUP1	E06	FPB-	-	D	AB01	T4-20					Pin 1, 2 and 8 are	PCU	230	PCU230 Pxx		
14	+28V Main PwrBus HIR	.RTN1	E06	FPB-	-	7	AB01	T4-20					haled at P-Conn.	PCU	230	PCU230 Pxx		
02	+28V Main PwrBus HIR	.SUP2	E06	FPB-	-	D	AB01	T4-20						PCU	230	PCU230 Pxx		
15	+28V Main PwrBus HIR	.RTN2	E06	FPB-	-	7	AB01	T4-20					Pin 14, 15 and 21 are	PCU	230	PCU230 Pxx		
oa	+28V Main PwrBus HIR	.SUP3	E06		-	D							shorted at P-Conn.					
21	+28V Main PwrBus HIR	.RTN3	E06		-	7												
03	+28V Pul LoadBus HIR	.SUP1	E08	WPB-	-	D	CB00	T4-20					Pin 3 and 4	PCU	230	PCU230 Pxx		
16	+28V Pul LoadBus HIR	.RTN1	E08	WPB-	-	7	CBOO	T4-20					Pin 16 and 17	PCU	230	PCU230 Pxx		
04	+28V Pul LoadBus HIR	.SUP2	E08		-	D							are shorted each					
17	+28V Pul LoadBus HIR	.RTN2	E08		-	7							at the P-Conn.					
05	+28V Pul LoadBus HIR	.SUP3	E08	WPB-	-	D	CB00	T4-20					Pin 5, 6 and 9	PCU	230	PCU230 Pxx		
18	+28V Pul LoadBus HIR	.RTN3	E08	WPB-	-	7	CB00	T4-20					Pin III, 19 and 22	PCU	230	PCU230 Pxx		
06	+28V Pul LoadBus HIR	.SUP4	E08		-	D							are shorted each					
19	+28V Pul LoadBus HIR	.RTN4	E08		-	7							at the P-Conn.					
09	+28V Pul LoadBus HIR	.SUP5	E08		-	D												
22	+28V Pul LoadBus HIR	.RTN5	E08		-.	7												
07	+28V Swt ILM BUS HIR	.SUP	E07	BPB-	-	D	BB00	TP-24						PCU	230	PCU230 Pxx		
20	+28V Swt ILM BUS HIR	.RTN	E07	BPB-	-	7	DBOO	TP-24						PCU	230	PCU230 Pxx		
11	+ IOV I/F Bus HIR	SUP	E09	DPB-	-	D	DB01	TP-24						NIU	240	NIU240 Pxx		
24	+10V I/F Bus HIR	.RTN	E09	DPB-	-	7	DB01	TP-24						NIU	240	NIU240 Pxx		
25	Signal Gnd P02 HIR	.GND		GND-				SL-20						NIU	240	NIU240 Pxx		
13	Chassis Gnd HIR	.-																
IO	NC	.-																
12	NC	.-																
23	NC	.-																

Table 3.4.5/3 : Pin Allocation List of Connector PO2

(For Information Only)

Not used al METOP level

Table 3.4.5/4 : Pin Allocation List of Connector PO8

3.5. SIGNAL ELECTRICAL INTERFACES

3.5.1. Overview

An overview on the signal electrical interfaces between PLM and the HIRS/4 is presented in Figure 3.5.1-1.

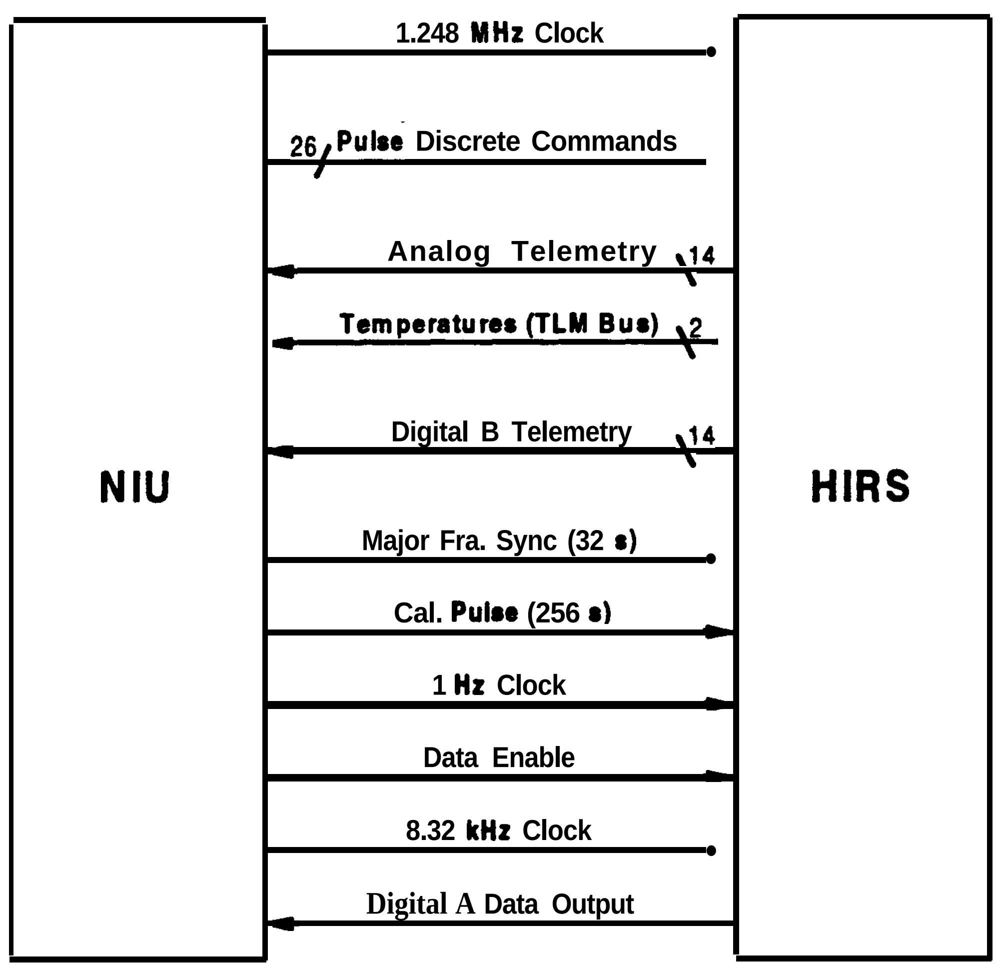


Fig. 3.5.1-1 : Signal ***Electrical Interfaces PLM ⇔ HIRS/4***

3.5.2. Signal Electrical Interface Requirements

Table 3.5.2-l lists all signals of the HIRS/4 interfaces and gives references to the Interface Data Sheets in § 3.5.2.1 as well as the interface circuits in § 3.5.2.2.

Table *3.5.2-1* : Signal *to Data Sheets & Interface Circuits Assignments (1/2)*

Signal	Data Sheet Code	Interface Circuit	Remarks
1.248 MHz Clock HIRS/4	CLR	Fig. 35.2.2-l	Timing : see Fig. 3.2.6-1
Instrument Pow. On HIRS/4 Instrument Pow. Off HIRS/4 Electronics On HIRS/4 Electronics Off HIRS/4 Scan Motor On HIRS/4 Scan Motor Off HIRS/4 Filter Motor On HIRS/4 Fllter Motor Off HIRS/4 Int. Warm Target Pos. HIRS/4 Int. Cold Target Pos. HIRS/4 Filter Heat On HIRS/4 Filter Heat Off HIRS/4 Pos. Disable HIRS/4 Cooler Heater On HIRS/4 Cooler Heater Off HIRS/4 Patch Contr. On HIRS/4 Patch Contr. Off HIRS/4 Space Position HIRS/4 Nadir Position HIRS/4 Cooler Door Enable HIRS/4 Cooler Door Disable HIRS/4 Calibration Enable HIRS/4 Calibration Disable HIRS/4 Cooler Door Deploy HIRS/4 Filter Motor Pow. High HIRS/4 Filter Motor Pow. Normal HIRS/4	CCO	Fig. 3.5.2.2-2	Pulse Discrete Commands

Table 3.5.2-I: Signal to Data Sheets & Interface Circuits Assignments (2/2)

Signal	Data Sheet Code	I/F Circuit	Remarks
Baseplate Temp. HIRS/4 Scan Motor Temp. HIRS/4	TLA	Fig. 3.5.2.2-3	Temperatures (Sw. TLM Bus)
Radiator Temp. HIRS/4 Electronics Temp. HIRS/4 Patch Temp. HIRS/4 Filter Motor Temp. HIRS/4 Filter Housing Current HIRS/4 Filter Motor Current HIRS/4 Scan Motor Current HIRS/4 +15 VDC TLM HIRS/4 +10 VDC TLM HIRS/4 +7.5 VDC TLM HIRS/4 +5 VDC TLM HIRS/4 -7.5 VDC TLM HIRS/4 -15 VDC TLM HIRS/4 Patch Contr. Power HIRS/4	TLA	Rg. 3.5.224	Analog HK Telemetry
Instrument Pow. On/Off TLM HIRS/4 Electronics On /Off TLM HIRS/4 Filter Motor On/Off TLM HIRS/4 Scan Motor On/Off TLM HIRS/4 Cooler Heater On/Off TLM HIRS/4 Filter Housing. Heat On/Off TLM HIRS/4 Cover Release Enable./Disable TLM HIRS/4 Filter Motor Pow. Norm./High TLM HIRS/4 Patch Temp. Contr. On/Off TLM HIRS/4	TLD	Fig. 3.5.2.2-5	Digital B HK Telemetry
Window Heater On/Off TLM HIRS/4	TLD	Fig. 3.5.2.2-6	Digital B HK Telemetry
Go to Nadir Position On/Off TLM HIRS/4 Calib. Sequ. Enable/Disable TLM HIRS/4	TLD	Fig. 3.5.2.2-7	Digital B HK Telemetry
cover Closed Yes/No TLM HIRS/4 Cover Open Yes/No TLM HIRS/4	TLD	Fig. 3.5.2.2-8	Digital B HK Telemetry
Major Frame Sync (32s) HIRS/4 Cal. Pulse (256 s) HIRS/4	SYT	Fig. 3.5.2.2- 11	
1 Hz Clock HIRS/4	SYR	Fig. 3.5.2.2-10	
Data Enable HIRS/4	DEN	Fig. 3.5.2.2-11	Timing see § 3.3 Measurement Data
8.32 kHz Clock HIRS/4	CLU	Fig. 3.5.2.2-11	Timing see § 3.3 Measurement Data
Data Output HIRS/4	DOA	Fig. 3.5.2.2-9	Timing see § 3.3 Measurement Data

3.5.2.1. Signal Electrical Interface Data Sheets

On the following pages the elecaical characteristics of the signal elecuical interfaces are defined with one Data Sheet per signal. In § 3.5.2 'Signal Electrical Interface Requirements' and § 3.5.4 'Signal Pin Allocation' is referenced to these Data Sheets.

The performances specified in the Data Sheets are maintained during the mission lifetime and under nominal load and temperature range conditions. Source specifications have to be measured at the connector of the source and load specifications have to be measured at the connector of the load unless specified otherwise.

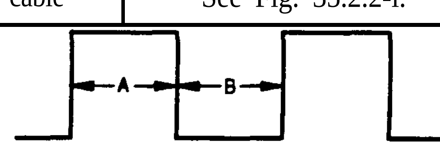
The Fault Voltage Protection is the maximum externally induced voltage that the specified input or output can withstand without damage. The Fault Voltage Emissions is the maximum internally generated voltage that the specified input or output can create under worst case fault conditions.

Signal Nomenclature	**1.248 MHz Clock**	
Code	CLR	
EMC Class	RF	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
Low Level	-0.2 ... +0.2 V	line to 10 V I/F ground
High Level	+9.3 ... +10.7 V	line to 10 V I/F ground
Frequency (initial setting)	1.248 MHz ± 1.10^{-6}	square wave
Stability	5.10^{-9} / sec	
Frequency Drift per Week	5.10^{-6}	over temperature range
Frequency Drift per Year	1.10^{-6}	at constant temperature
Rise Time 10% to 90%	< 60 ns	cable length < 5 m
Clock Symmetry	> 82 %	see figure below
Output Impedance	< 120 Ω	CMOS buffer output
Source Current	> 2.8 mA	@ V_{OH} = 9.5 V
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 100 Ω
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCO
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
Low Level	-0.5 . . . +2.0 v	line to 10 V I/F ground
High Level (V_{IH})	+8.0 . . . +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 90 kΩ	
Fault Voltage Emissions	0 v ... V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 v . . . V_{DD} + 0.5 v	V_{DD} defined in Data Sheet CCO
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	Double shielded cable	See Fig. 35.2.2-l.

Symmetry

A / B x 100% if B > A

B/Ax 100% if A > B



Signal Nomenclature	Pulse Discrete Commands (Long)	
Code	CCO	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level / 'TRUE	-0.2 . . ..+0.2 v	line to 10 V I/F ground
'0' - Level / 'FALSE' (V_{OH})	+9.3 . . . +10.7 v	line to 10 V I/F ground
Rise Time 10% to 90%	< 12 µs	cable length < 5 m
Fall Time 90% to 10%	< 12 µs	cable length < 5 m
Pulse Duration	0.5 ... 1.5 s	'1' - Level
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current	> 1 mA	@ V_{OH} = 9.5 V
Fault Voltage Emissions	0 V . . . V_{DD}	R_S > 100 Ω
Fault voltage Protection	-0.5 v . . . V_{DD} + 0.5 v	V_{DD} see Note
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'I'-Level/TRUE	-0.5 . . . +2 v	line to 10 V I/F ground
'0' - Level / 'FALSE	+8.0 . . . +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 90 kΩ	
Fault Voltage Emissions,	0 V . . . V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 v . . . V_{DD} + 0.5 v	V_{DD} see Note
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24. single line	return via +10 V I/F ground

Note : V_{DD} is the common supply voltage for the source and the load circuit
Definition of V_{DD} : see Data Sheet '+ 10 V Interface Bus - DPB' in § 3.4.3.1.

Signal Nomenclature	Analog HK Telemetry	
Code	TLA	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
Voltage Range	0 ... 5.12 V	load > 2 MΩ
Spectral Frequency Range	0 ... 200 Hz	for f > 200 Hz filter required ; sampling rate : see under Load
Output Impedance	2 kΩ ... 15 kΩ	
Source Current	> 3 µA	
Fault Voltage Emissions	TBD_{HIR}	TBD_{HIR}
Fault Voltage Protection	TBD_{HIR}	TBD_{HIR}
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
Input Voltage Range	0 ... 5.12 V	Line to return
Sampling Rate	0.125 ... 16 s	
Conversion Resolution	8 bit	20 mV/LSB
Measurement Accuracy	20 mV	
Sink Current	< 3 µA	
Fault Voltage Emissions	-15 ... +15 V	$R_S > 2$ kΩ
Fault Voltage Protection	-15 . . . +15 v	
Input Impedance	> 2 MΩ	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24. Single Line	Return via Signal Ground or Sw. TLM Ground (see Interface Circuits)

Signal Nomenclature	Digital B Telemetry	
Code	TLD	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.1 . . . +0.5 v	Ground reference : see Interface Circuit
'0' - Level	+3.5 . . . +5.7 v	Ground reference : see Interface Circuit
Spectral Frequency Range	0 . . . 200 Hz	for f > 200 Hz filter required ; sampling rate : see under Load
Output Impedance	2 kΩ . . . 15 kΩ	
Source Current	> 60 µA	
Fault Voltage Emissions	TBD_{HIR}	TBD_{HIR}
Fault Voltage Protection	TBD_{HIR}	TBD_{HIR}
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 . . . +0.8 V	line to 10 V I/F ground
'0' - Level	+3.0 . . . +5.7 v	line to 10 V I/F ground
Sink Current	< 60 µA	
Sampling Rate	0.125 . . . 16 s	
Fault Voltage Emissions	-15 . . . +15 v	R_S > 0.2 kΩ
Fault Voltage Protection	-15 . . . +15 v	
Input Impedance	> 100 kΩ	
Harness Design		
Parameter	Requirement	**Remarks**
Wiring Type	AWG 24, single line	return via 10 V I/F ground

Signal Nomenclature	**Sync. 32 s / 256 s**	
Code	**SYT**	
EMC **Class**	signal	
Source Circuit **Specification**		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 . . . +0.2 v	**line to 10 V I/F ground**
'0' - Level (V_{OH})	+9.3 . . . +10.7 v	**line to 10 V I/F ground**
Repetition Rate	**32 s / 256 s**	
Stability	**tolerances : see** Table 3.3.2-1	
Pulse Width	**240.4 ±** 2.7 **µs**	at '1' - Level
Rise Time 10% to 90%	**< 2 µs**	**cable length < 5 m**
Fall lime 90% to 10%	**< 2 µs**	**cable length < 5 m**
Output Impedance	**< 1.5 kΩ**	R (CMOS output) + 200 **Ω**
Source Current	**> 1 mA**	**@ V_{OH}** = 9.5 v
Fault Voltage Emissions	**0 V ... V_{DD}**	**R_S > 100 Ω**
Fault Voltage **Protection**	-0.5 v . . . V_{DD} + 0.5 v	**V_{DD} defined in Data Sheet CCO**
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 . . . +2 v	**line to 10 V I/F ground**
'0' - Level	+8.0 . . . +10.8 V	**line to 10 V I/F ground**
Sink Current	**< 1 mA**	
Input **Impedance**	**> 15 kΩ**	
Fault Voltage Emissions	**TBD_{HIR}**	**TBD_{HIR}**
Fault Voltage **Protection**	**TBD_{HIR}**	**TBD_{HIR}**
Harness Design		
Parameter	Requirement	**Remarks**
Wiring Type	AWG 24. single line	**return** via **+10** V **I/F** ground

Signal Nomenclature	sync 1 s	
Code	SYR	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
Low Level	-0.2 . . . +0.2 v	**line to 10 V I/F ground**
High Level (V_{OH})	+9.3 . . . +10.7 v	**line to 10 V I/F ground**
Repetition Rate	**1 pps**	**Square** wave
Stability	**Tolerances : see Table** 3.3.2-1	
Clock Symmetry	**> 70 %**	**see figure Data Sheet CLR**
Rise Time 10% to 90%	**< 2 µs**	**cable length < 5 m**
Fall Time 90% to **10%**	**< 2 µs**	**cable length < 5 m**
Output Impedance	**< 1.5 kΩ**	**R (CMOS output) + 200 Ω**
Source Current	**> 1 mA**	**@ V_{OH} = 9.5 V**
Fault Voltage Emissions	**0 V . . . V_{DD}**	**R_S > 100 Ω**
Fault Voltage Protection	-0.5 V . . . V_{DD} + 0.5 V	**V_{DD} defined in Data Sheet CCO**
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 . . . +2 v	**line to 10 V I/F ground**
'0' - Level	+8.0 . . . +10.8 V	**line to 10 V I/F ground**
Sink Current	**< 1 mA**	
Input Impedance	**> 15 kΩ**	
Fault Voltage Emissions	**0 V . . . V_{DD}**	**R_S > 2 kΩ**
Fault Voltage **Protection**	-0.5 v ... V_{DD} + 0.5 v	**V_{DD} defined in Data Sheet CCO**
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	**single line**	**return via +10 V I/F ground**

Signal Nomenclature	Data Enable	
Co&	DEN	
EMC Class	Signal	
Source circuit **Specification**		
Parameter	**Requirement**	**Remarks**
'1' -Level	**-0.2 ... +0.2 V**	**line to 10 V I/F ground**
'0' - Level (V_{OH})	**+9.3 ... +10.7 V**	**line to 10 V I/F ground**
Number of Samples	**36 per 100 ms**	
Stability	**derived from 8.32 kHz Clock**	**see Data Sheet CLU/CLR**
Pulse Width	**(39/5)** x **(1/8.32 kHz** Clock)	**at '1' - Level**
Rise Time 10% to 90%	**< 2 µs**	**cable length < 5 m**
Fall Time 90% to 10%	**< 2 µs**	**cable length < 5 m**
Output Impedance	**< 1.5 kΩ**	R (CMOS output) + 200 **Ω**
Source Current	**> 1 mA**	**@ V_{OH} = 9.5** v
Fault Voltage Emissions	0 v . . . **V_{DD}**	**R_S > 100 Ω**
Fault Voltage Protection	-0.5 v . . . **V_{DD}** + 0.5 v	**V_{DD} defined in Data Sheet CCO**
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	**-0.5 ... +2 V**	**line to 10 V I/F ground**
'0' - Level	**+8.0 . . . +10.8** V	**line to 10 V I/F ground**
Sink Current	**< 1 mA**	
Input Impedance	**> 15 kΩ**	
Fault Voltage Emissions	0 v . . . **V_{DD}**	**R_S > 2 kΩ**
Fault Voltage Protection	-0.5 v . . . **V_{DD}** + 0.5 v	**V_{DD} defined in Data Sheet CCO**
Harness **Design**		
Parameter	**Requirement**	**Remarks**
Winnp Type	AWG 24. single line	**return via 10 V I/F ground**

Signal Nomenclature	**8.32 kHz Clock**	
Code	CLU	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 ... +0.2 V	line to 10 V I/F-ground
'0' - Level (V_{OH})	+9.3 ... +10.7 V	line to 10 V I/F ground
Repetition Rate	8.32 kpps	tolerance depends on 1.248 MHz Clock
Stability	derived from 1.248 MHz Clock	see Data Sheet CLR
Pulse Width	24 µs ± 1.7 µs	at '1' - Level
Rise Time 10% to 90%	< 2 µs	cable length < 5 m
Fall Time 90% to 10%	< 2 µs	cable length < 5 m
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current	> 1 mA	@ V_{OH} = 9.5 V
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 100 Ω
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCO
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 ... +2 V	line to 10 V I/F ground
'0' - Level	+8.0 ... +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 15 kΩ	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 v . . . V_{DD} + 0.5 v	V_{DD} defined in Data Sheet CCO
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, single line	line to 10 V I/F ground

Signal Nomenclature	Dataoutput	
Code	DOA	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 . . . +0.2 v	line to 10 V I/F ground
'0' - Level (V_{OH})	+9.3 ... +10.7 V	line to 10 V I/F ground
Data Word Rate (Burst)	36 x 8-bit words per 100 ms	
Rise Time 10% to 90%	< 2 µs	cable length < 5 m
Fall Time 90% to 10%	< 2 µs	cable length < 5 m
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current	> 1 mA	@ V_{OH} = 9.5 v
Fault Voltage Emissions	TBD_{HIR}	TBD_{HIR}
Fault Voltage Protection	TBD_{HIR}	TBD_{HIR}
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 . . . +2 v	line to 10 V I/F ground
'0' - Level	+8.0 . . . +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input impedance	> 90 kΩ	
Fault Voltage Emissions	0 V . . . V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 V . . . V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCO
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24. single line	return via 10 V I/F ground

3.5.2.2. Signal Interface Circuits

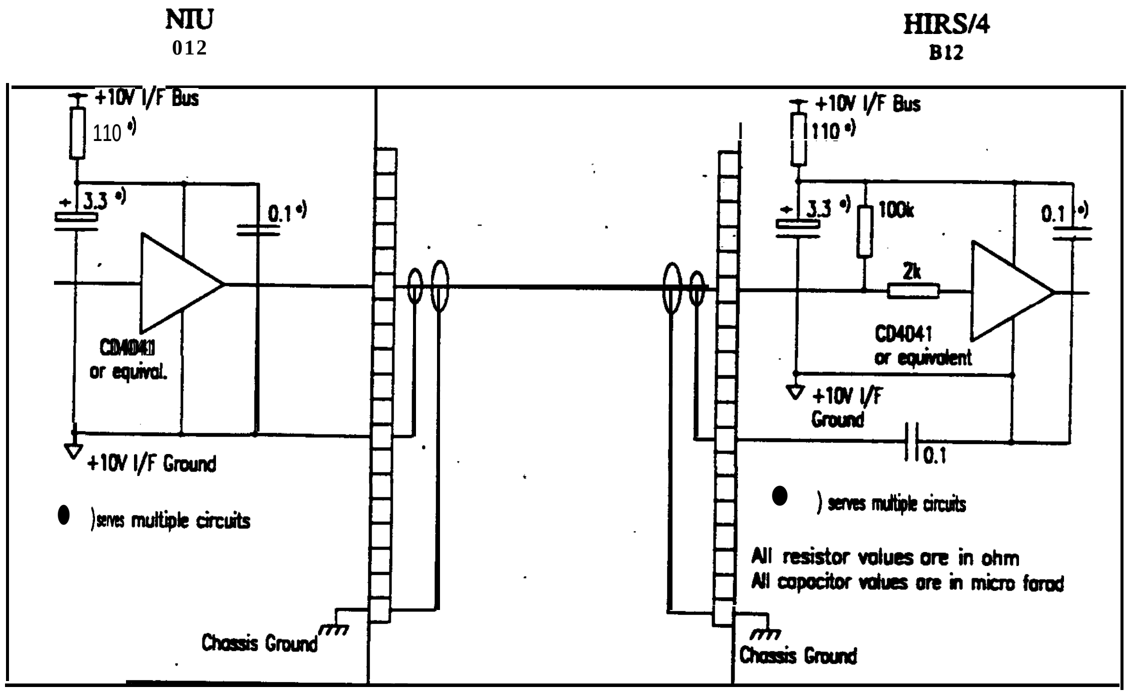


Fig. 3.5.2.2-1 : HIRS/4 1.248 MHz Clock Interface Circuit

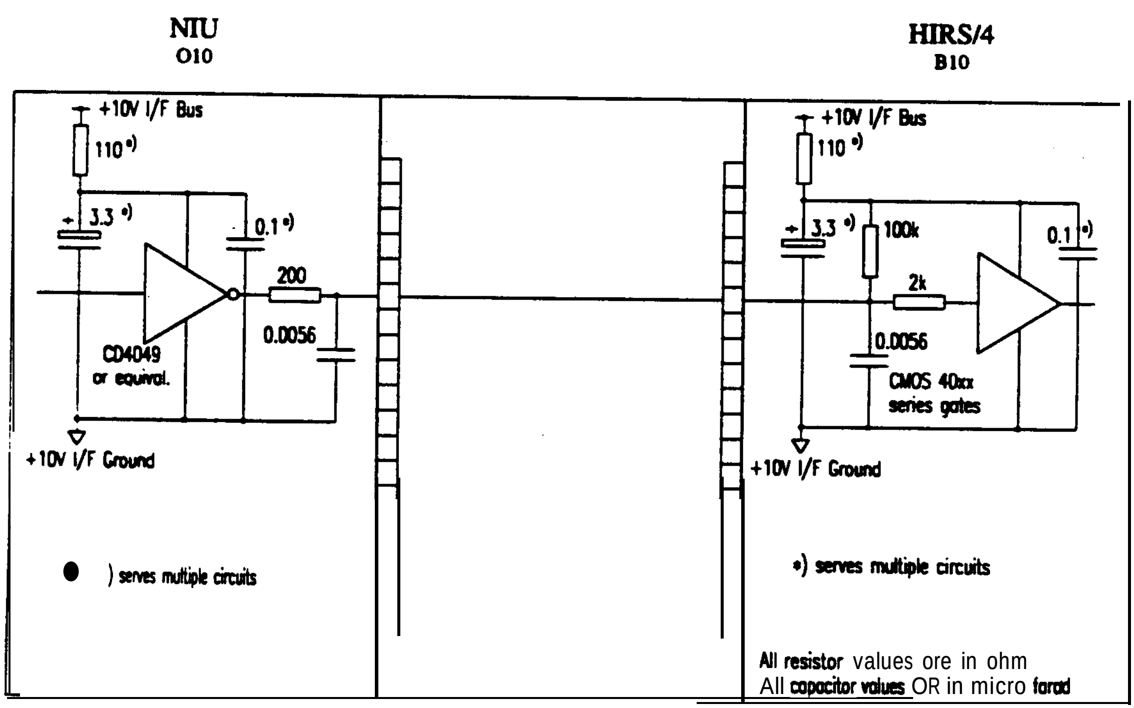
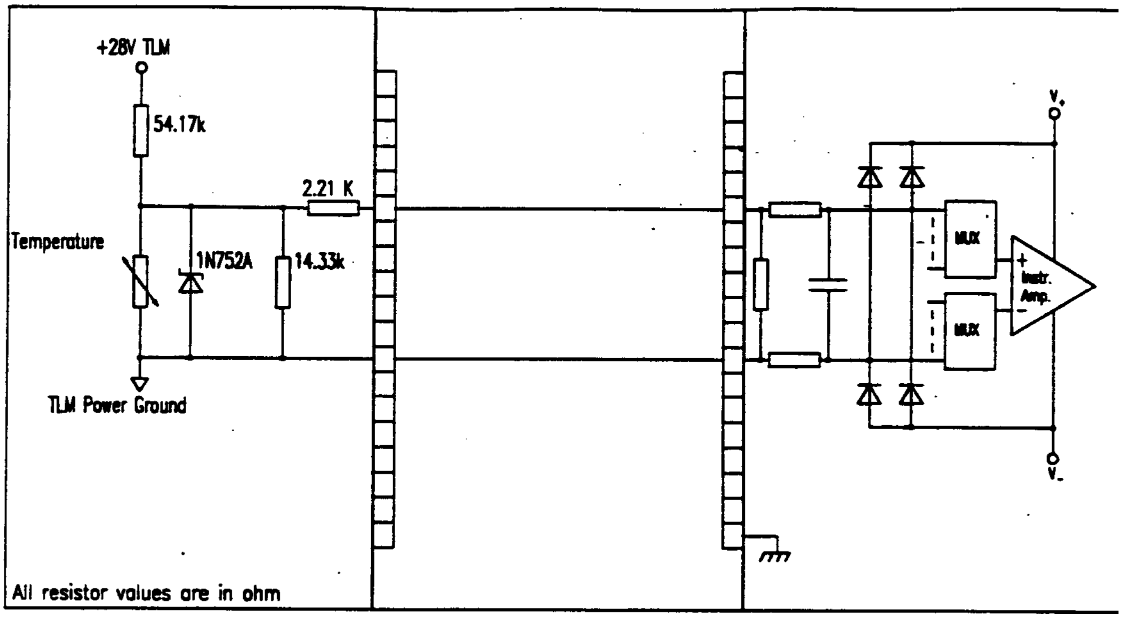
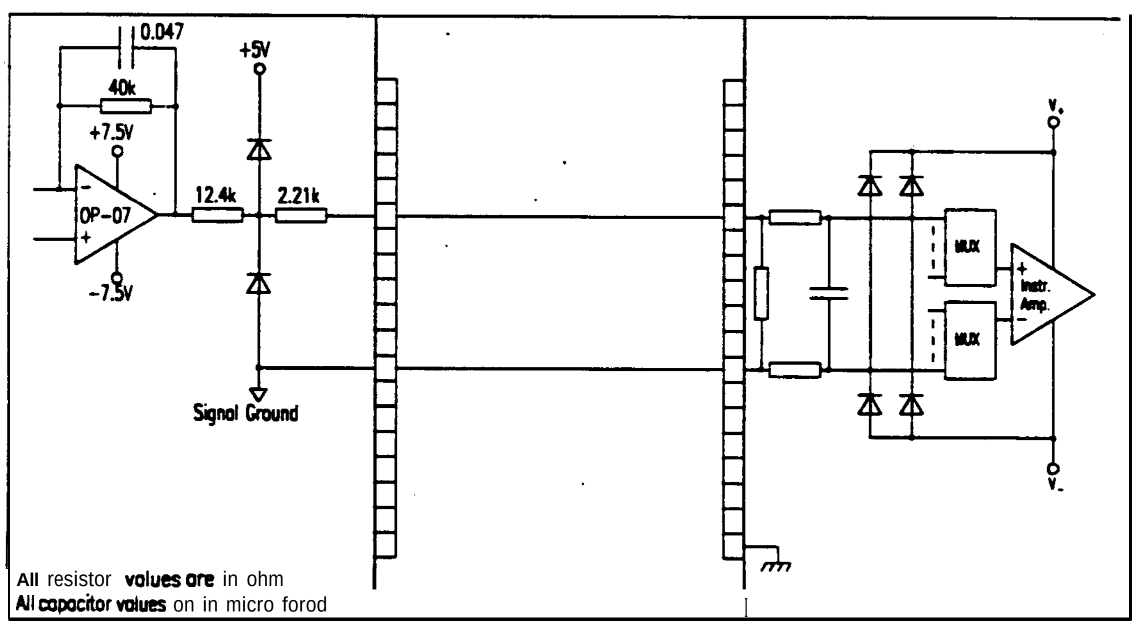


Fig. 3.5.2.2-2 : HIRS/4 Command Receiver for Relay Drive Interface Circuit



Only one +28 V Switched TLM Ground line is provided from HIRS/4 for all temp. (Sw. TLM Bus) interfaces.

*Fig. **3.5.2.2-3 : HIRS/4** Full **Time** Temperature **Telemetry Interface** circuit*



Note : HIRS/4 diodes are IN6642 (for information only)

Only one Signal Ground line is provided from HIRS/4 for all analog TLM interfaces.

*Fig. **3.5.2.2-4 : HIRS/4 Typical** Analog **Telemetry Interface** Circuit*

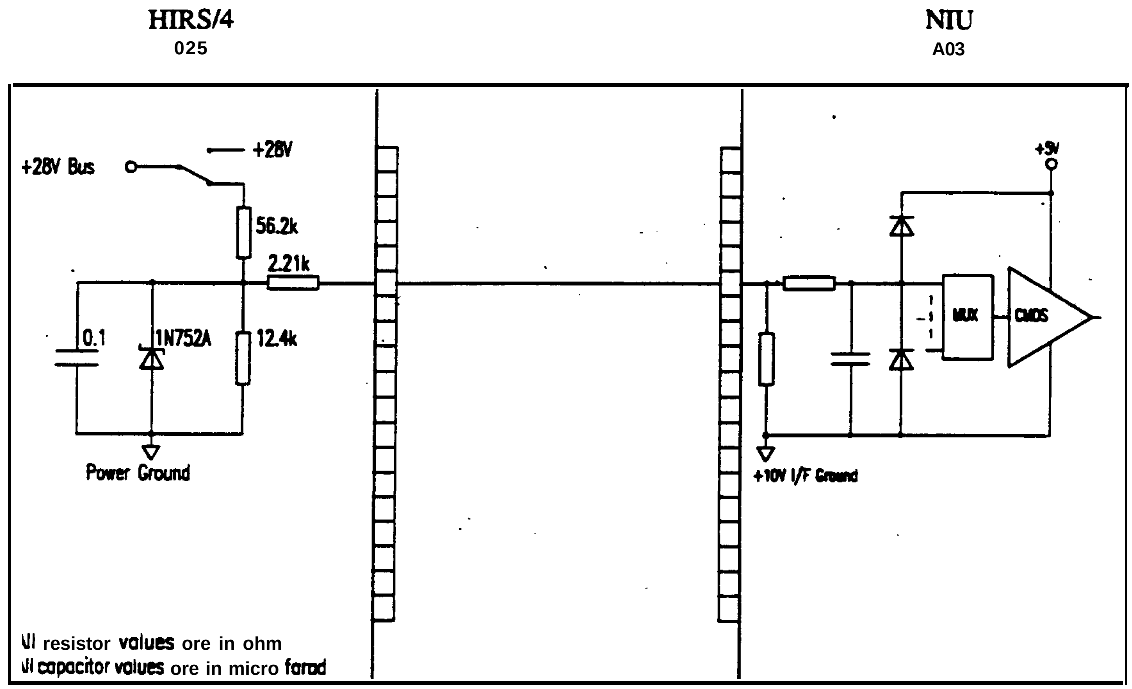


*Fig. 3.5.2.2-5 : **HIRS/4 Standard** Digital B Telemetry **Interface** Circuit*

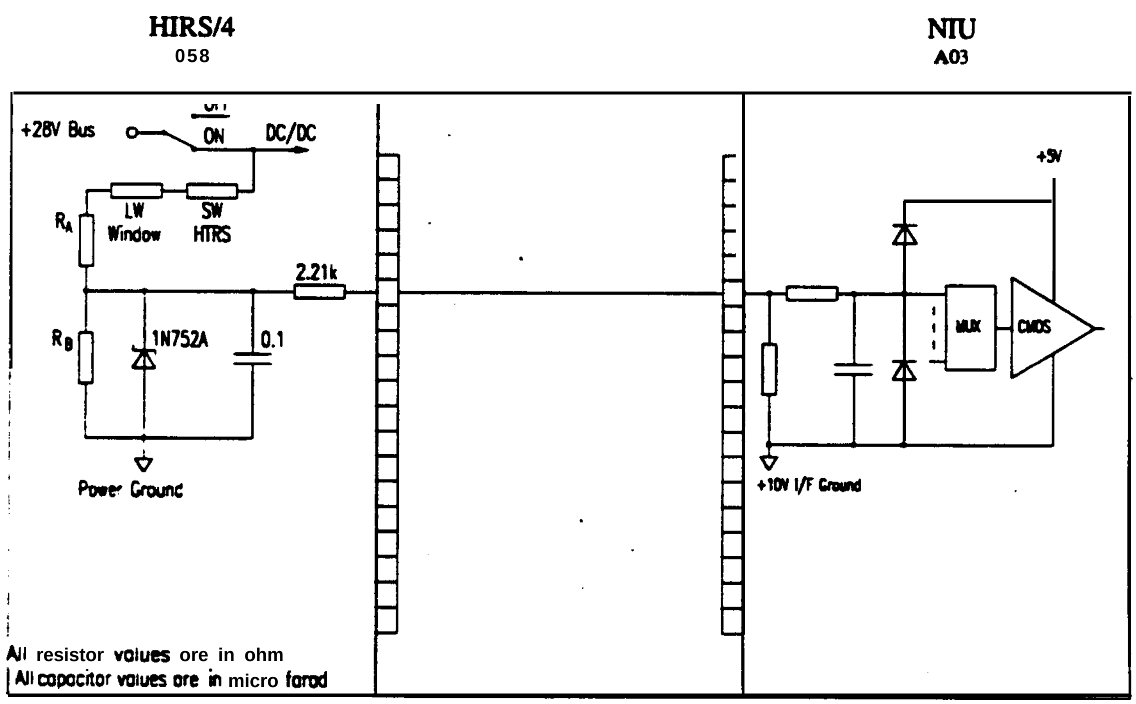


*Fig. **3.5.2.2-6** : **HIRS/4** Digital B Window Heater Telemetry **Interface** Circuit*

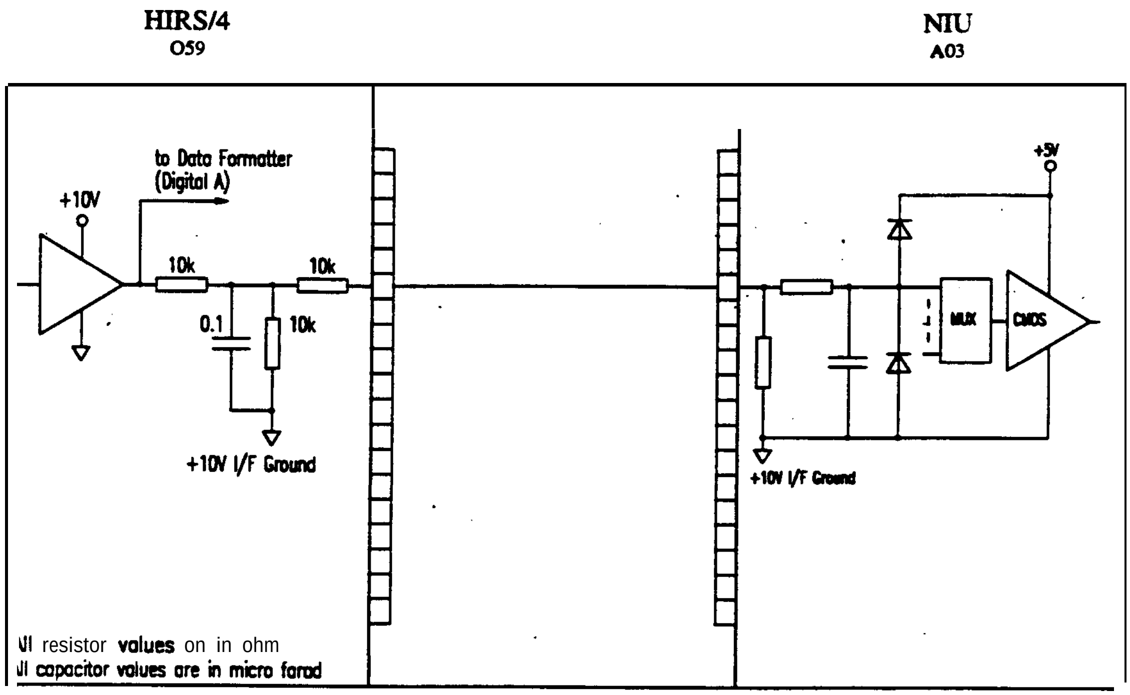


Fig. 3.5.2.2-7 : HIRS/4 Digital B Logic Controlled Telemetry Interface Circuit

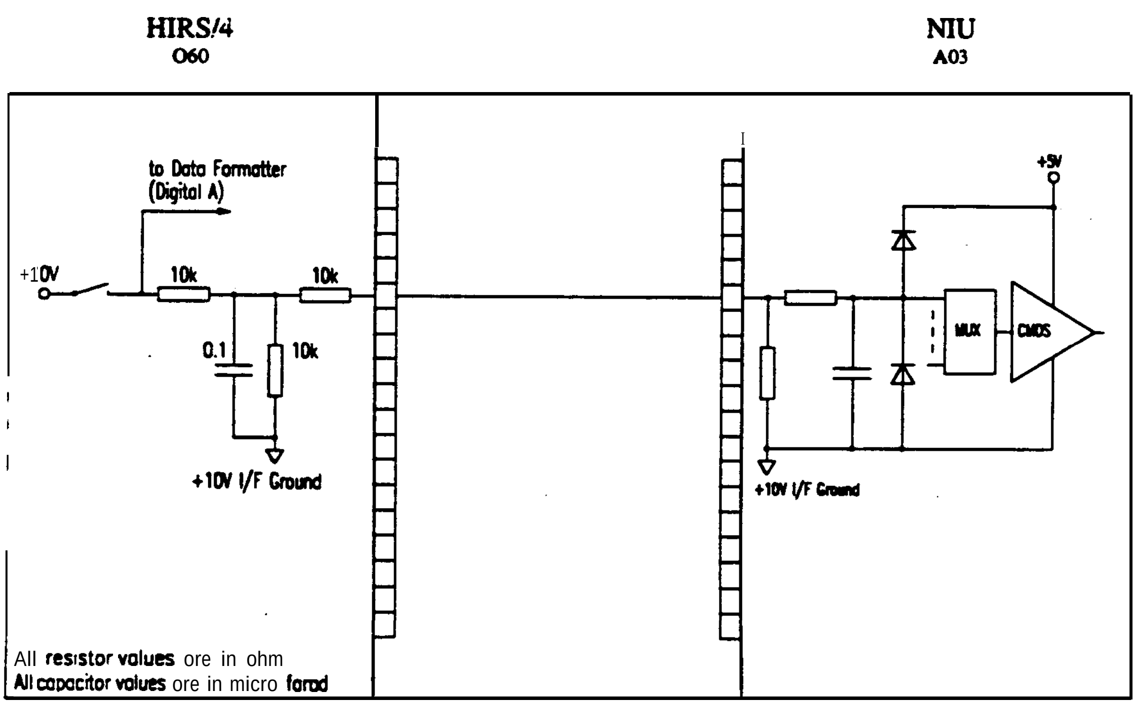


Figure 3.5.2.2-8 : HIRS/4 Digital B Cover Telemetry Interface Circuit

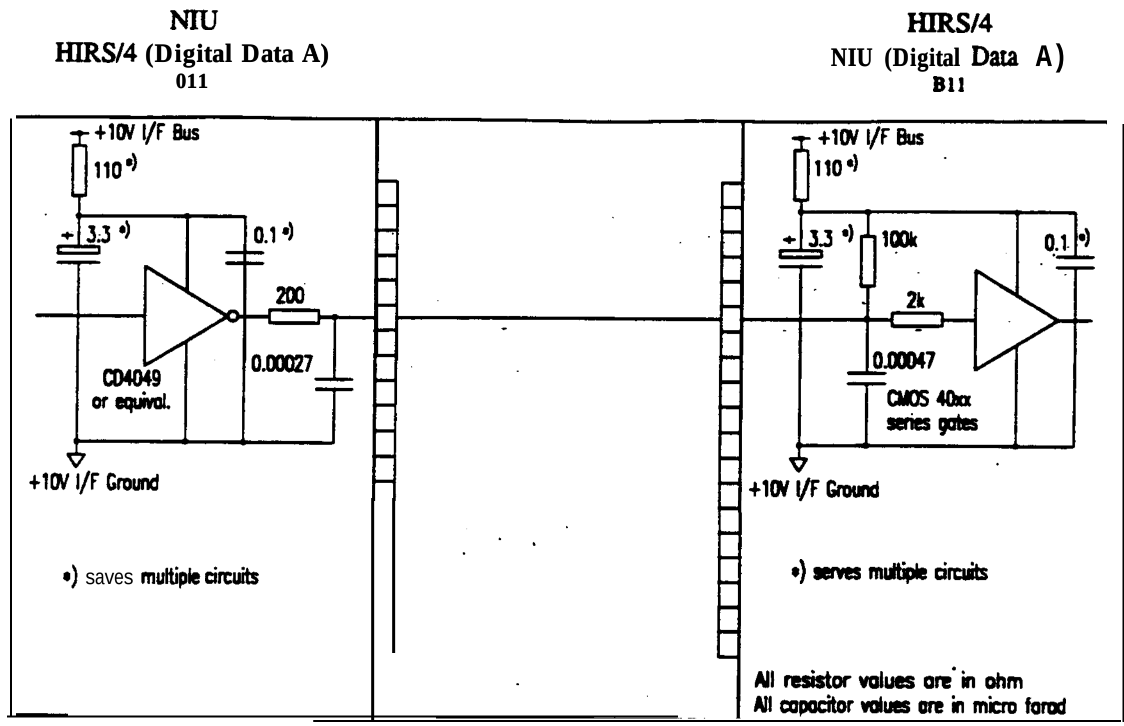


*Figure 3.5.2.2-P **HIRS/4** Fast CMOS-CMOS **Interface** Circuit*

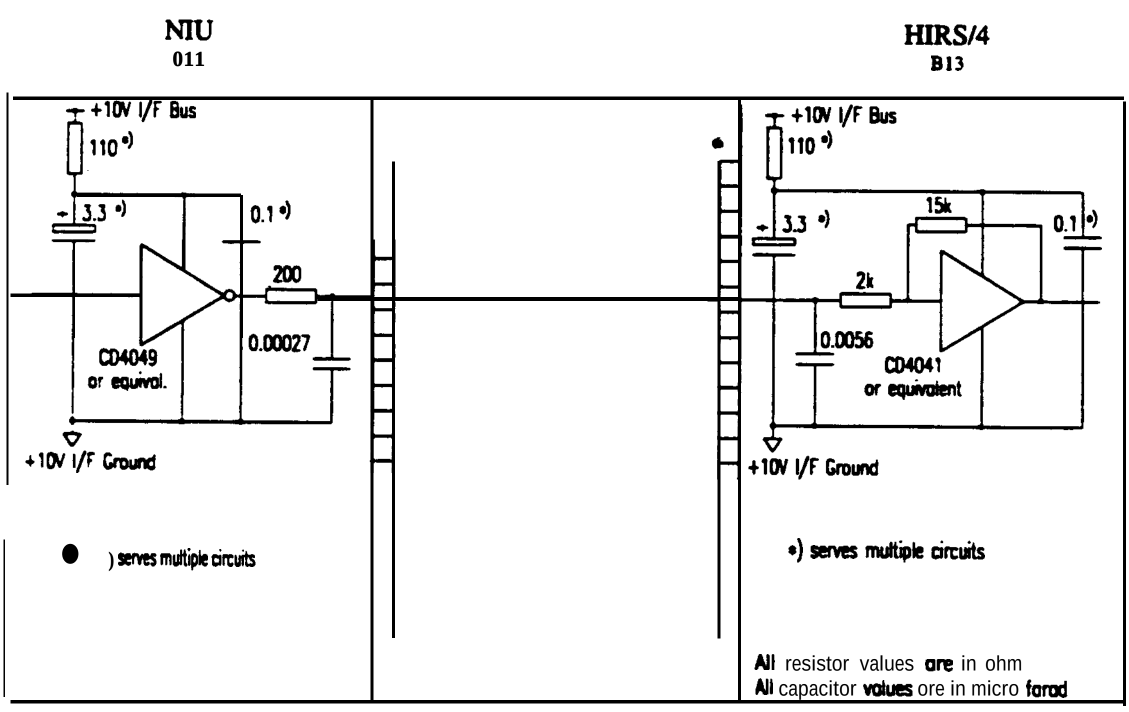


*Figure **3.5.2.2-10** : I Hz Clock **Interface Circuit***

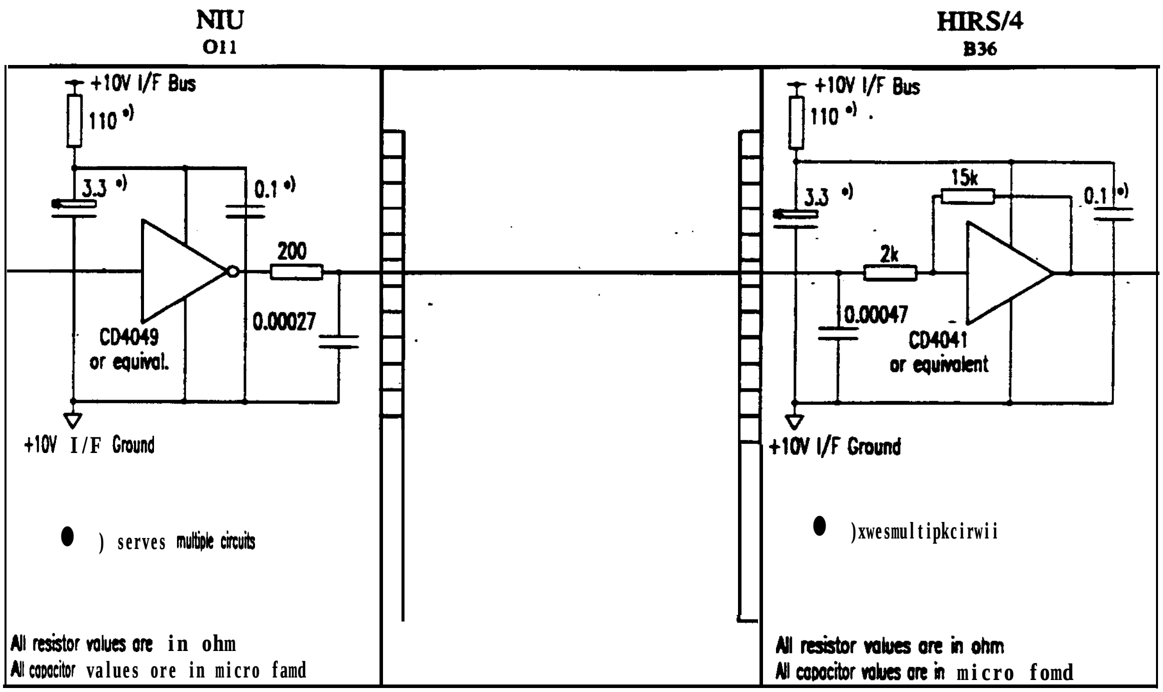


Figure 3.5.2.2-11 : HIRS/4 Fast CMOS-CMOS Interface Circuit With Hysterisis

3.5.3. Signal Electrical Connectors

Table 3.5.3-1 identifies the signal electrical connector types at the HIRS/4 boxes and Table 3.5.3-Z identifies the signal electrical connector types at the HIRS/4 harness.

Connector	Connector-Type	Function
J01	DEMA-9P	Clock
J03	DCMA-37P	Command
J04	DCMA-37S	Analog TM
J05	DBMA-25S	Digital TM
J06	DAMA-15P	Data (Digital A)

Table 3.5.3-1 : Signal Electrical Connector Types at HIRS/4 Boxes

Connector	Connector-Type	Function
P01	DEMA-9S-NMB	clock
P03	DCMA-37S-NMB	Command
P04	DCMA-37P-NMB	Analog TM
P05	DBMA-25P-NMB	Digital TM
PO6	DAMA-15S-NMB	Data (Digital A)

Table 3.5.3-2 : Signal Electrical Connector Types at HIRS/4 Harness

35.4. Signal Electrical Pin Allocation Lists

In these lists, the cross reference between connector pin, signal designation, Interface Data Sheet, target connector and target connector pin is defined and recorded as data base. Per connector one list is prepared.

Interface Data Sheets can be found in § 3.5.2.1.

The individual pin allocation lists are specified by 9 characters of a alpha numerical connector number. For the HIRS/4 the first 3 characters are HIR. The 7th character is J for a box connector or P for a harness connector. The last two characters define the connector number.

Since these lists also specify the wiring and shielding, they will form the basis far harness manufacturing.

The signal connector pin allocations at instrument level are described in Tables 3.5.4/1 to /5. The signal connector harness are described in Tables 3.5.4/6 to /10.

Note that the following instrument connector pins are currently spared on TIROS applications:

Connector	Table #	Pin Number	TIROS Assignment
J03	3.5.4/2	34 35	Spare Spare

Connector : FHIR305J01 Item: HIR305 Function : Clock Backshell : N/A
EMC-Category : F Conn.-Type : DEMA-09P

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Shd	Cable	Twist	Comment	New
01	1.248 MHz Clock HIR	SIG	B12	CLR- -	D	CR00					
0:	1.248 MHz Clock HIR	.ISHD	B12	CLR- -	7	CR00				see Fig. 35.22-l	
03	CABLE SHIELD	.OSHD	SHD		- 0					Pin 3 and 4 are	
04	CABLE SHIELD	.OSHD	SHD		- 0					shorted at the J-Conn.	
05	Chassis Gnd HIR	.-									
0b	SC	.-									
07	SC	.-									
08	SC	.-									
09	Signal Gad P01 HIR	.GND		GNDT -		GD00					

Table 3.5.4/1 : Pin Allocation List of Connector J01

Connector : 2HIR305J03 Item : HIR305 Function : Command Backshell : N/A
EMC-Category : 2 Conn.-Type : DCMA-37P

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Shd	Cable	Twist	Comment	New
01	Instr Pwr On HIR	SIG	B10	CCO- -	D	CO00					
02	Instr Pwr Off HIR	SIG	B10	CCO- -	D	CO01					
03	Elec On HIR	SIG	B10	CCO-	-.D	C O O 2					
04	Elec Off HIR	SIG	B10	CCO- -	D	CG03					
05	Scan Mot On HIR	SIG	B10	CCO- -	D	CO04					
06	Scan Mot Off HIR	SIG	B10	CCO- -	D	CO05					
07	Filter Mot On HIR	SIG	310	CCO- -	D	CO06					
08	Filter Ma Off HIR	SIG	310	CCO- -	D	CO07					
09	Int Warm Tgt Pos HIR	SIG	310	CCO- . -	D	CO08					
10	Int Cold Tgt Pos HIR	SIG	310	CCO- -	D	cGO9					
II	Filter Htr Go HIR	SIG	310	CCO- -	D	CO10					
12	Filter Htr Off HIR	SIG	310	CCO- -	D	CO11					
13	Pos Dis HIR	SIG	110	CCO- -	D	CO12					
14	NC	.-									
15 .	NC	.-									
16	NC	.-									
17	NC	.-									
18	NC	.-									
19	Chassis Gnd HIR	.-									
20	Coolr Htr On HIR	.SIG	110	CCO- -	D	CO13					
21	Coolr Htr Off HIR	SIG	110	CCO- -	D	CO14					
22	PatchCtl Go HIR	SIG	110	CCO- -	D	CO15					
23	PatchCtl Off HIR	SIG	110	CCO- -	D	CO16					
24	Space Pos HIR	SIG	110	CCO- -	D.	CO17					
25	Nadir Pos HIR	SIG	110	CCO- -	D	CO18					
26	Coolr Door En HIR	.SIG	110	CCO- -	D	CO19					
27	Coolr Door Dis HIR	SIG	110	CCO- -	D	CO20					
28	Cal Eo HIR	SIG	110	CCO- -	D	CO21					
29	Cal Dis HIR	SIG	110	CCO- -	D	CO22					
30	Coolr Door Dpl	SIG	110	CCO- -	D	CO23					
31	Filter MotPwr Hi HIR	SIG	310	CCO- -	D	CO24					
32	Filter MotPwrNor HIR	.SIG	310	CCO- -	D	co25					
33	SC	.-									
34	+10V MGSDA HIR	.RTN		NALR -		N710				*	
35	+10V I/F GSD B HIR	.RTN		NALR -		N711				*	
36	SC	.-									
37	Signal God PO3 HIR	.GND		GND- -		GD02					

* : METOP requirement.

Table 3.5.4/2 : Pin Allocation List of Connector JO3

Connector : 2HIR305J04 Item: HIR305 Function : Analog TLM Backshell : N/A
EMC-Category : 2 Conn.-Type : DCMA-37S

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Shd	Cable	Twist	Comment	New
01	Radiator Temp HIR	SIG	024	TLA- -	D	TA22					
02	Baseplate Temp HIR	SIG	057	TLA- -	D	TA23					
03	Elec Temp HIR	SIG	024	TLA- -	D	TA24					
04	Patch Temp HIR	SIG	024	TLA- -	D	TA25					
05	FilterHousingCurrHIR	SIG	024	TLA- -	D	TA26					
06	San Ma Temp HIR	SIG	057	TLA- -	D	TA27					
07	Filter Ma Temp HIR	SIG	024	TLA- -	D	TA28					
08	NC	-									
09	+5 VDC TLM HIR	SIG	024	TLA- -	D	TA29					
10	+10 VDC TLM HIR	SIG	024	TLA- -	D	TA30					
11	+7.5 VDC TLM HIR	SIG	024	TLA- -	D	TA31					
12	-7.5 VDC TLM HIR	SIG	024	TLA- -	D	TA32					
13	+15 VDC TLM HIR	SIG	024	TLA- -	D	TA33					
14	-15 VDC TLM HIR	SIG	024	TLA- -	D	TA34					
15	NC	-									
16	NC	-									
17	NC	-									
18	NC	-									
19	Chassis Gnd HIR	-									
20	Filter Ma Curr HIR	SIG	024	TLA- -	D	TA35					
21	Scan Mot Curr HIR	SIG	024	TLA- -	D	TA36					
22	Patch Ctl Pwr HIR	SIG	024	TLA- -	D	TA37					
23	NC	-									
24	SC	-									
25	SC	-									
26	SC	-									
27	SC	-									
28	SC	-									
29	SC	-									
30	SC	-									
31	NC	-									
32	SC	-									
33	SC	-									
34	SC	-									
35	SC	-									
36	SC	-									
37	Signal Gnd P04 HIR	GND		GND- -		GD03					

Table 3.5.4/3 : Pin Allocation List of Connector J04

Connector : 2HIR305J05 Item : HIR305 Function : **Digital B TLM** **Backshell :** N/A
EMC-Category : 2 **Conn.-Type :** DBMA-25S

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Shd	Cable	Twist	Comment	New
01	InstrPwr OO TLM HIR	SIG	O25	TLD-	- D	TD15					
02	ElecPwr OO TLM HIR	SIG	O25	TLD-	- D	TD16					
03	FltMotPwr OO TLM HIR	SIG	025	TLD-	- D	ID17 .					
04	ScnMotPwr OO TLM HIR	SIG	025	TLD-	- D	TD18					
05	CoolrHtr OO TLM HIR	.SIG	025	TLD-	- D	TD19					
06	FltHosHtr OO TLM HIR	.SIG	025	TLD-	- D	TD20					
07	CoverRelsEnDisTLMHIR	SIG	O25	TLD-	- D	TD21					
08	WindowHtr OO TLM HIR	.SIG	058	TLD-	- D	TD22					
09	GtoNadPos OO TLM HIR	SIG	059	TLD-	-D	TD23					
10	CalSeq EnDis TLM HIR	SIG	O59	TLD- -	D	TD24					
11	CoverClosedYN TLMHIR	SIG	060	TLD-	-D	TD25					
12	CoverOpen YN TLM HIR	.SIG	O60	TLD-	-D	ID26					
13	Chassis Gnd HIR .	.-									
14	FltMotPwrNorHiTLMHIR	SIG	O25	TLD-	-D	ID27					
15	PatTempCtlOO TLM HIR	SIG	O25	TLD-	- D	ID28					
16	NC	.-									
17	NC	.-									
18	NC	.-									
19	NC	.-									
20	NC	.-									
21	NC	.-									
22	NC	.-									
23	NC	.-									
24	NC	.-									
23	Signal Gad PM HIR	.GND		GND-	-	GD04					

***Table 3.5.4/4** : Pin **Allocation List** of Connector JO5*

Connector : 2HIR305J06 **Item :** HIR305 Function : **Digital A Data** **Backshell :** N/A
EMC-Category : 2 **Conn.-Type :** DAMA-15P

			Interface-Code			Grouping					
Pin	**Signal Designation**		**Circ**	**Signal**	**Pos.**	**Ch. ID**	**Shd**	**Cable**	**Twist**	**Comment**	**New**
01	MjrFrm SycPul32s HIR	SIG	B11	SYT- -	D	ST00					
02	Cal Pul 32s HIR 256s	SIG	B11	SYT- -	D	ST01					
03	Data En HIR	SIG	B11	DEN- -	D	DN00					
04	8.32kHz Clock HIR	SIG	B11	CLU- -	D	CU00					
05	Data Output HIR	SIG	011	DOA- -	D	DA00					
06	1 Hz Clock HIR	SIG	B13	SYR- -	D	SR00					
07	NC	.-									
08	Chassis Gnd HIR	.-									
09	NC	.-									
10	NC	.-									
11	NC	.-									
12	NC	.-									
13	NC	.-									
14	NC	.-									
15	Signal God P06 HIR	.GND		GND- -		GD05					

Table 3.5.4/5 : *Pin Allocation List of Connector JO6*

Connector : FHIR305P01 **Item :** HIR305 Function : Clock **Conn.-Type :** DEMA-09S-NMB
EMC-Category : F **Location :** 305 **Backshell :** TBD

			Interface-Code			Grouping										
Pin	**Signal Designation**		**Circ**	**Signal**	**Pos.**	**Ch. ID**	**Wiring**	Shd	**Cable Twist**	**Comment**	**End-It.**	**Loc.**	**Connector**	**Pin**	**New**
01	1.248 MHz Clock HIR	.SIG	B12	CLR- -	D	CR00	TRI-24				NIU	240	NIU240 Pxx		
02	1.241 MHz Clock HIR	.ISHD	B12	CLR- -	7	CR00	TRI-24			see Fig. 3.5.2.2-I	NIU	240	NIU240 Pxx		
03	CABLE SHIELD	.OSHD	SHD	-	0					Pin 3 and 4 are					
04	CABLE SHIELD	.OSHD	SHD	-	0					shorted at the -J Conn.					
05	Chassis Gnd HIR	.-													
06	NC	.-													
07	NC	.-													
08	NC	.-													
09	Signal Gnd P01 HIR	.GND		GNDT -		GD00	SL-24				NIU	240	NIU240 Pxx		

*Tab& **3.5.4/6 :** Pin **Allocation** List of Connector **P01***

*(For **Information Only)***

Connector : 2HIR305P03 **Item :** HIR305 **Function :** Command **Conn.-Type :** DCMA-37S-NMB
EMC-Category : 2 **Location :** 305 **Backshell :** TBD

Pin	Signal Designation		Interface-Code Circ	S W	Pos.	Ch. ID	Wiring	Grouping Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin	New
01	Instr Pwr On HIR	.SIG	B10	CCO-	D	C000	SL-24					NIU	240	NIU240 Pxx		
02	Instr Pwr Off HIR	.SIG	B10	CCO-	D	C001	SL-24					NIU	240	NIU240 Pxx		
03	Elec On HIR	.SIG	B10	CCO-	D	C002	SL-24					NIU	240	NIU240 Pxx		
04	Elec Off HIR	.SIG	B10	CCO-	D	C003	SL-24					NIU	240	NIU240 Pxx		
05	San Mot On HIR	.SIG	B10	CCO-	D	C004	SL-24					NIU	240	NIU240 Pxx		
06	Scan Mot Off HIR	.SIG	B10	CCO-	D	C005	SL-24					NIU	240	NIU240 Pxx		
07	Filter Mot On HIR	.SIG	B10	CCO-	D	C006	SL-24					NIU	240	NIU240 Pxx		
08	Filter Mot Off HIR	.SIG	B10	CCO-	D	C007	SL-24					NIU	240	NIU240 Pxx		
09	Int Warm Tgt Pos HIR	.SIG	B10	CCO-	D	C008	SL-24					NIU	240	NIU240 Pxx		
10	Int Cold Tgt Pos HIR	.SIG	B10	CCO-	D	C009	SL-24					NIU	240	NIU240 Pxx		
11	Filter Htr On HIR	.SIG	B10	CCO-	D	C010	SL-24					NIU	240	NIU240 Pxx		
12	Filter Htr Off HIR	.SIG	B10	CCO-	D	C011	SL-24					NIU	240	NIU240 Pxx		
13	Pos Dir HIR	.SIG	B10	CCO-	D	C012	SL-24					NIU	240	NIU240 Pxx		
14	NC															
15	NC															
16	NC															
17	NC															
18	NC															
19	Chassis Gnd HIR															
20	Coolr Htr On HIR	.SIG	B10	CCO-	D	C013	SL-24					NIU	240	NIU240 Pxx		
21	Coolr Htr Off HIR	.SIG	B10	CCO-	D	C014	SL-24					NIU	240	NIU240 Pxx		
22	PatchCtl On HIR	.SIG	B10	CCO-	D	C015	SL-24					NIU	240	NIU240 Pxx		
23	PatchCtl Off HIR	.SIG	B10	CCO-	D	C016	SL-24					NIU	240	NIU240 Pxx		
24	Space Pos HIR	.SIG	B10	CCO-	D	C017	SL-24					NIU	240	NIU240 Pxx		
25	Nadir Pm HIR	.SIG	B10	CCO-	D	C018	SL-24					NIU	240	NIU240 Pxx		
26	Coolr Door En HIR	.SIG	B10	CCO-	D	C019	SL-24					NIU	240	NIU240 Pxx		
27	Coolr Door Dis HIR	.SIG	B10	CCO-	D	C020	SL-24					NIU	240	NIU240 Pxx		
28	Cal En HIR	.SIG	B10	CCO-	D	C021	SL-24					NIU	240	NIU240 Pxx		
29	Cal Dis HIR	.SIG	B10	CCO-	D	C022	SL-24					NIU	140	NIU240 Pxx		
30	Coolr Door Dpl	.SIG	B10	CCO-	D	C023	SL-24					NIU	240	NIU240 Pxx		
31	Filter MotPwr Hi HIR	.SIG	B10	CCO-	D	C024	SL-24					NIU	240	NIU240 Pxx		
32	Filter MotPwrNor HIR	.SIG	B10	CCO-	D	C025	SL-24					NIU	240	NIU240 Pxx		
33	NC															
34	+10V I/F GND A HIR	.RTN		NALR -		N710	SL-24					NIU	240	NIU240 Pxx		
35	+10V I/F GND B HIR	.RTN		NALR -		N711	SL-24					NIU	240	NIU240 Pxx		
36	NC -	.-														
37	Signal Gnd P03 HIR	.GND		GND- -		GD02	SL-20					NIU	240	NIU240 Pxx		

*Table 3.5.4/7 : Pin Allocation **List** of Connector PO3*
*(For **Information** Only)*

Connector : 2HIR305P04 Item : HIR305 Function : Analog TIM Conn.-Type : DCMA-37P-NMB
EMC-Category : 2 Location : 305 Backshell : TBD

Pin	Signal Designation		Interface Code Circ	Signal	Pos.	Grouping Ch. ID	Wiring	Shd	Cable'	Twist	Comment	End-It.	Loc.	Connector	Pin	New
01	Radiator Temp HIR	.SIG	024	TLA-	D	TA22	SL-24					NIU	240	NIU240 Pxx		
02	Baseplate Temp HIR	.SIG	057	TLA-	D	TA23	SL-24					NIU	240	NIU240 Pxx		
03	Elec Temp HIR	.SIG	024	TLA-	D	TA24	SL-24					NIU	240	NIU240 Pxx		
04	Patch Temp HIR	.SIG	024	TLA-	D	TA25	SL-24					NIU	240	NIU240 Pxx		
05	FilterHousingCurrHIR	.SIG	024	TLA-	D	TA26	SL-24					NIU	240	NIU240 Pxx		
06	Scan Mot Temp HIR	.SIG	057	TLA-	D	TA27	SL-24					NIU	240	NIU240 Pxx		
07	Filter Mot Temp HIR	.SIG	024	TLA-	D	TA28	SL-24					NIU	240	NIU240 Pxx		
08	NC	.-														
09	+5 VDC TLM HIR	.SIG	024	TLA-	D	TA29	SL-24					NIU	240	NIU240 Pxx		
10	+10 VDC TLM HIR	.SIG	024	TLA-	D	TA30	SL-24					NIU	240	NIU240 Pxx		
11	+7.5 VDC TLM HIR	.SIG	024	TLA-	D	TA31	SL-24					NIU	240	NIU240 Pxx		
12	-7.5 VDC TLM HIR	.SIG	024	TLA-	D	TA32	SL-24					NIU	240	NIU240 Pxx		
13	+15 VDC TLM HIR	.SIG	024	TLA-	D	TA33	SL-24					NIU	240	NIU240 Pxx		
14	-15 VDC TLM HIR	.SIG	024	TLA-	D	TA34	SL-24					NIU	240	NIU240 Pxx		
15	NC	.-														
16	NC	.-														
17	NC	.-														
18	NC	.-														
19	Chassis Gnd HIR	.-														
20	Filter Mot Curr HIR	.SIG	024	TLA-	D	TA35	SL-24					NIU	240	NIU240 Pxx		
21	Sun Mot Curr HIR	.SIG	024	TLA-	D	TA36	SL-24					NIU	240	NIU240 Pxx		
22	Patch Ctl Pwr HIR	.SIG	024	TLA-	D	TA37	SL-24					NIU	240	NIU240 Pxx		
23	NC	.-														
24	NC	.-														
25	NC	.-														
26	NC	.-														
27	NC	.-														
28	NC	.-														
29	NC	.-														
30	NC	.-														
31	NC	.-														
32	NC	.-														
33	NC	.-														
34	NC	.-														
35	NC	.-														
36	NC	.-														
37	Signal Gnd P04 HIR	.GND		GND-		GD03	SL-20					NIU	240	NIU240 Pxx		

Table 3.5.4/8 : Pin Al&cation List of Connector PO4

*(For **Information Only**)*

Connector : 2HIR305P05 **Item :** HIR305 **Function :** Digital B TLM **Conn.-Type :** DBMA-25P-NMB

EMC-Category : 2 **Location** : 305 **Backshell** : TBD

Pin	Signal Designation		Circ	Signal		Pos.	Ch. ID	Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin	New
			Interface-Code				Grouping										
01	InstrPwr OO TLM HIR	.SIG	025	TLD-	-	D	TD15	SL-24					NIU	240	NtU240 Pxx		
02	ElecPwr OO TLM HIR	.SIG	025	TLD-	-	D	TD16	SL-24					NIU	240	NtU240 Pxx		
03	FltMotPwr OO TLM HIR	.SIG	325	TLD-	-	D	TD17	SL-24					NIU	240	NIU240 Pxx		
04	ScnMotPwr OO TLM HIR	.SIG	025	TLD-	-	D	TD18	SL-24					NIU	240	NIU240 Pxx		
05	CoolrHtr OO TLM HIR	.SIG	025	TLD-	-	D	TD19	SL-24					NIU	240	NIU240 Pxx		
06	FltHoslltr OO TLM HIR	.SIG	025	TLD-	-	D	TD20	SL-24					NIU	240	NIU240 Pxx		
07	CoverRelsEnDisTLMHIR	.SIG	025	TLD-	-	D	TD21	SL-24					NIU	240	NIU240 Pxx		
08	WindowHtr OO TLM HIR	.SIG	358	TLD-	-	D	TD22	SL-24					NIU	240	NIU240 Pxx		
09	GtoNadPos OO TLM HIR	.SIG	059	TLD-	-	D	TD23	SL-24					NIU	240	NIU240 Pxx		
10	CalSeq EnDis TLM HIR	.SIG	059	TLD-	-	D	TD24	SL-24					NIU	240	NIU240 Pxx		
11	CoverClosed YN TLMHIR	.SIG	060	TLD-	-	D	TD25	SL-24					NIU	240	NIU240 Pxx		
12	CoverOpen YN TLM HIR	.SIG	060	TLD-	-	D	rD26	SL-24					NIU	240	NIU240 Pxx		
13	Chassis Gnd t HR	.-															
14	FltMotPwrNorHiTLMHIR	.SIG	025	TLD-	-	D	TD27	SL-24					NIU	240	NIU240 Pxx		
15	PatTempCtlOO TLM HIR	.SIG	025	TLD-	-	D	TD28	SL-24					NIU	240	NIU240 Pxx		
16	NC	.-															
17	NC	.-															
18	NC	a-															
19	NC	*.															
20	NC	.-															
21	NC	.-															
22	NC	.-															
23	NC	.-															
24	NC	.-															
25	Signal Gnd P05 HIR	.GNI		GND-			GD04	SL-20					NIU	240	NIU240 Pxx		

Table 3.5.4/9 : Pin Allocation List of Connector PO5

(For Information Only)

Connector : 2HIR305P06 **Item :** HIR305 **Function :** Digital A Data **Conn.-Type :** DAMA-15S-NMB
EMC-Category : 2 **Location :** 305 **Backshell :** TBD

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Ch. ID	Grouping Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin	New
01	MjrFrm SycPul32s HIR	.SIG	311	SYT-	D	ST00	SL-24					NIU	240	NIU240 Pxx		
02	Cal Pul 32s HIR 256s	.SIG	311	SYT-	D	ST01	SL-24					NIU	240	NIU240 Pxx		
03	Data En HIR	.SIG	311	DEN-	D	DN00	SL-24					NIU	240	NIU2.40 Pxx		
04	8.32kHz Clock HIR	.SIG	311	CLU-	D	CU00	SL-24					NIU	240	NIU240 Pxx		
05	Data Output HIR	.SIG	311	DOA-	D	DA00	SL-24					NIU	240	NIU240 Pxx		
06	1Hz Clock HIR	.SIG	313	SYR-	D	SR00	SL-24					NIU	240	NIU240 Pxx		
07	NC	.-														
08	Chassis Gnd HIR	.-														
09	NC	.-														
10	NC	.-														
11	NC	.-														
12	NC	.-														
13	NC	.-														
14	NC	.-														
15	Signal Gnd P06 HIR	.GND		GND-		GD05	SL-20					NIU	240	NIU240 Pxx		

*Table **3.5.4/10 : Pin Allocation List of** Connector PO6*

*(For **Information** Only)*

3.6. TEST INTERFACES

3.6.1. Electrical Test Interface Requirements

3.6.1.1. Interface Data Sheets

N/A.

-3.6.1.2. Interface Circuits

N/A

3.6.2. Electrical Test Interface Connectors

Table 3.6.2-1 identifies the test connector type at the HIRS/4.

This connector is not **for use on the METOP** satellite

Connector	Connector-Type	Function
J07	DDMA-SOS-NMB	Test
J09	DAMA-15S-NMB	*Cool* Test

Table 3.62-I: ***Measurement*** Data ***Connector Types at HIRS/4 Boxes***

3.63. Electrical Test Interface Pin Allocation List

N/A.

3.7. HARNESS

The harness between METOP units and the HIRS/4 is under the responsibility of the PLM. based on the connector & pin lay-out definition and electrical performances from § 3.4 and 35.2.

3.8. EMC INTERFACE DESCRIPTION

31.1. Electrical Bonding

3.8.1.1. General

The HIRS/4 is electrically bonded to the METOP spacecraft structure by means of a METOP supplied bonding strap that is bolted to the instrument at location TBD_{MET}.

3.8.13. Joint Faces

Not applicable for HIRS/4.

3.8.1.3. Structural Parts

Not applicable for HIRS/4.

3.8.1.4. Unit Housings

3.8.1.4.1. Bonding of Unit Cases

All unit cases within the HIRS/4 are electrically connected via the equipment box feet. METOP accommodation bonds the HIRS/4 feet to the spacecraft structure.

3.8.1.4.2. Bonding of Thermally isolated Boxes

N/A.

3.8.1.4.3. Bonding of Unit Mounted on CFRP of Non-Conductive Parts

N/A.

3.8.1.4.4. DC Resistance between Adjacent Unit Case Parts

NJA.

3.8.1.4.5. DC Resistance between Bonding Stud and Mounting Feet

N/A.

3.8.15. Thermal Blankets

3.8.1.5.1. Bonding of Thermal Blankets

Thermal blanket foil shall carry a conductive layer. Each electrically conductive layer of ML1 shall be grounded to suucture. Surfaces which are smaller than 100 cm? do not need to be grounded to structure.

The number of bonding points per sheet of MLI material shall be at least two points, at diagonal corners.

3.8.1.5.2. Thermal Blanket Surface Resistance

The DC resistance between the MLI bonding point and any point belonging the metallized face of any foil shall be less than 50 Ω. TBE(HIRS)

3.8.1.6. **Other** Conductive **Components**

N/A to HIRS/4.

3.8.1.7. Cable and Harness Shields

N/A to HIRS/4.

3.8.1.8. Connectors

Bonding Resistance of Connector Receptacle

The connector receptacle shall be bonded to the equipment case with a DC resistance of ≤ 10 mΩ.

3.82. Grounding and **Isolation**

The grounding system of the instrument shall use **separate grounds** (see Figure 3.8.2-l) as follows :

- **+ 28 V Main Power Ground**
- **+ 28 V Switched TLM Bus**
- **+ 28 V Pulse Load Bus**
- **+ 10 V Interface Ground**
- Signal Ground

Each ground shall be electrically isolated from all other grounds within the instrument and from chassis by 100 kΩ or greater DC resistance.

Between the signal ground and the +28 V main power ground, the isolation is 1 MΩ.

3.83.1. + **28** V **Main** Power Ground

The + 28 V main power return is grounded within the PCU to structure.

3.8.2.2. + 28 V Switched **Telemetry** Ground

The + 28 V switched telemetry **return** is grounded within the PCU to structure.

3.8.2.3. **+ 28 V Pulse Load Ground**

The + 28 V pulse load return is grounded within the PCU to structure.

3.8.2.4. + 10 **V Interface Ground**

The+ **10 V interface return is grounded within the NIU to structure.**

3.8.25. Signal Ground

Signal **ground** is the power return line for the **secondary** side of the **instrument DC/DC converters**. The signal ground is provided on a pin of an **instrument** connector.

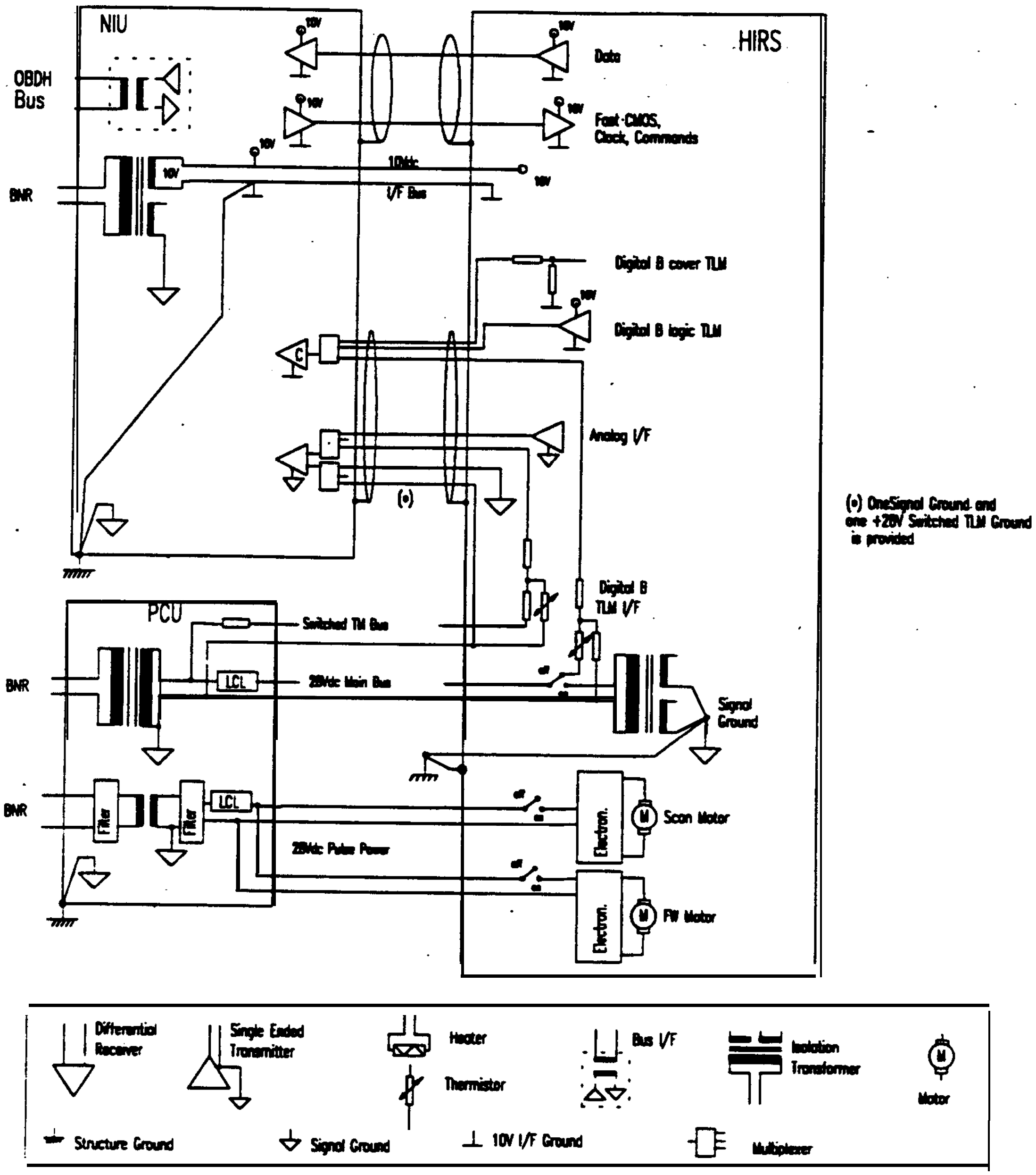


Figure 3.62-I : Grounding and Isolation Concept for HIRS/4

3.8.3. shielding

3.8.3.1. Wire Shielding

3.8.3:1.1. Bonding of Shields

N/A.

3.8.3.1.2. Overall Shield

N/A.

3.8.3.1.3. Shields as Current-Carrying Conductors

Shields shall not be used as intentional current-carrying conductors and not as return lines for power and signal with exception of the RF coaxial lines.

3.83.2. Case Shielding

N/A to HIRS/4.

3.8.4. HIRS/4 Frequency Characteristics

The internal frequencies are :

Source	Frequency	User
Sync.	1 Hz	
Voltage Converter	78 kHz	
Sync.	1.248 MHz	

The channel characteristics are given in § 1.22

3.8.5. Magnetic Moment

The maximum magnetic moment of the instrument shall not exceed 500 mAm^2 (TBC) NASA. The magnetic moment correspond to a magnetic field of 100 nT at 1 m distance (1 Gauss equals to 10^{-4} T).

List of Magnetic Material

Magnetic materials used in the instrument are listed in Table 3.8.5.-1

Material	standard	Magnetic Characteristic	Remark
name of material	*AISI etc.*	*soft / hard*	
TBD_{HIRS}	TBD_{HIRS}	TBD_{HIRS}	

Table 3.8.5.-1 : Magnetic Materials Used in the Instrument

3.8.6. EMC Performance Requirements

The EMC performances for the HIRS/4 are dealt within § 4.3.

3.9. RF INTERFACE DESCRIPTION

Not applicable for HIRS/4.

4. INSTRUMENT VERIFICATION DESCRIPTION

BLANK

4.1. MECHANICAL / STRUCTURAL VERIFICATION

4.1.1. Structural Analysis

4.1.1.1. Quasi-Static Loads

Requirement for analysis will be determined by outcome of accommodation analytic results.

The METOP requirements are dealt with in § 2.28.

4.1.1.2. Structural /Dynamic Analyses

Requirement for analysis will be determined by outcome of accommodation analytic results.

4.1.13. Instrument Shock Environment

The HIRS/4 will be subject to the following shock environment, in bath launch and in-orbit configuration :

METOP Shock Levels (g peak, See notes)		Notes
100 Hz	37 g	The acceleration shall be derived from the curve obtained by linear connection on a logarithmic chart of the provided points
900 Hz	350 g (Q > 10) 310g (Q = 10)	The shock spectrum in each direction of the three orthogonal axes shall be equivalent to a half sine pulse of 05 ms duration and 200 g (zero to peak) amplitude.
2000 Hz	350 g (Q > 10) 310g (Q = 10)	
4000 Hz	300 g	

4.13. S-Tests

4.1.2.1. Structural Mathematical Model Validation

Delivered structural mathematical models, as required in § 2.2.8.5., shall be verified by test and validated.

4.131. Vibration Test : High Level Sine Sweep

The HIRS/4 will be subject to the sine vibration satellite level testing. Preliminary predictions of the worst case imposed environment are as follows :

METOP High Level Sine Sweep Levels (TBC$_{MET}$ *)	
	All three axes
Q U A L	6 to 20 Hz ±9.3 mm 20 to 60 Hz ±15 g 60 to 100 Hz ±6 g Sweep rate : 2 Oct/min.
	All three axes
A C C	6 to 20 Hz ±7.5 mm 20 to 60 Hz ±12 g 60 to 100 Hz ±4.8 g Sweep rate : 4 Oct/min.

* : To be confirmed / updated after structural model testing.

Notching : TBD$_{HIR}$.

Note : for instruments with natural frequencies below 100 Hz, notching shall be defined to maintain the instrument interface loads within those predicted when the quasi-static design load is applied to the instrument, consistent with the launcher requirements.

Test instrumentation for sine vibration at system level : TBD$_{HIR}$

4.1.2.3. Vibration Test : Sine Burst

METOP has no sine burst test requirement.

4.1.2.4. Vibration Test : Random Levels

The HIRS/4 will be subject to an acoustic environment during satellite tests which will result in an equivalent random input at the instrument interface. Preliminary prediction of this input is as follows :

METOP Random Vibration Levels (TBC$_{MET}$ *)			
	All Three Axes		
	Frequency Range (Hz)	Power Spectral Density g²/Hz	Slope (dB/Oct.)
Q	20 to 100		+3
U	100 to 400	0.107	
A L	400 to 2000		-3 out-of-plane -4 in-plane
	Overall level : 10.3 g rms normal, 9.5 g rms lateral Duration 2 min per axis		
	All Three Axes		
	Frequency Range (Hz)	Power Spectral Density g²/Hz	Slope (dB/Oct.)
A	20 to 100		+3
C	100 to 400	0.069	
C	400 to 2000		-3 out-of-plane -4 in-plane
	Overall level : 8.3 g rms normal, 7.6 g rms lateral Duration 1 min per axis		

* : To be confirmed / updated after structural model testing.

4.1.2.5. Acoustic Test

The HIRS/4 will be subject to an acoustic test at satellite level. as follows :

Octave Band Centre Frequency (Hz)	Qualification Level (dB)	Acceptance Level (Flight Limit)	Test Tolerance (dB)
31.5	132	128	-2. +4
63	134	130	-1, +3
125	139	135	-1, +3
250	143	139	-1. +3
500	138	134	-1, +3
1000	132	128	-1, +3
2ooo	128	124	-1. +3
4000	124	120	-4, +4
8000	120	116	-4, +4
Overall level	146	142	-1, +3
Test Duration	2 minutes	1 minute	

The equivalent random environment is illustrated in § 4.1.2.4.

4.2. THERMAL VERIFICATION : THERMAL TESTS

43.1. Thermal Balance Test

A thermal Balance Test (TB) shall validate the instrument thermal control and accommodation on METOP, and the HIRS/4 thermal mathematical model used for the temperature predictions for all flight cases (correlation of this instrument model within the METOP thermal environment with an accuracy better than ± 5 deg. C on instrument transient and steady-state cases). This will be performed during the METOP system TB test. The evaluation of test results at instrument level is Instrument Supplier responsibility.

433. Thermal Vacuum Tests

The thermal cycle vacuum tests at instrument level evaluate and demonstrate the functional performance of each unit under the extreme and nominal modes of operation while in vacuum and at temperatures more extreme than predicted for the orbit conditions.

~~The instrument qualification thermal vacuum test includes TBD_{HIRS} cycles and the extreme temperature levels are TBD_{HIRS} deg. C (min.) / TBD_{HIRS} deg. C (Max).~~

The instrument acceptance thermal vacuum test includes TBD_{HIRS} cycles and the extreme temperature levels are TBD_{HIRS} deg. C (min.) / TBD_{HIRS} deg. C (Max).

4.3. EMC VERIFICATION

43.1. EMC Performance Requirements

43.1.1. **Conducted Emission**

The conducted emission on each individual power line shall not exceed the limits as given below.

4.3.1.1.1. **HIRS/4 Design Requirements**

Conducted **Emissions** on the **+28** Volt Main Bus and **+28** Volt Switched Telemetry Bus

Load Current Ripple

The peak to peak amplitude of the steady state load current ripple shall not exceed 15 mA. The fundamental frequency of load current ripple shall not exceed 1 MHz.

Inrush Current Rate (Load Current Rate)

The rate of change of load current shall not exceed 20 **mA/µs.**

Inrush Current (Transient Load Current)

Requirement per individual bus.
Exclusive of **instrument turn-on,** transient load currents drawn by **the instrument** shall not exceed 150 **% of the maximum average steady state current drawn from the respective +28 V Main bus. Steady State operation shall be attained by within 30 ms from the start of the transient. A transient is defined as an** event having a duration of less than 50 **ms, non-repetitive.** Steady State is defined as an event having a duration of greaterthan 50 **ms,** non **repetitive.**

Requirement for combined **28** V busses.
At turn-on, the combined current drawn from all +28 Volt busses shall not exceed 3 Amperes peak. Steady state operation shall be attained within 1 **second form** the start of the turn-on transient.

Conducted **Emissions** on the **+28** Volt Pulse Load Bus

Load Current Ripple

The peak to **peak** amplitude of steady state load current ripple shall not exceed 100 **mA.** This **current** ripple excludes repetitive current pulses **created** by stepper motor or **heater** switching loads. The fundamental frequency of the load current ripple shall **not** exceed 1 **MHz.**

Inrush *Current Rate (Load Current Rate)*

The rate of change of load current shall not exceed 30 **mA/µs.**

Inrush *Current (Maximum Current Pulse* ***Load)***

The maximum current pulse load shall not **exceed** 1 Ampere and shall have a maximum duration of 1 second.

Conducted Emissions on the **+10 Volt Interface** Bus

Load Current Ripple

3mA

The peak to peak amplitude of the steady state load current ripple shall not ~~exceed 5% of the maximum average steady state current drawn by the unit from the +10 V bus~~. **The fundamental frequency** of load **current** ripple shall not exceed 25 MHz.

Inrush Current Rate (Load Current Rate)

The rate of change of load current shall not exceed 20 **mA/µs.**

Inrush Current (Transient Load Current)

Transient load currents drawn by the instrument shall not exceed 125 % of the maximum average steady state current drawn **from the +10** V bus. Steady State operation shall be **attained** by within 50 ms **from the start** of the transient

Test methods **CE01** and CEO3 are used in **accordance** with **§** 4.3.3. **An** oscilloscope with a current probe (D.C. to 30 **MHz** minimum **bandwidth) may be used in lieu of the EMI meter specified by the test** method.

4.3.1.1.2. **METOP Requirements**

contractor works under the assumption that is compatible

For instrument characterisation only. **METOP** ~~assumes compatibility of~~ **the instrument with these** requirements.

For **the** 28V Main Bus, **Switched** TLM Bus and Pulse Load Bus, the **fundamental frequency** of load current ripple shall not exceed **100 kHz**.

The limits for the load current ripple are :

a) **+28** V Main Power Bus :	< 2% of the maximum average steady state current drawn by **the unit from the +28 V Main bus**
b) + 28 V Switched **TLM** Bus :	**< 1 mA_{pp}**
c) +28 V Pulse Load bus :	**< 600 mA_{pp}**
d) + 10 V Interface Bus :	**< 3 mA_{pp}**

Conducted emission in the frequency range 30 Hz to 9 **MHz. which may** appear on **+28** V Main Bus positive and return leads in differential and common **mode**, shall be within **the** maximum specified levels of the **Figure 4.3.1.1-1.**

Note : **The** maximum frequency of 50 MHz has been reduced to the highest frequency (+ 9 harmonics) used by the instrument

The Common Mode **CE** requirement is a specific **METOP** quirement.

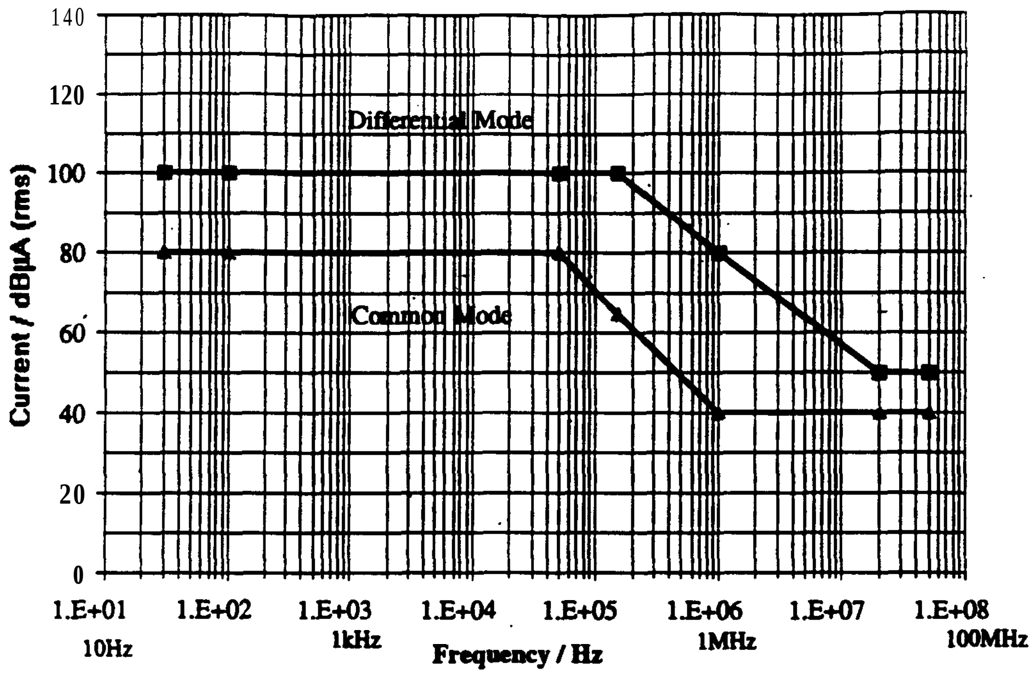


*Fig. 4.3.1.1-I : Conducted **Emission** L&nit, NB, **DM,** CM, 28V Reg. Power Leads, **PLM Instrument***

43.13. Conducted Susceptibility

Frequency Domain

The instrument shall operate without degraded performance in the presence of sinusoidal noise coupled into the power lines between the frequency range 30 Hz and 150 kHz :

+28 V Main Bus / 28 V Switched TLM Bus	injected Voltage	300mVpp
+28 V Pulse Load bus	injected Voltage	400 mVpp
+10 V Interface Bus	injected Voltage	100 mVpp

The test shall be conducted according methods CS01 and CS02 of AD4. The test method CS01 applies for the frequency range of 30 Hz to 50 kHz and test method CS02 applies to the frequency range of 50 kHz to 150 kHz. The scope of test shall be in accordance to § 4.3.3.

Time Domain

The instrument shall operate without degraded performance when subjected to a series of transient pulses, 10 µsec in width and PRF of 10 Hz applied to the power lines for 10 min. :

+28 V Main Bus / 28 V Switched TLM Bus	spike level	+10 V / -12 V
+28 V Pulse Load bus	spike level	+8 V / -13 V
+10 V Interface Bus	spike level	+1 V / -1 V

The test shall be conducted according methods CS06 of AD4. The scope of test shall be in accordance to § 4.3.3.

Special METOP Requirement

see 4.3.1.12

For instrument characterisation only. METOP assumes compatibility of the instrument with these requirements.

In addition to above requirements, the HIRS/4 will experience a common mode sinusoidal noise 300 mV_{pp} in the frequency range 100 kHz and 50 MHz. The noise will be injected between :

the +28 V main bus return line and unit housing, according to Figure 4.3.1.2-1

and the + 10 V interface bus return line and unit housing. according to Figure 4.3.1.2-2

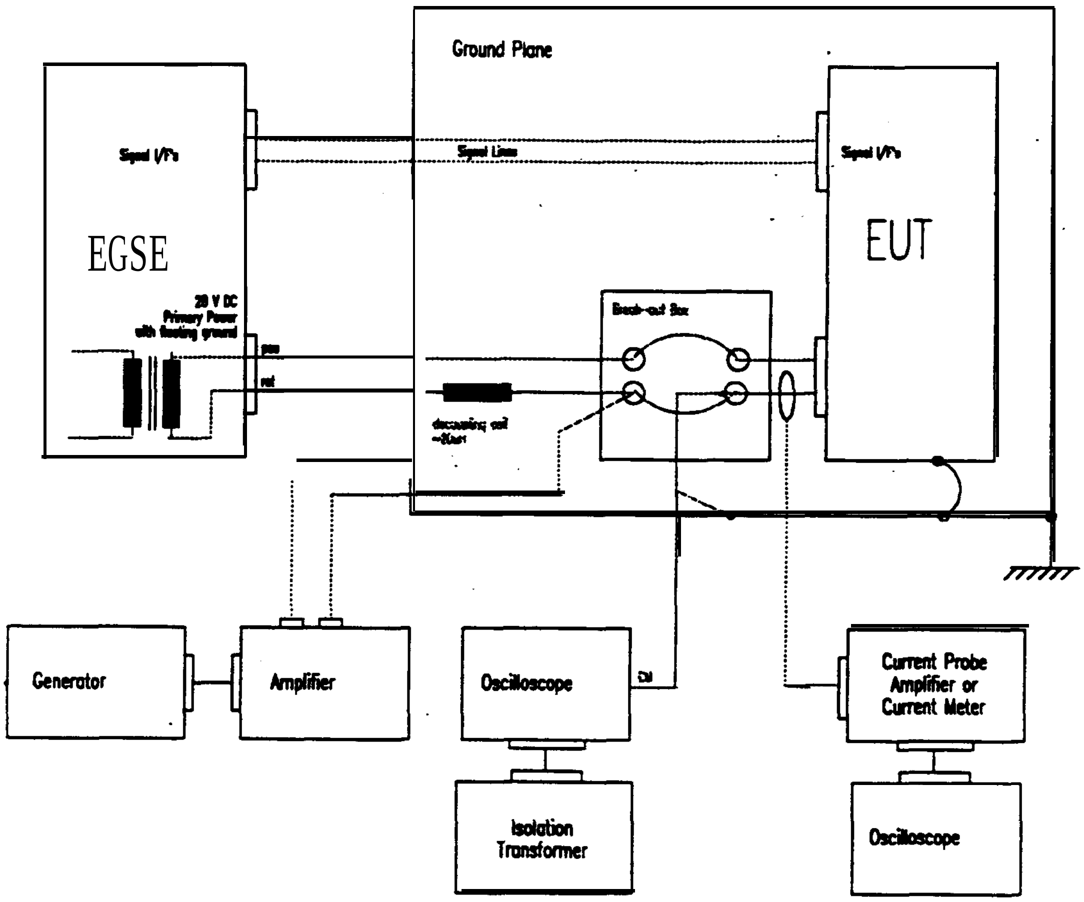


Fig. 4.3.1.2-1 : Common Mode Noise Test on the +28 V Main Bus

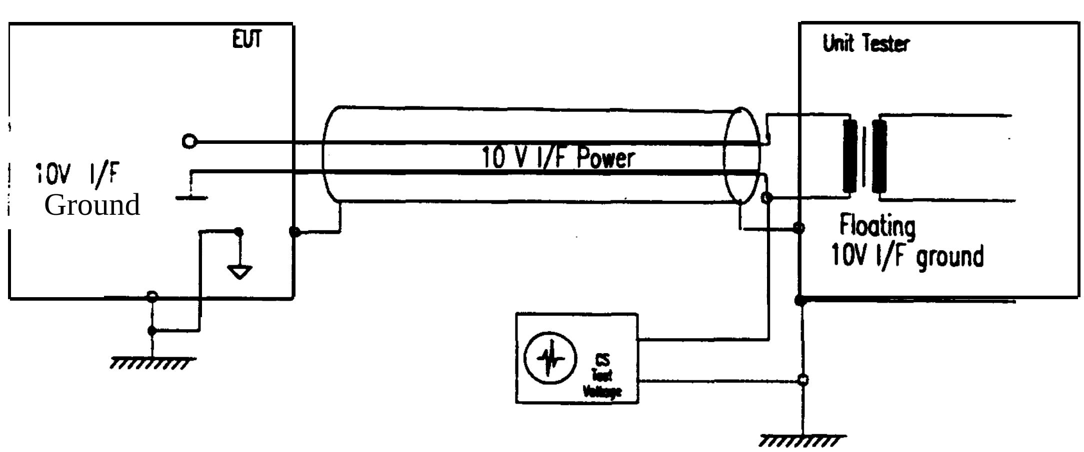


Fig. 4.3.1.2-2 Common Mode Noise Test on the + 10 V Interface Bus

43.13. Radiated **Emission**

4.3.1.3.1. Mil-std-REO2 **Requirements**

Broad-band and **Narrow-band** radiated emission **measurements shall be made over the frequency range** of 14 **kHz** to 2 **GHz in accordance** with **Mil-Std 461/462 RE02 requirements.** For **the** discrete **ADCS and SARP-3 sensitive bands listed below, broad-band noise and discrete signals shall not exceed -60 dBm when tested in accordance** with **the** methods of **§** 4.3.i.3.2 below.

59.458 MHz ± 0.5 **kHz**	60.100 **MHz ±** 0.5 **kHz**
141.360 **MHz ±** 0.5 **kHz**	142.900 MHz **±** 0.5 **kHz**
282.733 MHz **±** 0.5 **kHz**	285.813 **MHz ±** 0.5 **kHz**
371.921 **MHz ±** 0.5 **kHz**	375.972 **MHz ±** 0.5 **kHz**
624.925 **MHz ±** 0.5 **kHz**	631.730 MHz **±** 0.5 **kHz**
743.841 MHz **±** 0.5 **kHz**	**751.944 MHz ± 0.5 kHz**

4.3.1.3.2. **SARR, SARP-3 and ADCS Receiver Channel Guard Limits**

Emission measurements shall be made in accordance with **Mil-Std-461/462 RE02** with the **EMI** meter replaced by a **MITEQ** preamp (AU-2A-0550 or **equivalent) and** a **spectrum analyzer** (HP 8566a or equivalent). The **instrument under** test and the associated clock and control signals shall have power applied and the difference in the analyzer levels shall be noted for both white noise and spurious signals.

The test antenna shall be tuned to the centre of each of the four bands below. Prior to making the actual measurements, the test antenna shall be demated and **the** cable terminated in 50 ohms.. **The noise floor** of **the equipment shall be verified to be below the specified** maximum level for each **measurement** level. A guideline for establishing the resolution bandwidth is 100 Hz for both the -150 and -145 **dBm** levels, 1 **kHz** for the -125 **dBm** levels **and** 3 **kHz for the** -100 **dBm** levels. The specified maximum radiation limits for all discrete signals and noise power are listed below.

Frequency range (MHz)	Radiation Limit (dBm)	E-field Limit (dB µV/m) For Reference Only	Notes
118.00 - 120.000	-100	18.9	121.5 MHz
120.000 - 121.450	-125	-6	121.5 MHz
121.450 - 121.485	-145	-26	121.5 MHz
121.485 - 121.515	-150	-31	121.5 MHz
121.515 - 121.550	-145	-26	121.5 MHz
121.550 - 123.000	-125	-5.9	121.5 MHz
123.000 - 125.000	-100	19.2	121.5 MHz
236.000 - 240.000	-100	24.9	243.0 MHz
240.000 - 242.925	-125	0	243.0 MHz
242.925 - 242.975	-145	-20	243.0 MHz
242.975 - 243.025	-150	-25	243.0 MHz
243.025 - 243.075	-145	-20	243.0 MHz
243.075 - 246.000	-125	0.1	243.0 MHz
246.000 - 250.000	-100	25.3	243.0 MHz
396.100 - 401.100	-100	29.4	406.05 MHz
401.100 - 405.900	-125	4.5	406.05 MHz
405.900 - 406.000	-145	-15.5	406.05 MHz
406.000 - 406.100	-150	-20.5	406.05 MHz
406.100 - 406.200	-145	-15.5	406.05 MHz
406.200 - 411.000	-125	4.6	406.05 MHz
411.000 - 416.000	-100	29.9	406.05 MHz
396.000 - 401.500	-125	4.4	401.65 MHz
401.500 - 401.600	-145	-15.6	401.65 MHz
401.600 - 401.700	-150	-20.6	401.65 MHz
401.700 - 401.800	-145	-15.6	401.65 MHz
401.800 - 406.000	-125	4.5	401.65 MHz

4.3.1.3.3. METOP Requirements

For instrument characterisation only. METOP assumes compatibility of the instrument with this requirement.

The radiated emissions in the frequency range 14 kHz to 2 GHz shall not exceed the limit given in Table 4.3.1.3-1.

Frequency Range	E-Field Limits (dBμV/m) TBC_{MET}	Remark
10 kHz ... 2 GHz	+ 50	Covered by Mil-Std 461/462 RE02 *
2 GHz ... 40 GHz	+ 70	

* : The requirements of Mil-Std 461/462 RE02 are more stringent than tbe METOP RE limits

Table 4.3.1.3-I : RE-E- Field Limit (NB, AC, Electrical Fields)

Radiated emissions in the METOP payload and system receiver channel guard bands shall not exceed the limits defined here below :

Frequency Range (MHz)	Radiation Limit (dBm)	E-Field Level (dBμV/m) TBC_{MET}	Remark
1217 - 1257	N/A	+ 21	GRAS
1565 - 1614	N/A	+ 23	
205 1.9 - 2055.0	N/A	+ 9	SBS
5254.7 - 5255.3	N/A	+ 24	ASCAT
400 - 500	N/A	+ 20	Applies during launch only to
5450 - 5825	N / A	+ 61	active circuits of HIRSH

Table 4.3.1.3-2 : Radiated Emission Notches for HIRS/4

4.3.1.4. Radiated Susceptibility

The instrument will experience a radiated electric field of 1 Vrms/m for frequencies between 14 kHz and 1 GHz, and 2 Vrms/m for frequency between 1 GHz and 18 GHz. The test shall be done with at least 7 discrete frequencies / decade. The radiated E-Field shall be amplitude modulated by a sine wave at 1 kHz with a modulation depth of 50 %.

The test method is defined in § 4.3.3.

In addition, the instrument will be exposed to the following levels :

Frequency	Level TBC_{MET}	Modulation	Source Unit
5.25 GHz	40 Vrms/m	Pulse width = 8.22 ms, chirp rate = -50 kHz/ms, PRF = 4.94	ASCAT
		Pulse width = 10.32 ms, chirp rate = ±24 kHz/ms, PRF = 4.94 Hz	
7.8 GHz	8 Vrms/m	Pulsed 35 MHz PRF, duty cycle 50%	XBS
. 1.7013 GHz	20 Vrms/m	Pulsed 2.25 MHz PRF, duty cycle 50%	HRPT
468 MHz	14 Vrms/m	Pulsed 1 kHz PRF, duty cycle 50%	A-DCS
137.1 MHz	28 Vrms/m	Pulsed 38.25 kHz PRF. duty cycle 50%	LRPT
1.5445 GHz	7 Vrms/m	FM, 400 kHz peak deviation modulation index M=1	SARR
2.230 GHz	10 Vrms/m	Pulsed 4 kHz PRF, duty cycle 50%	S-Band Downlink

4.3.2. EMC Analysis

The EMC of the HIRS/4 shall be characterised by test and test discrepancies will be described by the Instrument Supplier. **METOP** will **further** assess the impacts on **METOP performance**.

Magnetic Moments

The magnetic moments shall be determined by analysis or test.

433. EMC Tests

EMC tests **shall** be performed in accordance with **MIL-STD-462C**.

Compliance with EMC **requirements** shall be **demonstrated on all models delivered to METOP.**

The Radiated Emission tests are applicable on all models delivered to **METOP.**

The Conducted Emission tests are applicable only on the first instrument **model** delivered to **METOP.**

4.4. ELECTRICAL FUNCTIONAL VERIFICATION

In general, the test which are described here below are performed to ascertain the instrument functional performances and culminate with the instrument calibration,

As regards the tests performed after delivery, they are described in § 5 and mainly deal with instrument health checks performed both at ambient and in thermal vacuum environment.

4.4.1. Electrical Interface Tests

In general, throughout the instrument build-out, every interface is thoroughly checked to ensure the compatibility, the adequacy of the electrical interfaces, in propagation from the sensor output / input up to the instrument electronics outputs to the spacecraft on-board equipment, for the basic circuitry and signals : power, measurement data, housekeeping data, commands, clocks, sampling signals...

From a system point of view, the essential step is the measurement of the spacecraft interface signals and characteristics. The operational mode of the spacecraft system shall be simulated to ascertain interface adequacy : special attention is to be paid for the command and acquisition timing and circuit loading should be representative of the on-board characteristics.

4.4.2. Functional Test

It is the sole responsibility of the Instrument Supplier to define and verify the proper functions of the instrument prior to delivery to METOP. This type of tests are tailored to the specific instrument function verification and they serve as instrument health checks that are performed routinely throughout the instrument development programme.

A subset of these tests will constitute later the core of the system testing when the instrument is integrated on-board the PLM.

4.43. Performance Test

It is also the sole responsibility of the Instrument Supplier to define and verify the ultimate mission performances of the instrument prior to delivery to METOP. This type of tests are tailored to the specific instrument performances and they are achieved ultimately with the instrument calibration which requires a rather sophisticated and controlled test set-up.

A subset of these tests may later constitute the system performance test with a reduced on-ground set-up. A go / no-go approach is preferred at system level (PLM and Satellite), due to the complexity of the test set-up and the AIT schedule limitations.

Calibration

It is the sole responsibility of the Instrument Supplier to calibrate the instrument prior to delivery to METOP. Recalibration, if deemed necessary, will also be under the responsibility of the Instrument Supplier. The calibration data shall be made available on-request for the preparation of the system integrated instrument performance test.

APPENDIX : INSTRUMENT ACHIEVED QUALIFICATION STATUS

Vibration Test : High Level Sine Sweep

The instrument has not been subject to a High Level Sine Sweep test.

Vibration Test : Sine Burst

The instrument has been subject to the following Sine Burst environment :

	Sine Burst Test Levels
QUAL	**All three axes** Test level : 19.44 g **Frequency : 30 Hz** **Duration : 0.5 second**
ACC	**All three axes** Test level : 15.64 g **Frequency : 30 Hz** **Duration** : 0.5 second

Vibration Test : Random Levels

The instrument has been subject to the following random environment :

Random Vibration Test Levels		
	All Three Axes	
QUAL. & ACC.	**Frequency Range (Hz)**	**Power Spectral Density g^2/Hz**
	20 to 2000	0.023
	Overall level : 6.8 g rms Duration 1 min per axis	

5. INSTRUMENT GSE AND AIV INTERFACES

TBC

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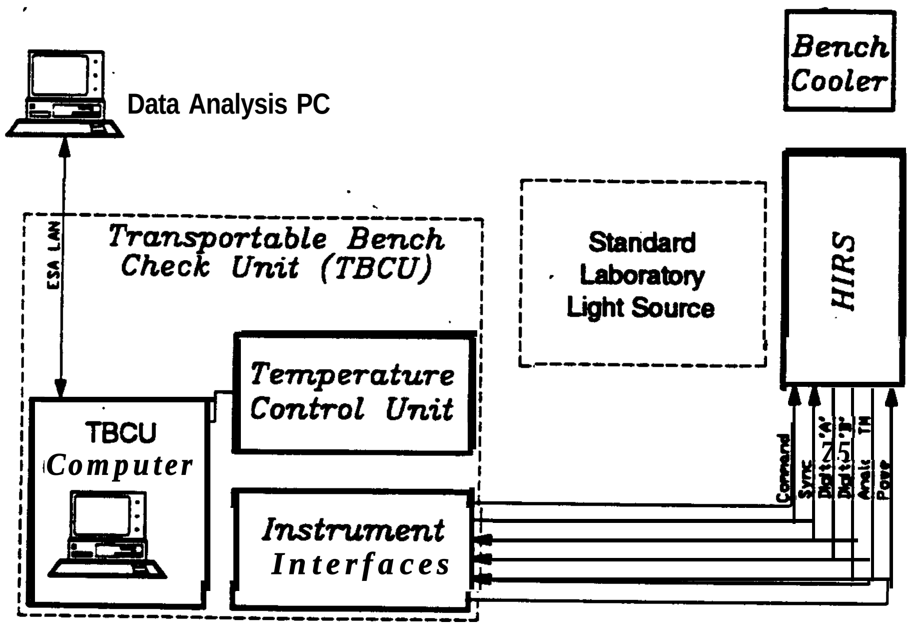
5.1. INSTRUMENT GSE DESCRIPTION

5.1.1. Bench Test Equipment

The Instrument Supplier will provide all test equipment required for bench test of the HIRS/4. This equipment shall include devices to power and command the HIRS/4.

Figure 5.1.1-1 provides an overview of the bench test set-up.



Note : the Temperature Control Unit of the TBCU is not used during bench testing.

Figure 5.1.1-I : Bench Test Set-Up

The HIRS/4 GSE consists of the following items

a) A Transportable Bench Check Unit (TBCU)

b) Lifting fixture (AD13)

c) Bench cooler (AD12)

The TBCU contains the power supplies for the instrument and all interfaces to the HIRS/4. A dedicated network card will be installed for communications with a workstation located in US (see § 5.2.4.6.).

For bench testing at ambient a bench cooler will be mounted to the instrument. The relevant mounting interface is the instrument radiant cooler vacuum housing. This device brings the HIRS/4 radiant cooler temperature down to approximately 95 K. There will be a stand alone controller on the bench cooler that will not interface to tbe TBCU.

A standard laboratory light source will be available for testing the HIRS/4 under ambient pressure conditions, with the bench cooler attached to the instrument (visible channel only, TBC_{HIR}). The source consists of a standard laboratory integrating sphere and is provided by METOP.

The HIRS/4 instruments are equipped with internal targets, the internal warm target (IWT) and internal cold target (ICT), for the IR channels. The temperatures of these targets are available through the normal instrument data stream. The internal targets will be sufficient to meet the radiometric test objectives on PLM and higher level for the IR channels. However, for proper instrument operation the bench cooler will be required to cool the detectors to the proper operating temperature.

The following pieces of standard equipment will be supplied by METOP for use during bench tests of the HIRS/4 instruments :

1. **Oscilloscope**
2. **Digital Voltmeter**
3. Standard **laboratory integrating** sphere **(TBD_{HIR}).**
   This item could be identical to the one for **AVHRR/3.**
4. General mechanical tool set and support

5.12. GSE for **Integration with** PLM OCOE

5.1.2.1. Ambient Testing

Under ambient conditions, the same set-up is used as for bench testing except that the instrument is operated via the PLM EGSE. For **further** details **see §** 5.2. Figure 5.1.1-1 shows **the configuration** for' instrument level testing (bench test) and Figure 5.2.1.1-l for PLM level testing. Sufficient **clearance,** accessibility of the **instrument coolers with the bench cooler needs are TBC_{MET}.**

5.133. **Thermal Vacuum Testing**

For thermal vacuum testing, the following target will be **used (provided** by the **Instrument** Supplier) :

- **Radiant cooler** target **(TBC_{MET})**

In thermal vacuum tests, a vacuum chamber shroud panel cooled with LN2 (80 **K)** will be used as the radiant cooler target. This target will provide **the** proper **thermal** inputs for **the** operation of the radiant cooler. **The** distance **and** size of the shroud panel with respect to the **instrument** patch shall be such that **the** patch can be adequately cooled (approximately 115 **K,** see **RD9).** This temperature is required to obtain useful data to check IR detector **aliveness.**

No other external target is baselined for use during TV testing. Back-up consists in **Instrument** Supplia provided radiant cooler target **(RD10),** to be mounted in **front** of the instrument radiant cooler.

Only the Instrument Supplier provided targets are controlled by the TBCU.

The TBCU will carry out the **instrument** digital A data **processing.** The interface between the **HIRS/4** TBCU and the **METOP** N-DAPB shall be via a LAN as defined in **§** 5.2 below.

5.1.3. Mechanical Ground Support Equipment

The Instrument Supplier shall provide a handling fixture which can be used for safely lifting and transporting the HIRS/4. The handling fixture shall be capable of mounting the instrument when the spacecraft is either in vertical or horizontal position. Provisions shall be made to lift with a crane. (Drawing AD13).

Need for drill template is TBD_{MET}.

Containers shall be supplied for shipping and storage for each of HIRS/4 deliverable instruments, to provide for all storage of instruments at the METOP integration and test sites. The instrument storage containers will be sealed and back-filled with dry N_2 to one atmosphere.

Scan cavity and radiative cooler protective covers and connector dust caps shall be delivered with each instrument. Installation and removal procedure shall be in accordance with TBD_{HIR}.

5.1.4. Self-Contained Special Test Equipment

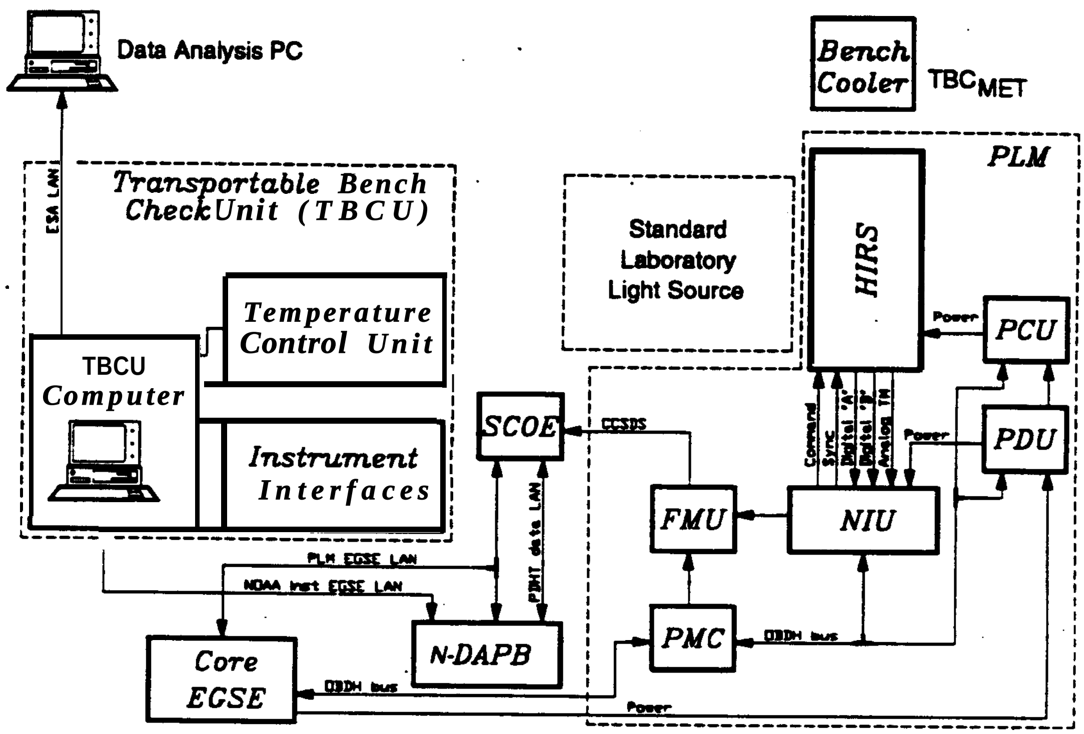
The bench cooler is a stand-alone system : once started, it will automatically maintain the instrument detectors at the proper temperature. The bench cooler has no external electrical interfaces with the METOP OCOE.

5.2. INSTRUMENT GSE INTERFACES

5.2.1. Interfaces with PLM OCOE

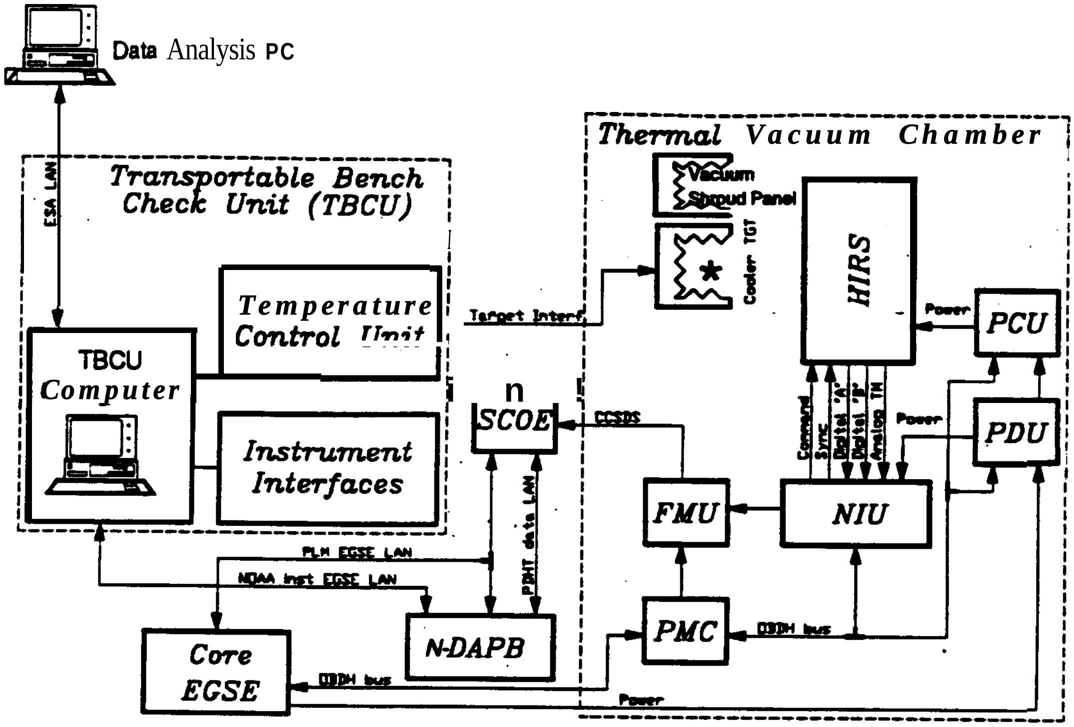
5.2.1.1. General

The configuration of HIRS/4 test equipment within the overall check-out equipment far the METOP payload module is shown in Figure 5.2.1.1-l for the ambient test configuration and in Figure 5.2.1.1-2 for TV testing. In all cases, the only interface between the OCOE and the instrument test equipment will be a LAN connection between the NOAA instrument DAPB (N-DAPB) and the instrument data processing equipment. Details can be found in RD11.



Note : The Temperature Control Unit and the Instrument Interfaces unit of the TBCU are not used during PLM testing at ambient.

Figure 5.2.1.1-I : HIRS/4 Test Set-up in PLM Configuration (Ambient)



* Only as a back-up

Note : The instrument Interfaces unit of the TBCU is not used during TV testing.

Figure 5.2.1.1-2 : HIRS/4 Test Set-up in PLM TV Configuration

Test set-up in TB is TBD_{MET}.

53.13. Stimulus/Feedback Equipment Interface

5.2.1.2.1. Physical / Electrical Interface

For ambient testing : Not applicable.

The bench cooler is a stand alone system, once started, will automatically maintain the instrument detectors at the proper temperature. The bench cooler has no external electrical interfaces. with the exception of the power source.

The standard light source is also a stand-alone equipment.

For TV testing : Not applicable.

If used. the cooler target will be directly acquired by the TBCU.

5.2.1.2.2. Protocol Interface

Not applicable.

5.2.1.2.3. Stimulus/Feedback Data Handling Requirements

The target temperature data (if the Cooler Target is used) will be acquired and processed in the TBCU. The data shall be formatted into standard CCSDS source packets and transferred to the N-DAPB for archiving purpose. No processing of the target temperature data in the N-DAPB is required.

52.13. **Interface with** Instrument **provided Data Processing Equipment**

5.2.1.3.1. Physical / Electrical Interface

The HIRS/4 measurement data shall be made available to the TBCU via a 100/10 Base-T Ethernet LAN interface.

5.2.1.3.2. Protocol Interface .

The data sent to the TBCU is the complete source packet as generated by the NIU.

For support of the measurement data processing, HIRS/4 related housekeeping data, like digital "B" and analog data, as well as a copy of instrument related commands sent to the NIU, can be made available. For all communication between the instrument data processing equipment and tbe METOP provided N-DAPB, standard CCSDS source packets shall be used as unique protocol data units.

Further details on the protocol are defined in AD10 and AD5.

5.2.1.4. **Measurement Data Evaluation**

5.2.1.4.1. Instrument Measurement Data Format Definition

The instrument measurement data format is defined in § 3.3. The data is acquired by the NIU in a cyclic manner according to the timing specified in § 3.3. As a consequence, each HIRS/4 source packet at the output of the NIU will contain the same data in the same sequence.

The overall source packet layout is defined in Figure 5.2.1.4- 1 below. The instrument measurement data format as defined in § 3.3 presents the user data space.

PACKET PRIMARY HEADER (6 Octets)							PACKET DATA FIELD		
Packet Identification (2 octets)				Packet Sequence Control (2 octets)		Packet Length (2 octets)	Secon-dary Header (6 oct.)	Source Data: User Data - (2304 oct.)	Source Data: Packet En-or Control (2 octets)
Version Number 3 bits	Type Indic. 1 bit	Sec. Header Flag 1 bit	AP ID 11 bits	Seq. Flag 2 bits	Packet Seq. Count 14 bits		Time Stamp	See § 33.3.	
16 bits				16 bits		16 bits	48 bits		16 bits

Figure 5.2.4.1-I : ***HIRS/4*** Source ***Packet Lay-Out***

Primary Header Field

Packet Identification

The Packet ID **Field** will follow the following format :

Bit Position	Subfield Name	Set to	Code
0..2	Version Number	'Version 1'	000
3	Type Indicator	'TM'	0
4	Packet Secondary Header Flag	-	1
5..15	Application Process Identifier (APID)	'HIRS/4'	38

Packet Sequence Control

The Packet Sequence **Control** Field will follow the following format :

Bit Position	Subfield name	Set to	Code
0..1	Sequence Flag	'Unsegmented'	11
2..15	Packet Sequence count	Incremented for each packet	Sequential binary continuous count

Packet Sequence **Count is** a method of counting the **number** of packets **generated** by the application. This significant parameter is a sequential count of the Packet **Sequence** Control Fields. This field will start with a value of zero and increment to 3FFF (HEX, or 16384). At this point it will roll-over and continue again from zero. The count will re-start from zero after power-on. No reset of the count is allowed before reaching 16383.

*Packet **Length***

This field contains a binary number which permits to identify the length of the User Data and Packet Error Control fields. Its value is defined as follows ***: number of octets of the Packet Data field - 1.***

Padcet Data **Field**

The Source Data field is split in three parts.

The first part is the Secondary Header which is used for time code information. For HIRS/4, the time stamp contains the NIU on-board time latched at the falling edge of the NIU internal 6.4 second synchronization pulse.

The second part is the area that contains the user data, as described in § 3.3.3.

The third part is the Packet Error Control (PEC) field that consists of a Cyclic Redundancy Checksum (CRC), computed over all the octets composing the packets, except the PEC. The generator of the polynomial is : $G(x) = x^{16} + x^{12} + x^5 + 1$.

5.2.1.4.2. Reference Data Presentation

For each of the relevant test configurations, i.e. with the light source / bench cooler for functional tests at ambient pressure, there will be a reference data set available obtained from the instrument level check-out. Representativity of ambient conditions reference data set far IR channels is TBD_{HIR}.

For thermal vacuum test, the reference data shall be generated emulating at instrument level the conditions at PLM level.

The instrument GSE software shall be capable of delivering the reference data, obtained during tests at instrument level, on a computer readable medium, in a format that can be imported in the Core EGSE local data base.

5.2.1.4.3. Data Comparison Requirements

Actual measurement data from the instrument. including radiometric data, shall be checked against reference data sets, inside the TBCU, according the requirements of NASA (TBD). The software for making the comparison will be part of the data processing software that will be delivered with the TBCU.

5.2.1.4.4. Data Processing Algorithms

All required data processing algorithms shall be incorporated into the software supplied with the instrument TBCU.

5.2.2. Interfaces with the PLM On-Board Equipment

5.2.2.1. Test Harness and Connectors

Not applicable

5.233. Special Test Adapters (T-Junctions, Break-Out Boxes)

HIRS/4 to PLM avionics interfaces are **all via standard** sub-D type **connectors, therefore no** special adapter is needed from the instrument. Connector **types** are **defined in** § 3.4.4 **and** 3.5.4. **Connector** locations on the instrument are illusuated in interface drawing from **§ 2.1.4.**

The HIRS/4 instrument is supplied with **connector** savers.

5233. Stimuli Source Configuration /Arrangement Requirement.

The bench cooler shall mate to the instrument radiant cooler. The arrangement of the bench cooler to the instrument radiant cooler is **TBD$_{HIR}$**.

During bench tests and PLM ambient tests. the **METOP** supplied light **source shall** be placed in front of the scan cavity. The exact **arrangement** is **TBD$_{HIR}$**.

5.2.3. Interfaces with other PLM GSE

N/A

5.2.4. Interfaces with AIT and Launch Site Facilities

5.2.4.1. Mains Power

Instrument test equipment **will** be operated from mains power via a **METOP-provided** isolation **transformer** with the following **output characteristics:**

- Voltage : 230 V AC (± 10%). 10 A max.. single phase
- Frequency : **50 Hz ± 1** Hz
- **Power** plug standards used within the **METOP** project for 230 V is DIN **49441/CEE7,** power sockets **DIN 499440/CEE7**

The actual estimated steady state power consumption of **the instrument is as follows (@** 230 **V)**:

- **TBCU** : 4.9 A **TBC$_{HIR}$**
- Bench cooler : 8.0 A

For the **HIRS/4** GSE, two single-phase isolation transformers are required one for the bench cook **and** one for the rest of the GSE.

53.43. Cooling / Thermal Dissipation Requirements

The HIRS/4 GSE has no requirement for additional cooling provisions beyond natural convection.

5.2.4.3. Purging Gas Requirements

After ambient testing with the bench cooler connected and in operation, when the instrument has been brought back to room temperature, 6 litres of dry GN_2 is required to back-fill the radiant cooler vacuum housing in order to avoid condensation on the detectors.

5.2.4.4. GN_2 / LN_2 Supply

For back-filling of transport and storage containers GN_2 per Fed. Spec. BB-N-441b Type 1, Class 1, Grade A or equivalent shall be used.

For bench cooler purge valves, GN2 per Fed standard, or equivalent, shall be used.

The LN_2 (80 K) consumption during bench cooler operation is approximately 10 litres/hour.

During thermal vacuum target operation, LN_2 consumption is :

- Radiator target . 10 litres/hour (back-up)

5.2.4.5. Test Chamber Wall Feed-Through Panels

The TV-chamber feed-through panels shall provide 2 LN_2 (80 K) ducts for the radiant cooler target, if used (Note : The number of feed-through ducts may possibly be reduced by running some targets in series. This approach will need to be proven by analysis)

3 electrical feed-throughs for K-type thermocouples and 8 electrical PRT's are needed in the chamber panels. TBD_{HIR} electrical feed-throughs are required for the radiant cooler target heater lines, if used.

5.2.4.6. Public Data Net Communication Requirements

The METOP AIT and launch site facilities will provide access to a public data network in order to enable data exchange with the Instrument Suppliers for off-line data evaluation at the HIRS/4 Instrument Supplier premises.

As a baseline the file transfer procedures (FTP) via INTERNET will be used, however other TCP / IP application layers via INTERNET and / or modem can be discussed. Requirements are TBD_{HIR}.

53.4.7. Physical Interfaces

For set-up of the bench test equipment an area of 20 m^2 as a minimum shall be provided in a temperature and humidity controlled class 100,000 clean area.

5.3. INSTRUMENT GROUTUD OPERATION REQUIREMENTS

53.1. General

Instrument operational constraints are presented in § 1.4.1. Test procedures may deviate from these.

Instrument modes and in-orbit operations are described in § 1.4. and 1.5.

HIRS/4 telecommands are desaibed in **§** 3.2.2.

For the ground operations, the acknowledgement of the commands by the instrument is done using Analog Housekeeping and Digital B data **from the instrument,** as described in **§** 3.2.3.

Conditions for Testing

If a solar simulator is illuminating the i[redacted]ent, the scan mechanism must be running.

The Electronics ON command, when the radiant cooler is at ambient temperature (IR detector patch not cooled), must not be **sent,** to prevent potential **deterioration** of **the** IR detectors **(on-ground** critical **command).**

5.3.2. Command and Control Sequences

The testability of the **instrument depends** on the usage of stimuli **and** cooler **equipment** as outlined in Table 5.3.2-l below. **Command** and control sequences will be **implemented** in **the check-out software** of the **METOP** overall **check-out equipment** in terms of control files for automated testing. **The control files will ensure that the instrument is operated and tested in accordance with the objectives given below.** Control files will be coded **on the** basis of test **procedures** prepared by **the METOP AIT** team following inputs from the **Instrument Supplier,** and checked by **the Instrument** supplier.

Control files shall take into **account** the **generic** operation **requirements given** above, and **the** special requirements for **ambient** and TV testing given in **the** following **subchapters.**

	TEST CONFIGURATION		
	PLM Eiectricai Test S/L Test	Incoming Inspection Pre-Integration PLM Eiectricai Test (TBC$_{MET}$) S/L Test (TBC$_{MET}$)	PLM TV Test
Test Objective	No external stimulus No cooler Ambient pressure	Standard lab. light source Bench Cooier Ambient pressure	Only internal targets (IWT, ICT) Cooled Shroud Panel TV Cond.
Command Handling	Verification of command acceptance and execution (Note 1)	Verification of command acceptance and execution	
HK Telemetry Check	Monitoring of HK telemetry data against pre-defined limits and change of commands		
Scan Motor Operation	Functional check		
Filter Wheel Drives	Functional check		Channel 1 period monitor check
Visi bie Channel Data	Not applicable (not authorized) (Note 2)	Coarse caiibration check against data baselined at instrument level	Noise performance data and coarse caiibration against data baselined at instrument level (view of chamber interior)
infrared Channel Data	Not applicable (not authorized)	Presence of data and noise performance check against data baselined at insuument level	Resenceofdataandnoise performance check against databaselined at instrument level

Note 1 : excluding the Electronics On command that switches the IR channels on. and all commands involving the IR channels.

Note 2 : the HIRS/4 design disallows the switching of the visible channel apart from the IR channels.

Note 3 : the TB test is not dealt with in this table since it is not relevant to instrument performance test.

Table 5.3.2-l : *Test Objectives Versus Test Configurations*

533.1. Ambient Conditions

Operation of the instrument under ambient conditions is subject to the following constraints :

1. IR detector temperature, as determined from the extended patch temperature telemetry, should never exceed 35 deg. C.
2. Patch temperature should be maintained to prevent condensation.
3. IR channels shall not be activated with no bench cooler or equivalent. [1]

Warning : Door should be manual restrained so that it does not impact the stops during testing (see § 5.6.1).

Procedure to open the radiant cooler door with the bench cooler attached is TBD_{HIR}.

Note : during bench cooler operations an exhaust line or filter, provided by METOP, shall be installed on the bench cooler vacuum exhaust.

The normal operation mode and switch-on sequence for ambient pressure and temperature operation is as follows (these procedures are intended as general guidelines ; the procedures will be specified in the operation manuals supplied with the GSE) :

(1) Initial Sequence (to assure that each instrument section is reset properly)

1) Instrument OFF
2) Fllter Housing Heater OFF
3) Patch Temp. Controller OFF
4) Filter Wheel Motor Normal

(2) Switch-On Sequence

1) Pump down the bench cooler to a pressure of 10^{-5} Torr (= 1.33 10^{-5} mbar)
2) Instrument ON
3) Scan Motor ON
4) Filter Wheel Motor ON (Off mode)
5) Turn on cooler heater (decontamination), maintain for 6 hours min. Detector temperature should be monitored and the heater turned off if detector reaches 35 deg. C.
6) After 0.5 hours, mm off cooler heater. Cool until patch reaches operating temperature.
7) Filter Housing Heat ON
8) Electronics ON. Allow time for patch temperature to stabilise before taking measurements.
9) Patch Temperature Controller ON
10) Calibration Enable

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[1] Remark : in case IR channels are activated at ambient without cooling, there is no damage to tbe HIRS/4 as soon as the patch temperature telemetry is below 35 deg. C : this limits the activation of IR channels to maximum 2 minutes starting from nominal temperature range.

Remark : With no bench cooler, use only steps # 2, 3, 4, 7, 9 and 10.

(3) *Switch-off Sequence*

1) **Turn on instrument outgas heater.**
2) **Turn on bench cooler heater**
3) **Bring bench cooler shroud to room temperature, being sure that this temperature does not exceed IR detector temperature.**
4) **Wait until all temperatures reach room temperature (note : patch may be 30 deg. C)**
5) **Cooler** Heater OFF
6) **Electronics OFF**
7) Patch Temp. Controller OFF
8) Scan Motor OFF
9) **Filter Wheel Motor OFF**
10) Instrument OFF
11) Back fill to **ambient pressure, using** dry N_2.

Remark : With no bench cooler, use only steps # 6, 7, 8, 9 and 10.

5.3.2.2. *Thermal* Vacuum Conditions

Operation of the instrument in thermal vacuum is subject to **the** following **constraints**:

1. IR detector temperature. as **dete—ed** from the extended patch temperature **telemetry**, should never exceed 35 deg. C.
2. Patch **temperature** should be maintained to prevent condensation.

The cooler door will normally be closed at the start of pump-down. When the pump-down is completed the outgassing heater must be turned on before starting **to cool** the radiant cooler shroud and target.

24 hours after the cooler heater is turned on and when the cooler target is fully cooled down, the cooler door may be opened. When the door is open the operating mode command sequence may be sent.

The normal operation mode **and** switch-on sequence for vacuum and **end** of vacuum **operation** is as **follows (these procedures are intended as general guidelines ; the procedures will be specified in the** operation manuals supplied with the GSE) :

(A) *Initial Sequence (to assure that each* ***instrument*** *section is reset* ***properly)***

1) Instrument OFF
2) Filter Housing Heater OFF
3) Patch Temp. Controller OFF
4) Filter Wheel Motor Normal

(B) *Beginning of Vacuum Test*

1) **Pump down the chamber to a pressure of less than 10^{-5} mbar and confirm**

2) Instrument ON
3) Scan Motor ON
4) Filter Wheel Motor ON
5) Turn on cooler heater (decontamination) and confirm
6) Cool shroud (or cooler target) to operating temperature.
7) After 48 hours, turn off cooler heater. Detector temperature should be monitored and the heater turned off if detector temperature reaches 35 deg. C.
8) Open cooler door
9) Electronics ON
10) Patch Temperature Controller ON
11) Calibration Enable

(C) End of Vacuum Test

1) Electronics OFF
2) Patch Temp. Controller OFF
3) Scan Motor OFF
4) Filter Wheel Motor OFF
5) Turn on cooler heater (decontamination)
6) Bring shroud to room temperature, being sure that this temperature does not exceed IR detector temperature.
7) Instrument OFF
8) Back fill to ambient pressure, using dry N_2.

Note : it is recommended that the cooler heaters be turned on during warm-up to prevent the cooler from becoming contaminated.

533. Hazards / Precautions

Assure adequate clearance exists far cooler door deployment. The cooler cover shall be removed prior to deploying the cooler door.

Persons handling the instrument must wear ESD dissipating smock. caps and gloves as a minimum.

Proper caution should be observed in maintaining clearance around the instrument when removing the handling fixture.

The instrument is an ESD sensitive device.

Remove connector savers before restoring the instrument into its shipping container.

5.4. INSTRUMENT ACCEPTANCE AT AIT SITE

5.4.1. Unpacking/Packing and Handling Requirements

For all instrument handling and mounting the delivered handling fixture shall be used. The instrument shall be handled only with anti- static gloves

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5.41. Incoming Inspection

The incoming inspection starts as soon as instrument equipment arrives at the integration site. After unpacking under cleatroom conditions, the following will be carried out :

- Visual Inspection of Instrument and GSE
- Dimensional /flatness check
- Units Weighing
- Ben&Testing

Bench Level **Tests**

Prior to installation and to the PLM and electrical integration with PLM avionics, the instruments shall undergo a bench level check-out to demonstrate aliveness and instrument readiness for the subsequent system level AIT activities.

The instrument will be set up on a test bench (e.g. a table with conductive surface) and shall be connected to the instrument test equipment and bench cooler. Then a series of check-out activities shall be carried out as required to validate the instrument readiness (including visible and IR channels).

The test equipment (e.g. a portable bench test equipment) shall be provided by the Instrument Supplier and shall reside at the PLM and satellite AIV sites to support instrument troubleshooting if necessary. Operation of the instrument and its bench test equipment is done by the Instrument supplier team with support of the METOP AIV team in accordance to the following instrument-provided procedures and manuals :

Incoming test procedures (incl. pass / fail criteria) : TBD_{HIR}

Test equipment handling and assembly procedures : TBD_{HIR}

The test configuration is as per Table 5.3.2-1.

5.43. Instrument Self-Compatibility Test

N/A

5.5. INTEGRATION ON METOP

5.5.1. Pre-Integration

Prior to the installation in the PLM, the instrument will be pre-integrated with the NIU and parts of the NIU test equipment as well as the power conditioning unit The corresponding set-up of on-board units and ground support equipment is shown in Figure 5.5.1-1.

The purposes of the pre-integration activities is-to verify electrical interfaces between insuuments and NIU and PCU, to develop instrument specific test sequences, and to refine and validate the DAPB operation separately from the PLM level AIT in order to reduce the overall integration time.

The activities carried out with the instruments in the NIU pre-integration are electrical integration and instrument IST's as described in § 5.5.3 below.

The physical arrangement of the instruments during pre-integration will be on desks with conductive surface. The interconnection to the NIU and PCU is accomplished with a METOP provided test cable harness. Pre-integration activities are done in a clean room environment as required.

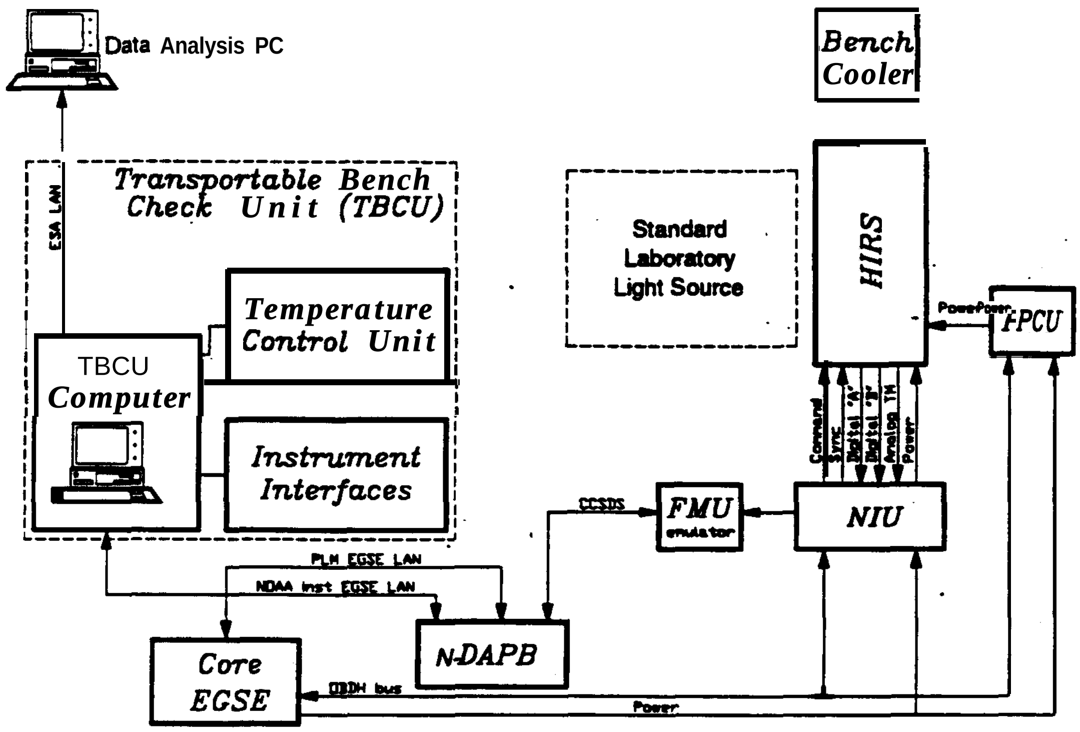
After completion of the pre-integration activities the instruments together with the NIU and the PCU will be installed in the payload module. An abbreviated electrical integration and part of the IST's are then repeated.

The test configuration is as per Table 5.3.2-l.

55.2. Mechanical / Thermal Integration

The instrument mechanical /thermal integration includes the following activities :

- Physical installation to associated PLM panels according to agreed procedures including thermal insulation/filling and other
- Mechanical adjustment as required
- installation of thermal fillers / insulators as required
- Mounting of thermal blankets
- Bonding measurement between equipment case and PLM structure
- Mechanical integration of pre-integrated instrument panels to the payload carrier structure



Note : The Temperature Control Unit and. the Instrument Interfaces unit of the TBCU are not used during PLM testing.

Figure 5.5.1-1 : HIRS/4 Test Set-Up in Pre-integration Configuration

5.5.3. Electrical Integration and IST's

The electrical integration of the instrument is done after the integration of its GSE. The purpose of the electrical integration of the instrument on-board equipment is twofold : to verify that the interfaces between the instrument and the PLM avionics are as specified, and to accomplish instrument operation commissioning within the PLM environment

The following activities are carried out for electrical interface verification :

Instrument Grounding / Isolation Check : before mating any connector with the system harness, it is verified that designated grounding pins are properly terminated to chassis, and other connector pins are isolated.

Safety Check : it is verified, before connecting the system harness, that there is no unexpected dangerous voltage, nor a short to chassis ground

T-Junction Tests : instrument connectors are mated with the PLM harness one by one via T-junctions, which allow measuring signal characteristics. Power connectors are mated first, followed by command interface connectors and telemetry interface connectors. The instrument is operated from the PLM Command & Control Block (CCB) by sending commands manually. Essential signal parameters such as rise/fall times, signal levels; signal timing, inrush currents and power consumption are recorded and compared against expected (ICD) values.

The instrument electrical integration procedures will be prepared by the PLM AIT team on the basis of inputs from the Instrument Supplier, and reviewed and supported by the Instrument Supplier.

An instrument IST will follow the verification of the instrument interfaces. The purpose of this test is to perform a reference instrument check-out in the overall system environment.

The instrument will be operated in all relevant modes including degraded modes and redundancy activation. Full instrument operability validation is achieved in the IST. This comprises both the on board equipment and the ground support equipment and check-out software. It is to be noted that the check-out software, at least the AIT data base with the TM/TC parameter definitions will be re-used during mission operation. Instrument specific control files will be refined and validated in the IST.

In addition to the above objectives, the IST serves to produce reference data sets for the subsequent environmental and system function test programs.

The test configuration is as per Table 5.3.2-l.

Operations of the instrument with the bench cooler attached would allow the checking of the IR detectors. This test set-up requires free access of the bench cooler to the radiative cooler of the instrument with neighbourhood instruments (AVHRR/3, IASI) adjacent. Feasibility of this set up is presently TBC_{MET} due to compatibility between bench cooler physical envelope and PLM configuration.

55.4. Integration of GSE

5.5.4.1. Integration of GSE with the Flight Equipment

N/A

53.42. GSE Integration with PLM OCOE

The EGSE integration is done prior to the integration of the on-board equipmax. During this activity, the instrument provided test equipment shall be connected with the METOP provided PLM EGSE. Generally, EGSE integration basically consists of an end-to-end communication check to demonstrate full operability under control of the Command and Control Block (CCB).

The instrument GSE integration procedures will be prepared by the PLM AIT team on the basis of inputs from the Instrument Supplier, and reviewed and supported by the Instrument Supplier.

5.6. INSTRUMENT OPERATION CONSTRAINTS DURING PLM & S/C SYSTEM TESTS

5.6.1. System Environmental Test Levels

Ground operation of the radiant cooler door :

During all METOP integration and test programme, the solenoid release shall be limited to a total of :

1 time without shock damping

unlimited when manual damping (procedure TBD_{INST}).

5.6.1.1. Structural Tests

During the actual vibrations the scan motor and the filter wheel drive shall be switched on.

For vibration testing the following items shall be removed from the instrument :

- scan cavity dust cover

- cooler dust covk

5.6.1.2. Thermal Tests

For thermal vacuum testing the following items shall be removed from the instrument :

- scan cavity dust cover

- cooler dust covk

5.6.13. EMURFC Tests

For EMC/RFC testing the following items shall be removed from tbe instrument :

- scan cavity dust cover

- cooler dust covk

The maximum magnetic flux experienced by tbe instrument shall not exceed 2.0 gauss and the instrument shall not be exposed to a radiated electric field greater than one volt/meter for frequencies between 150 kHz and 500 MHz.

5.63. Function and Performance Tests

The following descriptions shall provide a better understanding of the system level tests and are to be understood as for iuformation only.

The test configuration is as per Table 5.3.2-l.

5.6.2.1. System Functional Tests (SFT)

The system functional test will verify the overall system performance and operability in a series of mission relevant modes. Back up modes, degraded modes and mode transitions will be included. The SFT procedures will be composed of control files which have been validated during IST's.

5.6.2.2. Special Performance Test (SPT)

SPT's serve to execute specific performance verifications in the overall system configuration for all those parameters which have contributions from more than one subsystem or far test cases which require a special set-up and operation condition. A typical example is a bit error performance test which involves elements of data acquisition, formatting and transmission.

For the instrument it is assumed that full performance has been demonstrated as part of the instrument acceptance test program, and therefore no instrument specific performance testing is required on system level.

5.6.2.3. Abbreviated Functional Tests (AFT)

The abbreviated function test is composed of a subset of control files and procedures from the system functional test. Its purpose is to demonstrate system integrity after major set-up changes and after transport. No measurement data evaluation will be included in the AFT's but ouly a verification that the measurement data streams are present. Therefore, no instrument stimulus generation and feedback data acquisition will be done.

5.7. INSTRUMENT CONSTRAINTS ON GROUND ENVIRONMENTAL CONDITIONS

5.7.1. AIT Site

HIRS/4, when held by handling fixture, may be positioned in any orientation.

The test connector covers for J7 and J9 are flight hardware. The J9 connector cover contains fuses and shall never be removed from the instrument.

The scan cavity dust cover shall be installed at all times except when the instrument is in the thermal vacuum, vibration or RFC testing. The dust cover on the cooler shall be installed at all times except when the instrument is in the thermal vacuum or vibration testing or when the bench test cooler is installed.

Connector dust caps shall be installed when the instrument is not in use.

During bench cooler operations, an exhaust line or filter provided by METOP, shall be installed on the bench cooler vacuum pump exhaust.

5.73. Launch site

Temperature, humidity and cleanliness conditions to which the instrument is exposed while at launch site are to be equivalent to those of the AIT site. Scan cavity and cooler dust covers shall be installed at all times. In the event that these covers are removed for an inspection of the scan mirror or cooler surfaces, the instrument shall be in class 100.000 or better clean area as defined in FED-STD-209B. In the event that it may not be possible to maintain the entire launch site area in which the instrument is located to the clean conditions given above, the instrument shall be bagged to prevent contamination.

5.73. Transportation

To avoid damage to the instrument, when not yet integrated to the spacecraft, it shall be hand-carried by authorised personnel in a sealed container, pressurized with dry N_2. For transport, monitoring shock and temperature recorders integrated into the transit case shall be used.

5.7.4. Storage

For instrument storage the sealed containers shall be back-filled with dry N_2 to one atmosphere. Purging is not required.

The storage temperatures shall be as per § 2.3.2.1.

The humidity limits shall not exceed 90 percent when the insuument is in the shipping container and sealed. When the shipping container is open, the humidity limit is less than 55 percent. Under no conditions shall the humidity be allowed to approach the dew point.

Other maintenance, as for example re-calibration, is not planned during storage.

5.8. LAUNCH CAMPAIGN

5.8.1. Launch Preparation

Check-Out on the Launch Range

Instrument launch operations before encapsulation of the satellite into the launcher fairing will be a series of functional tests as already done during the AIT phase. After encapsulation of the satellite, there will be only limited command and control access via umbilical to the service module and the payload module avionics. Therefore, instruments will generally not be operated after spacecraft encapsulation. However, the HIRS/4 scan motor and the filter wheel drive shall be powered during lift off.

Before encapsulation access to the scan mirror is required far inspection purposes.

During launch preparation the alignment mirrors (2 off) have to be taped with a low reflectivity tape far stray-light suppression reasons. Furthermore it has to be assured that the test connector cover is installed.

5.8.2. Red Tagged Items

- Dust cover on scan cavity
- Dust cover on cooler door
- Connector dust caps