VENUS EXPRESS

SPICAV

Flight User / Operations Manual

A-1. Approval Page:

Written by: J.P. Dubois, Service d'Aéronomie du CNRS

Approved by :

....
ESA

Authorised for Venus Express Project:

....

Authorised for the Principal Investigator:

....
J.L. Bertaux, Principal Investigator

A-2. List of contents:

A-3. Documentation change record:

Issue	Rev.	Sec.	Page	Date	Changes
1		All	All	02 10 07	Baseline
2	2	All		04 02 04	updates
3	1	All	All	05 08 01	Update after IQAR

A-4. Distribution list:

Recipient	Institute	No. of Copies

A-5. List of Acronyms:

A/D	Analog to Digital
AOTF	Acousto-optic tunable filter
BE	Bloc electronique
BIRA	Belgisch Instituut voor Ruimte-Aëronomie
CCD	Charge Coupled Device
DPU	Dedicated Processor Unit
EGSE	Electrical Ground support Equipment
FM	Flight Model
GSE	Ground support Equipment
IASB	Institut d'Aeronomie Spatiale de Belgique
I/O	Input/Output
IR	Infrared
MOC	Mission Operation Center
NA	Not Applicable
NIR	Near Infrared
PI	Principal Investigator
PM	Project Manager
SA	Service d'Aeronomie du CNRS
S/C	Spacecraft
SPICAV	SPectroscopy for the Investigation of Characteristics of the Atmosphere of Venus
SIR	Spicav Sensor IR
SOIR	Solar Occultation IR sensor
SUV	Spicav Sensor UV
SU	Spicav Sensor Unit
TBC	To Be Confirmed
TBD	To Be Defined
TC	Telecommand
TM	Telemetry
UV	Ultra Violet

PURPOSE

This document contains all the information needed to correctly operate in-flight Spicav in both nominal and emergency conditions.

CONTENT

This document describes the specific operational rules (and constraints) to operate the instrument during the spacecraft non-ground lifetime.

1. General Description:

1.1. Overview:

This document presents the Flight User Manual (FUM) for the Venus Express payload instrument SPICAV . It defines the mission objectives, physical and functional configuration and operations modes of the instrument and also describes how the instrument can be controlled, operated and monitored by ground operations.

1.1.1. Documentation

The following documents are referenced in this Flight User Manual, and may be referred to if more information is required.

Applicable documents

DA0	MEX PID A Issue 2	MEX.MMT.SP.007 Iss2
	+ VEX Change Request	VEX.T.ASTR.CR.00009 Iss4
DA1	VEX Pid-A	VEX.T.ASTR.SP.0992 Iss1
DA2	Spicav Electical Interface Document	SPV-DES-012 Iss4.1 (04.04.15)
	+ Update of EICD	VEX.SPV.CP.004 (04.07.07)
DA3	Spicav Payload Database Definition Document	VEX.T.ASTR.DDD.01213, Iss1
DA4	Mission Guideline	VEX.T.ASTR.TCN.00174, Iss2.1

Reference documents

RD1	Spicav Document List	SPV-SA-999, Iss3, 05.06.06
RD2	MEX SGICD	ME-ESC-IF-501, Iss2, 20/12/99
RD3	SOIR Internal heaters	SPV-SOIR-HT-01, 25/11/04

1.1.2. Content

This FUM consists of 9 major Sections and the contents of these are summarised here and details are presented in the different individual sections.

Section 1 ‘General Description’

presents the scope of this document and a summary of scientific objectives

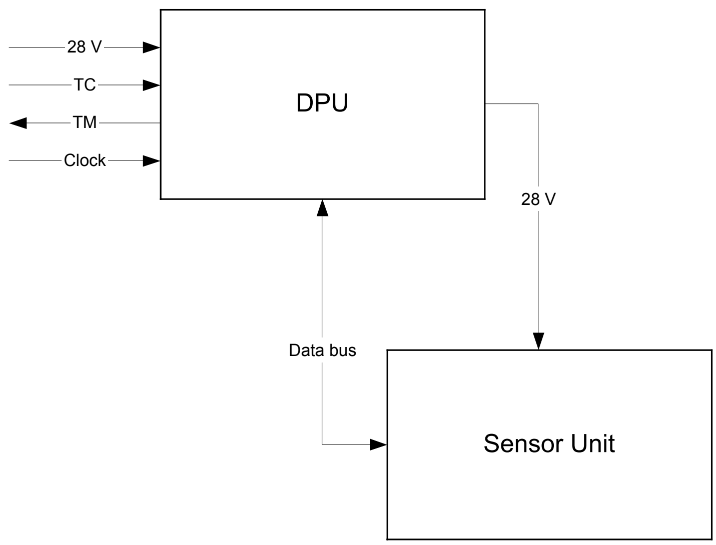
Section 2 ‘Instrument Configuration’

presents electrical and software configuration and gives all budgets
Section 3 ‘Detailed Description’ presents instrument description
Section 4 ‘Instrument Operations’ presents the nominal operations plan
Section 5 ‘Modes Description’ describes the various modes of operations of the instrument
Section 6 ‘Interfaces’ describes the interfaces with S/C
Section 7 ‘Nominal and Contingency Operations Procedures’ describes all procedures
Section 8 ‘Summary of Telemetry and Telecommand Data’ describes all telemetry packets
Section 9 ‘Data Operations Handbook'

1.2. Instrument summary:

SPICAV is a collaboration of Service d'Aéronomie, Verrieres le Buisson, France; IASB, Bruxelles, Belgique and IKI, Moscou, Russia.

The Spicav instrument is made of 2 boxes. The first box called DPU acts as the main electronic interface with the Spacecraft. The other is the sensor box or unit. This sensor unit has one channel (named SUV) in the ultraviolet wavelength range- 118-320 nm - ,one (named SIR) in the near infrared wavelength range - 0.7-1.7 µm, and a third one (SOIR) in the Infrared wavelength range 2.2 -4.4 µm.



SPICAV: DPU electronic block, Data processing Unit (same as MEX)
SU Sensor Unit composed of
- lower part: Mars Express Spicam experiment adapted
- upper part: SOIR channel (not on MEX)

Description of the DPU equipment:
Surface properties is Black anodized (no MLI, Inox screws)

Description of the SU equipment:
Internal surface properties is Black anodized
External surface properties is black anodized with MLI (except the bottom and +Z lower part without MLI and treated with Alodine 1200).
Titanium screws and shrims, 8 feet instead of 6 on MEX.
Interface on SOIR for a spacecraft thermal strap (180x40 mm2 on +Y side) see annex 1

A shutter (mechanism and interface board) is integrated on +Z side (lower part) of the Sensor Unit. It is electrically independant of the DPU and SU and is interfacing directly with the spacecraft. There was no shutter on MEX.

External Sunshields are integrated on the Spacecraft +Z wall.

Table 1.1. SPICAV Main characteristics summary Table

Spectral bands	118 - 320 nm (UV) 0.7 - 1.7 μm (IR) 2.2 - 4.4 μm (SOIR)
Spectral sampling	UV: 0.55 nm/pix IR: 0.8 nm/pix at 1.5 μm SOIR: 0.32 cm^{-1} at 2.4 μm 0.15 cm^{-1} at 4.0 μm
Mass	DPU+harness 0.865 kg SU 13.05 kg Total 13.915 kg Sunshields 0.47 kg
Power	DPU+SU 17.6 W, 26.4 W, 51.4 W
Volume	DPU: 161 x 142 x 70 mm^3 SU: 504 x 400 x 350 mm^3
Data rate	9, 34, 66 kbit/s (*)
Data Volume	Typ. 100 Mbits / day TBC
Observations	One Board Time TC, One Spicav TC Duration: 5 to 30 mn typ.
Pointing (orientation)	Inertial Star Inertial Sun Nadir

(*) averaged over several seconds

1.3. Scientific objectives:

The experiment is looking through the atmosphere of Venus either at :

a star :	vertical profiles by stellar occultation technique (CO_2, Temperature, ...)
the Nadir:	integrated profiles (O_3, ...)
the Limb :	vertical profiles of high atmosphere emissions
the Sun :	vertical profiles by solar occultation technique

The Sensor SOIR is only used in the Sun looking mode.

The suite of measurements of SPICAV in the various operation modes are addressing key questions of the atmosphere of Venus, present state, climate and evolution.

Chemistry: Simultaneous measurements of O_3 and H_2O will allow to validate and/or modify chemistry models, from which will be derived an assessment of the oxidation environment (effect of solar UV, O_3, H_2O_2, O, on minerals and oxidation molecules).

Structure/Dynamics/Meteorology: Vertical profiles of density / temperature (20-160 km) will provide unique information about the global structure and dynamics of the atmosphere, in particular in the altitude region crucial for aerocapture and aerobraking, and a better understanding of meteorological systems.

Clouds/dust/ aerosols: Occultation measurements will allow to detect, measure and characterise the physical nature of aerosols, and dust particles, and their vertical distribution.

Ionosphere/escape rate: Vertical profiling of daylight aeronomic emissions (H, C, O, CO, CO_2^+) will allow to adjust a comprehensive model of the ionosphere, from which an estimate of escape processes may be derived (evolution of the atmosphere), and to study the interaction with the solar wind.

In order to fulfill the previous scientific objectives, there are four configurations summarized below:

	Mode	Expected results
UV	Stellar occultation	Concentration vertical profile
UV+IR+SOIR	Solar occultation	Concentration vertical profile
UV+IR	Nadir	Total column abondance
UV+IR	Limb emissions	Vertical profiling of aeronomic emissions

SUMMARY OF SPICAV SCIENTIFIC OBJECTIVES

<u>SOIR targets</u> :

Species	**Spectral range (µm)**	**Altitude, precision/threshold**
CO_2	2.7 , 4.3	60-200 km
CO_2 isotopes		
H_2O	2.56	60-105 km
HDO	2.56, 3.7	60-90 km
$H_2{}^{18}O$	2.56	Similar to HDO
CO	2.35	60-150 km, 600 ppb
OCS	3.44	130
H_2S	2.63, 3.7	150
HCl	3.6	30
HF	2	1
SO_2	4.0	60-70 km, 1.7 ppb ?
C_2H_6	3.4	50 ppb

All minor at ~ 60-100 km

UV, IR targets :

Species	**Measurements**			**Accuracy**	**Altitude range**
	Scientific objective	**Mode (occultation, nadir, limb)**	**Spectral range**		
O_3	Concentration vertical profile	Stellar / Solar occultation	220 –300 nm	2 – 10 %	10 – 50 km
O_3	Total abundance	Nadir	220 –300 nm	5 % (>0.15 μ–atm)	N.A.
CO_2	Atmospheric density and temperature vertical profile	Solar / Stellar occultation	180 nm	2 – 10 % 5 K	20 – 160 km
Aerosols	Vertical profile of characteristics	Solar / stellar occultation	UV	10^{-3}(=photo-metric)	5 – 60 km
O_2	Concentration vertical profile	Stellar occultation	200 nm	20 %	35 – 90 km (never done before)
H, C, O, CO_2^+,CO	Vertical profiling of aeronomic emissions	Limb emission	118– 320 nm	20 %	80 – 400 km
H_2O_2	Total abundance	Nadir	210 nm	20 %	Never done before
SO_2	Total abundance	Nadir	220 nm		Tentative

CO_2	Surface pressure	Nadir	200 nm 1.43 μm	0.2 mbar 0.05 mbar	N.A.
H_2O	Total abundance	Nadir	1.38 μm	0.2. pr. μm (detectable)	5 x 5 km ground
Aerosols	Mapping of properties	Spectro polarimetry in nadir	1.2 to 1.7 μm	10^{-3} (=photometric)	Exploratory
Soil	surface studies	Spectro polarimetry in nadir	1.2 to 1.7 μm	10^{-3} (=photometric)	5 x 5 km ground

1.4. Design Description:

The DPU main functions are:
electrical interfaces with S/C
send commands and get data from the subunits
formatting data before transmission to S/C
In this document, flight software means software of the DPU.

The Sensor Unit is made of:
the UV channel (as on MEX)
the IR channel (same concept as on MEX)
the SOIR channel
the Servitudes unit, managing UV and IR channels (as on MEX).

As on MEX/Spicam, the Sensor Unit has two openings for Nadir viewing, one for UV channel, the other for IR channel located on the Nadir face of S/C. In addition, there are two openings for Solar viewing in spacecraft wall (not on the S/C Nadir face).

A shutter has been mounted on the +Z side of the experiment to avoid Sun light inside UV and IR spectrometers. This shutter was not on MEX/Spicam. It is activated by S/C commands, and has no electrical interfaces with DPU or SU. It is mechanically mounted on +Z side of the lower part of the sensor Unit.

The Spicam part has two mechanisms, one which moves On and Off a slit in the UV channel, the other which moves a internal shutter on the Solar aperture. Spicav mechanisms are fully autonomous and no separate commands are needed for mechanism operations. Each mechanism has two statuses, ON and OFF for slit, OPEN and CLOSED for shutter. They are returned in Science data.

The UV channel is a spectrometer with an optical baffle, an off axis parabolic mirror, a slit with two positions, a grating and a detector which an intensified CCD. On the CCD, the rows which are parallel to the unit baseplate, are the spectral dimension.

The IR channel is made of an entrance lens, an AOTF and two double pixels detectors : 2 detectors for each polarisation ; 2 pixels for two ranges. As the AOTF acts as a filter, the IR spectrum is obtained by electrically scanning the AOTF frequency.

The SOIR channel is made of an entrance folding mirror (‘periscope’), an AOTF acting as a bandwith selector, an off axis parabolic mirror, a high resolution spectrometer with echelle grating, and a multi pixel detector with cooler.

All the channels have their own digital electronics which performs all operations at detector level and digitalizes the data, then waiting for transmission to the DPU through a RS422 link at 937 kbits/s.

~~There is no redundancy in the instrument, unless the Data and power connectors.~~

For thermal aspects related to Venus mission, a MLI covers the Sensor Unit except the +Z lower part (where is mounted the shutter) and the bottom (treated with Alodine 1200).

The Sensor Unit is ‘isolated’ from the shearwall by titanium screws and shrims.

The Sensor Unit is linked to a radiator via a spacecraft thermal strap mounted at SOIR level (180x40 mm2 on +Y side). The aim of the strap is to cold SOIR baseplate.

The temperature of the SOIR baseplate is controlled by the spacecraft via internal thermistances and heaters to avoid low temperatures during solar observations (for optical reasons).

On DPU, there is no MLI, nor titanium screws, but inox screws as on MEX.

2 external Sunshields are mounted on S/C +Z wall to avoid Sun Straylight in the experiment. One is dedicated to UV channel and the other one is dedicated to IR channel. There was no Sunshields on MEX.

1.5. Operating principles.

There are four kinds of observations for SPICAV :
- Nadir observations, for Sensor Unit (UV and IR detectors):
- Star Occultation mode (UV channel):
- SUN Occultation mode (UV, IR, and SOIR channels):
- Bright limb observations (UV and IR channels):

For Star, Sun, Limb modes, a dedicated attitude from Spacecraft is needed.

The observation is executed totally automatically, under S/C control, in a schedule defined on ground, loaded well before execution.

The operating principle for one observation is:
- Put Spacecraft in good attitude for one kind of observation
- Switch On by S/C
- Send Spicav observation TC by S/C
- Record TM by S/C
- Switch Off by S/C at the end of observation.
- Put Spacecraft in nominal attitude

1.6. Operational profile

The operation modes are derived from the scientific objectives and correlated Spacecraft attitudes.
For more details see section 5.

1.7. Performance

Spectral resolution and SNR performances:

The following table shows for each observation mode, data product and estimated performances of UV Channel (resolution and SNR). SNR is calculated with summation of pixels along the slit.

Observation Mode	product	Resolution (nm) [1]	estimated SNR (at 250 nm)	Comments
Star	density, T vertical profile	1	50	1 sec integration visual magnitude = 0.04
SUN	density, T vertical profile	2	> SNR star	
Nadir	Integrated density (O_3, H_2O,)	2	280/600	1 sec integration 100 pixels summ narrow/ 40 pixels summ large
Limb	Emission vertical profile	2	45	4 sec integration 50 pixels summ narrow

(1): along the narrow slit for extended sources.
with large slit, resolution is 11 nm, SNR is increased accordingly.

The following table shows data product and estimated performances of IR Channel in Nadir mode for two wavelengths.

wavelength (micron)	Signal at The detector, nW	Resolution (nm)	estimated SNR	Comments
1.3	1.4	~ 0.7	100	
1.7	1.41	1.12	150	

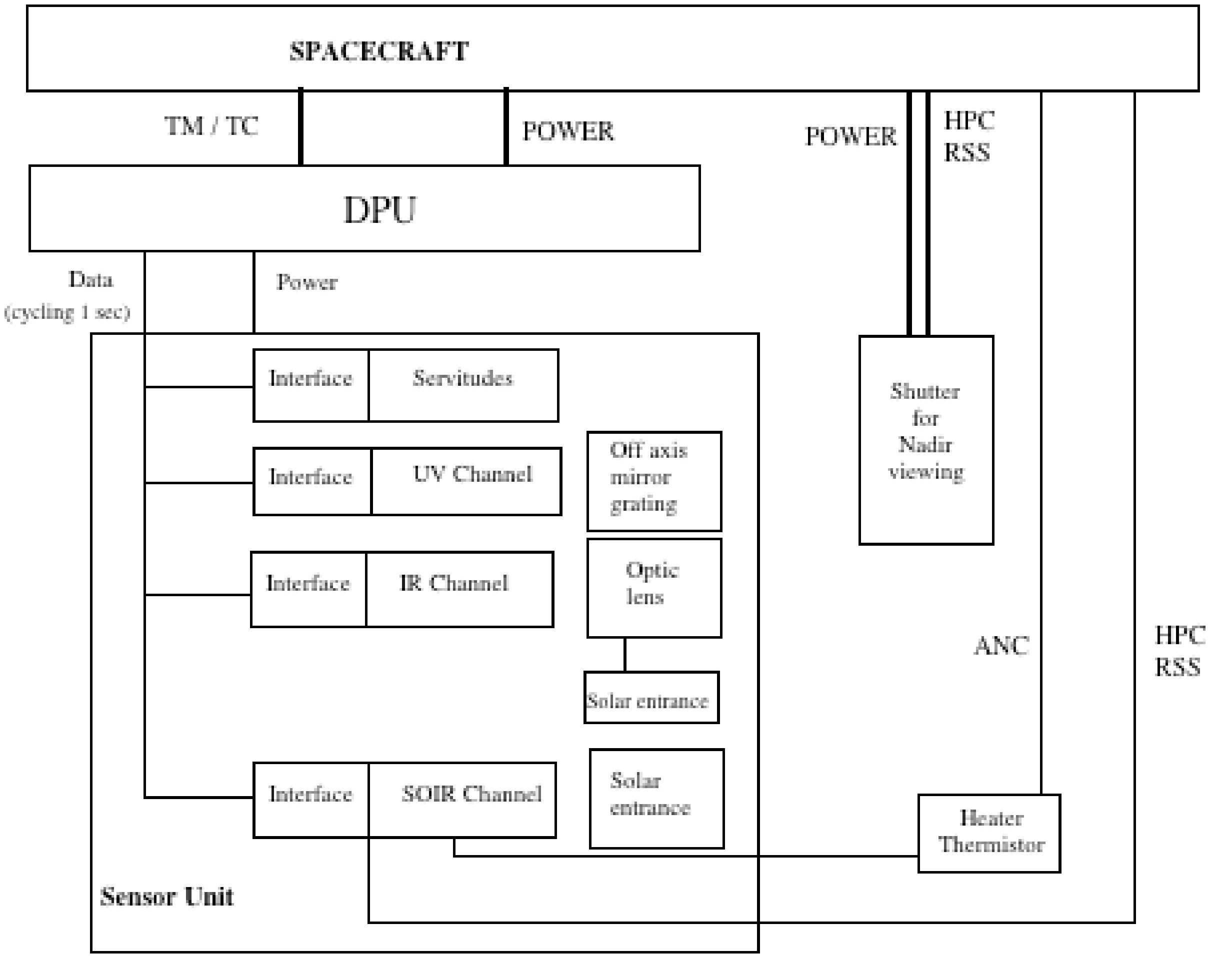
SOIR S/N in solar occultation at 3.7 μm = 1000

The end-to end performances are summarized in the Scientific objectives paragraph (section 1.3).

2. Instrument configuration:

2.1 Hierarchical configuration:

The relationship between the subsystems are shown in the the synoptic below.



SPICAV synoptique 03 04 04

The DPU has the general control of the Sensor Unit. It sends commands to the sub units and retrieves data. Then it formats and produces telemetry packets.

Servitudes refers to non-detector elements of Sensor Unit (Spicam part).

The polling of the sub units is done by the DPU, at a rate defined in the SPICAV Telecommand.

Depending on the operationg mode, the IR channel is switched On or not.

The Shutter has no electrical interfaces with DPU or SU. It is mechanically mounted on +Z side of the lower part of the sensor Unit. It is powered and activated by S/C.

2.2 Physical configuration:

The Sensor Unit has two main directions of sight, one is Nadir (s/c +Z), the other is Solar direction defined on S/C +Y side (with dedicated attitude) :

The Sensor Unit has two openings for Nadir viewing, one for UV channel, the other for IR channel located on the Nadir face of S/C. The instrument's optical axis is parallel to the baseplate and perpendicular to the Nadir face of the spacecraft.

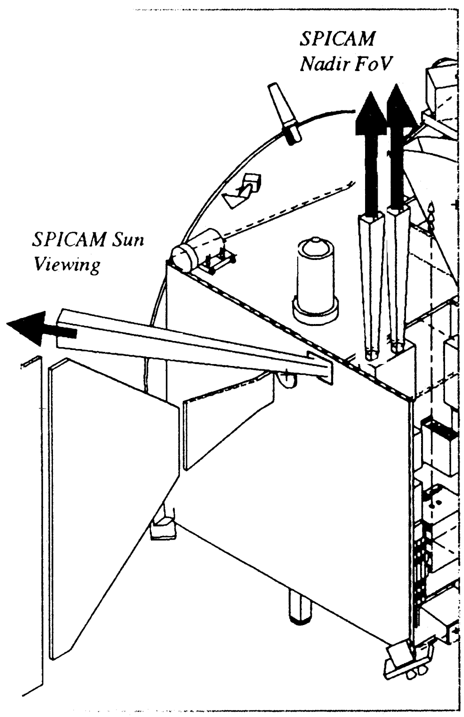
These two openings can be obtured by a shutter on the Nadir side of the sensor unit to avoid solar light (but not dust).

In addition, there are openings for Solar viewing. Two openings are built in the base plate of the Sensor Unit for UV and IR channels. They can be closed by a mechanical solar shutter activated by Sensor Unit (parameter in Spicav TC). One hole on spacecraft wall is dedicated to these two openings.

SOIR entrance is a 'periscope' with specific aperture. A second hole on spacecraft wall is needed for SOIR.

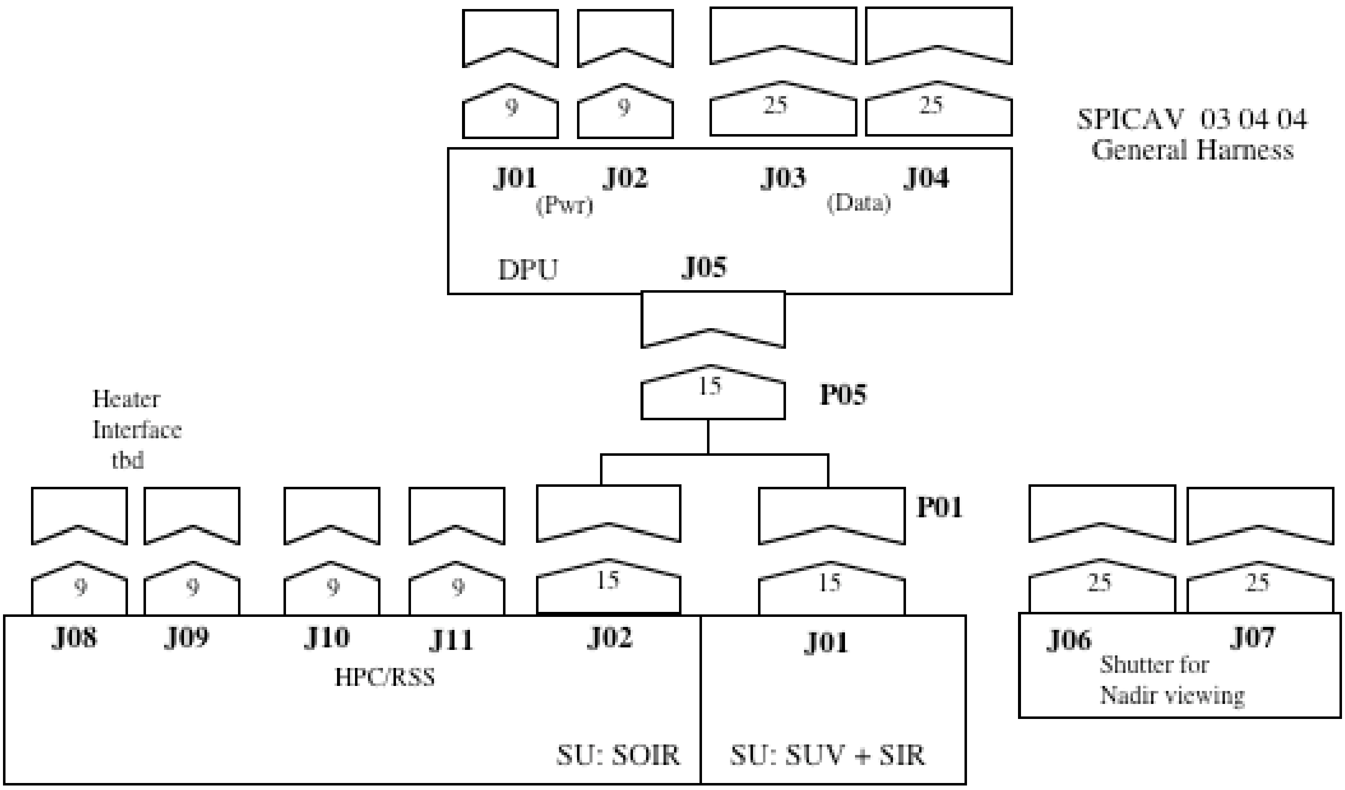
All these openings will have to be oriented towards the Sun prior to each solar occultation observation. Spacecraft holes are on +Y wall.

Below is the Spicam accomodation on Mars Express to show the different light of sight of the instrument (similar for Venus Express with another hole for SOIR).



2.3 Electrical configuration:

The interconnections between S/C, DPU and Sensor Unit are depicted below:



Spacecraft interfaces:

to DPU	Four connectors		two for TM/TC (nominal and redundant)
			two for Power (nominal and redundant)
	Latch current limiter power:		LCL class E
to shutter	Two connectors		for Power+ statuses (nominal and redundant)
	Latch current limiter power:		LCL class B
to SOIR	Four connectors		two for HPC+statuses (nominal and redundant)
			two for heaters/thermistances

Shutter interfaces :

Shutter Electrical Interfaces are only with Spacecraft. 28V is directly provided by spacecraft and the shutter is powered via relays and HPC.

Statuses are returned to spacecraft. They are not relays statuses but shutter position.

Power interfaces:

Spacecraft provides 28 V to DPU. There is no internal relays in the DPU. The power lines will feed DC/DC Interpoint modules in the two boxes (DPU and SU) of SPICAV through power lines filters. All the channels (UV, IR and SOIR) are powered via DPU.

As soon as the instrument is switched On, DPU, Servitudes and UV channels are powered.

IR channel is switched on with a parameter included in the Spicav TC.

SOIR channel is powered via relays telecommanded by S/C (HPC). Relays statuses are returned to S/C.

The sensor unit has two mechanisms in Spicam part, one for slit motion and one for SUN aperture shutter. They are activated by two motors connected to 28V.

Heater Lines:

There are 2 heater lines dedicated to SOIR (direct interfaces, Nominal and Redundant). The aim of these lines is to maintain SOIR baseplate in a defined temperature range (baseline is –5° ; 0°C) during Solar occulations with SOIR.

Values of Thermistances ("SPICAV ANC Temp1", "SPICAV ANC Temp2", "SPICAV ANC Temp3") included in SOIR are returned to Spacecraft and heaters (included in SOIR) are controlled by S/C software according to SOIR baseplate temperature.

** Extracted from DR3 - SOIR Internal heaters

Assumption (during Progress Meeting n°10) is :

- ANC1 and ANC3 are connected to RTU A
- ANC2 is connected to RTUB

- ANC1 and ANC2 are detected via Nominal SOIR Heater connector J08
- ANC3 is detected via Redundant SOIR Heater connector J09

The control will be performed using so-called "Median Selection Strategy" ie that the value of the thermistor between the 2 others is used.

In case of failure of RTU A, the control will be done via RTU B (only one thermistor).

In case of failure of RTU B, the control will be done via RTU A (with two thermistor connected).
Strategy :

- Median selection strategy is used due to Rosetta heritage (PM10).
- In case of « Median strategy », **ANC1** will be used for thermal control.

**

The control temperature can be activated or not at spacecraft level. It is not needed to have a permanent control temperature during all the phases.

TM lines:

All other TM lines (data and clock) are directed to DPU only.

There are 3 main interfaces lines identified:

- Clock line (on board time) is needed inside the instrument in order to time tag the science data. Time is needed on a basis of one information per second (external clock). It is supposed that the on board time reference can be correlated to Earth time with 0.1 s accuracy (or better 0.01 s TBC).
- TC lines: On the DPU side, the TC buffer will be a FIFO.
- TM lines: On the DPU side, the TM buffer will be a FIFO.

Conclusion : List of required signals

		Nominal	Redundant	Remarks
HPC	High Power Command	4	4	For SOIR and Shutter
MLC	Memory Load	1	1	131 Kbps (TC)
TSY	Time Synchro	1	1	
ANC	Thermistor Acquisitions	2	1	
ANS	Analog Acquisitions	0	0	
ANP	Platinum Sensors	0	0	
SDT	Serial Digital (16 bits) telemetry	1	1	131 Kps, same clock as MLC
RSS	Relay Switch Status	6	6	Only (4, 4) are useful
BLD	Bi-level Digital	0	0	
HFC	High Frequency Clock	1	1	
CK	Clock Signals	1	1	for TM and TC

Names of signals used in TM/TC:

MLC	Memory Load Command		
		MLS	Sampling Line
		MLD	Data Line
		SDT or SDC	Clock Line
SDT	Serial Digital Telemetry		
		SDS	Data Sampling
		SDD	Data line
		SDT or SDC	clock line (same as for MLC)
HFC	High Frequency Clock		
TSY	Timer Synchronization Pulse		

TM/TC redundancy selection:

TC selection (nominal or redundant) is done by:

detection of rising edge of SDS (nom or red)

then latch of corresponding SDS, MLS, MLD, SDC

This selection is done after interface circuits (in DPU/Interface board) by a FPGA Actel.

2.4. Software:

2.4.1. Software operations overview

The Spicav DPU flight software has in charge all TM/TC interfaces with the S/C (HPC and Statuses not included).

The software general concept is the following:

switch on experiment (by S/C) induces start of flight software
wait for time update and start time synchronization (before, data are not time-tagged)
wait for stop time synchronization
wait for 1 TC defining operating modes
configure instrument following TC parameters
wait for end of SOIR detector cooling (in Sun mode with SOIR)
loop
    starts polling of Spicav subsystems
    format TM
    end loop
    switch off (by S/C) is needed to terminate the loop

The current Spicav implemented rules are:
use FIFO as telemetry buffer (contains telemetry blocks),
do not change telemetry blocks generation. (FIFO is able to store TBC sec of Spicav TM blocks)
Spicav observation duration is typically between 5 mn to 30 mn.
Components are latch free.
Spicav is switched ON and OFF for each observation. This allows hard reset at each switch ON.
    -software is stored in PROM
    -at switch ON, software is transferred in RAM
    -instrument parameters are set either :
        by selection of predefined values stored in tables (in PROM and so in RAM)
        or by TC which allows to update all instrument parameters in RAM
TC are only used to select or update instrument parameters

2.4.2. Autonomy concept

The following characteristics are used in Spicav:
TC is needed to initiate observation and to get sensors data.
Software (and hence observation) is terminated by switch off.

Preliminary telecommand description:
Spicav uses packet telecommand structure
For Spicav we consider only one type of TC.
Main assumptions:
    To operate Spicav (nominal mode) only one TC packet is needed.
    If a second TC packet is sent, it is ignored.
    Length of application data of TC packet is variable
    In Spicav it is planned to use TC for
        Operational mode selection (nadir,...)
        Spicav DPU parameters (repetition rate of TM...)
        Sensor Unit parameters (Star mode, exposure time, gain...)

For another observation (other TC, others parameters), it is needed to switch off the instrument, switch on again ans sent the other TC.

All telemetry data are Science data. TM data are formatted in packets. At the beginning of observation, two (2) housekeeping packets are generated and sent to TM. We do not use event packets.

When SOIR is activated, supplementary housekeeping packets are generated every 20s during SOIR detector cooling.

Power switch off is the nominal way to terminate an observation. So, an observation is totally defined by Time start and Time end defined on ground. (The duration of observation is also defined in telecommand allowing to stop sending of science packets from detetcors and to send only Servitudes (BE) packets in order to save telemetry allocation).

For any reason, switch off can occur at any time, without need of instrument reconfiguration (done automatically at next switch on). There is no TC for what we call reconfiguration. In fact, at switch On, there is a reset of everything; solar shutter and slit are put in default position (internal shutter closed and slit On).

2.4.3. Software maintenance:

There is no in flight maintenance. The whole instrument configuration is defined by TC.
The software is totally frozen.
There is no capability to patch flight software.

With this approach,
software rely on PROM only
any event occurring during an observation has no impact on next switch ON (next observation).

2.4.4. Data delivery concept

Two Process ID = 96 and 97 are used by Spicav.

Process ID	Packet Category	Packet Type	Usage
96	12	TC	For ALL Telecommands packets
	12	time	Time update
	12	TM	Science data
	4	TM	SPICAV Housekeeping
97	4	TM	SOIR housekeeping

For each observation, there are only two SPICAV HK packets:
one after the Board Time is received
the other at the beginning of Sensor Unit sampling data

In Sun mode, when SOIR is activated, and during cooling, SOIR HK packets are sent every 20 s.

Spicav packets:
Depending on Spicav observation phase we may have:

DPU	144 octets
DPU + UV	3248 octets

DPU + UV + IR 4298 octets
DPU + UV + IR + SOIR 8256 octets

Two or more packets are assembled to form a TM block and then put in the the telemetry buffer, ready for transmission to S/C.

see Section 2.5 and Section 3 for details on Command and Data handling.

The telemetry flow is the following:

- at switch on, DPU packets are sent
- when Board Time is received, first HK packet is sent
- when Spicav TC is received :
  - in Sun mode with SOIR, SOIR HK packets are sent during cooling period
  - before detector sampling, second HK packet is sent
- either DPU+UV or DPU+UV+IR, or DPU+UV+IR+SOIR packets are sent
- until the end of observation,

2.4.5. Timing requirements

Spicav DPU uses the High frequency clock, Time Update and Pulse synchronization to maintain time accuracy.

High frequency clock is used to fill a counter. The ticks of this counter gives an internal reference. The Time Update and the Time Synchronization Pulse gives an absolute time reference which is then put in TM data.

The following concept is used: when DPU gets data from sensor, these data are time tagged and then packetized. So the time associated to each data is the time of the end of exposure duration.

(Note that before Time Synchronization, DPU/Servitudes data are not time-tagged).

2.5 Budgets:

Spicav configurations of operations:

- For all budgets the following definitions are used:
  - duration is typical for all computations.
    - Exact duration has to be computed on ground before observations
  - a same hardware configuration is used in several scientific objectives
    - resources are the same
    - only target is different

Configuration	Scientific objective	Duration	Subsystem	Comment
OFF				Instrument OFF
STAR	Star occultation Limb observation	5 mn	DPU+UV (+ IR)	from 2 to 8 mn
NADIR	Nadir observation	30 mn	DPU+SUV+SIR	
SUN	Sun occultation	16 mn	DPU+UV+IR+SOIR	

Mass budget

Copy of document SPV.NT.ME.710 Iss2

SU Spicav	13 048 gr
DPU Spicav	770 gr
DPU-SU harness	95 gr

Total Mass FM2 Spicav 13 913 gr

External baffles not included (UV baffle + IR baffle + spacers) : 470 gr

Power budget:

For more details, see section Annex 4

DPU	2.2 W
UV	15.4 W
IR	8.8 W
SOIR	25 W

Spicav Power (all channels in Sun mode) : 51.4 W

SOIR Heaters 32 W

Shutter 6 W

Energy budget:

Configuration	Power (W)	Duration (h) Typ.	Energy (Wh)	Remarks
STAR	17.6	0.1	1.8	1 observation
NADIR	26.4	0.5	13.2	1 observation
SUN	51.4	0.3	15.4	1 observation

This energy budget is for Spicav **only**, without Spacecraft effects due to dedicated attitude.

Spicav TM/TC budget:

See Section 3.3, 3.4.

Spicav has several bitrates selectable by TC. So, a same mode can be used with several bitrates. The following table gives the various science packet lengthes (for a typical observation) and the identification between the Spicav TC and the corresponding bitrate.

Rappel taille packet ESA (source = Pk-26, source max = 4096)

	Source	Spi head	Pk head	Pk
BE	128	0	16	144
UV	3078	10	16	3104
IR	1024	10	16	1050
SOIR1	1250	10	16	1276
SOIR2	2250	10	16	2276
SOIR3	3932	10	16	3958

Identification Bitrates / Modes **TMbitrate00.x4**
See also TMstat20

02 04 17 BE modes identification and bitrates

Spicam modes Identification and Bitrates:

Labels

TC Spicam	Hex configuration of TC
Database name	case sensitive, see Database in annex
pIR	sampling period of UV channel
pUV	sampling period of IR channel

	TC Spicav (First Hex)	Database Name	Spicav name	pUV (sec)	pIR (sec)	pSoir (sec)	Power (W)	Bitrate (kbps)
~~0~~	~~0xxxxxxx~~	~~Dummy TC~~	~~mini~~	~~0~~	~~0~~	~~0~~	~~16.2~~	~~1.1~~
1	1xxxxxxx	TestN	NadirMini	4	4	0	16.2	8.6
2	2xxxxxxx	TestS	StarMedi	1	1	1	16.2	66.1
~~3~~	~~3xxxxxxx~~	~~Cmde directe~~	~~mini~~	~~0~~	~~0~~	~~0~~	~~16.2~~	~~1.1~~
4	4xxxxxxx	Limb	LimbMini	2	2	0	26.4	17.2
5	5xxxxxxx	StarLimb1	StarLowi	1	0	0	17.6	26.0
6	6xxxxxxx	StarLimb2	StarMaxi	1	1	0	26.4	34.4
7	7xxxxxxx	StarLimb3	StarMedi	1	2	0	26.4	30.2
8	8xxxxxxx	Nadir1	NadirMaxi	1	1	0	26.4	34.4
9	9xxxxxxx	Nadir2	NadirMedi	2	2	0	26.4	17.2
10	Axxxxxxx	Nadir3	NadirLow	4	4	0	26.4	8.6
11	Bxxxxxxx	Align	FullFrame	1	1	0	26.4	34.4
12	Cxxxxxxx	TIprog	StarLowi	1	0	0	17.6	26.0
13	Dxxxxxxx	Sun1	SunMaxi	1	1	1	51.4	66.1
14	Exxxxxxx	Sun2	SunMedi	1	1	0	26.4	34.4
15	Fxxxxxxx	Sun3	SunLow	1	0	0	17.6	26.0

2 modes defined for MEX are not used on VEX (n°1, n°3)

Expected size of TC for each observation (**TBC**)

Modes	Length (16 bits word)	Remarks
Board Time	9	
Nominal operations Star, Sun, Nadir, Limb	8 to 72	instrument parameters : 2 to 64 (*)

(*) for ground use, TC is fixed length, hence maximum length is kept with 0 padding

Software budget:

Item		Remark
Software	25 Ko	no patch capability
Data	35 Ko	
TC	2	One Board Time TC One SPICAV TC
TM	2 types	Science packets (variable length) 2 HK packets if SOIR, 1 HK pk every 20s during cooling (typ. 10 min) TM starts at Switch ON (without TC)
TM bitrate	variable	Can be selected by TC (between 8596 to 66000 bits/sec) (1)
Initialisation		At Switch ON only
Test Mode	Yes (2)	NO external constraints

(1) see section 3.3 and 5.1 for details
(2)Test mode is a mode which can be run without any attitude constraints.

Synchronization and datation budget

Datation objective	Computation of geometrical parameters with orbit elements (ground post processing)
Datation reference	High Frequency clock Time Update and Pulse synchronization, at the beginning of each observation
Datation elements	individual spectra are dated (telemetry)
Datation tolerance	10 ms for each spectra

MXcp

Alignment budget

Subsystem	Type of alignment	Measurement tolerance	Reference system
SU	CAT 5 measured (3 axes TBC)	better than 5 arcmin	Spacecraft axis and/or Star sensor
DPU	NA		

MXcp

Pointing budget:

The following table gives the summary about "pointing".
The columns 1 and 2 are copy of PID-A section 2.7.
The summary of Spicav Req are the maximum requirements of Spicav including Star and Sun occultations.

AOCS performances	PID-A specification	Summary of Spicav Req.	Spicav compliance
Attitude knowledge w.r.t.a stellar direction	0.05°	0.05°	Full
Pointing accuracy w.r.t.a stellar direction	0.06°	max 0.1°	Full
Attitude knowledge w.r.t.the Nadir direction	0.12°	0.5°	Full
Pointing accuracy w.r.t.the Nadir direction	0.15°	1°	Full
Rate stability	0.003°/s	0.04°	Full
Rate stability over 10 s	0.005°	0.1°	Full
Pointing stability over 60 s	0.009°	0.1°	Full
On board orbit knowledge	6 km	not used	N/A
On ground orbit knowledge	< 6 km	6 km	N/A

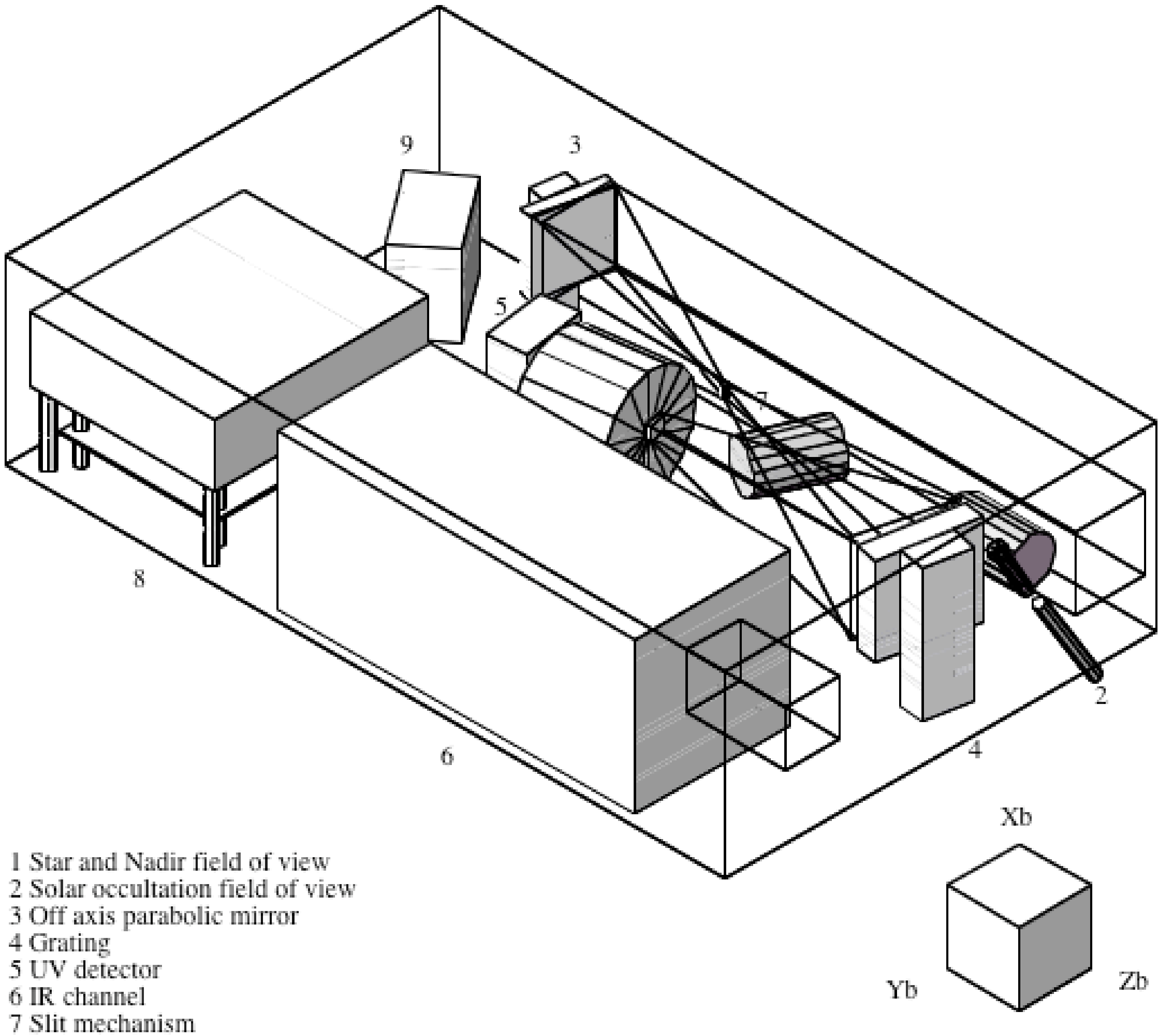
MXcp

The Spicav requirements are totally fullfilled with the AOCS performances.

3. Detailed description:

3.1 Sensor Unit:

The following drawing gives the optical layout of the Spicam part (lower stage) of the Sensor Unit.



1 Star and Nadir field of view
2 Solar occultation field of view
3 Off axis parabolic mirror
4 Grating
5 UV detector
6 IR channel
7 Slit mechanism
8 Electronics
9 HVPS

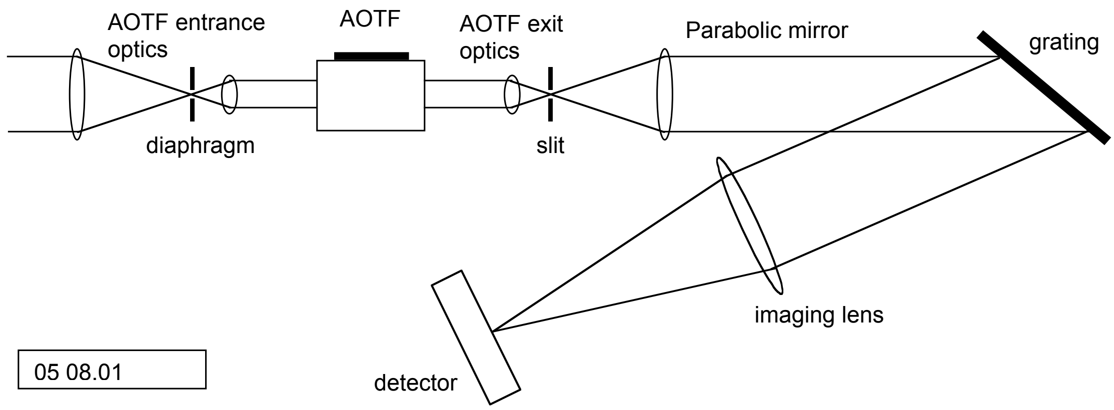
SPICAM Light Sensor Unit Overview
oct 22 1999

The Spicam part has two openings for Nadir viewing, one for UV channel, the other for IR channel. In addition, the UV and IR channels have an opening for Solar viewing (2).

Spicam part Apertures definition:

apertures Nadir face (perpendicular to Zb)	42 x 45 mm^2
	diameter 32 mm
aperture in (Yb,Xb) at 60 deg from Yb (UV and IR Sun occultation)	diameter 5 mm (TBC)

The following drawing gives the optical layout of SOIR (upper stage of the Sensor Unit).



SOIR aperture on ‘ periscope’.in (Yb,Xb) at 60 deg from Yb. Periscope includes 2 flat mirrors which are leading the light to the AOTF entrance optics.

Optical apertures summary

The Sensor Unit has 4 apertures:
- UV aperture on Nadir face.
- IR aperture on Nadir face.
- Secondary UV and IR aperture for Sun viewing
  internal mirrors and fiber bent the Solar light in the instrument main optical axis
- SOIR aperture

n°	Operational Mode	Target	Subsystem Aperture
1	Test Mode	NA	NA
2	Sun Mode	Sun	Sun Secondary UV+IR aperture and SOIR aperture
3	Star Mode	Star	UV aperture on Nadir face
4	Nadir Mode	Nadir	UV+IR apertures on Nadir face
5	Limb Mode	Limb	UV+IR apertures on Nadir face

Pointing, general assumptions:

Assume pointing is done by Spacecraft
Assume rotation of 90°, duration is around 11 mn (0.14 deg/s TBC,from MEX).

It seems that Spicav is quite demanding concerning S/C manoeuvers and resources availibility. We examine resources needed by Spicav:

- manoeuver duration: is dependant on orbit parameters, actual Spacecraft attitude and desired inertial direction (selected objective) and will be computed.
- Other resources as wheel usage and power: Wheel usage is a resource to be shared between instruments. Nadir pointing is more wheel consuming than fixed inertial attitude. Power is not a concern for Sun occultation (it drops to 0 anyway). For Star occultation, the angle around +Z axis is a free parameter and therefore can be adjusted for maximum power collection if necessary.

In the Inertial mode, pointing direction is any inertial (relative to stars) direction. This direction must be kept fixed during observation duration of 2 to 8 mn. It is defined as any star direction which may be occulted by Venus in dark side of Planet. (see operational modes for details)
In nadir mode, nominal nadir pointing (as other instruments) in bright side of Planet.

The following table gives the Experiment viewing requirements for each objective.

Objective	FOV (*) (UV)	Pointing Direction	Duration (typical)
Star (UV)	1° x 3°	Inertial STAR	2 to 8 mn
Sun (UV+IR)	slit	Inertial SUN	Cooling + 2 to 8 mn
Nadir (UV+IR)	slit	Venus (Nadir)	30 mn
Limb (UV)	slit	Inertial	2 to 8 mn

(*) Spicav fields of view:

UV channel			
	Full field of view		4 deg x 3 deg (detector)
	STAR mode	no slit	1 deg x 3 deg without vignetting
	Nadir, Limb	slit	1.3 arc min x 3 deg
	Sun	pinhole	2 arc min (tbc)
IR channel			
	Nadir		2 deg circular
	Sun	pinhole	2 arc min (tbc)
SOIR channel			
	Sun	slit	0.06 x 3 mm2, f = 375 mm 15’ x 40’’

<u>Illumination constraints</u> :
FOV avoidance 34° x 34° on Nadir side. See Section 7.3

Subsystems:
List of elements of Sensor Unit:

UV channel
- parabolic off axis mirror, focal length = 120 mm
- slit with two positions
- grating
- intensified CCD with electronics box

IR AOTF channel

SOIR channel

entrance mirror ('periscope')
AOTF for bandwith selection
slit
Parabolic mirror
echelle grating
optics+ cooled IR detector

--->Servitudes Unit:
(see Annex4 for detailed diagrams)

This block is made of two boards:
power board, which provides individual power for UV and IR
UV needs +5, +15, -15 V
IR needs +5, +12, +/-15V
Peltier cooler (UV and IR) 3.3 V
The input 28V is coming from DPU where it is filtered.
microprocessor board, this board controls:
the two mechanisms,
the IR switch on,
the high voltage level (for UV channel)
and retrieves 8 temperatures.

--->UV detector Unit:
The UV detector is made of 3 parts:
a CCD camera with the head and two electronic boards (follow on of Mars96)
an intensifier (Hamamatsu) with a 12 mm window which is coupled to the CCD by fiber optics
a programmable high voltage (Hamamatsu) for the intensifier
In the head, the CCD (TH 7863) is mounted on a one stage Peltier cooler for a delta T around 15 °C.

The two electronic boards of the CCD camera are mechanically mounted on the servitudes boards.

The CCD detector head is mounted in such a way that the columns are perpendicular to the baseplate of the Sensor Unit. The rows direction is the spectral dimension.

The UV detector records a window of 5 rows allowing to have at the same time, in Star mode, the Star spectrum surrounded by the background spectra. The rows can be elementary pixels or binned pixels (binned columns) The nominal binning is between 4 and 8. The position of the rows is programmable.

--->IR Channel Unit:
The IR channel is made of an entrance lens, an AOTF crystal which acts as a negative filter, two (Hamamatsu) double pixels detectors (two polarisations, two wavelenght ranges) with their own Peltier cooler, and an electronic board. When the AOTF is powered (at a certain frequency), it selects a wavelength which goes up to the detectors. A full spectrum is then obtained by scanning the frequencies. The measurement is obtained by the difference between the AOTF on and off.

--->SOIR Channel Unit:
The SOIR Channel is made of an entrance optics('periscope') which leads the Sunlight to the AOTF entrance optic (in plane Y,Z). When the AOTF is powered (at a certain frequency), it selects a bandwidth to be analysed by the spectrometer including a parabolic mirror and an echelle grating (selection of right order). Associating AOTF and echelle grating (4 grooves/mm) permits to have a

high reolution spectrometer. Spectra is collected, via optic lenses,by an IR detector. It is a Sofradir detector coupled with a cooler.

--->SOIR Channel Unit:
see Annex 10

3.2 DPU and flight software:

The DPU is made of 3 boards:

the power board which has 28V Interpoint filter modules for the whole instrument and provides 5V for the DPU itself (Interpoint module)

the microprocessor board, based on a 80C32 chip, with Ram, Prom, Fifos as buffer for telemetry, and counters for time maintenance.

the interface board which has an Actel FPGA RH1020 for telecommand/telemetry logic and interfaces circuits to S/C lignes.

The DPU has two connectors for data lines (one nominal and one redundant), two connectors for power lines, and one connector towards the Sensor Unit.

Hardware characteristics:

microprocessor	80C32 30 MHz	
Eprom	32 Ko	
Ram	128 Ko for 2 pages	
Fifo TC	32 x 8 Kbits	
Fifo TM	3 x 32 x 8 Kbits	(able to store 16 sec TBC of telemetry data)

Software characteristics:

Software code	26 Ko
External data	43 Ko
CPU load	< 50 %

At Switch on, software code is transferred from Prom to Ram, then it is started.

Sequencing is done at a 1 second basis (minimal period). In each second, detectors are polled at fixed times. There are 256 interrupts coming from internal timer (see further) with the following steps: **TBC**

tic	1	UV data reading
tic	75	IR data reading
tic	110	SOIR data reading
tic	145	Servitudes and TC processing
tic	185	TM processing

Date and Time logic software:

wait for receipt of Board Time TC
set interrupt TSY (TSY = pulse every 8 sec)
wait for TSY
If interrupt
save Board time
start internal timer
disable TSY (will never be used again)
Interrupt from timer gives 1/256 sec sequencing tic
Date and time values are built from timer+ Board Time

Telecommand logic software:

```
If TC fifo not empty
    wait 3 sec      (completion of TC, spec page E-IDS 7.2, t=2,2 sec)
    If TC Spicav already received
        clear fifo
    Otherwise
        read fifo
        verify length and copy in TM buffer
        read APID
            If Spicav
                read Type and Subtype
                    If 9, 1                  ( OK for Spicav Board Time)
                        Board Time processing
                        Board Time received
                    Otherwise
                        set error flag in TM
                    If 226, 1                ( OK for Spicav TC)
                        If Board Time Received
                            TC Spicav processing
                        Otherwise
                            Do nothing
                    Otherwise
                        set error flag in TM
            Otherwise
                clear Fifo
                ignore TC received
                set error flag in TM
Otherwise
    Do nothing
```

Global Software limitations:

All packets services NOT implemented.
The first TC MUST be Board Time. Only one Board Time TC is expected.
After TC Time correctly received, the TC Spicav is expected (others ignored)
Due to TC analysis duration, Time update has to stopped before sending of TC Spicav.
After TC Spicav received, all others TC ignored

Accordingly:

If no TC Board Time ---> no sampling of detectors
If no TC Spicav ---> no sampling of detectors
Each TC is related to one observation
To start another observation, Switch Off is needed for reinitialisation

3.3 Command and Data Handling:

Telemetry sampling:
Preliminary comment:
It is stated (page E-IDS-71) that:
each Packet Terminal shall not be polled more than once per sec
each PT shall be able to buffer its TM for a period of 16 sec

Summary of TM requirements and Packet description:

Spicav has several bitrates selectable by TC. So, a same mode can be used with several bitrates. The following table gives the various science packet lengthes (for a typical observation) and the identification between the Spicav TC and the corresponding bitrate.

Rappel taille packet ESA (source = Pk-26, source max = 4096)

	Source	Spi head	Pk head	Pk
BE	128	0	16	144
UV	3078	10	16	3104
IR	1024	10	16	1050
SOIR1	1250	10	16	1276
SOIR2	2250	10	16	2276
SOIR3	3932	10	16	3958

TM packet header is 16 octets
Spicav has four types of Science packet. The packet length is (Packet data + header)

Depending on Spicav observation phase we may have the combinations:

DPU	144 octets
DPU + UV or	3248 octets
DPU + UV+ IR	4298 octets
DPU + UV+ IR + SOIR	8256 octets

Spicav data production rate:

Spicav data are made of successive spectra. The rate of spectra recording is 1 sec .Assuming the worst case, data production rate is

(144+3104+1050+3958) = 8256 octets per second

-----> Spicav maximum AVERAGE bit rate is 66048 bps

Spicav has three nominal modes which are NADIR ,STAR or SUN mode:

NADIR mode: DPU+SU+IR. In this mode, the average bit rate is 34384 bps. We are in case where there are constraints on the actual active instruments.

STAR mode: DPU+SU. In this mode, the typical data sampling frequency is one per 1 sec. The average bit rate is (144+3104)*8 = 25984 bps. We are in case where there are constraints on the actual active instruments.

SUN mode: DPU+SU. In this mode, the typical data sampling frequency is one per 1 sec. The average bit rate is (144+3104+1050+3958)*8 = 66048 bps. We are in case where there are constraints on the actual active instruments.

---> All instruments cannot work together with Spicav at their maximum data rate without data loss. The good point is that in the STAR or SUN mode, there is a dedicated attitude (which is not Nadir) and so it is not foreseen that there are many other instruments active at this time.

To avoid problems observed during tests, a DMS software modification has been implemented. It consists in polling Spicav twice consicutively in order to increase the average polling frequency. There is no problem to do it without waiting any delay (in particular, there is no wait for the currently nominal 125 ms delay between tow polling tasks. The loading of the data block in the FIFO is done such as the delay between the writing of 2 consecutive words of a same data block is always significantly lower than 122 µs (the current Spicav writing delay is 57 µs).

Buffer size:

The Spicav TM buffer size depends only on the data production. The TM buffer is made of FIFO whose size will be 768 kbits .

Spicav TM block:

In all operating modes, Spicav will provide a TM block corresponding to data produced every second..

Maximum TM block length (words of 16 bits)

StarLim	2149
Nadir	2149
Limb	2149
Sun	4128

To avoid data loss, Spicav experiment needs to be polled every second

TM block building:

<u>Sortie des packets:</u>

Conformément à la spécification ESA, la sortie des packets se fait par l'intermédiaire d'un bloc TM précédé du nombre(16 bits) de mots du bloc qui peut comporter plusieurs packets.

On choisit:

de demander un prélèvement toutes les secondes

de grouper les packets et les sortir toutes les secondes (à cause du débit TM)

Toutes les 1 sec, les packets (s'il y en a) sont regroupés afin de faire un block TM (dans la fifo) qui est lu par le S/C. Vu de l'extérieur (simulateur sol), on voit la TM arriver toutes les 1 sec.

Le nombre de packets par block TM peut varier de:

1 pk	BE seul, toutes les secondes
4 pk	BE+UV+IR+SOIR toutes les sec

```
count = 0
Every Timestep loop
                    (Timestep is 1 for STAR and 4 for Nadir)
    increment count
    get, compress, generate and store UV packet (PUV1 or PUV2)
    get, compress, generate and store IR packet (PIR1 or PIR2)
    get, generate and store servitudes and DPU packet (PPU1 or PPU2)
    If count = 1 Then
        count = 0
        If FIFO TM full then
                    ( very abnormal situation )
                    ( try to recover even with loss of data )
                    empty FIFO TM
        generate TM block = PUV1+PIR1+PPU1 + PUV2+PIR2+PPU2
        put length + TM block in FIFO TM
    endif
end loop
```

Conclusion:

Our TM system delivers TM blocks of one measurement. Therefore, our FIFO can be emptied by polling sequence (if combination of experiment data rates allows it) faster than it is fed by the instrument.

3.4 Summary of bitrates:

For each operating mode, we have the capability to change the averaged bitrate by adjustment of the sampling period of the sub units, for example from 1 to 4 seconds (at the cost of reduced spatial resolution). This capability can be defined as sub mode or "mode BE". It is useful for Nadir observations, but it can be used in other modes.

The sampling period is defined in the Spicav TC, the first 4 bits of the Spicav TC, between 0 and 15 and named as "mode BE", with corresponding labels

The following table gives the bitrates according to the sampling period of the Spicav sub units:

Identification Bitrates / Modes **TMbitrate00.x4**
See also TMstat20

02 04 17 BE modes identification and bitrates

Spicam modes Identification and Bitrates:

Labels

TC Spicam	Hex configuration of TC
Database name	case sensitive, see Database in annex
pIR	sampling period of UV channel
pUV	sampling period of IR channel

	TC Spicav	Database Name	Spicav name	pUV	pIR	pSoir	Power	Bitrate
	(First Hex)			(sec)	(sec)	(sec)	(W)	(kbps)
~~0~~	~~0xxxxxxx~~	~~Dummy TC~~	~~mini~~	~~0~~	~~0~~	~~0~~	~~16.2~~	~~1.1~~
1	1xxxxxxx	TestN	NadirMini	4	4	0	16.2	8.6
2	2xxxxxxx	TestS	StarMedi	1	1	1	16.2	66.1
~~3~~	~~3xxxxxxx~~	~~Cmde directe~~	~~mini~~	~~0~~	~~0~~	~~0~~	~~16.2~~	~~1.1~~
4	4xxxxxxx	Limb	LimbMini	2	2	0	26.4	17.2
5	5xxxxxxx	StarLimb1	StarLowi	1	0	0	17.6	26.0
6	6xxxxxxx	StarLimb2	StarMaxi	1	1	0	26.4	34.4
7	7xxxxxxx	StarLimb3	StarMedi	1	2	0	26.4	30.2
8	8xxxxxxx	Nadir1	NadirMaxi	1	1	0	26.4	34.4
9	9xxxxxxx	Nadir2	NadirMedi	2	2	0	26.4	17.2
10	Axxxxxxx	Nadir3	NadirLow	4	4	0	26.4	8.6
11	Bxxxxxxx	Align	FullFrame	1	1	0	26.4	34.4
12	Cxxxxxxx	TIprog	StarLowi	1	0	0	17.6	26.0
13	Dxxxxxxx	Sun1	SunMaxi	1	1	1	51.4	66.1
14	Exxxxxxx	Sun2	SunMedi	1	1	0	26.4	34.4
15	Fxxxxxxx	Sun3	SunLow	1	0	0	17.6	26.0

2 modes defined for MEX are not used on VEX (n°1, n°3)

see paragraph 5.1 for details bitrates

4. Instrument Operations:

4.1. Overview of Operating principles

The following paragraph describes the operating principle for SPICAV observation:
- Put Spacecraft in good attitude for one kind of observation
- Switch On by S/C
- Send observation TC by S/C
- Record TM by S/C
- Switch Off by S/C at the end of observation.
- Put Spacecraft in nominal attitude

Summary of operational constraints: see Section 7.3

There is no default observation scenario for SPICAV (TC Spicav is always needed).

		Duration (typical)	Number /orbit	Conditions	Comments
1	Stellar occultation	5 mn	<=4	Star set Dark side of Venus Spacecraft (Nadir side) oriented towards star	11 12 13
2	Solar occultation	5 mn	1	Sunset and/or Sunrise Spacecraft (solar entrance) oriented towards Sun	21 22
3	Nadir	30 mn	1	Bright side of Venus Spacecraft (Nadir side) oriented towards Nadir	31
4	Limb emissions	5 mn	<=1	Venus bright Limb Spacecraft (Nadir side) oriented towards Limb	 41

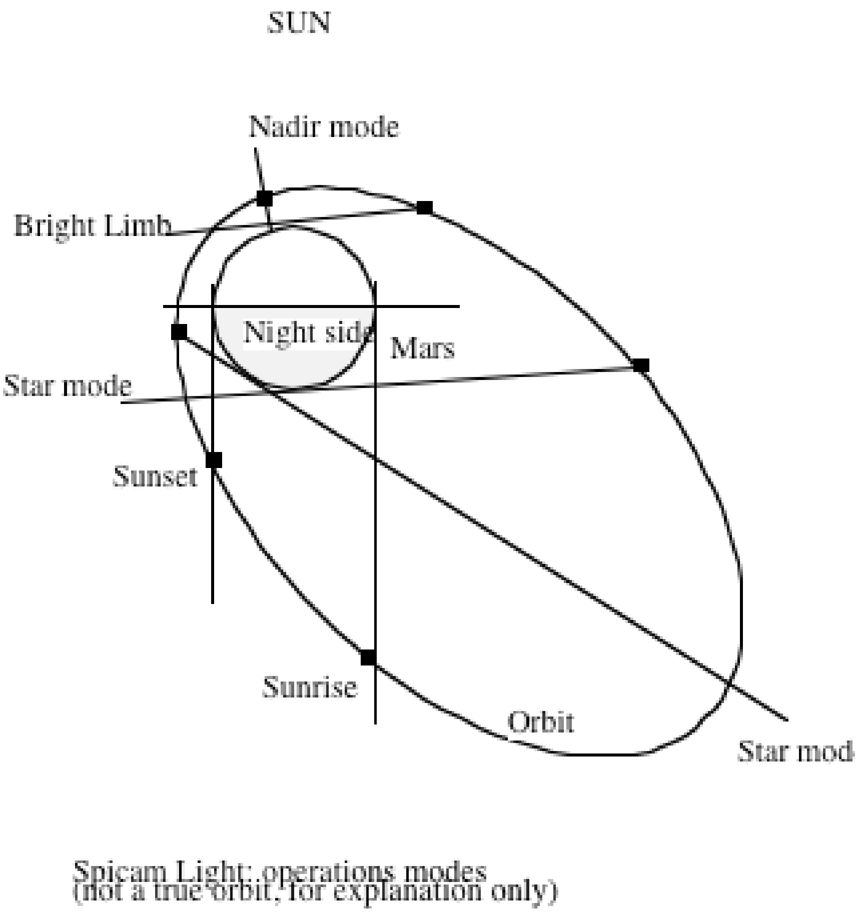
Comments:

11. Occultation time must be computed prior to observation
Duration of occultation is computed prior to observation
(depending on the geometry of occultation versus local horizon, vertical or not)
Observation (sampling) starts 60 sec min before the occultation (target at 200 km tbc of altitude)
Observation (sampling) stops 30 sec min after the end of occultation (disparition of target behind Venus).
Service d'Aéronomie will provide Star catalog (about 40 stars) see Annex6
Star catalog is fixed and defined well in advance.
No update is foreseen, at the present time, during the mission.
Targets are defined by α, β, (J2000), format to be agreed.

Latitude and longitude coverage is provided by selection of star
12. A few occultations on bright side of Venus are possible
13. Only Spacecraft attitude is required
Spacecraft position along the orbit is indifferent
Line of sight is defined by Spacecraft position (NOT attitude) and star direction
Vertical resolution depends only on sampling of detectors
Measurements (spectra) are done every second. During one second, the effective exposure
time depends on the brightness of the star occulted and can be adjusted by TC.
21. We suppose that Sun occultation exists
(occultation through a special aperture, not on Nadir face)
~~Sun occultations are described in the Orbit Analysis document (M. Hechler))~~
All occultations are potentially good for science investigation (latitude coverage)
Sunset and sunrise are independant
Experiment is off during eclipse (TBC according of eclipse duration)
Observation (sampling) starts 60 sec min before the occultation/de-occultation
Latitude and longitude depends on geometry of Sun occultation
22. Vertical resolution of concentration profile depends on the altitude of the Spacecraft
Lower altitude gives better vertical resolution
31. Same attitude as all others Nadir experiments
Latitude and longitude coverage is done by satellite track
41. Lower altitude of the Spacecraft gives better vertical resolution

4.2. Nominal Operations Plan

The following diagram shows a possible orbit with SPICAV operational capability.
The only purpose of this diagram (from MEX, available for VEX) is explanation.



Squares are Venus Express positions.

Timing and commands for all SPICAV modes are described in the following table :

Time	Commande	TM
T0- yy	HPC SOIR Off	Reset, yy= 5s (if SOIR, yy = 10s)
T0-xx	HPC Soir ON	IF SOIR, xx= 5s
T0	LCL SPICAV ON	 TM BE not synchronised …
T0 + 25	Time Update	Copy TC (TB) HK1 TM BE synchronized …
T0+45	Stop Time Update	
T0 + 60	TC Spicav	Copy TC Spicav HKSOIR every 20s if SOIR TM BE HK2
T1 = T0+60 + cooling duration		TM BE TM UV TM IR TM SO si SOIR

		(if no SOIR, cooling duration = 0)
T1 + observation duration	LCL SPICAV OFF HPC SOIR OFF	If SOIR

T1 is the duration before science data are produced by sub units. Between T0 and T1, Only data from DPU are produced. The data rate is 1.1 kbps. This is useful for "precise" TM volume computation.

The number of observations during one orbit depends only on the resources available at the time of observation. Most of time, during occultations, no other instrument (TBC) is working (except Aspera which would benefit of this type of observation). Recommendation is to have one Nadir and one inertial attitude for each orbit.

For one observation, the following table shows the distribution of functions for nominal flight operations:

Source	Action	Destination
On Ground	Operations preparation	
spacecraft	Send HPC SOIR On (if SOIR)	SOIR
spacecraft	Switch On	DPU
spacecraft	Send Time, Stop Time	DPU
spacecraft	Send TC	DPU
Sensor Unit	Science data	DPU
DPU	Send TM	spacecraft
spacecraft	Switch Off	DPU
spacecraft	Send HPC SOIR Off (if SOIR)	SOIR
On Ground	TM processing	

Shutter Operations

Due to geometry and specific attitudes during the mission, it is possible than the SUN is directed to the UV and IR apertures (SC +Z axis). It mainly happens during Earth communication phase at specific time during the mission (see DA4, Mission Guideline, Iss2.1 dated 12/12/03).

Other occurrences : TBD.

Then, the UV and IR apertures have been equipped with a shutter defined according DA4 (no shutter on MEX). This one is operated directly by the S/C, and has no elecrical interfaces with Spicav DPU or Spicav Sensor Unit. It is totally independant.

The nominal position of the shutter is always OPEN.

The shutter has to be closed ONLY when the +Z side is illuminated (closed before illumination and opened after illumination). According to Illumination constraints (see Section 7.3), check has to be done by Flight Dynamics team.

4.2.1. Ground operations plan:

The following paragraphs describe all the actions which are needed for operations of Spicav :

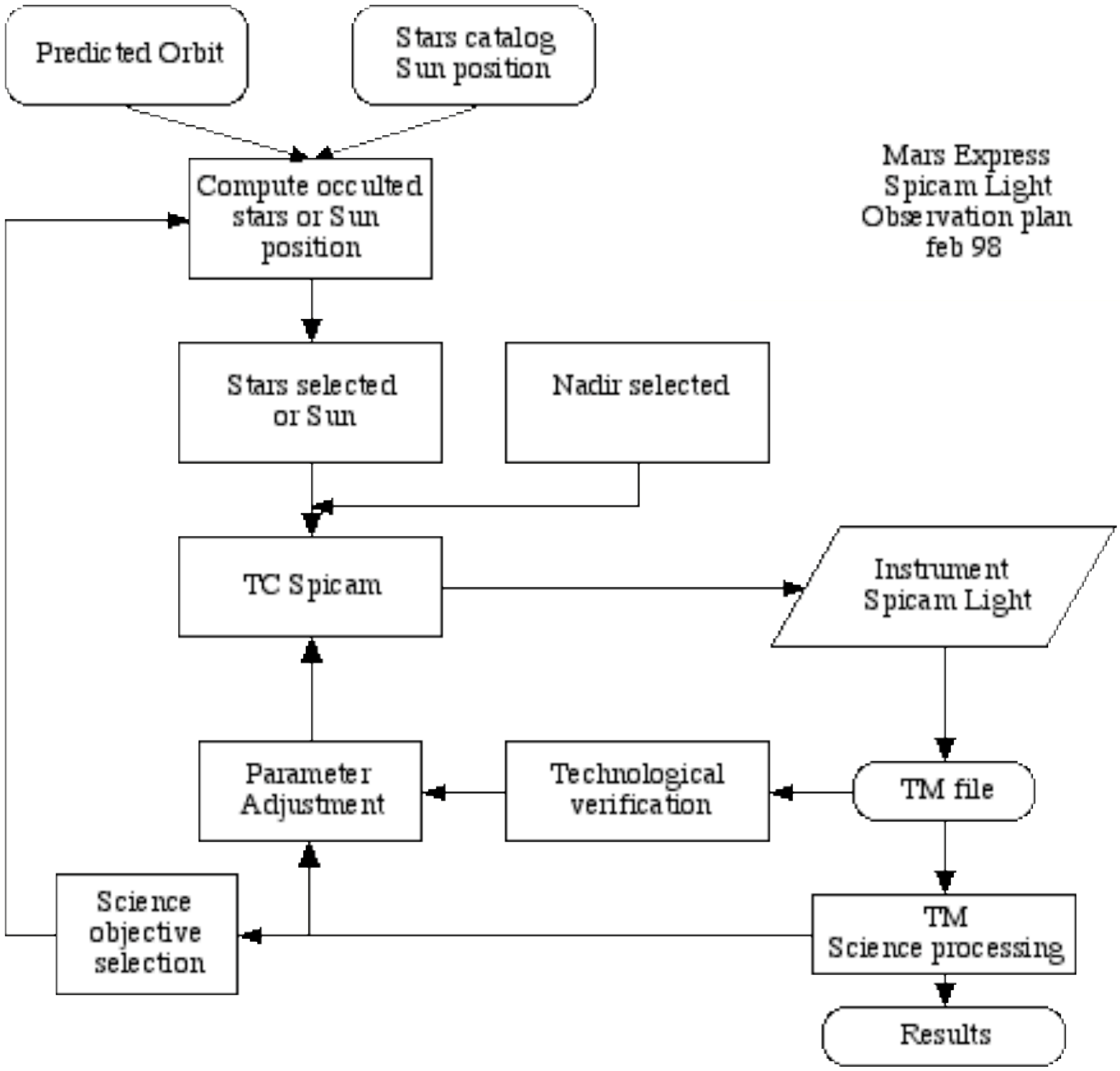
(see annex9 for Spicav activities)

We propose the following phases:

Data Needed	Actions	Actioner	Remarks
<u>Pre-mission</u>			
Targets	Star catalog	SA	
<u>Communication Phase / other</u>			
Sun Illumination	Check Illumination	ESOC	
	Shutter action if needed	ESOC	
<u>Mission, every month</u>			
Orbit data	Compute predicts	ESOC	
Occulted targets	Compute attitude	ESOC	In parallel at SA
Selected Stars	Choice by Science team	SA	
Attitude parameters	Elaboration	ESOC	verification by SA
TC Spicav	Elaboration	SA	

SA = Service d'Aéronomie

Spicav Observations: Operations functional diagram



This diagram reflects the Spicav operations (from MEX, available for VEX). Interfaces during commissioning and routine phases will be described later.

Our minimal requirements in different phases are described in the following paragraphs.

4.2.2. Near Earth Verification phase (NEV)

Reference Document = VEX-ESC-PL-5000, Iss1, dated 06/12/2004

2 Phases : SPICAV Commissioning and Pointing Scenario/Multiple Instruments.

SPICAV Commissioning.
Objectives: SPICAV Switch ON and health check
Constraints:

SPICAV First Switch ON in EV phase has to be in the later part of EV phase activities to allow instrument degassing.
No required attitude

For more details, see SPICAV NECP1 plan ref SPV-NT-NECP-FS-01 (timing to be updated).
Spicav activities are :

1 – SPICAV TestS Mode
2 - Wait xx min at least
3 – SPICAV Sun Mode test (SOIR baseplate thermal control activation : TBC)
4 – Wait xx min at least
5 – Activity Spicav Shutter **TBC**
6 – Wait xx min at least
7 - SPICAV Short Performance Test. **TBC**
8 – Wait xx min at least
7 – Activity Spicav Shutter (to come back to the initial position) **TBC**

During the Launch, the shutter is closed because Sun is illuminated the +Z face a few days after launch (see DA4). According to illumination constraints, the shutter will be open or not.

Pointing Scenario/Multiple Instruments.
Objectives: SPICAV Switch ON with pointing (alignment check)
Constraints: required attitude

For more details, see document ref SPV-OPS-100
Three slots are required.

Slot1 :
1 star observation with star in FOV (shutter open)
1 star observation without star in FOV (shutter open)
Solar observation : 3 X 3 different inertial pointings.

Slot 2 : same as slot1

Slot 3 : 1 Solar observation (could be postponed during the cruise)

Participation to the straylight operations required by VIRTIS (TBC)

For Solar observations, SOIR baseplate thermal control has to be activated xx hours before.

4.2.3. Interplanetary Cruise phase (IC):

In order to avoid any possible failure due to no motion of mechanisms during the long cruise phase of the mission, SPICAV team requested activation of SPICAV and execution of Test Mode once every month. In this mode, the two internal mechanisms are activated three times each.
In the same time, we require to run StarAlign, Nadir and Sun mode.
General conditions:
no attitude required
duration is 5 mn each, Sun 16min Total 30 mn

support by PI if required by ESOC

Pointing phase (January 2006 TBC)
Complementary slots to Pointing Scenario/Multiple Instruments during NECP.
Star observation with Star in FOV (shutter open)

During IC phase, the SOIR baseplate thermal control is not activated, except during the Solar observations (to be activated xx hours before).

End of IC phase: (pre-Venus Orbit Insertion)
The payload instrument checks at the end of Interplanetary Cruise (IC) phase is limited to instrument Switch ON and minimal health checks only. Test Mode will be used.

4.2.4. Venus Commissioning phase (MC)

initial proposal, dated Feb 2004 : to be reviewed.

Objectives:
In flight, there is no specific mode for calibration and the baseline operational modes are used. Observation can be done even if there is no occultation of star or Sun. The main purpose of observation during commissioning is to verify and adjust a few instrument parameters as exposure time, gain...
The following actions will be done in flight:
- verification of main performances characteristics
- adjustment of parameters as exposure time
- verification of alignment

Constraints:
Dedicated Spacecraft attitude is needed.
Total time: around 1 hour (TBC) (with maneuvers) for each observation
All sequences are purely repetitive, off-line and remotely executed (as nominal ops).

The SPICAV requirements for the Venus Commissioning phase are as under:
- Nadir Observation: 2 orbits of observation.
- Limb Observation: Bright and Dark limb with 2 orbits of observation for each.
- Star Observation:
  - a. Optics Alignment check: 1 orbit of observation
  - b. Star Occultation: 2 orbits of observation
- Sun Occultation: 2 orbits of observation

In all the cases requiring two orbits of observation there should be enough spacing between the two orbits to enable performance evaluation and consequent fine adjustment of instrument parameters (if any).

Note: It is envisaged that from the spacecraft operations point of view the minimum gap will be 1 to 2 days between such commissioning phase test observations. The actual gap will depend upon the time required by the SPICAV team to analyze the data and to plan next step in SPICAV commissioning activity.

4.2.5. Flight operations plan by mission phase

TBD
Will be completed when Mission Planning will be issued.

For Spicav, the following strategy rules are applied in order to maximize the Sicence return:
- use of Instrument bitrate flexibility
  - for Nadir mode with low bitrate (8.6 kb/s), Spicav can always be operated.
- use of target opportunity
  - for Star mode, selection of target out of Pericenter/Nadir phase

4.3. Failure Detection and Recovery Strategy:

Instrument is switched On and Off (and so totally resetted) for each observation.
Failure detection is done through telemetry.
As observation time for occultation is short (a few minutes), there is no in flight recovery procedure and in case of SW or HW problem, ground analysis of problem is required.

In case of failure, the following rules will be applied (following TM analysis):

--> TM present but degraded performances
PI analysis of problem

--> No TM
- use Spicav TC "TestN" — NO constraints
  - If OK — continue nominal operations plan
  - If No TM
    - Switch to Power redundant lines
    - use Spicav TC
      - If OK — continue nominal operations plan
      - If No TM
        - Switch to Data redundant lines
        - use Spicav TC
        - If OK — continue nominal operations plan
        - If No TM — main failure

Mechanisms Failure Scenario:

The two possible failure scenarios of the mechanisms are the openings either permanently closed or open.
(a) If the openings are permanently closed no observation is possible in that particular viewing mode.
(b) If openings are permanently in Open state observation is feasible. The Sun occultation experiment can be switched on at any time and there is no constraint in activating the Sun occultation observation mode.

4.4. Routine operations:

As Spicav bitrates are mode dependant (see paragraph 3.4), the POR (payload operations request) will include data rate and data profile requirements, in addition to other informations as TC Spicav...

5. Modes description:

5.1. Summary of nominal modes:

Mode definitions:

Definitions of mode:
a mode is defined if one of the following conditions occurs:
change in demand on S/C resources (power...)
specific S/C operational status (pointing)
functionnaly distinct operating mode of instrument

Experiment Mode	Power Usage (W)	Data rate (Kbits/s) max	Functional use
Test	17.6	26.0	ground use
Sun	51.4	66.1	Science, occultation
Star	17.6	26.0	Science, occultation
Limb	26.4	34.4	Science, Bright limb
Nadir	26.4	34.4	Science, Nadir

~~(*) Data rate is not constant , this value is averaged see section 3.4~~

For Spicav, observations modes are a combination of
Experiment mode (which subsystem)
Spacecraft attitude (which target)
Spacecraft position (Venus viewing)

There are 5 operational modes defined for Spicav (all modes use DPU).

n°	Operational Mode	Target	Subsystem	Spacecraft attitude	Duration
1	Test Mode	NA	-	NA	2 to 8 mn
2	Sun Mode	Sun	UV (+IR+SOIR)	Inertial Sun	2 to 8 mn(*)
3	Star Mode	Star	UV	Inertial Star	2 to 8 mn
4	Nadir Mode	Nadir	UV (+IR)	Nadir attitude	30 mn typ.
5	Limb Mode	Limb	UV (+IR)	Inertial	2 to 8 mn

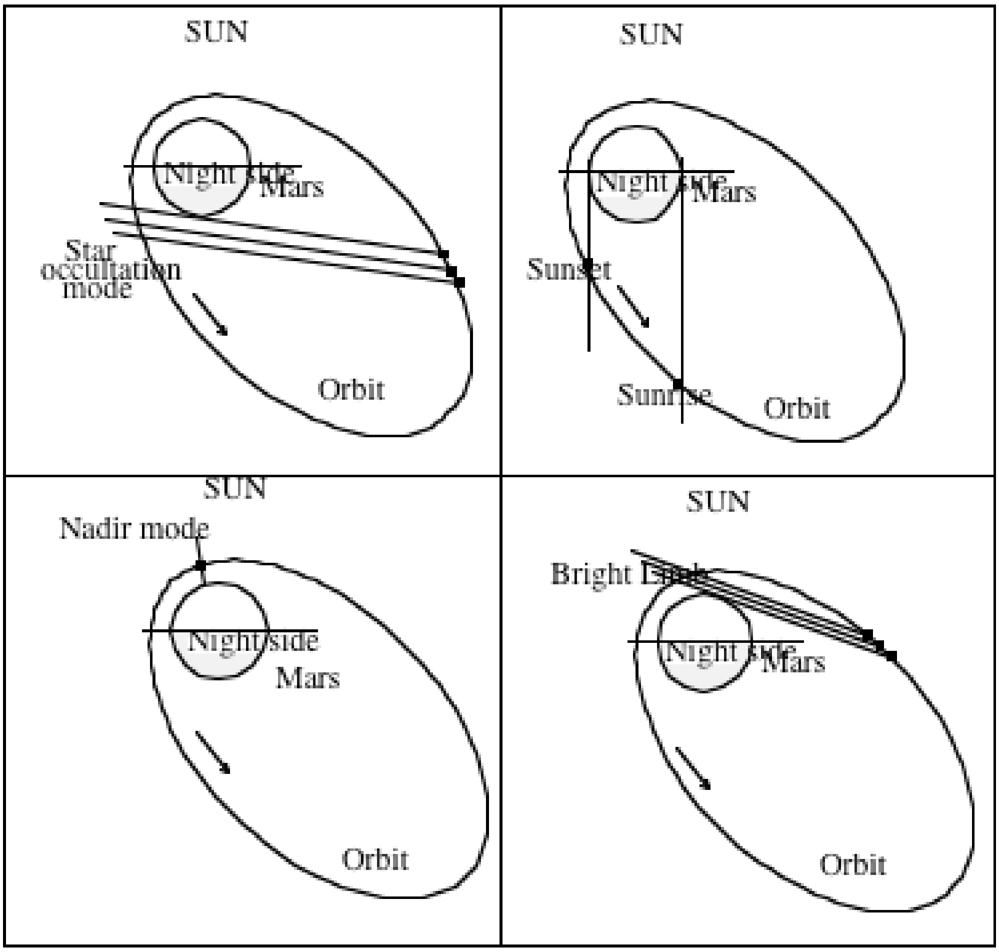
(*) Spicav needs to be switched on 11 mn before for SOIR detector cooling. The time indicated in the table is the time of high rate scinece

The sequencing of all modes are identical see section 2.4.1

In addition of the mode previously defined, Spicav has several bitrates selectable by TC. So, a same mode can be used with several bitrates.

See TM/TC budgets in section 2.5

Exemples of Spicav operations modes:



Spicam Light: operation modes
(not a true orbit, for explanation purpose only)

For star occultation, the distance to the Venus surface is not a relevant parameter. The star is a ponctual source, and the line of sight is only defined by Star and S/C positions.

For Limb observation (secondary objective), attitude is inertial, and the distance to Venus is a relevant parameter. Strategy is flexible and may accomodate other S/C constraints.

The distance to Venus impact is also valid for Sun mode.

The following table gives preliminary values concerning preferred distances in order to get maximum spatial resolution.

Mode	Min distance	Max distance	Remark
Star	NA	NA	
Limb	200	3000	km
Sun	200	*	km

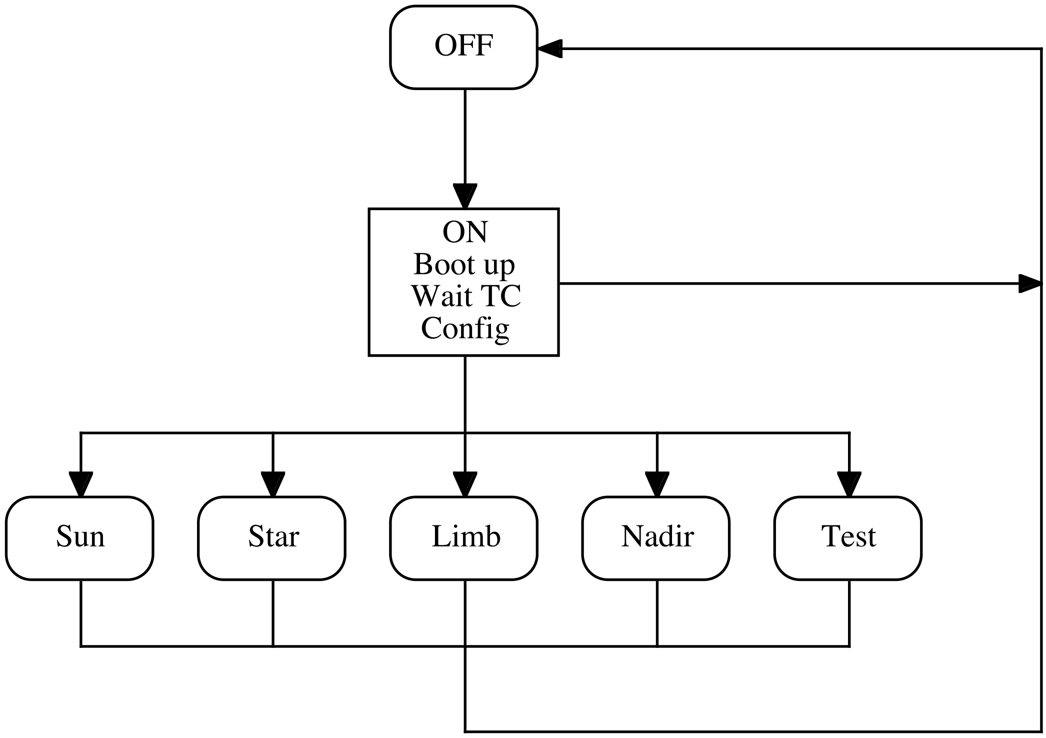
To be updated for venus mission

(*) Distance is defined by geometry, no choice possible

During flight, and for occultations, there is no specific calibration mode.

1. Experiment does not need any specific calibration because measurement is "absolute", i.e. comparison between spectra inside and outside atmosphere is instrument independent.
2. To verify experiment performances, the previous nominal operational modes will be used. The only difference is that during these specific observations, there is no occultation foreseen.

5.2. Mode transition diagram:



5.3. Detailed modes description:

5.3.1. Test mode:

In this mode, there is no sampling of detectors, and Science data are simulated. TM/TC functional performance is totally nominal.

There is no attitude constraints to run this mode.

5.3.2. Star occultation mode

Star Occultation mode (UV channel): StarLimb1 mode

In order to operate Spicav with sensor UV in occultation mode, the following assumptions hold:

- no on board ephemeris, i.e. operations are planned on Earth ground
- several potential targets (about 50 to 70 stars) see paragraphe 4.1
- star occultation computation (ESOC, SA)
- dedicated spacecraft attitude for Star occultation

5.3.3. Sun occultation mode:

SUN (UV, IR, and SOIR channels): SOIR is only working in mode SUN1

Three things are needed:

- Solar occultation time, computed from orbit characteristics (ESOC, SA)

Spacecraft dedicated attitude
Internal configuration of the instrument (exposure time...)

5.3.4. Limb mode:

Bright limb observations : Limb, StarLimb2, StarLimb3
Computation of direction and S/C attitude is done on ground (as for STAR mode).
The spacecraft Nadir face is oriented (inertial) towards bright limb of Venus (as a virtual star).
Scan altitude is provided by orbital motion.

5.3.5. Nadir mode:

Nadir observations Sensor Unit (UV and IR detectors):
There are no special constraints.
The instrument is operated (ON, OFF) during Spacecraft Nadir Mode (day side).
Bitrate can be selected (low, medium or high).

6. Interfaces:

Summary of Spicav interfaces:

Power demand is mode dependant (from 16 to 52 W).

Alignment can be verified in flight.

There is no on board control or monitoring of instrument parameters.
But ANC signals are used to control temperature of baseplate SOIR by powering or not heater lines.
Baseplate of SOIR is connected to external radiator by a thermal strap. The Sensor Unit is covered by MLI and is thermally individually controlled.

TM/TC:
TM and TC interface with the spacecraft only concern the DPU of Spicav .
One TM channel and one TC channel are required.
All telemetry informations (science and associated housekeeping) are sent through the TM channel. Telemetry data will be time tagged and formatted by the DPU into packets according to standards defined for the mission. Inside packets, data can be sorted by means of identification (, Servitudes, sensor UV, sensor IR or sensor SOIR).
Once the DPU is switched on, while waiting for a TC it will send back a few telemetry packets. After TC reception, the DPU will select the mode of operations and hence sensor UV or IR or SOIR, and will return telemetry to the spacecraft. This process continues until the DPU is switched off.
The TC received by DPU has two fields:

mode selection	mandatory
instrument parameters	optional

Science Data:
As already explained all telemetry information is considered as science data.
In the DPU, upon TC selection, several parameters can be used in order to adjust the total volume of telemetry (mainly for Nadir observations). As an example the following features are be implemented:

-change of the rate of science data sampling from sensor: minimum time between science measurements is 1 sec, it can be increased until 15 sec.

~~-the DPU has the capability to just add successive spectra before sending them to telemetry.~~

7. Nominal and Contingency Operations procedures:

7.1. On-board control procedures:

None (TBC)

7.2. Flight control procedures:

Status on 01 Aug 2005 after SVT1c.

List of Nominal Procedure/TC Sequence List Applicable to SPICAV

Italis : to be checked

Dubois					**EsocProclist02V**						
				T1, T2	ON OFF times						
File	**Label**	~~**Mira mode**~~	**Prefixe**	**Duration**	**FCP Title**	LCL A	LCL B	data	**Pwr**	**Kbps**	**Spicav Comments**
SI-FCP-001	ASIF001A	*PREO*		50 s (*)	Nominal Switch ON	16-N/R			*16.2*	*1.2*	1 st proc (other than FCP-061)
SI-FCP-002	ASIF002A	*PREO*		55 s (*)	Nominal Switch-On with SOIR	16-N/R			*16.2*	*1.2*	1 st proc with FCP-061
SI-FCP-003	ASIF003A	*PREO*		15 s	Nominal Shutter On	26 -N/R			*16.2*	*1.2*	
SI-FCP-006	ASIF006A	*N/A*		10 s	Nominal Switch OFF	16-N/R					Must follow Obs procedure
SI-FCP-007	ASIF007A	*PREO*		15 s	Nominal Switch-Off with SOIR	16-N/R			*16.2*	*1.2*	Must follow SOIR Obs procedure
SI-FCP-008	ASIF008A	*PREO*		10 s	Nominal Shutter Off	26 -N/R			*16.2*	*1.2*	Must follow Shutter On (deltat:125s)
SI-FCP-050	ASIF050A	*TESTN*	1	T1, T2	*Spicav Test Nadir Mini Mode*				*16.2*	*8.6*	
SI-FCP-051	ASIF051A	*TESTS*	2	T1, T2	*Spicav Test Star Medi Mode*				*16.2*	*66.1*	
SI-FCP-052	ASIF052A	*LIMB*	4	T1, T2	*Spicav Limb Mini Observation*				*26.4*	*17.2*	
SI-FCP-053	ASIF053A	*STARLIMB1*	5	T1, T2	*Spicav StarLimb1 low Observation*				*17.6*	*26.0*	
SI-FCP-054	ASIF054A	*STARLIMB2*	6	T1, T2	*Spicav StarLimb2 maxi Observation*				*26.4*	*34.4*	
SI-FCP-055	ASIF055A	*STARLIMB3*	7	T1, T2	*Spicav StarLimb3 medi Observation*				*26.4*	*30.2*	
SI-FCP-056	ASIF056A	*NADIR1*	8	T1, T2	*Spicav Nadir 1 maxi Observation*				*26.4*	*34.4*	
SI-FCP-057	ASIF057A	*NADIR2*	9	T1, T2	*Spicav Nadir 2 medi Observation*				*26.4*	*17.2*	
SI-FCP-058	ASIF058A	*NADIR3*	A	T1, T2	*Spicav Nadir 3 mini Observation*				*26.4*	*8.6*	
SI-FCP-059	ASIF059A	*ALIGN*	B	T1, T2	*Spicav Full frame of CCD*				*26.4*	*34.4*	
SI-FCP-060	ASIF060A	*TIPROG*	C	T1, T2	*Spicav program star low mode*				*17.6*	*26.0*	
SI-FCP-061	ASIF061A	*SUN1*	D	T1, T2	*Spicav Sun 1 maxi Observation*				*51.4*	*66.1*	to be used with FCP-002 and FCP-007
SI-FCP-062	ASIF062A	*SUN2*	E	T1, T2	*Spicav Sun 2 medi Observation*				*26.4*	*34.4*	
SI-FCP-063	ASIF063A	*SUN3*	F	T1, T2	*Spicav Sun 3 low Observation*				*17.6*	*26.0*	
				* Duration On: 60s (including 15s at end) + Obs+5s							

Additional Procedures

Extracted from ESOCProclist02V.xls

File	**Label**	**FCP Title**	data	**Spicav Comments**
SI-FCP-064	ASIF064A	Spicav Switch ON and Run in Test Mode		to be deleted TBC (mailJPD 16.06.05:17.44)
SI-FCP-065	ASIF065A	Spicav Switch ON and Run Test Observation		to be deleted TBC (mailJPD 16.06.05:17.44)
SI-FCP-075	ASIF075A	Spicav selection of Nominal TM/TC branch	N	
SI-FCP-076	ASIF076A	Spicav Time Update		to be deleted TBC (mailJPD 16.06.05:17.44)
SI-FCP-095	ASIF095A	SSMM/DMS config for Spicav		??

Sequence of FCP for an operationg mode

One observation includes, at least, 3 FCP :

FCP Switch On

FCP Observation mode

FCP Switch Off

In Sun mode with SOIR, the sequence is :

overall delta time	block delta time	duration proc	procedure	Description	procedure
00.00.00	00.00.00	00.00.55	SI-FCP-002	SPICAV Nominal Switch ON with SOIR	SI-CRP-507
00.01.10	00.01.10	00.15.00 typ.	SI-FCP-061	SPICAV Sun1 Observation	SI-FCP-061
00.16.10	00.15.00	00.00.15	SI-FCP-007	SPICAV Nominal Switch OFF with SOIR	SI-CRP-526

Extracted from ESOCProclist02V.xls

For all other observation modes (xx= 50 to 60, + 62,63), the sequence will be :

Extracted from ESOCProclist02V.xls

overall delta time	block delta time	duration proc	procedure	Description	Red proc.
00.00.00	00.00.00	00.00.50	SI-FCP-001	SPICAV Nominal Switch ON	SI-CRP-506
00.01.05	00.01.05	00.05.00 typ.	SI-FCP-xxx	SPICAV Observation	SI-FCP-xxx
00.06.05	00.05.00	00.00.10	SI-FCP-006	SPICAV Nominal Switch OFF	SI-CRP-525

The procedures must be run sequentially and never in parallel. It is required to have no overlap between two procedures.

<u>Sequence of TC, valide for all operating modes :</u>
(Nominal or Redundant TM/TC branch)

Send HPC SOIR off
If SUN1 Send HPC Soir On

Switch ON experiment	through S/C LCL (no relay in Spicav) via RTU N+R hard reset, expected duration = 1 to 2 sec
TC Enable	defined at 5 sec after switch on
TM polling (from S/C)	defined at 3 sec after TC Enable, every one second
Send TM	after TM polling, then every second
Time update (from S/C)	about 20 sec after Switch ON (absolute time reference)
Time sync pulse	(within 8 sec)
Stop Time Update	about 20 sec after Start Time Update.
Spicav TC	defined at 15 sec after Stop Time update

Start of science observation following Spicav TC received

End of observation is done by switch OFF experiment (by S/C)
Disable TM Polling
Disable TC link
Switch off experiment — through S/C LCL via RTU N+R
If SUN1 switch OFF HPC Soir

Sequence for Shutter activities.

Extracted from ESOCProclist02V.xls

overall delta time	block delta time	duration proc	procedure	Description	procedure
00.00.00	00.00.00	00.00.15	SI-FCP-003	SPICAV Shutter ON	SI-CRP-508
00.00.15	*00.00.15*	*00.01.50*		*Activation*	
00.02.05	00.02.05	00.00.10	SI-FCP-008	SPICAV Shutter Off	SI-CRP-527
00.02.50	00.00.45 (*)	00.00.15	SI-FCP-003	SPICAV Shutter ON	SI-CRP-508
00.03.05	*00.00.15*	*00.01.50*		*Activation*	
00.04.55	00.02.05	00.00.10	SI-FCP-008	SPICAV Shutter Off	SI-CRP-527

(*) delta time at SVT1c

One motion (**opening or closing**) is done by the following sequence:

FCP-003 : switch on (means 'beginning of motion')

FCP-008 : switch off (means 'final position is assumed reached, off power')

To open and close the shutter, two motions are needed as shown in the table above.

7.3. Operational constraints:

~~Summary of operational constraints: (see section 4.1).~~

--SPICAV has no constraint on altitude for Nadir observation.
--There is no default observation scenario for SPICAV (TC Spicav is always needed).
-- SOIR Cryo cooler operations: Quantity of On/Off and operating duration will be not monitored at Flight operation levels, but at spicav team level.

Illumination constraints :

When Spicav is ON, the detectors should not be exposed to the Sun directly within the instrument FOV (**34 x 34 deg** (*)) on the nadir face since the detectors could get damaged.

When Spicav is Off: the optics should not be exposed to the Sun directly within the instrument FOV (**34 x 34 deg** (*)) on the nadir face since the optics could get damaged.

The Nadir boresight of the instrument is aligned with the S/C +Z axis.
It is assumed that the nominal shutter position is OPEN
If SZA (the angle between the Sun direction and the instrument boresight) is smaller than 17° (*) then close the shutter.
If SZA becomes again bigger than 17 deg (*) then open the shutter (**TBC**).

(*) 34° FOV is a baseline value and we understand that this value could be changed in the Flight Operations constraints after observations in flight.

Thermal constraints :

--Spicav DPU is collectively controlled with S/C.
--Spicav Sensor Unit is individually controlled with S/C.

Preferred Thermal Range for Spicav operations: -20°, +40°C.

--Observations constraints :
Spicam/Spicav design is not foreseen for long duration observations.
Max duration is 30 min as baseline.
According to thermal environment, PI will decide to increase max duration.
For successive observations

- switch off the instrument after 30 minutes max
- wait xx minutes, accordind to the duration of last observation and themal environment.
- switch on again for a 30 minutes period.

Successive SOIR observations :
Typical observation duration with SOIR is 16 minutes including 1 min before TC reception, 10 min for cooling and 5 min for observation.
Baseline for 2 succesive operations is :
- either the second observation is just after the last one (in case of TC parameters modification).
- either it is required to wait **45 min** before next observation. this is due to the SOIR detector temperature which increases at switch off and managing of the cooling which could damage the detector for intermediate temperatures.

-- ~~Off mode limits: -80°, +100°C.~~

-- SOIR baseplate templerature :
Inside SOIR, on baseplate, there are heaters (nominal and redundant) and 3 thermistors, power controlled by S/C via 3 thermistors included in SOIR. The baseline temperature range is (-5 ; 0 °C).
Heaters lines are activated during all eclipse season (in routine phase).
Others phases : Heaters lines activated xx hours before Solars observations with SOIR.

7.4. Contingency recovery pocedures:

Status on 01 Aug 2005 after SVT1c.

Extracted from ESOCProclist02V.xls

File	Label	~~Mira mode~~	Prefixe	Duration	FCP Title	LCL A	LCL B	data	Spicav Comments
SI-CRP-500	ASIC500A				Spicav Anomalies Recovery-Top level guideline				
SI-CRP-501	ASIC501A				Recovery from 'No telemetry' failure				
SI-CRP-502	ASIC502A			0	Spicav Redundant TM/TC			R	Vex-050623
SI-CRP-505	ASIC505A			40 s	Switch ON via red LCL		16-N		**No update done**
SI-CRP-506	ASIC506A			50 s (*)	Redundant Switch On		16-N/R		update 050623
SI-CRP-507	ASIC507A			55 s (*)	Redundant Switch On with SOIR		16-N/R		update 050623
SI-CRP-508	ASIC508A			15 s	Shutter redundant On		26-N/R		Vex-050623
SI-CRP-515	ASIC515A			40 s	Switch ON using Redundant data branch		16-N	R	**No update done**
SI-CRP-525	ASIC525A			10 s	Redundant Switch OFF		16-N/R		update 050623
SI-CRP-526	ASIC526A			15 s	Redundant Switch OFF with SOIR		16-N/R		update 050623
SI-CRP-527	ASIC527A			10 s	Redundant shutter Off		26-N/R		update 050623
SI-CRP-540	ASIC540A				Emergency Switch OFF				update 050623 ??
SI-CRP-550	ASIC550A				Mecanism Failure Recovery				
				* Duration On: 60s (including 15s at end) + Obs+5s					

List of new CRP to be defined for SVT2 : **TBD – in progress**

7.5. Safe Mode Procedure

In case of a detected anomaly, the mission operations are stopped and the S/C enters the Safe Mode: payloads are switched OFF and the S/C goes to a safe attitude (sun pointing first and then, Earth pointing). When the S/C enters the Safe Mode, a P/L Safing procedure is executed by the OBSW to put the payloads in a safe configuration, e.g. close the covers if open when the anomaly occurs.

At Spicav level :

- switch Off the experiment
- Close the shutter (see procedure in annex 11).

8. Summary of Telemetry and Telecommand data:

8.1. List of dangerous commands:

None.

8.2. Summary of Telemetry and Telecommand packets:

In this paragraph we describe the general rules of telemetry / telecommand utilisation. The detailed description on TM/TC packets is done in Annex 2.

Packet service compliance:

Sub-type	Service Requests (TC)	Sub-type	Service Reports (TM)	C*
	Service 1: TC Acknowledge			
		1	Acceptance success	
		2	Acceptance failure	
	Service 3: Housekeeping Reporting			
5	Enable HK			
6	Disable HK			
		25	Housekeeping packets	X
	Service 5: Event Reporting			
		1	Normal progress report	
		2	Anomaly report - no action	
	Service 9: Time Synchronization			
1	Accept Time Update			X
2	Send time to User			(1)
3	Stop Time update to User			(1)
	Service 17: Connection Test			
1	Request connection test response			
		2	Connection test report	

	Service 20: Science Data Transfer			
1	Enable Science Packet			
2	Disable Science Packet			
		3	Science report	X
	Service 226: Private services payload			
1	Telecommand for Spicav			X

(*) Services used by Spicav experiment, the others services are NOT useful (Service 12 TBC), for software simplification reasons (waiver issued for MEX, available for VEX).
(1) useful but not managed at instrument level

Rationale for Implementation of separate HK packets:

Heritage from Mars Express, rational available for VEX

Spicav has two main modes of observations which are STAR and NADIR.

Spicav is switched on and off for each observation.

The STAR duration is typically 5 mn and The NADIR one is about 30 mn.

Concerning the flight software, the STAR mode is the most stringent mode. NADIR mode will follow the STAR mode constraints, the only parameter change is duration. (the duration is fixed by the switch OFF experiment). The constraints on STAR mode are the following:

Data are recorded every second and no loss of data is allowed. The time of observation is very well defined (by computation on ground) and no shift can occur otherwise, occultation is missed.

So from Spicav point of view, we do not need to generate any HK packets because:
-there is no in flight action
-we do not need any parameter monitoring,
-we want to design a simple and sequential (fully testable) flight software.

Current Spicav implementation of HK packet:

There is a strong requirement from ESOC/MMS to produce HK packets. To our understanding, the reason for that is not linked to Science requirements. The implementation of HK packets introduces some complication in software, because we have to take care of HK services coming at any time (?) from DMS.

The present flight software requirements are fulfilled:

The flight software is separated in two main phases:

-init phase: in this phase, which duration is about 1 mn, the following actions are taken:
 hardware and software resets
 start of detector cooling
 waiting for Time Update
 waiting for Spicav TC mode
 waiting elapsed 1 mn
 At the end of this phase, it is not foreseen to receive anything else from DMS.

-observation phase: in this phase, spectra are recorded:
 data are compressed, formatted and timetagged
 this phase is not interruptible (unless by OFF experiment)

The only thing we can do is that during the "init phase" we produce 2 HK packets at the beginning (after Time update received by Spicav) and after Spicav TC received.

For VEX :
SOIR: HK packets (APID 97) are implemented during cooling phase. SOIR HK packets are generated every 20 sec.

Telecommand, general Description:

Spicav Telecommand:
Preliminary telecommand description:
Spicav uses packet telecommand structure
For Spicav we consider only one type of Spicav TC.
Main assumptions:
To operate Spicav (nominal mode) only one TC packet is needed.
Length of application data of TC packet is variable
In Spicav it is expected to use TC for
Operational mode selection (nadir,...)
Spicav DPU parameters (repetition rate of TM...)
Sensor Unit parameters (Star mode, exposure time, gain...)

Telecommand function definition:

Telecommand Packet	Information		
Packet Name	SPITC	Instrument	SPICAV
Packet Function	Instrument configuration		
Verification rules	copy in Science TM		
Header Information			
Process ID	96	Packet category	12 'PRIVATE'
Service Type	226	Service subtype	1
Structure ID	N/A	Packet length (octets) (application data)	variable, max = 232 Spicav :128
Data Field Information			
Data Field	Field structure	Remarks Science instrument configuration	
Notes:			

Telecommetry, general Description

MXcp

General assumptions: (*from PID/URD ANNEX p 68*)
Spicav uses "Packet Telemetry", Spicav is seen as a Packet Terminal.
Polling capability:

at least once per 8 sec
not more than once per 1 sec
--->Spicav requires polling at once per 1 sec
Acquisition rate is 131 KHz

Summary of TM packet structure:

(P. is for packet)

P.id	P. seq. control	P. length	P. field header	Source Data
16 bits	16	16	80	variable

Spicav scientific data (without Packet headers) is called "Source Data".

Spicav Source data:
Source data as defined in Packet Telemetry is Spicav Science Data.
All telemetry of Spicav is considered as Science Data:

Source data type contents:
spectra
repetition rate from 1sec to 15 sec
pixel number is variable
source data length between 1 and 4096 octets
associated parameters (dark current, temp, status mode, exposure time...)
repetition rate from 1sec to 8 sec
source data length is fixed = 128 octets

Telemetry packet definition:

Science:

Telemetry Packet	Information		
Packet Name	SPINSCI	Instrument	SPICAV
Packet Function	Science		
Generation rules	every 1 sec		
Header Information			
Process ID	96	Packet category	12 'PRIVATE'
Service Type	20	Service subtype	3
Structure ID		Packet length	variable, max = 8596
Data Field Information			
Data Field	Field structure	Remarks Science data	
Notes:			

Housekeeping:

Telemetry Packet	Information		
Packet Name	SPINHK	Instrument	SPICAV
Packet Function	Housekeepig		
Generation rules	after Time board received after Spicav TC received		
Header Information			
Process ID	96	Packet category	4
Service Type	3	Service subtype	25
Structure ID		Packet length (octets) source data	4
Data Field Information			
Data Field	Field structure	Remarks HK data, 2 temperatures	
Notes:			

SOIR Housekeeping:

Telemetry Packet	Information		
Packet Name	SOIRHK	Instrument	SPICAV
Packet Function	Housekeepig		
Generation rules	after Time board received after Spicav TC received		
Header Information			
Process ID	97	Packet category	4
Service Type	3	Service subtype	25
Structure ID		Packet length (octets) source data	4
Data Field Information			
Data Field	Field structure	Remarks HK data, 2 temperatures	
Notes:			

see Annex 2 for packets structure details 'TM/TC description'

8.3. Summary of Telemetry and Telecommand parameters:

Housekeeping Telemetry data:

Two temperatures (8 bits), allowable values 0-255.

Temperature of Servitudes board

Temperature of base plate near High Voltage power supply

No operational constraints on these values.

No on board monitoring

During SOIR Cooling: SOIR HK

Two temperatures (8 bits), allowable values 0-255.

Temperature of *Cooler board TBC*

Temperature of *SOIR base plate TBC*

8.4. Summary of Software parameters:

In the telecommand, there are 2 sets of parameters:

Field2	ZSI01001
arguments	SCOE:="TMTCSC",ACKBITS:="NONE", FSID0022:="TestN",FSID0023:0BV:=0xE, FSID0024:0BV:=0x000000,FSIG0011:0BV:=0xABCD

The fisrt set	FSID0022, FSID0023 and FSID0024, defines experiment modes (and bitrates)
The second set	FSIG0010 to FSIG0073 defines instrumental parameters default values are 00 (Hex)

As TC is fixed length, all default parameters are filled with 00 (hex) and sent to the instrument.

9. Data Operations Handbook:

Following data are extracted from
Spicav Payload Database Definition Document, ref VEX.T.ASTR.DDD.01213, Iss1, dated 09-Mar-04
VEX system database V12.1

Telecommand Function definitions:

Item	Meaning	Verdi Name
Command Description	**Accept Time update**	
TC Identification Number (TC ID)		ZSI02001
Instrument Name	Spicav	
Instrument subsystem (affected by TC)	DPU	
Instrument Assembly (affected by TC)	none	
Type of TC	9	
TC Address Parameters		
TC Function	Board Time to Spicav	
Constraints	1 st TC to Spicav	
Verification (TM parameter to be monitored for confirmation of TC execution)	Time in HK packet	
Corrective Action	none	
Alternative TC (if any)	redundant lines	ZSI02011 TBC
Complementary TC (If any)	none	
Remarks		

Item	Meaning	Verdi Name
Command Description	**Spicav TC**	
TC Identification Number (TC ID)		ZSI01001
Instrument Name	Spicav	
Instrument subsystem (affected by TC)	DPU	
Instrument Assembly (affected by TC)	none	
Type of TC	226	
TC Address Parameters		FSID0022, FSID0023, FSID0024 FSIG0010 to FSIG0040
TC Function	Instrument configuration	
Constraints	After TC Board Time	
Verification (TM parameter to be monitored for confirmation of TC execution)	Science TM Packets	
Corrective Action	none	
Alternative TC (if any)	redundant lines	ZSI01011 TBC
Complementary TC (If any)	none	
Remarks		

Telemetry Packet Definitions (minimum details to be required):

Item	Meaning	Verdi Name
Description	**Spicav Science**	
TM Identification Number (TM ID)		YSI01001
Instrument Name	Spicav	
Instrument subsystem	DPU	
Instrument Assembly	none	
TM Address Parameters (if possible and firm address)		NSIA0101, NSIA0102, NSIA0103, NSIA0104, NSIA0105, NSIA0106, NSIA0107,
Calibration Data (if possible and final data) (e.g. 0 = Enabled, 1= Inhibited)		
Function	Science data DPU	
Validity		
Surveillance (i.e. TC which has impact on this TM)	None	
Corrective Action	None	
Alternative TM	Redundant lines	YSI01011 TBC
Remarks		

Item	Meaning	Verdi Name
Description	**Spicav HK**	
TM Identification Number (TM ID)		YSI02001
Instrument Name	Spicav	
Instrument subsystem	DPU	
Instrument Assembly	none	
TM Address Parameters (if possible and firm address)		NSIA0001, NSIA0002, (NSID0001)
Calibration Data (if possible and final data) (e.g. 0 = Enabled, 1= Inhibited)		
Function	HK Spicam	
Validity		
Surveillance (i.e. TC which has impact on this TM)	None	
Corrective Action	None	
Alternative TM	Redundant lines	
Remarks		

Item	Meaning	Verdi Name
Description	**Spicav HK SOIR**	
TM Identification Number (TM ID)		YSI02001
Instrument Name	Spicav	
Instrument subsystem	DPU	
Instrument Assembly	none	
TM Address Parameters (if possible and firm address)		NSIA0003, NSIA0004, (NSID0003)
Calibration Data (if possible and final data) (e.g. 0 = Enabled, 1= Inhibited)		
Function	HK SOIR	
Validity		
Surveillance (i.e. TC which has impact on this TM)	None	
Corrective Action	None	
Alternative TM	Redundant lines	
Remarks		

Event Packet Definitions	None
Anomaly Report Definitions	None
Context File Definition	None
Data and Dump File Definitions	None

Annex:

Annex1: Spicav Contact point:

Name	Telephone	Fax	Email	Address
BERTAUX Jean Loup	33 (0) 1 64 47 42 51	(2)	bertaux@aerov.jussieu.fr	(1)
DUBOIS Jean Pierre	33 (0) 1 64 47 43 31	(2)	dubois@aerov.jussieu.fr	(1)
DIMARELLIS Emmanuel	33 (0) 1 64 47 42 87	(2)	dimarellis@aerov.jussieu.fr	(1)
VILLARD Eric	33 (0) 1 64 47 42 87	(2)	villard@aerov.jussieu.fr	(1)
NEEFS Eddy	32 23 73 03 62	(4)	Eddy.Neefs@bira-iasb.be	(3)
NEVEJANS Dennis	32 23 73 04 82	(4)	Dennis.Nevejans@bira-iasb.be	(3)

(1) Address

Service d'Aeronomie du CNRS
BP 3
91371 Verrieres le Buisson
France

(2) Fax number is 33 (0) 1 69 20 29 99

(3) Address

BIRA - IASB
3, Avenue Circulaire
B-1180 BRUXELLES
Belgique

(4) Fax 32 23 74 84 23

Annex2: TM/TC description:

A2.1. Conventions and Definitions:

MXcp

Bit numbering (from PSS-04-107)

Bit 0	Bit N-1
Bit0 = first bit transmitted = MSB	

Functions of the DPU concerning Telemetry:

receives data from Sensor Unit (detectors)
timetag detector data
formats all scientific and technology data in packets and update headers
put packets in Fifo (TM ready)

Format of data ready for acquisition: TM blocks: (from PID/URD ANNEX p 68)

elementary unit is 16 bits word
first word is the length of following TM words

	16 bits word	**Name**	**Contents**
		TM Block Length	number of following 16 bits TM words
1		TM Block Data	Spicav Packets
....		=	
n		=	

TM Block Data may contain:

at least one Spicav packet
--->several Spicav packets

A2.2. TM/TC Packet structure:

<u>Note on PUS value :</u>

The TM(3,25) YSI02001 is emitted with PUS=0 in the packet data field header (meaning that this TM packet is to be processed only by Ground).

It could be generated with PUS=2 (meaning TM packet to be processed both by the Ground and the DMS software), in accordance with Vex Generic TM/TC ICD VEX-T.ASTR-ICD-00326 section 5.1.2.1 Data Field Header :

"For Payloads, the code to be used is "0" (TM destination = Ground only for category = Private science, and "2" (TM destination = Ground and DMS software) for all other packet categories."

In all TM packets emitted by Spicav (Science and HK), PUS=0 . We had already this rule on Mars Express (see ME-ESC-IF-5001, Iss2)

Then for TM(3,25) , we have PUS=0 (YSI02001= TM KH Spicam and YSI02002 = TM HK SOIR).

The currently implemented PUS=0 restricts the action of DMS S/W to route this packet to SSMM or TFG (*TFG to clarify*), and prevents DMS S/W from performing any data extraction in its datapool. This therefore forbids the definition and subsequent implementation of automatic on board monitorings for the TM parameters of this packets.

Conclusion :

There is no on-board monitoring of TM packets (3,25) by DMS S/W.

The packets are only routed to SSMM and will be analysed on ground.

TM Packet structure:

	Packet Header (48 bits)							Packet Data Field		
	Packet ID				Packet sequence control		Packet length	Packet Field header	Source Data	Packet error control
bits	16 bits				16 bits		16 bits	80	variable	0
	Version number	Type	Data field Header Flag	APID = pid+pcat	Segmen-tation Flag	Source Seq Count				NOT USED
bits	3	1	1	7+4=11	2	14				

BIN	000	0	1	xxx(a)	11	n (b)	(c)	(d)	(e)
Hex				0E0C		Cxxx			

(a) APID is concatenation de pid+pcat
pid is 96 (decimal) or 60 (Hex)
pcat is 12 (for science telemetry = 1100 bin
APID is 110 0000 1100 bin = 60C Hex = **1548** dec
Packet ID is 0000 1110 0000 1100 Bin = 0E0C Hex = 3596 dec

(b) number associated with APID, start at 0 at power on

(c) number of octets -1 of Packet Data Field
min 9 (10 + no source data)
max 4106 (10 + 4096 source data)

(e) experiment data variable
min 0 octets
max 4096 octets

(d) Packet Field Header Structure

	Time	PUS version	Check-sum Flag	Spare	Packet Type	Packet Subtype	Pad
bits	48	3	1	4	8	8	8
BIN	TBD	000	0	0000	00010100	00000011	0
					(a)	(b)	
Hex	x---x		0	0	14	03	00

(a) packet type is 20 (packet category is 12)
(b) subtype is 3

Spicam HK Packet structure: 2 packets only

c'est en fait un packet TM avec des parametres particuliers

	Packet Header (48 bits)							Packet Data Field		
	Packet ID				Packet sequence control		Packet length	Packet Field header	Source Data	Packet error control
bits	16 bits				16 bits		16 bits	80	variable	0
	Version number	Type	Data field Header Flag	APID = pid+pcat	Segmen-tation Flag	Source Seq Count			4 octets	NOT USED
bits	3	1	1	11	2	14				

BIN	000	0	1	xxx(a)	11	n (b)	(c)	(d)	(e)
Hex				0E04		Cxxx	000D		

(a) APID is concatenation de pid+pcat
pid is 96 (decimal) or 60 (Hex)
pcat is 4 (for housekeeping = 0100 bin
APID is 110 0000 0100 bin = **1540** dec
Packet ID is 0000 1110 0000 0100 Bin = 0E04 Hex = 3588 dec

(b) number associated with APID, start at 0 at power on

(c) number of octets -1 of Packet Data Field
min 9 (10 + no source data)
max 4106 (10 + 4096 source data)

(e) experiment data for HK = 4 octets = 00 01 xx yy Hex **so (c) = 13 octets**
xx = recopie octet 6 du message servitude
yy = recopie octet 10 du message servitude

(d) Packet Field Header Structure

	Time	PUS version	Check-sum Flag	Spare	Packet Type	Packet Subtype	Pad
bits	48	3	1	4	8	8	8
BIN	TBD	000	0	0000	00000011	00011001	0
					(a)	(b)	
Hex	x---x		0	0	03	19	00

(a) packet type is 3, packet category is 4 (for housekeeping)
(b) subtype is 25

<u>VEX SOIR HK Packet structure: during cooling, every 20 s</u>
c'est en fait un packet TM avec des parametres particuliers

	Packet Header (48 bits)							Packet Data Field		
	Packet ID				Packet sequence control		Packet length	Packet Field header	Source Data	Packet error control
bits	16 bits				16 bits		16 bits	80	variable	0
	Version number	Type	Data field Header Flag	APID = pid+pcat	Segmen-tation Flag	Source Seq Count			4 octets	NOT USED
bits	3	1	1	11	2	14				

BIN	000	0	1	xxx(a)	11	n (b)	(c)	(d)	(e)
Hex				0E14		Cxxx	000D		

(a) APID is concatenation de pid+pcat
pid is 97 (decimal) or 61 (Hex) HK SOIR
pcat is 4 (for housekeeping = 0100 bin
APID is 110 0001 0100 bin = **1556** dec
Packet ID is 0000 1110 0001 0100 Bin = 0E14 Hex = 3604 dec
(b) number associated with APID, start at 0 at power on
(c) number of octets -1 of Packet Data Field
min 9 (10 + no source data)
max 4106 (10 + 4096 source data)

(e) experiment data for HK = 4 octets = 00 01 xx yy Hex **so (c) = 13 octets**
xx = recopie octe t ?? du message SOIR type 0
yy = recopie octet ?? du message SOIR type 0

(d) Packet Field Header Structure

	Time	PUS version	Check-sum Flag	Spare	Packet Type	Packet Subtype	Pad
bits	48	3	1	4	8	8	8
BIN	TBD	000	0	0000	00000011	00011001	0
					(a)	(b)	
Hex	x---x		0	0	03	19	00

(a) packet type is 3, packet category is 4 (for housekeeping)
(b) subtype is 25

VEX TC Packet structure:

	Packet Header (48 bits)							Packet Data Field		
	Packet ID				Packet sequence control		Packet length	Data Field header	Application Data	Packet error control
bits	16 bits				16 bits		16 bits	32	variable	16
	Version number	Type	Data field Header Flag	APID (pid + pcat)	Sequence Flag	Source Seq Count	**137**		**132** (4+128)	
bits	3	1	1	7+4	2	14				

BIN	000	1	1	(a)	11	(b)	(c)	(d)	(e)	(f)
Hex				1E0C		Cxxx	**0089**			
Dec							137			

(a) APID is concatenation de pid+pcat
pid is 96 (decimal) or 60 (Hex), = 110 0000 bin
pcat is 12 (decimal) 1100 bin
APID is 110 0000 1100 Bin = 60C Hex = 1548 dec,
Packet ID is 0001 1110 0000 1100 bin = 1E0C Hex = 7592 dec
(b) number associated with APID, start at 0 at power on — Mex
(c) number of octets -1 of Packet Data Field c = 132+6-1=137 89 Hex — 73 49h
total packet length is 137 + 7 = 144 octets — 80
min 5 (6 + no source data)
max 241 (6 + 236 source data)
(e) max is 236 octets
(f) CRC checksum

(d) Packet Field Header Structure

	PUS version	Check-sum Flag	Ack	Packet Type	Packet Subtype	Pad
bits	3	1	4	8	8	8
BIN	000	1	0000	11100010	00000001	0...0
	(a)		(b)	(c)	(d)	
Hex		1	0	E2	01	00

(a) direct TM responses to this TC processed by Ground
(b) no acknowledge report required
(c) packet type is 226, (packet category is 12)
(d) packet subtype is 1

Board Time Packet structure: (en reception) , SGICD p 44

C'est un packet TC avec des paramètres particuliers:

	Packet Header (48 bits)							Packet Data Field		
	Packet ID				Packet sequence control		Packet length	Data Field header	Application Data	Packet error control
bits	16 bits				16 bits		16 bits	32	variable	16
	Version number	Type	Data field Header Flag	APID (pid + pcat)	Sequence Flag	Source Seq Count			6 octets	
bits	3	1	1	7+4	2	14				
BIN	000	1	1	(a)	11	(b)	(c)	(d)	(e)	(f)
Hex				1E0C		Dxxx	000B			

(a) APID is concatenation de pid+pcat
pid is 96 (decimal) or 60 (Hex), = 110 0000 bin
pcat is 12 (decimal)   1100 bin
APID is 110 0000 1100 Bin ,
Packet ID is 0001 1110 0000 1100 bin = 1E0C Hex

(b) number associated with APID, start at 0 at power on

(c) number of octets -1 of Packet Data Field   total packet length is 18 octets
min 5 (6 + no source data)
max 241 (6 + 236 source data)

(e) for board Time = 6 octets   **so (c) = 11 octets = B hex**

(f) CRC checksum

(d) Packet Field Header Structure

	PUS version	Check-sum Flag	Ack	Packet Type	Packet Subtype	Pad
bits	3	1	4	8	8	8
BIN	010	1	0000	00001001	00000001	0...0
	(a)		(b)	(c)	(d)	
Hex		5	0	09	01	00

(a) direct TM responses to this TC processed by Ground
(b) no acknowledge report required
(c) packet type is 9, (packet category is 12)
(d) packet subtype is 1

<u>Annex3: VERDI Database:</u>

Reference document is :
Spicav Payload Database Definition Document, ref VEX.T.ASTR.DDD.01213, Iss1, dated 09-Mar-04
VEX system database V12.1

It includes :

GENPACK_SI.HTM
CALIB_SI.HTM
CALIB_VAR_ELT_SI.HTM
CALIB_VAR_SI.HTM
PCKBLK_ELT_SI_PKBC.HTM
PCKBLK_ELT_SI_PKBM.HTM
PCKBLK_SI_PKBC.HTM
PCKBLK_SI_PKBM.HTM
TC_PARAM_SI_OCMD.html
TC_PARAM_SI_TCGP.HTM
TCPCK_SI_NULL_NULL.html
TMPCK_SI_NULL_NULL.HTM
TCPCK_ELT_SI_NULL_NULL.html
TM_PARAM_SI_TMGA.HTM
TM_PARAM_SI_TMGS.HTM
TMPCK_ELT_SI_NULL_NULL.html

<u>Action in progress</u> :
AI AST-1 from IQAR (20 june 2005) :
Following correction on temperature values for ANC2, Astrium will check to implement either database change (add calibration curves) or the thermal control SW modification (in case DB approach is not sufficient).
DB Change request issued : see VEX-MMT-DCR-2190

GENPACK_SI.HTM

NAME	SE	SU	LNAME	TM	DA	OB L	DE	CH	IN	HE	SD	SD	SD
ETC00201D0OO	2	1	Distribute On/Off Commands	TC	Y	VAR	Y	Y	N	12	N		
ETM00325HKPK	3	25	Housekeeping Packet	TM	Y	VAR	N	N	N		Y	17	1
ETC00901TSAC	9	1	Accept Time Update	TC	Y	FIX	Y	Y	N	12	N		
ETM02003SDRP	20	3	Science Report via RTU Link	TM	Y	VAR	N	N	N		N		
ETC22601	226	1	SPICAM TC	TC	Y	FIX	Y	Y	N	12	N		

CALIB_SI.HTM

NAME	GC	LNAME	CALC	RE	PTIT NA	AD
CSIV0001	N	SPICAM- BE Modes naming	SVAL	Y	ISISPICA	
CSIY0001	N	SPICAM- TC parameters string	CPOL	Y	ISISPICA	

CALIB_VAR_ELT_SI.HTM

CALC NA	MOD	CALTYPE	XV	XV	YV	YDIGTEXT
CSIV0001	SVAL	DEFAULT	0	15		Dummy
			1	15		TestN
			2	15		TestS

			3	15		Cmde directe
			4	15		Limb
			5	15		StarLimb1
			6	15		StarLimb2
			7	15		StarLimb3
			8	15		Nadir1
			9	15		Nadir2
			10	15		Nadir3
			11	15		Align
			12	15		Tiprog
			13	15		Sun1
			14	15		Sun2
			15	15		Sun3

CALIB_VAR_SI.HTM

CALC_N	**CALC**	**MODL M**	**GC**	**LNAME**	**CO**	**CO**	**DEFAU**
CSIV0001	SVAL	DEFAULT	N	BE modes naming			ERROR
CSIY0001	CPOL	DEFAULT	N	TC parameters string	0	1	

PCKBLK_ELT_SI_PKBC.HTM

K	**K**	**B**	**L**	**T**	**B**	**I**	**E**	**A**		**C**	**K**	**K**	**X**	**E**	**G**

PCKBLK_ELT_SI_PKBM.HTM

A	A	N	C	Y	C	I	P	T	B	A	O

PCKBLK_SI_PKBC.HTM

A	A	N	C	Y	C	I	P	T	B	A	O

PCKBLK_SI_PKBM.HTM

A	A	N	C	Y	C	I	P	T	B	A	O

TC_PARAM_SI_OCMD.html

NAME	CATEG	LNAME	GCPASS	USAGE	SGRPNAME	PTC	PFC	TCPASIZE	CALIBTYPE	CALCNAME1	UNITCAL1	ENGLABEL	DEFVALUE	ISMODIF	LIMSNAME	TCDPTCGPNAME	TCDPSTARTBIT	OBSW	CMDTYPE	BCPLER	ADR1N	ADR1R	ADR2N	ADR2R	PROT	BCPLERRed	ADR1NRed	ADR1RRed	ADR2NRed	ADR2RRed	PROTRed
PSIG8610	OCMD	SPICAV SOIR OFF	N	7	SSISPICA	2	16	16	NONE		USISPICA			Y				DMS	HIGHP	RBDRTUSS	10	138									
PSIG8611	OCMD	SPICAV SOIR ON	N	7	SSISPICA	2	16	16	NONE		USISPICA			Y				DMS	HIGHP	RBDRTUSS	11	139									
PSIG8600	OCMD	SPICAV SHUT OFF	N	7	SSISPICA	2	16	16	NONE		USISPICA			Y				DMS	HIGHP	RBDRTUSS	8	136									
PSIG8601	OCMD	SPICAV SHUT ON	N	7	SSISPICA	2	16	16	NONE		USISPICA			Y				DMS	HIGHP	RBDRTUSS	9	137									
PSIG9901	OC	Switch MLC for	N	7	SSISPI	2	16	16	NON		USISPIC			Y				DM	MEM	RBDR	1				0A;1A						

	MD	Spicav			CA				E	A					S	ORY	TUSS										
PSIG9991	OCMD	MLC for Spicav	N	7	SSISPICA	2	16	16	NONE	USISPICA		Y			DMS	MEMORY	RBDRTUSS	2				FFFF	RBDRTUSS	2			FFFF

Dernière mise à jour le 28/07/03
Par DUBOIS JP

TC_PARAM_SI_TCGP.HTM

NAME	CATEG	LNAME	GC	US	SGRP NAM	PT	PF	TC	CALIB	CALCNA	UNIT CAL1	ENG	DEF	IS	LI	TCDPTC	TC	OBSV
FSIG0002	TCGP	BE Configuration Global Param	N	7	SSISPICA	0	32	32	NONE		USISPICA	NA	0	Y				NONE
FSID0022	TCDP	BE Modes	N	7		3	0	4	DIG	CSIV0001		NA		Y		FSIG0002	0	NONE
FSID0023	TCDP	BE Configuration Bit Field	N	7		3	0	4	NONE					Y		FSIG0002	4	NONE
FSID0024	TCDP	BE Configuration Bit Field	N	7		3	13	24	NONE					Y		FSIG0002	8	NONE
FSIG0004	TCGP	On-Board Time at Next TBP	N	7		0	48	48	NONE					Y				NONE
FSID0041	TCDP	On-Board Time at Next TBP (Coarse)	N	7		3	14	32	NONE					Y		FSIG0004	0	NONE
FSID0042	TCDP	On-Board Time at Next TBP (Fine)	N	7		3	12	16	NONE					Y		FSIG0004	32	NONE
FSIG0010	TCGP	SPICAM Command Parameter #1	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0011	TCGP	SPICAM Command Parameter #2	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0012	TCGP	SPICAM Command Parameter #3	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0013	TCGP	SPICAM Command Parameter #4	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0014	TCGP	SPICAM Command Parameter #5	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0015	TCGP	SPICAM Command Parameter #6	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0016	TCGP	SPICAM Command Parameter #7	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0017	TCGP	SPICAM Command Parameter #8	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0018	TCGP	SPICAM Command Parameter #9	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0019	TCGP	SPICAM Command Parameter #10	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0020	TCGP	SPICAM Command Parameter #11	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0021	TCGP	SPICAM Command Parameter #12	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0022	TCGP	SPICAM Command Parameter #13	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0023	TCGP	SPICAM Command Parameter #14	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0024	TCGP	SPICAM Command Parameter #15	N	7		3	12	16	NONE			NA	0	Y				NONE
FSIG0025	TCGP	SPICAM Command Parameter #16	N	7		3	12	16	NONE			NA	0	Y				NONE

FSIG0026	TCGP	SPICAM Command Parameter #17	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0027	TCGP	SPICAM Command Parameter #18	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0028	TCGP	SPICAM Command Parameter #19	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0029	TCGP	SPICAM Command Parameter #20	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0030	TCGP	SPICAM Command Parameter #21	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0031	TCGP	SPICAM Command Parameter #22	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0032	TCGP	SPICAM Command Parameter #23	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0033	TCGP	SPICAM Command Parameter #24	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0034	TCGP	SPICAM Command Parameter #25	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0035	TCGP	SPICAM Command Parameter #26	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0036	TCGP	SPICAM Command Parameter #27	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0037	TCGP	SPICAM Command Parameter #28	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0038	TCGP	SPICAM Command Parameter #29	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0039	TCGP	SPICAM Command Parameter #30	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0040	TCGP	SPICAM Command Parameter #31	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0041	TCGP	SPICAM Command Parameter #32	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0042	TCGP	SPICAM Command Parameter #33	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0043	TCGP	SPICAM Command Parameter #34	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0044	TCGP	SPICAM Command Parameter #35	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0045	TCGP	SPICAM Command Parameter #36	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0046	TCGP	SPICAM Command Parameter #37	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0047	TCGP	SPICAM Command Parameter #38	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0048	TCGP	SPICAM Command Parameter #39	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0049	TCGP	SPICAM Command Parameter #40	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0050	TCGP	SPICAM Command Parameter #41	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0051	TCGP	SPICAM Command Parameter #42	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0052	TCGP	SPICAM Command Parameter #43	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0053	TCGP	SPICAM Command Parameter #44	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0054	TCGP	SPICAM Command Parameter #45	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0055	TCGP	SPICAM Command Parameter #46	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0056	TCGP	SPICAM Command Parameter #47	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0057	TCGP	SPICAM Command Parameter #48	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0058	TCGP	SPICAM Command Parameter #49	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0059	TCGP	SPICAM Command Parameter #50	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0060	TCGP	SPICAM Command Parameter #51	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0061	TCGP	SPICAM Command Parameter #52	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0062	TCGP	SPICAM Command Parameter #53	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0063	TCGP	SPICAM Command Parameter #54	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0064	TCGP	SPICAM Command Parameter #55	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0065	TCGP	SPICAM Command Parameter #56	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0066	TCGP	SPICAM Command Parameter #57	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0067	TCGP	SPICAM Command Parameter #58	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0068	TCGP	SPICAM Command Parameter #59	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0069	TCGP	SPICAM Command Parameter #60	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0070	TCGP	SPICAM Command Parameter #61	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0071	TCGP	SPICAM Command Parameter #62	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0072	TCGP	SPICAM Command Parameter #63	N	7		3	12	16	NONE			NA	0	Y			NONE
FSIG0073	TCGP	SPICAM Command Parameter #64	N	7		3	12	16	NONE			NA	0	Y			NONE

TCPCK_SI_NULL_NULL.html

NAME	LNAME	PKGE NAME	PID	PCK CATEG	GCP ASS	SCOPE	AUTH	PRECOND	ACK TYPE	COMPRES	MIN LENGTH	MAX LENGTH	CALC SIZE	SUBSCHEDID	CMDCLASS	TCPK CONSTR	TIMEEXP	ACTION	COMPLPCK	REDPCK	NOTE	T
ZSI01001	SPICAM Private TC Packet	ETC22601	96	12	N	SPACE	N	TRUE	NONE		144	144	1152									N
ZSI02001	SPICAM-Accept Time Update	ETC00901TSAC	96	12	N	SPACE	N	TRUE	NONE	NONE	18	18	144									N
ZSI08600SHOF	SPICAV SHUT OFF	ETC00201D0OO	1	12	N	SPACE	Y		RECP	NONE	18	18	144									N
ZSI08601SHON	SPICAV SHUT ON	ETC00201D0OO	1	12	N	SPACE	N		RECP	NONE	18	18	144									N
ZSI08610SROF	SPICAV SOIR OFF	ETC00201D0OO	1	12	N	SPACE	N		RECP	NONE	18	18	144									N
ZSI08611SRON	SPICAV SOIR ON	ETC00201D0OO	1	12	N	SPACE	N		RECP	NONE	18	18	144									N
ZSIR8600SHOF	SPICAV SHUT OFF (Red)	ETC00201D0OO	1	12	N	SPACE	Y		RECP	NONE	18	18	144									N
ZSIR8601SHON	SPICAV SHUT ON (Red)	ETC00201D0OO	1	12	N	SPACE	N		RECP	NONE	18	18	144									N
ZSIR8610SROF	SPICAV SOIR OFF (Red)	ETC00201D0OO	1	12	N	SPACE	N		RECP	NONE	18	18	144									N
ZSIR8611SRON	SPICAV SOIR ON (Red)	ETC00201D0OO	1	12	N	SPACE	N		RECP	NONE	18	18	144									N

Dernière mise à jour le 28/07/03
Par DUBOIS JP

TMPCK_SI_NULL_NULL.HTM

NAME	LNAME	PKGE NAME	PID	PC	GC	SCOPE	SD	COMP	MI	MAX	CA	INIT ST	FRE	PH	START	OBSW	OBSW	NO	TO
YSI01001	SPICAM-Science Report via RTU Link	ETM02003SDRP	96	12	N	SPACE		NONE	2	4096	16	AUTH	1	0	DATA	OTHER	NONE		N
YSI02001	SPICAM: Housekeeping Packet	ETM00325HKPK	96	4	N	SPACE	1	NONE	4	4	32	AUTH	1	0	DATA	OTHER	NONE		N
YSI02002	SPICAM: Housekeeping Packet	ETM00325HKPK	97	4	N	SPACE	1	NONE	4	4	32	AUTH	1	0	DATA	OTHER	NONE		N

TCPCK_ELT_SI_NULL_NULL.html

TCPK NAME	TCPE ORDER	ELT TYPE	ITEM OFFSET	TCPE SIZE	FIXED VALUE	REPEAT	CALC SIZE	PKBL NAME	PKBL CATEG	TCPA NAME	TCPK NAME	EXCP CODE	DESCRIPTION	NGRP SIZE

								INNER
ZSI01001	0	PARAM	0	32	1	32	FSIG0002	
ZSI01001	1	PARAM	32	16	1	16	FSIG0010	
ZSI01001	2	PARAM	48	16	1	16	FSIG0011	
ZSI01001	3	PARAM	64	16	1	16	FSIG0012	
ZSI01001	4	PARAM	80	16	1	16	FSIG0013	
ZSI01001	5	PARAM	96	16	1	16	FSIG0014	
ZSI01001	6	PARAM	112	16	1	16	FSIG0015	
ZSI01001	7	PARAM	128	16	1	16	FSIG0016	
ZSI01001	8	PARAM	144	16	1	16	FSIG0017	
ZSI01001	9	PARAM	160	16	1	16	FSIG0018	
ZSI01001	10	PARAM	176	16	1	16	FSIG0019	
ZSI01001	11	PARAM	192	16	1	16	FSIG0020	
ZSI01001	12	PARAM	208	16	1	16	FSIG0021	
ZSI01001	13	PARAM	224	16	1	16	FSIG0022	
ZSI01001	14	PARAM	240	16	1	16	FSIG0023	
ZSI01001	15	PARAM	256	16	1	16	FSIG0024	
ZSI01001	16	PARAM	272	16	1	16	FSIG0025	
ZSI01001	17	PARAM	288	16	1	16	FSIG0026	
ZSI01001	18	PARAM	304	16	1	16	FSIG0027	
ZSI01001	19	PARAM	320	16	1	16	FSIG0028	
ZSI01001	20	PARAM	336	16	1	16	FSIG0029	
ZSI01001	21	PARAM	352	16	1	16	FSIG0030	
ZSI01001	22	PARAM	368	16	1	16	FSIG0031	
ZSI01001	23	PARAM	384	16	1	16	FSIG0032	
ZSI01001	24	PARAM	400	16	1	16	FSIG0033	
ZSI01001	25	PARAM	416	16	1	16	FSIG0034	
ZSI01001	26	PARAM	432	16	1	16	FSIG0035	
ZSI01001	27	PARAM	448	16	1	16	FSIG0036	
ZSI01001	28	PARAM	464	16	1	16	FSIG0037	
ZSI01001	29	PARAM	480	16	1	16	FSIG0038	
ZSI01001	30	PARAM	496	16	1	16	FSIG0039	
ZSI01001	31	PARAM	512	16	1	16	FSIG0040	
ZSI01001	32	PARAM	528	16	1	16	FSIG0041	
ZSI01001	33	PARAM	544	16	1	16	FSIG0042	
ZSI01001	34	PARAM	560	16	1	16	FSIG0043	
ZSI01001	35	PARAM	576	16	1	16	FSIG0044	

ZSI01001	36	PARAM	592	16		1	16	FSIG0045	
ZSI01001	37	PARAM	608	16		1	16	FSIG0046	
ZSI01001	38	PARAM	624	16		1	16	FSIG0047	
ZSI01001	39	PARAM	640	16		1	16	FSIG0048	
ZSI01001	40	PARAM	656	16		1	16	FSIG0049	
ZSI01001	41	PARAM	672	16		1	16	FSIG0050	
ZSI01001	42	PARAM	688	16		1	16	FSIG0051	
ZSI01001	43	PARAM	704	16		1	16	FSIG0052	
ZSI01001	44	PARAM	720	16		1	16	FSIG0053	
ZSI01001	45	PARAM	736	16		1	16	FSIG0054	
ZSI01001	46	PARAM	752	16		1	16	FSIG0055	
ZSI01001	47	PARAM	768	16		1	16	FSIG0056	
ZSI01001	48	PARAM	784	16		1	16	FSIG0057	
ZSI01001	49	PARAM	800	16		1	16	FSIG0058	
ZSI01001	50	PARAM	816	16		1	16	FSIG0059	
ZSI01001	51	PARAM	832	16		1	16	FSIG0060	
ZSI01001	52	PARAM	848	16		1	16	FSIG0061	
ZSI01001	53	PARAM	864	16		1	16	FSIG0062	
ZSI01001	54	PARAM	880	16		1	16	FSIG0063	
ZSI01001	55	PARAM	896	16		1	16	FSIG0064	
ZSI01001	56	PARAM	912	16		1	16	FSIG0065	
ZSI01001	57	PARAM	928	16		1	16	FSIG0066	
ZSI01001	58	PARAM	944	16		1	16	FSIG0067	
ZSI01001	59	PARAM	960	16		1	16	FSIG0068	
ZSI01001	60	PARAM	976	16		1	16	FSIG0069	
ZSI01001	61	PARAM	992	16		1	16	FSIG0070	
ZSI01001	62	PARAM	1008	16		1	16	FSIG0071	
ZSI01001	63	PARAM	1024	16		1	16	FSIG0072	
ZSI01001	64	PARAM	1040	16		1	16	FSIG0073	
ZSI02001	0	PARAM	0	48		1	48	FSIG0004	
ZSI08600SHOF	0	FIXED	0	8	0	1	8		Pad
ZSI08600SHOF	1	FIXED	8	8	1	1	8		N (1 Byte)
ZSI08600SHOF	2	FIXED	16	1	0	1	1		Route
ZSI08600SHOF	3	FIXED	17	7	0	1	7		Pad
ZSI08600SHOF	4	FIXED	24	5	21	1	5		RTU S/S address
ZSI08600SHOF	5	FIXED	29	3	0	1	3		Pad
ZSI08600SHOF	6	FIXED	32	4	0	1	4		Pad

ZSI08600SHOF	7	FIXED	36	4	2	1	4	HPC
ZSI08600SHOF	8	FIXED	40	8	8	1	8	Channel selection address
ZSI08601SHON	0	FIXED	0	8	0	1	8	Pad
ZSI08601SHON	1	FIXED	8	8	1	1	8	N (1 Byte)
ZSI08601SHON	2	FIXED	16	1	0	1	1	Route
ZSI08601SHON	3	FIXED	17	7	0	1	7	Pad
ZSI08601SHON	4	FIXED	24	5	21	1	5	RTU S/S address
ZSI08601SHON	5	FIXED	29	3	0	1	3	Pad
ZSI08601SHON	6	FIXED	32	4	0	1	4	Pad
ZSI08601SHON	7	FIXED	36	4	2	1	4	HPC
ZSI08601SHON	8	FIXED	40	8	9	1	8	Channel selection address
ZSI08610SROF	0	FIXED	0	8	0	1	8	Pad
ZSI08610SROF	1	FIXED	8	8	1	1	8	N (1 Byte)
ZSI08610SROF	2	FIXED	16	1	0	1	1	Route
ZSI08610SROF	3	FIXED	17	7	0	1	7	Pad
ZSI08610SROF	4	FIXED	24	5	21	1	5	RTU S/S address
ZSI08610SROF	5	FIXED	29	3	0	1	3	Pad
ZSI08610SROF	6	FIXED	32	4	0	1	4	Pad
ZSI08610SROF	7	FIXED	36	4	2	1	4	HPC
ZSI08610SROF	8	FIXED	40	8	10	1	8	Channel selection address
ZSI08611SRON	0	FIXED	0	8	0	1	8	Pad
ZSI08611SRON	1	FIXED	8	8	1	1	8	N (1 Byte)
ZSI08611SRON	2	FIXED	16	1	0	1	1	Route
ZSI08611SRON	3	FIXED	17	7	0	1	7	Pad
ZSI08611SRON	4	FIXED	24	5	21	1	5	RTU S/S address
ZSI08611SRON	5	FIXED	29	3	0	1	3	Pad
ZSI08611SRON	6	FIXED	32	4	0	1	4	Pad
ZSI08611SRON	7	FIXED	36	4	2	1	4	HPC
ZSI08611SRON	8	FIXED	40	8	11	1	8	Channel selection address
ZSIR8600SHOF	0	FIXED	0	8	0	1	8	Pad
ZSIR8600SHOF	1	FIXED	8	8	1	1	8	N (1 Byte)
ZSIR8600SHOF	2	FIXED	16	1	0	1	1	Route
ZSIR8600SHOF	3	FIXED	17	7	0	1	7	Pad
ZSIR8600SHOF	4	FIXED	24	5	21	1	5	RTU S/S address
ZSIR8600SHOF	5	FIXED	29	3	0	1	3	Pad
ZSIR8600SHOF	6	FIXED	32	4	0	1	4	Pad

ZSIR8600SHOF	7	FIXED	36	4	2	1	4	HPC
ZSIR8600SHOF	8	FIXED	40	8	136	1	8	Channel selection address
ZSIR8601SHON	0	FIXED	0	8	0	1	8	Pad
ZSIR8601SHON	1	FIXED	8	8	1	1	8	N (1 Byte)
ZSIR8601SHON	2	FIXED	16	1	0	1	1	Route
ZSIR8601SHON	3	FIXED	17	7	0	1	7	Pad
ZSIR8601SHON	4	FIXED	24	5	21	1	5	RTU S/S address
ZSIR8601SHON	5	FIXED	29	3	0	1	3	Pad
ZSIR8601SHON	6	FIXED	32	4	0	1	4	Pad
ZSIR8601SHON	7	FIXED	36	4	2	1	4	HPC
ZSIR8601SHON	8	FIXED	40	8	137	1	8	Channel selection address
ZSIR8610SROF	0	FIXED	0	8	0	1	8	Pad
ZSIR8610SROF	1	FIXED	8	8	1	1	8	N (1 Byte)
ZSIR8610SROF	2	FIXED	16	1	0	1	1	Route
ZSIR8610SROF	3	FIXED	17	7	0	1	7	Pad
ZSIR8610SROF	4	FIXED	24	5	21	1	5	RTU S/S address
ZSIR8610SROF	5	FIXED	29	3	0	1	3	Pad
ZSIR8610SROF	6	FIXED	32	4	0	1	4	Pad
ZSIR8610SROF	7	FIXED	36	4	2	1	4	HPC
ZSIR8610SROF	8	FIXED	40	8	138	1	8	Channel selection address
ZSIR8611SRON	0	FIXED	0	8	0	1	8	Pad
ZSIR8611SRON	1	FIXED	8	8	1	1	8	N (1 Byte)
ZSIR8611SRON	2	FIXED	16	1	0	1	1	Route
ZSIR8611SRON	3	FIXED	17	7	0	1	7	Pad
ZSIR8611SRON	4	FIXED	24	5	21	1	5	RTU S/S address
ZSIR8611SRON	5	FIXED	29	3	0	1	3	Pad
ZSIR8611SRON	6	FIXED	32	4	0	1	4	Pad
ZSIR8611SRON	7	FIXED	36	4	2	1	4	HPC
ZSIR8611SRON	8	FIXED	40	8	139	1	8	Channel selection address

NAME	CATE	LNAME	GC	US	SRGPNA	PT	PF	T	CALI	CALCNA	CALCNA	UNIT CA	UNIT CAL2
NSIA9999	TMGA	Spicam SDT data nom/red	N	7	SSISPICA	3	12	16	NONE			USISPICA	
NSIA1001	TMGA	SPICAV ANC 1	N	7	SSISPICA	3	12	16	NONE	CSBYIDEN	CDMY0206	USISPICA	UDMRTUBSM000
NSIA1002	TMGA	SPICAV ANC 2	N	7	SSISPICA	3	12	16	NONE	CSBYIDEN	CDMY0206	USISPICA	UDMRTUBSM000
NSIA1003	TMGA	SPICAV ANC 3	N	7	SSISPICA	3	12	16	NONE	CSBYIDEN	CDMY0206	USISPICA	UDMRTUBSM000

suite

NAME	ENG	T	ST	VA	IS	IS	CN	CN	CN	OBS	ADATYP	AD	MEAS TYP	BCPLER	AD	AD	AD	AD	PROT	BC	AD	AD	AD	AD	PR	ACQF	AC	Ti	Ti
NSIA9999					N	N				DMS	T_WORD		SERIAL	RBDRTUSS	202	234			Generic SDT							ASYN	0	0	0
NSIA1001	TBD				N	N				DMS	T_WORD		THERMIST	RBDRTUSS	56											1	0	0	
NSIA1002	TBD				N	N				DMS	T_WORD		THERMIST	RBDRTUSS	57											1	0	0	
NSIA1003	TBD				N	N				DMS	T_W		THERMIST	RBD	184											1	0	0	

											ORD			RTUSS															

TM_PARAM_SI_TMGS.HTM

NAME	CATEG	LNAME	GC	US	SRGP NAM	PT	PF	TM	CALIB	CALC NA	CA	UNITCAL1	UNI	ENG	TM	ST	VA	IS	IS	CN	CN	CN	OBSW	AD	AD
NSIA0001	TMGS	Temp_BT2	N	7	SSISPICA	3	4	8	ANA	CSIY0001		USISPICA		NA				N	N				NONE		
NSIA0002	TMGS	Temp_Struct	N	7	SSISPICA	3	4	8	ANA	CSIY0001		USISPICA		NA				N	N				NONE		
NSIA0003	TMGS	Temp_Soir Baseplate	N	7	SSISPICA	3	4	8	ANA	CSIY0001		USISPICA		NA				N	N				NONE		
NSIA0004	TMGS	Temp_Soir ColdFinger	N	7	SSISPICA	3	4	8	ANA	CSIY0001		USISPICA		NA				N	N				NONE		
NSIA0101	TMGS	Raw Science Data Word	N	7	SSISPICA	3	12	16	NONE			USISPICA		NA				N	N				NONE		
NSIA0102	TMGS	Science Data UV-1	N	7	SSISPICA	3	12	16	NONE			USISPICA		NA				N	N				NONE		
NSIA0103	TMGS	Science Data UV-2	N	7	SSISPICA	3	12	16	NONE			USISPICA		NA				N	N				NONE		
NSIA0104	TMGS	Science Data IR	N	7	SSISPICA	3	12	16	NONE			USISPICA		NA				N	N				NONE		
NSIA0105	TMGS	Science Data Soir1	N	7	SSISPICA	3	12	16	NONE			USISPICA		NA				N	N				NONE		
NSIA0106	TMGS	Science Data Soir2	N	7	SSISPICA	3	12	16	NONE			USISPICA		NA				N	N				NONE		
NSIA0107	TMGS	Science Data Soir3	N	7	SSISPICA	3	12	16	NONE			USISPICA		NA				N	N				NONE		

TMPCK_ELT_SI_NULL_NULL.html

TMPK NAME	TMPE ORDER	ELT TYPE	ITEM OFFSET	TMPE SIZE	FIXED VALUE	REPEAT	CALC SIZE	PKBL NAME	PKBL CATEG	TMPA NAME	EXCP CODE	NGRP SIZE
YSI01001	0	PARAM	0	16		1	16			NSIA0101	VR_NOC	
YSI02001	0	FIXED	0	8	0	1	8					
YSI02001	1	FIXED	8	8	1	1	8					
YSI02001	2	PARAM	16	8		1	8			NSIA0001		
YSI02001	3	PARAM	24	8		1	8			NSIA0002		
YSI02002	0	FIXED	0	8	0	1	8					
YSI02002	1	FIXED	8	8	1	1	8					

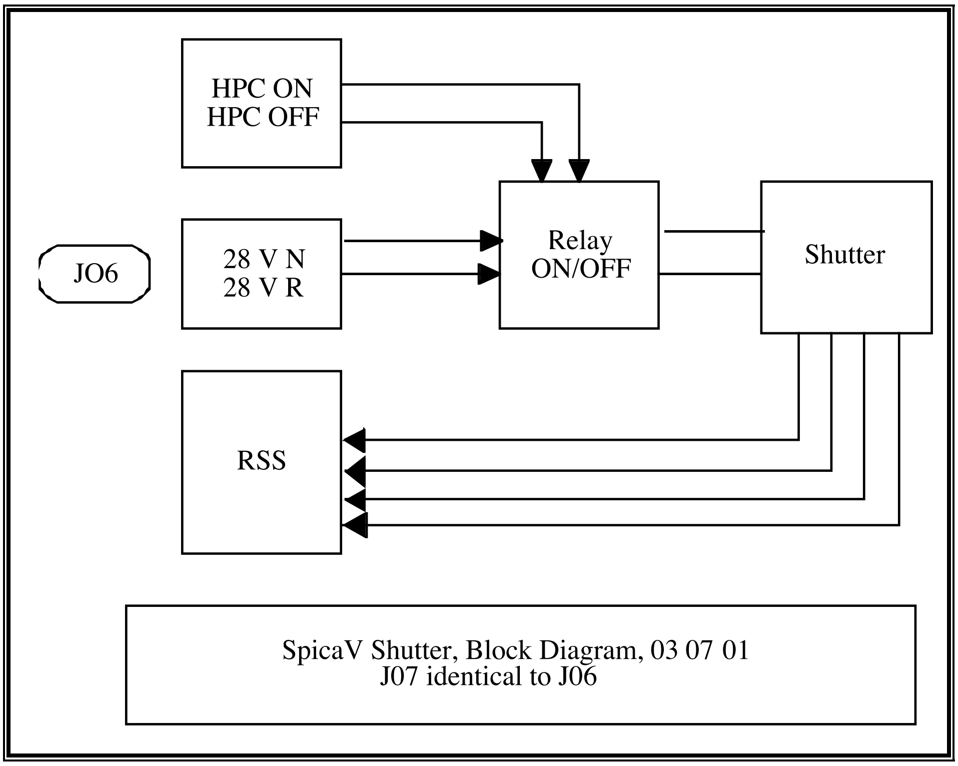
YSI02002	2	PARAM	16	8		1	8			NSIA0003		
YSI02002	3	PARAM	24	8		1	8			NSIA0004		

Dernière mise à jour le 28/07/03
Par DUBOIS JP

Annex4: Spicav Diagrams:

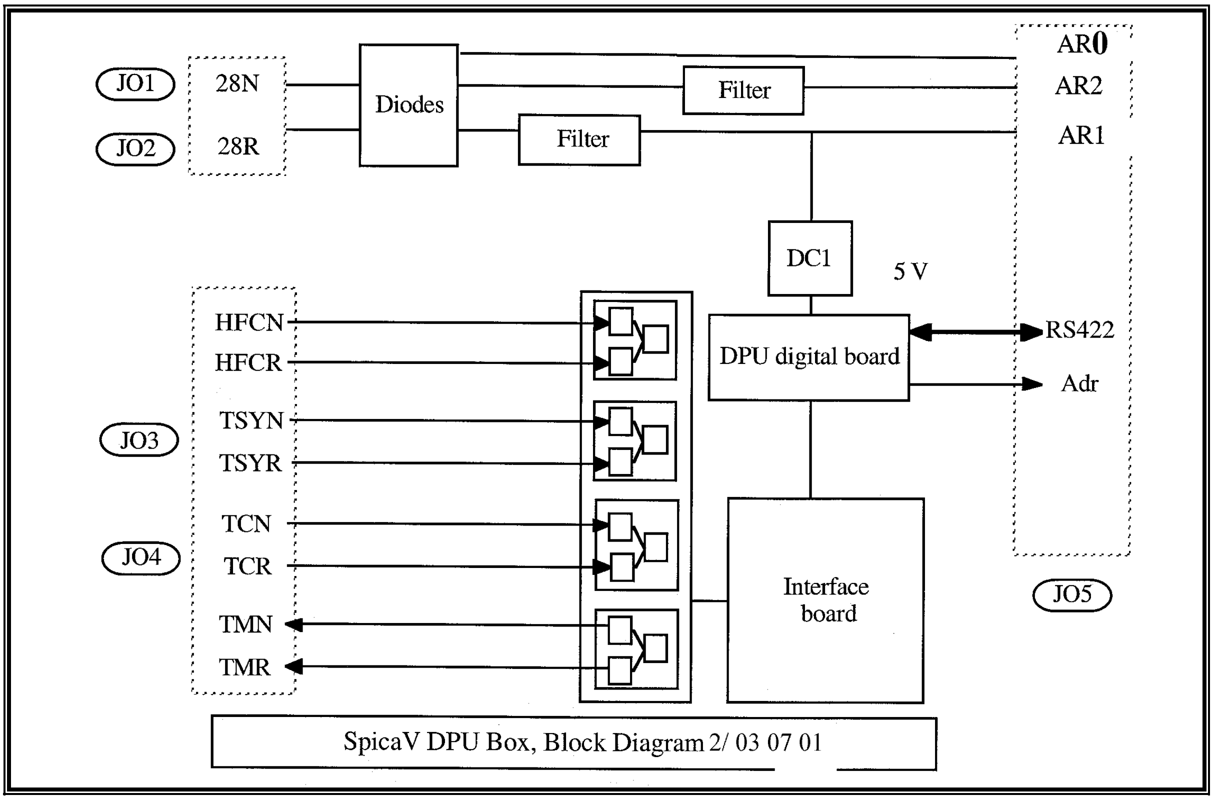
Extracted from Spicav EICD, ref SPV-DES-012, Iss 4.2, dated June 02, 2005
Timings are typical and are not in agreement with FCP.

Shutter

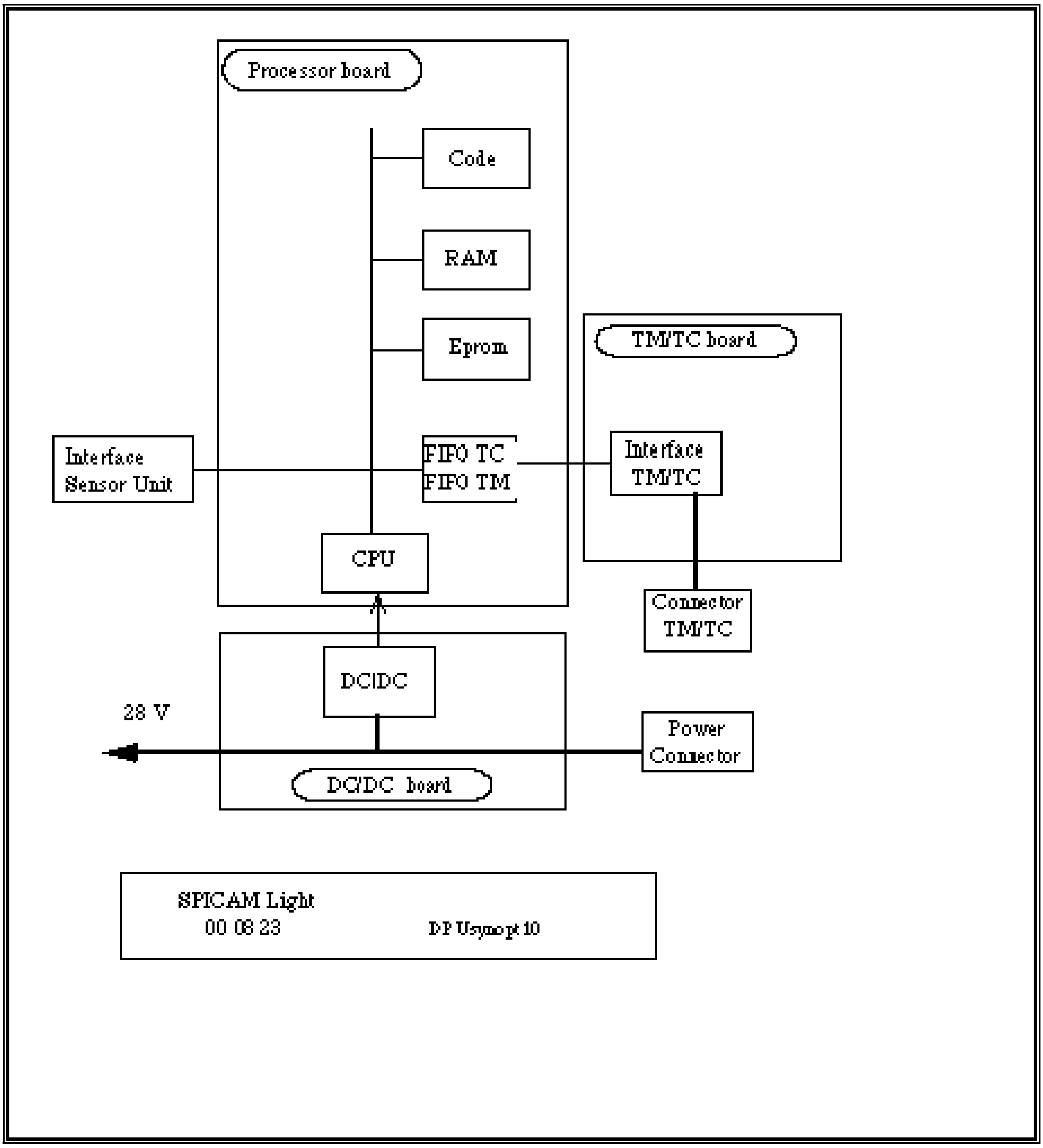


Note: 4 RSS initially foreseen, 2 of them are not used.

Functional Block Diagram DPU:

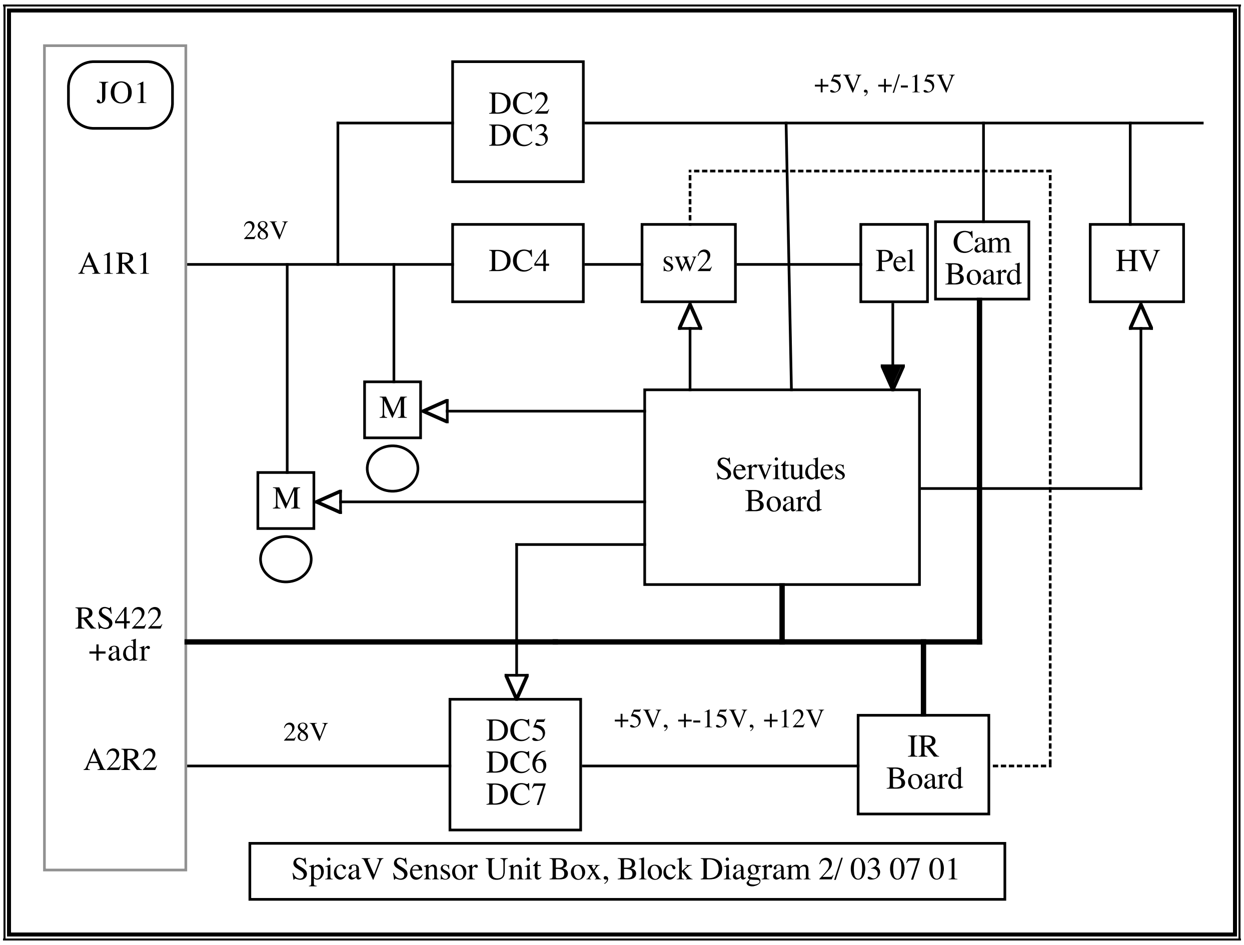


DPU synoptic

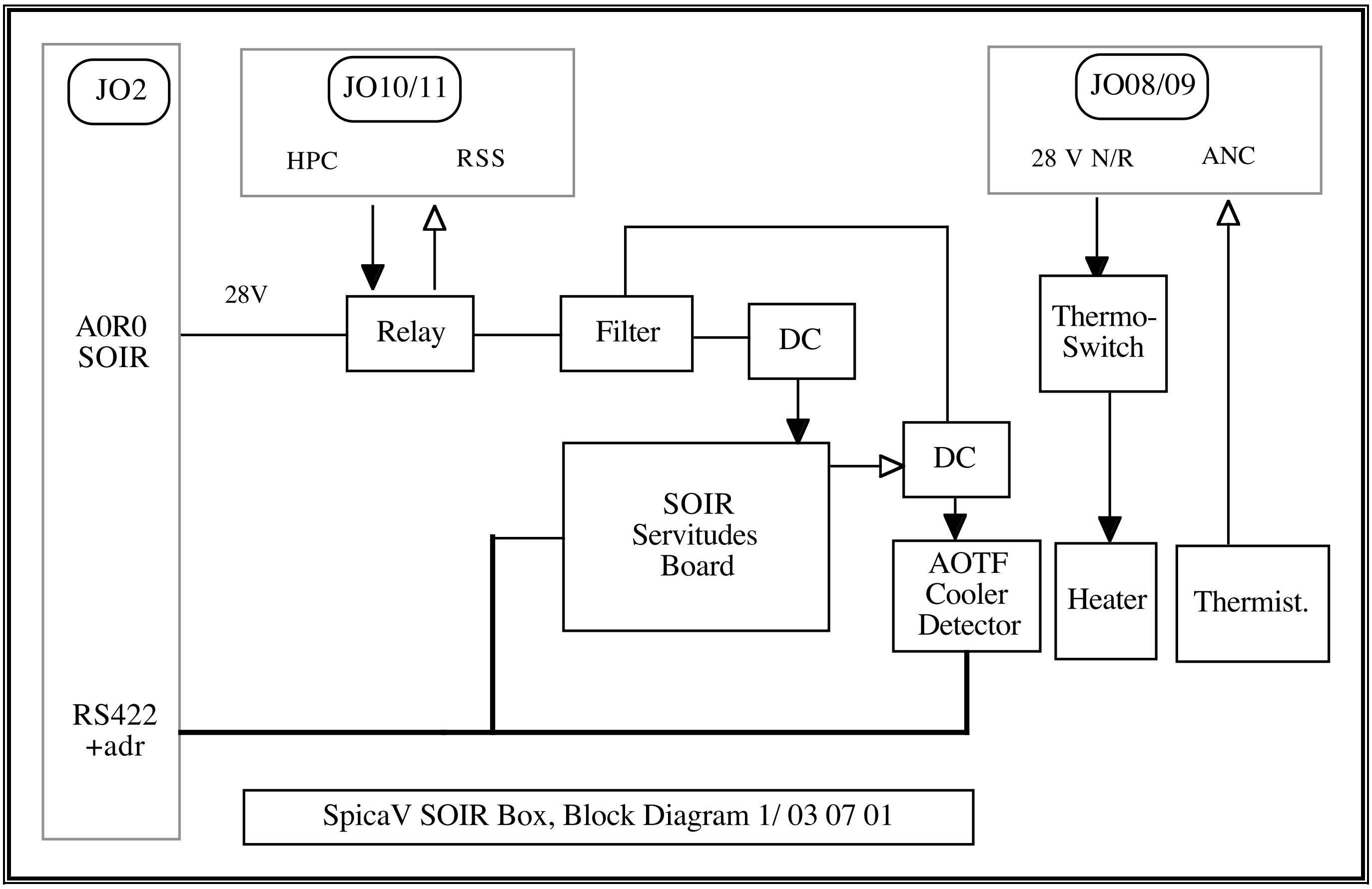


available for VEX/SPICAV

Functional Block Diagram SUV + SIR (sensor unit):



Functional Block Diagram SOIR:



~~Now, no thermoswitch. (drawing to be updated)~~
Heater are controlled by spacecraft by monitoring thermistances.

Power Demand:

Power Lines	Average Power BOL [W]				Average Power EOL [W]				Long Peak Power		Short Peak Power	
	Modes				Modes				Peak (1)[W]	Duration[s]	Peak [W]	Duration[s]
	Sdby	Star	Nadir	Sun	Sdby	Star	Nadir	Sun				
28 V nom	0	17.6	26.4	51.4	0	17.6	26.4	51.4	+ 5	0,15	0	
28 V red	0	17.6	26.4	51.4	0	17.6	26.4	51.4	+5	0,15	0	

(1) Long peak power: slit and sun shutter actuation for SUV and SIR channels (SFMI actuator, 28 V, 140 ohms, 5W), 150 ms each

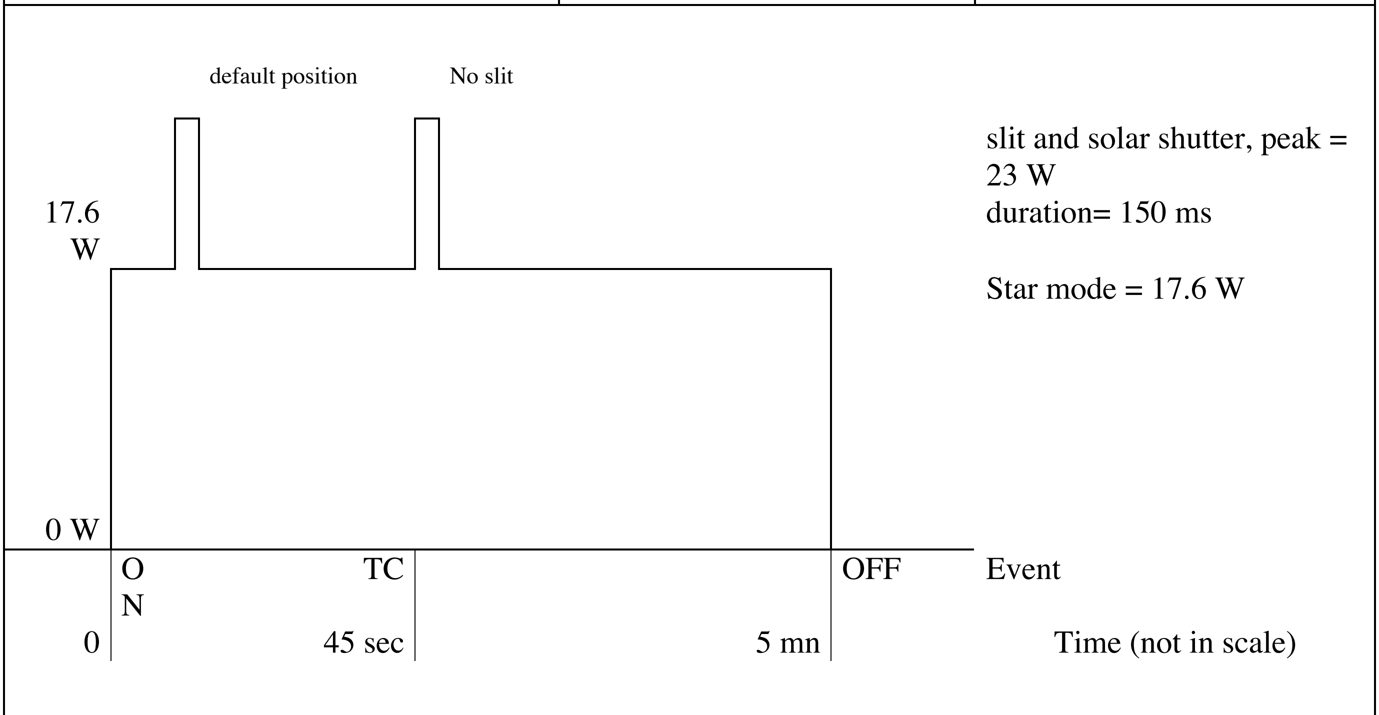
Nota:

1 – Nadir Shutter Opening/Closing: **6 W**, 28 V, (98 s typ., 110s max)

2 – SOIR heaters: 32 W on Nominal and redundant channel for FM2 (SOIR op)

Power Profile Star Mode:

POWER PROFILE	INSTRUMENT SPICAV	MODEL All
	Power Line	28 V nom

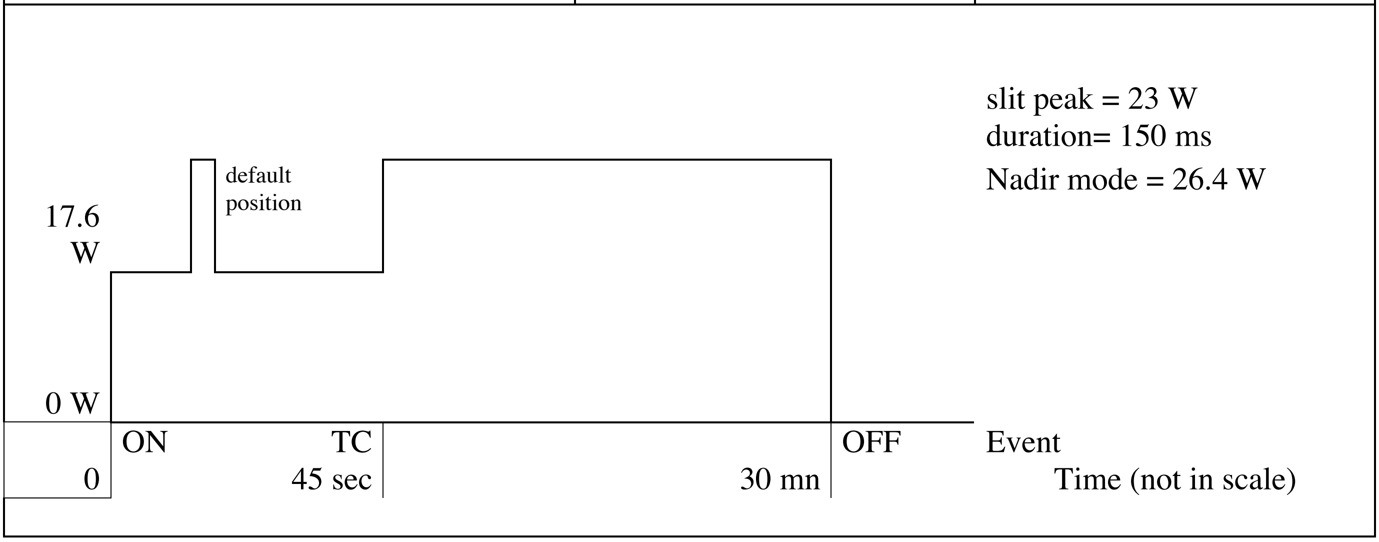


Actuators default position: Nadir configuration (solar shutter closed, slit on)

Timings are typical and are not in agreement with FCP.

Power Profile Nadir or Limb Mode:

POWER PROFILE	INSTRUMENT SPICAV	MODEL All
	Power Line	28 V nom

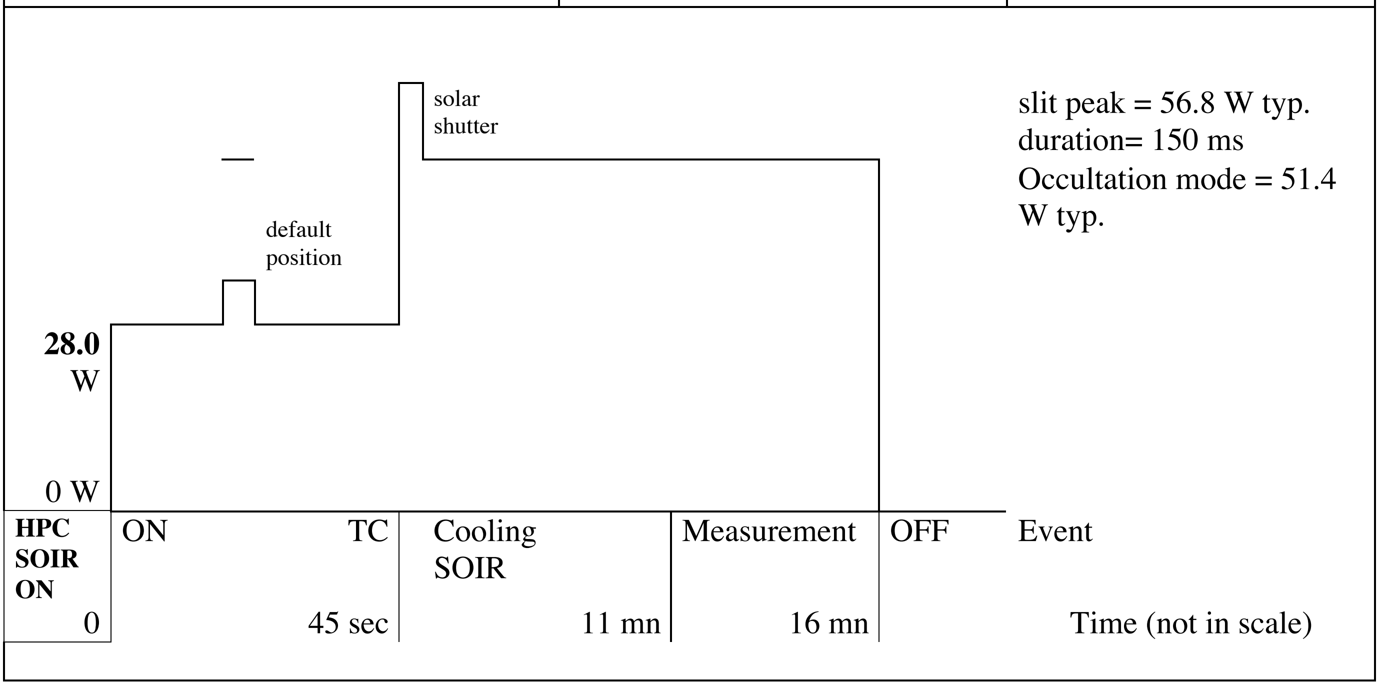


Actuators default position: Nadir configuration (solar shutter closed, slit on)

Timings are typical and are not in agreement with FCP.

Power Profile Sun Occultation Mode:

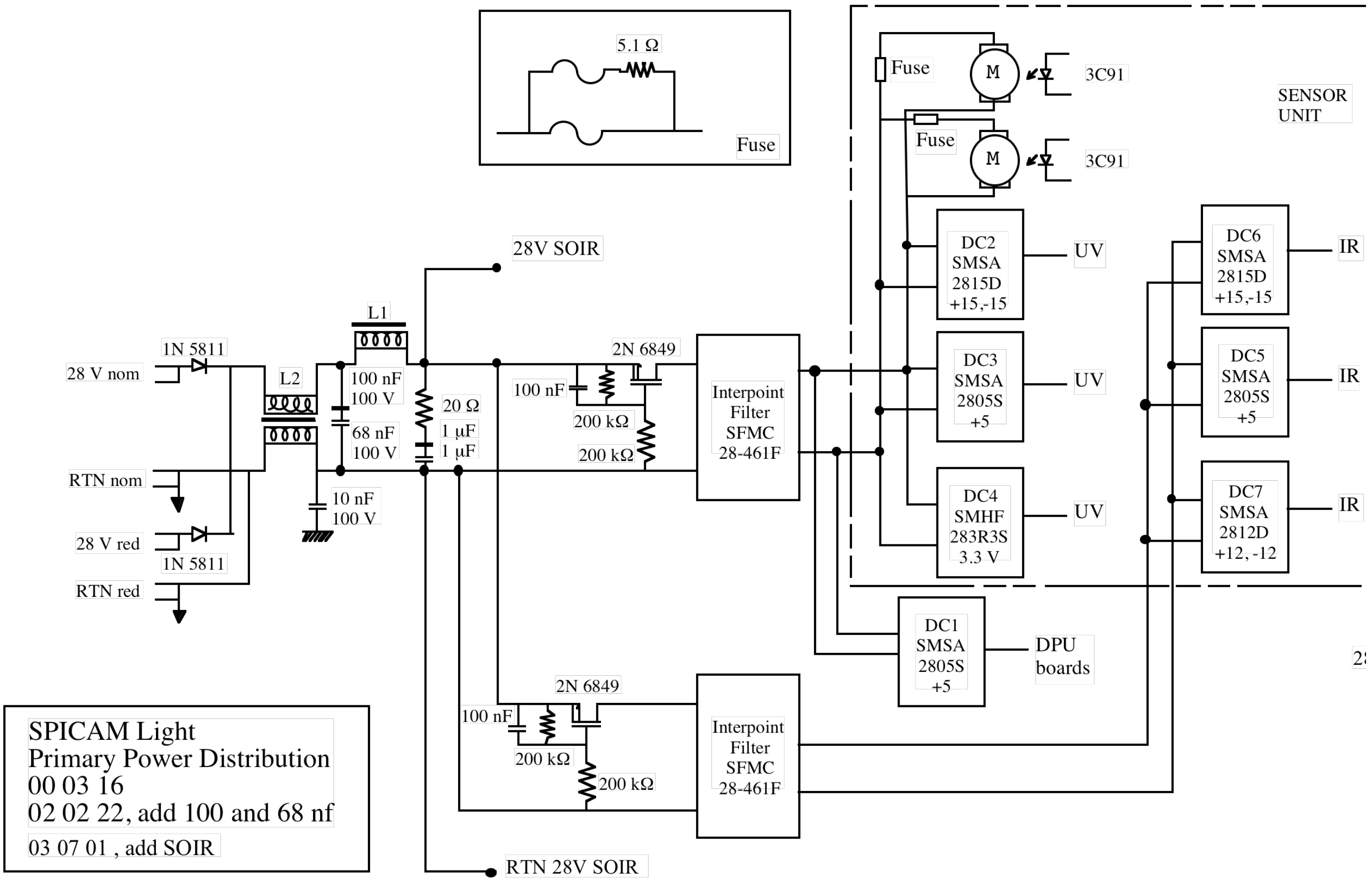
POWER PROFILE	INSTRUMENT SPICAV	MODEL All
	Power Line	28 V nom



Actuators default position: Nadir configuration (solar shutter closed, slit on)

Timings are typical and are not in agreement with FCP.

DPU Power Distribution and Interfaces circuits:



Annex5: Auxilliary data:

MEX auxilliary data:

Accuracy will be determined by Flight Dynamics, following numbers are given for information.

ORBIT AND ATTITUDE DATA CONSOLIDATED REQUIREMENTS

Data required	**Timing**	**Data source**	**Resp.**	**Delivery Method**	**Freq.**	**Sam-pling**	**Accuracy (Required)**
Major S/C events (Orbit Manoeuvres, Eclipse etc)	Planned and Predicted	Ground	ESOC	DDS (Aux Data)	Monthly	TBD	TBD
Long range Orbit Prediction	Predict	Ground	ESOC	DDS (Aux Data)	Monthly	1 / min	< 25 km
Near Term Orbit Prediction	Prediction	Ground	ESOC	DDS (Aux Data)	Weekly	1 / min	5 km
Quick look Orbit Estimation	Post-obs	Tracking Data	ESOC	DDS (Aux Data)	Once in 2 days	1 / sec	2 km
Precision Orbit Estimation	Post-obs	Tracking Data	ESOC	DDS (Aux Data)	Once in 2 weeks	1 / sec	0.5 km
Predicted Attitude	Prediction	Ground	ESOC	DDS (Aux Data)	Weekly	1 / min	0.1 deg
Reconstituted Attitude (Attitude and Rates)	Post-obs.	S/C Data + Ground	ESOC	DDS (Aux Data)	Weekly	1 / sec	0.05 deg

Data required	Timing	Data source	Resp.	Delivery Method	Freq.	Sam-pling	Accuracy (Required)
Rotation Angle of SA (with respect to S/C frame of reference)	Post–obs.	S/C Data	ESOC	DDS (Aux Data)	Week		
Pericentre 'TICK'	Prediction	Ground	ESOC	DDS (Aux Data)	Week	Every Orbit	1 sec
Orbit Time Period	Prediction	Ground	ESOC	DDS (Aux Data)	Week	Every Orbit	1 sec
Thruster Firing Times (Start Time & Duration)	Prediction & Post-obs.	Ground	ESOC	DDS (Aux Data)	Event related	Every Manoeuvre	1 sec
Sun Zenith Angle (Over Pericentre)	Prediction	Ground	ESOC	DDS (Aux Data)	Week	one sample / 10 sec	0.5 deg
Times of Occultation (Star/Sun) (Refer to SPICAV Star Catalogue)	Prediction	Ground	ESOC	DDS (Aux Data)	Week	NA	< 5 sec
Spacecraft Position (PSO)	Post Ops (2)	Ground	ESOC	DDS (Aux Data)	Week	1 sec	0.5 km
Longitude & Latitude of occulted Venus point	Post Ops (2)	Ground	ESOC	DDS (Aux Data)	Week	NA	0.1 deg
Solar Zenith Angle (of occulted Venus Point)	Post Ops (2)	Ground	ESOC	DDS (Aux Data)	Week	NA	0.1 deg
Duration of Occultation (between 200 Km and 0 Km)	Prediction	Ground	ESOC	DDS (Aux Data)	Week	NA	< 5 sec

Comments:

(2) these data are for Post processing, our requirements for Prediction are defined in the associated table "Instrument Data Requirements (4)", see next sheet

For these data, sampling and accuracy are not the same if they are 'Prediction ' or 'Post Obs.'

SPICAV auxilliary data:

Instruments Data Requirements (4)

SPICAV						
Data required	**Timing**	**Data source**	**Responsibility**	**Delivery Method**	**Frequency**	**Accuracy**
Star/Sun Occultation Observations: - Star occulted by Venus.	Prediction	Ground	ESOC	DDS (ESOC)	Once/ month	
- Time of occultation.	Prediction	Ground	ESOC	DDS (ESOC)	Once/ month	< 5 sec
- Spacecraft Position (PSO).	Prediction	Ground	ESOC	DDS (ESOC)	Once/ month	6 km ?
- Duration of occultation (between 200 and 0 Km).	Prediction	Ground	ESOC	DDS (ESOC)	Once/ month	< 5 sec
- S/C attitude (for Sun Occultation).	Prediction	Ground	ESOC	DDS (ESOC)	Once/ month	0.1 deg
- Latitude and Longitude of occulted Venus point.	Prediction	Ground	ESOC	DDS (ESOC)	Once/ month	0.5 deg
- Solar Zenith Angle of occulted Venus point.	Prediction	Ground	ESOC	DDS (ESOC)	Once/ month	0.5 deg

Annex6: Star Catalog:

```
25 03 2002 Etoiles Spicav (flux > 800 at 164 nm), 39 stars,  Dimarellis
 1  Spicav number
 2  BSC number
 3  Name
 4  Spectral Type
 5  Visual magnitude
 6  Right ascension (deg) J2000
 7  Declinaison (deg) J2000

   2   264 Gam Cas B0IVe  2.47  14.18  60.72
   5   472 Alp Eri B3Vpe  0.46  24.43 -57.24
   8  1203 Zet Per B1Ib   2.85  58.53  31.88
   9  1220 Eps Per B0.5V  2.89  59.46  40.01
  12  1713 Bet Ori B8Ia:  0.12  78.63  -8.20
  14  1790 Gam Ori B2III  1.64  81.28   6.35
  16  1852 Del Ori O9.5I  2.23  83.00  -0.30
  17  1879 Lam Ori O8III  3.54  83.78   9.93
  18  1899 Iot Ori O9III  2.77  83.86  -5.91
  19  1903 Eps Ori B0Ia   1.70  84.05  -1.20
  20  1948 Zet Ori O9.7I  2.05  85.19  -1.94
  21  2004 Kap Ori B0.5I  2.06  86.94  -9.67
  25  2294 Bet CMa B1II-  1.98  95.68 -17.96
  28  2491 Alp CMa A1Vm  -1.46 101.29 -16.72
  29  2618 Eps CMa B2II   1.50 104.66 -28.97
  36  3165 Zet Pup O5f    2.25 120.90 -40.00
  41  3734 Kap Vel B2IV-  2.50 140.53 -55.01
  44  4199 The Car B0Vp   2.76 160.74 -64.39
  46  4621 Del Cen B2IVn  2.60 182.09 -50.72
  48  4730 Alp1Cru B0.5I  1.33 186.65 -63.10
  49  4731 Alp2Cru B1V    1.73 186.65 -63.10
  53  4853 Bet Cru B0.5I  1.25 191.93 -59.69
  55  5056 Alp Vir B1III  0.98 201.30 -11.16
  56  5132 Eps Cen B1III  2.30 204.97 -53.47
  57  5191 Eta UMa B3V    1.86 206.88  49.31
  59  5231 Zet Cen B2.5I  2.55 208.88 -47.29
  60  5267 Bet Cen B1III  0.61 210.96 -60.37
  62  5440 Eta Cen B1.5V  2.31 218.88 -42.16
  65  5469 Alp Lup B1.5I  2.30 220.48 -47.39
  70  5944 Pi  Sco B1V+B  2.89 239.71 -26.11
  71  5953 Del Sco B0.3I  2.32 240.08 -22.62
  73  5984 Bet1Sco B1V    2.62 241.36 -19.81
  74  6084 Sig Sco B1III  2.89 245.30 -25.59
  76  6165 Tau Sco B0V    2.82 248.97 -28.22
  77  6175 Zet Oph O9.5V  2.56 249.29 -10.57
  84  6527 Lam Sco B2IV+  1.63 263.40 -37.10
  86  6580 Kap Sco B1.5I  2.41 265.62 -39.03
  89  7121 Sig Sgr B2.5V  2.02 283.82 -26.30
  91  7790 Alp Pav B2IV   1.94 306.41 -56.74
```

Baseline is MEX catalogue.
Update is TBC

Annex7: Polling mechanism

To be completed

Annex8: Ground test sequence:

To be completed

Annex9: Detailed Ground operations plan:

The following paragraphs describe all the actions which are needed for operations of Spicav :
SA = Service d'Aéronomie

We propose the following phases:

Data Needed	Actions	Actioner	Remarks
Pre-mission			
Targets	Star catalog	SA	
Communication Phase / other			
Sun Illumination	Check Illumination	ESOC	
	Shutter action if needed	ESOC	
Mission, every month			
Orbit data	Compute predicts	ESOC	
Occulted targets	Compute attitude (1) (2)	ESOC	In parallel at SA
Selected Stars	Choice by Science team	SA	
Attitude parameters	Elaboration	ESOC	verification by SA
TC Spicav	Elaboration	SA	
Mission, every week			
Spicav master schedule uplink		ESOC	
Spicav health and status monitoring		ESOC	
TM	Retrieval	SA	SA Ground Segment
	Verification	SA	
	Processing	SA	

(1) For STAR mode, the following is a preliminary list of what has to be computed:
with predicted orbit and star catalog compute:
stars possible to be occulted by Venus
time and S/C position on the orbit
duration of occultation between 200 and 0 km
S/C attitude of the +Z axis (other axis are free)
coordinates of occulted point on Venus and SZA (Solar Zenith Angle) angle
Then resources availibility reduces the possibilities
if several targets are possible, selection by PI
Then calculations of orientation timeline by ESOC to put S/C in good attitude at proper time
Preparation of TC for Spicav (by experiment team)
Uplink to S/C
(2) For LIMB mode, the direction of observation is defined by alpha, delta, as a "virtual" star.
The S/C attitude is defined by the orientation of the slit of the spectrometer.
Computation to be done by Experiment team (TBC).
Computation is TBD.

Calibration and error budget:

On ground, calibration tests will be done at equipment level and instrument level (under ambient conditions and in thermal vacuum).

Main performances tests are following:
detection chain measurements:
DC maps
Dark Noise
Detection chain gain (elctrons per DN, and electrons per photoevent)
Readout Noise
opto mechanical verification
straylight
specific tests
spectral bands, wavelength assignment
spectro radiometric sensitivity
spectro Signal to Noise ratio
Linearity
Uniformity

Annex10: User manual for the shutter

Copy of SPV-NT-SH-03, Iss 1.0, dated 29.04.05

Timings have been updated in procedures validated during SVT.

****

E. Villard (29/04/05)

The purpose of the shutter (UV and IR palettes) is to protect the entrance optics of both channels when the Sun is along or close to the +Z axis of the S/C (same axis for SPICAV).

This situation can happen at any time during the mission, but mostly it will happen during certain communication phases with the Earth.

This shutter was not present on Mars Express and therefore, represents a new addition to the original instrument. Thus, to limit the modifications on SPICAM, it was decided that the shutter would be an independent subsystem (except mechanically) with its own electronics and its own LCL (class B).

The first “motor” that was chosen to drive the palettes was a paraffin actuator (Starsys). The main reason was its simplicity of operation (and therefore, its little amount of electronics needed). As we understood it initially, it only needed power to heat the paraffin, which would expand and translate the actuator, rotating the axis in one direction. Then, after switching off the power, the paraffin would cool down, the actuator would retract and the axis would rotate in the opposite direction.

But, for various reasons, we decided to give up this solution and continue with a “classical” electrical motor. However, since the electrical interfaces had already been defined, we had to keep the same philosophy of operation.

Therefore, now, when the shutter electronics are powered up, the actual position of the palettes is automatically detected (via microswitches whose status is not relayed back to the S/C) and the motor is powered such that the palettes rotate in the good direction. When the final position is detected (still via microswitches), the electronics automatically power down the motor, which stops the rotation.

Incidentally, one can notice that, after the rotation, the shutter still consumes a small amount of power: this is due to the electronic circuits, which are still powered up. This is one reason why the HPC off must be sent after the rotation. The other reason is that the process of detecting the actual position of the palettes and deciding in which direction to rotate them is only performed when the electronics are powered up (from off to on).

Therefore, the procedures “SI_Shutter_Switch_ON” and “SI_Shutter_Switch_OFF” do not relate to the opening and closing of the shutter but to the beginning and the end of ONE motion of the shutter, either opening or closing. The following table summarizes the principle of operation:

Initial status of the shutter	Objective	Actions
Closed	Open the shutter	1. SI_Shutter_Switch_ON 2. Wait (typ. 110secs) 3. SI_Shutter_Switch_OFF
	Close the shutter	None
Open	Open the shutter	None
	Close the shutter	1. SI_Shutter_Switch_ON 2. Wait (typ. 110secs) 3. SI_Shutter_Switch_OFF

Now, there is also the possibility that the LCL is unexpectedly cut while the palettes are rotating (e.g. after a S/C safe mode). Then, when the shutter is powered up again, the electronics cannot detect either an open or closed position. In this specific situation (no microswitch is detecting a final position), it was decided that the shutter would open by default.

Evidently, this principle of operation requires that the initial status of the shutter be known in order to decide whether it needs to be powered up (to reach the desired position). The microswitches cannot be used as their status is not relayed back to the S/C. For this specific purpose, there are two proximity detectors (ILS based) that are directly relayed back to the S/C, one for the open position and one for the closed position. These contacts are triggered by a magnet attached to the rotating axis. When the palettes are closed (resp. open), the magnet is short-circuiting the ILS “closed” (resp. “open”) and not the ILS “open” (resp. “closed”). This is summarized by the following table:

Status of the shutter	Status of the ILS “open”	Status of the ILS “closed”
Open	0	1
Intermediate (neither closed nor open)	1	1
Closed	1	0

It was then decided to have the following calibration in the database:

	Measured value	Calibrated value
ILS “open”	1	Closed
	0	Open
ILS “closed”	1	Open
	0	Closed

Therefore, we obtain the following table:

Status of the shutter	Status of the ILS “open”	Status of the ILS “closed”
Open	Open	Open
Intermediate (neither closed nor open)	Closed	Open
Closed	Closed	Closed

The status of the ILS “Open” (on the nominal channel) is parameter NDAD0526.
The status of the ILS “Closed” (on the nominal channel) is parameter NDAD0527.
The status of the ILS “Open” (on the redundant channel) is parameter NDAD0626.

The status of the ILS “Closed” (on the redundant channel) is parameter NDAD0627.
Theses statuses give the position of the shutter, not the state of the ILS itself.

One should also know that the proximity detectors (ILS) are not switching status instantaneously once the palettes have left their initial position. This is due to the proximity of the magnet which still activates the detector a couple of tens of seconds after the beginning of the rotation. Similarly, the proximity detector of the final position is activated a couple of tens of seconds before the palettes reach their final position.

****

end of copy

Annex11: Shutter in Safe Mode

Copy of document SPV-NT-SF-01, Issue 2, provided by Spicav team to Astrium to define the Shutter procedure in case of spacecraft safe mode.

Action is to close the shutter.

Note that, since issue 2, waiting duration between HPC On and HPC Off (initially at 60 seconds) has been increased to 110 seconds (consistent with timing including in FCP/CRP).

****

In case of a detected anomaly, the mission operations are stopped and the S/C enters the Safe Mode : payloads are switched OFF and the S/C goes to a safe attitude (sun pointing first and then, Earth pointing). When the S/C enters the Safe Mode, a P/L Safing procedure is executed by the OBSW to put the payloads in a safe configuration, e.g. close the covers if open when the anomaly occurs.

SPICAV Shutter commands

HPC_ON enables the 28V to power the shutter engine, in order to:

- Close the shutter if the shutter was open
- Open the shutter if the shutter was closed

HPC_OFF disables the 28V to the shutter engine. This 28V_cut_OFF is detected by the shutter electronics and is used as a prerequisite to enable the next HPC_ON, such as 2 consecutive HPC_ON will not open and then close the shutter (or close and then open).

There is a specific LCL to provide the 28V to the shutter engine. After the command HPC_ON, this LCL must stay ON during 60 sec, to leave time to the shutter to complete the motion (open or close). The actual value for a complete motion is 30 sec, and SPICAV experts recommend a margin of 30 sec.

SPICAV Shutter statuses

A number of 4 RTU statuses are available to determine if the shutter is closed or open: 2 are provided via RTU i/o A and 2 via RTU i/o B.

They all change their value once the shutter is completely closed or completely open. Example: if HPC_ON is sent to close the shutter and HPC_OFF is sent only 15 sec after, the motion will not be completed. The open status will indicate 'closed' and the closed status will indicate 'open'. The next HPC_ON will automatically open the shutter.

Note on the status :

On the shutter, there are two kinds of position detection which are totally separated.

The first one based on microswitches controls internally the motor and the motion. No interface, no status with the spacecraft .

The second one based on ILS (magnetic system: magnet on the rotating axis) provides only the status of the position and is returned to the spacecraft. These statuses are used for this procedure.

As the two position detection (for motion and interface status) are totally separate and due to the hysteresis of the ILS system, interface status for one position can be detected before the stop motion or just after the beginning of motion.

Small mechanical adjustments are possible to reduce the delays between the two detection systems.

SRD Command Logical Name (VERDI NAME)	VERDI NAME (*)	Data Acquisition Type	Engineering Value	Raw Value Hex
SPICAV_shutter_open_ST_N	NDAD 0526	bit	”O_NOK” “O_OK”	1 0
SPICAV_shutter_open_ST_R	NDAD 0626	bit	”O_NOK” “O_OK”	1 0
SPICAV_shutter_closed_ST_N	NDAD 0527	bit	”C_OK” “C_NOK”	0 1
SPICAV_shutter_closed_ST_R	NDAD 0627	bit	”C_OK” “C_NOK”	0 1

(*) Name provided in RID, not checked by Spicav

Procedure to be implemented in the CDMU software:

If RTU A = safe then all statuses and LCLs shall be via RTU A

Else all statuses and LCLs shall be via RTU B

Note: in the following, X represents A or B to indicate “RTU A” or “RTU B”.

Note : when this procedure starts, DMSOT has already performed:

- switch OFF LCL A -> SPICAV shutter A
- switch OFF LCL B -> SPICAV shutter B

If SPICAV_shutter_closed_ST_X = C_NOK and SPICAV_shutter_open_ST_X = O_ OK

Then perform the following steps:

(this is the case when shutter is open)

- Switch off SPICAV shutter A (HPC_OFF)
- Switch off SPICAV shutter B (HPC_OFF)

(the above commands are in case previous HPC_ON was not followed by a HPC_OFF)

- Switch on LCL A -> SPICAV shutter A, via RTU X (DML_ON)
- Switch on LCL B -> SPICAV shutter B, via RTU X (DML_ON)
- Wait 5 sec
- Switch on SPICAV shutter A (HPC_ON to close the shutter)
- Switch on SPICAV shutter B (HPC_ON to close the shutter)
- Wait 60 sec
- Switch off SPICAV shutter A (HPC_OFF)
- Switch off SPICAV shutter B (HPC_OFF)
- If SPICAV_shutter_closed_ST_X = C_NOK and SPICAV_shutter_open_ST_X = O_ OK
  - Then perform the following steps

  (this case is applied when, previoulsy, the shutter status was detected open while the shutter was not totally open. Due to separate detection system for motion, opening has been previously finished. Another motion is needed to close the shutter)

  - Switch on SPICAV shutter A (HPC_ON to close the shutter)
  - Switch on SPICAV shutter B (HPC_ON to close the shutter)
  - Wait 60 sec
  - Switch off SPICAV shutter A (HPC_OFF)
  - Switch off SPICAV shutter B (HPC_OFF)
  - Else do nothing
- Switch off LCL A -> SPICAV shutter A, via RTU X (DML_OFF)
- Switch off LCL B -> SPICAV shutter B, via RTU X (DML_OFF)

Else if SPICAV_shutter_closed_ST_X = C_NOK and SPICAV_shutter_open_ST_X = O_ NOK

Then perform the following steps:

(this is the case when shutter is not open and not closed, i.e. closure or opening have been aborted before end. For the next HPC ON, priority has been given to opening)

- Switch off SPICAV shutter A (HPC_OFF)

- Switch off SPICAV shutter B (HPC_OFF)

(this is in case previous HPC_ON was not followed by a HPC_OFF)

- Switch on LCL A -> SPICAV shutter A, via RTU X (DML_ON)
- Switch on LCL B -> SPICAV shutter B, via RTU X (DML_ON)
- Wait 5 sec
- Switch on SPICAV shutter A (HPC_ON to open the shutter)
- Switch on SPICAV shutter B (HPC_ON to open the shutter)
- Wait 60 sec
- Switch off SPICAV shutter A (HPC_OFF)
- Switch off SPICAV shutter B (HPC_OFF)
- if SPICAV_shutter_closed_ST_X = C_NOK and SPICAV_shutter_open_ST_X = O_ OK
  - Then perform the following steps

  (this case is applied when the the shutter is open after the previous operation. Second motion would not be applied if, for an unknown reason, the shutter has not been totally opened)

  - Switch on SPICAV shutter A (HPC_ON to close the shutter)
  - Switch on SPICAV shutter B (HPC_ON to close the shutter)
  - Wait 60 sec
  - Switch off SPICAV shutter A (HPC_OFF)
  - Switch off SPICAV shutter B (HPC_OFF)
  - Else do nothing
- Switch off LCL A -> SPICAV shutter A, via RTU X (DML_OFF)
- Switch off LCL B -> SPICAV shutter B, via RTU X (DML_OFF)

Else if SPICAV_shutter_closed_ST_X = C_OK and SPICAV_shutter_open_ST_X = O_ OK

Then perform the following steps:

(this is the case when shutter is closed and open, i.e. anomaly in the position detection; the position is unknown)

- Switch off SPICAV shutter A (HPC_OFF)
- Switch off SPICAV shutter B (HPC_OFF)

(this is in case previous HPC_ON was not followed by a HPC_OFF)

- Switch on LCL A -> SPICAV shutter A, via RTU X (DML_ON)
- Switch on LCL B -> SPICAV shutter B, via RTU X (DML_ON)

- Wait 5 sec
- Switch on SPICAV shutter A (HPC_ON to open the shutter)
- Switch on SPICAV shutter B (HPC_ON to open the shutter)
- Wait 60 sec
- Switch off SPICAV shutter A (HPC_OFF)
- Switch off SPICAV shutter B (HPC_OFF)
- if SPICAV_shutter_closed_ST_X = C_NOK and SPICAV_shutter_open_ST_X = O_ OK
  - Then perform the following steps

  (this is the case where the shutter is open after the first operation, shutter to be closed)
  - Switch on SPICAV shutter A (HPC_ON to close the shutter)
  - Switch on SPICAV shutter B (HPC_ON to close the shutter)
  - Wait 60 sec
  - Switch off SPICAV shutter A (HPC_OFF)
  - Switch off SPICAV shutter B (HPC_OFF)
  - Else do nothing
- Switch off LCL A -> SPICAV shutter A, via RTU X (DML_OFF)
- Switch off LCL B -> SPICAV shutter B, via RTU X (DML_OFF)

Otherwise do nothing.

Notes : There is nothing to do when Shutter is already closed

~~The case when both statuses show OK (i.e. closed and open) is not considered.~~

Recall of Used SPICAV Commands

Command	VERDI LNAME	Name (*)	Command Type	Via RTU I/O
switch off LCL A -> SPICAV_shutter_A	SPICAV_shutter_A (LCL_26A OFF)	**PPWM2291**	DML	A/B
switch off LCL B -> SPICAV_shutter_B	SPICAV_shutter_B (LCL_26B OFF)	**PPWM2239**	DML	A/B
switch on LCL A -> SPICAV_shutter_A	SPICAV_shutter_A (LCL_26A ON)	**PPWM2213**	DML	A/B
switch on LCL B -> SPICAV_shutter_B	SPICAV_shutter_B (LCL_26B ON)	**PPWM2161**	DML	A/B
switch off SPICAV shutter A	SPICAV SHUT OFF	**PSIG8600**	HPC8	A
switch off SPICAV shutter B	SPICAV SHUT OFF	**PSIG8600**	HPC136	B
switch on SPICAV shutter A	SPICAV SHUT ON	**PSIG8601**	HPC9	A
switch on SPICAV shutter B	SPICAV SHUT ON	**PSIG8601**	HPC137	B

(*) Name provided in RID, not checked by Spicav

****

end of cop