The Spacewire interface for HERSCHEL/SCORE suborbital mission

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Overview

- The HERSCHEL suborbital mission
- The HERSCHEL/SCORE instrument
- The SCORE CCD cameras
- The SpaceWire interface
The HERSCHEL mission

HERSCHEL is a suborbital mission borned by the collaboration between:

- Naval Research Laboratory (NRL)
- Goddard Space Flight Center
- A group of Italian Research Institutes

INAF - Osservatorio di Torino  U. Padova - INFM  U. Firenze  U. Pavia
HElium Resonant Scattering in the Corona and HELiosphere

The HERSCHEL experiment will observe the solar corona and the Sun disc. It will be launched with a Terrier-Brant booster drawing a ballistic trajectory with an apogee of 335 km.

HERSCHEL will observe only for ~300 sec, when the rocket will be beyond 250 km of altitude, and the coronal radiation is not absorbed by the earth atmosphere.
HElium Resonant Scattering in the Corona and HELiosphere

- The HERSCHEL payload consists of:
- A telescope
  HERSCHEL Extreme Ultraviolet Imaging Telescope (HEIT)
  HeII, OVI, FeX, FeXII solar disc images
- And 2 Coronagraphs
  HERSCHEL EUV Coronagraph (HECOR) HI, HeII,
  Sounding CORona Experiment (SCORE) HI, HeII,
  Visible Light (VL)
HElium Resonant Scattering in the Corona and HELiosphere

HERSCHEL objectives:

• First He observation in the extended corona (1÷3 R☉)
• First He and H EUV images in the corona + Sun disc
• He abundance measurement in the corona (He/H)
• Verification of solar wind models based on He abundance
• Test of instrumentation for future missions (Solar Orbiter)
The SCORE instrument consists of an externally occulted, off-axis Gregorian telescope with multilayer coated optics.
The SCORE instrument

- Primary mirror M1
- Internal occulter
- Filter Mechanism
- Secondary mirror M2
- Polarimeter

SCORE optical bench top view
The SCORE instrument

HI (121.6 nm) and visible simultaneous observation
The SCORE instrument

ICCD detector

CCD detector

Hell (30.4 nm) observation
The SCORE Cameras

Overview

Rocket skin
The SCORE Cameras

- Detector
- Clock generator
- Power supply
- Peltier controller
- Communication interface
- Signal analyzer and converter

Data
Commands
Ack
Why not commercial?

- Customized geometrical requirements
- Space application!
- High customization
- Automatic acquisition procedures (only 5 min!!)
- Smart Elettronics – the on board computer must send a minimal set of commands
Which communication protocol?

- SCORE cameras have to acquire images with a high rate (Exposure time for the visible channel is only 5s)

- The image downlink must be faster than the exposure time in order to not introduce unacceptable delay

- The selected detectors produce 4Mb of data for each image
Which communication protocol?

We needed a communication protocol:

- Reliable
- With high data rate
- offering low power consumption
- Space compliant

SPACEWIRE
IEEE 1355-1995

- The on board computer had a Spacewire PCI implementing the standard IEEE1355-1995

- We chose to implement the same protocol on the SCORE cameras using the SMCSLite device (Atmel T7906E).
SCORE Spacewire interface

Scheme

Spacewire interface

- FIFOs
- UART
- SMCSlite
- GPIO
- LVDS
- UART
- μcontroller
- Host IF
- Parallel link
- IEEE1355

16 bits data

8 bits
The SCORE Spacewire interface

CCD camera

Polarimeter Controller

VL channel

SpaceWire (IEEE1355)

16 bits DATA + header
Check
Housekeeping
Commands

CMD
DATA

EtherSpaceLink

Commands
Housekeeping

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SCORE Spacewire interface
The SCORE Spacewire interface:

- Manages the acquisition procedures
- Checks that the other camera board work properly
- Sends Housekeeping
- Accomplishes the data download
- Manages the communication with the on-board computer
- Implements an autonomous flight software
Although our SpaceWire interface has been developed for a custom application, its design is quite versatile:

• The several procedures and functionalities that it offers, are all realized by means of software implementation.

• The choice of reprogrammable devices enables to fit the performances of the interface to a specific applications easily changing the microcontroller firmware.

• It is able to write and store data in the internal FIFOs with an input rate ranging from 0 to 1 MHz without any change.

• It has a SpaceWire link but also other auxiliary interfaces
SCORE Spacewire interface

Features and performances:

- 16 bits input data bus with a writing rate from 0 to 1 MHz.
- 8Mb Storing capacity
- 1 SpaceWire link (IEEE-1355 DS/DE) with a maximum data rate of 130Mb/s currently
- 1 general purpose 8 bits parallel link
- 3 UARTs
- Customizable procedures
- It is vacuum compatible and (to be tested) vibrational resistant (not space compliant)
- ASAP fully Spacewire compatible (next year).
The Spacewire interface for HERSCHEL/SCORE suborbital mission

Thank you for your attention!
CCD Cameras scheme

Detector

Communication interface

Operating Status

Housekeeping

Data

SCORE Camera

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SCORÉ Spacewire interface

**Scheme**

- **Spacewire interface**
  - FIFOs
  - CPLD
  - UART
  - μcontroller
  - LVDS
  - GPIO
  - UART
  - Parallel link
  - IEEE1355

- **16 bits data**
- **8 bits**

**IEEE 1355** Parallel link

**Transmit**
The HERSCHEL mission

**HElium Resonant Scattering in the Corona and HELiosphere**

The HERSCHEL experiment will investigate coronal heating and solar wind acceleration from a range of solar source structures by obtaining simultaneous observations of the electrons, protons and helium abundances in the solar corona.
Why HERSCHEL?

- the actual knowledge of helium at coronal altitudes is essentially based on theoretical studies.
- Despite this crucial role, there is a lack of observations of He in the corona.