bit (Bi-directional Iridium Telemetry)

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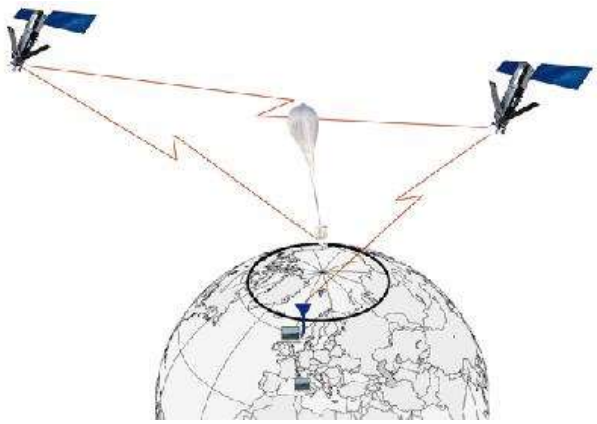
Introduction



MSITEL module family is a telemetry system to be used onboard stratospheric balloons. Its design allows interface with one or more intelligent I/O units, like those realized in cooperation with INAF-IASF Bologna, as well as different (user provided) instrumentation. MSITel provides the remote control through any available satellite system (e.g. Iridium) using a specific data modem. Current configuration Main features: Management of two Iridium modem devices up 4800 bps; Management of the 2 integrated GPS units; Several type of I/O line available (analogue/digital/RS232); Storage of the acquired data into non-volatile support (Compact Flash); Low power consumption, 250 mA @12V in stand-by mode. MSITel is a modular system, that allows up to 38.4 (with Iridium) kbps by using up to 8 units. In case of using more than one MSITel unit, another device must be used to collect/distribute data from/to such 2- 8 units. This Data Collector unit is also available by LEN. The Ground Station setup needs only one or more laptop PC and modem(s). Telemetry data can be shared via Ethernet link according to user's policy. The Ground Station S/W allows an easy monitoring of both housekeeping and scientific data. The MSITel allows extended function customization according to user defined instruction (through meta-language scripts). If needed, the users can create their own Ground Station S/W and Quick-Look by following instructions into the Technical Manuals.

1 Telemetry system

The BIT telemetry unit (Fig. 1) is a custom version of the MSITel module [4,5,6], a Control Telemetry Unit designed and tested to match the requirements of a system to be used onboard stratospheric balloons. Its design allows interface with one or more intelligent I/O units, like those realized in cooperation with the INAF-IASF Bologna, as well as different user provided instrumentation.
MSITel (MultiSource Intelligent Telemetry) provides the remote control through any available satellite network system using a specific data modem. All the satellite systems are supported, such as Iridium, Inmarsat, Globalstar, Thuraya and any other communication systems because MSITel is easily adaptable to all modems that are AT command compatible up to bit-rate of 19200 bps. No h/w changes are needed but only the s/w shall be modified. The version used in the Sureca BIT-10 mission has been optimized and tested for Iridium platform, which is the one able to guarantee full coverage all over the World.
The Iridium modems are by NAL Research (mod. A3LA-D).


Figure 1.0 The BIT telemetry system

The BIT telemetry system MSITel has 2 GPS units integrated with external antennas and several I/O, both analog and
Furthermore MSITel system is available in different versions and it is easy customizable.
All the data acquired by the unit, even if not transmitted according to user defined priority rules, are stored in compact flash cards (up to 8 Gbytes). MSITel makes use of a real-time clock, synchronized with onboard GPS, to provide absolute timing for the data storage. This provides a safe time correlation for all stored events. The connection with the Iridium modems (both the master and the back-up units) is provided by a 9-wire RS-232 serial line (hardware handshake). The power supply to each modem unit is provided separately. The bandwidth (bit-rate) can be doubled by using both the onboard modem units (split mode), simultaneously. The MSITel board unit has also additional sensors for monitoring Power Supply Voltage, internal VDC and the unit actual temperature.
The MSITel allows extended function customization according to user defined in struction (by meta-language scripts - MTL) and up to six MSITel modules can be used to have higher (up to 28800 bps) telemetry bit-rate by using an additional unit (available by LEN).
Since the BIT system have to manage the scientific data coming from the CZT detector and the two webcams, the basic module was equipped with a PC104 unit operating as scientific data central manager.

After the switch ON of both the PC104 and the CZT sensor by a proper telemetry command, the Ground station user asks either for CZT or webcam image data BIT, which forward the request to the PC104 (Fig. 2).
Each event arriving from the CZT detector is stored in a packet (each packet contains up to 190 events). When at least a packet is full the PC104 sends it to MSITel (if requested), which provides to send it to ground stations and to store the data in the compact flashes.
The Ground Station S/W allows an easy monitoring of both housekeeping and scientific data. The *MSITel* allows extended function customization according to user defined instruction (by meta-language scripts) If needed, the users can create their own Ground Station S/W and Quick-Look by following instructions into the Technical Manuals.

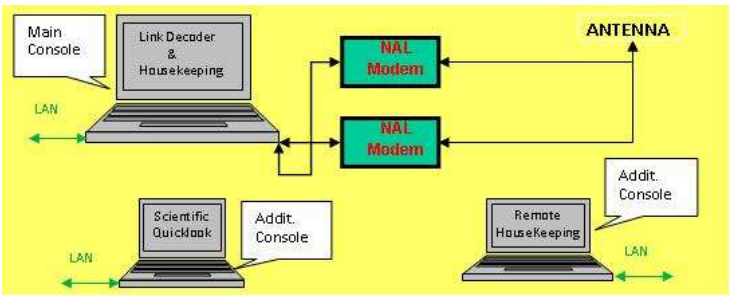


Figure 2.0 The scientific payload organization

2 The scientific payload

The scientific payload included a high energy radiation detector based on a CZT sensor made by IMEM/CNR-Parma, using material developed and grown by the same group, and an interface module generating an RS232 data stream that could be directly connected to one of the BIT telemetry serial port (Fig. 3).

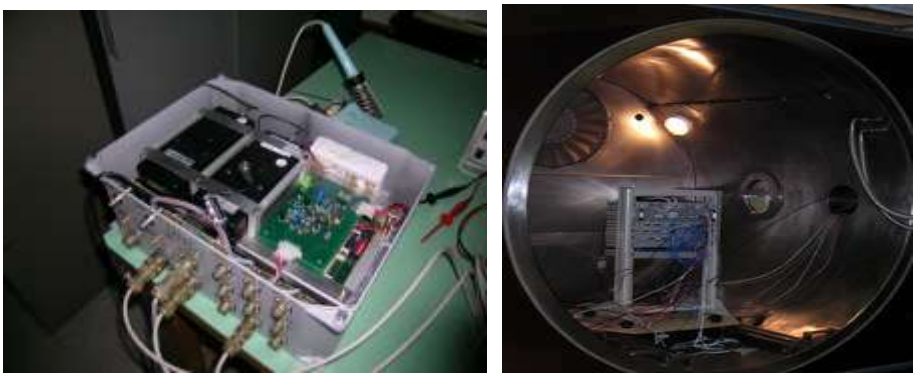


Figure3.0 STRADIUM-LDB inside the thermal vacuum chamber at IASF-Bologna

The sensor, with planar mono-electrodes, is a CZT crystal of 1.6×1.4×0.2 cm3 implemented in a small metallic box providing both light and electromagnetic shielding and containing:
The high voltage (up to 1200 V) supply for the CZT sensor based on a EMCO DC-DC converter;
-The analogue readout chain of the detector signals based on CREMAT hybrid devices: a charge sensitive preamplifier CR-110 and a shaping amplifier CR-200. The sensor box has a 9-pin tray connector for power supply (+/- 12 volts) and a BNC connector for analog signal output. On the same side a trimmer screw for adjusting the high voltage and a jack for the monitor of the HV are available. The CZT sensor is normally operated between 200 and 400 volts.

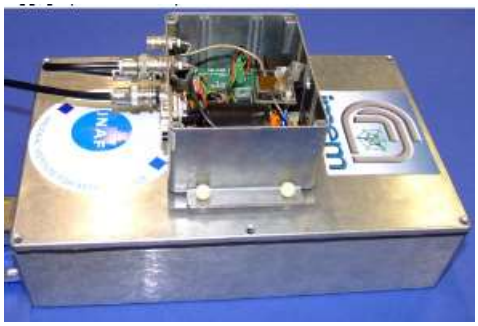


Figure 4.0. The detector system: the CZT sensor (visible on the right) box screwed on top of the interface unit.

A separate box contains the interface module that get the signal output (in volts) from the sensor module, discriminates the signals above a selected threshold and integrates them over a defined time. Then it sends, by RS232 communication, the number of counts per second to the corresponding connector of BIT. This scientific instrumentation had two main purposes:
-To determine the count rate from 30 to several hundred keV of X/gamma and charged particles as a function of latitude and longitude and as a function of altitude.
-To verify the performance and the robustness of CZT sensors developed entirely with Italian technology in a pseudo space environment and to assess their suitability for the realization of compact space radiation monitors.

3 Flight

In July a Long Duration Balloon has been launched from Longyearbyen (Svalbard Islands) by the Italian Space Agency together with Andoya Rocket Range. Onboard there was even the new telemetry system BIT (Bi-directional Iridium Telemetry) made by INAF-IASF Bologna and by LEN srl on the MSITel board (LEN srl). BIT has provided continuous real time telemetry and telecommand link for the SIDERALE experiment, realized by a national collaboration lead by INAF-IASF Milano (IASF-MI/BO/PA/RM). BIT has provided also the ballast management for the whole payload in additon to other services. BIT worked perfectly for the whole flight duration and during landing, that took place near Pond Inlet (Baffin Island, Canada) on July 4th at about 00:30 AM local time.

Figure 5.0. Balloon flight trajectory

After landing BIT has continued to work untill batteries finished, about two days later. The main Ground Station, the one from which telecommands were sent, was situated at the LEN laboratories near to Genova (Italy). The use of BIT has allowed scientists to get real time scientific and housekeeping data from more than 30 ground stations located in Italy and Norway.