MSG's Communications Payload

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The highly reliable communications system needed for data transmission and distribution for the mission is provided by the MSG Communications Payload (MCP) carried on the spacecraft. It consists of three main elements, namely the Antenna Subsystem, the MCP Transponder, and the TTC Transponder.

The Antenna Subsystem
The MSG telecommunications system has to provide a number of mission-critical services, each of which requires a particular type of antenna:
- Reception of telecommands and transmission of housekeeping data: the S-band transponder is responsible for this task and is connected to a dedicated telemetry, tracking and command (TTC) antenna.
- Transmission of the measured radiometer (SEVIRI) data, coming from the data-handling subsystem, to the primary ground station: the Electronically Despun Antenna (EDA) used for this task operates at L-band.
- Reception of pre-processed images with associated data: a Toroidal Pattern Antenna (TPA) operating at S-band is used for this task.
- Transmission to users: this relies on the L-band EDA antenna for low-resolution and high-resolution data.
- Reception data from Data Collection Platforms (DCPs): this requires an electronically switched circular array antenna and uses the UHF EDA operating at 402 MHz.
- Transmission of the DCP data: this is provided by the L-band EDA antenna.
- Reception of emergency (Search & Rescue): this relies on the UHF EDA operating at 406 MHz.
- Transmission of Search & Rescue messages: this is provided by the L-band EDA antenna.

Figure 1 shows the flight-model MSG Antenna Subsystem.

The S-band TTC antenna is a low-gain, wide-coverage antenna, the design of which has been optimised for MSG, taking into account the spacecraft's much larger body compared to the previous Meteosat satellite series.

The Toroidal L- and S-band antennas are narrow-band, reduced-height, slotted-wave-

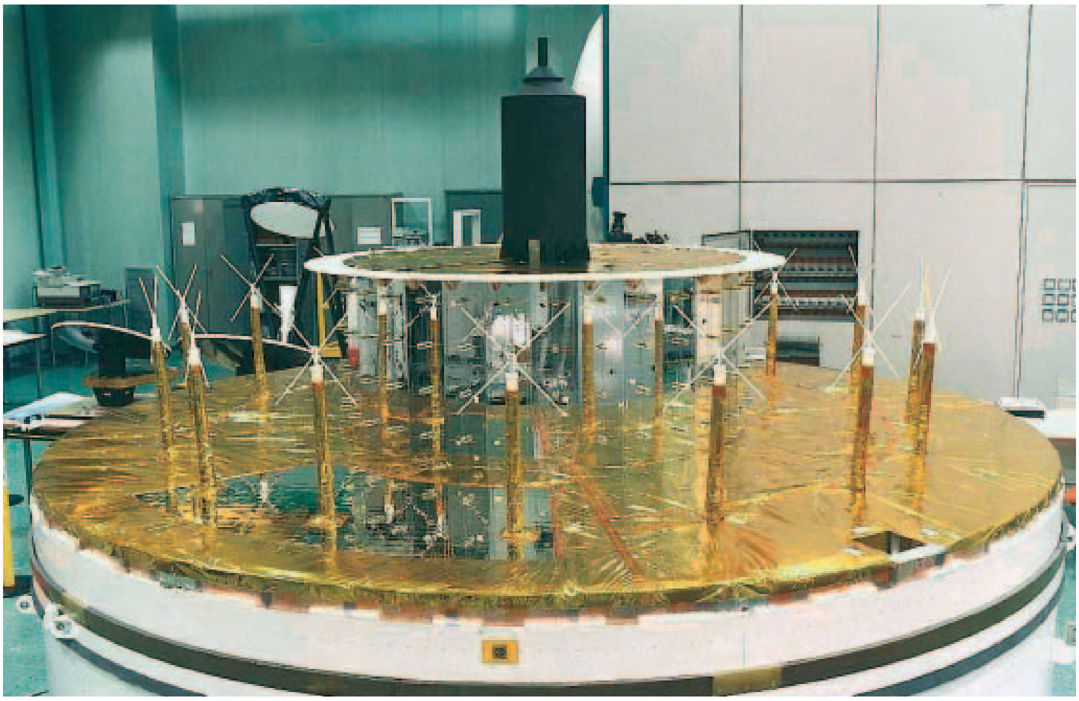

Figure 1. The flight-model MCP Antenna Subsystem

guide antennas, which provide toroidal patterns in the plane perpendicular to the satellite spin axis.

The L-band EDA is used in transmit mode only, to send the raw image data to the primary ground station and the processed data, received via the S-band link, to the secondary users. As the satellite rotates at 100 rpm and the high-gain antenna beam needs to be aimed continuously at the ground, an electronic means of despinning this beam in the opposite direction to the satellite's rotation is implemented. This antenna is composed of 32 columns of 4 dipoles each, and is mounted on a cylindrical construction close to the top of the satellite.

The UHF-band EDA is used to receive the meteorological data from the DCPs operating in the UHF band and the newly implemented Search & Rescue mission on MSG. An electronically switched UHF array of 16 crossed dipoles has been selected for the purpose. Of the 16 dipoles, four are used to form the beam, whereby the next dipole is selected every 22.5° synchronised with the satellite's spin rate.

To control and supply all of the complex timed switching for the various active elements of the antenna subsystem, a dedicated piece of equipment known as the Common Antenna Control Electronics (CACE) is used. It receives synchronisation signals from the Data Handling Subsystem and generates the correctly timed drive signals for the Antenna Subsystem.

The MCP Transponder Subsystem

The MCP Transponder Subsystem's tasks on-board the satellite are the reception, amplification and transmission of the following channels:

- Raw Data Channel: down-linking to the Primary Ground Station (PGS) of the SEVIRI (and GERB when applicable) raw data stream, plus auxiliary/ancillary information received from the Data Handling Sub-system.
- HRIT Channel: high-data-rate dissemination to the user community (High-Rate User Stations, or HRUSs) of processed meteo-rological data and images received from the PGS.
- LRIT Channel: low-data-rate dissemination to the user community (Low-Rate User Stations, or LRUSs) of processed meteo-rological data and images received from the PGS.
- DCP Channel: relay of messages from the Data Collection Platforms to the PGS for further distribution.
- Search & Rescue Channel: relay of distress signals from emergency beacons on the visible Earth's disc to dedicated ground stations (Cospas/SarSat network).

Figure 2 gives a block diagram of the MCP, and Figure 3 is a photograph of the first flight transponder during integration.

The raw data signal coming from the Data Handling Subsystem is fed to the Raw Data Modulator (internally redundant), which performs the QPSK (quaternary phase-shift keying) modulation before the data enters the Intermediate Frequency Processor (IFP). The IFP also receives the HRIT and LRIT signals coming from the S-band antenna via the

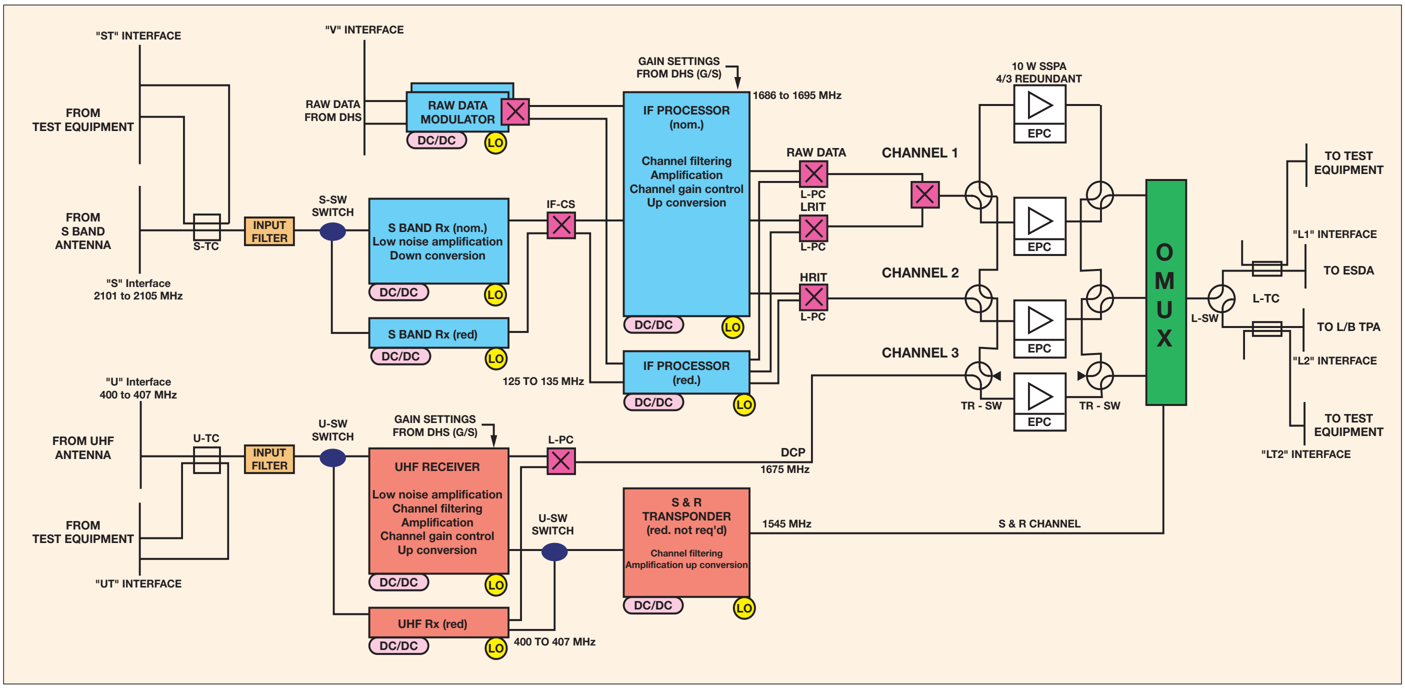

Figure 2. Block diagram of the MSG Communications Payload (MCP)

S-band filter and the S-band receiver (two in cold redundancy), which provide the necessary low-noise amplification and frequency down-conversion. The IFP equipment, which operates in cold redundancy, filters and up-converts the three signals separately and amplifies them to a selected output level or with a certain fixed received-signal (RD, HRIT and LRIT) gain set by ground command. The output signals of the IFP drive the Solid-State Power Amplifiers (SSPAs) directly to their chosen operating points.

The multi-carrier DCP channel, which can be composed of up to 460 individual carriers, enters the transponder together with the Search & Rescue signal via the UHF filter and feeds the two UHF receivers (configured in cold redundancy). They perform the low-noise amplification and frequency up-conversion to the corresponding down-link frequency in L-band. The DCP signal is then forwarded to the SSPA matrix for further amplification.

The SSPA matrix is composed of four SSPAs (output power about 10 W per amplifier) in a 4:3 redundancy scheme. One SSPA is allocated to the HRIT channel, one is used by the RD and LRIT channels simultaneously, and one is dedicated to the DCP channel. The remaining redundant SSPA can be used by any of the other channels in the event of a failure.

The Search & Rescue signal is pre-amplified by the UHF receiver and then further filtered, frequency up-converted and power-amplified in the Search & Rescue Transponder.

After power amplification, all of the channels (RD+LRIT, HRIT, DCP and S&R) are filtered and combined in the output multiplexer (OMUX), before being fed to the Antenna Subsystem.

The TTC Transponder Subsystem

The Telemetry, Tracking and Command (TTC) Subsystem consists of two S-band transponders and it performs the following functions:

- Reception and demodulation of the up-link command and ranging subcarriers of the S-band signal transmitted by the ground control station.
- Delivery of the telecommand video signal to the on-board Data Handling Subsystem.
- Modulation of the down-link carrier by the received and demodulated ranging signal and the telemetry signals received from the on-board Data Handling Subsystem.
- Power amplification and delivery of the S-band down-link carrier to the Antenna Sub-system.

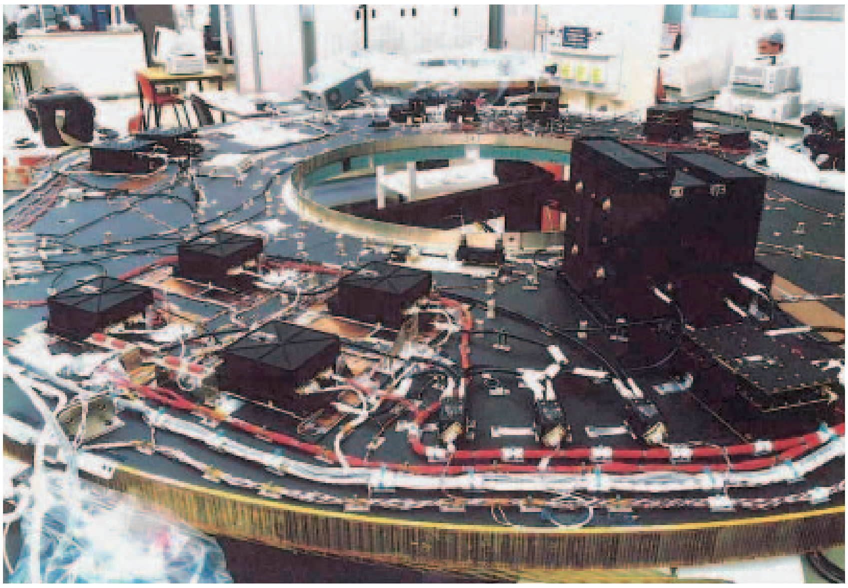

Figure 3. Integration of the first flight-model MCP Transponder

The down-link carrier can be generated coherently or non-coherently with respect to the up-link carrier received from the ground station.

The TTC Subsystem is composed of two identical transponders, each consisting of several modules packaged in a single unit (Fig. 4). The receiver and transmitter of each transponder are electrically independent, except for the necessary interconnections to perform the ranging operations. The receivers and the transponders will always be 'on' throughout the satellite's lifetime, with the transmitters operated in cold redundancy.

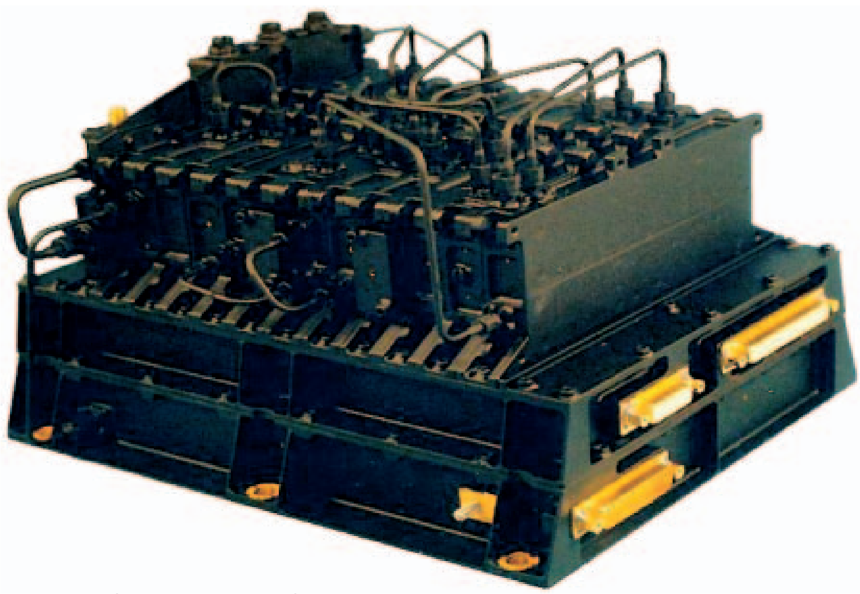

Figure 4. One of the two TTC Transponders