THE GMES SENTINEL-1 C-SAR INSTRUMENT

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1. INTRODUCTION

In the frame of the 'Global Monitoring for Environment and Security (GMES)' programme, ESA is undertaking the development of the European Radar Observatory Sentinel-1, a European polar orbiting satellite system for the continuation of SAR operational applications. Sentinel-1 is an imaging radar mission in C-band, aimed at providing continuity of data for user services, in particular with respect to the ESA ERS and Envisat missions.

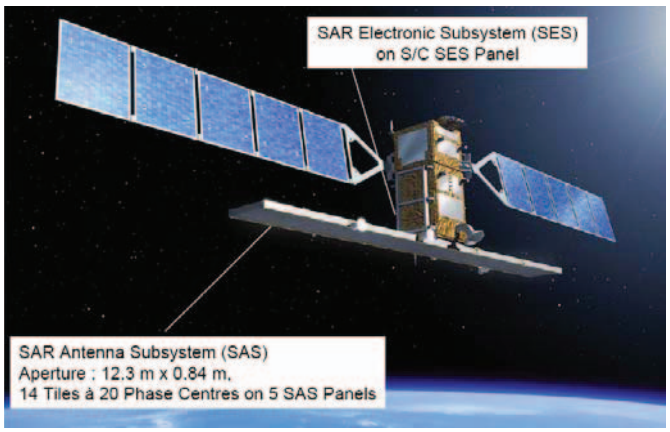


Fig. 1 Sentinel-1 Space segment with indication of SAR Instrument Subsystems location

The Sentinel-1 space segment is designed and build by an industrial consortium with Thales Alenia Space Italia as prime contractor and EADS Astrium GmbH as C-SAR instrument responsible. The detailed design phase will be concluded by a Critical Design Review (CDR) in April 2010 and flight hardware manufacturing released.

2. SAR INSTRUMENT DESIGN

The C-SAR instrument for the Sentinel-1 mission is composed of two major subsystems, the SAR Electronics Subsystem (SES) and the SAR Antenna Subsystem (SAS), whose design and development statuses are outlined in the following subsections. An artist's view of the space segment with indications of the locations of the SES and the SAS is given in Figure 1.

2.1 SAR Electronics Subsystem (SES)

The fully redundant SES comprises three basic elements, the Integrated Control Electronics (ICE), the Transmit Gain Unit (TGU) and the Mission Dependent Filter Equipment (MDFE). A block diagram of the SES is shown in Figure 2. To keep the diagram simple, only the nominal chain is shown.

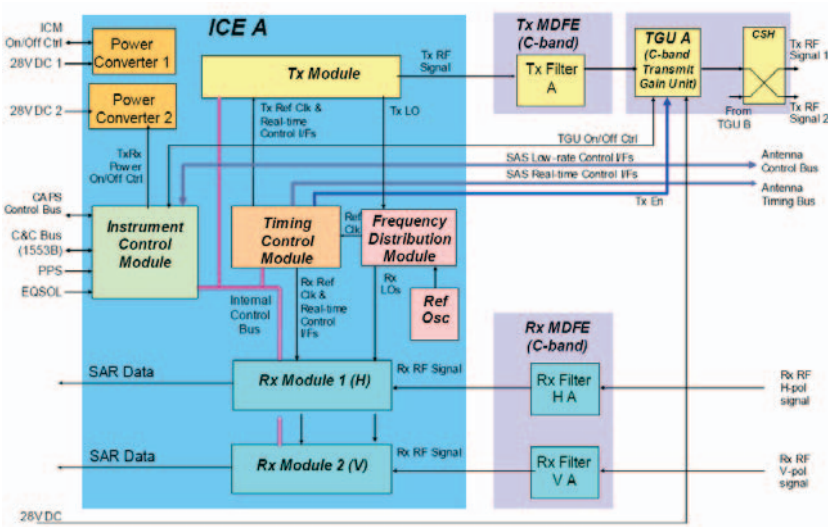
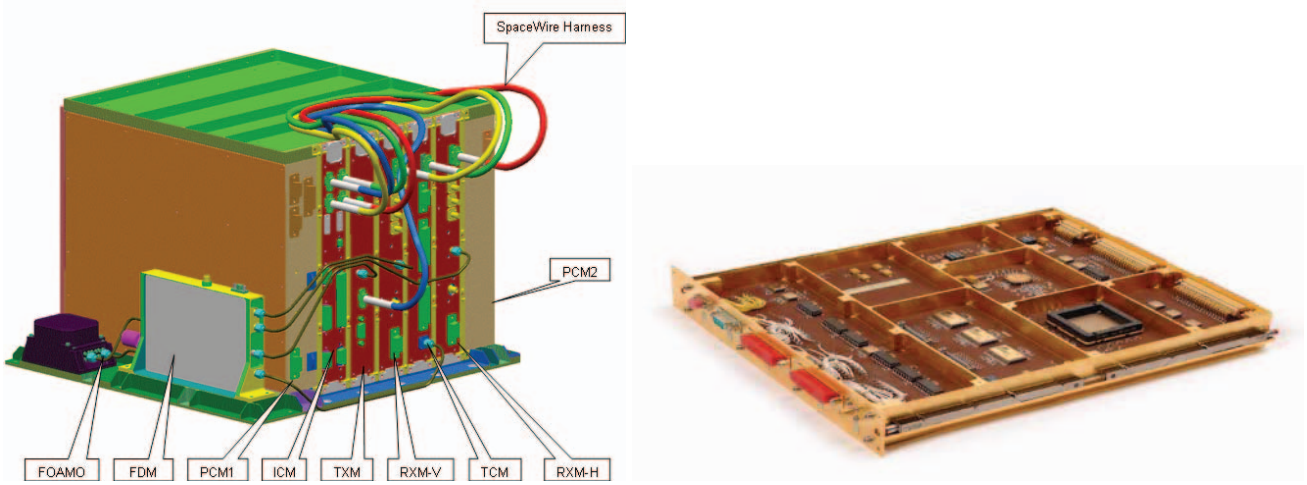


Fig. 2 Sentinel-1 SES Electrical Block Diagram (only nominal chain shown)

The signal is generated by a digital chirp generator in the TX Module, up-converted to C-band and then sent via the Tx filter of the MDFE and the C-band amplifier in the TGU towards the antenna. The received echoes coming from the antenna are filtered by the two Rx filters in the MDFE and handed over to the Rx Module in the ICE, where they are A/D converted, digitally filtered, compressed and formatted.



a) b)

Fig. 3 a) CAD Model of Sentinel-1 SES Integrated Control Electronic (ICE) and b) Engineering Model of ICE Time Control Module (TCM)

The whole process is controlled by the Instrument Control Module (ICM), which forms also the command and control interface to the platform, and which controls the antenna via the Antenna Control Bus. The timing of the SES is generated by the Timing Control Module (TCM) within the ICE. It provides also the timing signals for the antenna via the Antenna Timing Bus. Fig. 3a shows a CAD Model of the ICE electronic box indicating the different slices of which it is composed. Fig. 3b provides a photograph of one of these slices, i.e. the Engineering Model of the ICE Time Control Module (TCM).

2.2 SAR Antenna Subsystem (SAS)

The Sentinel-1 SAR Antenna Subsystem (SAS) is a deployable planar phased array antenna carrying 280 phase centres, which are organised in 20 rows (elevation) and 14 columns (azimuth) as outlined in Figure 1. The antenna comprises such 14 identical SAS Tiles, which form the smallest functional entity of the SAR Antenna Subsystem. An electrical block diagram of the antenna and the SAS Tiles is shown in the figure below.

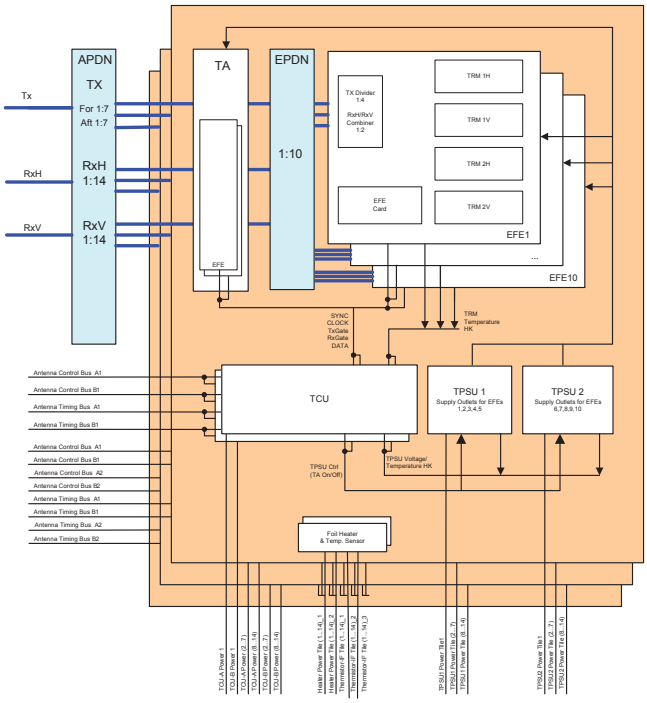


Fig. 4 Sentinel-1 Electrical SAS Block Diagram

The signal received form the SES is distributed by the Azimuth Plane Distribution Network (APDN) to the 14 Tiles. There it is amplified by a cold-redundant Tile Amplifier and distributed to the Transmit/Receive Modules in the so-called EFEs via the Elevation Plane Distribution Network (EPDN). Each of the 10 pairs of dual polarised low-loss slotted waveguide radiators of each SAS Tile is fed by a single dual polarised EFE, which consists internally out of 4 single polarized Transmit/Receive Modules. The EFEs on each Tile are controlled by a cold redundant Tile Control Unit (TCU) and supplied by two Tile Power Supply Units (TPSU).

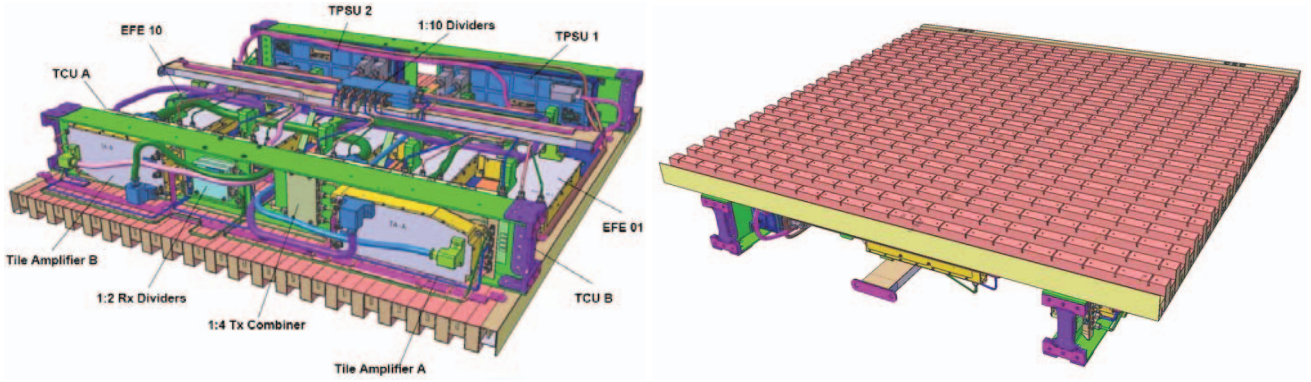


Fig. 5 CAD Model of Sentinel-1 SAS Tile : a) Back View showing the SAS electronic equipment and b) Front View showing the SAS waveguides

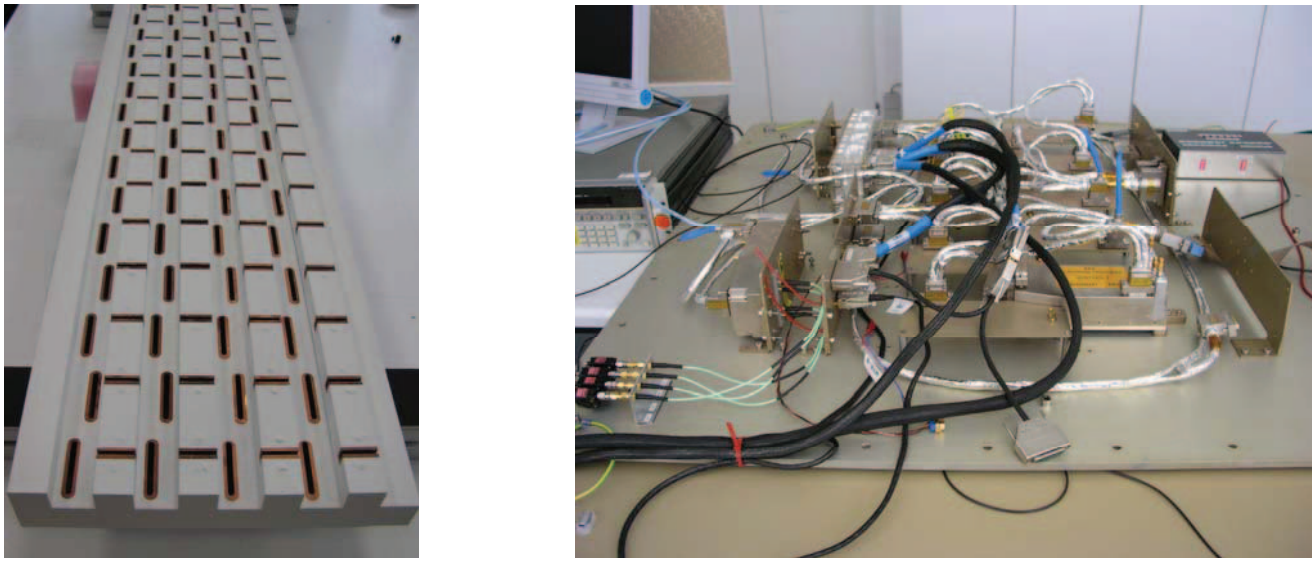


Fig. 6 a) Demonstration Model of SAS Waveguides b) SAS Mini-Tile Engineering Model (EM)

The location of the different electronic and RF equipment on the SAS Tile is illustrated in Fig. 5. A Demonstration Model (DM) of the Waveguide Radiator Assembly with four dual polarized waveguides is shown in Fig.6a. Early functional verification with Engineering Models (EM) of the SAS electronic equipment is currently performed with the so-called Mini-Tile EM shown in Fig. 6b, which provides the basic functionality of a SAS Tile.

The presentation will give an overview on the Sentinel-1 C-SAR instrument and its current programmatic and technical status. After a presentation of the instrument design and its key design features, the presentation will conclude with an overview on the predicted instrument SAR performance.

3. REFERENCES

[1] E. Attema, *ESA Mission Requirement Document for the European Radar Observatory Sentinel-1, ES-RS-ESA-SY-007*, ESA-ESTEC, July 2005

[2] Evert Attema, Malcolm Davidson, Paul Snoeij, Bjorn Rommen, Nicolas Floury, "Sentinel-1 Mission Overview," *Proceedings of International Geoscience and Remote Sensing Symposium (IGARSS) 2009*, July 2009