SMWD 2023, KTH Royal Institute of Technology, Stockholm, 23rd – 25th May 2023

Low Loss L-band Feed Assembly

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This paper will present the L band feed assembly which will be used as a part of the radiometer instrument for the ESA Copernicus Imaging Microwave Radiometer (CIMR) satellite mission. The L band feed assembly is the feed for a large deployable mesh reflector pointing at the Earth. The CIMR instrument will measure the temperature and salinity of the ocean surface, and the sea ice extension in the polar ice caps.

The L band feed assembly is an array of 12 dual polarized (horizontal and vertical) Patch Excited Cup (PEC) elements, where the element is an evolution of Beyond Gravity heritage designs. The PEC element is designed to be compatible with close-packed arrays. The antenna is designed for a center frequency of 1.4135 GHz with a bandwidth of 27 MHz. The array includes an integrated beam forming network (BFN), combining the signals from the elements in the array to two outputs (horizontal and vertical polarization).

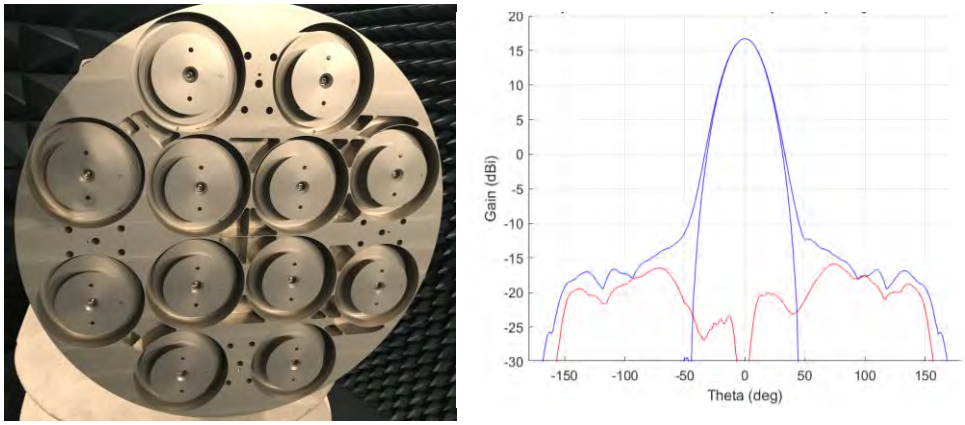

Figure 1. L band Feed Assembly and measured co and cross radiation pattern (min/max over phi).

A radiometer antenna measures the black-body radiation temperature. From an antenna point of view the measured temperature can be divided into three temperatures, the main lobe temperature, the side lobe temperature, and the antenna ohmic loss temperature. Here we are only interested in the main lobe temperature and the side lobe and ohmic loss temperatures can be seen as uncertainties in the measurements. Therefore, it is important to keep the sidelobe and ohmic losses of the antenna to a minimum. It is also important to verify these quantities with high precision to keep the uncertainty down.

The sidelobes are mainly affected by the amplitude tapering of the array elements. The amplitude tapering also affects the main lobe beamwidth and further the reflector performance. So, the amplitude tapering is a trade-off between the sidelobe level and the main lobe performance.

The L band feed assembly has been designed to have very low losses. The design is an all-metal one, with only small amounts of dielectric stand-offs for support of the internal feed/phasing networks and for the tower feed.

To measure precise antenna loss is a challenging task. Usually, the antenna loss is measured by a standard gain horn substitution method in an anechoic chamber. This results in a loss uncertainty of 0.2 – 0.3 dB.

For the L band feed assembly a method combining measurements and simulations has been used to evaluate the ohmic losses and reduce the loss uncertainties. The measurements were also performed over a temperature range. The method includes a specially designed back-to-back model where the losses can be measured by measuring the S-parameters using a network analyzer. The back-to-back model includes everything in the feed assembly except the radiating patches and the cups. As the feeding of each patch includes a sufficiently long coaxial line, we can build a mirror part of the first part to finalize the back-to-back model without changing the electromagnetic currents feeding the patches. Now the S-parameter measurement only consists of one two-port measurement which reduces the measurement uncertainties to a minimum. The back-to-back model can be seen in Figure 2, and the measured ohmic losses per polarization and over temperature for the back-to-back model can

be seen in Figure 3. The measurements were then correlated with simulations which were performed in Ansys HFSS. The measured ohmic loss of the back-to-back model is twice the actual losses for feed assembly minus the losses of the patches and the cups. Using the information from the correlated simulation we can build an Ansys HFSS simulation model of the complete feed assembly including the patches and cups. The ohmic loss for the patches and cups is then extracted and added to the total ohmic loss of the L-band feed assembly. The added analyzed loss for the patches and cups is 0.01 dB, and hence the temperature dependency is negligible within the measured temperature range.

The result of the measurements and analyses for the L band feed assembly is that the ohmic losses are 0.12 dB at ambient temperature with an uncertainty of ±0.03 dB.

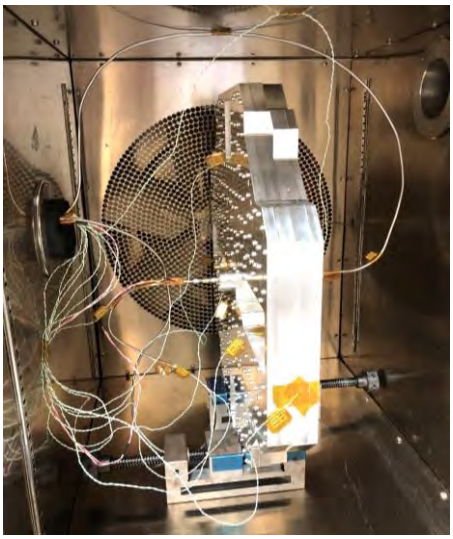

Figure 2. L band Feed Assembly ohmic loss measurement, back-to-back model.

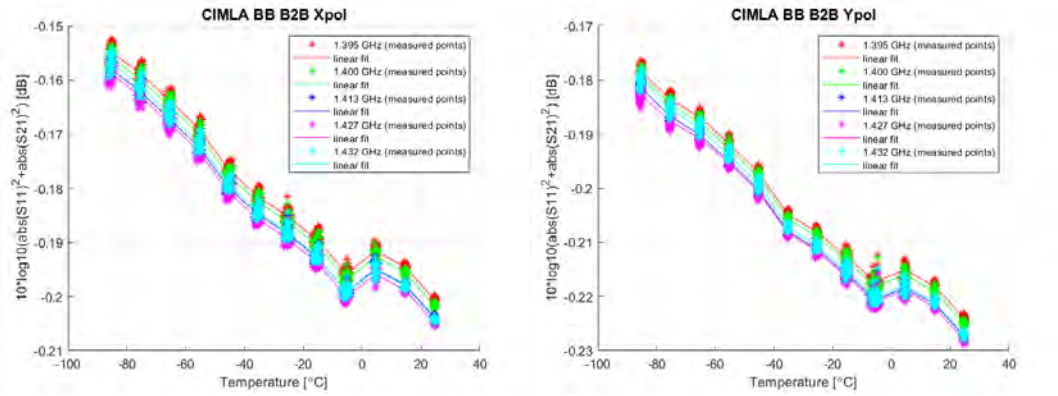

Figure 3. Measured back-to-back model losses versus temperature, V and H polarisation.