POLARIZATIONS OF VSOP AND RADIOASTRON RADIO LINKS

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25 July 1992

This memo is intended to describe unambiguously the specified link polarizations for Radioastron and VSOP. For the Green Bank earth station, it is quite important that there be no confusion about this, as will be explained below.

For Radioastron, the specified polarizations [1] are:

Timing uplink, 7.215 GHz	LEFT CIRCULAR;
Timing downlink, 8.47 GHz	RIGHT CIRCULAR;
*Data downlink, 15.06 GHz	RIGHT CIRCULAR.

For VSOP, the specified polarizations [2] are:

Timing uplink, 15.3 GHz	LEFT CIRCULAR;
*Data and timing downlink, 14.2 GHz	LEFT CIRCULAR.

In accordance with standard definitions [3], we take "RIGHT circular" polarization to mean that the electric field vector in the propagating wave rotates CLOCKWISE when viewed from the transmitting antenna.

The most important consideration here, from our point of view, is that the data downlinks for the two spacecraft (marked "*" in the lists above) have opposite senses of circular polarization. This is because of the unfortunate choice of VSOP uplink frequency very close to the Radioastron downlink frequency, plus the requirement that the VSOP links have the same polarization in both directions. The VSOP downlink receiver must have a filter at its input to reject very strongly the uplink transmitter signal; this filter cannot pass the Radioastron downlink signal without significant attenuation. Therefore, either a separate receiver for Radioastron or a complex and lossy switching scheme must be introduced if both spacecraft are to be supported. A separate receiver, without switching, can be implemented in the opposite polarization.

To illustrate this concretely, consider the block diagram of the Green Bank earth station front ends, shown in Figure 1. At Ku band we have a dual-circular-polarization transducer from coax to circular waveguide, with the latter connected directly to the feed horn. Each coaxial port connects to an independent receiver, with the left circular channel (VSOP) containing a transmit/receive diplexer consisting of a circulator and an band-reject filter. Due to the filter, this channel has very low sensitivity at the Radioastron downlink frequency; however, the right circular channel (Radioastron) retains full sensitivity at this frequency. At X band, polarization diplexing is used to separate the uplink and downlink, since the spacecraft will use opposite polarizations in the two directions.

In our implementation, it is easy to reverse the senses of polarization of the two channels of one front end. Thus, at Ku band, VSOP could just as well use the right circular channel and Radioastron the left. However, this reversal requires a major disassembly of the dewar and should only be done once. Installation of switches to allow this reversal to be done quickly and repeatedly would be possible, but

it is highly undesirable because of the loss in performance and reliability that it would introduce. It is therefore important to insure that the VSOP and Radioastron data downlinks use OPPOSITE circular polarizations.

Note that the polarizations described here refer to waves propagating in free space. The polarization of a feed horn of a reflector antenna will have the reverse sense of polarization if the wave undergoes an odd number of reflections.

The information in this memo has been reviewed by both ISAS and Astro Space Center, and we have received positive confirmation that the polarizations to be used by each spacecraft are as described here.

REFERENCES

[1] N. Kardashev, V. Andreyanov, V. Rogalskiy, V. Altunin, "Radioastron Radiolink and Tracking Station Specification<." Astro Space Center, 1990.

[2] Z. Yamamoto, fax message to L. D'Addario dated 2/2/91.

[3] IEEE Standard Test Procedures for Antennas, IEEE Std. 149-1979, Institute of Electrical and Electronics Engineers, New York, 1979.'

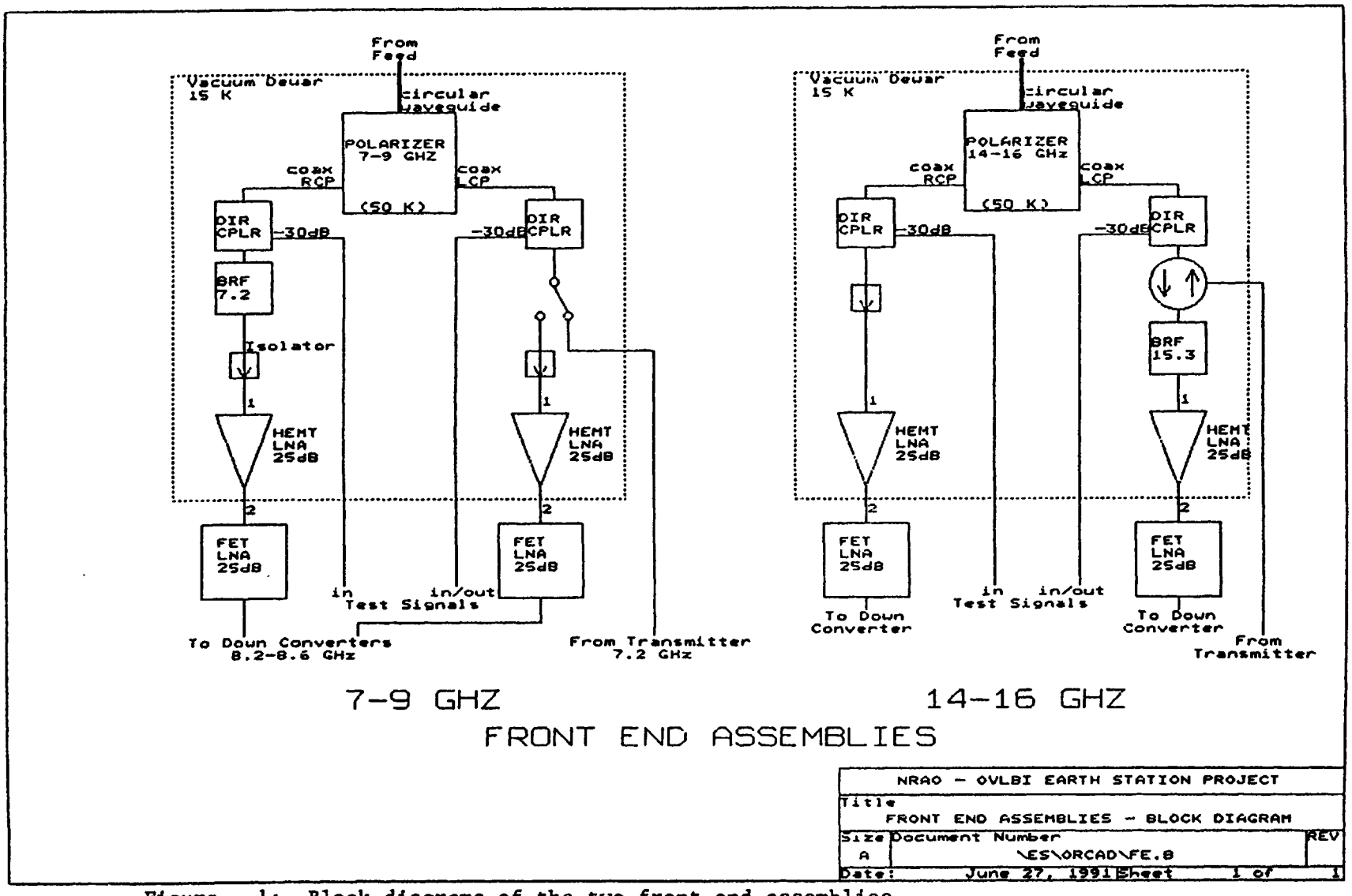

Figure 1: Block diagrams of the two front end assemblies.