MEASUREMENT OF CRYOGENIC PERFORMANCE OF 4-8 GHz PAMTECH ISOLATORS S/N 108-112

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ABSTRACT

This report presents the results of the measurements of input and output reflection, insertion loss and isolation of the first five 4-8 GHz cryogenic isolators (SN 108 to 112) to be used in the development of mixers by different groups of the consortium of the HIFI instrument for FIRST. The Isolators were specified by PAMTECH at 77 K, and the goal of these measurements was to determine the correct operation of the devices at lower cryogenic temperature (15 K). It is planed to use them even at lower temperature (4 K) in HIFI.

1 MEASUREMENT SYSTEM

The isolators were measured in a Dewar with a CTI 1020 refrigerator. The input and output transitions were stainless steel coaxial air lines with K (2.92 mm) home-made vacuum seals. The measurements were performed with a Vector Network Analyzer HP8510 C. A full two-port calibration of the VNA was done with reference planes in the interface of the K connectors at the end of the flexible cables of the VNA (outside the Dewar). As the reflection was masked by the effect of the transitions, a time domain gate was applied to extract the reflection coefficient of the isolator. To correct for losses in the input and output lines, the values of S21 and S12 were normalized respect to the value of a short, low loss, u-shaped cable connecting input and output ports inside the Dewar. The attenuation of the stainless steel input and output lines is assumed to remain constant with temperature, as have been determined by previous tests. The input port of the isolator was connected to the female connector of the stainless steel line using a K male-male transition (RADIALL R127 703 001). The output was connected using a small length of semi-flexible cable (SUCOFORM 141 by SHUNER) with male SMA connectors (RADIALL R125 055) in both ends (Figure 1). The validity of this measurement procedure was checked by comparing the results obtained at room temperature for the isolator inside the Dewar with that of the same isolator directly connected to the VNA cables (see figures 2 and 3). In general, the precision is sufficient to see the general trend for all the parameters, although it is not a highly accurate method. The residual ripples of S21 (insertion loss) make more difficult the comparison of this parameter with the specification.

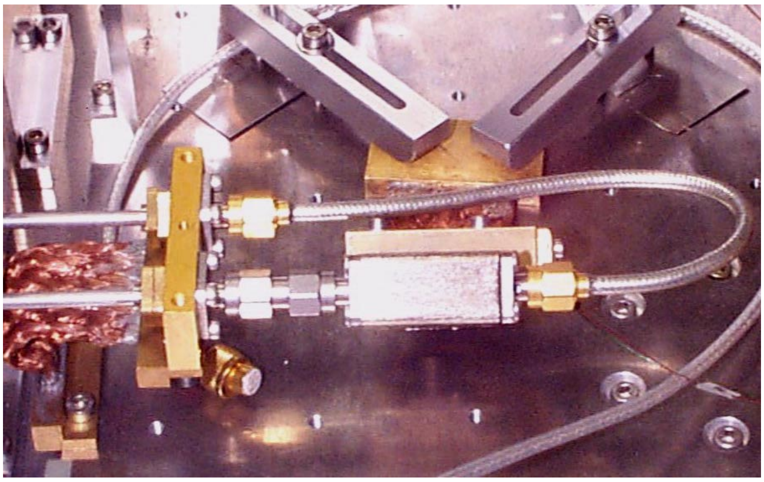

Figure 1: Isolator PAMTECH Inside test Dewar.

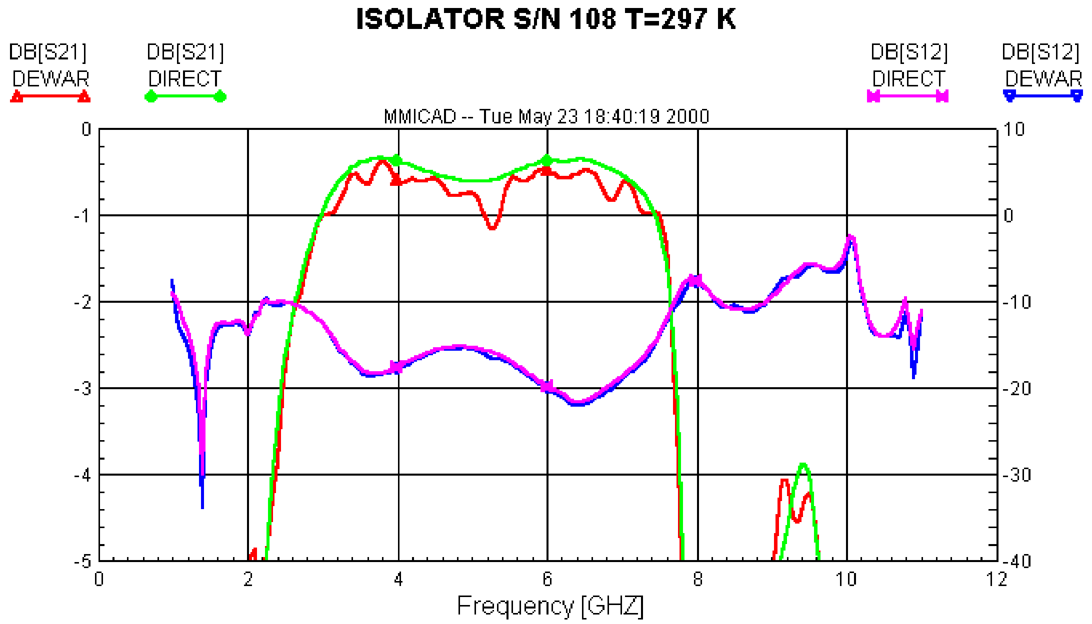

Figure 2: Isolator PAMTECH CTH1365K4 S/N A015-108 at T=297 K. Insertion loss and isolation measured in the Dewar compared with direct connection to the VNA.

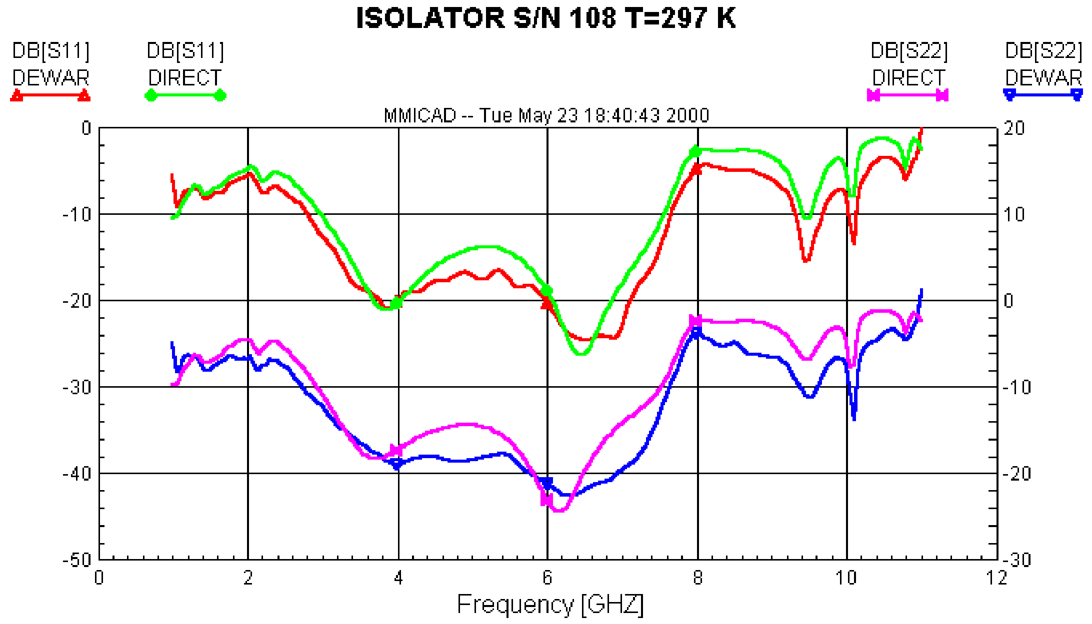

Figure 3: Isolator PAMTECH CTH1365K4 S/N A015-108 at T=297 K. Input and output reflection measured in the Dewar compared with direct connection to the VNA.

2 MEASUREMENTS:

The results of the measurements are shown in figure 4 to 8. The worst case values are presented in Table I and compared with the data from PAMTECH

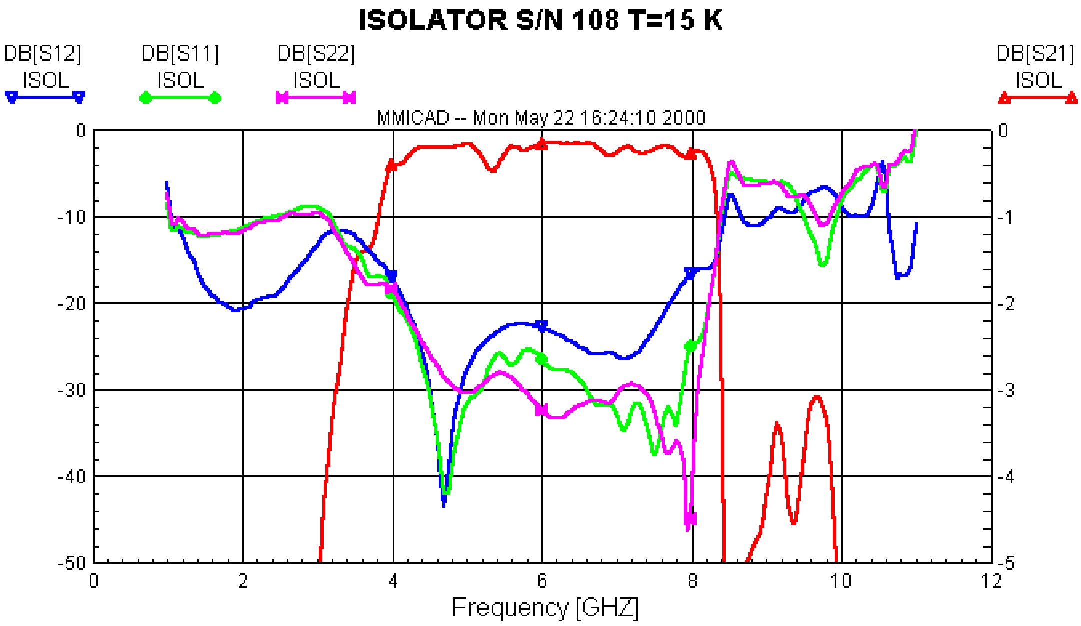

Figure 4: Isolator PAMTECH CTH1365K4 S/N A015-108.

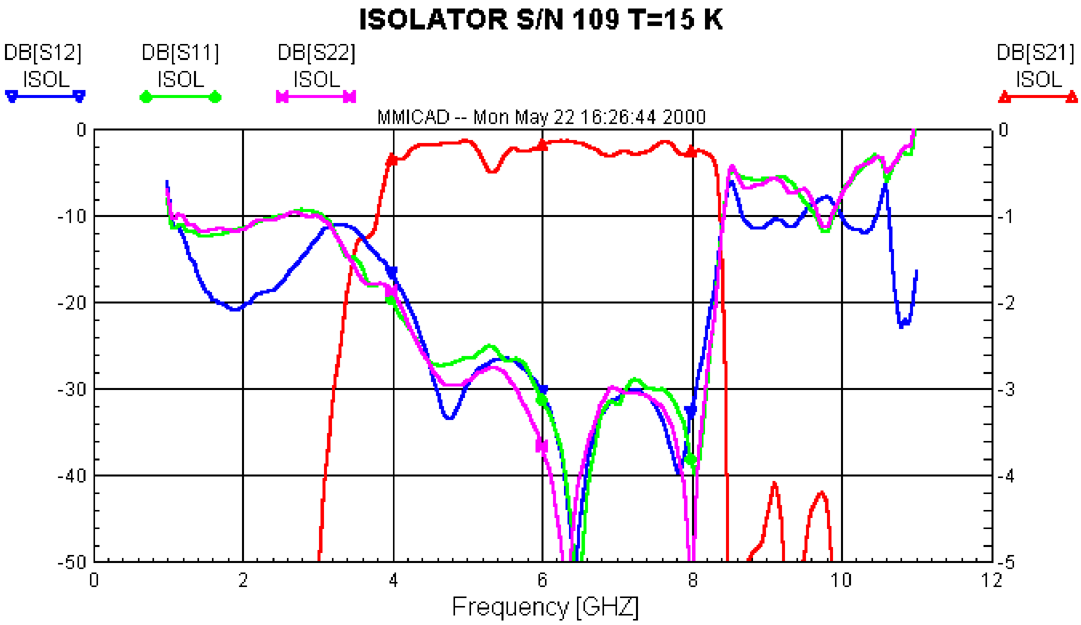

Figure 5: Isolator PAMTECH CTH1365K4 S/N A015-109.

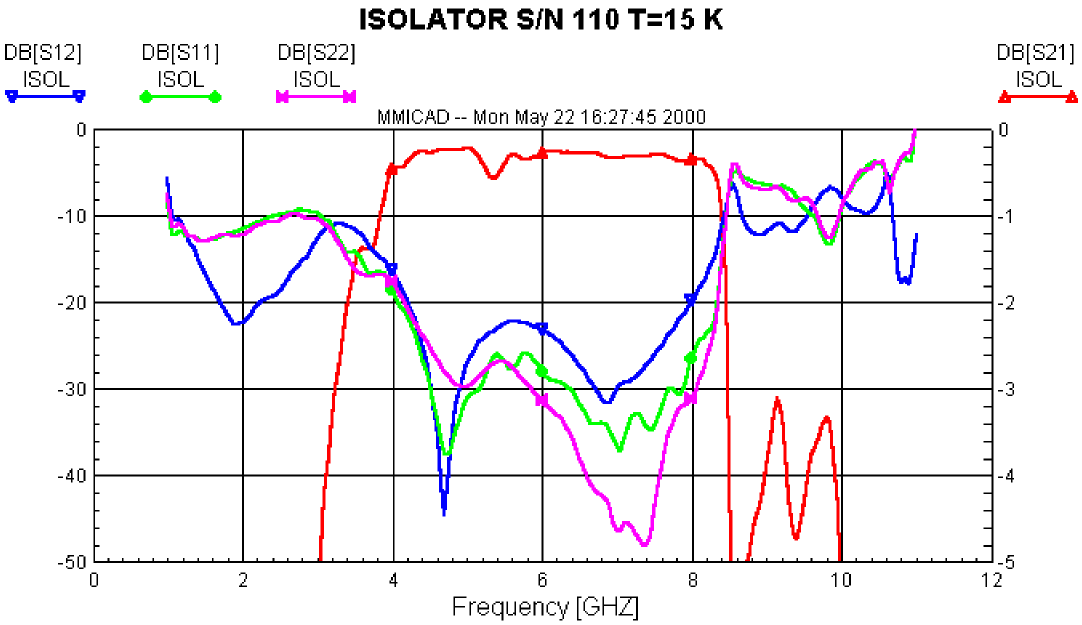

Figure 6: Isolator PAMTECH CTH1365K4 S/N A015-110.

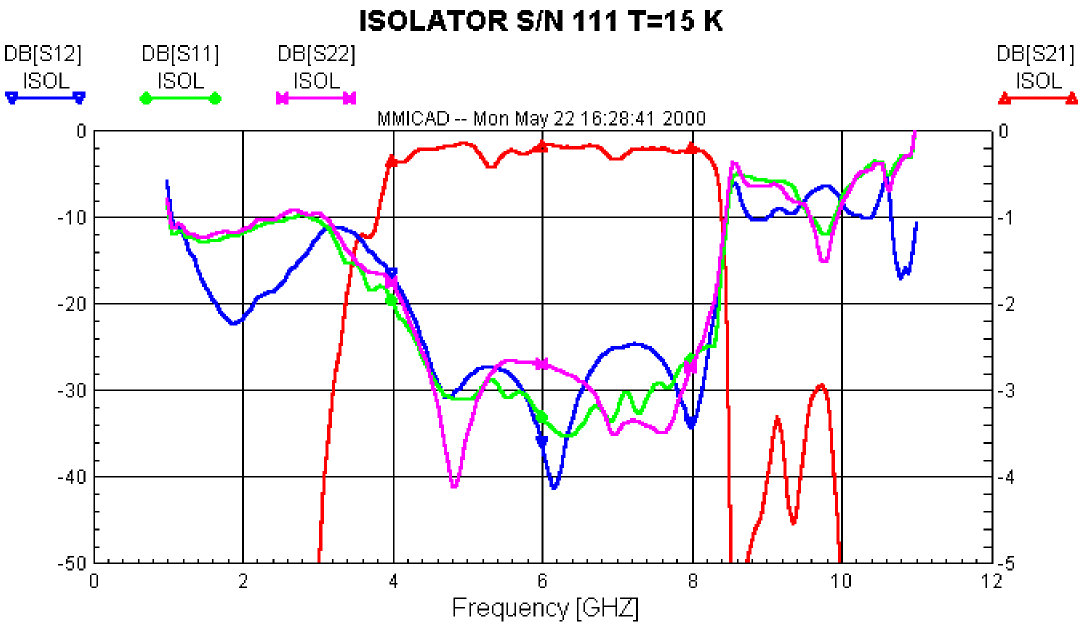

Figure 7: Isolator PAMTECH CTH1365K4 S/N A015-111.

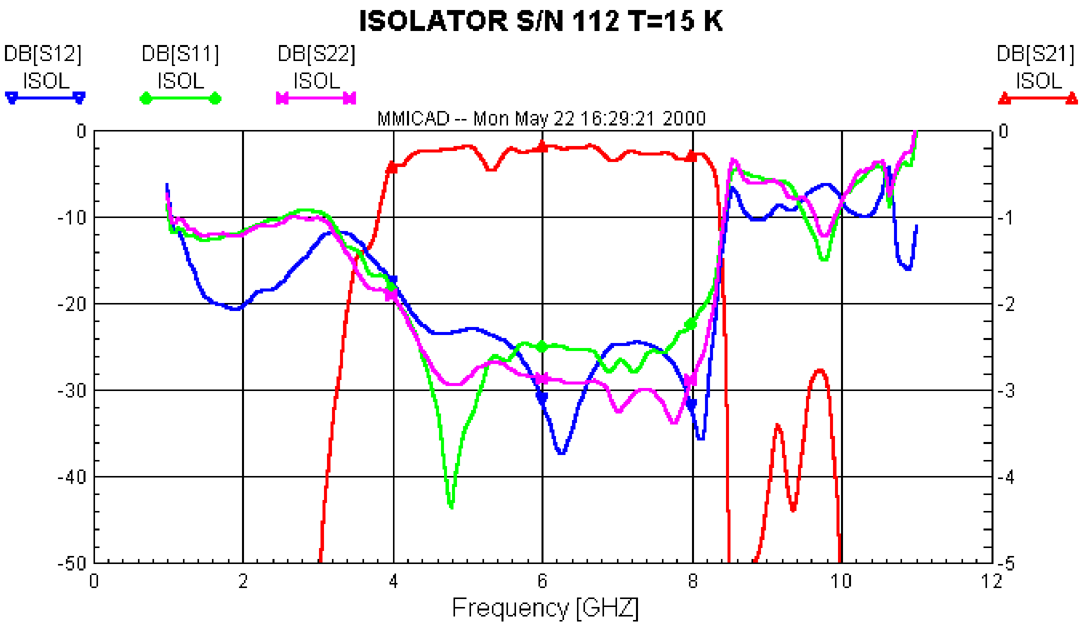

Figure 8: Isolator PAMTECH CTH1365K4 S/N A015-112.

TABLE I

Results of measured S parameters compared with data from PAMTECH[1]

	MEASURED @ 15 K				PAMTECH DATA @ 77 K			
S/N	S_{11} (dB)<	S_{12} (dB)<	S_{21} (dB)>	S_{22} (dB)<	S_{11} (dB)<	S_{12} (dB)<	S_{21} (dB)>	S_{22} (dB)<
108	-18.7	-16.5	-0.40	-18.3	-19.7	-21.5	-0.22	-19.7
109	-19.5	-16.5	-0.34	-18.2	-19.7	-20.3	-0.25	-19.1
110	-18.5	-16.2	-0.46	-17.4	-19.4	-19.9	-0.21	-19.1
111	-19.6	-16.5	-0.34	-17.0	-20.4	-20.6	-0.20	-19.4
112	-18.2	-17.4	-0.41	-19.0	-20.1	-20.3	-0.20	-19.7

[1] The worst case of S_{21} presented at 15 K is the value obtained at 4 GHz, although in most cases the value at the "dip" at ~5.3 GHz is worse. The "dip" at 5.3 GHz is not real, and it was considered more meaningful to take the data at the edge of the band, were there is a real degradation of performance due to the shift when the device was cooled below 77 K.

3 CONCLUSIONS

During the cooling procedure it was observed a clear shift in all the parameters to higher frequencies when the temperature was reduced. Near 77 K, the band-pass was well defined and perfectly centered. However, when the temperature was further reduced from 77 K to 15 K, the band was shifted in excess, and a degradation of performance appeared at the low frequency end of the band (4 GHz). As the performance is severely degraded at the edges of the band, for future versions of these isolators it will be important to center the band for the real working temperature of the device, and not for 77 K as was done in these prototypes. Other than this, the isolators perform quite well, and are usable at 15 K.

It should be noted that the small ripple appearing in the figures, and clearly visible in S_{21}, is not a characteristic of the device but an effect of the measuring system. The big "dip" observed at 5.3 GHz and the smaller one at 6.9 GHz are related with effects of reflections not completely corrected with our method. The value presented in Table I was obtained in all cases at 4 GHz although the value for the "dip" at 5.3 GHz was worse in most cases. The measured value at the "dip" was considered a bad estimation (too pessimistic) of the maximum insertion loss.

4 ADNOWLEDGMENTS

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