Electronics Division Technical Note No. 188

Frequency Selective Surface (Dichroic) for use with the 211-275 GHz System

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In order to test the harmonic response of the Band 6 (211-275 GHz) receiver, a high-pass filter is needed to suppress the normal response of the system. Figure 1 shows the predicted response of a 350 GHz high-pass filter calculated for various incidence angles using the theory of C.-C. Chen [1]. This shows that such a filter can be designed for use at incidence angles of less than about 10 degrees before the first diffracted order enters the desired frequency range (422-550 GHz). This filter would consist of 20-mil holes on a triangular lattice with hole-to-hole spacing of 22 mils and thickness of 125 mils. In order to test the accuracy of the theory, a previously made filter of different design was calculated and measured using the time domain gated network analyzer [2]. This filter consisted of 65-mil holes on a triangular lattice pattern with hole-to-hole spacing of 130 mils and thickness of 125 mils. Figure 2 shows the measured response over the extended frequency range 68.5 to 118 GHz for incidence angles of approximately 0, 10, 40, and 55 degrees. The noise floor for these measurements is also given (curve transbg). Figure 3 gives the calculated responses for 0, 10, 40 and 54 degrees (the latter matched the measured curve best).

Figures 2 and 3 show that such a filter can be designed and that its performance closely matches the calculations.

A filter for the 211-275 GHz system has been manufactured (thanks to Tony Marshall and Mike Meek in the CDL workshop). Its performance was measured with the HP8510 network analyzer over the band 68.5 to 118 GHz where it had a S21 of less than -60 dB, which is the dynamic range of the system. When placed in front of the 211-275 GHz system, no response was seen, indicating that the system harmonic response of the receiver is very low, so that the loss could not be measured, the combined filter and conversion loss being > 25 dB.

[1] C.-C. Chen, “Transmission of Microwave Through Perforated Flat Plates of Finite Thickness,” *IEEE Trans. on Microwave Theory & Tech.*, vol. MTT-21, no. 1, Jan. 1973, pp. 1-6.

[2] G. A. Ediss, A. R. Kerr and D. Koller, “Measurements of Quasi-Optical Windows with the HP8510,” ALMA Memo No. 295 (3/9/2000). Http://www.alma.nrao.edu/memos/html-memos/abstracts/abs295.html

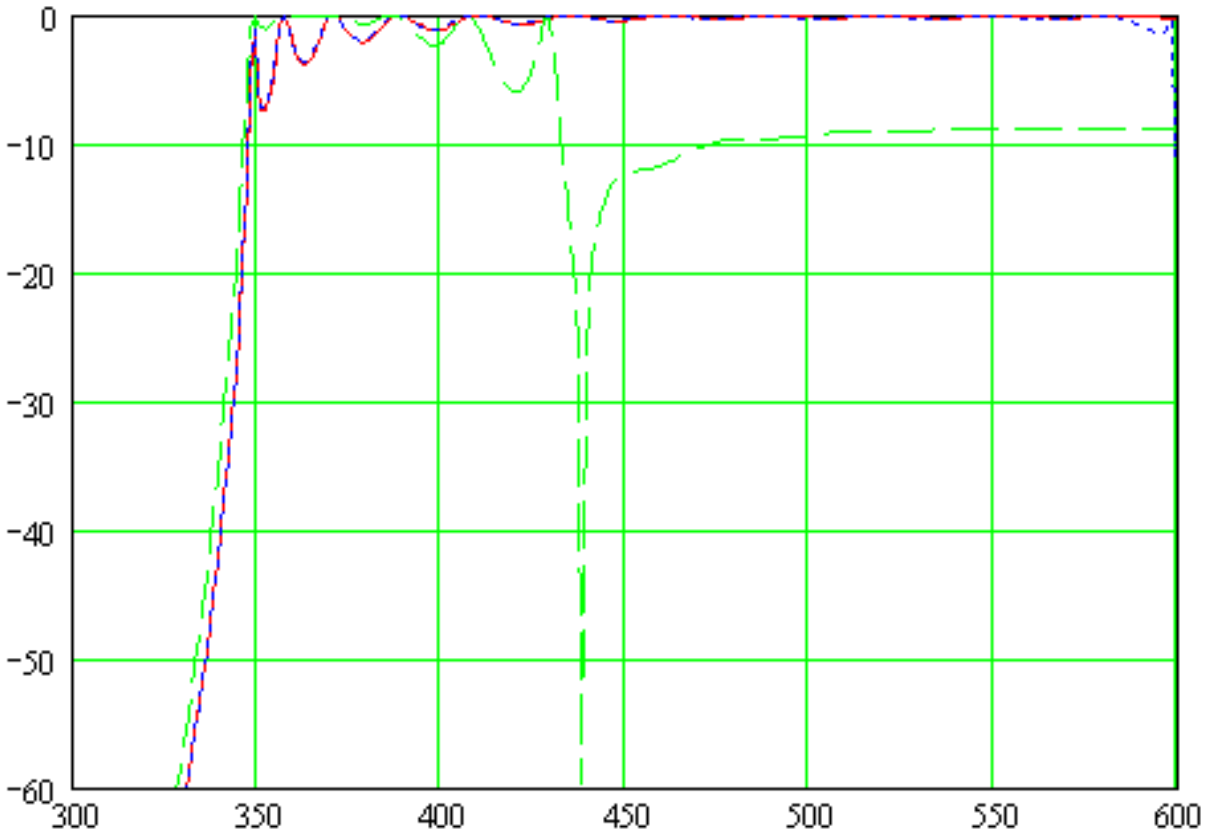

Figure 1. Calculated transmission (dB) versus frequency (GHz) of the 350 GHz high-pass filter for incidence angles 0 degrees (red line), 10 degrees (blue dashed line - almost identical to the 0 degree line) and 45 degrees (green dashed line).

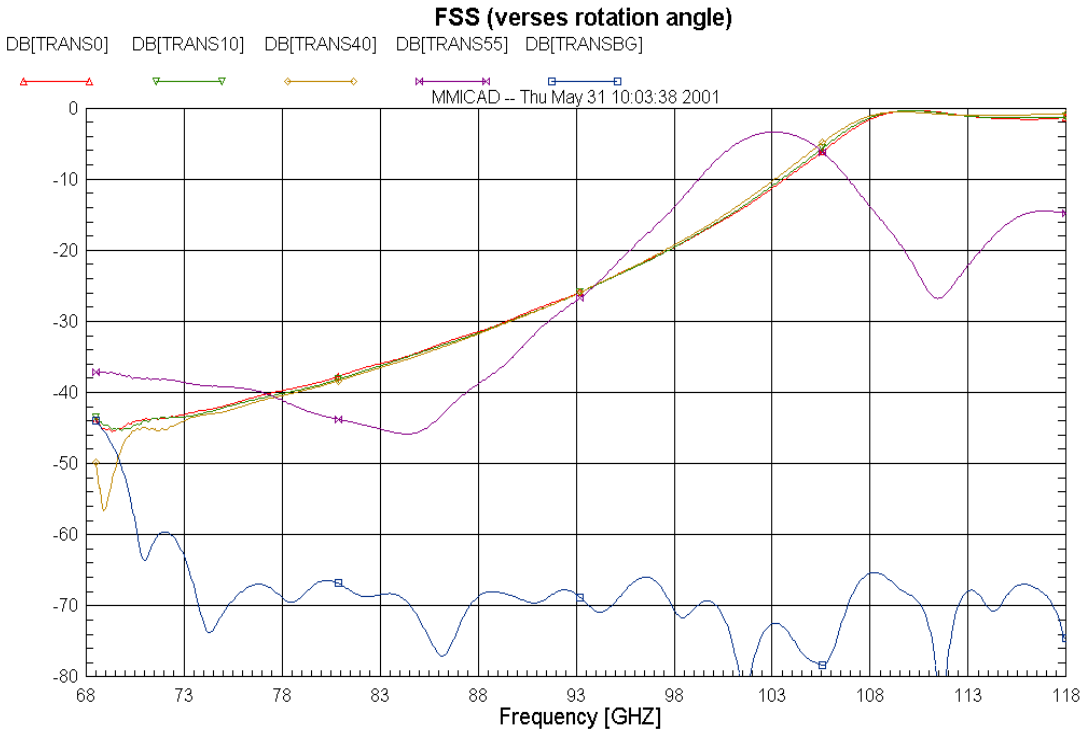

Figure 2. Measured performance (dB) of the110 GHz high-pass filter for incidence angles 0 degrees (red line), 10 degrees (green), 40 degrees (yellow), and 55 degrees (magenta). Also shown is the noise floor with the optical path blocked (blue).

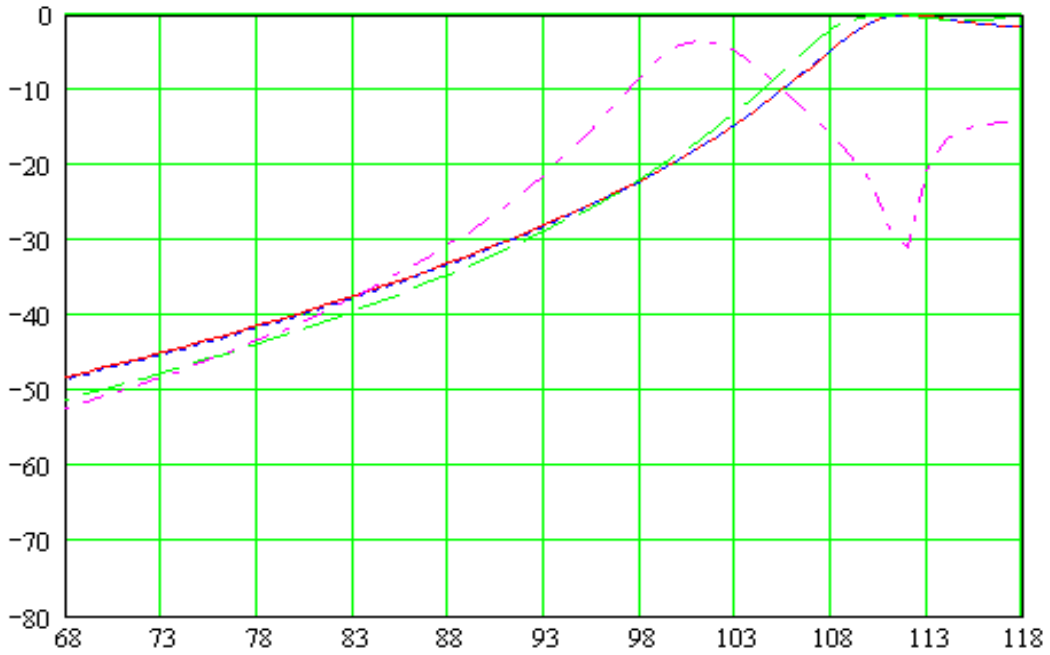

Figure 3. Calculated transmission (dB) versus frequency (GHz) of the 110 GHz high-pass filter for incidence angles 0 degrees (red line), 10 degrees (blue dashed), 40 degrees (green dashed), and 54 degrees (magenta dashed).