Heating and Cooling Test

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Description

- We monitor the behavior of the antenna after two cooling and heating rounds.
- In addition to the square tubes in the usual places, the antenna is supported by four more tubes at the interface between panels. Also, nylon strings pull the panels to the floor in a way that reduces the freedom of rotation about the vertical axis.
- S_{11} is measured regularly every 30 seconds after averaging 20 traces.
- The measurement lasts for $\sim$ 40 minutes.
- At the end, the antenna was rotated about its vertical axis by pushing horizontally the tip of one of the panels by $\sim$ 1 cm and then releasing.
- During the measurements, the sky was completely cloudy and the temperature decreased from 38°C to 36°C.

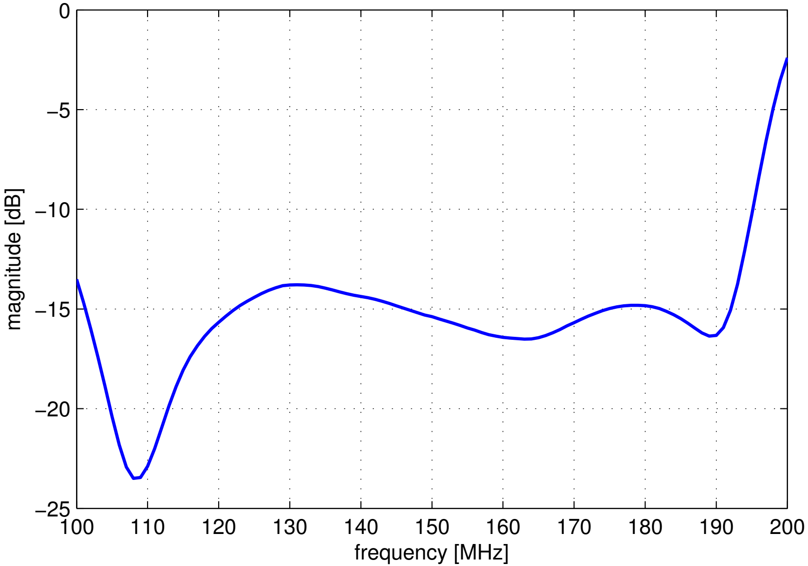

Figure: (1): First reference trace.

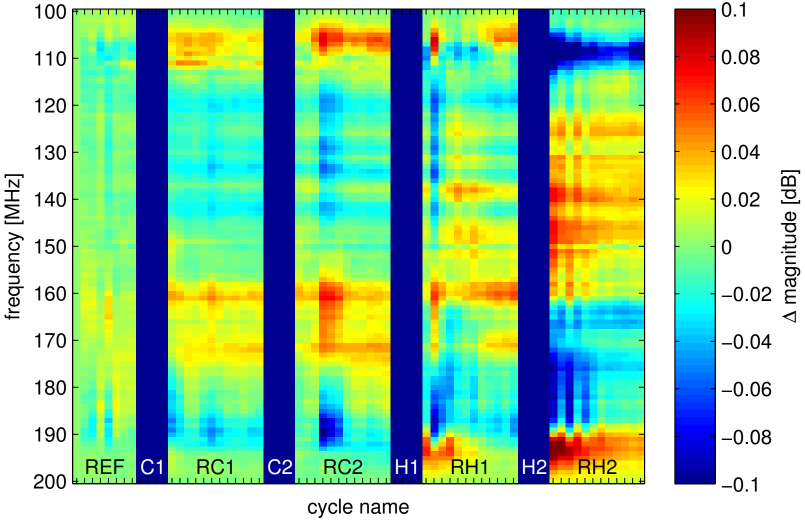

Figure: (2): Results of the cooling/heating test. Labels at the bottom indicate each case. REF corresponds to the 8-trace-long period that sets the reference at the beginning (4 minutes). CX and HX (blue vertical stripes) indicate periods of cooling or heating that last 4 traces, (2 minutes). RCX and RHX are the recovering cycles that last 12 traces each (6 minutes). Comments on the next page.

Comments about previous figure

- No corrections are applied to the measurements. The air temperature was decreasing monotonically since the beginning.
- Even during the REF cycle at the beginning it is possible to observe a dipole effect developing, pivoting at $\sim$ 160 MHz. This could be explained by the top plate cooling down with air temperature.
- During the first two cycles recovering from cooling (RC1 and RC2), the dipole pattern become stronger. The cooling spray claims that it can cool down components to -65°F (-54°C). It was evenly applied for almost 2 minutes both times. It seems that in 6 minutes the top plate cannot fully recover its original state at ambient temperature.
- In the middle of RC2 there are three consecutive traces (a total of 1.5 minutes) that show a higher deviation from the reference. There were no alterations to the measurement in that period, and we can only attribute these changes to either wind (see Figure 4, with the results of the shaking test), or the natural change of shape of the top plate as its temperature changes.
- The first recovering from heating cycle (RH1) seems to be a transitional state between a *cold* top plate and a *hot* one.
- RH2 shows the typical pattern of a *hot* top plate. The deviations from the reference do seem to decrease faster than the previous ones, although 6 minutes are not enough for a full return to normal.
- Starting with RC1, ripples of period $\sim$ 10 MHz are evident as a second order effect.

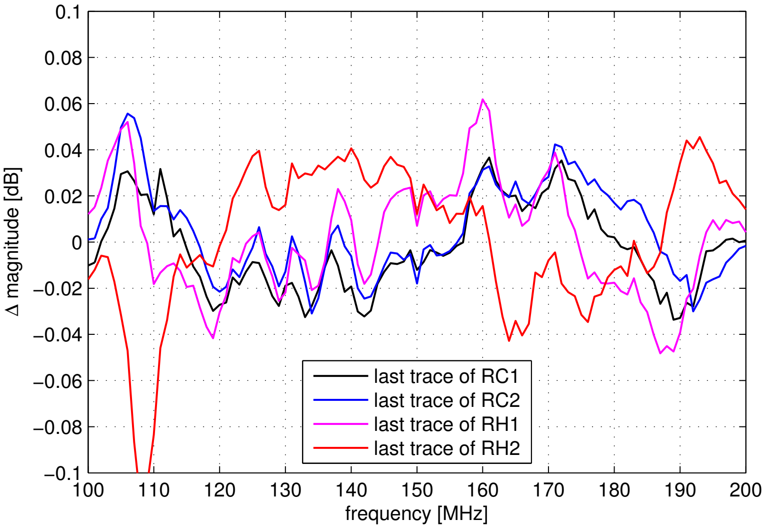

Figure: (3): Last residual traces of the recovering periods (after 6 minutes of recovering from cooling or heating). When recovering from cooling (black and blue) the patterns are very similar, with a negative/positive peak below/above 155 MHz. The first recovering from heating has a pattern that seems transitional. The second recovering from heating has the pattern observed before, with a positive/negative peak below/above 160 MHz, opposite to the cooling cases. The amplitudes are of order ± 0.06 dB above 120 MHz, since below this value the reflection coefficient is very low and the peaks are larger. More time for stabilization of the top plate seems necessary.

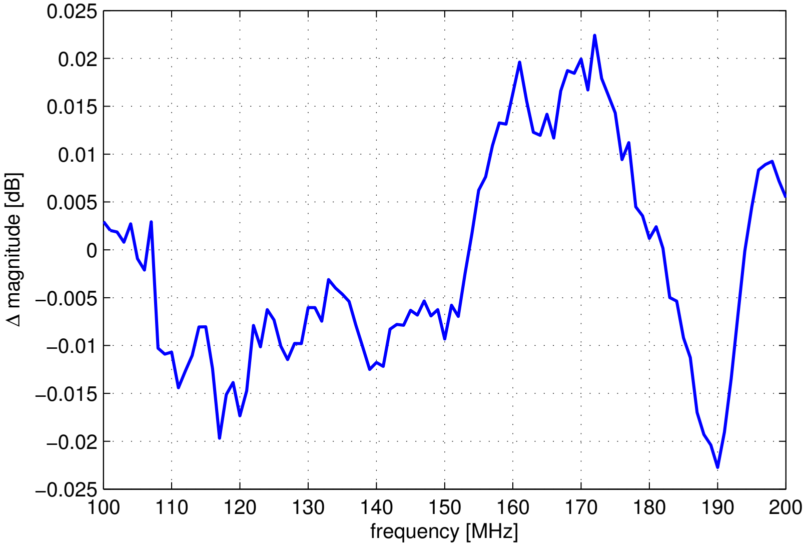

Figure: (4): Result of the shaking test. The residual trace corresponds to $|S_{11}|_{after} - |S_{11}|_{before}$. This shape seems surprisingly close to the case when the top plate is cooled.

Conclussion

- In this test, the top plate undergoes extreme temperature changes not expected in a real measurement.
- The response does change with temperature, although at a slower rate and with some delay. During H1 the top plate was heated for almost 2 minutes, but the response of S_{11} is only transitional. This is suspicious if the actual top plate (with high thermal conductivity) were causing the changes in S_{11}. This hints to something connected to the top plate and suffering the temperature changes with attenuation and delay.
- At least during RH2 the response seems to be converging to a neutral state. 6 minutes is insufficient for a total convergence.
- The departures from a neutral state are of order $\pm$ 0.06 dB above 120 MHz after 6 minutes in all cases.
- With all the extra support, the effect of perturbing the antenna horizontally about its vertical axis is similar to that obtained when the top plate is cooled. More tests are necessary to assess the repeatability of this behavior and its possible connection to the changes of the antenna due to temperature changes.