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To: EDGES Group

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Subject: Effects of temperature on internal loads in automated antenna S11 measurements.

The EDGES receiver has an automated S11 measurement system for measuring the antenna S11 in the field. This system relies on measurements of internal open short and load using Agilent open, short and load in the laboratory. These lab measurements, which are made during the receiver calibration rely on the constancy of the internal open, short and load between the lab and the deployment at the MRO. If the load is very temperature sensitive a change in its S11 between its value in the lab and the field will result in a systematic error in the antenna S11. Figure 1 shows a simulation of the error in antenna S11 which results from a 0.1 ohm increase in the load resistance and Figure 2 shows what effect this has on the observed spectrum with 4 polynomial terms removed.

The root of this potential problem is an excessive temperature sensitivity of a load. Table 1 shows the results of measuring the change in resistance for various loads when heated from 25 to 100 C.

Type	Change in resistance ohms	S11 tempCo
MCL ANNE-50+	+0.2	+27 ppm/C
MECA SMA	-1.0	-130 ppm/C
Pasternack	-0.2	-27 ppm/C
AmphenolACX1252	+0.6	+60 ppm/C
Maury 8031B5	-07	-93 ppm/C
Anritsu OSLK50	-0.5	-66 ppm/C

Table 1. Temperature coefficient of S11 for various loads.

The internal open and short are not expected to change significantly. Even the most sensitive of these samples (the MECA load) would need to be subject to a temperature change of 7.7 C for a change of 0.1 ohm so that with temperature controlled to within 1 C of the nominal 25 C in the lab. This should not pose a problem but the choice of a load with low temperature coefficient along with better thermal conduction between the switch, on which the load is mounted, and the thermal plate should ensure that this source of systematic error can be reduced to an acceptable level.
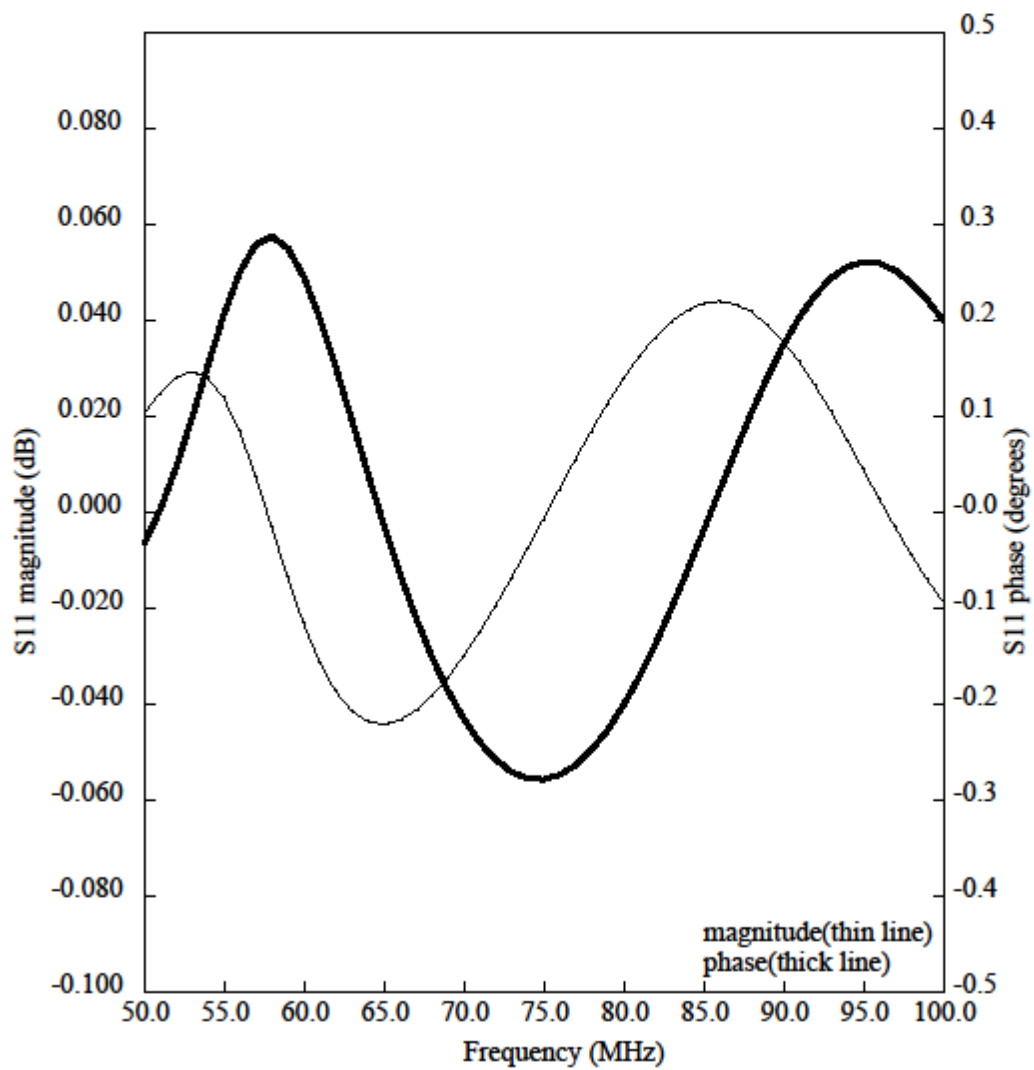
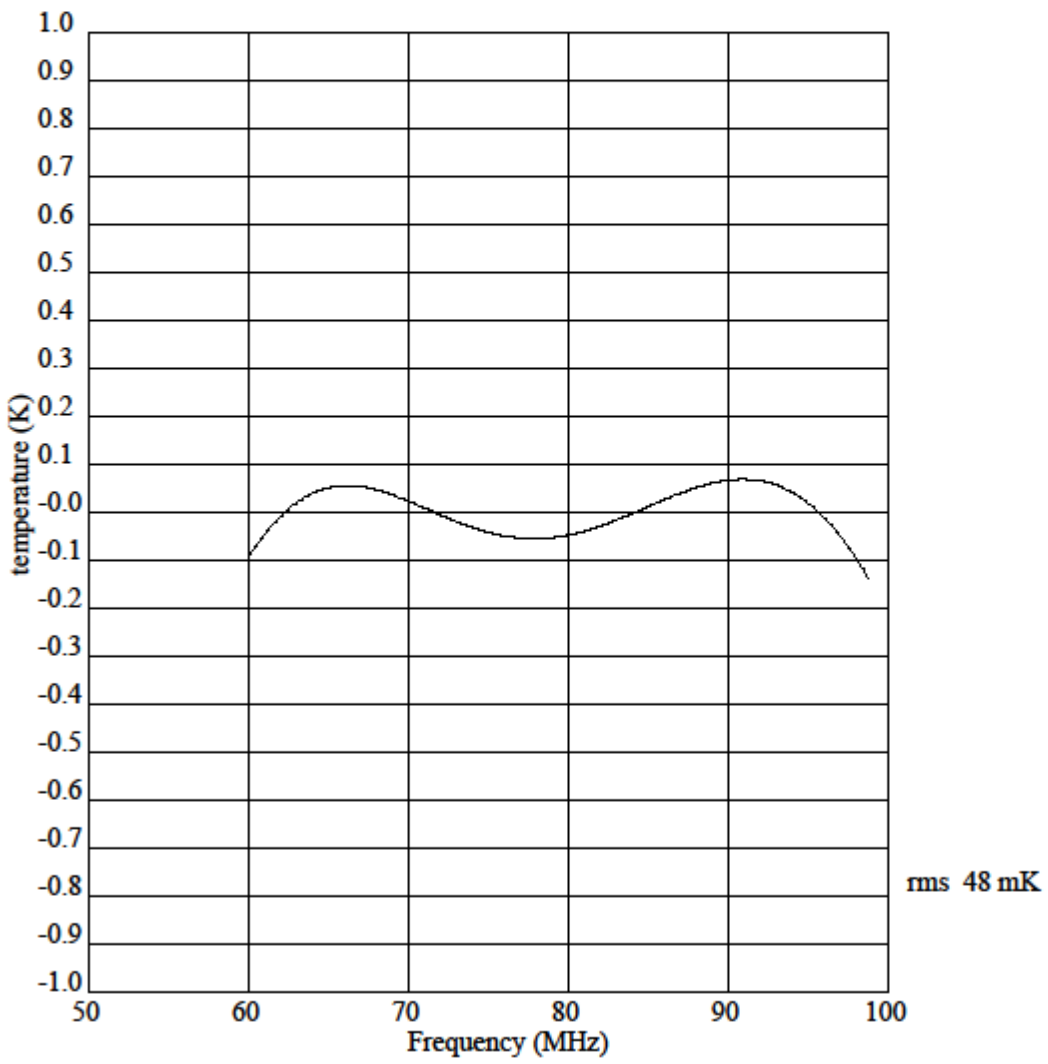Figure 1. Simulated difference in lowband1 antenna S11 with 0.1 ohm change in internal load.

Figure 2. Simulated effect on the spectrum at GHA = 12 hrs.