EDGES MEMO #108

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**
**HAYSTACK OBSERVATORY**
**WESTFORD, MASSACHUSETTS 01886**

March 12, 2013

*Telephone*: 781-981-5400
*Fax*: 781-981-0590

To: EDGES Group

From: Alan E.E. Rogers

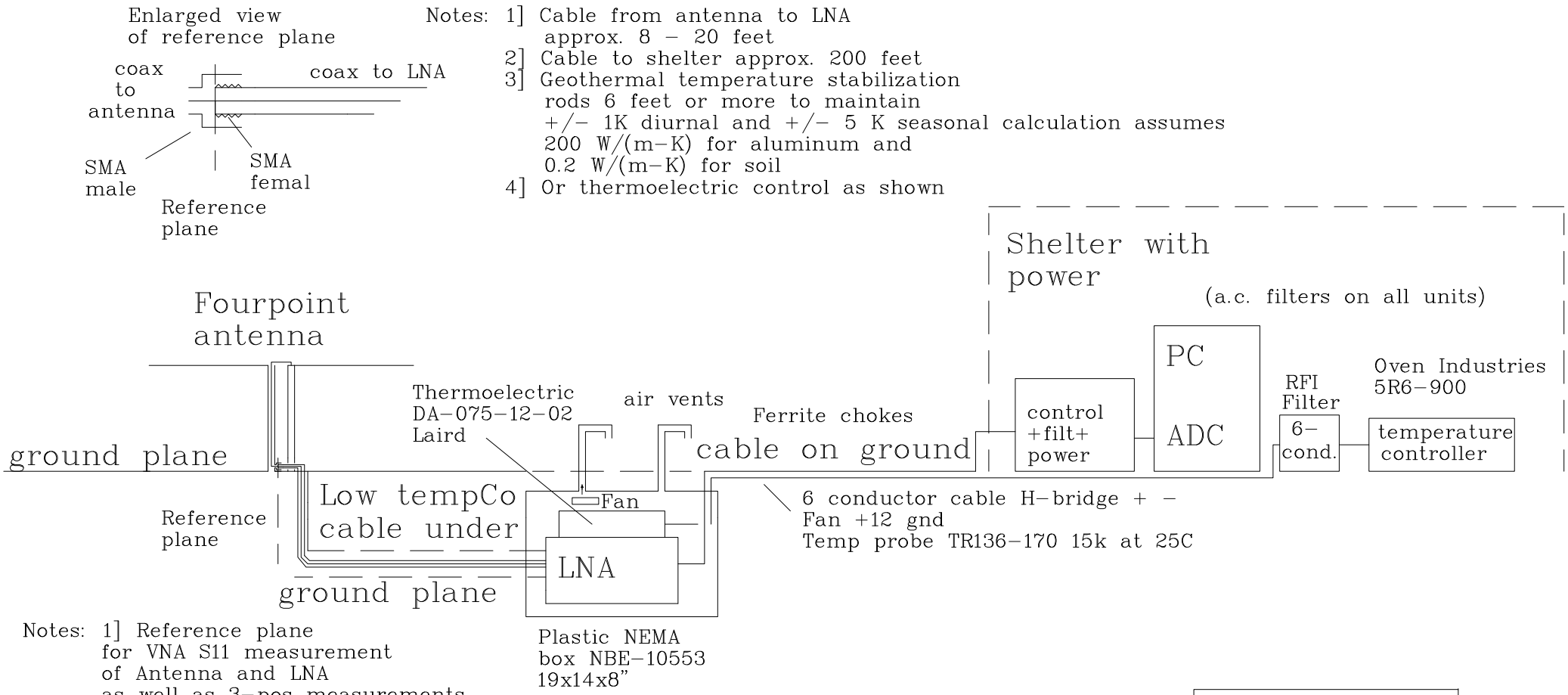
Subject: Proposed EDGES2 installation

The EDGES2 accuracy is based on absolute calibration. The calibration requires accurate S11 measurements of the antenna, LNA as well as the hot and ambient loads used to calibrate the 3-position switched spectrometer. The proposed installation is shown in Figure 1. It assumes that the antenna S11 is measured at the input and is referred to the reference plane at this interface. Further it is assumed that the antenna S11 remains stable or changes in S11 can be accurately estimated from measurements of the ambient air temperature and humidity (see memo #74). The LNA, 3-position switch, comparison load and noise diode are maintained at a constant temperature using a thermoelectric heat exchanger and an associated controller. Preliminary tests of the thermoelectric heat exchanger and controller show that it may be possible to hold the temperature of the LNA module to within 0.1 K. The LNA module is connected to the antenna via a low temperature coefficient cable whose temperature will range from ambient at one end to the temperature of the LNA module at the other end.

The 3-position switched spectrometer is calibrated using a hot, ambient load, and an open and short. The open and short in conjunction with the cable allow the calibration of the LNA noise waves.

The advantages of the proposed installation is that it simplifies the calibration as much as possible and the cable between the antenna and LNA helps decorrelate instrumental errors with EoR signature. This advantage can only be realized if an extremely stable cable can be realized. The end of the cable needs to be flexible enough to allow it to be disconnected from the antenna and connected to the ambient and hot loads. The cable could consist of a long piece of semi-rigid connected to a short cable which is stable with changes in temperature and flexure. While commercial cables are being examined but if performance is not acceptable an airline of gold plated brass piping with quartz spacers is expected to have a coefficient of 0.36 ps/K for 20 ns cable which corresponds to 0.02 degrees/K at 150 MHz. using the same material for the inner and outer tube ensures constant impedance. A fall back plan is to use a short enough cable to ensure that the effects of temperature change are negligible. In this case a longer open ended cable whose S11 is known will be needed for noise wave calibration.

Figure 1




Notes: 1] Reference plane
for VNA S11 measurement
of Antenna and LNA
as well as 3–pos measurements
of hot, ambient, open and short
is at output of Roberts balun

Ancillary parts needed:
VNA, VNA SOL calkit
Hot, ambient loads of known S11

Proposed
EDGES2
installation
aeer 5mar13