AQUARIUS RADIOMETER:
PRE-LAUNCH PERFORMANCE AND CALIBRATION

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1. INTRODUCTION

The NASA-CONAE Aquarius/SAC-D observatory for measuring the changing global distribution of sea surface salinity at unprecedented accuracy from space is scheduled to launch in 2010 [1]. The Aquarius Instrument comprises a 1.4 GHz radiometer and a 1.2 GHz scatterometer, both of which share a common reflector antenna, feed network, and other electronics. The ability to measure sea surface salinity hinges upon the radiometer error meeting a stringent 0.15 K requirement after post-launch calibration. To do so, the inherent calibration stability of the radiometer antenna temperature measurement must be better than 0.13 K over 7 days. Additionally, pre-launch calibration must also compensate for subtle changes in RF component temperatures over the changing seasons for the duration of the mission.

As previously reported at IGARSS 2008, the radiometer electronics subsystem completed integration and test (I&T) activities and met its performance requirements. Since that time, the electronics have been integrated, along with the scatterometer, to compose the Aquarius Instrument and completed system level I&T. Calibration measurements were made at several stages during the integration. Final test results indicate the completed instrument met its performance requirements and pre-launch calibration was validated over a temperature range exaggerated beyond the expected. The Aquarius Instrument is currently in Argentina being integrated with CONAE's SAC-D service platform (spacecraft bus) to form the Aquarius/SAC-D Observatory.

2. RADIOMETER PERFORMANCE

To meet inherent calibration stability, Aquarius is designed with precision thermal control of key components [2]. Thus, loss and noise contributions from components outside the internal reference load

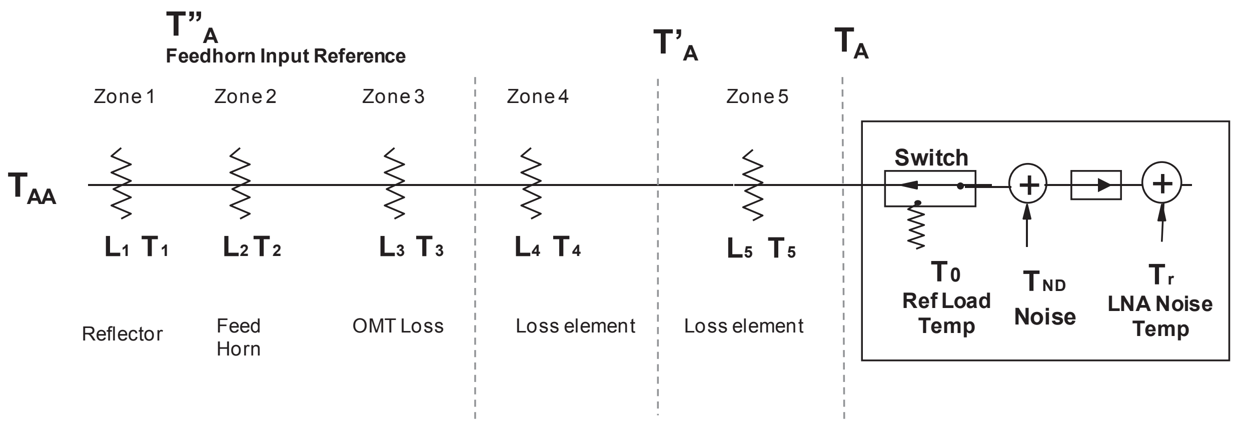

Fig. 1. Simplified calibration model for Aquarius radiometer.

and noise diode calibration loop are nearly constant over days at a time. This leads to a system with very low 1/*f*-type noise. Test results indicate the radiometer NEDT is 0.06±0.01 K matching the theoretical estimate. Gain stability measurements exhibit a white spectrum down to the mHz region; below this frequency the spectra is dominated by albeit slight orbital temperature variations. Finally, tests results of radiometric calibration repeatability indicate an RMS variation of typically less than 0.08 K derived from 9 measurements spaced over almost 7 days. The synthesis of these data results in an inherent 7-day stability of typically 0.11 K or less. A full system level measurement made under realistic orbiting thermal conditions with the scatterometer and radiometer operating simultaneously also confirms this result.

3. PRE-LAUNCH CALIBRATION

Over the course of a year, the calibration of the radiometer would drift if left uncorrected because the changing thermal flux environment slowly perturbs the mean temperature of the RF hardware by about 1 ^{o}C. If the calibration where not corrected for changes in physical temperatures, then the antenna temperature would drift at a rate of ~0.4 K/^{o}C. Thus, a calibration and correction approach similar to [3] was utilized to compensate for temperature drifts and fluctuations. A simplified calibration model is shown in Fig. 1. Different tests were designed and executed to measure losses and their temperature coefficients (where necessary) as well as the noise source excess noise temperature and temperature coefficient. The dominant component is the noise source, which varies ~2.5ppt/^{o}C referred to the feed horn input.

An independent verification test was also carried out to determine whether or not the pre-launch calibration tests were successful. That is, does the calibration model coupled with calibration data compensate for changes in physical temperature to an acceptable degree? The test utilized a different black-body target than used above. Additionally, the instrument physical temperature was varied 15 ^{o}C – a much larger range than expected on orbit – while keeping the target at a nearly constant cold temperature. Using the calibration scheme, it was determined that the corrected antenna temperature drifted at a rate of 60 mK/ ^{o}C, a 6-X factor of improvement.

4. REFERENCES

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