A Dual-Polarized, Dual-Frequency, Corrugated Feed Horn for SMAP

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Outline

– Overview of the Soil Moisture Active and Passive (SMAP) Mission & Instrument
– Basic Layout of SMAP “E” Configuration
– Feed Horn Components
– Major Design Drivers & Requirements
– Thermal and Alignment Tolerances
– OMT Split Design
– SMAP Scale Model
– RL & Pattern Measurements
– Conclusions
Mission Overview

• NASA’s Soil Moisture Active and Passive (SMAP) mission will measure Earth’s soil moisture and its freeze/thaw state over a 3 year period

• Applications:
  – More accurate and longer-term weather and climate predictions
  – Earlier drought warnings
  – Improved flood and landslide predictions
  – Improved agricultural production predictions
  – Better understanding of the global carbon cycle

• Near-polar, sun-synchronous orbit of 680 km
• Planned launch date of November 2014
Instrument Overview

- An L-band Synthetic Aperture Radar (SAR) and L-band radiometer (RAD) share an offset 6-m deployable mesh reflector and feed.
- The antenna boresight beam is pointed 35.5° off nadir.
- The instrument spins at approximately 14.6 RPM around the nadir axis.
- The result is a 1000-km swath on the ground.
- The radiometer data is more accurate than the SAR data, but has a spatial resolution of about 40-km; the SAR spatial resolution is 1 – 3 km.
SMAP “E” Configuration

35.5°

6m
Cut-away Isometric View

~1.2 m

~52 cm

Transition to Circular Waveguide
WCA Prototype Measurement

WCA Prototype being tested with WR650 Cal Kit
Major Design Drivers & Requirements

- Combined SAR & RAD RF bandwidth of 16%
- Radiometer beamwidth & main beam efficiency
  - RAD Beamwidth between 2.29° and 2.5°
  - RAD MBE > 87%
  - SAR Beamwidth < 2.8°
- Radiometer antenna pattern stability
  - RAD Earth Lobe power < 3%
  - RAD off-Earth Lobe power < 10%
- SAR gain and gain stability
  - SAR Gain > 35.55 dBi
  - SAR Gain stability < 0.07 dB
- SAR pointing stability
  - 50 m° ± 40 m° in Elevation
  - 0 m° ± 10 m° in Azimuth
Worst Case Thermal + Alignment Tolerances

![Graph showing return loss vs frequency for SAR and RAD bands with nominal and worst case H-Port and V-Port tolerances.](image-url)
SMAP Scale Model
SMAP Complete Scale Model
Scale Model Feed
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Return Loss Measurements
 Radiation Pattern Measurement
Close-up of the Scale Model Feed Horn

Scale Model Feed Horn on Antenna Range Positioner

Scale Model Feed Horn with Absorber in Place
SAR V-pol Scale Model Pattern

Directivity [dB]

Theta [deg]

Calculated E-Plane
Calculated H-Plane
Calculated X-Pol
Measured

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Flight Feed Horn RL

Return Loss [dB]

Frequency [GHz]

SAR Band

RAD Band

V-Port

H-Port
Feed Horn RL into SM OMT
Conclusions

• A dual-polarized, dual-frequency, corrugated feed horn for SMAP was designed and meets all mission requirements

• A scaled model of the feed was fabricated and tested showing an excellent agreement with predicted performance

• These results along with the “tunability” built-in into the flight model make us feel confident that the flight model will meet all mission requirements
Thank you!
Back-Up
SMAP Instrument

Flight Model

Scale Model
RF Models

Flight RF Model

Scale Model RF Model
SMAP Scale Model Instrument