Design, Fabrication, and Measurement of On-Board UHF Turnstile Antennas with Optimized Radiation Patterns

Lightning Talk

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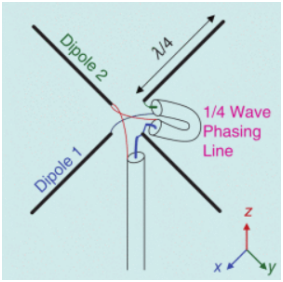
ODTÜ METU

TAMSAT

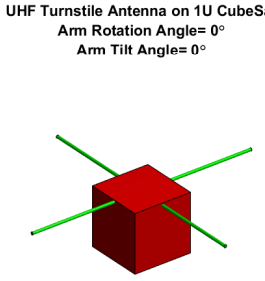
Turnstile antenna

- A turnstile antenna is a circularly polarized antenna configuration that consists of perpendicularly placed dipole antennas in phase quadrature.
- It is posible to change its radiation pattern by the optimization of the orientation of its arms.
- Thanks to its compact mechanical structure, turnstile antenna is suitable to be placed on-board.

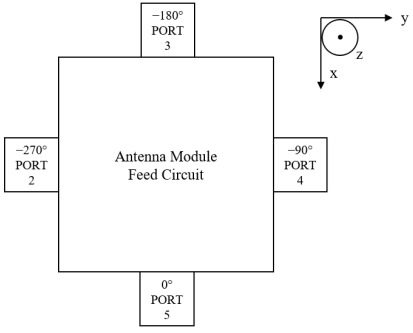


S. X. Ta, I. Park and R. W. Ziolkowski, "Crossed Dipole Antennas: A review.," in IEEE Antennas and Propagation Magazine, vol. 57, no. 5, pp. 107-122, Oct. 2015, doi: 10.1109/MAP.2015.2470680.

Design and simulation of radiating structure



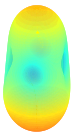
The mechanical model of the UHF turnstile antenna with no rotation or tilt of antenna arms



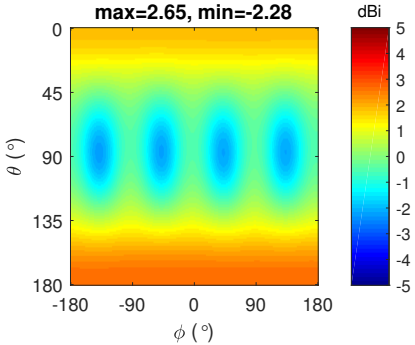
Generic antenna module feed circuit, which supports up to four arms

Gain of the UHF turnstile antenna with no rotation or tilt of antenna arms

UHF Turnstile Antenna on 1U CubeSat
Arm Rotation Angle= 0°
Arm Tilt Angle= 0°
Gain, 3D Polar Plot
max=2.65, min=-2.28

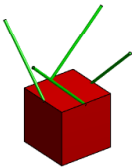


UHF Turnstile Antenna on 1U CubeSat
Arm Rotation Angle= 0°
Arm Tilt Angle= 0°
Gain, 3D Planar Plot
max=2.65, min=-2.28

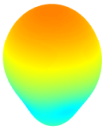


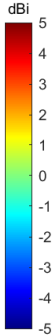
Upper pole optimization results

Upper Pole Optimization Results
Arm Rotation Angle= -45°
Arm Tilt Angle= 90°



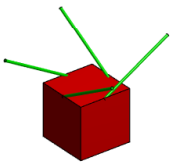
Radiation Pattern
Gain(θ=0°, ϕ=0°)=2.46 dBi
AR(ϕ=0°)<3 dB Beamwidth= 92°



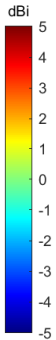


Lower pole optimization results

Lower Pole Optimization Results
Arm Rotation Angle= 60°
Arm Tilt Angle= 90°

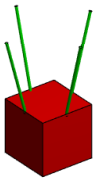


Radiation Pattern
Gain(θ=180°, ϕ=0°)=3.27 dBi
AR(ϕ=0°)<3 dB Beamwidth= 86°

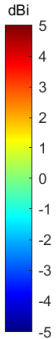


Minimum gain optimization results

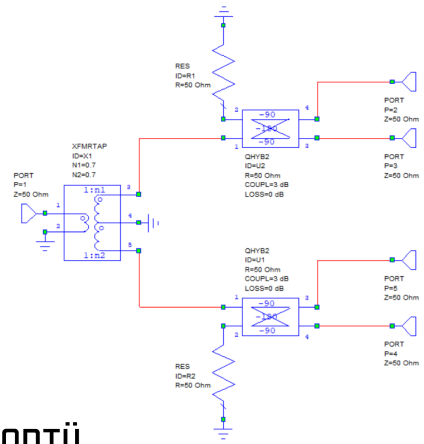
Minimum Gain Optimization Results
Arm Rotation Angle= 0°
Arm Tilt Angle= 75°



Radiation Pattern
Max. Gain= 1.06 dBi
Min. Gain= -0.37 dBi



Design of feed circuit



Surface Mount

RF Transformer

50Ω 8 to 600 MHz

ADT2-1T-1P+

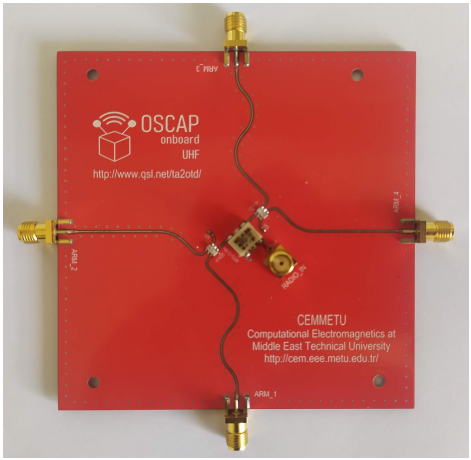
Ultra-Small Ceramic

Power Splitter/Combiner

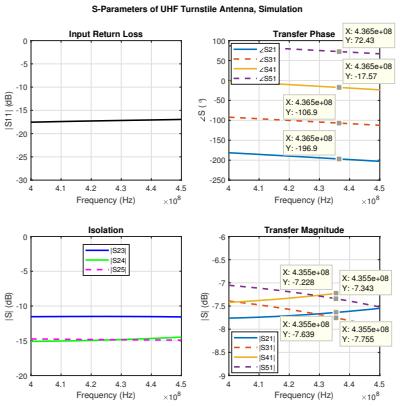
2 Way-90° 50Ω 220 to 470 MHz

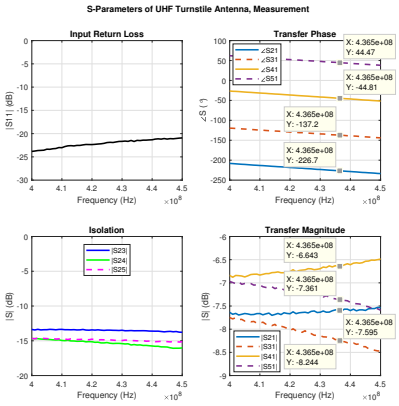
QCN-3+

Fabrication of feed circuit

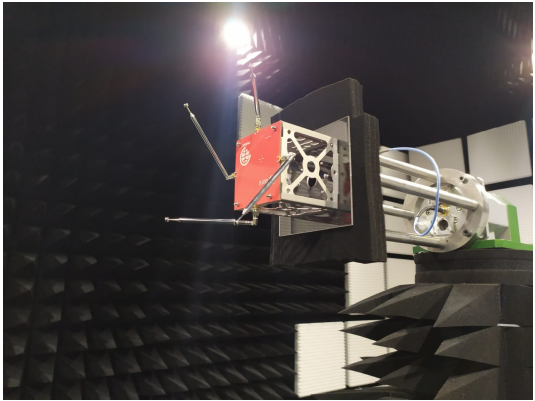


Simulation and measurement results of feed circuit



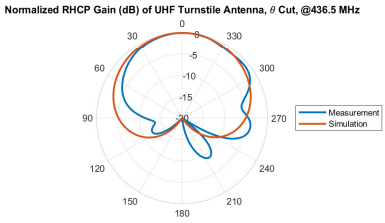


Radiation pattern measurements and monopole arms

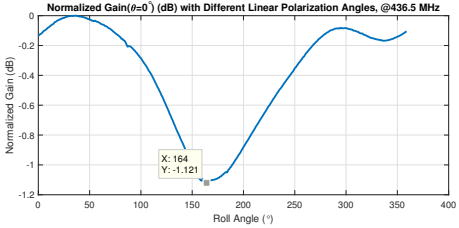


Monopole antenna tuning with aluminum tape

Simulation and measurement results of the UHF turnstile antenna



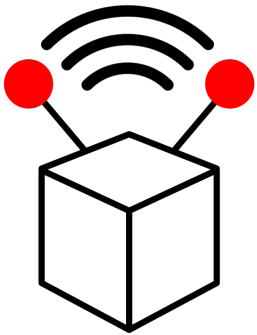
Measurement and simulation results for the radiation pattern.



Normalized gain obtained with different polarization directions of the linearly polarized measurement antenna.

Conclusions and further studies

- UHF on-board turnstile antenna prototype is designed, simulated, optimized, fabricated, and tested.
- Study will continue with:
  - Dual-band V/UHF turnstile antenna,
  - Further optimization of feed circuits and antenna arms,
  - Deployment mechanism,
  - Releasing project outputs.



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Project

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Thanks for your attention!

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