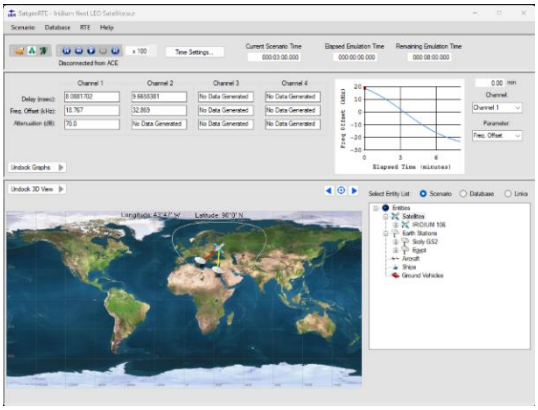
Emulating LEO Doppler Shift using the ACE9000 SATGEN Modeling Tool

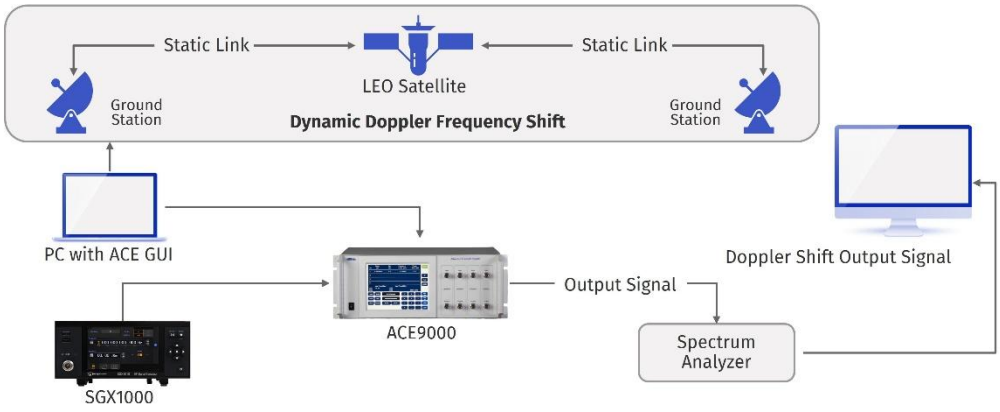
Satellite communication links involving Low-Earth Orbit (LEO) satellites experience dynamic Doppler frequency shifts due to the relative motion between the satellite and ground station. Doppler shift must be emulated during satellite link testing to evaluate LEO modem performance.



The SATGEN modeling tool showing a LEO satellite pass and calculated dynamic link parameters.

This demonstration uses SATGEN, a satellite impairment modeling software program for the Maury Microwave ACE9000 Advanced Channel Emulator, to generate a dynamic Doppler shift scenario. In this exmaple, a LEO satellite traveling at approximately 17,500 mph produces about 20 kHz of Doppler frequency shift on the RF link between the ground station transmitter and the onboard satellite receiver. Using two-line element (TLE) orbital data, SATGEN calculates time-varying signal delay, frequency offset, and attenuation associated with the moving satellite. The resulting Doppler profile is applied to a CW signal generated by the Maury SGX1000 RF signal generator. A spectrum analyzer displays the carrier frequency shift over time, illustrating the dynamic Doppler effect observed during a LEO satellite pass.

Demo Setup



Target Users

Target users include design engineers and system integrators who need to understand the effects of Doppler shift in LEO satellite communication systems and NTN.

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Product Overview

ACE9000 Advanced Channel Emulator

The ACE9000 Advanced Channel Emulator (ACE) is the most advanced non-terrestrial RF channel emulation solution to date. The emulated impairments include delay, signal Doppler, attenuation, phase offset, AWGN, frequency hopping, payload, and multipath fading. The instrument can house up to four 600 MHz instantaneous bandwidth channels. Impairment emulation can be set to fixed values in Static Mode or continuously changed in real time in Dynamic Mode without any phase discontinuities.

KEY SPECIFICATIONS AND FEATURES:

- 600 MHz of instantaneous bandwidth per channel
- Timing synchronization up to 16 channels
- Link emulation including:
    - Phase continuous delay, Doppler, and attenuation changes
    - AWGN and Eb/No
    - 12 tap (path) multipath fading with Rayleigh, Rician, and CW. Angle of Arrival (AOA), k-factor, and correlation controls
    - RF frequency-agile up/down converters
- Payload emulation including:
    - IMUX/OMUX amplitude and group delay distortion
    - Amplifier compression (AM/AM and AM/PM)
    - Phase noise
- Static and dynamic link emulation
- Ephemeris data generation using SATGEN
- Remote instrument control through ACE Client application

SATGEN II Satellite Orbit Modeling Software

SATGEN II is a GUI-based satellite orbit modeling software program used to generate data files necessary for the Dynamic Mode of the ACE9000 Advanced Channel Emulator. The program calculates Doppler, delay, and path loss for up to eight entities per channel, and up to four channels. Entities include a fixed location earth transponder, a moving land vehicle or ship, aircraft, and specified satellite orbits.

More Resources

Visit maurymw.com/info/satellite-2026 to learn more about Maury solutions.

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