National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Communications

Tunable Multi-Tone, Multi-Band, High-Frequency Synthesizer

Pioneering synthesizer enables game-changing new capabilities in satellite communications

Innovators at NASA's Glenn Research Center have developed a multi-tone, multi-band, high frequency synthesizer that enables unprecedented satellite communications and atmospheric studies. Because of the increased congestion at currently used frequency bands, it would be game-changing to open other millimeter-wave frequency bands for satellite communications with stations on Earth. When used as part of a CubeSat beacon transmitter, the synthesizer would enable rigorous characterization of atmospheric effects (e.g., rainfall, climate change, hurricane monitoring, cloud cover, and gaseous adsorption). Although the synthesizer can be used on other platforms, the use of the CubeSat allows these studies to be conducted without the huge expense of a larger satellite. The synthesizer can also be used for space-borne active remote sensors such as scatterometers.

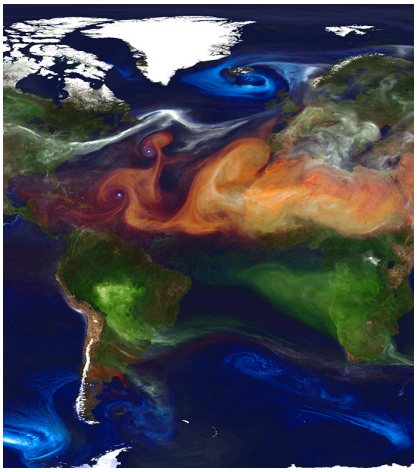
BENEFITS

- Flexible: Generates and transmits signals that are tunable over wide frequency ranges, including Q-band (37-42 GHz), V/W-band (71-76 GHz), and K-band (18-26GHz)
- Reliable: Provides more accurate wideband characterization through multi-tone frequency generator, with noise less than -70dBc
- Efficient: Has smaller antenna size and lower mass, which yield fuel savings
- Compact: Has small size and weight, enabling integration into the CubeSat platform
- Simple: Uses harmonic generation of high-frequency beacon signals rather than direct generation, which requires much more complex circuitry
- Accurate: Excellent frequency stability because the input drive signal is locked to a stable crystal oscillator

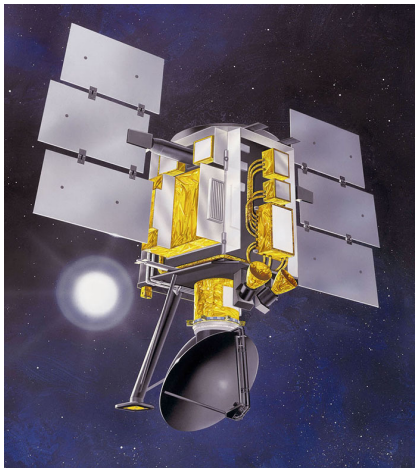
THE TECHNOLOGY

Glenn's revolutionary new multi-tone, high-frequency synthesizer can enable a major upgrade in the design of high data rate, wide-band satellite communications links, in addition to the study of atmospheric effects. Conventional single-frequency beacon transmitters have a major limitation: they must assume that atmospheric attenuation and group delay effects are constant at all frequencies across the band of interest. Glenn's synthesizer overcomes this limitation by enabling measurements to be made at multiple frequencies across the entire multi-GHz wide frequency, providing much more accurate and actionable readings.

This novel synthesizer consists of a solid-state frequency comb or harmonic generator that uses step-recovery semiconductor diodes to generate a broad range of evenly spaced harmonic frequencies, which are coherent and tunable over a wide frequency range. These harmonics are then filtered by a tunable bandpass filter and amplified to the necessary power level by a tunable millimeter-wave power amplifier. Next, the amplified signals are transmitted as beacon signals from a satellite to a ground receiving station. By measuring the relative signal strength and phase at ground sites the atmospheric induced effects can be determined, enabling scientists to gather essential climate data on hurricanes and climate change. In addition, the synthesizer can serve as a wideband source in place of a satellite transponder, making it easier to downlink high volumes of collected data to the scientific community. Glenn's synthesizer enables a beacon transmitter that, from the economical CubeSat platform, offers simultaneous, fast, and more accurate wideband transmission from space through the Earth's atmosphere than has ever been possible before.



Glenn's innovative technology allows satellites to use multiple-frequency bands, improving the accuracy of their readings



Glenn's novel synthesizer can help scatterometers, like the one pictured above, collect rigorously characterized and actionable wind data

APPLICATIONS

The technology has several potential applications:

- Communications satellites
- CubeSats
- Climate studies (e.g., analysis of hurricanes, climate change)
- Space-to-ground communications
- Active remote sensors (e.g., scatterometers)

PUBLICATIONS

Patent No: 10,564,248

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More Information

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