National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Communications

Multimode Directional Coupler

Makes additional frequencies available for satellite communication

Researchers at NASA's Glenn Research Center have patented a novel multimode directional coupler (MDC). This rugged and easily constructed waveguide is used to extract second- or higher-order harmonics, which are generally unused but contain sufficient power to be amplified and transmitted to a receiving station on Earth. Glenn's innovators developed the MDC as a means to extract signal harmonics from a satellite transmitter, with minimum perturbation to a fundamental frequency. The ability of the MDC to allow the fundamental frequency to propagate with negligible power losses makes it a substantial upgrade over the conventional diplexer. Glenn's MDC offers an innovative way to increase the number of terrestrial stations that can receive signals from a single satellite, potentially increasing the return on the investment involved in launching and maintaining satellites.

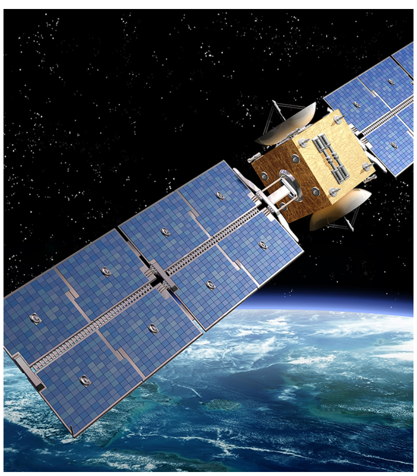
BENEFITS

- Versatile: Allows configuration to support second-order and higher harmonics
- Efficient: Extracts harmonics with negligible perturbation to the fundamental frequency
- Cost-effective: Permits transmitters to communicate with more than one receiving station at a time
- Easy to construct and maintain: Relies on rugged traditional waveguide and is simple to fabricate

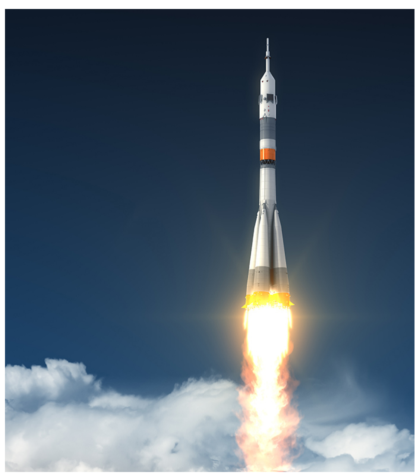
THE TECHNOLOGY

Glenn's researchers originally created the MDC to improve the beacon sources for atmospheric propagation studies. These studies are typically conducted to test atmospheric conditions to determine the signal strength needed for satellite communications. A low-power transmitter (e.g., a beacon source) is attached to the satellite, and transmits a continuous waveform (CW) signal to a receiving station on Earth. However, when a separate frequency is desired, building a new beacon source for the transmitter on the satellite - especially one that will operate at higher frequencies - presents numerous challenges. For one, a single-frequency beacon source requires a temperature-stabilized oscillator for frequency generation separate from that provided by the spacecraft receiver.

To solve such problems, Glenn's innovators fabricated the MDC from two sections of waveguide: a primary waveguide for the fundamental frequency (Ku-band), and a secondary waveguide for the harmonics (Ka-band). These sections are joined together so that precision-machined slots in the second waveguide selectively couple the harmonics, for amplification and transmission. The harmonics can then be used as an additional beacon source with very small power losses to the fundamental signal. Once the separation takes place, the second or higher harmonic can be amplified and transmitted to a station on Earth. The efficiency and performance of the MDC can be optimized through appropriate computer modeling software and currently available high-precision fabrication techniques. Without the complexity and expense involved in building separate traveling wave tube amplifiers to generate additional frequencies, Glenn's MDC enables satellites to produce multiple signals that can be received by multiple stations - a significant leap forward in satellite productivity.



Glenn's MDC offers a novel way to increase the number of terrestrial stations that can receive signals from a single satellite



Applications for Glenn's MDC include communications for spacecraft, unmanned aerial vehicles (UAVs), and terrestrial broadband

APPLICATIONS

The technology has several potential applications:

- Satellite beacon
- Satellite communication
- Atmospheric testing
- Terrestrial transmission strength modifier

PUBLICATIONS

Patent No: 9,252,477; 10,249,929

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More Information

National Aeronautics and Space Administration

Agency Licensing Concierge

Glenn Research Center

21000 Brookpark Road
Cleveland, OH 44135
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

www.nasa.gov

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