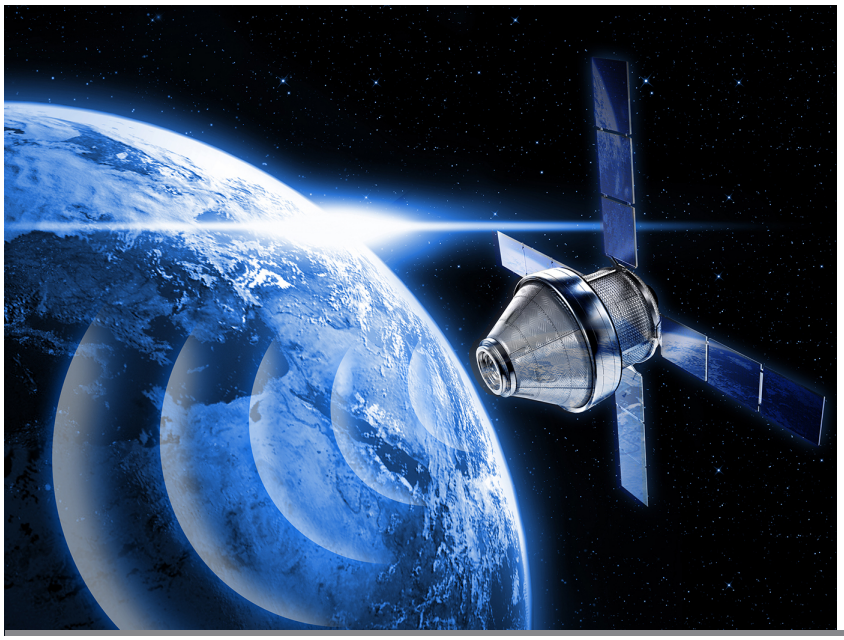


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Communications

Microwave Power Combiner

Enables MMIC amplifiers to be combined more efficiently for use in near-Earth and deep-space communications

To achieve power levels necessary for communications in space, several monolithic microwave integrated circuit (MMIC) amplifiers must be combined. One problem with this process is that conventional power combiners require MMICs with identical amplitude and phase characteristics, but even minor variations in manufacture cause MMIC power outputs to be unequal. To solve this problem, scientists at NASA's Glenn Research Center have developed a novel waveguide hybrid power combiner for solid-state power amplifiers based on MMICs. Glenn initially demonstrated the proof-of-concept at Ka-band frequencies, from 31.8 to 32.3 GHz, which is NASA's deep-space frequency band. However, the design can be scaled to other frequencies of interest.

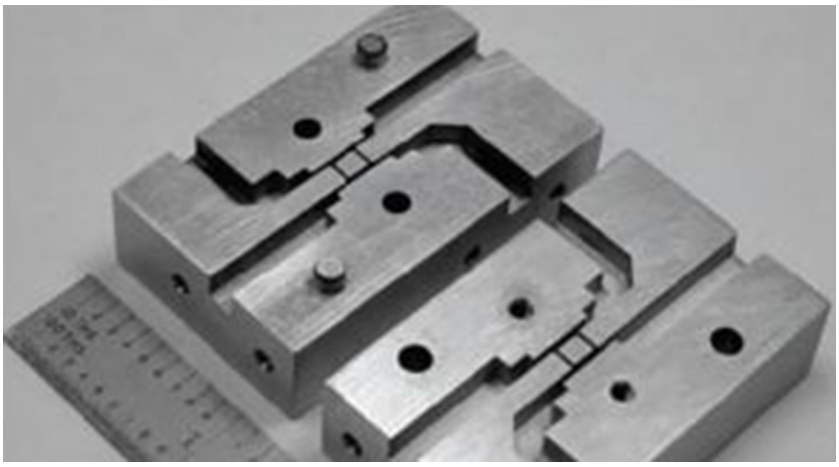
BENEFITS

- Flexible: Enables the efficient combination of multiple MMICs, even when each possesses different output power
- Economical: 3-D printing permits use of metal-plated plastic, reducing material, cost, and weight
- Scalable: Features a design that can be scaled to any arbitrary power-combining ratio and port impedance and to a wide range of communication frequencies
- Versatile: Can be run in reverse to create a power divider

THE TECHNOLOGY

MMICs are a type of integrated circuit that operates at microwave frequencies to amplify electronic signals. The system has at least two power amplifiers; input ports to receive power from the amplifiers; at least one power combiner, which receives power from each input port and combines them to produce maximized power; an output port that sends this maximized power to its destination; and an isolated port, either grounded or match-terminated, that receives no or negligible power from the combiner. The output port can be connected to a load, and can employ more than one combiner, so that the power from another combiner and an input port can be combined, for example, in a 3-way unequal power combiner.

Glenn's Ka-band demonstration power combiner has an output return loss better than 20 dB, and a high degree of isolation between the output port and the isolated port, as well as between the two input ports. When the ratio of output power for two MMICs is two-to-one, the combined efficiency is better than 90%. However, the design is not limited to a two-to-one ratio; it can be customized to any arbitrary power output ratio. This means that a low-power gallium arsenide MMIC can be combined with a high-power gallium nitride MMIC, giving designers much more flexibility. The output impedance of the MMIC power amplifier is matched directly to the waveguide impedance, without first transitioning into a transmission line. This technique eliminates the losses associated with a transition and enhances the overall efficiency. Furthermore, the MMIC power combiner is dual purpose- run in reverse it serves as a power divider. To reduce the cost and weight the combiner can be manufactured using 3-D printing and metal-plated plastic. By combining MMIC amplifiers more efficiently, Glenn's technology greatly enhances communications from near-Earth and deep space-to-Earth.



Glenn's technology combines unequal output powers, permitting more flexibility in space communications system design

APPLICATIONS

The technology has several potential applications:

- Near-Earth and deep-space communication
- Microwave/Millimeter-wave frequency solid-state power amplifiers

PUBLICATIONS

Patent No: 9,484,613; 10,033,083

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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