



• Demonstration of a Submillimeter-Wave HEMT Oscillator Module at 330 GHz

This low-mass, low-power module may be useful for hidden weapons detection and airport security.

NASA's Jet Propulsion Laboratory, Pasadena, California

In this work, radial transitions have been successfully mated with a HEMT-based MMIC (high-electron-mobility-transistor-based monolithic microwave integrated circuit) oscillator circuit. The chip has been assembled into a WR2.2 waveguide module for the basic implementation with radial E-plane probe transitions to convert the waveguide mode to the MMIC coplanar waveguide mode. The E-plane transitions have been directly integrated onto the InP substrate to couple the submillimeter-wave energy directly to the waveguides, thus avoiding wirebonds in the RF path. The oscillator demonstrates a measured 1.7 percent DC-RF efficiency at the module level.

The oscillator chip uses 35-nm-gate-length HEMT devices, which enable the high frequency of oscillation, creating the first demonstration of a packaged

waveguide oscillator that operates over 300 GHz and is based on InP HEMT technology. The oscillator chip is extremely compact, with dimensions of only $1,085 \times 320 \mu\text{m}^2$ for a total die size of 0.35 mm^2 . This fully integrated, waveguide oscillator module, with an output power of 0.27 mW at 330 GHz, can provide low-mass, low DC-power-consumption alternatives to existing local oscillator schemes, which require high DC power consumption and large mass.

This oscillator module can be easily integrated with mixers, multipliers, and amplifiers for building high-frequency transmit and receive systems at submillimeter wave frequencies. Because it requires only a DC bias to enable submillimeter wave output power, it is a simple and reliable technique for generating power at these frequencies. Future work will be directed to further improving the

applicability of HEMT transistors to submillimeter wave and terahertz applications. Commercial applications include submillimeter-wave imaging systems for hidden weapons detection, airport security, homeland security, and portable low-mass, low-power imaging systems.

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• Flexible Peripheral Component Interconnect Input/Output Card

The card has applications in quality and testing systems for product design verification and manufacturing testing.

Lyndon B. Johnson Space Center, Houston, Texas

The Flexible Peripheral Component Interconnect (PCI) Input/Output (I/O) Card is an innovative circuit board that provides functionality to interface between a variety of devices. It supports user-defined interrupts for interface synchronization, tracks system faults and failures, and includes checksum and parity evaluation of interface data. The card supports up to 16 channels of high-speed, half-duplex, low-voltage digital signaling (LVDS) serial data, and can interface combinations of serial and parallel devices. Placement of a processor within the field programmable gate array (FPGA) controls an embedded application with links to host

memory over its PCI bus. The FPGA also provides protocol stacking and quick digital signal processor (DSP) functions to improve host performance. Hardware timers, counters, state machines, and other glue logic support interface communications.

The Flexible PCI I/O Card provides an interface for a variety of dissimilar computer systems, featuring direct memory access functionality. The card has the following attributes:

- 8/16/32-bit, 33-MHz PCI r2.2 compliance,
- Configurable for universal 3.3V/5V interface slots,
- PCI interface based on PLX Technol-

- ogy's PCI9056 ASIC,
- General-use 512K×16 SDRAM memory,
- General-use 1M×16 Flash memory,
- FPGA with 3K to 56K logical cells with embedded 27K to 198K bits RAM,
- I/O interface: 32-channel LVDS differential transceivers configured in eight, 4-bit banks; signaling rates to 200 MHz per channel,
- Common SCSI-3, 68-pin interface connector.

The Flexible PCI I/O Card was integrated into the Shuttle Mission Simulator (SMS) as a more efficient means of interfacing between the Silicon Graphic Inc. (SGI) simulation host and the Simulator Interface Device (SID). The