Electronics/Computers

In-Phase Power-Combined Frequency Tripler at 300 GHz

This compact, tunable, broadband, high-power design is suitable for radar as well as for driving imaging arrays of heterodyne spectrometers.

NASA's Jet Propulsion Laboratory, Pasadena, California

This design starts with commercial 85- to 115-GHz sources that are amplified to as much as 250 mW using power amplifiers developed for the Herschel Space Observatory. The frequency is then tripled using a novel waveguide GaAs Schottky diode frequency tripler. This planar diode produces 26 mW at 318 GHz. Peak conversion efficiency is over 15 percent, and the measured bandwidth of about 265–330 GHz is limited more by the driving source than by the tripler itself.

This innovation is based on an integrated circuit designed originally for a single-chip 260- to 340-GHz balanced tripler. The power-combined version has two mirror-image tripler chips that are power-combined in-phase in a single waveguide block using a compact Y-junction divider at the input waveguide, and a Y-junction combiner at the output waveguide. The tripler uses a split-block waveguide design with two independent DC bias lines. The input waveguide is split in two by a Y-junction to evenly feed two circuits, each featuring six Schottky planar varactor diodes of about 16 fF on a 5 µm-thick GaAs membrane. The chips are mounted in two independent channels that run between their respective input and output waveguides. The two reduced-height output waveguides are combined by a Y-junction that is seen by each branch of the circuit as a simple waveguide step.

On each chip, an E-plane probe located in the input waveguide couples the signal at the input frequency to a suspended microstrip line. This line has several sections of low and high impedance that are used to match the diodes at the input and output frequencies, and to prevent the third harmonic from leaking into the input waveguide. The third harmonic produced by the diodes is coupled to the output waveguide by a second E-plane probe. In order to balance the circuit, the dimensions of both the channel and the circuit are chosen to cut off the TE-mode at the second (idler) frequency. The dimensions of the output waveguide ensure that the second harmonic is cut off at all frequencies measured, and the balanced geometry of the chips ensures that the power at the fourth harmonic of the input is strongly suppressed.

The tripler can be used to pump subharmonic mixers used as high-resolution spectrometers to measure temperature, pressure, velocity, and chemical composition of planetary atmospheres. The high output power makes this source ideal for driving frequency multipliers to very high frequencies. For example, the Earth observing system microwave limb sounder (EOS-MLS) instrument has a 2.5-THz channel. High power also makes this source suitable for radars as well as for driving imaging arrays of heterodyne spectrometers.

This work was done by Alain Maestrini of the Université Pierre et Marie Curie and John Ward, Robert Lin, John Gill, Choonsup Lee, Imran Mehdi, Hamid Javadi, and Goutam Chattopadhyay of Caltech for NASA's Jet Propulsion Laboratory.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Electronic System for Preventing Airport Runway Incursions

Portable units would perform monitoring, signaling, and automatic warning functions.

Marshall Space Flight Center, Alabama

The figure is a block diagram of a proposed system of portable illuminated signs, electronic monitoring equipment, and radio-communication equipment for preventing (or taking corrective action in response to) improper entry of aircraft, pedestrians, or ground vehicles onto active airport runways. Such an entry, denoted a runway incursion, poses a risk of collision with an aircraft properly moving on the affected runway. The major causes of runway incursions are mistakes by pilots, ground-vehicle drivers, and control-tower personnel. Heretofore, there have been no automated, systematic, reliable means of monitoring and regulating airport ground traffic to prevent or correct for runway incursions. The main overall functions of the proposed system would be to automatically monitor aircraft ground traffic on or approaching runways and to generate visible and/or audible warnings to affected pilots, ground-vehicle drivers, and control-tower personnel when runway incursions take place.

The system would include one or more portable units, denoted runway intersection display and monitor (RIDAM) units, that could be placed near taxiways. Each RIDAM unit would include an illuminated sign [and, optionally, a red ("stop") and a green ("go") traffic light mounted on top] that would be remotely controlled by means of encrypted signals transmitted from the control tower via a free-space or carrier-current radio-frequency (RF) link. The sign, lights, and associated communication and monitoring