OE6.2 Use of Picosecond Optical Pulses and FETs Integrated With Printed Circuit Antennas to Generate Millimeter Waves

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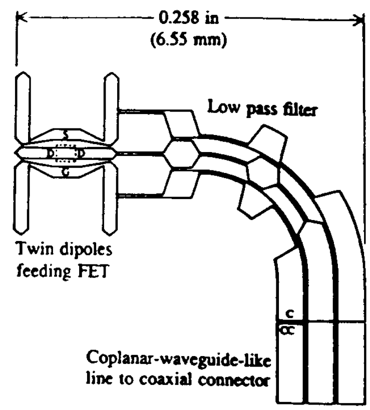
Millimeter wave radiation has been generated from FETs, integrated with printed circuit antennas, and illuminated with picosecond optical pulses. Sidebands on the millimeter waves were obtained by applying a swept RF modulation to the FET gate. Heterodyne detection and display demonstrates continuously tunable radiation from 45 GHz to 75 GHz.

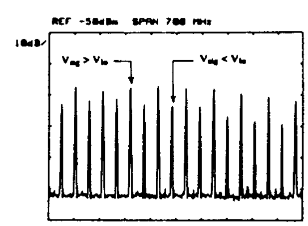
New Technique Using
3 Terminal Devices

- FETs and HEMTs, integrated with printed circuit antennas, are used to generate millimeter wave radiation.
- Picosecond optical pulses used to generate electrical pulses (in devices) which drive antennas. Device impedance is reduced to <10 ohms.
- Electrical modulation is applied to transmitter gate. Modulation is a propagating sideband on optically generated carrier.
- Millimeter wave power large enough to be detected using heterodyne techniques.

INTEGRATED ANTENNA

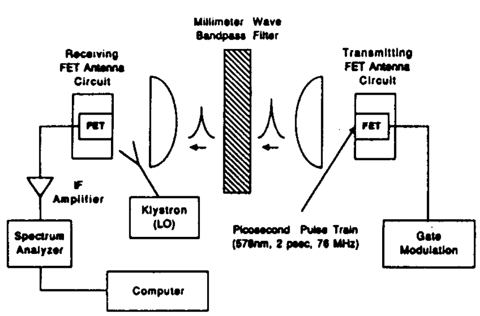


Millimeter Wave Radiation Comb Generated With Optical Pulse Train

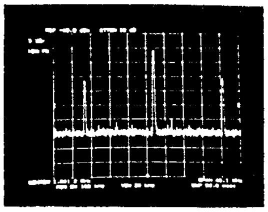


- Radiation at 61 GHz is shown.
- Radiation measured from 45 GHz to 75 GHz. Components spaced at modelocking frequency (76 MHz).
- Estimated average power is >100 nW.
- Radiation detected in real time using heterodyne detection.

Pulsed Millimeter Wave Radiation Experimental Set-up

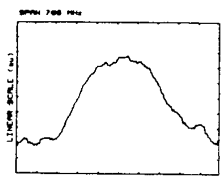


Gate Modulation adds Sidebands to Optically Generated Carrier



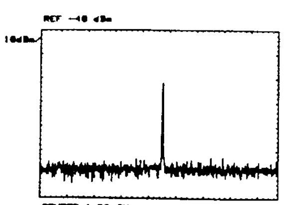
- Optically generated carrier is at 61 GHz.
- Electrically generated sidebands are at 14.0 MHz. 0 dBm of electrical signal applied to transmitting FET gate.
- Using this technique, information can be put on the carrier via electrical gate modulation.

Gate Modulation Provides Complete Spectral Coverage



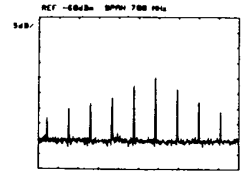
- Applying swept RF electrical modulation to transmitter gate fills in filter response.
- Technique requires ratioing the response of the filter with and without gate modulation.
- Tunable, CW radiation would provide direct measurement.

Tunable, CW, Millimeter Wave Radiation



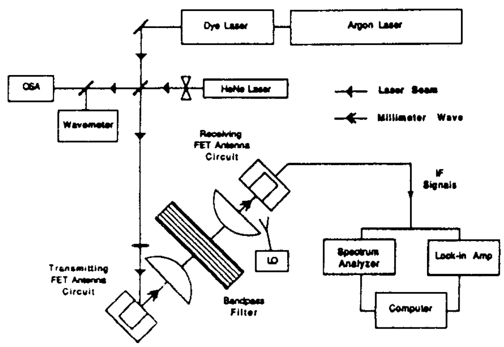
- Millimeter wave frequency: 60.1 GHz.
- Typical Signal/Noise is 35-40 dB.
- Signal optimized at 60 GHz due to high gain antenna.

Spectroscopic Applications: Measurement of the Response of a Filter



- Filter (Fabry-Perot) consists of 50 lines/inch metal meshes.
- Measurement of filter characteristics show:
  a) Signals in the lower sideband are rejected.
  b) Signals in the upper sideband are attenuated.

CW Millimeter Wave Radiation



Conclusions

- Three terminal devices and picosecond optical pulses used to generate millimeter wave radiation.
- Three terminal devices and cw lasers used to generate millimeter wave radiation.
- Millimeter wave power large enough to be detected in real time using heterodyne techniques.
- Gate terminal electrically modulated and thus places sideband modulation on optical carrier.
- Performance of transmitter can be both characterized and optimized.

Future Work

Semiconductor Lasers

Fiber Optics

Monolithic Integration of Lasers and FET/Antenna Circuit