1.5 THz ALL-PLANAR MULTIPLIED SOURCE

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A complete source for 1.5 THz has been built using a cascade of four planar doublers following a MMIC based HEMT power amplifier. This driver is in turn driven by a times nine multiplier so that the complete source may be synthesizer controlled. The source is intended for cryogenic use but initial tests have mostly been at room temperature.

The power amplifier is a single GaAs MMIC driven by three driver stages so that the required input power is only 2 mW. The output power is 200 mW near 94 GHz but the maximum safe input power for the multiplier chain is 170 mW. The first stage doubler is a six diode planar balanced device using two series diode arrays on a single GaAs chip. DC bias is introduced via a thin film capacitor on GaAs so that no distributed filters or additional substrates are used in the design. The second stage is a similar doubler but using just four diodes. The third doubler is similar but using only two diodes. All of these stages operate in varactor mode with diodes reverse biased, and with relatively low bias current in actual use. Substrate thickness varies from 40 μm for the first stage to 12 μm for the third. Beam leads are used on the chips for bias and grounding. The fourth stage doubler is a membrane substrate device on 3 μm thick GaAs. It is a balanced device with two diodes, operating in a varistor mode with a bias current of 0.5 mA and a bias voltage in the forward direction. The output powers of the various stages are: first stage 42 mW, second stage 9 mW, third stage 0.7 mW and final stage 3.5 μW, all measured at room temperature. This output was measured near 1484 GHz, although >1 μW is produced over a range of frequencies up to 1520 GHz. The tuning behavior has not been explored outside this range, since the main goal of this initial work was to find a spot sufficiently far from a water absorption for testing an HEB mixer. Based on preliminary testing with a lower power source, it is expected that a power of 1 μW is sufficient to drive the mixer.

The final doubler was originally designed for tests with a laser so the input is a conical feed horn. This required adding a feed horn to the third stage doubler so that they could be coupled. The coupling works well although there are certain to be problems with this technique at some frequencies and in the future these devices will be linked by waveguide only.

Actual use of this chain in its intended spacecraft environment will be at 120 K, and at this temperature the output power should increase greatly since the second stage output will double. The behavior of the higher stages at low temperature is not know in detail, but they will work better at higher input power both because they are underdriven at room temperature, and because their inherent efficient should increase.