tance is added in series with the diode to produce resonance near band center, the diode is effectively decoupled from the external circuitry at high frequencies. Hence, the stability condition must be that the diode be open-circuit stable. This implies that

$$C_p\left(\frac{L}{R_N C_j} - R_s\right) < \frac{R_s R_D C_j}{R_D - R_s} \quad (2)$$

where C_p is package capacitance, a condition which is more easily met than is (1). In fact it is easily seen that (1) guarantees (2), but not vice versa. Physically this is understood by observing that resonance with C_p must occur above diode series resonance.

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X To K Band Broadband Varactor Frequency Doubler

This correspondence describes a broadband X to K band varactor frequency doubler. Instantaneous bandwidths of 12 percent at 20 percent efficiency or 19 percent at 2 percent efficiency were obtained. Typical bandwidths of varactor multipliers at these frequencies had been reported at about one percent. Broadband varactor frequency multipliers with C-band or lower output frequencies, designed in coaxial or strip transmission line circuits, had been reported by C. L. Cuccia [1] and by R. J. Wenzel [2].

Our X to K band doubler is designed in the waveguide circuit, as shown in Fig. 1.

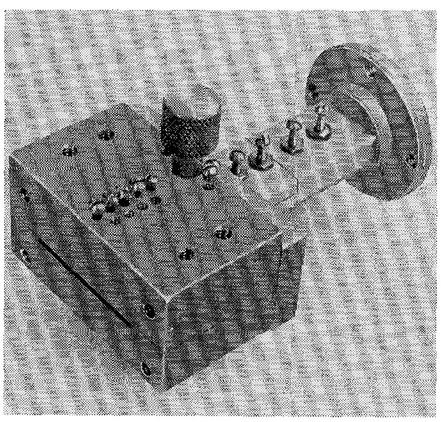

Fig. 1. Doubler with tuning screws in waveguide section.

The input circuit consists of a reduced-height WR90 waveguide section with several tuning screws preceding the Sylvania D5047B varactor. The floating-bias arrangement was used—that is, one end of the varactor open-circuited. The output waveguide WR42 contains a three-quarter wavelength section stepped-impedance transformer (binomial characteristic impedance distribution) with trim-tuning screws. A variable series capacitance tuner is located at the open end of the varactor. The input to the doubler was provided by an X band frequency sweeper followed by a TWT amplifier. The power inputs were in the 15 to 160 mW range with a ± 0.5 dB maximum ripple in the doubler input band. The doubler was tuned during the tests to various frequencies, and different input-power levels were used. The results in terms of bandwidth vs. efficiency are shown in Fig. 2, where the output frequency bands and input power levels are indicated. A typical output power vs. frequency curve is shown in Fig. 3 (10 mW output, 16 to 18 Gc/s band). The skirts of the doubler frequency band fall off sharply at the edges and no off-band responses have been observed. The ripple in the pass band seen in Fig. 3 was due in part to slight variations of input-power level. The doubler output bandwidth was sensitive to input-power levels, but could be corrected by slight retuning of the input screws.

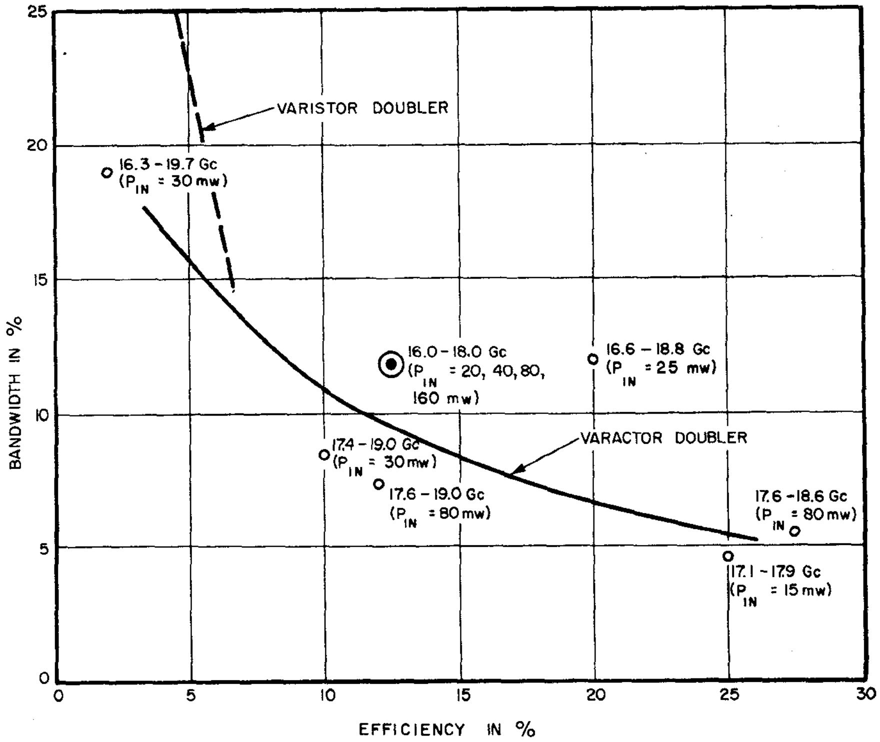

Fig. 2. Bandwidth vs. efficiency.

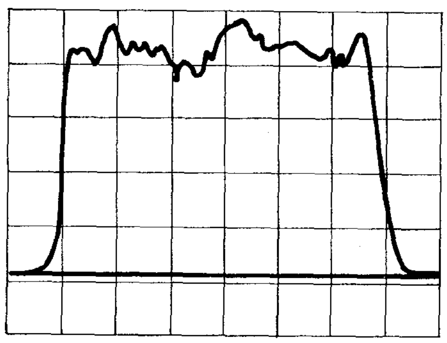

Fig. 3. Output power vs. frequency characteristics.

It should be pointed out that all measurements were performed at the input frequency sweep rate between 1 and 100 c/s. Varying the sweep rate normally caused a reduction in bandwidth and/or ripple in output-power level. This was determined to be due to the floating bias arrangement and could be corrected by introducing a constant dc bias voltage across the varactor.

The data in Fig. 2 indicate that a considerable advantage in efficiency can be obtained by replacing the variable resistance element by a varactor in an X to K band frequency doubler when bandwidths of 12 percent or below are required. Theoretical analysis of a simplified equivalent circuit of a doubler indicates that 25 to 30 percent bandwidths with present-day varactors should be possible at these frequencies but may require a different varactor imbedding circuit.

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