Study of Nonlinear Transmission Line Parameters and Their Effect on Output Harmonic Generation

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This abstract highlights a study of the effect of various nonlinear transmission line (NLTL) parameters on wideband harmonic generation. The nonlinearity of the NLTLs originates from varactor diodes that have been loaded in shunt along the length of a coplanar waveguide transmission line. This study focuses on minimal power degradation out to the 10^{th} harmonic (flatness), while maintaining as high as possible harmonic power levels. Dependence on input power, varactor diode characteristics, diode spacing, diode bias, and line impedance are investigated within two input frequency ranges: 50-150 MHz and 500-1000 MHz.

Diode characteristics are found to be a major contributor to NLTL performance. Diodes with large packaging parasitics severely degrade harmonic output power levels. Additionally, the grading coefficient, or slope of the logarithmic capacitance versus reverse bias voltage curve, needs to be high. The location and spacing of diodes on the line is also a significant contributor to NLTL performance. Since a section of the NLTL has a voltage-dependent capacitance per unit length, the impedance and phase constant change along the line. Diode spacing determines an optimal line length. An optimal bias voltage utilizes the highly nonlinear portion of the diode capacitance curve. This decreases the need for high input power and allows for greater harmonic power generation. Hyperabrupt junction tuning varactor diodes were soldered across the CPW gap in pairs, with five pairs giving the best performance.

Lines were optimized for input power between 18-30 dBm, with 30 dBm giving best results. Within about 65% of a frequency for which the output was optimized for, power levels and flatness are appropriately maintained before severely degrading. The smallest flatness recorded is 4.2 dB between the 6^{th} and 10^{th} harmonic with a 25.9 dBm 100 MHz CW input and 2.797 V reverse bias. These power levels range between -4.2 and -8.4 dBm, showing close agreement with a nonlinear simulation range of -4.5 to -8.7 dBm. For the 500-1000 MHz frequency range, degradation of 10 dB occurs between the 6^{th} and 10^{th} harmonic with a 24 dBm 750 MHz CW input and 2.4 V reverse bias. Output power levels range between 1 and -9 dBm.