ANALYSIS OF PERFORMANCES FOR BROADBAND MILLIMETER WAVE FOLDED WAVEGUIDE TWTs

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ABSTRACT
On the basis of computation of dispersion and coupling impedance for folded waveguide circuit (FWC), main performances: interact coefficient, saturated gain and output power are analyzed. Computation shows that if FWC is used in MMW amplifier, high power and wide band can be easy reached.

INTRODUCTION
At present, helix and coupled cavity are high frequency circuit in power TWT. Even helix has wide bandwidth and simple structure, but in MMW the dimension of helix is extreme tiny, power capability is lower. If solder helix is used, power lever can reach hundred watts\(^1\)\(^2\), but soldering technology is very difficult. Coupled cavity is suitable for high power TWT, however operating frequency range is narrow, it is not satisfied for MMW broadband system.

FWC is whole metal structure (Fig.1), it exists higher power capability, easy manufacture, wide bandwidth and inexpensive cost. It is important problem, that interacts coefficient and operating bandwidth whether are satisfied for system. According to TWT theory cold attenuation, interact coefficient, saturated gain and output power for Ka-band folded waveguide TWT are computed. Analysis and computation show that FWC is suitable for broad high power MMW TWTs.
Figure 1  Cross-Sections of folded waveguide circuit

DISPERSION AND COUPLING IMPEDANCE

It is assumed that a TE_{10} mode is propagated in FWC and \(\lambda_c\) is cut-off wavelength. For the fundamental wave, delay ratio of the circuit is\[^{[4]}\]

\[
c / v_p = \left( s / p \right) \sqrt{1 - \left( \lambda / \lambda_c \right)^2 + \left( \lambda / 2 \beta \right)}
\]

(1)

where

\[
\begin{align*}
    s &= l_0 + l_1 \left\{1 + \left( b / r \right)^2 \left[ 1 / 2 - \left( 2 \pi b / \lambda_c \right)^2 / 5 \right] / 12 \right\} \\
    l_0 &= \text{length of the straight waveguide} \\
    l_1 &= \text{length of the waveguide bend} \\
    r &= \text{curvature radius of the waveguide bend}
\end{align*}
\]

Phase velocity is easy calculated from the dimensions of the FWC.

Coupling impedance of the FWC is given by\[^{[4]}\]

\[
K_c = Z_c \left\{ 1 / \beta \sin \left( \beta b / 2 \right) / \left( \beta b / 2 \right) \right\}
\]

(2)

where

\[
Z_c = 377 \left( 2 b / a \right) / \sqrt{1 - \left( \lambda / \lambda_c \right)^2}
\]

When \(\beta b = 2.3311\), \(K_c\) is maximum. But considering wide bandwidth, the waveguide height \(b\) must be selected less than \(2.3311 / \beta\). Dispersion character and coupling impedance for the FWC in Ka-band are shown in Fig.2 and Fig.3 respectively.