Ku-Band Traveling Wave Slot Array Using Simple Scanning Control

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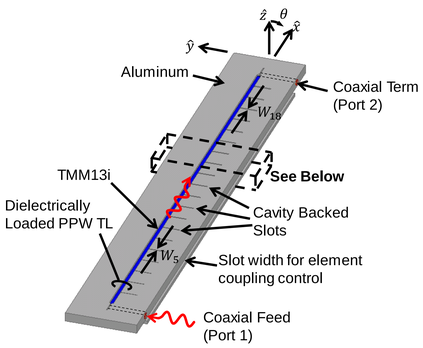
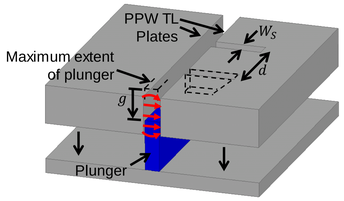
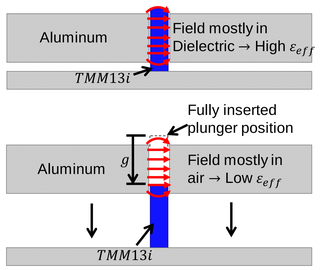
Abstract: This poster introduces a feeding concept aimed at simplifying the backend (phase shifters) of traditional phased arrays. As an alternative to traditional phased arrays, we employ a traveling wave array (TWA) using a single feedline whose propagation constant is controlled via a single, small mechanical movement without a need for phase shifters to enable scanning. Specifically, a dielectric plunger is positioned within a parallel plate waveguide (PPW) transmission line (TL) that feeds the TWA. By adjusting the position of the dielectric plunger within the PPW feeding the TWA, beam steering is achieved. A 20 element array is designed at 13GHz shown to give stable realized gain across the angular range of $-25° \leq \theta \leq 25°$. A proof of concept array is fabricated and measured to demonstrate and validate the concept's operation.

1 Operation Principle

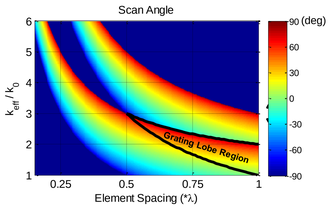




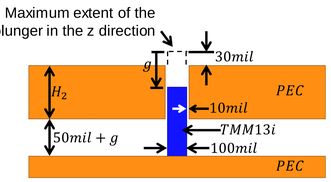
- **Array elements fed via propagation reconfigurable transmission line**
- **k_{eff} reconfigured via small mechanical movement**
- **Phase delivered to each element a function of k_{eff}**
- **Array scanned with only the small mechanical movement**

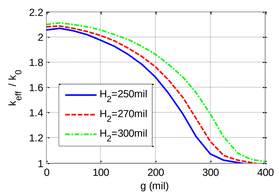


2 Transmission Line Design

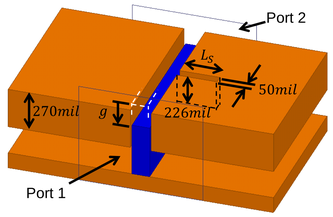


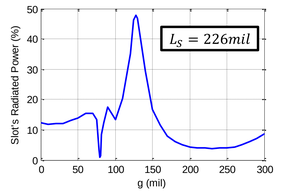
- **Scan range a function of element spacing and TL k_{eff}**
- **$-30° \leq \theta \leq 30°$ scanning is achieved with $1.04 \leq \frac{k_{eff}}{k_0} \leq 2.04$ for and element spacing of 0.65λ**
- **Line achieves the necessary k_{eff} agility at $H_2 = 270mil$**

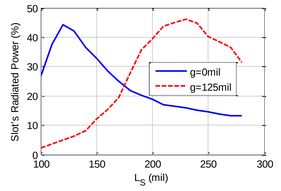




3 Rectangular Cavity Backed Slot

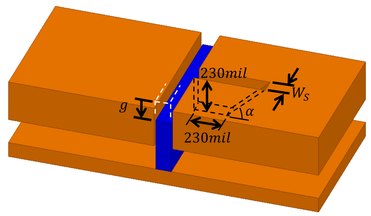


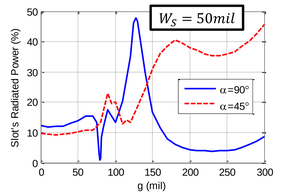


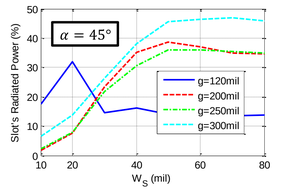


- **Cavity backed slot becomes detuned as the plunger is adjusted**
- **Resonant length of the cavity backed slot varies with plunger position**

4 Non-Rectangular Cavity Backed Slot

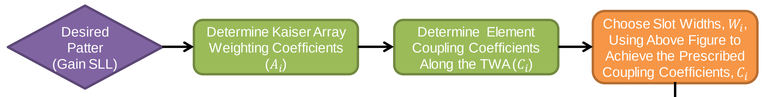






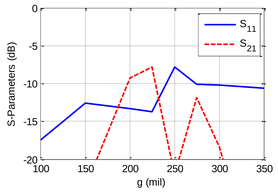
- **By angling the back of the cavity we lower the Q value**
- **W_S is used to control the coupling to each element**
- **A large range of coupling achievable is desired**

5 Array Design Procedure

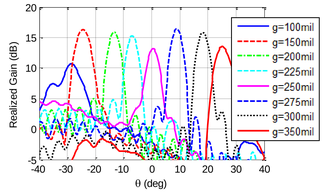


- **Characterize coupling from element over a range of slot widths**
- **Choose the element widths along the TWA to achieve the desired Kaiser taper**
- **Iteratively adjust slot widths to account for element reflections and mutual coupling until desired pattern is achieved**

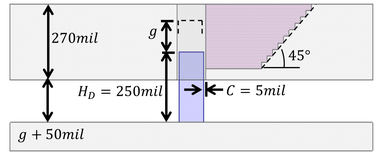
6 Initial Design Performance

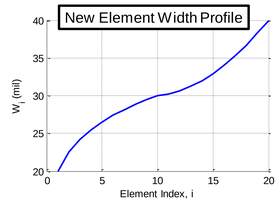


- **S-Parameters generally less than $-10dB$ except around boresight scan as expected**
- **Scanning of $-25° \leq \theta \leq 25°$**
- **Consistent realized gain level across scan range**



7 Increased Manufacturability



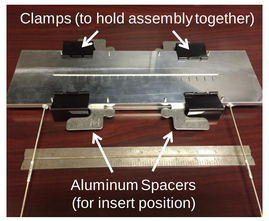


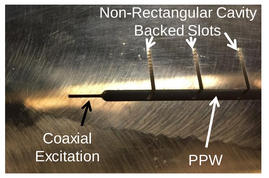
Reduce fabrication complexity

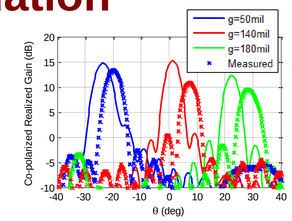
- **10 Steps to approximate cavity back**
- **Reduced plunger height**
- **Alter TL geometry and element spacing to achieve desired scan range**

Variable	Initial Design	Final Design
Cavity Back	Straight	Stepped
H_D	350mil	250mil
C	10mil	5mil
Element Spacing	0.65λ	0.54λ

8 Prototype Validation







- **Measurements generally agree with simulation**
- **Realized gain is down compared to simulated due to differences in TL geometry**
- **Measured scan angle is more positive, also due to differences in TL geometry**