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 $-25^\circ \leq \theta \leq 25^\circ$. 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 $k_{eff}$
- $-30^\circ \leq \theta \leq 10^\circ$ scanning is achieved with $1.04 \leq k_{eff} \leq 2.04$ for and element spacing of 0.65λ
- Line achieves the necessary $k_{eff}$ agility at $H_{2} = 270\text{mil}$

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
- $W_{2}$ 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 $-10\text{dB}$ except around boresight scan as expected
- Scanning of $-25^\circ \leq \theta \leq 25^\circ$
- 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

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