Reduced-Height, Wide Bandwidth Single Polarized Array of Doubly-Mirrored Balanced Antipodal Vivaldi Antennas (SP-DmBAVA)

Wajih Elsallal and Daniel Schaubert

Department of Electrical and Computer Engineering - University of Massachusetts, Amherst

Summary of Key Results
The Balanced Antipodal Vivaldi Antenna (BAVA) operates well as traveling-wave antenna, but numerical simulations of large arrays (infinite) show limited operating bands (1.4:1 at boresight) due to troublesome impedance anomalies. Based on new understanding, the antenna geometry is adjusted so that one of the anomalies is shifted out of the frequency band of interest. Furthermore, differential excitation of mirrored elements eliminates a second anomaly from the operating band. These observations and techniques have led to a design of:
1. Reduced-height (array depth $D < 0.56\lambda_{\text{highest-frequency}}$),
2. More than octave bandwidth,
3. Wide scan angle,
4. Module comprised of one BAVA element,
5. Single polarized array.

Single element BAVA Analysis
Design parameters:
- Element width, $H_a = 2.90$cm
- Element depth, $D = 6.9$cm
- Substrate: 60mil RT/Duriod 5870

Observation:
- Begins to work well: $H_a \approx \frac{\lambda_{\text{lowest-freq}}}{2}$, $D \approx 1 - 2\lambda_{\text{lowest-freq}}$
- Bandwidth varies inversely with opening rate ($R_1$)

Infinite Array Analysis
Conventional configuration of BAVA:
- Bandwidth is bounded by anomalies.
- Anomaly #1 depends on array parameters.
- Anomaly #2 depends on antenna depth.
- Return loss between anomalies depends on aperture width ($H_a$) and opening rate ($R_1$)

Doubly-mirrored configuration of BAVA (DmBAVA):
Design parameters:
- Element width = 1.26cm
- Element depth = 1.5cm
- Substrate: 90mil (er=3.0)
- Grating lobe freq=10GHz

Summary of Key Results
The Balanced Antipodal Vivaldi Antenna (BAVA) operates well as traveling-wave antenna, but numerical simulations of large arrays (infinite) show limited operating bands (1.4:1 at boresight) due to troublesome impedance anomalies. Based on new understanding, the antenna geometry is adjusted so that one of the anomalies is shifted out of the frequency band of interest. Furthermore, differential excitation of mirrored elements eliminates a second anomaly from the operating band. These observations and techniques have led to a design of:
1. Reduced-height (array depth $D < 0.56\lambda_{\text{highest-frequency}}$),
2. More than octave bandwidth,
3. Wide scan angle,
4. Module comprised of one BAVA element,
5. Single polarized array.