A La Carte Elliptical Polarization for ATSC 3.0

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Why ATSC 3.0

- Consumer behavior is changing
  - Demand for content on multiple devices
- Enables different use cases:
  - fixed
  - mobile
  - handheld
- Flexibility
- Ability to personalize / interact

ATSC 1.0 vs 3.0

- Higher data capacity
- Multiple PLPs
- Greater reception robustness
- Advanced compression techniques
- Future extensibility
- IP based STLs

Immobile Channel

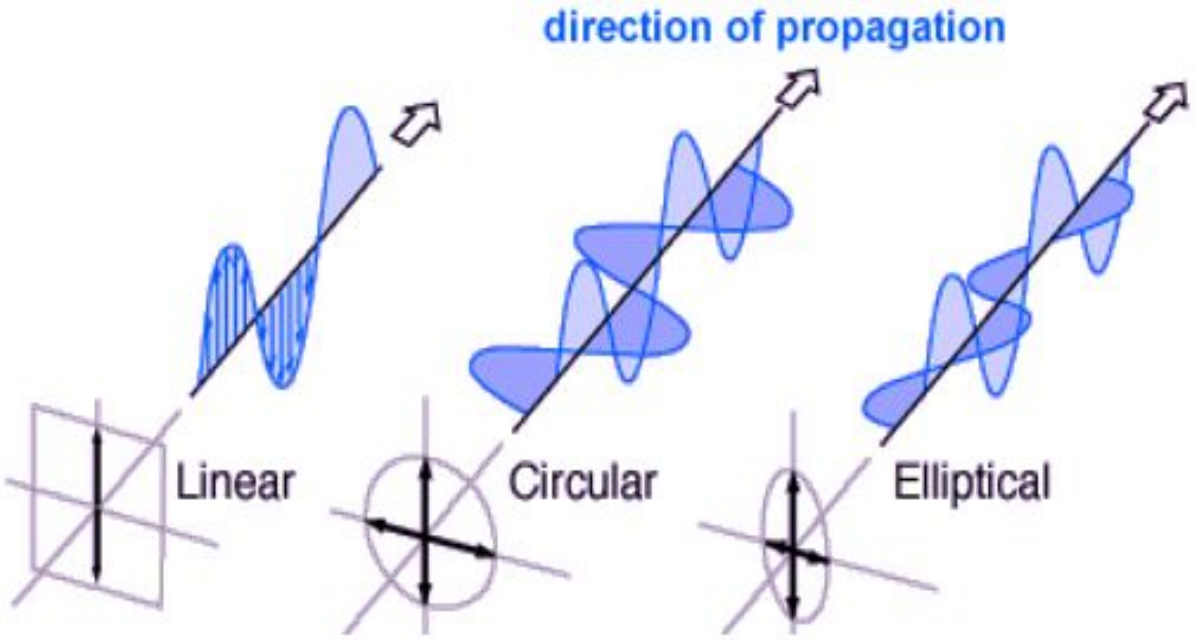
Population Coverage Considerations

- Azimuth Pattern
  - Many H-Pol antennas in use today
  - V-Pol to improve QoS for mobile, handheld, and in-building reception
    - 10-15% premium**
  - Optimized with Anechoic Chamber
  - Range testing

Polarization

- Polarization is an expression of the orientation of the lines electric flux in a electromagnetic field.
- Polarization can be constant i.e. existing in particular orientation at all times or it can rotate with each wave cycle.

Types of polarization



Polarization Loss Factor

- For two linearly polarized antennas that are rotated from each other by a angle “φ” the power loss due to this polarization mismatch will be described by the *Polarization loss factor.*

$$PLF = cos^2\varphi$$

Axial Ratio (AR)

- The axial ratio is the ratio of the two orthogonal components of an E-field.
- The circular and linear polarizations are special cases of the elliptical polarization
- If AR = 1 it is circular polarization and if AR = ∞ it is linear polarization.

Benefits of Elliptical polarization

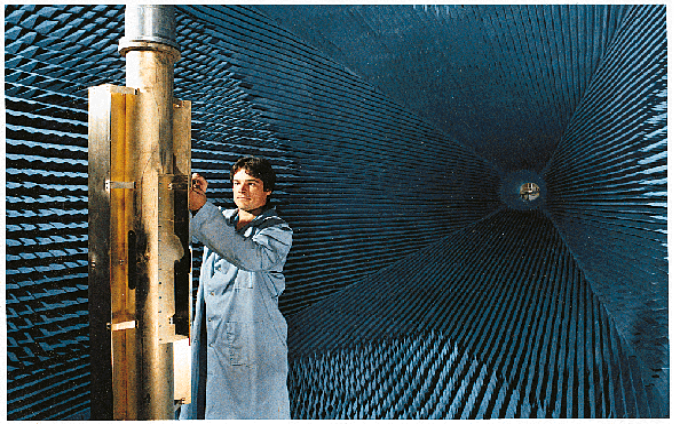
- Increase in coverage
  - For varying receive antenna orientations
  - For indoor reception
- No need to double the transmitter power output.
  - Make best use of available TPO

FCC Polarization Standard (TV)

- Dual polarized antenna may be employed if desired, in which case clockwise (right hand) rotation must be used.
- The maximum ERP of vertical polarized component should not exceed the maximum ERP of horizontal polarized component in any azimuth.

TV Broadcast Design

- THE DESIGN PROCESS
  - Full scale chamber modeling
  - Measured radiator data
  - Computer generated top level design
    - Tunability
    - Power handling
    - VSWR
    - Elevation pattern performance
  - Probe measurement to verify actual performance

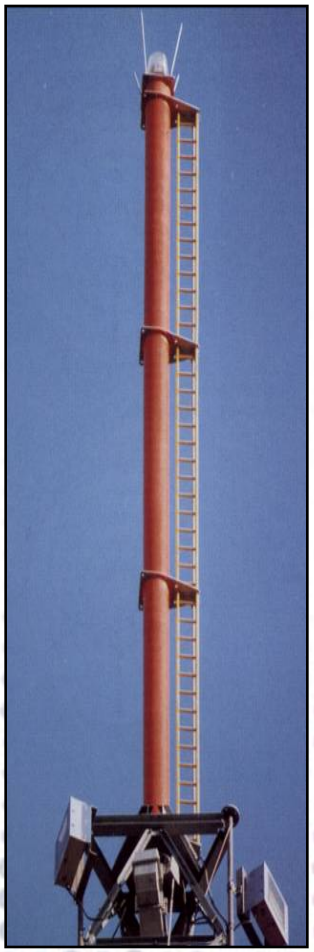


Elliptical Polarization Antenna Design

- Two types
  - Static elliptical polarization design
    - Slot antennas
    - Panel antennas
  - Dynamic elliptical polarization antenna
    - Panel Antennas

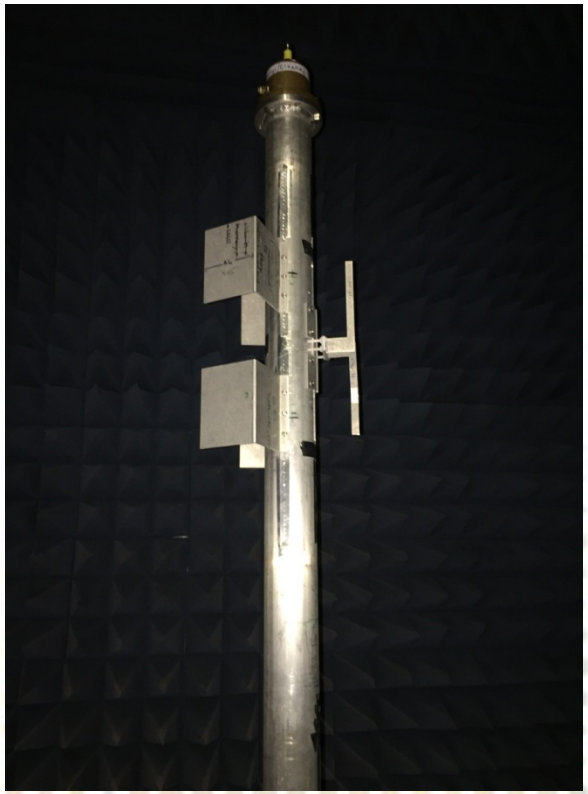
Elliptically Polarized Slot Antenna Design

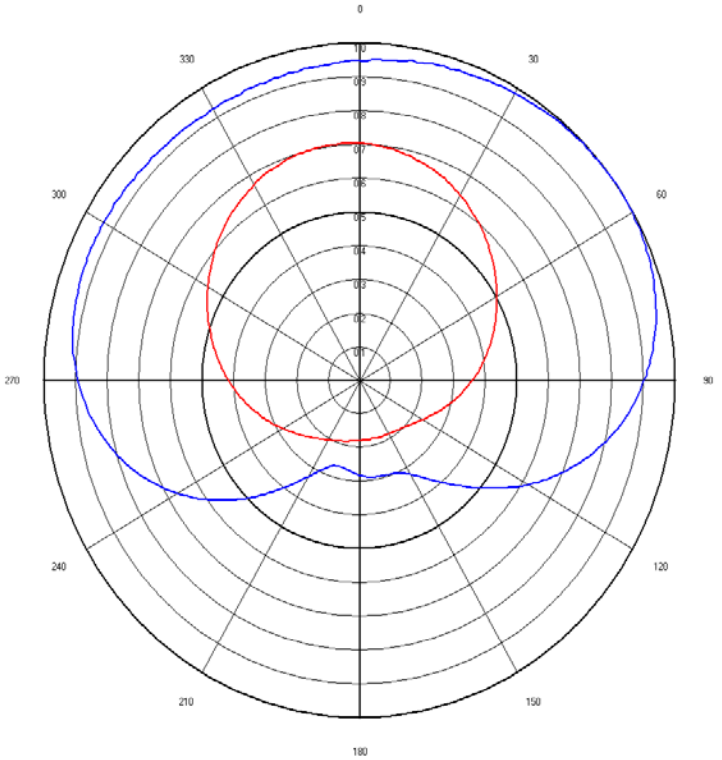
- Two types
  - Parasitically coupled
  - Directly coupled



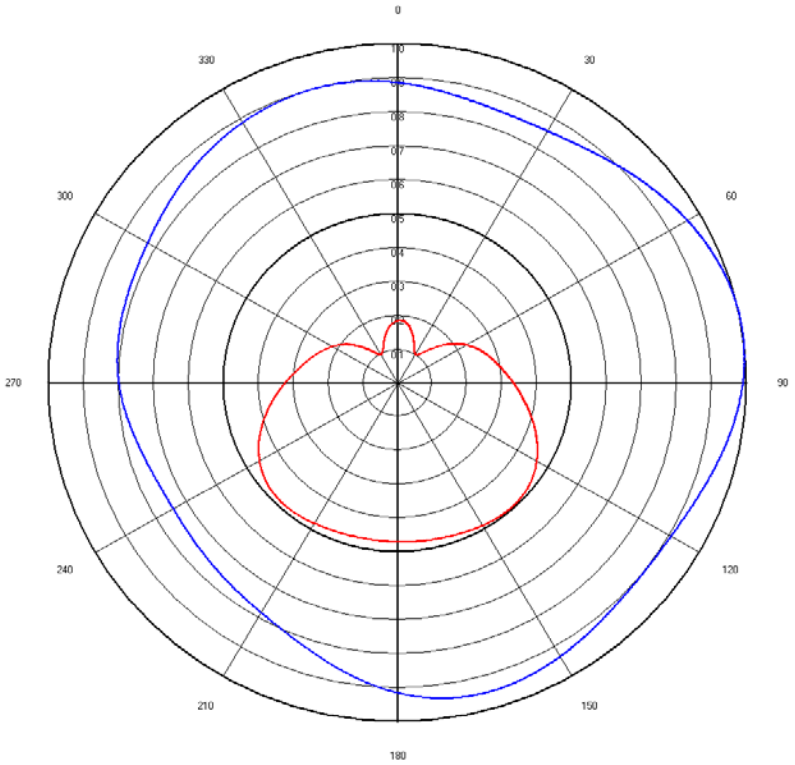
Circularly Polarized Antenna

Parasitically Coupled Vertical Polarized Component

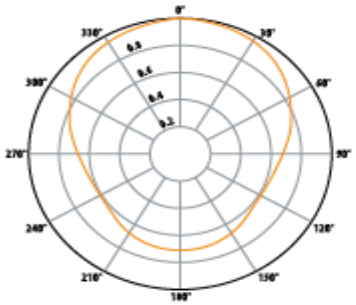




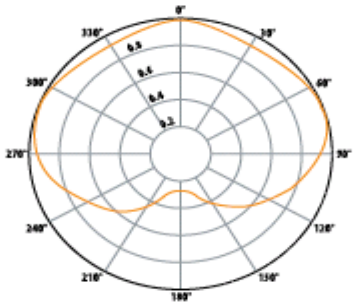
Directly Coupled Vertical Polarized Component



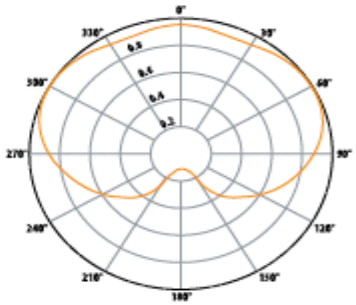
Low Power Slot Antenna Standard Patterns



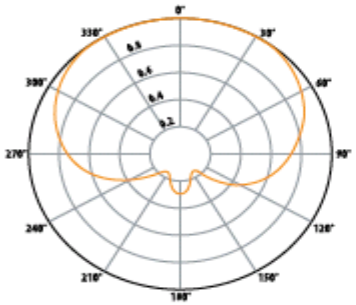
Omnioid™ (Omnidierctional)		
Type	OC	
Directivity	1.70	(2.30 dB)



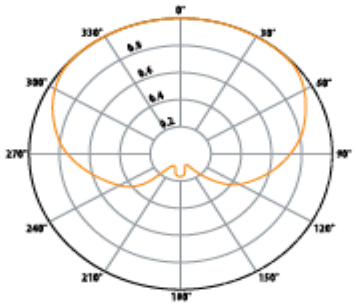
Wide Cardioid		
Type	W	
Directivity	1.56	(1.93 dB)



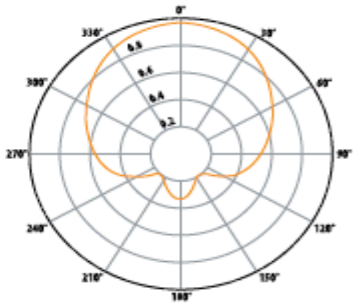
Wide Cardioid - Reduced Rear (H-Pol Only)		
Type	WR	
Directivity	1.69	(2.28 dB)



Extended Cardioid		
Type	E	
Directivity	1.86	(2.70 dB)

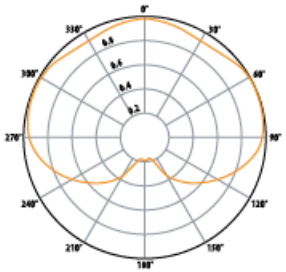


Extended Cardioid - Reduced Rear (H-Pol Only)		
Type	ER	
Directivity	1.93	(2.86 dB)

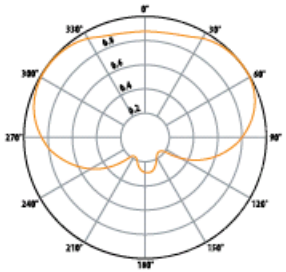


Medium Cardioid		
Type	M	
Directivity	2.54	(4.05 dB)

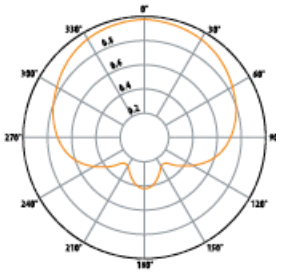
High Power Slot Antenna Standard Patterns



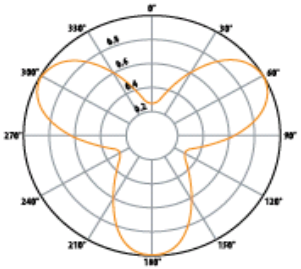
Type	C1	
Directivity	1.52	(1.82 dB)



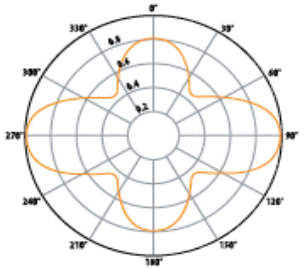
Type	C2	
Directivity	1.80	(2.55 dB)



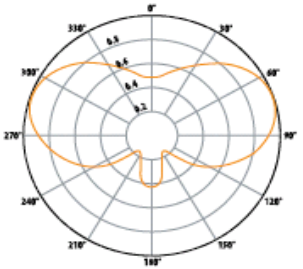
Type	C3	
Directivity	2.00	(3.01 dB)



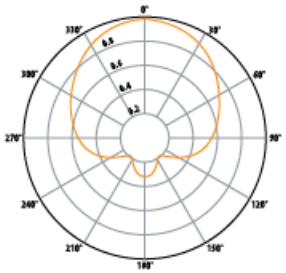
Type	T2	
Directivity	2.18	(3.38 dB)



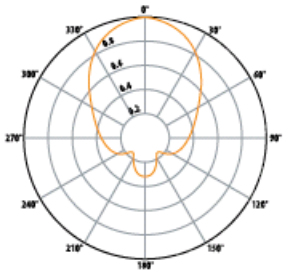
Type	P1	
Directivity	1.82	(2.83 dB)



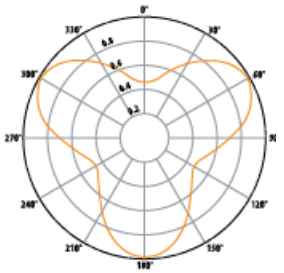
Type	P2	
Directivity	2.20	(3.42 dB)



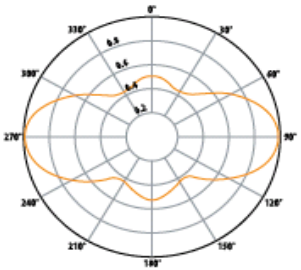
Type	C4	
Directivity	2.54	(4.05 dB)



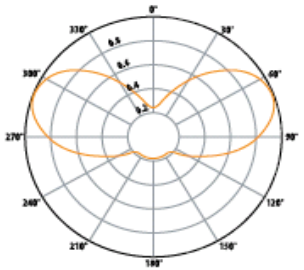
Type	C5	
Directivity	3.40	(5.31 dB)



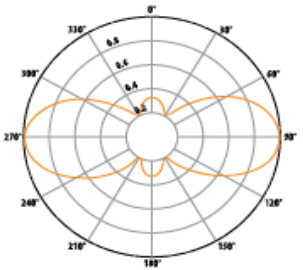
Type	T1	
Directivity	1.78	(2.50 dB)



Type	P3	
Directivity	2.24	(3.50 dB)



Type	P4	
Directivity	2.85	(4.55 dB)



Type	P5	
Directivity	2.90	(4.62 dB)

Slot Antenna Advantages - 1

- Weight and wind loading is 50 – 75% less than panel antennas.
- Various power levels from low to high.
- Tailoring of vertical and horizontal component pattern orientation as desired.

Slot Antenna Advantages - 2

- Azimuth patterns – standard and custom.
- Elevation patterns – standard and smooth pattern.
- Mechanically simplistic
- Easy to install.

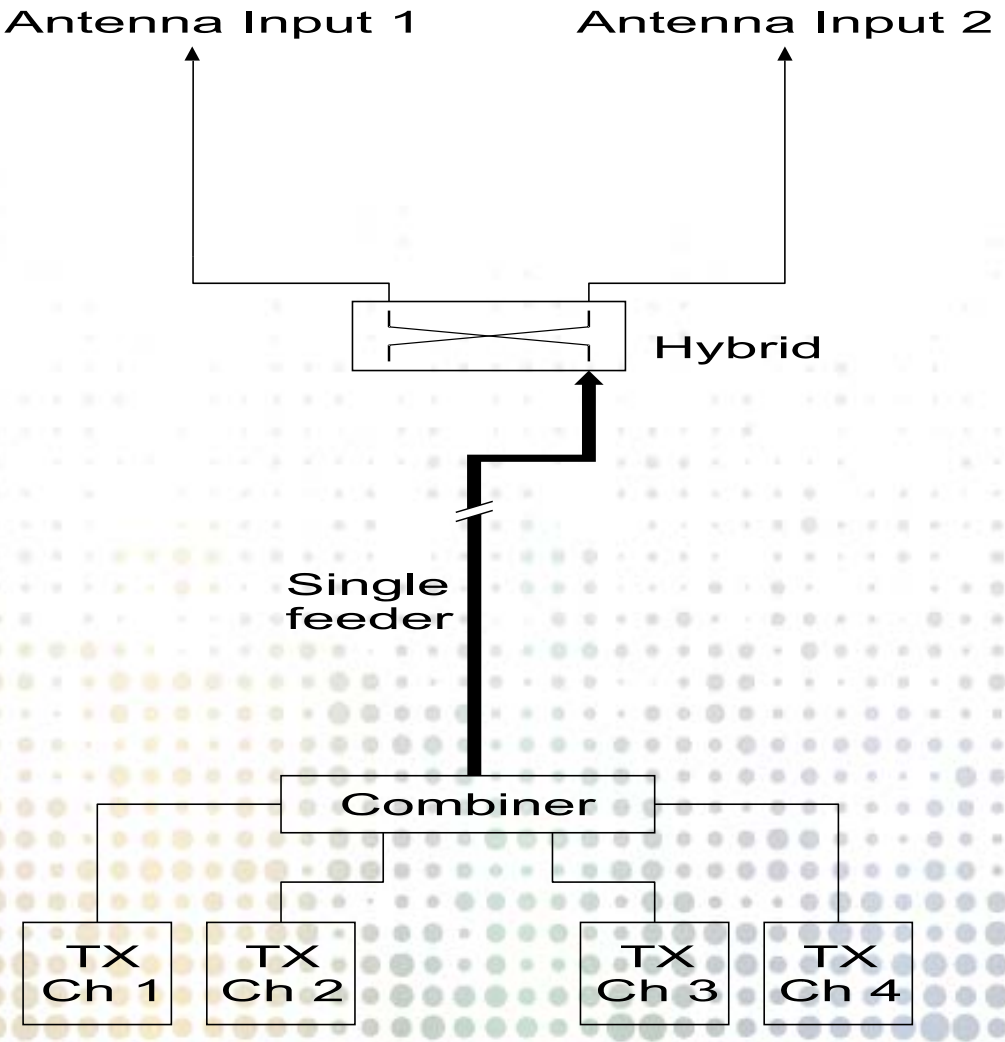
Slot Antenna Disadvantages

- Bandwidth limited
- Tower effects – for side mounts
- Cannot change polarization or add other channels once design is done

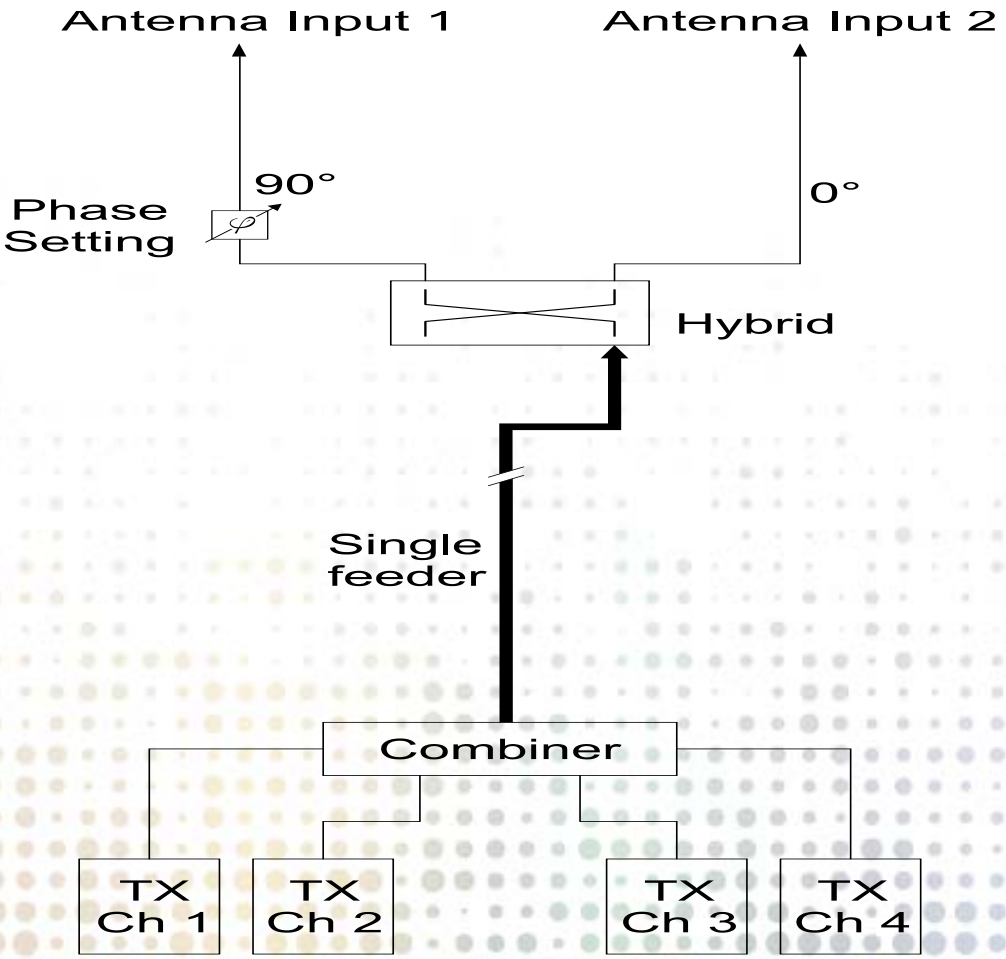
Elliptically Polarized Panel Antenna Design

- Two types
  - Static Elliptical Polarization
  - Dynamic Elliptical Polarization

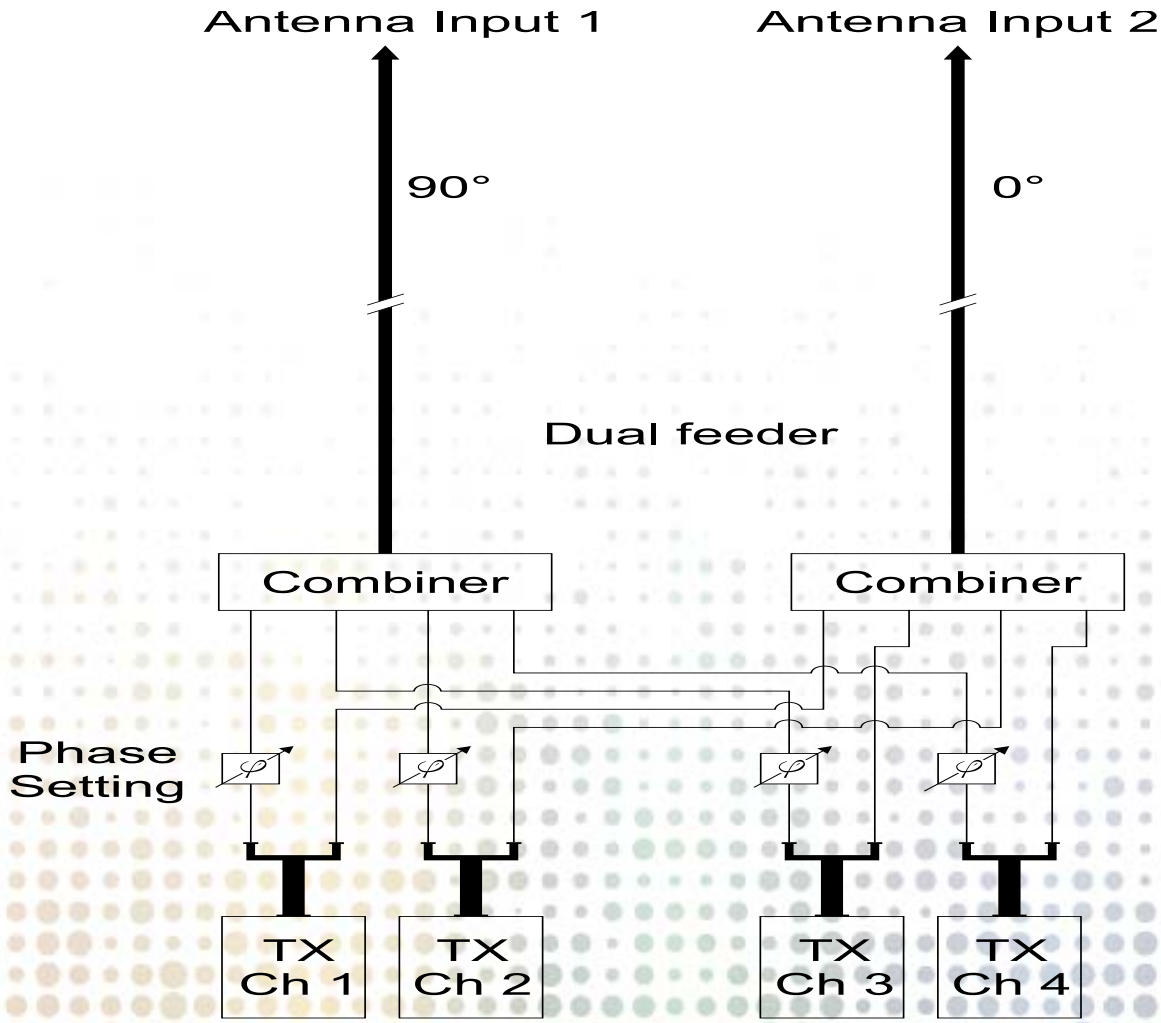
Static Elliptically Polarized Panel Antenna Design



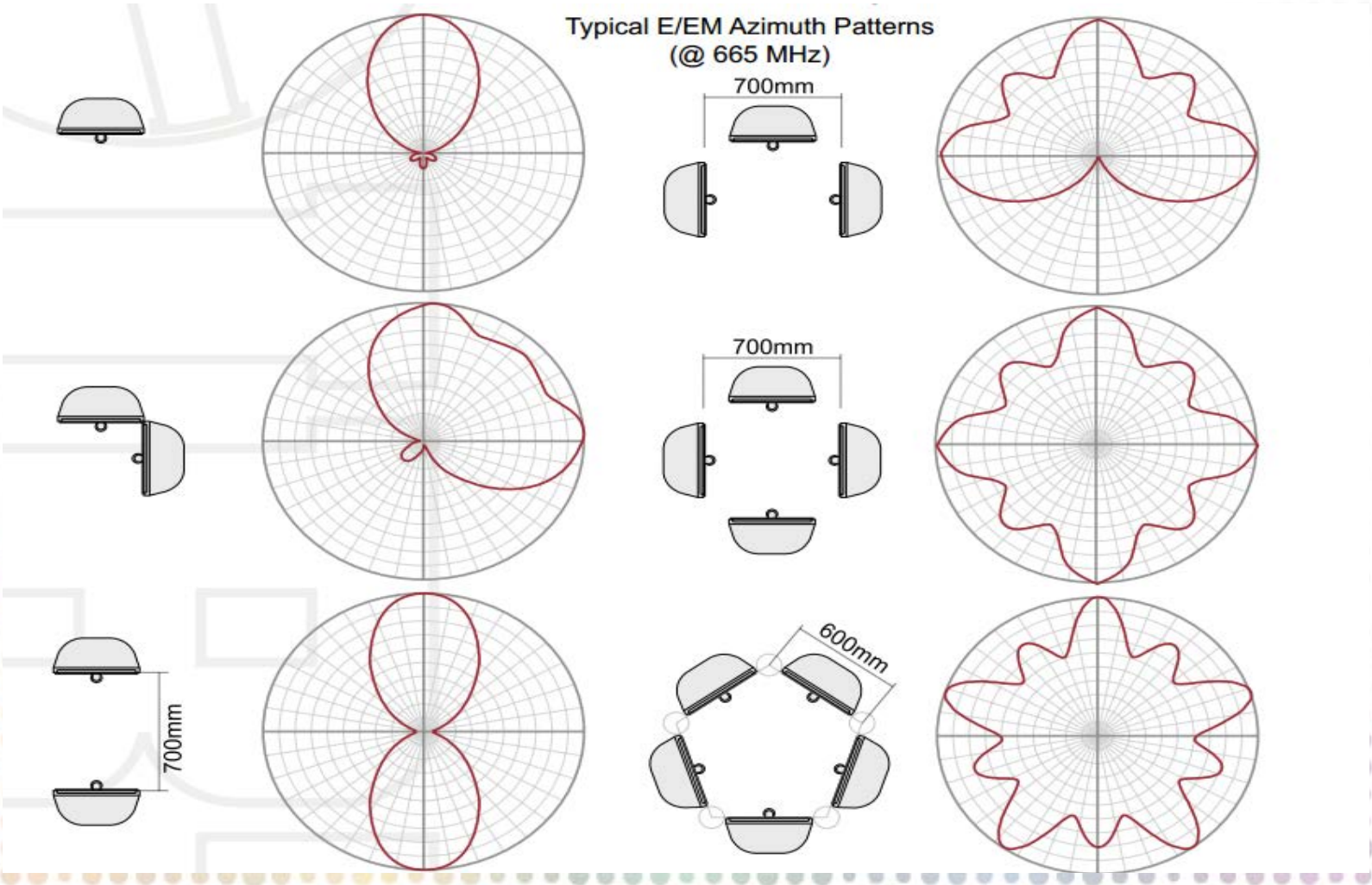
Dynamic Elliptically Polarized Panel Antenna - Constant AR



Dynamic Elliptically Polarized Panel Antenna - Variable AR



Panel Antenna Standard Patterns



Panel Antenna Advantages

- Broadband in nature
  - Hi-Band VHF (174-216 MHz)
  - UHF Band (470-860 MHz)
- Dynamic polarization capability
- Various power levels from low to high
- Azimuth patterns – standard and custom
- Elevation patterns – Beam tilt and null fill
- No single source of failure

Panel Antenna Disadvantages

- Many Panels
- High weight and wind loading
- Corporate feed – many cables, splitters, dividers
- Complex installations
- Complexity increases further for dynamic polarization

Real World Example

- WRAL, Channel 39
  - Raleigh, North Carolina
- ERI Broadband UHF Panel Antenna
  - Fixed E-pol
- ERI UF10000 Tunable Mask Filter

Conclusion

- Indoor reception for mobile devices is essential for ATSC 3.0 coverage
- The broadcaster has many choices to choose when considering an antenna.
- A dynamic panel antenna design offers flexibility to support future business models.

Thank you

Visit us at our booth on the floor for more information