SWTEST
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On-Chip 5G and ADAS Microstrip Patch Antennas Test Interfaces

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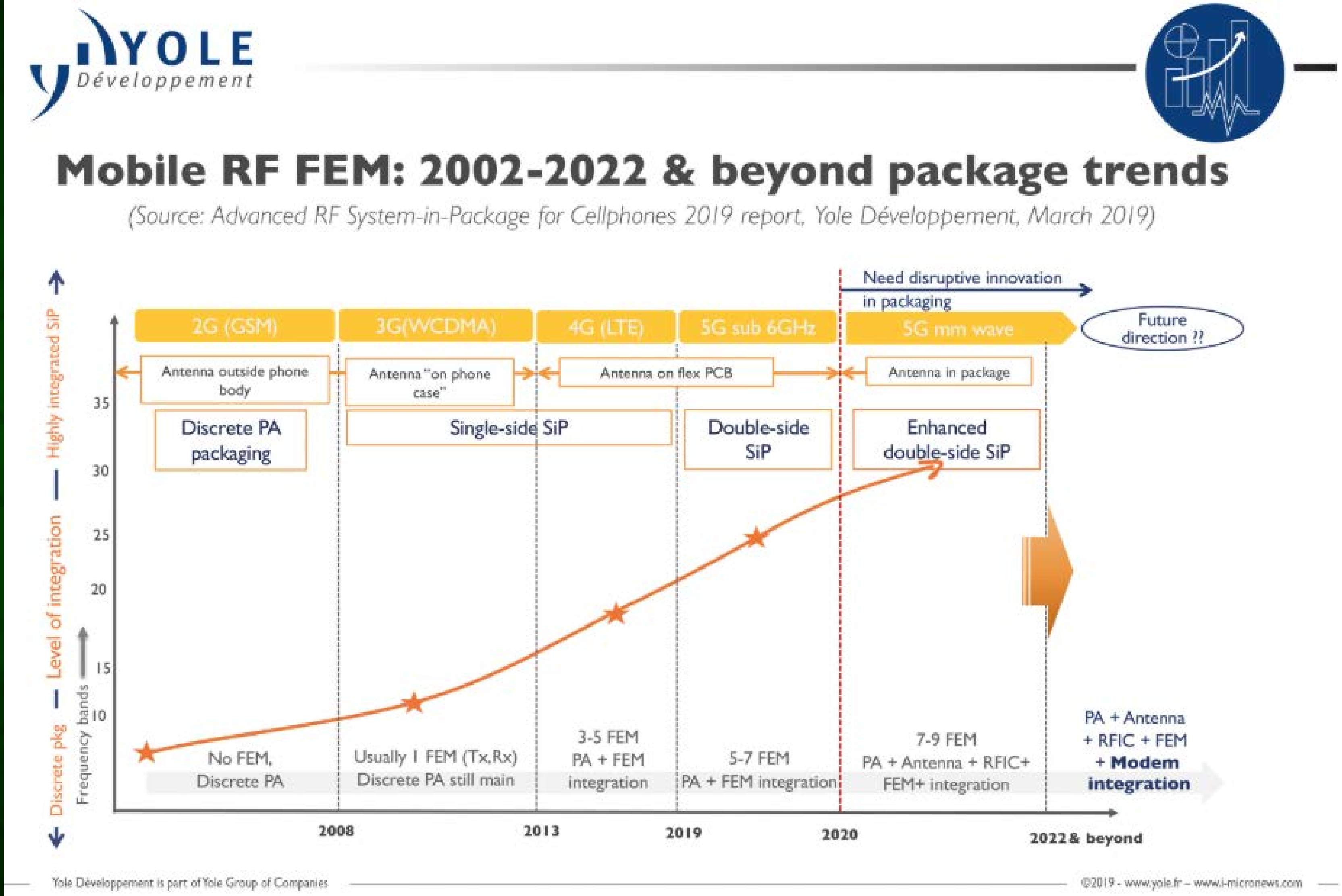
Overview

- **Introduction to Microstrip Patch Antennas**
  - Construction
  - Geometry
  - Analysis
  - Examples
- **Alternative Antenna Test Interface Structures**
- **Summary**

5G RF Antenna Integration Trends

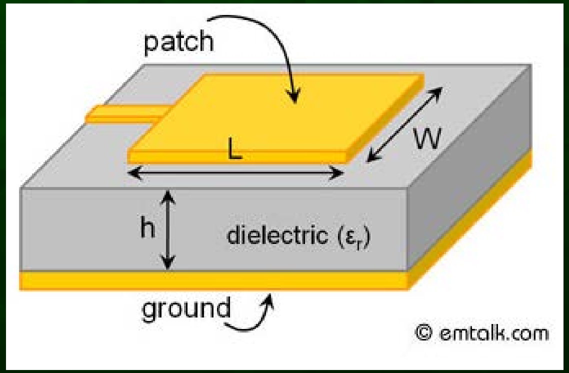


Microstrip Patch Antenna - Introduction

- A microstrip or patch antenna is a low-profile antenna that has a number of advantages over other antennas: it is lightweight, inexpensive, and electronics like LNA's and SSPA's can be integrated with these antennas quite easily

- Testing over-the-air devices at the die and package level effectively with microstrip patch antennas

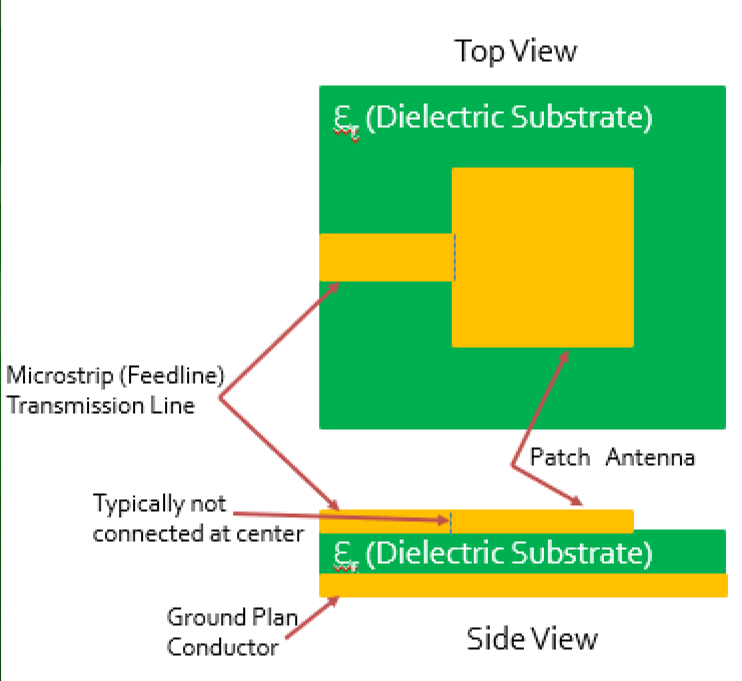
- While the microstrip patch antenna can be a 3-D structure (wrapped around a cylinder, for example), it is usually flat and that is why patch antennas are sometimes referred to as planar antennas.



Microstrip Patch Antenna - Construction

- **The original microstrip or patch antenna was patented in 1955**

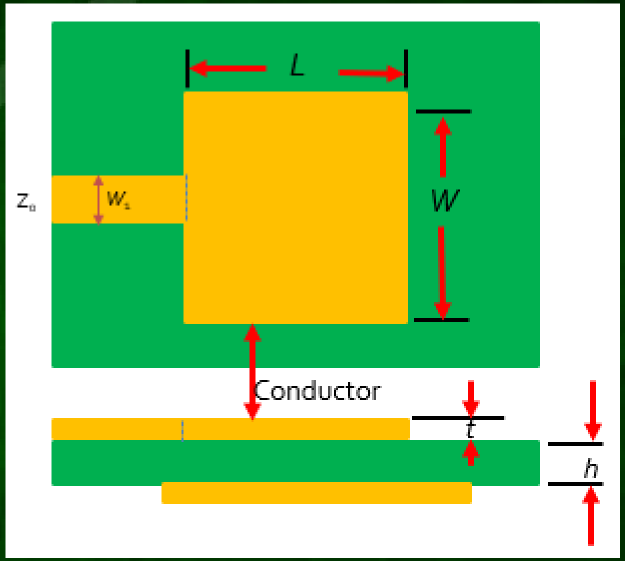
- **Construction of the microstrip antenna includes:**
  - Dielectric substrate
  - Ground plan conductor
  - Thin radiating conductor element
  - Microstrip feedline



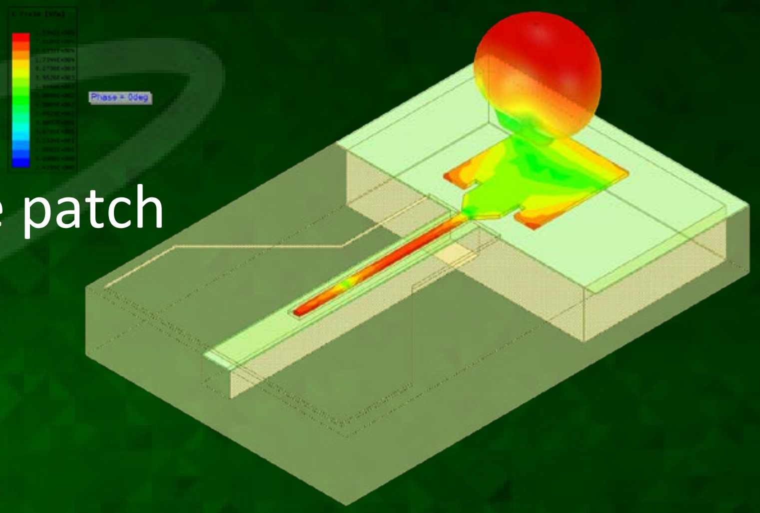
- **In a properly designed microstrip antenna the radiation intensity is in a direction normal to the radiating element, i.e., broadside**

Microstrip Patch Antenna - Geometry

- **The shape and size of an antenna is a function of its purpose**
- **L is the Length and it is the resonant dimension**
  - L=λ/2: Typically 1/2 Wavelength
- **W is the Width affects the bandwidth**
  - W= 1.5 L is typical
- **The position of the transmission line is relative to impedance**
  - t is the thickness of the conductor
  - h is the height of the dielectric, typically should be < 0.05 λ
- **The ground plan needs to be as big as the patch and is typically a little larger than the patch**



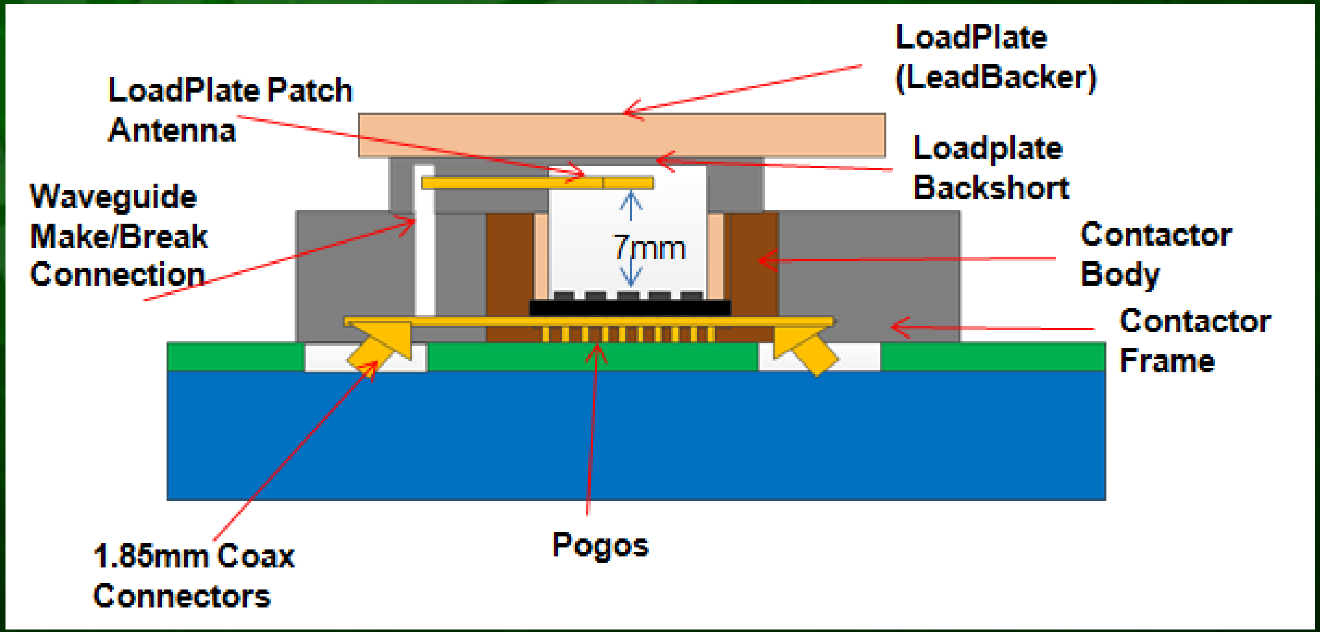
Microstrip Patch Antenna - Analysis



- **Why does it radiate?**
  - We have a transmission line connected to this patch
  - We have energy flowing down the transmission line to the patch
  - The patch is terminated as an open circuit
  - So the current has no where to go
  - Consider the current voltage distribution
    - When current terminates in this open circuit situation it forces the voltage and current to come out of phase, i.e. It turns out to be 90° degrees out of phase
    - 90° degrees out of phase is actual key to the radiation of the patch and that the reflection coefficient gamma $|\Gamma|$ equals 1
    - When ever you have the magnitude of the reflection coefficient equal to one, your current and voltage are going to be 90 degree out of phase

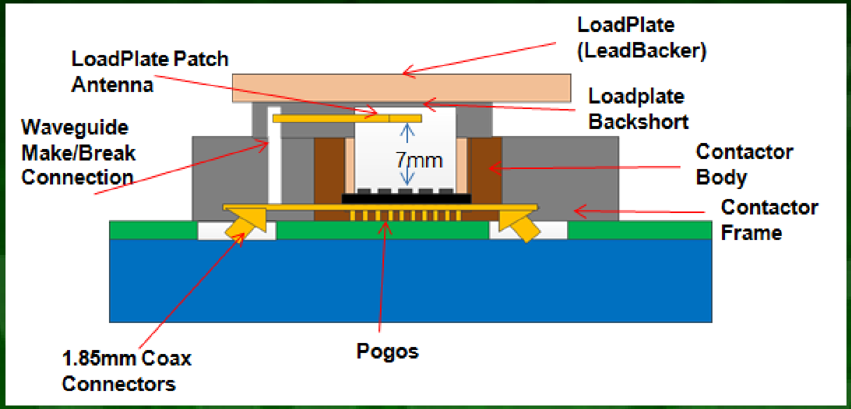
Microstrip Patch Antenna - Backshorts

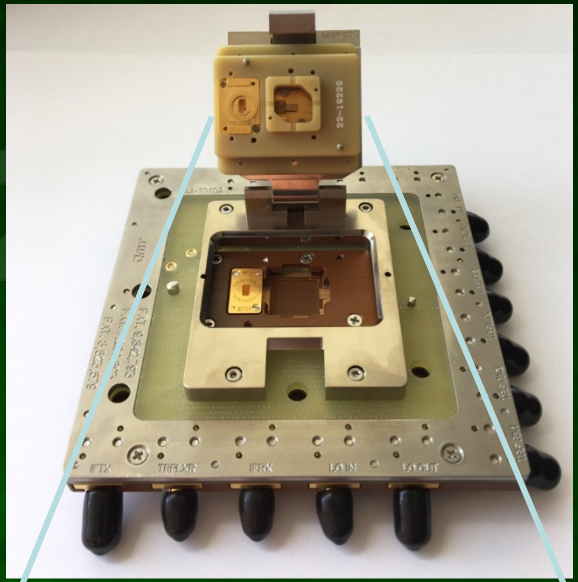
- Defines the impedance of the trace and the antenna patch
- Trace impedance = 50 ohms, Patch Antenna = 300-500 ohms
- Back short is a deflector for the radiation out of the patch and directs it upwards

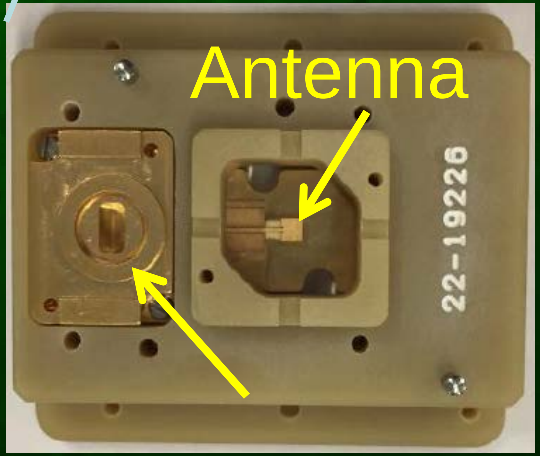


72GHz xWave OTA for Pick and Place Handler (MT2168)

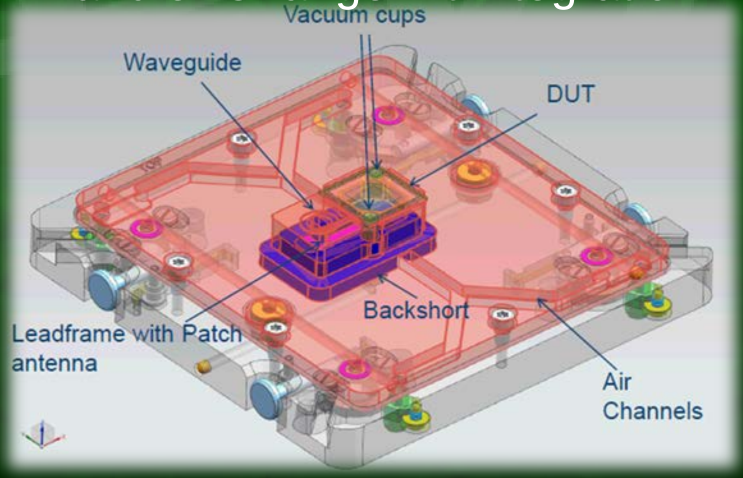
- xWave Contactor with Integrated Patch in Workpress/Leadbacker
- Broadband Performance and Wide Beamwidth
- Far-field Communication with NO IMPACT TO TEST CELL







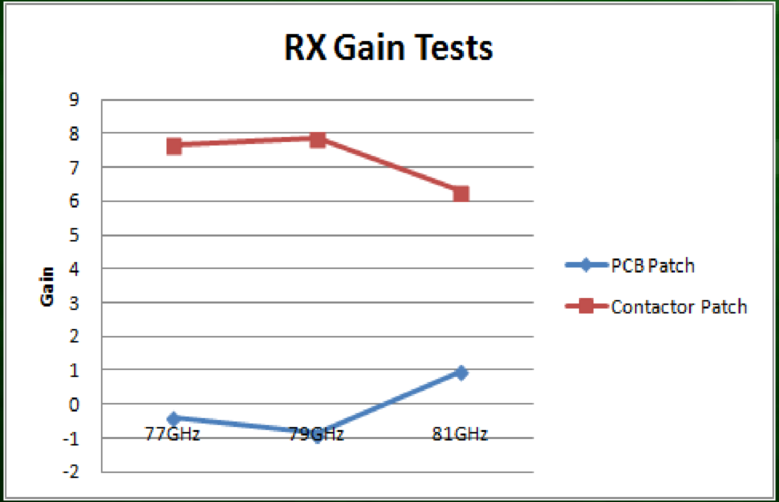
Handler Change Kit Integration

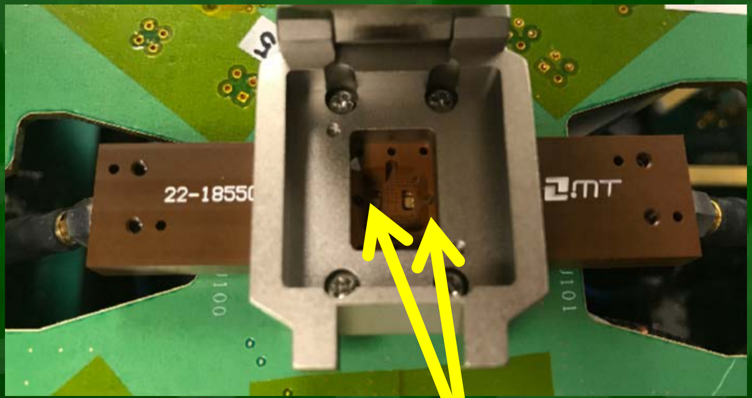


81GHz xWave OTA Automotive Radar Testing

- xWave Contactor with integrated Patch Antennas outperforms PCB patches
- Uses 81GHz Kestrel tester module cabled directly to patches in contactor
- Integrated with Cohu MX tester

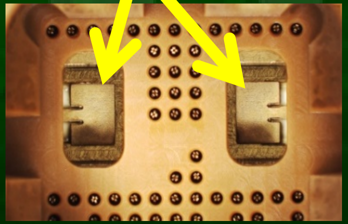
	RX Gain Tests		
	Low Band	Mid Band	High Band
Test Fixture	77GHz	79GHz	81GHz
PCB Patch	-0.37	-0.87	0.96
Contactor Patch	7.65	7.85	6.27



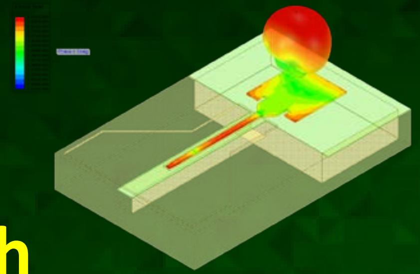


PCB Patch

Dual Tx/Rx Patch antenna in contactor

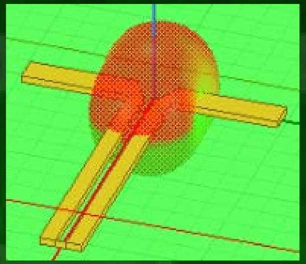


Alternative Antenna Test Interface Structures



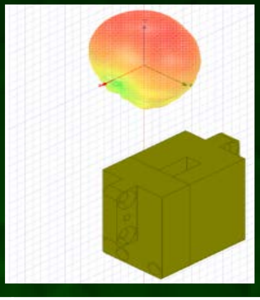
Patch

Shape	Square
Size=f(frequency)	λ/4
Bandwidth	Medium
Beam width	Medium
Gain	8-9dB
Polarization	Dual



DiPole

Shape	2 arms
Size=f(frequency)	λ/2
Bandwidth	Medium
Beam width	Medium
Gain	2-5dB
Polarization	Single



WaveGuide

Shape	waveguide
Size=f(frequency)	λ/2 to λ
Bandwidth	Wide
Beam width	Narrow-Wide
Gain	5-20dB
Polarization	Single

Microstrip Patch Antenna Test Interface Summary

- Increased levels of antenna integration in mobile RF FEMs will continue to drive disruptive packaging technologies that will require adaptable production OTA test interface solutions

- Microstrip Patch Antennas are a good option when space is limited for integration into a handler leadbacker for testing singulated modules or into a probehead for testing WLCSP or 3DICs with Antenna on Chip

- Alternative antenna structures such as waveguide, dipole, or exotic patch designs could be driven by specific applications to address requirements such as gain, phase, or polarization