ANTENNAS

16 December 2021 EMİN BİLİR

WHY ?

- If you’re one of the antenna, telecom, rf, telecommunication engineer.
- If there are basic concepts that a doctor or software developer needs to know, we also need to know these basic concepts about antennas.
- Never do not say what this will benefit for me , you don't know if it will benefit you or not.
- Antennas are used in many areas from defense industry, communication applications, remote technology, satellite technologies to mobile network applications.

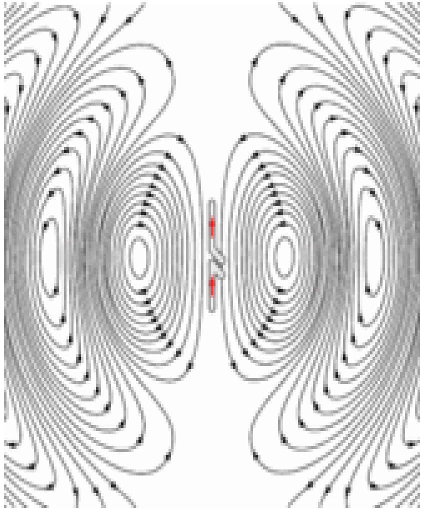
AGENDA

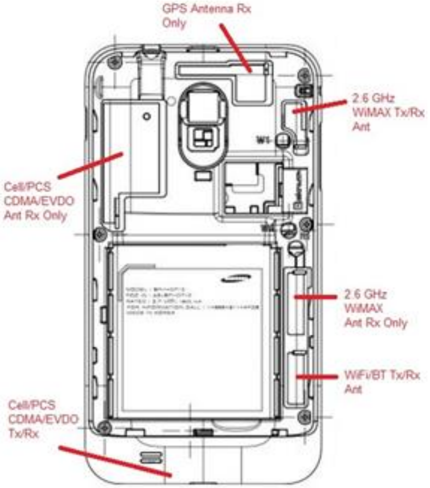
- What is antenna ?
- How to convert ?
- Fundamental Parameters of Types of Antennas
  Radiation pattern,Return Loss,VSWR,bandwith…..
- Huawei Antenna Datasheet Review
- Antenna Tilt
- HFSS Feco

What is ANTENNA ?

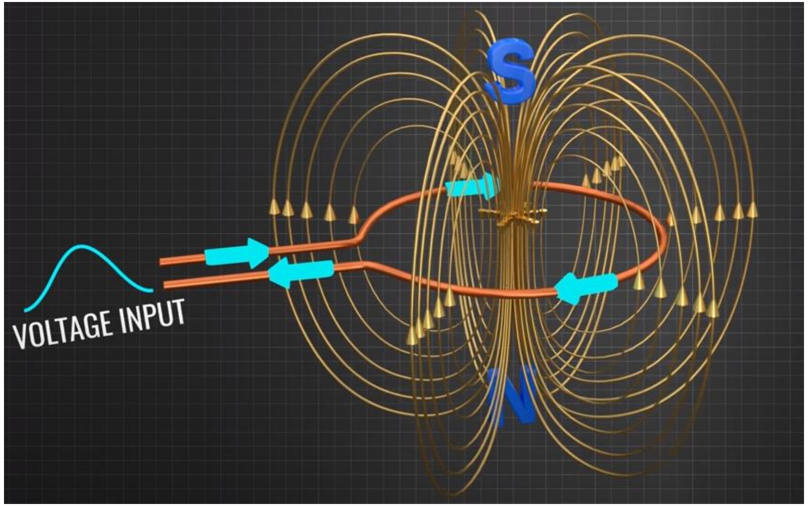
Türk Telekom

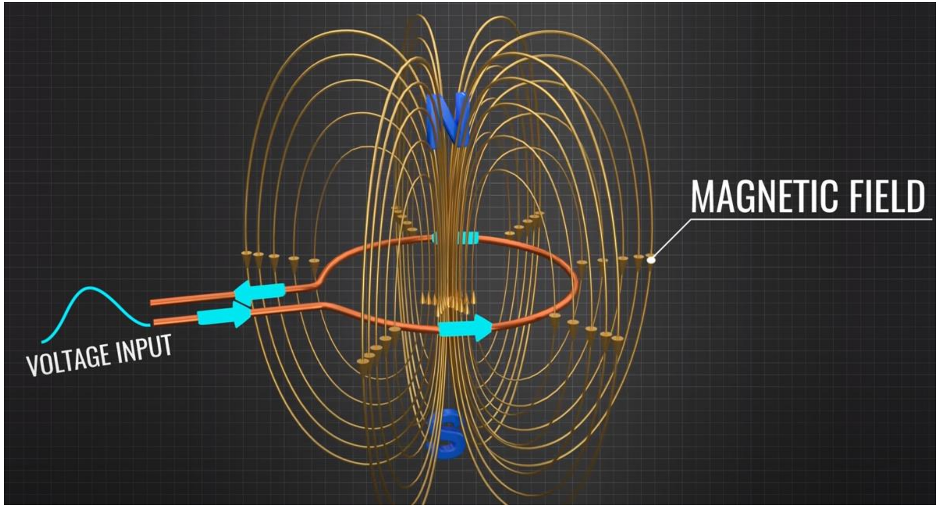
- An antenna is a metallic structure that captures and/or transmits radio electromagnetic waves which is transmitted into space.
- Antennas receive an electromagnetic waves and convert it to an electric signal and vice versa.

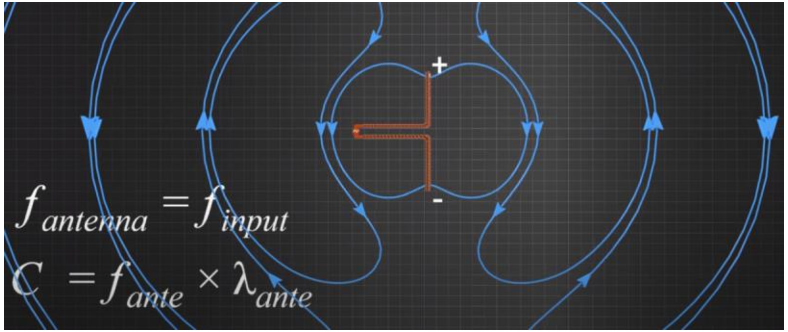


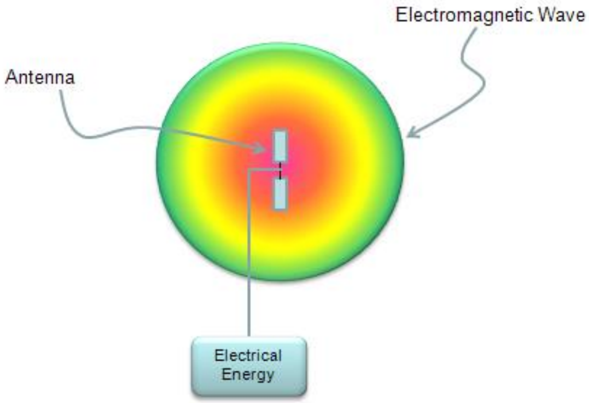
How to convert?

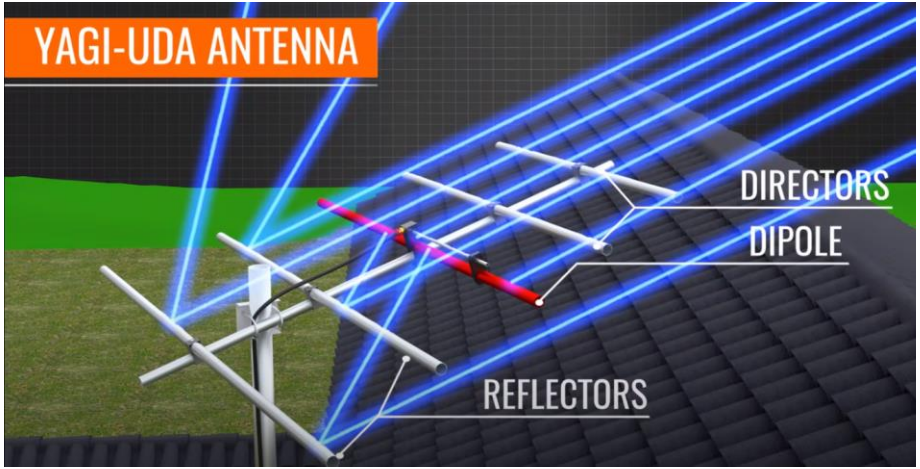




How to convert?

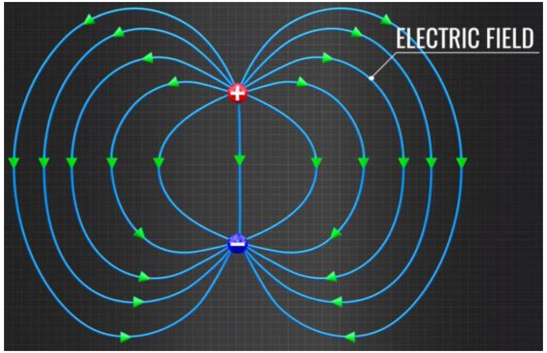


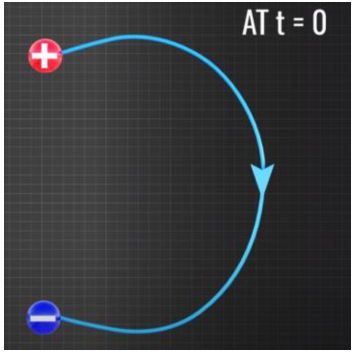


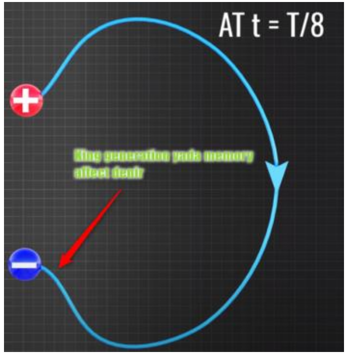


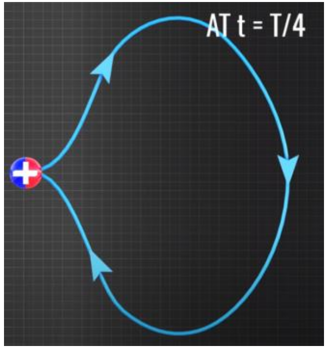
How to convert?

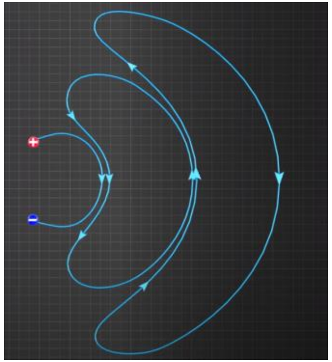
- ❑ Electric signal ->Electromagnetic wave





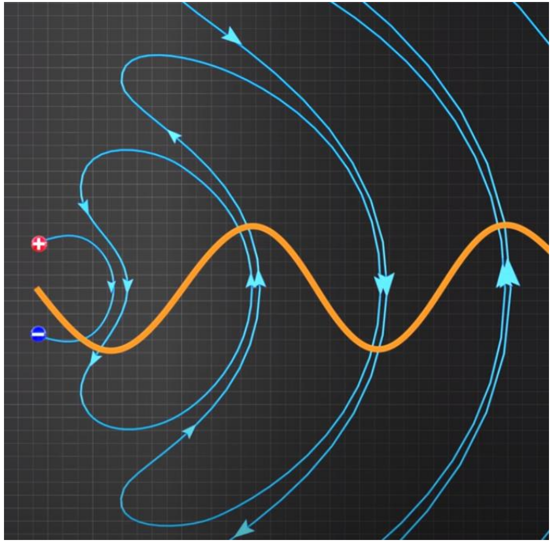


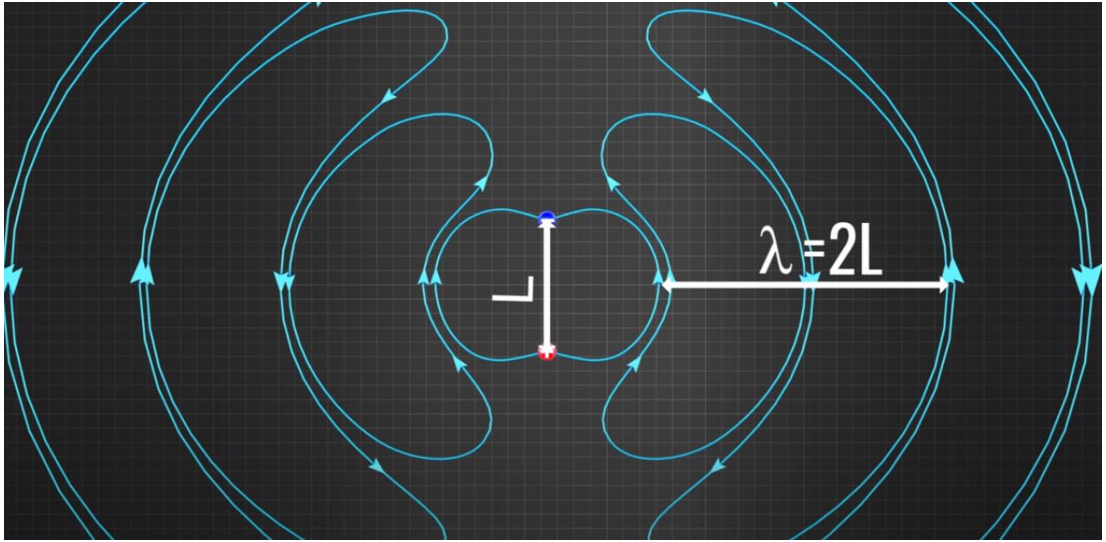




How to convert?

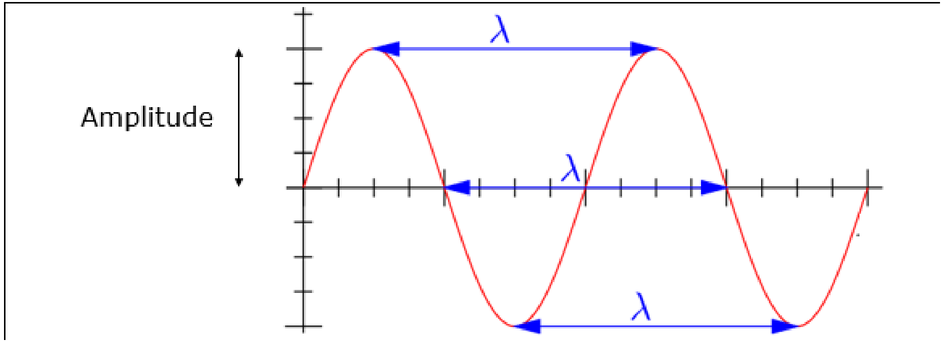
- Electric signal ->Electromagnetic wave

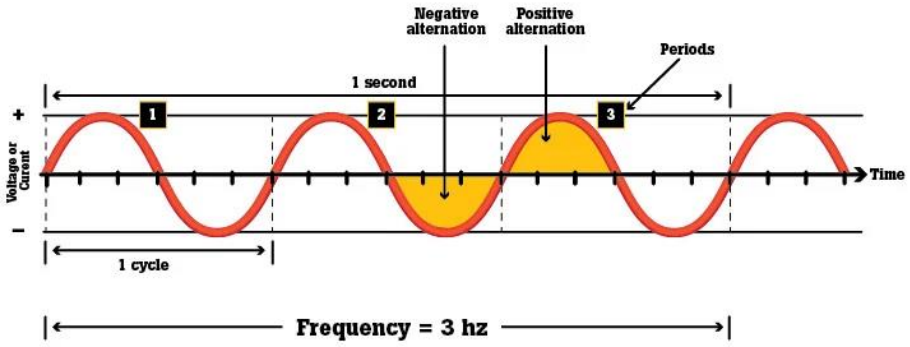




Fundamental Parameters of Types of Antennas

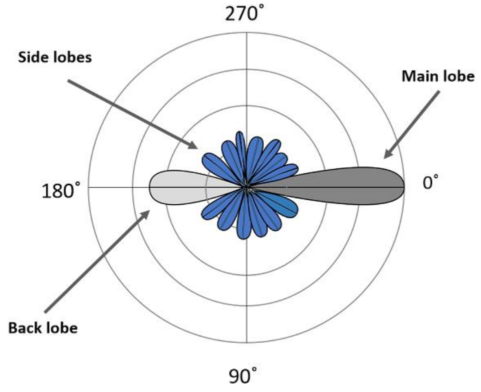
- Radiation Pattern of Antenna
- Polarization of Antenna
- Beamwidth
- Gain & Directivity
- VSWR
- Return Loss
- Bandwidth
- Power Gain & Radiation Efficiency
- Effective Length
- Input Impedance





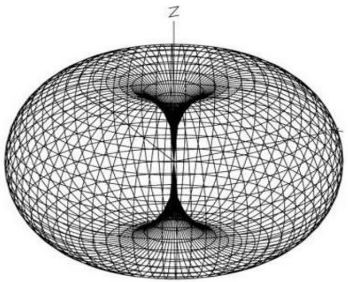
Radiation Pattern of Antenna

- The energy radiated by an antenna is represented by the **Radiation pattern** of the antenna. Radiation Patterns are diagrammatical representations of the distribution of radiated energy into space, as a function of direction.

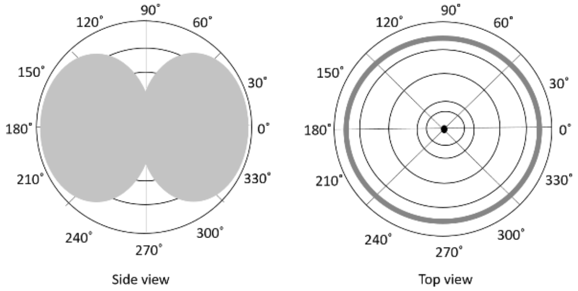


Lobe Formation

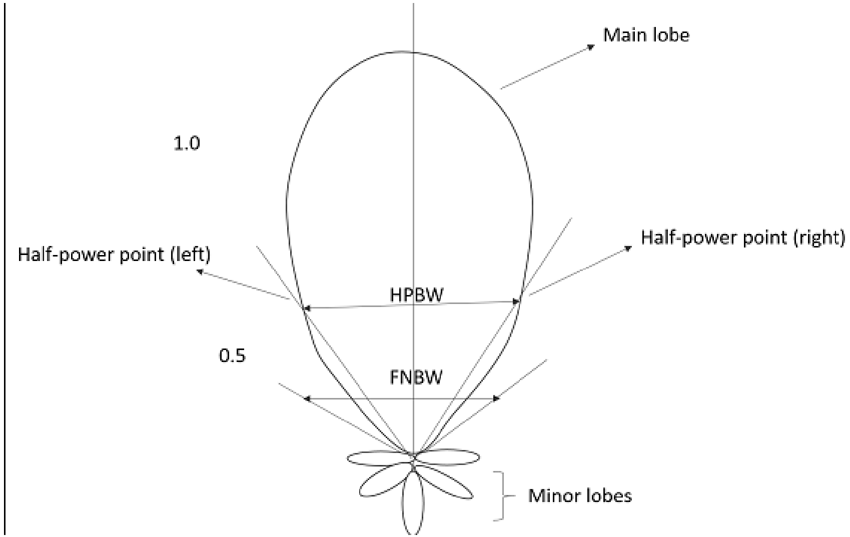
Radiation Pattern in 3D

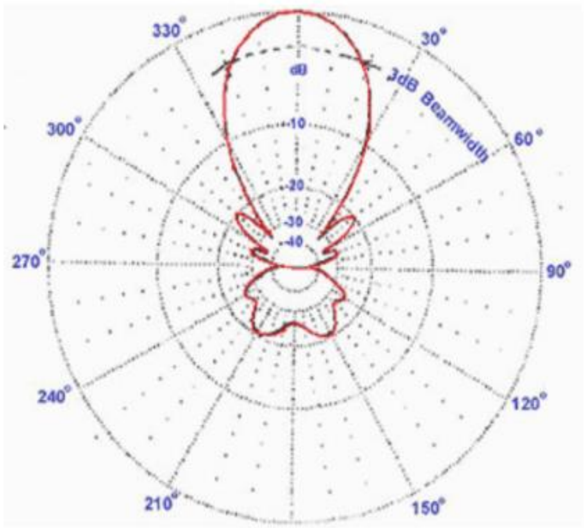


Radiation Pattern in 2D

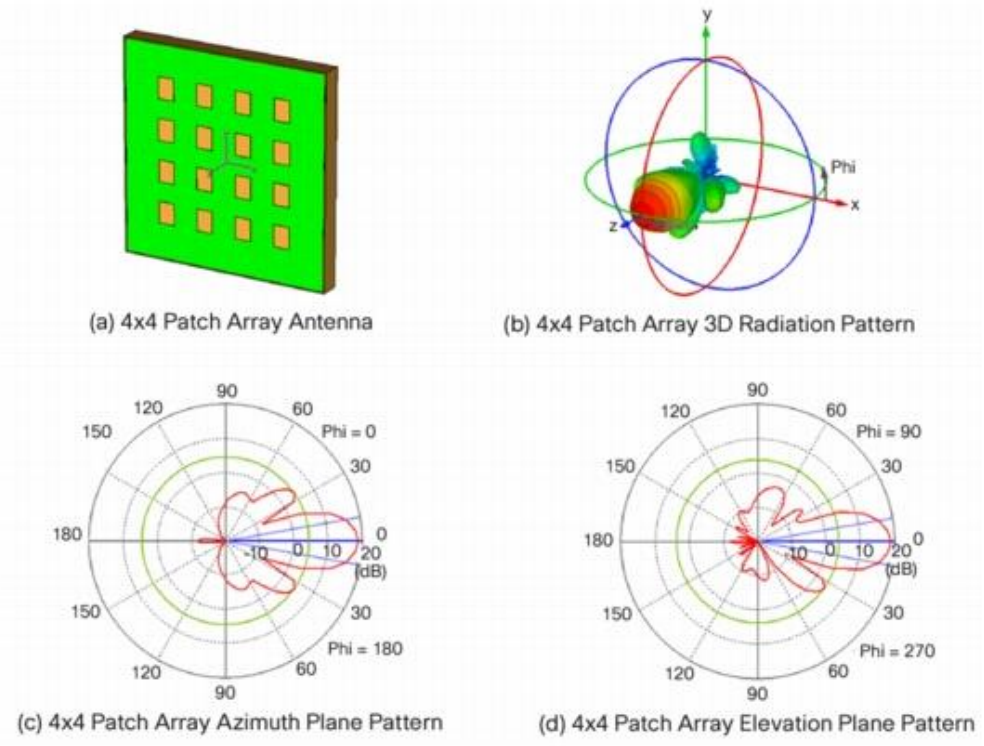


HPBW-FNBW of Antennas

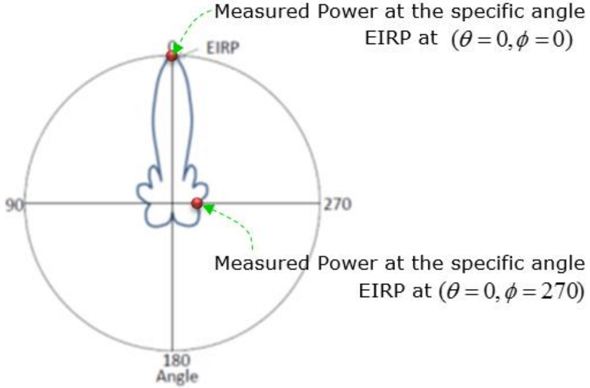




HPBW-FNBW of Antennas



EIRP of Antennas



it does not mean the absolute power (in dBm), it is a kind of relative power with reference to istropic power. That's why is called Equivalent Isotropic Radiated Power. When we channel that power into a single direction and calculate the power it is known as EIRP. This is calculated from a couple of different parameters that can directly be measured or just given.

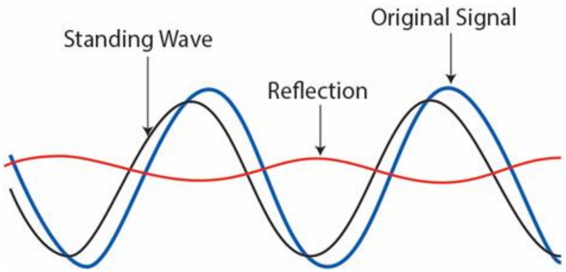
EIRP = Tx RF Power(dBm) + G(dB) - L(dB)

Tx RF Power :RF power measured at RF connector of the unit
G :Antenna gain
L : Feeder loss(cable loss or any other loss)

VSWR(Voltage Standing Wave Ratio) & Return Loss

Türk Telekom

- If the impedance of the antenna, the transmission line and the circuitry do not match with each other, then the power will not be radiated effectively. The term. which indicates the impedance mismatch is **VSWR**.



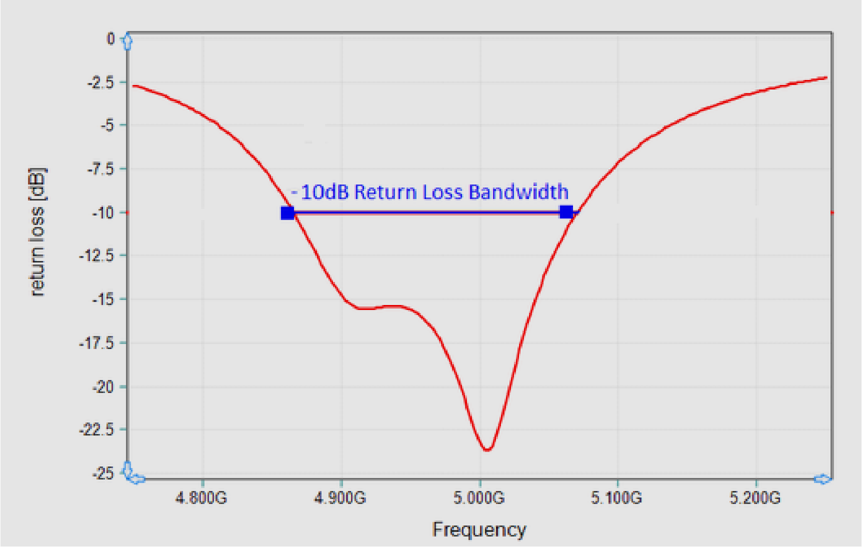
- When a signal is transmitted through a transmission line, some signal power is always reflected or returned to the source due to discontinuities in the transmission line. The measure of this reflected power is called **Return Loss**. The Return Loss is expressed in dB.

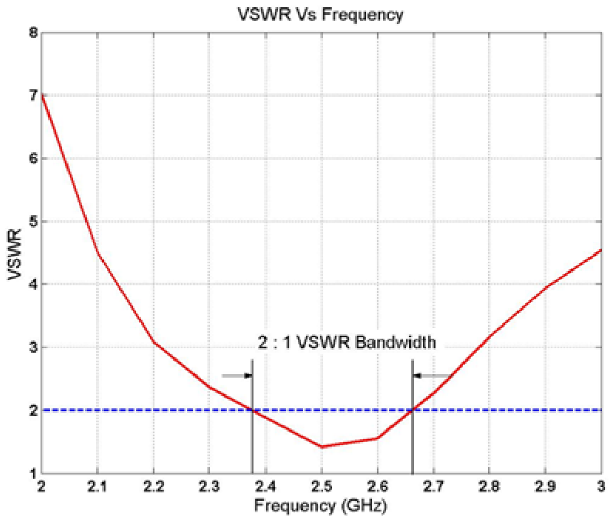
$$Return\ Loss = -20\log_{10}\left(\frac{VSWR-1}{VSWR+1}\right) dB \qquad VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

Antenna Bandwidth

Türk Telekom

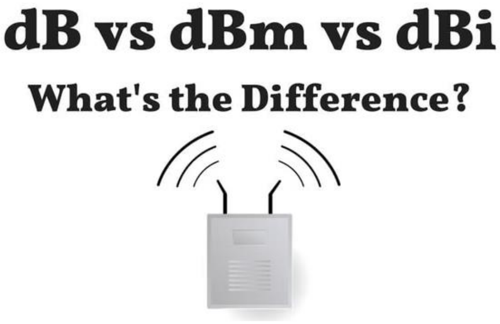
- Bandwidth describes the range of <u>frequencies</u> over which the antenna can properly radiate or receive energy.





Dbm-Dbi-Db

Türk Telekom

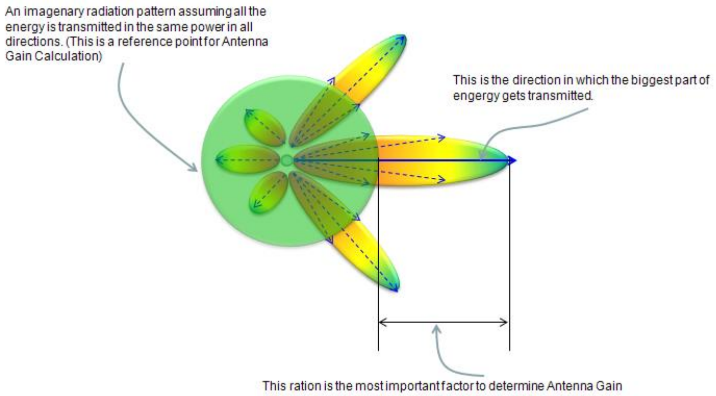


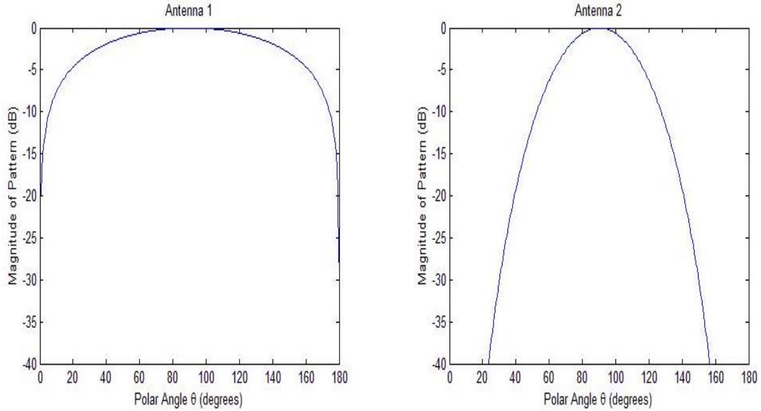
dB: is the difference (gain or loss) between two power levels, so if the difference is 0dB, then the two power levels are the same. A 3dB gain is a doubling in power but the scale is logarithmic (as opposed to linear) so that a 6dB gain is a 4x multiple.1.000.000 ratio=60dB

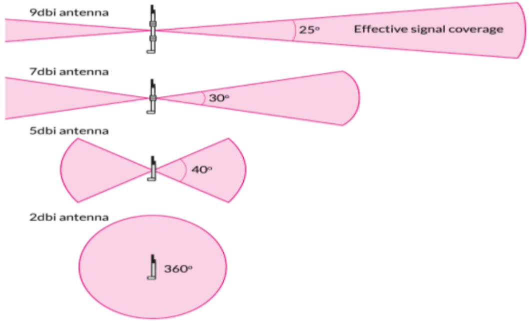
dBi:A 'perfect' antenna would output its signal in a perfect sphere around itself (an 'isotropic' pattern). A true isotropic aerial doesn't actually exist. It's useful for comparing antennas because it's theoretical because it's always the same. A common reference unit is dBi, which denotes the gain of an antenna as an antenna is referenced.(dBd also used)

dBm:is actual power output. 0dBm is equal to approximately 1mW, and 20dBm is approximately 100mW.

Gain & Directivity







The term **Antenna Gain** describes how much power is transmitted in the direction of peak radiation to that of an isotropic source

It is a measure of how 'directional' an antenna's radiation pattern is. An antenna that radiates equally in all directions would have effectively zero directionality, and the directivity of this type of antenna would be 1 (or 0 dB).

Gain & Directivity

The amount of the energy transmitted in the direction with the strongest power

$$D = 4\pi\left(\frac{U_{\max}}{P_{rad}}\right)$$

$$P_{rad} = \int_0^{2\pi}\int_0^{\pi} U(\theta,\phi)\sin(\theta)\, d\theta\, d\phi$$

Total amount of energy being transmitted in all directions

$$G = E \cdot D$$

Gain

Directivity

Antenna efficiency
(The indicator to represent how much of electrical energy gets converted into electromagnetic energy. This is a kind of energy conversion ratio)

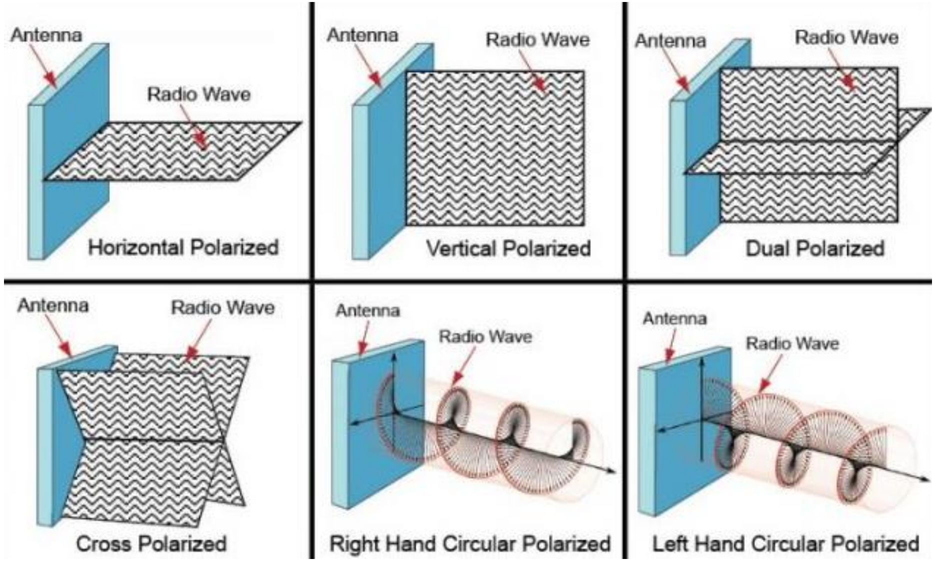
$$dBi = 10\log(G)$$

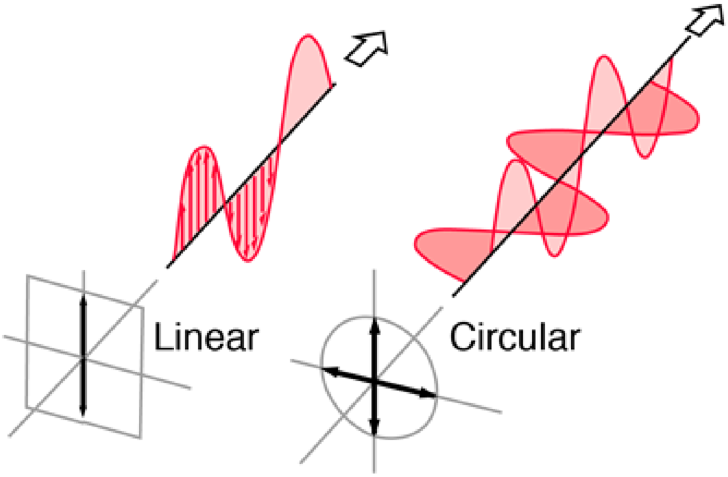
Antenna Polarization

Türk Telekom

- <u>**Linear polarization:**</u>The **linear polarization**of the antenna helps in maintaining the wave in a particular direction, avoiding all the other directions.
- <u>**Circular polarization:**</u>The mode of rotation may also be different at times. However, by using **circular polarization**, the effect of multi-path gets reduced and hence it is used in satellite communications such as **GPS**.
- <u>**Horizontal polarization**</u>:Horizontal polarization makes the wave weak, as the reflections from the earth surface affect it. They are usually weak at low frequencies below 1GHz. **Horizontal polarization** is used in the transmission of **TV signals** to achieve a better signal to noise ratio.
- <u>**Vertical polarization:**</u> The low frequency vertically polarized waves are advantageous for ground wave transmission. These are not affected by the surface reflections like the horizontally polarized ones. Hence, the **vertical polarization** is used for **mobile communications**.
- Each type of polarization has its own advantages and disadvantages. A RF system designer is free to select the type of polarization, according to the system requirements.

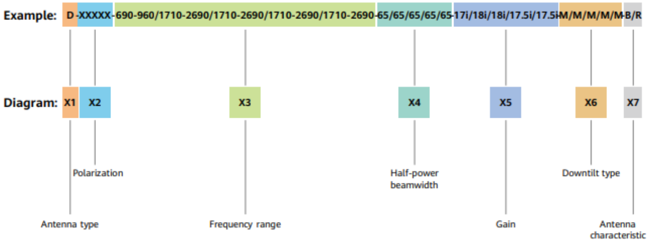
Antenna Polarization





Huawei Antenna Datasheet Review

Türk Telekom



X1	D	Directional
	O	Omni-directional
	C	Cluster
	I	Indoor
	Number + M	Multi Beam, 3M means three beams
	CP	Camouflage Pipe
	CS	Camouflage Square Column
X2	X	X Polarization
	V	Vertical Polarization
	H	Horizontal Polarization
	C	Circular Polarization
X3	Number	Frequency Bandwidth
X4	Number	Half-power Beam Width
X5	Number	Gain(dBi)
X6	Number + Letter	0F: Fixed Downtilt
	Letter	M: Electrical Downtilt
X7	C	Combiner Integrated
	B	Bias Tee Integrated
	T	TMA Integrated
	R	RCU Integrated
	AS	Azimuth Steering
	HE	High Efficiency
	ESLS	Enhanced Side Lobe Suppression
	AISU	Antenna Information Sensor Unit

A704517R0v06

DX-690-960-65-17.5i-M-R

EasyRET Low-Band 2- Port Antenna with 1 Integrated RCU - 2.6m

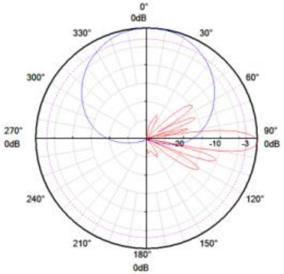
HUAWEI

Antenna Specifications

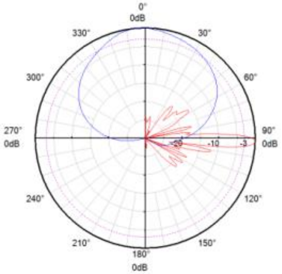
Electrical Properties					
Frequency range (MHz)		690 - 960			
		690 - 803	790 - 862	824 - 894	880 - 960
Polarization		+45° , -45°			
Electrical downtilt (°)		0 - 10 , continuously adjustable			
Gain (dBi)	at mid Tilt	16.5	16.7	17.0	17.2
	over all Tilts	16.4 ±0.3	16.6 ±0.4	16.7 ±0.4	16.9 ±0.5
Side lobe suppression for first side lobe above main beam (dB)		> 17	> 18	> 18	> 17
Horizontal 3dB beam width (°)		69 ±1.0	68 ±1.2	67 ±1.2	65 ±2.0
Vertical 3dB beam width (°)		8.7 ±0.6	8.0 ±0.5	7.7 ±0.4	7.2 ±0.5
VSWR		< 1.5			
Cross polar isolation (dB)		≥ 30			
Front to back ratio , ±30° (dB)		> 25	> 26	> 26	> 26
Cross polar ratio (dB)	0°	> 18	> 18	> 18	> 18
Max. power per input (W)		500 (at 50℃ ambient temperature)			
Intermodulation IM3 (dBc)		≤ -153 (2 x 43 dBm carrier)			
Impedance (Ω)		50			
Grounding		DC Ground			

Huawei Antenna Datasheet Review

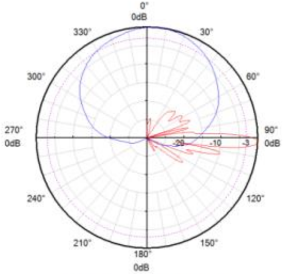
Pattern sample for reference



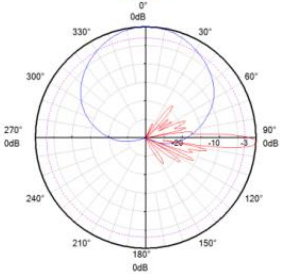
690 - 960 MHz



1695 - 2690 MHz (Ry3)

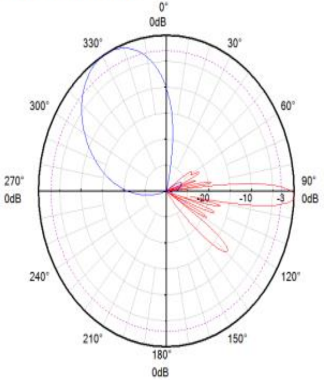


1695 - 2690 MHz (Cy2)

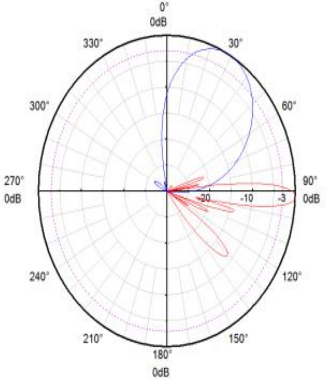


1695 - 2690 MHz (Ly1)

Pattern sample for reference



1695 - 2690 MHz (y2)



1695 - 2690 MHz (y1)

Antenna Tilt

Figure 3:
Phase variations for a fixed el. downtilt

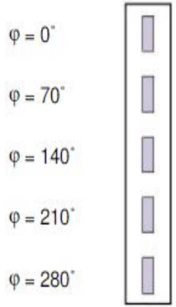


Figure 4:
Changes in the radiation pattern using various downtilt angles

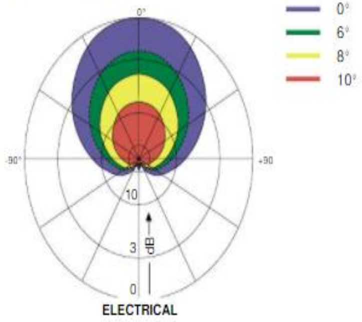


Fig. 1:
Mechanically downtilted A-Panel

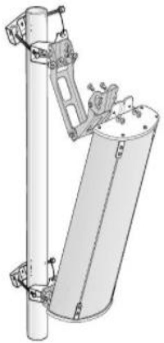
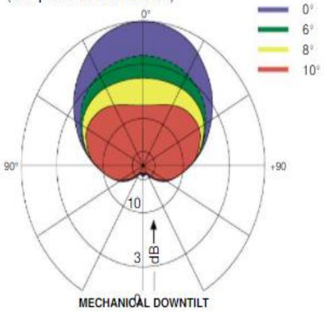
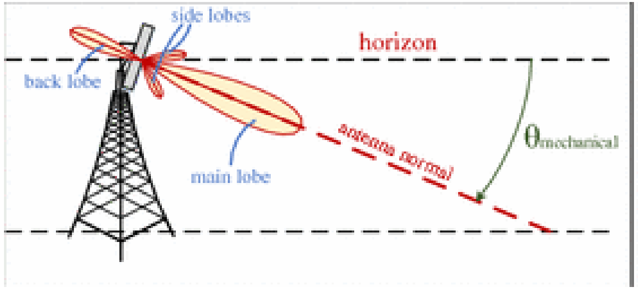
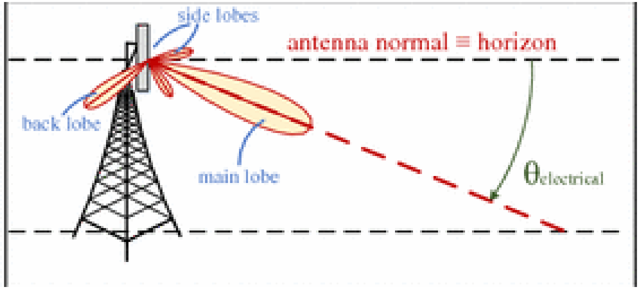


Fig. 2:
Changes in the horizontal radiation pattern when various downtilt angels are used (compared to the horizon)



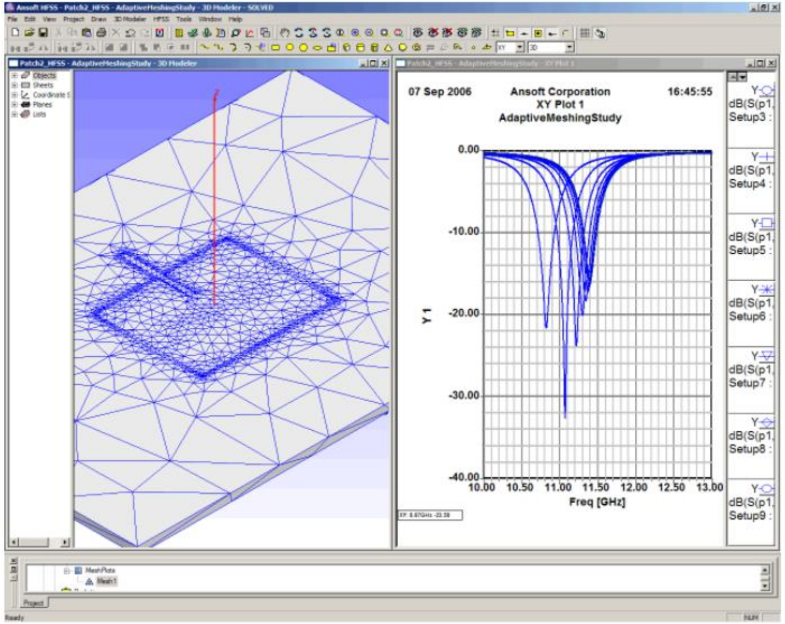
3

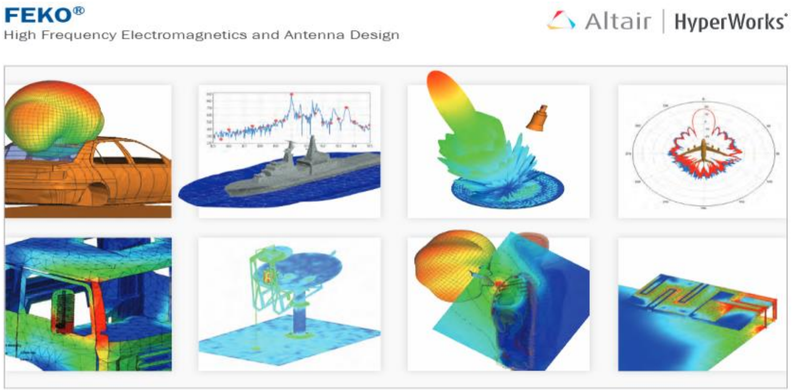


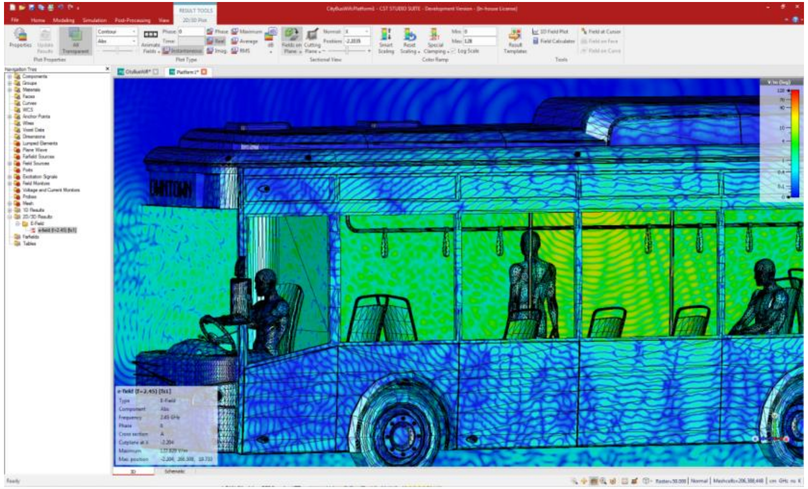


HFSS-Feco-CST

Türk Telekom

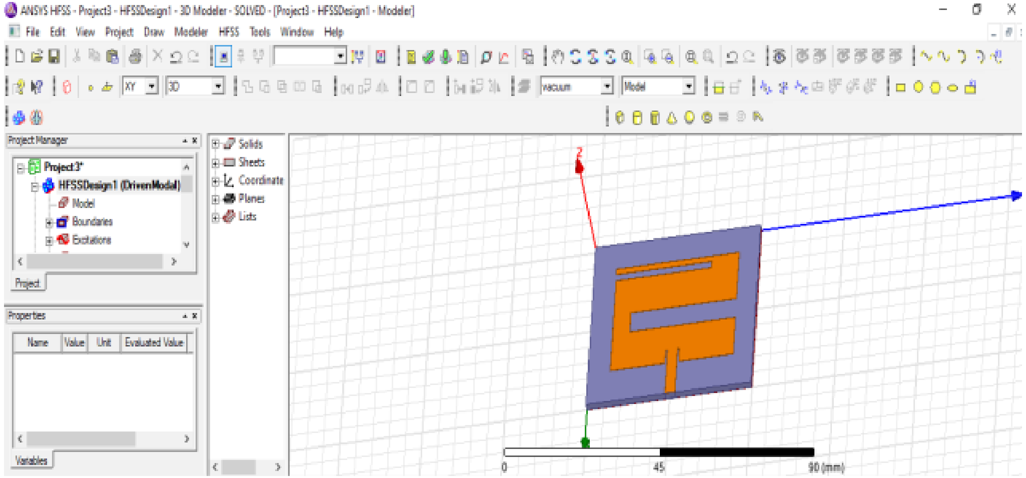


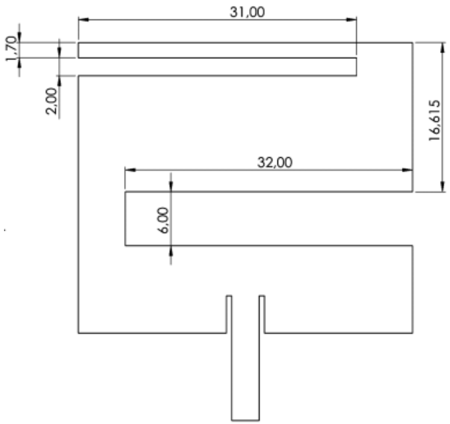




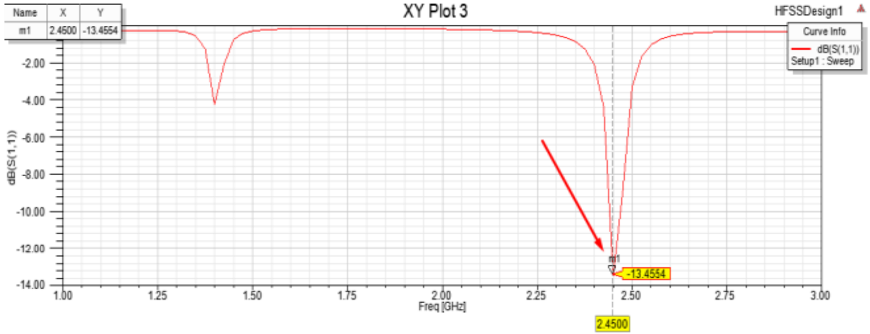
HFSS-Feco-CST

Türk Telekom

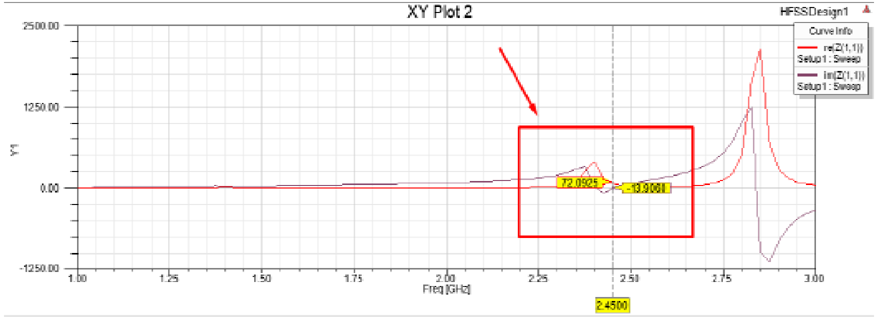




S(1,1)- Return Loss Parametresi

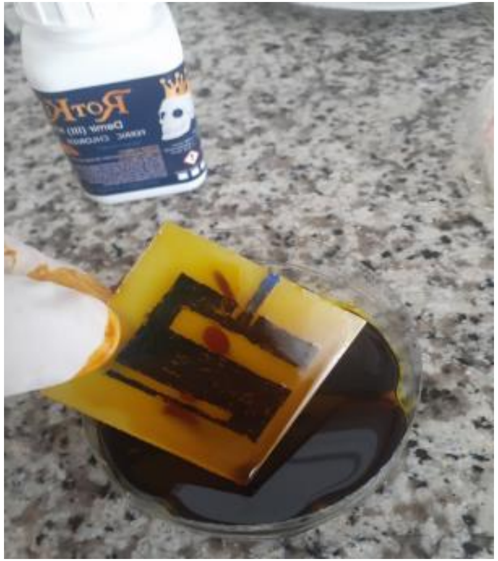


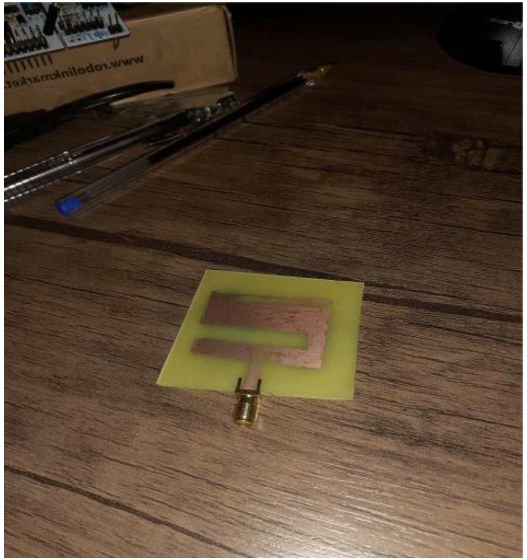
Z Parametresi Reel ve Sanal Grafiği



HFSS-Feco-CST

Türk Telekom





3 BOYUTLU KAZANÇ GRAFİĞİ

Thank you!


USA
Virginia
Reston
EUROPE
Romania
Bucharest
USA
California
Pleasanton
LATAM
Mexico
Mexico City
EUROPE
UK
London
EUROPE
Turkey
Istanbul, Izmir
APAC
Singapore