Review Paper on Comparative Study of Dual Band Microstrip Patch Antenna

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ABSTRACT
In this paper we survey a dual band microstrip patch antenna for improvement of bandwidth, gain and directivity. The comparisons of different paper with simulated and validated result are presented. We discussed the different technique used by the author to propose a dual band and also observed what happen if we used different dielectrics materials.

Keywords
Bandwidth, gain, dual-band

1. INTRODUCTION
Microstrip patch antenna is used in many applications such as cellular phone and satellite communication due to their light weight & low profile, for increasing the performance of base station. For developing the microstrip patch antenna printed-circuit method are use. In this method antenna are design on fixed surface, and easy to design with MMIC ,When the shape of particular patch are selected, they are very changeable in form of resonant frequency, pattern, polarization, and impedance.

When load are connecting between the patch and the ground plane, the changeable resonant frequency, pattern, impedance and polarization can we designed. The microstrip antenna also operates electromagnetic application at particular frequency outside the working band. There are different type feeding techniques are used for design the microstrip patch antenna.

In this paper we are represent the comparative study on different dual band and multiband patch antenna .The number of author are design different type of antenna. The fractal like geometrical structures with self transformation property are use for multiband wireless communication antenna design .The design methodology are based on self transformation of fractal-like multi rectangular section [1].

For the hexa-band operations internal printed direct-fed antenna are design, That the designed antenna are capable to operate two impedance bands[2].In the wireless mobile communication system we are required the many frequency band for different operation. So for solving this problem the multiband (GSM/DCS/PCS/UMTS/WLAN/WiMAX)antenna are designed[3]-[5].For the wide area wireless communication system the higher frequency band antenna are design[6]-[8].for the Bluetooth, GSM, DCS and other low frequency band operation the lower frequency band antenna are design[9]. And for higher frequency application the desired antenna are designed [10].

2. LITRETURE SERVEY
R.S. Aziz et al.[1] proposed a new multiband fractal-like antenna. This antenna design based on a technology that utilizes the self transformation principle of fractal-like rectangular profile to generate multiband operation .The simulated and measured results are good and explain the performance of the design technology and proposed antenna structure.

The designed antenna are multiband antenna, that antenna are cover the no. of frequency band (GSM/DCS/PCS/UMTS/ISM).this antenna are basically design for mobile communication system. In this paper fractal-like geometrical structure with self transformation property developed for multiband wireless communication antenna operation.

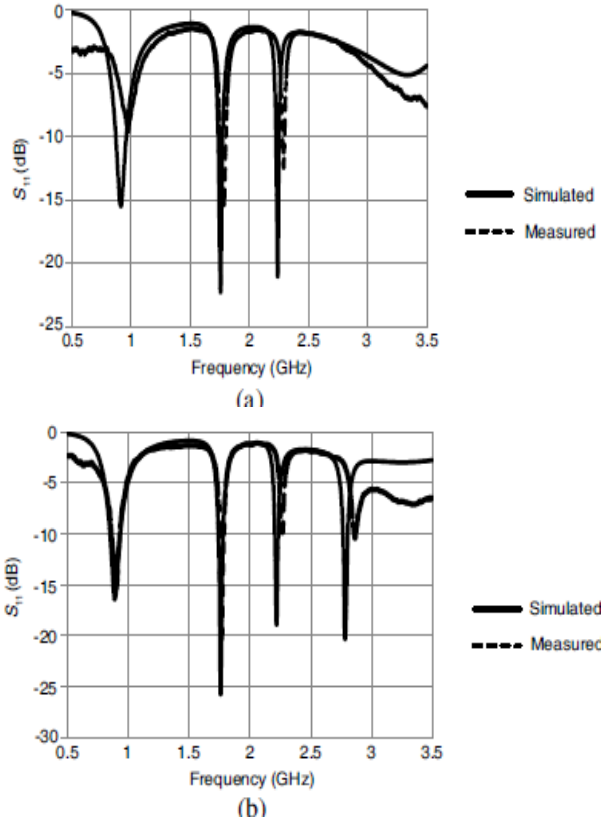

Figure-1 simulated and measured s_{11} of the proposed (a) triple band fractal-like antenna (b) quad band fractal-like antenna

The figure-1 shows the simulated and measured result of proposed triple and quad band antenna. The observed result is good for all frequency band .It is capable to cover the required multiband (GSM/DCS/PCS/UMTS/ISM). The resonance frequency for triple band antenna are 895MHz, 1720MHz, 2230MHz. and for quad band 880MHz,1760MHz,2220MHz,and 2800MHz.

J.-Y. Sze et al.[2] proposed a planar hexa-band internal antenna design for mobile phone application. The designed antenna are to suitable and capable for GSM850, GSM900, DCS, PCS.UMTS and 2.4-GHz WLAN operation.

In this paper author design a internal printed direct-fed antenna for desired hexa-band operation. The designed antenna is suitable for dual band frequency operation. The frequency range for lower band is 824-960MHz and for upper band 1710-2484MHz. That is suitable for all the desired operating frequency band.

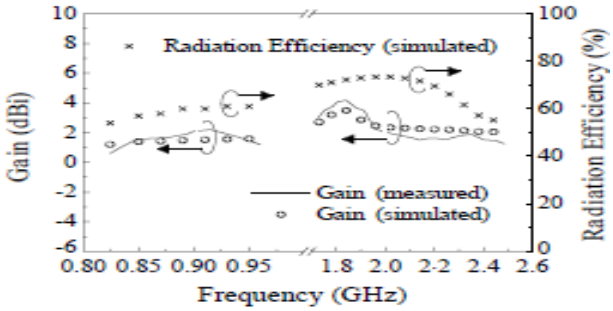

Figure-2 antenna gains and antenna efficiencies in the two operating bands of the design antenna

The antenna gains and the antenna efficiency are shown in figure-2 in this figure we get the 0.6-2.2dBi peak antenna gain for lower band and 1.5-2.2dBi for upper band. The efficiency of lower and upper operating band efficiency is 60% and 70%. The designed antenna is cover the multiple frequency bands.

C. Mahatthanajatuphat et al.[3] proposed a multiband slot antenna with modifying fractal geometry fed by coplanar waveguide transmission line. This antenna is operated at multiple resonant frequencies and to achieve the bidirectional radiation pattern for all operating frequencies.

In the design methodology the modified fractal slot antenna are fed by coplanar waveguide (CPW) and it is to work in digital communication system (DCS) .That antenna are suitable for different operating frequency band (DCS ,WiMAX ,WLAN). The modified fractal slot is use for create the multiple resonance frequencies.

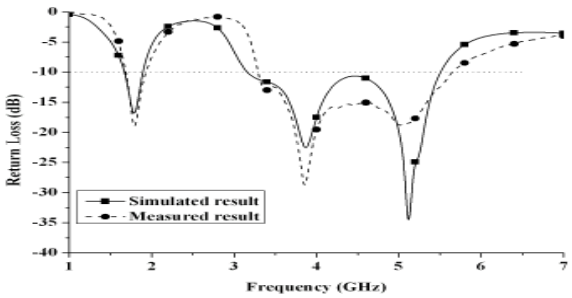

Figure-3 return loss for the proposed antenna

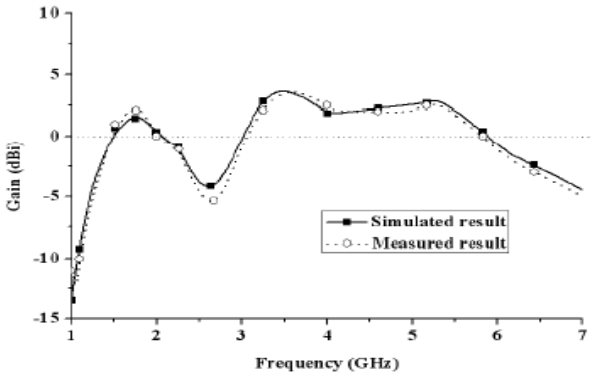

Figure-4 gains of the proposed antenna

The figure-3 shows the return loss of the proposed antenna and figure-4 shows the gains of the proposed antenna and this figure are shows the 2dBi peak antenna gains for each frequency band. It is suitable for digital communication system (DCS1800), WiMAX, IMT advance system or 4G mobile communication systems.

Y.-L. Ban et al.[4] proposed a planar printed wideband antenna for eight band LTE/GSM/UMTS/WWAN wireless USB dongle applications. To achieve a narrow band over the LTE700/GSM850/900(698-960MHz) operation and desired upper band is covering DCS1800/PCS1900/UMTS2100/ LTE3200/2500(1710-2690MHz) band.

In this paper the author design an antenna for multi band operation especially for the 3G and 4G mobile communication system. Its cover a different frequency band(LTE/GSM/UMTS/WWAN).That antenna have planar structure and is suitable to be disposed on a small non-ground board space of $20\times19mm^2$.

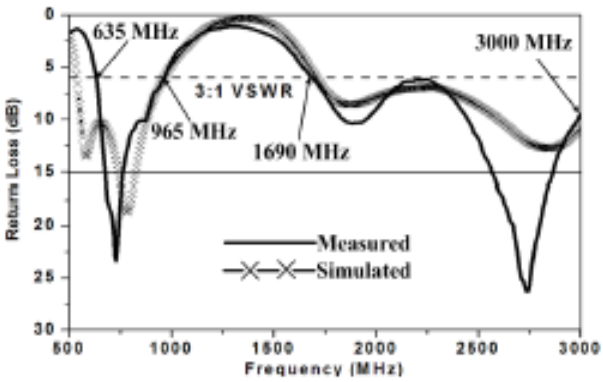

Figure-5 return loss of the proposed antenna

The return loss result curves of the proposed antenna are shown in the figure-5. And the antenna gain and radiation efficiency of proposed antenna are shown in figure-6 and we observed the gain and radiation efficiency, we get (a) antenna gain 2.1-3.9dBi (max. gain across3.2dBi) and the radiation efficiency 51%-78% for lower band and (b) antenna gain 2.5-6.1dBi (peak gain4.1-6.4dBi) and the radiation efficiency 65% for upper band and.

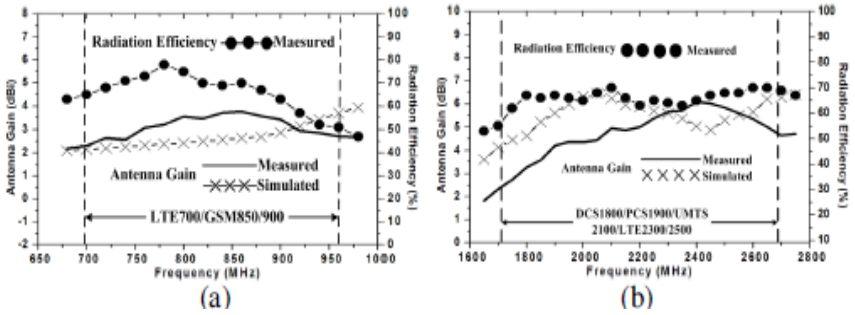

Figure-6 antenna gain and radiation efficiency-(a) lower band (b) upper band

W.-S. Chen et al.[5] design a novel multi-band monopole antenna for FDA phone. To get a bandwidth based on 6-dB return loss from 1550 to 2490 MHz it is suitable for DCS, PCS, UMTS and WLAN.

The proposed antenna is basically design for mobile communication system. For better performance by to addition more function into a single communication product. And this antenna has to operate in multiple frequency bands. Author use a simple Inverted-U-Shaped driven element, a low frequency meander path and a matching stub with a truncated slit to achieve the application requirements.

The return loss result of the designed antenna are shown in figure-7,in this figure the band-width based on 6-dB return loss for low frequency band 868 to 995 MHz(GSM) and for upper frequency band 1550 to 2490 MHz(DCS,PCS,UMTS and WLAN) application.

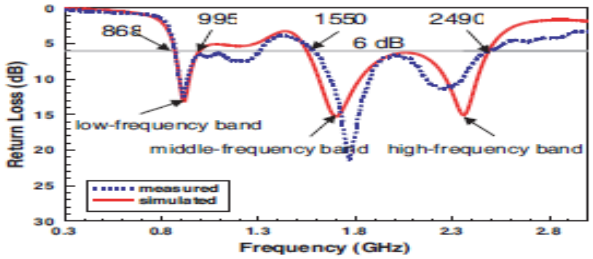

Figure-7 return loss of the designed antenna

The figure-8 shows the antenna gain and radiation efficiency of the proposed antenna. For the GSM frequency band (880-960MHz) the gain is from -1.1 to 2dBi and for DCS/PCS/UMTS/WLAN(1710-2484MHz) band is from 1.45 to 4.4 dBi & and the radiation efficiency for lower band 34.5% to 52% and for upper band 53.5% to 89%.

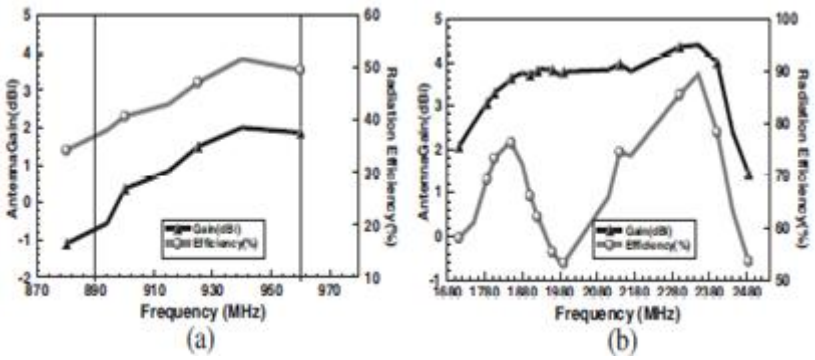

Figure-8 gain and radiation efficiency of the proposed antenna at (a) 880-960 MHz and (b) 1710-2484MHz.

J.Y.Sze et al.[6] design a compact dual-band annular ring slot antenna (ARSA) for use in 2.4/5 GHz wireless to achieving ARSA.

Due to the importance of large impedance bandwidth and low profiles printed slot antenna (PSAs) have get much attention in current year. Some PSAS were designed to get circularly polarized waves with required application. Some were improve in their bandwidth & others to support dual band operation. No. of them are design to cover the 2.4/5 GHz wireless local-area network (WLAN) bands in the past different frequency bands of a PSA. In the literature some PSAs have been generated that not only are compact but can also cover the required 2.4/5 GHz.

The figure-9 shows the return losses of the reference antenna, in this fig. we observed return-loss curve for the reference antenna, and this antenna has two resonant bands along with VSWR $\leq$ 2. One band is observed at 3333MHz with a bandwidth of 419MHz and second at 6568MHz with a bandwidth of 715MHz.

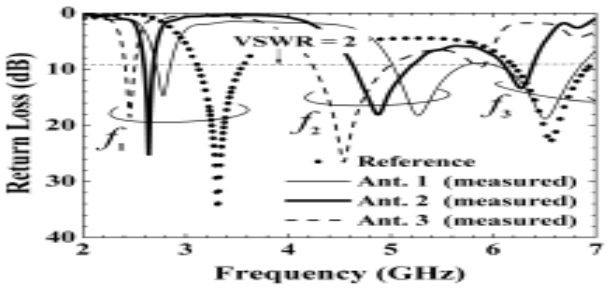

Figure-9 return losses of the reference antenna and antennas 1-3

M.A. Alkanhal et al.[7] proposed a novel compact dual-band reconfigurable square ring microstrip antenna is presented the resulting lower resonance frequency is range from 1.37 to 1.7 GHz in the voltage range from o to 30v.Microstrip antennas are used in different wireless communication system due to their profile.

In this paper author proposed a new squaring antenna with tunable dual band operation. The tuning is achieved by loading.

The square ring with a square patch perturbation at an inner corner and then attaching a varactor diode at the free corner of the patch. The square patch perturbation break the degenerate modes to loaded and unloaded modes and the ring perform dual-modes and the ring perform dual-mode resonance at two different frequencies

The figure-10 shows the simulation result of the tunable-band square-ring antenna for a voltage change from 0 to 30v, this fig. shown below. We observe the simulation result in this observation we get simultaneous impedance match at both bands in the given range ,result shows that to increasing the dc bias from 0 to 30v .The first resonance fi range from 1.378 to 1.69 GHz and upper frequency f_2 from 1.88 to 1.884 .

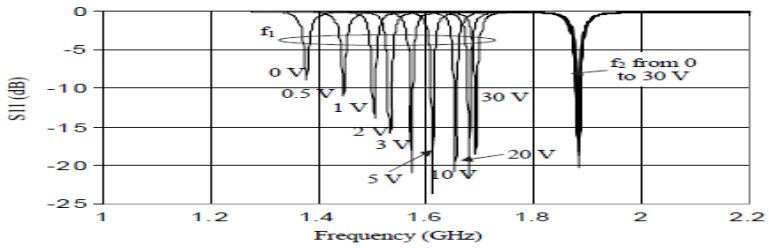

Figure-10 simulation result of the tunable-band square-ring Antenna for a voltage change from 0 to30 v

S.Behera et al.[8] design an electromagnetically coupled micristrip ring antenna for dual-band operation ,by widening two opposite of square ring antenna. It has also been observed that for the dual frequency configuration studied .The ratio of the resonant frequencies(f_{r2}/f_{r1})can range between 1.55 to 2.01.

Wireless communication system are grew fast in this time by improvements in RF circuit fabrications In this paper a modification is proposed to the basis square ring antenna to improve the band width and the primary mode.

The comparison of the simulated performance of the ring antenna it is shown below in table 1. In this observation we get first resonance simulated frequency2.431GHz along with bandwidth 36.4MHz and second resonance simulated frequency 5.228GHz along with bandwidth 144MHz (for uniform width antenna) and for other antenna the first simulated frequency 2.992GHz along with bandwidth 50.2MHz and second 4.787 along with bandwidth 73MHz (for dual frequency antenna) and for non-uniform antenna this is shown in table 1.

Table-1 the comparison of the simulated performance of the ring antenna

		Uniform width antenna		**Non-uniform width antenna**		**Dual frequency antenna**	
		Simulated	**Measured**	**Simulated**	**Measured**	**Simulated**	**Measured**
First resonance	**Frequency[GHz]**	2.431	2.431	3.152	3.15	2.992	2.99
	Bandwidth[MHz]	36.4	36	75.2	75.5	50.2	52
Second resonance	**Frequency[GHz]**	5.228	5.23	5.478	5.48	4.787	4.78
	Bandwidth[MHz]	144	144	77.2	76	73	71.5

W.-J. Liao et al.[9] design a compact multi band (GSM/DCS/ PCS/UMTS/Bluetooth/WLANS/Wi-MAX) planer monopole antenna simulation and measurement result present good agreement for reflection coefficient the proposed

Antenna is particularly used for mobile system that integrates multiple systems.

The observation of figure-11 we observe the performance of proposed antenna and we get multiple bands along with -10dB return losses. In This figure the lowest band from 890-960MHz (GSM) and second band is 1.72-2.3GHz (DCS/PCS/UMTS) third is 2.4-2.48 GHz (Bluetooth and WLAN), fourth band is 3.1-4.4GHz (WI-MAX)

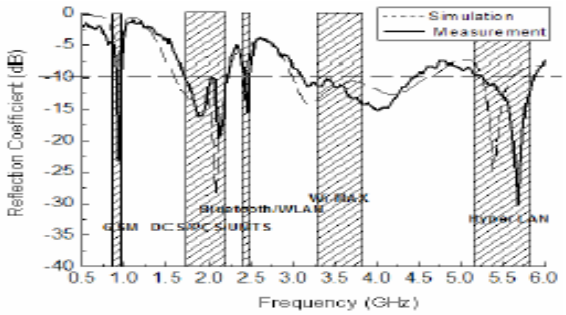

Figure-11 reflection coefficient spectra of the proposed antenna

The gain and efficiency of the proposed multiband antenna is compare through the table 2, this table are shown below.

Table-2 gain and efficiency of the proposed multiband antenna

Application	Resonant frequency(GHz)	Peak Gain (dBi)	Total Efficiency (%)
GSM (890-960MHz)	0.94GHz	2.89dBi	61.71%
DCS (1.71-1.88GHz)	1.82GHz	3.32dBi	68.98%

Wireless communication system have growth up fast in current year, the mobile communication device integrate multiple communication system includes UMTS,GSM ,Wi-Fi, Bluetooth and GPS as well since each communication protocol may operate in a different frequency band using more antennas. It is highly required to have one broadband or multi-band antenna to meet the antenna needs of multiple systems.

J.Montero-de-paz et al.[10] are proposed multi frequency self-diplexed single patch antennas to achieving the working frequency can be arbitrarily chosen and frequency ratios lower than 1.07.

Wireless communication system have grown up fast in current year. The no. of antenna is design for increasing the performance of communication system, the antenna is design for different bands. In this ref. paper the inclusion of metamaterial cells has allowed achieving high isolation self-diplexed multi frequency antenna based on a single patch. The Antenna split ring resonators (SRRS) have been used to load both the antenna and the filtering lines in a to two layer structure in comparison with previous multilayer structure.

The reflection coefficients of the triple frequency patch antenna loaded with SSRs result shown in figure-12 and table 3.And we observe the small shift in the resonance frequency of the notches that the resonant frequencies can be arbitrary chosen and the ratio between any pair of them is different.

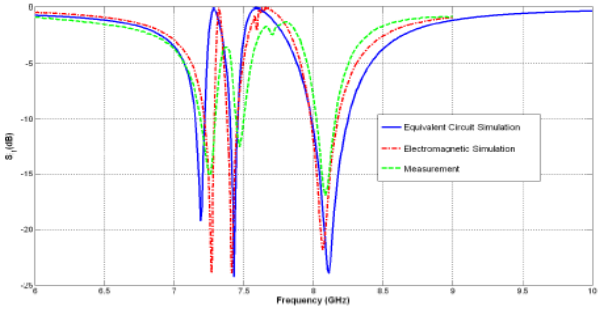

Figure-12 reflection coefficients of the triple- frequency patch antenna loaded with SSRs.

Table-3 reflection coefficient of the triple frequency antenna

Simulation		Measurement	
Frequency	**Relative BW $_{-10dB}$**	**Frequency**	**Relative BW $_{-10dB}$**
7.25GHz	0.87%	7.26 GHz	1.17%
7.15 GHz	1.11%	7.18 GHz	0.71%
8.10 GHz	2.18%	8.09 GHz	1.68%

3. RESULT COMPARISION

AUTHOR	JOUNRAL	VSWR	GAIN	BANDWIDTH	USE
R .S. Aziz [1]	PIER, vol.29, 339-354,2011		1dBi- lower band, and 4-dBi upper band		Use in GSM/DCS/ IMT/WiMAX frequency band
J.-Y. Sze [2]	PIER,vol.107, 413-425,2010	≤3	0.6-2.2dBi-lower band, and 1.5-4.2 dBi upper band		GSM/DCS/PCS/ UMTS/ WLAN frequency band
C. Mahatthanajat -uphat [3]	PIER, vol.95, 59-72,2009		2dBi average gains for each operating frequency		Multiband communication (DCS/WiMAX/IMT)

Y.-L. Ban [4]	PIER, vol.128, 313-329,2012	<3	2.1-3.9dBi for lower band and 2.5-6.1dBi for upper band		GSM/DCS/PCS/UMTS/ WWAN frequency band
W.-S. Chen [5]	PIER, vol.14, 101-109,2010		-1.1-2dBi (lower) band and 1.45-4.4 dBi (upper) band		GSM/DCS/PCS/ UMTS/WLAN
J.Y.Sze [6]	PIER, vol.95, 299-308,2009	≤2	1dBi-lower band, 3.6dBi-upper band	Resonant bands one centered at 3333 MHz with a bandwidth of 419 MHz and the other at6568 MHz with a bandwidth of 715 MHz	2.4/5 GHz wireless local-area network(WLANs)
M.A. Alkanhal [7]	PIER, vol.70, 337-349,2007			The resulting lower resonance freq. is1.37to 1.7 GHz in the voltage range from 0 to 30v.	Suitable for wireless handset mobile application
S.Behera [8]	PIER,vol.93, 41-56,2009		1-6.21dBi 2-6.25dBi 3-6dBi	1-2.23(%B.W) 2-1.87(%B.W) 3-1.795(%B.W)	Wireless communication
W-J .Liao [9]	PIER,vol.109, 1-16,2010		1-2.89dBi(GSM) 2-3.32dBi(DCS) 3-4.37dBi(PCS)		For Mobile device multiband (GSM/DSC /PSC/UMTS)
J.Montero-de-paz[10]	PIER,vol.113, 47-66,2011			0.87% 1.11% 2.48%	x-band

4. CONCLUSION

In the recent year the mobile communication systems grew up fast. For increasing the performance of wireless network the different type multiband antenna are design .This paper is based on the comparative study on dual-band microstrip patch antenna. We observe the simulated and validated result of different dual-band and multiband antenna. We get the different range of bandwidth and different range of gain.

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