Golden Research Thoughts
ISSN 2231-5063
Impact Factor : 3.4052(UIF)
Volume-4 | Issue-6 | Dec-2014
Available online at www.aygrt.isrj.org

DESIGN AND IMPLEMENTATION OF A PANEL TYPE ANTENNA

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Abstract: An element of information transmission on which more research is being made is related to unguided media due to the relative ease of reaching remote locations without being subject to a cable. This translates to ease of mobility for the end user.

This article designs, simulates, optimizes and implements a panel type antenna with a single dipole to increase the bandwidth over 30%.

Keywords: Design and Implementation , information transmission , optimizes and implements .

1. INTRODUCTION

An antenna is a device consisting of a set of drivers coupled to a generator, allowing the emission of radio frequency waves [1], or if connected to impedance serves to capture the waves emitted by a distant source [2]. Among the many types of antennas are: Opening, Sleeve, monopoles, panels, Long and Short Dipoles, Yagi, Logarithmic, [3] each of them having a specific application.

Panels in particular consist of multiple dipoles. The gain ranges from 9 dBi (10 x 12 cm) to 21 dBi (45 x 45 x 4.5 cm) [4]. It presents a very good gain / occupied volume ratio and also has a performance of around 85-90% [5]. These antennas are not made beyond this maximum gain, because of coupling problems (losses) between the dipole levels and it would also be necessary to double the surface. The volume of this type of antenna is marginal.

2. ANTENNA DESIGN AND CONSIDERATIONS.

The design of the panel was based on the premise that the dipole should resonate at a frequency of 1100 MHz, and that a 30 % bandwidth increase (equation 1) should be guaranteed.

$$\lambda = \frac{C}{f} = \frac{300}{1100} = 0.27272727 \; mts. \qquad (1)$$

The copper wire to be used for implementing the dipole was AWG 4 with a radius of 1.294mm.

Using table 1, and on the basis of the fact that the L-Nominal is $\frac{\lambda}{2}$, and is equal to:

$$\text{L} = \frac{\lambda}{2} = \frac{0.272727}{2} = 0.1363635 mts \qquad (2)$$

$$\text{A} = \frac{L/D}{1+(L/D)} = \qquad (3)$$

$$\frac{0.1363635/0.02588}{1+(0.1363635/0.02588)} = \frac{5.26906879}{6.2690687} = 0.8404$$

L-Práctica = 0.48A λ

L-Práctica = 0.48(0.8404)(300/1100)

L-Práctica = 0.1110016 mts.

$$0.47\lambda \le L_{reson} \le 0.48\lambda$$

Dipolo largo resonante

L- Nominal	R_{in}	L- Práctica
$\lambda/2$	67Ω	$0.48A\lambda$
λ	$R_n^2/67$	$0.96A\lambda$
$3\lambda/2$	95	$1.44A\lambda$
2λ	$\frac{R_n^2}{95}$	$1.92A\lambda$

$$R_n = 150\log\frac{L}{D}$$

$$A = \frac{L/D}{1+L/D}$$

Table1. Practical length for a resonant dipole.

Taking these design values to software MMANA-GAL [6], and taking a distance to ground of 0.25 λ (6.8 cm), the following values were obtained:

Z = 66.30 – j 16.40 Ω
SWR = 1.41
I = 14.21 + j 3.52 mA

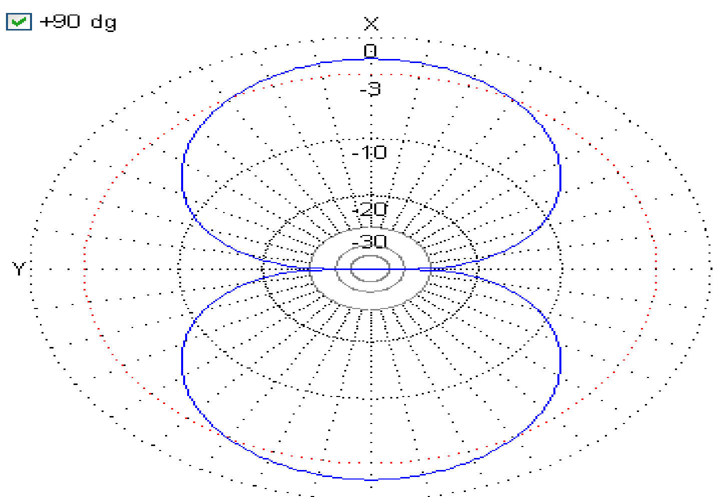
It can be observed that the impedance is relatively good.
The radiation pattern obtained (Figure 1) is omnidirectional as corresponds to dipoles.

This implied that the design criteria were good so far. However the bandwidth obtained did not exceed the bandwidth proposed in the design (Figure 2):

BW = 184.999 MHZ.

On the other hand (as seen in Figure 2) the panel was resonating at a frequency well below the design criteria:

F_R = 894.067 MHZ.



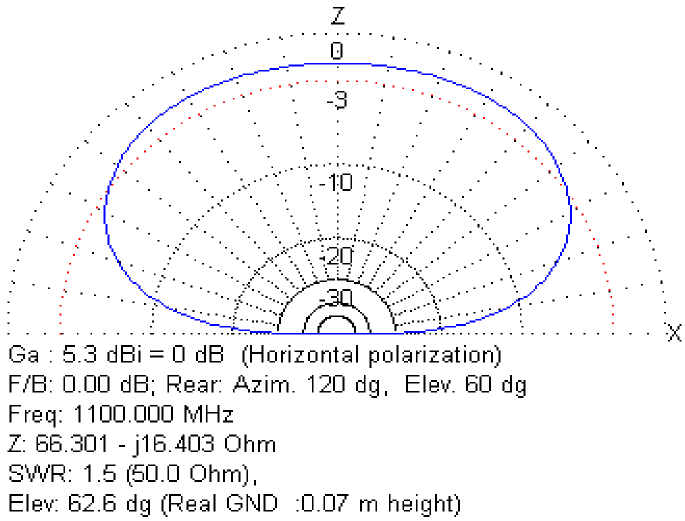


Figure 1. Radiation Diagram

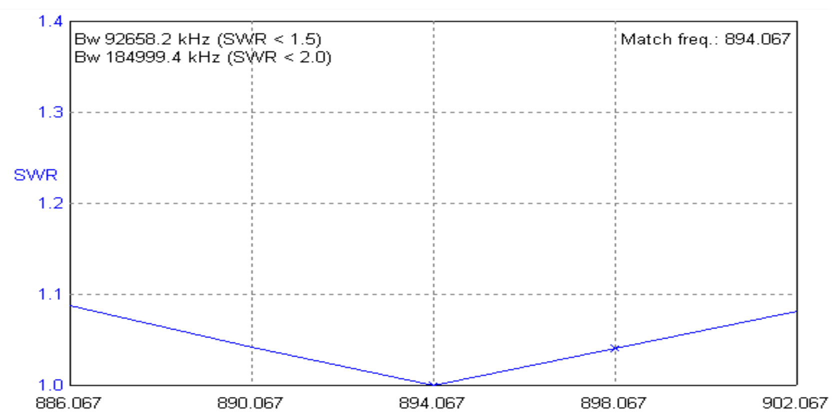


Figure 2. Bandwidth against SWR.

3. OPTIMIZATION.

Once the optimization provided by software-GAL MMANA was applied, the following parameters were modified:

L = 0.1328 m
R = 10 mm
Distance to ground = 0.07 m.

The results are summarized in Table 2

Freq	R	jX	Ga	F/B	ON
1090.0					Off
1095.0					Off
1100.0	129.8	-4.5	5.4	0.0	On
1105.0					Off
1110.0					Off

Table 2. Results by MMANA-GAL.

From Table 2, we conclude that impedance soared to Z = 129.8 - j 4.5 Ω, which implies decoupling problems.

Other data found were:

SWR = 2.60
I = 7.70 + j 0.27 mA

The corresponding radiation diagram retrieved is shown in Figure 3.

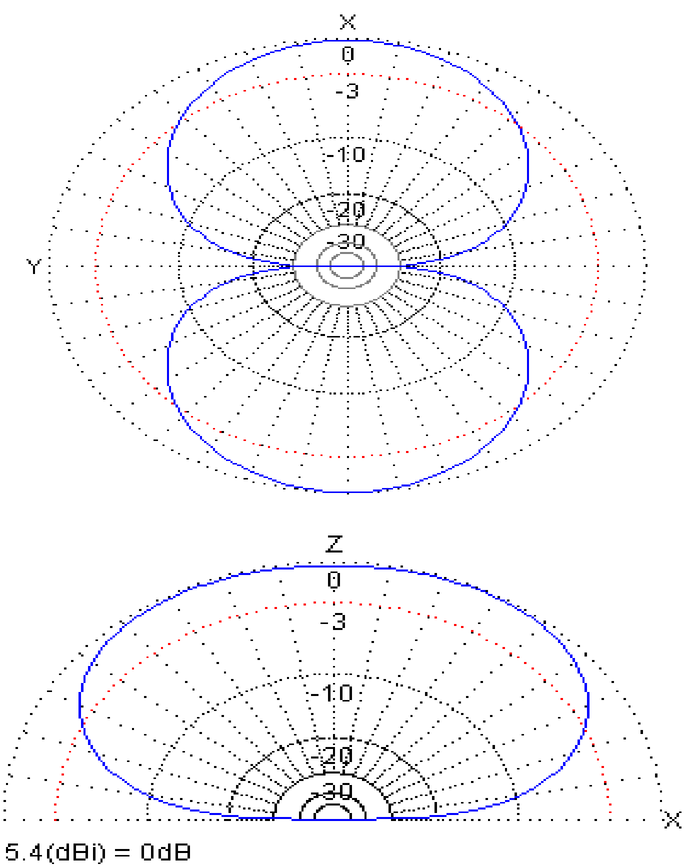


Figure 3. Radiation diagram

That they remain similar to those obtained before applying optimization.
The achieved bandwidth is shown in Figure 4.

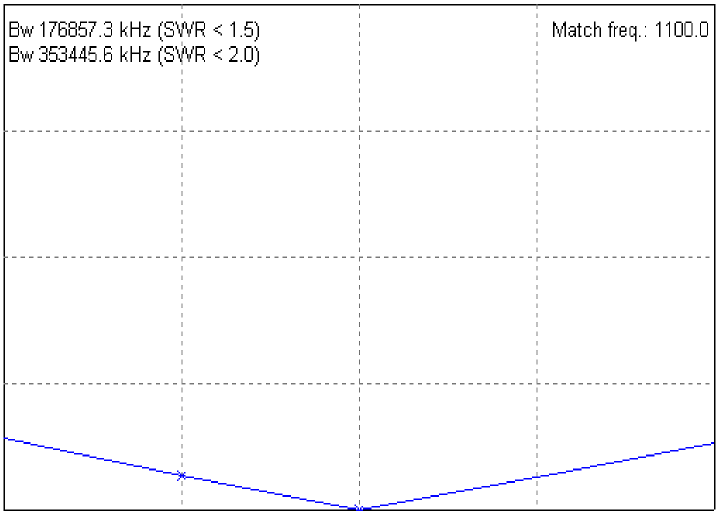


Figure 4. Optimized bandwidth

From Figure 4, it is clear that in this case AB = 353.4456 MHZ is guaranteed, which would ensure the requirement initially raised, in addition to the fact that the antenna would resonate at the desired frequency:

F_R = 1100 MHZ.

4. LABORATORY RESULTS

The implemented antenna is shown in Figure 5

Figure 5. Panel Implementation

Importantly, measurements of the antenna are:

Dipole length L = 0.1328 m
Dipole diameter D = 20 mm
Reflector length λ = 0.525
Separation Dipole and Reflector = 0.068m
Balun Bazooka Length = λ / 4 = 0.06818m

The design criterion to evaluate was the panel AB. The results are shown in Table 3, where it can be seen from a comparative point of view, the FR and AB values for the design, optimization, and practical implementation found during the applied research development.

Table 3. Analysis of the FR and AB variables.

Variable	Design and simulation	Optimization	Practical implementation
F_R (MHZ)	894.067	1100	977
AB (MHZ)	184.999	353.4456	8.92%

In the previous table it can be noted that from the point of view of design and simulation of the antenna it can be seen that the data retrieved through the application of equations differ from the expected, most likely because they do not take into account a number of variables that can have a major impact, such as soil conductivity, the type of metal to be used [7] [8], etc.

The frequency response shown by the network analyzer can be observed in Figure 6 and confirms what is shown in Table 3.

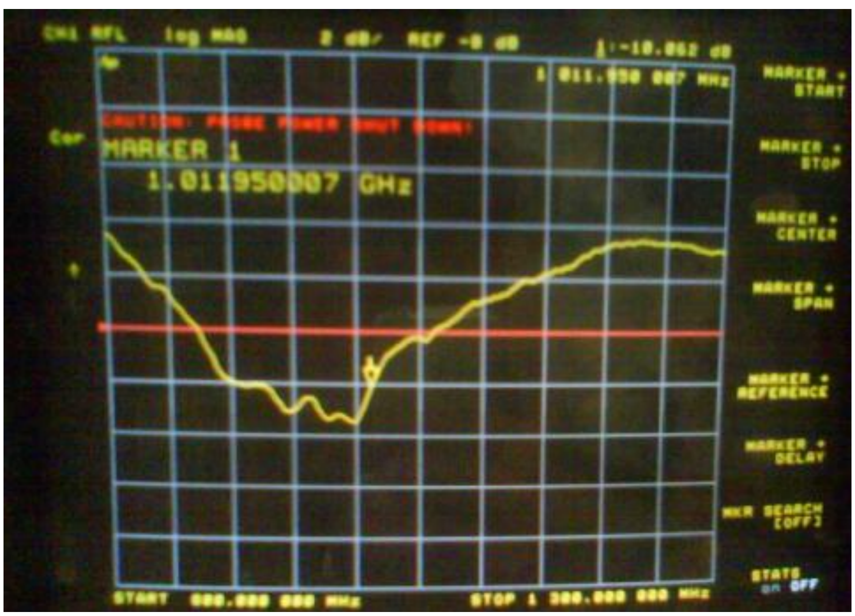


Figure 6. Bandwidth of the deployed antenna

As can be noted from the above graph the AB can be obtained:

F_L = 925.50 MHZ
F_H = 1.012 GHZ

The Central frequency is obtained from the lower and upper frequencies:

$$F_C = \frac{1012 + 925.50}{2} = 968.75 \text{ MHZ.}$$

$$AB = \frac{1012 - 925.50}{968.75} = 8.92\%$$

From the software point of view once the optimization is applied, some parameters such as bandwidth (BW) are improved but others are downgraded or altered, such as the impedance (Z), the cable length and diameter which in certain cases is difficult to secure either because the accuracy cannot be guaranteed or the diameter of the element is not available commercially.

Because of this there are errors when comparing the values obtained by simulation and those achieved empirically.

5. CONCLUSIONS

The practical research posed for an antenna design is correct since it allows verifying and comparing the theoretical and practical results.

MMANA-GAL software is a powerful simulation tool because it allows an antenna manufacturer to predict its behavior before producing the finished product.

Panel type antennas are ideal for deploying point to point and point to multipoint applications.

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