Design of Yagi-Uda Antenna for CDMA Modems at 800 MHz

Adik Putra Andika, Vinsensius Letsoin, Rapha Nichita Kaikatui, Paulus Mangera, Damis Hardiantono

Departement of Electrical Engineering, Faculty of Engineering, Musamus University, Jl. Kamizaun, Merauke, Indonesia

andika_ft@unmus.ac.id

Abstract. Nowadays CDMA and GSM modem technology are still widely used by the community, especially in rural areas and small towns that are quite far from the BTS location. This paper designs the Yagi-Uda antenna for CDMA modems on the 800 MHz frequency. The number of elements used is 1 driven, 1 reflector and 16 directors. The antenna design simulation uses NEC-Win Pro 1.6 and Ansoft HFSS 13.0 software. Simulations using NEC-Win get VSWR values 1.59 and S11 -13 dB (uses Matlab). Next, the simulation using Ansoft HFSS obtained the results of VSWR 200000 and S11 -9 dB. The simulation results also show that antenna design already has a directional radiation pattern.

1. Introduction

The development of telecommunications and communication infrastructure in Indonesia is still slow and has not spread evenly [1] [2]. Communities that are particularly located in rural areas and small towns are still difficult to access good telecommunications and internet quality. This is due to the location of the BTS (Base Transceiver System) that is far from where the user (community) lives [2]. The solution is to add other devices such as modems with CDMA (Code Division Multiple Access) or GSM (Global System for Mobile communication) networks. CDMA is a system of access together which in the distribution of channels through data coding [3].

The ability of modem connections, in general, is also limited. To overcome this obstacle, an antenna is needed which functions to receive electromagnetic waves [4] emitted by BTS to be able to strengthen the modem signal. One type of antenna is a Yagi-Uda antenna that has been widely adopted for TV signal reception [5]. Yagi-Uda antennas are also commonly used for data communication [6]. This antenna is directional which is to add gain to only one direction [7].

The Yagi-Uda antenna uses the HF, VHF and UHF systems [6]. Then the frequency band used by CDMA is 800-1900 MHz [8] [9]. So, this paper makes the design of a Yagi-Uda antenna as a CDMA modem amplifier at 800 MHz frequency. The design of this antenna will be simulated using NEC-Win Pro 1.6 and Ansoft HFSS 13.0 software.

2. Antenna Design

The first step in designing this Yagi-Uda antenna is to determine the size of each component or antenna element. These elements are driven, reflector, and director [10]. The driven element has a length of \( \frac{1}{2} \lambda \) (lambda). So the formula for calculating total length driven is:
\[ \lambda = \frac{c}{f} \]  \hspace{1cm} (1)

\[ L = 0.5 \times K \times \lambda \] \hspace{1cm} (2)

where:
- \( f \) is the desired work frequency
- \( \lambda \) is the wavelength in the air
- \( L \) is the length of driven
- \( K \) is a factor velocity in metals taken at 0.95

Then, the value of wavelength and length of driven are:

\[ \lambda = \frac{300}{866} = 0.347 \text{ meters} \hspace{1cm} (3) \]

\[ L = 0.5 \times 0.95 \times 0.347 = 0.19 \text{ meters} \hspace{1cm} (4) \]

Furthermore, the length of the reflector is designed 7% longer than the length of the driven, namely:

\[ \text{Reflector} = 0.07 \times 0.19 = 0.196 \text{ meters} \hspace{1cm} (5) \]

The director's length is designed to be 5% shorter than driven length, namely:

\[ \text{Director} = 0.05 \times 0.19 = 0.165 \text{ meters} \hspace{1cm} (6) \]

If the antenna is designed to have more than 3 director elements, then the 2nd director is designed to be slightly shorter than the first director. Then, the 3rd director is slightly shorter than the 2nd director and so on reaches the last director. In detail, the size of all elements used is in table 1.

| Table 1. Size of the antenna element |
|--------------------------------------|
| Element    | Length (mm) | Distance (mm) |
|-----------|-------------|---------------|
| Reflector | 190         | 30            |
| Driven    | 178         | 75            |
| Director 1| 169         | 35            |
| Director 2| 166         | 45            |
| Director 3| 164         | 45            |
| Director 4| 162         | 45            |
| Director 5| 160         | 45            |
| Director 6| 159         | 45            |
| Director 7| 157         | 45            |
| Director 8| 155         | 45            |
| Director 9| 153         | 45            |
| Director 10| 150       | 45            |
| Director 11| 148        | 45            |
| Director 12| 146        | 45            |
| Director 13| 144        | 45            |
| Director 14| 142        | 45            |
| Director 15| 140        | 45            |
| Director 16| 138        | 45            |

Furthermore, the antenna simulation parameters taken are VSWR, S11 and radiation patterns. Antenna design is simulated using NEC-Win Pro 1.6 and Ansoft HFSS 13.0 software.
3. Simulation Results

This NEC-Win Pro 1.6 and Ansoft HFSS 13.0 software has been widely used by researchers and academics to design an antenna. The software is easy to use and has a high level of output accuracy.

3.1. NEC-Win Pro 1.6

3.2. Ansoft HFSS 13.0
4. Conclusion
The design of Yagi-Uda antennas for CDMA modem amplifiers at 800 MHz can be simulated using NEC-Win Pro 1.6 and Ansoft HFSS 13.0 software. The antenna design simulation using NEC-Win Pro 1.6 gets the VSWR value of 1.59 and S11 -13 dB (uses Matlab). Next, the simulation using Ansoft HFSS obtained the results of VSWR 200000 and S11 -9 dB. Need to optimize the simulation using Ansoft HFSS to get the desired VSWR value. Then, the simulation results also show that the antenna has a directional radiation pattern.

5. References
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