# Antenna Impedance Phase Measurement System

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## 1 INTRODUCTION

The system developed by Efe KİRAZ and Faruk ASLAN HATIK in 2021 is designed for antenna characterization in an undergraduate laboratory setting. It utilizes a turntable approach to measure key parameters such as antenna gain, directivity, and radiation pattern [1]. While the system is effective in these areas, it does not have the capability to measure the phase of the antenna's impedance, which is crucial for a complete antenna analysis. Our project aims to enhance this existing system by incorporating impedance phase measurement, thereby providing a more comprehensive solution. By combining these features, we aim to create an affordable, easy-to-use alternative to commercially available systems, all while staying within a $1000 budget using off-the-shelf components and specially designed RF circuits.

## 2 METHOD

The Antenna Gain Measurement System consists of five main components:

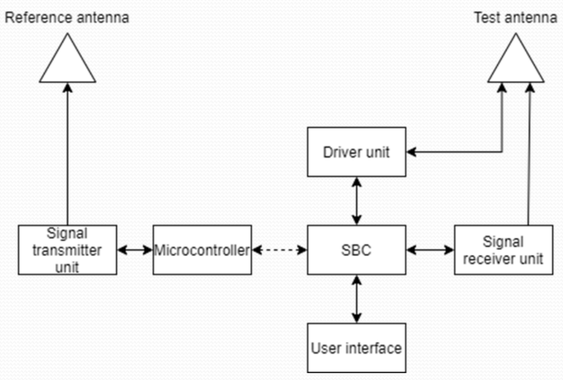
***Control Unit:*** A Single Board Computer (SBC) is used to manage both the receiver and transmitter units, enabling far-field measurements across various frequencies and antenna dimensions.

***User Interface Unit:*** The SBC also handles the user interface, providing an intuitive graphical interface for easy interaction between the user and the system.

***Driver Unit:*** To measure the radiation pattern, a motor driver connected to the antenna allows it to rotate 360 degrees, enabling successful pattern acquisition.

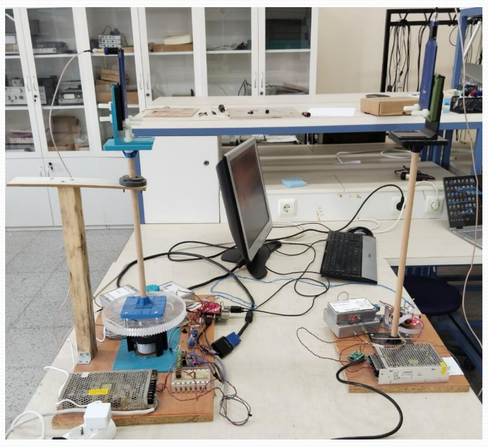
***Transmitter Unit:*** This includes a Phase Locked Loop (PLL) with a Voltage-Controlled Oscillator (VCO) for signal generation, along with amplifiers to boost the signal for detection by the receiver.

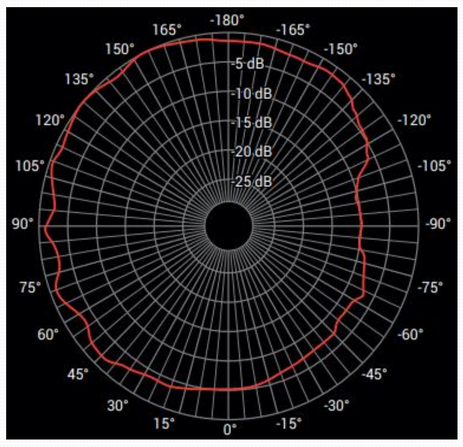
***Receiver Unit:*** The receiver features an RF detector for signal detection and an Analog-to-Digital Converter (ADC) for processing the measurement data. The receiver also incorporates the control, motor driver, and user interface functions, all managed by the SBC.




## 3 EXPERIMENT / SIMULATION

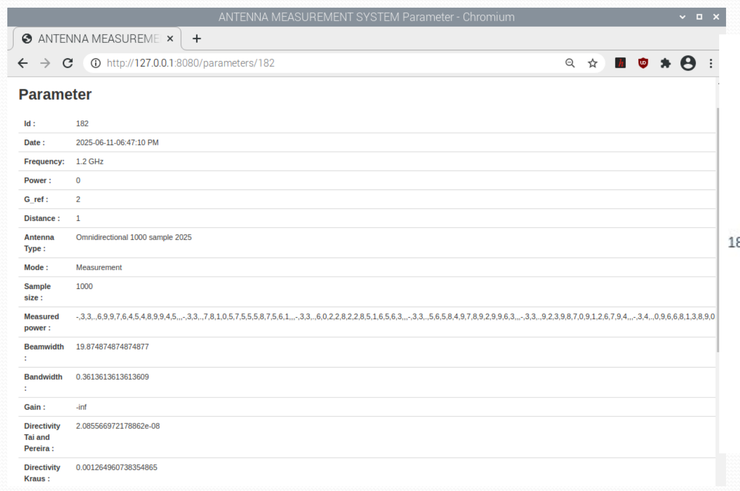
The measurement was conducted using OmniLOG 70600 antennas, chosen for their frequency compatibility with the system. The system was set to operate at 1.2 GHz, and a sample size of 1000 was used for this measurement. The antennas are nominally matched to 50 ohms. The experimental setup and the expected radiation pattern of OmniLOG 70600 can be seen as follows,






## RESULTS 4

The measurement results revealed slight deviations from the expected omnidirectional radiation pattern, primarily due to a mismatch between the antenna and the system at 1.2 GHz. This mismatch resulted in only 20% of the signal being transferred to the antenna, reducing radiation efficiency. Despite this, the measured pattern still resembled the expected one, confirming that the RF detection and amplification components functioned as intended. Future adjustments to the antenna's impedance matching could improve accuracy.




## COST ANALYSIS 5

For the restoration of the antenna gain measurement system, no additional expenses were incurred, as we worked with existing components. To provide context, the estimated cost of the project in 2021 was ₺5,177.75, which equates to approximately $622.32 USD based on the exchange rate of 1 TL = 0.1202 USD at the time. This budget reflects the cost of the system's initial design and implementation. With the addition of the gain measurement system, we estimate the total cost of the combined system to be within or around $1000.

| Procurement of Materials | Price |
|---|---|
| Materials for PCB Manufacturing | 910.41TL |
| Passive Components & Connectors | 623.09 TL |
| Radio-Frequency ICs | 1220 TL |
| Aluminium Boxes | 187 TL |
| Tariffs | 37.75 TL |
| Total | 2977.75 TL |

| Procurement of Materials | Price |
|---|---|
| Stationery Expenses | 30 TL |
| Books | 0 TL |
| Materials for PCB Manufacturing | 50 TL |
| Materials for Mechanical Infrastructure | 450 TL |
| Consumable Materials | 70 TL |
| Electronic Equipment | 1650 TL |

Environmental Impacts:

PCB Usage & Disposal

Chemical Substances Usage & Disposal

High Frequency Radiation

Economical & Social Impacts:

Cost Reduction

Commercialization Potential

Education & Research Quality Enhancement

## CONCLUSION 6

The antenna gain measurement system has been successfully restored, and measurements have been taken. Key issues within the system have been identified and will be addressed. Moving forward, this system will be integrated with the phase measurement system to create an affordable, easy-to-use alternative to commercial antenna gain measurement systems.

## REFERENCES 7

[1] KIRAZ, E., HATIK, F. A., and GÜNEL, S., "Standalone Antenna Measurement System," 2022 International Conference on Applied Electronics (AE), Pilsen, Czech Republic, 2022, pp. 1-5.

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