

Development of VSWR Meter

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ABSTRACT: This article is based on the development of 6 GHz SWR meter for testing telecommunications systems for applying in telecommunication engineering. The hardware consists of Arduino microcontroller with two parts multi frequency oscillator and digital SWR meter using directional coupler of 6 GHz operating frequency. The quality is of high level for the developed SWR meter evaluation. The developed SWR meter has not exceeded $\pm 5\%$ of error while comparing to standard instruments after testing accuracy. The developed SWR meter can be used efficiently.

KEYWORDS: SWR meter, Arduino microcontroller, Directional coupler.

I. INTRODUCTION

In 21st century, the education has been developed using modern technologies and innovations. It is necessary to have industrial aids which are appropriate and sufficient for learning and teaching both in theory and practice in the field of telecommunication engineering. Most classrooms do not support telecommunications systems which lacks modern equipments. Because it has very high evolution and high frequency communication technologies which are complicated. Thus, the development of modern learning innovation is done with demonstration set, measuring sensors, simulation program, visual laboratory set, modern instruments and etc. This makes teachers encouraging in managing teaching effectively by encouraging learners. The recent research studies shows that researchers have designed and developed high-frequency instruments, such as the analyzer for basic electrical laboratory in networks, in measuring non-interference electrical signals of small antennas using the small integrated circuit network analyzer and etc. These researches helps in learning media with teaching and learning, also by applying to create innovations for industries. Most research results does not respond in the radio or microwave frequencies due to the limitations in circuit structure and microwave devices. This paper is based on the development of a 6 GHz standing wave ratio meter which was proposed by testing the quality and functionality by applying in the field of telecommunication systems. Also it can be applied in the research and development of modern innovations of IEEE 802.11a and 802.11n standard wireless networks.

II. RELATED WORK

A. Standing wave

Telecommunications systems consists of transmitters, transmission lines and receivers are necessary for communication. For transmitting or receiving antenna is the main component which transforms electrical energy into electromagnetic waves or vice versa. Therefore, it is important for designing and considering an effective telecommunications system with the maximum power transmission. To test an efficient telecommunication system, the SWR meter is used widely in measuring standing wave. Thus, the standing wave is a voltage pattern of causing the incident wave from the source and reflected waves at the load resistance. The voltage standing wave ratio (VSWR) is the highest and lowest value of the observed waveform which looks like a stationary point along the transmission line. The equations relating between the VSWR calculation and reflection coefficient.

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$$VSWR = \frac{1 + \text{reflection coefficient}}{1 - \text{reflection coefficient}}$$

$$\frac{V_{\text{reverse}}}{V_{\text{forward}}} = \frac{1 - VSWR}{1 + VSWR}$$

The interfacing of SWR meter is done between the transmitter and load.

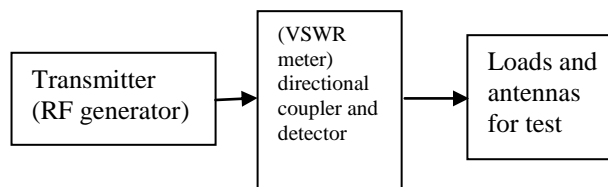


Fig.1 Interfacing SWR meter for testing

B. Directional couplers

A directional coupler is a four port passive device that is used to sample a small amount of input signal power for measurement purpose. This coupler splits the input signal and distributed power. It also couples a part of the transmission power by a specific factor by one port. They are used in variety of applications which involves power measurement. It is made from transmission lines (coaxial) or micro strip line. The micro strip lines are designed by using a quarter-wavelength ($\lambda/4$) directional coupler base on FR-4 circuit board. The power on the port 3 flows in the opposite direction to the power on the main line. Due to this the port arrangements are not similar, but the numerical remains the same.

This directional coupler is 4-port type circuits consisting a micro strip line with two quarter-wavelength lines ($\lambda/4$) and two matching loads.

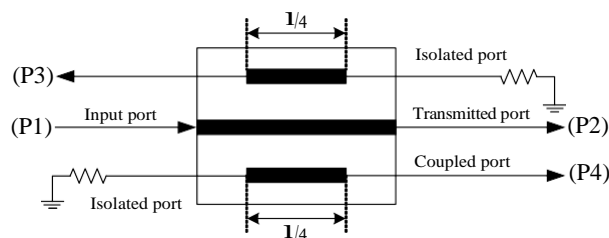


Fig.2 Directional Couplers

The directional coupler on the microwave circuits are based on the design of the conductor strips, which is to be parallel with the proper space. The performance of coupling factor depends on the dimensional tolerances for spacing of the two-coupled lines. Thus, the length of directional coupler must be of $1/4$ lambda to have appropriate coupling power.

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III. DEVELOPMENT OF STANDING WAVE RATIO METER

For measuring the quality of mobile phone system or related communication systems, the development of a high frequency SWR meter is designed at 6 GHz operating frequency. The block diagram of the developed SWR meter consists of the directional coupler, the peak detector and microcontroller.

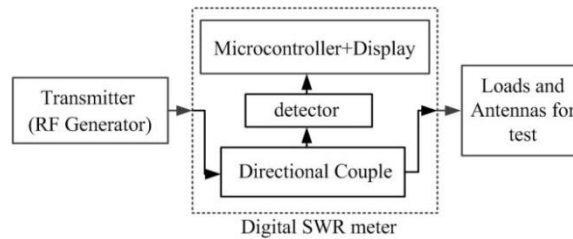


Fig.3 Block diagram of SWR meter

A. The 6 GHz generator for testing

The signal generator with 6GHz oscillator is implemented by using the audio and video transmissions module with 32 channels and transmitted power of 200mw.

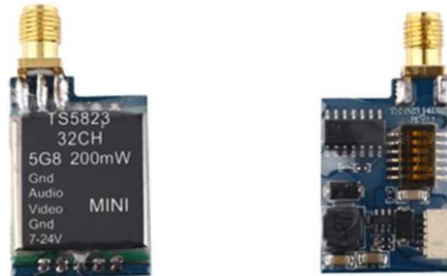


Fig.4 Audio and Video transmission

B. Directional coupler design

A directional coupler for usable frequency at 6 GHz is designed using the CST emulator and implemented on FR-4 printed circuit boards. The length of the coupler is $1/4$ and load impedance is 50 Ohms connecting at port 5 and 6 (Isolated port), as shown in Fig.5. After implementing, the comparison of frequency response between simulated result and actual measurement using the network analyzer is presented. The actual generator has a good response in the frequency range of 6 GHz, the power flow from the port 1 to port 3 is about -10 dB and there is a little energy transferring from port1 to port4.

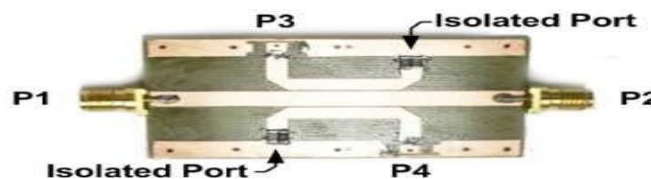


Fig.5 The developed directional coupler

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C. Microcontroller unit

Arduino microcontroller (MCU) is an important component in connecting to other electronic devices. Because of flexibility and comfort, the Arduino board has many models to use control system which differs in the size of the board or specification, such as the number of data bits and input/output ports, memory, the voltage used, the efficiency of the MCU, etc. Thus, in this, the microcontroller unit is implemented using the Arduino UNO-R3 processing board at 16 MHz of operating frequency, with 8-bit processing and a 4-line LCD display, as shown in Fig.10. The hardware is used to control the interfacing analog input channel by receiving voltage from the developed directional coupler. The voltage signals of transmitted and reflected wave is converted to digital signal and then transferred to the voltage standing wave ratio.

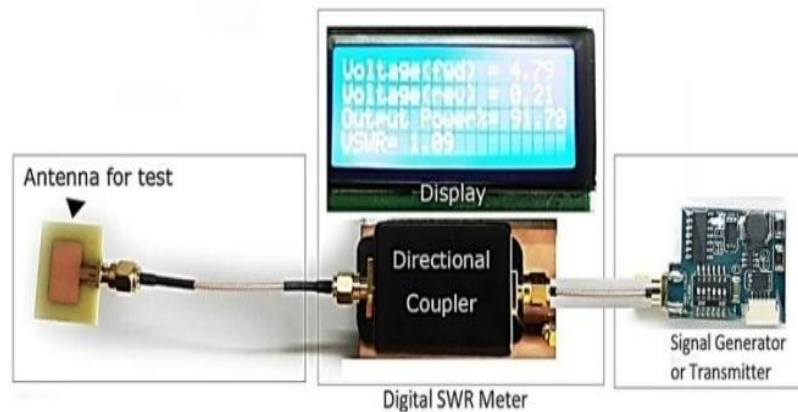


Fig.6 The 5.8 GHz SWR meter for Testing

D. Programming and its algorithm

Programming for Arduino boards is programmed according to the C/C ++ language. Thus, the programming for controlling Arduino is done by C programming language and its libraries. The flow chart of program for the digital 15.8 GHz SWR meter.

IV. EXPERIMENTAL RESULTS

The testing result of the developed SWR meter has 50 Ohms at the operating frequency of 6 GHz. The developed SWR meter has measured by network analyzer and developed SWR meter both having the load of 50Ω. The frequency range of 6 GHz with the tolerance of cannot more than ±5% in the voltage standing wave ratio. Thus are due to the effect of losses line, assembly and connection of the circuit. Telecommunication education engineering can be used in instrumental media communication. It can encourage learners to improve the skills and knowledge.

V. CONCLUSION

In this the development of a SWR meter has been measured by the standard wave in microwave frequency. SWR meter measurement can be used for innovative learning for telecommunication engineering. The development of signal range is 6 GHz in SWR meter and the digital developed SWR meter using Arduino microcontroller unit. The results tested are accurate and efficient while comparing to standard result.

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