

UNIVERSITI TEKNOLOGI MARA

**MINIATURIZATION OF PRINTED
MONOPOLE ANTENNA USING
DOUBLE E-SHAPED MEANDER
LINE FOR ULTRA HIGH
FREQUENCY APPLICATIONS**

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ABSTRACT

This study proposed an effective method to miniaturize the printed monopole antenna using a double E-shaped meander line structure that were combination of several slots and a meander line. The proposed antenna was also incorporated with defected ground structure (DGS) at the bottom layer. The proposed design is intended to overcome the limitation of the wire monopole antenna, where the size of the wire monopole is quite bulky besides it is unable to be integrated into modern portable device. Flame retardant type 4 (FR-4) with dielectric constant, ϵ_r of 4.3 and thickness, h of 1.6 mm was used as a base substrate. The design was simulated using electromagnetic simulation package software to analyze the antenna reflection coefficient, voltage standing wave ratio (VSWR), input impedance, bandwidth, antenna gain and surface current distribution. The design started from a typical square printed monopole as a reference antenna with overall size of $83.80 \times 143.74 \text{ mm}^2$ covering 878 MHz for forward scatter radar (FSR) network. Parametric analysis has been carried out comprehensively to provide desired antenna performances at targeted frequency band. The miniaturization was achieved due to the fact that the slot and meander line increased the current distribution along the radiating area, in which, the effective capacitance and inductance of the radiator was increased as well. Hence, this led to the reduction in resonant frequency that allows miniaturization of antenna to obtain the targeted frequency. The new structure of the double E-shaped meander line patch reducing the overall size of the design to $46.80 \times 74.00 \text{ mm}^2$ corresponding to $0.137\lambda_0 \times 0.217\lambda_0$ where λ_0 is a wavelength at 878 MHz. The results revealed that the proposed structure reducing the overall size of the antenna up to 71.2 % compared to the reference antenna. Spectrum Analyzer with built-in Vector Network Analyzer function was used to measure the reflection coefficient and voltage standing wave ratio (VSWR) of the fabricated antenna while antenna radiation pattern was measured in anechoic chamber. Comparison between measurement and simulation results showed that both results matched with omnidirectional radiation pattern of simulated and measured gain of 0.948 dBi and -1.18 dBi, respectively. The performances of the proposed antenna have been compared to other antennas in literature where it is found that the proposed antenna achieve smaller physical size with sufficient antenna gain and efficiency. Design equations for the proposed antenna also developed based on the radiating patch configuration. For a proof of concept, the design equations has been applied to develop miniature printed monopole antenna operating at 155 MHz for Very High Frequency (VHF) applications. An equivalent circuit has been modeled for both UHF and VHF antennas using Advanced Design System (ADS) simulator for electrical theory explanation where both responses from ADS and CST having similar response. Throughout this study, there are four contributions towards the knowledge which are; the innovative design structure of the double E-shaped meander line printed monopole antenna with DGS, miniature and compact printed monopole antenna, design equations, and equivalent circuit model of the miniature antenna.

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