

A SUB-12 GHZ UWB-TO-NARROWBAND RECONFIGURABLE ANTENNA USING VARACTOR DIODES SCALABLE FOR 6G IRS METASURFACES



Author(s): Chai Han Ming¹, Shaharil Mohd Shah², Huda A Majid³, Zuhairiah Zainal Abidin⁴, Saizalmursidi Md Mustam⁵, Nor Surayahani Suriani⁶, Munirah Az Zahra Abdul Rashid⁷

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Abstract:

This work presents a UWB-to-narrowband reconfigurable microstrip patch antenna using varactor diodes, developed as a tunable unit cell architecture intended for intelligent reflecting surfaces (IRS) in future 6G communication systems. While evaluated at sub-12 GHz frequencies for prototype verification, the proposed design methodology is inherently scalable to millimetre-wave bands. The proposed antenna initially exhibits an ultra-wideband (UWB) response from 3.22 GHz to 11.26 GHz, covering an 8.04 GHz bandwidth. By integrating two SMV1405-040LF varactor diodes, the antenna's operational mode is dynamically reconfigured to a narrower band from 5.11 GHz to 5.83 GHz (0.72 GHz bandwidth), targeting WLAN frequencies. The design inherits its geometry from a slotted UWB configuration to ensure structural stability and enable direct performance comparisons across tuning implementations. A reference configuration using copper bridges replaces the varactor diodes to emulate ideal switching conditions, thereby

¹ Graduate Researcher, Department of Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia, +60-7-4537000, Email: isaginji@gmail.com

² Associate Professor, Department of Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia, +60-7-4537000, Email: shaharil@uthm.edu.my

³ Associate Professor, Department of Electrical Engineering Technology, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia, +60-7-4537000, Email: mhuda@uthm.edu.my

⁴ Associate Professor, Department of Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia, +60-7-4537000, Email: zuhairia@uthm.edu.my

⁵ Senior Lecturer, Department of Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia, +60-7-4537000, Email: saizal@uthm.edu.my

⁶ Associate Professor, Department of Electronic Engineering, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Johor, Malaysia, +60-7-4537000, Email: nsuraya@uthm.edu.my

⁷ Application Engineer, R&D Applications, Avery Dennison Smartrac, 09000 Kulim, Kedah, Malaysia, +60-4-4019100, Email: azzahramunirah@gmail.com

isolating the effects of active tuning. Results confirm that bandwidth reconfigurability is achieved with minimal impact on gain and efficiency. The antenna demonstrates effective radiation control and tuning behavior, confirming its suitability for frequency-agile IRS metasurfaces. This approach offers a practical pathway for signal propagation optimization in 6G wireless networks operating in the Ka-band.

Keywords: UWB-to-Narrowband, Reconfigurable antenna, Varactor diodes, 6G IRS applications, Ka-band

For full paper, contact:

Prof Muhammad Imran Aslam

Editor-in-Chief, NED University Journal of Research

Ph: +92 (21) 99261261-8 Ext:2670; Fax: +92 (21) 99261255

Email: NED-Journal@neduet.edu.pk

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