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Dual-band Reconfigurable RF Transmitter for 5G/6G communications

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I. Introduction

Meeting the requirements of both the commercialized 5G and the forthcoming 6G mobile communications necessitates transmitters that satisfy both the sub-6GHz and mid-band mmWave bands [1], [2]. Particularly during transmission, the gain control function is crucial for reducing the side lobes of the phased array antenna system or suppressing its operation as a blocker in other bands. This paper proposes a reconfigurable transmitter that satisfies these conditions by integrating a variable gain amplifier(VGA), a switch, and a two-stage power amplifier(PA).

II. Circuit Design

Fig. 1 illustrates the block diagram of the proposed transmitter. This circuit is designed to target the 3.6 GHz and 7.7 GHz bands. The VGA is designed with a wide bandwidth to cover both target bands effectively. Both the input and output of the VGA are optimized using a three-stage matching network. Additionally, the bias network is designed with a dual-band approach to operate exclusively in these two bands.

To implement reconfigurable operation, an SPDT switch is connected following the VGA. The bias operation of the switch ensures that it connects to the power amplifier optimized for either the 3.6 GHz or 7.7 GHz band. Each path is matched to its respective frequency band.

Lastly, the two-stage power amplifier is designed to achieve high gain in the first driver stage and high output power in the second main stage. This is accomplished through careful gain and power matching specific to each stage. The resulting configuration ensures that the transmitter performs efficiently across both targeted frequency bands.

III. Conclusion

The proposed circuit has demonstrated a gain of over 43.5 dB in the 3.55 – 3.70 GHz frequency range and a gain of more than 15 dB in the 7.1 – 8.4 GHz range. The gain control range obtained through the VGA operation was 8 dB for the lower band and 17 dB for the higher band. Furthermore, the PA drain efficiency reached a maximum of 68.8% at 3.6 GHz and 35% at 7.7 GHz. These results confirm that the proposed circuit operates effectively as a transmitter suitable for both 5G and 6G applications.

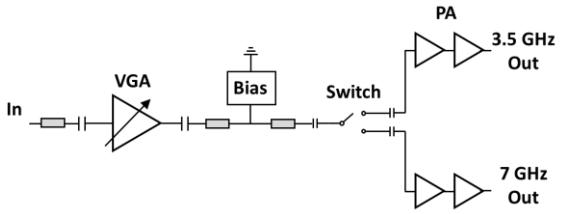

Fig. 1. Block diagram of the proposed dual-band reconfigurable transmitter.

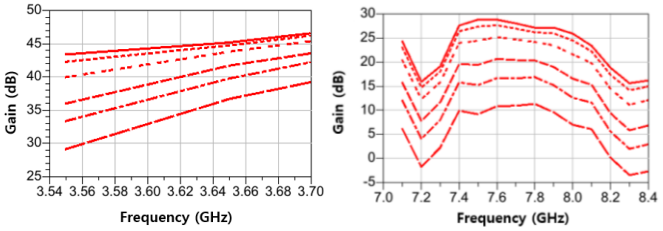

Fig. 2. 3.6 GHz and 7.7 GHz band small signal gain response.

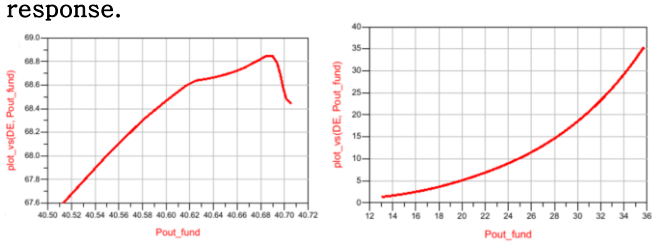

Fig. 3. 3.6 GHz and 7.7 GHz band drain efficiency.

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