

# A V-band ×4 Amplifier-Frequency-Multiplier Chain

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#### Introduction

A high-frequency band offers a wide range of applications including communications, radar, and imaging system thanks to its wide bandwidth capabilities. To construct the high-frequency system, it is essential to develop a signal source with excellent phase noise performance. This is typically achieved by frequency multiplication of a stable low-frequency source [1]. In this work, a amplifier-frequency-multiplier chain (AMC) with 3-dB bandwidth of 14 GHz is designed based on 28-nm CMOS technology.

#### **1. Circuit Design**

- Fig. 1. illustrates the schematics of proposed AMC.
- In Fig. 1, the AMC consists of two-stage frequency doubler, with one-stage drive amplifier placed before each doubler stage.
- Each amplifier consists of 1-stage common-source amplifier followed by push-push frequency doubler.
- By employing a differential topology that facilitates the virtual ground, the circuit can be made less sensitive to the ground route.



#### Fig. 1. Schematics of the AMC.



- Cross-coupled capacitors  $(C_{1-4})$  are utilized to enhance the stability factor (k) and maximum available gain (MAG) of each drive amplifier stage.
- Conjugate impedance matching was implemented with transformers to minimize the area and simplify the biasing network.
- Fig. 2 shows the chip photo of the AMC.

## 2. Simulation Result

- Fig. 3 shows the output power over output frequency when input signal power is 0 dBm.
- In Fig. 3, the peak output power is 0.5 dBm at 50 GHz.
  The 3-dB bandwidth is 14 GHz, ranging from 43 GHz to 57 GHz.
- The chip size is 1254  $\times$  588  $\mu m^2$  including pads.

1254 μm

Fig. 2. Chip photo of the AMC.



Fig. 3. Output power over output frequency.

#### Conclusion

In this work, A amplifier-frequency-multiplier chain has been designed based on Samsung 28-nm CMOS technology. It has peak output power of 0.5 dBm with 14-GHz 3-dB bandwidth. With a higher frequency frequency multiplier, the designed AMC can be applied to terahertz systems, including wireless communication, radar and imaging systems.

#### Acknowledgement

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### Reference

[1] G. Lim, J. Yoo, H. Son, D. Kim, and J.-S. Rieh, "A WR3.4 x12 Frequency Multiplier Chain Based on InP HBT Technology," in IEEE Asia-Pacific Microwave Conference (APMC), 2021, doi: 10.1109/apmc52720.2021.9661595.

