Tranceiver Mixer MMICs Employing Cascode Circuit Structure for Personal Area Network (PAN) Applications

Young Yun, Young-Bae Park, Jang-Hyeon Jeong, Bo-Ra Jung, Jeong-Gab Ju, and Suk-Youb Kang

***Abstract*—MMIC (monolithic microwave integrated circuit) chip set was developed for application to wireless PAN. Concretely, cascade type transceiver mixers employing GaAs p-HEMT were fabricated on GaAs substrate. The mixer MMICs showed good RF performances. Concretely, the conversion gain of the receiver mixer was 9.6 dB at a LO input of 8 dBm, and 9.6 ± 1.6 dB at a RF frequency range of 62.5 - 63.5 GHz. The chip size of the receiver mixer was 2.7 mm x 1.35 mm. The conversion gain of the transmitter mixer was 6.5 dB at a LO input of 8.5 dBm, and 6.5 ± 0.25 dB at a IF frequency range of 1.9 - 2.9 GHz. The chip size of the transmitter mixer was 2.7 mm x 1.35 mm. 0.2 µm**

***Index Terms*—MMIC (monolithic microwave integrated circuit), mixer, PAN (personal area network).**

I. Introduction

60 GHz is ideally suited for personal area network (PAN) applications [1-5]. A 60-GHz link can be used to replace various cables used today in the office or home, including gigabit Ethernet (1000Mbps), USB 2.0 (480Mbps), or IEEE 1394 (~800Mbps). Currently, the data rates of these connections have precluded wireless links, since they require so much bandwidth. While other standards are evolving to address this market (802.11n and UWB), 60-GHz is another viable candidate[6-10].. The intended range of wireless PANs is ten meters or less, which covers the size of most offices, medium-size conference rooms, and rooms in the home.

Wireless PANs can interconnect various electronic devices, including laptops, cameras, PDAs, and monitors. Applications include wireless display, wireless docking station, and wireless streaming of data from one device to the other[11]-[18].

In this work, we developed MMIC (monolithic microwave integrated circuit) chip set for application to wireless PAN. Concretely, transceiver mixers employing GaAs p-HEMT were fabricated on GaAs substrate.

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II. Circuit Design

Fig. 1 shows RF block of conventional wireless communication system. In this work, we fabricated receiver and transmitter mixers. Figure 2 (a), (b) and (c) show the schematic diagram, schematic circuit and layout of the receiver mixer. The chip size is 2.2 mm x 1.3 mm. 0.2 µm GaAs p-HEMT was used for circuit design, and cascade mixer type [19] was employed for a high isolation between RF and LO input. LO and RF signals are applied to the gates of two FETs of first stage mixer, and IF signal is extracted from the drain of the upper FET. To increase the conversion gain, IF amplifiers were connected to the next stage of the mixer. Open stubs were used for 60 GHz impedance matching of the input stage.

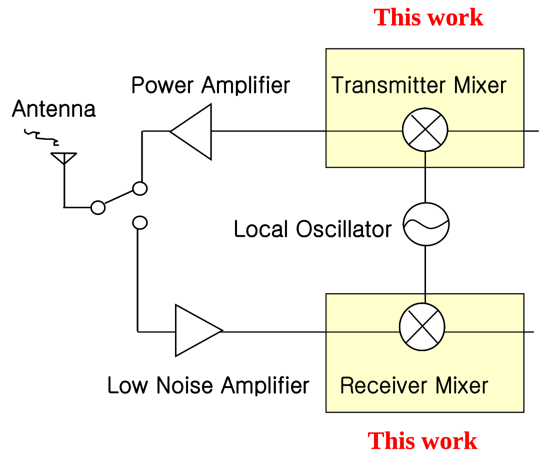
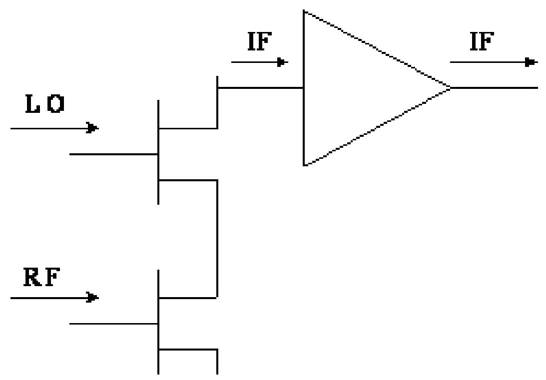
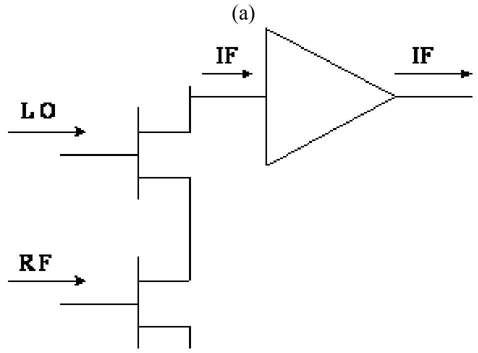


Fig. 1. RF block of wireless communication system.



(a)



(b)

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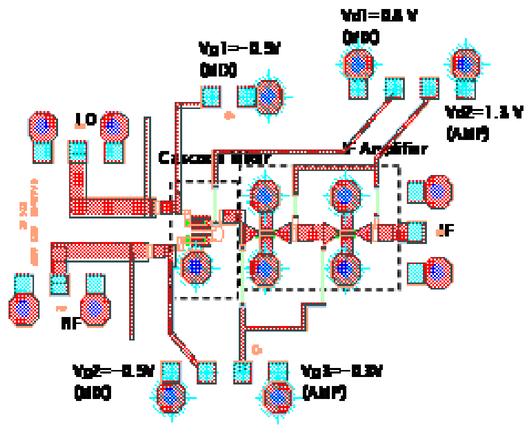
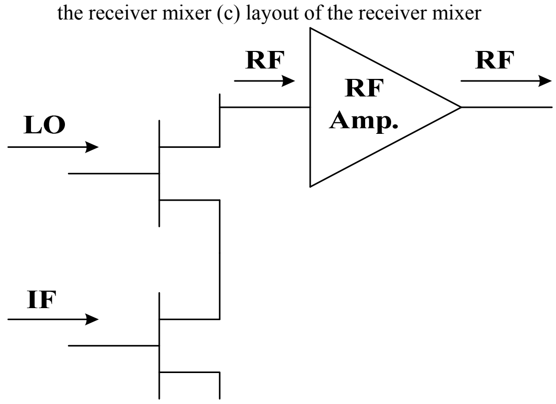
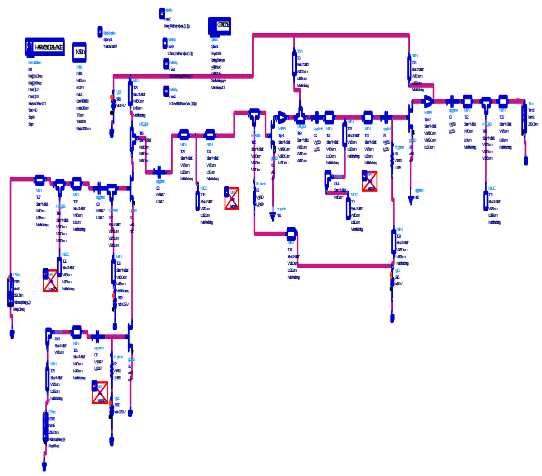


(c)

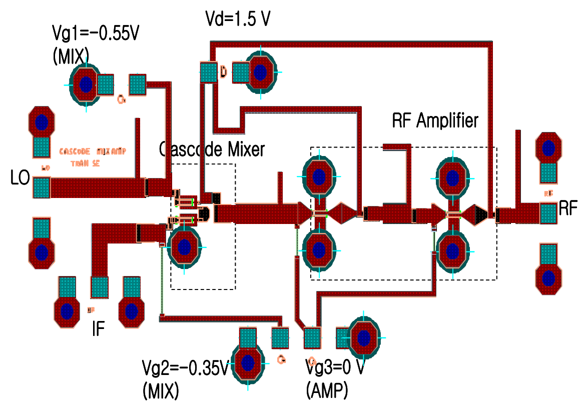
Fig. 2 (a). Schematic diagram of the receiver mixer (b) schematic diagram of the receiver mixer (c) layout of the receiver mixer



(a)



(b)



(c)

Fig. 3 (a). Schematic diagram of the transmitter mixer (b) schematic diagram of the transmitter mixer (c) layout of the transmitter mixer

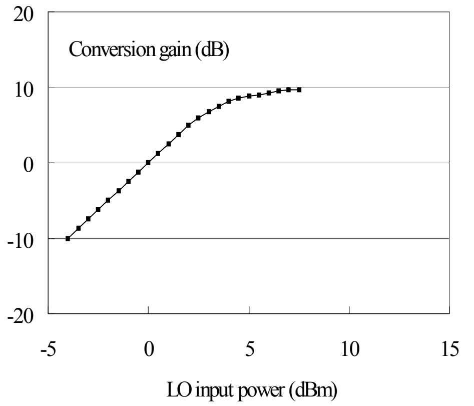


Fig. 4. Conversion gain characteristic of receiver mixer

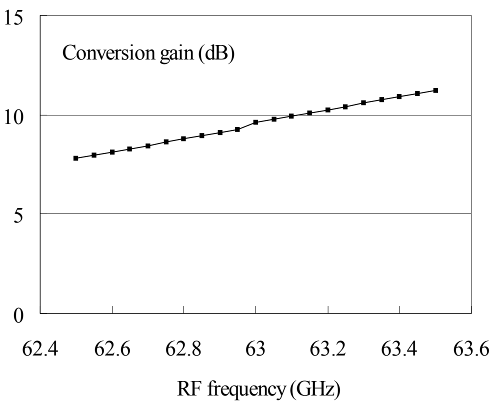


Fig. 5. Dependency of conversion gain on RF frequency

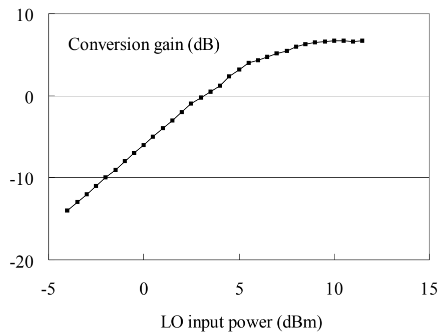


Fig. 6. Conversion gain characteristic of transmitter mixer

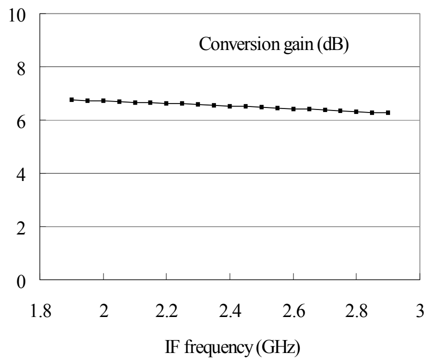


Fig. 7. Dependency of conversion gain on IF frequency

Fig. 3 (a), (b) and (c) show the schematic diagram, schematic circuit and layout of the transmitter mixer. The chip size is 2.7 mm x 1.35 mm. 0.2 μm GaAs p-HEMT was used for circuit design, and cascode mixer type [19] was employed for a high isolation between RF and LO input. LO and IF signals are applied to the gates of two FETs of first stage mixer, and RF signal is extracted from the drain of the upper FET. RF amplifiers were connected to the next stage of the mixer.

III. Measured Results

The performance of cascade mixers using 0.2-μm p HEMT technology was investigated. Fig. 4 shows conversion gain characteristic of receiver mixer. The RF and LO frequency are 63 and 60.6 GHz, and IF frequency is 2.4 GHz. As shown in this figure, the conversion gain is 9.6 dB at a LO input of 8 dBm. Fig. 5 shows dependency of conversion gain RF frequency. As shown in this figure, the conversion gain is 9.6 ± 1.6 dB at a RF frequency range of 62.5 - 63.5 GHz.

Fig. 6 shows measured conversion gain characteristic of transmitter mixer. The IF and LO frequency are 2.4 and 60.6 GHz, and RF frequency is 63 GHz. As shown in this figure, the conversion gain is 6.5 dB at a LO input of 8.5 dBm. Fig. 7 shows dependency of conversion gain IF frequency. As shown in this figure, the conversion gain is 6.5 ± 0.25 dB at a IF frequency range of 1.9 - 2.9 GHz.

IV. Conclusion

In this work, we developed MMIC (monolithic microwave integrated circuit) chip set for application to wireless PAN. Concretely, cascade type transceiver mixers employing GaAs p-HEMT were fabricated on GaAs substrate. The mixer MMICs showed good RF performances. Concretely, the conversion gain of the receiver mixer was 9.6 dB at a LO input of 8 dBm, and 9.6 ± 1.6 dB at a RF frequency range of 62.5 - 63.5 GHz. The chip size of the receiver mixer was 2.7 mm x 1.35 mm. The conversion gain of the transmitter mixer was 6.5 dB at a LO input of 8.5 dBm, and 6.5 ± 0.25 dB at a IF frequency range of 1.9 - 2.9 GHz. The chip size of the transmitter mixer was 2.7 mm x 1.35 mm. 0.2 μm.

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