

應用於毫米波接收機之寬中頻 CMOS 混頻器研究

研究生：蘇昭維

指導教授：周復芳 博士

國立交通大學電信工程學系碩士班

摘要

本論文的目標在於設計適用於毫米波接收機的混頻器元件，其中 RF 模組所使用的混頻器是用來將 78.3-113.1GHz 的訊號降頻到 DC-34.8GHz；而 IF 模組中另外三個混頻器的功能，則是分別將 8.7-17.4、17.4-26.1、26.1-34.8GHz 的訊號降頻到 DC-8.7GHz。所有混頻器其 RF、LO、IF 端的輸入反射係數均低於-10dB，並且擁有至少 5dB 正的轉換增益，各埠間隔絕度在 30dB 以上，而線性度(IIP3)則至少大於 0dBm。除此之外，電路中使用來產生相差 180 度平衡訊號的重要元件—莫氏巴倫，也需要小心的設計。經過我們多方的努力，一個訊號振幅誤差小於 0.2dB，並且相位誤差小於 2 度的莫氏巴倫將會被提出。

在本論文中我們將首先設計 IF 模組所使用的三個混頻器；並且對最高頻段 26.1-34.8GHz 的混頻器，我們提出了它次諧波混頻的兩個改良版本，目的是為了降低所需之 LO 頻率與功率，以減少 LO 模組設計者的負擔。並且我們打算利用轉換矩陣理論來對我們所使用之寬中頻混頻結構的原理提出解釋。最後，我們將運用前面設計電路所得到的經驗來完成用於 RF 模組之 W 波段混頻器。

Design of Wide-IF-Band CMOS Mixers for Millimeter Wave Receiver Application

Student: Jau-Wei Su

Advisor: Christina F. Jou

Department of Communication Engineering
National Chiao Tung University

Abstract

This thesis aims to design the mixing components used in a millimeter-wave receiver, where the mixer of the RF module will down-convert the 78.3-113.1GHz signal to DC-34.8GHz while the three mixers used in the IF module transform the 8.7-17.4, 17.4-26.1 and 26.1-34.8GHz signals to their DC-8.7GHz counterparts, respectively. All these mixers have their RF, IF, and LO input return loss below -10dB; conversion gain larger than 5dB; port-to-port isolation more than 30dB; and the linearity (IIP3) expected to be better than 0dBm. Besides, performance of the critical elements, such as Marchand balun for producing balanced signals, has each been optimized. In our design, the balun has less than 0.2dB magnitude error and 2-degree phase error which outperforms any existing one, and will be presented in detail.

In this thesis, the three IF mixers have all been design and measure. As for the 26.1-34.8GHz frequency range, two types of sub-harmonic mixers have been proposed for allowing lower LO frequency (and power), thus, alleviate the difficulty in the design of LO module. Furthermore, we intend to explore the theoretical aspect of the wide-IF-band mixer using conversion matrix. Finally, with the experience from the IF mixers, we will start working on the design of the W-band mixer.

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CONTENTS

Chinese Abstract	I
English Abstract	II
Acknowledgement	III
Contents	IV
List of Tables	VI
List of Figures	VII
Chapter 1 Introduction.....	-1-
1.1 Background and motivation.....	-1-
1.2 Thesis organization.....	-3-
Chapter 2 Wide-IF-Band CMOS Mixers for Millimeter-Wave Applications.....	-4-
2.1 Introduction.....	-4-
2.2 Wide-IF-band mixer design.....	-6-
A. LO balun.....	-6-
B. Input RF circuit.....	-10-
C. Mixer core.....	-11-
D. Output IF circuit.....	-12-
2.3 Simulated and measured results.....	-14-
2.4 Wide-IF-band mixers at higher band.....	-22-
2.5 Simulated results of the 17.4-26.1GHz mixer.....	-23-
2.6 Simulated and measured results of the 26.1-34.8GHz mixer.....	-27-

2.7 Wide-IF-band sub-harmonic mixer design.....	-32-
A. Mixer circuit design.....	-32-
B. Simulated results of the double-balanced sub-harmonic mixer.....	-32-
C. Simulated results of the single-balanced sub-harmonic mixer.....	-35-
2.8 Reference.....	-37-

Chapter 3 Discussion on Inconsistency between Measurement and

Simulation..... -40-

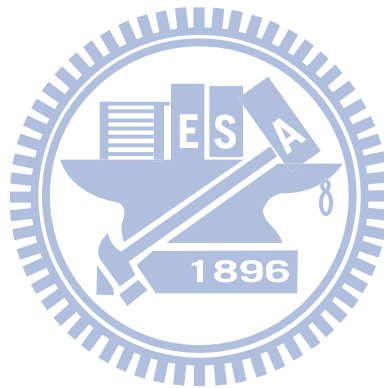
3.1 Introduction.....	-40-
3.2 The 9.7-17.4GHz mixer.....	-40-
A. The inductor series with LC-tank.....	-43-
B. Mixer core bias.....	-46-
C. Ground plane.....	-47-
3.3 The 26.1-34.8GHz mixer.....	-51-
A. Ground plane and EM-simulation setup.....	-53-
3.4 Conclusion.....	-57-

Chapter 4 Conclusion and Future Work..... -58-

3.1 Conclusion.....	-58-
3.2 Future work.....	-58-
A. Theory analysis.....	-58-
B. W-band wide-IF-band mixer design.....	-59-
C. Reference.....	-60-

LIST of TABLE

Table 2-1	Comparison of the 8.7-17.4GHz Mixer's simulated and measured results.....	-21-
Table 2-2	Simulated results of the 26.1-34.8GHz Mixer.....	-26-
Table 2-3	Comparison of the 26.1-34.8GHz Mixer's simulated and measured results.....	-31-
Table 2-4	Simulated results of the double-balanced sub-harmonic Mixer.....	-34-
Table 2-5	Simulated results of the single-balanced sub-harmonic Mixer.....	-37-



LIST of FIGURE

Fig. 1-1	Schematic of the wideband millimeter wave receiver.....	-2-
Fig. 2-1	Schematic of the wide-band receiver.....	-5-
Fig. 2-2	Schematic of the wide-IF-band mixer used in 8.7-17.4GHz.....	-6-
Fig. 2-3	Proposed broadside-coupled Marchand balun.....	-8-
Fig. 2-4	Simulated output magnitude and phase errors of the balun.....	-8-
Fig. 2-5	Simulated input reflection coefficient of the balun.....	-9-
Fig. 2-6	Schematic of the input RF circuit.....	-11-
Fig. 2-7	Schematic of the mixer core.....	-12-
Fig. 2-8	Schematic of the output IF circuit.....	-13-
Fig. 2-9	CMRR of the output IF circuit.....	-13-
Fig. 2-10	(a) Layout (b) Chip photograph of the Wide-IF-band 8.7-17.4GHz mixer.....	-14-
Fig. 2-11	Arrangement of DC and RF probes.....	-15-
Fig. 2-12	The measured arrangement of S-parameter.....	-16-
Fig. 2-13	The measured arrangement of conversion gain.....	-17-
Fig. 2-14	The measured arrangement of IIP3.....	-17-
Fig. 2-15	RF port return loss where the RF signal is 8.7-17.4GHz.....	-18-
Fig. 2-16	LO port input return loss where the LO is fixed at 17.4GHz.....	-18-
Fig. 2-17	IF port return loss for IF equals to DC-8.7GHz.....	-19-
Fig. 2-18	Conversion gain versus RF frequency with LO fixed at 17.4GHz.....	-19-
Fig. 2-19	P1dB of the 8.7-17.4GHz mixer.....	-20-
Fig. 2-20	Total schematic of the wide-IF-band mixer at higher band.....	-22-
Fig. 2-21	Layout of the Wide-IF-band 17.4-26.1GHz mixer.....	-23-

Fig. 2-22	RF port return loss where the RF signal is 17.4-26.1GHz.....	-24-
Fig. 2-23	LO port input return loss where the LO is fixed at 26.1GHz.....	-24-
Fig. 2-24	IF port return loss for IF equals to DC-8.7GHz.....	-25-
Fig. 2-25	Conversion gain versus RF frequency with LO fixed at 26.1GHz.....	-25-
Fig. 2-26	(a) Layout (b) Chip photograph of the Wide-IF-band 26.1-34.8GHz mixer.....	-28-
Fig. 2-27	RF port return loss where the RF signal is 26.1-34.8GHz.....	-29-
Fig. 2-28	LO port input return loss where the LO is fixed at 34.8GHz.....	-29-
Fig. 2-29	IF port return loss for IF equals to DC-8.7GHz.....	-30-
Fig. 2-30	Conversion gain versus RF frequency with LO fixed at 34.8GHz.....	-30-
Fig. 2-31	Layout of the Wide-IF-band double-balanced sub-harmonic mixer...	-33-
Fig. 2-32	RF, IF and LO port return loss.....	-33-
Fig. 2-33	Conversion gain versus RF frequency with LO fixed at 17.4GHz.....	-34-
Fig. 2-34	Layout of the Wide-IF-band single-balanced sub-harmonic mixer....	-35-
Fig. 2-35	RF, IF and LO port return loss.....	-36-
Fig. 2-36	Conversion gain versus RF frequency with LO fixed at 17.4GHz.....	-36-
Fig. 3-1	RF port return loss where the RF signal is 8.7-17.4GHz.....	-41-
Fig. 3-2	LO port return loss where the LO signal is fixed at 17.4GHz.....	-41-
Fig. 3-3	IF port return loss where the IF signal is DC-8.7GHz.....	-42-
Fig. 3-4	Conversion gain versus RF frequency with LO fixed at 17.4GHz.....	-42-
Fig. 3-5	Schematic of the inductor series with LC-tank.....	-43-
Fig. 3-6	Schematic of the test structure.....	-44-
Fig. 3-7	Gain of the test structure within the series inductor in the LC-tank...	-45-
Fig. 3-8	Conversion gain versus RF frequency under VLO equals to 0.6, 0.8, and 1.0V respectively.....	-46-

Fig. 3-9	EM-simulated ground plane, balun, and LC-tanks.....	-48-
Fig. 3-10	Balanced performance of Marchand balun within and without ground plane. (a) RF balun. (b) LO balun.....	-50-
Fig. 3-11	Conversion gain versus RF frequency which is measured, simulated within ground plane, and simulated without ground plane.....	-50-
Fig. 3-12	RF port return loss where the RF signal is 26.1-34.8GHz.....	-51-
Fig. 3-13	LO port return loss where the LO is fixed at 34.8GHz.....	-51-
Fig. 3-14	IF port return loss where the IF signal is DC-8.7GHz.....	-52-
Fig. 3-15	Conversion gain versus RF frequency with LO fixed at 34.8GHz.....	-52-
Fig. 3-16	RF port return loss which is measured, simulated with new EM-simulation setup, and simulated with original setup.....	-53-
Fig. 3-17	EM-simulated ground plane.....	-54-
Fig. 3-18	Conversion gain versus RF frequency which is measured, simulated within ground plane, and simulated without ground plane.....	-55-
Fig. 3-19	Balanced performance of Marchand balun within and without ground plane.....	-55-
Fig. 3-20	EM-simulated RF balun within ground plane.....	-56-
Fig. 3-21	Balanced performance of Marchand balun within and without ground plane.....	-56-