IDEC Chip Design Contest

Unbalanced CMOS Switch for D-band Dicke Imaging System

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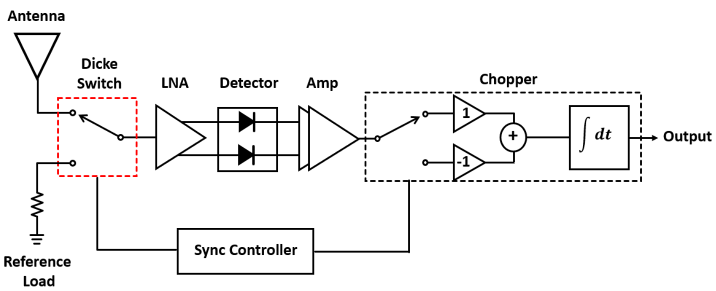
Background

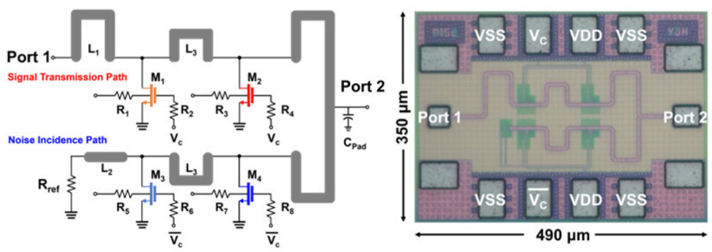
1. Performance of the millimeter-wave imaging systems greatly rely on the sensitivity of the receiver system.
2. A Dicke switch eliminates noise contained in the signal flowing from antenna, providing a high signal-to-noise ratio in the receiver front-end.
3. Previous researches are implemented with rather high-cost technologies, originating from symmetric single-pole double-throw (SPDT) topologies, which cannot overcome the trade-off relationship between insertion loss and isolation characteristics.

Methods

✓ Millimeter-wave Dicke-radiometer architecture



✓ Proposed Dicke Switch Circuit



1. Shunt transistor size design

→ Modeling the transistors with on-state resistors and off-state capacitors to determine the optimum size of transistors.

2. Priorities of the two paths

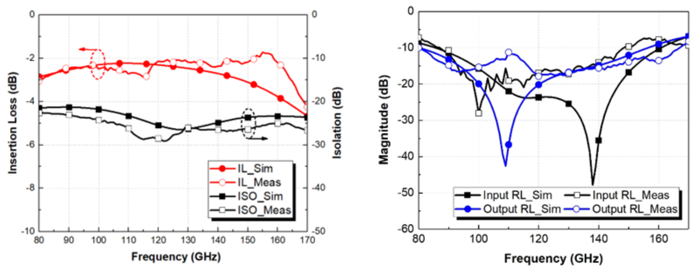
→ Unbalanced transistors give the best solution, as each path requires different traits, alleviating the trade-off relationship.

3. Impedance mismatch by asymmetric structure

→ Different lengths of transmission line are designed to achieve impedance matching for the antenna and reference load path.

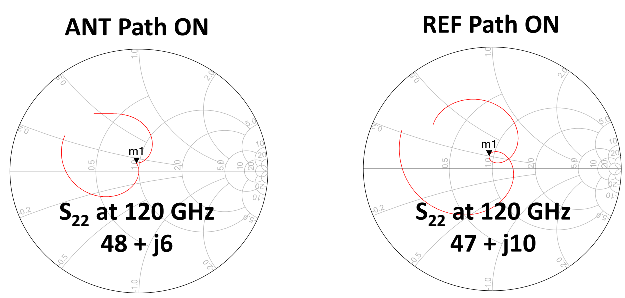
Results

✓ Measured S-parameter results



Minimum 1.7 dB Insertion loss & maximum 29 dB Isolation.

✓ Noise flow analysis for each path



Similar output reflection coefficient corresponding to the control signal. → **Noise signal successfully eliminated through the Dicke switch operation.**

	This Work	[1]	[2]
Technology	65-nm CMOS	90-nm SiGe BiCMOS	130-nm SiGe BiCMOS
Frequency (GHz)	80-150	110-170	110-170
Isolation (dB)	22-29	20	30
Insertion Loss (dB)	1.7-2.8	2.5	2.6

[1] R. Ben Yishay, et al, "D-band Dicke-radiometer in 90 nm SiGe BiCMOS technology," Proc. IEEE MTT-S International Microwave Symposium, Honolulu, HI, USA, Jun. 2017.
[2] B. Cetindogan, et al, "A D-band SPDT switch utilizing reverse-saturated SiGe HBTs for Dicke-radiometers," Proc. 11th German Microwave Conference, Freiburg, Germany, Mar. 2018.

Conclusion

Unbalanced topology proves enhanced performance suitable for millimeter-wave Dicke radiometers.

< Acknowledgement >

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