We2H – 4

A Novel Multi-Functional Coupled Resonator Based Balun Filter in Waveguide Technology

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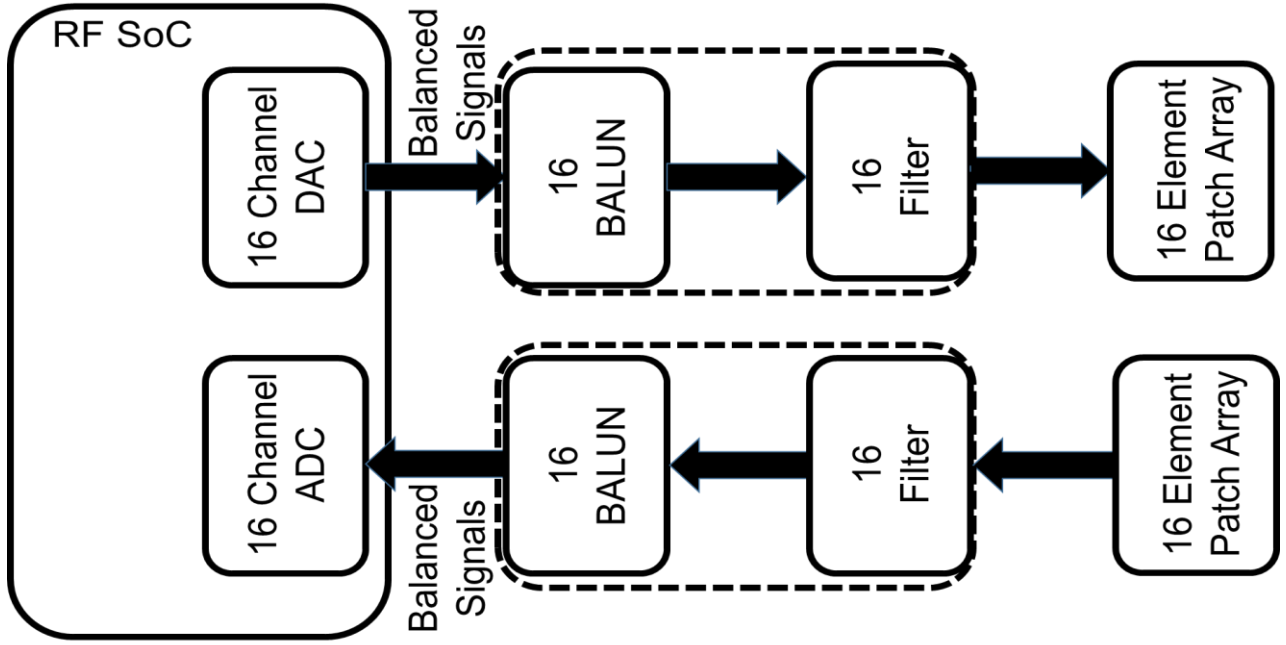
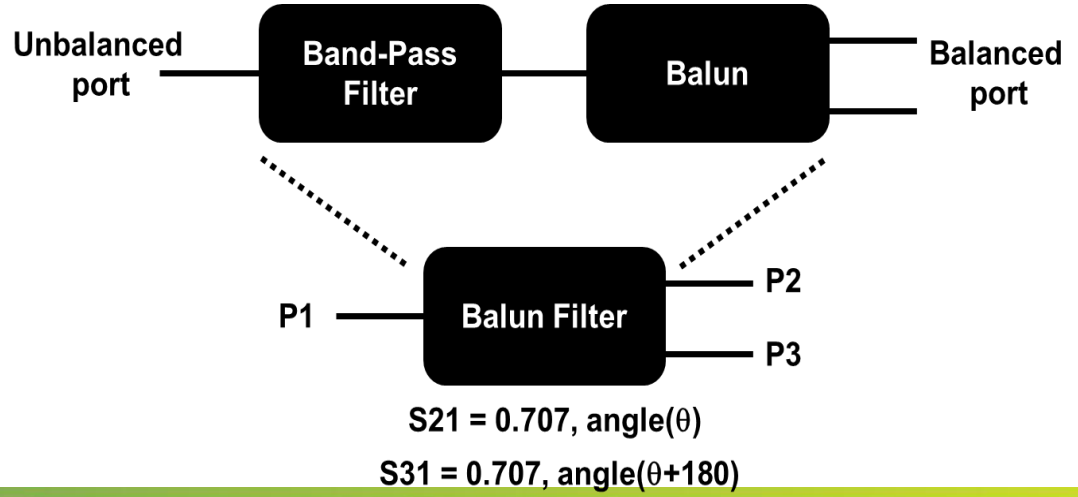
Contents

- Motivation / Application
- Concept and Design Methodology
- Balun Filters
  - Microstrip Technology
  - Coaxial Technology
  - Waveguide Technology
- Comparison
- Conclusion

Motivation / Application

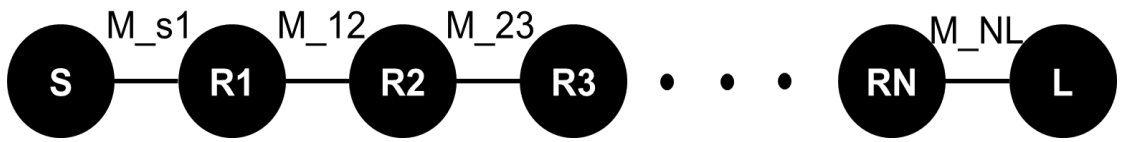
- RF SoC : ZCU216 (Xilinx)
- 5G and MIMO Transceiver
- Balun + BPF = Balun Filter
  - Functional integration
  - Eliminates cascaded mismatch loss
  - Eliminates additional insertion loss
  - All port impedances are 50 Ω
    - No need of impedance-matching circuit

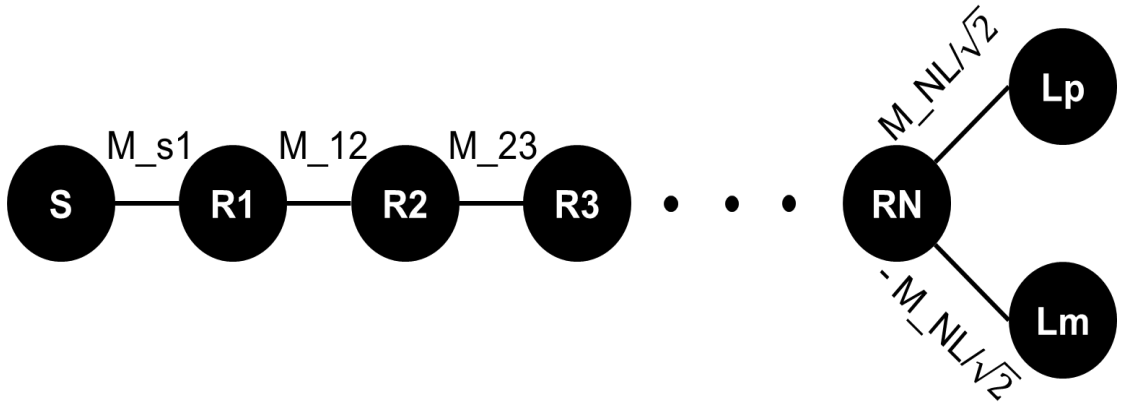


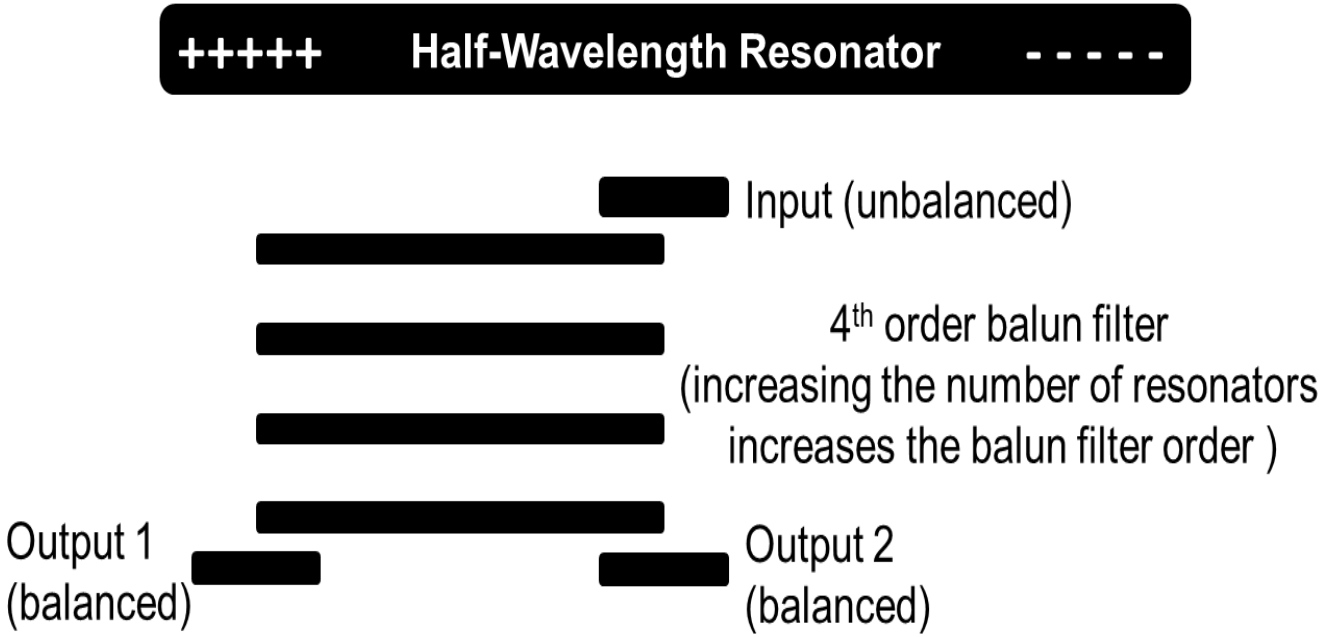


Concept

- Half-wavelength resonator : inherently balanced structure
- Unbalanced port : single feed
- Balanced port : symmetric dual feed



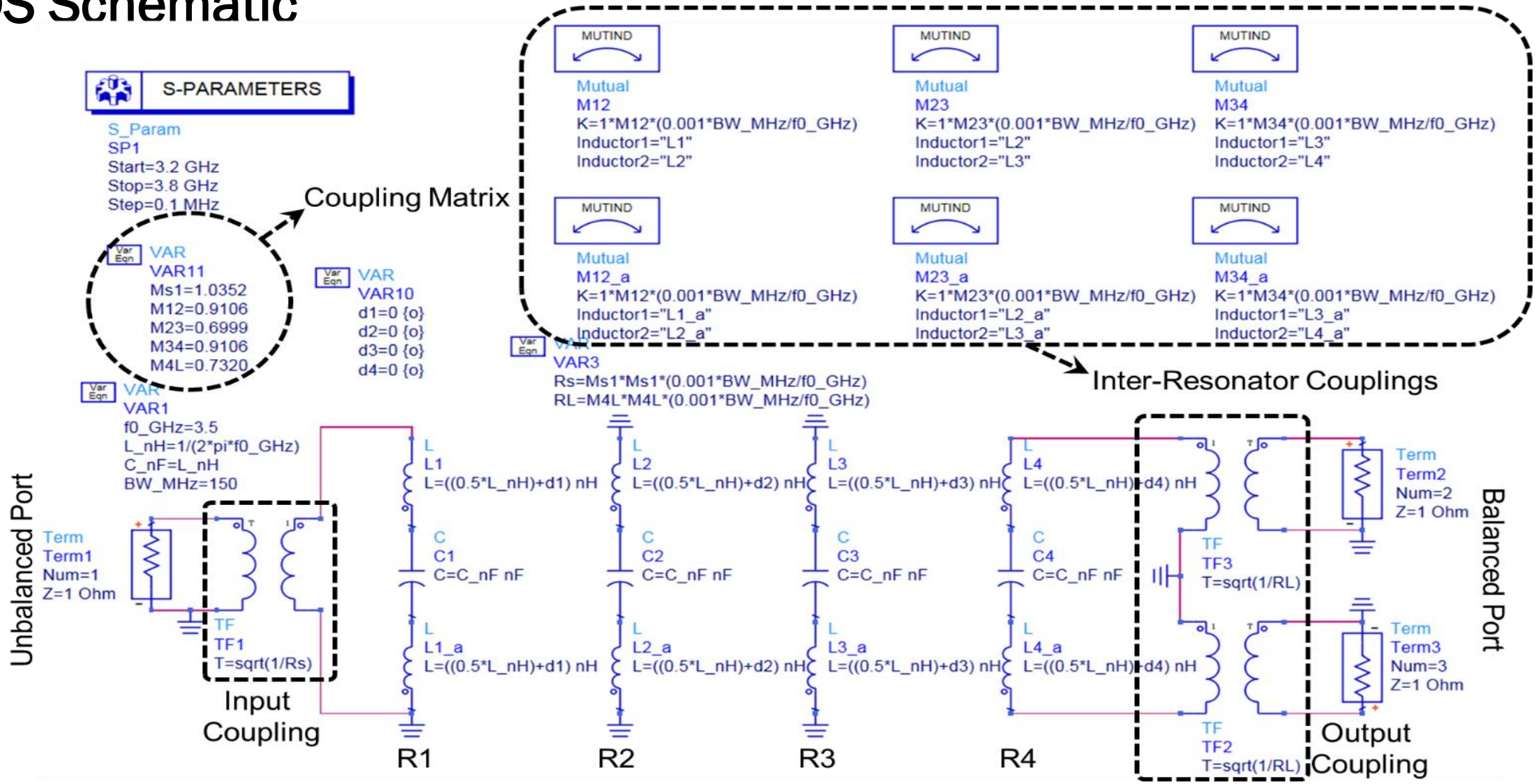




- Coupling matrix based design
- Systematic design methodology
- Any of the BPF synthesis techniques

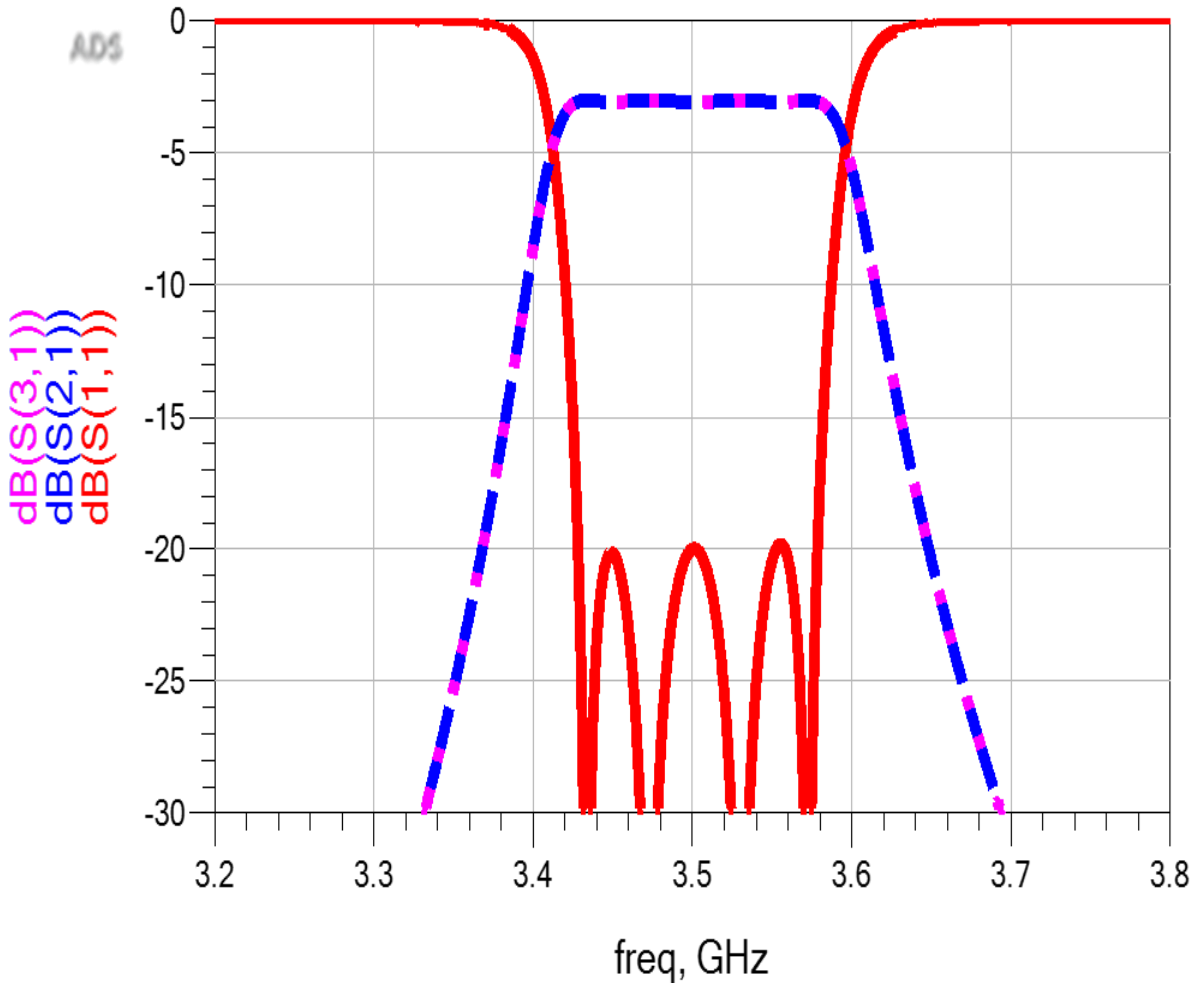
Concept

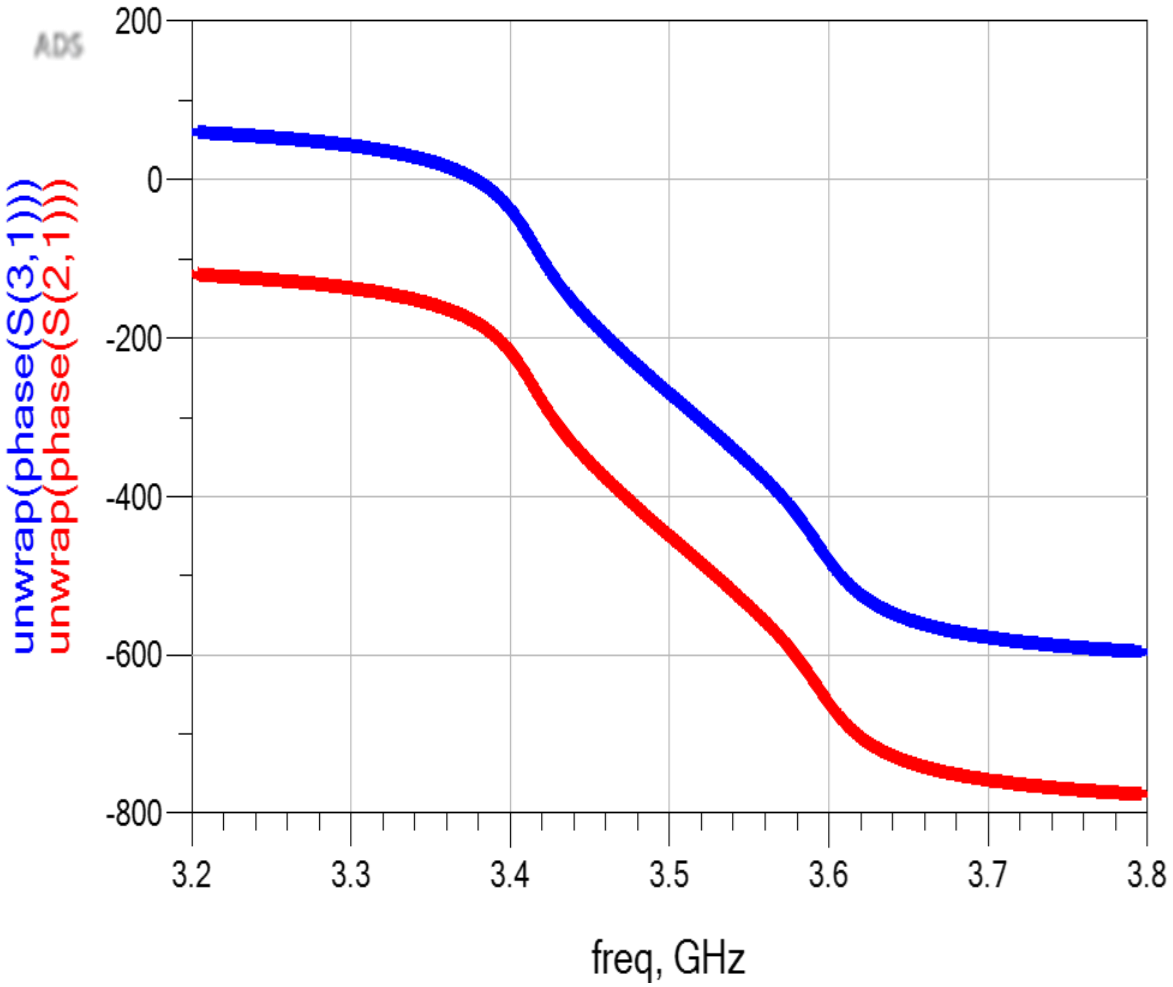
- ADS Schematic



Concept

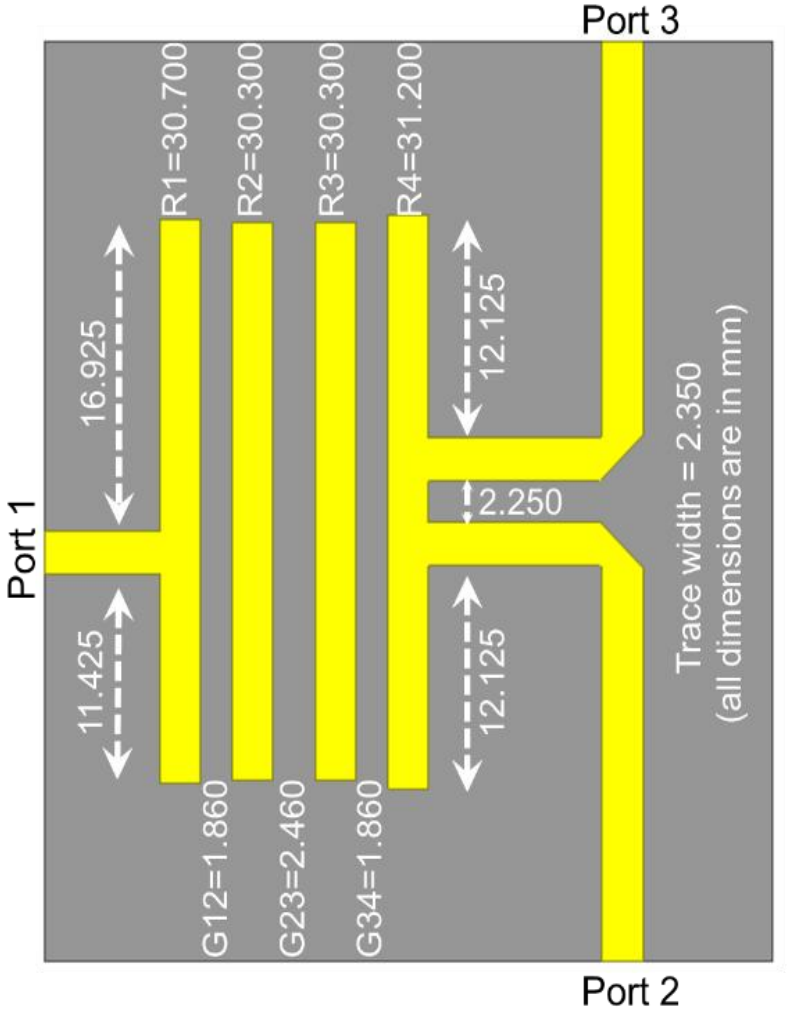
- ADS Schematic

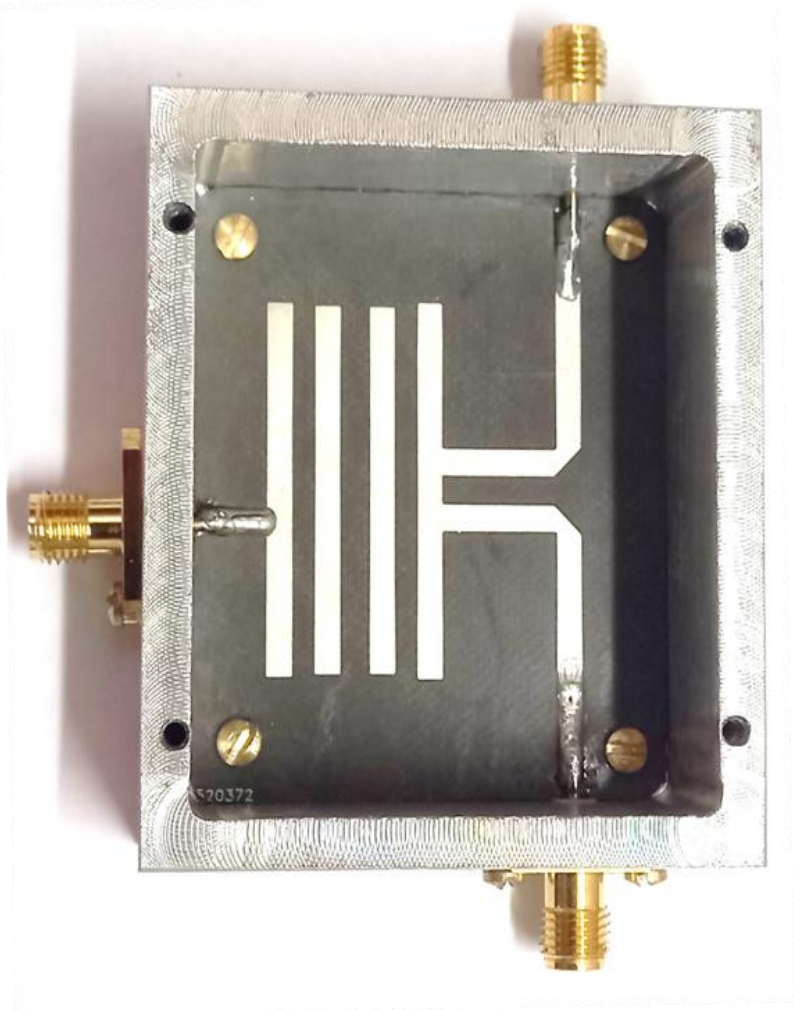




Balun Filters

- Microstrip Technology





3.5 GHz, 150 MHz,

4th order,

All pole balun filter

7 design variables (2N-1)

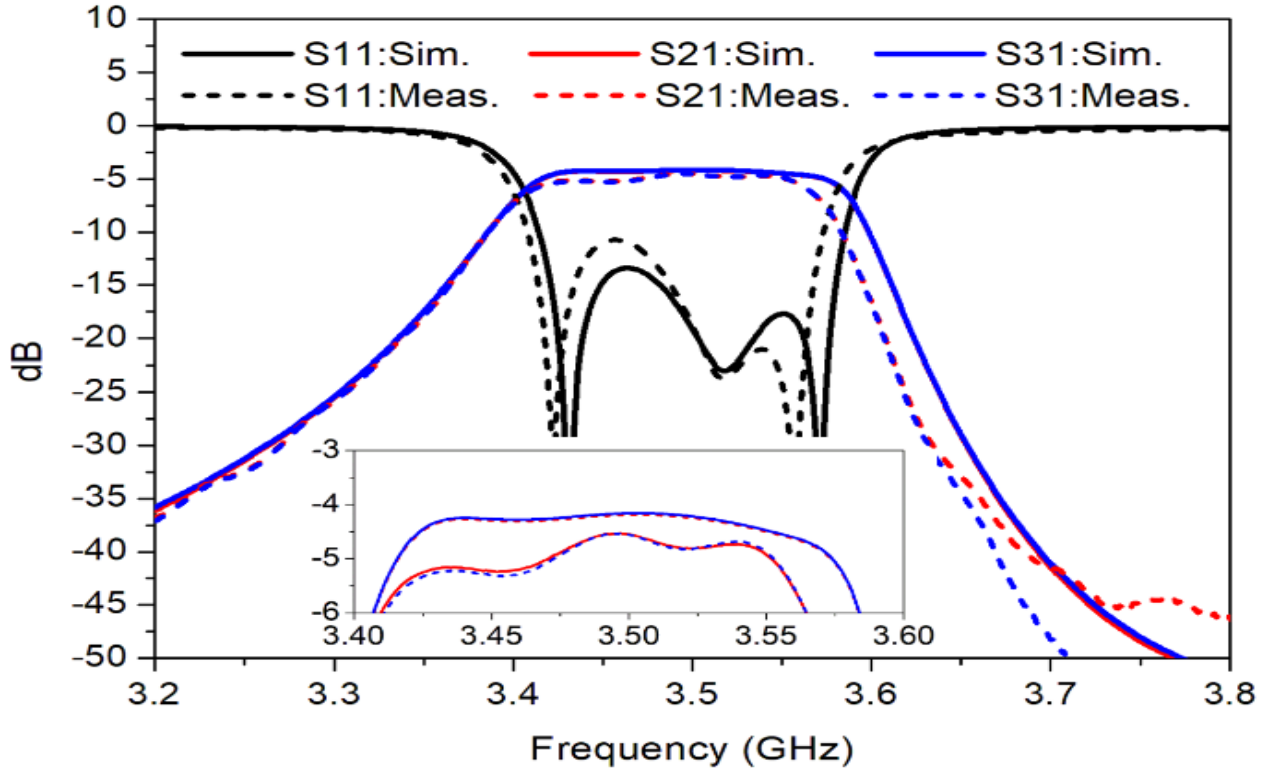
RT5880, 30 mils, 1 Oz

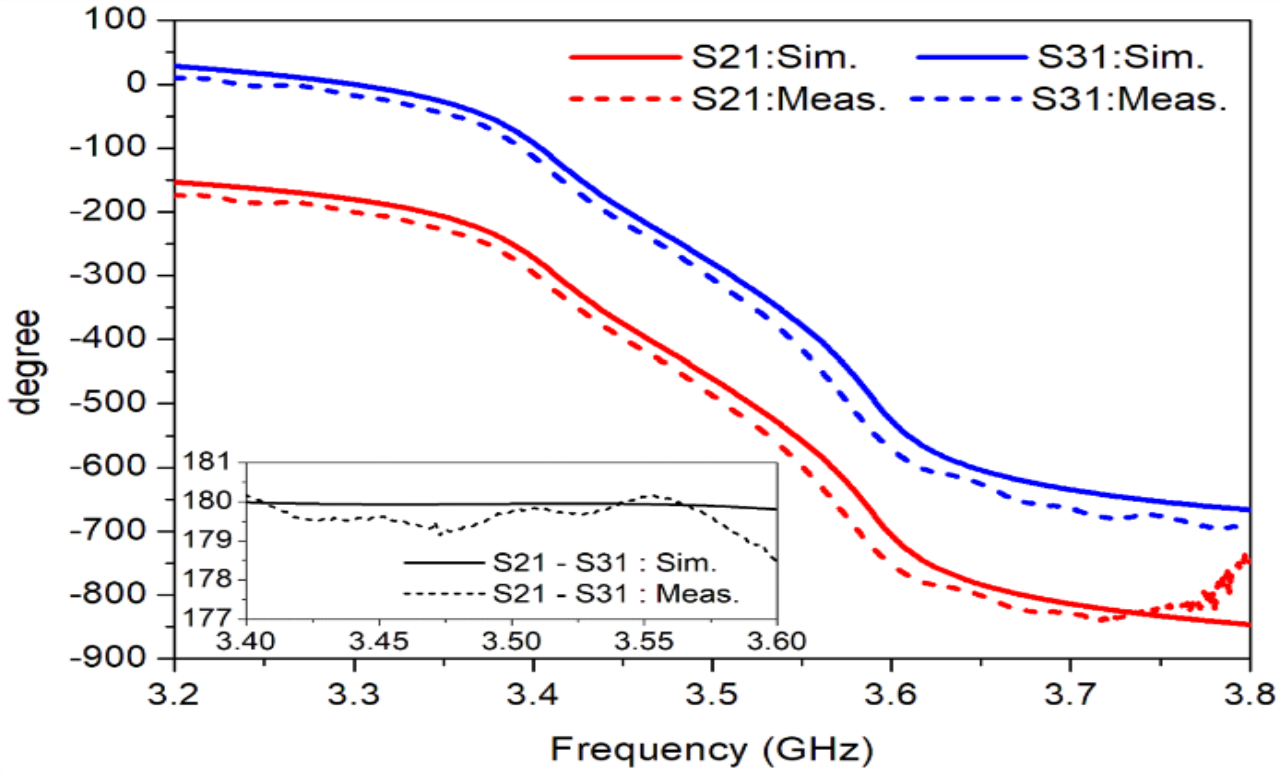
IR coupling : Gap

IO coupling : Tap

Balun Filters

- Microstrip Technology



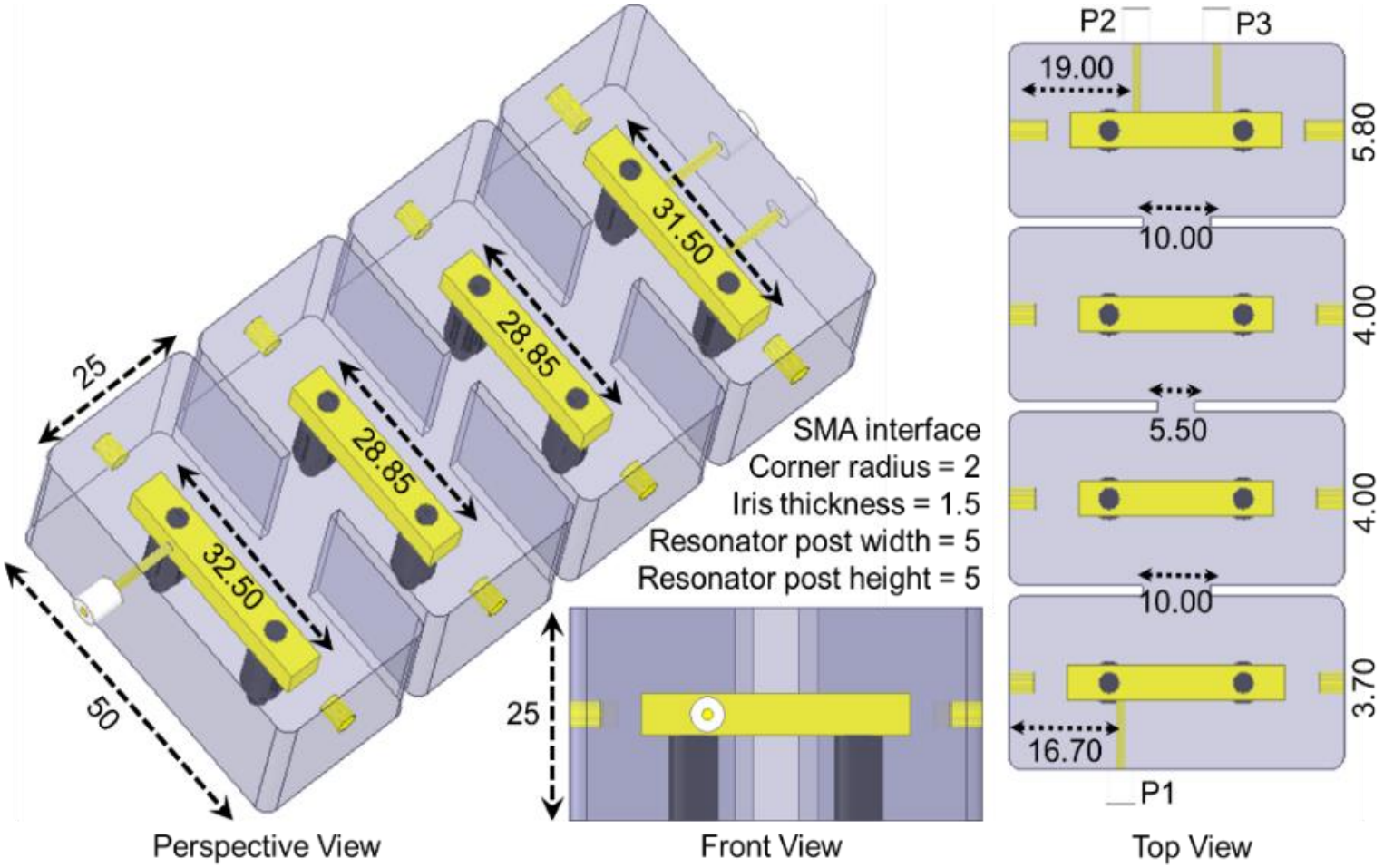


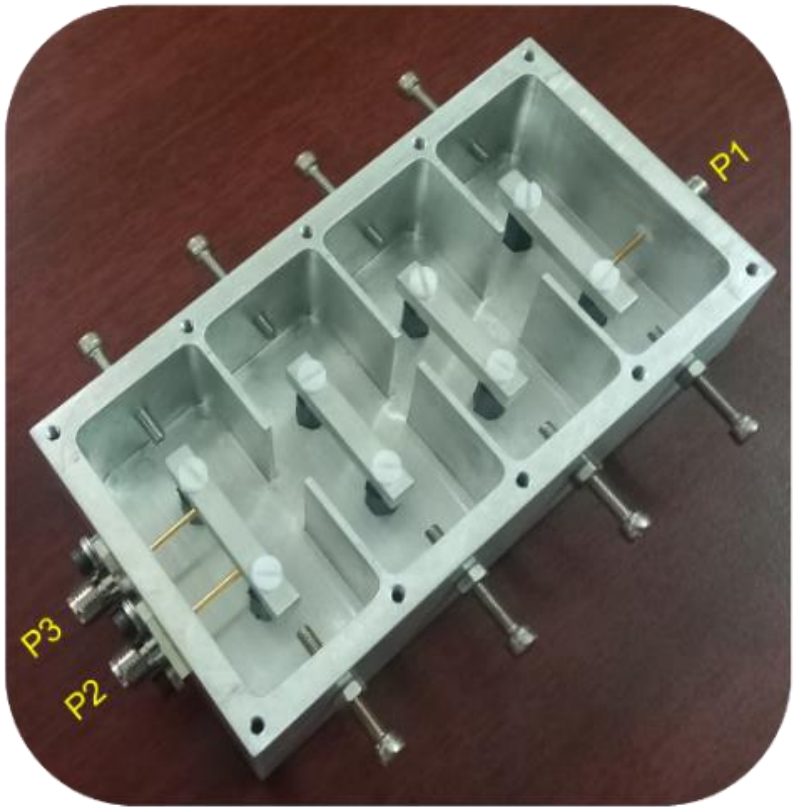
Measured IL = 1.5 dB, Amp. Imb = 0.1 dB, Phase Imb. = 0.5 deg

(fabrication tolerance, substrate parameter variations)

Balun Filters

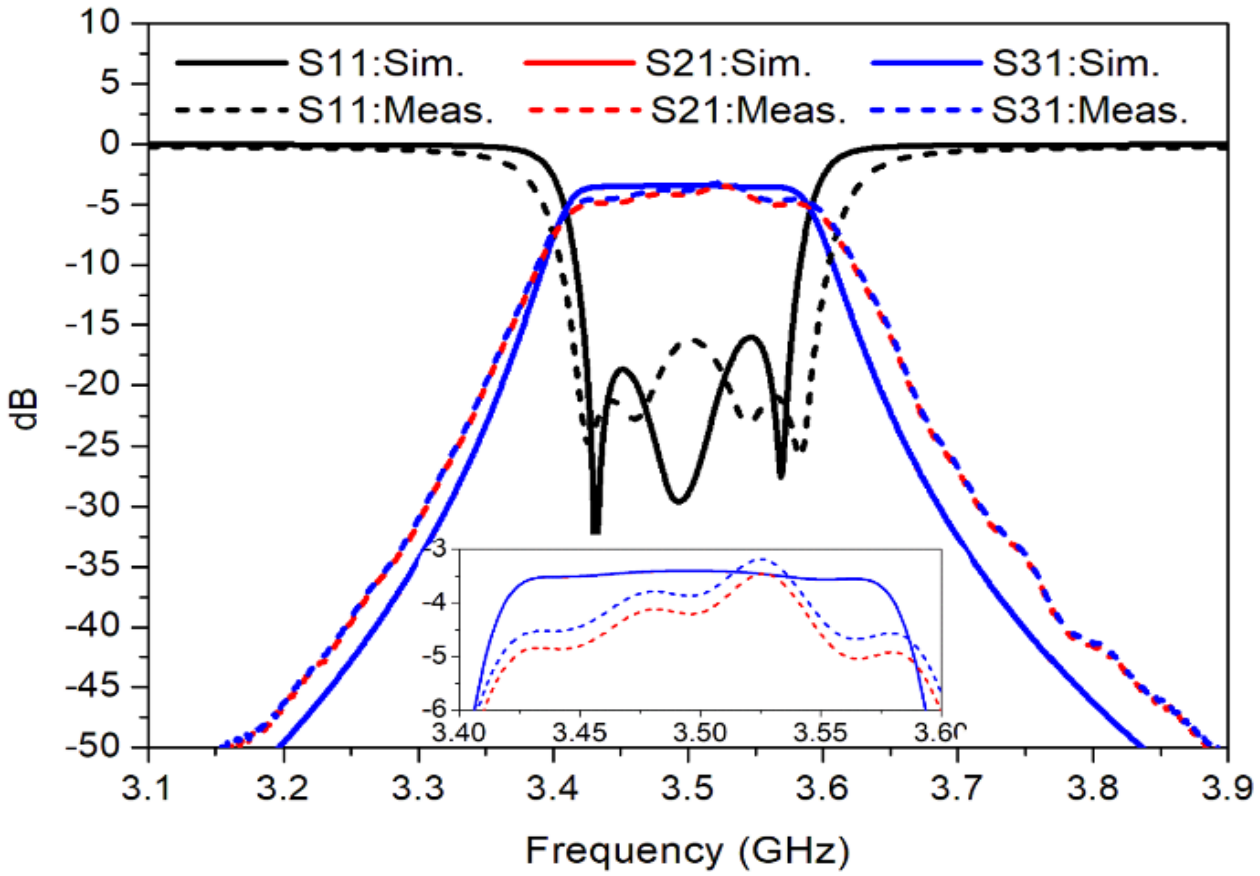
- Coaxial Technology

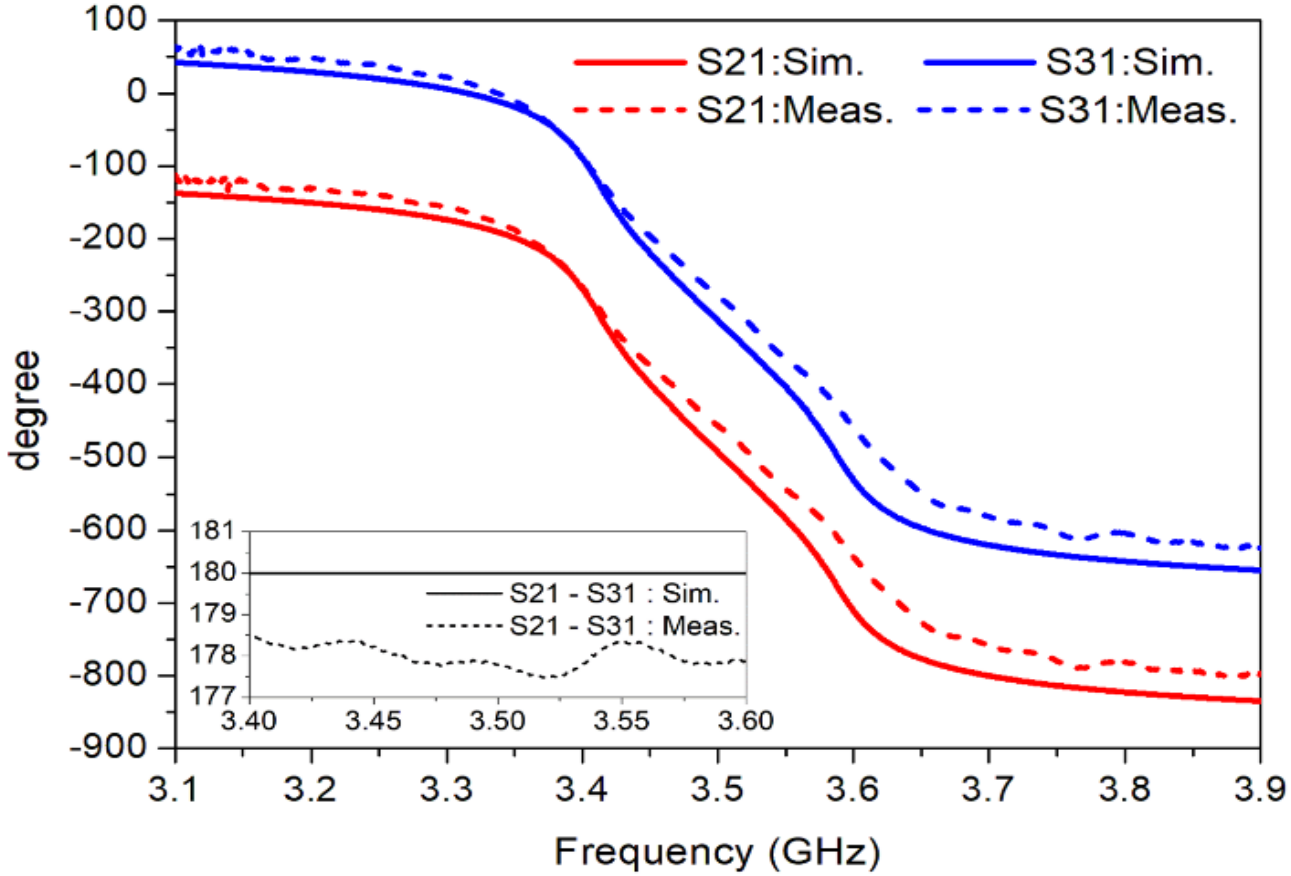




Balun Filters

- Coaxial Technology



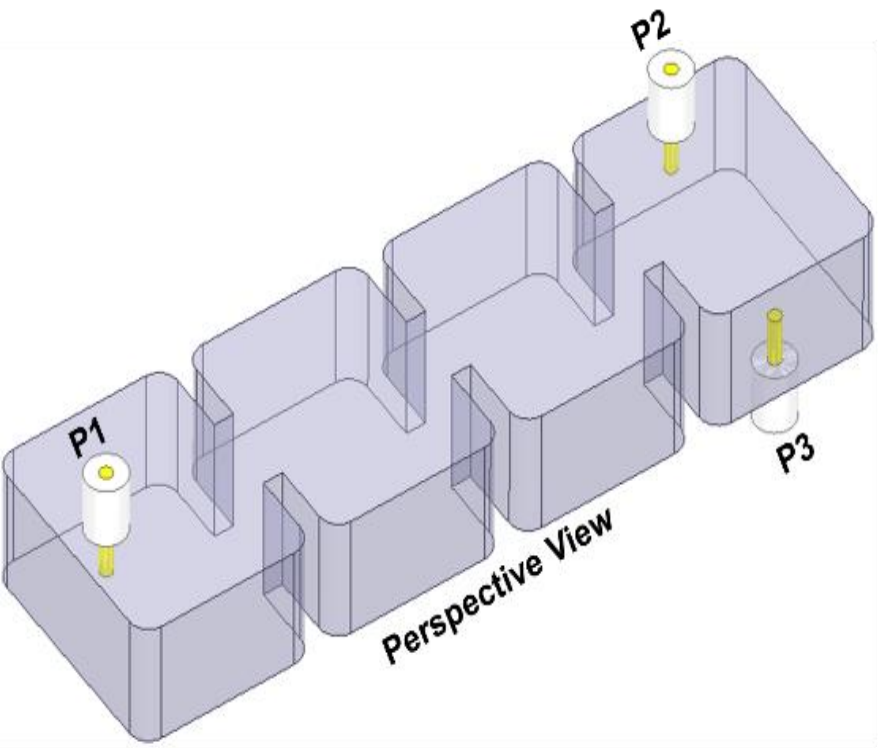


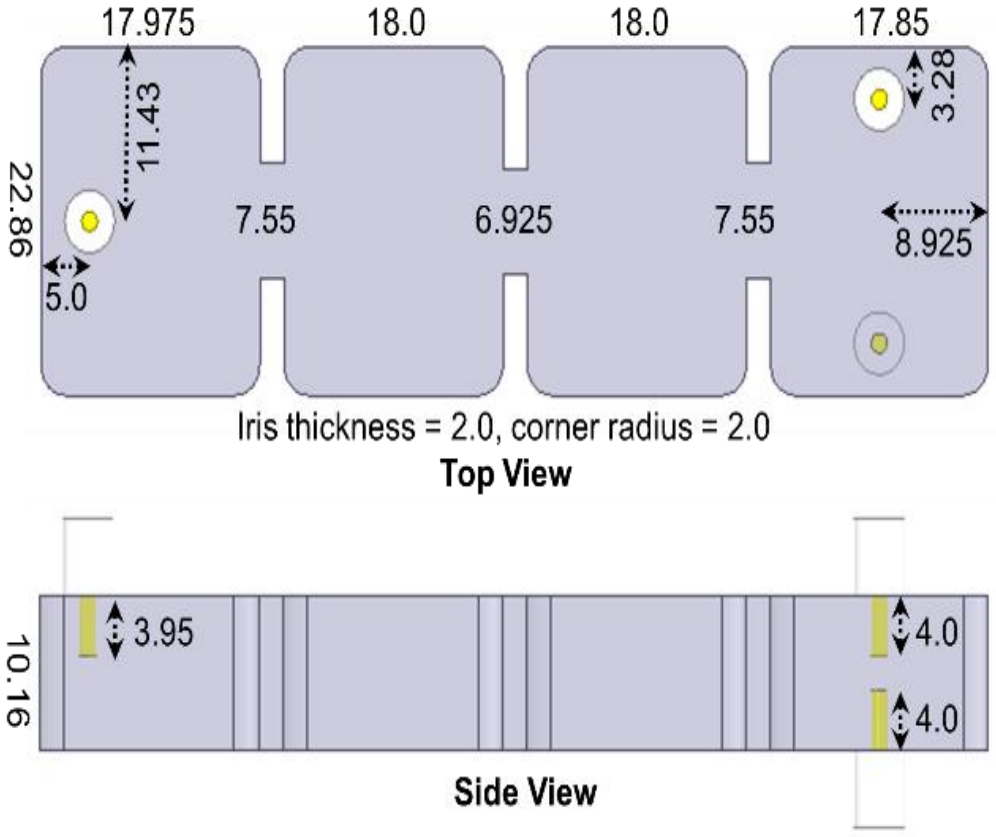
Measured IL = 0.5 dB, Amp. Imb = 0.4 dB, Phase Imb. = 2.5 deg

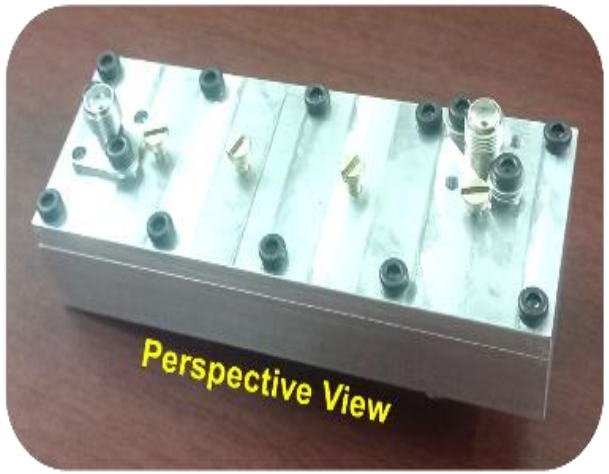
(fabrication tolerance, Nylon spacers and screws simulation)

Balun Filters

- Waveguide Technology



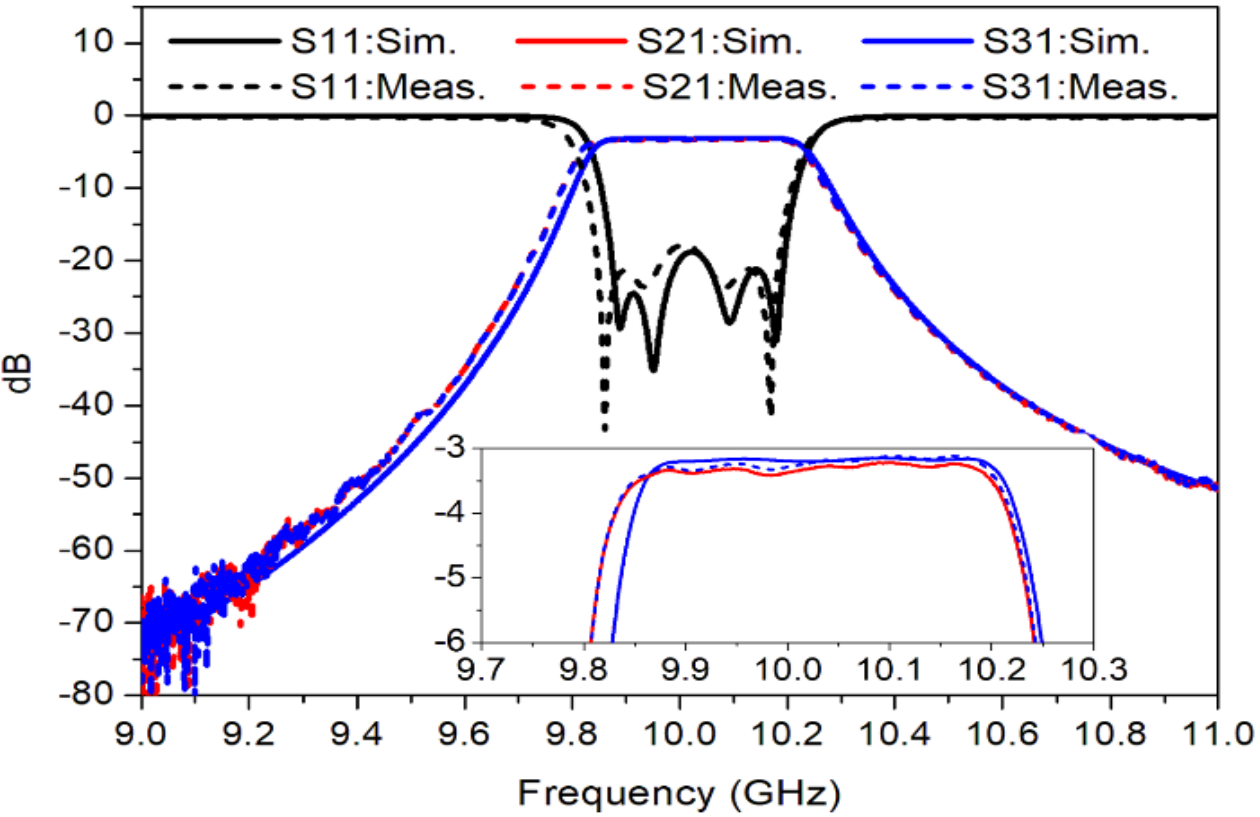


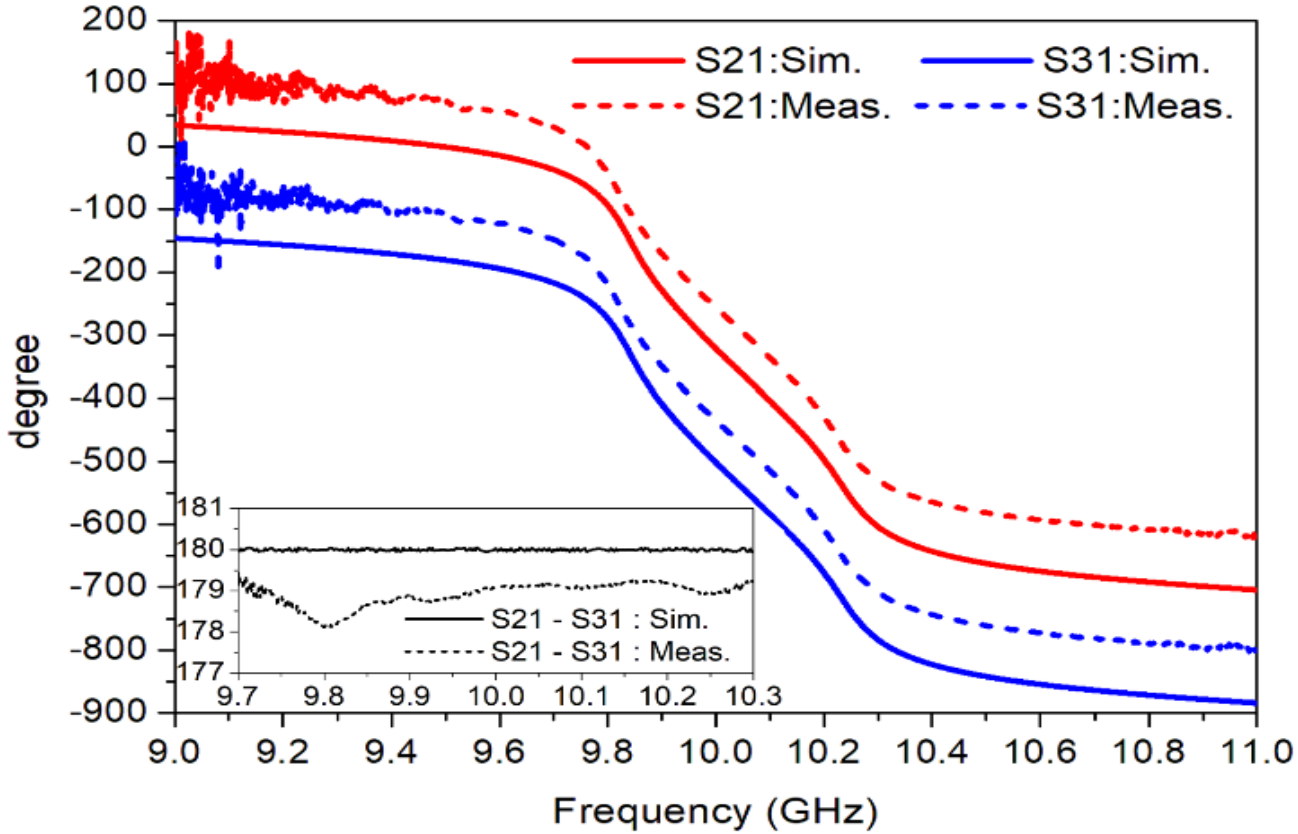


TE101 mode,
balanced ports (180 deg) → opposite broadside (E-field inversion)

Balun Filters

- Coaxial Technology



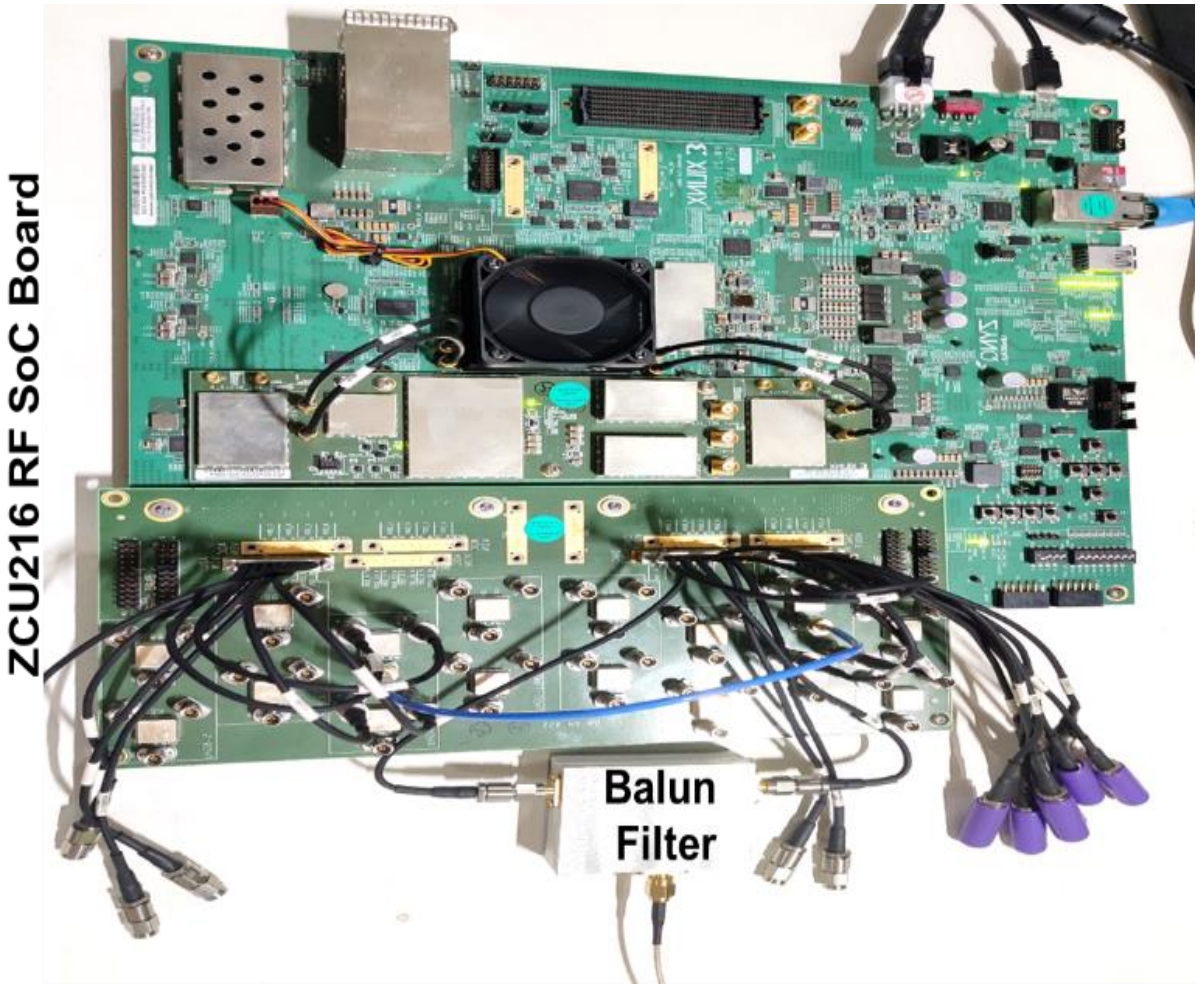


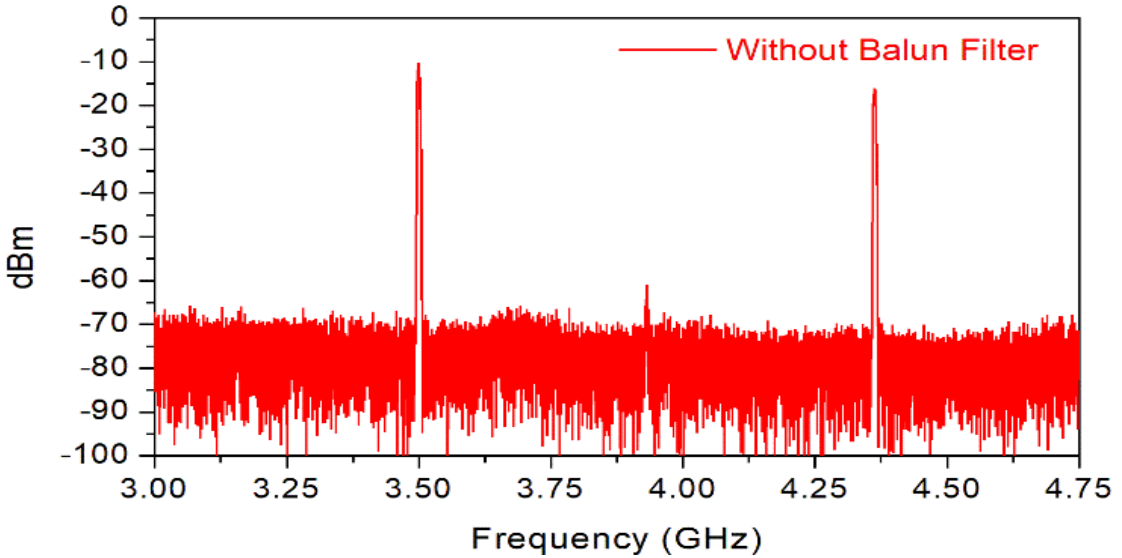
Measured IL = 0.25 dB, Amp. Imb = 0.2 dB, Phase Imb. = 1.25 deg

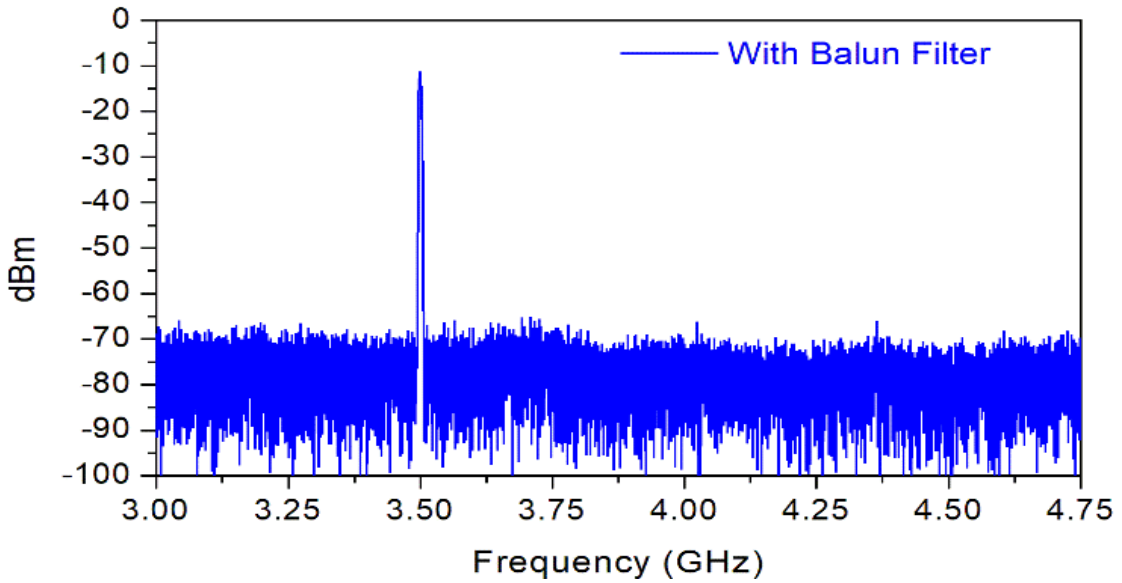
(fabrication tolerance, SMA pin lengths)

System Testing : 5G signals

- Microstrip Technology







Comparison Table

Ref.	Tec.	N	Fc (GHz) [BW (MHz)]	Ins. Loss (dB)	Amp. Imb. (dB)	Ph. Imb. (deg)	Scalable to higher order filters
2	us	2	2.45 [40]	2.4	1	4	No
3	us	2	2.45 , 5.8 [300 , 300]	-	0.2 , 0.9	2 , 9	No
4	us	4	2.45 [230]	1.7	NR	NR	No
5	us	4	2.75 [300]	1.4	0.2	0.8	No
6	us	3	2.95 [3215]	0.9	1	9	No
7	us	2	2.78 [650]	1.2	0.5	5	No
8	us	3	2.00 [1917]	-	0.6	5	No
9	us	2	1.59 , 1.92 [110 , 180]	1.5 , 1.4	0.4	5	No
10	us	2	3.5 [735]	1.9	0.3	2	No
tw	us	4	3.5 [150]	1.5	0.1	0.5	Yes
tw	co.	4	3.5 [150]	0.5	0.4	2.5	Yes
tw	wg.	4	10.0 [350]	0.25	0.2	1.25	Yes

Conclusion

- Balun + BPF = Balun Filter
  - Functional integration, compact,
  - no cascaded mismatch loss, all ports 50 ohms,
- Systematic scalable design methodology
  - Coupling matrix based approach
  - Any of the BPF synthesis techniques
- Proof of the concept
  - Microstrip, Coaxial, and Waveguide Technologies
  - System testing

Thank you ☺