IW13AB

Integrated Passive Devices (IPD) for 5G RF Front-End Designs

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Xpeedic Technology

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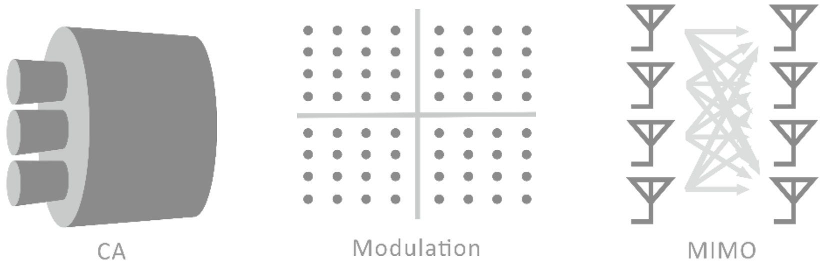
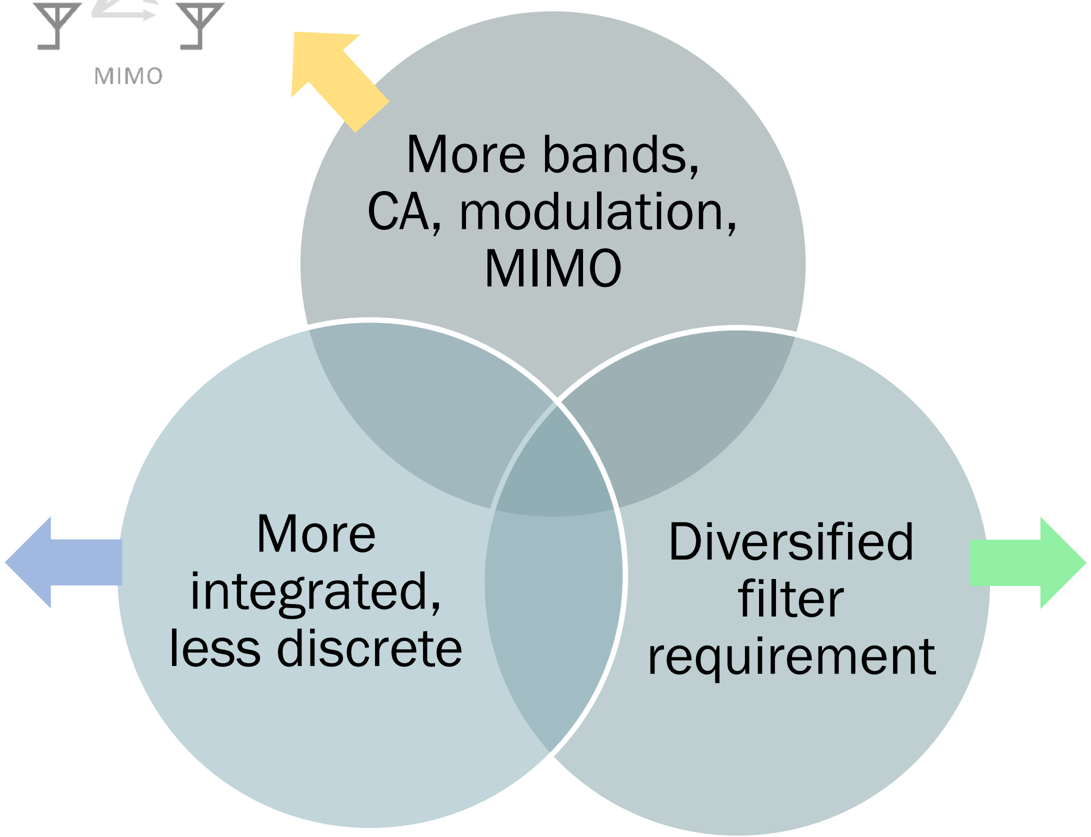
Outline

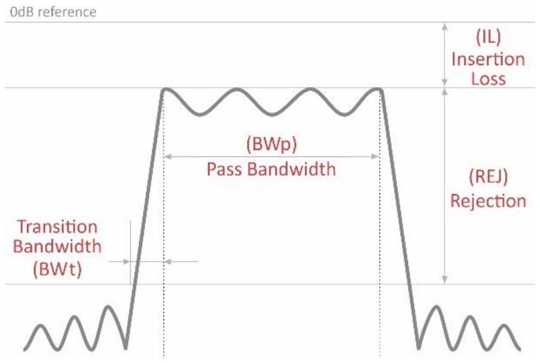
- Filter trend in 5G RF front end
- IPD solution for RF front end
- Dedicated IPD solution from Xpeedic
  - HRSi-based IPD
  - TGV-based IPD
- IPD for 5G NR
- Summary

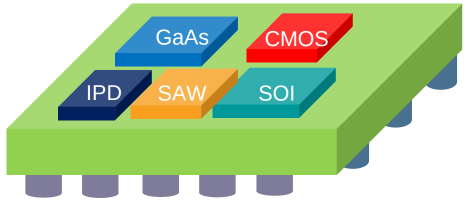
Filter Trend in 5G RF Front End



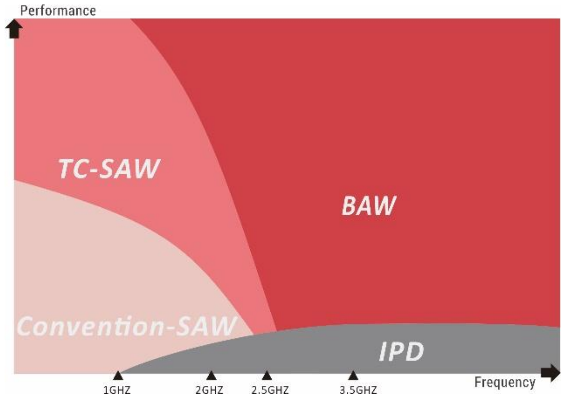
More filters







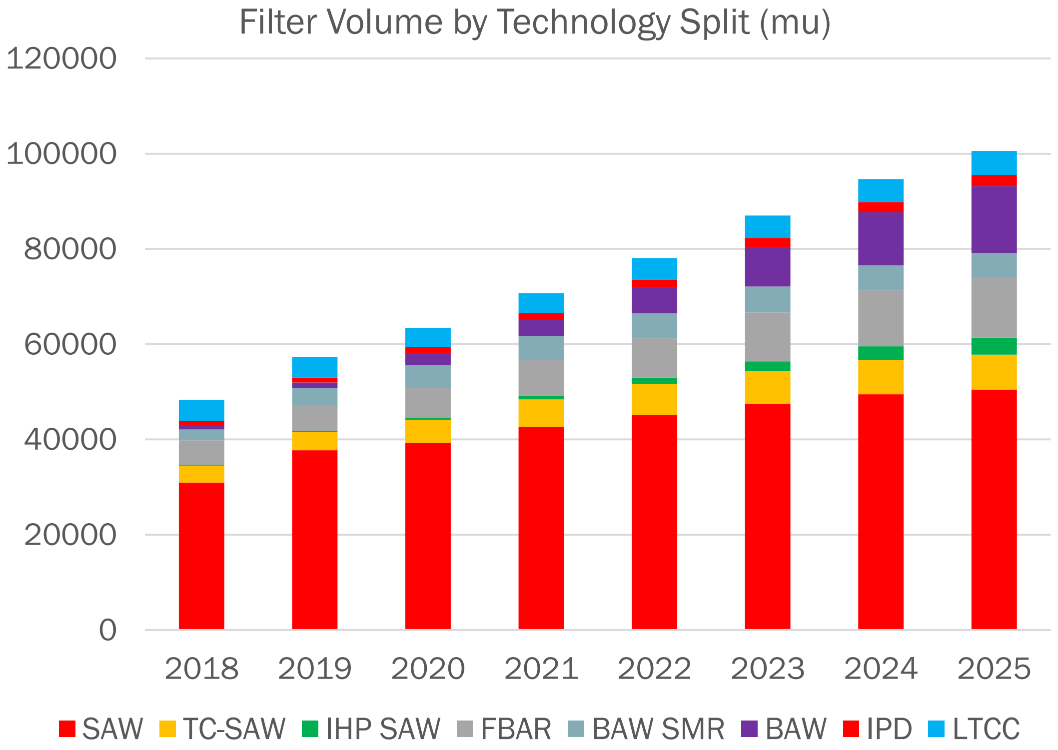
SiP for RF FEM

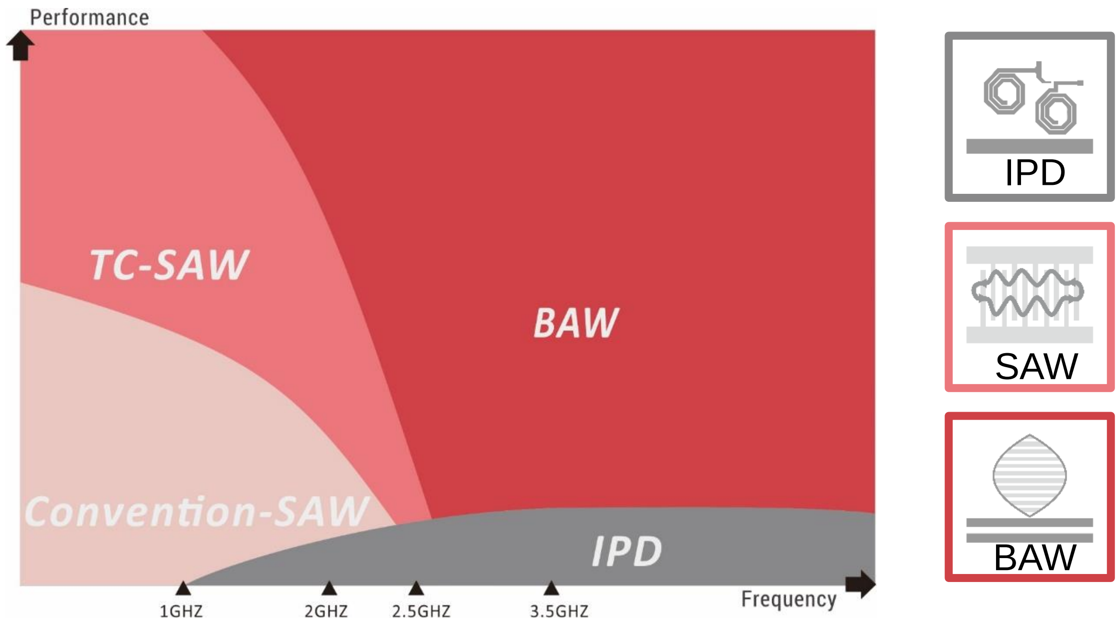


Different filter technologies

5G's Impact on Filters

- Filter landscape is reshaping with 5G coming
- Various filter technologies such as LTCC, IPD, SAW and BAW and their combination are needed for 5G

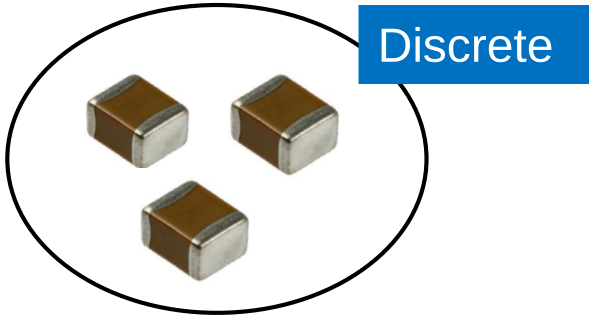


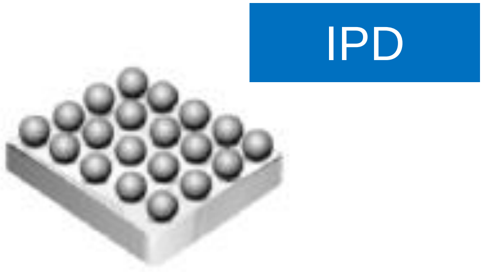


Source: Yole

IPD for RF Front End

- Integrated Passive Device (IPD) advantages over discrete
  - Miniaturization, high consistency, low cost, high integration,



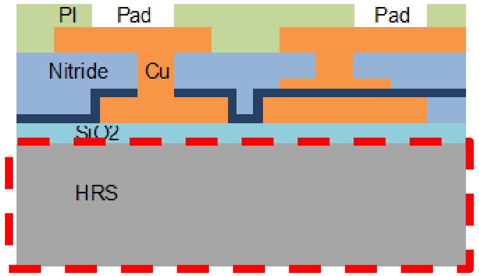


- Discrete R, L,C
- Bulky
- Poor tolerance control

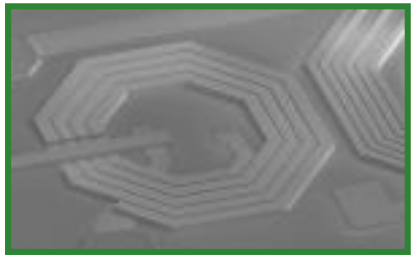
- Multiple R, L, C
- Small size, low profile
- High performance
- Consistency
- High integration

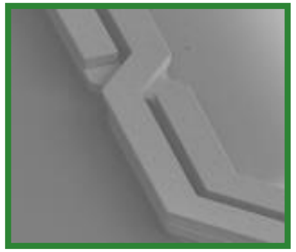
IPD Evolution

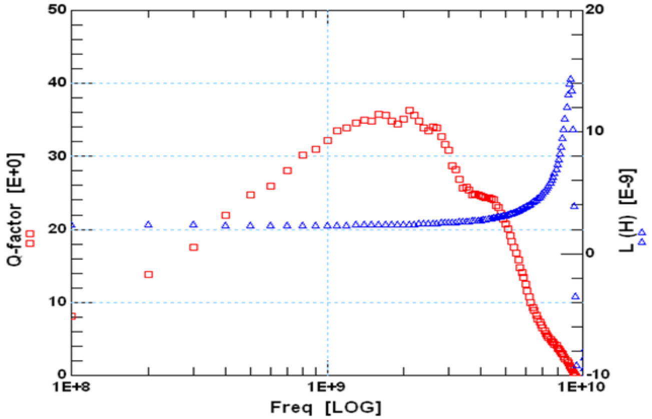
- High resistivity silicon (HRSi) based IPD



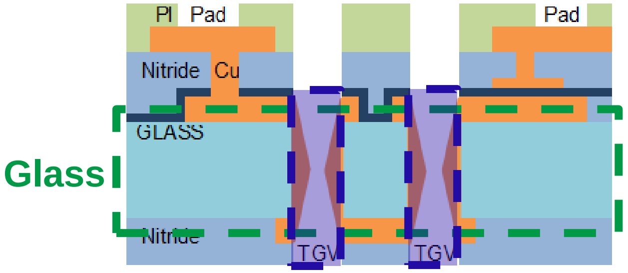
High Resistivity Silicon (HRSi)



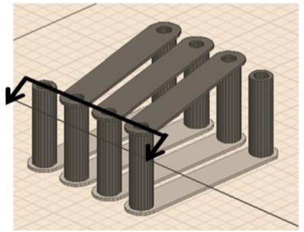


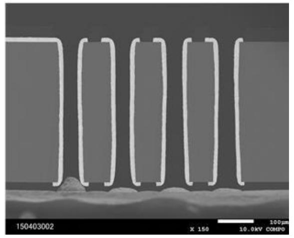


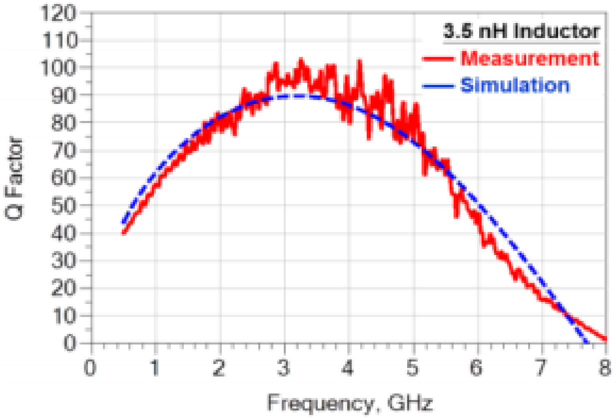
- Through-glass-via (TGV) based IPD



Through Glass Via (TGV)







Xpeedic Dedicated IPD Service

- One-stop IPD service provides fast way from spec to volume production
  - Foundry eco-system and in-house dedicated EDA tools

IPD Foundries

SMIC tsmc CORNING ON Semiconductor ST

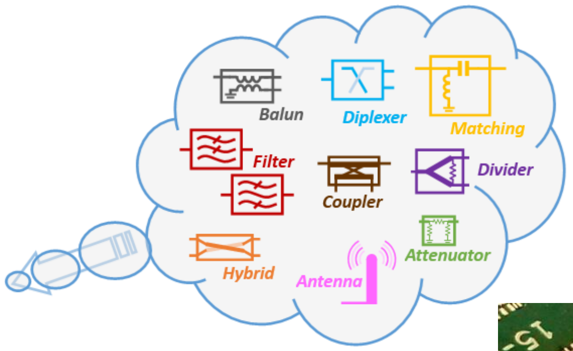
Dedicated EDA Tools

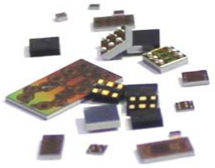
IPD Suite

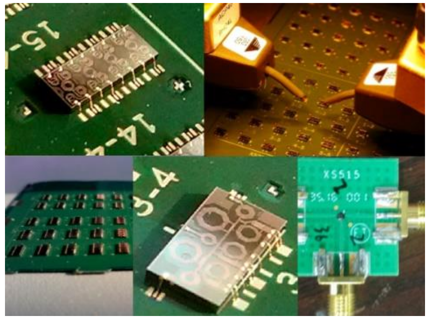
IRIS iModeler SnpExpert

SiP Suite

HERMES RF Metis

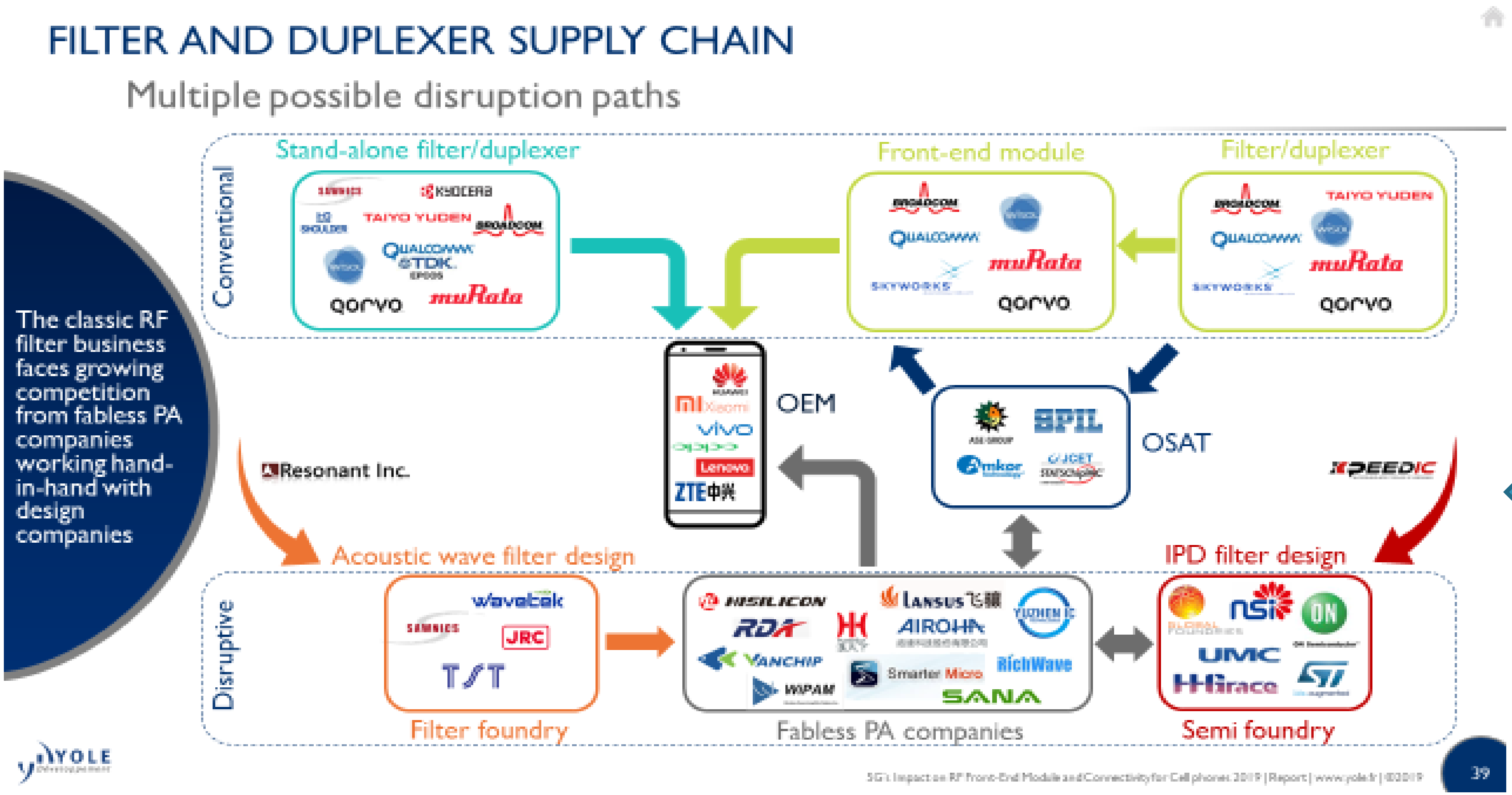






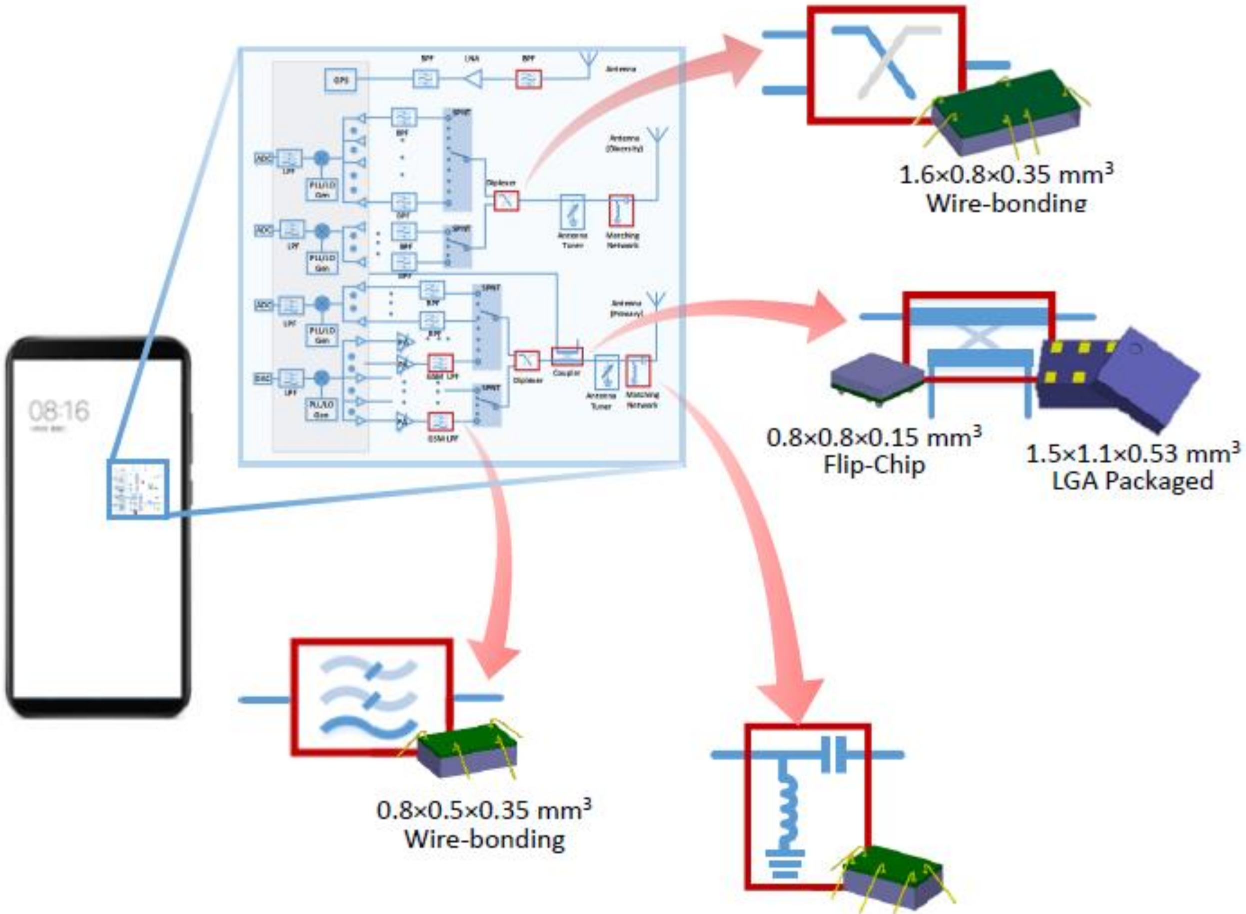
Yole Report:

5G's Impact on RFFE Module and Connectivity for Cell Phones, Aug 2019



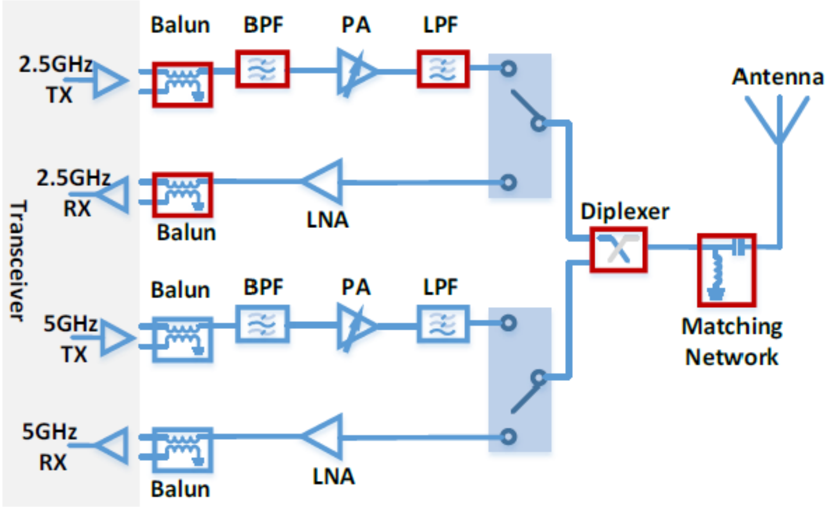
Dedicated IPD Filter design house

HRSi IPD Library

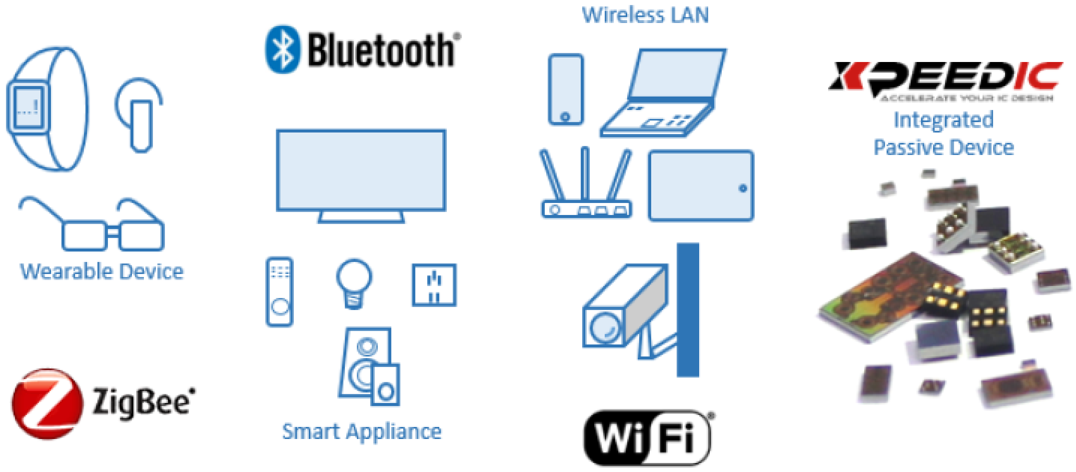


Device	Xpeedic Part NO.	Size(mm³)
IPD Filter	XS0805L960MWA45	0.8×0.5×0.35
	XS0808L960MWA58	0.8×0.8×0.35
	XS0805L1G91WA47	0.8×0.5×0.35
IPD Diplexer	XS1608D960MWA04	1.6×0.8×0.35
IPD Coupler	XS1511C2G12BM10	1.5×1.1×0.23
	XS0808C2G12FM12	0.8×0.8×0.15
	XS1008C2G12FM17	1.0×0.8×0.15
IPD Matching	XS0805N1G85WA05	0.8×0.5×0.35

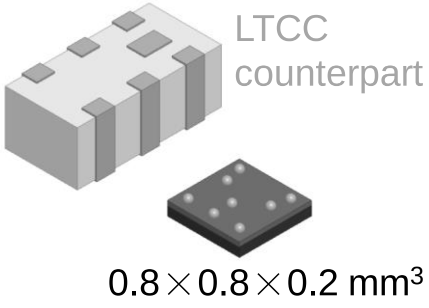
HRSi IPD Library(Cont'd)

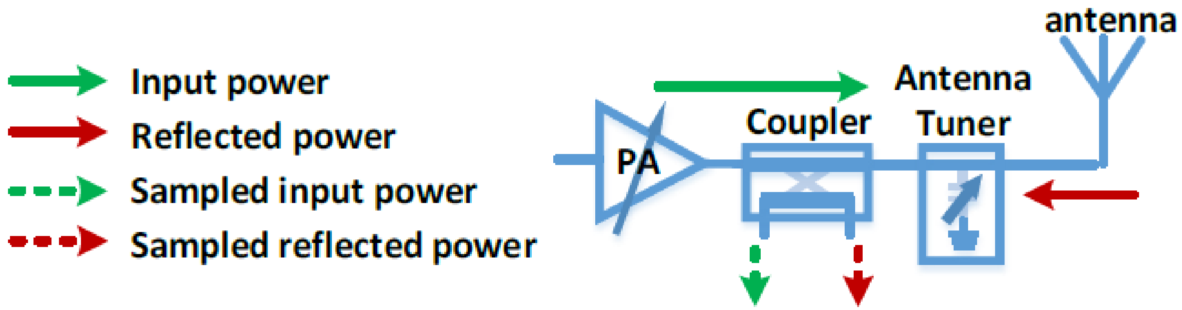


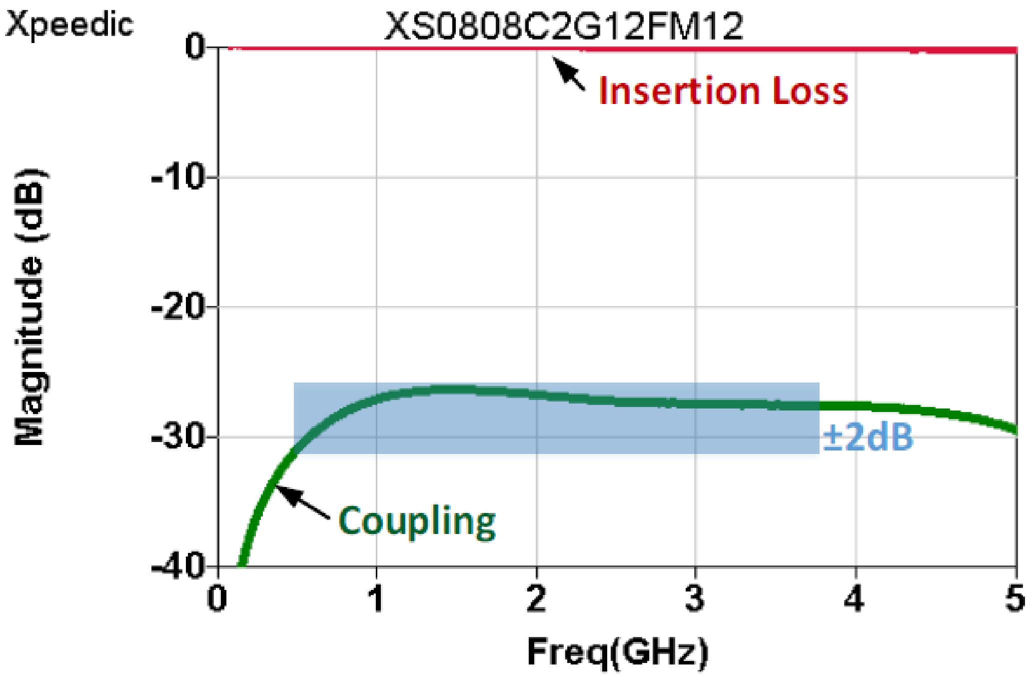
Device		Xpeedic Part NO.	Size(mm³)
	IPD Filter	XS1005L2G50WA57	1.0×0.5×0.35
		XS1005F2G45WA97	1.0×0.5×0.35
		XS1005F5G40WA014	1.0×0.5×0.35
		XS0808F5G40WA016	0.8×0.8×0.35
	IPD Diplexer	XS0808D2G50WA03	0.8×0.8×0.35
	IPD Balun	XS0505B2G45WA20	0.5×0.5×0.35



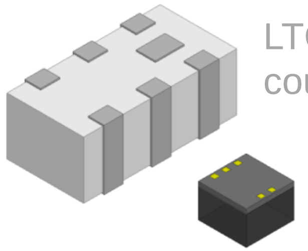
HRSi-based Directional Coupler



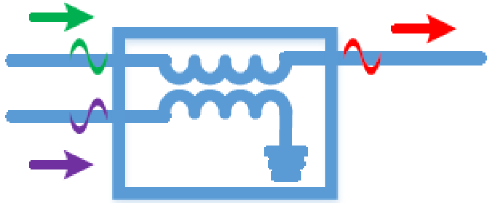


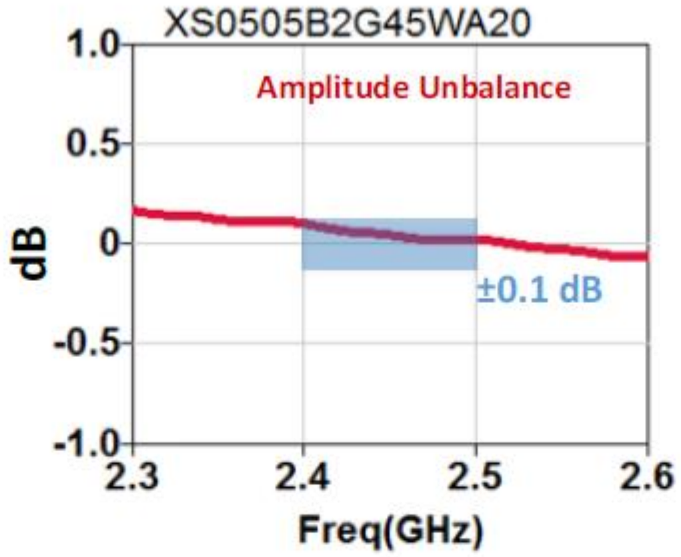


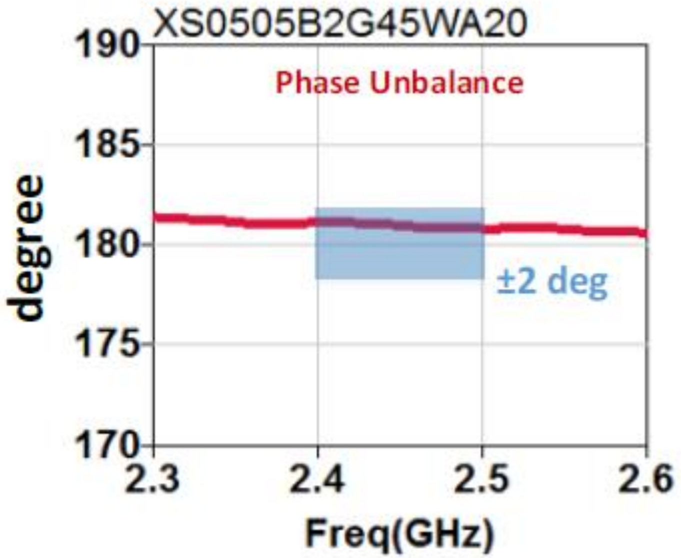
HRSi-based Balun



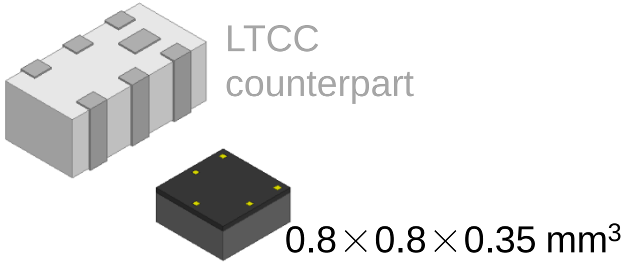
$0.5 \times 0.5 \times 0.35\ mm^3$

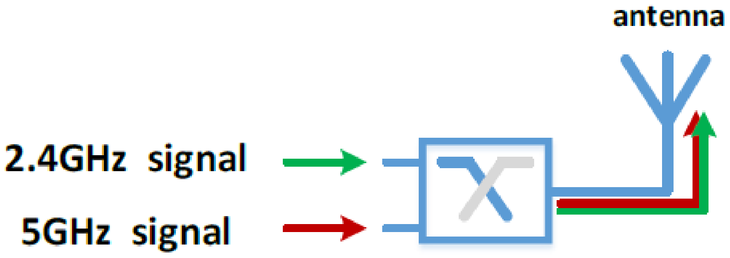


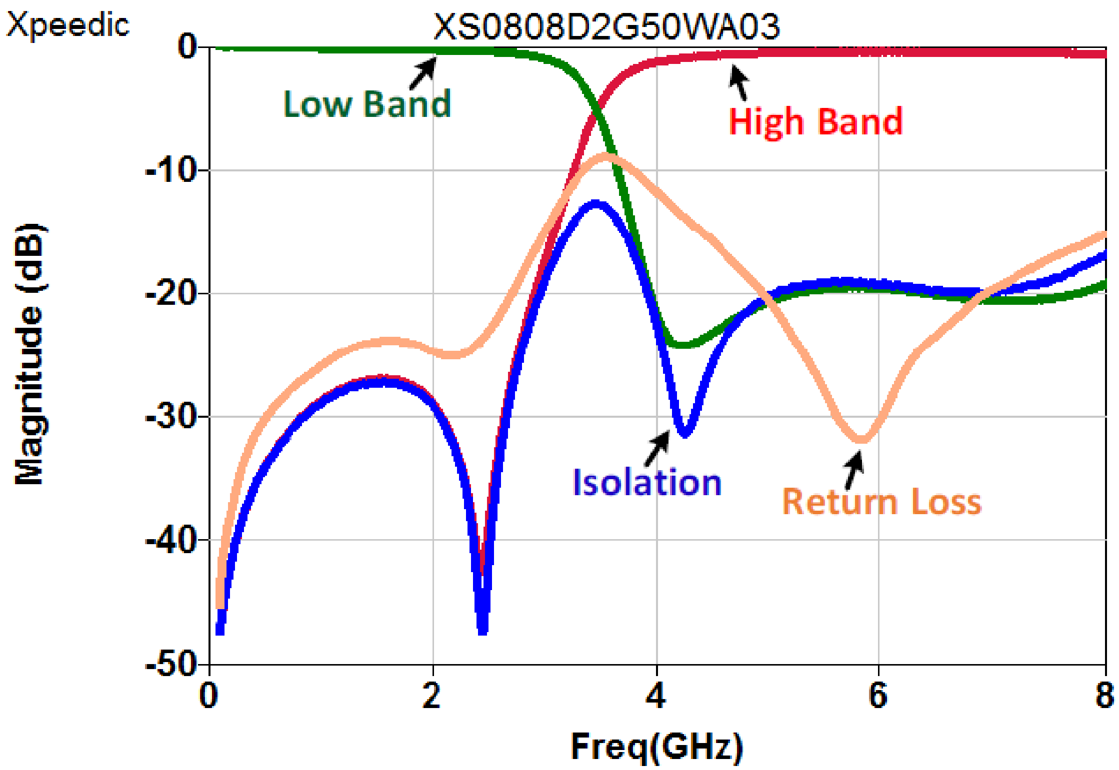




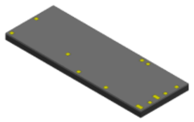
HRSi-based WLAN Diplexer



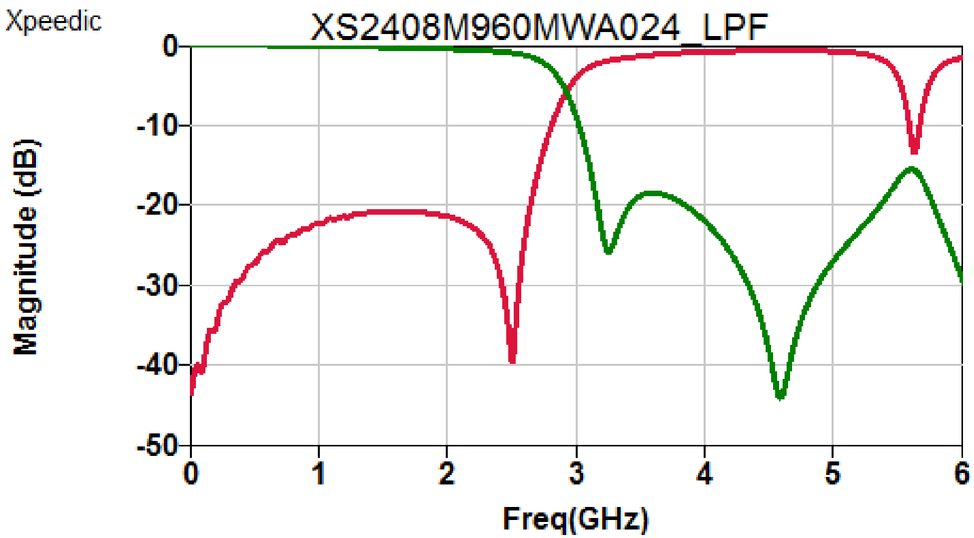


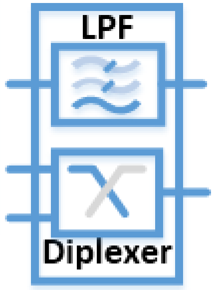


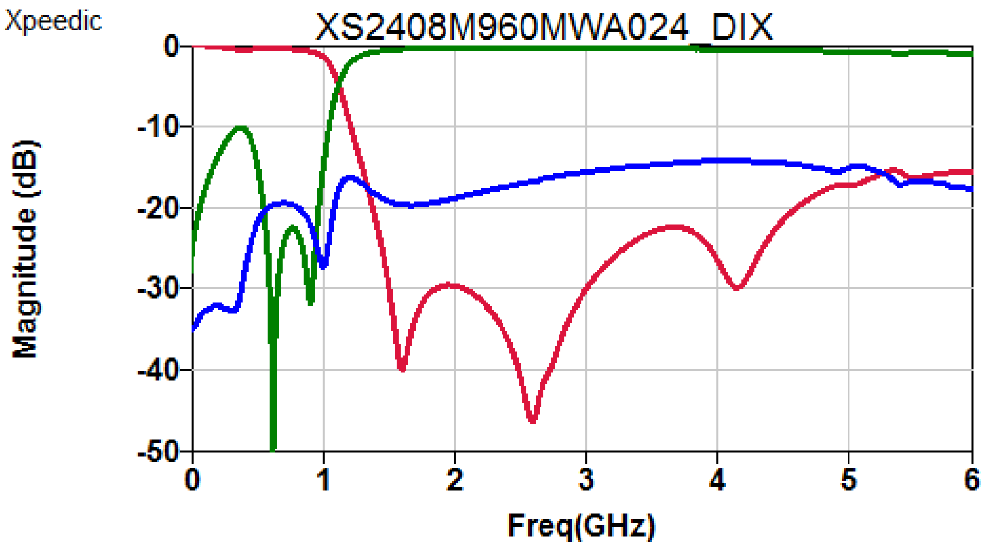
HRSi-based LPF + CA Diplexer



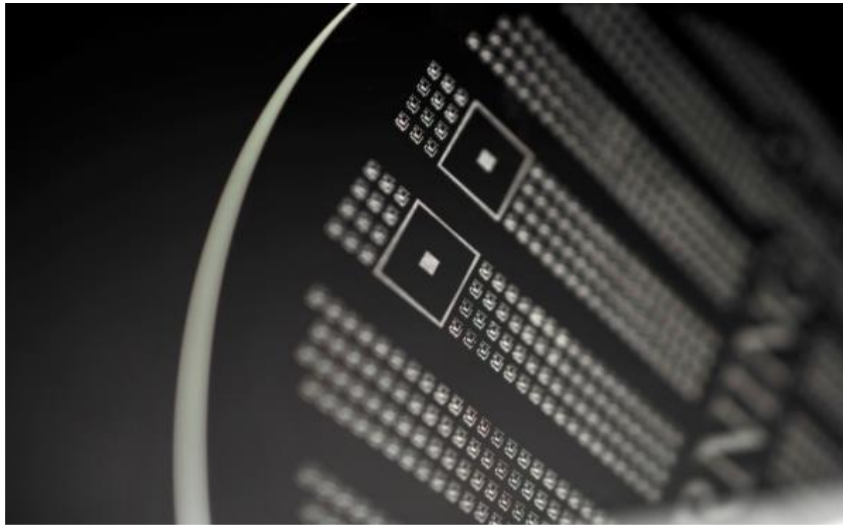
0.8×2.4×0.1 mm^3







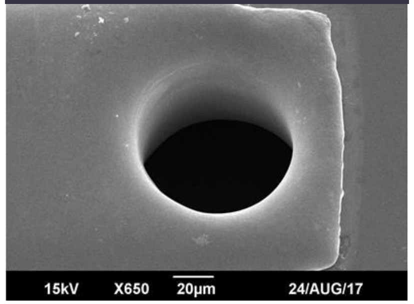
TGV-based IPD



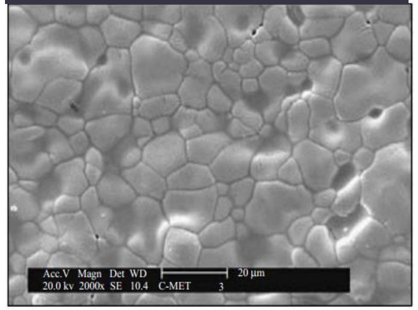
Glass size:
•Wafers: 100-300mm
•Panels: Up to 500x500mm

Thickness: 100-500µm
Positional Accuracy: <+/-10µm
Pitch: Minimum 2x via diameter
Via Diameter: 100-30µm

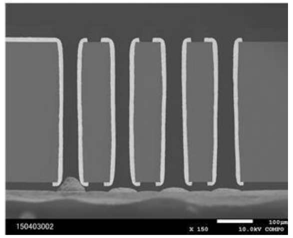
Cu on Glass



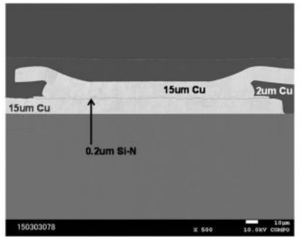
Ag on LTCC



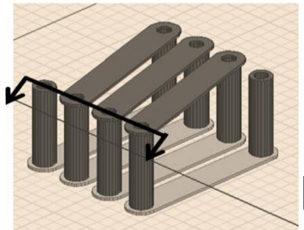
- Smooth metal on glass leads to low loss



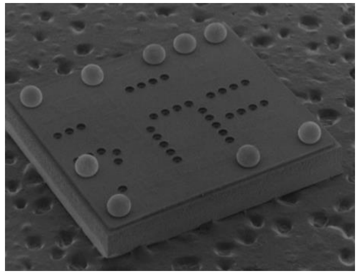
TGV



MIM Cap



Inductor

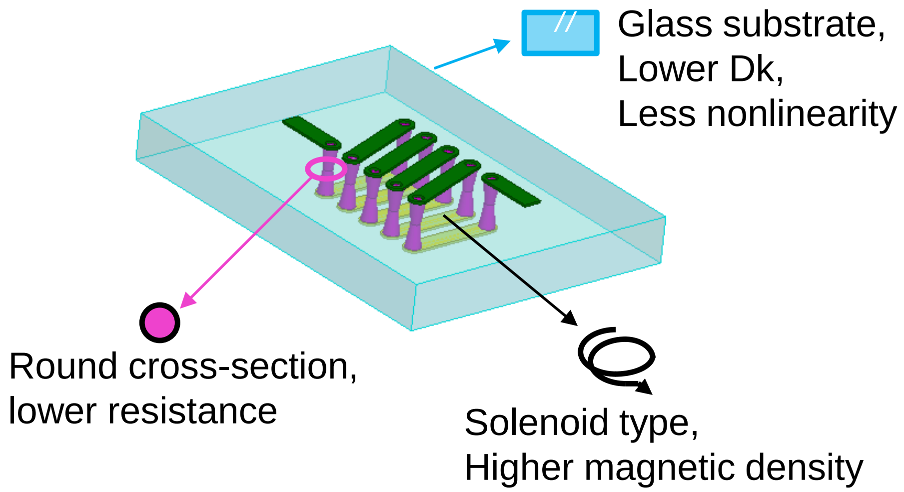


Complete LC network

TGV-based IPD(Cont'd)

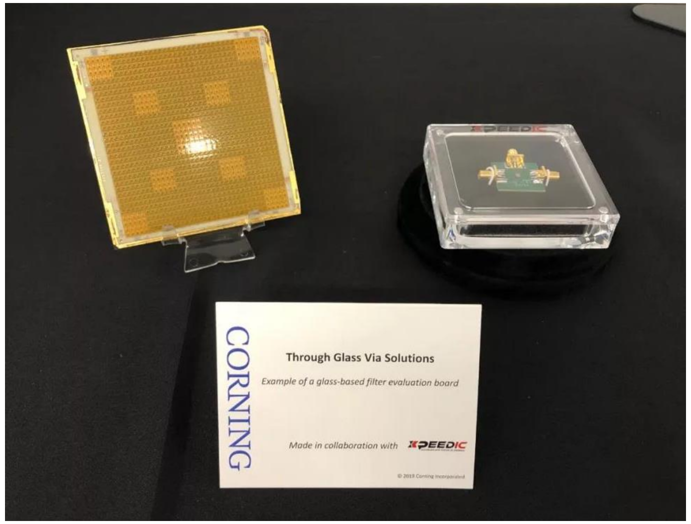
TGV device development

- Make use of TGV advantage

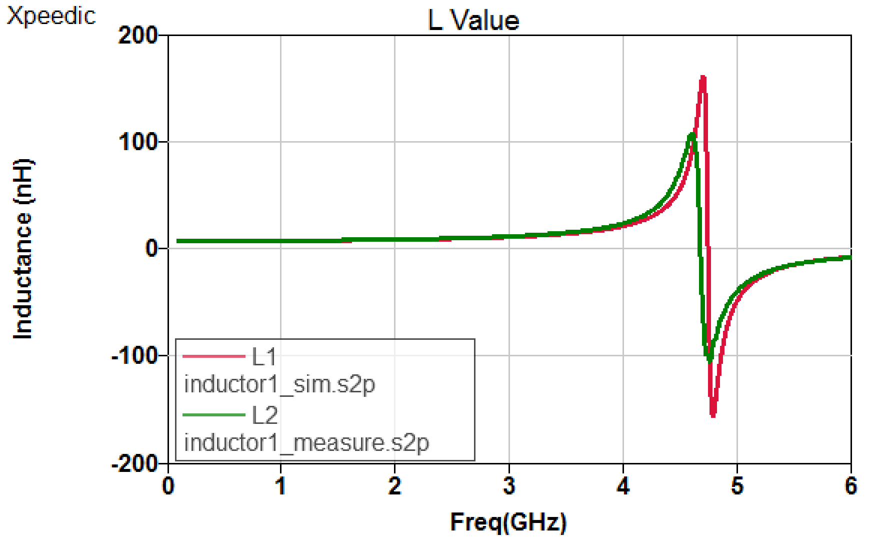


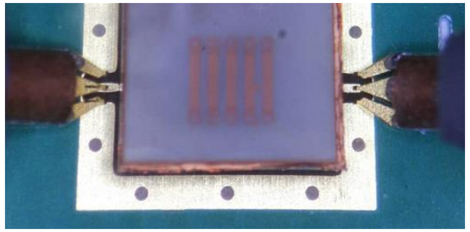
TGV device measurements

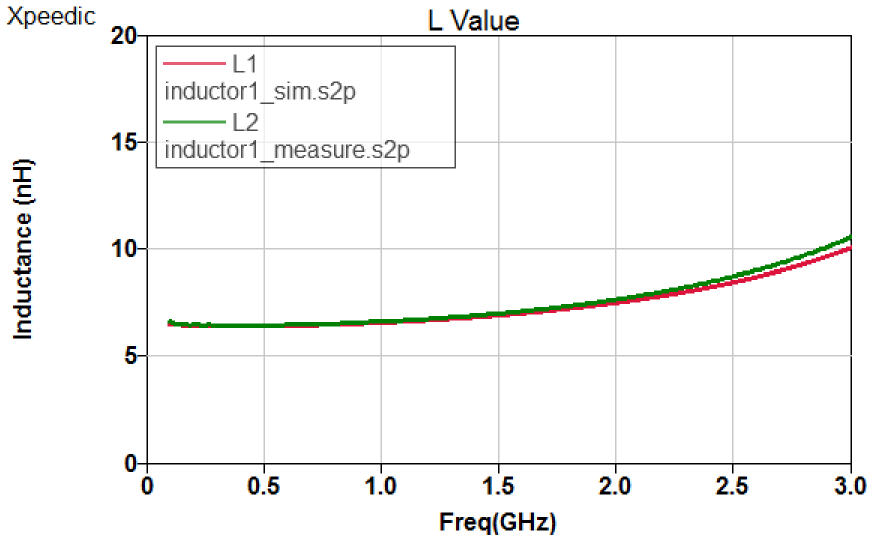
- Inductor and diplexer

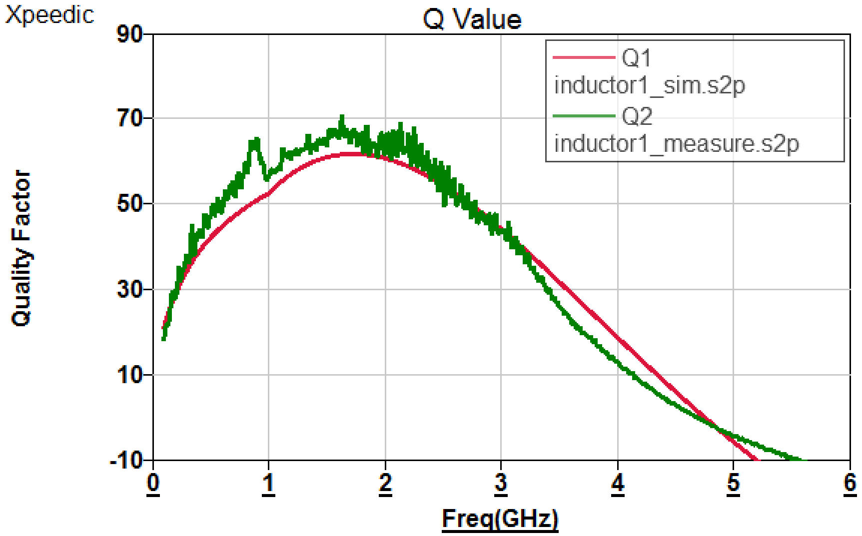


TGV Inductor

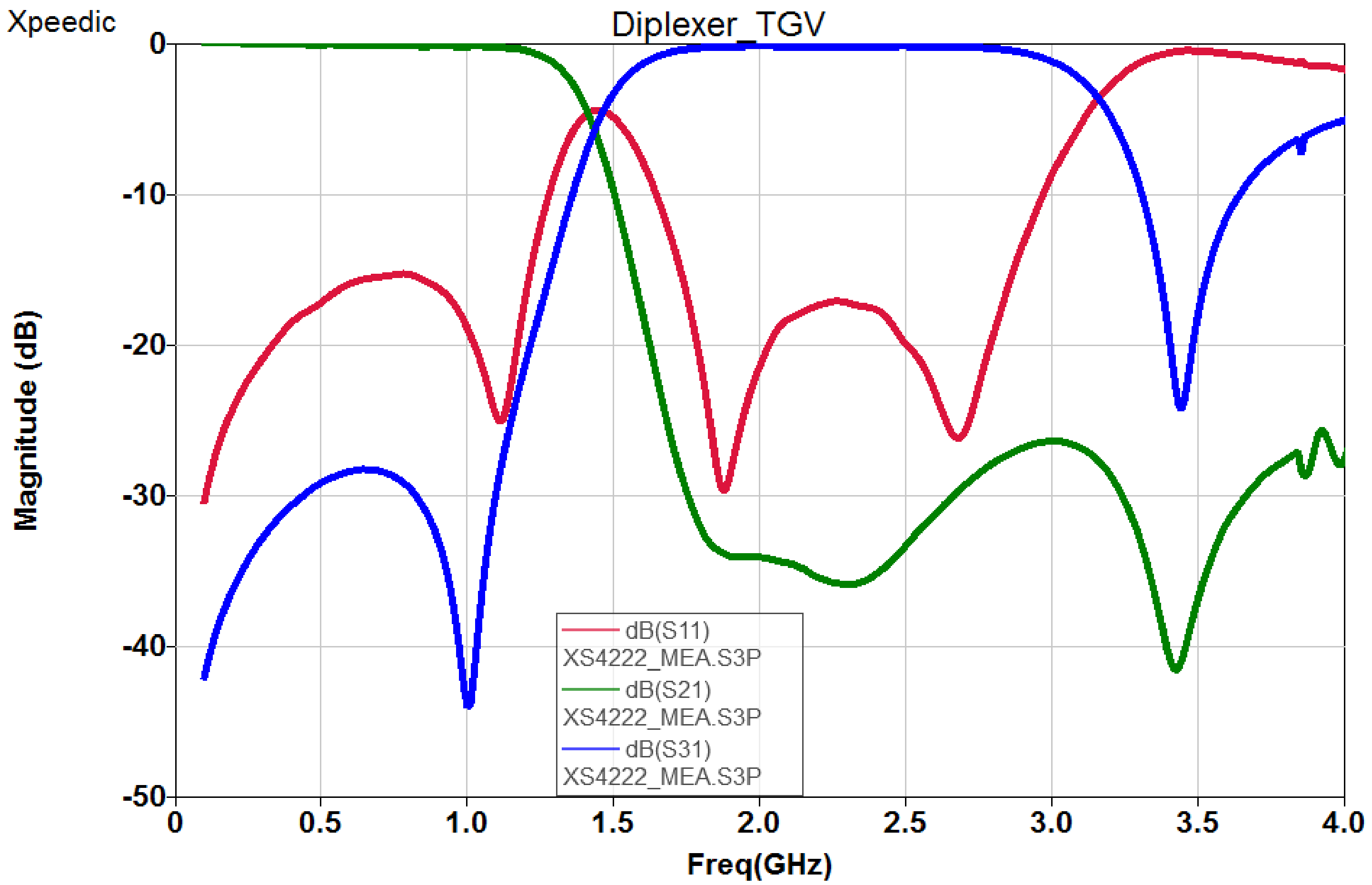








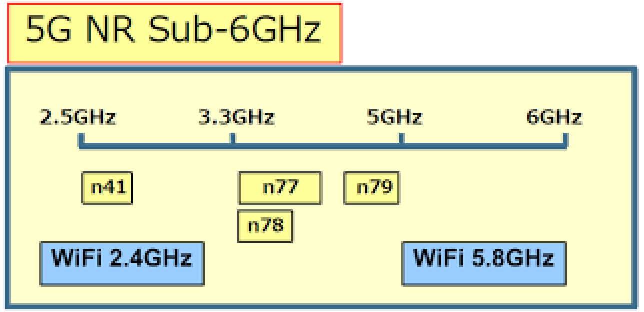
TGV Diplexer



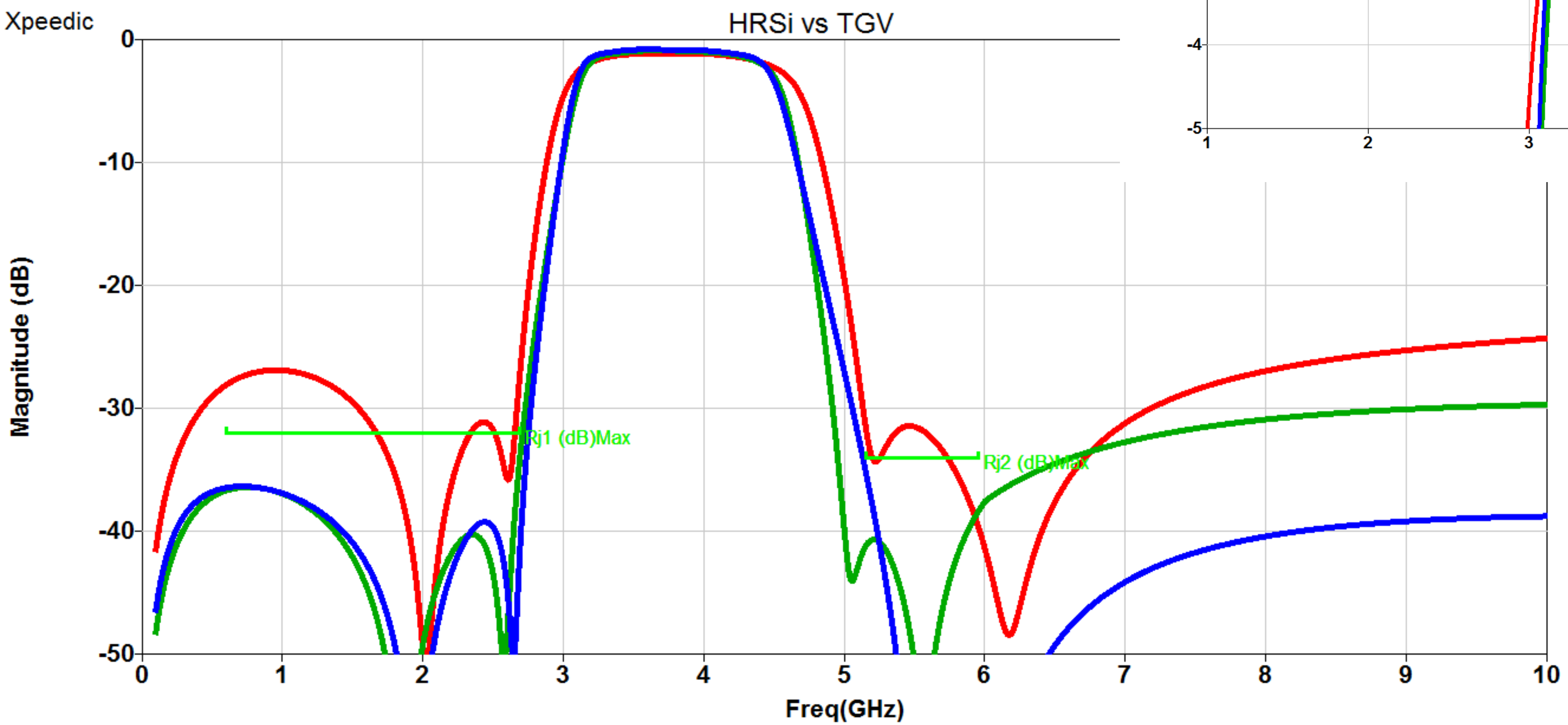
Item	Freq(MHz)	Spec. Min	Spec. Max	Mea.
Insertion Loss(dB)	698~960	—	0.30	0.3
	1800~2700	—	0.45	0.4
Isolation (dB)	698~960	25	—	28
	1800~2700	25	—	28
Attenuation (dB)	698~960	25	—	28
	1800~2700	25	—	29
	3240~3820	5	—	6.0

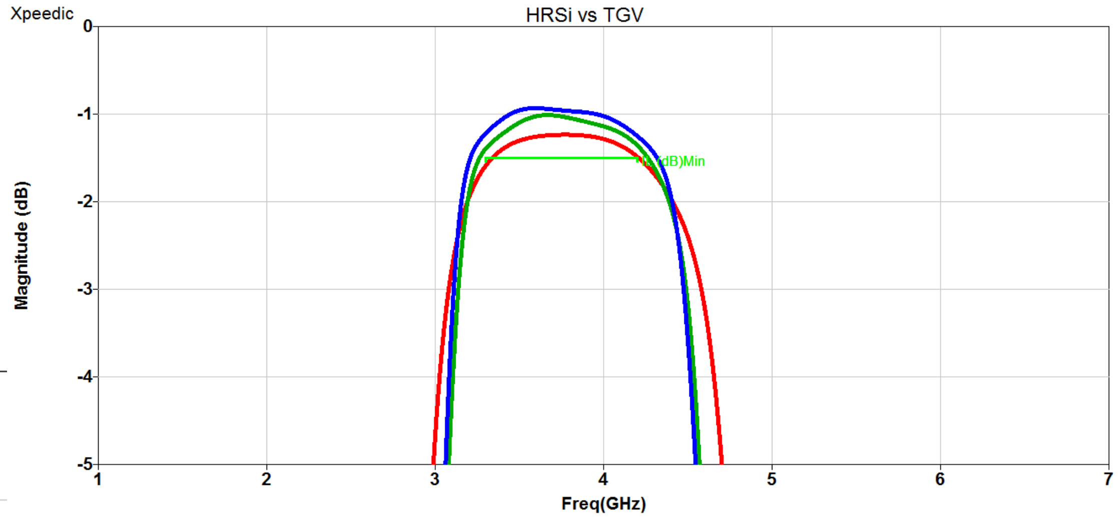
IPD for 5G NR Sub-6GHz

- Requirement
  - –Large bandwidth
  - –High isolation/rejection
  - –Co-existence with WiFi



5G NR Filter with TGV: N77





HRSi
TGV_50/250
TGV_100/300

Summary

- Filter is a critical piece for 5G RF front end.
- Various filter technologies such as LTCC, IPD, SAW and BAW and their combination are needed for 5G.
- IPD is indispensable for 5G RF front end.
- Xpeedic has demonstrated both HRSi- and TGV-based IPD technologies for 5G.

Contact Information for Further Questions

- Please contact the email address provided below for any follow-up questions:

support@xpeedic.com