



Connecting Your Life With RichWave WiFi 6 & 6E

Richwave Technology Corp.

2020/12/18

WIRELESS ADOPTION to EVERYWHERE

BEFORE _INDOOR



STUDY ROOM



OFFICE

FUTURE _OUTDOOR



SMART Lighting



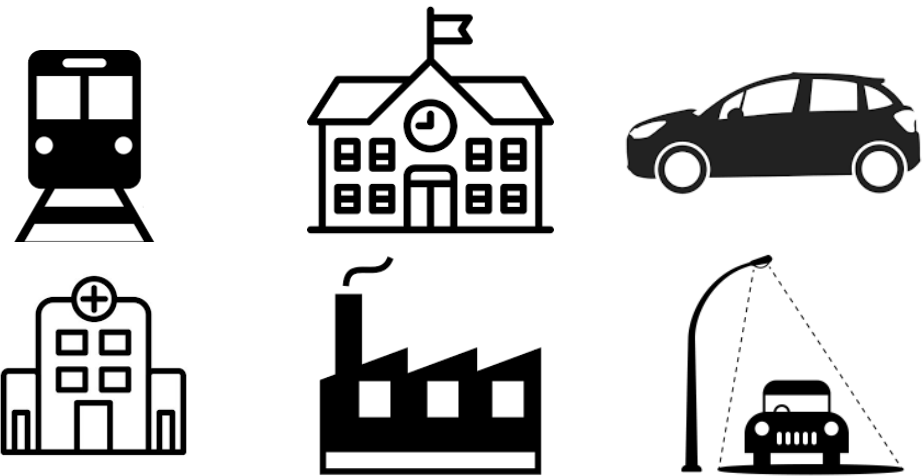
Surveillance



SMART Appliance



Gaming



(*all pictures are from the Internet)

RICHWAVE BOOSTs RF DEVICES in ALL

Market

B2C

Entertainment
Convenience
Security

B2B

Data/Video Transition
Communication
Autonomous

B2G

Location
Big Data Collection
Energy Saving

Applications

Client Device

Mobile Phone
Computer
IOT/Smart Devices

AP/Router

Retail Router
Enterprise Router
Customer Premise Equip.

Sensors

Smart Home
Smart City
Smart Factory



Noise Rejection

SAW Filter
- LTE filter
- WiFi Co-Existence Filter
Diplexer

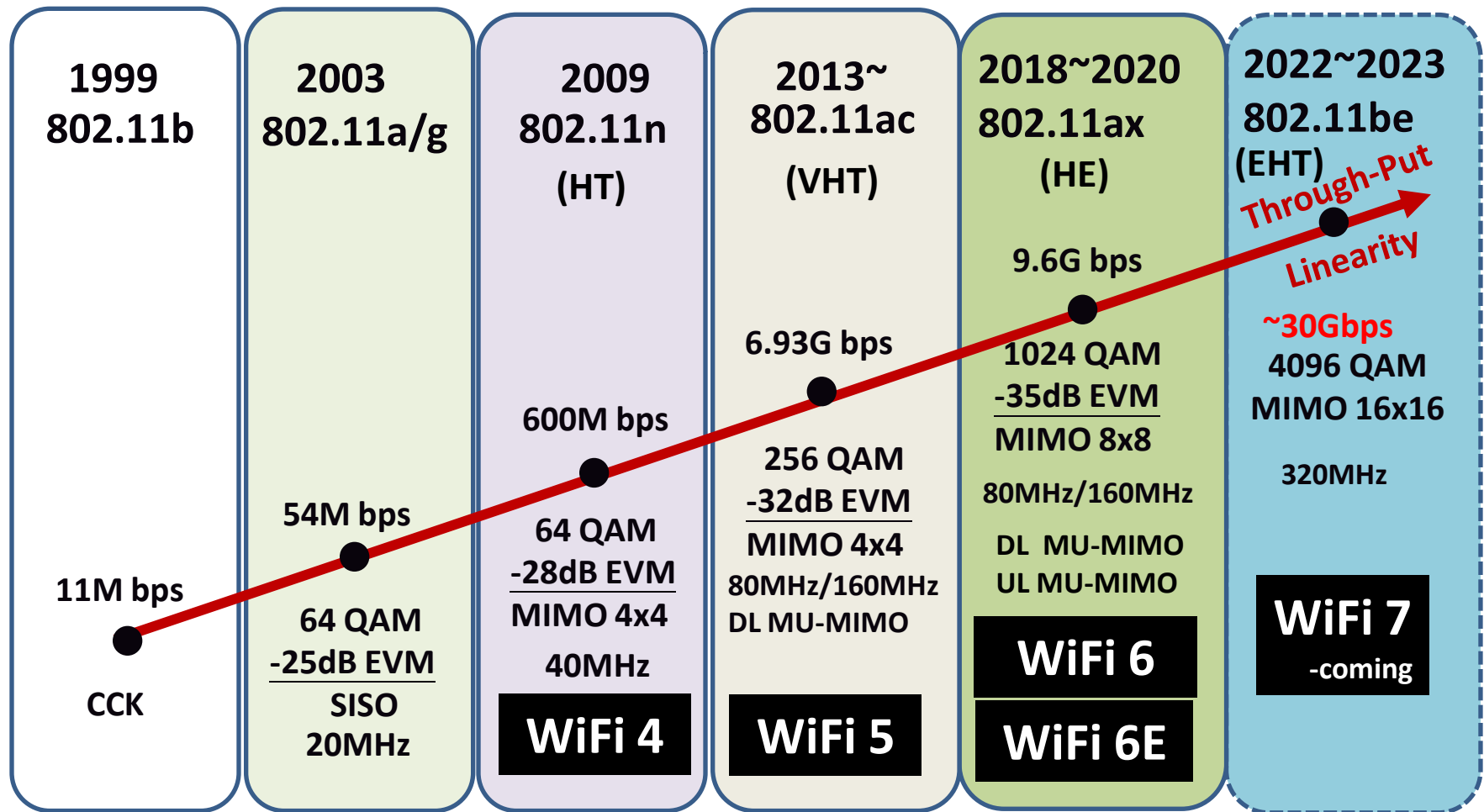
Extend Range

Power Amplifier (PA)
- High/Middle Power
- High Efficiency

Increase Coverage

Low Noise Amplifier(LNA)
- Low Noise Figure
- High Signal Gain

RICHWAVE is FRONTIER with WIFI Evolution



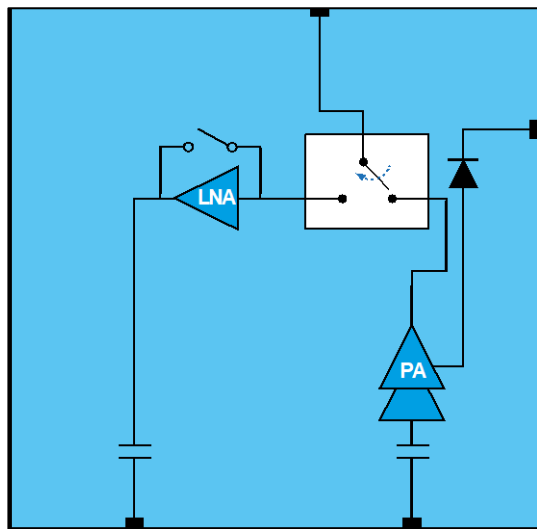
**RichWave
Support**

Host: AP/Router/CPE Gateway

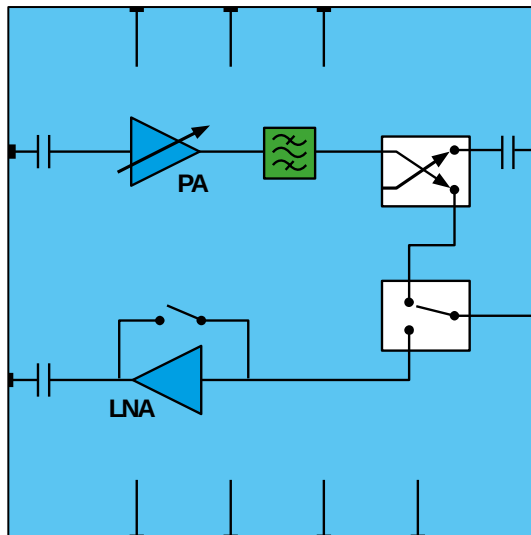
Client: Computing/Mobile/IOT

WIFI 6E PRODUCT POTOFOLIOs

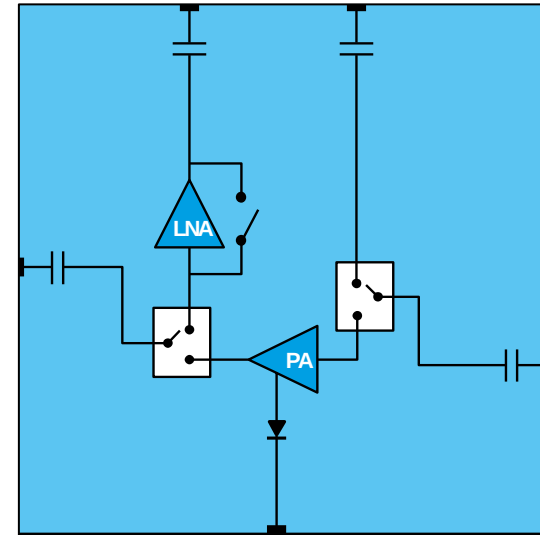
Part Number	Feature	Category	Application	Package
RTC66903	WiFi 6E FEM (6GHz)	Middle High Power	AP Router	3mmx3mm
RTC66910	WiFi 6/6E FEM (5-7GHz)	Middle Power (RF Coupler Feedback)	5G Mobile/Computing	2mmx2mm
RTC66916	WiFi 6/6E FEM (5-7GHz)	Middle Power (Voltage Feedback)	5G Mobile/Computing	2mmx2mm



RTC66903



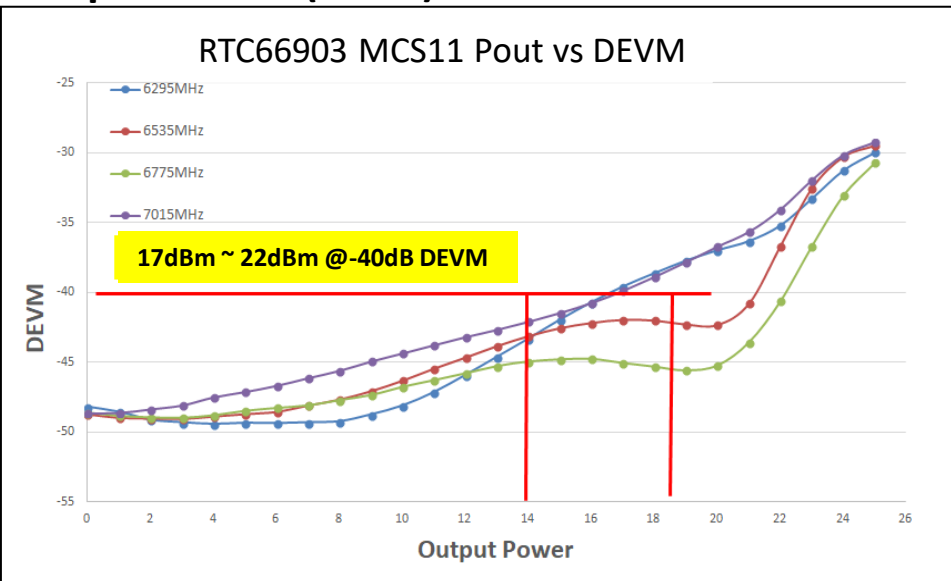
RTC66910



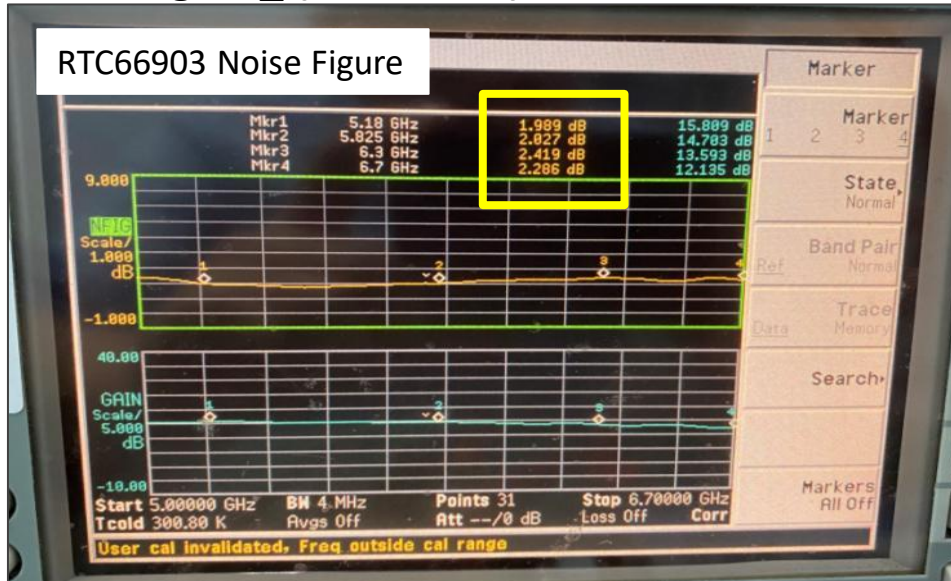
RTC66916

WiFi 6E Linearity and Noise Figure in 802.11ax

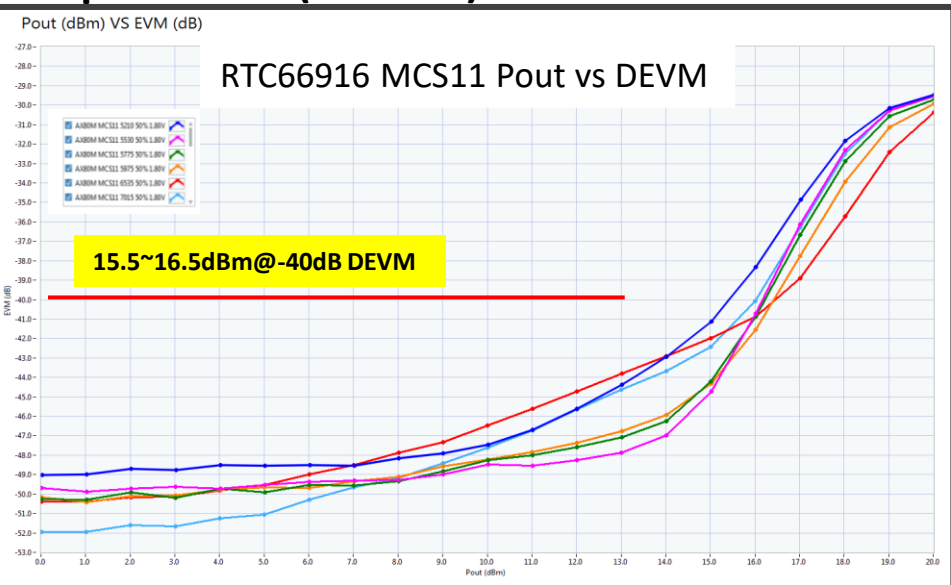
Output Power (6GHz)



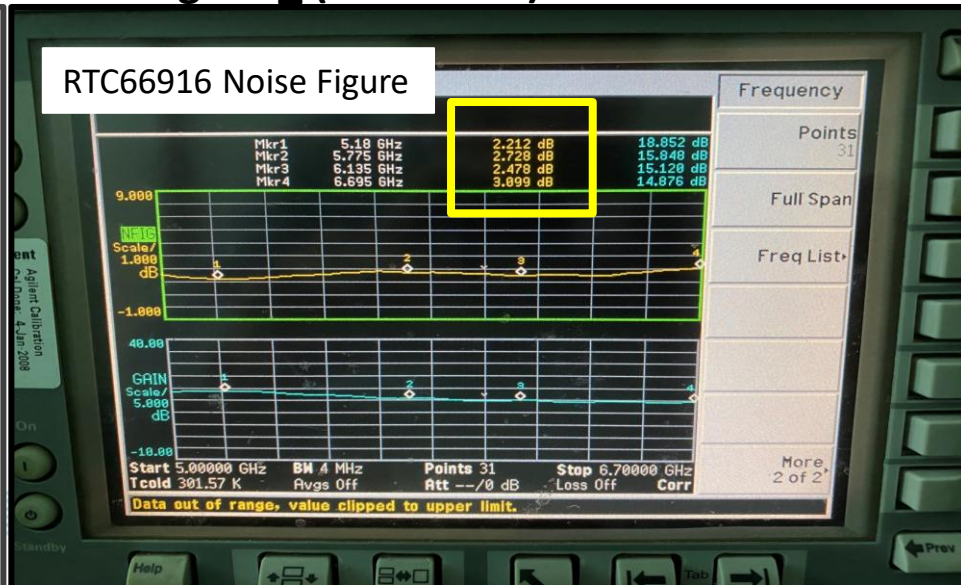
Noise Figure_ (1.8~2.0dB)



Output Power (5- 7GHz)



Noise Figure_ (2.0~2.7dB)



RichWave Full Lineup for WiFi6 Product Portfolios

Full Range of Output Power Line

- High Data Rate Output Power Range_18dBm/20dBm/>21.5dBm

Sustain Low Noise Figure

- Noise Figure _ < 2dB for 2.4G and 5G

Provide High Efficiency Line of Solutions

- Linear Solutions with <1W per chain
- Nonlinear Solutions with DPD support

Small Form Factor/ Compatible Solutions

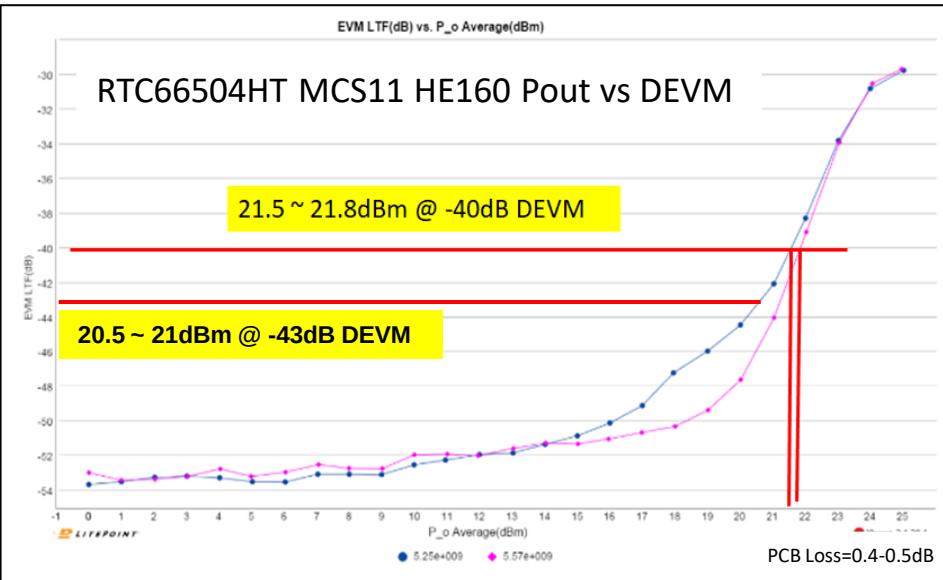
- From 3.0x3.0mm down to 2.0x1.7mm package

Support Variety Feedback Methodology

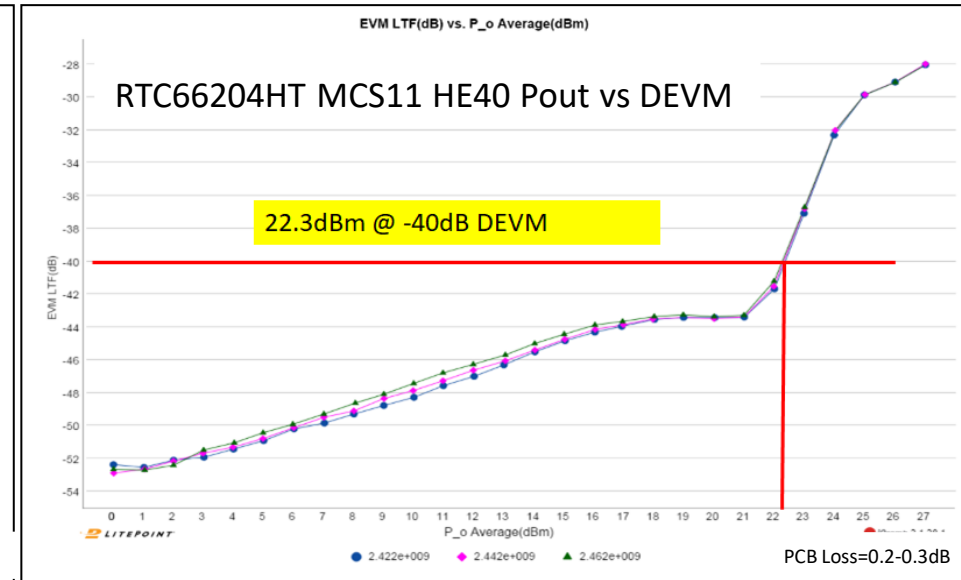
- RF Power Feedback / Voltage Diode Detector / Log-Det. Feedback

Full Range of Output Power FEM Candidates (High PWR)

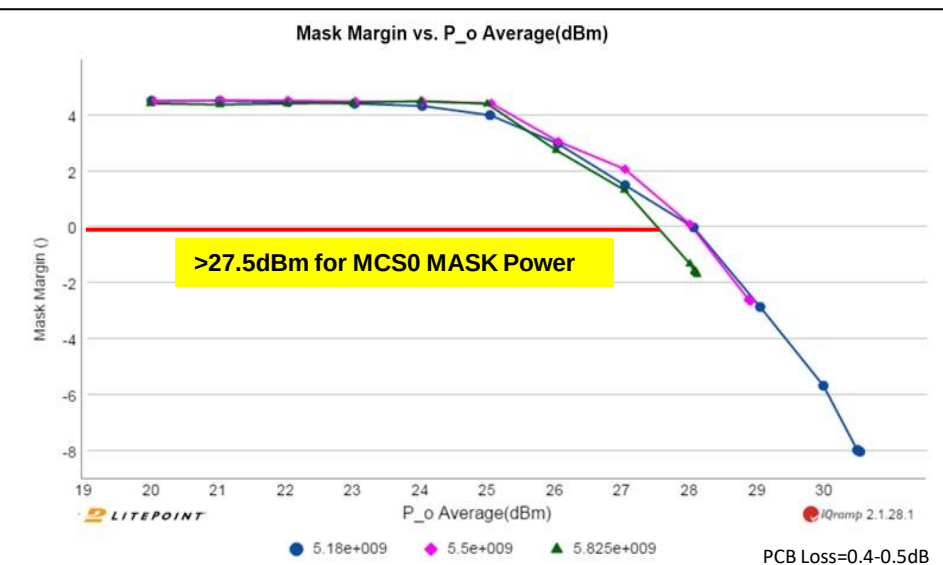
High Output Power _ (5GHz)



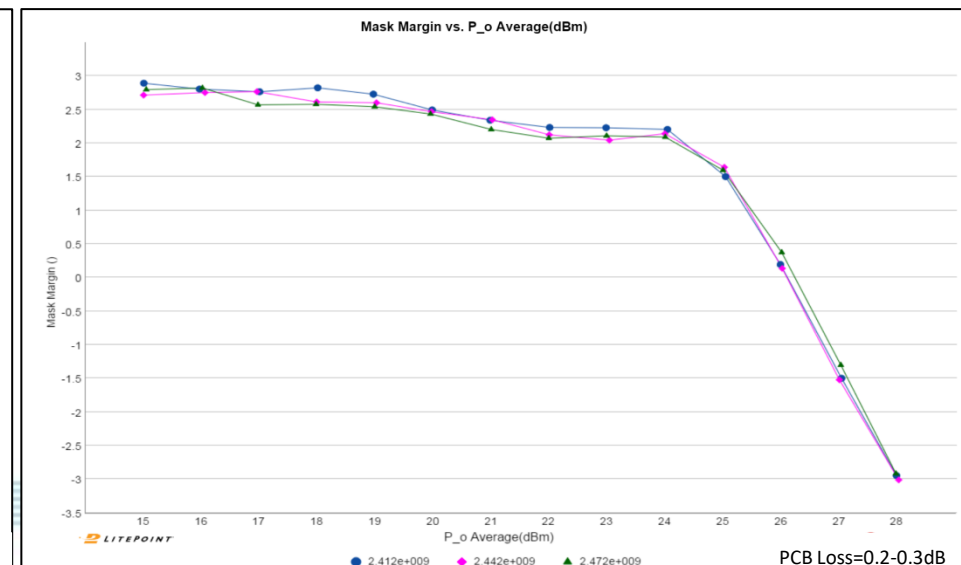
High Output Power _ (2.4GHz)



RTC66504HT MCS0 Mask Compliance Power

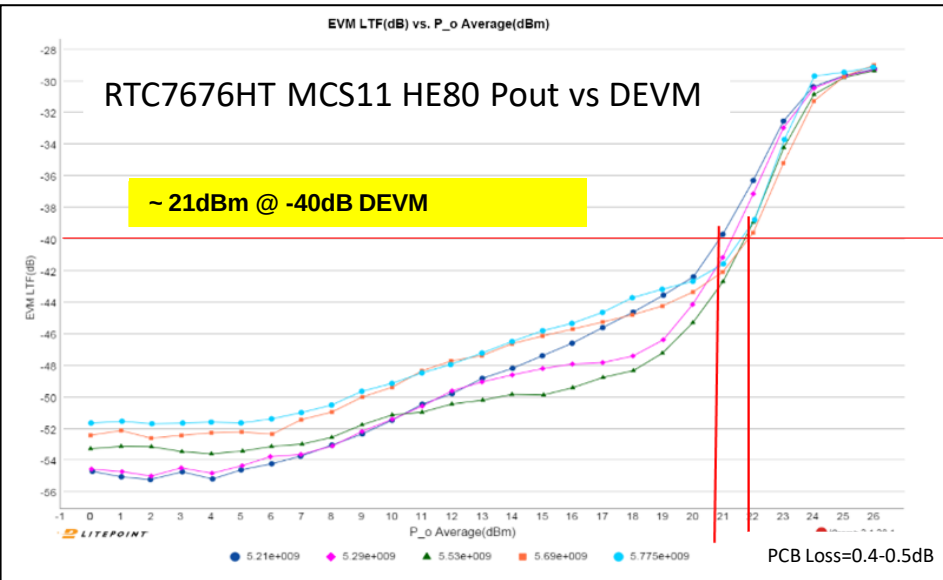


RTC66204HT MCS0 Mask Compliance Power

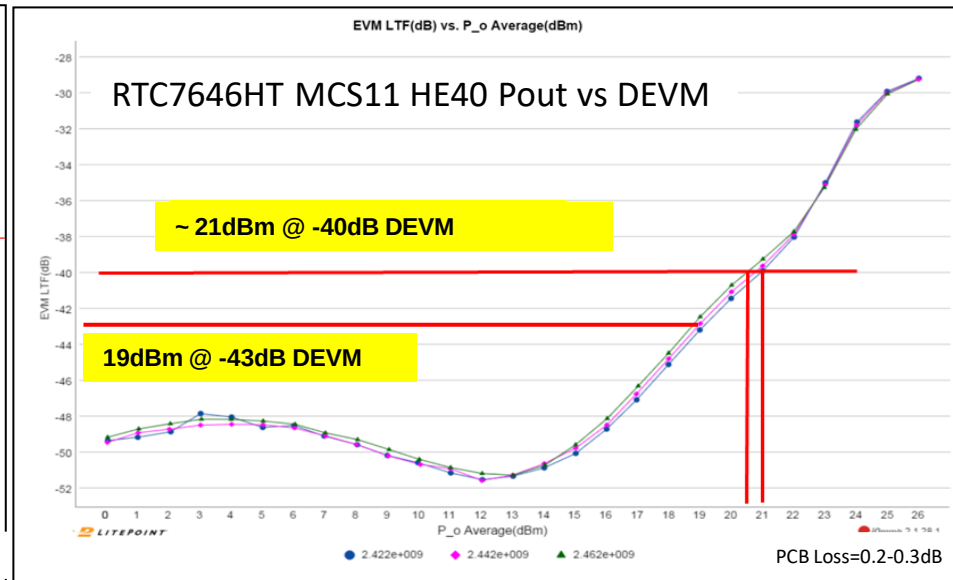


Full Range of Output Power FEM Candidates (Mid-High PWR)

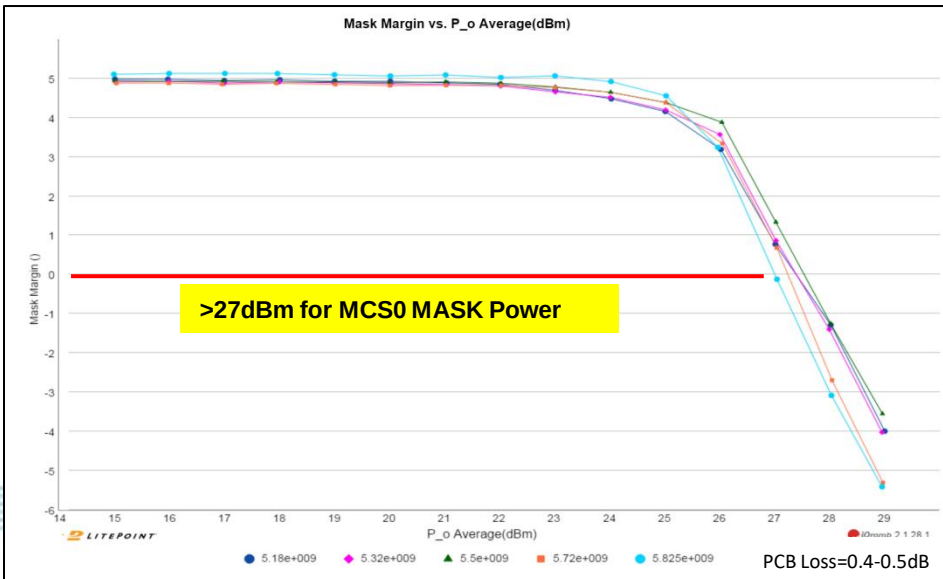
Middle High Output Power _ (5GHz)



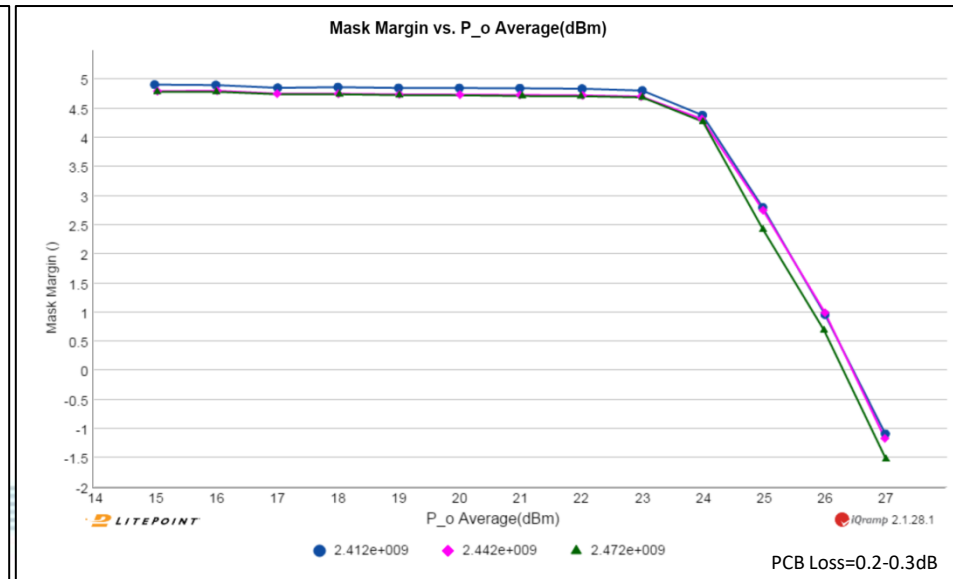
Middle High Output Power _ (2.4GHz)



RTC7676HT MCS0 Mask Compliance Power



RTC7646HT MCS0 Mask Compliance Power



Superior Receive Sensitivity Enhancement

5GHz Solutions

1.6~1.8dB

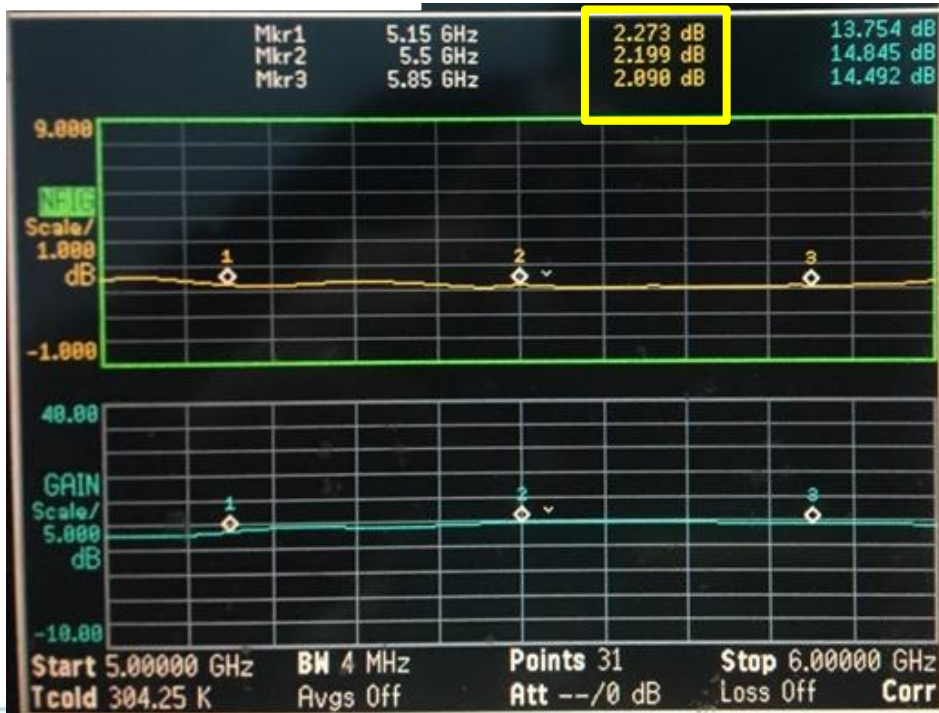
2.4GHz Solution

1.65~1.75dB

(Remark: De-embedded EVB Loss 0.2~0.3dB for 2.4GHz/ 0.4~0.5dB for 2.5dB)

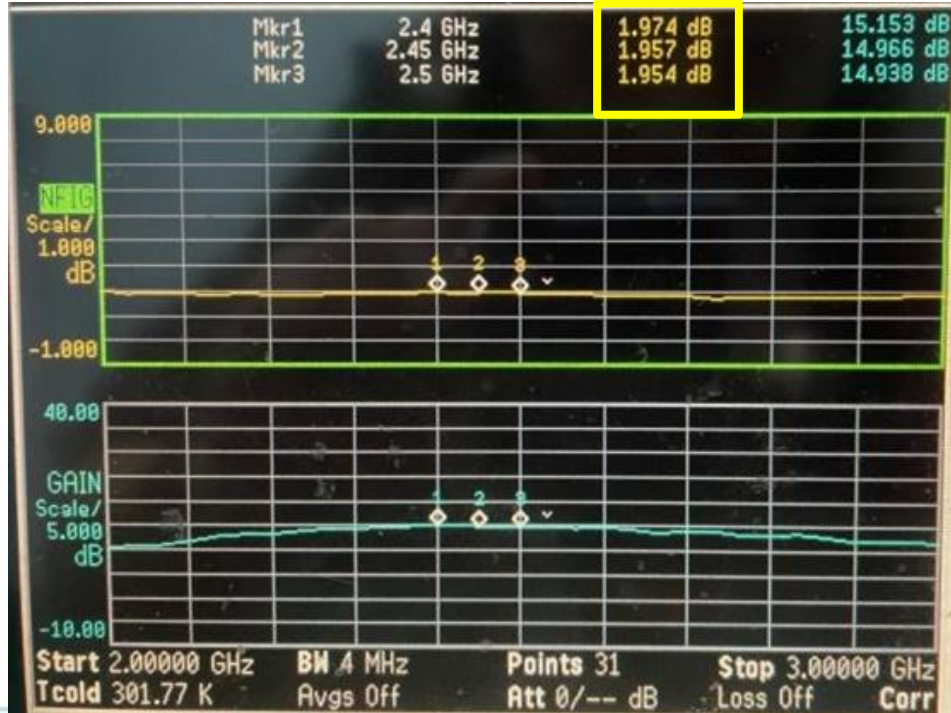
Low Noise Figure_ (5GHz)

RTC66569 Noise Figure



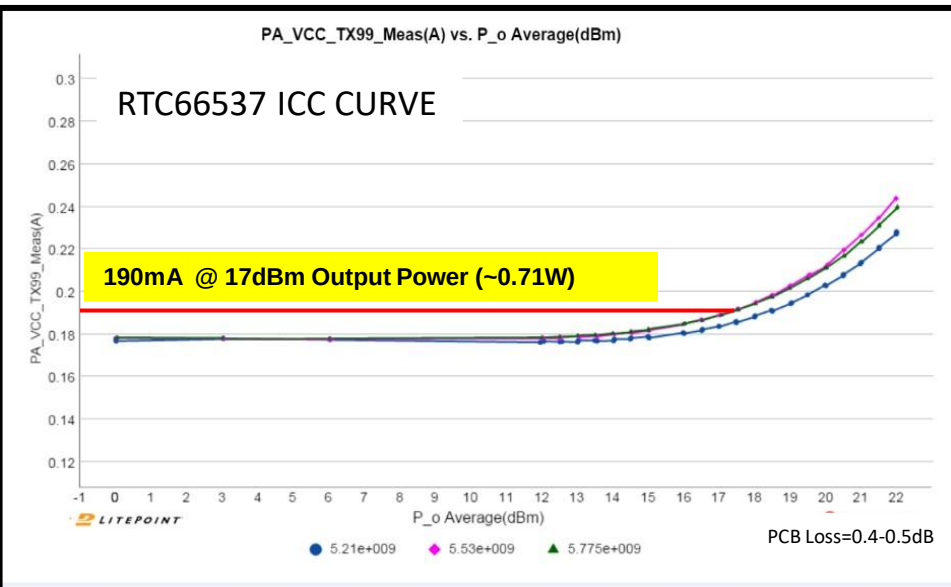
Low Noise Figure_ (2.4GHz)

RTC66266 Noise Figure

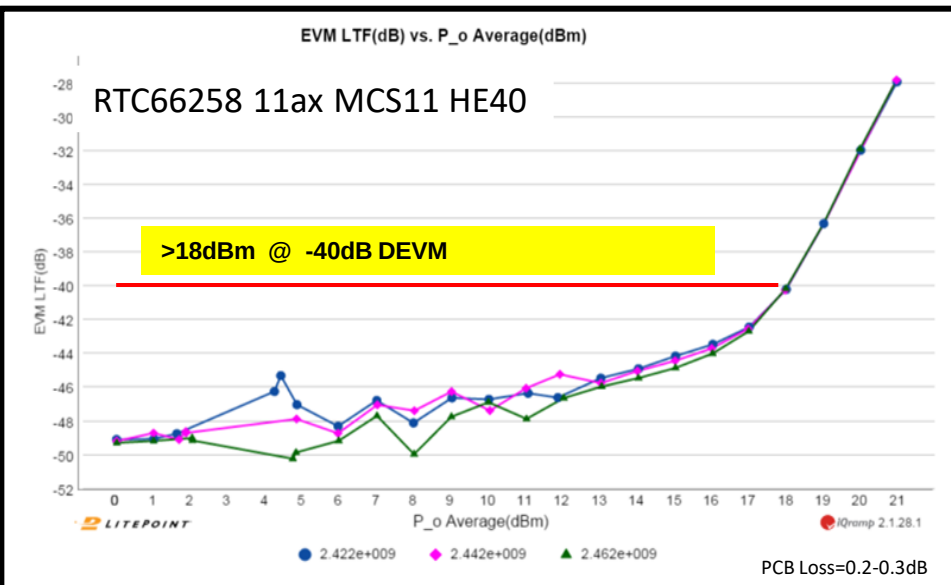
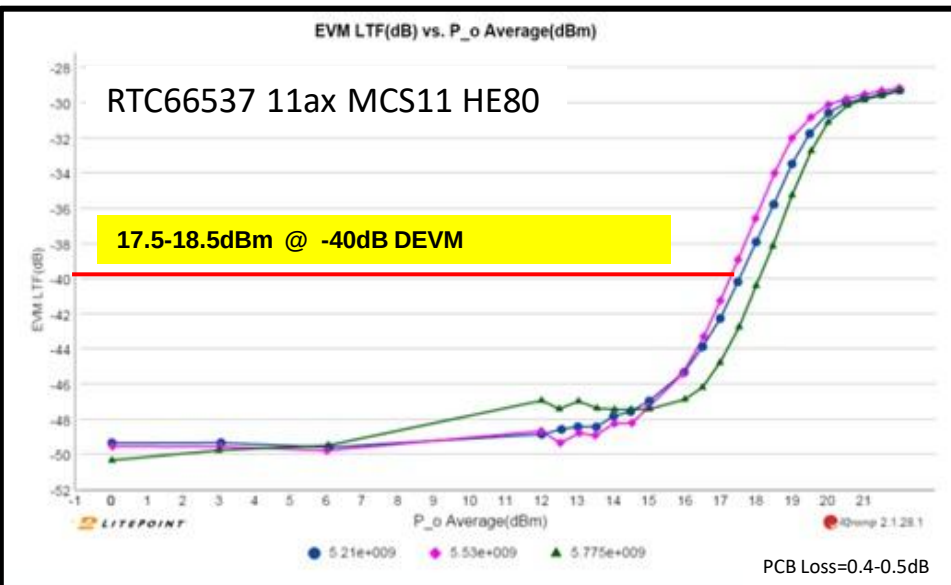
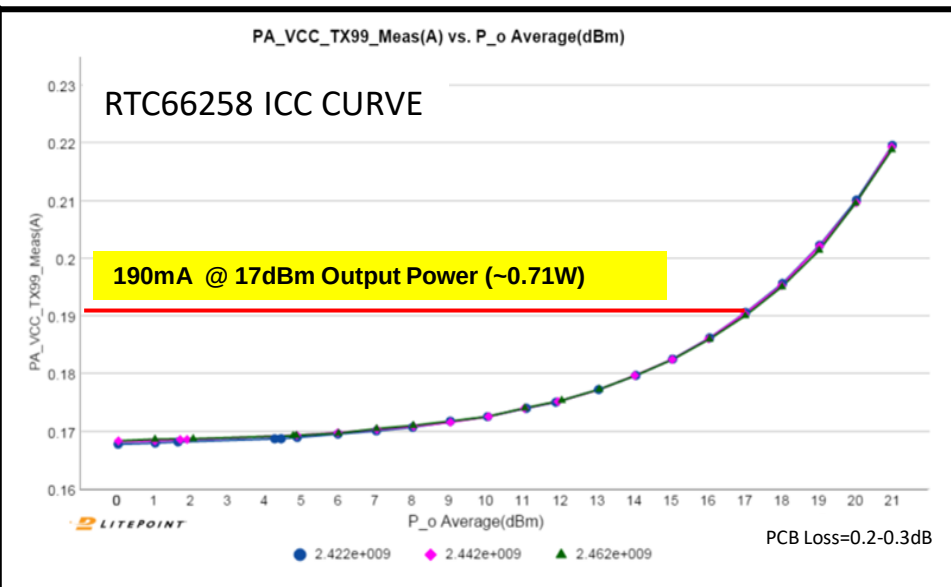


Provide High Efficiency Solutions

Linear Solution _ (5GHz 4G/5G Mobile)



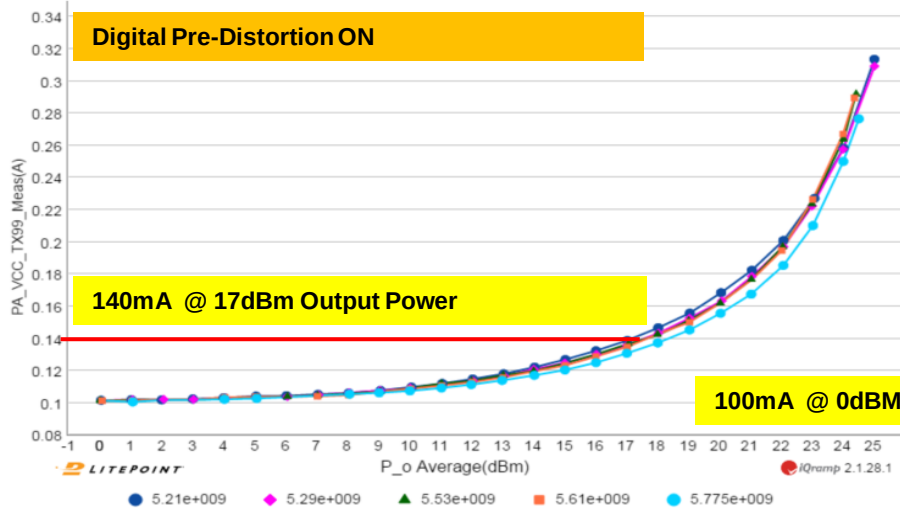
Linear Solution _ (2.4GHz 4G/5G Mobile)



Provide High Efficiency Solutions

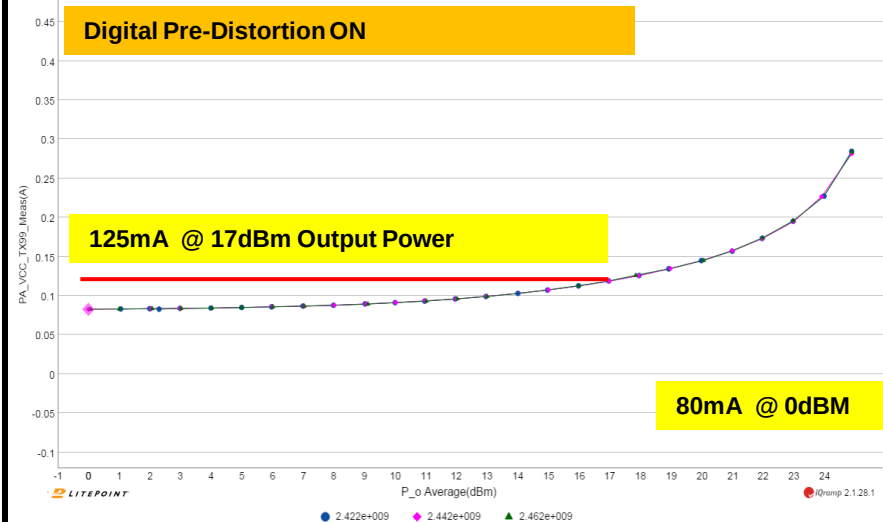
NonLinear Solution _ (5GHz)

PA_VCC_TX99_Meas(A) vs. P_o Average(dBm)

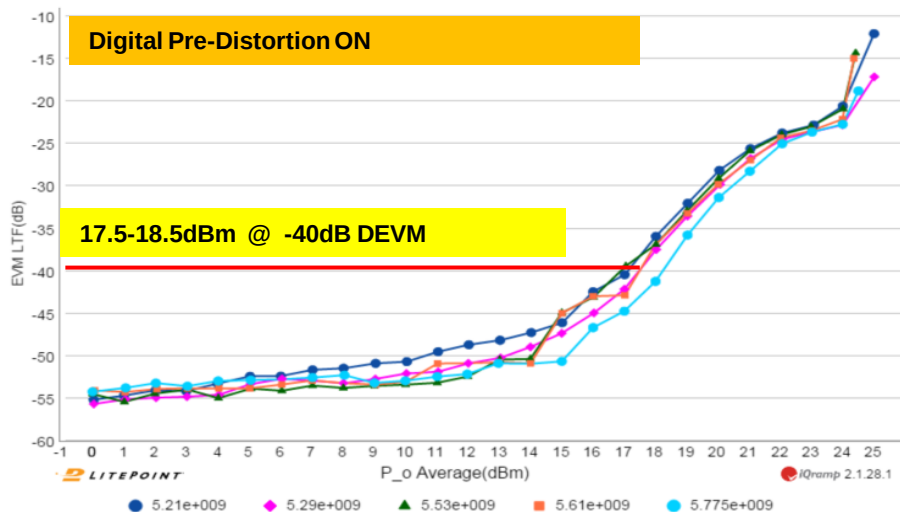


NonLinear Solution _ (2.4GHz)

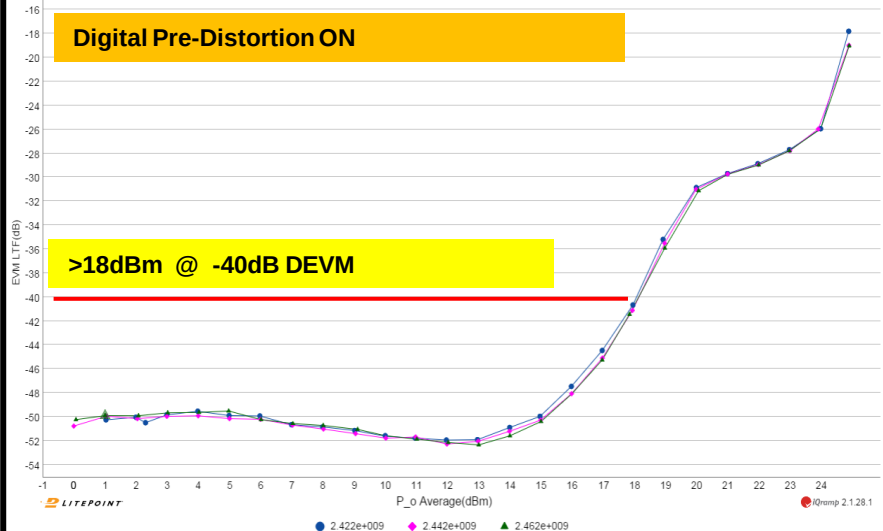
PA_VCC_TX99_Meas(A) vs. P_o Average(dBm)



EVM LTF(dB) vs. P_o Average(dBm)



EVM LTF(dB) vs. P_o Average(dBm)

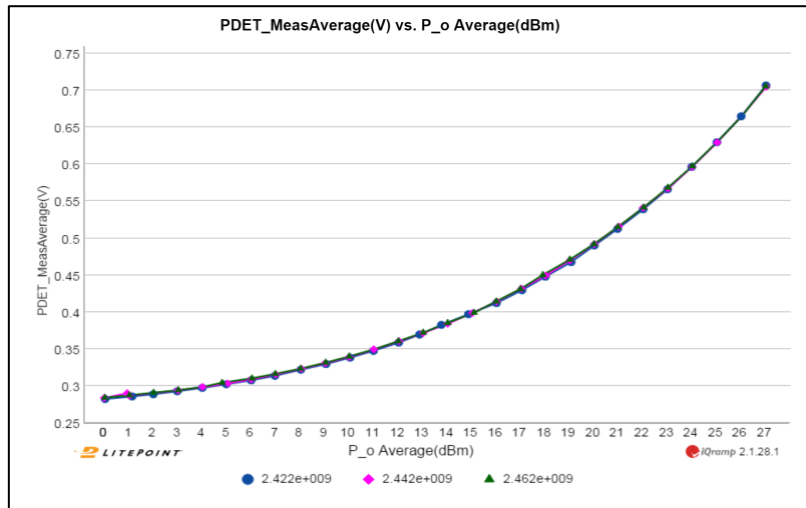




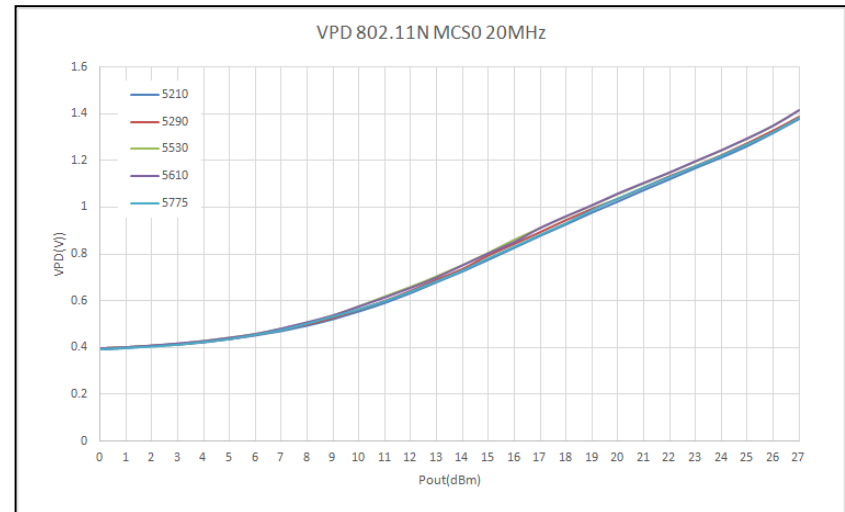
Support Multiple Feedback Mode for SOC Chipsets

Voltage Detector Feedback

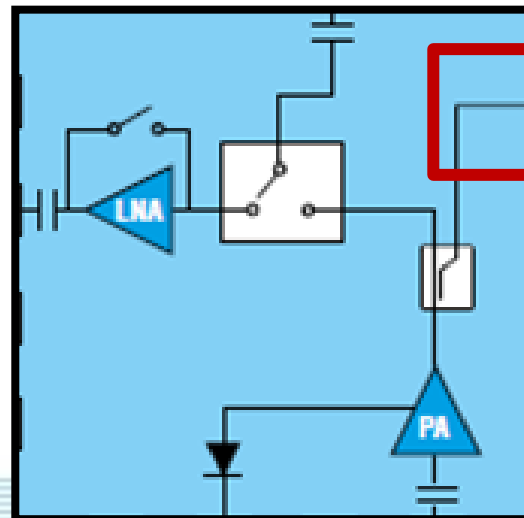
Diode Exponential Curve



Log Linear Type Curve



RF Power Detector Feedback

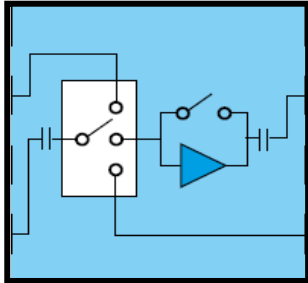


RF Signal
Feedback Output

Chipset

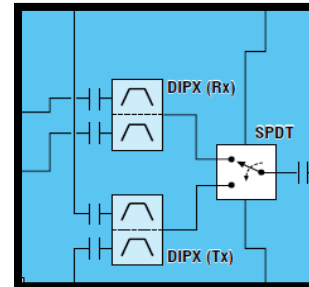
RICHWAVE OFFERS COMPLETE RF LINE

Rx-FEM



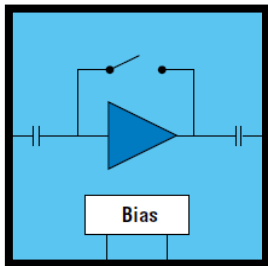
- LNA + SW only
- WiFi 4/5/6/6E
- QFN or WLCSP

Dual Passive FEM



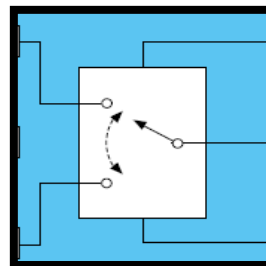
- Diplexer + SW
- Support 2.4+5GHz
- QFN Package

LNA



- Bypass Support
- 2.4/5/6GHz
- QFN Package

Switch



- High/Normal PWR Handling
- 2.4/5/6GHz
- QFN or WLCSP

SAW Filter



- Reject LTE
- WiFi 2.4GHz
- QFN Package

Our Competiveness to Customers

Maximizing Customers' Satisfaction and Value

Complete R&D Teams

RF Circuit Design
Transceiver Design
Analogue Circuit Design
Digital Circuit Design
Thermal Analysis

Strong Manufacture Support & Control Teams

Product Engineering
Testing Engineering
Quality Analysis
Manufacture Control

Global Sales & FAE Support Teams

Taiwan- Taipei (HQ)
US- San Jose
China- Shanghai, Shenzhen
Korea- Gyeonggi-do
European Sales Rep.
Japan Sales Rep.

Support Value Propositions



RichWave



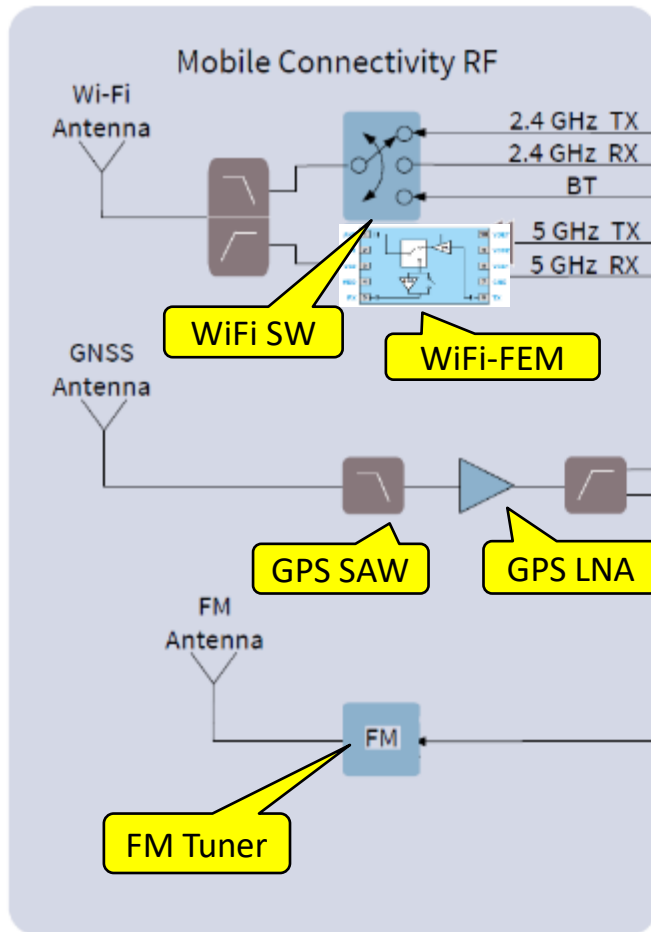
RichWave 5G RF Components Direction and Prospects

RichWave Technology Corp.

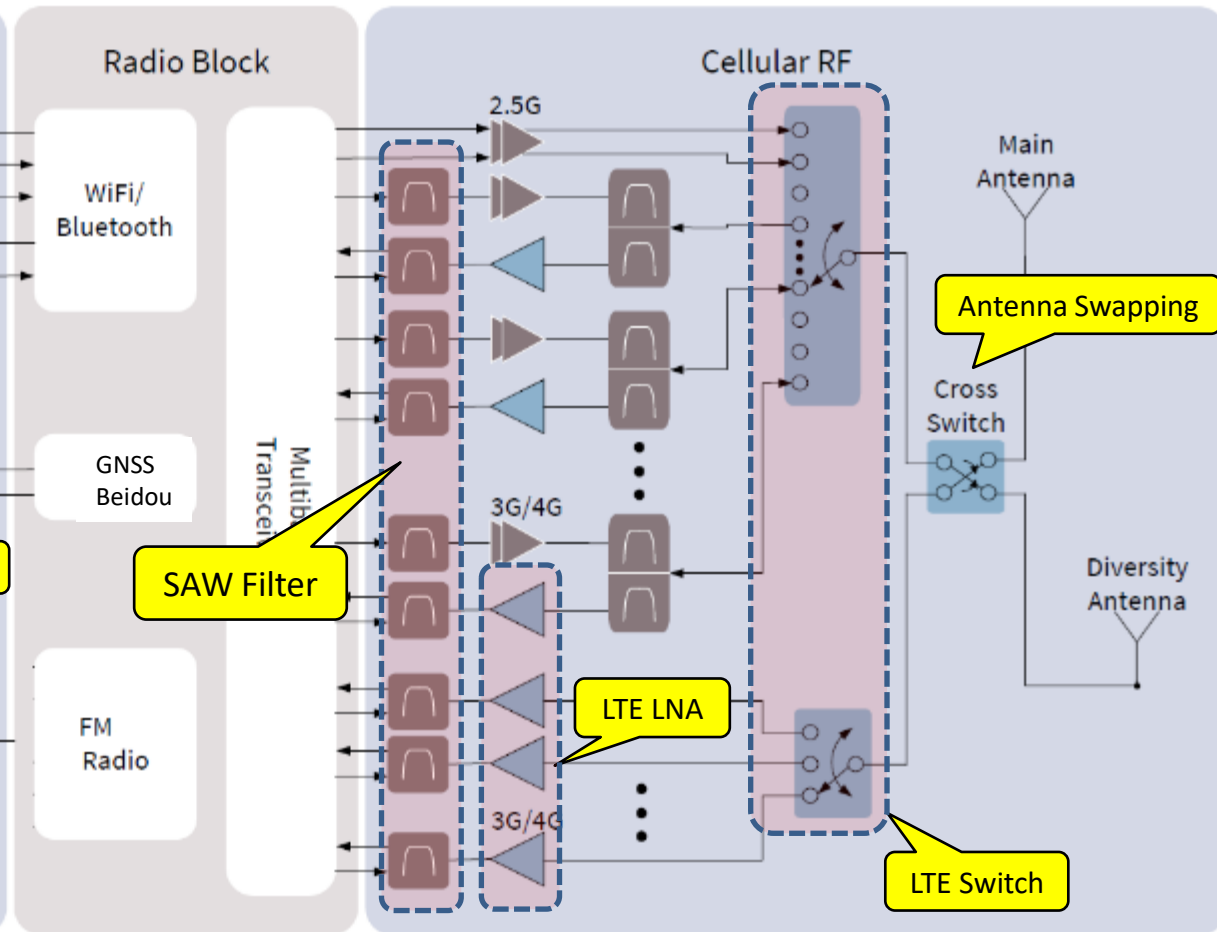
2020/12/18

RichWave Product Line in 4G Mobile Phone

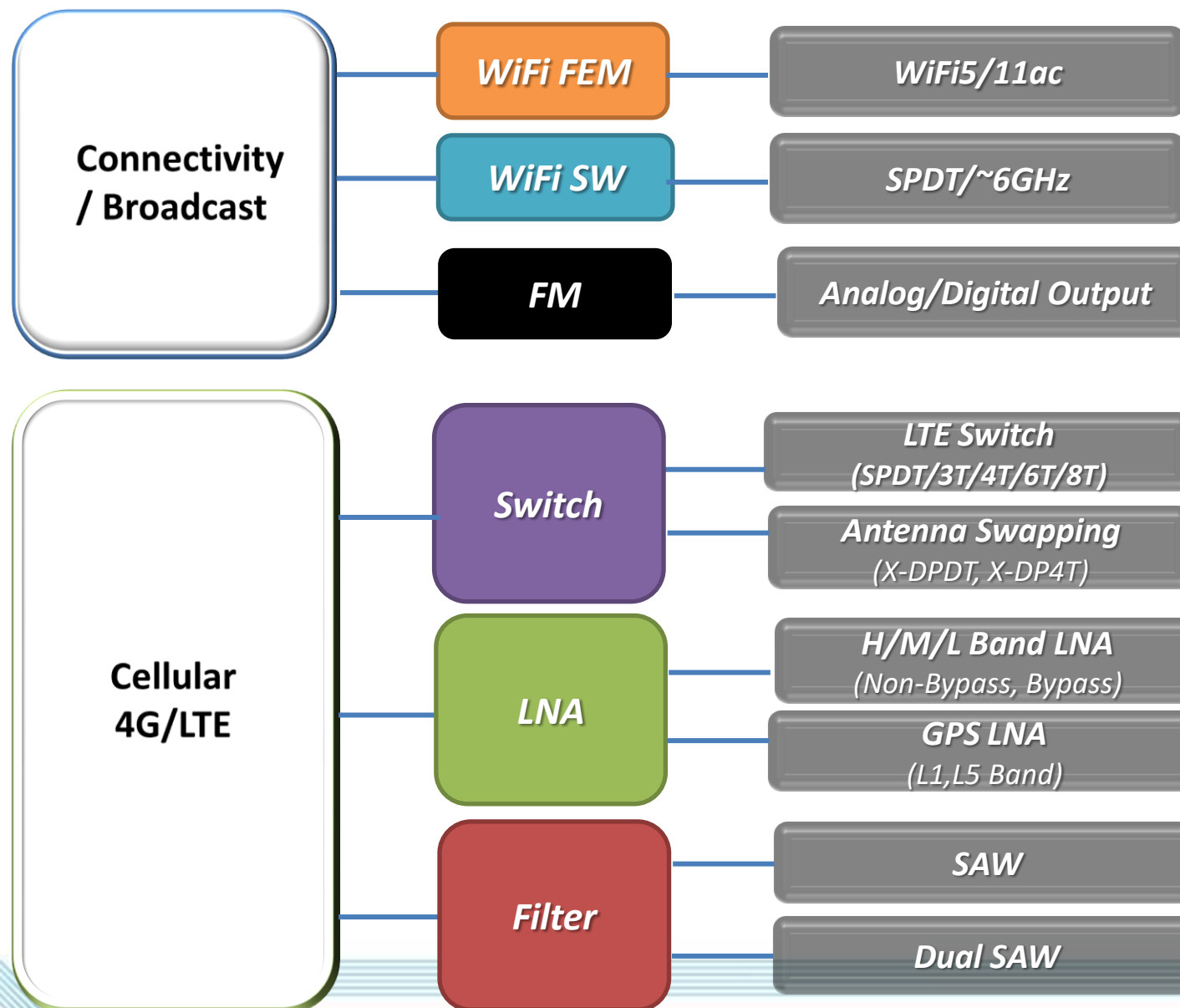
Connectivity/ Broadcast



Cellular 4G/LTE



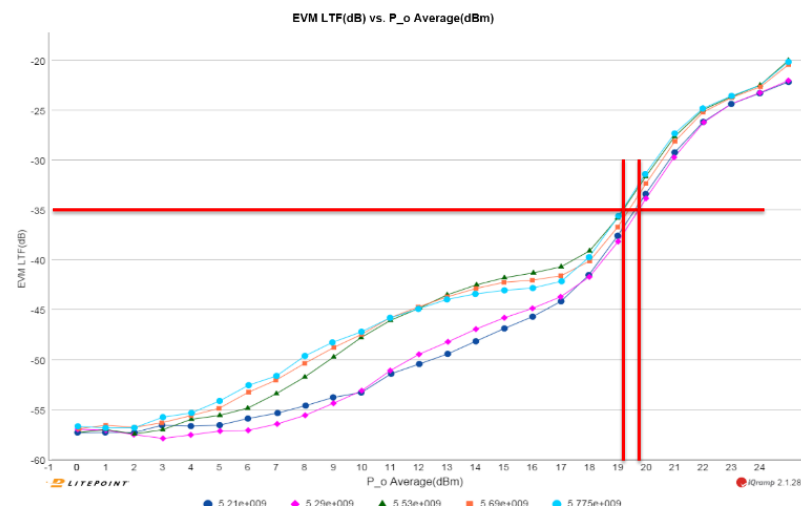
RichWave Products for 4G Mobile



WiFi FEM Product Line

11ac MCS9 VHT80 DEVM@-35dB=19.1~19.8dBm

- Fully Support QCOM&MTK 11ac platform
- Super-linear:
 - 2G: 20dBm@11ac,MCS9/DEVM=-35dB
 - 5G: 19dBm@11ac,MCS9/DEVM=-35dB
- Small Package Size:
 - 2G:QFN 2.0*2.0 / 5G:QFN 2*1.7

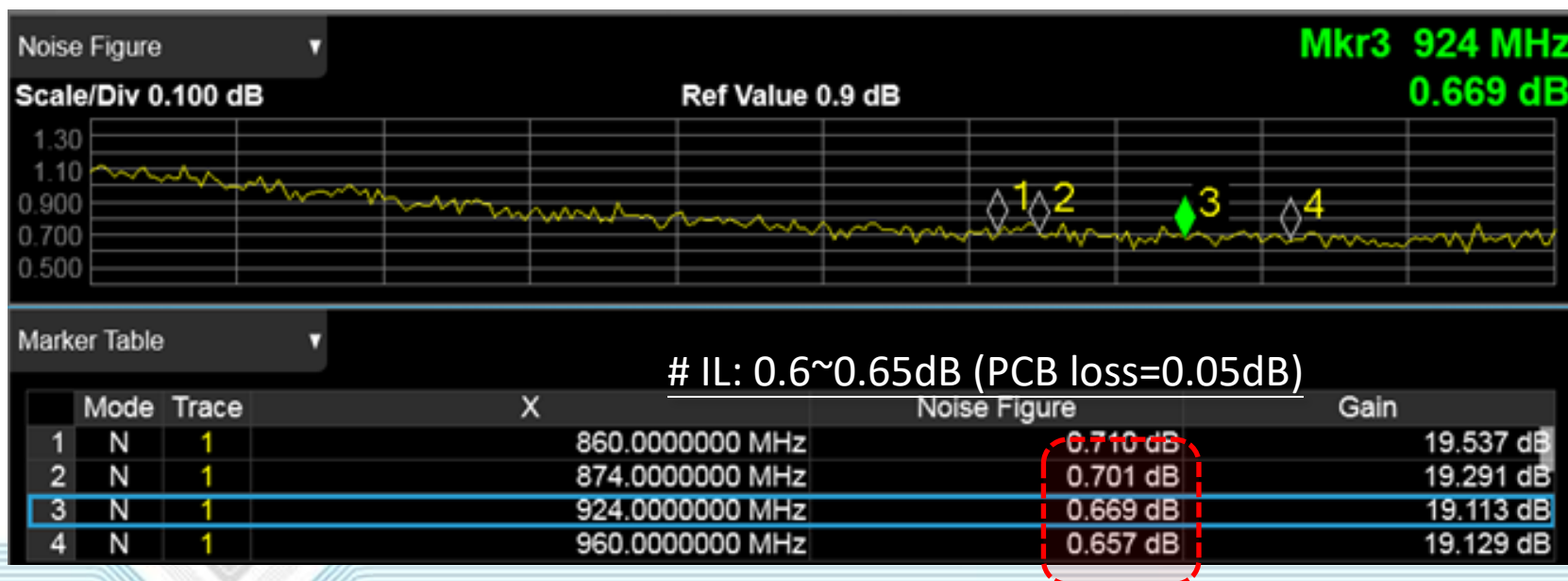


P/N	Feature	Platform
RTC7667	2G FEM (QFN2.3*2.3)	QCOM
RTC7637S	5G FEM (QFN2.3*2.3)	
RTC7682	2G FEM (QFN 2.0*2.0)	
RTC7639	5G FEM (QFN 2.0*1.7)	
RTC66526	RX FEM (QFN 1.5*1.5)	MTK
RTC66202	2G FEM (QFN2.3*2.3)	
RTC7637S	5G FEM (QFN2.3*2.3)	
RTC7639	5G FEM (QFN 2.0*1.7)	

4G LNA Product Line

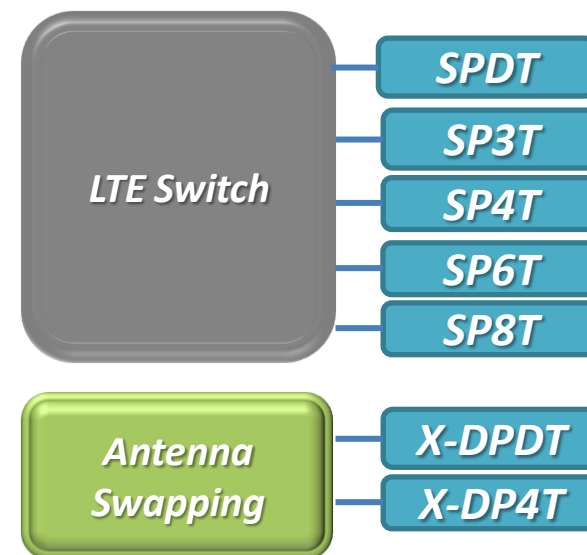
- Low Supply Voltage: 1.8V/2.8V
- Full Cover 4G Freq: 617~2690MHz
- Ultra-Low Noise Figure: 0.6~0.65dB
- Small Package Size: QFN 1.1*0.7

Gain	Freq. Range	Feature	Package
13/15/18dB	L/M/H Band	Bypass & Non-Bypass Mode	QFN 1.1*0.7



4G Switch Product Line

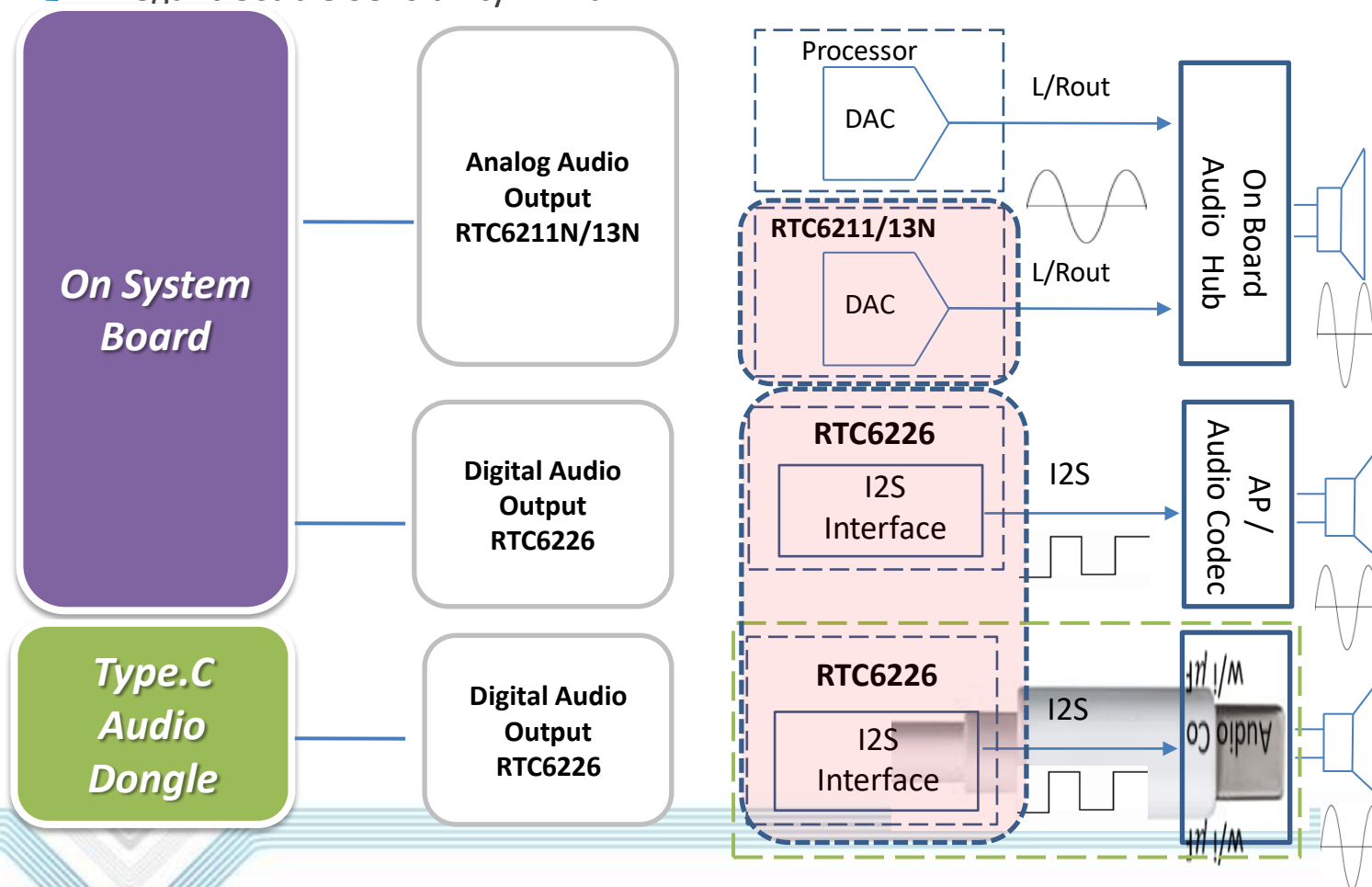
- General Switch Part for QCOM & MTK
- Full Cover 4G Freq: 617~2690MHz
- Low Insertion Loss
- High P0.1dB: 38dBm



Feature	Insertion Loss (dB)	RF to RF Isolation (dB)	Input P0.1dB (dBm)	Package (mm, typ)
SPDT	0.20 @1.0 GHz 0.24 @2.7 GHz 0.37 @ 6.0 GHz 0.60 @ 7.125 GHz	39 @1.0 GHz 28 @2.7 GHz 19 @ 6.0 GHz 15 @ 7.125 GHz	32	6L QFN 1.1x0.7x0.50
SP8T	0.45 @1.0 GHz 0.75 @2.7 GHz	33 @1.0 GHz 23 @2.7 GHz	36	14L QFN 2.0x2.0x0.55
X-DP4T	0.16 @1.0 GHz 0.32 @2.7 GHz	27 @1.0 GHz 26 @2.7 GHz	30	10L QFN 1.2x1.6x0.55
X-DPDT	0.31 @1.0 GHz 0.41 @2.7 GHz	28 @1.0 GHz 20 @2.7 GHz	38	12L QFN 2.0x2.0x0.55

FM Product Line for Mobile

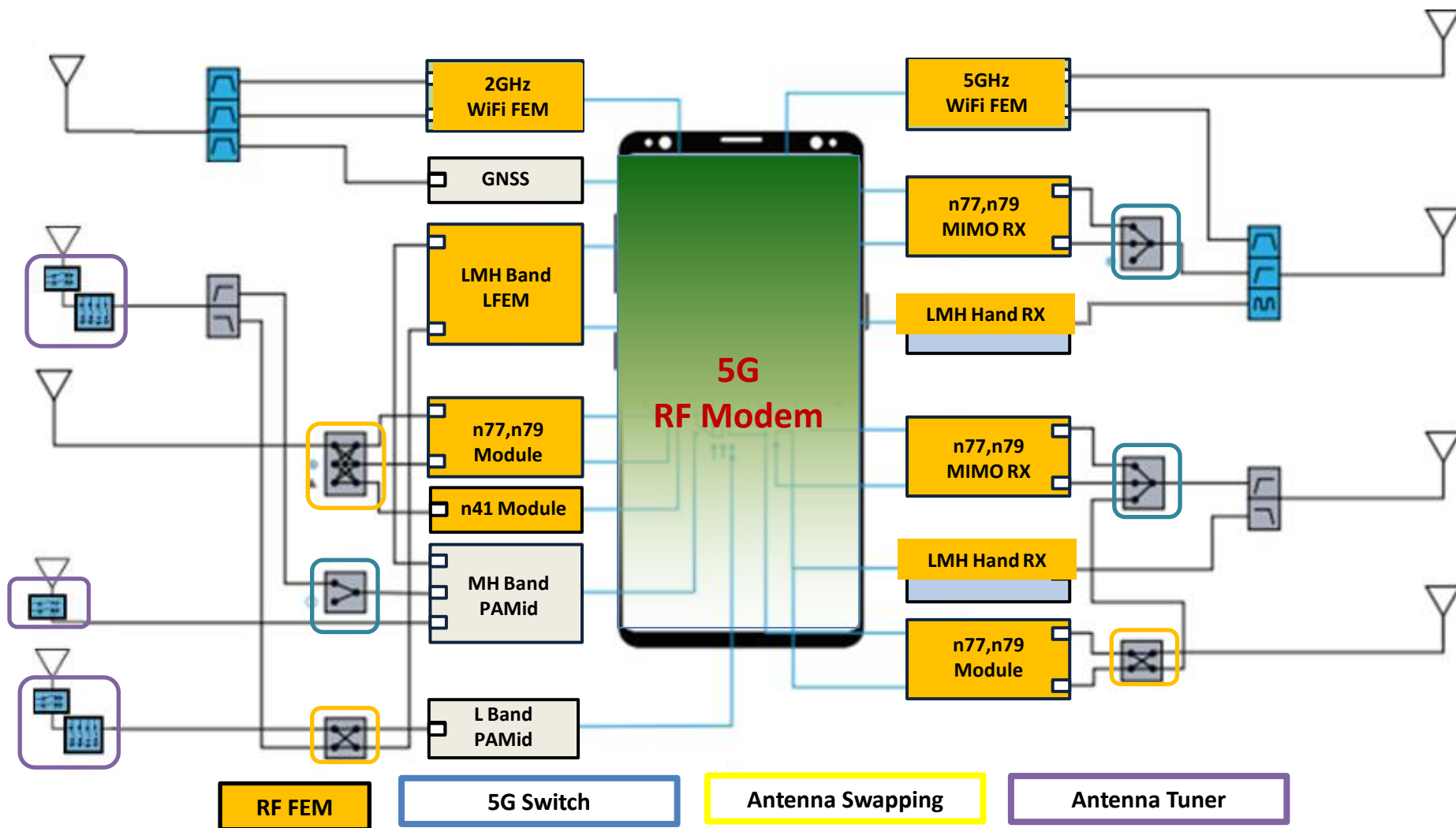
- Worldwide FM band support (64~108 MHz)
- Support Analog & Digital Output (I2S Output)
- Robust Auto-seeking Algorithm
- Support RDS Function
- Elegant Usable Sensitivity: 1.2 μ V EMF



4G SAW Filter Product Line

GPS/ WIFI Application			
Part Number	Support Band	Package (mm ²)	Application
RTC46S2RUKA	GPS L1	0.9x0.7	GPS SAW
RTC46S3RUKA	GPS L5	0.9x0.7	GPS SAW
Cellular Application (Single SAW)			
RTC46SARUHA	B1 Rx	1.1x0.9	Cellular Rx SAW
RTC46SCRUHA	B3 Rx	1.1x0.9	Cellular Rx SAW
RTC46SQTUHA	B40 Tx	1.1x0.9	Cellular Tx SAW
RTC46SGRUHA	B8 Rx	1.1x0.9	Cellular Rx SAW
RTC46SKRUHA	B26 Rx	1.1x0.9	Cellular Rx SAW
RTC46SPRUHA	B39 Rx	1.1x0.9	Cellular Rx SAW
RTC46SQRUHA	B40 Rx	1.1x0.9	Cellular Rx SAW
RTC46SRRUHA	B41 Rx	1.1x0.9	Cellular Rx SAW
Cellular Application (Dual SAW)			
RTC48ACRUFA	B1/B3 Rx	1.5x1.1	Cellular Rx SAW
RTC48PRRUFA	B39/B41 Rx	1.5x1.1	Cellular Rx SAW
Cellular Application (Duplexer)			
RTC47CCTUDA	B3 DPX	1.8x1.4	Cellular DPX
RTC47EETUDA	B5 DPX	1.8x1.4	Cellular DPX
RTC47GGTUDA	B8 DPX	1.8x1.4	Cellular DPX
RTC47FFTUDA	B7 DPX	1.8x1.4	Cellular DPX
RTC47AATUDA	B1 DPX	1.8x1.4	Cellular DPX
RTC47BBTUDA	B2 DPX	1.8x1.4	Cellular DPX
RTC47DDTUDA	B4 DPX	1.8x1.4	Cellular DPX

5G Phone Architecture



5G NR RF Front End Challenge

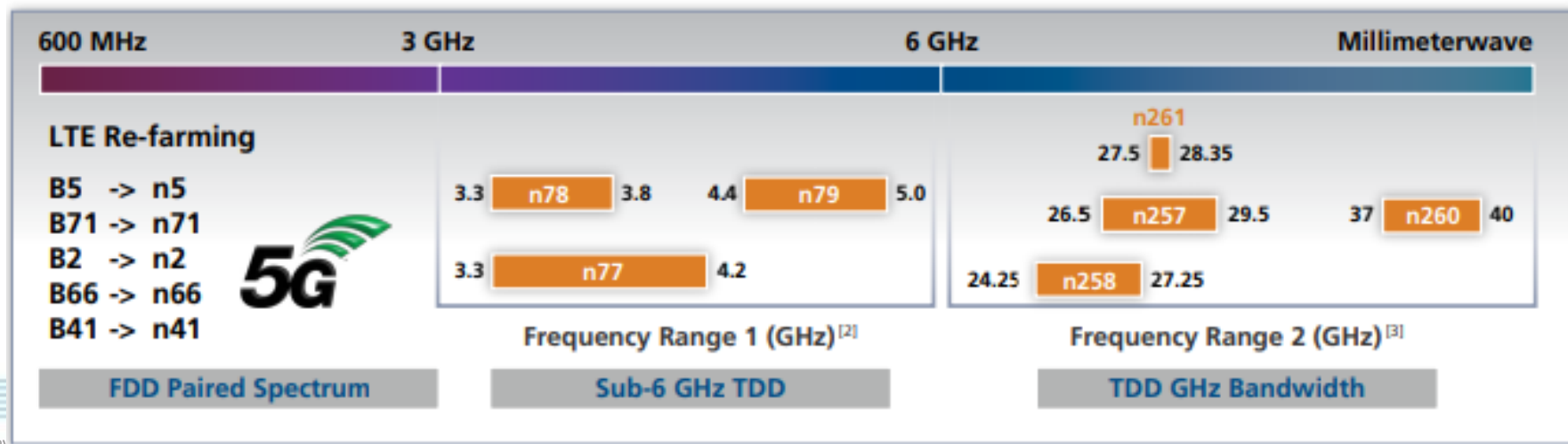
- PA: High PAPR for uplink (UL) with 256QAM
 - 26dBm (5G HPUE) requirement at the antenna port.
 - PA with back-off with lower distortions with less than 1.85% EVM
 - Wider channel BW for FR1 up to 100MHz
- High Integration and Module Miniaturization
 - Seamless transition from 4G to 5G
 - Adapt the old legacy system (2G/3G/4G) and the co-existence of multiple WiFi6, BT and GPS
 - New 5G dedicated bands for sub-6GHz such as n77/n78 (3.3-4.2GHz), n79 (4.4-5GHz) and eLAA bands B46, B47 (5.15GHz-5.92GHz)
 - Support 8 to 10 Antennas
 - Support EN-DC (LTE/NR Dual Connectivity)
 - LAA and eLAA for CA both in UL and DL
 - 2x2 UL-MIMO and DL for cost effective



5G Freq Range and Challenge

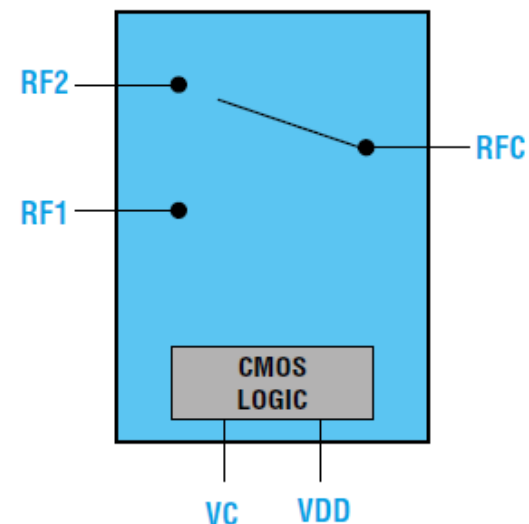
- High linearity Power Amplifier
- Wideband high Q filter
- Wideband multi-gain stage LNA
- Multi-technologies integration
- Compact module integration

SPEC. ITEMS	5G NR FR1
Frequency Bands (GHz)	n41: 2.469GHz~2.690GHz n77: 3.3GHz~4.2GHz N78: 3.3GHz~3.8GHz N79: 4.4GHz~5.0GHz
Channel BW (MHz)	Up to 100MHz
Subcarrier Spacing (KHz)	15, 30, 60KHz
FFT Size	3276 (up to 4096)
Highest Modulation	Up to 256QAM
Waveform	CP-OFDMA (UL/DL) DFT-s-OFDMA(UL)
EVM (dB) for System	-29.1dB (3.5%)
EVM (dB) for PA	34.66dB (1.85%)



5G SRS Low Power Switch

- Freq. Range: 0.6GHz ~ 8.25GHz
- Low Supply Voltage: 1.8V
- Ultra-Low IL: 0.36dB @ 6GHz
- Fast switching time: 160ns
- Small Package Size: QFN 1.1*0.7



Freq. Range	Insertion Loss (dB)	Switching Time
617 ~ 960 MHz	0.2	160ns
960 ~ 2170 MHz	0.23	
2170 ~ 2700 MHz	0.24	
3300 ~ 3800 MHz	0.28	
4000 ~ 6000 MHz	0.36	
6000 ~ 7000 MHz	0.54	
7000 ~ 8000 MHz	0.84	
8000 ~ 8250MHz(UWB)	0.91	

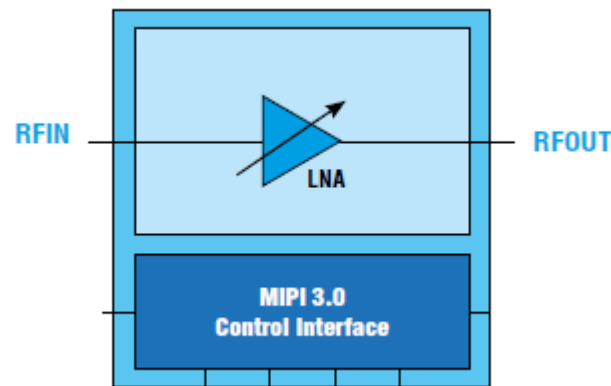
5G High Power Switch ~SPDT and SP4T

- Freq. Range: 0.6GHz ~ 6GHz
- Low Supply Voltage: 1.8V
- Ultra-Low IL

Feature	Package	Parameter	Symbol	Freq. Condition	Typ	Unit
SPDT	QFN 1.1*0.7	Insertion Loss (All RF Ports)	IL	617 – 960 MHz	0.24	dB
				960 – 2170 MHz	0.26	
				2170 – 2700 MHz	0.285	
				3300 – 3800 MHz	0.327	
				3800 – 4200 MHz	0.33	
				4400 – 5000 MHz	0.36	
				5150 – 5925 MHz	0.417	
		Input Power for 0.1dB Compression	PO.1dB	2.7 GHz, CW	39	dBm
SP4T	QFN 1.1*1.1	Insertion Loss (All RF Ports)	IL	617 – 960 MHz	0.26	dB
				960 – 2170 MHz	0.27	
				2170 – 2700 MHz	0.35	
				3300 – 3800 MHz	0.37	
				3800 – 4200 MHz	0.42	
				4400 – 5000 MHz	0.55	
				5150 – 5925 MHz	0.88	
		Input Power for 0.1dB Compression	PO.1dB	2.7 GHz, CW	37	dBm

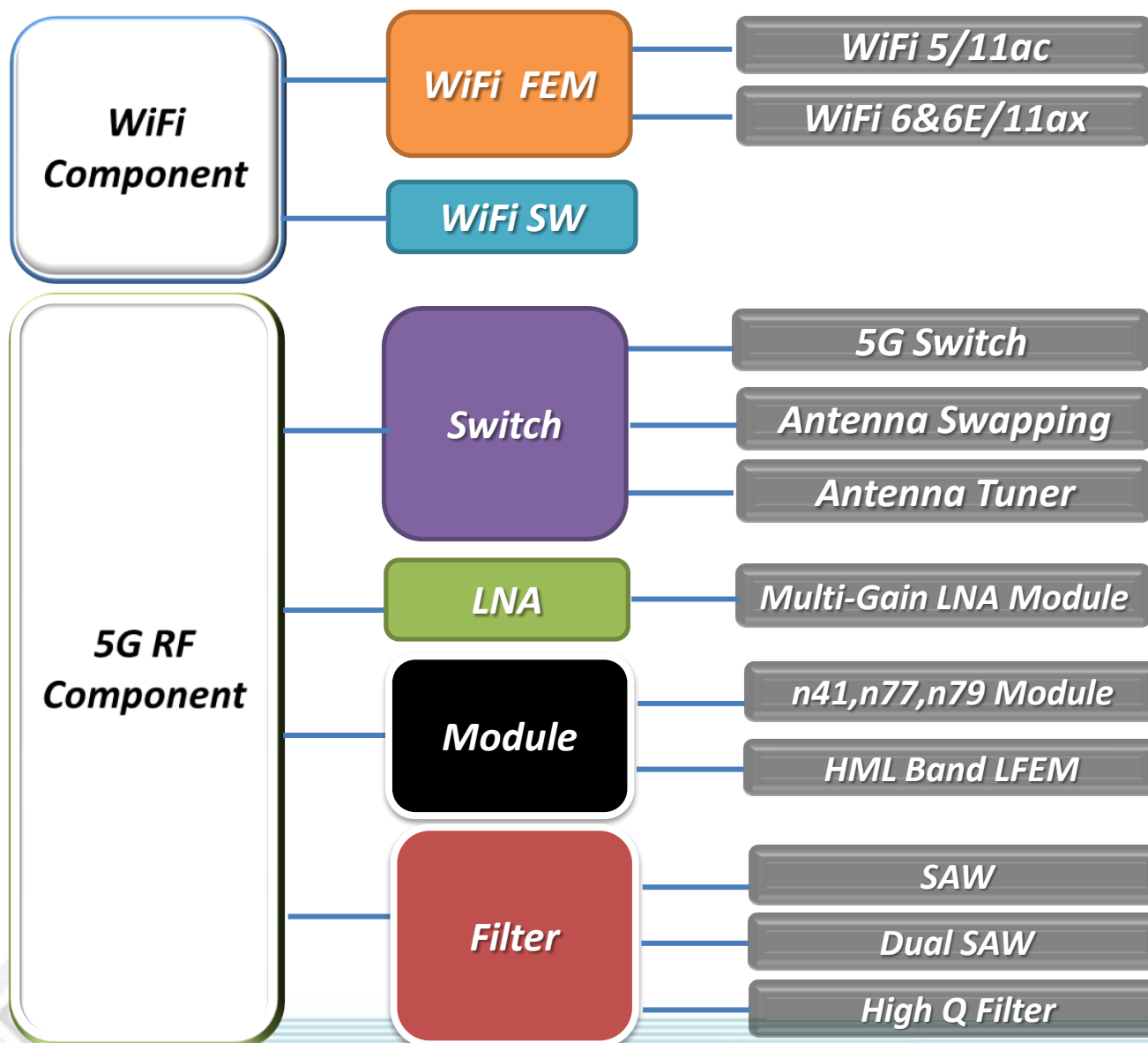
Multi-gain LNA for LAA

- Operating freq.: 5150 – 5925 GHz(B46)
- Low Supply Voltage: 1.8 V
- Integrated 6-stages gain control
- High gain (19dB) and low NF (1.2dB)
- MIPI 3.0 control interface



Parameter	Symbol	Typ.	Unit
Operation Frequency	f		MHz
Power Gain	G6	19	dB
	G5	13	
	G4	7	
	G3	1	
	G2	-5	
	G1	-11	
NF	G6	1.2	dB
	G5	2	
	G4	3.8	
	G3	11.9	
	G2	14.6	
	G1	17	

Richwave Product Line for 5G Mobility





RichWave



Extending to IoT and Automotive with RichWave RF Offerings

RichWave Technology Corp.

2020/12/18

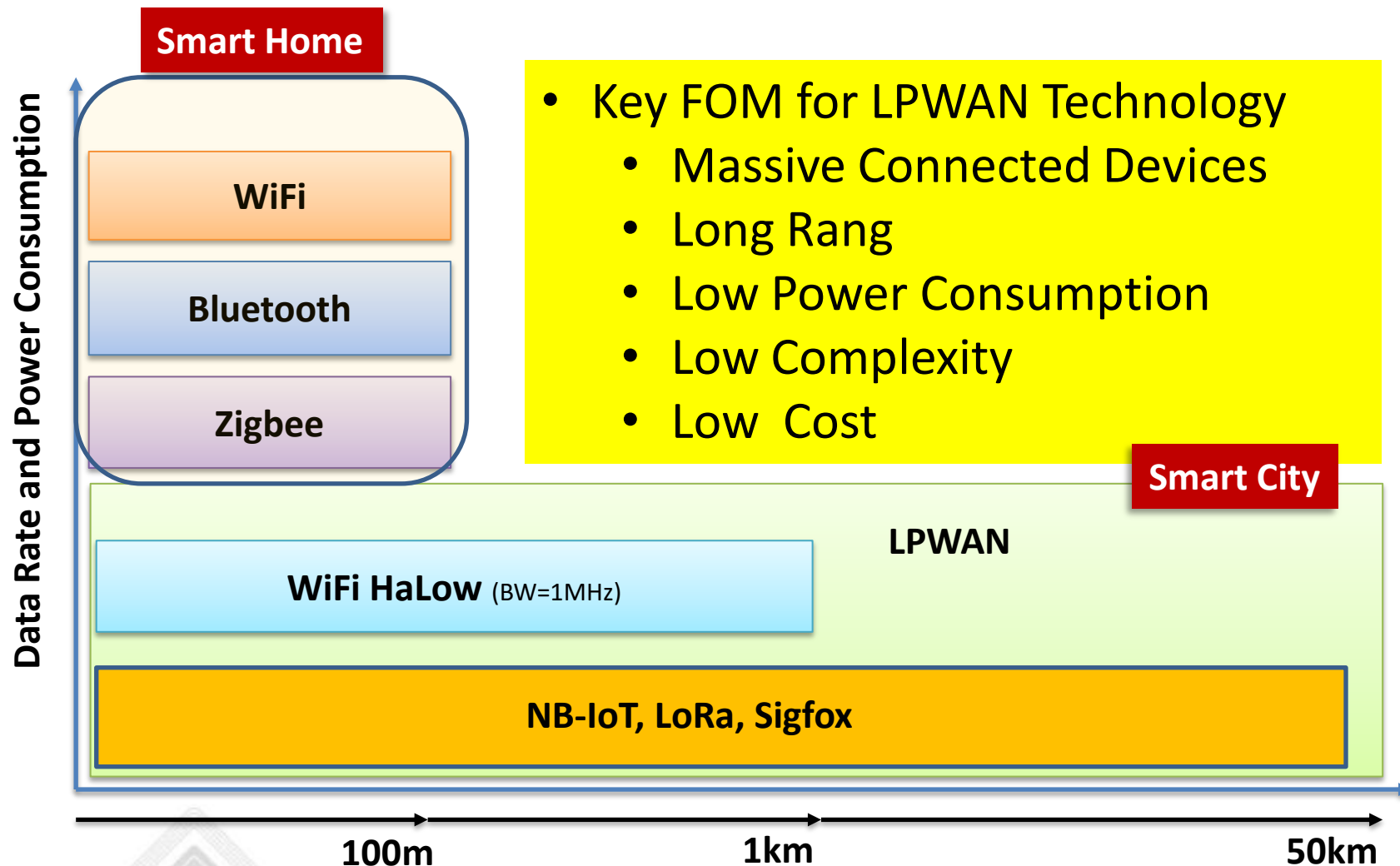


WiFi Bluetooth Zigbee

NB-IoT LoRa Sigfox WiFi-HaLow

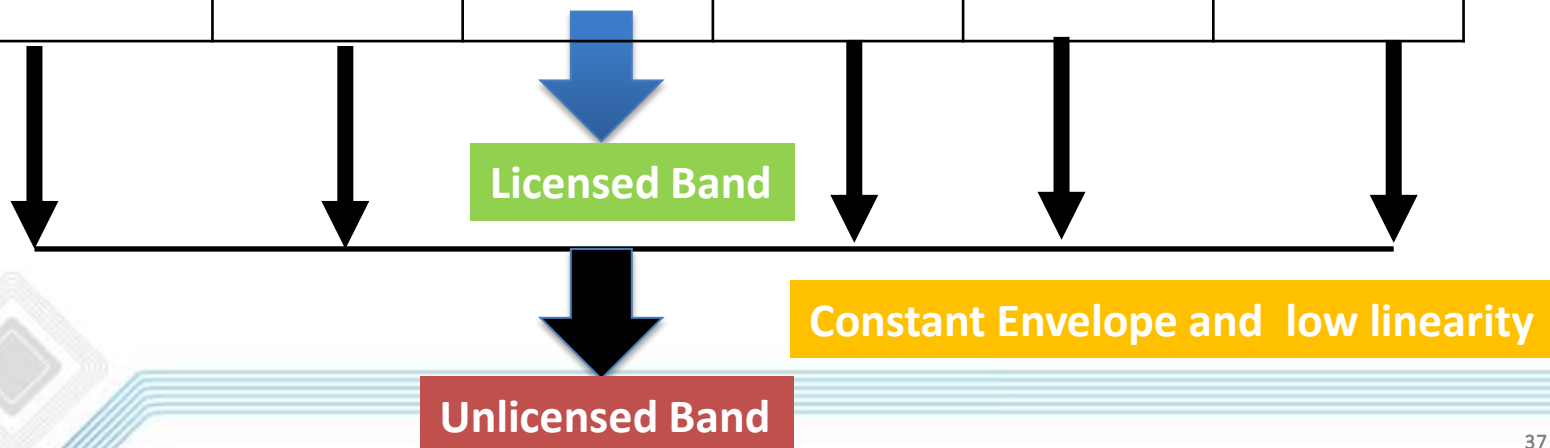


IoT Technology FOM (Figure of Merit)

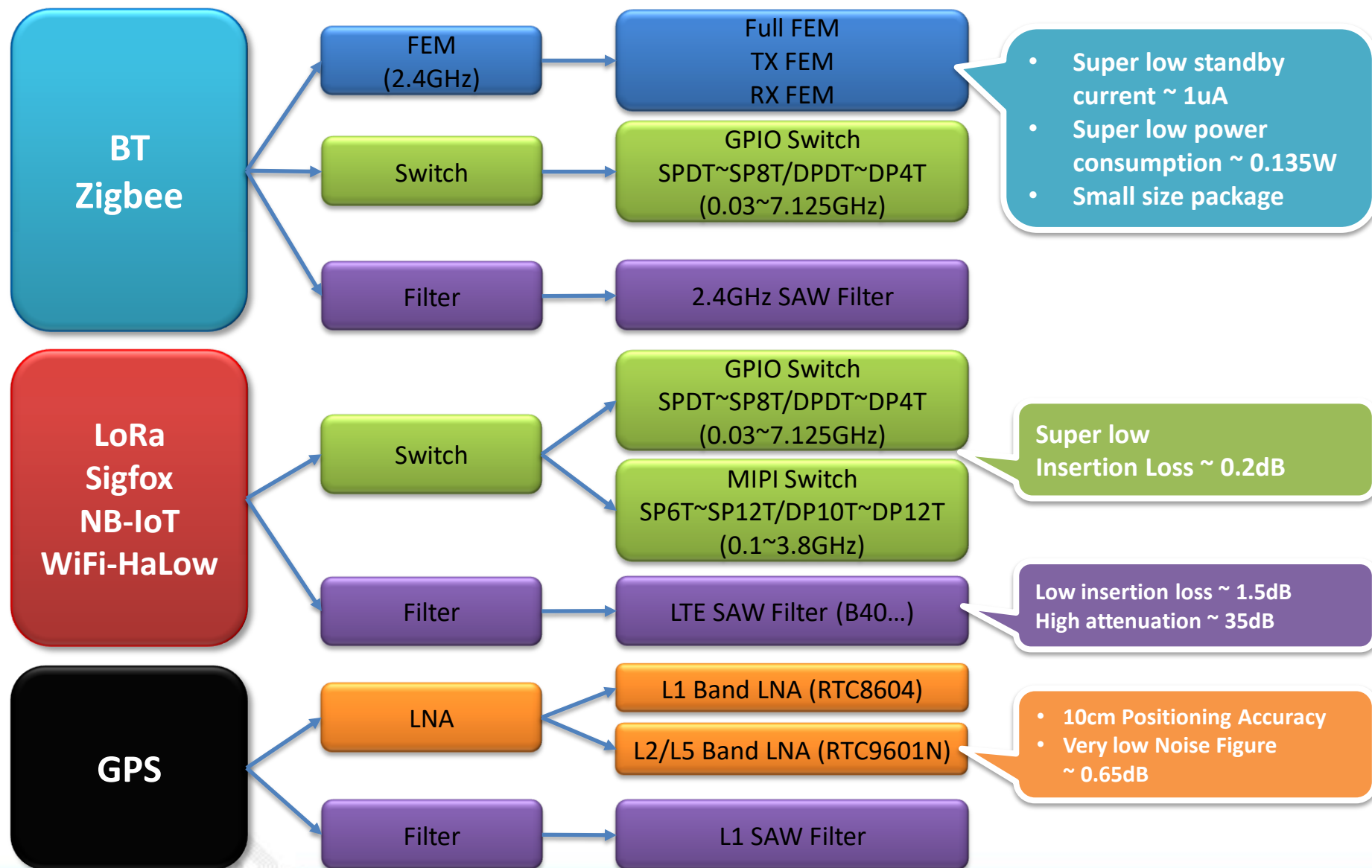


IoT PHY Specification Comparison

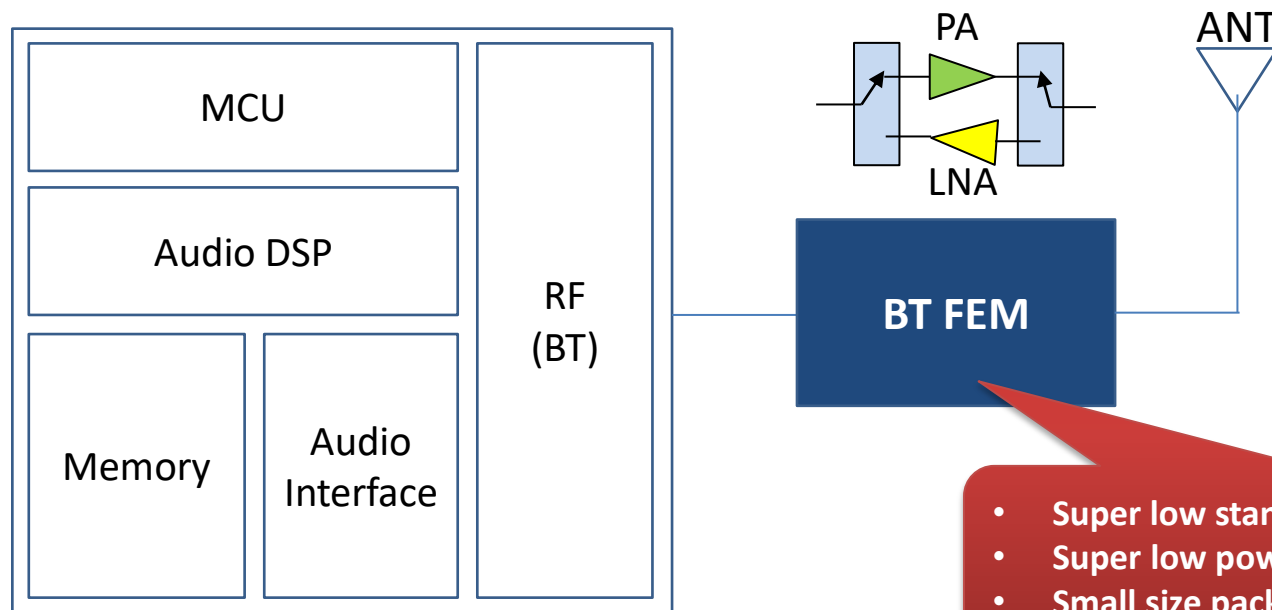
	LoRa	Sigfox	NB-IoT	WiFi HaLow	Zigbee	Bluetooth
Frequency	Sub-1GHz ISM (433/868/915MHz)	Sub-1GHz ISM (868/915MHz)	Sub-1GHz/LTE licensed bands (700MHz~2.5GHz)	Sub-1GHz/LTE (868/915MHz)	869/915MHz 2.4GHz	2.4GHz
Bandwidth Data Rate	125K/250K/500KHz 300bps~50Kbps	100Hz 100bps/600bps	180KHz 50Kbps	1/2/4/8/16MHz 150Kbps~86.7MHz	0.3/0.6/2MHz 20K~250Kbps	1MHz 1~48Mbps
Transmission Range Modulation	20km CSS	50km UNB	20km DL: OFDMA UL: SC-FDMA	1km OFDM	10~100m BPSK QPSK (2.4GHz)	10~300m GFSK
Network Nodes	1 million	1 million	100000	8191	65536	8 (32767 for LE)
Features	1. low-cost infrastructure 2. unlicensed bands 3. low power 4. high penetration ability 5. Open SW architecture	1. unlicensed bands 2. optimal low power 3. ultra long range 4. global networking services 5. provides users with existing networking infrastructure and cloud services	1. operates in licensed bands with minimal interference 2. more stable connection 3. integration in existing LTE and 5G networks	1. low-cost infrastructure 2. unlicensed bands 3. higher transmission speed 4. high penetration ability	1. low-cost infrastructure 2. better than BT in power consumption 3. high-level security 4. low connectivity drop-offs	1. higher transmission speed 2. high-level security 3. widely used in personal communication devices



RichWave IoT Product Portfolio



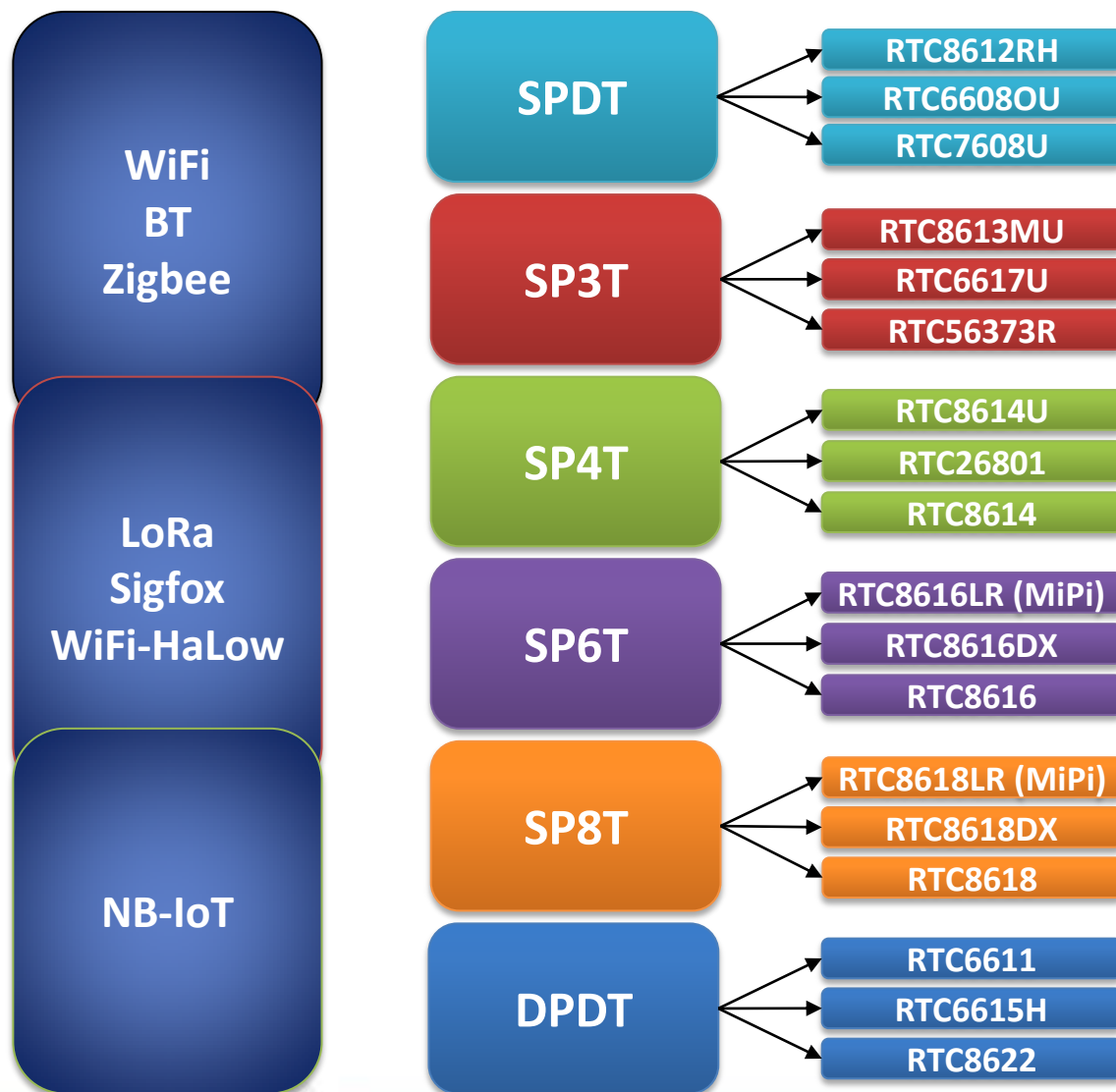
FEM for Bluetooth/Zigbee Speaker/ Earpod/Wireless Keyboard/Wearable



- Super low standby current $\sim 1\mu\text{A}$
- Super low power consumption $\sim 0.135\text{W}$ (OP)
- Small size package

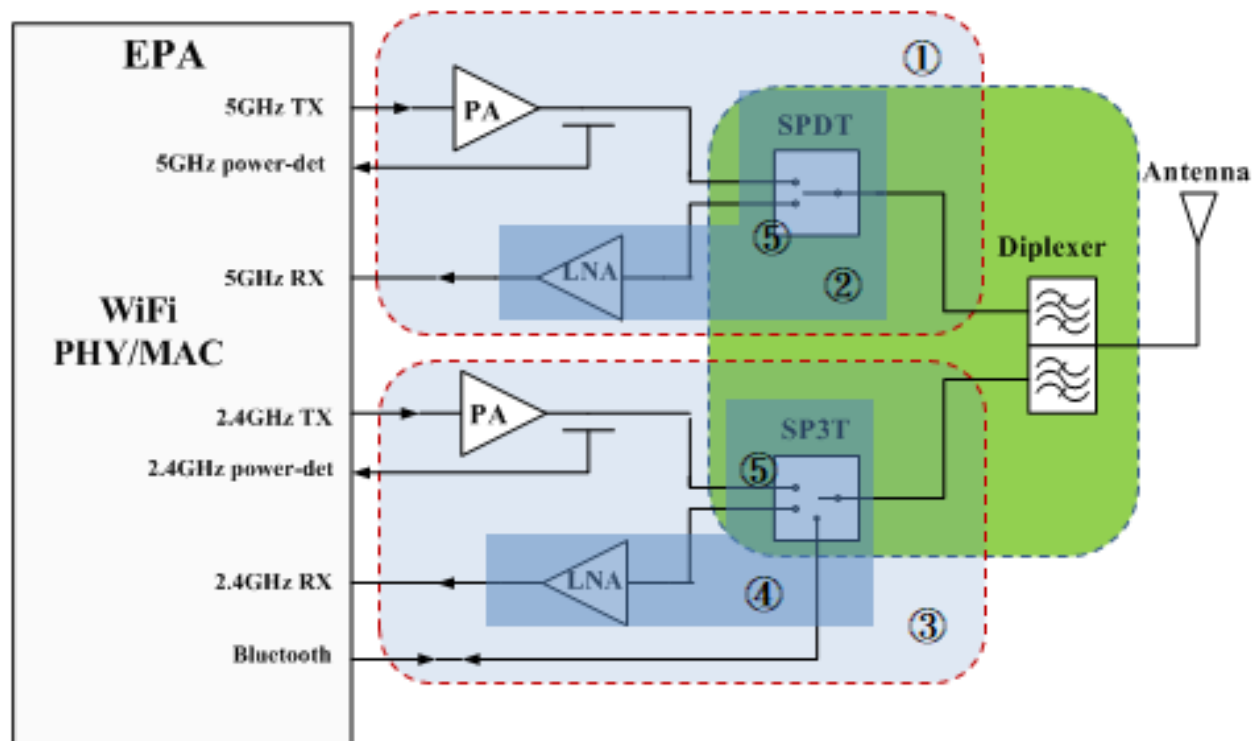
Part Number	Feature	Package Size	Support EDR	
RTC2624	PA+LNA+Switch	16L QFN 2.4x2.4x0.8 mm	NO	Output Power $\sim 23\text{dBm}$
RTC2624E	PA+LNA+Switch	16L QFN 2.4x2.4x0.8 mm	Yes (14dBm)	Output Power $\sim 23\text{dBm}$
RTC26202E	LNA+Switch	6L QFN 1.0x1.0x0.75 mm	NO	Noise Figure $\sim 2.0\text{dB}$
RTC2620	PA+Switch	8L LGA 1.5x1.5x0.6 mm	Yes (14dBm)	Output Power $\sim 23.5\text{dBm}$

GPIO and MiPi Switch for IoT



- Very low IL ~ 0.2dB
- Switching time < 200ns
- Cover 0.03~7.125GHz
- High P0.1dB ~ 38.5dBm
- Mid P0.1dB ~ 29dBm
- Low P0.1dB ~ 21.5dBm
- Small size ~ 1.0x1.0mm
- Support GPIO and MiPi

RichWave Automotive Product Solution



5GHz Full FEM (3-in-1)

- ① RTC1630 (11ac, +20dBm)
RTC16504 (11ax, 16.5dBm)

- ② 5GHz RX FEM (2-in-1)
RTC1631 (LNA+SPDT)

- ③ 2.4GHz Full FEM (3-in-1)
RTC1620(11n, +21dBm)
RTC16204 (11ax, 15dBm)

- ④ 2.4GHz RX FEM (2-in-1)
RTC1621 (LNA+SP3T)

- ⑤ Switch
RTC1601(SP3T)
RTC1602(SPDT)
RTC1603(SPDT)
RTC1604(SPDT)

AEC-Q100 Certification for Temperature Grade 2

Test Item	Condition	Method
High Temperature Operating Life (HTOL)	Ta=105°C, Vcc max., 1000hrs	JESD22-A108
Electrostatic Discharge Human Body Model (HBM)	Start from 100V to 2000V, Step: 100V Positive / Negative pulse	AEC Q100-002
Electrostatic Discharge Charged Device Model (CDM)	Start from 250V to 1000V, Step: 250V Positive / Negative pulse	AEC Q100-011
Preconditioning (PC)	MSL-3, 30°C/60%RH, 192hrs Reflow x3 at 260°C	JESD22-A113 J-ST020
Biased HAST (HAST)	130°C/85%RH, VCC Max., 96hrs	JESD22-A110
Unbiased HAST (UHST)	130°C/85%RH, 96hrs	JESD22-A118
Temperature Cycling (TC)	-55°C~125°C (Air to Air), 1000 cycles	JESD22-A104
High Temperature Storage Life (HTSL)	125°C bake, 1000hrs	JESD22-A103
Temperature Humidity Bias (THB)	85°C/85%RH, Vcc max., 1000hrs	JESD22-A101





RichWave



RichWave RF Passive Components Planning & Prospects

RichWave Technology Corp.

2020/12/18

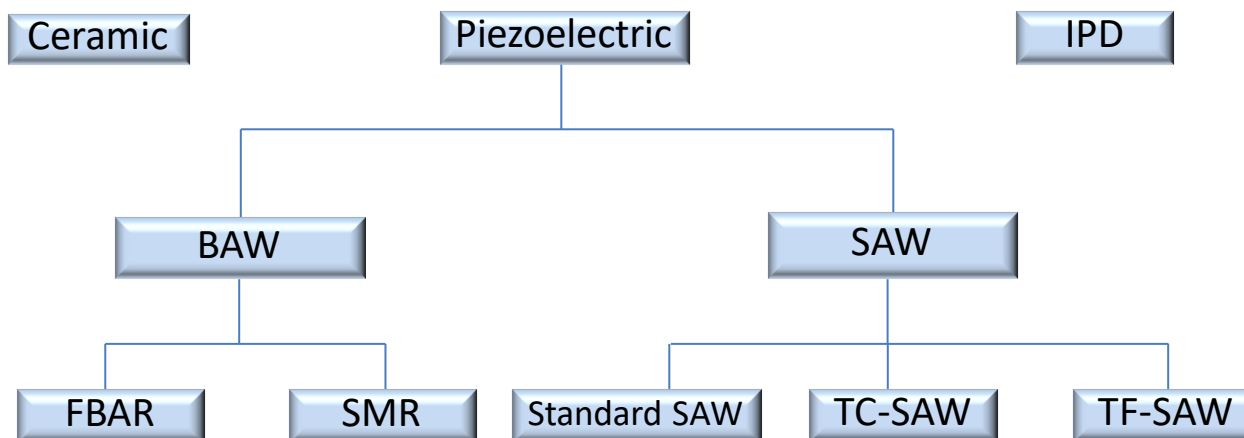
Filters on Cellular and Connectivity Application



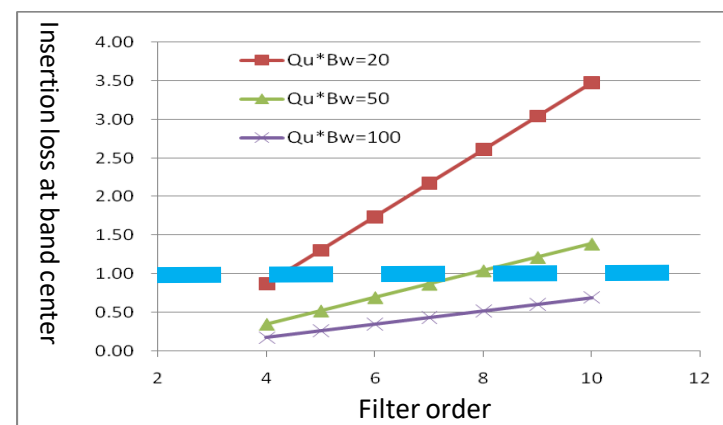
Application	Cellular Market	Connectivity Market
Richwave Solution	0.7-3 GHz SAW Filter/Duplexer 1.7-2.2GHz Quadplexer 2-6GHz BAW Filter/Duplexer	2.4GHz SAW/BAW Filter 5-7GHz BAW Filter WIFI Duplexer
Market	Smart phones, Tablets, GPS	Routers, Set-Top Boxes, CPE



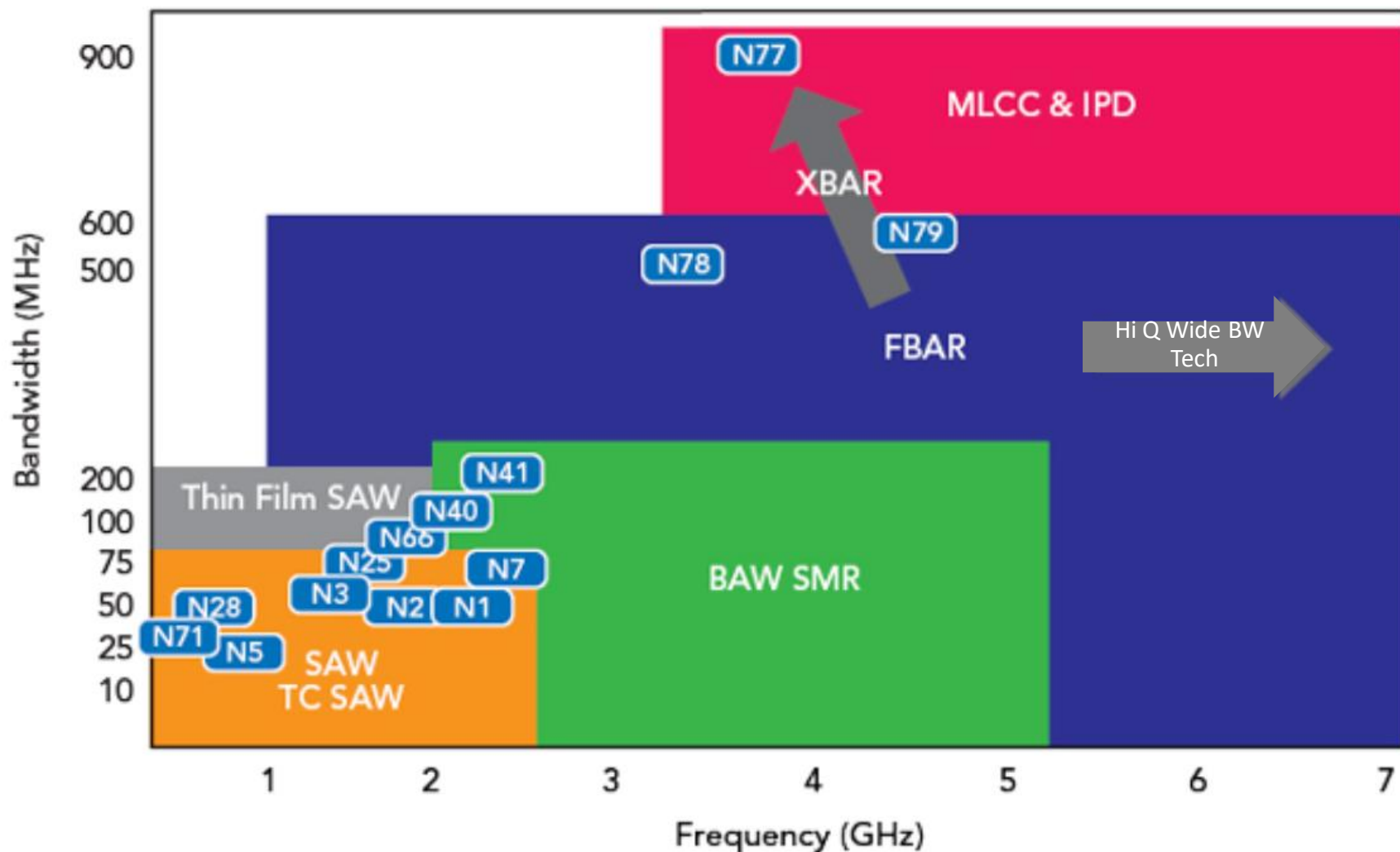
Filter Technology



- Ceramic:
 - Monoblock: Q: 200~600, BW: 3~5% , up to 20%
 - LTCC: Q: 60~100, BW > 10%
- IPD:
 - Q : 30~50, BW >10%

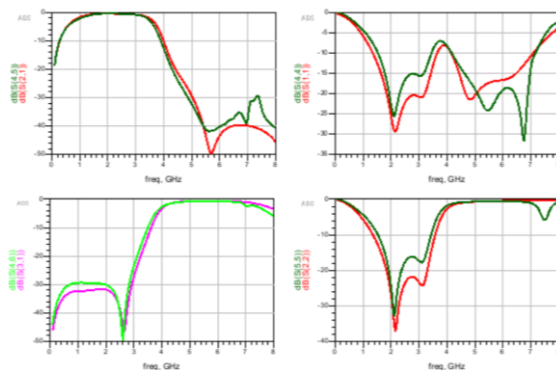
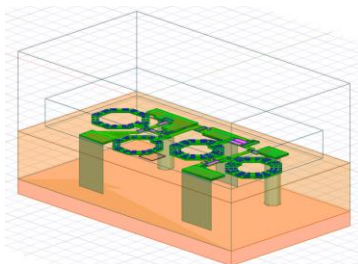
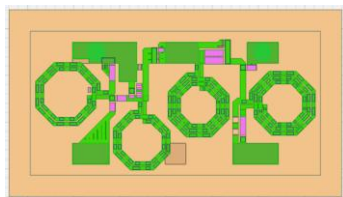


Filter Technology in 5G NR Band

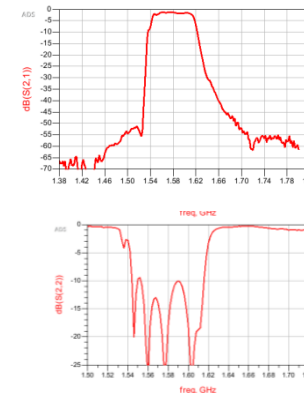
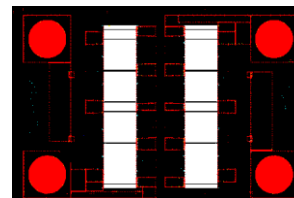


Richwave RF Passive Components

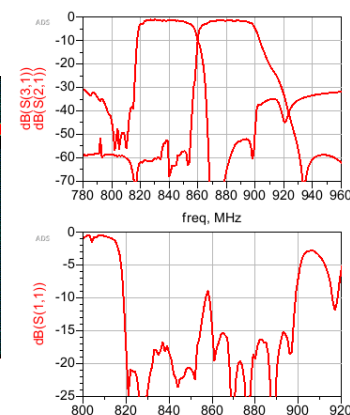
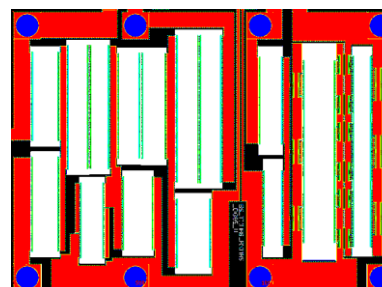
WIFI Diplexer



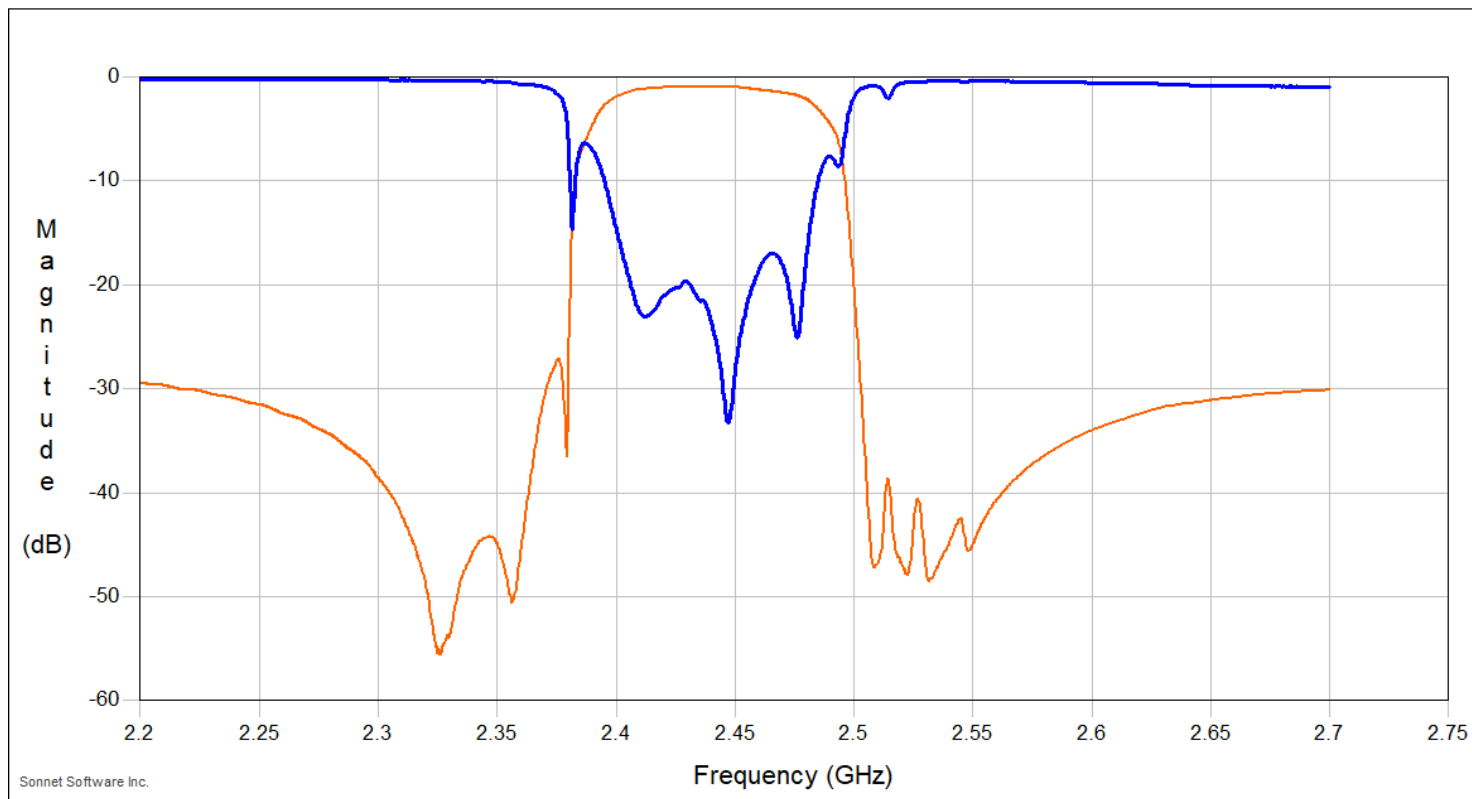
GPSL1 SAW Filter



B8 SAW Duplexer



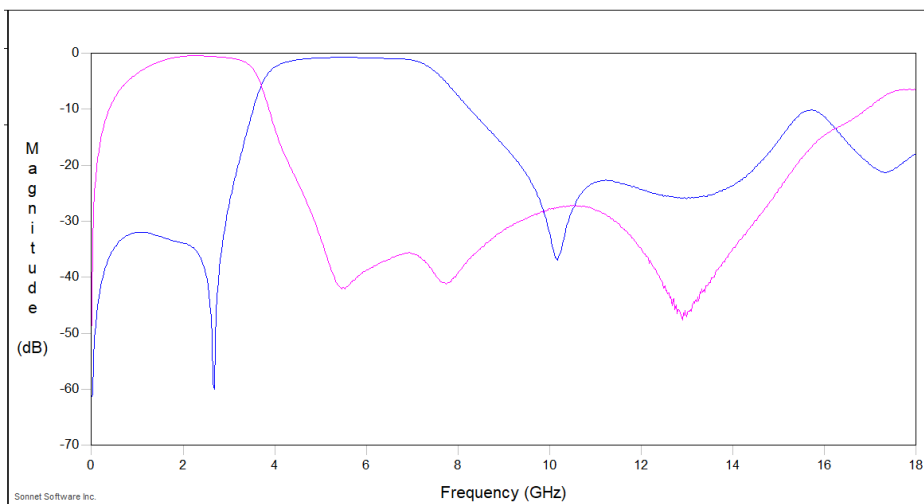
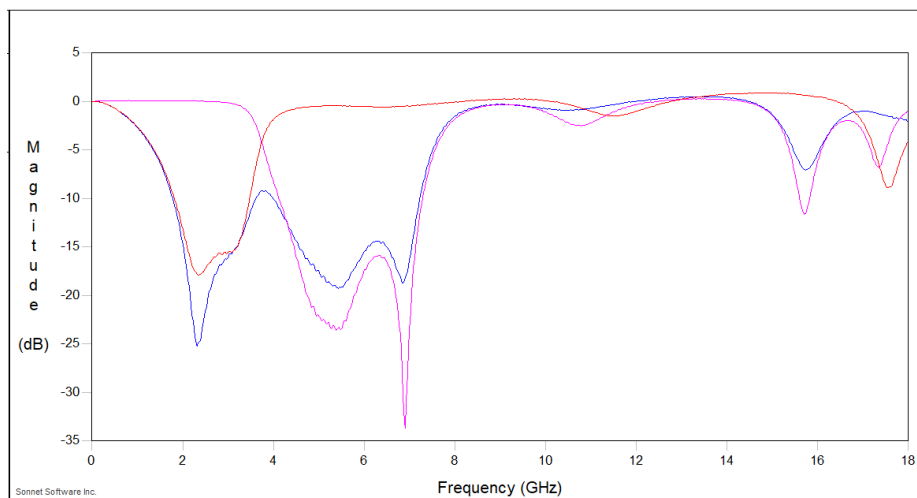
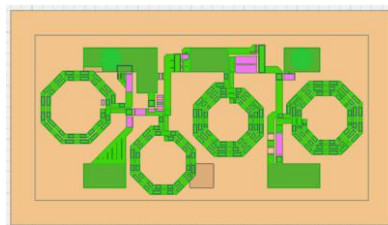
WIFI SAW Filter



WIFI 2.4GHz SAW Filter has low insertion loss and good attenuation at LTE(B40,B41) frequency



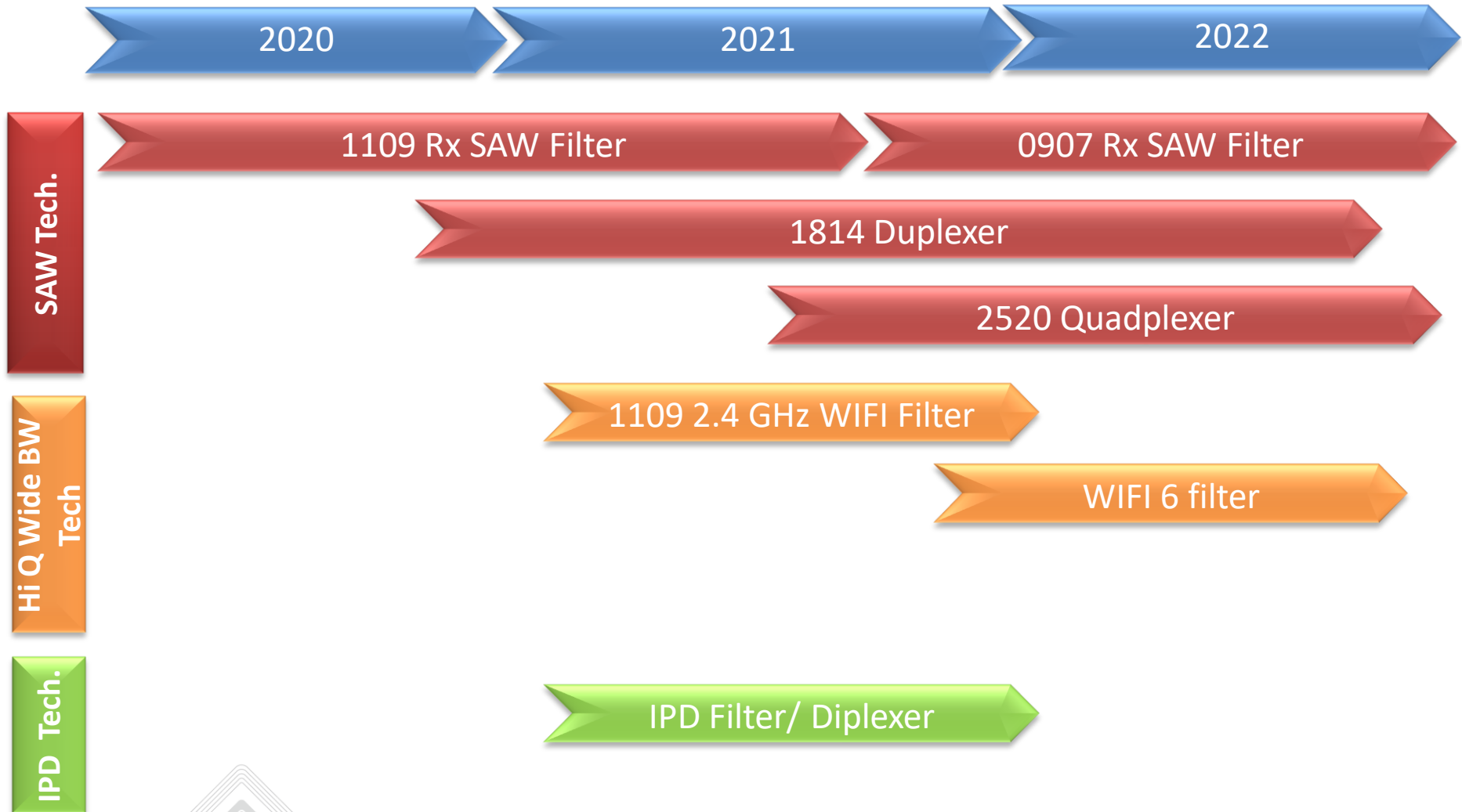
WIFI Diplexer



WIFI diplexer has low insertion loss and good return loss.



RF Filter Roadmap



Richwave SAW Filters Lineup in 2020

	Band 1	Band 2 Band 25	Band 3	Band 4	Band 5 Band 26	Band 7	Band 8	Band 12	Band 13	Band 20	Band 34	Band 39	Band 40	Band 41
US	v	v	v	v	v		v	v	v					v
EU	v		v		v	v	v			v				
China	v		v		v		v				v	v	v	v

GPS/ WIFI Application			
Part Number	Support Band	Dimension (mm2)	Application
RTC46S2RUHA	GPS L1	1.1x0.9	GPS SAW
RTC46S0TUHA	WIFI (2.4GHz)	1.1x0.9	WIFI SAW
Cellular Application (Single SAW)			
RTC46SQTUHA	B40 Tx	1.1x0.9	Cellular Tx SAW
RTC46SGRUHA	B8 Rx	1.1x0.9	Cellular Rx SAW
RTC46SKRUHA	B26 Rx	1.1x0.9	Cellular Rx SAW
RTC46SPRUHA	B39 Rx	1.1x0.9	Cellular Rx SAW
RTC46SQRUHA	B40 Rx	1.1x0.9	Cellular Rx SAW
RTC46SRRUHA	B41 Rx (narrow band)	1.1x0.9	Cellular Rx SAW
IOT Application (Single SAW)			
RTC46SUTUHA	B24 Tx	1.1x0.9	IOT SAW
RTC46SURUHA	B24 Rx	1.1x0.9	IOT SAW

GPS/ IOT/ WIFI/ Cellular filters development

Richwave SAW Filters Lineup in 2021

GPS/ WIFI Application			
Part Number	Support Band	Dimension (mm ²)	Application
RTC46S2RUKA	GPS L1	0.9x0.7	GPS SAW
RTC46S3RUKA	GPS L5	0.9x0.7	GPS SAW
Cellular Application (Single SAW)			
RTC46SARUHA	B1 Rx	1.1x0.9	Cellular Rx SAW
RTC46SCRUHA	B3 Rx	1.1x0.9	Cellular Rx SAW
Cellular Application (Dual SAW)			
RTC48ACRUFA	B1/B3 Rx	1.5x1.1	Cellular Rx SAW
RTC48PRRUFA	B39/B41 Rx	1.5x1.1	Cellular Rx SAW
Cellular Application (Duplexer)			
RTC47CCTUDA	B3 DPX	1.8X1.4	Cellular DPX
RTC47EETUDA	B5 DPX	1.8X.1.4	Cellular DPX
RTC47GGTUDA	B8 DPX	1.8X1.4	Cellular DPX
RTC47FFTUDA	B7 DPX	1.8x1.4	Cellular DPX
RTC47AATUDA	B1 DPX	1.8x1.4	Cellular DPX
RTC47BBTUDA	B2 DPX	1.8x1.4	Cellular DPX
RTC47DDTUDA	B4 DPX	1.8x1.4	Cellular DPX

Smaller size filters

Duplexer and dual SAW development



RichWave



Making Life Better with RichWave Radar Sensors

RichWave Technology Corp.

2020/12/18

RichWave Radar Sensors

	RTC6012	RTC6013/31
Frequency	5.8GHz	10GHz
Radar type	Doppler radar RF front-end	CW/FMCW radar front-end (RTC6013), radar SoC with DSP (RTC6031)
Features	Ultra low power motion detection	Motion, Range and AoA detection
Applications	Smart lighting Proximity Detection	Presence detection Smart home applications Vital Sign Detection Level Gauge
Status	MP @ 2020/Q3	MP @ 2021/Q1

Microwave Sensor Application

Smart Lighting



Indoor Light



Outdoor Light



Street Light

Smart Home



Smart Speaker



IP Camera



Air Conditioner

Microwave Sensor Application

Smart Home



Automatic Faucet



Wall Switch
(Gesture)



Wall Switch
(Present)

Smart Home



Smart White
Electronic



Automatic
Door Opener



Liquid Level Sensor

Microwave Sensor Application

Smart City



Waste Collection



Parking



Traffic Monitor

E-Health



Vital Sign



Sleep Monitor



Fitness

HVAC (Heating, Ventilation, and Air Conditioning)

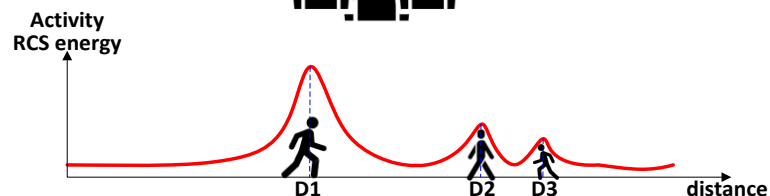


- Consumes 40% of electricity in buildings (in US).
- Useful information from sensor fusion:



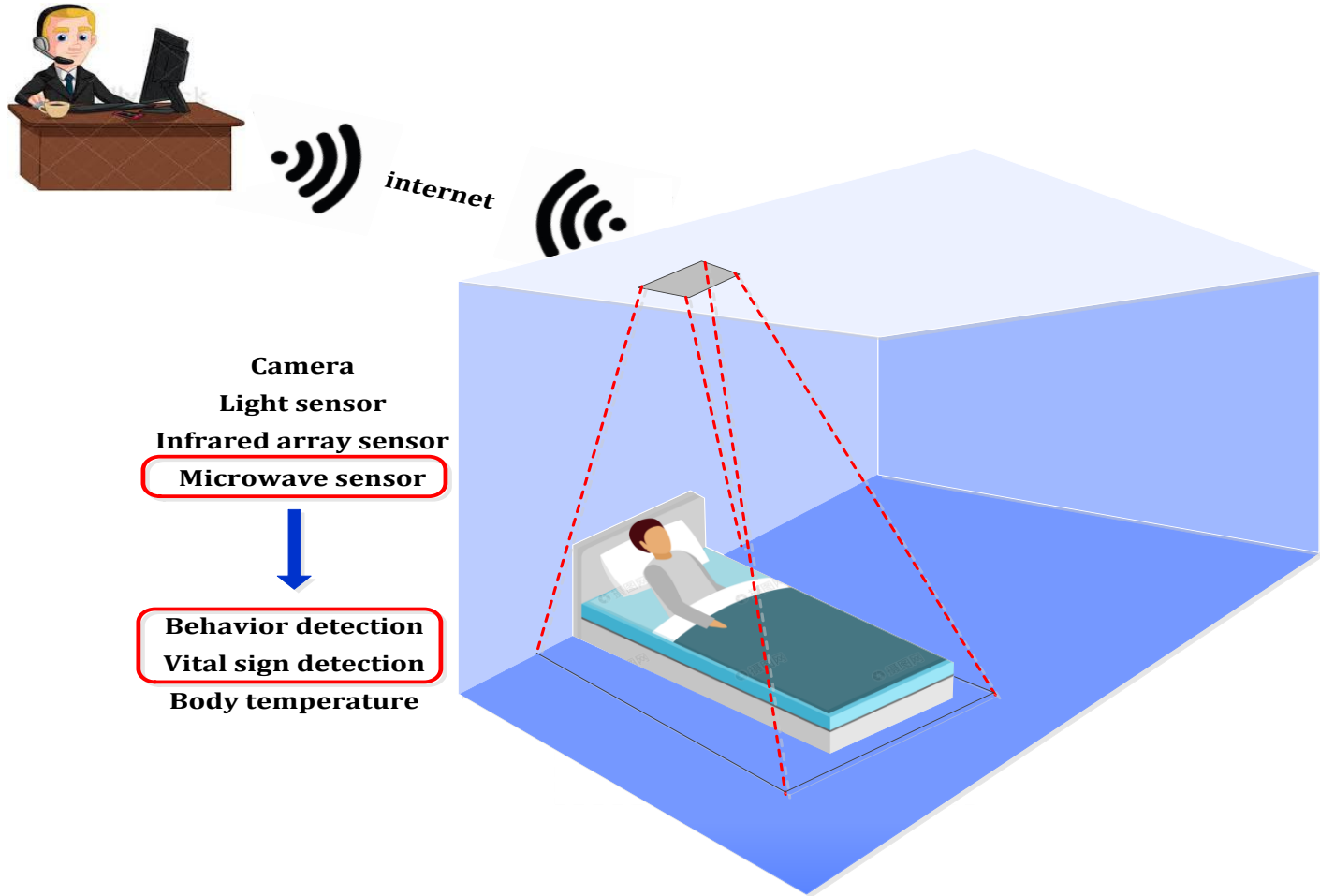
Human motion detection

Human occupancy count



Location distribution of human activity

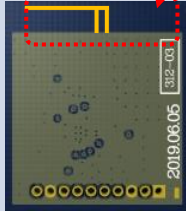
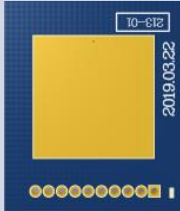
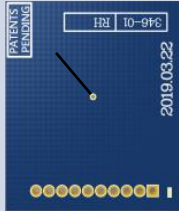
E-Health



RTC6012 Feature List

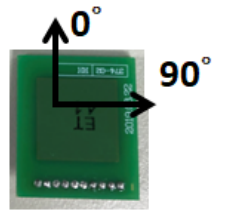
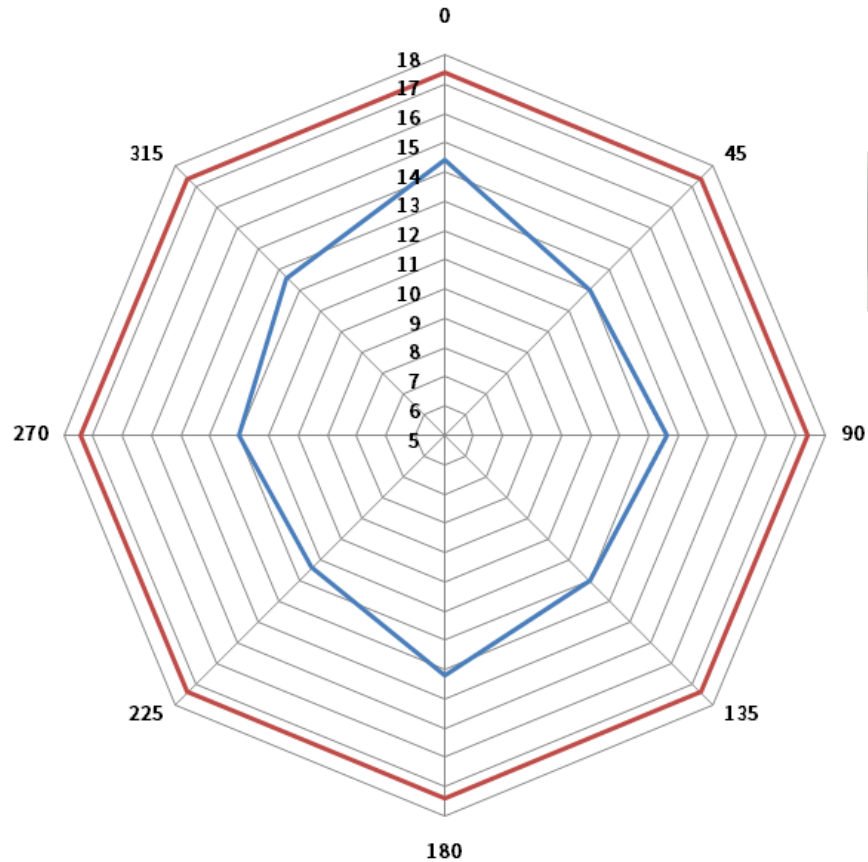
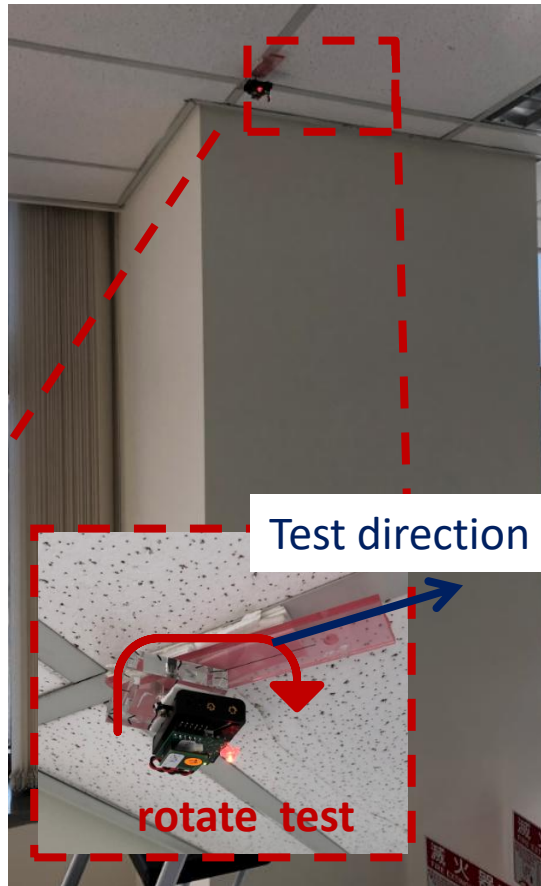
- 5.8 GHz ISM band
- WiFi Co-existence
- High TX output power
- High gain IF-Amplifier
- Capable of single antenna applications (Patents pending)
- 2-wire control Interface
- Fast settling time for duty-cycle operation
- Very low operation current (75uA)
- World's smallest footprint : 2.2mm x 2.2mm x 0.6mm package

Referenced RTC6012 Sensor Module

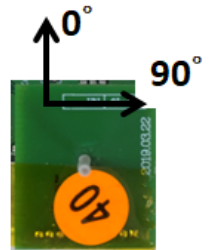
	M1P (PIFA ANT)	M1S (Patch ANT)	M1M (Monopole ANT)
RTC6012			
Board Size (mm)	17x20	17x20	17x20
Detection Range ※	~5m	~15m	~15m
Detection Angle	360°	120°	360°

※Indoor scenario is applied for range detection.

Ceiling Pattern at 3M height



— M1S
— M1M#40



RTC6013/RTC6031 Feature List

	RTC6013 / RTC6031
Fully integrated single chip solution	○ / ○
CW/FMCW transceiver	
9.5 to 10.6 GHz coverage	○ / ○
Motion detection (CW)	○ / ○
Range detection (FMCW)	○ / ○
Superiors SNR	○ / ○
Highly accurate FMCW chirp engine	○ / ○
Digital sensing raw data output	○ / ○
Embedded DSP core	✗ / ○
Detection algorithms	✗ / ○

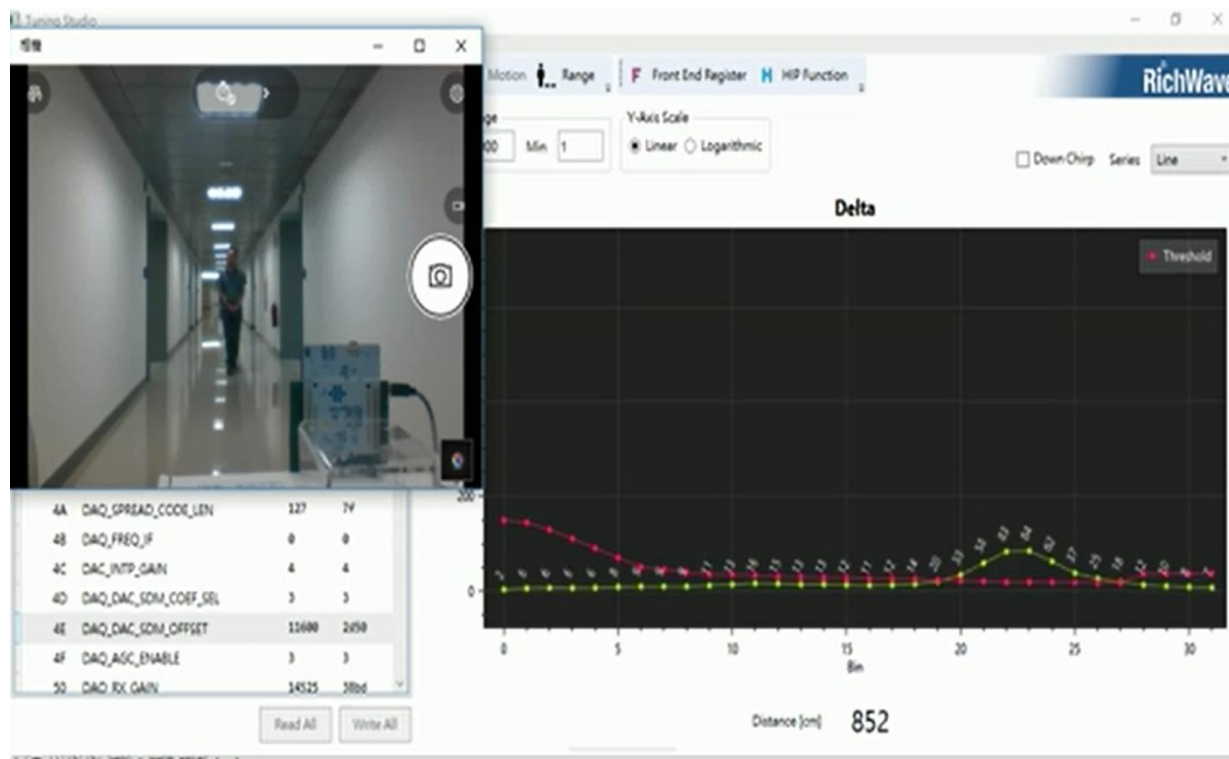


10GHz App 1 - Distance Report

- Report nearest moving object's distance at 8m and 15m



Turnkey

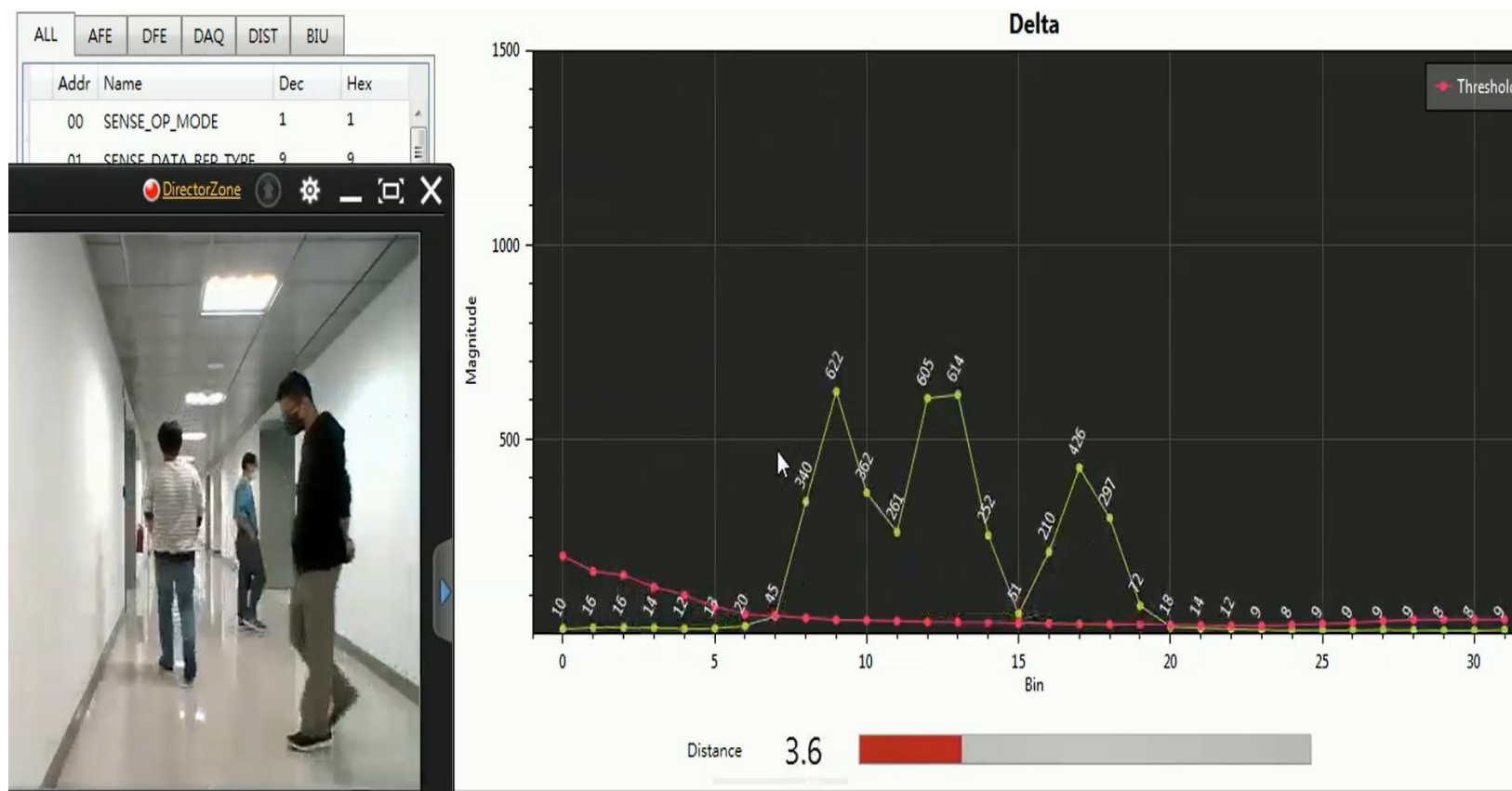


Tuning Studio



10GHz App 2 - Activity Point Detection

- Multiple points activities was detected simultaneously



10GHz App 3 – Vital Signal Detection

- Quick breath & heartbeat rate detection response





RichWave



RichWave Supply Chain Planning & Management

Production capacity & capability

RichWave Technology Corp.

2020/12/18

Capacity Management



Strategic Alliance

Global logistic, local operation
Value creating, benefit sharing

Economies of Scale

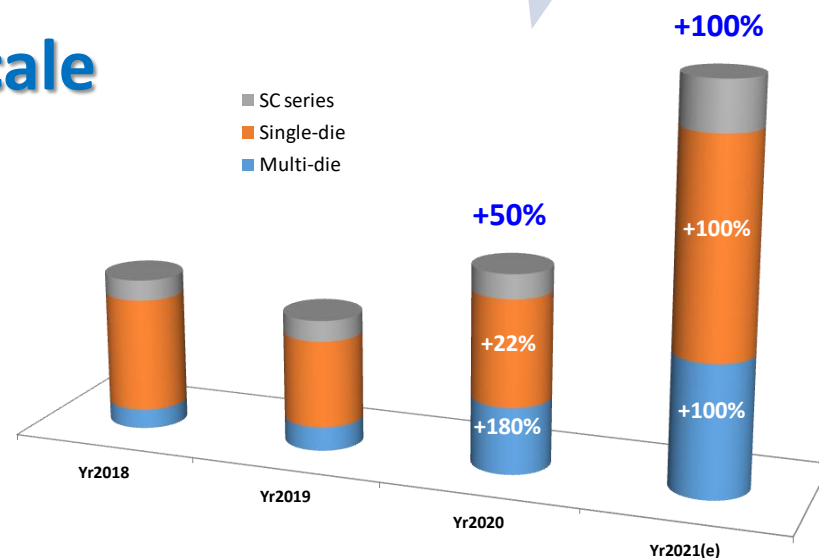
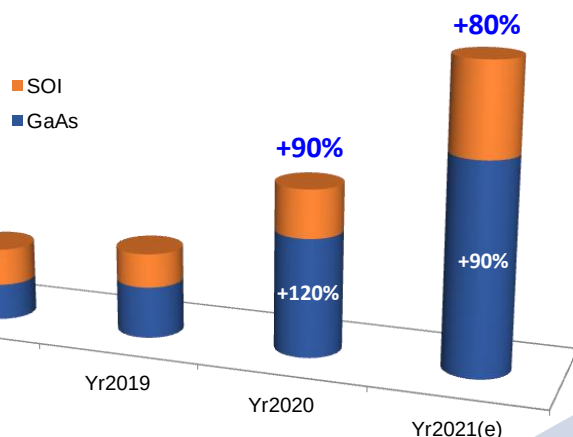
Plan +100% in Yr2021

High Volume Manufacturing

Double capacity secured in Yr2020

Capacity consign

Multi-site porting



Assembly Roadmap

High Integration & High Performance



Higher thermal performance

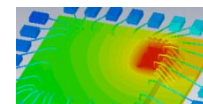
Sputtered EMI shield

Flip-chip; Die bond with stacking

High Density

WLCSP, MCM, SiP

with SAW/BAW filter, Passive components



Smaller & Thinner

For mobile/handheld, SAW/BAW



Testing Roadmap



Flexibility & Compliance

5G NR FR1/FR2 FEM sub-8.5GHz
mmWave and Wi-Fi 6/6E/7 (7.125GHz)
Radar Sensors (10GHz~60GHz)
Industrial, Automotive Certification

Advance Testing Platform

SG9000, GS I2C, NI STS T4, PAx RedDragon
Low/High temperature characterization

High Quality & High Efficiency Cost Competiveness

Dual/Quad-site production



Cohu





RichWave