May 2021 Munich, Germany @qualcomm

Qualcomm

RFFE Auto

Peter Schrey

Sr. Manager, Product Marketing
RF360 Europe GmbH

Agenda

Auto Telematics

- Automotive Electronics
- Innovation
- Telematics 4G/5G
- Wi-Fi / Bluetooth
- Digital Radio
- Extractor
- Positioning / GNSS
- Car Access / RKE
- Look up
- Q&A

Automotive

Automotive applications with RFFE

Customer benefits

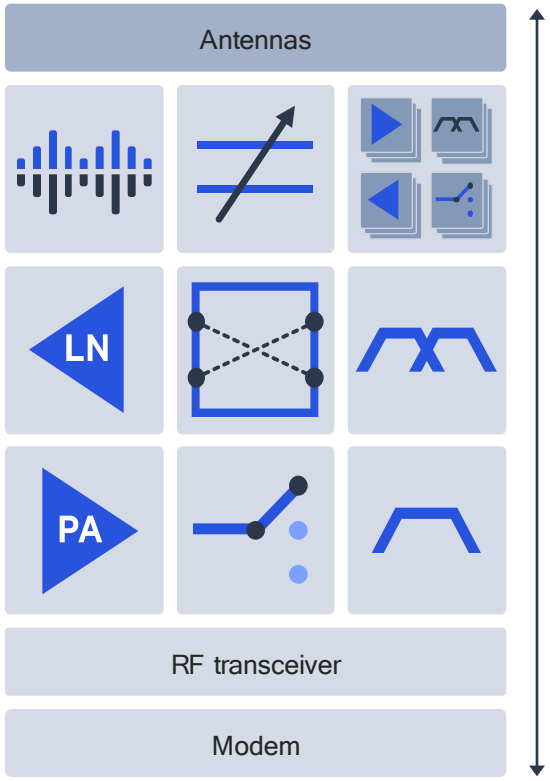
Qualcomm Technologies offers a specialized RFFE portfolio for automotive applications

- Component qualification in line with AEC-Q100/200
- Long lifetime / production cycle
- PPAP available
- Discrete components certified to automotive standard IATF 16949
- Special frequencies and customized product solutions
- Comprehensive application support

Qualcomm® RF Front End (RFFE) solution

Creating value for customers in the more and more complex RF environment

Qualcomm Technologies unique modem-to-antenna solution



Qualcomm Technologies brings together a vast set of advanced RF front-end technologies to

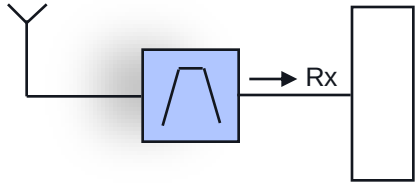
- build a comprehensive mobile platform that is designed to maximize throughput and thermal performance
- accelerate time-to-launch for 5G multimode devices in challenging automotive designs.

SAW/BAW automotive component qualification

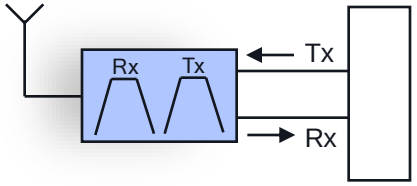
Package technology	Automotive Ceramic	Automotive Qualcomm® CSSP™
Package size [x.x mm * y.y mm]	2520, 3025, **3030**, 3838	**1109**, 1411, 1511, **1612**, 1814, 2016
AEC-Q200 grade	yes → grade 1 (-40 to +125 °C)	yes → grade 3 (-40 to +85 °C) grade 2 (-40 to +105 °C) grade 1 (-40 to +125 °C)
Temperature cycling	1000 cycles @ (-40°C to +125°C)	1000 cycles @ (-40°C to +85 / 105 / 125 °C)
Biased or static humidity @ 85°C, 85% rel. humidity	1000 hours	1000 hours

Filter Types

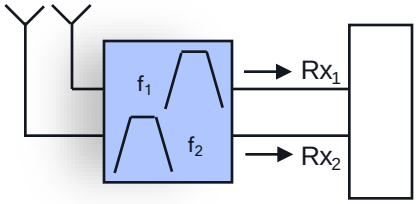
Single



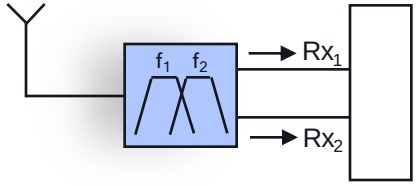
Duplexer



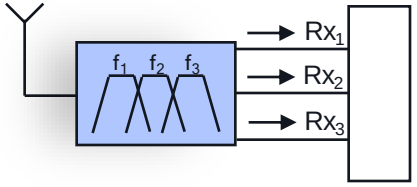
2 in 1



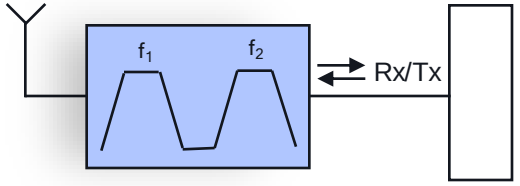
Diplexer



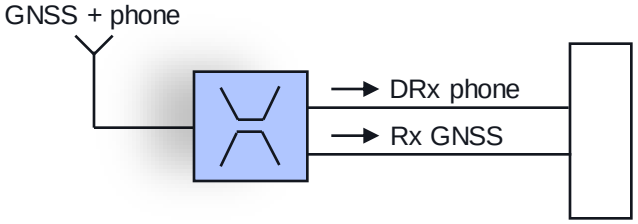
Triplexer



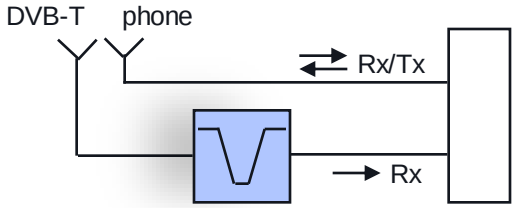
Double hump



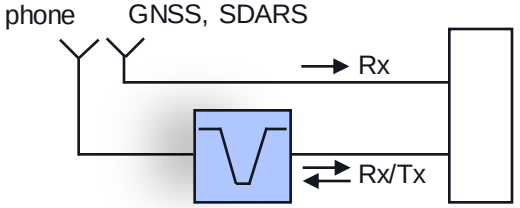
GNSS extractor



LTE band stop filter



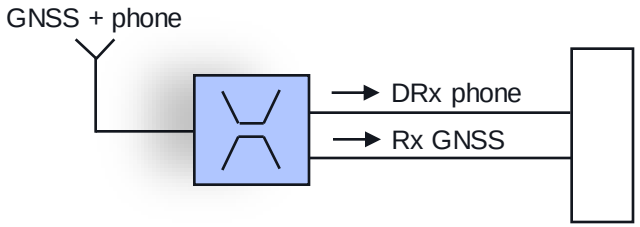
GNSS/SDARS band stop filter



Function: Extractor vs Notch Filter

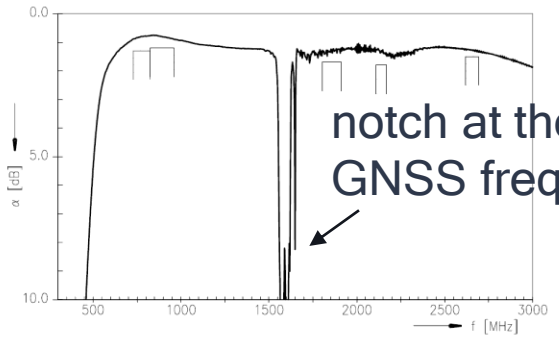
Example: GNSS extractor and SDARS notch (band-stop) filter

GNSS extractor

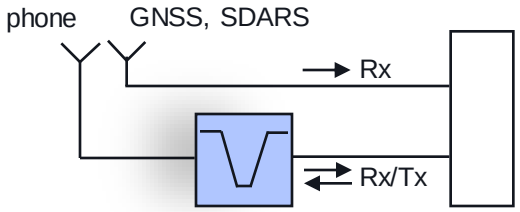


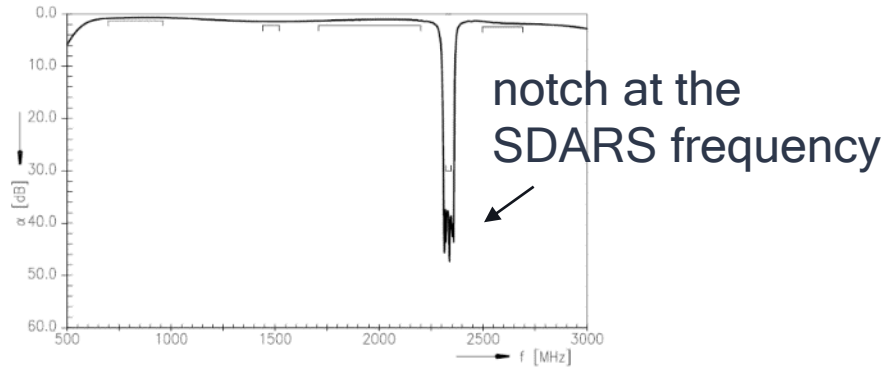
The GNSS extractor is a splitter with:

- notch functionality in the phone path (and)
- band pass filtering in the GNSS path.



SDARS notch filter



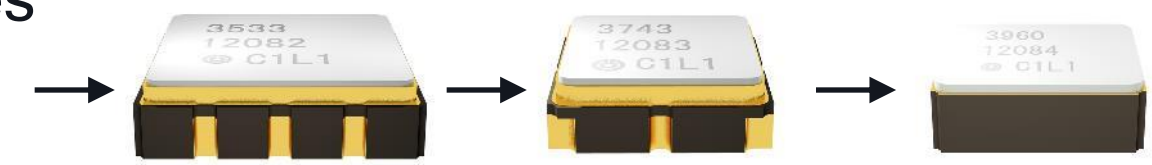


The band-stop filter offers a much deeper notch than the extractor.

Size Evolution

Miniaturization of automotive package

- Ceramic packages



3838 3030 2520

- Automotive CSSP for duplexers

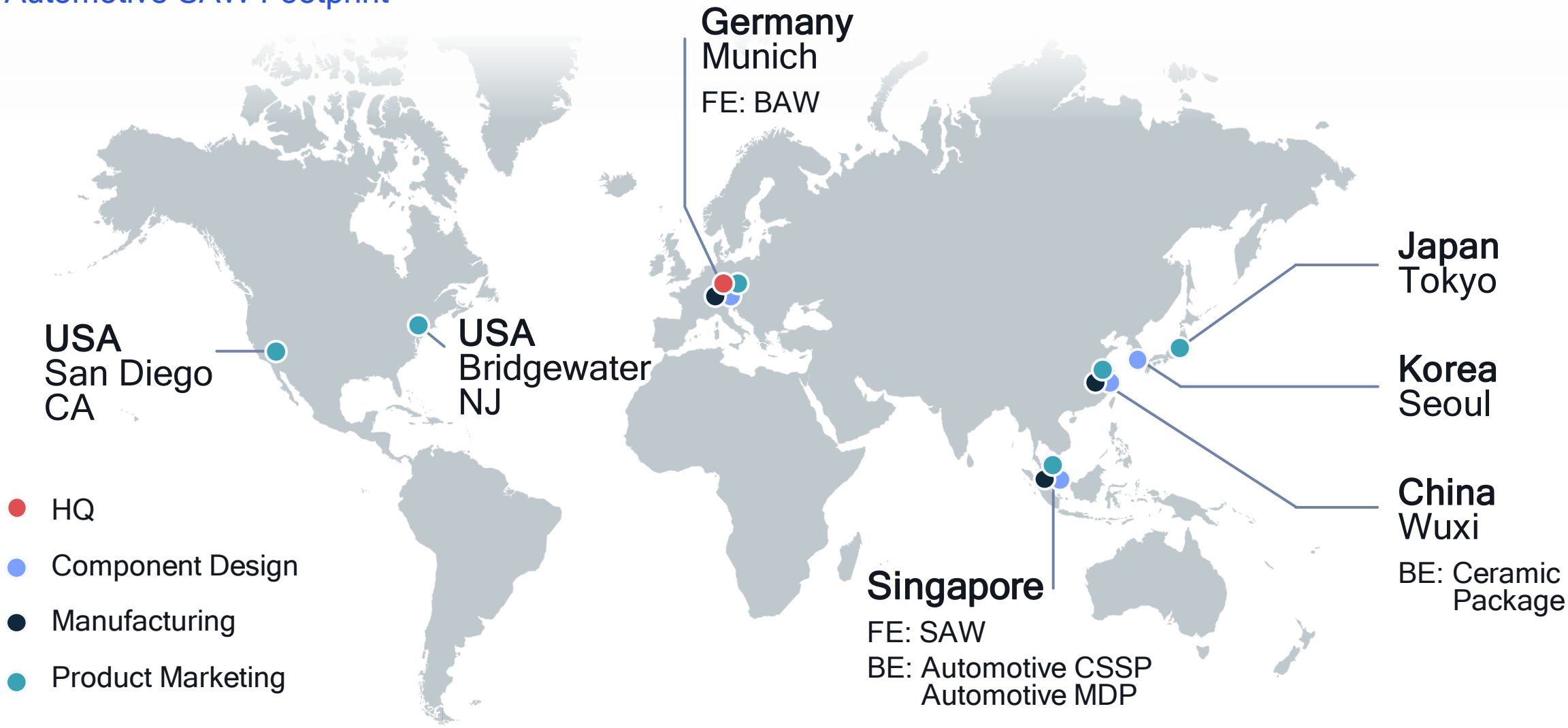
2016 1814 1612

- Automotive CSSP for filters

1411 1109

Global Presence

Automotive SAW Footprint



Plant in Munich, Germany

RF360 Europe GmbH, Qualcomm Germany RFFE GmbH

Wireless terminals components (front-end)

- SAW duplexers
- BAW duplexers
- RF filters and multipexer for cellular, GPS, Bluetooth and WLAN applications
- Qualcomm® TFAP™ (Thin Film Acoustic Package) technology
- Qualcomm® ultraSAW Filter Technology

32,500 m²
Founded in 1968
Employees: 1250 (RF360), 120 (RFFE)

Certification

- ISO 9001
- IATF 16949
- ISO 14001
- ISO 50001

Plant in Singapore

RF360 Singapore Pte. Ltd.

- SAW automotive and infrastructure systems (front-end)
  - RF filters
  - IF filters
  - Resonators

- SAW communications (front- and back-end)
  - SAW duplexers
  - BAW duplexers
  - RF filters and multiplexer for cellular, GPS, Bluetooth and WLAN applications
  - CSSP and TFAP packaging technology

66.858 m²
(K1: 20.487; K2: 3.927; K3: 6.136; K4: 36.308)
Founded in 1997
Employees: 1450

Certification

- ISO 9001
- IATF 16949
- ISO 14001

Plant in Wuxi, China

RF360 Technology (Wuxi) Co., Ltd., Qualcomm CSR RF Technologies (Wuxi) Co., Ltd (RFFE)

Discrete SAW components (back-end):

- RF filter/duplexer, IF filter and resonators for cellular, automotive and industrial applications
- Ceramic and CSSP packaging technology

Modules (back-end):

- Bare Die SAW components assembly and test
- Cellular
- Connectivity
- Prototyping
- Testing

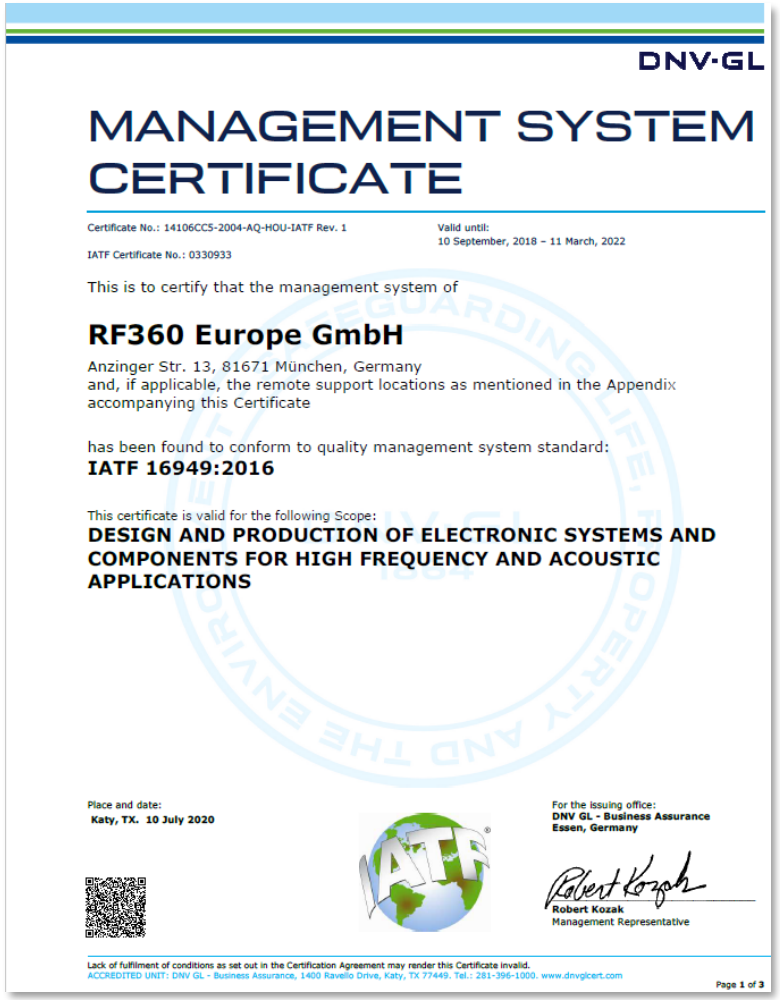
34,750 m²
Founded in 2000
Employees: 1750 (RF360), 90 (RFFE)

Certification

- ISO 9001
- IATF 16949
- ISO 14001

Automotive Electronics – Certificates

Certified to automotive standard IATF 16949:2016



DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No.: 14106CC5-2004-AQ-HOU-IATF Rev. 1
Valid until: 10 September, 2018 – 11 March, 2022
IATF Certificate No.: 0330933

This is to certify that the management system of

RF360 Europe GmbH

Anzinger Str. 13, 81671 München, Germany
and, if applicable, the remote support locations as mentioned in the Appendix accompanying this Certificate

has been found to conform to quality management system standard:
IATF 16949:2016

This certificate is valid for the following Scope:
DESIGN AND PRODUCTION OF ELECTRONIC SYSTEMS AND COMPONENTS FOR HIGH FREQUENCY AND ACOUSTIC APPLICATIONS

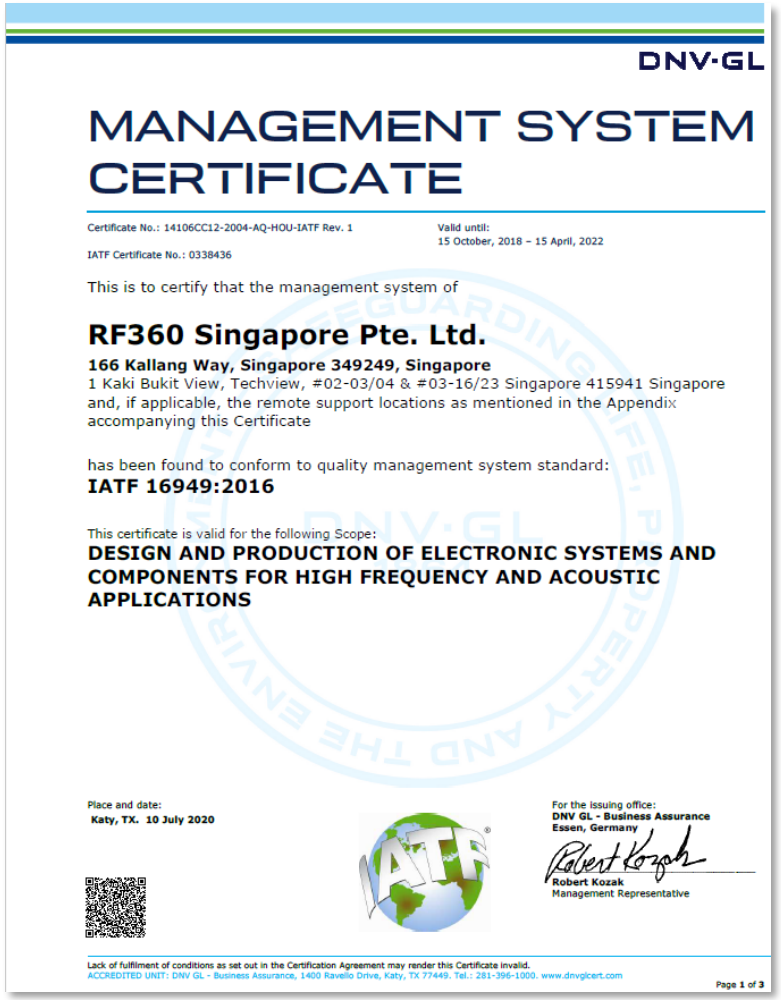
Place and date:
Katy, TX. 10 July 2020

For the issuing office:
DNV GL - Business Assurance
Essen, Germany

Robert Kozak
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL - Business Assurance, 1400 Ravello Drive, Katy, TX 77449. Tel.: 281-396-1000. www.dnvglcert.com

Page 1 of 3



DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No.: 14106CC12-2004-AQ-HOU-IATF Rev. 1
Valid until: 15 October, 2018 – 15 April, 2022
IATF Certificate No.: 0338436

This is to certify that the management system of

RF360 Singapore Pte. Ltd.

166 Kallang Way, Singapore 349249, Singapore
1 Kaki Bukit View, Techview, #02-03/04 & #03-16/23 Singapore 415941 Singapore
and, if applicable, the remote support locations as mentioned in the Appendix accompanying this Certificate

has been found to conform to quality management system standard:
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DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No.: 14106CC3-2004-AQ-HOU-IATF Rev. 2
Valid until: 27 September, 2018 – 28 March, 2022
IATF Certificate No.: 0336527

This is to certify that the management system of

RF360 Technology (Wuxi) Co., Ltd.

No.17 Xi Shi Road, Xinwu District, Wuxi, 214028 Jiangsu, P.R. China
and, if applicable, the remote support locations as mentioned in the Appendix accompanying this Certificate

has been found to conform to quality management system standard:
IATF 16949:2016

This certificate is valid for the following Scope:
DESIGN AND PRODUCTION OF ELECTRONIC SYSTEMS AND COMPONENTS FOR HIGH FREQUENCY AND ACOUSTIC APPLICATIONS

Place and date:
Katy, TX. 10 July 2020

For the issuing office:
DNV GL - Business Assurance
Essen, Germany

Robert Kozak
Management Representative

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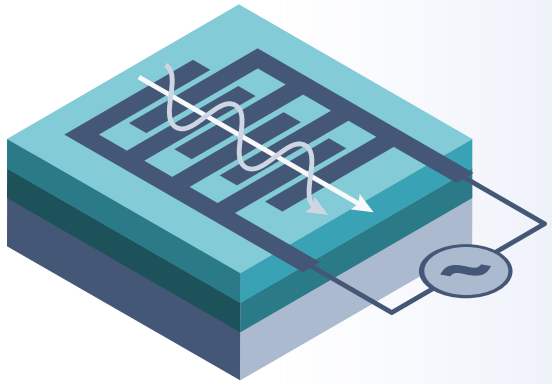
Innovation

Qualcomm ultraSAW Technology

Thin-film filter technology for high performance at low cost

- **Excellent** transmit, receive and cross **isolation**
- **High frequency selectivity**
- **Q-factor** as high as **5000**
- Very low insertion loss
- Excellent temperature stability – Single-digit ppm/Kelvin range



Frequencies: 0.6 – 2.7 GHz

Quality factor: Q > 5000

PA modules (PAMiDs)

Front-end modules (FEMiDs)

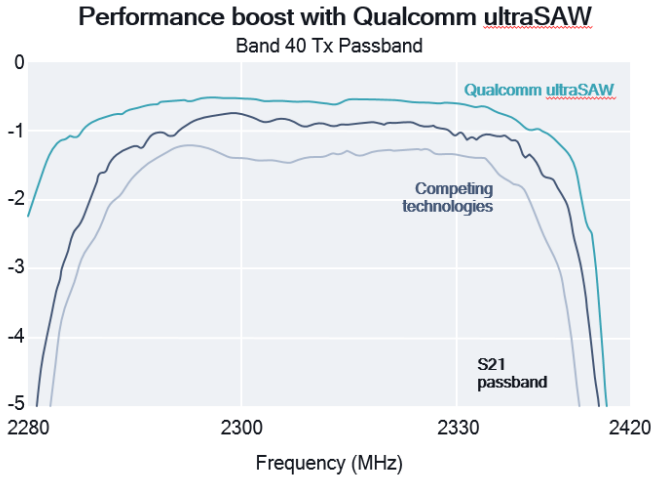
Diversity modules (DRx)

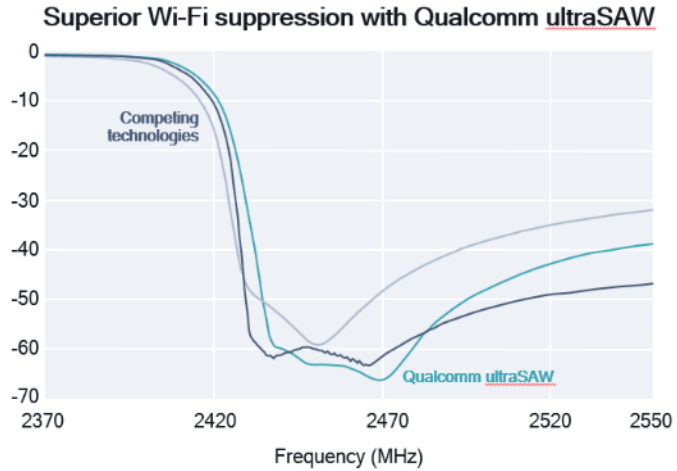
Wi-Fi extractors

GNSS extractors

Discrete ultraSAW filters

High performance filter technology enhances RF Front-End portfolio including modules and discrete filters





Source: Calibrated measurements in Qualcomm Technologies' labs comparing Qualcomm UltraSAW pre-commercial components with commercially available products

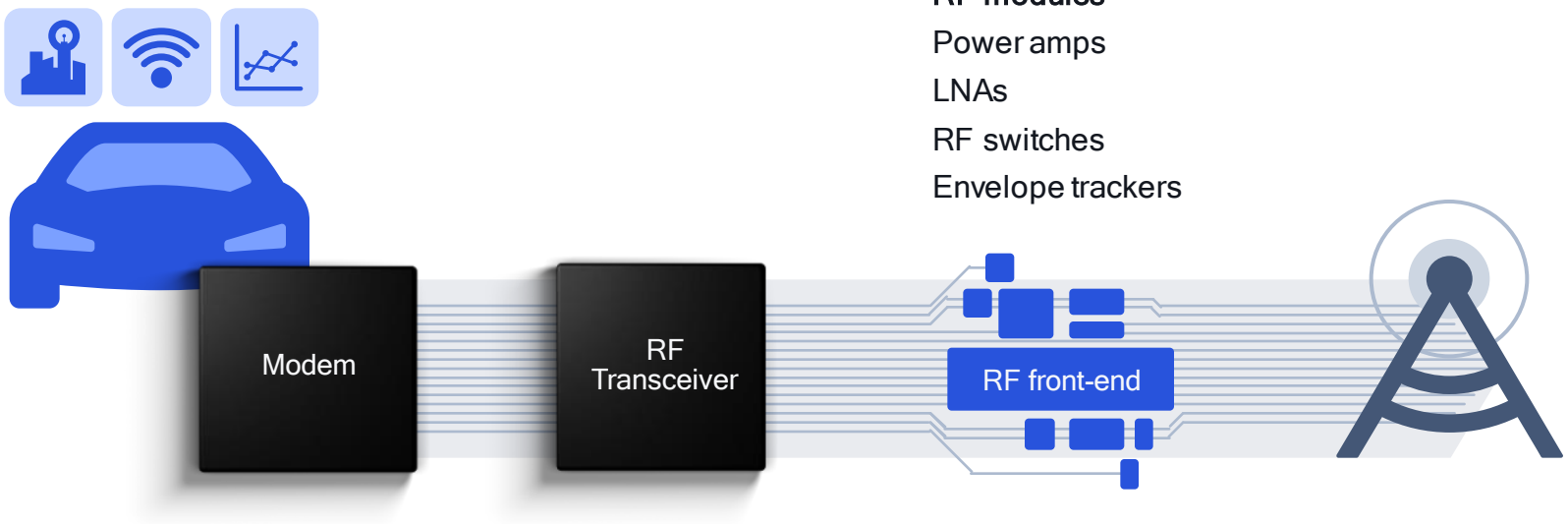
4G 5G

Telematics

Qualcomm RF Front End (RFFE) solution

Modem-RF system
for LTE, LTE-A and 5G

Modem-to-antenna system addresses 4G and the massive complexity of 5G



Acoustic Filters

RF modules

Power amps

LNAs

RF switches

Envelope trackers

5G impact on system requirements

4G

5G

Up to 100 MHz UL BW
Up to 100 MHz DL BW

Expanded frequency range (0.6-6 GHz)

More aggregated carriers

4G/5G dual connectivity (EN-DC)

Antennas

- Number of antennas
- Wide bandwidths
- Antenna sharing with Wi-Fi, GPS
- Antenna tuning optimization

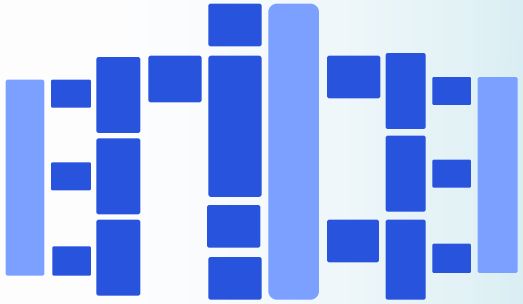
Power efficiency

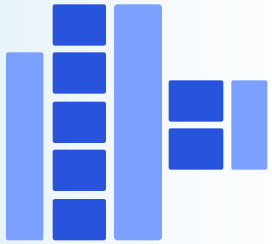
- High Tx power
- High peak-to-avg power ratio
- Wide-band power tracking

Architecture

- High perf antenna swapping
- 5G power tracking
- Highly integrated PA+filter modules

Requirements for 5G NR sub-6 GHz





Discrete

- High flexibility
- Optimized cost
- Individual design
- Up to LTE Cat 9

Hybrid

Choose the best of both concepts according to the individual needs

Modular

- High integration
- High performance
- Small PCB area
- Less supplier handling
- Max CA/EN-DC support

Flexible RFFE design approach based on customer need

Comparison of different approaches

4G and 5G RF Front End for Telematics

SA415M

Discrete RFFE

Regional options

4G MMPA + Switch

- LMHB MMPA
- High band switch

4G LNAs

- Low band
- Mid High band

Average power tracking

- APT

Filtering

- Auto Grade Filters / Duplexer / Quadplexers

Modular RFFE

Global solution

4G L-PAMiD

- Low Band
- Mid band
- High band

4G DRX Modules

- Low band
- Mid High band

Envelope tracking

- 60 MHz ET

Config options

- GSM PA
- C-V2X LNA
- C-V2X PA
- Auto Grade Filters / Duplexer / Quadplexers

SA515M

Modular RFFE

Global solution

5G L-PAFs n41 PAF

- n77 n78 L-PAF
- n79 L-PAF
- n41 PAF

5G Sub 6 DRX Modules

- Band n77/ n78
- Band n79

Envelope tracking

- 60 MHz ET
- 100 MHz ET

4G & Refarmed to 5G L-PAMID

- Low band
- Mid High band

4G & Refarmed to 5G DRX Modules

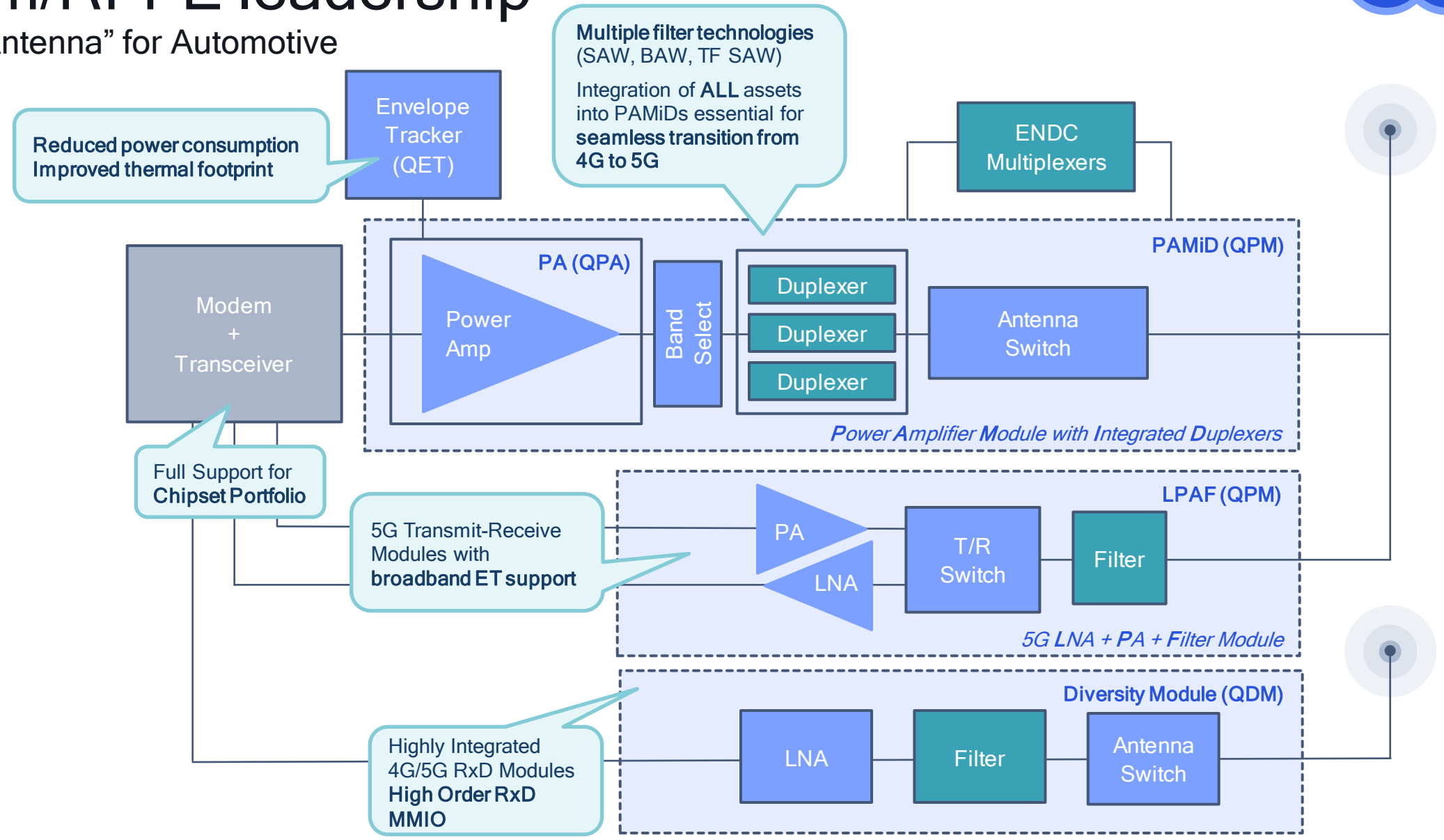
- Low band
- Mid High band

Config options

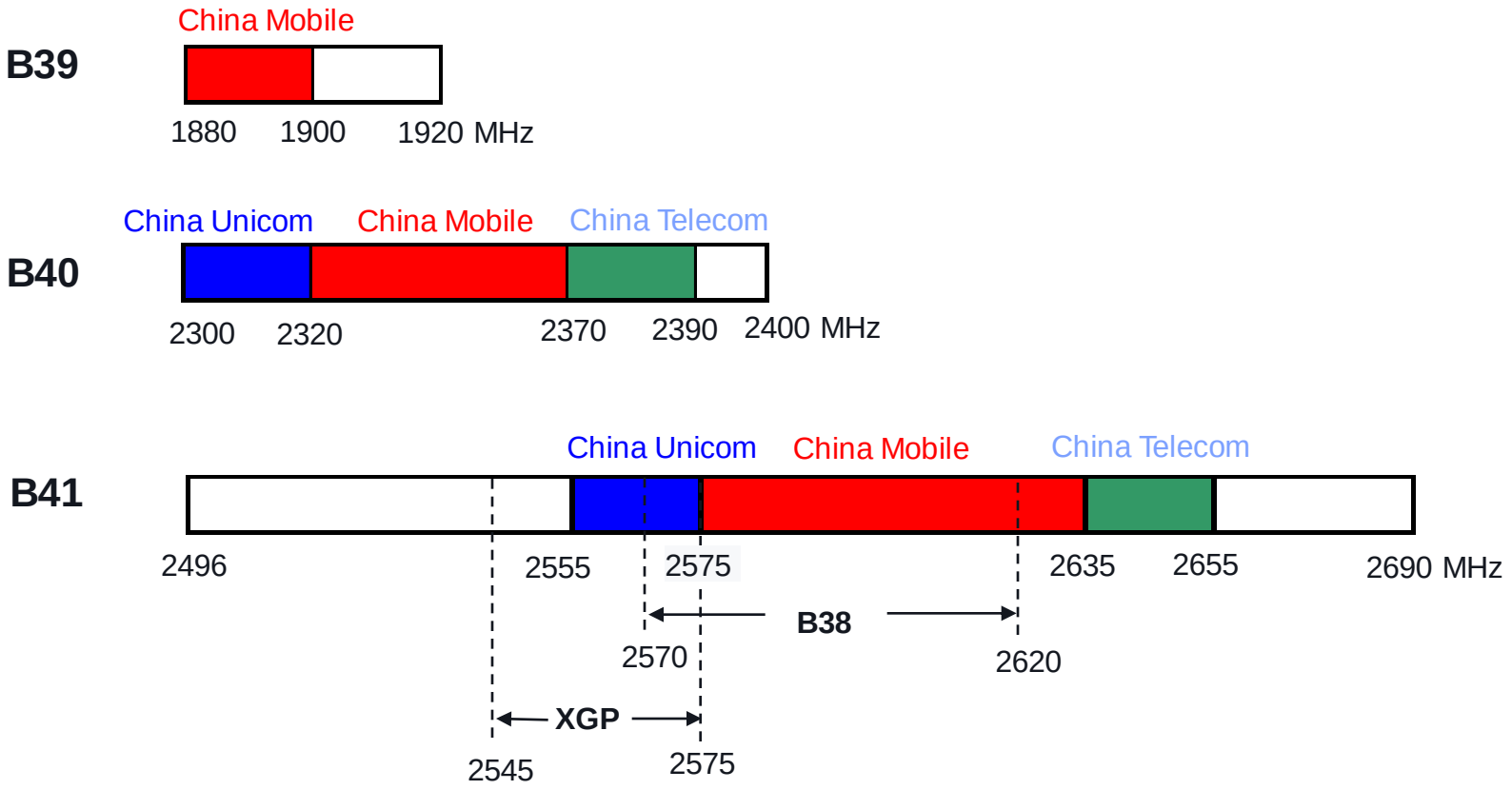
- GSM PA
- C-V2X LNA
- 4G/5G MMPA
- C-V2X PA
- MHB MIMO NA
- MHB MIMO ROW
- Auto Grade Filters / Duplexer / Quadplexers

Modem/RFFE leadership

"Digital to Antenna" for Automotive



China - TDD licenses



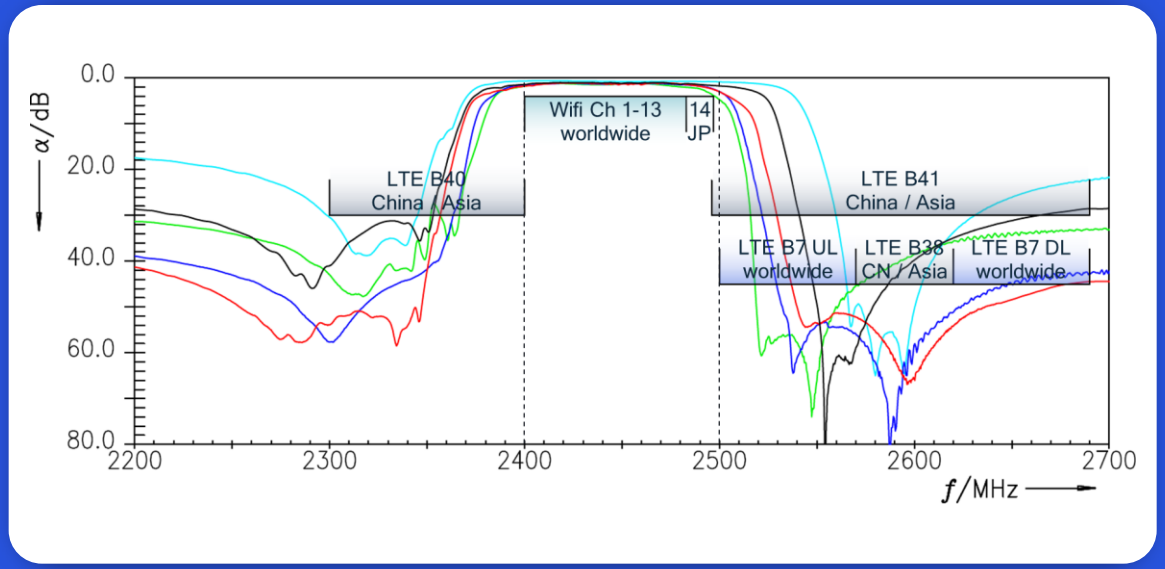
Wi-Fi
Bluetooth

Source sample text

Wi-Fi 2.4GHz

Solutions for different needs

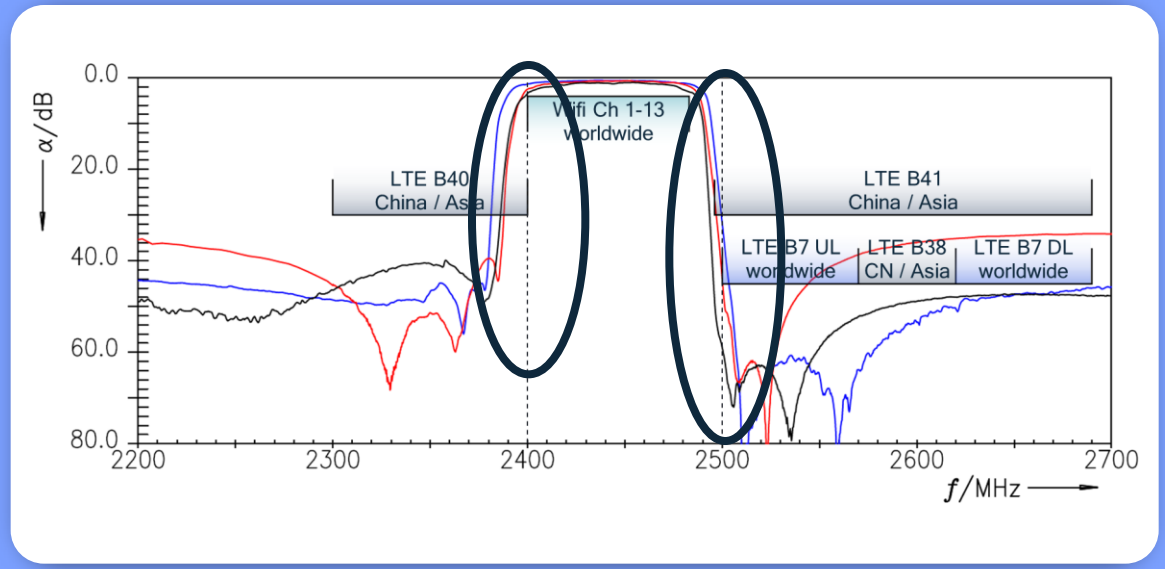
Standard filter portfolio



All channels,
incl. Ch 14 for Japan

Cost-efficient
solution

Coexistence filter portfolio



High-performance
solution

Coexistence
with B7 / B40 / B41

The band information is only for illustration. The dB level is not a specification.

Wi-Fi 5 / 6 / 6E

In addition to 2.4 GHz band

Wi-Fi for 5+ GHz is getting more important in the market

Enhancing the filter portfolio
→ More to come

Frequencies

Wi-Fi 5/6 5170-5890 MHz

Wi-Fi 6E 5925-7125 MHz

Portfolio expansion

2.4 GHz / 5 GHz Diplexer

2.4 GHz / 5 GHz Double Hump

5+ GHz Passband filter

5 GHz Notch

Digital Radio

- SDARS
- DAB

SDARS

Satellite Digital Audio Radio Service

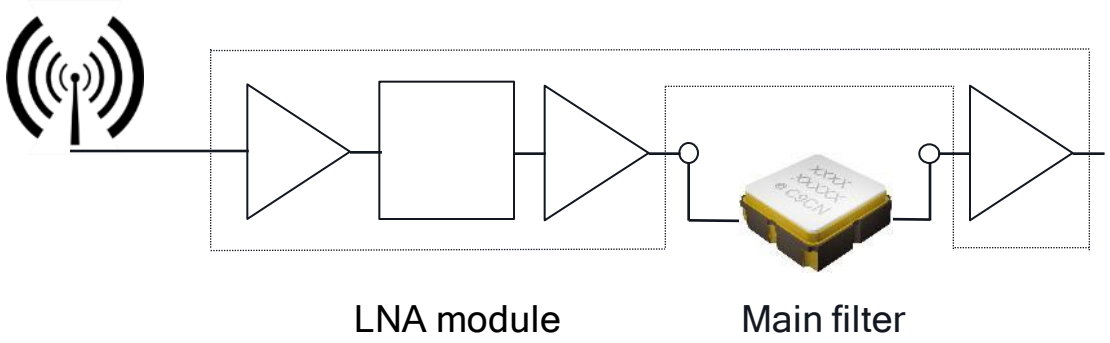
- Radio program via satellite
- In North America: USA, Canada
- History: Sirius + XM → SiriusXM (merger in 2008)
- Lineup: 150 full time channels (USA) / 130 for Canada
- Paid service: 15 USD/m and more depending on channel
- Applications:
  - Home based
  - Option for car radio
- Similar ground based radio infrastructure in other regions:
  - Germany DAB / DAB+ (free service)

Automotive SAW filters for SDARS satellite antenna

Based on reference design

blue: Latest Product [size]

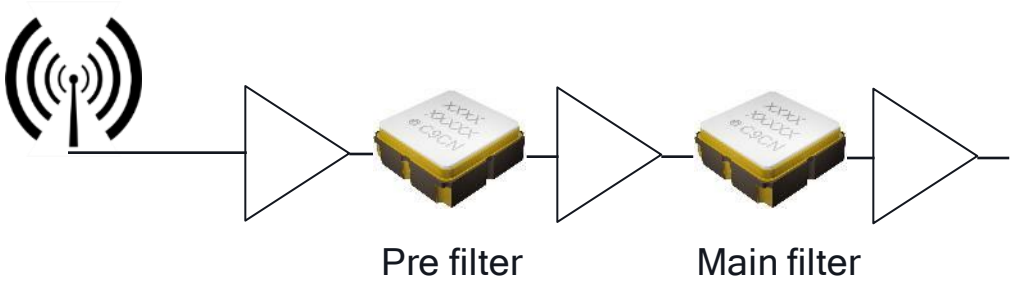
A)



- Module from competition
- High performance filter with WCS rejection

→ Less relevant solution according to market success

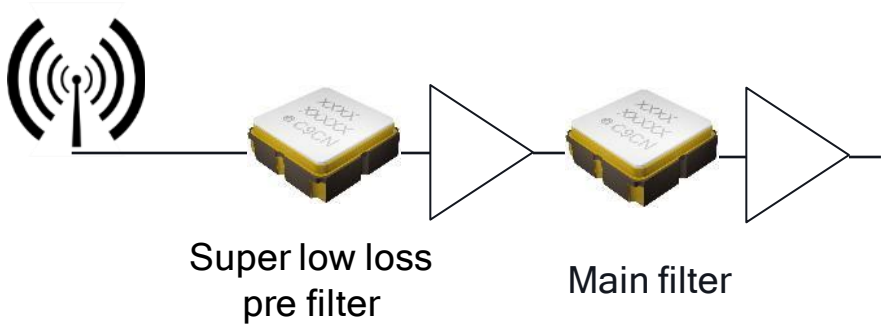
B)



- Non coexistence solution with WCS band
- 3 LNAs
- Super low loss filter
- High performance filter with WCS rejection

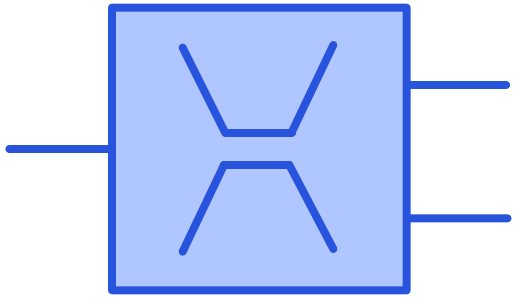
→ Medium relevant solution according to SDARS

C)



- Coexistence solution with WCS band
- 2 LNAs
- Super low loss filter to avoid LNA saturation
- High performance filter with WCS rejection

→ Most relevant solution in the market



Extractor / Notch

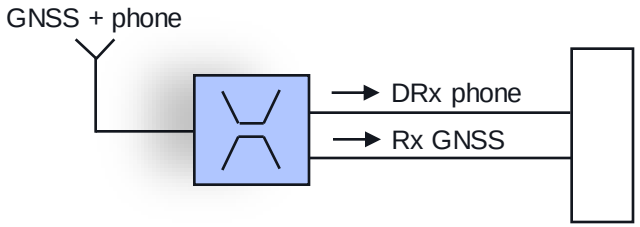
- GNSS
- Wi-Fi
- SDARS

Source sample text

Function: Extractor vs Notch Filter

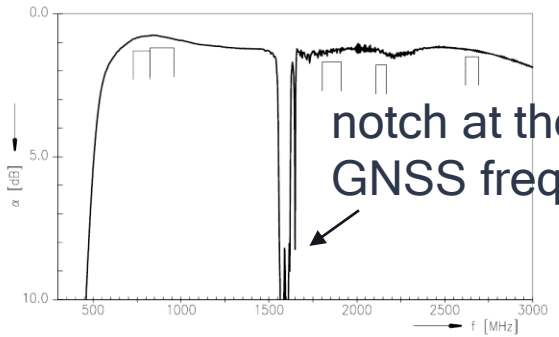
Example: GNSS extractor and SDARS notch (band-stop) filter

GNSS extractor

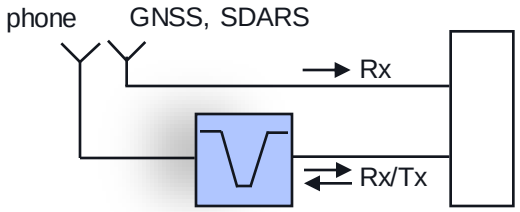


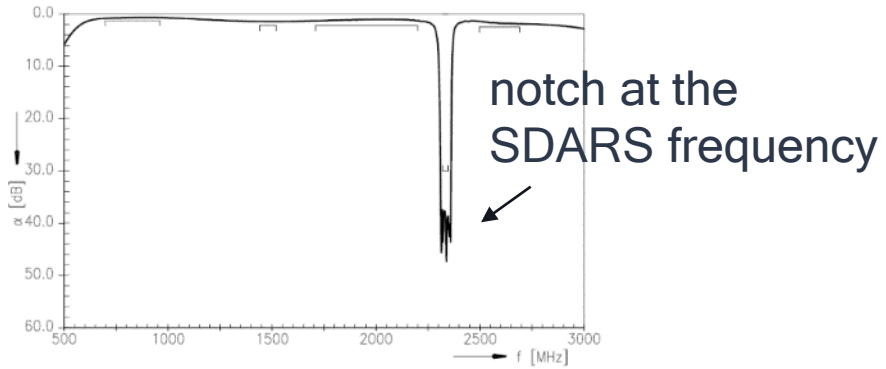
The GNSS extractor is a splitter with:

- notch functionality in the phone path (and)
- band pass filtering in the GNSS path.



SDARS notch filter





The band-stop filter offers a much deeper notch than the extractor.

Positioning GNSS

Source sample text

High Variety
Pre- and Post- LNA filters

Available 2019

Higher Performance
All-rounder TC filters

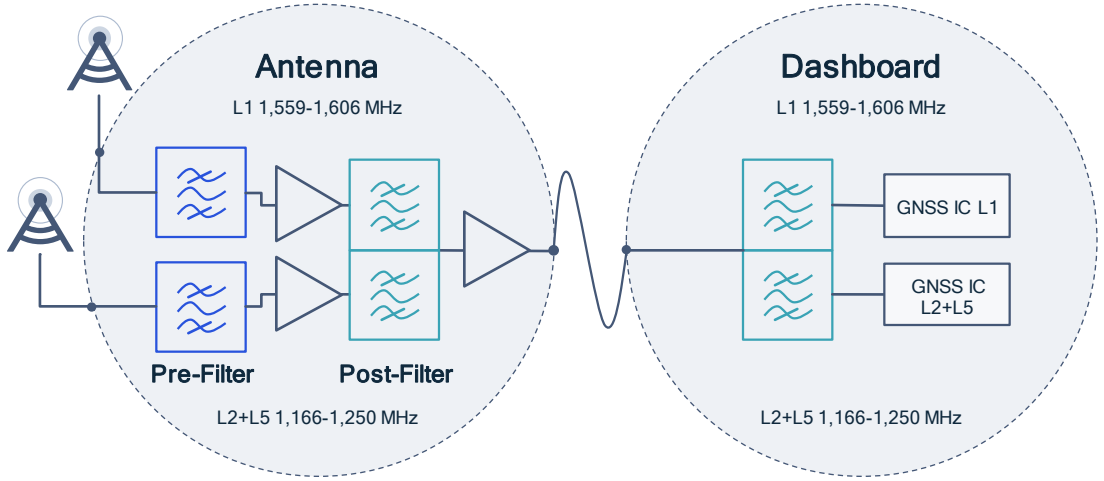
Available 2020

Additional portfolio expansion

More to come in 2021

Low IL Pre-Filter; **High Att Post-Filter** @ low GDR
Single, Diplexer & Double Hump solutions

Low IL & High Att @ low GDR
all-in-one filter, Diplexer



Besides being a major supplier for all standard GNSS products, RFFE offers **high-performance filter solutions** to address the growing **multi-frequency, high-precision** market requirements with optimized SAW filters using advanced temperature compensation technology.

RFFE Automotive GNSS Filter solutions

→ Separate presentation specialized on Positioning / GNSS

Car Access RKE

Car access evolution

Classic Key Fob

- Remote keyless entry
- Immobilization

ISM

Transmitter - **Receiver***
LF

Smart Key

- Passive keyless entry / start
- Display key and diagnostics
- Remote control of car functions

ISM NFC

Transceiver - **Transceiver***
NFC / LF

Advanced Smart Key

- Smartphone / Smart Watch access
- Cloud-based virtual key management
- Car sharing and fleet management

NFC Bluetooth UWB

Transceiver* - Transceiver*
NFC / LF
UWB*
Bluetooth*

*** Integrated Automotive SAW/BAW filters from RFFE**

→ Separate presentation specialized on Car Access / RKE

Look Up

- Internet
- Flyer

Source sample text

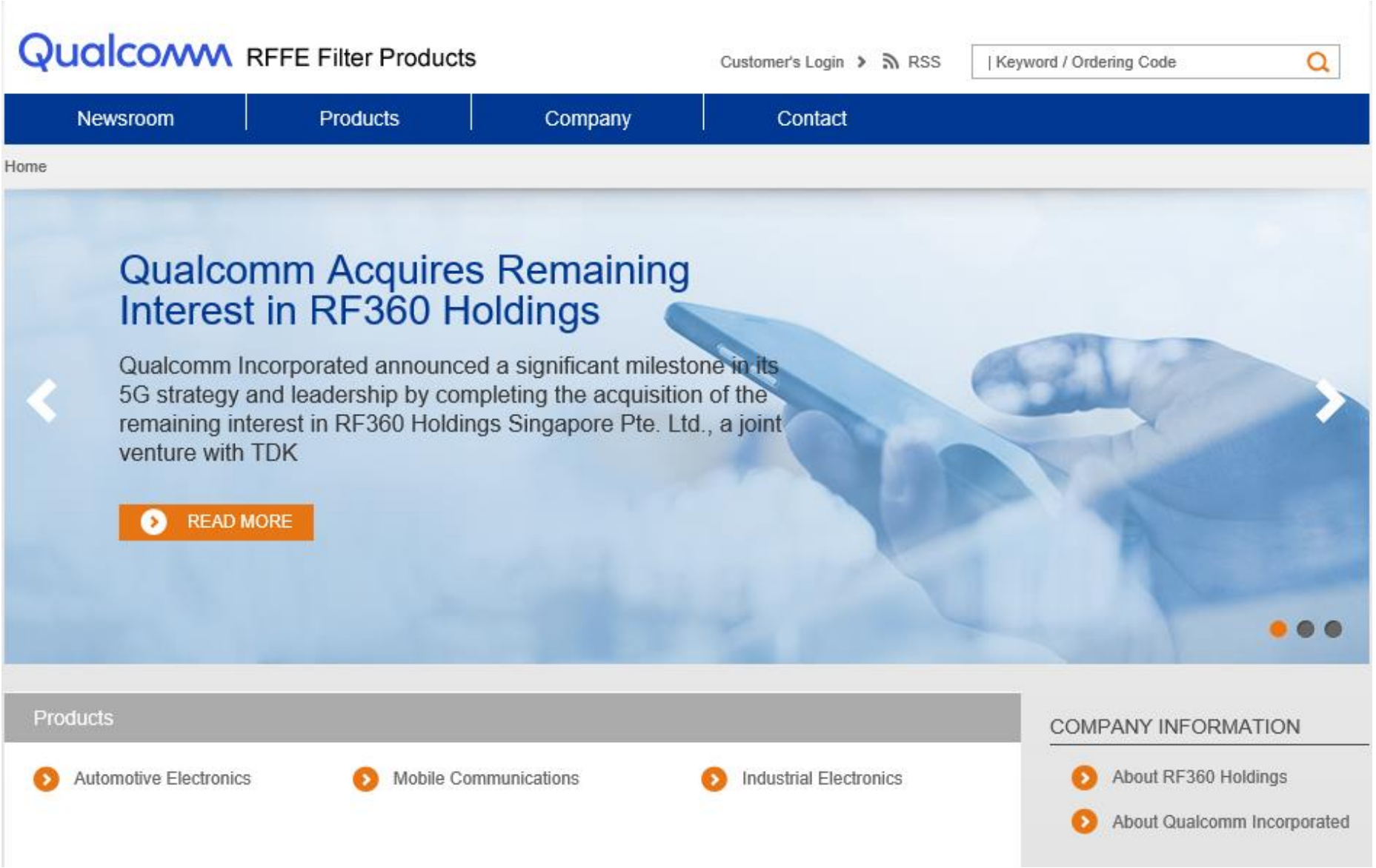
Look Up

Internet

https://rffe.qualcomm.com

Products

- Automotive
- Mobile
- Industrial

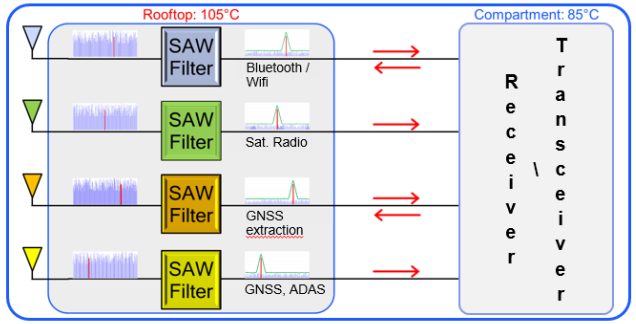


Look Up

Flyer: Antenna

Qualcomm

SAW filters for Automotive: Antennas



Why SAW filters are needed?

- ✓ Every RF front-end needs to have very high sensitivity, while being immune to any RF interference from other applications
- ✓ SAW filters, typically placed between antenna & receiver IC, offer superior protection compared to any other filter technology, such as LC or ceramic filters, due to higher selectivity
- ✓ In transmit paths (Tx), SAW filters suppress harmonics
- ✓ In receive paths (Rx), SAW filters improve th with image frequencies being rejected & pov

BAW technology is part of th

Key facts of automotive SAW filters

- ✓ Package size → RF board = small! → 3030 → 1411 → 1109
- ✓ Frequency spectrum → All: Unlicensed, Proprietary, Licensed
- ✓ Temperature range → -40 °C up to +125 °C
- ✓ Power handling → Transceiver or front-end module dependent
- ✓ Reliability → 1000 h in 85%/85 °C, 1000 TS, 1000 h HTOL
- ✓ Product Life Cycle → 5 - 7 years min
- ✓ Performance → Superior to any other filter technology

Free samples, eval boards & RF-support included

Customer be

- ✓ Component qualification to AEC-Q200, Rev.
- ✓ PPAP available
- ✓ Hermetically sealed package for operation ir enhanced reliability
- ✓ Long product lifecycle
- ✓ Special frequencies & customized product s
- ✓ Comprehensive application support

World leader in SAW A

Qualcomm

SAW Filters for Automotive: Antennas

BT / Wifi

Bands & Applications	f_c (MHz)	Size (mm^2)	Part Number
WiFi/Bluetooth 2.4 GHz	2448.5	3.0x3.0	B3912
WiFi/Bluetooth 2.4 GHz	2441.75	3.0x3.0	B3918
WiFi/Bluetooth 2.4 GHz	2441.75	1.4x1.1	B4347
WiFi/Bluetooth 2.4 GHz	2442	1.1x0.9	B2614*
WiFi/Bluetooth 2.4 GHz	2441.75	1.1x0.9	B4360

Satellite Radio

Bands & Applications	f_c (MHz)	Size (mm^2)	Part Number
SDARS	2332.5	3.0x3.0	B1669
SDARS	2332.5	3.0x3.0	B3595
SDARS	2332.5	3.0x3.0	B3404
SDARS	2332.5	3.0x3.0	B3416
SDARS	2332.5	3.0x3.0	B3442

GNSS extract.

Bands & Applications	f_c (MHz)	Size (mm^2)	Part Number
LTE + GPS/GLONASS (L1)	1590.155	3.0x2.5	B3405**
LTE + GPS/GLONASS/Beidou (L1)	1582.47	3.0x2.5	B3478**

GNSS + SDARS

Bands & Applications	f_c (MHz)	Size (mm^2)	Part Number
GPS/Galileo/Glonass (L1) + SDARS	1591.21 + 2332.5	3.0x3.0	B3927

* BAW
** Extractor

GNSS, ADAS

Bands & Applications	Start Freq (MHz)	Stop Freq (MHz)	Size (mm^2)	Part Number
GPS/Galileo/Glonass/Beidou (L1)	1559.05	1605.89	1.1x0.9	B2611
GPS/Galileo/Glonass/Beidou (L1)	1559.05	1605.89	1.1x0.9	B2618
GPS/Galileo/Glonass/Beidou (L1)	1559.05	1605.89	1.4x1.1	B2617
GPS/Galileo/Glonass/Beidou (L1)	1559.05	1605.66	1.4x1.1	B4353
GPS/Galileo/Glonass/Beidou (L1)	1559.05	1605.89	1.4x1.1	B4348
GPS/Galileo (L1)	1572.42	1578.42	3.0x3.0	B3923
GPS/Galileo (L1)	1572.42	1578.42	3.0x3.0	B3525
GPS/Galileo (L1)	1574.42	1576.42	3.0x3.0	B3528
GPS/Galileo (L1)	1574.40	1576.44	3.0x3.0	B3400
GPS/Galileo/Glonass (L1)	1565	1606	3.0x3.0	B3519
GPS/Galileo/Glonass (L1)	1565	1605.89	3.0x3.0	B3414
GPS/Galileo/Glonass (L1)	1565	1607	3.0x3.0	B3517
GPS/Galileo/Glonass/Beidou (L1)	1560	1616	3.0x3.0	B3913
GPS/Galileo/Glonass/Beidou (L1)	1559	1616	3.0x3.0	B3412
GPS/Galileo/Glonass/Beidou (L1)	1559	1616	3.0x3.0	B3413
GPS/Galileo/Glonass/Beidou (L1)	1559	1606	3.0x3.0	B3415
GPS/Galileo (L1)	1572.42	1578.42	2.5x2.0	B3524
GPS/Glonass (L1)	1571.42	1605.89	2.5x2.0	B3401
GPS/Glonass/Beidou (L1)	1559	1605.70	2.5x2.0	B3431
GPS (L1)	1572.42	1578.42	3.0x2.5	B3470
GNSS (L2/G2) GNSS (L1/G1)	1196 1559	1250 1606	3.0x2.5	B3436
GNSS (E5b/L2/G2)	1196	1250	3.0x3.0	B3596
GNSS (L6)	1273.75	1283.75	3.0x3.0	B3428
GNSS (L)	1525	1559	3.0x3.0	B3421
GNSS (L1/E1/G1)	1560	1606	3.0x3.0	B3423
GNSS (L/L1/E1/G1)	1525	1606	3.0x3.0	B3424

85

Look Up

Flyer: IoT

Qualcomm

Product Guide: RF360 SAW / BAW Filters for IoT and Industrial Applications

Web: www.rf360jv.com **Email:** info@rf360jv.com

RF360 SAW and BAW filters are designed for spectrum challenging applications. With their small packaging footprint as small as 1.1 mm x 0.9 mm they can easily incorporated into the smallest applications. There are two reliability grades available, consumer grade and industrial grade. Industrial grade filters are optimized for harsh environments like high temperature and humidity.

Wireless IoT standards:

Short range and LP-WAN like LoRa®, Sigfox, Wifi, Bluetooth, Zigbee, Z-Wave, HaLow, Wi-SUN, OMS®

Application examples:

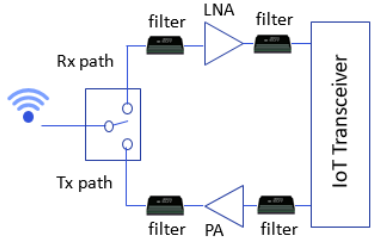
Smart metering, energy control, home comfort, temperature control, thermostat, air conditioning, security, surveillance, smoke detector, (street) lighting, small and white good appliance, remote control, traffic control systems (e.g. parking spot detection, traffic light control), etc.

Features of RF360 filters:

- Frequency spectrum 300 MHz to 2.4 GHz
- Package sizes [mm x mm]: 11x09, 14x11, 15x11, 17x13 and 30x30
- Operating temperature up to -40°C to +125 °C
- Available in 2 different reliability grades: Commercial grade and industrial grade

Test criteria	Commercial grade	Industrial grade
Package size [mm x mm]	11x09, 14x11, 17x13	11x09, 14x11, 15x11, 30x30
Temperature cycling	100 cycles @ -40°C to +85°C	1000 cycles @ -40°C to +85 / 95 / 125 °C
Biased or static humidity @ 85°C, 85% rel. humidity	168 hours	1000 hours
Input power capability	depending on type	

Example of an IoT front end design:



Qualcomm

Product Range:

Pass Band [MHz]				Package Size [mm x mm]				
Lower Frequency [MHz]	Center Frequency [MHz]	Upper Frequency [MHz]	Bandwidth [MHz]	1.1 x 0.9	1.4 x 1.1	3.0 x 3.0 5.0 x 5.0 [1]	Top, max [°C]	Comment
169,40	169,50	169,60	0,2			B3942 [1]	125	
344,60	345,00	345,40	0,8			B3408	125	
433,00	433,92	434,71	1,7			B3710	125	Ref. Design Semtech SX1301 - SX1255
470,00	480,00	490,00	20,0			B3427	125	Rx filter, codesigned with B3426 for duplexing
500,00	505,00	510,00	10,0			B3426	125	Tx filter, codesigned with B3427 for duplexing
863,00	866,50	870,00	7,0		B4377	B3717	125	Ref. Design Semtech SX1308 Picocell Gateway - EU B3717: Semtech SX1301 - SX1257 Macro Gateway - EU
863,00		870,00	7,0			B3420	125	high power version of B3717
865,60	866,80	868,00	2,4			B3441	125	temperature compensated filter - LTE co-existance
863,00	868,00	873,00	10,0			B3430	125	
868,15	868,30	868,45	0,3			B3734	125	
868,00		868,60	0,6			B3744	125	
868,00	868,60	869,20	1,2			B3948	125	
868,00		869,20	1,2			B3746	125	
868,70	868,95	869,20	0,5			B3941	125	
862,00	869,00	876,00	14,0		B2600		125	
868,00		870,00	2,0		B4365	B3440	125	temperature compensated filter - LTE co-existance B3440: Semtech SX1301 Macro Gateway - EU
868,00		870,00	2,0		B4316	B3715	85 / 125	
868,00		870,00	2,0			B3716	125	GSMattenuation
868,00		870,00	2,0			B3725	125	improved nearby attenuation
868,00		870,00	2,0		on request (GT)		85	
863,00	869,50	876,00	13,0			B3418	125	
868,00	872,00	876,00	8,0			B3443	125	temperature compensated filter
902,00	908,50	915,00	13,0			B3429	125	Rx filter, codesigned with B3433 for duplexing
923,00	925,50	928,00	5,0			B3433	125	Tx filter, codesigned with B3429 for duplexing
908,27	908,42	908,57	0,3			B3943	125	Z-Wave
908,00	912,50	917,00	9,0			B3406	125	
902,00	915,00	928,00	26,0		B4344	B3728	85 / 125	Ref. Design Semtech SX1308 Picocell Gateway - NAFTA B3728: Semtech SX1301 - SX1257 Macro Gateway - NAFTA B4344: steep left skirt
902,00		928,00	26,0	B2671 (GT)	B2672 (GT)		85	for indoor applications only - NAFTA
902,00		928,00	26,0	B4379			125	NAFTA
902,00		928,00	26,0		B4301		85	NAFTA; 125 °C version on request
902,00		928,00	26,0			B3435	125	NAFTA; se/bal pin configuration
910,00		920,00	10,0			B3726	125	NAFTA
910,00		920,00	10,0			B3434	125	NAFTA; steeper skirts than B3726
912,80	915,70	918,60	5,8			B3432	125	low IA
914,25	916,00	917,75	3,5			B3718	125	
915,90	916,50	917,10	1,2			B3300	125	
921,27	921,42	921,57	0,3			B3949	125	Z-Wave
915,00	921,50	928,00	13,0		B2615		125	Australia
920,00	922,50	925,00	5,0		B2619	B3407	125	Hong Kong
923,40	924,00	924,60	1,2			B3945	125	New Zealand
920,60	924,15	927,70	7,1			B3419	125	
922,00	924,50	927,00	5,0		B2616		125	New Zealand
923,40	925,00	926,60	3,2			B3919	125	
922,20	925,15	928,10	5,9		B4336		85	Japan
922,20		928,10	5,9		B8331 (GT)		85	for indoor applications only - Japan
922,30	925,20	928,10	5,8			B3926	125	Japan
923,50	925,50	927,50	4,0			B3446	125	temperature compensated filter - LTE coexistence
922,30	925,80	928,10	5,8			B3916	125	Japan - low IA
923,50		928,10	4,6			B3921	125	Japan - high selectivity
2400,00	2441,75	2483,50	83,5	B4360	B4347	B3918	125	B4347 and B3918 with SDARS co-existence
2401,50	2442,00	2480,50	79,0	B2614	B4346		105 / 85	both are BAWs; with B7/B40/B41 co-existence
2400,00	2448,50	2497,00	97,0			B3912	125	
2401,50	2442,00	2480,50	79,0		B9634		95	BAW; with B7/B40/B41 co-existence
2401,50	2442,00	2480,50	79,0		B8328 (GT)		85	BAW; with B7/B40/B41 co-existence;
2401,50	2442,00	2480,50	79,0	B8857 (GT)			85	for indoor applications only
2401,50	2442,00	2480,50	79,0	B8873 (GT)			85	with B7/B40/B41 co-existence; for indoor applications only

December 11th, 2018

Remark: Type codes followed by "(GT)" indicate commercial grade components. All other components are industrial grade.

Look Up

Flyer: GNSS

Qualcomm

Automotive RF360 Filters for GNSS Applications

Automotive SAW, TCSAW and BAW filters by RF360 are designed for challenging requirements. With highly robust packaging footprints down to 1.1 mm x 0.9 mm, they can easily be incorporated into the smallest automotive grade applications. The RF360 Filters are available in two package technologies:

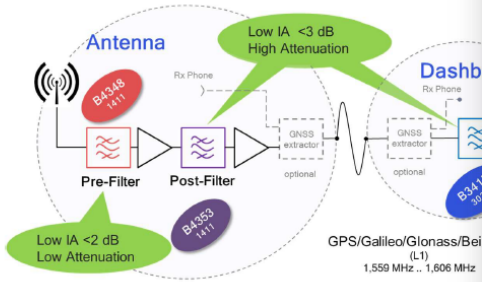
Package Technology	Ceramic Packages	Automotive CSSP ™
Package Size [mm]	2520, 3025, 3030, 3838	1109, 1411, 1511, 1814, 2016
AEC-Q200 grade	Up to grade 1 (-40 to 125 °C)	
Temperature cycling	1,000 cycles @ -40 to 125 °C	
Biased or static humidity	1,000 hours @ 85 °C, 85% rel. humidity	

Standard single frequency L1 Band GNSS

Standard single frequency L1-Band GNSS are being used for convenience Car-Navigation as well as positioning systems (eg. E-call). The requirements for L1-Band GNSS filters are:

- Low **Insertion Attenuation** and amplitude ripple for better sensitivity (low noise figure)
- **High attenuation at the LTE bands** to mitigate interferences disturbing the GNSS signal reception.
- **The AEC-Q200 grade requirement** depends on the application (Antenna or Dashboard)

Example of a Standard single frequency L1 Band G block diagram:



Application	f_c [MHz]	Start Freq [MHz]	Stop Freq [MHz]	Usable bandwidth [MHz]	Insertion Attenuation [dB]	Typ
GPS/Galileo/ Glonass/BeiDou	1,582.47	1,559.05	1,605.89	46.84	0.8 – 1.0	B434
	1,582.40	1,559.05	1,605.66	46.61	1.0 – 1.5	B435
	1,582.50	1,559.00	1,606.00	47.00	2.0	B341

For more details about the Diplexers, Passband and Bandstop filte portfolio please contact your local sales partner or refer to the SA Device Selection Table AE

Technical data subject to change. Filter specification must be taken from the respective product Data Sheet.

Qualcomm

Automotive RF360 Filters for GNSS Applications

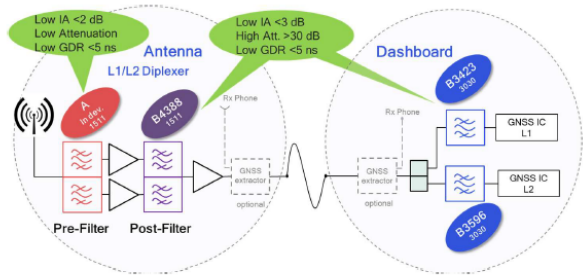
High precision multifrequency GNSS ADAS

Advanced Driver Assistance Systems (ADAS) are designed to help the driver to make decisions or, in the case of autonomous vehicles, take decisions on their own. Further, ADAS generates warning signals for critical events, such as collision avoidance, speed control, braking, blind spot detection and park assist.

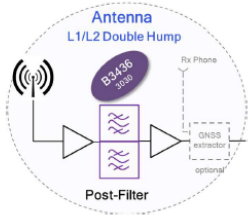
ADAS is deployed in combination with high precision multifrequency **GNSS**, used to generate data required for precise location-based warnings (e.g. high speed warning in advance of a tight curve) and/or relevant driving commands.

An enabling component of these high precision GNSS modules are the RF filters. It is imperative that an appropriate filter is selected. The requirements for high precision ADAS/GNSS filters are:

- **The Group Delay Ripple** requirement is very strict. The target is around **5ns** for the specific GNSS sub-bands in order to be able to achieve the precise positioning requirements → avoiding collisions.
- **Low Insertion Attenuation and amplitude ripple** for better sensitivity (low noise figure).
- **High attenuation at the LTE bands** to mitigate interferences disturbing the GNSS signal reception.
- **The AEC-Q200 grade requirement** depends on the application (Antenna or Dashboard)



Application		f_c [MHz]	Start Freq [MHz]	Stop Freq [MHz]	Usable bandwidth [MHz]	Insertion Attenuation [dB]	Type	G
GNSS	L2/G2	1223	1197	1249	52	1.2	Target Spec A	1
Diplexer	L1/G1	1583	1559	1606	47	1.4		
GNSS	L2/G2	1223	1197	1249	52	1.8-2.3	B4388	1
Diplexer	L1/G1	1583	1559	1606	47	1.7-2.2		
GNSS L1/G1		1583	1560	1606	46	2.2	B3423	1
GNSS L2/G2		1223	1196	1250	54	2	B3596	1



Please contact your local sales partner for other configuration variants.

Technical data subject to change. Filter specification must be taken from the respective product Data Sheet.

2

Q&A

Source sample text

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Thank you

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