RF Front-End Module Technical Comparison 2019

Apple iPhone Xs/Xs Max, Apple iPhone Xr, Samsung Galaxy S9 Plus, Samsung Galaxy S10 Plus, Huawei Mate 20 Pro, Huawei P30 Pro, Xiaomi Mi8 Explorer Edition, Oppo Find X.

July 2019 – Sample
Report by Stéphane ELISABETH; Lab. Analysis done by Nicolas RADUFFE
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Executive Summary

This comparative technology study has been conducted to provide insight on technology data for RF Front-End modules and components in Smartphones. The report includes the study of at least fifty Front-End Modules and several components found in eight flagship smartphones: Apple iPhone Xs/Xs Max, Apple iPhone Xr, Samsung Galaxy S9 Plus X (US vs. European version), Samsung Galaxy S10 Plus European Version, Huawei Mate 20 Pro, Huawei P30 Pro, Xiaomi Mi8 Explorer Edition, and Oppo Find X.

With teardowns of a large variety of smartphones, the main RF Modules & components have been extracted and physically analyzed, from the output of the transceiver to the antenna. Sizes and technologies are studied to provide a large panel of OEM technical and economical choices and an overview of the market. In terms of design win in these smartphones, Qorvo is now a major player along with Skyworks and Broadcom/Avago but several other players like Murata, Qualcomm also exist and have been analyzed.

The report includes a description of each component and statistical analyses for most of front-end modules. It also tries to explain the OEMs choice and the supplier tendencies

Note:
Antenna Tuner has been integrated in this report
Wifi and Bluetooth Module analyses are not included in this report
Apple Smartphone History & RF Major Players

Apple try and succeed to developed one processor each year in order to improve the last series or to propose a new series.
Samsung Smartphone History & RF Major Players

Samsung utilizes a fully integrated IDM model. They perform design, manufacturing, assembly and wafer testing.

2016

Samsung Galaxy S7

EU Version

Avago Technologies

Skyworks

Qorvo

USA Version

Avago Technologies

Murata

Qorvo

2017

Samsung Galaxy S8

2018

Samsung Galaxy S9

2019

Samsung Galaxy S10

EU Version

Avago Technologies

Skyworks

Qorvo

USA Version

Avago Technologies

Murata

Qorvo
Huawei P30 Pro Teardown

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Huawei P30 Pro Teardown
# Huawei P30 Pro Teardown

## RF Board Area:

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      - Main Suppliers & Functions
      - OEMs Main Suppliers
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- **Market Analysis**
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- **Related Reports**
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- Component Distribution per Function
  - Antenna Tuner 33%
  - Diversity Switch 14%
  - Switch 9%
  - LNA 7%
  - FEM 3%
  - Switch/LNA 5%
  - HB PAMiD 2%
  - MB PAMiD 2%
  - LB PAMiD 8%
  - PAM 7%
  - HB/MB PAMiD 7%
  - Multiplexer 3%

- Component Distribution per Supplier
  - Qorvo 11%
  - Skyworks 8%
  - Broadcom 7%
  - Murata 2%
  - Qcomm 3%
  - Infineon 3%
  - HiSilicon 2%
  - Sony 1%
  - On Semi 3%
  - STM 32%
  - NXP 8%
Smartphone Comparison – Area Distribution per Supplier

Area Distribution per supplier

RF Board Area (mm²)

- Find X
- Mi8 Explorer
- P30 Pro
- Mate 20 Pro
- Galaxy S10+
- Galaxy S9+ EU
- Galaxy S9+ US
- iPhone Xr
- iPhone Xs Max

- Qorvo
- Skyworks
- Broadcom
- Qualcomm
- Murata
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- Sony
- On Semi
- NXP
- NXP
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- STM
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    - Area Distribution by Function
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    - Distribution in Module
    - 2017 vs. 2018 vs. 2019 Silicon Consumption
    - RFRE Report 2017 vs. 2018 vs. 2019 Apple, Samsung, Huawei, Xiaomi

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Smartphone Comparison – Material Distribution

Material Distribution per smartphone (mm²)

- iPhone X Max
- iPhone XR
- Galaxy S9+ US
- Galaxy S9+ EU
- Galaxy S10+
- Mate 20 Pro
- P30 Pro
- Mi8 Explorer
- Find X

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Smartphone Comparison – Silicon Distribution – 2017 vs. 2018 vs. 2019

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- Area Distribution by Supplier
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Component family market forecast

Cellular module market forecast

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<thead>
<tr>
<th>Manufacturer</th>
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<th>OEMs</th>
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<td>Huawei</td>
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<td>GM78013</td>
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Related Reports
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- Qorvo Analysis
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- Infineon Analysis
- HiSilicon Analysis
- Sony Analysis
- On Semi Analysis
- NXP Analysis
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QM77031 – Package View & Dimensions

- Package Type:
- Dimensions:
- Pin Pitch:
- Marking:

Package Top View – Optical View ©2019 by System Plus Consulting

Package Bottom View – Optical View ©2019 by System Plus Consulting

Package Side View – Optical View ©2019 by System Plus Consulting

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Physical Comparison

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QM77031 – Actives – Power Amplifier

Package Opening – Optical View

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QM77031 – Actives – Switch SPxT

Package Opening – Optical View
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• Die Area:
• Die Marking:
• Die Substrate:
QM77031 – Actives – LNA

- Die Area:
- Die Marking:
- Die Substrate:
QM77031 – Actives – RFIC

• Die Area:

• Die Marking:

• Die Substrate:
QM77031 – Passives – Filters

Package Opening – Optical View
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# QM77031 – Component Summary

## Component Distribution (Qorvo QM77031)

### Component Area Distribution (Qorvo QM77031)

### Related Reports
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- Skyworks Analysis
- Murata Analysis
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### Table: MB/HB PAMiD vs. Total Die Area

<table>
<thead>
<tr>
<th>MB/HB PAMiD</th>
<th>Number of dies in Module</th>
<th>Total Die Area (mm²)</th>
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<tr>
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<tr>
<td>Switch</td>
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<tr>
<td>Power Amplifier</td>
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<td>Blank Space</td>
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<td>Total</td>
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</tbody>
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5G’s Impact on RF Front-End Module and Connectivity for Cell phones 2019 – by Yole Développement

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- RF front-end technology breakdown forecast
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- Qualcomm 60GHz WiGig/WiFi 802.11ad Chipset World’s First Smartphone Edition
- RF Front-End Module Comparison 2018
- Qorvo TQF6405 in iPhone 6s Plus
- Avago AFEM8030 in iPhone 6s Plus
- Cavendish Kinetics 32CK417R

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- Advanced RF System-in-Package for Cellphones 2019

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**RF Devices**
- Antenna for 5G and 5G-related Applications – Patent Landscape Analysis
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Extensive overview of 100 RF Front-End modules and components found in eight leading flagship smartphones from Apple, Samsung, Huawei, Xiaomi, and Oppo.

In 2019 RF Front-End Module suppliers have brought through new communication technology. This follows the disruptive choices made in 2018 by the high-end smartphone original equipment manufacturers (OEMs). Some chose the Diversity Switch (RxDM), others picked mixed Mid-Band/High Band Power Amplifier integrated Duplexers (MB/HB PAMiDs). Today, the choices are becoming even more diverse, due to the upcoming fifth generation (5G) wireless technology. High-end smartphone OEMs are seeking new ways to integrate more into one device, along with better isolation techniques for all the front-end communication devices, in a market with high-quality competitors. To keep track of the industry’s evolution and see what’s coming, this is the perfect time to look the players by comparing the integration technologies between the smartphone brands, the module suppliers and last year’s technologies.

This comparative technology study has been conducted to provide insight into technology data for Radio-Frequency (RF) Front-End Modules and components in smartphones. The report includes the study of Front-End Modules and components found in eight flagship smartphones: the Apple iPhone Xs/Xs Max, Apple iPhone Xr, Samsung Galaxy S9 Plus X US and European version, Samsung Galaxy S10 Plus European Version, Huawei Mate 20 Pro, Huawei P30 Pro, Xiaomi Mi8 Explorer Edition, and the Oppo Find X.

With teardowns of a large variety of smartphones, the main RF Modules and components, from the output of the transceiver to the antenna, have been extracted and physically analyzed. We have studied packaging, sizes and technologies to provide a large panel of the smartphone producers’ technical and economical choices and an overview of the market. In terms of design wins in these smartphones, Qorvo is now a major player, along with Skyworks and Broadcom/Avago. Several other players like Murata and Qualcomm are also involved and have been analyzed.

The report includes a description of each component and statistical analyses for most front-end modules. It also tries to explain the smartphone-making OEMs choices and supplier preferences. Wi-Fi and Bluetooth Module analyses are not covered in this report.

COMPLETE TEARDOWN WITH
• Detailed photos
• Precise measurements
• Complete bills-of-materials of the modules
• Comparison between suppliers
• Comparison between OEMs
• Comparison with 2017 and 2018 smartphones
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