RF Front-End Module & Components Comparison

Apple iPhone X, Apple iPhone 8 Plus, Apple Watch Series 3, Samsung Galaxy S8, Huawei P10, Xiaomi Mi6, ASUS Zenfone 4 Pro, Sony Xperia XZs

RF report by Stéphane ELISABETH
April 2018 – version 1
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Executive Summary

• This comparative technology study has been conducted to provide insight on technology data for RF Front-End modules in Smartphones and a new Smartwatch. The report includes the study of at least 40 Front-End Modules and several components found in eight flagship smartphones: Apple Watch Series 3, Apple iPhone 8 Plus, Apple iPhone X (US vs. Japanese version), Samsung Galaxy S8 Edge (US vs. European version), Huawei P10, Asus Zenfone 5 Pro, Sony Xperia XZs and Xiaomi Mi6.

• With teardowns of a large variety of smartphones and one smartwatch, the main RF Modules have been extracted and physically analyzed. Sizes and technologies are studied to provide a large panel of OEM technical and economical choices and an overview of the market. Skyworks is now a major player along with Broadcom/Avago but several other players like Qorvo, Murata, Epcos/TDK 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: 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. Using two different modem, the RFFE suppliers are different.
Apple iPhone 8 & X Teardown

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Apple iPhone 8 & X Teardown
Apple iPhone X Teardown

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<th>Type</th>
<th>Dimensions</th>
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</table>

### Apple iPhone X Physical Analysis

- **A1902**

### Apple Watch Physical Analysis

### Samsung Galaxy S8 Physical Analysis

### Huawei P10 Physical Analysis

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RF Components Market Forecast
### Apple iPhone X Physical Analysis
- **Synthesis**
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    - AFEM-8072
    - SKY78140
    - SKY77366
    - SKY13760
    - SKY13762
  - A1901
    - AFEM-8056
    - AFEM-8066
    - QM76041
    - DS353
    - SKY13764
    - SKY13767
    - N

### Samsung Galaxy S8 Physical Analysis

### Huawei P10 Physical Analysis

### Sony Xperia XZs Physical Analysis

### Asus ZenFone 4 Pro Physical Analysis

### Xiaomi Mi6 Physical Analysis

---

### AFEM-8072 – Package View & Dimensions

- **Package Type:**
- **Dimensions:**
- **Pin Pitch:**
AFEM-8072 – Package Opening

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  - Synthesis
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      - SKY77366
      - SKY113760
      - SKY113762
    - A1901
      - AFEM-8056
      - AFEM-8066
      - QM176041
      - DS353
      - SKY113764
      - SKY113767
      - N

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AFEM-8072 – Active devices – Power Amplifier

Package Top View – Optical View
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  - AFEM-8066
  - QM76041
  - DS353
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  - N

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- AFEM-8066
- QM76041
- D5353
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RFIC Top View – Optical View
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Die Area:

Die Marking:

Die Substrate:
AFEM-8072 – Active/Passive devices – Antenna Matching IC

- Die Area:
- Die Marking:
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AFEM-8072 – Passive devices – Capacitors & Resistors

SMD 0201
number:

SMD 01005
number:

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Apple iPhone X Physical Data Summary – A1902

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2018 is a new year for RF Front-End Module suppliers, and a turning point for some smartphone-making original equipment manufacturers (OEMs). In 2017, we saw an important choice in adopting Power Amplifier Module integrated Duplexers (PAMiDs) that distinguished high-end and mid-range smartphones. Today, the distinction between these categories is becoming wider as companies work towards fifth generation (5G) wireless communication protocols. High-end OEMs are seeking new ways to integrate more capabilities into one device, which creates space on printed circuit boards for 5G components in the future.

At the same time, isolation techniques for all front-end communication devices are getting better, in a market with high-quality competitors. Now is the perfect time to track the field’s developments, and to see what’s coming. System Plus has therefore opened up Front-End Modules in ten flagship products. We provide information on every player and compare integration technologies between the OEMs, module suppliers and against last year’s models.

We have conducted this comparative technology study to provide insights and technology data for RF Front-End Modules in smartphones and a new smartwatch. The report studies over 40 Front-End Modules and several other components found in ten flagship products, the Apple Watch Series 3, Apple iPhone 8 Plus, Apple iPhone X, US and European versions, Samsung Galaxy S8+, US and European versions, Huawei P10, Asus Zenfone 5 Pro, Sony XZs and Xiaomi Mi6.

With tear-downs of a large variety of smartphones and one smartwatch, we have extracted the main RF Modules and physically analyzed them. We have studied component sizes and technologies to provide a large panel of OEM technical and economic choices and an overview of the market. Skyworks is now a major player along with Broadcom/Avago, but we also encountered and analyzed devices from several other players, like Qorvo, Murata, and Epcos/TDK.

The report includes a description of each component and statistical analyses for most front-end modules. It also tries to explain OEM and supplier choices. Wifi and Bluetooth Modules analysis are not covered in this report.
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### Dr. Stéphane Elisabeth

Stéphane has joined System Plus Consulting's team in 2016. He has a deep knowledge of Materials characterizations and Electronics systems. He holds an Engineering Degree in Electronics and Numerical Technology, and a PhD in Materials for Micro-electronics.

### Nicolas Radufe (Lab)

Nicolas is in charge of physical analysis at System Plus Consulting. He has a deep knowledge in chemical and physical analyses. He previously worked in microelectronics R&D for CEA/LETI in Grenoble and for STMicroelectronics in Crolles.

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1.32. User Rights User License: means the User Rights User License referred to in Article 4.3.

1.33. Written: means the Written Notice referred to in Article 3.2.
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