RF Front-End modules and components for cellphones

2017 sample
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REPORT OBJECTIVES

Provide a clear understanding of the RF Front-End (RFFE) market and related technologies.

Ecosystem identification and analysis:
- Determine market dynamics
- Technical market description
- Economic requirements by segment
- Key players by market and analysis
- Market size and market forecast in $M and Munits

Analysis and description of the market and technologies involved:
- Major players on a global basis
- Technology identification for different devices and processes
- Competing technologies
- Main technical challenges
- Future directions
Yole’s market forecast model is based on the following elementary structured blocks:
SCOPE OF THE REPORT

Focus of the report

RF components (PA, LNA, filters, switches, antenna tuners)

4G and 5G technologies

Modems, transceivers, baseband processors, Wi-fi & Bluetooth modules…

Antennas, IPDs,…

Topics NOT included in the report

Only RF components in Front-End modules are considered in this report.
In the past four years, numerous mergers and acquisitions have happened in the RF industry.
EVOLUTION OF MOBILE TELECOMMUNICATION TECHNOLOGIES

<table>
<thead>
<tr>
<th>Year</th>
<th>Technology</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-1990</td>
<td>1G</td>
<td>Analog signal AMPS-based technology, Voice calls in a single country</td>
</tr>
<tr>
<td>1991-2000</td>
<td>2G</td>
<td>Digital signal GSM-based technology, SMS/MMS enabled, Email/ Web/ Camera with 2.5G</td>
</tr>
<tr>
<td>2001-2010</td>
<td>3G</td>
<td>First mobile broadband, Global roaming, Smartphone era, Web, TV and multimedia access</td>
</tr>
<tr>
<td>2010+</td>
<td>4G</td>
<td>IP-based protocols (LTE), Mobile broadband, Cost efficient compared to 3G</td>
</tr>
<tr>
<td>2020+</td>
<td>4G+/5G</td>
<td>Higher QoS, Evolution of 4G LTE-A</td>
</tr>
<tr>
<td>2025+</td>
<td>5G mmW</td>
<td>New RAT/RAN, Ubiquitous connectivity, Higher capacity and speed, Will include 4G networks</td>
</tr>
</tbody>
</table>

New mobile standards have arisen every 10 years, opening up new applications for end users.
THE RISING NUMBER OF SUPPORTED BANDS DRASTICALLY INCREASES RFFE COMPLEXITY

Total supported bands in iPhones

Up to 40 bands are handled today in high-end smartphones.
A PAM is composed of a MMMB PA, a PA switch and filtering solutions.

**Power Amplifier Module - PAM**

- **Wideband PA (MultiMode – MultiBand)**
- **RF Switch**
- **RF Filters / Duplexers**

- **Modulated Tx Signal**
- **Modulated and Filtered Rx Signals**
- **Modulated, Amplified and Filtered Tx Signals**
LNA modules can include either a LNA and a RF switch only, or a LNA, a RF switch and antenna switching and filtering solutions.

Note that in a RDM multiple LNAs, one on each RF line, after each filter, can be used instead of a LMM.
ECOSYSTEM OF THE RF DEVICES & FRONT-END MODULE INDUSTRY

2016–2022 Forecast

The growth is not evenly distributed.
Filters represent the biggest business in the RF Front End industry.

-- Total RF components & FEM/PAMiD module manufacturers

- Filters
- Antenna tuners
- Switches
- PAs & LNAs

2016

- $36M
- $3,848M
- $1,026M
- $5,208M
- $10,118M

2022

- $2,014M
- $4,187M
- $16,311M
- $272M
- $22,777M

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RF COMPONENT AND MODULE SUPPLY CHAIN (KEY PLAYERS)

RF component stage
- RF switch
- PA/LNA
- RF filter
- Antenna device (tuner & switch)

FEM stage
- OSAT services
- Pure players
- Integrated players
- (Module maker + test + assembly)

Handset device stage
- Platform providers
- Discrete components
- Integrated modules

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Innovation in RFFEs can be in one of three areas.

**Materials**
(RF SOI, Bonded Wafers, etc.)

**Architecture**
(Converged and Hybrid Modules, PAMiD, etc.)

**Design**
(Transistor types, PA internal design, etc.)
AND MANY MORE INFORMATION

GLOBAL MOBILE DATA TRAFFIC GROWTH

CELLPHONES AIR INTERFACE STANDARD DEVELOPMENT

MARKET FORECAST HYPOTHESIS

GROWING RF CONTENT PER HANDSET

HUGE RF SIGNAL LOSS IN MOBILE PHONES

YOLE Development

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Smartphone RF Front-End Module Review

Review of RF front-end modules and components found in five flagship smartphones: Apple iPhone 7 Plus, Samsung Galaxy S7, Huawei P9, LG G5, and Xiaomi Mi5

The upcoming 5G communication technology is creating a new order in the communication market. All the major RF front-end players are battling to provide devices that could be integrated in smartphones. Not all technologies suit the 5G requirement, but every player could win something. There will be opportunities for low cost competitors in the SAW filter market for low band communications like GSM, 2G or 3G, as high quality competitors shift focus to the 4G and 5G market with BAW filters. This comes along with better integration of all the front-end communication devices, now in just one module. This is therefore the perfect time to examine every player, and particularly to compare integration technologies of the original equipment manufacturers (OEMs) who make smartphones and the RF front-end module suppliers.

This comparative technology study provides technology data for RF front-end modules in smartphones. The report includes at least 16 front-end modules and several components found in five flagship smartphones: the Apple iPhone 7 Plus, Samsung Galaxy S7 Edge, Huawei P9, LG G5 and Xiaomi Mi5.

After teardowns of a large variety of smartphones, we have extracted and physically analyzed the main RF modules. We have studied their sizes and technologies, and present a large panel of OEM technical and economical choices and an overview of the market. The major players remain Broadcom/Avago and Qorvo but there are several other players, including Skyworks, Murata, Epcos/TDK, and we have analyzed their products.

The report includes a description of each component and statistical analyses for most front-end modules. It also tries to explain the OEMs’ choices and supplier tendencies. Wi-Fi and Bluetooth module analyses are not covered in this report.
AUTHORS:

Stéphane Elisabeth
Stéphane 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 microelectronics.

Nicolas Radufe (Lab)
Nicolas is in charge of physical analysis. He has 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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    ✓ Package Openings
    ✓ Active Die Views and Dimensions
      ✓ Power Amplifier
      ✓ SPxT Switch
      ✓ RFIC
    ✓ Passive Die View and Dimensions
      ✓ SAW Filters
      ✓ BAW Filters
      ✓ IPDs
      ✓ SMD Components
    ✓ Component Summaries
    ✓ Area and Section Number Comparison
Comparison Analysis
  • Apple vs. Samsung vs. Huawei vs. LG vs. Xiaomi
  • Integration Comparison

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RF Front End Modules and Components for Cellphones, Technology and Market report by Yole Développement

A dynamic market with high responsivity to technical innovation, the RF front end industry is set to grow at 14% CAGR to reach $22.7B in 2022.

KEY FEATURES OF THE REPORT

• Market landscape and forecast for 2016-2022 including revenues, players, and volumes
• Back to Basics: A detailed description of each RF device function, their challenges and key characteristics
• 4G and 5G characteristics and the future outlook, including QAM, CA, MIMO and OFDM coding
• Roadmap for technology evolution and future developments
• RF front-end industry strategy

Date: March 2017
Format: PDF & Excel file
Price: EUR 6,490
Bundle offer: EUR 8,890 with Smartphone RF Front-End Module Review by System Plus Consulting
Avago AFEM-9040
Avago’s New Generation Front-End Module

Avago has introduced a new generation of film bulk acoustic resonator (FBAR-BAW) technology in the Samsung Galaxy S7.

Qorvo TQF6405 in iPhone 6s Plus SMR-BAW High Band Filter

Apple integrates in its smartphone the innovative Solid Mounted Resonators developed by Qorvo.

Murata SAW Thermo-Compensated Band 8 Filter in Low Band Front-End Module

Murata has introduced thermo-compensated filter technology with a ceramic substrate in the Samsung Galaxy S7’s front-end module.

Pages: 112
Date: June 2016
Full report: EUR 3,290*

Pages: 86
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- Ask for our Bundle and Annual Subscription offers: With our bundle offer, you choose the number of reports you are interested in and select the related offer. You then have up to 12 months to select the required reports from the Yole Développement, System Plus Consulting and KnowMade offering. Pay once and receive the reports automatically (multi-user format). Contact your sales team according to your location (see the last slide).
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To meet the growing demand for market, technological and business information, Micronews Media integrates several tools able to reach each individual contact within its network. We will ensure you benefit from this.

<table>
<thead>
<tr>
<th><strong>ONLINE</strong></th>
<th><strong>ONSITE</strong></th>
<th><strong>IN PERSON</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>@Micronews e-newsletter</td>
<td>Events</td>
<td><strong>Targeted audience involvement equals clear, concise perception of your company’s message.</strong> Webcasts are a smart, innovative way of communicating to a wider targeted audience. Webcasts create very useful, dynamic reference material for attendees and also for absentees, thanks to the recording technology.</td>
</tr>
<tr>
<td>i-Micronews.com</td>
<td>Brand visibility, networking opportunities</td>
<td><strong>Unique, cost-effective ways to reach global audiences.</strong> Online display advertising campaigns are great strategies for improving your product/brand visibility. They are also an efficient way to adapt with the demands of the times and to evolve an effective marketing plan and strategy.</td>
</tr>
<tr>
<td>i-Micronewsjp.com</td>
<td>7 main events planned for 2017 on different topics to attract 140 attendees on average</td>
<td>Benefit from the i-Micronews.com traffic generated by the 8,500+ monthly visitors, the 11,500+ weekly readers of @Micronews e-newsletter</td>
</tr>
<tr>
<td>FreeFullPDF.com</td>
<td>Gain new leads for your business from an average of 300 registrants per webcast</td>
<td>Seven main events planned for 2017 on different topics to attract 140 attendees on average</td>
</tr>
</tbody>
</table>

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