

# 射频前端模块产业<sup>1</sup>

## 苹果的技术选择是什么？

### 内容概览：

- 市场预测：  
RF<sup>2</sup>前端和连接市场有望实现两位数增长，截至2025年市场规模预期将达到254亿美元。  
Yole Développement（Yole）预期从2019年至2025年间的CAGR<sup>3</sup>为11%。  
PA<sup>4</sup>模块市场将从2019年的54亿美元增长到截至2025年的89亿美元。  
FEM<sup>5</sup>模块市场将从2019年的26亿美元增长到截至2025年的46亿美元。
- 技术趋势：  
随着宽带PA和滤波器的发展，5G对RF前端产业提出了挑战。  
为了支持5G应用，各RF前端公司决定进行大量投资，特别是在设计和材料工程方面。
- 竞争格局：  
苹果失去了市场份额，而来自中国的4家主要原始设备制造商则全都取得了显著进展。  
村田制作所、思佳讯、博通、Qorvo和高通这五家大企业在总业务量中所占份额近80%。  
组成RF前端竞争格局其余部分的是来自中国、韩国、日本和欧洲的多家公司。

“在2016年到2020年的iPhone系列手机中，苹果在2017年之前的起初策略是降低电路板级别来缩小射频面积”，[System Plus Consulting](#)的射频与先进封装成本分析师 **Stéphane Elisabeth**博士称。“但从那时起，电路板级别就在增加，而射频面积所占比例也稳定下来，即使在5G集成下也是如此。2017年到2020年间，英特尔是苹果唯一的

<sup>1</sup>摘自：

《2021年RF前端模块比较 - 第1辑——聚焦苹果》，System Plus Consulting

《2020年5G对RF前端和手机连接的影响》，Yole Développement

《2020年SAW滤波器比较》，System Plus Consulting

<sup>2</sup>RF：射频

<sup>3</sup>CAGR：年均复合增长率

<sup>4</sup>PA：功率放大器

<sup>5</sup>FEM：前端模块

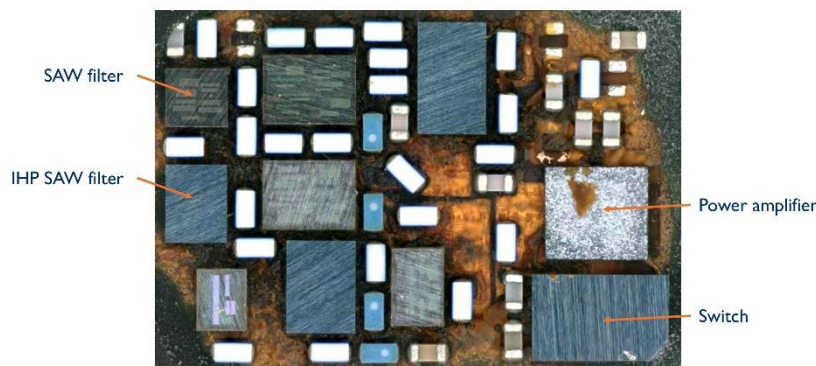
调制解调器和收发器 (RxTx) 供应商。2017年失去市场的高通在2020年开始涉足iPhone设计，而且由于5G，有可能在2021年被保留。2022年，苹果有望实现调制解调器和RxTx的内部自研。”

2020年刚刚发布的iPhone 12系列中，通信方面的几项创新已经得以实施。逆向工程和成本分析公司System Plus Consulting在其最新的比较报告：[《2021年RF前端模块比较 - 第1辑——聚焦苹果》](#)中对Apple所做的技术选择进行了深入分析。

这些创新包括带一个附加控制器的NFC<sup>6</sup>芯片和手机背面的NFC天线，用于配件识别；集成了新频段L5（1175兆赫）的GPS<sup>7</sup>芯片具有经过改善的信号结构、更高的发射功率和更宽的带宽；5G通信功能和整合了多频段兼容性，如毫米波频段中的n260和n261。

## RF front-end module - Apple iPhone Pro 12 max component opening

(Source: RF Front-End Module Comparison 2021 – Vol. 1 – Focus on Apple, System Plus Consulting)



© 2021 | www.systemplus.fr - www.reverse-costing.com

同属于Yole企业集团旗下的System Plus Consulting及其合作伙伴Yole Développement (Yole) 共同对颠覆性射频技术和相关市场进行了深入研究。

今天发布的[《2021年RF前端模块比较 - 第1辑——聚焦苹果》](#)报告提供了对射频前端模块技术与成本数据的洞见，并分析了自2016年以来苹果iPhone系列18款智能手机中经过挑选的部分组件。

与此同时，市场研究与战略咨询公司Yole已在2020年底发布了[《2020年5G对RF前端和手机连接的影响》](#)报告。这份2020版的报告详细分析了每种射频技术的优势和劣势，并对整个产业生态提供了详细的总览。Yole的研究包含市场趋势与预测、市场份额，产业生态系统和对中美贸易战的分析，并指出新冠疫情对射频前端和连接业务的影响。

<sup>6</sup>NFC: 近场通信

<sup>7</sup>GPS: 全球定位服务

射频前端模块制造商和OEM<sup>8</sup>的技术选择是什么？不同模块间的成本差异如何？有哪些不同的制造工艺步骤？如何解释智能手机制造商们的选择和供应商们的倾向？

System Plus Consulting和Yole在今天带来他们对射频前端模块产业中最新创新技术的展望。

### RF front-end module - Apple iPhone Pro 12 max filter opening

(Source: RF Front-End Module Comparison 2021 – Vol. 1 – Focus on Apple, System Plus Consulting)



© 2021 | www.systemplus.fr - www.reversc-costing.com

根据System Plus Consulting团队在新发布的《2021年RF前端模块比较 - 第1辑——聚焦苹果》报告中的分析，第12代iPhone中的5G Sub-6和毫米波集成使得该模块所占面积增大。其射频模块面积比OnePlus等其他竞争企业要大近40%。System Plus Consulting列出的受益于5G的竞争企业还包括博通、村田制作所、Qorvo和高通。在封装方面，像DSBGA<sup>9</sup>这样的颠覆性解决方案逐渐成为FEM的标准封装。但在2020年，模块供应商将追随村田制作所的脚步，更进一步地开发DSMBGA<sup>10</sup>。自2016年以来，村田制作所一直保持着主要供应商的地位，跟随其后的是Qorvo、思佳讯和博通。由于其超过90%的组件是集成设备，苹果依靠高度集成的美国供应商，如Qorvo，博通或思佳讯，但它们各自在设计中都占据独特的位置。此外，使用Qorvo的天线调谐器能让苹果的智能手机只需少量天线。

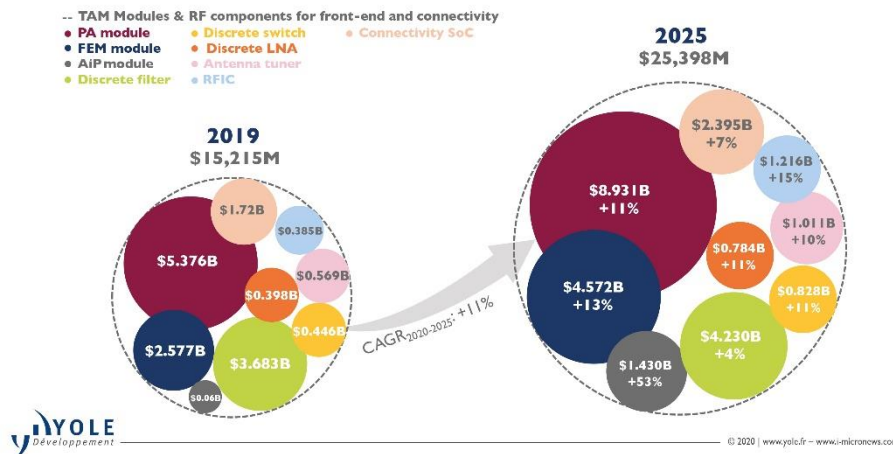
<sup>8</sup>OEM：原始设备制造商

<sup>9</sup>DSBGA：双面球栅阵列

<sup>10</sup>DSMBGA：双面铸模BGA

## 2020-2025 RF front-end and connectivity market forecast - Per type of component

(Source: 5G's Impact on RF Front-End and Connectivity for Cellphones 2020 report, Yole Développement, 2020)



作为射频前端模块产业的一部分，SAW<sup>11</sup>滤波器发挥着关键作用。System Plus Consulting在其《2020年SAW滤波器比较》报告中对此进行了检验。IHP<sup>12</sup> SAW过滤器与iPhone Xs Max一同在2018年出现，因为它仅用于村田制作所小批量生产的组件。但在最新一代手机，即iPhone 12系列中，BAW<sup>13</sup>滤波器的专用面积显著增加（6倍）。事实上，随着5G和WiFi 6的兴起，几乎所有的市场领导者都在寻求BAW解决方案。System Plus Consulting的Stéphane Elisabeth和Yole射频器件与技术业务的技术与市场分析师Cédric Malaquin有幸为《微波杂志》（Microwave Journal）专门撰文并阐述他们的专业观点，文章也发表在i-Micronews上。

### 媒体联络人

**Sandrine Leroy**，公共关系主管，[leroy@yole.fr](mailto:leroy@yole.fr)

**Marion Barrier**，公共关系助理，[marion.barrier@yole.fr](mailto:marion.barrier@yole.fr)

Le Quartz, 75 Cours Emile Zola – 69100 Villeurbanne – Lyon – France – +33472830189  
[www.yole.fr](http://www.yole.fr) - [www.i-micronews.com](http://www.i-micronews.com) – [LinkedIn](#) – [Twitter](#)

<sup>11</sup>SAW: 声表面波

<sup>12</sup>IHP: 令人难以置信的高性能

<sup>13</sup>BAW: 体声波

### About our analysts

**Stéphane Elisabeth, PhD** is Senior Technology and Cost Analyst at System Plus Consulting, part of Yole Développement (Yole). Stéphane regularly works on numerous reverse engineering and costing reports while also managing custom projects in the RF electronics and advanced packaging fields. His mission at System Plus Consulting is to provide an in-depth understanding of the technologies selected by the leading semiconductor companies as well as the ecosystem around a device. In this context, Stéphane is leading a strategic watch to identify the latest innovative devices and collaborates closely with System Plus Consulting's laboratory to analyze devices or components. His aim is to reveal the link between functionality and the technical choice made by the device maker. Based on the identification of each process step and process flow, our analysts can then provide an accurate evaluation of the manufacturing cost. His significant industrial and technical knowledge allows him also to update internal simulation tools developed by System Plus Consulting's experts. In addition, Stéphane supports the development of RF electronics activities through key customer projects, including presentation of their results. Prior to this collaboration with System Plus Consulting, Stéphane worked on projects in partnership with THALES for the development of innovative hybrid RF circuits. He also regularly publishes articles and interviews within key RF electronics and packaging magazines. Stéphane holds an engineering degree in electronics and numerical technology (Université de Nantes, France) as well as a PhD. in Materials for Microelectronics (Université de Nantes, France).

**Nicolas Radufe** 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.

As a Technology & Market Analyst, specialized in RF devices & technologies within the Power & Wireless division at Yole Développement (Yole), **Cédric Malaquin** is involved in the development of technology & market reports as well as the production of custom consulting projects. Prior his mission at Yole, Cédric first served Soitec as a process integration engineer during 9 years, then as an electrical characterization engineer during 6 years. He deeply contributed to FDSOI and RFSOI products characterization. He has also authored or co-authored three patents and five international publications in the semiconductor field. Cédric graduated from Polytech Lille in France with an engineering degree in microelectronics and material sciences.

**Antoine Bonnabel** works as a Technology & Market Analyst for the Power & Wireless team of Yole Développement (Yole). He carries out technical, marketing and strategic analyses focused on RF devices, related technologies and markets. Prior to Yole, Antoine was R&D Program Manager for DelfMEMS (FR), a company specializing in RF switches and supervised Intellectual Property and Business Intelligence activities of this company. In addition, he also has co-authored several market reports and is co-inventor of three patents in RF MEMS design. Antoine holds a M.Sc. in Microelectronics from Grenoble Institute of Technologies (France) and a M.Sc. in Management from Grenoble Graduate School of Business (France).

### About the reports

#### **RF Front-End Module Comparison 2021 – Vol. I – Focus on Apple**

*Technical and cost overview of the evolution of the radio frequency front-end module technologies integrated in the Apple iPhone series from 2016 - 2020. – Performed by System Plus Consulting*

#### **5G's Impact on RF Front-End and Connectivity for Cellphones 2020**

*An intensifying US-China competition for RF technology supremacy. – Performed by Yole Développement*

#### **SAW Filter Comparison 2020**

*Deep dive analysis and cost review of key SAW filter technologies from Murata, Skyworks, Qorvo, Qualcomm, Wisol, Taiyo Yuden, Kyocera, Tai-SAW, SAWNICS and Shoulder. – Performed by System Plus Consulting*

### Related reports

- [RF Front-End Module Comparison 2020 – Volume 4](#)

- [Broadcom AFEM-8200 PAMiD in the Apple iPhone 12 Series](#)

#### **About Yole Développement**

Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide... [More](#)

#### **About System Plus Consulting**

System Plus Consulting specializes in the cost analysis of electronics, from semiconductor devices to electronic systems. Created more than 20 years ago, System Plus Consulting has developed a complete range of services, costing tools and reports to deliver in-depth production cost studies and estimate the objective selling price of a product... [More](#)

**For more information and images, please visit our website [i-Micronews](#)**  
**###**