The radio-frequency (RF) front end and components market for cellphones is highly dynamic. From being worth $10.1B last year, it is expected to reach $22.7B in 2022. Such high growth is definitely something that players in other semiconductor markets would envy. However, the growth is not evenly distributed. Filters represent the biggest business in the RF front end industry, and the value of this business will more than triple from 2016 to 2022. Most of this growth will derive from additional filtering needs from new antennas as well as the need for more filtering functionality due to multiple carrier aggregation (CA).

Power amplifiers (PAs) and low noise amplifiers (LNAs), the second biggest business, will be almost flat over the same period. High-end LTE PA market growth will be balanced by a shrinking 2G/3G market. The LNA market will grow steadily, especially thanks to the addition of new antennas. Switches, the third biggest business, will double. This market will mainly be driven by antenna switches. Lastly, antenna tuners, a small business today with an estimated $36M market value, will expand 7.5-fold to reach $272M in 2022. This growth is mainly due to tuning being added to both the main and the diversity antennas.

However, the RF front end market’s double digit annual growth rate comes with a severe penalty: added complexity! Deployment and access to the 3G/4G network has accelerated the smartphone trend. It allows consumption of more messaging, music, photo, movie streaming and video chatting. High quality video download and upload is definitely driving needs for enhanced bandwidth and peak data rates. This continual growth of mobile data has led to a need to use more of the radio spectrum. In mobile communication, this resource becomes scarce as the number of users and technologies explodes.

In order to face this overflowing demand, handsets have to meet complex requirements such as:

- Multi-band for regional and global roaming
RF FRONT END MODULES AND COMPONENTS FOR CELLPHONES

• Multi-mode to support multiple cellular modes including 2G, 3G, 4G, WiFi/Bluetooth (BT), Near Field Communications (NFC) and Global Positioning System (GPS)
• Multiple-Input Multiple-Output (MIMO) to allow higher data rates and higher effective range
• Smart antenna techniques such as beamforming or diversity to enhance the performance of a single data signal
• CA to support broader bandwidths, which improves broadband experience, offering higher peak data rates, higher overall network capacity and lower latency. This was introduced in 3GPP release 10 in 2012 and has been since used and enhanced in LTE-Advanced.

All these requirements bring a huge challenge to handset RF front end architecture, design and manufacturing to handle bands that span from low-to-high-frequency.

Thus an extremely interesting aspect of the RF front-end industry is its high responsivity to innovation. Innovation in RF front-ends can come from three different sources:

• **Materials**: e.g. the development of a new RF silicon-on-insulator (SOI) substrate, like SOITEC’s e-Si substrate, in order to reduce current leakage from the transistors into the substrate or to reduce parasitic capacitances

• **Design**: e.g. new internal component design such as ACCO Semiconductor’s power amplifiers that can improve SOI-based PA performance and be cost competitive with GaAs PAs for low- and mid-band frequencies

• **Architecture**: e.g. the integration of three duplexers into a hexaplexer, or the creation of multi-mode multi-band PA modules working on all low-band, high-band or mid-band frequencies.

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FOUR PLAYERS ACCOUNT FOR 90% OF THE RF FRONT END MARKET: HOW CAN NEW PLAYERS PENETRATE?

Broadcom, Skyworks, Qorvo and Murata are well established. New players have to be able to deliver high volumes and fit all industry requirements, while being supported by the large corporates that today own the market.

On the other hand, once a new technology arrives, it can literally take over the market in five years’ time, completely reconfiguring the manufacturer and supplier landscape.

As an example, in antenna RF-switches, SOI switches went from less than 20% market share in 2010 to 95% in 2016, with players such as Peregrine Semiconductor switching from silicon-on-sapphire to SOI.

When such innovation occurs, other players have to adapt or leave the market. This is what happened with Sony’s GaAs-based switch market share, which has shrunk over the years. Similar technology replacements are expected with the SOI PAs, for example, which will replace GaAs PAs over time.
When such changes occur, the complete industrial chain and the value flow changes. Substrate suppliers as well as foundry service providers can be deeply impacted by such a rapid technology change.

Over the short term, players like Cavendish Kinetics with its low loss RF MEMS xPxT switches can enable new RF front end architecture without costly diplexers/multiplexers.

In the longer term, possible developments could even render RF front-ends obsolete. Seamless waves, for example, is developing a CMOS-based tunable analog-to-digital converter and tunable digital-to-analog converter that can actively center on a specific frequency and adjusts its bandwidth, thus converting only the needed part of the incoming signal. If this technology manages to get the low power consumption and small size required for smartphones, it could disrupt the industry and allow more innovative developments such as on-phone cognitive radio. This would create a totally different industry!

COMPANIES CITED IN THE REPORT (non exhaustive list)


Even render RF front-ends obsolete. Seamless...

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