Qorvo helps advance 5G efforts with RF filter innovations for smartphones

Steve Taranovich - June 18, 2017

In my article, "A major change in smartphone RF filters and front ends as 5G approaches," I discussed smartphone filter architectures for the coming 5G standard with regards to LTE carrier aggregation (CA) and beyond, as well as multiple-in-multiple-out (MIMO) designs to increase capacity and data downlink/uplink speeds. This will necessitate multiple frequency bands operating simultaneously through one antenna (that challenge makes designers dizzy).

With RF front-end (RFFE) complexity increasing, the insertion loss and link budgets will increase. Plus, HPUE/Power Class 2 requirements will add more complexity to the designs. Here is what designers need to know in order to design a robust RF front-end for the coming mobile devices.

To get another aspect on this difficult dilemma, I sought out Ben Thomas, director of technical marketing at Qorvo and asked his opinions on the subject regarding what it means for radio frequency (RF) solutions that enable receive and transmit out of handsets. What can we expect for filtering out a constantly increasing set of frequency bands and multiple antennas being added to the phone, and how can the next generation of smartphones reach the needed Gigabit speeds?

Thomas said that Qorvo sees that as 5G approaches, there will be a fundamental shift in how mobile data is being used globally. For an entirely new generation, streaming video is the new baseline for entertainment, information, and much more.

These are several, real-time questions impacting smartphone manufacturers today. Qorvo is helping solve RF complexities for the handset OEMs by addressing several key challenges:

- Meeting rapidly changing standards including carrier aggregation and MIMO
- Balancing size with performance
- Enabling CA combinations with filters and multiplexers
- Offering an RFFE solution option for premium and mid-tier smartphones

Qorvo has a 2017 RF Fusion Solution now that consists of multiple modules which will enable global CA-band coverage in a small form factor for the industry’s flagship smartphones (**Figure 1**).

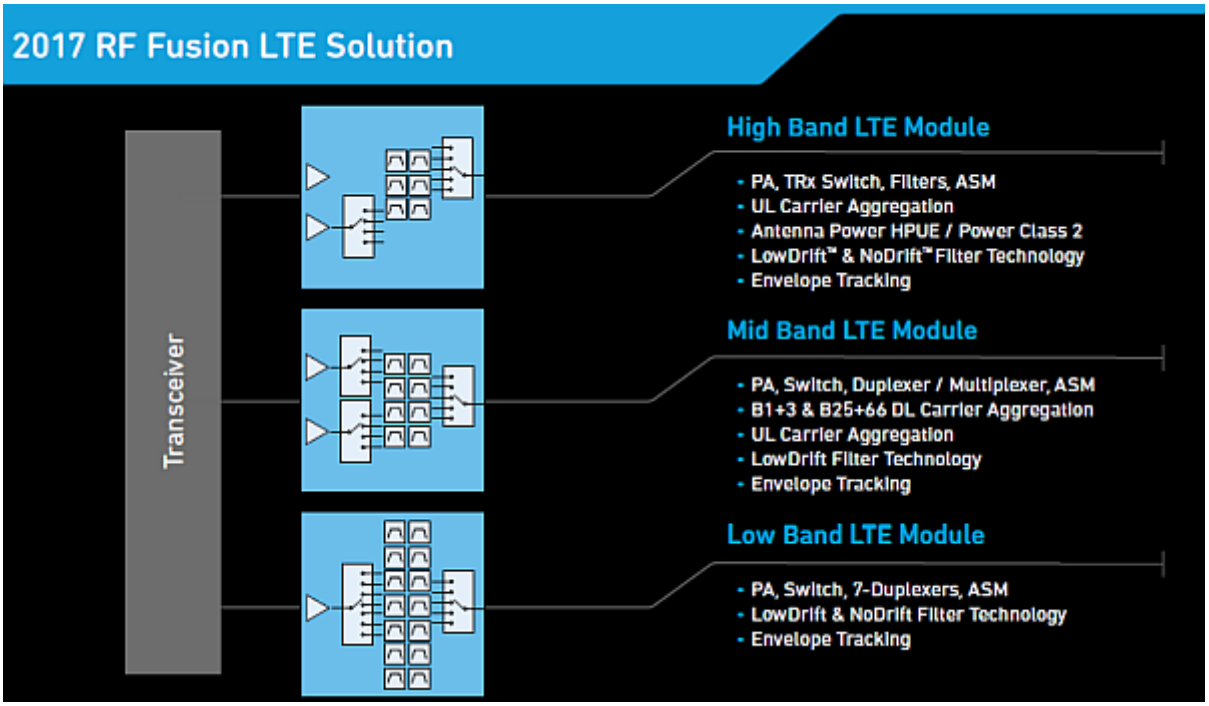

Figure 1 2017 RF Fusion LTE Solution (Image courtesy of Qorvo)

Of course, they have a roadmap that extends into 2018, when the PyeongChang Olympics will showcase many early 5G architectures (**Figure 2**).

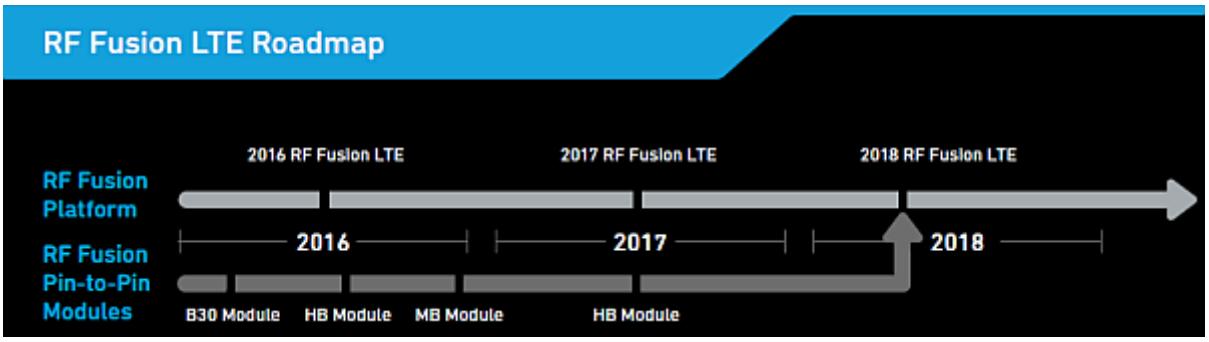

Figure 2 RF Fusion roadmap into 2018 (Image courtesy of Qorvo)

The challenge going forward is that the smartphone arena has a few categories with different design goals and priorities. Two important categories are flagship phones that are designed for super-regional/global usage and mid-tier and entry-level phones for regional usage.

In a super-regional/global capable phone, there will need to be a high level of RFFE integration. Many bands are needed here along with uplink and downlink CA combinations for different performance needs. These small, sleek form factor handsets need to maximize the use of space to also house batteries and multiple antennas as an added challenge. Qorvo has an RF Fusion solution for this class of phones that combines all the necessary transmit/receive functionality demanded, including major frequency bands. This solution has three modular solutions that cover high, mid, and low-band regions of the spectrum. The modules incorporate power amplifiers (PAs), switches, and filters. **Figure 3** shows an example of the high-band module block diagram. Electronic Products' teardown of the Samsung Galaxy S7 with the QM78064 inside, includes the bill of materials (BOM).

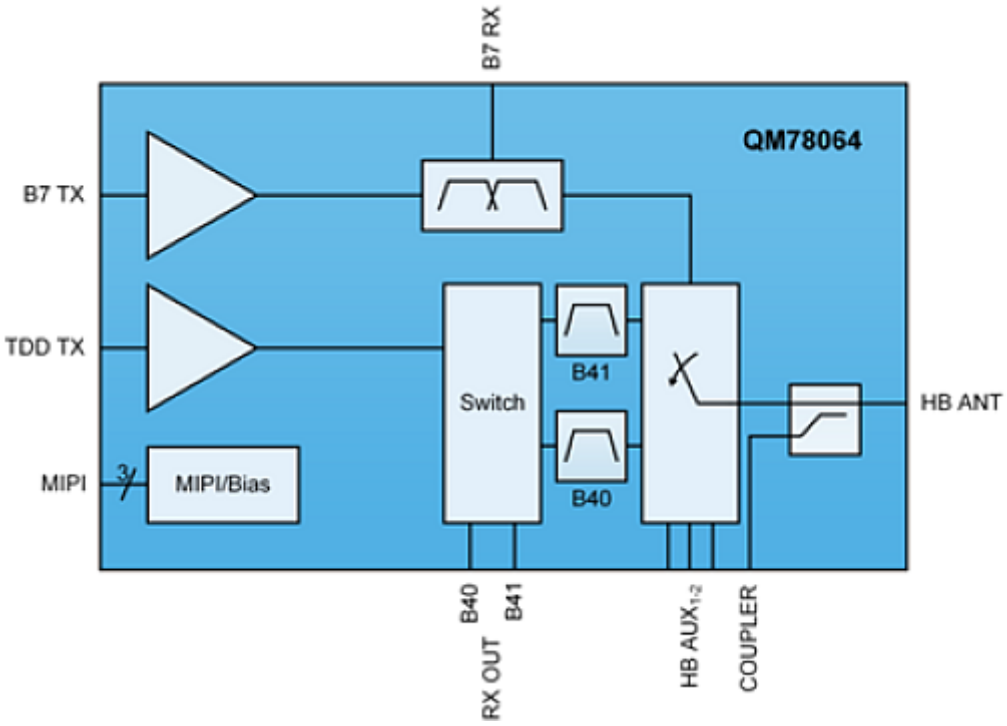

Figure 3 Qorvo's RF Fusion QM78064 high-band module supports FDD-LTE (with an integrated Band 7 duplexer) and TDD-LTE (Bands 40 and 41), and has a wideband B41 lowdrift bulk acoustic wave (BAW) filter that enables 20 MHz + 20 MHz uplink CA. There is also an antenna switch and it can support envelope tracking (ET) and average power tracking (APT) to increase efficiency of the transmit power amplifier, which improves power efficiency and helps extend battery life. (Image courtesy of Qorvo)

Eliminating redundant on-board matching to reduce losses

Another area that reduces losses is to eliminate redundant on-board matching that is used in most traditional design architectures. The power amplifier and integrated duplexer (PAMiD) architecture gives a "direct" match to the filter while reducing matching losses for the receive (RX) and transmit (TX) channels as much as 0.5 dB (**Figure 4**).

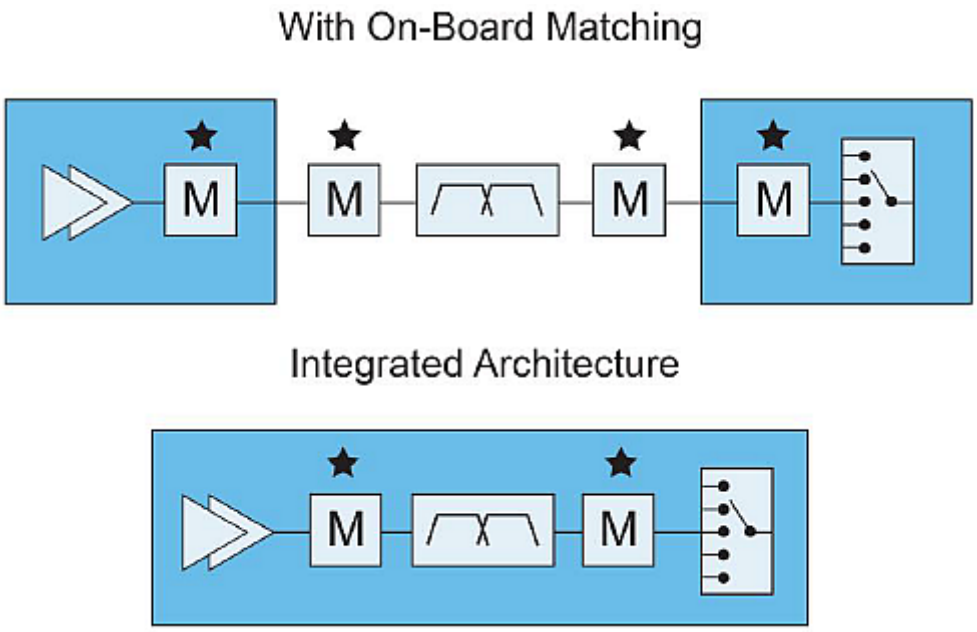

Figure 4 RF Fusion architecture eliminates redundant on-board matching, thus improving TX and

RX losses by as much as 0.5 dB. (Image courtesy of Qorvo)

Using a bulk acoustic wave-solidly mounted resonator (BAW-SMR) filter technology in the mid- and high-bands, which are the most difficult bands, for CA is the optimum design technique in smartphones. Learn more about RF filters with RF Filter Technologies for Dummies.

Smartphones are demanding more mobile data as we move toward the 1 Gb/s goal. Challenges are daunting, but the industry is up for the challenge. Smartphones need to handle the new frequency bands that worldwide carriers are adding with more spectrum being allocated to them. So many of these bands are being combined as they support multi-carrier operation and this leads to smartphones operating on multiple carrier frequencies simultaneously.

MIMO is also enabling simultaneous data streams in the new phones which create a great deal more RF complexity. This complexity will only be increasing, and the addition of higher orders of modulation will only add to more challenges in RF design.

Ben Thomas commented that Qorvo can even employ the innovations made in their infrastructure and defence products (IDP) business in which they have solid designs in mmWave technology and associated power amplifiers, as well as low noise amplifiers (LNAs) for defense.

The next phases of development will include Europe, China, Japan, and Korea. Towards these efforts, Qorvo was the first RF supplier to join the China Mobile 5G Innovation Center in late January 2017.

They have also recently announced four 28 GHz RF solutions for 5G base stations using GaN-on-SiC and GaAs processes. The products are a phase shifter, two transmit amplifiers, and a power amplifier. And more recently, they introduced the first 39 GHz dual-channel GaN front-end module in June 2017.

This is certainly an exciting time in RF electronics as we approach the 2018 Olympics and the 2020 Olympics in Tokyo, which will be inflection points for 5G advances toward meeting the full capability of the proposed standard.

Stay tuned to *EDN*'s 5G Design Center for more exciting tech innovations as 5G progresses toward reality and please also share your comments and ideas with our readers below. You will need to register on EDN first, but it's a good thing to be associated with EDN, a 60+ year old electronics publication that continues to bring you the best in technical electronics information for your use and design efforts. We have the best, highly technical, worldwide, and diverse audience in the industry with our huge online presence.

Steve Taranovich is a senior technical editor at EDN *with 45 years of experience in the electronics industry.*

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- A major change in smartphone RF filters and front ends as 5G approaches
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- Test & characterize RF filters in IC production: a new approach
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