Redefining Filter Performance

Choose Qorvo's Advanced NoDrift™ & LowDrift™ Filtering Solutions

qorvo™

all around you

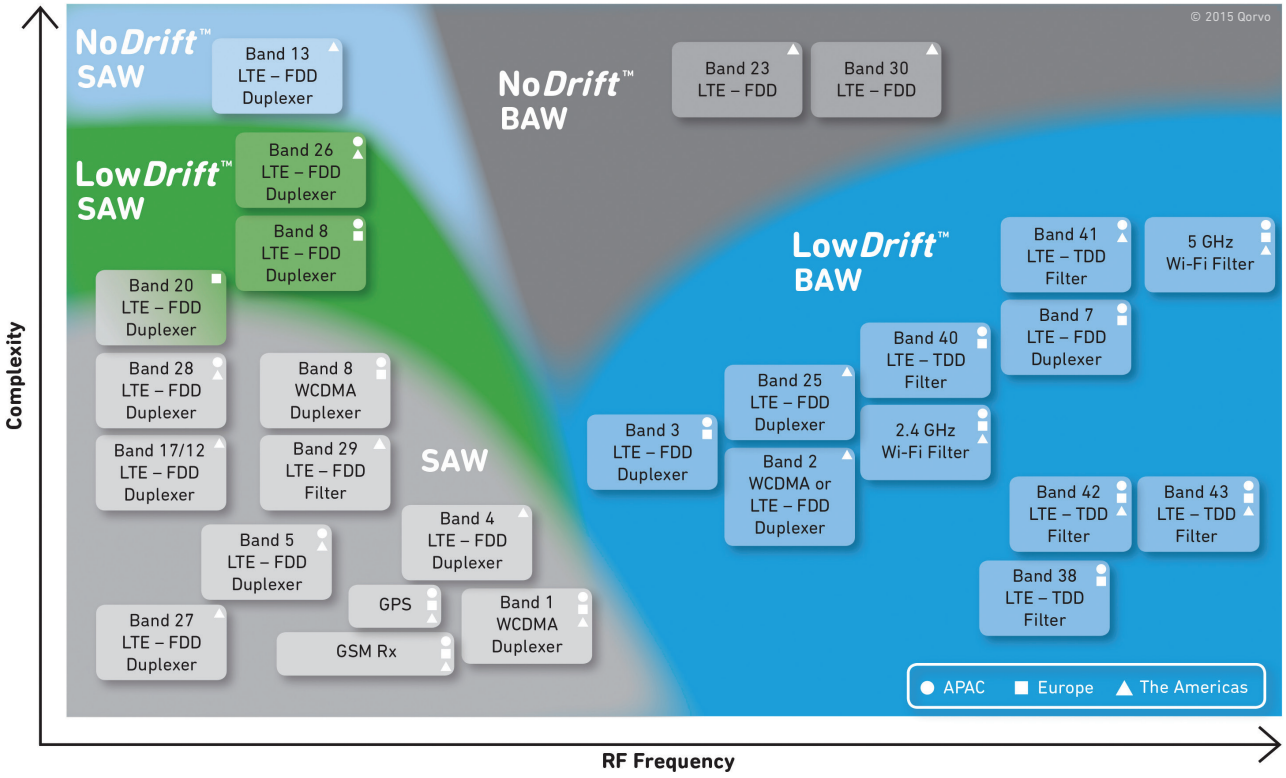
Enabling LTE Advances

Solving complex LTE interference challenges is a key design consideration for next-gen smartphones, as the information provided below makes clear. With every model you create, you need to develop multiple platforms tailored for different regions, and then factor in global roaming, too. The average number of bands in a smartphone has more than doubled in the last few years and will double again over the next two years. As band counts rise and higher filter performance is required, Qorvo is leveraging its advanced filter technologies, such as NoDrift™ and LowDrift™ BAW and SAW, to help you tackle the industry's toughest interference problems.

Key Frequency Bands

Band	Mobile Phone Tx Band (MHz)			Mobile Phone Rx Band (MHz)			Duplexer / Filter Mode	LTE Bandwidths	Filter Technology	Region(s) of Usage
1	1920	-	1980	2110	-	2170	FDD	5, 10, 15, 20	SAW	Asia, EMEA, Japan
2	1850	-	1910	1930	-	1990	FDD	1.4, 3, 5, 10, 15, 20	LowDrift BAW	LatAm, N. Amer.
3	1710	-	1785	1805	-	1880	FDD	1.4, 3, 5, 10, 15, 20	LowDrift BAW	Asia, EMEA
4	1710	-	1755	2110	-	2155	FDD	1.4, 3, 5, 10, 15, 20	SAW	LatAm, N. Amer.
5	824	-	849	869	-	894	FDD	1.4, 3, 5, 10	SAW	LatAm, N. Amer.
7	2500	-	2570	2620	-	2690	FDD	5, 10, 15, 20	LowDrift BAW	Asia, EMEA
8	880	-	915	925	-	960	FDD	1.4, 3, 5, 10	SAW / LowDrift SAW	EMEA, LatAm
12	699	-	716	729	-	746	FDD	1.4, 3, 5, 10	SAW	N. Amer.
13	777	-	787	746	-	756	FDD	5, 10	NoDrift SAW	N. Amer.
17	704	-	716	734	-	746	FDD	5, 10	SAW	N. Amer.
20	832	-	862	791	-	821	FDD	5, 10, 15, 20	SAW / LowDrift SAW	EMEA
23	2000	-	2020	2180	-	2200	FDD	1.4, 3, 5, 10, 15, 20	LowDrift BAW	N. Amer.
25	1850	-	1915	1930	-	1995	FDD	1.4, 3, 5, 10, 15, 20	LowDrift BAW	N. Amer.
26	814	-	849	859	-	894	FDD	1.4, 3, 5, 10, 15	LowDrift SAW	Japan, N. Amer.
27	807	-	824	852	-	869	FDD	1.4, 3, 5, 10	SAW	LatAm
28	703	-	748	758	-	803	FDD	3, 5, 10, 15, 20	SAW	Asia, LatAm
29	N/A	-	N/A	717	-	728	FDD	3, 5, 10	SAW	N. Amer.
30	2305	-	2315	2350	-	2360	FDD	5, 10	NoDrift BAW	N. Amer.
32	N/A	-	N/A	1452	-	1496	FDD	5, 10, 15, 20	SAW	Japan, EMEA
34	2010	-	2025	2010	-	2025	TDD	5, 10, 15	LowDrift BAW	China
38	2570	-	2620	2570	-	2620	TDD	5, 10, 15, 20	LowDrift BAW	Asia, EMEA
39	1880	-	1920	1880	-	1920	TDD	5, 10, 15, 20	LowDrift BAW	China
40	2300	-	2400	2300	-	2400	TDD	5, 10, 15, 20	LowDrift BAW	China, India
41	2496	-	2690	2496	-	2690	TDD	5, 10, 15, 20	LowDrift BAW	China, N. Amer.
42	3400	-	3600	3400	-	3600	TDD	5, 10, 15, 20	LowDrift BAW	Japan, EMEA
43	3600	-	3800	3600	-	3800	TDD	5, 10, 15, 20	LowDrift BAW	EMEA

Leveraging Advanced Filter Technology for Regional Demands

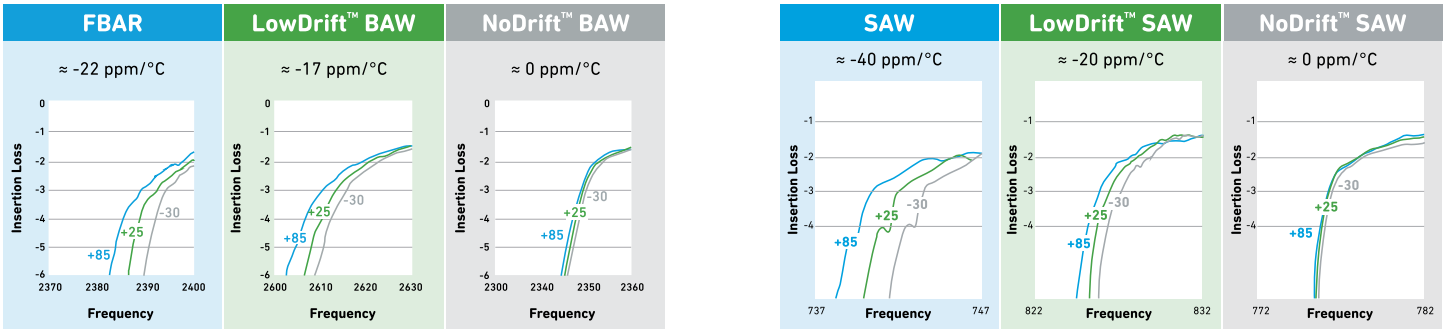


Breakthrough Filter Performance

Qorvo's LowDrift™ and NoDrift™ filter technologies enable system designers to solve band coexistence problems which are unaddressed by any other technology. As more LTE bands are squeezed into the crowded global RF spectrum, the space between bands is shrinking. In some cases, the transition between the passband and stop-band is as small as 2MHz, which makes it almost impossible to meet requirements using traditional filter technologies. That's because the variation in filter response, which is dominated by temperature drift, can exceed the width of the transition band itself. The result is unacceptable interference, high insertion loss, or both.

Qorvo's new advanced LowDrift™ and NoDrift™ technology deliver SAW and BAW filters with dramatically reduced temperature sensitivity for some of today's most challenging interference specifications. They combine low insertion loss with extremely precise selectivity. Using temperature-compensated filters, operators and manufacturers can deliver higher speeds and greater bandwidth by utilizing spectrum that might be lost with older filtering technologies.

TCF (Temperature Coefficient of Frequency)



Qorvo Advanced Filtering Solutions

Bands	Part #	Description	Filter Technology	Size (mm)	Features
Band 2 (PCS) (BC1)	TQM966002	PCS SE / SE Duplexer	LowDrift BAW	2.5x2.0x0.9	Excellent Triple Beat Performance
Band 3	TQQ1003	LTE SE / SE Duplexer	LowDrift BAW	1.8x1.4x0.73	High Isolation and ISM Rejection
Band 7	TQQ1007	LTE SE / SE Duplexer	LowDrift BAW	1.8x1.4x0.73	40dB ISM Rejection to Enable Wi-Fi Coexistence
Band 7	TQM976027	LTE SE / SE Duplexer	LowDrift BAW	2.0x1.6x0.9	Excellent Insertion Loss
Band 13	TQQ1013	LTE SE / SE Duplexer	NoDrift SAW	2.5x2.0x0.9	Solution for Public Safety NS_07 Requirements
Band 13	856879	LTE SE / BAL Duplexer	LowDrift BAW	2.5x2.0x0.6	1.5dB (Tx) / 1.6dB (Rx) Insertion Loss
Band 25 (BC14)	TQM963014	LTE SE / SE Duplexer	LowDrift BAW	2.6x2.1x0.9	Excellent Triple Beat Performance
Band 30	885014	2332.5MHz BAW Filter	NoDrift BAW	1.7x1.3x0.5	Enables Coexistence of SDARS with WCS Radios
Band 30	TQQ1030	LTE SE / SE Duplexer	NoDrift BAW	1.8x1.4x0.73	2dB Max Tx Insertion Loss, 11dB Attenuation at 9MHz Offset Across Temperature
Band 38	885026	LTE B38 Tx / Rx Filter	LowDrift BAW	1.4x1.2x0.5	40dB Min WLAN Rejection to Enable Wi-Fi Coexistence
Band 38 and 40	885043	LTE B38 / 40 Tx Filter	LowDrift BAW	1.7x1.3x0.5	2-in-1 Filter for Full Band 40 Coverage with Low Loss
Band 40	885049	LTE B40 Tx / Rx Filter	LowDrift BAW	1.4x1.2x0.5	Tx or Rx B40 Filter
Band 40W	885075	LTE B40 Wide Tx Filter	LowDrift BAW	1.1x0.9x0.52	Smallest B40 Wide Filter
Band 41	TQQ0041T	LTE B41 SE Tx Filter	LowDrift BAW	1.8x1.4x0.73	Smallest Industry Band 41 Duplexer
Band 41	TQQ0041E	LTE B41 SE Tx Filter	LowDrift BAW	2.0x1.6x0.73	High ISM Band Rejection
Band 41	TQQ0041	LTE B41 Rx Filter	LowDrift BAW	2.0x2.0x0.8	Low IL and High Wi-Fi Attenuation
BC0 / Band 13	857031	BC0 Notch Filter for Applications SVLTE	LowDrift SAW	2.5x2.0x0.6	Low Loss, High Attenuation and High Linearity
BC0 / Band 13	857061	B13 Notch Filter for SVLTE Applications	LowDrift SAW	2.5x2.0x0.6	Low Loss, High Attenuation and High Linearity
Wi-Fi	885067	LTE / Wi-Fi Coexist Filter	LowDrift BAW	1.1x0.9x0.52	WLAN BPF, Best IL for Full Channel 1-13 Opportunities
Wi-Fi	885033	LTE / Wi-Fi Coexist Filter	LowDrift BAW	1.4x1.2x0.5	WLAN BPF with High Rejection B38 / 40
Wi-Fi	885032	LTE / Wi-Fi Coexist Filter	LowDrift BAW	1.4x1.2x0.5	WLAN BPF with High Rejection B7 / 41
Wi-Fi	885062	LTE / Wi-Fi Coexist Filter	LowDrift BAW	1.4x1.2x0.5	+28dBm MCS7, Hi Rej B38 / 40, Hermetic MSL0, Temp -40 to 95°C
Wi-Fi	885071	LTE / Wi-Fi Coexist Filter	LowDrift BAW	1.4x1.2x0.5	+29dBm MCS7, Hi Rej B7 / 41, Hermetic MSL0, Temp -40 to 95°C
Wi-Fi	885070	LTE Coexist / Wi-Fi Bandedge Filter	LowDrift BAW	1.7x1.3x0.5	+30dBm MCS7, Bandedge Rej 2390 & 2483.5MHz, Hermetic MSL0, Temp -40 to 95°C

Delivering Reliable Filter Performance

Qorvo's LowDrift™ and NoDrift™ technologies are redefining filter performance — moving beyond simply achieving low insertion loss to also ensure reliable performance as temperatures fluctuate. As the tables below show, these advanced filter processes achieve much lower, or virtually non-existent, temperature drift. That's dependable performance you can count on.

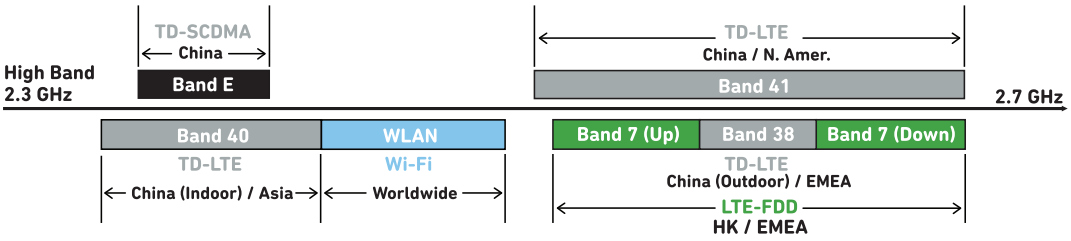
SAW Processes	
Process	**Temperature Drift**
Standard SAW	-35 to -45 ppm°C
LowDrift™ SAW	-22 ppm°C
NoDrift™ SAW	0 +/-2 ppm°C

BAW Processes	
Process	**Temperature Drift**
Competition (FBAR)	-22 to -31 ppm°C
LowDrift™ BAW	-17 ppm°C
NoDrift™ BAW	0 +/-2 ppm°C

Leveraging Technology for Coexistence in the Crowded Spectrum

As LTE deployments accelerate worldwide, Qorvo's LowDrift™ filters are solving LTE coexistence issues. For example, the 2400 - 2482MHz spectrum used by Wi-Fi lies between Bands 40 and 41, which are used to deliver TDD-LTE service in China. The upper edge of Band 40 (2400MHz) directly abuts the Wi-Fi spectrum, with no transition band at all. Solving this Wi-Fi coexistence challenge requires RF filters that are capable of rejecting closely adjacent frequencies. At the same time, the filters must minimize insertion loss in the WLAN transmission pathway, to help maintain the high signal-to-noise ratio and correspondingly low error vector magnitude (EVM) required for 802.11n. Qorvo's LowDrift™ BAW filters can achieve quality factors (Q values) that are superior to other traditional acoustic technologies. As a result, the filter skirts will be very steep while insertion losses remain low even at the edges of the passband, minimizing the need to sacrifice LTE or Wi-Fi bandwidth.

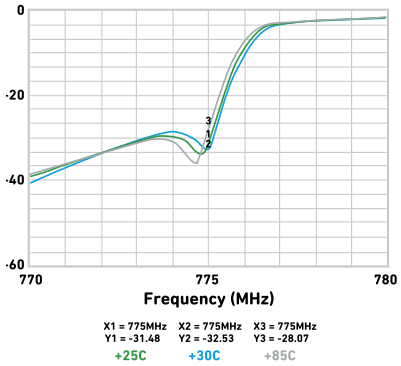
Spectrum Example for Asia / EMEA



Band 13 Coexistence Challenge

Band 13 requires an even higher level of temperature-compensation. The challenge, shown below, is that the Band 13 uplink at 777 – 787MHz is very close to narrowband public safety communications in the 769 – 775MHz region. To avoid interference problems, the 3GPP standards body defined a network signaling case (NS_07) whereby the network signals mobile devices when there is a narrowband public safety system in the area. In response to this signal, mobile devices must reduce emissions in the 769 -775MHz range by 22dB.

Band 13 NoDrift™ filter performance

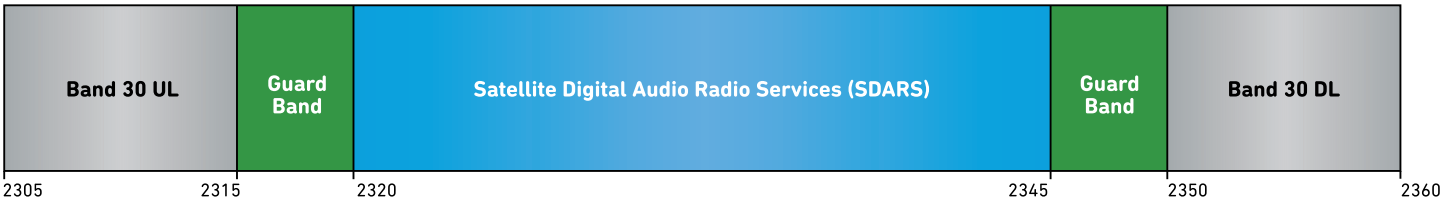


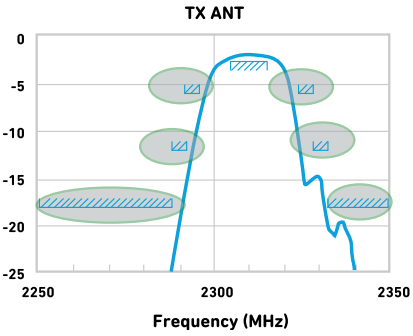
In initial Band 13 deployments, the only feasible way to achieve this was to reduce the output power of the mobile device, sometimes as high as 12dB. Because a power reduction of this size significantly impacts system performance and user experience, the operators using Band 13 have long wanted a solution capable of addressing the interference issue without reducing output power.

To meet the specification, filtering solutions need to provide 22dB of attenuation at 775MHz while still passing 777MHz, the lower edge of Band 13. Complicating the problem is the need to provide this attenuation over a wide temperature range, typically from -20°C to + 85°C. As the figure to the left shows, only NoDrift™ SAW can meet the requirements.

Band 30 Coexistence Challenge

Qorvo's NoDrift™ BAW filters solve the challenge of Band 30 coexistence with satellite radio services, which are widely used to deliver in-car entertainment. The satellite radio spectrum is sandwiched into the duplex gap between the Band 30 uplink and Band 30 downlink. The Band 30 spectral emission mask is tightly constrained to protect the satellite radio service as well as government bands below Band 30.





Performance of NoDrift™ BAW satellite radio service filter over temperature range

As shown in the band diagram above, the most difficult attenuation points are at 2296MHz and 2324MHz in order to achieve the required spectral emission mask for a Band 30 uplink filter. These are only 9MHz away from the passband edge and require at least 11dB of absolute attenuation. This challenge cannot be met with standard SAW or FBAR filters because of thermal drift.

Only Qorvo's NoDrift™ BAW filter can meet these requirements over the entire temperature range at the critical 2324MHz point. Filtering for satellite radios is met by embedding a bandpass filter using the NoDrift™ BAW process into the car's antenna or satellite radio unit. The figure on the left shows how Qorvo's filter meets the requirements for low insertion loss across the entire passband, as well as the attenuation required to avoid interference with the Band 30 uplink and downlink communications.

Integrating for Performance & Size

Packing More Functionality in Smaller Form Factors

Qorvo's advanced filtering solutions raise high performance and small size to new levels when integrated with power amplifiers, switches and other front-end RF components. The LTE build-out is expanding band counts in handsets dramatically, driving increased demand for broadband PAs and high-performance filters. The average number of bands in a smartphone has more than doubled in the last few years and will double again over the next two years. This is creating a strong push toward integrated modules that combine premium filters with highly-efficient broadband amplifiers to reduce RF size and complexity in a smartphone.

Qorvo uses dense packaging technologies — like our CuFlip™ copper flip interconnect and wafer level packaging (WLP) — to combine high-performance broadband amplifiers with premium filters in a simplified integrated solution that speeds time to market for our customers. We are committed to providing industry-leading performance in the world's smallest form factors.

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