Technology Focus

Murata Promotes SAW Filters for TD-LTE Terminals

Mobile phones have evolved over time with the integration of a number of features, such as camera, Global Positioning System (GPS), mobile TV, and near field communication (NFC) for contactless communication, on top of the basic calling function. More recently, with the increasing proliferation of smartphones and tablet computers, which are high-functional mobile terminals equipped with a high-performance application processor, new value-added services have risen, such as comfortable and high-speed browsing, streaming, data access, cloud computing support, and navigation, making it essential to further improve the quality of communication functions.

One functional requirement for all these mobile terminals is their compatibility to a variety of communication standards. Conventionally, the 2G system called Global System for Mobile (GSM) communication was the main communication standard for mobile phones, but it has become common for most terminals to incorporate Universal Mobile Telecommunications System (UMTS), a 3G system that has achieved more high-quality data transfer and higher transfer rates than GSM. More recently, services compatible with the next-generation communication standard called Long Term Evolution (LTE) have started. LTE allows wireless data communication at high speed close to that of wired communication.

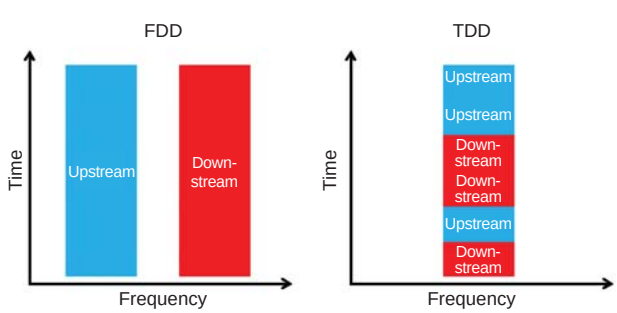

Fig. 1: Comparison between TDD and FDD

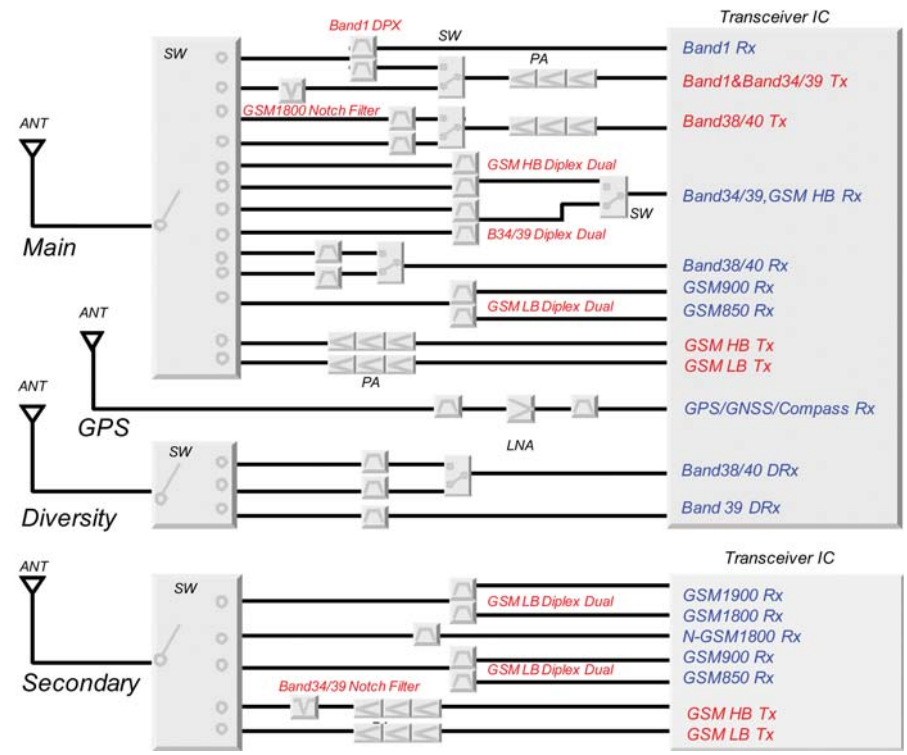

Fig. 2: Circuit diagram of TD-LTE (supporting SGLTE)

Simultaneous Voice and LTE (SVLTE) communication services, which allow mobile data communication even during a conversation, have already started in North America. Also, in China, Simultaneous GSM and LTE (SGLTE) communication services, which allow GSM voice services and TD-LTE data communication simultaneously, are being planned. Along this line, IC makers and assembly manufacturers are stepping up preparations to pave the way for these latest services.

LTE Technology Classification

Time Division Duplex (TDD) is a method for bidirectional communication between base stations and mobile terminals in which upstream and downstream lines are established using radio waves with the same frequency (Fig. 1). Unlike TDD, a method in which radio waves with different frequencies are used for upstream and downstream lines is called Frequency Division Duplex (FDD).

LTE is a communication standard for mobile phones, and its specifications were established by the standards body Third Generation Partnership Project (3GPP) in March 2009. It is a crossover technology between UMTS and fourth-generation (4G) mobile phones technologies, and was initially termed 3.9G. However, since the International Telecommunication Union (ITU) approved the term 4G technology, LTE has been classified as 4G standard. At present, it does not have a unified name in the market.

Table 1: Product line of dual filters for TD-LTE

Size (mm)	Application	Balanced /Unbalanced	Impedance (Ω)	Murata P/N	Pin assignment	Comment
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-200	SAWFD1G90CP0F0A	2in4out	
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-200	SAWFD1G90CQ0F0A	2in4out	
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-200	SAWFD1G90CA0F0A	1in4out	
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-200	SAWFD1G90CB0F0A	1in4out	
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-100	SAWFD1G90CR0F0A	2in4out	
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-100	SAWFD1G90BH0F0A	2in2out	
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-100	SAWFD1G90AH0F0A	1in2out	
1.5 x 1.1 x 0.5	Band34_Band39	Unbalance	50-50	SAWFD1G90KA0F0A	1in2out	
1.5 x 1.1 x 0.5	Band34_Band39	Unbalance	50-50	SAWFD1G90KC0F0A	1in2out	
1.5 x 1.1 x 0.5	Band34_Band39	Unbalance	50-50	SAWFD1G90LA0F0A	2in2out	
1.5 x 1.1 x 0.5	Band34_Band39	Unbalance	50-50	SAWFD1G90KZ0F0A	1in1out	
1.5 x 1.1 x 0.5	Band38_Band40	Balance	50-100	SAWFD2G35CM0F0A	2in4out	
1.5 x 1.1 x 0.5	Band38_Band40	Balance	50-100	SAWFD2G35CA0F0A	1in4out	
1.5 x 1.1 x 0.5	Band34_Band39	Balance	50-100	SAWFD2G35BJ0F0A	2in2out	
1.8 x 1.4 x 0.5	Band34_Band39	Unbalance	50-50	SAWEN1G90PA0F0A	1in2out	Post PA
1.8 x 1.4 x 0.5	Band38_Band40	Unbalance	50-50	SAWEN2G35PN0F0A	1in2out	Post PA

Table 2: Product line of notch filters for TD-LTE

Size (mm)	Application	Balanced /Unbalanced	Impedance (Ω)	Type	Murata P/N	Comment
1.4 x 1.1 x 0.5	N-DCS	Unbalance	50-50	Notch	SACEA1G81TA0F0A	Post PA
1.4 x 1.1 x 0.5	N-DCS	Unbalance	50-50	Notch	SACEA1G81TB0F0A	Post PA
1.4 x 1.1 x 0.5	N-DCS	Unbalance	50-50	Notch	SACEA1G82TA0F0A	Post PA
1.4 x 1.1 x 0.5	Band34_Band39	Unbalance	50-50	Notch	SACEA1G90TB0F0A	Post PA

Generally, FDD-LTE is called LTE and an LTE technology other than FDD-LTE that uses TDD is called TD-LTE for classification purposes. In TD-LTE networks, the same frequency can be used for both transmission and reception, and therefore, in general, it is easier to allocate frequencies in networks of TD-LTE than in those of FDD-LTE. Other the mentioned differences, TD-LTE is basically technologically identical to FDD-LTE and uses the same frequency as that of 3G, allowing selection and use of frequency bands from 1.4, 3, 5, 10, 15, and 20MHz according to the circumstances.

LTE only supports packet communication, while Voice over Internet Protocol (VoIP) technology called Voice over LTE (VoLTE) supports voice communication. With this technology, however, data communication is generally used and it will take time for the voice services to be put into full-scale use.

TD-LTE is expected to spread globally as China is actively promoting the launch of commercial services based on this technology, with 2.5GHz band services having started in Japan and new services being planned in North America.

RF Circuit for TD-LTE

Fig. 2 illustrates a circuit of TD-LTE (SGLTE). Present terminals that support TD-LTE certainly need to carry dual mode or triple mode to support GSM or UMTS in order to offer voice communication. For GSM, the four bands, 850MHz, 900MHz, 1800MHz, and 1900MHz, are generally supported for international roaming, and one filter is incorporated for each band on the receiving side. For UMTS, since its Band 1 is for FDD, a duplexer (antenna-sharing device) is required.

In China, Band 38, Band 39, and Band 40 are allocated as the bands for TD-LTE by 3GPP. Since systems are based on TDD, a duplexer is not required. Moreover, a filter for high power on the transmission side and on receiving side, which are used at their respective bands on the main circuit, are available. As an LTE system supports multiple-input, multiple-output (MIMO) technology to work as a multi-antenna system, one more filter is incorporated for reception on the diversity circuit.

The circuit in Fig. 2 is an SGLTE-supporting circuit capable of data communication even during voice communication, and is characterized by the incorporation of two transceiver ICs used to simultaneously operate GSM and TD-LTE. However, when transmission is performed on two lines simultaneously using one terminal, transmission power output by one circuit could be brought into the other circuit, causing interference and lowering the receiving sensitivity. It is, therefore, necessary to sufficiently attenuate electrical power of receiving frequencies on each transmission circuit, and this considerably increases the difficulty in design of complete products.

Murata Manufacturing Co., Ltd. has commercialized notch filters for TD-LTE or filters that attenuate only specific frequencies, as well as receiving filters for GSM1800 that rapidly attenuate TD-LTE bands, in response to the needs of assembly manufacturers in the development of SGLTE terminals.

SAW Devices Lineup for TD-LTE

Tables 1 to 3 show the product lines of surface acoustic wave (SAW) filters for TD-LTE that Murata Manufacturing has released so far. Dual filters are listed in Table 1, notch filters in Table 2, and single filters in Table 3.

Murata Manufacturing has commercialized dual filters with combinations of Band 34 and Band 39, and of Band 38 and Band 40, at the request of IC makers and assembly manufacturers who want to reduce the area of radio frequency (RF) blocks, after TD-LTE was selected. While there are a variety of dual filters, products into which functions of peripheral components are consolidated tend to be popular and favorably used.

For pin connection, the following balanced types of products have been developed: standard 2-in 4-out type, 1-in 4-out type into which input SW functions are consolidated, and 2-in 2-out type capable of reducing the number of LNAs by one by combining filter outputs. Also, the following three unbalanced types of products have been developed: standard 2-in 2-out type, 1-in 2-out type into which input SW functions are consolidated, and Murata Manufacturing's unique 1-in 1-out type in which both in-

puts and outputs are combined. The type of pin connections required depends on the transceiver ICs used by assembly manufacturers and the design concept.

Table 2 shows the notch filter models that pass transmission frequencies and attenuate signals of receiving frequencies in other bands, positioned after a power amplifier. Murata has already been mass producing notch filters for frequencies of around 800MHz, but this time it was necessary to commercialize new notch filters for high frequencies of 1.8 or 1.9GHz. Generally, the higher the frequencies, the more difficult it is to design notch filters; however, products have been developed by making full use of Murata's unique circuit design technology and electromagnetic field simulator.

Table 3 shows the product line of single filters. Under the Application column, an N-DCS indicates that the product is a narrow-band filter for GSM1800. This is a product designed for attenuation of TD-LTE bands, and two types are being mass produced at customers' request. Murata is appropriately responding to the detailed requirements of customers and is enhancing its product lines, for example, by commercializing 2.5GHz band filters supporting unique AXGP, which is used only in Japan, in addition to filters aimed at the Chinese market, to play an important part in spreading TD-LTE throughout the world.

Table 3: Product line of single filters for TD-LTE

Size (mm)	Application	Balanced /Unbalanced	Impedance (Ω)	Murata P/N	Comment
1.1 x 0.9 x 0.5	N-DCS	Balance	50-150	SAFFB1G81AB0F0A	For GSM1800
1.1 x 0.9 x 0.5	N-DCS	Balance	50-150	SAFFB1G82AB0F0A	For GSM1800
1.1 x 0.9 x 0.5	Band38	Balance	50-100	SAFFB2G59FL0F0A	
1.1 x 0.9 x 0.5	Band39	Balance	50-100	SAFFB1G90FB0F0A	
1.1 x 0.9 x 0.5	Band39	Balance	50-100	SAFFB1G90FC0F0A	
1.1 x 0.9 x 0.5	Band40	Balance	50-100	SAFFB2G34FA1F0A	
1.1 x 0.9 x 0.5	Band40	Unbalance	50-50	SAFFB2G35AA0F0A	
1.4 x 1.1 x 0.5	AXGP	Unbalance	50-50	SAFEA2G56MA0F00	Post PA
1.4 x 1.1 x 0.5	AXGP	Unbalance	50-50	SAFEA2G56MB0F00	Post PA
1.4 x 1.1 x 0.5	AXGP	Unbalance	50-50	SAFEA2G56MC0F0A	Post PA
1.4 x 1.1 x 0.5	AXGP	Unbalance	50-50	SAFEA2G56KA0F00	
1.4 x 1.1 x 0.5	AXGP	Balance	50-100	SAFEA2G56FC0F00	
1.4 x 1.1 x 0.5	AXGP	Balance	50-200	SAFEA2G56FB0F00	
1.4 x 1.1 x 0.5	Band34	Unbalance	50-50	SAFEA2G01MA0F0A	Post PA
1.4 x 1.1 x 0.5	Band34	Unbalance	50-50	SAFEA2G01AL0F00	
1.4 x 1.1 x 0.5	Band34	Balance	50-100	SAFEA2G01FA0F0A	
1.4 x 1.1 x 0.5	Band34	Balance	50-200	SAFEA2G01FL0F00	
1.4 x 1.1 x 0.5	Band38	Unbalance	50-50	SAFEA2G59MA0F00	Post PA
1.4 x 1.1 x 0.5	Band38	Unbalance	50-50	SAFEA2G59MB0F0A	Post PA
1.4 x 1.1 x 0.5	Band38	Unbalance	50-50	SAFEA2G59KB0F00	
1.4 x 1.1 x 0.5	Band38	Balance	50-100	SAFEA2G59FM0F0A	
1.4 x 1.1 x 0.5	Band38	Balance	50-150	SAFEA2G59FL0F00	
1.4 x 1.1 x 0.5	Band38+AXGP	Unbalance	50-50	SAFEA2G58MA0F00	Post PA
1.4 x 1.1 x 0.5	Band38+AXGP	Balance	50-100	SAFEA2G58FA0F00	
1.4 x 1.1 x 0.5	Band39	Unbalance	50-50	SAFEA1G90MA0F0A	Post PA
1.4 x 1.1 x 0.5	Band39	Unbalance	50-50	SAFEA1G90AA0F00	
1.4 x 1.1 x 0.5	Band39	Balance	50-100	SAFEA1G90FA0F0A	
1.4 x 1.1 x 0.5	Band40	Unbalance	50-50	SAFEA2G34MA1F0A	Post PA
1.4 x 1.1 x 0.5	Band40	Balance	50-100	SAFEA2G34FA1F0A	
1.4 x 1.1 x 0.5	Band40	Unbalance	50-50	SAFEA2G35MB0F00	Post PA
1.4 x 1.1 x 0.5	Band40	Unbalance	50-50	SAFEA2G35MC0F0A	Post PA
1.4 x 1.1 x 0.5	Band40	Unbalance	50-50	SAFEA2G35KB0F00	
1.4 x 1.1 x 0.5	Band40	Balance	50-100	SAFEA2G35FC0F0A	
1.4 x 1.1 x 0.5	Band40	Balance	50-150	SAFEA2G35FB0F00	

Future Outlook

In the existing UMTS and LTE markets, the range of frequencies (bands) is being expanded in order to further improve quality and expand the service areas. As TD-LTE allows transmission and reception on the same frequency, it is easier to allocate frequencies in networks of TD-LTE than in those of FDD-LTE; this will possibly help much more widely popularize TD-LTE in an attempt to make effective use of frequency, which is a limited, precious resource. Also, with multi-band and multi-mode products being demanded by the market, the area of RF blocks is becoming a major issue in complete products.

Murata Manufacturing has so far mainly expanded the product lines of single filters and dual filters, and is enhancing the compatibility of module products in order to reduce the number of components and the area of RF blocks and to shorten the total development time spent by assembly manufacturers. Further miniaturization of built-in SAW filters is essential to reduce the size of a module product. Murata Manufacturing has already commercialized products that were miniaturized into a die size by applying the firm's unique process technologies, and is considering further reduction of size and thickness.

In order to continue to respond to various needs of assembly manufacturers, such as reduction of size, thickness, and price, and consolidation, Murata Manufacturing will promote combination of filtering technologies and its strong points—multi-layer substrate technologies and module design technologies. By doing this, it will enhance its product lines that provide synergy between its comprehensive range of component technologies, contributing to the increasing development of the mobile market.

About This Article:

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