

Murata's SAW Devices Breach Mainstream Industry Features

The company has implemented simulation technology coupled with optimal element design and chip mounting techniques to develop ultra small, radio frequency filters.

Today's mobile phones are equipped with an extensive list of functions, such as camera, music player, Global Positioning System (GPS) navigation, mobile TV broadcasting, and Bluetooth technology, and mobile phone applications have remarkably diversified over time. Aside from functionalities, the requirements from consumers for the mobile handset design have become varied that can range from slim type to slider type mobile phones.

Amid the trends for small, multifunctional mobile phones and assorted styles, significant miniaturization and increase in functionalities of electronic parts and components play important roles in driving the technologies that underpin these trends.

Radio frequency filters, which help achieve stable communications by picking the necessary signals from radio waves received by an antenna, are indispensable electronic components for a mobile phone.

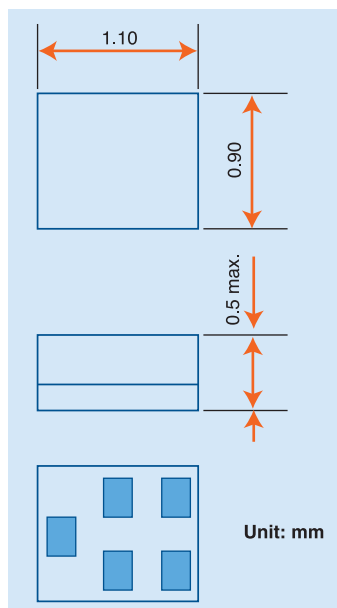


Fig. 1: Outline of a single filter

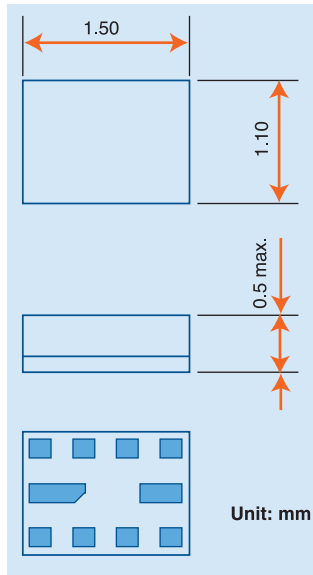


Fig. 3: Outline of a dual filter

Among them, the surface acoustic wave (SAW) filter is one of the electronic components that have contributed to the evolution of mobile phones in terms of size, function, and design by taking advantage of its features, such as small size and effective selection of signals.

Mobile phones are being promoted to support multiple systems and multiple

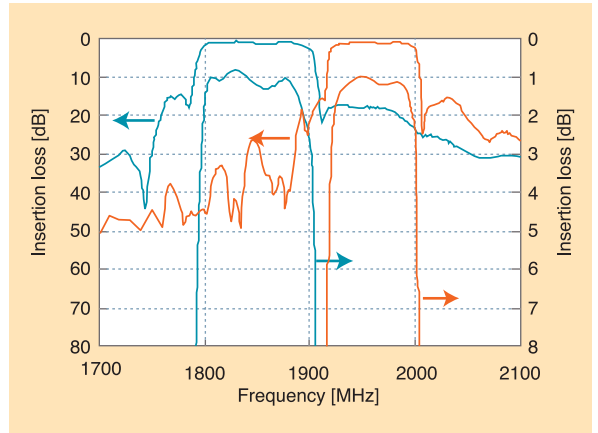


Fig. 4: Electrical characteristics of the receiving SAW filter GSM1800/1900 with part number SAWFD1G84CN0F00

bands to be able to use the same mobile terminal all over the world, and to enhance the quality and speed of communications. For these reasons, the number of components required for these mobile phones inevitably increases, as well as the need for smaller electronic components.

Murata Manufacturing Co., Ltd. has developed the smallest-in-class SAW devices to date used for mobile phones. The latest trends in ultra small SAW devices for mobile phone applications are described below.

Highly Efficient Ultra Small Filter

The SAW filters used in the radio frequency wireless communication circuits of mobile phones include the Code Division Multiple Access (CDMA) system-compliant interstage filters for transmission and reception, and the Global System for Mobile Communications (GSM) system-compliant top filters for reception. These filters are required to have low insertion loss and high attenuation characteristics in order to enhance the receiver sensitivity of wireless communications and maintain a stable communication quality.

Also, as more wireless communication circuits become compliant with multiple

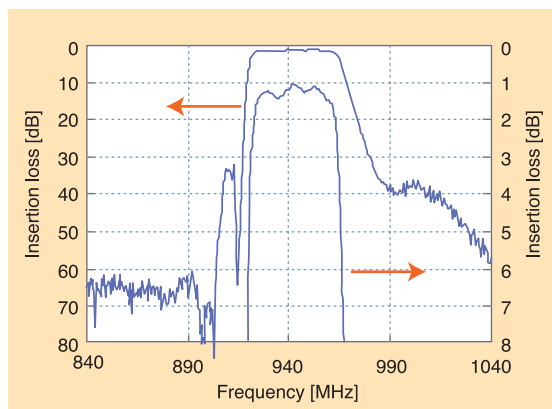


Fig. 2: Electrical characteristics of the receiving SAW filter GSM900 with part number SAFFB942MFL0F00

More Compact Dual Filter

At present, a dual filter measuring $1.80 \times 1.35 \times 0.5\text{mm}$ is the most common. In order to align the length of the longer side of a single filter to that of the short side of the dual filter, it has been scaled down to achieve the compact size of $1.50 \times 1.10 \times 0.5\text{mm}$, resulting in a smaller mounting area that is 68 percent that of the existing product (See Fig. 3).

As an example, the transmission characteristics of the receiving dual filter GSM1800/1900, in this case product with part number SAWFD1G84CN0F00, are shown in Fig. 4. The GSM1800 filter achieves a typical in-band insertion loss of 1.3dB, while the GSM1900 filter achieves typical in-band insertion loss of 1.4dB. Both rates are lower by 0.2 to 0.3dB from the insertion loss of existing products.

As a measure to reduce the mounting area on a circuit substrate, it is highly effective to enhance the performance of the filter in addition to making it smaller. This performance is enhanced by incorporating the functions of the peripheral components into the filter. Accordingly, Murata Manufacturing has come up with dual-filter products by making full use of its original technologies.

The dual filters include the 1-in/4-out product, in which the unbalanced input ports are unified, and the 2-in/2-out product, in which the balanced output ports are unified. By unifying the unbalanced ports on the input side, the number of ports of the switch to be connected to the filter or the number of switch can be reduced. Also, by unifying the balanced ports on the output side, the number of ports of the radio frequency IC to be connected to the filter can be reduced (See Fig. 5). The integration of these ports is made possible by the ingenuity in the element design of the SAW filters in terms of impedance and phase adjustments. When used in the multiband-compliant radio frequency wireless communication circuits, these filters can contribute to simplifying the peripheral circuits, to scale down the size of the whole circuit, and to lower the cost.

Murata Manufacturing has already commercialized these filters for use in conventional products, and will pursue the creation of a product lineup for compact dual filters.

Boundary Elastic Wave Filter

As another solution to scaling down the

(Continued on page 38)

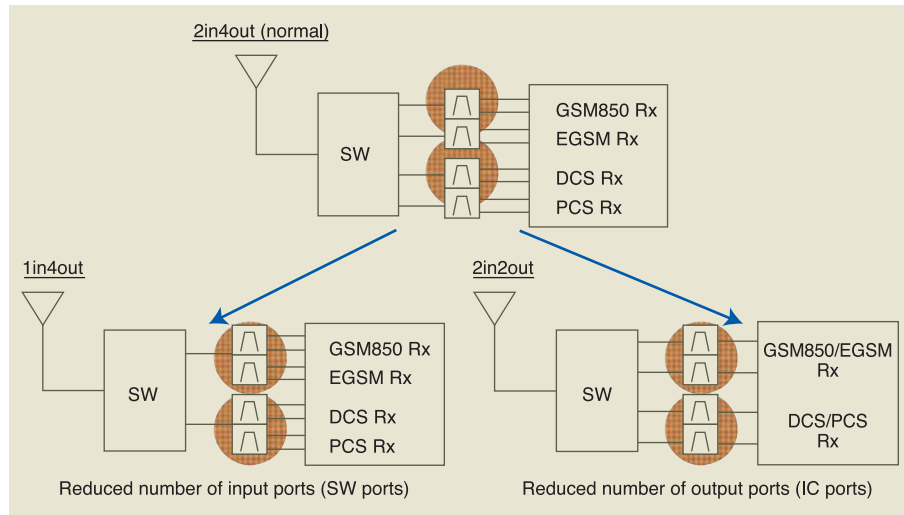


Fig. 5: Example of an I/O port configuration of a dual filter

bands, a dual filter, which integrates filters for two bands in a single package, is being used along with a single filter in many cases. In relation, demand for the multiple combinations of these filters has been increasing. Murata Manufacturing has developed a compact single filter as well as a dual filter, which can reduce the mounting area on the circuit substrate while maximizing its performance.

Single Filter: 30 Percent Smaller

A single filter measuring $1.35 \times 1.05 \times 0.5\text{mm}$ is most commonly used on mobile phones today. By making full use of simulation technology like element layout and process technologies like chip mounting technology, Murata Manufacturing has developed a compact single filter with dimensions of $1.10 \times 0.90 \times 0.5\text{mm}$, and requires 70 percent mounting area of the present product (See Fig. 1).

Figure 2 presents the transmission characteristics of the receiving SAW filter GSM900, in this case a SAW filter with part number SAFFB942MFL0F00. An optimal element design has allowed a typical in-band insertion loss of 1.5dB, which is equivalent with or superior to the existing models. This has been achieved despite concerns over possible effects caused by the increase in floating capacitance due to the product's size reduction.

As mobile phones become multifunctional, an increasing number of models are being integrated with the GPS navigation function and Near Field Communication systems, such as Bluetooth and Wi-Fi. As these applications are installed in a single mobile terminal, it is neces-

sary to prevent interference between the waves transmitted and received by a mobile phone and the communication waves of each application.

As radio waves used by mobile phones have increasingly become compliant with multiple bands, it becomes necessary to eliminate the transmitting and receiving waves of other bands. Therefore, a smaller filter with higher performance will be highly demanded.

In order to meet these needs, Murata Manufacturing will further develop its original technologies earned both in the design and process aspects, and apply them to enhance its lineup of compact filter products.

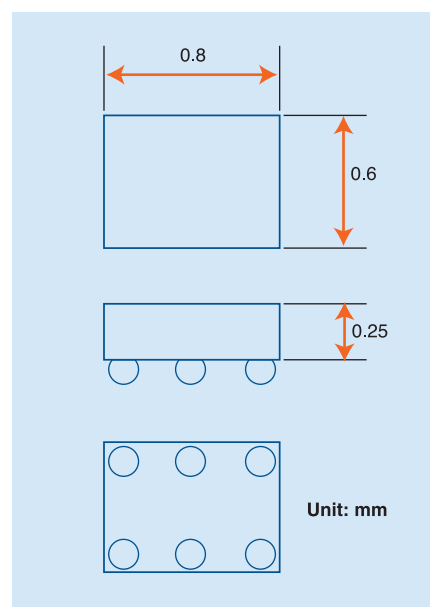


Fig. 6: Outline of a filter BPAW

Murata's SAW Devices Breach...

(Continued from page 35)

size of the filters, Murata Manufacturing has already brought to the market a compact size filter BPAW. The filter BPAW is a wave that propagates on the surface boundary of two closely attached substances. The filter BPAW is created based on the planer type (flat plate type) laminated structure, which does not require the formation of an air-sealing hollow structure. Thus, the filter becomes suitable for size and height reduction, and is highly reliable.

Figure 6 shows the outline of the filter BPAW. Measuring $0.8 \times 0.6 \times 0.25\text{mm}$, the filter device has achieved the world's smallest size of its class. To allow easy installation, ball grid array (BGA) is adopted for the first time for a passive filter component. The filter has achieved a low height of 0.25mm without solder balls. In Fig. 7, the transmission characteristics of the receiving filter GSM1900 with part number SAFAM1G96FA0B00 was used as an example. With a typical in-band insertion loss of 2.5dB, the filter is relatively inferior in performance to the SAW filters.

The filter BPAW was designed to facilitate installation into a system in package (SiP) or wafer level package (WLP). The filter is considered to become a key component when integrating passive components, and is being improved to obtain the characteristics equivalent with or superior to those of the SAW filters.

Future Prospects

In order to further reduce the size of the radio frequency wireless communication circuits, incorporating the radio frequency passive components into a single package or in module form have been implemented.

There is a great demand for smaller and lower-profile passive components with higher reliability. To satisfy this demand, Murata Manufacturing has marketed the filter BPAW, as mentioned earlier. The company intends to further improve the characteristics of the filter BPAW along with the SAW devices in order to make them either module-based or discrete-based to meet the market demand, and eventually increase the lineup of both products.

As mobile phones feature smaller size and become increasingly multiband-compliant, duplexers are much required to become smaller. In addition, enhanced performances of radio frequency ICs and radio frequency component surrounding the ICs have created the demand for duplexers having balanced output on the receiver side. Murata Manufacturing will apply the balance filter design technology, which the company has accumulated in developing the interstage filters, to duplexers and integrate the technology with the filter downsizing technology. Thereby, the company intends to develop the compact SAW duplexers for

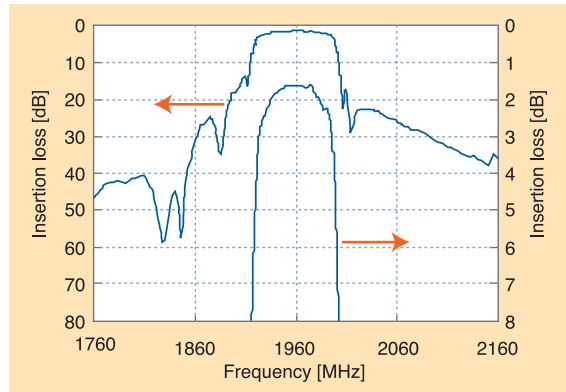


Fig. 7: Electrical characteristics of the receiving filter BPAW GSM1900 with part number SAFAM1G96FA0B00

various bands.

Mobile phones have been constantly evolving from the present third-generation (3G) mobile phones to the target fourth-generation (4G) devices through the 3.9-generation (3.9G) technology, aiming for much faster communication speed. Accordingly, mobile phones will have to support more bands, and the frequency bands to be used for mobile phones will become even higher. Murata Manufacturing will pursue the expansion of SAW device application, and further work on the technological challenges in a bid to contribute to the development of wireless communication technologies.

About This Article:

The author, Tajima Toshiyuki, works in the Product Designing Sec. 1, Microwave Products Dept. 1 of Kanazawa Murata Manufacturing, Co., Ltd.