# Quadplexer Boosts CA Function in Two Bands with Minimal Current

In recent years, there has been a significant change in the cellular phone market. Smaller size and higher functionality has became among the most important requirements for cellular phones. Considering these market situations, Murata Manufacturing Co., Ltd. is now developing surface acoustic wave (SAW) multiplexers that integrate transmission and reception filtering functions for multiple bands. This article first focuses on the history of the cellular phone market in order to develop an understanding of the background of the development of this product. Figure 1 summarizes these market trends.

Speaking of old mobile communication devices, car phones or handheld mobile phones come to mind. These devices were transformed into various forms, such as stick-shaped cellular phones and flip-type cellular phones, and finally into the present smartphones. As their displays are being increased in size for visibility, their bodies are being reduced in thickness and weight for appearance and portability; therefore, it is easy to imagine the development process in the integration of internal components that happened inside these devices.

Also, as the integration of Internet function to cellular phones and Internet functionality has emerged, cellular phones, which used to be just a means for voice calls, are now required to have higher functionality. Most smartphone users turn to their devices to browse videos, upload images and videos to social networking sites, or make video calls. As shown by these examples, the entry of smartphones has paved the way for the improvement of functionality, and such developments in multimedia are continuously building up communication traffic at an exponential rate.

Then, what about the radio frequency (RF) front ends that process high-frequency wave signals inside a smartphone? Actually, while the integration of RF front ends is progressing, demand for higher-speed, higher-capacity communication is increasing in association with the increase in communication traffic. In order to achieve this level of communication, three main trends are involved: 1) Improvement in the efficiency of communication methods (example: transition from WCDMA to LTE, etc.); 2) Increase in communication traffic (example: Multiple-Input and Multiple-Output (MIMO), Carrier Aggregation (CA), etc.); and 3) Increase in the number of components in RF front ends (example: increase in the number of LTE supported bands, demand for MIMO filters, etc.).

As a result of these trends, the following have become important factors in the selection of components for RF front ends: how to achieve high-speed, high-capacity communication, and how to integrate components (save space) while their number is increasing.

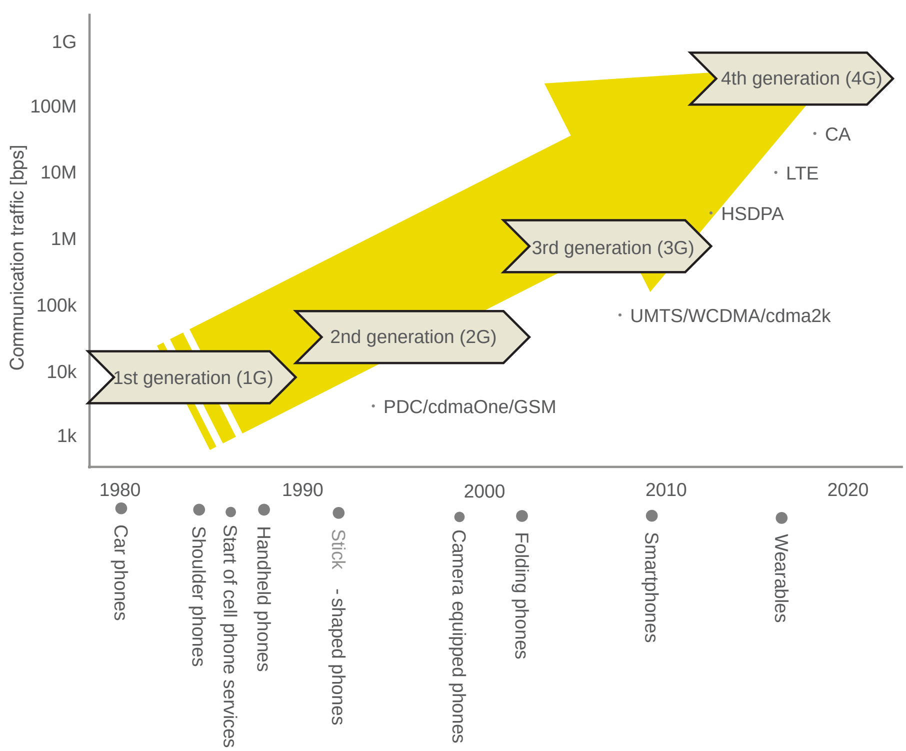


**Figure 1: Trend in the cellular phone market**


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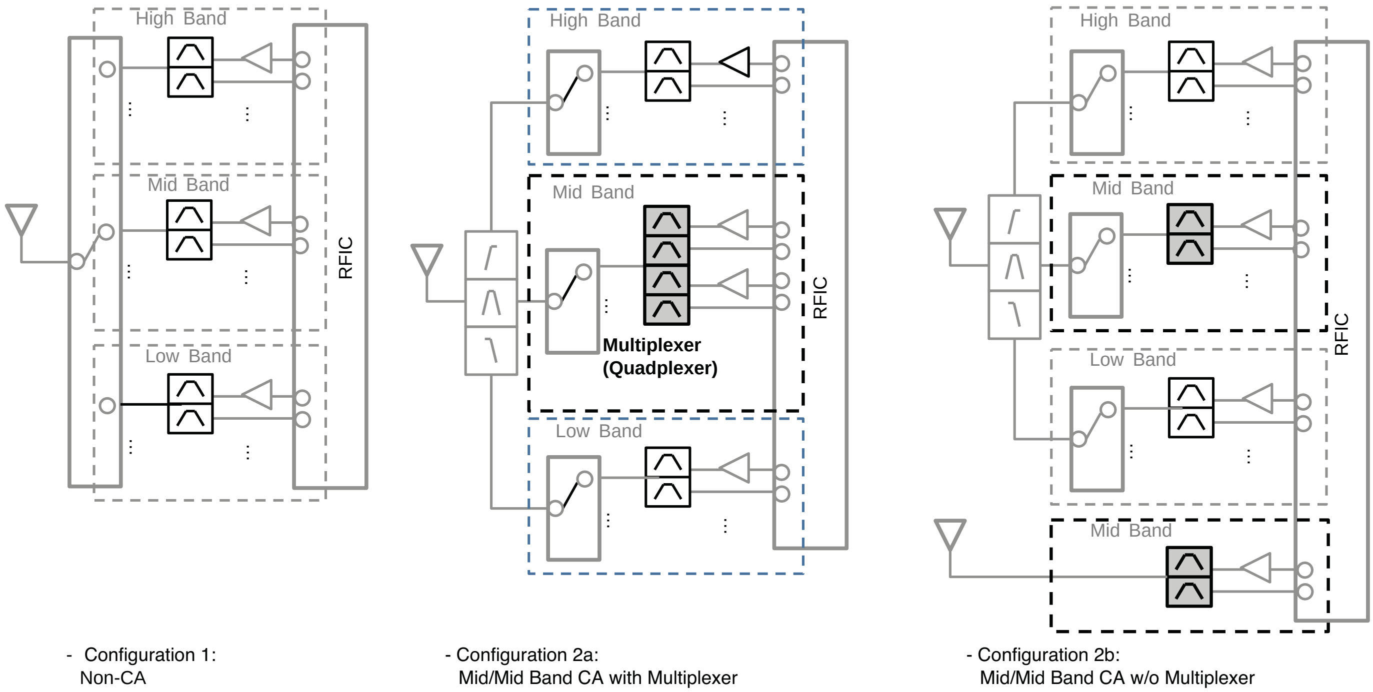


**Figure 2: Configuration examples of RF front ends with or without Carrier Aggregation**

This article describes multiplexers for which demand has been generated as a result of these trends, and also describes the development of multiplexers by Murata.

## Functions, Problems with Carrier Aggregation

The increase in demand for multiplexers results from the higher CA demand in the market. Carrier aggregation is a method for increasing communication speeds in which multiple LTE bands are used for simultaneous LTE communication to increase communication traffic. In order to achieve this CA function, changes have been made in the configuration of an RF front end as shown in Figure 2.

Note that a combination of bands whose respective frequencies are significantly different, such as a combination of the low band (1GHz or less) and high band (2.3GHz or more), allows simultaneous communication in multiple bands via a diplexer. Equally, for a combination of bands whose respective frequencies are close to each other, there are configurations to achieve CA that use either a multiplexer or multiple antennas as shown in configuration examples 2a and 2b in Figure 2.

Basically, however, device designers who are bothered by the relationship between design space and improved functionality of cellular phones and the increased number of their components, which are contradictory as described above, tend to avoid increasing the number of antennas. Therefore, there is an increasing demand for multiplexers and multi-filter devices that have a (diplex) structure where functions for multiple bands are incorporated in one package, and whose multiple frequency signals are aggregated at an antenna port. The use of this structure allows the implementation of CA without increase in the number of components, such as an additional antenna.

Also, for CA in a frequency division duplex (FDD) system that performs simultaneous transmission and reception separately at each individual frequency, it is necessary to consider not only in-band isolation but also inter-band isolation (cross-isolation). Since, however, a multiplexer is designed with this cross-isolation in mind, it eliminates the need for device designers to put in extra efforts to ensure cross-isolation in an RF front-end configuration. This is one reason why device manufacturers have high expectations about multiplexers.

Currently the most common configuration of CA uses two bands, and a quadplexer, shown in configuration example 2a, is drawing attention.

## Murata's Quadplexer

A quadplexer has a structure for diplexing of four bands in total, two bands each for transmission and reception, at an antenna port. Therefore, it is more likely to cause loss due to the combination of multiple filters than a duplexer, making

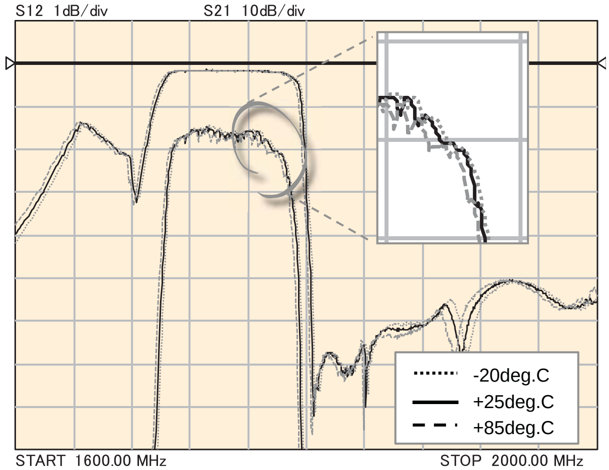


**Figure 3: BAND3 transmission properties of SAHRT1G-74BB0B0A**


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it difficult to compensate for insertion loss. Especially in bands, such as Band 3, that have a wide bandwidth and a narrow frequency interval between transmission and reception, how to ensure isolation while achieving low insertion loss has become an issue. In addition, it is becoming more difficult to meet the requirements for spurious emission and blocking of unnecessary waves, such as a harmonic component, in duplexer design than before. Therefore, duplexer manufacturers are in fierce competition to ensure these properties.

Here, a 3620-size Band-1 and 3 quadplexer (product name: SAHRT1G74BB-0B0A) is described, which is under development by Murata. This product is a quadplexer that involves Band 3, a highly challenging band, and is a product for which it is difficult to ensure the properties as described above. Figure 3 shows Band 3 transmission properties as an example of the properties of this product.

This product utilizes SAW device properties with a high electromechanical coupling coefficient, achieving low insertion loss even in Band 3, which has a wide bandwidth. Also, it uses TC-SAW[1)] technology and so can minimize frequency drift associated with temperature change to about -20ppm/°C or less. As a result, its specification considering temperature properties ensures sufficient isolation while achieving the world's lowest level of insertion loss. Also, because of using SAW device properties and TC-SAW technology, it can offer low insertion loss properties without using a bandwidth expansion circuit, thereby allowing sufficient attenuation of harmonic waves. As a result, it enables a terminal device to reduce current consumption and ensure sufficient reception sensitivity, and so is considered to be one of the most promising products in the market. This product, instead of having a module structure, has a structure where design elements are incorporated in one package, potentially contributing to miniaturization. Murata will respond to integration requirements from the market in terms of properties as well as size.

## Future Outlook

It is planned that CA with three bands or more will be introduced in parallel with the integration of RF front ends, and probably the forms of RF front ends will be diversified and complicated. Murata is carrying out development, aiming at solutions integrated with more bands, such as hexaplexer and pentaplexer. Band combinations, antenna peripheral configurations, etc. for the current CA configurations are still partially changing. Carrying out sufficient market research on these, Murata will expand its product lines according to the market situation and demand.

Also, because of the diversification of CA, Inter Modulation Distortion (IMD) and power durability have become a technical issue. This is because an increase in the number of bands for simultaneous transmission due to more multi-band configurations makes it necessary to consider the effects of IMD and because an increase in insertion loss of front ends due to increasingly complicated front-end configurations makes the output of power amplifiers higher. Currently, Murata is carrying out research and development on these, and will implement solution designs according to the market demand.

Murata will continue to launch SAW device products including multiplexers that are all suitable for the market trends and needs, and will deliver comprehensive innovations to the RF market to achieve customer satisfaction.

*Note:*

*[1)] ßTemperature Compensated-Surface Acoustic Wave (TC-SAW): A technology that characteristically reduces frequency drift when temperatures change.*

**About This Article:**

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