TDK
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RF components in DSSP technology

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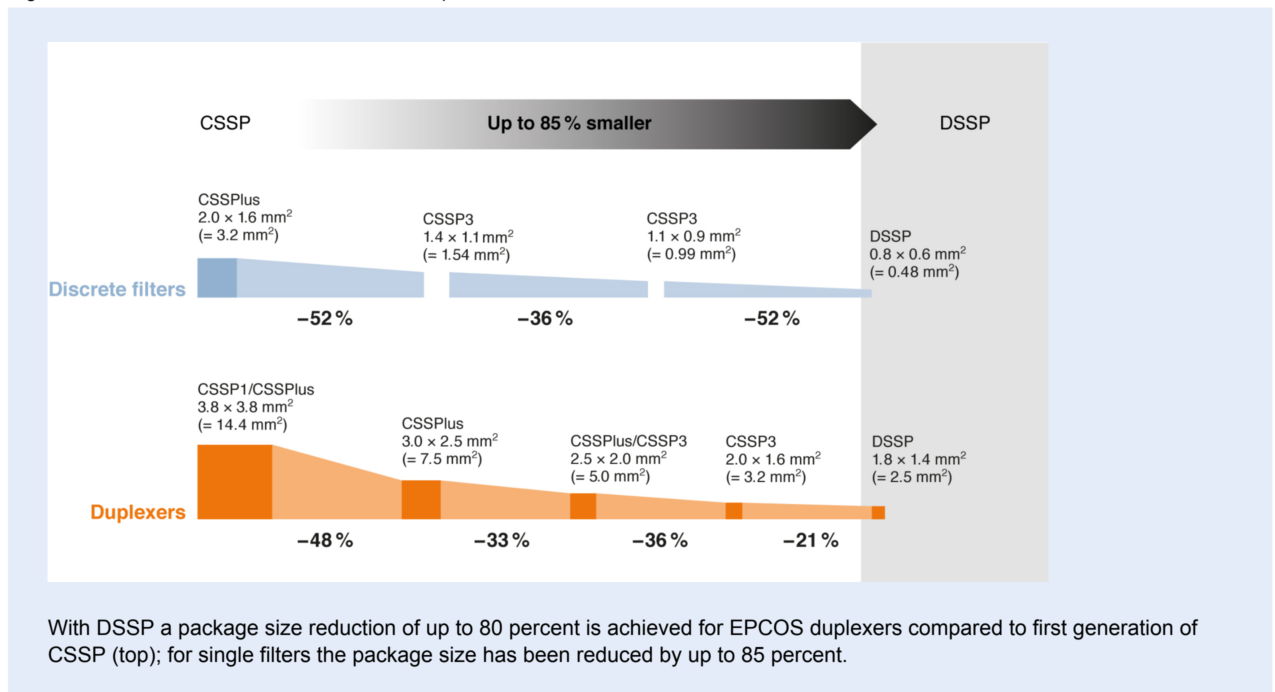
A new dimension in miniaturization

The success of smartphones with more and more functions and features is growing around the globe, and the miniaturization of electronic components remains one of the leading trends in mobile communications. With innovative die-sized SAW packaging technology DSSP® from EPCOS, TDK is a driving force in this field.

By 2014 it is expected that up to 40 percent of all mobile phones will be smartphones. In order to offer worldwide coverage, smartphones must support more RF bands than ever and feature growing numbers of functionalities. Despite the fact that their RF circuits are becoming more complex, the phones must remain as compact and flat as ever.

As the global market leader in SAW products for mobile communications, EPCOS has and continues to play a leading role in the miniaturization of RF components and modules. Through the introduction and further development of its patented CSSP® technology (chip-sized SAW packaging), the size of discrete RF filters and duplexers has been steadily reduced. Now with DSSP®, the components are up to 85 percent smaller than the first generation CSSP products (Figure 1).

Figure 1: Miniaturization of SAW filters and duplexers

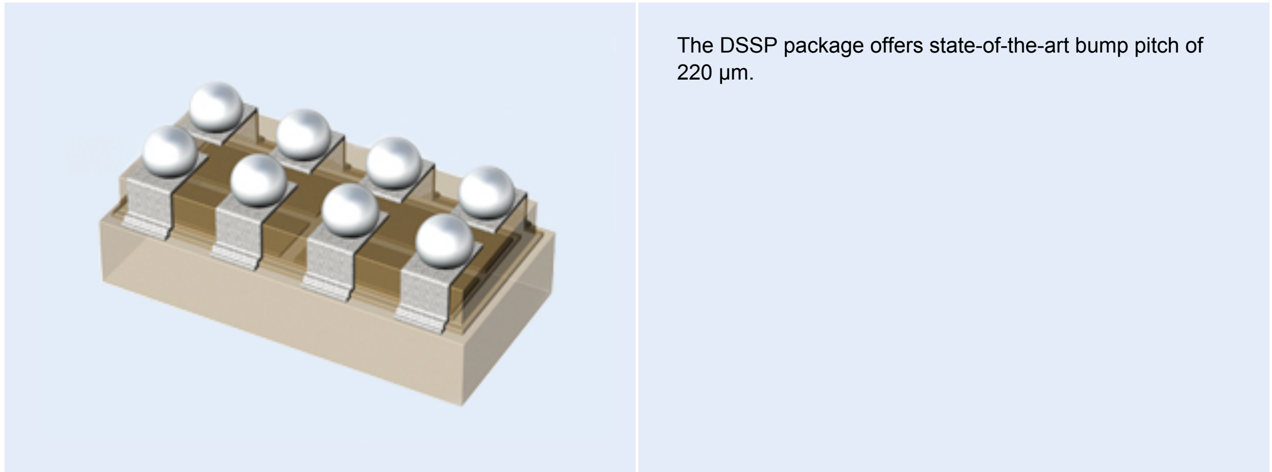


With DSSP a package size reduction of up to 80 percent is achieved for EPCOS duplexers compared to first generation of CSSP (top); for single filters the package size has been reduced by up to 85 percent.

Wafer-level packaging

DSSP offers the highest degree of miniaturization currently available in the market. Filters and duplexers in DSSP technology are designed primarily for use in RF modules, as these require the maximum in miniaturization both in terms of surface area and insertion height. With an insertion height of just 0.25 mm DSSP components are significantly flatter than products manufactured in other currently available packaging technologies.

Figure 2: EPCOS SAW filter in DSSP

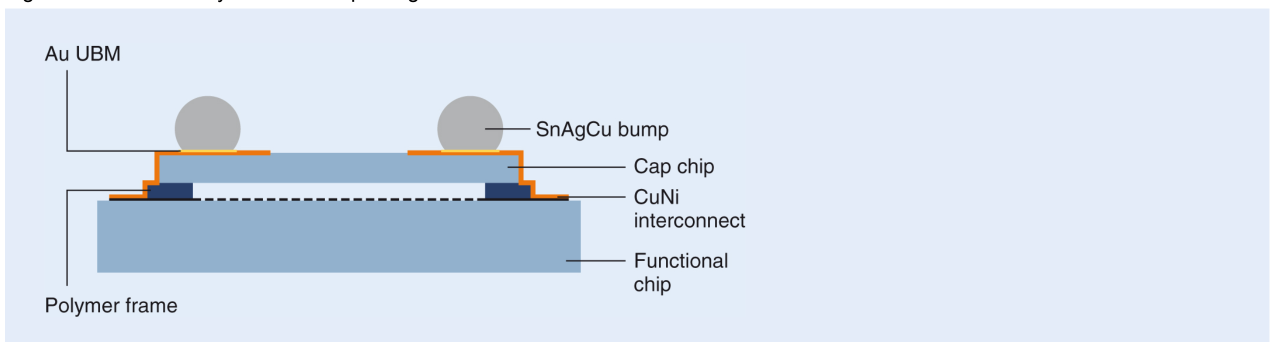


The DSSP package offers state-of-the-art bump pitch of 220 µm.

With a fine pitch of only 220 µm the DSSP technology takes full advantage of the state of the art in module manufacturing (Figure 2). The latest equipment is typically able to assemble components with pitches this small. During the module production process, DSSP products can withstand molding at pressures of up to 80 bar and are tested according to IPC/JEDEC J-STD-020B MSL2a.

With DSSP technology components sizes are achieved that are identical with the chip size. DSSP components consist of a filter wafer and a cap wafer made of the same material (lithium tantalate or niobate). Both wafers are bonded at wafer level. CuNi traces, defined by 3D-photolithography, have to be routed across the vertical side wall of the package for their electrical interconnection (Figure 3). Following a wafer bumping process, the wafer is diced into individual DSSP components. As a final step after automated testing, the filters are packaged into the tape and reel.

Figure 3: Schematic layout of DSSP package



The mass production of first DSSP products has already begun and the product portfolio of RF duplexers and filters for WCDMA, GSM, and navigation systems is being extended.

DSSP duplexers

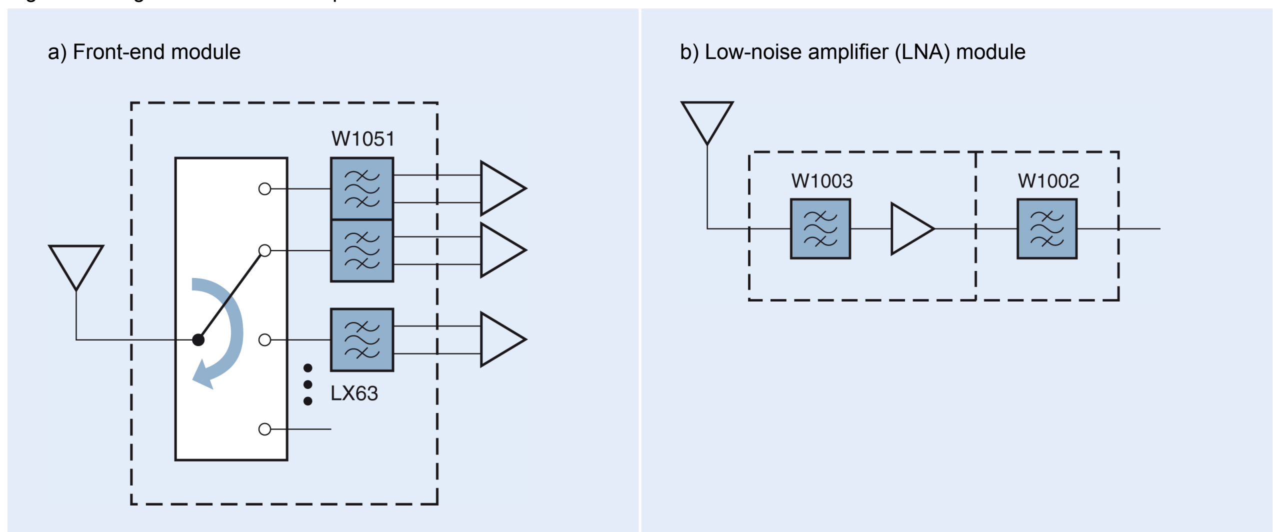
DSSP duplexers will be mainly used for integration in FEMiDs (front-end modules with integrated duplexers), duplexer banks, and PAiD (power amplifier modules with integrated duplexers). DSSP duplexers offer not only best-in-class performance, but also a smaller footprint and significant savings in insertion height. The typical surface area of the first DSSP duplexers will be 1.8 × 1.4 mm² with an insertion height of 0.25 mm. Customer samples are already available for duplexers for W-CDMA bands V (LY50) and VIII (LY93).

DSSP filters

The DSSP filter portfolio may be divided into two categories. Cellular RF filters for GSM systems, for example, and filters for navigation systems. GSM filters are offered either as single filters or as 2in1 filters. The latter are designed as one chip with two filter functions, for example, GSM 1800 and GSM 1900. The application for GSM filters in DSSP technology is very similar to that of duplexers, and they can be used to miniaturize any RF front-end module. The front-end module shown in Figure 4a integrates both a GSM 2in1 filter (W1051) and a single filter (LX63).

Currently, several EPCOS GSM filters in DSSP technology are available, for example, standard GSM 2in1 filters for 1800/1900 MHz (W1050) and 800/900 MHz (W1051).

Figure 4: Integration of DSSP components in modules



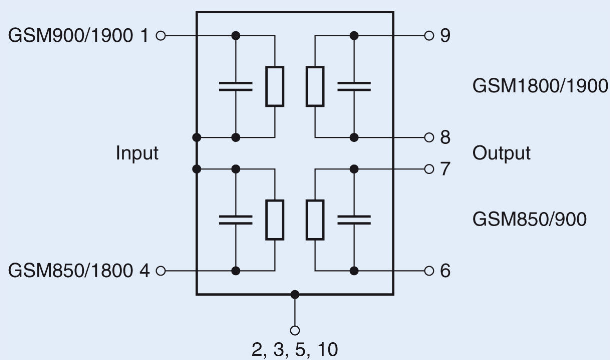
The main application for navigation filters is in LNA (low-noise amplifier) modules for mobile phones or personal navigation devices. LNA modules generally integrate one or two SAW filters with the LNA (Figure 4b). The filters W1002 and W1003 are classified as post- and pre-LNA filters, respectively. The pre-LNA GPS filter (W1003), with a footprint of 0.8 × 0.6 mm², offers a very low insertion loss of 0.5 dB (typical). The post-LNA GPS filter (W1002), with a surface area of 0.95 × 0.6 mm², offers out-of-band isolation higher than 40 dB. TDK-EPC also offers a pre-LNA low loss filter (W1004) for both GPS and the Russian navigation system Glonass with a miniature footprint of only 0.6 × 0.55 mm². Of course, DSSP filters can also be integrated into more complex systems that also include chipsets such as SiPs (systems in package).

Further miniaturization with CSSP too

DSSP technology enables a further advance in miniaturization. Nevertheless, mobile phone manufacturers often opt to employ discrete duplexers and filters instead of modules. Further innovations in the EPCOS CSSP3 packaging technology are reducing the size of these components as well. The new standard package sizes for the different product categories are:

- Duplexers: 2.0 x 1.6 mm²
- 2in1 filters: 1.5 x 1.1 mm²
- 4in1 filters: 1.8 x 1.4 mm²
- Single filters: 1.1 x 0.9 mm²

Today EPCOS duplexers are offered in 2.0 × 1.6 mm² for WCDMA bands I, II, IV, V, VI, VIII and IX. Discrete 2in1 filters are available in 1.5 × 1.1 mm² for all GSM bands (G850, G900, G1800 and G1900).
The latest product development in CSSP3 packaging technology is an input and output diplexed 4in1 GSM filter, which integrates 4 GSM filters into a single chip.



The new concept allows not only for miniaturization, but also for cost savings on a system level:

- The number of throws of the T/R switch can be reduced from 4 to 2 due to the input diplexing, thus enabling the use of a less costly switch.
- Chipsets will require only 2 LNAs, thus reducing the pin count and consequently the area of the semiconductor. The chipset will also be less costly.
- The use of the 4in1 duplexer enables a standardization in the PCB routing for GSM and consequently to less design effort due to a simplified PCB layout.