2P3-2
Proceedings of Symposium on Ultrasonic Electronics, Vol. 33 (2012) pp. 197-198
13-15 November, 2012

Structural Study on High power application for small SAW Duplexer

小型 SAW　Duplexer に適用する高耐電力構造の検討

Osamu Kawachi, Takayuki Suzuki, Toshio Nishizawa, Tooru Takezaki (TAIYO YUDEN Mobile Technology Co., Ltd.)
川内　治，鈴木　孝幸，西澤　年雄，竹崎　徹　(太陽誘電モバイルテクノロジー株式会社)

1. Introduction

The cellular RF Front End market has recently seen an increase in carrier spectrum due to the addition of several systems (i.e. NCDMA, GSM, WCDMA, LTE and LTE-Advanced). Spectrum requirements and regulations are moving toward multi-band and multi-mode systems for mobile phones.

'RF Front End' has become the common term for the radio frequency components located between the RFIC and Antenna. In terms of function, the miniaturization of the Duplexer is required. For example, a 0.45mm min. height device is mandatory for building a module with a 1.0mm max. height. Of course, high reliability (e.g., high power handling, MSL1) and stable electrical performance in the operating temperature condition must be maintained.

In this paper, we will report on the realization of a 2.0x1.6x0.45mm^3 (2016) sized Band V duplexer by using a CSSD (Chip Size SAW Devices) technology of our original structure to meet the recent demands from the cellular RF market.

2. Issue of down sizing

With SAW Duplexer designs, high power handling can be achieved by using certain techniques (shown in the Table-1.) to control heat radiation.

1) Divided resonator is used to reduce the concentration of power per area.
2) Additional bumps and better thermal conductivity substrate improves heat radiation.
3) Metal searing provides MSL1 hermetic level.

However, divided resonator structures *increase* die area, making further miniaturization far more difficult. And smaller filter die area reduces the available area for heat-conducting bumps. As the physical demands of ever-shrinking duplexer package sizes continue, so do the challenges of improving heat radiation.

In the next section, we will discuss a key feature of CSSD in addressing this issue.

Table-1 Technology for Duplexer

Item	Solutions	Advantage
1)	Divided resonator	Power dispersion
2)	Additional Bump	Heat radiation
3)	Metal searing	Hermetic seal

3. Structure of CSSD

In order to solve the issues mentioned above, we utilized our proprietary CSSD packaging technology. Fig.1 shows a CSSD structured Duplexer.

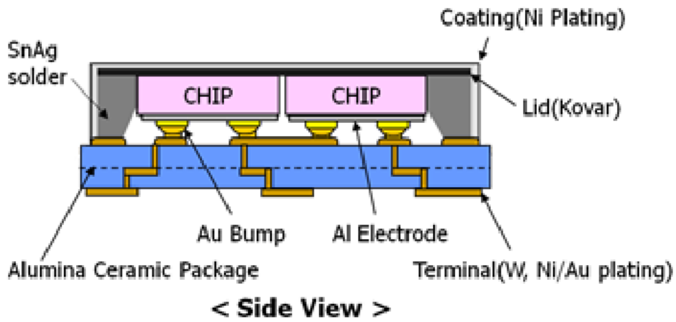

Fig.1 Cross section of CSSD Duplexer

The CSSD structure uses a simple ceramic substrate without a cavity. Because the chips are molded with a Sn-Ag solder, the gap between chips and seal ring around the substrate can be smaller. In addition, the seal ring width can be narrower because the outside of the lid and solder is coated by Ni plating while still achieving hermetic performance.

Another feature is that the back and side of the chips are touching the metal lid and the Sn-Ag solder. There is no space between chip and lid, which helps realize a lower profile. Therefore, the improvement of heat radiation can be expected

osamu.kawachi@jmty.yuden.co.jp

because the CSSD structure has an additional heat radiation route (chip to lid and solder) which the CSP structure does not have. This improvement avoids the need for divided resonators and allows for a reduction in the number of Au bumps, permitting further miniaturization of the dies and overall device size.

In the next section, we analyze the heat dissipation effect of the CSSD structure.

4. Analysis of heat radiation

There are essentially three paths of heat radiation in the CSSD package.

Path 1: The path from the die to the lid, then radiating into the air.

Path 2: The path from the die to the package thru the bumps, then radiating to the board.

Path 3: The path from the back and side of the die to the package through the seal ring, then radiating to the board.

Fig. 2 is the thermal analysis data by ANSYS.

Left one is CSSD model with 3 paths.

Middle one is the model that ignores the Path 1.

Right one is the model ignores the Path 3.

From these results, it can be seen that the effect of CSSD is dominant for heat radiation.

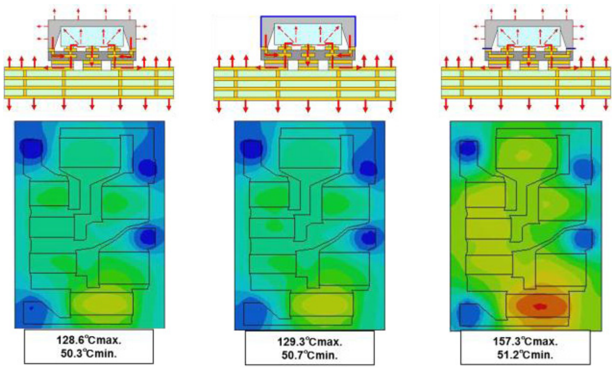

Fig.2 Thermal analysis by ANSYS

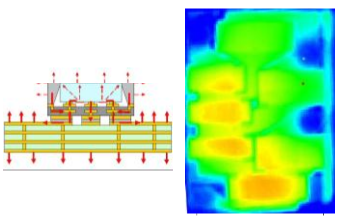

Fig.3 Thermo Scan measurement

In addition, we have taken thermal measurements in order to verify the accuracy of the simulation. Fig.3 shows measured thermal scan data. The localized heat radiation observed within the CSSD structure correlates well with the simulation results.

5. Result of small duplexer performance

Fig.4 shows the power durability comparison of several Band V Duplexers. The 2520 CSP type has a much shorter life time compared with 3025 CSP type because some divided resonators were eliminated due to die size limitations. However, on the 2520 CSSD type Duplexer, we have improved the power durability by changing the packaging structure from CSP to CSSD. Furthermore, by optimization of die design and bump layout, we have realized an 1814 CSSD Duplexer with similar power durability as the 2520 CSSD Duplexer.

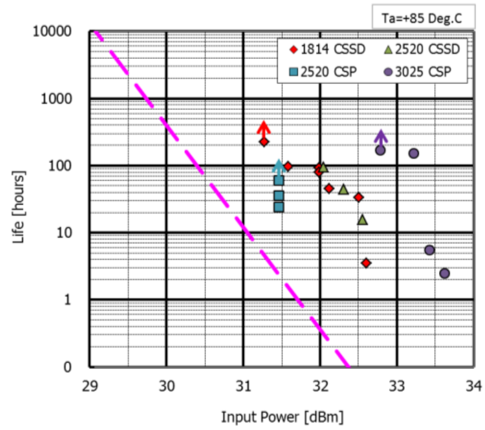

Fig.4 Power durability of Band V Duplexers

6. Conclusion

We have proposed a solution to heat radiation challenges faced when miniaturizing duplexers. We have analyzed the heat dissipation of our CSSD package technology and confirmed the heat radiation effects. As a result, Band V Duplexers using our CSSD structure were able to be realized with high power durability by excellent heat radiation.

References

1. T. Nishizawa, G. Endo, M. Tajima. S. Ono. and O. Kawachi: Proc. IEEE Ultrasonics Symp. 2009, p.903.
2. O. Kawachi, K. Sakinada, Y. Kaneda, and S. Ono: Proc. IEEE Ultrasonics Symp. 2006, p.2289.
3. M. Miura, S. Inoue, J. Tsutsumi, T. Matsuda, M. Ueda, Y. Satoh, O. Ikata and Y. Ebata: IEEJ Trans. EIS. Vol.127 No.8 2007, p.1161.

osamu.kawachi@jmty.yuden.co.jp