Murata’s New ESR Capacitors Tackle Anti-Resonance

Ideally, the electrical characteristics of a capacitor are quoted only by equivalent series capacitance (ESF), which indicates capacitance. In reality, however, dielectric (material) loss and internal electrode loss produce a coil component called equivalent series inductance (ESL), and a resistive component called ESR. For this reason, the impedance characteristics express a dipping curve (Fig. 1). Although monolithic ceramic capacitors have the advantage of a low ESR value (high Q value), this low ESR in some cases causes anti-resonance with capacitors of different capacitances or with the capacitance component of an LSI package. The advantage of the LLR Series is its bathtub-curve impedance characteristics, which is achieved by increasing the ESL value of the capacitor (by reducing the Q value) to prevent anti-resonance. An ideal way to control the load fluctuations of an LSI is to reduce the ESL value of the capacitor and improve the charge and discharge characteristics. However, the conventional ESR control method, which changes the internal electrode patterns of a monolithic ceramic capacitor, has a downside because it causes the ESL value to increase at the same time. Murata has adopted its own design to successfully control the ESL value while the ESR value remains the same.

In this way, Murata’s new LLR Series achieves the capacitor performance for operating in the broadband region. Using LLR Capacitors

Anti-resonance can be generated when the ESL value of a capacitor is too low. In the case of a standard circuit configuration, various capacitors are placed between a high-performance LSI and a DC-DC converter that supplies power to this LSI (Fig. 2). The on-package capacitors, or capacitors mounted on an LSI package board, (shown as C01 in Fig. 2) are used as decoupling devices for high-frequency range support, whereas the high-capacitance ceramic capacitors and aluminum electrolytic capacitors mounted on the LSI package are used as decoupling devices for mid- and low-frequency range support.

In a circuit configuration, such as the one in this figure, the area between the LSI package and the on-package capacitors (C01) is susceptible to anti-resonance. Anti-resonance is generated there because of LC resonance caused by an extremely small capacitance component of an LSI package and an ESL component of a capacitor (C01) mounted on the package.

Three methods are available to control this anti-resonance. One is to increase the capacitance contained in an LSI package. Another method is to reduce the ESL value of the capacitor. The values for the first and second methods are determined by the components selected during the equipment design phase. Therefore, the third method, which increases the ESL value, is the easiest way to control anti-resonance. The LLR Series has been developed to achieve this purpose.

Fig. 3 shows simulation data of the circuit impedance profile when all capacitors (C01) mounted on the LSI package are replaced with the LLR Series capacitors. This graph shows that the higher the resistance value, the lower the anti-resonance peak. In this simulation, the peak value of the LLR Series is reduced by a factor of one-fiftieth. Therefore, noise reduction in a target frequency range can be expected.

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Established in 1997, MediaTek Inc., a leading Taiwanese fabless semiconducto
r company, has been promoting the leading-edge system-on-a-chip (SoC)
solutions relating to digital consumer electronics, including high-definition (HD) TVs, optical
storages and DVD and Blu-ray-Disc (BD) products, along with wireless communication
device. The company has been stepping up as well its presence in the global market.

The company posted sales of US$3.5 billion in 2009. “MediaTek not only provides silicon
chips to our customers but we also provide market-proven software and reference system de-
velopments, aiming to become a complementary partner to them,” says Ryan Chen, General
Manager, Digital TV BU at MediaTek.

Taking TV products as an example, MediaTek proposes to its customers either
MediaTek chipset and a driver-based platform solution, or a more complete solution with middle-
dware and applications included, in accordance with TV manufacturers’ product strate-
gies. This is the “WW Common Platform (worldwide common platform) solution,” which
reduces customers’ TV development resources and shortens the time to market.

In order to propose flexible business models in accordance with customers’ situations,
MediaTek constantly invests energy in grasping the trends of the worldwide TV market and the
changes in the environment surrounding TVs, as well as in the research and development of tech-
nological trends that respond to those changes. Chen says, “Consumer electronics have en-
tered the digital convergence and Internet-enable era. The system complexity is getting
more and more sophisticated, especially for TVs and BD products. For this season, TV manufac-
turers are required to attain wide coverage of leading-edge system-on-a-chip (SoC) technologies and make tremendous re-
source investments.”

“MediaTek can optimize the system performance and cost by the product design, says Ryan Chen, General
Manager, Digital TV BU at MediaTek Inc.

Emergence of ESR Control

In the past, the only requirements for monolithic ceramic capacitors have been large-capacitance and low-ESR characteristics for maintaining the power supply line and I/O line at low impedance. As more functions are added to electronic equipment, the new idea of ESR control has emerged. Murata believes that the value of monolithic ceramic capacitors as an easy-to-use passive component can be further improved through flexible respons-
es to such new needs. Murata intends to further develop the LLR Series and extend the lineup featuring this product.

About this Article
The author is Masayuki Tsuruzono, Product
Development Section 3, Product Development
Department 2, Fuku Murata Manufacturing Co., Ltd.