Murata Addresses Squealing in Mobile, A/V Devices

Latest electronic devices tend to generate less noise. In consequence, the squealing caused by capacitor vibration, which was not easily audible before, has emerged as an issue in designing power supply circuits for various applications, such as notebook computers, cellular phones, digital cameras, and flat TVs. This article introduces small-sized capacitors with metal terminals developed by Murata Manufacturing Co., Ltd. for mobile devices and audio-video (A/V) equipment as a solution for the squealing problem (Photo 1).

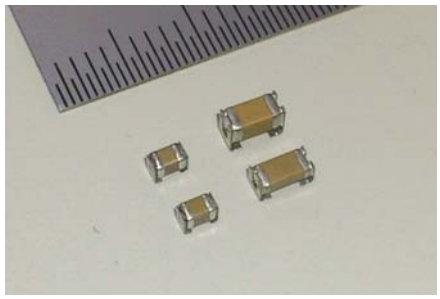

Photo 1: Small-sized monolithic ceramic capacitors with metal terminals

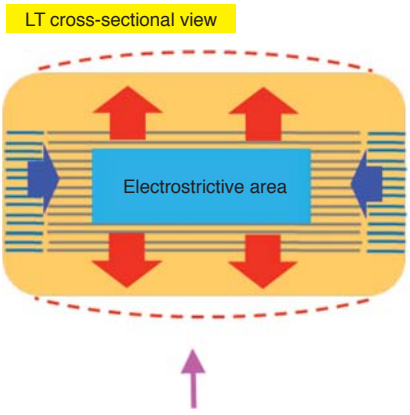

Fig. 1: Chip deformation caused by electrostrictive effect when voltage is applied

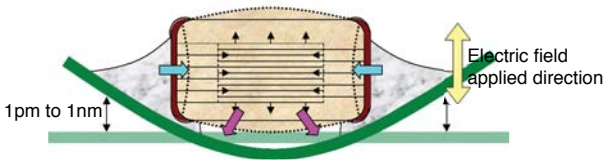

Fig. 2: Circuit board deformation caused by electrostrictive effect

Squealing Mechanism of Monolithic Ceramic Capacitor

When an alternative voltage is applied, the electrostrictive effect of ferroelectric ceramics causes the monolithic ceramic capacitor chip to stretch and contract in its layer-stacking direction. As shown in Fig. 1, the chip stretches and contracts in the direction perpendicular to the layer-stacking direction (in other words, the direction parallel to the circuit board) in accordance with the standard value of Poisson's ratio of dielectrics (0.3). As a result, the circuit board vibrates along the surface, which can be heard as noise. As there is a difference in the acoustic impedance between the air and a discrete capacitor, the sound of the discrete capacitor by itself almost cannot be heard as noise. When the capacitor, however, is mounted on a circuit board, the circuit board functions as an impedance transformer, and the sound is converted to a "zheee" noise when the amplitude cycle reaches the human's audible frequency band (20Hz to 20kHz). The amplitude of the chip and circuit board is just 1pm to 1nm, but it would be audible even to the human ear as noise (Fig. 2).

As a measure against the squealing of capacitors due to vibration of a circuit board, capacitors that suppress squealing are already available in the market. These capacitors use lower permittivity materials in order to reduce the capacitor strain amount. There is another method for suppressing squealing. In this method, the capacitor is mounted with a terminal plate or similar device to float the chip instead of directly contacting with a circuit board so that the transmission of vibration to the circuit board is suppressed. To suppress squealing, Murata has developed capacitors that have metal terminals on the external electrode part. These newly developed Murata capacitors are outlined below.

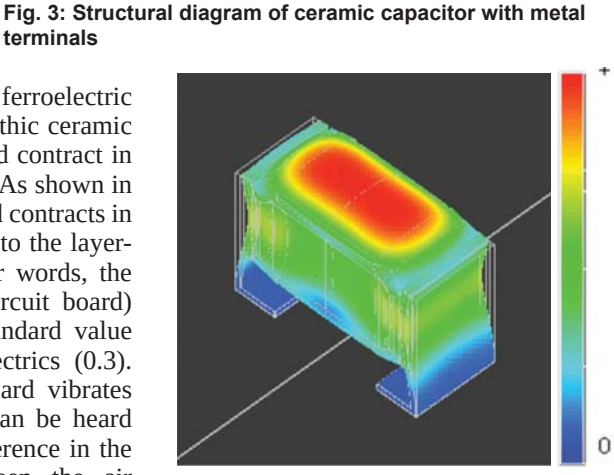

Fig. 3: Structural diagram of ceramic capacitor with metal terminals

Fig. 4: Simulation of displacement amount when bias voltage is applied

Suppressing Squealing with Metal Terminals

Fig. 3 shows the structural diagram of a typical monolithic ceramic capacitor with metal terminals. This capacitor has a structure with metal terminals attached on the chip's external electrodes using adhesive material (lead-free high-temperature solder) and the chip is attached to the circuit board via these metal terminals. The elastic reaction of these metal terminals suppresses

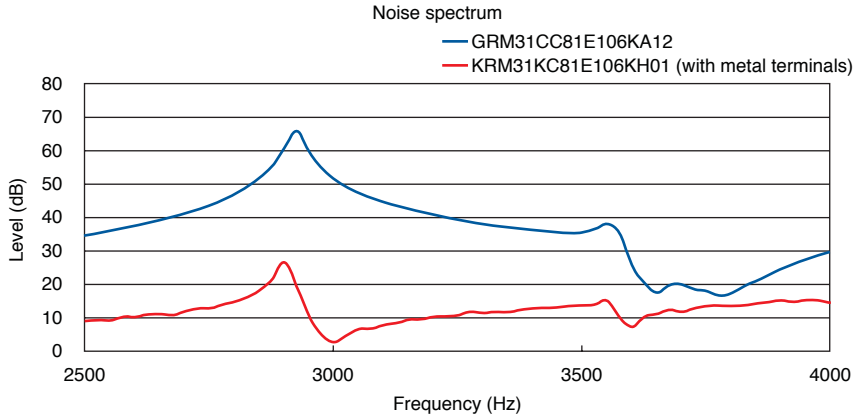

Fig. 5: Result of comparison between the measured squealing levels of a capacitor with metal terminals (KRM31KC81E106KH01) and a monolithic capacitor (GRM31CC81E106KA12)

Table 1: Murata's ceramic capacitors with metal terminals

Series	Length x Width (mm)	Maximum height (mm)	Temperature characteristics	Rated voltage	Capacitance (3 digits)					
					105	225	475	106	226	476
KRM	2.2 × 1.25	1.9	X5R	DC25V						
	3.5 × 1.7	2.0	X5R	DC25V						
		2.9	X6S	DC25V						
				DC35V						
			X7R	DC50V						
				DC100V						

In mass production

Due for mass production in Q4 (October to December) 2012

transmission of vibration to the circuit board (Fig. 4).

Fig. 5 shows a typical example of squealing comparison data. Murata has a measurement system that performs stable evaluation of the sound pressure level of squealing in a circuit board mounted with the capacitor. The squealing of the capacitor can be measured quantitatively using this system.

The level of squealing of a discrete capacitor chip to which metal terminals are attached can be significantly reduced. The level of squealing can be reduced further by using a ceramic capacitor that uses low-permittivity materials.

Product Lineup, Prospects

The product lineup of ceramic capacitors with metal terminals for suppressing squealing is seen in Table 1.

Besides the squealing issue, ceramic capacitors with metal terminals could also be a solution for the issue involving the mounting of a capacitor on a circuit board. For example, there are cases of short-circuit trouble in monolithic ceramic capacitors because of cracks produced on the ceramics due to deflection stress from the circuit board. When metal terminals are attached to the chip to float the chip with no direct contact with the circuit board, the bending resistance of the circuit board will improve dramatically and higher reliability is assured. Murata will continue positively with efforts toward achieving miniaturization and larger capacitance to enhance its product lineup. The company also intends to offer wide-ranging solutions taking full advantage of these new capacitors with metal terminals.

About This Article:

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