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Reduce acoustic noise from capacitors

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Some surface-mount capacitors exhibit acoustic noise when operated at frequencies in the audio range. A recent design uses 10-µF, 35V X5R 1206 ceramic capacitors that produce noticeable acoustic noise. To quiet such a board, you can use acoustically quiet capacitors from manufacturers such as Murata (www.murata.com) and Kemet (www.kemet.com). Unfortunately, they tend to cost more than standard parts. Another option is to use capacitors with a higher voltage rating, which could reduce the noise. Those parts may also be more expensive than standard capacitors. A third path is to make a physical change to the PCB (printed-circuit board).

A ceramic capacitor expands when you apply a voltage and contracts when you reduce the voltage. The PCB flexes as the capacitor changes size because the ends of the capacitor mechanically couple to the PCB through solder (**Reference 1**).

Figure 1a shows a capacitor with no applied voltage, and **Figure 1b** shows an exaggerated condition of PCB flexing when you apply voltage to a capacitor. Applying the voltage makes the PCB operate as a speaker. Keeping that fact in mind, consider two methods for improving the situation. The first technique is relatively simple: If your circuit uses one capacitor, replace it with two in parallel, each with half the capacitance of the noisy capacitor. This approach lets you place a capacitor on top of the board and the other on the bottom of the board; the capacitors lie directly above each other, and their orientations are the same. As the upper capacitor tries to flex the board down, the lower capacitor tries to flex the board up. These two stresses tend to cancel each other, and the PCB generates little sound.

Adding a second capacitor increases cost but not as much as replacing the noisy capacitor with one that might not create noise. A ceramic capacitor from Digi-Key (www.digikey.com) sells for approximately 27 cents (1000). A quieter KPS-series part from Kemet costs approximately $1.50. The second method involves making a slot in the PCB near each end of the capacitor (**Figure 2**). When the capacitor expands and contracts, it flexes only a small portion of the PCB, which should reduce the noise.

A test with five 10-µF, 25V ceramic capacitors connected in parallel showed that putting three capacitors on top of the PCB and two on the bottom reduces the noise by 14 dBA (acoustic decibels). Routing a slot on both sides of the five capacitors reduces the noise by 15 dBA. Both are substantial noise reductions. A Murata JG8-series capacitor reduces the noise by 9.5 dBA. Combining these techniques should further reduce the noise. EDN

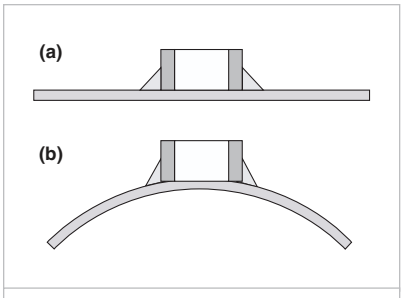

Figure 1 A ceramic capacitor expands when you apply a voltage (a) and contracts when you reduce the voltage (b).

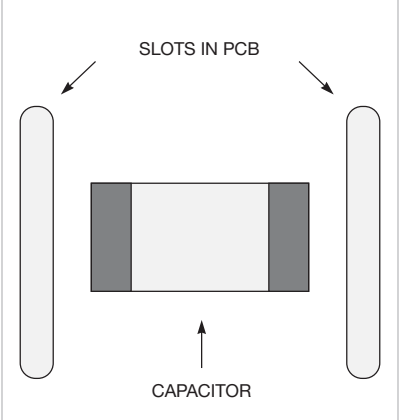

Figure 2 Adding a second capacitor increases cost but not as much as replacing the noisy capacitor with one that might not create noise.

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