Reduce acoustic noise of IS31FL3236 EVB

Abstract: Since IS31FL3236 outputs' PWM frequency is about 3.65kHz, when the driver consume big AC current form the power supply and the monolithic capacitor chip (MLCC), the monolithic capacitor chip (MLCC) will cause acoustic noise. To avoid this acoustic noise problem, we have some advices in this application note.

Key Words: FxLED, Acoustic noise, MLCC (monolithic capacitor chip)

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Where is Acoustic Noise from?

Recent design of our IS31FL3236 EVB, when we use 0.1uF (surface-mount, 0603 MLCC) +10uF (surface-mount, 0805 MLCC) or 0.1uF (surface-mount, 0603 MLCC) +1uF (surface-mount, 0603 MLCC) as the bypass capacitor of the VCC pin and when all outputs' PWM value is 0x80 (half, about 50% duty cycle), we can hear acoustic noise when we our ears close to the capacitors. If we remove the 1uF or 10uF, then the noise disappears.

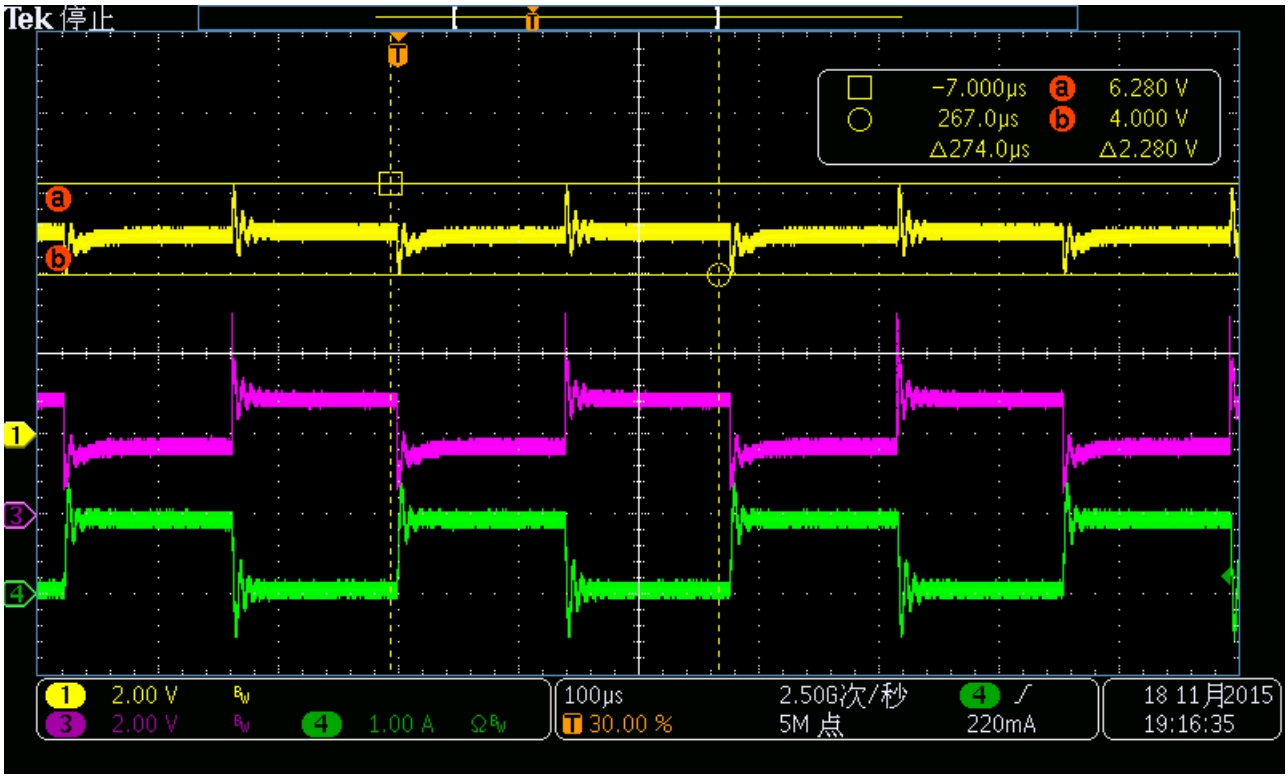

Fig. 1: 0.1uF+1uF

CH1: VCC Voltage (2V/Div), CH3:OUT1 Voltage (2V/Div), CH4: Power current (1A/Div)

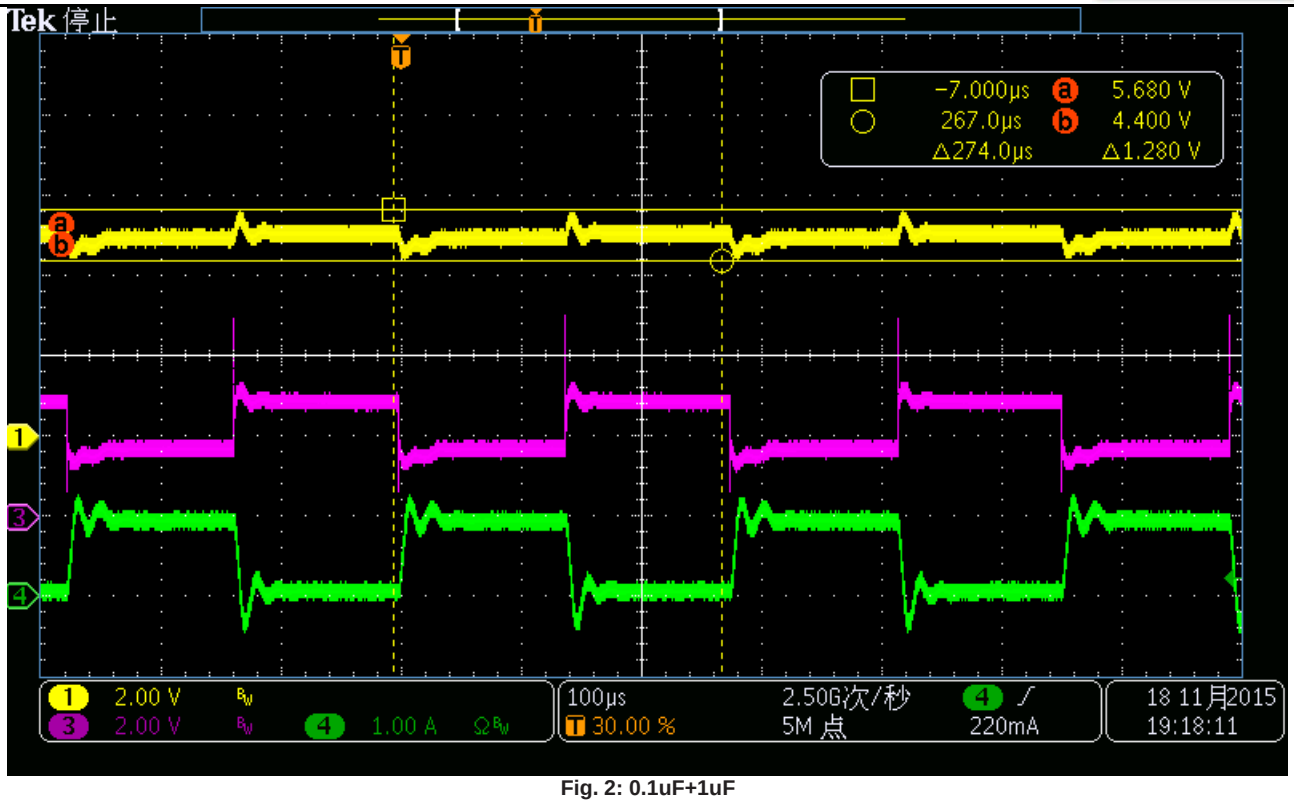

Fig. 2: 0.1uF+1uF

CH1: VCC Voltage (2V/Div), CH3:OUT1 Voltage (2V/Div), CH4: Power current (1A/Div)

Cap close to VCC pin	Cap close to Power 0603 SMD unless otherwise specified	Ripple	Result
0.1uF	NC	5.0V	Flicker, even shutdown
0.1uF	0.1uF	3.88V	No acoustic noise
0.1uF	0.22uF	3.76V	Have litter acoustic noise (ear need to very close to the second cap)
0.1uF	0.33uF	3.64V	Have acoustic noise
0.1uF	0.47uF	2.76V	Have acoustic noise
0.1uF	0.68uF	2.52V	Have acoustic noise
0.1uF	1.0uF	2.28V	Have acoustic noise
0.1uF	10uF	1.28	Have big acoustic noise

Tab. 1: Cap close to Power supply

As shown in Fig.1, Fig.2 and Tab.1, due to the total current of the LED is about 920mA, and the frequency is about 3.65kHz, if the cap is large than 0.1uF, there will have acoustic noise. In some cases, you can't remove the bypass capacitor of the power supply, but how doses the acoustic noise come out from the ceramic capacitor?

When AC ripple voltage is applied to a monolithic ceramic capacitor chip it expands and contracts due to the ferroelectric ceramics (high dielectric constant capacitors with temperature

characteristics of B, R, X5R, X7R, Y5V, and so on). A MLCC alone is in most cases not sufficient to generate a problematic or disruptive Sound Pressure Level (SPL). But soldered on a PCB board the MLCC generates a spring mass system, which increases or dampens the oscillations depending on the frequencies. If the frequency range of AC voltage between 20HZ to 20KHZ, the capacitors will produces noise, the so called a

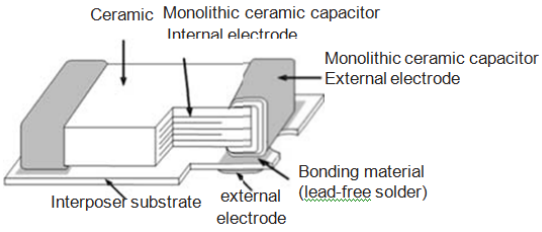

Fig. 1: Structure of Mono Lithic Ceramic Capacitor with interposer substrate

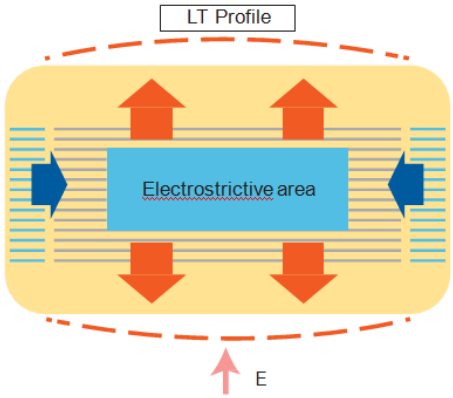

Fig. 2: Deformation of chip caused by electrostrictive phenomenon when volt- age is applied

Reduce acoustic noise on capacitor

1. 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, figure 4a shows a capacitor with no applied voltage, and Figure 4b shows an exaggerated condition of PCB flexing when you apply voltage to a capacitor. Applying the voltage makes the PCB operate as a speaker. If your circuit uses one capacitor, replace it with two in parallel, each with half the capacitance of the noisy capacitor as shown in figure 4c. 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.

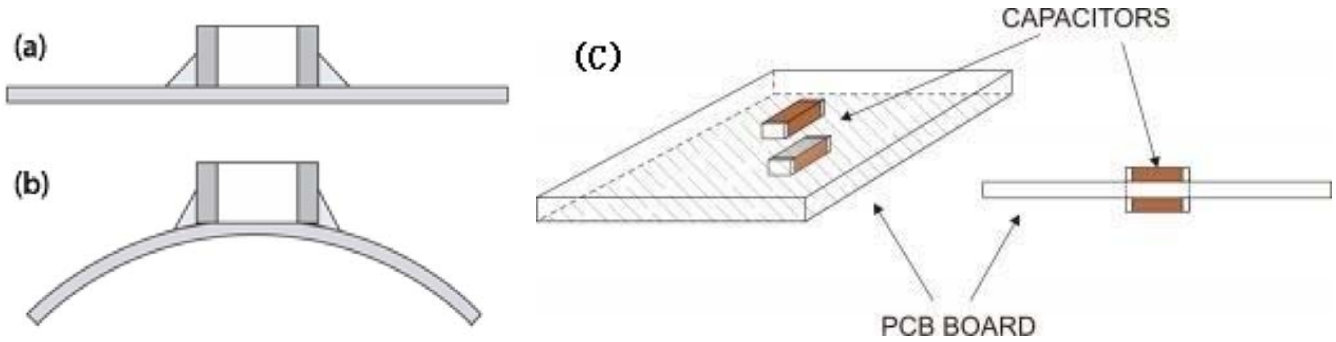

Fig. 4: A ceramic capacitor expand (a), contracts (b) and recommend placement (c)

2. The second method involves making a slot in the PCB near each end of the capacitor (Fig.4). When the capacitor expands and contracts, it flexes only a small portion of the PCB, which should reduce the noise.

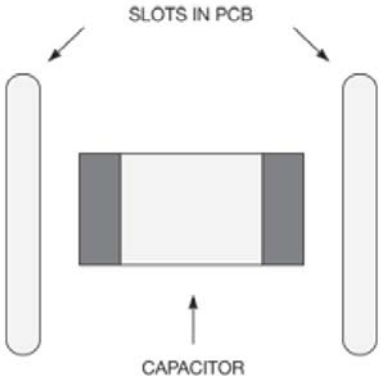

Fig. 4: Making two slots in the PCB

3. Use a larger size capacitor. The same capacitance of a larger size capacitor will generate a lower noise than a smaller one. For the same physical size, a lower capacitance will require fewer layers and will thus create less deformation

4. Use a thicker PCB. The thicker PCB create less deformation and have less acoustic noise.

5. Use glue fix the noise capacitor.

6. Change the capacitor type and capacitance value. Tantalum capacitors, electrolytic capacitors, and Film capacitors will have almost no acoustic noise. Murata also provide ZRA Series capacitor to reduce acoustic noise. Also the test result shows, for ceramic capacitor, larger capacitance value will have acoustic noise more easily, so in some case, a large capacitance value Tantalum capacitor together with a small capacitance value ceramic capacitor will be good choice.

References

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