AIC31xx/DAC31xx Devices and EMI Filtering on Speaker Outputs

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ABSTRACT

The intent of this application note is to identify proper component selection for EMI filtering for the Class-D output stages of the AIC31xx and DAC31xx product families. Throughout this application note, the AIC31xx and DAC31xx families will be referring to the AIC3110, AIC3111, AIC3100, AIC3120, DAC3100 and DAC3120, respectively. The AIC31xx and DAC31xx family of highly integrated, high-performance codecs and DAC's from Texas Instruments include class-D output stages, able to operate in filter-free mode. Normally an L-C filter would be required to eliminate noise and block high frequency content. While the L-C filter may be rendered unnecessary however, many customers still employ EMI filtering at the outputs to pass FCC testing and block very high frequency emissions, typically using ferrite bead inductors and a capacitor. Component selection can become critical for these filters, as the AIC31xx and DAC31xx families employ integrated over-current protection (OCP) circuits, which can be unintentionally tripped due to improper implementation of the EMI filter.

1 Introduction

When designing an EMI filter, both space and cost come into play as well as performance. For this reason ferrite bead inductors are an excellent choice for eliminating high frequencies. Most EMI filters use a ferrite bead inductor in conjunction with a capacitor, such as the filter shown in the recommendations for the TPA2012D2 datasheet (http://focus.ti.com/lit/ds/symlink/tpa2012d2.pdf).

However, it should be noted that the overcurrent protection threshold is much higher for standalone amplifiers such as the TPA2012D2 than for integrated audio codecs and DACs such as the AIC31xx and DAC31xx devices. For this reason, the filter recommended in the TPA2012D2 datasheet is not recommended for AIC31xx and DAC31xx devices.

When designing the EMI filter, one must be wary of impedance drops at high frequencies, based on the L-C network that is created. It should also be noted that some ferrite bead inductors can be prone to more ringing or oscillation. The combination of these factors can cause overcurrent protection trips in the AIC31xx and DAC31xx devices if they are not accounted for. This application note will recommend a specific ferrite bead inductor and specific capacitance value. With proper evaluation and testing, other components can be used to implement an EMI filter if necessary.

2 Over Current Protection (OCP)

The TLV320AIC31xx and DAC31xx devices have short-circuit protection for the speaker drivers and headphone output drivers that are always enabled. This over-current protection is implemented by means of a current shunt monitor that is internal to the device. The minimum overcurrent threshold point of the AIC31xx and DAC31xx devices is an expected value of 0.9A. If the Class-D or Headphone output is short-circuited, the respective output stage shuts down. In the case of a short-circuit on either channel, the output is disabled and a status flag is provided as a read-only bit on page 1, register 32 (decimal), bit D0. This bit is not permanent and can be thought of as an “interrupt.” Two sticky-bits, or bits that are permanently set until system reset, are located on page 1, register 44, bits D7–D6.

If shutdown occurs due to an overcurrent condition, then the device requires a reset to re-enable the output stage. This can be done in two ways. First, the master reset can be used, which requires either toggling the $\overline{\text{RESET}}$ pin or using the software reset. If master reset is used, it resets all of the device settings. Second, a dedicated speaker or headphone power-stage reset can be used that keeps all of the other device settings. The speaker power-stage reset is executed by setting page 1, register 32, bit D7 for the left channel speaker driver and by setting page 1, register 32, bit D6 for the right channel speaker driver, assuming a stereo speaker output. If a mono output is used, only bit D7 needs to be set. If the fault condition has been removed, then the device returns to normal operation. If the overcurrent condition is still present, then another shutdown occurs. Repeated resetting (more than three times) is not recommended, as this could lead to overheating.

3 EMI Filter Component Recommendation

When choosing components for EMI filtering of the class-D output, there are a few additional specifications to be aware of. Regarding the ferrite bead inductor, it must be ensured that the current rating is at least 1.5A to prevent distortion of the class-D output signal. Meanwhile, a high impedance is desired at high frequencies to ensure the application passes FCC and CE testing. A capacitor that is not overwhelmingly large in relation to the impedance of the ferrite bead is also needed to prevent large drops in impedance at high frequencies. Shown below is a recommended EMI Filter for AIC31xx and DAC31xx devices.

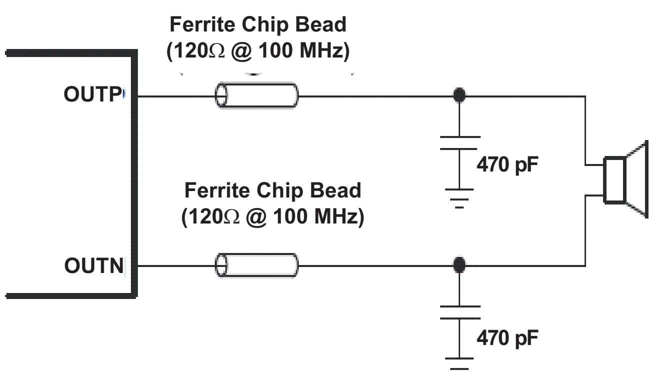

Figure 1. Recommended Class-D EMI Filter for AIC31xx and DAC31xx Devices

The ferrite bead inductor shown in the above circuit is the Murata BLM15EG121SN1D. It has a DC resistance of 120 Ω at 100MHz, and is rated for 1.5A. The capacitor shown in Figure 1 circuit is the TDK C1005X7R1H471K at 470pF.

4 Conclusion

When designing an EMI filter that is optimized for space and cost, a ferrite bead and capacitor are often an excellent choice. This is contingent on proper selection of components however, as improper selection can trigger overcurrent protection in the AIC31xx and DAC31xx devices.

For further questions, consult TI through the E2E forum or your local sales representative.

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