

AIC31xx/DAC31xx Devices and EMI Filtering on Speaker Outputs

Patrick Galvin

Audio Interface Products

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 **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.

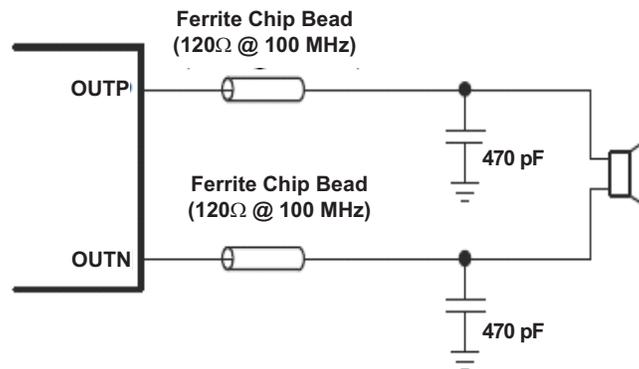


Figure 1. Recommended Class-D EMI Filter for AIC31xx and DAC31xx Devices

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.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video
Wireless	www.ti.com/wireless-apps

TI E2E Community Home Page

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated