

# AIC321x, AIC326x EMI Filtering on Speaker Outputs

---

*Ben Kasemsadeh**Audio Interface Products*

## ABSTRACT

This application report identifies suitable components for EMI filtering on the Class-D output stages of the AIC321x and AIC326x audio codecs. The AIC321x and AIC326x are highly integrated, high-performance audio codecs from Texas Instruments which include class-D output stages that can be operated in filter-free mode.

Since the switching of Class D amplifiers results in EMI emissions, employing EMI filtering at the outputs can be a helpful step in blocking high frequency emissions and in passing FCC and CE testing. This is particularly important when system mechanics dictate long PCB traces or speaker wires of the Class D outputs.

Typically, EMI filters use a ferrite bead inductor and a capacitor. Component selection can become critical for these filters, as the codecs employ integrated overcurrent protection 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.

Care must be taken not to trip the overcurrent protection of the AIC321x and AIC326x, which shuts down the output stage of the amplifier if a short circuit of the output is detected.

This application report recommends 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

The AIC321x and AIC326x has a short-circuit protection feature for the speaker drivers that is always enabled to provide protection. If the output is shorted, the output stage shuts down on the overcurrent condition. (Current limiting is not an available option for the higher-current speaker driver output stage.) In the event of a short circuit on either channel, the output is disabled and a status flag is provided as a read-only bit on B0\_P0\_R44\_D7 for SPKL and on B0\_P0\_R44\_D6 for SPKR. If shutdown occurs due to an overcurrent condition, then the device requires a reset to re-enable the output stage.

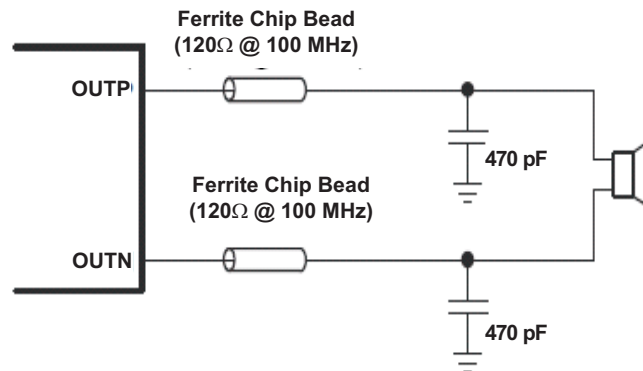
A potential issue is that ferrite beads appear as almost a short circuit at the switching frequency, their impedance typically begins to rise above 1 MHz, with peak impedance near 100 MHz. Because the impedance is low at the Class D amplifier switching frequency, ferrite beads can increase the peak current during output transitions. It should also be noted that some ferrite bead inductors can be prone to more ringing or oscillation. If not accounted for, the combination of these factors can cause overcurrent protection trips.

### 3 EMI Filter Component Recommendation

Ferrite bead filters for Class D amplifiers are derived empirically while measuring the radiated emissions. A ferrite bead should be rated for at least the peak load of the audio signal into the load impedance to prevent distortion of the class-D output signal. For example, if the Class D amplifier operates from 5 V into a 4- $\Omega$  load, a ferrite bead with at least 1.5-A peak current capability should be selected. An impedance rating of 100  $\Omega$  or higher at high frequencies is recommended to ensure a high level of EMI suppression.

A capacitor that is not large in relation to the impedance of the ferrite bead is also needed to prevent large drops in impedance at high frequencies. The value for these capacitors is often determined empirically, but 470 pF is a good starting point.

Figure 1 shows a recommended EMI Filter for AIC321x and AIC326x.



**Figure 1. Recommended Class-D EMI Filter for AIC321x and AIC326x**

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

### 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 AIC321x and AIC326x 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, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)