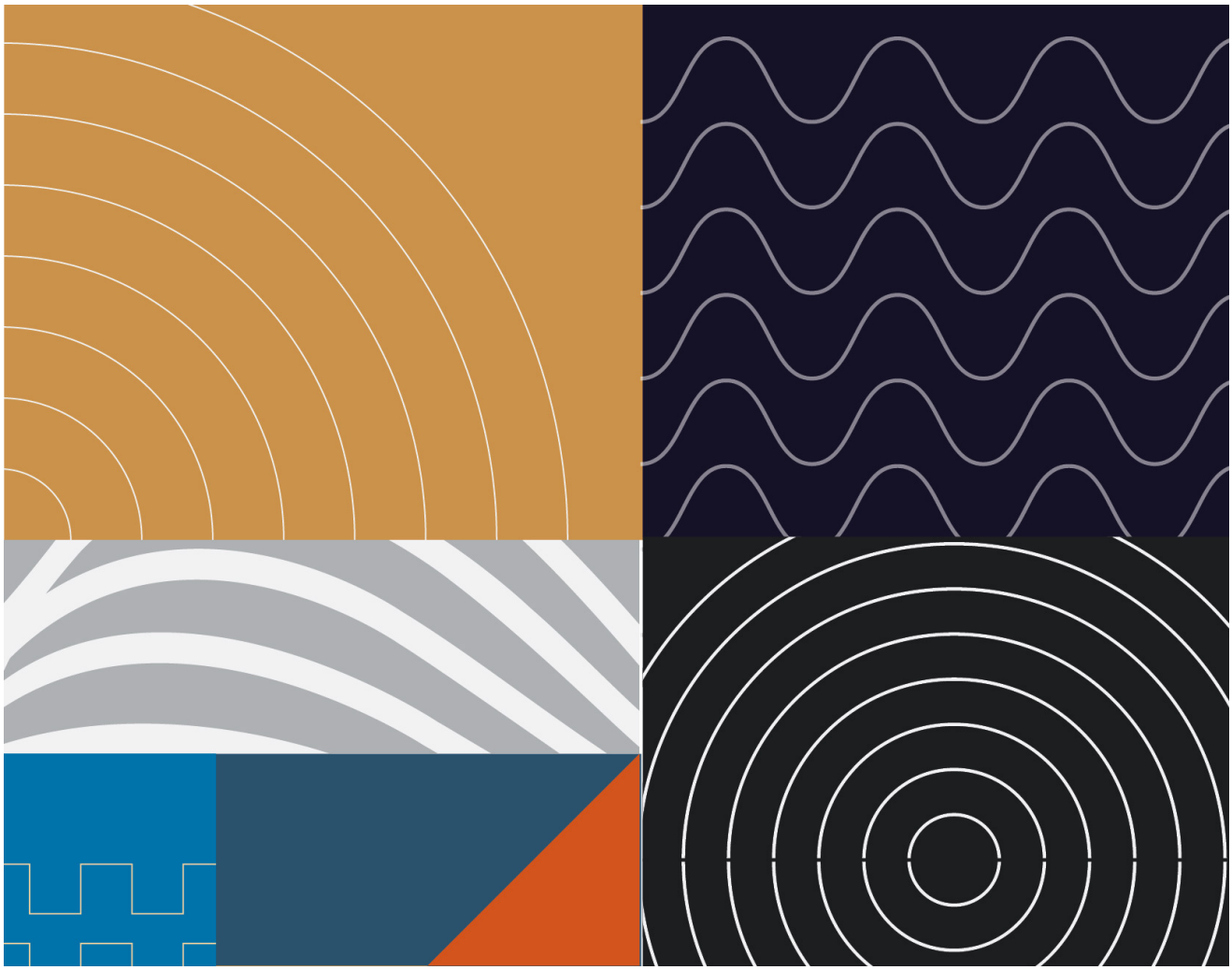
NEW PRODUCT INTRODUCTION
April 2024

Lead Free Buzzers



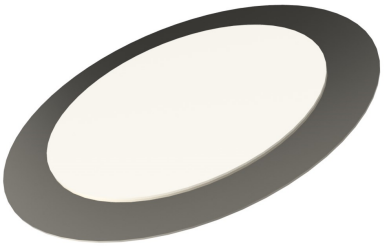
PUIAUDIO.COM

Announcement

We are thrilled to share our latest lead-free innovation at PUI Audio with enhanced piezoelectric properties as we continue to set the standard for cutting-edge audio solutions. Our latest Piezoelectric benders and buzzers utilize Potassium Sodium Niobate, K0.5Na0.5NbO3 (KNN), a material widely recognized by researchers as among the most feasible lead-free alternatives to highly efficient, lead-based Piezoelectric Lead Zirconate Titanate (PZT).

We have various lead-free benders designed with a range of resonant frequencies and mounting configurations, and we are excited to launch a series of new audio buzzers to expand our environmentally sustainable portfolio. Our new lead-free products exhibit a strong piezoelectric effect, even with a slimmer profile. This advancement opens possibilities in the medical, industrial, automotive, and consumer sectors to provide alerts without requiring any regulatory exemptions!

Our new devices adhere to RoHS compliance without any exemptions, which is crucial in medical as well as other sensitive applications.



New Lead Free Buzzers

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Benders, Indicators & Transducer

Key Features:

- Lead Free Material
- Ultra-thin Bender
- Simple Self Driven Indicators
- Externally Driven multiple tones

Part	Dimensions *(mm)* (ø)	Rated Voltage *(V_{p-p})*	Resonant Frequency *(kHz)*	
ABLF2040A (Bender)	20mm	30	4.0KHz	
ABLF2722A (Bender)	27mm	30	2.2KHz	
AILF-2830-TT -HT (Indicator)	28mm	12	3.0KHz	
Coming Soon! AILF-3227-TT-HT (Indicator)	32mm	12	2.7KHz	
AILF-3235-TT-HT (Indicator)	32mm	12	3.5KHz	
AILF-4228-TF-HT-LW140 (Indicator)	42mm	12	2.8KHz	
AILF-4228-TF-HT-2-LW140 (Indicator)	42mm	12	2.8KHz	
Coming Soon! ATLF-3055-TT-HT (Transducer)	30mm	18	2KHz-6KHz	

Material behind lead-free piezoelectric?

For decades, Lead zirconate titanate (PZT) has been the most common ferroelectric ceramic widely used for audio buzzers due to its strong piezoelectric response. PZT is composed of lead and zirconium, combined with titanate. It is formed under extremely high temperatures and is highly regarded for its superior sensitivity and higher operating temperature compared to other piezoelectric ceramics.

Potassium Sodium Niobate (KNN) is the alternate material to replace PZT used in traditional audio devices. The main challenges, up until recently, in creating lead-free piezoelectric materials include understanding the fundamental processes, the temperature sensitivity of the desired piezoelectric response, and developing compositions conducive to easy fabrication. Oxides originating from Potassium Sodium Niobate exhibit favorable characteristics, such as a high Curie temperature and environmental compatibility.

Conventional high-temperature heat treatment processes for KNN-based piezoceramics may inadvertently compromise their piezoelectric response due to the volatility of potassium and sodium ions. Researchers have now uncovered an alternative method called two-step sintering (TSS), aimed at reducing the volatilization of alkali metals. TSS involves initially exposing the ceramic to high temperatures for a short duration, followed by rapid cooling to a lower temperature for a prolonged period.

PUI Audio is proud to state that our lead-free ceramics undergo a robust established manufacturing process to demonstrate excellent piezoelectric response for the end-applications.

RoHS Compliance Vs Lead Free

Many people mistakenly equate RoHS-compliant with "lead-free," but this is not entirely accurate. Frequently, there's confusion or a misunderstanding regarding the distinction between "Compliant" and "Exempt.".

RoHS compliance requires all manufacturers of electrical and electronic equipment to comply with RoHS 2.0 regulations. The RoHS directive aims to reduce the use of hazardous substances, including lead, but it does allow for a small percentage of these substances. There is an increasing focus on lead-free solutions in electronic components and systems due to environmental concerns, particularly within the semiconductor and electronics industries.

Lead was identified as a major concern in global environmental regulations, prompting the need for lead-free devices in electronic components and systems, which remains a focal point for the semiconductor and electronics industry. Electronics components labeled as "PB Free" or "Lead-Free" are indeed compliant with RoHS regulations. However, being RoHS compliant does not necessarily mean completely free of lead.

RoHS Compliance stipulates that lead content must be less than 1000 PPM, with exceptions occasionally allowed. Green products adhere to even stricter standards, with lead content required to be below 90 ppm.

When considering the adoption of lead-free products, it is crucial to understand the RoHS directive. PUI Audio is at the forefront of offering sustainable solutions, aiming to provide audio solutions that adhere to the highest environmental standards.

CONCLUSION

The RoHS directive in the European Union sets out restrictions on hazardous substances like lead, cadmium, and mercury in electrical and electronic equipment. PUI Audio offers RoHS Compliant lead-free audio products such as benders, indicators, and transducers, ensuring adherence to these regulations.

Lead, a toxic substance, poses significant risks to both human health and the environment. Our piezoelectric ceramic solution minimize these risks across the manufacturing, usage, and disposal phases.
By embracing our innovative RoHS compliant lead-free ceramic solution, customers will enjoy the benefits of improved environmental sustainability, compliance with regulations, and enhanced safety, all while maintaining technical excellence. This marks an exciting step forward in PUI Audio's commitment to providing superior audio solutions to meet the evolving needs of our global customers.

As RoHS regulations aim to protect human health and the environment, such exemptions cannot be viewed as permanent. The result is a complex, ongoing requirement for companies to manage and PUI Audio team is committed to help support our customers to implement RoHS compliant lead-free ceramic solution.
We plan to expand our lead-free audio product portfolio, contact us to learn more about our roadmap and customize solutions to meet your application needs.

Additional Products:

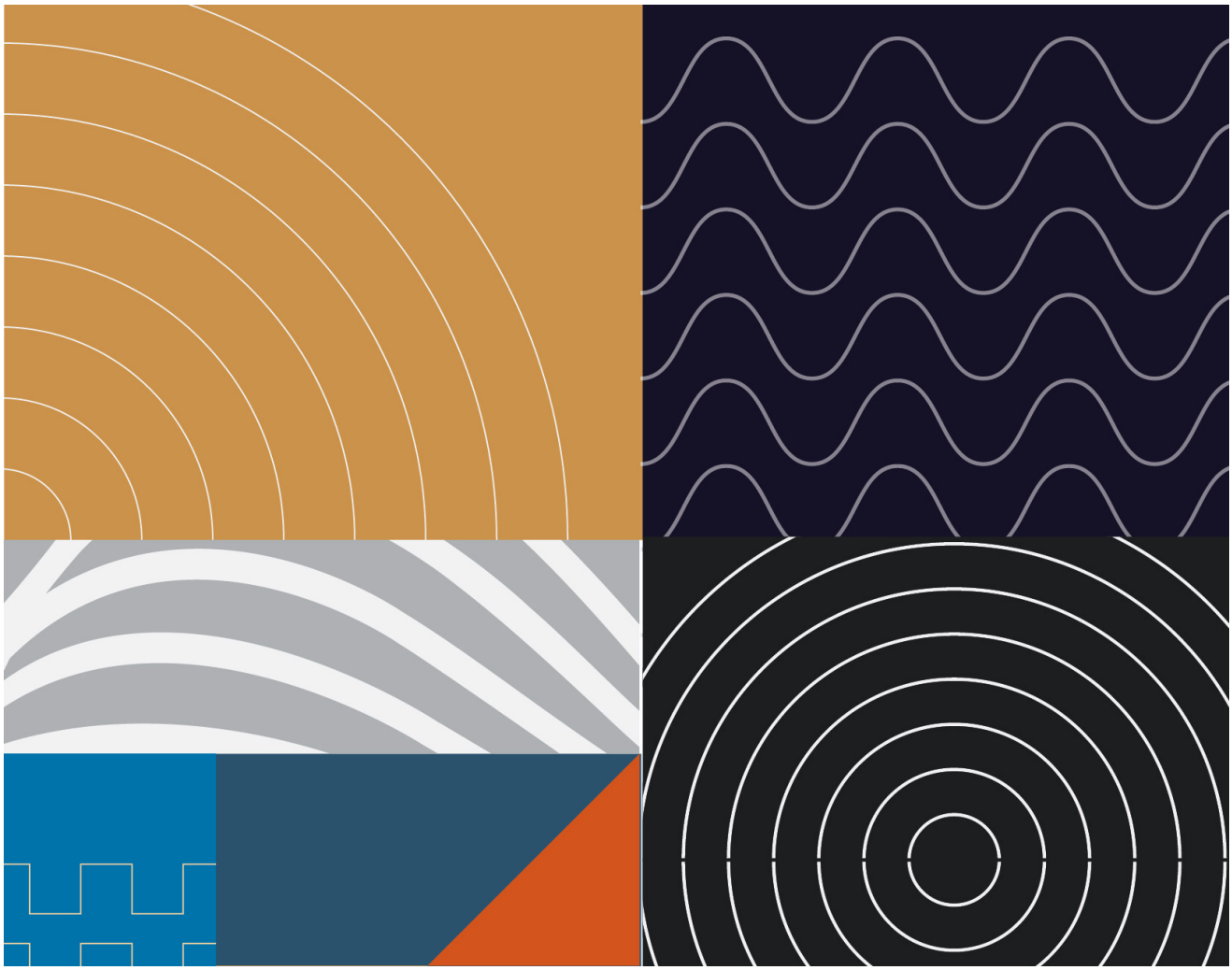
https://puiaudio.com/find/findproducts/

PUIaudio
WHEN IT NEEDS TO BE HEARD

Appendix

Exemption 7c
Exemptions Timeline

Reference: European Commission



What is ROHS?

RoHS stands for the Restriction of Hazardous Substances. The original RoHS, informally referred to as RoHS I, was implemented in the European Union in 2003 under EU Directive 2002/95/EC. It set limit values for lead, cadmium, and several other chemicals in specified types of electrical and electronic equipment, including a lead maximum of 0.1%.

RoHS 1 & 2 Restricted Substances

The following six substances have remained through the original RoHS and the newer RoHS 2.0 rules:

- Lead (pB): 0.1% by weight (<1000 ppm)
- Mercury (Hg): 0.1% by weight (<100ppm)
- Cadmium (Cd): 0.01% by weight (<100ppm)
- Hexavalent Chromium (Cr VI)I: 0.1% by weight (<1000 ppm)
- Polybrominated Biphenyls (PBB): 0.1% by weight (1000 ppm)
- Polybrominated Diphenyl Ethers (PBDCE): 0.1% by weight (<1000 ppm)

RoHS 2.0 launched in 2008, also known as RoHS Directive 2011/65/EU, is an updated version of the original Restriction of Hazardous Substances Directive (RoHS). It was adopted by the European Union in 2011 and became effective on January 3, 2013. RoHS 2.0 expands the scope of the original directive and imposes stricter regulations on the use of hazardous substances in electrical and electronic equipment (EEE).

Directive 2015/863/EU, informally known as RoHS III, came into force on July 22, 2019. Medical devices, monitoring and control tools received an additional two years to comply. Notably, RoHS III added four new restricted substances which are different types of phthalates used in plasticizers. These chemicals are not present in copper alloy semi-fabricated products such as brass rod. A new "catch-all" product category was also added to cover electrical/electronic equipment not specified in other categories.

Maximum concentration Values

Table 1: EU RoHS Maximum Concentration Values (MCV)	
Substance	**RoHS Maximum Concentration Value in a Homogeneous Material % by weight or (ppm)**
Lead (Pb)	0.1% or 1,000 ppm
Mercury (Hg)	0.1% or 1,000 ppm
Cadmium (Cd)	0.01% or 100 ppm
Hexavalent chromium (Cr +6)	0.1% or 1,000 ppm
Polybrominated biphenyl (PBB) flame retardants	0.1% or 1,000 ppm
Polybrominated diphenyl ether (PBDE) flame retardants. Note:Lenovo includes Decabromodiphenyl ether in this category	0.1% or 1,000 ppm
Bis (2-ethylhexyl) phthalate (DEHP)	0.1% or 1,000 ppm
Butyl benzyl phthalate (BBP)	0.1% or 1,000 ppm
Dibutyl phthalate (DBP)	0.1% or 1,000 ppm
Diisobutyl phthalate (DIBP)	0.1% or 1,000 ppm

Amendment

Piezoelectric devices under the latest revision of the directive (RoHS III) as summarized in the amendment to Annex III published in May 2018 and shown in the excerpt below. The expiry date for the current renewal cycle is July 21, 2021, 2023 and 2024 depending on the product category.

In Annex III to Directive 2011/65/EU, point 7(c)-I is replaced by the following:

'7(c)-I	Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound	Applies to categories 1-7 and 10 (except applications covered under point 34) and expires on 21 July 2021. For categories 8 and 9 other than *in vitro* diagnostic medical devices and industrial monitoring and control instruments expires on 21 July 2021. For category 8 *in vitro* diagnostic medical devices expires on 21 July 2023. For category 9 industrial monitoring and control instruments, and for category 11 expires on 21 July 2024.'

Key features of RoHS 2.0 include:

Broadened Scope: RoHS 2.0 extends beyond the original directive by covering all electrical and electronic equipment (EEE), cables, and spare parts, with some exemptions.

CE Marking: Compliance with RoHS 2.0 requirements is indicated by affixing the CE marking, which demonstrates that the product meets all relevant EU directives and regulations.

Increased Responsibility for Manufacturers: Manufacturers are now responsible for ensuring the compliance of their products throughout the supply chain. This includes conducting conformity assessments, maintaining technical documentation, and keeping records for up to 10 years after placing the product on the market.

Exemptions and Review: RoHS 2.0 includes provisions for exemptions from the restrictions on certain hazardous substances, subject to periodic review and renewal by the European Commission.

Exemptions Status

Exemption No.	Description	Current EU Expiration Date	Current Status
5(b)	Lead (Pb) in glass of fluorescent tubes not exceeding 0.2% by weight	-	Extension requested for Categories 1 to 7 and 10
6(a)	Lead (Pb) as an alloying element in steel for machining purposes and in galvanized steel containing up to 0.35% lead by weight	30-June-2019 -	Expired for Categories 1 to 7 and 10 --- Extension requested for Categories 8, 9 and 11
6(a)-I	Lead as an alloying element in steel for machining purposes containing up to 0.35% lead by weight and in batch hot dip galvanised steel components containing up to 0.2% lead by weight	-	Extension requested for Categories 1 to 7 and 10
6(b)	Lead (Pb) as an alloying element in aluminum containing up to 0.4% lead by weight	30-June-2019 -	Expired for Categories 1 to 7 and 10 --- Extension requested for Categories 8, 9 and 11
6(b)-I	Lead as an alloying element in aluminium containing up to 0.4% lead by weight, provided it stems from lead-bearing aluminium scrap recycling	-	Extension requested for Categories 1 to 7 and 10
6(b)-II	Lead as an alloying element in aluminium for machining purposes with a lead content of up to 0.4% lead by weight	-	Extension requested for Categories 1 to 7 and 10
6(c)	Copper alloy containing up to 4% lead (Pb) by weight	-	Extension requested for Categories 1 to 7 and 10
7(a)	Lead (Pb) in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead)	- -	Extension requested for Categories 1 to 7 and 10 --- Extension requested for Categories 8, 9 and 11
7(c)-I	Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound	- -	Extension requested for Categories 1 to 7 and 10 --- Extension requested for Categories 8, 9 and 11
7(c)-II	Lead in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC or higher	-	Extension requested for Categories 1 to 7 and 10

8(b)-I	Cadmium and its compounds in electrical contacts used in:
	
	- circuit breakers,
	- thermal sensing controls,
	- thermal motor protectors (excluding hermetic thermal motor protectors),
	- AC switches rated at:
	  o 6A and more at 250V AC and more, or
	  o 12A and more at 125V AC and more,
	- DC switches rated at 20 A and more at 18 V DC and more, and
	- switches for use at voltage supply frequency ⩾ 200 Hz.
		-	Extension requested for categories 1 to 7 and 10

9(a)-II	Up to 0,75% hexavalent chromium by weight, used as an anticorrosion agent in the cooling solution of carbon steel cooling systems of absorption refrigerators: - designed to operate fully or partly with electrical heater, having an average utilised power input ⩾ 75 W at constant running conditions; - designed to fully operate with non-electrical heater.	-	Extension requested for categories 1 to 7 and 10
13(b)	Cadmium and lead in filter glasses and glasses used for reflectance standards		Expired for Categories 1 to 7 and 10 --- Extension requested for Categories 8, 9 and 11

13(b)-(I)	Lead in ion coloured optical filter glass types	-	Extension requested Categories 1 to 7 and 10
13(b)-(II)	Cadmium in striking optical filter glass types; excluding applications falling under point 39 of this Annex	-	Extension requested for Categories 1 to 7 and 10
13(b)-(III)	Cadmium and lead in glazes used for reflectance standards	-	Extension requested for Categories 1 to 7 and 10
15	Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages		Expired for Categories 1 to 7 and 10
15(a)	Lead in solders to complete a viable electrical connection between the semiconductor die and carrier within integrated circuit flip chip packages where at least one of the following criteria applies: —a semiconductor technology node of 90 nm or larger; —a single die of 300 mm2 or larger in any semiconductor technology node; —stacked die packages with die of 300 mm2 or larger, or silicon interposers of 300 mm2 or larger. Applies to categories 1 to 7 and 10 and expires on 21 July 2021.	-	Extension requested for Categories 1 to 7 and 10
24	Lead in solders for the soldering to machined through hole discoidal and planar array ceramic multilayer capacitors	-	Extension requested for Categories 1 to 7 and 10
34	Lead in cermet-based trimmer potentiometer elements	-	Extension requested for Categories 1 to 7 and 10
37	Lead in the plating layer of high voltage diodes on the basis of a zinc borate glass body		Expired for Categories 1 to 7 and 10
39(a)	Cadmium selenide in downshifting cadmium-based semiconductor nanocrystal quantum dots for use in display lighting applications (less than 0.2 microgram Cd per mm2 of display screen area)	-	Extension requested for all categories

Many countries and regions have implemented stringent regulations and guidelines governing the use of lead in electronic components. Choosing lead-free audio buzzers ensures compliance with these regulations, preventing potential legal complications and market restrictions.

Performance and Reliability: Lead-free piezo benders deliver exceptional piezoelectric properties, offering high responsiveness, precision, and durability. These components provide reliable and consistent performance, ensuring optimal application functionality.

Additional products and resources at:

https://puiaudio.com/find/findproducts/

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WHEN IT NEEDS TO BE HEARD