

Supporting Safety in Military Ammunition

Piezoelectric Generator Fuze Systems



In military ammunition, a fuze is the part of a device that initiates functioning. Fuze systems are safety mechanisms, protecting users from premature or accidental detonation. In addition, the fuze can be designed to be initiated by a timer, on impact, by proximity to the target, or a combination of these. Piezoelectric devices are used as generators or energy harvesters within fuze systems, creating electrical energy either at launch or impact.

Advanced fuze systems require the use of low energy consumption electronics. Batteries have been widely used to power advanced fuze systems, but are limited in terms of performance and storage life. This leads to high maintenance costs and low reliability. Piezoelectric generators provide a durable, vibration-resistant solution with improved packaging size and shelf life.



HOW IT WORKS

When launched, artillery projectiles and rockets are submitted to an initial rapid acceleration that is 20 to 50 thousand times higher than the acceleration of gravity (G). This setback acceleration leads to high inertial forces within the device. Under the action of a seismic mass, piezoelectric ceramic devices compress at high pressure. Due to this stress, and through the piezoelectric effect, the device generates a dielectric charge (voltage on its terminals). That energy is collected by storage and regulation electronics, and enables the fuze electronics to perform functions such as timing, communication, or measurement. On the contrary, if the projectile is dropped or submitted to a shock during handling, the acceleration will remain below the safety threshold and the energy generated will not be sufficient to activate detonation.

Upon impact and through the same physical mechanism, another piezoelectric element generates electrical energy at a high voltage to power an electro-spark detonator. In advanced devices such as tandem warheads, the detonation can be timed within a few microseconds to adapt the function to the target.

WHICH PIEZO ELEMENTS CAN BE USED FOR FUZE APPLICATIONS?

Bulk (single layer) components are typically used for high-voltage generation upon impact. A ring shape is typical and facilitates integration. Multilayer generators deliver electrical energy at lower voltages, and are therefore preferred for setback generators to power electronics. Depending on the size and complexity of a device, either a plate or ring shape could be used. Small caliber ammunition can utilize a 2*2*2mm generator made with our NCE51 piezoelectric ceramic material. The table below details selected options from our standard product range.

	Plate Generators			Ring Generators	
	NAC2001	NAC2002	NAC2003	NAC2122	NAC2123
Dimensions (mm)	2x2x2	3x3x2	5x5x2	Ø8xØ3x2	Ø12xØ6x2
Capacitance (nF)	150	400	1080	200	380
Estimated Energy Generation ¹ (µJ)	1.2	2.7	7.5	86	170



CTS 8x3x2 Ring Actuator

¹Stress 300MPa, into matched storage capacitor

CTS CUSTOM CAPABILITIES

Each company that CTS partners with has unique needs that require custom solutions. Our internal team of engineers and subject matter experts work directly with customers, designing solutions that meet demanding specifications. Typical customization opportunities for multilayer generators in fuze applications are:

- **PZT material.** Several material formulations are available, providing alternatives in terms of power density versus impedance matching.
- **External electrode material.** Surface electrodes can be designed to match the assembly process. Gold electrodes are preferred for mechanical contacting, while silver or silver-palladium electrodes are adapted for soldering or bonding to a circuit board with conductive adhesive.
- **External electrode design.** While standard electrodes are located on opposite faces, custom and wrap-around electrodes provide alternative placement to facilitate integration and contacting.
- **Internal layer thickness.** CTS can design the internal construction of a part to match the required output impedance, and therefore tune the output voltage level. For a given part volume, thinner layers provide higher capacitance and lower voltage output at similar energy levels.

Custom design inquiries can be discussed with our team.

PIEZOELECTRIC EXPERTISE

A leading developer and manufacturer of high-performance piezoelectric materials and components, CTS' piezo products come in a variety of compositions, geometries, and dimensions with high quality standards to meet demanding requirements. Our portfolio encompasses bulk and multilayer ceramics, single crystal, as well as sub-assemblies, composites, and transducers based on these products.

ABOUT CTS

CTS is a leading designer and manufacturer of products that Sense, Connect, and Move. We manufacture sensors, actuators, and electronic components in North America, Europe, and Asia, and provide solutions to OEMs in the aerospace & defense, medical, industrial, communications, information technology, and transportation industries.

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