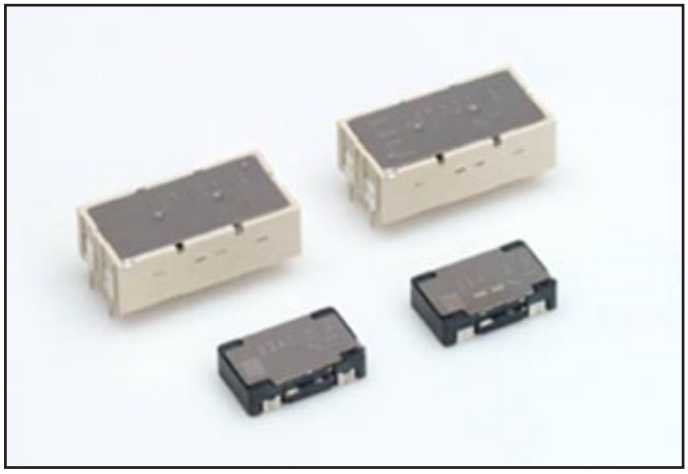
Piezoelectric Devices 2

● NEC TOKIN's Piezoelectric Devices

- Ceramic Gyro™
- Piezoelectric Inverters

● Ceramic Gyro™

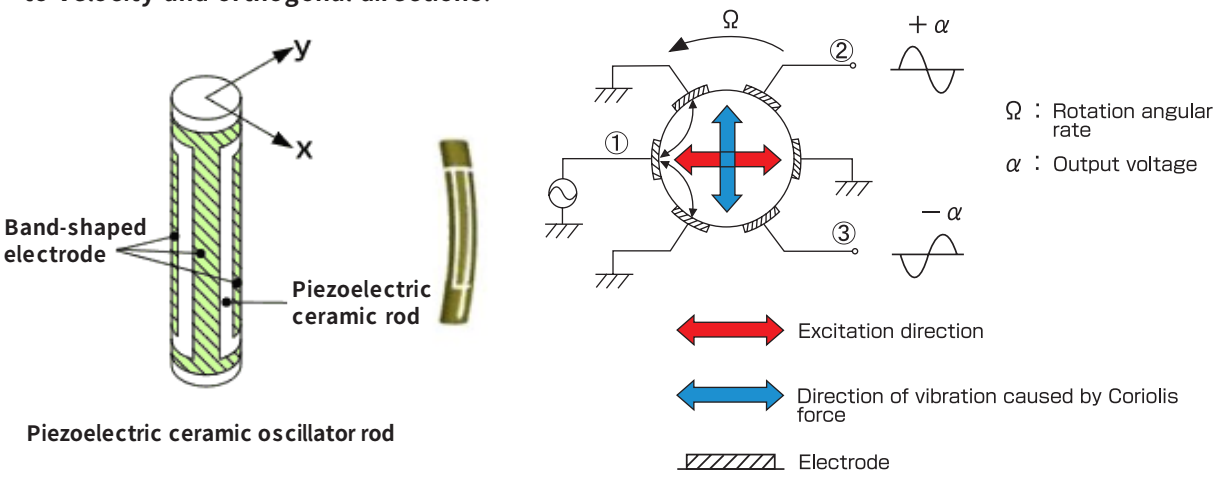


Piezoelectric gyroscopes are sensors which use piezoelectric oscillators to capture the rotational movements of objects, and are essential for compensating for hand shaking in video and digital still cameras.
The principle of piezoelectric gyroscopes is the same as that of the Foucault pendulum. A piezoelectric element vibrates a rod, which causes it to work as a pendulum. Then, the Coriolis force that occurs when movement is applied is extracted after it is converted into voltage by the piezoelectric element.

What is Gyroscope?

Rotational Angular Velocity Sensor

Operation principle: An angular velocity sensor that works by using the phenomenon generated by Coriolis force when angular velocity is applied to a moving object in relation to velocity and orthogonal directions.



A feature of the NEC TOKIN Ceramic Gyro is that the vibrating element is made up of a cylindrical piezoelectric ceramic oscillator rod. On this rod, six electrodes are printed and polarized. This structure is as effective as that of a rod carrying three piezoelectric elements. When voltage is applied to the piezoelectric ceramic oscillator rod, it torsionally vibrates. When the rod rotates, it outputs voltages in proportion to the rotational velocity.
The greatest advantage of the structure of the oscillator--a cylindrical ceramic rod--is that it can easily be processed with high accuracy. When conventional square-shape rods were used, it was difficult to accurately make the thickness and horizontal width, as well as the lengthwise and crosswise proportions uniform. On the other hand, high accuracy can be achieved with rods because they can be processed while they are rolled; therefore they are highly effective in downsizing elements with high performance.
In fact, the CG-L53, our flagship gyroscope, employs a downsized ceramic rod with a thickness of 0.8 mm and a length of 9 mm. Since Ceramic Gyro are highly sensitive to movement, they can detect a wide range of movement from low-speed rotation (0.1 °per sec.) to high-speed rotation (1500 °per sec.).

Specifications of Ceramic Gyro

Features of CG-L53:
- Conforms to image stabilizing system specifications
- Smallest size in industry
- Supports SMD and lead-free reflow soldering

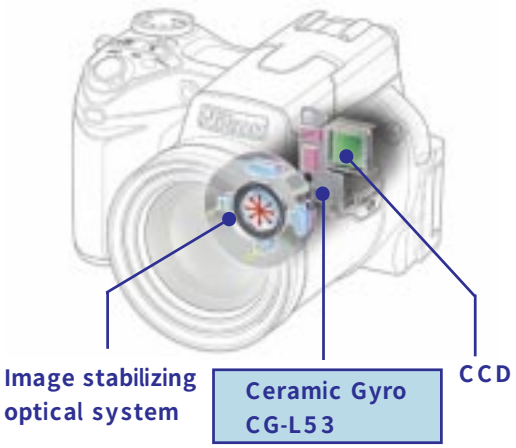
CG-L43 (L), CG-L53 (R)

	Ceramic Gyro CG-L43	Ceramic Gyro CG-L53
Dimensions (mm)	8 × 15.5 × 5	6.0 × 10 × 2.5
Oscillator dimensions (mm)	ϕ 1.5 × 13	ϕ 0.82 × 9
Supply voltage (V)	3	3
Sensitivity (mV/deg/s)	0.66	0.66
Output voltage at zero angular rate (mV)	−5 to + 75	−5 to + 75
Temperature characteristics of sensitivity (%)	−15 to + 5	−15 to + 5

The NEC TOKIN Ceramic Gyro has so far been widely used as sensor devices for stabilizing the images of video cameras. However, the downsizing of the gyro has opened the way to new applications--one of which is the application of the gyro to digital still cameras.
Digital still cameras are one of the new three sacred treasures of digital consumer electronics. Many people are interested in them. Recently, image stabilizing systems are being highlighted in them. Since compact and stylish bodies are required for them, downsized piezoelectric gyroscopes that take up little space are indispensable to realizing an added value, image stabilization.

Image stabilizing systems will continuously be highlighted. In the foreseeable future, Camera module for cellular phones will have an image stabilizing system.
Since our Ceramic Gyro contributes to the downsizing of products, we will provide it for the image stabilizing systems of various camera devices.

COOLPIX 8800 by NIKON CORPORATION



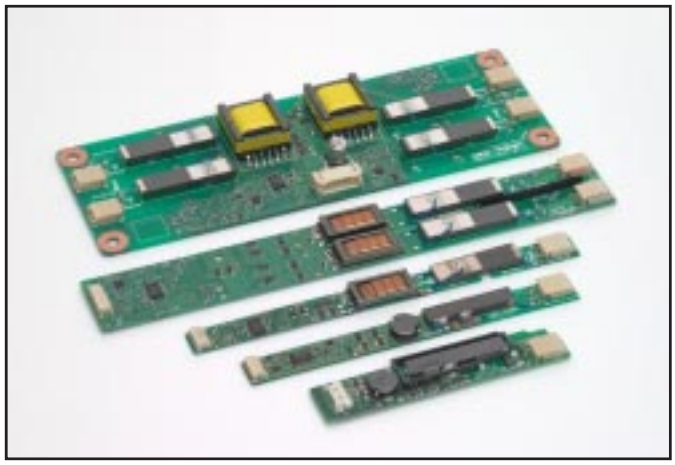
In addition, Ceramic Gyro are being employed in game software cartridges; this is a brand-new application.
Nintendo provides game software, "Wario Ware Twisted!", for Game Boy Advance. Unlike other conventional games, this game software enables the user to enjoy various mini games while the game machine is held and rotated right and left. This is an unprecedented game system and highly esteemed in the game industry. The game itself is sensorial and enjoyable.
The sensor of "Wario Ware Twisted!" employs our Ceramic Gyro. The downsized and high-performance gyro is a key device for realizing this enjoyable game. In sum, it can be said that our Ceramic Gyro has opened a new possibility in the field of games.

Our Ceramic Gyro is also used for 3D motion sensors. Since 3D motion sensors contain three Ceramic Gyro™, the use of our latest miniature gyros has drastically downsized the capacity of the sensors from 30 cc to 6 cc. This means that the 3D motion sensors containing the miniature gyros can easily be used for robots and virtual reality systems.
Furthermore,Ceramic Gyro are used for the attitude control systems of radio-controlled cars and helicopters.
Our Ceramic Gyro, downsized and high-performance gyroscopes, will be used in various fields in the future.

Game Boy Advance SP by Nintendo Co.,Ltd.
※ Actual cartridge is not transparent.

Extracted from the " Wario Ware Twisted! "(Nintendo website)
http://www.nintendo.co.jp/n08/rzwj/mawaru/index.html

● Piezoelectric Inverters

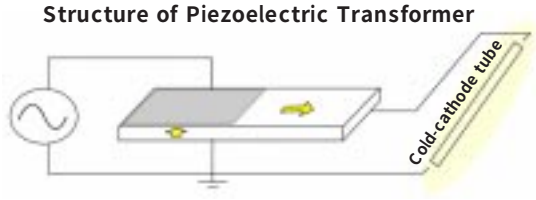


Piezoelectric Inverters

Principle Behind Piezoelectric Transformers

Electrical energy → Mechanical vibration energy → Electrical energy

Structure of Piezoelectric Transformer



Input: 10 to 30 Vrms
Driving block

Output: 600 to 2000 Vrms
Power generation block

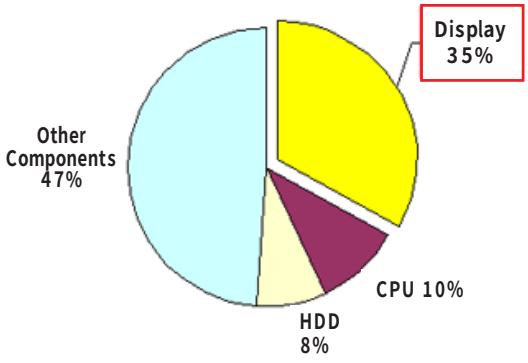
A tendency to realize high-performance notebook PCs has slowed down recently. Instead, stylish chassis and extended battery life have emerged as crucial factors for attracting users.
To accurately respond to the needs of the time, piezoelectric inverters that employ piezoelectric transformers are indispensable.
For recent stylish notebook PCs, the following features are required: (1) the whole LCD block should be as thin as a plate; (2) the frame should be as slim as possible; and (3) the LCD should be wide in relation to the overall size of the PC. These requirements indicate that the space for necessary parts is limited in such PCs.
While low power consumption CPUs have been realized, LCDs have become wider, with increased resolution and brightness. Accordingly, the LCD uses 30 to 40% of the total power consumed by current notebook PCs.
A key to solving the problem is inverters for the backlights of LCDs. Such inverters must be installed in tight spaces, not emit noise, and be highly efficient without excessive heat.
It is difficult for conventional electromagnetic inverters to satisfy these demanding requirements. The reasons are that the thickness of electromagnetic inverters cannot be reduced because isolation voltage has to be guaranteed, Also, their efficiency cannot easily be improved upon because of various losses.

Reducing of Power Consumption of Notebook PCs

Important task for all notebook PC manufacturers

EBL (Extended Battery Life)

Intel Corporation announced at Intel Technology Symposium in Sep. 2003



Ratio of power consumption of notebook PCs (%)

30 to 40% of power is consumed by LCDs

Piezoelectric inverter is solution

	Piezoelectric Inv.	Electromagnetic Inv.
Light control duty	5%	20%
Inverter power consumption	0.5W	2.5W
PC power consumption	10.0W	12.0W
Battery life	6 H	5 H

(Based on comparison of min. brightness)

On the other hand, piezoelectric inverters, which function by converting electricity into vibration and then converting the vibration into electricity again, are downsized, thin, highly efficient, and emit little noise. Furthermore, they have excellent features such as low heat emission and nonflammability. Therefore, they are devices which are suitable for cutting-edge LCDs.
The piezoelectric inverters are especially useful for notebook PCs because of their compact size and high efficiency. They can be installed in thin or narrow spaces and their high efficiency can extend battery life by more than 10 minutes compared with electromagnetic inverters.
Their excellent characteristics such as small sizes, high efficiency, and low heat as well as low noise emissions are also useful for large LCD televisions.
Compared with electromagnetic inverters, piezoelectric inverters are especially advantageous in regards to the safe usage of large LCD televisions that require high voltage.

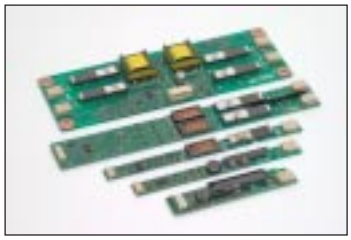
Comparison of Piezoelectric Inv. and Electromagnetic Inv.(For Notebook PCs)

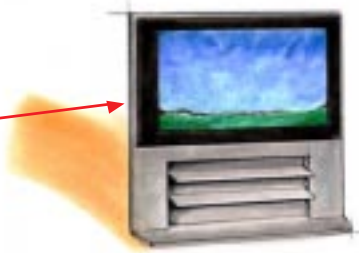
		Piezoelectric		Electromagnetic (Separate Resonator)	
Shape	Thick-ness	○	3.9 mm or more	△	4.5 mm or more
	Width	○	8.5 mm or more	△	10 mm or more
Efficiency		○	80 to 85%	○	70 to 85%
Noise		○	No leakage flux	×	Influenced by leakage flux
Dimming control		○	Brightness level can be reduced to 2% or less due to no buzz noise	△	Brightness level cannot be reduced because of buzz noise might be generated
Buzz noise		○	None	△	Possible
Tube life		○	Almost complete sinusoidal voltage	△	Loosely shaped voltage waveform
			Tube current is balanced without affecting tube life		Current balance may collapse depending on control methods

○ → Suitable, △ → Can be used, × → Not suitable

NEC TOKIN is now developing piezoelectric inverters which contain transformers with 30 watts or more.
Large LCD televisions with a display of 30 inches or more employ 10 to 20 or more backlights, each one of which requires an inverter. On the other hand, a transformer with 30 watts or more can turn on four backlights for a 30-inch or larger display. Thus, piezoelectric inverters contribute to a simpler circuit, reduce the number of parts and improve efficiency.
NEC TOKIN provides optimum devices whose materials have carefully been selected, by utilizing high technical capabilities applied to all production stages--from ceramic materials to elements, devices, and units--of piezoelectric devices. NEC TOKIN has capabilities and systems for quickly responding to the accelerated development speed of products by using accumulated technologies and processing materials so that the loss and heat emissions of the piezoelectric devices are suppressed.
The piezoelectric inverters of NEC TOKIN will widely be used behind the scenes to support future LCDs.

Piezoelectric Inverter Applications





Multi tube piezoelectric inverter for backlight of LCD TV

Single or Double tube piezoelectric inverter for backlight of note book PC