

## Automotive SMD Crystal Unit Series: Benefits of special Internal Structures

### Introduction

Crystal unit is a unique electronic component that controls and selects frequencies with high accuracy and stability by its high Quality factor. It is widely used not only as a "frequency standard" but also as a reference for "time".

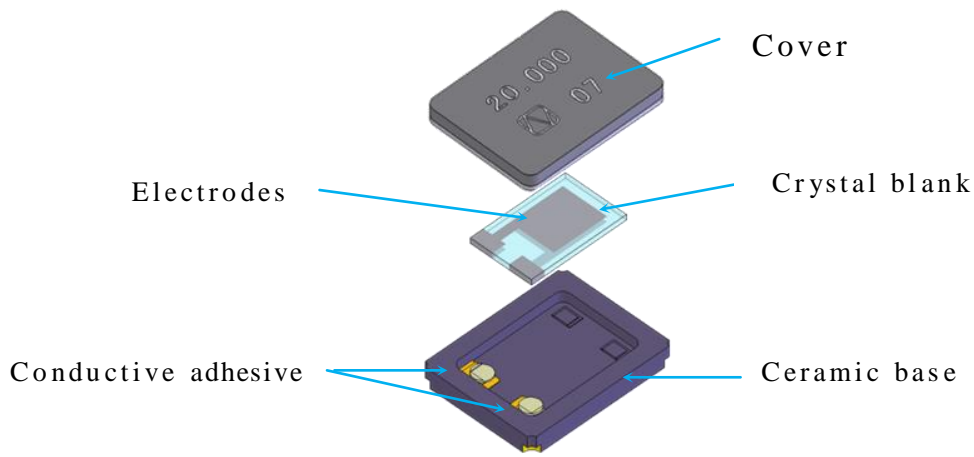
The crystal unit is used in a variety of applications, including watches, smartphones, TVs, audios, and other home appliances, as well as cars. In recent years, cars have become increasingly electronic, and higher demand for automotive crystal unit. Therefore, sophisticated designing technologies that improve high reliability and robustness according to their applications are required.

This paper explains the advantages of the internal structure of the automotive SMD crystal unit series, which is proposed by the Nihon Dempa Kogyo Co., Ltd. ("NDK"), which keeps more than 50% of market share.

### 1. Crystal unit structures

The crystal unit packages are hollow-structured, and the external and internal terminals are wired and connected to the ceramic base. The crystal blank mounted in crystal unit packages is cut, polished, and contoured with synthetic quartz(\*1) to form a thin film electrodes on the front and back sides of the individualized crystal blank. To electrically connect and mechanically hold the electrodes formed on the front and back sides of the crystal blank, use conductive adhesive to hold the crystal blank to the ceramic base at two points. The crystal unit is hermetically sealed with ceramics bases (holding the crystal blank) and ceramic covers. By connecting the ceramic-based external terminal to the oscillator, the crystal unit can obtain its own frequencies by converting the internally connected crystal blank into electric signals that vibrate at mechanical resonances.

This section introduces our automotive crystal unit NX3225GA (3.2mm x 2.5mm).

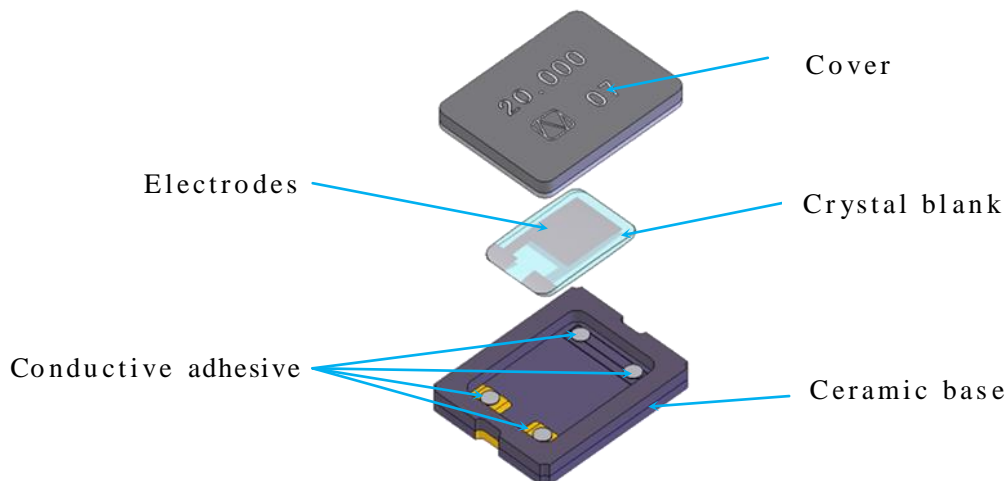


## 2. Crystal blank holding structures

As described above, the crystal blank may be held at two points even in the automotive crystal unit. Reliability required for automotive applications even if the crystal blank is held at two points. This is a structure that is fully satisfied with AEC-Q200 (\*2), etc.

However, in automotive applications, the need for high reliability and improved robustness has been increasing, and the internal structure has been developed. The crystal blank is held at four points.

This section introduces the inner construction of our automotive crystal unit: NX3225GB (3.2mm x 2.5mm).



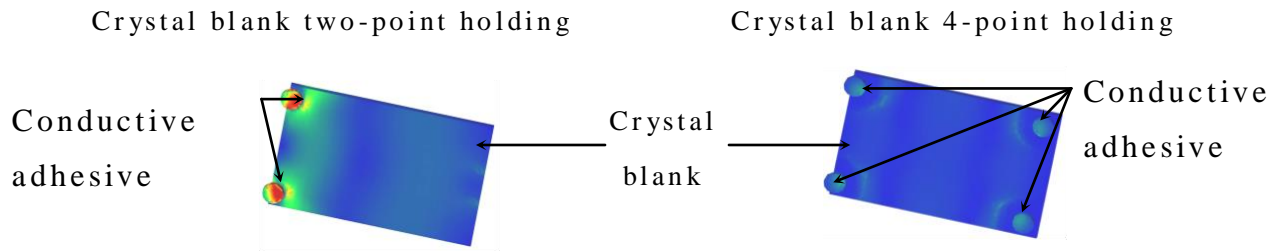
## 3. Advantages of a crystal blank four-point holding structure

NDK utilizes the latest simulation technology to design structures. This time, we conducted a simulation of the drop impact and the structural resonance point.

### (1) Improvement of drop impact resistance

The following shows the results of simulated stresses applied to the crystal blank holder during a drop impact.

\* Simulation Condition: Stresses applied to an adhesive (crystal blank and conductive adhesive) when an impact is applied to a crystal unit.



If the stress applied to the holding part is 1 in the crystal blank two-point holding structure, the stress is 1/5 in the crystal blank four-point holding structure. This is because the four-point crystal blank holding structure disperses stresses.

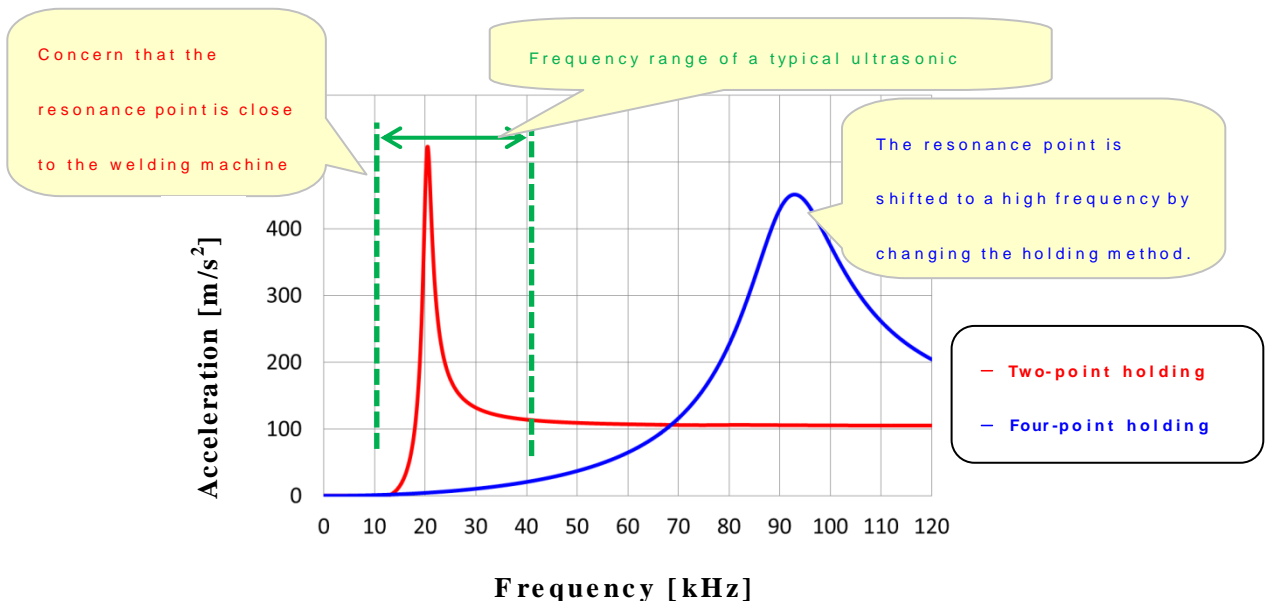
This four-point crystal blank holding system improves the impact resistance against falling, and provides a crystal unit that continues to oscillate even when 200 times falling impacts from 3m above are applied to concrete.

In this way, NDK has developed a lineup of four-point crystal blank holding structure products with improved reliability and robustness by dispersing the stresses applied to crystal blank holding, and meets the needs of customers.

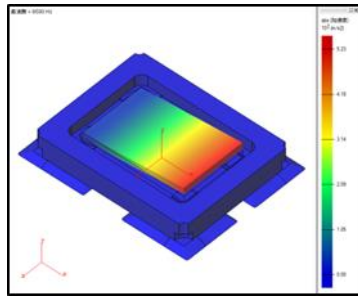
(2) Avoiding ultrasonic welding machines and crystal unit resonances

Usually, when board assembly is performed by ultrasonic welding, the frequency of the ultrasonic welding machine is done at about 10 kHz to 40 kHz.

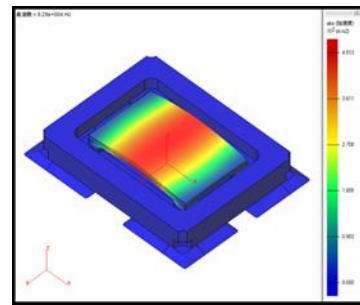
Simulation results of crystal unit (3.2 mm x 2.5 mm) structure resonance-point are shown.



Crystal blank two-point  
holding structures



Crystal blank four-point  
holding structures



In the crystal blank two-point holding structure, the structure resonant point is found to be approximately 20 kHz. On the other hand, it can be seen that the four-point crystal blank holding structure has a structural resonant point at about 90 kHz.

When an ultrasonic welding machine is used by customers, the frequency of the ultrasonic welding machine and the frequency of the two-point crystal blank holding crystal unit may cause the resonance point to overlap, and the crystal unit may be internally destroyed by the resonance phenomena. In order to avoid this problem, NDK provides a lineup of four-point crystal blank holding structural products designed to meet the needs of customers as below.

Automotive crystal unit 3225 series NX3225GB • NX3225GD • NX3225SA • NX3225SC  
2016 series NX2016GC • NX2016SJ(Please contact us)

\*1. Synthetic quartz is produced by NDK.

\*2. AEC stands for "Automotive Electronics Council (Automotive Electronic Components Council)". It is an industry organization for the standardization of reliability and certification standards, consisting of major U.S. car manufacturers and major electronic component manufacturers.

Q200 is an accreditation standard that establishes various reliability tests for passive components. Crystal unit is classified as AEC-Q200.