

# Crystal Handling Precautions

Crystals should be handled in a proper way to reduce the risk of performance deterioration. This note describes some common factors affecting the crystal operation which would cause to the oscillation circuit malfunction.

## Common Factors Affecting Crystal Operation

### 1. Ultrasonic Frequency

Ultrasonic technology is widely used in the industrial equipment. Two popular applications of those equipments found in the manufacturing are in the Ultrasonic cleaning process and Ultrasonic welding process.

The ultrasonic machines are usually operating in frequency of 20kHz to 60kHz in some applications. This frequency is close to the tuning fork crystal frequency of 32.768KHz and might destroy the crystal blank due to resonance effect.

With the natural frequency of the crystal structure, the ultrasonic frequency also affects AT-cut crystals.

Some suggestions are described below to reduce crystal failure when products required to performing ultrasonic processes:

- Check the ultrasonic machine if it is suitable for use with the crystals. If possible, perform some crystal dummy tests in advance to verify the performance.
- Ensure the crystal has some space apart from the product housing, this avoids inducing ultrasonic frequency to the crystal structure during assembly of the product.
- For PCB component placement, crystal should be placed in the center part of PCB.
- Change other crystal type if problem has been found in one package type.
- If the ultrasonic machine has control functions available, switch the ultrasonic frequency far away from crystal frequency and reduce the operation power of the machine.
- Some cleaning fluid might damage the crystal package, check its suitability before use.

### 2. PCB Cutting

In most cases, small size PCB would be cut from a large PCB board after completed the components assembly. The cutting force on the PCB would be induced to the crystal which placed near to the cutting edge of the board. If this force is too large, it would damage the crystal structure. Generally, the failure is board position dependent; i.e. those small PCBs having problem would always be found at the same position of the large boards.

Crystal should be placed in the center of the PCB or keep away from the cutting edge when designing the PCB layout, this would reduce the risk of failure rate due to cutting force effect.

### 3. Soldering Condition

- Soldering conditions (such as hand soldering, reflow, wave soldering) are not universal to frequency products regarding the holder types and the materials that used. For example, lead free soldering process has higher thermal stress than that of non-lead free type.
- Increase or decrease the wave soldering / reflow temperature rapidly would cause crystal failure. Hence it is strongly recommended to follow the wave soldering / reflow profile provided by crystal manufacturer.
- PCBA might be required to go through the reflow process two times, especially the board has components on both sides. Excessive thermal energy would damage the electrical and reliability parameters of crystals, as a result crystal would then have high potential of failure after the reflow process in high temperature for two times. Hence it is suggested crystal should always be processed by the reflow one time only.
- For ES/FS/S7/S8 package series, it is not recommended for inverted reflow as the weight of the inverted crystal would have risk to be detached from the board. If inverted reflow is necessary, it is strongly recommended to fix the crystal by glue or tape on the board

For more information of soldering condition/temperature profiles, please contact our representatives.

### 4. Mounting Precaution

#### 4.1 Thru Hole/Leaded Crystal and Oscillator

The glass bead which is located at the base should in no cases be damaged. In the case of damage occurs, crack or leakage that would lead to malfunction or instability to the unit.

Customers are recommended to pay special attention during wire cutting, lead bending and mounting, such as but not limit to:

- Avoid exerting unnecessary force to the unit (recommended reading is less than 2 lb or 900 gram).
- Do not bend the lead directly from the base. If necessary, 1.5mm or longer distance from the crystal body is recommended.
- Do not bend the lead wire more than 3 times under any circumstances.
- Do not apply excessive force when inserting the unit into the board.
- Make sure the distance between holes on the PCB equals the distance between the terminals of the unit.
- Make sure no movement will be occurred after mounting as the glass bead would have damage.

#### 4.2 SMD Crystal and Oscillator

- Mechanical stress may be induced by deformation of PCB, the stress may lead to crack formation of the soldering & package joint, which leads to malfunctioning and long term instability problems.
- Severe temperature change condition on crystal unit may lead to crack formation of the solder joint.
- If an automatic pick and place machine is applied, please test and confirm that operation would not cause any damage of the crystal.
- Make sure that the warping of PCB is not serious as this may affect the soldering joint and the structure of the crystal.
- Ultrasonic welding, cleaning or routing process may cause damage to crystal blank by resonance.

## 5. Flexing Board

After the PCB installed to the product housing, it is necessary to check if the board has some degree of bending. This mechanical bending stress would cause peeling off portions of soldering or have high potential to crack the package of on-board crystal.

## 6. Shock by Dropping

Crystal might be damaged when dropping from the work bench to the hard floor, as it would receive excessive shocks when hitting the floor. These crystals should not be used if they have dropped on the floor or received high shocks in whatever conditions.

It is suggested to put a carpet on the floor under the work bench to avoid the excessive shock to the crystal when dropped to the floor.

Other potential shocks to the crystal are :

- Shock caused by mounting the crystal on board.
- Piezo buzzer, speaker etc would cause vibration to the crystal.

## 7. PCBA Rework

For the PCBA rework, de-soldering the crystal might be required and it is usually done by hand soldering. The temperature of soldering iron and the soldering time should be carefully controlled.

For through-hole packages, the temperature of soldering iron is suggested to be 300~340°C, and the soldering time should be less than 10 seconds. Always follow the soldering instructions provided by crystal manufacturer.

For SMD crystals, they are much smaller in dimension and hence they are very sensitive to thermal stress. Frequency drift may occur if temperature and soldering time are not properly controlled. The following table gives a guide line of soldering temperature and time for various packages:

Package	Temperature	Soldering Time	Distance from Hot Air Gun
7050	280°C	≲ 30 seconds	~ 1cm
5032	280°C	≲ 15 seconds	~ 1cm
3225	260°C	≲ 10 seconds	~ 1cm
2520	260°C	≲ 8 seconds	~ 1cm

For Tuning Fork crystal, the soldering temperature would be controlled carefully, details are described in other application note [1].

## 8. PCB Design Crystal Oscillation Circuit

Circuit designer should pay attention to the following points in order to avoid the crystal failure.

- Crystal should be placed at the less stressed position of the PCB.
- Crystal should be placed at the center position of PCB and keep away from the part having mechanical vibration, e.g. piezo buzzer.
- For accuracy and stable frequency operation, large parasitic capacitance should be avoided. Hence, crystal should be placed close to IC pins and the crystal connection lines should be routed as short as possible.
- High frequency signal lines and the components which generating high noise should not be placed close to the crystal circuit on PCB layout.

## 9. Storage

Frequency products are recommended to be kept in the original packing before using, to be stored in 10 – 40degC and 40 – 60%RH, to be used within 6months after delivery, and to be used as soon as possible after unpacked.

Being exposed to high temperature/damp/chloride/sulfide/based gases or other critical environment could induce change of the electrical characteristics, as well as physical properties such as but not limit to outlook, dimension and solderability.

During in-house transportation and handling, precaution should be advised to prevent the products from dropping.

## Reference

[1] HKC application notes no.: ANENG-XTL-0001, "Tuning Fork Crystals (Cylindrical Type) Handling Precaution", 2014.