18-D3259

水晶製品 使用上の注意事項
Crystal products handling notes

March, 2009

東京電波株式会社

Tokyo Denpa Co.,Ltd.

はじめに

Introduction

First of all we would like to thank you for your business with our products.

1934

Our company started to manufacture the crystal products in 1934. In order to meet needs in accordance with miniaturizations and high speed networking products, we always try to take one step ahead in development for high accurate crystal devices with next generation smaller size package.

Since crystal products always progress with improvement day by day as mentioned above, we make this handling note which explains the crystal products. In order to have sufficient performance demonstrated more safety, we would be appreciated it if you would read this notes.

We have carefully paid attention in undertaking to make the notes but your suggestions and questions are always welcome so that we would like to make the most of it to our future reference.

Your continued patronage to our products is very much appreciated.

Tokyo Denpa Co.,Ltd.

INDEX

1.

1. Explanation of quartz crystal products

1.1

1905

George Spezia

1953

1959

1 7 kg

1973 1 m^3

4 m^3

1 2

1977

Artificial crystal

1.1 Artificial Crystal

It is beginning that, as for the history of artificial crystal growing, Mr. George Spezia of Italy raised an artificial crystal with the hydrothermal crystallization method in 1905 and Japanese researchers started exercises at Yamanashi University in 1953.

The growing process has significantly improved by the high-temperature and high-pressure growing furnace, called autoclave. The growing technology was also optimized and industrialization was started at production volume by 7 kg per one growing furnace in 1959.

The mass production with high quality of artificial crystal were attained by progress of technology and enlargement of autoclave was also progressed. The certain autoclaves by one m^3 or even larger appeared in 1973 and full-scale mass production was started. There is also autoclave exceeding the internal volume four m^3 now, and the amount of production per set has also become 2t or more.

TEW built a factory for artificial crystal in 1977. High quality artificial crystal is produced by the newest equipments with severe quality control. The artificial crystal is variously used for electrical quartz products, such as a crystal unit and a crystal filter.

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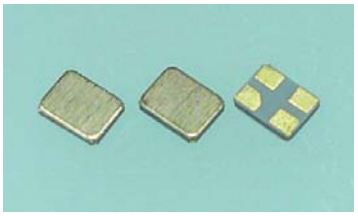
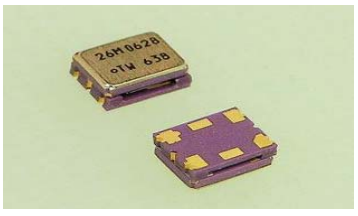
2

(Au-Sn)



Crystal unit

1.3



Crystal oscillator

1.2 Crystal Unit

A crystal unit is a passive component but, which creates an oscillation keeps frequency accurately by the piezoelectric effect of quartz crystal.

A common crystal unit stores the crystal blank which is a piezoelectric and it is sandwiched by two electrodes.

TEW's crystal units are particularly designed for demands of high precise specifications, such as mobile communications and satellite communications use.

Moreover, ultra-miniature crystals are available with high reliability of seam sealed type and besides that world top class ultra-thin special encapsulation technique by tin gold (Au- Sn), called TAS type.

1.3 Crystal Oscillator

A crystal oscillator has an oscillating circuit which controls oscillation frequency using a crystal unit.

The output frequency of a crystal oscillator is determined by the oscillation of crystal unit.

Since the crystal oscillators constitute the stable oscillating circuit, it allows them to control the frequency stability over a temperature change accurately. Our demand is growing in recent years as control and standard signal of the frequency to electric products and electric communication facilities are demanding more stable crystal oscillators. The use in fields such as a reference signal for the terminals of satellite communication, base stations and image processing are expanded quickly in these days.

The outstanding temperature compensating and measurement technology are provided with years of experiences in accordance with various kinds of crystal oscillators which are made by ceramic package with a reliable crystal unit and circuit technology.

1.4

1.4 Crystal Filter

A crystal filter is formed by the crystal units which have resonance characteristic in stable and steep frequency over a temperature range.

A crystal filters are categorized by discrete type crystal filters and monolithic crystal filters.

The discrete type crystal filters are made up in a set combining one or more crystal units and coils or capacitors with circuit composition by the Ya-Mann circuit.

1

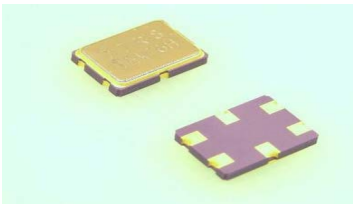
2

A monolithic crystal filter is formed by two or more resonances, which arrange two or more pairs of electrodes onto quartz blank in one sheet and characteristics are depended on the combination between a blank and electrodes. Due to limitations of design and manufacturing, a range of characteristics are less flexible but it is small and light weight.

10MHz 200MHz

Our crystal filters are widely used in communication systems and TEW offers it with center frequency ranging from 10 to 200MHz.

It are globally consumed for radio communications, which carried out by special design with original thin blank technology and provide excellent quality and reliability as well.



Crystal filter

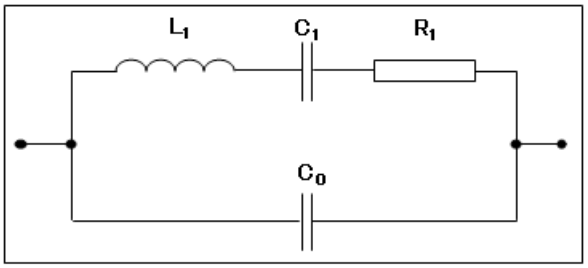
2.

2. Handling note

2.1

1

L_1
C_1
R_1
C_0



1.

Fig.1. Electric equivalent circuit of crystal unit

2.1.1

$P = I^2 R_L$

I

R_L

R_L R_1 $1+C_0/C_L$ ^{2}

100 μW

2.1 Crystal Unit

You are requested to approve our data sheet and to confirm the environment surrounding for a crystal unit as well.

In order to demonstrate sufficient performance, please read the following notes.

A crystal unit can be expressed in the electric equivalent circuit which connected an equivalent constant, which is shown in figure 1.

L_1: Motional inductance
C_1: Motional capacitance
R_1: Motional resistance
C_0: Shunt capacitance

2.1.1 Drive Level

A drive level is electric power so a crystal unit can be oscillated. It can be expressed with the following formula.

Drive level: $P = I^2 \times R_L$
I: Current which flows into crystal unit
R_L: Load resonance resistance
R_L: $R_L = R_1 (1+C_0/C_L)^2$

If a drive level exceeds a regular level, the oscillation will be unstable.

When the drive level generates excessive electric power, various other vibration modes are created. This impacts stress which creates unexpected changes in output frequency and crystal impedance.

The drive level to a crystal unit should not be more than the maximum excitation level. The standard maximum drive level is 100 microwatts at our company unless you do not have particular request.

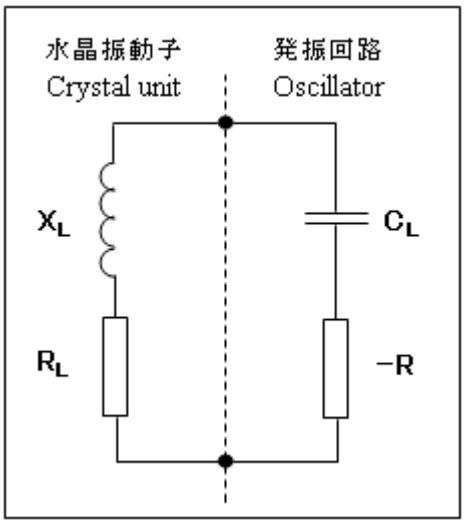
2.1.2

2

X_L
R_L
C_L
-R

(-R)
(R_L)

5
10



2.

Fig.2. Equivalent circuit of crystal unit and oscillator

2.1.2 Oscillation start up conditions

A simplified equivalent circuit of crystal unit and oscillator is shown in figure 2.

X_L Reactance of a crystal unit
R_L Load resonance resistance
C_L Load capacitance
-R Negative resistance

A crystal unit will not be oscillated, if negative resistance (-R) of a circuit is smaller than the load resonance resistance (R_L) of a crystal unit.

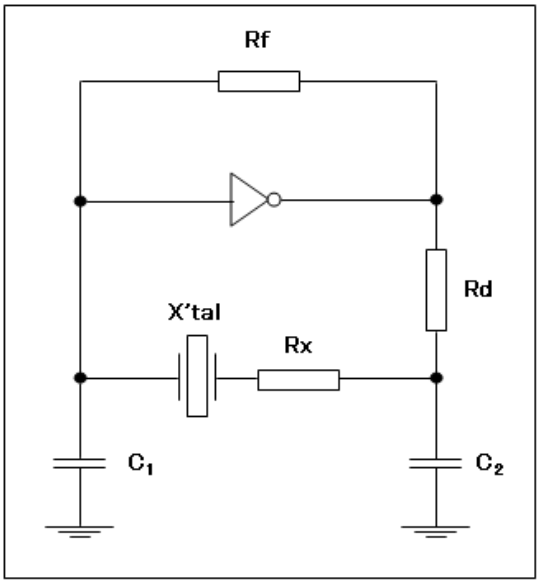
Even if negative resistance is almost the same as load resonance resistance or somewhat large, an oscillation may not start or start up time may become slow.

In order to oscillate a crystal unit certainly, it is necessary to make negative resistance of a circuit much larger than the load resonance resistance of a specification standard value. Consumer and communication applications shall be five times or more and in-vehicle applications shall be ten times or more.

< >

3
(Rx)

10



3.
Fig.3. Crystal oscillation circuit

2.1.3

4

<A check method of oscillation start up >

In order for negative resistance of a circuit to check whether it has taken more than the load resonance resistance of a crystal unit, it is necessary to get us know the negative resistance of a circuit.

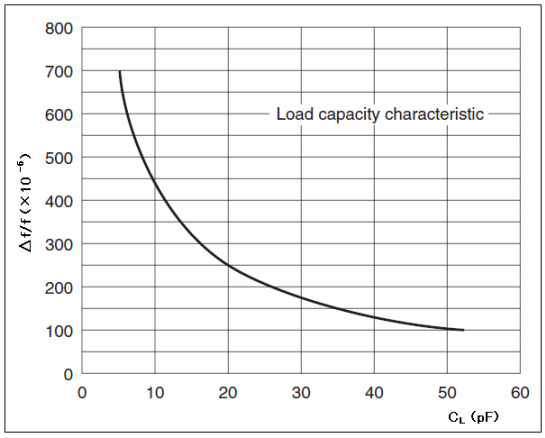
At our company, as shown in Fig. 3, you are requested to put a resistance (Rx) which should be added to a crystal unit in series. It should be changing into small resistance from large resistance and it will allow us to see the oscillation starting point.

The total resistance value which applied the load resonance resistance of the crystal unit to the resistance inserted in the crystal unit in series turns into an approximate value of negative resistance of that circuit.

It can be judged that the margin should be enough, if this resistance inserted in series become more than 10 times compare from the load resonance resistance value. If not, change of a circuit design is needed.

2.1.3 Load Capacity

The output frequency of a crystal unit is changed by load capacitance as shown in Fig. 4. When the load capacitance of an oscillating circuit is not suitable, it oscillates on different frequency from the frequency of which it is expected. When you order a crystal unit, please specify the load capacitance of the circuit.



4.
Fig.4. load capacity characteristic

2.1.4

2.1.4 Temperature Characteristics

It differs from the frequency temperature characteristics measured only with the crystal unit than the frequency temperature characteristics which were measured at an oscillator.

If you expect the frequency temperature characteristics too tight, it may not be satisfied at crystal unit.

In such a case, please have crystal units ordered frequency temperature characteristics which accommodate stability by the temperature characteristics of the oscillating circuit.

Furthermore when you require high accurate temperature stability, we recommend you to consider using a crystal oscillator by which temperature compensating was carried out.

2.2

2.2 Crystal Oscillator

You are requested to approve our data sheet and confirming the environment surrounding a crystal oscillator as well.

In order to demonstrate sufficient performance, please read the following notes.

2.2.1

2.2.1 Power Supply Voltage

A power supply connection shall follow at a terminal predetermined as a catalog shows.

If positive/negative is connected conversely or it connects with terminals other than predetermined, there is a case where the parts currently used for the inside of a crystal oscillator are damaged and it stops operating as an oscillator.

There is a possibility that the same failure as the above may arise also when the voltage beyond a rated value impressed. It is certainly shall be used by a rated voltage.

2.2.2

In addition when the voltage below than a rated value impressed, you may see a case what it does not satisfy performance.

2.2.2 Load Conditions

Load impedance shall be connected by a rated value.

When load impedance is connected by other than a rated value, output frequency and output level may not be satisfied. And also it may become a cause of matter like an output waveform is distorted.

2.2.3

2.2.3 Output Frequency

When you measure the output frequency or the output level of a crystal oscillator, the input impedance of a measuring instrument shall be adjusted in the load impedance of a crystal oscillator.

When the input impedance of a measuring instrument differs from the load impedance of a crystal oscillator, it shall be measured by the high impedance which can disregard the impedance of a system of measurement.

2.2.4

2.2.4 Noise

If excessive visitor noise is impressed to a power supply and an input terminal, the spurious phenomenon in which electric waves other than the frequency made into the latch rise phenomenon between a power supply and grounding are discharged may be caused and it may become a cause of malfunction.

2.2.5

IC

Please do not place what generates a high noise near the crystal products.

2.2.5 Static Electricity

Since IC may be destroyed when too much static electricity is charged, please consider using a conductive staff for packing and a conveyance container.

For soldering equipment and a measurement circuit etc, please consider using a staff without high-voltage leak and also consider having electrostatic measurements grounded.

2.3

2.3 Crystal Filter

You are requested to approve our data sheet and confirming the environment surrounding a crystal filter as well.

In order to demonstrate sufficient performance, please read the following notes.

2.3.1 LC

2.3.1 Necessity for LC Tuned Circuit

When the stray capacitance of the PCB which mounts a crystal filter is large, the tuned circuit for offsetting the stray capacitance may be needed.

2.3.2

2.3.2 Termination Impedance

The original characteristic in a pass band, insertion loss, ripple and bandwidth characteristic are no longer acquired when termination impedance differs from a rated value. The circuit impedance shall be measured accurately and it has consistency to match on termination conditions.

Please keep in mind that a passage region will move in particular, if termination impedance does not match.

2.3.3

2.3.3 Maximum Level

An input level shall be less than a rated value. If the input level beyond a rated value impressed, a crystal resonance characteristic will be deteriorated and the original characteristic will no longer be acquired as a crystal filter.

2.3.4

2.3.4 Separation between Input and Output

In order to prevent electromagnetic combination between input and output, please have shielded certainly. If it has the combination between input and output, the incoming signal may go to the output side directly in the attenuation domain. The amount of guarantee attenuation will less achievable and the original characteristic of crystal filter will no longer be acquired.

There is grounding as one of the method. It enables to have the crystal filter grounded with attachment screw or grounding terminal.

The internal part of crystal filter may be damaged, if it solders to a case directly. In addition the case of a crystal filter is grounded certainly because potential difference can be eliminated at the circuit side.

2.3.5

2.3.5 Direct-Current Superposition

When you charge direct-current, please do not have the current beyond a rated current value. Internal transformer will generate a heat and it will create a cause of bad insulation or disconnection, if excess direct current goes through filter than the rated value.

2.4

2.4 Common handling notes

Please use it within the range of parameters in the specifications besides that confirming the system requirements of each product.

Moreover, please read the following notes for you to demonstrate the performance that can be satisfied.

2.4.1

2.4.1 Shock and Vibration

Please do not give parts excess mechanical vibration during conveyance and too much shock such as falling and striking accidentally at mounting process. It creates a crack of the piece of crystal and damage to internal parts. There is a case where it stops operating.

2.4.2

(1)

2.4.2 Notes on Mounting

1 Through hole type

(1) When you mount crystal products on a PCB, please consider to keep certain gap at top of crystals as for instance please consider mounting other electrical components which are taller than the crystal products so as to avoid a shock from the upper side of parts.

(2)

(2) When you mount crystal products on PCB closely, please set up the interval of PCB's hole accurately with the terminal interval of crystal part.

(3)

(3) A lead portion gets fatigued by mechanical resonance of crystal and it may get the lead damaged when it mounts crystal products on a PCB but not stick. TEW recommends making parts close adherence to a PCB with being soldered.

(4)

(4) When crystal products are moved after mounting crystal products at PCB, it creates a crack at the glass part of a package which impacts the performance negatively.

(II) Surface Mount type

(1) (1) When the material of a mounting board has a different expansion coefficient from the material of a package under the environment which repeats a severe temperature change for a long period of time, there is a possibility

(2) of creating a crack in the fillet portion of solder.

(2) Please be advised that you could see negative impact in characteristics when excess shock was brought by automatic mounting machine. Since there is a possibility that a local impact increases along with making to a small diameter of the nozzle, please make test runs before starting volume production.

(3) (3) If a PCB is bent after soldering crystal products, it may create an exfoliation at soldering part by mechanical stress and also creates a crack at a package of crystal products.

2.4.3 2.4.3 Adhesives and a sealing agent

If crystal products have salt contacted or a corrosive material which make atmosphere such as a chlorine or sulfide gas for a long time, it has a minor chance but have a leakage at package by corrosion.

The dielectric constant of adhesives may cause change of frequency. Please carefully take deep consideration in terms of selection of the adhesives used for the circumference of a crystal product and a potting agent, etc.

2.4.4

350

3 2

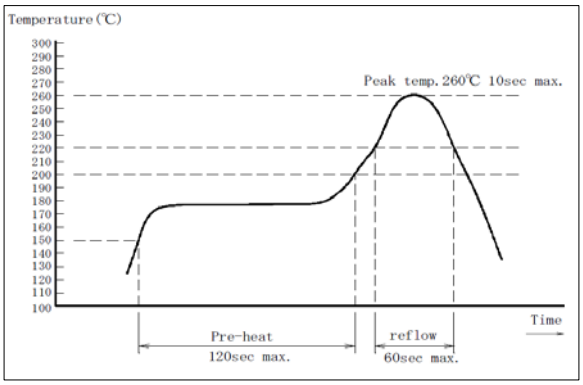
350

3 2

5

Au-Sn( ) TAS

278



5.

Fig.5. re-flow temperature profile

2.4.5

2.4.4 Soldering Conditions

(I)Through hole type

As a reference but 2 times for 3 seconds at approximately 350-degree C by hand solder heat is a condition, which you are allowed.

(II) Surface Mount type

As a reference but 2 times for 3 seconds at approximately 350-degree C by hand solder heat is a condition, which you are allowed.

Please refer to the figure 5 for surface-mount type soldering re-flow temperature profile.

In terms of the Au-Sn type crystals, we have to note that gold- tin will melt when the heat by 278 degrees C or more is given to crystals. Please pay an attention in terms of the peak temperature.

2.4.5 Washing Conditions

Ultrasonic washing is possible. However the wire connection inside of ceramic package may be damaged because of a possibility of bad influence by particular conditions. Please confirm with us before being used.

Also please do not wash any open type products.

2.4.6

Au-Sn( ) TAS
278

2.4.6 Removal Conditions

When you remove crystal products from a PCB at the time of occurring of an abnormality etc., please do not give it excess heating.

Moreover, please note that the characteristic might be deteriorated when heat by 278 or more is given to the TAS products which have sealed with Au-Sn (Tin-Gold).

2.4.7

(15 35)
(25 75)

(6)

(75
)

2.4.7 Storage Conditions

The crystal products shall be kept in normal temperature (+15 to +35 degrees C) and normal humidity (25 to 75%).

The above condition is a reference when power supply voltage is not impressed but we recommend to not leave it more than 6 months because of deterioration of quality by ageing and deterioration at surface of solder contact.

Please avoid any storage condition to generate such as heat and high humidity (75% or more of relative humidity), and corrosive gas.

Under a condition which is exposed to briny air and high humidity, please consider to select crystal products which have the hermetic sealed structure.

2.4.8

(6)

6 1

2.4.8 Handling of Prolonged Article in Custody

Please check surface conditions at soldering contacts and soldering performance for long term inventory (six months or more).

Please process an extra baking to crystal oscillators that passed one week after being opened prevention-of-moisture packing or after six months at prevention-of-moisture packing for the moisture removal prior to mount it.

2.4.9
(
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2.4.9 Use
Our products are manufactured on the assumptions that are used for general electric devices (communication devices, control apparatus, measurement apparatus, etc.).
Please ask us to consulate when you plan to use our parts with high safety applications, for instance in-vehicle apparatus or such as space apparatus, nuclear control apparatus and medical equipment related to a human life.

2.4.10

2.4.10 In Addition to this
When abnormality is found, please return it to our company as it is.
Please do not add any hand such as opening because other breakage may be induced secondarily and repair may be impossible by hands. You are requested to inform us details of abnormality so that investigation, repairing and corrective action can be done properly.

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1)
2) “
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(2007)

<Bibliography>
1) The catalog of our company
2) Quartz Industries Association of Japan Technical committee: "Description and application of a crystal device" Quartz Industries Association of Japan (2007)