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| RECIPIENT |
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SPECIFICATIONS

Product No. : X1A000061000800

MODEL : FC-12M

SPEC. No. : Q13-122-6A

DATE: Aug. 17. 2013

SEIKO EPSON CORPORATION

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SPECIFICATIONS

1. Application

- 1) This document is applicable to the crystal unit that are delivered to _____ from Seiko Epson Corp.
- 2) This product complies with RoHS Directive.
- 3) This Product supplied (and any technical information furnished, if any) by Seiko Epson Corporation shall not be used for the development and manufacture of weapon of mass destruction or for other military purposes. Making available such products and technology to any third party who may use such products or technologies for the said purposes are also prohibited.
- 4) This product listed here is designed as components or parts for electronics equipment in general consumer use. We do not expect that any of these products would be incorporated or otherwise used as a component or part for the equipment, which requires an systems, and medical equipment, the functional purpose of which is to keep extra high reliability, such as satellite, rocket and other space life.

2. Product No. / Model

The product No. of this crystal unit is X1A000061000800.
The model is FC-12M.

3. Packing

It is subject to the packing standard attached.

4. Warranty

Defective parts which originate with us are replaced free of charge in the case of defects being found with 12 months after delivery.

5. Amendment and/or termination

Amendment and/or termination of this specification is subject to the agreement between the two parties.

6. Contents

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[1] Absolute maximum ratings

| No. | Item | Symbol | Rating value | | | Unit | Note |
|-----|---------------------------|--------|--------------|------|-------|------|------------------------------------------------|
| | | | Min. | Typ. | Max. | | |
| 1 | Storage temperature range | T_stg | - 55 | | + 125 | °C | Suppose to be within CI STD at + 25 °C ± 3 °C. |
| 2 | Maximum level of drive | GL | | 0.5 | | μW | |

[2] Operating range

| No. | Item | Symbol | Rating value | | | Unit | Note |
|-----|-----------------------------|--------|--------------|------|------|------|------|
| | | | Min. | Typ. | Max. | | |
| 1 | Operating temperature range | T_use | - 40 | | + 85 | °C | |
| 2 | Level of drive | DL | 0.01 | 0.1 | 0.5 | μW | |
| 3 | Vibration mode | | Fundamental | | | | |

[3] Static characteristics

| No. | Item | Symbol | Value | Unit | Conditions | |
|-----|---------------------------------------|-----------------------|----------|--------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 1 | Nominal Frequency | f_nom | 32.768 | kHz | | |
| 2 | Frequency tolerance | f_tol | ± 20 | × 10 ⁻⁶ | CL = 9 pF Ta = + 25 ± 3°C Level of drive : 0.1 μW Not include aging | |
| 3 | Motional resistance | R1 | 90 Max. | kΩ | CI meter : Saunders 140B Level of drive : 0.5 μW | |
| 4 | Motional capacitance | C1 | 6.4 Typ. | fF | | |
| 5 | Shunt capacitance | C0 | 1.3 Typ. | pF | | |
| 6 | Frequency temperature characteristics | Turnover temperature | Ti | + 25 ± 5 | °C | Values are calculated by The frequencies at + 10, + 25, + 40°C with C-MOS circuit. |
| | | Parabolic coefficient | B | - 0.04 Max. | × 10 ⁻⁶ /°C ² | |
| 7 | Isolation resistance | IR | 500 Min. | MΩ | DC 100 V± 15, 60 seconds Between terminal # 1 and terminal # 2 | |
| 8 | Frequency Aging | f_age | ± 3 | × 10 ⁻⁶ /year | Ta = + 25 °C ± 3 °C Level of drive : 0.1 μW | |

[4] Environmental and Mechanical characteristics

| No. | Items | Value | Conditions |
|-----|-------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Shock resistance | *3Δ f/f : ± 20 × 10 ⁻⁶ | 100g dummy(Epson Toyocom Standard), Natural drop from 1 500 mm height on to the concrete. 3 directions × 10 times *2 |
| 2 | Vibration resistance | *3Δ f/f : ± 5 × 10 ⁻⁶ | 10 Hz to 55 Hz amplitude 0.75 mm 55 Hz to 500 Hz acceleration 98 m/s ² 10 Hz → 500 Hz → 10 Hz 15 min./cycle 6 h (2 hours , 3 directions) *2 |
| 3 | Soldering heat resistance | *3Δ f/f : ± 8 × 10 ⁻⁶ | For convention reflow soldering furnace (3 times) |
| 4 | High temperature storage | *3Δ f/f : ± 15 × 10 ⁻⁶ | + 125 °C × 1 000 h *1 |
| | | *3Δ f/f : ± 7 × 10 ⁻⁶ | + 85 °C × 1 000 h *1 |
| 5 | Low temperature storage | *3Δ f/f : ± 10 × 10 ⁻⁶ | -55 °C × 1 000 h *1 |
| 6 | High temperature and humidity | *3Δ f/f : ± 10 × 10 ⁻⁶ | + 85 °C × 85%RH × 1 000 h *1 |
| 7 | Temperature cycle | *3Δ f/f : ± 10 × 10 ⁻⁶ | - 55 °C ↔ + 125 °C 30 minutes at each temperature × 100 cycles *1 |
| 8 | Sealing | *3 1 × 10 ⁻⁸ hPa·1 / s Max. | For He leak detector |
| 9 | Shear | No peeling-off at a soldered part | 10 N press for 10 ± 1 s. Ref. IEC 60068-2-21 |
| 10 | Pull - off | No peeling-off at a soldered part | 10 N press for 10 ± 1 s. Ref. IEC 60068-2-21 |
| 11 | Substrate bending | No peeling-off at a soldered part | Bend width reaches 3 mm and hold for 5 s ± 1 s × 1 time Ref. IEC 60068-2-21 |
| 12 | Solderability | More than 95 % covered by solder | Dip into methyl alcohol solution of rosin for 3 sec. at + 235 ± 5 °C |

< Notes >

*1 Each test shall be done independently.

*2 Measuring 2 h to 24 h later leaving in room temperature after each test. Drive level : 0.5 μW

*3 Pre conditionings

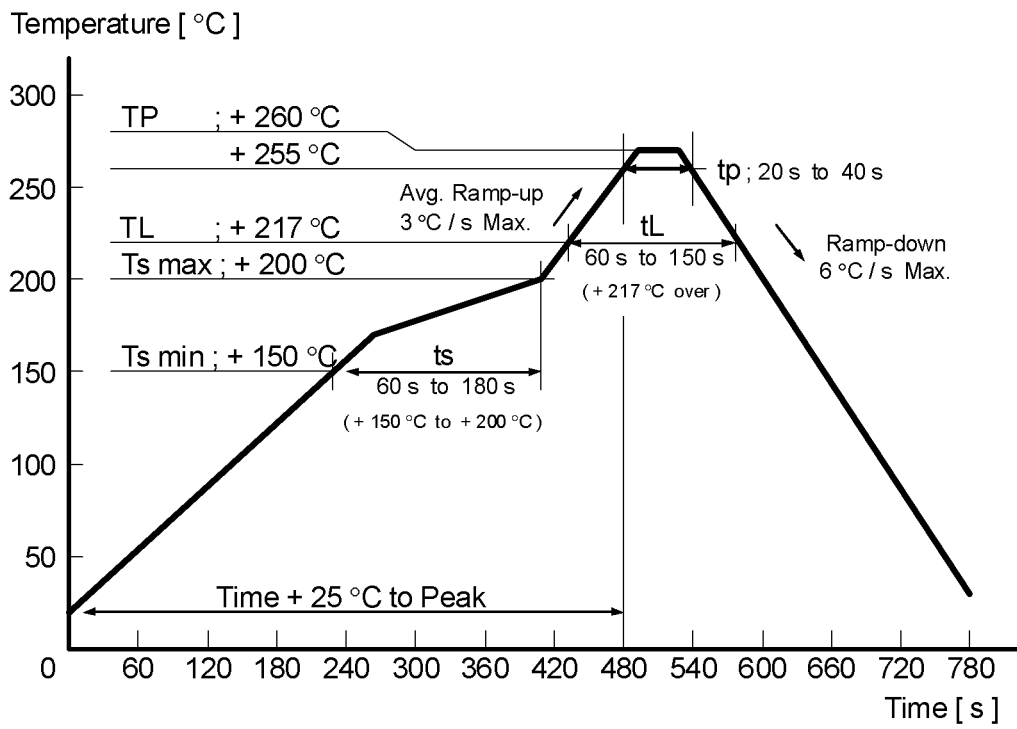
1. + 125 °C × 24 h to + 85 °C × 85 % × 168 h ± 1 h → reflow 3 times

2. Initial value shall be after 24 h at room temperature.

Shift of series resistance at before and after the test should be less than ± 30 % or less than ± 20 kΩ.

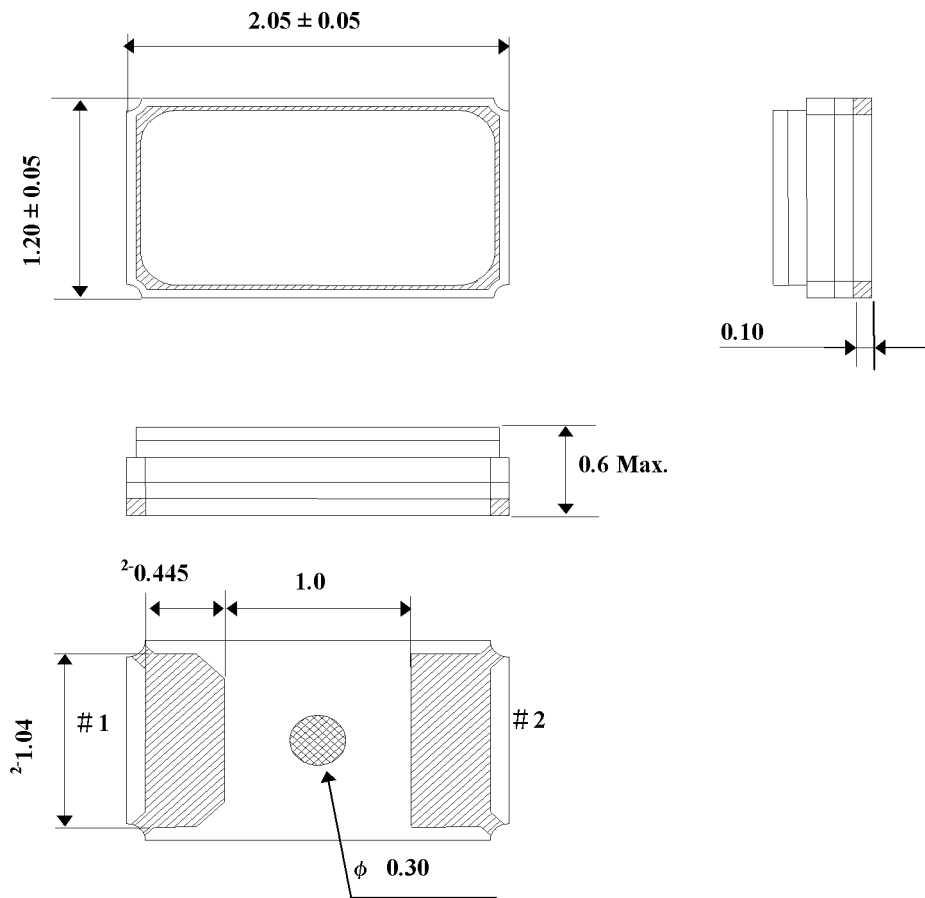
In case high temperature storage(+ 125 °C × 1 000 h), Soldering heat resistance, shift of series resistance at before and after the test should be less than ± 40 % or ± 30 kΩ.

◆ Reflow condition (follow to IPC / JEDEC J-STD-020C)

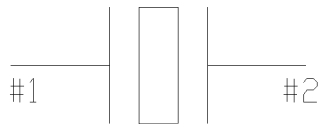


[5] Dimensions and Marking layout

1. Dimensions



2. Internal Connection

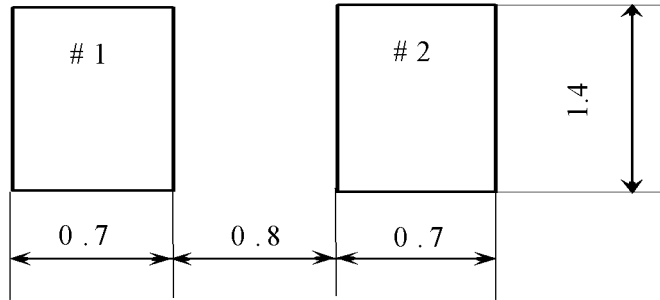


Package : Ceramic(Al_2O_3)
 Terminal Au plate : $0.5 \mu\text{m}$ Min.
 Lid : Metal

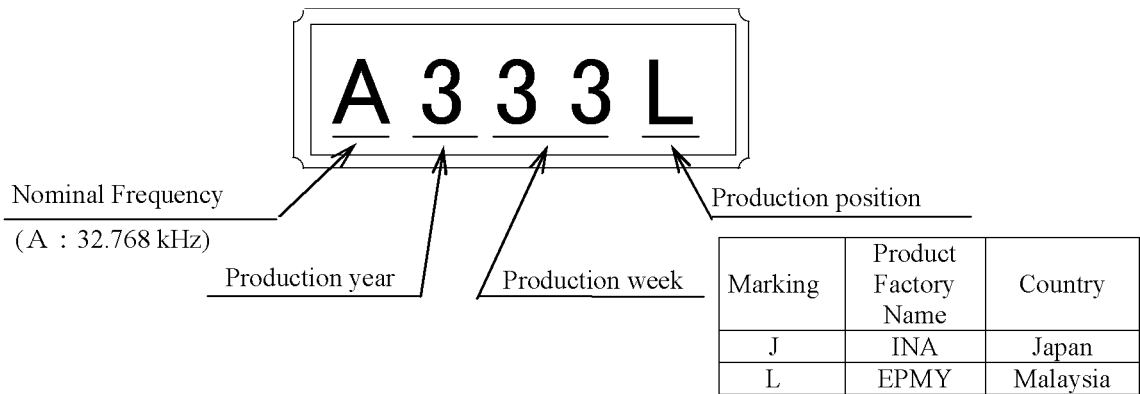
| | | | |
|------|--------|------|----------|
| Type | FC-12M | Unit | 1 = 1 mm |
|------|--------|------|----------|

3. Recommended soldering pattern

Unit : 1 = 1 mm



4. Marking layout



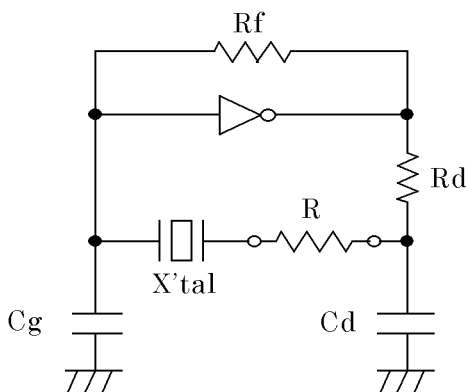
* The above marking layout shows only marking contents and their approximate position and it is not for font, size and exact position.

| | | | |
|------|--------|------|----------|
| Type | FC-12M | Unit | 1 = 1 mm |
|------|--------|------|----------|

[6] Notes

1. Max three (3) times reflow is allowed. Once miss soldering is happened, hand work soldering by soldering iron is recommended. (+ 350 °C × within 5 s)
2. Patterning should be followed by our recommended one.
3. Applying excessive excitation force to the crystal resonator may cause deterioration damage.
4. Unless adequate negative resistance is allocated in the oscillation circuit, start up time of oscillation may be increased, or no oscillation may occur.

How to check the negative resistance.



- (1) Connect the resistance (R) to the circuit in series with the crystal resonator.
- (2) Adjust R so that oscillation can start (or stop).
- (3) Measure R when oscillation just start (or stop) in above (2).
- (4) Get the negative resistance
 $-R = R + CI$ value.
- (5) Recommended -R
 $|-R| > CI \times (5 \sim 10)$

5. The shortest patterning line on board is recommendable.
Too long line on board may cause of abnormal oscillation.
6. This device must be stored at the normal temperature and humidity conditions before mounting on a board.
7. Too much exciting shock or vibration may cause deterioration on damage.
Depending on the condition such as a shock in assembly machinery, the products may be damaged.
Please check your condition in advance to maintain shock level to be smallest.
8. Depending on the conditions, ultrasonic cleaning may cause resonant damage of the internal crystal resonator. Since we are unable to determine the conditions (type of cleaning unit, power, time, conditions inside the bath, etc.) to be used in your company, we cannot guarantee the safety of this unit when it is cleaned in an ultrasonic cleaner.
9. Please refer to packing specification regarding how to storage the products in the pack.

TAPING SPECIFICATION

1. APPLICATION

This document is applicable to FC-12M.

2. CONTENTS

| Item No. | Item | Page |
|----------|----------------------|--------|
| [1] | Taping specification | 1 to 2 |
| [2] | Inner carton | 3 |
| [3] | Shipping carton | |
| [4] | Marking | 4 |
| [5] | Quantity | |
| [6] | Storage environment | |
| [7] | Handling | |

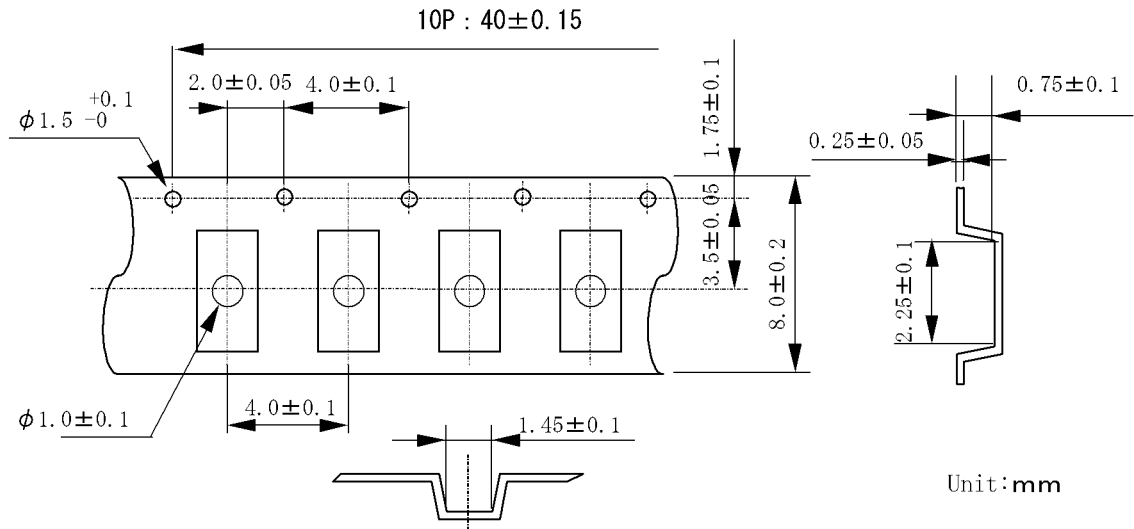
[1] Taping specification

Subject to EIA-481 , IEC 60286.

(1) Tape dimensions TE1204L

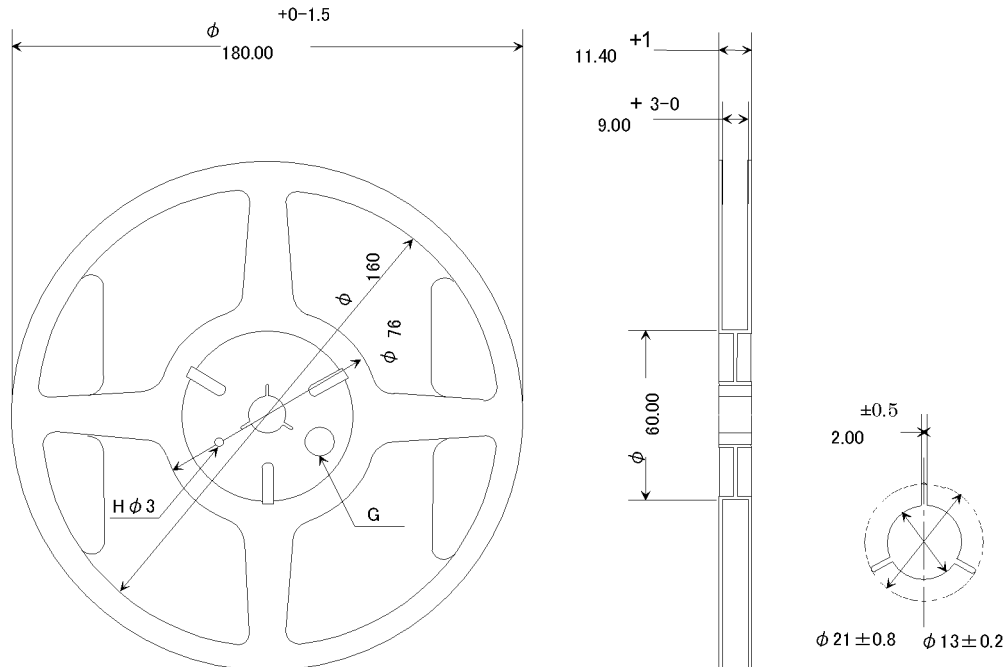
Material of the Carrier Tape : PS (Electrically conductive)

Material of the Top Tape : PET+PE



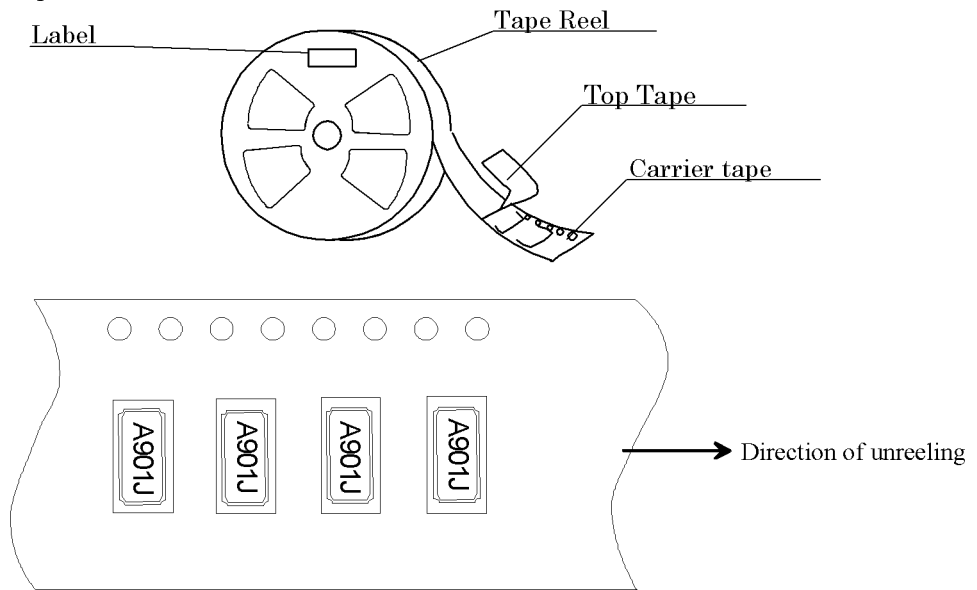
(2) Reel dimensions

Material of the Reel : PS

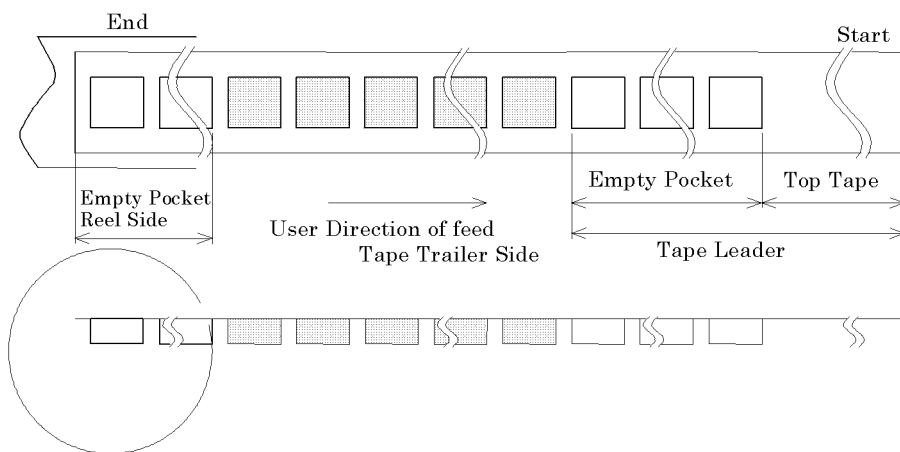


Form and Size of reel window shows are one of the example

(3) Packing
 (a) Tape & Reel



(b) Start & End Point

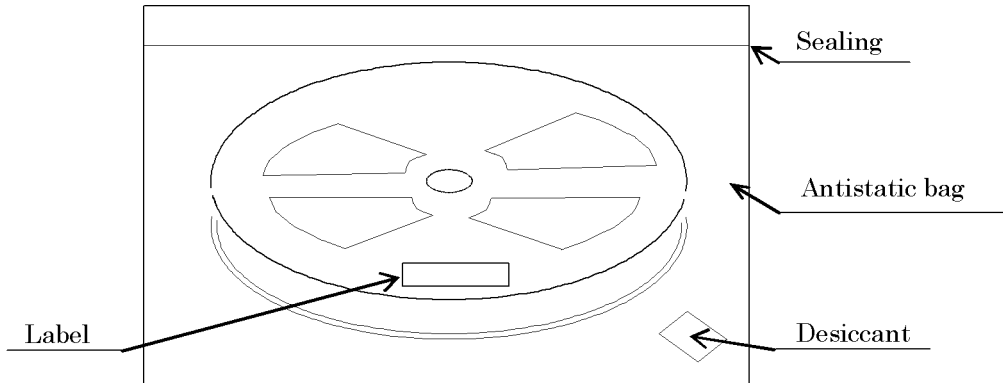


| Item | | Empty Space |
|--------------|--------------|---------------|
| Tape Leader | Top Tape | Min. 1 000 mm |
| | Carrier Tape | Min. 80 mm |
| Tape Trailer | Top Tape | Min. 0 mm |
| | Carrier Tape | Min. 80 mm |

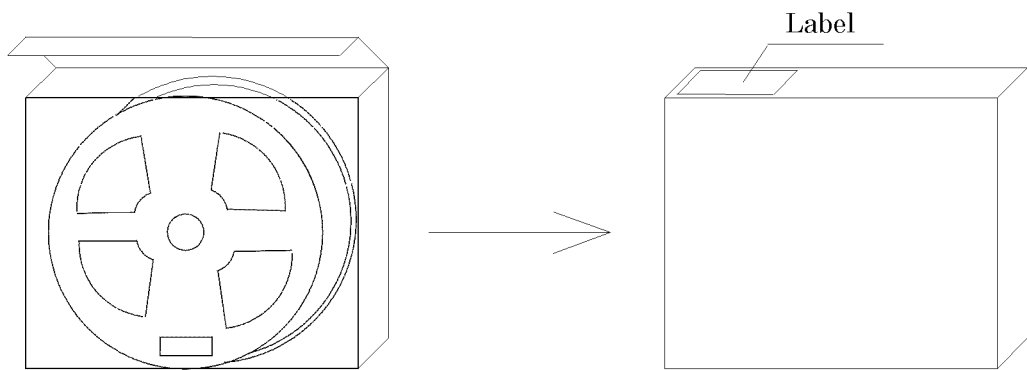
- (4) Peel force of the cover tape
 (a) angle : cover tape during peel off and the direction of unreeling shall be 165° to 180°.
 (b) peel speed : 300 mm/min

[2] Inner Carton

a) Packing to antistatic bag

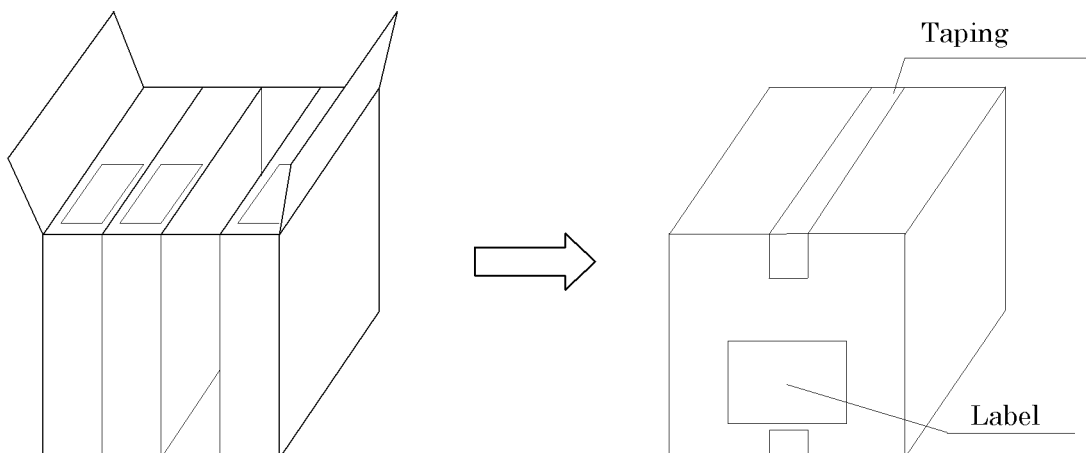


b) Packing to innercarton



[3] Shipping Carton

- Put inner boxes into an outer box.
- If there are room in the outer box, material is put in a shock absorbing together.



[4] Marking

- (1) Reel marking
 - Reel marking shall consist of :
 - 1) Parts name
 - 2) Quantity
 - 3) Manufacturing Date or symbol
 - 4) Manufacturer's Date or symbol
 - 5) Others (if necessary)
- (2) Inner carton marking
 - Same as Reel marking.
- (3) Shipping carton marking
 - Shipping carton marking shall consist of :
 - 1) Parts name
 - 2) Quantity

[5] Quantity

- 3 000 pcs./reel

[6] Storage environment

- (1) Before open the packing, we recommend to keep less than +30 °C and 85 %RH of Humidity, and to use it less than 6 months after delivery.
- (2) We recommend to open Package in immediately before use. After open Package, We recommend to keeps less than 6 month. No need dry air before soldering work if it is less than temperature +30 °C, 85 humidity %RH.
- (3) Not to storage with some erosive chemicals.
- (4) Nothing is allowed to put on the reel or carton to prevent mechanical damage

[7] Handling

To handle with care to prevent the damage of tape, reel and products.

PROCESS QUALITY CONTROL

FC-12M

No. C-0702-AIE-2

2008/11/14

| Manufacturing process chart | No. | Section In Charge | Standard | Inspection Control Item | Inspection Methods | Instruments | Record |
|-----------------------------|-----|----------------------------------------|----------------------------------------------------------|-------------------------------------------------------|------------------------------------|------------------------------------------------------|------------------------------------|
| | 1 | Inspection Section (INA Plant QA) | Purchasing Specification Incoming Inspection Standard | Appearance Demension | Sampling Sampling | Microscope Tool Microscope | In-coming Inspection Data Sheet |
| | 2 | INA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 3 | INA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 4 | INA Plant | Manufacturing Instruction Sheet | — | — | — | — |
| | 5 | INA Plant | Manufacturing Instruction Sheet | — | — | — | — |
| | 6 | INA Plant | Manufacturing Instruction Sheet | Frequency | 100% Inspection | Frequency Adjustment Machine | Data Sheet |
| | 7 | INA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 8 | INA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 9 | INA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 10 | INA Plant | Manufacturing Instruction Sheet | Frequency Crystal Inpedance | 100% Inspection 100% Inspection | Characteristics In- spection Machine | Process Data Sheet |
| | 11 | INA Plant | Specification Outgoing Inspection Standard | Electrical Characteristics Appearance Demension | Sampling Sampling Sampling | Measuring Equipment Microscope Tool Microscope | Outgoing Inspection Data Sheet |
| | 12 | INA Plant | Packing Instruction Daily Shipping List | Customers Type Quantity | — — — | — — — | Shipping List |

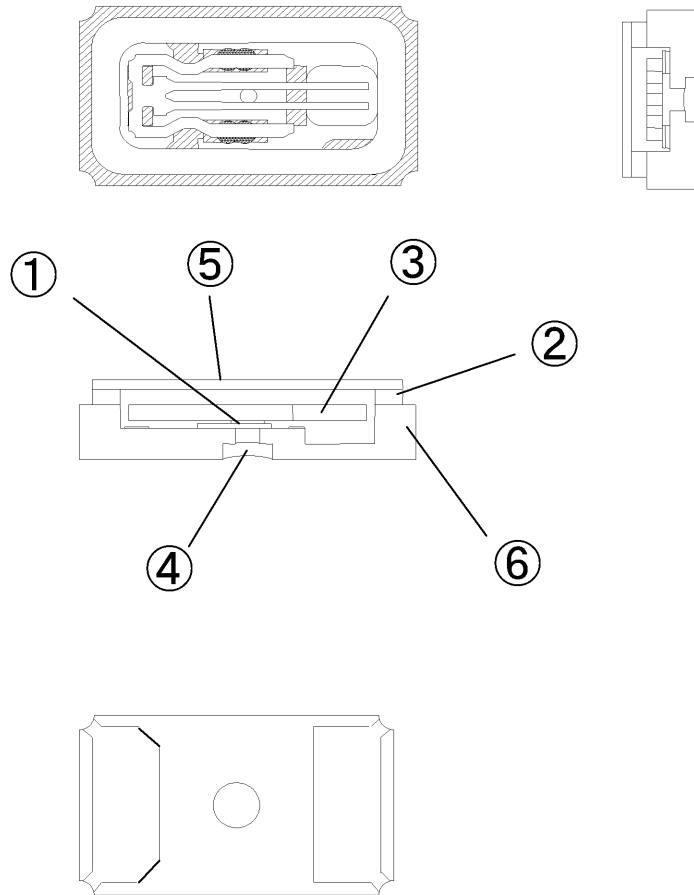
PROCESS QUALITY CONTROL

FC-12M
No. C-0702-AME-1

2010/1/27

| Manufacturing process chart | No. | Section In Charge | Standard | Inspection Control Item | Inspection Methods | Instruments | Record |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------|----------------------------------------------------------|--------------------------------------------|------------------------------------|-----------------------------------------|------------------------------------|
| <p>Crystal</p> <p>Base, Lid</p> <p>1 In-coming Inspection</p> <p>2 Crystal Setting</p> <p>3 Mounting</p> <p>4 US Cleaning</p> <p>5 Annealing</p> <p>6 Frequency Adjustment</p> <p>7 Lid Sealing</p> <p>8 Hermetic Sealing</p> <p>9 Marking</p> <p>10 Finish Products Inspection & Taping</p> <p>11 Outgoing Inspection</p> <p>12 Packing</p> <p>Shipping</p> <p>Base, Lid</p> <p>Ball</p> | 1 | Inspection Section (AKITA Plant QA) | Purchasing Specification Incoming Inspection Standard | Appearance Demension | Sampling Sampling | Microscope Tool Microscope | In-coming Inspection Data Sheet |
| | 2 | MALAYSIA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 3 | MALAYSIA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 4 | MALAYSIA Plant | Manufacturing Instruction Sheet | -- | -- | -- | -- |
| | 5 | MALAYSIA Plant | Manufacturing Instruction Sheet | -- | -- | -- | -- |
| | 6 | MALAYSIA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Frequency Adjustment Machine | Data Sheet |
| | 7 | MALAYSIA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 8 | MALAYSIA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 9 | MALAYSIA Plant | Manufacturing Instruction Sheet | Appearance | 100% Inspection | Microscope | Process Data Sheet |
| | 10 | MALAYSIA Plant | Manufacturing Instruction Sheet | Frequency Crystal Impedance | 100% Inspection 100% Inspection | Characteristics In- spection Machine | Process Data Sheet |
| | 11 | MALAYSIA Plant | Specification Outgoing Inspection Standard | Appearance Electrical Characteristics | 100% Inspection Sampling | Microscope Measuring Equipment | Outgoing Inspection Data Sheet |
| | 12 | MALAYSIA Plant | Packing Instruction Daily Shipping List | Demension Customers Type Quantity | Sampling -- -- -- | Tool Microscope -- -- -- | Shipping List |

Structure diagram FC-12M



LIST

| | Name of part | Material |
|---|------------------|-------------------------------------------|
| ① | Crystal Adhesive | Ag Paste |
| ② | Sealing | Seal ring |
| ③ | Crystal chip | tuning fork |
| ④ | Sealing | Au/Ge |
| ⑤ | Lid | Kovar |
| ⑥ | Package | Ceramic (Al ₂ O ₃) |

RELIABILITY TEST DATA

Product Name : FC-12M

The Company evaluation condition

We evaluate environmental and mechanical characteristics by the following test condition .

No. F-C-0702-06-004E

| No. | ITEM | TEST CONDITIONS | VALUE *1 *2 | | TEST Qty [n] | FAIL Qty [n] |
|-----|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|----------------------------------------------------------|----------------|----------------|
| | | | $\Delta f / f$ [1×10^{-6}] | | | |
| 1 | Shock resistance | 100 g dummy (ETC Standard) drop from 1 500 mm height on to the concrete 3 directions 10 times | *3 | ± 20 | 22 | 0 |
| 2 | Vibration resistance | 10 Hz to 55 Hz amplitude 0.75 mm 55 Hz to 500 Hz acceleration 98 m/s ² 10 Hz → 500 Hz → 10 Hz 15 min / cycle 6 h (2 h × 3 directions) | *3 | ± 5 | 22 | 0 |
| 3 | Resistance to soldering heat | IPC/JEDEC J-STD-020C Reflow (3 times) | | ± 8 | 22 | 0 |
| 4 | High temperature storage | a) +125°C × 1 000 h | *3 | a) ± 15 | a) 22 | a) 0 |
| | | b) +85 °C × 1 000 h | *3 | b) ± 7 | b) 22 | b) 0 |
| 5 | Low temperature storage | -55 °C × 1 000 h | *3 | ± 10 | 22 | 0 |
| 6 | Temperature humidity storage | +85 °C × 85 %RH × 1 000 h | *3 | ± 10 | 22 | 0 |
| 7 | Temperature cycle | -55 °C ⇔ +125 °C 30 min at each temp. 100 cycles | *3 | ± 10 | 22 | 0 |
| 8 | Sealing | For He leak detector | *3 | 1×10^{-8} hPa·l / s Max. | 11 | 0 |
| 9 | Shear | 10 N press for 10 s ± 1 s Ref. IEC 60068-2-21 | | No peeling - off at a solder part | 11 | 0 |
| 10 | Pull - off | 10 N press for 10 s ± 1 s Ref. IEC 60068-2-21 | | No peeling - off at a solder part | 11 | 0 |
| 11 | Substrate bending | Bend width reaches 3 mm and hold for 5 s ± 1 s × 1 time Ref. IEC 60068-2-21 | | No peeling - off at a solder part | 11 | 0 |
| 12 | Solderability | Dip termination into solder bath at +235 °C ± 5 °C for 3 s (Using Rosin Flux) | | Termination must be 95 % covered with fresh solder | 11 | 0 |

Notes

*1 Each test shall be done independently.

*2 Measuring 2 h to 24 h later leaving in room temperature after each test. Drive level : 0.5 μ w

*3 Pre conditionings

1. +125 °C × 24 h to +85 °C × 85 % × 168 h ± 1 h → reflow 3 times

2. Initial value shall be after 24 h at room temperature.

Shift of series resistance at before and after the test should be less than ± 30 % or less than ± 20 k Ω .

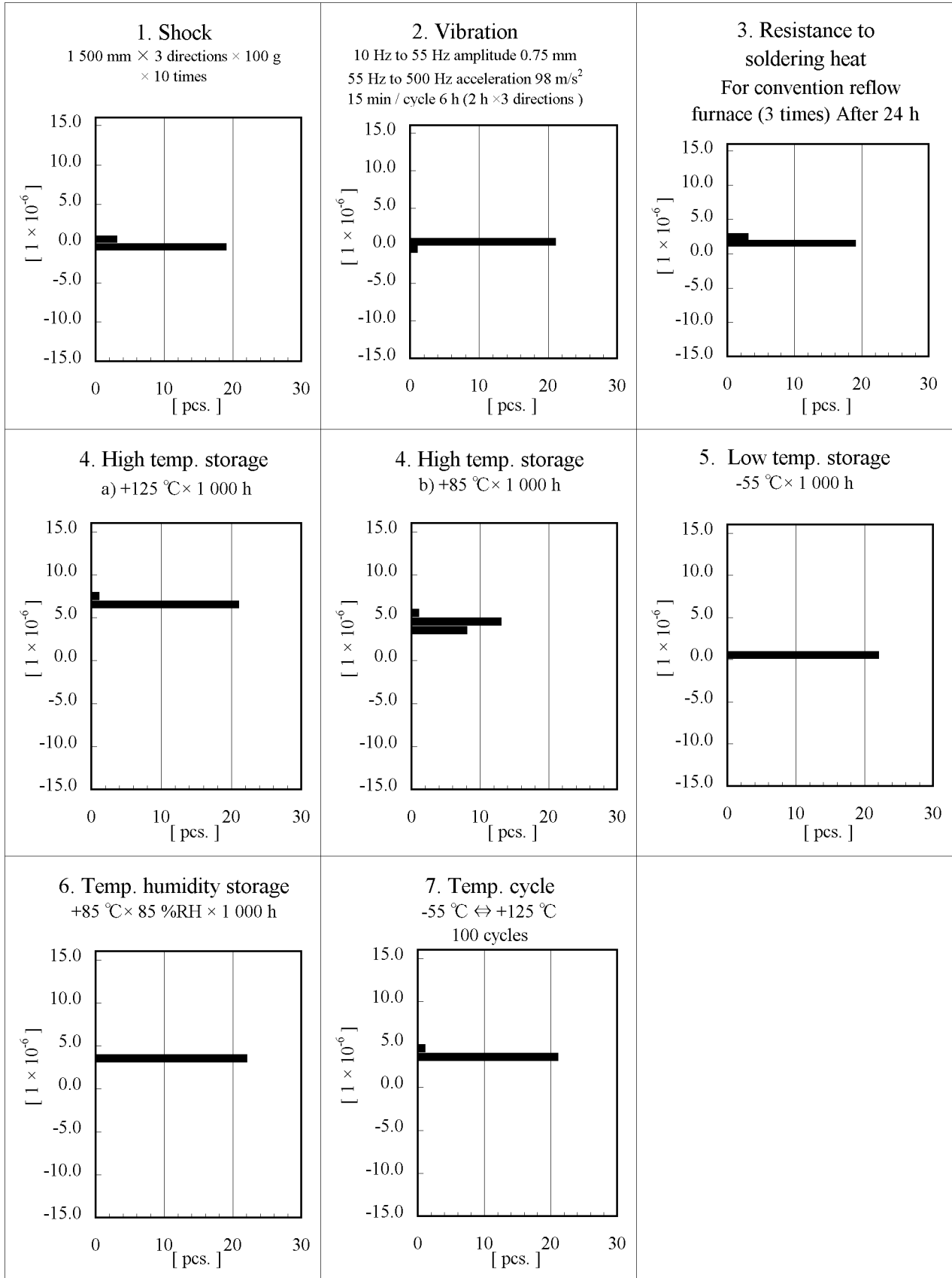
In case high temperature storage(+125 °C × 1 000 h), Soldering heat resistance, shift of series resistance at before and after the test should be less than ± 40 % or ± 30 k Ω .

Qualification Data

Product Name : FC-12M

$\Delta f / f$

No. F-C-0702-06-005E

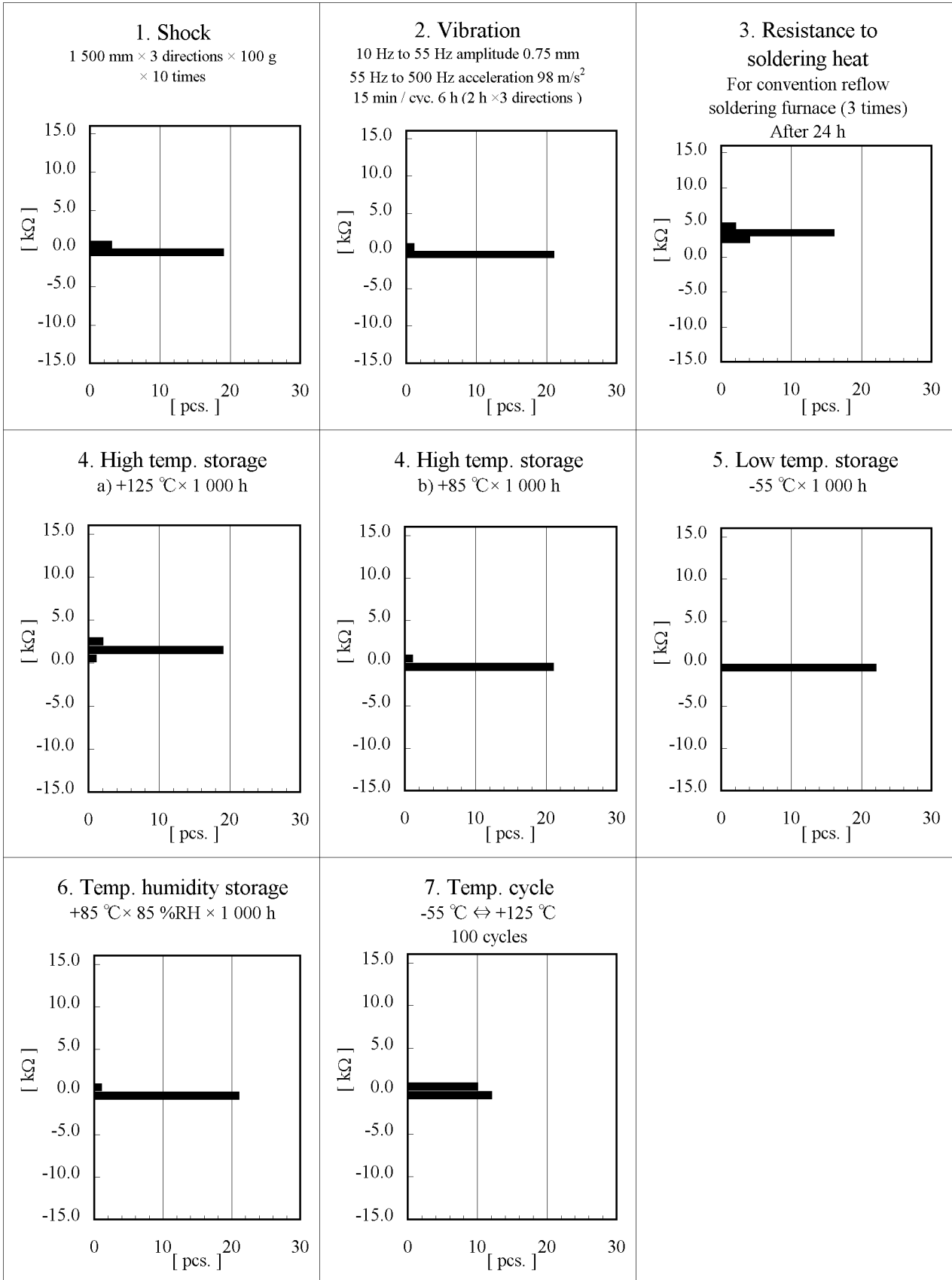


Qualification Data

Product Name : FC-12M

Δ CI

No. F-C-0702-06-006E



Qualification Data