

| RECIPIENT |
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| |

SPECIFICATIONS

| | |
|--------------------|------------------------|
| Model : | FC-135 |
| | 32.768kHz |
| Spec. No. : | 9pF+/-20ppm |
| Date : | Nov. 25th, 2005 |

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SPECIFICATIONS

1. Application

This document is applicable to the crystal resonators that are delivered to **customer** from EPSON TOYOCOM Corp.

This product is not authorized for use as critical components in life support device or systems.

2. Production code

This crystal resonator's production code is FC-135.

3. Packing

It is subject to the packing standard of EPSON TOYOCOM Corp.

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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Level <1.0uW is also acceptable.

[1] Absolute maximum ratings

| Item | Symbol | Rating value |
|---------------------|--------|-----------------|
| Storage temperature | TSTG | -55°C to +125°C |
| Maximum drive level | DL | 1.0 μ W |

[2] Operating range

| Item | Symbol | Value | | |
|-----------------------------|--------|--------------|-------------|-------------|
| | | Min. | Typ. | Max. |
| Operating temperature range | TOPR | -40°C | | +85°C |
| Drive level | DL | 0.01 μ W | 0.1 μ W | 0.5 μ W |
| Vibration mode | | Fundamental | | |

[3] Static characteristics

| Item | Symbol | Value | |
|-------------------------|--------------|---|--|
| Frequency | f_1 | 32.768 kHz | |
| Frequency tolerance | $\Delta f/f$ | $\pm 20 \times 10^{-6}$ | CL = 9 pF Max: <=9pF Ta = +25 \pm 3°C, Drive level : 0.1 μ W Not include aging |
| Series resistance | R1 | 70 k Ω Max. Max: <80K | |
| Motional capacitance | C1 | Typ. 3.4 fF | CI meter : Saunders 140B Drive level : 0.5 μ W |
| Shunt capacitance | C0 | Typ. 1.2 pF Max: <2pF | |
| Turnover temperature | θT | +25 \pm 5 °C | Values are calculated by the frequencies at +10, +25, +40°C with C-MOS circuit. |
| Temperature coefficient | a | $-4.0 \times 10^{-8} / ^\circ\text{C}^2$ Max. | |
| Isolation resistance | IR | 500 M Ω Min. | DC 100V, 60 seconds Between terminal #1 and terminal #2 |
| Aging | fa | $\pm 3 \times 10^{-6}$ / year | Ta = +25 °C \pm 3 °C Drive level : 0.1 μ W |

[4] Environmental and Mechanical characteristics

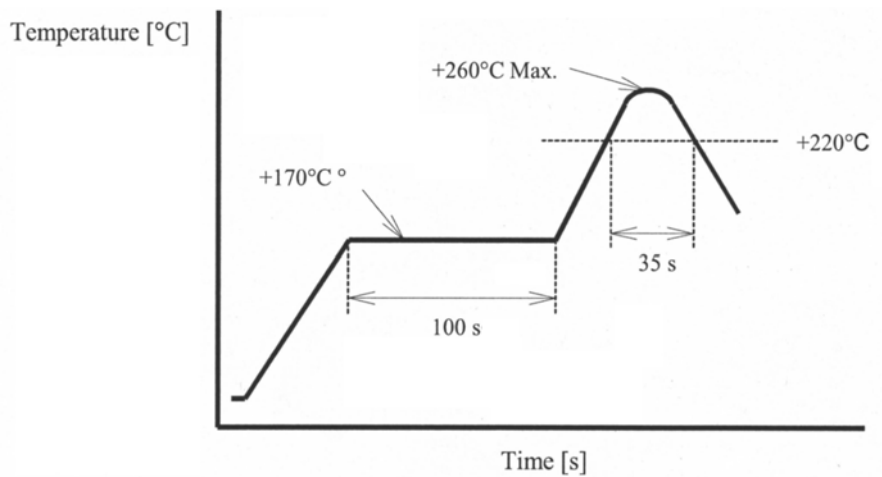
| No. | Items | Value | Conditions |
|-----|---------------------------------------|---|---|
| 1 | Shock resistance | $*\Delta f/f : \pm 8 \times 10^{-6}$ | 100g dummy(SEIKO EPSON Standard), Free drop from 1500 mm height on to the concrete. 3 directions \times 10 cycles *2 |
| 2 | Vibration resistance | $*\Delta f/f : \pm 3 \times 10^{-6}$ | 10 ~ 500 Hz 1.5mm p-p or 10G 10 Hz \rightarrow 500 Hz \rightarrow 10 Hz : 15 min./cycle Log. Sweep 6 h (2 hours \times 3 directions) *2 |
| 3 | Soldering heat resistance | $\Delta f/f : \pm 5 \times 10^{-6}$ | Testing Process 1) Leave in $+85 \pm 2^\circ\text{C} \times 85 \pm 5\%\text{RH} \times 24 \pm 1\text{Hrs}$ 2) Measure (Reference data) 24 hours later at leaving in room temperature after item 1) treatment 3) Treat the Reflow 2 times by the following profile in the next page 4) Measure the data at 1 hour and 24 hours after the item 3) treatment |
| 4 | High temperature storage | $*\Delta f/f : \pm 10 \times 10^{-6}$ | $+125^\circ\text{C} \times 1000$ hours *1 |
| | | $*\Delta f/f : \pm 7 \times 10^{-6}$ | $+85^\circ\text{C} \times 1000$ hours *1 |
| 5 | Low temperature storage | $*\Delta f/f : \pm 10 \times 10^{-6}$ | $-55^\circ\text{C} \times 1000$ hours *1 |
| 6 | High temperature and humidity storage | $*\Delta f/f : \pm 10 \times 10^{-6}$ | $+85^\circ\text{C} \times 85\% \text{RH} \times 1000$ hours *1 |
| 7 | Temperature cycle | $*\Delta f/f : \pm 10 \times 10^{-6}$ | $-55^\circ\text{C} \leftrightarrow +125^\circ\text{C}$ 30 minutes at each temperature \times 100 cycles *1 |
| 8 | Aging | $*\Delta f/f : \pm 3 \times 10^{-6}$ | $+25 \pm 3^\circ\text{C} \times 1$ year (No-bias) |
| | | $*\Delta f/f : \pm 3 \times 10^{-6}$ | $+25 \pm 3^\circ\text{C} \times 1$ year (Bias by SEIKO EPSON STD circuit) |
| 9 | Sealing | $1 \times 10^{-8} \text{ hPa} \cdot \text{l} / \text{s}$ Max. | For He leak detector |
| 10 | Shear | No peeling-off at a soldered part | 10 N press for 10 ± 1 s. Ref. IEC 60068-2-21 |
| 11 | Pull - off | No peeling-off at a soldered part | 10 N press for 10 ± 1 s. Ref. IEC 60068-2-21 |
| 12 | Substrate bending | No peeling-off at a soldered part | Bend width reaches 3 mm and hold for $5 \text{ s} \pm 1 \text{ s} \times 1$ time Ref. IEC 60068-2-21 |
| 13 | Solvent resistance | The marking shall be legible | Ref. JIS C 0052 or IEC 60068-2-45 |

< Notes >

1. *1 Each test done independently.
2. *2 Measuring 2 h to 24 h later leaving in room temperature after each test. Drive level : 0.5 μ W
3. *3 Pre conditionings (Treat the Reflow 2 times with the following profile) Initial value shall be after 24 h at room temperature.
Shift of series resistance at before and after the test should be less than ± 20 % or less than $\pm 15 \text{ k}\Omega$.
In case high temperature storage ($+125^\circ\text{C} \times 1\,000 \text{ h}$), Soldering heat resistance, shift of series resistance at before and after the test should be less than ± 30 % or $\pm 20 \text{ k}\Omega$.

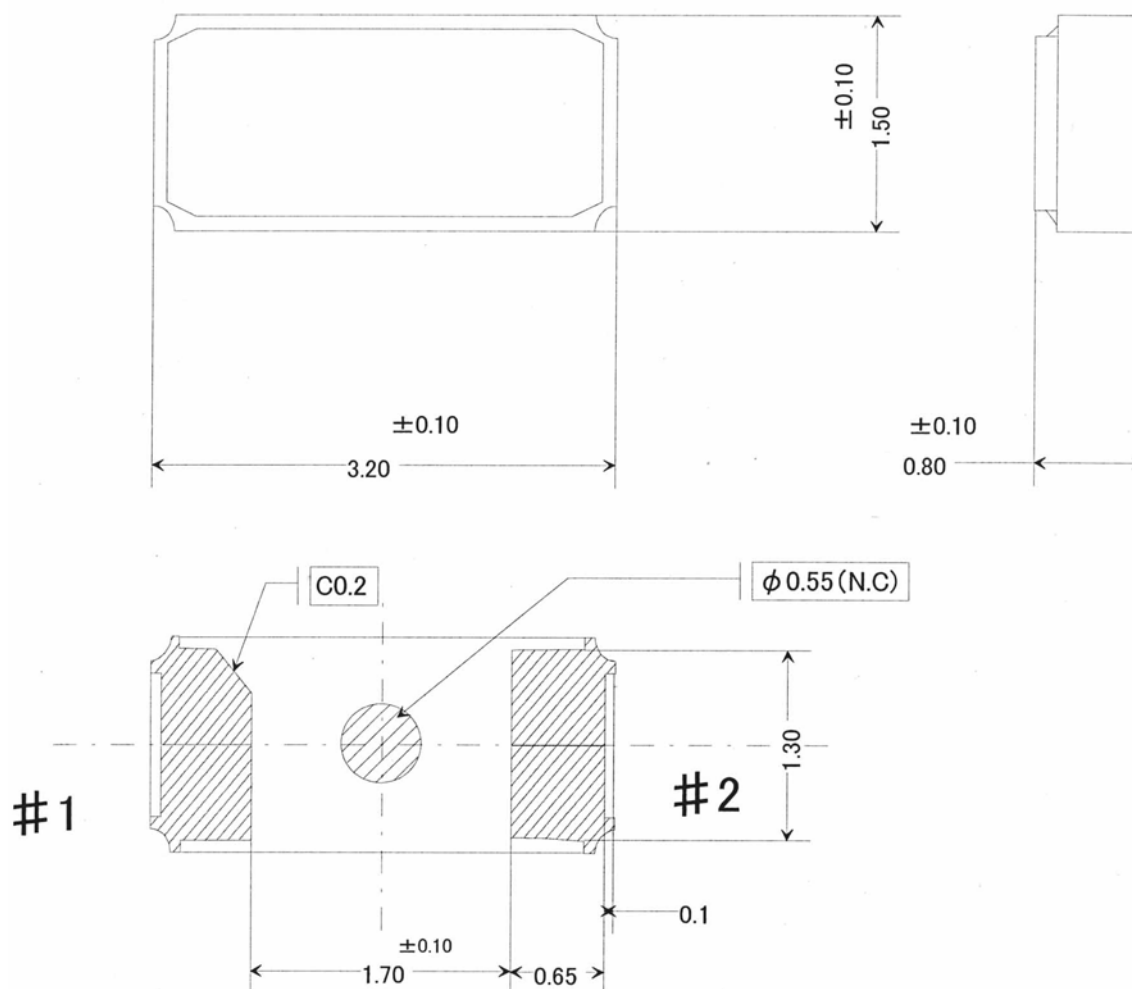
◆ Infrared-reflow

| | | | |
|-------------------------|------------------------|------------------|-----------|
| Pre heating temperature | : $+170^\circ\text{C}$ | Pre heating time | : 100 [s] |
| Heating temperature | : $+220^\circ\text{C}$ | Heating time | : 30 [s] |



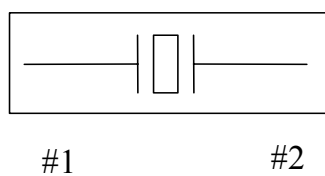
[5] Dimensions and Marking layout

1. Dimensions



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

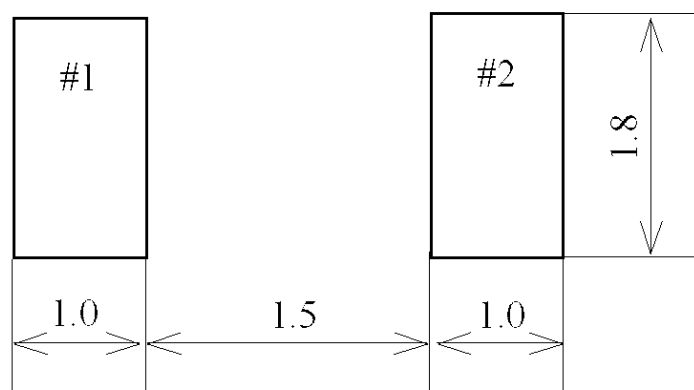
2. Internal Connection



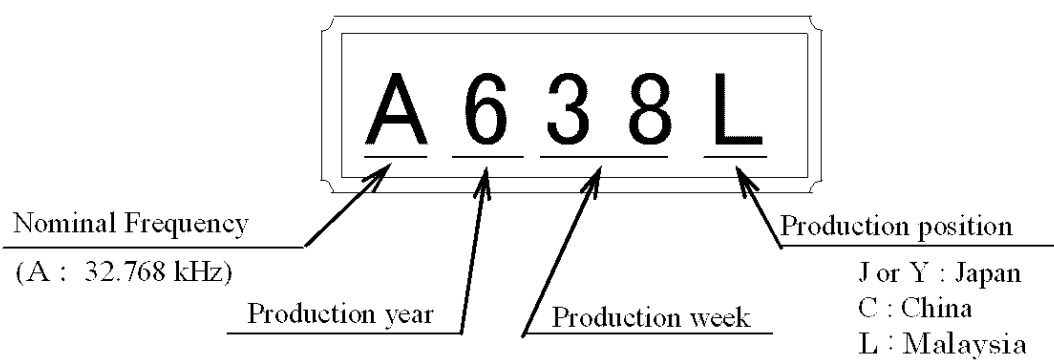
| Type | FC-135 | Terminal treatment | Solder plate | Unit | 1 = 1 mm |
|------|--------|--------------------|--------------|------|----------|
|------|--------|--------------------|--------------|------|----------|

3. Recommended soldering pattern

Unit : 1 = 1 mm



4. Marking layout



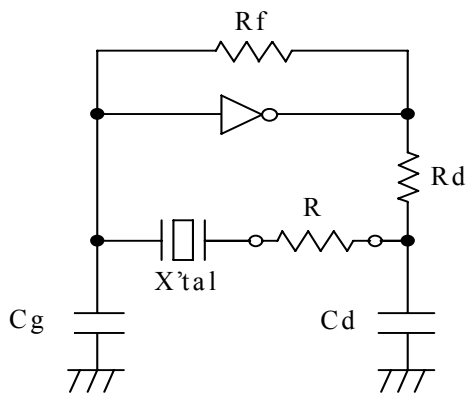
* The above marking layout shows only marking contents and their approximate position and it is not for font, size and exact position.

| | | | |
|------|--------|------|--------|
| Type | FC-135 | Unit | 1=1 mm |
|------|--------|------|--------|

[6] Notes

1. Max two (2) times reflow is allowed. Once miss soldering is happened, hand work soldering by soldering iron is recommended. ($+350^{\circ}\text{C} \times \text{within } 5 \text{ s}$)
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
 $-R = R + CI \text{ value.}$
- (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. To avoid mull function, no pattern under or near the crystal is allowed.
Solder paste should be more than $150 \mu\text{m}$ thickness.
7. This device must be stored at the normal temperature and humidity conditions before mounting on a board.
8. 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.
9. 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.
10. Ink marking may be damaged by some kind of solvent, please take precautions when choosing solvent by your selves.
11. Please refer to packing specification regarding how to storage the products in the pack.

EPSON**SEIKO EPSON Quartz Device Div.**Date of Issue Sep. 15, 2004**RELIABILITY TEST DATA****Product Name : FC-135**Signature T. Yamagisawa

The Company evaluation condition

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

No. C-0102-01

| No. | ITEM | TEST CONDITIONS | VALUE *1 *2 | TEST | FAIL |
|-----|---------------------------------|---|--|--------------|--------------|
| | | | $\Delta f / f$ [1×10^{-6}] | Qty [n] | Qty [n] |
| 1 | Shock | 100 g dummy (SEIKO EPSON Standard) drop from 1 500 mm height on to the concrete 3 directions 10 times | *3 ± 8 | 44 | 0 |
| 2 | Vibration | 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 x 3 directions) | *3 ± 3 | 22 | 0 |
| 3 | Resistance to soldering heat | For convention reflow soldering furnace (2 times) | ± 5 | 22 | 0 |
| 4 | High temperature storage | a) +125°C x 1 000 h | *3 a) ± 10 | a) 22 | a) 0 |
| | | b) +85 °C x 1 000 h | *3 b) ± 7 | b) 22 | b) 0 |
| 5 | Low temperature storage | -55 °C x 1 000 h | *3 ± 10 | 22 | 0 |
| 6 | Temperature humidity storage | +85 °C x 85 %RH x 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 | 1×10^{-8} hPa · l / s Max. | 11 | 0 |
| 9 | Shear | 20 N press for 10 s ± 1 s Ref. IEC 60068-2-21 | No peeling - off at a solder part | 11 | 0 |
| 10 | Pull - off | 20 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 x 1 time Ref. IEC 60068-2-21 | No peeling - off at a solder part | 11 | 0 |
| 12 | Solvent resistance | Ref. JIS C 0052 or IEC 60068-2-45 | The marking shall be legible | 11 | 0 |

Notes

- *1 Each test done independently.
- *2 Measuring 2 h to 24 h later leaving in room temperature after each test. DL : 0.5 μ W
- *3 Pre conditionings Initial value shall be after 24 h at room temperature.
- Shift series resistance at before above tests should be less than ± 20 % or less than ± 15 k Ω .
In case Resistace to solder heat and High temperature storage (+125 °C x 1 000 h) shift series resistance
at before above tests should be less than ± 30 % or less than ± 20 k Ω .

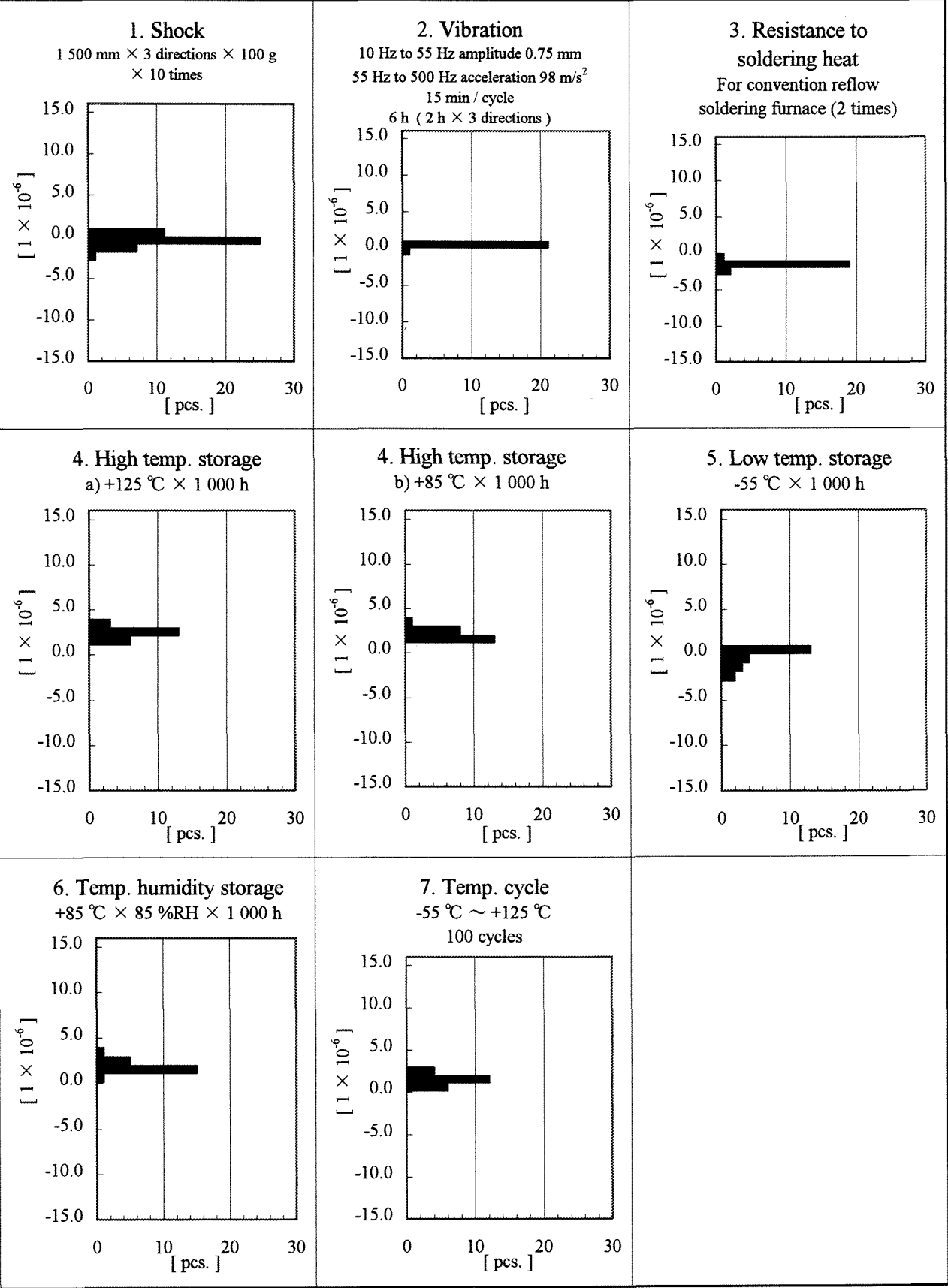
SEIKO EPSON CORP. Quartz Device Div.
Quality Assurance Dept.

Qualification Data

Product Name : FC-135

$\Delta f/f$

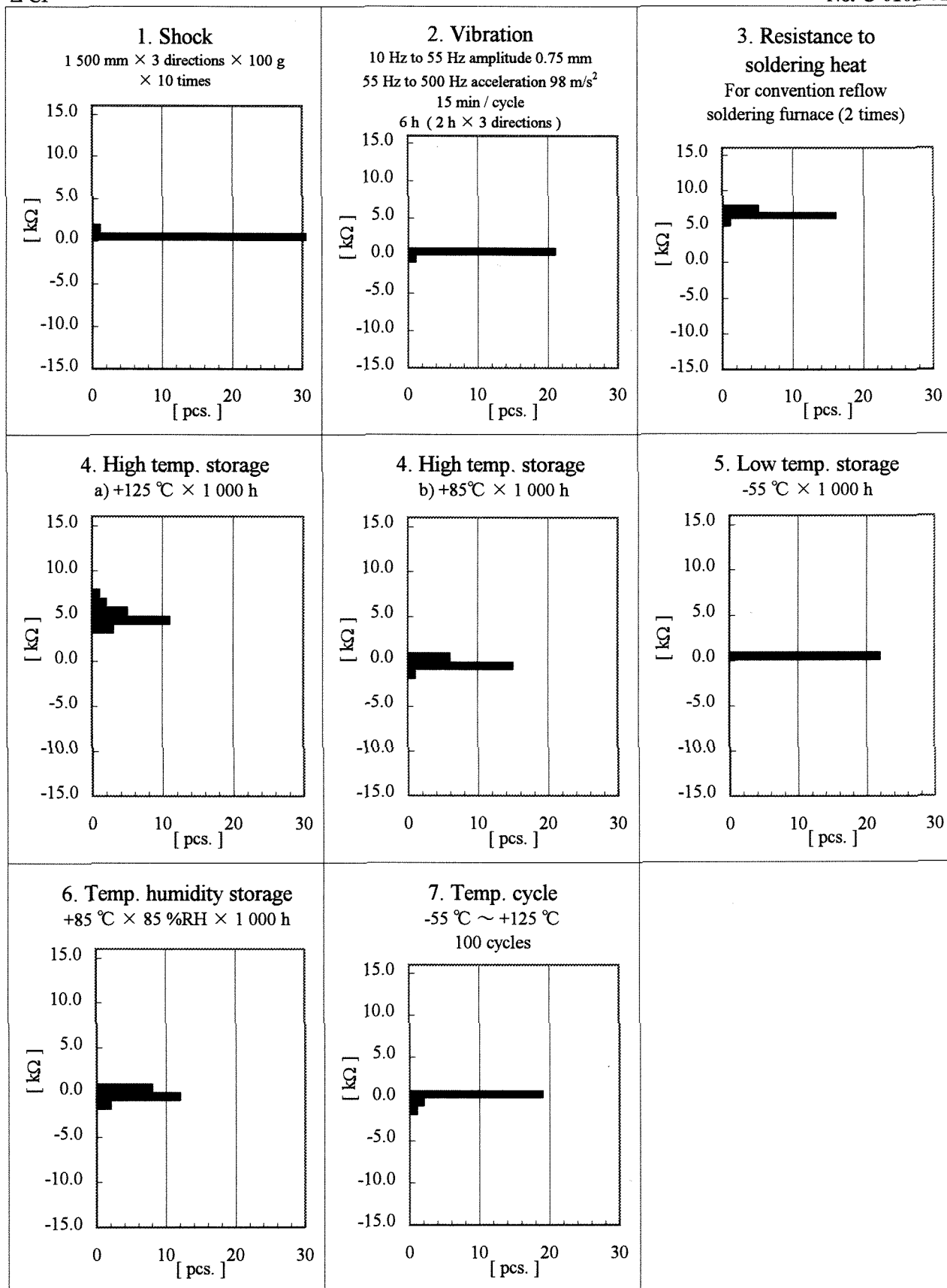
No. C-0102-01



Product Name : FC-135

Δ CI

No. C-0102-01



TAPING SPECIFICATION

1. APPLICATION

This document is applicable to FC-13F.

2. CONTENTS

| Item No. | Item | Page |
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| [3] | Shipping carton | |
| [4] | Marking | 4 |
| [5] | Quantity | |
| [6] | Storage environment | |
| [7] | Handling | |

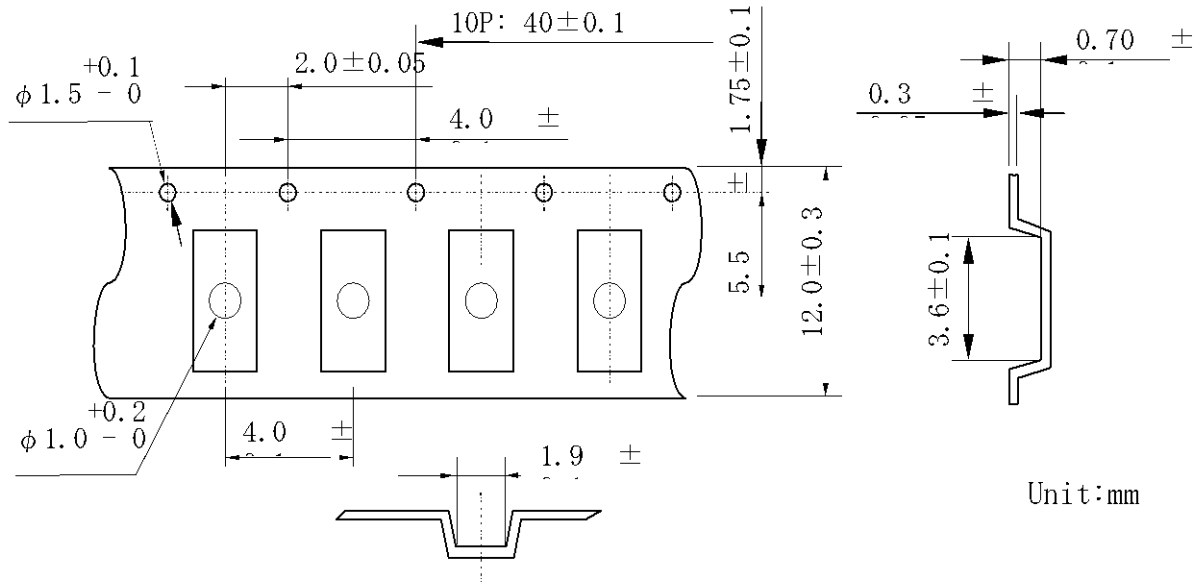
[1] Taping specification

Subject to EIA-481 , EIAJ EDX7602 , IEC 60286 , and JIS C0806.

(1) Tape dimensions TE1208L

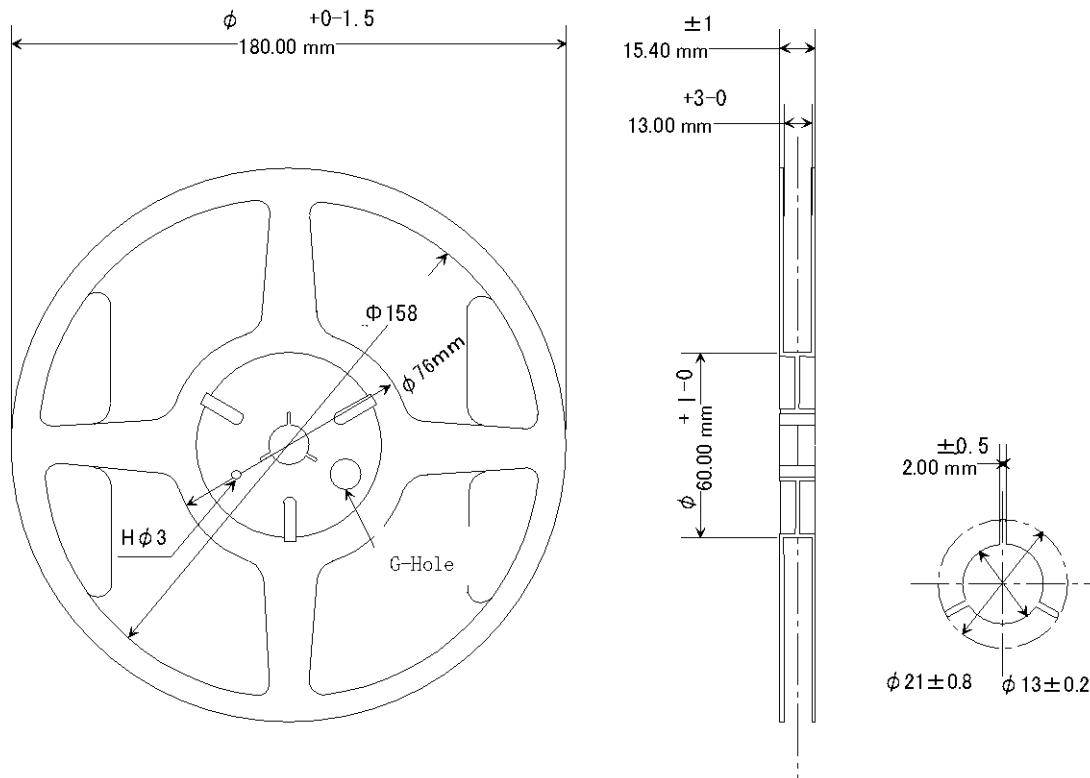
Material of the Carrier Tape : PS

Material of the Top Tape : PET+PE



(2) Reel dimensions

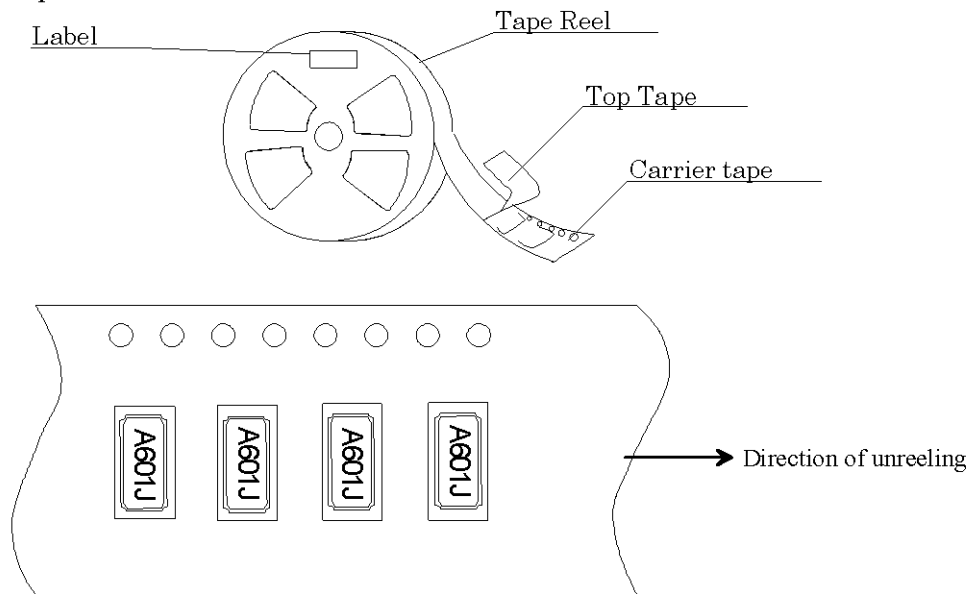
Material of the Reel : PS



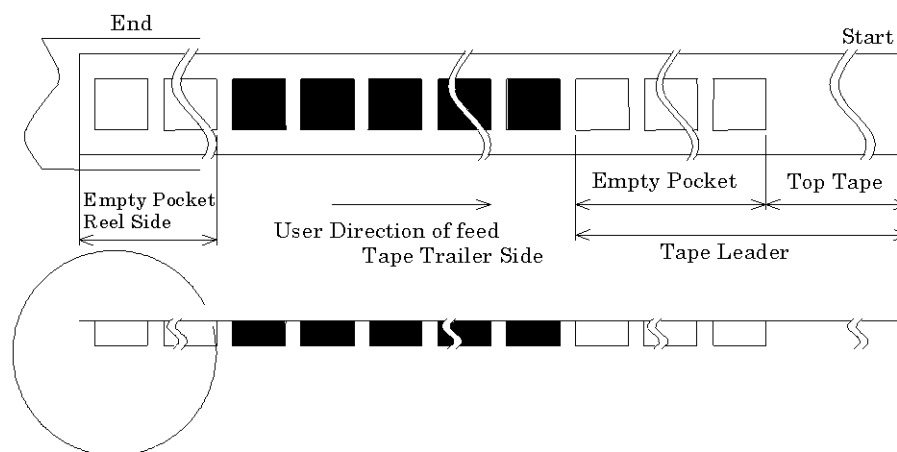
Form and Size of reel window shows are one of the example

(3) Packing

(a) Tape & Reel



(b) Start & End Point



(c) Peel force of the cover tape

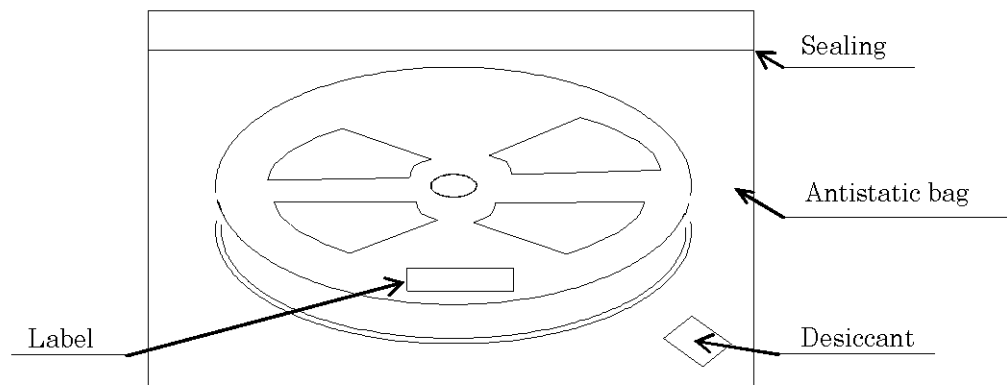
(1) angle : cover tape during peel off and the direction of unreeeling shall be 165° to 180° .

(2) peel speed : 5 mm/s.

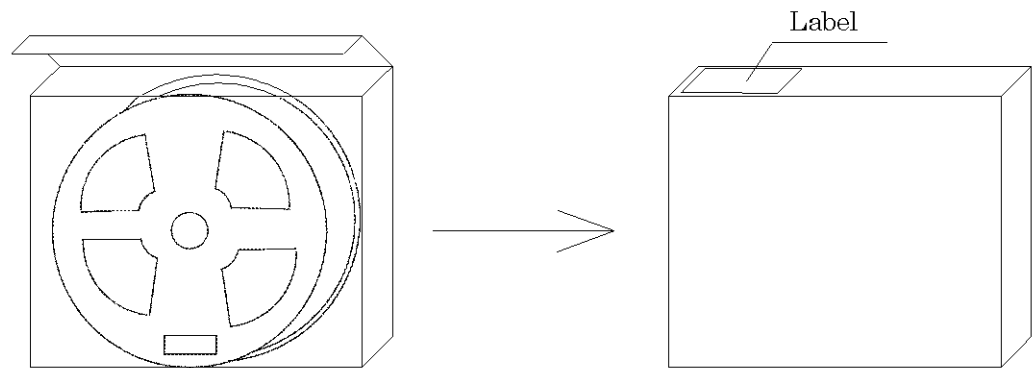
| Item | | Empty Space |
|--------------|--------------|-----------------|
| Tape Leader | Top Tape | Min. 1 000 mm |
| | Carrier Tape | Min. 20 pockets |
| Tape Trailer | Top Tape | Min. 0 mm |
| | Carrier Tape | Min. 20 pockets |

[2] Inner Carton

a) Packing to antistatic bag

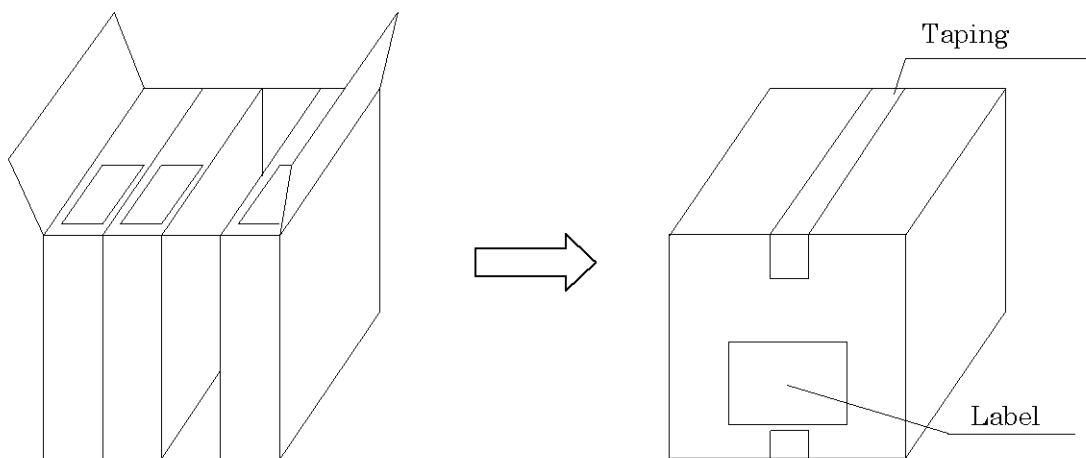


b) Packing to innercarton



[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

- 5 000 pcs./reel

[6] Storage environment

- (1) To storage the reel at +15 °C to +35 °C, 25 %RH to 85 %RH of Humidity.
- (2) To open the packing just before using.
- (3) Not to expose the sun.
- (4) Not to storage with some erosive chemicals.
- (5) 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.