RECIPIENT

SPECIFICATIONS

2.05mm x 1.2mm x 0.6mm 32.768 kHz

MODEL: FC-12M

Part Number: TBD

Ordering Part Number: X1A000061000500

SPEC. No. : Q20-047-6B

DATE: Jul. 21. 2020

SEIKO EPSON CORPORATION

8548 Naka-minowa
Minowa-machi Kamiina-gun
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SPECIFICATIONS

1. Application

1) This document is applicable to the crystal unit that are delivered to Apple Inc. 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. Model

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

[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	$\times 10^{-6}$	CL = 12.5 pF Ta = + 25 ± 3°C Level of drive : 0.1 μW Not include aging
3	Motional resistance		R1	80 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.	$\times 10^{-6}$ /°C^2	
7	Isolation resistance		IR	200 Min.	MΩ	DC 25 V± 15, 60 seconds Between terminal # 1 and terminal # 2
8	Frequency Aging		f_age	± 3	$\times 10^{-6}$/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 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•l / 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

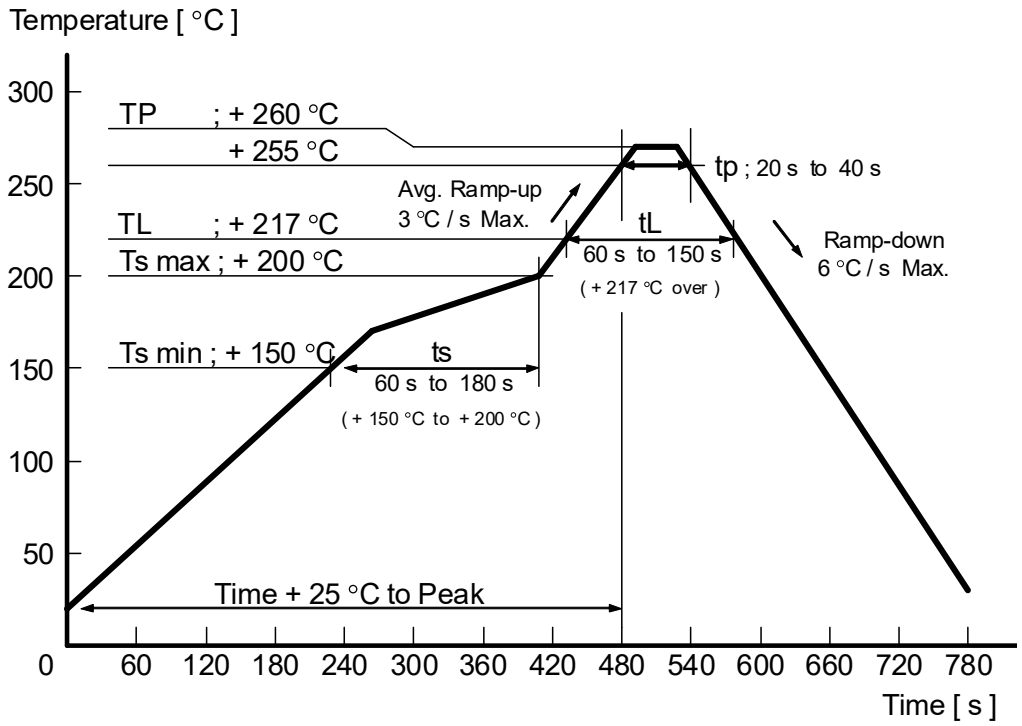
*3 Pre conditionings

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.

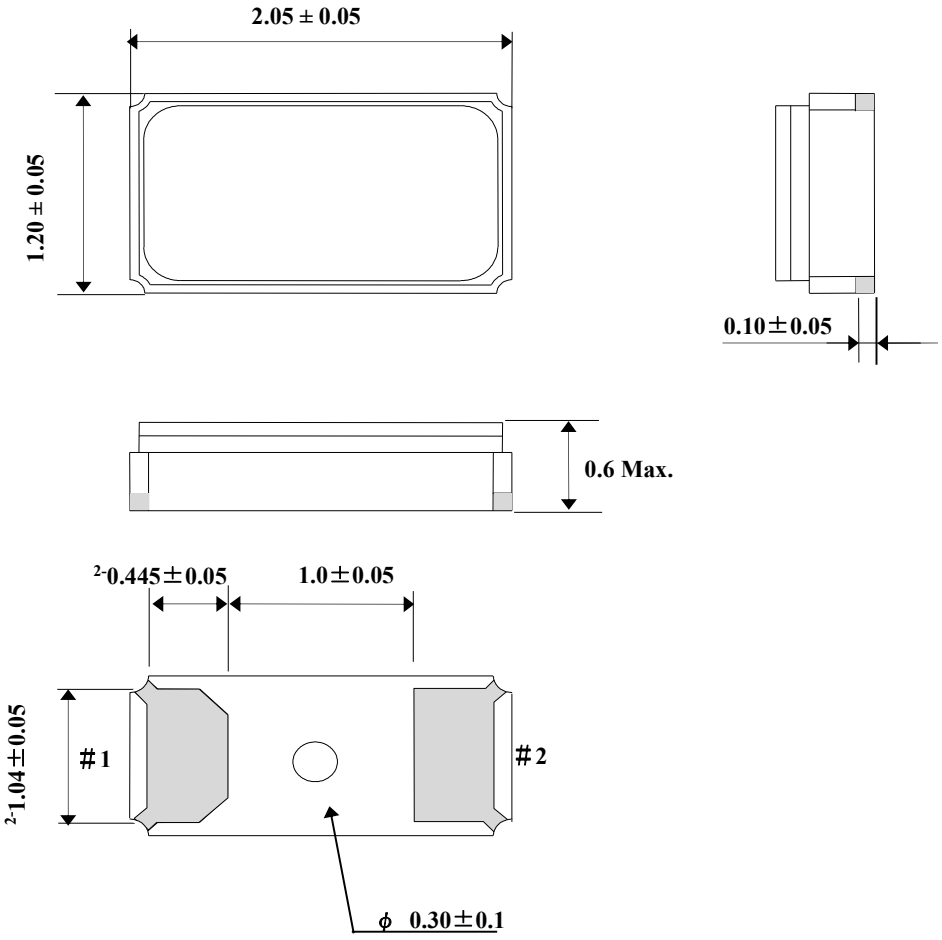
In case high temperature storage(+ 125 °C × 1 000 h), Soldering heat resistance,shift of series resistance at before and after the test should be less than ± 40 % or ± 30 kΩ.

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

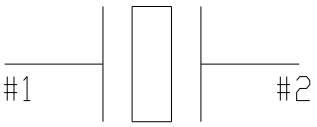


[5] Dimensions and Marking layout

1. Dimensions



2. Internal Connection

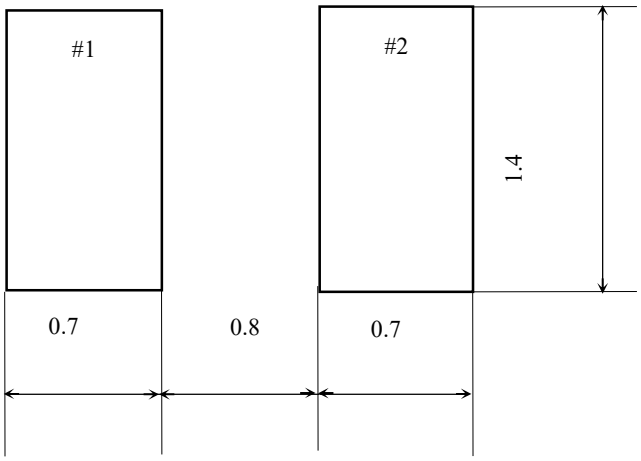


Package : Ceramic(Al_2O_3)
Terminal Au plate : 0.5 μm Min.
Lid : Metal

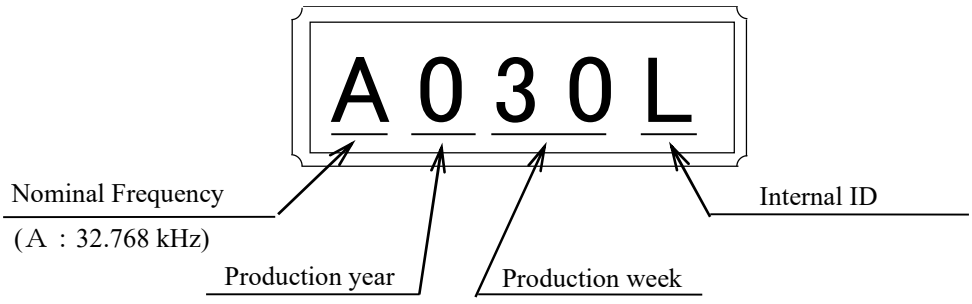
Type	FC-12M	Unit	1 = 1 mm

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

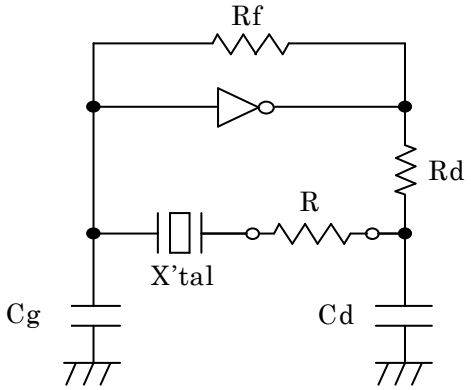
1. Max three (3) times reflow is allowed. Once miss soldering is happened, hand work soldering by soldering iron is recommended. (+ 350 °C × within 5 s)

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
テープ梱包基準書

1. APPLICATION 適用範囲

This document is applicable to FC-12M.
本基準書は、FC-12M のテーピング梱包について規定する。

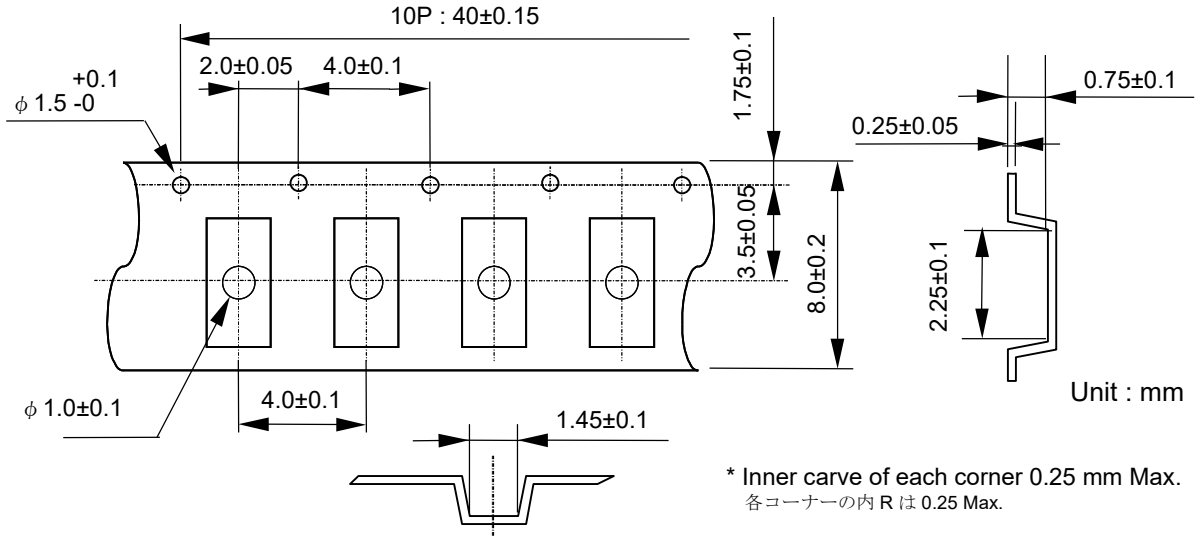
2. CONTENTS 目次

[1] Taping specification テーピング仕様

Subject to EIA-481 , IEC 60286 , JIS C0806.
「EIA-481」「IEC 60286」「JIS C0806」に準拠する。

(1) Tape dimensions TE0804L

Material of the Carrier Tape キャリアテープ材質: PS (Electrically conductive)
Material of the Top Tape トップテープ材質 : PET+PE

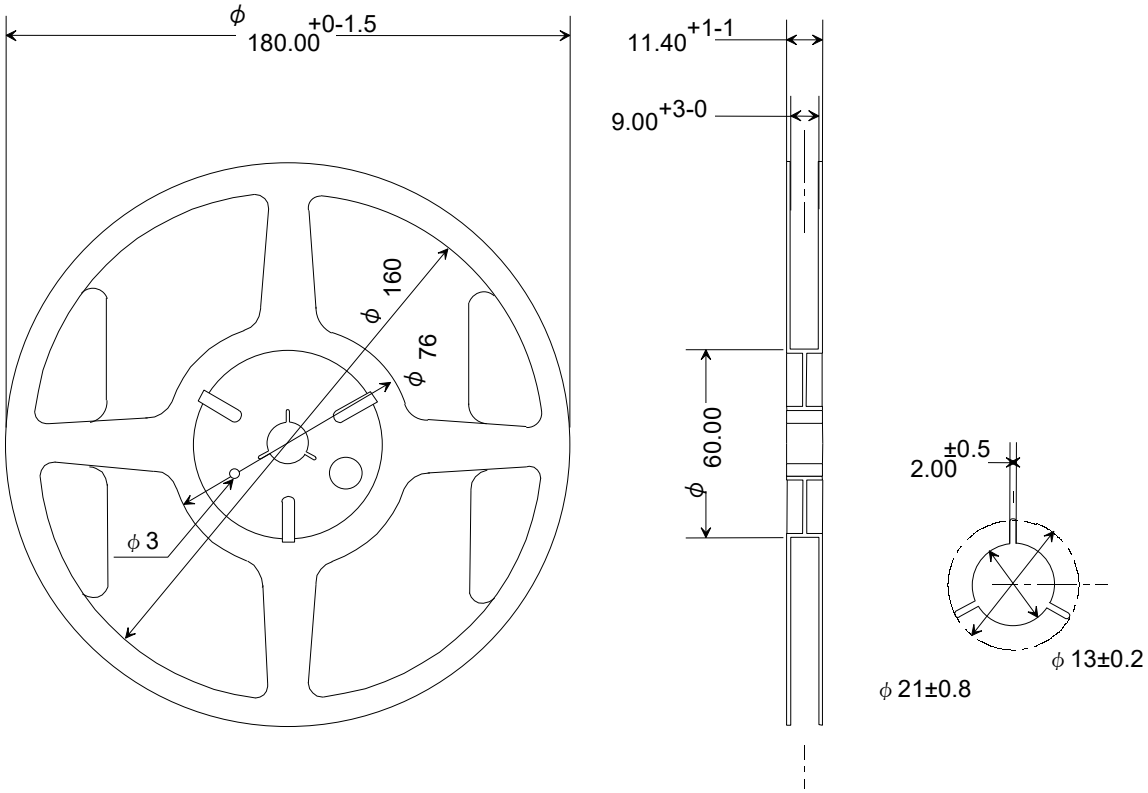


* Inner carve of each corner 0.25 mm Max.
各コーナーの内 R は 0.25 Max.

*各コーナーの抜きテーパーは 5°Max.

(2) Reel dimensions

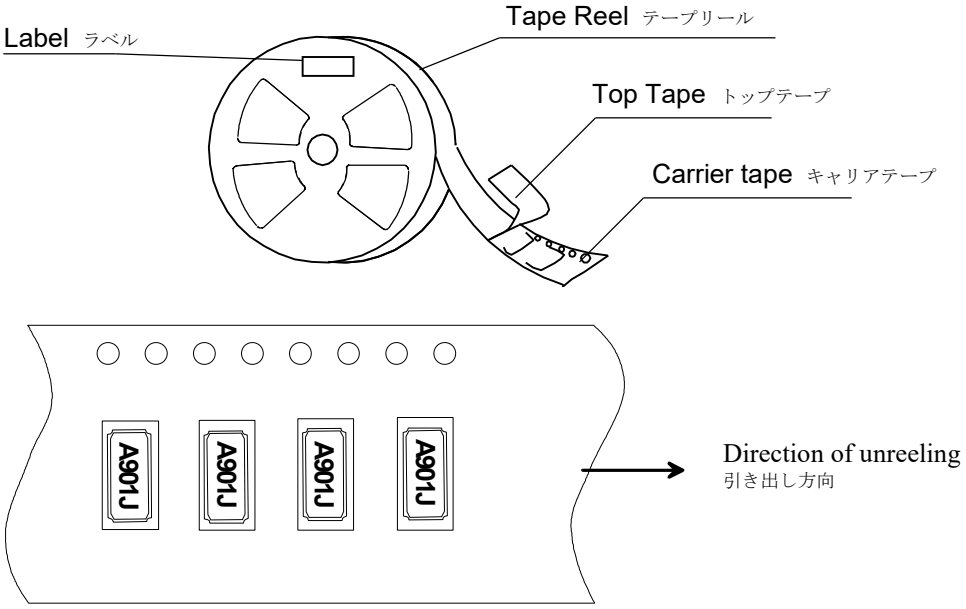
Material of the Reel リール材質: PS



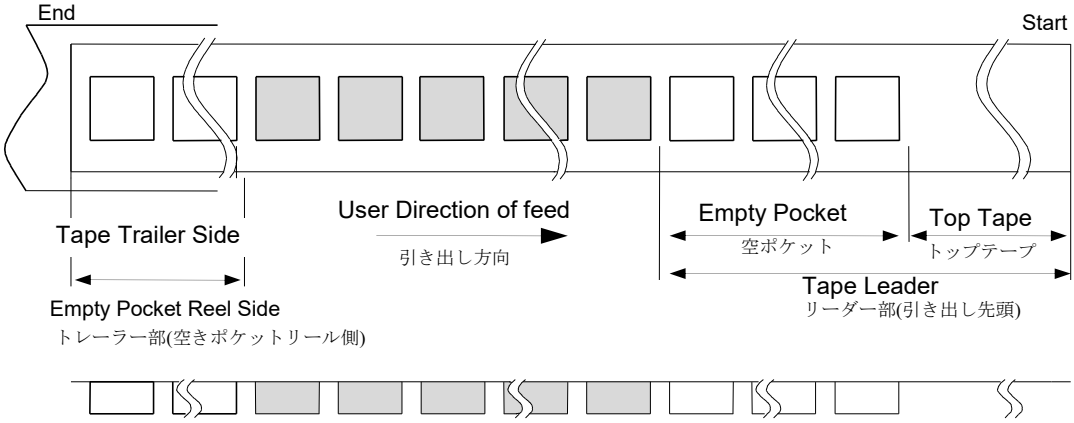
Form and Size of reel window shows are one of the example
リールの窓の形状は代表例を掲載。

(3) Packing 収納形態

(a) Tape & Reel デバイス収納方法



(b) Start & End Point 引き出し先頭側及びリール側の処理



Item		Empty Space 空きスペース	Note 備考
Tape Leader (引き出し先頭側)	Top Tape	Min. 1 000 mm	**Feeding in the Top tape, the tip is fixed with tape.** トップテープ単独で繰り出し、先端はテープにより固定。
	Carrier Tape	Min. 80 mm	**Winding method is a diagram of the above** リールへの巻き取り方法は、上図の通り。
Tape Trailer (リール側)	Top Tape	Min. 0 mm	**Tip is fixed to the reel.** 先端はリールに固定。
	Carrier Tape	Min. 80 mm	

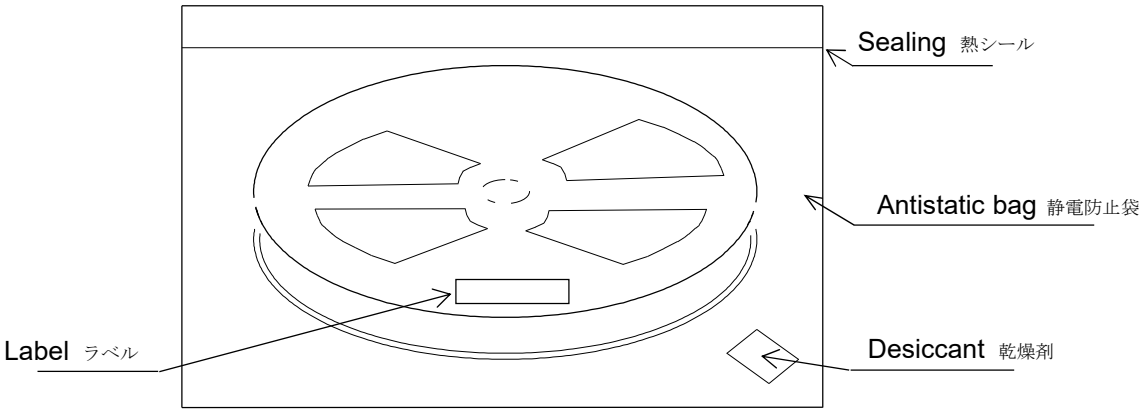
(4) Peel force of the cover tape トップテープの剥離強度

(a) angle : cover tape during peel off and the direction of unreeling shall be 165° to 180°.
剥離角度:テープの接着面に対し 165～180 度とする。

(b) peel speed : 300 mm/min
剥離速度:300 mm/min とする。

[2] Shipping Carton 外装箱への収納

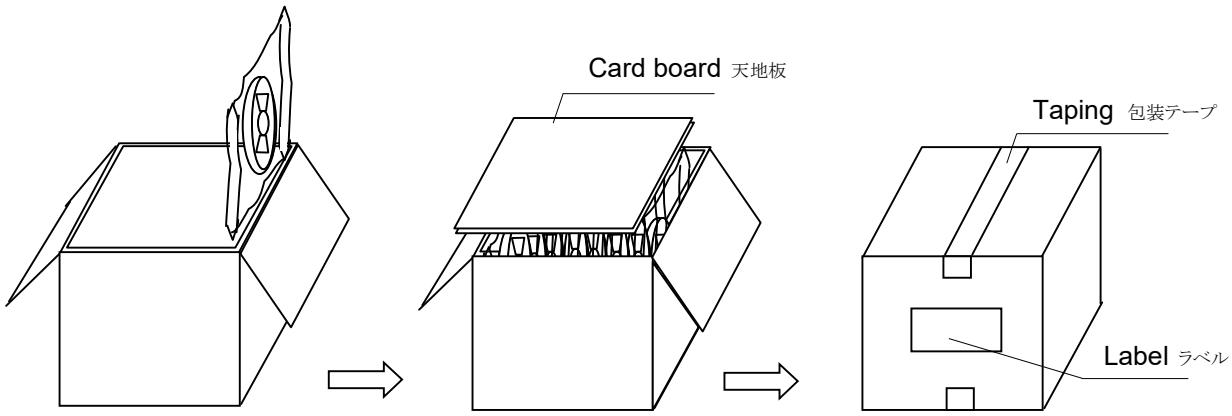
a) Packing to antistatic bag 袋への収納



b) Packing to shipping carton 外装箱への収納

If there is space in the outer box, material is put in a shock absorbing together.

空間ができた時は、クッション材を入れる。



[3] Marking 表示

(1) Reel marking リールへの表示

- Reel marking shall consist of

下記内容をリール表面に表示できるラベルを貼る。:

1) Parts name 製品名称
2) Quantity 製品数量
3) Manufacturing Date or symbol 製品の製造年月又はこれを示す記号
4) Manufacturer's Name or symbol 製品の製造業者又はその略号
5) Others (if necessary) その他必要事項

(2) Shipping carton marking 外装箱への表示

- Shipping carton marking shall consist of :

下記内容を外装箱表面に表示できるラベルを貼る。:

1) Parts name 製品名称
2) Quantity 製品数量

[4] Quantity 収納数量

- 5 000 pcs./reel

[5] Storage environment 保管環境

(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.
開梱前の製品は、温度 +30 °C、湿度 85 %RH 以下での保管をして下さい。
貴社納入後、袋未開封で 6 ヶ月以内の実装を推奨します。

(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.
使用直前まで開梱せず、袋開封後は 6 ヶ月以内の実装を推奨します。
温度 +30 °C、湿度 85 %RH 以下では、はんだ付け作業前に乾燥不要です。

(3) Not to storage with some erosive chemicals.
化学薬品類との同居を避ける。

(4) Nothing is allowed to put on the reel or carton to prevent mechanical damage
外装箱がゆがまないようまた、外圧がかからないように保管して下さい。

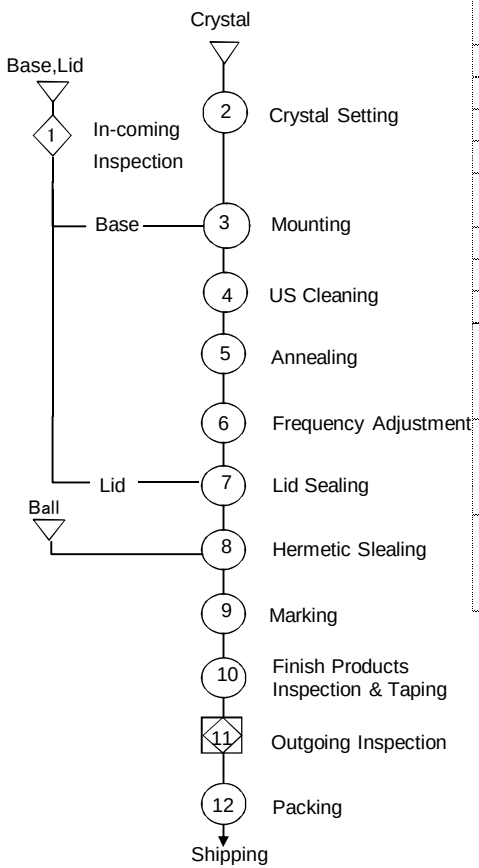
[6] Handling リール取扱い

To handle with care to prevent the damage of tape, reel and products.
リールの取扱いについては、中のテープ・製品を変形させないようにして下さい。

PROCESS QUALITY CONTROL

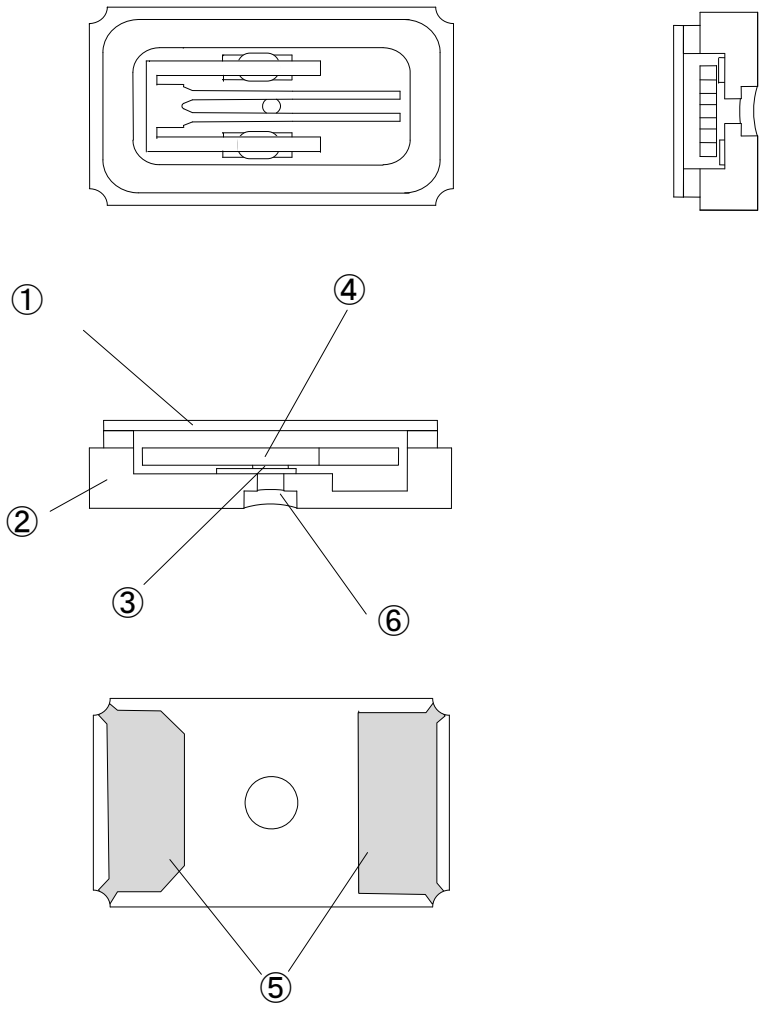
FC-12M
No. C-0702-AME-1

2015.03.10
FC12M_Q_0001



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

Structure Diagram 構造図	Rev.02
Model 型式	FC-12M
Document No. 管理No.	FC12M_D_0001



No.	Name of Part 部品名
①	Lid リッド
②	Package パッケージ
③	Crystal adhesive 接着材
④	Crystal chip 水晶片
⑤	Terminal 端子
⑥	Seal hole 封止孔

To : Apple

EPSON
EXCEED YOUR VISION

No.QA-B20-029
27/May/2020
SEIKO EPSON CORPORATION
TD・CS Quality Assurance Dept.

Results of reliability evaluation of trapezoid shape (corective action for frequensy shift)

Type : FC-12M
Nominal Frequency : 32.768000kHz

Conclusion

All the reliability test results were OK.
There is no difference compared to conventional products.
Therefore, this 4M fluctuation will not affect the product quality.

RELIABILITY TEST DATA

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

No.	ITEM	TEST CONDITIONS	VALUE *1 *2	FALL Qty Test Qty	
			⊿f/f [1 × 10^{-6}]	Conventional product	4M
1	Shock resistance	100 g dummy (SE Standard) drop from 1 500 mm height on to the concrete 3 directions 10 times	*3 ± 20	0/22	0/22
2	Vibration resistance	10 Hz to 55 Hz amplitude 0.75 mm 55 Hz to 500 Hz acceleration 98 m/s2 10 Hz → 500 Hz → 10 Hz 15 min / cycle 6 h (2 h × 3 directions)	*3 ± 5	0/22	0/22
3	High temperature storage	+125°C× 100 h	*3 ± 15 (1000h standard)	0/22	0/22
4	Temperature cycle	-55 ℃ ⇔ +125 ℃ 30 min at each temp. 100 cycles	*3 ± 10	0/22	0/22

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.

Checked: _____ **/ Manager of TD・CS Quality Assurance Dept.**

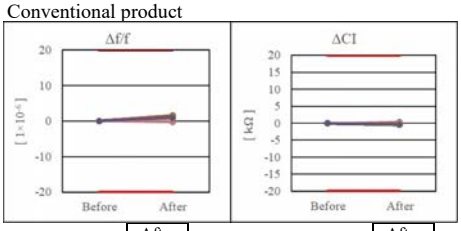
Prepared : K. Miyazawa **/ Engineer of TD・CS Quality Assurance Dept.**

Test data

1. Shock resistance n=22

100 g dummy (SE Standard) drop from 1 500 mm height on to the concrete 3 directions 10 times

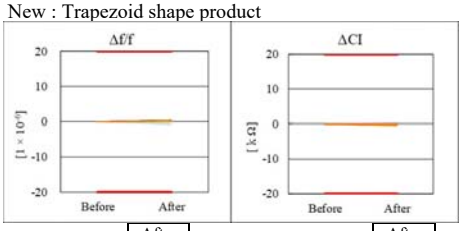
Conventional product



	After
Average	1.07
Stdev	0.37

	After
Average	-0.27
Stdev	0.22

New : Trapezoid shape product



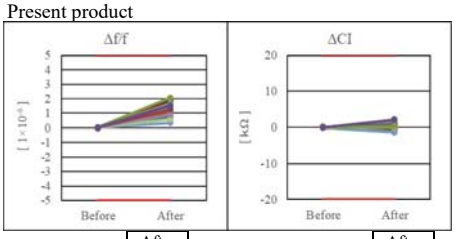
	After
Average	0.11
Stdev	0.24

	After
Average	-0.14
Stdev	0.20

2.Vibration resistance n=22

10 Hz to 55 Hz amplitude 0.75 mm 55 Hz to 500 Hz acceleration 98 m/s2
10 Hz → 500 Hz → 10 Hz 15 min / cycle 6 h (2 h × 3 directions)

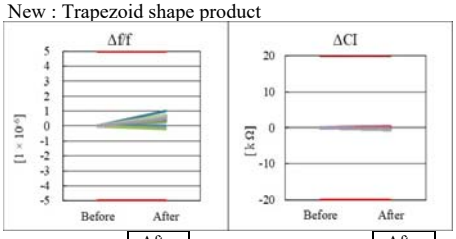
Present product



	After
Average	1.31
Stdev	0.42

	After
Average	0.41
Stdev	0.84

New : Trapezoid shape product



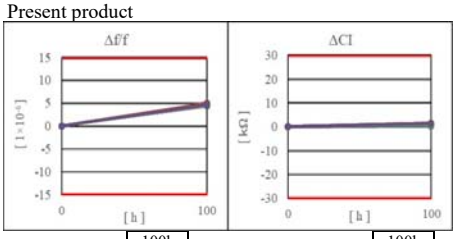
	After
Average	0.54
Stdev	0.26

	After
Average	-0.27
Stdev	0.24

3. High temperature storage n=22

'+125°C× 100 h

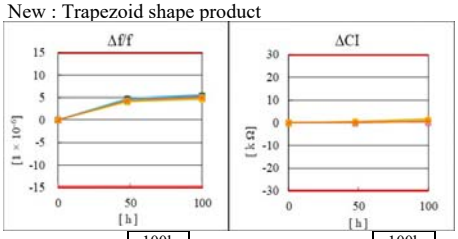
Present product



	100h
Average	4.72
Stdev	0.15

	100h
Average	0.88
Stdev	0.36

New : Trapezoid shape product



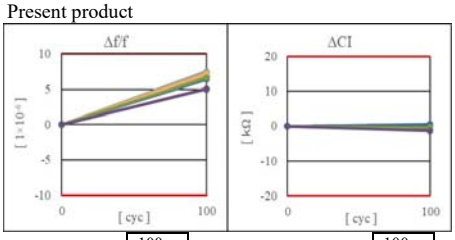
	100h
Average	5.08
Stdev	0.25

	100h
Average	0.73
Stdev	0.30

4.Temperature cycle n=22

-55°C ⇔ +125°C 30 min at each temp. 100 cycles

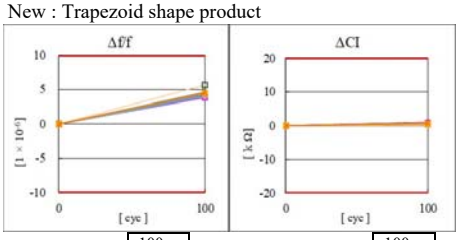
Present product



	100cy
Average	6.82
Stdev	0.64

	100cy
Average	0.02
Stdev	0.42

New : Trapezoid shape product



	100cy
Average	4.28
Stdev	0.37

	100cy
Average	0.55
Stdev	0.20