RoHS Compliant
Directive 2011/65/EU

Crystal Bridge to the Future

SPECIFICATION

Customer: RICHWELL/OPPO

Item:	Crystal Unit
Type:	NX2016SF
Nominal Frequency:	38.4 MHz
Customer's Spec. No.:	---
NDK Spec. No.:	EXS00A-CS10536

Receipt

Revision Record

Rev.	Rev. Date	Items	Contents	Approved	Checked	Drawn
---	29. Mar. 2017	Issue	---	I. Miyahara	---	K.Tsukumo

1. Customer Specifications Number : ---

2. NDK Specification Number : EXS00A-CS10536

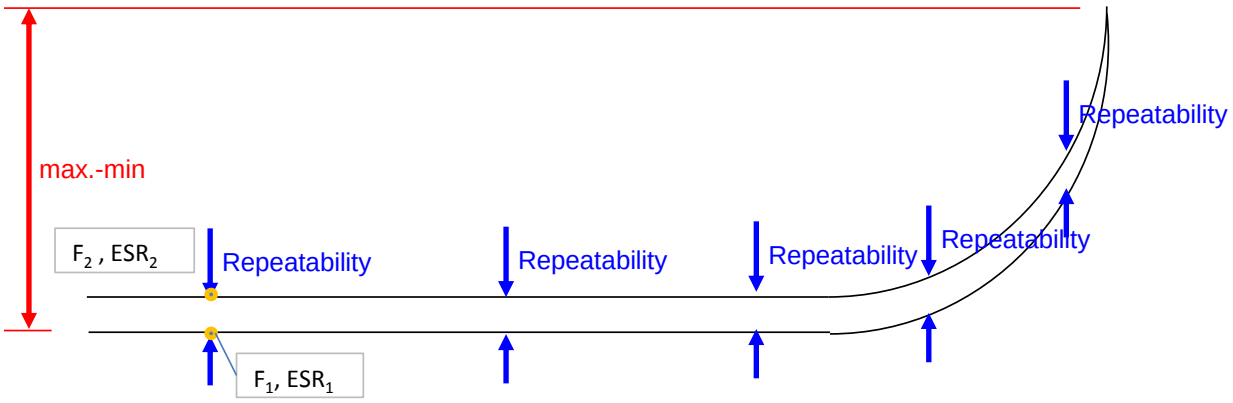
3. Type : NX2016SF

4. Electrical Characteristics

	Parameters	SYM.	Electrical Spec.				Notes
			Min	TYP	MAX	Units	
1	Nominal frequency	f_{nom}	38.4			MHz	-
2	Overtone order	-	Fundamental			-	AT-CUT
3	Frequency tolerance	-	-10	-	+10	ppm	at +25°C
4	Frequency versus temperature characteristics	-	-12	-	+12	ppm	at -30~+85°C The reference temperature shall be +29°C
5	Equivalent resistance	-	-	-	30	Ω	IEC π-Network / Series
6	Load capacitance	C_L	-	8	-	pF	IEC π-Network
7	Level of drive	DL	10	-	200	μW	-
8	Inflection point	T0	27.5	29	30.5	^oC	
9	Constant range	C0	-10	-	10	ppm	
10	1^{st} order curve fitting parameter	C1	-0.4	-	-0.1	ppm/^oC	
11	2^{nd} order curve fitting parameter	C2	-4.5	-	+4.5	x 10^{-4} ppm/$^oC^2$	
12	3^{rd} curve fitting parameter	C3	+8.5	-	+11.5	x 10^{-5} ppm/$^oC^3$	
13	Pulling Sensitivity	PS	10	-	16	ppm/pF	CL=8pF/ Not grounded This value is calculated by following formula. $PS = [ppm/pF] = \frac{Cm \times 1000}{2(Cp + C_L)^2}$ Unit: C_p(pF), C_m(fF) and C_L(pF)
14	Quality factor (Q)	-	75,000	-	-	-	-
15	Spurious mode series resistance	-	1,100	-	-	Ω	±1MHz
16	Aging	-	-0.7	-	0.7	ppm	1^{st} year
17	Frequency drift after reflow	-	-2	-	2	ppm	after two reflow passed.
18	Insulation resistance	-	500	-	-	MΩ	Terminal to terminal insulation resistance also terminal to cover insulation resistance when DC100V ±15V is applied.
19	Operating temperature range	-	-30	-	+105	°C	-
20	Storage temperature range	-	-40	-	+105	°C	-
21	Air-tightness	-	-	-	1.1×10^{-9}	Pa m^3/s	Helium leak detector
22	MSL	-	-	-	-	-	MSL 1
23	ESD(HBM)	-	-5	-	+5	ppm	Guarantee voltage: 1000V
24	ESD(MM)	-	-1	-	+1	ppm	Guarantee voltage: 200V

5. Drive level dependency (DLD) : Measurement method and specs are defined below.

Measurement condition		Freq.	ESR
Drive level	0.01uW to 100uW to 0.01uW		
Number of points	29 points (15 points up, 15 points down)		
Max. – Min. spec.	Difference between max and min in two way measurement. Freq.: F_{MAX}-F_{MIN} ESR: (ESR_{MAX}-ESR_{MIN})/ESR_{MIN}	<3ppm	<20%
Repeatability spec.	Repeatability of two way measurement in above condition. Freq.: F_2-F_1 ESR: (ESR_2-ESR_1)/ESR_1 ESR_1: first measurement on each drive levels ESR_2: second measurement on each drive levels	<0.7ppm	<10%



6. 1. Residual frequency stability slope : ±50 ppb/°C Max.

Condition 1A - Test condition (continuous temperature rate change of ~1.0°C/min)

- The residual is defined as the difference between the crystal measured FT curve and the 5th order polynomial fit of the FT curve. Frequency is measured between -30 to +85°C every 1°C. Residual slope is calculated by the formula below.

$$FIT\Delta f(t_N) = a(t_N - t_0)^5 + b(t_N - t_0)^4 + c(t_N - t_0)^3 + d(t_N - t_0)^2 + e(t_N - t_0) + f$$

$t_1 = -30, t_2 = -29$ ・ ・ $t_{114} = +84, t_{115} = +85°C$

$t_0 = +29°C$

$$RES(t_N) = F(t_N) - FIT\Delta f(t_N)$$

$$RES\_SLP = RES(t_{N+1}) - RES(t_N)$$

6.2. 5°C small hysteresis 1 : ±50 ppb/°C Max. Ta = -30 to +85°C

Condition1B test condition (continuous temperature rate change of ~1.0°C/min.)

- Measure FT points every 0.5°C while cycling temperature over a 5°C small temperature orbit, an example 5°C small orbit temperature cycle is +30°C to +35°C to +30°C.
- During every individual heating/cooling cycle there should be 11 points; discard the first point of each heating and cooling cycle; this leaves 10 points for each heating and cooling cycle.

- Subtract the fifth-order polynomial best fit from 1A for each of the 10 points, and then calculate the slope of the residual for each of these heating and cooling 10 point curves.
- The residual slope should be within +/-50 ppb/°C.

6.3. 5°C small orbit hysteresis 2 : 100 ppb (magnitude) peak-peak. Ta = -30 to +85°C

Condition 2 test condition (continuous temperature rate change of ~1.0°C/min.)

- Measure FT points every 0.5°C while cycling temperature over a 5°C small temperature orbit, an example 5°C small orbit temperature cycle is +30°C to +35°C to +30°C.
- During every individual heating/cooling cycle there should be 11 points; discard the first and last point of each heating and cooling cycle, which results in 9 temperature points. Calculate the average measured peak-to-peak frequency difference for these 9 temperature points.
- The average difference is the magnitude of the small orbit hysteresis 2.
- The temperature is based on thermistor.

7. Thermistor characteristics

7.1. Size	: 0.6×0.3×0.15 (mm)
7.2. Resistance value (at +25°C)	: 100 (kΩ) ±1%
7.3. B Constant (+25/+50°C)	: 4250 (K) ±1%
7.4. Rated power (at 25°C)	: 100 (mW) Max.

8. Examination results document

Since a performance is guaranteed, an examination results document does not submit.

9. Application drawing

9.1. Dimension Drawing	: EXD14B-00584
9.2. Taping and Reel figure	: EXK17B-00371
9.3. Holder Marking	: EXH11B-00319
9.4. Packing Label	: EXK17B-00422
9.5. Reliability assurance Item	: EXS30B-01042

10. Notice

10.1. Order items are manufactured according to specification. As to conditions, which are not indicated in this specification and unpredictable such as applied condition and oscillation margin, please check them beforehand.

10.2. Unless we receive request for modification within 3 weeks from the issue date of this NDK specification sheet, we will supply products according to this specification. Also, if you'd like to modify specification of order, which has been placed with delivery request within 3 weeks from the issue data of this specification sheet, we would like to discuss with you separately.

10.3. In no event shall the company be liable for any product failure resulting from an inappropriate handling or operation of the product beyond the scope of its guarantee.

10.4. Where any change to the process condition is made due to the change(s) in the production line, inform personnel of the specifications.

10.5 Should this specification data give rise to any disputes relating to any intellectual property rights or any other rights of a third person, the company shall not indemnify anyone for any damage. Their disclosure must not be construed as the grant of a license to use any of the intellectual property rights owned by the company.

10.6. If you intend to use products listed on this specification for applications that may result in loss of life or assets (controls relating to safety, medical equipment, aeronautical equipment, space equipment, etc.), please do not fail to advise us of your intention beforehand.

10.7. In the company's production process whatever amount of ozone depleting substances (ODS) as specified in the Montreal protocol is not used.

10.8. Information contained in this specification must not be quoted, reproduced or used for other purposes including processing either in part or in full without obtaining prior approval from the company.

10.9. Crystal units will be damaged by ultrasonic welding process due to resonance of crystal wafer itself. NDK does not recommend using ultrasonic welding. If Ultra Sonic welding used, NDK strongly recommend verifying crystal unit damage by ultrasonic weld.

10.10. The appearance color has a different case by purchasing it more than 2 suppliers of the component, but characteristic and reliability are guaranteed.

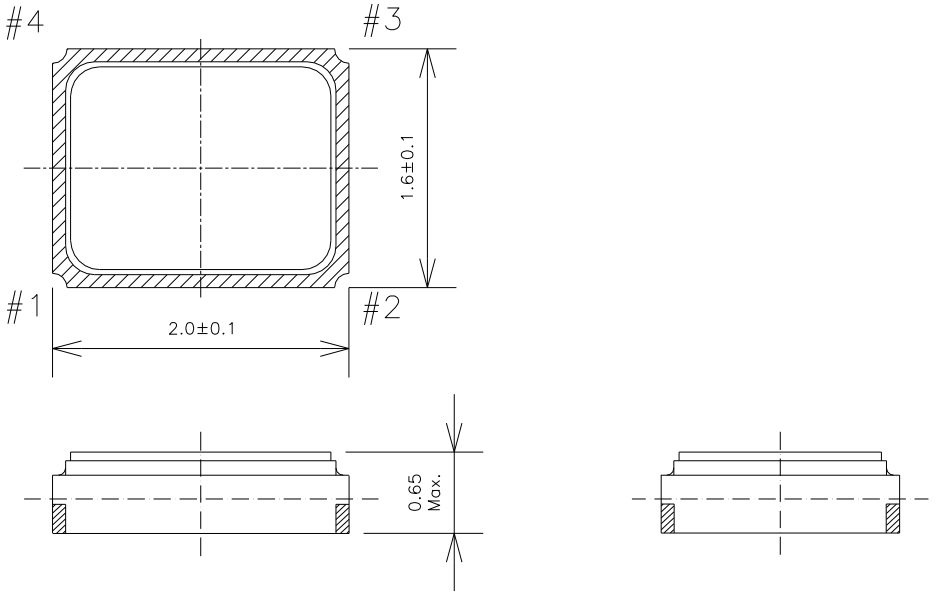
10.11. In case of the product long time keep at high temperature and humidity, may affect product characteristic (solder ability) and a packing condition. Please keep at storage condition of temperature +5°C ~+35°C, humidity ~85%RH.

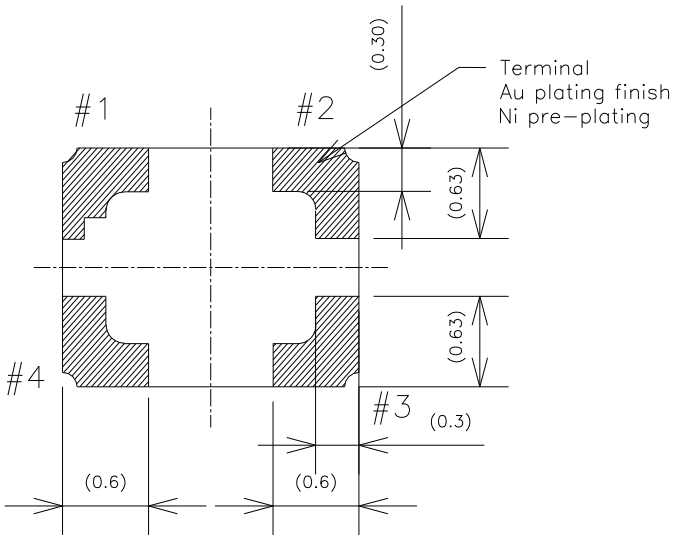
11. Prohibited items

Be sure to use the product under the following conditions. Otherwise, the characteristics deterioration or destruction of the product may result.

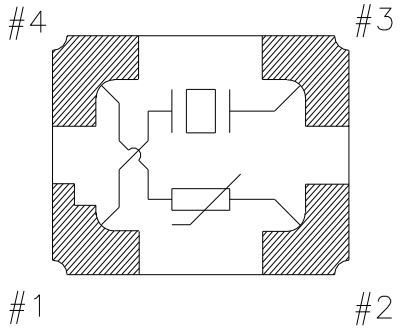
(1) Reflow soldering heat resistance
Peak temperature: 265°C, 10 sec
Heating: 230°C or higher, 40 sec
Preheating: 150°C to 180°C, 120 sec
Reflow passage times: three times

(2) Manual soldering heat resistance
Pressing a soldering iron of 400°C on the terminal electrode for four seconds (twice).





Terminal land connection (TOP VIEW)



#1	XTAL IN
#2	THERMISTOR OUT, GND
#3	XTAL OUT
#4	THERMISTOR IN

	Date of Revise	Charge	Approved	Reason

	Date	Name	Third Angle Projection	Tolerance	Scale
Drawn	15. Mar. 2013	15. Mar. 2013	Dimension:mm	----	--/--
Designed	15. Mar. 2013	15. Mar. 2013	Title	Drawing No.	Rev.
Checked	15. Mar. 2013	15. Mar. 2013	**NX2016SF** Dimension Drawing	**EXD14B-00584(1/2)**	
Approved	15. Mar. 2013	15. Mar. 2013			

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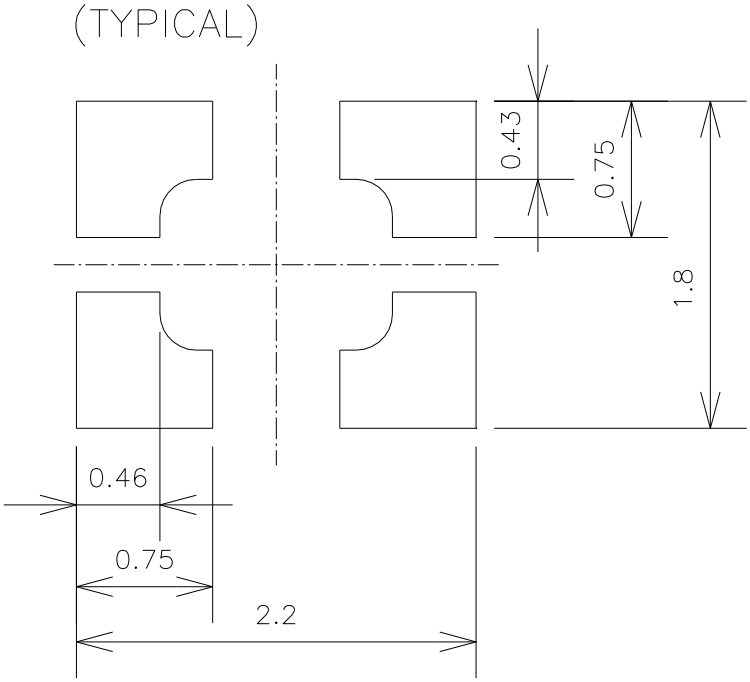
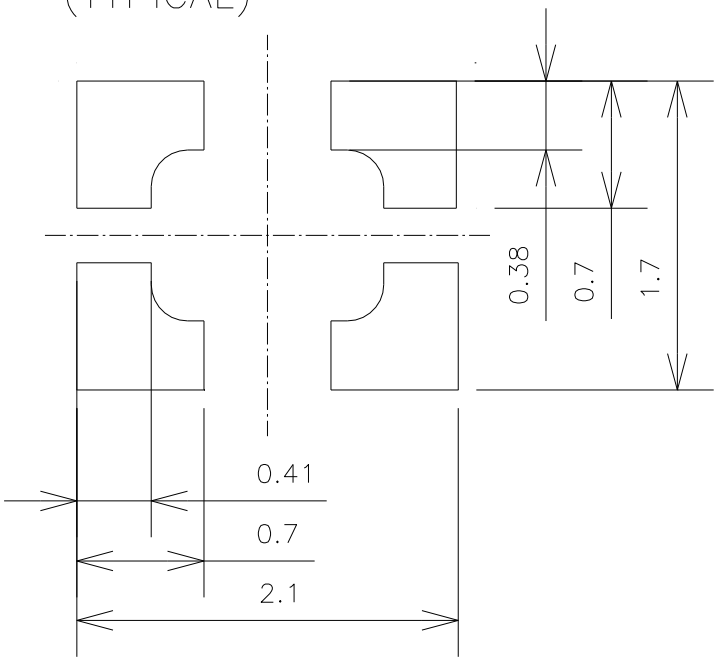
LAND PATTERN 1
(TYPICAL)



LAND PATTERN 2
(TYPICAL)



	Date of Revise	Charge	Approved	Reason

	Date	Name	Third Angle Projection	Tolerance	Scale
Drawn	15. Mar. 2013	T.Asamizu	Dimension:mm	----	--/--
Designed	15. Mar. 2013	T.Asamizu	Title	Drawing No.	Rev.
Checked	15. Mar. 2013	I.Miyahara	**NX2016SF** Dimension Drawing	**EXD14B-00584(2/2)**	
Approved	15. Mar. 2013	M.Kubota			

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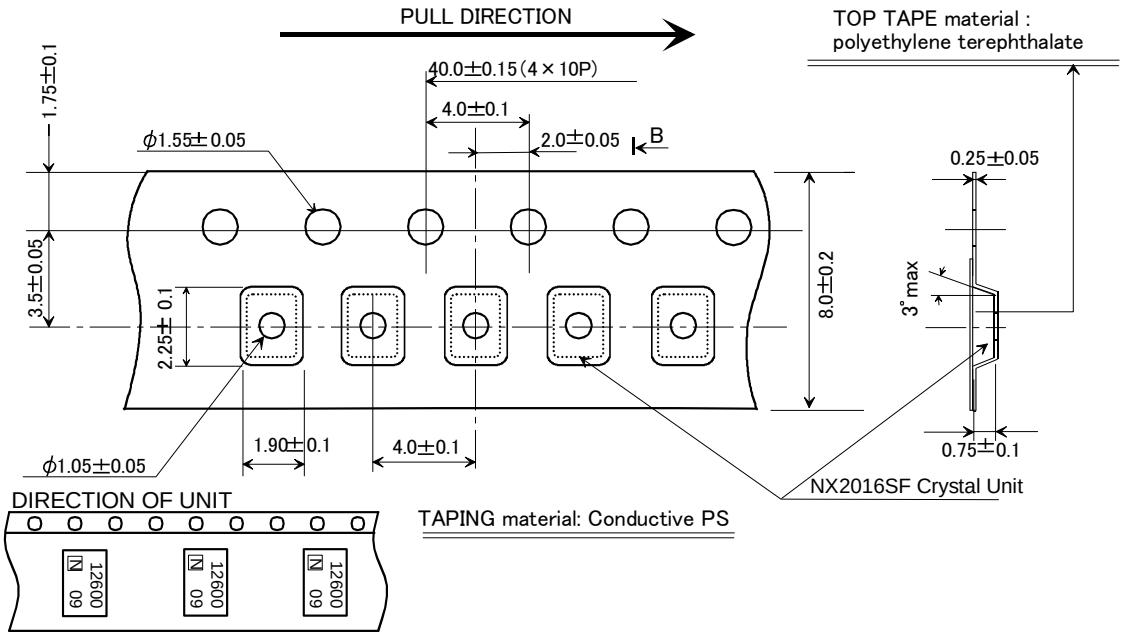

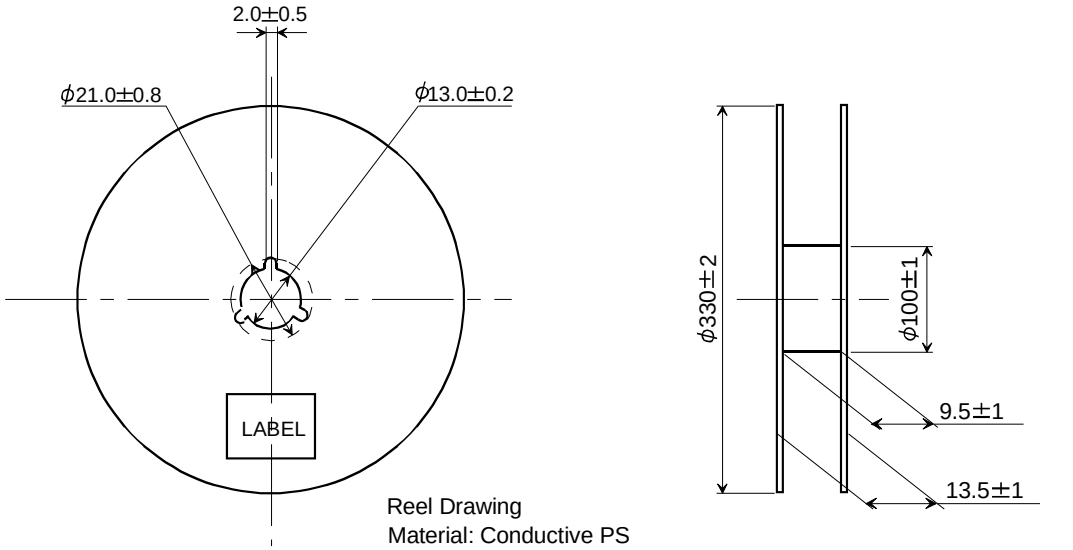

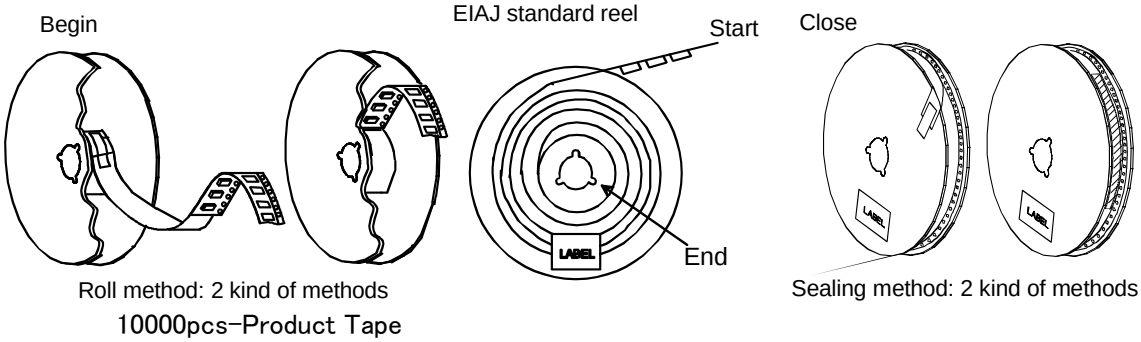

10000pcs-Product Tape

	Date of Revise	Charge	Approved	Reason
C	27 Jan. 2017	H. Ohkubo	H. Murakoshi	Change of the product amount.

	Date	Name	Third Angle Projection	Tolerance	Scale
Drawn	30 Jul. 2013	H. Ohkubo	Dimension:mm		/
Designed	30 Jul. 2013	H. Ohkubo	Title	Drawing No.	Rev.
Checked	---	---	**NX2016SF Taping and Reel Spec.**	**EXK17B-00371**	C
Approved	30 Jul. 2013	K. Oguri			

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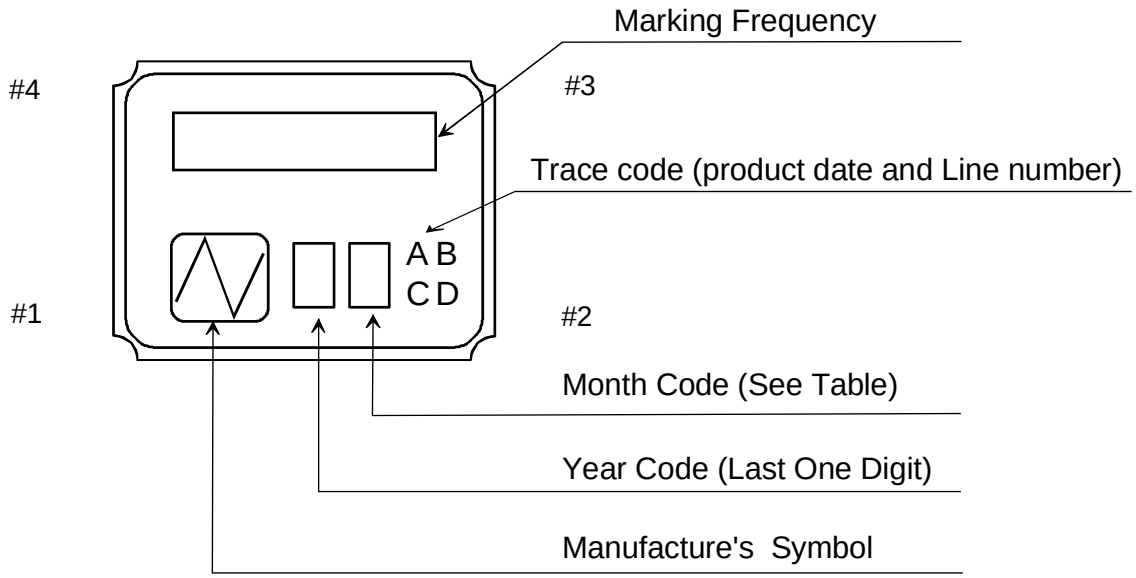

NOTE

1. Month Code Table

Month	1 Jan.	2 Feb.	3 Mar.	4 Apr.	5 May.	6 Jun.	7 Jul.	8 Aug.	9 Sep.	10 Oct.	11 Nov.	12 Dec.
Month Code	1	2	3	4	5	6	7	8	9	X	Y	Z

*Marking digits are not include a decimal point and dot mark.

	Date of Revise	Charge	Approved	Reason
A	10. Jul. 2008	T.Asamizu	K.Kubota	Delete application period.

	Date	Name	Third Angle Projection	Tolerance	Scale
Drawn	14. Feb. 2006	T.Asamizu	Dimension:mm		/
Designed	14. Feb. 2006	T.Asamizu	Title	Drawing No.	Rev.
Checked	14. Feb. 2006	I.Miyahara	**Crystal Holder Marking**	**EXH11B-00319**	A
Approved	14. Feb. 2006	K.Okamoto			

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Reliability assurance item (1/2)

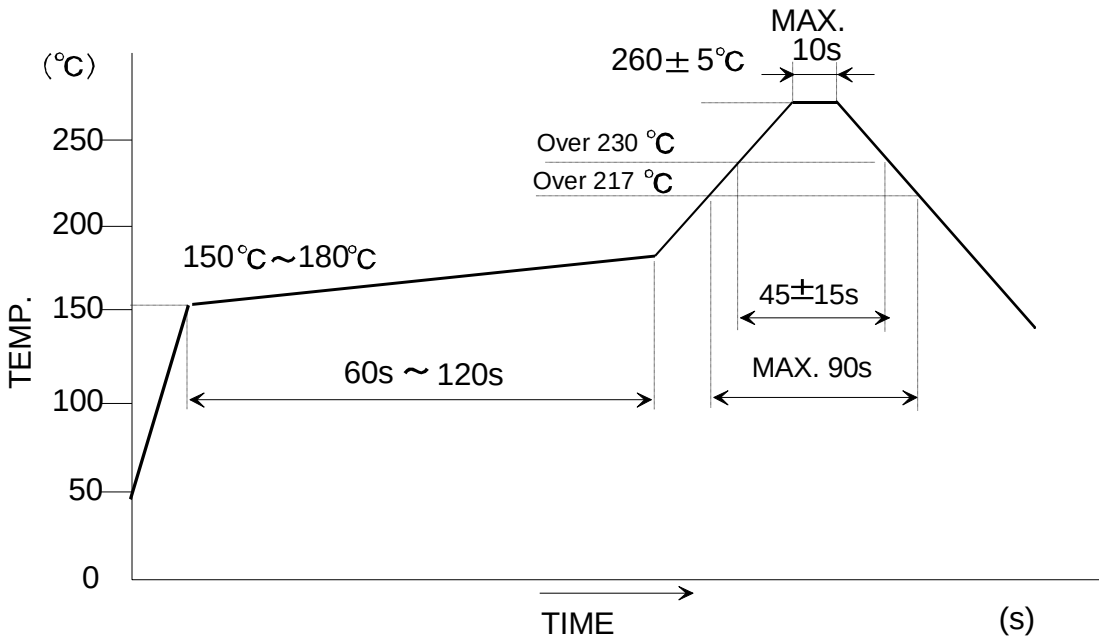
(page: 1/2)

No.	Test Item	Test Methods		Spec. Code
1	High temperature	Temperature: +125 °C Test time: 1000 Hr.		C, D
2	Cold resistance	Temperature: –40 °C Test time: 1000 Hr.		B, D
3	Humidity	at +85 °C with 85 % RH for 1000 hr.		B, D
4	Thermal shock (TS)	-55 +/- 3°C / +125 +/- 3°C 300 cycles/1H per cycles		C, D
5	Vibration	Frequency Range	10 to 2000Hz	A, D
		Amplitude or Acceleration	1.52 mm or 10G	
		1 cycle	20 minutes	
		Test time	Three mutually perpendicular axes each 6 times.	
6	Bending	Push the center of the substrate down with indenter, speed 1mm/s, bends, 5 mm, the state is held for 5 s +/- 1 s		A, D
7	Shock 1	Shock	Device are put on the weight of 150 g onto concrete.	B, D
		Height	1.8 m onto concrete.	
		Drop times	2 times for each 6 side direct 2 times 8 corners 1 times for each 12 edge directions Totally 26 drops.	
8	Shock 2	Shock	PCB (36mm '90mm)attached by 6 screws to a housing of 150g.	B, D
		Height	1.0 m onto concrete	
		Equipment	1.0mm +/- 0.1mm thick	
		Drop times	300 drops . 12 rotation / min.	
9	Reflow resistance	Temperature cycle as shown in (Fig2.) for 3 cycle.		A, D
10	Air Tightness	Helium leak test.		E

Specification code	Specification
A	$\Delta F/F \leq \pm 1.0$ ppm $\Delta CI \leq \pm 15$ % or $\pm 2\ \Omega$ greater value
B	$\Delta F/F \leq \pm 2.0$ ppm $\Delta CI \leq \pm 25$ % or $\pm 2\ \Omega$ greater value
C	$\Delta F/F \leq \pm 5.0$ ppm $\Delta CI \leq \pm 15$ % or $\pm 2\ \Omega$ greater value
D	Thermistor resistance: $\Delta R/R \leq 5\%$
E	No leak

Reliability assurance item(2/2)

Recommended reflow profile



A: 150 to 180 °C (90 ± 30 sec.)
B: 230°C min. (30 sec. max.)
C: Peak temperature. 260°C ± 5 °C (10sec. max.)
D: 217 °C Min. (90 sec. max.)