DAISHINKU CORP.

TO: HONHEVER

S1180090-2
Oct 26, 2018
DAISHINKU CORP.

Manager	Charge
T. Kusai	Y. Matsui

DSA321SDN 34.368 MHz VC-TCXO Failure Analysis Report

With regard to the failure issue, we would like to report as follows.
We would appreciate any feedback that you could give.

1. Failure Situation at your company

Sample code No. : ZZ05584
Description : DSA321SDN 34.368MHz
Date Code : 620 (20th week of 2016)
Returned Q'ty : 13pcs (NG 7pcs Good 6pcs)
Problem : Characteristic failure
Received Date : Apr 22, 2018
Received Date 2nd :Sep 24, 2018

2. Results of our investigation

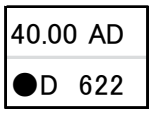
The electrical characteristics investigation results of returned parts are shown as follows.
All the returned parts including the had failure the specification.
(※No.13 was 40MHz)

電気的特性結果を下表に示します。 ＮＧ品については、異常を確認しました。
（※No.13は 40MHｚでした）

Table1. Electric characteristic investigation results

No. (Marking)	Date Code	Frequency	Output Voltage	Current Consumption	Frequency Control		Judgment
		±1.5ppm	0.8vp-p min	2.0mA max	+0.5V	+2.5V	
					±9ppm min		
1	620	-	0.00	0.20	-	-	NG
2	620	-	0.00	0.60	-	-	NG
3	620		0.00	0.62	-	-	NG
4	620	65.2	0.94	1.82	0.02	-0.03	NG
5	620		0.00	0.18	-	-	NG
6	620	-10.6	0.51	1.16	-1.86	-1.30	NG
7	620		0.00	0.62	-	-	NG
Good Samples							
8	620	-0.44	0.90	1.36	-10.26	10.67	Good
9	620	-0.20	0.88	1.36	-11.90	12.63	Good
10	620	-0.22	0.88	1.36	-11.59	12.19	Good
11	620	-0.35	0.88	1.36	-12.06	12.71	Good
12	620	-0.49	0.90	1.36	-11.66	12.55	Good
13	622	40Mz	0.88	1.47	-13.50	13.40	-

Test Condition ： Vcc=+3.3V, Vcont=+1.5V, LOAD=10kohm//10Pf



No.13 was 40MHz .

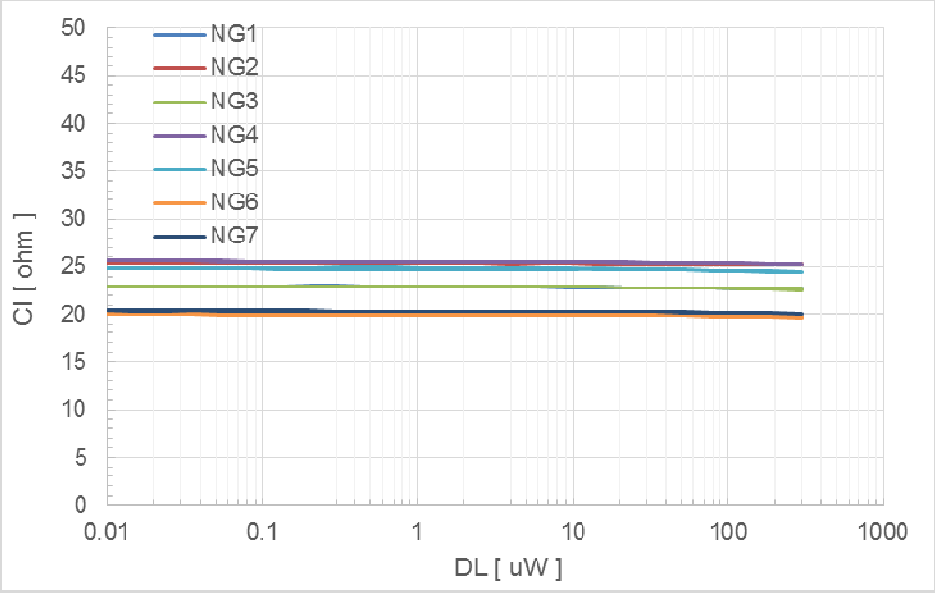
It is No.13 returned as a good product, but one with a different frequency was included. It seems to be mixed. As to the circumstances of incorporation, please do survey at your company.

良品としてご返却いただきましたNo.13ですが、別の周波数のものが入っておりました。混入と思われます。混入した経緯につきましては、御社にてご調査いただけますようお願い申し上げます。

Next, in order to investigate the characteristics of the crystal resonator inside the TCXO, the DLD characteristics were investigated. The results are shown below.
No abnormality was confirmed.

次に、TCXO内部にある水晶振動子の特性を調査する為に、水晶振動子特性を調査した結果を下記に示します。　結果、異常は確認されませんでした

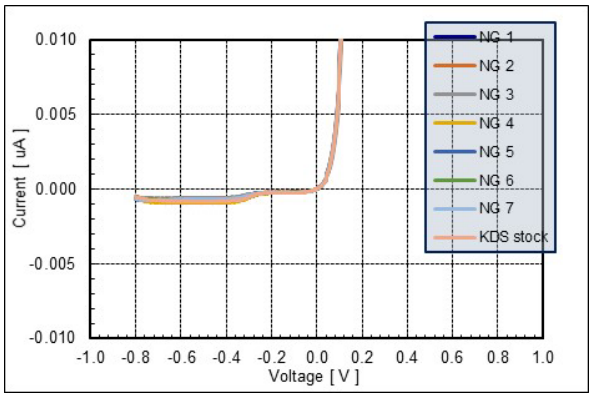
DLD characteristic test result



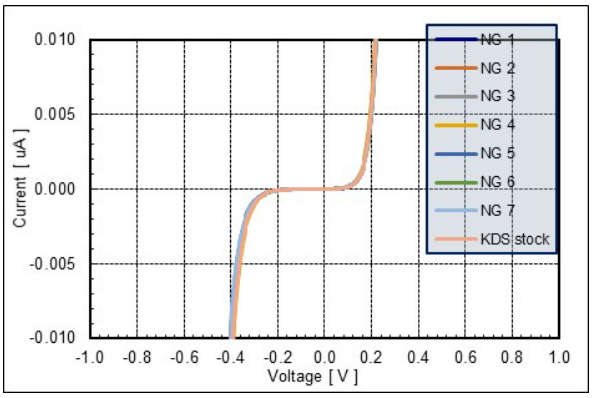
The result of examining the diode characteristics of the IC is shown in the Graph 1~3 below.
(The protection diode is connected to the input terminal of the IC.)
As a result, abnormality was confirmed in diode characteristics between Output terminal and GND terminal.

水晶の特性に異常が確認されなかったことから、ICの特性を調査した結果を下記グラフ1～3に示します。
（ICの入力端子には、保護ダイオードが接続されています。）
結果、Output 端子とGND 端子間のダイオード特性に異常が確認されました。

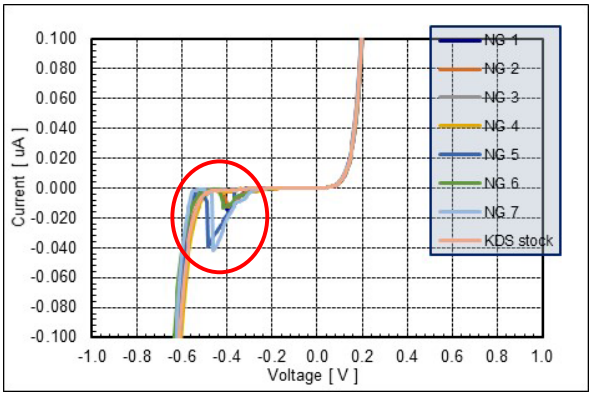
IC Diode Characteristics



Graph1. Vcont-GND diode characteristics



Graph2. Vcc-GND diode characteristics



Graph3. Otput-GND diode characteristics

3 Result

ESD breakdown, overvoltage, and overcurrent may be the cause of the IC's protection diode being broken. I would like you to confirm whether such things did not happen inside the company. In addition, we have heard that this product was a reliability test. I would like to inform you what kind of exam contents it is.

Also, this product is considered to be a malfunction of the IC. I would like to approve the IC survey to ask manufacturers to ask for survey, thank you for your permission.

ICの保護ダイオードが壊れた原因として、ESD破壊や、過電圧、過電流が考えられます。御社内にて、そのようなことが起こらなかったか、ご確認いただきたいと存じます。また、本品は信頼性試験を行ったものと伺っております。どのような試験内容であるか連絡いただきたいと存じます。

また、本品は、ICの故障と考えられます。ICをメーカーに調査依頼したく、開封調査について、ご許可のほどお願いいたします。

2018/10/26 add

I lost returned NG 7pcs

I'm sorry.

We advanced an investigation from the situation of the product of 7pcs (return items) that it was reported last time.

私たちは　前回返却された製品を紛失してしまいました。

申し訳ありません。

前回報告いたしました。7pcsの状況から　検証を進めました。

First

・No.1,2,3,5,7 ：No oscillation 5pcs → Vpp :0 and Icc=0.20, 0.60, 0.18, 0.62mA
Therefore we guess this IC breakdown.

・No.4：F+ 1pcs→+65.2ppm → Vpp: 0.94Vpp and AFC +0.02ppm at 0.5V , -0.03ppm at 2.5V
The AFC function is broken. Therefore we guess this IC breakdown.

・No.7：F- 1pcs→ -10.6ppm → Vpp: 0.51Vpp and AFC -1.86ppm at 0.5V , -1.30ppm at 2.5V
The AFC function and output unit are broken. Therefore we guess this IC breakdown.

まず内訳として

No.1,2,3,5,7：不発振　5pcs→出力振幅出ない→Icc: 0.20, 0.60, 0.62, 0.18, 0.62 mAより

IC 故障と推測

No.4：F+ 1pcs→+65.2ppm AFC機能不能→ Vpp: 0.94Vpp AFC +0.02ppm at 0.5V , -0.03ppm at 2.5Vより

IC 故障と推測

No.7：F- 1pcs→ -10.6ppm 出力振幅小、AFC機能不能→Vpp: 0.51Vpp AFC -1.86ppm at 0.5V , -1.30ppm at 2.5V より

IC 故障と推測

↓

We confirmed whether there was abnormality in a crystal part.

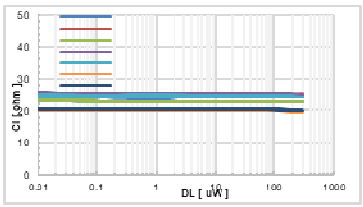
We measured DLD measurement, and 7 were no problem completely.

We confirmed that there is no abnormality in a crystal.

水晶振動子部分に異常が無いかを確認

DLD測定し、7個とも　問題無し

→水晶に異常が無いことを確認



↓

This IC breakdown was judged as this factor.

FTA was made and the cause was narrowed down. (Refer to Separate FTA sheet)

As this factor.

① Thermal shock test ② EOS ③ Reverse loading ④ ESD are considered.

↓

IC故障が今回の要因と判断し、FTAを作成し、原因の絞り込みを行いました。（別紙 FTA 参照）

今回の要因として

① 冷熱衝撃試験 ② EOS ③ 逆搭載 ④ ESD が考えられ、これらに対して再現検証を行いました。

Inspection result

① Thermal shock test -40～125℃ 12cycle

（ Because it was no oscillation after H/S in your reliability test, it's tested.）

Fraction stock of KDS is used (n=10pcs)

→ We confirm the special quality before and after thermal shock test.

It was judged to be no problem.

Judgement of standard： Before and after that's tested, that there is no abnormality in electrical characteristics.

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検証結果

① 冷熱衝撃試験 -40～125℃ 12cycle （貴社信頼性試験にてH/S後 不発振となったことからテストを実施）

KDS 端数在庫を使用（n=10pcs）

→ 冷熱衝撃試験前後の特性を確認 問題無し

判定：試験前後における電気的特性に異常なき事

Heat shock TEST

n=10pcs　-55～125℃　12cycle

No	Ref [Hz]	After H/S 12c [Hz]	Δf [Hz]	Δf [ppm]
1	34367999.7	34368006.5	6.8	0.20
2	34368011.7	34368016.2	4.5	0.13
3	34368006.6	34368009.1	2.4	0.07
4	34367998.4	34368003.8	5.5	0.16
5	34367989.8	34367993.2	3.4	0.10
6	34368003.4	34368005.5	2.1	0.06
7	34367999.6	34367996.3	−3.3	−0.09
8	34368018.5	34368016.8	−1.7	−0.05
9	34368009.8	34368013.8	4.0	0.12
10	34367992.5	34367996.0	3.4	0.10
Ave	34368003.0	34368005.7	2.7	0.08
3σ	26.6	25.6	9.2	0.27
Min	34367989.8	34367993.2	−3.3	−0.09
Max	34368018.5	34368016.8	6.8	0.20
N	10	10	10	10

② EOS TEST

We added the excessive voltage and made them break down until we troubled between Vcc-GND.

And we check diode characteristics (Vcc-GND, Output-GND)

→ n=2pcs used

It breaks down by Vcc=12V. Output is no-oscillation. Icc is 18-20mA at Vcc=3.3v.

And another breaks down by Vcc=10V. Output is no-oscillation. Icc is 18-20mA at Vcc=3.3v.

→ That's no oscillation, but the oscillation items no oscillation of the return items is different from Icc 0.2-0.62mA in the state small.

And also different in 2, F+ and F- items, the state is less than 2.0 mA of Icc .

→ We infer that it isn't a EOS factor.

② EOS TEST

製品のVcc-GND間に、故障するまで過度の電圧を加えて、故障させ、その製品のダイオード特性を確認

→ n=2個に対して

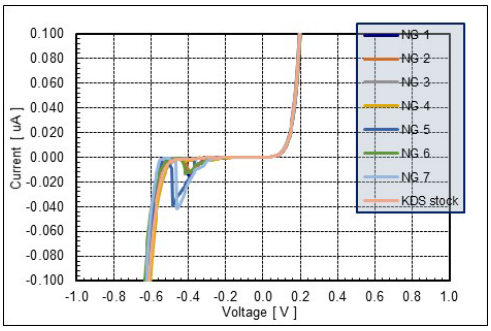
- Vcc=12V で 故障：症状不発振 Vcc=3.3V時 Icc 18～20mA
- Vcc=10V で 故障：症状不発振 Vcc=3.3V時 Icc 18～20mA

→ 不発振であるが、返却品の不発振品は Icc 0.2～0.62mA と小さく状態が異なる。

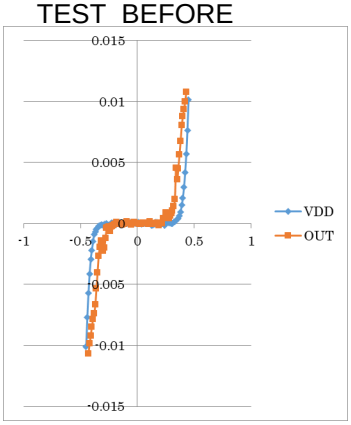
F+、F-品の２個についても Icc 2.0mA以下 であり状態が異なる。

→ EOS要因では無いと推測される。

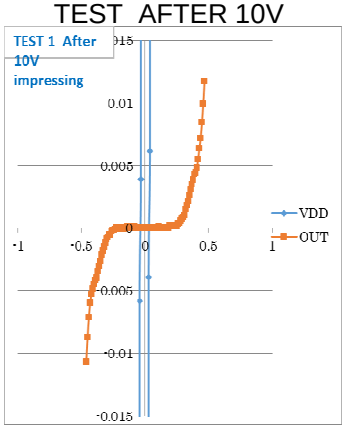
The claim items



TEST BEFORE



TEST AFTER 10V



③ About a possibility of the reverse loading.

Reverse loading is assumed and the voltage is impressed between Output - GND (n=1pcs).

→ It breaks down by 9V: Output is no-oscillation. Icc is 20mA at Vcc=3.3V

→ It'll be the no oscillation by applying an overvoltage and an over-current to a Output terminal.

The no oscillation items of the return items is Icc 2.0mA and different in the state.

→We infer that it isn't a reverse loading factor.

③ 逆搭載の可能性について

逆搭載を想定し、Output-GND 間に電圧を印加 （n=1pcs）

→9V で故障：症状不発振 Vcc=3.3V時 Icc 20mA

→Output端子に過電圧・過電流を掛けることで不発振となるが、

返却品の不発振品は、Icc 2.0mAであり状態が異なる。

→逆搭載要因では無いと推測される。

④ ESD TEST

It was tested until it was no oscillation or oscillation unusualness at machine model and human body model .

→ Machine Model (MM) r/n=3/5pcs no oscillation at 500V

→ Human Body Model (HBM) r/n=3/7pcs oscillation unusualness at 6000V（frequency shift ）

※The specification is (MM) V=±200V (C=200pF, R=0Ω)

(HBM) V=±1500V (C=100pF, R=1500Ω)

Requirements: The electrical characteristics are satisfied.

④　ESD　TEST

・マシンモデル　ヒューマンボディモデル　で　不発振や発振異常となるレベルまで実施した。。

→　マシンモデル　　500Vで、r/n= 3/5　不発振

→　ヒューマンモデル　　6000Vで、r/n=3/7 発振異常（周波数変化大）

※仕様：(MM) V=±200V (C=200pF,　R=0Ω)

(HBM) V=±1500V (C=100pF, R=1500Ω)

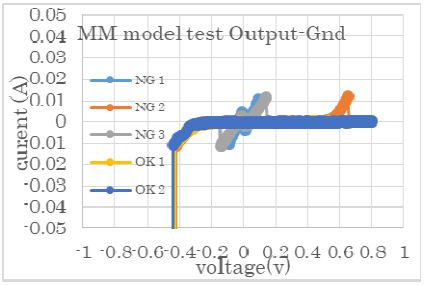
判定基準　電気的特性に異常無きこと。

・Machine model(MM):　3pcs of no oscillation at 500V　and 2pcs of　good products at 400V　ware measured diode characteristics between Output – GND.

→　The abnormality like this defect is confirmed about 3pcs of no oscillation items.

・マシンモデル　500Vで不発振3pcsと、400Vで残存分2pcsをOutput-GND間のダイオード特性を測定

→　不発振品3pcsについて、今回の不具合と同様の異常を確認



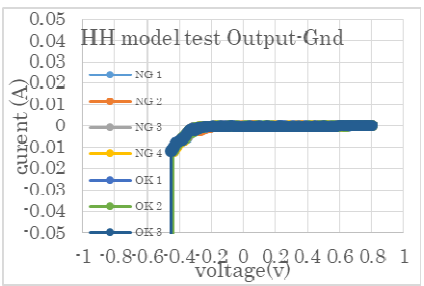
・Human Body Model (HBM)：　4pcs of　oscillation unusualness at 6000V　and 3pcs of　good products at 5000V　ware measured diode　characteristics between Output – GND.

→　Abnormality wasn't seen between Output-GND.

（We guess output terminal isn't a breakdown from the point that products don't come to the no oscillation.）

・ヒューマンモデル　6000Vで 発振異常4pcsと、5000Vで残存分3pcsをOutput-GND間のダイオード特性を測定

→　Output-GND間で異常は見られませんでした(不発振に至っていない点からもOutput端子は故障とはなっていない)



Conclusion

ESD test , Machine model confirmed that no oscillation occurs in 500V.

(The terminal to which the voltage has been added in a ESD test is Vcc-GND, Vcc-Output. ,

Vcc-Vcont, Output-Vcont, Output-GND, Vcont-GND)

The one which is a machine model more than a human body model, the degree of destruction can see the big tendency.

It seems the symptom near the return items.

Oscillation check is being performed at the time of our shipment.

We think that it occurred after shipment – transportation - your company evaluation.

I'd appreciate it if you confirm these concerns and can evaluate again.

If you'd accept it, I'll prepare and ship a sample for evaluation (later of arrangements for 10 days).

Thank you.

結論

ESD試験　マシンモデルにて　500Vにて　不発振が発生することを確認しました。

(ESD試験にて電圧を加えた端子はVcc-GND, Vcc-Output. ,Vcc-Vcont, Output-Vcont, Output-GND, Vcont-GND)

ヒューマンモデルよりもマシンモデルの方が破壊度が大きい傾向が見られます。

返却品に近い症状と思われます

弊社出荷時は、発振チェックを行っており、弊社出荷後～運搬～貴社ご評価の際に発生したと考えます。

誠に恐縮でございますが、これらの懸念点をご確認頂き再度のご評価頂ければ幸いです。

ご了承頂けましたら、ご評価用サンプルを準備・出荷いたします（手配後10日）

よろしくお願いいたします。

以上。

Fig.1　FTA attribution analysis of an IC breakdown