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February 4, 2009

SUB: Component testing after Long Period on Shelf

## **Reliability testing of solid and liquid type aluminum electrolytic capacitor after long storage**

The following pages show the reliability of solid and liquid aluminum electrolytic capacitors after long storage times (from two years up to nine years storage).

### **Summary of reliability data after long storage**

#### Liquid Type Aluminum Electrolytic Capacitor

1. Initial electrical characteristics measured for 10 pcs of 3 NACE items (SMT V-Chip +85°C rated) after 2-year storage did not show any significant change of capacitance,  $\tan\delta$  and leakage current. All within error tolerance level of measurement.
2. Observed capacitance decreased by 2~4 % after 3 year or 4 year storage for 20pcs of 2 type V-chip (SMT) item in annual measurement of electrical characteristics. There was no change of leakage current.
3. In high temperature load life test conducted on long term storage items ranging 5-year up to 9-year storage, the life curves are very consistent with newly manufactured capacitors and no significant deterioration in endurance performance was observed.
4. Zero cross time testing was used to evaluate wetting ability of Sn100% or Sn/Bi0.5% plated terminal installed in lead free V chip items. Wetting times increased after steam aging at 105oC for 8 hours or 16 hours, but remained stable under such highly accelerated conditions.
  - According to one correlation method between steamed aging and floor aging, 8hr steam aging may be translated to 1.6 year storage in 30oC/70%RH environment and 16 hr aging corresponds to 3.2 year natural storage. Within these testing conditions, solderability degradation did not occur.

#### Solid Type Aluminum Electrolytic Capacitor

1. Initial characteristics measured for 10 pcs of three NPC items (SMT Flat Chip +105°C rated) after 2-year, 4-year and 5-year storage did not show any significant change of capacitance,  $\tan$ , ESR and leakage current. All within error tolerance level of measurement.
2. Comparison between newly manufactured capacitors and 4-year storage sample of NPC series, showed very similar performance in reliability testing for high temperature load life, high temperature storage, damp heat, shelf test and temperature cycling test.
3. In solderability comparison testing, 8-hour steam aged samples showed good solderability using test method of dipping and zero cross time wetting test.

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## Reliability Test Data after Long Storage

### Liquid Type Aluminum Electrolytic Capacitors

1. Typical electrical characteristics change over two years storage (Page 3)
2. Typical electrical characteristics change over three years storage (Page 4)
3. Typical electrical characteristics change over four years storage (Page 5)
4. Reliability test of long term storage items
  - High temperature life data
    - i. Comparison between new and 5 year storage (Page 6 & 7)
    - ii. SMT V-chip after 5 year storage (Page 8 & 9)
    - iii. Radial LDD after 6 year storage (Page 10 & 11)
    - iv. Radial LDD after 9 year storage (Page 12 & 13)
  - Solderability test data (Zero cross time)
    - i. ZCT comparison data (Pages 14 & 15)



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### Liquid Type Aluminum Electrolytic Capacitors

- The characteristic change after long times storage
  - Electrical characteristics of three NACE part numbers after 2 year storage
  - No significant change of electrical properties of NACE after 2 year storage

Part No: NACE4R7M25V4x5.5F

NO	CAP(uF) ↓		Capacitance change	DF(%) ↓		LC(uA) ↓	
	before storage	after 2 year		before storage	after 2 year	before storage	after 2 year
1	4.90	4.85	-1.02%	2.70	3.34	0.14	0.15
2	4.86	4.88	0.41%	3.10	3.74	0.49	0.17
3	4.89	4.92	0.61%	3.20	3.19	0.23	0.14
4	4.88	4.87	-0.20%	2.70	3.36	0.18	0.11
5	4.97	4.85	-2.41%	2.90	3.24	0.22	0.10
6	4.98	4.88	-2.01%	3.10	3.30	0.16	0.09
7	4.97	4.97	0.00%	2.90	3.54	0.24	0.14
8	4.94	4.88	-1.21%	3.10	3.59	0.31	0.10
9	4.89	4.86	-0.61%	2.80	3.50	0.28	0.12
10	4.94	4.90	-0.81%	3.20	3.90	0.15	0.09
AVERAGV	4.92	4.89	-0.007	2.97	3.47	0.24	0.12

Part No: NACE220M16V4x5.5F

NO	CAP(uF) ↓		Capacitance change	DF(%) ↓		LC(uA) ↓	
	before storage	after 2 year		before storage	after 2 year	before storage	after 2 year
1	21.10	21.13	0.14%	9.60	12.67	0.43	0.38
2	20.90	21.20	1.44%	10.40	12.23	0.43	0.50
3	21.60	21.21	-1.81%	10.40	12.35	0.31	0.39
4	20.60	20.96	1.75%	11.00	12.69	0.42	0.43
5	21.90	21.17	-3.33%	9.70	12.41	0.80	0.46
6	21.70	21.14	-2.58%	10.00	12.60	0.57	0.37
7	21.10	21.10	0.00%	9.90	12.31	0.53	0.72
8	20.90	21.13	1.10%	10.00	11.03	0.54	0.41
9	21.00	20.83	-0.81%	9.50	12.68	0.96	0.30
10	21.40	21.41	0.05%	10.10	11.33	0.34	0.24
AVERAGV	21.22	21.13	-0.004	10.06	12.23	0.53	0.42

Part No: NACE101M6.3V6.3x5.5F

NO	CAP(uF) ↓		Capacitance change	DF(%) ↓		LC(uA) ↓	
	before storage	after 2 year		before storage	after 2 year	before storage	after 2 year
1	97.10	97.26	0.16%	6.70	8.24	0.22	0.42
2	96.50	95.55	-0.98%	6.50	7.87	0.23	0.29
3	97.40	94.32	-3.16%	6.60	7.74	0.23	0.32
4	99.90	96.01	-3.89%	6.50	7.79	0.16	0.33
5	95.20	95.09	-0.12%	7.70	8.00	0.31	0.34
6	95.70	95.61	-0.09%	6.60	8.19	0.24	0.34
7	96.90	97.01	0.11%	6.50	7.65	0.20	0.25
8	97.60	95.59	-2.06%	6.90	8.52	0.28	0.23
9	96.80	94.21	-2.68%	6.80	7.83	0.15	0.26
10	96.40	97.46	1.10%	6.80	8.56	0.16	0.28
AVERAGV	96.95	95.81	-0.012	6.76	8.04	0.22	0.31



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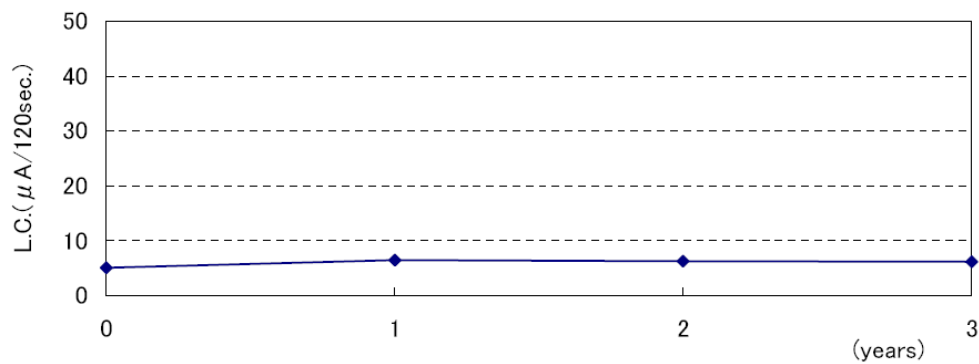
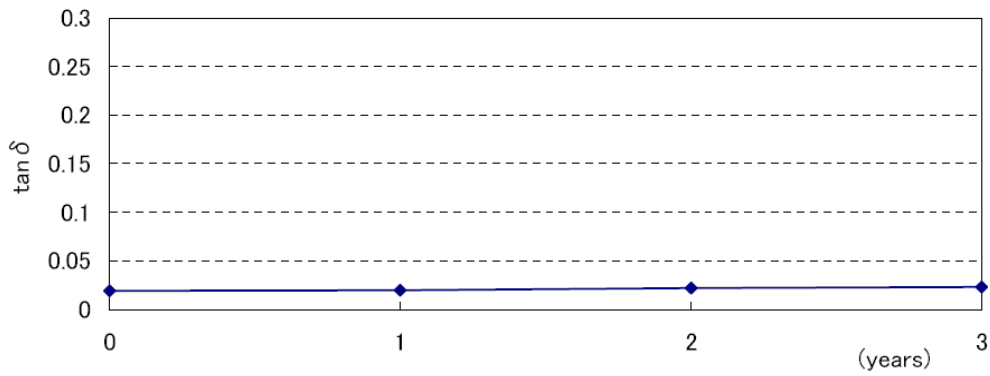
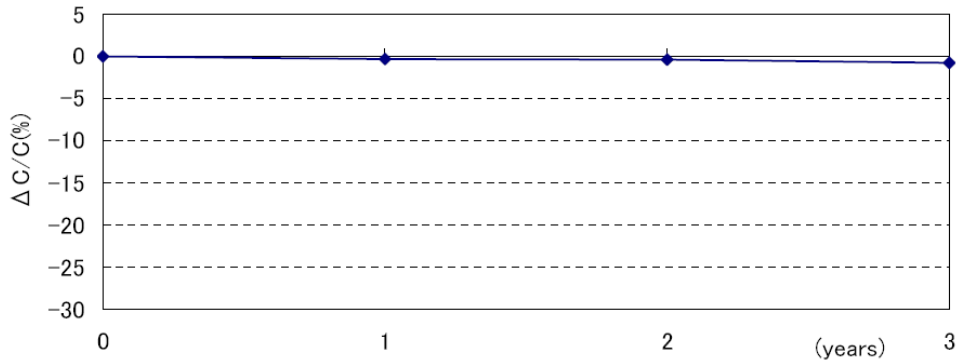
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### Liquid Type Aluminum Electrolytic Capacitors

#### Change of electrical properties during 3 year storage

TEST CONDITION : 3 years at room temperature with no voltage applied.

Part Number: NATT470M100V12.5X14HBF      n = 20pcs.





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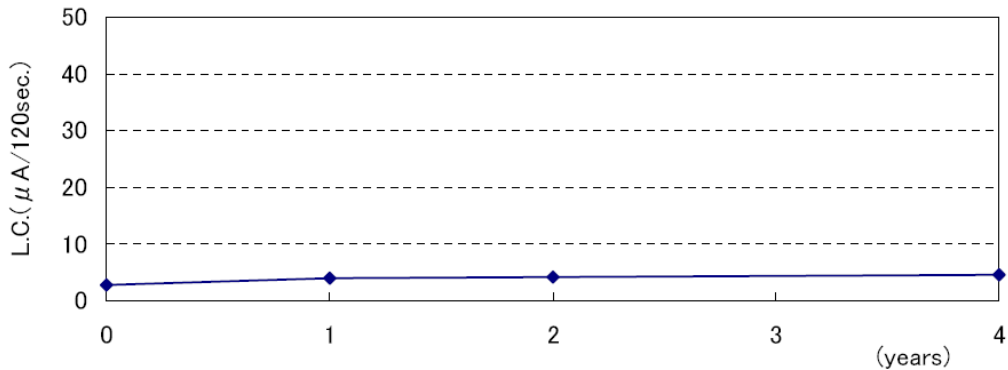
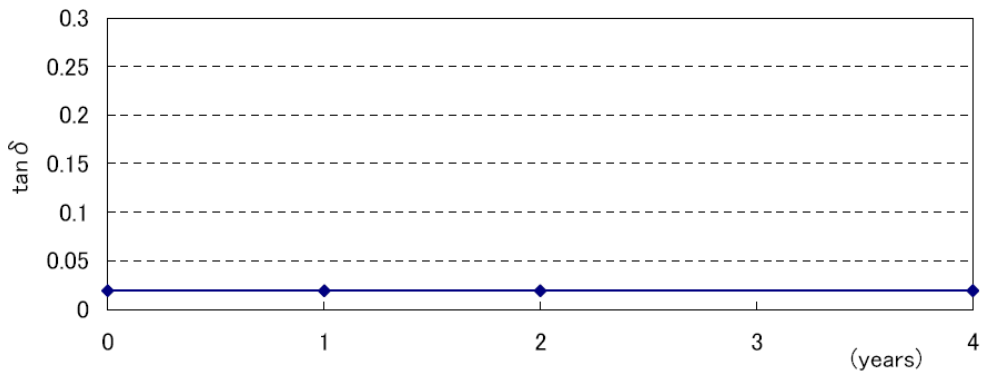
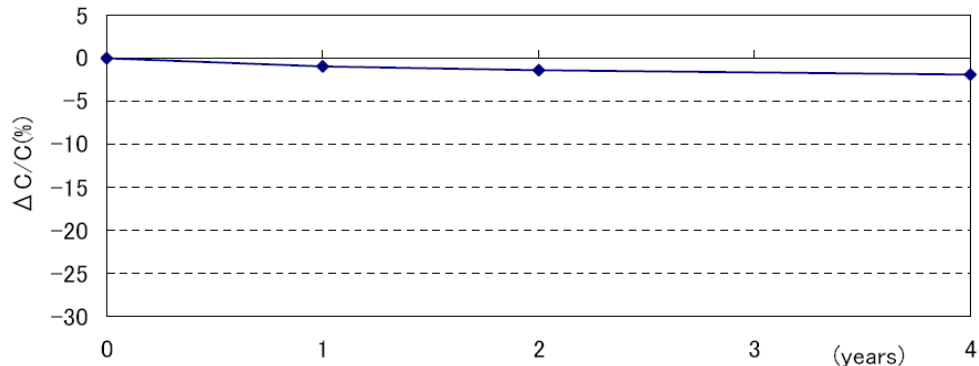
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### Liquid Type Aluminum Electrolytic Capacitors

#### Change of electrical properties during 3 year floor storage

TEST CONDITION : 4 years at room temperature with no voltage applied.

Part Number: NRSZ101M100V12.5X20F n = 20pcs.





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### Liquid Type Aluminum Electrolytic Capacitors

#### LIFE TEST COMPARISON - ALUMINUM ELECTROLYTIC CAPACITORS

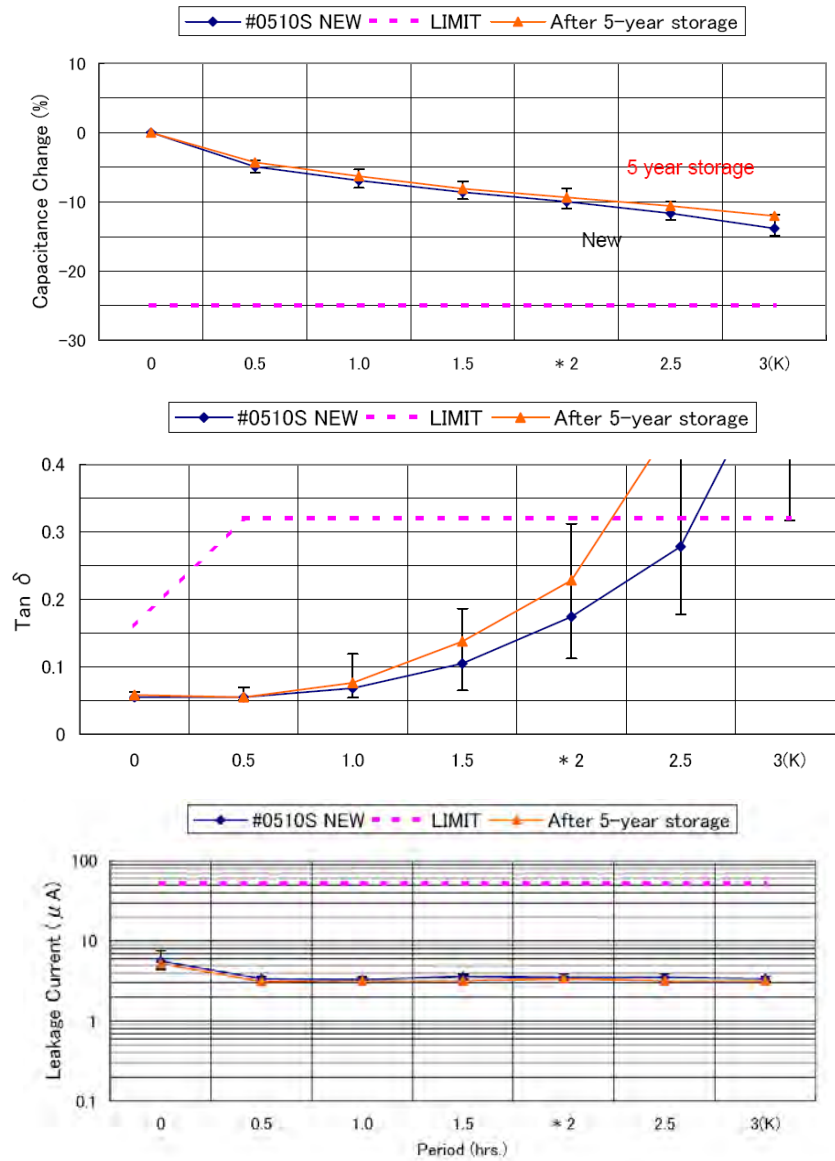
Comparison between **newly produced** and **5-year storage samples**

Part Number: NRW331M16V10X12.5 ... Rated for 2000 hours @ +125°C

Number of samples = 10pcs

Testing Duration: 3,000 hours @ +125°C

Graphed Data (Charted data on 2<sup>nd</sup> page)





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**Liquid Type Aluminum Electrolytic Capacitors**

Part Number: NRWX331M16V10X12.5 ... Rated for 2000 hours @ +125°C

Number of samples = 10pcs

Testing Duration: 3,000 hours @ +125°C

Charted Data

**Newly produced - NRWX331M16V10X12.5**

Period	0	0.5	1.0	1.5	* 2	2.5	3(K)
Capactance	328.658	312.5490	305.95	300.378	295.819	290.377	283.109
%	-25	-25	-25	-25	-25	-25	-25
	0.000	-4.901	-6.909	-8.605	-9.992	-11.648	-13.859
MAX	0.629	-3.982	-5.307	-7.032	-8.068	-9.886	-11.815
MIN	-1.281	-5.760	-7.996	-9.595	-10.956	-12.589	-14.878
+	0.000	0.920	1.602684	1.572332	1.924	1.762	2.044
-	0.000	0.858	1.087	0.991	0.964	0.941	1.019

Period	0	0.5	1.0	1.5	2.0	2.5	3.0
	0.16	0.32	0.32	0.32	0.32	0.32	0.32
Tan $\delta$	0.055	0.055	0.068	0.105	0.174	0.278	0.595
MAX	0.062	0.069	0.119	0.186	0.312	0.552	1.759
MIN	0.053	0.050	0.054	0.065	0.112	0.178	0.317
+	0.007	0.014	0.051	0.081	0.138	0.274	1.164
-	0.002	0.005	0.014	0.040	0.062	0.100	0.278

Period	0	0.5	1.0	1.5	2.0	2.5	3.0
	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Lrackage Current	5.600	3.400	3.300	3.600	3.500	3.500	3.400
MAX	7.600	3.700	3.500	3.800	3.900	3.900	3.700
MIN	4.400	3.000	3.000	3.300	3.200	3.100	3.100
+	2.000	0.300	0.200	0.200	0.400	0.400	0.300
-	1.200	0.400	0.300	0.300	0.300	0.400	0.300

Charted data

**After 5 year storage - NRWX331M16V10X12.5**

Period	0	0.5	1.0	1.5	* 2	2.5	3(K)
Capactance	301.636	288.7667	282.684	277.196	273.378	269.706	265.28
%	-25	-25	-25	-25	-25	-25	-25
	0.000	-4.267	-6.283	-8.102	-9.368	-10.586	-12.053
MAX	0.960	-4.037	-5.606	-7.400	-8.908	-9.931	-10.576
MIN	-0.922	-4.676	-6.853	-8.602	-9.703	-11.219	-14.467
+	0.000	0.230	0.677474	0.702039	0.460	0.654	1.477
-	0.000	0.409	0.569	0.500	0.334	0.634	2.414

Period	0	0.5	1.0	1.5	2.0	2.5	3.0
	0.16	0.32	0.32	0.32	0.32	0.32	0.32
Tan $\delta$	0.058	0.055	0.076	0.137	0.228	0.477	1.466
MAX	0.062	0.073	0.131	0.232	0.384	1.113	4.364
MIN	0.055	0.050	0.055	0.089	0.152	0.263	0.487
+	0.004	0.018	0.055	0.095	0.156	0.636	2.898
-	0.003	0.005	0.021	0.048	0.076	0.214	0.979

Period	0	0.5	1.0	1.5	2.0	2.5	3.0
	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Lrackage Current	5.200	3.100	3.200	3.200	3.400	3.200	3.200
MAX	12.100	3.400	3.700	3.300	3.700	3.800	3.500
MIN	2.800	2.700	2.900	2.800	3.100	2.700	2.900
+	6.900	0.300	0.500	0.100	0.300	0.600	0.300
-	2.400	0.400	0.300	0.400	0.300	0.500	0.300



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### Liquid Type Aluminum Electrolytic Capacitors

#### LIFE TEST RESULTS - ALUMINUM ELECTROLYTIC CAPACITOR

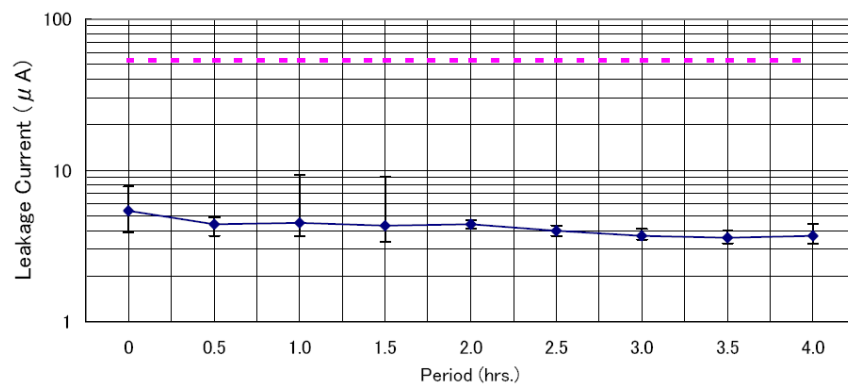
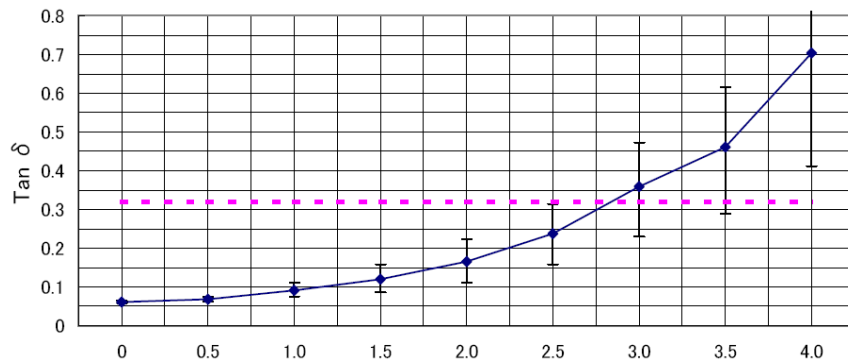
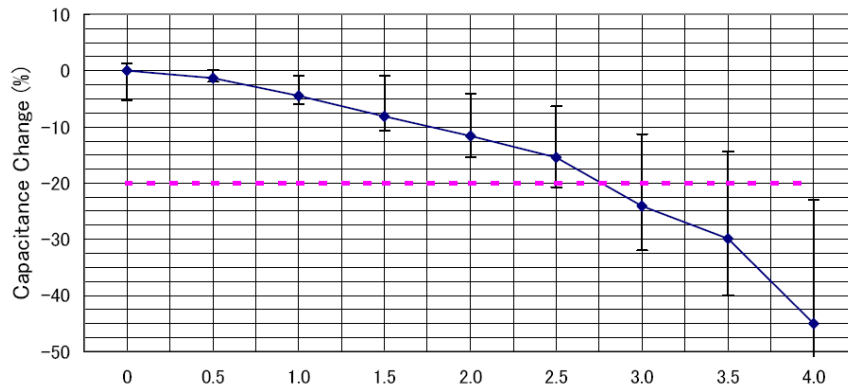
Life test **after 5-year storage** under normal condition

Part Number: NACZ331M16V8X10.5 ... Rated for 2000 hours @ +105°C

Number of samples = 10pcs

Testing Duration: 4,000 hours @ +105°C

#### Graphed Data





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### Liquid Type Aluminum Electrolytic Capacitors

Life test **after 5-year storage** under normal condition

Part Number: NACZ331M16V8X10.5 ... rated for 2000 hours @ +105°C

Number of samples = 10pcs

Testing Duration: 4,000Hrs hours @ +105°C

Charted data

Period	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Capactance	336.861	332.4080	321.796	309.62	297.638	284.775	255.803	236.177	185.366
%	-20	-20	-20	-20	-20	-20	-20	-20	-20
	0.000	-1.322	-4.472	-8.087	-11.644	-15.462	-24.063	-29.889	-44.973
MAX	1.246	0.190	-0.862	-2.352	-4.022	-6.318	-11.233	-14.362	-23.032
MIN	-5.200	-1.972	-5.927	-10.690	-15.411	-20.754	-31.926	-39.985	-61.013
+	1.246	1.512	3.6102	7.225	7.621	9.144	12.829	15.526	21.941
-	5.200	0.650	1.455	2.603	3.767	5.292	7.864	10.096	16.040

Period	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Tan $\delta$	0.061	0.069	0.091	0.120	0.166	0.238	0.359	0.461	0.704
MAX	0.065	0.076	0.110	0.159	0.223	0.315	0.473	0.616	1.101
MIN	0.059	0.063	0.076	0.087	0.111	0.159	0.231	0.288	0.412
+	0.004	0.007	0.019	0.039	0.057	0.077	0.114	0.155	0.397
-	0.002	0.006	0.015	0.033	0.055	0.079	0.128	0.173	0.292

Period	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Irakage Current	5.400	4.400	4.500	4.300	4.400	4.000	3.700	3.600	3.700
MAX	7.800	4.900	9.400	9.100	4.700	4.300	4.100	4.000	4.400
MIN	3.900	3.700	3.700	3.400	4.100	3.700	3.500	3.300	3.300
+	2.400	0.500	4.900	4.800	0.300	0.300	0.400	0.400	0.700
-	1.500	0.700	0.800	0.900	0.300	0.300	0.200	0.300	0.400



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### Liquid Type Aluminum Electrolytic Capacitors

#### LIFE TEST RESULTS ALUMINUM ELECTROLYTIC CAPACITOR

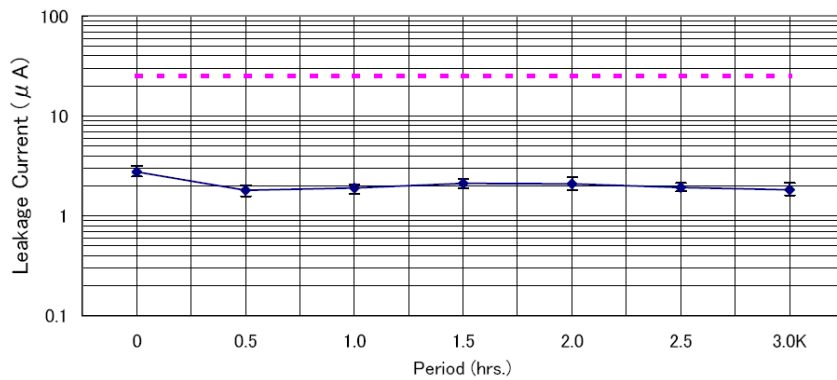
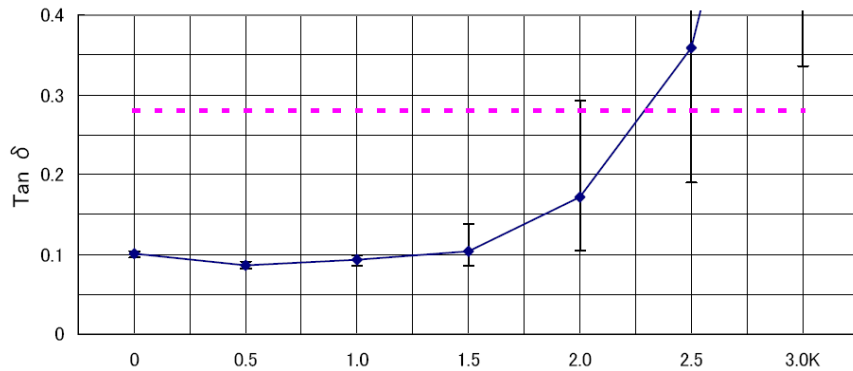
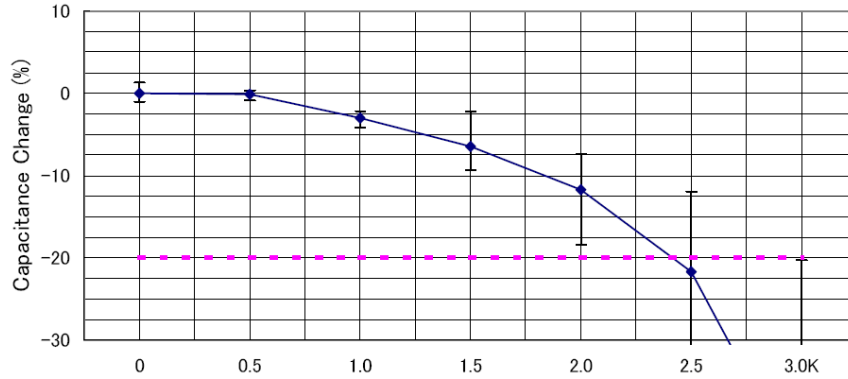
Life test **after 6-year storage** under normal condition

Part Number: NRWA101M25V6.3X11 ... rated for 1000 hours @ +105°C

Number of samples = 10pcs

Testing Duration: 3,000Hrs hours @ +105°C

Graphed Data (Charted data on 2<sup>nd</sup> page)





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Life test **after 6-year storage** under normal condition

Part Number: NRWA101M25V6.3X11 ... rated for 1000 hours @ +105°C

Number of samples = 10pcs

Testing Duration: 3,000 hours @ +105°C

Charted data

Period	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Capactance	336.861	332.4080	321.796	309.62	297.638	284.775	255.803	236.177	185.366
%	-20	-20	-20	-20	-20	-20	-20	-20	-20
	0.000	-1.322	-4.472	-8.087	-11.644	-15.462	-24.063	-29.889	-44.973
MAX	1.246	0.190	-0.862	-2.352	-4.022	-6.318	-11.233	-14.362	-23.032
MIN	-5.200	-1.972	-5.927	-10.690	-15.411	-20.754	-31.926	-39.985	-61.013
+	1.246	1.512	3.6102	7.225	7.621	9.144	12.829	15.526	21.941
-	5.200	0.650	1.455	2.603	3.767	5.292	7.864	10.096	16.040

Period	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Tan $\delta$	0.061	0.069	0.091	0.120	0.166	0.238	0.359	0.461	0.704
MAX	0.065	0.076	0.110	0.159	0.223	0.315	0.473	0.616	1.101
MIN	0.059	0.063	0.076	0.087	0.111	0.159	0.231	0.288	0.412
+	0.004	0.007	0.019	0.039	0.057	0.077	0.114	0.155	0.397
-	0.002	0.006	0.015	0.033	0.055	0.079	0.128	0.173	0.292

Period	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Drakage Current	5.400	4.400	4.500	4.300	4.400	4.000	3.700	3.600	3.700
MAX	7.800	4.900	9.400	9.100	4.700	4.300	4.100	4.000	4.400
MIN	3.900	3.700	3.700	3.400	4.100	3.700	3.500	3.300	3.300
+	2.400	0.500	4.900	4.800	0.300	0.300	0.400	0.400	0.700
-	1.500	0.700	0.800	0.900	0.300	0.300	0.200	0.300	0.400



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### Liquid Type Aluminum Electrolytic Capacitors

#### LIFE TEST RESULTS ALUMINUM ELECTROLYTIC CAPACITOR

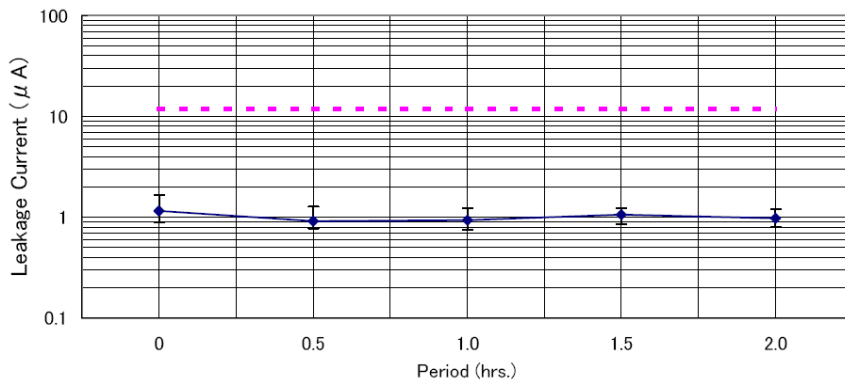
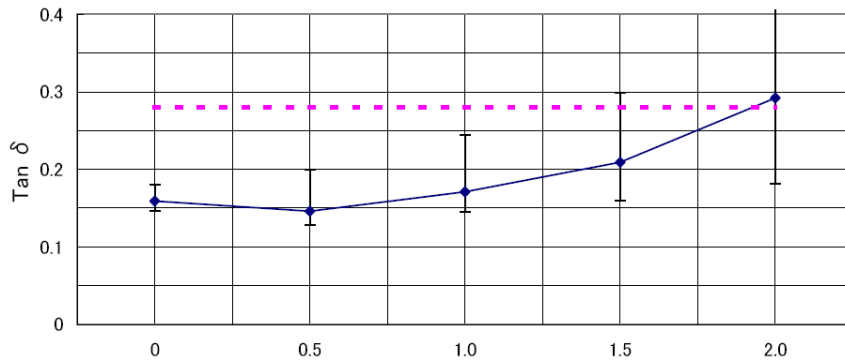
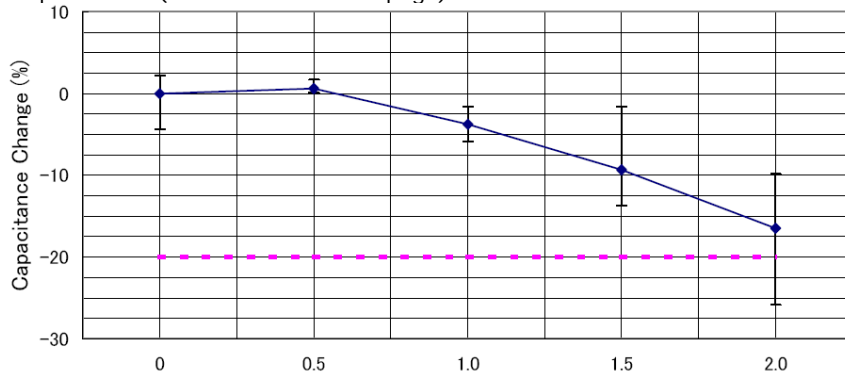
Life test **after 9-year storage** under normal condition

Part Number: NRWA470M25V5X11 ... .. rated for 1000 hours @ +105°C

Number of samples = 10pcs

Testing Duration: 2,000 hours @ +105°C

Graphed Data (Charted data on 2<sup>nd</sup> page)





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### Liquid Type Aluminum Electrolytic Capacitors

Life test **after 9-year storage** under normal condition

Part Number: NRWA470M25V5X11 ... rated for 1000 hours @ +105°C

Number of samples = 10pcs

Testing Duration: 2,000 hours @ +105°C

Charted data

Period	0	0.5	1.0	1.5	2.0
Capactance	41.8001	42.0721	40.2258	37.9104	34.9114
%	-20	-20	-20	-20	-20
	0.000	0.651	-3.766	-9.305	-16.480
MAX	2.188	1.718	-1.596	-5.827	-9.845
MIN	-4.383	0.086	-5.931	-13.729	-25.867
+	2.188	1.068	2.170553	7.710	6.635
-	4.383	0.565	2.164	4.423	9.387

Period	0	0.5	1.0	1.5	2.0
	0.28	0.28	0.28	0.28	0.28
Tan $\delta$	0.159	0.146	0.171	0.209	0.292
MAX	0.180	0.200	0.245	0.299	0.473
MIN	0.146	0.128	0.145	0.159	0.181
+	0.021	0.054	0.074	0.090	0.181
-	0.013	0.018	0.026	0.050	0.111

Period	0	0.5	1.0	1.5	2.0
	11.75	11.75	11.75	11.75	11.75
Lrakage Current	1.160	0.920	0.940	1.060	0.980
MAX	1.680	1.270	1.230	1.220	1.200
MIN	0.890	0.770	0.760	0.860	0.800
+	0.520	0.350	0.290	0.160	0.220
-	0.270	0.150	0.180	0.200	0.180



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### Liquid Type Aluminum Electrolytic Capacitors

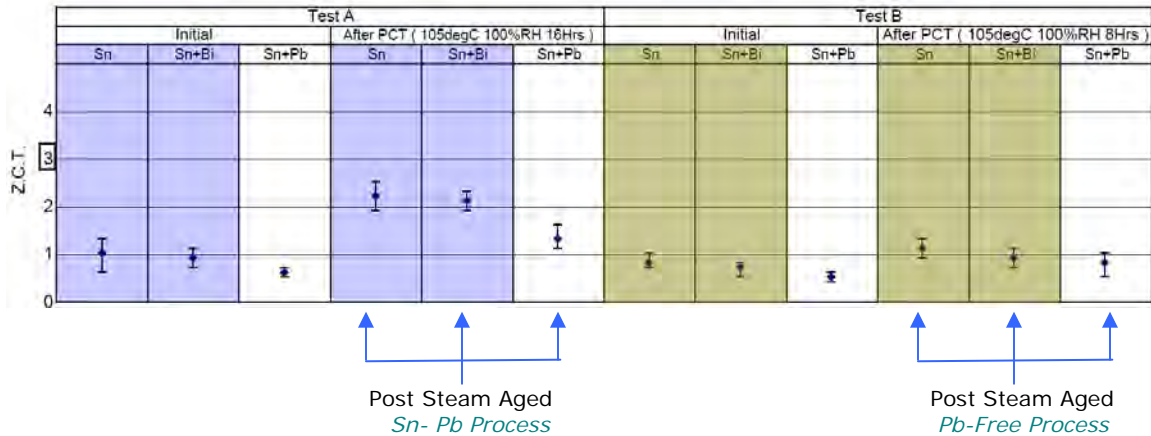
#### Solderability test data (Zero Cross Time)

After performing PCT (Steam Aging) treatment, measure Z.C.T. ( Zero Cross Time ) with Meniscus Measurement apparatus SAT-5000 made by RHESCA

- NA-200 flux made by Tamura Kaken be used as soldering flux [ <http://tamurauusa.com> ]
- Three terminal materials compared
  - Sn finish
  - Sn + Bi finish
  - Sn + Pb finish

Solder Alloy (Each n=10)	A	H63A <i>Sn-Pb</i>
	B	Sn- 2.5Ag - 1Bi - 0.5Cu <i>Pb-Free</i>
Solder Temperature	A	230 +/- 2°C <i>Sn-Pb</i>
	B	245 +/- 2°C <i>Pb-Free</i>
PCT (Each n=10)	A	Temperature 105degC 100%RH 1.22X*10(5) Pa, Aging 16Hrs
	B	Temperature 105degC 100%RH 1.22X*10(5) Pa, Aging 8Hrs

Lead Wire diameter: 0.45mm



#### FINDING:

8-Hour & 16-Hour steam aging (~ equivalent to 3.2 years normal storage) has minimal impact on wetting ZCT conditions



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**Liquid Type Aluminum Electrolytic Capacitors**

Solderability test data (Zero cross time)

ZCT Test Result –

Measuring Temperature - 25°C Humidity : 41%

Solder: Senju Kinzoku SnAgCu

Pretreatment: PCT 105oC Humidity 100% Pressure 1.22\*10(5) 8Hrs

Part Name	Size	Lot No	M705 (at 245°C)			
			As received		After PCT	
			(+)	(-)	(+)	(-)
			ZCT (sec)	ZCT (sec)	ZCT (sec)	ZCT (sec)
NACZ101M16V Sn 100%	φ 6.3	4D249H7	1.44	1.95	2.25	2.94
			1.44	1.31	2.99	2.61
NACEW151M16V Sn+Bi	φ 6.3	4O149Z4	1.41	2.10	1.57	1.99
			2.05	1.91	2.07	2.32
NACEW221M35V Sn 100%	φ 8	4D139U3	1.70	2.13	3.42	3.37
			1.47	2.03	3.51	2.75
NACEW331M10V Sn+Bi	φ 8	45179U3	1.41	1.43	1.98	2.17
			1.93	1.54	2.18	2.03
NACZ471M25V Sn 100%	φ 10	52179U5	1.47	1.46	2.21	1.89
			1.73	1.16	1.95	1.95
NACZ471M25V Sn+Bi	φ 10	52179U5	1.53	1.34	1.79	1.92
			1.28	1.38	1.61	1.98



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## Reliability Test Data after Long Storage

### Solid Type Aluminum Electrolytic Capacitors

1. The electrical characteristic impact of long time storage

- 2-year, 4-year and 5-year storage (Page 17)

2. Reliability test of long times storage items

Comparison reliability test of newly produced and long time storage (after 4 years) items

- Endurance Test (Page 18)
- Shelf Test (Page 19)
- Damp Heat (Page 20)
- Temperature Cycling (Page 21)

Comparison of new samples and samples after 8-Hour Steam Aging

- Solderability (Dipping – Page 22)
- Solderability (ZCT wetting – Page 24)



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### Solid Type Aluminum Electrolytic Capacitors

Characteristic change after long times storage

Solid electrolyte construction does not exhibit deterioration (by chemical reaction) of anode foil.  
Measurement result of the characteristic change under long time storage.

Measurement results of long time storage (2-, 4- & 5-years) product (n = 10)

NPC221M2D7XATRF ... **After 5-year storage** under normal condition

	Inspection data in 2003				→	Re-measurement result in 2008			
	Capacitance	Tanδ	ESR	L.C		Capacitance	Tanδ	ESR	L.C
	120Hz / μF	120Hz / %	100kHz / mΩ	40sec / 2V / μA		120Hz / μF	120Hz / %	100kHz / mΩ	40sec / 2V / μA
Ave	225.5	0.91	5.13	0.69	230.3	0.98	5.32	0.72	
σ	3.83	0.06	0.43	0.76	4.04	0.07	0.44	0.89	
Max	234.6	1.48	7.83	6.93	239.5	1.34	7.65	7.01	
Min	215.4	0.81	4.59	0.34	225.0	0.84	4.63	0.02	

NPC221M2D7XATRF ... **After 4-year storage** under normal condition

	Inspection data in 2004				→	Re-measurement result in 2008			
	Capacitance	Tanδ	ESR	L.C		Capacitance	Tanδ	ESR	L.C
	120Hz / μF	120Hz / %	100kHz / mΩ	40sec / 2V / μA		120Hz / μF	120Hz / %	100kHz / mΩ	40sec / 2V / μA
Ave	230.7	0.97	6.24	0.77	227.6	0.98	6.45	0.81	
σ	3.97	0.06	0.38	0.86	3.72	0.07	0.41	0.91	
Max	243.0	1.27	7.97	6.91	234.2	1.15	7.73	6.21	
Min	219.3	0.88	5.64	0.42	222.1	0.87	5.71	0.12	

NPC221M2D7XATRF ... **After 2-year storage** under normal condition

	Inspection data in 2006				→	Re-measurement result in 2008			
	Capacitance	Tanδ	ESR	L.C		Capacitance	Tanδ	ESR	L.C
	120Hz / μF	120Hz / %	100kHz / mΩ	40sec / 2V / μA		120Hz / μF	120Hz / %	100kHz / mΩ	40sec / 2V / μA
Ave	230.4	0.97	6.12	0.70	220.9	0.95	6.00	0.69	
σ	1.65	0.08	0.51	0.74	5.34	0.09	0.48	0.81	
Max	233.6	1.29	7.14	5.24	227.9	1.15	7.43	4.34	
Min	225.7	0.85	5.30	0.49	205.5	0.83	5.28	0.39	

Solid type aluminum electrolytic capacitors (NIC NPC & NSP series) should be stored under the shipping condition (sealed moisture barrier bag)



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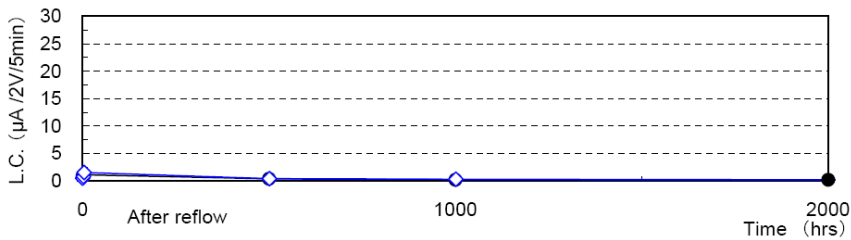
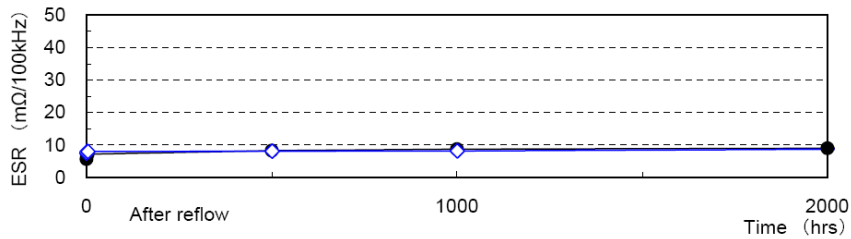
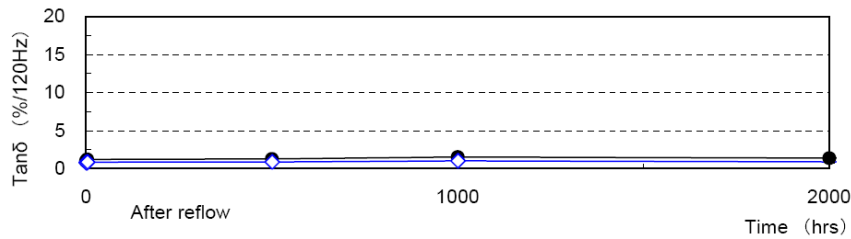
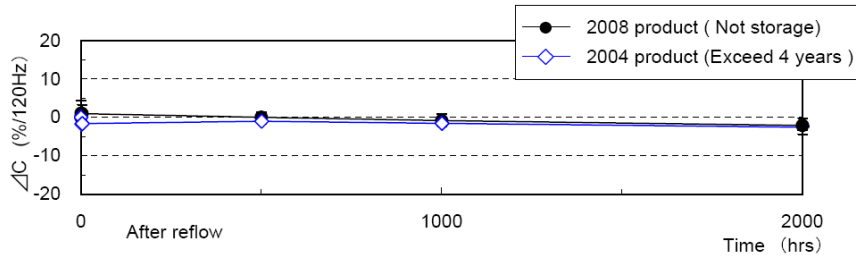
### Solid Type Aluminum Electrolytic Capacitors

Comparison reliability test of newly produced and long time storage (after 4 years) items

#### Endurance Test

Part Number: NPC221M2D7XATRF

Test conditions	Reflow condition	260deg.C × 2 times
	Before reflow condition	30°C 70%RH 168hrs
	Applied Voltage	<b>Rated voltage (2 VDC)</b>
	Temperature	105°C
	Time	2000 hrs
	Number	n=20



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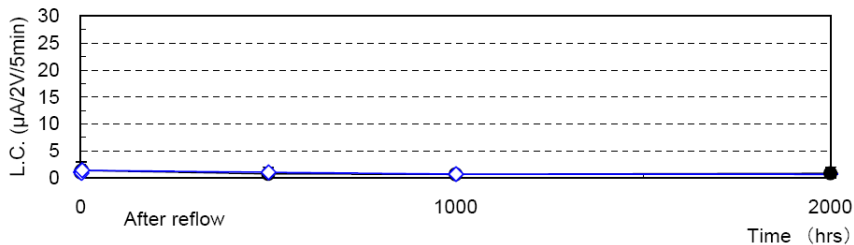
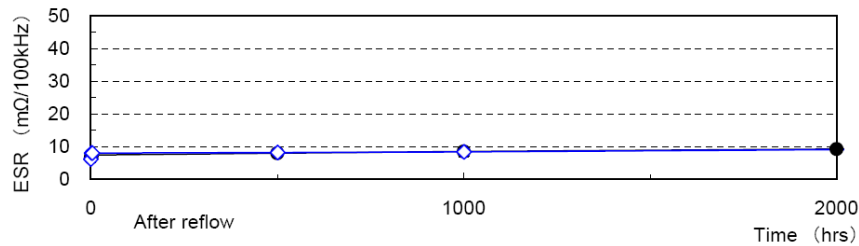
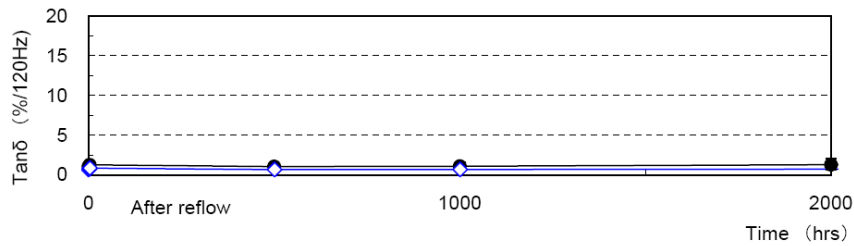
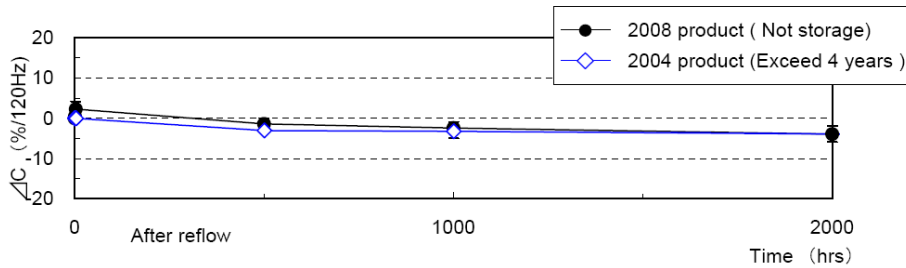
### Solid Type Aluminum Electrolytic Capacitors

Comparison reliability test of newly produced and long time storage (after 4 years) items

#### Shelf Test

Part Number: NPC221M2D7XATRF

Test conditions	Reflow condition	260deg.C × 2 times
	Before reflow condition	30°C 70%RH 168hrs
	Applied Voltage	<b>No applied voltage (0 VDC)</b>
	Temperature	105°C
	Time	2000 hrs
	Number	n=20





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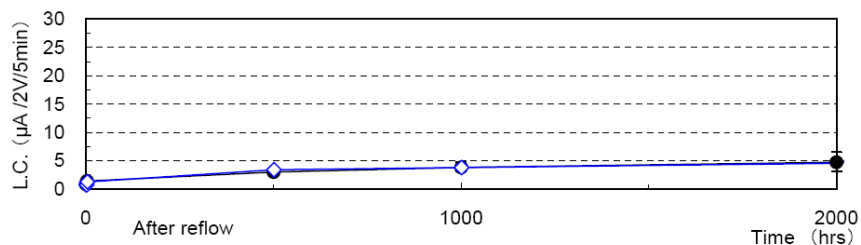
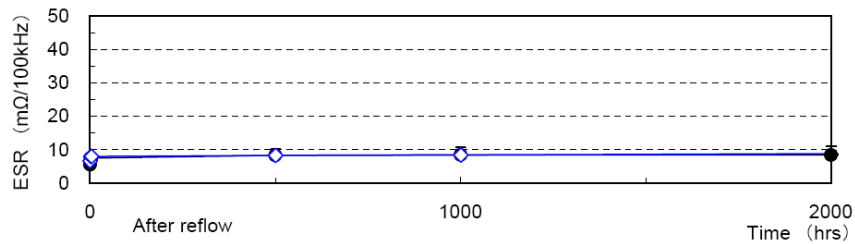
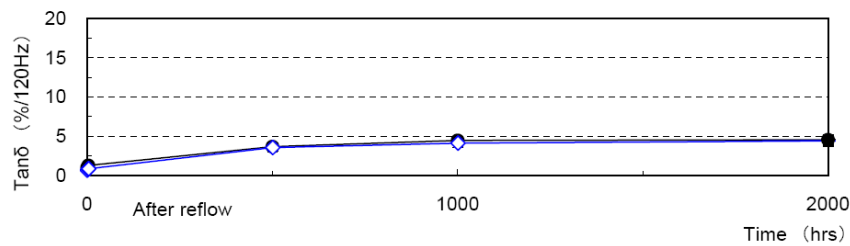
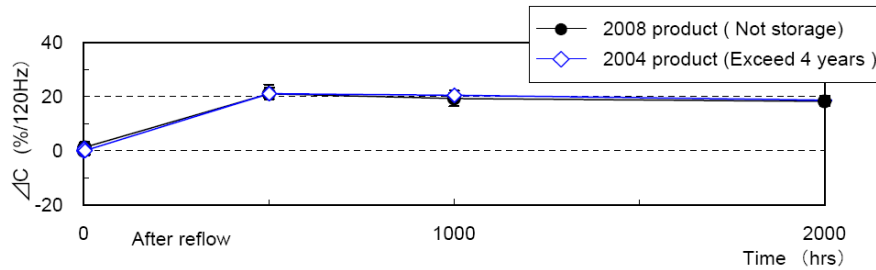
### Solid Type Aluminum Electrolytic Capacitors

Comparison reliability test of newly produced and long time storage (after 4 years) items

#### Damp Heat Test

Part Number: NPC221M2D7XATRF

Test conditions	Reflow condition	260deg.C × 2 times
	Before reflow condition	30°C 70%RH 168hrs
	Applied Voltage	<b>No applied voltage</b>
	Temperature	<b>60°C 90%R.H</b>
	Time	2000 hrs
	Number	n=20





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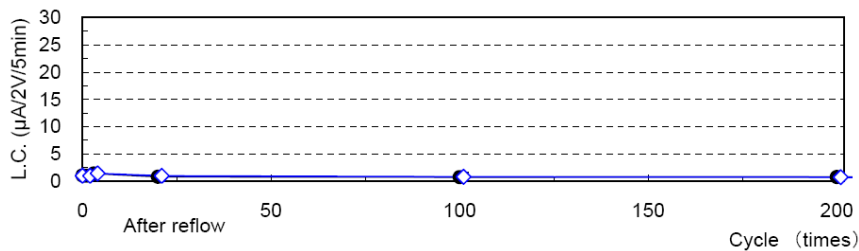
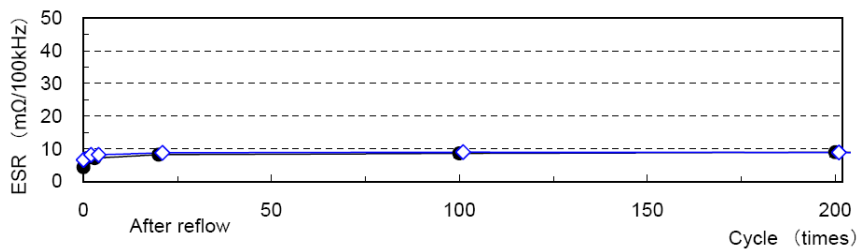
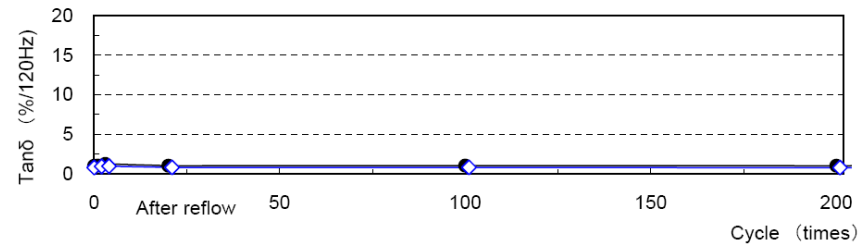
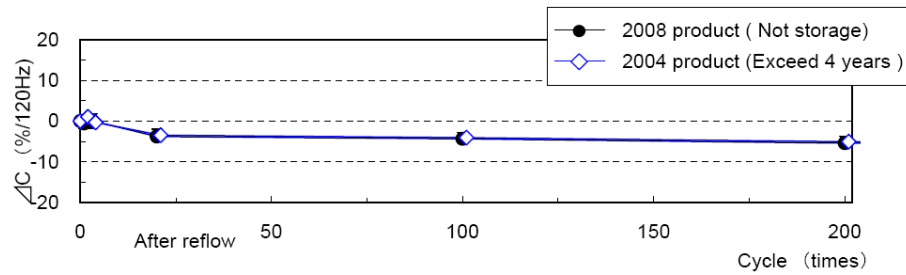
### Solid Type Aluminum Electrolytic Capacitors

Comparison reliability test of newly produced and long time storage (after 4 years) items

#### Temperature Cycling Test

Part Number: NPC221M2D7XATRF

Test conditions	Reflow condition	260deg.C × 2 times
	Before reflow condition	30°C 70%RH 168hrs
	Applied Voltage	<b>No applied voltage</b>
	Temperature	<b>-55°C / 30min ⇄ 105°C / 30min</b>
	Time	200 cycles
	Number	n=20





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### Solid Type Aluminum Electrolytic Capacitors

#### Solderability (post steam-aging) Dip Test

Part Number: NPC221M2D7XATRF

Test conditions	Before test condition	PCT 105°C 100%RH 1.22MPa for <b>8 hours</b>
	Solder Type	Pb Free (Sn-3.0Ag-0.5Cu)
	Flux	<b>Resin ethanol solution ( 25wt%)</b>
	Solder Temperature	<b>245±2°C</b>
	Immersing depth	3±0.5 sec
	Zero cross time	n=10

Test result of **no processing product**



Cathode Terminal  
(W-H surface)



L-W surface



Anode terminal  
(W-H surface)

Test result of **PCT 105°C 100%RH 8 hours**



Cathode Terminal  
(W-H surface)



L-W surface



Anode terminal  
(W-H surface)

95% or more of the terminal is covered with solder.



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**Solid Type Aluminum Electrolytic Capacitors**

**Solderability (post steam-aging) Zero Cross Time Wetting Test**

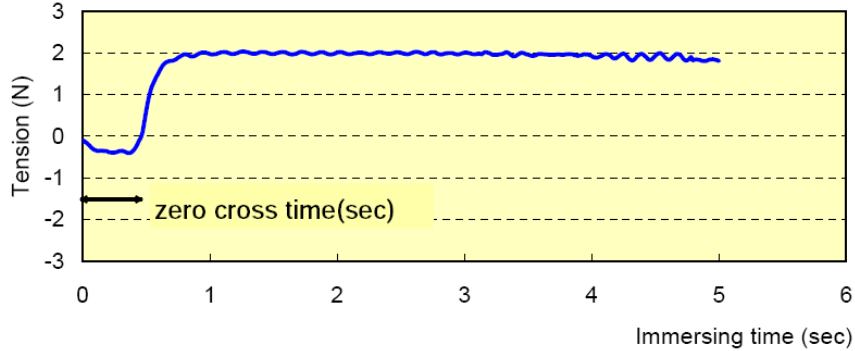
Part Number: NPC221M2D7XATRF

Test conditions	Before test condition	PCT 105°C 100%RH 1.22MPa <b>8 hours</b> No processing
	Solder Type	Pb Free (Sn-3.0Ag-0.5Cu)
	Flux	Resin ethanol solution ( 25wt%)
	Solder Temperature	245±2°C
	Immersing speed	2mm / sec
	Immersing depth	0.1mm
	Zero cross time	Within 3sec
	Number	N=10

Test Result:

	No processing	PCT 105°C 100%RH <b>8 hours</b>
Ave	0.67	0.66
Max	1.47	1.24
Min	0.23	0.22

Test result of **no processing product**



Test result of **PCT 105°C 100%RH 8 hours**

