

(2024.07.23. revised)

Comparison Evaluation of MPF (Metalized Polypropylene Film) Capacitors

フィルムキャパシタ比較試験結果報告Vol.1



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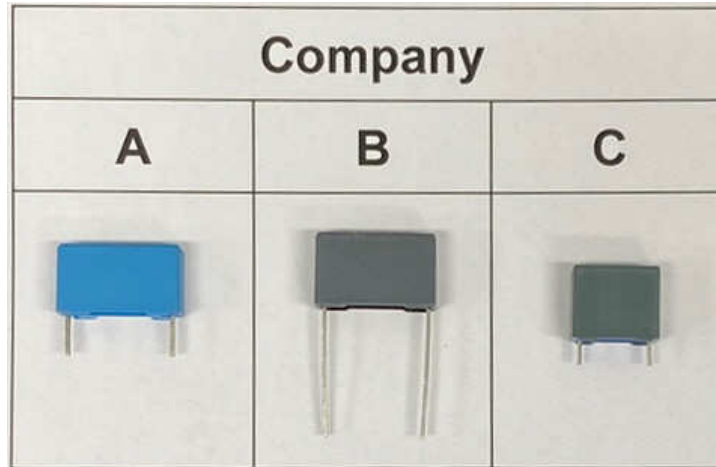
I. Introduction



Introduction

- **Specimen:** MPF(Metalized PolyPropylene Film) Capacitor
- **Test:**
 - Environmental test
 - Electrical characteristic evaluation
 - X-ray analyses
 - SEM analyses
- **Test term:** 2024. 04. 11. ~ 2024. 06. 18.
- **Test environment:** (25 ± 5) °C, Below 75% room humidity
- **Test apparatuses:**
 - Climate chamber (SXN403, ETAC, Japan)
 - HALT chamber (Typhoon-3.0, QualMark, U.S.A.)
 - Vibration testing system (IPA120H/I537M, ETS Solution, China)
 - Precision LCR meter (4284A, Agilent, U.S.A.)
 - Withstanding voltage tester (TOS-9201, Kikusui, Japan)
 - X-ray (XT V 160, Nikon, Japan)
 - Focused Ion Beam (Quanta 3D DualBeam, FEI, Netherland)
- **Etc:** Blind test
- **Contact:** Lee, Ju Ho ☎ +82-31-789-7282 / leejuho@keti.re.kr

Specimens



Sample	Capacitance (nF)	Rated voltage (V _{DC})	Capacitance tolerance (%)	Housing (mm)	Lead length (mm)	Operation Temp. (°C)
A	220	450	± 10	18.0×10.5×5.0	6.0±1.0	-55 ~ +125
B	220	450	± 10	17.5×11.0×5.0	15.0±0.5	-55 ~ +105
C	220	450	± 10	12.5×11.0×5.0	5.0±1.0	-40 ~ +105

- A社 : TDK EPCOS (日本) (B32672P4224K000)
- B社 : Faratronic (中国) (C352S224K-6S000)
- C社 : Pilkor (韓国) (PCMP372DR4224)

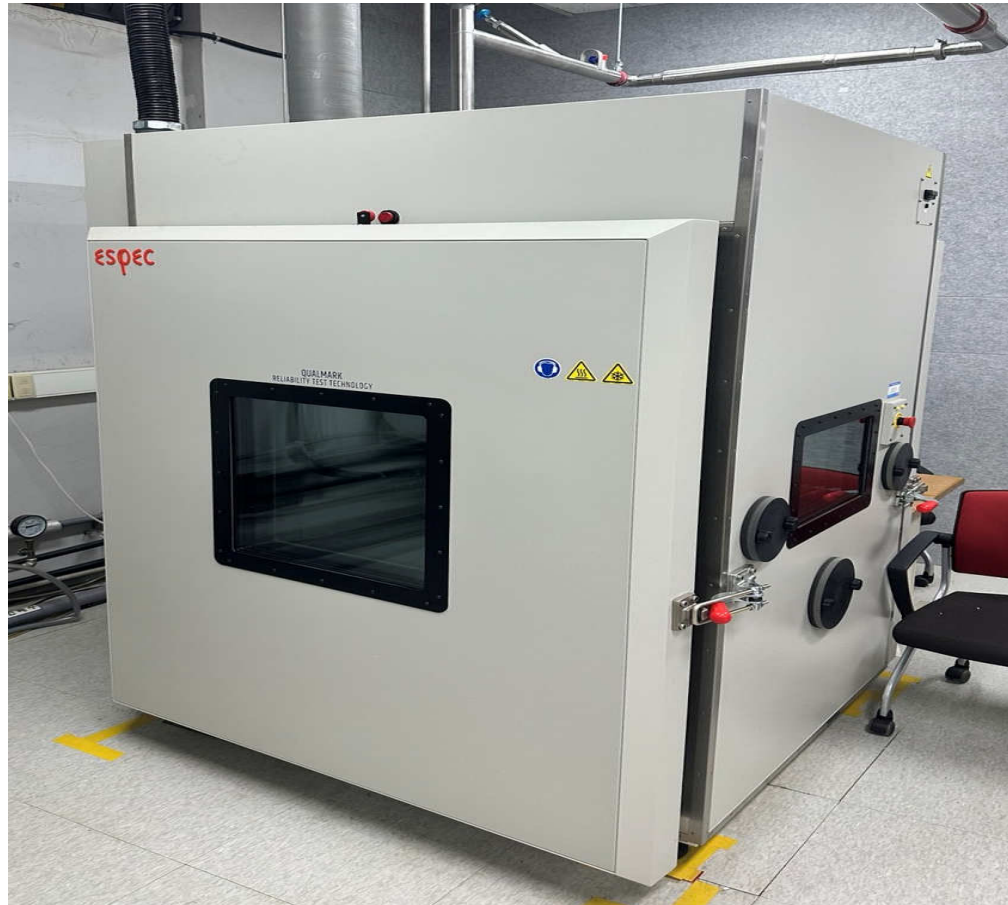
Introduction

- **Test apparatuses:**
 - Climate chamber (SXN403, ETAC, Japan)



Introduction

- **Test apparatuses:**
 - HALT chamber (Typhoon-3.0, QualMark, U.S.A.)



Introduction

- **Test apparatuses:**
 - Vibration testing system (IPA120H/I537M, ETS Solution, China)



Introduction

- Test apparatuses:
 - Precision LCR Meter (4284A, Agilent, U.S.A.)



Introduction

- **Test apparatuses:**
 - Withstanding voltage tester (TOS-9201, Kikusui, Japan)



Introduction

- **Test apparatuses:**
 - X-ray (XT V 160, Nikon, Japan)



Introduction

- **Test apparatuses:**
 - Focused Ion Beam (Quanta 3D DualBeam, FEI, Netherland)



II. Environmental test

(raw data, graphs)



Environmental test conditions

- **Test:**

- High temperature test: 110 °C, 16 hr
- Low temperature test: -55 °C, 2 hr
- Thermal shock test: (-55~110) °C, each 10 min., 10 cycles
- Vibration test: (min 10 Hz, max 55 Hz), 0.75 mm, each 2 hr/X,Y,Z
- High humidity test ①: 40 °C, 93 %R.H., 500 hr
- High humidity test ②: 40 °C, 93 %R.H., 1,000 hr
- * Leakage currents were measured every 200 hours.
- Withstanding voltage: 500 V_{DC}, 60 sec, 10 mA
- Insulation resistance: 500 V_{DC}, 60 sec, 10 MΩ

Summary

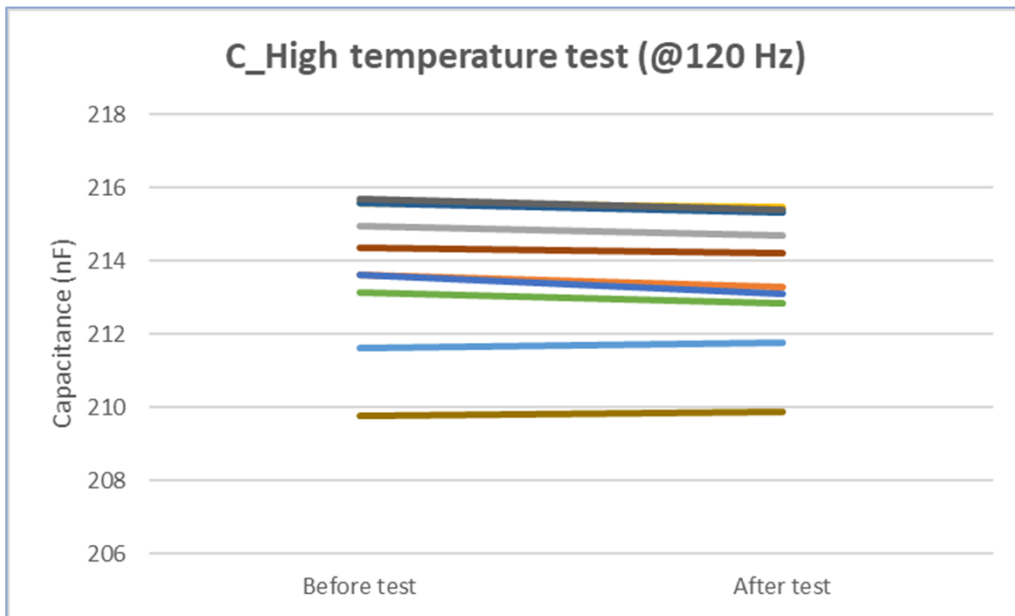
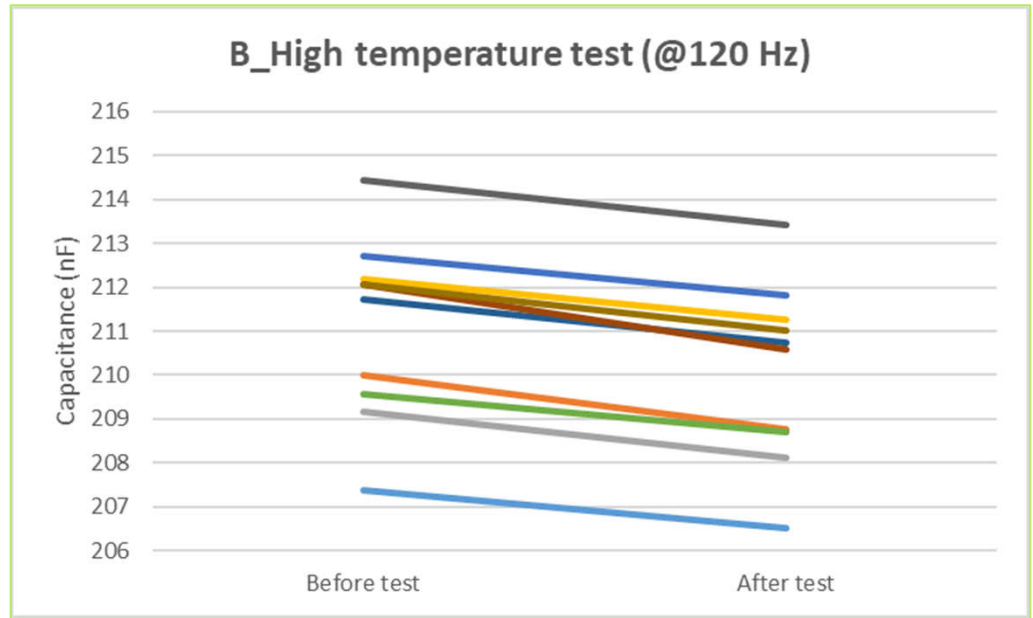
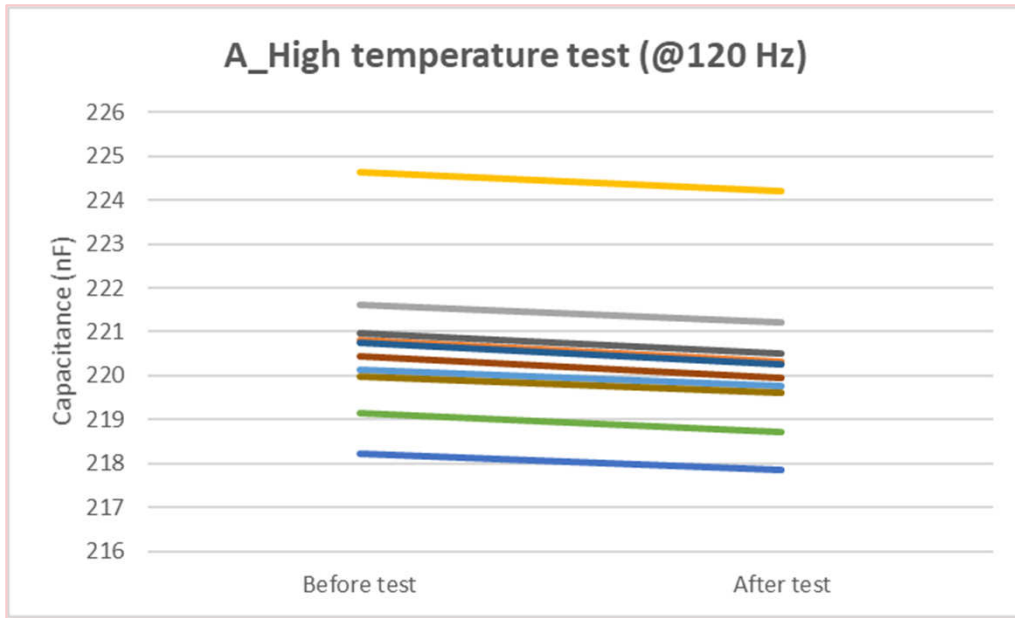
- 環境試験によるキャパシターの静電容量の変化 (@120 Hz) (平均値)

High temp.	Rate of change (%)	Low temp.	Rate of change (%)	Thermal shock	Rate of change (%)	Vibration	Rate of change (%)	High hum.	Rate of change (%)
A1	-0.17%	A1	-0.05%	A1	-0.13%	A1	-0.02%	A1	-0.01%
A2	-0.21%	A2	-0.03%	A2	-0.11%	A2	-0.05%	A2	0.03%
A3	-0.19%	A3	-0.05%	A3	-0.10%	A3	0.00%	A3	0.01%
A4	-0.19%	A4	-0.03%	A4	-0.11%	A4	-0.02%	A4	0.00%
A5	-0.18%	A5	-0.05%	A5	-0.09%	A5	-0.05%	A5	0.02%
A6	-0.20%	A6	-0.03%	A6	-0.15%	A6	-0.02%	A6	0.02%
A7	-0.23%	A7	-0.04%	A7	-0.10%	A7	-0.01%	A7	0.02%
A8	-0.22%	A8	-0.04%	A8	-0.09%	A8	-0.02%	A8	0.02%
A9	-0.21%	A9	-0.04%	A9	-0.08%	A9	-0.01%	A9	0.02%
A10	-0.16%	A10	-0.02%	A10	-0.09%	A10	-0.01%	A10	0.00%
average	0.20%	average	0.04%	average	0.10%	average	0.02%	average	0.02%
B1	-0.42%	B1	-0.06%	B1	-0.09%	B1	-0.07%	B1	-0.02%
B2	-0.59%	B2	-0.08%	B2	-0.08%	B2	-0.06%	B2	0.02%
B3	-0.51%	B3	-0.05%	B3	-0.09%	B3	-0.03%	B3	-0.07%
B4	-0.43%	B4	-0.07%	B4	-0.07%	B4	-0.03%	B4	-0.05%
B5	-0.41%	B5	-0.04%	B5	-0.07%	B5	-0.08%	B5	0.01%
B6	-0.40%	B6	-0.04%	B6	-0.11%	B6	-0.07%	B6	0.00%
B7	-0.46%	B7	-0.05%	B7	-0.09%	B7	-0.06%	B7	0.00%
B8	-0.69%	B8	-0.07%	B8	-0.10%	B8	-0.08%	B8	0.02%
B9	-0.48%	B9	-0.03%	B9	-0.09%	B9	-0.07%	B9	0.01%
B10	-0.50%	B10	-0.08%	B10	-0.10%	B10	-0.03%	B10	0.02%
Average	0.49%	Average	0.06%	Average	0.09%	Average	0.06%	Average	0.02%
C1	0.06%	C1	-0.11%	C1	-0.09%	C1	-0.04%	C1	0.01%
C2	-0.16%	C2	-0.07%	C2	-0.08%	C2	-0.04%	C2	-0.03%
C3	-0.12%	C3	-0.05%	C3	-0.08%	C3	-0.02%	C3	0.04%
C4	-0.05%	C4	-0.09%	C4	-0.08%	C4	-0.06%	C4	0.04%
C5	-0.24%	C5	-0.07%	C5	-0.08%	C5	-0.01%	C5	0.04%
C6	-0.14%	C6	-0.06%	C6	-0.10%	C6	-0.05%	C6	0.00%
C7	-0.12%	C7	-0.07%	C7	-0.08%	C7	-0.02%	C7	0.08%
C8	-0.08%	C8	-0.06%	C8	-0.12%	C8	-0.04%	C8	0.02%
C9	-0.13%	C9	-0.08%	C9	-0.07%	C9	-0.03%	C9	0.02%
C10	0.05%	C10	-0.05%	C10	-0.12%	C10	-0.03%	C10	0.05%
average	0.12%	average	0.07%	average	0.09%	average	0.03%	average	0.03%

Summary

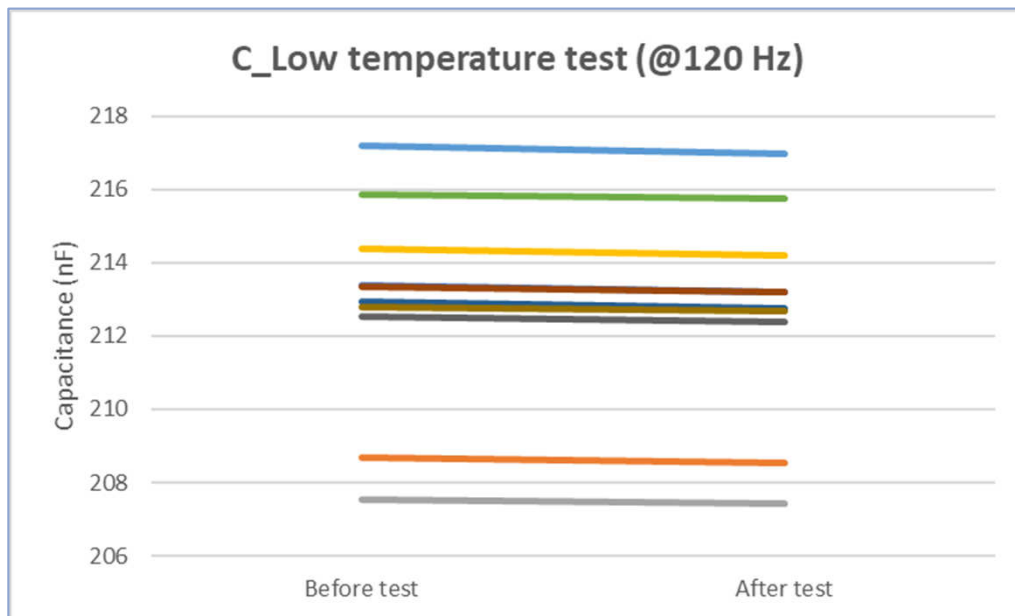
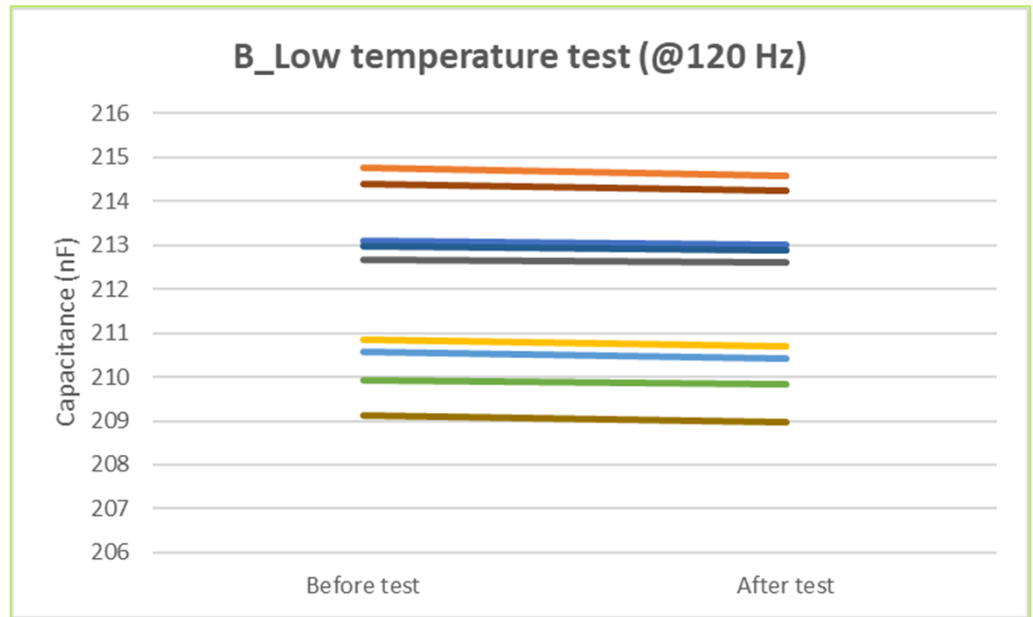
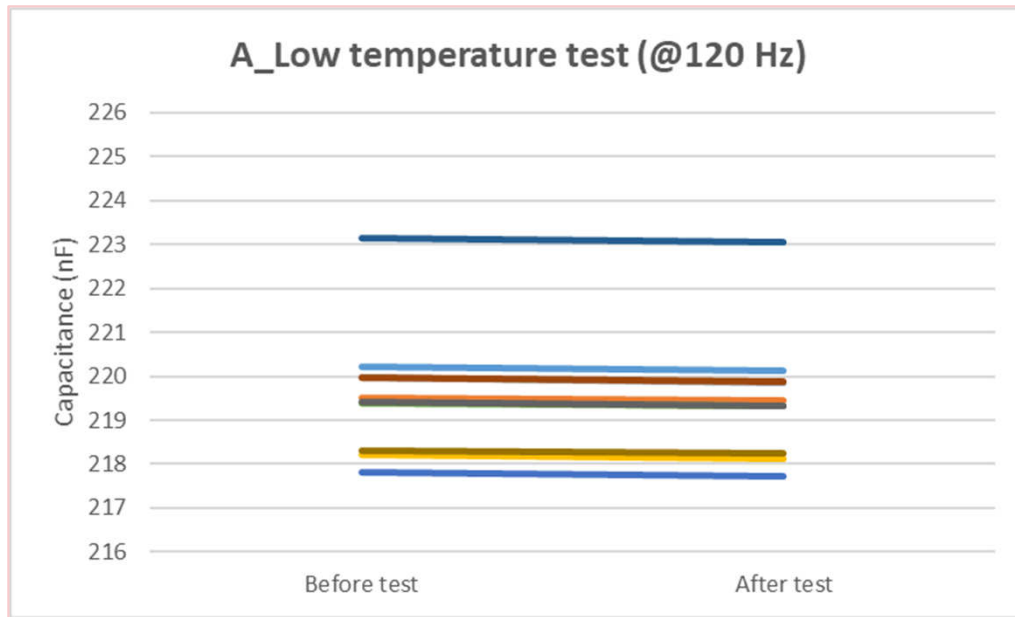
- 環境試験によるキャパシタの静電容量の変化 (@1 kHz) (平均値)

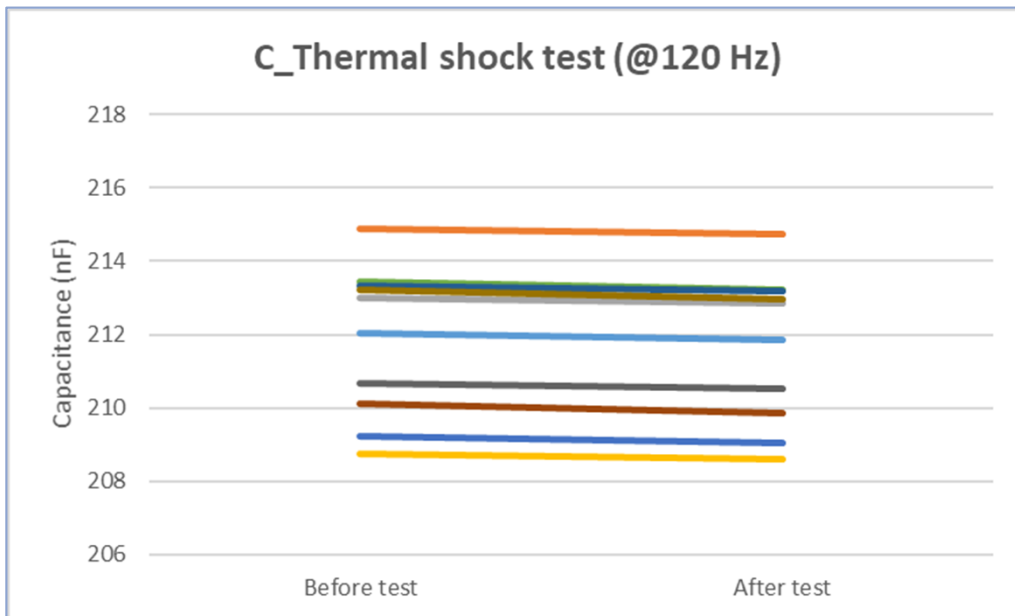
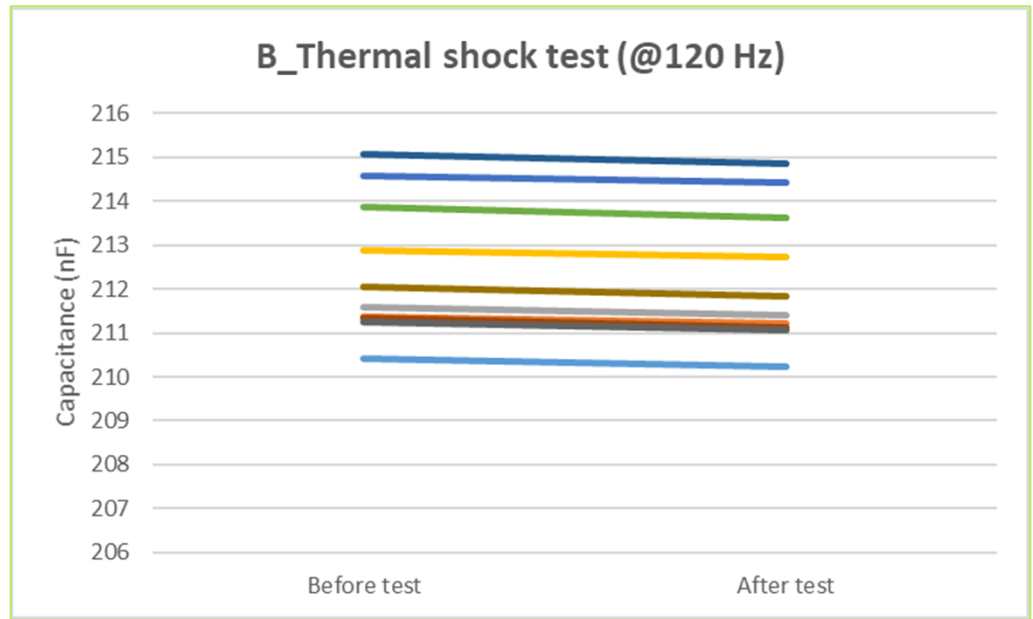
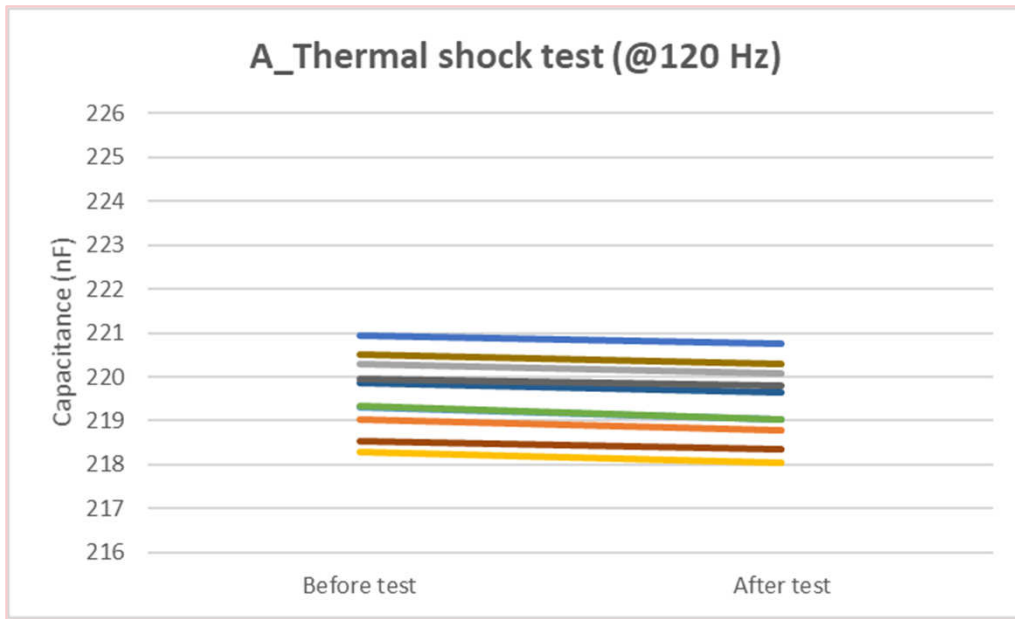
High temp.	Rate of change (%)	Low temp.	Rate of change (%)	Thermal shock	Rate of change (%)	Vibration	Rate of change (%)	High hum.	Rate of change (%)
A1	-0.18%	A1	-0.04%	A1	-0.11%	A1	-0.05%	A1	0.03%
A2	-0.21%	A2	-0.07%	A2	-0.11%	A2	-0.03%	A2	0.03%
A3	-0.18%	A3	-0.04%	A3	-0.10%	A3	0.01%	A3	0.00%
A4	-0.20%	A4	-0.04%	A4	-0.12%	A4	-0.01%	A4	0.00%
A5	-0.17%	A5	-0.04%	A5	-0.09%	A5	-0.09%	A5	0.02%
A6	-0.20%	A6	-0.04%	A6	-0.14%	A6	-0.01%	A6	0.02%
A7	-0.24%	A7	-0.04%	A7	-0.10%	A7	-0.01%	A7	0.01%
A8	-0.23%	A8	-0.04%	A8	-0.09%	A8	-0.01%	A8	0.01%
A9	-0.21%	A9	-0.03%	A9	-0.08%	A9	0.00%	A9	0.02%
A10	-0.17%	A10	-0.03%	A10	-0.10%	A10	-0.01%	A10	-0.01%
average	0.20%	average	0.04%	average	0.10%	average	0.02%	average	0.02%
B1	-0.42%	B1	-0.07%	B1	-0.07%	B1	-0.09%	B1	-0.02%
B2	-0.60%	B2	-0.07%	B2	-0.09%	B2	-0.04%	B2	0.01%
B3	-0.50%	B3	-0.05%	B3	-0.10%	B3	-0.03%	B3	-0.10%
B4	-0.43%	B4	-0.06%	B4	-0.07%	B4	-0.02%	B4	-0.04%
B5	-0.39%	B5	-0.04%	B5	-0.07%	B5	-0.09%	B5	0.00%
B6	-0.40%	B6	-0.04%	B6	-0.10%	B6	-0.05%	B6	0.00%
B7	-0.47%	B7	-0.06%	B7	-0.10%	B7	-0.08%	B7	-0.01%
B8	-0.70%	B8	-0.07%	B8	-0.10%	B8	-0.05%	B8	0.01%
B9	-0.47%	B9	-0.04%	B9	-0.09%	B9	-0.08%	B9	0.01%
B10	-0.50%	B10	-0.08%	B10	-0.09%	B10	-0.03%	B10	0.01%
Average	0.49%	Average	0.06%	Average	0.09%	Average	0.06%	Average	0.02%
C1	0.07%	C1	-0.13%	C1	-0.07%	C1	-0.06%	C1	0.00%
C2	-0.21%	C2	-0.07%	C2	-0.09%	C2	-0.03%	C2	-0.04%
C3	-0.15%	C3	-0.04%	C3	-0.08%	C3	-0.02%	C3	0.01%
C4	-0.06%	C4	-0.09%	C4	-0.08%	C4	-0.05%	C4	0.01%
C5	-0.25%	C5	-0.08%	C5	-0.09%	C5	-0.02%	C5	-0.01%
C6	-0.20%	C6	-0.07%	C6	-0.10%	C6	-0.04%	C6	-0.02%
C7	-0.10%	C7	-0.09%	C7	-0.06%	C7	-0.01%	C7	0.04%
C8	-0.08%	C8	-0.06%	C8	-0.12%	C8	-0.04%	C8	0.00%
C9	-0.11%	C9	-0.08%	C9	-0.08%	C9	-0.04%	C9	-0.01%
C10	0.06%	C10	-0.05%	C10	-0.12%	C10	-0.02%	C10	0.05%
average	0.13%	average	0.07%	average	0.09%	average	0.03%	average	0.02%

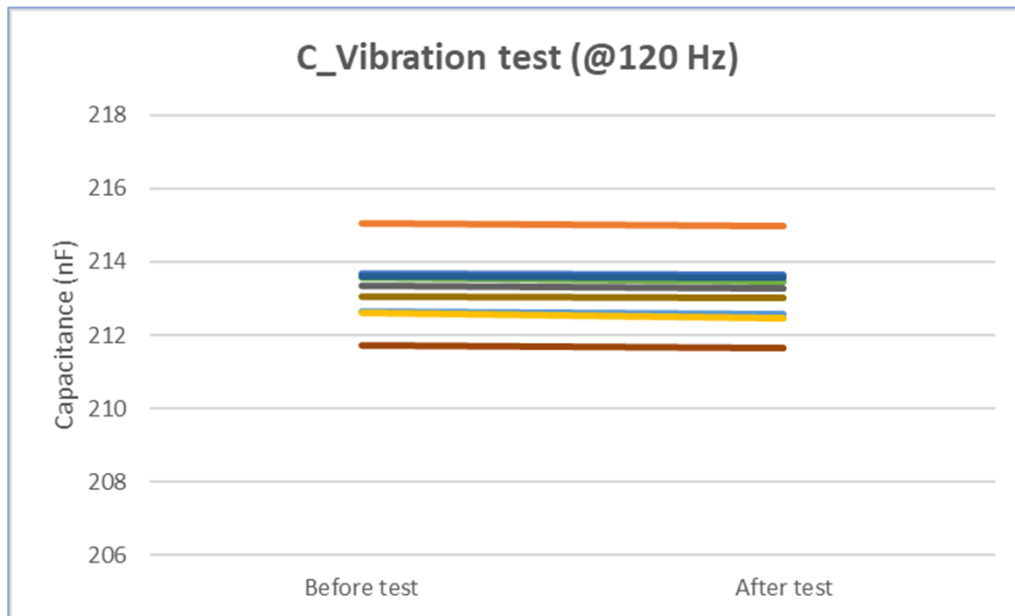
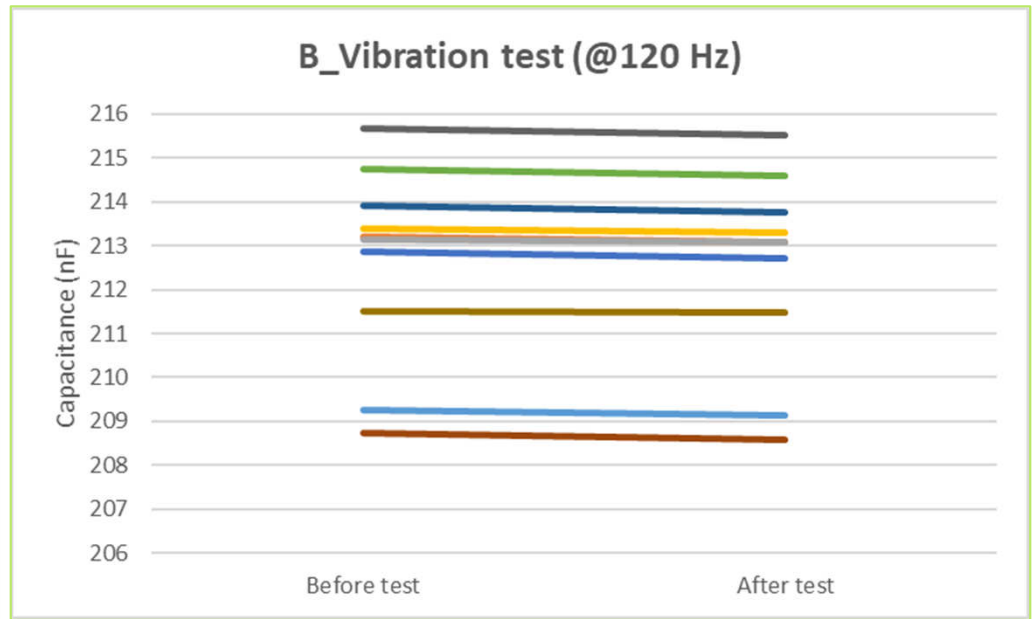
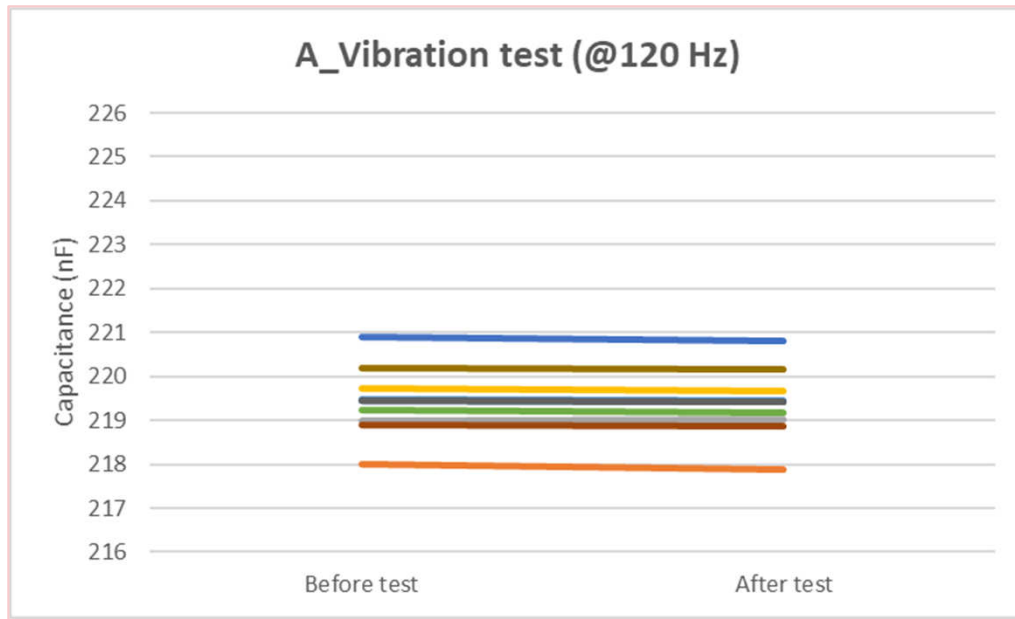


Summary

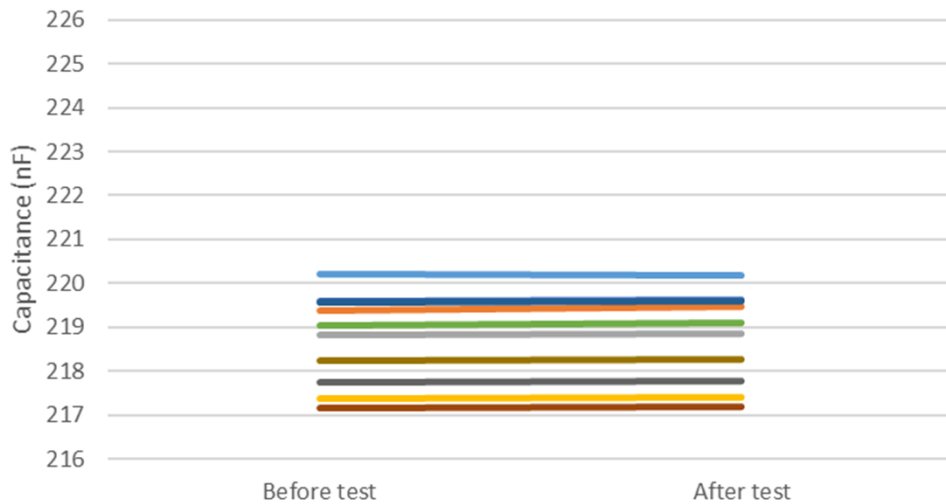
Low temperature test_Capacitance (nF) @120 Hz



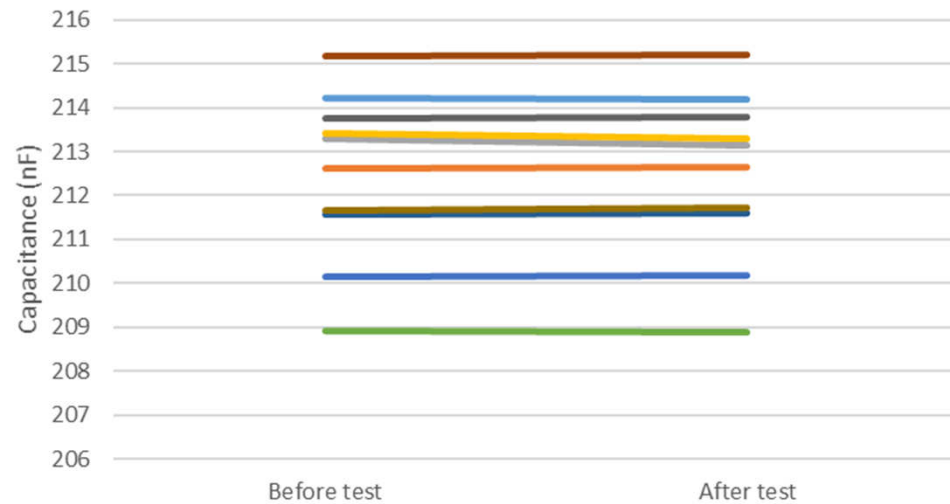




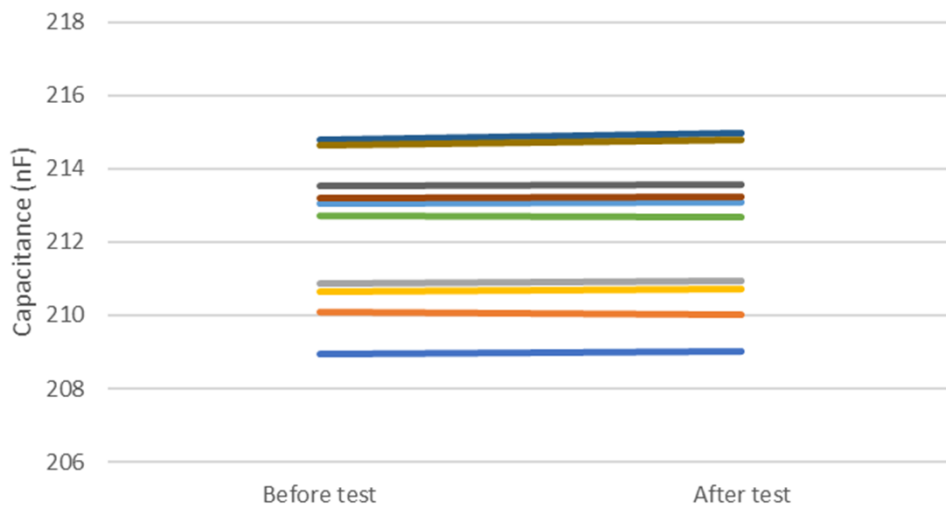
A_High humidity test (@120 Hz)



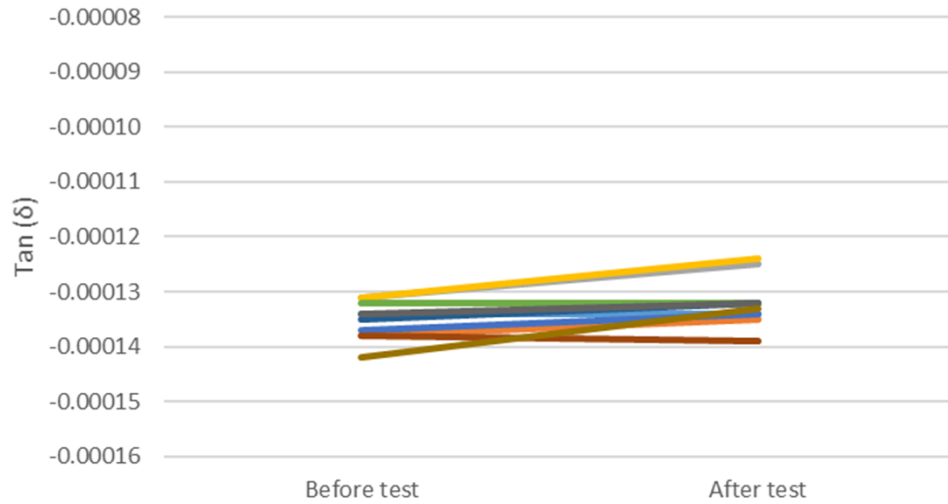
B_High humidity test (@120 Hz)



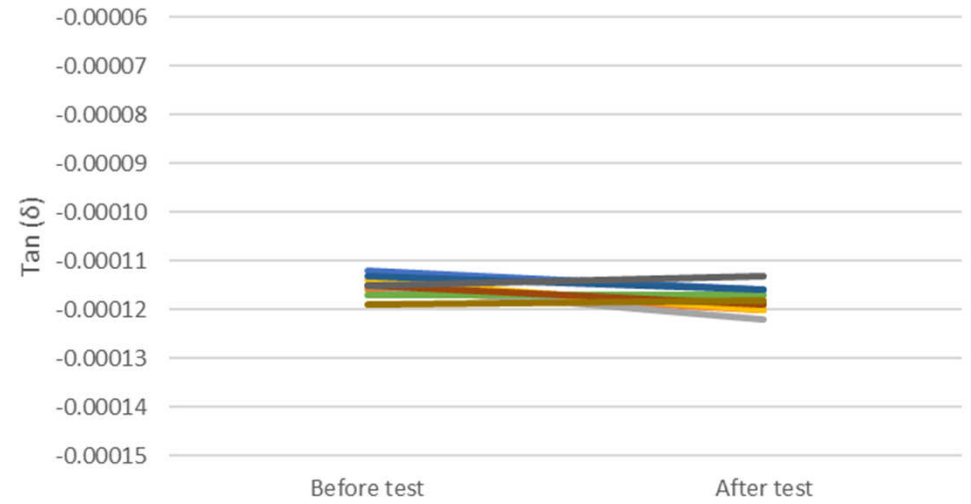
C_High humidity test (@120 Hz)



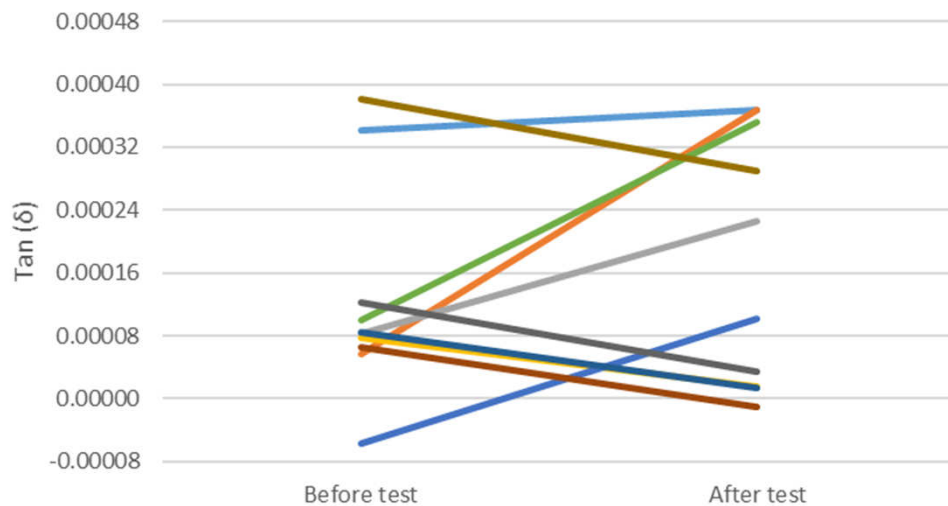
A_High temperature test (@120 Hz)



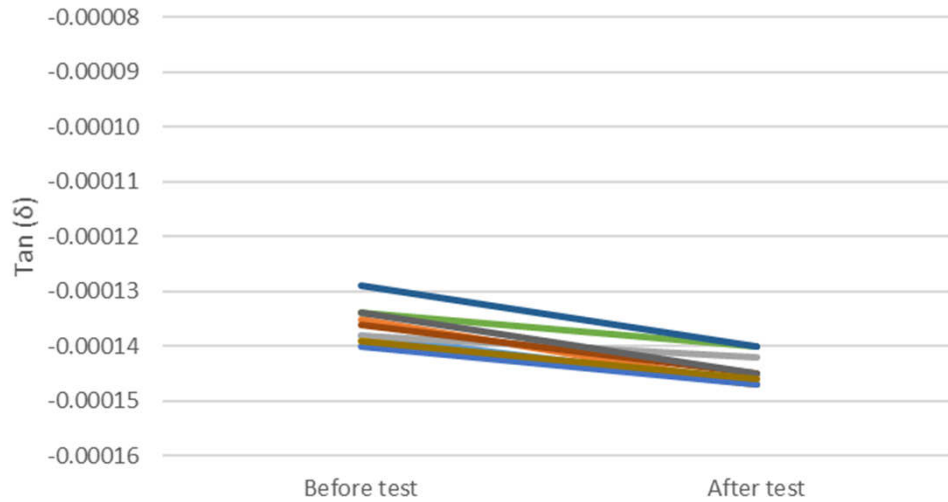
B_High temperature test (@120 Hz)



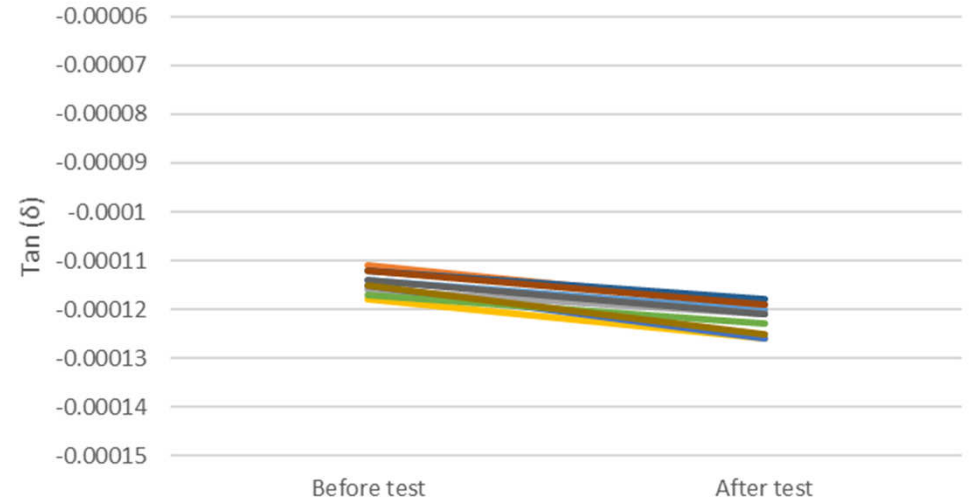
C_High temperature test (@120 Hz)



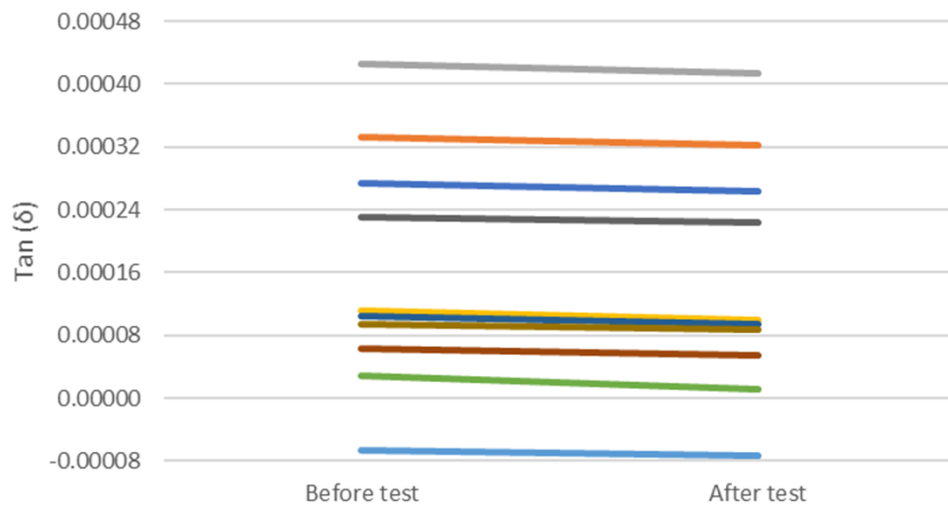
A_Low temperature test (@120 Hz)

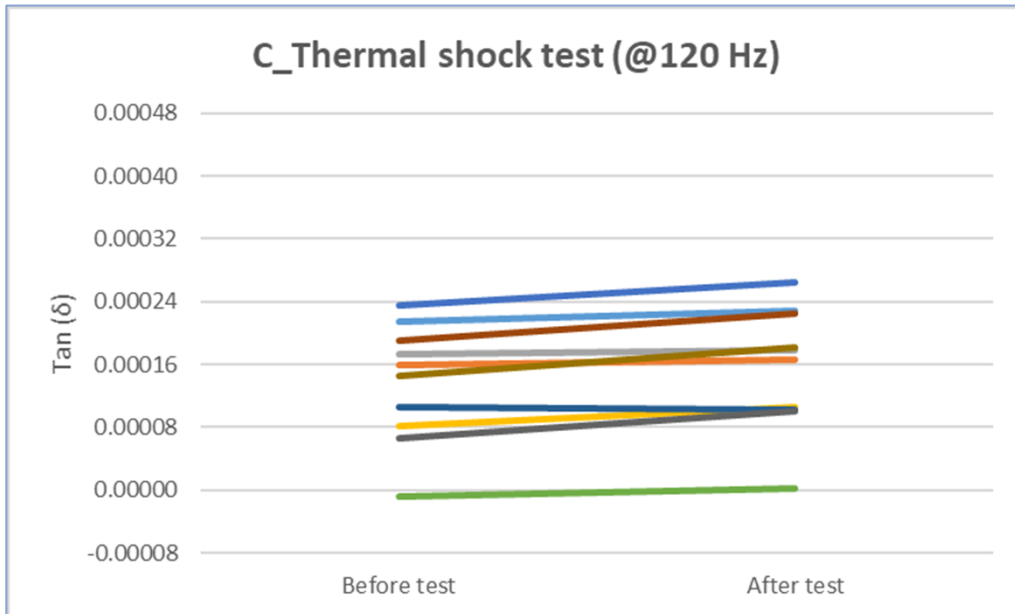
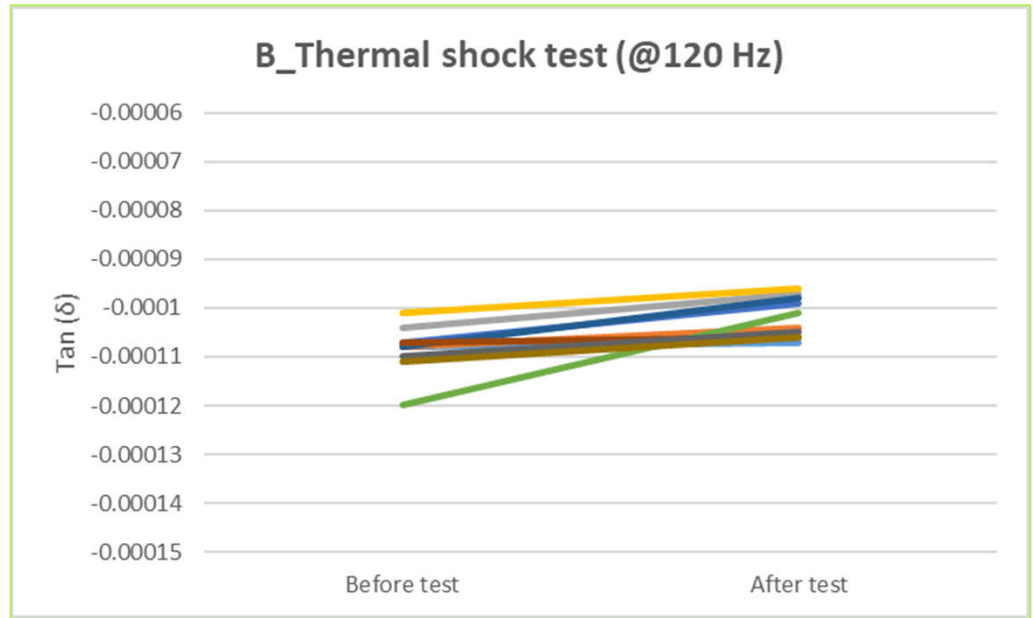
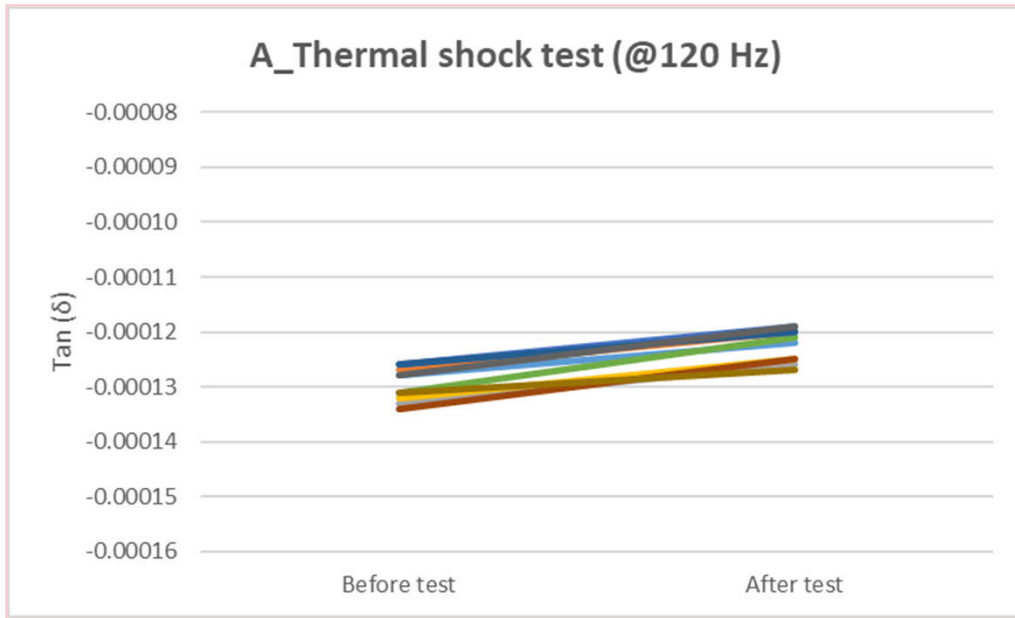


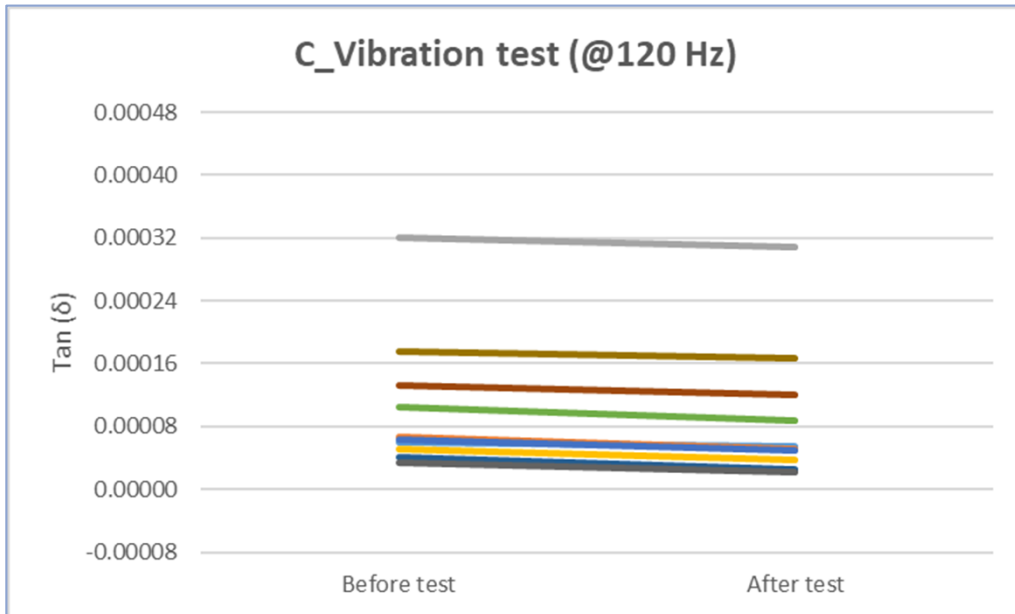
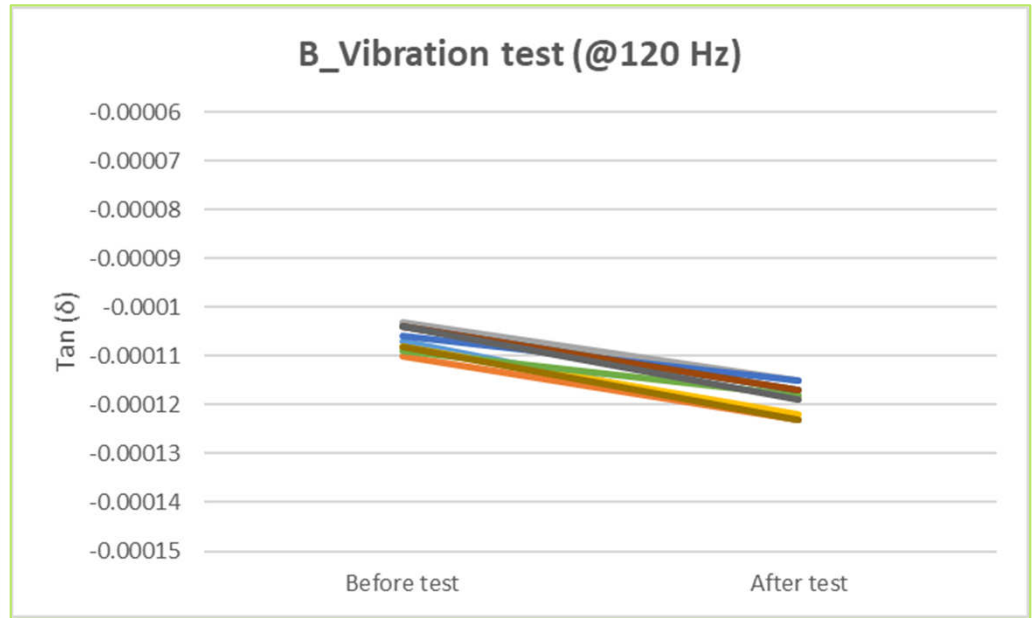
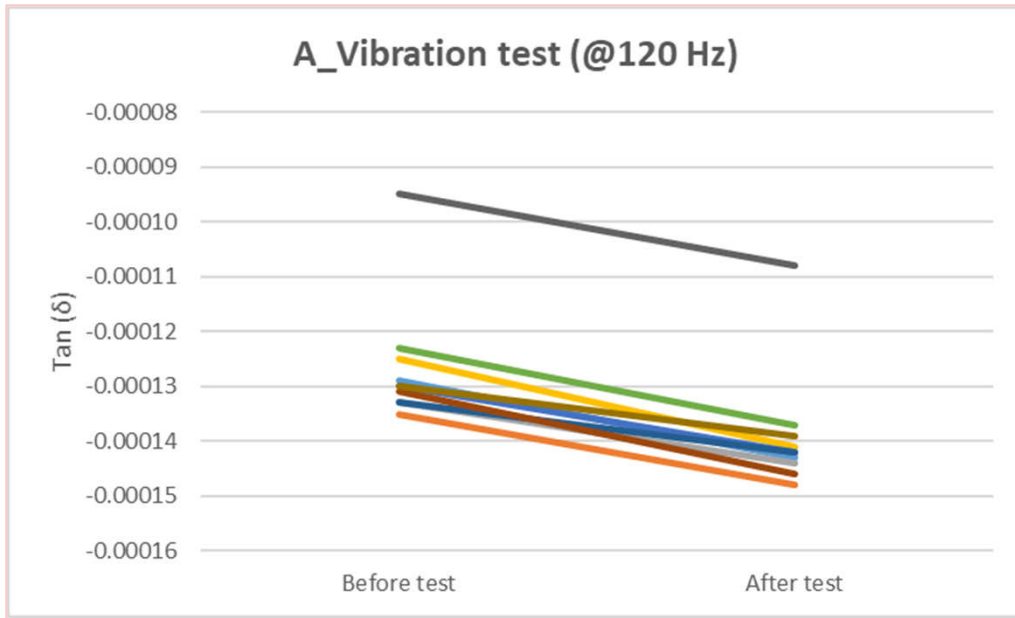
B_Low temperature test (@120 Hz)



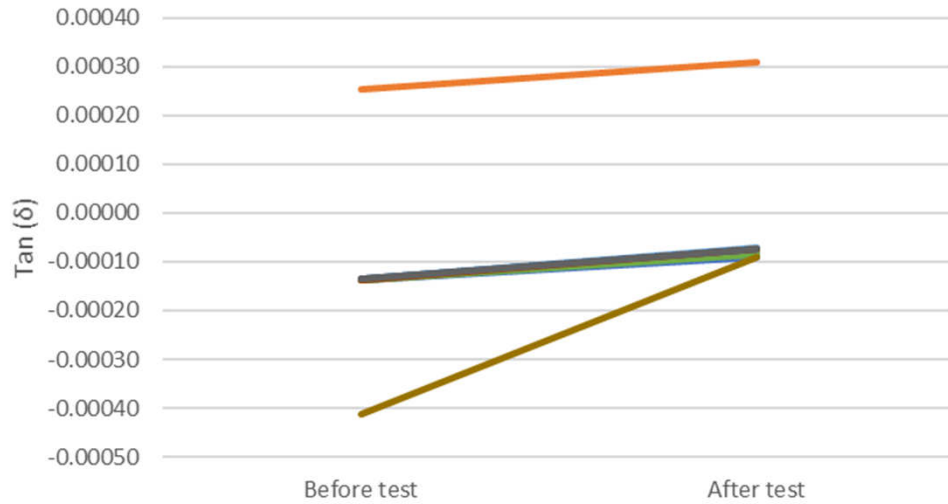
C_Low temperature test (@120 Hz)



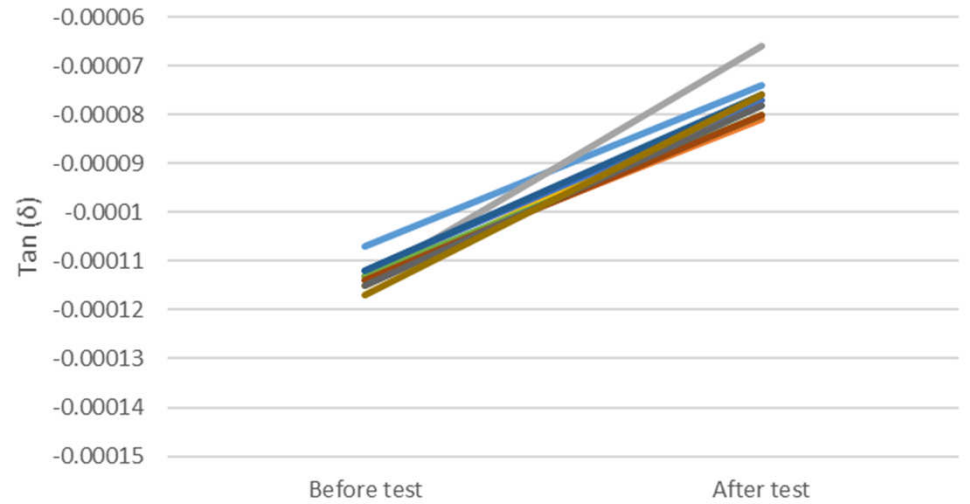




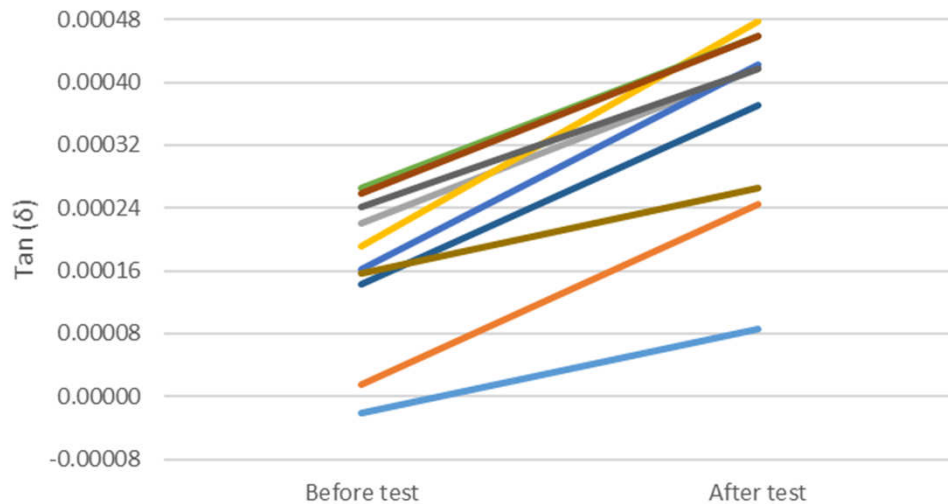
A_High humidity test (@120 Hz)

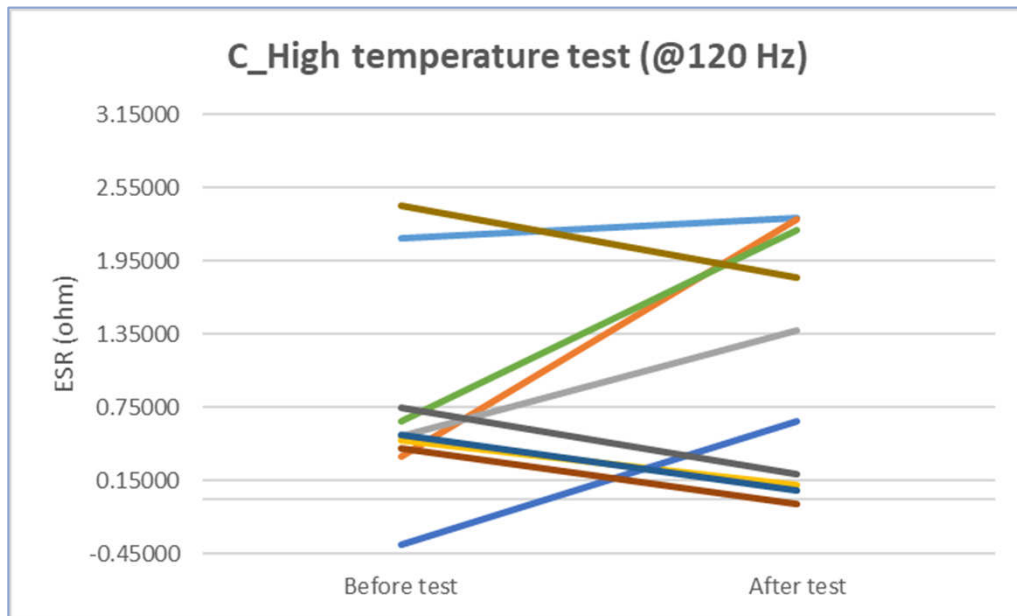
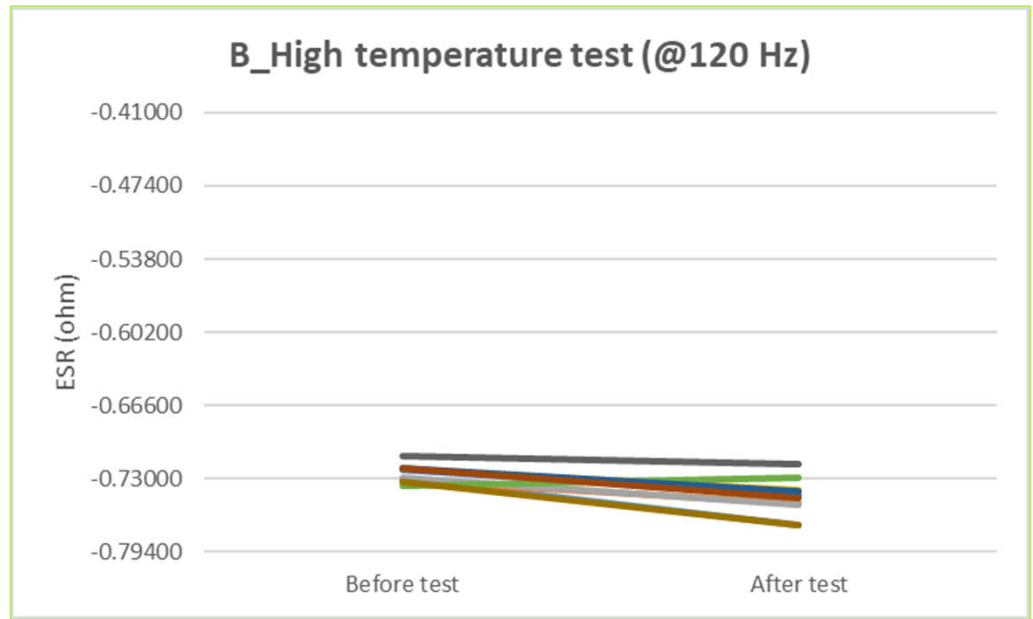
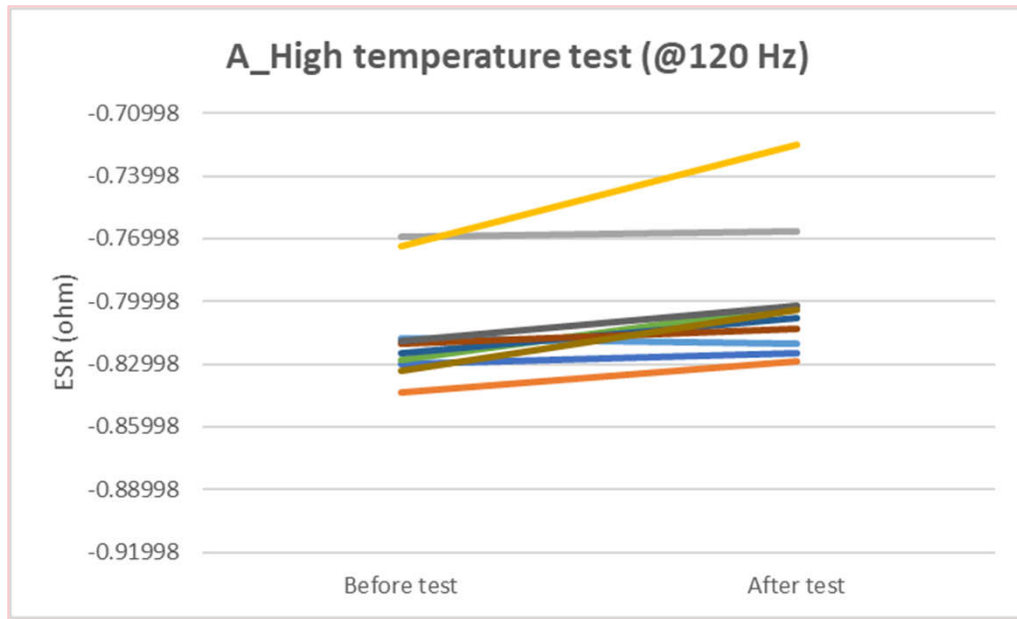


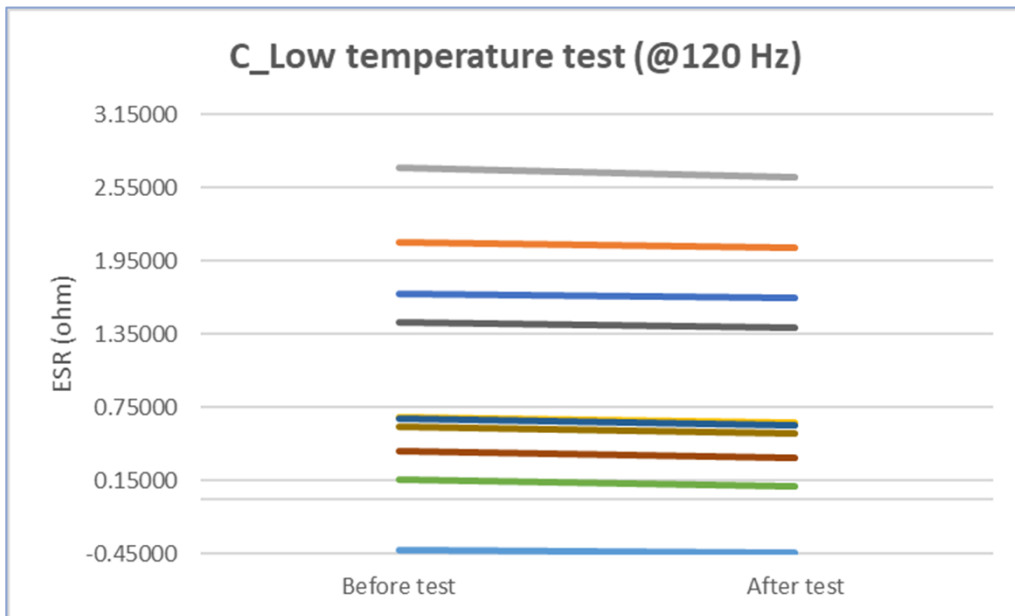
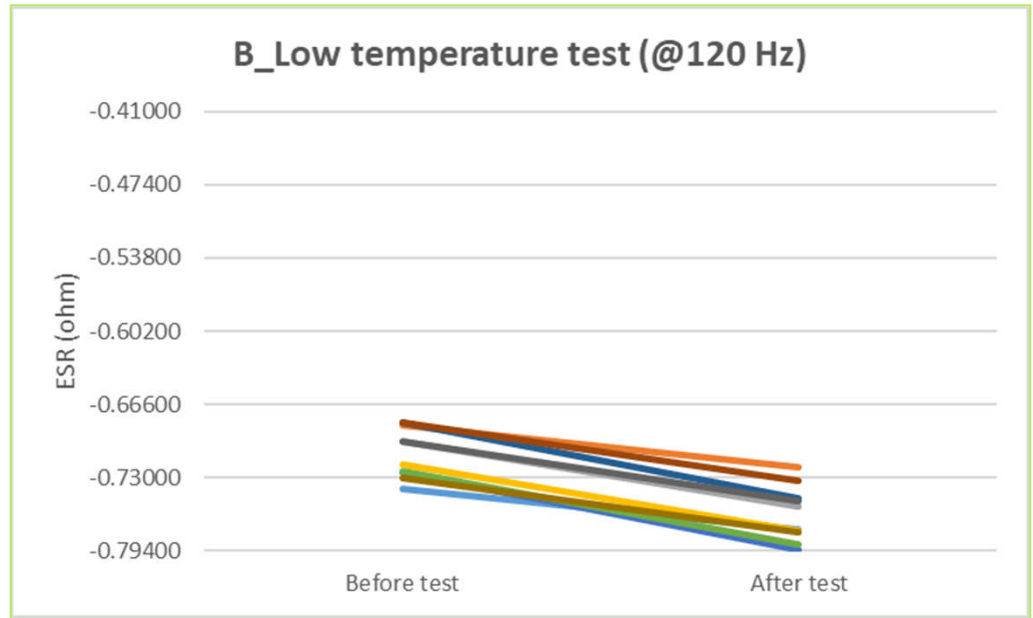
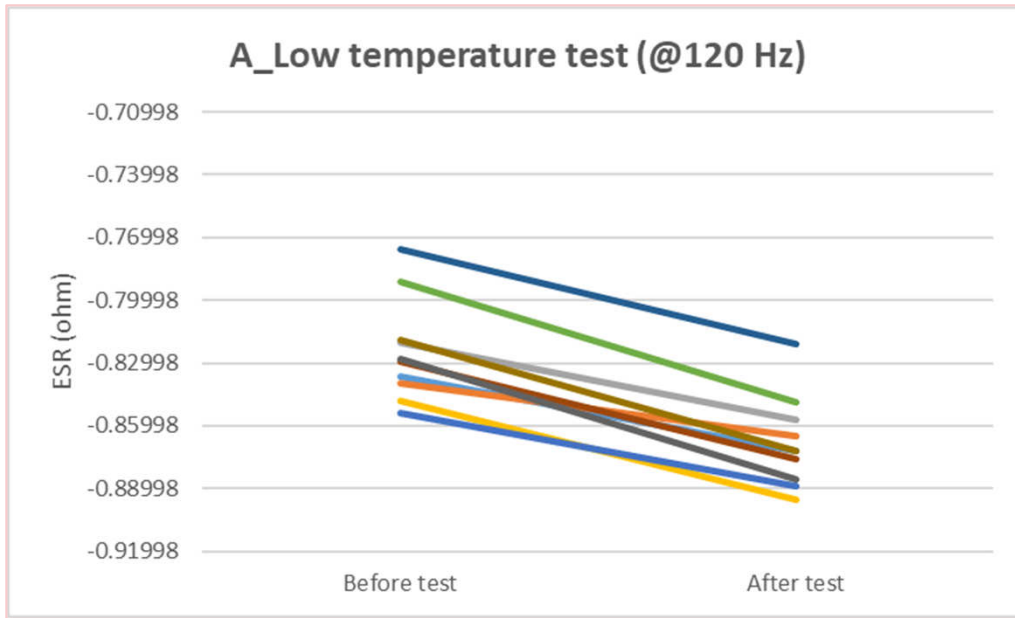
B_High humidity test (@120 Hz)

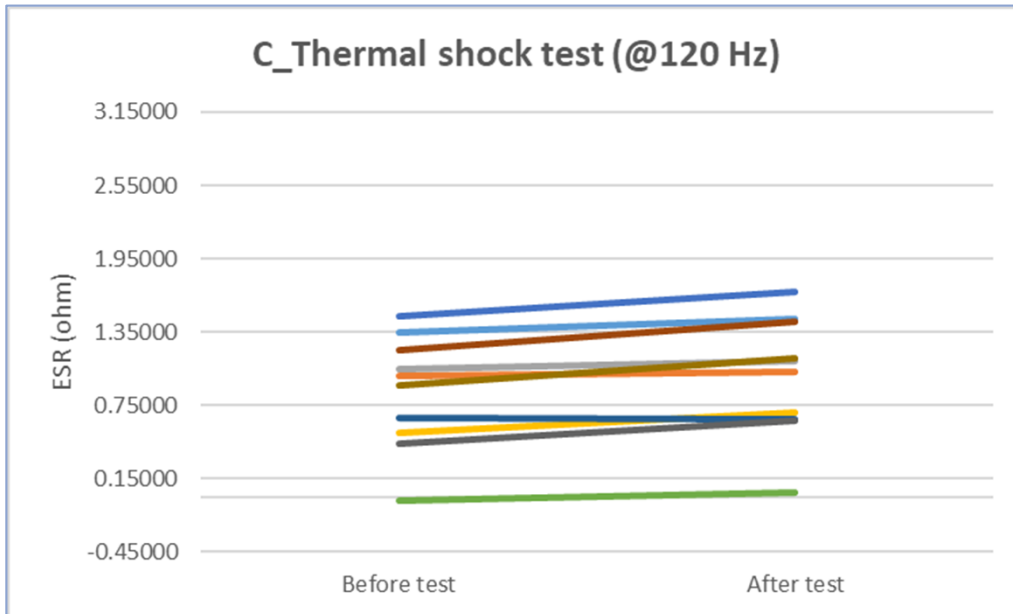
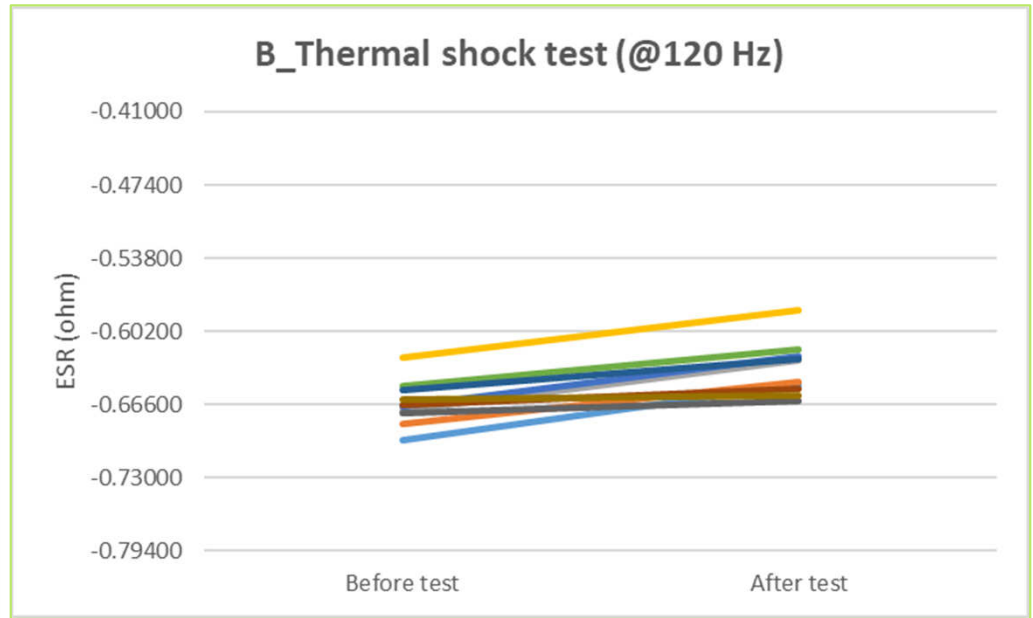
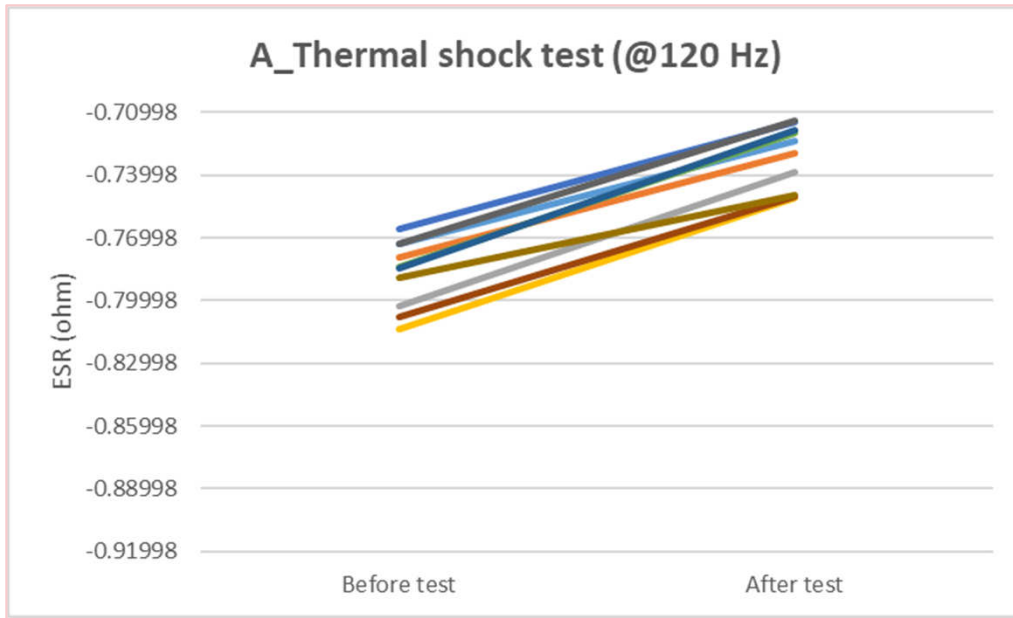


C_High humidity test (@120 Hz)

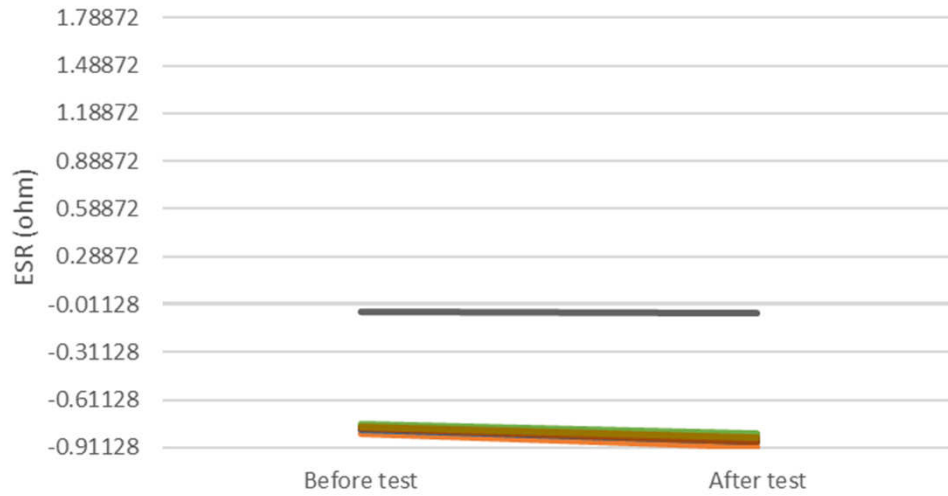




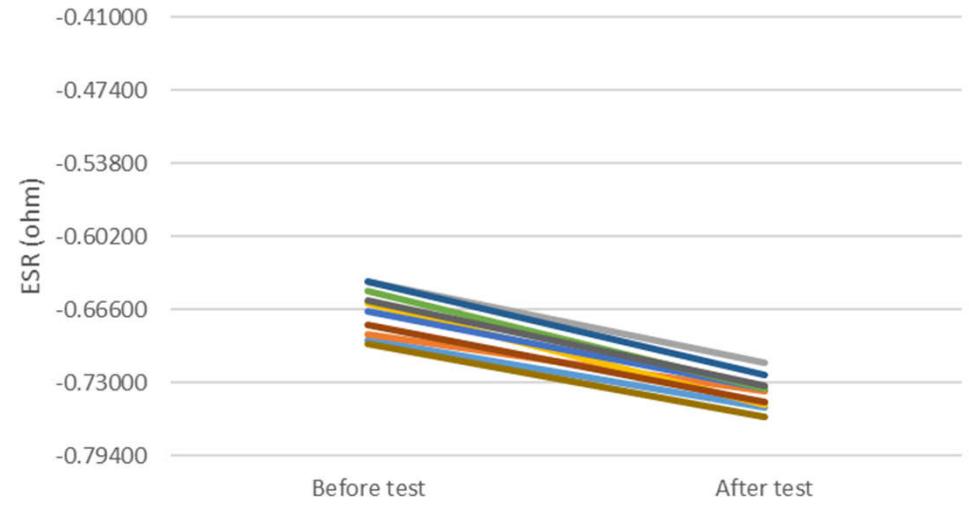




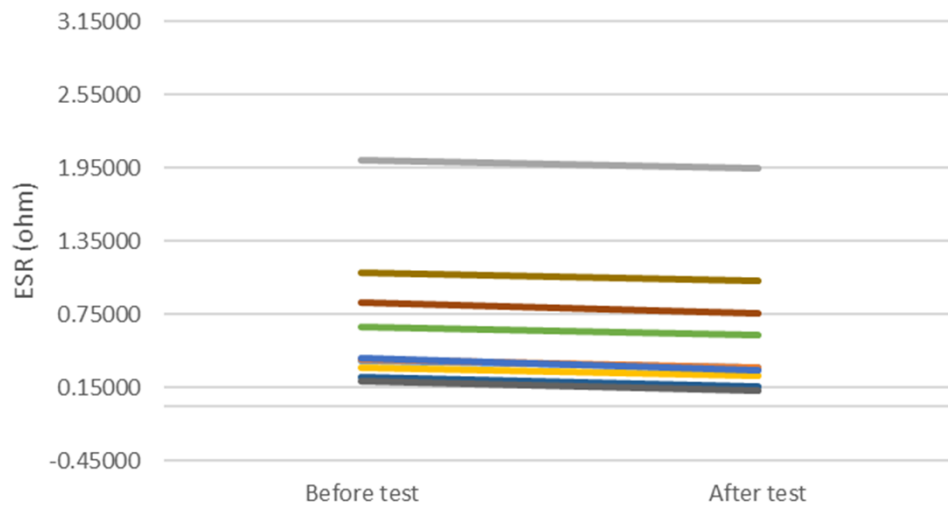
A_Vibration test (@120 Hz)



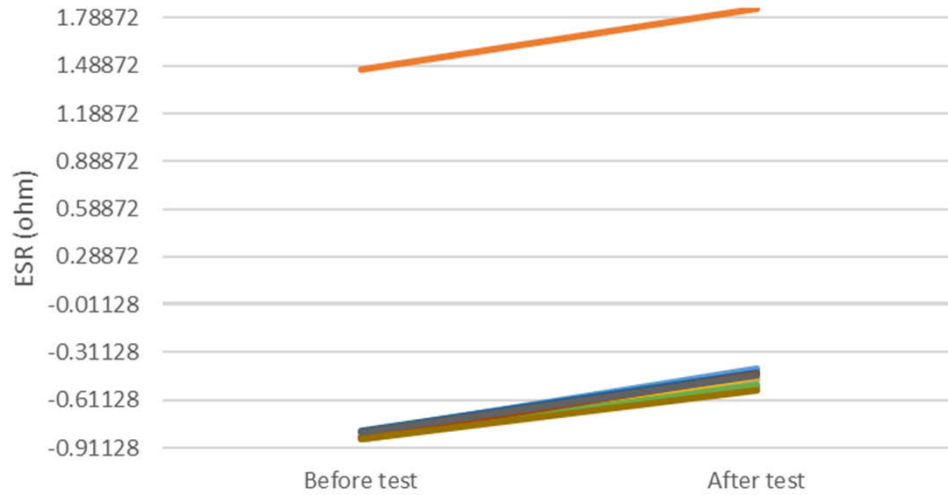
B_Vibration test (@120 Hz)



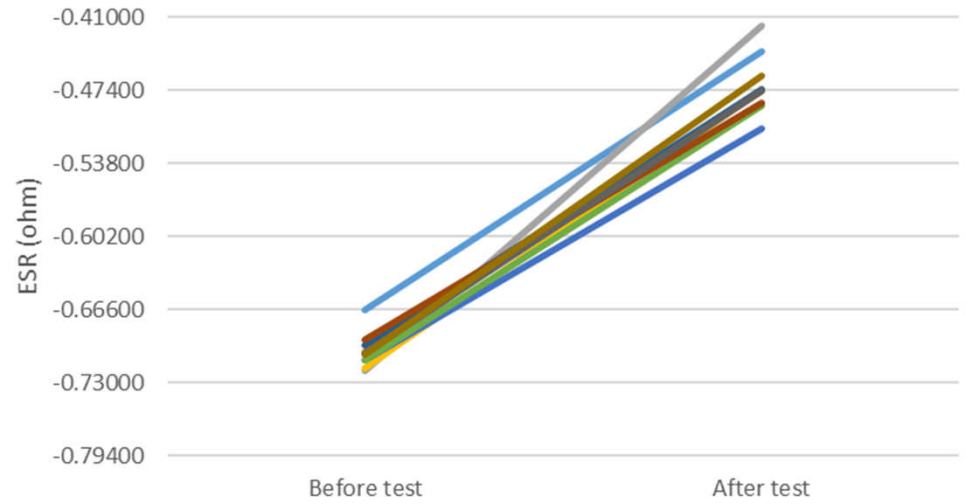
C_Vibration test (@120 Hz)



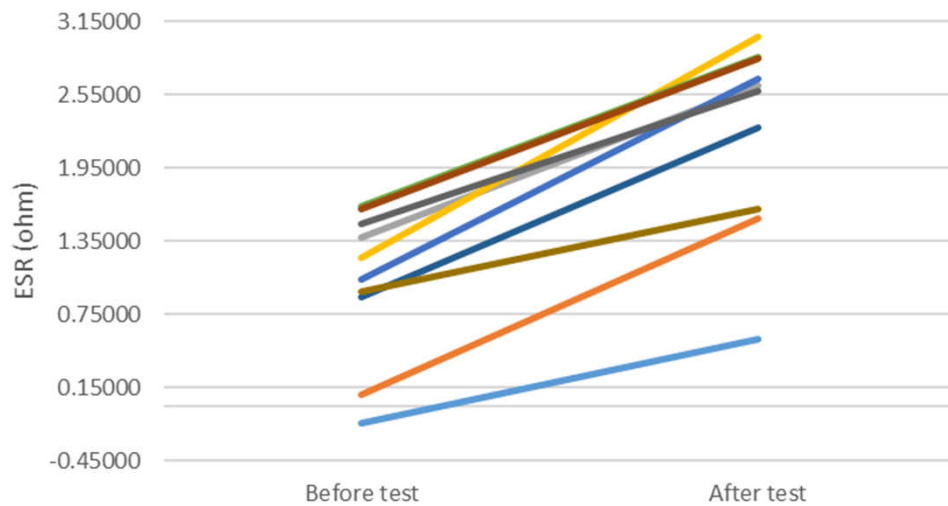
A_High humidity test (@120 Hz)

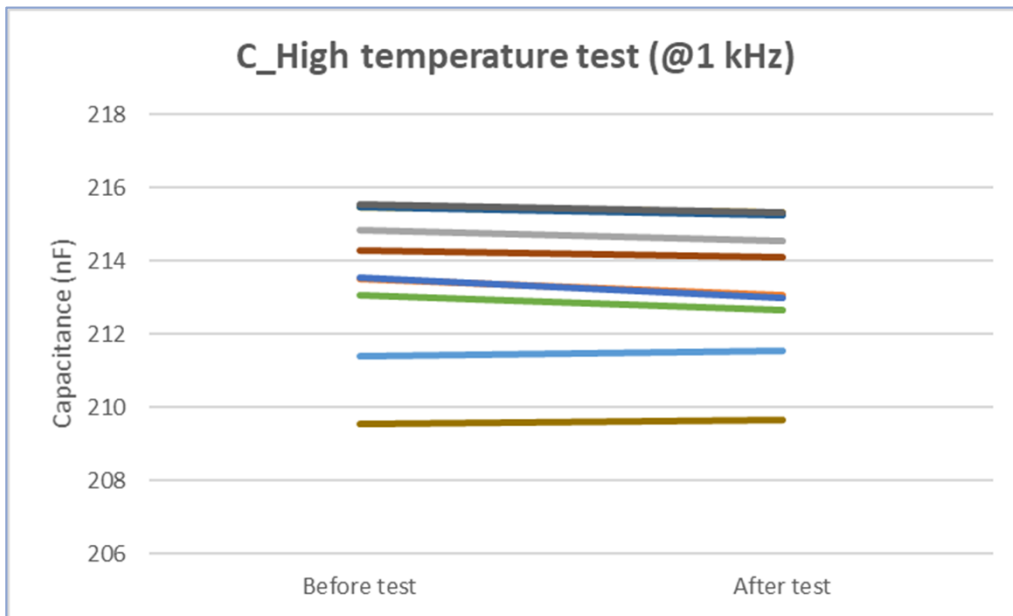
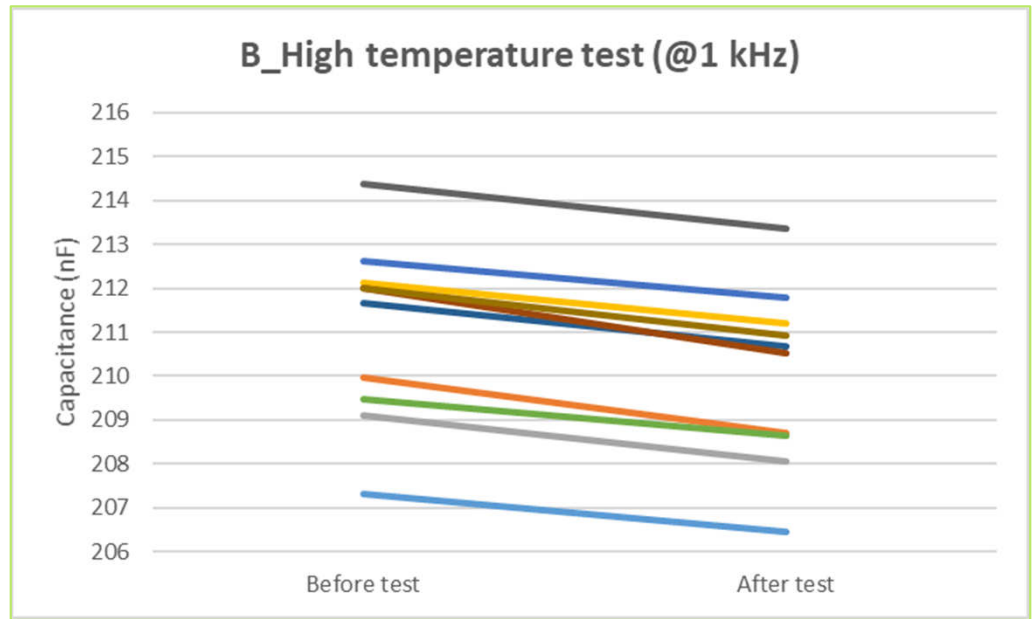
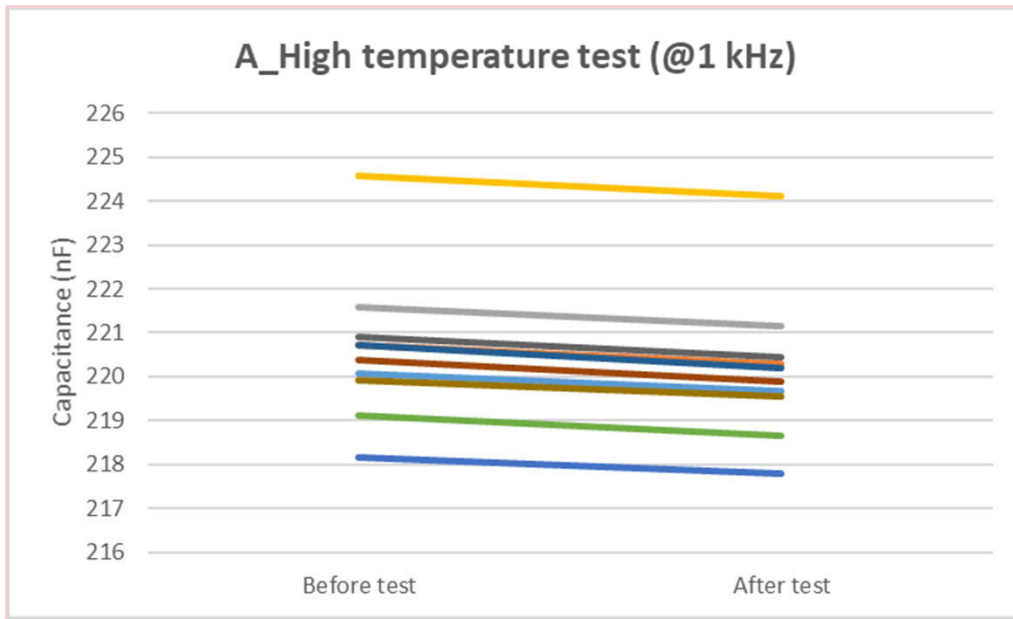


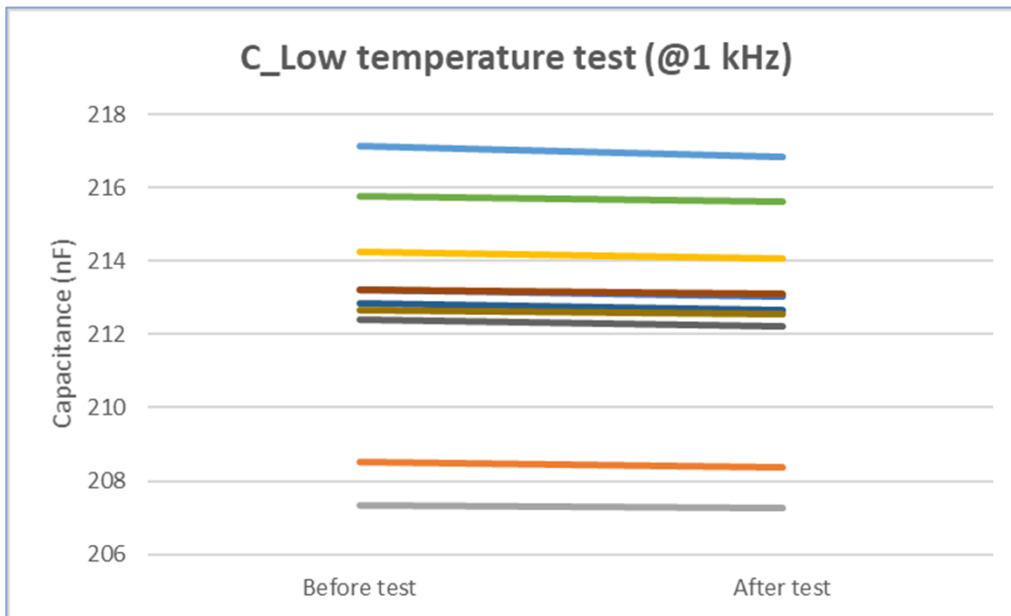
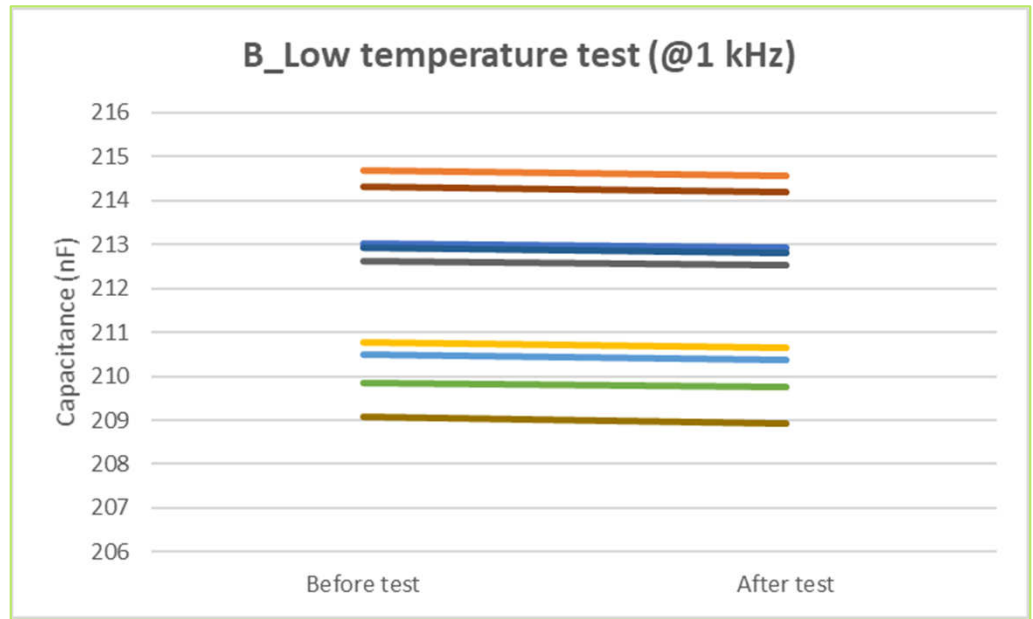
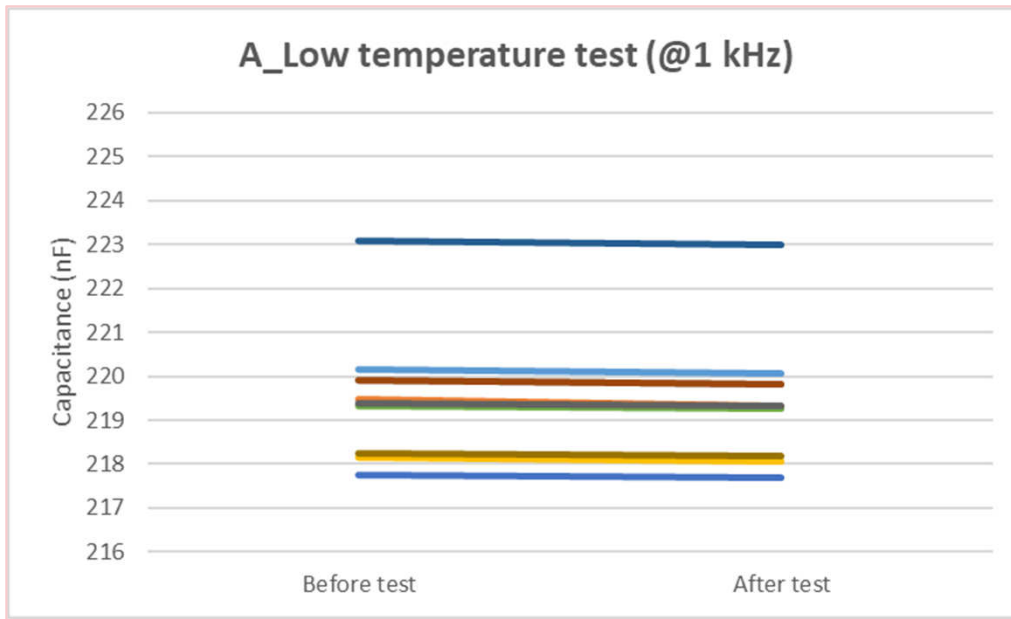
B_High humidity test (@120 Hz)

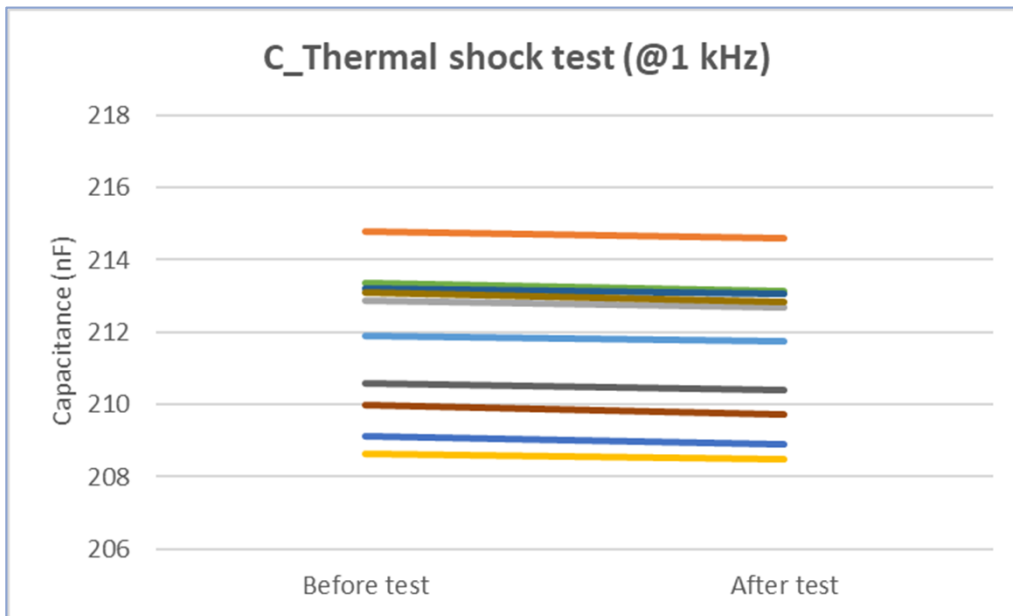
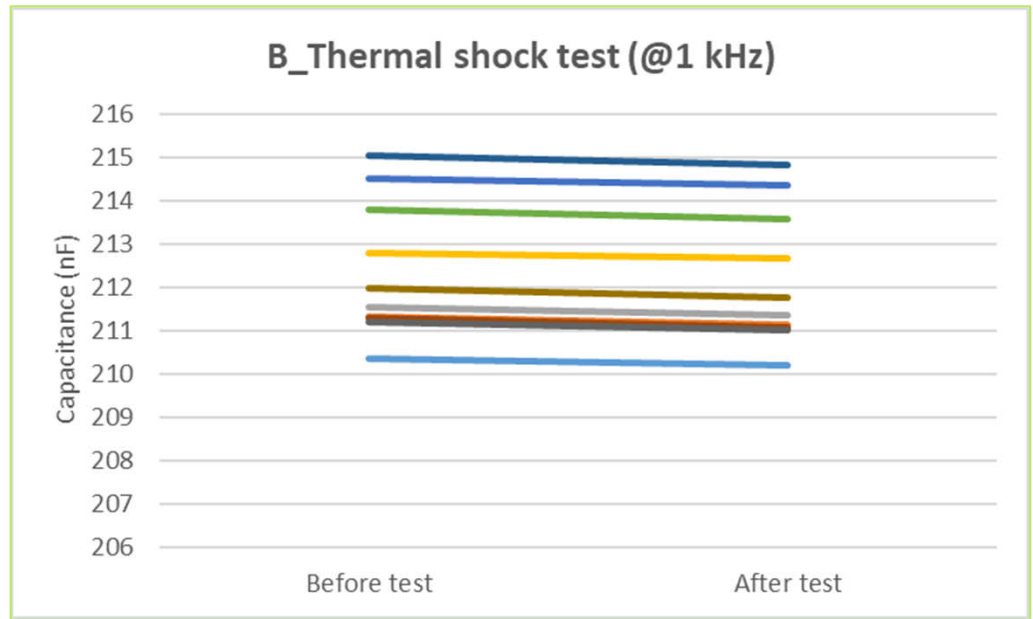
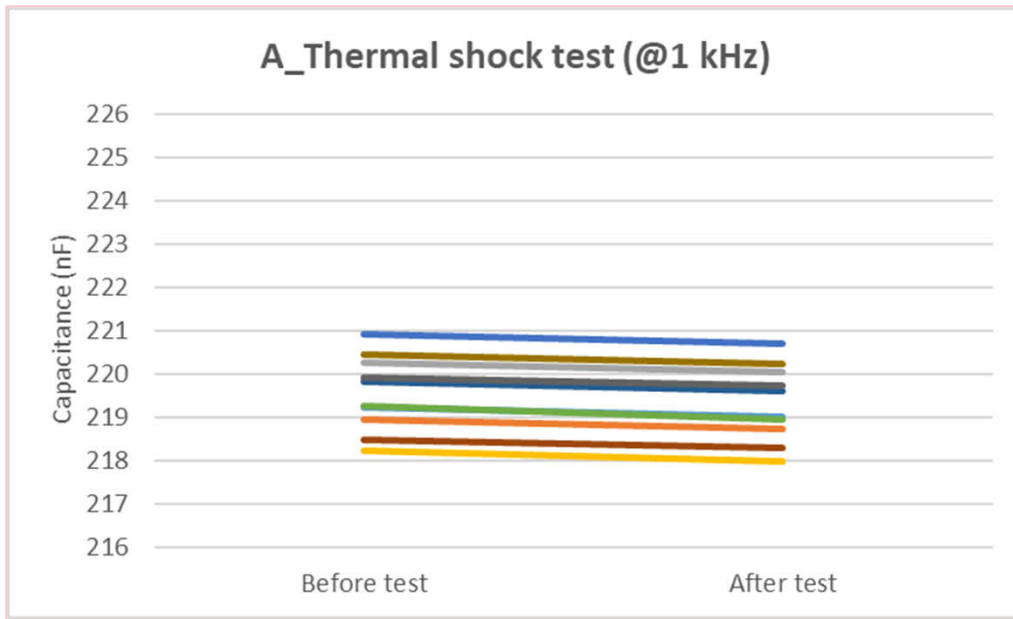


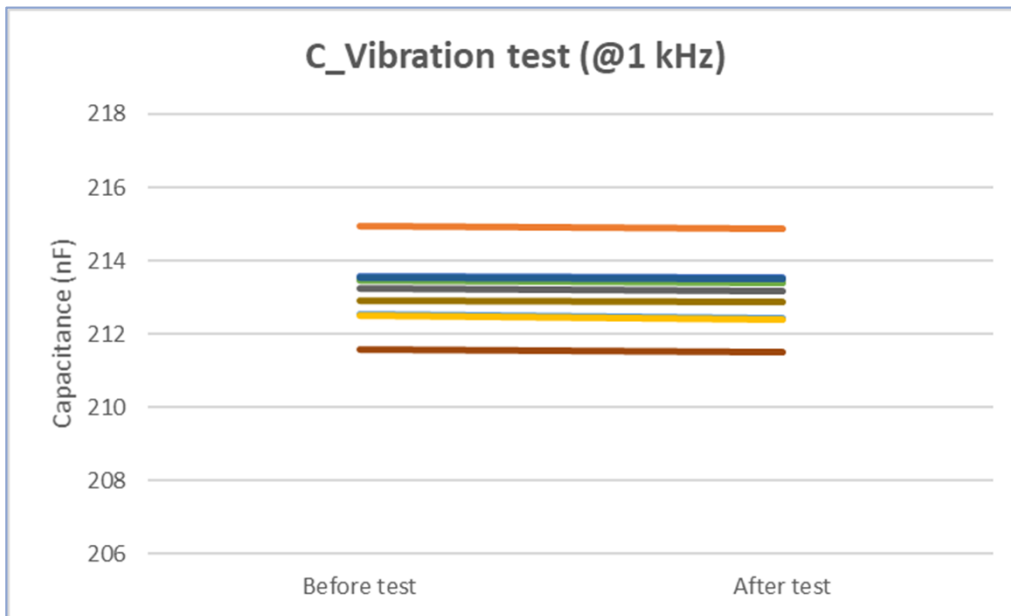
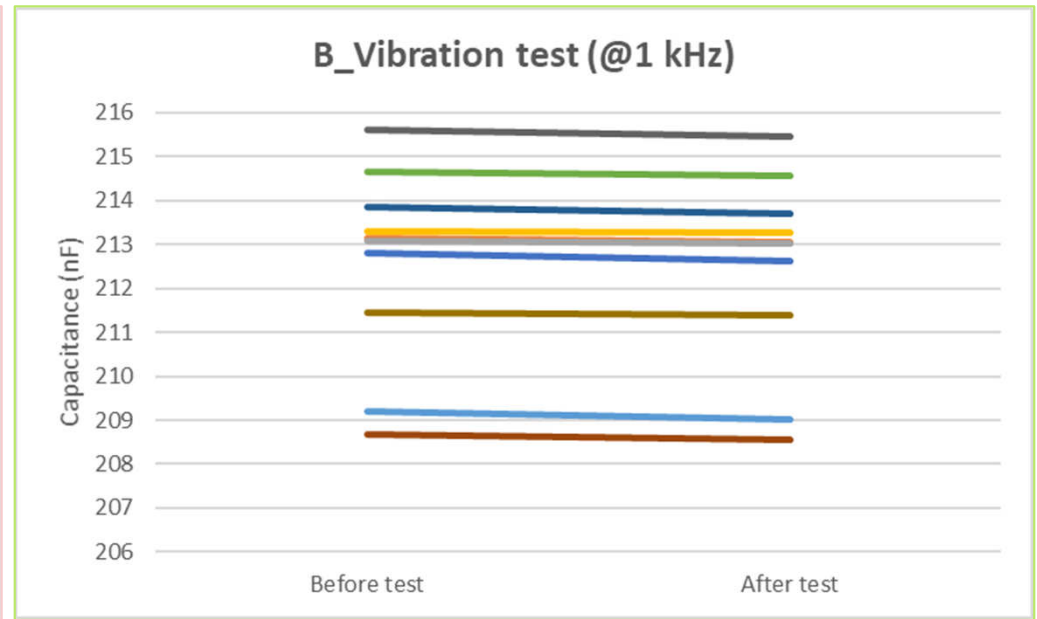
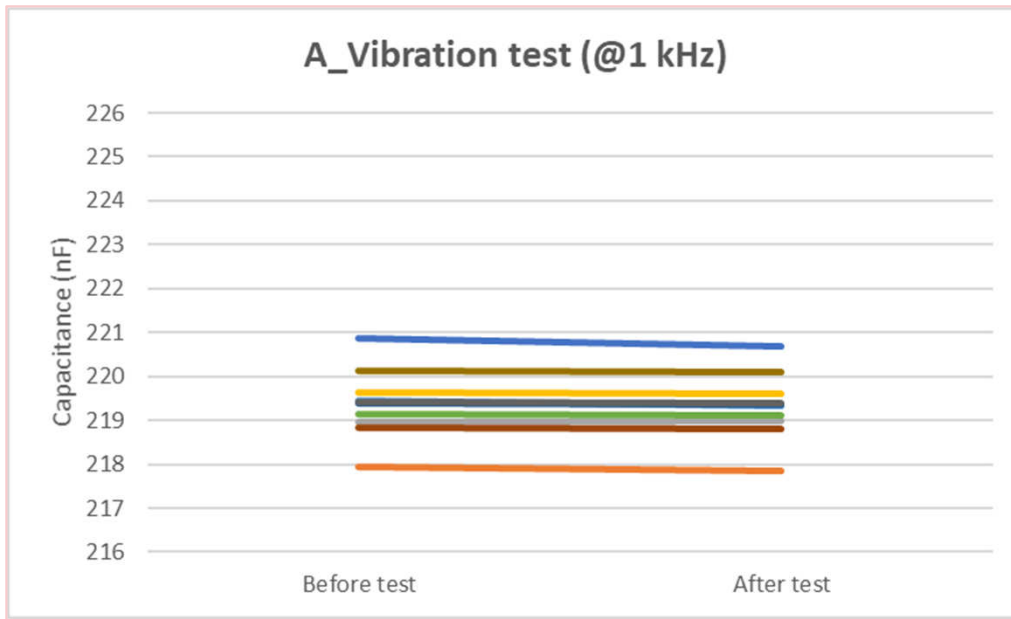
C_High humidity test (@120 Hz)

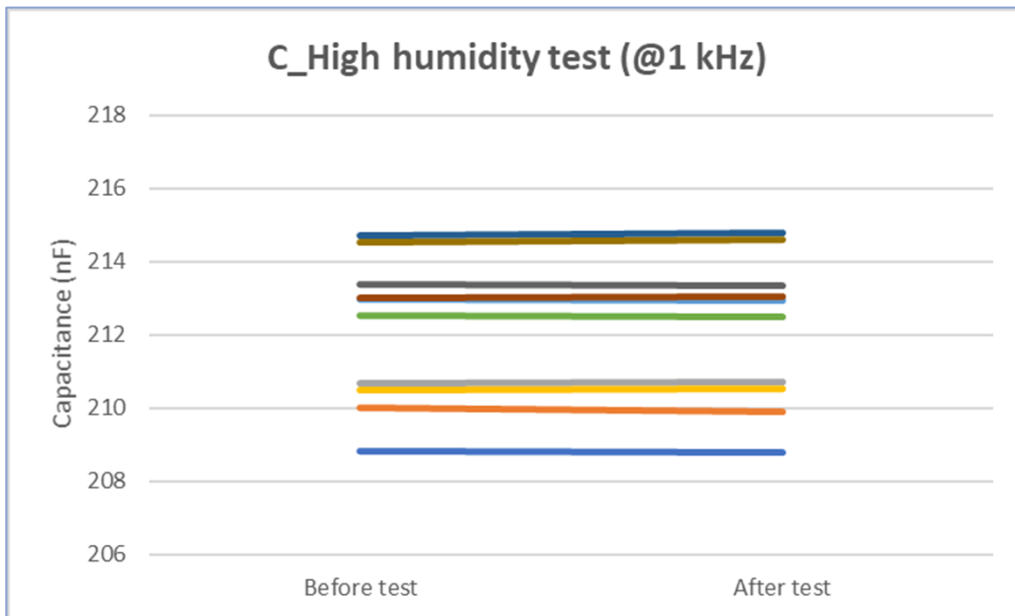
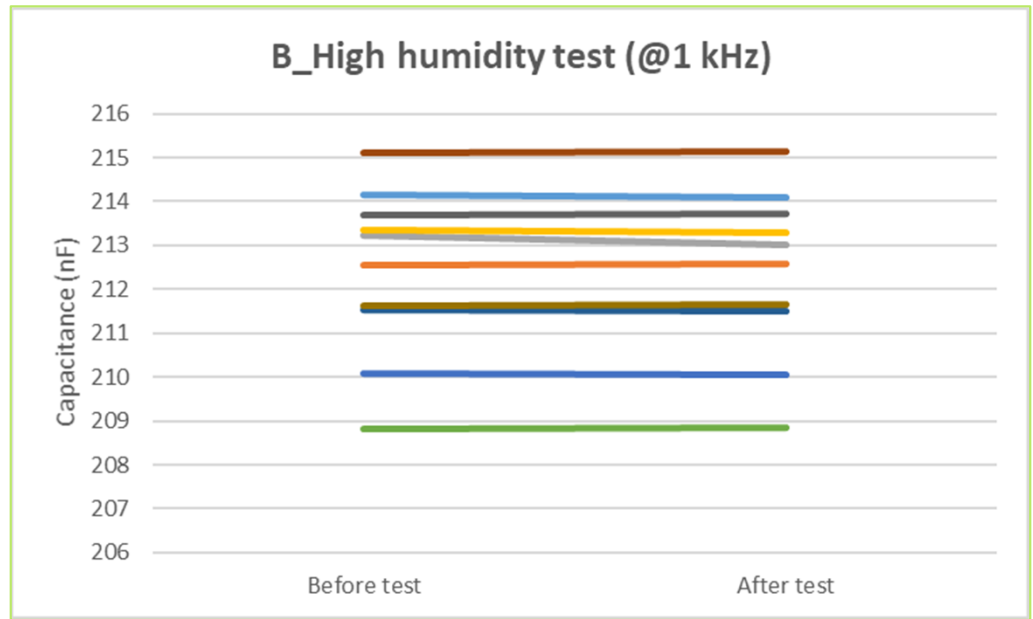
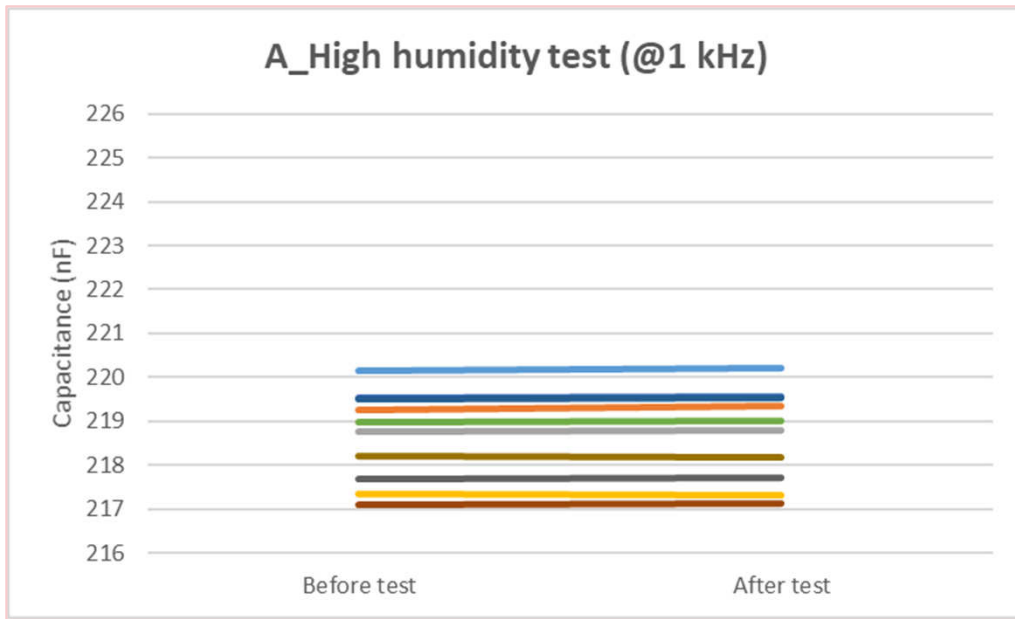


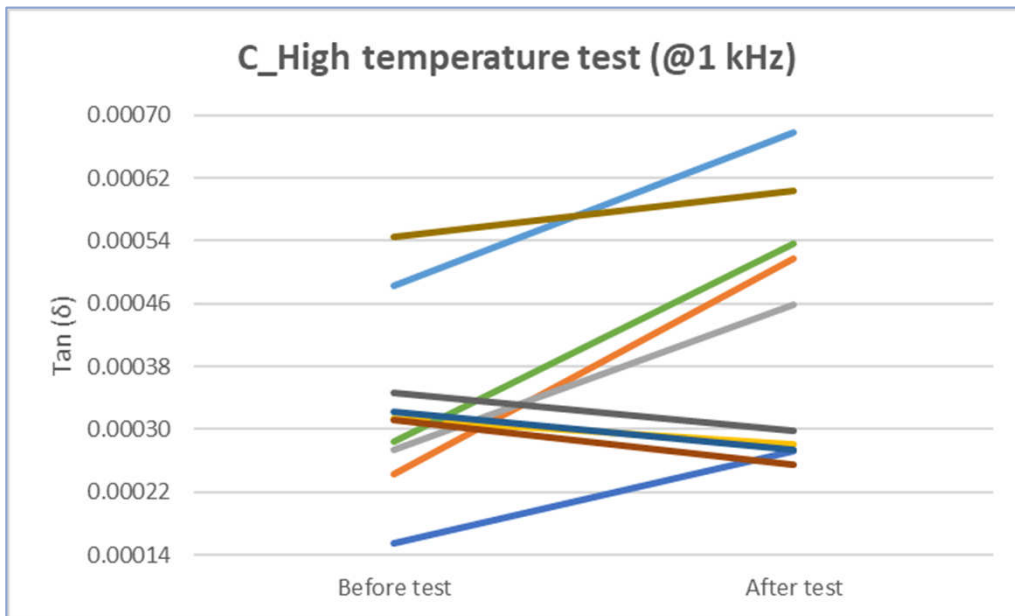
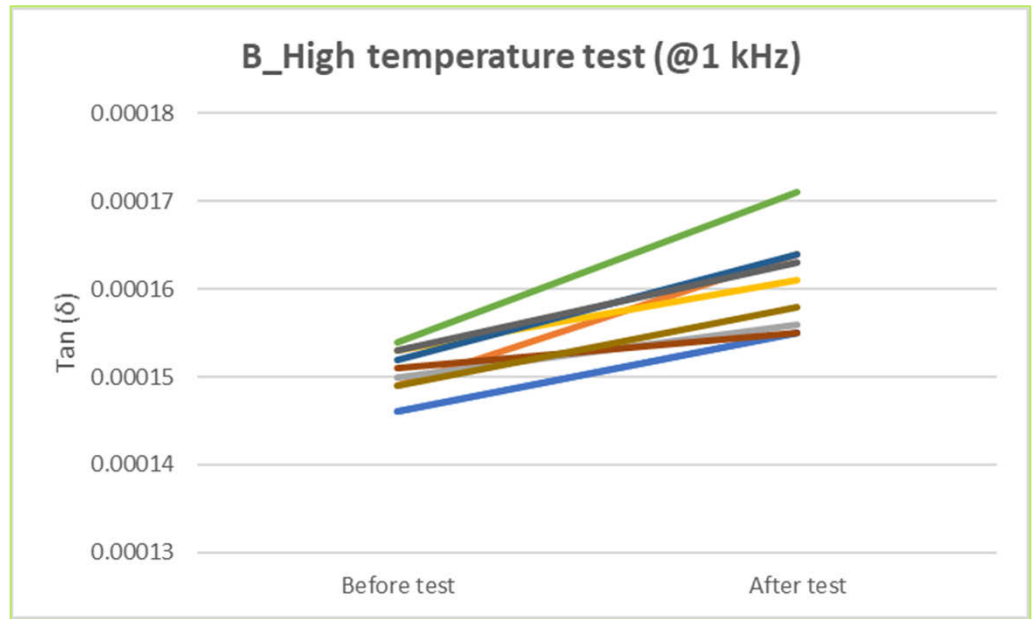
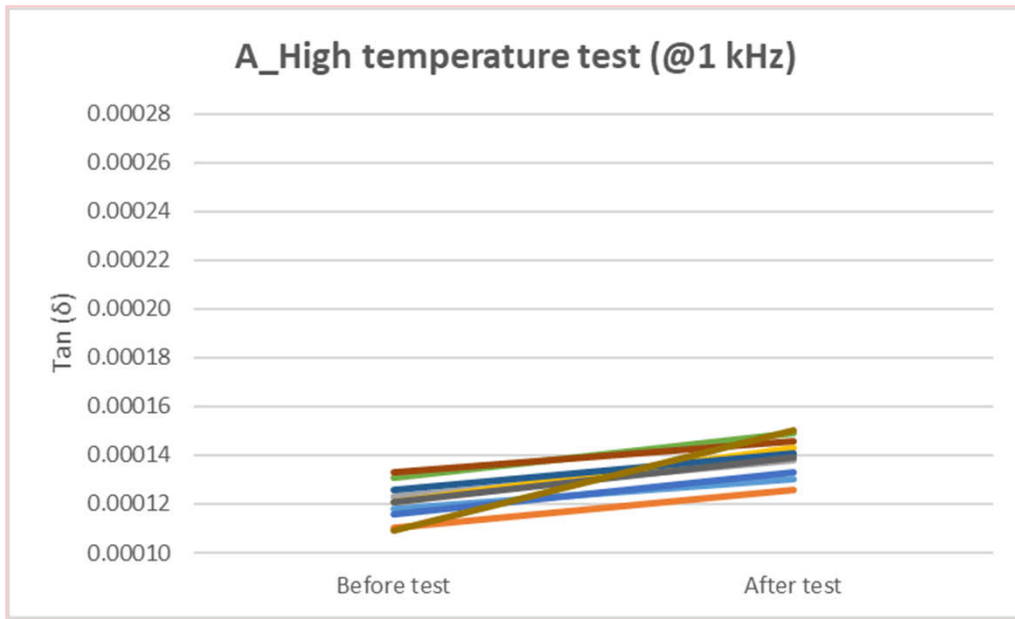


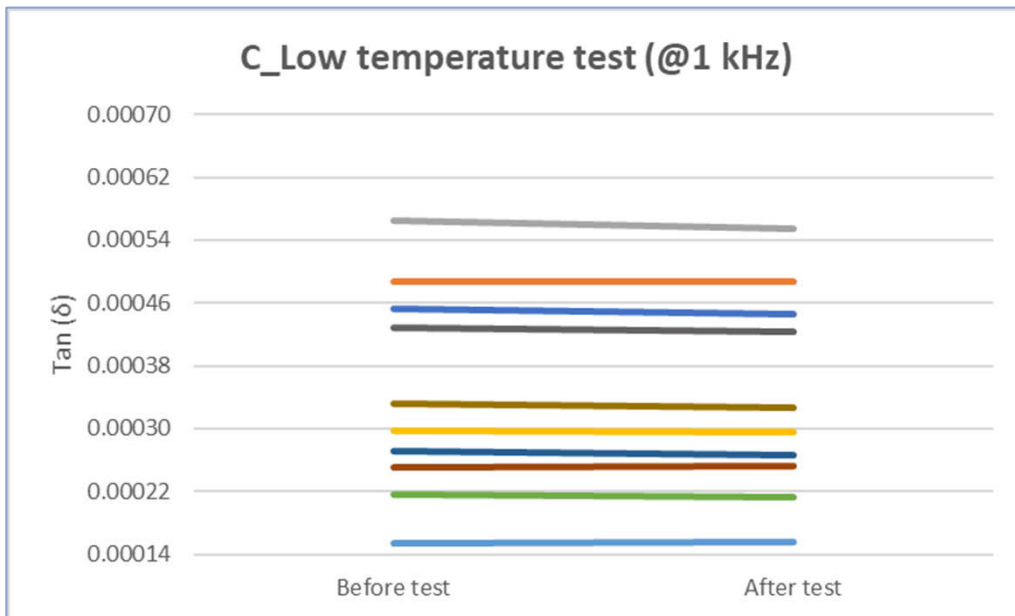
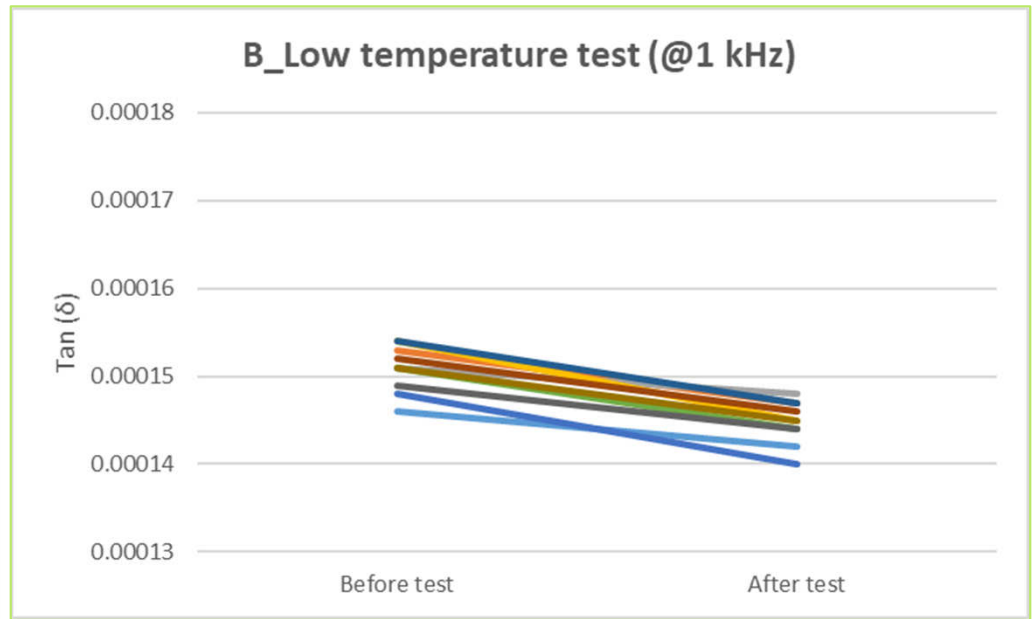
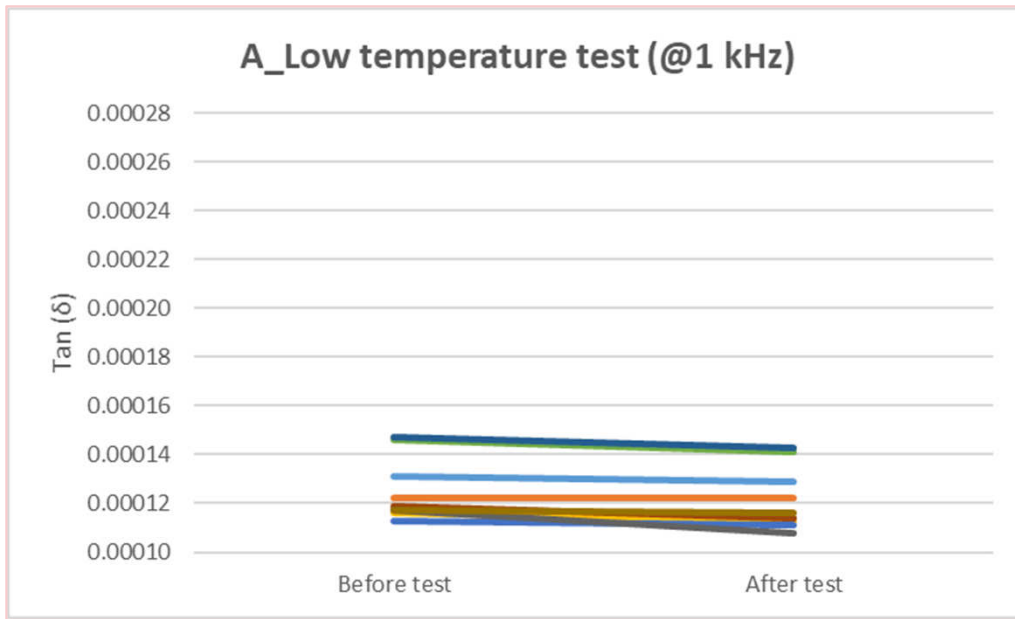




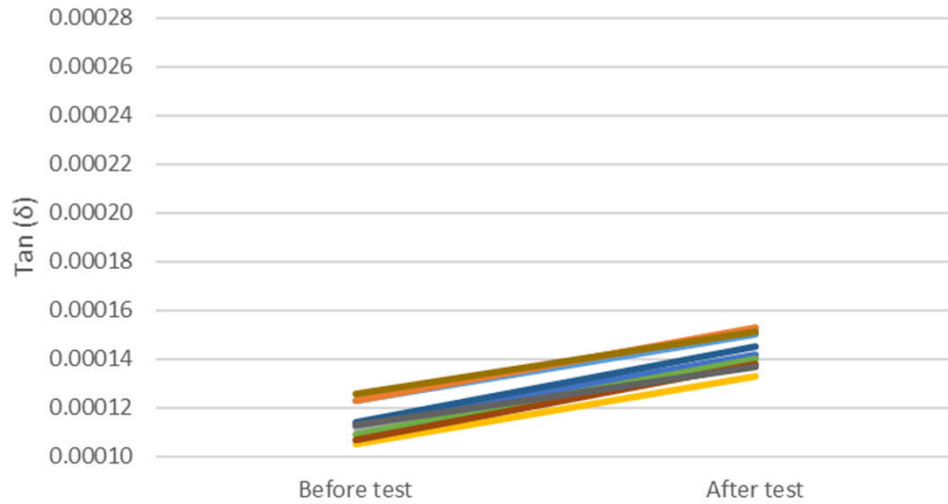




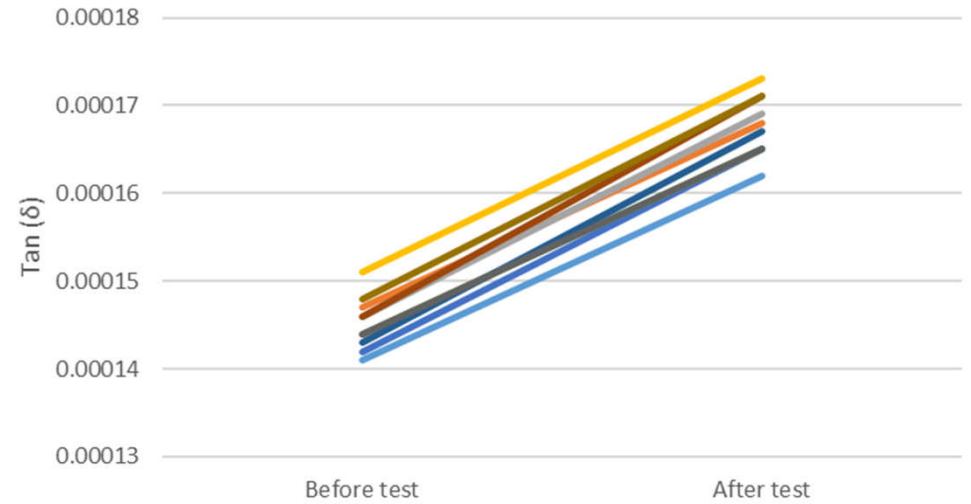




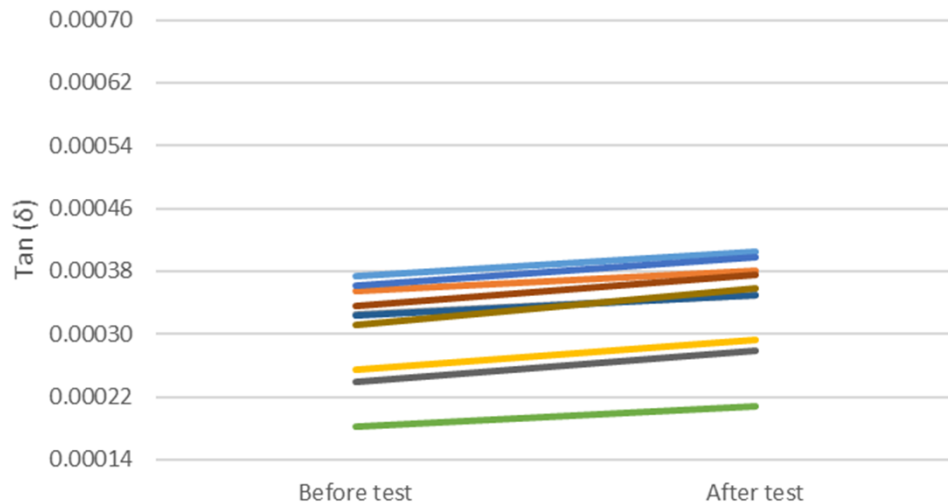
A_Thermal shock test (@1 kHz)

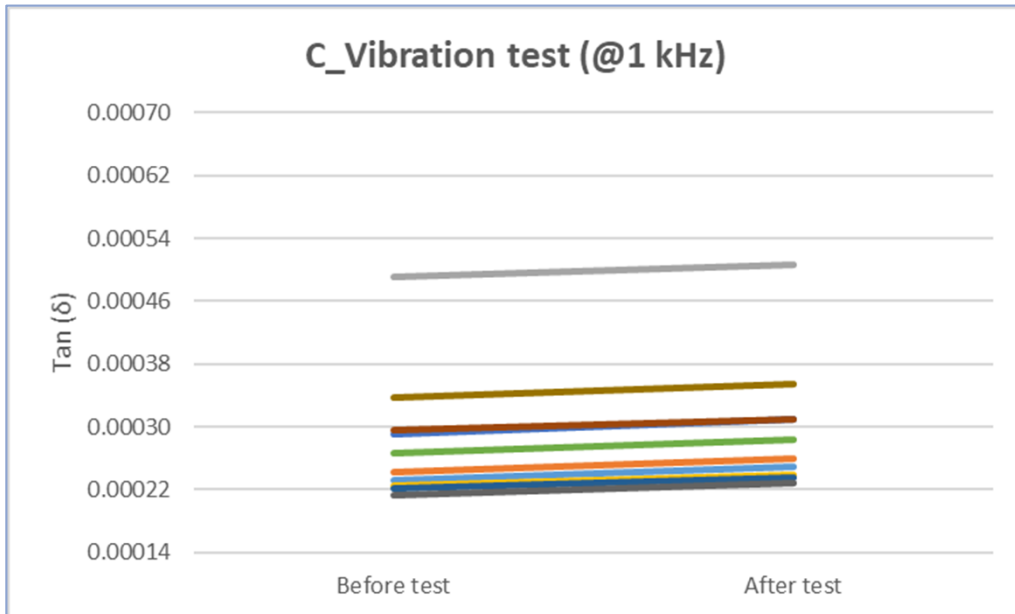
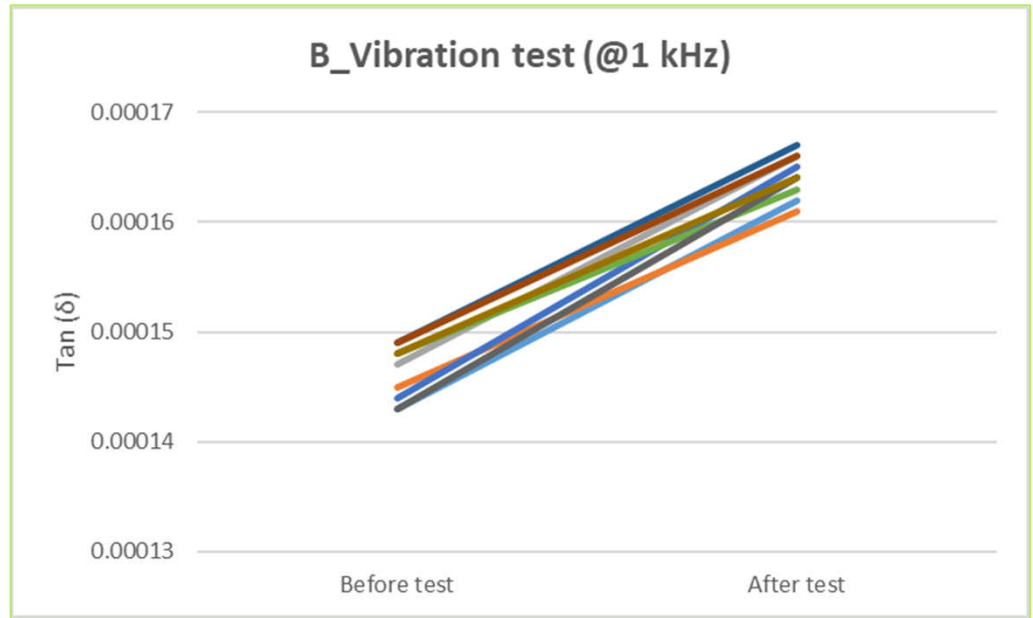
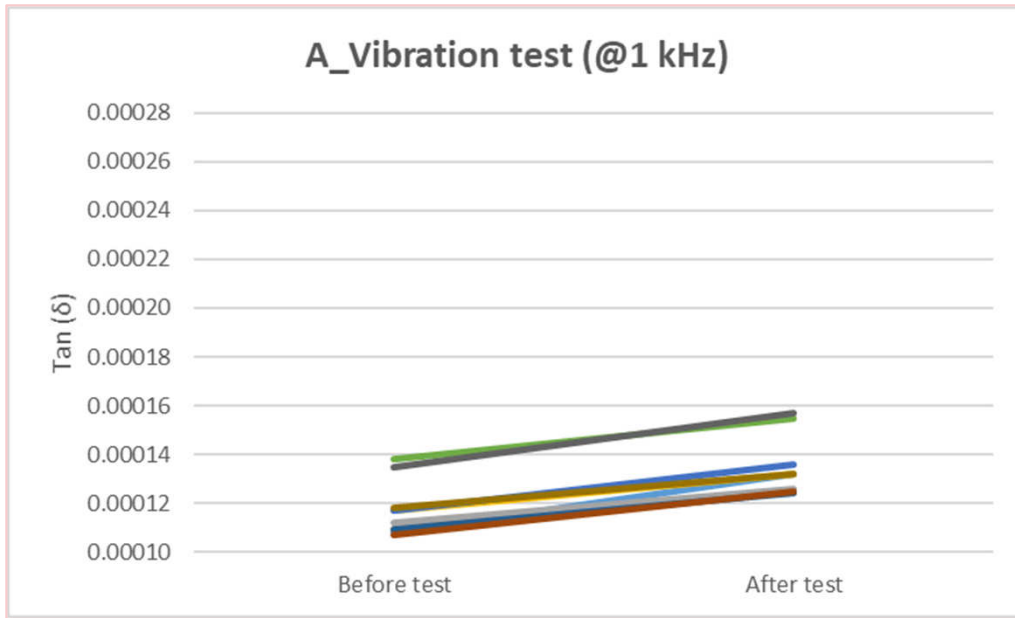


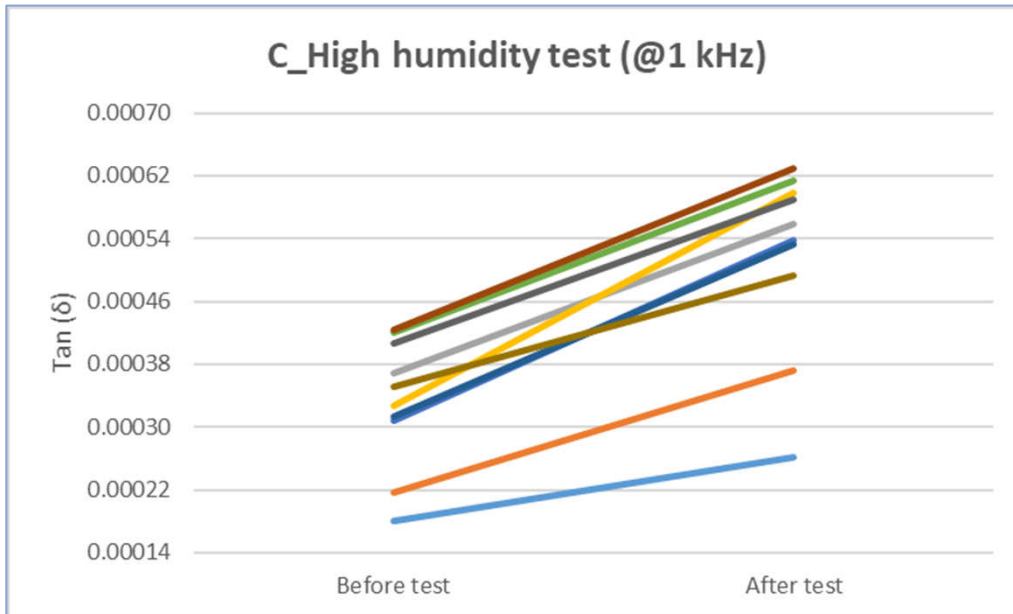
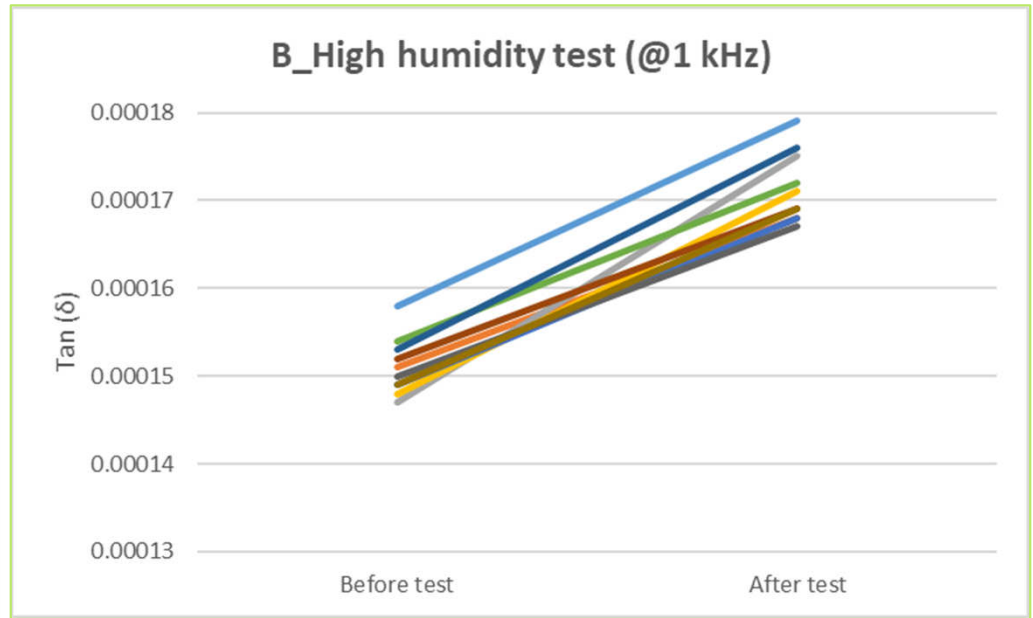
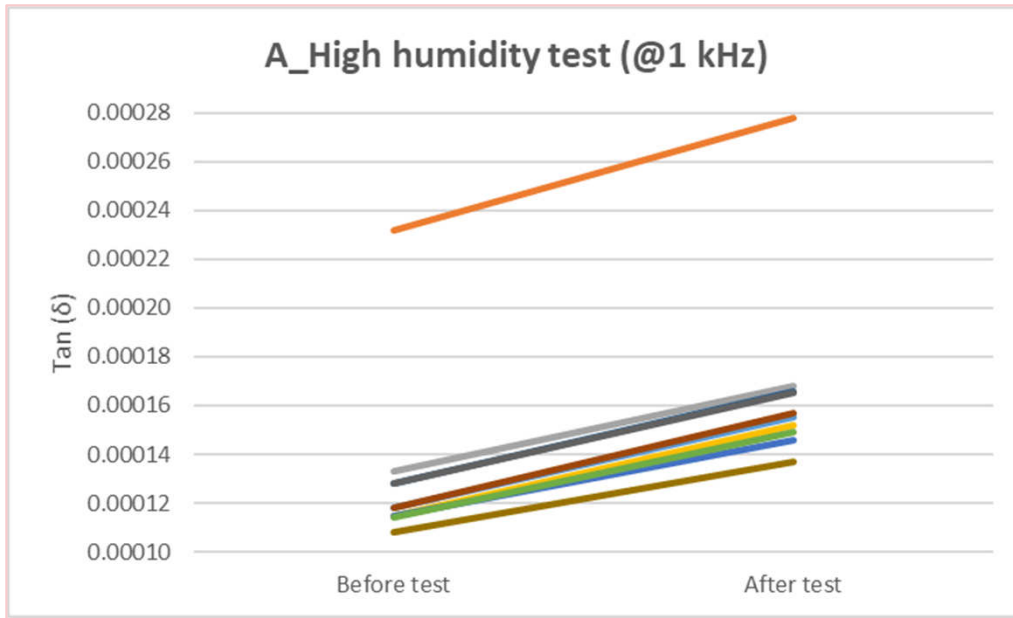
B_Thermal shock test (@1 kHz)



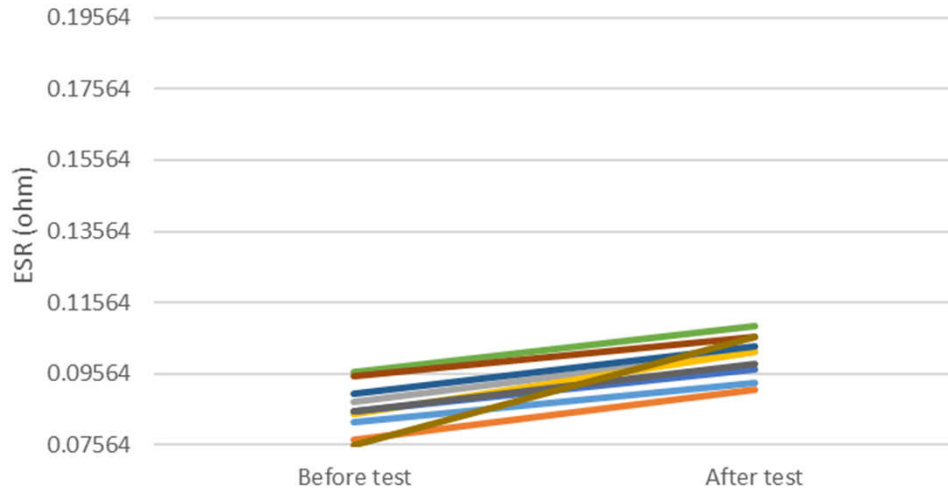
C_Thermal shock test (@1 kHz)



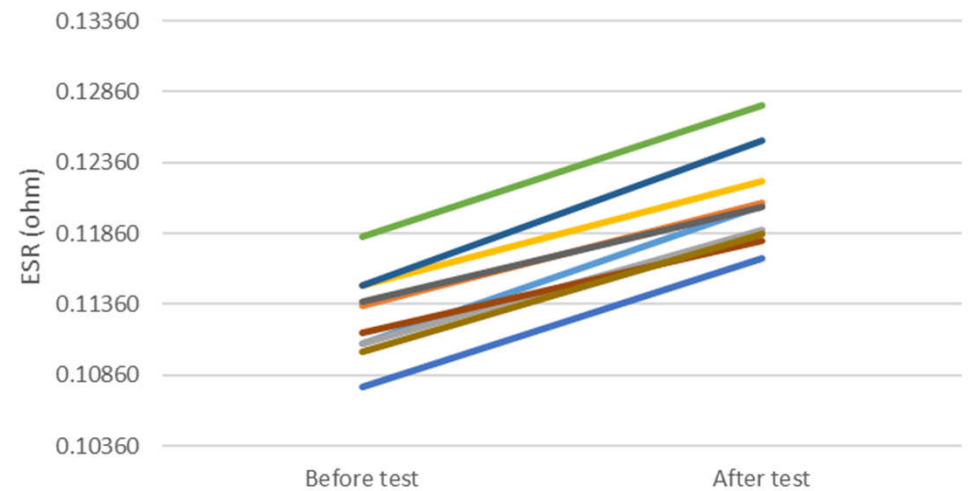




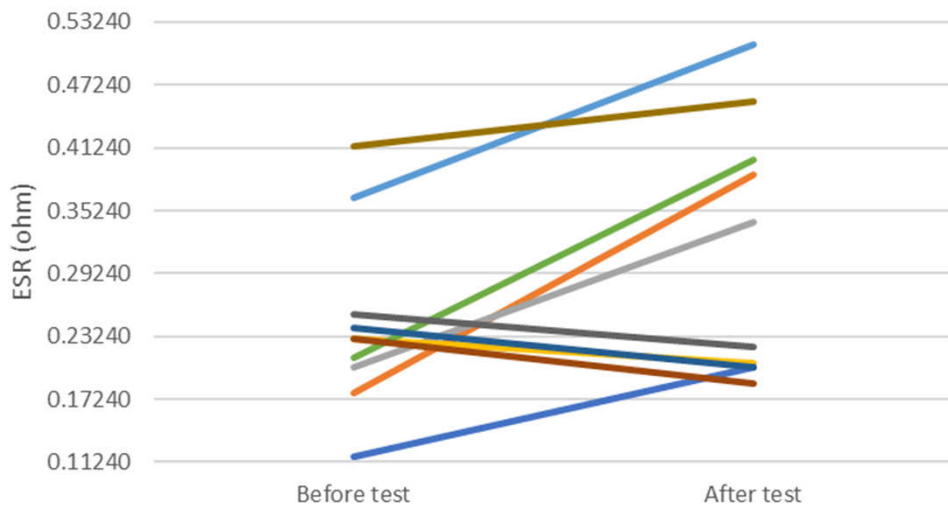
A_High temperature test (@1 kHz)



B_High temperature test (@1 kHz)



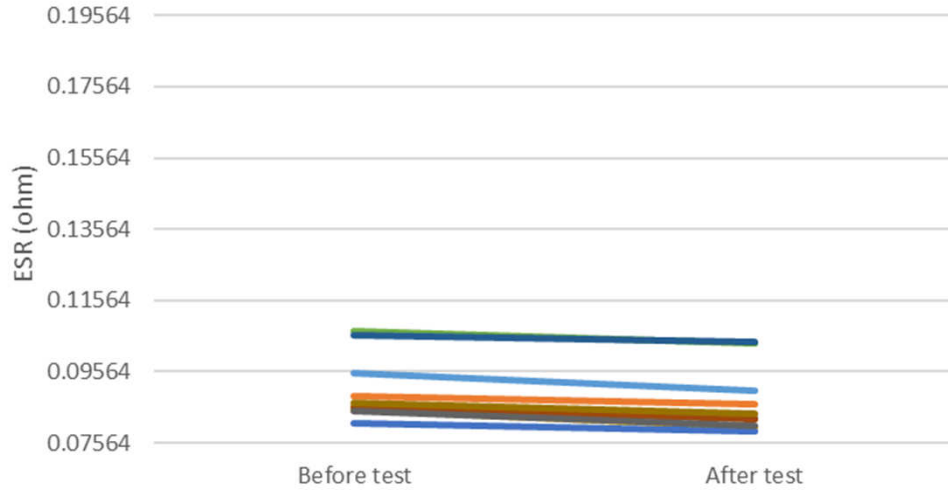
C_High temperature test (@1 kHz)



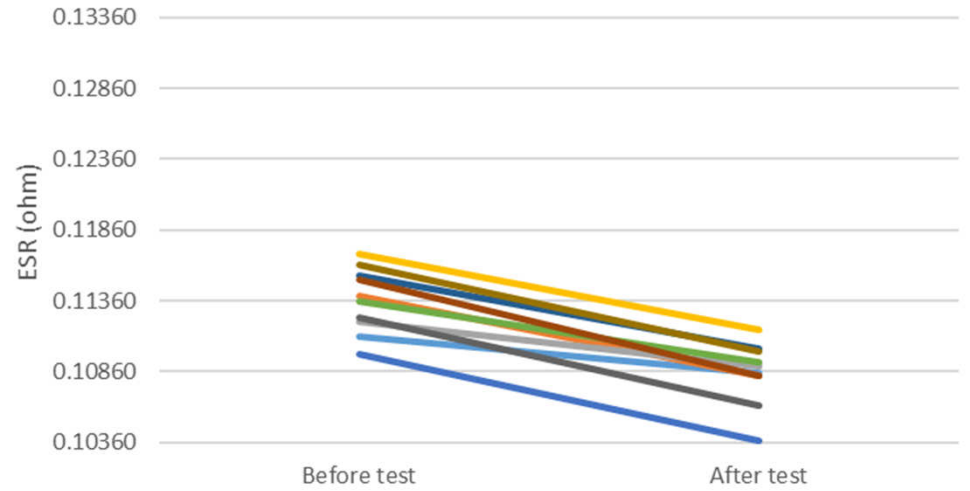
Summary

Low temperature test_ESR (ohm) @1 kHz

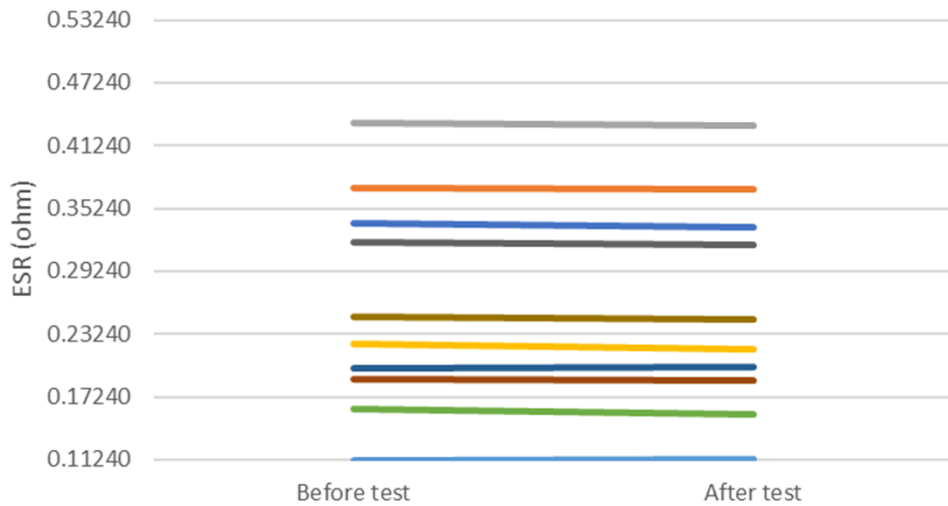
A_Low temperature test (@1 kHz)



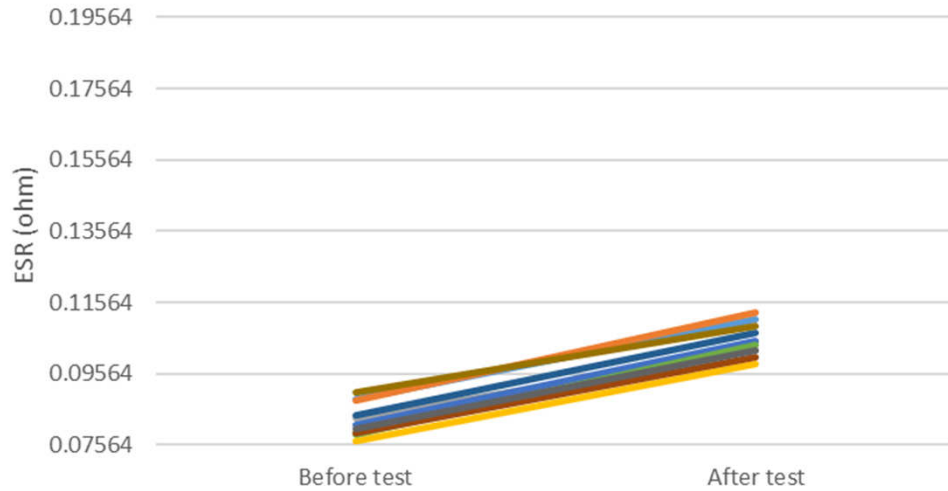
B_Low temperature test (@1 kHz)



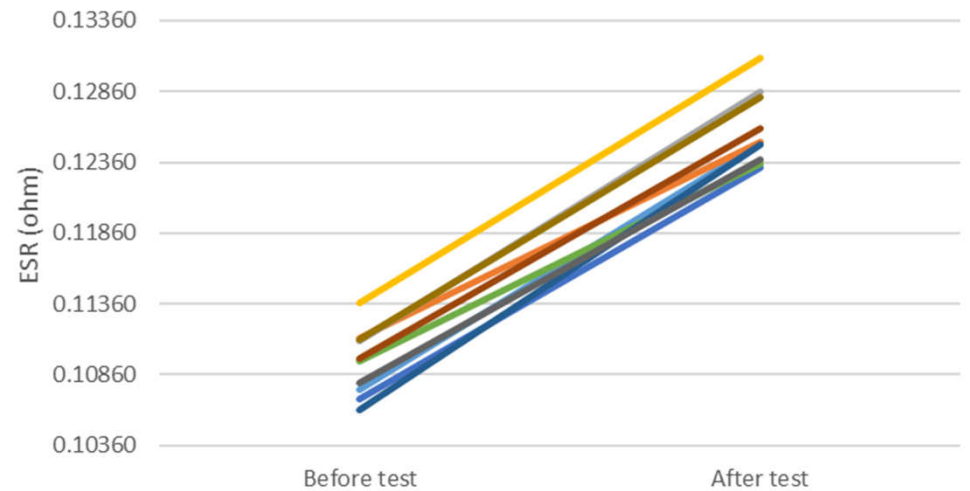
C_Low temperature test (@1 kHz)



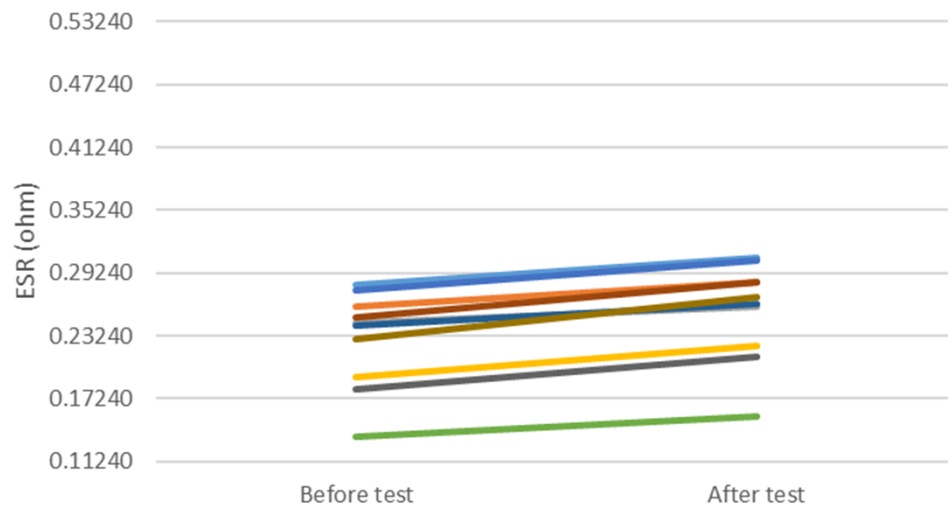
A_Thermal shock test (@1 kHz)



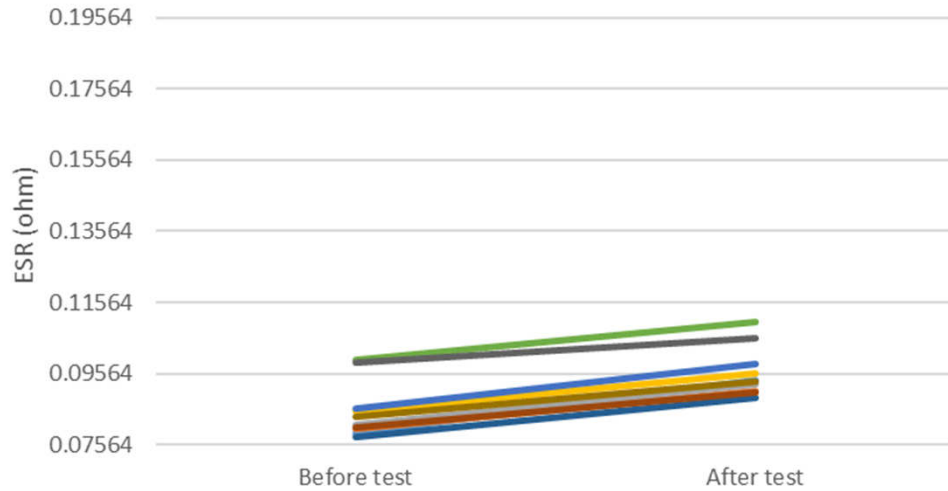
B_Thermal shock test (@1 kHz)



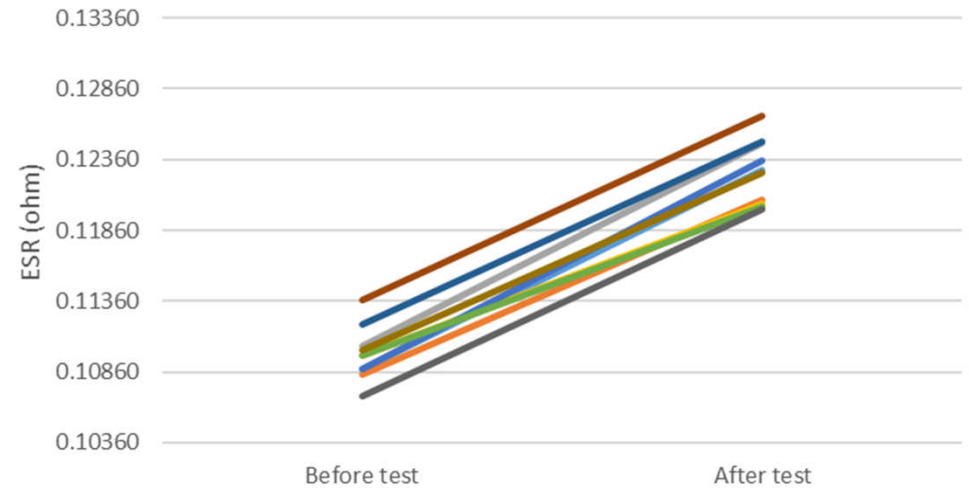
C_Thermal shock test (@1 kHz)



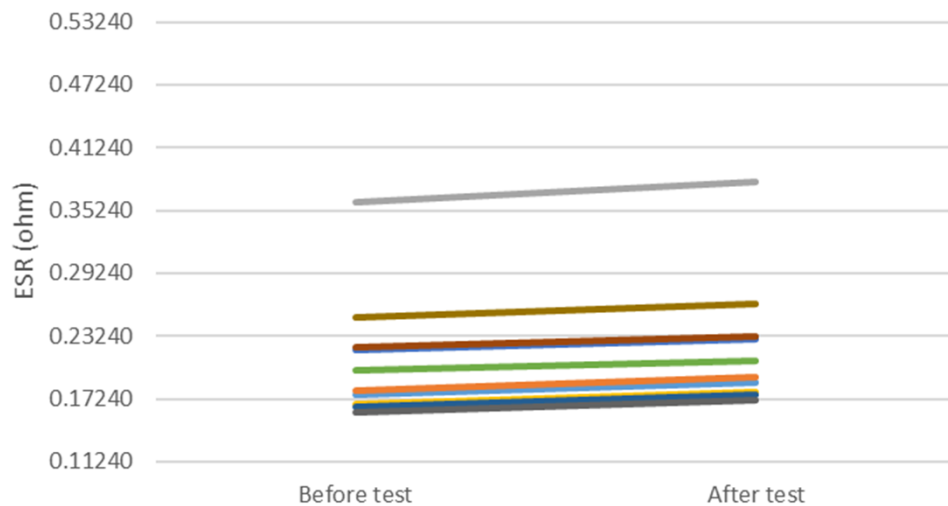
A_Vibration test (@1 kHz)

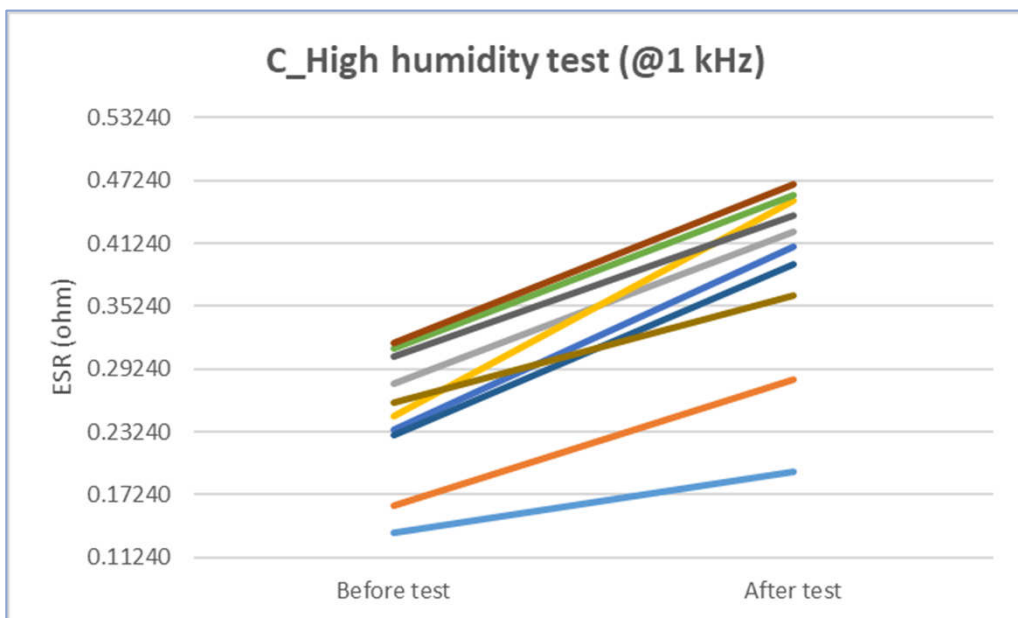
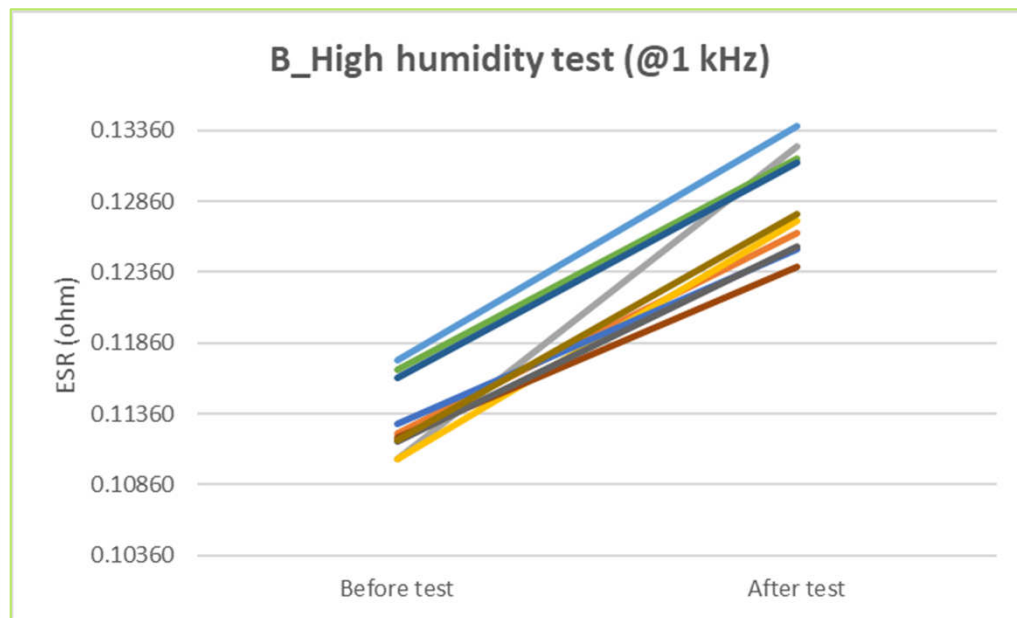
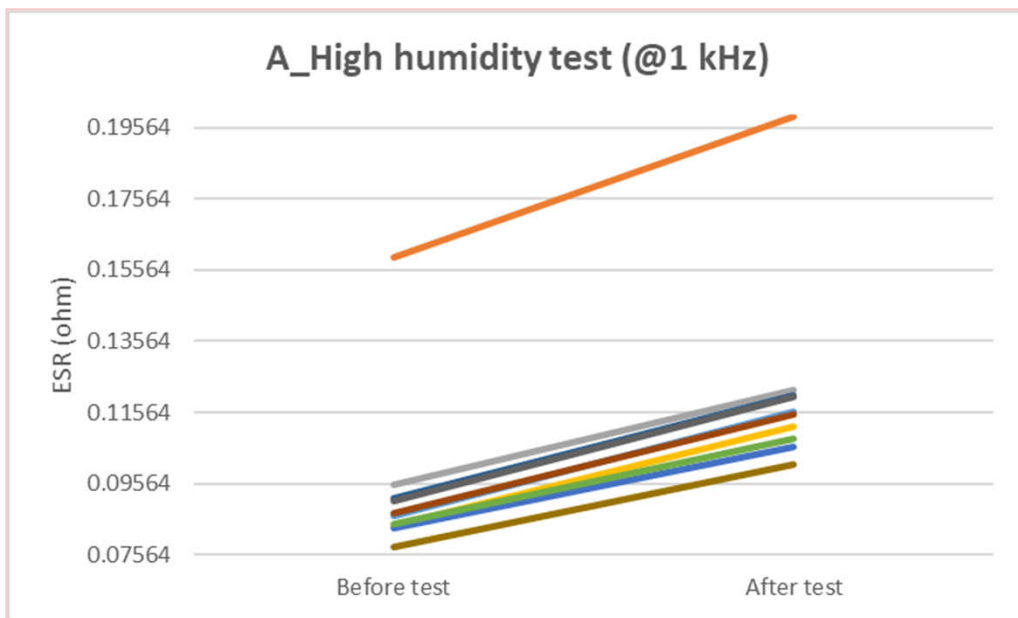


B_Vibration test (@1 kHz)



C_Vibration test (@1 kHz)





* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	220.134	219.755	-0.17217	-0.000134	-0.000134	0.00000	-0.81736	-0.82014	0.34012
2	220.801	220.334	-0.21150	-0.000138	-0.000135	-2.17391	-0.84333	-0.82882	-1.72056
3	221.627	221.211	-0.18770	-0.000131	-0.000125	-4.58015	-0.76921	-0.76632	-0.37571
4	224.621	224.200	-0.18743	-0.000131	-0.000124	-5.34351	-0.77356	-0.72482	-6.30074
5	218.231	217.845	-0.17688	-0.000137	-0.000134	-2.18978	-0.82963	-0.82445	-0.62437
6	219.161	218.715	-0.20350	-0.000132	-0.000132	0.00000	-0.82799	-0.80208	-3.12926
7	220.761	220.248	-0.23238	-0.000135	-0.000132	-2.22222	-0.82483	-0.80762	-2.08649
8	220.435	219.952	-0.21911	-0.000138	-0.000139	0.72464	-0.81993	-0.81304	-0.84032
9	220.962	220.491	-0.21316	-0.000134	-0.000132	-1.49254	-0.81894	-0.80198	-2.07097
10	219.977	219.622	-0.16138	-0.000142	-0.000133	-6.33803	-0.83319	-0.80423	-3.47580
Min	218.231	217.845	-0.17688	-0.000142	-0.000139	-2.11268	-0.84333	-0.82882	-1.72056
Max	224.621	224.200	-0.18743	-0.000131	-0.000124	-5.34351	-0.76921	-0.72482	-5.77086
Avg	220.671	220.237	-0.19654	-0.000135	-0.000132	-2.36686	-0.81580	-0.79935	-2.01607

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	220.222	220.122	-0.04541	-0.000138	-0.000147	6.52174	-0.83613	-0.87179	4.26489
2	219.505	219.450	-0.02506	-0.000135	-0.000147	8.88889	-0.83958	-0.86484	3.00865
3	219.956	219.855	-0.04592	-0.000138	-0.000142	2.89855	-0.82027	-0.85697	4.47414
4	218.201	218.125	-0.03483	-0.000139	-0.000147	5.75540	-0.84818	-0.89553	5.58254
5	217.808	217.709	-0.04545	-0.000140	-0.000147	5.00000	-0.85384	-0.88856	4.06634
6	219.384	219.328	-0.02553	-0.000134	-0.000140	4.47761	-0.79090	-0.84854	7.28790
7	223.149	223.053	-0.04302	-0.000129	-0.000140	8.52713	-0.77540	-0.82118	5.90405
8	219.965	219.888	-0.03501	-0.000136	-0.000145	6.61765	-0.82900	-0.87600	5.66948
9	219.420	219.337	-0.03783	-0.000134	-0.000145	8.20896	-0.82785	-0.88549	6.96261
10	218.296	218.256	-0.01832	-0.000139	-0.000146	5.03597	-0.81874	-0.87202	6.50756
Min	217.808	217.709	-0.04545	-0.000140	-0.000147	5.00000	-0.85384	-0.89553	4.88265
Max	223.149	223.053	-0.04302	-0.000129	-0.000140	8.52713	-0.77540	-0.82118	5.90405
Avg	219.591	219.512	-0.03566	-0.000136	-0.000145	6.16740	-0.82399	-0.86809	5.35238

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	219.319	219.036	-0.12904	-0.000128	-0.000122	-4.68750	-0.77289	-0.72365	-6.37089
2	219.022	218.771	-0.11460	-0.000127	-0.000120	-5.51181	-0.77921	-0.72952	-6.37697
3	220.305	220.087	-0.09895	-0.000133	-0.000126	-5.26316	-0.80247	-0.73846	-7.97662
4	218.285	218.048	-0.10857	-0.000132	-0.000125	-5.30303	-0.81335	-0.75060	-7.71501
5	220.946	220.750	-0.08871	-0.000126	-0.000119	-5.55556	-0.76605	-0.71488	-6.67972
6	219.344	219.014	-0.15045	-0.000131	-0.000121	-7.63359	-0.78367	-0.71969	-8.16415
7	219.869	219.653	-0.09824	-0.000126	-0.000120	-4.76190	-0.78468	-0.71860	-8.42127
8	218.550	218.347	-0.09288	-0.000134	-0.000125	-6.71642	-0.80811	-0.75027	-7.15744
9	219.960	219.793	-0.07592	-0.000128	-0.000119	-7.03125	-0.77294	-0.71427	-7.59050
10	220.498	220.302	-0.08889	-0.000131	-0.000127	-3.05344	-0.78920	-0.74943	-5.03928
Min	218.285	218.048	-0.10857	-0.000134	-0.000127	-5.22388	-0.81335	-0.75060	-7.71501
Max	220.946	220.750	-0.08871	-0.000126	-0.000119	-5.55556	-0.76605	-0.71427	-6.75935
Avg	219.610	219.380	-0.10459	-0.000130	-0.000122	-5.55556	-0.78726	-0.73094	-7.15395

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	219.494	219.444	-0.02278	-0.000129	-0.000143	10.8527	-0.79125	-0.84980	7.39968
2	218.000	217.888	-0.05138	-0.000135	-0.000148	9.62963	-0.82088	-0.91127	11.0114
3	219.019	219.023	0.00183	-0.000133	-0.000144	8.27068	-0.79438	-0.85816	8.02890
4	219.725	219.682	-0.01957	-0.000125	-0.000141	12.8000	-0.78430	-0.83382	6.31391
5	220.908	220.799	-0.04934	-0.000130	-0.000142	9.23077	-0.78033	-0.84623	8.44515
6	219.220	219.175	-0.02053	-0.000123	-0.000137	11.3821	-0.76471	-0.82142	7.41588
7	219.437	219.420	-0.00775	-0.000133	-0.000142	6.76692	-0.80045	-0.87774	9.65582
8	218.911	218.875	-0.01645	-0.000131	-0.000146	11.4501	-0.79085	-0.87084	10.1144
9	219.462	219.444	-0.00820	-0.000095	-0.000108	13.6842	-0.05606	-0.06576	17.3134
10	220.192	220.169	-0.01045	-0.000130	-0.000139	6.92308	-0.78374	-0.84495	7.80999
Min	218.000	217.888	-0.05138	-0.000135	-0.000148	9.62963	-0.82088	-0.91127	11.0114
Max	220.908	220.799	-0.04934	-0.000095	-0.000108	13.6842	-0.05606	-0.06576	17.3134
Avg	219.437	219.392	-0.02046	-0.000126	-0.000139	9.96835	-0.71669	-0.77800	8.55378

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	220.204	220.177	-0.01226	-0.000134	-0.000070	-47.7612	-0.81457	-0.41052	-49.6029
2	219.391	219.456	0.02963	0.000254	0.000310	22.0472	1.46403	1.84698	26.1573
3	218.826	218.846	0.00914	-0.000136	-0.000080	-41.1765	-0.83554	-0.48207	-42.3044
4	217.395	217.399	0.00184	-0.000137	-0.000077	-43.7956	-0.84416	-0.46656	-44.7309
5	219.590	219.636	0.02095	-0.000138	-0.000090	-34.7826	-0.84618	-0.52673	-37.7520
6	219.036	219.085	0.02237	-0.000139	-0.000085	-38.8489	-0.85553	-0.51699	-39.5708
7	219.556	219.593	0.01685	-0.000134	-0.000073	-45.5224	-0.80166	-0.43484	-45.7576
8	217.155	217.193	0.01750	-0.000138	-0.000075	-45.6522	-0.85018	-0.44756	-47.3570
9	217.736	217.772	0.01653	-0.000134	-0.000073	-45.5224	-0.81086	-0.45751	-43.5772
10	218.268	218.275	0.00321	-0.000412	-0.000091	-77.9126	-0.85757	-0.54712	-36.2011
Min	217.155	217.193	0.01750	-0.000412	-0.000091	-77.9126	-0.85757	-0.54712	-36.2011
Max	220.204	220.177	-0.01226	0.000254	0.000310	22.0472	1.46403	1.84698	26.1573
Avg	218.716	218.743	0.01257	-0.000125	-0.000040	-67.6282	-0.60522	-0.24429	-59.6360

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	220.071	219.676	-0.17949	0.000118	0.000130	10.1695	0.08223	0.09329	13.4501
2	220.735	220.280	-0.20613	0.000110	0.000126	14.5455	0.07727	0.09113	17.9371
3	221.573	221.164	-0.18459	0.000123	0.000138	12.1951	0.08792	0.10168	15.6506
4	224.578	224.126	-0.20127	0.000121	0.000143	18.1818	0.08451	0.10194	20.6248
5	218.168	217.801	-0.16822	0.000116	0.000133	14.6552	0.08510	0.09684	13.7955
6	219.108	218.659	-0.20492	0.000131	0.000149	13.7405	0.09598	0.10904	13.6070
7	220.709	220.183	-0.23832	0.000126	0.000141	11.9048	0.08988	0.10329	14.9199
8	220.384	219.884	-0.22688	0.000133	0.000146	9.77444	0.09501	0.10591	11.4725
9	220.903	220.443	-0.20824	0.000121	0.000139	14.8760	0.08502	0.09852	15.8786
10	219.927	219.546	-0.17324	0.000109	0.000150	37.6147	0.07564	0.10616	40.3490
Min	218.168	217.801	-0.16822	0.000109	0.000126	15.5963	0.07564	0.09113	20.4786
Max	224.578	224.126	-0.20127	0.000133	0.000150	12.7820	0.09598	0.10904	13.6070
Avg	220.616	220.176	-0.19917	0.000121	0.000140	15.4801	0.08586	0.10078	17.3826

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	220.153	220.069	-0.03816	0.000131	0.000129	-1.52672	0.09511	0.09016	-5.20450
2	219.465	219.311	-0.07017	0.000122	0.000122	0.00000	0.08886	0.08665	-2.48706
3	219.898	219.811	-0.03956	0.000118	0.000114	-3.38983	0.08506	0.08278	-2.68046
4	218.155	218.059	-0.04401	0.000116	0.000113	-2.58621	0.08483	0.08006	-5.62301
5	217.762	217.679	-0.03812	0.000113	0.000111	-1.76991	0.08120	0.07908	-2.61084
6	219.333	219.248	-0.03875	0.000146	0.000141	-3.42466	0.10689	0.10366	-3.02180
7	223.080	222.997	-0.03721	0.000147	0.000143	-2.72109	0.10584	0.10399	-1.74792
8	219.909	219.818	-0.04138	0.000119	0.000114	-4.20168	0.08572	0.08242	-3.84974
9	219.371	219.314	-0.02598	0.000117	0.000108	-7.69231	0.08478	0.08059	-4.94220
10	218.239	218.174	-0.02978	0.000117	0.000116	-0.85470	0.08681	0.08395	-3.29455
Min	217.762	217.679	-0.03812	0.000113	0.000108	-4.42478	0.08120	0.07908	-2.61084
Max	223.080	222.997	-0.03721	0.000147	0.000143	-2.72109	0.10689	0.10399	-2.71307
Avg	219.537	219.448	-0.04031	0.000125	0.000121	-2.80899	0.09051	0.08733	-3.50900

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	219.235	218.997	-0.10856	0.000123	0.000150	21.9512	0.08864	0.11107	25.3046
2	218.960	218.722	-0.10870	0.000123	0.000153	24.3902	0.08823	0.11274	27.7797
3	220.252	220.031	-0.10034	0.000112	0.000140	25.0000	0.08299	0.10207	22.9907
4	218.225	217.970	-0.11685	0.000105	0.000133	26.6667	0.07671	0.09844	28.3275
5	220.903	220.709	-0.08782	0.000113	0.000142	25.6637	0.08134	0.10497	29.0509
6	219.266	218.954	-0.14229	0.000109	0.000140	28.4404	0.07844	0.10355	32.0117
7	219.831	219.605	-0.10281	0.000114	0.000145	27.1930	0.08387	0.10704	27.6261
8	218.480	218.281	-0.09108	0.000107	0.000138	28.9720	0.07901	0.10008	26.6675
9	219.907	219.734	-0.07867	0.000113	0.000137	21.2389	0.08001	0.10216	27.6840
10	220.439	220.223	-0.09799	0.000126	0.000151	19.8413	0.09019	0.10900	20.8560
Min	218.225	217.970	-0.11685	0.000105	0.000133	26.6667	0.07671	0.09844	28.3275
Max	220.903	220.709	-0.08782	0.000126	0.000153	21.4286	0.09019	0.11274	25.0028
Avg	219.550	219.323	-0.10348	0.000115	0.000143	24.8035	0.08294	0.10511	26.7280

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	219.443	219.335	-0.04922	0.000108	0.000132	22.2222	0.07914	0.09402	18.8021
2	217.927	217.860	-0.03074	0.000109	0.000125	14.6789	0.08011	0.09068	13.1944
3	218.961	218.981	0.00913	0.000112	0.000126	12.5000	0.08146	0.09258	13.6509
4	219.643	219.625	-0.00820	0.000117	0.000132	12.8205	0.08491	0.09565	12.6487
5	220.877	220.669	-0.09417	0.000117	0.000136	16.2393	0.08571	0.09844	14.8524
6	219.133	219.109	-0.01095	0.000138	0.000155	12.3188	0.09947	0.11035	10.9380
7	219.394	219.383	-0.00501	0.000109	0.000124	13.7615	0.07801	0.08902	14.1136
8	218.834	218.806	-0.01280	0.000107	0.000125	16.8224	0.08055	0.09027	12.0670
9	219.414	219.408	-0.00273	0.000135	0.000157	16.2963	0.09883	0.10566	6.91086
10	220.123	220.098	-0.01136	0.000118	0.000132	11.8644	0.08341	0.09335	11.9170
Min	217.927	217.860	-0.03074	0.000107	0.000124	15.8879	0.07801	0.08902	14.1136
Max	220.877	220.669	-0.09417	0.000138	0.000157	13.7681	0.09947	0.11035	10.9380
Avg	219.375	219.327	-0.02165	0.000117	0.000134	14.8718	0.08516	0.09600	12.7313

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	220.134	220.201	0.03044	0.000118	0.000155	31.3559	0.08654	0.11591	33.9381
2	219.268	219.342	0.03375	0.000232	0.000278	19.8276	0.15928	0.19889	24.8682
3	218.774	218.778	0.00183	0.000133	0.000168	26.3158	0.09544	0.12189	27.7137
4	217.344	217.342	-0.00092	0.000115	0.000152	32.1739	0.08406	0.11188	33.0954
5	219.535	219.572	0.01685	0.000115	0.000146	26.9565	0.08319	0.10611	27.5514
6	218.986	219.019	0.01507	0.000114	0.000149	30.7018	0.08415	0.10809	28.4492
7	219.505	219.537	0.01458	0.000128	0.000166	29.6875	0.09174	0.12062	31.4803
8	217.102	217.126	0.01105	0.000118	0.000157	33.0508	0.08748	0.11507	31.5386
9	217.685	217.727	0.01929	0.000128	0.000165	28.9063	0.09096	0.12008	32.0141
10	218.216	218.200	-0.00733	0.000108	0.000137	26.8519	0.07805	0.10105	29.4683
Min	217.102	217.126	0.01105	0.000108	0.000137	26.8519	0.07805	0.10105	29.4683
Max	220.134	220.201	0.03044	0.000232	0.000278	19.8276	0.15928	0.19889	24.8682
Avg	218.655	218.684	0.01349	0.000131	0.000167	27.8075	0.09409	0.12196	29.6209

* *印加電圧: 450Vdc

No.	Leakage current (uA)					
	Before Test	After 200 hr	After 400 hr	After 600 hr	After 800 hr	After 1000 hr
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1

* *印加電圧: 450Vdc

No.	Leakage current (uA)					
	Before Test	After 200 hr	After 400 hr	After 600 hr	After 800 hr	After 1000 hr
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1

* *印加電圧: 720Vdc

Original sample			After the high temperature test sample		
No.	Leakage current (uA)	Withstanding voltage (PASS/FAIL)	No.	Leakage current (uA)	Withstanding voltage (PASS/FAIL)
1	1	PASS	11	1	PASS
2	1	PASS	12	1	PASS
3	1	PASS	13	1	PASS
4	1	PASS	14	1	PASS
5	1	PASS	15	1	PASS
6	1	PASS			
7	1	PASS			
8	1	PASS			
9	1	PASS			
10	1	PASS			

* *印加電圧: 100Vdc

Original sample		After the high temperature test sample	
No.	Insulation resistance(GΩ)	No.	Insulation resistance(GΩ)
1	Over 99.9	11	Over 99.9
2	Over 99.9	12	Over 99.9
3	Over 99.9	13	Over 99.9
4	Over 99.9	14	Over 99.9
5	Over 99.9	15	Over 99.9
6	Over 99.9		
7	Over 99.9		
8	Over 99.9		
9	Over 99.9		
10	Over 99.9		

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	207.371	206.505	-0.41761	-0.000115	-0.000119	3.47826	-0.73083	-0.77023	5.39113
2	210.007	208.758	-0.59474	-0.000116	-0.000120	3.44828	-0.73170	-0.75178	2.74429
3	209.176	208.115	-0.50723	-0.000115	-0.000122	6.08696	-0.72943	-0.75321	3.26008
4	212.176	211.264	-0.42983	-0.000114	-0.000120	5.26316	-0.72209	-0.74004	2.48584
5	212.703	211.828	-0.41137	-0.000112	-0.000116	3.57143	-0.72246	-0.74404	2.98702
6	209.557	208.713	-0.40275	-0.000117	-0.000117	0.00000	-0.73592	-0.72963	-0.85471
7	211.718	210.743	-0.46052	-0.000113	-0.000116	2.65487	-0.72049	-0.74054	2.78283
8	212.054	210.599	-0.68615	-0.000115	-0.000119	3.47826	-0.72129	-0.74642	3.48404
9	214.435	213.416	-0.47520	-0.000115	-0.000113	-1.73913	-0.71024	-0.71740	1.00811
10	212.055	211.004	-0.49563	-0.000119	-0.000118	-0.84034	-0.73249	-0.77065	5.20963
Min	207.371	206.505	-0.41761	-0.000119	-0.000122	2.52101	-0.73592	-0.77065	4.71926
Max	214.435	213.416	-0.47520	-0.000112	-0.000113	0.89286	-0.71024	-0.71740	1.00811
Avg	211.125	210.095	-0.48819	-0.000115	-0.000118	2.51955	-0.72569	-0.74639	2.85244

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	210.558	210.429	-0.06127	-0.000114	-0.000121	6.14035	-0.73936	-0.77546	4.88260
2	214.768	214.589	-0.08335	-0.000111	-0.000119	7.20721	-0.68381	-0.72095	5.43133
3	212.996	212.885	-0.05211	-0.000116	-0.000121	4.31034	-0.69872	-0.75533	8.10196
4	210.843	210.701	-0.06735	-0.000118	-0.000126	6.77966	-0.71841	-0.77700	8.15551
5	213.088	212.994	-0.04411	-0.000115	-0.000126	9.56522	-0.72617	-0.79295	9.19619
6	209.914	209.828	-0.04097	-0.000117	-0.000123	5.12821	-0.72420	-0.78904	8.95333
7	212.978	212.877	-0.04742	-0.000112	-0.000118	5.35714	-0.68248	-0.74861	9.68966
8	214.387	214.241	-0.06810	-0.000112	-0.000119	6.25000	-0.68220	-0.73329	7.48901
9	212.674	212.603	-0.03338	-0.000114	-0.000121	6.14035	-0.69906	-0.75021	7.31697
10	209.136	208.970	-0.07937	-0.000115	-0.000125	8.69565	-0.72997	-0.77771	6.53999
Min	209.136	208.970	-0.07937	-0.000118	-0.000126	6.77966	-0.73936	-0.79295	7.24816
Max	214.768	214.589	-0.08335	-0.000111	-0.000118	6.30631	-0.68220	-0.72095	5.68015
Avg	212.134	212.012	-0.05775	-0.000114	-0.000122	6.55594	-0.70844	-0.76206	7.56834

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	210.419	210.240	-0.08507	-0.000108	-0.000107	-0.92593	-0.69671	-0.64915	-6.82637
2	211.380	211.217	-0.07711	-0.000108	-0.000104	-3.70370	-0.68346	-0.64652	-5.40485
3	211.597	211.401	-0.09263	-0.000104	-0.000097	-6.73077	-0.67157	-0.62678	-6.66945
4	212.872	212.724	-0.06953	-0.000101	-0.000096	-4.95050	-0.62472	-0.58324	-6.63977
5	214.572	214.423	-0.06944	-0.000107	-0.000099	-7.47664	-0.66776	-0.62365	-6.60567
6	213.866	213.636	-0.10754	-0.000102	-0.000101	-0.98039	-0.64934	-0.61805	-4.81874
7	215.067	214.865	-0.09392	-0.000108	-0.000098	-9.25926	-0.65297	-0.62562	-4.18855
8	211.344	211.140	-0.09653	-0.000107	-0.000106	-0.93458	-0.66630	-0.65201	-2.14468
9	211.257	211.075	-0.08615	-0.000110	-0.000105	-4.54545	-0.67370	-0.66242	-1.67434
10	212.036	211.824	-0.09998	-0.000111	-0.000106	-4.50450	-0.66176	-0.65778	-0.60143
Min	210.419	210.240	-0.08507	-0.000111	-0.000107	-3.60360	-0.69671	-0.66242	-4.92170
Max	215.067	214.865	-0.09392	-0.000101	-0.000096	-4.95050	-0.62472	-0.58324	-6.63977
Avg	212.441	212.255	-0.08779	-0.000107	-0.000102	-4.40901	-0.66483	-0.63452	-4.55862

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	209.269	209.122	-0.07024	-0.000107	-0.000123	14.9533	-0.69211	-0.75203	8.65758
2	213.210	213.085	-0.05863	-0.000110	-0.000123	11.8182	-0.68729	-0.73762	7.32296
3	213.131	213.074	-0.02674	-0.000103	-0.000115	11.6505	-0.64194	-0.71237	10.9714
4	213.376	213.304	-0.03374	-0.000108	-0.000122	12.9630	-0.66086	-0.74880	13.3069
5	212.867	212.706	-0.07563	-0.000106	-0.000115	8.49057	-0.66755	-0.73512	10.1221
6	214.736	214.588	-0.06892	-0.000109	-0.000118	8.25688	-0.65016	-0.73489	13.0322
7	213.902	213.763	-0.06498	-0.000104	-0.000117	12.5000	-0.64111	-0.72354	12.8574
8	208.741	208.573	-0.08048	-0.000104	-0.000117	12.5000	-0.67896	-0.74629	9.91664
9	215.669	215.522	-0.06816	-0.000104	-0.000119	14.4231	-0.65770	-0.73287	11.4292
10	211.520	211.465	-0.02600	-0.000108	-0.000123	13.8889	-0.69605	-0.75990	9.17319
Min	208.741	208.573	-0.08048	-0.000110	-0.000123	11.8182	-0.69605	-0.75990	9.17319
Max	215.669	215.522	-0.06816	-0.000103	-0.000115	11.6505	-0.64111	-0.71237	11.1151
Avg	212.642	212.520	-0.05733	-0.000106	-0.000119	12.1355	-0.66737	-0.73834	10.6342

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	214.216	214.176	-0.01867	-0.000107	-0.000074	6.14035	-0.66617	-0.44008	4.88260
2	212.608	212.644	0.01693	-0.000113	-0.000081	7.20721	-0.70307	-0.47437	5.43133
3	213.286	213.131	-0.07267	-0.000114	-0.000066	4.31034	-0.71932	-0.41823	8.10196
4	213.406	213.299	-0.05014	-0.000115	-0.000076	6.77966	-0.71658	-0.47299	8.15551
5	210.148	210.164	0.00761	-0.000112	-0.000077	9.56522	-0.70959	-0.50818	9.19619
6	208.904	208.899	-0.00239	-0.000113	-0.000080	5.12821	-0.71063	-0.48766	8.95333
7	211.601	211.608	0.00331	-0.000112	-0.000076	5.35714	-0.69652	-0.47373	9.68966
8	215.164	215.199	0.01627	-0.000114	-0.000080	6.25000	-0.69281	-0.48481	7.48901
9	213.763	213.793	0.01403	-0.000115	-0.000078	6.14035	-0.70388	-0.47465	7.31697
10	211.668	211.712	0.02079	-0.000117	-0.000076	8.69565	-0.70485	-0.46177	6.53999
Min	208.904	208.899	-0.00239	-0.000117	-0.000081	6.77966	-0.71932	-0.50818	7.24816
Max	215.164	215.199	0.01627	-0.000107	-0.000066	6.30631	-0.66617	-0.41823	5.68015
Avg	212.476	212.463	-0.00654	-0.000113	-0.000076	6.55594	-0.70234	-0.46965	7.56834

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	207.309	206.446	-0.41629	0.000146	0.000155	6.16438	0.11082	0.12059	8.81610
2	209.955	208.702	-0.59679	0.000149	0.000164	10.06711	0.11346	0.12078	6.45161
3	209.107	208.066	-0.49783	0.000150	0.000156	4.00000	0.11081	0.11883	7.23761
4	212.120	211.201	-0.43325	0.000153	0.000161	5.22876	0.11493	0.12227	6.38650
5	212.608	211.787	-0.38616	0.000146	0.000155	6.16438	0.10776	0.11682	8.40757
6	209.489	208.646	-0.40241	0.000154	0.000171	11.03896	0.11840	0.12763	7.79561
7	211.664	210.674	-0.46772	0.000152	0.000164	7.89474	0.11490	0.12520	8.96432
8	211.992	210.513	-0.69767	0.000151	0.000155	2.64901	0.11156	0.11812	5.88024
9	214.374	213.366	-0.47021	0.000153	0.000163	6.53595	0.11379	0.12049	5.88804
10	211.998	210.939	-0.49953	0.000149	0.000158	6.04027	0.11022	0.11860	7.60298
Min	207.309	206.446	-0.41629	0.000146	0.000155	6.16438	0.10776	0.11682	8.40757
Max	214.374	213.366	-0.47021	0.000154	0.000171	11.03896	0.11840	0.12763	7.79561
Avg	211.062	210.034	-0.48687	0.000150	0.000160	6.58683	0.11267	0.12093	7.33857

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	210.506	210.360	-0.06936	0.000146	0.000142	-2.73973	0.11109	0.10847	-2.35845
2	214.701	214.553	-0.06893	0.000153	0.000147	-3.92157	0.11395	0.10828	-4.97587
3	212.942	212.828	-0.05354	0.000151	0.000148	-1.98675	0.11208	0.10895	-2.79265
4	210.784	210.651	-0.06310	0.000154	0.000145	-5.84416	0.11694	0.11155	-4.60920
5	213.019	212.938	-0.03802	0.000148	0.000140	-5.40541	0.10985	0.10375	-5.55303
6	209.858	209.766	-0.04384	0.000151	0.000144	-4.63576	0.11352	0.10921	-3.79669
7	212.921	212.801	-0.05636	0.000154	0.000147	-4.54545	0.11535	0.11025	-4.42133
8	214.328	214.186	-0.06625	0.000152	0.000146	-3.94737	0.11508	0.10829	-5.90024
9	212.618	212.542	-0.03574	0.000149	0.000144	-3.35570	0.11239	0.10624	-5.47202
10	209.075	208.915	-0.07653	0.000151	0.000145	-3.97351	0.11615	0.11003	-5.26905
Min	209.075	208.915	-0.07653	0.000146	0.000140	-4.10959	0.10985	0.10375	-5.55303
Max	214.701	214.553	-0.06893	0.000154	0.000148	-3.89610	0.11694	0.11155	-4.60920
Avg	212.075	211.954	-0.05715	0.000151	0.000145	-4.04241	0.11364	0.10850	-4.52130

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	210.348	210.192	-0.07416	0.000141	0.000162	14.89362	0.10752	0.12492	16.18304
2	211.322	211.140	-0.08612	0.000147	0.000168	14.28571	0.11117	0.12504	12.47639
3	211.541	211.335	-0.09738	0.000146	0.000169	15.75342	0.11103	0.12857	15.79753
4	212.798	212.657	-0.06626	0.000151	0.000173	14.56954	0.11370	0.13093	15.15391
5	214.515	214.362	-0.07132	0.000142	0.000165	16.19718	0.10687	0.12322	15.29896
6	213.795	213.578	-0.10150	0.000144	0.000165	14.58333	0.10960	0.12355	12.72810
7	215.023	214.810	-0.09906	0.000143	0.000167	16.78322	0.10616	0.12486	17.61492
8	211.273	211.068	-0.09703	0.000146	0.000171	17.12329	0.10979	0.12603	14.79188
9	211.209	211.016	-0.09138	0.000144	0.000165	14.58333	0.10799	0.12377	14.61246
10	211.961	211.764	-0.09294	0.000148	0.000171	15.54054	0.11113	0.12818	15.34239
Min	210.348	210.192	-0.07416	0.000141	0.000162	14.89362	0.10616	0.12322	16.07008
Max	215.023	214.810	-0.09906	0.000151	0.000173	14.56954	0.11370	0.13093	15.15391
Avg	212.379	212.192	-0.08772	0.000145	0.000168	15.42700	0.10950	0.12591	14.98776

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	209.214	209.029	-0.08843	0.000143	0.000162	13.2867	0.10883	0.12284	12.8733
2	213.148	213.062	-0.04035	0.000145	0.000161	11.0345	0.10846	0.12070	11.2853
3	213.080	213.014	-0.03097	0.000147	0.000166	12.9252	0.11045	0.12473	12.9289
4	213.305	213.254	-0.02391	0.000148	0.000164	10.8108	0.10976	0.12044	9.73032
5	212.814	212.626	-0.08834	0.000144	0.000165	14.5833	0.10882	0.12354	13.5269
6	214.664	214.561	-0.04798	0.000148	0.000163	10.1351	0.10971	0.12028	9.63449
7	213.855	213.694	-0.07528	0.000149	0.000167	12.0805	0.11199	0.12486	11.4921
8	208.665	208.552	-0.05415	0.000149	0.000166	11.4094	0.11372	0.12671	11.4228
9	215.622	215.447	-0.08116	0.000143	0.000164	14.6853	0.10686	0.12006	12.3526
10	211.455	211.402	-0.02506	0.000148	0.000164	10.8108	0.11016	0.12266	11.3471
Min	208.665	208.552	-0.05415	0.000143	0.000161	12.5874	0.10686	0.12006	12.3526
Max	215.622	215.447	-0.08116	0.000149	0.000167	12.0805	0.11372	0.12671	11.4228
Avg	212.582	212.464	-0.05555	0.000146	0.000164	12.1585	0.10988	0.12268	11.6550

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	214.138	214.095	-0.02008	0.000158	0.000179	13.2911	0.11742	0.13394	14.0692
2	212.558	212.584	0.01223	0.000151	0.000168	11.2583	0.11220	0.12633	12.5936
3	213.233	213.015	-0.10224	0.000147	0.000175	19.0476	0.11037	0.13250	20.0507
4	213.352	213.276	-0.03562	0.000148	0.000171	15.5405	0.11043	0.12727	15.2495
5	210.094	210.086	-0.00381	0.000149	0.000168	12.7517	0.11285	0.12518	10.9260
6	208.846	208.851	0.00239	0.000154	0.000172	11.6883	0.11674	0.13163	12.7548
7	211.539	211.528	-0.00520	0.000153	0.000176	15.0327	0.11617	0.13130	13.0240
8	215.093	215.125	0.01488	0.000152	0.000169	11.1842	0.11195	0.12399	10.7548
9	213.702	213.718	0.00749	0.000150	0.000167	11.3333	0.11168	0.12542	12.3030
10	211.614	211.641	0.01276	0.000149	0.000169	13.4228	0.11178	0.12772	14.2602
Min	208.846	208.851	0.00239	0.000147	0.000167	13.6054	0.11037	0.12399	12.3403
Max	215.093	215.125	0.01488	0.000158	0.000179	13.2911	0.11742	0.13394	14.0692
Avg	212.417	212.392	-0.01177	0.000151	0.000171	13.4348	0.11316	0.12853	13.5818

* *印加電圧: 450Vdc

No.	Leakage current (uA)					
	Before Test	After 200 hr	After 400 hr	After 600 hr	After 800 hr	After 1000 hr
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1

* *印加電圧: 450Vdc

No.	Leakage current (uA)					
	Before Test	After 200 hr	After 400 hr	After 600 hr	After 800 hr	After 1000 hr
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1

* *印加電圧: 720Vdc

Original sample			After the high temperature test sample		
No.	Leakage current (uA)	Withstanding voltage (PASS/FAIL)	No.	Leakage current (uA)	Withstanding voltage (PASS/FAIL)
1	1	PASS	11	1	PASS
2	1	PASS	12	1	PASS
3	1	PASS	13	1	PASS
4	1	PASS	14	1	PASS
5	1	PASS	15	1	PASS
6	1	PASS			
7	1	PASS			
8	1	PASS			
9	1	PASS			
10	1	PASS			

* *印加電圧: 100Vdc

Original sample		After the high temperature test sample	
No.	Insulation resistance(GΩ)	No.	Insulation resistance(GΩ)
1	Over 99.9	11	Over 99.9
2	Over 99.9	12	Over 99.9
3	Over 99.9	13	Over 99.9
4	Over 99.9	14	Over 99.9
5	Over 99.9	15	Over 99.9
6	Over 99.9		
7	Over 99.9		
8	Over 99.9		
9	Over 99.9		
10	Over 99.9		

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	211.630	211.761	0.06190	0.000342	0.000367	7.30994	2.14042	2.30155	7.52796
2	213.611	213.278	-0.15589	0.000056	0.000368	557.143	0.35049	2.29085	553.614
3	214.935	214.681	-0.11818	0.000082	0.000225	174.390	0.52093	1.37804	164.535
4	215.571	215.456	-0.05335	0.000078	0.000015	-80.7692	0.48025	0.11069	-76.9516
5	213.628	213.105	-0.24482	-0.000058	0.000101	-274.138	-0.37220	0.63487	-270.572
6	213.154	212.846	-0.14450	0.000099	0.000352	255.556	0.64283	2.20125	242.431
7	215.596	215.338	-0.11967	0.000085	0.000014	-83.5294	0.52332	0.07077	-86.4767
8	214.374	214.209	-0.07697	0.000065	-0.000011	-116.923	0.41015	-0.04204	-110.250
9	215.685	215.410	-0.12750	0.000123	0.000034	-72.3580	0.74485	0.20578	-72.3730
10	209.758	209.871	0.05387	0.000382	0.000290	-24.0838	2.40334	1.81817	-24.3482
Min	209.758	209.871	0.05387	-0.000058	-0.000011	-81.0345	-0.37220	-0.04204	-88.7050
Max	215.685	215.456	-0.10617	0.000382	0.000368	-3.66492	2.40334	2.30155	-4.23536
Avg	213.794	213.596	-0.09294	0.000125	0.000176	39.9522	0.78444	1.09699	39.8445

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	217.194	216.960	-0.10774	-0.000066	-0.000073	10.6061	-0.41436	-0.44502	7.39936
2	208.673	208.533	-0.06709	0.000333	0.000322	-3.30330	2.09857	2.05885	-1.89272
3	207.526	207.418	-0.05204	0.000426	0.000413	-3.05164	2.70634	2.63511	-2.63197
4	214.383	214.180	-0.09469	0.000111	0.000100	-9.90991	0.66955	0.62698	-6.35800
5	213.366	213.210	-0.07311	0.000274	0.000264	-3.64964	1.68324	1.64171	-2.46727
6	215.876	215.750	-0.05837	0.000028	0.000012	-57.1429	0.15851	0.10212	-35.5750
7	212.922	212.763	-0.07468	0.000105	0.000095	-9.52381	0.65426	0.59806	-8.58986
8	213.335	213.201	-0.06281	0.000063	0.000055	-12.6984	0.39611	0.33544	-15.3165
9	212.534	212.370	-0.07716	0.000231	0.000224	-3.03030	1.44921	1.39815	-3.52330
10	212.785	212.685	-0.04700	0.000094	0.000087	-7.44681	0.58727	0.53814	-8.36583
Min	207.526	207.418	-0.05204	-0.000066	-0.000073	10.6061	-0.41436	-0.44502	7.39936
Max	217.194	216.960	-0.10774	0.000426	0.000413	-3.05164	2.70634	2.63511	-2.63197
Avg	212.859	212.707	-0.07160	0.000160	0.000150	-6.25391	0.99887	0.94895	-4.99725

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	212.031	211.847	-0.08678	0.000214	0.000229	7.00935	1.34637	1.45342	7.95101
2	214.901	214.732	-0.07864	0.000159	0.000167	5.03145	0.98632	1.02810	4.23595
3	213.004	212.838	-0.07793	0.000173	0.000179	3.46821	1.05066	1.11010	5.65740
4	208.747	208.585	-0.07761	0.000082	0.000106	29.2683	0.52110	0.68654	31.7482
5	209.222	209.048	-0.08317	0.000235	0.000265	12.7660	1.48301	1.68151	13.3850
6	213.437	213.233	-0.09558	-0.000008	0.000003	-137.500	-0.03473	0.03303	-195.105
7	213.340	213.174	-0.07781	0.000106	0.000102	-3.77358	0.64249	0.63571	-1.05527
8	210.106	209.861	-0.11661	0.000190	0.000224	17.8947	1.20060	1.43310	19.3653
9	210.673	210.517	-0.07405	0.000066	0.000100	51.5152	0.43379	0.61964	42.8433
10	213.210	212.948	-0.12288	0.000146	0.000182	24.6575	0.91197	1.12957	23.8604
Min	208.747	208.585	-0.07761	-0.000008	0.000003	-137.500	-0.03473	0.03303	-195.105
Max	214.901	214.732	-0.07864	0.000235	0.000265	12.7660	1.48301	1.68151	13.3850
Avg	211.867	211.678	-0.08911	0.000136	0.000156	14.2333	0.85416	0.98107	14.8584

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	212.650	212.563	-0.04091	0.000059	0.000054	-8.47458	0.37101	0.31800	-14.2880
2	215.054	214.968	-0.03999	0.000066	0.000052	-21.2121	0.38349	0.31836	-16.9835
3	213.652	213.615	-0.01732	0.000321	0.000309	-3.73832	2.01045	1.94460	-3.27539
4	212.600	212.470	-0.06115	0.000052	0.000038	-26.9231	0.31026	0.25190	-18.8100
5	213.684	213.653	-0.01451	0.000063	0.000050	-20.6350	0.39152	0.29211	-25.3908
6	213.573	213.469	-0.04870	0.000104	0.000088	-15.3846	0.64255	0.58557	-8.86779
7	213.614	213.581	-0.01545	0.000040	0.000025	-37.5000	0.23577	0.15545	-34.0671
8	211.715	211.638	-0.03637	0.000133	0.000120	-9.77444	0.84545	0.75317	-10.9149
9	213.353	213.284	-0.03234	0.000034	0.000022	-35.2941	0.20323	0.12264	-39.6546
10	213.061	213.000	-0.02863	0.000175	0.000167	-4.57143	1.09066	1.02814	-5.73231
Min	211.715	211.638	-0.03637	0.000034	0.000022	-35.2941	0.20323	0.12264	-39.6546
Max	215.054	214.968	-0.03999	0.000321	0.000309	-3.73832	2.01045	1.94460	-3.27539
Avg	213.296	213.224	-0.03352	0.000105	0.000093	-11.6523	0.64844	0.57699	-11.0180

* 120 Hzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	213.078	213.102	0.01126	-0.000022	0.000086	-490.909	-0.13580	0.54346	-500.192
2	210.085	210.026	-0.02808	0.000015	0.000245	1533.33	0.08804	1.53238	1640.55
3	210.856	210.945	0.04221	0.000220	0.000418	90.0000	1.37685	2.61990	90.2822
4	210.635	210.720	0.04035	0.000192	0.000477	148.438	1.20946	3.02489	150.103
5	208.944	209.027	0.03972	0.000162	0.000423	161.111	1.03888	2.67674	157.656
6	212.697	212.694	-0.00141	0.000265	0.000458	72.8302	1.63808	2.85717	74.4219
7	214.799	214.961	0.07542	0.000142	0.000371	161.268	0.88670	2.28169	157.324
8	213.196	213.243	0.02205	0.000259	0.000459	77.2201	1.61333	2.84916	76.6012
9	213.518	213.559	0.01920	0.000242	0.000418	72.7273	1.48781	2.58113	73.4852
10	214.654	214.772	0.05497	0.000157	0.000265	68.7898	0.93445	1.61605	72.9413
Min	208.944	209.027	0.03972	-0.000022	0.000086	-490.909	-0.13580	0.54346	-500.192
Max	214.799	214.961	0.07542	0.000265	0.000477	80.0000	1.63808	3.02489	84.6607
Avg	212.246	212.305	0.02766	0.000163	0.000362	121.814	1.01378	2.25826	122.756

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	211.405	211.552	0.06953	0.000482	0.000678	40.6639	0.36481	0.51065	39.9770
2	213.524	213.069	-0.21309	0.000242	0.000518	114.050	0.17840	0.38675	116.788
3	214.840	214.528	-0.14522	0.000273	0.000458	67.7656	0.20256	0.34073	68.2119
4	215.455	215.331	-0.05755	0.000313	0.000281	-10.2236	0.22936	0.20626	-10.0715
5	213.546	213.005	-0.25334	0.000155	0.000272	75.4839	0.11701	0.20315	73.6176
6	213.061	212.639	-0.19807	0.000284	0.000537	89.0845	0.21192	0.40122	89.3262
7	215.466	215.251	-0.09978	0.000323	0.000273	-15.4799	0.24026	0.20337	-15.3542
8	214.282	214.100	-0.08493	0.000311	0.000254	-18.3280	0.23041	0.18764	-18.5626
9	215.551	215.309	-0.11227	0.000346	0.000298	-13.8728	0.25391	0.22216	-12.5044
10	209.552	209.678	0.06013	0.000545	0.000603	10.6422	0.41394	0.45717	10.4435
Min	209.552	209.678	0.06013	0.000155	0.000254	63.8710	0.11701	0.18764	60.3624
Max	215.551	215.331	-0.10206	0.000545	0.000678	24.4037	0.41394	0.51065	23.3633
Avg	213.668	213.446	-0.10390	0.000327	0.000417	27.4282	0.24426	0.31191	27.6969

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	217.124	216.840	-0.13080	0.000154	0.000156	1.29870	0.11241	0.11265	0.21350
2	208.503	208.360	-0.06858	0.000487	0.000487	0.00000	0.37239	0.37094	-0.38938
3	207.333	207.244	-0.04293	0.000564	0.000555	-1.59574	0.43382	0.43095	-0.66156
4	214.252	214.065	-0.08728	0.000297	0.000296	-0.33670	0.22248	0.21836	-1.85185
5	213.208	213.046	-0.07598	0.000452	0.000445	-1.54867	0.33795	0.33424	-1.09780
6	215.777	215.636	-0.06535	0.000216	0.000212	-1.85185	0.16116	0.15537	-3.59270
7	212.829	212.648	-0.08504	0.000271	0.000266	-1.84502	0.20079	0.20104	0.12451
8	213.225	213.089	-0.06378	0.000251	0.000252	0.39841	0.18954	0.18789	-0.87053
9	212.395	212.227	-0.07910	0.000428	0.000423	-1.16822	0.32046	0.31761	-0.88935
10	212.661	212.556	-0.04937	0.000331	0.000327	-1.20846	0.24879	0.24567	-1.25407
Min	207.333	207.244	-0.04293	0.000154	0.000156	1.29870	0.11241	0.11265	0.21350
Max	217.124	216.840	-0.13080	0.000564	0.000555	-1.59574	0.43382	0.43095	-0.66156
Avg	212.731	212.571	-0.07502	0.000345	0.000342	-0.92727	0.25998	0.25747	-0.96431

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	211.881	211.733	-0.06985	0.000374	0.000405	8.28877	0.28105	0.30743	9.38623
2	214.769	214.586	-0.08521	0.000354	0.000381	7.62712	0.26084	0.28341	8.65281
3	212.866	212.698	-0.07892	0.000326	0.000350	7.36196	0.24527	0.26053	6.22171
4	208.644	208.474	-0.08148	0.000254	0.000292	14.9606	0.19292	0.22256	15.3639
5	209.106	208.910	-0.09373	0.000361	0.000398	10.2493	0.27543	0.30438	10.5108
6	213.357	213.138	-0.10264	0.000183	0.000208	13.6612	0.13622	0.15551	14.1609
7	213.191	213.055	-0.06379	0.000323	0.000350	8.35913	0.24267	0.26305	8.39824
8	209.986	209.729	-0.12239	0.000335	0.000375	11.9403	0.25005	0.28371	13.4613
9	210.578	210.413	-0.07836	0.000240	0.000279	16.2500	0.18140	0.21194	16.8357
10	213.082	212.821	-0.12249	0.000311	0.000359	15.4341	0.22992	0.26887	16.9407
Min	208.644	208.474	-0.08148	0.000183	0.000208	13.6612	0.13622	0.15551	14.1609
Max	214.769	214.586	-0.08521	0.000374	0.000405	8.28877	0.28105	0.30743	9.38623
Avg	211.746	211.556	-0.08987	0.000306	0.000340	10.9768	0.22958	0.25614	11.5700

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	212.550	212.429	-0.05693	0.000232	0.000249	7.32759	0.17578	0.18776	6.81534
2	214.939	214.870	-0.03210	0.000243	0.000260	6.99588	0.18005	0.19294	7.15912
3	213.471	213.425	-0.02155	0.000490	0.000507	3.46939	0.36030	0.37903	5.19845
4	212.500	212.402	-0.04612	0.000225	0.000239	6.22222	0.16763	0.17833	6.38311
5	213.581	213.533	-0.02247	0.000291	0.000309	6.18557	0.21864	0.22923	4.84358
6	213.463	213.385	-0.03654	0.000267	0.000284	6.36704	0.19974	0.20922	4.74617
7	213.522	213.495	-0.01265	0.000222	0.000235	5.85586	0.16506	0.17620	6.74906
8	211.591	211.516	-0.03545	0.000295	0.000309	4.74576	0.22113	0.23239	5.09203
9	213.262	213.180	-0.03845	0.000213	0.000229	7.51174	0.15904	0.17175	7.99170
10	212.926	212.874	-0.02442	0.000337	0.000354	5.04451	0.25001	0.26281	5.11980
Min	211.591	211.516	-0.03545	0.000213	0.000229	7.51174	0.15904	0.17175	7.99170
Max	214.939	214.870	-0.03210	0.000490	0.000507	3.46939	0.36030	0.37903	5.19845
Avg	213.181	213.111	-0.03265	0.000282	0.000298	5.68384	0.20974	0.22197	5.83013

* 1 kHzで測定

No.	Capacitance (nF)			Tan (δ)			ESR (ohm)		
	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)	Before Test	After test	Change rate (%)
1	212.986	212.984	-0.00094	0.000181	0.000261	44.1989	0.13561	0.19401	43.0647
2	209.992	209.901	-0.04333	0.000216	0.000372	72.2222	0.16193	0.28260	74.5199
3	210.704	210.731	0.01281	0.000368	0.000559	51.9022	0.27876	0.42317	51.8044
4	210.512	210.531	0.00903	0.000327	0.000598	82.8746	0.24734	0.45309	83.1851
5	208.840	208.825	-0.00718	0.000308	0.000537	74.3506	0.23464	0.40926	74.4204
6	212.528	212.493	-0.01647	0.000420	0.000614	46.1905	0.31251	0.45873	46.7889
7	214.694	214.778	0.03913	0.000313	0.000532	69.9681	0.22932	0.39304	71.3937
8	213.029	213.031	0.00094	0.000423	0.000629	48.6998	0.31778	0.46830	47.3661
9	213.370	213.353	-0.00797	0.000407	0.000589	44.7174	0.30431	0.43909	44.2904
10	214.515	214.612	0.04522	0.000352	0.000493	40.0568	0.26067	0.36258	39.0954
Min	208.840	208.825	-0.00718	0.000181	0.000261	44.1989	0.13561	0.19401	43.0647
Max	214.694	214.778	0.03913	0.000423	0.000629	48.6998	0.31778	0.46830	47.3661
Avg	212.117	212.124	0.00325	0.000332	0.000518	56.3801	0.24829	0.38839	56.4266

* *印加電圧: 450Vdc

No.	Leakage current (uA)					
	Before Test	After 200 hr	After 400 hr	After 600 hr	After 800 hr	After 1000 hr
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1

* *印加電圧: 450Vdc

No.	Leakage current (uA)					
	Before Test	After 200 hr	After 400 hr	After 600 hr	After 800 hr	After 1000 hr
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	1	1	1	1
10	1	1	1	1	1	1

* *印加電圧: 720Vdc

Original sample			After the high temperature test sample		
No.	Leakage current (uA)	Withstanding voltage (PASS/FAIL)	No.	Leakage current (uA)	Withstanding voltage (PASS/FAIL)
1	1	PASS	11	1	PASS
2	1	PASS	12	1	PASS
3	1	PASS	13	1	PASS
4	1	PASS	14	1	PASS
5	1	PASS	15	1	PASS
6	1	PASS			
7	1	PASS			
8	1	PASS			
9	1	PASS			
10	1	PASS			

* *印加電圧: 100Vdc

Original sample		After the high temperature test sample	
No.	Insulation resistance(GΩ)	No.	Insulation resistance(GΩ)
1	Over 99.9	11	Over 99.9
2	Over 99.9	12	Over 99.9
3	Over 99.9	13	Over 99.9
4	Over 99.9	14	Over 99.9
5	Over 99.9	15	Over 99.9
6	Over 99.9		
7	Over 99.9		
8	Over 99.9		
9	Over 99.9		
10	Over 99.9		