

(2023.11.13. revised)

Comparison Evaluation of SMD type Aluminum Electrolytic Capacitors

面実装型電解コンデンサ試験結果報告Vol.1



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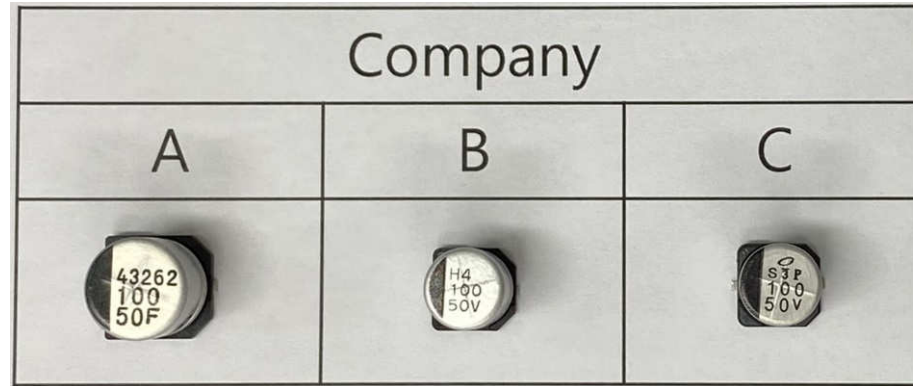
I. Introduction



Introduction

- **Specimen:** SMD Aluminum Electrolytic Capacitors
- **Test:**
 - Environmental test
 - Electrical characteristic evaluation
 - X-ray analyses
 - SEM analyses
- **Test term:** 2023. 08. 01. ~ 2023. 10. 31.
- **Test environment:** (25 ± 5) °C, Below 75% room humidity
- **Test apparatuses:**
 - Climate chamber (SXN403, ETAC, Japan)
 - Climatic chamber (C-480/70/20ESS, Weisstechnik, Germany)
 - Dew condensation test chamber (ShockEvent T/120/V2, Weisstechnik, Germany)
 - Vibration testing system (IPA120H/I537M, ETS Solution, China)
 - Precision LCR meter (4284A, Agilent, USA)
 - Withstanding voltage tester (TOS-9201, Kikusui, Japan)
 - Digital multimeter (34401A, KEYSIGHT, USA)
 - X-ray (XT V 160, Nikon, Japan)
 - Focused Ion Beam (Helios 5 UX, Thermo Fisher, USA)
- **Etc:** Blind test
- **Contact:** Lee, Ju Ho ☎ +82-31-789-7282 / leejuho@keti.re.kr

Specimens



| Sample | Capacitance (μF) ($\pm 10\%$) | Rated voltage (V_{DC}) | Capacitance tolerance (%) | Shelf life (Hr) | Operation Temp. ($^{\circ}\text{C}$) | Dimensions (mm) |
|--------|--|---|---------------------------------|-------------------------------------|---|---------------------|
| A | 100 | 50 | ± 20 | 1000 Hr at 105°C | -55 ~ +105 | $\Phi 10 \times 10$ |
| B | 100 | 50 | ± 20 | 1000 Hr at 105°C | -55 ~ +105 | $\Phi 8 \times 10$ |
| C | 100 | 50 | ± 20 | 1000 Hr at 105°C | -55 ~ +105 | $\Phi 8 \times 10$ |

- A社 : SAMWHA (韓国) (RC1H107M10010)
- B社 : SU'SCON (台湾) (CH050M101F10PKKKV00R)
- C社 : NICHICON (日本) (UWT1H101MNL1GS)

Introduction

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



Introduction

- **Test apparatuses:**
 - Climatic chamber (C-480/70/20ESS, Weisstechnik, Germany)



Introduction

- **Test apparatuses:**
 - Dew condensation test chamber (ShockEvent T/120/V2, Weisstechnik, Germany)



Introduction

- **Test apparatuses:**
 - Vibration testing system (IPA120H/1537M, ETS Solution, China)



Introduction

- **Test apparatuses:**
 - Precision LCR Meter (4284A, Agilent, USA)



Introduction

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



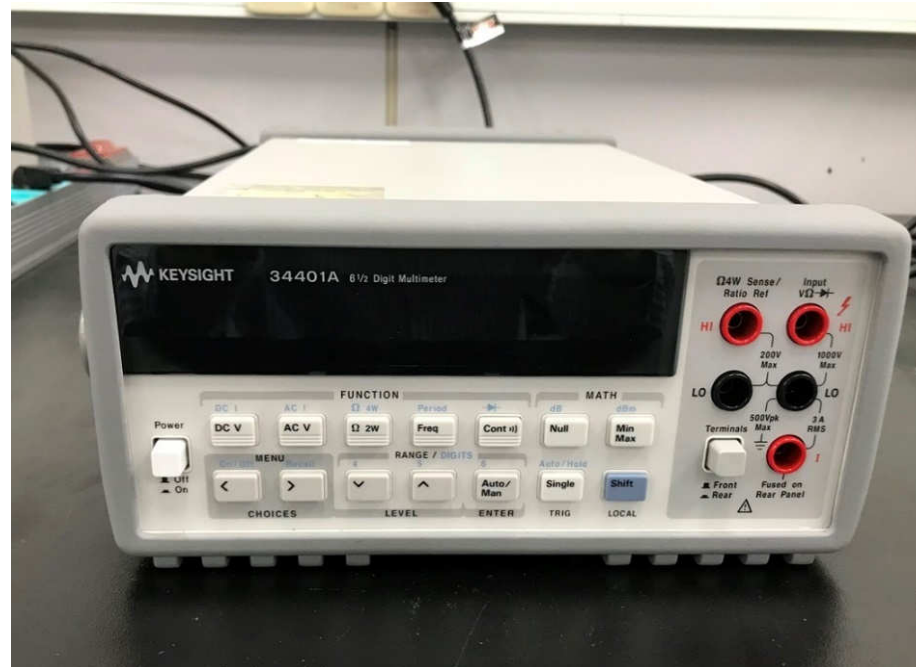
Introduction

- **Test apparatuses:**
 - DC power supply (OPE-503Q, ODA, Korea)



Introduction

- **Test apparatuses:**
 - Digital multimeter (34401A, KEYSIGHT, USA)



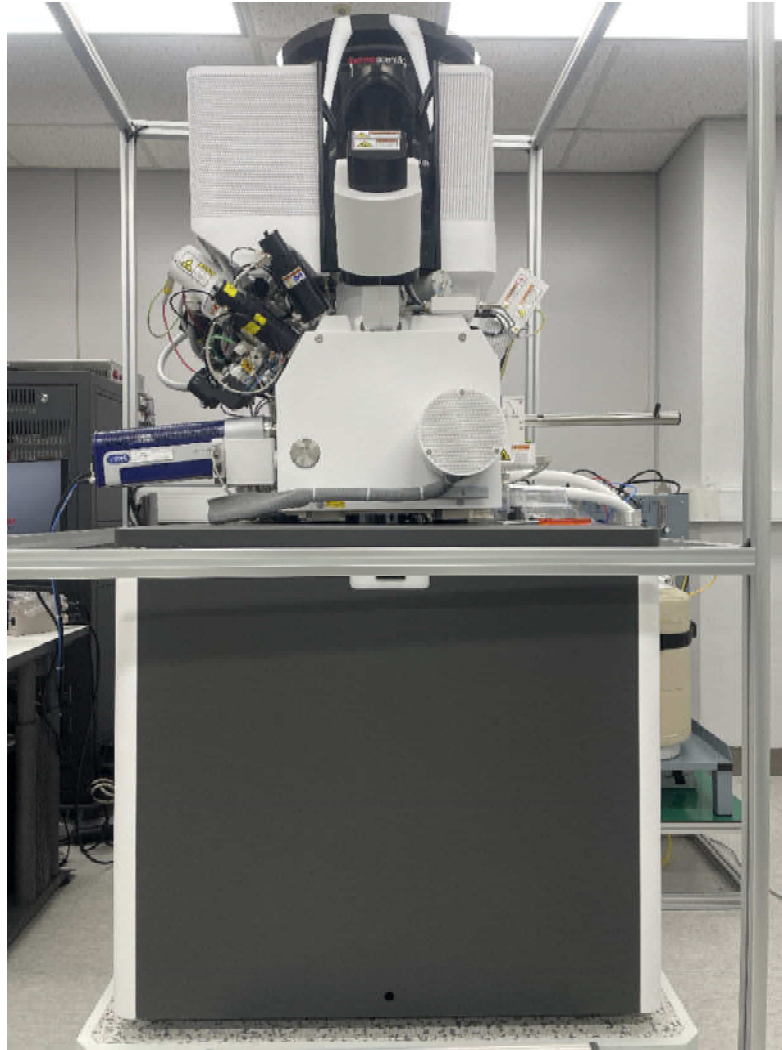
Introduction

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



Introduction

- **Test apparatuses:**
 - Focused Ion Beam (Helios 5 UX, Thermo Fisher, USA)



II. Environmental test (raw data, graphs)



Environmental test conditions

- **Test:**

- High temperature test: 105 °C, 16 hr
- Low temperature test: -55 °C, 2 hr
- Thermal shock test: (-55~105) °C, each 10 min., 15 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 | -0.56% | A1 | -0.26% | A1 | -0.36% | A1 | -0.11% | A1 | -0.12% |
| A2 | -0.37% | A2 | 0.07% | A2 | -0.12% | A2 | -0.15% | A2 | -0.54% |
| A3 | -0.79% | A3 | -0.10% | A3 | -0.14% | A3 | -0.02% | A3 | -0.09% |
| A4 | -0.65% | A4 | -0.06% | A4 | -0.02% | A4 | -0.11% | A4 | -0.21% |
| A5 | -0.59% | A5 | -0.02% | A5 | -0.08% | A5 | -0.23% | A5 | -0.12% |
| A6 | -0.57% | A6 | -0.07% | A6 | 0.09% | A6 | -0.14% | A6 | -0.27% |
| A7 | -0.64% | A7 | 0.21% | A7 | -0.10% | A7 | -0.03% | A7 | -0.13% |
| A8 | -0.73% | A8 | -0.27% | A8 | -0.04% | A8 | -0.19% | A8 | -0.18% |
| A9 | -0.61% | A9 | -0.03% | A9 | 0.00% | A9 | -0.15% | A9 | -0.13% |
| A10 | -0.59% | A10 | -0.06% | A10 | 0.07% | A10 | -0.19% | A10 | -0.19% |
| average | -0.61% | average | -0.06% | average | -0.07% | average | -0.13% | average | -0.20% |
| B1 | -0.56% | B1 | 0.03% | B1 | -0.36% | B1 | -0.11% | B1 | -0.12% |
| B2 | -0.57% | B2 | 0.06% | B2 | -0.12% | B2 | -0.15% | B2 | -0.54% |
| B3 | -0.66% | B3 | 0.02% | B3 | -0.14% | B3 | -0.02% | B3 | -0.09% |
| B4 | -0.33% | B4 | -0.06% | B4 | -0.02% | B4 | -0.11% | B4 | -0.21% |
| B5 | -0.65% | B5 | -0.17% | B5 | -0.08% | B5 | -0.23% | B5 | -0.12% |
| B6 | -0.26% | B6 | -0.02% | B6 | 0.09% | B6 | -0.14% | B6 | -0.27% |
| B7 | -0.33% | B7 | -0.03% | B7 | -0.10% | B7 | -0.03% | B7 | -0.13% |
| B8 | -0.58% | B8 | 0.03% | B8 | -0.04% | B8 | -0.19% | B8 | -0.18% |
| B9 | -0.51% | B9 | -0.20% | B9 | 0.00% | B9 | -0.15% | B9 | -0.13% |
| B10 | -0.44% | B10 | -0.03% | B10 | 0.07% | B10 | -0.19% | B10 | -0.19% |
| Average | -0.49% | Average | -0.04% | Average | -0.07% | Average | -0.13% | Average | -0.20% |
| C1 | -1.57% | C1 | -0.02% | C1 | -0.47% | C1 | -0.19% | C1 | -0.19% |
| C2 | -1.32% | C2 | -0.20% | C2 | -0.28% | C2 | -0.07% | C2 | -0.35% |
| C3 | -1.07% | C3 | -0.22% | C3 | -0.30% | C3 | -0.13% | C3 | -0.34% |
| C4 | -1.13% | C4 | -0.15% | C4 | -0.52% | C4 | -0.04% | C4 | -0.32% |
| C5 | -1.26% | C5 | -0.29% | C5 | -0.39% | C5 | -0.02% | C5 | -0.24% |
| C6 | -1.17% | C6 | -0.32% | C6 | -0.52% | C6 | -0.05% | C6 | -0.25% |
| C7 | -1.38% | C7 | -0.15% | C7 | -0.53% | C7 | -0.12% | C7 | -0.19% |
| C8 | -1.23% | C8 | -0.13% | C8 | -0.64% | C8 | -0.14% | C8 | -0.31% |
| C9 | -1.26% | C9 | -0.41% | C9 | -0.47% | C9 | -0.23% | C9 | -0.26% |
| C10 | -1.16% | C10 | -0.15% | C10 | -0.55% | C10 | -0.09% | C10 | -0.33% |
| average | -1.26% | average | -0.20% | average | -0.47% | average | -0.11% | average | -0.28% |

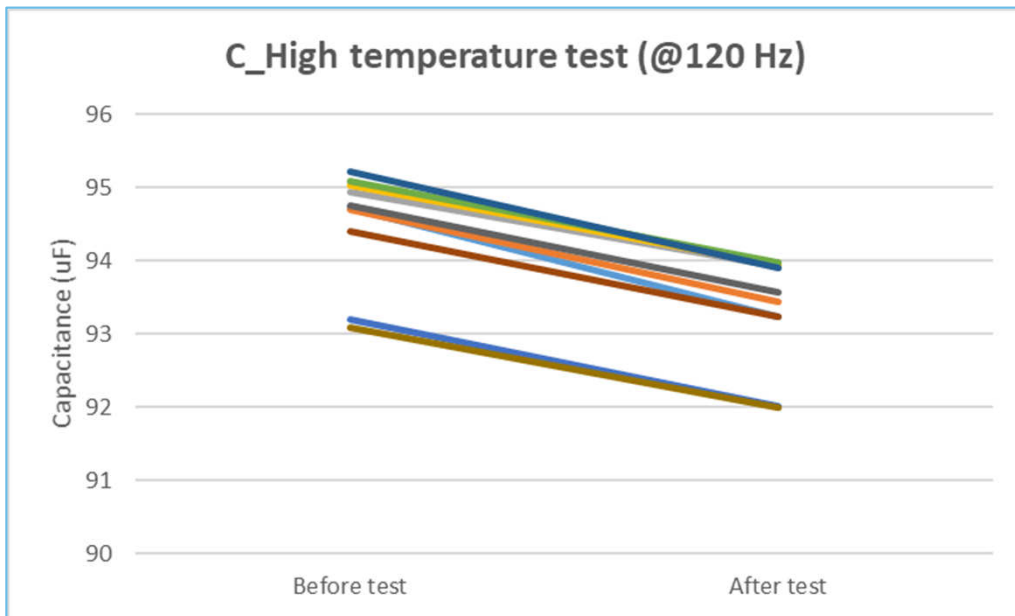
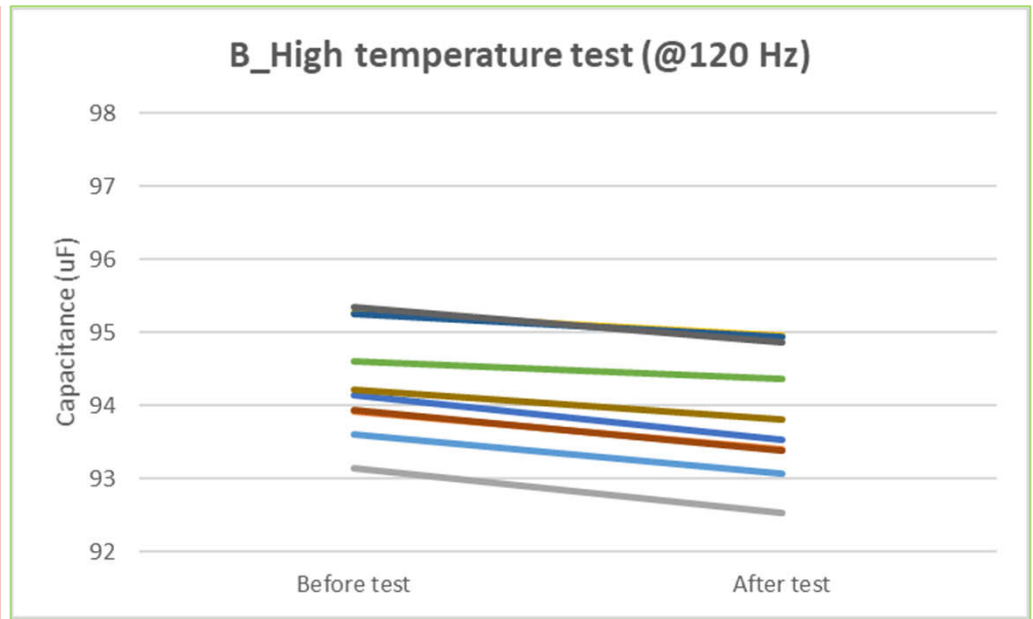
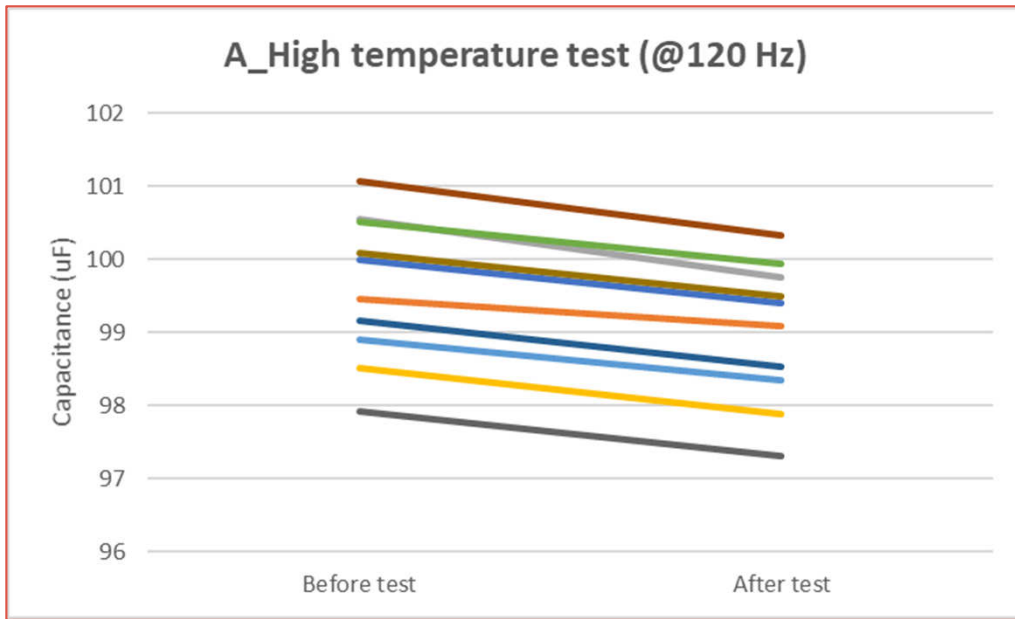
Summary

- 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 | 0.31% | A1 | -0.81% | A1 | -1.77% | A1 | -0.74% | A1 | -0.61% |
| A2 | 2.27% | A2 | -0.44% | A2 | -0.59% | A2 | -0.46% | A2 | -0.98% |
| A3 | -0.14% | A3 | -0.63% | A3 | -0.86% | A3 | -0.50% | A3 | -0.51% |
| A4 | -0.49% | A4 | -0.43% | A4 | -0.41% | A4 | -0.31% | A4 | -0.43% |
| A5 | -0.13% | A5 | -0.90% | A5 | -0.61% | A5 | -1.04% | A5 | -0.50% |
| A6 | 0.26% | A6 | -1.04% | A6 | -0.62% | A6 | -0.37% | A6 | -0.54% |
| A7 | -0.05% | A7 | -0.22% | A7 | -0.14% | A7 | -0.64% | A7 | -0.58% |
| A8 | 0.19% | A8 | -0.84% | A8 | -0.76% | A8 | -0.54% | A8 | -0.53% |
| A9 | 0.15% | A9 | -0.51% | A9 | -0.96% | A9 | -0.78% | A9 | -0.45% |
| A10 | 0.10% | A10 | -0.51% | A10 | -0.33% | A10 | -0.55% | A10 | -0.42% |
| average | 0.25% | average | -0.63% | average | -0.70% | average | -0.59% | average | -0.55% |
| B1 | 0.62% | B1 | 0.09% | B1 | -0.25% | B1 | -0.09% | B1 | 0.31% |
| B2 | 0.61% | B2 | 0.06% | B2 | -0.35% | B2 | -0.35% | B2 | -0.18% |
| B3 | 0.27% | B3 | 0.19% | B3 | 0.32% | B3 | -0.19% | B3 | 0.02% |
| B4 | 0.74% | B4 | 0.01% | B4 | 0.09% | B4 | -0.12% | B4 | -0.22% |
| B5 | 0.74% | B5 | -0.34% | B5 | 0.10% | B5 | -0.11% | B5 | -0.15% |
| B6 | 0.96% | B6 | -0.37% | B6 | 0.14% | B6 | -0.16% | B6 | -0.15% |
| B7 | 1.06% | B7 | -0.12% | B7 | -0.20% | B7 | -0.06% | B7 | 0.12% |
| B8 | 0.63% | B8 | -0.39% | B8 | -0.34% | B8 | -0.13% | B8 | -0.32% |
| B9 | 0.92% | B9 | -0.41% | B9 | 0.24% | B9 | 0.00% | B9 | -0.03% |
| B10 | 0.74% | B10 | -0.54% | B10 | -1.05% | B10 | -0.16% | B10 | -0.74% |
| Average | 0.73% | Average | -0.18% | Average | -0.13% | Average | -0.14% | Average | -0.13% |
| C1 | -0.68% | C1 | -0.92% | C1 | -0.38% | C1 | -0.40% | C1 | 0.08% |
| C2 | 0.15% | C2 | -0.41% | C2 | 1.20% | C2 | -0.43% | C2 | -0.81% |
| C3 | 0.49% | C3 | -2.12% | C3 | 0.63% | C3 | -0.40% | C3 | -0.68% |
| C4 | -0.15% | C4 | -0.17% | C4 | 0.20% | C4 | -0.31% | C4 | -1.14% |
| C5 | 1.40% | C5 | -3.08% | C5 | 0.15% | C5 | 0.03% | C5 | -0.25% |
| C6 | 0.06% | C6 | -0.66% | C6 | 1.05% | C6 | 0.18% | C6 | -2.08% |
| C7 | -0.13% | C7 | -1.44% | C7 | -0.26% | C7 | -0.57% | C7 | -1.15% |
| C8 | -0.24% | C8 | -1.42% | C8 | 0.42% | C8 | -0.25% | C8 | -0.38% |
| C9 | 0.80% | C9 | -1.39% | C9 | -0.14% | C9 | -0.66% | C9 | -0.94% |
| C10 | -0.41% | C10 | -1.13% | C10 | 0.91% | C10 | -0.16% | C10 | 0.03% |
| average | 0.13% | average | -1.27% | average | 0.38% | average | -0.30% | average | -0.73% |

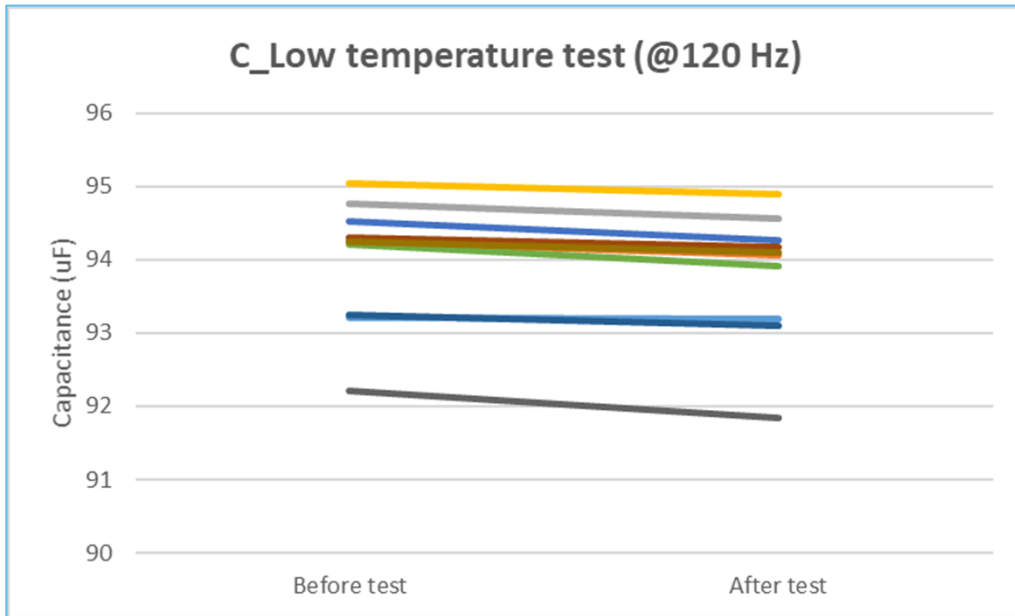
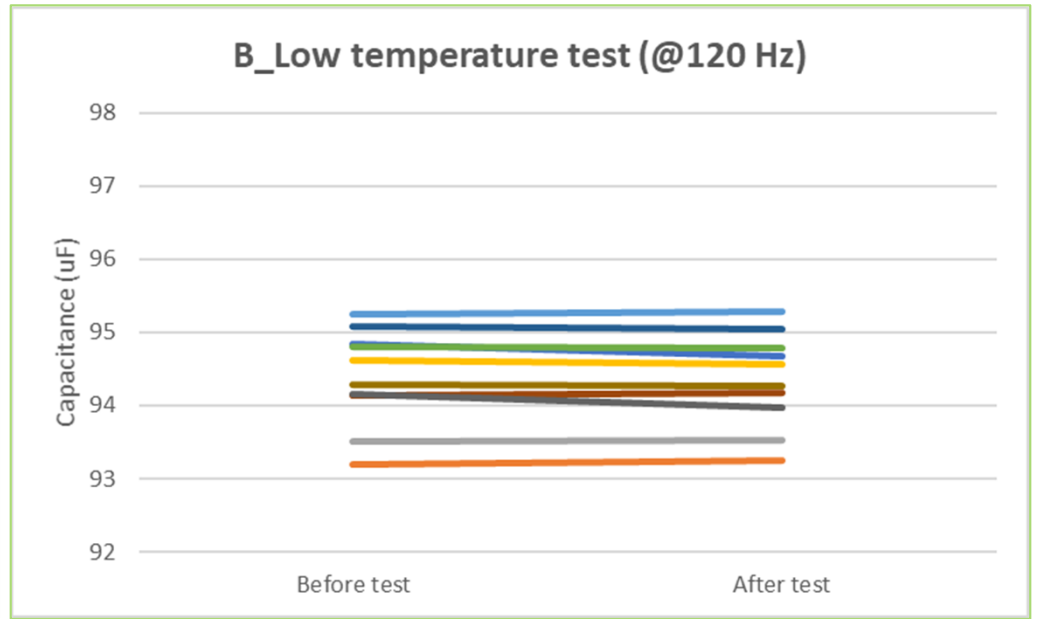
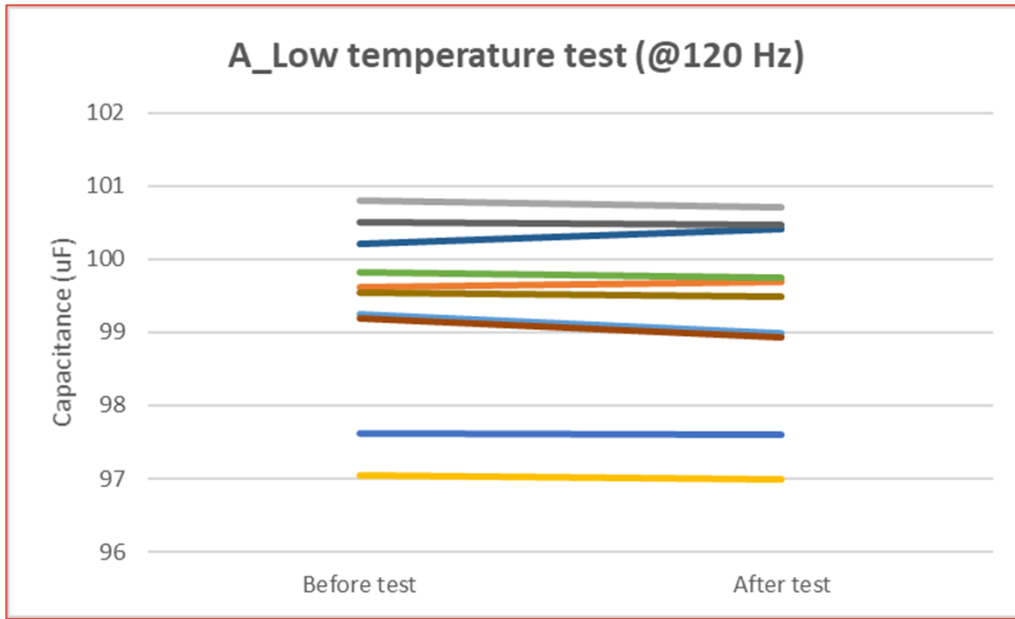
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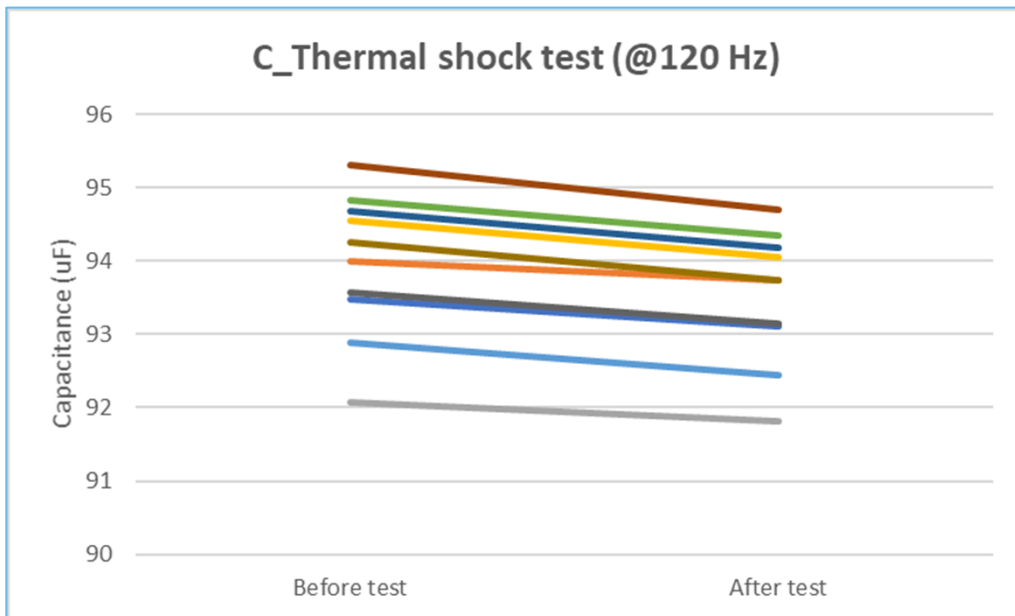
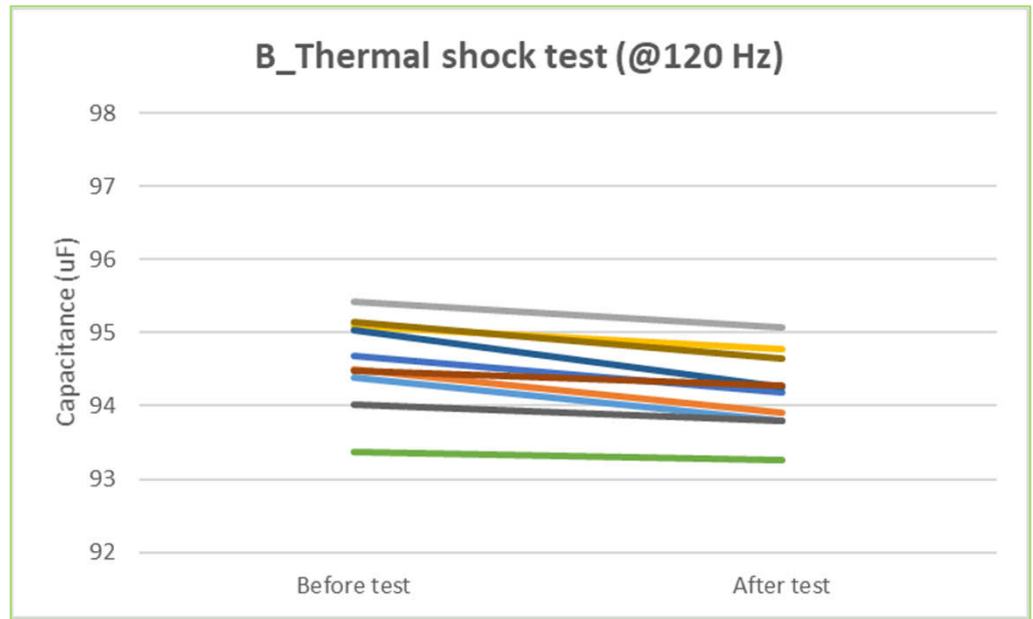
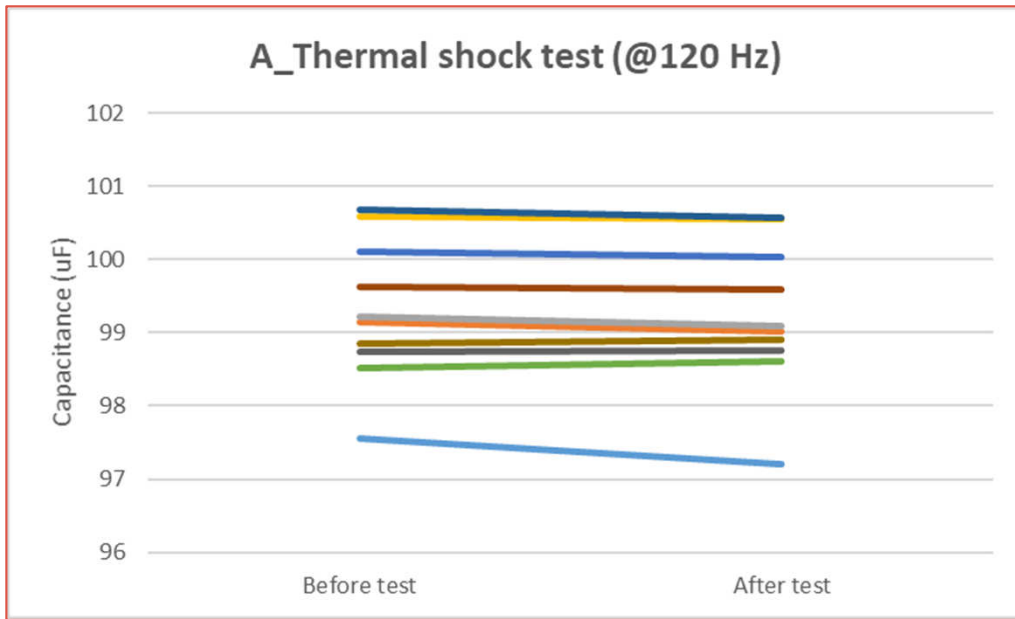
High temperature test_Capacitance (uF) @120 Hz

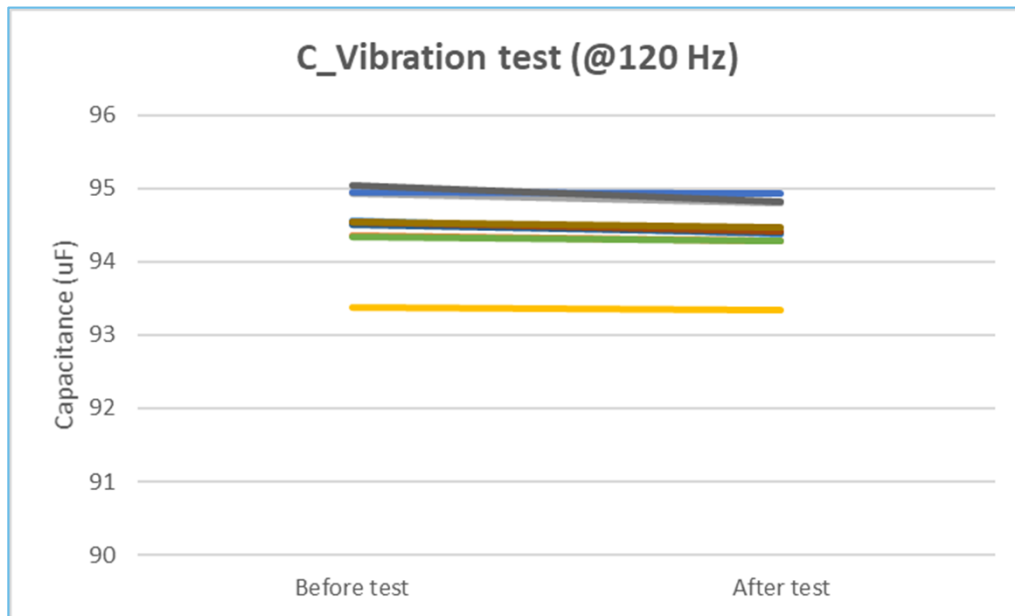
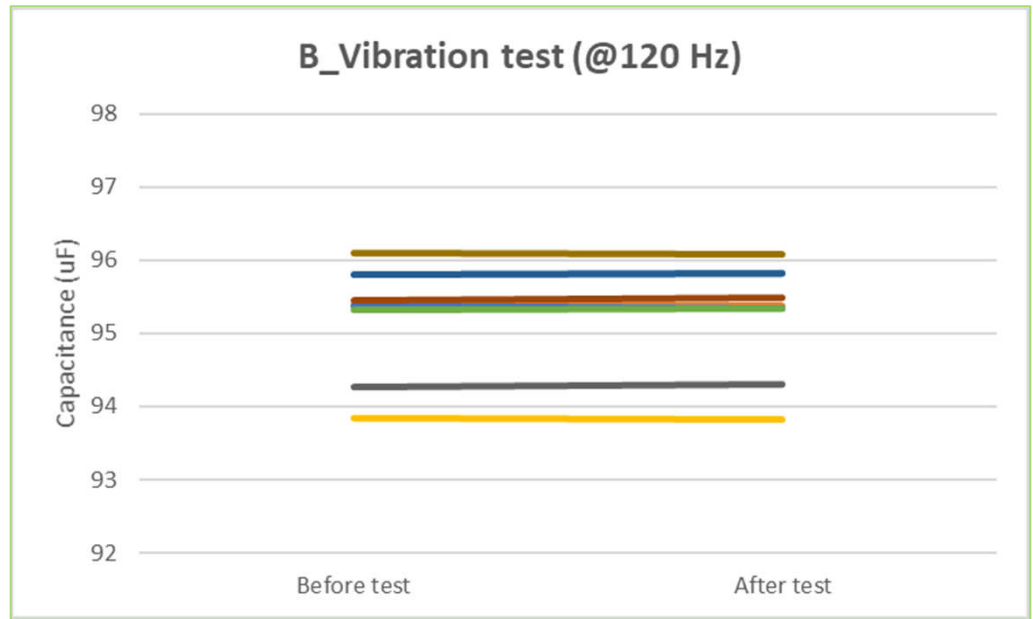
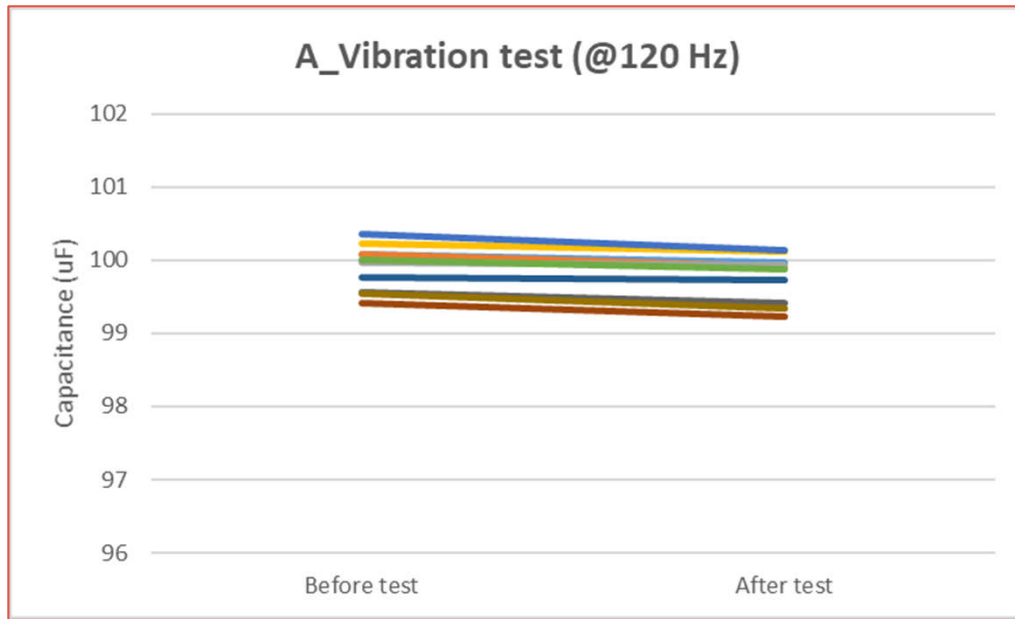


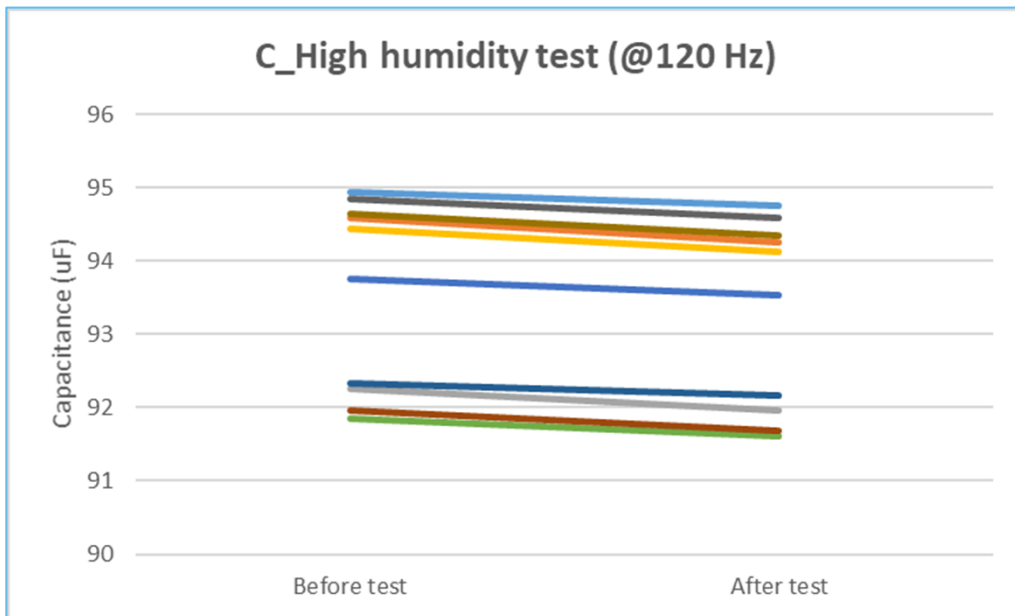
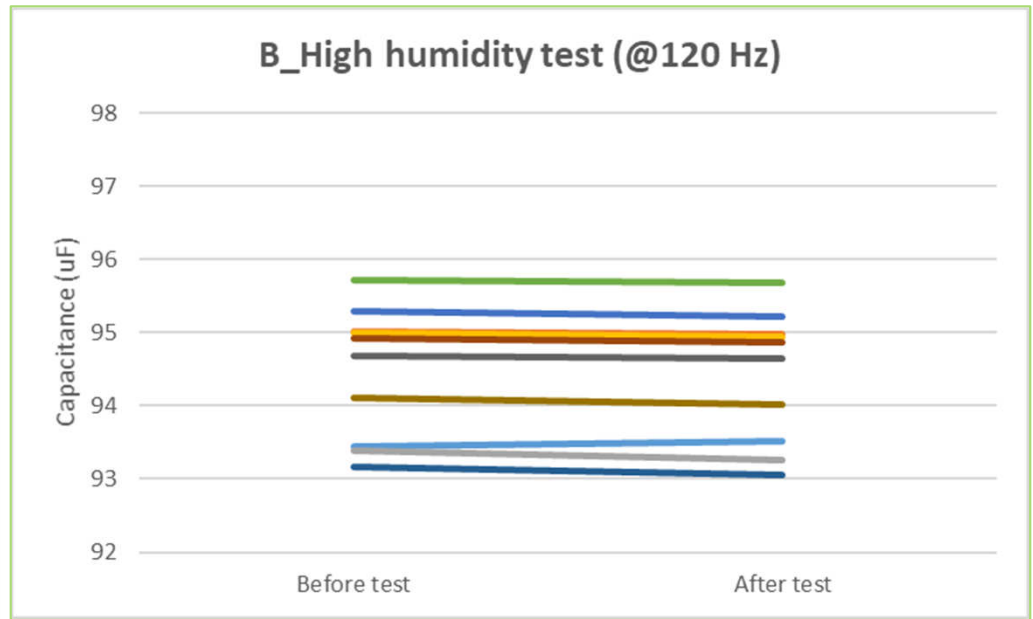
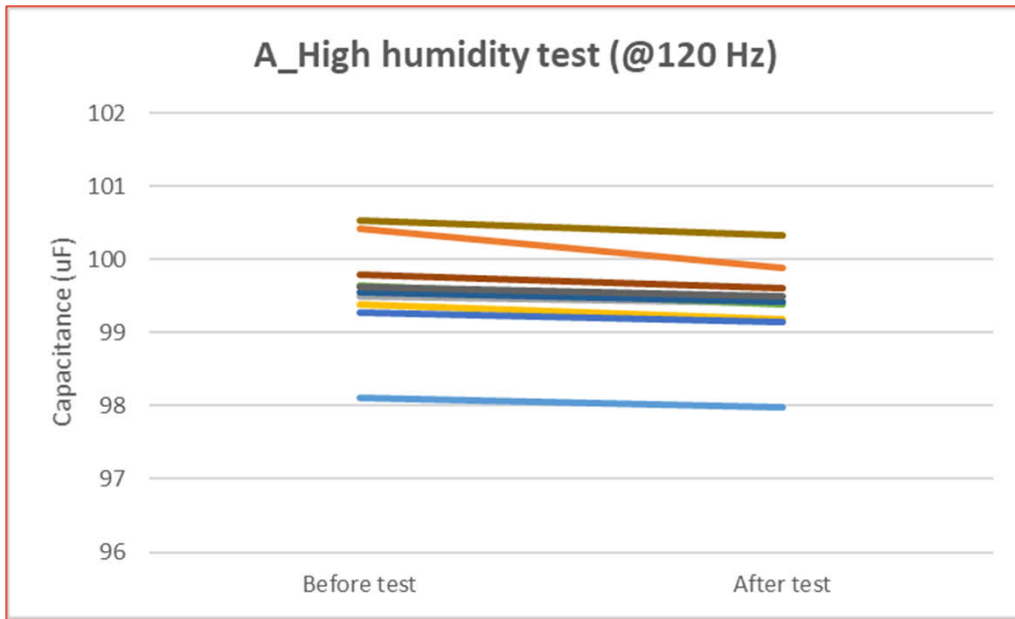
Summary

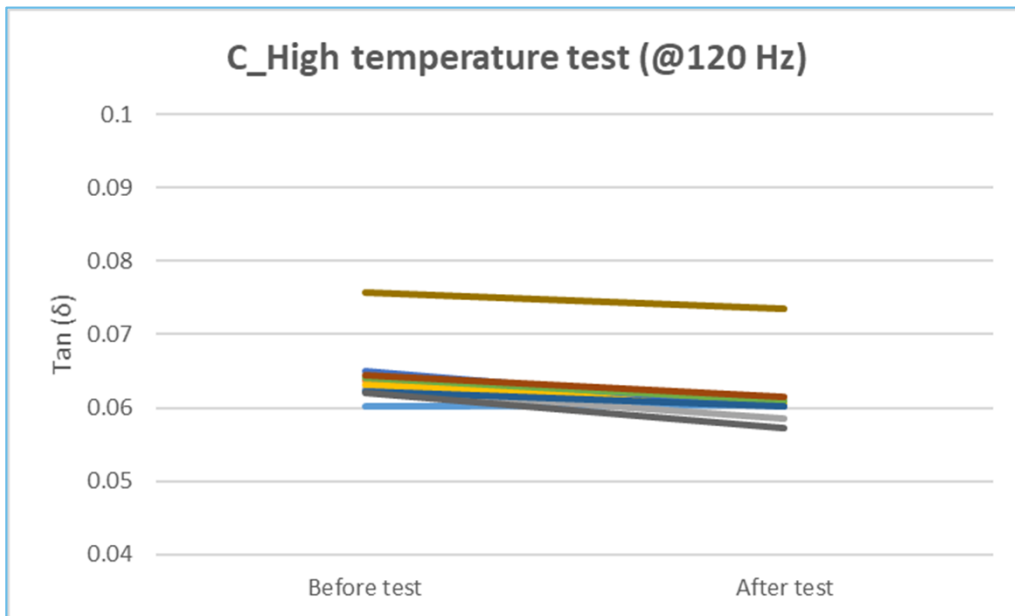
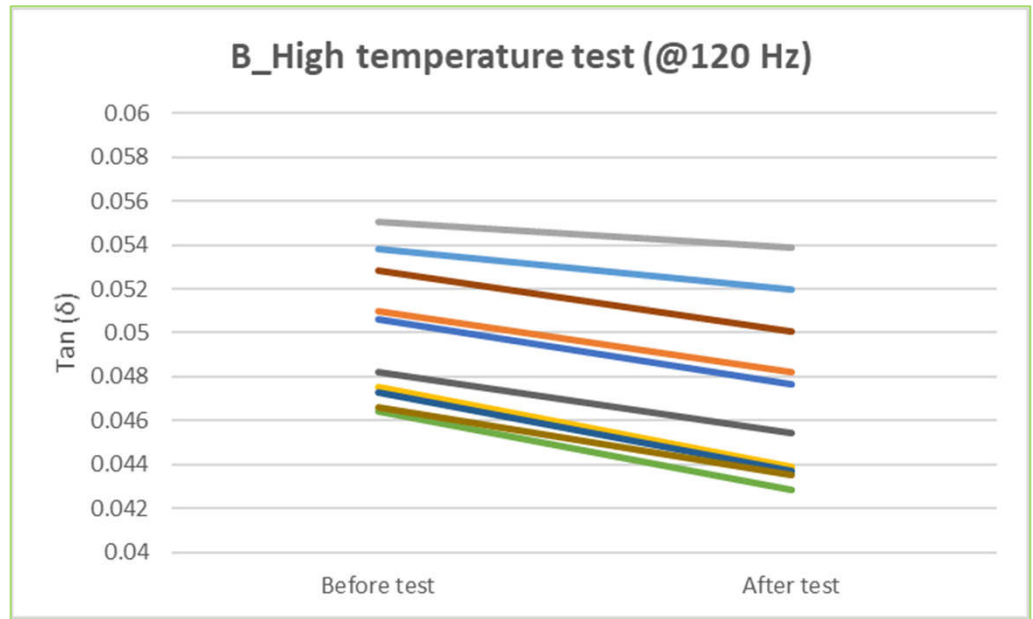
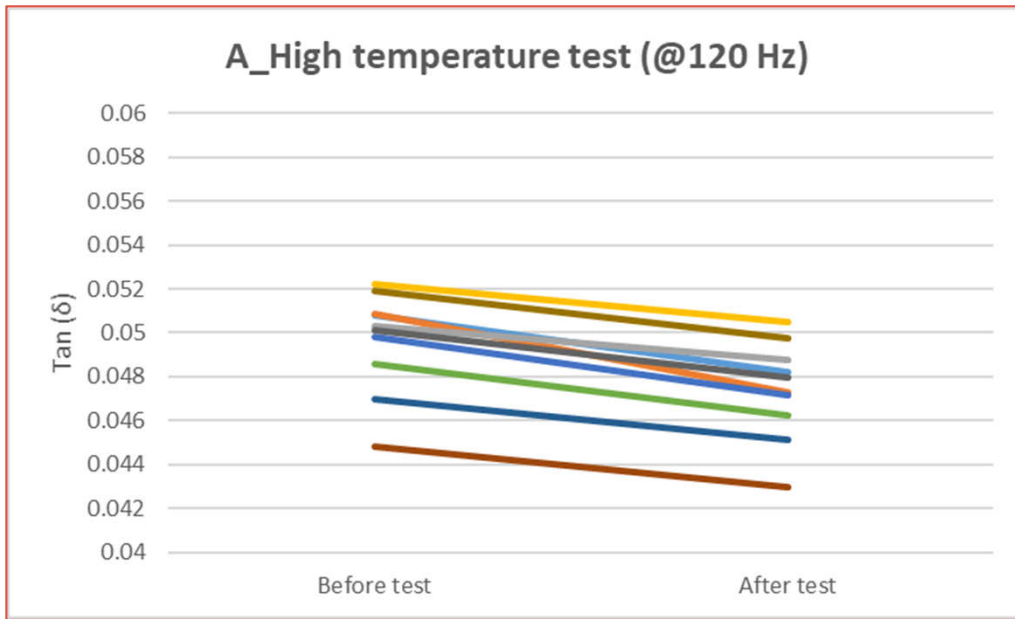
Low temperature test_Capacitance (uF) @120 Hz

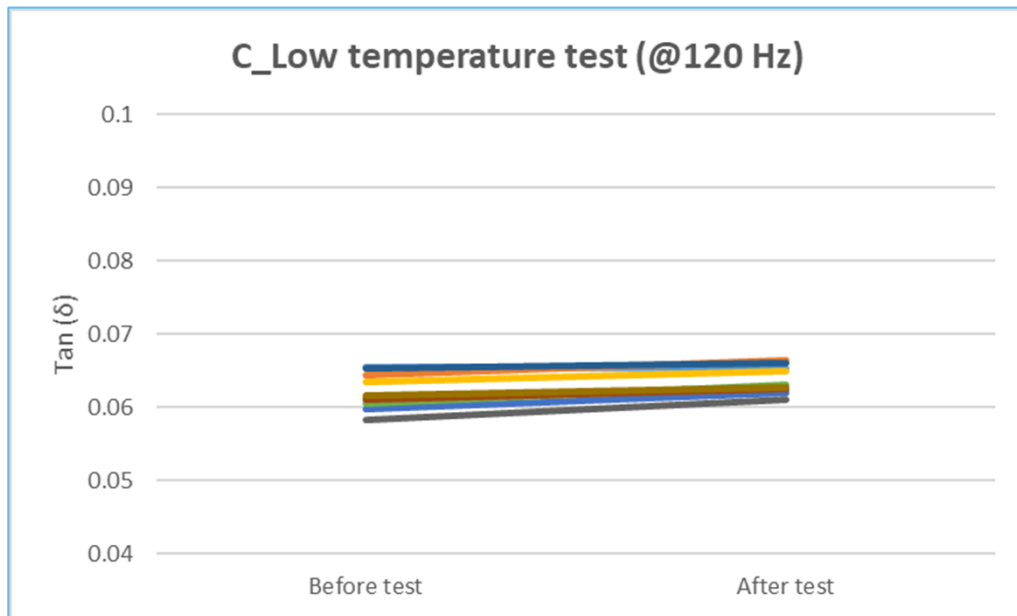
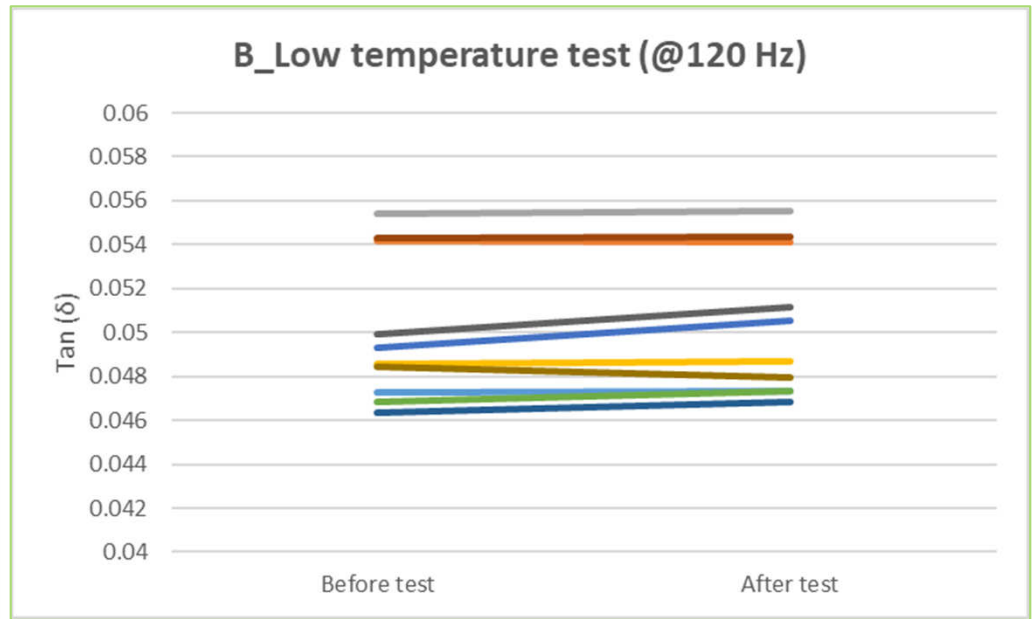
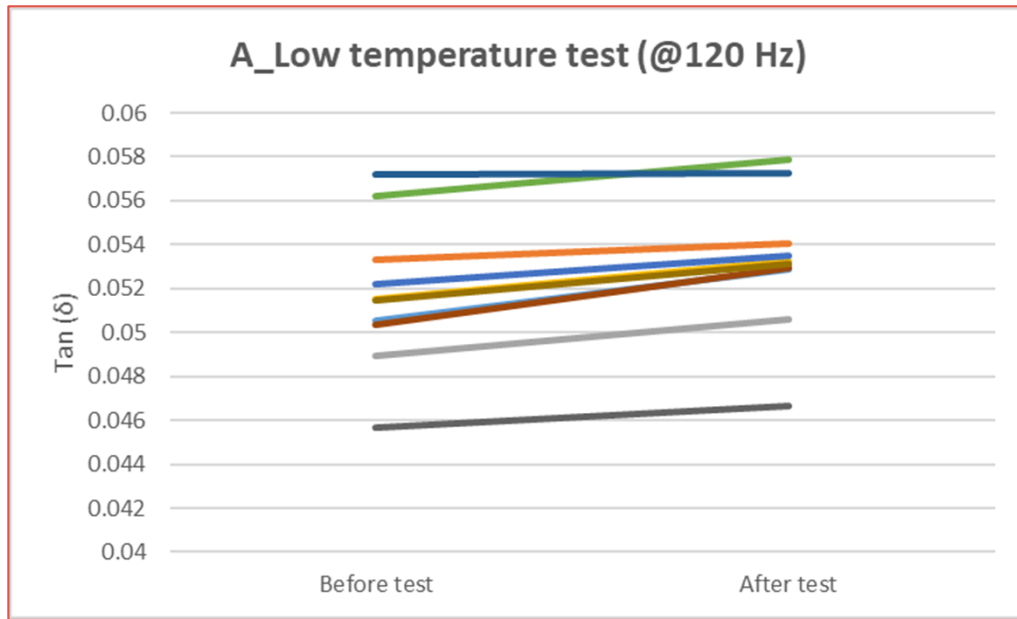


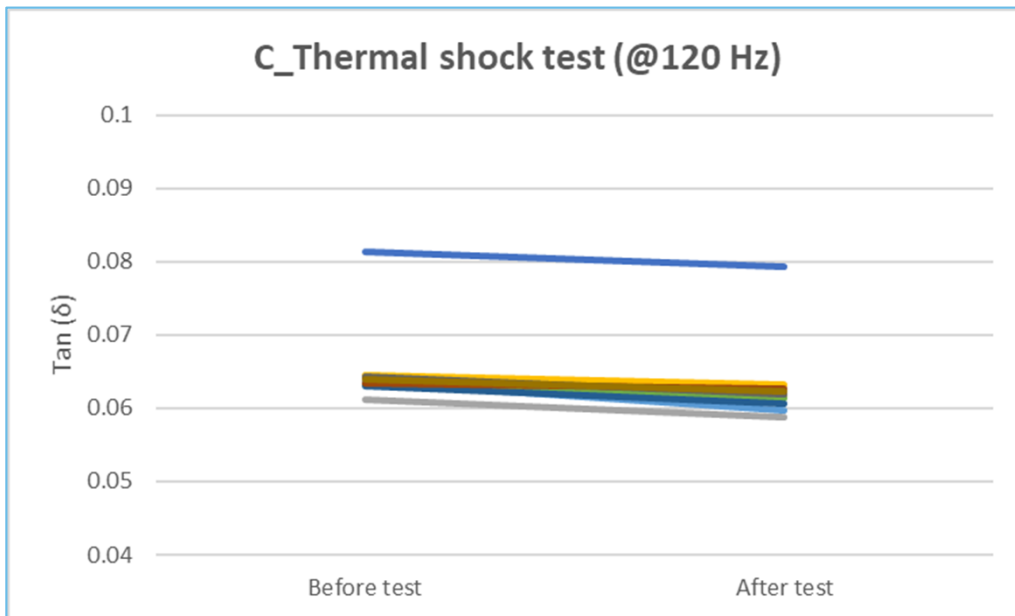
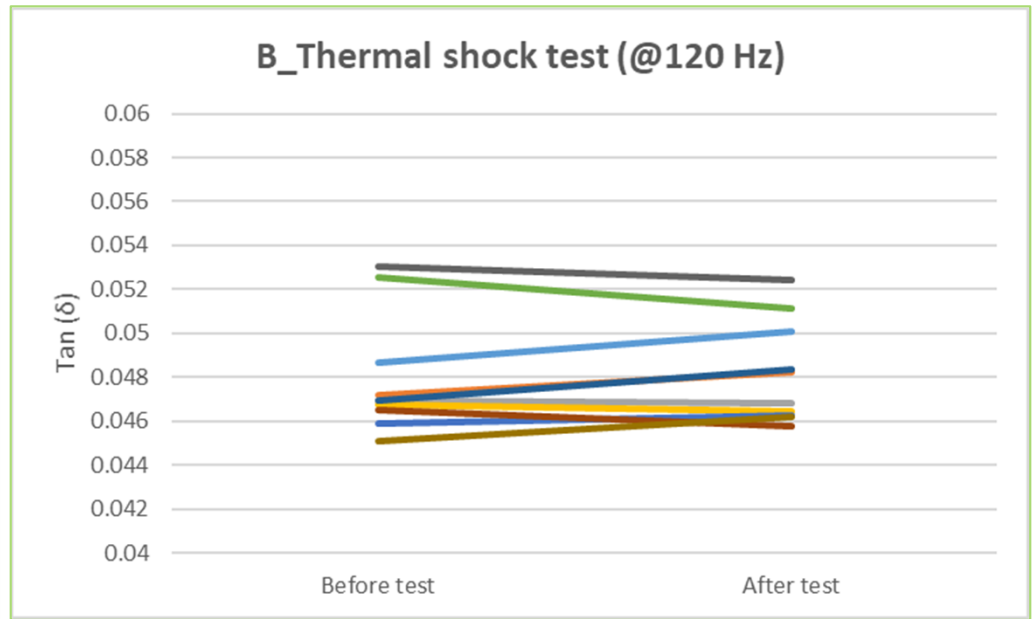
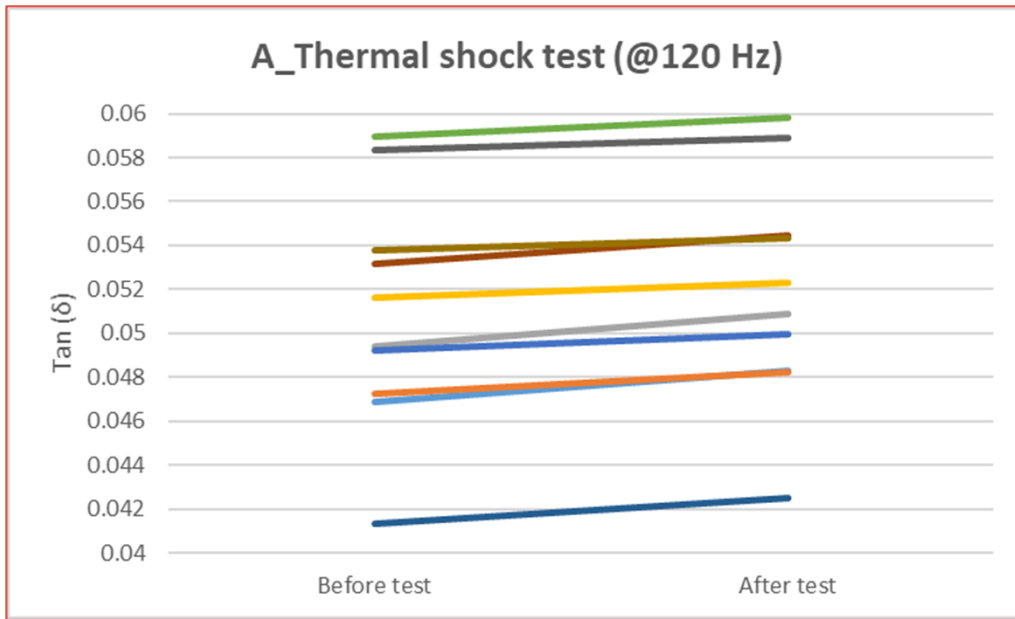


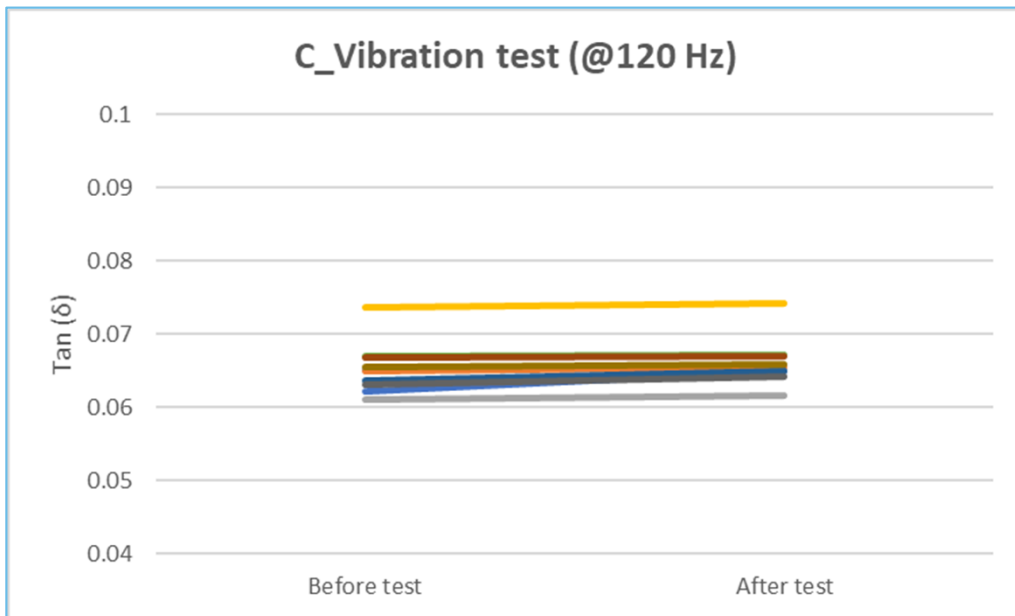
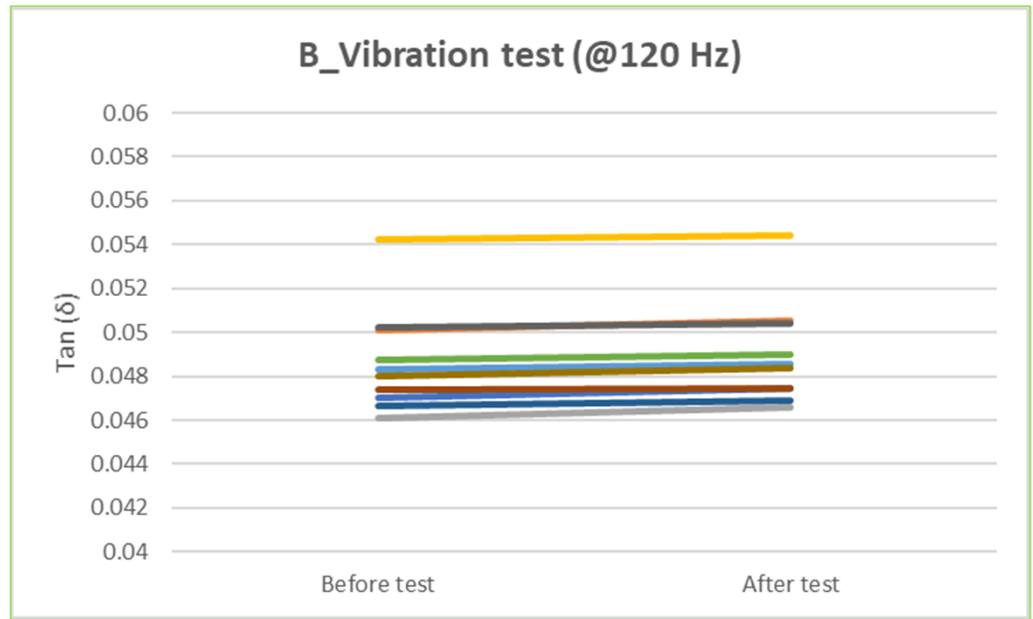
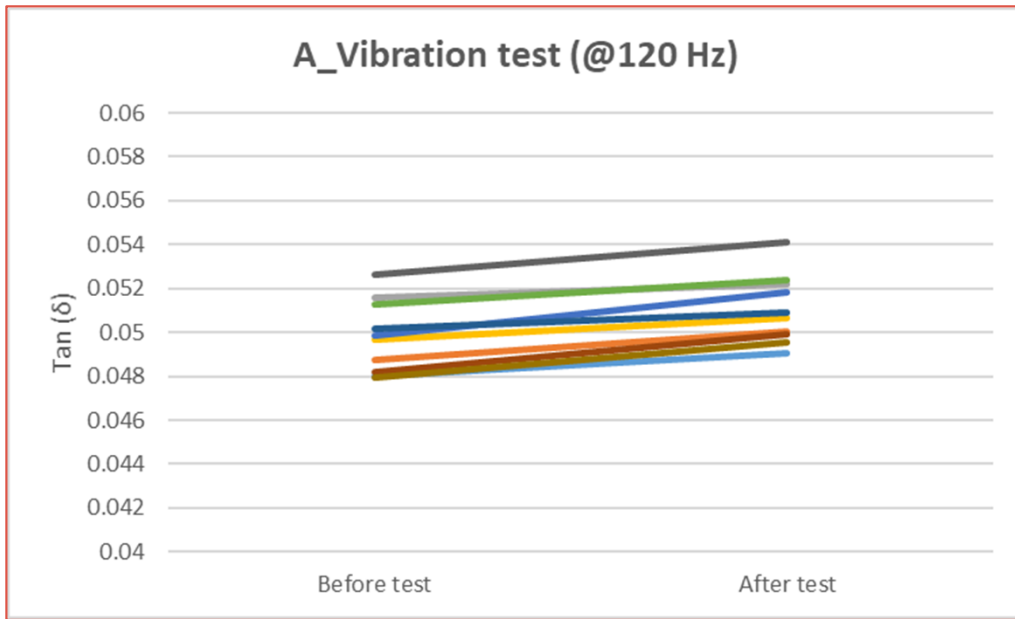


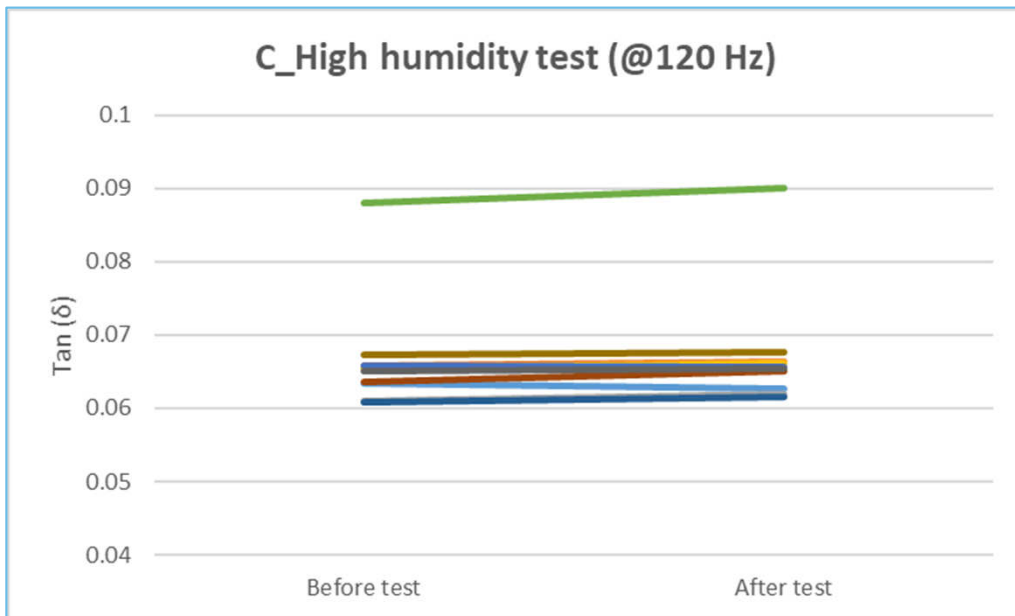
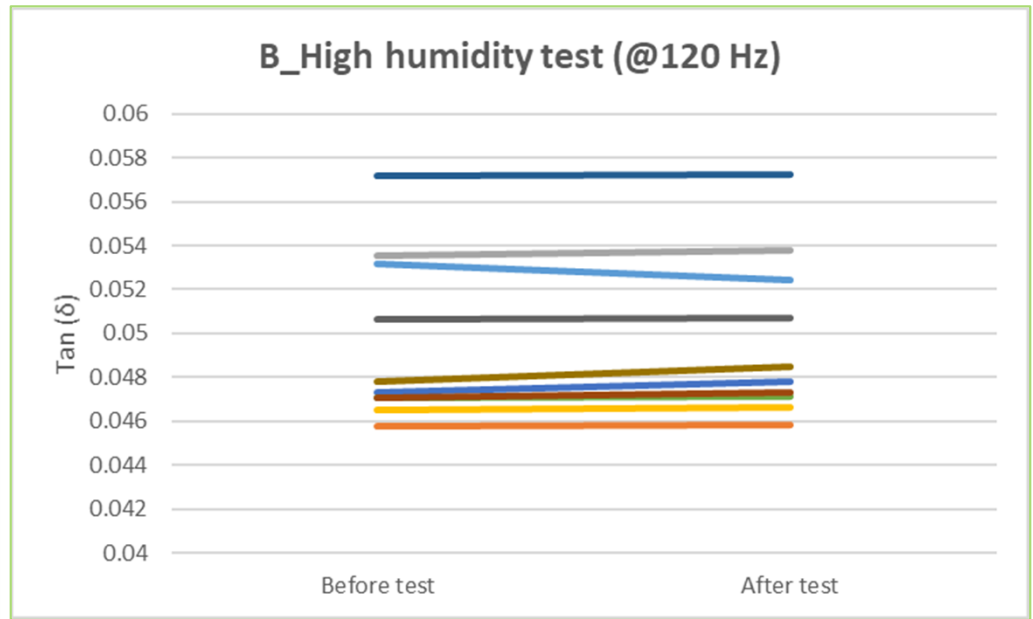
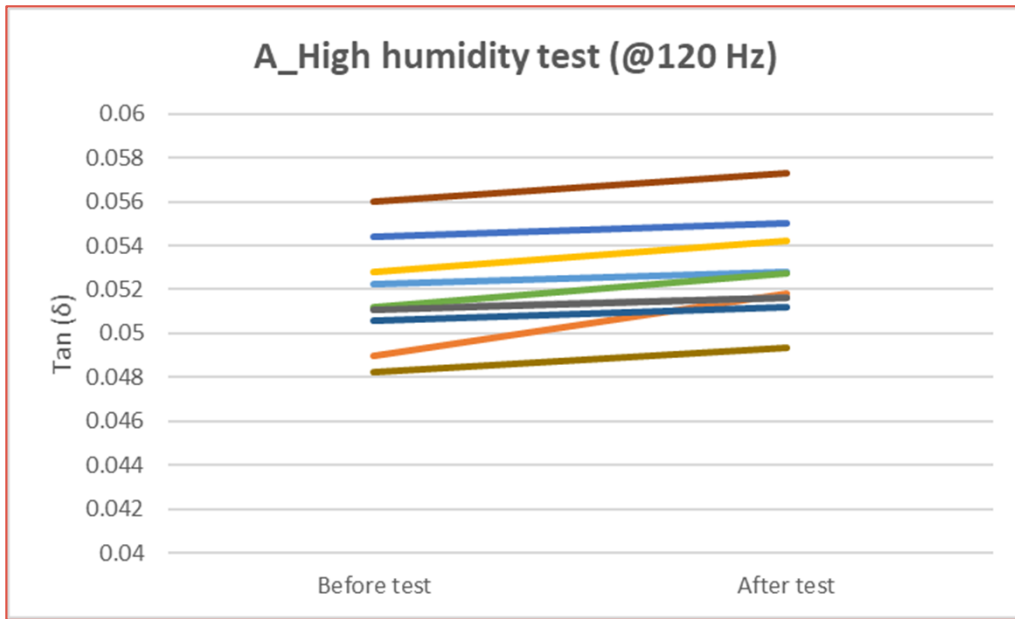


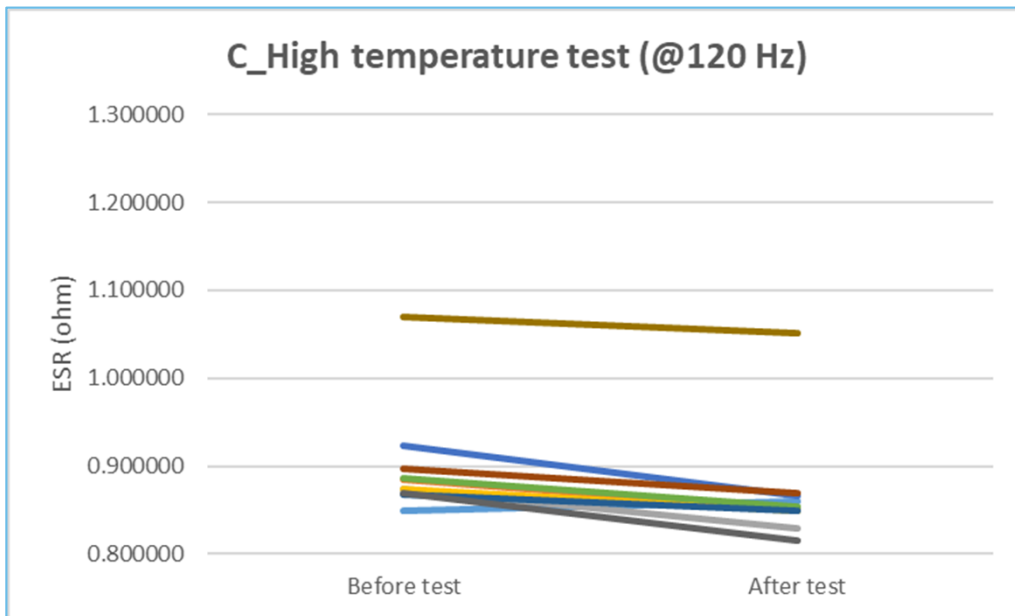
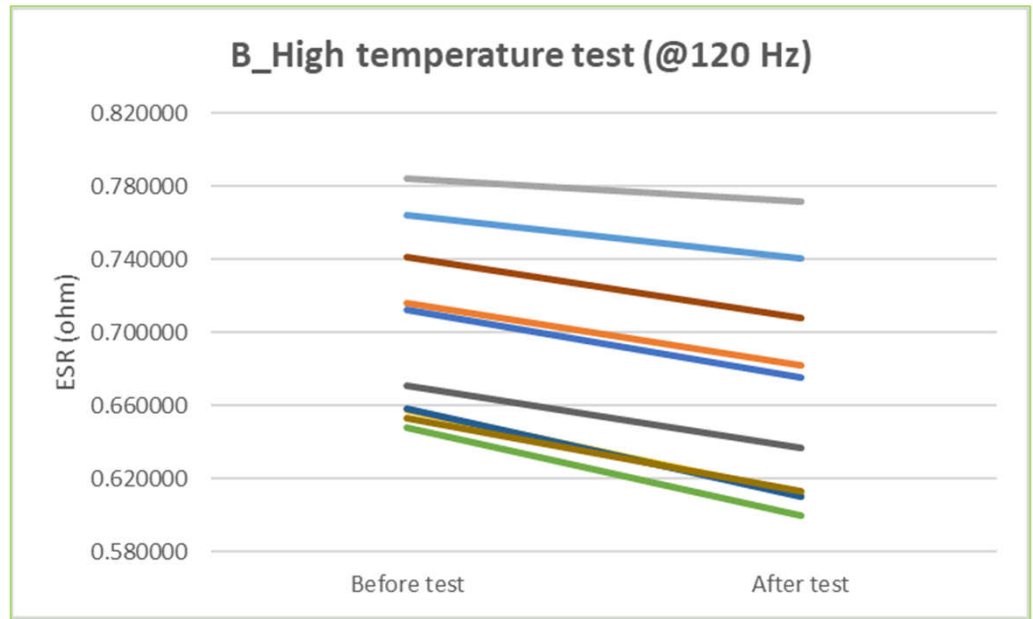
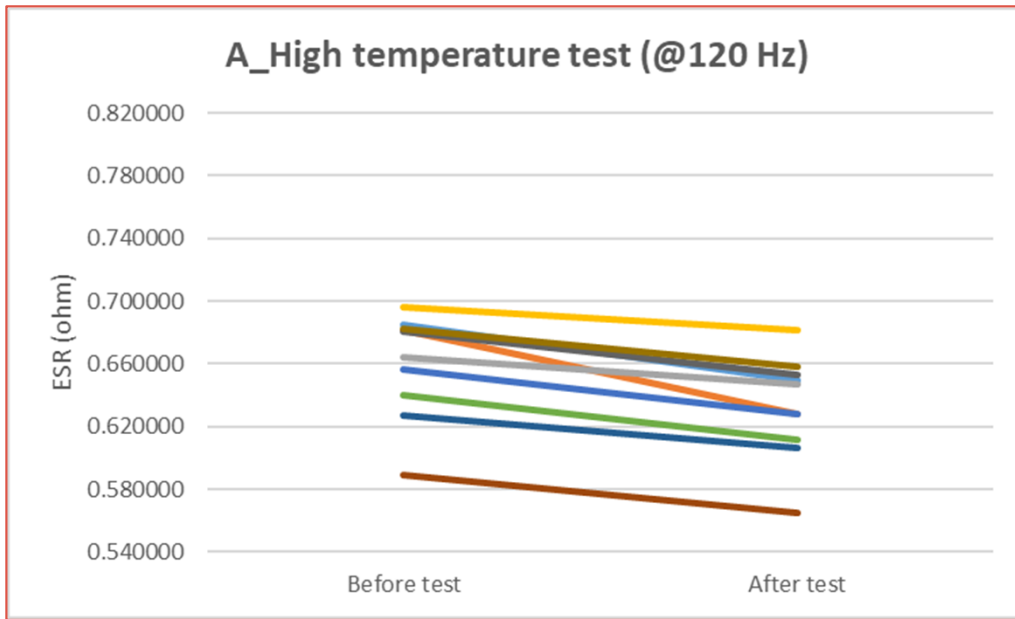


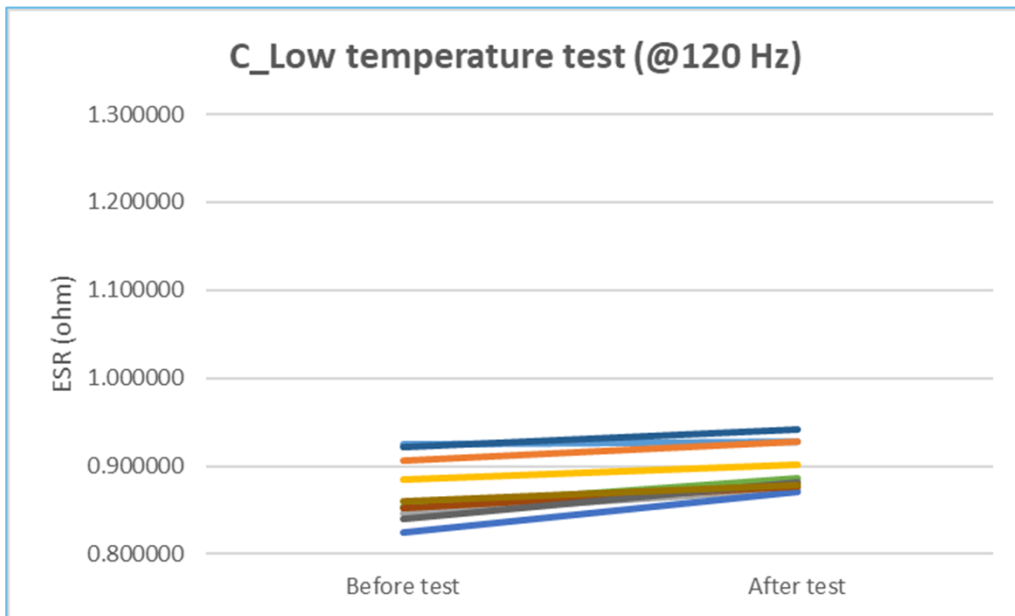
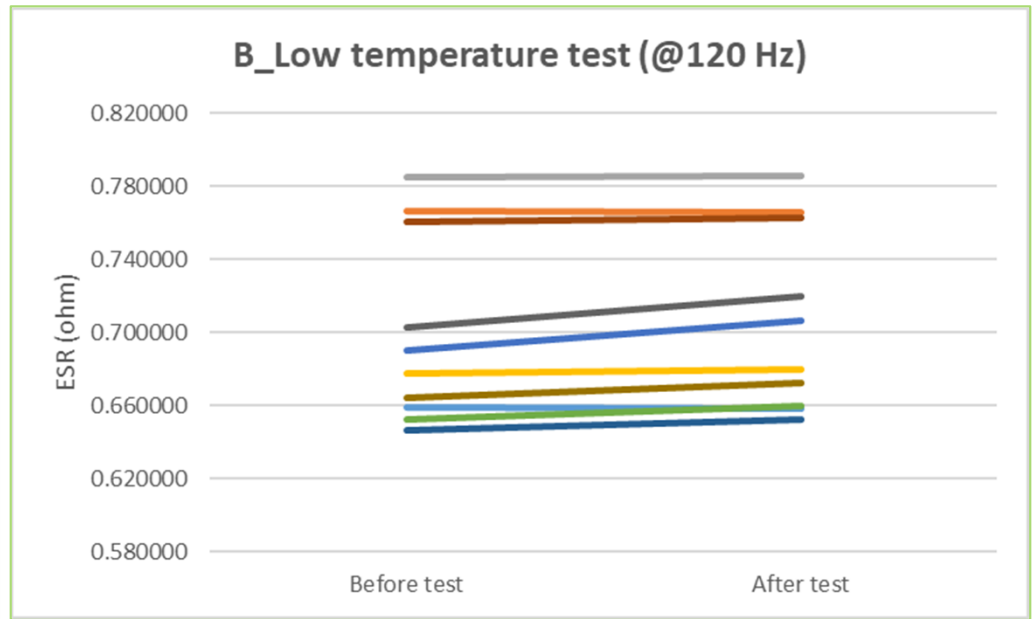
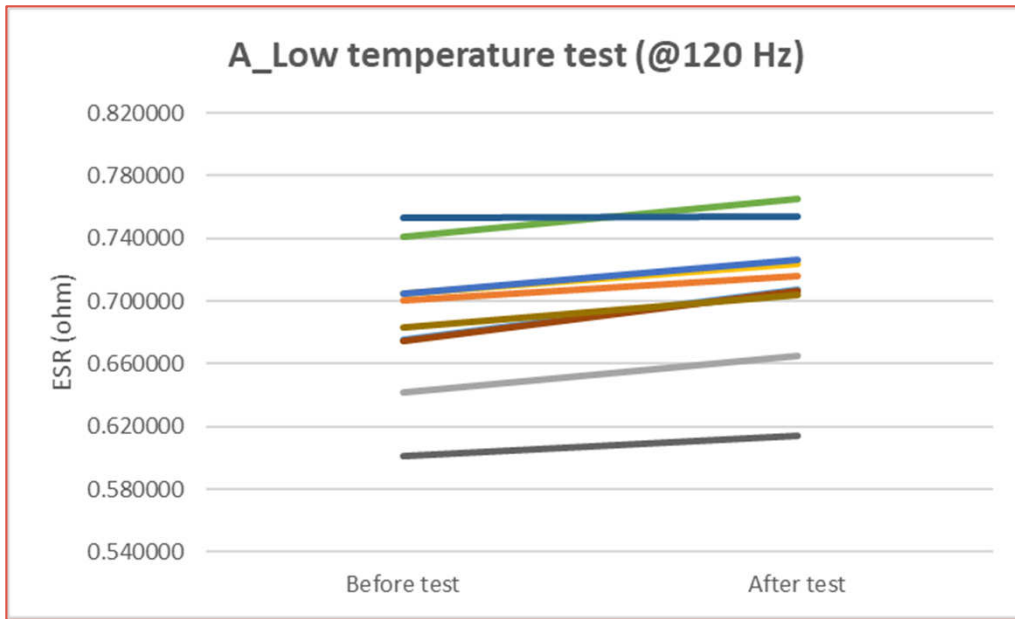


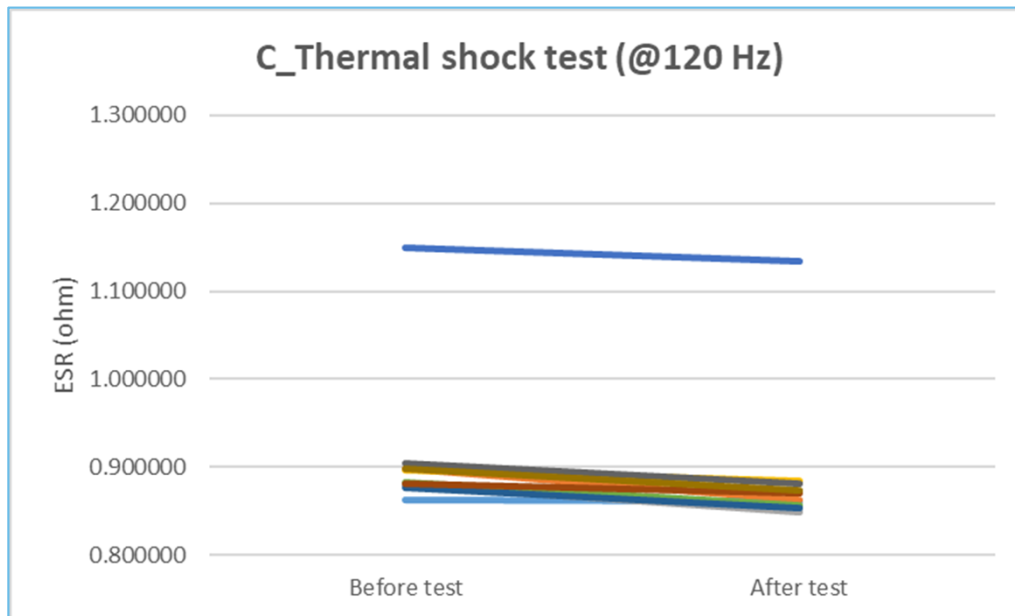
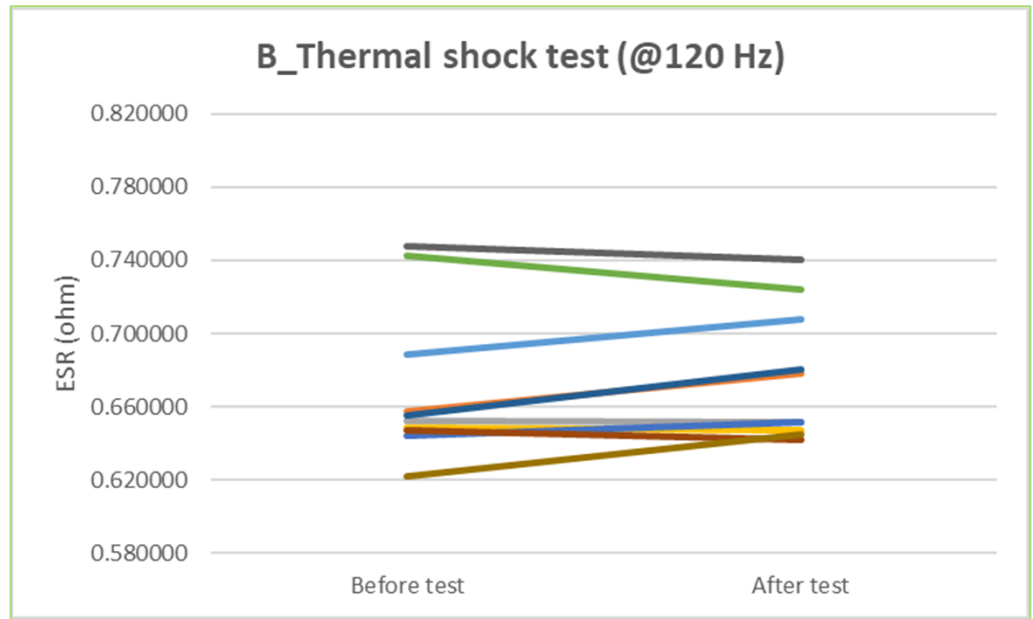
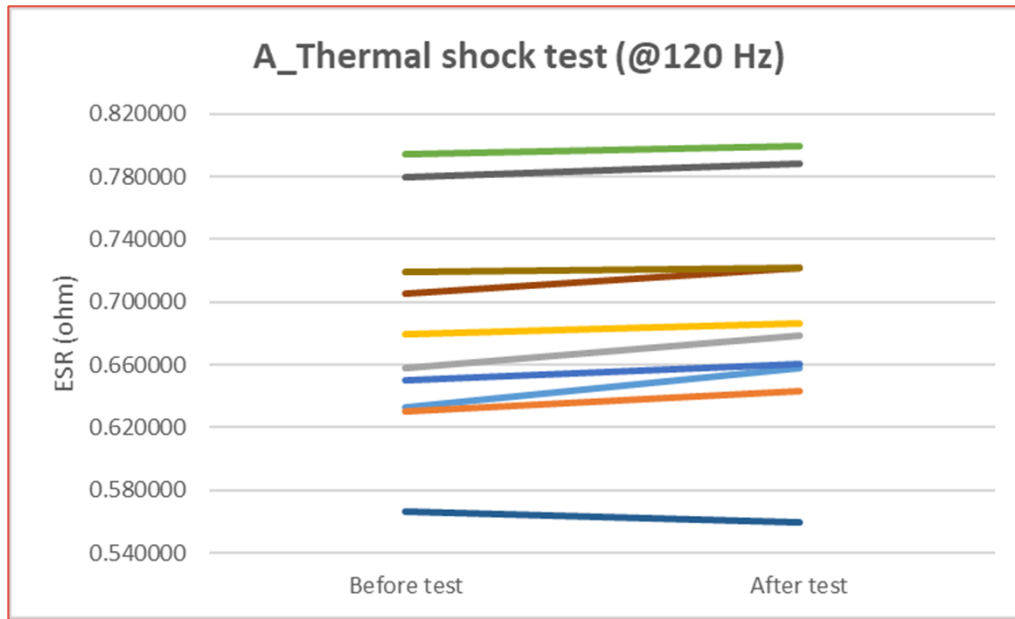




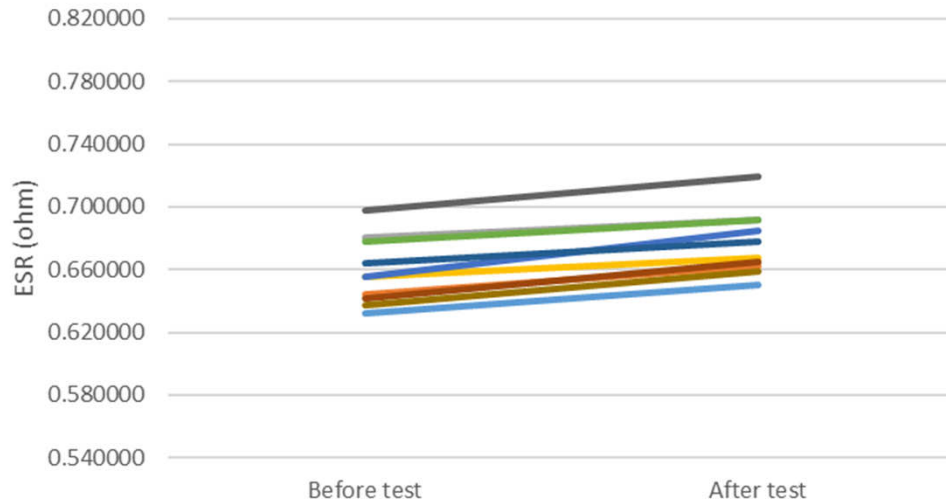




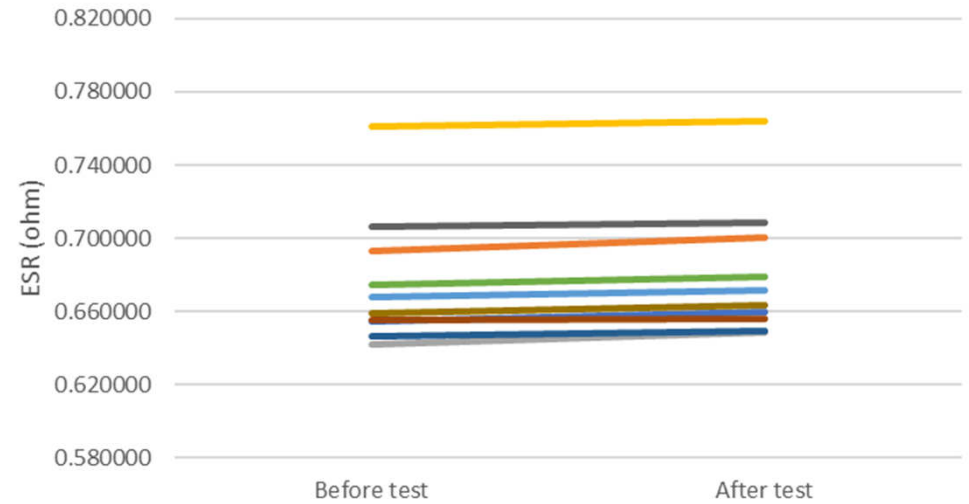




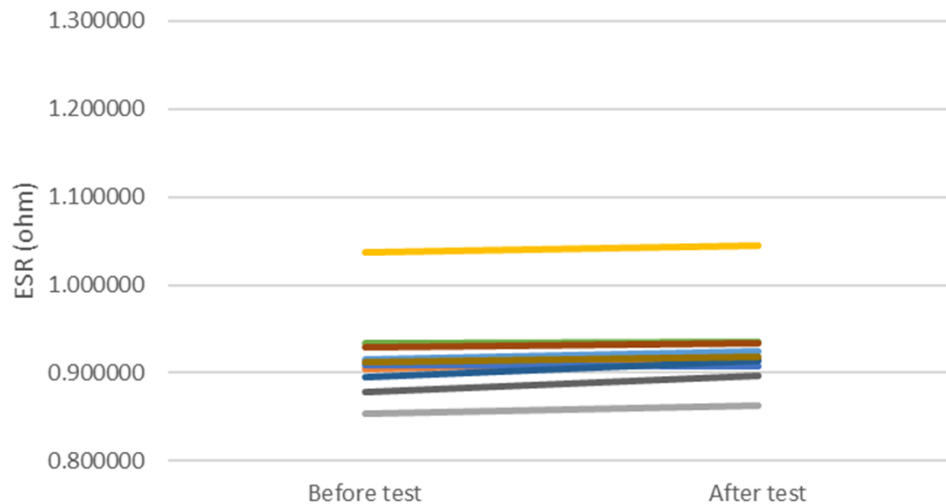
A_Vibration test (@120 Hz)

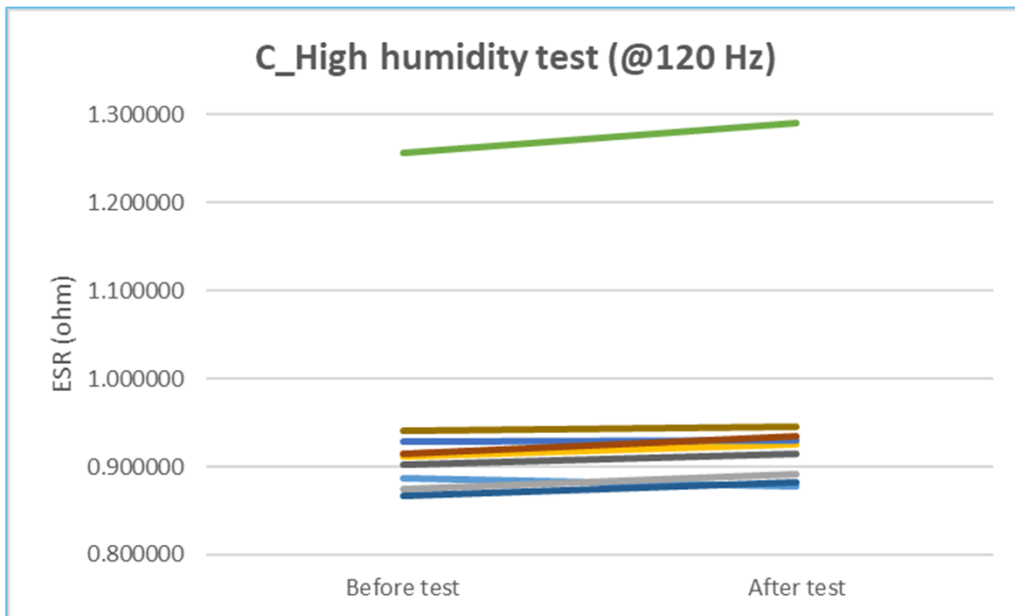
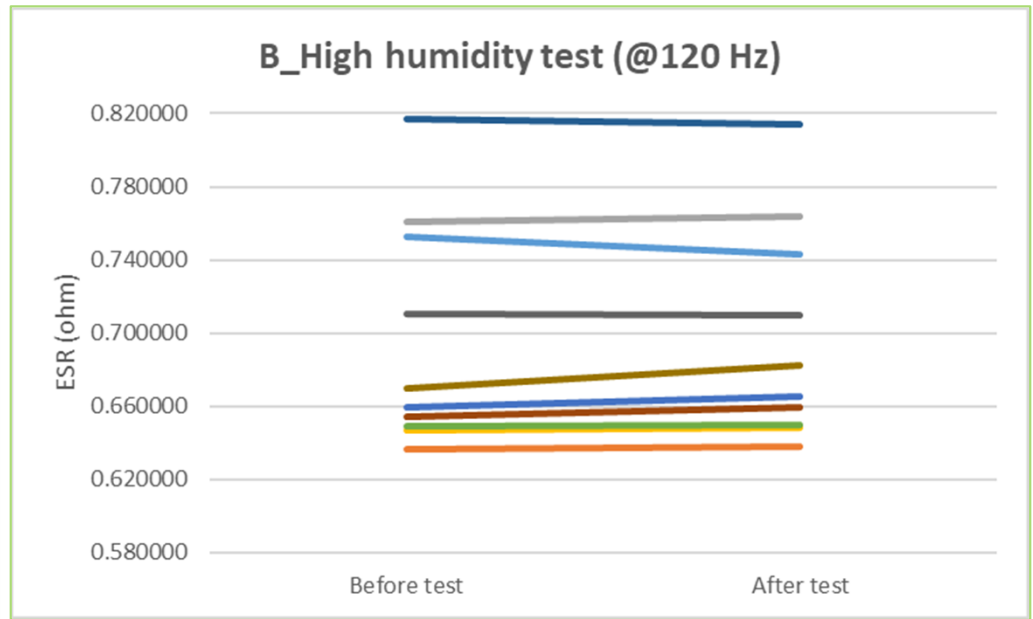
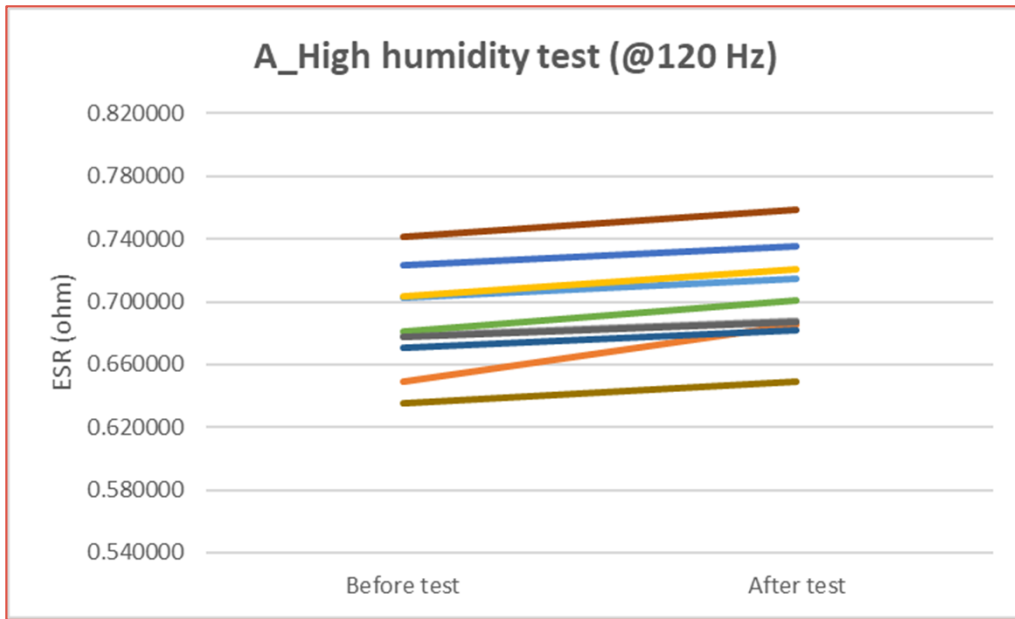


B_Vibration test (@120 Hz)



C_Vibration test (@120 Hz)

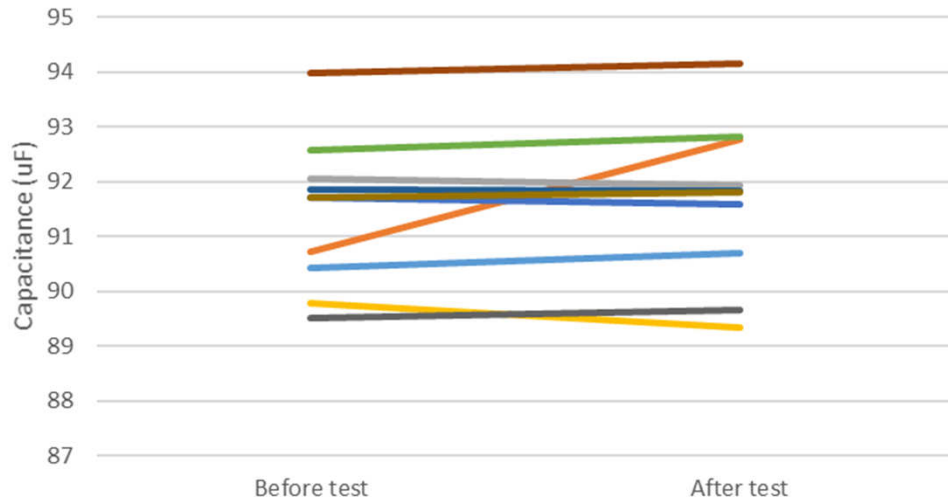




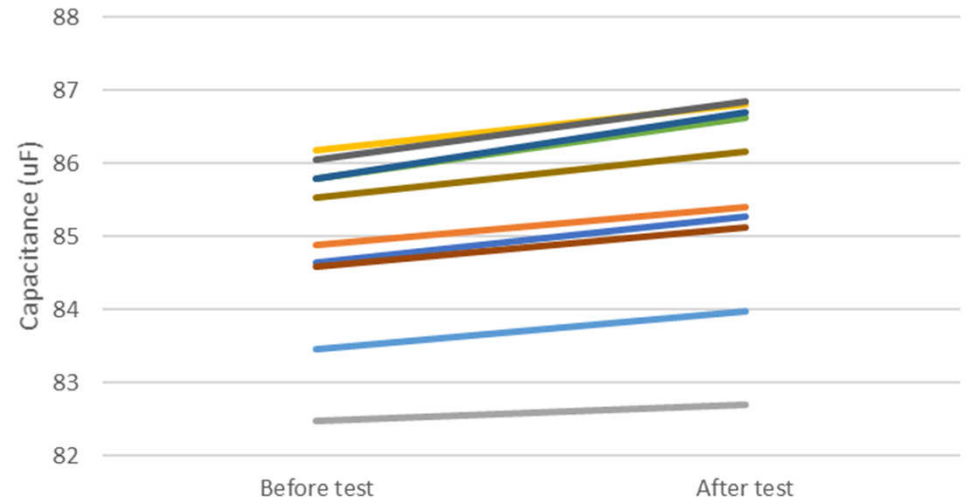
Summary

High temperature test_Capacitance (uF) @1 kHz

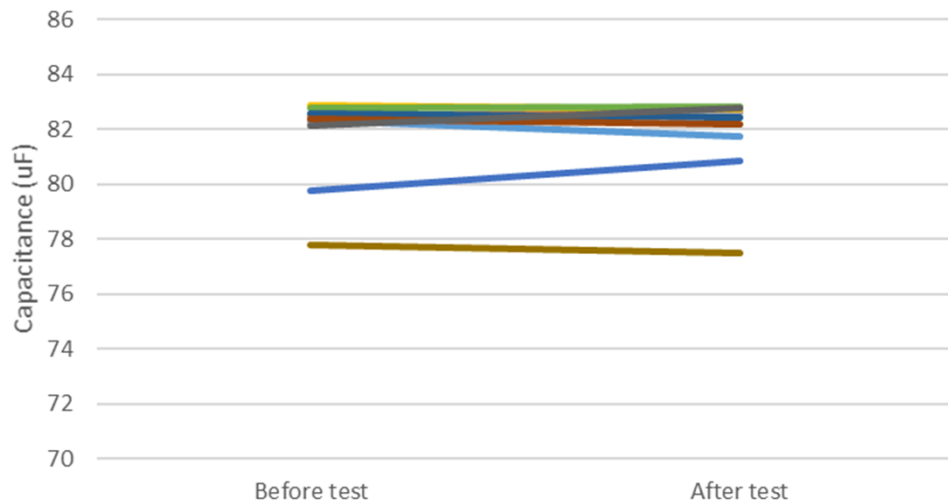
A_High temperature test (@1 kHz)

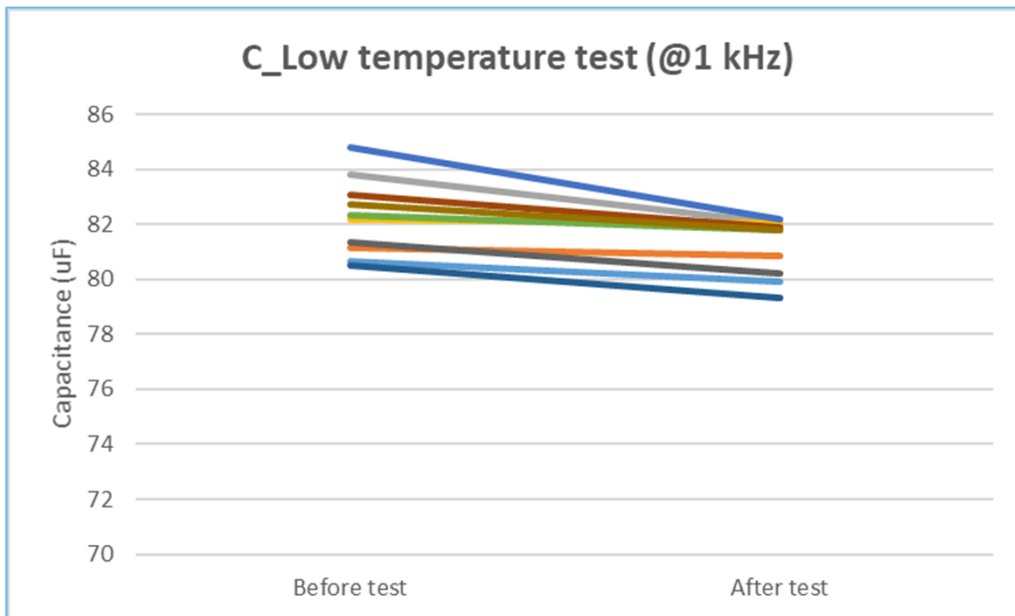
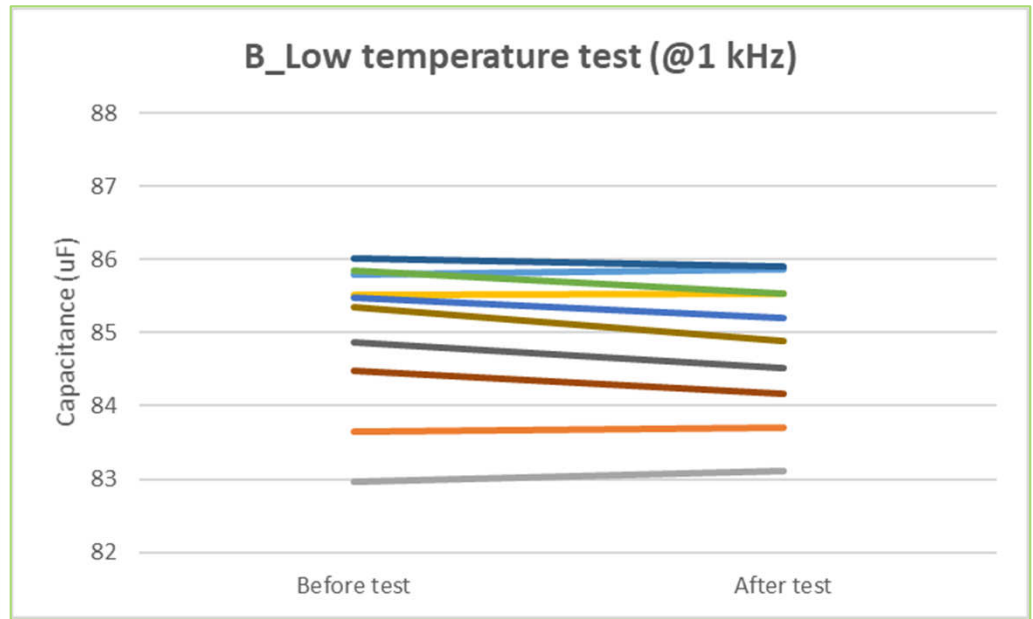
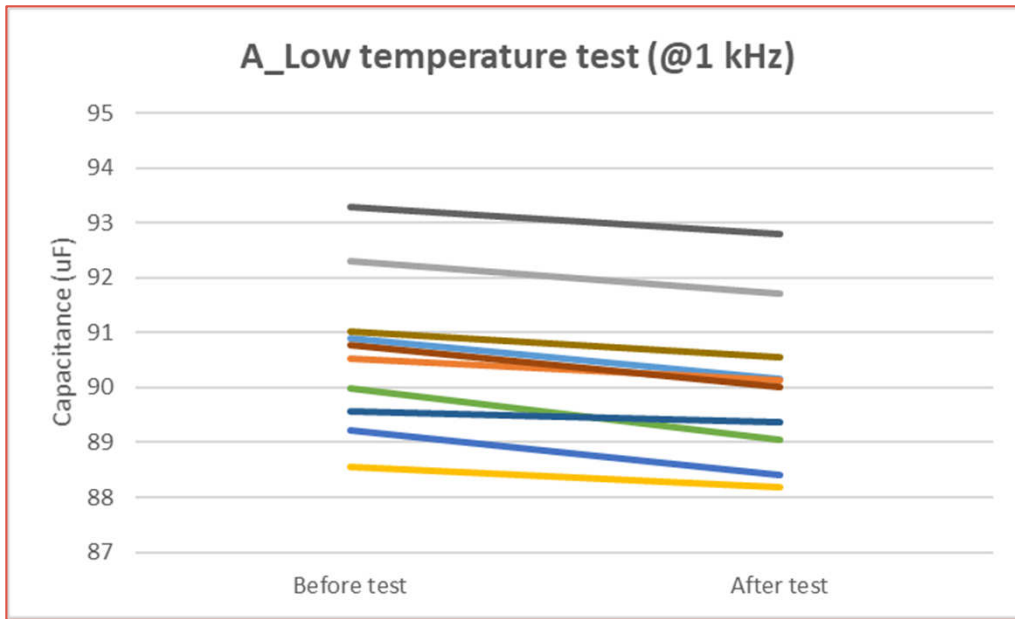


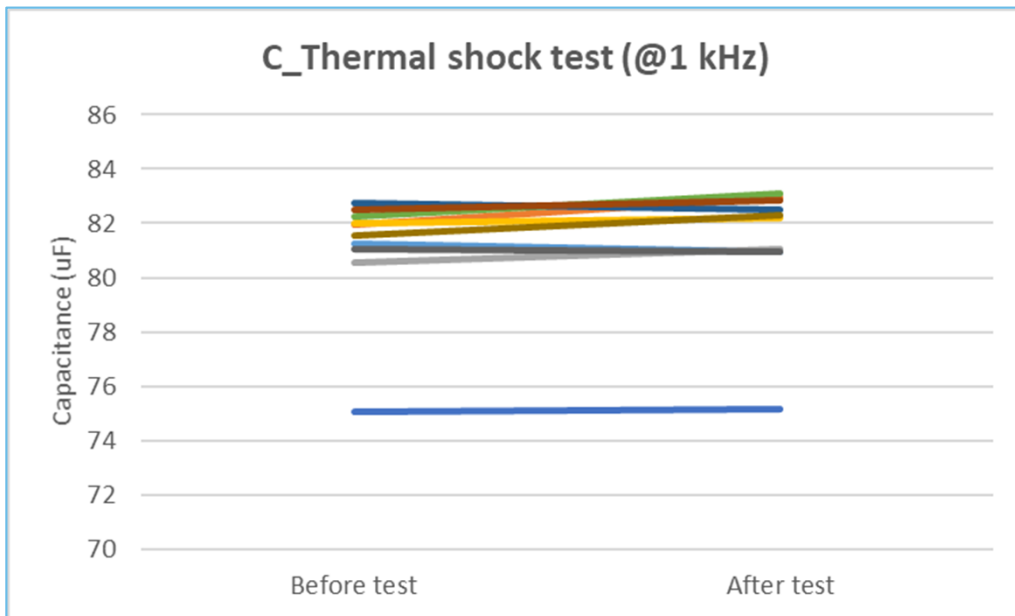
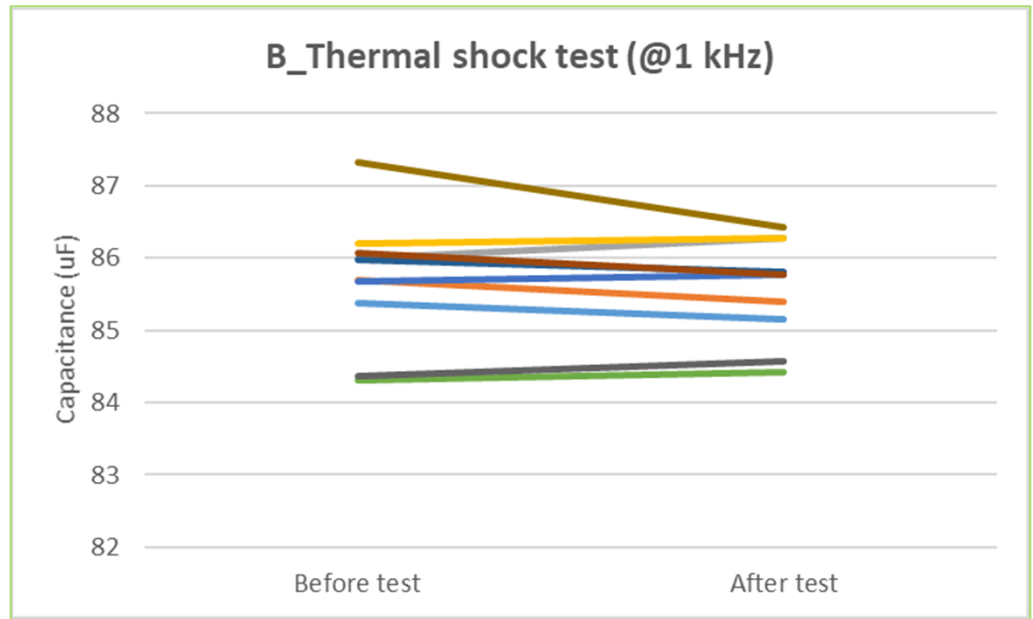
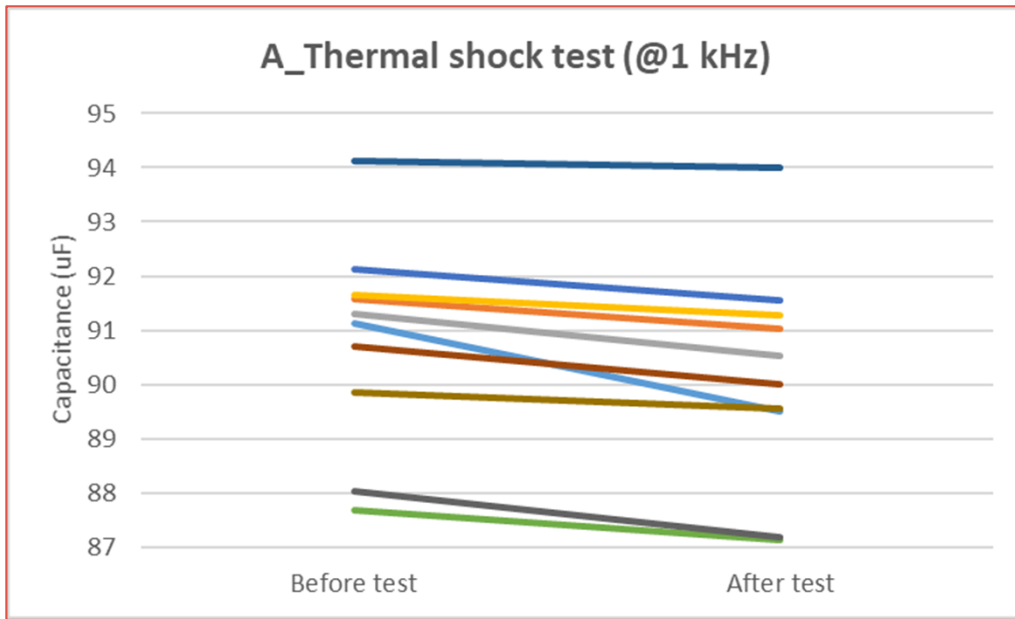
B_High temperature test (@1 kHz)

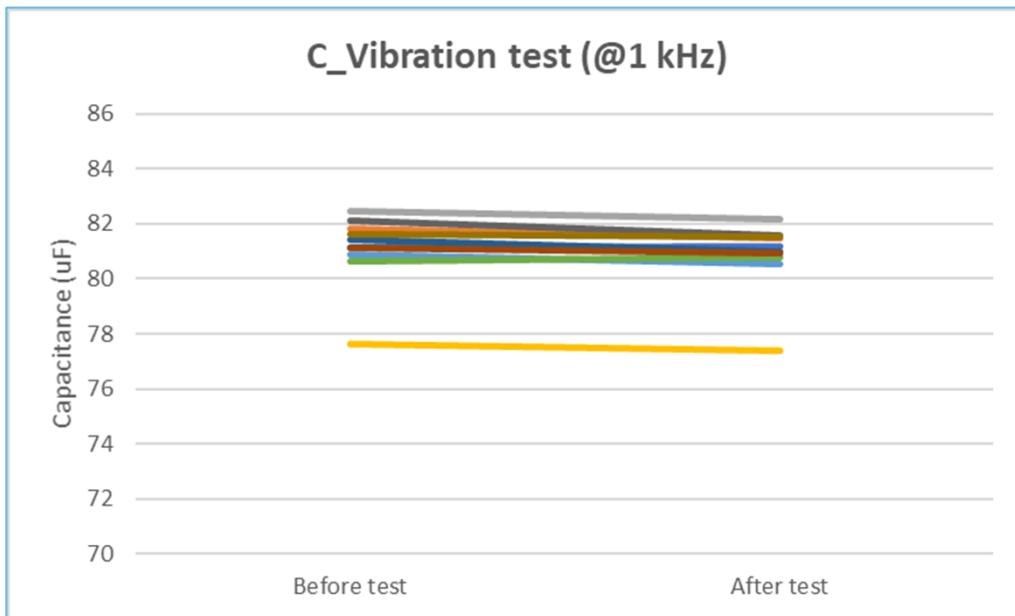
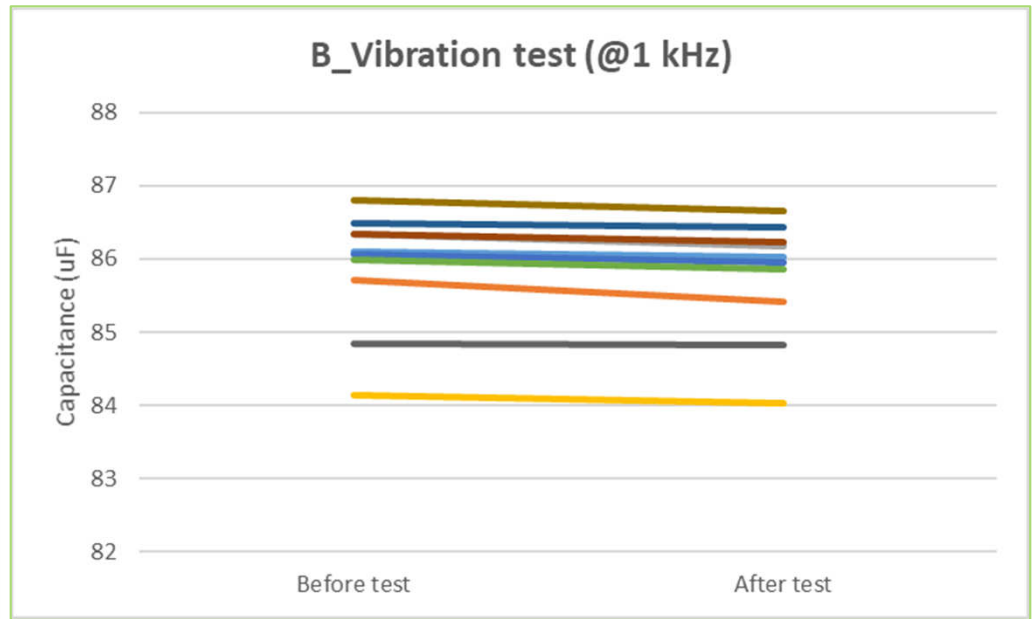
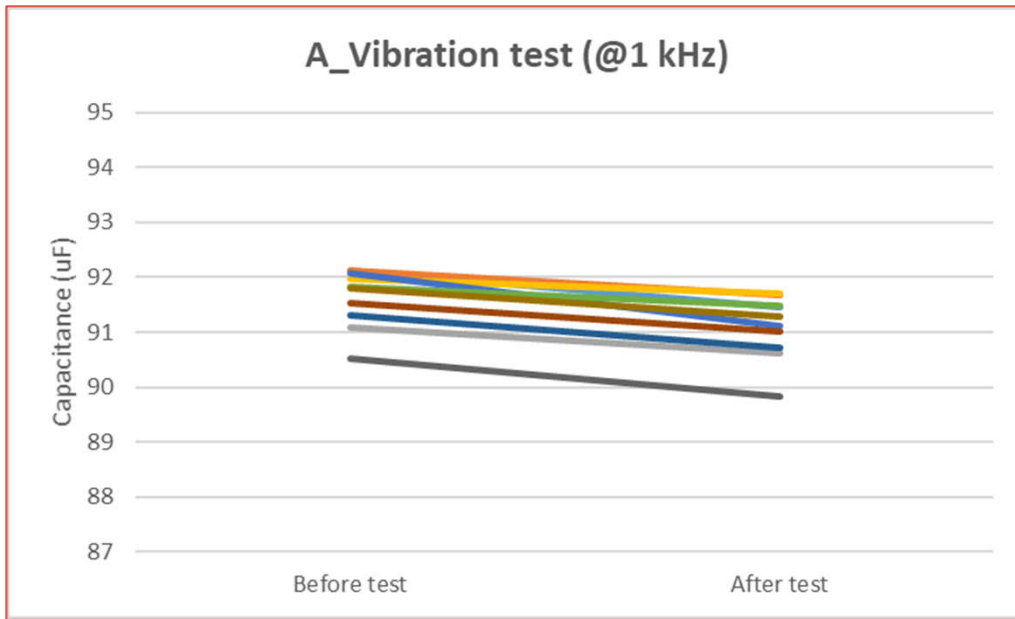


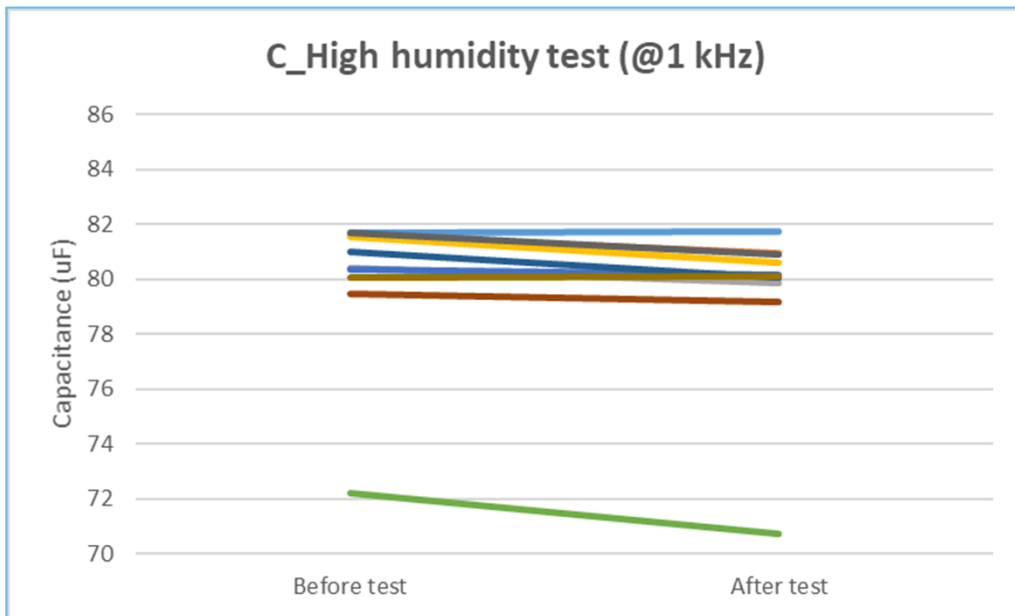
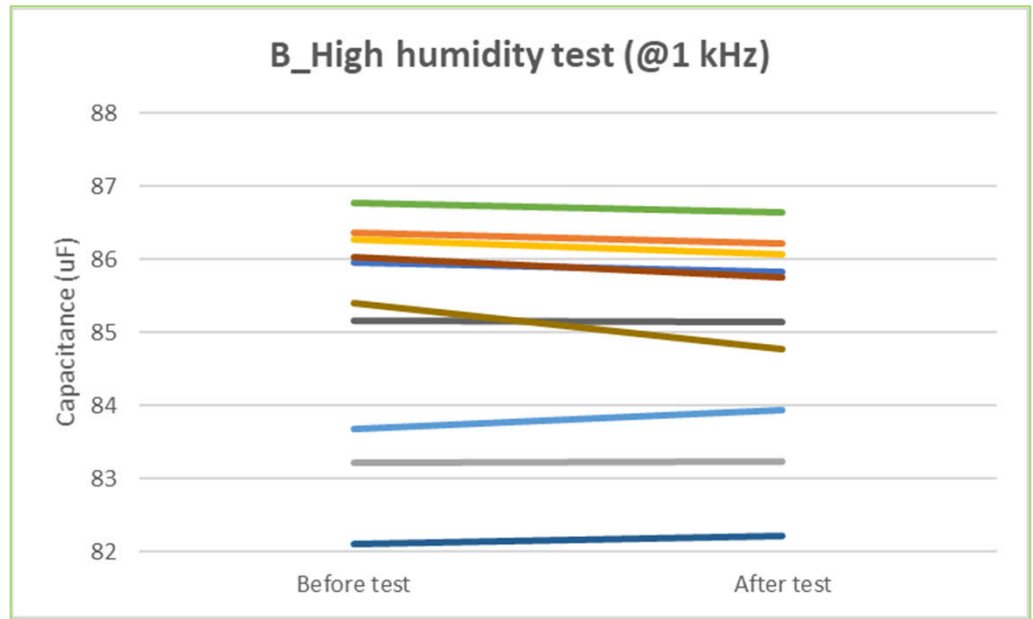
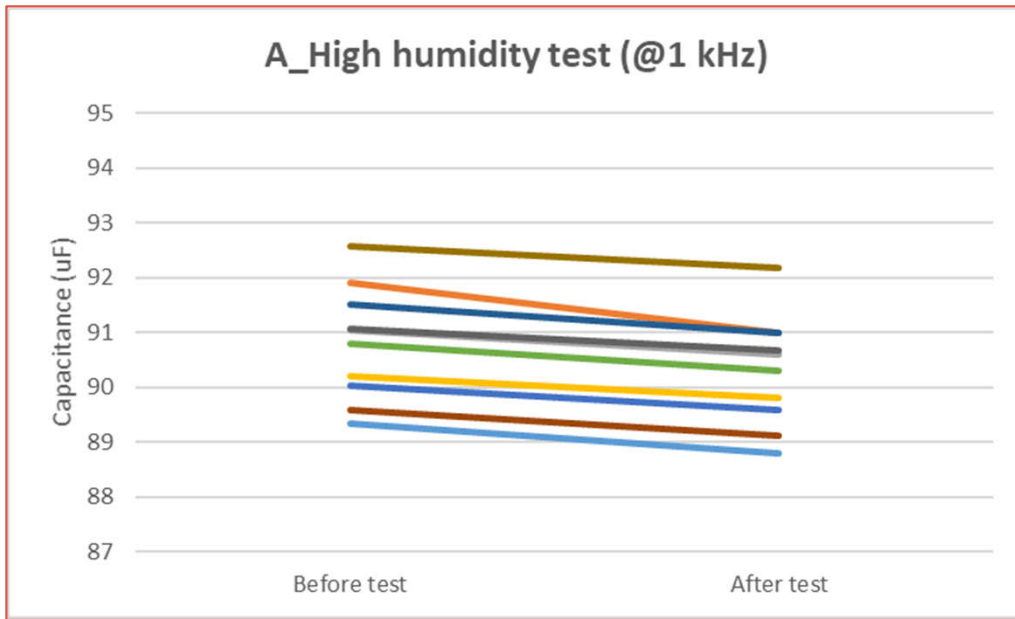
C_High temperature test (@1 kHz)



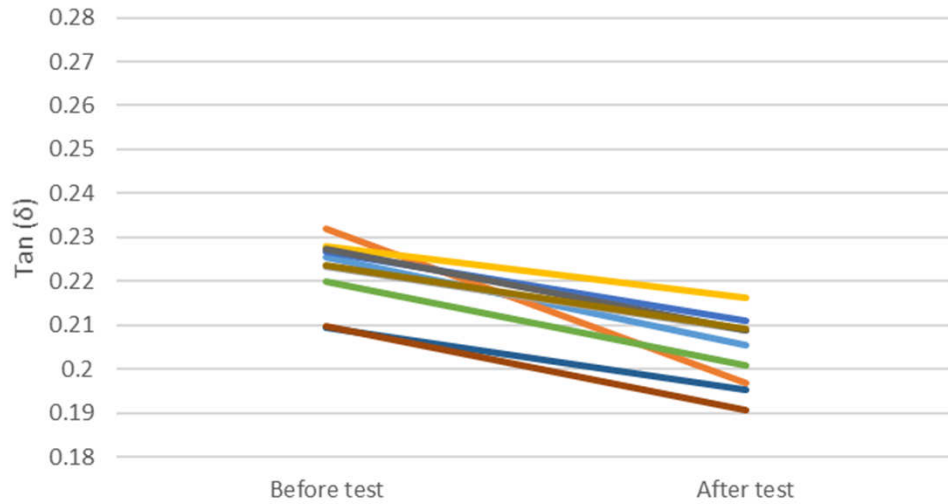




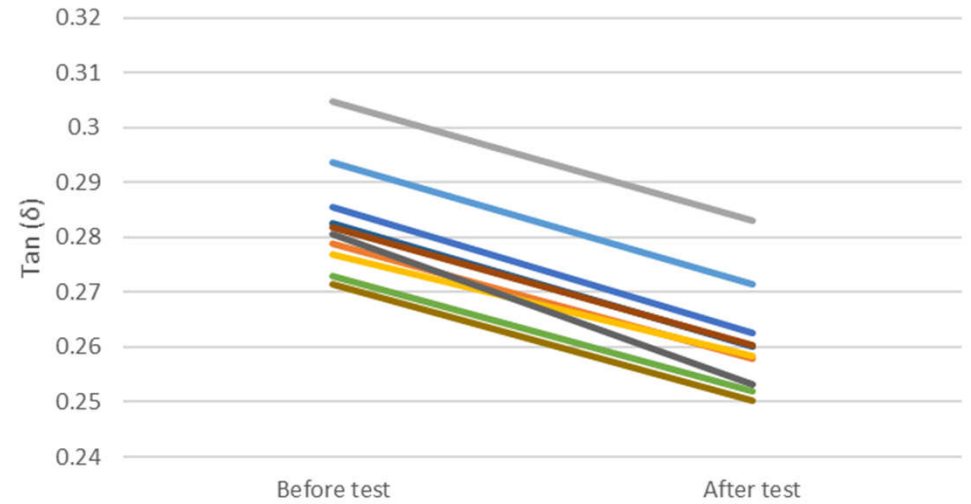




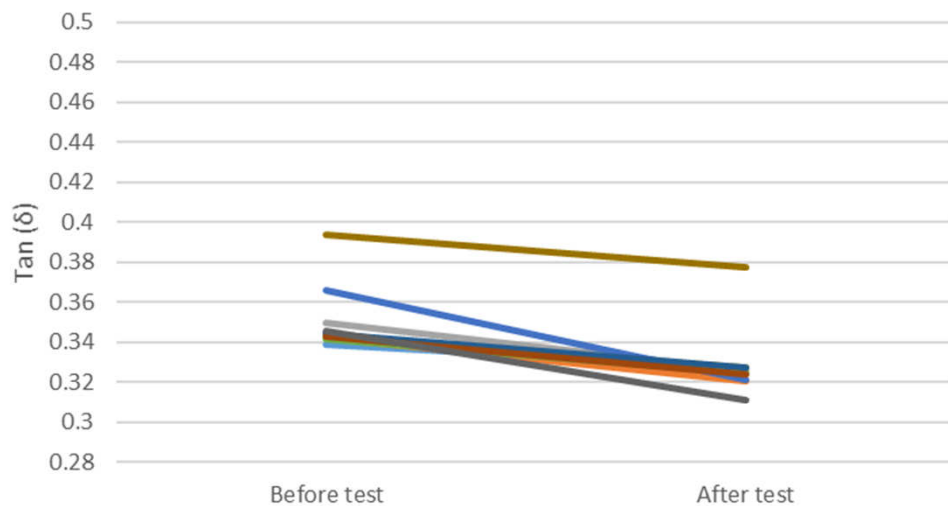
A_High temperature test (@1 kHz)

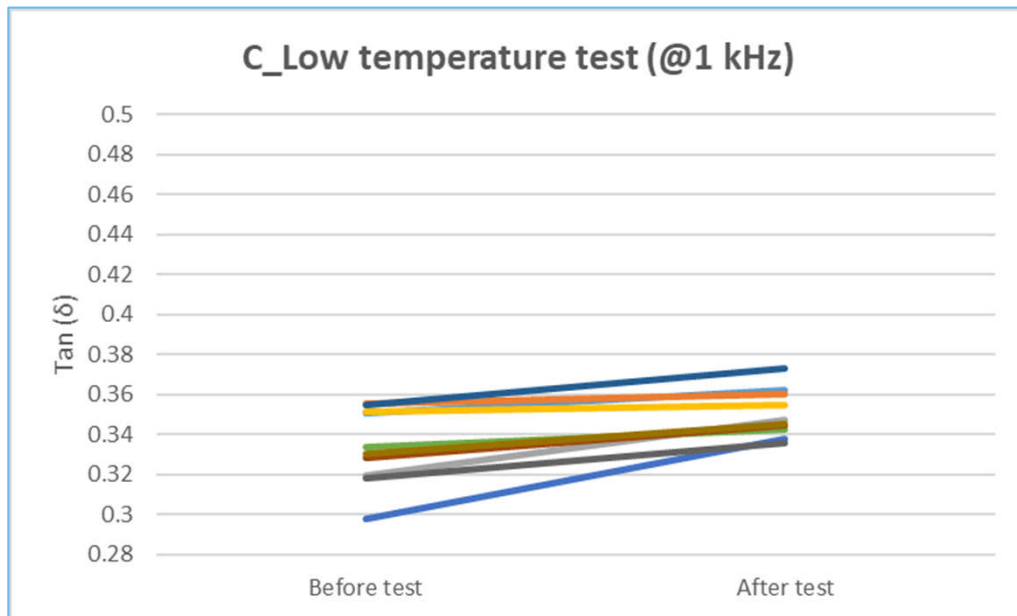
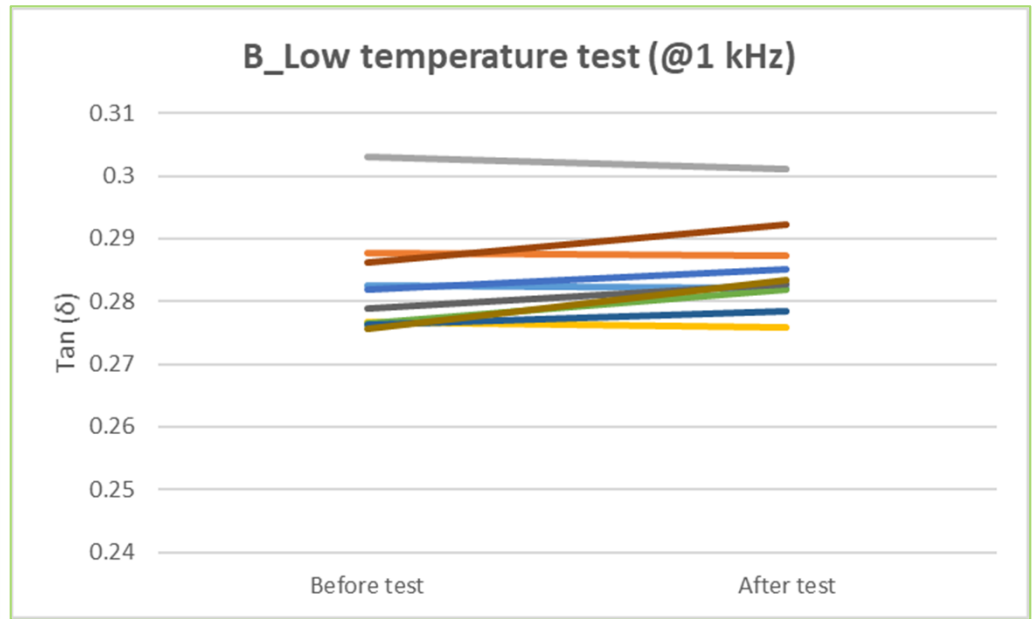
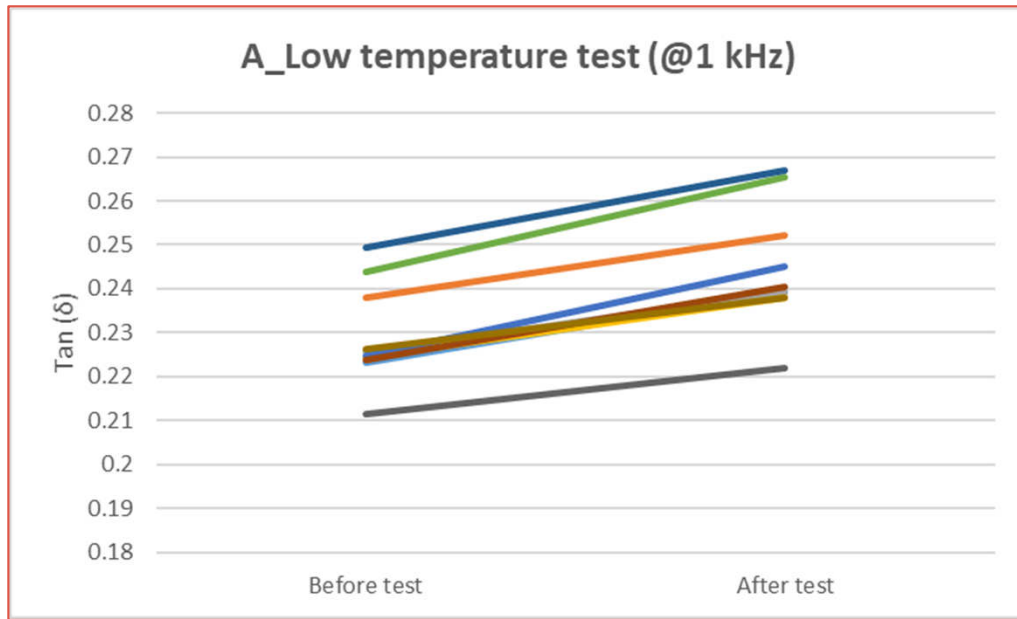


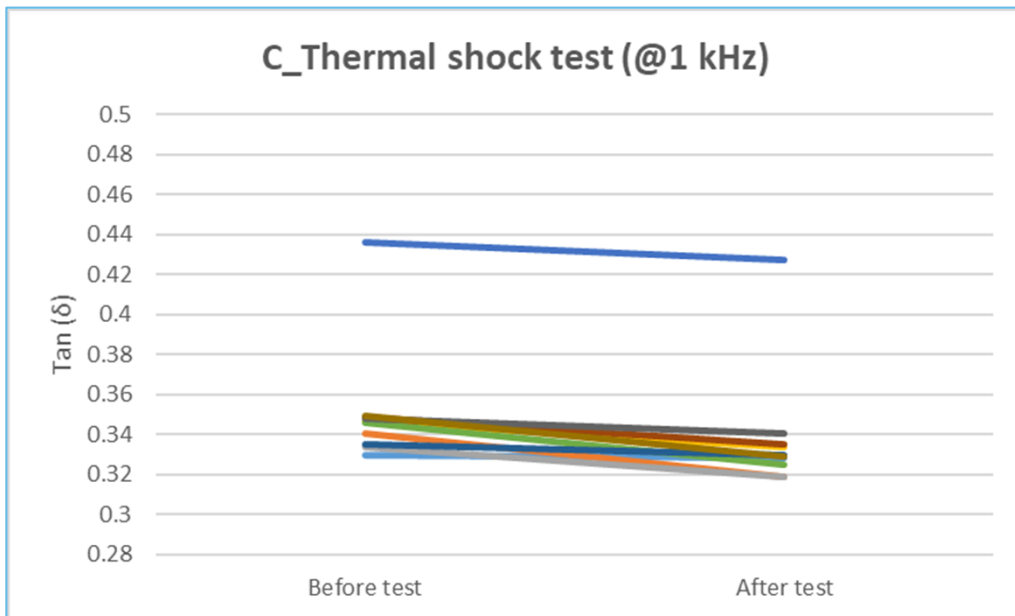
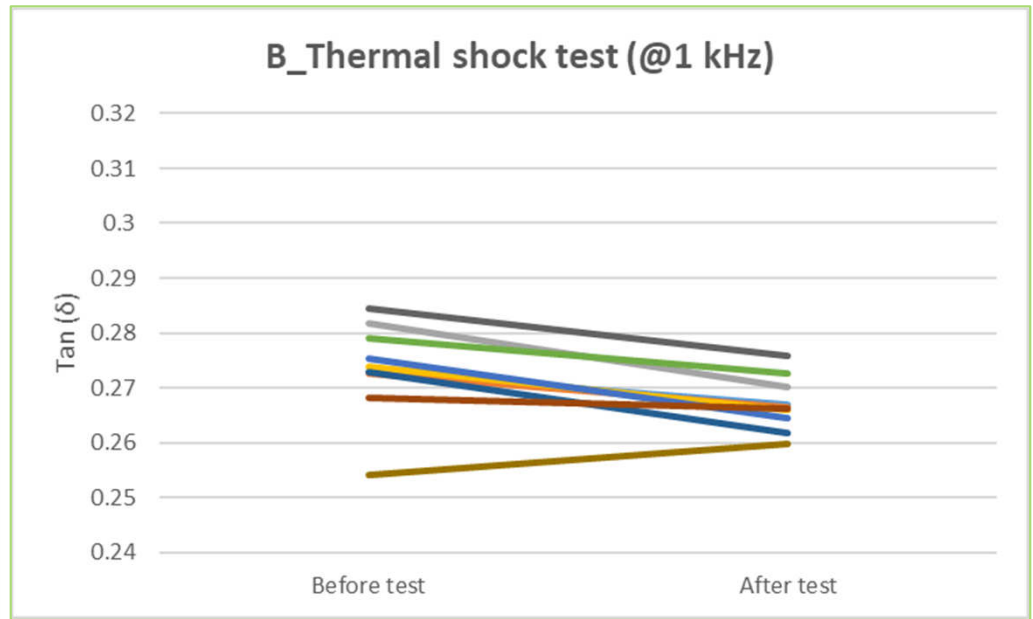
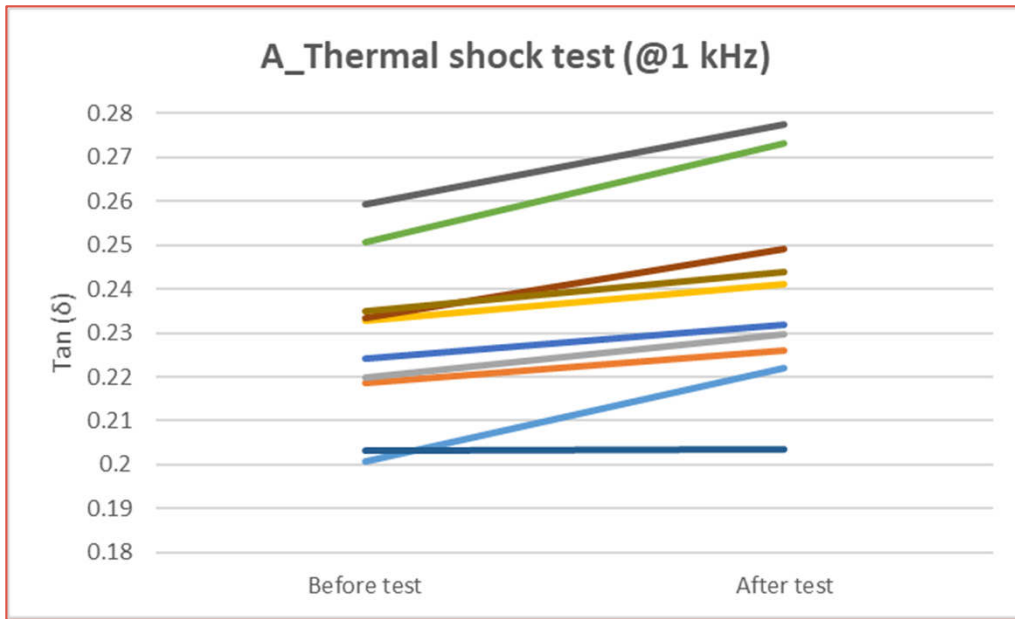
B_High temperature test (@1 kHz)



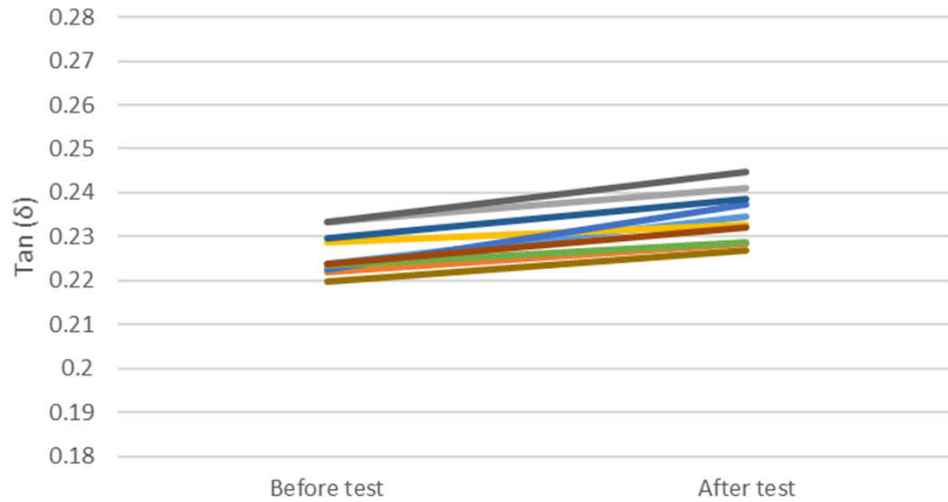
C_High temperature test (@1 kHz)



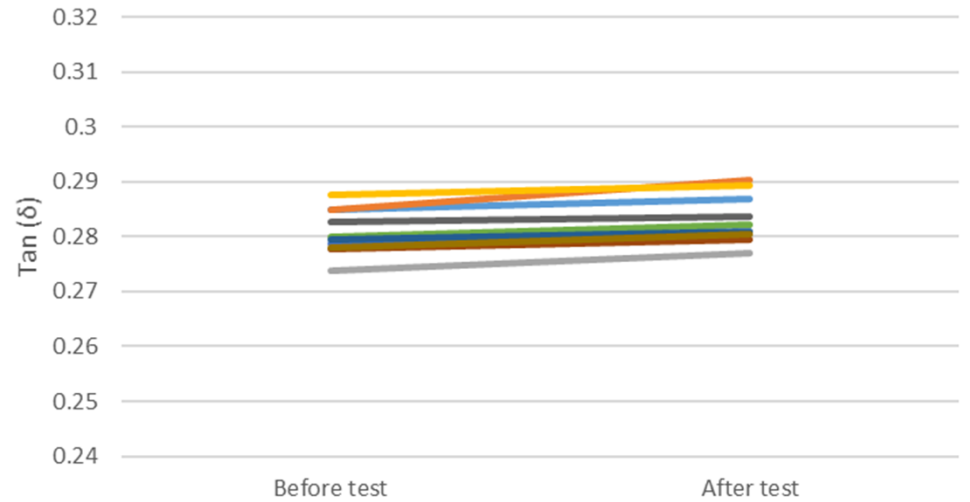




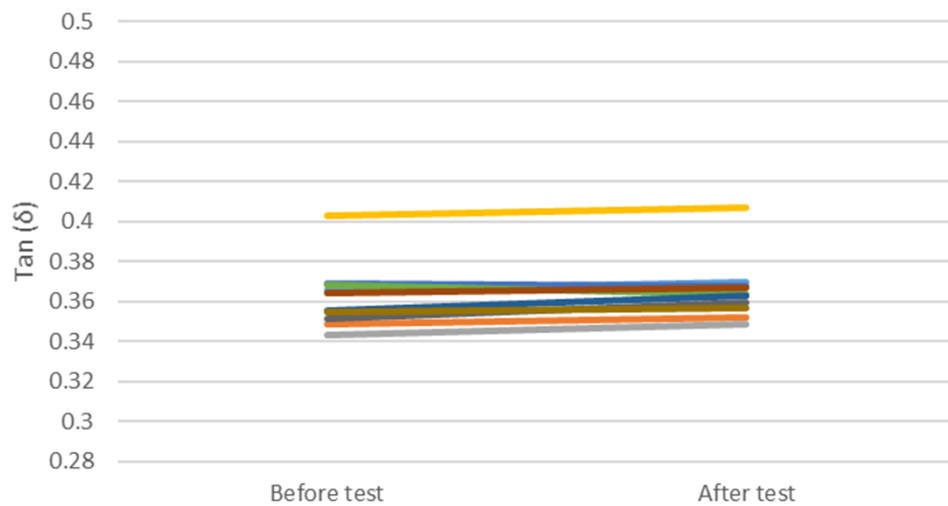
A_Vibration test (@1 kHz)

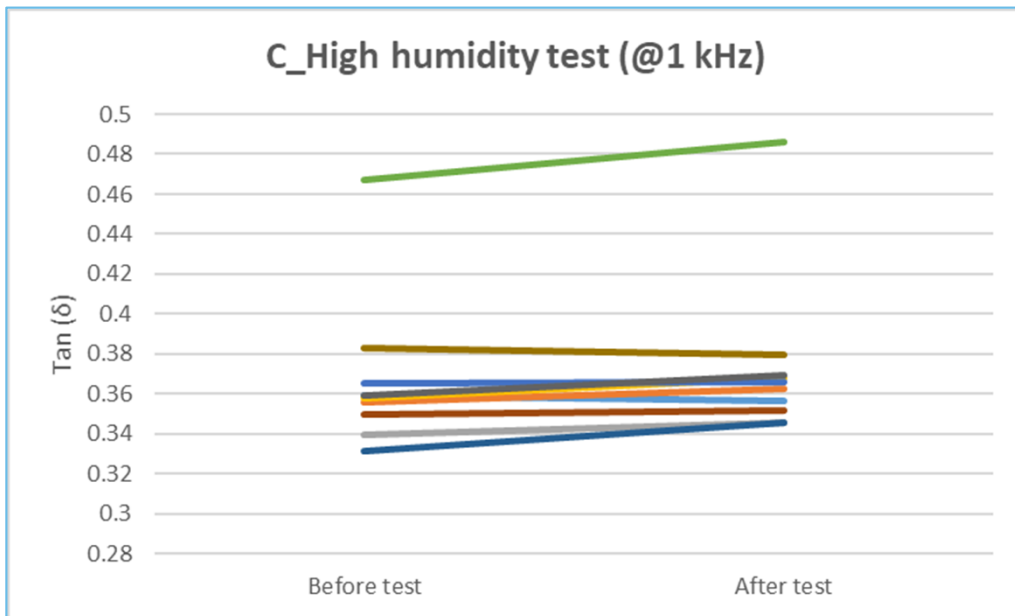
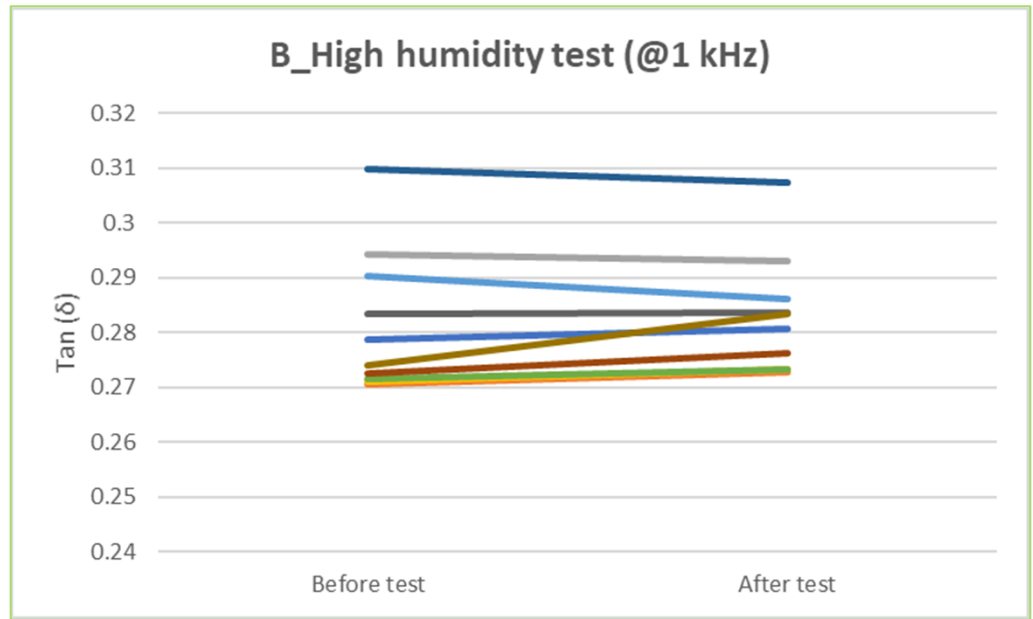
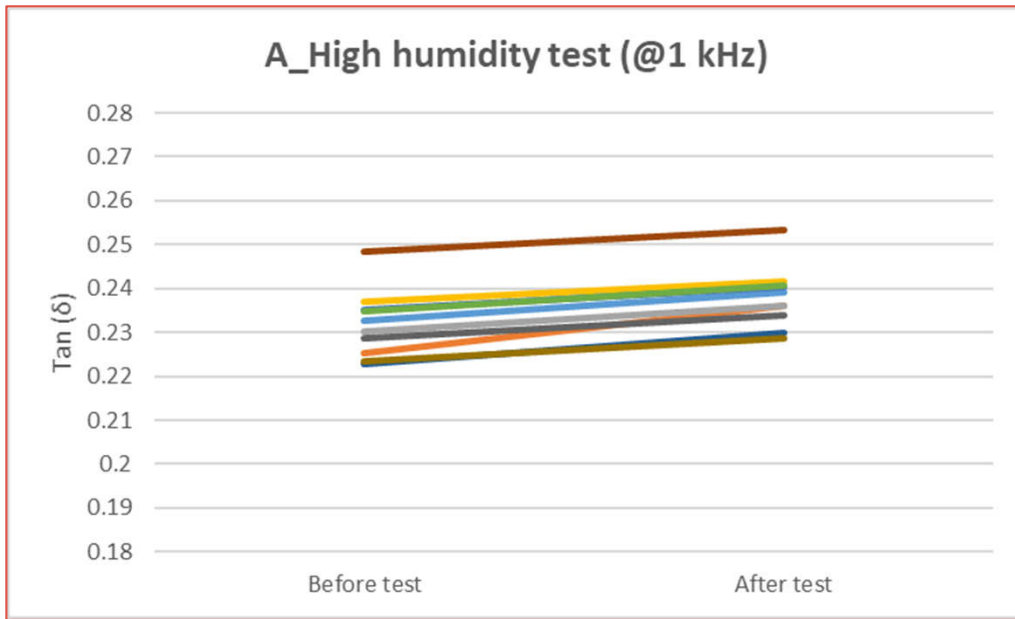


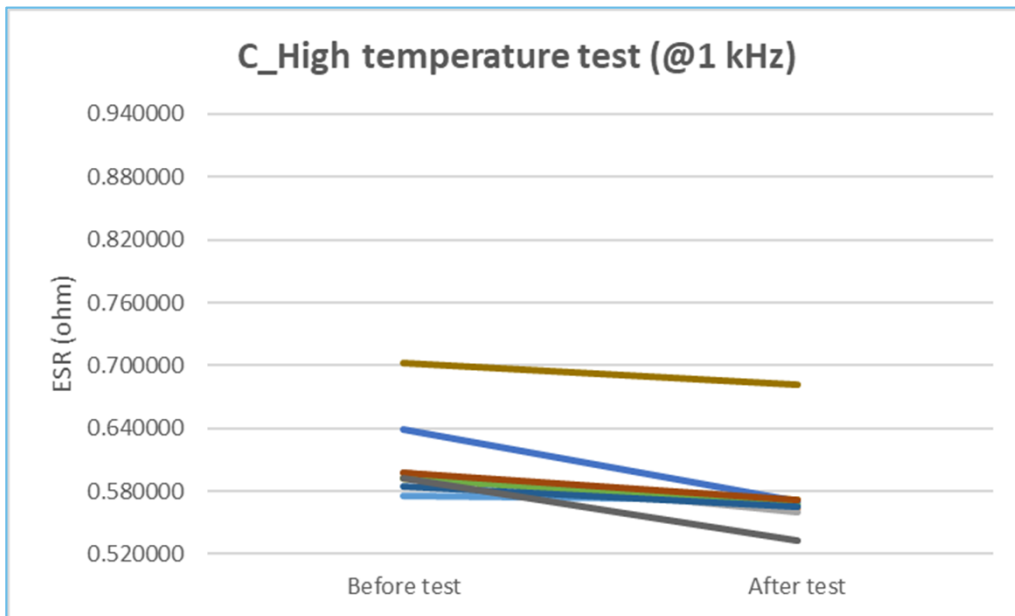
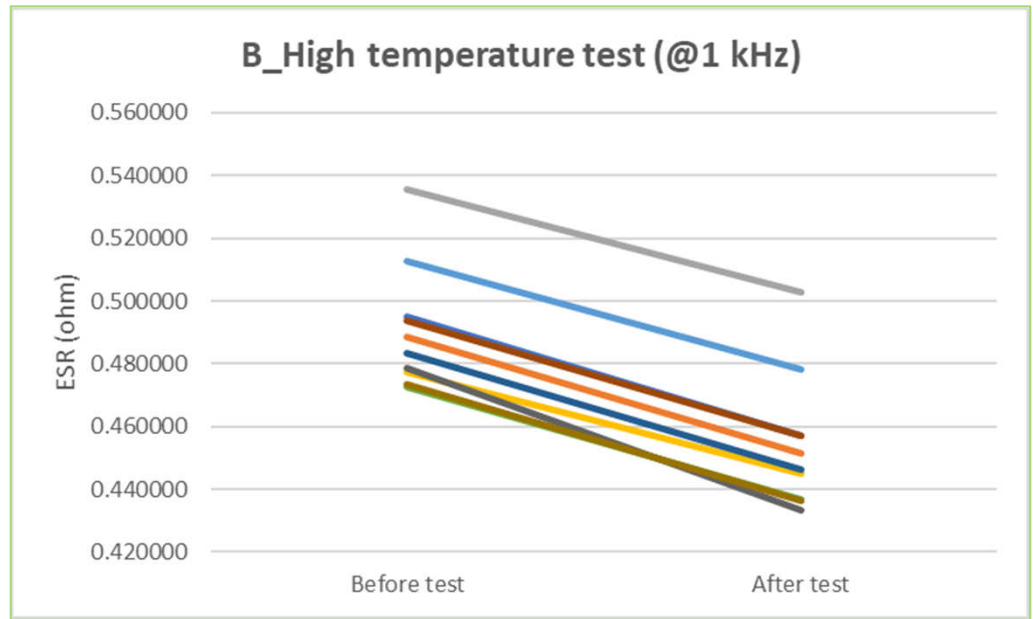
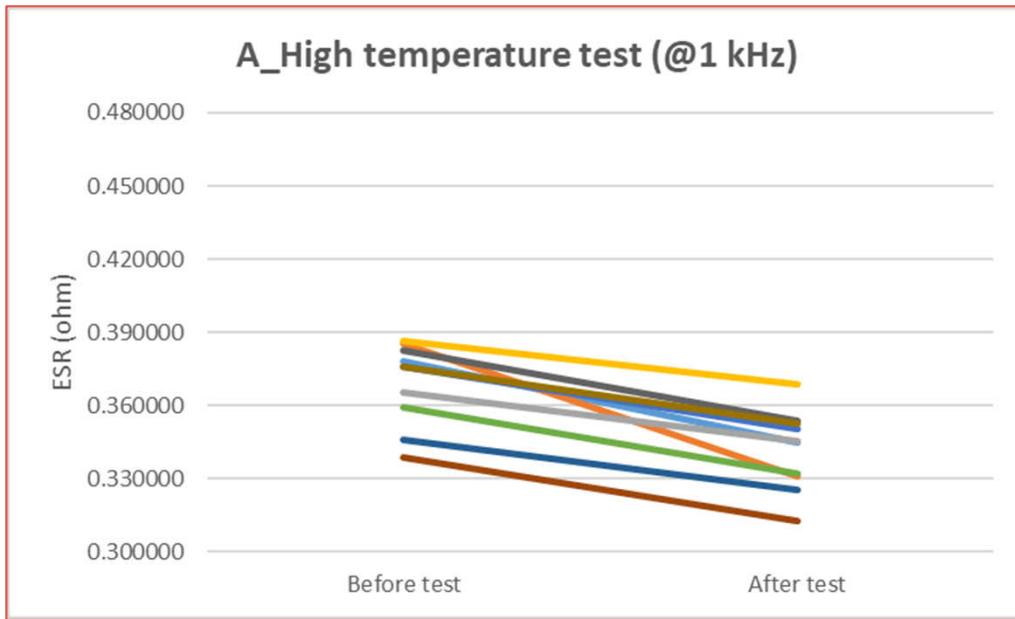
B_Vibration test (@1 kHz)



C_Vibration test (@1 kHz)

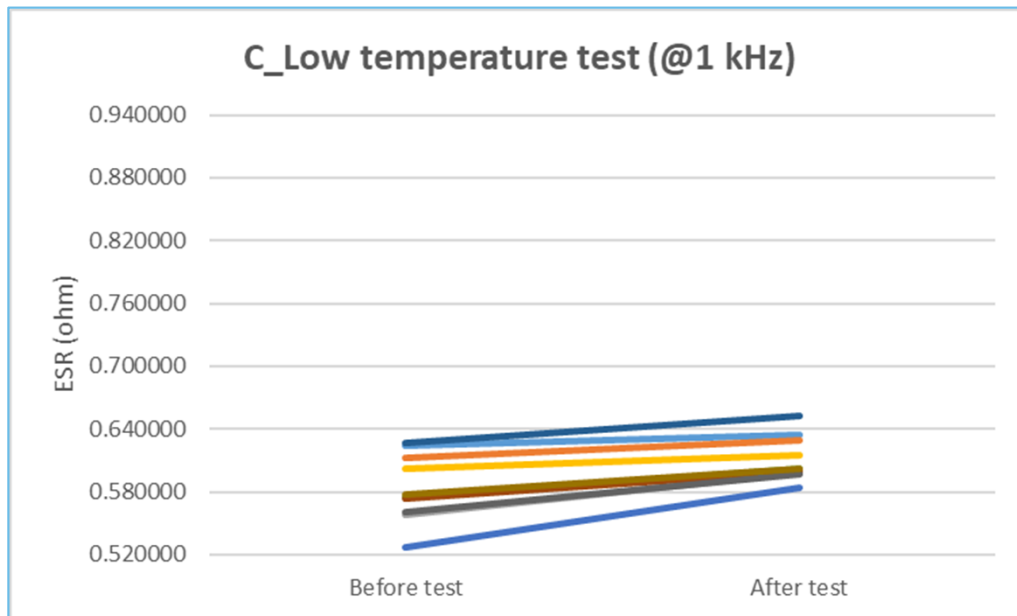
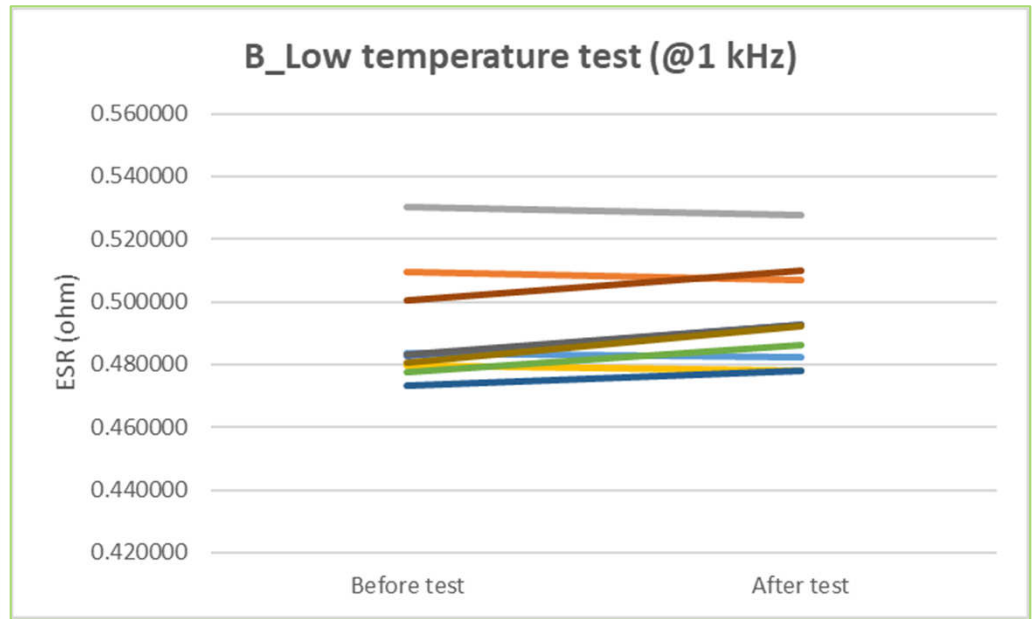
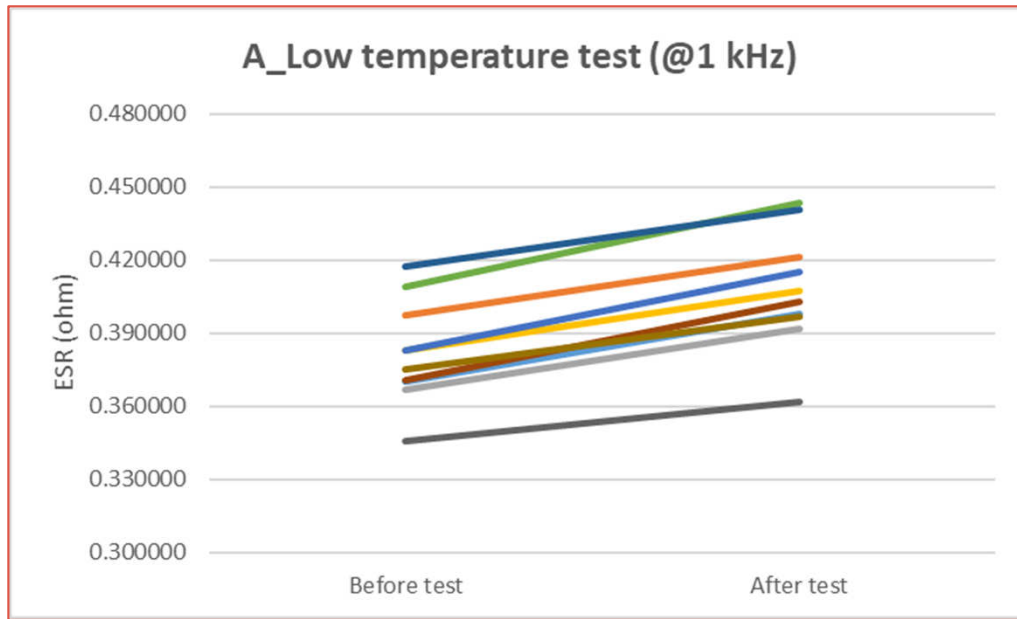


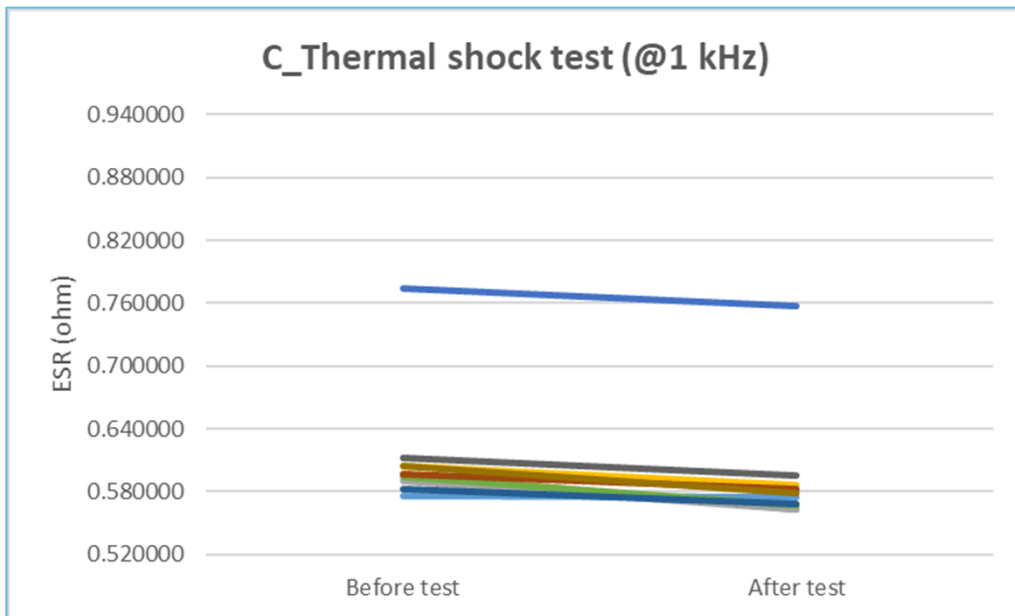
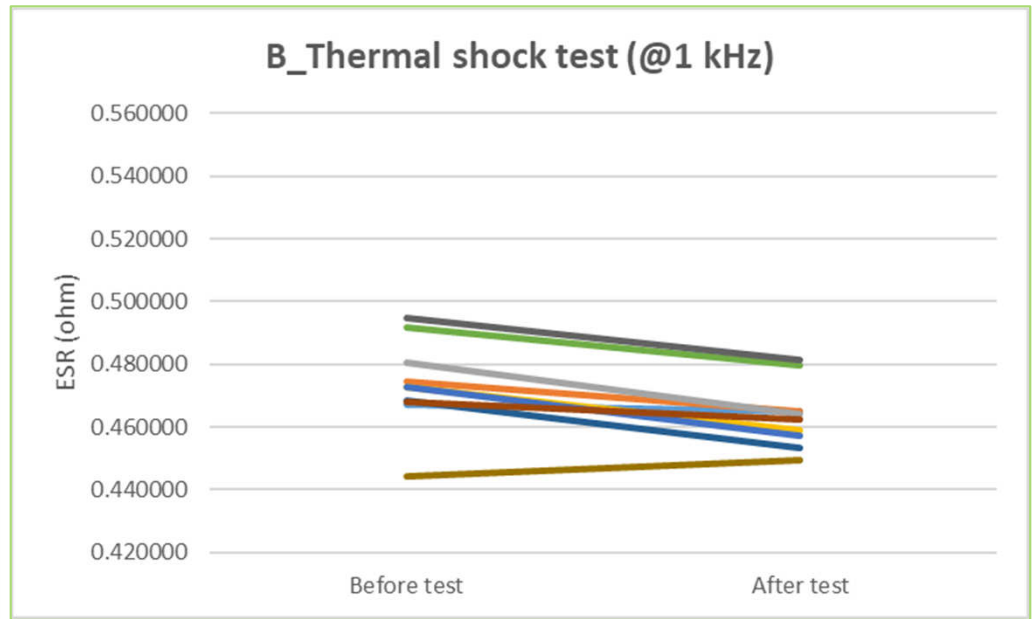
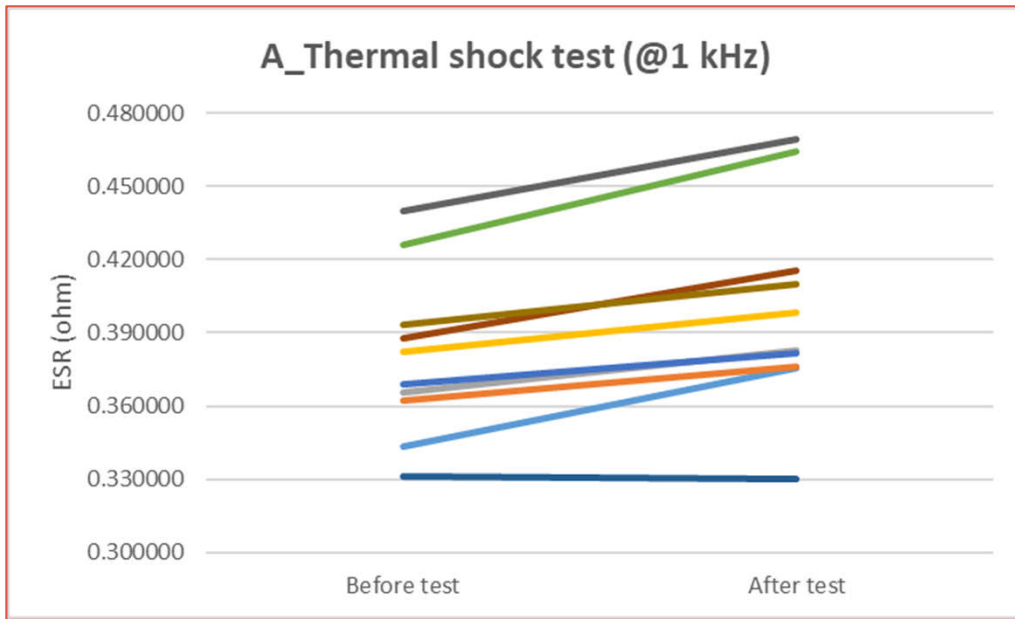




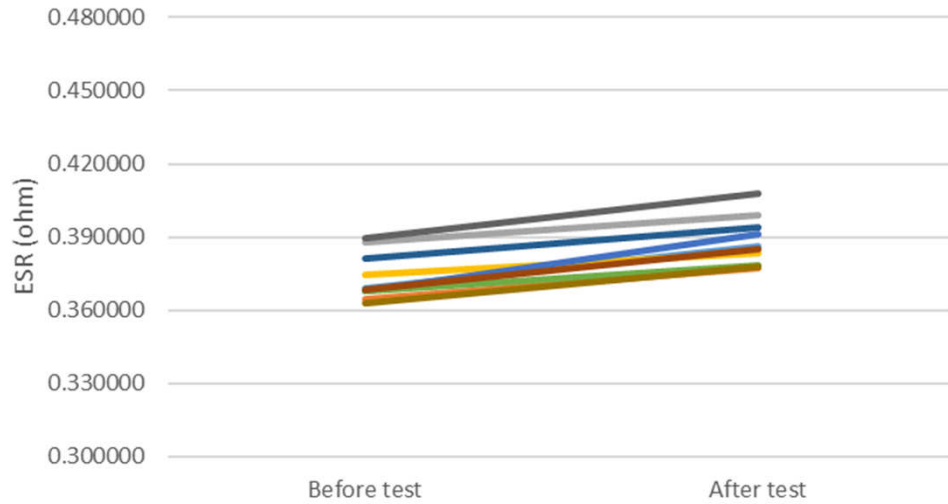
Summary

Low temperature test_ESR (ohm) @1 kHz

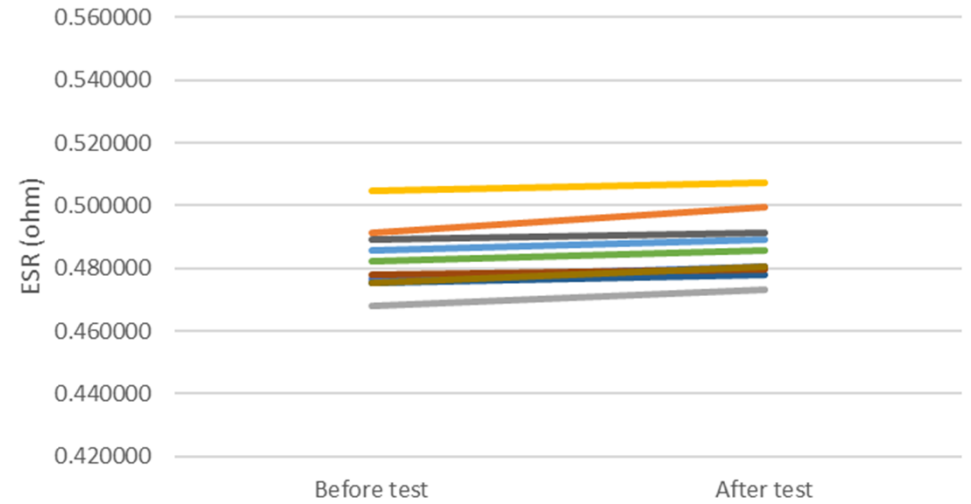




A_Vibration test (@1 kHz)



B_Vibration test (@1 kHz)



C_Vibration test (@1 kHz)

