Reliability of SuperCapacitors: Paper 2

Long-Term Reliability Test Data

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Introduction

Extensive testing of electronic components is required for an understanding of their device physics, their degradation behavior and their failure mechanisms for establishing their long-term reliability. Gaining a better understanding of part characteristics results in the utilization of the right part which can be recommended to customers depending on the application's operating conditions such as voltage, temperature and relative humidity. Samples of all products produced are evaluated and tested for up to 4,000 hours to establish reliability test data. As we strive to be an industry leader in reliability of our supercapacitors or electric double-layer capacitors, we do our due diligence by backing our product with an understanding of long term reliability of our product mix. This publication presents extensive 4,000-hour reliability test data available for customer evaluation and we have determined that this data is invaluable in various applications.

Long-Term Test Data

AVX tests samples of all currently manufactured SuperCapacitor series of products offered to customers. Parts are tested under various test conditions to gain a deeper understanding of the lifetime characteristics. Particularly, Capacitance vs. Time and Equivalent Series Resistance (ESR) vs. Time under various test voltages and shelf life at varying temperatures are established and this assists us in providing the best recommendation on lifetime expectancy of our products. Variables are altered to simulate harsh environmental test conditions such as high and low temperatures and relative humidity. The data collected enables use of our product with confidence so that the customer can establish the reliability of AVX SuperCapacitors.

Figure 1 below displays 4,000-hour Capacitance vs. Time data for SCCR12B105SRB. At room temperature, this part is rated at 2.7V and 1F, and at 70°C a derated voltage of 2.1V was

applied for long-term testing. The plot shows that capacitance reaches an asymptotic value as the 4,000-hour mark is reached.

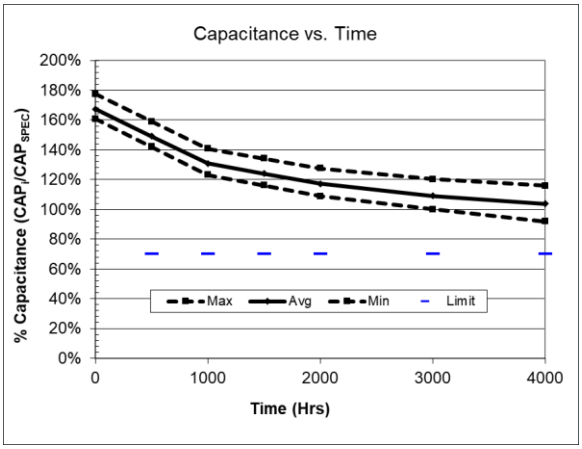


Figure 1: SCCR12B105SRB tested with 2.1V applied and held at 70°C for 4,000 hours.

Figure 2 shows the same part number tested with rated voltage applied and held at 70°C for 4,000 hours. At the conclusion of 4,000 hours, capacitance easily withstood the test conditions.

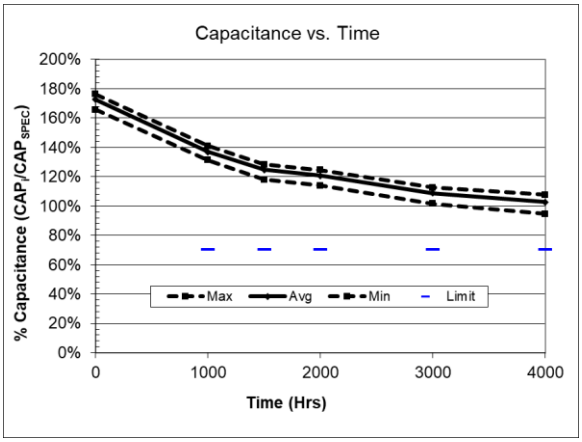


Figure 2: SCCR12B105SRB tested with 2.7V applied and held at 70°C for 4,000 hours.

Similar to data presented in our paper "*Reliability of SuperCapacitors: Paper 1"*, Figure 3 below features a 30% voltage derating (1.9V) for a 10F part (rated at 2.7V at room temperature) and held at 85°C, and this part easily passes the requirements as shown in the ESR vs. Time graph. The main difference here is that this is a cylindrical-style supercapacitor instead of a module that was featured in Paper 1.

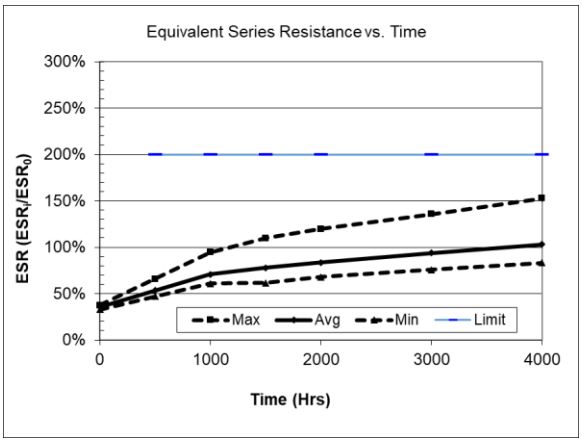


Figure 3: SCCS30B106SRB tested with 1.9V applied and held at 85°C for 4,000 hours.

Here is a Capacitance vs. Time plot of an unbalanced 0.47 F module tested at rated voltage (5.0V) and held at 70°C for 4,000 hours as seen in Figure 4. The curve shows that the capacitance reaches an asymptotic value showing slow degradation of capacitance.

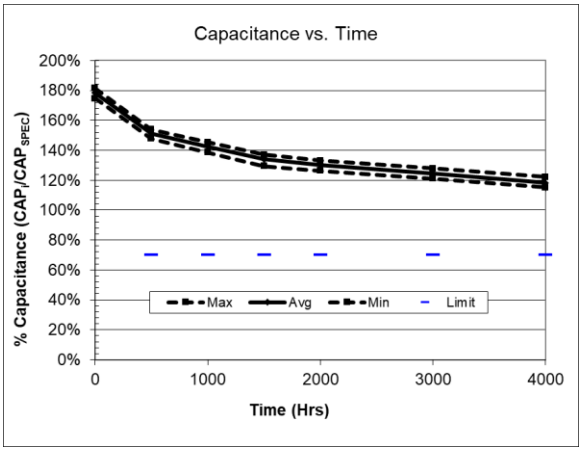
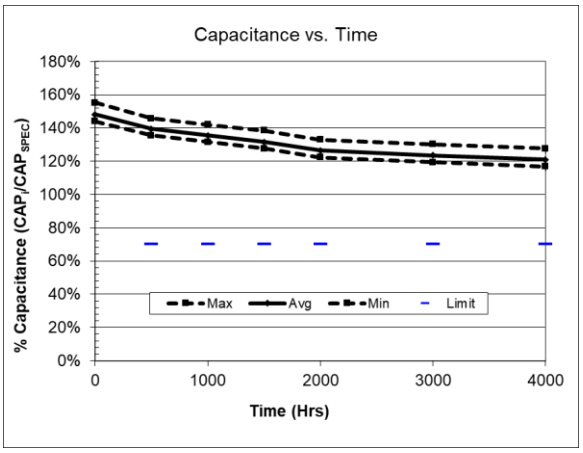


Figure 4: SCMR14C474MRBA0 tested with 5.0V applied and held at 85°C for 4,000 hours.

The next two plots, Figure 5a and 5b, show Capacitance vs. Time and ESR vs. Time, respectively. The part number tested was SCMR18C105MRBA0 which is an unbalanced 5.0V, 1F rated module. Test conditions were 40°C and 95% relative humidity for 4,000 hours. Based on plots already reviewed, it is easy to see that this part easily passed both tests and is suitable under the noted conditions.



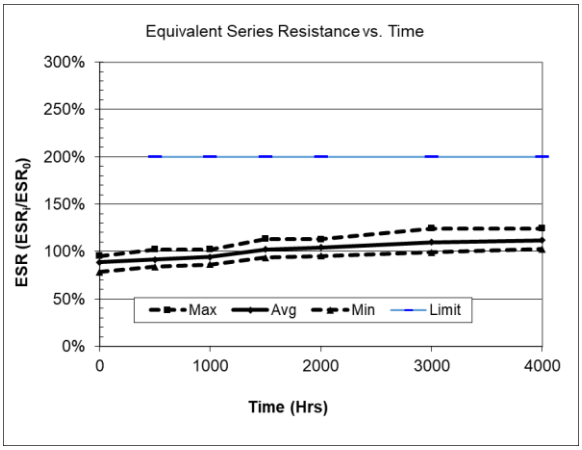


Figure 5a (left) and Figure 5b (right): SCMR18C105MRBA0, an unbalanced 2-cap module, tested with 5.0V applied and held at 40°C / 95% relative humidity for 4,000 hours.

Conclusions

This paper features long-term, 4,000-hr reliability test data to demonstrate that AVX SuperCapacitors are well within rated specifications at elevated temperatures. When derated to typical operating temperatures between 25°C and 45°C these parts are expected to last more than 20 years. Long-term data gives higher confidence in these parts compared to equivalent competitor parts.