KEMET Life Expectancy Model (K-LEM v2.0) Tool Tutorial

1- Introduction

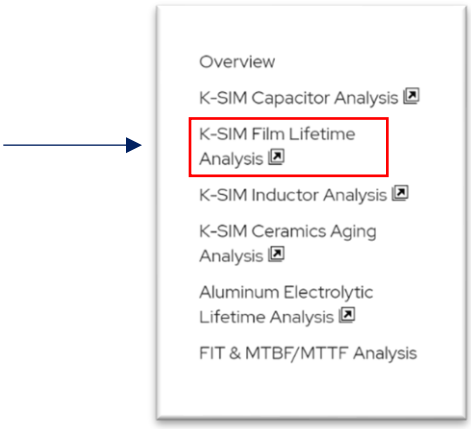
K-LEM is a powerful film capacitor design tool that can help circuit designers predict the service life of KEMET, Metallized Film Capacitors capable of withstanding Harsh Environmental conditions. It is the first of its kind tool to consider three key factors in a capacitor's life: Ambient **T**emperature, Relative **H**umidity, and Applied Voltage **B**ias (THB). It is based on a regression model developed at KEMET Corporation. The upgraded version of K-LEM 2.0 is available as K-SIM Film Lifetime Analysis on the KEMET Web Site at www.kemet.com.

As a key parameter, the Maximum Lifetime Expectancy in K-LEM for the capacitor is determined by the maximum variation in the Capacitance value of the Film Series, with a variation up to ***ΔC/C=-20%*** of the initial capacitance value. Other key design factors as DF and IR are also considered key variables in the internal calculation code per series and part numbers of the tool.

2- How to Access K-LEM (KEMET Life Expectancy Model) Tool

The K-LEM design tool is available on the KEMET website under the Design Tool section.

1) Open an Internet browser and visit the KEMET Web Site at https://ksim3.kemet.com/film-lifetime
2) In the top navigation menu select Design Analysis Tools and a drop-down menu will appear
3) Select K-SIM Film Lifetime Analysis



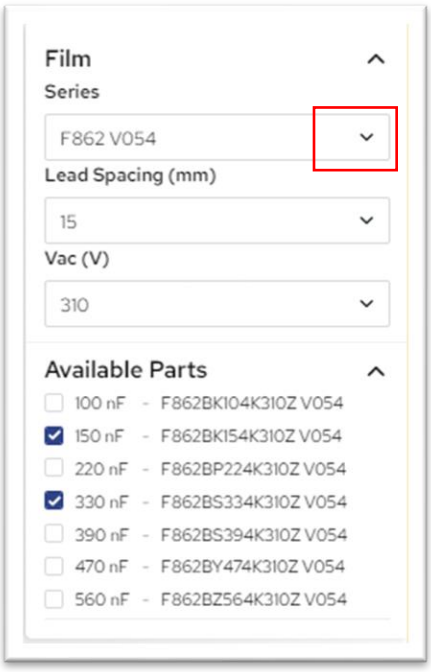
4) A new browser window will open with the K-LEM application

The second option to access K-LEM is through the Overview page, which will appear in the drop-down menu, after selecting Design Analysis Tools in the navigation menu.

1) Select the K-SIM Film Lifetime Analysis icon
2) A new browser window will open with the K-LEM application.

3- Selecting Series, Part Number(s), and Generating a Life Profile(s) for the Capacitor(s)

a. On the left scroll-down menus, select the Film capacitor series, Lead Spacing, and Part Number that you would like to analyze. Click on the down arrow to every line and a drop-down menu will appear.



b. Currently, K-LEM V2.0 offers the following Harsh Environmental Film Capacitor Series:

F862-V054	X2 EMI Suppression capacitor; 310 V_{AC}, According to Grade IIB per IEC 60384-14.4.
F863	X2 EMI Suppression Capacitor; 310 V_{AC}, 85 °C/85% RH at 240 V_{AC}
R41T	Y2/X1 EMI Suppression Capacitor; 125 °C, 300 VAC. According to Grade IIIB per IEC 60384-14.4
R41B	Y2/X1 EMI Suppression Capacitor; 125 °C, 350 VAC. According to Grade IIIB per IEC 60384-14.4
R52	X2 EMI Suppression capacitor; 110°C,310 V_{AC}, According to Grade IIB per IEC 60384-14.4.
C4AF-T	Power Film AC Filtering Capacitor with a voltage range of 250, 310, 350, and 400 V_{AC}
C4AF-F	Power Film AC Filtering Capacitor with a voltage range

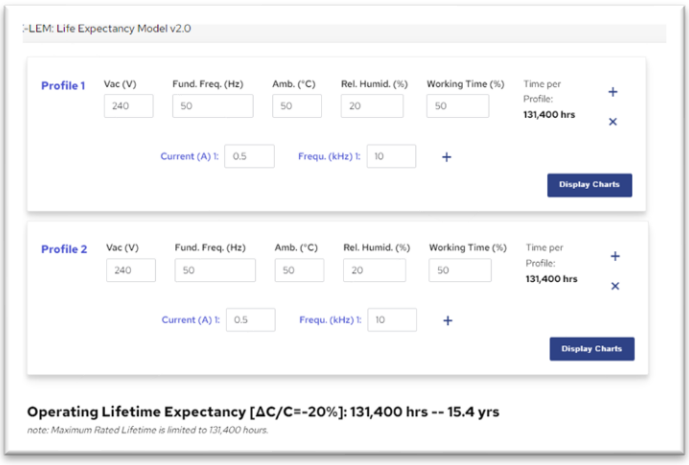
*The VAC (V) voltage listed is(are) the VAC nominal of the series.

c. K-LEM v2.0 offers additional Environmental Test Data, at fixed parameters, to the following series:

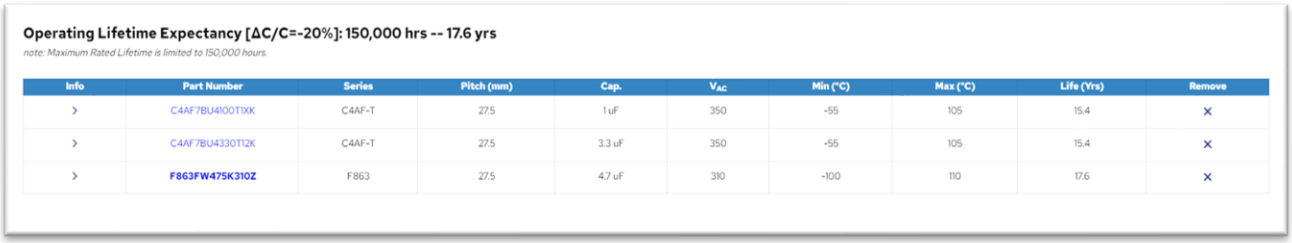
C4AK	DC – Link Capacitor; 900 V_{DC}
C4AQ-M	DC – Link Capacitor; 1200 V_{DC}
C4AQ-P	DC – Link Capacitor; 1100 V_{DC}
C4AU	DC – Link Capacitor; 1200 V_{DC}
R52 (pitch 15)	X2 EMI Suppression capacitor; 110°C,310 V_{AC}, According to Grade IIB per IEC 60384-14.4.
R53	X2 EMI Suppression capacitor; 110°C,310 V_{AC}, According to Grade IIIB per IEC 60384-14.4.
R53B	X2 EMI Suppression capacitor; 125°C,350 V_{AC}, According to Grade IIIB per IEC 60384-14.4.
R75H	Pulse Capacitor, 125°C, 2000V_{DC}, Harsh Environment capability

d. The user can select several series and part numbers with a single click on each part number available.

e. Initially, two default Profile Conditions are displayed on the right-hand portion of the tool with the life calculation per profile on the right-hand side, and the Total Operational Life (in Years) of the selected series is shown on the list on the left-down area of the calculator.

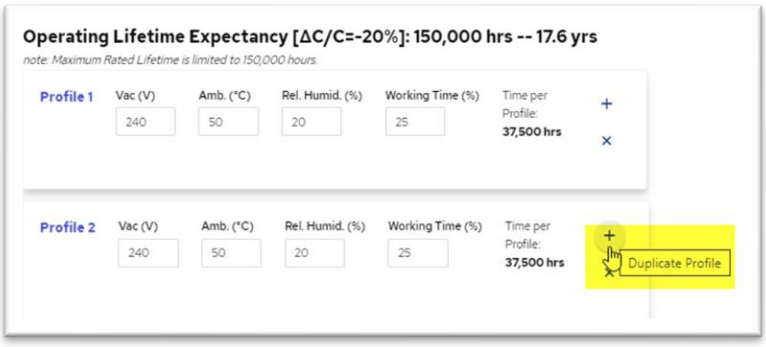


If several series are selected, the total Operational Life is shown on top, and the bottom of the profiles area is referred to the part number highlighted in bold characters on the table of p/n's. The Total life per part numbers, combining all the same profiles, are listed in the Life (Yrs) column. See the snapshot below as an example:



f. The user can duplicate, modify, remove, and add new profiles. With a single click on the (+) and (x) icons of the Profile and Part Number tables.

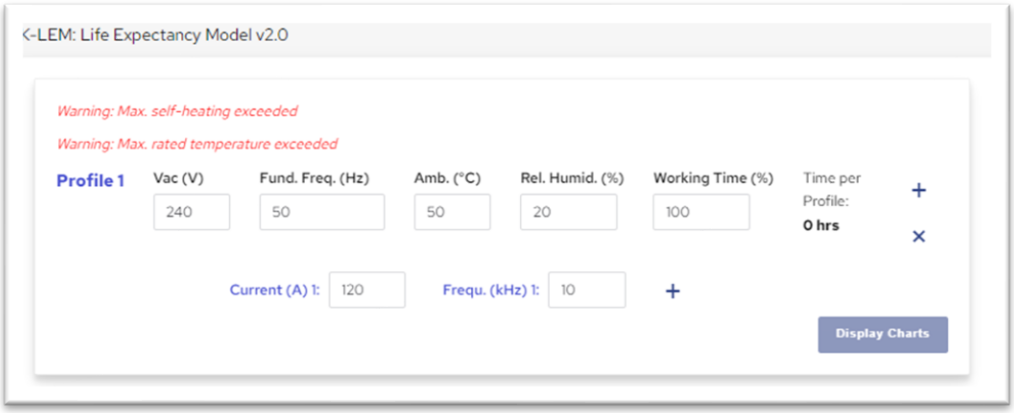
g. New profiles can be added with a single click on the + button. A duplicate of that profile is added to the calculation with a split of Working Time (%) of the initial profiles.



h. Once one or a set of profiles is entered, the tool displays the output result as "Operational Lifetime Expectancy" for the capacitor in hours and years.

4- K-LEM v2.0 new features

a. In addition to the previous version, current and frequency have been added as input parameters. These 2 play also very important roles in the calculation of the lifetime.



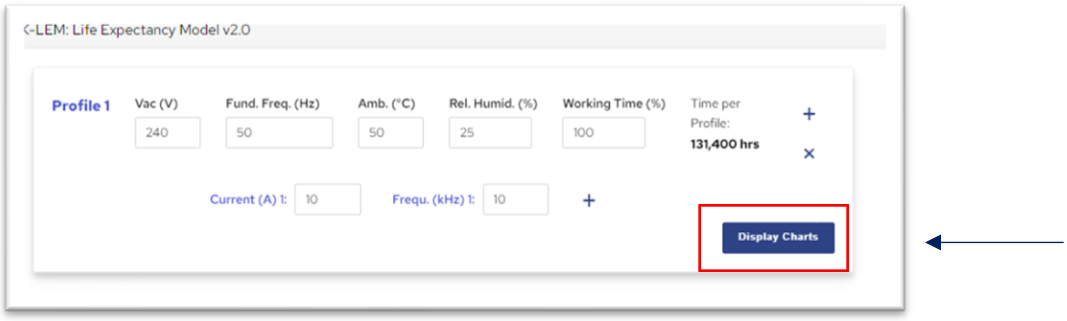
*If the parameters exceed the permissible limit, a red warning line will be shown on top of the profile.

b. Totally new features are the Display Charts

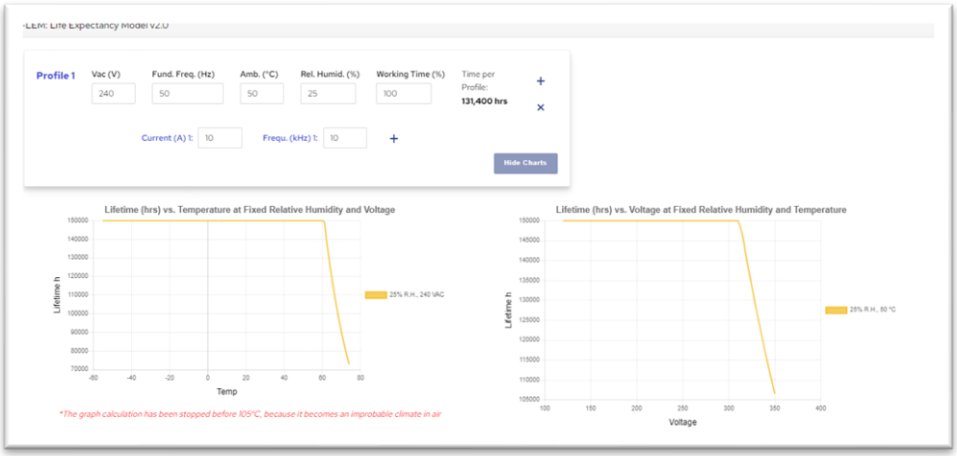
   i. Lifetime(hrs) vs Temperature at Fixed Relative Humidity and Voltage

   ii. Lifetime(hrs) vs Voltage at Fixed Relative Humidity and Temperature

After all white input fields are filled, click on the Display Charts button.



Two graphs will appear below the profile where the graphs are selected. The value can be read following the yellow line. For each profile, there are different display charts available.



5- Important Notes

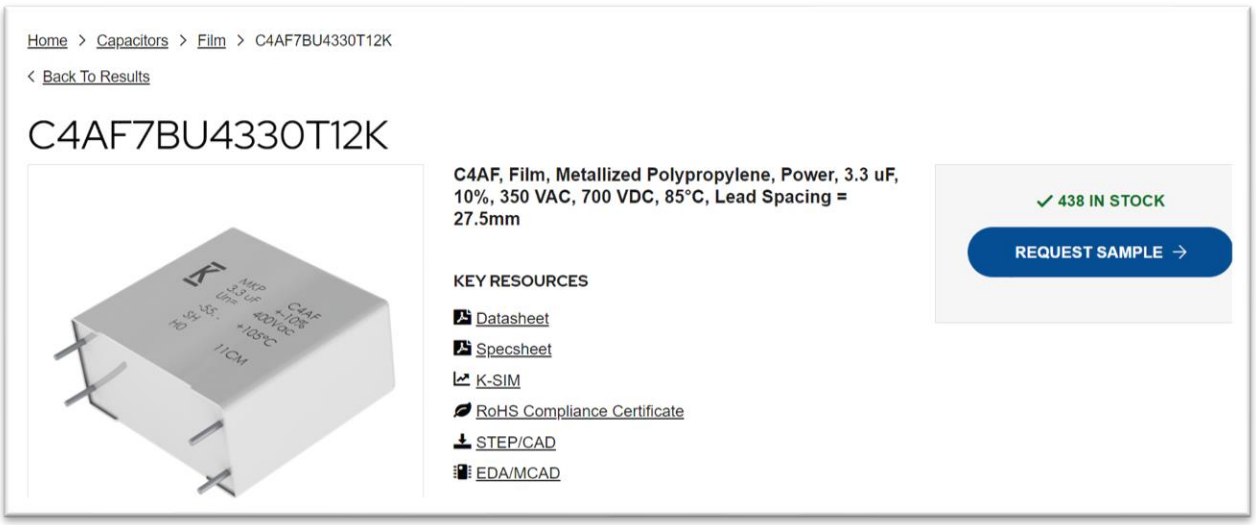
- **Note 1:** The accumulative **Working Time (%)** for the different profiles must add up to 100% Total criteria. Adjust your system mission profiles accordingly. The system automatically adjusts (to a default value) each profile when the user duplicates or erases a profile. The user needs to tune the default values based on his/her design criteria.
- **Note 2:** An Out of Range error is displayed if the values entered for the **VAC** and **Amb** exceed the capacitor series minimum or maximum specification. The Relative Humidity range should be between 2% and 100%.
- **Note 3**: The parameter used by KEMET to determine the capacitor's operational Life is set to a maximum variation in capacitance drop of ΔC/C= -20%.
- **Note 4**: The capacitor's maximum Rated Life is limited to 150,000 hours following KEMET standard specifications for the Film Capacitor series available in KLEM (F862-V054; F863; R52, R41T, 131,400 hours for C4AF-T and C4AF-F).

6- Key Definitions and Variables

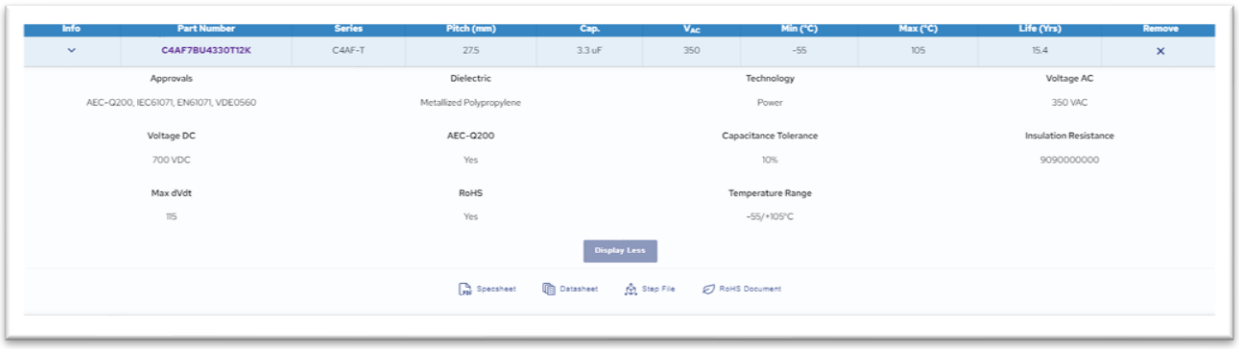
a. **VAC (V):** Operational voltage of the capacitor in VAC at 50 Hz or 60 Hz condition.
b. **Fund. Freq (Hz):** Fundamental Frequency of the main harmonic (50 Hz, 60Hz up to 120 Hz) in hertz
c. **Amb (°C):** Ambient Temperature near the capacitor body in the circuit in Celsius.
d. **Rel. Humidity (%):** Relative Humidity condition surrounding the capacitor in the system, in percentage value.
e. **Working Time (%):** Percentage of operational working time for the capacitor in the Life expansion of the system, in percentage. Ex: Percentage of the Profile on the total Duty Cycle of the system.
f. **Current (A) 1:** I_{rms} Current value of the harmonic 1 in ampere
g. **Frequ. (kHz) 1:** Frequency value of the harmonic 1 in hertz

7- Extra Features

a. Spec-Sheets of each selected part number are now linked to the KEMET Component Edge system on Kemet.com. A single click on the part number opens a new window with more details (parameters, datasheet, stock value etc) of the specific p/n selected. See the example below.



b. A click on the Info column arrow expands the details of the series and part number for better design reviews and extra links to key documentation related to the series. See the example below.



Please refer to our Sales/FAE/PM team for a more technical understanding of K-LEM capabilities.