HDP User Group International, Inc.
Pb Free Mini Power Cycling Reliability Assessment

February 26, 2014

Igor Perez-Uria-Ericsson– Project Manager
Larry Marcanti - Facilitator

© HDP User Group International, Inc.

Pb Free Mini-Power Cycles -Background

- High traffic operational cyclical modes, coupled with energy saving modes at the component level, have the potential to induce new reliability challenges by adding new types of thermo-mechanical stress and strain to equipment.
- Rapid and frequent mini-power cycling is now being coupled with the well-known stress from diurnal cycling and typical thermal operating conditions.
- The advent of Sn-based, Pb-free alloys for solder assembly is expected to increase susceptibility to power cycling-induced damage.

Project Proposal

HDP USER GROUP INTERNATIONAL, INC.®

Investigate these new operating modes and their potential impact on reliability of Sn-based, Pb-free alloys.

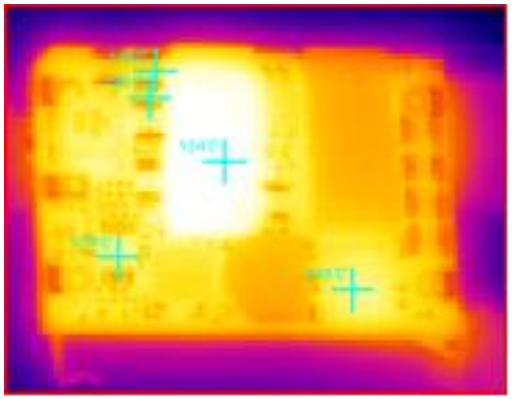
The objective is to provide realistic assessment of the interaction between emerging, higher-stress operating conditions and the Pb-free alloy formulations.

Power Cycling -Product: Power Module Failure analysis C1/C2

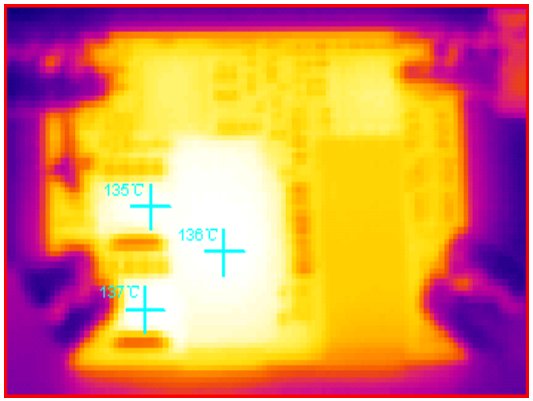
Test:
Operational life test -1000h

Test results:
2 failures of 30 tested modules.
Failure1: Module 774, C1, failed after 632 h
Failure2: Module 777, C2, failed after 848 h

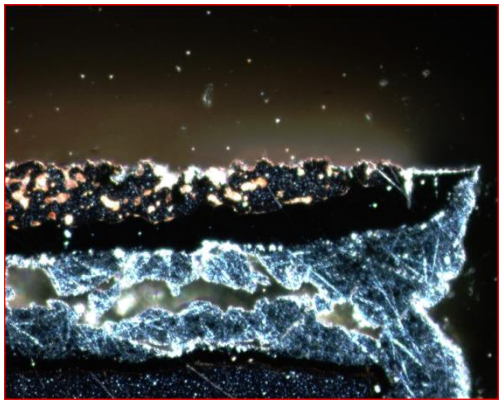
Power supply Capacitor Failures



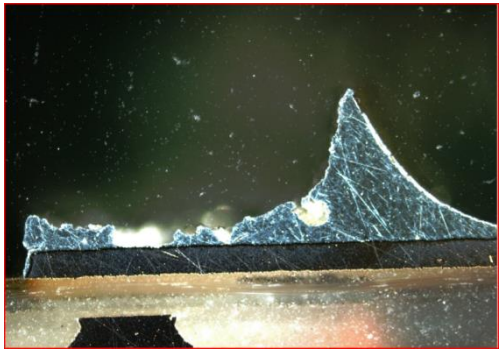
IR picture of top side with some ref temperatures.
Note: max temperature in op. life test is about 20°C below temperatures in this fig.



IR picture of bottom side.
Note that max temperature in op. life test is about 20°C below temperatures in this fig.

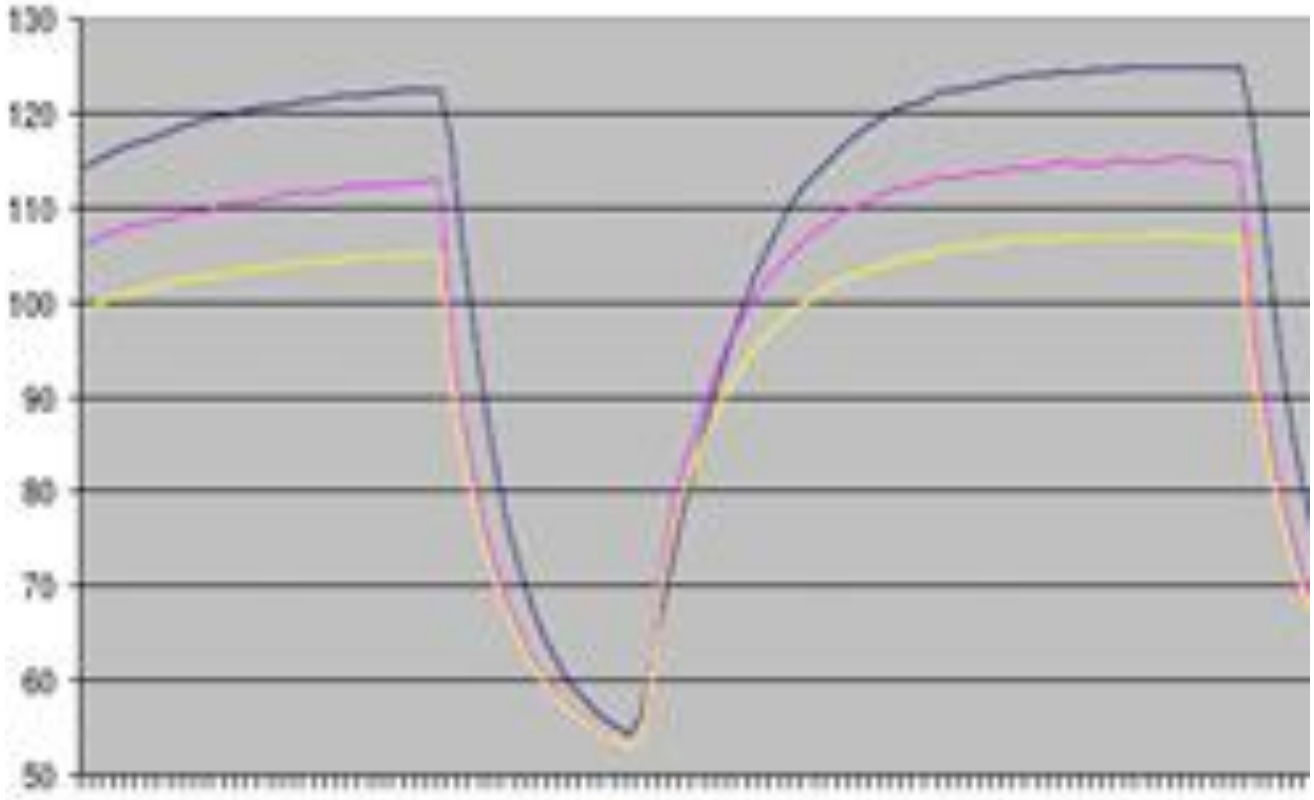


C1 left



C1 right

Typical Temperature Cycles



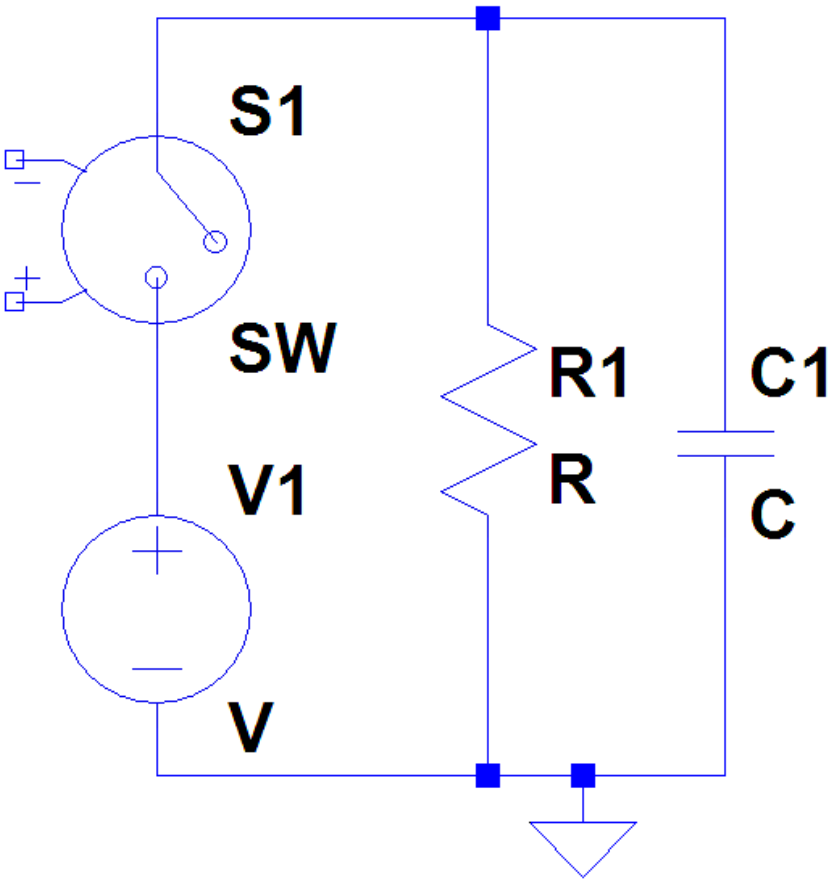
Temp curve Op. life

Simple approach

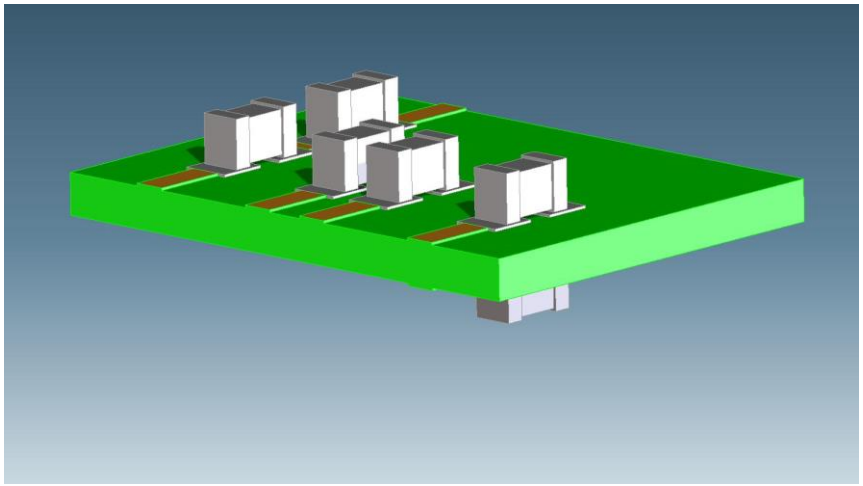
- Use simple and cheap components (basically capacitors and resistors, but maybe also diodes and even integrated LDOs, preferably components that don't need any control)
- Use power cycling (switching the supply power off and on)
- For components without (or almost without) internal losses, add a resistor close by (e.g. mount a resistor next to a capacitor or resistor on the backside of the board just below the other component.
- Use voltage to control the losses (i.e. the losses is generated/controlled by the resistors)
- The IPC 9592 cycle (either the Burn-In cycle or the HTOB cycle), or a steady cycle with a cycle time of about a few minutes to maximum 20 minutes)

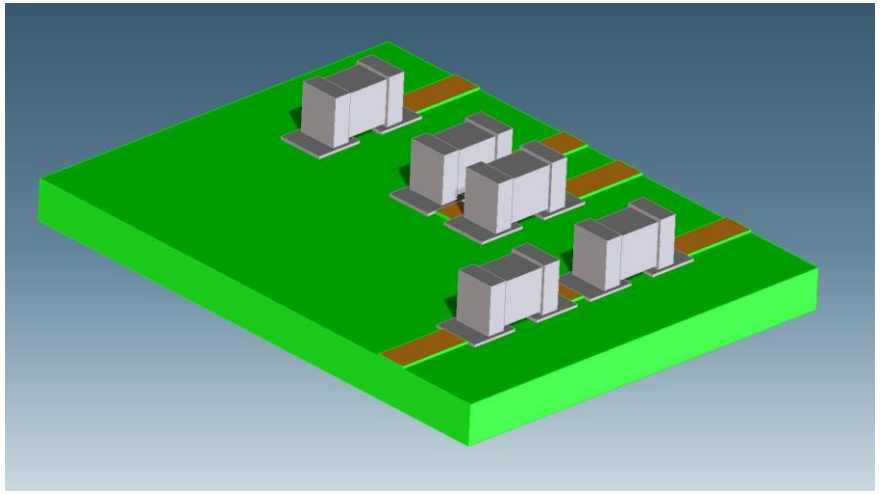
Circuit diagram

- Simple circuit diagram describing the idea. V1 is the voltage source. C1 is the device under test (and so is R1). The source voltage is used to control the losses (and by choosing resistor values). Many circuits could (and should) operate in parallel, all controlled by a single switch and fed from one single voltage source.
- (The switch is probably not really needed, controlling the voltage would be good enough)



Visualization of the idea





Solder pastes considered by Ericsson

- Low silver pastes:
  - SAC105 + 0.05Mn (Indium)
  - SAC105 + 0.02Ti (Indium)
- SAC305 pastes:
  - GT-R (Almit)
  - F620CU0.5-88M3 (Heraeus)

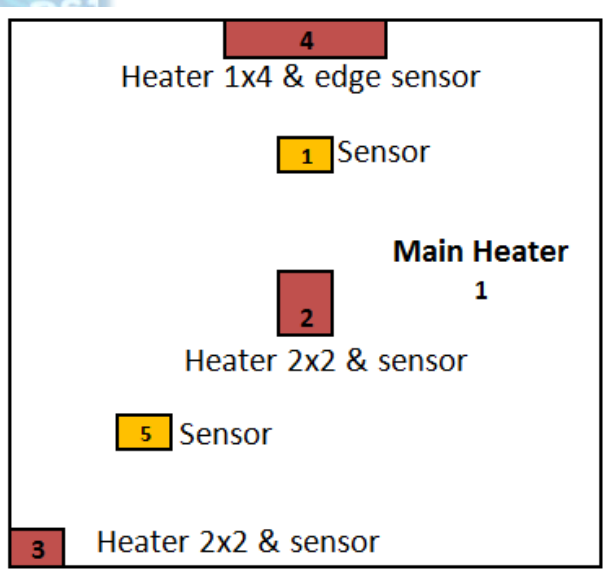
(type 4 pastes, vendor in parenthesis)

Next steps

- Need additional resources for test vehicle build. Plan would be to build a few test vehicles to validate test as first step.
- Additional devices, alloys and testing can still be proposed
- This project is in idea phase it is still open to input from other members.
- We will be having another project call in two weeks to take input from other members and then make decision on going to definition.

Update on original idea

- The first mini-power cycle project idea to look at intra package effects on large processor die that are in BGA packages. It was put on shelf because of component costs. There is still interest in this study.
- Freescale does have heater die that may be available. Would still require packaging.



90 Watt 15.8mm x 15.4mm