
EIGHTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 5 - 8, 2017
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 2
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Session 2

Jason Mroczkowski

Session Chair

BiTS Workshop 2017 Schedule

Performance Day

Monday March 6 - 1:30 pm

Performance Prediction

"Coaxial Test Socket - Evolution & Optimization"

Frank Zhou - Smiths Connectors

"100G Testing Fixture Design and Verification"

Jackie Luo - Shanghai Zenfocus Semi-Tech

"Inductance Rise Due To Plating"

Gert Hohenwarter - GateWave Northern, Inc.

"Spring probe current-carrying capacity (continuous vs pulse) analysis and improvement"

Yuanjun Shi - TwinSolution Technology Ltd

BiTS 2017 Burn-in & Test Strategies Workshop

Spring probe current-carrying capacity (continuous vs pulse) analysis and improvement

Yuanjun Shi
TwinSolution Technology

BiTS Workshop
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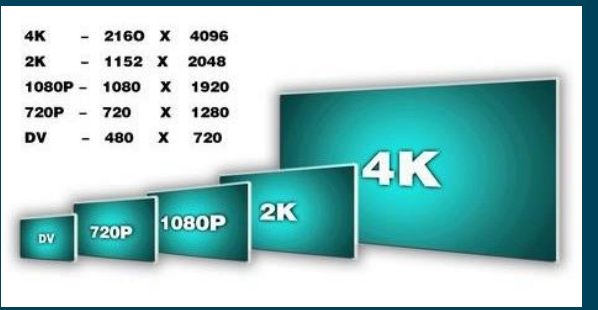
Contents

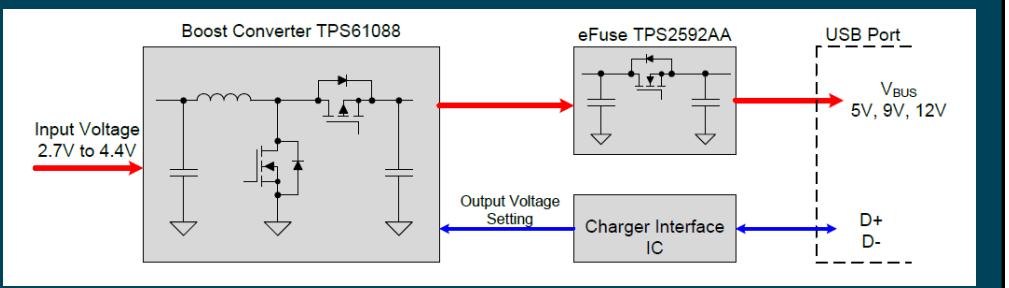
- Mobile power devices current Amps up
- Objective
- Experiment Setup
- Pulse Vs Frequency
- Thermal Analysis Model Setup
- Spring Material Impact
- Sliding Bearing Impact
- Assembly Mode Impact
- Summary & Discussion
- Future Plan

Mobile power devices current Amps up

1. More and more density requirement for the screen driving the current increase.



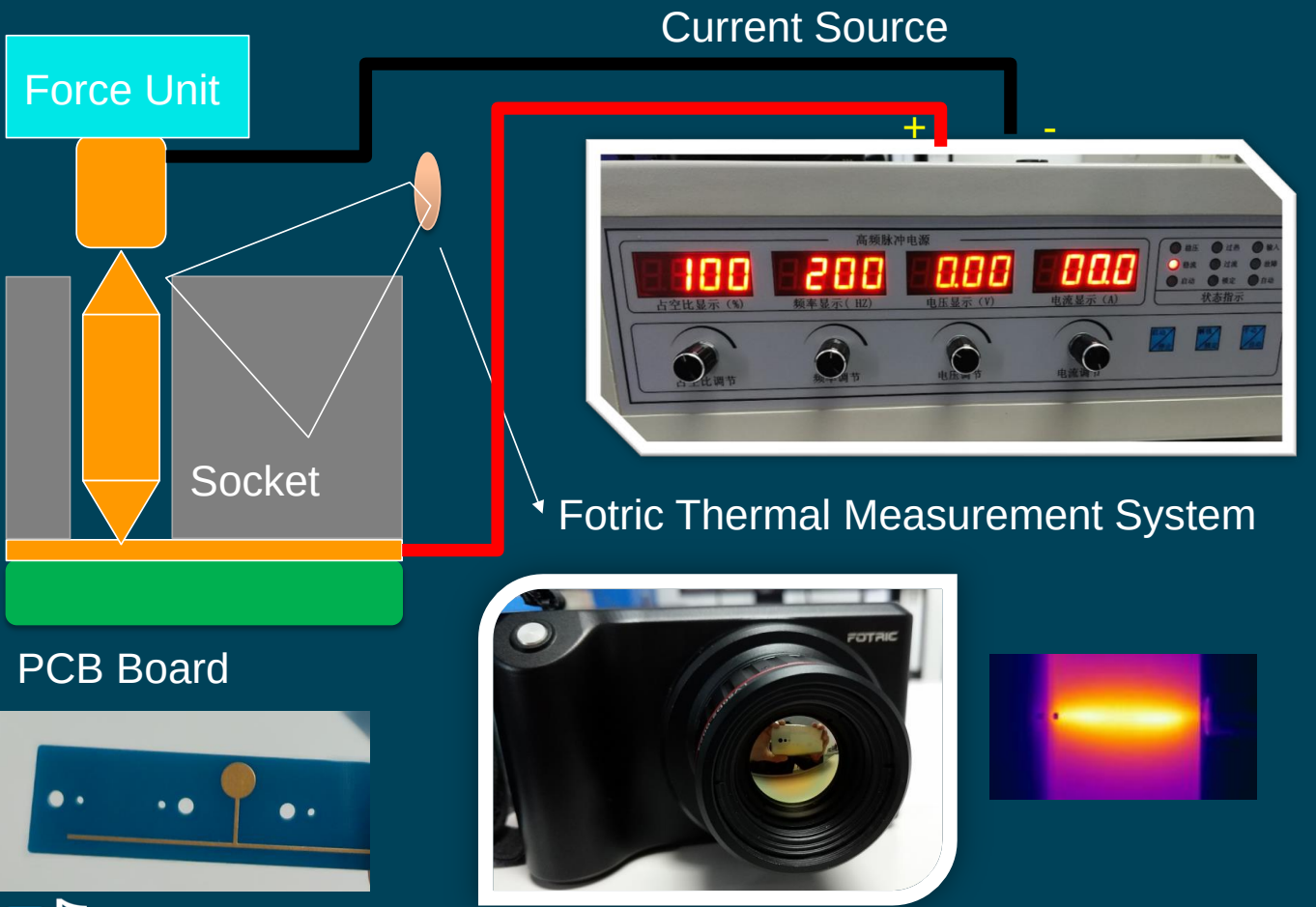
2. The function becomes more and more complex, and the secondary power management unit needs to be increased
3. Quick Charge
   - 5 V – 3 A
   - 9 V – 2 A
   - 12 V – 1.5 A



Objective

- This paper is going to discuss the influence of different current levels and modes.
- Continuous vs pulse, on a spring probe and how to improve its performance.
- Data from both FEA analysis and lab measurement are presented and compared.

Measurement Platform Setup



Voltage, Pulse Width, Frequency

- **Orthogonal Trial Design**
  - **3 factors (Voltage, Pulse Width, Frequency).**
  - **Each factors has 3 level.**
  - **Repeat 3 times, random block.**

Standard Order	Run Order	PtType	Block	Voltage	Frequency	Pulse Width
79	1	1	1	3	3	1
77	2	1	1	3	2	2
57	3	1	1	1	1	3
62	4	1	1	1	3	2
56	5	1	1	1	1	2
58	6	1	1	1	2	1
⋮						
7	80	1	1	1	3	1
14	81	1	1	2	2	2

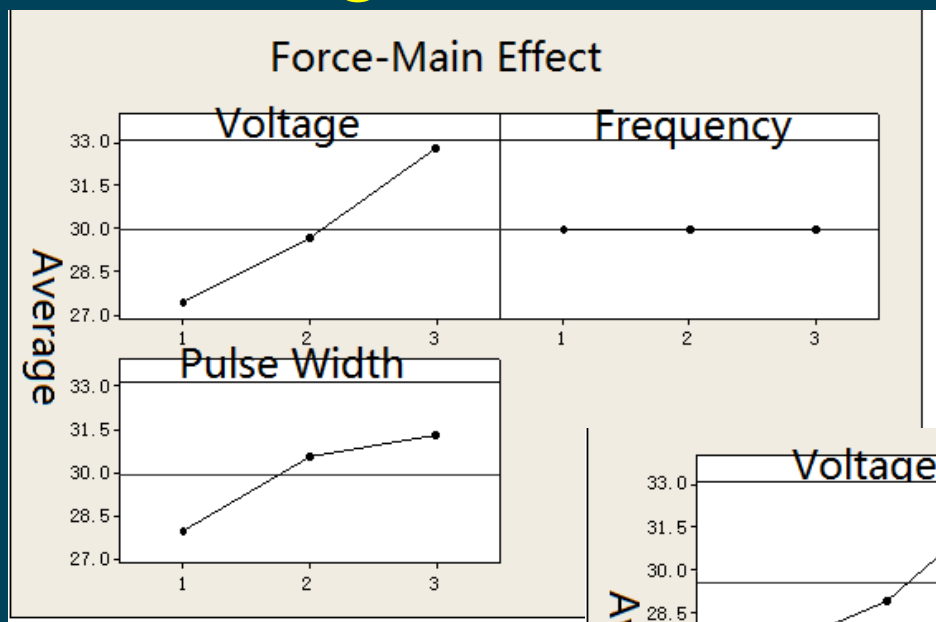
Voltage, Pulse Width, Frequency

Source	Freedom	F	P
Voltage	2	1899	0.000
Frequency	2	0.43	0.652
Pulse Width	2	685.2	0.000
Voltage * Frequency	4	1.47	0.232
Voltage * Pulse Width	4	210.7	0.000
Frequency * Pulse Width	5	1.63	0.181
Frequency * Pulse Width * Voltage	8	0.85	0.561
Error	54		
Total	80		

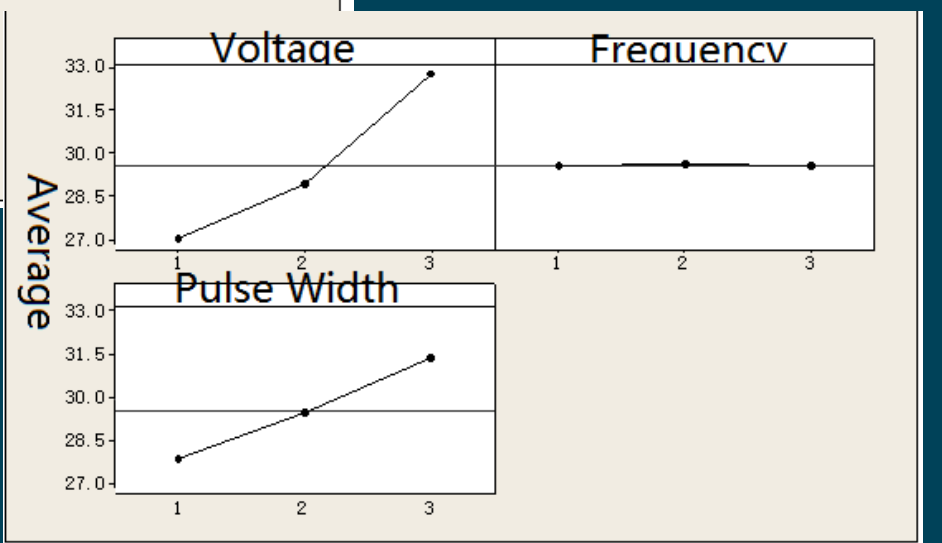
S = 0.598661 R-Sq = 99.11% R-Sq(Adjust) = 98.69%

Voltage and Pulse Width is significant to the temperature rising.

Voltage, Pulse Width, Frequency



ANOVA Analysis



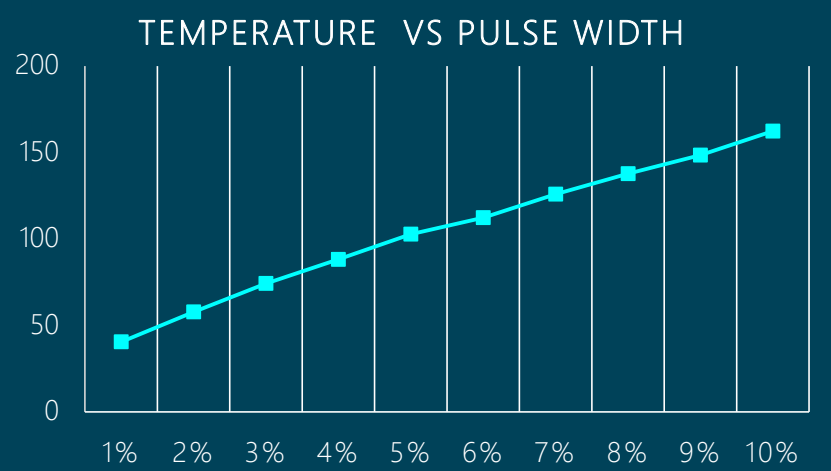
Average

Spring probe current-carrying capacity analysis and improvement 11

Pulse Width Vs Temperature

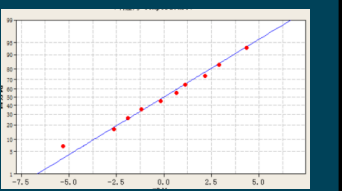
- **Test Condition (2.5 mm Length Pin)**
  - **Constant Current （15.6 A）**
  - **Fix Voltage （7 V）/ 500 Hz**
  - **Increase Pulse Width （1% ~10%）**

Pulse Width	Temp °C
1%	40.5
2%	57.8
3%	74.3
4%	88.2
5%	102.8
6%	112.3
7%	125.9
8%	137.8
9%	148.5
10%	162.4



Temperature = 32.6 + 1316 Pulse Width

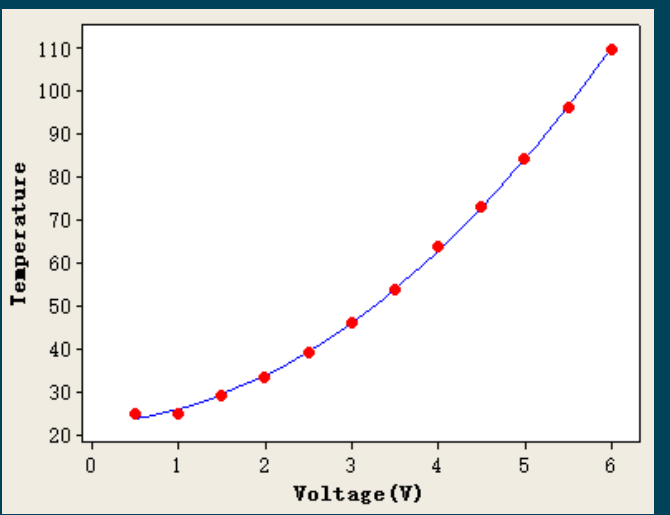
S = 3.03232
R-Sq = 99.5%
R-Sq (Adjust) = 99.4%



Voltage Vs Temperature

- **Test Condition (2.5 mm Length Pin)**
  - **Fix Pulse Width (10%) / 500 Hz**
  - **Increase Voltage（0.5 V ~ 6 V）= Current**

Voltage (V)	Current (A)	Contact Force (gf)	Temperature (^{0}C)
0.5	1.2	29	25
1	2.3	28	25
1.5	3.4	30.9	29
2	4.5	34.3	33.2
2.5	5.6	34.6	39.2
3	6.7	33.2	46.2
3.5	7.8	32.4	54
4	8.9	32.6	63.8
4.5	10	32.4	73.1
5	11.2	32	84.3
5.5	12.3	32.4	96.5
6	13.4	31.3	110



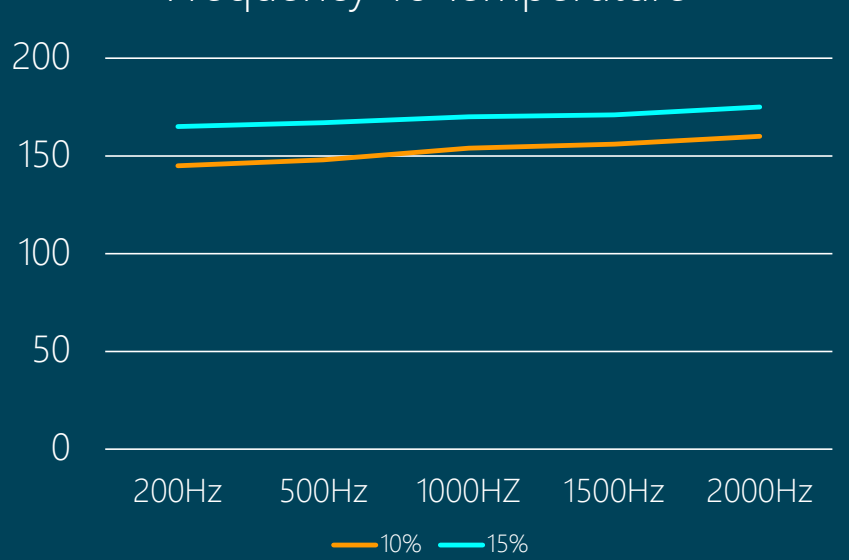
S = 0.643740

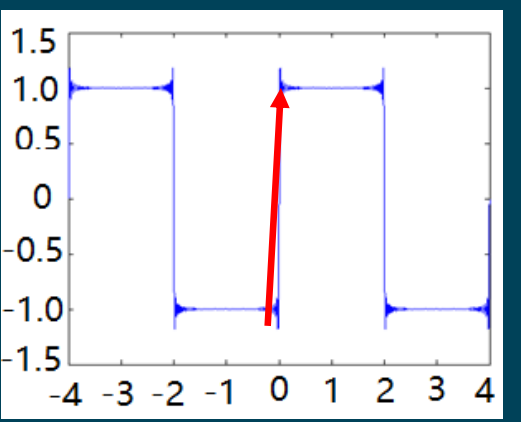
R-Sq = 100.0%,R-Sq (Adjust) = 100.0%

Temperature = 22.78 + 0.9404 Voltage(V) + 2.272 Voltage(V)**2

Frequency Vs Temperature

- **Test Condition (2.5 mm Length Pin)**
  - **Fix Pulse Width (10%/15%)**
  - **Constant（7 V)**
  - **Increase Frequency (200 Hz / 2000 Hz)**

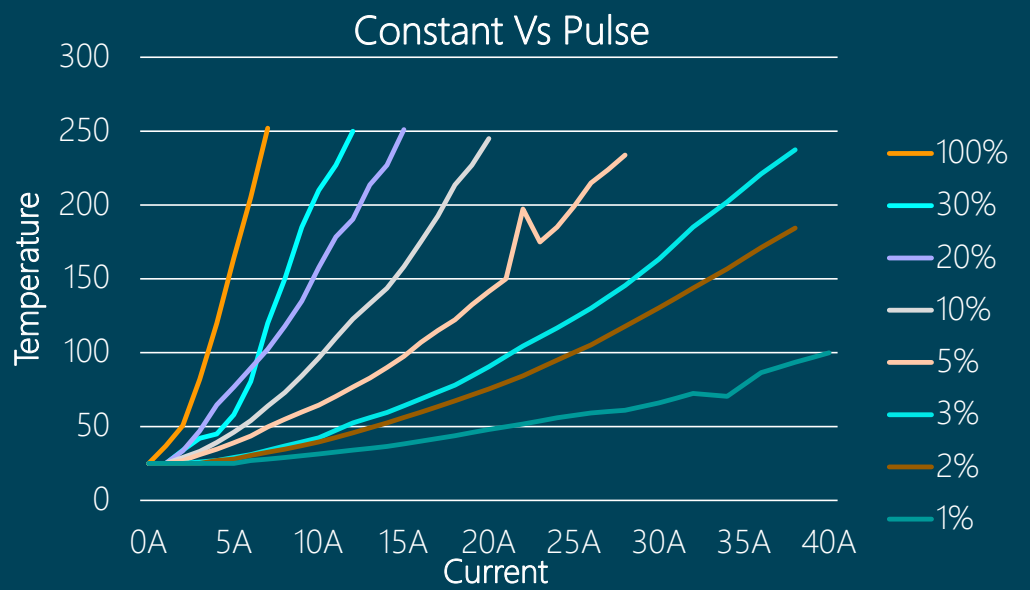




How fast of the rise time impact the temperature around 10 ^{0}C

Constant Vs Pulse

- **Test Condition (2.5 mm Length Pin)**
  - **Constant Current**
  - **Pulse Current (500 Hz – 2 ms)**

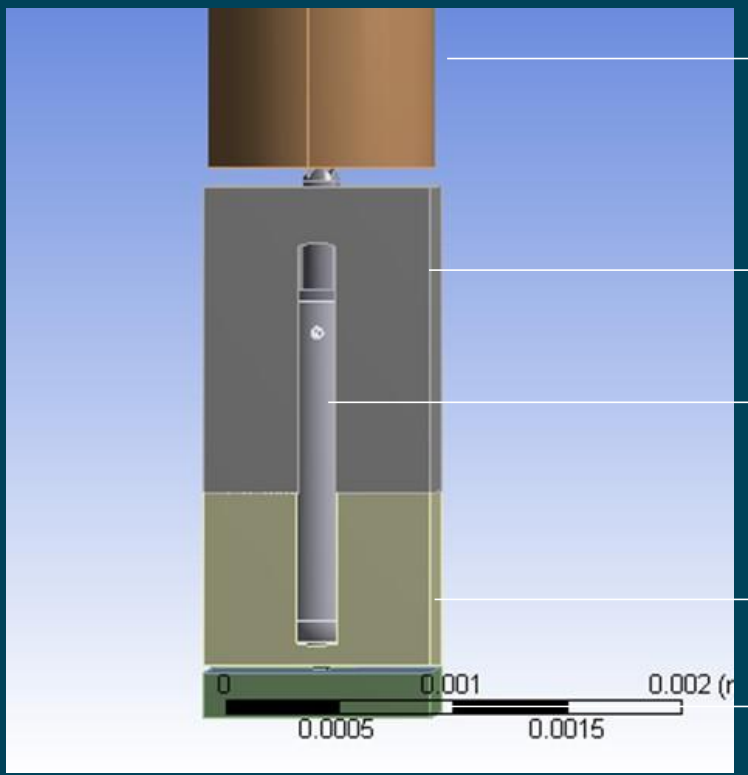


1/Pulse Width	Current
0.01	3.5
0.034	6.4
0.05	6.7
0.1	10.5
0.2	15
0.334	21.5
0.5	25
1	41

Apw =36.8*(100-Pw)/(100*Pw)+Aconst

What about pulse width < 1%?

- **FEA Model Setup**



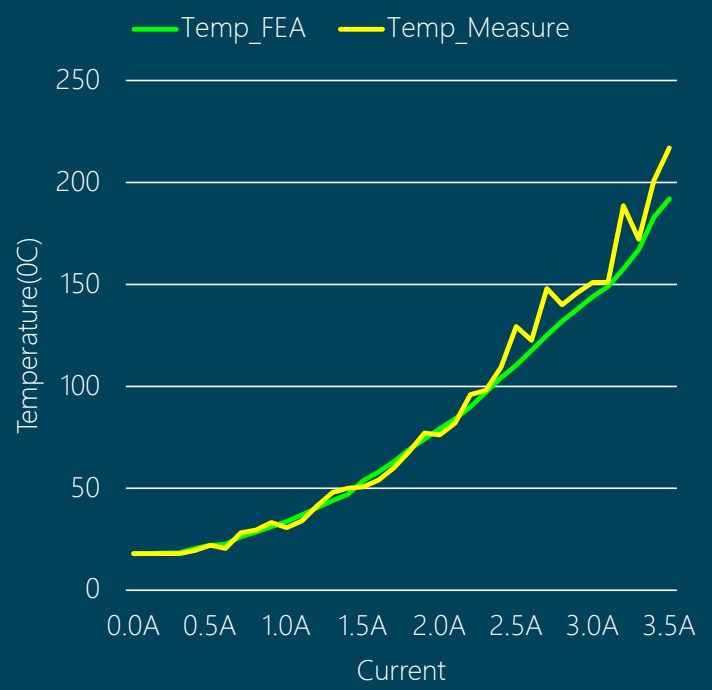
FEA Analysis

- Two kinds of Analysis
  - 1) Static Analysis :
  - 2) Transient analysis: T as a function of time.
- The material properties needed
  - Thermal conductivity, **k**, in w/mK
  - For transient analysis, also need
  - Specific heat, **Cp**, in J/kg K , specific gravity, **ρ**, in kg/m3
- Thermal loading/ Boundary condition
  - 1) **Set constant temperature** for selected nodes
  - 2) Set **convection condition** for selected nodes
  - 3) Apply **heat generation rate** for some elements

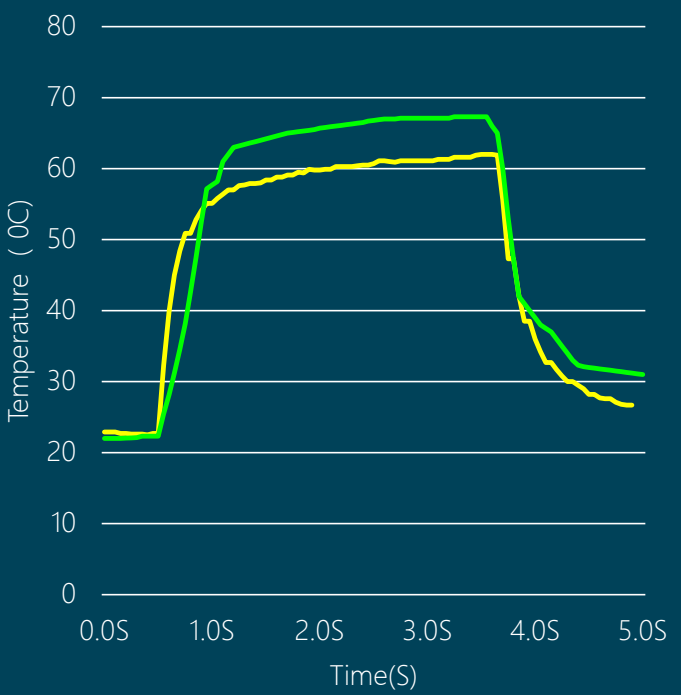
Material	Thermal conductivity k, W/ m. K	Specific heat Cp, J/Kg K	Specific gravity r, kg/ m3
Copper Alloy	400	386	8920
FR4	0.23	393	1900
Vespel	0.35	1130	1430

Model Validation

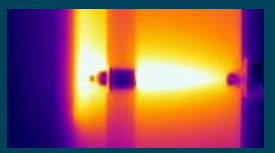
Steady Thermal



Transient Thermal

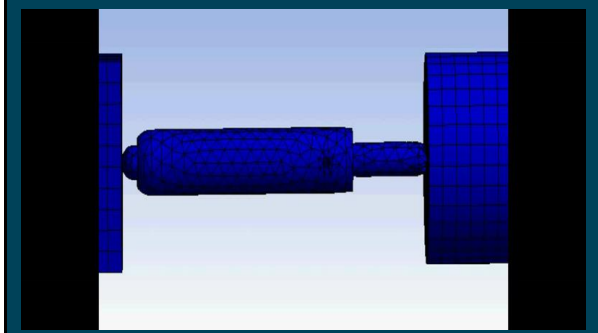


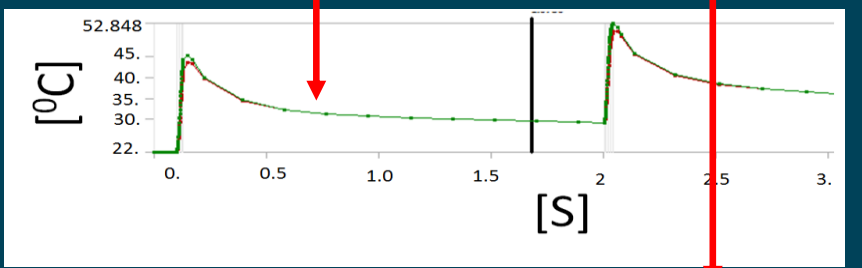
Yellow: Measurement Data,
Green : FEA Data

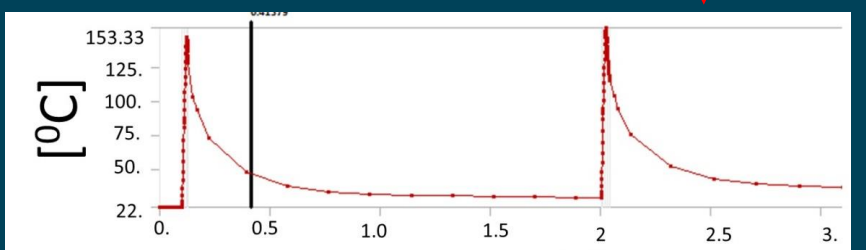


Pulse Current Temperature

- **Test Condition**
  - **9 A / 20 mseconds**
  - **2 S delay**

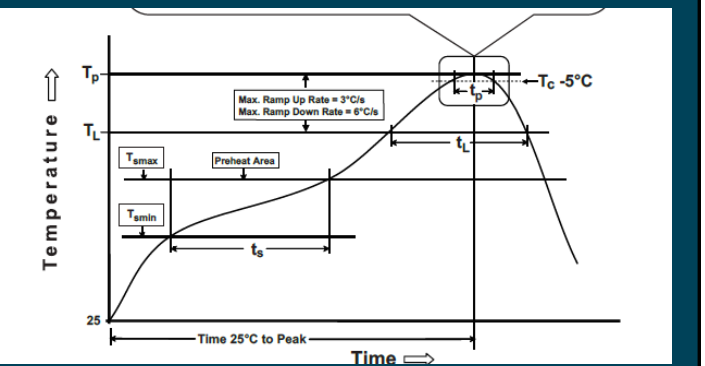






Temperature for CCC

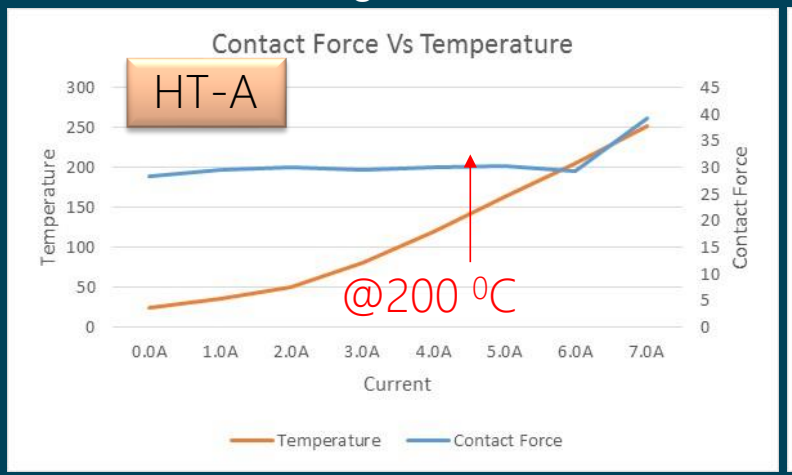
- **Solder Melt Temperature**
  - **Sn-Pb / 100^{0}C**
  - **Pb- Free / 150^{0}C**

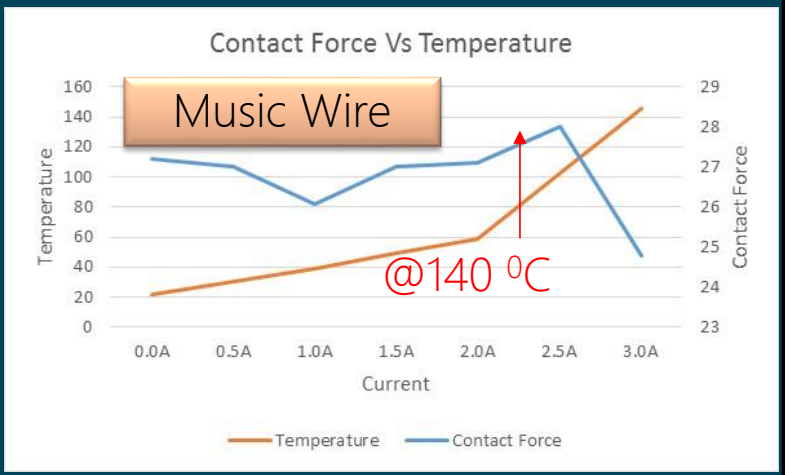


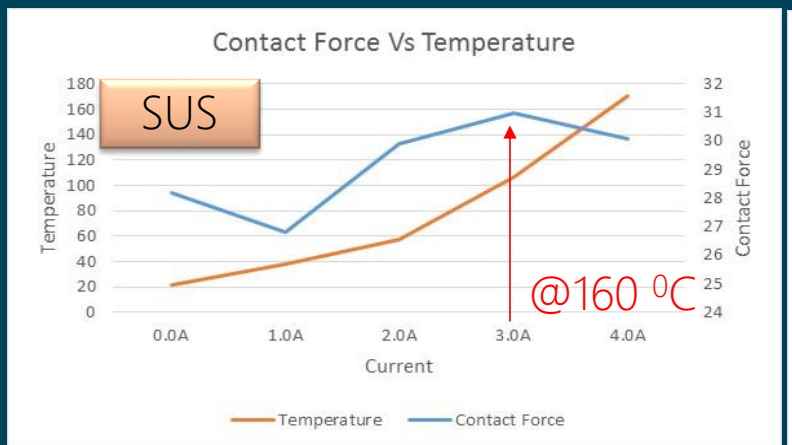
Profile Feature	Sn-Pb Eutectic Assembly	Pb - Free Assembly
Preheat/Soak	100^{0}C	150^{0}C
Temperature Min (T_{smin})	150^{0}C	200^{0}C
Temperature Max(T_{smax})	183^{0}C	217^{0}C
Ramp-up Rate (T_l to T_p)	60-120 second max.	60-120 second max.
Time(t_p)* with 5^{0}C of the specified classification temperature(T_c)	20*seconds	30*seconds
Time 25^{0}C to peak temperature	6 minutes max.	8 minutes max.

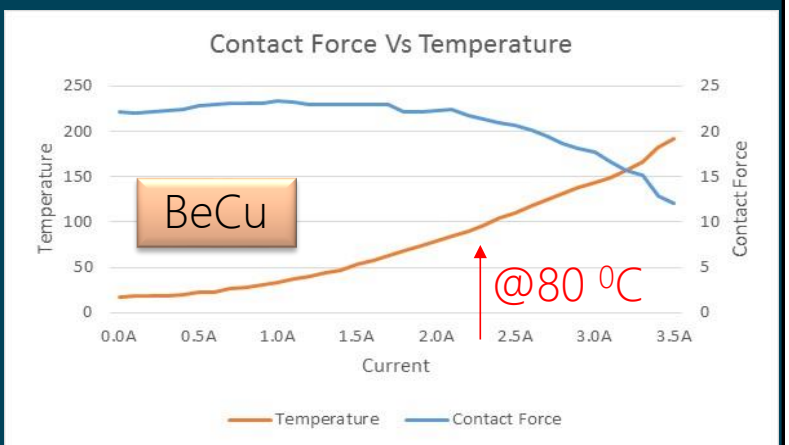
Unit:
Temperature: ^{0}C
Contact Force: gf

Spring Material



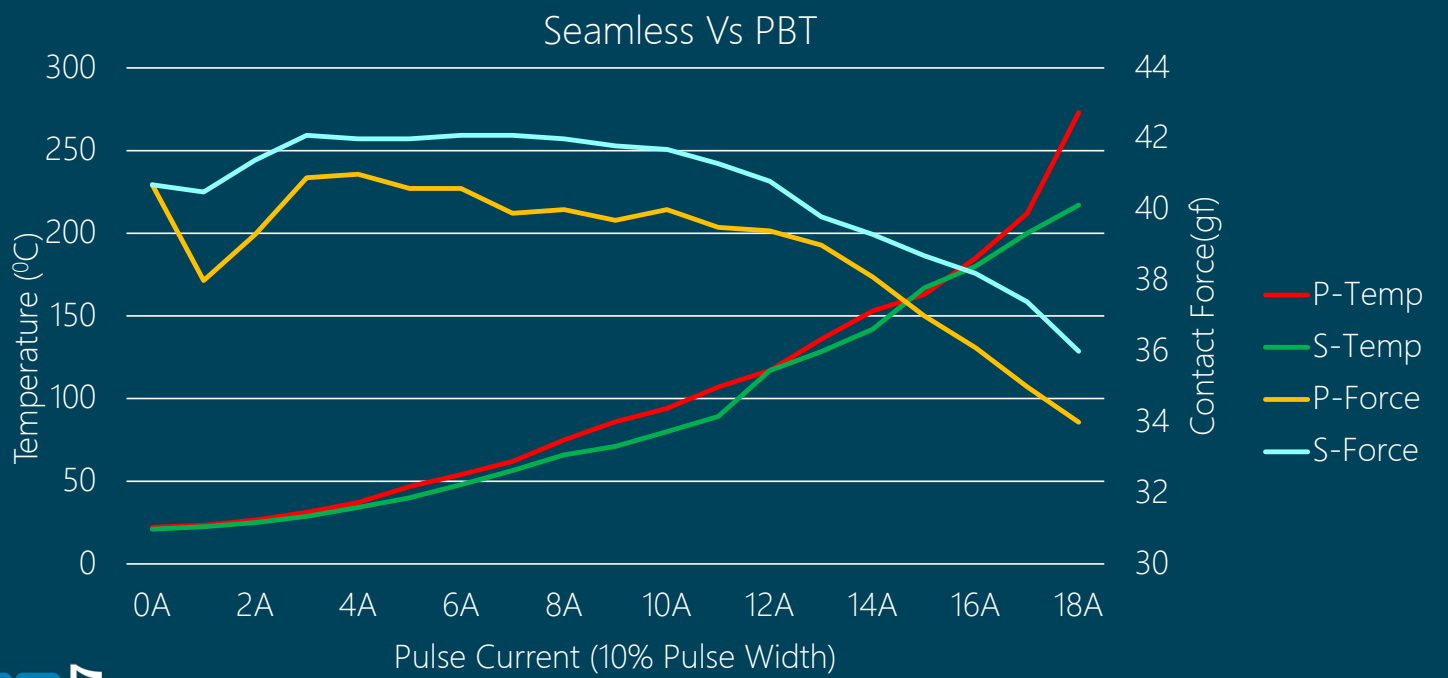






Barrel Material

- **Test Condition (4.75 mm Length Pin)**
  - **Pulse Current (500 Hz – 2 ms)**
  - **Pulse Width (10%)**
  - **Material: Seamless/Normal Tube (5 samples each)**



Sliding Bearing

- **Test Condition (4.75 mm Length Pin)**
  - **Pulse Current (500 Hz – 2 ms)**
  - **Pulse Width (10%)**
  - **Material: Phosphor Bronze Tube(5 samples each)**
  - **3 Type of bottom bearing select (Short, Medium, Long)**

Summary & Discussion

- Discussed which factor is more sensitive to temperature rise across Voltage, Pulse Width, and Frequency.
- Setup the model for Steady State and Transient spring pin temperature analysis with current loading.
- Setup the model for analysis long pulse width and low frequency current.
- Discussion of few improvements on spring pin design for increased current carry capacity.

Future Plan

- What will be the impact for the life span of the spring pin while we are temperature cycling the pin?