

MINIATURISATION OF SURFACE MOUNTED MULTILAYER CERAMIC CAPACITORS

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EUROFARAD

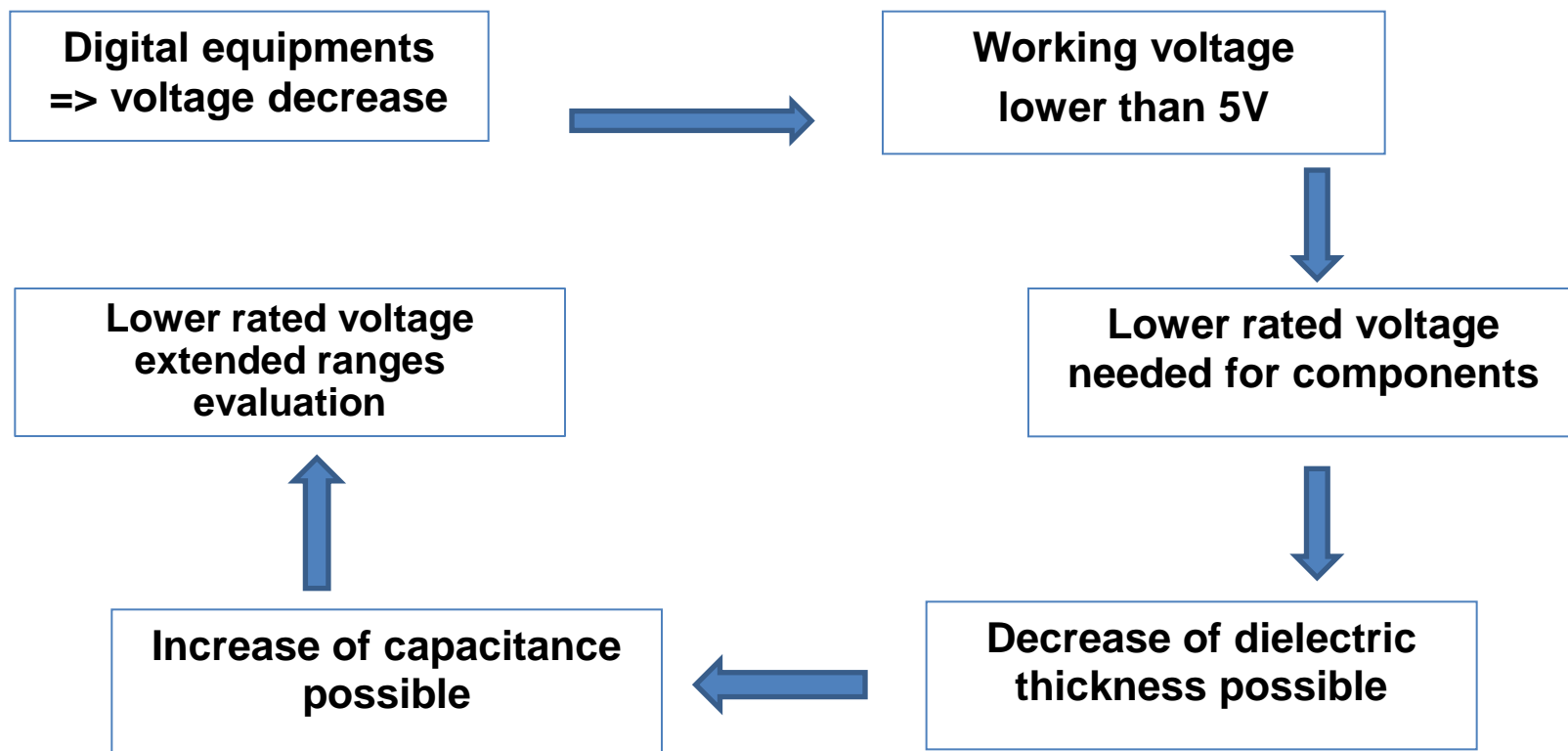
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Work done with support of 

The text "Work done with support of" is followed by the logo for CNES (Centre National d'Études Spatiales), which consists of a blue stylized "c" shape followed by the letters "cnes" in a bold, blue, sans-serif font.



EFD miniaturization plan :

- ✓ **Dielectric thickness decrease => lower rated voltage range (16V)**
- ✓ **New smaller size (0603)**
- ✓ **Flexible termination technology**

Dielectric thickness decrease :

- ✓ **Need of very homogeneous dielectric green tapes => Adaptation of dielectric slurries formulations**

- ✓ **Need of more accurate casting process (green tape thickness $\ll 10 \mu\text{m}$) => new casting equipment :**
 - ✓ **Thickness measurement precision**
 - ✓ **Thickness homogeneity**

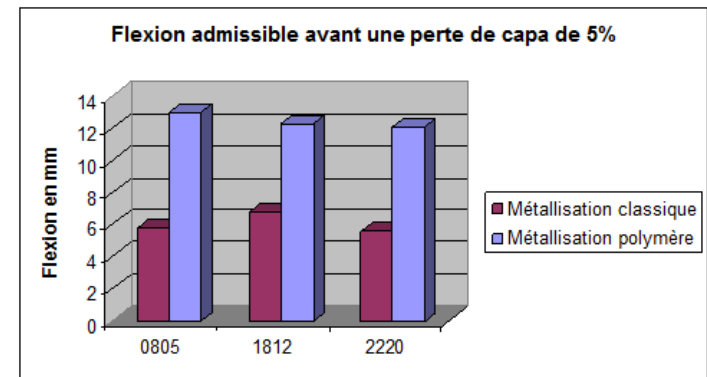
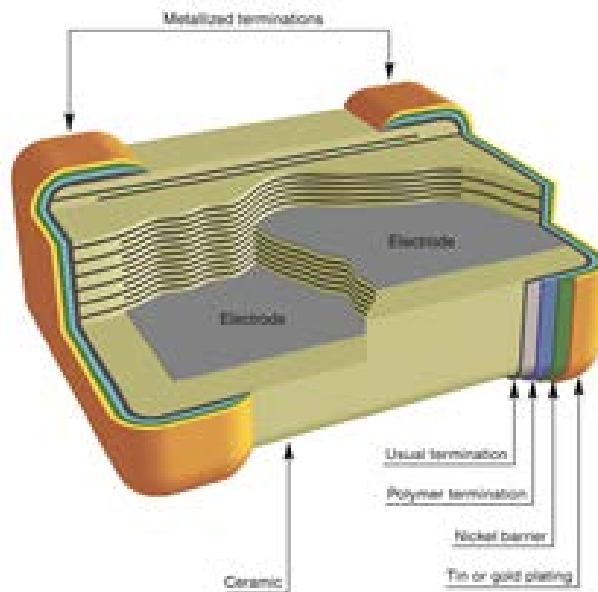
- ✓ **No green sheets handling process => new printing-stacking equipment**

0603 size :

- ✓ **New printing-stacking equipment allows a more accurate building of the capacitor's structure (better registration of the layers)**
 - ⇒ **Reduced margins**
 - ⇒ **Increase of active surface**
 - ⇒ **Increase of volumic capacitance**

Flexible termination technology :

- ✓ Addition of a flexible overlayer, to improve the parts resilience



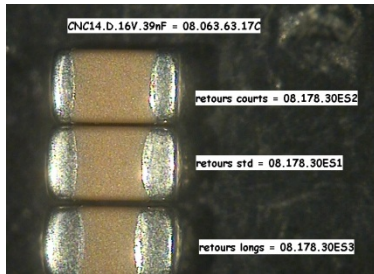
Tests programs for 0603-2220 16V-100V ranges :

- ✓ **Evaluation based on ESCC23400 – Qualification based on ESCC3009**
- ✓ **Special test added : 100 thermal shocks cycles + 1000h/1.5V/85°C/85% damp heat, to better detect and evaluate the impact of possible microcracking due to mounting (leading to IR decrease and shorts)**

Tests programs for 0603-2220 16V-100V ranges :

- ✓ **Comparison of different technological configurations on 0603.16V.39nF and 2220.100V.1 μ F (mounting methods and boards materials) :**
 - ✓ **Band ends length (short / standard / long)**
 - ✓ **For 0603, mounting direction (bottom /side)**
 - ✓ **Soldering paste quantity (standard / more)**
 - ✓ **Mounting substrates nature and design (alumina with AgPd pads / high Tg epoxy (SnPb plated pads)**
 - ✓ **Sn60-Pb40 soldering paste reflow method (hot plate / vapor phase / iron hand soldering)**

Mounting configurations tests description :



**Band ends length
(short / standard / long)**



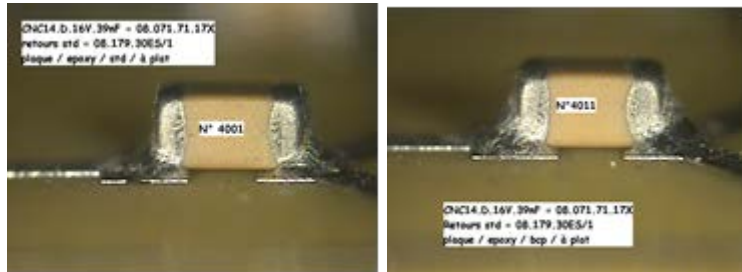
Mounting direction (bottom /side)

**Mounting substrates nature (alumina with AgPd pads) / high Tg epoxy (SnPb plated pads)
and design (better fitting between pads and parts ends)**



**Sn60-Pb40 soldering paste reflow method
hot plate / vapor phase / iron hand)**





Soldering paste quantity (standard / more)

Results on mounting configuration tests :

- ✓ **Good results, however the combination of :**
 - ✓ Long band ends
 - ✓ Excessive quantity of soldering paste
 - ✓ Iron hand soldering (2200 size)
- may be risky**

EXTENDED RANGE EVALUATION

Configuration chosen for extended range evaluation :

- ✓ **Standard band ends length**
- ✓ **Standard soldering paste quantity**
- ✓ **High Tg epoxy mounting substrates**
- ✓ **Hot plate reflow**
- ✓ **Comparison of classical and flexible termination technologicise**

- ✓ **Test vehicles : 0603.16V.100nF and 1206.16V.1 μ F**

Extended range feasibility : role of flexible termination (CerUflex) on reliability

Temperature (up to 170°C) and voltage (up to 5.5Un) step-stresses

Model	CNC12.16V.1μF		CNC14.16V.100nF	
Termination	Standard termination	CerUflex termination	Standard termination	CerUflex termination
V final step-stress (5.5Un)	80% OK	80% OK	90% OK	100% OK
T° final step-stress (170°C)	90% OK	100% OK	100% OK	100% OK

Thermo-mechanical tests = thermal shocks and damp heat test

Model	CNC12.16V.1μF		CNC14.16V.100nF	
Termination	Standard termination	CerUflex termination	Standard termination	CerUflex termination
Thermal shocks (500 cycles)	90% OK	100% OK	80% OK	100% OK
Damp heat (100 cycles + 1000h)	40% OK	100% OK	0% OK	90% OK

Relief action of CerUflex termination on thermo-mechanical stresses

Extended range feasibility : role of flexible termination (CerUflex) on reliability

Life-tests (125°C/4000h) under 2Un and 4Un

Model	CNC12.16V.1μF		CNC14.16V.100nF	
	Standard termination	CerUflex termination	Standard termination	CerUflex termination
LT 2Un (4000h)	85% OK	100% OK	95% OK	100% OK
LT 4Un (4000h)	80% OK	90% OK	90% OK	100% OK



Better reliability with CerUflex termination

Conclusion of the development of 0603 (CEC-CNC14) and 16V rated parts

- ✓ Very good reliability, both for NP0 and 2C1/2R1 non-extended ranges
- ✓ Flexible termination needed for extended 16V ranges

⇒ **0603-2220 16V-100V ranges entered ESCC QPL :**

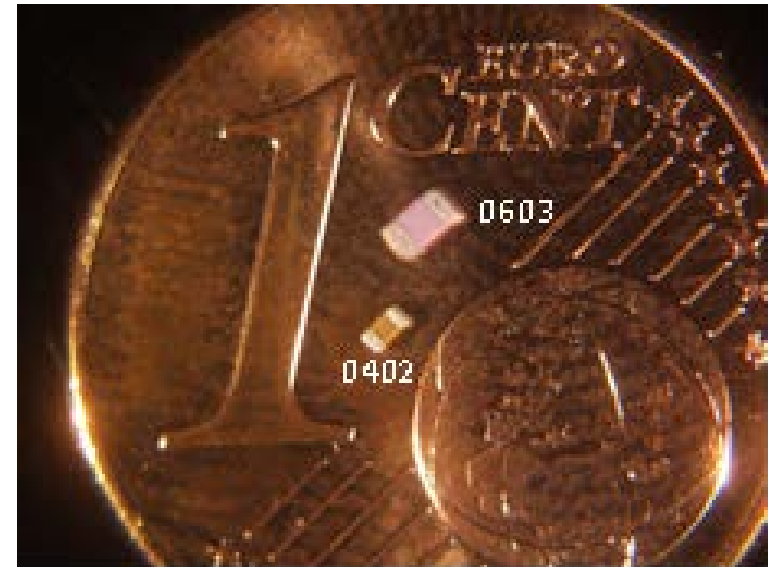
- **Type 1 (CEC) parts (classical termination) : certificate n°323**
 - Up to CEC14 (0603).16V.1nF
 - Up to CEC7 (2220).16V.68nF
- **Type 2 (CNC) parts (both classical and flexible termination) : certificate n°324**
 - Up to CNC14 (0603).16V.39nF for classical termination
 - Up to CNC14 (0603).16V.100nF for flexible termination
 - Up to CNC12 (1206).16V.390nF for classical termination
 - Up to CNC12 (1206).16V.1µF for flexible termination
 - Up to CNC7 (2220).16V.3,9µF for both classical and flexible termination

For further miniaturization : current developments

- ✓ Parts size decrease

- => from 0603 down to 0402

- => part's volume reduction of almost 2/3



- ✓ Rated voltage decrease, down to 10V, on 0402 to 1210 sizes

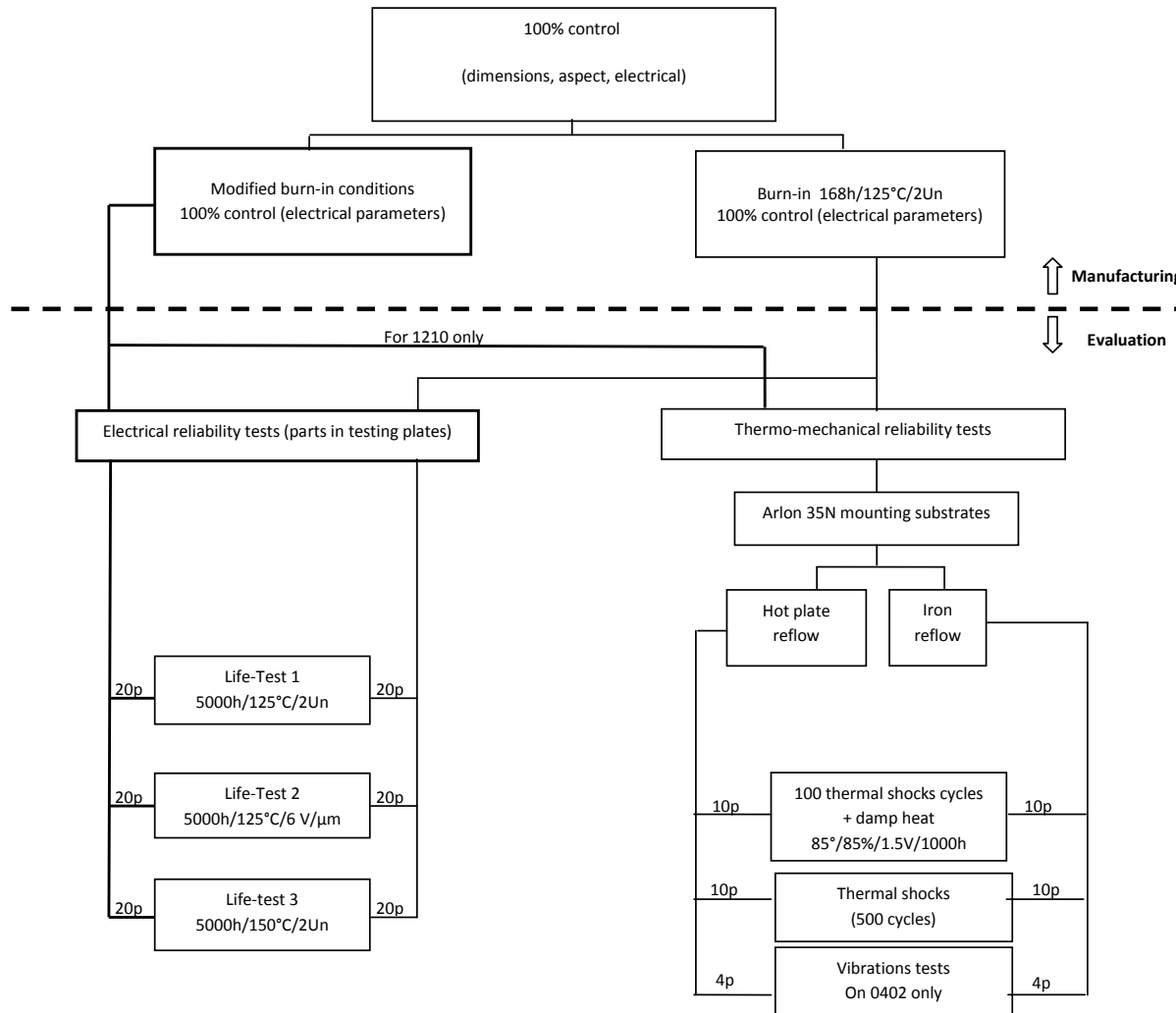
- => dielectric thickness decrease (from 7 μ m to 5 μ m)

- => capacitance improvement

Current development of 0402 and 10V ranges :

- ✓ **Definition of burn-in conditions for low-voltage ranges (is $2U_n$ still the most efficient ?)**
- ✓ **Data collection on low voltage components behaviour, with different voltage/temperature accelerated LT (up to 5000h), up to 150°C**
- ✓ **Validation of mounting conditions, with 10V and 16V rated parts comparison**
- ✓ **Validation of iron soldering (mounting process used for repairs), on parts which may be sensitive to thermomechanical stress (high metal/ceramic ratio)**

Current development of 0402 and 10V ranges :



Current development of 0402 ranges :

- ✓ **On 0402, which are much more smaller than 0603, some equipments adaptations were needed (for control, measure, burn-in)**
- ✓ **On our standard equipments, intermittent contact issue => new tooling, using specific design of testing plates and very specific probes**
- ✓ **0402 evaluation still in progress**



Thank you for your attention

Current development of 10V ranges :

On 10V ranges (0603-1210 sizes), thermo-mechanical tests and life-tests (up to 5000h duration) have been completed :

- ✓ **Positive role of flexible termination confirmed, both on thermomechanical and LT tests**
- ✓ **Non standard burn-in seems efficient ; to be confirmed on all test vehicles**
- ✓ **Similar thermomechanical results between both mounting technics**