EXXELIA TECHNOLOGIES

SPCD 2016

NOORDWIJK

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EVALUATION OF A NEW CERAMIC FOR BOTH LOW AND HIGH VOLTAGE APPLICATIONS

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AIM OF THE WORK

DRIVING FORCE : MINIATURIZATION

- SIZE REDUCTION
- COMPACITY INCREASE

BUT HEAT DISSIPATION IS MORE DIFFICULT

→ 2 SOLUTIONS TO CONSIDER :

- INCREASE COMPONENT'S RELIABILITY (to propose components with the same reliability despite of a higher working temperature)
- REDUCE COMPONENT'S LOSSES

DIELECTRIC CHARACTERISTICS OF CERAMIC MATERIALS

NPO DIELECTRICS	X7R DIELECTRICS
LOW DF → NO HEATING	HIGH DF
NO CAPACITANCE CHANGE UNDER VOLTAGE	BIG CAPACITANCE UNDER VOLTAGE
NO CAPACITANCE CHANGE WITH TEMPERATURE	FAIR CAPACITANCE CHANGE WITH TEMPERATURE
LOW DIELECTRIC CONSTANT → ONLY SMALL CAPACITANCE VALUES CAN BE MANUFACTURED	HIGH DIELECTRIC CONSTANT

CONCLUSION ON THE STATE OF THE ART

- NOR NPO CERAMIC DIELECTRICS, NOR X7R MATERIALS ARE ABLE TO DO THE JOB AT BEST

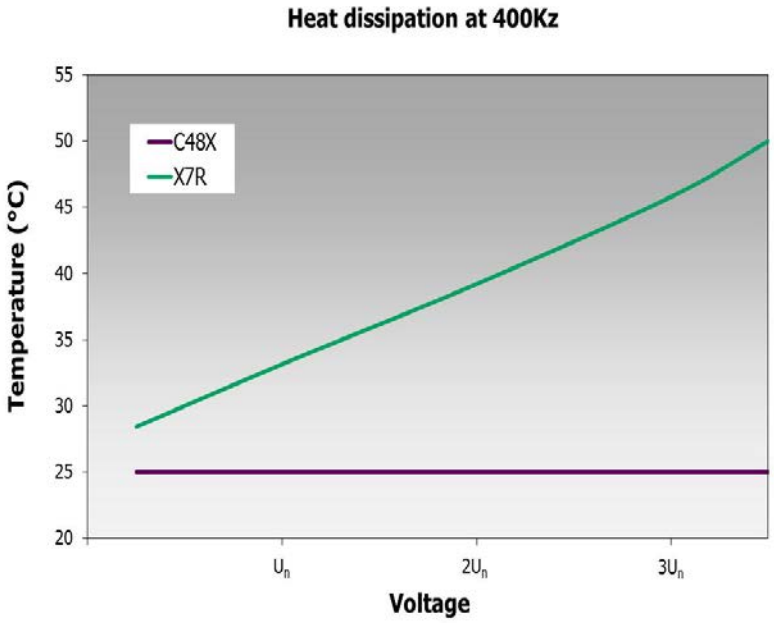
- NECESSARY TO FIND A MATERIAL WHICH COMBINES THE BEST OF BOTH FAMILIES WITH A SPECIAL EMPHASIS ON :
    - LOW DF TO MINIMIZE EQUIPMENT HEATING
    - FAIR DIELECTRIC CONSTANT AND / OR MATERIAL COMPATIBLE WITH A HIGH DIELECTRIC FIELD TO ACHIEVE ENOUGH CAPACITANCE UNDER WORKING CONDITIONS (TEMPERATURE, VOLTAGE, FREQUENCY)

MATERIAL CHOICE → .C48X. RANGES

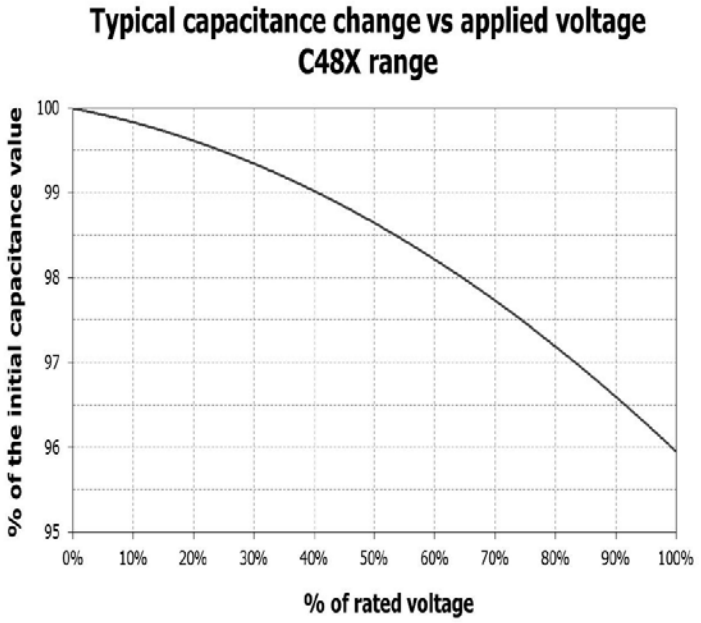
CERAMIC DIELECTRIC WITH A **DIELECTRIC CONSTANT** OF **450** AND THE HEREBELOW CHATACTERISTICS

PARAMETER	PERFORMANCE
Dissipation factor (DF) 1khz, 1Veff	$< 5.10^{-4}$
Typical DF at 400Hz, 1Veff	$< 5.10^{-4}$
Insulation Resistance (20°C, 500Vdc)	> 20 000 MΩ or 1 000 MΩ.µF
Dielectric withstanding voltage	> 1,4Ur
Temperature coefficient	-2 200 ± 500 ppm/°C
dV/dt withstanding pulses	Up to 10kV/µs

MAIN PERFORMANCES



« Heating performances » in comparison with X7R materials



Variation of the C48X capacitance when a DC bias is applied

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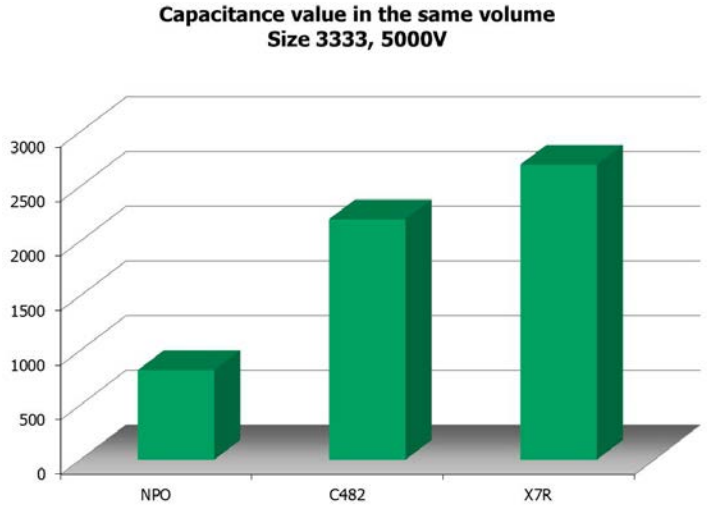
WHAT CAN BE ACHIEVED ?

- MEDIUM K (=450) LOWER THAN K OF X7R MATERIALS
- MATERIAL ABLE TO WITHSTAND HIGHER ELECTRICAL FIELDS THAN X7R

→ CAPACITANCES SLIGHTLY LOWER THAN X7R AT 1Vcc



BUT

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CAPACITANCE UNDER NOMINAL VOLTAGE

- VERY LOW CAPACITANCE DECREASE UNDER VOLTAGE FOR C48X RANGES
- BIG CAPACITANCE DECREASE FOR X7R UNDER VOLTAGE (UP TO 60%)

→ CONSEQUENCE : SAME CAPACITANCE UNDER WORKING CONDITIONS FOR C48X THAN FOR X7R AND NO HEATING (NO ENERGY DISSIPATION)

= NICE SOLUTION FOR POWER APPLICATIONS

A FEW HIGH-REL EXAMPLES

Electrical characteristics	500nF 400V 400Hz application chips size 6560	1µF 500V Stack of 5 chips size 4040	6,8nF 2000V chips size 1812	100nF 1600V chips size 40440
Presentation	Varnished radial lead	DIL leads for through hole mounting	Single SMD chips	Chips
Application	Motor regulation	Missile	Lightning protection	Charge/Discharge

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NPO RANGES EXTENSION

- DIELECTRIC CONSTANT OF 450
- VERY LOW DF (< 5.10^{-4})
- VERY LOW CAPACITANCE VARIATION WITH VOLTAGE APPLIED

→ IDEA IS TO EXTEND NPO RANGES

- FOR SMALL SIZES (DOWN TO 0603)
- FOR MEDIUM VOLTAGES (100V TO 1kV)

→ AN INCREASE OF THE ALLOWABLE CAPACITANCES VALUES BY A FACTOR 3 TO 4 IS EXPECTED

SPACE EVALUATION

WITH THE HELP OF THE FRENCH AGENCY = CNES

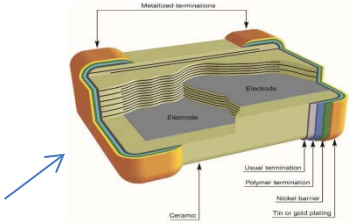
2 MAIN ACTIONS CONDUCTED IN PARALLEL

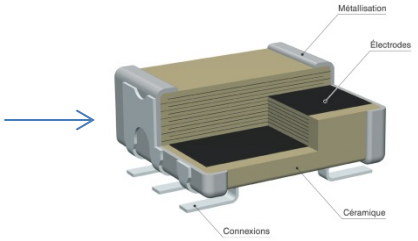
- BIG SIZES HIGH VOLTAGE PARTS (POWER APPLICATIONS)
- SMALL SIZES MEDIUM VOLTAGES PARTS (EXTENSION OF NPO RANGES)

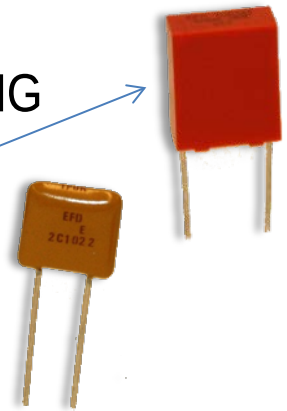
- EVALUATION BASED ON ESCC 2 263 000

BIG SIZES – HIGH VOLTAGE PARTS EVALUATION (A)

- CHIPS SIZE FROM 1812 TO 6560
- RATED VOLTAGE FROM 200V TO 5kV
- TERMINATIONS
  - POLYMER TERMINATION UP TO SIZE 4040
  - SMD CONNECTIONS FOR BIGGEST SIZES (5440 AND 6560)
  - THROUG HOLE MOUNTING
    - MOLDED CAPACITORS
    - DIPPED CAPACITORS







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MAIN FEATURES OF (A)

- EVALUATION BASED ON ESCC 2 263 000 BUT
- ADDITIONNAL TESTING
  - 500 THERMAL SHOCKS (-55°C / +125°C)
  - 100 THERMAL SHOCKS ON MOUNTED PARTS FOLLOWED BY 1000 HOURS LOW VOLTAGE HUMIDITY TEST
  - VIBRATIONS AND SHOCKS
  - CORONA TESTS FOLLLOWED BY LIFE TESTS CONDUCTED IN PARALLEL ON :
    - PARTS INSIDE THE MAIN VALUES DISTRIBUTION
    - PARTS OUTSIDE THE MAIN VALUES DISTRIBUTION (IF ANY)
  - HEATING UNDER ALTERNATIVE CURRENT/VOLTAGE CONDITIONS IN PARALLEL WITH NPO AND X7R PARTS

SMALL SIZES – MEDIUM VOLTAGE PART PRE-EVALUATION (B)

- CHIPS SIZE FROM 0603 TO 1210
- RATED VOLTAGE FROM 100V TO 1kV
- TERMINATIONS :
    - CLASSICAL TERMINATION SNPB 60/40 ON NICKEL BARRIER
    - POLYMER TERMINATION

MAIN FEATURES OF (B)

- EVALUATION NOT FULLY PERFORMED ACCORDING TO ESCC 2 263 000
- MAIN CHARACTERIZATIONS
  - HOT INSULATION RESISTANCE (NOW NO MORE REQUIRED BY ESCC3009)
  - CAPACITANCE VARIATIONS WITH TEMPERATURE (NOW NO MORE REQUIRED BY ESCC3009)
  - 100 THERMAL SHOCKS ON MOUNTED PARTS FOLLOWED BY 1000 HOURS LOW VOLTAGE HUMIDITY TEST (85°C, 85% RELATIVE HUMIDITY, 1,5V)
  - VOLTAGE STEP-STRESS

EVALUATION STATUS

- PARTS MANUFACTURING ON GOING (SHOULD BE FINISHED END OF NOVEMBER)
- TESTING WILL START END 2016 AND SHOULD BE COMPLETED 2nd HALF 2017

- ANY QUESTION ?

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