Passive EEE Components for Space: trends, standards, roadmap

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TEC-QTC - ESA

ESSCON
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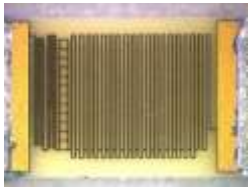
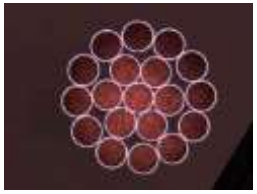
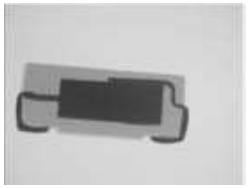
Outline

- ESCC standard for passive components
  - Current updates and evolution

- Passive component European development, evaluation and qualification for space applications
  - On-going activities, trends and needs :
    - Capacitors (Ceramic, Film, Tantalum)
    - Supercapacitors
    - Fuses
    - Connectors
    - Cables
    - RF devices
    - & other passive components
- Conclusion
- SPCD: Space Passive Components Days, 2nd edition conference

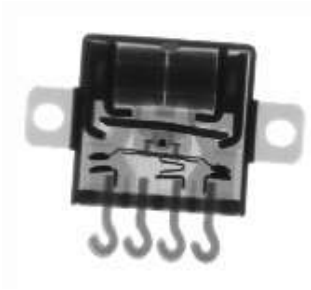
ESCC standard for passive components

No power and no command

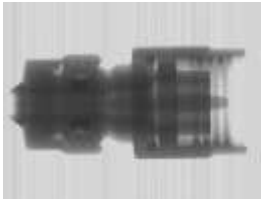
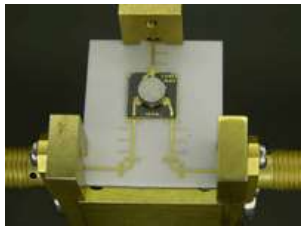





ESCC: add crystal, oscillator and relays





And RF

- 31 ESCC generic and more than 200 ESCC detail specifications
-
- 90% ESCC qualified manufacturers are passive ones

What is on going?

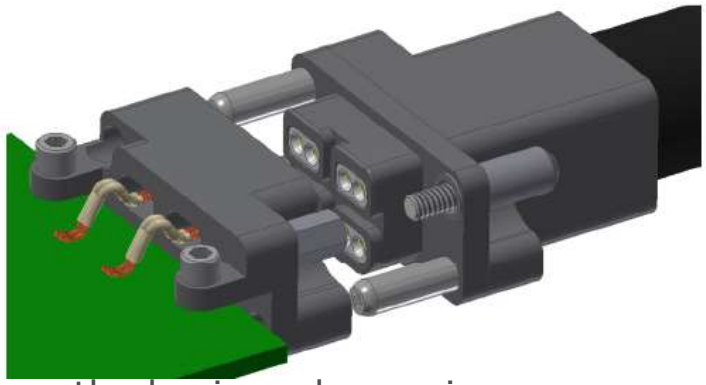
Update of current specifications:

- Relays with increase vibration and mechanical shock requirements
- Ceramic capacitor: removal of some tests e.g. low voltage 85/85 humidity test
- Connectors mainly to update the test methods and remove some tests considered as not relevant anymore.
- RF passive components specifications are out of date due to the evolution of test methods and requirements:
  - ✓ done for circulators/isolators: 3202
  - ✓ on-going for couplers/dividers: 3402

What is on going?

More complex devices need to be considered under ESCC e.g. oscillators and cable assemblies:

- Oscillators:
  - No European standard -> no qualified sources.
  - New standard is today available for XO, VCXO and TCXO oscillator: ESCC 3503
- For several applications the qualification of cables and connectors separately does not allow to fully address all the requirements. The followings applications are identified:
  - RF cable assembly
  - 1553 bus
  - Space wire
  - High data rate
  - High voltage



Since 2012 a specific WG is working to issue the basic and generic specifications needed. RF cable assembly generic specification will be issued this year.

What is next?

Thin dielectric layer ceramic chip capacitors like the new MIL-PRF-123. This will be needed for the next generation of thin layer ceramic capacitors.

Integrated passives

- Silicon die with different types of component like capacitors, resistor sand inductors on the same die.
- Embedded passives in PCB:
  - Discrete
  - Formed layer

  How to test and procure these components? Does assembly have an impact?

Ceramic Capacitors

Different directions

- Smaller sizes down to 0603 today, 0402 under evaluation by CNES

- Lower voltage down to 16V to increase capacitor value
  - Chip capacitor ESCC 3009
  - Stack capacitor ESCC 3001/037

- BME capacitor ESCC 3009/041

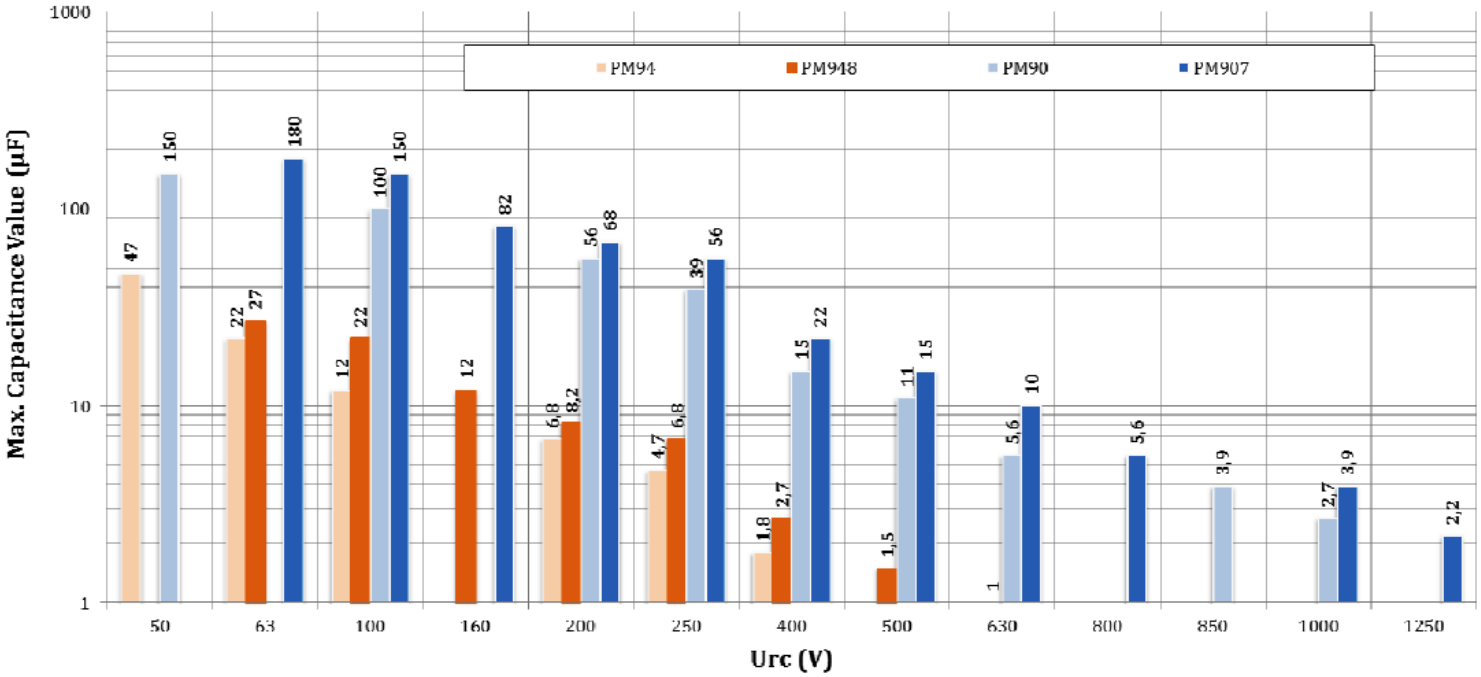
- Flexi type termination on PME and BME for crack issue mitigation

- Next step is to increase the range in term of capacitance: 0805/4,7microF; 0603/2,2microF; 0402/330nF

Film Capacitors

ESCC qualification PM948 and PM907 in 2016. Parts in EPPL.

Existing range (PM90S and PM94S from Eurofarad) not optimised for 100V application.

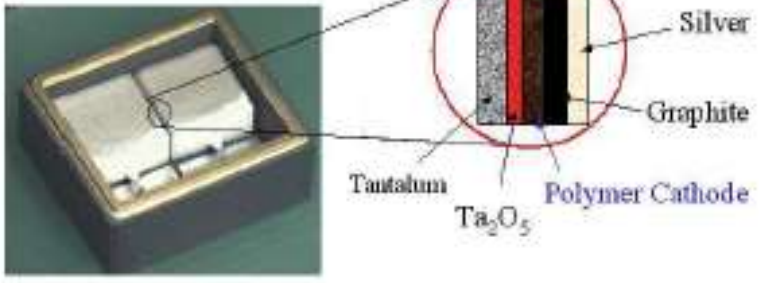


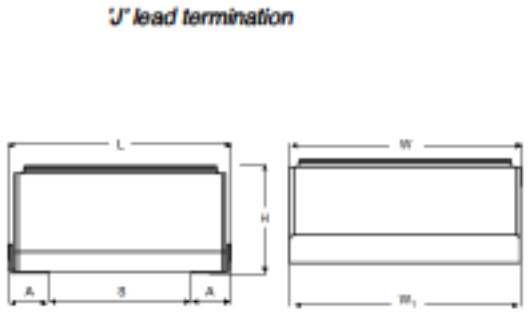
Improvement based on specific process that guarantee an equivalent level of quality and reliability, despite a reduction of dielectric thickness of the metallized polyethylene terephthalate film.

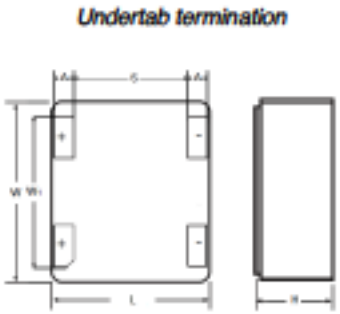
Tantalum capacitors

Need lower and lower ESR

- Multi-anode type (TES)- qualified in 2013 : ESCC3012/004
  - Low profile tantalum capacitors development for embedded applications
  - Polymer tantalum capacitors
    - ✓ Single anode polymer capacitor evaluation on-going with Kemet in Portugal. In EPPL.
    - ✓ Hermetic tantalum capacitor in ceramic package. Not in EPPL due to assembly issues with this type of package.





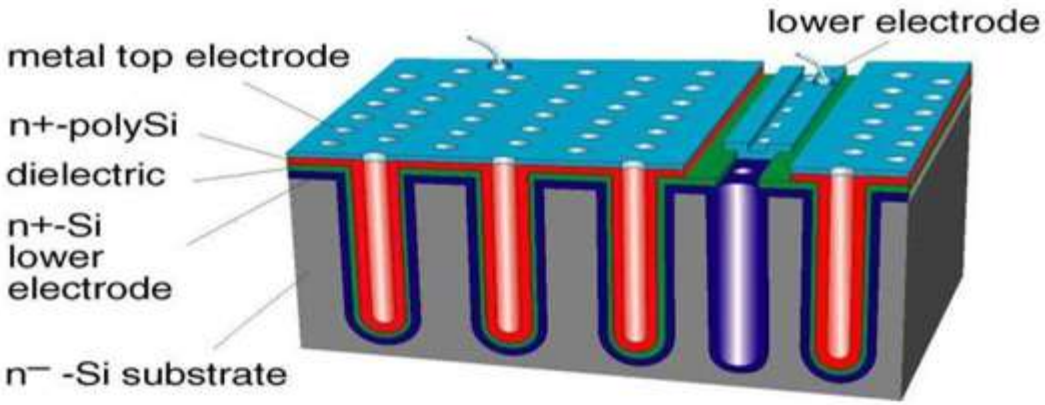


- Next step multi-anode polymer tantalum capacitor

Other on-going studies on capacitors and resistors

Evaluation of silicon capacitor focus on IPDIA product:

- Aim is to get reliability data on single capacitor die including radiation.
- Evaluation test plan is based on ESCC evaluation

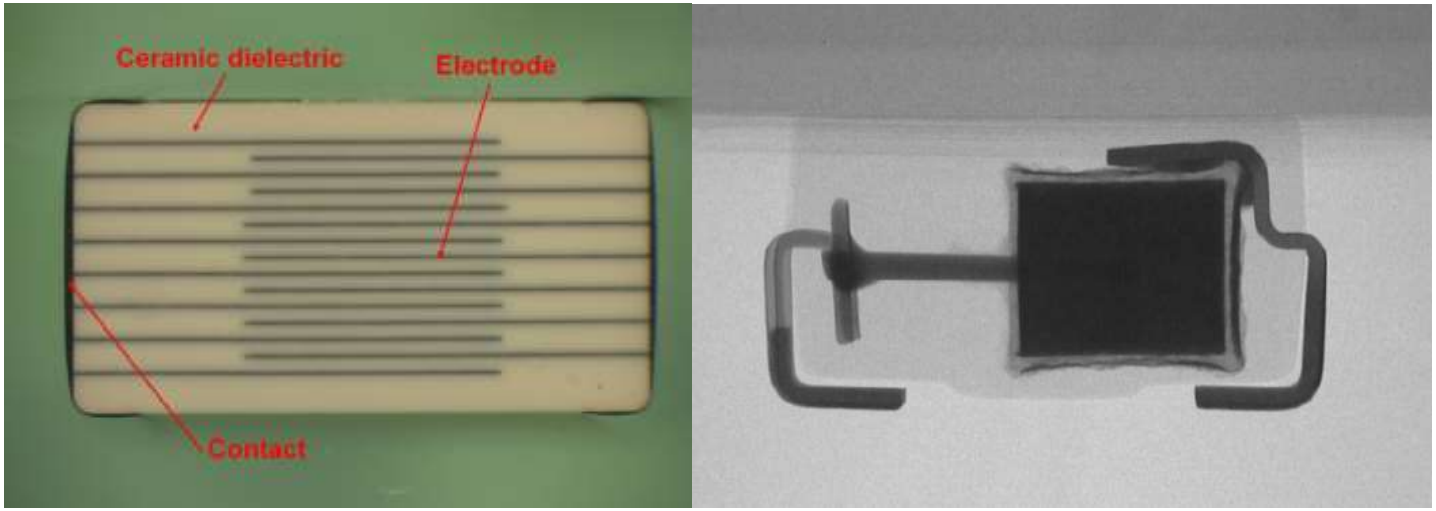


- Should not lead directly to qualification as manufacturer think that integrated passive is the trend.

Other on-going studies on capacitors and resistors

High temperature capacitor and resistor selection and evaluation:

- Alter perform tests on ESCC qualified parts and high temperature designed parts.



- Goal is to determine which type of parts can be used on some generic applications around a baseplate temperature of 100°C without too much derating.

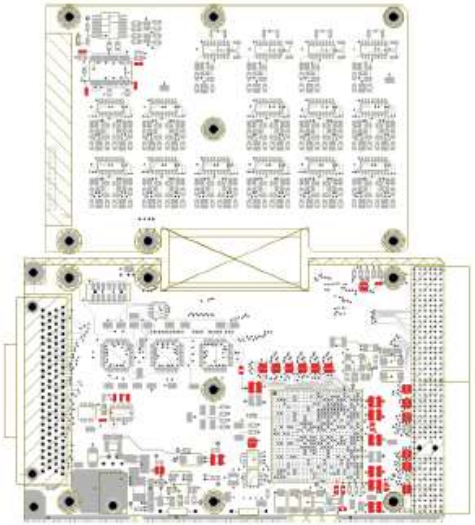
Other on-going studies on capacitors and resistors

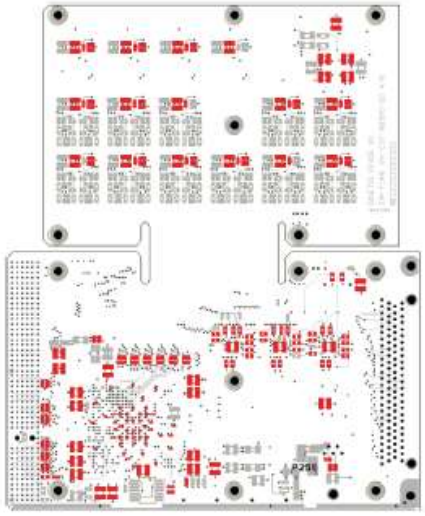
Embedded passive components in PCB

- Reliability testing on embedded passive limited to chip capacitors and resistors
- Evaluate gains and drawbacks on an existing flight board design

Activity lead by IMEC working with AT&C (PCB) and QineticQ Space.

The first lesson learn is that the range of available components is rather restricted in term of voltage. The flight board could not respect the derating rules.





Supercapacitors

Development of ionic liquid based electrolytes pouch cell (Hutchinson/ADS)

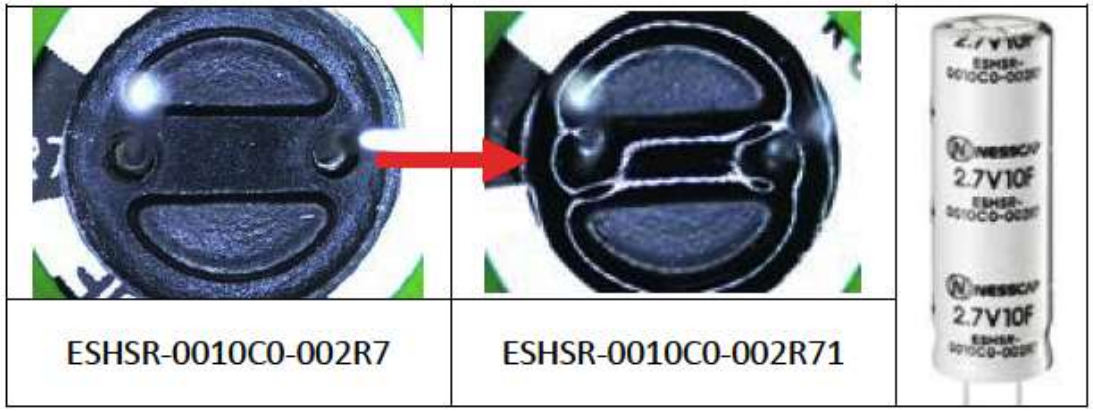
- Ionic liquids are interesting and promising electrolytes to develop reliable supercapacitors with higher specific energy than conventional systems because they are non volatile, non flammable.
- They present a high temperature range of stability and a high potential window (> 3.0V).

- First results promising but reliability improvement still needed for long term applications

Supercapacitors

Evaluation of NESCAP 10F supercapacitor (ADS, CSRC and EGGO)

- Based on calendar and cycling test on individual cell and bank of supercapacitors.
- Goal is to have these supercapacitors in EPPL.



New TRP activity will be launched for validation of supercapacitors for launcher applications in the end of 2016.

Fuses

Due to ITAR issue, we work with Schurter to develop a range of fuses for space applications

- MGAS fuses ESCC qualified since 2008, ESCC4008/001
- Development and qualification of HCSF, today qualified up to 10A. Remaining range qualification scheduled in 2016.

Rated Current [A]	Rated Voltage [VAC]	Rated Voltage [VDC]	Breaking Capacity	Voltage Drop 1 In typ. [mV]	Cold Resistance typ. [mΩ]	Melting I²t 10 In typ. [A²s]	ESCC Component Number	Order Number
5	63	125	1)	86	–	1.9	4008xxxxx	3409.0007
6.3	63	125	1)	–	–	–	4008xxxxx	3409.0008
7.5	63	125	1)	92	–	4	4008xxxxx	3409.0009
8	63	125	1)	–	–	–	4008xxxxx	3409.0010
10	63	125	1)	90	–	12.7	4008xxxxx	3409.0011
12	63	125	1)	–	–	–	4008xxxxx	3409.0013
15	63	125	1)	86	–	31.3	4008xxxxx	3409.0015

Connectors

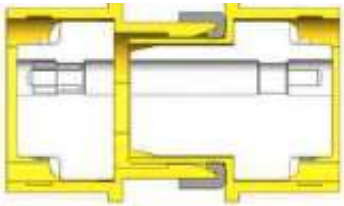
Need for miniaturization

- Development of nanoD connectors with Axon. Results are compliant with requirement but the market is still low then not in EPPL
- Micro modular connectors for removable power and coax contacts. Evaluation testing closed with good results.
- High density connectors for AIT testing

Improved performances

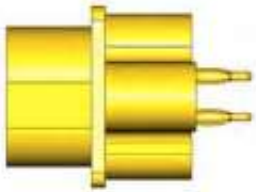
- EMI connectors development for 360 electrical continuity through the complete link
- Spacewire connectors development to be compliant with higher data rate without a size increase.
- Improvement of D-sub connectors supported by CNES.

Keying feature

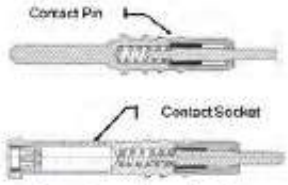


EMC sealing feature

SMT termination



Press fit termination

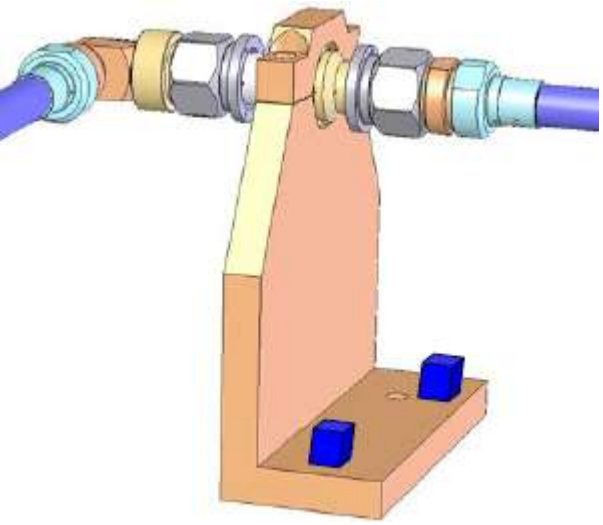


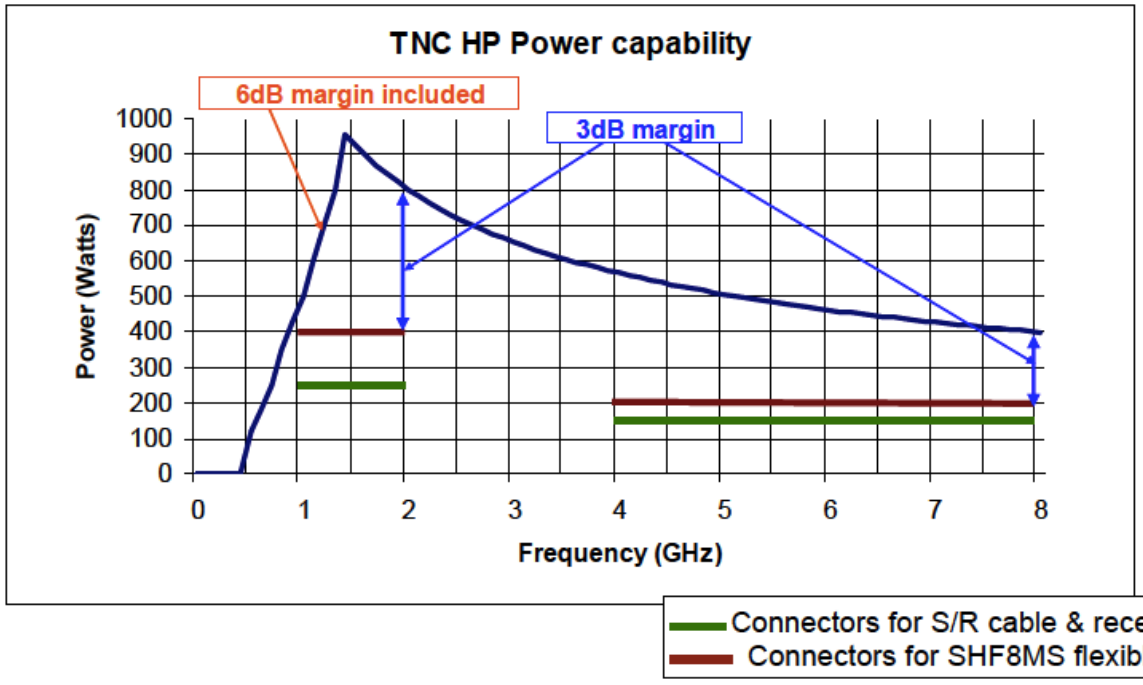
Spring loaded contacts

Connectors

High power RF TNC connectors and cable assemblies developed by Radiall

- ESCC qualification under progress and expected in 2016

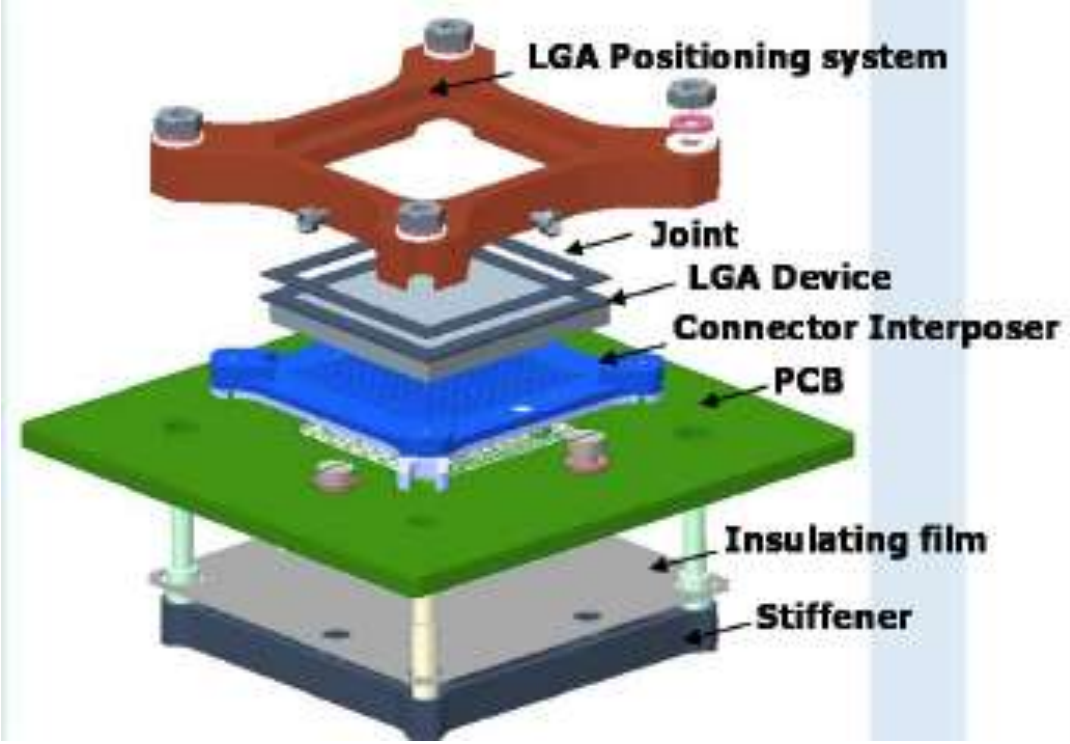




Connectors

Solderless interposer for high pin LGA devices.

- First prototypes developed for 600 pin by Hypertac with CNES support
- Currently evaluated for solderless assembly in an ESA funded study.



Cables

What is leading the development is outside the application:

- ESCC qualification of high temperature (250°C) cable with determination of the current derating rules for usual operating ambient temperature. Test successful except for resistance to ergols.

Gauge	Current ESCC Max Amp (A)	**Proposal : Max amp. (A)**
AWG 1237	23	**35**
AWG 1419	17	**25**
AWG 1619	13	**19**
AWG 1819	10	**15**
AWG 2019	7.5	**11**
AWG 2219	5	**9**
AWG 2419	3.5	**6**
AWG 2619	2.5	**4**
AWG 2819	2	**3.5**
AWG 3007	1.5	**3**

- High voltage cable assembly ESCC qualification. Range definition on-going
- Development of antistatic cable. The activity aims at developing a new formulation of satellite cable insulator made of ETFE. This new material must have antistatic properties for cable used outside the satellite structure (solar panels, electrical propulsion).
  - Used master batch available material
  - Develop a specific material
- Revision of derating rules for bundles

RF devices

Currently, there are no qualified RF devices except for connectors.

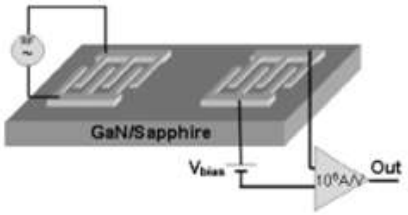
Several activities were launched to address this issue focusing on coaxial circulators/isolators:

- L, S and C band high power circulators/isolators
  - Evaluation are closed with good results and qualification expected in 2016.

- Ka band isolator already in EPPL.
  - Qualification results acceptable. Should be in QPL in 2016.

Other on-going activities

- Development of SAW filters based on GaN/SiC



- Development of electro-mechanical relays for high level vibration and mechanical shock
- ESCC qualification of XO oscillators with Rakon for flat pack, DIL and J lead
- ESCC evaluation of platinum sensors for European independence
- Low temperature electronic for exploration and robotic mission

What are the driving applications

- Electrical propulsion
  - High voltage capacitors
  - High voltage relays (European)
  - Cable assemblies for electrical propulsion
  - Planar transformers
- Point of Load
  - Decoupling capacitors: ceramic, tantalum, silicon?
  - Planar transformers
  - High current chip inductors
- RF application are leaded by the increase of power (hundreds of Watt) and frequencies (Q/V bands)

Space Passive Component Days 2nd edition

Join us at

Space Passive Component Days, 2nd edition

12-14 October 2016,

ESA/ESTEC, The Netherlands

http://www.congrexprojects.com/spcd2016

The SPCD international Symposium is the premier European technical conference dedicated to Passive components for space applications.

SPCD is an exceptional venue to learn more about the latest advances in this field and meet recognized experts from industry, academia and agencies.

Space Passive Component Days
2nd edition

Aim of the SPCD symposium

- promote the discussion of recent developments and trends
- encourage the exchange of technical expertise
- share information

covering a broad range of EEE passive components for space applications:

Capacitors & Supercapacitors

Connectors

Fuses

Magnetics

Relays & Switches

RF switches & Phase shifters

Thermal Sensors & Heaters

Circulators & Isolators

Crystals & oscillators

Loads & Attenuators

Power dividers & couplers

Resistors

SAW Devices

Wires & Cable assemblies

EPCI INTRODUCTION

Tomas Zednicek Ph.D.
president

EPCI | Bringing European Passive Professionals Together

EPCI European Passive Components Institute

EPCI | Bringing European Passive Professionals Together

The EPCI Institute will become a premium resource of European passive components industry knowledge, prosperity, awareness and prestige growth.

mission

Historical Milestones

The first meeting of The Czech Passive Component Manufacturers, Ministry of Transport and Universities with ESA in Lanskroun, Czech Republic to follow the ESA Czech Incentive Program Initiative

Passive components and sensors industry / academia annual meetings established to share experience and opportunities.

March 2015

annual meeting at sensor manufacturer location, the venue expanded to two days. Attended by 7 manufacturers, 2 Universities, 1 Space customer

July 2015

The **European Passive Components Institute** established by founder and passive component meetings organizer Tomas Zednicek

2016 Targets

- Web site Up & Running
- Wide Industry Awareness
- Agencies, Government Organisation Links Established

www.passive-components.eu

EPCI European Passive Components Institute

People

Dipl.-Ing. Tomáš Zedníček Ph.D., Czech Republic

email.: tom@passive-components.eu

- Electrotechnology Degree by Technical University of Brno,Czech Republic in 1993
- Ph.D. in Tantalum Capacitors in 2000
- > 21 years working for tantalum capacitor manufacturer
- > 15 years in position of Worldwide Technical Marketing Manager
- more than 60 technical papers and 1 US/international patent
- 4 outstanding/best award technical papers at CARTS passive component conference
- 2005 Dr. Zandman award for a great contribution to passive component industry
- Lecturer of capacitor technologies, presentation skills and inter-culture communication
- July 2015 - Founder of the European Passive Components Institute

President & Founder

Dominique Vignolo, France

- DUT Genie Electrique option Electronique (IUT Nice, France) in 1977
- Field Service Manager for 10 years
- 22 years working for resistor manufacturer
- 13 years in position of Worldwide Global Product Marketing Manager for High Precision Products
- Technical papers about high precision products specially in high temperature and space applications
- Manufacturers' representative at ESA CTB Passive Component Technology Board for fife years
- Marketing skills (launching of marketing operations, organization of exhibitions)

Dipl.-Ing. Reiner W. Kühl, Germany

- Dipl.-Ing. degree in Physics by University of Applied Science in Luebeck, Germany in 1973;
- > 25 years product and process R&D, working for thin film resistor manufacturers;
- 15 years in position of Technology and Quality-Customer-Service Senior Management;
- More than 20 technical papers and 1 European / international patent;
- 2 Outstanding Paper Awards at CARTS passive component conferences;
- 2000 Highly Commended Award from the LITERATI Club of MCB University Press;
- 2008 Dr. Felix Zandman Passive Electronic Components Industry Technology Award for Recognition of Acknowledged Industry Leadership & Perseverance of Vision;
- Expertise in components' reliability & failure analysis, thin film resistors' technology (MELF, chip), barrel electroplating, electro-isolation lacquer, laser machining, etc.

External Co-Operators

EPCI European Passive Components Institute

Support Tools

European Passive Industry Database

database of European passive components manufacturers, distributors, testhouses and universities with passive component continuous research projects

e-PassiveBook

on-line passive components handbook based on famous P-O.Fagerholt's CLR handbook

25.4. 2016 Community Conference

e-Symposium

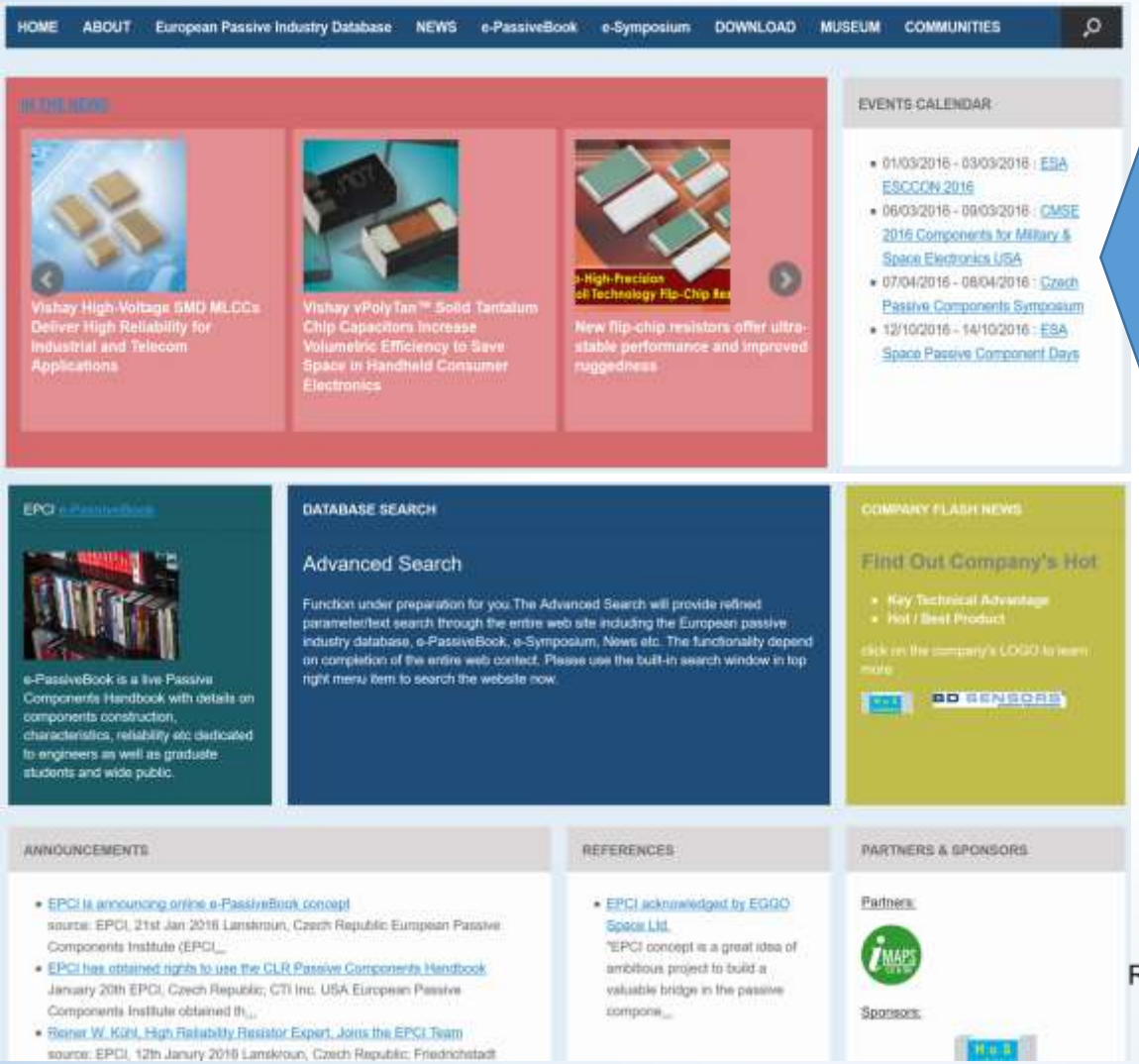
Searchable database of passive component technical papers. The papers can be packed in a simple software into a symposium like chapters

Others

- collection of daily worldwide passive components news
- passive components dossier (Q3CY16)
- interviews, Q&A, museum, stories
- hot company news, event calendar
- passive components consultancy services
- job offer announcement etc.

www.passive-components.eu

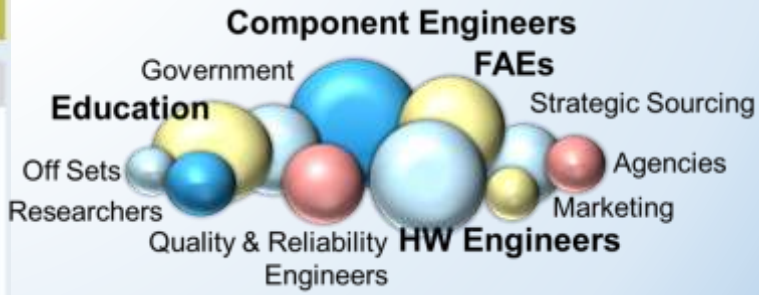
EPCI European Passive Components Institute



EPCI website

www.passive-components.eu

Target Group Benefits
(end customers, manufacturers, students)



EPCI European Passive Components Institute

European Passive Industry Database

call for registration

- Database of more than 120 manufacturers, distributors, testhouses, universities
- Public sources initial entry, registered companies with verified information
- Details on manufacturing locations, products, certifications etc.

e-PassiveBook under construction

call for sponsors to financially support transformation into an online handbook

- Online open (free access) passive component handbook
- Basic content based on licensed industry well-known P-O.Fagerholt's CLR handbook
- Application guidelines, updates to be added in next phase (examples completed)

e-Symposium under preparation

call for papers

- Passive components mfgs and universities technical paper database
- Annual company small fee for their employees unlimited access
- Custom content selection of papers for e-proceeding/hardprints (fee may apply)

How to Support EPCI & the European Passive Component Industry

Companies / Institutions

- Register to EPCI database (European passive industry)
  suggested small annual registration fee for large and global companies
- Share/submit your passive component technical papers to e-Symposium database
- Share interesting stories, history, opinions about passive components
- Sponsorship of ePassiveBook – the free online passive component handbook
- Register at e-Symposium as a company users (under preparation)
- Sponsorship of the EPCI – bronze, silver, gold sponsorship

Individuals

- Review and recommend EPCI website to colleagues, friends, partners, customers as a valuable source of information (if you like it)
- Follow us on LinkedIn and share with your contacts
- Send us your comments / suggestions for improvements / notes

more info at

www.passive-components.eu

email: secretary@passive-components.eu

Thank You