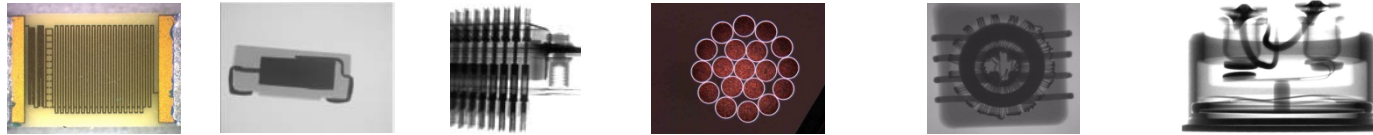


Passive component trends

Denis Lacombe, Olivier Perat
ESCCON 2013
12/03/2013

Passive components definition

No power and no command



At ESA: add crystal, oscillator and relays



Another definition: passive are not mission enabling

- Main function is support
- Development not driven by mission needs
 - Most of the time we take what is available

Support means:

Passive cover a wide range of function for numerous applications and conditions

Then

Difficult to propose a standardisation, in contrary we need to propose the widest range possible

We have to propose/qualify the adequate component at the good time for our projects but nobody will tell you what he really needs.

1. Passive represent 70 to 90% of EEE parts used
 - a. High % of the mass and volume
 - b. Increase possibility of failure

We need to

- a. Reduce the number of part
- b. Have high reliability part

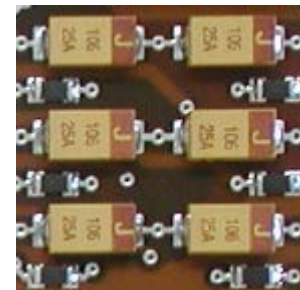
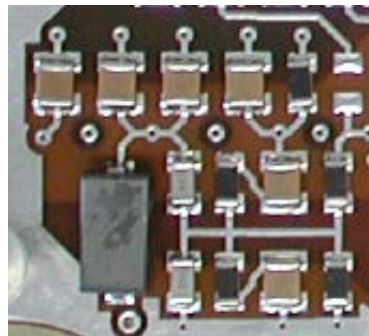
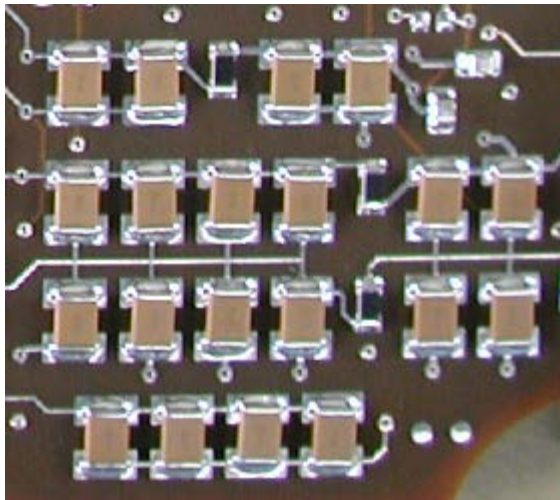
Compromise between performances (lead by commercial product) and high reliability (lead by military/automotive/drilling/medical)

2. Passives are sometimes single point of failure:
 - high reliability
 - Adequate procurement
 - Proper use

Example: bank of capacitor

Example of bank of capacitor

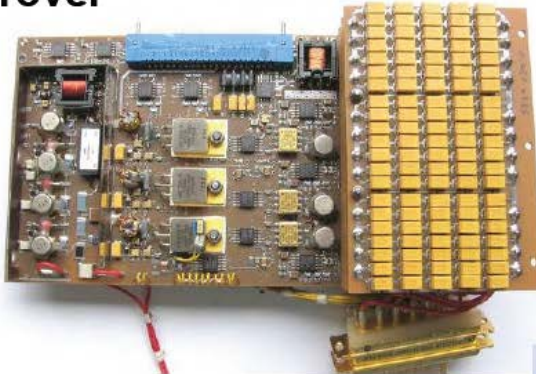
- a. Different type of capacitor
- b. Different number



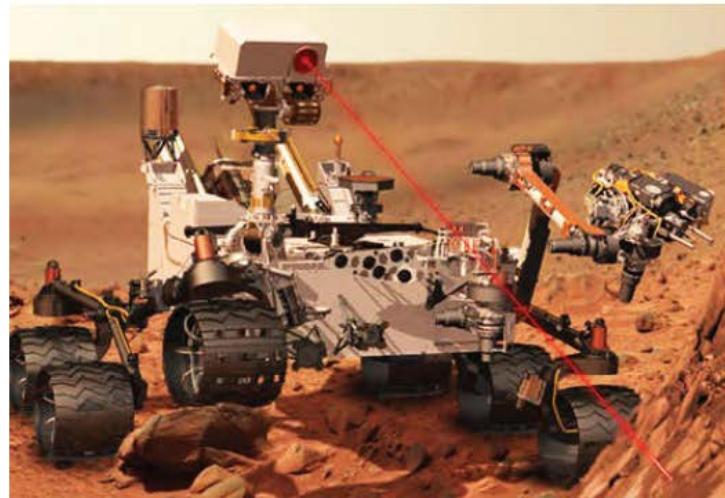
Example: bank of capacitor

AVX tantalum powers Curiosity's ChemCam Laser on Mars

630 units of AVX TBM tantalum capacitors power the laser of ChemCam module on curiosity Mars rover



TBM low ESR multi-anode tantalum capacitors manufactured by AVX Lanskroun, Czech Republic and up-screened to SRC9000 space level reliability at the AVX Biddeford facility in Maine, USA



source:www.nasa.gov



ChemCam was designed by a joint U.S.-French team led by Los Alamos National Laboratory; NASA's Jet Propulsion Laboratory in Pasadena, California; the IRAP and CNES in Toulouse.

Tantalum capacitors have been selected and designed by co-operation between IRAP and AVX Lanskroun, Czech Republic

ChemCam board pictures - courtesy of IRAP Institut de Recherche en Astronomie et Planétologie, France



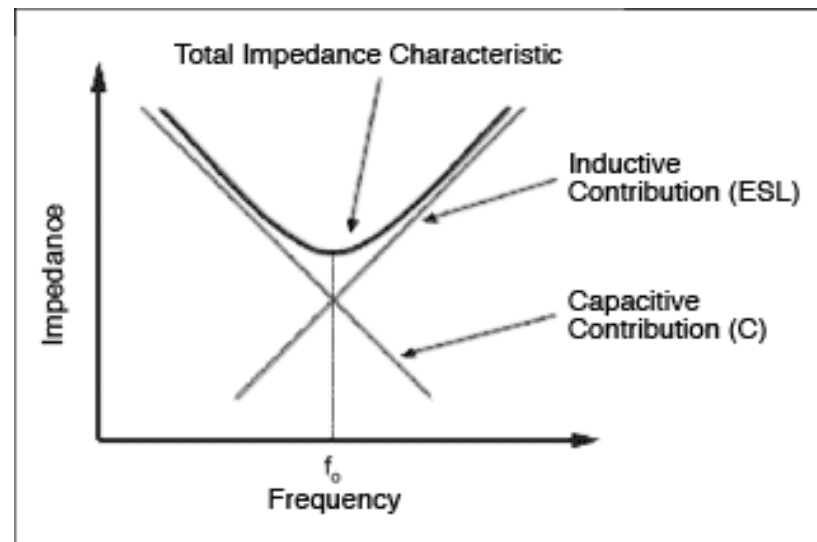
Example: bank of capacitor

Why: decoupling

Need to provide current without drop of voltage

$$V = ZI$$

$$Z = [ESR^2 + (1/\omega C - \omega L)^2]^{1/2}$$

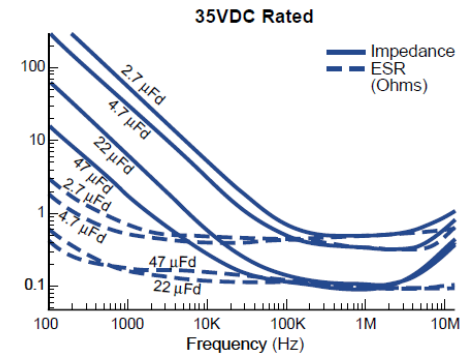
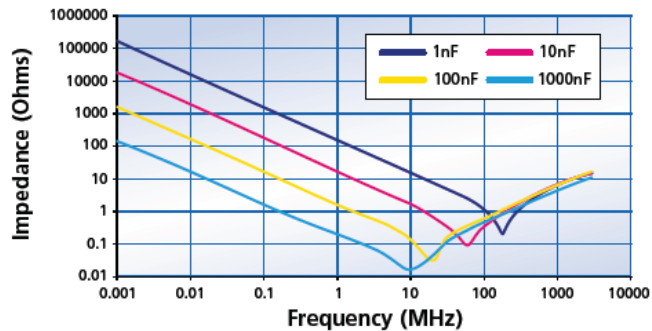


Example: bank of capacitor

We need Z as small as possible

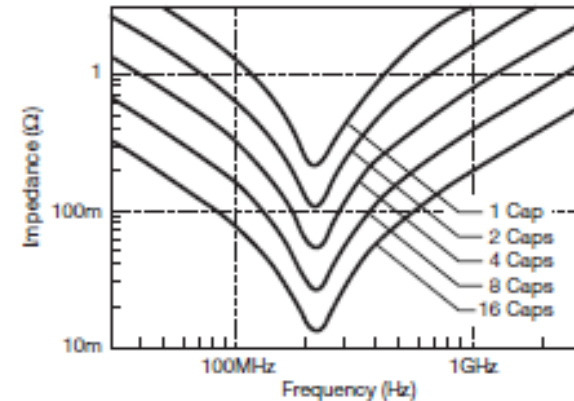
a. Low ESR: techno dependant

Stable X7R dielectric



b. Bank of capacitor:

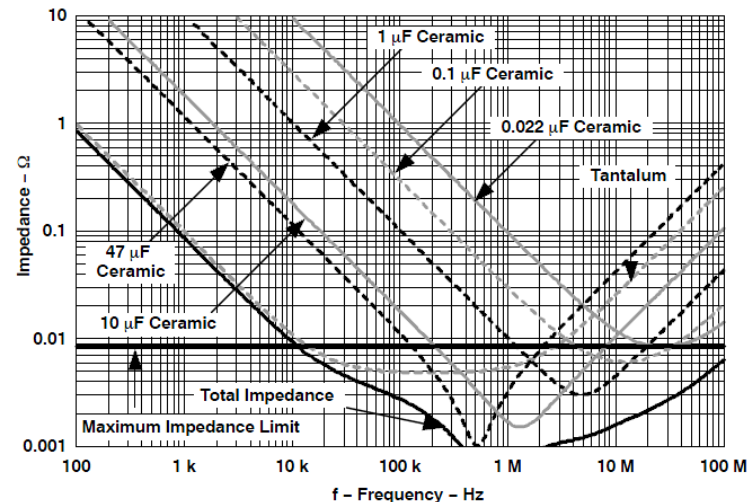
- Increase C
- Reduce ESR



Example: bank of capacitor

1. Selection

- a. Frequency: tantalum, ceramic, film
- b. High capacitance value and low ESR
- c. Size and mass



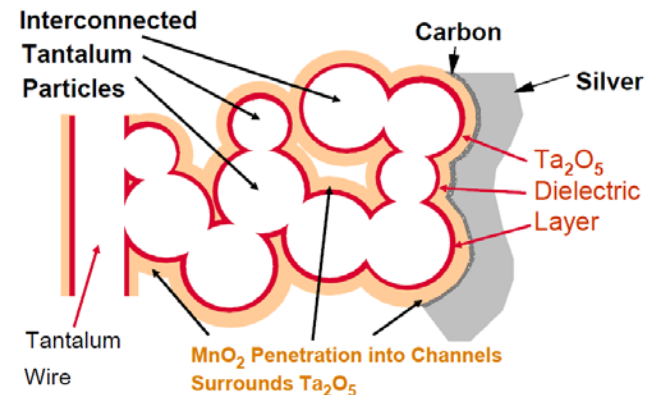
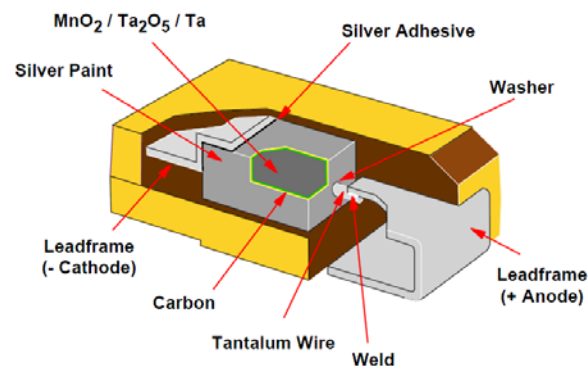
*Application Report
SLTA055-FEBRUARY 2006
Texas Instrument*

2. Development

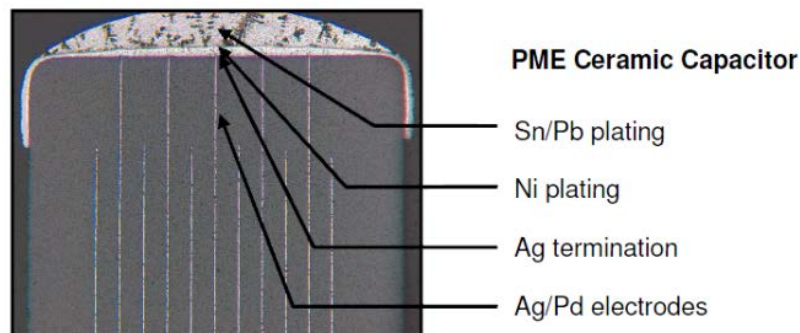
- a. Increase capacitance value/volume
➡ Ceramic capacitor
- b. Decrease ESR
➡ Tantalum capacitor

Capacitors 5 years ago (ESCC qualified range)

1. Tantalum: TAJ **high ESR**, high C



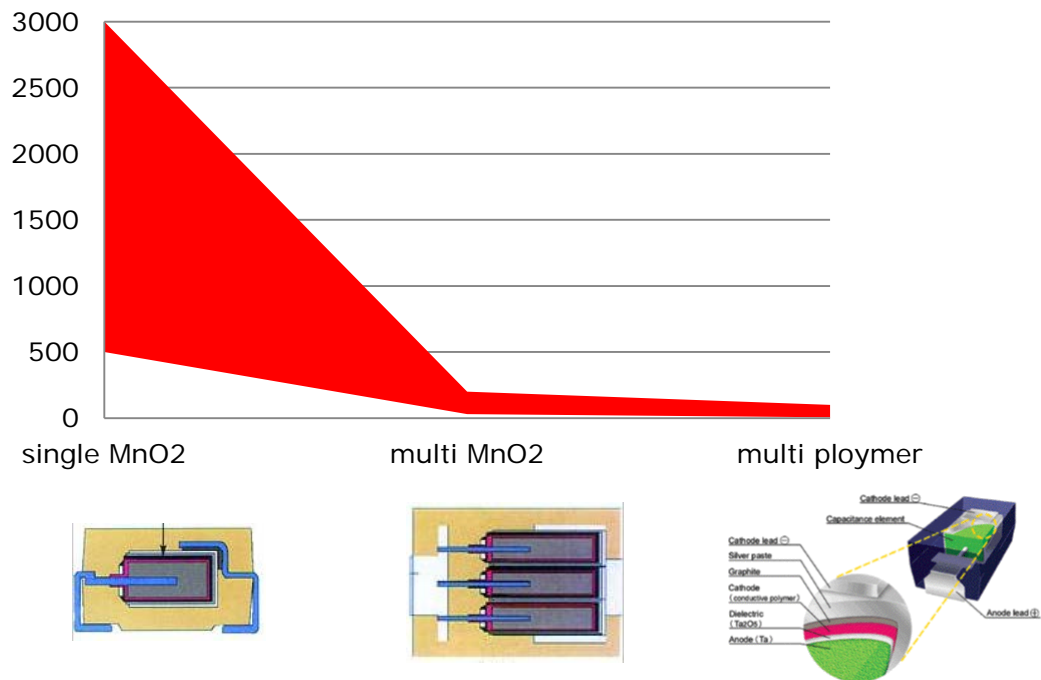
2. Ceramic: type I and II (50 and 100V), low ESR and **relatively low C**



Tantalum: improvement regarding ESR

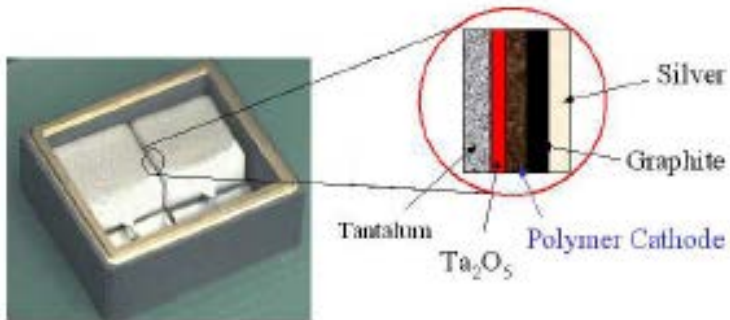
- a. Multi anode
- b. Polymer

ESR by technology

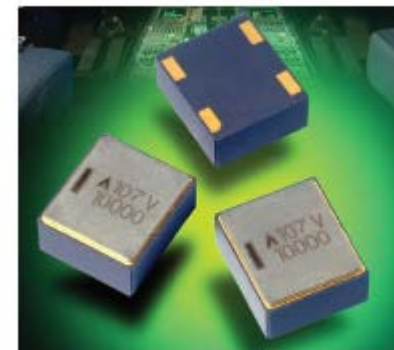


Last development: AVX TCH series

1. Multi anode: low ESR
2. Polymer: no more explosion
3. Hermetic: no sensitivity to humidity



TCH SERIES

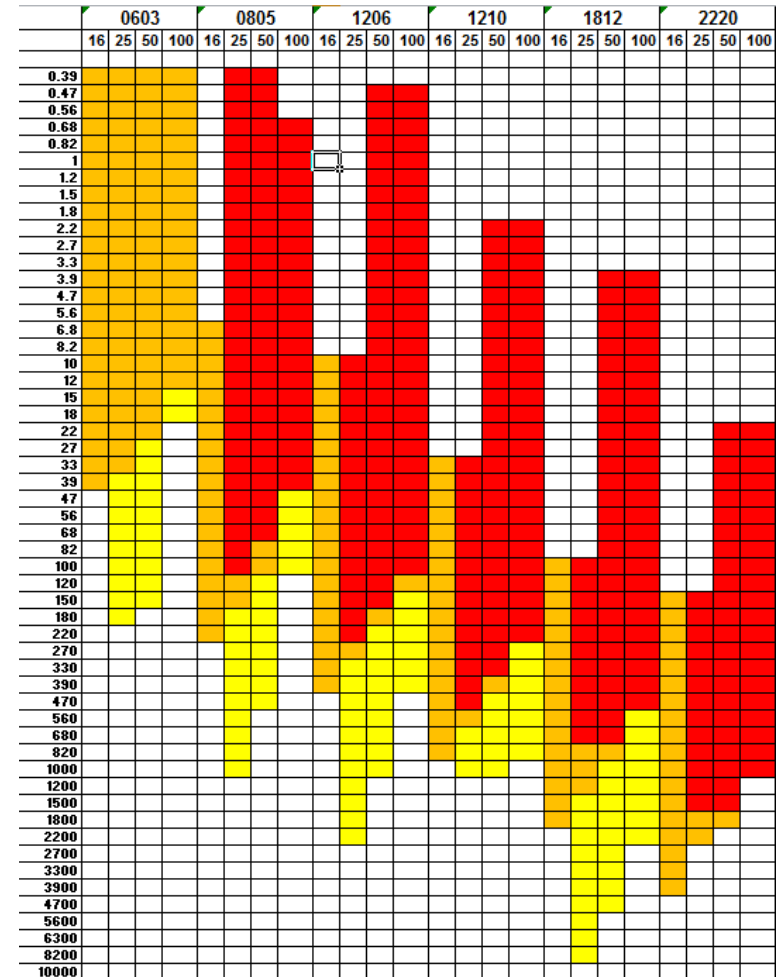
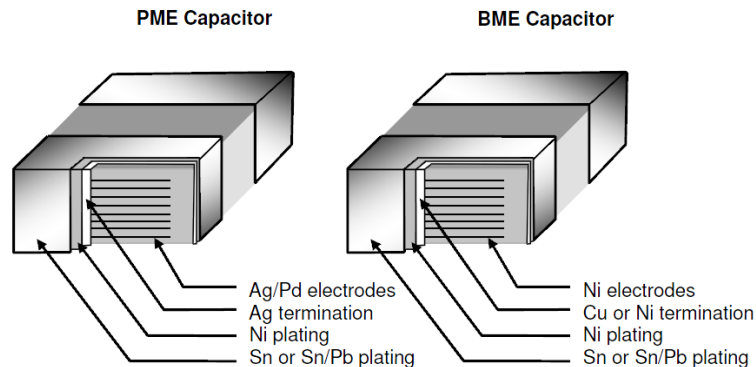


Ceramic: increase capacitance value

a. Lower voltage

- Lower dielectric thickness
- Increase number of layer

b. BME

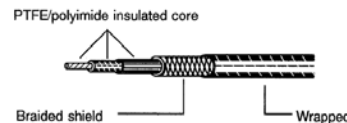
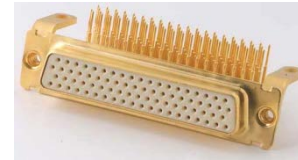


Ex. 2 : Interconnection Components



Interconnection Components :

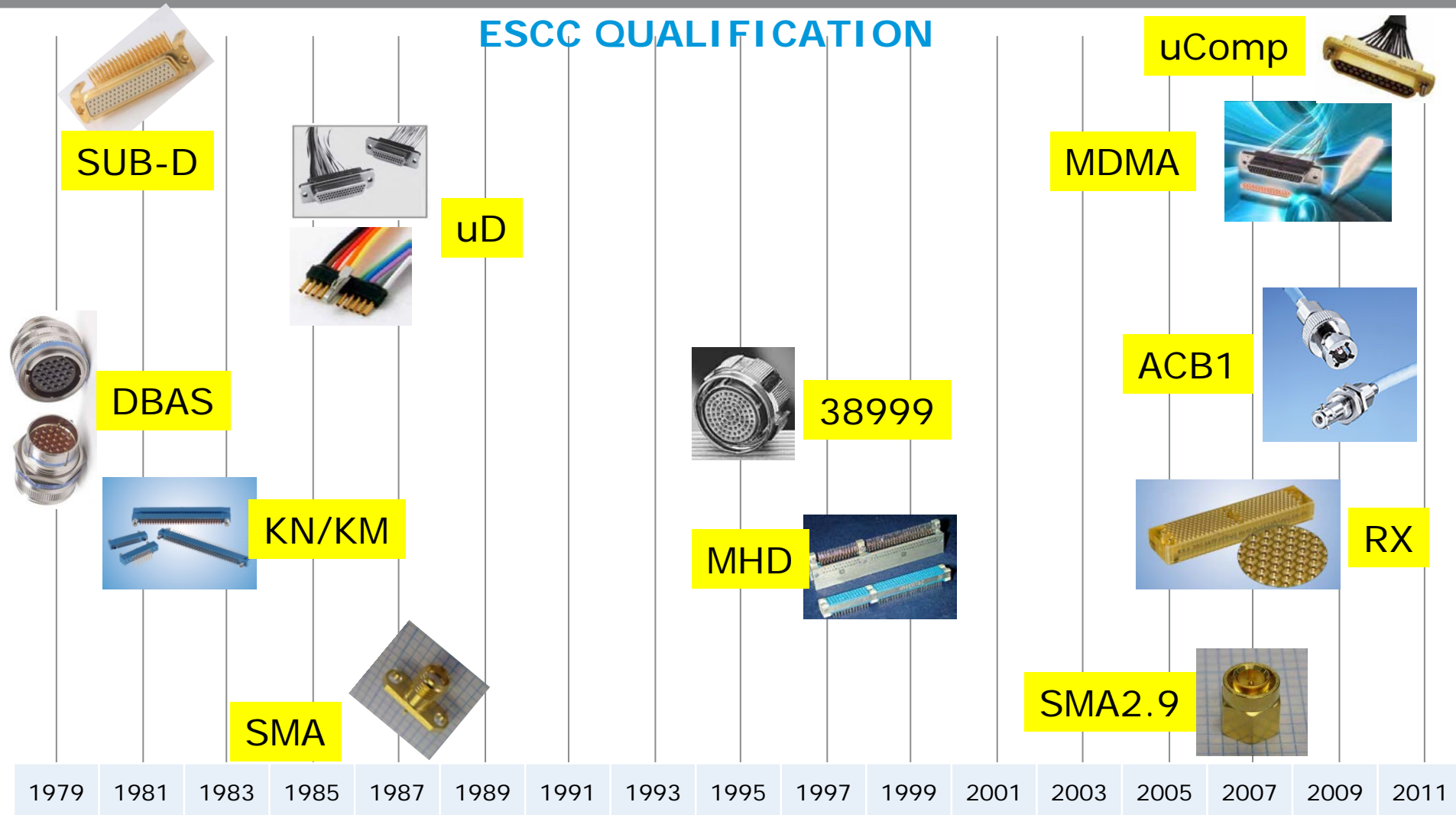
- **Connectors** (ESCC 3401, 3402)
- **Wires & Cables** (ESCC 3901, ESCC 3902)
- **Cable assemblies** (ESCC xxxx)



- **Single point of failure, Specific requirements (outgassing, plating, etc.)**
- Not only EEE functions but also **mechanical/integration constraints**
- **Numerous parts in the ESCC QPL**
 - ✓ 12 qualified Manufacturers, 47 certificates, >80 ESCC specifications
- **Important parts of EEE components of spacecraft :**
 - ✓ For large telecom satellite 60.000 connections, 20km of wires
 - ✓ 30% parts procured for ATV

Ex. 2 : Status for Connectors

ESCC QUALIFICATION



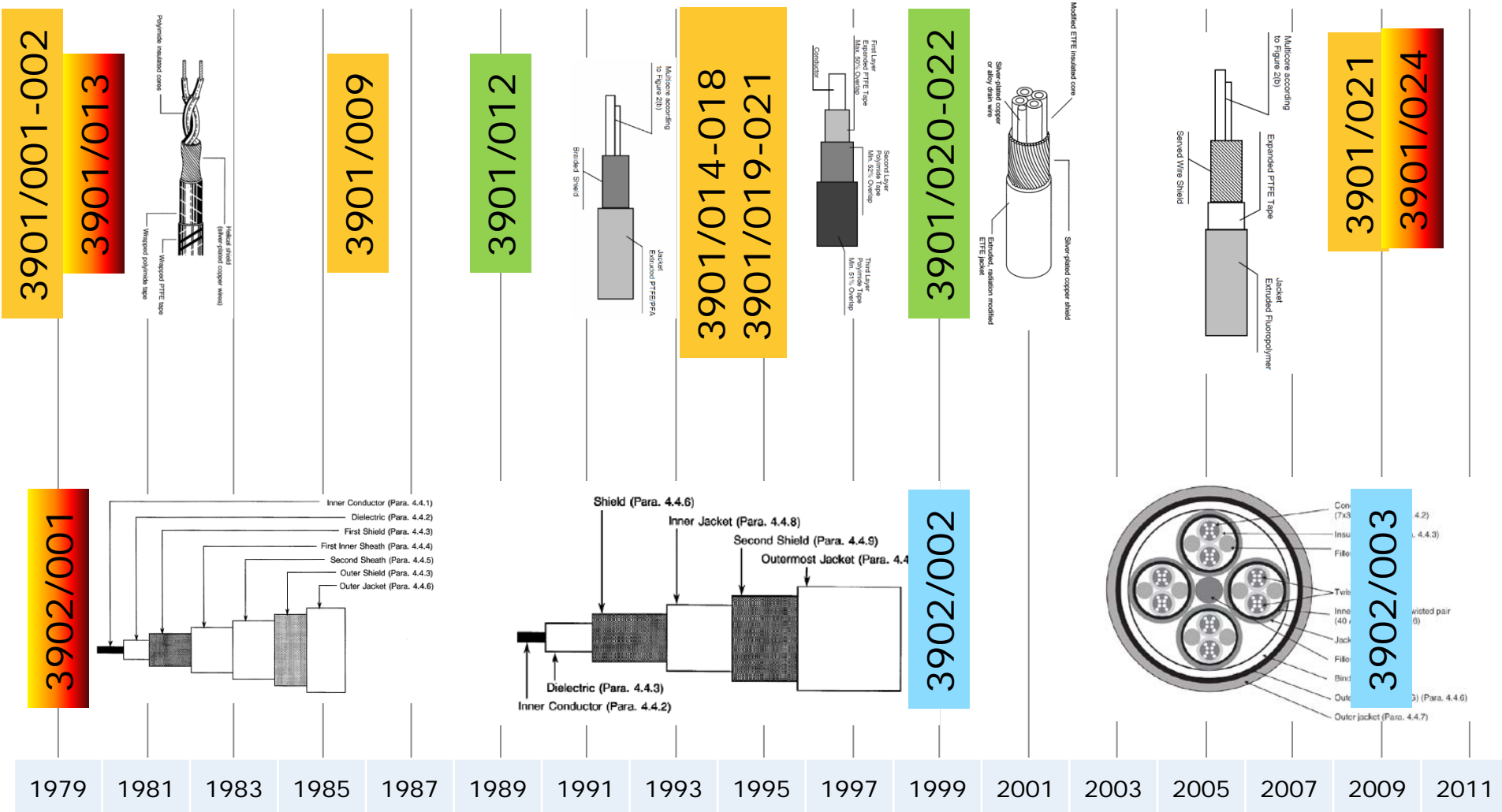
Ex. 2 : Status for connectors



- Parts qualified in the 80's are based on old design (50')
- Mainly single source except for D-SUB connectors
- ESCC QPL covers current needs : DSUB, DBAS, 38999, MDM, KN/KM, MHD, SMA +
- New products qualified as of 2007 :
 - ✓ Improvement of performances : SMA -> SMA2.9
 - ✓ Miniaturization : DMA -> MDMA, RX/IHD
 - ✓ Assembly and integration (removable contacts uComp, MDMA)
 - ✓ New need (ACB1 for 1553 bus)

Nota : Qualification of products designed for space application (RX/IHD, MDMA)

Ex. 2 : Status for Wires and Cables



Ex. 2 : Status for Wires and Cables

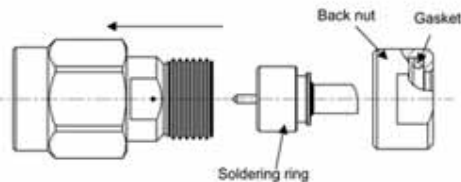


- ❖ For Low Frequency, several sources for similar wires and cables
- ❖ Qualifications as per need based on Polyimide and PTFE, Ag plated Cu
- ❖ Temperature range up to 200C => limitation in Current (A) => harness weight
- ❖ More complex cables being developed/qualified (space wire, space fiber)
- ❖ RF cables not ESCC qualified due to lack of European Source (Semi-rigid) or because CA solution are preferred

Ex. 2 : Status for Cable Assemblies

A cable assembly is composed by the assembly of single elements, two connectors and one or two cables to realize complex electrical functions with given performances which can only be validated through the cable assembly.

Connectors

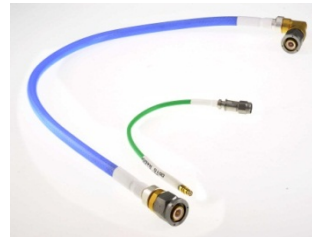


Delivered in piece parts.

Lack of testing or performed only by sampling

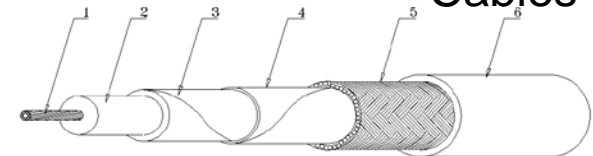
No validation of electrical requirements

Cable assembly



- Common Functional spec/tests. :
Frequency range, Attenuation, VSWR, IL, IR, DWV, weight dimension, ...
Validation of electrical requirements

Cables



Only basic properties can be validated :
Coating test, Conductor resistance, Bending, cold bend test, Resistance to fluid, radiation, Spark test, AB

No validation of complex electrical function or requirements

Cable assembly shall be considered as component but cable assembly screening/eval/qualif/lat shall cover particular testing of connector and cables

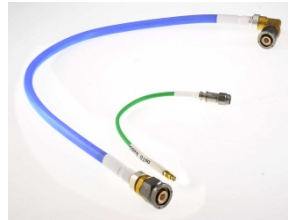
Current ESCC specifications or ECSS standards do not allow to do so
No CA ESCC qualified

Ex. 2 : Status for Cable Assemblies



RF CA

ESCC 3902/xxx : QFX, Flexible, semi-rigid
ESCC 3402/001, 002, 003 : SMA
ESCC 3402/021, 22, 23 : SMA2.9
ECSS Q-ST-70-18C : assembly
=> Needs for High Power



High Voltage CA

No ESCC spec, No ECSS spec
Draft under preparation
=> No European Alternative

Space Wire CA

ESCC 3902/003 : SpW
ESCC 3401/077, Solder MDM (NQ)
ECSS Q-ST-50-12C : design but not process
ECSS Q-ST-70-26C : crimping
ECSS Q-ST-70-08C : soldering
=> Mass saving, flexibility



High Data Rate CA

ESCC 3902/0xx : QFX, Flexible,
ESCC 3401/0xx : MDSA HR
ECSS Q-ST-70-26C : crimping
=> New needs (10Gb/s)



- For these examples, it is not possible to qualify cables or connectors without testing the assembly.
- Manufacturer know-how is key point to achieve high level performance customer requirements

Ex. 2 : On going and Planed Activities



HV, HT, HI cables - AXON/DE (GSTP.1)

Evaluation of Nanod - AXON/UK (TRP)

Evaluation of PCB LGA package devices - HYPERTAC/FR (CNES)

CNT Cable Development - AXON/FR (CNES)

ESCC Qual. RF connectors – ROSENBERGER/DE (DLR)

High Power RF Connectors & CA - RADIALL/FR (ARTES3-4)

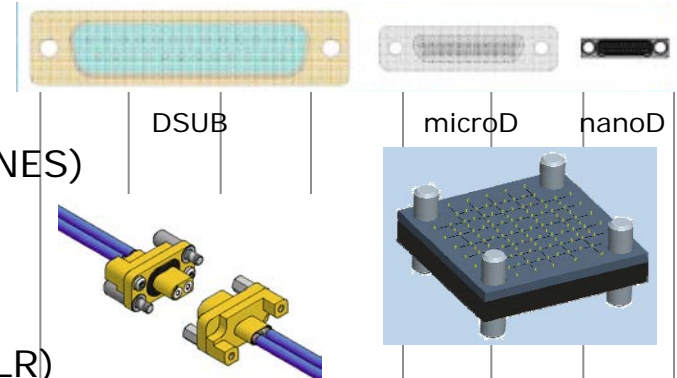
Miniaturisation of power/coaxial Connectors- AXON/FR (TRP)

ESCC eval/qualif of High temperature cable - AXON/DE (ECI 3)

Layer insulation cables (TRP)

High Density Modular Connectors (ARTES 5.1)

ESCC Eval./Qualif. High Voltage CA (ECI IV)



Performance Increase
Miniaturization
New Functionalities
Ease procurement/Integration

2011				2012				2013				2014				2015				cy
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	

Trends In Passive EEE parts



- ❖ Large Domain : technologies, needs, constraints and applications
- ❖ From **small monolithic components** (resistors, capacitors) to more **complex non-monolithic** components (relays, XO oscillators, Cable assemblies)
- ❖ For **capacitors, resistors, magnetics** selection of most relevant technologies for ESCC qualification highest performances available (automotive, military, etc.)
- ❖ More complex passives parts (**CA, relays, oscillators, RF isolators**) are more often **blocking points** (size, performances, etc.) and need **specific** developments.
- ❖ For some others (temperature sensors, fuses), commercial technologies can be adapted to meet space requirements and to guarantee availability.

Passive Components Technology Board (PCTB) has defined a roadmap and more than **50** activities, with priorities based on needs and urgency

Developments/Evaluation/Qualification Activities are on going or foreseen to

- ☐ Achieve **higher performances** (V, I, T, RF),
- ☐ **Miniaturize** (mass/size saving),
- ☐ **Ease AIT** activities,
- ☐ Guarantee **European Independence**
- ☐ **Improve procurement** (cost saving, delivery time)

Trends In Passive

N	Activity		Priority = Interest + Urgency			TRL												Cost, LT	Miniaturisation	Independence	Disruptive techno	Performance	use improvement
			P	I	U	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020							
	Passive test facilities		10	5	5																X		
2	Oscillators XO		10	5	5		2	3	4	6							X		X		X		
3	Relays 100V/15A		10	5	5		2		2	4	6						X		X	X			
1	Temperature sensors Pt Film		10	5	5				2	3	4	6					X	X	X	X			
2	Temperature sensors 100µm		10	5	5		2		3	4	6						X						
Type		Activities		9	5	4				4	6										X		

Type	Activities
Capacitors	11
Connectors	11
Multi	6
Relays	5
Wires & Cables	4
Oscillators/quartz	4
Magnetics	3
Heaters	3
Temperature sensors	2
Fuses	2
Piezzo components	1
Cable assemblies	1
Resistors	1

Objectives	Activities
Miniaturisation	25
Performances	24
Procurement ease	21
Disruptive technologies	20
Use improvement	11
Independence	10

For more information on Passive EEE Parts



CALENDAR OF EVENTS

Call for papers	15 January 2013
Abstract Submission	28 February 2013
Notification to authors	15 April 2013
Preliminary programme	14 June 2013
Early registration	18 July 2013
Final programme	6 September 2013
Conference dates	24-26 September 2013

REGISTRATION

The registration fee (excl 21% VAT) includes: admission to all sessions and the exhibition, on-site lunches, welcome drink and conference dinner.

Early registration fee	: Euro 300
Late registration fee	: Euro 400
Student registration fee	: Euro 150
Exhibition Stand Fee	: Euro 400

FURTHER INFORMATION

Further information, including instructions for the submission of abstracts and information for exhibitors is available on the symposium website
<http://www.congrexprojects.com/13A04>

CONTACT

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+31 (0) 71 565 5005
Scientific questions:
Olivier.perat@esa.int / denis.lacombe@esa.int

**SPACE PASSIVE COMPONENT DAYS,
1st International Symposium**

ESA/ESTEC
Noordwijk, The Netherlands
24-26 September 2013

First announcement and Call for Papers

esa DLR cnes ESCC

European Space Agency