# Space Passive Component Days

## Airbus Defence and Space - Roadmap

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# Agenda

1 - Airbus Defence and Space – Space Equipment
2 - Introduction
3 - High Runners
4 - Design-for-Manufacturing
5 - Major Trends in Electronics
6 - Miniaturization
7 - Technology Status in Europe
8 - Constellation
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# 1 - Airbus Defence and Space - Space Equipment (1/2)

Space Equipment

- 5 countries, 8 sites
- 1,300 employees (2015)

Our customers are mainly the Internal business divisions: telecom, earth observation, navigation and science. But external business is increasing.

Main Projects in Development

- METOP-NG
- Ariane 6
- Neosat
- New Constellation Avionics



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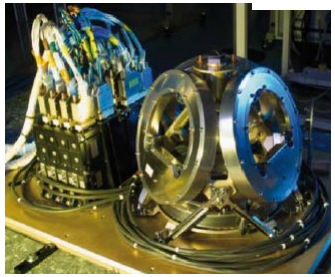
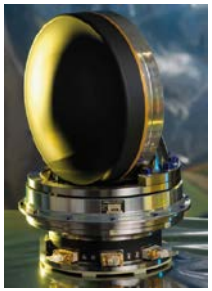
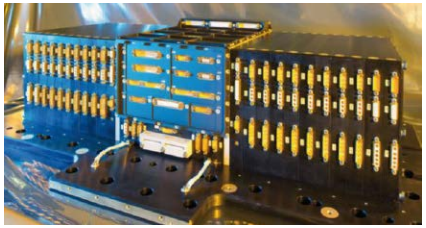
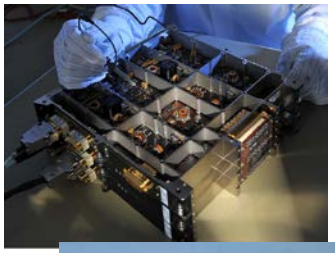
# 1 - Airbus Defence and Space - Space Equipment (2/2)

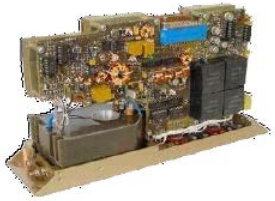
## Product Portfolio

- Avionic
  - On Board Computer
  - Interface Units
  - Gyros
  - CMGs
  - GNSS Receiver
  - AOCS Sub-system
- Power
  - Primary Power Management (PCU, PSR, PCDU)
  - Secondary DC/DC Converters
  - EPC for SSPA
  - High Voltage Electric Propulsion
  - Solar Arrays
- Pay-load
  - Data Handling & Timing
    - Solid State Recorder
    - Instrument Control Unit
    - Instrument Front End







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# 2 – Introduction (1/2)

Passive parts are rarely driving the design, but they are key elements for the design performance.

They represent ~80% of the components used in a satellite ~800,000 pieces are procured per year for Airbus DS, mainly resistors and capacitors

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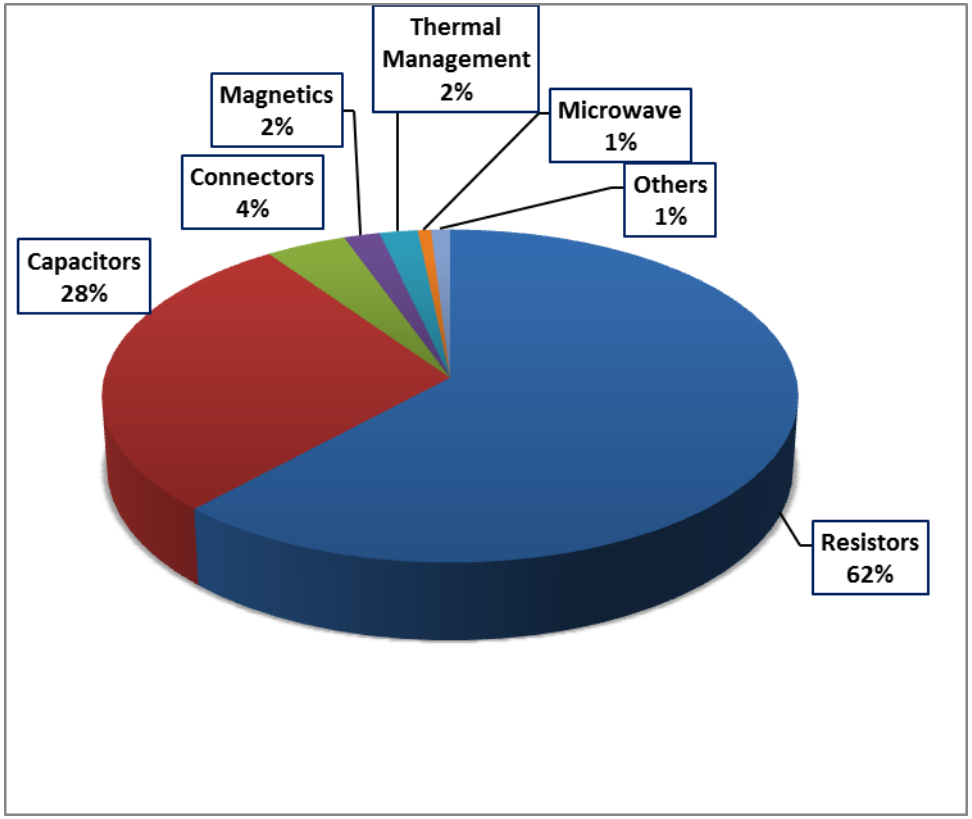



For reliability reasons, most of the passive component technologies are mature.
Nevertheless, more recent technologies shall be used to break a technical deadlock.

# 2 – Introduction (2/2)

What are the main drivers for the present and the future?

- Cost reduction
  - By standardization → High runners
  - Within assembly operation → Design-for-manufacturing
- New technologies needs in relation with the majors trends in electronics
- Technical performances requiring miniaturization
- Independence → Technology status in Europe
- Future for space equipment → Constellation

# 3 - High runners

Capacitors

- The most part of the capacitors used in satellites come from the MIL qualified range due to their low price.
- Ceramic capacitors:
  - Chips “standards values” from QPLs (from size 0805 to 2220)
  - Chips small size 0603 and 0402, for large VLSI decoupling
- Ceramic capacitors SMPS (multi-chips stacked series) for input/output filtering in power electronics
- Film capacitors (PM90/907 and PM94/948 from Exxelia): for their self-healing properties and good stability vs temperature, mainly used in power electronics and tend to replace SMPS.
- Chip solid tantalum capacitors: standard and low ESR type from QPLs and extended range; more and more used for output filtering (DC-DC converter and POL), energy tank and decoupling

Resistors

- Chips thick and thin film from QPLs (from 1206 down to 0402 size)
- Chips PHR (10ppm/°C) when precision is needed
- Shunt: SMS and SMV from Isabellenhütte

Connectors: Sub D, Sub D HD, MDM, MHD,
Relays: mainly latching relays (GP250, TL12, EL215) and thermostats
Others : thermistors NTC 15kΩ @25°C

# 4 - Design-for-Manufacturing

Our goal: 100% in automatic placement and vapor-phase soldering

- Success:
  - Almost all resistors, including shunts
  - All capacitors: chip ceramic and film capacitors PM94/948, removal of SMPS
  - Almost all inductors and pulse transformer

- Remaining components with hand-soldering process
  - Connectors for external and internal interfaces
  - High power resistors: not available in chip version
  - Power transformers
  - Relays

- Assembly qualification
  - Passive parts are critical, in addition with the standard  criteria on joint-solders, electrical measurements should be after assembly process, vibrations and shocks

# 5 - Major Trends in Electronics (1/4)

Digital IC , like FPGA, ASIC, Bus-Interface, Memory

- Lower and lower supply voltage: the standard is 3.3V and 2.5V, down to 1.8V
- Need many different supply voltages: 5V, 3.3V, 2.5V, 1.8V, on the same board
- Higher operating frequency: from some MHz to some 100MHz
- Lots of decoupling capacitors required for large VLSI

Example Supply voltage of DDR memory:

| | Year | Vcc | Speed (MHz) |
|---|---|---|---|
| DDR | 2002 | 2V5 | 266 |
| DDR2 | 2004 | 1V8 | 400 |
| DDR3 | 2007 | 1V5 | 1066 |
| DDR4 | 2013 | 1V2 | 2133 |

Example: decoupling of FPGA RTG4

Chip Ceramic
- 0402 10nF x 150
- 0402 100nF x 230
- 1812 8.2µF x 40

Solid Tantalum x 16

# 5 - Major Trends in Electronics (2/4)

Analogue Circuits
- Rail-to-rail operations with supply voltage down to 5V even less
- But, some components still need ±15V voltage (like multiplexer, Mosfet drivers)

DC-DC Converter
- Waiting for GaN Fet transistor for high switching frequency >1MHz
- PoL for VLSI requiring capacitors with high capacitance and low ESR

Interface Circuits
- High data-rate requiring high frequency oscillators (>500MHz) and high speed connectors (>6Gbps, up to 15Gbps)

100V power bus
- Switching performances of relays and thermostats should be increased

High Power for PPU
- Higher voltage and higher current management: several kW for voltage from 300V up to several kV
- More complex architecture management, including cross-strap, therefore relays are mandatory

# 5 - Major Trends in Electronics (3/4)

RF General

- Needs on 27-31 GHz parts are increasing
- Developments for Q/V Band are running
- Rated Power is increasing

RF Connectors

- TNC connector comes to their multipaction limits
- SMP fast locking is in principle got but each manufacturer has its one system → single source problem
- Attenuator, Load (low power)
  - Often 1W at max operating temperature is required, this is not covered by the current QPL parts.
- Isolator, Load (high power coaxial)
  - For the L and S Band required power is increasing over 200W together with the multipaction requirements
  - TNC connectors comes too their limit.

# 5 - Major Trends in Electronics (4/4)

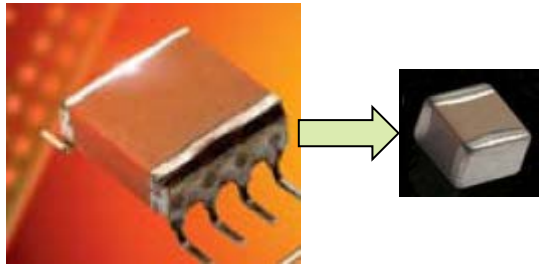
New technologies

- Self-regulated heaters
- Super-capacitors
  - Bus regulation ( bank of supercaps)
  - Complement to Battery
  - Impulsive power application to blow actuator or VHLC switching
  - Memory supply …
- Development of an integrated isolator and a divider

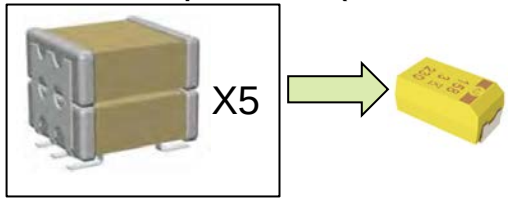
# 6 - Miniaturization

2 mains reasons: lowest voltages supplying for IC and highest operating-frequency

- Chip ceramic capacitors for VLSI decoupling:
  - 0402  chip size (instead of 0603 for the current VLSI)
  - 1812 size ~10µF → BME shall be used (with respect to HiREL rules).



- PoL and LDO filtering
  - Solid Tantalum capacitors: lower voltages and the new generation of low ESR tantalum capacitors (MnO2 multi anodes or polymer multi anodes)
  - Small size of surface mount inductor




- Chip resistors:
  - the standard size will be the 0603 instead of 0805 for analogue designs
  - 0402 for digital
  - But 0201 is not yet planned

Size reduction of the electronics is a reality but we still have the same number of external signals to be managed

- Connectors are the limitation
  - The operating current and voltage limit the miniaturization
  - Handling operation is another limitation

# 7 - Technology Status In Europe (1/3)

| | |
|---|---|
| **Resistors** | |
| • Chips from standard (100ppm/°C 1%) to high stability in temperature and time (5ppm/°C and 0.01%) | • QPL Available |
| • Shunt in surface mount package (down to mΩ and 50ppm/°C) | • QPL Available |
| • High power dissipation in small sizes: 1W in 1206 | • Not yet available |
| **Capacitors** | |
| • Chip ceramic: low voltage, small size, high capacitance, including BME | • QPL Available, but still very expensive, 0402 size is missing |
| • SMPS ceramic, including high voltage | • QPL Available |
| • Solid tantalum, very low ESR with multi anode construction, new polymer technology | • QPL Available, Polymer multi-anode in development |
| • New generation of metallized film | • QPL Available |

# 7 - Technology Status In Europe (2/3)

Magnetics

- Power inductors, surface mount package — QPL Available, but not competitive
- RF inductors — QPL Available, but complete frequency range not covered

- Pulse transformer for 1553 Bus interface — Available but not in QPL
- Current and command transformer — Available but not in QPL
- Power transformer — Waiting for a QML

Other families — All are QPL Available

- Fuse Cermet Technology
- Thermistors
- Heaters
- Thermo-switches
- Electro-mechanical relays
- Connectors

# 7 - Technology Status In Europe (3/3)

The needs expressed by the space industry are almost covered with ESA qualified and/or evaluated components with the support of national agencies (CNES DLR)

- For the last 5 years, many new components have been introduced in QPL
  - Chip ceramic low size (0603) →in 2012
  - Low ESR solid tantalum in multi-anode → in 2013
  - Chip ceramic in BME techno (from 0603 to 8.2µF 25V in 1812 size) → in 2015
  - Fast locking system for Sub-D series → in 2016
  - New generation of polyester metallized film capacitors → in 2016
  - Cermet fuse high current → in 2016
- And in EPPL
  - MDSA-HDR series for high data-rate connection
  - Nano-D connector series
  - Solid Tantalum polymer

Some missing components

- Chip ceramic BME in 0402 size
- Multi-anode polymer tantalum capacitors
- Electro-mechanical relays operating under high voltage and current conditions
- Improved switching-current capability under 100V for relays and thermostats
- New connector to ease assembly operations: press-fit, BGA
- High efficient magnetics in surface mount package

# 8 - Constellation

Mega-constellation: Several hundreds of satellites, even more …launched in one-year period of time

The goal is not a gain of 30%, neither of 2, on the component cost, but 20 to 50!
→ only COTS can be used with any additional screening
→ With some limitations, like outgassing requirements and radiations

The major question is: what will be the early failure rate of those components in space?

Is a revolution in motion?
We have to wait between 5 to 10 years!

# 9 - Conclusion

For the last 10 years, lots of efforts from space agencies have been done to propose new technologies or new ranges of space qualified components to cover the current and future needs.

The results are in line with the expectations. But we must find a way to reduce the time to qualification (market) and the component cost.

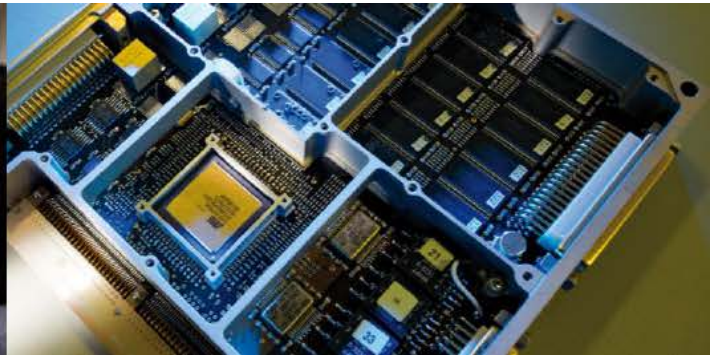
Industrial companies and space agencies must keep on working closely together, it is the key for the space activities in Europe.

Nevertheless, we must anticipate what will be the space business in the next ten years with the introduction of the mega-constellation

# Thank You for Your Attention

# Question?







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