SELECTOR

THE FUTURE OF SPACE IS HIGH MINIATURIZATION

SPCD

SPACE PASSIVE COMPONENT DAYS

Miniature RF switch for compact redundancy ring

Olivier Berenfeld (Radiall), Olivier Vendier (TAS)

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csem

ThalesAlenia Space

a Thales / Leonardo company

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UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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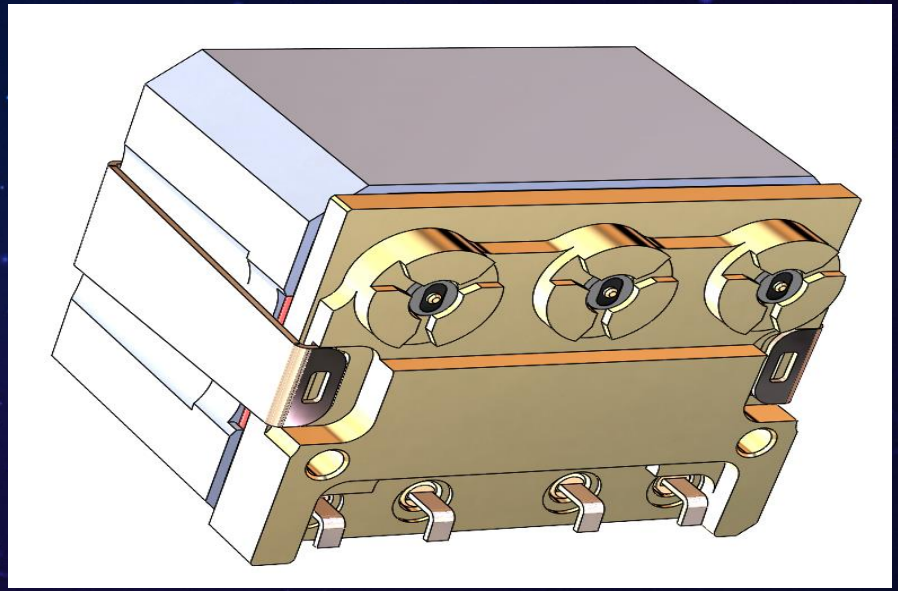
European Commission

TABLE OF CONTENTS

SELECTOR
THE FUTURE OF SPACE IS HIGH MINIATURIZATION



INTRODUCTION

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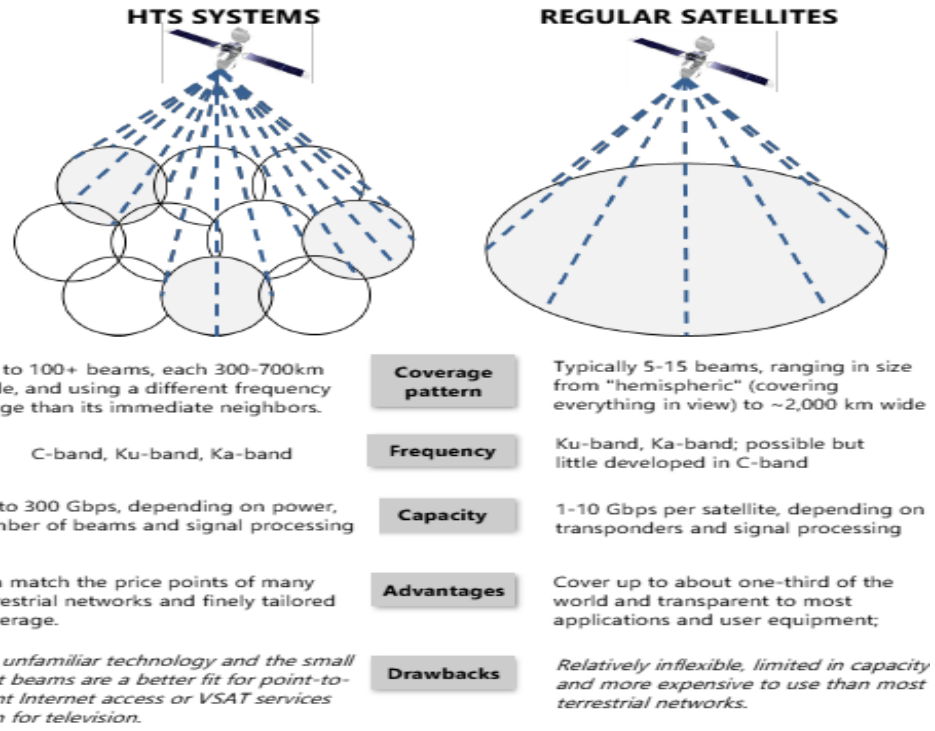
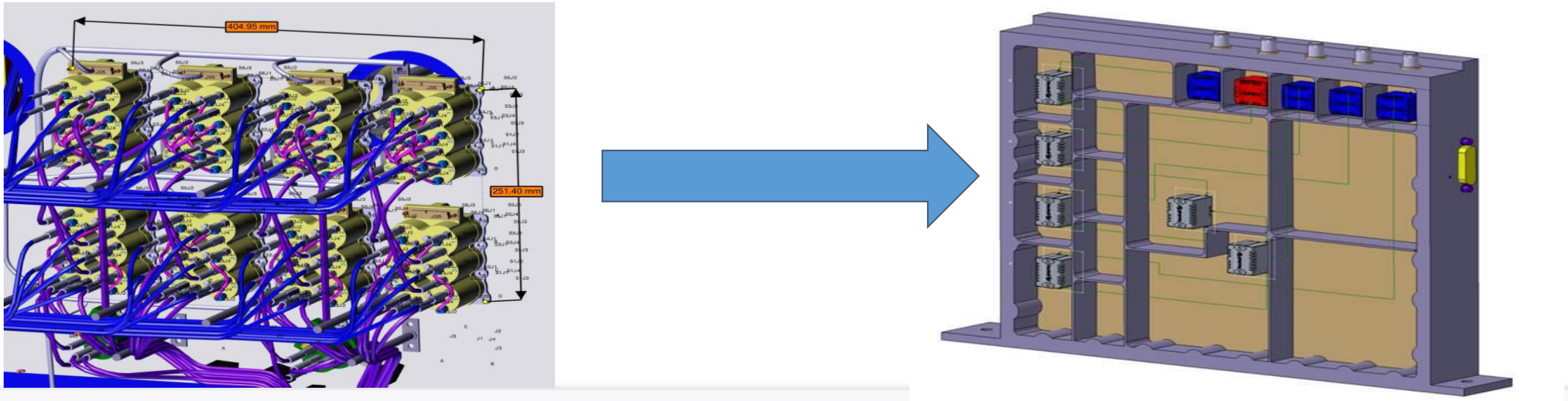
NEW TELECOM PAYLOAD TECHNOLOGY TRENDS

- **Satellite telecom market is changing** from the **classical television** broadcast application towards an **IP-based broadband market** requiring **Very High Throughput Satellites** (high capacity x100 Gbps) and **flexibility** to mitigate business uncertainties
- **New Telecom payloads** based on **highly capacitive digital processors** and **active antennas** are currently proposed, leading to **important changes for microwave units** in terms of architecture and technologies to cope with cost, mass, integration, DC consumption, thermal dissipation **and redundancy/connectivity challenges**.



TARGET

- **Use of a new component :** Micro Electro Mechanical Relay (MEMR) SMT compatible
- **Enable highly demanding connectivity** within reconfigurable new generation processed telecom payload
- **Compatibility with RF on PCB technology**, keeping mass and volume at minimum as compared to standard RF harness complex connectivity matrices



DESIGN

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DESIGN

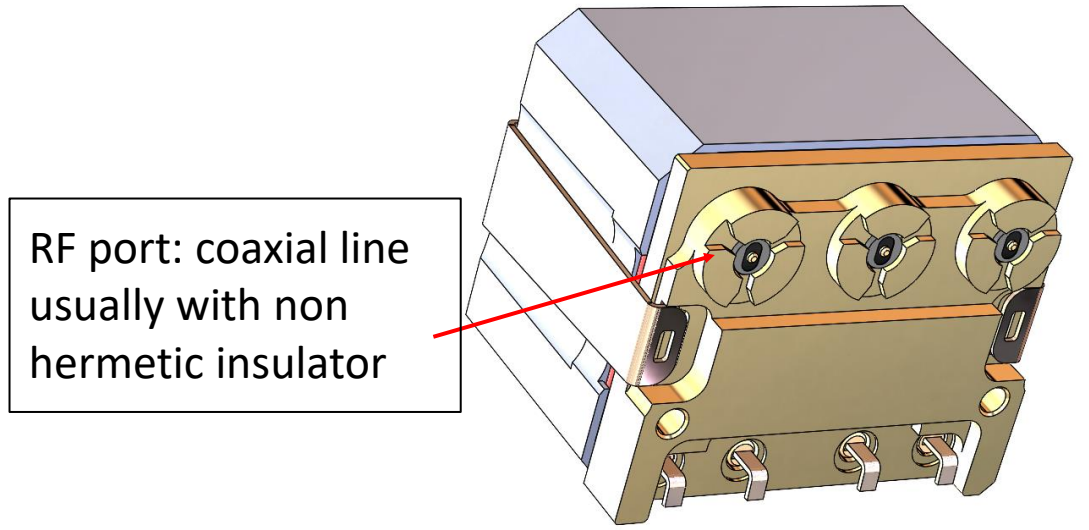
- Development based on Quartz series : this relay has already been qualified for test & measurements and MIL market → significant heritage and return on experience

- **How to meet space requirements ?**

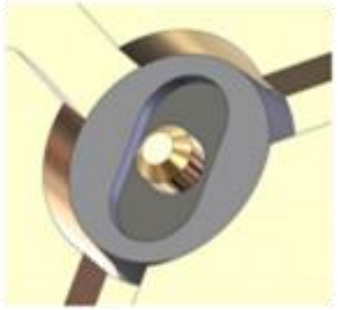
  - Waterproof (IP 67)
  - Microwave performance (DC- 32 GHz)
  - Improve shielding effectiveness (< - 40dB)
  - Gain in mass compared to existing Quartz (standard) version
  - Harsh environment (random vibrations 50Grms 10 to 2000 Hz, mechanical shocks up to 3000g)

WATERPROOF

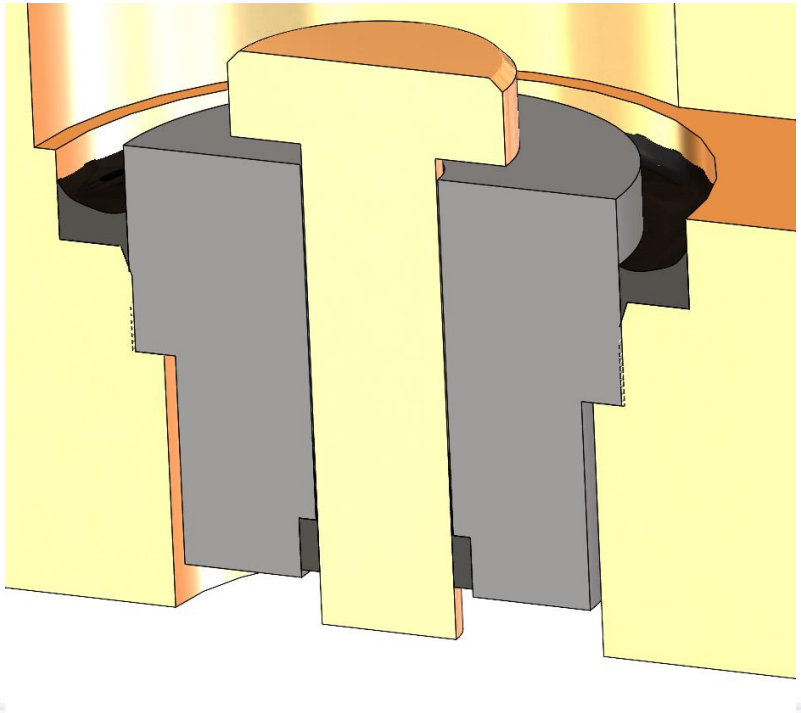
- **Why ?**
  - To facilitate the cleaning of the soldering area.
- **Where ?**
  - The unique weakness of this switch about hermeticity against liquid was the RF access.
- **How ?**
  - In order to be IP67 we had to adapt the structure of the switch by adding a resin on the insulator



WATERPROOF

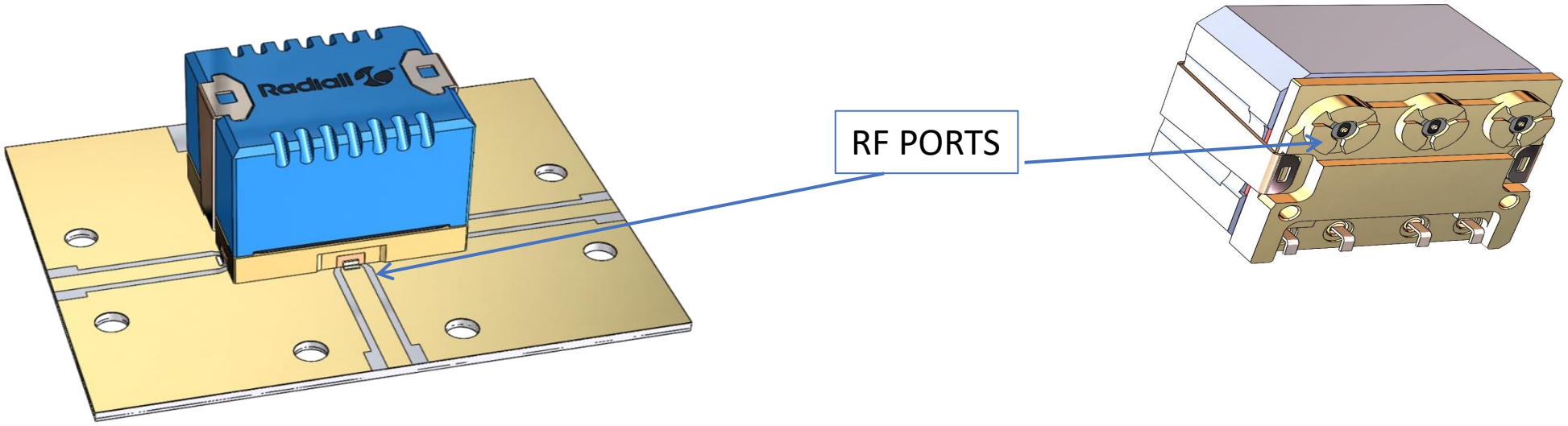


- Optimized glue shape
- Ridge to prevent glue bleeding
- Optimized glue thickness
- Counterbore to facilitate the glue deposit



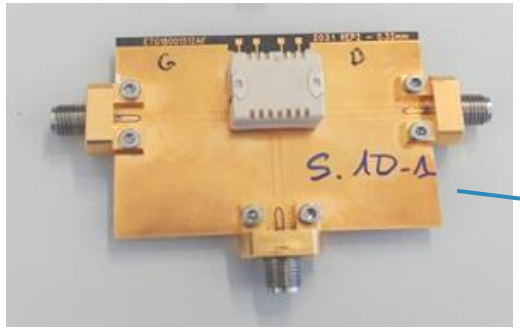
RF PERFORMANCES IMPROVEMENTS

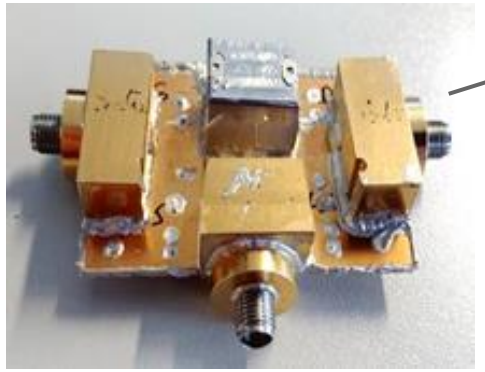
- RF ports have been modified to meet new requirements:
  - Hermeticity
  - Direction of RF ports
  - => The whole RF line has been redesigned and optimized

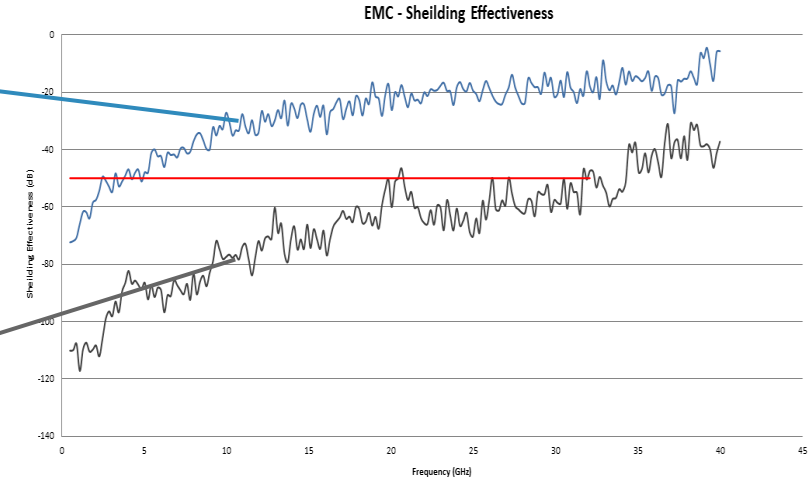


RF PERFORMANCES IMPROVEMENTS

- Some improvements were performed to increase RF shielding effectiveness such as
  - Metallic cap,
  - Conductive gasket,
  - Shielding of RF access,
  - Shielding of Printed Circuit Board
- These improvements allow to reach -50dB typical of shielding effectiveness

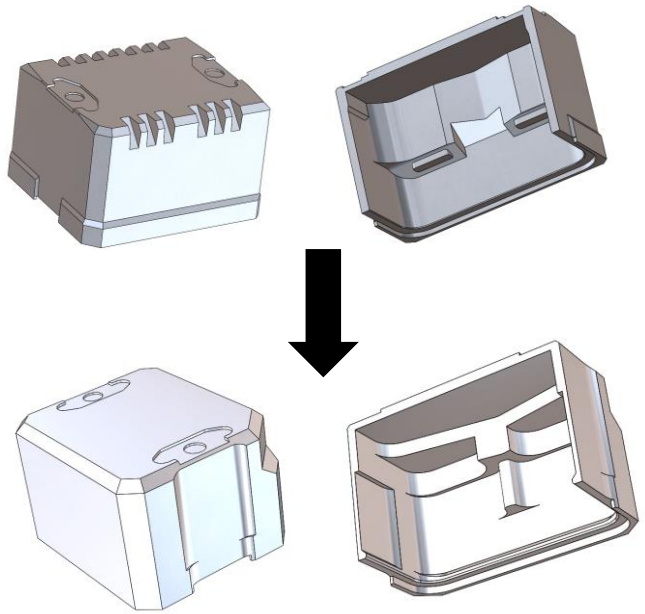


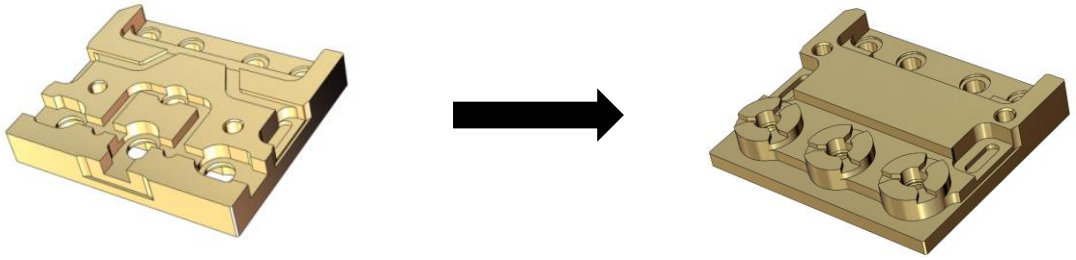




GAIN IN MASS

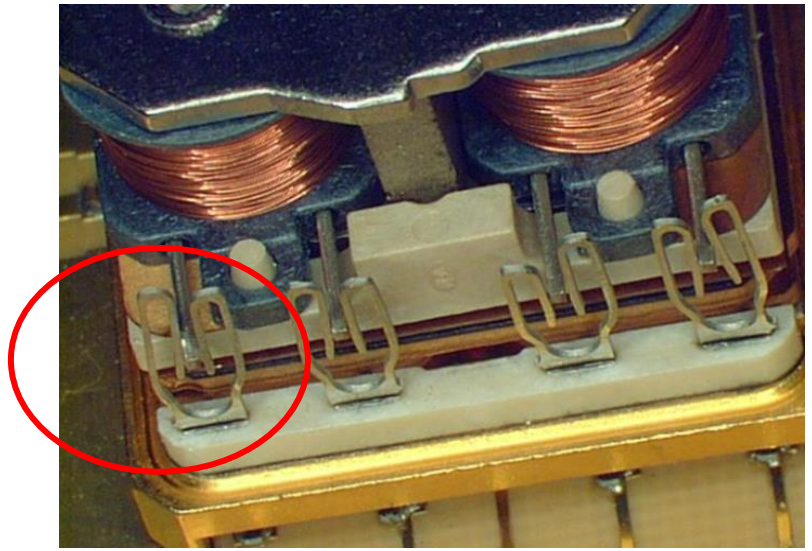
- The cover
  - Use of aluminium to improve shielding effectiveness increases the weight
  - Shape optimization, remove material :
    - 2.05 g => 1.23 g.
- The RF plate
  - Shape optimization of the RF body :
  - Same process as the cover, less material:
    - 2.65 g => 2.33 g.





HARSH ENVIRONMENT

- Harsh environment (Vibrations and shocks):
  - Pins induce resonance and deform the coil contacts
  - To resist such vibration levels, the coils have to be immobilized.



FEATURES

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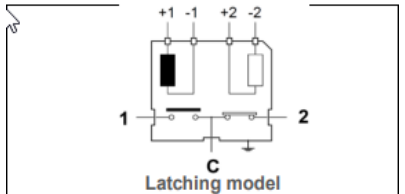
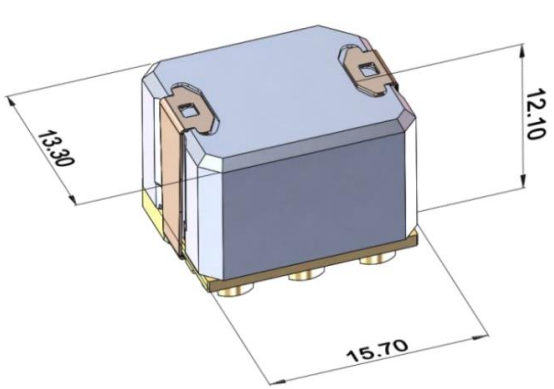
DESCRIPTION OF THE RELAY

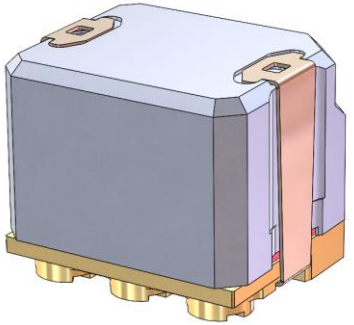
- SPDT : Single Port Double Throws
- Latching, without telemetry
- Actuation voltage : 6 or 12 V
- Frequency band: DC - 32 GHz
- Weight : 7.5 g
- Dimensions : 15.7 x 13.3 x 12.1 mm

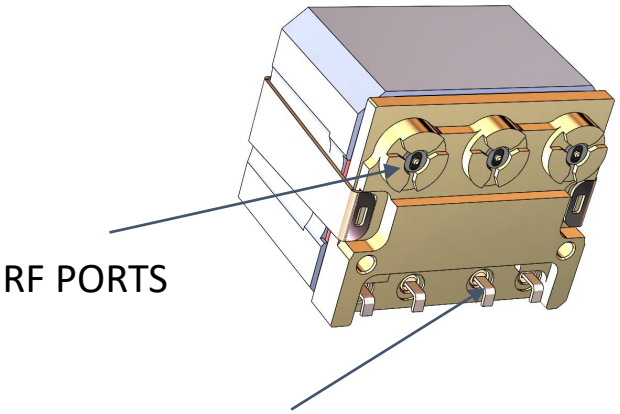


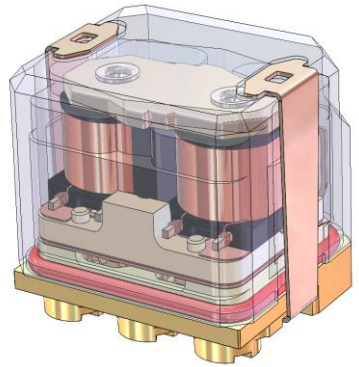
Latching model

Voltage		RF Continuity
-1	+1	C ↔ 1
-2	+2	C ↔ 2



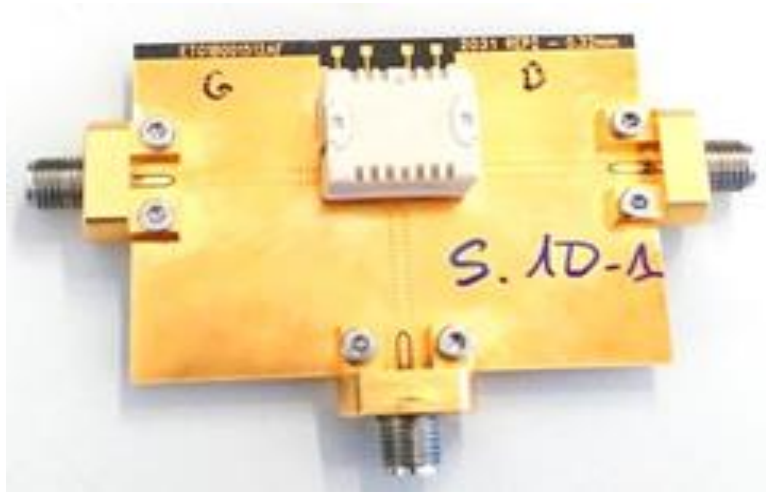


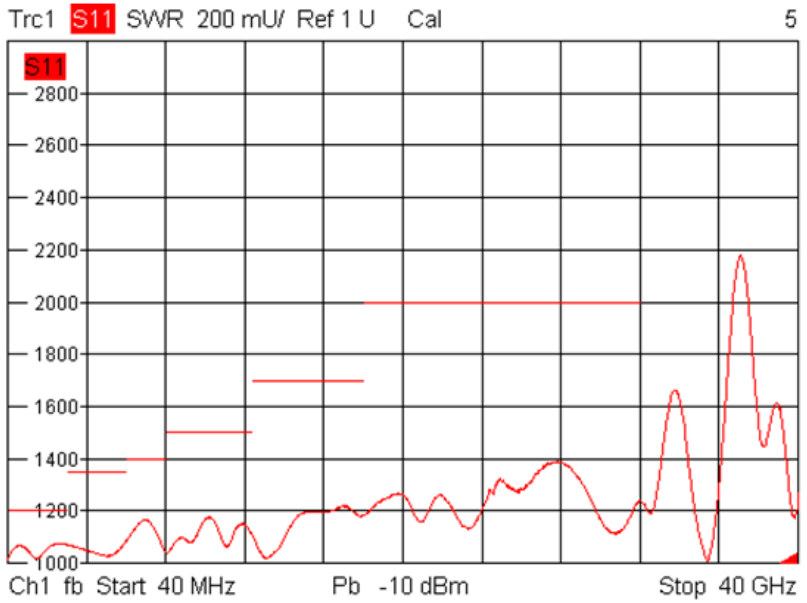


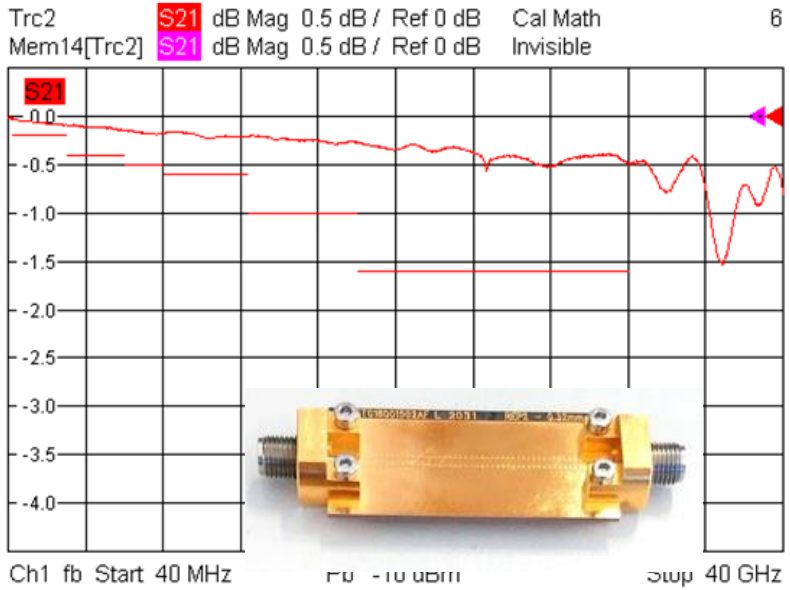


FEATURES

- Microwave performance improvement - StackUp HF Measurement



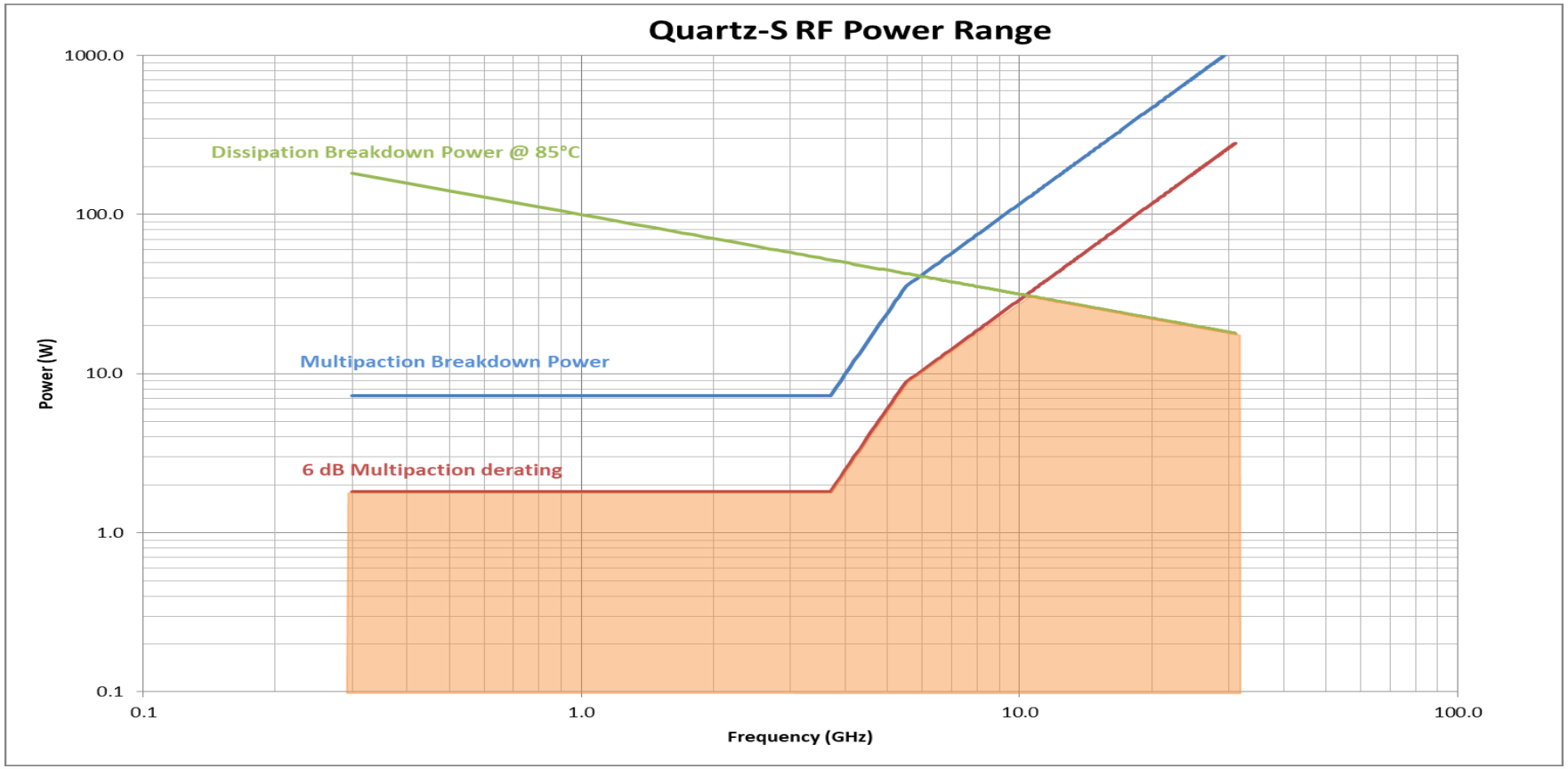




Circuit Losses subtracted

FEATURES

- Power Handling and Multipaction: based on simulation and test campaigns



FEATURES

Characteristics	SPDT QUARTZ-S
Size (L x l x h)	15.4 x 13.3 x 12.1 mm
Mass	Less than 10 g
Interface	SMT (coaxial line, gold plated access)
Sealing	Waterproof IP67
Vibration	Random 50 Grms overall Sine 30g
Mechanical shocks	1500 g / 0.3ms, ½ sine
Temperature range	-40 °C / + 85°C
Operating mode	Latching

FEATURES

Characteristics	SPDT QUARTZ-S
Frequency	DC - 32 GHz
VSWR max	<1.25
IL (dB typical)	Typical : < 0.2 @ 3 GHz; < 0.6 @ 32 GHz
Isolation (dB min)	45
EMI Shielding (dBi min)	- 40
Supply voltage (Volts)	6 or 12
Switching time (ms max)	5
Actuation life	1 million cycles (cold switching) 500 000 cycles (Hot switching, 1W)

STATUS OF PROJECT

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QUALIFICATION

- Specifications: generic & detail

Page 1 of 37

**RELAYS, ELECTROMAGNETIC,
RF SWITCH, LATCHING**

ESCC Generic Specification No. 3603

Page 1 of 18

**RF ELECTROMAGNETIC RELAY, LATCHING,
SMT, Micro-SPDT, BREAK-BEFORE-MAKE,
LOW POWER, DC TO 32GHz**

ESCC Detail Specification No. 323 (3603/007)

QUALIFICATION TEST PLAN

LATCHING SELECTOR SMT Power Micro-SPDT 32 GHz								
Ref	R517832611						R517831611	
SN	1	2	3	4	5	6	1	2
Degolding on RF pins	•	•					•	•
Solder heat Test	•	•	•	•	•	•	•	•
Soldering on PCB	•	•	•	•	•	•	•	•
Cleaning	•	•	•	•	•	•	•	•
Visual Inspection test (1)	•	•	•	•	•	•	•	•
Initial functional test	•	•	•	•	•	•	•	•
Visual inspection test (2)	•	•	•	•	•	•	•	•
Sine survey test (1)	•	•	•	•	•	•	•	•
Sine vibration test	•	•	•	•	•	•	•	•
Sine survey test (2)	•	•	•	•	•	•	•	•
Random vibration test	•	•	•	•	•	•	•	•
Sine survey test (3)	•	•	•	•	•	•	•	•
Visual inspection test (3)	•	•	•	•	•	•	•	•
Mechanical shock test	•	•	•	•	•	•	•	•
Sine survey test (4)	•	•	•	•	•	•	•	•
Thermal Vacuum	•	•	•	•	•	•	•*	•
Life test (cold switching)	•		•	•				
Life test (hot switching)		•			•	•		•
EMC	•	•	•	•	•	•		•
Final functional test	•	•	•	•	•	•		•
Seat test	•	•	•	•	•	•		•
DPA	•	•	•	•	•	•	•	•

STATUS OF QUALIFICATION

- ✓ Qualification test according to ESCC3603 => EPPL in 2022
- ✓ Industrialization: done
- ✓ Few hundreds of EM already delivered
- First FM batch (200p) to be delivered in november 2022
- Target: to be ESA QPL in 2023

MAIN OUTPUTS OF THE SELECTOR PROJECT

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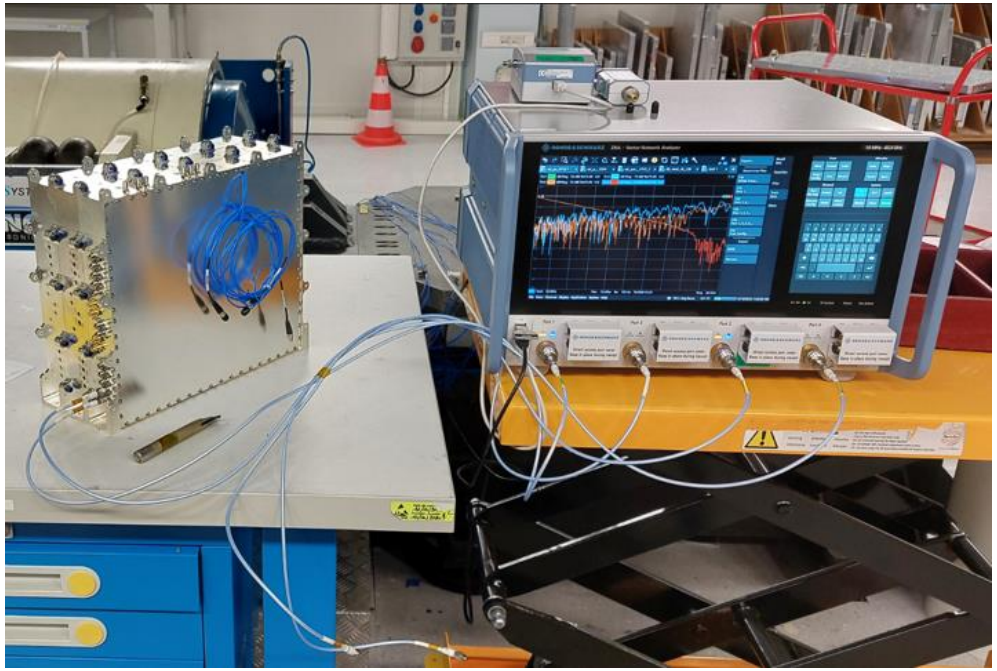
MAJOR ACHIEVEMENTS

- MEMR SPDT switch component validating a TRL 6
- Dedicated redundancy ring building blocks validated up to a TRL 6
  - I/O interconnects
  - SMT mounting of MEMR
  - Multilayer RF PCB
- MEMR SPDT demonstration into a compact redundancy ring using RF on PCB technologies available at TAS validating a TRL 3
  - Up to 2 redundancy rings 27:30 into the same assembly
  - Scalable patented architecture and design
  - Wide band frequency

- Assembly of 3 slices prior to vibration testing



MAJOR ACHIEVEMENTS

- Performance assessment in C band
  - Return loss better than -20 dB
  - Less than 3 dB insertion loss between shortest/longest path
  - Channel to channel RF isolation better than -65 dB
  - Temperature range validation : from -15 to 95 °C
- Good match between measurements and 3D EM RF multiscale models

- Next : Further effort for equipment industrialization and higher frequency operation

- S parameter measurement vs temperature

Thanks for your attention / **Any questions ?**