

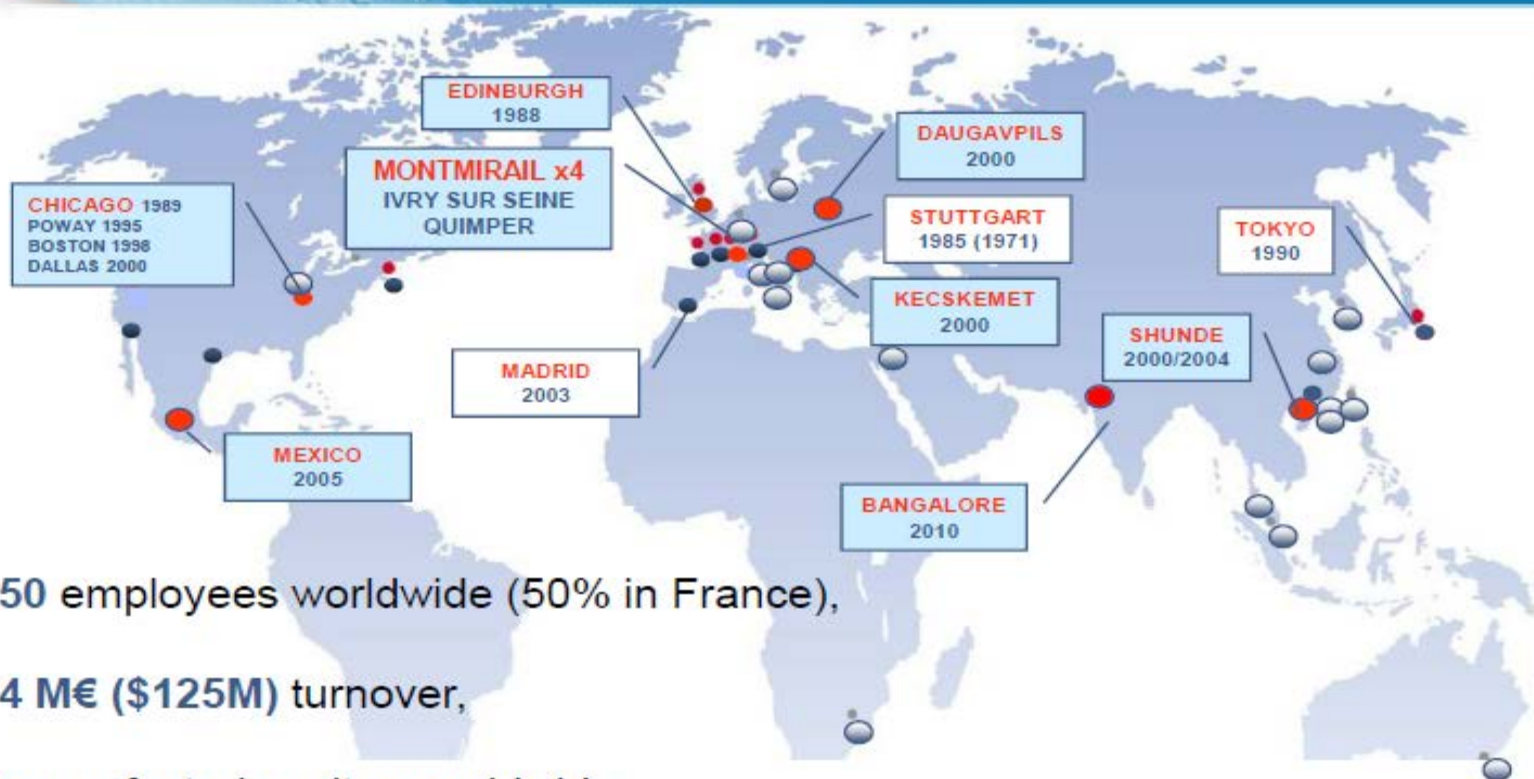
Cabling miniaturisation



Space passive component days
24 – 26 September 2013,
ESTEC



The AXON' Group worldwide



- ✓ 1550 employees worldwide (50% in France),
- ✓ 104 M€ (\$125M) turnover,
- ✓ 13 manufacturing sites worldwide,
- ✓ 30 representatives in the world,

SALES
DESIGN
PRODUCTION

SALES
DESIGN



Content of the presentation

- **PART A:** Saving mass and volume using high density connectors for signals and power harnesses.
- **PART B:** Reducing mass of high data rate assemblies using Low Mass Spacewire cable.
- **PART C:** Increasing data rate transmissions using AxoMach.



Mass and Volume saving

- **High density Micro/Nano D connectors** for space applications.
- They have been **evaluated** for space use.
- **ESCC specifications are existing.**



CONNECTORS, ELECTRICAL, RECTANGULAR,
NANOMINIATURE, NON-REMOVABLE CRIMP
CONTACTS AND UNINSULATED SOLID WIRE
CONTACTS

BASED ON TYPE NANO-D

ESCC Detail Specification No. 3401/086

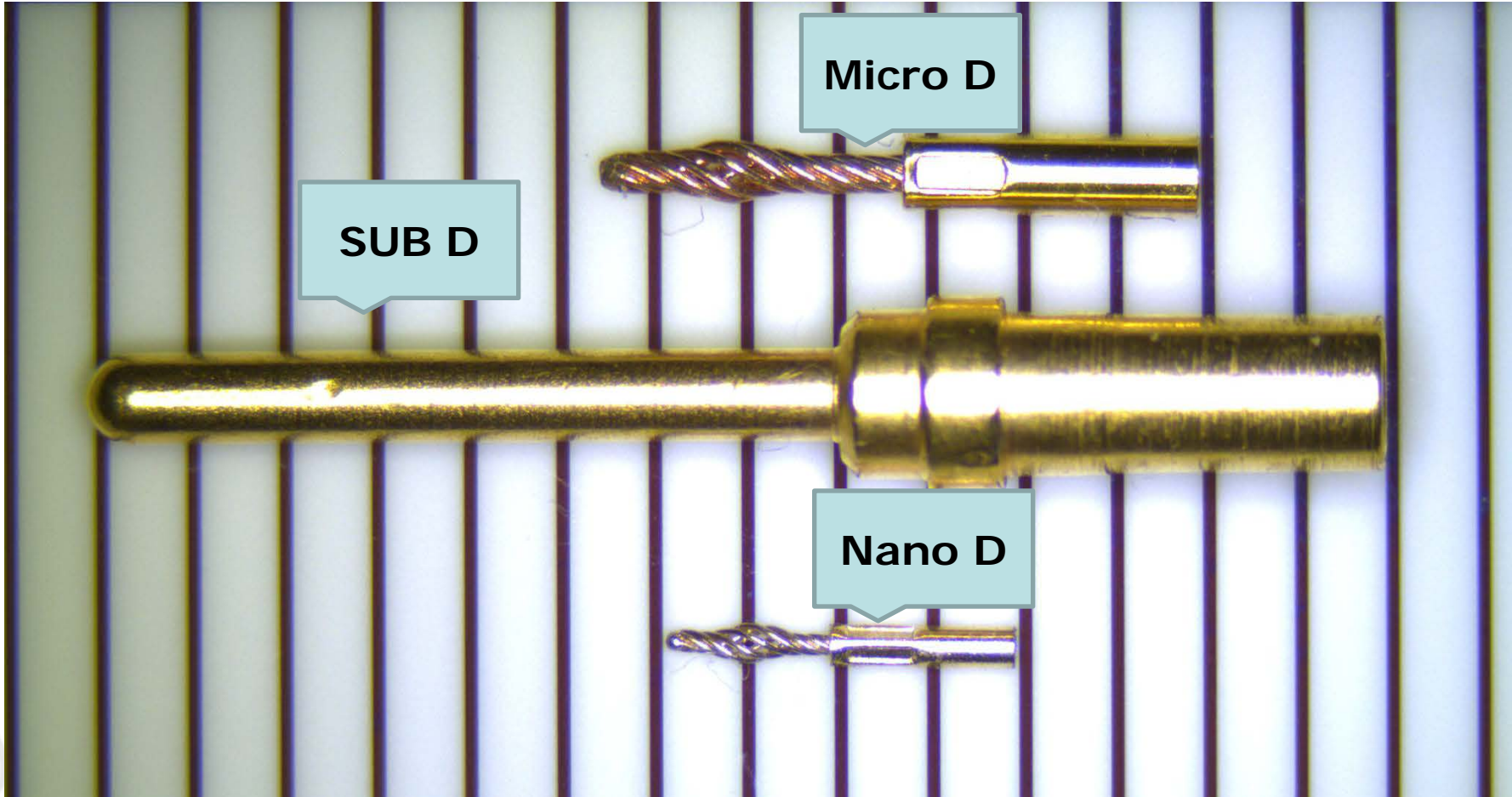
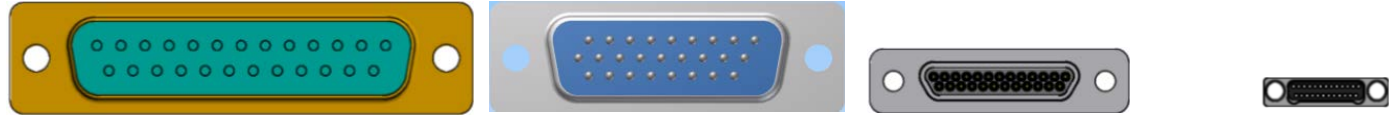
Nano-D connectors

- **Extreme Miniaturisation**

- Twist pin contact, crimped technology
- 1 Amp rated current contact for AWG 30
- Insulation Resistance :
5000Mohms/100VDC
- 7 shell sizes: 9-15-21-25-31-37-51
contacts
- Nickel over Aluminium plating



DSUB, DSUB HD, MICRO D & NANOD

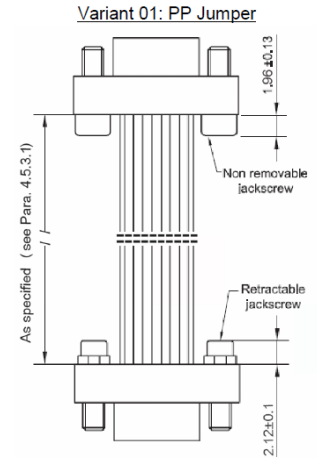
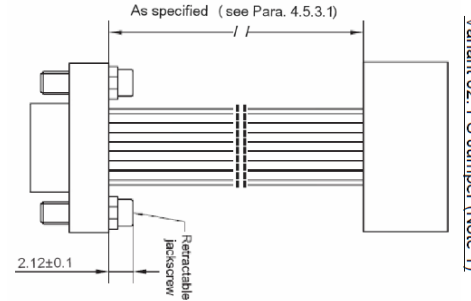


Volume and mass reductions

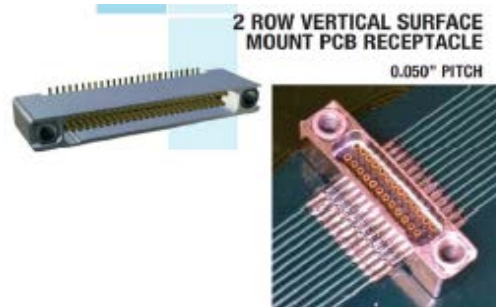
- **Surface is reduced:**
 - by a ratio of 2.8 from D-SUB to Micro-D.
 - by a ratio of 5 from Micro-D to Nano-D
 - by a ratio of 14 from D-SUB to Nano-D.
- **Mass is reduced:**
 - by a ratio of 3 from D-SUB to Micro-D.
 - by a ratio of 3 from Micro-D to Nano-D
 - by a ratio of 9 from D-SUB to Nano-D.

Nano D availability

- **JUMPERS**



- **PCB (CBR-SMV) connectors**



- **Specification and user guide (integration recommendations).**

Nano D status

- **Nano D status**
 - ESA specification ESCC3401/086
 - Extensive evaluation done
 - Thermal test
 - 333 cycles from -125°C to +80°C
 - 1300 cycles from -55°C to + 150°C
 - Mechanical
 - Vibrations, shocks, 700 mechanical endurance
 - Overload current and voltage...
 - ...
 - PID & User guide for integration recommendations.
- **Applications**

Where there are confined areas.
(electronic boxes, Pan Cam, Star tracker...).



CONNECTORS, ELECTRICAL, RECTANGULAR,
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Mass reduction on high data rate assemblies

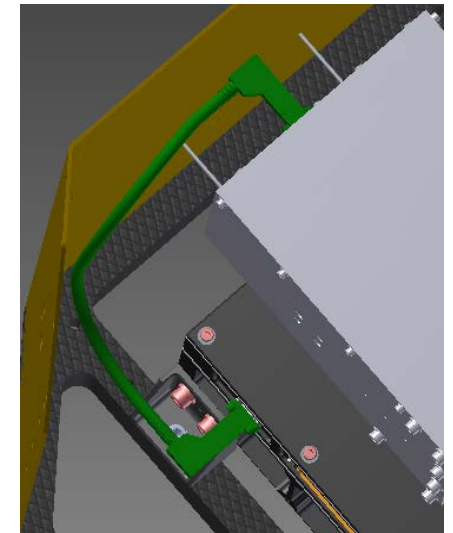
Development and evaluation of low mass SpaceWire cable and assemblies

- ✓ Mass reduction: 50% (half the mass)
- ✓ Improve flexibility
- ✓ Improve shield bonding
- ✓ Improve radiation tolerance
- ✓ Retain existing electrical performances



Input from Users

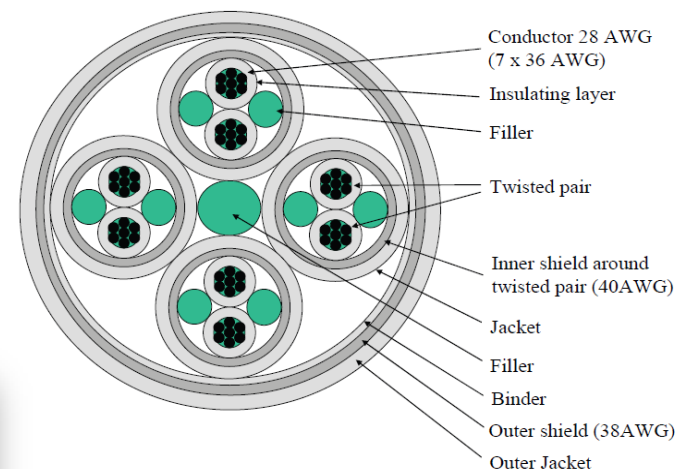
- Application in GEO satellite harness can request up to **90 metres** in total of SpW cable.
- In such case mass saving is more **than 3 Kg.**
- Bending capability of the cable is important for optimised arrangement of the harness,
 - especially in the vicinity of the unit connectors.



Existing SpaceWire specifications

Generic specification ESCC3902 & Detailed specification ESCC3902/003

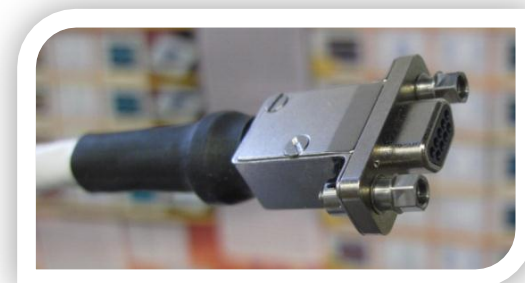
- Variant 01: 28AWG (7x36 AWG) : **80g/m**
- Variant 02: 26AWG (7x34 AWG)



ECSS-E-ST-50-12C

§ 5.3 Connectors :

- Refer to ESCC3401/029
- Axon' is EPPL2 since 2006
- Micro-D connector shell size 9



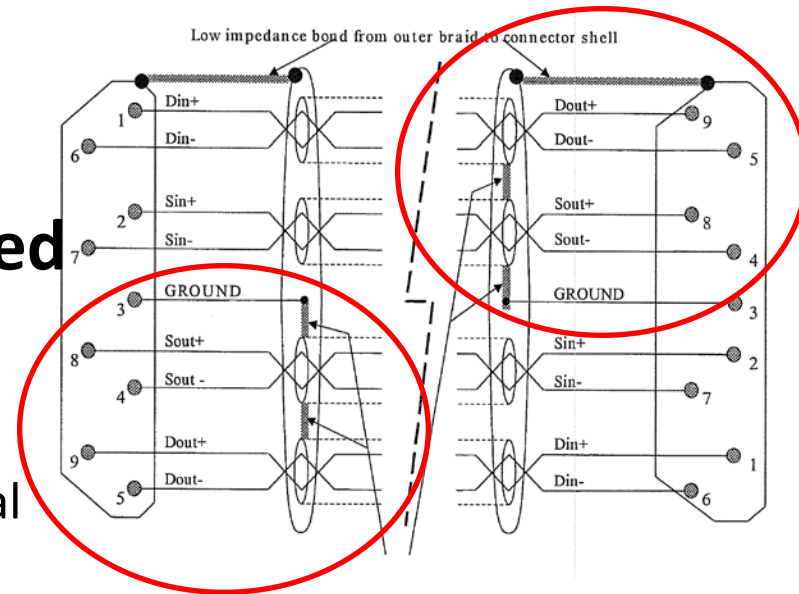
Specified layout and bonding : ECSS-E-ST-50-12C

Existing shield bonding:

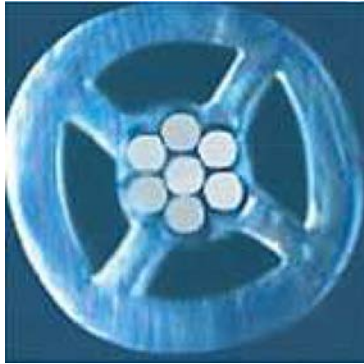
- ✓ outer braid terminated to the backshell
- ✓ Inner braids only connected at one end to pin 3

EMC Recommendations followed on LmSpW

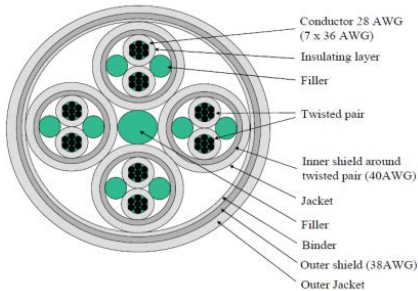
- Shielding bonded at both ends.
- Outer and inner shielding in electrical contact.
- 360° shield termination Connector backshell (low impedance ground connection)



Ways of reducing cable mass



- **Use lighter materials**
 - Change copper shield to aluminium
 - Change plastic materials
 - a-PTFE insulator instead of e-PTFE
 - Kapton tape for outer jacket instead of PFA



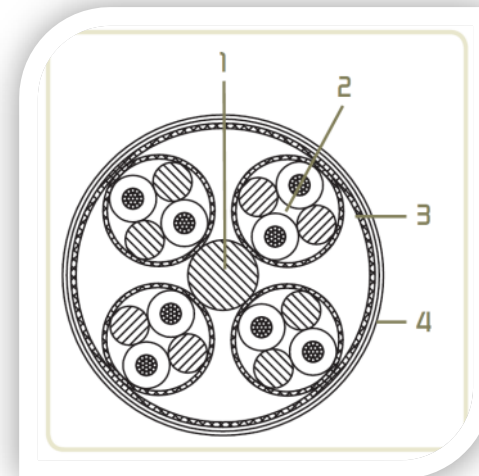
- **Different construction techniques**
 - Remove insulation of pairs
- **Flexibility**
 - Use of AWG**2819** instead of AWG2807



Low mass 28AWG SpaceWire

CONSTRUCTION

- 1 - Celloflon® Expanded PTFE filler
- 2 - 4 x 100 Ω AWG **2819** Bus Lines **A_{liveolar}** PTFE inner braided shield made with **silver plated aluminium**
- 3 - Braided shield made with **silver plated aluminium**
- 4 - Outer jacket **Expanded PTFE tape (CELLOFLON®) under a Polyimide tape**

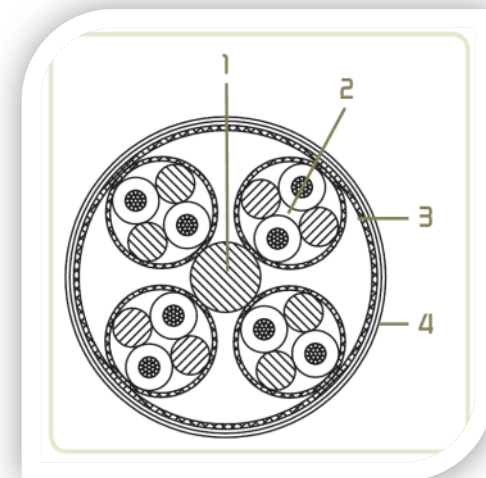
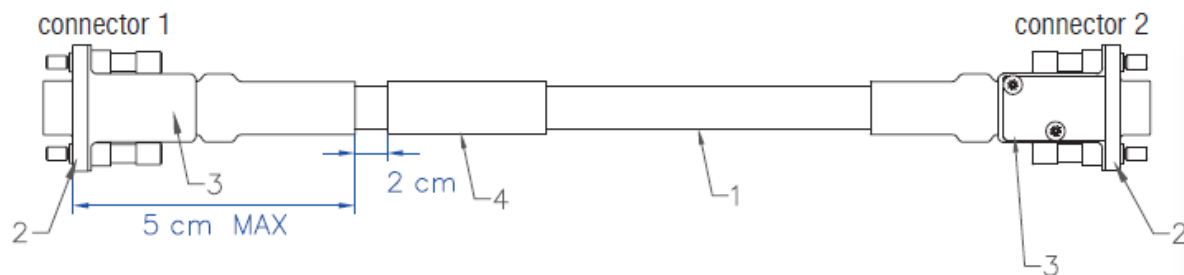


MAIN CHARACTERISTICS

- Outer diameter: **6 mm** maximum.
- Bend radius: **25 mm** minimum (for fully static applications).
- Weight: **42 g/m** maximum.
- Operating temperature: -200 / +180°C.
- Impedance (between wires of a pair): 100 Ω ($\pm 6\Omega$) at 400 MHz.
- All inner shields are in contact with overall shield.

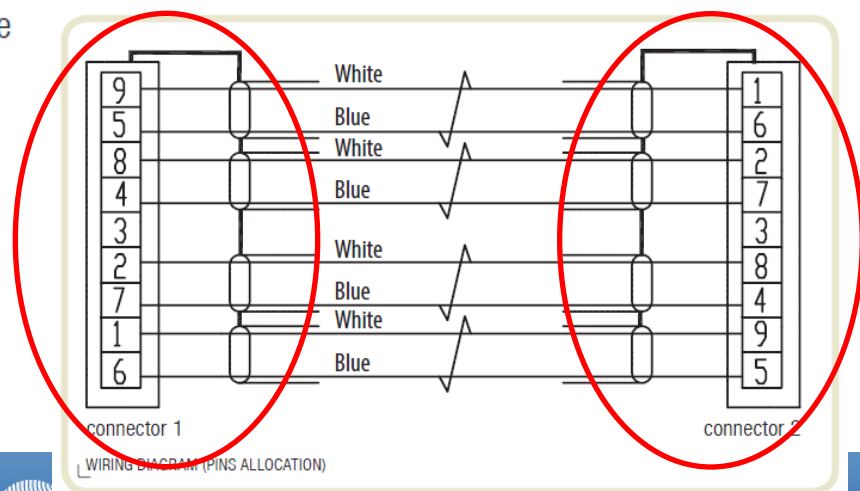


Low mass SpaceWire High speed link



Part list

- 1 - Low mass SpaceWire cable (P551259)
- 2 - Micro-D plug connector (MDSA209P000B: 9 ways / high phosphorous nickel plated)
- 3 - High phosphorous nickel plated backshell and stainless steel 2-56 UNC-2A fasteners
- 4 - Marking sleeve



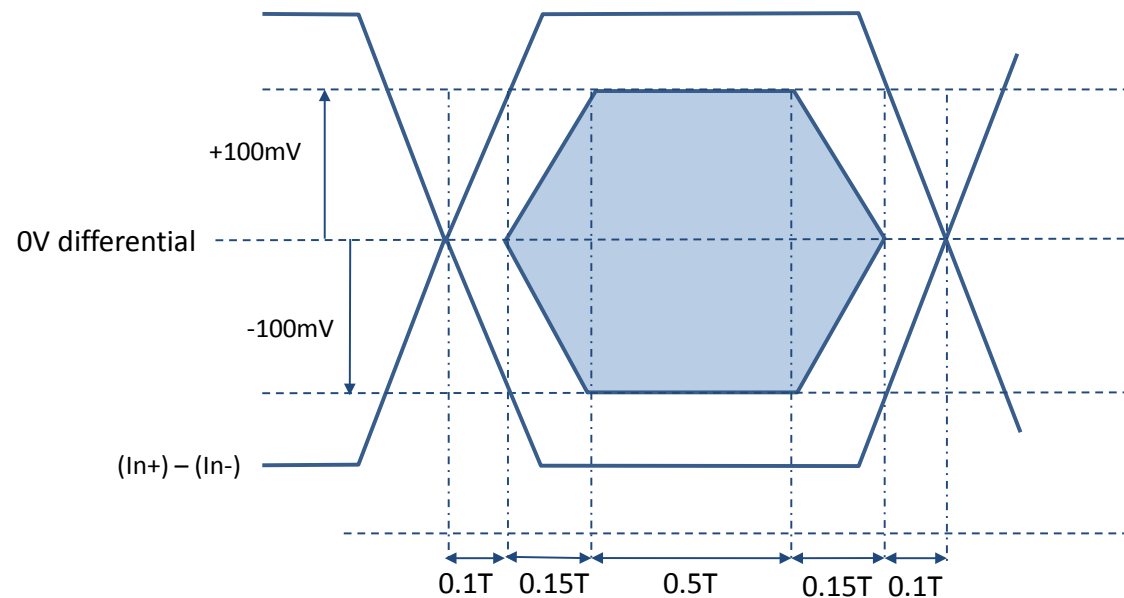
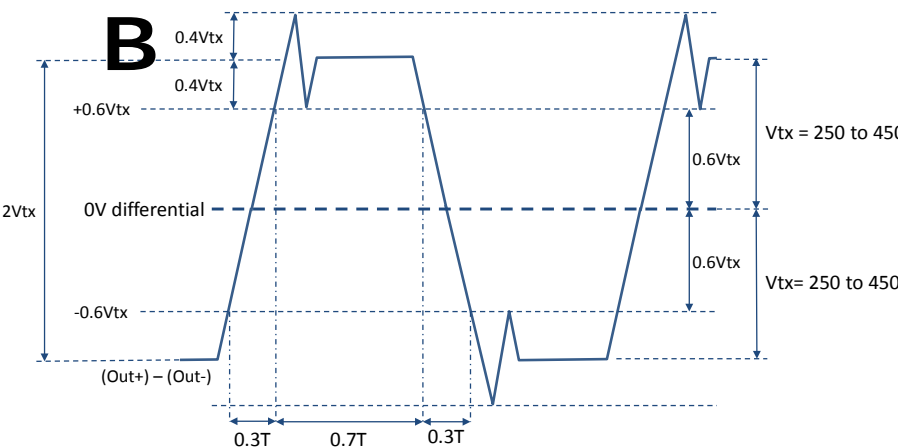
Current versus LowMass cable

ESCC3902.003	Variant 1 (Current SpW)	Variant 03 New LMSPW
Mass (g)	80 max	42 max
Overall Φ (mm)	7 max	6.1 max
Bend Radius	45mm	20mm
Flexibility vs var1	0	+
Impedance (Ω)	100+/-6	100+/-6
Capacitance (pF)	<50 / 90	<50 / <90
Dc R (Ω /m)	0.23	0.23
Intra Skew (ps/m) Inter Skew (ps/m)	<80 <130	<50 <100
Jitter (pS) _{@400Mb/s}	64 L=5m	64 L=5m
α (dB/m) @1Ghz L cable for -6dB	-1.5 4.5m max*	-1.4 4.6m max*
Eye pattern Qfactor @400Mb/s	10 L=5m	10 L=5m



Eye pattern mask new requirement

When the signals from the transmitter have passed through the SpaceWire connectors and cable assembly, the eye pattern of the SpaceWire signal at the receiver termination resistor shall be outside the mask shown below:

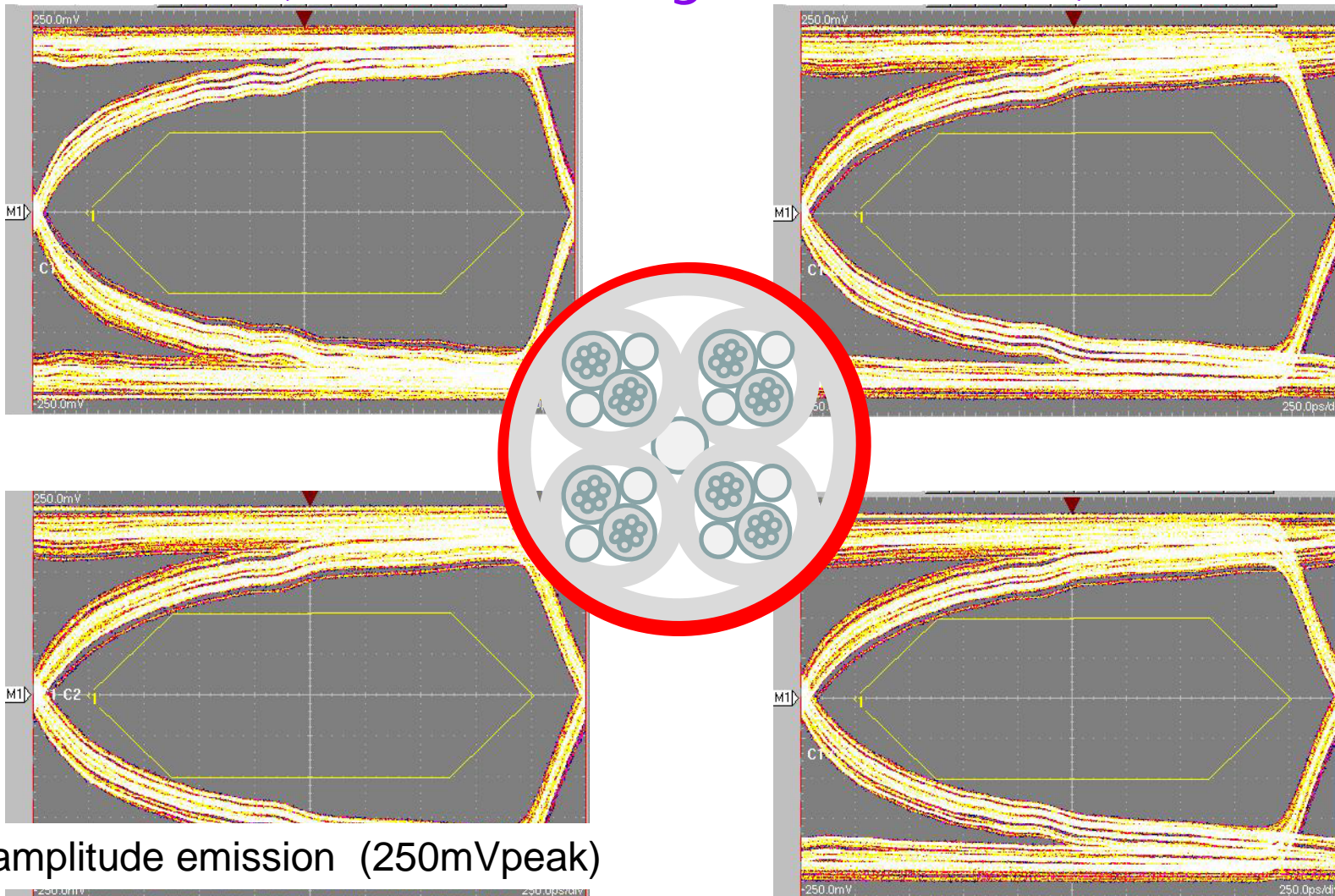


LVDS transmitter output signals

LVDS receive signal eye pattern mask

P
A
R
T
B

Eye pattern mask at 400Mb/s (Assembly L=4.5m)



Worst case of amplitude emission (250mVpeak)

LmSpW Status

- **Positive evaluation: *Targets met***

- ✓ Mass reduced (50%),
- ✓ flexibility increased,
- ✓ shielding and bonding improved
- ✓ Radiation resistance improved from 30 to 200 Mrads



- **New revisions** of specifications to come

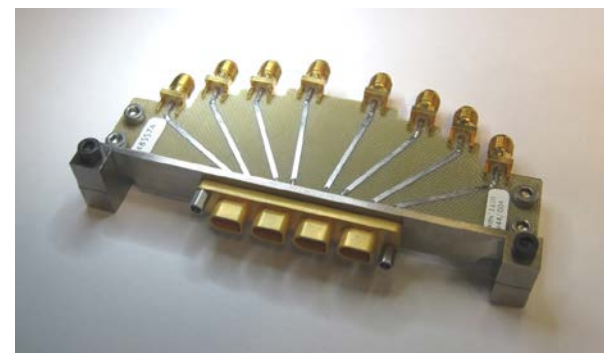
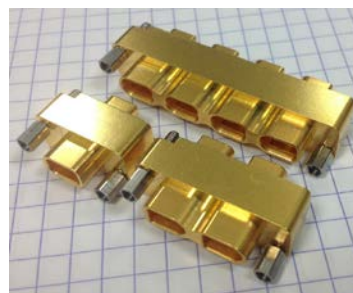
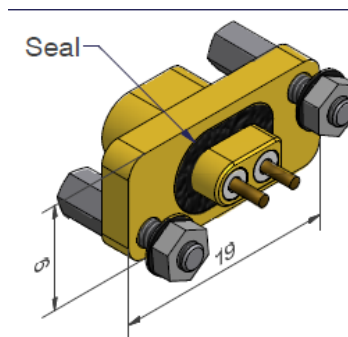
- including current standard and Low Mass variants:

- ✓ New issue of ESCC3902/003
- ✓ New issue of ECSS-E-ST-50-12

axoMach™ Solutions

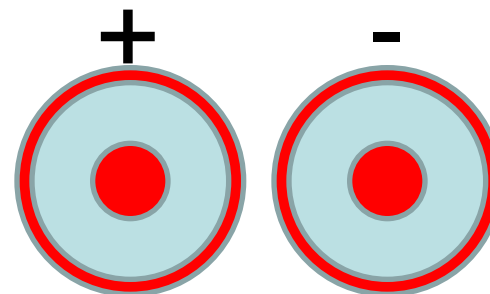
Axomach assemblies allows very high serial data link

- ✓ Up to 10 Gb/s
- ✓ 1,2 and 4 ways
- ✓ Jumper
- ✓ PCB connectors
 - Paralell gap
 - QFX connectors
- ✓ Savers



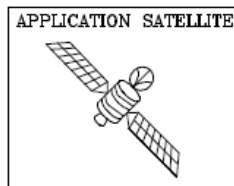
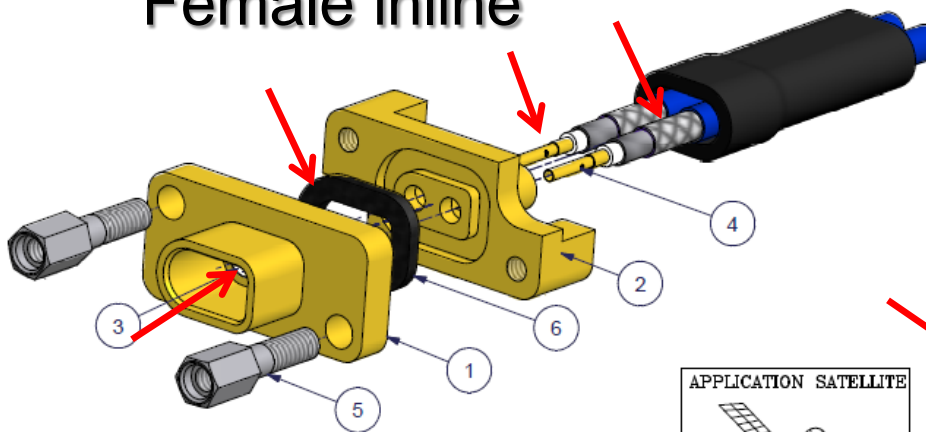
Design : heritage of microD

- MicroD space contacts (MDSA)
- PTFE inserts ($Z_c = 100$ Ohms)
- Coaxial cable (2 times **ax2.4S**)
- EMI gasket
- Retractable jack screw

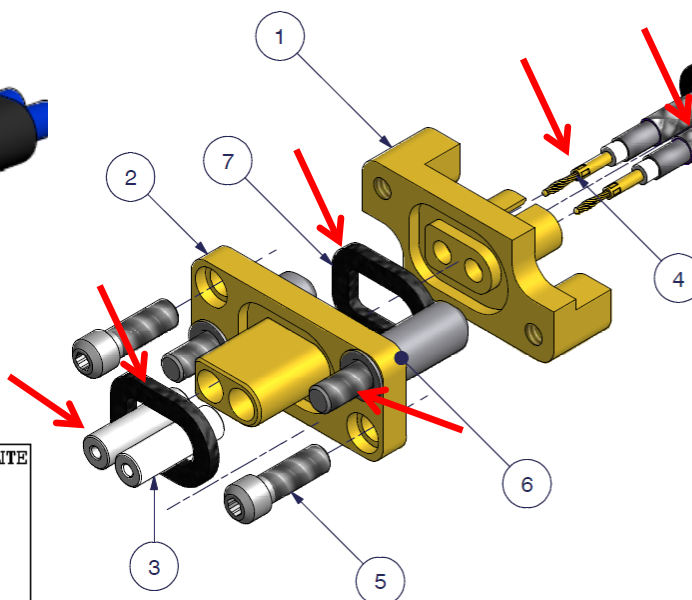


2 coaxial cables per way

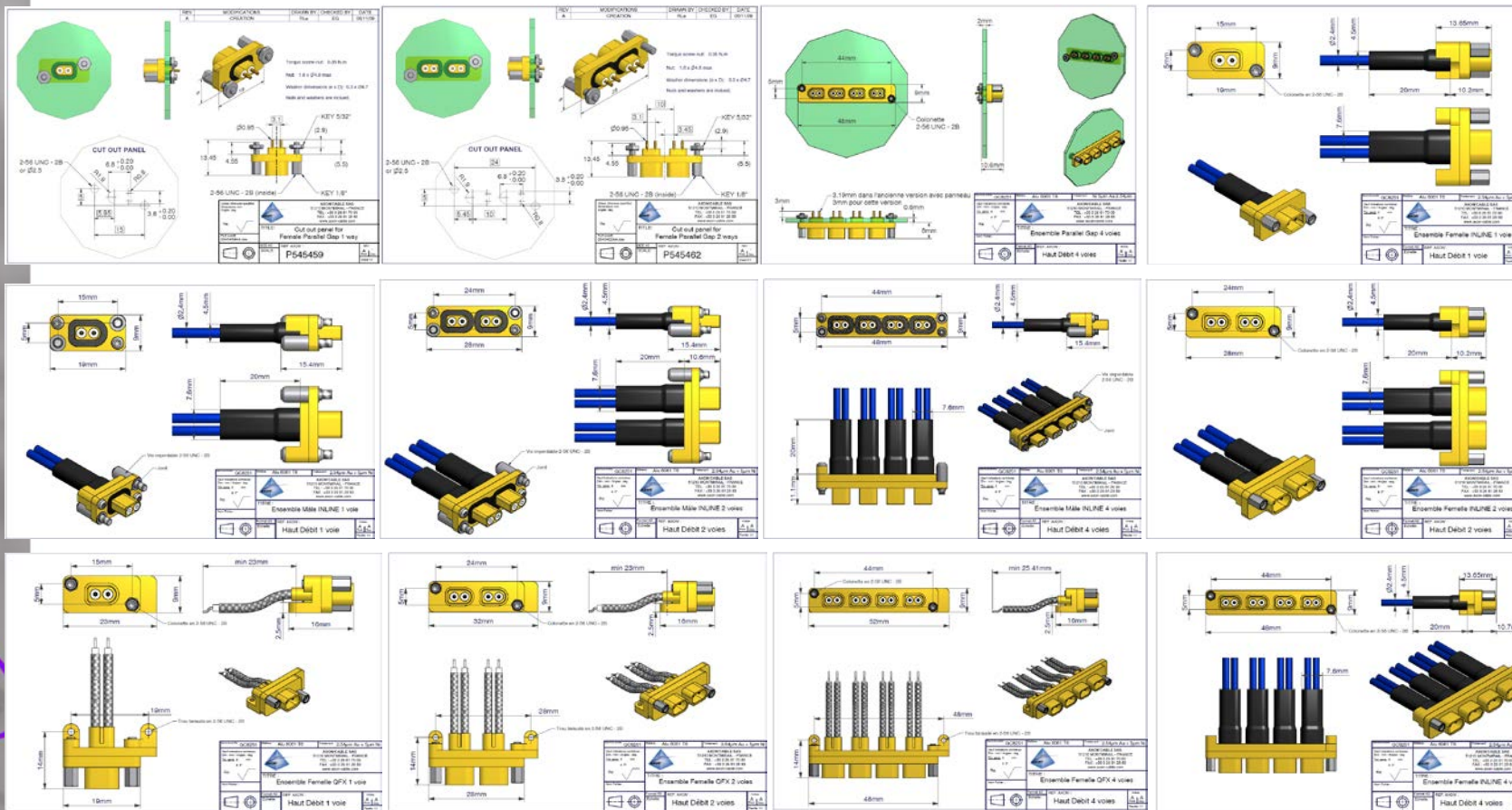
Female inline



Male inline

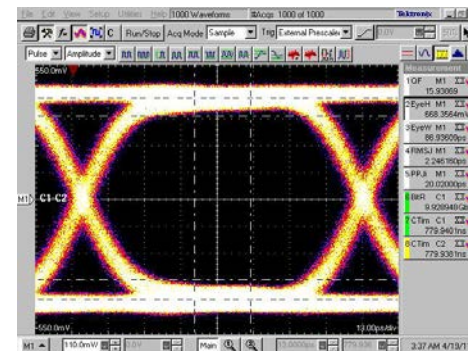


Up to 12 variants available : 1 way to 4 ways

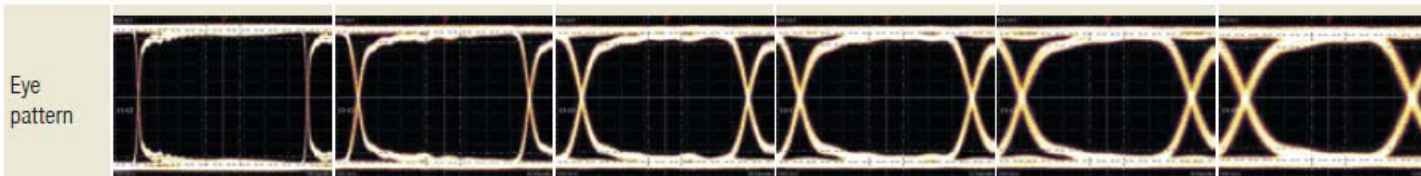


axoMach™ main features

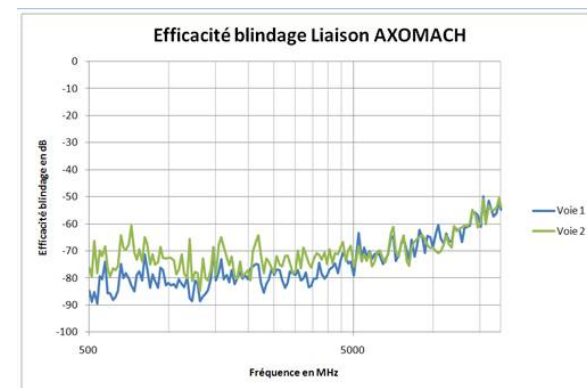
- -55 to +125°C (Space Environment)
- Up to 10Gb/s per way (L<4m)
- Low Skew <10ps per connector couple
- Low Xtalk between ways <-35dB 0-10GHz
- High shielding effectiveness <-60dB 0-10GHz
- Open solution not dedicated to a digital logic family standard (LVDS, LVPECL, CML,...)



DATA RATE	1 GHz	3 GHz	5 GHz	6 GHz	8 GHz	10 GHz
Jitter PP	< 20 ps	< 20 ps	< 20 ps	< 20 ps	< 20 ps	< 20 ps
Jitter RMS	< 5 ps	< 5 ps	< 5 ps	< 5 ps	< 5 ps	< 5 ps
Quality factor	> 20	> 15	> 10	> 10	> 10	> 10

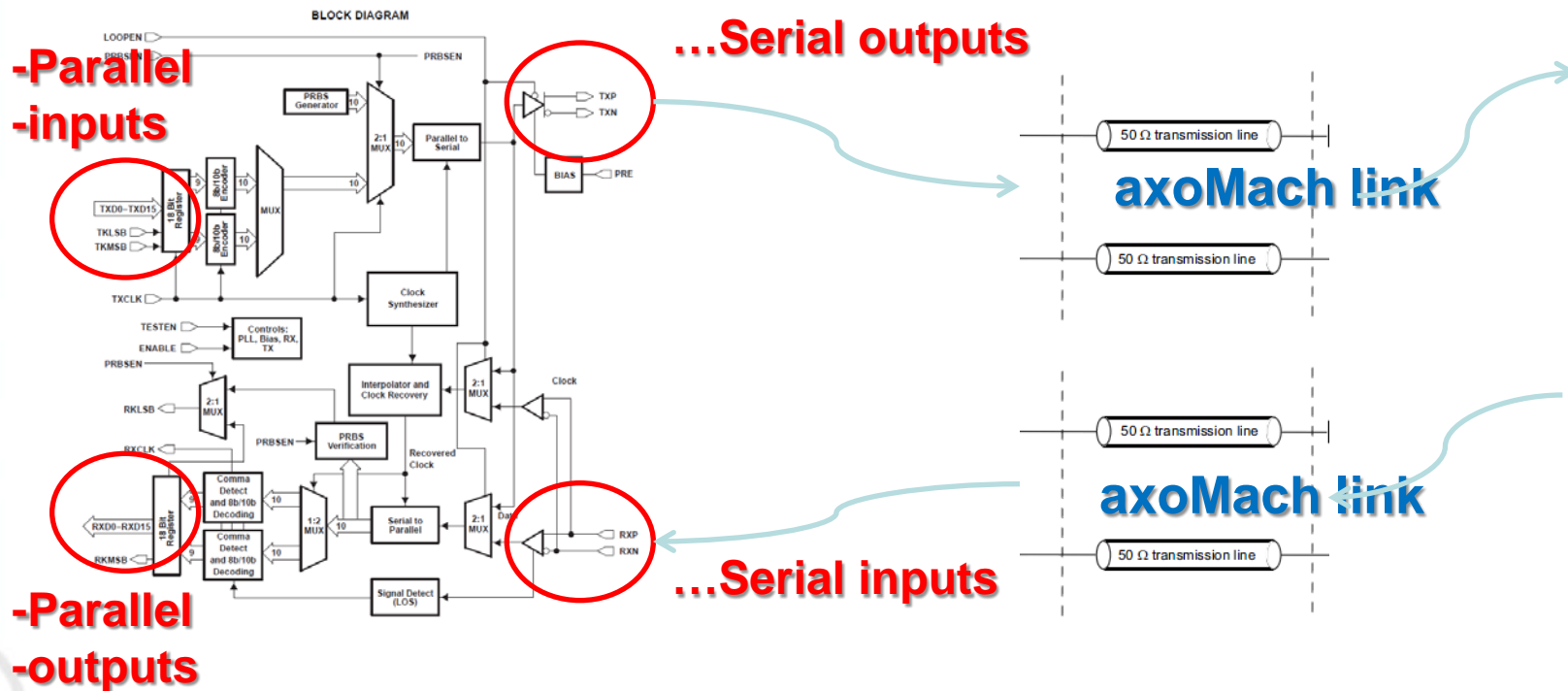


Skew (between coaxial cables)	< 20 ps	< 20 ps	< 20 ps	< 20 ps	< 20 ps	< 20 ps
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axoMachtm applications examples

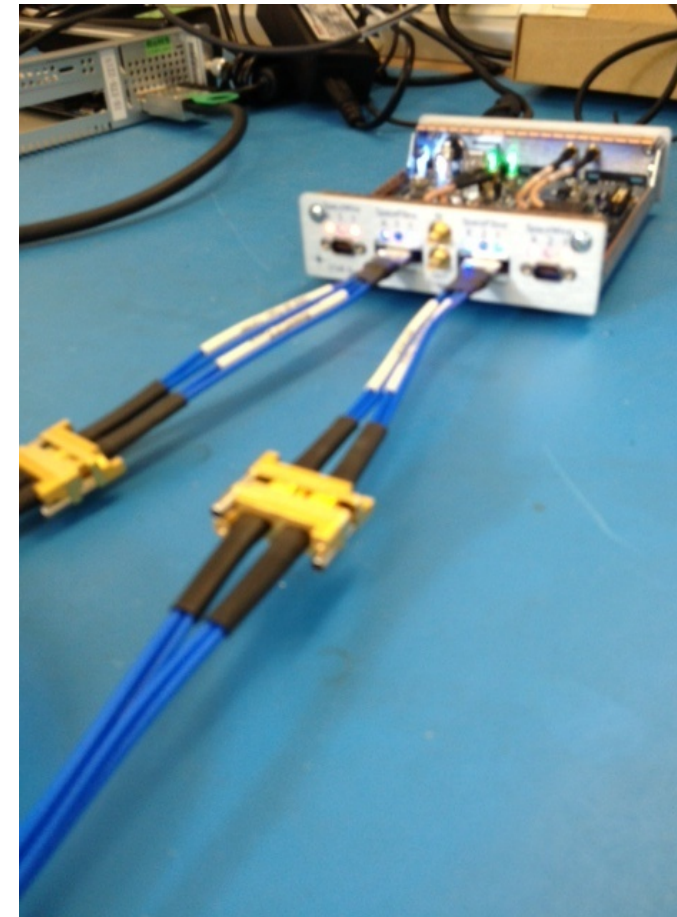
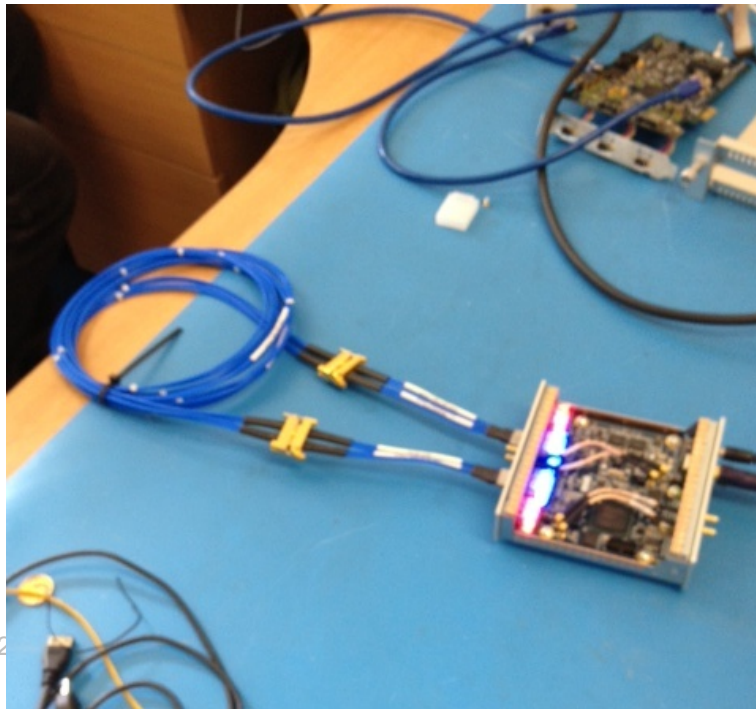
Serialiser deserialiser links : **High-Speed Video Applications, High-Speed Point- to-Point Transmission**



High speed assembly

2 High data rate assemblies: Axomach

- ESA future **SPACEFIBER**:
.Working at 2.5 Gb/s.
Axomach can be a solution





axoMachtm Status

P
A
R
T
C

- Extensive evaluation done
- First sale on different programs
- Process Identification Document
 - Manufacturing & assembly process
 - Control process
 - Flow chart
- Harness specification under ESCC form
- User's guide
- Technical Brochure

“ASF” agreed and Followed by
CNES –
Audit every 2 years

Conclusion

- Axon has solutions to reduce mass of electrical harnesses and high data rate assemblies
- Axomach assemblies can be used to transmit serial data rate up to 10 Gb/s.

Tank you for your attention.