# Cable and connectors suggestions for ePIC SVT

## CB-FIB control cable

**Some requirements** (from various emails)

From James
“cable and connector option for a (digital) low voltage and (digital) signal cable to also go on these FIBs (interconnecting them to a Control Board)”
“The current consideration is a 25-pin nano-D connector”
“a surface mount, right-angle connector on the CB and a through-hole, straight connector on the FIB.”
“These would be connected with a shielded cable of the required 25 wires (each wire a minimum of 30AWG)”
(NR: note that Nano-D connectors cannot support wire larger than 30AWG)

From Georg
“We want multicore with common shield. There are no particularly fast digital signal, just control signals.
Material is copper-clad aluminium, as with the other cables.”

“We need radiation hardness up to 10krad, so not particularly demanding.
They should be non-magnetic, but I can’t give you a numeric specification (we never had one for ATLAS).

(NR: I would suggest the magneticity value of ‘<=200nT’? I believe this is the spec of the standard AXON connectors? See the slide on non-magnetic connectors. From previous AXON email “[AXON] have been involved with at least one space-based science experiment where our standard connector types … already had sufficiently low magnetism levels”)

Also

How many assemblies? (estimate)

What is the estimated maximum length of the assembly?

Calculation of the voltage drop along the wires may be needed because it is a very thin (30AWG) aluminium wire

Assumption: the cable assembly is terminated at both ends with connectors, nano-D connectors cannot be terminated by the end user

Assumption: ARACON low mass shielding required

**Initial suggestions**

I understand that ‘AXON cable’ is a company that has supplied custom cable for the Atlas project at CERN, and they say that they can customise cable and connectors to customer requirements. Therefore, I have made it the focus of my search.

It seems that there is no straightforward solution off the catalogue, a level of customisation is required.

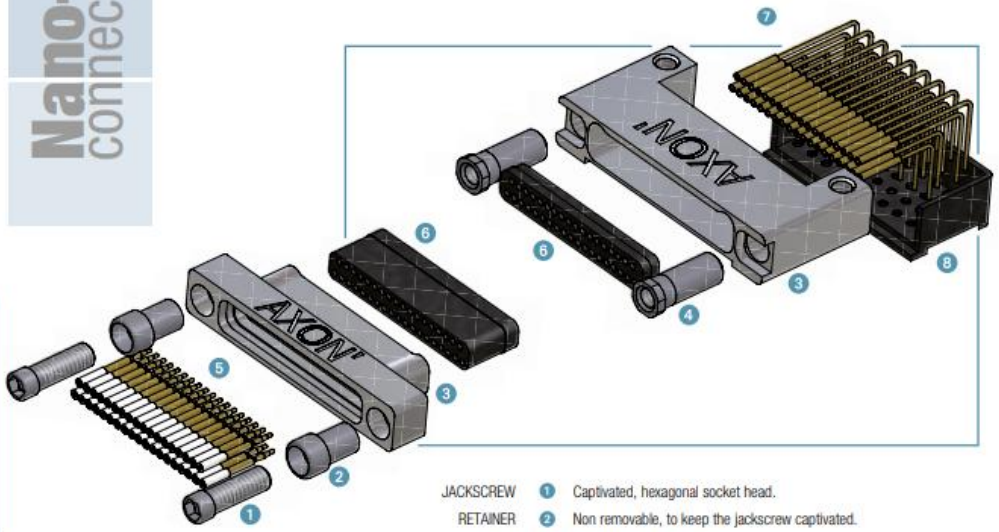
After going through their website and various literature, I have come out with some suggestions for you to evaluate.

Please review the information in this document and consult the datasheets for information that you require and is not included in this presentation.

From previous emails, AXON says

“customisation is an everyday occurrence for us and not the exception … a custom solution would not be more costly or take longer than a catalogue one for us”

# GLOSSARY OF TERMS




| | | |
|---|---|---|
| JACKSCREW | 1 | Captivated, hexagonal socket head. |
| RETAINER | 2 | Non removable, to keep the jackscrew captivated. |
| SHELL | 3 | Metal connector body. |
| THREADED INSERT | 4 | Non removable, mates with jackscrew. |
| TWIST PIN | 5 | Male contact, fitted to plug connector. |
| INSERT | 6 | Moulded insulation housing, separating each connection. |
| SOCKET | 7 | Female contact, fitted to socket connector (also known as socket). |
| TRAY | 8 | Junction box used for PCB connectors only. |

| | |
|---|---|
| Standard connector | Manufactured to the standard dimensions and specifications. |
| Special connector | A standard connector modified to meet specific requirements. |
| Custom made connector | Designed to meet specific customer requirements. |
| Connector saver | Used to reduce wear and tear on equipment and systems while testing. |
| CBR connector | Condensed Board Right Angle connector. |
| BS connector | Board Straight connector. |
| SMV connector | Surface Mount Vertical connector. |
| SMH connector | Surface Mount Horizontal connector. |
| Pigtail connector | Connector with insulated or uninsulated wires. |
| Cord | Cable harness with 2 connectors only. |
| Jumper/ Extension cord | Cord with 1 plug and 1 receptacle connector of the same number of ways. |
| Harness | Multi-branched cable assembly. |
| LCP | Liquid Crystal Polymer. |
| Potting | Epoxy compound used as an encapsulant. |

# ‘AXON cable’ nano-D connectors

A link to the datasheet\catalogue [axon-nano-D-connectors_cg.pdf]

## Characteristics

- 0.635 mm (.025") contact spacing (double the density of a Micro-D).
- Number of ways: 9, 15, 21, 25, 31, 37 and 51.
- Single or double row.
- High reliability twist pin contacts.
- Metal shell construction with captivated hardware.

AXON' has also developed custom designed Nano-D connectors:
- High density circular Nano-D connectors.
- Single row Nano-D strip connectors.

Special Nano-D connectors available on request.

## SUMMARY OF CHARACTERISTICS

| ELECTRICAL & MECHANICAL PERFORMANCE | |
|---|---|
| CURRENT RATING | 1 A max. |
| CONTACT RESISTANCE | 71 mΩ max. |
| INSULATION RESISTANCE | 5000 MΩ min. @ 100 VDC |
| DIELECTRIC WITHSTANDING VOLTAGE | Sea level: 250 VAC |
| | Altitude 21 km (70,000 ft): 100 VAC |
| CONTACT ENGAGING FORCE | 141 g max. (5 oz) |
| CONTACT SEPARATING FORCE | 11 g min. (0.4 oz) |
| CONTACT RETENTION | 0.9 kg (2 lbs) |
| DURABILITY | 200 mating cycles min. |
| VIBRATION | 20g's – No discontinuity > 1 µs |
| SHOCK | 100g's – No discontinuity > 1 µs |

| MATERIAL & FINISH | |
|---|---|
| SHELL | Aluminium alloy 6061 or 300 series stainless steel or titanium alloy, see page 209 for finish |
| BACKSHELL | Aluminium alloy 6061 with nickel plating |
| MOULDED INSULATOR | Liquid Crystal Polymer (LCP) |
| PIN CONTACT | Precious gold alloy |
| SOCKET CONTACT | Precious gold alloy |
| ENCAPSULANT | Epoxy resin |
| HARDWARE | 300 series stainless steel, passivated |

Any preference for the gender of the connectors on the boards?

**Connector for the FIB board**
ND2A 2 25 P BS P G 1 ?



# BS TYPE

## DUAL ROW VERTICAL PCB PLUG

### 0.050" PITCH

- Reliability for micro-miniature operating systems.
- Several tail lengths available.
- Operating temperature: 150°C or 200°C.
- 7 contact arrangements (9 to 51 contacts).



## IDENTIFICATION CODE

| ND2A | 2 | 15 | P | BS | P | G | 1 |
|---|---|---|---|---|---|---|---|

**SERIES**
**ND2A**: Nano-D 2-row AXON'.

**CONNECTOR TYPE**
**2: Aluminium with electroless nickel plating and epoxy 150°C.**
**3**: Aluminium with electroless nickel plating and epoxy 200°C.
**Other materials available on request (eg Titanium, Stainless Steel).**

**NUMBER OF CONTACTS**
**09, 15, 21, 25, 31, 37, 51.**
**Other versions available on request.**

**CONNECTOR TYPE**
**P: Plug connector.**

**FAMILY**
**BS: AXON' Vertical PCB connector.**

**HARDWARE**
**P: Threaded hole #0-80 UNF (non removable jackposts).**
**Other versions available on request.**

**TAIL PLATING**
**G: Gold, AWG30.**
**D**: Flash gold plated solid conductor AWG30.
**Other tail plating available on request.**

**TAIL LENGTH**
**1: 2.77 mm (0.109").**
**2**: 3.56 mm (0.140").
**3**: 4.37 mm (0.172").
**4**: 2.29 mm (0.090").
*Tolerance: ± 0.25 mm (0.010").*

Connectors are supplied with
#0-80 UNF screws 1/4" long (for PCB mounting).

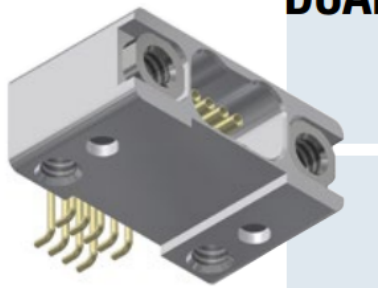
**Connector for the CB board**
ND2A 2 25 S SMH P G 1 ?

PCB RECTANGULAR CONNECTORS

# SMH TYPE

## DUAL ROW HORIZONTAL SURFACE MOUNT PCB RECEPTACLE

### 0.025" PITCH



- Reliability for micro-miniature operating systems.
- Surface Mount.
- Operating temperature: 150°C or 200°C.
- 7 contact arrangements (9 to 51 contacts).

DUAL ROW NANO-D CONNECTORS

Nano–D connectors

## IDENTIFICATION CODE

| ND2A | 2 | 15 | S | SMH | P | G | 1 |
|---|---|---|---|---|---|---|---|

**SERIES**
**ND2A**: Nano-D 2-row AXON'.

**CONNECTOR TYPE**
**2: Aluminium with electroless nickel plating and epoxy 150°C.**
**3**: Aluminium with electroless nickel plating and epoxy 200°C.
**Other materials available on request (eg Titanium, Stainless Steel).**

**NUMBER OF CONTACTS**
**09, 15, 21, 25, 31, 37, 51.**
**Other versions available on request.**

**CONNECTOR TYPE**
**S: Receptacle connector.**

**FAMILY**
**SMH: AXON' Horizontal surface mount PCB connector.**

**HARDWARE**
**P: Threaded holes #0-80 UNF (non removable jackposts).**
**Other versions available on request.**
**B**: None.

**TAIL PLATING**
**G: Gold, AWG30.**
**D**: Flash gold plated solid conductor AWG30.
**Other tail plating available on request.**

**TAIL LENGTH**
**1: Standard** ***(see page 237 for dimensions).***

Connectors are supplied with
#0-80 UNF screws 1/4" long (for PCB mounting).

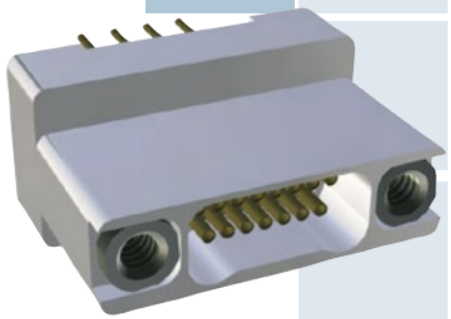
**Connector for the FIB board**
ND2A 2 25 S BS P G 1 ?



# BS TYPE

## DUAL ROW VERTICAL PCB RECEPTACLE

### 0.050" PITCH



- Reliability for micro-miniature operating systems.
- Several tail lengths available.
- Operating temperature: 150°C or 200°C.
- 7 contact arrangements (9 to 51 contacts).



## IDENTIFICATION CODE

| ND2A | 2 | 15 | S | BS | P | G | 1 |
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*Tolerance: ± 0.25 mm (0.010").*

Connectors are supplied with
#0-80 UNF screws 1/4" long (for PCB mounting).

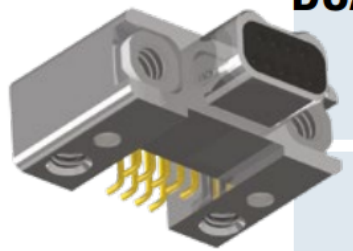
**Connector for the CB board**
ND2A 2 25 P SMH P G 1 ?



# SMH TYPE

## DUAL ROW HORIZONTAL SURFACE MOUNT PCB PLUG

### 0.025" PITCH



- Reliability for micro-miniature operating systems.
- Surface Mount.
- Operating temperature: 150°C or 200°C.
- 7 contact arrangements (9 to 51 contacts).



## IDENTIFICATION CODE

| ND2A | 2 | 15 | P | SMH | P | G | 1 |
|---|---|---|---|---|---|---|---|

**SERIES**
**ND2A**: Nano-D 2-row AXON'.

**CONNECTOR TYPE**
**2: Aluminium with electroless nickel plating and epoxy 150°C.**
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**09, 15, 21, 25, 31, 37, 51.**
**Other versions available on request.**

**CONNECTOR TYPE**
**P: Plug connector.**

**FAMILY**
**SMH: AXON' Horizontal surface mount PCB connector.**

**HARDWARE**
**P: Threaded holes #0-80 UNF (non removable jackposts).**
**Other versions available on request.**
**B**: None.

**TAIL PLATING**
**G: Gold, AWG30.**
**D**: Flash gold plated solid conductor AWG30.
**Other tail plating available on request.**

**TAIL LENGTH**
**1: Standard** ***(see page 239 for dimensions).***

Connectors are supplied with
#0-80 UNF screws 1/4" long (for PCB mounting).

# CABLE ASSEMBLY



RECTANGULAR CONNECTORS FOR CABLES

## EMI RANGE

### SHIELDED DUAL ROW PIGTAIL & JUMPER

- Reliability for micro-miniature operating systems.
- High performance metal connector and PTFE wire.
- Panel mount available for receptacle connector.
- For ultra miniature EMI requirements.
- 360° screen termination.
- Operating temperature: 150°C or 200°C.
- 7 contact arrangements (9 to 51 contacts).

**IDENTIFICATION CODE** | **ND2A** | **2** | **15** | **P** | **S** | **EMI1** | **D** | **1** | **L** | **50** | **R** | **P**

**SERIES**
**ND2A**: Nano-D 2-row AXON'.

**CONNECTOR TYPE**
**2: Aluminium with electroless nickel plating and epoxy 150°C.**
3: Aluminium with electroless nickel plating and epoxy 200°C.
**Other materials available on request (eg Titanium, Stainless Steel).**

**NUMBER OF CONTACTS**
**09, 15, 21, 25, 31, 37, 51. Other versions available on request.**

**1st CONNECTOR TYPE**
**P: Plug connector.**
**S**: Receptacle connector.
**M**: Panel mount receptacle connector.

**2nd CONNECTOR TYPE**
**P: Plug connector.**
**M**: Panel mount receptacle connector.
**S**: Receptacle connector.
**W**: No second connector - free wires.

**EMI FAMILY**
**EMI1**: Shielded pigtail or harness, shield soldered to the backshell

**CONNECTIONS (see jumper wiring on page 216)**
**D**: Direct pin 1 to pin 1.
**I: Indirect (usual for plug-plug jumper).**
**X**: Pigtail.

**WIRE CODE**
**1: ET 3007, AWG 30, 7 strands, 250 V.**
**2**: ET 3207, AWG 32, 7 strands, 250 V.
**3**: ET 3407, AWG 34, 7 strands, 250 V.
**4**: ET 3607, AWG 36, 7 strands, 250 V.
**Other versions available on request.**

**COLOUR CODE**
**L: White.**
**F**: Yellow.
**W**: 10 colour repeat.
***See page 215 for colour code.***

**WIRE LENGTH (in cm)**
Attention! Wire length in centimetres - (1cm = 10 mm = .394").

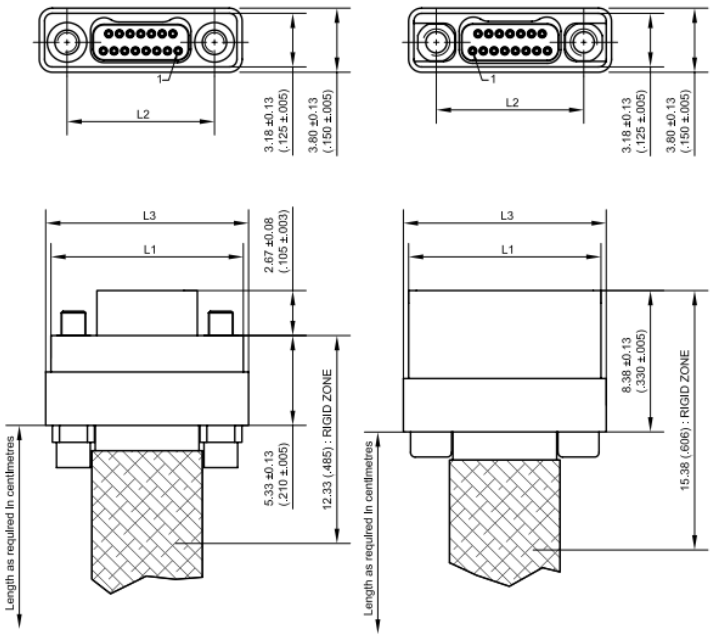
| L in cm (inches) | 5 ≤ L ≤ 10 (1.97 ≤ L ≤ 3.940) | 10 < L ≤ 100 (3.940 < L ≤ 39.40) | L > 100 (39.40) |
|---|---|---|---|
| TOLERANCE in cm (inches) | -0 / +0.5 (-0 / +0.200) | -0 / +3 (-0 / +1.180) | -0 / +5 (-0 / +1.970) |

**HARDWARE 1st CONNECTOR**
**P: Threaded hole #0-80 UNF (non removable jackposts).**
**R: Retractable short hex socket head jackscrews #0-80 UNF (semi-captivated).**

**HARDWARE 2nd CONNECTOR**
See above.
**X**: Pigtail.

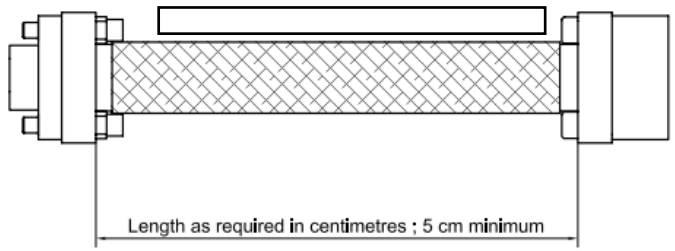
IN BOLD: FACTORY STANDARD

## PLUG




## RECEPTACLE



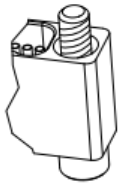




1 centimetre = 10 millimetres = 0,393 inch

## SPECIFIC HARDWARE CONFIGURATION

Treaded holes #0-80 UNF for plug shell (code: P)

Jackscrew #0-80 UNF for socket shell (code: R/L)



Cable to be ordered as 'jumper cable'
plug with jackscrews at one end
and receptacle with jackscrews at other end
likely identification code:

**ND2A**
**2**
**25**
**S**
**P**
**EMI** (custom spec, ARACON, clamp, not soldered)
**Connections** (D, pin1 to pin1, custom?)
**Wire code** (custom spec, 30 AWG AXALU wire)
**L**
**Wire Length in cm**
**R**
**R**

Note: orient the connectors on the boards so that the cable is not twisted when connected

## Wire for the cable

AXALU® silver plated aluminium conductor, thickness of silver plating is 2um

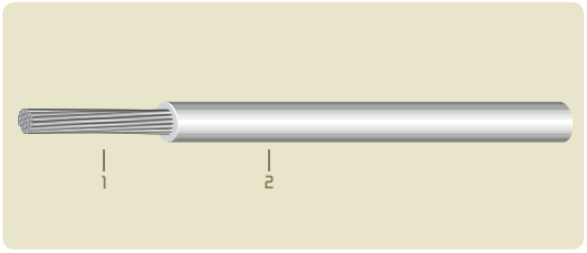
A Link to datasheet\catalogue here: axon-space-ESA-Axalu_cg.pdf

### AXALU® / aluminium wires

Crosslinked ETFE insulation

Operating temperature: -100°C up to +150°C

Voltage rating: 600 VAC max.




**Construction**

1 - Stranded silver plated aluminium conductor.
2 - Extruded crosslinked ETFE insulation.

**Main characteristics**

- 30 to 40 % weight saving compared to equivalent copper wires,
- good cut-through resistance,
- good resistance to radiation,
- good X-Ray response.

| AXON' REFERENCE | AWG | CONDUCTOR | | | | SINGLE WIRE MAX. Ø mm | BUNDLE MAX. Ø mm | MAX. WEIGHT g/m |
|---|---|---|---|---|---|---|---|---|
| | | STRANDING Nb x Ø mm | MAX. Ø mm | NOM. CROSS SECTION mm² | MAX. DC RESISTANCE AT 20°C Ω / km | | | |
| AXL 1 M 2419 AS2 | 24 | 19x0.12 | 0.62 | 0.215 | 150 | 0.83 | 1.66 | 2.56 |

Note: it is not Copper Clad Aluminium wire, but if necessary, AXON should be able to source them

Note: wire gauge of the standard catalogue product is 24 AWG, but AXON should be able to custom produce a 30 AWG gauge wire

Note: wires to be made into a custom made cable

## Insulation for the wire

Note: insulation of the standard catalogue product is 'Extruded crosslinked ETFE' which is not LSZH but they can custom produce the wire with a radiation resistant and LSZH insulation, see below for available wire insulation types.

A link to datasheet\catalogue here: axorad-radiation-resistant-cables_cg.pdf

### Expertise in custom designed products

Based on radiation resistant wires AXORAD AXON' is able to propose hybrid composite round or flat cables as well as terminated harnesses including circular, rectangular, Micro-D, Nano-D or any other type of specific connector. Custom design is AXON's speciality, do not hesitate to contact us.

### Radiation resistance, temperature resistance and Halogen free, LSZH behaviour

| wire insulation | RADIATION RESISTANCE (*) | | TEMPERATURE RATING (°C) | HALOGEN FREE LSZH |
|---|---|---|---|---|
| | IN STANDARD ATMOSPHERE | IN INERT ATMOSPHERE | | |
| TPI - EXTRUDED POLYIMIDE | 20 MGy (2000 Mrad) | 70 MGy (7000 Mrad) | 240 | YES |
| TAPED POLYIMIDE | 10 MGy (1000 Mrad) | 50 MGy (5000 Mrad) | 250 | YES |
| NEUTRAX™ (PAEK BASED) | 5 MGy (500 Mrad) | 10 MGy (1000 Mrad) | 240 | YES |
| POLIAX | 3 MGy (300 Mrad) | 6 MGy (600 Mrad) | 135 | YES |
| TPU - THERMOPLASTIC ELASTOMER | 1 MGy (100 Mrad) | 2 MGy (200 Mrad) | 125 | YES |
| PE/PO and XLPE/XLPO based | 500 kGy (50 Mrad) | 1 MGy (100 Mrad) | 100 | YES |
| ETFE | 100 kGy (10 Mrad) | 300 kGy (30 Mrad) | 155 | NO |

## Low mass shielding for the cable

The low mass shielding for the cable is another custom requirement.

A link to the datasheet here: 330185-Micro-Coax-datasheet-41316139.pdf


ARACON®
Lightweight EMI Shielding
only from
MICRO-COAX®
Leading the way in transmission line solutions.

**Shielding Grade, Nickel Plated, Composite**
**ARACON® EMI/RFI Tubular Braided Sleeving**

## Clamp for the cable shielding

AXOCLAMP® EMI Band termination system

A link to datasheet\catalogue here: axon-space-interconnect_cg.pdf

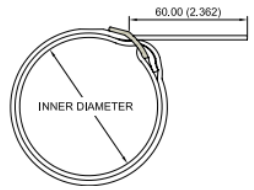
ACCESSORIES

# AXOCLAMP® EMI
# Band termination system

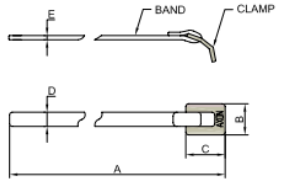
## TYPE AX CL xx

Shieding termination for connectors can be carried out on 360°with a patented metal band called AXOCLAMP®. This ensures the continuity of shielding efficiency at the cable/connector junction.

COILED AXOCLAMP®




STRAIGHT AXOCLAMP®




Dimensions are in millimetres (inches)

## IDENTIFICATION CODE

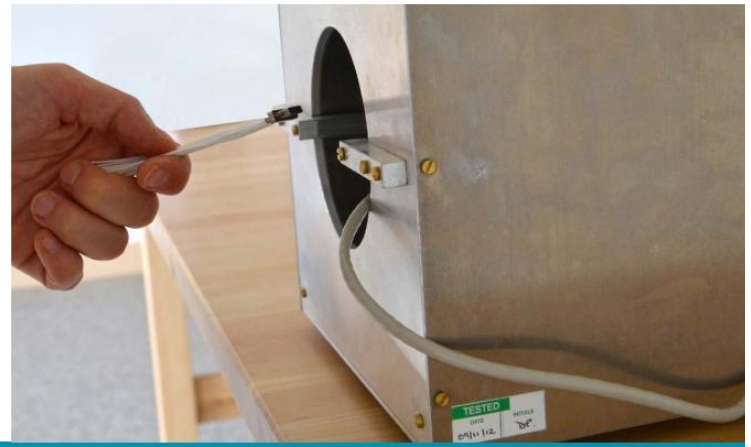
| AX CL | 01 |
|---|---|
| AXOCLAMP® | BAND TYPES<br>01: STANDARD<br>02: MICROBAND DOUBLE WRAPPED<br>03: MICROBAND DOUBLE WRAPPED |

The standard version is coiled but straight AXOCLAMP® can be delivered on request (reference example AXCL03D).
Minimum quantity: 100 pieces per reference.

# ‘AXON cable’ capabilities for non-magnetic connectors

# ‘AXON cable’ non-magnetic connectors [axon-micro-D-connectors-rectangular-non-magnetic_cg.pdf](#) [axon-connectors_br.pdf](#)

## Non magnetic connectors |



TEST EQUIPMENT

A standard Micro-D connector made to the requirements of MIL-DTL-83513 contains materials such as austenitic stainless steel, which can easily be magnetized.

To avoid interference from interconnects, Axon’ has developed a new product range: non-magnetic Micro-D connectors. (3 levels of performance).

These connectors have limited or no influence on magnetic field lines, improving the reliability of magnetic measurements, even down to nanoTesla level, $10^{-4}$ times lower than the Earth’s magnetic field.

Available in PCB and pigtail versions.

| GENERAL PERFORMANCES | |
|---|---|
| RESIDUAL MAGNETIC LEVEL | NMB*: ≤ 200 nT RESIDUAL MAGNETISM LEVEL<br>NMC*: ≤ 20 nT RESIDUAL MAGNETISM LEVEL<br>NMD* ON REQUEST: ≤ 2 nT RESIDUAL MAGNETISM LEVEL |
| OPERATING TEMPERATURE RANGE | -55°C / +200°C |
| CURRENT RATING | 3 A MAX |

*: NMB, NMC & NMD LEVELS ARE DEFINED BY NASA GSFC S-311 FOR NON-MAGNETIC SUBMINIATURE CONNECTORS AND ADAPTED TO THE DIMENSIONS OF MICRO-MINIATURE CONNECTORS.

| GENERAL PERFORMANCES | |
|---|---|
| Residual Magnetic Level | NMB*: ≤ 200 nT residual magnetism level<br>NMC*: ≤ 20 nT residual magnetism level<br>NMD* on request: ≤ 2 nT residual magnetism level |
| Operating temperature range | -55°C / +200°C |
| Current rating | 3 A max |

*: NMB, NMC & NMD levels are defined by NASA GSFC S-311 for non-magnetic subminiature connectors and adapted to the dimensions of microminiature connectors.

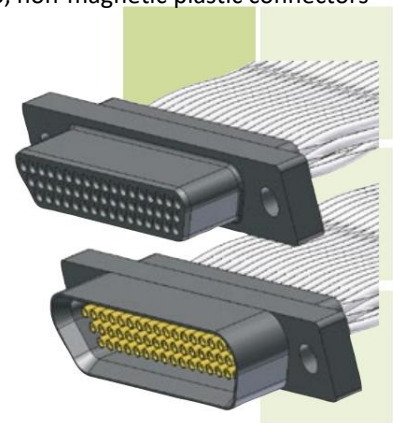
| MATERIAL & FINISH | |
|---|---|
| SHELL | Aluminium alloy 6061 with custom non-magnetic plating or titanium |
| MOULDED INSULATOR | Liquid Crystal Polymer (LCP) |
| INTERFACIAL SEAL | Fluorosilicone rubber |
| PIN CONTACT | Copper and beryllium copper, gold over nickel plating (custom non-magnetic plating) |
| SOCKET CONTACT | Copper alloy, gold over nickel plating (custom non-magnetic plating) |
| ENCAPSULANT | Epoxy resin |
| HARDWARE | Titanium TA6V and beryllium copper |
| SOLID UNINSULATED WIRES & PCB TERMINALS | AWG 25 Silver Plated Copper |

***LOWER MAGNETISM LEVEL: Please contact us for a 2 nT residual magnetism level or for other magnetic requirements***

Also, non-magnetic plastic connectors

NON–MAGNETIC CONNECTORS

*Rectangular Micro–D connectors*



# NON-MAGNETIC CONNECTOR

## PLASTIC SHELL

- For strong magnetic field environments.
- Minimal magnetic disturbance.
- High performance plastic connector and PTFE wire.
- Environmentally sealed.
- Operating temperature: 125 or 200°C.
- 9 to 51 contacts.

IDENTIFICATION CODE

| MDN | P | 51 | S | 4 | L | 050 | B |
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# Next step

After reviewing the information in this presentation, if you are generally happy with this proposed solution, we can go ahead with contacting AXON and ask them to give us some of their time to see if it is feasible and work out the details.

We could ask

The radiation resistance and magneticity of the assembly components, to see if they meet the requirements

To produce a drawing (with specs) of the cable

To produce a drawing (with specs) of the cable assembly (give an estimated value for the maximum length of the cable assembly)

To produce a quote with likely lead times (give an estimate of the quantity needed)

Buy some samples of their off the catalogue cable assembly and connectors, as a close physical mock up to play with?

From previous AXON email

“Based on previous experience, it could easily take us 2-3 months to come to a final quote”