Fiber Optics Applications Within Harsh Environments
Interconnect Solutions And Technologies
Typical Applications Within Harsh Environments

- Avionics
- Antenna
- Space
- Mining
- Military / Defense
- Solar Plants
- Industries
- Transportation
- Wind Farm
- Oil & Gas
- Container Terminal
Challenges / Requested Properties For HE Applications

The products must be able to withstand:

- Adverse temperatures and weather conditions
- Shocks, vibrations, tensile stress
- External pressure, corrosive surroundings, etc.
- Dirt and humidity

Polarization Maintaining PM
High Power Technology PS
Field repairable
SM/MM
IP65 – IP68
APC / PC
Unparalleled high Return Loss (RL)
Customizable
DM4 – Compact & Modular Solution
HE-2000®, MIL-38999 DM4 Family, MIL-83526 DM4 Compact DM4
DM4 (Multipurpose Termini) - Main Features

- Based on 2.5-mm Fusion Alberinos with integrated springs to prevent termini separation
- Up to 4 optical and / or electrical channels
- Genderless mating and self-aligning design
- Easy front-face ferrule access for cleaning & inspection
- Simple assembly and disassembly of contacts for on-site integration and repair
Features Of Optical & Electrical DM4 Termini

- Compatible with several fiber types such as HCS, MM, SM, PM, Power Solution and small-core fibers
- Available in PC and APC versions
- Steady and repeatable low Insertion Loss (IL) and high Return Loss (RL)
- High and steady Extinction-Ratio (ER) when terminated with PM fibers
- Compatible with tight cable construction and semi-loose cable / fiber construction
- Field repair and termination available with the Diamond Fusion Crocodile Alberino and Diamond ZEUS D50 HE fusion splicer
- Titanium ferrule front face
- Electrical pin: 20 AWG
- Lensed ferrule available
# Optical And Electrical Specifications

## Optical Performances

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<tr>
<th>MEASUREMENT/TEST</th>
<th>MULTIMODE</th>
<th>SINGLE MODE PC/APC</th>
<th>STANDARDS</th>
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<tr>
<td>Insertion loss (std. version)</td>
<td>typ. 0.20 dB max. 0.50 dB</td>
<td>typ. 0.15 dB max. 0.45 dB</td>
<td>IEC 61300-3-4 ((\lambda = 1310 / 1550) nm)</td>
</tr>
<tr>
<td>Insertion loss (fusion version)</td>
<td>typ. 0.20 dB max. 0.50 dB</td>
<td>typ. 0.25 dB max. 0.45 dB</td>
<td>IEC 61300-3-4 ((\lambda = 1310 / 1550) nm)</td>
</tr>
<tr>
<td>Insertion loss (PM) version</td>
<td>-</td>
<td>typ. 0.25 dB max. 0.45 dB</td>
<td>IEC 61300-3-4 ((\lambda = 1310 / 1550) nm)</td>
</tr>
<tr>
<td>Return loss</td>
<td>min. 40 dB</td>
<td>min. 75 dB (APC) min. 50 (PC)</td>
<td>IEC 61300-3-6 ((\lambda = 1550) nm)</td>
</tr>
<tr>
<td>Extinction Ratio</td>
<td>-</td>
<td>typ. 23 dB min. 20 dB</td>
<td>Diamond validated cross polarizers method ((\lambda = 1550) nm)</td>
</tr>
</tbody>
</table>

## Electrical Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation resistant test</td>
<td>Resistance &gt;200 MΩ</td>
<td>IEC 60512-3-1: 2002 (5000 V / 60 s)</td>
</tr>
<tr>
<td>Voltage Proof fest</td>
<td>PASS</td>
<td>IEC 60512-4-1: 2003 (25000 V / 60 s / 50 Hz)</td>
</tr>
</tbody>
</table>
DM4 (Multipurpose Termini) Modularity

MIL-38999 DM4 Family

Custom Housing

DM4

Compact DM4

MIL-83526 DM4

HE-2000®
Add up to 4 functions

- Singlemode (SM)
- Multimode (MM)
- Power Solution (PS)
- Polarization Maintaining (PM)
- PIN/PS

Add polishing

- RC
- APC 8
- APC 4

Choose housing

- HE 2000™
- MIL-38029 DH4 Family
- MIL-83526 DH4
- Custom Housing
- Compact DH4

* Standard options, custom configurations available upon request.
HE-2000® - Main Features

- Automatic protection shutter on connector IP 65
- Bulkhead IP67 (manual shutter) or IP54 (automatic shutter)
- Harsh-environment plastic shell, made from nylon with 25% fiber-glass
- Reinforcement
- Easy front-face ferrule access for cleaning & inspection
- Push-pull mechanism for easy handling
HE-2000® Connector Configuration

Type C/1 Connector with mini-break cable (ø 5.0 mm or ø 5.5 mm)

Type C/2 Connector with protection tube for fiber 900µm max.

Type C/3 Connector with fan-out cable (ø 6200µm)

Type C/4 Connector with breakout cable (ø 6500µm - 7700µm)
HE-2000® Bulkhead Configuration

Type B/1  Bulkhead IP 67 for simplex cable (ø 1.6 - 3.0 mm) or fiber 900µm max.

Type B/2  Bulkhead IP 54 for simplex cable (ø 1.6 - 3.0 mm) or fiber 900µm max.
# Mechanical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change of temperature</td>
<td>-55 / + 85 °C</td>
<td>IEC 61300-2-22 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Low temperature</td>
<td>-55 °C (96h)</td>
<td>MIL-STD-810G (λ = 1310 / 1550 nm)</td>
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<tr>
<td>High temperature</td>
<td>+85 °C (96h)</td>
<td>MIL-STD-810G (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Humidity</td>
<td>95% r.h. / 10 cycles</td>
<td>MIL-STD-810G (λ = 1310 / 1550 nm)</td>
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<tr>
<td>Temperature shock</td>
<td>-55 / + 85 °C</td>
<td>MIL-STD-810G (λ = 1310 / 1550 nm)</td>
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<tr>
<td>Low pressure / altitude</td>
<td>110 mbar / 15240 m</td>
<td>MIL-STD-810G (λ = 1310 / 1550 nm)</td>
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<tr>
<td>Vibration</td>
<td>10/2000 Hz (3h)</td>
<td>MIL-STD-202G (λ = 1310 / 1550 nm)</td>
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<tr>
<td>Mating durability</td>
<td>500 cycles</td>
<td>IEC 61300-2-2 (λ = 1310 / 1550 nm)</td>
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<tr>
<td>Cable torsion</td>
<td>+/-180° / 25 cycles</td>
<td>IEC 61300-2-5 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Flexing of strain relief</td>
<td>+/-90° / 25 cycles</td>
<td>IEC 61300-2-4 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Static side load</td>
<td>2N/90° (5min.)</td>
<td>IEC 61300-2-2 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Cable retention on connector side</td>
<td>800N on multi-fiber cable</td>
<td>IEC 61300-2-4 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Cable retention on bulkhead side</td>
<td>70N on simplex cable</td>
<td>IEC 61300-2-4 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Fibre retention</td>
<td>5N</td>
<td>IEC 61300-2-4 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Shock</td>
<td>1.2m / 28 drops</td>
<td>MIL-STD-810G (λ = 1310 / 1550 nm)</td>
</tr>
</tbody>
</table>
MIL-38999 DM4 Size 13 - Main Features

- Compatible with tight cable construction, semi loose cable/fibre construction
- IP67 rated enclosures (connector and bulkhead)
- Easy front-face ferrule access for cleaning & inspection
MIL-38999 DM4 Size 13 Connector Configuration

**Type C13/1**  Connector with mini-break cable (5mm or 5.5mm)

**Type C13/2**  Connector with protection tube for fiber 900um max.

**Type C13/3**  Connector for simplex cable version (1.6 - 2mm, 2.5 - 3mm) with IP protection

**Type C13/4**  Connector for simplex cable (1.6-3mm) or fiber 900um max. without IP protection
MIL-38999 DM4 Size 13 Bulkhead Configuration

Type B13/1S  Bulkhead for simplex cable (1.6 - 2mm, 2.5 - 3mm) with IP protection

Type B13/1R  Bulkhead for simplex cable (1.6 - 2mm, 2.5 - 3mm) with IP protection

Type B13/2S  Bulkhead for simplex cable (1.6 - 3mm) or fiber 900µm max. without IP protection

Type B13/2R  Bulkhead for simplex cable (1.6 - 3mm) or fiber 900µm max. without IP protection
MIL-38999 DM4 Size 25 - Main Features

- All features of the DM4 (3 x DM4) 12 channel
- Compatible with tight cable construction, semi loose cable / fiber construction
- IP67 rated enclosures (connector and bulkhead)
- Easy front-face ferrule access for cleaning and inspection
MIL-38999 DM4 Size 25 Configurations

**Type C25/1** Connector with mini-break cable (6mm - 8.8mm)

**Type C25/2** Connector with protection tube for fiber 900um max.

**Type C25/3** Connector for simplex cable version (1.6 - 3mm) or fiber 900um max. without IP protection

**Type B25/15** Bulkhead for simplex cable (1.6 - 3mm) or fiber 900um max. without IP protection
# Mechanical Specifications

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<td>Temperature shock</td>
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<td>500 cycles</td>
<td>IEC 61300-2-2 (λ = 1310 / 1550 nm)</td>
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<td>+/-180° / 25 cycles</td>
<td>IEC 61300-2-5 (λ = 1310 / 1550 nm)</td>
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<td>Flexing of strain relief</td>
<td>+/-90° / 25 cycles</td>
<td>IEC 61300-2-44 (λ = 1310 / 1550 nm)</td>
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<tr>
<td>Static side load</td>
<td>2N/90° (5min.)</td>
<td>IEC 61300-2-42 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Cable retention on connector side</td>
<td>800N on multi-fiber cable</td>
<td>IEC 61300-2-4 (λ = 1310 / 1550 nm)</td>
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<tr>
<td>Fibre retention</td>
<td>5N</td>
<td>IEC 61300-2-4 (λ = 1310 / 1550 nm)</td>
</tr>
<tr>
<td>Shock</td>
<td>1.2m / 26 drops</td>
<td>MIL-STD-810G (λ = 1310 / 1550 nm)</td>
</tr>
</tbody>
</table>
MIL-83526 DM4 - Main Features

- Rugged construction for highly reliable optical connections
- IP class IP68
- Easy ferrule front-face access for cleaning and inspection
- Keyed, self aligning, connector housing aides in “blind mating” applications
- Shell aluminum and hard eloxate, rubber handle
- Easy termini insertion and removal for field termination and repair
# Mechanical specifications

## Mechanical and environmental conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
<th>Standard</th>
</tr>
</thead>
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<tr>
<td>Change of temperature</td>
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<td>500 cycles</td>
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<tr>
<td>Cable torsion</td>
<td>+/-180° / 25 cycles</td>
<td>IEC 61300-2-5 (λ =1310 / 1550 nm)</td>
</tr>
<tr>
<td>Flexing of strain relief</td>
<td>+/-90° / 25 cycles</td>
<td>IEC 61300-2-44 (λ =1310 / 1550 nm)</td>
</tr>
<tr>
<td>Cable retention on connector side</td>
<td>600N on multi-fiber cable</td>
<td>IEC 61300-2-4 (λ =1310 / 1550 nm)</td>
</tr>
<tr>
<td>Shock</td>
<td>1.2m / 26 drops</td>
<td>MIL-STD-810G (λ =1310 / 1550 nm)</td>
</tr>
<tr>
<td>Tensile strength of coupling mechanism</td>
<td>200 N</td>
<td>IEC 61300-2-6 (λ =1310 / 1550 nm)</td>
</tr>
</tbody>
</table>
Compact DM4 - Main Features

- Easy ferrule front-face access for cleaning & inspection
- Aluminum shell and hard eloxate
- Easy termini insertion and removal for field termination and repair
- No IP protection
# Mechanical specifications

## Mechanical and environmental conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change of temperature</td>
<td>-40 / + 85 ºC</td>
<td>IEC 61300-2-22 (λ=1310 / 1550 nm)</td>
</tr>
<tr>
<td>Low temperature</td>
<td>-40 ºC (96h)</td>
<td>IEC 61300-2-17 (λ=1310 / 1550 nm)</td>
</tr>
<tr>
<td>High temperature</td>
<td>+85 ºC (96h)</td>
<td>IEC 61300-2-18 (λ=1310 / 1550 nm)</td>
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<tr>
<td>Vibration</td>
<td>10/2000 Hz (3h)</td>
<td>MIL-STD-202G (λ=1310 / 1550 nm)</td>
</tr>
<tr>
<td>Mating durability</td>
<td>500 cycles</td>
<td>IEC 61300-2-2 (λ=1310 / 1550 nm)</td>
</tr>
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</table>
Expanded Beam Interconnects

Robust. Versatile. Easy-To-Use
Expanded Beam Technology

Butt-joint connection

- Non-contact connection
- State-of-the-art optical performance
- High rate of mating cycles
- Insensitive to dirt and debris
- Low risk of damage
- High data rate capacity
- Easy cleaning process
- 150 x larger beam area

Expanded Beam connection
A Modular Approach: "Lens" Your Connection

**XB LENSED-FERRULE**

- **E-2000® XB**
  - Channels: 1
  - New applications, Power Solution, fiber sensors, RFoF

- **XB2**
  - Channels: 2
  - Avionics, lidars, new applications, Power over fiber, fiber sensors, RFoF

- **DM4 XB Size 13**
  - Channels: 4
  - Avionics, Military tactical, outside broadcast, petrochemical plant, mining, offshore systems, RFoF, Fiber sensors, Power over Fiber

- **DM4 XB Size 25**
  - Channels: 12
  - Military tactical, outside broadcast, petrochemical plant, mining, offshore systems, RFoF, fiber optic sensors, Power over fiber
Revos E-2000®

- Robust IP65-rated enclosure
- Dust-tight and protects against water jets
- Integrated caps and shutters for Laser eye safety
- E-2000® connector with Active Core Alignment
- Exceptional optical performance
- Easy lever locking
- Available for MM, SM (PC/APC), PM and small core fibers
- Available as terminated connector or fusion set for field assembly

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th></th>
<th>MULTIMODE</th>
<th>SINGLE MODE</th>
<th>SINGLE MODE</th>
<th>UNITS</th>
<th>TEST CONDITIONS</th>
</tr>
</thead>
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<tr>
<td></td>
<td>0° PC</td>
<td>0° PC</td>
<td>8° APC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion Loss (IL) Standard</td>
<td>typ. 0.1 max. 0.25</td>
<td>typ. 0.1 max. 0.25</td>
<td>typ. 0.1 max. 0.25</td>
<td>dB</td>
<td>IEC 61300-3-4; λ = 1300/1550nm</td>
</tr>
<tr>
<td>Insertion Loss (IL) Fusion</td>
<td>typ. 0.25 max. 0.5</td>
<td>typ. 0.25 max. 0.5</td>
<td>typ. 0.25 max. 0.5</td>
<td>dB</td>
<td>IEC 61300-3-4; λ = 1300/1550nm</td>
</tr>
<tr>
<td>Return Loss (RL)</td>
<td>typ. 40</td>
<td>min. 50</td>
<td>min. 75*</td>
<td>dB</td>
<td>IEC 61300-3-6; λ = 1300/1550nm</td>
</tr>
<tr>
<td>Repeatability of IL</td>
<td></td>
<td></td>
<td>max. ±0.1</td>
<td>dB</td>
<td>Over service life</td>
</tr>
<tr>
<td>Service life</td>
<td></td>
<td></td>
<td>500 mate/demate cycles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td></td>
<td></td>
<td>-40/+85**</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

* Measured with high precision reflectometer
** May be further limited by cable specifications
Interlock For DM4

- Deactivation security when using PS Technology
- Unfortunately we must sacrifice two optical fiber connections
- In laboratory phase
Cerbero

- System to divide the fibers
- Possibility to splice fiber / fiber
- Fixing special cable
X-BEAM Lens Based Connector

- Genderless tactical connector which uses lens based expanded beam technology for ease of cleaning and mating in outdoor applications
- The lens system protects the fiber endface
- Compatible with MM & SM Tyco connectors
- Compatible with MM & SM Stratos connectors
  (for SM compatibility X-BEAM is manufactured with special alignment)
X-BEAM Lens Based Connector

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Field Installation And On-site Repair Cleaning & Inspection
Field Installation And On-site Repair with ZEUS D50 HE

Fast, easy and high performance field termination and repair of:

Harsh Environment connectors:

Splice-On Connectors (SOC):
- F-3000®, E-2000®, SC, ST, FC

The Alberino HE has no bi-adhesive and is therefore glue-based; this makes it more suitable for harsh environment application which are requesting to withstand severe conditions.
ZEUS D50 HE - Main Features

- User friendly all-in-one system allows stripping, cleaving and splicing processes to be carried out in order to ensure safe cable manipulations
- Enhanced cable handling for 3-8mm outdoor/Mil cables thanks to special holders granting a higher splice yield
- Complete Kit of all the tools required to carry out all processes ranging from cable preparation to connector body assembly
- IP64 carrying case for use in harsh environments
Cleaning And Inspection

DiaClean Features
- Easy to use, lightweight, robust and field-proven
- Contains all necessary tools for proper cleaning and inspection procedures to help ensure optimal connector performance.

Video Microscope Features
- Safe, reliable and quality system incorporating the performance of a laboratory microscope into a portable, easy-to-use field inspection tool.
- Up to 200/400x magnification for inspection of 1.25 & 2.5mm (PC/APC) mated & unmated connectors
- Inspection probe with USB connection for Laptop application