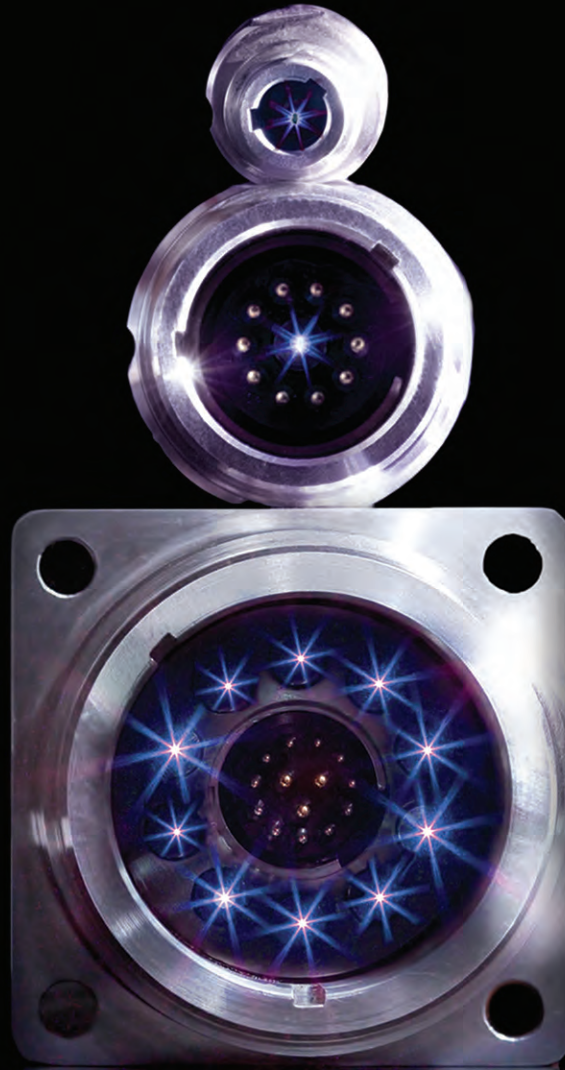


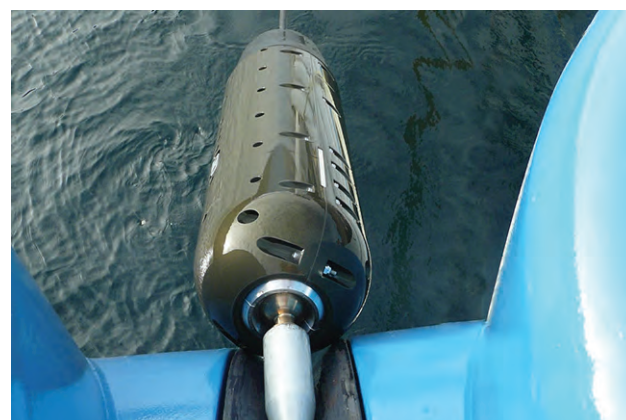
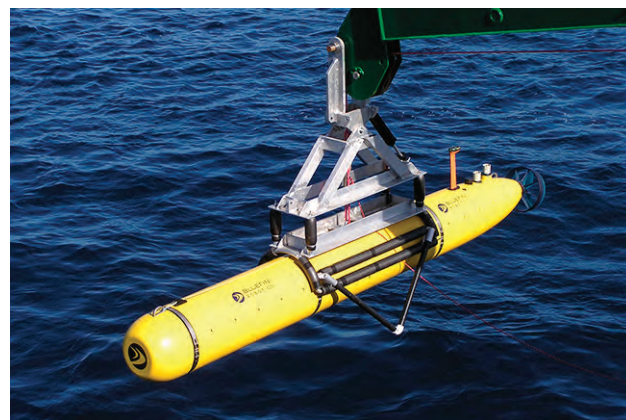
BIRNS Millennium™ Connector Series



*High Performance . . .
Under Pressure®*

www.birns.com

Company Overview	1
Quality	2
Product Overview	3
Specific Benefits	4
Pin Configurations	5
Graphical Overview	6
Part Numbering	7
Tabulated Dimensions	8
Technical Specifications - Materials	9
Technical Specifications - Electrical	10
Technical Specifications - Optical	11
Technical Specifications - Coaxial	12
Technical Specifications - Receptacle	13
Key Options	14
EOM Terminations	15
Disclaimer Notice	16

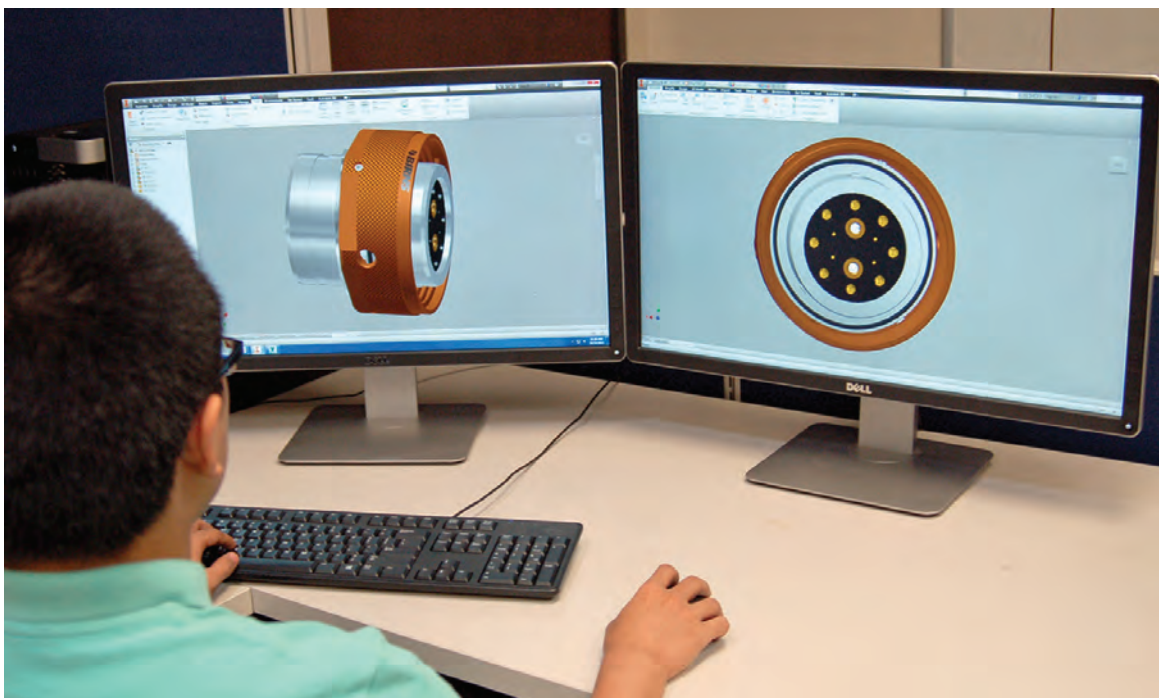


Millennium Connector Series Brochure Rev. B

Established in 1954, BIRNS is a global leader in the design and manufacturing of high performance connectors, penetrators and cable assemblies for deep ocean vehicles (manned and unmanned), subsea electronics, commercial diving and security applications. Thus, our quality certifications and manufacturing capabilities meet or exceed the most exacting requirements. Our world-class cable facility is SUBMEPP-certified to NAVSEA S9320-AM-PRO-020, only one of seven such commercial organizations in the U.S. All BIRNS QA personnel and production technicians are certified to both J-STD-001 and WHMA-A-620-A Class 3^[1], and we hold ABS Product Design Assessment Certification for all of our man-rated submarine and SAT-system penetrators.

Our dedicated engineers have deep in-field experience and use the latest 3D parametric solid modeling software to deliver outstanding solutions with precision and speed. All designs are performed in model space. BIRNS designs and performs mechanical termination of load-bearing cables with central or coaxial stress members of Aramid fiber or steel, and performs in-house molding of epoxy, polyurethane, polychloroprene and other materials. We can produce items designed for a diverse range of highly specific needs, or modify items tailored to customers' specifications.

Our ongoing investments in our processes, equipment and protocols continue to increase our capabilities—while reducing costs and lead times—to effectively meet the changing needs of our customers.



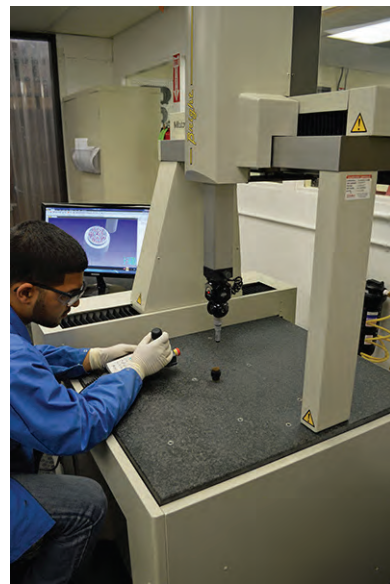
^[1] Class 3 is for products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

Our emphasis is always to provide the ultimate in product quality and performance. Thus, our comprehensive quality program is fully integrated throughout every department, from sales, design, and production; to detailed receiving, in-process and final inspection; and ultimately through delivery and customer service. As part of our ongoing commitment to our customers, our Quality Management System is certified to ISO 9001:2008 by DNV and complies with 10CFR50 App. B (NQA-1). Our attention to detail is unmatched, with consistent, extensive employee training and cross training, and internal oversight. The entire QMS is process based and dedicated to continual process improvement.

We utilize advanced digital inspection equipment, including a Mitutoyo DCC CMM (Coordinate Measuring Machine) and a Starrett HDV300 Video Measuring system—new technology that combines the power of an optical comparator with digital video, hi-res cameras, telecentric optics and LED illumination. Additionally, we use Mantis 3D binocular scopes with digital imaging, and all digital precision measuring instruments.

BIRNS has provided industry-leading testing, exceeding stringent ABS/DNV requirements, for man-rated electrical penetrators and complex connector solutions since 1995. By adding saltwater testing in 2006, BIRNS now affords the industry's greatest volume of cost-effective hydrostatic and helium pressure testing. Our custom-engineered hydrostatic pressure testing system has digital data recording capabilities and can be controlled remotely or via automatic programming. In it, our technicians can simultaneously test three independent pressure circuits in six chambers at pressures up to 20,000 PSI (138 MPa), in fresh or salt water.

Our electrical test system was custom-designed and made for us by Kikusui and permits the simultaneous testing of up to 16 electrical circuits, automatically, with up to 99 different programmable test sequences, at voltages up to 10kV, while subjected to hydrostatic/hydrodynamic pressure.



Introduction/General Features

The BIRNS Millennium series is a high performance, high density dry-mate connector range suitable for deep submergence applications to 6km depth. This series can be used with solid (molded) or oil-filled cables in straight or 90° configurations and is available in high and low voltage, coax, fiber-optic, and hybrids of electro-coax, electro-optical and electro-opto-mechanical formats.

Non-coax configurations are open-face rated to 6,000 meters and preclude pressure vessel flooding without need for glass-sealing. Our revolutionary new coax contacts are open face pressure rated to 1433m. Although many manufacturers' connectors cannot resist more than 2,000-3,000 PSI (1,300m-2,000m) while mated to oil-filled cables, BIRNS Millennium connectors are rated to 6,000m when used with PBOF or molded cables.

- **User-friendly:** Replaceable electrical inserts (for Receptacles and Plugs); Insulated solder pots; and User-friendly termination with thick gold plating (50 microns) on all contacts
- **Rugged:** Square Acme threads resist mechanical damage; Integral, square stainless CP keys; 15° lead-in O-ring chamfers; Oil-filled adapters incorporate double-ferrule hydraulic fittings
- **Durable:** Hard phosphor bronze coupling rings, with special Higbee threads; Heat-treated BeCu sockets keep spring strength
- **Adaptable:** Receptacles available in 316-SS or Titanium; Available Receptacle Types: FR, OR, BR, and CR; Conductor sizes 22-, 20-, 16-, 14-, and 10-AWG; No incompatible regular and long shells; Three key options available for purposeful incompatibility



Design/Construction

- Dual redundant O-ring seals—with 15° lead-in angles—assure long-term sealing reliability
- Dual integral (machined from solid bar) long, square keys provide positive indexing

Mechanical Performance










- Anti-vibration locking mechanism precludes inadvertent connector loosening
- Stainless steel positive stops preclude over-tightening
- Rugged, sturdy coupling rings resist mechanical damage

User-friendly Termination

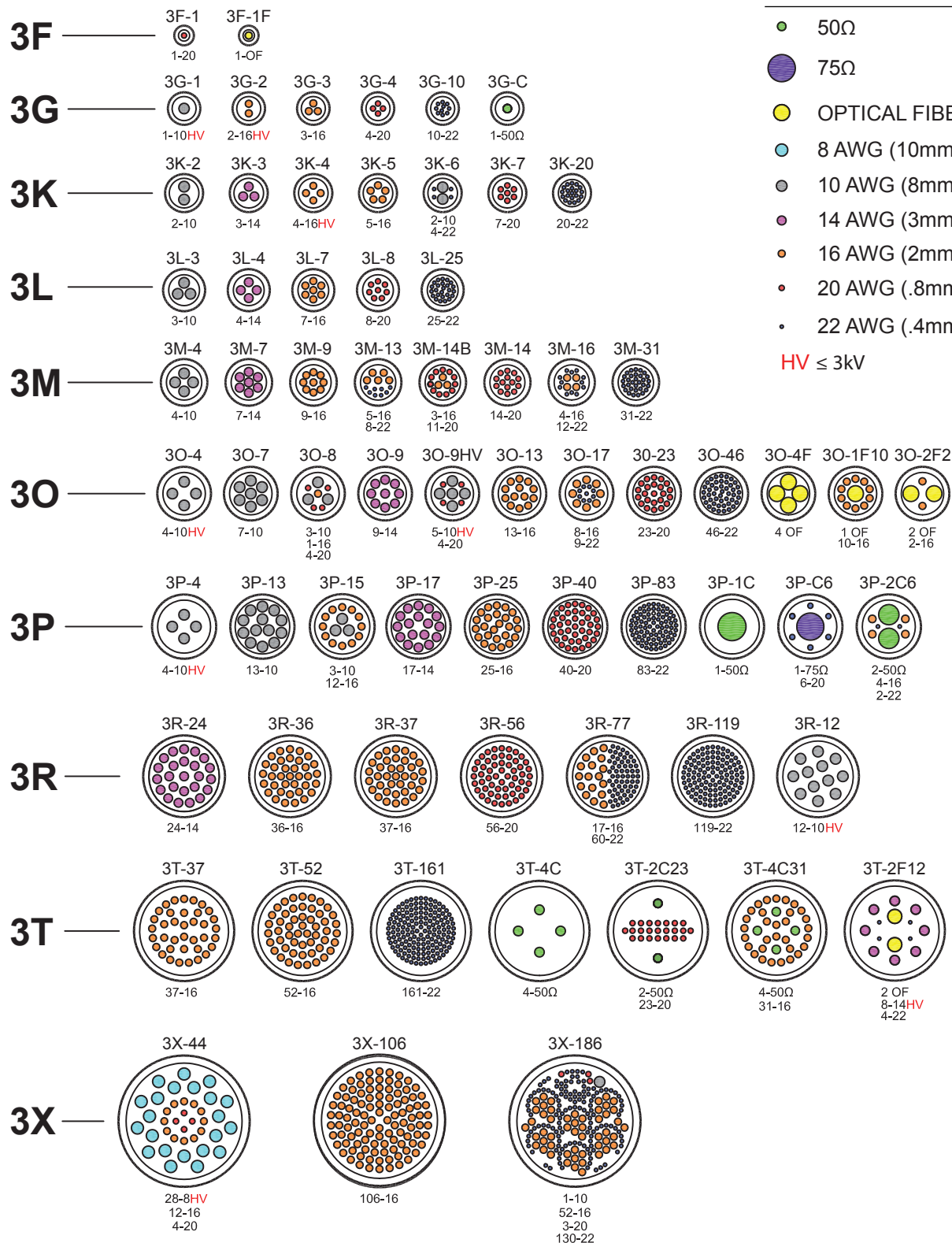
- No wings or other obstructions limit soldering access
- All solder pots are scalloped and face outward
- Inserts can be terminated outside the shell
- Solder pots accept the largest stranding of any wire size per MIL-STD-39029D
- Insulated solder pots are easy to cover with heat-shrink tubing

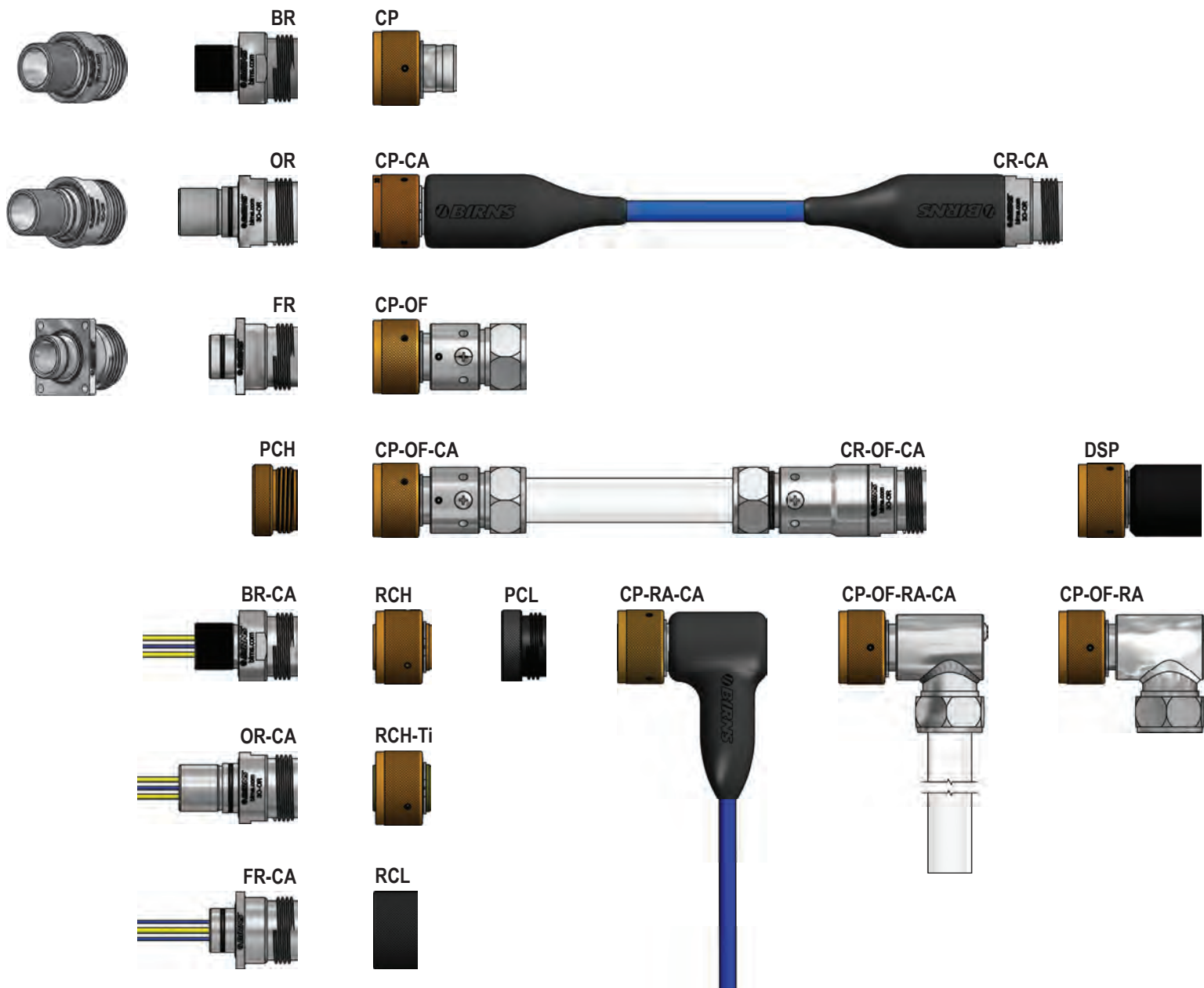


LEGEND

	50Ω	
	75Ω	
	OPTICAL FIBER (OF)	Ampacity
	8 AWG (10mm ²)	40A
	10 AWG (8mm ²)	33A
	14 AWG (3mm ²)	15A
	16 AWG (2mm ²)	12A
	20 AWG (.8mm ²)	4A
	22 AWG (.4mm ²)	2A

HV ≤ 3kV





BR: Bulkhead Receptacle	BR-CA: Bulkhead Receptacle-Cable Assembly
CP: Cable Plug	RCH: Receptacle Cap, High Pressure
OR: Dual O-ring Receptacle	PCL: Plug Cap Low Pressure
CP-CA: Cable Plug-Cable Assembly	CP-RA-CA: Cable Plug-Right Angle-Cable Assembly
CR-CA: Cable Receptacle-Cable Assembly	CP-OF-RA-CA: Cable Plug-Oil Filled-Right Angle-Cable Assembly
FR: Flanged Receptacle	CP-OF-RA: Cable Plug-Oil Filled-Right Angle
CP-OF: Cable Plug-Oil Filled	OR-CA: Dual O-ring Receptacle-Cable Assembly
PCH: Plug Cap High Pressure	RCH-Ti: Receptacle Cap, High Pressure-Titanium
CP-OF-CA: Cable Plug-Oil-Filled-Cable Assembly	FR-CA: Flanged Receptacle-Cable Assembly
CR-OF-CA: Cable Receptacle-Oil-Filled-Cable Assembly	RCL: Receptacle Cap Low Pressure
DSP: Dummy Sealing Plug	

3M-13-CP-TI-K2-OF-RA-13-CA

SHELL SIZE

F
G
K
L
M
O
P
R
T

CONTACTS

SHELL TYPE

CP: Cable Plug
FR: Flanged Receptacle
OR: Dual O-ring Receptacle
BR: Bulkhead Receptacle
CR: Cable Receptacle

SHELL MATERIALS

(blank): 316 SS
TI: Ti 4A16V

TERMINATION

(blank): no termination
CA: terminated, assembled, and overmolded if applicable

TUBING SIZE

13: 1/2" OD tube
19: 3/4" OD tube
25: 1" OD tube
32: 1 1/4" OD tube

CABLE ANGLE

(blank): 180°
RA: 90°

CABLE ATTACHMENT

(blank): molded, solid cable
OF: oil-filled, double-ferrule swage-style hydraulic fitting
OH: oil-filled, hose-clamp

KEY OPTIONS

(blank): standard key
K2: (240°)
K3: (210°)
K4: (180°)

Dummy Sealing Plugs

3M-13-DSP

Shell Size

Contacts

Dummy Sealing Plug
Special Cap for
3__-CR-OF

Pressure Caps

3M-RC H-TI

Shell Size

RC: Receptacle Cap
PC: Plug Cap

L: IP56
H: 1,000m
H-TI: 6,000m

Oil Filled Tubing Adapters

3K-PF-RA-19

SHELL SIZE

F
G
K
L
M
O
P
R
T

ADAPTER FOR

P: CP
B: BR
O: OR
F: FR

FITTING STYLE

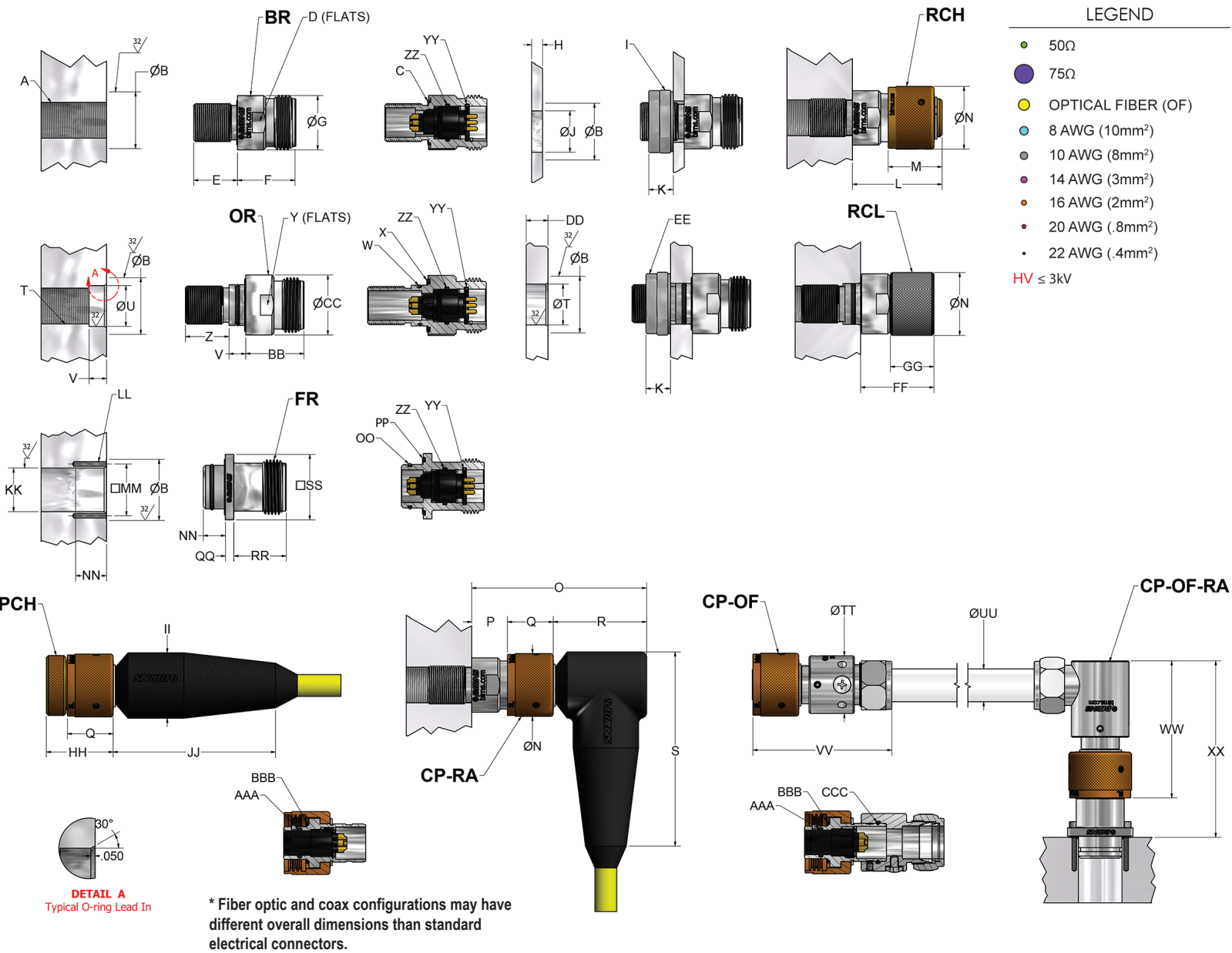
H: Hose Barb
F: Swagelok

TUBING SIZE

13: 1/2" OD
19: 3/4" OD
25: 1" OD

ANGLE

Blank: 1,000m
RA: 90m



Callout	Description	3F	3G	3K	3L	3M	3O	3P	3R	3T
A	BR Mounting Thread	1/2-20 UNF-2B	5/8-24 UNEF-2B	3/4-20 UNEF-2B	7/8-20 UNEF-2B	1-20 UNEF-2B	1 1/8-16 UN-2B	1 1/4-16 UN-2B	1 1/2-16 UN-2B	2-16 UN-2B
B	O-Ring Spot Face	0.88	1.13	1.13	1.38	1.38	1.50	1.88	2.07	2.38
C	BR Face O-Ring	2-015	2-017	2-020	2-021	2-024	2-026	2-028	2-031	2-034
D	BR Wrench Flats	3/4	7/8	1	1 1/8	1 3/8	1 1/2	1 5/8	2	N/A
E	BR Thread Length	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.00
F	BR Body Height	0.88	1.00	1.40	1.34	1.13	1.33	1.34	1.57	1.34
G	BR Body Diameter	0.82	1.00	1.13	1.25	1.50	1.62	1.75	2.25	2.50
H	BR Vessel Thickness, Drilled	0.50	.56 max	.44 max	.44 max	.48 max	.44 max	.44 max	.69 max	.44 max
I	BR Nut/Washer Assy P/N	24I-120	24I-625	24I-075	24I-088	24I-102	24I-350	24I-125	24I-150	24I-200
J	BR Drilled Hole Diameter	0.52	0.64	0.77	0.89	1.02	1.14	1.27	1.52	2.02
K	BR/OR Nut and Washer Height	0.56	0.36	0.56	0.56	0.52	0.56	0.56	0.56	0.56
L	BR/RCH Combined Height	1.33	1.63	2.06	2.05	1.83	2.05	2.06	2.29	2.04
M	RCH Height	0.86	0.98	1.24	1.23	1.25	1.24	1.23	1.24	1.28
N	Engaging Nut Diameter	0.75	1.06	1.32	1.44	1.56	1.69	1.94	2.25	2.63
O	BR/CP-RA Combined Height	N/A	2.56	3.43	3.36	3.48	3.66	3.12	3.69	3.52
P	CP to Face Distance, on BR	0.45	0.65	0.89	0.82	0.61	0.79	0.48	1.05	0.59
Q	Engaging Nut Height	0.75	0.78	1.05	1.05	1.05	1.05	1.05	1.05	1.03
R	RA Overmold Height	N/A	1.13	1.49	1.49	1.82	1.82	1.59	1.59	1.90
S	RA Overmold Length	N/A	2.24	3.78	3.78	4.50	4.50	4.49	4.49	5.79
T	OR Mounting Thread	1/2-20 UNF-2B	9/16-20 UN-2B	11/16-20 UNEF-2B	7/8-20 UNEF-2B	1-20 UNEF-2B	1 1/16-20 UNEF-2B	1 1/4-16 UN-2B	1 1/2-16 UN-2B	2-16 UN-2B
U	OR Shaft Seal Diameter (+.002/-0.000)	0.562	0.625	0.750	0.937	1.000	1.125	1.250	1.625	2.000
V	OR Shaft Seal Depth	0.38	0.43	0.43	0.40	0.40	0.43	0.42	0.43	0.40
W	OR Shaft Seal O-Ring	2-013	2-014	2-016	2-019	2-020	2-022	2-024	2-029	2-032
X	OR Face Seal O-Ring	2-016	2-017	2-026	2-022	2-024	2-026	2-028	2-132	2-034
Y	OR Wrench Flats	0.75	0.88	1.00	1.30	1.30	1.50	1.62	1.92	N/A
Z	OR Thread Length	1.00	1.00	1.13	1.00	1.00	1.00	1.00	1.25	1.03
BB	OR Body Height	0.88	1.00	1.40	1.34	1.12	1.32	1.29	1.85	1.37
CC	OR Body Diameter	0.93	1.00	1.38	1.38	1.50	1.63	1.75	2.19	2.50
DD	OR Vessel Thickness, Drilled	0.88	.90 max	.95 max	.82 max	.86 max	.82 max	.82 max	1.06 max	.82 max
EE	OR Nut/Washer Assy P/N	24I-120	24I-562	24I-069	24I-088	24I-102	24I-113	24I-125	24I-150	24I-200
FF	OR/RCL Combined Height	1.07	1.15	1.73	1.62	1.52	1.72	1.75	1.75	1.75
GG	RCL Height	0.60	0.60	1.00	1.00	1.00	1.00	1.05	1.05	1.06
HH	Engaging Nut/PCH Comb. Height	1.07	1.18	1.34	1.53	1.53	1.51	1.63	1.91	1.74
II	Straight Overmold Diameter	0.75	1.11	1.50	1.50	1.50	1.63	1.82	2.02	2.50
JJ	Straight Overmold Length	1.05	2.20	3.39	3.75	3.39	4.43	4.50	5.25	5.75
KK	FR Shaft Seal Diameter (+.002/-0.000)	0.500	0.687	0.750	1.000	1.000	1.000	1.500	1.500	2.000
LL	FR Mounting Screw Size	#4	#4	#6	#6	#8	#10	#10	1/4	1/4
MM	FR Mounting Screw Pattern	0.780	0.906	1.020	1.188	1.186	1.446	1.850	1.768	2.086
NN	FR Shaft Seal Depth	0.50	0.50	0.50	0.50	0.50	0.60	0.50	0.50	0.50
OO	FR Shaft Seal O-Ring	2-012	2-015	2-016	2-020	2-020	2-020	2-028	2-028	2-032
PP	FR Face Seal O-Ring	2-016	2-019	2-020	2-024	2-024	2-024	2-030	2-031	2-034
QQ	FR Flange Thickness	0.19	0.19	0.30	0.20	0.15	0.20	0.30	0.25	0.30
RR	FR Body Height	0.68	0.81	1.15	1.20	1.10	1.20	1.16	1.22	1.24
SS	FR Flange Dimension	1.00	1.13	1.25	1.50	1.50	1.75	2.36	2.25	2.62
TT	CP-OF Body Diameter	0.75	1.05	1.05	1.32	1.32	1.50	1.62	2.13	N/A
UU	Oil-Filled Tubing Diameter	1/2	1/2 or 3/4	1/2 or 3/4 or 1	3/4 or 1	3/4 or 1	1	1	1	N/A
VV	CP-OF Overall Length	2.40	2.82	3.17	3.18	3.18	3.54	3.52	3.72	N/A
WW	CP-OF-RA Height	N/A	2.66	3.05	3.19	3.72	3.42	3.42	3.83	N/A
XX	FR/CP-OF-RA Clearance Height	N/A	3.10	3.97	3.94	4.28	4.28	4.05	4.48	N/A
YY	Mating Axial Seal O-ring	2-011	2-014	2-016	2-018	2-019	2-023	2-025	2-029	2-031
ZZ	Receptacle Insert Seal O-ring	2-006	2-014	2-016	2-018	2-019	2-023	2-025	2-029	2-031
AAA	Plug Insert Seal O-ring	2-006	2-012	2-014	2-015	2-016	2-018	2-119	2-026	2-028
BBB	Mating Face Seal O-ring	2-012	2-015	2-018	2-020	2-023	2-025	2-028	2-030	2-033
CCC	OF Adapter Seal O-ring	2-013	2-016	2-018	2-020	2-021	2-023	2-026	2-030	N/A

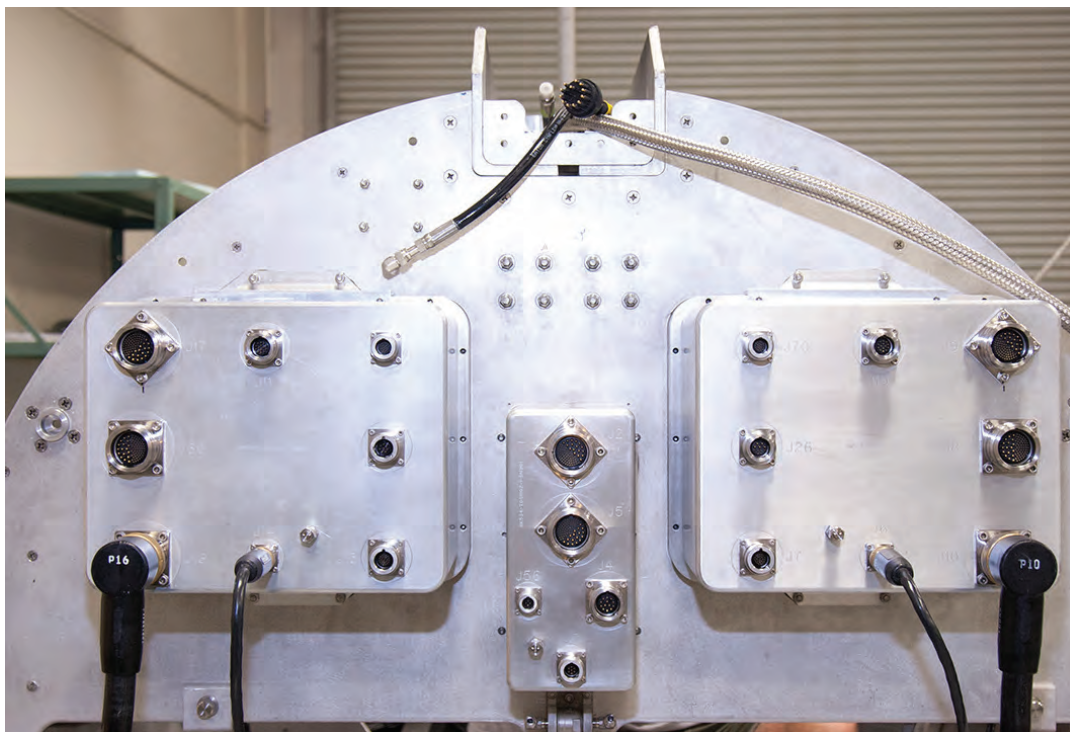
Note: The face seal O-rings for the Millennium CP shells in sizes 3M, 3O, and 3P have changed with an improved shell design. The improved shells may be identified by their rectangular, machined-in keys. Old style CP shells have round, pressed in keys. The face seal O-rings for the old style shells are: 3M: 2-021 3O: 2-024 3P: 2-026

Materials

- Cable Plug shell: 316 SS, passivated per ASTM A967
- Receptacle shell: 316 SS, passivated per ASTM A967 (standard)
- Titanium Grade 5 (Ti6Al4V) passivated per ASTM B600 also available
- Coupling ring: C54400 Phosphor Bronze per ASTM B139, hard temper H04
- Hardware: 300-series SS
- Insert: GRE (glass-reinforced epoxy)
- Pins: C36000 Copper
- Sockets: heat-treated C17300H Beryllium-Copper
- Optical Ferrules and alignment sleeves: Zirconia ceramic
- Contact plating: 50μ Au over 50μ Ni per MIL-G-45204 Type II Grade D Class 1
- O-rings: NBR (Nitrile rubber) standard

Temperature Range

- -30°F to +250°F (-34°C to +121°C) with NBR Nitrile O-rings
- -15°F to +329°F (-26°C to +165°C) with optional FKM Viton™ O-rings



Electrical Performance

BIRNS Millennium electrical connectors are ideal for any high performance subsea system requiring power and fast data transfer. Inserts are available with both high (≤ 3.6 kV) and low (≤ 600 V) contact combinations. They provide excellent contact engagement per MIL-STD-39029D, and have insulated solder pots to minimize EMI, noise and cross-talk. Each socket is engineered with heat-treated BeCu for longevity and superior electrical contact, and all contacts have 50 μ of hard gold plating for superior data transmission.



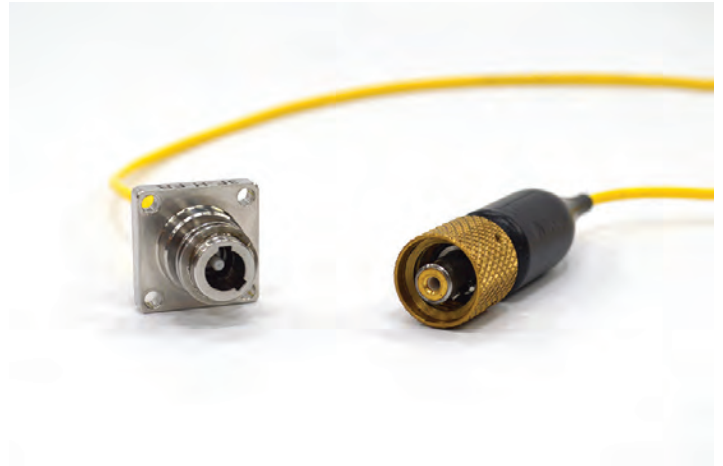
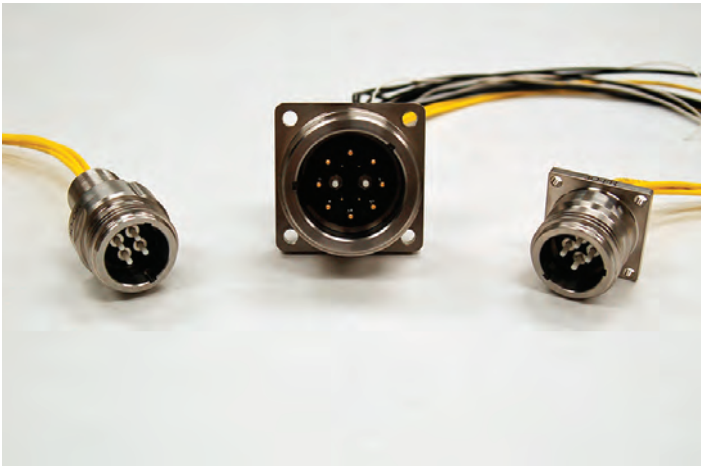
As there is not a true "standard" AWG, actual measurements of AWG sizes can vary from manufacturer to manufacturer. The conductors in BIRNS connectors are slightly larger than some standard sizes—we use larger conductors to give more flexibility to the electrical systems of our customers.

Contact ("AWG")	Actual BIRNS Size			Current I_{max} (A)	Voltage (Max. V)	Max. Wire ϕ	
	ϕ (mm)	ϕ (in.)	A (mm ²)			(mm)	(inches)
22	.76	.030"	.45	2	700	.91	.036"
20	1.02	.040"	.81	4	700	1.02	.040"
16	1.59	.063"	1.98	12	700	1.78	.070"
14	1.98	.078"	3.08	15	700	2.36	.093"
10	3.18	.125"	7.92	33	700	3.18	.125"

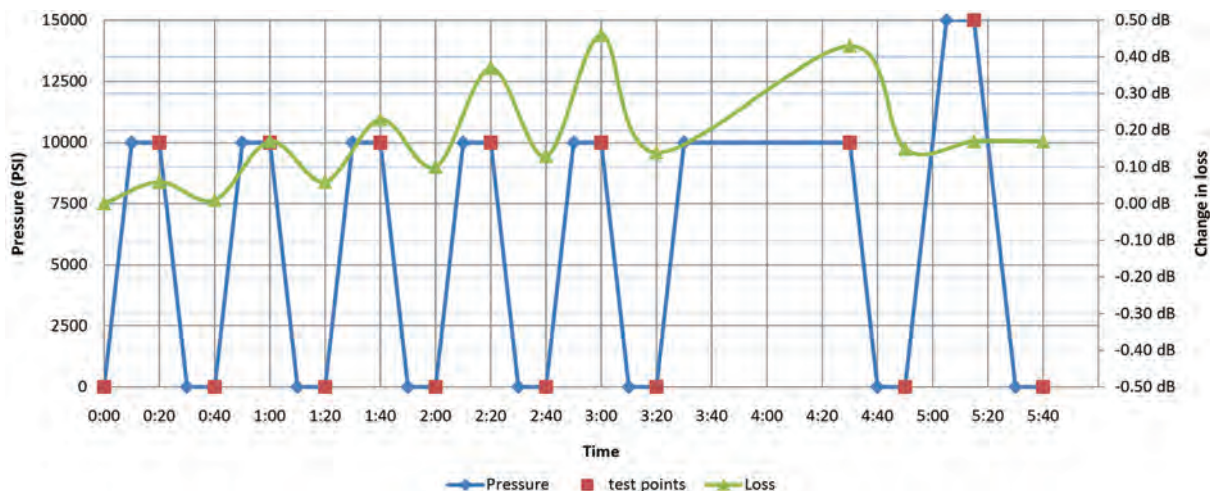
Optical Performance

The series' optical configurations deliver advanced subsea connectivity for demanding applications that require massive data rates—often in a small footprint. They provide combinations of single-mode or multi-mode fibers, and can be paired in hybrid configurations with both high and low voltage contacts and mechanical load bearing > 50,000 lbs.

- Insertion Loss (per ANSI/TIA/EIA-455)
 - Single-mode: .5dB max [typical: .1dB]
 - Multi-mode: 1dB max [typical: .25dB]
- Return Loss
 - 35 dB min



Optical Loss During Cyclical Pressure Testing of Mated 3F-1F Connector Pair



Coaxial Performance

BIRNS Millennium coax connectors feature a superior polyethylene dielectric, making them ideal for GPS-frequency systems, large data and HD video signal applications. A number of shell sizes are available with impedance of 50 or 75Ω and most can be hybridized with electrical contacts and/or optical ferrules.



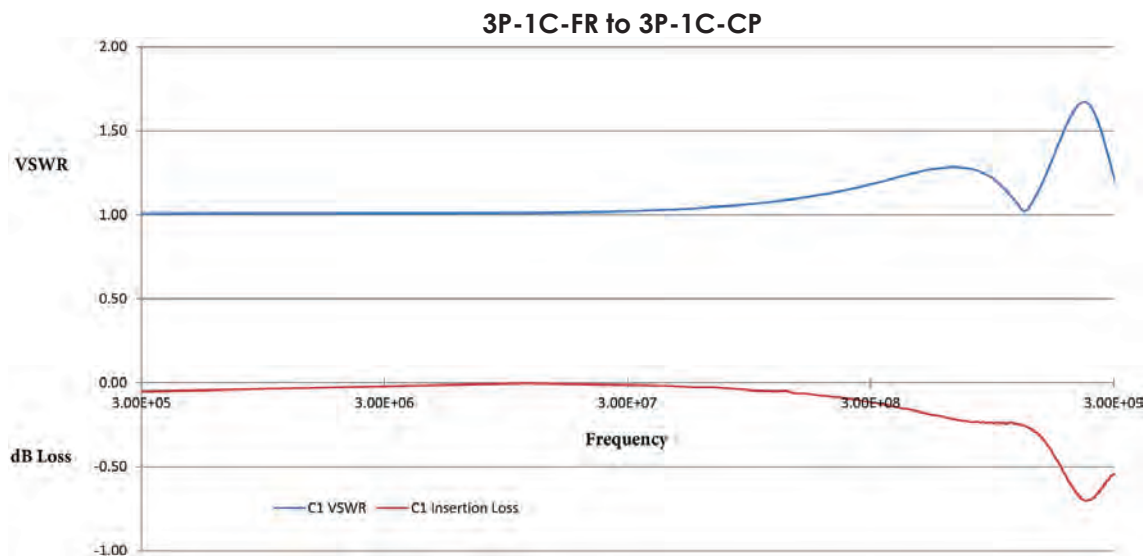
We've been getting exciting, groundbreaking testing results on our new coax contacts, which demonstrate open face pressure resistance to 1433m, so far in initial testing protocols, with more testing currently under way. The series has a maximum insertion loss of 0.7 dB to 3GHz, with an associated maximum SWR of 1.7:1



3P-1C



3P-2C6



Millennium Connector Series Brochure Rev. B

Receptacle Caps

There are four versions of BIRNS Millennium Receptacle Caps:

1. RCL: "Receptacle Cap, Low pressure"—made of Delrin, splash-proof only
2. RCH: "Receptacle Cap, High pressure"—made of Brass, proof to 1,000m
3. RCH-Ti: "Receptacle Cap, High pressure, Titanium"—made of Titanium, proof to 6,000m
4. DSP: "Dummy Sealing Plug"—a modified version of a CP, used for reverse pressure



RCL



RCH



RCH-Ti



DSP

Reverse Pressure

Receptacle

The BIRNS Millennium Receptacle is front-loaded and designed to withstand the high face pressure it experiences in its standard configuration (BR, OR or FR mounted into a 1-atmosphere pressure vessel). However, in two configurations the Receptacle insert can experience reverse (rear) pressure:

- When the Receptacle is part of an oil-filled cable (CR-OF)
- When the Receptacle is installed on an oil-filled pressure-compensated canister

In these configurations, the Receptacle must not be capped with a RCH. Rather, it must:

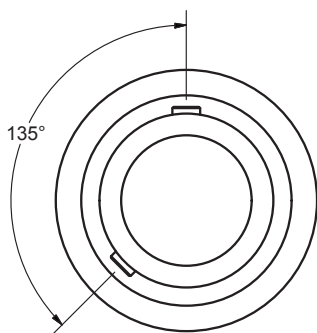
- Be mated to a CP or CP-OF
- Remain unmated (open to seawater)
- Be capped with a SPECIAL cap, the "DSP" (Dummy Sealing Plug) which is a special high-pressure cap for the CR-OF. The DSP mimics a CP: when mated to the Receptacle the DSP minimizes the air gap and supports the Receptacle insert.

The DSP is specific to each CR-OF: a 3L-25-DSP mates to a 3L-25-CR-OF, a 3L-7-DSP mates to a 3L-7-CR-OF, etc.

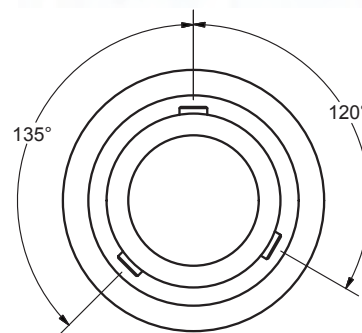
Plug

The BIRNS Millennium Plug is designed to withstand high 'rear' pressure because it is usually in a standard configuration (CP or CP-OF) and is mated to a receptacle. To withstand high rear pressure, the Plug insert is rear-loaded. When installed in an oil-filled cable assembly, the CP-OF can withstand 100 bar while capped with the PCH.

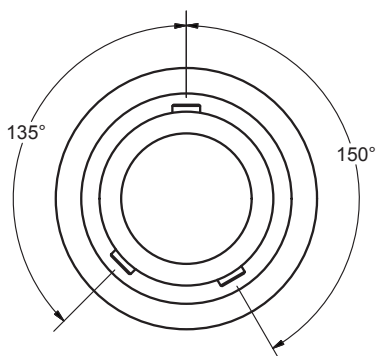
As the BIRNS Millennium series is specifically engineered for challenging power and signal applications and systems requiring electro-opto-mechanical solutions, keys for the series are designed to meet these demands while providing ease of use. The keys are fully machined, as opposed to commercially available press fit versions, and feature a squared silhouette, providing maximum strength and making the keying process more seamless, secure and user-friendly. Users have the option of a third key, providing purposeful incompatibility of different positions between the same connector with different circuits. This precludes inadvertent mis-connection in the field when more than one of the same connector—with the same pin configurations but different circuits, for example—are being used in a subsea system. The optional third key can be specified in one of three positions, which are designated by part number nomenclature: K2, K3, or K4.



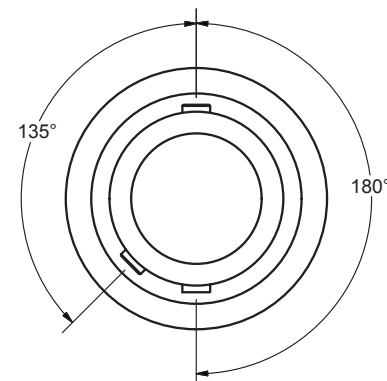
Standard Key
(Not Key Option 1)



Key Option 2



Key Option 3



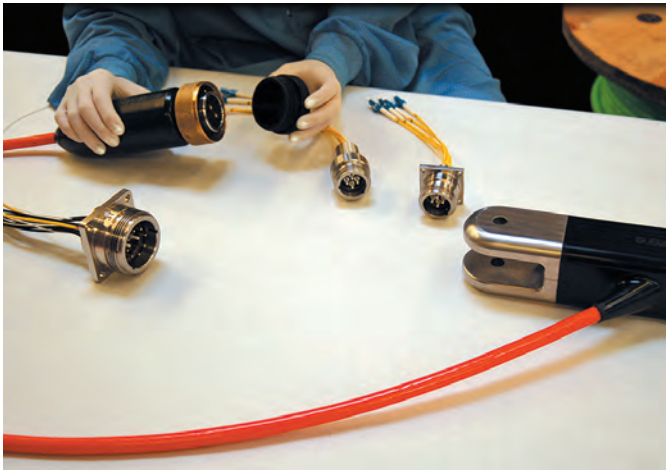
Key Option 4

Note: Face of cable plug shown.
Receptacles are mirror image.

Millennium Connector Series Brochure Rev. B

BIRNS' Electro-Opto-Mechanical (EOM) cable assemblies provide immense performance capabilities and are developed with precision to preserve the integrity of the delicate optical fibers. They deliver huge levels of power, signal and data and withstand extreme environments, while capable of providing load strengths of > 50,000 lbs.

Whether your system requires steel, Kevlar, Vectran, or other strength members, single-mode or multi-mode fibers, low or high voltage electrical conductors—BIRNS can engineer a custom EOM solution for you.



Technical/Warranty

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