

PROTERIAL

High Performance Medical Solutions



**Wire and Cable Medical Solutions
Medical Extrusion & Tubing Solutions**

VISION
Making the best quality available to everyone.
 1 Striving for the highest standards in our original technologies, processes, and people, we will bring new levels of value to customers around the world.

MISSION
Leading sustainability by high performance.
 2 Through the creation of best-in-class materials, to be a company that solves individual customer issues and contributes to the prosperity and vitality of all.

VALUES
Unflinching Integrity. Earn the trust of our customers and other stakeholders by being honest and sincere.
 3 **United by Respect.** We respect diversity and the free & independent exchange of opinions.

About Proterial Cable America, Inc.

Proterial Cable America, Inc. (PCA) formerly Proterial Cable America, is a global manufacturer of highly specialized and innovative technologies for the medical, data communications, and automotive industries.

PCA consists of three divisions, the High Performance Medical Solutions Division (HPMS) Performance Cable Division, the Automotive Products Division.

The High Performance Medical Solutions Division provides ISO-13485:2016 compliant manufacturing services of components and finished medical devices for OEMs worldwide. The division specializes in complex high performance catheter tubing, braided tubing and high pressure braided tubing, secondary operations, medical machining and fabrication, 3D additive manufacturing, cable assemblies and full device assembly. Products such as PICC catheters, introducer sheaths, fluid transport tubing, ultrasound devices, endoscopic camera catheters, and advanced diagnostic or surgical catheters are common. HPMS products are manufactured within the United States with production centers in Rhode Island, Connecticut, and New Hampshire.

The Performance Cable Systems and Materials Division has been designing and manufacturing copper and fiber optic communication cables and assemblies to support applications such as Ethernet, video, power over Ethernet, HDMI, InfiniBand and more, in their Manchester, New Hampshire facility since 1986.

The Automotive Products Division designs and manufactures high-performance materials and components used by OE manufacturers within the automotive industry. Products include power cable harnesses for electric / hybrid vehicles, brake hose products and electric sensor harnesses. The Automotive Products Division operates two manufacturing facilities in Mexico.



Proterial Competencies & Technologies

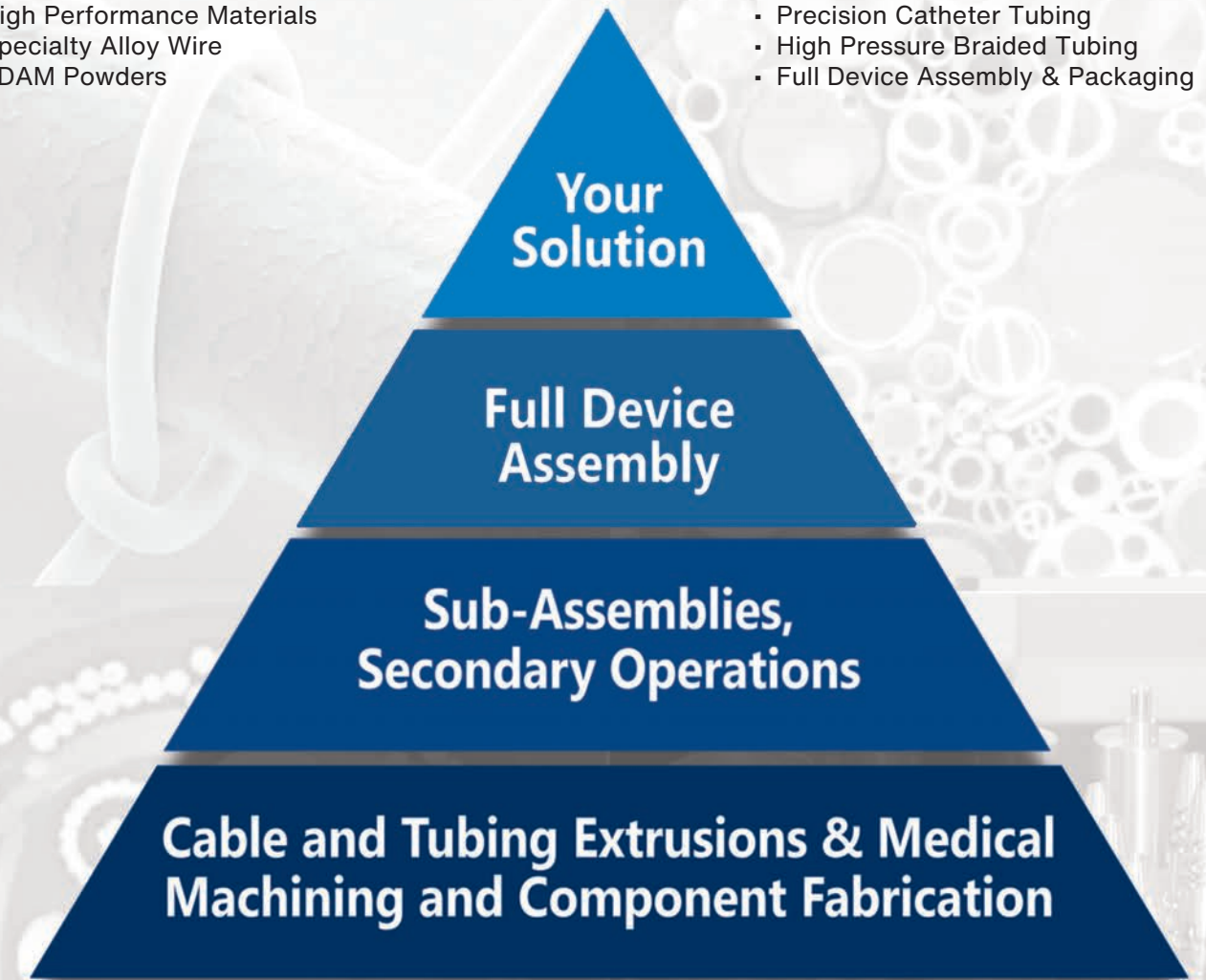
Proterial HPMS provides services and solutions that meet the most stringent of medical needs. Our rich line-up of quality products and industry experience allow us to reach new frontiers in medical science and development. Whether it's a novel material, a component requirement, or a complex assembly, our team is prepared to solve your specialized needs.

Material Development

- High Performance Materials
- Specialty Alloy Wire
- 3DAM Powders

Extruded Tubing

- Precision Catheter Tubing
- High Pressure Braided Tubing
- Full Device Assembly & Packaging



Discrete Wire & Bundled Cable

- Fine Wire & Cable Production
- Cable Preparation Services
- Cable Assembly

Machining & Fabrication

- Extrusion Tooling
- Medical Machining

Cables & Assemblies

There are many types and uses for medical cables. Proterial offers a broad range of products and capabilities to support varying applications.

One of Proterial's many strengths is building complex fine wire bundles. These are traditionally found in ultrasound imaging environments for medical probe cables in both medical and non-medical applications where precision and performance are paramount.

Proterial offers customized cables to meet specific needs depending on the application or equipment. This expertise can be expanded upon to other applications such as endoscopes, catheters, and animal probes. We strive to listen to the needs of our customers and develop standard and custom solutions that OEMs require.

Proterial has become a recognized leader in the medical cable space. Since our founding in 1910, Proterial has lived up to our founders mission: "Contribute to society through the development of superior, original technology and products." Some recent examples are:

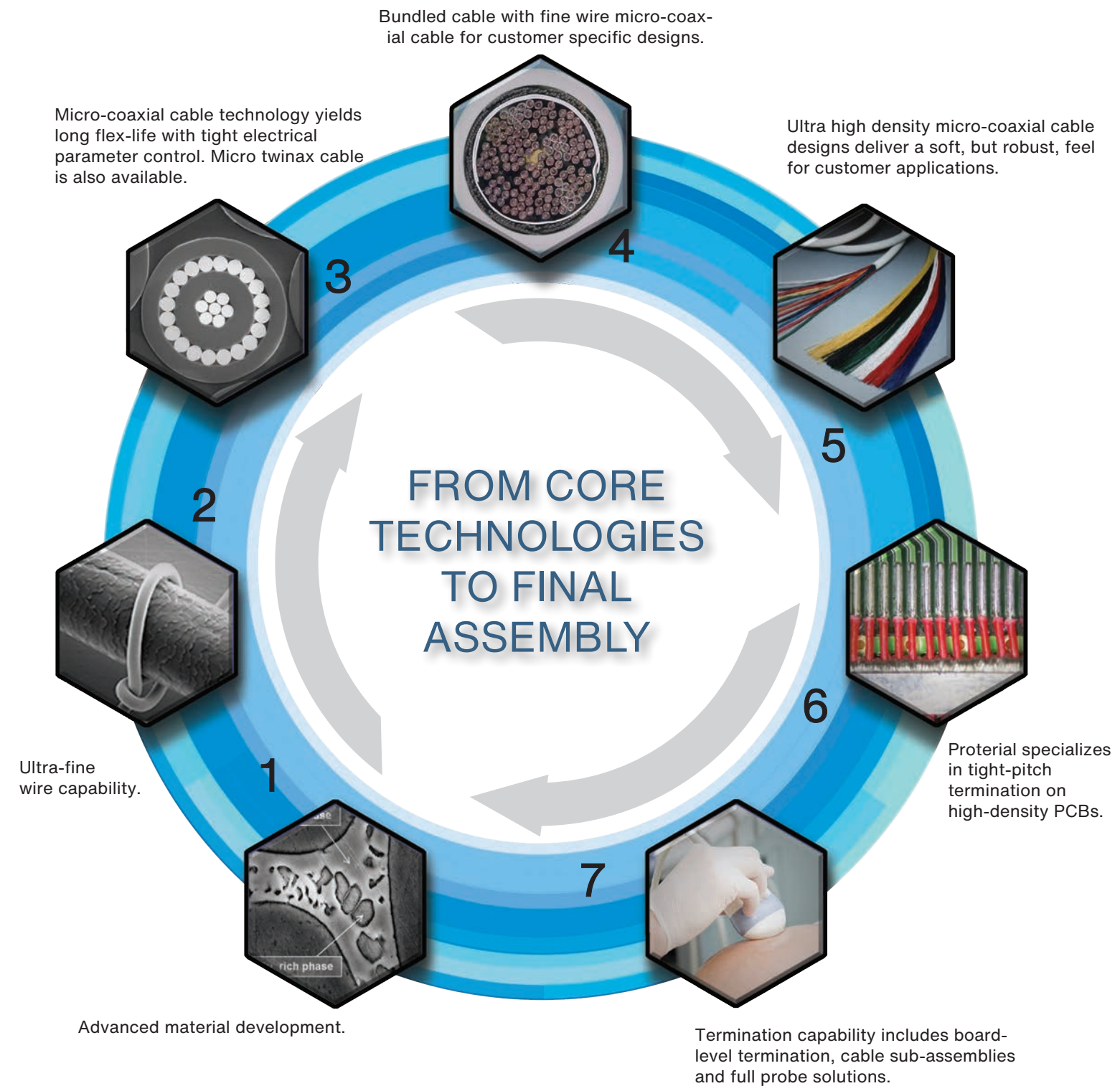
- SONOEASE®, a bundling technology offering softer and superior flexibility/limpness to reduce operator fatigue and increase the product life cycle.
- Our HiFC® alloy provides improved conductivity when required.
- Our 48 gauge (AWG) low capacitance coax is among the smallest in the industry.
- Our new non-tacky silicone jacketing offers unsurpassed performance for harsh environment and sterilization requirements.
- 50 gauge (AWG) coax, 46 gauge (AWG) STP/UTP designs and Twinax as small as 40 gauge (AWG) with alloys that outperform the competition.

Applications

- Ultrasound
- Endoscopy
- Non-destructive inspection



Cables & Assemblies Competencies



In addition to our core technologies identified above, Proterial Cable America also offers expert design services which include concept development, rapid prototyping, CAD and Solid modeling.



PCA Technologies



Material

The control of metallurgical microstructures with an in-depth study of thermal and mechanical influences is essential to realizing a High-Strength / High-Conductivity conductor. It is because of our advanced analytical techniques and broad experience that we have become a leader in high performance materials.



Design

When it comes to custom specifications, we have the materials and expertise to produce highly unique designs. Our cable development team can quickly predict with a degree of high accuracy the success of a specific design. In doing so, we can reduce lead times and minimize waste, all while creating novel characteristics that satisfy the need.



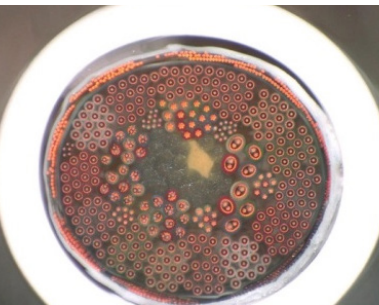
Extruding

The determining factor in the performance of a micro-coaxial cable is the state of the insulation layer. Low capacitance coaxial cable relies on the precise extrusion of the foamed PFA material. 50AWG coaxial cable cannot be produced without tight controls on ultra-thin PFA. Therefore, the stable characteristics of our cables are created by precisely controlling the extrusion process.



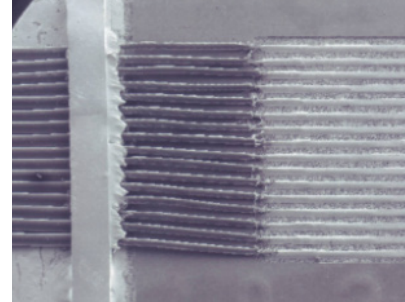
Cable Test

We possess specialized cable test equipment to evaluate and confirm product reliability ranging from the flex testing machines evaluating the mechanical characteristics of flex and twist resistance, to the laboratory devices required for measuring the electrical characteristics such as capacitance and impedance.



Cabling

To achieve the targeted characteristics, it is imperative to control the raw materials as well as the processes from beginning to end. Thermal and tensional conditioning along with spatial adherence is paramount and is applied at every stage of production to build a cable that not only meets but often exceeds the engineered intent.



Assembly

Terminating a cable is sometimes just as challenging as making one. Often, the finer a coaxial cable becomes, the narrower the soldering pitch needs to be. We encourage our customers to involve Proterial early in the design so that these termination considerations are taken into account. Through dialogue we can advise of suitable polymers and lead-free solder, or other processes, for the assembled structures. If customers desire, we can manage both assembly and final product packaging in our controlled facilities.



Micro-Coaxial Cable

Micro-Coaxial Cable is used in a wide array of precision medical products and cabling applications, where limited space, high-reliability, high-sensitivity and outstanding signal, capacitance and impedance characteristics are important. Micro-coaxial cable is ideal for ultrasound probes, catheters, endoscopy, oximetry systems, sensors, robotics and industrial automation and inspection. We offer a full range of standard sizes from **32 to 50 gauge (AWG)** using high-strength silver-plated or tinned-copper alloys that are rated to +200°C. Our micro-coaxial cable is a market leader due in part to our proprietary high-strength alloys with outstanding low-loss characteristics. PFA dielectric and jacket material provide stable properties for outstanding signal integrity, low loss, and consistent controlled impedance resulting in smaller diameter cables with improved flexibility and life. Our precision cabling technology enables our customers to use complex bundles while providing size and performance advantages without compromising on today's Healthcare or Industrial standards.

At Proterial, we offer a wide range of turn-key design and manufacturing support. Whether buying bulk cable or receiving a completely manufactured assembly, we are perfectly positioned to meet your needs.

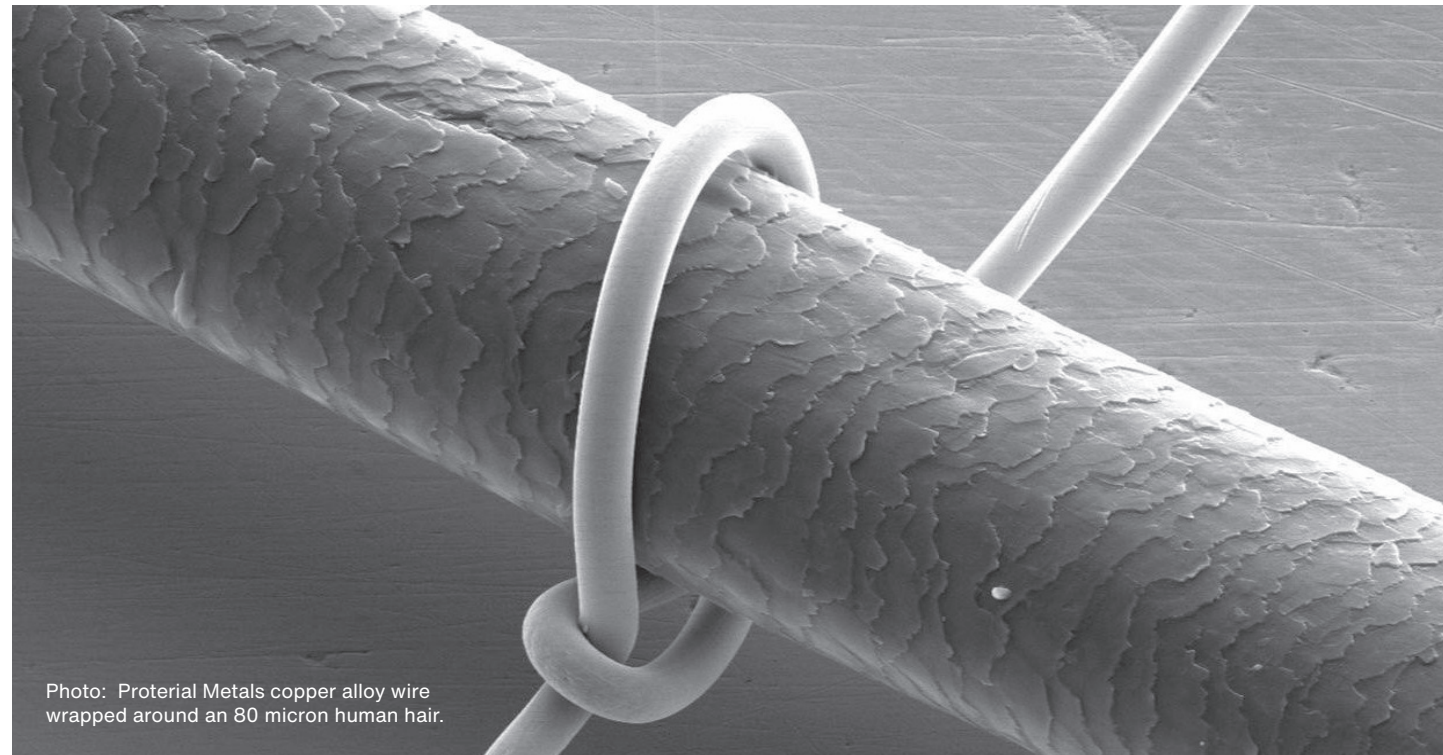


Photo: Proterial Metals copper alloy wire wrapped around an 80 micron human hair.

Features & Benefits

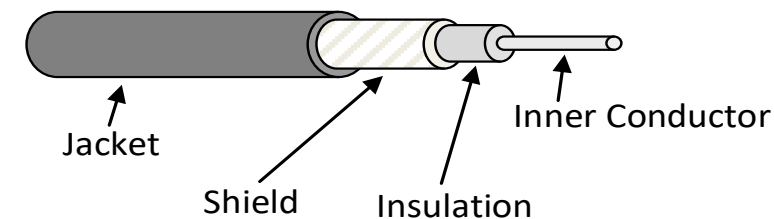
- Micro diameter and light weight
- Excellent heat resistance and electrical characteristics with fluorocarbon polymer insulation
- Excellent mechanical strength and flexible performance with copper alloy conductor
- Custom designs for bundled cables are available upon request



High Capacitance Micro-Coaxial Cable

PCA offers a broad selection of copper alloy wire with precision wire gauges ranging from 36 to 50 gauge (AWG). These superfine, high strength, highly conductive 7 strand constructions are useful for small diameter flexible cables. We offer standard 50 & 60 Ohm impedance products. **Please call if alternate constructions are required.**

Coaxial Product Number	Inner Conductor		Conductor DCR@20°C Ω/kft (Ω/km)	Insulation Material	Shield Material	Jacket		Capacitance pF/ft. (pF/m)	Impedance @10MHz (Ω)						
	AWG (Stranding)	Material				Material	Diameter Inch (mm)								
5361-110	36 (7/44) (7/0.05 mm)	Tinned Copper	479 (1,569)	PFA2	Tinned Copper	PFA2	0.021 (0.54)	33.6 (110)	50						
5381-110	38 (7/46) (7/0.04 mm)	Tinned Copper Alloy	1,007 (3,300)				0.017 (0.44)								
5382-110		HiFC®	6101 (2,000)												
5401-110	40 (7/48) (7/0.031 mm)	Tinned Copper Alloy	1,525 (5,000)				Tinned Copper Alloy			Polyester tape3 or PFA2	0.013 (0.32)				
5402-110		HiFC®	9751 (3,200)		0.012 (0.31)										
5411-110	41 (7/49) (7/0.028 mm)	Silver Plated Copper Alloy	1,525 (5,000)		0.011 (0.29)										
5421-1104	42 (7/50) (7/0.025 mm)		2,227 (7,300)		0.011 (0.27)										
5431-110	43 (7/51) (7/0.023 mm)		2,288 (7,500)		0.010 (0.24)										
5441-110	44 (7/52) (7/0.02 mm)		3,203 (10,500)		0.009 (0.22)										
5451-110	45 (7/53) (7/0.018 mm)		3,752 (12,300)		PFA2	PFA2					0.008 (0.20)	35.1 (115)			
5461-1154	46 (7/54) (7/0.016 mm)		4,728 (15,500)								0.007 (0.17)	36.6 (120)			
5481-1204	48 (7/56) (7/0.012 mm)	Silver Plated Copper Alloy	7,010 (23,000)		Silver Plated Copper Alloy	PFA2					0.006 (0.15)	38.1 (125)			
5501-1254	50 (7/58) (7/0.01 mm)		11,430 (37,500)												
5401-090	40 (7/48) (7/0.031 mm)		Silver Plated Copper Alloy				1,525 (5,000)			PFA2	Tinned Copper Alloy	Polyester tape3	0.015 (0.37)	27.5 (90)	60
5411-090	41 (7/49) (7/0.028 mm)						1,525 (5,000)						0.014 (0.35)		
5421-090	42 (7/50) (7/0.025 mm)	2,227 (7,300)			0.013 (0.32)										
5431-090	43 (7/51) (7/0.023 mm)	2,288 (7,500)		0.012 (0.3)											
5441-090	44 (7/52) (7/0.02 mm)	3,203 (10,500)		0.011 (0.27)											



Note: Custom designs available.

1 HiFC® = Proterial Fine Copper

- HiFC® is a new generation of pure copper with a high conductivity, the same as that of a high purity 6N copper. This results in a cable with lower resistance and 20% improvement in attenuation but the bend life is reduced as compared to our standard copper alloy.

- HiFC® is a registered trademark of Proterial Metals, Ltd in Japan.

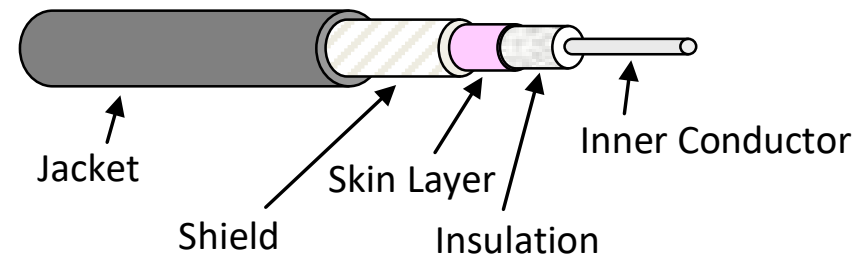
2 PFA = Perfluoroalkoxy

3 Polyester tape is standard for the part numbers shown. PFA Jacketed versions are available under alternate part numbers not listed here.

4 Part numbers shown in red are items that we typically stock, all other part numbers shown throughout the catalog are built to order with standard MOQs and lead times.

Low Capacitance Micro-Coaxial Cable

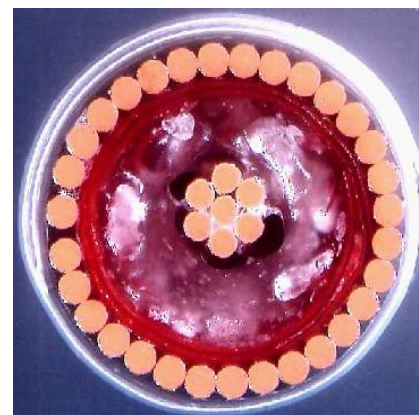
Proterial's advanced foam PFA extrusion process delivers low capacitance cable with reliable performance. We utilize a polyester tape skin over the foam to deliver the dielectric withstand voltage required by the medical industry. 38 AWG to 48 AWG wire sizes are available. These are 70, 75, and 85 Ohm impedance cables.



Coaxial Product Number	Inner Conductor		Conductor DCR@20°C Ω/kft (Ω/km)	Insulation Material	Shield Material	Jacket		Capacitance pF/ft. (pF/m)	Impedance @10MHz (Ω)
	AWG (Stranding)	Material				Material	Diameter Inch (mm)		
5381-060	38 (7/46) (7/0.04 mm)	Silver Plated Copper Alloy	1,007 (3,300)	Cellular PFA (+Polyester tape skin)	Tinned Copper Alloy	Polyester tape	0.021 (0.54)	18.3 (60)	75
5401-060	40 (7/48) (7/0.03 mm)		1,525 (5,000)				0.016 (0.41)		
5411-060	41 (7/49) (7/0.028 mm)		1,525 (5,000)				0.014 (0.36)		
5421-0601	42 (7/50) (7/0.025 mm)		2,227 (7,300)				0.013 (0.34)		
5431-060	43 (7/51) (7/0.023 mm)		2,288 (7,500)				0.012 (0.31)		
5441-060	44 (7/52) (7/0.02 mm)		3,203 (10,500)				0.011 (0.28)		
5461-0601	46 (7/54) (7/0.016 mm)		4,728 (15,550)				0.01 (0.25)		
5481-070	*48 (7/56) (7/0.013 mm)		7,010 (23,000)				PFA with Airspace Aperture (+Polyester tape skin)		
5401-050	40 (7/48) (7/0.03 mm)	Silver Plated Copper Alloy	1,525 (5,000)	Cellular PFA (+Polyester tape skin)	Tinned Copper Alloy	Polyester tape	0.019 (0.47)	15.3 (50)	85
5411-050	41 (7/49) (7/0.028 mm)		1,525 (5,000)				0.016 (0.4)		
5421-050	42 (7/50) (7/0.025 mm)		2,227 (7,300)				0.016 (0.41)		
5431-050	43 (7/51) (7/0.023 mm)		2,288 (7,500)				0.014 (0.35)		
5441-050	44 (7/52) (7/0.02 mm)		3,203 (10,500)				0.013 (0.32)		

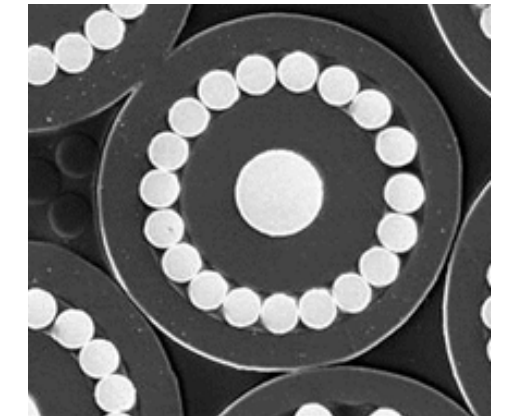
Note: Custom designs available.
 1Part numbers shown in red are items that we typically stock, all other part numbers shown throughout the catalog are built to order with standard MOQs and lead times.

*48 gauge (AWG - American Wire Gauge)
 Our newly developed coaxial cable for medical applications uses multiple fluorocarbon polymer monofilaments as a wrapped insulation layer surrounding the wire as opposed to the foam fluorocarbon polymer extruded directly over the wire. Our new product will make such medical devices as ultrasound diagnostic equipment and endoscopes more user-friendly and capable of producing higher-definition diagnostic images. We will continue to introduce new wire and cable products for medical applications that advance state-of-the-art medical technology. 50 gauge (AWG) is currently under development, call for more information.



Solid Conductor Coaxial Cable

Proterial solid conductor constructions combine all the attributes of the stranded wire coaxials while offering a slightly smaller diameter with improved current carrying capacity, and lower loss.



Features & Benefits

- High Capacitance
- Various solid conductor sizes : 40 through 50 gauge (AWG)
- Custom designs to suit specific requirements

Coaxial Product Number	Inner Conductor		Conductor DCR@20°C Ω/kft (Ω/km)	Insulation Material	Shield Material	Jacket		Capacitance pF/ft. (pF/m)	Impedance @10MHz (Ω)
	AWG (Solid)	Material				Material	Diameter Inch (mm)		
5403-110	40 (1/40) (1/0.08 mm)	Silver Plated Copper Alloy	1,372 (4,500)	PFA	Silver Plated Copper Alloy	Polyester Tape (0.02 mm Thick)	0.013 (0.33)	33.6 (110)	50
5423-110	42 (1/42) (1/0.064 mm)		2,134 (7,000)				0.011 (0.274)		
5443-110	44 (1/44) (1/0.051 mm)		3,353 (11,000)				0.009 (0.221)		
5463-115	46 (1/46) (1/0.040 mm)		5,395 (17,700)				0.007 (0.19)		
5483-120	48 (1/48) (1/0.030 mm)		9,601 (31,500)				0.006 (0.156)		
5503-125	50 (1/50) (1/0.025 mm)		13,868 (45,500)				0.005 (0.139)		

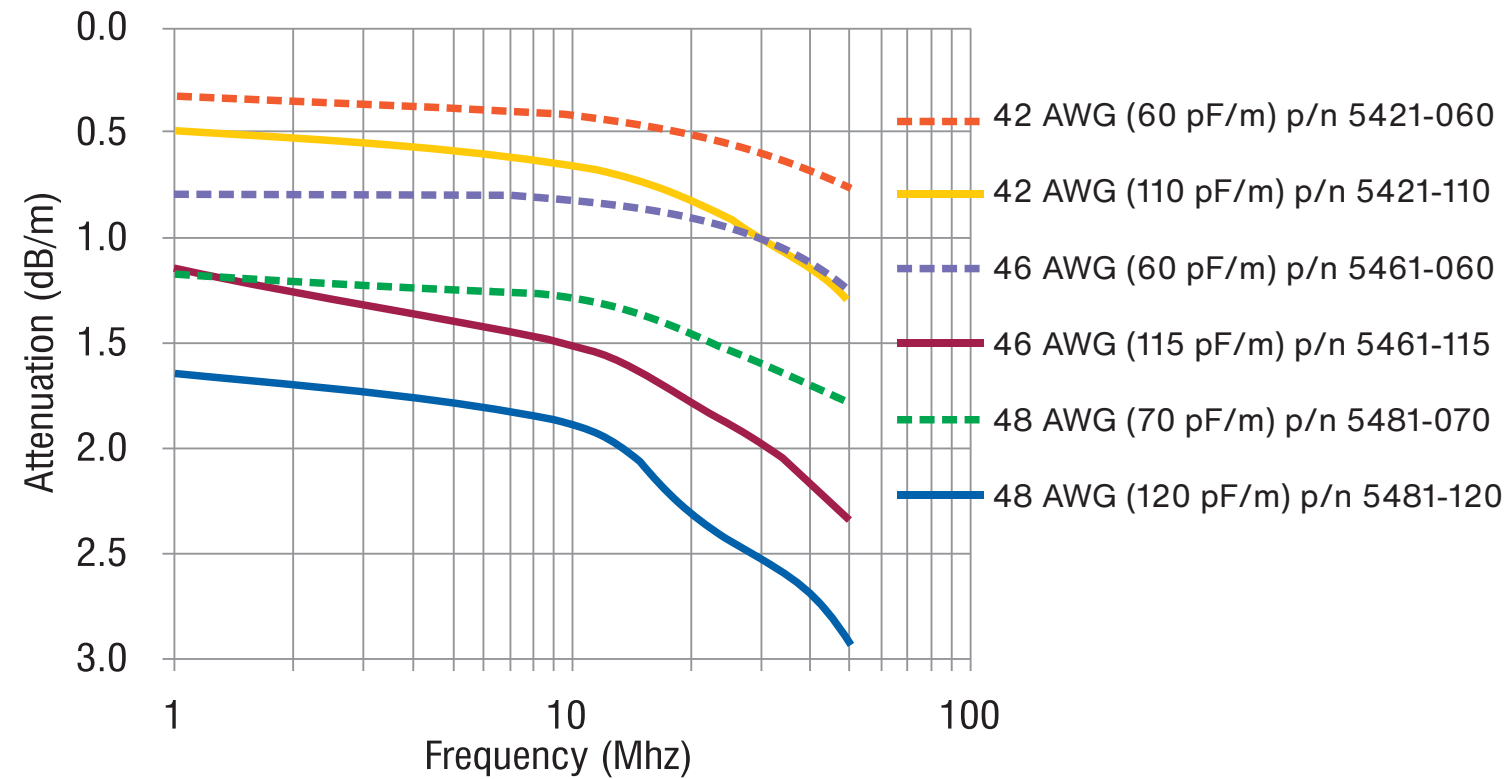
Comparison of Proterial Conductors vs Industry Conductors

	Composition	Breakdown Tensile Strength (Mpa)	Electrical Conductivity (% IACS)	Bending Repetitions (# Times)	AWG Size	Conductor (Strands / Wire Dia. Um)	Standard Conductor Resistance (ohm/km)	
							NN	S-MF-AG
NN (Proterial Standard)	Cu-0.19% Sn -0.20% In	890	76	1.2x104	43	43 (7/51) (7/0.023 mm)	7,500	6,700
S-MF-AG* Proterial-High Performance	Cu-2.0 % Ag	950	85	1.2x104	44	44 (7/52) (7/0.20 mm)	9,800	8,900
Conventional Industry Alloy A	Cu-0.3 % Sn	875	73	1.1x104	45	45 (7/53) (7/0.018 mm)	12,300	11,000
Conventional Industry Alloy B	Cu-0.8 % Cr	460	90	6.0x103	46	46 (7/54) (7/0.016 mm)	15,500	14,000
Conventional Industry Alloy C	Cu-Be-Ni-Co	895	40	8.5x103	48	48 (7/56) (7/0.012 mm)	23,700	21,500
					50	50 (7/58) (7/0.10 mm)	N/A	35,500

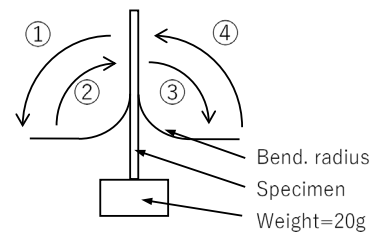
*10% resistance BENEFIT when using the S-MF-AG (high-strength/high conducting) alloy vs. the NN (standard).

Micro-Coaxial Performance

The chart below is a useful tool for understanding the behavior of a single coaxial (with 7 strand conductors) in relation to size, group bundling, frequency and flex life.



Item	48 AWG (7/56) (7/0.012 mm) (120 pF/m)	46 AWG (7/54) (7/0.016 mm) (115 pF/m)	48 AWG (7/56) (7/0.012 mm) (70 pF/m)	46 AWG (7/54) (7/0.016 mm) (60 pF/m)
Diameter of micro-coaxial	.006 in (0.165 mm)	.008 in (0.195 mm)	.0085 in (0.215 mm)	.010 in (0.250 mm)
Cable Diameter (128 micro-coaxials)	.122 in (3.1 mm)	.138 in (3.5 mm)	.150 in (3.8 mm)	.169 in (4.3 mm)
Characteristic impedance (at 10 MHz)	50 Ω	50 Ω	70 Ω	75 Ω
Capacitance (at 1 kHz)	120 pF/n	115 pF/n	70 pF/n	60 pF/n
Inner Conductor Resistance	21.5 Ω/m	14.5 Ω/m	21.5 Ω/m	14.5 Ω/m
Attenuation (at 10 MHz)	2.1 dB/m	1.45 dB/m	1.3 dB/m	0.85 dB/m
Attenuation (at 50 MHz)	2.9 dB/m	2.35 dB/m	1.8 dB/m	1.25 dB/m
+/- 90 degrees bend test (Radius = 2 mm)	Over 500k cycles	Over 500k cycles	Over 500k cycles	Over 500k cycles



The image above illustrates flex testing using the "tick-tock" test configuration.

Bundled Cable

A number of micro-coaxials are bundled for ultrasound probe cable. Typical design specifications should include the style of coax, the number of coax, the shield configuration, flexibility requirements, type of sheath and sheath color. Custom designs are also available upon request.

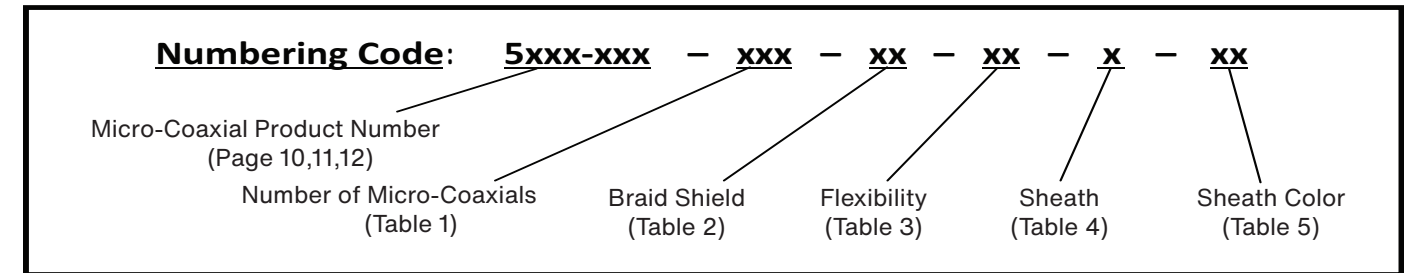
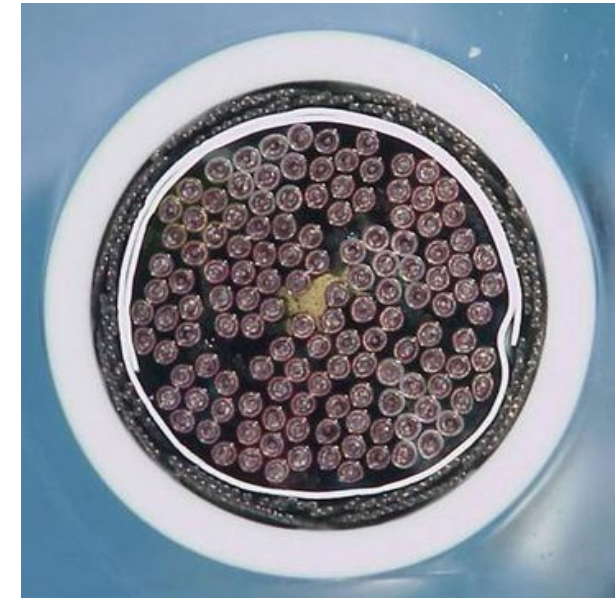
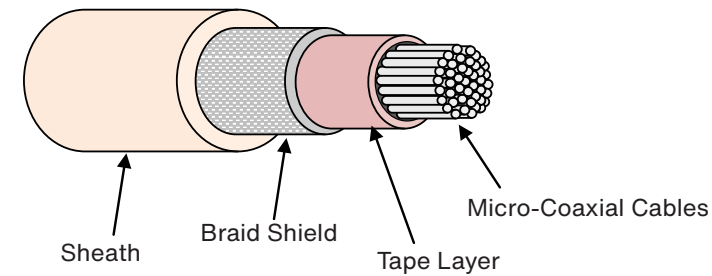


Table 1: Number of Micro-Coaxials

18, 34, 64, 68, 96, 128, 192

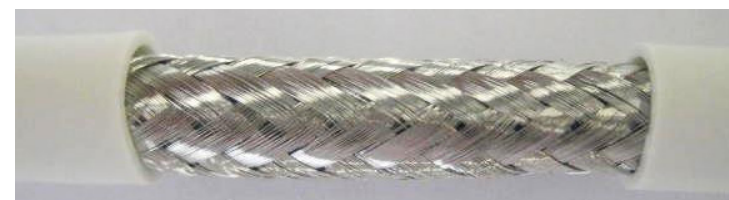
Note: 18, 34, 68, 132 conductor cables utilize a urethane outer jacket. Add 0 to front of 2 digit quantities when building part number. Ex: 18 = 018

Table 2: Braided Shield

Code	Material	Coverage %	Bend/Twist Lift Test*	Advantage
CA	Tinned Copper Alloy	90%	300k cycles<	Low cost
NN	Tinned Proterial Metals NN High-Strength Copper	90%	300k cycles<	High strength (>850MPa)
SX	Tinned SX**	95%	300k cycles<	Most Flexible

*Bend Radius equals 3x the cable diameter utilizing a 500g weight. Twist equals 300mm length utilizing a 500g weight.

**Tinned spiral wrapped tinsel copper conductor.



High Strength NN alloy braid shield



Highly Flexible SX braid shield

Bundled Cables Continued

Table 3: Cable Flexibility

CODE	Flexibility / Limpness - (less resistance to bending / conforming to gravity)
SE	SonoEase®, highly flexible (PVC Only and not available with NN braid)
HS	High Standard, very flexible (Diameter consistent with Standard diameter)
ST	Standard, average flexibility

Table 4: Sheath (jacket) Material

CODE	Material	Operating Temperature	Advantage	Application
P	PVC	-10 to 60°C	Low cost	Medical
U	TPU	-40 to 100°C	Resists cut through, abrasions, chemicals & solvents	Medical, Industrial
S	Silicone Rubber	-60 to 120°C	Resists most stains and is easy to clean	Surgical
SS	Non-Sticky Silicone Rubber	-60 to 120°C	WNon-stick surface provides reduced friction and ease of cleaning	Surgical

Table 5: Sheath Color

Color Code	
PVC	(IV) Ivory, (BK) Black
Polyurethane	(WH) White, (BK) Black
Silicone Rubber	(IV) Ivory, (GR) Gray
Non-Sticky Silicone Rubber	(IV) Ivory, (GR) Gray

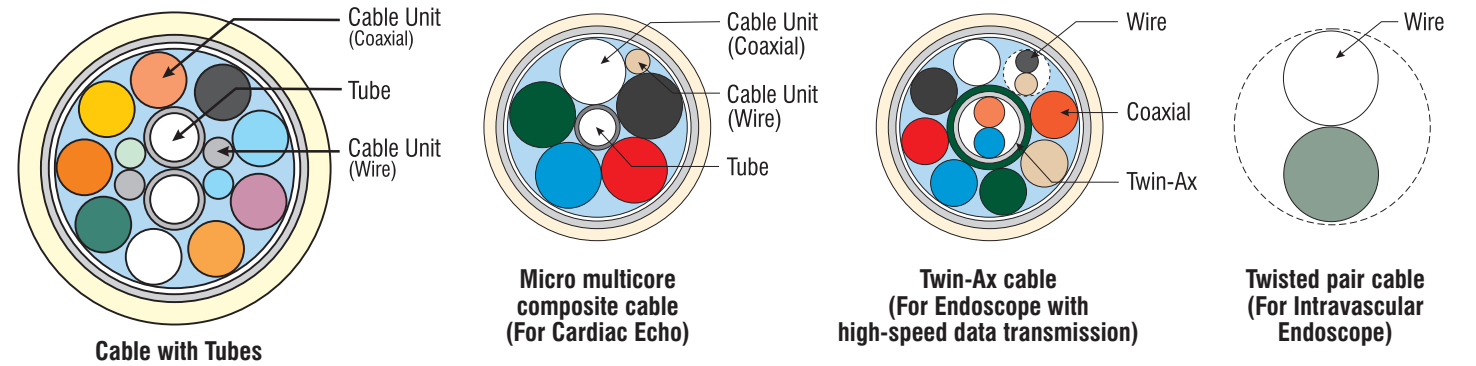
Examples of Bundled Cable

Coaxial Product Number	Inner Conductor AWG (Stranding)	Jacket Diameter Inch (mm)	Capacitance pF/ft (pF/m)	Number of Coax	Braid Shield Material	Cable Flexibility (Limpness)	Sheath (Jacket)		
							Material	Color	Diameter Inch (mm)
5401-110-064-CA-ST-P-IV	40 (7/48) (7/0.031 mm)	0.013 (0.32)	33.6 (110)	64	Tinned Copper Alloy	Standard	PVC	Ivory	0.220 (5.6)
5401-110-096-CA-ST-P-IV				96					0.248 (6.3)
5401-110-128-CA-ST-P-IV				128					0.272 (6.9)
5401-110-192-CA-ST-P-IV				192					0.303 (7.7)
5441-060-064-SX-SE-P-BL	44 (7/52) (7/0.02 mm)	0.011 (0.27)	18.3 (60)	64	Tinned SX	SonoEase®*	PVC	Black	0.216 (5.5)*
5441-060-192-SX-SE-P-BL				192					0.295 (7.5)*
5501-125-064-SX-HS-P-IV	50 (7/58) (7/0.01 mm)	0.005 (0.14)	38.1 (125)	64	Tinned SX	High Standard	PVC	Ivory	0.075 (1.9)
5501-125-096-SX-HS-P-IV				96					0.087 (2.2)

*The diameter of SonoEase® cable will be about 0.5mm larger than the Standard cable. SonoEase® is a registered trademark of Proterial Metals, Ltd in Japan.

Cable for Specific Usage

The applications for medical probe cables, typically used in ultrasound diagnostic apparatus, can be expanded to other medical equipment such as endoscopes, catheters, and animal probes. Proterial Cable offers customized cable to meet specific needs depending on the application or equipment.



Fine Wire for Surgical, Catheter & Endoscopy

Our high strength micro-coaxial cable with ultra-thin medical grade jacketing is the optimal solution for advanced catheter applications.

Features & Benefits

- Various lineup of micro-coaxial and twinaxial cable:
- ~50 gauge (AWG) minimum
- Ultra-thin fluorine resin PFA jacket: ~15µm minimum available
- Ultra-accurate extrusion & cabling technology
- Custom designs available



Catheter Cable (OD = 280µm, 46 AWG conductor, 0.02 mm thick PFA jacket KZ10-333A)

Hybrid Bundled Cables

Our bundles can include many different styles of cables in addition to micro-coaxial cable. Proterial offers various tubing for air or fluidics, specialty optical fiber for data and power transport, or just basic data and power copper wiring. We custom design each cable for whatever evolving and demanding need occurs. Hybrid bundling of a multi-function cable is also available.

Features & Benefits

- Various coaxial/twinaxial cable, data cables, tubes, fiber optic and power wires available
- Accurate extrusion & cabling technology
- Multi-layered cable capability
- Custom designs available



4D Ultrasound Cable with Air-cooling Tube (non-migration PVC, 9.8 mm O.D., 0.9 mm thick, SP06-23-53005)





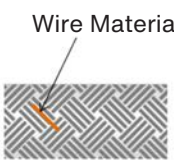
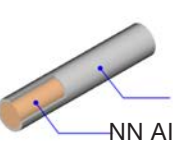
Industrial Endoscope Cable (non-migration PVC, 9.7 mm O.D., 0.9 mm thick, KZ09-138F)

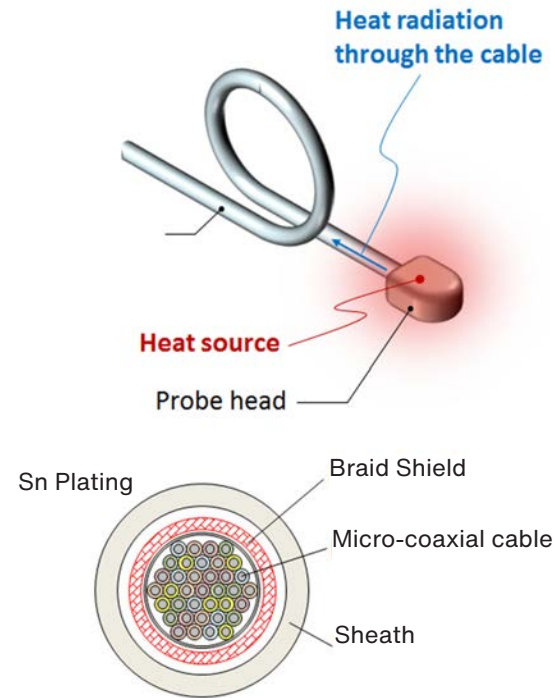
NOTE: Medical Grade Cables meet Biocompatibility requirements: USP Systemic Toxicity, USP Intracutaneous Toxicity, ISO Sensitization, Pyrogen, and Cytotoxicity.

Methods for Reducing Thermal Resistance

Thermal Management of Medical Cables and Devices is becoming increasingly challenging and critical to the reliability and usability of advanced surgical, imaging and implantable devices. As the trend for lighter, smaller and more operable cables continues so will the trend for finer wire with increased coaxial counts. This will drive the ongoing need for improved cable and device thermal management. When designing a cable, the shield design can have a significant impact on thermal resistance. Secondly, an improved shield can be further improved with a proper thermal connection. Contact Proterial for additional support to maximize your design's performance.

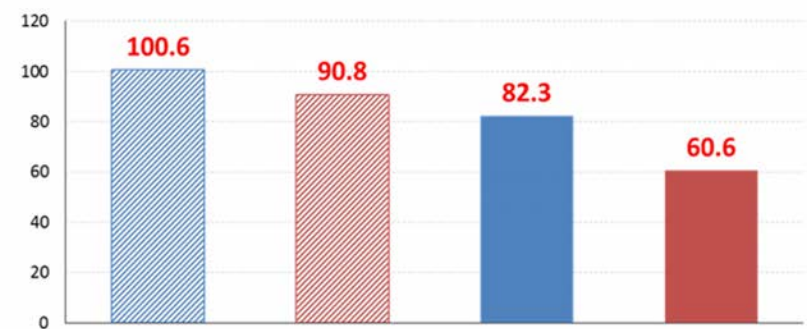
Construction of Cable:

Tested Cable	#1 (SX shield)	#2 (SB shield)
Photo of probe cable		
Braid Shield Material	SX Braid shield Tinsel wire	SB Braid shield Tinned copper alloy
Wire Material	 Cu Foil Nylon Fiber (Strand Number:208)	 NN Alloy (Strand Number:256)



Thermal Resistance Reduction

	Without thermal connection of shield material		With thermal connection of shield material	
	SX	SB	SX	SB
Heat conduction coef λ [W/mK]	6.1	7.0	18.5	34.1
Heat transfer coef h [W/m ² K]	17.6	18.9	17.5	17.5



Single Lead Wire

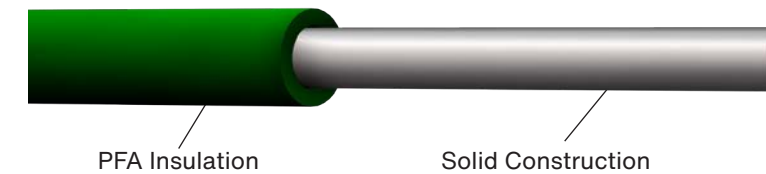
In addition to micro-coaxial cable, Proterial offers high performance single lead wire which is at the heart of our micro-coaxial cable line. Providing extremely thin wall PFA and our standard alloy materials, our lead wire offers the same exceptional characteristics that customers have come to expect.



Physical Construction Description

Insulated hook-up wire, consisting of 1 conductor, unshielded and unjacketed made with PFA.

Single Lead Wire Product Number	Inner Conductor		Conductor DCR@20°C Ω/kft (Ω/km)	Insulation Material	Diameter Inch (mm)
	AWG (Stranding)	Material			
ME-PFA 1X36 AWG	36 (7/44) (7/0.05 mm)	Tinned Annealed Copper	479 (1,572)	PFA	.010 (0.26)
ME-PFA 1X38 AWG	38 (7/46) (7/0.04 mm)	Tinned Copper Alloy	1,006 (3,300)		.008 (0.21)
ME-PFA 1X40 AWG	40 (7/48) (7/0.031mm)		1,524 (5,000)		.006 (0.16)
ME-PFA 1X41 AWG	41 (7/49) (7/0.028 mm)		1,524 (5,000)		.006 (0.155)
ME-PFA 1X42 AWG	42 (7/50) (7/0.025 mm)	Silver Plated Copper Alloy	2,286 (7,500)		.005 (0.135)
ME-PFA 1X43 AWG	43 (7/51) (7/0.023 mm)		2,286 (7,500)		.005 (0.13)
ME-PFA 1X44 AWG	44 (7/52) (7/0.02 mm)		3,200 (10,500)		.005 (0.12)
ME-PFA 1X45 AWG	45 (7/53) (7/0.018 mm)		3,749 (12,300)		.004 (0.11)
ME-PFA 1X46 AWG	46 (7/54) (7/0.016 mm)		4,724 (15,500)		.004 (0.095)
ME-PFA 1X48 AWG	48 (7/56) (7/0.012 mm)		7,315 (24,000)		.003 (0.085)
ME-PFA 1X50 AWG	50 (7/58) (7/0.01 mm)		11,430 (37,500)		.003 (0.075)



Single Lead Wire Product Number	Inner Conductor		Conductor DCR@20°C Ω/kft (Ω/km)	Insulation Material	Diameter Inch (mm)
	AWG (Stranding)	Material			
ME-PFA 1X40 AWG (1/0.08)	40 (1/40) (1/0.080 mm)	Silver Plated Copper Alloy	1,373 (4,500)	PFA	.0055 (0.14)
ME-PFA 1X42 AWG (1/0.064)	42 (1/42) (1/0.064 mm)		2,135 (7,000)		.005 (0.124)
ME-PFA 1X44 AWG (1/0.051)	44 (1/44) (1/0.051 mm)		3,355 (11,000)		.004 (0.101)
ME-PFA 1X46 AWG (1/0.04)	46 (1/46) (1/0.040 mm)		5,399 (17,000)		.003 (0.080)
ME-PFA 1X48 AWG (1/0.03)	48 (1/48) (1/0.030 mm)		9,608 (31,500)		.003 (0.070)
ME-PFA 1X50 AWG (1/0.025)	50 (1/50) (1/0.025 mm)		13,878 (45,500)		.0025 (0.065)

NOTE: Custom colors and adjustments in wall thickness available upon request.

Medical Twisted Pairs & Twinaxial Cables

Standard twisted pairs can be used for differential signal lines (putting equal but opposite voltage on each of the wires). This ensures that noise effects are significantly reduced. Twinaxial constructions have the pairs laid parallel to each other. This approach allows for very high bandwidth applications greater than that of common twisted pairs. They result in lower attenuation due to a shorter travel distance, better impedance characteristics and better control of skew within the pair. Typically twisted pairs reach their limits around ~2-4 Gbps while twinaxials can perform well

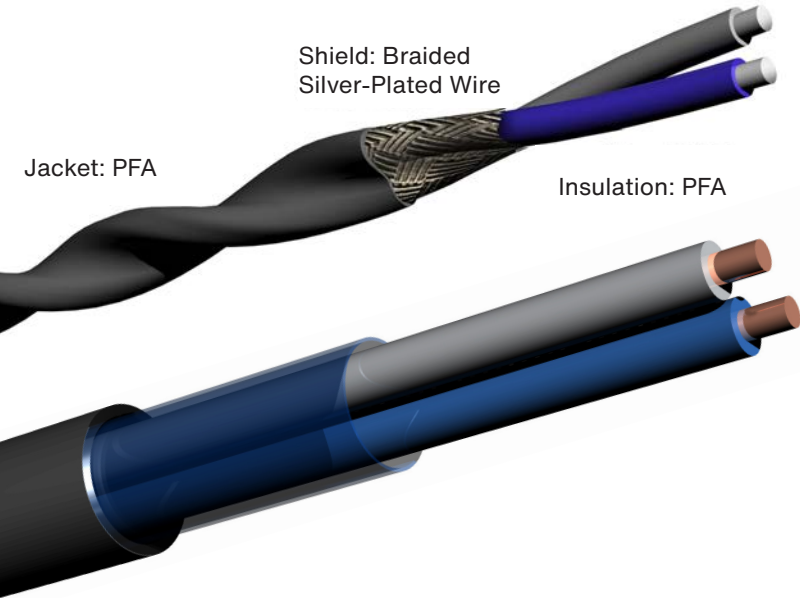
at higher transmission rates. Twinax signals on the other hand are especially good at 5 Gbps+ up to and as high as 25 Gbps / channel currently. Twisted pairs may have better flex characteristics over twinaxial designs.

Conductor:
Silver-Plated
Copper or Alloy

Shield: Braided
Silver-Plated Wire

Insulation: PFA

Jacket: PFA



Features & Benefits:

- Twisted quad cable available:
~48 gauge (AWG) minimum
- Solid conductor wire available:
Pair ~48 gauge (AWG) minimum
Quad ~46 gauge (AWG) minimum
- Custom designs available, call for design support

Cable Specification Examples:

	Structure		Inner conductor		Insulation	Pair	Shield	Jacket		Capacitance pF/ft. (pF/m)	Impedance @10MHz (Ω)
			AWG (Stranding) Material	DCR@20°C Ω/kft (Ω/km)		Diameter Inch(mm)	Material	Material	Diameter Inch(mm)		
1	Shielded Twinax	w/o Jacket	40 (7/48)	16,404 (5,000)	PFA	.008 x .016 (0.203 x 0.406)	6 Ends 46 AWG Hard Tin Copper	-	-	48 pF/m	100 +/- 5
2	Shielded Twinax	with Jacket	40 (7/48)			.008 x .016 (0.203 x 0.406)	6 Ends 46 AWG Hard Tin Copper	PET TAPE	.016 x .024 (0.406 x 0.610)	48 pF/m	100 +/- 5
3	Unshielded Twisted Pair	w/o Jacket	48 (7/56)	24,000 (7,230)	PFA	.007 (0.178)	-	-	-	TBD	TBD
4		with Jacket	7/0.013 mm			.007 (0.178)	-	PFA	.009 (0.229)	TBD	TBD
5	Shielded Twisted Pair		Silver plated copper alloy			.007 (0.178)	Silver plated copper alloy	PFA	.011 (0.279)	TBD	TBD
6	Unshielded Twisted Pair	w/o Jacket	50 (7/58) 7/0.01 mm	40,500 (12,370)	PFA	.0055 (0.14)	-	-	-	TBD	TBD
7		with Jacket				.0055 (0.14)	-	PFA	.008 (0.203)	TBD	TBD
8	Shielded Twisted Pair		Silver plated copper alloy			.0055 (0.14)	Silver plated copper alloy	PFA	.009 (0.229)	TBD	TBD

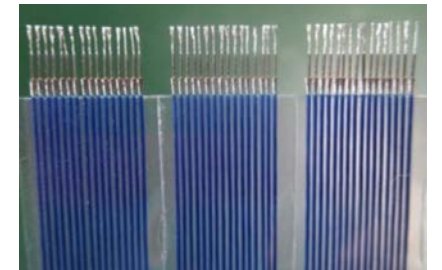
CABLE EXAMPLES

Assemblies

Proterial offers a broad range of additional assembly services and capabilities to meet your production needs. Our certified facilities offer RoHS compliance, conflict mineral verification, external biocompatibility testing and sterilization support if required. We also provide vendor managed inventory programs for critical production projects.

Stripping and Wire Preparation

- Fine gauge ribbonizing and small wire preparation from 36 gauge (AWG) to 50 Gauge (AWG) wire are in production with finer pitch wire under development
- Wires can be ribbonized on pitch
- Fine pitch configurations available
- Soldering and assembly services available



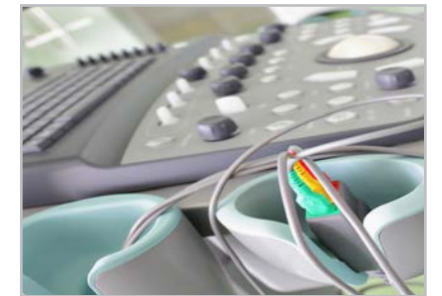
PCB & Component Assembly

- Flexible and rigid board designs as well as discrete components.
- Watertight sealing and device encapsulation
- Direct wire to board bonding or wire to connector assembly
- Fine pitch terminations down to 0.15 mm 50 gauge (AWG) wire with finer pitch under development
- Custom strip lengths available
- Custom Overmolding
- For disposable and reusable devices
- Standard medical grade materials available (PVC, TPE and TPU)
- Low-cost, Halogen free materials are available
- Two part overmold bonding and sealing expertise
- Customized connector bodies & logo pad printing available
- Proterial can work with a variety of standard off-the-shelf component and custom connector solutions



Full Assembly

- From simple to complex fully packaged assemblies
- Complete probes and devices
- Partial pigtailed cable assemblies also available for final customer termination
- Biocompatibility, sterilization and specialty coating support, available upon request



Test Expertise

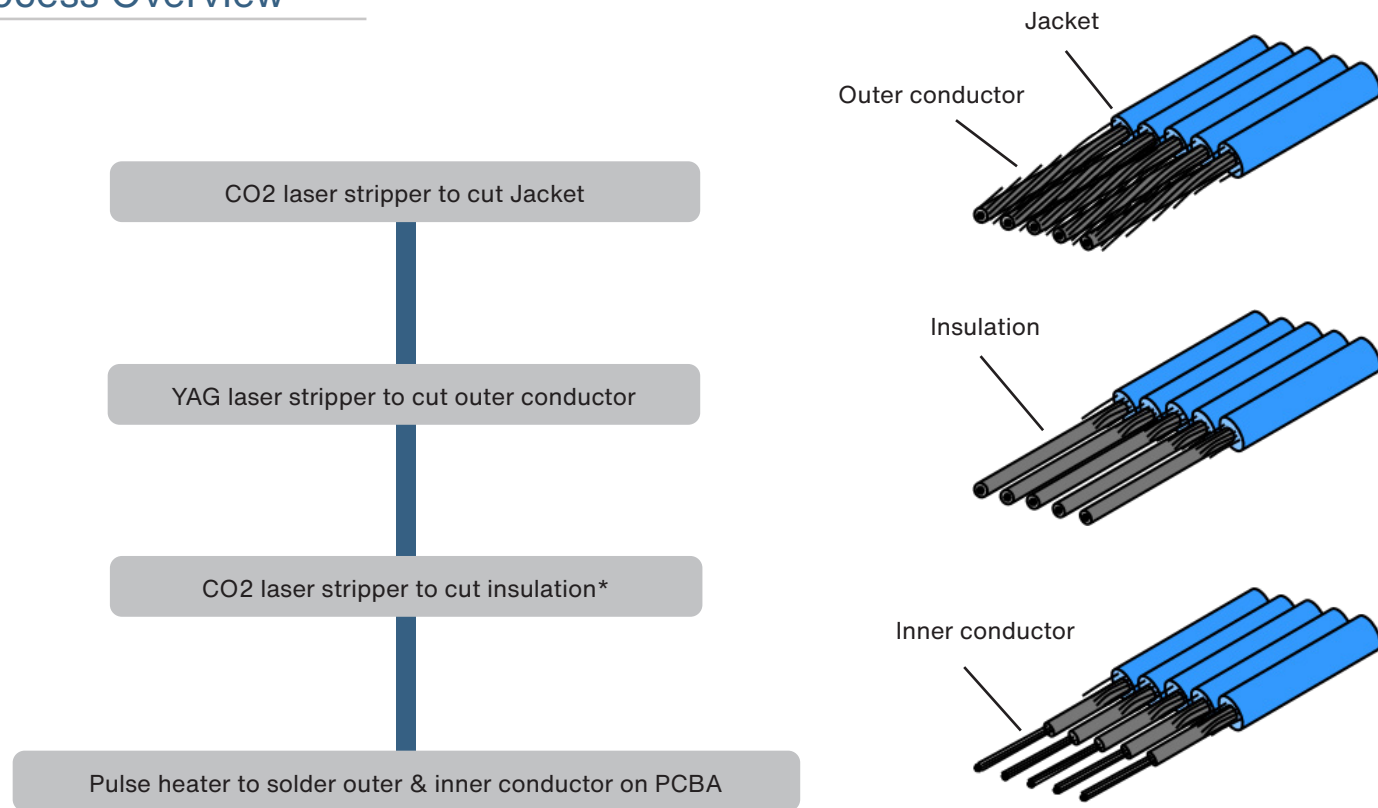
- Specialty testing & product validation
- Small to large volume capacity management
- Repeated in-line testing validation throughout the assembly process.



Wire Preparation & Drive Soldering

Working with fine gauge wire is not a trivial matter. It is critical that there is a consistent and precise process employed to guarantee maximum performance and quality. As the gauges grow larger and the wire gets smaller, the challenges can become extreme. Proterial has a long history of experience producing ultrasound cable assemblies and dealing with high volume, tight pitch, small wire applications. We can help you from cable preparation to final termination and we can recommend solutions for specific technical challenges.

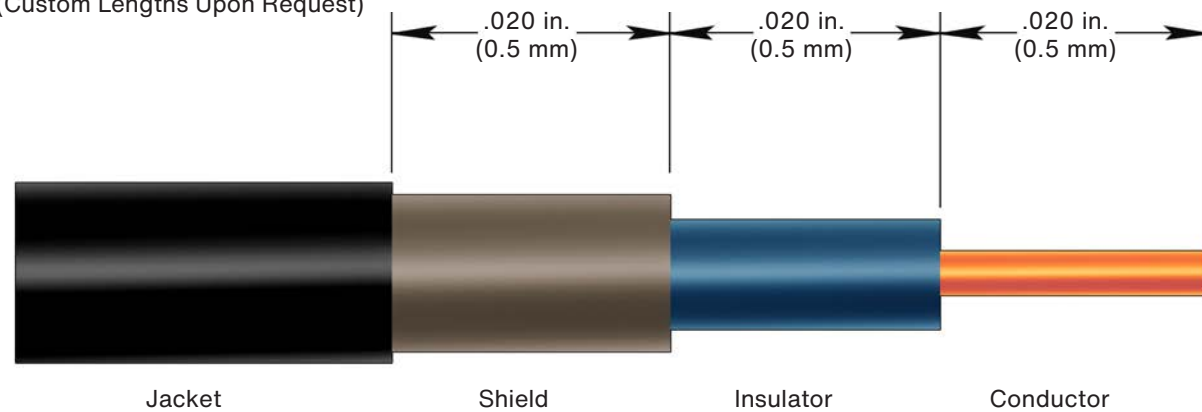
Process Overview



Note:

*The CO2 cut section is cleanly stripped off prior to soldering.

Typical
Prep Lengths
(Custom Lengths Upon Request)



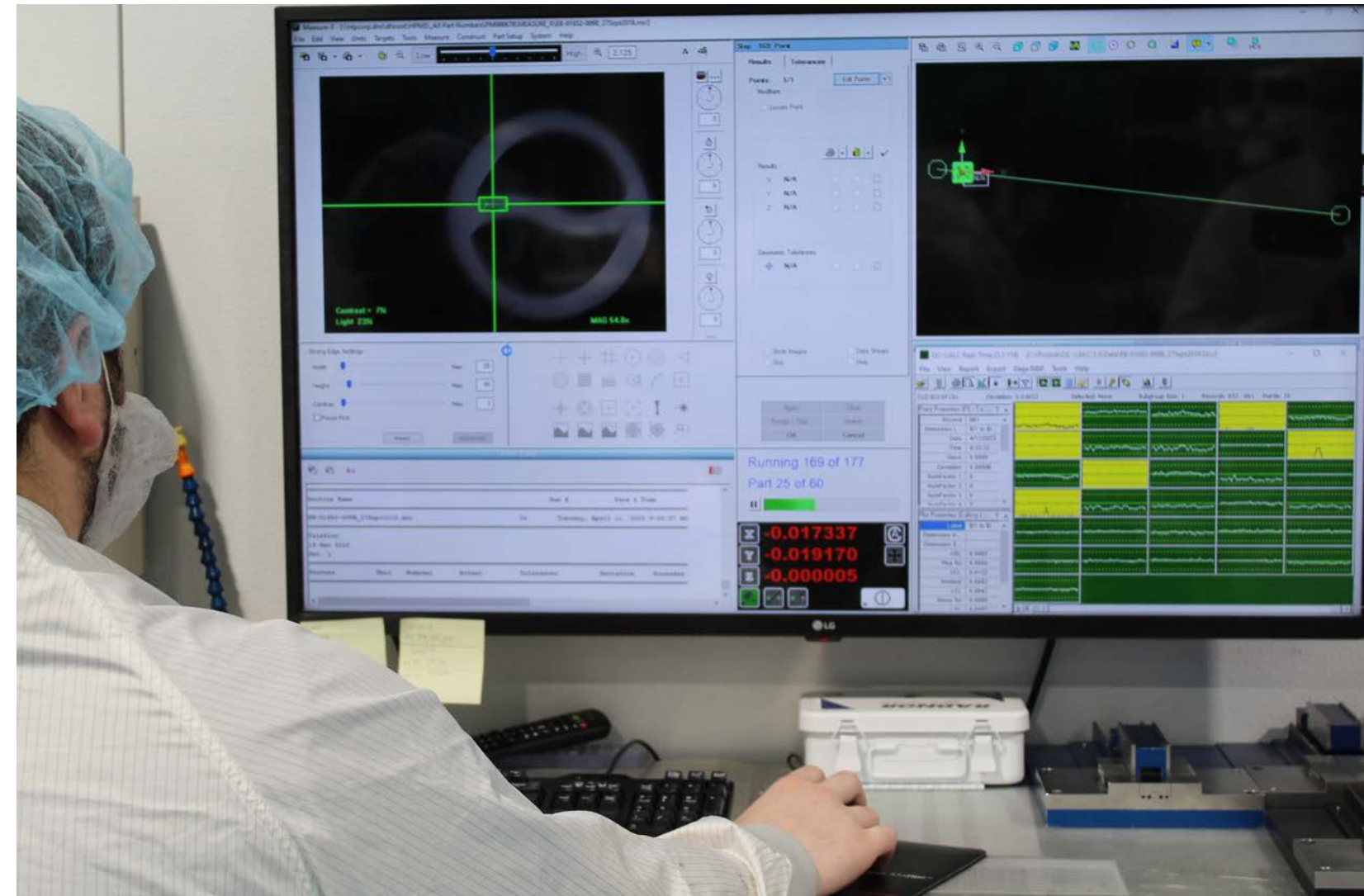
High Performance Medical Solutions

HPMS is a global contract manufacturer for Medical OEMs worldwide. With over 20 years of experience in the OEM value stream, we are dedicated to providing complete in-house medical tubing and cable solutions for surgical, catheter, endoscopy and ultrasound markets. Medical wire and tubing are vital components to many critical, life-saving devices.

We offer unrivaled expertise and vertical integration. At HPMS, we have over 30,000 sq. ft. of ISO Class 8 and ISO Class 9 cleanrooms. We ensure exceptional quality and compliance for every finished medical device component. Choose us for reliable and efficient contract manufacturing solutions.

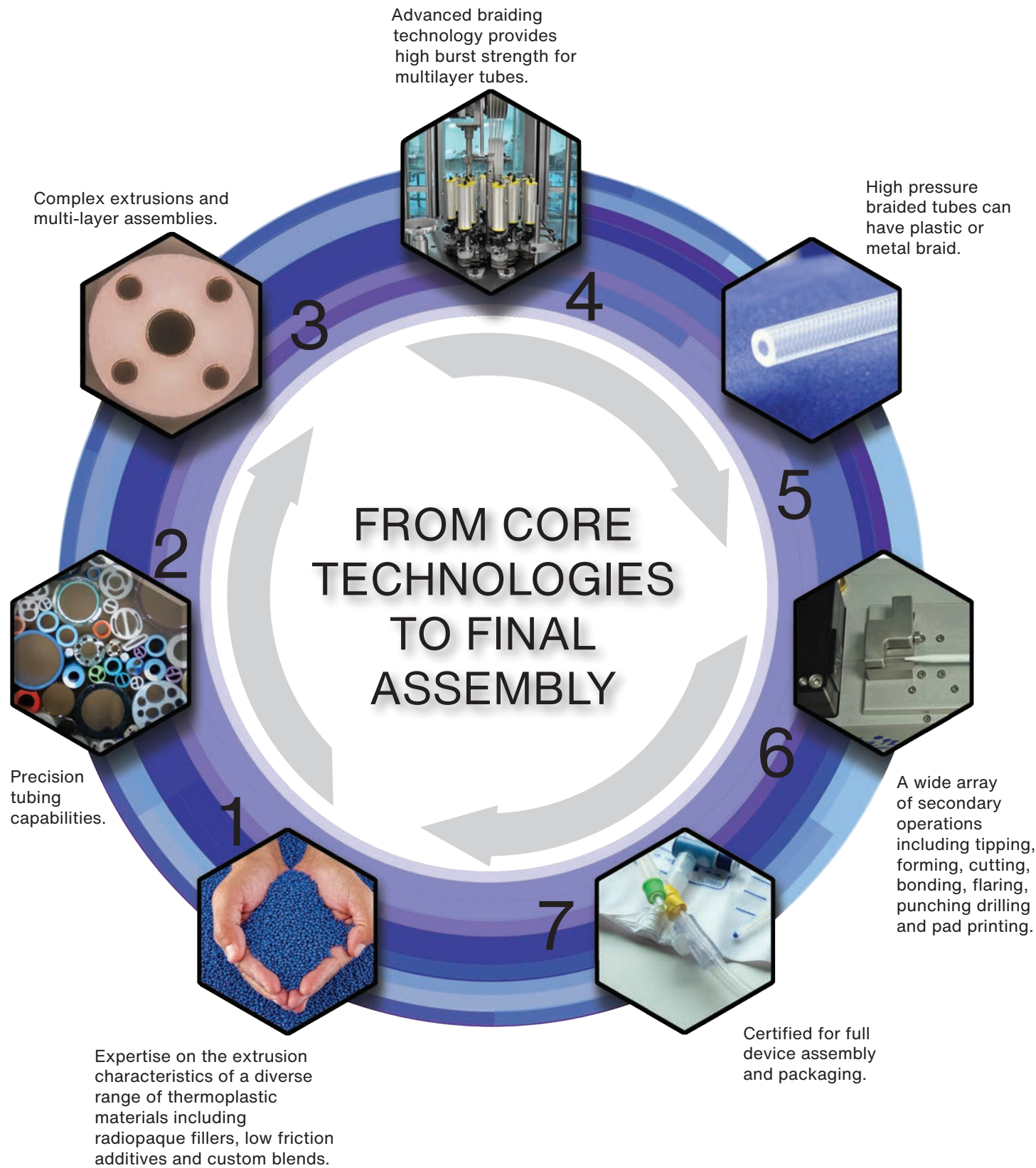
High Performance Medical Solutions (HPMS) offers a variety of complex and highly advanced tubing solutions with the ability to manufacture to the tight tolerances that today's minimally invasive designs require.

Our expertise at manufacturing bump tubes encompass the most simplistic, single lumen catheters, up to and including the most complex multi-lumen designs. We manufacture custom multi-lumen tubing built to your exact specifications. We utilize a vast assortment of medical grade compounds in multiple durometers, in almost any geometric configuration. Allow HPMS to be your custom extrusion partner.



Tubing & Assembly Competencies

HPMS Technology



Material

We offer material expertise in conjunction with compounding services that allow our customer to procure the exact raw materials and needed formulas. We take great care to manage all materials from procurement through production to ensure that the material quality remains consistent from lot to lot. We work with the full spectrum of standard and specialty materials such as PEEK, Nylons, TPU, PP, PE, TPE, and Polyimide, including resins with radiopaque fillers and other functional additives.



Tool Design & Manufacturing

We offer a full service in house CNC machine shop providing us the capability to take an existing print, design and manufacture the tooling, extrude the tubing with various trials as required and make whatever fine adjustments that are needed quickly. With a strong understanding of machine design and material behavior, our team of experts can help you realize even the most complex of design.



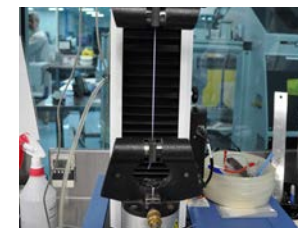
Tube Extrusion & Braiding

State of the art extrusion expertise with 1/2 inch (12.70 mm) to 1-1/2 inch (38.1 mm) single screw extruders. We use a wide array of proprietary techniques and equipment ranging from proprietary take-off equipment, pullers and bump pullers, to product control systems. All products are continuously monitored from beginning to end so that we may ensure only the highest quality leaves our facilities. Our specialty is tapered ("bump") tubing, micro-tubing, multi-layer and multi-lumen tubing and high pressure braided tubing.



Secondary Operations

No tubing product is complete without the supporting secondary operations that make most of our capabilities so unique. We offer pad printing reflow capability, marker band assembly, annealing services, in-line printing and secondary marking, overmolding services, forming, drilling, welding, bonding solutions, packaging, and more!



Device Testing

All products are manufactured to meet and exceed customer expectations. We provide process validation, in-line continuous gaging on O.D. / I.D. / Wall thickness, SPC controls as well as function performance testing like tensile strength, elongation testing, leak and burst testing. When proprietary solutions require additional validation we will go above and beyond to ensure that those needs are met and that the quality is highly repeatable and traceable.



Assembly

ISO 13485:2016 facilities provide full device assembly and contract manufacturing services as needed to ensure that volumes are met and quality remains priority one. Whether it is a component or sub-assembly for OEM final manufacturing or a fully packaged device, we offer our customers solutions and a partner in Proterial that ensures reliable service and solutions that are scalable and global if needed.



Applications

Market Segment	Key Technologies Used
Cardiology & Peripheral Vascular	Braiding, Co-extrusion, RF tipping, Multi-lumen, High Precision Single Lumen
Vascular Access	Precision Polyurethane, Tapered / Bump Multi-lumen, RF Tipping
Gastroenterology	Co-extrusion, Precision Single Lumens, Multi-lumen, RF Tipping
Urology	Single Lumen, Multi-lumen, RF Forming, Skiving & Punching
Surgery	High Temperature Materials, Multi-lumen, Precision Single Lumen
Neurovascular	Braiding, Co-extrusion, Micro-extrusion, Striping
Structural Heart	RF Tipping, Over-jacketing Extrusion, Single Lumen Extrusion



Medical Tubing



Proterial High Performance Medical Solutions offers a variety of complex and highly advanced tubing solutions with the ability to manufacture to the tight tolerances that today's minimally invasive designs require. PCA is full ISO 13485:2016 certified for full device manufacturing

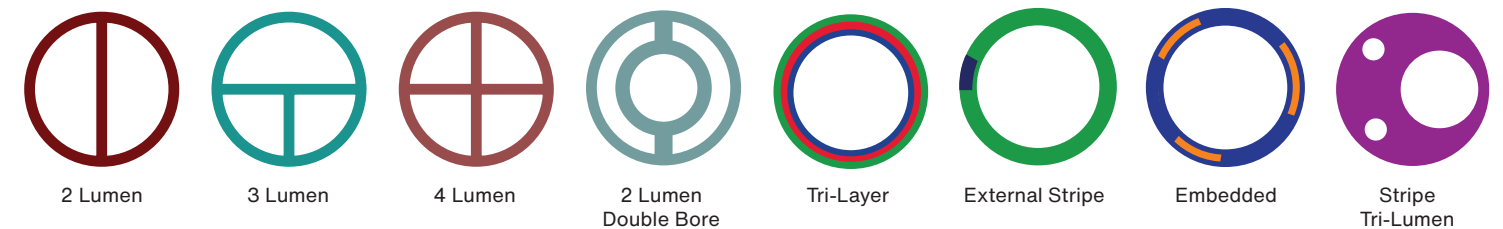
Medical Tubing Options:

- Single-lumen, multi-lumen, multi-layer, profile tubing
- High-pressure braided tubing, reinforced tubing
- Taper / Bump tubing
- Balloon tubing
- Core Mandrel, beading tubing
- Embedded / Encapsulated wire and cable tubing
- Integrated markings, radiopaque fillers, color striping tubing
- Specialty additives and compounded materials

Standard Materials:

ABS	Hytrel®	Pellethane®	PCDF
Carbothane™	LCP	PET	PVC
ECTFE	LDPE	PFA	Quadraflex™
EFEP	LLDPE	Polycarbonate	
ETFE	Nylon	Polyimide	
EVA	PBT	Polypropelene	
FEP	Pebax™	Polysulfone	
HDPE	PEEK	POM	

Configuration Proficiencies:

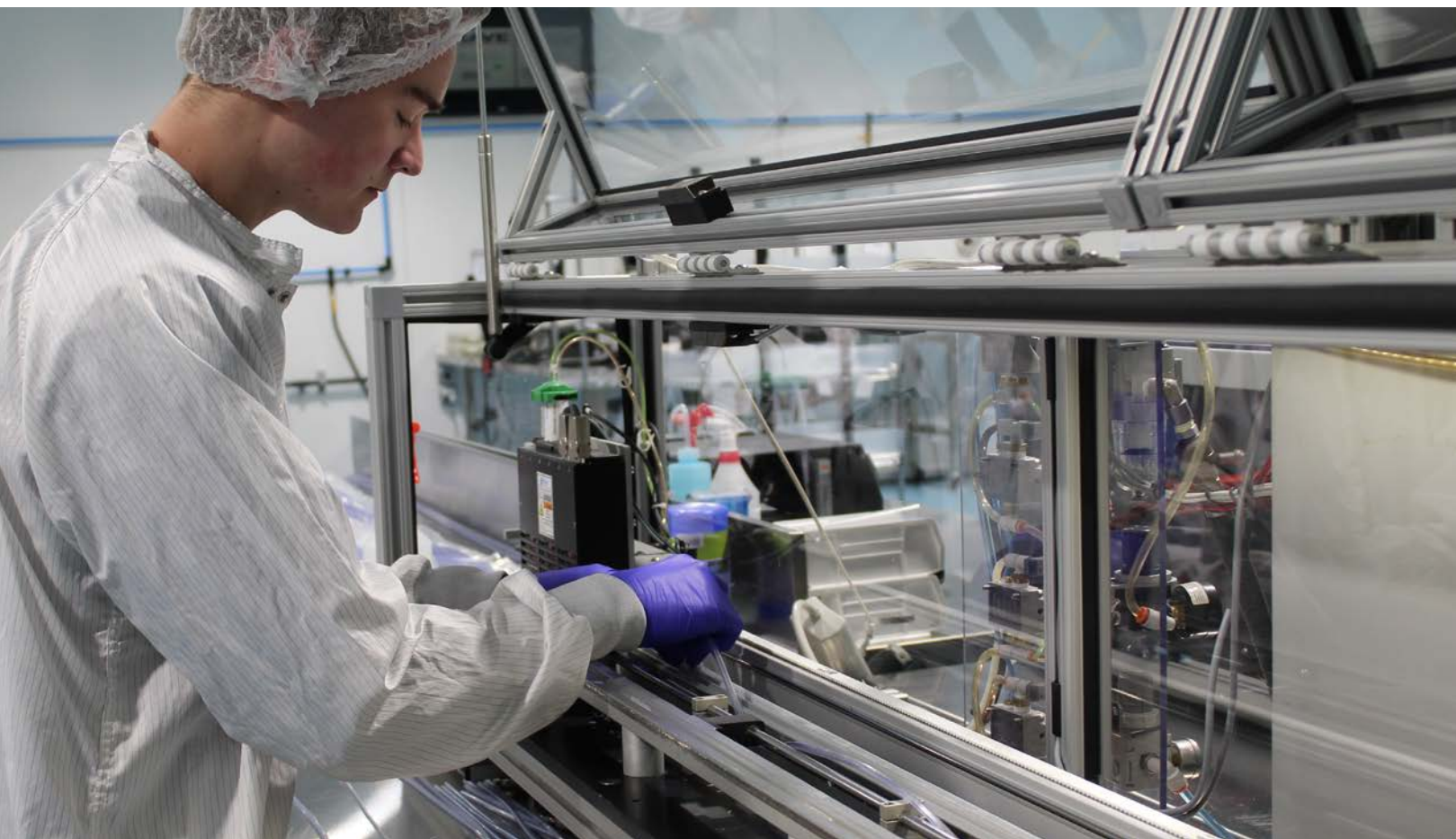


Outer Diameter:
 0.005 in. (0.12 mm) minimum
 0.875 in. (22 mm) maximum
Inner Diameter:
 0.003 in. (0.08 mm) minimum
Wall Thickness:
 0.001 in. (0.025 mm) minimum

HPBT Diameter:
 0.006 in. (0.15 mm) with variable pitch
 Nylon monofilament and SS flat/round wire
Maximum Number of Lumen: Up to 24
Number of Layers: Up to 5
Number of Durometer Changes: Up to 2 via extrusion & multiple via secondary bonding
Number of Taper Transitions: Up to 3

Note:

Carbothane™ is a trademark of the LUBRIZOL ADVANCED MATERIALS, INC. registered by NOVEON IP HOLDINGS CORP. CORPORATION.
 Hytrel® is a registered trademark of E. I. DU PONT DE NEMOURS & COMPANY.
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 Tecoflex™ is a registered trademark of LUBRIZOL ADVANCED MATERIALS, INC. registered by THERMO ELECTRON CORPORATION.
 Tecothane™ is a registered trademark of LUBRIZOL ADVANCED MATERIALS, INC. registered by THERMEDICS INC.
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Braided & Non-Braided High Pressure Tubing

Medical fluid management tubing is designed for a large range of procedural applications. Our low pressure, high pressure, and pressure monitoring tubing are available in various materials, reinforcements and size.

Specifications

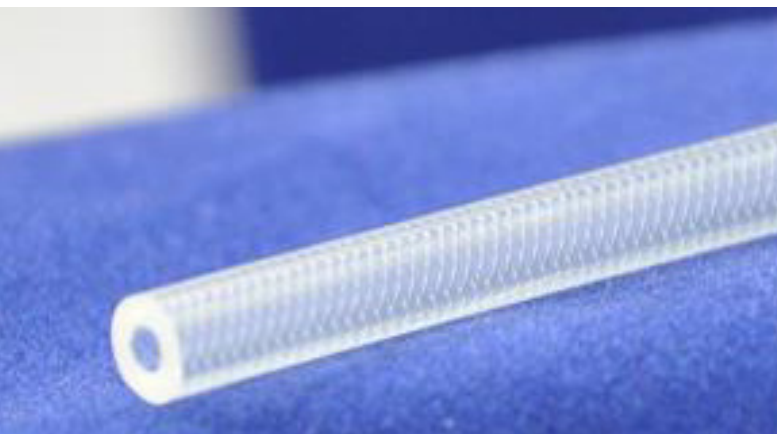
Common Braided Styles	High Pressure Braided Tubing (HPBT)		High Pressure Co-Extrusion (HPCE)	
Pressure Rating	1,200 psi (82.73 bar)		1,200 psi (82.73 bar)	
Common Sizes* ID/OD Inches (ID/OD mm)	STYLE 1	0.071 x 0.142 (1.80 x 3.61 mm)	STYLE 1	0.071 x 0.142 (1.80 x 3.61 mm)
	STYLE 2	0.088 x 0.188 (2.24 x 4.78 mm)	STYLE 2	0.088 x 0.188 (2.24 x 4.78 mm)
Material	Polyurethane with Nylon Braid		Polyurethane / Nylon Co-extrusion	
Length* Inches (mm)	10, 20, 24, 30, 48, 60, 72 (254, 508, 762, 1219, 1524, 1829 mm)		10, 20, 24, 30, 48, 60, 72 (254, 508, 762, 1219, 1524, 1829 mm)	
Flexibility	High		Medium	
Clarity	Medium		High	

*Diethylhexyl Phthalate, DEHP is the most common member of the class of phthalates which are used as plasticizers and have been deemed harmful to humans. All materials mentioned are Phthalate free PVCs used.

Luer Attachment, Product Customization, and OEM Assemblies

HPMS has the ability and capacity to customize your tubing and assembly. If our variation of common sizes doesn't fit your needs, we are happy to customize an extrusion to your specification. We can build a wide variety of custom products with luer attachments using solvent bonding, RF welding and custom over molding.

- Fixed and Rotating Luer Locks
- Clamps
- Caps and Covers
- Spikes
- Drip Chambers
- Syringes
- Valves
- Manifolds

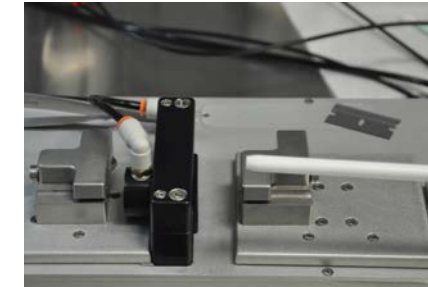


Applications:

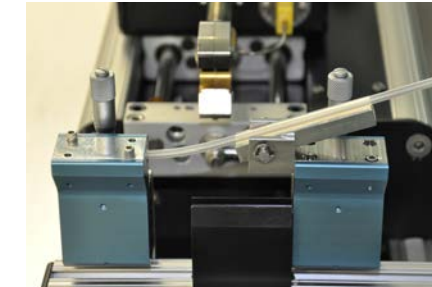
- Contrast Injection
- Interventional Cardiology
- Radiology
- Vascular Access
- Pressure Monitoring
- Stent Placement
- Inflation Tubing
- Fluid Administration
- Vacuum Procedures
- Waste Management

Secondary Operations

Value-added operations are an integral part to any successful product design. Understanding the secondary operation involved and planning for them up front can dramatically decrease product costs and often increase product performance. Secondary operations can often help engineers achieve ideas that might have otherwise been impossible and they can often reduce the overall complexity of a final assembly when properly managed.



RF TIPPING



THERMAL FORMING



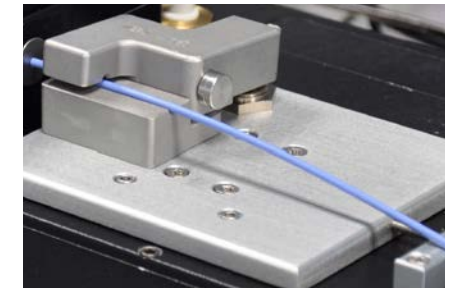
PRECISION CUTTING



PAD PRINTING



BRAIDING



RF BONDING



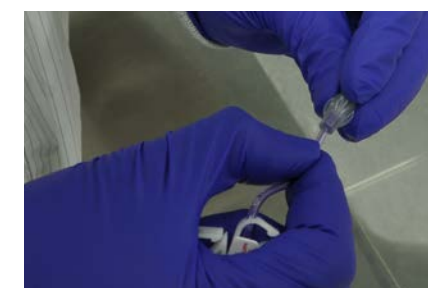
SKIVING



KITTING & ASSEMBLY



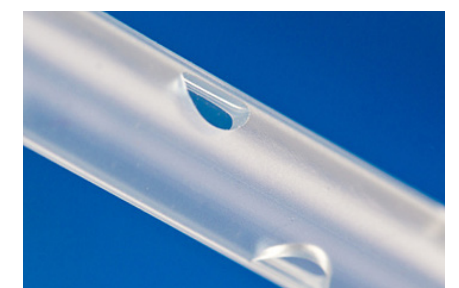
INJECTION MOLDING



ADHESIVE BONDING



RF FLARING



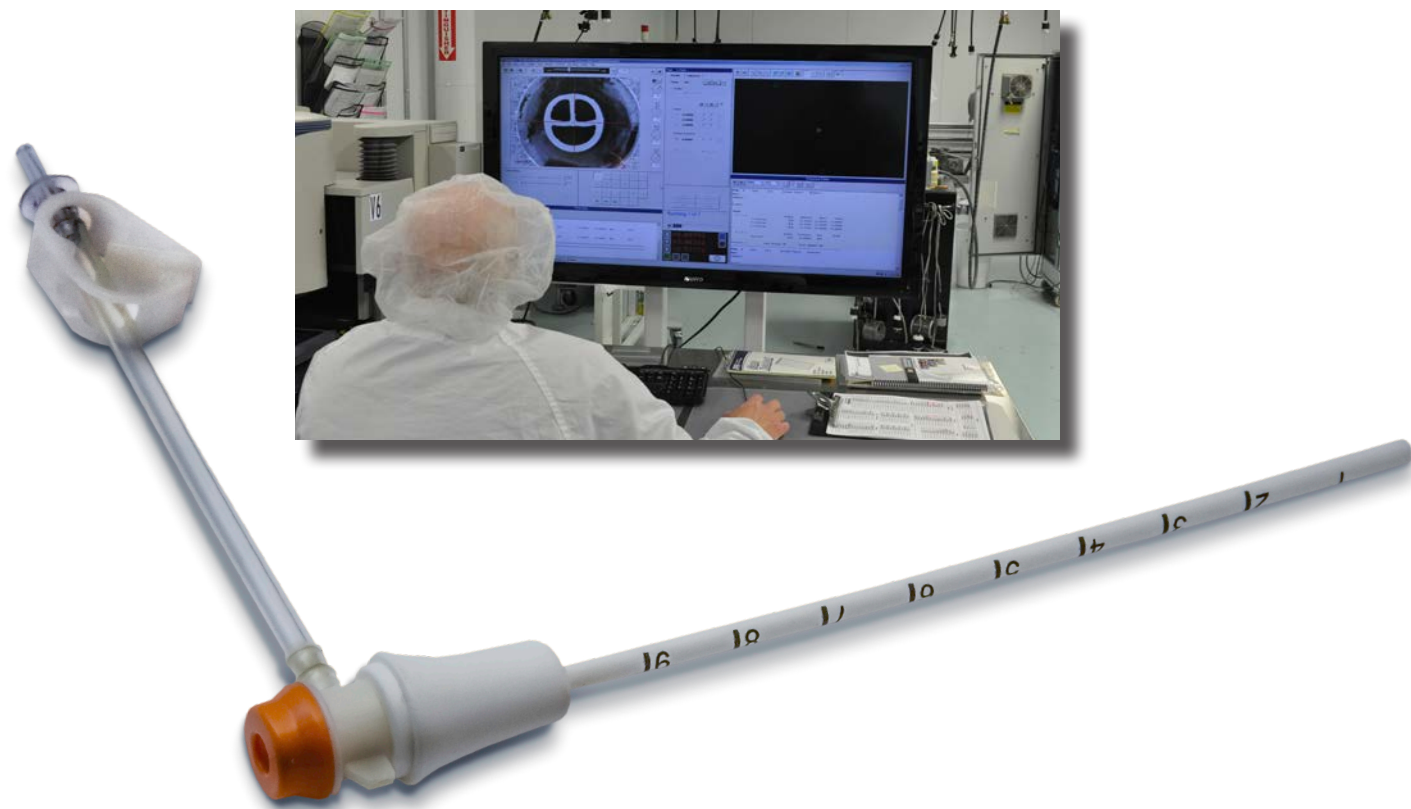
DRILLING/PUNCHING

Full Assembly

At HPMS, we have the expertise and systems in place to see new products through from concept to production. We offer partial and full assembly services in a Class 8 cleanroom with product labeling, complete packaging, sterilization management if required, shipping support for sterilization activities, inventory management and warehousing when required. We pride ourselves on our ability to provide a one-stop, hassle-free contract manufacturing source with exceptional quality, service and our commitment to excellence. Whether it is a final molded assembly or a multi-step conglomeration of secondary operations leading to a final packaged assembly, we are able to serve the needs of the large OEMs and the small startups alike.



Photo of enlightenVue, surgiVue microendoscope cleanroom packaging



Quality and Value-Added Testing



HPMS products are designed to improve the quality of life for individuals in need of medical care. From premature infants to elderly patients, our products provide vital support for a wide range of individuals. We're dedicated to producing these products with the highest level of quality control, in accordance with industry standards.

Our commitment to excellence extends beyond the manufacturing process, as we also provide in-process validation and support for our customers. As a result, we are proud to manufacture lifesaving tools that have a positive impact on people's lives across the globe.

Our commitment to quality extends to our strict adherence to industry regulations, including the ISO 13485:2016 standard and the FDA 21 CFR part 820 regulation. These regulations ensure that our products are manufactured to the highest possible standards, providing medical professionals with the tools they need to provide effective care for their patients. By following these regulations, we are able to consistently produce products that meet the needs of our customers and the individuals they serve.

Tubing	Cable/Fiber	Machining	Proterial Metals Japan
<ul style="list-style-type: none"> Tensile/elongation testing Burst testing X-Ray imagery Automated optical inspection 	<ul style="list-style-type: none"> Cirris testing for wire to wire or ground shorting Continuity and high potential testing (dielectric withstanding) up to 1000V, capacitance, impedance, velocity of propagation, skew, time delay and attenuation up to 50 GHz measurements. Flex testing Optical Time Domain Reflectometer (OTDR) for fiber optic cable Thermal cycling chambers for ship/shock testing 	<ul style="list-style-type: none"> Automated optical/pin gauge inspection Surface finish and flatness testing Specialty steels material testing Coating validation 	<ul style="list-style-type: none"> Highly specialized testing for material science of metals and polymers Scanning Electron Microscope IR & Raman Spectroscopy Biological and environmental validation Robotic flex testing



Applications

Machining Applications

- Production machining components for medical and commercial solutions.
- Extrusion Tooling, Crossheads, in-line heads, profile dies, multi-lumen, multi-layer, rubber/silicone.

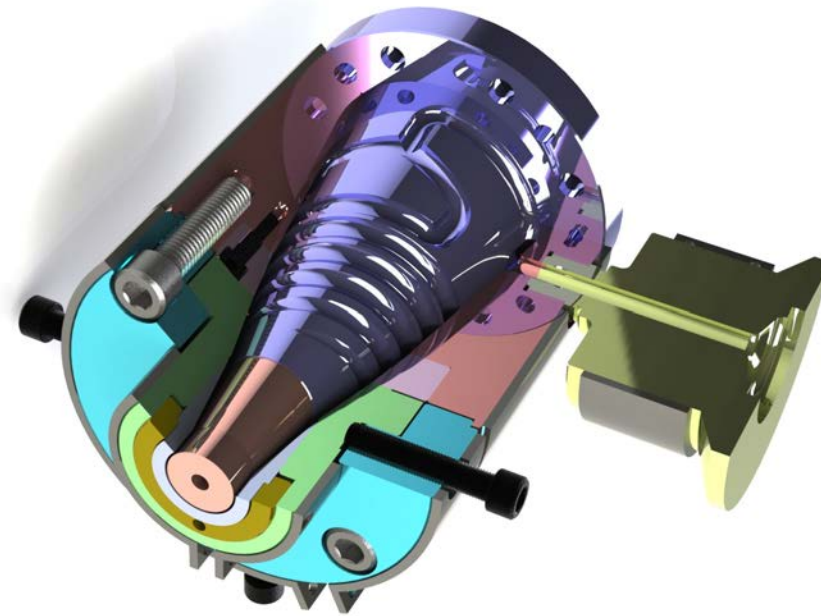
Medical Extrusion Tooling

Our innovative designs provide for quick tooling change out, fast material transitions, decreased tooling costs, improved material flow that reduces weld lines, and leak free seals. We can provide standard or custom tooling solutions which reduces set up times, material loss, and overall manufacturing costs.



Equipment Lineup

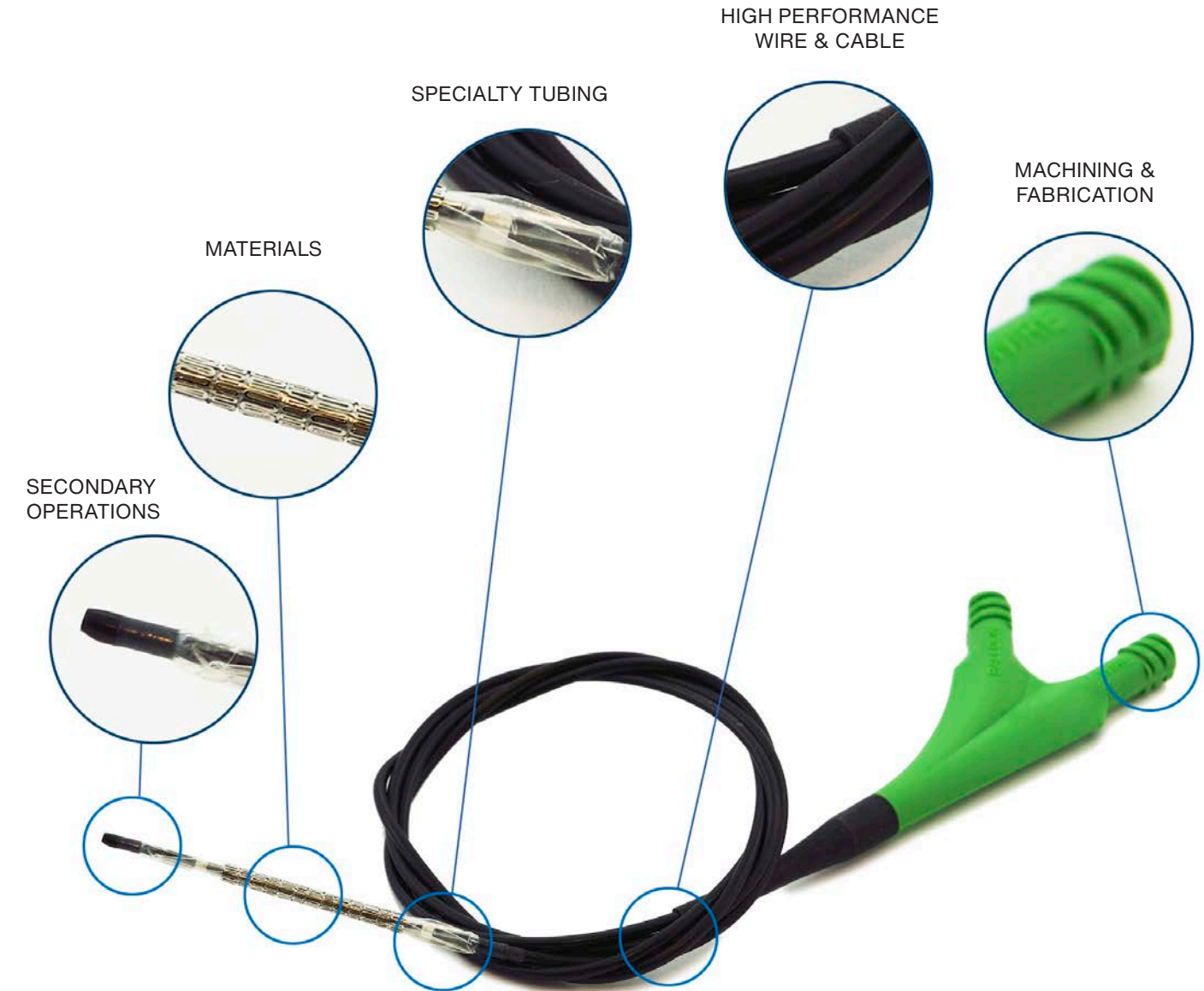
- Crossheads and in-line heads (.25 in. (6.35 mm) to 3.5 in (88.9 mm) standard die capabilities)
- Multi-lumen tools
- Profile dies
- Pelletizing stand dies
- Rubber & silicone heads
- Multi-layer crossheads
 - 2 and 3 layer standard heads, up to 5 layers
 - External and encapsulated striping
 - Adjustable layer control
- Support tooling
 - Breaker plates
 - Barrel flange adapters
 - Tool carts and stands
 - Vacuum sizing tooling
 - Custom fixtures and replacement parts
- In-house Design & Manufacture
 - Extrusion Tooling
 - Spiral Flow Heads
 - Tips & Dies
 - Crossheads & In-line Extrusion Heads
 - Mold Tooling
- Services
 - Milling
 - EDM
 - Turning
 - Grinding
 - Swiss Screw (Partner Service)
 - Inspection & Measurement
- Medical Component Machining
 - Titanium & Specialty Metals
 - Tool Carts & Stands
 - Custom Fixtures
- Tool Maintenance & Repair
- 3D Additive Manufacturing



Please note that this is a stock photo example of a representative product which HPMS could manufacture. Due to strict confidentiality we do not openly share our customers' details or images unless very specific approvals are provided and authorized. This is not a final device manufactured by HPMS. The assembly represents a strong conglomeration of capabilities and services that can be offered.

Assembly Integration

Proterial's global presence and portfolio of technologies allow us to provide solutions that are highly complex yet simple when viewed from a single source partner relationship. Our customers benefit from the Proterial Group Company resources and expertise and OEMs can rely on us for high volume production expectations because, as Proterial, we have the resources and wherewithal to support the ever-changing needs.





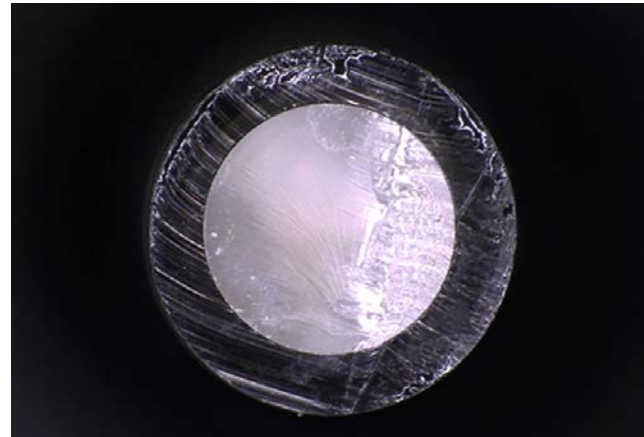
Specialty Fiber

Proterial offers unique fiber optic solutions for medical equipment and infrastructure needs. Our plastic optical fiber offers high temperature resistance in harsh environments as well as our TPU jacketed fiber cables.

Plastic Optical Fiber (POF)

Whether it is for a semiconductor sensor device or for an industrial medical inspection device, our plastic optical fiber offers significant advantages. Heat resistance to 302° F (150° C), cold resistance to -140° F (-60° C), heat deformation resistance and resistance to oils, acids, alkaline and many common chemicals.

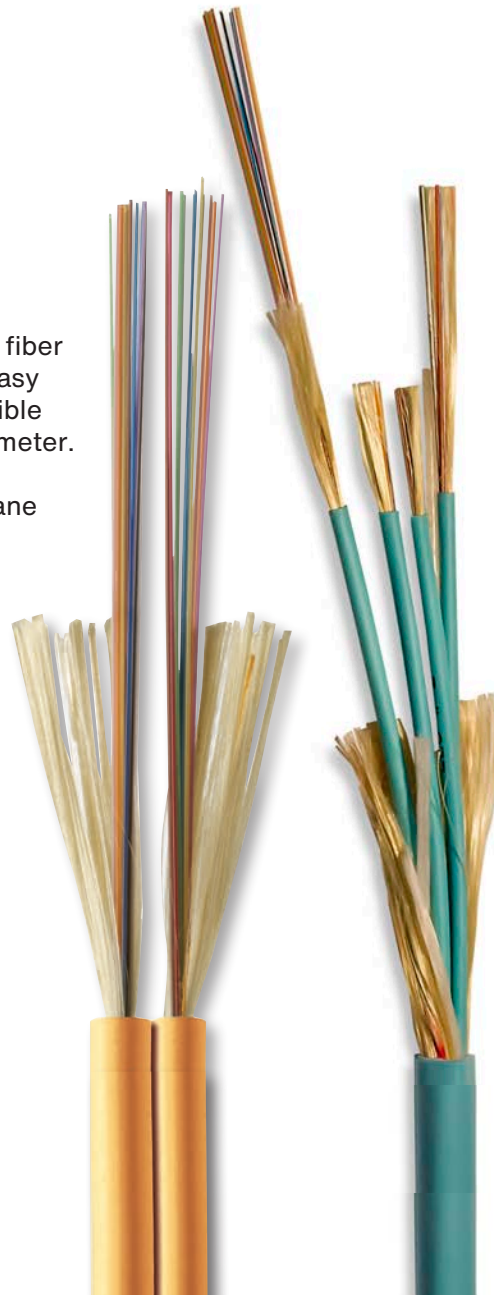
Simplex	Part Number Description	Fiber Diameter x Number Jacket O.D. / Material Operating Temperature
	HPOF 1.5 / 2.2 SP Highly Heat-Resistant Plastic Optical Fiber (HPOF)	0.059 in x 1 (1.5 mm x 1) 0.087 in (2.2 mm) / Fluorinated Ethylene Propylene (FEP); Black -68°C to + 302°F (-20°C to +150°C)
	HPOF-S 1.5 / 2.2 SP Highly Heat-Resistant Plastic Optical Fiber (HPOF-S)	0.059 in x 1 (1.5 mm x 1) 0.087 in (2.2 mm) / Fluorinated Ethylene Propylene (FEP); Inner Clear, Outer Black -68°C to + 302°F (-20°C to +150°C)



NanoCore™ Cable (Plenum & Riser)

Proterial's NanoCore™ Single-Jacket Micro Distribution cables offer 250 micron fiber optic strands in a loose tube cable design. Each fiber strand is color coded for easy identification. The cable is flexible and easy to handle and uses lightweight, flexible aramid yarns to enhance strength. Subunits with 12 strands are only 2mm in diameter. NanoCore™ Interconnect Micro Distribution cable is ideal for MPO (MTP®) style connectors where higher data rates are desired. Custom designs with polyurethane jackets are available for improve cleaning performance.

Fiber Type	Core / Clad Size	Wavelength (nm)	Maximum Distance Reach	
			1 GbE	10 GbE
OM1 62.5 um	62.5/125	850	300 m	33 m
		1300	550 m	220 m
OM2 50 um	50/125	850	750 m	82 m
		1300	550 m	220 m
OM3 50 um Laser Optimized Multi-mode Fiber	50/125	850	1,000 m	300 m
		1300	550 m	220 m
OM4 50 um Laser Optimized Multi-mode Fiber	50/125	850	1,100 m	400 m
		1300	550 m	220 m
OM5 Wideband Multi-mode Fiber	50/125	850	n/a	400 m
		1300	550 m	220 m
OS2 Single Mode	8.3/125	1310	> 25,000 m	10,000 to 25,000 m
		1550	>40,000 m	40,000 m



Appendix

Material Comparison

	PFA	FEP	PVC with Plasticizer	TPU	Silicone	Proterial Non-Sticky Silicone	TPE/TPR	ETFE
Sodium Hypochlorite (Bleach 10%)	Good	Good	Good	Poor	Good	Good	Excellent	Good
Isopropyl Alcohol	Excellent	Excellent	Good	Poor	Excellent	Excellent	Excellent	Excellent
Glutaraldehyde (Cidex)	Good	Good	Fair	Good	Good	Good	Excellent	Good
Dry Heat	Good	Good	Fair	Fair	Good	Good	Good	Good
Sterrad ASP & NX (low temp. hydrogen peroxide plasma gas)	Good	Good	Good	Good	Excellent	Excellent	Good	Good
Steris VPHP (Vapour phase hydrogen peroxide)	Good	Good	Good	Good	Excellent	Excellent	Good	Good
Steam (Autoclave)	Excellent	Good	Fair	Poor	Excellent	Excellent	Fair/Good	Good
Steris (Paracetic Acid Liquid)	Good	Good	Good	Good	Good/Excellent	Good/Excellent	Good/Excellent	Good
Ethylene Oxide (EtO)	Excellent	Good	Good	Good	Good	Good	Excellent	Good
Gamma	Poor	Fair	Fair/Good	Good	Fair/Good	Fair/Good	Excellent	Good/Excellent
Electron Beam	Good	Fair	Good	Good	Good	Good	Poor	Poor
Ozone	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Good	Excellent
Flexibility	Excellent	Excellent	Good	Good	Excellent	Excellent	Good	Good
Haptic Feel	Excellent	Excellent	Good	Good	Good	Excellent	Good	Good
Colorability	Good	Good	Excellent	Excellent	Good/Excellent	Good/Excellent	Excellent	Excellent
Biocompatibility	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Excellent
Plasticizers or Undesirable Additives	No	No	Yes	No	No	No	No	No
Chemical Resistance	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Good/Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Poor	Good/Excellent	Excellent	Excellent	Fair/Good	Excellent
Temperature Range - (Celsius) Fahrenheit	-240°C to +260°C (-400°F to +500°F)	-240°C to +260°C (-400°F to +500°F)	100°C to 260°C (212°F to 500°F)	-40°C to 125°C (-40° to 257°F) (-40°F to 51°F)	-55°C to 300°C (-67°F to 572°F)	-55°C to 300°C (-67°F to 572°F)	-68°C to 99°C (-90°F to 210°F)	-240°C to +260°C (-400°F to +500°F)
Low Friction (non-sticky)	Excellent	Excellent	Good	Fair/Good	Poor	Excellent	Fair/Good	Excellent
Cleanability / Wipe down	Excellent	Excellent	Good	Good/Excellent	Good	Excellent	Good/Excellent	Excellent
Non-staining Properties	Excellent	Excellent	Poor	Fair/Good	Poor	Excellent	Poor	Excellent
Anti-yellowing Properties	Excellent	Excellent	Poor	Poor	Good/Excellent	Excellent	Good/Excellent	Excellent
Jacket Durability (toughness)	Good	Good	Fair	Excellent	Fair/Good	Fair/Good	Good	Excellent

PROTERIAL

High Performance Medical Solutions

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