PRODUCTS, SERVICES & CAPABILITIES FOR

SPACE

Ruggedized Interconnect Solutions Supporting the Entire Space Ecosystem

Satellite Integration
Laser Communications
Spacecraft & Launch Vehicles
Deep Space Exploration
RF Power Handling

CARLISLE®
INTERCONNECT TECHNOLOGIES

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CarlisleIT
in Space

Our broad range of interconnect solutions has been ensuring mission success for decades in the space industry. From spacecraft and launch vehicles to satellite integration and ground support equipment, our RF Connectors, Cable Assemblies, Filter Connectors, Seamless Wire, Fiber Optics, and other specialized products provide high performance and reliability in the harshest and most demanding environments.

Here at CarlisleIT, we design and test our products to meet the requirements of extreme vibration during launch, thermal cycling, outgassing, and radiation once payloads are operational in orbit. In space, there is no option to repair or replace interconnect products — they need to work the first time, every time.

Whether your mission is deep space exploration and discovery or a Low Earth Orbit constellation supporting the “space internet,” we have you covered.

50+ Years of Space Heritage

Supported Programs by:
- NASA
- ESA
- JAXA

Deep Space Missions:
- Voyager
- MAVEN
- Cassini
- Mars Rover

Satellites:
- NEO/LEO
- MEO
- GEO

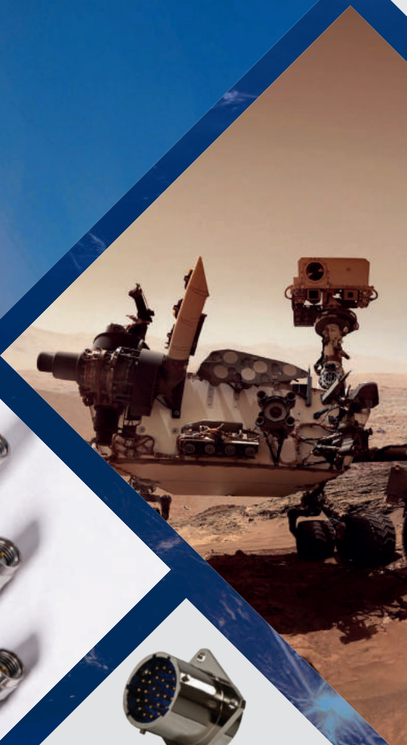
Qualified for:
- COSMIC-2
- Europa
- GRACE
- GOES
- James Webb Space Telescope
- JPSS
- LUCY
- Orion Artemis












Ultra-Low-Loss Highly Flexible
Coaxial Cable Assemblies
Radiation-Hardened
Fiber Optic Assemblies
Board-to-Board
RF Interconnects
Ganged RF
Interconnects

OISL COMMUNICATION TERMINAL

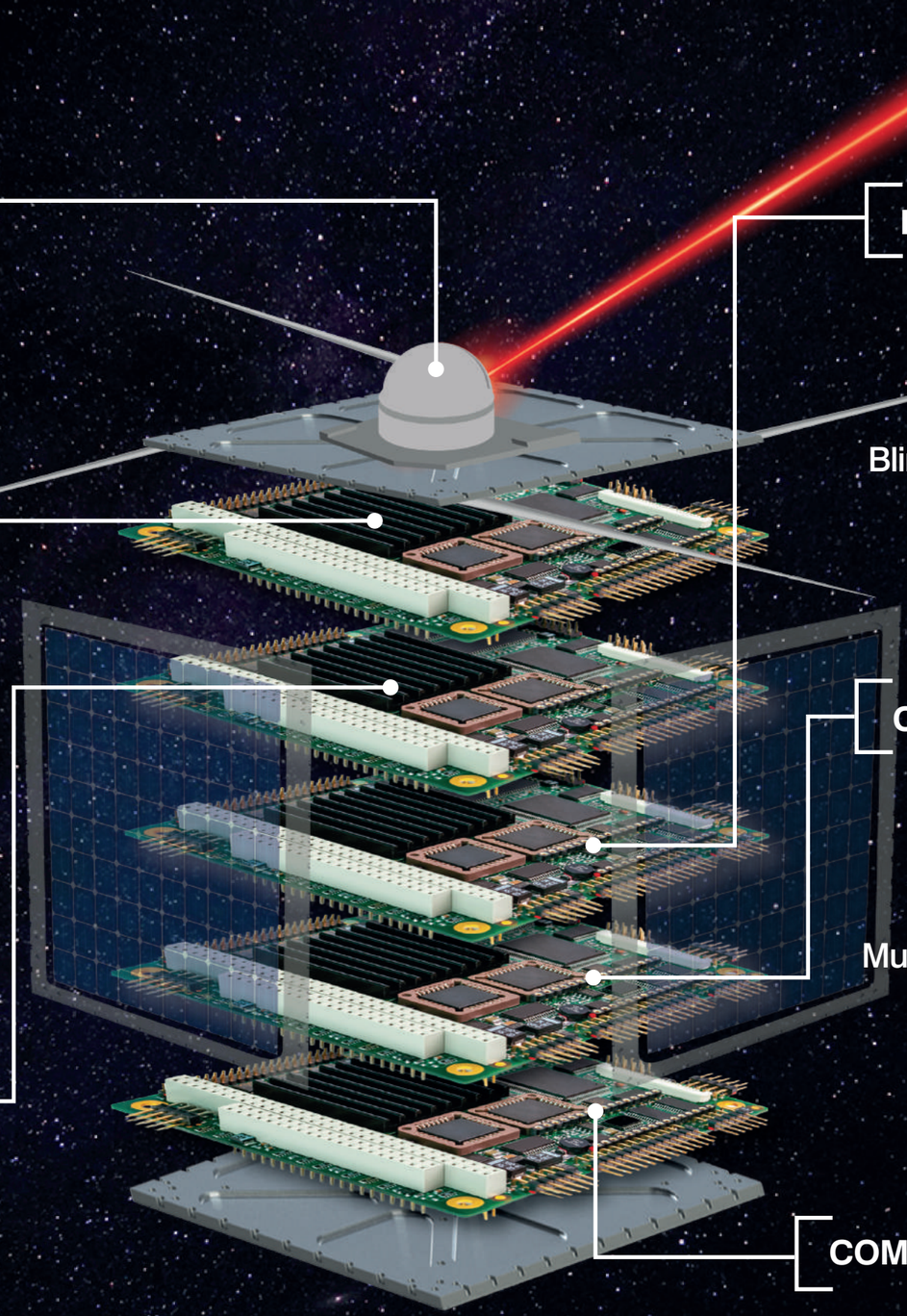
Fast Steering Mirror (FSM) Sensors

ATTITUDE DETERMINATION & CONTROL

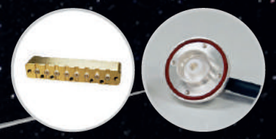
Ganged Interconnect Solutions
Ganged CoreHC™

PAYLOAD/HIGH-VOLTAGE CONTROL

High-Speed Data Connectors
Filter Connectors
Precision RF Connectors

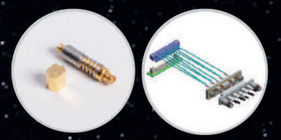


ELECTRICAL POWER SYSTEM



Board-to-Board RF Connectors
Blind-Mate High-Power Interconnects

COMMAND & DATA HANDLING



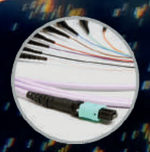
SMP/SSMP Bullets
Multi-Way Quick-Connect RF Harness

COMMUNICATION SYSTEM

UTiFLEX® Ultra-Light RF Assemblies
UTiPHASE™ Phase-Linear RF Assemblies

Fast Steering Mirror
(FSM) Sensors

Radiation-Hardened
Fiber Optic Assemblies



Octax® Gigabit Ethernet
Interconnect Solutions

LAUNCH ABORT SYSTEM

Fire-Resistant, Moisture-Resistant, SWAMP Wire

Harsh-Environment High-Energy Optical Cable

Blind-Mate High-Power Interconnects

Filter Connectors for EMI Protection

SERVICE & NAVIGATION MODULES

Filter Connectors for EMI Protection

Ganged CoreHC™

Precision RF Connectors

RF Adapters

Flexible & Phase-Linear Microwave Cable Assemblies

ROCKET ENGINE/PROPULSION

Ruggedized Fiber Optic Cable

Semi-Rigid Cable

Conformable RF Cable Assemblies

Ultra-Flexible High-Voltage Shielded Composite Cable

PAYLOAD & FAIRING

ARACON® Braids for EMI Shielding

Flexible & Phase-Linear Microwave Cable Assemblies

RF Connectors

Blind-Mate High-Power Interconnects

High-Voltage Wire & Cable

Seamless PTFE Wire Insulation
& Cable Jacket Technology

RF Connectors

Ultra-Low-Loss
Highly Flexible RF
Cable Assemblies

ARACON® Braided
EMI Shielding

RF Adapters

Precision RF Connectors

Blind-Mate High-Power Connectors

Filter Connectors for EMI Protection

Conformable & Semi-Rigid RF Cables & Assemblies

Phase-Linear & Flexible Microwave Cable Assemblies

Harsh-Environment Fiber Optic Interconnects

TVAC T&M RF Assemblies

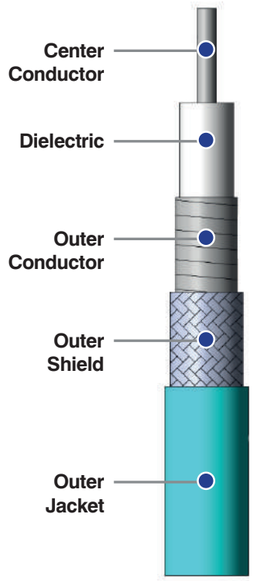
The UTiPHASE™ family of flexible coaxial microwave cables flatten the phase vs. temperature response curve and are designed for use in phase-critical flexible cable applications.

UTiPHASE™ Phase-Linear Microwave Cable Assemblies

Our UTiPHASE™ line combines every traditional feature of UTiFLEX with a thermally phase-stable proprietary dielectric that eliminates the PTFE “knee.” UTiPHASE also leverages the same cable assembly terminations and proven connector families that have made UTiFLEX famous, thus saving money, validation schedules, and lead times.

FEATURES	BENEFITS
Linear thermal phase performance	• Minimizes system phase variation • Increases accuracy • Eliminates PTFE “knee”
Naturally ruggedized with sturdy concentric core	• Improved reliability • Improved crush-resistance
Vertically integrated	• Controlled fluoropolymer performance • Reliable delivery
Typical velocity of propagation 80%	• Excellent insertion loss • Drop-in replacement for many competing cables
Universally configurable with standard connectors and armor	• Proven UTiFLEX® assembly reliability and performance • Reduced lead time using existing assembly hardware and techniques

UTiPHASE Part Number	Center Conductor Material	Outer Shield Material	Outer Jacket Material	Outer Diameter (in)	Nominal Weight (g/ft)
MCX088D	SPCW	ARACON	ETFE	0.088	3.3
UFP088D	SPCW	HSSPC	FEP	0.088	4.0
MCX142A	SPC	ARACON	ETFE	0.142	8.4
UFP142A	SPC	SPC	FEP	0.142	9.5
MCX205A	SPC	ARACON	ETFE	0.250	15.9
UFP205A	SPC	SPC	FEP	0.250	18.7
MCX311A	SPC	ARACON	ETFE	0.311	35.6
UFP311A	SPC	SPC	FEP	0.311	45.7



The **Center Conductor** types, which are either silver-plated copper (SPC) or silver-plated copper-weld steel (SPCW), meet the requirements of MIL-DTL-17. The **Dielectric** used on the cables detailed here consists of a proprietary fluoropolymer. The **Outer Conductor** is silver-plated copper (SPC) per ASTM B-298. The **Outer Shields** are either silver-plated copper (SPC) per ASTM B-298; ARACON (silver-plated polyparaphenylene terephthalamide) for up to 15% weight savings; or high-strength, high-conductivity copper alloy (HSSPC) per UNS C17510, silver coated per ASTM B-298. The **Outer Jacket** is either extruded fluorinated ethylene propylene (FEP) per MIL-DTL-17, Type IX; or ethylene tetrafluoroethylene (ETFE) in accordance with ASTM D-3159.

Optimized for frequencies ranging from 18 to 70 GHz

Electrical Performance Comparisons

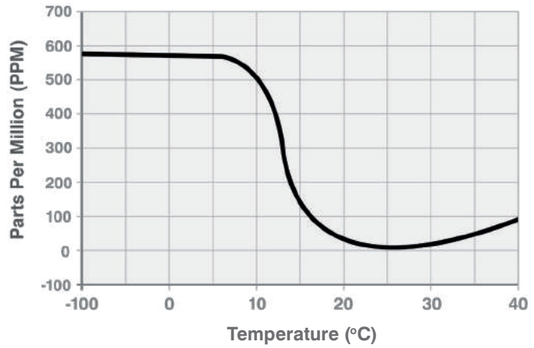


Fig 1: Typical phase change vs. temperature for cables with ultra-low-density PTFE dielectric

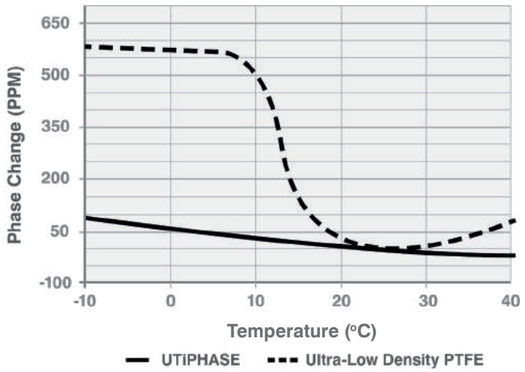


Fig 2: Typical phase change vs. temperature for flexible microwave cables

Fig 2: Multiple lots of cable were tested for electrical length from -65 °C to 100 °C with startling results. The abrupt phase change and total change inherent in PTFE dielectrics was eliminated. Figure 2 shows the typical phase change for UTiPHASE cables versus flexible cables with ultra-low-density PTFE dielectric.

Fig. 3: Direct comparison of the UTiPHASE product and cables manufactured with other dielectric materials reveals superior performance in maintaining electrical phase length. Figure 3 shows the typical phase change for UTiPHASE cables versus flexible cables with various PTFE dielectrics.

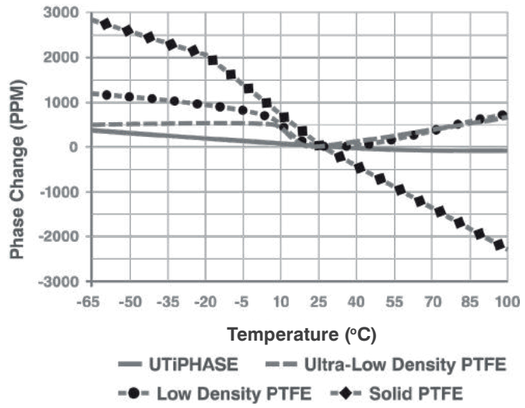


Fig 3: Typical phase change vs. temperature for flexible microwave cables with different dielectrics

UTiFLEX® Ultra-Light Cable Assemblies

UTiFLEX® Ultra-Light cable assemblies are optimized for spaceflight applications. They provide the lightest weight, lowest insertion loss, and best radiation resistance in a flexible cable construction. The cables utilize our ARACON for the outer shield, an ultra-low-density PTFE for the dielectric, and a DuPont™ TEFZEL® jacket. If required, cable assemblies are manufactured in a Class 10,000 clean-room by certified solder technicians.

Key Features

- ARACON® outer shield for superior weight savings
- Up to 25% weight savings for spaceflight applications
- Low VSWR (1.25:1 to 40 GHz typical)
- Excellent shielding effectiveness
- Precision phase matching

Space Qualified

- J-STD-001 Space Addendum Certified assemblers and inspectors
- Class 10,000 clean-room assembly processes
- Low-outgassing materials (<1% TML, <0.1% CVCM per ASTM E-595)
- Radiation resistant up to 100 Mrads
- Real-time X-ray capability

MECHANICAL CHARACTERISTICS

UTiFLEX TYPE	MCJ088D	MCJ1151A	MCJ142A	MCJ185A	MCJ205A	MCJ311A
Outer Diameter *in (mm)*	0.088 (2.24)	0.115 (2.92)	0.142 (3.61)	0.185 (4.70)	0.205 (5.21)	0.310 (7.87)
Center Conductor Type	Solid	Solid	Solid	Solid	Solid	Solid
Maximum Weight *g/ft (g/m)*	3.6 (11.8)	5.5 (18.0)	8.8 (28.9)	12.4 (40.7)	16 (52.5)	35 (114.8)
Minimum Bend Radius *in (mm)*	0.25 (6.35)	0.375 (9.53)	0.38 (9.65)	0.38 (9.65)	0.5 (12.70)	1.25 (31.75)

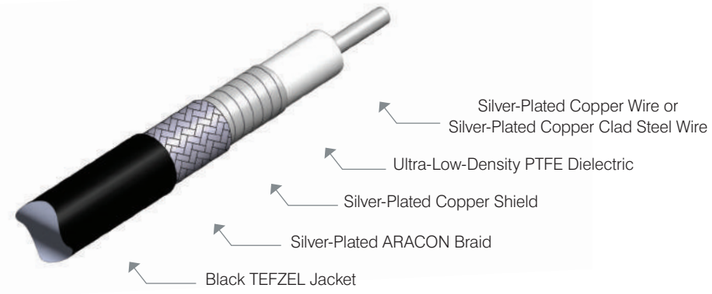
ELECTRICAL CHARACTERISTICS

Impedance (Ω)		50	50	50	50	50	50
Frequency Range		DC - 18 GHz	DC - 55 GHz	DC - 40 GHz	DC - 32 GHz	DC - 26.5 GHz	DC - 18 GHz
Velocity of Propagation		80%	82%	83%	83%	84%	83%
Capacitance *pF/ft (pF/m)*		25.5 (83.7)	24.75 (81.2)	24.5 (80.4)	24.5 (80.4)	24.2 (79.4)	24.5 (80.4)
Shielding Effectiveness	@ 1 GHz	>100 dB	>100 dB	>100 dB	>100 dB	>100 dB	>100 dB
Maximum Insertion Loss *dB/ft (dB/m)*	@ 1 GHz	0.20 (0.66)	0.11 (0.35)	0.10 (0.33)	0.08 (0.26)	0.07 (0.23)	0.05 (0.16)
	@ 10 GHz	0.66 (2.17)	0.48 (1.57)	0.33 (1.08)	0.27 (0.89)	0.23 (0.75)	0.15 (0.49)
	@ 18 GHz	0.89 (2.92)	0.64 (2.11)	0.44 (1.44)	0.36 (1.18)	0.32 (1.05)	0.21 (0.66)
	@ 26.5 GHz	1.13 (3.70)	0.79 (2.58)	0.54 (1.77)	0.44 (1.44)	0.39 (1.28)	-
	@ 32 GHz	1.25 (3.93)	0.86 (2.83)	0.60 (1.97)	0.49 (1.61)	-	-
	@ 40 GHz	1.42 (4.65)	0.97 (3.18)	0.68 (2.23)	-	-	-
	@ 55 GHz	1.70 (5.57)	1.14 (3.75)	-	-	-	-
	@ 70 GHz	1.94 (6.38)	-	-	-	-	-
Phase Stability vs. Flexure*	@ 10 GHz	2°	2°	2°	2°	1°	3°
	@ 18 GHz	2°	3°	3°	6°	2°	5°

*Cable wrapped once around a 3" diameter mandrel

ENVIRONMENTAL CHARACTERISTICS

Temperature Range	-150 °C to 165 °C	-150 °C to 165 °C	-150 °C to 165 °C	-150 °C to 165 °C	-150 °C to 165 °C	-150 °C to 165 °C



TVAC T&M Cable Assemblies

Thermal vacuum testing is a risk mitigation strategy utilized in some high-rel applications, notably space equipment such as satellites. Our TVAC T&M cable assemblies are thermal vacuum compatible for use with TVAC chambers. These assemblies utilize high-performance, ultra-low-loss UTiFLEX cable and are produced to exacting space-grade standards utilizing low-outgassing materials and vented connectors.

Key Characteristics

- Low outgassing per ASTM E-595 (<1% TML and <0.1% CVCM)
- Temperature Range: -65 °C to 165 °C (typical, consult factory for individual types)
- Ideal phase performance due to ultra-low-loss dielectric materials
- Superior cable mechanical stability and connector captivation techniques to address increasing thermal extremes of the space market
- Clean-room manufacturing and real-time X-ray upon request
- High-power configurations available. All high-power TVAC T&M cable assemblies are manufactured in a clean-room environment to full space-grade standards. Contact us for specific power/frequency requirements.
- Individually bagged to prevent post-assembly contamination
- Vented connectors

PART NUMBER DESIGNATION (EXAMPLE)	
Base Part Number	**Phase Matching (optional)**
UFB142A-0-XXXX-20V20V TV	AM
XXXX is cable assembly length in 0.1″ increments. Length Tolerance = -0 / +0.5″ (XXXX <= 100″) Length Tolerance = -0 / + 0.5% (XXXX >= 100″)	
If absolute phase matching is required, then add “AM” code. For phase-matched assemblies, length tolerance is not applicable.	

LITEflight® EP Fiber Optic Cable

Ruggedized Simplex

We have many options for radiation-hardened, single-mode, and multi-mode fiber optic cable compliant to MIL-PRF-49291. LITEflight® EP (Enhanced Performance), our family of aerospace-grade fiber optic cables, provides all the performance and benefits of its predecessor, LITEflight HD, but with:

- Lower loss
- Tighter bend radius
- Improved thermal stability
- Better handling during termination and installation

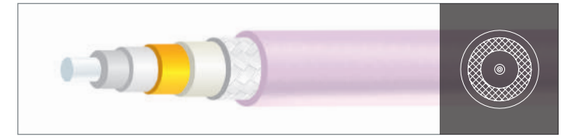
Unlike tight-structured cables, LITEflight EP semi-loose-structured cables are compatible with all commercially available fiber optic termini and connectors. It is available in multiple sizes, configurations, and temperature ratings to 260 °C in order to meet the most demanding application requirements.

LITEflight EP Characteristics	NFO(EP)-125-1	NFO(EP)-125-3M4
	Typical Value	**Typical Value**
Outside Diameter	1.8 mm	1.8 mm
Cable Weight	4.6 kg/km	4.6 kg/km
Minimum Bend Radius		
Short Term (Installation)	6.0 mm	6.0 mm
Long Term (Operation / Storage)	9.0 mm	9.0 mm
Attenuation		
850 nm	2.8 dB/km	2.9 dB/km
1300 nm	0.6 dB/km	0.8 dB/km
Temperature Cycling	0.10 dBΔ/30 m	0.10 dBΔ/10 m
Thermal Shock	0.10 dBΔ/30 m	0.10 dBΔ/10 m
Buffer Push-In Force	2.0 N/.45 mm	2.0 N/.45 mm
Cable Kink Resistance		
6.3 mm Loop Diameter	0.18 dBΔ	0.19 dBΔ

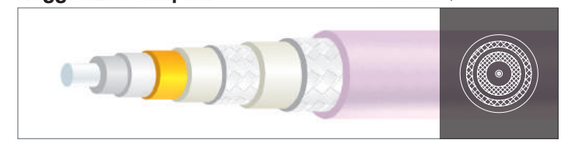
*All testing performed in accordance with EN-3745 or ARINC 802 methods.

STANDARD CONFIGURATIONS OVERVIEW

Simplex — Actual Size / 1.8 mm



Ruggedized Simplex — Actual Size / 2.74 mm



Ruggedized Duplex — Actual Size / 4.95 mm

Ruggedized Quad — Actual Size / 5.72 mm

Semi-Rigid Coaxial Cable

Semi-rigid coaxial cables are available in a wide variety of sizes, materials, and characteristic impedances. To be considered a semi-rigid coaxial cable, the cable must employ a solid metallic tube for the outer conductor. Most semi-rigid coaxial cables are less than 0.250" in diameter; however, some select cables are as large as 0.500". A silver-plated copper center conductor, polytetrafluoroethylene (PTFE) dielectric, and copper outer conductor are the most common materials. Impedances are available from 5 to 100 Ω. Typical maximum operating temperatures range from 125 °C to 250 °C.

Key Characteristics

Semi-rigid coaxial cables are used to transmit and receive microwave signals up to 110 GHz. These cables are the best pure microwave transmission medium available in the world.

- RF shielding in excess of -130 dB
- Lowest attenuation and lightest weight for any given geometry
- Unequaled impedance control and VSWR performance
- Smallest overall diameters available in a microwave cable
- Very tight bend radii allow utilization in the tightest configurations
- Environmentally sealed with no concern over jacket cuts or abrasions
- Numerous connector options available off the shelf from many different suppliers

Because semi-rigid coaxial cables can be precisely formed, they allow maximum packaging efficiency with no wasted space. While semi-rigid cables will hold their shape once formed, most are still pliable enough to provide some flexibility during system integration.

Semi-rigid coaxial cables are the benchmark against which all other coaxial cables are compared.

Seamless PTFE wire insulation wrap

Seamless PTFE Wire Insulation Wrap

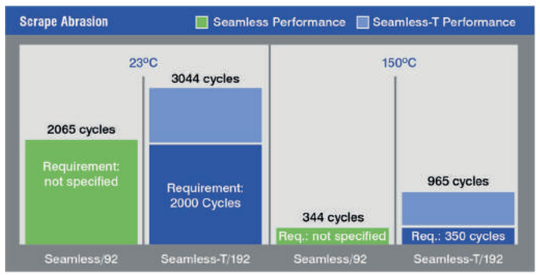
Our Seamless technology has been designed and used on several space applications. It is available in a variety of sizes and configurations, including ultra-light weight, ultra-high strength, thermocouple, single or multiconductor, shielded, unshielded, matched impedance, and even qualified to International SSQ 21655 Space Station MIL-STD-1553 databus specification.

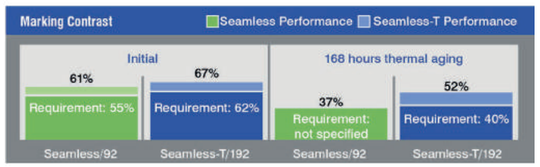
Seamless Comparison Charts

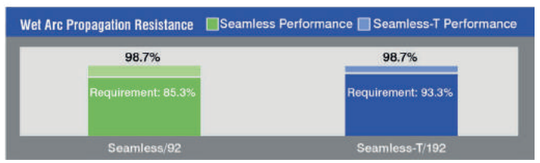
PRODUCT CHARACTERISTICS	SEAMLESS TAPE-WRAP /80 - /92	SEAMLESS TAPE-WRAP /180 - /192
Scrape Abrasion	●●	●●●
Hydrolytic Resistance	●●	●●
Wet Arc Propagation Resistance	●●●	●●●
UV Laser Marking	●●	●●●
Strips Easily and Cleanly	●●	●●

Better ●●
Best ●●●

Seamless and Seamless-T Products Exceed AS22759/92 and /192 Requirements







ARACON® Fiber

ARACON® fiber combines the strength, light weight, and flexibility of genuine DuPont™ Kevlar® with the electrical conductivity and corrosion resistance of nickel and solderability of silver. When braided or woven, the natural tendency for the fine, lightweight fiber is to spread out for high optical coverage. This translates into superior shielding effectiveness when compared to copper wire.

ARACON braids are available in standard sizes ranging from 0.062" to 2" inner diameter with both a nickel and silver finish. Also available are blends of ARACON with plated copper wire. The blended braids enhance lower frequency shielding performance and provide additional lightning protection while still offering substantial weight savings compared to the traditional full-metal shield.

FEATURES	BENEFITS
Reliable	• Military and spaceflight qualified • Will perform in the harshest environments
Industry-Leading Electrical Conductivity	• Low transfer impedance • Better RF shielding
Lightweight	• Up to 80% lighter weight than copper in typical applications • Save fuel, more payload
Stronger Than Steel	• Built on DuPont Kevlar • No more broken wires during installation
Flexible	• Feels like a textile • Easier to shape into the most difficult configurations • Longer flex life • Lower maintenance cost
Affordable	• The most cost-effective composite solution • Will satisfy almost any cost-weight benefit analysis

WEIGHT: ARACON-BRAIDED EMI SHIELD

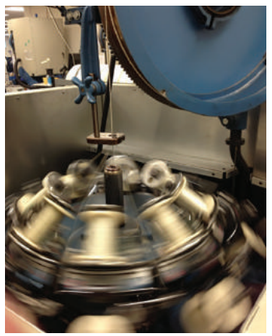
Inner Diameter in (mm)	Weight Savings			
	Nickel-Plated		Silver-Plated	
	100%	Blend	100%	Blend
0.125 (3.18)	62%	43%	66%	49%
0.250 (6.35)	62%	44%	66%	49%
0.500 (12.70)	62%	43%	66%	48%
0.750 (19.05)	63%	45%	67%	50%
1.00 (25.40)	81%	72%	83%	75%
1.50 (38.10)	81%	72%	83%	75%

RESISTIVITY: ARACON-BRAIDED EMI SHIELD

Inner Diameter in (mm)	Resistance (mΩ/ft)			
	Nickel-Plated		Silver-Plated	
	100%	Blend	100%	Blend
0.125 (3.18)	75.9	26.8	75.9	18.8
0.250 (6.35)	36.7	9.1	36.7	9.1
0.500 (12.70)	17.8	4.4	17.8	4.4
0.750 (19.05)	11.9	5.6	11.9	2.9
1.00 (25.40)	8.5	4.3	8.5	2.4
1.50 (38.10)	5.7	1.3	5.7	1.3

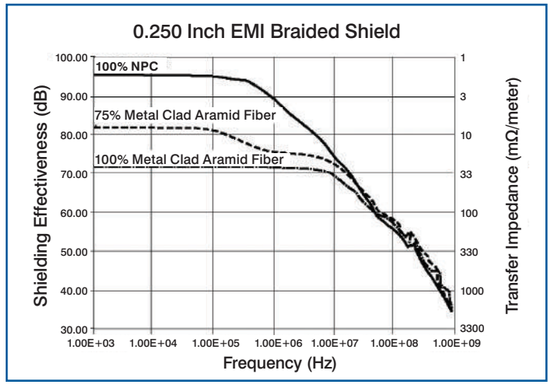
Capabilities

- Manufacturing
- Electro-less and electrolytic plating
- Braiders: 8, 16, 24, 64, 72, and 96 carrier
- Class 10,000 clean-room
- Fully equipped metallurgical laboratory
- Tensile tester
- Transfer impedance test set
- RF shielding test to 18 GHz
- Environmental testing – thermal and corrosion
- Optical, X-ray, and SEM material analysis

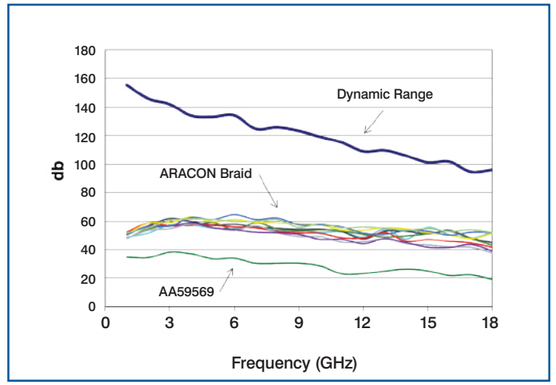


High-speed braiding

ARACON Transfer Impedance

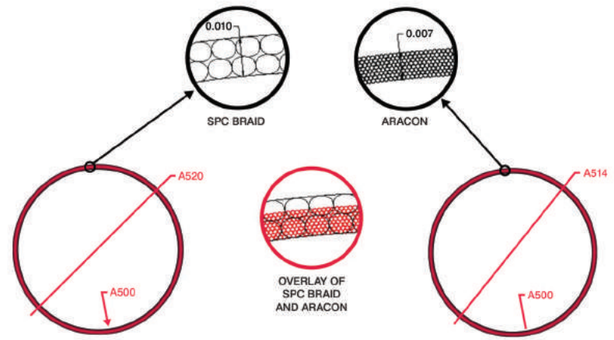


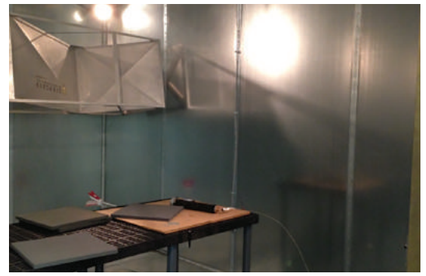
ARACON RF Shielding Effectiveness

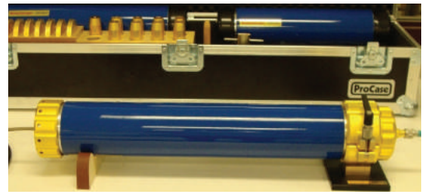


Hidden EMI Shielding Advantage

Conformal Coverage Targeting 90%







In-house RF shielding & transfer impedance testing

Performance Summary

Thermal Environments

- Operating range: -65 °C to 150 °C intermittent exposure to 200 °C
- Thermal aging: 150 °C for seven days
- Thermal shock: 50 cycles full operating range

Altitude

- Operating sea level to vacuum; no change in DC resistance
- Low-outgassing material

Corrosive Environments

- Nickel material meets 500 hr salt fog and 48 hr sulfur dioxide
- Broad range of resistance to fluid immersion

Lightning Susceptibility

- Level 3 to Level 5 multistrike capability per ANSI/EIA 364-75 and RTCA DO-160
- Capability exceeds 25kVA Waveform 5B

Flammability

- Does not burn when tested per FAA, Boeing, and Airbus methods

Smoke Density & Toxicity

- Complies with FAA, Boeing, and Airbus requirements

Flexibility

- Life cycle of over 50,000 cycles over 180° arc

Left to Right: Octax-Solo JRN, Octax-Solo IR, Octax-Solo plug, Octax-Solo flange-mount receptacle

Octax®-Solo 10 Gbps Ethernet Interconnect System

Our Octax®-Solo 10 Gbps Ethernet Connector is a single-port, standalone connector designed for a wide variety of aerospace and military applications. The Octax connector:

- Uses innovative inserts that isolate each twisted pair and contact, virtually eliminating near-end crosstalk
- Features cable and twists that are maintained extremely close to the contacts, minimizing characteristic impedance mismatch
- Delivers 10x the transmission speed (10 Gbps signal) and 2x the density compared to Quadrax-type solutions

FEATURES	BENEFITS
Gigabit and 10 Gb Ethernet data transfer speed	• Allows for higher data quantities to transfer at quicker speeds covering a variety of 1 Gb applications and emerging 10 Gb needs
Field repairable	• Designed for easier and less costly on-site termination repair
Uses standard 22D crimp contacts (M39029)	• Standard off-the-shelf contacts are readily available and require no special tooling
Small form factor	• Critical space savings for highly dense applications
Anti-decoupling/self-locking mechanism for rugged environments	• Connector will not disconnect/uncouple in a high-vibration application

Suggested Applications

- Single-port 10 Gbps Ethernet connector (compatible with Gigabit series Ethernet cables)
- Aerospace & military
  - Avionics
  - IFEC
  - High-definition video displays
  - Data loading
- Any high-speed Ethernet application

Part Number & Description

Part Number	Description	Finish
OCTAX-SOLO-FMR	Flange mount receptacle connector	Ni PTFE
OCTAX-SOLO-JNR	Jam nut receptacle connector	Ni PTFE
OCTAX-SOLO-IR	Inline (flange-less) receptacle connector	Ni PTFE
OCTAX-SOLO-P	Plug connector	Ni PTFE
OCTAX-SOLO-FM-PCB*	Straight PCB flange mount receptacle connector	Ni PTFE
OCTAX-SOLO-FMR-W	Flange mount receptacle connector	CADMIUM OD
OCTAX-SOLO-JNR-W	Jam nut receptacle connector	CADMIUM OD
OCTAX-SOLO-IR-W	Inline (flange-less) receptacle connector	CADMIUM OD
OCTAX-SOLO-P-W	Plug connector	CADMIUM OD

*Jam nut design also available

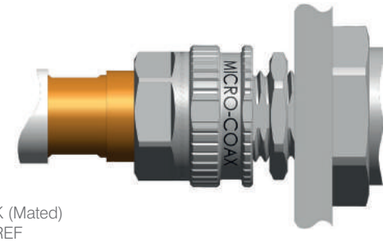
Safe-D-LOCK® Connectors & Cable Assemblies

Safe-D-LOCK® connectors offer a reliable alternative to conventional self-locking connectors, adhesive compounds, or safety wire. The unique design installs quickly without wasting valuable mass or space in the host system.

Safe-D-LOCK locks to the D-FLAT on the mating connector, providing a true lock that cannot be compromised when the cable is rotated.

Safe-D-LOCK technology is contained entirely in the coupling nut of the connector, which allows the feature to be easily ported into different implementations, including low-profile, right-angle connectors.

Safe-D-LOCK (Unmated)
Mass: 5.6 g REF

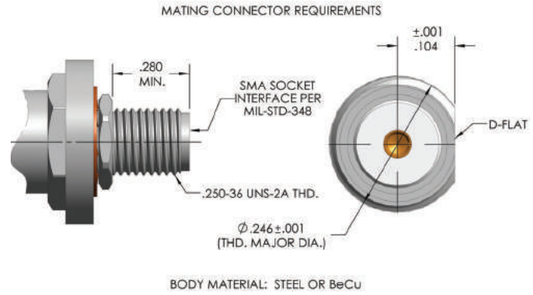


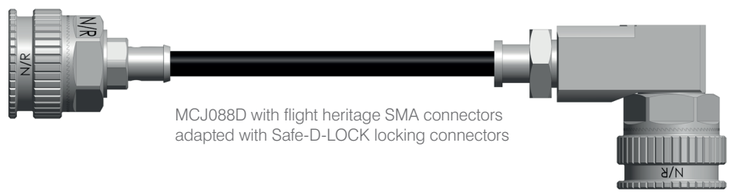
Safe-D-LOCK (Mated)
Mass: 5.6 g REF

NOTE: Conventional self-locking connector mass: 10.3 g REF

Key Characteristics

- Eliminates post-mate staking adhesives or FOD-prone safety wires
- Flight heritage cryogenic operation to 20 Kelvin
- Mated interfaces overcome cable integration torque, guaranteeing glitch-free signal integrity
- 50% weight savings over conventional self-locking connectors
- Modular design ports easily and economically to all SMA, 2.92 mm, and 3.5 mm connector families





MCJ088D with flight heritage SMA connectors adapted with Safe-D-LOCK locking connectors

Cryogenic Applications:
The BeCu center conductor and stainless-steel jacket, which provide excellent thermal conductivity and dimensional stability, partners with the Safe-D-LOCK mechanical locking feature in lieu of adhesive staking, which will crack and fail.

SMP-L Interconnect Series

SMP-L Connectors

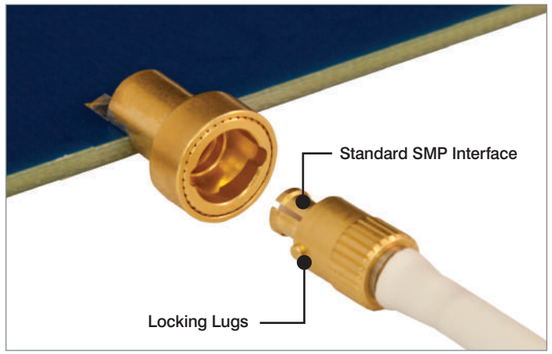
The introduction of push-on blind-mateable connectors, such as the SMP, galvanized the RF/Microwave industry as their use enabled designers to increase package density. This created the ability to stack PC boards while also simplifying the assembly and test of these designs.

We have advanced the design of traditional SMP connectors even further with our line of SMP-L connectors. These connectors incorporate Secure-Lok™, a patented locking mechanism, into the standard SMP interface, which reinforces holding power, making them:

- Less susceptible to vibration and other environmental factors present in high-vibration, rugged applications
- A reliable alternative to threaded connectors

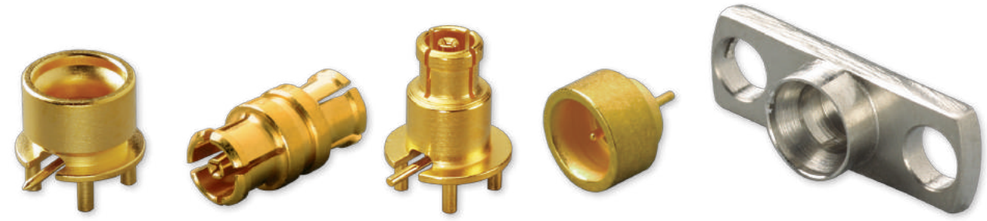
Features

- Secure-Lok mechanism (US Patent No. 8579659)
- Frequency range: DC - 40 GHz
- Superior ruggedability and performance compared to standard push-on connectors
- Fully compatible with SMP standard product line



Secure-Lok Mechanism

SMPM® Interconnect Series



SMPM Connector Product Line

We have designed the SMPM® Connector product line to further improve the package density of RF/Microwave systems. With an interface about 30% smaller than its predecessor, the SMPM Connector is now an industry standard (as outlined in the MIL-STD-348 document) for RF/microwave applications and has enabled design engineers to increase design performance and complexity while improving form factor.

The durable construction and ability to tolerate radial and axial misalignment allows for a blind-mate interconnect solution capable of withstanding multiple engagement/disengagement cycles without degradation in electrical performance.

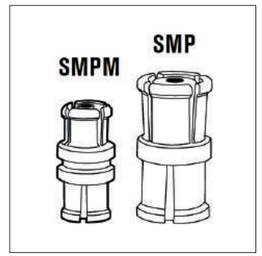
Due to its high-frequency performance and blind-mate configuration, the SMPM Connector is a standard interface in many applications, including:

- Antennas
- Broadband
- Wireless
- Military
- Instrumentation

Features

- DC - 65 GHz frequency range
- 50 Ω impedance
- Blind-mate configuration
- MIL-PRF-39012 compliant
- Ability to withstand radial/axial misalignment
- Board-mount, field replaceable, bullets, hermetic, and cable connector configurations
- Custom connectors available

Specifications



The SMPM Connector is about 30% smaller than its predecessor, the SMP Connector.

Left: SMPM Female to 2.92 mm Male Adapter (P123-1CCSF) Right: SMPM Female to .047" Cable (P107-1CC)

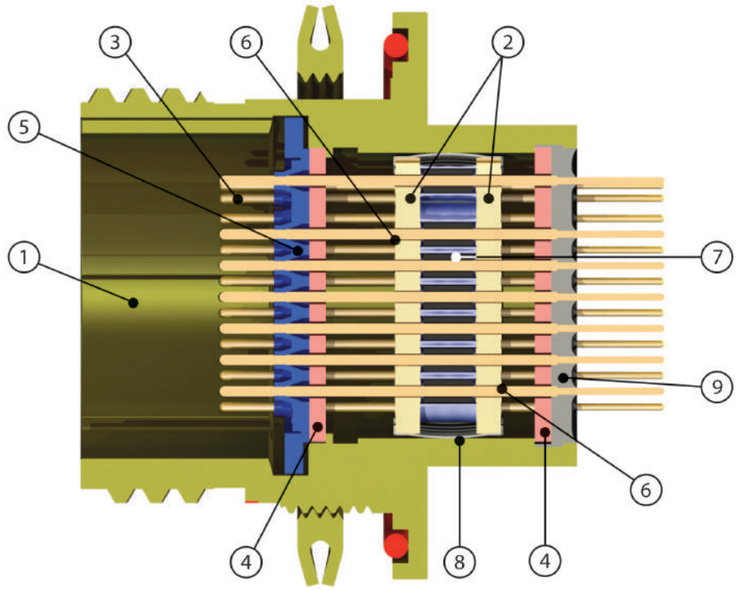
Parameter		Specifications
Impedance		50 Ω
Frequency Range		DC - 65 GHz*
VSWR		1.02 + 0.012 x F (GHz)
Insertion Loss		0.04 x √F (GHz)
DWV		325 Vrms
Insulation Resistance		5000 MΩ (min)
RF High Pot		190 Vrms @ 5 MHz
Force to Engage	Detent	6.5 lb. (max)
	Smooth Bore	2.5 lb. (max)
Force to Disengage	Detent	4 lb. (min)
	Smooth Bore	1.5 lb. (min)
Radial Misalignment		+/- .010"
Axial Misalignment		0.000/0.010"
Temperature Range		-55 ºC to 165 ºC
Thermal Shock		MIL-STD-202, Method 107, Cond C
Moisture Resistance		MIL-STD-202, Method 106, except step 7b
Corrosion		MIL-STD-202. Method 101, Cond B
Vibration		MIL-STD-202, Method 204, Cond D
Shock		MIL-STD-202, Method 213, Cond I

Why Filters in a Connector?

Theory & Types

If your circuitry is suffering the ill effects of interference from radio waves, stray transmissions, electric power lines, or electric motor noise, you are experiencing EMI (electromagnetic interference). This leads the circuit designer to consider EMI filters. A second issue, EMP (electromagnetic pulse), is driven from the catastrophic effects of extremely high voltage and short duration pulses of energy. Traditionally, concern for nuclear attack was high priority. Now, in the military and aerospace environments, protection from lightning strikes and similar high-energy sources is a top priority. Protection from this sudden, unwanted overvoltage situation is more commonly referred to as TVS (transient voltage suppression).

EMI and EMP are looking for a path to your circuits, and that path is usually an antenna or a cable set running to the circuit that is acting as an antenna. The key warrior against EMI is a capacitor element. Typically, we battle transient voltage with a Zener diode. Where is the best place to put these elements? Often military and avionics boxes house the critical circuitry. If the cable set is the antenna, then the best placement for the filter is at the cable/box interface, preventing the unwanted signals from entering the system. A multi-pin filter or TVS connector is the ideal solution.



Typical “Pi” filter construction

1. **Shell** – Plated aluminum alloy
2. **Capacitors** – Ceramic, planar
3. **Contacts** – Brass for pin contacts; copper alloy for socket contacts; gold plate finish
4. **Insulators** – High-grade thermoplastic/thermoset or epoxy glass laminate
5. **Interfacial/Peripheral Seal** – Typical construction is fluorosilicone
6. **Solder**
7. **Inductors** – Ferrite beads
8. **Ground Spring** – Beryllium copper plated, 360° orientation inside of shell
9. **Epoxy**

Filter Connector Options

Circular Filter Connectors

For EMI Protection

Left to Right:
26482, 38999 III
38999 IV

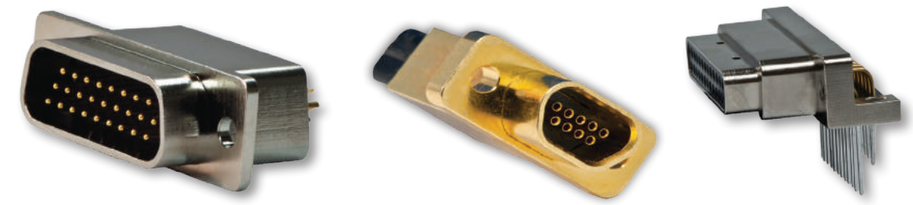
Our Circular Filter Connectors meet the requirements of their specific connector MIL-SPECS, including shock and vibration at temperature. These low-pass filter connectors include the most popular circuits, C, CL/LC, Pi, and T. They are constructed using planar filter technology for maximum strength and high performance, from low to high frequencies. Multiple capacitance values, circuits, feedthroughs, and/or grounds can be incorporated into the arrangement to produce the desired performance. All thermal processes are profiled and controlled, cleanliness checked, and electrical testing of 100% of the contacts is done to ensure a quality product.

Performance, Benefits, and Certifications

- Planar design
- Sealed (for aqueous cleaning)
- Ferrite immobilization
- Can offer solderless designs
- Space qualified
- Can incorporate filtering plus transient voltage suppression

Rectangular Filter Connectors

For EMI Protection



Left to Right:
D-Sub, Micro-D,
D-Sub Right Angle

Our D-Sub and Micro-D Filter Connectors meet all the requirements of MIL-PRF-24308 and MIL-PRF-83513 while providing filtering in accordance with the attenuation curves noted here. MIL-PRF-24308 connectors (standard and high density) and MIL-PRF-83513 are manufactured in all layouts offering maximum contact density in a minimum of space.

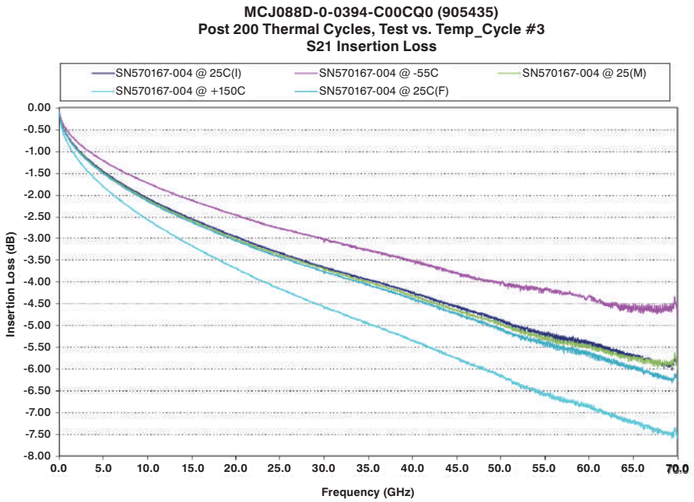
Both series of connectors are offered with the standard variations in mounting hardware, standard straight or right angle contacts and PCB, solder cup, and crimp termination.

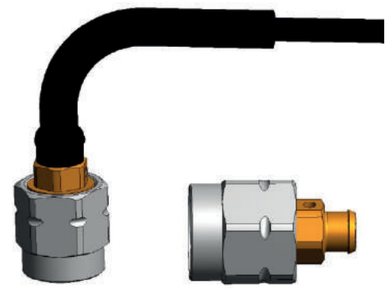
Performance, Benefits, and Certifications

- Planar design
- Machined shells
- Ferrite immobilization
- Space qualified
- Can incorporate filtering plus transient voltage suppression
- Can meet DO-160 lightning requirements

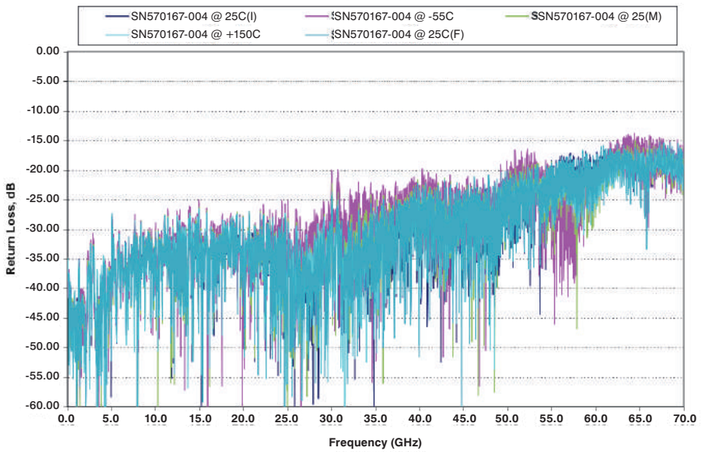
High-Frequency Cable Assemblies

- MCJ088D 70 GHz S-parameters over temperature
- Increasing operational frequency for qualified MCJ0888D cable
- 1.85 mm interfaces maintain connector interface control and baseline electrical performance through 200 thermal cycles, -50 °C to 100 °C, and post 200 thermal cycle S-parameters versus temperature



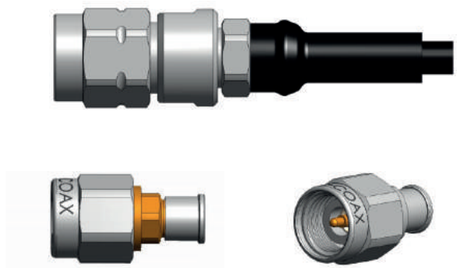


Precision-formed ends for optimal electrical performance

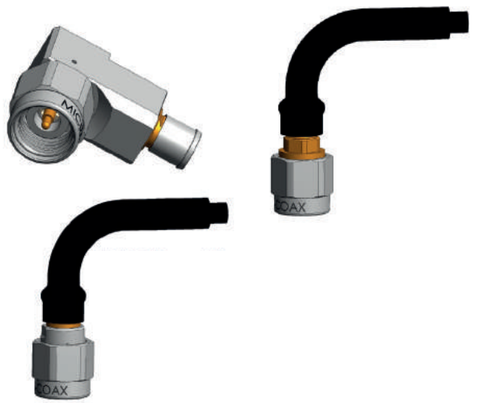


Frequency-Optimized Cable Assemblies

- MCJ115A 55 GHz flexible cable assembly configurations
- Improved dB/ft (dB/m) vs. 0.088" diameter to address V-band operation



Precision 2.4 mm connectors



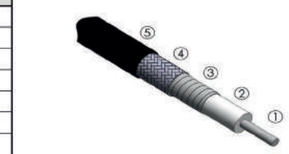
Swept and block right-angle connector options

UTiFLEX PRODUCT SPECIFICATION

Part Description	Item Number	Rev.
MCJ115A	118817	B

Construction Layers and Standards

1	Center Conductor	Silver-plated copper per ASTM B-298
2	Dielectric	Ultra-Low-density PTFE in accordance with MIL-DTL-17
3	Outer Conductor	Silver-plated copper per ASTM B-298
4	Outer Shield	Silver plated poly-para-phenylene terephthalamide
5	Jacket	ETFE-Fluoropolymer, black in color, in accordance with ASTM D-3159
6	Cable Marking	None



Mechanical / Physical Properties

Temperature Range (°C)	-65 / +125		
Center Conductor Diameter [inch(mm)]	0.0296	(0.75)	
Dielectric Diameter [inch(mm)]	0.0820	(2.08)	
Outer Conductor Diameter [inch(mm)]	0.0900	(2.29)	
Outer Shield Diameter [inch(mm)]	0.105	(2.67)	
Jacket Diameter [inch(mm)]	0.115 (2.92)	± 0.004	(0.10)
Jacket Wall Thickness [inch(mm)]	≥ 0.004	(0.102)	
Weight [grams/ft (grams/m)]	≤ 5.5	(18.0)	
Min Static Bend Radius [inch(mm)]	0.375	(9.53)	
Flex Life - Snake® [Cycles]	50,000		
Center Conductor Strands	1		

Environmental Properties

Where applicable after each test, the assembly shall show no damage, insertion loss and VSWR shall remain within the specified limits, and connector interface dimensions remain within the specified limits of MIL-PRF-39012.

Thermal Shock	MIL-STD-202, Method 107, 20 Cycles, -65 to +125 °C
Aging Stability	MIL-DTL-17, Paragraph 4.8.16, +125 °C for 168 hours
Vibration	MIL-STD-202, Method 204, Test Condition B
High Pressure	Pressure increased ≤ 10 bar/min to 100 +/- 2 bar for 12 hrs.
Low Pressure	SAE-AS-13441, Method 1004.1
Humidity	MIL-STD-810, Method 108, Procedure 1 and 2
Salt Fog	MIL-STD-810, Method 509, Procedure 1
Sand and Dust	MIL-STD-810, Method 510, Procedure 1
Stress Crack Resistance	MIL-DTL-17, Paragraph 4.8.17
Cold Bend Test	MIL-DTL-17, Paragraph 4.8.19
Outgassing	Less than 1% TML and 0.1% CVCM
Radiation Resistance	100 Mrads

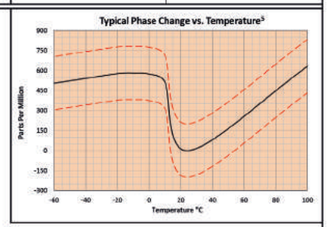
Maximum Attenuation,[1] Power, and VSWR[6,7] at 20°C and Sea Level

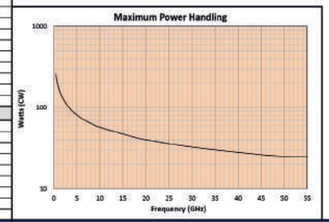
Frequency (GHz)	dB / 100ft	dB / m	Watts (CW)	VSWR
0.5	11.0	(0.35)	260	1.20
1	15.0	(0.49)	183	1.20
5	34.0	(1.10)	81	1.20
10	48.0	(1.57)	57	1.20
18	64.0	(2.11)	42	1.20
26.5	79.0	(2.58)	35	1.25
40	97.0	(3.18)	28	1.30
50	109.0	(3.57)	25	1.30
55	114.0	(3.75)	25	1.30

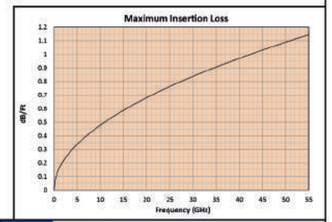
Electrical Properties

Impedance (Ohms)	50
Velocity of Propagation (%)	82.0
RF Shielding (dB)	≥ 100
Capacitance [pF/Ft pf/m)]	24.75 (81.20)
Cutoff Frequency (GHz)	55.88
Corona Extinction (VRMS @ 60Hz)	1500
Dielectric Withstanding (VRMS @ 60Hz)	5000
Insertion Loss Stability (% Change)[2]	≤ 5
K1 per Ft(m) : K2 per Ft(m)	14.89 (0.488) : 0.07 (0.002)

Phase vs. Bend – Contact Carlisle for specification







Notes:

1. Attenuation (db/100ft) = K1√F + K2F where F is Frequency in GHz
2. Insertion Loss change while vibrated at a frequency of 6 Hz and an amplitude of 1 inch
3. Connect both ends of cable to flex (snake) machine. The movement of the flex machine arm from 36 to 18 inches, stopping, and then returning to 36 inches shall be 1 flex cycle
4. Not used
5. Cable assemblies of equal length and connectors made from the same cable manufacturing lot shall phase track within 200 PPM of each other
6. Test Plots required with Shipment (Attenuation and VSWR)
7. VSWR testing to be performed on 20-foot minimum lengths with gating used to remove connector contributions. Minimum frequency points shall be 1601

Rev.	ECN #	DATE	INIT.	APPROVALS		
B	1950151	3/6/2019	VLF	DWN	NAP	5/9/2018
				ENG	JWF	3/14/2019
				QA	PR	3/28/2019

Specifications subject to change. Please contact Carlisle Interconnect Technologies for the latest document revision.

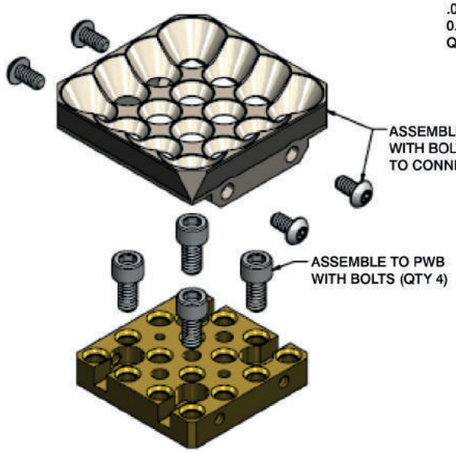
Carlisle Interconnect Technologies
206 Jones Blvd.
Pottstown, PA 19464

FSCM NO. 64639

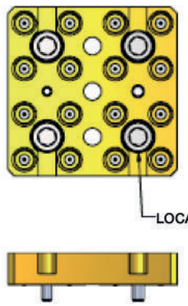
CARLISLE INTERCONNECT TECHNOLOGIES

MCJ115A CABLE SPECIFICATION

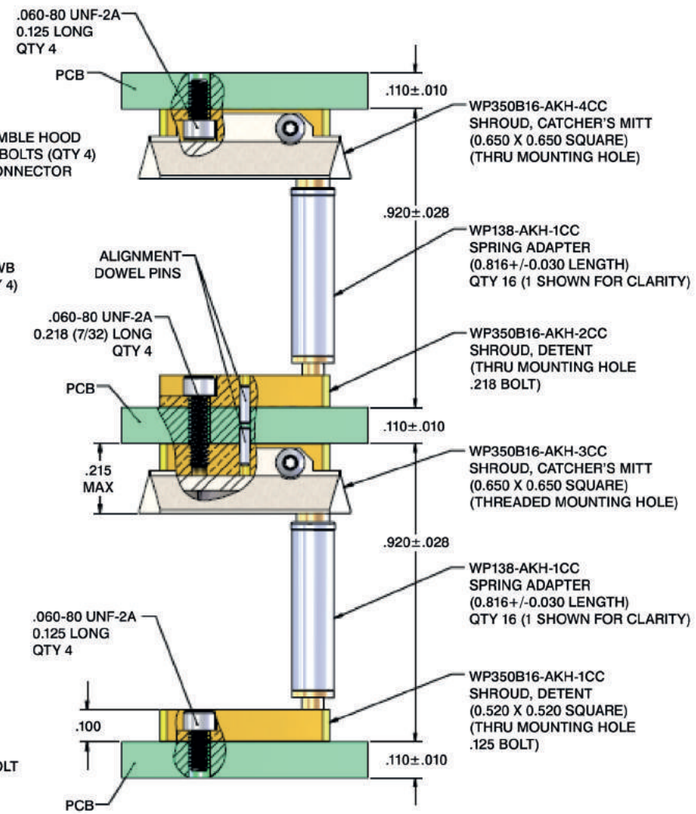
16-Position SMPS Board-to-Board Interconnect



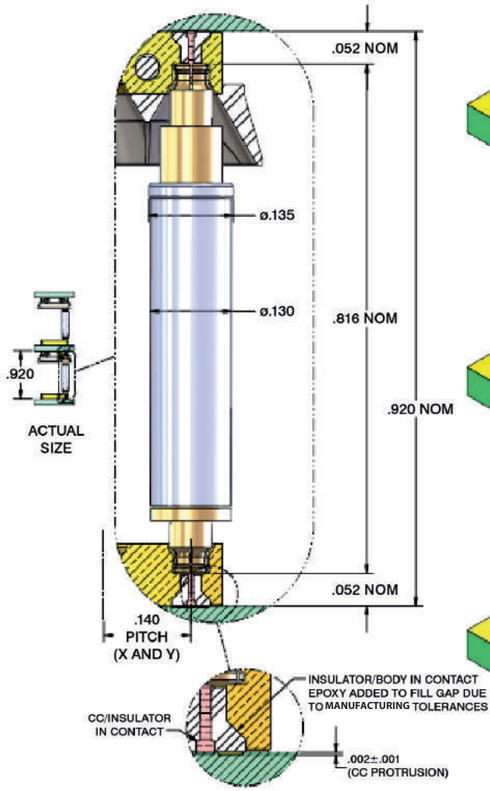
CATCHER'S MITT



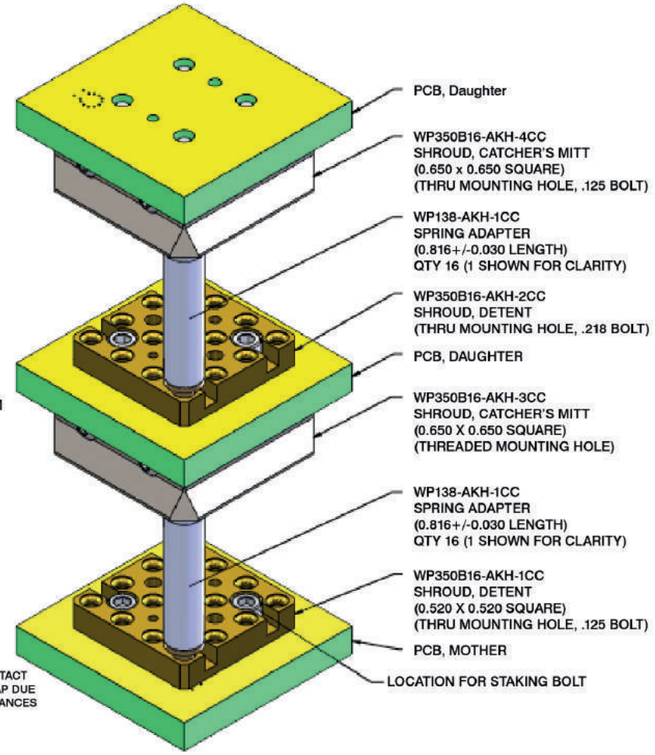
DETENT AND CATCHER'S MITT



SMPS LAYOUT
OPTION 1: COMPRESSION
CARLISLE INTERCONNECT TECHNOLOGIES
UPDATED: 02/06/2020



POSITIVE COMPRESSION: BEARING SURFACE
BETWEEN CC TO INSULATOR AND BETWEEN
INSULATOR TO BODY



SMPS LAYOUT
OPTION 1: COMPRESSION
CARLISLE INTERCONNECT TECHNOLOGIES
UPDATED: 02/06/2020

Solutions for

LEO SATELLITES

From the early 1990s' Teledesic "internet in the sky" concept to today's hundreds of LEO satellites, we have been prepared to support the market in all aspects. Our foundations of performance and quality are well established throughout the GEO satellite industry, partnering with technology leaders for more than 40 years. Pivoting from the GEO to the LEO market is an effortless transition thanks to our mature and stable global supply chain, command of logistics, engineering flexibility, and vertical integration of all satellite interconnect technologies.

All of our products are manufactured at one of our Centers of Excellence, each offering innovative packaging and adaptable configurations to reduce size, weight, and integration time. Even with its reduced life cycle, it's evident the LEO market demands the same reliable performance that has been delivered to the GEO market — but at commercial availability, volume, and pricing. And with our Carlisle Operating System (COS) guiding each of our Centers of Excellence, we are uniquely positioned to respond to that demand.

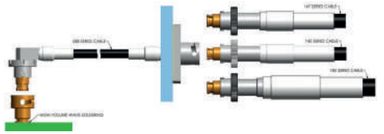
Why CarlisleIT?

- Priced to support the high-volume/cost-driven LEO satellite market
- Connector-to-cable termination designs that support high-volume cable assembly processing
- Supply chain structure that stabilizes cost over yearly long-term procurement cycles
- Multiport, quick-connect signal packaging that reduces time and complexity for the integrator without compromising reliability and performance
- Single-point, quick-connect integration based on our patented SMP-LOK technology to support heritage flight products
- Unwavering quality standards that have been delivered for more than 40 years to the global satellite integrator and satellite equipment market

Fast Steering Mirror Sensors

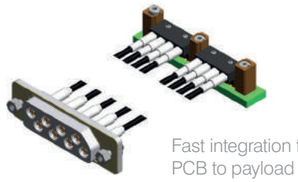
Fast & accurate nanometer control of optical inter-satellite links

New Space & Quick-Connect SMP-LOK Cable Assemblies



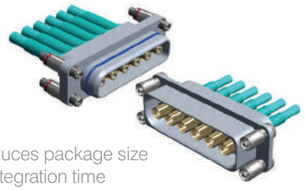
Innovated to address LEO cost targets

PCB Multiport Quick-Connect Harness



Fast integration from PCB to payload

Multiport Quick-Connect Harness With Push-On Type RF Interface



Reduces package size & integration time

Fast Steering Mirror Sensors

EDA500 Sensor-Driver System for FSM & Differential Sensing Applications

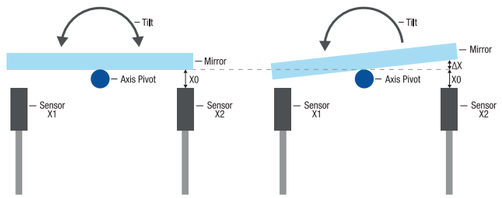
Featuring state-of-the-art Lion Precision Eddy Current Sensors, the new EDA500 controller is the ideal off-the-shelf solution for Fast Steering Mirror and differential sensing applications. The EDA500 system comes with two matched pairs of high-resolution noncontact Eddy Current Sensors, the driver with four sensor inputs (two per axis), an analog output, and a nine-pin connector interface for easy connectivity.

Designed for

- Fast Steering Mirrors (FSM)
- Telescope and microscope stabilization
- Image stabilization

How It Works

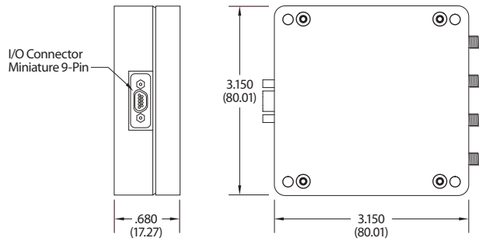
The differential system provides feedback from any change in the null position. As shown below, small changes in the tilt of the target are measured and sent to the actuator to allow fast and accurate control and positioning.



Features

- High bandwidth
- High resolution
- Low power consumption
- Excellent temperature stability
- Matched sensor for high stability and repeatability
- Radiation tolerant

The system can be customized for specific applications and is also available as a board without an enclosure for space savings and easy integration into a control system.



SPECIFICATIONS	
Input Voltage	±15 VDC
Power	1.0 watts
Output	± 5 VDC SE, opt. ±10 VDC diff.
Linearity Error	±0.3% F.S.
Operating Temperature	-25 °C to 55 °C
Probe Operating Environment	-25 °C to 55 °C
Weight (Electronics)	35 grams (board only) 157 grams (with enclosure)
Weight per Probe (1 meter)	13.4 grams
Null Gap*	0.5 mm
Measuring Range*	±0.35 mm
Thermal Sensitivity at Null	0.01% F. S./ °C
Frequency Response	18 kHz

**Standard range shown; custom ranges available upon request.*

New Space & Quick-Connect SMP-LOK Cable Assemblies

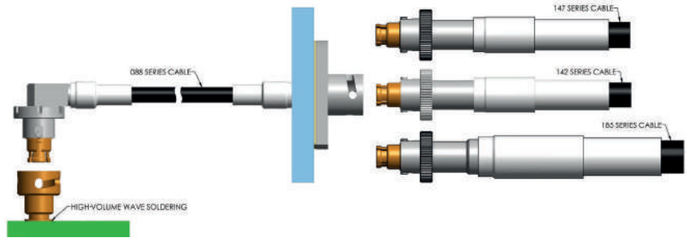
- Designed to support high-volume, quick-turn cable assembly processing
- Leveraging qualified designs supporting the GEO market for more than 20 years
- Patented SMP-LOK Quick-Connect option transitioning from PCB to Payload interconnects
  - Reduces time and complexity for the integrator
  - Same reliability and performance as heritage SMA/SMK threaded interface
  - Unwavering quality standards that have supported the global satellite integrator and satellite equipment market for over 40 years

New Space

SMA plug, 205 series cable

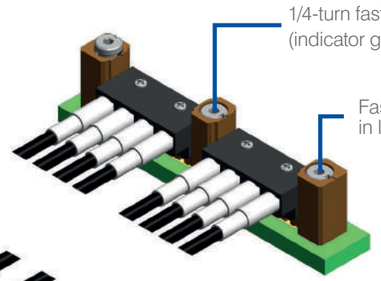
2.92 mm (K) plug, 205 series cable

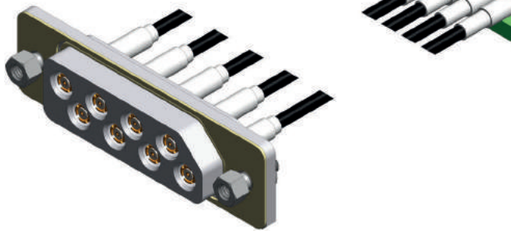
SMP-LOK

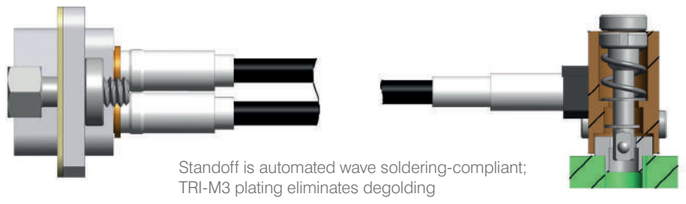


PCB Multiport Quick-Connect Harness

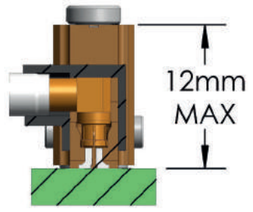
- Automated processing
- Top loading
- Solderless quick connect
- Modular 8-way & 4-way board interconnect





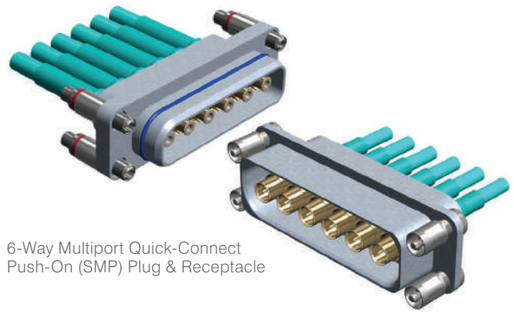


Standoff is automated wave soldering-compliant;
TRI-M3 plating eliminates degolding

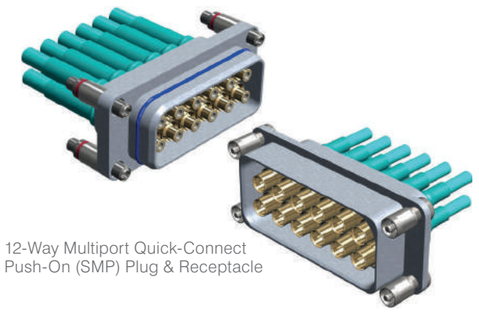


SMPM right-angle female
mated to board-mount SMPM
male typ. (8x)

Multiport Quick-Connect Harness With Push-On Type RF Interface



6-Way Multiport Quick-Connect
Push-On (SMP) Plug & Receptacle



12-Way Multiport Quick-Connect
Push-On (SMP) Plug & Receptacle

Our Multiport Quick-Connect Harness with push-on type RF interface is designed to reduce time and cost for the integrator without impacting reliability or performance. And like heritage single-point threaded interfaces such as SMA and SMK, the Multiport Quick-Connect Harness supports the same critical operating frequencies, return loss, and RF shielding specifications.

We also offer:

- Push-on male and female connector interfaces per MIL-STD-348
- Modular and configurable housings based on the preferred push-on type interface
- Controlled 1/4-turn quick connect with visual lock/unlock indicator
- Field-replaceable cable assemblies with extraction tool
- Full range of UTiFLEX®/UTiPHASE™ cable diameters, allowing for varying insertion loss performance
- Heat-shrink reinforcement with integration indicators and build-to-print labeling
- Design flexibility to support 2x – 12x transmission paths

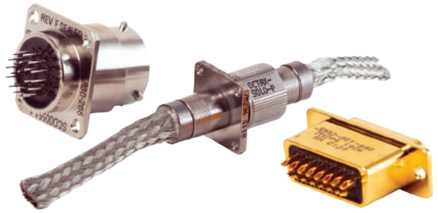
FEATURES	BENEFITS
40 GHz operation	• A single configuration to address all satellite communication bands
19 dB return loss and -80 dB RF shielding	• Offers the same high-performing RF output as single-point SMA and SMK interconnects
Spring-loaded, locking, 1/4-turn fastener with visual lock/unlock indicator	• Removes the need for controlling wrench torque and securing coupling nuts with epoxy
Flight, TVAC, and T&M availability	• No change in performance, whether it be a fully rated space flight model or test and measurement harness

Space-Grade Assembly Processes

- Burr-free connector components verified at 10x magnification along the entire internal and external surface area with the ability to inspect up to 1000x magnification as required
- Connector component plating quality controls exceeding industry standards
- Proprietary degolding processes, meeting the requirements of NASA-STD-8739.3 and J-STD-001ES
- Thermal stabilization of components prior to assembly
- Class 10,000 clean-room environment for the construction of spaceflight connectors and cable assemblies
  - Real-time X-ray to ensure proper connector-to-cable assembly and solder fill and workmanship to the stringent requirements of the space customer
  - 100% inspection of all electrical and mechanical requirements
  - Hand cleaning of all assemblies to include connector interfaces prior to packaging
- ESD-safe packaging purged and backfilled with nitrogen before being heat-sealed

Multipactor-Resistant Connector Designs

- Many custom and standard connector designs available for multipactor-sensitive applications
- Custom connector designs for multipactor applications designed in accordance with NASA, aerospace, and ESA guidelines

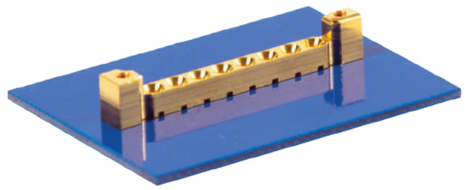


Radiation Resistance

- UTiFLEX® cable assemblies for spaceflight applications offered with FEP and TEFZEL® jackets
- Standard UTiFLEX FEP jacketed cable designs proven to resist up to 30 Mrads of radiation and TEFZEL jacketed designs up to 100 Mrads

Minimized Passive Intermodulation Interference

- Cable and connector materials and finishes carefully selected to minimize effects due to passive intermodulation
- Excellent thermal stability
- We offer a wide selection of cables that optimize loss and phase stability vs. temperature, along with excellent mechanical stability over a wide range of thermal extremes



Non-Outgassing Materials

- Our spaceflight cable assemblies are manufactured with parts and materials with a maximum Total Mass Loss (TML) of <1% or collectible volatile condensable material level of <0.1% when tested per ASTM E-595

Key Product Standards

- Electrical testing for AC, DC, RF, fiber optic-based products, including EMC
- Mechanical testing facilities for shock, vibration, crush resistance, and flex
- Environmental testing to various MIL-Def standards
- Overmolding capability
- 2D and 3D form board mockups

Operating Standards

- Space-certified trainers and operations
  - IPC-A-620 (including space addendum)
  - IPC-J-STD-001 (including space addendum)
  - IPC-A-610
  - IPC-A-600
  - NASA-8739.1 polymetric applications
  - NASA-8739.2 surface mount
  - NASA-8739.3 J-STD-001S soldering
  - NASA-8739.4 crimping and wiring
  - NASA-8739.5 fiber optic terminations
- Assembly test capabilities
  - X-ray, electrical length
  - Skew
  - Impedance (characteristic, differential, common mode)
  - Insertion loss, return loss/VSWR
  - TDR (time domain reflectometry)
  - Eye patter, jitter
  - Bit error rate testing (BERT) crosstalk
  - Propagation delay
  - Rise time, fall time, rise time degradation
  - Continuity/DC resistance
  - Hipot/dielectric strength

Summary of RF tests completed on our RF interconnect products available at: CarlisleIT.com/prod-info/space-standards-qualifications/

Global Manufacturing. **Local Support.**

Wherever you are, so are we. With manufacturing centers around the globe, our highly qualified team is up to any challenge. Our extensive worldwide manufacturing capabilities, coupled with end-to-end local project management and engineering support, allow us to design, build, test, and certify your product in-house, saving you the time and hassle of managing multiple vendors.

FACILITIES CERTIFICATIONS

AS 9100 CERTIFIED · ISO 9001 CERTIFIED · ISO 13485 CERTIFIED · ISO 14001 CERTIFIED · ISO 50001 CERTIFIED · FAA PMA · ITAR REGISTERED · FDA REGISTERED

Visit our website to view certifications listed by site.

PRODUCT CERTIFICATIONS

RoHS COMPLIANT · MILITARY STANDARD MIL-STD COMPLIANT · c UL us LISTED · SAE INTERNATIONAL

Contact us directly for products engineered to your specific compliance needs.

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