COTSWORKS®

Company Portfolio

www.cotsworks.com

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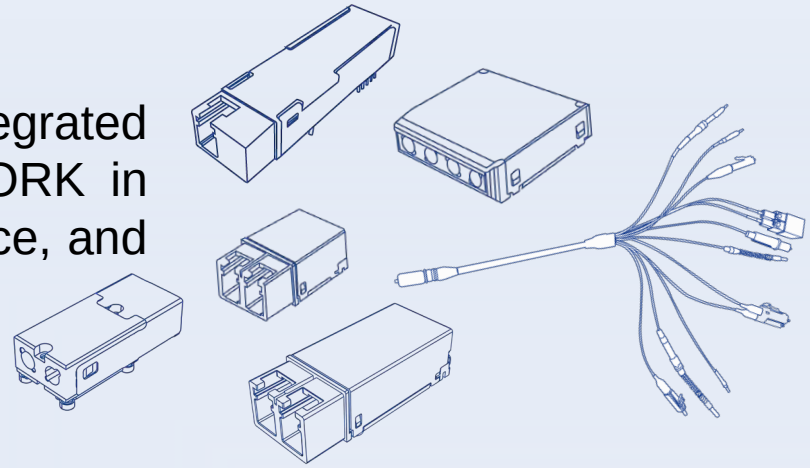
About COTSWORKS

COTSWORKS, INC. is an innovative manufacturer of rugged optical components and subsystems for harsh environment networking and sensing applications.

Commercial-Off-The-Shelf components are integrated across multiple engineering disciplines to WORK in the most consistent, highest quality, performance, and cost-effective ways.



These products are designed for Commercial and Military Aerospace, Military Tactical, Industrial & Energy, Rugged Networking, and Sensor markets.

COTSWORKS®

COTSWORKS PROCESS

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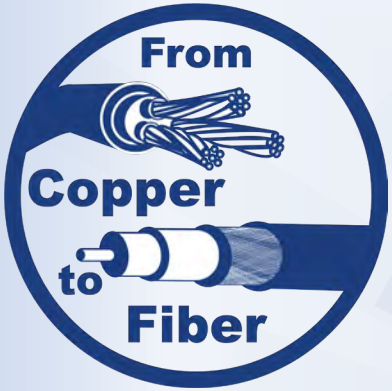
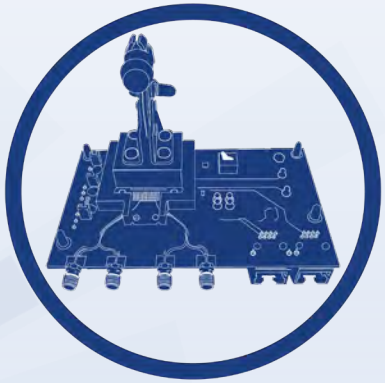
INNOVATION



CREATION

INTEGRATION



OPERATION

TRANSITION

DOCUMENTATION

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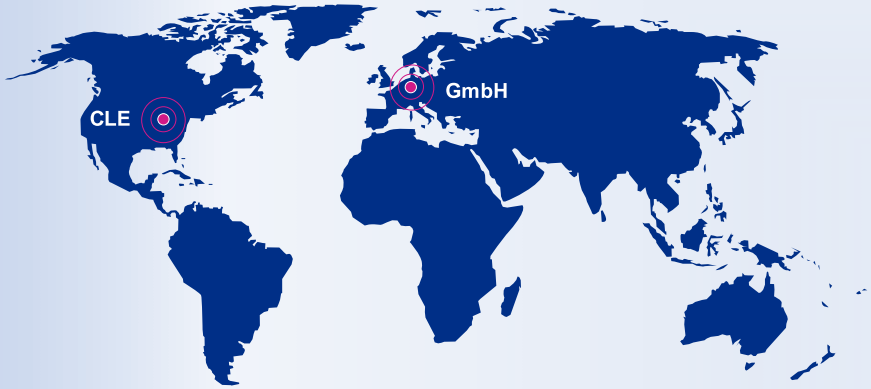
COTSWORKS®

Company History

- COTSWORKS, INC. is an innovative designer, developer and manufacturer of fiber optic transceivers, cables, complex cable assemblies, and optical test equipment for aerospace, defense, oil and gas, and other rugged industrial environments.
- Commercial-Off-The-Shelf components are integrated across multiple engineering disciplines to WORK in the most consistent and highest quality, performance, and cost-effective ways
- Our products are designed for commercial and military aerospace, military tactical, industrial & energy, rugged networking & sensor markets.

**Excluding Pandemic Years*



100+ Empl oyees

30,000 SQ FT high te ch facility

***21%** Annual Growth

100,000+ Parts shipped annual ly

2006 — WDM transceivers and passives ruggedized for Mil/Aero applications

2007 — COTSWORKS founded in Cleveland, Ohio USA

2008 — COTSWORKS expands mfg facility with advanced ESD implementation

2009 — COTSWORKS achieves ATEX certification for Oil & Gas product applications.

2010 — Enhanced RJ Transceiver released, supporting digital diagnostics, 5Gbps, and SM fiber

2011 — COTSWORKS achieves ISO 9001 certification for design and manufacturing of opto-electronic devices.

2012 — RCP is upgraded for new radar applications, offering 15 dB of link budget at 10Gbps

2013 — COTSWORKS achieves ISO 9001 certification for design and manufacturing

2014 — The RCP product platform is expanded to include quad Tx or Rx configurations in addition to standard duplex.

2015 — COTSWORKS named one of the top 100 fastest grow ing companies in Northeast Ohio

2016 — AS9100C certification achieved with production capacity exceeding 250,000 units/year

2017 — New production and engineering areas added to support grow th of complex cable assembly offerings

2018 — COTSWORKS receives R&D grant to build FORCE, a Fiber Optic Research Center of Excellence, in Ohio

2019 — COTSWORKS creates GmbH in Fulda, Germany to support rapid growth of EMEA market.

2020 — COTSWORKS celebrates 15th anniversary with >$100M in generated revenue & 600,000+ units delivered across 20k shipments to customers around the world.

2021 — Multi-year product development road-maps released publicall y, demonstrating alignment w ith grow ing mil/aero market needs. AS9100:D certification achieved.

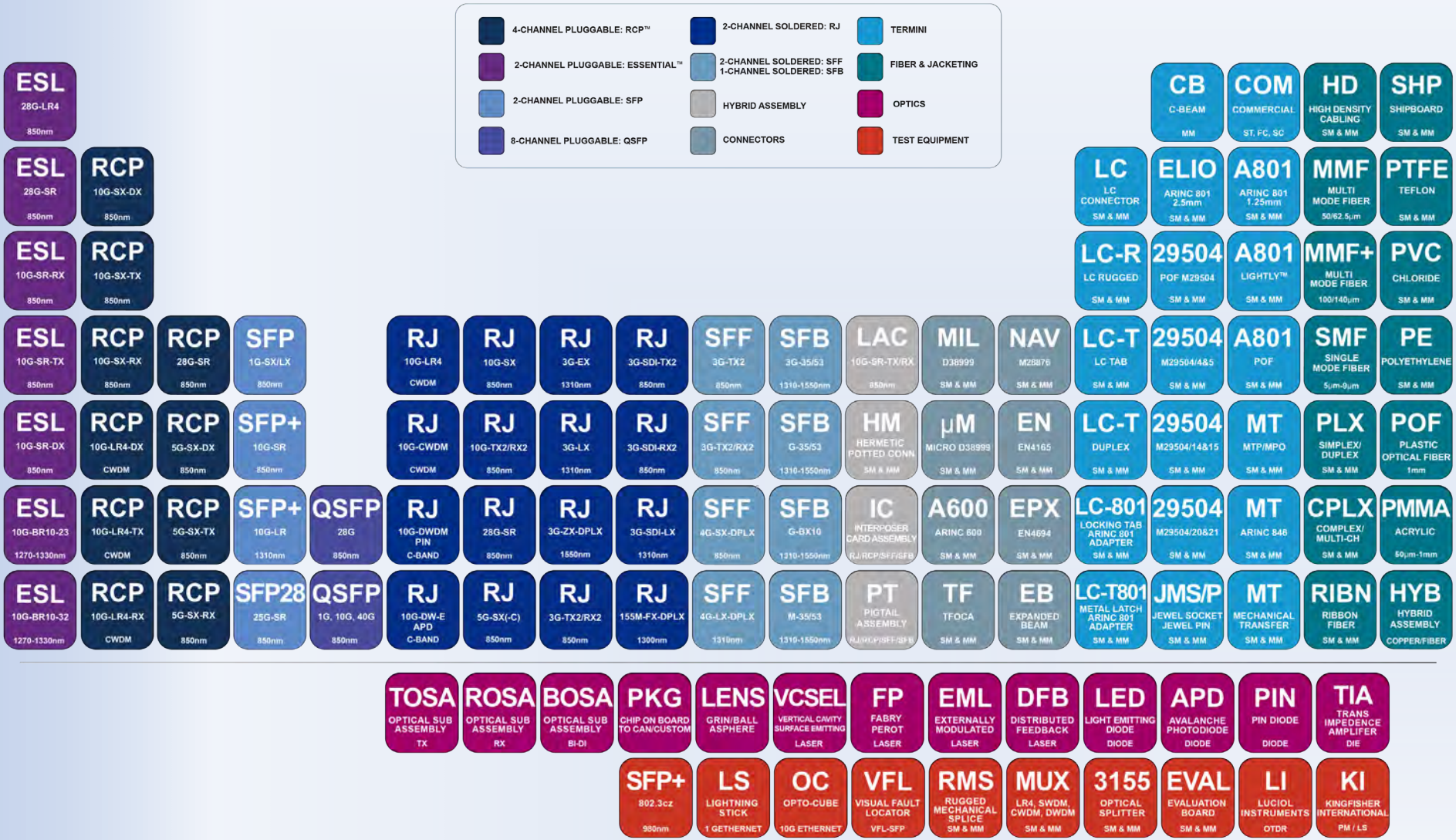
2022 — Rugged Mechanical Splice and POF termini released. COTSWORKS CEO accepts chair position at SAE AS-3 Fiber Optics & Applied Photonics Committee.

2023 — COTSWORKS celebrates 5-years at its GmbH o ffice in Fulda, German y. Phase II Update of FORCE to include single-mode assemblies & DFB lasers.

COTSWORKS VS COTS (Commercial-Off-The-Shelf)

COTSWORKS		COTS
Rugged Environmental Design, MIL and Aero Standards	**Product Design Goals & Criteria**	Low-cost focus, data/telecomm standards, limited obsolescence plans
3-5 year design cycle with 10+ year use and enhanced EOL support	**Product Lifecycle**	3 year product lifecycle, upgrades are cost and commodity driven
-40°C to +95°C , shock, vibration, humidity, and thermal cycling	**Operational Performance**	Commercial temperature operation
Solder or screw mount harsh environment electrical with Mil/Aero fiber termini	**Interface Design**	Card edge, optical quick release via plastic tabs
Controlled supply chain with approved locations for key vendors	**ITAR Requirements**	Commercial based supply chain
Tight control of mechanical configurations, incoming inspection, and design	**Design Tolerances**	Industry standard tolerances for international and cross vendor support
Controlled supporting data & documents	**Datasheet Specificity**	High level overviews with average performance and limited warranty
"2 Clicks" to a datasheet and application engineering support	**Customer Support**	Web, email, limited personal interaction
Configuration management with engineered solutions	**Customization**	Standard off-the-shelf product
RoHS 5/6 or 6/6, conformal coating, epoxy staking, and more	**Solder Compliance and Ruggedization**	RoHS 6/6, no clean flux

Elemental Product Platform



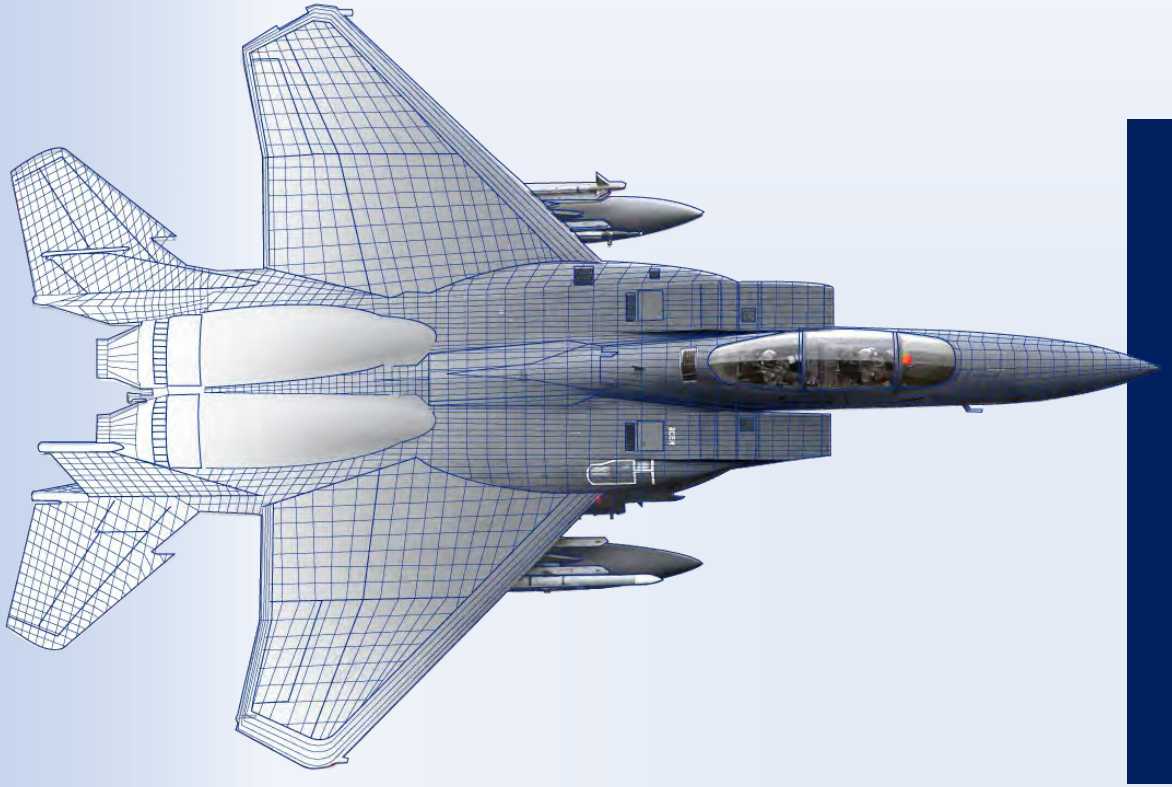
Commercial Aerospace Networking

Fiber Networking Advantages:

- Reduces EMI problems in aircraft with composite shells
- Reduces data wire weight by up to 70%
- Increase network bandwidth and enable multiple protocols
- Enables distributed network architectures

- Flight deck (HUD, display) graphics generators and receivers
- Core systems, sensors, and cameras
- In-Flight Entertainment and crew cabin interfaces

Military Aerospace Networking



Fiber Networking Advantages:

- Reduces EMI problems in aircraft with composite shells
- Reduces data wire weight by up to 70%
- Increase network bandwidth and enable multiple protocols
- Decreases electronic signature in the sky

- Flight deck (HUD, display) graphics generators, receivers
- Core communication systems, switches, storage
- Radar, flight recorders, gateway systems

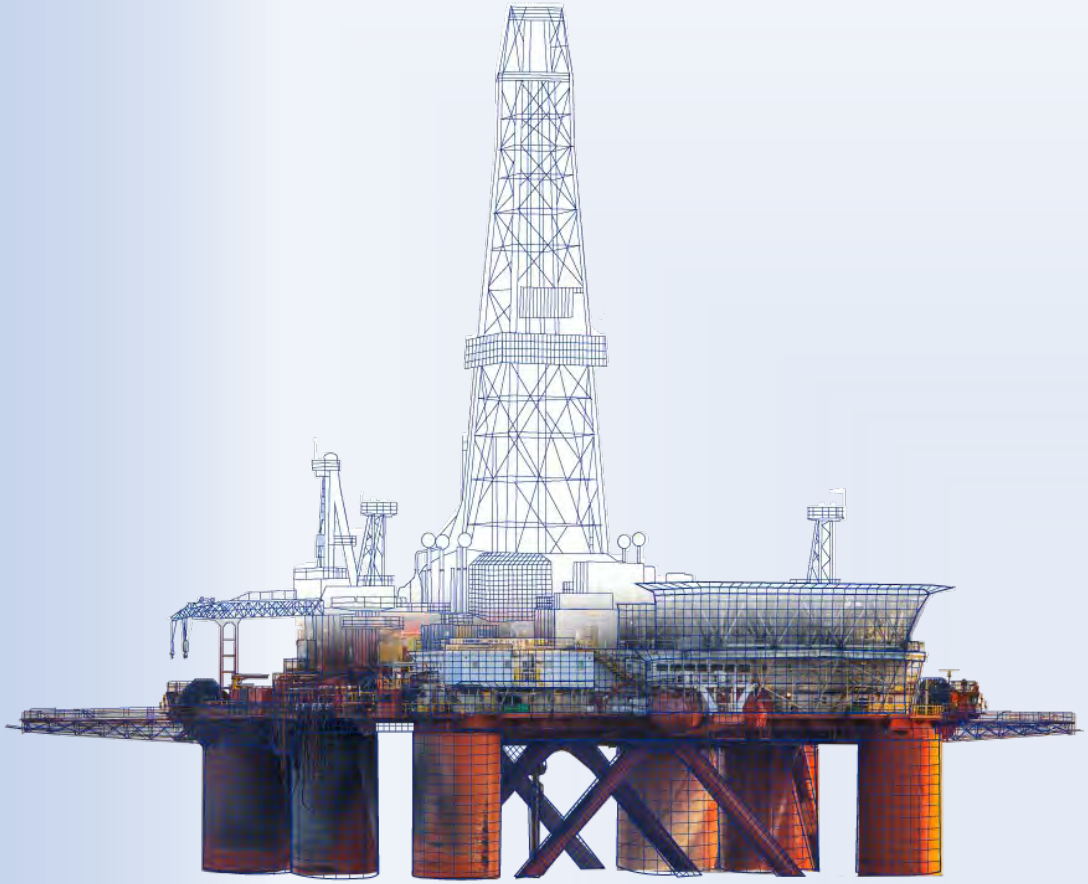
Military Tactical Vehicle Networking

Fiber Networking Advantages:

- Provides robust network communications on-the-move
- Provides the principal network backbone element to support mobile communication
- Provides remote connectivity for battlefield operations

- Radar, secure communications, sonar, displays
- Core communication systems, sensors, or cameras
- Reliable products built for theater of combat

Energy Exploration & Conservation

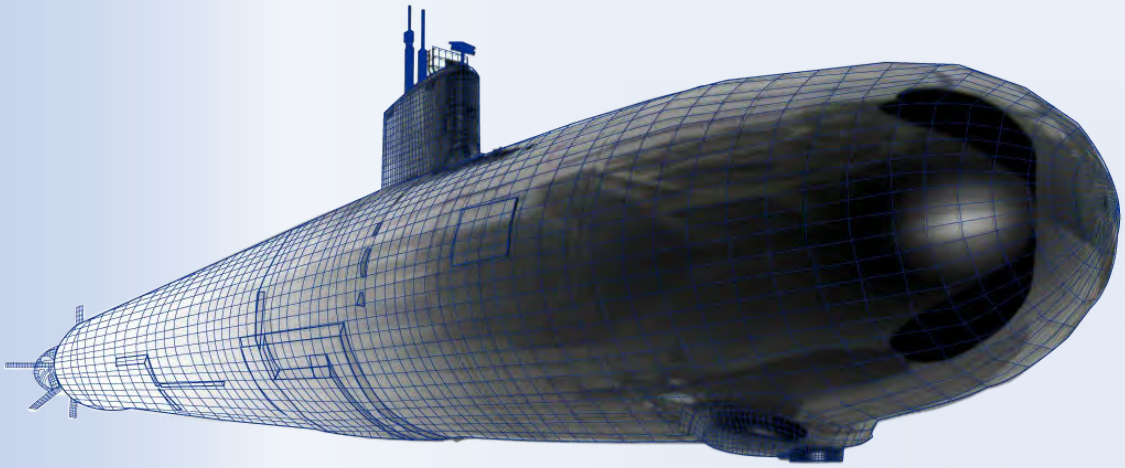


Fiber Networking Advantages:

- Rugged and sealed parts work in harsh outdoor environments incl. weather
- Higher throughput enables more efficient and smarter devices
- Eliminates ESD on outdoor platforms where static is deadly

- Oil exploration & safe environments through ATEX certified products
- Rugged designs last years

Undersea Networking

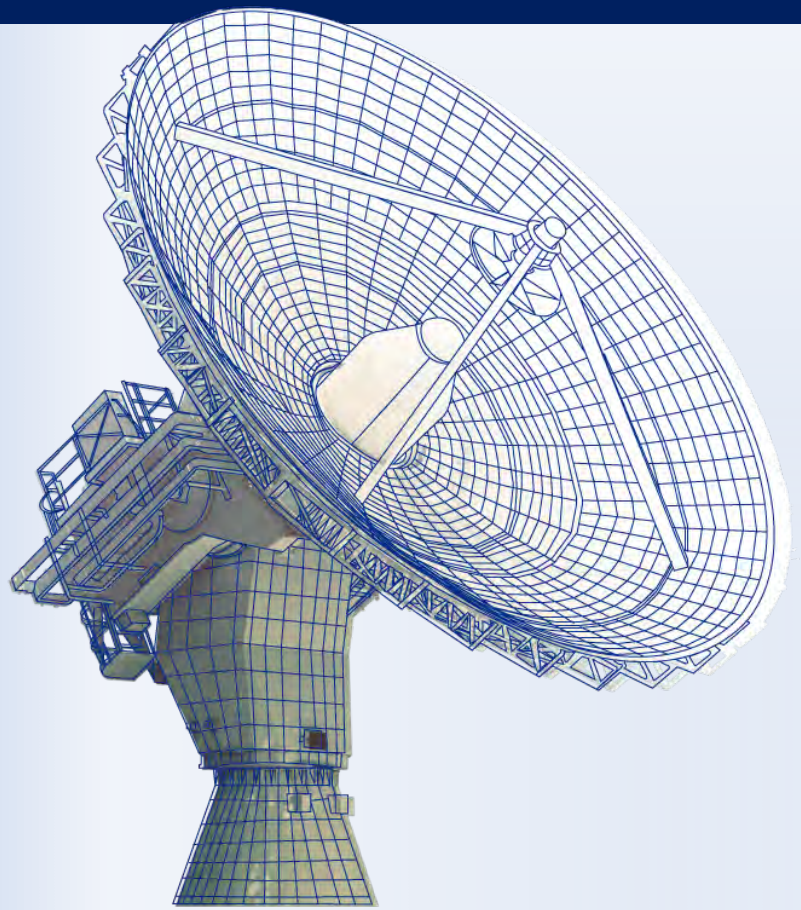


Fiber Networking Advantages:

- Fiber optic cable has smaller outside diameter than copper cable
- Protocol/speed independence enables high-speed links with multiple secure data links
- Contact COTSWORKS for more information

- Towed array networking and sensors
- Components with high reliability and extended optical link budgets
- High-speed and under high pressure

Military Sensing



Fiber Networking Advantages:

- Compatible with slip rings including field tested solutions
- Options up to 1Tbps active links for single or multi-pass rotary joints
- Contact COTSWORKS for more information

- Very high-speed 3D ground-based radar
- High speed, rugged airborne radar
- Directed sensing applications

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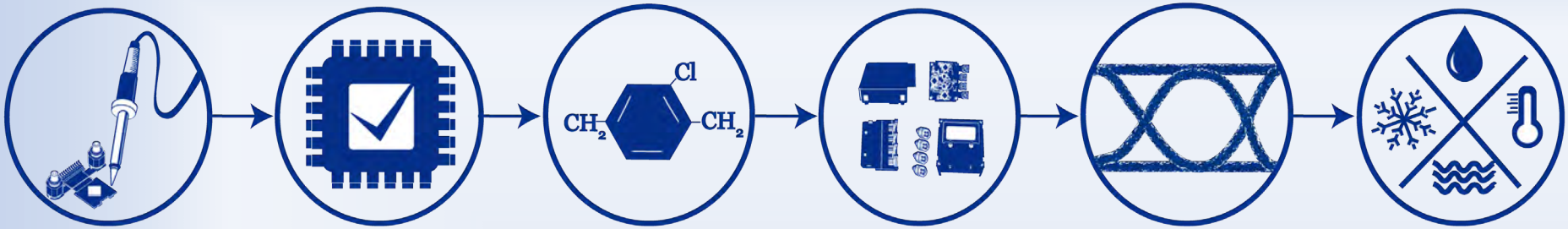
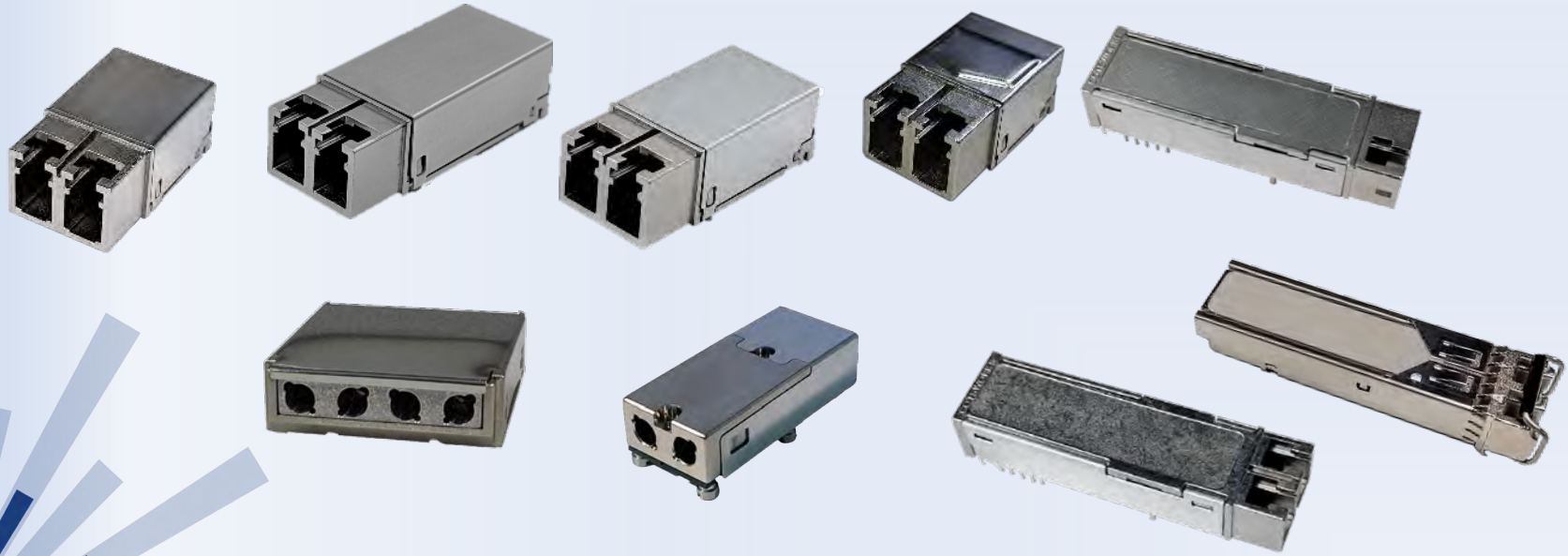
OPTO-ELECTRONIC



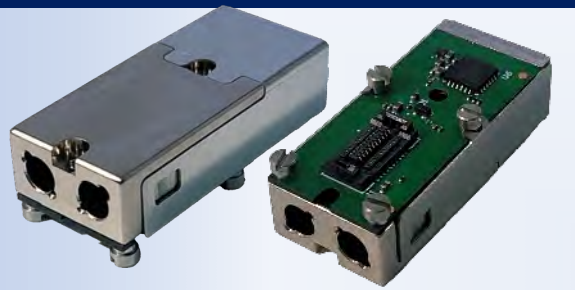
1. PCB Fabrication
2. Component Validation Test
3. Conformal Coating
4. Assembly & Test
5. Environmental Compliance Test
6. Final Calibration & Test



COTSWORKS®

ESL

The Essential™ is a two-channel electrically pluggable optical transceiver capable of duplex, dual transmitter or dual receiver configurations.



- Two ARINC 801 receptacles
- Typical reach of 82m on OM2, 300m on OM3, and 400m on OM4
- Board to board pluggable connector

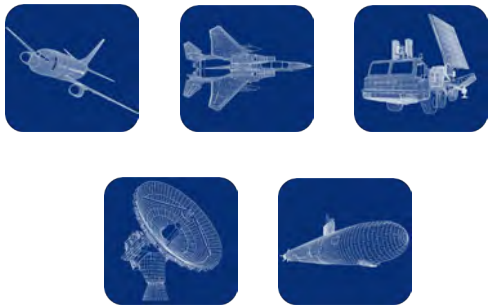
Ruggedization

- Parylene Type C coating can be used for conformal coating with a 1.0 mil ± 0.2 mil thickness through a deposition process.
- Parylene Type C has a 5600 VPM rating, withstands high temperatures, and is extremely resistant to oil, dirt, and object impact.
- Contact COTSWORKS for all MSDS and case composition information.

Environmental

Parameter	Sym.	Min.	Max.	Unit
Maximum Supply Voltage	V_{CC}	-0.3	4.0	V
Electrostatic Discharge, Data I/o pins	ESD		500	V
Storage Temperature	T_{STO}	-55	100	ºC
Relative Humidity	RH	0	95	%
Conformal Coating		0.8	1.2	mil

Application



Part Number	Data Rate	Fiber	Wavelength	TX	RX	P. Out Min	P. Out Max.	Rx Sens Max	Link Budget Min.	Operating Temperature Range		
ESL-10G-SR-DX	1-10Gbps	MMF	850nm	VCSEL	PIN	-5dBm	-1dBm	-11.1dBm	6.1dB	A: -40°C to 85°C	M: -40°C to 95°C	Z: -55°C to 110°C
ESL-10G-SR-TX				VCSEL	N/A	-5dBm	-1dBm	N/A	N/A			
ESL-10G-SR-RX				N/A	PIN	N/A	N/A	-12dBm	N/A			
ESL-10G-BR10-23/32	6-10Gbps	SMF	1330/1270nm	DFB	PIN	-4.2dBm	0.5dBm	-14.4dBm	10.2dB			
ESL-28G-SR/RL/LR4	28Gbps	MMF	850nm	VCSEL	PIN	TBD	TBD	TBD	TBD		M: -40°C to 95°C	Z: -55°C to 110°C

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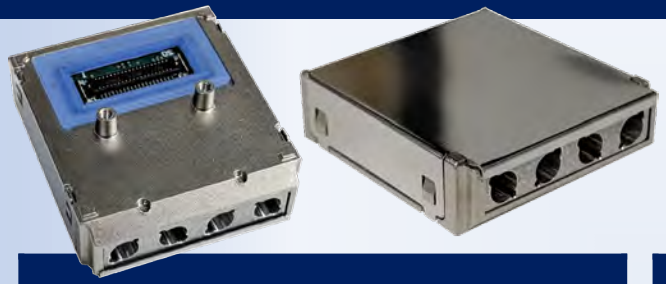
RCP

The Rugged Chip Scale Pluggable (RCP) is a four-channel, electrically pluggable quad transmitter, quad receiver, or dual-duplex device



- Electrical connector with four ARINC 801 optical interfaces
- Fiber tray aligns the laser receivers to the cables within the housing
- High-speed data transmission at industrial temperatures

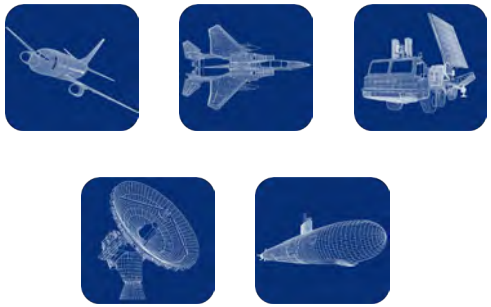
Ruggedization

- Parylene C coating can be used for conformal coating with a 1.0 mil ± 0.2 mil thickness through a deposition process
- Parylene Type C has a 5600 VPM rating, withstands high temperatures, and extremely resistant to oil/dirt, and object impact.
- Contact COTSWORKS for all MSDS, case composition, and burn analysis.

Environmental

Parameter	Sym.	Min.	Max.	Unit
Maximum Supply Voltage	V_{CC}	-0.3	4.0	V
Electrostatic Discharge, Data I/o pins	ESD		500	V
Storage Temperature	T_{STO}	-55	100	ºC
Relative Humidity	RH	0	95	%
Conformal Coating		0.8	1.2	mil

Application



Part Number	Data Rate	Fiber	Wavelength	TX	RX	P. Out Min	P. Out Max.	Rx Sens Max	Link Budget Min.	Operating Temperature Range		
RCP-10G-SX-DX	6-10Gbps	MMF	850nm	VCSEL	PIN	-5dBm	-0.8dbBm	-12dBm	7dB	-40°C to 85°C	-40°C to 95°C	-40°C to 100°C
RCP-10G-SX-TX					N/A			N/A	N/A			
RCP-10G-SX-RX				N/A	PIN	N/A	N/A	-12dBm	N/A			
RCP-10G-LR4-DX	6-10Gbps	SMF	CWDM	DFB	PIN	-5dBm	.05dBm	-14dBm	9dB			
RCP-10G-LR4-TX					N/A			N/A	N/A			
RCP-10G-LR4-RX				N/A	PIN	N/A	N/A	-14dBm	N/A			
RCP-5G-SX-DX	1-5Gbps	MMF	850nm	VCSEL	PIN	-5dBm	-1dBm	-14dBm	9dB		-40°C to 95°C	-40°C to 100°C
RCP-5G-SX-TX					N/A		-5dBm	N/A	N/A			
RCP-5G-SX-RX				N/A	PIN	N/A	N/A	-14dBm	-5dB			

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RJ

RJ Module Jack (RJ) is a high-performance miniature duplex data link for opto-electronic communication over single mode or multimode optical fiber.

- Compliant to 802.3z and 802.3ae Ethernet, Fibre Channel (1x/2x/4x), Infiniband, sFPDP, XAUI, FCAV and ARINC 818
- MIL-STD-883 certified
- Surface mount electrical connector with screw or solder posts for high shock/vibe environments

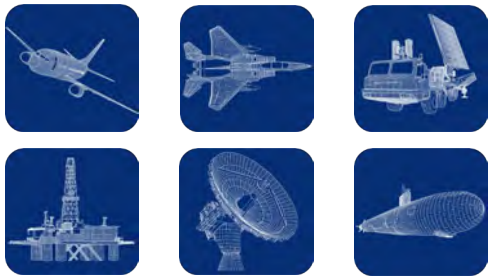
Ruggedization

- Parylene C coating can be used for conformal coating with a 1.0 mil ± 0.2 mil thickness through a deposition process o It has a 5600 VPM rating, withstands high temperatures, extremely resistant to oil/dirt, and object impact.
- This part is also available in a pigtail fiber optic version. Contact COTSWORKS for available fiber and termini options.
- Transceiver case is nickel-plated.

Environmental

Parameter	Sym.	Min.	Max.	Unit
Maximum Supply Voltage	V_{CC}	-0.3	4.0	V
Storage Temp	T_{STO}	-55	105	ºC
Operating Temp	T_{OP}	-40	85	ºC
Relative Humidity	RH	0	85	%
Hot Bar Soldering Temp			260	ºC
Lead Soldering Temp			260	ºC
Conformal Coating		0.8	1.2	mil

Application

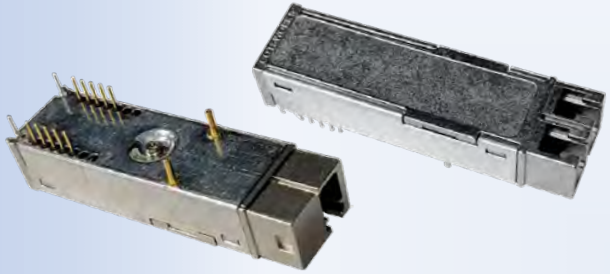


Part Number	Data Rate	Fiber	Wavelength	TX	RX	P. Out Min	P. Out Max.	Rx Sens Max	Link Budget Min.	Operating Temperature Range
RJ-28G-SR	3.-28Gbps	MMF	850nm	VCSEL	PIN	-3dBm	2.4dBm	-12dBm	9dB	A
RJ-10G-CWDM	5-10Gbps		CWDM	EML		-1dBm	3dBm	-15dBm	14dB	
RJ-10G-DWDM	6-10Gbps		DWDM C-BAND			-2dBm	2dBm		13dB	
RJ-10G-DW-E					APD	0		-22.8dBm	22.8dB	
RJ-10G-SX			850nm	VCSEL	PIN	-5dBm	-1dBm	-11dBm	6dB	A M Z
RJ-10G-TX2					N/A		-.8dBm	N/A	N/A	
RJ-10G-RX2				N/A	PIN	N/A	N/A	-12dBm		
RJ-10G-LR4		SMF	CWDM	DFB		-5dBm	.5dBm	-14dBm	9dB	A
RJ-5G-SX(-C)	1-5Gbps	MMF	850nm	VCSEL			-1dBm			A M Z
RJ-3G-TX2	1-3Gbps				N/A			N/A	N/A	
RJ-3G-RX2				N/A	PIN	N/A	N/A	-15dBm		A M
RJ-3G-LX	125Mbps-3Gbps	SMF	1310nm	FP		-5dBm	1dBm	-16dBm	15dB	
RJ-3G-EX				DFB		-1dBm	3dBm	-20dBm	19dB	A
RJ-3G-ZX			1550nm				5dBm	-16dBm	15dB	
RJ-3G-SDI-TX2	3Gbps	MMF	850nm	VCSEL	N/A	-5dBm	-1dBm	N/A	N/A	A M
RJ-3G-SDI-RX2				N/A	PIN	N/A	N/A	-15dBm		A
RJ-3G-SDI-LX	1-3Gbps	SMF	1310nm	FP		-7dBm	1dBm	-22dBm	15dB	A M Z
RJ-155M-FX	155Mbps	MMF		LED		-20dBm	-14dBm	-33dBm	13dB	A

A: 40°C to 85°C
M: 40°C to 95°C
Z: 55°C to 95°C

SFF/B

Small Form Factor and Bi-Directional (SFF/B) is a rugged industry standard form factor with options for duplex or bi-directional functionality.



- Industry standard MSA 2x5/7 electrical footprint
- Digital Diagnostics per SFF MSA SFF-8472
- Rugged LC connector housing including screw mounted OSAs
- Conformal coated for harsh environment use
- Ethernet, Fiber Channel, sFPDP, A818, Infiniband, PCIe

Ruggedization

- Parylene C coating can be used for conformal coating with a 1.0 mil ± 0.2 mil thickness through a deposition process.
  - Parylene Type C has a 5600 VPM rating, withstands high temperatures, and is extremely resistant to oil/dirt, and object impact.
- Available in a pigtailed fiber optic version.
- Contact COTSWORKS for all MSDS, case composition, and burn analysis.

Environmental

Parameter	Sym.	Min.	Max.	Unit
Maximum Supply Voltage	V_{CC}	-0.3	4.0	V
Electrostatic Discharge, Data I/o pins	ESD		500	V
Storage Temperature	T_{STO}	-55	100	ºC
Relative Humidity	RH	0	95	%
Conformal Coating		0.8	1.2	mil

Application

Part Number	Data Rate	Fiber	Wavelength	TX	RX	P. Out Min	P. Out Max.	Rx Sens Max	Link Budget Min.	Operating Temperature Range
SFF-4G-SX	622Mbps-4Gbps	MMF	850nm	VCSEL	PIN	-5dBm	-1dBm	-18dBm	13dB	-40°C to 85°C
SFF-3G-TX2	1-3Gbps				N/A			N/A	N/A	
SFF-3G-RX2				N/A	PIN	N/A	N/A	-15dBm		
SFF-4G-LX	100Mbps-4Gbps	SMF	1310nm	FP		-5dBm	-1dBm	-22dBm	17dB	
SFB-G-35	1.25Gbps	MMF	1310/1550nm			-6dBm	-6dBm	-22dBm	16dB	
SFB-G-53			1550/1310nm							
SFB-M-35	125-155Mbps		1310/1550nm			-9dBm	-9dBm	-31dBm	22dB	
SFB-M-53			1550/1310nm					-18dBm	9dB	

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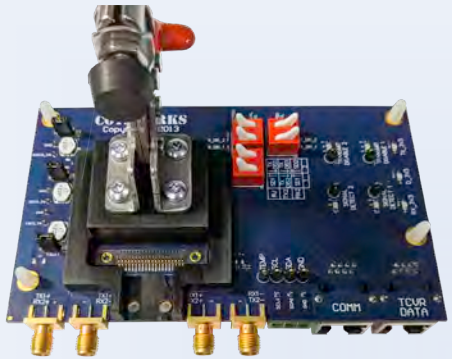
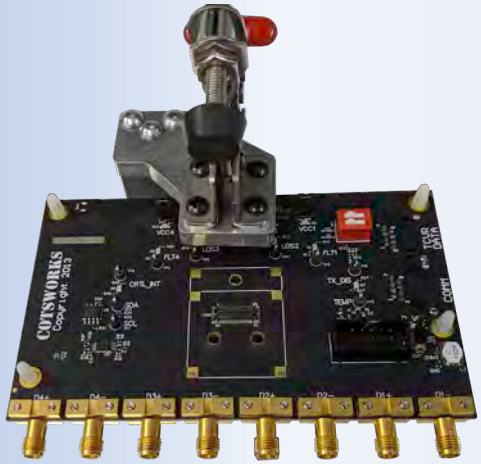
Test Boards & Built-In Diagnostics

Test Boards

LAC-10G



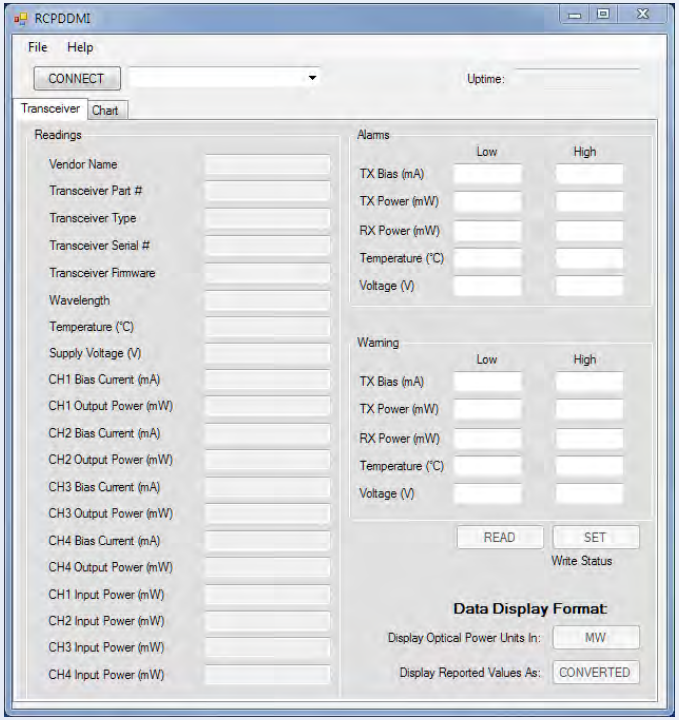
RJ-5G/10G



RCP-SX-DX

SFF/SFB

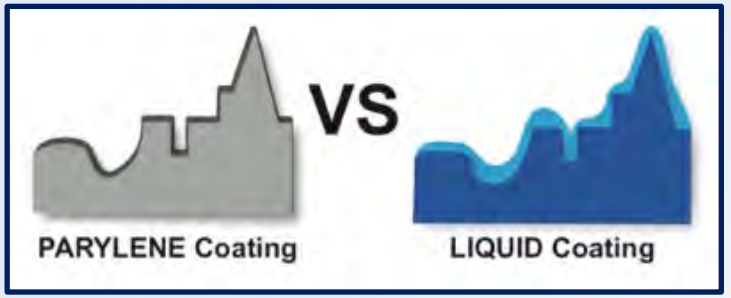
Digital Diagnostics



Parylene Conformal Coating

- Coatings seal components on boards, including optical sub-assemblies (OSAs), against moisture and corrosion
- Parylene vacuum deposition process creates even thickness on all surfaces and prevents uneven thermal expansion

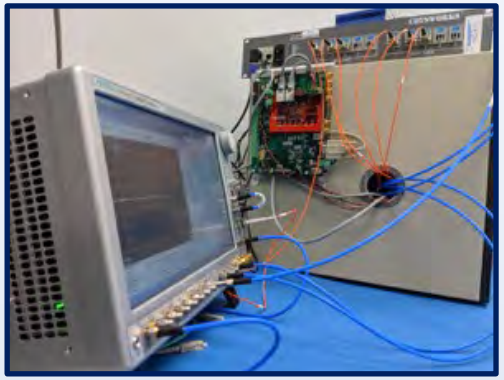
Attribute	Parylene C
Mil-I-46058C IPC-CC-830B	Yes
Colors Available	Clear
Application	CVD
Resistance to Acids	Excellent
Resistance to Bases	Excellent
Resistance to Solvents	Excellent
Cure Type	CVD
Shelf Life of raw material (months)	12
Operating Temp. Range ℃	-195 to +125
UV Additive	Yes
Dielectric Strength	6900 V/Mil
Dielectric Constant	3.10
Dielectric Factor	0.0027
Solubility	N/A

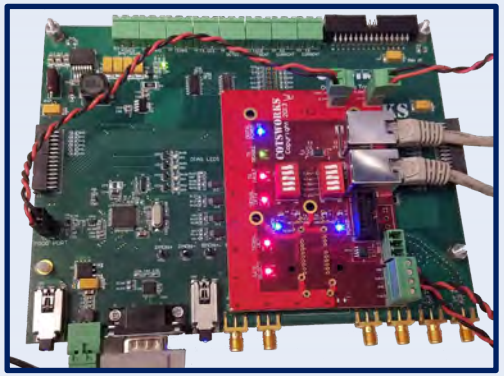


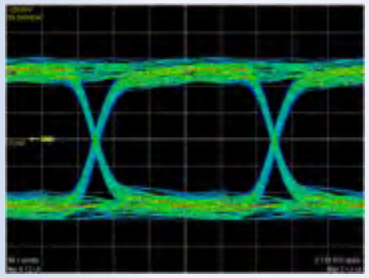
Transceiver Manufacturing Test

COTSWORKS Software/Hardware

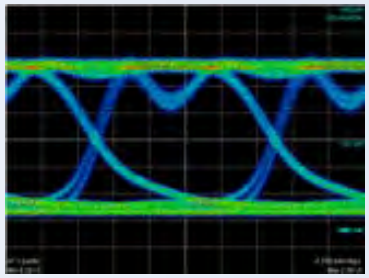
- All test data is recorded and readily retrievable by barcode
- All parts tracked by serial ID, lot #, technician, and linked to customer from PO to shipment
- Secure database of test results, performance trend analysis, and quality metrics tracking
- Shipment specific test data and certificates of conformance provided with every delivery.



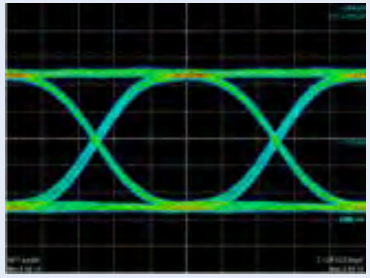




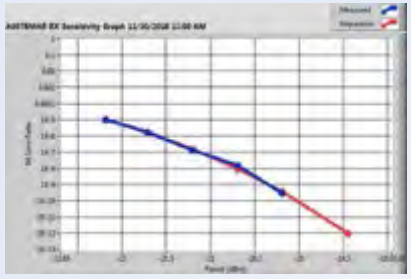
RX Eye Pattern



TX Un-Filtered Eye Pattern



TX Filtered Eye Pattern



RX Sensitivity Graph

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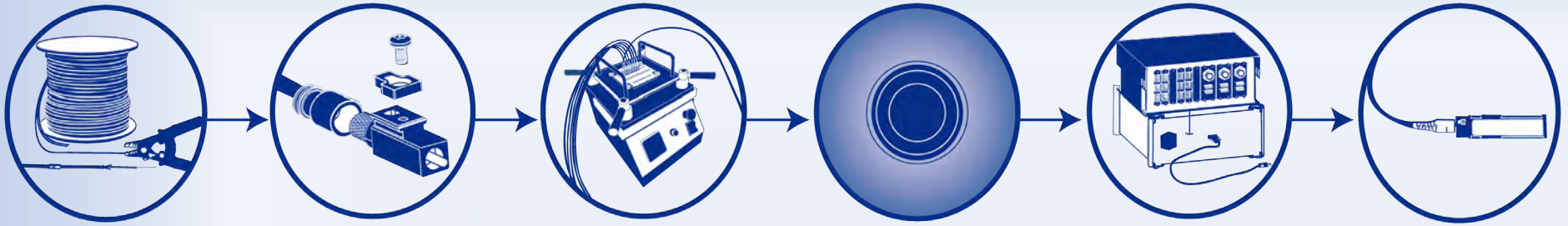
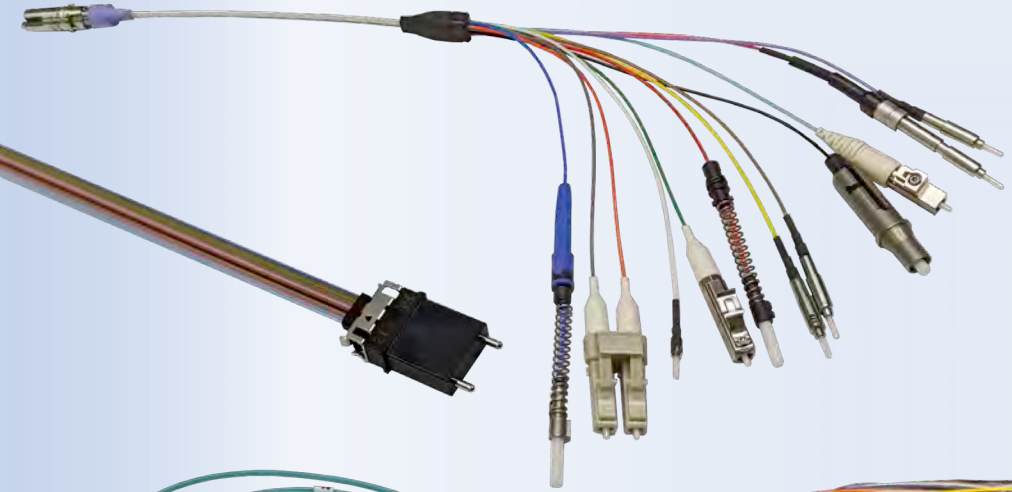
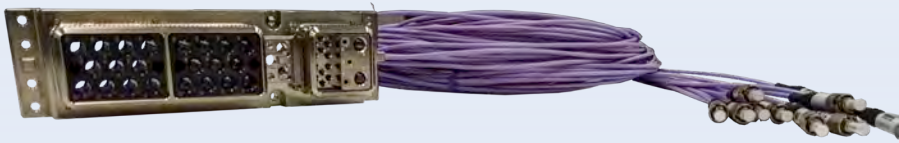
INTERCONNECT



1. Fiber Process
2. Termination
3. Polish
4. Endface Verification
5. IL/RL Testing
6. Complex Assembly & Packaging



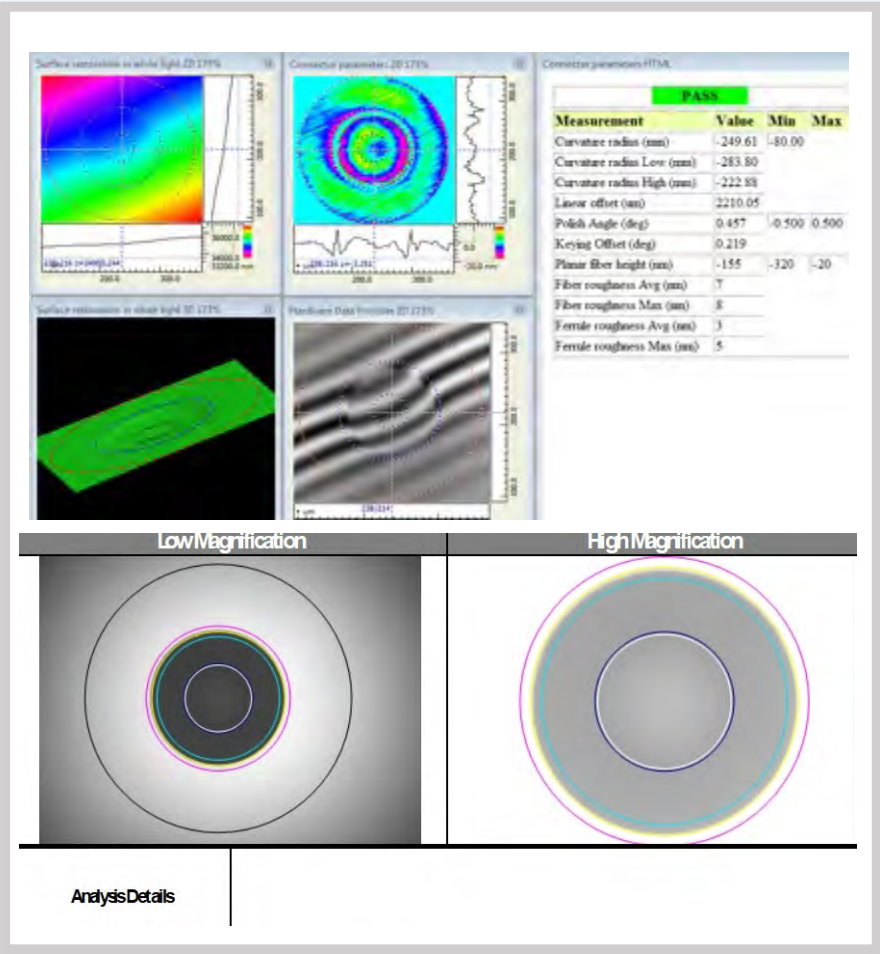


Rugged Termini

- **LC-Rugged** is an all-metal LC termini with a screw
  - 1.25mm ferrule with metal screw based latching system
  - Cables come w/locking termini & screw kits
  - MM or SM, tight or loose buffer
  - Shorter length than most standard LCs and boots
- **LC-T** Designed for Harsh Environments
  - All metal body, robust metal clip, no tools needed, high pull force
- **LCT801/LC801** converts LC receptacles to use ARINC 801
  - Inserts into LC receptacle and presents an ARINC 801 receptacle
  - No effect on insertion loss
- **Lightly**™ eliminates the need for an additional tool.
  - Includes insertion/removal function as part of the fiber optic component assembly with ARINC 801 size 16 termini body
  - Reduces handling time, improves testability and eliminates FOD risks

Interconnect Test

- COTSWORKS terminates and polishes to customer specified or industry standards.
- Every cable and termini is inspected visually—as well as with an interferometer—to ensure a pristine end-face geometry that meets or exceeds specifications.
- IL test data provided with every cable shipped. Screen shots of test measurements are available upon request.



COTSWORKS®

FORCE
Fiber Optic Research Center of Excellence

- ISO 7, Class 10,000 Cleanroom houses precision optical alignment, encapsulation, and test equipment capable of producing **OSAs** (Optical Sub-Assemblies) operating at 100M to 28Gbps with industry standard and novel functionality, performance, and mechanical characteristics.
- **Current Process Capability**: burn-in, active alignment and capping, curing, performance testing, harsh-environment reliability testing, visual and optical inspection, and design/modeling of novel optical systems.
- **Future Process Capabilities**: die attach, wire bonding, TO-can welding, mechanical testing, hermetic testing

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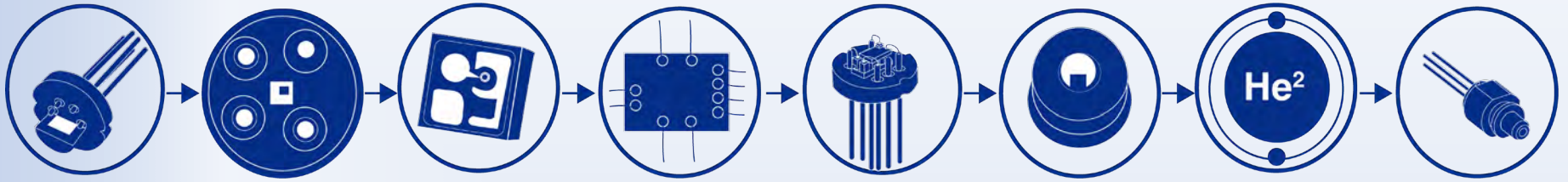
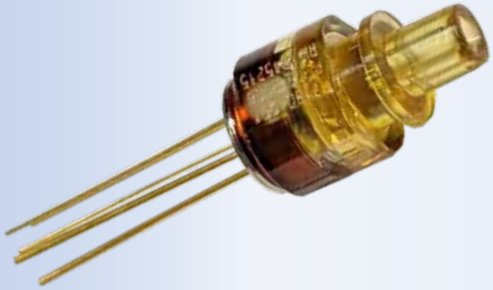
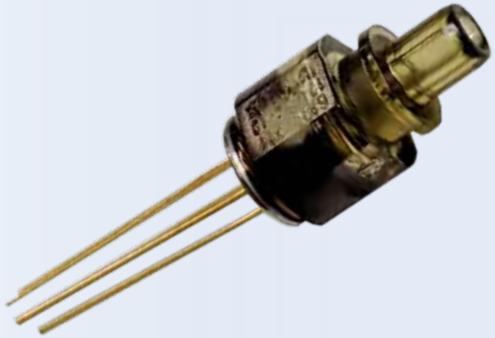
Optical Sub-Assemblies

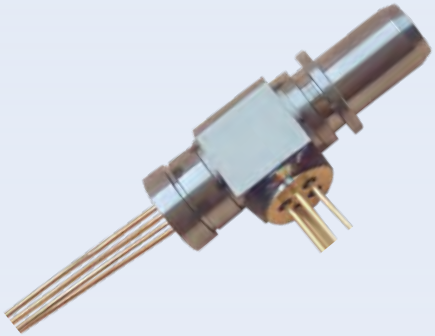




TOSA
Transmitter Optical Sub-Assembly



ROSA
Receiver Optical Sub-Assembly



BOSA
Bi-Directional Optical Sub-Assembly

TO-Can Burn-In Test

- All COTSWORKS TO parts built go through a burn-in test to confirm functionality during and after exposure to harsh conditions
- FORCE-developed parts are burnt-in for 96 hours at 85°C prior to assembly

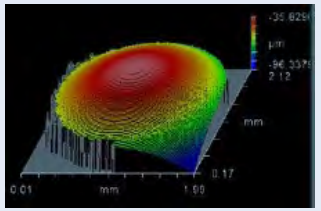
COTSWORKS®

Optical Test & Integration

HIGH-RESOLUTION OTDR: Photon counting or optical backscatter, 10cm–40µm resolution

CUSTOM: Optical to copper conversion, monitoring, or test in rugged cases for specific applications

OPTICAL DESIGN: Lens design, light path analysis, splitter/combiner creation, laser diode packaging



POWER METERS/LIGHT SOURCES: Single or multimode capability with NATA/NIST traceability

ACCESSORIES: Visual fault locators, cleaning supplies, measurement quality jumpers

Facility Overview

- Headquartered in Cleveland, Ohio, USA
- ISO, AS9100, JEDEC and IEC certifications
- Fiber Optic Research Center of Excellence (FORCE), packaging optical semiconductors for harsh environments
- Transceiver, Simplex and complex cable, and termini development, assembly and test
- Network equipment assembly, integration and test
- Rework/RMA station with dedicated engineering and equipment
- Secure areas for Opto-Electronic and Interconnect product lines
- Manufacturing Engineering area with dedicated equipment space
- GmbH in Fulda, Germany for Sales and Marketing

Company Information

Quality System:
ISO 9001:2015 + AS9100:D CERT-0124317
ATEX Compliant, OP IS
S20.20 ESD program
J Standard electronic parts work
Compliant to FAR 52.204-2, DFARS 252:204-7012
NIST 800-171 Compliance in process

Aerospace and Electronics Industry Quality Standards

FDA/CDRH Laser Safety Test and Manufacturing Support

International Traffic in Arms Regulations

ESD handling and Facility Testing, Operation, and Certification

Harsh environments including Oil and Gas compliance

Foreign Object Debris Procedures, Auditing, and Training

Company Information:
EIN/Tax ID: 20-4055028
Vendor License: 18-90016
CAGE Code: 49T62
ECCN: EAR99
ITAR: M37737

USA
749 Miner Rd
Highland Heights, OH 44143
p. 440.446.8800

EMEA
Am Alten Schlachthof 4
36037 Fulda, Germany
+49 (0) 661 9786 9200

www.ruggedfiberoptics.com

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