

Amphenol Alden
Your Medical Interconnect Solutions Provider

February 25, 2019

Agenda

- **Introductions**
- **Amphenol Worldwide**
- **Amphenol Alden**
 - Products
 - Technology
 - Applications
- **Discussion**
- **Next Steps**



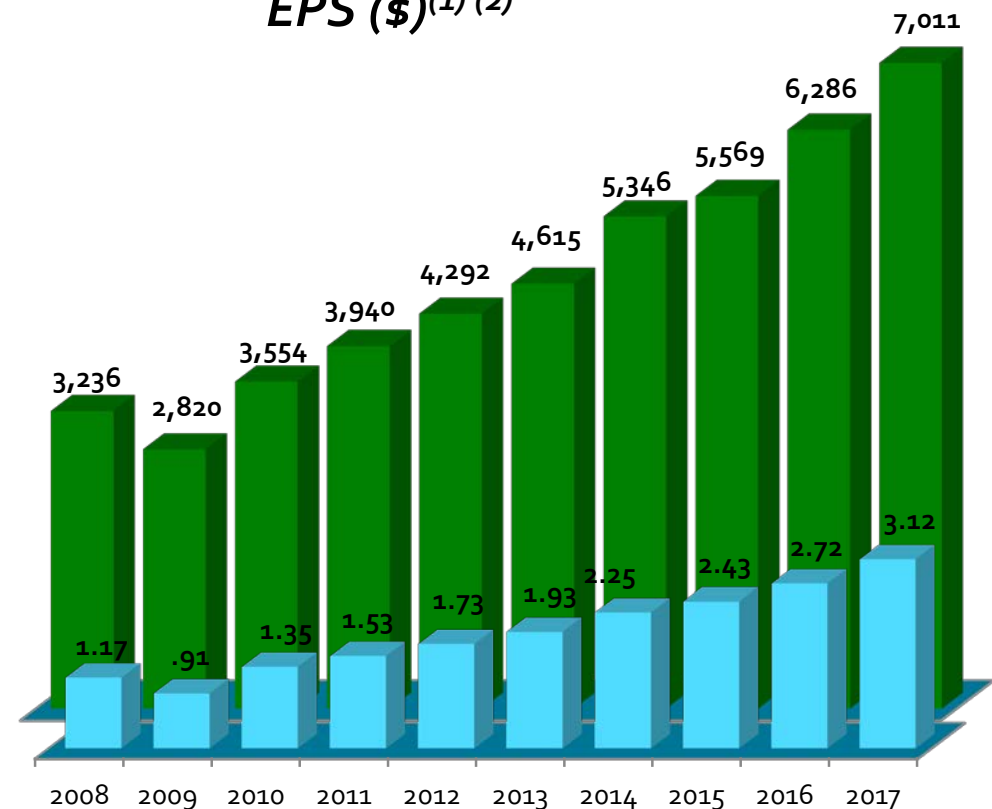
Amphenol Worldwide

Industry leading performance and growth

- The second largest interconnect company globally at \$7.0 billion in 2017
- Comprised of 100+ responsive stand-alone P&Ls
- Leading the industry in growth for over a decade*
- Our fiscal strength ensures an enduring partnership

Net Sales (\$ in millions)

EPS (\$)^{(1) (2)}



*According to Bishop and Associates

(1) Adjusted for stock split effective October 2014
 (2) Excluding one-time items

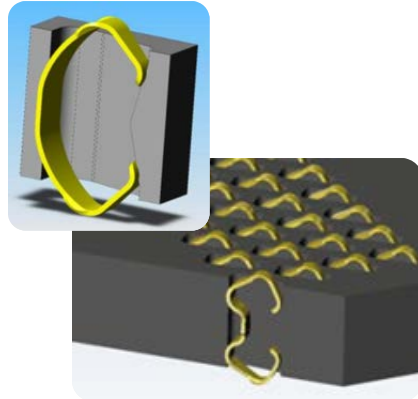
Amphenol Worldwide

Driven by technology and innovation

Sensors for temperature, pressure, humidity, and gas



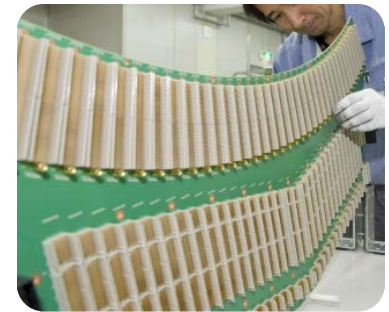
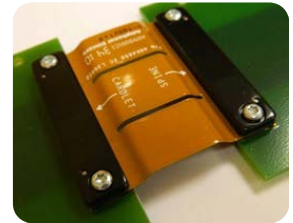
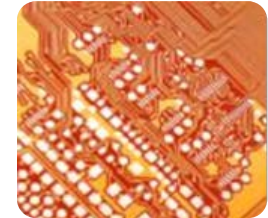
Contacts from high density to high current > 800 Amps



Fiber optic solutions for single-mode or multi-mode glass or plastic fiber wire using PC or expanded beam technologies

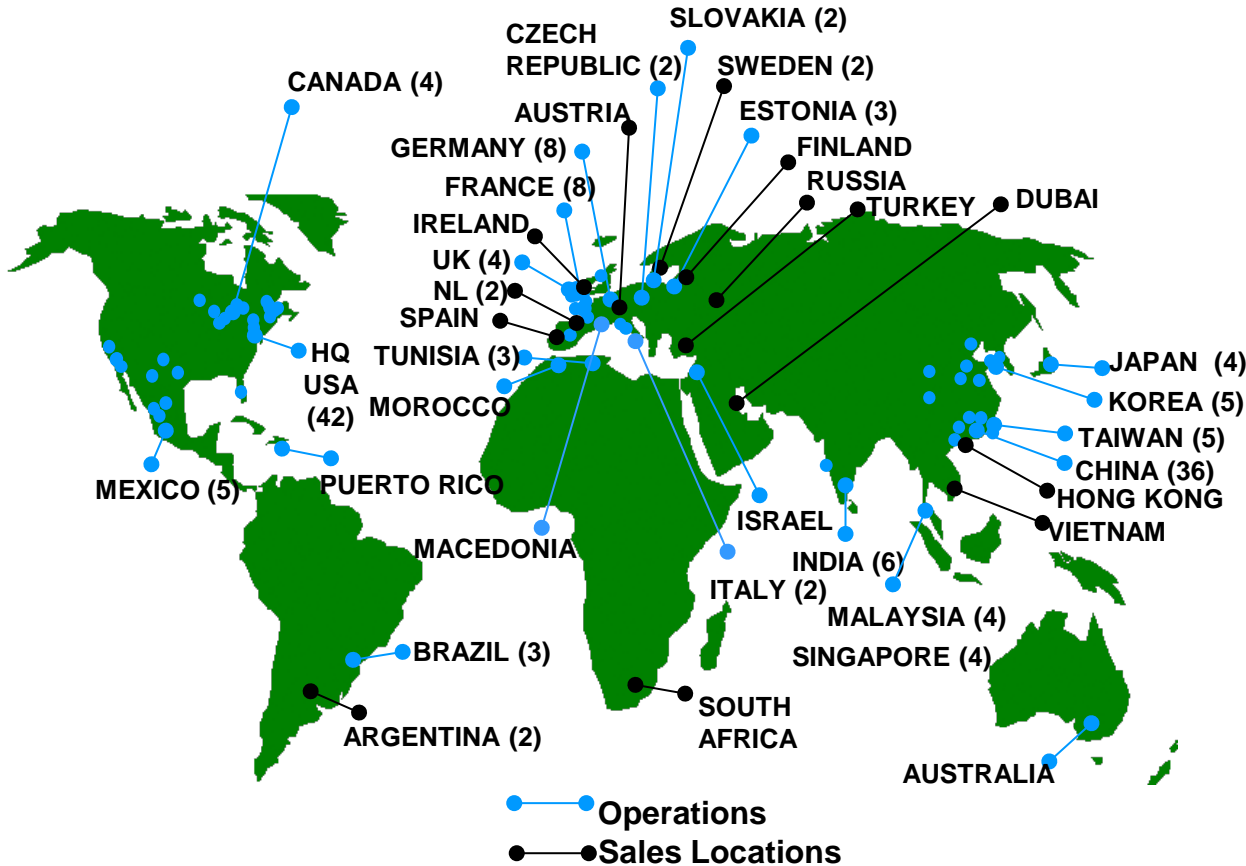


PCBA solutions for boards (flex, rigid-flex, and rigid from single- to multi-layer), backplanes, and high speed connectors



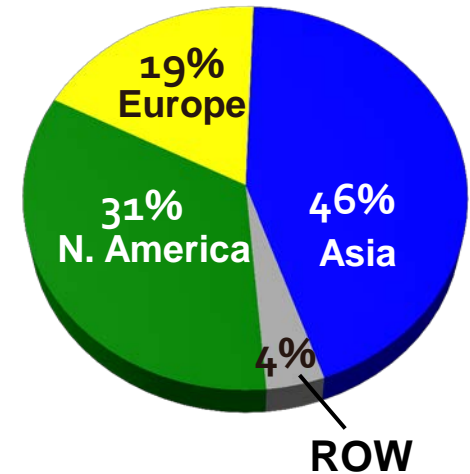
Amphenol Worldwide

Globally positioned to be where our customers need us



~62,000 Employees

% Sales By Region



**2017 Sales
\$7.0 Billion**

Amphenol Worldwide

Market diversification ensures business resiliency

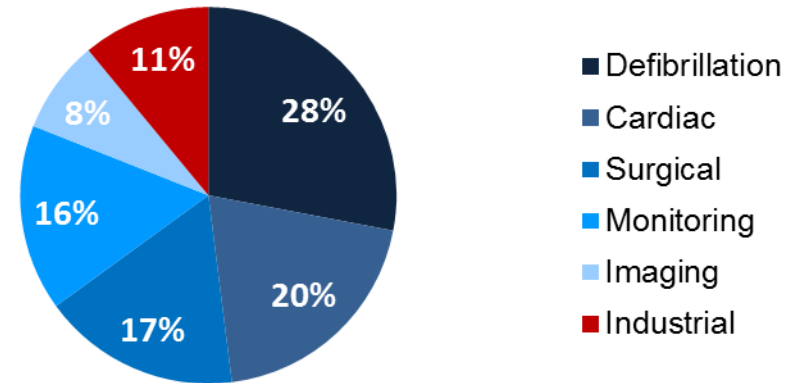


Amphenol Alden

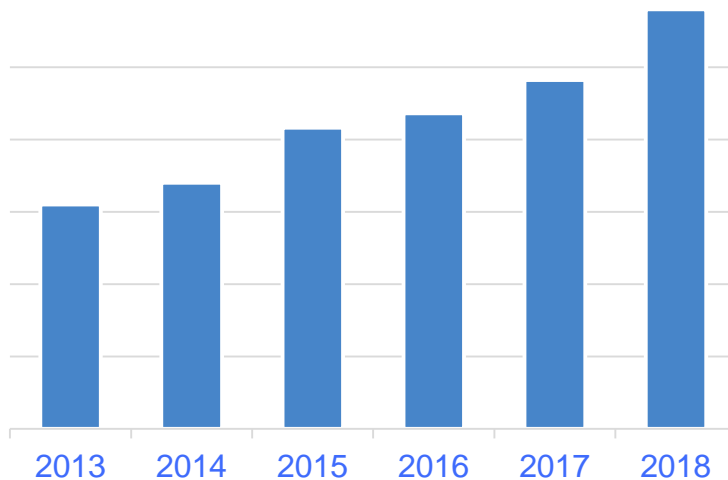
The medical division of Amphenol

- Driven by innovative solutions and industry leading technologies
- Sustained through extraordinary quality and superior service
- Enabled through worldwide resources and proactive risk management

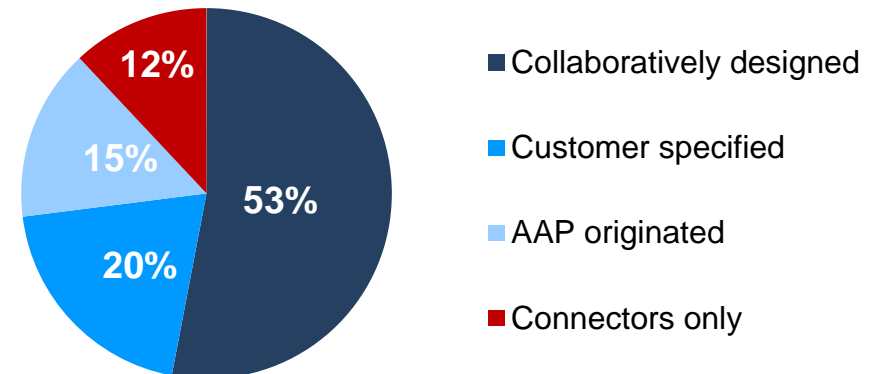
~ 89% of revenue from medical



11% CAGR over 7 Years



~ 88% of revenue from cable assemblies



Amphenol Alden

Speaking the language of the Medical Device OEM

Reliability

Works the first time and every time

- End user specifications well defined
- Disciplined verification and validation
- Robust change controls
- Strong supplier management

Efficacy

Fast and effective procedures

- Design for simplicity of use
- Seamless transmission of data
- Extraordinary image quality
- Precise energy delivery

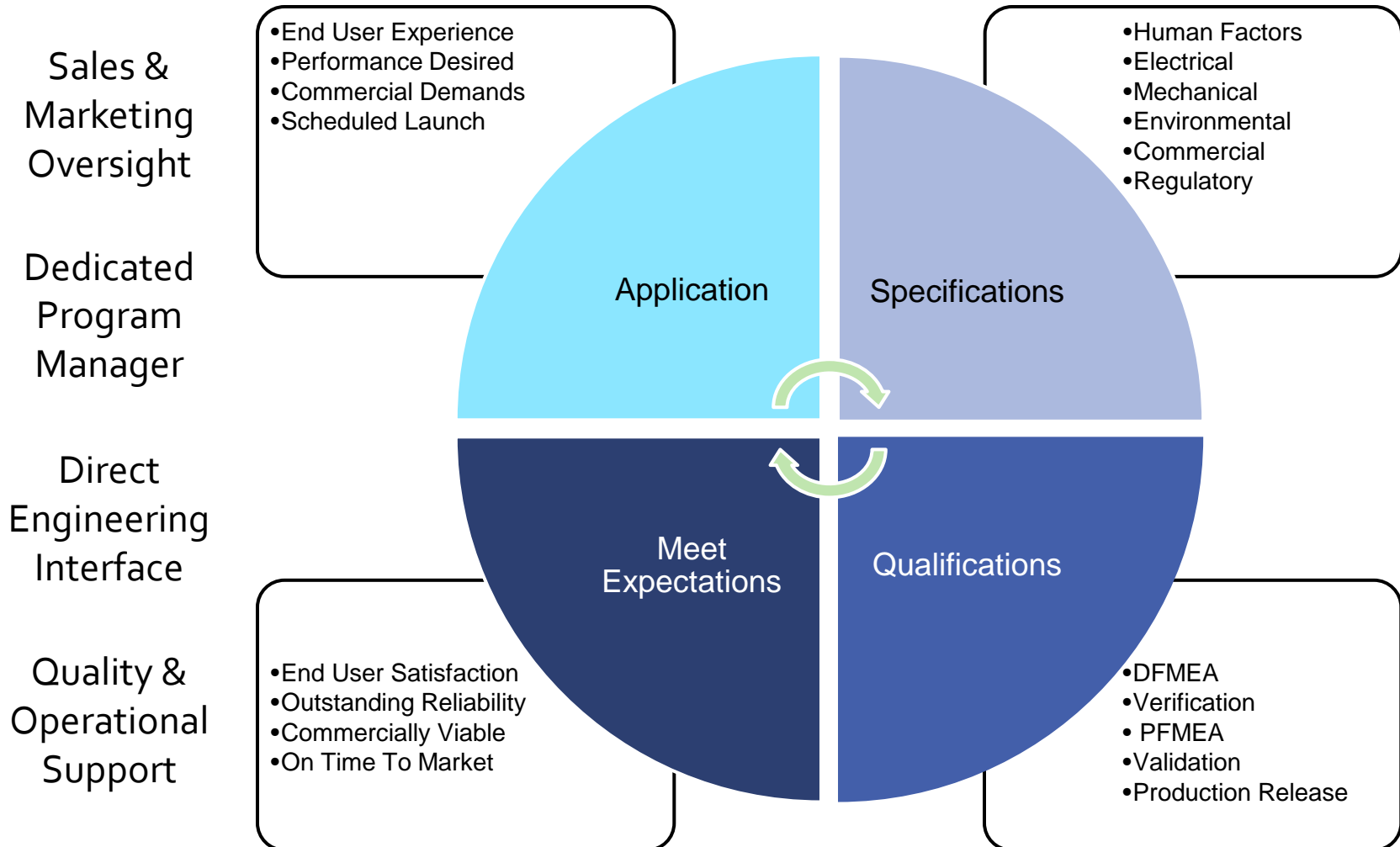
Cost

Lowest total cost of ownership

- Single use products at minimal cost
- Extended life for multiple-use products
- Optimal logistics for global supply of products
- Extraordinary service and on-time delivery

Amphenol Alden

Outstanding collaborative engineering process



Amphenol Alden

A global footprint with Quality that differentiates

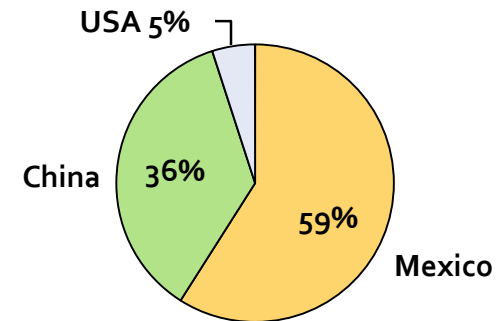
Facility Locations

- Brockton, Massachusetts
 - Corporate headquarters, marketing, engineering, customer service
 - Low-volume, high-mix manufacturing
- Hermosillo, Mexico
 - FDA registered
 - Engineering and customer service
 - Mixed-volume manufacturing
- Shenzhen, China
 - FDA registered
 - Design and manufacturing engineering
 - Strong quality and sourcing personnel
 - High-labor content and high-volume manufacturing
 - 'Controlled Environment' manufacturing
 - Particulate control to ISO Class 8 requirements



Certifications & Regulatory

- Certified to medical-grade quality standards, including:
- Dedicated environmental staff supporting:
 - RoHS
 - REACH
 - Conflict Metals
 - Latex Free
- Sustainability / EICC Code of Conduct
- UL listed Wire & Harness manufacturer



Revenue by Site '18



Amphenol Alden

Amphenol
Alden

Partnering with leading OEMs to improve patient outcomes



Medtronic



COVIDIEN



Abbott

GE Healthcare



SIEMENS

Ingenuity for life



ST. JUDE MEDICAL

stryker[®]

VOLCANO

Johnson & Johnson

Dräger

INTUITIVE

Boston
Scientific

ZOLL[®]



SURGICAL[®]

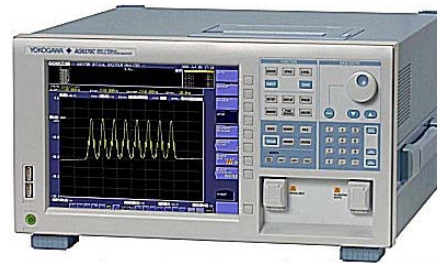
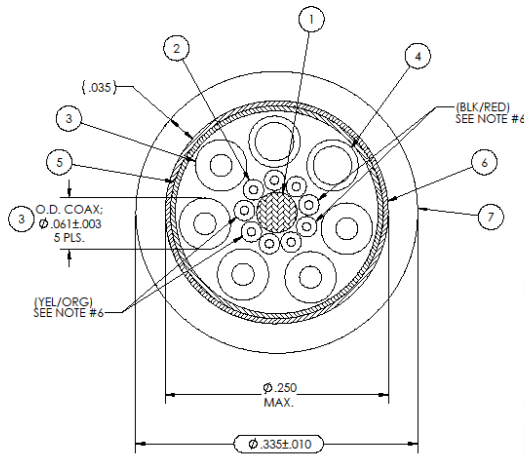
WelchAllyn[®]

VARIAN
medical systems

Technology

Electrical Engineering –

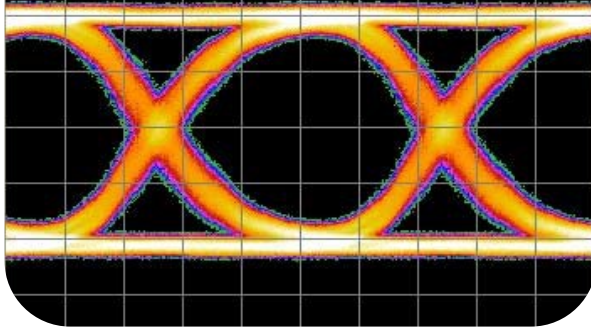
Optimizing cable design for outstanding performance



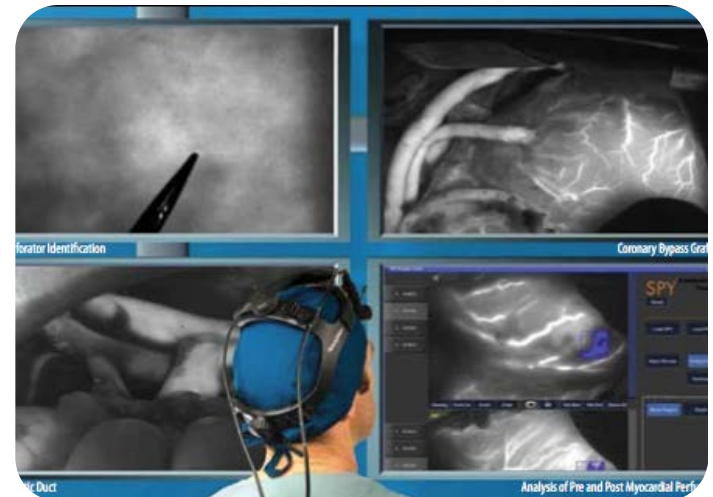
Engineered with customer participation

- High speed data-transmission up to 4+ Gbps (copper STP, coax) and 10+ Gbps (F/O)
- Designed per customer-specific req.'s
- Hybridize with integrated fiber optic wire or lumen tubes for easy modification
- In-house TDR / VNAs for analysis and product optimization

F/O E-beam eye diagram: 10Gbps



Improving image quality for
more successful procedures



Technology

Engineering Lab (Brockton, MA) –

Cutting edge equipment for verification and validation

- Solidworks, Mold Flow, & FEA
- 3D Printer – SLA
- IPX 4, 5, 6, 7, & 8 – Water Ingress Test Equipment
- Strain relief/flex cycle tester (2x)
- Tensile Tester
- Cable twist test fixture
- Thermal/humidity cycle environmental chambers
- R&D autoclave verification systems
- R&D J&J Sterrad 100NX sterilization chamber
- Steelco High Temp disinfectant washer
- Ultrasonic heated cleaning bath
- Vacuum Leak testers
- Helium Leak tester
- Digital X-Ray (90KV)
- Light intensity output measuring

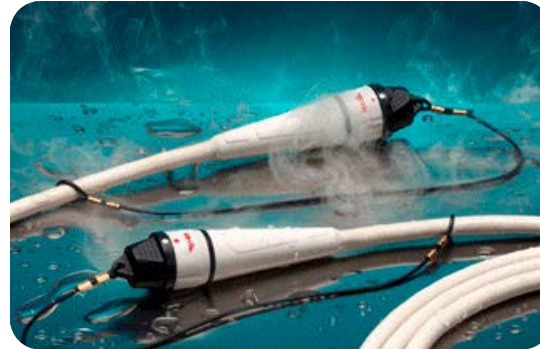
- Electrical Verification/Test Equipment
 - High voltage testing up to 200KVAC
 - Electrical safety analyzer
 - Vector Network Analyzer (VNA)
 - Time Domain Reflectometer (TDR)
 - Meridian/Cable Test
 - Cirrus Tester
 - Low Level circuit resistance (LLCR)
 - High current AC/DC Power Supply
 - Max operating current temperature rise verification capabilities
 - Triboelectric noise test capabilities
- Screw Machine capabilities
- Full Machine Shop
- Mold/tool repair shop
- Full-time test lab engineer



Expediting delivery of development and test iterations

Technology

*Sterilization reprocessing –
Increasing the service life of your product*



Material Performance Verification

- Two-part LIM Silicone Rubber
- Thermoplastic Polyurethanes
- Strong material bonds
- Superior flexibility
- In-house cleaning and sterilization equipment
 - Industrial machine washer
 - Autoclave chambers
 - Sterrad® system*



Lowering the total cost of ownership for your customer

Technology

*Controlled Environment Manufacturing –
When clean room results are required*

Clean and Controlled Assembly Areas

- Designed for ISO class 8 requirements
- Expansion planned in both our Shenzhen China and Hermosillo Mexico facilities
- Adding packaging and labeling capabilities in the near future



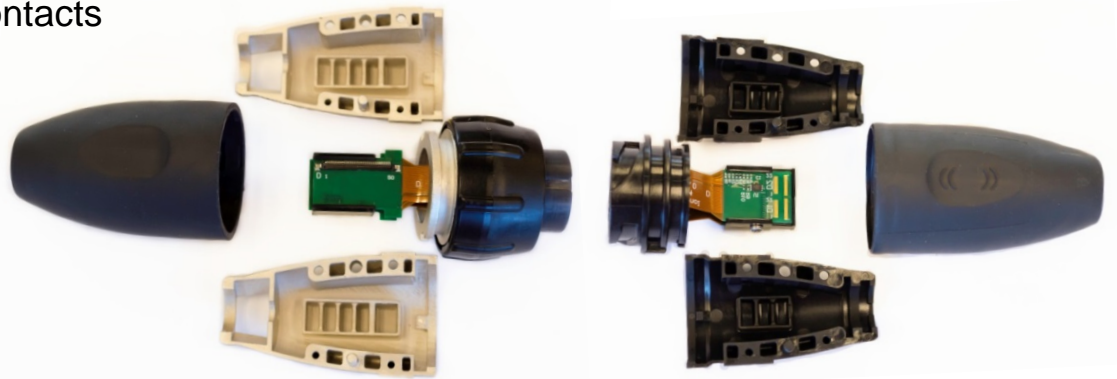
Reducing risk in as many ways as we can

Technology

*Higher Density Contact Arrays –
Providing more data in a smaller size package*

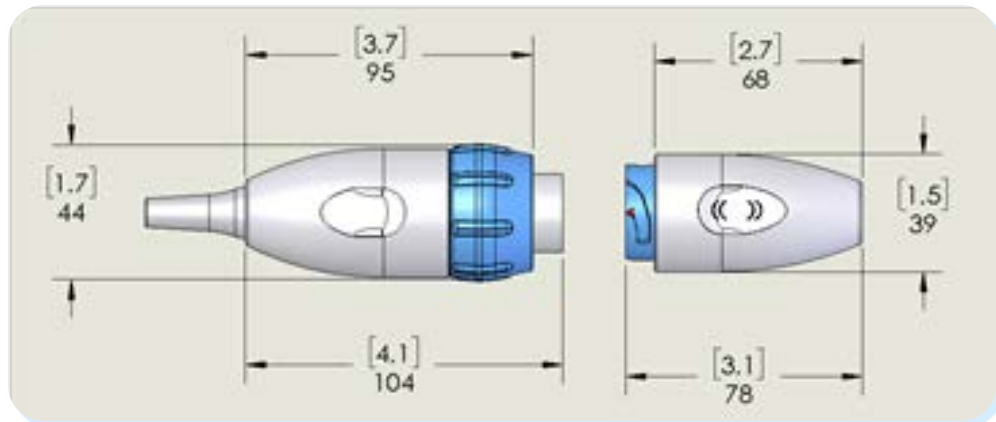
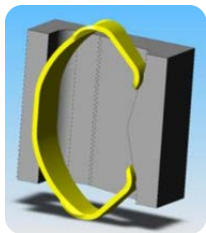
Plug (reusable) Side

- Utilize industry-proven 'C-Stack' contacts
- Rigid-flex PCB
 - SMT components optional
- Plug body shielding available
- Ergonomic slide-on boot



Receptacle (limited use) Side

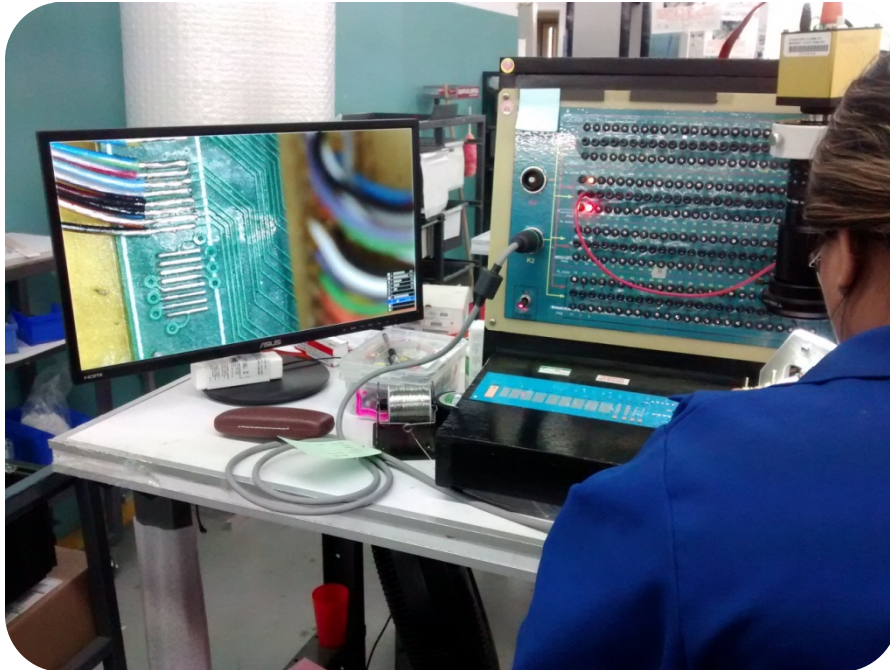
- Low-cost receptacle body
- Rigid-flex PCB
 - SMT components optional
- Ergonomic slide-on boot



Putting more information in the hands of the practitioner

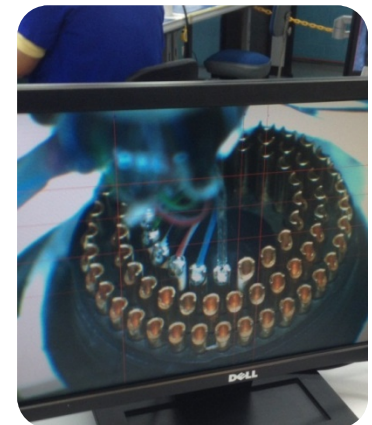
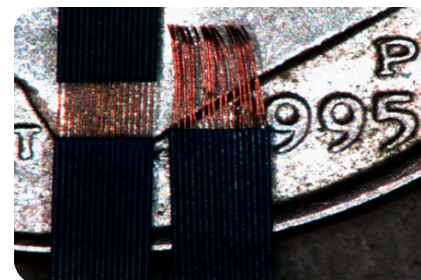
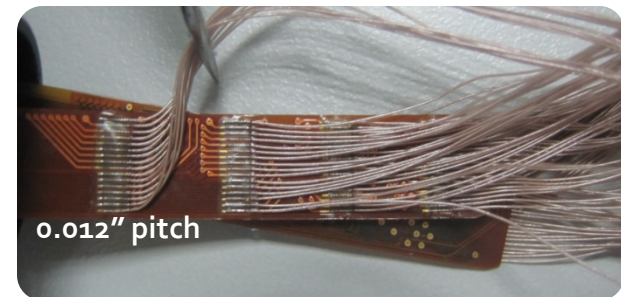
Technology

*Fine Gauge Wire Termination –
Working with conductors smaller than a human hair*



Vision System Assisted Soldering

- Signal, twisted-pair or coax to 44 AWG
- Terminate to PCB or connector contacts
- Compliant with industry IPC standards
- Custom test and inspection systems in process and at final inspection

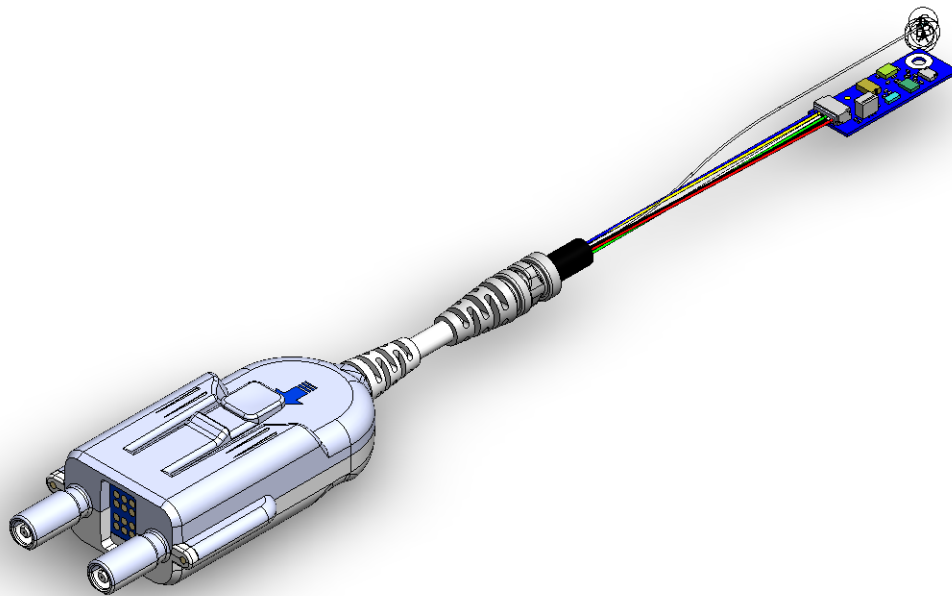


*Enhancing the user's experience with smaller,
more flexible and lighter weight cable*

Technology

Fiber Optic Integration –

Combining fiber optics with copper signal transmission



Light and Data Transmission

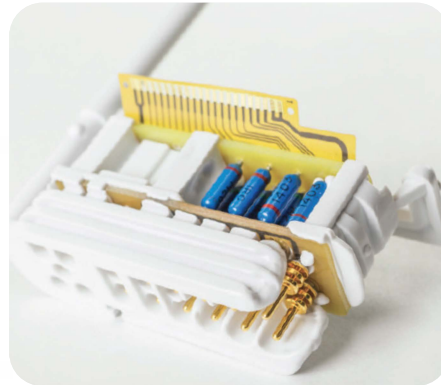
- Fiber and copper in a single interconnect package
- Simplifies use in the OR
- Reduces cleaning and sterilization costs by processing a single unit



*Multiple energy modalities for ablation,
data transmission, and illumination*

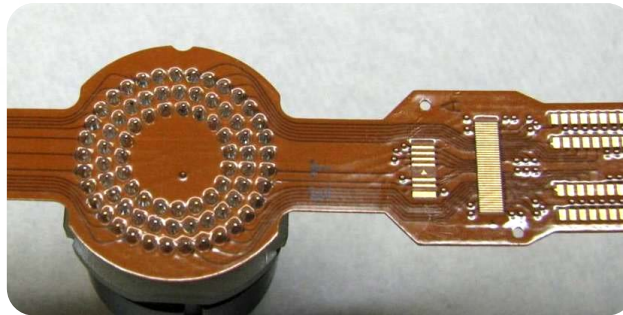
Technology

*Flexible Circuit Integration –
Reliable soldering of complex assemblies*



Vapor Phase Reflow Soldering

- Ideal for soldering high density connectors to flex circuitry
- Brings repeatability and reliability to soldering
- Compliant to industry workmanship standards



Improving functionality and lowering cost by placing electronics at their most effective locations



Standard Products

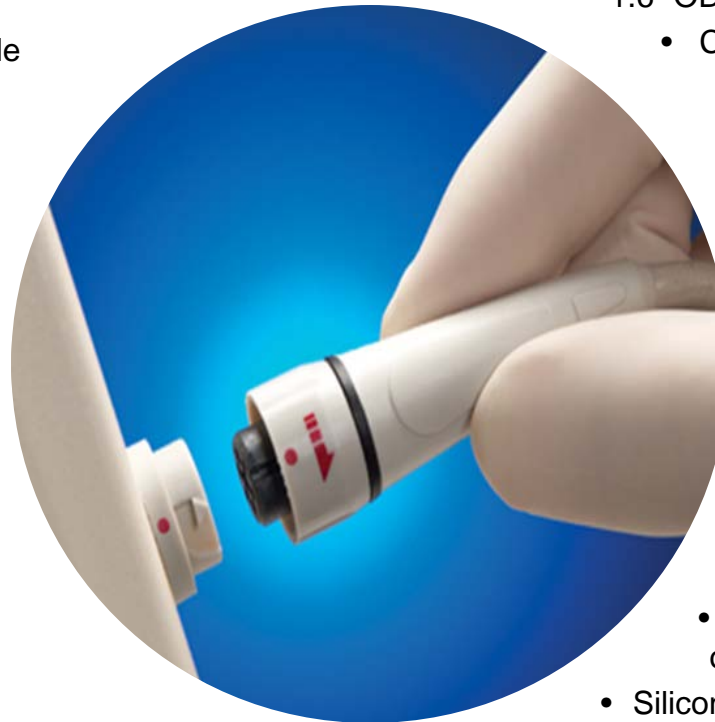
Pulse-Lok[®] circular connectors

Auto-Coupling

- Simply push the connectors together and they lock
- Provides audible, visible, and tactile confirmation of mate
- Positive latch prevents accidental disconnect
- Easily disengages with ¼ turn

Many Connector Options to Choose From

- Four circular shell sizes from 0.5" up to 1.6" OD
 - Circuits range from 1 to 128 contacts
 - Contacts range from 12 AWG to 28 AWG
 - Shell options include both metal and plastic



Environmentally Tough

- Sealed to IPx7 when mated
- Mating cycles in excess of 5,000 times
- Proven in military and industrial applications
- Some configurations also endure autoclave

Easily Customized

- Mix signal, power and high voltage in one
- Straight or right angle or any angle overmold
 - Silicone LIM, TPU, or TPE overmold options
- Standard or custom keys and color options

Standard Products

medi | mate circular connectors

Designed for backwards inter-matability

- Familiar push (locking) and pull (unlocking) latch mechanism
- Six (6) keying configurations per established standards
- Contact size, pole-count and layout per established standards
- Optional silicone slide-on bend relief

Many connector options to choose from

- From two (2) to 14 contacts per connector
- Cable, panel, and PCB-mount housing options available
 - Seven (7) standard color codes
 - Off-the-shelf options available for single-use disposable devices
 - Customize with selective loading of insulator



Outstanding performance

- Sealed to IP50 when mated
- Mating cycles in excess of 2,000 times
- Electrically and mechanically robust
- Compatible with industry-standard cleaning agents as well as EtO and steam sterilization re-processing

Finished cable assemblies

- Bundle diameters from 2.7 – 6.5 mm
- Silicone LIM, TPU, or TPE overmold bend-relief options
- Integrated cable clamp provides strain relief
- Easy customization to your exact needs

Standard Products

pulseOne[®] patient cables

Easy On and Off

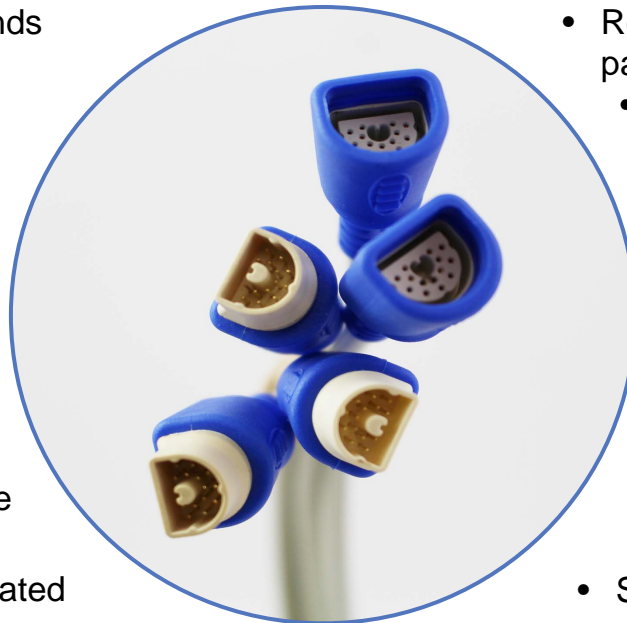
- Obvious visual and tactile “D” shape alignment
- Push on and pull off with no latch to unlock
- Ergonomic grip rests easily in hands of all sizes
- Soft “pop” confirms the mate is complete

Environmentally Tough

- Sealed to IPx7 when mated
- Mates up to 5,000 times (reusable model)
- Chemically robust to endure repeated cleaning
- EMI / RFI shielding available

Pre-configured on Cables

- Standard or custom cable options
 - Circuits range from 4 to 14 contacts 28AWG
 - Receptacles are either cable or panel mounted
 - Three standard keys, or custom key options
 - 1m standard length (configurable to any length specified)



Easily Customized to Specific Needs

- Can include intelligence on PCB option
- Straight, right angle, or any angle overmold
- Silicone LIM, TPU, or TPE overmold options
- Custom logos or colors are possible



Standard Products

Spectrum[®] fine-pitch connectors

Key features

- Proprietary Amphenol compression-style 'C-stack' contact
- Proven Pulse-Lok locking mechanism
- Terminate wire sizes as low as 44AWG
- Positive latch prevents accidental disconnect
- Limited-use options available

Multiple Connector Options

- SPL10 (linear): 1" OD x 3" long – 256 contacts
 - SPL12 (circular): 1.2" OD – 132 contacts
 - SPL20 (circular): 2.0" OD – 340 contacts



Environmentally Tough

- Sealed to IP67 when mated
- Mating cycles in excess of 5,000 times
- Contact technology proven in IC test industry

Easily Customized

- Selective population of contacts for greater flexibility
- Add IC components to flex-boards to make connector 'smart'
- Silicone LIM, TPU, or TPE overmold options
- Standard or custom keys and color options



Application Overview

Cable assemblies for endoscopy vision systems

Mechanical Robustness Ensures Integrity

- Tensile strength member eliminates stress on contact terminations
- Crush resistant to 'gurney wheel' test
- Flexibility ensured with automated 'minimum bend-radii' tester
- Silicone jacket improves resistance to environmental factors
- Stick-resistant coating minimizes binding / drag



Optimized Electrical Performance

- Low-loss multi-gigabyte data transmission over longer lengths
- Optimized combination of shielding prevents EMI, RFI and cross-talk issues
- High-density custom connectors optimized for your performance requirements
- PCBs enable use-limiting connectors



Hybrid Endoscopic Light and Power Cables

- Combines fiber optics and copper conductors in a small, flexible package
- Brings light and electrical energy to the surgical site
- Robust materials for autoclave and Sterrad® sterilization*
- Developed in conjunction with leading OEMs



*Sterrad is a registered trademark of J & J

Application Overview

High Voltage Interconnect for X-Ray

Receptacles and Cable Assemblies

- Mammography industry standard anode connectors
- Miniature 75kV DC plugs and receptacles
- Federal Standard 72 style receptacle assemblies
- Stator motor feed through connectors

Critical High-Voltage Applications

- From 1kVDC to 100kVDC
- In line, panel mount, and cable assemblies
- Receptacles are compatible with dielectric oil
- Receptacles are helium leak tested to 10^{-7} cc / sec

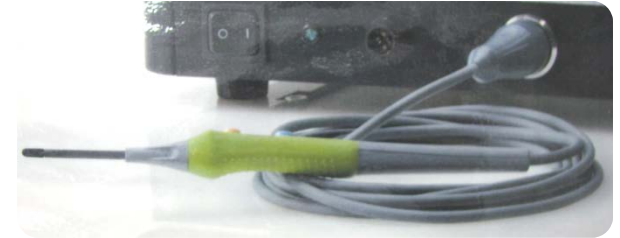


Application Overview

Cable assemblies for electro-surgical instruments

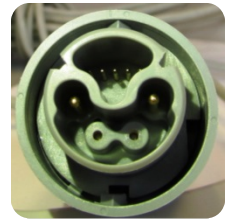
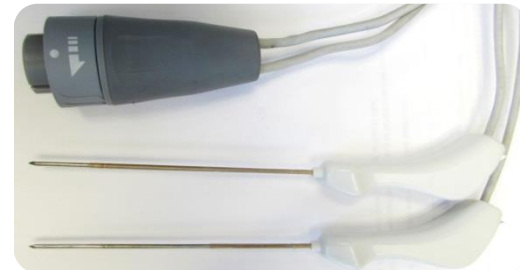
Single-use soft tissue cutting tools

- Low cost high volume disposable applications
- Assembly of connector, cable, and switch electronics
- Integration of RF and signal in one connector
- Ethylene Oxide (EtO) sterilization compatible



Ablation needles to kill tumors

- Pulsed DC high voltage energy
- Embedded RFID properly identifies probe
- Cable assembly is prepped for packaging and EtO
- Flexible silicone cable does not pull on probe placement



Connector system for skin treatment

- Designed to bring microwave energy to bear
- Incorporates signal and coaxial contacts
- Included low cost disposable portion at distal end



Application Overview

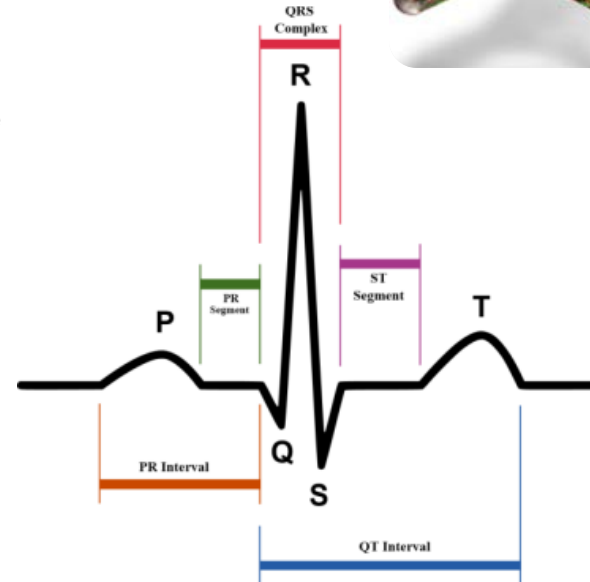
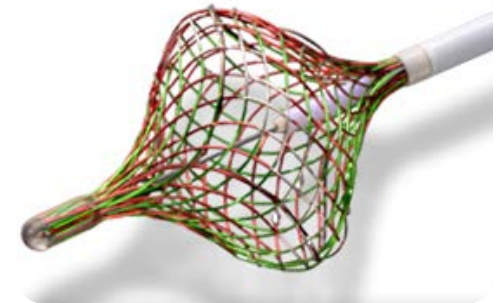
Cable assemblies for electrophysiology

Catheter Connectors and Cable Assemblies

- Robust Pulse-Lok or push-pull connectors
- Low cost high volume disposable solutions
- Intelligent connectors with use-limiting or part identification on board
- Pin counts from 2 to 132 in high density circular configurations
- Mixed mode mapping and therapy delivery in a single assembly

Intra-cardiac Echocardiography (ICE) Connectors

- Simplified flex circuit termination for fine AWG wire
- Customizable flex circuits add performance features
- Small, lightweight, and intuitive design



Success Story

High-speed data transmission via copper conductors

Device...

- Provides 3DHD video for minimally invasive surgery procedures

Product needs...

- Integration of illumination bundle + video transmission / control
- Electrical conductors for video transmission, camera power, and lens-control functions
- High flex-life cable bundle with flex-stable transmission of video-image (i.e. open eye-diagram maintained during flexing)
- Low-drag cable bundle

Our solution...

- Fully-customized connector designed for backwards compatibility with installed product base
- Material selection and geometry optimized to survive customer-specific reprocessing protocol
- Video transmission @ 2.6 Gbps over single 28AWG STP
- Recessed electrical contacts are finger-proof to reduce risk of electrical shock
- Application of special low-friction cable jacket coating to reduce risks associated with patient skin-contact



Success Story

Sterilization reprocessing resilience for a hybrid assembly

Device...

- 4k UHD video for minimally invasive surgery procedures

Product needs...

- 100x reprocessing via autoclave
- Integration of illumination bundle + video transmission / control
- Backwards compatibility with installed product base yet video transmission via multi-mode fiber wire
- High flex-life cable bundle with flex-stable transmission of video-image (i.e. open eye-diagram maintained during flexing)
- Low-drag cable bundle

Our solution...

- Use of specialty high-temp resistant fiber-wire + media converters from sister divisions
- Material selection and geometry optimized to survive customer-specific reprocessing protocol
- Recessed electrical contacts are finger-proof to reduce risk of electrical shock
- Application of special low-friction cable jacket coating to reduce risks associated with patient skin-contact



Success Story

Solution for high-density connector + fine-wire termination

Device...

- Next-gen. ultrasound device

Product needs...

- High contact count (> 128 contacts) connector in a small package
- Effective shielding
- Good signal integrity and isolation

Our solution...

- Semi-custom connector leveraging proven contact technology
- Receptacle connector occupies 30% smaller footprint on system compared with traditional solution
- Crosstalk $\leq -40\text{dB}$ at 2-10 MHz operating freq., 50Ω
- Recessed electrical contacts are finger-proof to reduce risk of electrical shock
- Mating cycle-life: 5,000+ cycles



Success Story

Cost-optimized assembly of a fiber optic assembly



Device...

- Provides information to inform treatment decisions of coronary physiology

Product needs...

- Fiber optic based pressure sensing cable assembly for intravascular measurement
- High-volume manufacturing capabilities (100k+ EAU)
- Improved value, service, and quality as compared to the incumbent source of finished cable assemblies

Our solution...

- Build-to-print solution leveraging Amphenol supply-chain depth and technologies
- Reduced cost of final assembly by leveraging our low-cost production center in China
- Robust QMS system enabled easy product transition from incumbent to AAP and creation of FDA notification documentation

Amphenol Alden

Your preferred medical interconnect solutions provider

Our company

- Innovative technology-driven organization
- Strong financials with focus on long term growth and stability
- Global manufacturing footprint

Our medical products & services

- Custom interconnect solutions
- Single use cable assemblies
- Standard circular connectors
- Engineered cable assemblies

Your collaborative solutions provider

- Partnership from concept through production providing unsurpassed value in engineering, service, and quality

Amphenol Alden

Your preferred medical interconnect solutions provider

Discussion

Action Items

Thank You For Your Time!