

**tyco**

*Electronics*

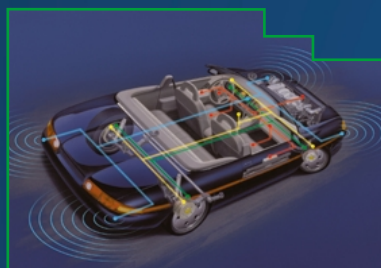
# Automotive Protection Products



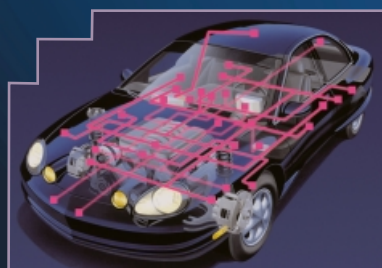
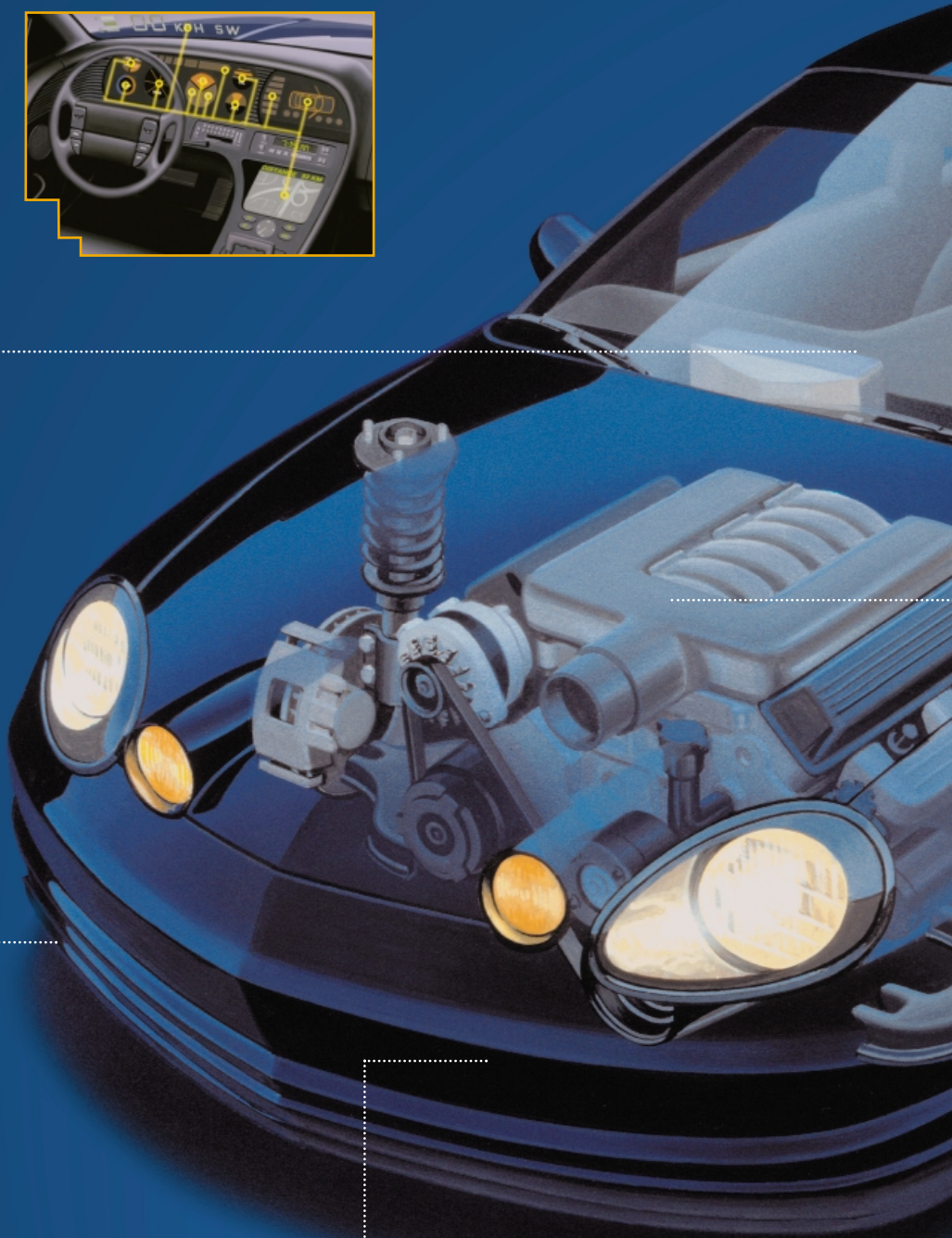
**GLOBAL AUTOMOTIVE DIVISION**

# TYCO ELECTRONICS GLOBAL AUTOMOTIVE DIVISION

## ▶ Driver Information



## ▶ Safety Systems

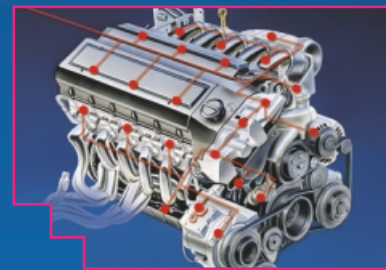


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# THE 7 APPLICATION AREAS

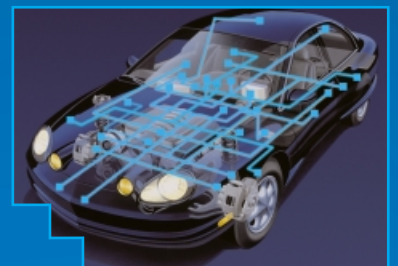


▶ Convenience

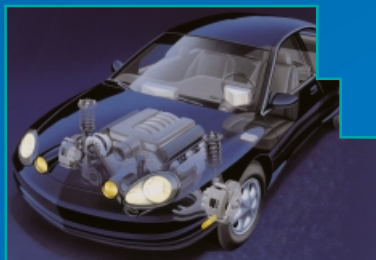


▶ Powertrain Systems

▶ Security



▶ Chassis Systems



## INNOVATIVE TECHNOLOGIES

***Tyco Electronics is one of the major business units of Tyco International Ltd. Headquartered in Harrisburg, Pennsylvania, USA, Tyco Electronics is the world's largest passive electronic components manufacturer and a world leader in cutting-edge wireless technologies. The company has facilities located in over 50 countries, serving customers in the aerospace, automotive, computer, communications, consumer electronics, industrial and power industries. The global automotive division follows the globalization goals of our customers, speeds up the integration of new technologies and enables our customers access to our vast product portfolio and services.***

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### TERMINALS & CONNECTORS



Tyco Electronics offers a broad range of high quality terminals and connectors. Our electrical and electronic interconnection products and solutions are used to electrically and mechanically join wires and cables, printed circuit boards, integrated circuit packages and batteries. Our continually expanding capabilities include new copper and fiber-optic connectors, wires, cables and cable management systems that are designed to meet automotive industry demands. The AMP brand encompasses the broadest range of connectors in the world, including high-density, high-speed designs for leading-edge communications equipment.

LITERATURE NO. 1308092

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### MECHATRONICS



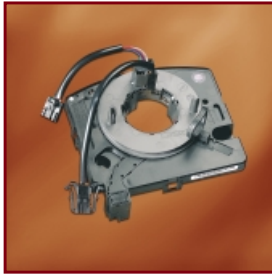
A variety of technical products is designed today by integrating mechanical components and electronic hardware into one packaging unit thus creating true mechatronic solutions. Mechatronic applications offer amazing and versatile potentials related to functionality, cost, space requirements and quality. Tyco Electronics contributes to those applications with its wide range of innovative and cost-effective product and process technologies.

Advanced stamping, injection molding and assembly techniques are applied along with highly selective surface plating methods.

LITERATURE NO. 1308091

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## CLOCKSPRING SYSTEMS



Automotive technology and integrated systems continue developing rapidly and particularly, the electric and electronic systems in today's vehicles play an increasingly important role for traffic safety and traveling comfort.

The Safety Systems (SAS) subdivision of Tyco Electronics' Global Automotive Division offers a wide range of engineering know-how and production facilities concerning electrical transfer units ("clocksprings") for steering wheel airbag devices. We pulled together a remarkable combination of

competences in development, production and related technologies as well as our unique application support thus ensuring the competitive edge for mutual business growth on a worldwide scale.

LITERATURE NO. 1308088

## SENSOR TECHNOLOGY



Tyco Electronics offers non-contact sensors for a variety of applications. As sensor manufacturer and processing partner, we also provide project planning support for new sensor applications, assistance in the selection of the appropriate sensor technology for the respective application, and assistance with defining the corresponding mechanical, electrical and magnetic interface. Tyco Electronics has a broad electromechanical portfolio that includes robust housing technologies, connector systems, and

temperature stable designs based on foil and cable networks. This combination of technologies and experience ensures that reliable and cost effective sensor solutions are available for all application types.

LITERATURE NO. 1308086

## WIRELESS TECHNOLOGIES RADAR SENSORS & ANTENNAS FOR TELEMATICS



Tyco Electronics delivers wireless sensors for just about any spot you can imagine. We are first to market in radar-based sensors for truck collision warning systems, autonomous cruise control systems, and meanwhile offer a variety of short-range sensor systems. Modern automotive on-board navigation systems use the Global Positioning System to pinpoint your car's location.

Automotive navigation/safety systems currently require two separate antennas for operation: a GPS antenna for navigation and tracking information, and a

second, separate whip antenna for cellular communication. Our latest innovation is a quad band antenna, which includes Satellite Radio (SDARS), GPS and two cellular bands.

LITERATURE NO. 1308090

## HIGH SPEED COMMUNICATION



With the introduction of the D2B Optical Networking System in 1997, the way was set for the automotive world to start reaping the benefits for optical data transmission. The D2B system enjoyed a successful launch which resulted in the system being introduced across the full product portfolio of the main car OEM who developed the D2B system technology.

The advantages of Optical Networking were attracting the attention of many other car OEM's and in 1998 with the foundation of the MOST® Cooperation

the first steps were taken to build on the work of the D2B technology and spread the benefits of the Optical Networking technology throughout the automotive world.

The MOST® Cooperation focused on developing an optical network specification defining all key interface points which would enable the automotive supplier market to develop components when based on the MOST® Specification to be compatible and interoperable.

**MOST® IS A REGISTERED TRADEMARK OF OASIS**

LITERATURE NO. 1308084

## RELAYS AND SWITCHING MODULES



Automotive technology and integrated systems continue to develop rapidly with electric and electronic systems in today's vehicles playing an increasingly important role for traffic safety and travelling comfort. Automotive Relays and Switching Modules (AR & SM) of Tyco Electronics' Global Automotive Division offer a wide range of the most important components for such systems and is the world's no. 1 player in this industry sector. It is our intent to bring closer to you our total competences in development, production and

related technologies as well as our unique application support thus ensuring the competitive edge for mutual business growth on a worldwide scale.

LITERATURE NO. 1308085

## POWER DISTRIBUTION SYSTEMS



The extensive net of electrical and electronic loads requires the next evolution of complex powernet structures including intelligent control and distribution systems.

Modules with intelligent technology combinations for power distribution units with integrated switching and protection functions together with a maximum of flexibility and modularity at highest package density tuned 100 % on customers needs, that's what Tyco Electronics is working on.

LITERATURE NO. 1308087

## INDUCTIVE SYSTEMS



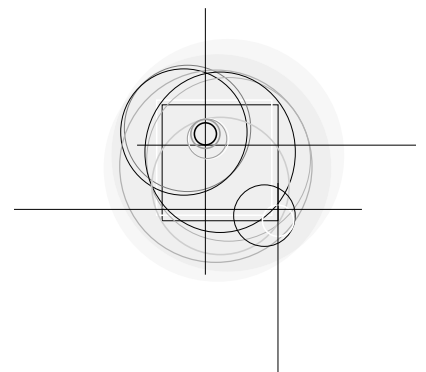
The Global Automotive Division is your source for interconnection and wireless technologies for automotive, truck and off-highway OEMs and Tier 1 suppliers. Tyco Electronics Inductive Systems is ready to offer you any LF-application component required in the automotive branches.

The Inductive Systems groups focus is on the customer requirement in order to design to the exact demand. This is achieved by high-technological, intelligent and cost-efficient engineering. In order to be a leader in design, our Inductive Systems has a vast product portfolio, which consists out of antennas, actuators and integrated modules. Next to that, several specific applications are designed.

LITERATURE NO. 1308089

## A VITAL PART OF YOUR WORLD

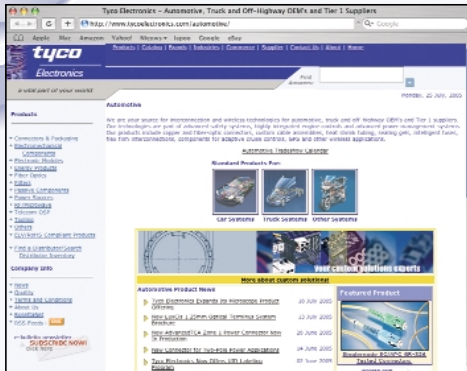
Tyco businesses operate in thousands of different areas of industry. The products and services we deliver all have one thing in common. They are vital to everyday living. Individuals and companies worldwide have critical needs. And every minute of every day, we satisfy them.







# TYCO ELECTRONICS "AT YOUR SERVICE"



## Internet Homepage

[www.tycoelectronics.com](http://www.tycoelectronics.com)  
[www.tycoelectronics.com/automotive](http://www.tycoelectronics.com/automotive)

## Electronic Internet Catalog

[www.catalog.tycoelectronics.com](http://www.catalog.tycoelectronics.com)

## Tyco Electronics Online

The Tyco Electronics Website is more than merely an Internet-guide. It is an innovative and interactive source for application tips, product update and technical information.

With our StepSearch-Software you can easily surf through all of our product lines.

## Product Information Center (PIC)

You can rely on our PIC Team's support.

Our experienced staff is an additional information source, and the team has been particularly trained to answer your technical questions.

To reach our PIC, please contact your local Tyco Electronics organization.



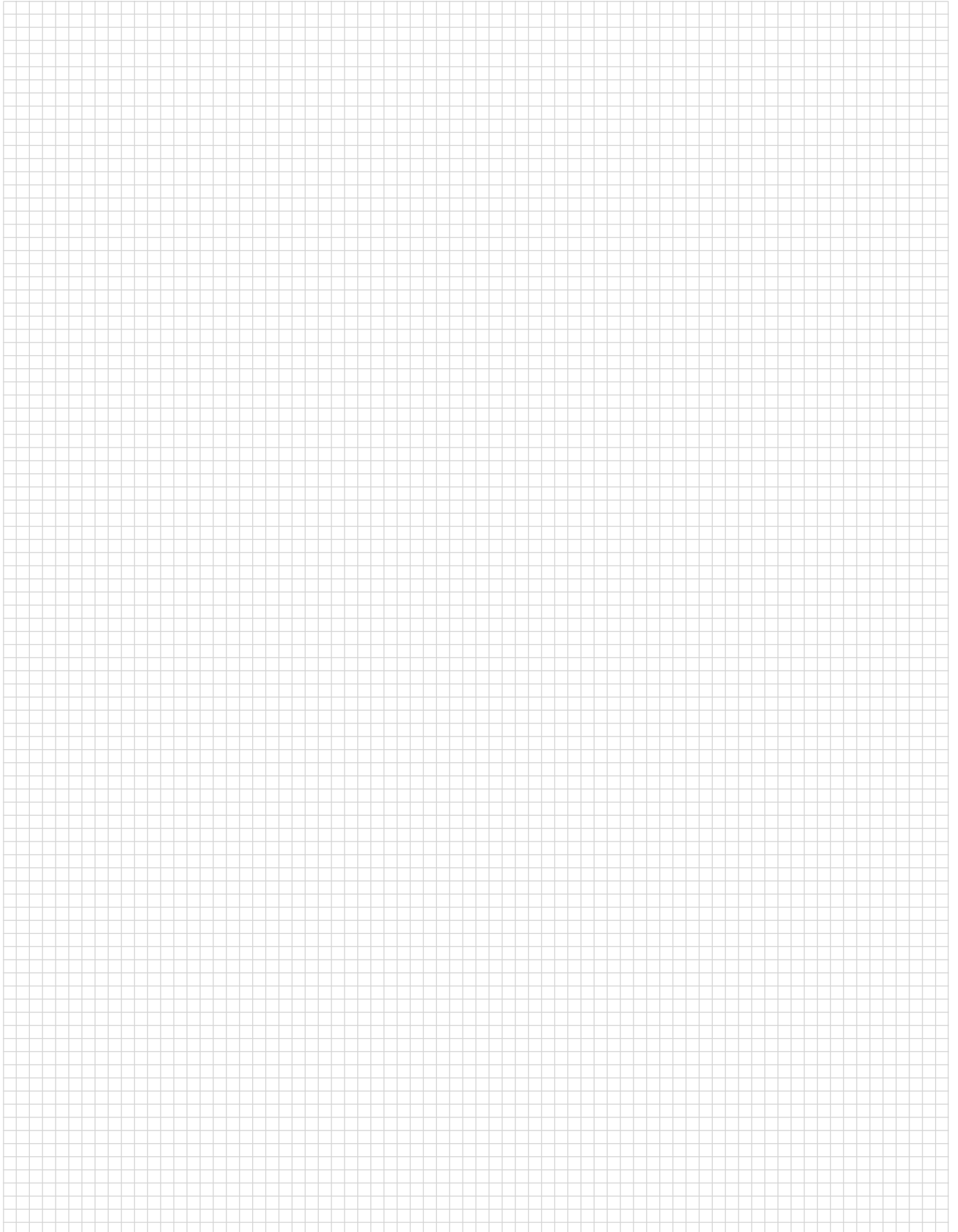
## Product and Machine Literature

For more information about Tyco Electronics' Global Automotive Division and its wide range of products we offer you a variety of literature such as product databooks and a lot of product specific brochures.

For databooks and product brochures please contact your local Tyco Electronics organization.



Engineering Notes



Tyco Electronics with headquarter in Harrisburg, Pennsylvania, USA, is one of the major business units of Tyco International Ltd.

Tyco Electronics is the world's largest passive electronic components manufacturer; a world leader in cutting-edge wireless, active fiber optic and complete power systems technologies; and is also rapidly developing extensive networking and building technology installation services.

The global automotive division follows the globalization goals of our customers, speeds up the integration of new technologies and enables our customers access to our vast product portfolio and services.

## **Raychem**

### **Automotive Protection Products**

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Tyco Electronics Raychem brand is the world leader in developing, supplying and manufacturing high quality, technologically advanced, heat-shrink protection products. Our products provide a perfect solution for your toughest engineering problems.

Tyco Electronics Raychem tubings are uniquely formulated materials that have been enhanced by radiation cross-linking, a technology that Raychem famously pioneered.

These easy-to-use products provide cost effective, proven solutions in a wide range of Automotive applications from sealing and protecting electrical splices to providing mechanical protection for fluid management systems in harsh environments.

For over forty-five years, customers have recognised the global capabilities of Raychem brand products. Combining these advanced products with superior technical support and global sales and service organisations, our worldwide customers count on Tyco Electronics to supply the knowledge and products they require to solve specific problems, which can effectively enhance the overall performance of their customers' systems.

Our single wall tubings have a wide range of characteristics. Choose them wherever you need reliable insulation, strain relief, protection from mechanical abrasion and chemical abuse or an ideal way to identify or code components, or simply use them to enhance aesthetics.

Our adhesive-lined range shows its strength where sealing and encapsulation are critical requirements, as well as demonstrating many of the features of the single wall products. The inner adhesive can deliver a true seal against moisture and fluid ingress.



#### **Product facts**

- Installation fast and simple and supported by a wide range of Tyco Electronics Raychem Application Equipment.
- Available in a wide range of materials, such as polyolefins, fluoropolymers and elastomers.
- Choose from tubings that are highly flexible or semi-rigid, designed for operation in high or low temperature environments.
- Halogen-free and flame retardant to meet a range of industry standards.
- Available in many sizes, constructions, lengths and colours.
- Available with shrink ratios of 2:1 up to 7:1

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**Tyco Electronics Raychem  
Heat-shrink Technology**

Since its founding in the 1950s, Raychem's material science expertise has pioneered many of the breakthrough technologies used to create today's most advanced environmental sealing and protection systems. Tyco Electronics Raychem heat-shrink products are in service throughout the world in automotive, telecommunications, power distribution, aerospace, defence, industrial and commercial applications. Renowned for their unrivalled performance and reliability in the most demanding of environments, they include a comprehensive range of automotive sealing and protection products. Produced using Tyco Electronics Raychem's state-of-the-art manufacturing facilities and processes, these products offer the most cost-effective and robust solution to all your interconnection needs.

**Automotive Sealing and  
Protection Products**

Tyco Electronics Raychem heat-shrinkable products have been developed to provide robust and reliable protection of automotive electronic components and electrical systems. Based on a broad range of cross-linked, shape-memory, polymeric materials, these products provide long-term protection against moisture ingress, corrosion, mechanical damage and extremes of temperature.

Tyco Electronics Raychem experience of product design ensures a repeatable, reliable, shrink to fit installation, compatible with present day manufacturing processes. Adhesive precoatings on heat-shrinkable sleeveings and moulded shapes produce a positive watertight seal for wire-to-wire and wire-connector splices and terminations for both automotive and truck applications.

Tyco Electronics Raychem brand of tubing was developed when our scientists pioneered the application of radiation cross-linking and the development of heat-shrinkable polymer products. Today, Tyco Electronics is recognized worldwide for its expertise in these areas. The Raychem brand of tubings based on polyolefins, fluoropolymers and elastomers enhanced by radiation cross-linking and heat-shrinkability. When heated, the tubing shrinks to conform to almost any shape. Single wall tubings are available. Dual-wall tubings have an inner wall – either adhesive or an encapsulant – that melts and flows during installation heating to protect against environmental damage.

Heat-shrinkable products for the automotive industry may be used for a wide variety of applications including connector sealing, wire sealing and mechanical protection.

**Core Technologies**

**• Polymer Formulation** Raychem formulations are blends of polymers and additives that are carefully designed to meet the stringent customer demands and international specification requirements. The selection of polymers, flame-retardants, anti-oxidants, UV-stabilisers and other additives is of great importance for products to meet requirements on properties such as tensile strength, elongation at break, flame retardancy, continuous operating temperature, heat shock, heat ageing, flexibility, chemical and solvent resistance and shrink temperature.

A wide range of Raychem compounds are available to manufacture a complete range of heat-shrinkable products. Heat-shrinkable tubing, manufactured with these compounds, will meet international standards & OEM approvals in many electronics markets.

Raychem hot melt adhesives are specially formulated to be compatible with individual heat-shrink tubing compounds. These adhesives include a balance of polymers and additives that allow the adhesive to melt, flow, seal and adhere to a range of substrates at the shrink temperature of the overall tubing.

**• Cross-linking** Radiation cross-linking was pioneered by Raychem to enhance polymer properties and to provide heat-shrinkability or shape memory. Polymeric tubing is extruded and the chemical structure then modified in a separate process to provide improved properties such as reduced deformation under load (creep), improved chemical and solvent resistance, increased abrasion resistance, improved impact properties and shape memory characteristics.

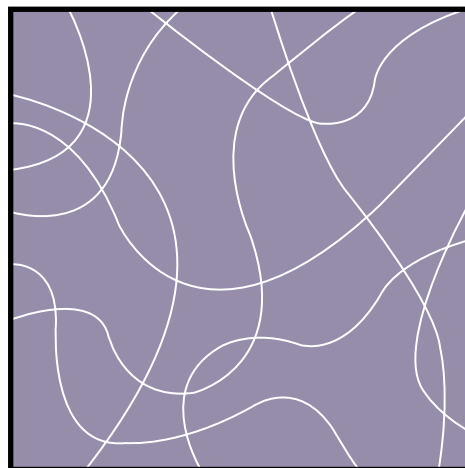
Due to the three dimensional cross-links which are formed during the cross-linking process, the tubing does not melt and obtains its perfect shape memory.

**• Manufacturing Technology**

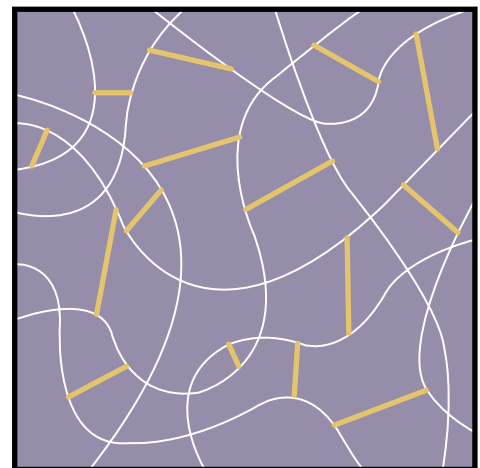
Based on many years of experience Raychem tubing is produced using optimised manufacturing processes by the following steps: compounding, extrusion, radiation cross-linking and expansion.

Firstly, compounding processes are used to mix selected polymers and additives. The resulting compounds are then extruded using optimised screw and die designs to produce homogeneous and consistent tubing. The tubing is then cross-linked using electron beam radiation.

In the expansion process the diameter of the tubing is increased by forces at high temperature. Immediately after the tubing reaches its required expanded size, the tubing is cooled down and retains its expanded dimensions. This stage is called the “expanded” state.



Unmodified polymer



Cross-linked polymer

### **Tubing Overview**

The Tyco Electronics Raychem brand of tubing was developed when our scientists pioneered the application of radiation cross-linking and the development of heat-shrinkable polymer products. Today Tyco Electronics is recognised worldwide for its expertise in these areas. The Raychem brand of tubings are made of polyolefins, fluoropolymers and elastomers enhanced by radiation cross-linking. When heated during installation the tubings shrink to conform to virtually any shape. They provide dependable insulation, mechanical protection and strain relief as well as aesthetic appeal. Single wall tubings are available in thin wall, medium wall and thick wall versions. These tubings are designed for operation in high or low temperature environments and can also be halogen-free and flame-retardant to meet a range of industry standards. With dual-wall tubing, an inner wall – either an encapsulant or an adhesive – melts and flows during installation heating to protect against environmental damage. Encapsulants protect connections and components from splashing and corrosion. Adhesives go a step further, sealing to plastic, metal, rubber or other substrates.

A unique, heat-shrinkable fabric tubing is available to provide mechanical abrasion protection for components such as rubber hoses, plastic pipes, and harness wiring bundles. This product, together with a range of cold installable braided sleeveings, is suitable for applications where exceptional flexibility combined with superior abrasion and cut resistance is required. The woven construction makes these products extremely flexible and resistant to trapping water, heat and humidity.

Tubings may be highly flexible or semi-rigid, designed for operation at high or low temperature environments, halogen-free and flame retardant to meet a range of industry standards. They are available in many sizes, constructions, lengths and colours to meet automotive, commercial and military specifications. Installation is fast and easy with a range of hand held heating tools and bench mounted heaters. A range of semi automatic installation equipment is also available for high volume applications.

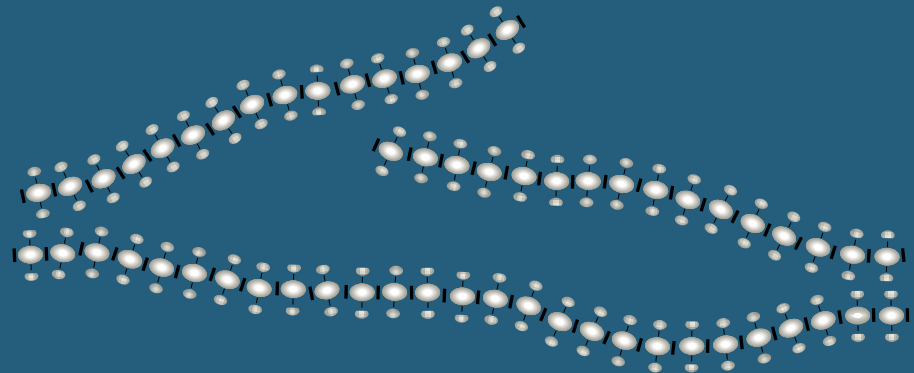
• **Splice, terminal and connector sealing** Today's vehicle wiring and manufacturing requirements result in many exposed multiple wire splices. Raychem dual-wall heat-shrink sleeveings are a reliable method of sealing crimped, soldered or ultrasonically welded splices. On heating these sleeveings shrink to a predetermined size, the outer wall providing a tough abrasion and fluid resistant electrically insulating covering for the splice and the inner meltable adhesive lining producing a reliable flexible water tight seal.

Advanced materials and product design have resulted in a complete line of products offering the most effective sealing available today. Adhesive-lined, heat-shrinkable tubing and caps seal and protect electronic components and in-line splices from fluids, moisture and corrosion whilst also providing strain relief. Heat-shrink caps lined with an adhesive or encapsulant form a moisture resistant barrier around stub splices and wire ends. Other heat-shrinkable, adhesive-lined products are available to environmentally protect connector to cable transitions.

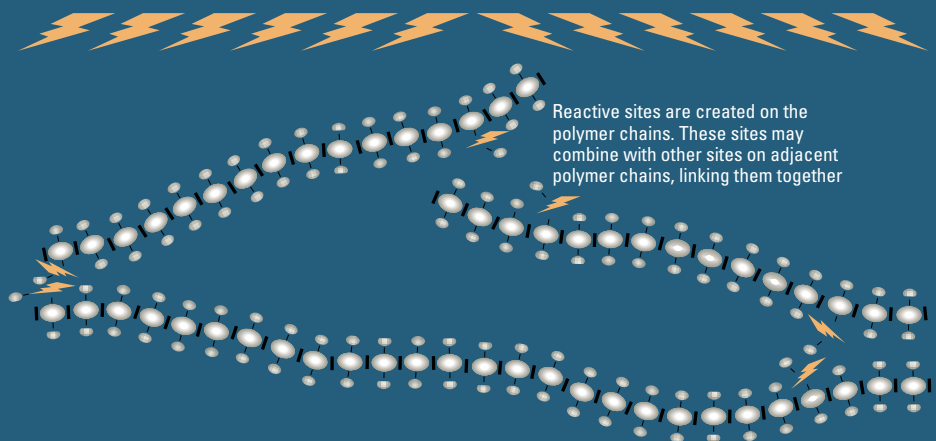


### What is Radiation Cross-linking?

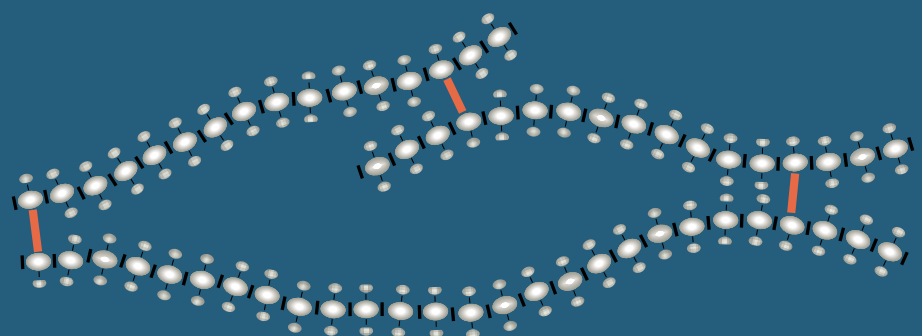
Uncross-linked polymer chains in insulation immediately after extrusion:  
Long chain molecules are free to slide over each other – polymer can be melted



To cross-link the insulation, high energy electrons are fired at it in a special chamber:



The resulting structure is a network of linked molecules:  
This acts as a single giant molecule. Because the chains are no longer free to move over one another, the cross-linked molecules will not melt



• **Wire Bundle Blocking** Water can cause severe damage to electrical systems. Terminations, splices and connections in areas remote from immediate soaking can be easily attacked by water migration along a wire bundle. The easily installed range of Rayblock products provide a moisture proof seal at any point along a multi-wire bundle cable. Installation can be carried out on or off harness. Bundle sealing products block multi-wire bundle cables.

• **Pipe and Hose Protection** Problems ranging from corrosion of exposed metal work of brake and fuel lines, to impact protection of wires and cables may be simply solved by using Raychem heat-shrinkable sleeveings. Available in a range of materials from flexible, fluid resistant elastomers to rugged rigid nylon, these sleeveings may be quickly and easily installed. Sleeveings may be supplied pre-coated with an internal adhesive liner, to provide additional moisture proofing and corrosion protection, once installed.

Highly flexible heat-shrinkable fabric tubing provides outstanding abrasion protection for components such as rubber hoses, plastic pipes and harness wiring bundles, recovering easily over awkward substrates such as bent hoses. Heat-shrinkable tubeings provide mechanical protection for hoses and pipes and also reduce wire chafing or cable abrasion.

#### **Application Equipment**

Providing application equipment is a service to our customers and is one of the keys to success in growing business in the Automotive market. Tyco's in-house product engineering group has designed a range of custom-built application equipment for installing heat-shrinkable products for the automotive industry. Manually operated and semi-automated equipment has been developed to permit rapid, reliable and reproducible installation of these products under factory floor conditions. The equipment provides an acceptable process, with high

quality and reliability, process robustness and cost effectiveness. Use of heat-shrink products together with the appropriate application equipment enables Tyco to provide the customer with a 'system' approach. Compliance with all CE legislation and hence optimised safety and reliability is a priority.

A wide range of hand-held heating tools is available for the rapid installation of heat-shrink products giving reliability and durability in any environment. Additionally, table-mounted and continuous processing equipment (e.g. conveyors, belt heaters) offer maximised productivity, process robustness and reliability for a wide variety of products and applications. 'On-Board', portable equipment gives adaptability for use in synchronisation with customer harness-build process.

Application equipment provides solutions and support for all aspects of heat-shrink insulation, sealing, protection and connection in a wide variety of applications.

**Continuous Improvement**

We visit our customers frequently to ensure their ongoing satisfaction with our products, and are always keen to listen to their views on any further refinements they would like to see. We also continuously review the performance of our products and introduce efficiency, quality and technical improvements with every iteration. Thus we ensure that our customers are able to benefit from the most advanced products available and we aim always to provide products with the leading price /performance ratio.

**Commitment to quality**

Our manufacturing plants are ISO TS approved and we are able to guarantee quality products manufactured to the most demanding performance and dimensional specifications on precision extrusion and processing equipment.

**End of Life Vehicle Directive**

All of our products meet the requirements of the published EC Directive on "End of Life Vehicles", 2000/53/EC, in that they do not contain mercury, lead or hexavalent chromium.

Note that these substances may be present as trace elements or natural impurities within raw materials used in our formulations at levels below 0.1%, which is the current threshold reporting level in several OEM standards.

**Declarable and Restricted Material Reporting**

Our standard electronic reporting method for product material content, including declareable or restricted materials, is via the International Material Data System (IMDS) by means of Material Data Sheet submissions to our customers upon request or new part approval.

IMDS is a joint development of Audi, BMW, Daimler Chrysler, Ford, Opel, Porsche, VW and Volvo. In IMDS all materials used for car manufacture are archived and maintained. Only in this way is it possible to meet the obligations placed on car manufacturers and thus on their suppliers by national and international standards, laws and regulations.

Compliance with other OEM's material reporting requirements is maintained by submission of relevant declaration forms as required against individual OEM specifications.

**Summary**

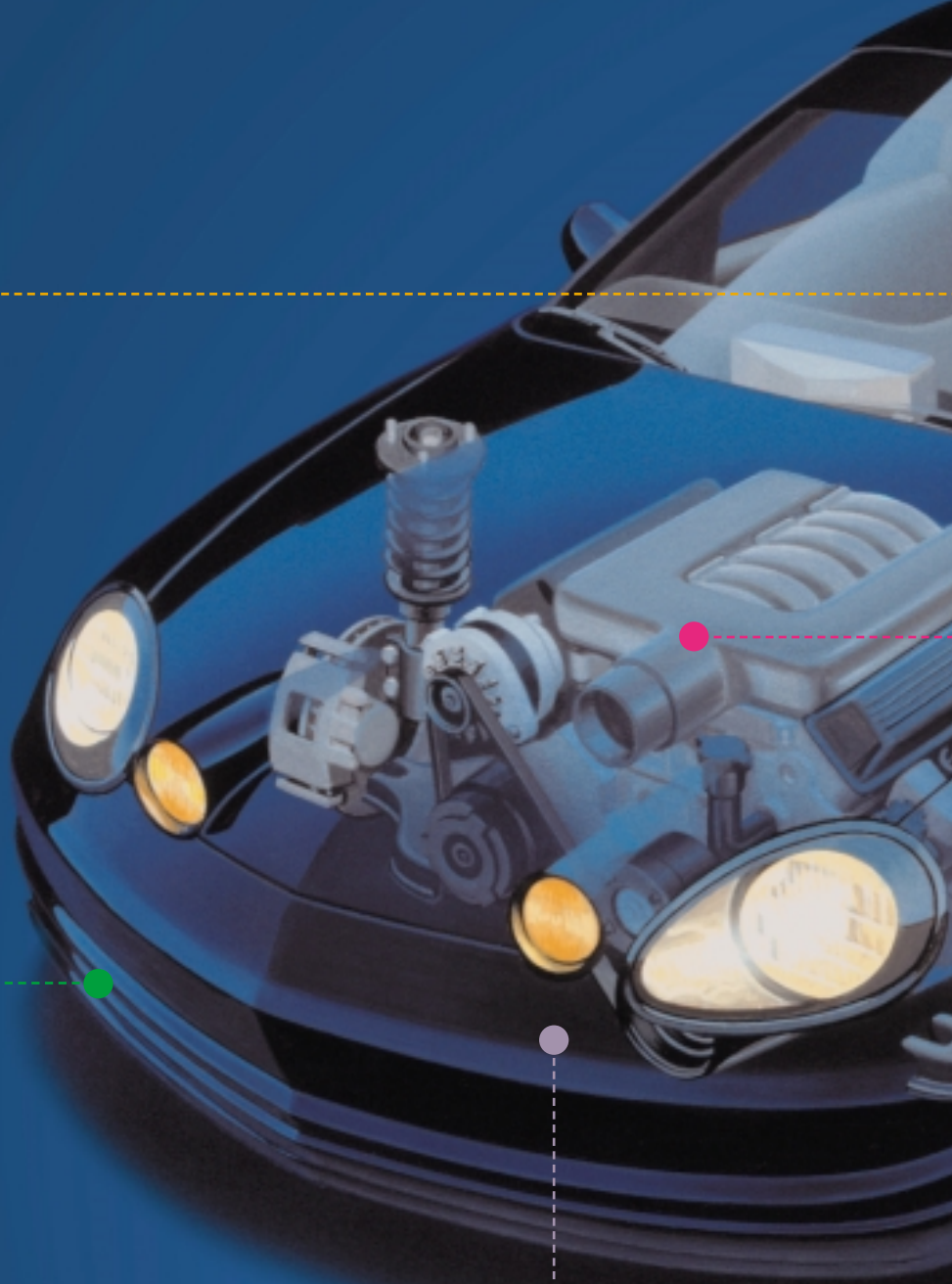
Designed to be durable and engineered to be cost effective. The wide range of Raychem tubing products is the way to provide effective electrical insulation, mechanical and environmental protection.



**Driver  
Information**



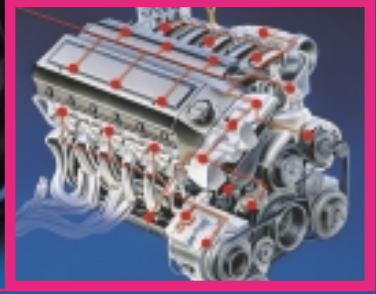
**Safety**



**Body**



Convenience



Powertrain



Security



Chassis Systems



# Harness Design Application Documents

**Sealing and protection for wire bundles, connectors,  
terminals and splices**

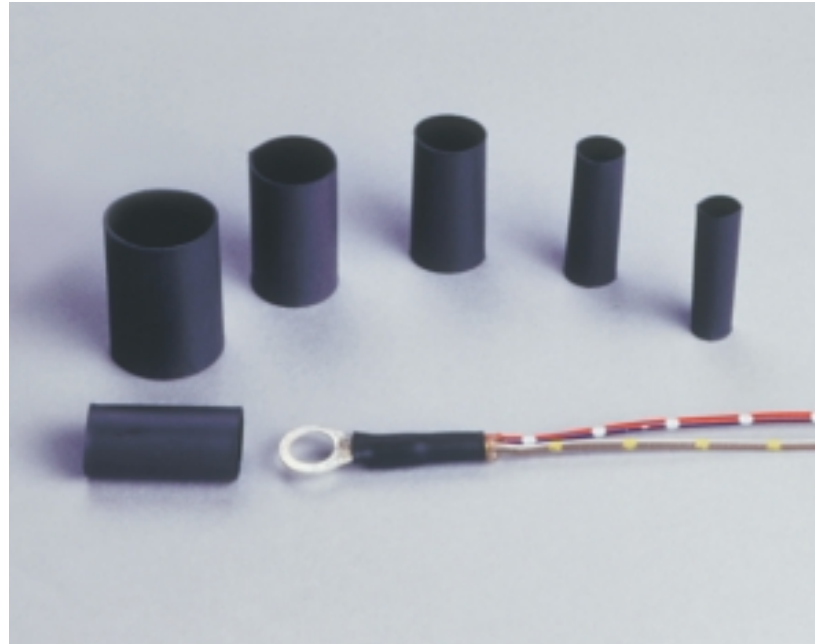
- **Splice sealing**
- **Connector sealing**
- **Wire bundle sealing**
- **Feedthroughs**

Sealing and protection for wire bundles, connectors, terminals and splices



## Sealing and protection for grounding ring terminals

RBK-ILS-125 product provides a one component solution to sealing, protecting and insulating vehicle harness ring terminals.



### The challenge facing manufacturers

Maintaining the electrical quality of ring terminal connections has always been critical. In today's cars it is even more important as manufacturers are increasingly using ring terminals to ground low current 'quiet' and 'logic' signal circuits. Any increase in resistance, usually caused by corrosion as a result of moisture entering the wire terminal connection, can critically impair these electrically sensitive circuits.

Mechanical damage can also reduce electrical performance, so protection during handling is important, as well as effective strain relief when in use.

### Conventional solutions

In some instances no protection at all is provided for ring terminals. While this may prove acceptable for noisy and high current grounds, such as electric motors, low current quiet signal and logic grounds usually require some form of sealing and protection, particularly in wet areas of the vehicle.

Tape is sometimes used to insulate ring terminals, however, this provides no effective sealing, no strain relief and limited protection from automotive fluids and physical abuse.

### The Tyco Electronics solution

Using Raychem adhesive-lined, heat-shrinkable tubings offering a single component solution to seal, protect and insulate ring terminals.

### Benefits

- Simultaneous sealing, protection and insulation – in one process pass
- Rapid, simple installation – over-expanded sizes allow placement of tubing over ring terminal after ground wires have been terminated
- Applications versatility – one tubing size covers a broad range of ground wire sizes and wire combinations
- Superior strain relief and mechanical protection – provided by tough outer jacket, plus tubing and adhesive combination
- Established application and installation procedures – meeting most harness production processes

### Tyco Electronics products

- Raychem RBK-ILS-125 tubing



## Product features

### **RBK-ILS-125**

- Continuous operating temperature from -40°C up to +125°C (3000 hrs)
- Mechanically tough, dual-wall polyolefin-based material
- Adhesive-lined to environmentally seal ring terminals – depending on terminal design
- High shrink ratio, allowing one size to fit a wide range of terminal sizes
- Highly resistant to automotive fluids and solvents

RBK-ILS-125 is an adhesive-lined, heat-shrinkable tubing which provides excellent moisture proof sealing of ring terminals in automobile applications, particularly in wet areas of the vehicle. This product also provides effective electrical insulation as well as strain relief and mechanical protection against flexing, abrasion and cut-through. RBK-ILS-125 is available in six sizes to cover a wide range of ring terminals – depending on terminal design. For multiple wire configurations it may be necessary to consider additional adhesive inserts. Please consult your local Tyco Representative.

**All RBK-ILS tubings are supplied in 27 mm cut lengths to suit ring terminal applications.**

### **RBK-ILS-125-Nr500**

- 5:1 expansion ratio, allowing installation over terminal

RBK-ILS-125-Nr500 is a highly over-expanded product which allows the product to be positioned and installed after the ring terminal has been crimped or ultrasonically welded to the ground wires.

**For full technical information on RBK-ILS-125 and RBK-ILS-125-Nr500 please see the relevant RBK data sheet, page 76.**

Sealing and protection for wire bundles, connectors, terminals and splices



**Powertrain Systems**



**Chassis Systems**



**Safety**



**Security**



**Body**



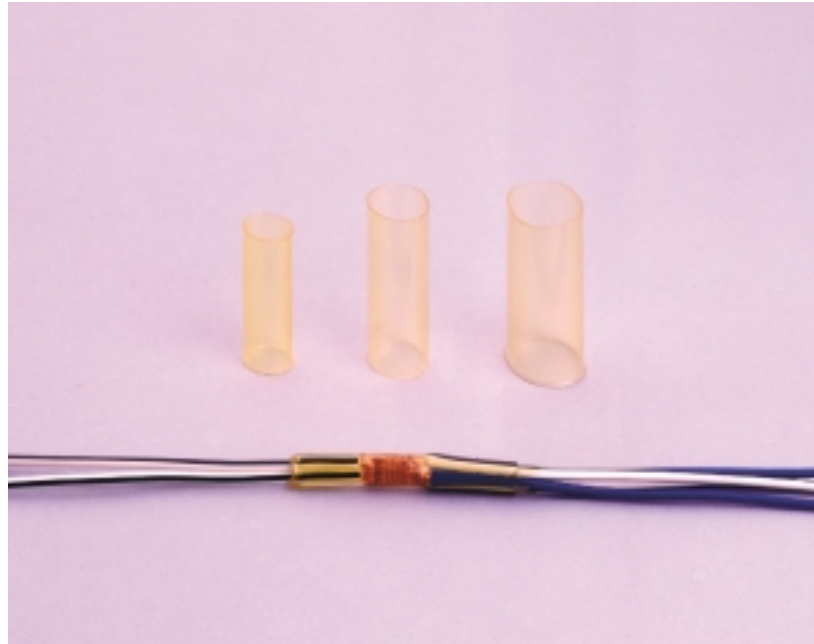
**Driver Information**



**Convenience**

Effective strain relief, protection and insulation for dry area splices

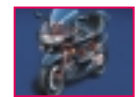
Tyco Electronics' heat-shrink splice protection technology provides a higher performance, cost-competitive alternative to PVC tape.



**Car Industry**



**Truck Industry**



**Other Industry**

**The challenge facing manufacturers**

All electrical splices in a wiring harness need to be insulated and protected from mechanical abuse. Effective protection is becoming even more critical as ultrasonic welding is increasingly being used to make the electrical connection. Ultrasonic welding, while providing a much better electrical connection than traditional crimping, is mechanically weak, especially in peel and tear, so additional mechanical protection and strain relief must be provided.

**Conventional solutions**

Hand-applied PVC tape has traditionally been used to insulate and protect dry area splices. However, its poor mechanical strength, its bulk and the inconsistency of the results achieved, now make it an increasingly unsatisfactory solution. PVC tape provides minimal tear resistance and tensile strength as well as poor cut-through and abrasion resistance. In addition, it is difficult to apply consistently and is prone to unravelling at certain temperatures.

Long manual installation processes make using tape an expensive option in terms of total installed cost.

**The Tyco Electronics solution**

Using Raychem RPPM tubings and ES caps can provide better mechanical protection and strain relief for dry area splices than any other commercially viable options. Tests show a 200% increase in tensile strength and a 500% + increase in tear strength, cut-through and abrasion resistance compared to PVC tape.

Shorter handling times also make tubing a less costly solution.

**Benefits**

- Single component solution – to insulate and protect almost all dry area splices
- Repeatable process – not subject to operator variability
- Low cost, high throughput process equipment available – cost competitive with PVC tape
- Rapid installation – up to 2000+ splices per hour
- Low profile protection – reducing the diameter of conduit required
- Reduced total installed cost – less handling than PVC over-taping more than off-sets higher material cost
- Tubing and adhesive combination – for superior strain relief
- High shrink ratios – allow one size to cover a wide range of splice combinations

**Tyco Electronics products**

- Raychem RPPM tubings
- Raychem ES caps

## Product features

### Raychem RPPM tubing

- Continuous operating temperature from -40°C up to +85°C (3000 hrs)
- High shrink ratio – up to 7:1, allowing one size to cover most splices
- Shrinks very quickly compared to most heat-shrink tubings
- Adhesive-lined for superior strain relief
- Flexible, while providing excellent strain relief
- Tubing is transparent over splice allowing easy inspection

RPPM is a flexible, heat-shrinkable dual-wall tubing with an integral adhesive liner which melts to provide a strong mechanical bond. The tough high density jackets also provide electrical insulation and excellent cut-through and abrasion protection for the splice.

**For full technical information on RPPM please see the RPPM data sheet, page 80.**

### Raychem ES caps

- Continuous operating temperature from -40°C up to +105°C (3000 hrs)
- Mechanically tough polyolefin-based materials
- High shrink ratios – three sizes cover a broad range of stub splices
- Adhesive-lined one-piece product for superior strain relief

ES caps are heat-shrinkable one-piece caps with a thick adhesive liner which melts to provide a strong mechanical bond. The cap, with a pre-crimped end, is placed over the splice and when it is heated, the adhesive melts and is squeezed around and between the crimped or welded wires by the shrinking action of the tube. The tough high density jackets also provide electrical insulation and excellent cut-through and abrasion protection for the splice.

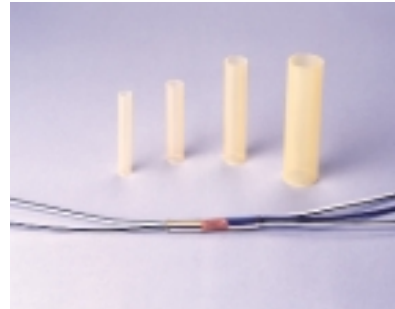
**For full technical information on ES stub splice sealing caps please see the ES caps data sheet, page 64.**

Sealing and protection for wire bundles, connectors, terminals and splices



Low cost,  
reliable  
splice  
sealing

Tyco Electronics' heat-shrink technology provides the standard splice sealing solution in the automotive industry today. Over 800 million splices are sealed with Tyco Electronics products worldwide.



**The challenge facing manufacturers**

An automotive wiring harness is only as strong as its weakest link. In many instances that weakest link is where wires are spliced together – either in the form of in-line splices or stub splices.

Non-sealed splices exposed to water, salt spray and other fluids in wet areas of the vehicle can rapidly corrode, degrading both the electrical and mechanical properties of the harness.

In addition, splice joints are mechanically weak. Welded splices, in particular, are highly susceptible to peel and tear loadings, and must be provided with effective strain relief.

**Conventional solutions**

Mastics, with a tape overwrap, are sometimes used to seal wire splices, but present a number of problems. Sealing performance is subject to operator variability. Mastics and tape overwrap can also add significantly to the overall diameter of the harness, which may mean more space and larger conduits are required.

Overmoulding splice seals can be another solution, however, this is expensive and demands a separate process, away from the harness board. These seals are typically high profile, and reliability rates can be poor.

Adhesive lined heat-shrinkable tubing is the predominant method used today to seal automotive wiring splices.

**The Tyco Electronics solution**

Tyco Electronics' wide offering of splice sealing tubings and caps provide excellent sealing performance for both in-line and stub splices, with exceptional reliability.

The ES/RBK system of tubings is a complete sealing solution including splice design and process standards, guidelines and process equipment (both on and off-board) and test equipment.

**Benefits**

- Single component solution – to seal, protect and insulate all in-line and stub splices
- Complete environmental and moisture sealing – for up to seven wires per side
- Tubing and adhesive combination – for superior strain relief
- Application equipment and installation procedures – to meet most harness production processes
- Meets most applicable world-wide automotive OEM splice sealing specifications

**Tyco Electronics products**

- Raychem RBK-ILS-125/VWS-125 tubings
- Raychem FL-2500 and QS-1500 tubings
- Raychem SCT (150°C) tubing
- Raychem ES Caps

## Product features

### **RBK-ILS-125, VWS-125, QS-1500 and FL-2500 tubings**

- Continuous operating temperatures from -40°C up to +125°C (3000 hrs)
- Mechanically tough polyolefin-based materials
- High shrink ratios – up to five sizes cover a broad range of splices
- Adhesive-lined to environmentally seal splices
- Highly resistant to automotive fluids and solvents
- Flame retardant (black only)
- Black and clear tubing optional

RBK-ILS-125/VWS-125, QS-1500 and FL-2500 are heat-shrinkable tubings with a thick adhesive liner which provide environmental and moisture sealing for in-line splices. The tubing is centred over the splice, and when it is heated, the adhesive melts and is squeezed around and between the crimped or welded wires by the shrinking action of the tube.

The tough high density jackets also provide electrical insulation, excellent mechanical cut-through and abrasion protection as well as effective strain relief for the splice.

**For full technical information on Tyco Electronics, RBK-ILS-125/VWS-125, QS-1500 and FL-2500 in-line splice seals please see the appropriate data sheets, pages 76, 78, 72 and 65.**

### **SCT (150°C) tubing**

Same features as other splice sealing tubing products, but also with a continuous operating temperature from -40°C up to +150°C (3000 hrs).

**For full technical information on SCT tubing please see the SCT data sheet, page 85.**

### **ES caps**

- Continuous operating temperatures from -40°C up to +125°C\* (3000 hrs) (\*with tape to help secure cap)
- Mechanically tough polyolefin-based materials
- High shrink ratios – three sizes cover a broad range of stub splices
- Adhesive-lined one-piece product to environmentally seal splices
- Highly resistant to automotive fluids and solvents
- Black and clear cap options

ES caps are heat-shrinkable one-piece caps with a thick adhesive liner which provide complete environmental and moisture sealing for stub splices. The cap, with a pre-crimped end, is placed over the splice and when it is heated the adhesive melts and is squeezed around and between the crimped or welded wires by the shrinking action of the tube.

The tough high density jackets also provide electrical insulation, excellent mechanical cut-through and abrasion protection as well as effective strain relief for the splice.

**For full technical information on ES caps please see the ES caps data sheet, page 64.**

Sealing and protection for wire bundles, connectors, terminals and splices



Easy to-install  
grommet and  
wire bundle  
sealing for  
up to 20 wires

Tyco Electronics' RayBlock heat-shrinkable water blocking systems provide low cost, consistent and reliable wire bundle sealing.



**The challenge facing manufacturers**

Low cost, but reliable sealing of multi-wire bundles of up to 20 wires is becoming increasingly important as vehicle harnesses grow in size and complexity. Typically, sealing is needed to provide a water block where the wire bundle passes through a moulded rubber boot into the back of a connector, or at a grommet between a wet and dry area, such as the engine to passenger compartment.

Ideally, this seal should not add significantly to the overall diameter of the bundle, allowing easy positioning of grommets and other components during the harness assembly.

**Conventional solutions**

Traditional sealing techniques using mastics or other hand-applied sealants are labour intensive and sealing reliability and consistency is highly dependent on operator skill.

Siphons or drip loops are also sometimes employed, however, these require a significant additional quantity of wire plus space to make the drip loop. Siphons and drip loops are also not a sealing technique as such.

Overmoulding can provide a satisfactory solution, though this requires expensive process equipment and involves another process stage, away from the harness board.

**The Tyco Electronics solution**

RayBlock is a heat-shrinkable wire bundle blocking system that uses simple, low cost heat processing equipment to provide consistent and reliable sealing for cable bundles of up to 20 wires.

A RayBlock system includes a high shrink ratio adhesive-lined tubing and a meltable adhesive profile (comb or sleeve) to contain and seal the wire bundle.

**Benefits**

- On or off-board installation
- Low profile, round, concentric seal - allowing easy positioning of other harness components
- Simple heat process - using simple standard available equipment
- Applications versatility - one product size can accommodate varying wire diameters and different bundle sizes

**Tyco Electronics products**

- Raychem RayBlock-85
- Raychem RayBlock-105

## Product features

### **RayBlock-85 and -105**

- Withstand continuous underbonnet temperatures up to 85°C (RayBlock-85) and 105°C (RayBlock-105)
- Provide ultra low profile seals only marginally larger than the cable bundle itself
- Highly resistant to automotive fluids and solvents
- Excellent electrical insulation and vibration resistance properties

RayBlock products consist of a section of dual-wall heat-shrink sleeving surrounding a hot-melt adhesive profile. The wires in the bundle are placed in the channels of the profile and are then covered by the heat-shrink sleeve. On heating, the adhesive profile melts, and the molten adhesive is pumped around and between the wires by the shrinking action of the sleeve.

RayBlock-85 and -105 are supplied in kit form in a choice of adhesive profiles with appropriate pre-cut sleeves.

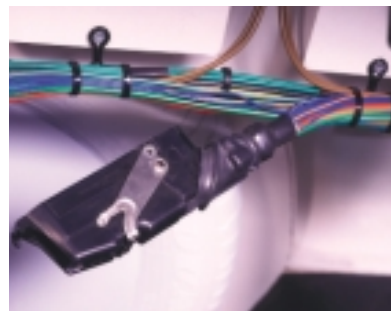
**For full technical information on Tyco Electronics' RayBlock water blocking systems please see the RayBlock-85 and RayBlock-105 data sheets, pages 73 and 74.**

Sealing and protection for wire bundles, connectors, terminals and splices



**Rapidly-installed wire bundle sealing for grommets or connectors (such as ABS)**

**The Raychem LMx wire bundle sealing system is approved by several major OEM's worldwide.**



**The challenge facing manufacturers**

The increasing use of in-car electronics has substantially increased the number of electrical circuits in a vehicle's wiring harness creating ever-larger wire bundles. Many of these wire bundles are located in wet areas of the vehicle where water can migrate into sensitive electronics between adjacent wires in the bundle. This can cause corrosion and malfunction at ABS connectors for example, or allow water to enter into the passenger compartment via bundles passing through the main feedthrough grommet. Designing and installing reliable, cost-effective wire bundle sealing systems can present substantial difficulties. Seals are often required to offer mechanical support to individual wires, but without impairing the flexibility of the harness. Seals may also need to provide an effective noise barrier, for instance, where the bundle passes between the engine and the passenger compartment.

**Conventional solutions**

Conventional bundle sealing technologies such as hand-applied mastics, epoxies, polyurethanes or thermoplastic adhesives are unable to meet the latest design and performance criteria. These technologies are labour intensive and sealing reliability and consistency is highly dependent on operator skill. Some of these are also two-part reactive processes which are difficult and hazardous to apply.

Siphons or drip loops require a significant additional quantity of wire and space and are not a sealing technique as such.

Overtaping does not provide an integral seal within the bundle and adds considerably to the stiffness of the harness. Overmoulding a feedthrough or grommet onto the bundle requires expensive process equipment and this technique is unsuitable for use on a harness board. Trapping wires in the moulds of off-board moulding machines is a significant problem. Additionally, the high exothermic temperatures that can occur in reaction injection moulding can damage wire insulations.

**The Tyco Electronics solution**

The Raychem LMx sealing system utilises induction heating to seal wire bundles rapidly and reliably with 100% blocking of the internal wire bundle voids. LMx has proved ideal for sealing ABS connectors at the interface between the cable and boot, as well as to seal main grommet feedthroughs, and is now widely used by auto manufacturers. The LMx sealing system includes dedicated induction heating equipment capable of sealing bundles of up to 100 wires (higher wire counts may be possible depending on the mix of primary wires, power cables and signal cables) with no significant risk of overheating or distortion.



## Product features

### Raychem LMx3500

- Continuous maximum operating temperatures to 125°C
- Near perfect blocking reliability for small to very large wire bundles
- Provides an ultra low profile seal only marginally larger than the cable bundle itself
- Highly resistant to automotive fluids and solvents

LMx sealing kits contain an adhesive-lined heat-shrink tubing and a number of hot-melt adhesive combs and slit sleeves. Wires are placed in the channels of the combs as the harness is assembled and the tubing is placed over the blocking area. A metallic filler contained in the adhesive comb and liner is heated by induction causing the adhesive to melt. At the same time, the heat-shrink tubing shrinks, pumping the adhesive around and between the wires to create a waterproof seal.

**For full technical information on the LMx sealing system please see the LMx3500 data sheet, and Clam Coil Installation system pages 69 and 108.**

### Benefits

- Cost reduction over conventional processes
- Rapid up to 100 wire sealing – in around 45 seconds, depending on wire and bundle size
- On or off-board installation
- One process – able to accommodate varying bundle sizes
- Versatile process – one product size fits a range of wire bundles
- Reduced noise transmission – with noise barrier performance equal to or better than a typical double decoupled barrier
- Minimal risk of wire damage – even with low temperature PVC wires
- Self-regulating heating process – providing common process conditions with no need for subsequent testing

### Tyco Electronics products

- Raychem LMx3500

Sealing and protection for wire bundles, connectors, terminals and splices



**Durable one-piece crimp splices and terminals**

Raychem DuraSeal products are a complete range of nylon crimp splices and terminals that comprehensively outperform polyolefin tubing devices.



**The challenge facing manufacturers**

Wiring harnesses may have to be repaired or reworked after they have been produced. Wires or connector pins can get damaged, or vehicle equipment specifications may change requiring extra wires to be spliced in. In particular, adding in-car entertainment systems, mobile telephones, immobilisers and other dealer-installed options can require significant additional splicing.

As the original harness was produced to withstand a range of temperature, moisture and other environmental factors, it is essential that any repair and rework is carried out to the same standard. This requires a range of high performance OEM-compatible sealed splice and terminal connectors that can be installed quickly and simply – at the harness shop, the car assembly plant or at the car dealership.

**Conventional solutions**

Many sealed crimp splices and terminals on the market use a polyolefin tubing. Polyolefin tubing – while adequate for less demanding applications – is less durable than materials such as nylon, and can become brittle and prone to splitting, allowing moisture to enter the seal.

Other repair or reworking splice and terminal options are typically two-piece products which create significant additional inventory and part selection problems.

**The Tyco Electronics solution**

Using Raychem DuraSeal products that are one-piece, heat-shrinkable crimp splices and terminals ideal for the rework and repair of wiring harnesses. Made from tough, durable, nylon, DuraSeal products combine to offer a complete electrical splicing and termination kit with crimp splices to connect, insulate and protect in-line and stub splices as well as terminals for ring, spade, fork, push-on, pin, tab and bullet connector applications.

DuraSeal products offer:

- A one-piece product – providing strain relief, moisture resistance and mechanical protection
- Long term impact resistance – from temperature-stable nylon tubing
- Easy installation – using a simple crimp then heat process
- Easy inspection of finished connection – through a transparent jacket

**Tyco Electronics products**

Raychem DuraSeal nylon crimp splices and terminals

## Product features

### **Raychem DuraSeal crimp splices and terminals**

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- Continuous operating temperature from -55°C up to +125°C (3000hrs)
- Moisture and abrasion resistant
- Provides strain relief
- Resists wire pull-out

DuraSeal products are crimp connectors with their crimp barrel or terminal encased in a heat-shrinkable nylon tubing containing a special hot-melt adhesive. After the connector has been crimped, heat is applied which shrinks the tubing and melts the adhesive to form a tough, moisture resistant and electrically insulated connection protected from mechanical abuse, wire pull-out and abrasion. DuraSeal products can accommodate wire sizes from 0.35 mm<sup>2</sup> (22 awg) to 2.8 mm<sup>2</sup> (10 awg) and are colour-coded for easy identification of sizes.

**For full technical information on Raychem DuraSeal products please see the DuraSeal data sheets, pages 88 – 93.**

Sealing and protection for wire bundles, connectors, terminals and splices



~~Powertrain Systems~~



Chassis Systems



Safety



Security



Body



Driver Information



Convenience

## Low-cost forming for power cables

One size of CRN tubing can form most typical power distribution cables used in vehicles.



~~Car Industry~~



Truck Industry



~~Other Industry~~

### The challenge facing manufacturers

Heavy gauge power distribution cables used in cars are typically long and heavy and can be difficult to work with, both during construction of the harness and installation of the harness into the car. Many of these cables have to accommodate bends and other shapes to fit in crowded underbonnet areas. In these situations it is often advantageous to pre-form the cables before assembly in the car.

Manufacturers need a quick, low cost cable forming process – ideally one that can be carried out without removing the cables from the harness board.

### Conventional solutions

Heat setting – where a cable is heated, bent to shape and then cooled in water – is sometimes used to pre-form cables. Heat setting, though, is a lengthy and costly process and cannot be carried out on the harness board. Installing thick wall, semi-rigid heat-shrinkable tubing around the cable can prove a more cost-effective option as this process can be carried out on the harness board. However, this tubing needs to have a high shrink ratio to avoid the inventory problems associated with stocking multiple tubing sizes to fit different cable gauges.

### The Tyco Electronics solution

Tyco Electronics' heat-shrink tubing technology offers a highly cost-effective cable forming process that can be applied both on and off-board. And unlike other thickwall, stiff, heat-shrink tubings, Tyco Electronics' high shrink ratios mean one tubing size fits a wide range of wire gauges.

### Benefits

- Low cost – significantly reduced total installed cost compared to heat-setting
- Versatile process – can be carried out both on and off-board
- Simple to install – using simple hot-air or infrared process equipment
- Minimal tooling and handling costs – simply cut what you need
- No waste – puts cable forming only where it is needed

### Tyco Electronics products

- Raychem CRN tubing

## Product features

### **Raychem CRN**

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- Continuous operating temperature from -55°C up to +135°C (3000 hrs)
- 2:1 shrink ratio
- Excellent abrasion resistance and mechanical performance
- Flame retardant
- Chemical and solvent resistant

CRN is a tough, semi-rigid, flame retarded polyolefin tubing capable of forming cables into tight radius bends and shapes. In addition, its excellent mechanical performance make it ideal for applications also requiring strain relief, cut-through and abrasion resistance.

**For full technical information on Raychem CRN please see the CRN data sheet, page 62.**

Sealing and protection for wire bundles, connectors, terminals and splices



Simple, versatile connector sealing for 2 to 18 way connectors

Raychem RBK-GTR sealing system for 2 and 3 way connectors and HTAT with adhesive SASR rings for sealing larger connectors



**The challenge facing manufacturers**

2 to 18 way connectors are frequently used on cars, often in wet and high temperature areas such as engine compartments. Manufacturers need simple, versatile sealing systems with a minimum number of components that provide connector sealing even when not all of the contact cavities are in use.

**Conventional solutions**

Individual discrete wire seals (also called SCAT seals) are often used in this application, however, these seals can only be used with connectors equipped with cavities for discrete wire seals. In addition, discrete wire seals are comparatively bulky and take up large amounts of space when combined to provide a multi-wire connection.

Monoblocks are also sometimes used, however, these require an extra process to fill any of the unused cavities, adding time and cost.

Push-on moulded rubber boots are sometimes used on 2 way and 3 way connectors, such as Mini and Junior Power Timer connectors, however, these do not seal the connector.

**The Tyco Electronics solution**

Tyco Electronics heat-shrink tubing technology provides two different connector sealing options.

For 2 and 3 way connectors Raychem RBK-GTR-125 tubing provides a one-piece heat-shrinkable tubing with a pre-installed adhesive insert that seals these connectors even when all the contact cavities are filled. Only two sizes of components are required to seal all wire size/quantity combinations.

For larger connectors, Raychem SASR adhesive tubing or RBK-85 adhesive combs can be clipped around every two wires and HTAT tubing placed on top and overlapped onto the connector to provide a complete seal between the wires and connector.

**Benefits**

Raychem RBK-GTR-125, and HTAT plus SASR or RBK-85 combs provide:

- Low profile mechanical protection, strain relief and sealing
- Seals a wide range of different number/gauge sizes of wires into the same connector housing
- Easy installation – using simple heat shrink process equipment

**Tyco Electronics products**

- RBK-GTR-125
- HTAT plus SASR or RBK-85 adhesive combs

## Product features

### **RBK-GTR-125**

- Continuous maximum operating temperature up to 125°C (3000 hrs)
- One-piece part
- Fast, controlled, repeatable installation using IR application equipment

RBK-GTR-125 is a one-piece, heat-shrinkable polyolefin tube with an integral adhesive ring specifically designed to provide moistureproof encapsulation for 2 and 3 way AMP-JPT (Junior Power Timer) connectors. On heating, the adhesive ring melts and flows around the wires and onto the connector lip (but not into the contact cavities) to form a tough moistureproof barrier.

**For full technical information on Raychem RBK-GTR-125 sealing system please see the RBK-GTR-125 data sheet, page 75.**

### **HTAT, plus SASR or RBK-85 adhesive combs**

- Continuous maximum operating temperature up to 125°C (3000 hrs)
- Approved by major vehicle manufacturers
- Used since the 1980's to seal MIC contact connectors

SASR is a slit adhesive tube which can be used with HTAT tubing to provide an additional adhesive liner. In multi-wire applications, SASR is clipped around every two wires and HTAT placed over the top, overlapping onto the connector. On heating, adhesive flows from the SASR insert around the wires, with adhesive from the HTAT jacket providing the bond onto the connector.

RBK-85 adhesive combs can also be used with HTAT tubing. Combs are available in 5, 6 and 7 channel sizes. Each channel in a comb can accommodate two wires. On heating, the adhesive comb melts and flows around the wires, with adhesive from the HTAT jacket providing the bond onto the connector.

**For full technical information on Raychem HTAT and RBK-85 adhesive combs please see the HTAT and RBK-85 data sheets, pages 68 and 73.**

Sealing and protection for wire bundles, connectors, terminals and splices



**Powertrain Systems**



**Chassis Systems**



**Safety**



**Security**



**Body**



**Driver Information**



**Convenience**

High temperature tubing with excellent chemical and abrasion resistance. All round general protection and insulation.

Tyco Electronics RW-175 tubing is extremely tough with thin wall insulation. The transparent, non-burning tubing has superior resistance to most automotive fuels, solvents and chemicals.



**Car Industry**



**Truck Industry**



**Other Industry**

**The challenge facing manufacturers**

The combination of vibration and increased temperatures has heightened the need for materials that can continue to provide mechanical protection in this challenging environment. This is particularly true in areas where the product has additional functionality, such as electrical insulation. The tubing must be tough enough to withstand the levels of abrasion and mechanical impact whilst maintaining the electrical insulation around the substrate beneath, subsequently preventing short circuits.

**Conventional solutions**

The use of polymeric tubing as the insulation is a well-proven solution. However, the selection of the correct material is critical to the life expectancy of the product and the handling during the installation process. High temperature resistant Braided Fibre or Push On sleeves can provide the protection and abrasion resistance at temperature, but also can create difficulties in installation due to the very flexible nature of the materials used. Also, the open weave structure of braid does not provide effective electrical insulation. The flexibility of these

products mean manual installation processes and the risks associated with manual handling. The use of heat-shrink tubing means that when the tubing is installed it is permanently fixed in position. The tube also lends itself to automated handling, therefore, removing the problems associated with manual handling such as cost and reliability.

**The Tyco Electronics solution**

Using Raychem RW-175 tubing, which is a PVDF based material; the tubing is mechanically very tough and gives a high degree of abrasion resistance whilst insulating the conductors beneath if required. The inherent rigidity of the expanded tube allows for automated pick and place handling of the tubing, and along with additional installation equipment such as a hot air gun the tube can be heated and shrunk into position at the same Pick and Place work station. This ensures a consistent process for every installation. Sensors installed within the equipment could detect any malfunction in the process.

**Benefits**

- Fixed in position ensures tubing is always in place
- Automated handling capability reduces manual handling and cost
- Resistant to abrasion ensures reliable product
- High shrink ratio to fit a range of substrates
- Smooth surface to avoid "snagging" at the installation stage
- Consistent installation giving reduced potential for variability in performance

**Tyco Electronics products**

- Raychem RW-175 tubing



## Product features

### **Raychem RW-175 tubing**

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- Excellent chemical resistance
- Highly abrasion resistant
- Tough, semi-rigid and thin wall
- High operating temperature  
175°C

**For full technical information  
on Raychem RW-175 please see  
the RW-175 data sheet, page 81.**

Sealing and protection for wire bundles, connectors, terminals and splices



## Heat-shrinkable strain relief boots for automotive sensors and connectors

Tyco Electronics manufactures the largest variety of Raychem heat-shrinkable moulded parts in the world. Automotive applications include battery terminal seals, gearbox connectors and ABS sensor boots



### The challenge facing manufacturers

Automotive electrical sensors and connectors need strain relief and sealing in wet areas of the vehicle. These include battery lead terminations, connectors to gearboxes and engine control functions, and in particular, ABS sensors. Moulded parts and boots are used in these applications and their design must reflect a number of important considerations. Manufacturers need products that are quick and easy to fit – that accommodate different wiring diameters, and products that do not risk damaging sensitive sensor components during installation.

Similarly, protection and strain relief must be provided for the point where wires meet grounding ring terminals to avoid poor electrical performance caused by flexing or other mechanical abuse.

### Conventional solutions

Over-moulding is often used to create protective boots, however, the process is expensive and demands separate tooling for each boot or connector size. In addition, over-moulding can damage certain sensors during the injection process.

EPDM push-on rubber boots are also used, though these must be mechanically expanded to fit, which can cause problems when installing boots over pre-installed terminals. Push-on rubber boots are also intolerant of different wire bundle diameters.

### The Tyco Electronics solution

Tyco Electronics offers the largest variety of Raychem heat-shrinkable moulded parts in the world, together with high volume manufacturing technology that provides exceptionally low costs.

Raychem heat-shrinkable moulded parts fit quickly and easily, even over pre-installed terminals, and one boot size can accommodate a wide range of wire bundle diameters.

### Benefits

- High volume manufacturing capability – reducing costs
- Lower installed cost – compared to over-moulding and synthetic rubber boots
- Application versatility – one size fits different wire bundle diameters
- High shrink ratios – for quick, easy installation over pre-installed connectors
- Stiffer than synthetic rubber – provides better installation ‘feel’
- Versatile process – can be carried out both on-board and off-board
- Controlled, repeatable installation – using custom-designed application equipment

### Tyco Electronics products

- Raychem 200 series heat-shrinkable moulded parts

## Product features

### **Raychem 200 series heat-shrinkable moulded parts**

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- Non-melting, available rated as Class 2 and 3
- Available in lipped, non-lipped, slim-line formats and the widest range of shapes and sizes
- Chemical and solvent resistant

Raychem heat-shrinkable moulded sensor and connector boots are made from semi-rigid polyolefin materials and include an integral adhesive lining (where appropriate) to provide a watertight seal. In addition, their excellent mechanical properties provide support, strain relief and abrasion and cut-through protection.

**For full technical information on the Raychem 200 series heat-shrinkable moulded parts please see the range of 200 series moulded parts data sheets which are available via your Tyco Representative.**



# Mechanical Protection Application Documents

- **Versatile protective coverings for automotive components**
- **Electric motor protection**
- **Wire harness protection**
- **Electronic component protection**

Versatile protective coverings for automotive components



**Cost-effective localised protection for wires and cables in high temperature environments**

Tyco Electronics products provide localised protection for wires and wire bundles in high temperature environments up to 200°C.



**The challenge facing manufacturers**

The search for greater vehicle fuel efficiencies has resulted in smaller engines that run hotter. This in turn raises underbonnet temperatures, placing additional demands on the materials used to protect electrical wiring harnesses from heat.

Ever increasing electrical content and functionality places greater constraints on space and increased contact between components which can lead to wear.

Over protection materials must resist splitting or cracking, despite rapid and frequent changes in temperature. They may also be required to provide abrasion and mechanical protection, and provide support to wiring bundles in both flexible and rigid solutions.

**Conventional solutions**

PVC tubing has traditionally been used as a durable, inexpensive insulation material, however, its environmental and high temperature performance deficiencies are driving the automotive industry away from PVC.

An alternative solution is silicone glass composite sleeving. Although the static temperature rating of these materials can be high, they suffer from poor mechanical properties and pose health risks to operators cutting and installing them.

Braided and woven materials are difficult to apply in tubular form and side entry variants are cosmetically poor and prone to becoming displaced in service.

PTFE is an ideal material for very high temperature applications, however, its cost is prohibitive and its temperature performance is often significantly higher than most specifications demand.

**The Tyco Electronics solutions**

Tyco Electronics offer a complete range of high temperature protection products rated up to 200°C that allow you to select the most cost-effective product for your individual temperature specification. These include heat-shrink and non-shrink tubings, conduits (with split option) and woven fabric tubings.

**Benefits**

- A complete range of heat insulation solutions up to 200°C – including tubings and flexible conduits, heat-shrinkable fluoroelastomer tubings and woven fabric tubings
- High temperature protection – without the cost of PTFE
- Cost-effective, non-melting substitutes for PVC – with ratings including Class 2 and 3
- A choice of high temperature products – rated 125°C, 135°C, 150°C, 180°C and 200°C
- Very flexible woven fabric tubings

**Tyco Electronics products**

- Raychem RNF-100
- Raychem CGPT
- Raychem HFT5000
- Raychem NETM
- Raychem HCTE

Versatile protective coverings for automotive components

**Product features**

**Raychem RNF-100**

RNF100 is a tough, flexible and flame retardant heat-shrinkable tubing. Designed to provide superior mechanical strength, RNF-100 is ideal for wire and cable heat protection where abrasion and cut-through could also occur.

**For full technical information on Raychem RNF-100 please see the RNF-100 data sheet, page 79.**

**Raychem HFT5000**

HFT5000 is a highly flexible heat-shrinkable fabric tubing which can provide heat and abrasion protection for cables and wire bundles. HFT5000 is woven from heat-shrinkable circumferential polyethylene filaments and non-shrinking longitudinal polyester fibres and is completely halogen-free.

**For full technical information on Raychem HFT5000 please see the HFT5000 data sheet, page 67.**

**Raychem NETM**

NETM products are durable non-shrinking polyolefin tubings which remain heat resistant up to at least 130°C. Specifically designed for use in electrical harnesses, NETM tubings are flame retarded and offer excellent abrasion resistance. NETM1000 is a more flexible 125°C product allowing it to follow wiring bundles routed in tight bends around underbonnet components. NETM2000 is designed for higher temperature applications rated up to 150°C.

**For full technical information on Raychem NETM tubings please see the NETM data sheet, page 71.**

**Raychem HCTE conduit**

HCTE is a flexible convoluted conduit manufactured from radiation crosslinked, modified Ethylene Tetrafluoroethylene (ETFE). Its helical construction combines a high degree of flexibility with excellent crush resistance. HCTE will operate continuously at temperatures up to 200°C and up to 300°C for limited periods.

**These specification control drawings are available through your Tyco Representative.**

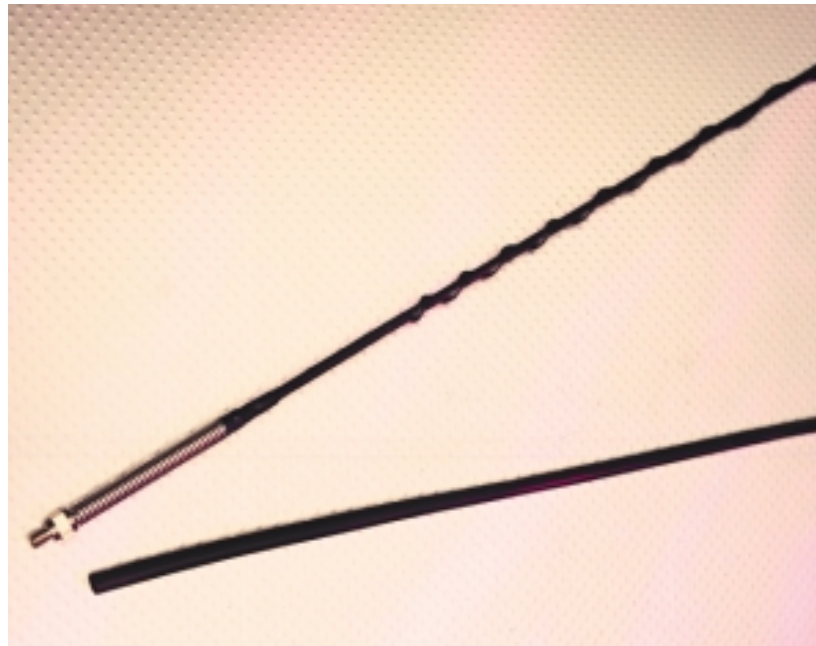
	<b>RNF-100/CGPT</b>	<b>HFT5000</b>	<b>NETM1000 &amp; 2000</b>	<b>HCTE</b>
Product type	Heat-shrink poly tubing	Heat-shrink fabric tubing	Non-shrink poly tubing	Fluoroelastomer conduit
Shrink ratio	2:1, 3:1	2:1	none	none
Continuous operating temperature	-55°C to 135°C	-40°C to 125°C	-40°C to 125°C (NETM1000) -40°C to 150°C (NETM2000)	-55°C to 200°C
Flame retardancy	Self extinguishing	MVSS 302	Self extinguishing	Self extinguishing
Fluid resistance	High	High	High	Very high
Abrasion resistance at high temperature	Medium	Very high	Medium	Very high

Versatile protective coverings for automotive components



**Easy-to-fit protection for car antennas**

Raychem RPPM-Nr801 high shrink ratio heat-shrink tubing provides superior abrasion protection and helps secure extra windings on vehicle antennas.



**The challenge facing manufacturers**

Car radio and cellular antennas need a protective coating to protect the antenna from mechanical abuse, abrasion and corrosion. The majority of antennas are straight and smooth and are typically painted or dip-coated. However, some antennas have a glass or fibre winding that extends around part or all of the antenna. In these cases a different protective covering is needed to hold the winding in place over the antenna base and provide abrasion protection to the entire assembly. Eliminating wind noise is also a critical factor in antenna design and any protective coating must address this goal.

**Conventional solutions**

Applying a heat-shrink tubing over the antenna winding is an obvious low cost solution, however, a number of performance-related considerations must be borne in mind.

Tubings must be very thin to provide minimal wind shear, yet they must be tough enough to withstand ice, grit, stones and other road debris thrown up at speed by road vehicles, plus the mechanical abuse associated with automated car washes.

Painting or dip-coating are other potential solutions, however, both these options demand significant process time, increasing costs. In addition, any paint or dip coating would have to adhere to a number of dissimilar materials, plus accommodate a high degree of component flexing.

**The Tyco Electronics solution**

Using Raychem RPPM-Nr.801 tubing which is flexible with a very high shrink ratio, made of a tough lonomer-based polymer material – the same material as golf ball covers. A simple heat process shrinks the tubing down over the antenna, locating and protecting the antenna winding, and protecting the bare metal section of the antenna. RPPM-Nr.801's high shrink ratio ensures the tubing fills the valleys between the winding spiral and allows a snug fit over both the higher profile wound section and the thinner bare metal part of the antenna.

**Benefits**

- Protects antenna and locates and protects antenna windings – in one simple process
- Adhesive lined – to fix winding and tubing permanently in position
- High shrink ratio (6:1) – providing a snug fit on both winding and bare antenna diameters
- Low wind noise – ultra thinwall tubing provides minimal wind shear
- Shiny black finish
- Minimal tooling and handling costs – simply cut what you need
- Versatile product – one tubing size shrinks to fit a range of antenna diameters
- Easy, low-cost installation process – using high volume hot air, convection or infra-red equipment

**Tyco Electronics products**

- Raychem RPPM-Nr.801 tubing



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Versatile protective coverings for automotive components

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## Product features

### **Raychem RPPM-Nr.801 tubing**

- Excellent mechanical strength
- Highly flexible
- High abrasion resistance
- 6:1 shrink ratio
- Resists automotive fluids and solvents

RPPM-Nr.801 is a flexible, heat-shrinkable dual-wall tubing with an integrally bonded meltable adhesive liner. The tough outer jacket offers excellent mechanical strength, yet is flexible enough to cater for a high degree of movement.

**For full technical information on RPPM-Nr.801 tubing please see the RPPM data sheet, page 80 or, contact your Tyco Representative for a specification control drawing.**

Versatile protective coverings for automotive components



Thin wall tubing, conforms and protects substrates as a cost-effective alternative solution to paint.

RPT-120 provides a resilient layer, protecting components from corrosion and damage, as well as giving a smooth and aesthetically pleasing finish.



**The challenge facing manufacturers**

Important functional components often need protection to maintain functionality, but also to be pleasing to the eye. Components are often exposed to mechanical damage. Throughout the life of the vehicle this mechanical damage can often lead to excessive corrosion, or at least reduce the pleasing appearance of the component.

**Conventional solutions**

The traditional solution for protection and aesthetics of the component has been conventional paint. The paint provides a thin layer of protection and has a good quality surface finish. However, drawbacks need to be considered; a thin layer of paint can easily be penetrated, which will expose the component underneath to environmental corrosion. The result of this will also be a damaged and unattractive surface finish.

Furthermore, from a manufacturing perspective the process of applying the paint also comes with its own inherent difficulties. The cost of setting up a paint shop that complies with the necessary Health and Safety standards can be very expensive. Equally the moving of an existing paint shop to a more convenient location also carries initial cost burdens.

**The Tyco Electronics solution**

Raychem heat-shrinkable tubing makes an interesting alternative to paint for some applications where the shape of the substrate allows tubing to be installed. Thin wall tubing when installed conforms to the shape of the component, encapsulating and protecting the surfaces beneath from mechanical and subsequent environmental damage. The surface finish of the tube is comparable with some paint finishes but more significantly the resilient surface gives the extra level of protection reducing penetrating scratches and thus not exposing metal which could significantly reduce the appearance of the component.

**Benefits**

- Provides a resilient layer protecting the component beneath from damage and corrosion
- Good surface finish giving a professional look to the final product
- Low cost installation equipment providing a lower cost of ownership for the supplier that can be passed on to the customer
- Less taxing Health and Safety considerations reducing the cost of process set up
- Low shrink temperature for fast installation
- Can be printed before installation to give component details

**Tyco Electronics products**

- Raychem RPT-120 tubing

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Versatile protective coverings for automotive components

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## Product features

### **Raychem RPT-120 tubing**

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- Provides a tough resilient layer to protect the component beneath.
- Easy to install with conventional heating equipment
- Low cost of set up

This resilient tubing offers an alternative to paint, particularly suitable for round substrates. It provides excellent mechanical and corrosion protection compared to paint and the high quality surface creates a quality image for the component being protected.

**For full technical information on Tyco Electronics' RPT-120 Replace Paint Product please contact your Tyco Electronics representative.**



# Fluid Management Application Documents

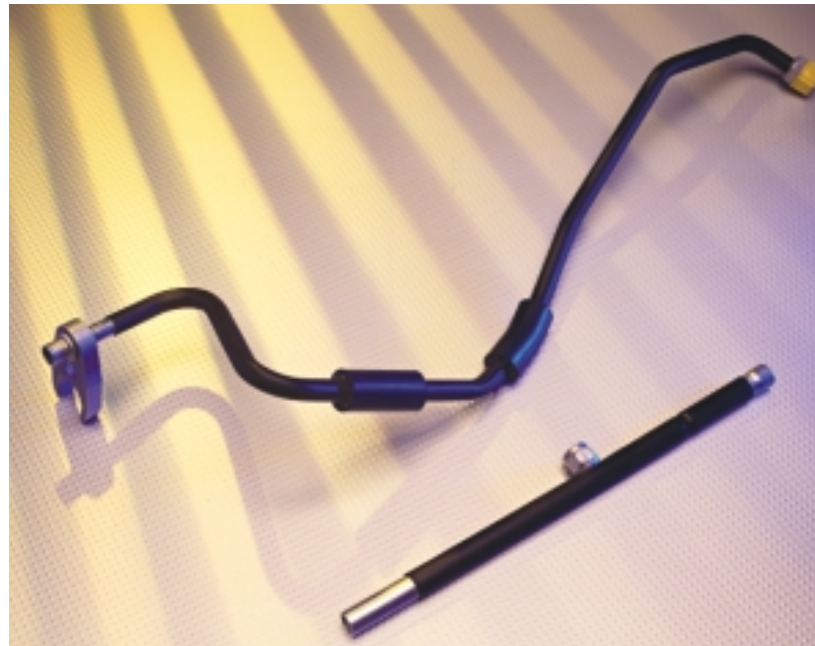
## **Automotive Hose and Pipe Protection**

- **Fluid line protection**
- **Hose coupling**
- **Cooling hose protection**



**Cost-effective thermal insulation, anti-noise and corrosion protection for automotive air-conditioning lines**

Raychem low temperature heat-shrinkable tubings offer excellent thermal insulation, anti-rattle and corrosion protection for automotive air-conditioning lines.



**The challenge facing manufacturers**

Automotive aluminium air-conditioning lines must be thermally insulated to ensure maximum efficiency of the vehicle's air-conditioning system. These lines must also be protected from metal-to-metal contact with the vehicle's frame and other components to prevent noise and vibration from being transmitted into the vehicle interior. Corrosion can also be a problem, particularly where lines are subject to road spray, and at the points where lines are clipped to the vehicle frame or other components.

**Conventional solutions**

Polymer dip-coats are often used to provide thermal insulation, anti-rattle and corrosion protection to air-conditioning lines, but this approach carries a number of cost penalties. The capital cost of installing dip-coat plant for pipe protection can make this approach uneconomic. Also, there are a number of environmental factors associated with the operation of dip-coat plant which add to manufacturers costs.

Slit foam sleeves have also been used to provide thermal insulation and anti-rattle protection to air-

conditioning lines. However, slit foam can only be applied after the pipe has been formed, it is difficult to fix effectively in position, offers negligible corrosion protection and cannot be placed between the line and its clip to help prevent the transmission of noise.

**The Tyco Electronics solution**

Raychem heat-shrinkable tubings offer thermal insulation, anti-rattle, anti-noise and corrosion protection for automotive air-conditioning lines with significant cost benefits over conventional solutions.

For optimum corrosion protection and no wrinkling of the tubing on the pipe, adhesion to the aluminium is desirable. This can be accomplished with a dual-wall product or a proprietary single-wall tubing that will strongly bond to aluminium.

**Benefits**

- Adds protection only where it is needed – minimising costs compared to whole pipe dip-coats
- Greater versatility – one size fits a range of pipes minimising inventory costs
- Minimal tooling and handling costs – simply cut what you need
- Easier, lower cost installation compared to dip-coat processes – simple heat-shrink process using hot air, convection or infrared equipment
- Reduced production times – as pipes can be formed after heat-shrink tubing is installed
- Simultaneous moistureproof sealing – hot-melt adhesive flows between tubing and pipe, preventing any moisture from coming into contact with the pipe

**Tyco Electronics products**

- Raychem AP-2000
- Numerous single wall options including:  
Raychem TUGA-GP  
Raychem RPT-120

## Product features

### Raychem AP-2000

- Provides both environmental and mechanical protection from corrosion
- Low shrink temperature for quick and easy installation

This rugged, dual-wall tubing offers excellent corrosion protection as well as mechanical protection against harsh road conditions. AP-2000 polyolefin heat-shrinkable tubing is designed to be positioned on straight pipe lengths before the pipe is formed. It can be supplied in pre-cut lengths, short continuous lengths or on reels for long continuous lengths or high volumes. AP-2000 shrinks rapidly on application of heat above 115°C and the adhesive melts and flows around the pipe to form a robust and permanent bond. Once installed, pipes are bent and formed.

**For full technical information on Raychem AP-2000 please see the AP-2000 data sheet, page 59.**

### Raychem TUGA-GP

- Offers excellent thermal insulation, anti-rattle, anti-noise and anti-corrosion protection
- Low temperature heat-shrink for easy, low-cost installation

TUGA-GP is a semi-flexible polyolefin tubing with excellent mechanical strength. With a shrink ratio of 2:1, and an operating temperature of -55°C to +125°C, TUGA-GP conforms to substrates more uniformly and with less longitudinal change than most PVC-based materials.

**For full technical information on Raychem TUGA-GP please see the TUGA-GP data sheet, page 84.**

### Raychem RPT-120

- Provides a tough resilient layer to protect the component beneath.
- Easy to install with conventional heating equipment
- Low cost of set up

This resilient tubing offers an alternative to conventional dip-coats and paint. It is particularly suitable for round substrates. RPT-120 provides excellent mechanical and corrosion protection with a high quality finish.

**For full technical information on Tyco Electronics' RPT-120, please contact your Tyco Electronics representative.**

Automotive Hose and Pipe Protection



Low cost, high performance abrasion and corrosion protection for automotive power steering lines

Raychem AP-2000 tubing, shown here, is the low cost solution to protecting power steering lines from abrasion, corrosion and mechanical stress.



**The challenge facing manufacturers**

Power steering lines are often routed low down at the front of the car where they are exposed to mechanical damage from flying stones and gravel chips. This damage can abrade the protective coating surrounding the pipe allowing corrosion to take place.

Automotive manufacturers must find cost-effective ways of protecting these pipes to meet ever-increasing standards of vehicle reliability and safety.

**Conventional solutions**

Metal coatings are frequently used to protect power steering lines. However, these are expensive to apply with lengthy process times and for some manufacturers this approach may require the installation of costly coating processes.

Polymer coatings similarly require costly dipping plant and are difficult to apply in sufficient wall thicknesses to provide adequate abrasion and cut-through protection.

Plastic mouldings may also provide a solution though these may involve substantial tooling costs.

**The Tyco Electronics solution**

Raychem adhesive-lined heat-shrinkable tubings offer light-weight and space-efficient abrasion and corrosion protection for power steering lines, with significant installed cost benefits over conventional solutions.

**Benefits**

- Adds protection only where it is needed – minimising costs compared to whole pipe dip-coats
- Greater versatility – one size fits a range of pipes minimising inventory costs
- Minimal tooling and handling costs – simply cut what you need
- Easier, lower cost installation compared to dip-coat processes – simple heat-shrink process using hot air, convection or infrared equipment
- Reduced production times – as the pipes can be formed after tubing installation
- Simultaneous moistureproof sealing – hot-melt adhesive flows between tubing and pipe, preventing any moisture from coming into contact with the pipe

**Tyco Electronics products**

- Raychem AP-2000 tubing
- Numerous single and dual-wall options available including CGPT and ATUM



## Product features

### **Raychem AP-2000**

- Provides both environmental and mechanical protection from corrosion
- Low shrink temperature for quick and easy installation

This rugged, dual-wall tubing offers excellent corrosion protection as well as mechanical protection against harsh road conditions. AP-2000 polyolefin heat-shrinkable tubing is designed to be positioned on straight pipe lengths before the pipe is formed. It can be supplied in pre-cut lengths, short continuous lengths or on reels for long continuous lengths or high volumes. AP-2000 shrinks rapidly on application of heat above 115°C and the adhesive melts and flows around the pipe to form a robust and permanent bond. Once installed, pipes are bent and formed.

**For full technical information on AP-2000 please see the AP-2000 data sheet, page 59.**

Automotive Hose Protection



**Low-cost abrasion protection for automotive cooling hoses**

**HFT5000 is a heat-shrinkable, fabric tubing that provides excellent abrasion resistance over a wide temperature range.**



**The challenge facing manufacturers**

Vehicle engine compartments are becoming ever more crowded and compact, often forcing cooling hoses to be routed in close proximity to high temperature engine components and under-bonnet parts. This makes hoses highly vulnerable to abrasion and chafing.

The same space considerations may require hoses to be designed with sharp bends and other radical shapes, making it difficult for manufacturers to fit protective sleeves where damage is likely to occur. An added complication is the effect that any over-protection may have on its surrounding components. Contacts between two hoses or a hose and a harness are hard to avoid. Where over-protection is used to alleviate this problem it needs to be non abrasive itself and protect both components.

**Conventional solutions**

A number of different approaches to protecting under-bonnet EPDM rubber hoses have been used. Polymer braid, or plastic spiral wraps are potential solutions if the protection system is designed optimally. These components tend to move on the hose during pressure pulsing and normal engine vibration. Any movement of the braid or wrap over the hose may result in loss of coverage of the contact area or worse still, the braid or wrap can itself abrade the hose it is 'protecting'. These solutions must therefore be fixed at both ends or must cover the entire length of the hose. The abrasive nature of these solutions requires that both contact surfaces be fully protected. If an unprotected hose or harness makes contact with a braid or spiral wrap then serious wear can often result. These design requirements carry significant cost penalties.

Conventional polymeric tubing or heat-shrinkable tubing can provide excellent abrasion protection to a hose at low temperatures. It is important to consider operating temperature because PVC and Polyolefin based tubing offer very little protection above 80°C.

**The Tyco Electronics Solution**

Tyco offers a range of over-protection options to its customers. Where braided polyester is specified Tyco Electronics can supply a range of competitive braided products. If heat-shrinkable tubing is appropriate, Tyco Electronics offers a complete range of Raychem tubing products including HFT 5000, a new revolutionary Raychem fabric technology for cooling hoses that need economic but robust protection.

**Benefits of HFT5000**

- Extremely tough – meeting even the most demanding automotive abrasion specifications
- Protect only where protection is needed – minimising cost
- Safe installation with no hot knife cutting equipment required – reduces investment
- Soft to handle so operators do not need to wear gloves – increases productivity
- Great versatility through wide range taking

**Tyco Electronics products**

- Raychem HFT5000
- Raychem M105

## Product features

### **Raychem HFT5000**

- Provides outstanding abrasion protection – even at temperatures as high as 150°C
- Highly flexible woven fabric construction for easy installation onto awkward substrates such as bent hoses
- Grips substrates tightly without additional fixing
- Resists harsh engine compartment environments
- Can be cut with conventional guillotines or even scissors
- Resists hose pulsing effects

HFT is a highly flexible heat-shrinkable fabric tubing designed to provide excellent mechanical abrasion protection for rubber hoses. HFT is woven from heat-shrinkable circumferential cross-linked filaments and non-shrinking longitudinal polyester fibres and is completely halogen-free.

HFT generally offers the lowest installed cost per metre protected due to low shrinkage compared to braids.

**For full technical information on Raychem HFT5000 please see the HFT5000 data sheet, page 67.**

### **Raychem M105 tunnel oven**

This industrial infrared tunnel oven is lightweight, low cost and has a modular design offering customised flexibility. It is designed to install Raychem HFT on automotive hoses for high volume hose manufacturers. The machine was developed specifically to provide high throughput, high quality and repeatable installations whilst minimising investment and space requirements.

As products pass through the belt-heater, the operator can be preparing the next hoses so that the shrinking process is cost neutral.

**For full technical information on the Raychem M105 tunnel oven please see the M105 data sheet, page 102.**



**Multi-versatile,  
low-cost hose  
positioning rings**

Heat-shrinkable moulded twin-rings let you space, separate and locate different pipe and hose diameters using the same ring.



**Car Industry**



**Truck Industry**



**Other Industry**

**The challenge facing manufacturers**

In order to protect pipe and hose assemblies from abrasion, vibration, and to prevent noise generation, vehicle manufacturers need a cost-effective way to space, separate and locate vehicle pipes and hoses.

Many pipes and hoses are twinned in automotive applications, with a 'send' and a 'return' line and ideally any separating and locating system should offer manufacturers the flexibility to combine pipes of different diameters within the same component.

**Conventional solutions**

Over-moulded plastic spacers are one solution to separating and locating pipes, however, over-moulding is expensive and new tooling is required for each shape and for each pipe diameter. Process times can also be lengthy.

Mechanical clips are also used in these applications, however, the clipping mechanism must be relatively sophisticated to provide the correct grip. Clips are also size specific, requiring a range of different diameters for each model type, increasing inventory management problems.

**The Tyco Electronics solution**

Tyco Electronics offers a range of low-cost, heat-shrinkable moulded 'twin-rings' with the versatility to separate and locate a range of different pipe diameters.

**Benefits**

- Rapid, simple installation – with no need for special tools
- Minimal total installed cost – less than over-moulded spacers
- Application versatility – one size fits a range of different pipe diameters, minimising inventory costs
- Design versatility – lets you combine pipes, cable and hoses within one ring
- Integral fixing – optional hot-melt adhesive holds the hose in the right orientation with no additional fixing
- Simultaneous fixing – ring shrinks to shape and bonds to the pipes and hoses in one process

**Tyco Electronics products**

- Raychem heat-shrinkable moulded twin rings

## Product features

### **Raychem heat-shrinkable moulded twin-rings**

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- Rapid, simple installation normally performed with a moving belt oven
- Robust materials with excellent abrasion and fluid resistance
- Proven in-service reliability
- Heat-shrinkable moulded twin-rings are offered in several different materials giving a range of mechanical properties and temperature capabilities. Each offers excellent abrasion and fluid resistance and can be installed on tight bends without puckering.

**Please contact Tyco Electronics for full technical information on heat-shrinkable moulded twin-rings.**



**Powertrain Systems**



**Chassis Systems**



**Safety**



**Security**



**Body**



**Driver Information**



**Convenience**

## Low-cost noise dampening for diesel fuel injection clusters

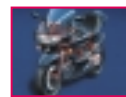
Raychem ATUM heat-shrinkable tubing can reduce noise from diesel fuel clusters by up to 100X\*.



**Car Industry**



**Truck Industry**



**Other Industry**

### The challenge facing manufacturers

Manufacturers are constantly searching for new ways to reduce engine noise, particularly in diesel vehicles where higher mechanical noise levels are perceived as a major disadvantage compared to petrol engines.

Research has shown that high pressure diesel fuel injection clusters, which take fuel from the fuel pump to the injectors, can emit a significant 'rushing' noise as fuel is transferred along the pipes. Tyco Electronics' heat-shrinkable tubing technology can provide highly effective noise dampening to these and other diesel lines, significantly reducing overall engine noise levels.

### Conventional solutions

Noise dampening of diesel fuel injection clusters has only recently been pioneered by a small number of vehicle manufacturers so, a range of approaches has yet to be established.

Adding PVC coatings to cluster lines is perhaps one solution. However, the complexity of diesel clusters – which may have six or more lines grouped closely together, often with sharp bends – means that the tooling and processing costs for adding PVC coatings may be prohibitive.

In addition, our tests have shown that to achieve an equivalent level of dampening, single layer coatings must almost always be thicker and heavier than our constrained layer dampening approach. This uses dual-wall tubing with a viscoelastic inner layer that is constrained when the tubing is heat-shrunk into place.

### The Tyco Electronics solution

Using Raychem heat-shrinkable tubing with meltable adhesive inner lining provides a low cost, easy-to-install noise reduction solution for diesel fuel clusters.

### Benefits

- Significant noise dampening performance – tests\* show 20X to 100X reductions in noise levels compared to non-dampened clusters
- Easier, lower cost installation compared to dip-coat processes – simply slide over substrate and shrink using hot air, convection or infrared equipment.
- Reduced production times – tubes can be bent or formed on the pipe
- Simultaneous moisture proof sealing – hot-melt adhesive flows between tubing and substrate to provide a permanent waterproof bond
- Application versatility – one size of tubing fits a range of substrate diameters minimising inventory costs
- Minimal tooling and handling costs – simply cut what you need

### Test Authorities

- \* Kolano & Saha Engineers, Detroit, USA.
- \* ISVR (Institute of Sound Vibration Research), Southampton, UK.

### Tyco Electronics products

- Raychem ATUM

## Product features

### **Raychem ATUM**

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- Provides excellent noise dampening performance on a range of substrate diameters
- High strength bonding to substrates
- Operating temperatures up to 105°C
- Engine oil and fuel resistant

ATUM is a semi-flexible, heat-shrinkable tubing which is diesel fuel, hydraulic fluid and lubricating oil resistant to ISO 37. It is available in both 3:1 and 4:1 shrink ratios to cover a wide range of substrate diameters and has a meltable adhesive inner lining to provide a high strength, moisture resistant bond.

**For full technical information on Raychem ATUM please see the ATUM data sheet, page 60.**



**Cost-effective abrasion and corrosion protection for automotive brake and fuel lines**

Raychem dual-wall tubing, shown here, is the cost-effective solution to protecting automotive brake and fuel lines from abrasion, corrosion and mechanical stress.



**Car Industry**



**Truck Industry**



**Other Industry**

**The challenge facing manufacturers**

Metal brake and fuel lines, particularly those routed underneath vehicle floorpans and near suspension components, are exposed to substantial mechanical damage from flying stones and gravel. This damage can compromise the integrity of the pipe and abrade the protective coating surrounding the pipe allowing corrosion to set in. Auto manufacturers must find cost-effective ways of protecting these pipes to meet ever-increasing standards of vehicle reliability and safety.

**Conventional solutions**

Vehicle manufacturers have employed a number of different solutions to this problem. Metal coatings are frequently used, however, these are expensive to apply and require coating of the entire line, not just the areas where damage is most likely to occur.

Polymer coatings require costly dip-plant and are difficult to apply in sufficient wall thickness to provide the required abrasion and cut-through protection.

Plastic spiral wrap is also sometimes employed to provide abrasion resistance to fuel lines, however, this provides no corrosion protection and may actually promote corrosion by harbouring moisture between the wrap and the pipe.

Plastic underbody shields have also been used in this application, however, this approach may require a number of different mouldings to be produced to suit different pipe contours within the vehicle involving substantial tooling costs.

**The Tyco Electronics solution**

Raychem single-wall and adhesive-lined dual-wall heat-shrinkable tubings offers light-weight and space-efficient abrasion and corrosion protection for brake and fuel lines with significant benefits over alternative solutions.

**Benefits**

- Adds protection only where it is needed – minimising costs compared to whole pipe coating
- Greater versatility – can be over-expanded to allow over end fitting
- Minimal tooling and handling costs – simply cut what you need
- Easier, lower cost installation compared to dip-coat processes – simple heat-shrink process using hot air, convection or infrared equipment
- Reduced production times – heat-shrink tubing can be installed on a straight pipe before it is formed to make a cluster
- Simultaneous moisture proof sealing – hot-melt adhesive flows between tubing and pipe, preventing any moisture from coming into contact with the pipe



## Product features

### **Tyco Electronics products**

- Raychem AP-2000 tubing
- Raychem DWTC tubing

### **Raychem AP-2000**

- Provides both environmental and mechanical protection from corrosion
- Low shrink temperature for quick and easy installation

This rugged, dual-wall tubing offers excellent corrosion protection as well as mechanical protection against harsh road conditions. AP-2000 polyolefin heat-shrinkable tubing is designed to be positioned on straight pipe lengths before the pipe is formed. It can be supplied in pre-cut lengths, short continuous lengths or on reels for long continuous lengths or high volumes. AP-2000 shrinks rapidly on application of heat above 115°C and the adhesive melts and flows around the pipe to form a robust and permanent bond. Once installed, pipes are bent and formed.

**For full technical information on AP-2000 please see the AP-2000 data sheet, page 59.**

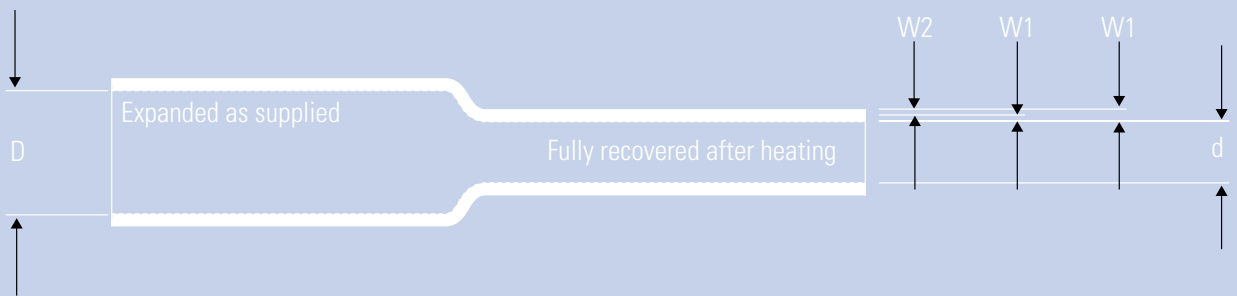
### **Raychem DWTC**

- Offers excellent mechanical strength abrasion resistance and environmental sealing
- High shrink ratio allowing one size to cover a range of pipes

DWTC is a high performance dual-wall tubing. The meltable adhesive liner provides complete moistureproof encapsulation. It has excellent mechanical strength with a high resistance to splitting.

The construction of DWTC provides enhanced pipe bending capability over AP-2000.

**For full technical information on DWTC please see the DWTC data sheet, page 63.**



# Tubing Data Sheets

**Tyco Electronics, for its Raychem products, pioneered the application of radiation cross-linking and the development of heat-shrinkable polymer tubing.**

**A range of protection products, made from a wide variety of materials, can provide comprehensive protection: mechanical protection, strain relief, resistance to abrasion and noise reduction, fluid resistance and thermal insulation.**



Operating temperature range



Shrinking ratio



Shrink temperature



Tensile strength



Elongation



Dielectric strength



Flame retarded



Fluid resistant

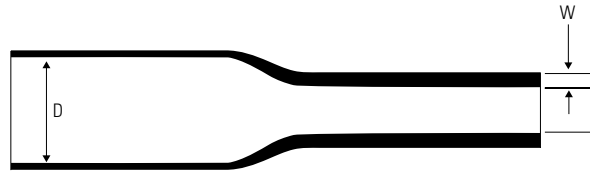


Canadian Standards Association



Underwriters Laboratories

Dual-wall polyolefin heat-shrinkable tubing to protect automotive metal pipework



- **Environmental and mechanical protection from corrosion**
- **Low shrink temperature for quick installation**

AP-2000 is designed for use on industry standard metal pipes to provide protection on automotive brake and fuel lines in areas exposed to mechanical abuse and moisture. The product is positioned on straight pipe lengths prior to the second end-nut fitting. Each size of AP-2000 tubing has been designed for use on specific standard size of metal pipe. The product rapidly shrinks on application of heat above 115°C and the adhesive melts and flows around the substrate, eliminating air gaps. Once installed, the pipes are bent and formed.

**Ordering information**

	Inside diameter	Wall thickness	
<b>Standard pipe diameter</b>	<b>D (min) Expanded as supplied</b>	<b>W (nom) Recovered after heating</b>	<b>Ordering description</b>
mm	mm	mm	
4.76	6.0	1.0	AP2000-6
6.35	8.0	1.0	AP2000-8
8.00	10.0	1.0	AP2000-10
10.00	15.0	1.0	AP2000-15
4.85	14.0	1.0	AP2000-NR101
3.50	5.0	1.0	AP2000-NR102

The size that corresponds to the pipe diameter shown in the table above should be ordered. Contact Tyco Electronics for non-standard pipe diameters.

The product may be supplied in cut pieces and 0.9m wooden reels for long continuous lengths or high volumes.

**Standard colours**

Colour	Black
Code	0

**Performance**

Longitudinal shrinkage:	0 to -10%
Heat ageing:	Maintains mechanical performance after 24hrs at 120°C:
	Tensile strength: 12 MPa (min)
	Ultimate elongation: 270% (min)
Deformation resistance:	50% (min)
Impact resistance:	No cracking at -35°C   ASTMD 746
Drop impact resistance:	No cracking
Stress cracking resistance:	No cracking, ASTMD1693 Section 5.3.6
Fluid resistance:	No cracking after 72hrs at +25°C for:
	Sulphuric acid (1.28 S.G.)
	Sodium hydroxide (0.1N)
	Motor vehicle brake fluid (SAE J1703)
	Unleaded petrol

All tests conducted as specified in Raychem RW 1001

**Installation**

Equipment to install AP-2000 will depend on production capacity and pipe length. Generally, conveyor belt type ovens with heaters situated above and below a mesh belt are used. The belt speed should be easily controlled and the heater powerful enough in order to achieve the required temperature profile on the metal pipe and surface of the tubing. Contact Tyco Electronics for more details.

**Specifications**

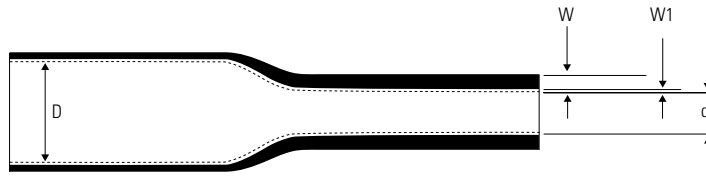
Raychem Specification RW 1001.  
Installation instructions available on request. - PIP 006  
Material Safety Data Sheet available on request.



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Semi-flexible, general purpose adhesive-lined, moisture proof heat-shrinkable tubing



**Ordering information**

Inside diameter		Wall thickness		Standard package									
D (min) Expanded as supplied	d (max) Recovered after heating	W (nom) Total wall recovered after heating	W1 (nom) Meltable wall recovered after heating	1.22m Length quantity		Ordering description							
mm	mm	mm	mm	m	m								
<b>3:1</b>	<b>4:1</b>	<b>3:1</b>	<b>4:1</b>	<b>3:1</b>	<b>4:1</b>	<b>3:1</b>	<b>4:1</b>	<b>3:1</b>	<b>4:1</b>	<b>3:1</b>	<b>4:1</b>		
3	4	1	1	1.00	1.00	0.5	0.5	30	30	Atum-3/1-colour code	Atum-4/1-colour code		
6	8	2	2	1.00	1.00	0.5	0.5	30	30	Atum-6/2-colour code	Atum-8/2-colour code		
9	12	3	3	1.40	1.40	0.6	0.6	30	30	Atum-9/3-colour code	Atum-12/3-colour code		
12	16	4	4	1.78	1.78	0.7	0.7	30	30	Atum-12/4-colour code	Atum-16/4-colour code		
19	24	6	6	2.25	2.25	0.8	0.8	30	30	Atum-19/6-colour code	Atum-24/6-colour code		
24	32	8	8	2.54	2.54	1.0	1.0	30	12	Atum-24/8-colour code	Atum-32/8-colour code		
40	52	13	13	2.54	2.54	1.0	1.0	12	6	Atum-40/13-colour code	Atum-52/13-colour code		

Standard colours	Colour	Black	Clear
	Code	0	X (only 3:1)
Non standard colours available on request			

Performance	Test	Test method	Test requirement
	Inner wall adhesion:		60 N per 25mm (min)
	ATUM to aluminium		
	Heat shock:	4 h at 225°C	Pass – no dripping, cracking or flowing of outer wall
	Heat ageing:	168 h at 150°C	Pass – no cracking
	Low temperature flexibility:	4 h at -55°C	Pass – no cracking
	Dielectric strength:	IEC 243	12 MV/m (min)
	Fluid resistance:	24 h at 23°C, ISO 37	Tensile strength: 7 MPa (min) Ultimate elongation: 300% (min) Inner wall adhesion: 60 N per 25mm (min)
	Test fluids:		Diesel Fuel (BS 2869 class A1) Hydraulic fluid (H-515) Lubricating oil (0-149)

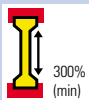
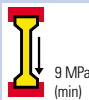
For full product performance details consult Raychem Specification RK 6025.

Specifications	Raychem Specification RK 6025. (Black) RK6024 (colours and clear)
	Material Safety Data Sheet available on request
	Installation instructions available on request

- Provides excellent environmental sealing
- 3:1 and 4:1 shrink ratios
- High strength bonding
- Operating temperature -55°C to +110°C

Atum is a semi-flexible, heat-shrinkable tubing with a melttable adhesive inner lining designed to provide moisture proof sealing to a wide range of substrates such as electrical wire splices, cable jackets, wire breakouts and electrical components.

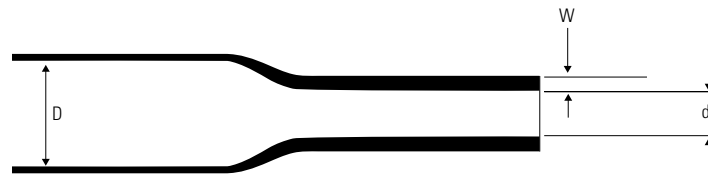
The high shrink ratios mean that only seven sizes are required to cover a wide range of substrate diameters. Typical applications are environmental sealing of electrical components including wire splices and harness breakouts as well as sealing cable ends against moisture ingress.



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General purpose, flame retarded, polyolefin heat-shrinkable tubing



- Very good chemical and solvent resistance
- Wide range of colours including green/yellow stripes
- Flexible
- Excellent physical and electrical performance

CGPT is a tough, flexible, general purpose polyolefin tubing with good resistance to common fluids and solvents and a high dielectric strength. Available in 2:1 and 3:1 shrink ratios its unique blend of chemical, electrical and physical properties makes it suitable for a wide range of applications including electrical insulation, strain relief, cable bundling, colour coding and identification of wires, cables, pipes and electrical and electronic components and mechanical protection.

**Ordering information**

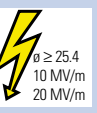
	Inside diameter	Wall thickness	Standard package	
mm	D (min) Expanded as supplied	d (max) Recovered after heating	W (nom) Recovered after heating	Spool quantity
2:1 Shrink ratio	1.2	0.6	0.45	300
	1.6	0.8	0.45	300
	2.4	1.2	0.50	150
	3.2	1.6	0.50	150
	4.8	2.4	0.50	150
	6.4	3.2	0.65	75
	9.5	4.8	0.65	121
	12.7	6.4	0.65	91
	19.0	9.5	0.75	60
	25.4	12.7	0.90	60
3:1 Shrink ratio	1.5	0.5	0.45	300
	3.0	1.0	0.55	150
	6.0	2.0	0.65	75
	9.0	3.0	0.75	75
	12.0	4.0	0.75	75
	18.0	6.0	0.85	75
	24.0	8.0	1.00	30
	39.0	13.0	1.15	30

\*Material supplied on Flat Spooled Packaging (FSP) as standard

Standard colours	Black	Red	Yellow	Green
Standard Code	0	2	4	5
	Blue	White	Clear	Green/Yellow stripes (sizes marked *)
	6	9	X	45
Non Standard Code	Brown	Orange	Violet	Grey
	1	3	7	8

Performance	Test	Test method	Test requirement
	Heat ageing:	ISO188 (168 h at 150°C)	Ultimate elongation 150% (min)
	Corrosion resistance:	ASTM D2671 (16 at 175°C)	No corrosion of mirrors
		Test fluids:	Petrol (100 octane) Lubricating oil (0.148) Hydraulic fluid (H515)

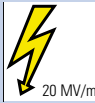
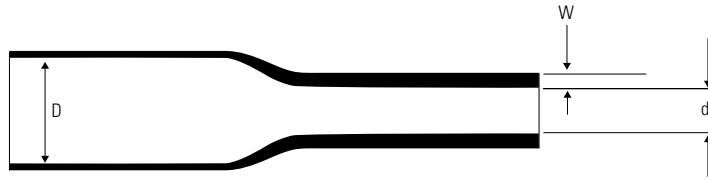
Specifications	
	Raychem Specification RW 2059.
	Material Safety Data Sheet available on request.
	Installation instructions available on request.



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A semi-rigid, flame-retarded polyolefin heat-shrinkable tubing



- **Excellent abrasion resistance**
- **Good strain relief performance**
- **Outstanding physical and electrical performance**
- **Excellent chemical and solvent resistance**

CRN semi-rigid, flame retarded, polyolefin based heat-shrinkable tubing displays excellent resistance to a wide range of chemicals and solvents combined with excellent electrical properties. The tubing is tough and semi-rigid which makes it ideally suitable for applications requiring strain relief or abrasion resistance. Widely used throughout industry for component protection and strain relief of sensitive areas such as solder and crimp joints.

**Ordering information**

Inside diameter	Wall thickness	Standard package *Pack size differ on colour options		
D (min) Expanded as supplied	d (max) Recovered after heating	W (nom) Recovered after heating	1.22m Length quantity	Ordering description
mm	mm	mm	m	
1.2	0.6	0.51	60	CRN-3/64-colour code
1.6	0.8	0.51	60	CRN-1/16-colour code
2.4	1.2	0.51	60	CRN-3/32-colour code
3.2	1.6	0.51	60	CRN-1/8-colour code
4.8	2.4	0.64	60	CRN-3/16-colour code
6.4	3.2	0.64	30	CRN-1/4-colour code
9.5	4.8	0.76	30	CRN-3/8-colour code
12.7	6.4	0.76	30	CRN-1/2-colour code
19.1	9.5	0.89	30	CRN-3/4-colour code

Other lengths, colours and sizes are available subject to special order.

Standard colours	Colour	Black
	Code	0

Performance	Test	Test method	Test requirement
	Heat ageing:	ISO188 (168 h at 175°C)	Ultimate elongation: 150% (min)
	Corrosion resistance:	ASTM D2671 (16 h at 175°C)	No corrosion of mirrors
	*Flame retardancy:	ASTM D2671 (Procedure B)	Duration of burning 60s max
	Fluid resistance:	24 h at 23°C, ISO 37	Tensile strength: 12 MPa (min)
			Ultimate elongation: 200% (min)
		Test fluids:	Aircraft & Fuel to ISO1817 test liquid B Phosphate Ester ISO1817 test liquid 103 Lubricating oil ISO1817 test liquid 101

\*Not clear product (X).

For full product performance details consult Raychem Specification RK 6003.

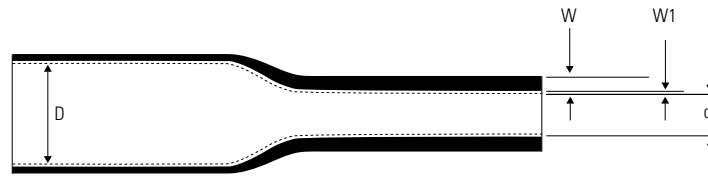
Specifications	Raychem Specification RW 6003
	Material Safety Data Sheet available on request
	Installation instructions available on request

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Flexible, dual-wall, moisture proof, heat-shrinkable tubing



- Excellent mechanical strength
- Excellent abrasion resistance
- Excellent optical clarity
- Environmental sealing
- Shrink ratio 4:1

Raychem DWTC is a flexible, heat-shrinkable, dual-wall tubing with an integrally bonded melttable adhesive inner liner designed to offer moisture proof encapsulation to a wide variety of substrates. Available in clear, DWTC offers excellent clarity for protection of substrates that may need to be inspected during service. The tough outer jacket gives excellent mechanical strength with a high resistance to splitting. The high shrinkage ratio means that only four sizes are needed to give protection to a full range of irregular shapes with widely varying dimensions.

**Ordering information**

Inside diameter		Wall thickness		Standard package	
D (min) Expanded as supplied	d (max) Recovered after heating	W (nom) Total wall recovered after heating	W1 (nom) Meltable wall recovered after heating	1.22m Length quantity	Ordering description
mm	mm	mm	mm	m	
4.0	1.0	0.8	0.25	30	DWTC-4/1-X
8.0	2.0	0.9	0.25	30	DWTC-8/2-X
12.0	3.0	1.2	0.40	30	DWTC-12/3-X
16.0	4.0	1.5	0.50	30	DWTC-16/4-X

The largest size that will recover snugly over the component to be covered should be ordered.  
The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage.  
Other lengths and sizes are available subject to special order.

**Standard colours**

Colour	Clear
Code	X

**Performance**

Test	Test method	Test Requirement
Inner wall adhesion: DWTC to aluminium		60 N/25 mm (min)
Heat shock:	4 h at 200°C	Pass – no dripping, cracking or flowing of outer wall
Heat ageing:	168 h at 120°C	Pass – no dripping, cracking or flowing of outer wall
Low temperature flexibility:	4 h at -55°C	Pass – no cracking
Fluid resistance:	24 h at 23°C, ISO 37	Tensile strength: 15 MPa (min) Ultimate elongation: 200% (min)
	Test fluids:	Diesel Fuel (BS 2869 class A1) Brake fluid (H-515) Lubricating oil (0-149)

For full product performance details consult Raychem Specification RK 6204.

**Specifications**

Raychem Specification RK 6204.  
Material Safety Data Sheet available on request.  
Installation instructions available on request.



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High-shrink-ratio, adhesive-lined semirigid polyolefin caps



**Ordering information**

Inside diameter (including core)		Recovered wall thickness**				
Standard length* as supplied	Maximum expanded as supplied	Maximum recovered after heating	Total wall after heating	Total jacket wall after heating	Total adhesive wall after heating	Ordering description
mm	mm/in	mm/in	mm/in	mm/in	mm/in	
30.35	5.72 (.225)	1.27 (.050)	1.20 (.047)	0.64 (.025)	0.56 (.022)	ES Cap-No. 1
30.35	7.44 (.293)	1.65 (.065)	1.52 (.060)	0.76 (.030)	0.76 (.030)	ES Cap-No. 2
40.50	10.85 (.427)	2.41 (.095)	1.91 (.075)	0.89 (.035)	1.37 (.054)	ES Cap-No. 3

\*\*The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage.

\*Other cap lengths available upon request.

Size selection Always order the largest size that will shrink snugly over the component to be covered. Other caps available on request.

Standard packaging In pieces

Marking Caps will be marked with the number sizes (for example ES-1, ES-2, or ES-3).

Ordering description Specify product name, size, colour, and length (for example, ES Cap-No. 2-X-35mm).

Standard colours	Colour	Black	Clear
	Code	0	X

Specifications
Raychem Specification RW-3006
Series ES Caps
Material Safety Data Sheet available on request
Installation instructions available on request



• **4:1 shrink ratio allows a few sizes to cover a wide range of splice and component diameters.**



• **Mechanically tough jacket provides strain relief and abrasion protection.**



• **Thick adhesive liner forms an effective barrier against fluids and moisture and performs well at an extended temperature range.**



Specially designed to provide mechanical and environmental protection of stub splices in electrical harnesses. Clear caps allow see-through inspection; black caps are flame-retardant.



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Fully flame-retardant, dual-wall, moisture proof, heat-shrink tubing



- **Excellent environmental seal**
- **Full flame retardancy and self extinguishing characteristics**
- **Mechanical protection against flexing, abrasion and cut through**
- **Temperature rated to 135°C for 3000 hours**

FL2500 dual-wall tubing comprises a tough cross-linked flame retardant polyolefin tubing lined with a new flame retardant adhesive to provide the optimum solution for applications where full retardancy is preferred, or specified. Rated to 135°C for 3000 hours, it is suitable for use in the automotive harness market and other harsh environments.

FL2500 with its high performance adhesive lining offers an economical and highly effective method for permanently sealing and protecting splices, fusible links, terminals and in-line components. As the tubing is heated and shrinks down onto its host, the adhesive lining melts and flows to fill all voids and create a complete seal against moisture, oils, chemicals etc.

FL2500 is available in a comprehensive range of sizes, to meet most component sealing requirements, and is compatible with a wide range of application equipment.

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**Ordering information**

Size	Expanded I. D. (min) mm	Recovered I. D. (max) mm	Recovered Total wall (average) mm	Ordering description
No 1	7.62	1.65	1.52±0.3	FL2500-NO.1-I8-0
No 2	9.02	2.29	1.52±0.3	FL2500-NO.2-I9-0
No 3	11.56	2.54	2.29±0.3	FL2500-NO.3-J1-0
No 4	17.79	4.45	2.54±0.3	FL2500-NO.4-J2-0

**Standard cut lengths**

	Print legends			
	Size	Code	Legend	Ink colour
27 mm, 50 mm, 65 mm and -STK (1220 mm)	No 1	I8	FL-1	White
27 mm, 50 mm, 65 mm and -STK (1220 mm)	No 2	I9	FL-2	White
27 mm, 65 mm, 75 mm and -STK (1220 mm)	No 3	J1	FL-3	White
27 mm, 75 mm, 90 mm and -STK (1220 mm)	No 4	J2	FL-4	White

**Temperature rating**

Operating temperature range:	-40°C to +135°C for 3000 hours
Shrink temperature	135°C
Shrink ratio	4:1

**Specifications**

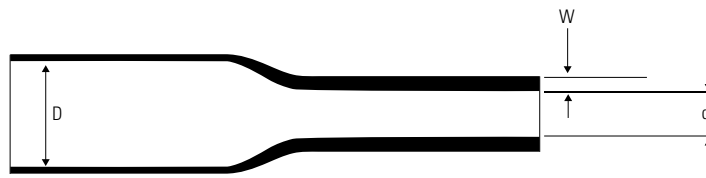
Raychem Specification FL2500.  
Material Safety Data Sheet available on request.  
Installation instructions available on request..

**Standard colours**

Colour	Black with a white adhesive liner
Code	0



Heat-shrinkable, flexible, thick-wall tubing



**Ordering information**

Inside diameter	Wall thickness	Standard package			
D (min) Expanded as supplied	d (max) Recovered after heating	W (nom) Recovered after heating	Spool quantity	Weight	Ordering description
mm	mm	mm	m	g/m	
3.2	1.6	0.8	50	7	FRAG-3.2/1.6-0
4.8	2.4	0.8	50	12	FRAG-4.8/2.4-0
6.0	3.5	0.9	50	15	FRAG-6/3.5-0
9.0	5.0	1.0	50	25	FRAG-9/5-0
12.0	7.0	1.25	30	40	FRAG-12/7-0
18.0	10.0	1.45	30	70	FRAG-18/10-0
25.0	13.0	1.8	30	110	FRAG-25/13-0
38.0	19.0	2.4	15	223	FRAG-38/19-0
51.0	25.0	2.8	15	341	FRAG-51/25-0
76.0	38.0	3.2	15	371	FRAG-7.8/38-0

The largest size that will recover snugly over the component to be covered should be ordered.

The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage.

Other lengths and sizes are available subject to special order.

Standard colours	Colour	Black
	Code	0

Performance	Test	Test requirement
	Heat ageing:	168 h at 160°C (ISO 188)
	Thermal endurance:	2,000 h at 150°C
	Burning rate:	100 mm/min max (MVSS 302)
	Fluid resistance:	Petrol 100 Octane Engine off Hydraulic Fluid SAE J 1703 Diesel Fuel ISO 1617 Antifreeze

For full product performance details consult Raychem Specification RK 6176.

Specifications	Raychem Specification RK 6176.
	Material Safety Data Sheet available on request.
	Installation instructions available on request.

- Operating temperature range -55°C to +150°C
- Flexible and abrasion resistant
- Flame retarded

FRAG is a heat-shrinkable, thick-wall tubing designed for harsh environments. It has excellent resistance to fluids at elevated temperatures and good long term heat resistance.

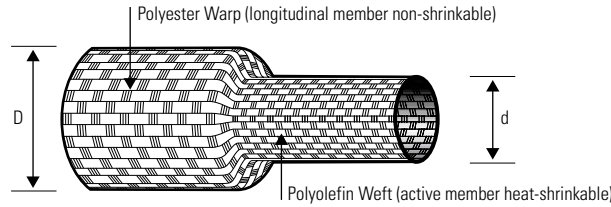
FRAG is flexible as well as abrasion resistant. These properties make it ideal for the protection of electrical cables or similar components.

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Heat-shrinkable fabric tubing



- Heat-shrinkable fabric tubing
- Highly flexible woven fabric tubing
- Polyethylene/polyester construction for excellent abrasion resistance
- Low shrink temperature
- Halogen free
- 2:1 shrink ratio

Raychem HFT5000 products are made of very flexible heat-shrinkable fabric material. Heated above 100°C, they shrink and fit snugly and securely around the underlying substrate. Designed primarily to provide mechanical abrasion protection for components such as rubber hoses, plastic pipes, and harness wiring bundles, they are also suitable for other applications, such as noise and rattle suppression.

Woven from heat-shrinkable circumferential polyolefin filaments and non-shrinking longitudinal polyester fibres, the product is halogen free. The woven construction makes HFT5000 extremely flexible and resistant to trapping water, heat and humidity. It provides outstanding abrasion, chafing and cutting protection, even at high temperatures. HFT5000 product is easy to install and can be cut with standard industrial cutting equipment.

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**Ordering information**

**Standard sizes**

**Inside diameter (mm/in)**

D (min.) Expanded as supplied	d (max.) Recovered after heating	Spool quantity (m/ft)	Product description
12 (0.47)	6 (0.24)	500 (1640)	HFT5000-12/6-0-SP
20 (0.79)	10 (0.39)	400 (1312)	HFT5000-20/10-0-SP
30 (1.18)	15 (0.59)	400 (1312)	HFT5000-30/15-0-SP
40 (1.57)	20 (0.79)	300 (984)	HFT5000-40/20-0-SP
50 (1.97)	25 (0.98)	200 (656)	HFT5000-50/25-0-SP
60 (2.36)	30 (1.18)	200 (656)	HFT5000-60/30-0-SP
70 (2.76)	35 (1.38)	150 (492)	HFT5000-70/35-0-SP

**Non-standard high volume sizes**

**Inside diameter (mm/in)**

D (min.) Expanded as supplied	d (max.) Recovered after heating	Spool quantity (m/ft)	Product description
25 (0.98)	12 (0.47)	400 (1312)	HFT5000-25/12-0-SP
34 (1.34)	17 (0.67)	350 (1148)	HFT5000-34/17-0-SP
80 (3.15)	40 (1.57)	100 (328)	HFT5000-80/40-0-SP

**Standard colours**

Colour	Black	Note: Fully recoverable fabric wall thickness: Approximately 1 mm (0.039in). Longitudinal change on full recovery is – 10% to -20% 0 = Black
Code	0	
Standard packaging	1 spool per box	

**Performance**

Test	Test method	Test requirement
Thermal ageing:	3000 hrs at 125°C	No deterioration in abrasion resistance at 80°C
	1000 hrs at 150°C	No deterioration in abrasion resistance at 80°C
Flammability:	MVSS302	Pass
Low temperature flexibility:	4 hours at -40°C, 10X diameter mandrel	No cracking
Cold impact:	200g weight from 100mm at -40°C	No cracking
Temperature/humidity cycling:	See RW2060 for details	No deterioration in abrasion resistance at 80°C
Thermal shock:	100 cycles between -40°C and 125°C	No deterioration in abrasion resistance at 80°C
Fluid resistance:	24 hr immersion at 23°C	No deterioration in abrasion resistance at 80°C
	Test fluids: (24hr immersion at 23°C)	Antifreeze (50% ethylene glycol) Engine oil (SAE 10W/30) Mineral hydraulic fluid Detergent (1% Teepol) Brake fluid (DOT 4) Unleaded gasoline Diesel fuel Battery acid (1.25 SG H <sub>2</sub> SO <sub>4</sub> )

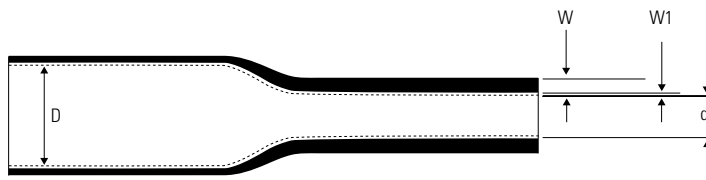
For full product performance details consult Raychem Specification RW 2060.

**Specifications**

Raychem Specification RW 2060.  
Material Safety Data Sheet available on request.  
Installation instructions available on request.



Semi-flexible, dual-wall moisture proof, heat-shrinkable tubing



**Ordering information**

Inside diameter		Wall thickness		Standard package	
D (min)	d (max)	W (nom)	W1 (nom)	1.22m length	Ordering description
Expanded as supplied	Recovered after heating	Total wall recovered after heating	Meltable wall recovered after heating	quantity	
mm	mm	mm	mm	m	
4.0	1.0	1.00	0.40	30	HTAT-4/1-0
8.0	2.0	1.00	0.50	30	HTAT-8/2-0
12.0	3.0	1.40	0.60	30	HTAT-12/3-0
16.0	4.0	1.75	0.75	30	HTAT-16/4-0
24.0	6.0	2.25	0.80	30	HTAT-24/6-0
32.0	8.0	2.50	1.00	12	HTAT-32/8-0
48.0	13.0	2.54	1.00	6	HTAT-48/13-0

The largest size that will recover snugly over the component to be covered should be ordered. The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage. Other lengths, colours (colour coded by size) and sizes are available subject to special order.

**Standard colours**

Colour	Black
Code	0

**Performance**

Test	Test method	Test requirement
Inner wall adhesion:		80 N per 25mm (min)
HTAT to aluminium		
Heat shock:	4 h at 225°C	Pass – no dripping, cracking or flowing of outer wall
Heat ageing:	168 h at 150°C	Pass – no dripping, cracking or flowing of outer wall
Low temperature flexibility:	4 h at -55°C	Pass – no cracking
Fluid resistance:	24 h at 23°C, ISO 37	Tensile strength: 7 MPa (min) Ultimate elongation: 300% (min)
	Test fluids:	Diesel Fuel (BS 2869 class A1) Hydraulic fluid (H-515) Lubricating oil (0-149)

For full product performance details consult Raychem Specification RW 2052.

**Specifications**

Raychem Specification RW 2052.  
Material Safety Data Sheet available on request.  
Installation instructions available on request.

- **Semi-flexible, dual-wall moisture proof, heat-shrinkable tubing**

- **Environmental sealing**
- **High strength bonding**

- **Ideal for connector sealing covering large diameter differences**

- **Shrink ratio 4:1**

HTAT is a semi-flexible, heat-shrinkable tubing with an integrally bonded meltable adhesive inner lining designed to provide moisture proof encapsulation for a range of substrates at elevated temperatures. Manufactured from radiation cross-linked polyolefins, the inner wall melts when heated and is forced into interstices by the shrinking of the outer wall, so that when cooled, the substrate is encapsulated by a tough, protective, moisture proof barrier. An operating range from -55°C up to +125°C and a high shrink ratio as standard, means that the tubing offers superior environmental protection to a wide range of irregular shapes with varying dimensions. The jacket is flame retarded to reduce flame propagation.



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Wire bundle sealing technology

**Benefits**

**Provides an environmental barrier**

- Stops water/fluid ingress
- Attenuates noise
- Provides a thermal barrier
- Electrically insulating

**User friendly application equipment**

- Rugged, robust and easy-to-use design
- Built-in process control features
- Clam shell induction heating units provide a solenoid coil that is easily opened and closed, fitting all bundle sizes
- Full installation and process guides are available

**Provides mechanical protection**

- Strain relief
- Limits chaffing

- Provides reliable environmental sealing & mechanical protection to 125°C
- Accommodates varying bundle sizes up to 125 wires\*
- Compatible with all common automotive wire and cable types
- Typical installation times of 60 seconds or less
- Single set of parameters for multiple bundle types

\*Depending on configuration

LMx technology is based on a proprietary adhesive, which rapidly flows and seals when subjected to an alternating magnetic field. The LMx system comprises of heat-shrinkable tubing lined with the LMx adhesive, a range of profiles and induction heating equipment, which integrates onto a carousel or workstation. Some amounts of magnetic material in the adhesive profile and tubing liner allow for very rapid installation at controlled autotherming temperature.



On and Off Board Installation Equipment of LMx System



Large wire bundle blocked using LMx technology



LMx Components



**Ordering information**

**LMx3500 Adhesive Profiles**

Dimensions						
Size	No of Channels	(A) (Nominal) mm	(B) (Nominal) mm	(C) (Nominal) mm	Length ±1mm mm	Weight ±15% (grams)
C5	5	2.7	5.0	19	7.0	0.8
C6	6	2.7	5.0	23	9.0	1.0
C7	7	2.7	5.0	26	9.0	1.2
C9	9	2.7	5.0	34	9.0	1.6
Properties: When used in an LMx3500 bundle seal the profile shall meet the requirements of RW-3020.						
Special sizes						
C6S	6	5.0	5.0	36	9	1.4
C9S	9	3.0	3.0	36	9	1.3

**LMx3500 Heat-shrinkable adhesive lined tubing**

Dimensions			
Size	(D) Minimum mm	(d) Maximum mm	(L) Length
18/6	18	6	Per Order
25/8	25	8	Per Order
30/10	30	10	Per Order
40/14	40	14	Per Order
52/18	52	18	Per Order
Properties: When used in an LMx3500 bundle seal the tubing shall meet the requirements of RW-3020.			

**LMx3500 Slit Adhesive Sleeve (SAS)**

Dimensions		
Size	Extruded L.D. (A) (Nominal) mm	Cut Length (B) (Nominal) mm
SAS-710	7	10
SAS-510	5	10
SAS-910	9	10
SAS-1112	11	12
Properties: When used in an LMx3500 bundle seal the sleeve shall meet the requirements of RW-3020.		

**Standard colours**

Colour Tubing – Black with grey adhesive liner  
Profiles – Grey

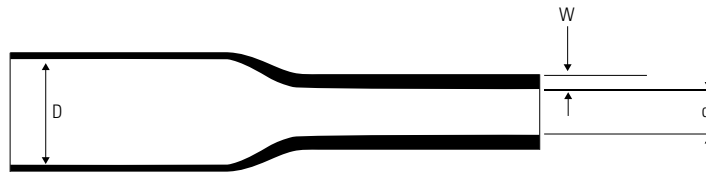
**Specifications**

Raychem Specification RW-3020.

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Low shrink temperature polyolefin heat-shrinkable tubing



**Ordering information**

Inside diameter		Wall thickness		Standard package	
D (min) Expanded as supplied	d (max) Recovered after heating	W (nom) Recovered after heating	Spool quantity	Ordering description	
mm	mm	mm	m		
1.6	0.8	0.50	300	LSTT-1.6-colour code	
2.4	1.2	0.55	150	LSTT-2.4-colour code	
3.2	1.6	0.55	150	LSTT-3.2-colour code	
4.8	2.4	0.55	150	LSTT-4.8-colour code	
6.4	3.2	0.65	75	LSTT-6.4-colour code	
9.5	4.8	0.65	75	LSTT-9.5-colour code	
12.7	6.4	0.65	75	LSTT-12.7-colour code	
19.0	9.5	0.80	75	LSTT-19-colour code	
25.4	12.7	0.95	30	LSTT-25.4-colour code	
32.0	16.0	1.05	30	LSTT-32-colour code	
38.0	19.0	1.05	30	LSTT-38-colour code	
52.0	26.0	1.14	30	LSTT-52-available in black only	

**Standard colours**

Standard Colour	Black	Red	Yellow	Blue	White
Code	0	2	4	6	9
Non Standard Colour	Green	Grey	Clear		
Code	5	8	X		

**Performance**

Test	Test method	Test requirement
Heat ageing:	ISO 188 (168 h at 125°C)	Tensile strength: 15 MPa (min)
		Ultimate elongation: 300% (min)
Corrosion resistance:	ASTM D2671 (16 h at 150°C)	No corrosion of mirrors
Flame retardancy:	MVSS 302	100 mm/min (max)
Fluid resistance:	24 h at 23°C, ISO 37	Tensile strength: 15 MPa (min)
		Ultimate elongation: 200% (min)
Test fluids:		Hydraulic fluid (J1703)
		Battery acid
		Anti freeze

For full product performance details consult Raychem Specification RK 2051.

To ensure dimensional stability, LSTT should be stored at temperatures not exceeding 40°C

**Specifications**

Raychem Specification RK 2051.  
Material Safety Data Sheet available on request.  
Installation instructions available on request.

- **Rapid recovery at low temperatures**
- **Can be used with temperature sensitive materials**
- **2:1 Shrink ratio**
- **Excellent physical and electrical performance**

LSTT is a highly flexible, low shrink temperature heat-shrinkable tubing. Easy to handle and install, its low shrink temperature offers exceptionally fast recovery for maximum efficiency in high volume commercial applications and makes it suitable for use on or near delicate temperature sensitive materials e.g. PVC (80°C) jacketed wire and cable. The material contains no known halogens. Although not flame retarded, LSTT meets the automotive flame propagation standard MVSS 302. LSTT gives good physical and electrical performance. Typical applications are electrical termination insulation, colour coding, covering of heat sensitive devices, cosmetic coverings and mechanical protection.

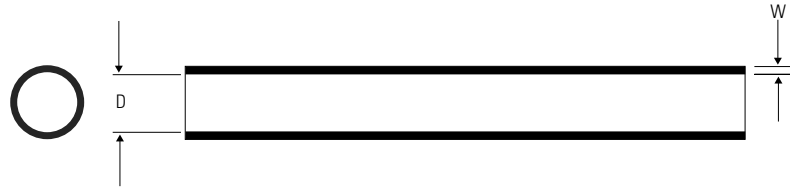


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Non heat-shrink harness tubing

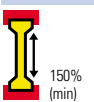


- **Excellent heat resistance**
- **Flexible**
- **Good mechanical strength**

NETM is a non heat-shrink tubing designed for electrical harnessing needs. Particularly suitable for the aggressive environment of car engines, NETM can withstand higher temperatures than traditional PVC materials whilst retaining its high level of performance. NETM1000 is the more flexible product, enabling it to be easily routed through engine spaces. NETM2000 offers greater mechanical strength and excellent abrasion resistance.

**Ordering information**

	Inside diameter		Product description
	D (nom) supplied	Wall thickness W (nom)	
<b>NETM1000</b>	3	0.5	NETM1000-3-0-SP
	4	0.5	NETM1000-4-0-SP
	5	0.5	NETM1000-5-0-SP
	6	0.5	NETM1000-6-0-SP
	8	0.5	NETM1000-8-0-SP
	10	0.5	NETM1000-10-0-SP
	12	0.5	NETM1000-12-0-SP
<b>NETM2000</b>	6	0.5	NETM2000-6-0-SP
	8	0.5	NETM2000-8-0-SP
	10	0.5	NETM2000-10-0-SP
	12	0.5	NETM2000-12-0-SP



Temperature rating	Operating temperature range:	NETM1000	-55°C to +135°C
		NETM2000	-40°C to +150°C

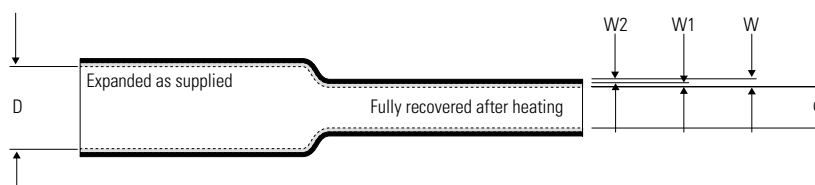
Standard colours	Colour	Black
	Code	0

Performance	Test	Test method	Test requirement	
			Tensile strength	ASTM D 2671
			NETM2000	15 MPa (min)
	Elongation	ASTM D 2671	NETM1000 & NETM2000	150% (min)
	Voltage withstand	ASTM D 2671	NETM1000 & NETM2000	1000 volts for 1 minute (min)

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Flame-retardant, high-shrink-ratio, adhesive-lined, flexible polyolefin tubing



**Ordering information**

Size	As supplied	As recovered	Minimum Recovered Jacket Wall (W2)	Minimum Recovered Adhesive Wall (W1)	Minimum Recovered Total Wall (W)
	Minimum Expanded I.D. Including Core (D)	Maximum Recovered I.D. Including Core (d)			
No. 1	5.72 (0.225)	1.27 (0.050)	0.64 (0.025)	0.56 (0.022)	1.20 (0.047)
No. 2	7.62 (0.300)	1.65 (0.065)	0.76 (0.030)	0.76 (0.030)	1.52 (0.060)
No. 3	11.55 (0.455)	2.41 (0.095)	0.89 (0.035)	1.02 (0.040)	1.91 (0.075)
No. 4	17.78 (0.700)	4.45 (0.175)	1.04 (0.041)	1.37 (0.054)	2.41 (0.095)

<b>Standard colour</b>	Colour	Black
	Code	0

**Material** Fabricated from flame-retarded cross-linked modified flexible polyolefin, with a thermoplastic adhesive liner.

Performance	Property	Requirements	Test method
	Specific Gravity	1.35 max	ASTM D 792 Note 1 (SCD)*
	Longitudinal Change	0 to -10%	ASTM D 2671
	Tensile Strength	1300 PSI min	ASTM D 2671 Speed 2 in./min. Note 2 (SCD)*
	Ultimate Elongation	200% min	ASTM D 2671 Speed 2 in./min
	Low Temperature Flexibility -40°C	No Cracking	ASTM D 2671
	Heat Shock 4 hrs. at 250°C	No Cracking	ASTM D 2671
	Heat Ageing 168 hrs at 175°C	No Cracking	Note 3 (SCD)*
	Dielectric Strength (jacket only)*	350Volts/mil min	ASTM D 149
	Volume Resistivity	10 <sup>12</sup> ohm-cm min	ASTM D 257
	Flammability	Self extinguishing in 1 minute	ASTM D 2671; Procedure B Mandrel size 50% of Expanded I.D.
	Water Absorption	1.0% max	ASTM D 570, Procedure A

\*Adhesive liner manually removed prior to testing.

Specifications	UL	CSA	Industry	Raychem
	E35586	LR31929	VDE 0341Pt9005	Please contact your Tyco representative for Specification Control Drawing (SCD)
	600V, 125°C	600V, 125°C	Type A and B	

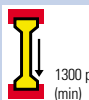
• **4:1 shrink ratio allows a few sizes to cover a wide range of splice and component diameters.**

• **Flame-retardant and mechanically tough, the tubing provides strain relief and abrasion protection of wire splices, terminals, and other components.**

• **Thick adhesive liner forms an effective barrier against fluids and moisture and performs well at an extended temperature range.**

• **UL recognized**

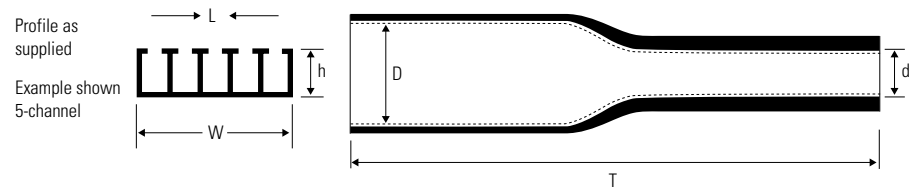
Specially designed for environmental sealing and electrical insulation of wire splices, terminations, and components.



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Heat-shrinkable water blocking systems for cable bundles and multi-wire electrical connectors up to 20 wires



- Excellent resistance to all common solvents and acids
- Outstanding vibration resistance
- Excellent electrical insulation
- Simple, reliable installation with Raychem designed application equipment

RayBlock-85 is designed to give consistent sealing for cable bundles and for multi-wire connectors, both large and small. The wires in the bundle are placed within the channels of a hot-melt adhesive profile, then covered by a piece of adhesive lined heat-shrinkable tubing. On heating, the profile melts and is squeezed around and between the wires by the shrinking action of the outer sleeve, creating a moisture-proof seal. The installed product is round and concentric, allowing easy positioning of other harness components such as feedthroughs and grommets. The overall diameter of the installed RayBlock is only marginally greater than the cable bundle itself. Installation is simple and may be carried out off-line, or on the harness board itself.

**Ordering information**

Profile	Tubing						Ordering description
	h (nom)	L (nom)	W (nom)	D (min)	d (max)	T (nom)	
Number of channels	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	
2	8.5	2.75	8.50	12.00	3.00	34.00	RBK-85 Kit 0102-AX
3	8.5	2.75	12.25	16.00	4.00	33.00	RBK-85 Kit 0103-AX
4	8.5	2.75	16.00	16.00	4.00	44.00	RBK-85 Kit 0104-AX
5	8.5	2.75	21.00	24.00	6.00	34.00	RBK-85 Kit 0105-AX
5	8.5	2.75	21.00	24.00	6.00	23.00	RBK-85 Kit 0305-AX
7	8.5	2.75	27.25	24.00	6.00	65.00	RBK-85 Kit 0107-AO
7	8.5	2.75	27.25	24.00	6.00	23.00	RBK-85 Kit 0607-AX
8	8.5	2.75	31.00	24.00	6.00	47.00	RBK-85 Kit 0208-AX
10	8.5	2.75	38.50	32.00	8.00	55.00	RBK-85 Kit 0510-AO

The selection table is intended for guidance only and individual bundles may well differ in requirement. Special designs may be possible on request to cater for large wires or larger cable bundles. Please contact Tyco Electronics Protection Products Division for further information. Maximum two wires per channel, for wires with maximum outside diameter 2.8 mm. For wires with an outside diameter greater than 2.8 mm, please consult Tyco Electronics. Standard packaging: 1000 pcs of profile plus 1000 pcs of tubing per box. Tyco Electronics offers a variety of heating tools for the installation of RayBlock-85. The range includes hot-air blowers, infra-red heaters and special automatic heating devices.

**Standard colours**

Colour	Black	Clear
Code	0	X

**Performance**

Physical	Sealing performance:	No leakage at +23°C after 1 min at 0.5 bar air pressure	
	Heat ageing:	No deterioration in sealing performance after 3000 h at +85°C	
	Cold impact:	No cracking and no deterioration in sealing performance after 4 h at -40°C	
Fluid	Resistance:	No deterioration in sealing performance after 24 h immersion at +23°C in:	
		Brake fluid SAE 1703	
		Anti-freeze 50/50 v/v	
		Engine oil SAE 10 W/40	
		Diesel fuel to BS2869	
	Car wash detergent		
Sequential	Product must pass sealing and electrical performance tests as specified in RW 2101 after the following programme:		
	Thermal shock:	50 cycles at -40°C to +105°C, 30 min at each temperature, then:	
	Sinusoidal vibration:	8 h test in two orthogonal directions, 10-25 Hz at 1 g acceleration and 25-500 Hz at 4.5 g acceleration, then:	
	Petrol immersion:	1 h total immersion in 100 octane petroleum spirit, then:	
	Temperature/humidity cycle:	10 cycles of:	
			16 h at +40°C in 95% relative humidity
			2 h at -40°C
			2 h at +85°C
			4 h at +23.5°C
	For full product performance details consult Raychem Specification RW 2101 and SCD.		

**Specifications**

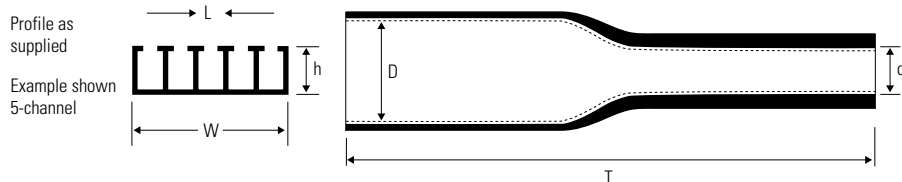
Raychem Specification RW 2101 and SCD
Material Safety Data Sheet available on request.

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Heat-shrinkable water blocking systems for cable bundles and multi-wire electrical connectors up to 20 wires



**Ordering information**

Profile	Tubing						Ordering description
	h (nom) mm	L (nom) mm	W (nom) mm	D (min) mm	d (max) mm	T (nom) mm	
2 channels	8.5	2.75	8.50	12.00	3.00	55.00	RBK-105 Kit 0702-AO
2 channels	8.5	2.75	8.50	19.00	4.00	50.00	RBK-105 Kit 1102-AO
3 channels	8.5	2.75	12.25	16.00	4.00	40.00	RBK-105 Kit 0103-AO
3 channels	8.5	2.75	12.25	16.00	4.00	50.00	RBK-105 Kit 1003-AO
4 channels	8.5	2.75	16.00	16.00	4.00	33.00	RBK-105 Kit 0204-AO
5 channels	8.5	2.75	19.75	24.00	6.00	45.00	RBK-105 Kit 0105-AO
7 channels	8.5	2.75	27.25	24.00	6.00	65.00	RBK-105 Kit 0107-AO
8 channels	8.5	2.75	31.00	24.00	6.00	47.00	RBK-105 Kit 0508-AO
10 channels	8.5	2.75	38.50	32.00	8.00	65.00	RBK-105 Kit 0110-AO
10/7 channels	8.5	2.75	38.50/28.60	32.00	8.00	60.00	RBK-105 Kit 0510-AO

The selection table is intended for guidance only and individual bundles may well differ in requirement. Special designs may be possible on request to cater for large wires or larger cable bundles. Please contact Tyco Electronics Protection Products Division for further information. Maximum two wires per channel, for wires with maximum outside diameter 2.8 mm. For wires with an outside diameter greater than 2.8 mm, please consult Tyco Electronics. Standard packaging: 1000 pcs of profile plus 1000 pcs of tubing per box. Tyco Electronics manufacture a variety of heating tools for the installation of RayBlock-105. The range includes hot-air blowers, infra-red heaters and special automatic heating devices.

Standard colours	Colour	Black	Clear
	Code	0	X

Performance		
Physical	Sealing performance	No leakage at +23°C after 1 min at 0.5 bar air pressure
	Heat ageing	No deterioration in sealing performance after 3000 h at +105°C
	Cold impact	No cracking and no deterioration in sealing performance after 4 h at -40°C
Fluid	Resistance	No deterioration in sealing performance after 24 h immersion at +23°C in:
		Brake fluid SAE 1703
		Anti-freeze 50/50 v/v
		Engine oil SAE 10W/40
		Diesel fuel to BS2869
	Car wash detergent	
Sequential	Product must pass sealing and electrical performance tests as specified in RW 2102 after the following programme:	
	Thermal shock:	50 cycles at -40°C to +120°C, 30 min at each temperature, then:
	Sinusoidal vibration:	8 h test in two orthogonal directions, 10-25 Hz at 1 g acceleration and 25-500 Hz at 4.5 g acceleration, then:
	Petrol immersion:	1 h total immersion in 100 octane petroleum spirit, then:
	Temperature/humidity cycle:	10 cycles of:
		16 h at +40°C in 95% relative humidity
		2 h at -40°C
	2 h at +105°C	
	4 h at +23.5°C	
For full product performance details consult Raychem Specification RW 2102 and SCD.		

Specifications	Raychem Specification RW 2102 and SCD. Material Safety Data Sheet available on request.
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- **Excellent resistance to all common solvents and acids**
- **Outstanding vibration resistance**
- **Excellent electrical insulation**
- **Simple, reliable installation with Raychem designed application equipment**

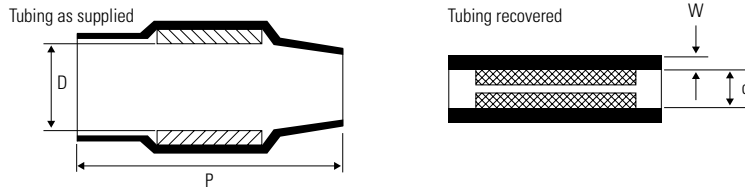
RayBlock-105 is designed to give consistent sealing for cable bundles and multi-wire connectors, both large and small. The wires in the bundle are placed within the channels of a hot-melt adhesive profile, then covered by a piece of adhesive lined heat-shrinkable tubing. On heating, the profile melts to be squeezed around and between the wire by the shrinking action of the outer sleeve, creating a moisture-proof seal. The installed product is round and concentric, allowing easy positioning of other harness components such as feedthroughs and grommets. The overall diameter of the installed RayBlock is only marginally greater than the cable bundle itself. Installation is simple and may be carried out off-line, or on the harness board as required.

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Flexible, single-wall jacket with integral adhesive ring, moisture proof, heat-shrinkable tubing



- **Environmental connector sealing**
- **High temperature rating**
- **One piece part**

RBK-GTR-125 is a one-piece, heat-shrinkable tubing with integral adhesive ring specifically designed to provide environmental encapsulation for 2 and 3 way AMP-JPT (Junior Power Timer) connectors up to +125°C (3000 hours).

The product is tapered for easy positioning on the connector. Manufactured from radiation cross-linked polyolefins, the inner adhesive ring melts when heated and flows around the wires and onto the connector lip, but not into the contact cavities. When cooled, the rear of the connector and wires are encapsulated by a tough, moisture proof barrier, and protected from flexing or vibration.

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**Ordering information**

AMP-JPT connector	Number of ways	Connector end inside diameter	Wall thickness	Length	Ordering description	
			<b>W (nom)</b>			
		<b>D (min) Expanded as supplied</b>	<b>d (max) Recovered after heating</b>	<b>Total wall Recovered after heating</b>	<b>P (nom) Expanded as supplied</b>	
		<b>mm</b>	<b>mm</b>	<b>mm</b>	<b>mm</b>	
0-014473	2	19.2	6.7	1.25	37.0	RBK-GTR-125-NR2/40
0-014474	3	22.2	7.5	1.25	37.0	RBK-GTR-125-NR3/40

Standard packaging: 1000 pieces in Galia packaging.

**Standard colours**

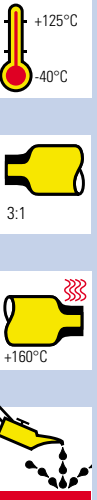
Colour	Black
Code	0

**Performance**

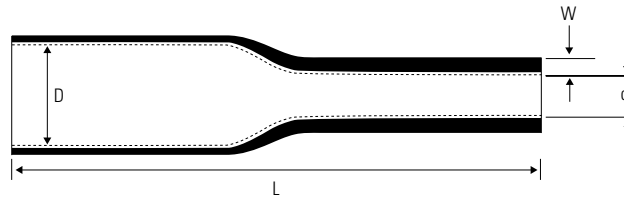
Sealing	No leakage at ambient temperature after 1 min. at 0.5 bar air pressure
Low temperature:	No cracking or deterioration in sealing performance after 3 h at -40°C
Long term heat ageing:	No cracking or deterioration in sealing performance after 3000 h at 125°C
Accelerated ageing:	No cracking or deterioration in sealing performance after 240 h at 150°C
Thermal shock:	No cracking or deterioration in sealing performance after 49 cycles of 2 h at +125°C followed by 2 h at -40°C
Anti-backout force:	75 N (min) at +50°C
Insulation resistance:	200 Mohms (min)
Salt fog:	No deterioration in sealing performance after 500 h
Temperature/humidity cycling:	No deterioration in sealing performance after 9 cycles each consisting of: 16 h at +40°C 75% R.H. 2 h at -40°C 2 h at +125°C 4 h at +23°C
Vibration:	No deterioration in sealing performance after vibration in 2 orthogonal planes for 8 h
Fluid resistance:	No deterioration in sealing performance after 24 h at 23°C for: Engine oil to SAE 10W/40 Brake fluid to SAE J 1703 Antifreeze to 50/50 v/v Car wash detergent 1% Teepol After 30 s at 23°C for: Diesel fuel to ISO 1817 Liquid F Petrol 100 Octane Battery acid 1.25 SG
Sequential:	The product must pass sealing performance tests after 9 sets of test sequences which simulate different operating conditions as specified in RW 2003
For full product performance details consult Raychem Specification RW 2003.	

**Specifications**

Raychem Specification RW 2003.
Material Safety Data Sheet available on request.
Installation instructions available on request.



Dual-wall moisture proof, heat-shrinkable tubing to protect electrical splices



**Ordering information**

Inside diameter		Wall thickness		Ordering description
D (min) Expanded as supplied	d (max) Recovered after heating	W (min) Recovered after heating	L (nom)	
5.75	1.25	1.15	50	RBK-ILS-125-NR1-0
7.4	1.65	1.4	50	RBK-ILS-125-NR2-0
11.0	2.4	1.8	65	RBK-ILS-125-NR3-0
14.0	3.0	2.1	65	RBK-ILS-125-3A-0
18.3	4.35	2.1	75	RBK-ILS-125-NR4-0

Refer to the Installation Guidelines document before selecting size. (PIP-019)

The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage.

Standard colours	Colour	Black
	Code	0

Installation	The product may be installed using a Raychem RBK-ILS Processor or other recommended application equipment. Consult your local Tyco Electronics office for more information
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Performance	Longitudinal change: 0 to -10%
Strain relief:	Insulation resistance does not drop below $2 \times 10^8$ ohms (min) after sample loaded to 50 N at 100 mm/min.
Flammability:	Self-extinguishing within 60 s (ASTM D2671 Proc B)
Heat ageing:	No cracking of jacket at 125°C after 3000 h Insulation resistance $2 \times 10^8$ ohms (min)
Split resistance:	No splitting at +200°C
Sequential:	The product must pass insulation resistance test $2 \times 10^8$ ohms (min) after each of the following tests:
Cold impact:	No cracking of jacket at -40°C for 4 h (ISO 6722)
Accelerated ageing:	+130°C for 168 h
Thermal shock:	5 cycles of +130°C for 1 h followed by immersion in saline solution at 0 to +5°C for 30 mins.
Temperature/humidity cycling:	5 cycles of +40°C for 12 h at 95% R.H. -40°C for 4 h +40°C for 3 h at 95% R.H. +23°C for 5 h
Mechanical vibration:	IEC 68-2-6 (BS 2011)
Flex test:	180° flex with differing loads for each sleeve size, 100 cycles at 12 cycles/min.
Fluid soak:	Samples soaked for 30 mins at 100°C in: Engine oil ISO 1817 No 1 Automatic transmission fluid Dexron™ 2
Fluid splash:	Sample immersed in each of the following fluids for 10 s: Diesel fuel ISO 1817 Liquid F Brake fluid Dot 4 Gunk degreaser Fuel C ISO 1817, 1985 Fuel 3 ISO 1817, 1985 Car wash detergent 1% Teepol/water by volume Battery acid BS 3031 (1.25 SG) Anti-freeze 50/50 v/v

All tests conducted are specified in Raychem Specification RK 6638

- **Excellent environmental seal**
- **Mechanical protection against flexing, abrasion and cut-through**
- **Small cross-sectional profile**
- **Temperature rated to 125°C continuous**

RBK-ILS-125 is a dual-wall, heat-shrinkable tubing designed to provide moisture proof encapsulation of an electrical splice in an automotive environment. Moisture may enter a splice area directly or indirectly via a capillary action between individual wires, thus causing corrosion.

The tubing is centred over the splice area and on heating the adhesive melts and is squeezed around where the wires are crimped or welded and between the conductors, by the shrinking action of the sleeve. The installed product provides low profile mechanical protection against flexing, abrasion and cut-through as well as electrical insulation. The jacket is flame-retarded. There are five sizes to cover the range of splice profiles found, and up to seven wires may enter either end of the product. The sleeves are marked with size, ie, RBK-1 to aid selection. The compact size of RBK-ILS-125 suits process line harness assembly.

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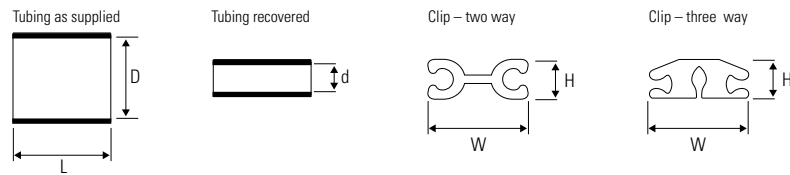
Flexible, two part connector sealing system for mini-timer connectors

- Environmental sealing
- Flexible after installation to avoid obstruction
- Simple to install
- Temperature rated to +105°C continuous

RBK-MTS is a flexible, two part connector seal designed to provide moisture proof encapsulation of AMP Junior Timer connectors. The product consists of a single wall, heat-shrinkable tubing and an adhesive clip which can accommodate a wide range of wire sizes. The clip is positioned at the back of the connector over the wires and the tubing placed over the lip of the connector. On heating, the adhesive clip melts and flows around the wires as well as the back of the connector. When cooled, the rear of the connector and wires are encapsulated by a moisture proof barrier and the contact given anti-backout protection.

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**Ordering information**

AMP connector	Number of ways	Tubing inside diameter	Tube length	Clip width	Clip Height	Ordering description	
		D (min) Expanded as supplied	d (max) Recovered after heating	L (nom)	W (nom)	H (nom)	
		mm	mm	mm	mm	mm	
AMP 0-827551-3	2	15.0	4.0	60.0	17.0	6.0	RBK-MTS-NR2/60
AMP 0-825414-3	2	15.0	4.0	115.0	17.0	6.0	RBK-MTS-NR2/160
AMP 0-827581-1	3	19.0	5.0	60.0	17.0	6.0	RBK-MTS-NR3/60

The product can only be ordered as a kit. Components cannot be ordered separately. The standard kit size is 1000 pieces.

**Standard colours**

Colour	Black
Code	0

**Performance**

Sealing:	No leakage after 1 min. at 0.5 bar air pressure
Low temperature:	No cracking or deterioration in sealing performance after 3 h at -40°C
High temperature:	No cracking or deterioration in sealing performance and insulation resistance 2 x 10 <sup>9</sup> ohms (min) after 3000 h at 105°C
Thermal shock:	No cracking or deterioration in sealing or electrical performance after 168 h at +125°C
Anti-backout force:	75 N (min) at +50°C
Flexural lifetime:	No cracking or deterioration in sealing performance after 90° flex for 500 cycles
Insulation resistance:	2 x 10 <sup>9</sup> ohms (min)
Salt fog environment:	No cracking or deterioration in sealing performance after 500 h in salt spray (ASTM B117)
Temperature/humidity cycling:	No cracking or deterioration in sealing or electrical performance after 10 cycles each consisting of: +40°C for 16 h at 95% R.H. -40°C for 2 h +105°C for 2 h +23°C for 4 h
Fluid resistance:	No cracking or deterioration in sealing performance after samples immersed for 24 h at 23°C in each of the following fluids: Engine oil to SAE 10W/40 Brake fluid to SAE J1703 Antifreeze to 50/50 v/v Car wash detergent 1% Teepol After 30 mins at 23°C: Diesel fuel to F54 Petrol 100 Octane Sulphuric acid 1.25 SG.

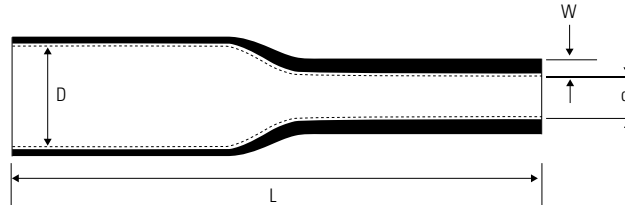
For full product performance details consult Raychem Specification RK 6636.

**Specifications**

Raychem Specification RK 6636.
Material Safety Data Sheet available on request – PIP 001.
Installation instructions available on request.



Clear, dual-wall, moisture proof, heat-shrinkable tubing to protect electrical splices



**Ordering information**

Inside diameter		Wall thickness		Length	
D (min)	d (max)	W (nom)	Total wall	L (nom)	Ordering description
Expanded as supplied	Recovered after heating	Recovered after heating	Recovered after heating		
mm	mm	mm	mm	mm	
5.7	1.27	1.5	50.0	50.0	RBK-VWS-125-NR1-X
8.0	1.65	1.8	50.0	50.0	RBK-VWS-125-NR2-X
10.8	2.40	2.2	65.0	65.0	RBK-VWS-125-NR3-X
17.78	4.45	2.41	75.0	75.0	RBK-VWS-125-NR4-X

Refer to the Installation Guidelines document before selecting size. (PIP-004)

The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage.

Standard colours	Colour	Clear
	Code	X

**Installation** The product may be installed using a Raychem RBK-ILS Processor or other recommended application equipment. Consult your local Tyco Electronics office for more information

Performance	Longitudinal change:	0 to -10%
	Strain relief:	Insulation resistance does not drop below $2 \times 10^8$ ohms (min) after sample loaded to 50 N at 100 mm/min.
	Heat ageing:	No cracking of jacket at 125°C after 3000 h Insulation resistance $2 \times 10^8$ ohms (min)
	Split resistance:	No splitting at +200°C

Sequential:	The product must pass insulation resistance test $2 \times 10^8$ ohms (min) after each of the following tests:	
	Cold impact:	No cracking of jacket at -40°C for 4 h (ISO 6722)
	Accelerated ageing:	+130°C for 168 h
	Thermal shock:	5 cycles of +130°C for 1 h followed by immersion in saline solution at 0 to +5°C for 30 mins.
	Temperature/humidity cycling:	5 cycles of +40°C for 12 h at 95% R.H. -40°C for 4 h +40°C for 3 h at 95% R.H. +23°C for 5 h
	Mechanical vibration:	IEC 68-2-6 (BS 2011)
	Flex test:	180° flex with differing loads for each sleeve size, (SEFT 527)
	Fluid soak:	Samples soaked for 30 mins at 100°C in: Engine oil ISO 1817 No 1 Automatic transmission fluid Dexron™ 2
	Fluid splash:	Sample immersed in each of the following fluids for 10 s at 30 min intervals for 24 hrs: Diesel fuel ISO 1817 Liquid F Brake fluid Dot 4 Gunk degreaser Fluid C ISO 1817, 1985 Fuel 3 ISO 1817, 1985 Car wash detergent 1% Teepol/water by volume Battery acid BS 3031 (1.25 SG) Anti-freeze 50/50 v/v

All tests conducted are specified in Raychem Specification RK 6640



- **Excellent environmental seal**
- **Mechanical protection against flexing, abrasion and cut-through**
- **Small cross-sectional profile**
- **Temperature rated to 125°C continuous**

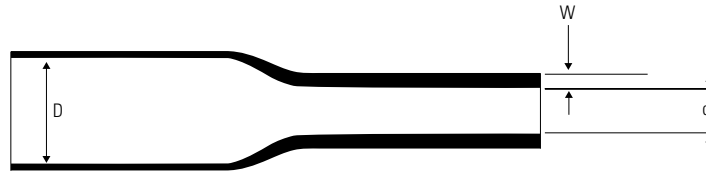
RBK-VWS-125 is a dual-wall, heat-shrinkable tubing designed to provide environmental sealing of an electrical splice in an automotive environment. Moisture may enter a splice directly or indirectly via capillary action between individual wires, thus causing corrosion. This effect is accelerated by variations in temperature. The tubing is centred over the splice area and during heating the adhesive melts and is 'squeezed' around where the wires are crimped or welded and between the conductors by the shrinking action of the sleeve. The installed product provides low profile mechanical protection against flexing, abrasion and cut-through as well as electrical insulation. There are four sizes to cover the range of splice profiles.

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A premium grade flame-retarded polyolefin heat-shrinkable tubing



- Outstanding all round performance
- Excellent physical and electrical performance
- Good chemical and solvent resistance
- Flexible

RNF-100 is a premium grade polyolefin based heat-shrinkable tubing with an outstanding overall balance of properties. The product has a wide range of industrial approvals. RNF-100 tubing possesses a unique blend of physical, chemical and electrical properties and is suitable for a wide range of applications.

Used extensively for lightweight harness jackets, insulation, colour coding, identification, protection against fluids and provides mechanical strength.

**Ordering information**

Inside diameter		Wall thickness		Standard package	
D (min)	d (max)	W (nom)	1.22m	Spool	Ordering description
Expanded as supplied	Recovered after heating	Recovered after heating	Length quantity	quantity	
mm	mm	mm	m	m	
1.2	0.6	0.45	60	300	RNF-100-3/64-colour code
1.6	0.8	0.45	60	300	RNF-100-1/16-colour code
2.4	1.2	0.50	60	150	RNF-100-3/32-colour code
3.2	1.6	0.50	60	150	RNF-100-1/8-colour code
4.8	2.4	0.50	60	150	RNF-100-3/16-colour code
6.4	3.2	0.65	30	75	RNF-100-1/4-colour code
9.5	4.8	0.65	30	121	RNF-100-3/8-colour code-FSP*
12.7	6.4	0.65	30	90	RNF-100-1/2-colour code-FSP*
19.0	9.5	0.75	30	60	RNF-100-3/4-colour code-FSP*
25.4	12.7	0.90	30	60	RNF-100-1-colour code-FSP*
31.0	16.0	0.95	12	30	RNF-100-1-1/4-colour code
38.0	19.0	1.00	12	91	RNF-100-1-1/2-colour code
51.0	25.4	1.15	6	30	RNF-100-2-colour code
76.0	38.0	1.25	6	15	RNF-100-3-colour code
102.0	51.0	1.40	6	15	RNF-100-4-colour code
127.0	63.5	1.52	6	30	RNF-100-5-colour code

\*Material supplied on Flat Spooled Packaging (FSP) as standard.

Standard colours	Colour	Clear	Black	Red	Yellow	Green	Blue	White
Code	X	0	2	4	5	6	9	

Non standard colour	Colour	Brown	Orange	Violet	Grey
Code	1	3	7	8	

Performance	Test	Test method	Test requirement
	Heat ageing:	ISO 188 (168h at 175°C)	Ultimate elongation: 150%(min)
	Corrosion resistance:	ASTM D2671 (16h at 175°C)	No corrosion of mirrors
	Dielectric strength:	IEC 243	Ø ≤ 25.4 20 MV/m Ø ≥ 25.4 10 MV/m
	Flame retardancy:	ASTM D876 UL 224 (All tube flame test)	Duration of burning 30s max
	Fluid resistance:	24 h at 23°C, ISO 37	Tensile strength: 7 MPa (min) Ultimate elongation: 200% (min)
	Test fluids:		Phosphate ester ISO1817 liquid 103 Lubricating oil ISO1817 liquid 101

For full product performance details consult Raychem Specification RK 6001.

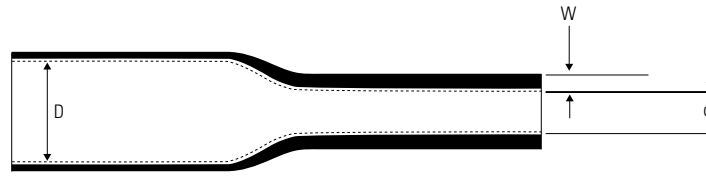
Specifications
Raychem Specification RK 6001.
Material Safety Data Sheet available on request.
Installation instructions available on request. (PIP-061)



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Flexible, dual-wall, moisture proof, heat-shrinkable tubing



- **Environmental protection**
- **Excellent mechanical strength**
- **Abrasion resistance**
- **4:1 shrink ratio**

RPPM is a flexible, heat-shrinkable, dual-wall tubing with an integrally bonded meltable adhesive liner. Available in clear and black, the tough outer jacket with both types offers excellent mechanical strength.

RPPM is used for moisture proof encapsulation of a wide variety of components. In particular, it adheres well to PVC. The high shrink ratio allows RPPM to be used with a range of dimensions.

Clear RPPM offers excellent clarity for protection of substrates that may need to be inspected during service. Black RPPM has a high gloss finish suitable for cosmetic applications.

**Ordering information**

Inside diameter		Wall thickness		Standard package	
D (min)	d (max)	W (nom)	1.22m		
Expanded as supplied	Recovered after heating	Total wall recovered after heating	Length quantity	Spool quantity	Ordering description
mm	mm	mm	m	m	
4.0	1.0	0.8	30	150	RPPM-4/1-colour code
8.0	2.0	0.9	30	200	RPPM-8/2-colour code
12.0	3.0	1.2	30	200	RPPM-12/3-colour code
16.0	4.0	1.5	30	200	RPPM-16/4-colour code
9.0	1.5	1.6	cut pieces	–	RPPM-NR510-X
6.4	1.0	0.8	cut pieces	–	RPPM-NR801-colour code

The largest size that will recover snugly over the component to be covered should be ordered.  
The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage.  
Other lengths and sizes are available subject to special order.

**Standard colours**

Colour	Clear	Black
Code	X	0

**Performance**

Test	Test method	Test requirement
Cold impact:	VDE 0472 Pt611	No cracking of outer jacket at -40°C
Inner wall adhesion:	RK 6214	To aluminium: 60 N/25 mm (min)
Split resistance:	RK 6214	No splitting at 100°C
Fluid resistance:	ISO 37 24h at 23°C	Tensile strength: 15 MPa (min) Diesel fuel (BS 2869 class A1) Brake fluid (J1703) Lubricating oil (0-149) Hydraulic fluid (DTD 900/4881 Skydrol 500B4) Antifreeze/water 50% v/v Battery acid (BS3031)

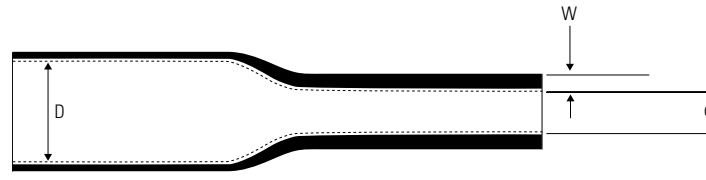
**Specifications**

Raychem Specification RK 6214  
Material Safety Data Sheet available on request

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High temperature polyvinylidene fluoride tubing



- Excellent chemical resistance
- Highly abrasion resistant
- Tough, semi-rigid and thin-wall
- High operating temperature 175°C
- Flame retarded UL224 VW1

RW-175 is an extremely tough, high temperature, thin-wall insulation tubing. This transparent, non-burning, semi-rigid tubing has superior resistance to most industrial fuels, solvents and chemicals.

Designed for applications requiring strain relief at temperatures up to 175°C, this product is unusually tough in its resistance to abrasion and cut through. Typical applications include high temperature applications, protection, strain relief, chemical resistance, mechanical and abrasion protection.

The natural rigidity of this material makes it suitable for automated installation via pick and place stations.

**Ordering information**

Inside diameter	Wall thickness	Standard package		
<b>D (min)</b>	<b>d (max)</b>	<b>W (nom)</b>	<b>1.22m</b>	
<b>Expanded as supplied</b>	<b>Recovered after heating</b>	<b>Recovered after heating</b>	<b>Length quantity</b>	<b>Ordering description</b>
<b>mm</b>	<b>mm</b>	<b>mm</b>	<b>m</b>	
1.2	0.6	0.25	60	RW-175- <sup>3</sup> / <sub>64</sub> -X
1.6	0.8	0.25	60	RW-175- <sup>1</sup> / <sub>16</sub> -X
2.4	1.2	0.27	60	RW-175- <sup>3</sup> / <sub>32</sub> -X
3.2	1.6	0.27	60	RW-175- <sup>1</sup> / <sub>8</sub> -X
4.8	2.4	0.27	60	RW-175- <sup>3</sup> / <sub>16</sub> -X
6.4	3.2	0.33	30	RW-175- <sup>1</sup> / <sub>4</sub> -X
9.5	4.8	0.33	30	RW-175- <sup>3</sup> / <sub>8</sub> -X
12.7	6.4	0.33	30	RW-175- <sup>1</sup> / <sub>2</sub> -X
19.0-	9.5	0.43	30	RW-175- <sup>3</sup> / <sub>4</sub> -X
25.4	12.7	0.48	30	RW-175-1-X
38.1	19.1	0.51	12	RW-175-1 <sup>1</sup> / <sub>2</sub> -X
50.8	25.4	0.51	6	RW-175-2-X

Standard colours	Standard colour	Clear
	Code	X
	Non-standard colour	Black
	Code	0

**Installation** The product may be installed using hot air or specialist application equipment. Consult your Tyco Electronics office for more information.

Performance	Test	Test method	Test requirement
	Heat ageing:	Tensile strength	15 MPa (min)
		Elongation	75% (min)
	Corrosion resistance:	No corrosion of mirrors	
	Breakdown voltage:	Refer to table 1 of RW-3029/1	
	Flame propagation:	15 second (max) UL224 VW1	
	Fluid resistance:	Tensile strength	25 MPa (min)
		Ultimate elongation	150% (min)

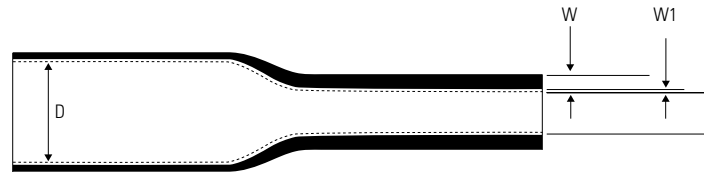
**Specifications** Raychem Specification RW-3029/1  
Material Safety Data Sheet available on request  
Installation instructions available on request

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Semi-rigid selectively crosslinked heat-shrinkable encapsulation tubing



- **Liner flows at 90°C**
- **UL approved construction is available**



- **One-step moisture proof encapsulation**
- **Shrink ratio 2.5:1**



Raychem SCL is a semi-rigid heat-shrinkable tubing with a meltable inner wall, designed to provide one-step moisture proof encapsulation of a wide variety of electrical parts including wire splices, breakouts and electronic components. Manufactured from radiation cross-linked polyolefins, SCL has an inner wall which melts when heated and is forced into the crevices and interstices by the shrinking action of the outer tubing. When cooled the entire mass becomes a rigid, tough, homogeneous covering with a controlled wall thickness. SCL shrinks to between 17% and 40% of its supplied diameter according to size and therefore few sizes are required to cover a range of irregular shapes with widely varying dimensions.



Unaffected by most solvents and chemicals and non-corrosive in contact with electrical joints, SCL also has a high dielectrical strength.

**Ordering information**

Inside diameter		Wall thickness		Standard package	
D (min)	d (max)	W (nom)	W1 (nom)	1.22m length quantity	Ordering description
Expanded as supplied	Recovered after heating	Total wall recovered after heating	Meltable wall recovered after heating		
mm	mm	mm	mm	m	
3.2	0.6	0.96	0.51	30	SCL-1/8-0
4.8	1.5	1.09	0.64	30	SCL-3/16-0
6.4	2.0	1.19	0.69	30	SCL-1/4-0
9.5	3.4	1.27	0.76	30	SCL-3/8-0
12.7	5.0	1.39	0.89	30	SCL-1/2-0
19.1	8.0	1.65	1.02	30	SCL-3/4-0
25.4	10.2	1.90	1.02	30	SCL-1-0

The largest size that will recover snugly over the component to be covered should be ordered.  
The wall thickness of the tubing will be less than specified if recovery is restricted during shrinkage.  
Other lengths, colours (colour coded by size) and sizes are available subject to special order.  
SCL is available in special UL approved constructions.

**Standard colours**

Colour	Black
Code	0

**Performance**

Test	Test method	Test requirement
Heat shock:	4 h at 250°C	Pass – no dripping, cracking or flowing of outer wall
Heat ageing:	168 h at 175°C	Pass – no dripping, cracking or flowing of outer wall
Low temperature flexibility:	4 h at -55°C	Pass – no cracking
Fluid resistance:	24 h at 23°C	Tensile strength: 7 MPa (min)
	ISO 37, ISO 1817	Ultimate elongation: 150% (min)
	Test fluids:	Aircraft fuel – test liquid B Phosphate, ester based – test liquid 103 Lubricating oil, ester based – test liquid 101

For full product performance details consult Raychem Specification RT-1301

**Specifications**

Raychem Specification RT-1301
Material Safety Data Sheet available on request

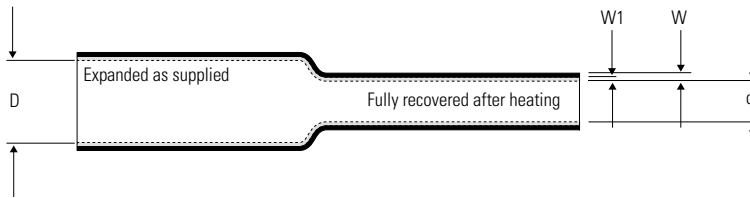
**Approvals**

UL E85381
AFS 2059/A

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Flame retardant, adhesive-lined, semi-rigid polyolefin, heat-shrinkable tubing (extended temperature range)



- 4:1 shrink ratio allows a few sizes to cover a wide range of splice and component diameters.
- Flame-retardant and mechanically tough, the tubing provides strain relief and abrasion protection of wire splices, terminals, and other components.
- Thick adhesive liner forms an effective barrier against fluids and moisture and performs well at an extended temperature range.

Specially designed to insulate and seal automotive wire splices and components in an under-the-hood automotive environment. Specially formulated to function at an extended temperature range.

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**Ordering information**

Size	Inside diameter		Recovered wall thickness*	
	D (min) Expanded as supplied mm/in	d (max) Recovered after heating mm/in	W (nom) Total wall after heating mm/in	W1 Melttable wall after heating mm/in
SCT No. 1	7.6 (.300)	1.7 (.065)	1.52±.30 (.060±.012)	.76 (.030)
SCT No. 2	9.0 (.355)	2.3 (.090)	1.52±.30 (.060±.012)	.76 (.030)
SCT No. 3	11.6 (.455)	2.5 (.100)	2.29±.30 (.090±.012)	1.40 (.055)
SCT No. 4	17.8 (.700)	4.4 (.175)	2.54±.30 (.100±.012)	1.52 (.060)

\*Wall thickness will be less if tubing recovery is restricted during shrinkage.

**Standard colours**

Colour	Black
Code	0

**Size selection**

Always order the largest size that will shrink snugly over the component being covered. Special order sizes are available upon request.

**Standard packaging**

Cut pieces

**Marking**

Tubing will be printed with its numbered size (such as SCT-1, SCT-2, SCT-3, SCT-4).

**Ordering description**

Specify product name, numbered size, colour and cut length (e.g. SCT-No.3-0-1220mm).

**Performance**

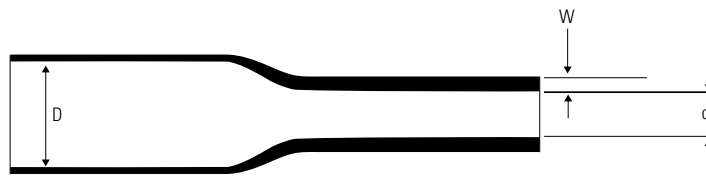
Property	Test method	Test requirements
Tensile Strength	ASTM D 2671	1500 PSI min
Ultimate Elongation	ASTM D 2671 Speed 2 in/min. Note 1 (per SCD)	300% (min)
Secant Modulus (Expanded Form)	ASTM D 2671 Speed 2 in/min. Note 1 (per SCD)	35000 PSI min
Longitudinal Change	ASTM D 2671	+0 to -10%
Concentricity (Expanded Form)	ASTM D 2671	60% min
Dielectric Strength (Jacket Only)	ASTM D 149	500 min Volts/mil
Volume Resistivity	ASTM D 257	10 <sup>13</sup> ohm-cm
Immersion Leak resistance	Note 2 (per SCD)	0.25 micro-amps max
Thermal Cycling	Note 3 (per SCD)	0.25 micro-amps max 25 cycles 40°C to 135°C Followed by:Immersion Leak resistance.Note 2.
Heat Shock 4 hrs @ 250°C	ASTM D 2671	No dripping, flowing, or cracking of jacket
Thermal Ageing	Note 4	0.25 micro-amps max 1000 hrs @ 150°C Followed by:Immersion Leak resistance.Note 2.
Fluid Resistance	Note 5	0.25 micro-amps max 24 hrs. @ 25° ± 3°C ASTM Reference Fuel C VV-F-800 Diesel Fuel 24 hrs @ 100°C ± 3°C ASTM No.3 Oil

**Specifications**

Type	Raychem
SCT	SCT SCD



A Commercial grade, general purpose heat-shrinkable tubing



**Ordering information**

Inside diameter		Wall thickness		Standard package
D (min)	d (max)	W (nom)		
Expanded as supplied	Recovered after heating	Recovered after heating	Spool quantity	
mm	mm	mm	m	Ordering description
1.2	0.6	0.4	1000	TUGA-GP-1.2/0.6-colour code
1.6	0.8	0.4	1000	TUGA-GP-1.6/0.8-colour code
2.4	1.2	0.5	1000	TUGA-GP-2.4/1.2-colour code
3.2	1.5	0.5	500	TUGA-GP-3.2/1.5-colour code
5.0	2.4	0.5	450	TUGA-GP-5/2.5-colour code
6.4	3.2	0.6	250	TUGA-GP-6.4/3.2-colour code
8.0	4.0	0.6	200	TUGA-GP-8/4-colour code
9.5	4.8	0.6	200	TUGA-GP-9.5/4.8-colour code
11.0	5.5	0.6	200	TUGA-GP-11/5.5-colour code
12.7	6.4	0.6	100	TUGA-GP-12.7/6.4-colour code
15.0	7.5	0.8	200	TUGA-GP-15/7.5-colour code
20.0	9.5	0.8	150	TUGA-GP-20/10-colour code
25.4	12.7	0.9	150	TUGA-GP-25.4/12.7-colour code
26.0	12.5	0.9	150	TUGA-GP-26/13-colour code
32.0	14.0	0.9	75	TUGA-GP-32/16-colour code
38.0	19.1	1.0	75	TUGA-GP-38/19-colour code

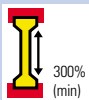
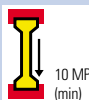
Standard colours	Colour	Black	Red	White
	Code	0	2	9

Performance	Test	Test method	Test requirement
	Heat ageing:	ISO 188 (168h at 120°C)	Ultimate elongation: 200% (min)
	Flame retardancy:	MVSS 302	100mm/minute (max)
	Fluid resistance:	ISO 1817 (24 h at 23°C)	Tensile Strength: 7 MPa (min) Ultimate Elongation: 250% (min)
		Test fluids:	Automotive Gasoline, BS4040 Engine Oil to SAE 20W/50 Brake Fluid to SAE J1703
For full product performance details consult Raychem Specification RW-2201.			

Specifications	Raychem Specification RW-2201. Material Safety Data Sheet available on request.
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- **2:1 Shrink ratio**
- **Semi-flexible, non-flame retardant**
- **Halogen-free**

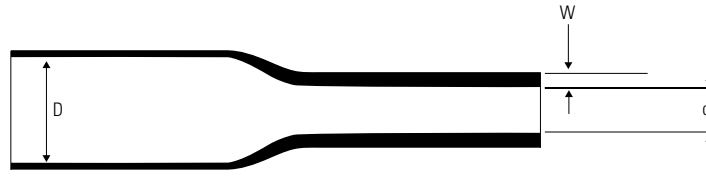
TUGA-GP is a commercial grade heat-shrinkable tubing. Designed for applications where a flame retardant product is not required but where electrical and mechanical insulation are important. Halogen-free, TUGA-GP conforms more uniformly, and with less longitudinal change than most PVC materials.



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Highly flame-retarded, low shrink temperature polyolefin heat-shrinkable tubing



- **Good chemical and solvent resistance**
- **Excellent physical and electrical properties**

Versafit highly flame-retarded, very flexible polyolefin heat-shrinkable tubing has been designed to meet the stringent requirements of UL 224 VW-1 and CSA-OFT and is, therefore, recommended for use in applications requiring the highest level of flame retardance. Versafit tubing will electrically insulate and protect in-line components, terminals and splices, bundle wires for very flexible, light duty harnesses and provide electrical insulation, mechanical protection, cable bundling and strain relief.

**Ordering information**

Inside diameter		Wall thickness		Standard package	
D (min)	d (max)	W	Spool quantity	Spool quantity	Ordering description
Expanded as supplied	Recovered after heating	Recovered after heating	Black only	varies for other colours	
mm	mm	mm	m		
1.63+/-2	0.58	0.40+/-08	300		VERSAFIT-3/64-colour code
1.85+/-2	0.79	0.43+/-08	300		VERSAFIT-1/16-colour code
2.79+/-2	1.17	0.51+/-08	150		VERSAFIT-3/32-colour code
3.43+/-2	1.57	0.51+/-08	150		VERSAFIT-1/8 -colour code
5.21+/-3	2.36	0.51+/-08	150		VERSAFIT-3/16 -colour code
7.11+/-3	3.17	0.64+/-08	75		VERSAFIT-1/4 -colour code
10.16+/-4	4.74	0.64+/-08	121		VERSAFIT-3/8 -colour code-FSP
13.72+/-4	6.35	0.64+/-08	91		VERSAFIT-1/2 -colour code-FSP
16.90+/-4	8.0	0.76+/-08	91		VERSAFIT-5/8 -colour code-FSP
20.45+/-4	9.52	0.76+/-08	60		VERSAFIT-3/4 -colour code-FSP
25.53+/-4	12.7	0.89+/-12	60		VERSAFIT-1 -colour code-FSP
33.40+/-7	15.88	1.02+/-15	45		VERSAFIT-1-1/4 -colour code
39.88+/-8	19.05	1.02+/-15	38		VERSAFIT-1-1/2 -colour code
52.83+/-1.0	25.4	1.14+/-16	38		VERSAFIT-2 -colour code
78.49+/-1.0	38.1	1.27+/-20	30		VERSAFIT-3 -colour code
104.14+/-1.3	50.8	1.40+/-23	30		VERSAFIT-4 -colour code

<b>Standard colour</b>	Colour	Black
	Code	0
	Description	Suffix-FSP Flat Spool Product.

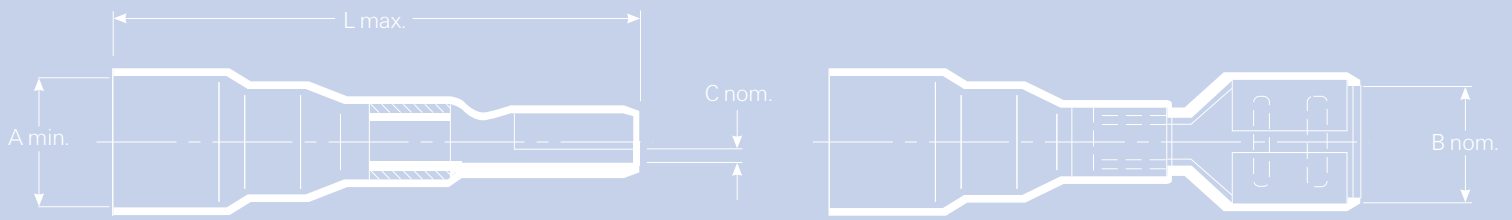
Performance	Test	Test method	Test requirements
	Heat ageing:	UL 224 (168h at 158°C)	Tensile strength: 70% retention
			Ultimate elongation: 100% (minimum)
	Copper contact corrosion:	ASTM D2671 (168h at 158°C)	Ultimate elongation: 100% (minimum)
	Flame retardancy:	UL 224	VW-1
For full product performance details consult Raychem Specification RW-3009.			

<b>Specifications</b>	Raychem Specification RW-3009 .
	Material Safety Data Sheet available on request.



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# Devices Product Data Sheets

**SolderSleeve splicing devices can be used to make sealed or unsealed splices. In a single step, they solder, insulate, encapsulate and strain-relieve a wide range of wire sizes.**

**DuraSeal heat-shrinkable nylon crimp splices are easy to use in factory or repair applications. They provide watertight sealing and superior protection against corrosion, abrasion and vibration.**

DuraSeal heat-shrinkable, environmentally sealed, nylon-insulated crimp splices



- Protects splices from water, condensation, salt, and corrosion.
- Provides strain relief.
- Protects against vibration in rugged environments.
- Completely insulates and protects electrical connections.
- Has adhesive lining for protection that is more reliable than conventional splices.
- UL, CUL, and Lloyd's listed.

Automotive/truck wiring repair and maintenance.

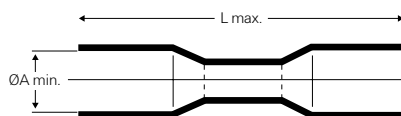
Automotive accessory installations.

OEM automotive/truck/RV wire harness fabrication.

Commercial wiring (pumps/-pools/spas).

<b>Specifications/ approvals</b>	Series	Agency	Tyco
	D-406	UL and CUL listed 91J4, File E87681	RB-107
		Lloyd's listed, File 65 247 HH 02-93	

**Product dimensions (mm/inches)** Butt splices



Part number	Butt splice dimensions			Wire dimensions		
	A min.	L nom	Colour	Conductor (AWG)	Insulation OD. (max.)	Insulation OD. (min.)
D-406-0001	3.68 (.145)	31.5 (1.25)	Red	22-18	3.56 (.140)	1.40 (.055)
D-406-0002	4.57 (.180)	31.5 (1.25)	Blue	16-14	4.45 (.175)	2.03 (.080)
D-406-0003	6.35 (.250)	37.5 (1.50)	Yellow	12-10	6.22 (.245)	

**Product selection process**

1. Determine wire size.
2. Select part number.

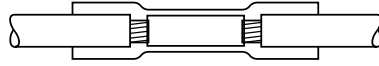
Wire size			
AWG	mm <sup>2</sup>	Part number	Colour
22-18	0.5-1.0	D-406-0001	Red
16-14	1.5-2.5	D-406-0002	Blue
12-10	3.0-6.0	D-406-0003	Yellow

<b>Product characteristics (typical)</b>	Physical properties	Cut-through resistance: 31 kg (70 lb) Wire pull-out after crimping and recovery: red: 11.3 kg (25 lb); blue: 22.7 kg (50 lb); yellow: 27.2 kg (60 lb) Not flame-retardant No cracking after heat ageing for 168 h at 160°C
	Chemical properties	Solvent resistance: isopropyl alcohol, trichloroethylene, gasoline, battery acid, diesel fuel, motor oil, antifreeze, brake fluid, 5% salt water.
	Electrical properties	Dielectric strength: 2500 Vac
	Insulation resistance:	1000 megohms at 100 Vdc.

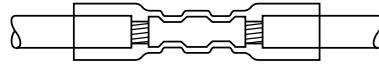
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**Installation**

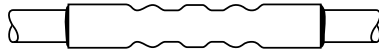
1. Select splice of appropriate size. Strip wire 7.5 mm (5/16 in). Insert into crimp barrel.



2. Crimp using Raychem AD-1522 crimp tool for preinsulated crimps.



3. Heat crimped splice with heat gun until tubing recovers and adhesive flows.



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**Installation requirements**

For proper installation of these devices, the correct crimp tool and a heating tool with a reflector attachment must be used. The Raychem AD-1522 crimp tool and HL1802E heating tool are recommended.

Refer to Raychem installation procedure RPIP 821-00 for detailed instructions.

DuraSeal is a trademark of Tyco Corporation.

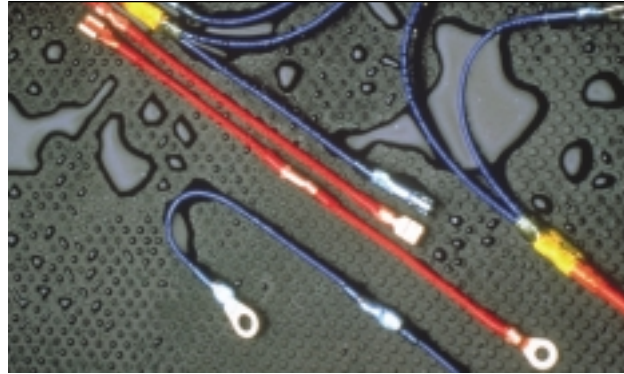
Users should independently evaluate the suitability of the product for their application. Before ordering check with factory for most current data.

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DuraSeal heat-shrinkable environmentally sealed, nylon insulated crimp terminals and disconnects



- Resistance to moisture and abrasion.
- Strain relief.
- Protection from wire pull-out.
- Easy installation.

DuraSeal products insulate and protect electrical connections from mechanical abuse, wire pull-out, and abrasion while resisting water, salt, and other contaminants.

DuraSeal devices provide a tough, environmentally sealed wire connection. Their crimp barrel or terminal, encased in rugged, heat-shrinkable nylon tubing lined with a special hot-melt adhesive, resists damage from abrasions and cuts.

DuraSeal devices retain flexibility and impact-resistance long after similar products have become brittle.

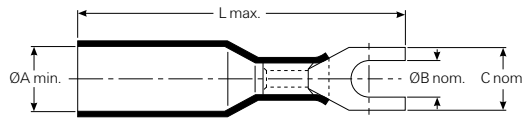
DuraSeal devices accommodate wire gauge sizes 22 to 10. They are colour-coded for easy identification of gauge sizes, yet transparent for inspection of the finished splice.

<b>Approvals and reference documents</b>	Agency approvals	UL listed component, file E87681, butt splices and terminals except quick connect terminals; file E157833, quick connect terminals
	Reference documents	Raychem specifications RB-107, Specification DuraSeal crimp splices Raychem specifications RB-108, Specification DuraSeal crimp terminals DuraSeal selection guide (H54153) DuraSeal installation guidelines (H54154)

**Product characteristics**

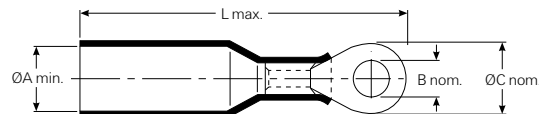
	Property	Unit	Requirement	Method of test
Physical	Dimensions	Inches	None	See product dimensions
	Tensile strength	Pounds	8 to 40 lbs depending on AWG	UL486C, IEC512-8
Electrical	Voltage drop	Millivolts	Less than equal length of wire	MIL-S-81824, IEC512-2
	Insulation resistance	Megohms	10 <sup>3</sup> min.	MIL-STD-202 method 302
	Dielectric withstand voltage	Kilovolts	2.5	MIL-STD-202F method 301, IEC512-2
Chemical	Diesel fuel		Meet electrical test	ASTM D 3032, ESA-603D
	Brake fluid		listed above after conditioning.	
	Antifreeze			
	5% salt water			
	Motor oil			
Environmental (Fluid resistance)	Humidity		Meet electrical test	MIL-STD-202F method 106, IEC68-2-30
	Immersion		listed above after conditioning.	MIL-STD-202F condition C, IEC68-2-14 test NC
	Vibration			MIL-STD-202F method 201, IEC68-2-6
	Bending			UL486C, IEC512-8
	Thermal shock			MIL-STD-202F method 107, IEC68-2-14 test N
	Heat ageing (168° @ 85°C)			MIL-STD-202F, IEC68-2-2
	Salt spray			MIL-STD-202F method 101, IEC68-2-11
Operating conditions	Temperature rating		-55°C to +125°C	None
	Minimum shrink temperature		180°C	None
	Voltage rating		600 Volt max	None

**Product dimensions (mm/inches) Fork terminals**



Part number	Fork terminal dimensions				Colour	Wire dimensions		
	A min.	B-stud recommended size	C nom.	L max.		Conductor (AWG)	Insulation O.D. (max.)	Insulation O.D. (min.)
B-106-2401	4.0 (.160)	4.0 (.169)	8.0 (.31)	32.0 (1.26)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-2402	4.6 (.180)	4.0 (.169)	8.0 (.31)	35.0 (1.38)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-2502	4.6 (.180)	5.0 (.207)	10.0 (.39)	35.0 (1.38)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-2403	6.5 (.250)	4.0 (.169)	8.0 (.31)	38.0 (1.50)	Yellow	12-10	6.5 (.250)	2.8 (.110)
B-106-2503	6.5 (.250)	5.0 (.207)	10.0 (.39)	40.0 (1.58)	Yellow	12-10	6.5 (.250)	2.8 (.110)

**Product dimensions (mm/inches) Ring terminals**



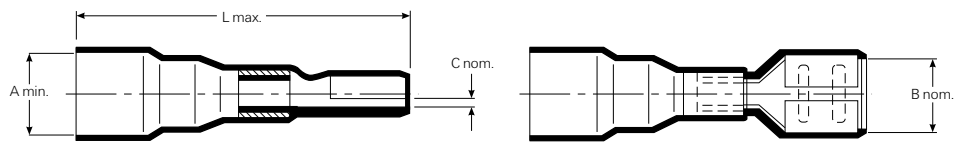
Part number	Ring terminal dimensions				Colour	Wire dimensions		
	A min.	B-stud recommended size	C nom.	L max.		Conductor (AWG)	Insulation O.D. (max.)	Insulation O.D. (min.)
B-106-1401	4.0 (.160)	4.0 (0.170)	8.0 (.310)	32.0 (1.26)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-1501	4.0 (.160)	5.0 (0.210)	10.0 (.39)	34.0 (1.34)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-1601	4.0 (.160)	6.0 (0.255)	10.0 (.47)	36.0 (1.42)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-1801	4.0 (.160)	8.0 (0.330)	14.0 (.55)	39.0 (1.54)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-1991	4.0 (.160)	10.0 (0.415)	18.0 (.70)	43.0 (1.70)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-1402	4.6 (.180)	4.0 (0.170)	8.0 (.31)	33.0 (1.30)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-1502	4.6 (.180)	5.0 (0.210)	10.0 (.39)	35.0 (1.38)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-1602	4.6 (.180)	6.0 (0.255)	11.0 (.47)	36.0 (1.44)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-1802	4.6 (.180)	8.0 (0.330)	14.0 (.55)	40.0 (1.58)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-1992	4.6 (.180)	10.0 (0.415)	18.0 (.70)	44.0 (1.73)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-1403	6.5 (.250)	4.0 (0.170)	8.0 (.31)	38.0 (1.50)	Yellow	12-10	6.5 (.250)	2.8 (.110)
B-106-1503	6.5 (.250)	5.0 (0.210)	10.0 (.39)	40.0 (1.58)	Yellow	12-10	6.5 (.250)	2.8 (.110)
B-106-1603	6.5 (.250)	6.0 (0.255)	11.0 (.47)	41.5 (1.64)	Yellow	12-10	6.5 (.250)	2.8 (.110)
B-106-1803	6.5 (.250)	8.0 (0.330)	14.0 (.55)	45.0 (1.78)	Yellow	12-10	6.5 (.250)	2.8 (.110)
B-106-1993	6.5 (.250)	10.0 (0.415)	18.0 (.70)	47.0 (1.85)	Yellow	12-10	6.5 (.250)	2.8 (.110)

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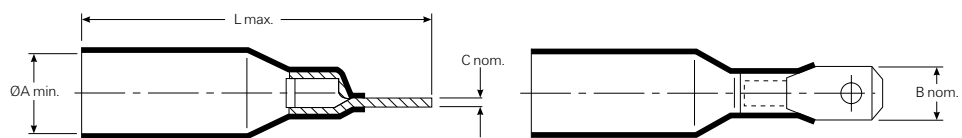
DuraSeal heat-shrinkable environmentally sealed, nylon insulated crimp terminals and disconnects

**Product dimensions (mm/inches)** Push-on terminals



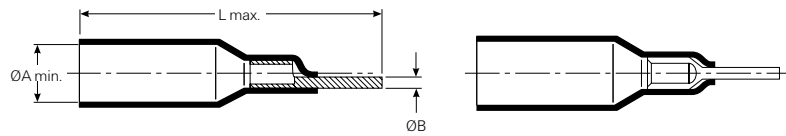
Part number	Push-on terminal dimensions				Colour	Wire dimensions			
	A min.	B nom.	C nom.	L max.		Conductor (AWG)	Insulation O.D. (max.)	Insulation O.D. (min.)	
B-106-3631	4.0 (.160)	6.6 (.260)	0.8 (.032)	30.0 (1.20)	Red	22-18	4.0 (.160)	1.4 (.055)	
B-106-3632	4.6 (.180)	6.6 (.260)	0.8 (.032)	32.0 (1.26)	Blue	16-14	4.6 (.175)	2.0 (.080)	
B-106-3633	6.5 (.250)	6.6 (.260)	0.8 (.032)	33.0 (1.30)	Yellow	12-10	6.5 (.250)	2.8 (.110)	
B-106-3281	4.0 (.160)	2.8 (.110)	0.5 (.020)	22.5 (.90)	Red	22-18	4.0 (.160)	1.4 (.055)	

Tab terminals



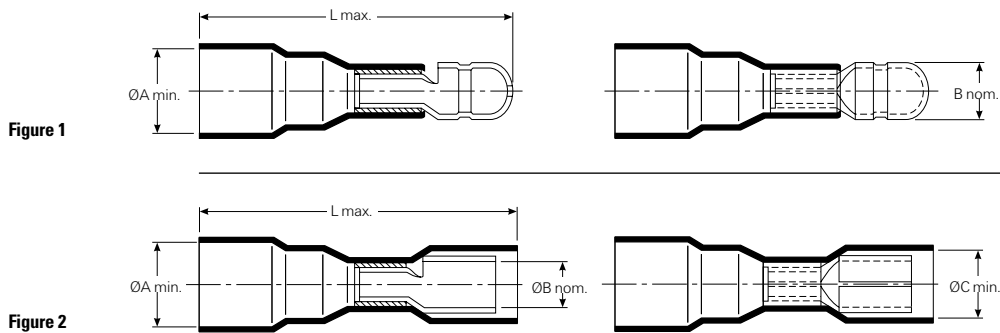
Part number	Tab terminal dimensions				Colour	Wire dimensions			
	A min.	B nom.	C nom.	L max.		Conductor (AWG)	Insulation O.D. (max.)	Insulation O.D. (min.)	
B-106-4631	4.0 (.160)	6.35 (.250)	0.8 (.032)	32.0 (1.26)	Red	22-18	4.0 (.160)	1.4 (.055)	
B-106-4632	4.6 (.180)	6.35 (.250)	0.8 (.032)	33.0 (1.30)	Blue	16-14	4.60 (.175)	2.0 (.080)	

**Product dimensions (mm/inches)** Pin terminals



Part number	Pin terminal dimensions			Colour	Wire dimensions		
	A min.	B nom.	L max.		Conductor (AWG)	Insulation O.D. (max.)	Insulation O.D. (min.)
B-106-6201	4.0 (.160)	2.0 (.080)	30.5 (1.22)	Red	22-18	4.0 (.160)	1.4 (.055)

Bullet terminals



Part number	Figure	Type	Bullet terminal dimensions				Colour	Conductor (AWG)	Insulation	
			A min.	B nom.	C min.	L max.			O.D. (max.)	O.D. (min.)
B-106-7401	1	M	4.0 (.160)	4.0 (.160)	-	33.0 (1.32)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-7502	1	M	4.6 (.180)	5.0 (.200)	-	34.0 (1.34)	Blue	16-14	4.6 (.175)	2.0 (.080)
B-106-8401	2	F	4.0 (.160)	4.0 (.160)	5.5 (.220)	30.0 (1.28)	Red	22-18	4.0 (.160)	1.4 (.055)
B-106-8502	2	F	4.6 (.180)	5.0 (.200)	6.0 (.240)	32.0 (1.26)	Blue	16-14	4.6 (.175)	2.0 (.080)

**Product dimensions (inches)**

Standard packaging

Product supplied in bulk, 500 or 1000 pieces per box, depending on size.

For other packaging options consult factory.

DuraSeal is a trademark of Tyco Electronics Corporation.

Users should independently evaluate the suitability of the product for their application. Before ordering check with factory for most current data.

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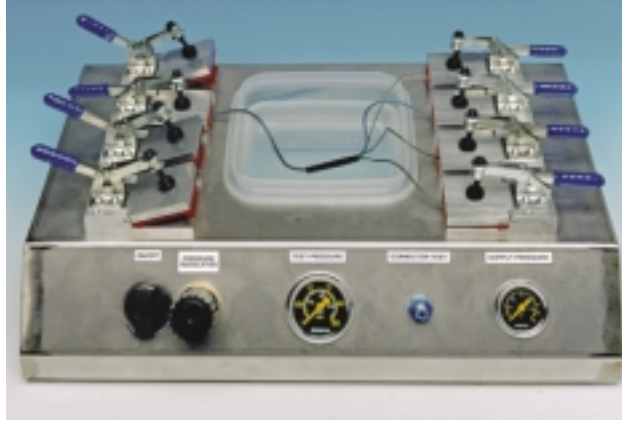
# Application Equipment Data Sheets

**Raychem application equipment is designed and engineered specifically for its installation of Raychem heat-shrinkable products.**

**Designed for general industry use or developed specifically in close collaboration with customers, using standard heater components.**

**This equipment provides the optimal heating temperatures, performance, and control features for maximum production efficiency.**

Seal test equipment, splice sealing and connector sealing evaluation – various products



**Applications**

The AD-3050-SEAL-TEST-EQUIP is a manually operated pneumatic device, intended for use as a convenient 'in-process' sampling technique for checking sealed splices. Different combinations of in-line or stub splices can be pressure tested in any of the combination of fixtures (8 in total). There is also a facility to allow leak testing of various connectors.

Tyco Electronics UK has seen good correlation between results obtained with the AD-3050 and those obtained through water immersion testing. However, testing in accordance with the OEM specification is the only guaranteed way of confirming that the OEM spec is being met. The splice products are located in clamps which deliver the test pressure. The product is immersed in water and pressure is delivered down the wire(s) to the sealed area. The test result is determined visually by looking for bubbles in the area of the sealing product.

Use of this equipment is described in Tyco Electronics UK procedure, reference No. PIP/017/95. This equipment does not check for poke through i.e. where individual wire strands poke through the installed heat-shrinkable sleeve. Poke through is eliminated by ensuring correct welding and subsequent handling conditions.

**Features and benefits**

- Simple fixture design allows fast sealing test result assisting determination of installation conditions for splice sealing products.
- Connector fixture adapter allows connector sealing verification.
- Strong portable container allows use in various locations.

**Technical specification**

**AD-3050-SEAL-TEST-EQUIP**

Pneumatic Supply	6 bar maximum, filtered supply. 2 bar test pressure maximum. (Test pressure typically 0.5 bar)
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Machine Cycle Times for seal testing:	Typically 1 minute.
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Total System Noise:	Negligible noise from air test
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Dimensions:	550 mm x 350 mm x 215 mm (22" x 14" x 8") (Excludes packing case)
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Weight:	4 Kg (8.80 lb) (Excludes packing case) 9.6 Kg (21.20 lb) (Includes packing case)
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**Ordering information**

	Description	Part number
Seal Test Equipment	AD-3050-SEAL-TEST-EQUIP	102119-000

**Recommended spares**

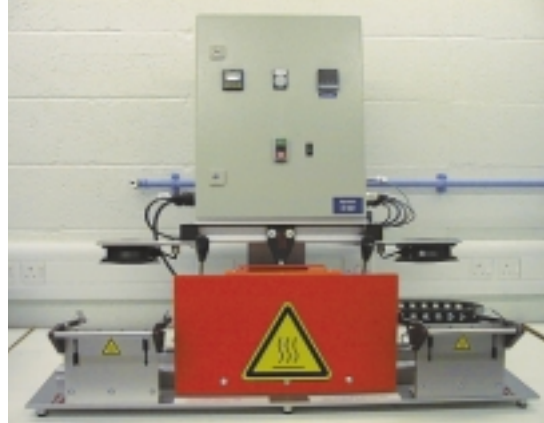
	Description	Part number
Tool Assembly	AD-3050-SEAL-TEST-EQUIP	102119-000
Set of 8 Seals**	AD-3050-SEAL-8-KIT	299155-000
Clamp assembly including seals	AD-3050-SEAL-CLAMP-ASSY	168927-000
Sealing tape	EPDM foam, 6 mm x 9 mm, with acrylic adhesive backing.	

\*\* - Full set of seals

As the equipment is designed to use readily available pneumatic components, these are listed on the parts list which is included with the equipment

Users should independently evaluate the suitability of the product for their application. Before ordering check with factory for most current data.

Shuttle machine – twin workstation heater for multiple installation of short length tubing products



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### Applications

The IR-1891 is suitable for the installation of a range of Raychem heat-shrinkable tubing products onto a variety of small components, e.g. ring terminals, faston terminals and small connectors etc. The machine is provided with two work stations and a moveable heating head.

Each workstation is provided with supports for tooling fixtures (which must be specified and ordered separately). These support the workpieces and locate the tubing products. The operator loads the workpieces into the fixtures at one of the workstations, ensures that the tubing product is correctly positioned and then slides the heat head into position before initiating the heating cycle. The operator then continues with loading / unloading the other work station whilst the heating cycle is taking place.

The IR-1891-220V-Shuttle-Retrn is provided with closed loop temperature control and in addition the heat head is 'locked' into position by use of an electromagnet during the heating cycle.

Once the other workstation has been loaded and the first installation is complete the heat head is moved into position over the product and the next heating cycle initiated. Heating times vary typically from 3 to 30 seconds depending on the size and type of tubing product. Process rates up to 1200 pieces/hour can be achieved depending on the heating time and the time taken by the operator to load and unload the workpieces. The installation temperature/power can be varied according to product type/size and required cycle times.

The heating elements, which are continuously energised, are of the infra-red medium wave length type and consist of a coiled resistance wire contained in quartz glass tubes. The closed loop temperature control uses similar elements but having integral thermocouple sensors.

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### Features and benefits

- Automatic cycle start once heater is manually positioned over product, which gives improved process control (recommended for adhesive lined heat-shrinkable tubing e.g. sealing applications).
- Automatic heating head retraction at end of cycle prevents damage to components.
- Multiple product fixture assemblies give increased process rates.
- Cooling fan above each fixture assembly maintains holding fixture at an acceptable temperature.

Technical specification	IR-1891 Shuttle machine	
Electrical Supply	230 V Single Phase	
Power Consumption	1600 W	
Operating Temperature	650°C max	
Process Rate	1200 / hour maximum depending on application and operator	
Heating Times	3 to 20 seconds depending on application	
System Noise	< 70 dB	
Dimensions – 613148-000 / 289588-000	L1100 mm x H900 mm x D500mm (L43" x H35" x D20")	
Base Plate Dimensions 289588-000	L1040 mm x D450 mm (L41" x D18")	
Base Plate Dimensions 613148-000	L1040 mm x D397 mm (L41" x D16")	

Product range	
	Wide range of Raychem tubing products in particular LSTT, RNF-3000, RNF-100, HTAT, ATUM.
	Maximum diameter 20 mm (0.8") and maximum length 60 mm (2")

Ordering information	Description	Part number
	IR-1891-220V-Shuttle-Retrn	289588-000
IR-1891-220V-Retrn-Syl	613148-000	
<p><b>Note:</b> The descriptions given here <b>do not</b> include the supply of the necessary tooling fixtures. These are designed for each individual application.</p>		
<p>A range of tooling fixtures designed for previous applications are available. Please contact your Tyco Electronics product representative. for details.</p>		
<p>Users should independently evaluate the suitability of the product for their application. Before ordering check with factory for most current data.</p>		

Conveyor heater for processing Raychem heat-shrinkable tubing and terminating devices



**Applications**

The Model 19 conveyor heater is the latest generation of reliable and versatile process heaters for a wide variety of heat-shrinkable products. Two sets of timing belts grip the individual assemblies and carry them through a closed-loop infrared heating zone, then through a cooling zone, and deposit the completed assemblies in a collection bin. The processor was designed to meet the requirements of the European Safety Directives and is CE approved, allowing for worldwide use. The processor is designed to operate on the following line voltages: 210 to 240 Vac, 20 A, 1 Ø, 50/60 Hz.

Options for this processor include:

- Powered or unpowered extension tables to support long or heavy harnesses.
- Kit for processing ring terminals and end terminations.
- Floor stand with wheels.
- Wider heating elements for tubing up to 178 mm (7") long.
- Narrow heating elements for SolderSleeve devices up to 10 mm (0.4") diameter and 45 mm (1.8") long or short length tubing less than 50 mm (2").

**Features and benefits**

- Closed-loop speed and temperature control.
- CE approved for worldwide use.
- Adaptable for different applications.
- Continuous controlled process.

**Product features**

**Controlled heating zone** The Model 19 has two etched-foil heating elements mounted under a quartz face. Consistent heating chamber temperatures are obtained with a closed-loop temperature controller. There is a lockout on the controller to prevent unauthorized changes.

**Speed control** Consistent speed is obtained with a closed-loop speed controller. The speed is adjusted using a 3-digit thumbwheel on the front control panel. There is a lockout on the thumbwheel to prevent unauthorized changes.

**Minimal skill requirements** There are clearly marked guides for aligning the assembly as well as the tubing or device being processed. The operator only has to center the assembly; the grippers carry it through the heating and cooling zone and deposit it into the unloading bin.

**Economical production** The throughput rate is determined by the rate at which an operator can load the processor.

**Versatility** The tool description CLTEQ-M19-BELT-HTR part number 714529-000 will handle tubing up to 25 mm (1") diameter and 102 mm (4") long. Tubing up to 178 mm (7") long can be handled with the use of tool description CLTEQ-M19-BELT-HTR-6IN part number 075131-000. The tool description CLTEQ-M19-BELTHEATER-SS part number D43037-000 will handle SolderSleeve devices up to 10 mm (0.4") diameter and 45 mm (1.8") long or short length tubing (less than 50 mm (2")), where applications require a narrow heat width.

**Self-diagnostic circuitry** There are several "self-diagnostic" circuits that alert the operator if any major component fails or if an unsafe processing condition occurs. A light will turn on and a lockout gate will lift in the entry zone, preventing the operator from loading assemblies until the situation has been corrected.

**Other features include:**

- Emergency stop.
- Automatic cool-down circuit to extend the life of components.
- Lockout on temperature and speed controllers to prevent unauthorized changes.

Technical specification	Model 19 Conveyor heater	
	Electrical	
Power requirements	210–240 Vac, 20 A, 1 Ø, 50/60 Hz	
Heating elements	Std= 3160W/ Wide= 3320W/ Narrow= 1760W	

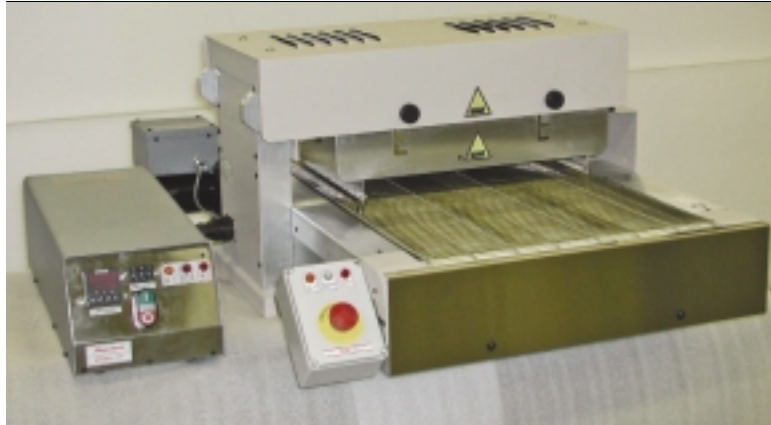
Mechanical	Conveyor belt system	Double-sided timing belts, 0.375" pitch – 9.5 mm
	Belt speed	Up to 152 cm/min (5.0 ft/min or 59.8"/min)
	Processor dimensions	53 cm (21") W, 135 cm (53") L, 45 cm (18") H
	Shipping dimensions	66 cm (26") W, 147 cm (58") L, 58 cm (23") H
	Shipping weight with crate	86 kg (190 lb)

Tubing sizes	Tubing diameter (max)	25 mm (1")
	Tubing length (max)	102 mm (4") 178 mm (7") wide heating element tool 50 mm (2") narrow heating element tool
	Work-piece length (min)	240 mm (9.5")

Ordering information	Description	Part number	
	Model 19 Standard	CLTEQ-M19-BELT-HTR	714529-000
	Model 19 Wide	CLTEQ-M19-BELT-HTR-6IN	075131-000
	Model 19 Narrow	CLTEQ-M19-BELT-HTR-SS	D43037-000

Users should independently evaluate the suitability of the product for their application.  
Before ordering check with factory for most current data.

Tunnel Oven



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**Applications**

Table conveyor heater that provides a controlled process system suitable for installing a wide variety of heat-shrinkable tubing products up to 76 mm (3") in diameter and unlimited in length. Ideally suited for efficient processing of fibre and fabric HFT and both single-wall and dual-wall tubing. Designed as an integrated modular unit. Assemblies are placed on the entry section of a mesh belt, transported through a heating chamber, across a bank of cooling fans then discharged from the rear of the conveyor.

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**Features and benefits**

- Closed-loop temperature control for a precise and repeatable thermal process.
  - Conveyor speed precisely set by a 3-digit potentiometer.
  - Operation that requires only minimal skill.
  - Contains numerous safety features.
  - Custom length conveyors for longer entry and/or exit sections available.
  - Optional accessories to customize the tunnel oven.
-



<b>Technical specification</b>		<b>Model 105 Tunnel Oven</b>			
<b>Electrical</b>	Power requirements	208/240 VAC, 1Ø, 50/60 Hz, 15 A			
	Heating elements	Two 1500 watt infrared stamped foil with black quartz face, one top and bottom			
	Operating temperature	Ambient to 650°C			
	Effective heating width	356mm (14")			
<b>Dimensions</b>	Control box	Length	515mm	(20")	
		Width	210mm	(8")	
		Height	178mm	(7")	
		Control box weight	7.7 kg	(17 lb.)	
	Heating conveyor	Length	990mm	(39")	
		Width	685mm	(27")	
		Height	417mm	(17")	
		Heating conveyor weight	68 kg	(150 lb.)	
	Shipping	Length	1346mm	(53")	
		Width	1168mm	(46")	
		Height	635mm	(25")	
		Shipping weight	146 kg	(320 lb.)	
	<b>Product range</b>	Inside diameter of tubing before heat	Up to 76.2mm	(3")	
		Length	Perpendicular to belt travel	356mm	(14")
			Parallel to belt travel	Unlimited	
	<b>Ordering information</b>	<b>Description</b>	<b>Part number</b>		
CLTEQ-M105-Tunnel-oven		955018-000			
Users should independently evaluate the suitability of the product for their application. Before ordering check with factory for most current data.					

Installation of splice sealing products adjacent to ultrasonic welder



**Applications**

The RBK-ILS-Processor MkII is a semi-automatic unit designed specifically to install splice sealing products onto ultrasonically welded or crimped splice joints used in automotive harnesses. The tool can operate in several modes:

- Stand-alone-operator sets time and temperature.
- Sequenced-preset times and temperature can be sequenced automatically (and can also be randomly selected from sequence stored).
- Automatic-communication with upstream ultrasonic welder can allow time and temperature to be automatically set without operator intervention.

The operator is able to efficiently load both machines and so minimise 'dead time'. Installing Raychem splice sealing products immediately after welding gives reduced installation time and earliest possible mechanical protection for the welded joint. The operator positions the splice sealing product centrally over the splice joint and then locates the assembly into the gripper mechanism. The wire assembly is automatically ejected, with the splice sealing product installed and the joint area sealed, insulated and strain relieved. In-line or stub-type splices can be installed.

**Features and benefits**

- Optimized heating element life.
- Installation times, temperatures and product size information storage (individual selection).
- Sequenced installations.
- Operator key lock/password protection levels.
- Automatic heater retraction on mains failure.
- Automatic calibration.
- RS232 interface allows time, temperature and product sizes for the next installation to be transferred from a remote machine (eg an ultrasonic welding tool).
- Machine hours and installation cycle counters.
- Software upgradeable to support special applications.

**Technical specification**

**RBK-ILS-Processor MkII**

Electrical supply	220V-240V-50Hz
Power consumption	1.7 Amps (Max)
Operating temperature	550°C (Max) (500°C recommended)
Machine cycle times for splice sealing products used on typical range of automotive splices	6 to 20 seconds depending on wire size and the number of wires used
Total system noise	<80dB
Dimensions	390mm x 365mm x 225mm (15" x 14" x 9")
Weight	18Kg (40 lb)

**Product range**

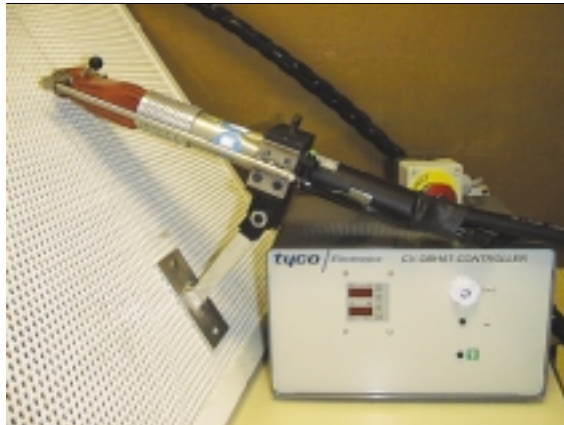
RBK-ILS-125 products	Sizes 1 to 3A
RBK-ILS-85 products	Sizes 6/1 to 12/3
For other Raychem products (eg RBK-VWS, RBK-ESS....)	Discuss with Product Management

Installation of splice sealing products adjacent to ultrasonic welder

**Ordering information**

	Description	Part number
Equipment	RBK-Proc-Mk2-Processor	740331-000
Accessories	RBK-ILS-Proc-Stub-Sp-Fix stub splice support fixture –	981721-000
	RBK-ILS-Proc-Air-Cool-Kit Air cooling kit for use with stub splice support fixture – high process rates	843800-000
	RBK-ILS-Proc-Termfix-08mm 8 mm ring terminal fixture	049857-000
Users should independently evaluate the suitability of the product for their application. Before ordering check with factory for most current data.		

On-board Stub Splice Sealing



**Applications**

The CV-OBHAT system is a lightweight, portable hot air tool, used to install Raychem ES-Cap Stub Splice Sealing products. The CV-OBHAT tool has been designed for use on-board with minimum board fixtures. Wire support and cap location fixtures are an integral part of the CV-OBHAT tool, hence only a simple board mounting/location post is required on the board. If suitably mounted the CV-OBHAT tool can be used off-board. The hot air pistol and control box are connected by a 6m umbilical. Loading and unloading product is made simple by the use of a hinged narrow reflector, which also minimises air spillage and potential damage to wires during the heating cycle. The CV-OBHAT tool utilises a closed loop temperature control system with a function, which disables the timing of the heat cycle until a pre-set temperature is achieved. By this method the effect of ambient temperatures and varying cycle duties can be minimised to ensure high quality, sealed installations. The tool is designed to have a heating and cooling segment to each installation cycle. The cooling segment produces cooled product that is safe and easy to handle as well as being mechanically strong at the end of an installation cycle. For an In-line Splice Sealing variant contact Product Management..

**Features and benefits**

- Capable of producing sealed stub splices on-board
- Wire support and cap holding fixtures integral part of pistol
- Small footprint on harness board
- Lightweight pistol connected to controller with 6m umbilical
- Audible signal at end of installation cycle
- Control system incorporating audible and visual process safety alarms
- Programmable heat cycle start temperature
- Optional board locking capability

**Technical specification**

<b>CV-OBHAT</b>	
Electrical supply	220/240V-50Hz Single Phase
Current maximum load	7 Amps
Compressed air supply	4 bar minimum
Programmable heat cycle timer	0 – 99.9 seconds
Programmable cool cycle timer	0 – 99.9 seconds from end of heat cycle
Programmable cap cooling fixture timer	0 – 99.9 seconds from end of heat cycle
Programmable board locking timer	0 – 99.9 seconds from end of heat cycle (board locking on during heat cycle)
Operating temperature	Recommended 250°C
Dimensions	380mm x 300mm x 180mm – Control box
Weight	15kg – complete system – (Control box + Pistol + Umbilical)
Umbilical length	6m

**Product range**

Raychem ES Caps	Sizes 1 & 2
	(Typical heat time 15s + 30s cooling)
	For size 3 contact Product Management

**Ordering information**

Description	PCN
CV-OBHAT-1600W-SYSTEM	776296-000 – Stub version
	For Inline version contact Product Management

Users should independently evaluate the suitability of the product for their application. Before ordering check with factory for most current data.

Hand-operated crimp tool



**AD-1522 Crimp Tool**

The Raychem AD-1522 crimp tool crimps all DuraSeal crimp products. It has a preset crimp depth that provides the optimum combination of tensile strength and insulation integrity in the finished splice.

**Ordering information**

Model	Description	Part number
AD-1522 DuraSeal crimp tool	AD-1522-1-CRIMPING TOOL	047011-000

Users should independently evaluate the suitability of the product for their application.  
Before ordering check with factory for most current data.

On-board and off-board installation of LMx-3500 Wire Bundle Sealing Products



**Applications**

The LMx Clam Coil Installation equipment is designed for use with Raychem LMx-3500 wire bundle sealing products with an approximate capability from 8 to 100 wires. The system uses the principle of induction heating to induce and control eddy currents in the sealing product, which results in a heating effect. This heating effect causes the outer sleeve to shrink and the adhesive comb to melt thus sealing the wire bundle.

The system is modular in design and comprises a control unit, and induction heating head and a cooling unit. The cooling unit is used to cool the induction coil, mounted in the heating head.

The control unit consists of a power generator, a power controller and an interface unit. The latter, controls all of the safety and process interlocks, which are required.

The heating head is designed to be used either as a mobile system, for use on moving harness boards, or as a fixed system, for incorporation into a static workstation. In both cases all fixtures needed for supporting the heads on the harness board or the harness at the workstation are to be provided by the customer.

The system can be expanded by the addition of a second heating head. When two heads are fitted they may be operated simultaneously. Simultaneous head operation requires an additional power generator unit.

In order to convert the Clam Coil head into a workstation a 'Clam Cradle' will need to be purchased, shown above.

**Features and benefits**

- Highly efficient induction field allows uniform heating of bundle sealing products
- Modular design allows on-board (carousel) or off-board (bench mounted use)
- Lockable controller and password protection prevents corruption of process parameters, maximising process reliability

On-board and off-board installation of LMx-3500 Wire Bundle Sealing Products			
<b>Technical specification</b>	<b>LMx – Clam Coil Installation System</b>		
	<b>Power unit and controller</b>		
	Electrical Supply	180 V – 260 V 50/60 Hz	
	Maximum Power Consumption	2.8 kW	
	Typical Average Heating Times	10 to 120 s	
	Storage Temperature	20°C to +70°C	
	Storage Humidity	0 – 95% (without condensation)	
	Dimensions	System Control	600 W x 680 D x 607 H mm
		Mobile Heating Head	200 W x 290 L x 290 H mm
		Fixed Heating Head	360 W x 300 D x 400 H mm (130 visible)
	Weight	System Control	90 Kg
		Mobile Heating Head	7.5 Kg (including Cable)
		Heating Head and Cradle	4.5 Kg (excluding Cable weight)
	<b>Water cooler</b>	Electrical Supply	>230 / 110 V ac Single Phase
		Maximum Power Consumption	3 A
		Cooling Capacity	14000 BTU/Hr 1.2 L/Min
		Pressure (bar)	3.0
		Tank Capacity (Litres)	11.4 L
		Dimensions (mm)	305 W x 337 H x 584 L
		Weight (kg)	18

**Product range** On-board and off-board installation of LMx-3500 Wire Bundle Sealing Products

<b>Ordering information</b>	<b>Description</b>	<b>Part number</b>
	<b>Equipment</b>	LMX-2000-EQ-UGPC-Sys-Ctl
<b>Accessories</b>	LMX-2000-EQ-Cooler-3	488127-000
	LMX-2000-EQ-Clam-Head	873861-000
	LMX-2000-EQ-Airhead-Box	669225-000
	LMX-2000-EQ-Balance-Unit	325711-000
	LMX-2000-EQ-Cable-Klt-10M	287979-000
	LMX-2000-EQ-Cable-Klt-20M	331861-000
	LMX-2000-EQ-Cable-Klt-5M	896787-000
	LMX-2000-EQ-Expans-Klt-10M	818419-000
	LMX-2000-EQ-UG-Pcube	829909-000
	LMX-2006 EQ-Clam-Cradle	406115-000

Users should independently evaluate the suitability of the product for their application.  
Before ordering check with factory for most current data.

Heavy-duty hot-air heating tools



**Applications**

Used for installing dual or single-wall tubing up to three inches in diameter and for installing SolderSleeve devices. Closed loop version (PID) also available.

**Features and benefits**

- Robust, double-insulated, heavy-duty unit
- Highest-wattage unit (1600–2260 watts)
- Integral stand that allows use as a bench tool
- Safe, quiet operation
- Variety of reflectors available
- Easy fixturing for dual opposing heating

**Technical specification**

**CV-1981, CV-1983**

Electrical supply	CV-1981-MK2	120V and 230V
	CV-1983	120V and 230V
	CV-1981 PID	120V and 230V
Power consumption	CV-1981-MK2	1600W
	CV-1983	2260W/3060W
	CV-1981 PID	1600W
Total system noise	CV-1981-MK2	65dB
	CV-1983	65dB
	CV-1981 PID	>70dB
Length	CV-1981-MK2	340 mm (13")
	CV-1983	320 mm (13")
	CV-1981 PID	350 mm (13")
Weight	CV-1981-MK2	1.3 kg (2.90 lb)
	CV-1983	1.5 kg (3.30 lb)
	CV-1981 PID	1.4 kg (3.10 lb)
Air flow	CV-1981-MK2	Max 230 l/min
	CV-1983	Max 500 l/min
	CV-1981 PID	230 l/min

**Product range**

All dual-wall, single-wall tubing and moulded part products.  
Various SolderSleeve devices products.  
For other Raychem products discuss with Product Management.



Heavy-duty hot-air heating tools

**Ordering information**

Equipment	Description	Part number	Voltage	Hz
CV-1981-MK2	CV-1981-120V1600W-CANMK2	A42716-000	120V	50/60 Hz
	CV-1981-120V1600W-UKMK2	E95798-000	120V	50/60 Hz
	CV-1981-230V1600W-MK2	813914-000	230V	50/60 Hz
	CV-1981-230V1600W-SEVMK2	F25836-000	230V	50/60 Hz
	CV-1981-230V1600W-UKMK2	340970-000	230V	50/60 Hz
CV-1983	CV-1983-110V-2260W-UK	441753-000	120V	50/60 Hz
	CV-1983-220V-2260W	773898-000	230V	50/60 Hz
	CV-1983-220V-2260W-UK	985426-000	230V	50/60 Hz
	CV-1983-220V-3060W	538361-000	230V	50/60 Hz
	CV-1983-220V-3060W-UK	231866-000	230V	50/60 Hz
CV-1981-PID	CV-1981-120V-1600W-CANPIDF	839218-000	120V	50/60 Hz
	CV-1981-120V-1600W-UKPID	928826-000	120V	50/60 Hz
	CV-1981-230V-1600W-PID	958770-000	230V	50/60 Hz
	CV-1981-230V-1600W-SEVPIDF	434366-000	230V	50/60 Hz
	CV-1981-230V-1600W-UKPIDF	385828-000	230V	50/60 Hz
CV-1983 Barrel adapter	AD-1962	989172-000		

**Accessories**

Description	Application	Part number
PR-12 reflector	Tubing: 6.3–25.4 mm (0.25"–1")	991973-000
PR-13 reflector	Tubing: Up to 6 mm (0.25")	991963-000
PR-13C reflector	Large SolderSleeve products	991974-000
PR-21 reflector	Tubing: Up to 25.4 mm (1")	991984-000
PR-24 reflector	Tubing/moulded parts: 25.4 –34.93 mm (1"–1.38")	991964-000
PR-24A reflector	Tubing/moulded parts: 34.93–60.33 mm (1.38"–2.38")	991989-000
PR-25 reflector	SolderSleeve products: Up to 7 mm (0.28")	991965-000
PR-25D reflector	SolderSleeve products: 6.3–12.7 mm (0.25"–0.50")	989523-000
PR-26 reflector	Small SolderSleeve products:	991967-000
PR-33 reflector	SolderSleeve products: 19.05–25.4 mm (0.75"–1")	997768-000
AD-1962 adapter for larger-barrel CV-1983		989172-000
PR-34 reflector	SolderSleeve products: 12.0–20.0 mm (0.47"–0.79")	989111-000
PR-51	Special narrow reflector for moulded part transitions (21.5 x 3.5 mm nozzle)	113069-000

Users should independently evaluate the suitability of the product for their application.  
Before ordering check with factory for most current data.

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