



철도용 보호 슬리브 선정 가이드

Systems Protection Railway Product Range Guide · English Edition

Global Industrial Cable Management Solutions



Federal-Mogul Systems Protection Railway Product Range

A guide to the choice of textile sleeving solutions



F-M Systems Protection Product Overview



All Industries



QuietShield GRN

Acoustic protection



ReflecTube 1592

Thermal protection



Flextrough 2534

Bundling/Abrasion protection



Thermojacket M

Thermal protection



Roundit VO EMI

EMI Shielding



Roundit

Abrasion protection



ReflexWrap 1463

Thermal protection



Expando

Abrasion protection



Thermojacket F

Thermal insulation



ReflectShield 1448

Thermal protection



Roundit 2000 NX

Abrasion Protection



FlatWrap 2535

Bundling/Abrasion protection



Expando EMI

EMI Shielding



Thermflex 1224

Thermal protection



Expando HTNS-L-HO

Abrasion protection



F-M – Systems Protection Customers

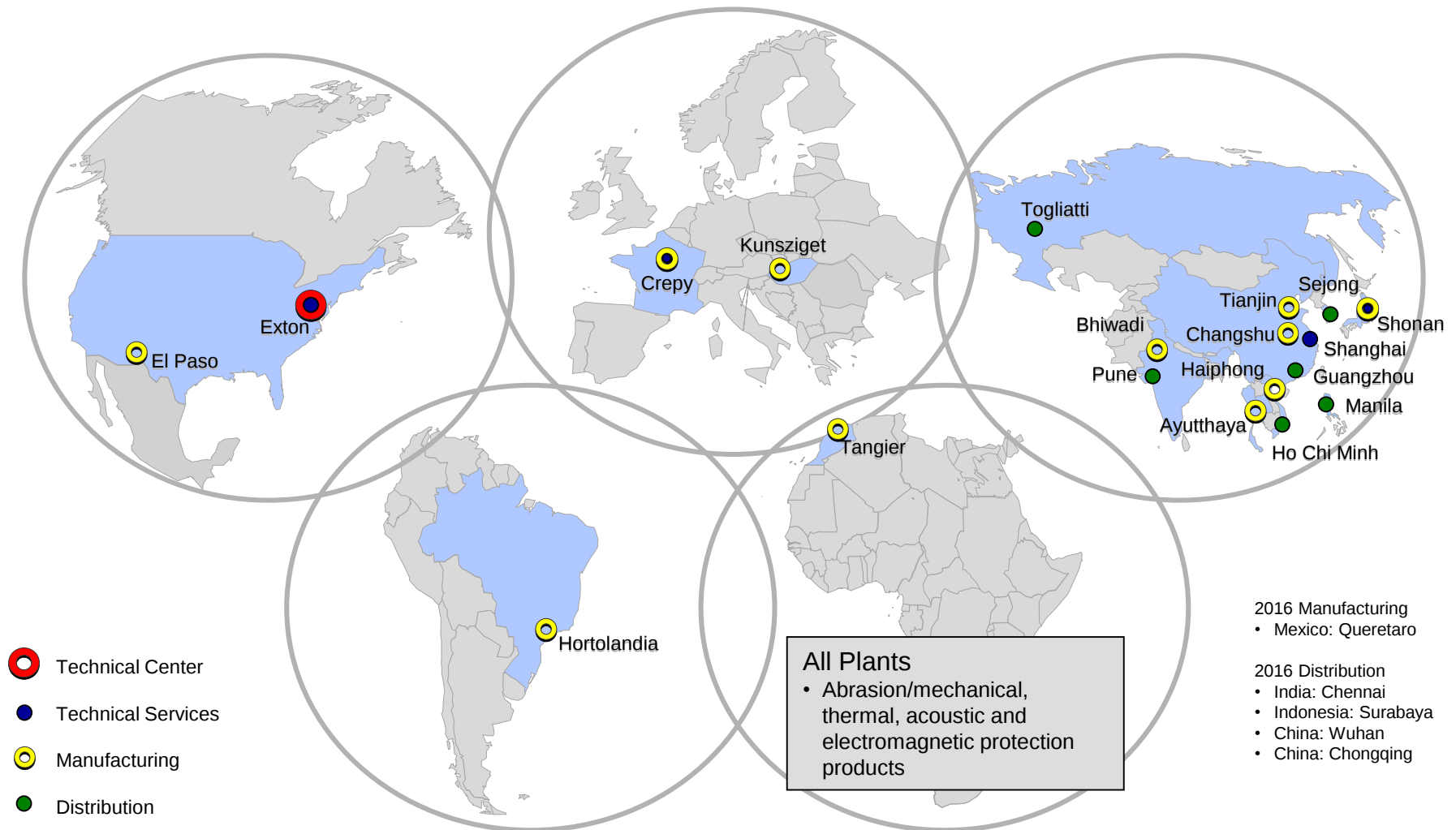


All Industries



... and 100's of further small customers

F-M – Systems Protection Manufacturing Footprint



Textile Sleeving Solutions Benefits for the railway industry

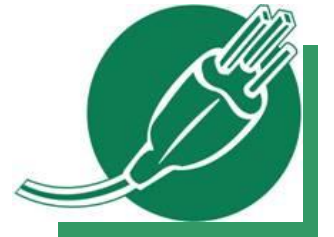


- Low weight
- Easy to install
- Fast to assemble
- Flexible solutions
- Low wall thickness
- Adopted by all key OEMs
- Sizes covering many applications
- Low toxicity and smoke emissions
- Complying with flammability regulations
- Interconnecting without use of additional accessories



A solution for all types of applications

- Abrasion Protection:
against chafing, sharp edges, vibrations and noise effects
- Thermal Isolation:
To protect from extreme heat & prevent fire hazards
- Electrical Isolation:
as an additional barrier to reinforce dielectric strength of cables
- Electromagnetic shielding:
to protect sensitive equipments or absorb emissions from power cables



General Benefits of Roundit

- Roundit is a self-wrapable system which provides multiple types of protection on your wire harness even when the harness is already fitted with connectors



General Benefits of Roundit

- With Roundit you can easily accomodate break-outs either symmetrical or asymmetrical



Example of an asymmetrical branch managed with 2 pieces of Roundit 2000FR



General Benefits of Roundit

- Roundit saves working hours when last minute protection needs are identified

Roundit EMI FMJ installed at the last minute to shield an EMI power cable



A solution for all types of applications

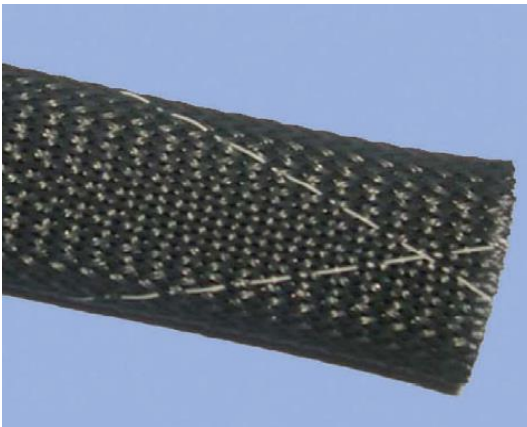
- Abrasion Protection:
against chafing, sharp edges, vibrations
and noise effects



Expando® TCP-V0

Tubular Braided Protection

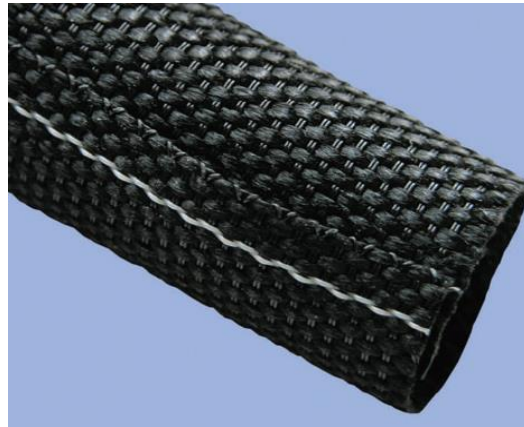
based on V0 rated raw material



Roundit™ 2000 FR

Self-wrapable Protection

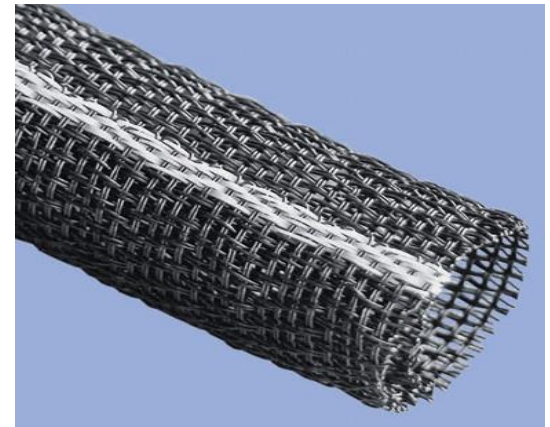
based on FR Polyester



Roundit™ 2000 V0

Self-wrapable Protection

based on V0 rated raw material

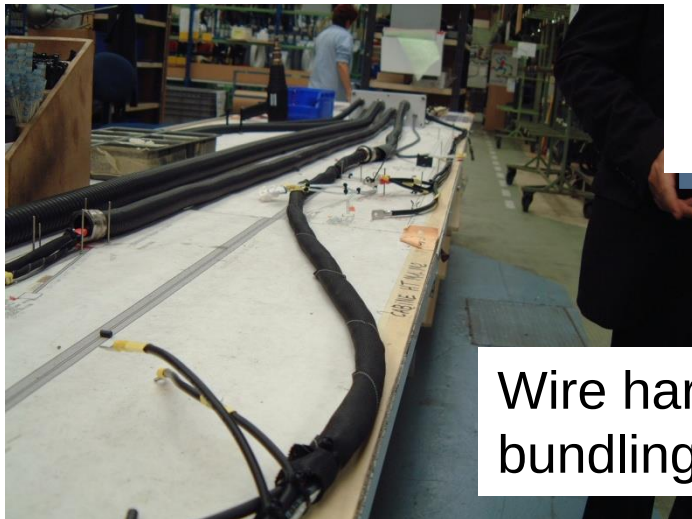


A solution for all types of applications



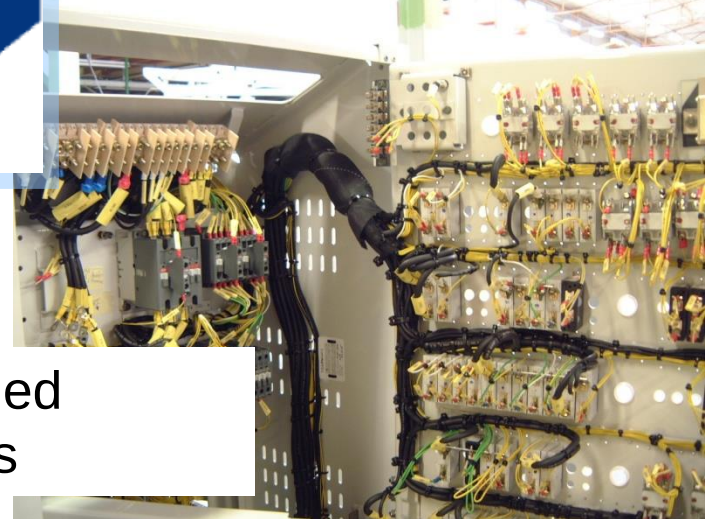
Rubbing inside
convolutes

Vibration against
metal parts



Wire harness
bundling

Confined
spaces



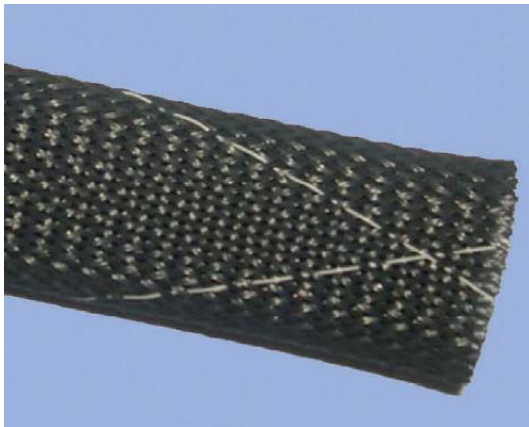
Abrasion Protection



Expando® TCP-V0

Tubular Braided Protection

based on V0 rated raw material



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+150°C
Cold Temperature	MIL-DTL-23053E	-50°C
Flammability - Smoke Density - Toxicity	UL94 (Raw Material)	V0
	NF16101-16102	I2-F1 – Zero halogen
	DIN 5510 (DB)	S4, SR2 & ST2
	UNI CEI 11 170-3	T= 1,3
	ASTM E 662-162	Pass
	EN 45545-2	R22: HL3 R23: HL3

Conditions of application:

- ✓ Expandable product, one size fits a range of diameters
- ✓ Hot cut with a TCP-Cut to prevent end-fray
- ✓ Optimized solution for long lengths without branches

Abrasion Protection

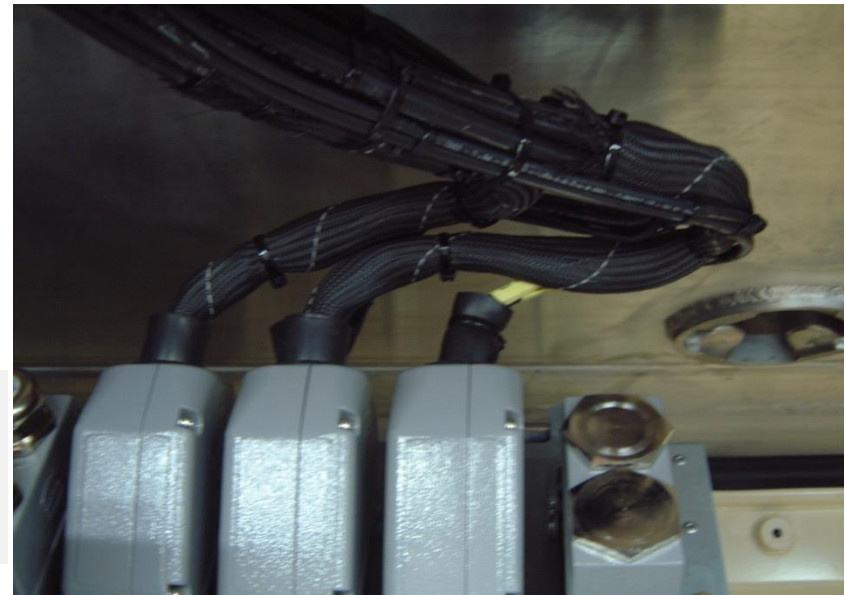


*Expando TCP-V0
for sharp bend
radius*



*Low wall thickness,
easy fit inside
packed raceways*

*Expando TCP-V0
for straight
branches*



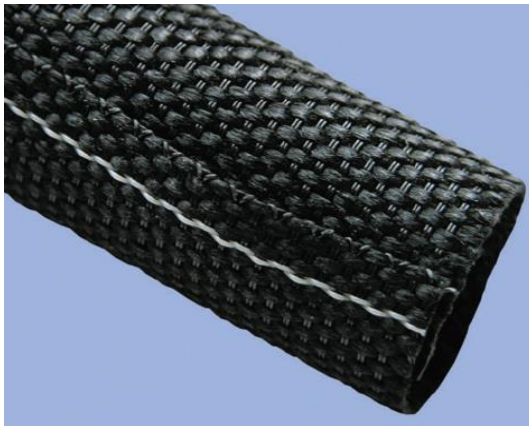
Abrasion Protection



Roundit® 2000 FR

Self-wrapable Protection

based on FR Polyester



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+150°C
Cold Temperature	MIL-DTL-23053E	-50°C
Flammability - Smoke Density - Toxicity	UL94 (Raw Material)	V0 on mono-filament
	NF16101-16102	I2-F2 – Zero halogen
	DIN 5510 (DB)	S4, SR2 & ST2
	UNI CEI 11170-3	T= 1,7
	ASTM E 662-162	Pass
	EN 45545-2	R22: HL3 R23: HL3

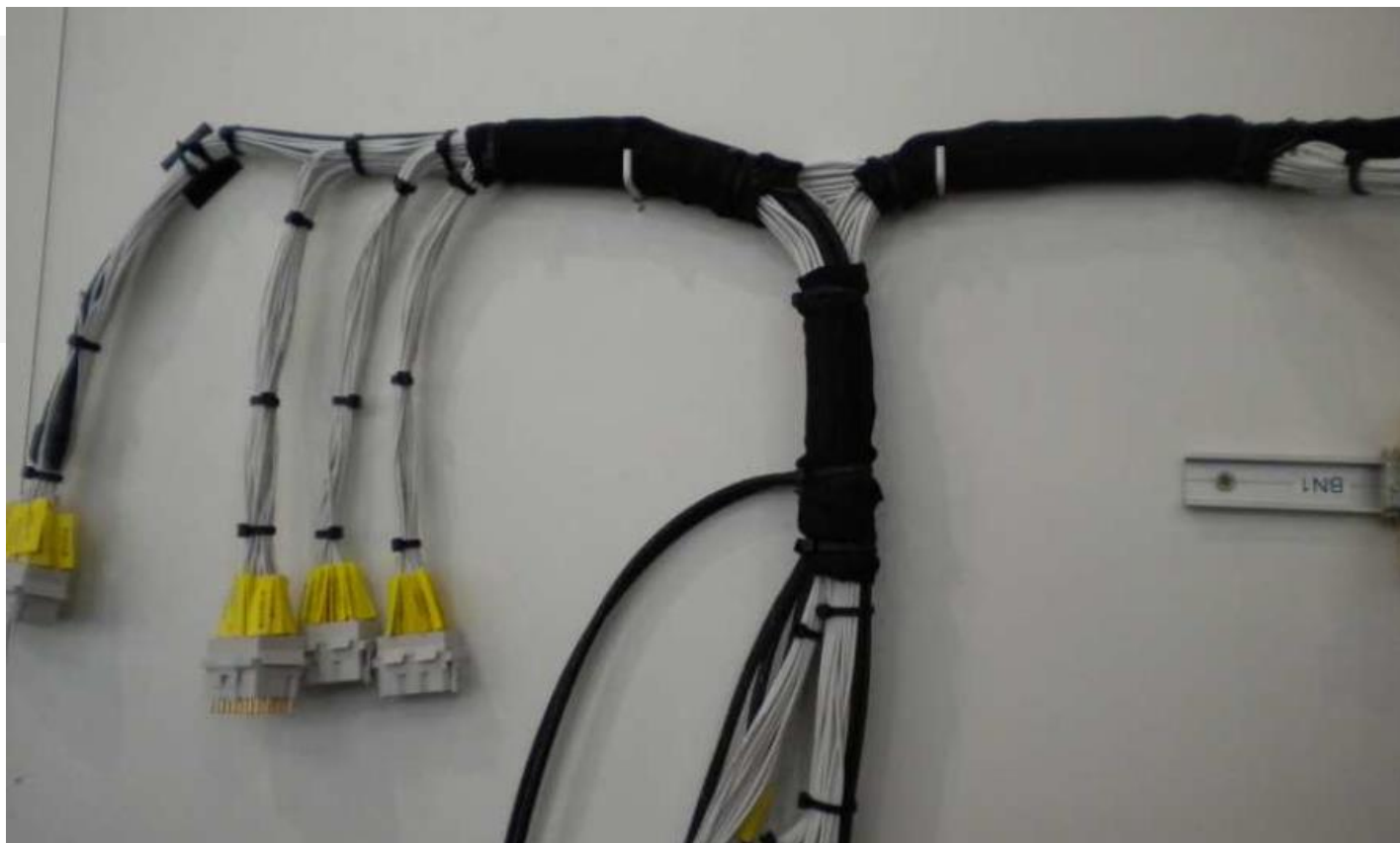
Conditions of application:

- ✓ Mix of mono- and multi-filaments to get 100% coverage
- ✓ Can be installed with connectors already in place
- ✓ Flexible abrasion protection soft to the cables inside

Abrasion Protection



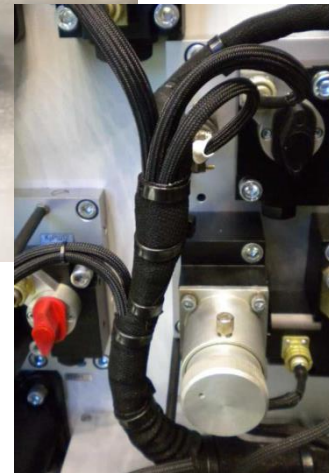
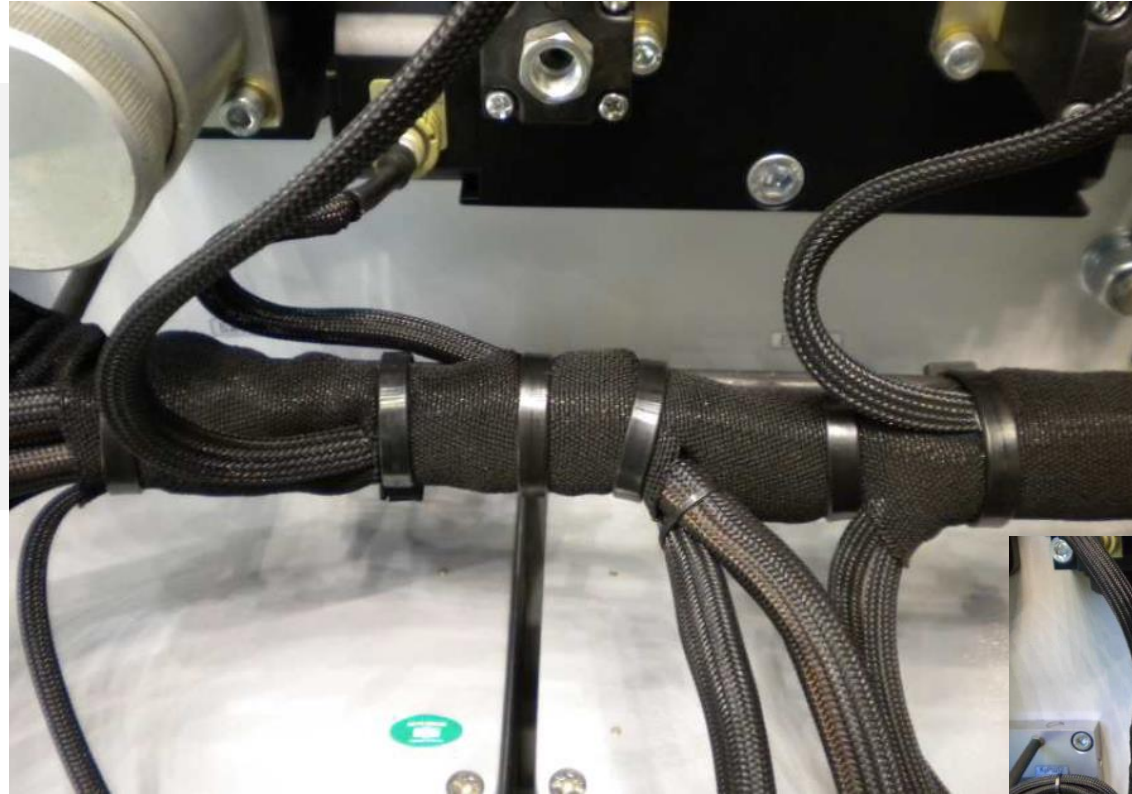
*Roundit 2000FR
is ideal when
only local
protection is
needed*



Abrasion Protection



Use of Expando TCP-V0 for short branches and Roundit 2000FR for the main bundle is making the most of the ease of insertion in a textile self-wrappable structure



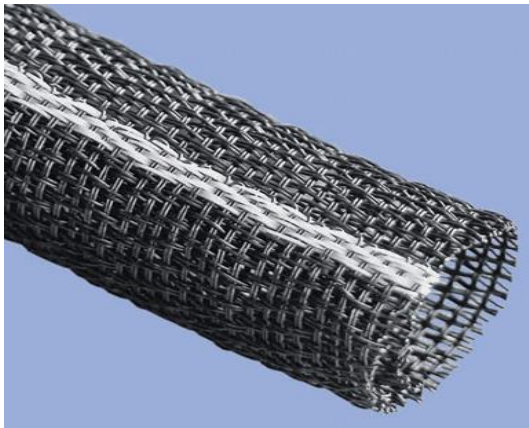
Abrasion Protection



Roundit® 2000 V0

Self-wrapable Protection

based on V0 rated raw material



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+150°C
Cold Temperature	MIL-DTL-23053E	-50°C
Flammability - Smoke Density - Toxicity	UL94 (Raw Material)	V0
	NF16101-16102	I2-F2 – Zero halogen
	BS6853	R= 1,3 A0= 0,193 OI= 34,9%
	DIN 5510 (DB)	S4, SR2 & ST2
	UNI CEI 11170-3	T= 1,4
	ASTM E 662-162	Pass
	EN 45545-2	R22: HL3 R23: HL3

Conditions of application:

- ✓ Outstanding abrasion protection
- ✓ Can be installed with connectors already in place
- ✓ Twist 2 turns/meters for a good fit around the wire harness



A solution for all types of applications

- Thermal Isolation:

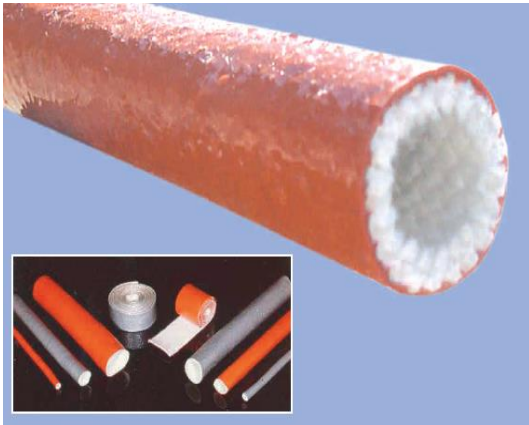
To protect from extreme heat & prevent fire hazards



Thermotubix®

Tubular Braided Protection

based on fiberglass & silicone



Tape 66N-67N

Self-amalgamating tapes

based on silicone and fiberglass



Thermojacket® S

Tubular Braided Protection

based on fiberglass with a coating



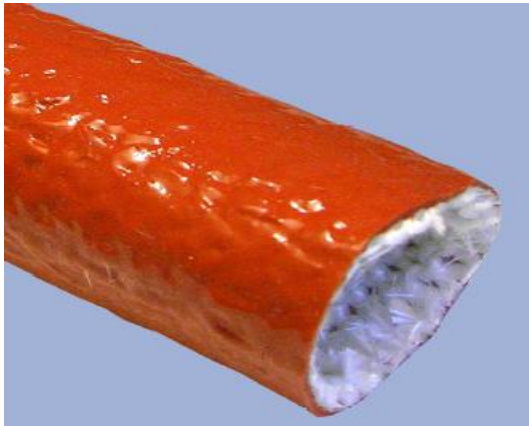
Thermal Isolation



Thermotubix®

Tubular Braided Protection

based on fiberglass & silicone



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+260°C
Cold Temperature	MIL-DTL-23053E	-54°C
Flammability - Smoke Density - Toxicity	Silicone coating	FR properties
	ASTM E-1354-02a	Effective heat of combustion 31.3 MJ/Kg
	NF16101-16102	I2-F0 – Zero halogen
	DIN 5510 (DB)	S4, SR2 & ST2
	ASTM E 662-162	Pass

Conditions of application:

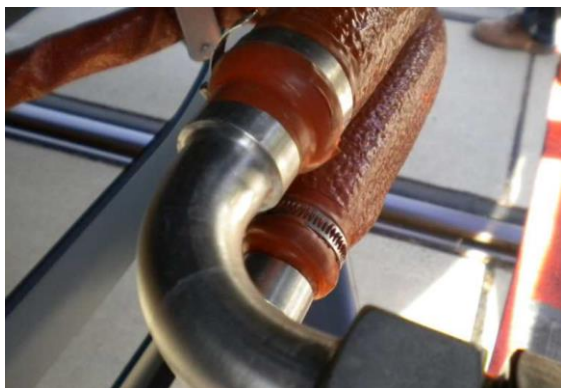
- ✓ Compatible with a range of self-amalgamating tapes
- ✓ Flame retardant silicone coating, expands over connectors
- ✓ Long term isolation & protection from metal molten splashes

Thermal Isolation



Protection against low temperatures using the Thermobande assembly

Protection of sensitive hoses against abrasion and stone inpingement



Use of Thermotubix and silicone self-amalgamating tapes

Protection of sensitive cables



Thermal Isolation



Tape 66N-67N-68N

Self-amalgamating tapes

based on silicone and fiberglass



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+250°C
Flammability - Smoke Density - Toxicity	NF16101-16102	I2F5 / I4F1
Amalgamation	QI-MCQ-47	Sticks on itself
Dielectric Strength	QI-MCQ-21	Average value 13 kV
Fluid Resistance	EN6059-303	No cracks
Tensile Strength	PPEQ 1019636030	44,43N for 10% elongation

Conditions of application:

- ✓ Wide range of applications from local protection to joints
- ✓ Compatible with entire range of silicone coated products
- ✓ Reinforced version available to improve stability in compression

Thermal Isolation



Thermojacket S

Impregnated fiberglass sleeve

Thermal isolation +540°C

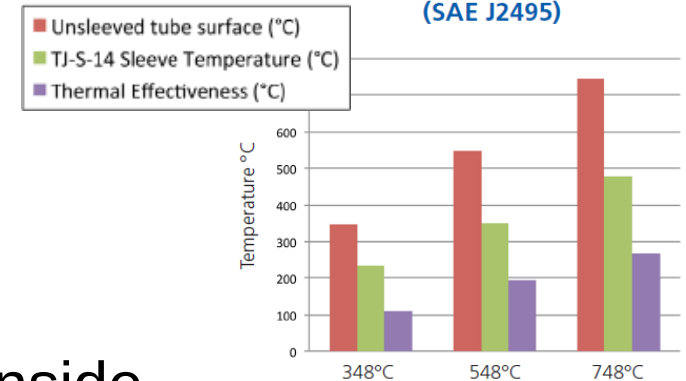


Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+240°C
Flammability - Smoke Density - Toxicity	DIN 5510 (DB)	S4, SR2 & ST2
	EN 45545-2	Int. R22 and R6: HL3, Ext. R23 and R9: HL3
	BS6853	Category 1A

Conditions of application:

- ✓ Silicone coating reduces end-fray
- ✓ Thermal isolation not trapping heat inside
- ✓ Expandable, can accommodate increase in diameter

Thermal Containment Efficiency
(SAE J2495)



Note: Thermal effectiveness is the difference between the unsleeved and sleeved tube surface temperatures

A solution for all types of applications

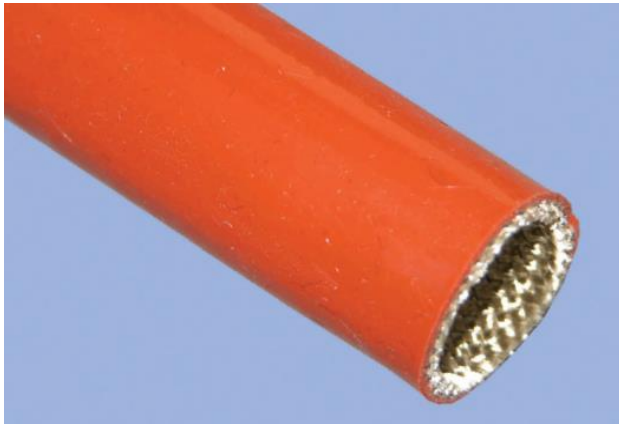
- Electrical Isolation:
as an additional barrier to reinforce dielectric strength of cables



GES 40/100

Tubular Braided Protection

based on fiberglass & silicone



Tape 66N-67N

Self-amalgamating tapes

based on silicone and fiberglass



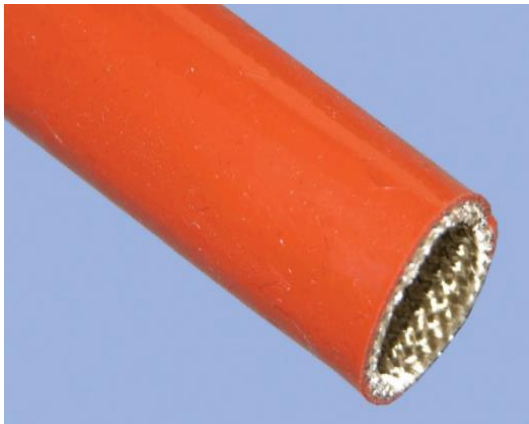
Electrical Isolation



GES 40/100

Tubular Braided Protection

based on fiberglass & silicone



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+220°C
Heat Release	ASTM E-1354-02a	Effective heat of combustion 40.7 MJ/Kg
Flammability - Smoke Density - Toxicity	NF16101-16102	I2F0 – Zero halogen
	UL1441	VW-1
	DIN 5510 (DB)	S4, SR2 & ST2
	EN 45545-2	R22: HL3 R23: HL3
Dielectric Strength	QI-MCQ-21 Ind C	4kV or 10 kV

Conditions of application:

- ✓ Compatible with a range of self-amalgamating tapes
- ✓ Flame retardant silicone coating, expands over connectors
- ✓ Long term isolation & protection from metal molten splashes

Electrical Isolation



GES installed on an equipment to insure electrical isolation and over protection of cables

Electrical Isolation



Tape 66N-67N-68N

Self-amalgamating tapes

based on silicone and fiberglass



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+250°C
Flammability - Smoke Density - Toxicity	NF16101-16102	I2F5 / I4F1
Amalgamation	QI-MCQ-47	Sticks on itself
Dielectric Strength	QI-MCQ-21	Average value 13 kV
Fluid Resistance	EN6059-303	No cracks
Tensile Strength	PPEQ 1019636030	44,43N for 10% elongation

Conditions of application:

- ✓ Wide range of applications from local protection to joints
- ✓ Compatible with entire range of silicone coated products
- ✓ Reinforced version available to improve stability in compression

A solution for all types of applications

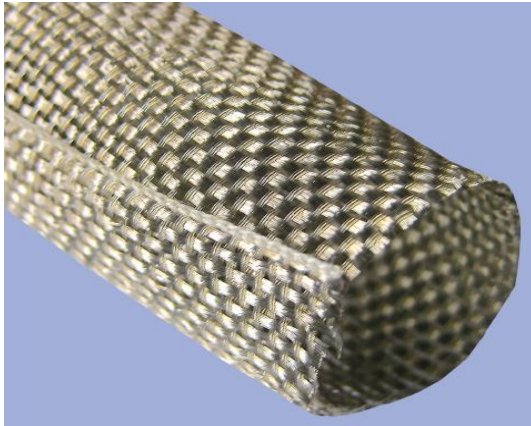
- Electromagnetic shielding:
to protect sensitive equipments or
absorb emissions from power cables



Roundit™ V0 EMI

Metal wire self-wrapable shielding

65% optical coverage , Cu/Ni C4



Roundit™ V0 EMI CuSn

Metal wire self-wrapable shielding

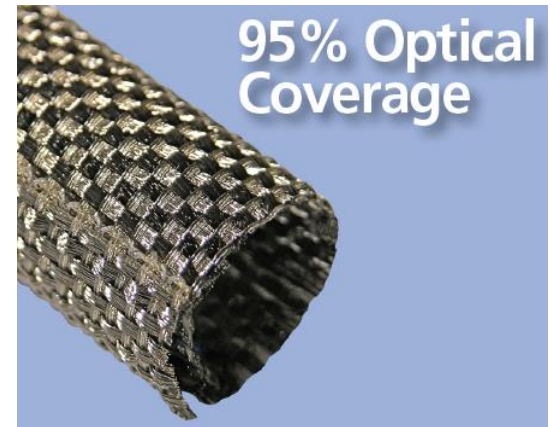
65% optical coverage, Cu/Sn



Roundit™ EMI FMJ

Metal wire self-wrapable shielding

95% optical coverage, Cu/Ni C4



EMI Shielding



Roundit™ V0 EMI

Metal wire self-wrapable shielding

65% optical coverage , Cu/Ni C4



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+200°C
Cold Temperature	MIL-DTL-23053E	-50°C
Flammability - Smoke Density - Toxicity	NF16101-16102	I2F1
	DIN 5510 (DB)	S4, SR2 & ST2
	EN 45545-2	R22: HL3 R23: HL3
Transfer Impedance	IEC 62153-4-3	1.2 nH Inductance
Resistance measurement	EN3475-301	R0 max 6 milliOhms/m
Salt Spray Resistance	EN2591-307	96 hours - Pass

Conditions of application:

- ✓ Mix of PPS V0 monofilaments and Nickel Plated Copper
- ✓ Very good resistance to fluids & corrosion (96h salt spray)
- ✓ Good level of EMI shielding, easy to install after connectors

EMI Shielding



Roundit™ V0 EMI CuSn

Metal wire self-wrapable shielding

65% optical coverage , Cu/Sn

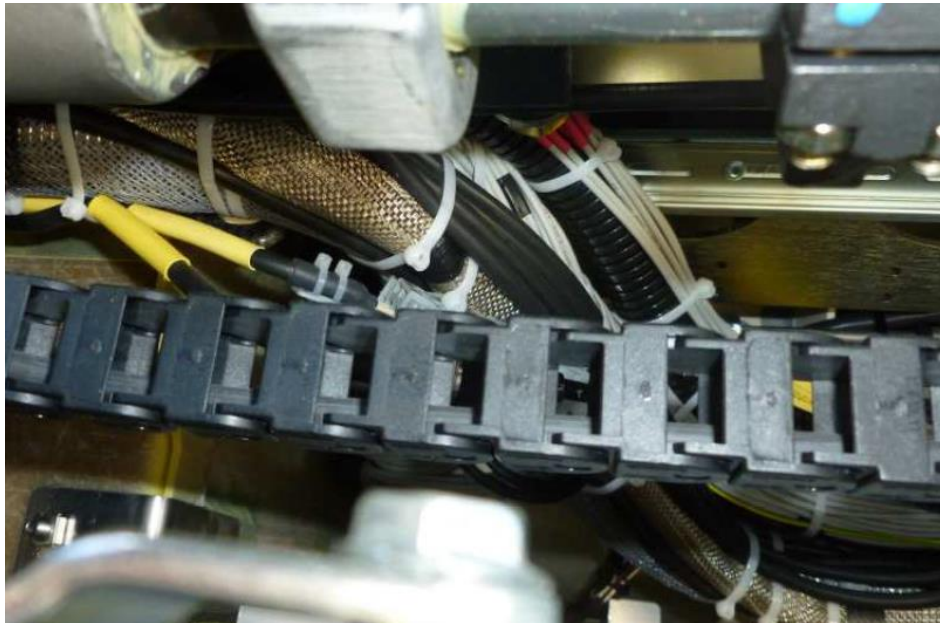


Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+125°C
Cold Temperature	MIL-DTL-23053E	-50°C
Flammability - Smoke Density - Toxicity	DIN 5510 (DB)	S4, SR2 & ST2
	EN 45545-2	R22: HL3 R23: HL3
Transfer Impedance	IEC 62153-4-3	1.2 nH Inductance
Resistance measurement	EN3475-301	R0 max 6 milliOhms/m
Salt Spray Resistance	EN2591-307	96 hours - Pass

Conditions of application:

- ✓ Mix of PPS V0 monofilaments and Tin Plated Copper
- ✓ Good resistance to fluids & corrosion (96h salt spray)
- ✓ Good level of EMI shielding, easy to install after connectors

EMI Shielding



Roundit V0 EMI insuring EMI performances in a tight environment where sharp bend radius do not allow the use of metallic raceways

Roundit EMI FMJ for an additional EMI protection where traditional braids can not be installed afterwards



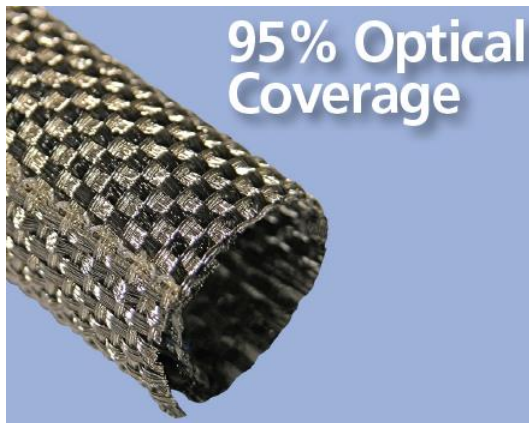
EMI Shielding



Roundit™ EMI FMJ

Metal wire self-wrapable shielding

95% optical coverage , Cu/Ni C4



Property	Test Methods	Test Results
Operating Temperature	EN6059-302	+200°C
Cold Temperature	MIL-DTL-23053E	-65°C
Flammability - Smoke Density - Toxicity	NF16101-16102	I3F0
	DIN 5510 (DB)	S4, SR2 & ST2
	EN 45545-2	R22: HL3 R23: HL3
Transfer Impedance	IEC 62153-4-3	0.6 nH Inductance
Resistance measurement	EN3475-301	R0 max 5 milliOhms/m
Fluid resistance	EN6059-303	Pass

Conditions of application:

- ✓ Easy installation of break-outs and grounding
- ✓ 95% Optical coverage Nickel Plated Copper C4 (ASTM-B355)
- ✓ Very high performance EMI shielding, corrosion, fluid resistant