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Bosch Group

Rexroth Connection System fibre optic cables

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- an Application Description

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Table of Contents

1 Fiber Optic Cable (LWL) – General Information

1.1 Introduction

The use of fiber optic cables, hereinafter called LWLs, has numerous advantages over conventional copper leads. Just in terms of EMC features alone (electro-magnetic compatibility) LWL signal transmission offers the greatest possible safety.

The LWLs used by INDRAMAT are available both as raw cables and standard, ready-ti-use cables. All leads and connectors meet the demands specified by the SERCOS interface (IEC 61491 or EN 61491) standard.

This document is intended to support the user when assembling and dimensioning LWLs.

Note: The setting for the best transmission power and the associated cable lengths are specified in the documentation of the unit (Project Planning or Application Description manuals).

The standard LWLs manufactured by Indramat will support operation. Using this document it is, however, possible to make individual components. All those components specified by Indramat such as cable and connectors are joint developments of INDRAMAT and carefully selected manufacturers and are subject to continuous manufacturing and quality control processes.

Note: Standard LWL components not recommended by INDRAMAT should not be used if the intention is to make components.

1.2 LWL Cables

INDRAMAT uses LWLs with a diameter of ∅ 2.2 mm and ∅ 6.0 mm. Both have a plastic LWL (PMMA) with step index profile with a ∅ of 1.0 mm.

Standard LWL **type IKO0982** **∅ 2.2 mm**

non-standard LWL **type INK0414**

This LWL is suited for use in The control cabinet. Do need use it when routing outside of The cabinet.

Standard LWL **type IKO0985** **∅ 6.0 mm**

non-standard LWL **type INK0435**

This LWL is suited for routing outside of the cabinet, within the area of the machine, in the cable channel or trailing cable installation.

Special features of LWLs

LWLs used by INDRAMAT have the following features:

- ⇒ no cross talk problems
- ⇒ no emissions along the length of the cable
- ⇒ no impairment from external interference fields
- ⇒ no grounding problems
- ⇒ favorable coupling conditions
- ⇒ metal-free structure
- ⇒ high flexibility
- ⇒ good temperature characteristics
- ⇒ rapid and cost-effective mounting
- ⇒ rapid and cost-effective production

2 Selection List of Standard Plastic LWLs

2.1 Ready-to-attach LWLs ∅ 2,2 mm

Note: Ready-to-attach LWLs may only be used in the control cabinet or inside the unit.

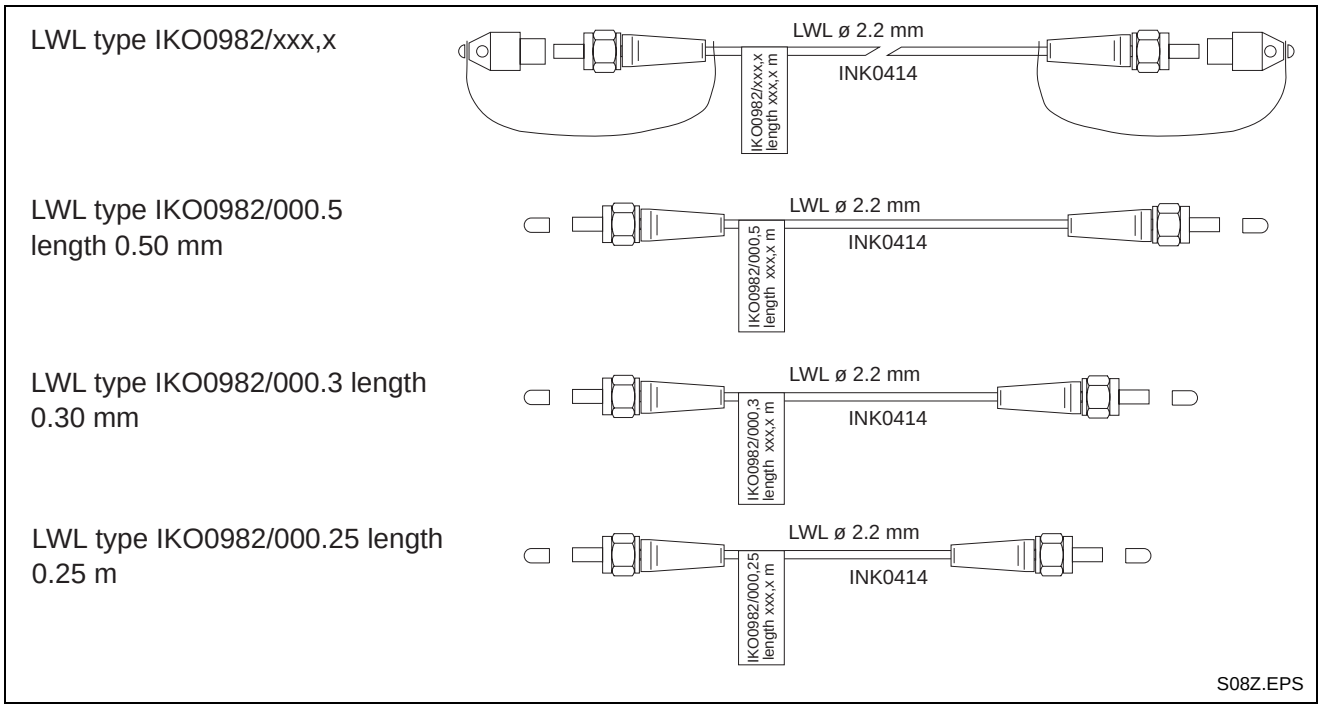


Fig. 2-1: Ready-to-attach LWLs ∅ 2.2 mm

Note: Cables IKO0982/000.25 and IKO0982/000.3 may only be used to connect units (no additional coupling locations). Allowed cable attentuation equals max. 5.0 dB.

How to order: From the above illustration select the connections needed, (e.g., order type IKO0982/xxx,x). Also specify the length of the cable as shown below.

Available cable lengths:

0.25m	**IKO0982/000.25**
0.30 m	**IKO0982/000.3**
0.50 m	**IKO0982/000.5**
any	**IKO0982/xxx.x**

Order text for cable length of 5.5 meters.

IKO0982/005.5

Note: Maximum total length equals 40 m.

2.2 Ready-to-Attach LWLs ∅ 6.0 mm

LWL cable type IKO0985/xxx,x.

(For routing within machine area – suited for trailing cable installation.)

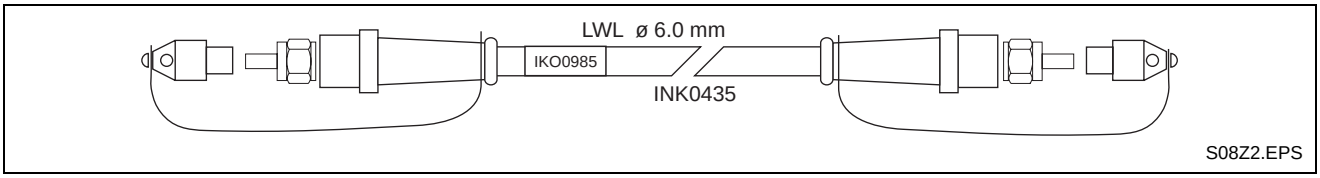


Fig. 2-2: Ready-to-attach LWLs ∅ 6.0 mm

How to order: Select the connection needed from the above illustration, e.g., order type IKO0985/xxx,x. The length of the cable must also be specified as shown.

Available cable lengths:

5.0 m	**IKO0985/005.0**
10.0m	**IKO0985/010.0**
15.0 m	**IKO0985/015.0**
20.0 m	**IKO0985/020.0**
any	**IKO0985/xxx,x**

Order text for a cable length of 5.5 m:

IKO0985/005.5

3 FSMA Selection List for Plug-In Connectors and LWLs

3.1 FSMA Connectors for cables ∅ 2.2 mm

Type INS0420

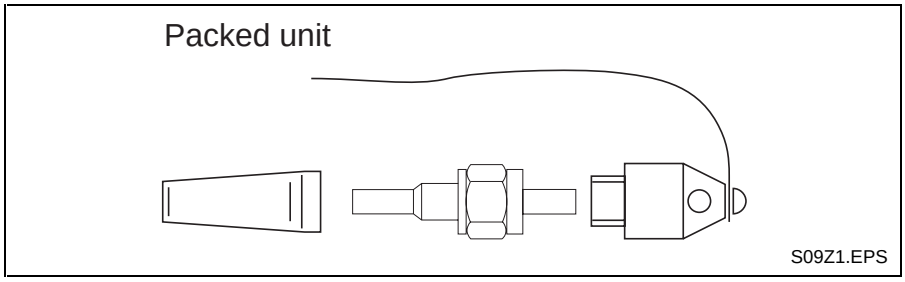


Fig. 3-1: Packaging unit 2.2 mm

The LWL which can be used

type INK0414

Note: LWLs with 2.2 mm ∅ may only be used in the control cabinet or inside the unit!

3.2 FSMA connector for cable ∅ 6.0 mm

Type INS0425

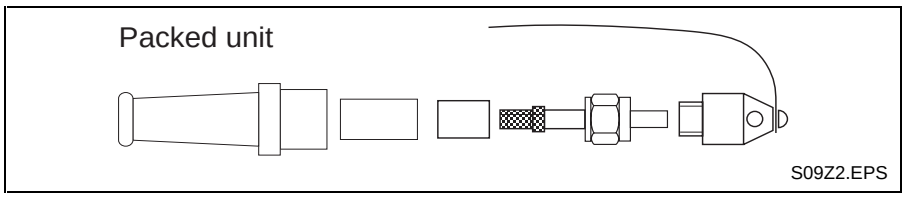


Fig. 3-2: Packaging unit 6.0 mm

LWL which can be used in a trailing cable installation.

type INK0435

Note: LWLs with ∅ 6.0 mm can be used in trailing cable installations.

3.3 LWL Accessories and Leadthroughs

3.4 LWL Leadthroughs

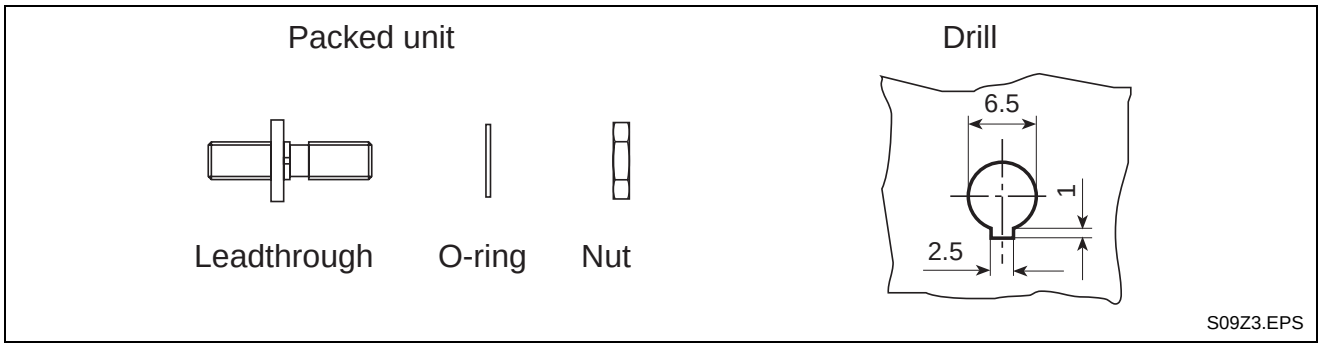


Fig. 3-3: Packaging unit LWL leadthrough

3.5 Protective Caps for LWL Connectors or Leadthroughs

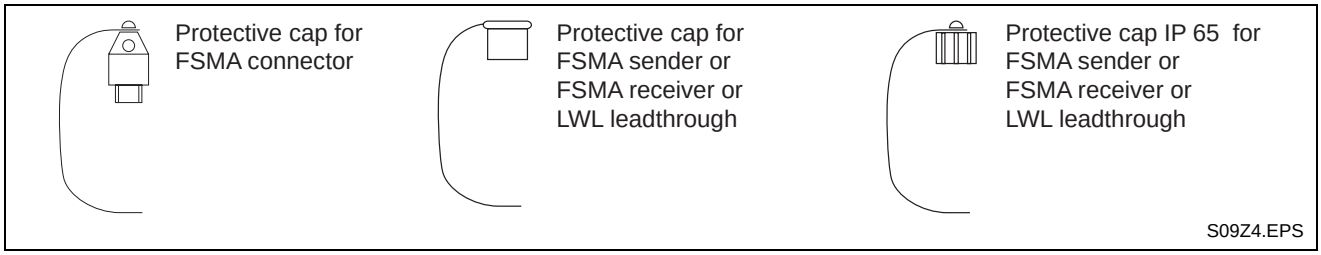


Fig. 3-4: Accessories

4 Routing Guidelines for LWLs

When routing and inserting LWLs it must basically be noted that specific load data may not be exceeded.

Inserting and routing LWLs

To insert a standard LWL it is possible and if necessary to thread twine or a wire through the lateral drill hole of the protective cap (may not, however, cut into the hole). It is first necessary to remove the latch from protective cap and LWL.

Maximum tensional force between connector and LWL may not be exceeded when doing this.

The minimum bend radius (even if pulled around corners) may not be exceeded.

Once inserted, the latch of the protective cap must be remounted.

Avoid routing over sharp edges or spiky uneven surfaces. Any cuts or other types of mechanical damage can lead to problems and breakdowns.

Transverse loads

Maximum transverse resistance (even if pulled around corners) may not be exceeded.

Torsion

Avoid twisting an LWL when routing. In every case, make sure that there is no tension at the end position.

Also note DIN VDE 0899, section 4.

5 Technical Data

5.1 Technical Data LWL – cable ∅ 2.2 mm type INK0414

Designation	**INK0414**
External mantle:	Polyamide
External diameter:	2.2 ± 0.07 mm
Bend radius short-term*:	> 30 mm (360°)
bend radius continuous:	> 50 mm (360°)
Tensile strength short-term:	< 150 N
Tensile strength continuous:	< 100 N
Tensile strength connector – cable:	< 50 N
Tensile strength protective cap – connector:	< 240 N
lateral resistance to pressure:	450 N/cm (60 sec.) upto 1250 loads (cycles)
resistance to alternating bend loads:	> 8000 cycles ≥ 90°, r = 20 mm, tensile force 2 N
Temperature range for storage:	- 40°C... + 85°C
Temperature range for operations:	- 20°C... + 70°C
core diameter:	1000 µm ± 20 µm
Specific attenuation:	< 0.2 dB/m at 650 n/m
Bend attenuation	additionally about 0.2 dB/m at 10 windings with r = 50 mm

Fig. 5-1: Overview of Technical Data INK0414

* While routing, not during operations!

5.2 Technical Data LWL – cable ∅ 6.0 mm type INK0435

This LWL (type INK0435) is suited for cable installations.

Note: When routing and inserting LWLs always ensure that the specific load data are not exceeded.

Designation	**INK0435**
External mantle:	PUR
External diameter:	6.0 ± 0.2 mm
bend radius short-term*:	> 30 mm
bend radius continuous:	> 80 mm
bend radius continuous in cable track:	> 100 mm
Tensile strength:	100 N
Tensile strength connector – cable:	< 100 N
Tensile strength protective cap – connector:	< 240 N
lateral resistance to pressure:	100 N/cm
resistance to alternating bend loads:	> 100000 cycles ± 90°; r=100 mm, tensile force 2 N
Temperature range for storage:	- 20°C... + 70°C
Temperature range for operations:	- 0°C... + 70°C
core diameter (Fiber):	1000 µm ± 20 µm
Specific attenuation:	< 0.2 dB/m at 650 n/m
Bend attenuation:	additional 0.2 dB/m at 10 windings; at r = 50 mm

Fig. 5-2: Overview of Technical Data INK0435

* While routing, not during operations!

Note: When inserting non-standard LWLs it may be necessary to expose the kevlar mantle and attached it to a tensile force wire.

5.3 Technical Data LWL – cable ∅ 3.0 mm type INK0436

Designation	**INK0436**
External mantle:	polyurethane (PUR)
External diameter:	3,0 mm
bend radius short-term*:	> 25 mm
Tensile strength short-term:	330 N
Tensile strength continuous:	110 N
lateral resistance to pressure:	1000 N/cm
resistance to alternating bend loads:	> 10000 Cycles ± 90°
Temperature range for storage:	- 40°C... + 85°C
Temperature range for operations:	- 40°C... + 85°C
core diameter optische Faser:	200 µm
Specific attenuation:	< 10 dB/km

Fig. 5-3: Overview of Technical Data INK0436

* While routing, not during operations!

6 Attenuation Measurements of the Standard Plastic LWLs

Equipment needed

- LWL level oscillator — e.g., 1XT from TS optoelectronic
- LWL reference cable IKO0982/1
- LWL measurement coupling
- LWL level meter — e.g., 4XT-S from TS optoelectronics with adapter TSO-2000-x for FSMA

To ensure the LWL transmission distances (see Fig. 6-1), it is necessary to determine the attenuation of all standard LWLs (intermediate distances).

Total attenuation of an LWL transmission distance (in dB) = sum of all individual attenuations (in dB).

6.1 LWLs

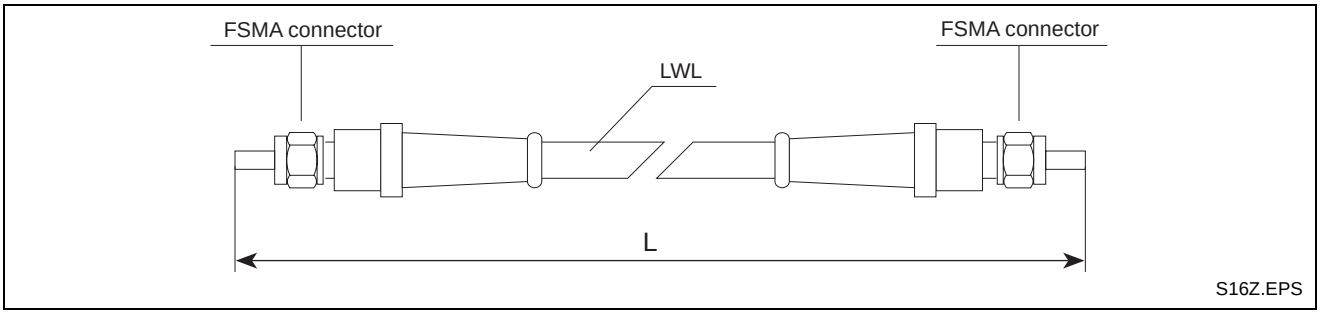


Fig. 6-1: LWL

$$A_{K\max} = a * L + A_S + P_F$$

Fig. 6-2: Maximum anticipated attenuation of standard LWLs

A_{Kmax}.:	max. anticipated cable attenuation	dB
a :	max. LWL lead attenuation	0.25 dB/m
L :	max. length of LWL in meters	m
As :	max. in/out coupling attenuation of both LWL plug-in connectors	1.5 dB
P_F :	finishing tolerances and test assembly	0.5 dB

Fig. 6-3: Legend

6.2 Measuring Procedure

The procedure is broken down into the referencing and attenuation measurements. Both are described below.

1st Reference:

⇒ LWL test sender, reference cable and LWL level meter must be connected as per Fig. 6-4.

⇒ Switch LWL test sender on.

The LED U_B OK (voltage monitor) has to light up.

⇒ Switch LWL level meter on.*

⇒ Set LWL level meter to dB.*

⇒ Set LWL once current LWL level meter attenuation is fixed to 0 dB.*

⇒ Separate reference cable from LWL level meter.

Do not switch LWL test sender and LWL level meter off.

* See instructions on LWL level meter.

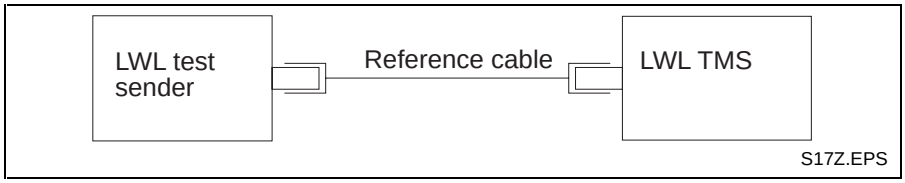


Fig. 6-4: Reference measurement

2nd Attenuation:

⇒ Connect LWL coupling, test piece and level meter to each other as per Fig. 6-5.

⇒ Read attenuation. The reading is the attenuation of the test piece.

⇒ Switch LWL test sender and level meter off.

⇒ Separate LWL coupling, test piece and level meter.

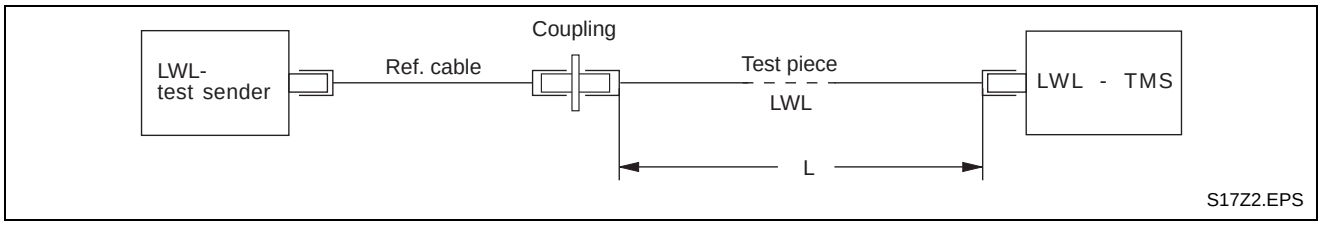


Fig. 6-5: Attenuation meter

Note: Reference measurement must be repeated prior to each measurement procedure. Maximum allowed cable attenuation equals 12.5 dB.

6.3 Maximum Allowed Cable Attenuation

The maximum allowed cable attenuation of the LWLs

IKO0982/xxx,x
IKO0985/xxx,x

can be determined using the following table.

The maximum allowed attenuation between sender and receiver (12.5 dB) is reached with a cable length of about 40 meters.

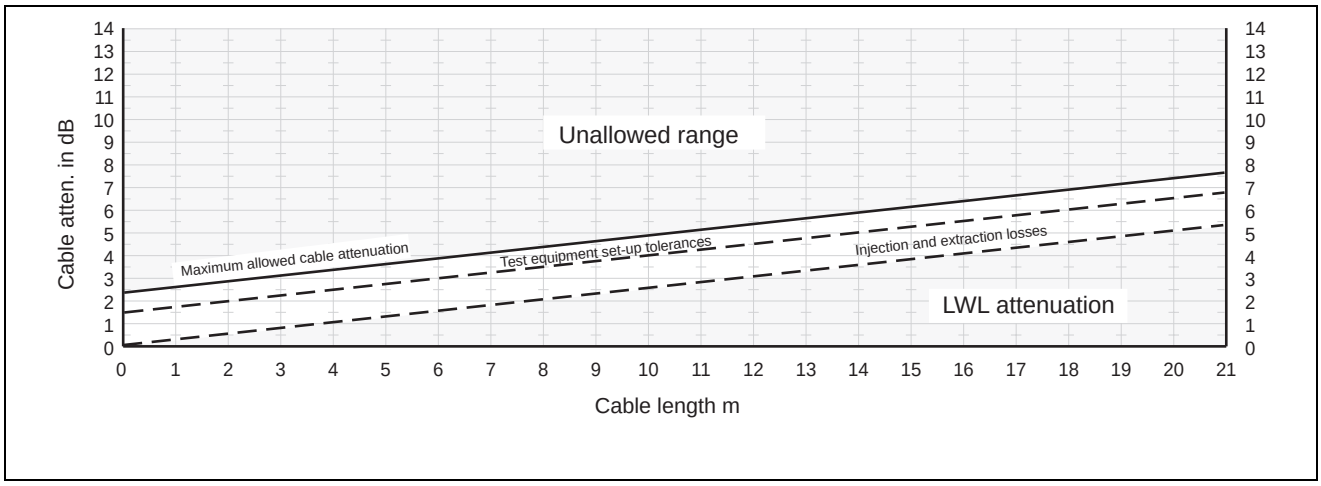


Fig. 6-6: Allowed cable attenuation

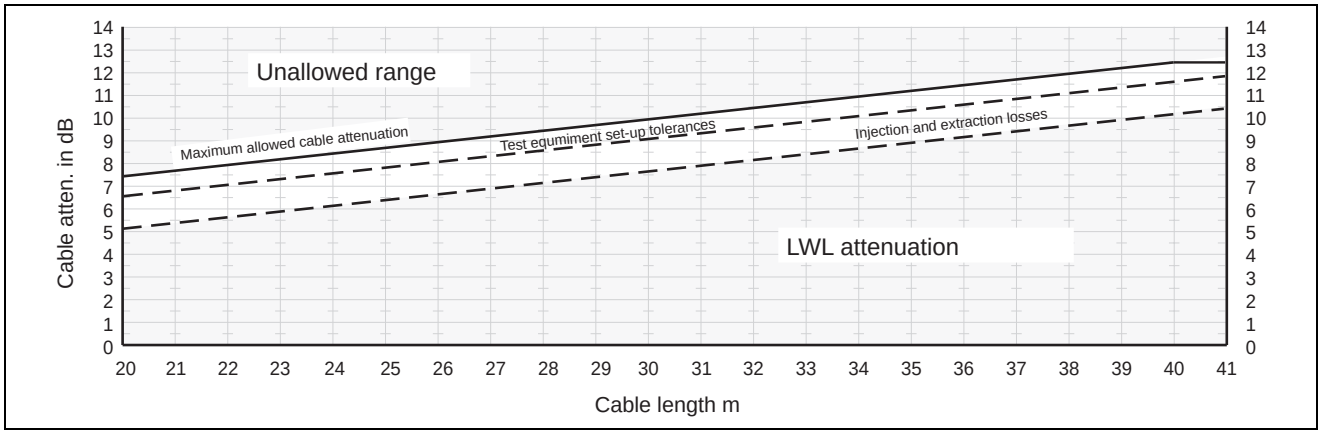


Fig. 6-7: Allowed cable attenuation

Exceptions:

With LWL cables **IKO0982/0.25**
and **IKO0982/0.30**
a maximum attenuation of 5 dB is allowed.

Note: Both cables may only be used to connect to pieces of equipment.

6.4 Converting Optic Transmission Power (dBm < -- > µW)

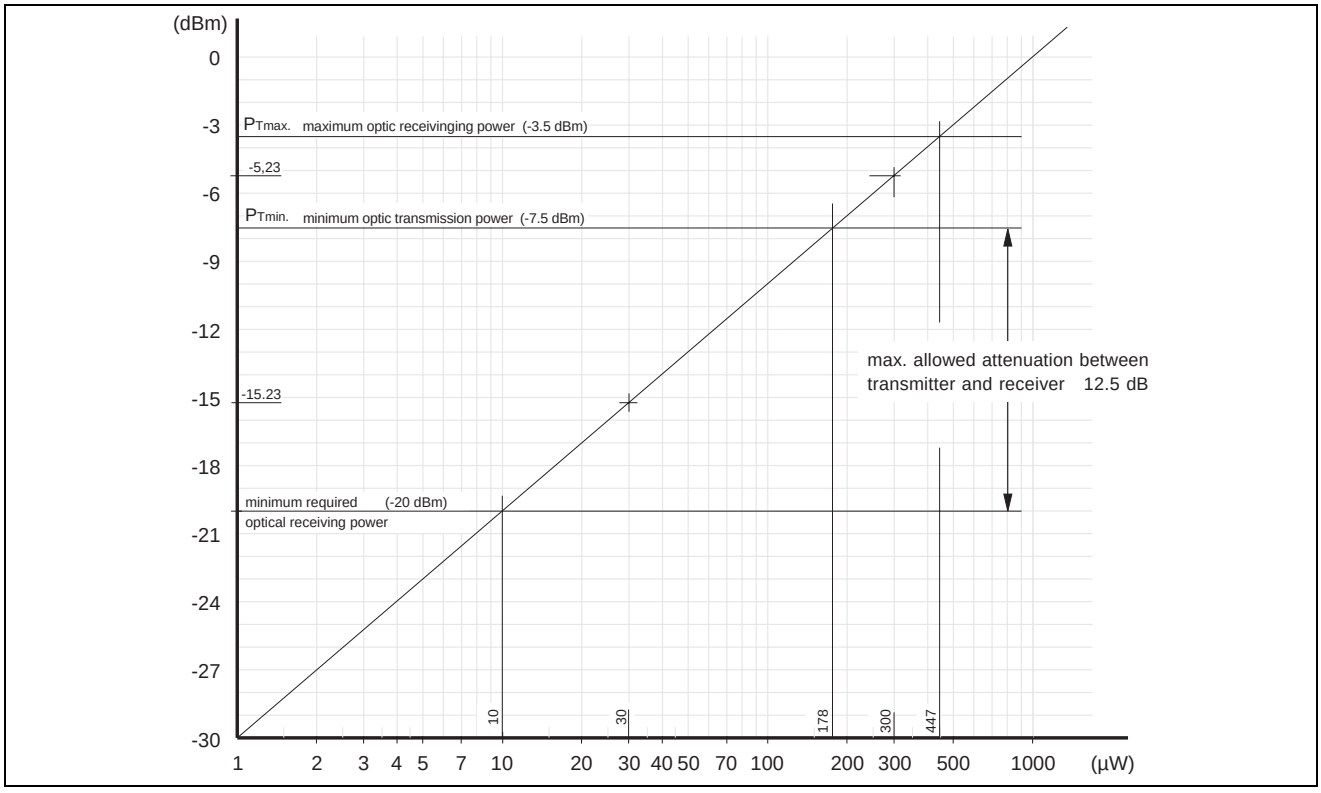


Fig. 6-8: Converting optic transmission power dBm < -- > µW

Optic transmission power	in dBm	in µW
PTmax. maximum transmission power	-3.5 dBm	447 µW
PTmin. minimum transmission power	-7.5 dBm	178 µW
PRmin. minimum receive power	-20 dBm	10 µW

Fig. 6-9: Optic transmission power

$$P_{(dBm)} = 10 \bullet \log \frac{P_{(\mu W)}}{1000 \mu W}$$

$$P_{(\mu W)} = 10^{\frac{P_{(dBm)}}{10}} \bullet 1000 \mu W$$

L: P (µW) optic power in µW
P (dBm) optic power

7 Assembly Guidelines

7.1 Assembly Guideline for FSMA connector ∅ 2.2 mm

Tools needed:

- Crimp plier
- Grinding disc LWL
- Stripper 2.2 mm
- Sandpaper LWL rough
- Sandpaper LWL fine

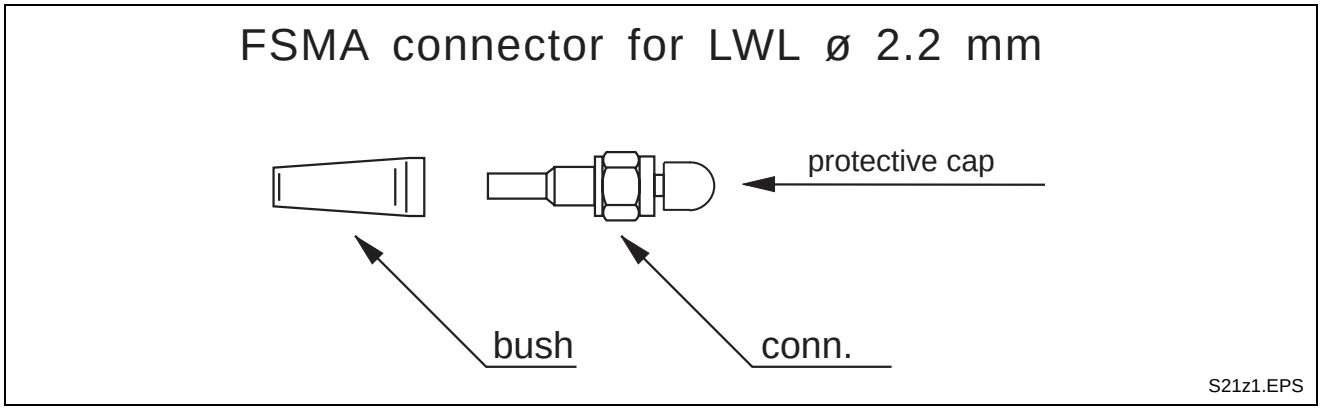


Fig. 7-1: FSMA connector for an LWL ∅ 2.2 mm

Preparing the LWL

⇒ Unpack connector.
⇒ Cut LWL to needed length.
⇒ Push strap of protective cap over cable.
⇒ Cut 1st stage of sleeve (at thin end) off.
⇒ Push sleeve narrow end first over cable.
⇒ Strip cable mantle with stripper 2.2 mm.

Note: Do not damage the LWL (∅ 1.0).

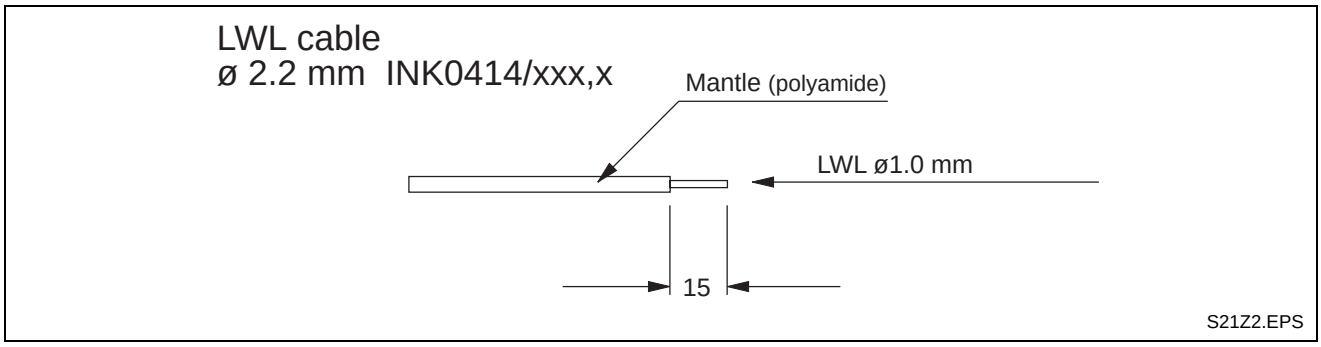


Fig. 7-2: LWL ∅ 2.2 mm

Making an LWL with an FSMA connector

⇒ Push connector with nut onto LWL.

⇒ Crimp with “A” opening of crimp plier per Fig. 7-3.

⇒ Shorten inside strand of LWL with sharp knife or similar to length of about 1 mm.

Note: Make sure there are no breaks in the LWL.

⇒ Push sleeve onto FSMA connector (sleeve clicks into place, see Fig. 7-4)

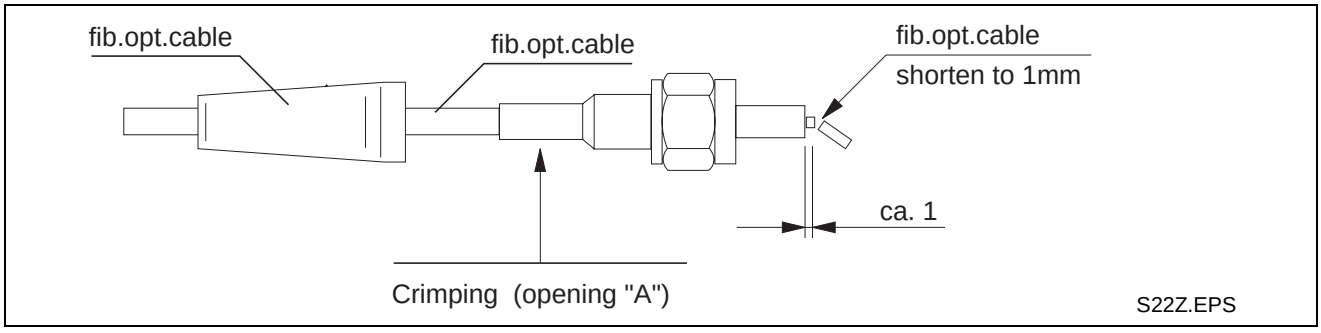


Fig. 7-3: Making an LWL with FSMA connector

Grinding the LWL

⇒ Place a sheet of sandpaper (rough) onto a flat surface, e.g., glass panel.

⇒ Screw the FSMA connector completely into the LWL grinding disc.

⇒ Grind the LWL to a length of about 0.5 mm. Grinding motions look like an 8.

⇒ Place a sheet of sandpaper (fine) onto a flat surface, e.g., glass panel.

⇒ Grind the LWL flush to the front edge of the connector. Grinding motions look like an 8.

⇒ Screw FSMS connector out of LWL grinding disc.

Note: If water or conventional lubricant is used during grinding, then better attenuation values can be achieved.

Final steps

⇒ Measure attenuation and record on cable label.

⇒ Glue cable label on.

⇒ Place protective foil over cable label.

⇒ Screw protective cap into place.

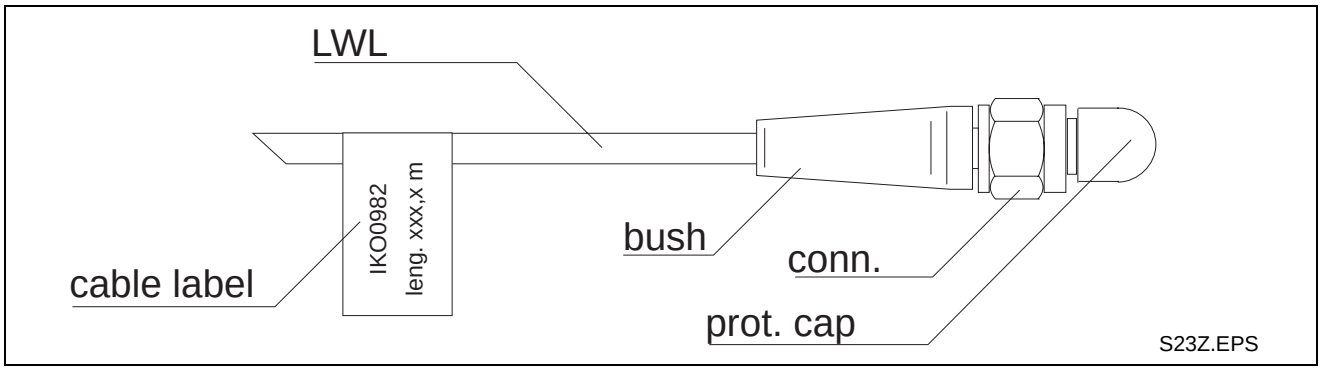


Fig. 7-4: FSMA connector 2.2 mm

7.2 Assembly Guideline for FSMA connector ∅ 6.0 mm

Tools needed

- Kevlar scissors
- Crimp plier
- Grinding disc LWL
- Stripping knife
- Stripper 2.2 mm
- Sandpaper LWL rough
- Sandpaper LWL fine

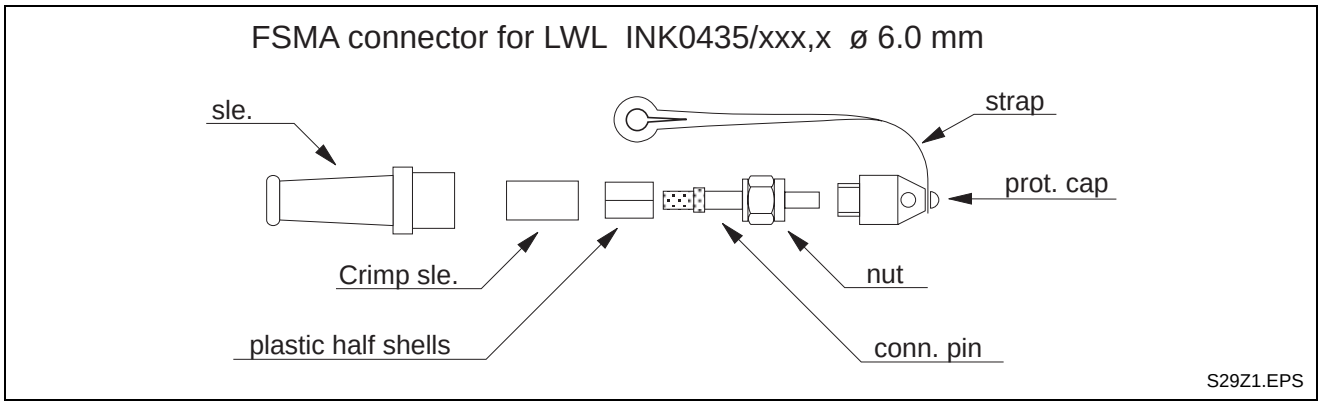


Fig. 7-5: FSMA connector for an LWL

Preparing the LWL

⇒ Cut LWL to needed length.
⇒ Push sleeve onto correct side of cable.
⇒ Push strap of protective cap over cable.
⇒ Strip PUR ext. mantle of cable with stripping knife per Fig. 7-6.
⇒ Push crimp sleeve over cable.
⇒ Strip inside mantle with stripper 2.2 mm (Fig. 7-6).

Note: Avoid all breaks in the LWL (∅ 1.0).

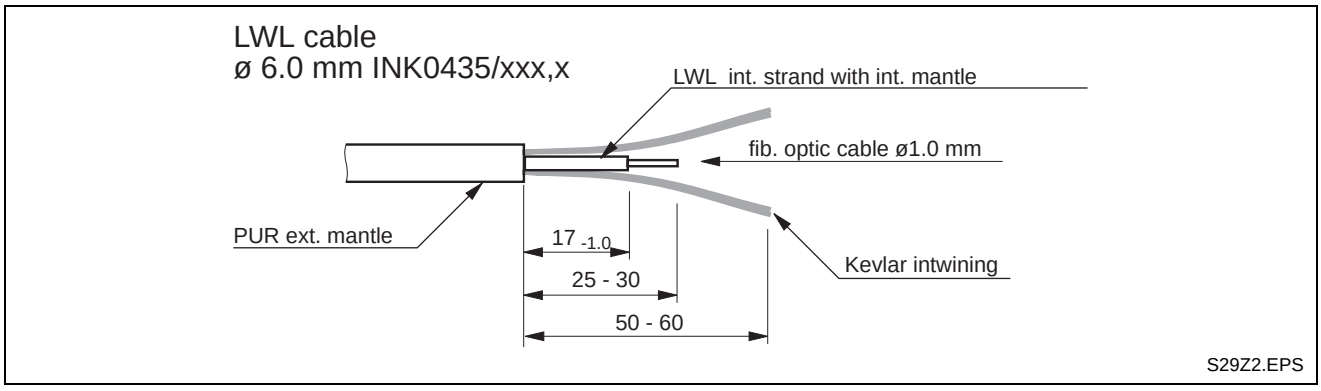


Fig. 7-6: LWL stripping information

Making an LWL with FSM connector

⇒ Push connector pin with nut onto cable. The knurled part of the PUR external mantle is also pressed in.

⇒ The inside lead crimped per Fig. 7-7 with opening „A“ of crimp pliers.

Note: Avoid all breaks in LWL.

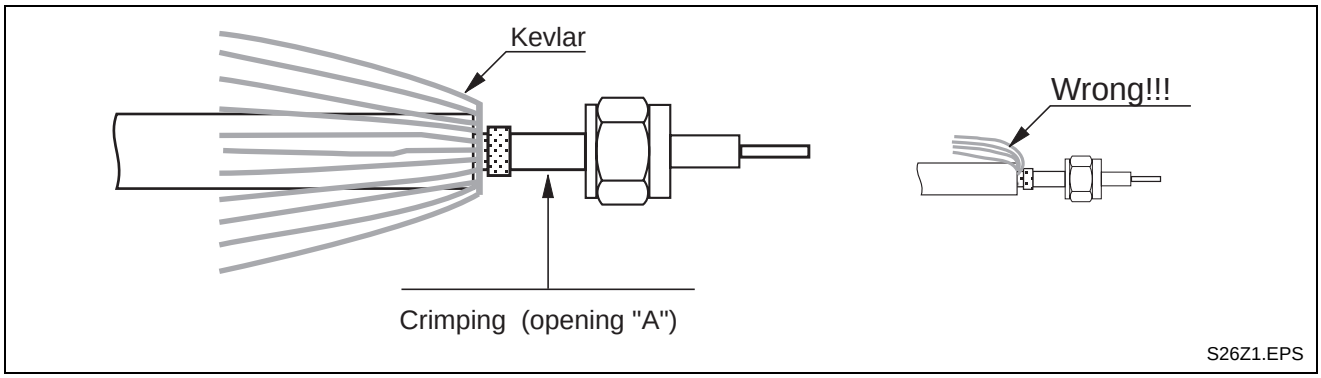


Fig. 7-7: Assembling an LWL connector

⇒ When pressing the FSMA connector into place the kevlar fibers could be shoved under the external mantle.

⇒ By pulling in connector direction, the kevlar fibers are stretched into place.

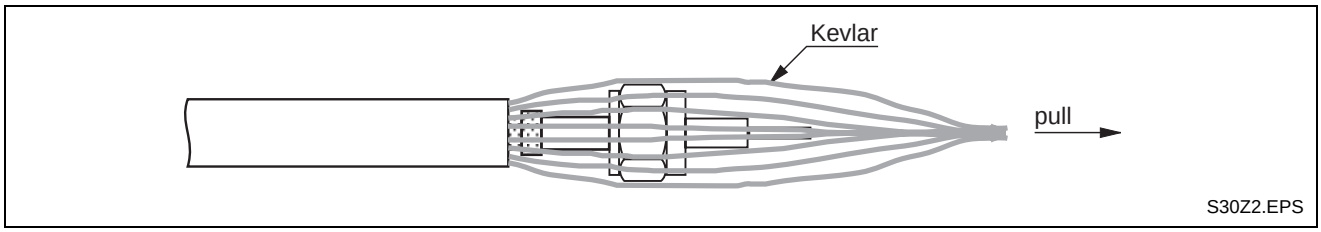


Fig. 7-8: Stretching the kevlar intwining

⇒ Shorten kevlar intwining with kevlar scissors to 6 – 8 mm.

⇒ Shorten LWL inside strands with sharp knofe to length of about 1 mm.

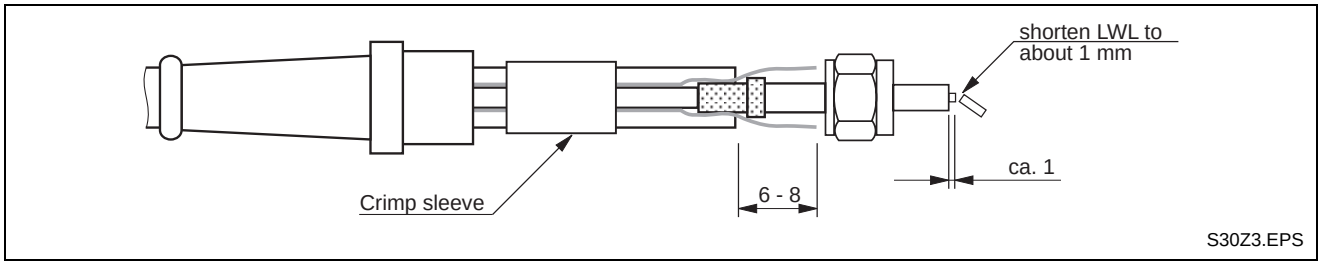


Fig. 7-9: Tension relief information

⇒ Place kevlar intwining around connector pin.

⇒ Place plastic half shells, do not separate these, around kevlar and connector pins as shown in Fig. 7-10.

⇒ Push crimp sleeve up to about 0.5 mm to the nut over the half shells.

⇒ Crimp crimp sleeves with „B“ opening of crimp pliers.

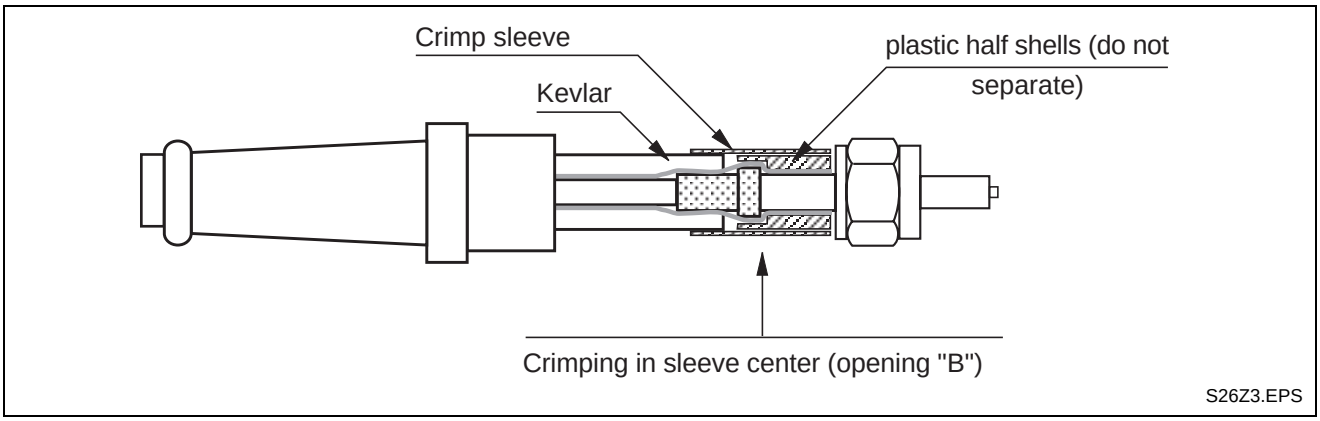


Fig. 7-10: Crimp instructions

Grinding the LWL

⇒ Place a sheet of sandpaper (rough) onto a flat surface, e.g., glass panel.

⇒ Screw the FSMA connector completely into the LWL grinding disc.

⇒ Grind the LWL to a length of about 0.5 mm. Grinding motions look like an 8.

⇒ Place a sheet of sandpaper (fine) onto a flat surface, e.g., glass panel.

⇒ Grind the LWL flush to the front edge of the connector. Grinding motions look like an 8.

⇒ Screw FSMS connector out of LWL grinding disc.

Note: If water or conventional lubricant is used during grinding, then better attenuation values can be achieved.

Final steps

⇒ Push sleeve on the nut, shown in Fig. 7-7
⇒ Measure attenuation and record on cable label
⇒ Glue cable label on.
⇒ Place protective foile over cable label.
⇒ Screw protective cap into place.

Note: Do not push sleeve over nut.

The sleeve is basically, in addition to a protection against bending, also vibration protection to prevent the nut from loosening. Do not push the sleeve into place until all work on the LWL has been completed.

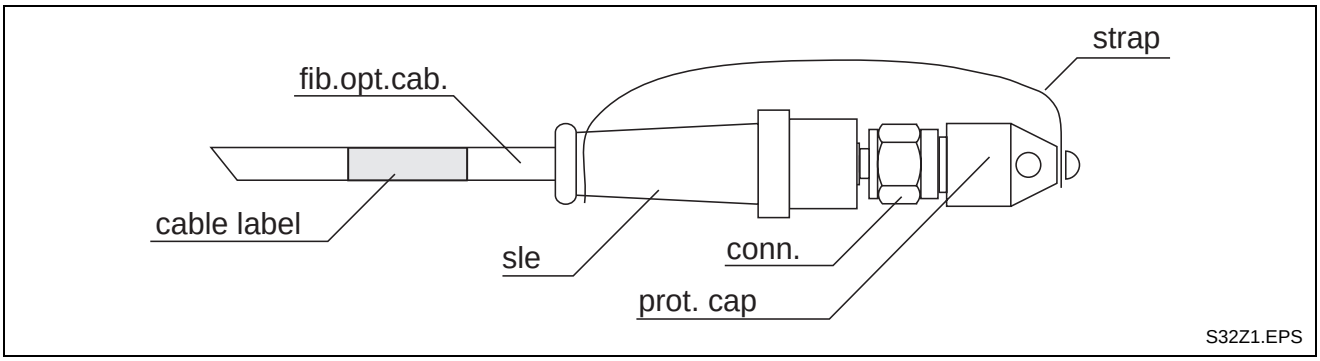


Fig. 7-11 Illustrated FSMA connector 6.0 mm

8 Tools for Assembly LWLs

8.1 Overview

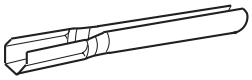
Illustration	Name	Order no.	Tool for cable types INK0414 to INK0435	
	Stripping plier LWL 6.0 mm	257 321	not needed	needed
	Kevlar scissors	244 011	not needed	needed
	LWL grinding disc	244 014	needed	needed
	Crimp plier ∅ 2.2 / 6.0 LWL	244 384	needed	needed
	socket wrench LWL FSMA	260 285	needed if FSMA plug-in connector not accesible	needed if FSMA plug-in connector not accesible
	stripper 2.2 mm	244 013	needed	needed
no illustration	sandpaper LWL rough	244 017	needed	needed
no illustration	sandpaper LWL fine	244 018	needed	needed

Fig. 8-1: Tools for Assembly LWLs

8.2 Test Tools for LWLs

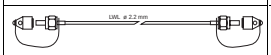
Illustration	Name	Order no.	Test tool for cable types INK0414 to INK0435	
	LWL test sender e.g., 1XT from TS-optoelectronics	not supplied by Indramat	not needed	not needed
	LWL reference measure type IKO0982/1	238 523	not needed	not needed
	LWL measure coupling	252 524	not needed	not needed
no illustration	LWL level meter e.g., 4XTS from TS-Optoelectronic with adapter TSO-2000-X for FSMA	not supplied by Indramat	not needed	not needed

Fig. 8-2: Test tool for LWL cables

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10 Kundenbetreuungsstellen - Sales & Service Facilities

Kundenbetreuungsstellen - Sales & Service Facilities

Deutschland - Germany

Vertriebsgebiet Mitte Germany Centre ☒V/S ☒Service INDRAMAT GmbH Bgm.-Dr.-Nebel-Str. 2 D - 97816 Lohr am Main Telefon: +49 (0)9352/40-0 Telefax: +49 (0)9352/40-4885	Vertriebsgebiet Ost Germany East ☒V/S ☒Service INDRAMAT GmbH Beckerstraße 31 D - 09120 Chemnitz Telefon: +49 (0)371/35 55-0 Telefax: +49 (0)371/35 55-333	Vertriebsgebiet West Germany West ☒V/S ☒Service INDRAMAT GmbH Harkortstraße 25 D - 40849 Ratingen Telefon: +49 (0)2102/43 18-0 Telefax: +49 (0)2102/41 315	Vertriebsgebiet Nord Germany North ☒V/S ☐Service INDRAMAT GmbH Kieler Straße 212 D - 22525 Hamburg Telefon: +49 (0)40/85 31 57-0 Telefax: +49 (0)40/85 31 57-15
Vertriebsgebiet Süd Germany South ☒V/S ☐Service INDRAMAT GmbH Ridlerstraße 75 D-80339 München Telefon: +49 (0)89/540138-30 Telefax: +49 (0)89/540138-10	Gebiet Südwest Germany South-West ☒V/S ☒Service INDRAMAT GmbH Böblinger Straße 25 D-71229 Leonberg Telefon: +49 (0)7152/9 72-6 Telefax: +49 (0)7152/9 72-727		INDRAMAT Service-Hotline INDRAMAT GmbH Telefon: +49 (0)172/660 04 06 oder Telefon: +49 (0)171/333 88 26

Kundenbetreuungsstellen in Deutschland - Service agencies in Germany

Europa - Europe

Austria ☒V/S ☐Service Mannesmann Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT Hägelingasse 3 A - 1140 Wien Telefon: +43 (0)1/9852540-400 Telefax: +43 (0)1/9852540-93	Austria ☐V/S ☒Service Mannesmann Rexroth G.m.b.H. Geschäftsbereich INDRAMAT Industriepark 18 A - 4061 Pasching Telefon: +43 (0)7221/605-0 Telefax: +43 (0)7221/605-21	Belgium ☒V/S ☒Service Mannesmann Rexroth N.V.-S.A. Geschäftsbereich INDRAMAT Industrielaan 8 B-1740 Ternat Telefon: +32 (0)2/5823180 Telefax: +32 (0)2/5824310	Denmark ☒V/S ☒Service BEC AS Zinkvej 6 DK-8900 Randers Telefon: +45 (0)87/11 90 60 Telefax: +45 (0)87/11 90 61
England ☒V/S ☒Service Mannesmann Rexroth Ltd. INDRAMAT Division 4 Esland Place, Love Lane GB - Cirencester, Glos GL7 1YG Telefon: +44 (0)1285/658671 Telefax: +44 (0)1285/654991	Finland ☒V/S ☐Service Rexroth Mecman OY Ansatie 6 SF-017 40 Vantaa Telefon: +358 (0)9/84 91 11 Telefax: +358 (0)9/84 91 13 60	France ☒V/S ☒Service Mannesmann Rexroth S.A. Division INDRAMAT Parc des Barbanniers 4, Place du Village F-92632 Gennevilliers Cedex Telefon: +33 (0)141 47 54 30 Telefax: +33 (0)147 94 69 41 Hotline: +33 (0)6 08 33 43 28	France ☒V/S ☐Service Mannesmann Rexroth S.A. Division INDRAMAT 270, Avenue de Lardenne F - 31100 Toulouse Telefon: +33 (0)5 61 49 95 19 Telefax: +33 (0)5 61 31 00 41
France ☒V/S ☐Service Mannesmann Rexroth S.A. Division INDRAMAT 91, Bd. Irène Joliot-Curie F - 69634 Vénissieux - Cedex Telefon: +33 (0)4 78 78 53 65 Telefax: +33 (0)4 78 78 52 53	Italy ☒V/S ☒Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via G. Di Vittoria, 1 I - 20063 Cernusco S/N.MI Telefon: +39 (0)2/92 36 52 70 Telefax: +39 (0)2/92 36 55 12	Italy ☒V/S ☒Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via Borgomanero, 11 I - 10145 Torino Telefon: +39 (0)11/7 71 22 30 Telefax: +39 (0)11/7 71 01 90	Italy ☒V/S ☐Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via del Progresso, 16 (Zona Ind.) I - 35020 Padova Telefon: +39 (0)49/8 70 13 70 Telefax: +39 (0)49/8 70 13 77
Italy ☐V/S ☒Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via de Nicola, 12 I - 80053 Castellamare di Stabbia NA Telefon: +39 (0)81/8 72 30 37 Telefax: +39 (0)81/8 72 30 18	Italy ☒V/S ☐Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Viale Oriani, 38/A I - 40137 Bologna Telefon: +39 (0)51/34 14 14 Telefax: +39 (0)51/34 14 22	Netherlands ☒V/S ☐Service Hydraudyne Hydrauliek B.V. Kruisbroeksestraat 1 P.O. Box 32 NL - 5281 RV Boxtel Telefon: +31 (0)411/65 19 51 Telefax: +31 (0)411/65 14 83	Netherlands ☐V/S ☒Service Hydrocare B.V. Kruisbroeksestraat 1 P.O. Box 32 NL - 5281 RV Boxtel Telefon: +31 (0)411/65 19 51 Telefax: +31 (0)411/67 78 14
Spain ☒V/S ☒Service Mannesmann Rexroth S.A. Divisiòn INDRAMAT Centro Industrial Santiga Obradors s/n E-08130 Santa Perpetua de Mogoda Barcelona Telefon: +34 937 47 94 00 Telefax: +34 937 47 94 01	Spain ☒V/S ☒Service Goimendi S.A. División Indramat Jolastokieta (Herrera) Apartado 11 37 E - 20017 San Sebastian Telefon: +34 9 43/40 01 63 Telefax: +34 9 43/39 17 99	Sweden ☒V/S ☒Service Rexroth Mecman Svenska AB INDRAMAT Division Varuvägen 7 S - 125 81 Stockholm Telefon: +46 (0)8/727 92 00 Telefax: +46 (0)8/64 73 277	Switzerland - East ☒V/S ☒Service Mannesmann Rexroth AG Geschäftsbereich INDRAMAT Gewerbestraße 3 CH-8500 Frauenfeld Telefon: +41 (0)52/720 21 00 Telefax: +41 (0)52/720 21 11
Switzerland - West ☒V/S ☐Service Mannesmann Rexroth SA Département INDRAMAT Chemin de l`Ecole 6 CH-1036 Sullens Telefon: +41 (0)21/731 43 77 Telefax: +41 (0)21/731 46 78	Russia ☐V/S ☒Service Tschudnenko E.B. Arsenia 22 RUS - 153000 Ivanovo Rußland Telefon: +7 093/223 96 33 oder/or +7 093/223 95 48 Telefax: +7 093/223 46 01	Slowenia ☒V/S ☒Service DOMEL Elektromotorji in gospodinjski aparati d. d. Otoki 21 SLO - 64 228 Zelezniki Telefon: +386 64/61 73 32 Telefax: +386 64/64 71 50	Turkey ☒V/S ☒Service Mannesmann Rexroth Hidropar A..S. Fevzi Cakmak Cad No. 3 TR - 34630 Sefaköy Istanbul Telefon: +90 212/541 60 70 Telefax: +90 212/599 34 07

Europäische Kundenbetreuungsstellen (ohne Deutschland)
European Service agencies (without Germany)

Außerhalb Europa - outside Europe

Argentina ☒V/S ☐Service

Mannesmann Rexroth S.A.I.C.
Division INDRAMAT
Acassusso 48 41/7
RA - 1605 Munro (Buenos Aires)

Telefon: +54 (0)1/756 01 40
+54 (0)1/756 01 36

Argentina ☐V/S ☒Service

NAKASE
Asesoramiento Tecnico
Calle 49, No. 5764-66
RA - 1653 Villa Balester
Provincia de Buenos Aires

Telefon: +54 (0) 1/768 24 13
Telefax: +54 (0) 1/768 36 43

Australia ☒V/S ☒Service

AIMS - Australian Industrial
Machinery Services Pty. Ltd.
Unit 3/45 Horne ST
Campbellfield 3061
AUS - Melbourne, VIC

Telefon: +61 (0)3/93 59 02 28
Telefax: +61 (0)3/93 59 02 86

Brazil ☒V/S ☒Service

Mannesmann Rexroth
Automação Ltda.
Divisão INDRAMAT
Rua Georg Rexroth, 609
Vila Padre Anchieta
BR - 09951-270 Diadema-SP
[Caixa Postal 377]
[BR-09901-970 Diadema-SP]

Telefon: +55 (0)11/745 90 60
+55 (0)11/745 90 70
Telefax: +55 (0)11/745 90 50

Canada ☒V/S ☒Service

Basic Technologies Corporation
Burlington Division
3426 Mainway Drive
Burlington, Ontario
Canada L7M 1A8

Telefon: +1 905/335 55 11
Telefax: +1 905/335-41 84

China ☒V/S ☐Service

Mannesmann Rexroth (China) Ldt.
Shanghai Office - Room 206
Shanghai Internat. Trade Centre
2200 Yanan Xi Lu
PRC - Shanghai 200335

Telefon: +86 21/62 75 53 33
Telefax: +86 21/62 75 56 66

China ☐V/S ☒Service

Mannesmann Rexroth (China) Ldt.
Shanghai Parts & Service Center
199 Wu Cao Road, Hua Cao
Minhang District
PRC - Shanghai 201 103

Telefon: +86 21/62 20 00 58
Telefax: +86 21/62 20 00 68

China ☒V/S ☐Service

Mannesmann Rexroth (China) Ldt.
15/F China World Trade Center
1, Jianguomenwai Avenue
PRC - Beijing 100004

Telefon: +86 10/65 05 03 80
Telefax: +86 10/65 05 03 79

China ☒V/S ☐Service

Mannesmann Rexroth (China) Ldt.
A-5F., 123 Lian Shan Street
Sha He Kou District
PRC - Dalian 116 023

Telefon: +86 411/46 78 930
Telefax: +86 411/46 78 932

Hongkong ☒
V/S ☒Service

Rexroth (China) Ldt.
19 Cheung Shun Street
1st Floor, Cheung Sha Wan,
Kowloon, Hongkong

Telefon: +852 27/41 13 51/-54
oder/or +852 27/41 14 30
Telefax: +852 27/86 07 33

India ☒V/S ☒Service

Mannesmann Rexroth (India) Ltd.
INDRAMAT Division
Plot. 96, Phase III
Peenya Industrial Area
IND - Bangalore - 560058

Telefon: +91 (0)80/8 39 21 01
Telefax: +91 (0)80/8 39 43 45

India ☒V/S ☒Service

Mannesmann Rexroth (India) Ltd.
INDRAMAT Division
Plot. A-58, TTC Industrial Area
Thane Turbhe Midc Road
Mahape Village
IND - Navi Mumbai - 400 701

Telefon: +91 (0)22/7 61 46 22
Telefax: +91 (0)22/7 68 15 31

Indonesia ☒V/S ☐Service

PT. Rexroth Wijayakusuma
Jl. Raya Bekasi Km 21
Pulogadung
RI - Jakarta Timur 13920

Telefon: +62 21/4 61 04 87
+62 21/4 61 04 88
Telefax: +62 21/4 60 01 52

Japan ☒V/S ☒Service

Rexroth Automation Co., Ltd.
INDRAMAT Division
1F, I.R. Building
Nakamachidai 4-26-44
Tsuzuki-ku, Yokohama-shi
J - Kanagawa-ken 224-004

Telefon: +81 459/42-72 10
Telefax: +81 459/42-03 41

Mexico ☒V/S ☐Service

Rexroth Mexico S.A. de C.V.
Calle Neptuno 72
Unidad Ind. Vallejo
MEX - 07700 Mexico, D.F.

Telefon: +52 5 754 17 11
+52 5 754 36 84
+52 5 754 12 60
Telefax: +52 5 754 50 73
+52 5 752 59 43

Korea ☒V/S ☒Service

Mannesmann Rexroth-Seki Co Ltd.
1500-12 Da-Dae-Dong
ROK - Saha-Ku, Pusan, 604-050

Telefon: +82 (0)51/2 60 06 18
Telefax: +82 (0)51/2 60 06 19

Korea ☒V/S ☒Service

Seo Chang Corporation Ltd.
Room 903, Jeail Building
44-35 Yeouido-Dong
Yeoungdeungpo-Ku
C.P.O.Box 97 56
ROK - Seoul

Telefon: +82 (0)2/7 80 82 08
+82 (0)2/7 80 82 09
Telefax: +82 (0)2/7 84 54 08

South Africa ☒V/S ☒Service

HYTEC Automation (Pty) Ltd.
28 Banfield Road,Industria North
RSA - Maraisburg 1700

Telefon: +27 (0)11/673 20 80
Telefax: +27 (0)11/673 72 69

Taiwan ☒V/S ☐Service

Rexroth Uchida Co., Ltd.
No.1, Tsu Chiang Street
Tu Cheng Ind. Estate
Taipei Hsien, Taiwan, R.O.C.

Telefon: +886 2/2 68 13 47
Telefax: +886 2/2 68 53 88

Kundenbetreuungsstellen außerhalb Europa - Service agencies outside Europe

Außerhalb Europa / USA - outside Europe / USA

USA ☒V/S ☒Service Mannesmann Rexroth Corporation INDRAMAT Division 5150 Prairie Stone Parkway USA -Hoffman Estates, IL 60192-3707 Telefon: +1 847/6 45 36 00 Telefax: +1 847/6 45 62 01	USA ☒V/S ☒Service Mannesmann Rexroth Corporation INDRAMAT Division Central Region Technical Center USA - Auburn Hills, MI 48326 Telefon: +1 248/3 93 33 30 Telefax: +1 248/3 93 29 06	USA ☒V/S ☒Service Mannesmann Rexroth Corporation INDRAMAT Division Southeastern Technical Center 3625 Swiftwater Park Drive USA - Suwanee Georgia 30174 Telefon: +1 770/9 32 32 00 +1 770/9 32 19 03	USA ☒V/S ☒Service Mannesmann Rexroth Corporation INDRAMAT Division Northeastern Technical Center 99 Rainbow Road USA - East Granby, Connecticut 06026 Telefon: +1 860/8 44 83 77 +1 860/8 44 85 95
USA ☒V/S ☒Service Mannesmann Rexroth Corporation INDRAMAT Division Charlotte Regional Sales Office 14001 South Lakes Drive USA - Charlotte, North Carolina 28273 Telefon: +1 704/5 83 97 62 +1 704/5 83 14 86			

Kundenbetreuungsstellen außerhalb Europa / USA
Service agencies outside Europe / USA

Rexroth
Bosch Group

Bosch Rexroth AG
Electric Drives and Controls
P.O. Box 13 57
97803 Lohr, Germany
Bgm.-Dr.-Nebel-Str. 2
97816 Lohr, Germany
Phone +49 (0)93 52-40-50 60
Fax +49 (0)93 52-40-49 41
service.svc@boschrexroth.de
www.boschrexroth.com

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