RFS RADIAFLEX® CABLES

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Summary

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RADIAFLEX® radiating cable is the world's leading "leaky feeder" cable solution. It's designed to deliver contoured indoor RF coverage with radio signals leaked from the apertures on the radiating cable's outer conductor. This allows network operators to provide scalable and practical broadband wireless services for confined areas, such as tunnels, mines and large building complexes.

1. INTRODUCTION

This Guideline shows materials/products usable for the installation of RFS RADIAFLEX® cables and the RFS CELLFLEX® feeder cables as well.

The short instructions were written for qualified and experienced personnel. They describe in short words the main points that must be noted during the installation of a RFS RADIAFLEX® cables and the CELLFLEX® feeder cables as well, without any claim of completeness. Also, it shows different usable materials and installation practices.

Any liability or responsibility resulting from improper use or unsafe installation practices is disclaimed.

In principle, care must be taken to avoid all such strain that may cause permanent deformation on the cables, e.g. going below admissible bending radii, kinking, applying too high tensile stress or forcible deformation of the cable (e.g. pulling over sharp edges, over tightening of clamps etc.).

Always enforce the installation instructions, included with accessories such as for each connector, grounding kit package etc.

The link to such instructions are also available at the data sheet of the products @ RFS Webpage www.rfsworld.com

PRODUCT DATASHEET
RAY158-50JFNA
1-5/8" RADIAFLEX® RAY Cable, A-series

RAY cable, A-series

Technical features

GENERAL SPECIFICATIONS

Size		1-5/8

ELECTRICAL SPECIFICATIONS

Max. Operating Frequency	MHz	1000
Cable Type		RAY
Impedance	Ohm	50 +/- 2
Velocity, percent	%	89
Capacitance	pF/m (pF/ft)	76 (23.2)
Inductance, uH/m (uH/ft)	µH/m (µH/ft)	0.19 (0.058)
DC-resistance inner conductor, ohm/km (ohm/1000ft)	Ω/km (Ω/1000ft)	1.62 (0.49)
DC-resistance outer conductor, ohm/km (ohm/1000ft)	Ω/km (Ω/1000ft)	1.47 (0.45)
Stop bands	MHz	240-300, 500-590, 750-860
Frequency Selection	MHz	600, 900

RAY158-50JFNA REV : P1 REV DATE : 2015/04/24 www.rfsworld.com

The mechanical specifications shown in the data sheet of the cables has to be noted.

- Minimum Bending radius single bending
- Minimum Bending radius repeated bending
- Bending moment
- Max. tensile force
- Recommended clamp spacing
- Max. clamp spacing
- Min. distance to wall
- Installation temperature

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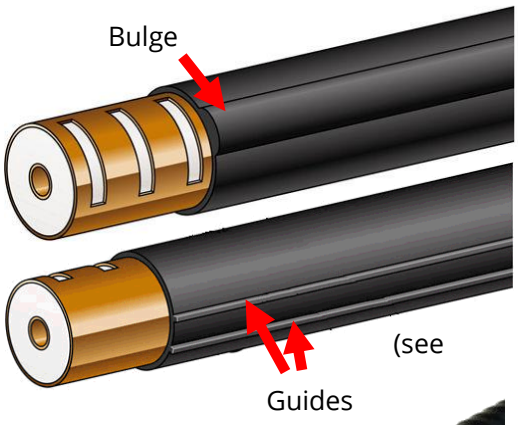
- Handle drums carefully - note the recommendations about stocking and transportation in the following pages
- Keep cable end always sealed – make sure that no humidity, dust or dirt are able to penetrate. Do not leave metallic particles when cutting the cable or installing the connector.
- Keep also all accessories such as connectors etc. clean
- Keep also clean the connector interfaces



RADIAFLEX® cables are available with bulges or guides

In order to achieve the best performance, the guides and the bulges should be installed in a defined position.

The defined position of both are shown in few of the following pages chapters 7.**) (see

Radiating waveguides

In order to achieve the best performance of radiating waveguides the slots should be installed in direction of coverage. The slots are indicated by the printing on the jacket.

Fixation of Clic clamps

Take care, use only flat-headed screws. Standard screws are able to damage the cable!

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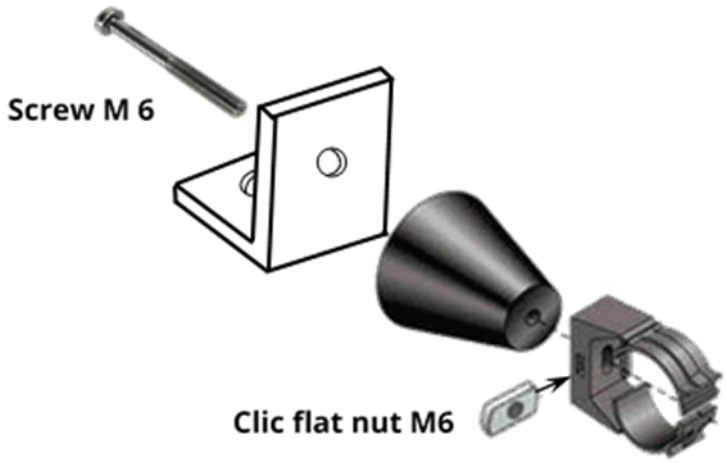
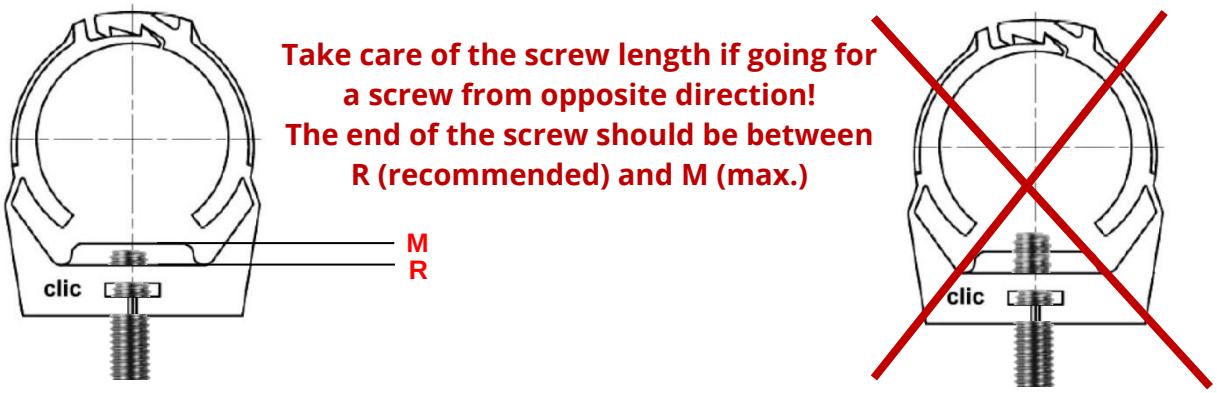
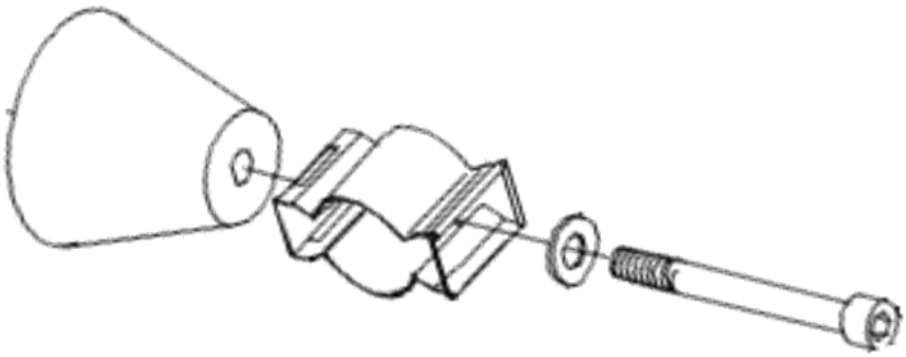
Example with screw and flat nut





Fixation of fire protection clamps (RSB clips)



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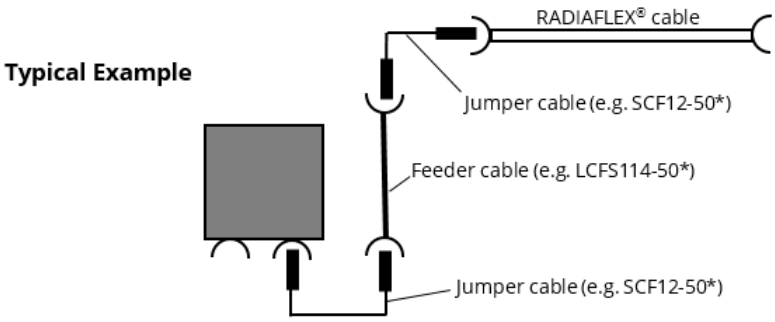
Cable – Connector connection

For easy planning, logistic and maintenance RFS recommend going for female connectors on both ends of RADIAFLEX® cables and Feeder cables as well. Then the Jumpers should have male connectors on both ends.



Distance to other cables

It is recommended to keep 30 cm (9,8 – 12 in) spacing in between of two RADIAFLEX® cables running in parallel.

Related to power cables there may be induced voltages/current into the outer conductor so usually a 30cm spacing reduces this to a low level but in any case, DC blocks are recommended to maintain a minimum isolation (few of the following pages provide more information about it).

The distance to catenary wires (high voltage) has to be larger.

The min. distance has to be defined with the operator of the tunnel system.

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2. VEHICLE AND MASCHINES

A cable trolley or cable-laying truck is suitable for transporting the drums to the site.

Installation in buildings is normally carried out using ladders or mobile scaffolds.

When installing in tunnels, track-bound trolleys belonging to the respective railway operator or other special vehicles can be used.

A conventional chalk line can be used for marking out. A roller marker is recommended for installations at a greater height.

Both mains- and battery-powered drills may be used for drilling the necessary holes for clamps etc.

The use of a cordless electric screwdriver is recommended for mounting the clamps.

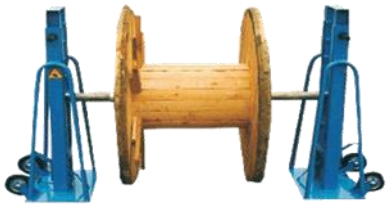
Hydraulic cable drum jacks are required for lifting the drums.

If cables have to be pulled over long distances (e.g. over the ground), then ground rollers should be used to protect the cable jacket.

The respective preparation tools should be used for mounting the connectors. These competitive items considerably ease the mounting of connectors. The quality of the connection is substantially improved.

A gas blowlamp or hot-air gun is required to shrink the heat-shrink sleeves over the connectors.

If cables have to be drawn through vertical cable ducts or conduits, then hoisting stockings should be used.



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3. TOOLS AND MATERIAL

3.1 Tools for Connector Installation

For Standard connectors for RADIAFLEX® cables with overlapping copper foil outer conductor

The required tools are shown in the installation instruction

For the installation of the standard connectors, only standard tools are required (manual installation)

3.2 Premium connectors (P02 series) for RADIAFLEX® cables with overlapping copper foil outer conductor

The required tools are shown in the installation instruction

For the installation of a Premium connector, the use of a Trimming tool is mandatory.
(the required Trimming Tool and the needed standard tools are shown in the installation instruction)

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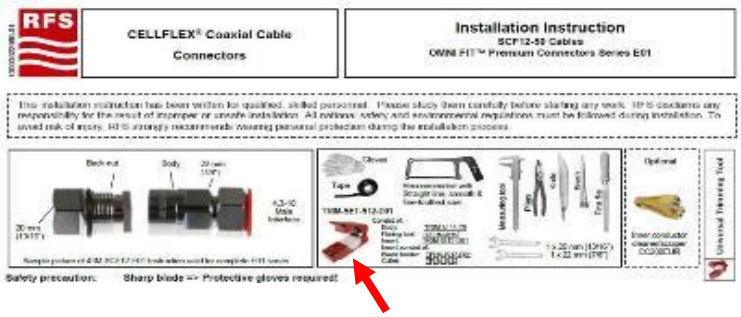
3.3 Connectors for RADIAFLEX® cables with corrugated outer conductor



For the RSF & SCF types of RADIAFLEX® cables, the same connectors are used as for CELLFLLEX® cables. (the recommended Trimming Tools and standard tools as well are shown in the installation instruction)

Note:
A heat shrink sleeve with adhesive lining must be used in addition for RSF & RCF cable types! These sleeves are not part of the Connector delivery (except connectors of the C02 & C03 family for SCF-12 cables).
Such sleeves must be ordered in addition!

Available types:

HEAT-338-012	for SCF12 connectors/cable
HEAT-328-018	for LCF12 connectors/cable
HEAT-3812-014	for LCF78 connectors/cable
HEAT-5016-024	for LCF114 connectors/cable
HEAT-6319-026	for LCF158 connectors/cable

For the installation of the heat shrink sleeves a gas blow torch or an efficient hot air gun is required. A detailed application note about the proper installation of heat shrink sleeves are available @ the link of the data sheets of the connectors.

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3.4 Connectors for CELLFLEX® cables

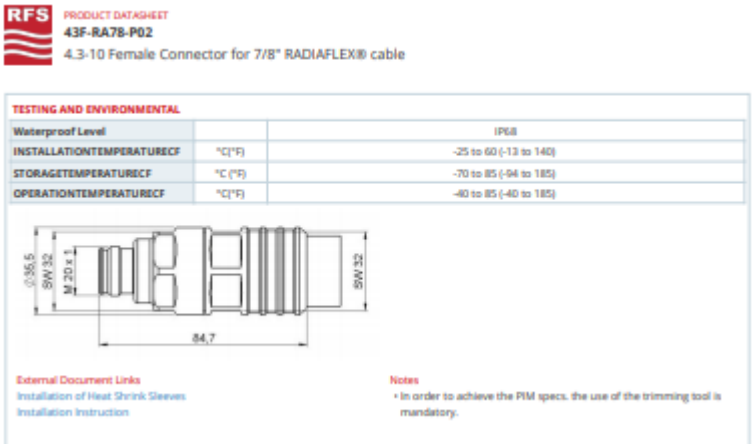
In order to achieve the best possible performance, the use of special Trimming tools are recommended. (usable Trimming Tool are shown in the installation instruction)

3.5 Preparation/Trimming tools for CELLFLEX® and RADIAFLEX® connectors

Usable tools are shown in the installation instruction of the connectors.

The Link to the installation instructions is available @ the data sheet of the connectors.
Please find the data sheet @ RFS Web page:
www.rfsworld.com/

The Universal Trimming Tool Series prepares foam – dielectric coaxial cables for connector attachment. The integrated chamfer and flare station eliminates the need for individual tools for jacket trimming, deburring and proper flaring.


PRODUCT DATASHEET
43F-RA78-P02
4.3-10 Female Connector for 7/8" RADIAFLEX® cable

TESTING AND ENVIRONMENTAL

Waterproof Level		IP68
INSTALLATIONTEMPERATURECF	°C(°F)	-25 to 60 (-13 to 140)
STORAGETEMPERATURECF	°C (°F)	-70 to 85 (-94 to 185)
OPERATIONTEMPERATURECF	°C(°F)	-40 to 85 (-40 to 185)

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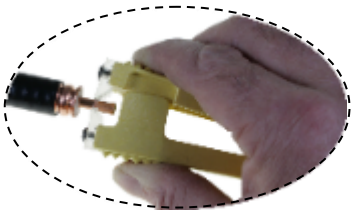
3.6 Helpful tools for the connector installation

Inner conductor cleaner

CC200EUR

This is an optional connector preparation tool for CELLFLEX® cables & RADIAFLEX® cables with solid inner conductor.
- It helps to remove the residual dielectric from the inner conductor of cables during the preparation for connector installation.
- It enables clean contact areas without any risk of surface degradation.



Toolbox

Hand tool kit with standard tools for CELLFLEX® feeder & jumper cables Mod. No. **TRIM-T01** (contents are shown at the data sheet)

The hand tool kit contains tools required for the installation of OMNI FIT™ connectors onto CELLFLEX® cables from SCF14 up to LCF158 using the manual way as described in the installation instructions of the connectors.
For easier installation and in order to get the highest possible quality of installation we recommend going for our Universal Trimming Tools (TRIM-SET-***-***) in addition.
For easier and safe installation of grounding kits and for the dismantling of cable jacket for the connector installation we recommend using our jacket stripping tools (JSTRIP-***-*).

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3.7 Tools and Utilities for connector installation

Protective gloves
1x protection for sharp knives,
1 x heat resistant

Solvent cleanser
e.g. spirit or cable cleaner

Measuring tool

Sandpaper/abrasive paper
~ 280 grain

Recommended with
Straight line, smooth &
fine- teeth saw

Knife

Tape

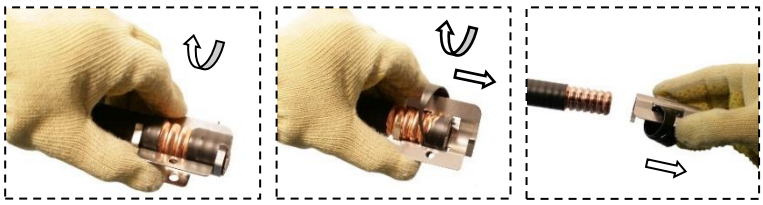
Cleaning
cloth

Brush

3.8 Tools for the installation of accessories

These Stripping tools are made for the installation of GKSPEED* grounding kits on LCF cables.
Just one turn and the work is done.

Cable jacket stripping tool for CELLFLEX® cables



also very helpful for removing the cable jacket for connector installations on LCF cable types.

Available types:

JSTRIP-12-3	for LCF12-50* cables
JSTRIP-78-2	for LCF78-50* cables
JSTRIP-114-2	for LCFS114-50* cables
JSTRIP-158-2	for LCF158-50* cables

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Hoisting grips (open types)

If cables have to be drawn through vertical cable ducts or conducts, then hoisting grips should be used. As well when long lengths have to be pull in a horizontal way.

One hoisting grip can hoist max. 70 m of cable

Available types:

HOIST1-12L for 1/2" cables

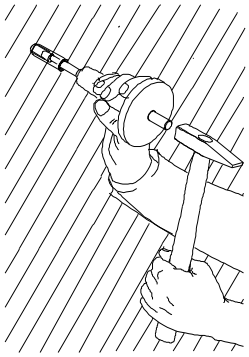
HOIST1-78L for 7/8" cables

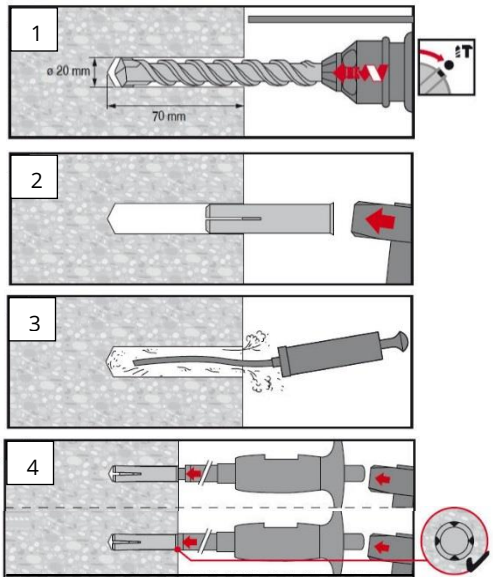
HOIST1-114L for 1 1/4" cables

HOIST1-158L for 1 5/8" cables & RE60 Waveguide

3.9 Setting Tool

Setting tool
TOOL-2





This Setting Tool is required for the installation of the Metal dowel PLUG-8-2 shown in few of the following pages.
If setting the dowel properly the tool leaves a visual setting check at the border of the dowel.

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Further tools for the installation

Additional tools are required for the installation of the cables and accessories, e.g. for the installation /fixation of cable clamps, these are shown at the following pages.

3.10 Sealing and protection material

Cold Shrink Kit

Cold Shrink Kit are used e.g. for the sealing of connector junctions.
As well as for personal protection insulation.

COLD-21
for feeder connections:
1/2" to 5/8", 5/8" to 7/8", including 7-16 DIN connectors

COLD-22
for feeder connections:
1/2" to 1-1/4", 1/2" to 1-5/8", 5/8" to 1-1/4", 5/8" to 1-5/8", 7/8" to 1 1/4", 7/8" to 1 5/8" including 7-16 DIN connectors

The shrinking process is done by simply unwinding a removable core.

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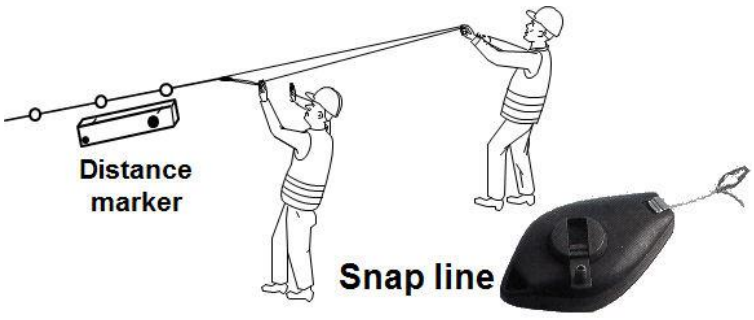
4. MARKING THE HEIGHT OF CABLE CLAMPS

Different Methods

In order to be able to work efficiently when drilling the holes for the clamps, it is necessary to mark the positions of the cable clamps accurately. There are several ways of doing this:

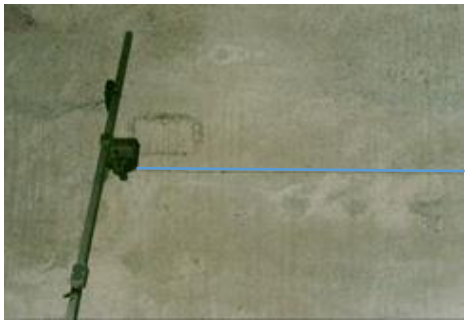
Snap-line

The horizontal mounting height for the clamps is marked using a standard chalk line. This task is often carried out on a ladder.
The clamp spacing (see RADIAFLEX® cable and CELLFLEX® cable data sheets) is then marked along this line using a spacer gauge. For example, a strip of wood with a screw at the right position and a pencil on the other end can be used.



Marking roller

In this method a roller is run along the wall at the mounting height. The roller is coated in chalk dust and is fixed to a mobile frame or directly on the installation vehicle.
The spacing of the clips is then marked along this line using a spacer gauge as described above.



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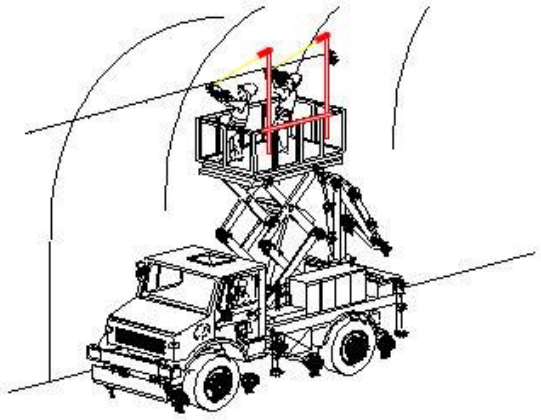
Point of light method

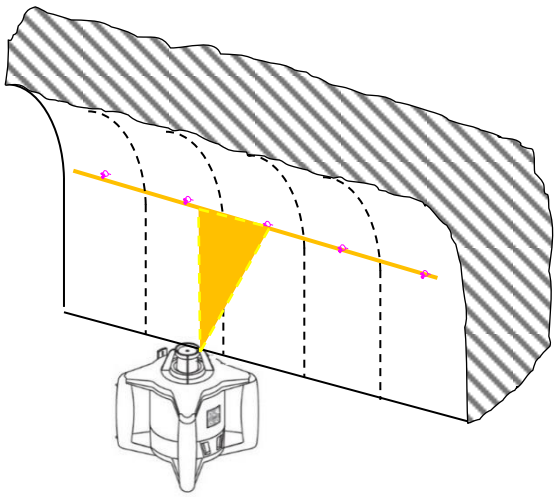
Here, at least two light sources (lasers or similar) are fitted to the platform of the installation vehicle in such a way that the points of light on the wall correspond exactly with mounting height and clamp spacing. Mounting both light sources on a mobile frame on the scaffold is advantageous.

This method enables marking and drilling to be combined in one operation. However, the movement of the vehicle's suspension can complicate this work considerably. The clamp spacing is shown automatically as the second point of light (as seen in the direction of movement) is aimed at the last hole drilled.



Rotation laser

This device is attached to a tripod or directly to the installation vehicle (scaffold or platform). The rotating laser (e.g. Hilti rotating laser PR 10) projects a continuous laser beam onto the wall intended for the installation. But if installing on a vehicle the movement of the vehicle's suspension can complicate the work.



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5. CABLE CLAMPS & CABLE TIES

5.01 Standard Clic clamp with round base – H = 80 mm

RADIAFLEX cables of the RLK, RAY and RLV series require a round base with a height H = 80 mm. These clamps are fixed with a plastic plug Ø 6 mm and a stainless-steel screw.

Care should be taken to ensure that the hole is drilled at right angles to the surface of the wall so that the clamps fit correctly to the wall during the subsequent assembly. The hole should be cleaned out with air-pump after drilling. The clamp is fixed by means of a round head woodscrew tightened with a TORX bit screw driver (T 25) or with a cordless electric screwdriver and corresponding TORX bit.

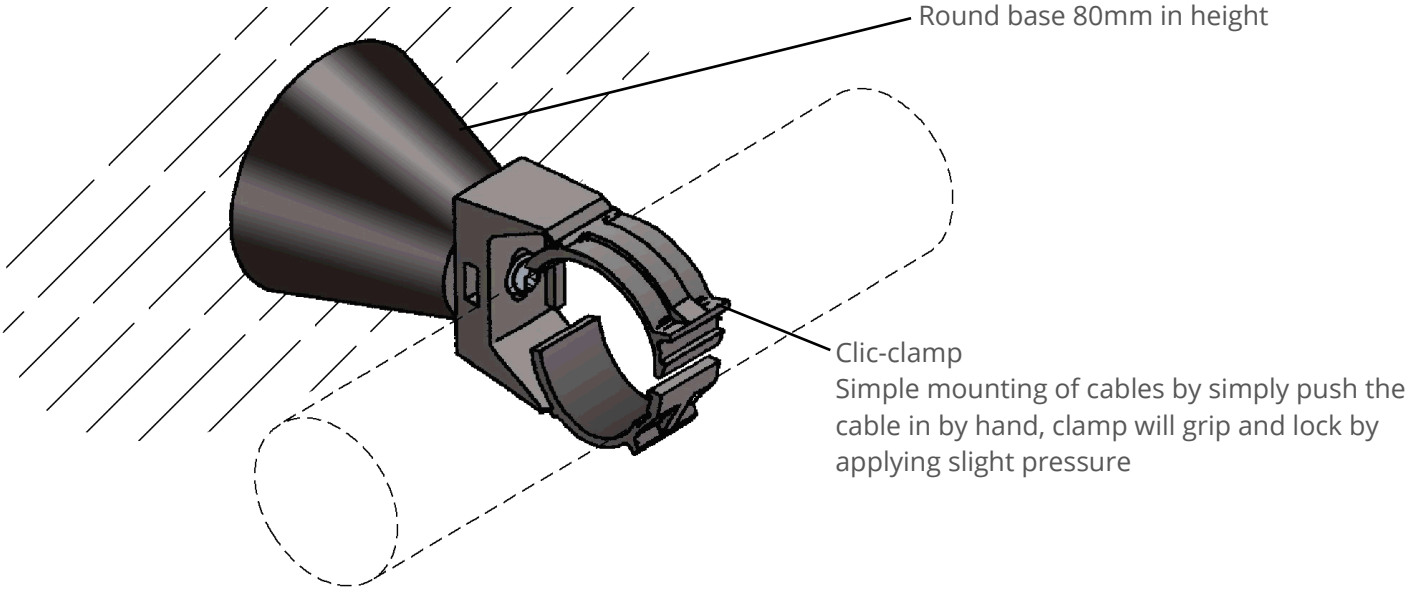
Make sure the clamps are lined up; otherwise, the cable will not run in an absolutely straight line.

The min. bending radii for installing cables should also be taken into account when fixing the clamps.

When attaching the cable, the action of pressing the cable into the clamp with the hand causes the clamp to close automatically.

Regarding the recommended clamp spacing, please refer to the data sheet of the individual cable.

Safe and efficient installation of RADIAFLEX® cable with Clic clamps. For train speeds up to 140 km/h



Installation of RADIAFLEX® cables with Clic clamps. For train speeds up to 140 km/h

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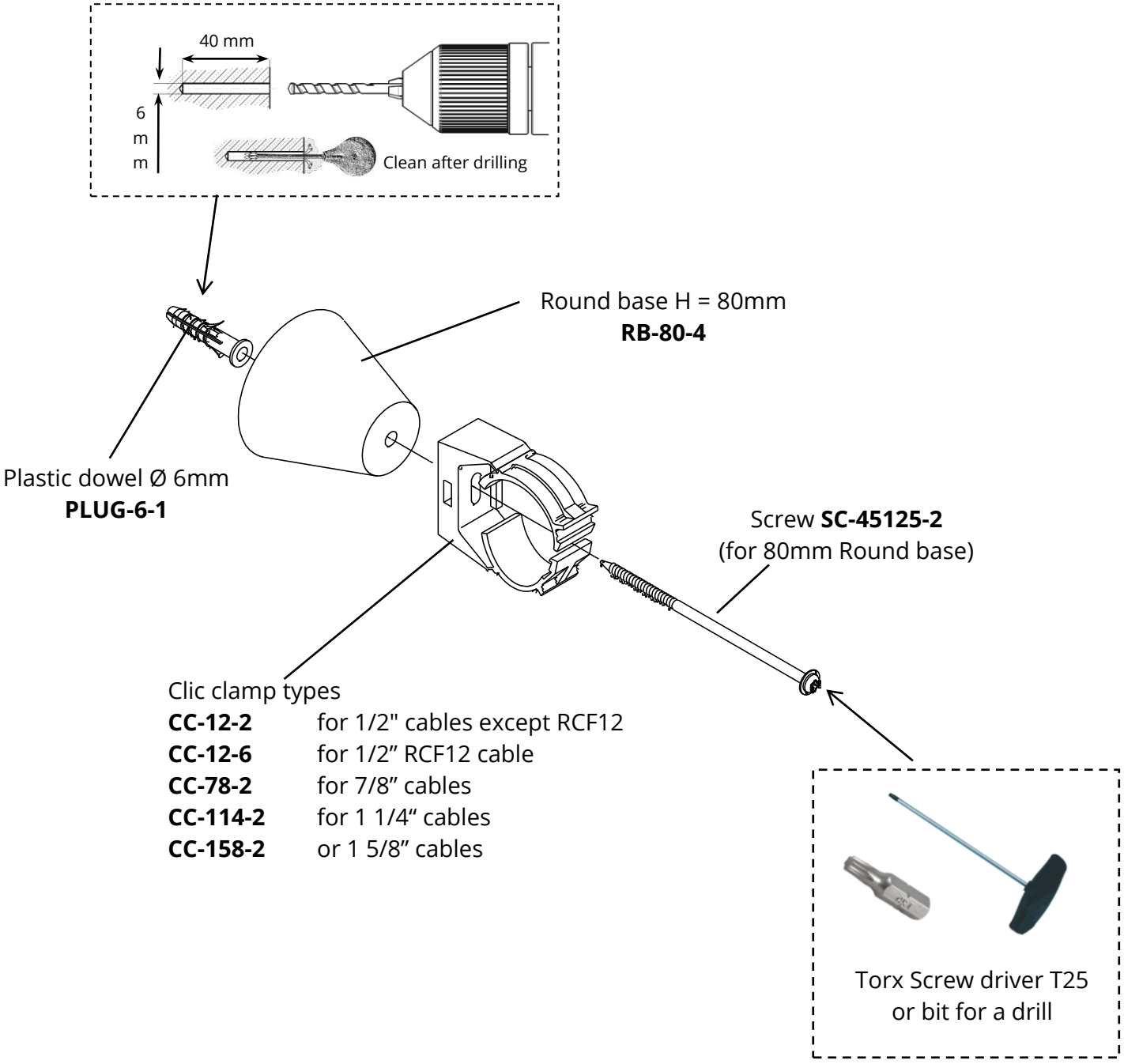
Installation of RADIAFLEX® cables with Clic clamps. For train speeds up to 140 km/h



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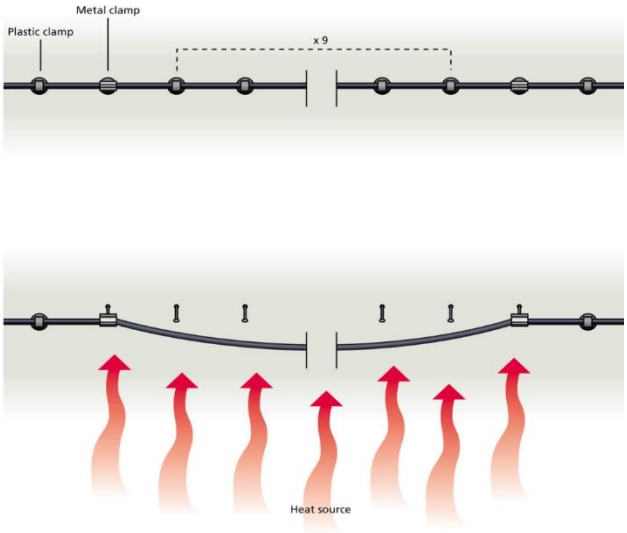
5.02 Round base with Fire-resistant clamps

This clamp type was developed for situations, which require the cable to remain functional for as long as possible in the event of a fire. The cable should not become detached from the wall or ceiling and in doing so perhaps also block an escape route.
These clamps are fixed using a stainless steel plugs .The clamps should be installed in addition to the normal clamps, not as a substitute.
Care should be taken to ensure that the hole is drilled at right angles to the surface of the wall so that the clamps do not become twisted during the subsequent assembly. The hole should be cleaned out with air-pump after drilling.
The plugs are driven into the wall with the Manual Setting Tool. The tool leaves behind a visual setting check.

The RSB-clips are fixed on a round base with H = 80 mm by means of a hexagon-socket screw M8 x 95. In doing so, a washer is placed between head of screw and RSB clip.
As the recommended installation spacing for these clamps is every approx. 8-10 m, the installation can be carried out with an Allen key, the use of a cordless electric screwdriver is hardly an advantage in this case.
Make sure the clamps are lined up; otherwise the cable will not run in an absolutely straight line.
The min. bending radii for installing cables should also be taken into account when fixing the clamps.
After installing the cable, the clips are closed by simply pressing the closure into position.



In case of fire the resistant part of the fixing will hold the cable in position and enables the cable to keep in operation as long as the cable itself allows. It also prevents the cable from detaching from the wall that might block any escape route.

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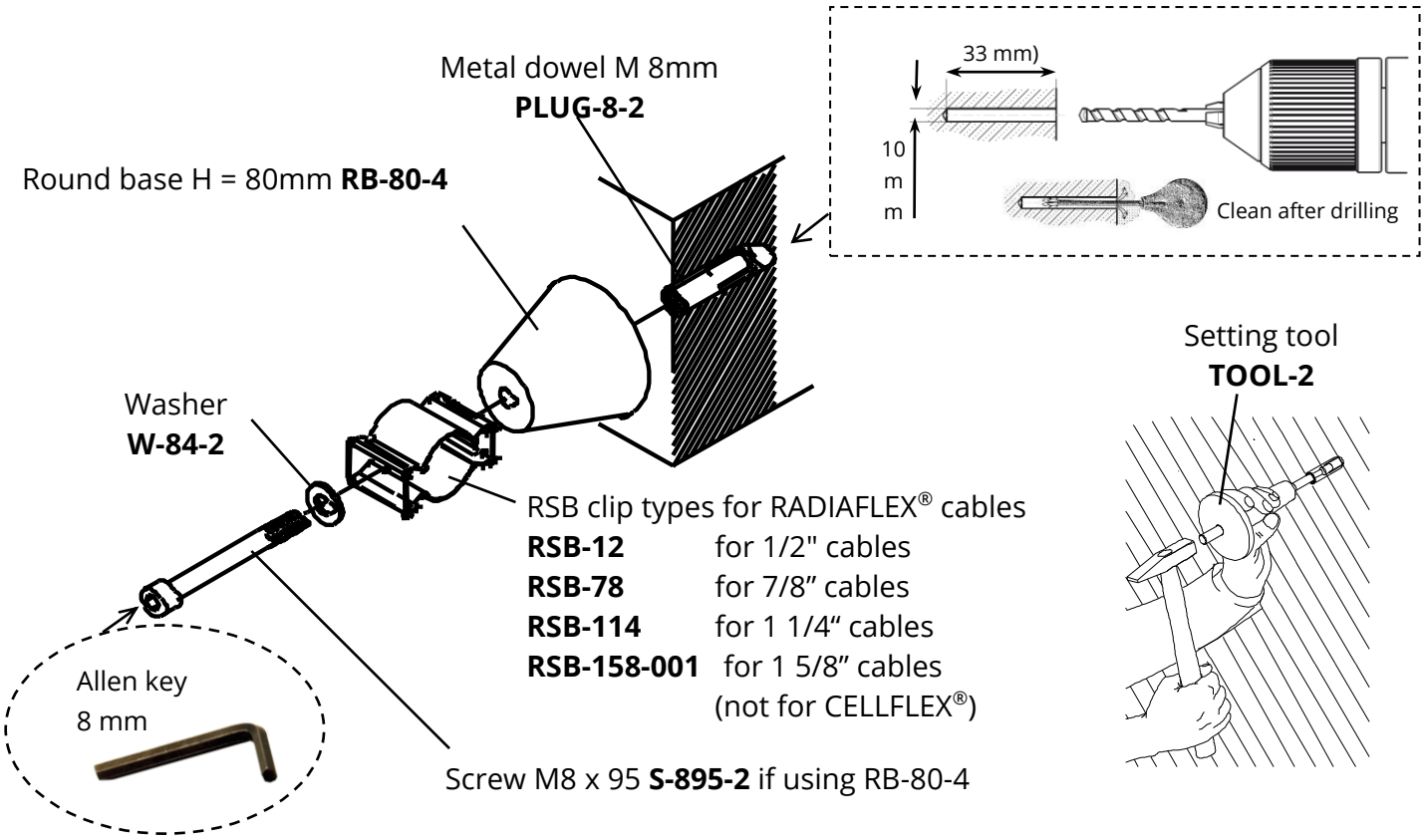

5.03 Heavy Duty Clamps fixed with metal plugs

This clamp is specially developed for use in railway tunnels for high-speed applications up to 300 km/h.

These clamps are fixed using stainless steel plugs. Care should be taken to ensure that the hole for the plug is drilled at right angles to the surface of the wall so that the clamps do not become twisted during the subsequent installation. The hole should be cleaned out with air-pump after drilling. The plugs are driven into the wall with the Manual Setting Tool. The tool leaves behind a visual setting check.

The screws can be tightened with a powerful cordless electric screwdriver. Make sure the clamps are lined up; otherwise the cable will not run in an absolutely straight line. The min. bending radii for installing cables should also be taken into account when fixing the clamps. After installing the cable, the clamps can be closed with the lock frame. Regarding the recommended clamp spacing, please refer to the data sheet of the individual cable.

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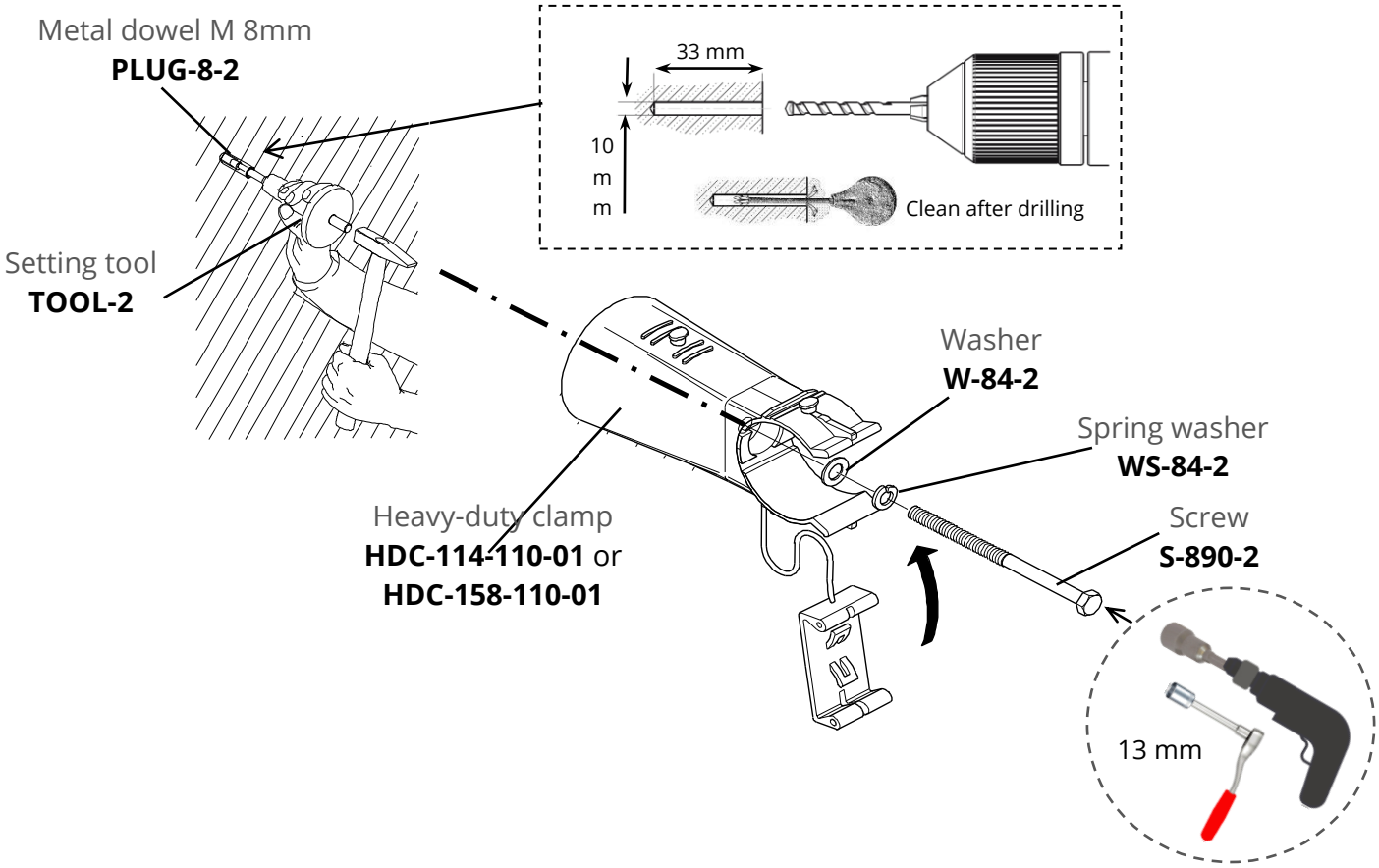
This clamp is specially developed for use in railway tunnels for high-speed applications up to 300 km/h. These clamps are fixed using stainless steel plugs. Care should be taken to ensure that the hole for the plug is drilled at right angles to the surface of the wall so that the clamps do not become twisted during the subsequent installation. The hole should be cleaned out with air-pump after drilling. The plugs are driven into the wall with the Manual Setting Tool. The tool leaves behind a visual setting check.
The screws can be tightened with a powerful cordless electric screwdriver. Make sure the clamps are lined up; otherwise, the cable will not run in an absolutely straight line. The min. bending radii for installing cables should also be taken into account when fixing the clamps. After installing the cable, the clamps can be closed with the lock frame. Regarding the recommended clamp spacing, please refer to the data sheet of the individual cable.



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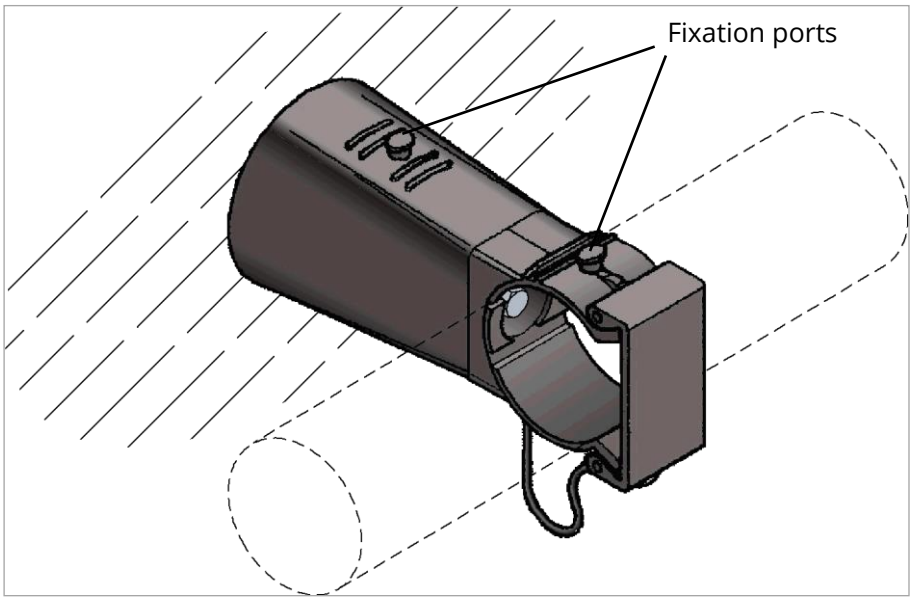
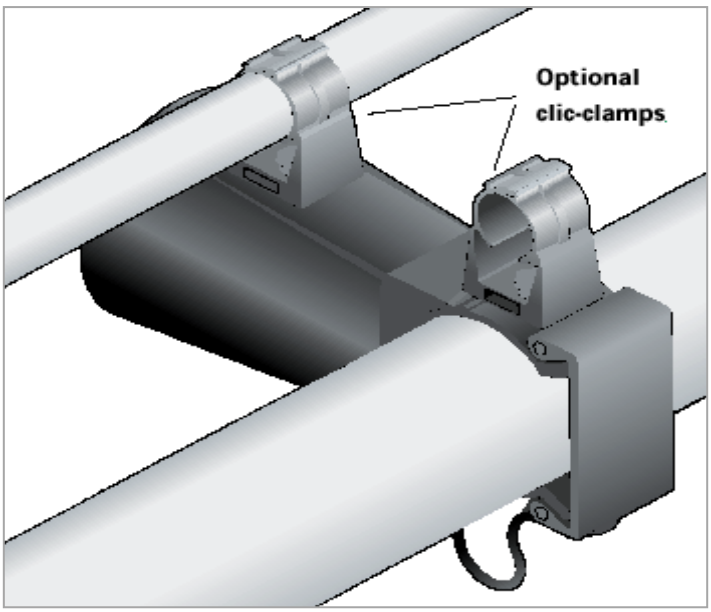
5.04 Heavy Duty Clamps with additional Clic clamps

The Heavy Duty Clamp **HDC-114-110-01** and **HDC-158-110-01** is equipped with four ports to carry additional Clic clamps. Optionally up to four Clic clamps could be mounted for installation of fibre optic backbone cables. We recommend using only two ports and mainly the back ports.

Suitable types are: **CC-12-2, CC-58-2 and CC-78-2**. They can directly be mounted without any tools and further accessories.





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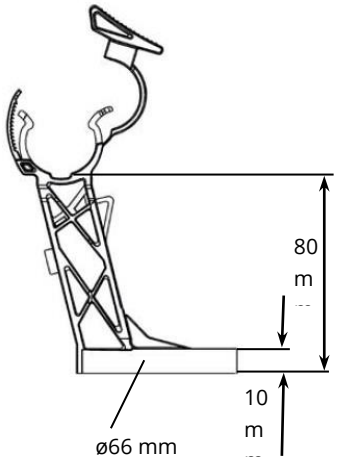
5.05 SFS Clamps

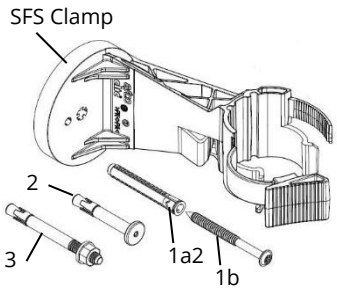
This Smart Fixing Solution provides a safe and fast to install clamp.

SFS clamp types

SFS-12-01	for 1/2" cables except RSF12 type
SFS-78-01	for 7/8" cables
SFS-114-01	for 1 1/4" cables
SFS-158-01	or 1 5/8" cables

The Smart Fixing Solution (SFS) clamp family ensures a safe and reliable RADIAFLEX cable installation in harsh environmental tunnel conditions. The SFS clamps also allow for an optimized installation process minimizing customer's total cost of ownership (TCO) – an aspect that is essentially important as installation time in tunnel environment is a key factor in deployments affecting overall solution cost.
The SFS clamps are based on a one-piece, self-closing plastic pipe clamp for the fixing of radiating cables in road, railway and metro tunnels. The SFS clamps also allow for more flexibility regarding compatibility regarding installation hardware such as e.g. screws, dowels and, consequently, allow for easier adaptation to customer specific installation need.
The SFS clamps in combination with RFS worldwide leading RADIAFLEX radiating cable portfolio have also been optimized to avoid any passive intermodulation (PIM) effects which is particularly important in highly reflective in tunnel environments to avoid network interferences and ensure highest possible network throughput.
The clamps also feature a fire secured mounting functionality by allowing additional metal cable ties to be installed together with the SFS clamps.



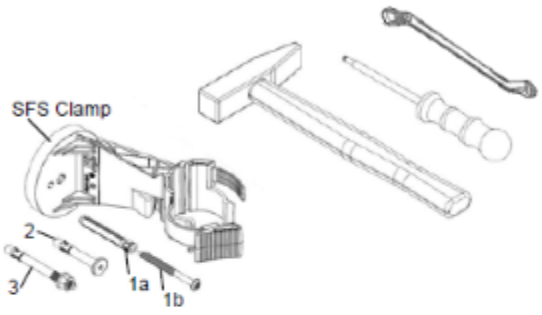


Fixation Options:

1. Plastic dowel:	**SFS-PLUG-6-01**
Screw for plastic dowel:	**SFS-SC650-02**
2. Metal Plug with head:	**SFS-FIX-644-02**
3. Metal Plug with nut:	**SFS-FIX-649-02**

RFS RADIAFLEX® CABLES

Fixation of the clamps (3 Options)



Clamps and Fixation Hardware (Options):

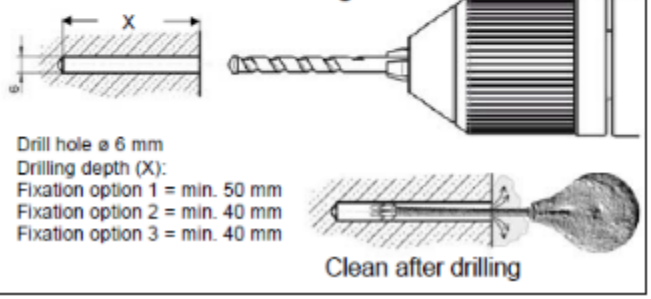
SFS Clamps: SFS-12-01, SFS-78-01, SFS-114-01, SFS-158-01

Fixation Options:

1) Plastic dowel : SFS-PLUG-6-01
   Screw for plastic dowel: SFS-SC650-02
2) Metal Plug with head: SFS-FIX-644-02
3) Metal Plug with nut: SFS-FIX-649-02

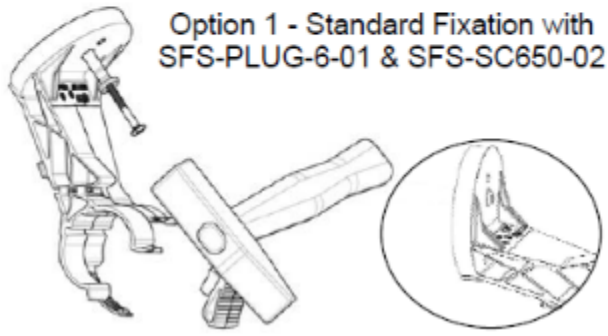
Tools:
Hammer (for all options)
Torx Wrench T-25 (optional for Fixation Hardware 1)
Wrench size 10 mm (optional for Fixation Hardware 3)

Drilling

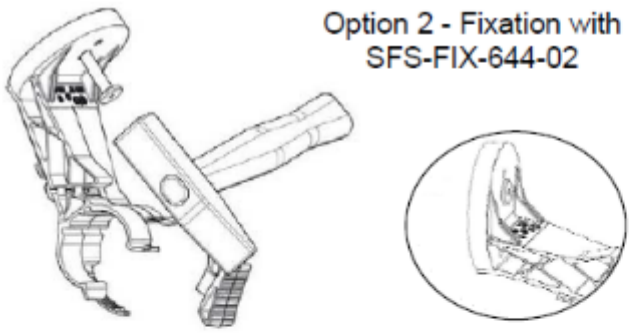


Drill hole ø 6 mm
Drilling depth (X):
Fixation option 1 = min. 50 mm
Fixation option 2 = min. 40 mm
Fixation option 3 = min. 40 mm

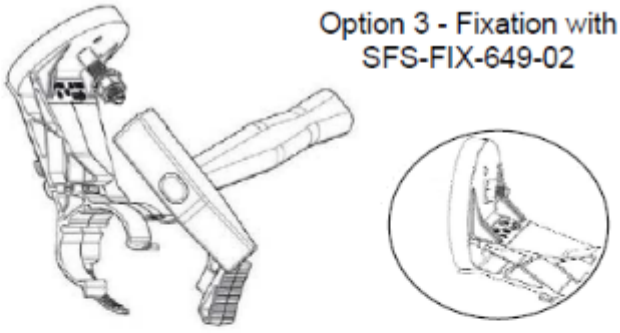
Option 1 - Standard Fixation with SFS-PLUG-6-01 & SFS-SC650-02



Option 2 - Fixation with SFS-FIX-644-02

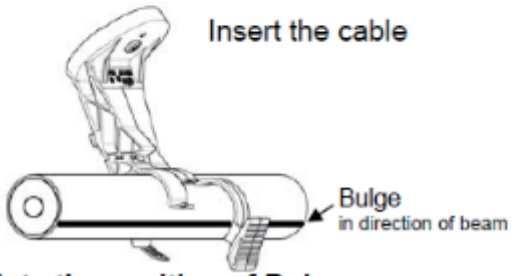


Option 3 - Fixation with SFS-FIX-649-02

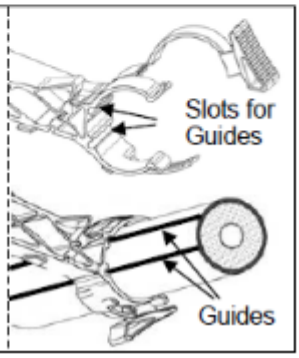


Fixation of the cables

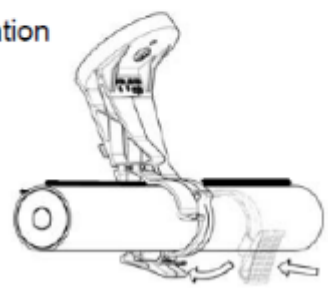
Insert the cable



Note the position of Bulge or Guides on the cable jacket



Fixation



Fix the cable by pressing in the strap

RFS RADIAFLEX® CABLES

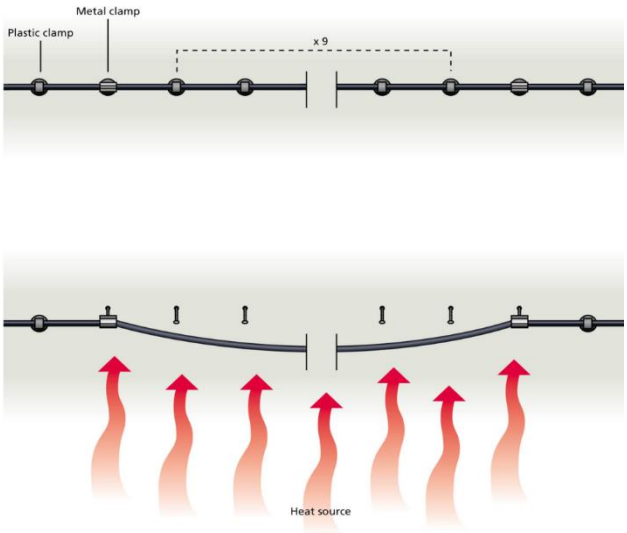
SFS Clamps offer:

- Simple and quick assembly
- Closing system without additional screws
- Secure closure, no opening
- Fixed wall distance 80 mm
- Integrated fire protection device
- Anchor and screw fastening available with standard products; Bolt setting technology is also available

RFS RADIAFLEX® CABLES

5.06 SFS Clamps with integral fire protection insert

This insert (metallic tie) for SFS clamp type is developed for situations, which require the cable to remain functional for as long as possible in the event of a fire. The cable should not become detached from the wall or ceiling and in doing so perhaps also block an escape route.



In case of fire, the resistant part of the fixing will hold the cable in position and enables the cable to keep in operation as long as the cable itself allows. It also prevents the cable from detaching from the wall that might block any escape route. Recommended installation spacing for these clamps is every approx. 8-10 m

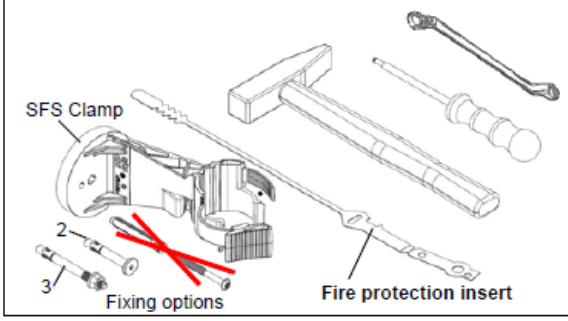
Fire protection inserts

for SFS fixing options with metallic dowels

SFS-12-F	for SFS-12-01 clamp (1/2”) L = 247 mm (9,72 in)
SFS-78-F	for SFS-78-01 clamp (7/8”) L = 300 mm (11,81 in)
SFS-114	for SFS-114-01 clamp (1 1/4”) L = 330 mm (12,99 in)
SFS-158-F	for SFS-158-01 clamp (1 5/8”) L = 335 mm (13,18 in)

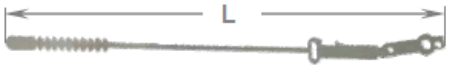
RFS RADIAFLEX® CABLES

Installation with Fire protection inserts – Recommended in a distance of ~10 m

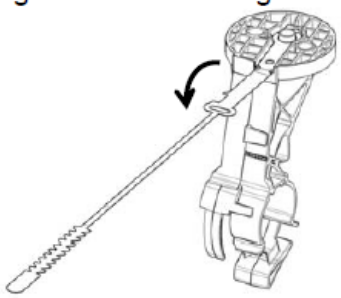


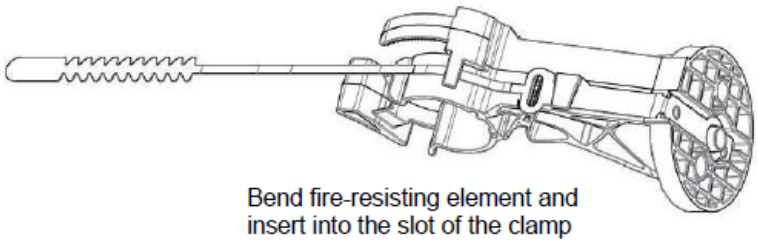
Fire protection inserts for fixing options 2 & 3 (shown on page 1)

- SFS-12-F for SFS-12-01 clamp (1/2")
  L = 247 mm (9,72 in)
- SFS-78-F for SFS-78-01 clamp (7/8")
  L = 300 mm (11,81 in)
- SFS-114 for SFS-114-01 clamp (1 1/4")
  L = 330 mm (12,99 in)
- SFS-158-F for SFS-158-01 clamp (1 5/8")
  L = 335 mm (13,18 in)



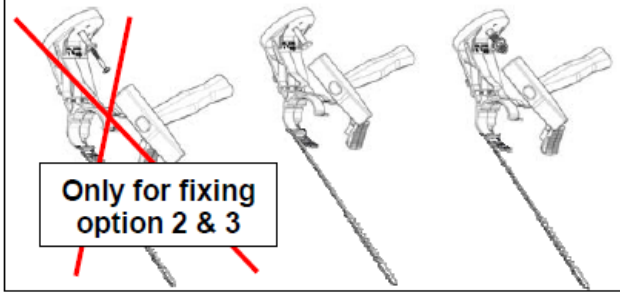
Mounting of the fire resisting element



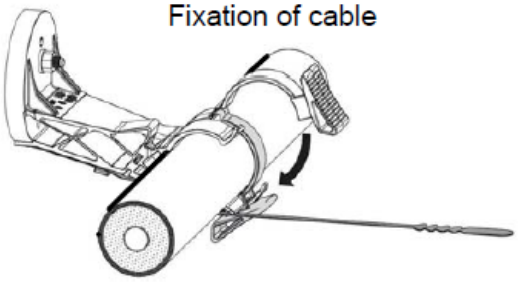


Bend fire-resisting element and insert into the slot of the clamp

Fixation – Same way as shown on page 1

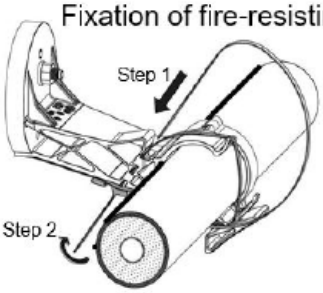


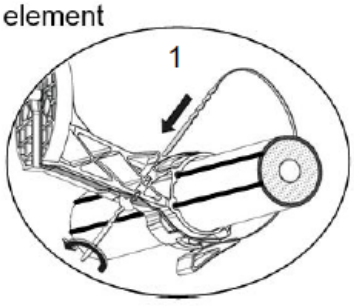
Fixation of cable

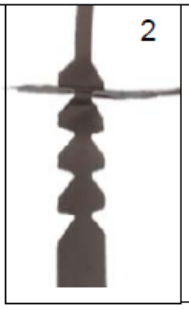


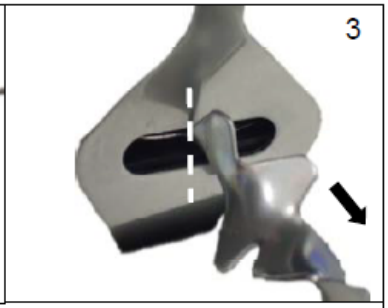
Insert the cable and fix it by pressing in the strap

Fixation of fire-resisting element









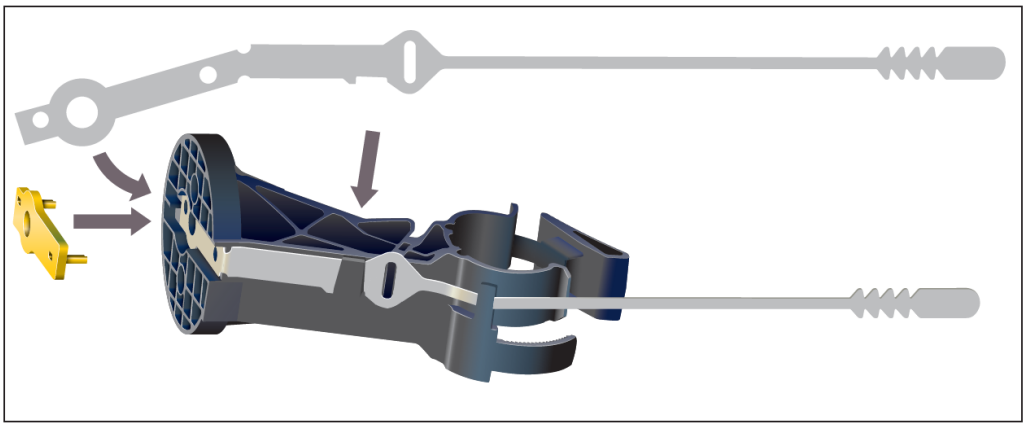
1) Enter the fire-resisting element into the foreseen slot, tighten it firmly and twist it by 360° to fix it
2) Use the last gap of metal strip and make sure it stands vertical (90°) to the slot when tighten
3) The metal strip must be tighten closed and stand of straight away from the clamp

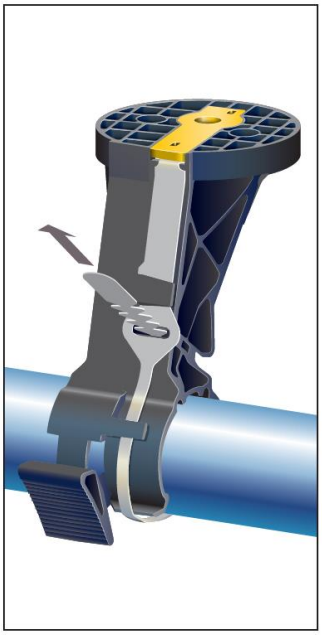
RFS RADIAFLEX® CABLES

5.07 SFS PIM Improved Installation

Radiating cables are distributed antennas and, consequently, metal obstacles in close proximity to the cable – notably to the radiating slots – may impact radiation behavior and might cause passive intermodulation (PIM) effects. This is especially true in scenarios where a metal dowel and the metal tie wrapped around the cable might make contact. PIM effects might significantly degrade overall system performance and KPI's for wireless communication systems. In order to avoid metallic contact between the fire secured tie and the metal dowel, a plastic insert has been provided to ensure the highest possible robustness against PIM interferences..

In order to avoid metallic contact between the fire secured tie and the metal dowel a plastic insert has been realized to ensure highest possible robustness against PIM interferences.





RFS RADIAFLEX® CABLES

5.08 RSB clip for CELLFLEX® cables (Feeder cables)

RSB clips are recommended for fixing CELLFLEX® cable used as a feeder line in radiating cable projects. These clamps are mainly fixed directly to walls and ceilings.

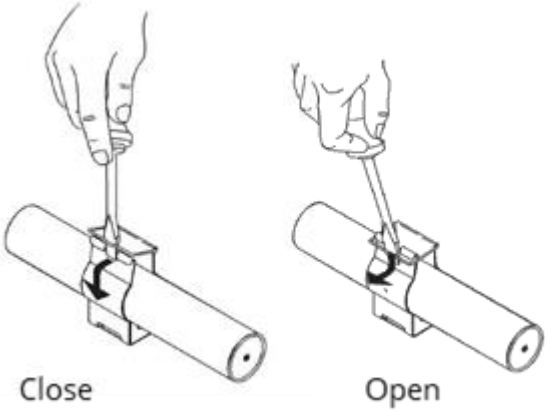
RSB clip for LCF cable types

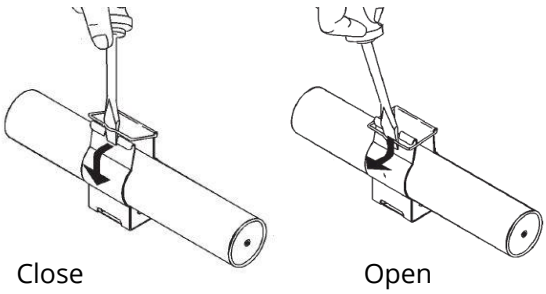
RSB clip with clamp lining for SCF cable types

RSB clip types

RSB-S12 for SCF1/2" cables (Super flexible Jumper cables)
RSB-12 for LCF1/2" cables
RSB-78 for 7/8" cables
RSB-114 for 1 1/4" cables
RSB-158 for 1 5/8" cables (note: not for RADIAFLEX® cables)
(for RADIAFLEX® cables RSB-158-001 is required)

Simply pressing the closure into position closes the clips. The use of RSB clips prevents the cable from deforming. However, the clips should only be closed after the cable has attained its final position, i.e. the cable should not be pulled through clips, which have already been closed.

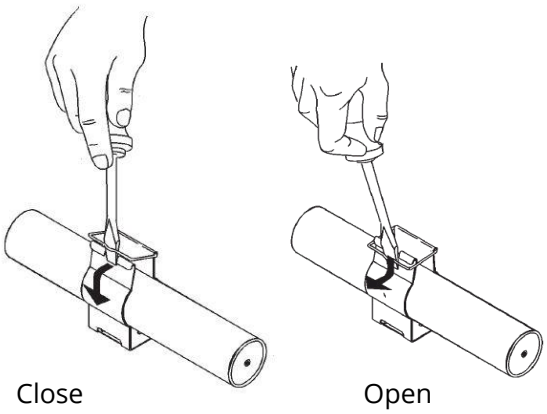




Simply pressing the closure into position closes the clips. The use of RSB clips prevents the cable from deforming. However, the clips should only be closed after the cable has attained its final position, i.e. the cable should not be pulled through clips, which have already been closed.

RFS RADIAFLEX® CABLES

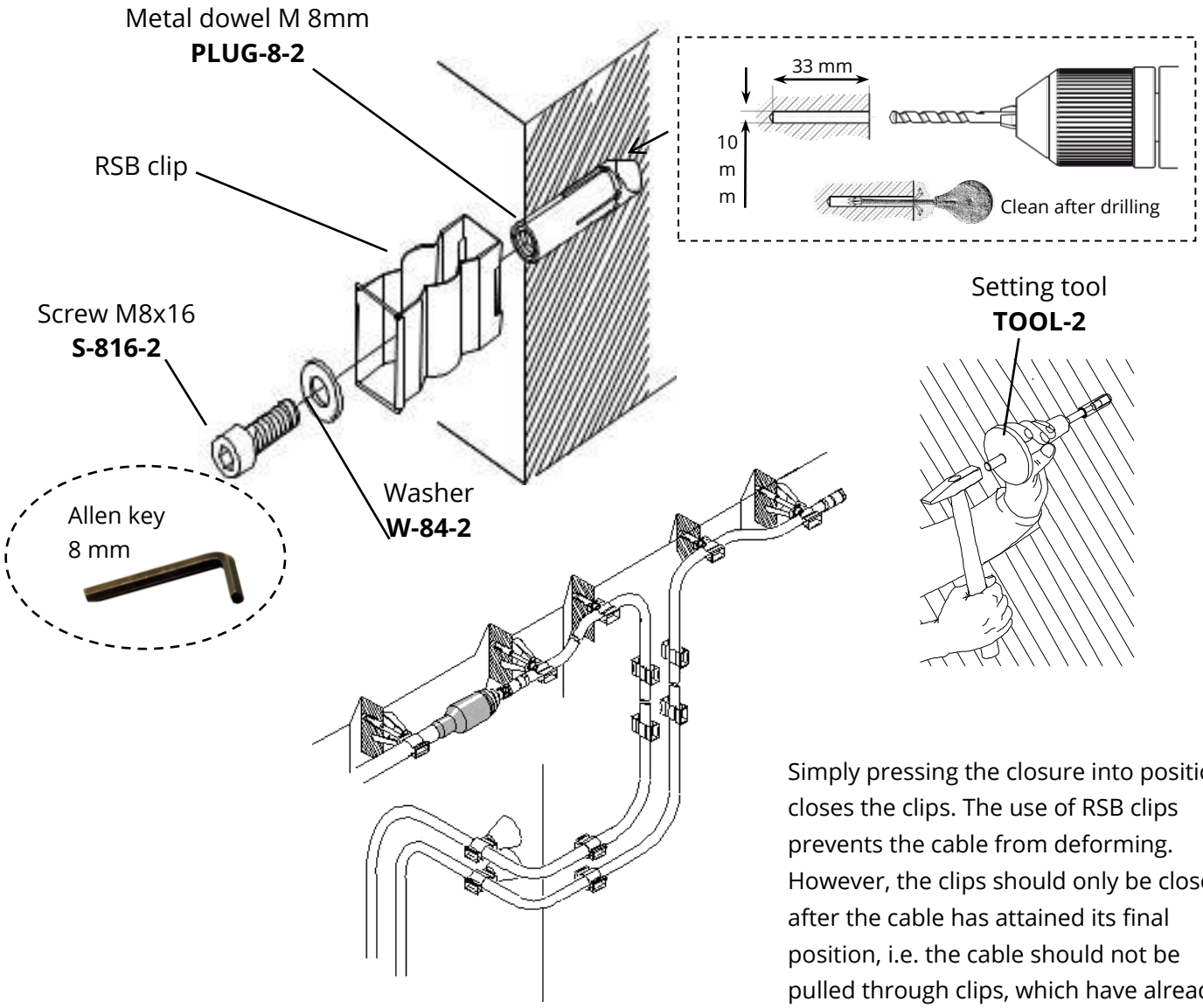
RSB clips are fixed using stainless steel plugs, or with plastic dowels and screws if fire protection is not important.
Care should be taken to ensure that the hole is drilled at right angle to the surface of the wall so that the clamps do not become twisted during the subsequent installation. The hole should be cleaned out with air-pump after drilling. The metallic plugs are driven into the wall with the Manual Setting Tool. The tool leaves behind a visual setting check.
The screws can be tightened with a powerful cordless electric screwdriver.
Make sure the clamps are lined up; otherwise the cable will not run in an absolutely straight line.
The min. bending radii for installing cables should also be taken into account when fixing the clamps.
Simply pressing the closure into position closes the clips. The use of RSB clips prevents the cable from deforming. However, the clips should only be closed after the cable has attained its final position, i.e. the cable should not be pulled through clips, which have already been closed.



Close Open

Simply pressing the closure into position closes the clips. The use of RSB clips prevents the cable from deforming. However, the clips should only be closed after the cable has attained its final position, i.e. the cable should not be pulled through clips, which have already been closed.

RFS RADIAFLEX® CABLES



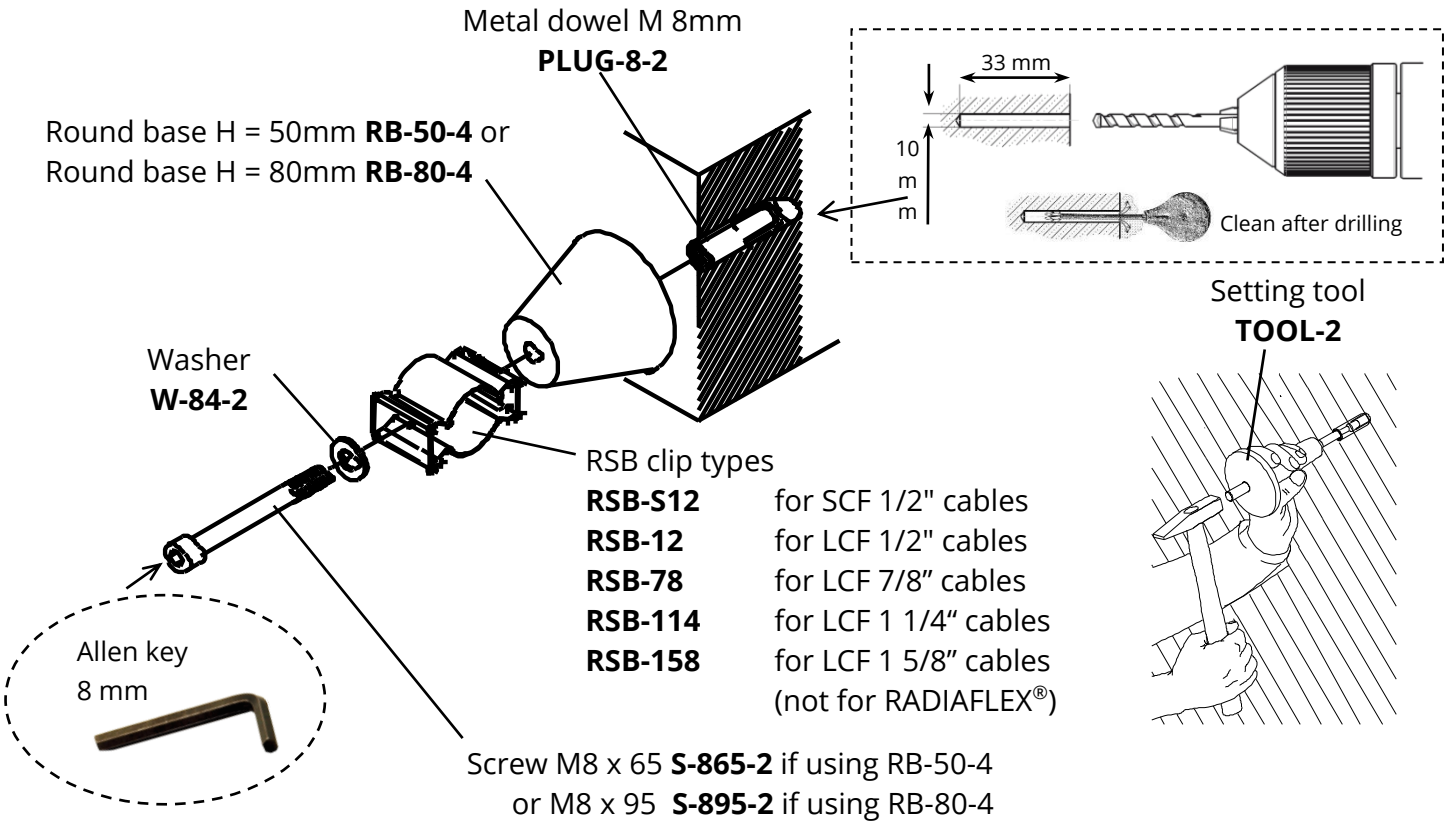
Simply pressing the closure into position closes the clips. The use of RSB clips prevents the cable from deforming. However, the clips should only be closed after the cable has attained its final position, i.e. the cable should not be pulled through clips, which have already been closed.

To equalize the distance between RADIAFLEX® cables

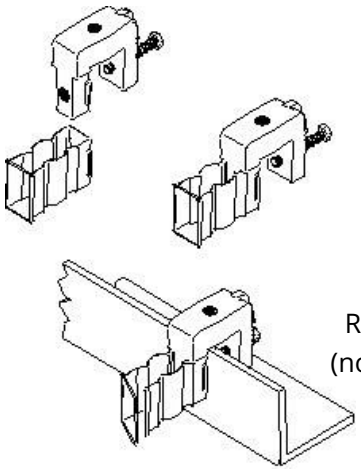
and walls as well as in sharp bends around corners

the additional use of standard round bases is recommended

RFS RADIAFLEX® CABLES

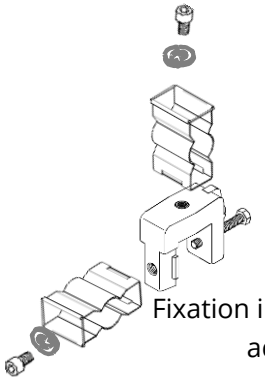


For fixing the RSB clip to existing steelwork (e.g. iron angles, cable ladders, or anchor bars) a range of accessories are available.



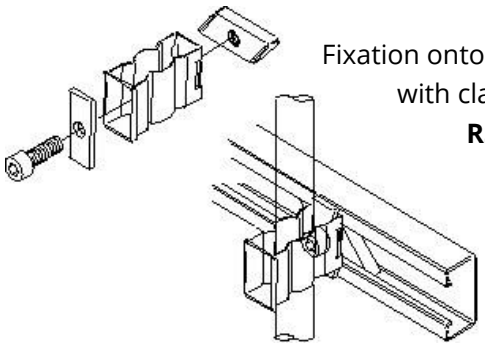
Fixation onto angle-, flat- or U-member with RSB Cleat
RSB-310

RSB clips snapped
(no screw is needed)

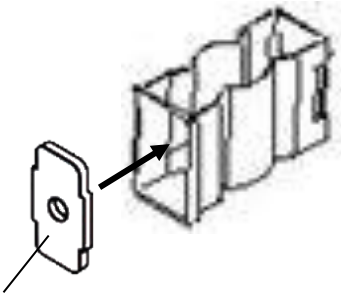


Fixation in other directions with additional screw M8 & washer.

RFS RADIAFLEX® CABLES



Fixation onto C-rail (anchor bar)
with clamping plate
RSB-315



Fixation onto wall
with Stiffening sheet with hole ø 6,2 mm
RSB-C-1 e.g. for fixation with plastic dowel and screw (provided by the customer)

Fixation with Round member
onto tubes.

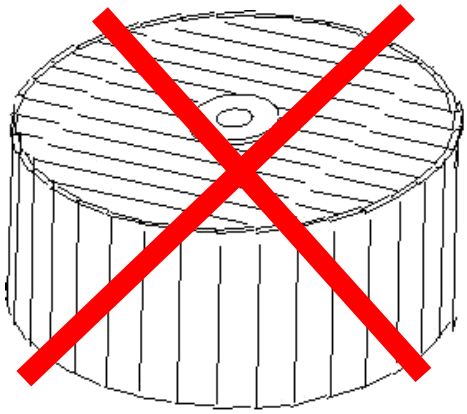
Stainless steel strapping kit
(30 m + 50 fasteners
STRAP-2

RFS RADIAFLEX® CABLES

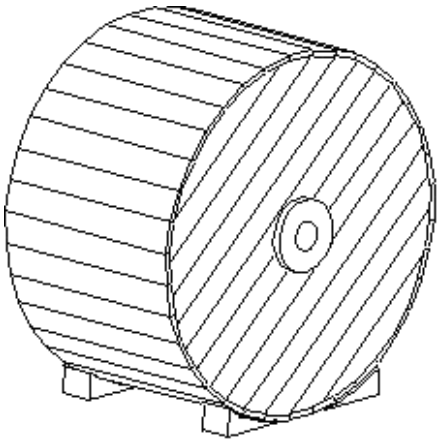
6. HANDLING OF CABLE DRUMS & CABLE RINGS

6.1 Stocking of drums & rings

In order to avoid damaging of cables the drums and cable rings must be handled very carefully.



Do not lay the drum on its side!
Reels must be transported and handled in its up – right position only



After carefully set down secure the drum!

Cable rings should be stocked in laying position. But not on top of each other

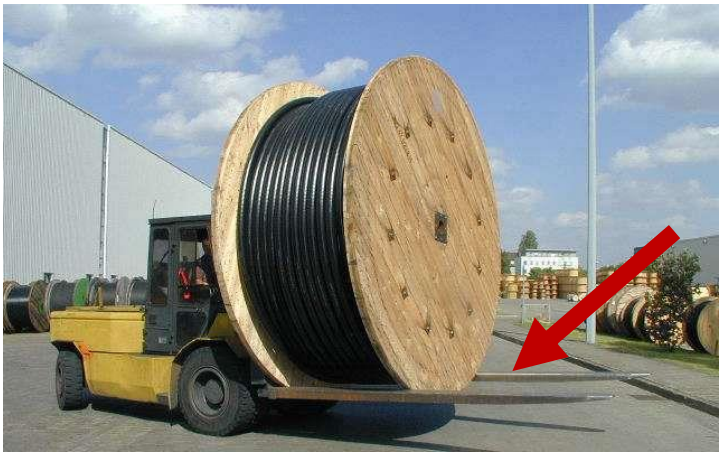
Keep the cable end properly sealed, fix the cable end closest as possible to the centre.

CELLFLEX® Coaxial Cables Shipping and Drum Information available here

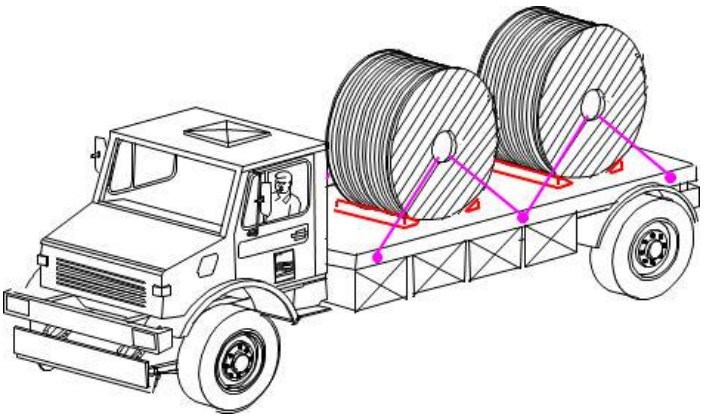
RFS RADIAFLEX® CABLES

6.2 Transportation of drums

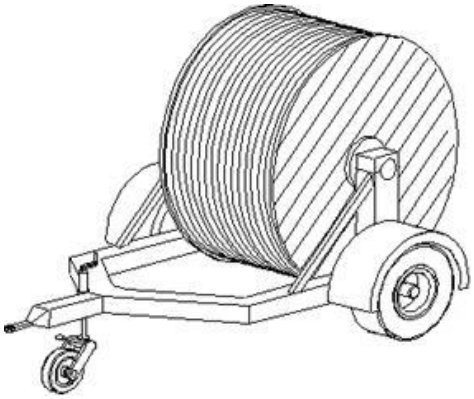
If a crane is used a special hanger is necessary to avoid damage of the drum flanges (if these special hangers are not available, a stable steel tubes/beam or a squared timber may be able to use).



If fork lifts are used, the forks must be long enough to engage both flanges of the drum to avoid cable damage!

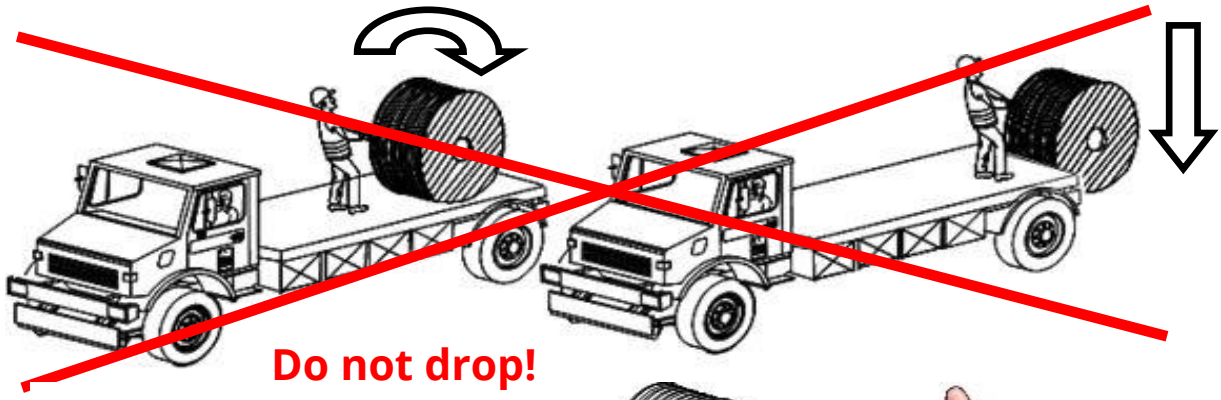


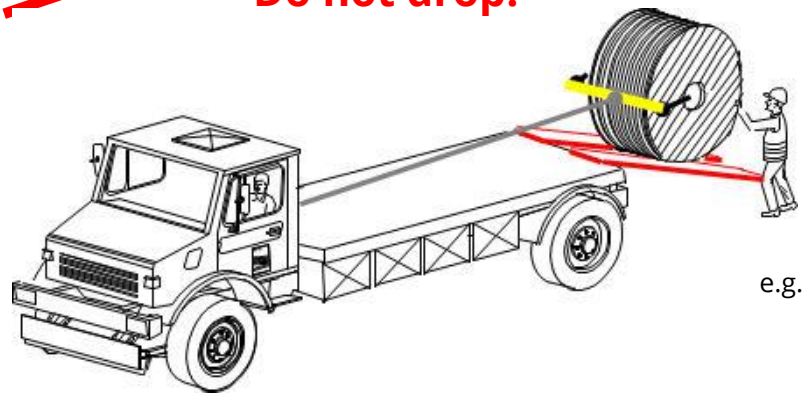
The drum(s) has to be secured carefully during transport!



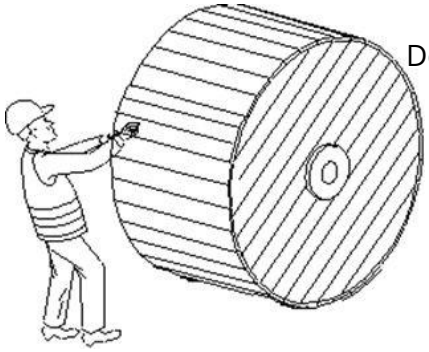
Cable drum trailer.
Easy and save for transportation & installation (pulling) as well.

RFS RADIAFLEX® CABLES

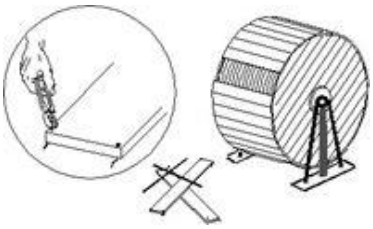




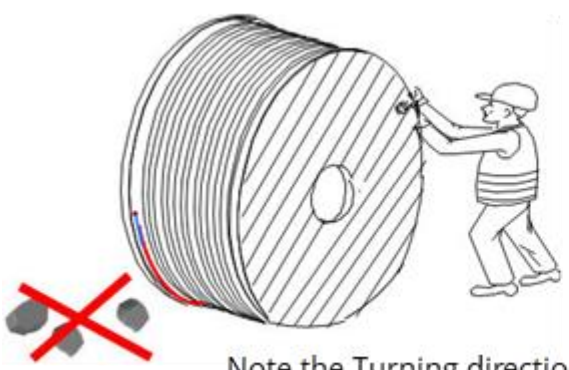
e.g. use wooden blanks as a ramp



Do not remove the wooden planks before the drum is in position



Note the safety aspects!



Note the Turning direction during transportation (is show on the labelling)

7. INSTALLATION OF THE CABLES

7.1 General recommendations

To avoid damaging of the cable the drums should be handled very carefully.

A cable-laying truck is recommended for transporting the drums. A cable drum trailer, open at the rear, which can be loaded by simply rolling the drum into the trailer from behind (no crane necessary) is advantageous. The integrated cable drum jack lifts the drum in the trailer.

If a cable drum trailer is not available, then stable drum supports should be used for uncoiling the cable from the drum. It is recommended that the shaft be adequately greased in order to guarantee smooth rotation of the drum when uncoiling the cable. The installation crew must ensure that the cable uncoils evenly. For further information about the min. bending radii, max. tensile forces, recommended clamp spacing, etc. see the corresponding data sheets.

On no account may a cable be bent to a radius smaller than the min. bending radius for single bending as given in the data sheet. During installation the larger radius for repeated bending must be adhered to.

If it is not possible to install cables directly from the drum, then short lengths can be pulled from the drum and wound into a coil. The diameter of the coil should not be less than that of the core of the drum.

The max. tensile forces given in the data sheet may not be exceeded when drawing the cable.

The use of a cable hoisting grip is strongly recommended – especially when pulling cables through vertical cable ducts. Note the max. pulling/hoisting length of one hoisting grip = 60 m.

It must be ensured that the cable is never pulled across sharp edges or corners. If cables have to be pulled over the ground for long distances or over small obstacles, then the use of ground rollers is recommended. When pulling the cables around corners or through narrow openings, installation personnel should monitor these critical points.

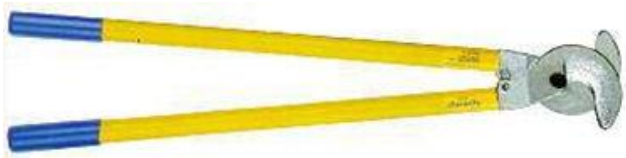
When cutting the cable it should be ensured that the place at which it is being cut is the lowest point in the cable run in order to prevent the ingress of dirt or copper particles into the inside of the cable. Both ends are to be cleaned and sealed. When bending the cable, apply the whole palm of the hand and avoid pressure at specific points.

After the connector has been fitted to the cable, the contact surfaces must be protected against dirt and moisture until the final connection is made. Temporary protection can be achieved by slipping the connector’s plastic packaging over the end.

RFS RADIAFLEX® CABLES

Cutting of cables

Keep the cutting area down, in order to avoid dirt or copper shavings falling into the cable!



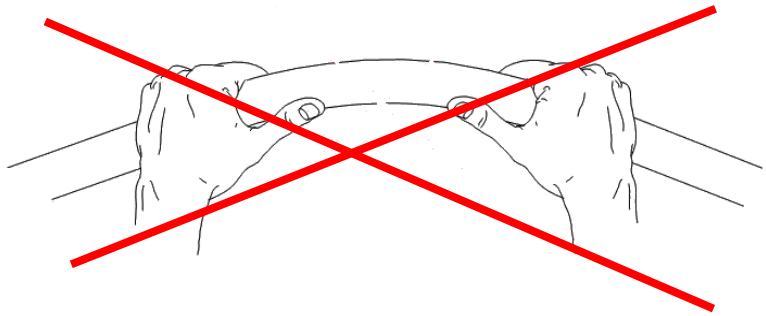
For provisionally cutting we recommend to use a cable trim to cut the cable. It produces nearly no copper chips during cutting.

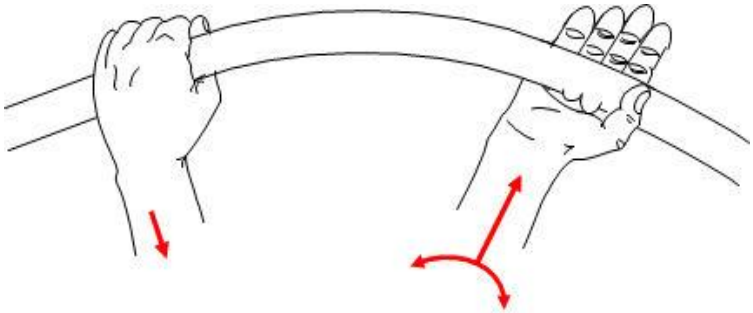
Sealing of cable ends

Seal the cable end with a sealing cap and sealing tape

RFS RADIAFLEX® CABLES

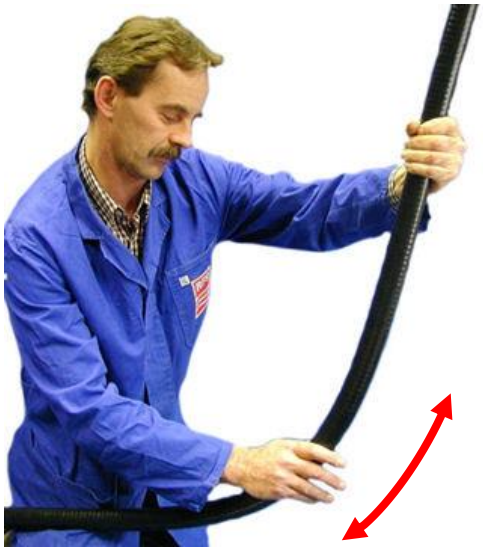
Bending of cables





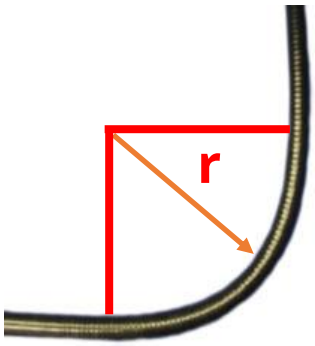
Pull carefully

while pressing
slide your hand



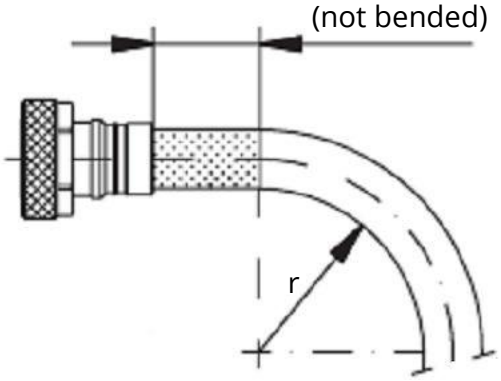
Do not press in the middle of the bow only, go along the complete bow with the same pressure

Note the minimum bending radius mentioned in the data sheet!



Straight part
(not bended)

Do not bend directly behind the connector



RFS RADIAFLEX® CABLES

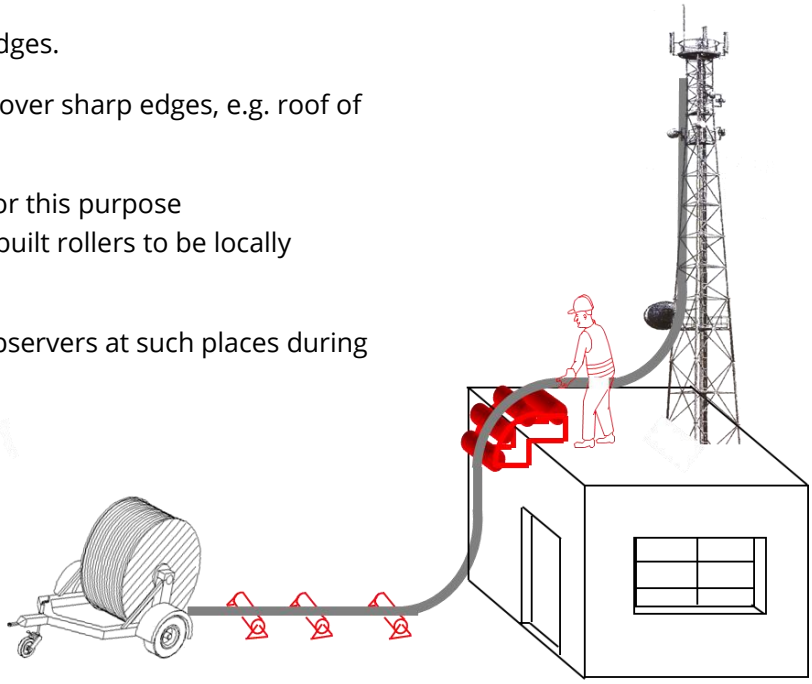
Pulling of cables

Do not drag the cable over sharp edges.

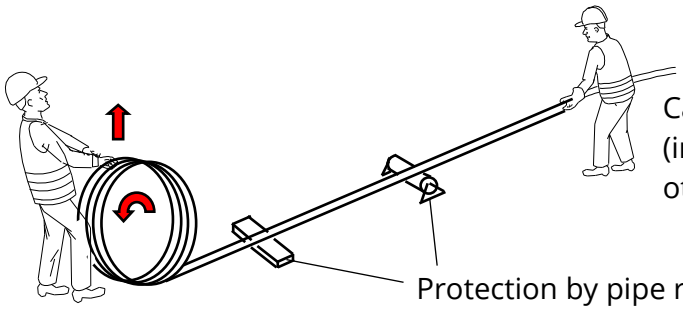
Protect the cable where it is pulled over sharp edges, e.g. roof of a building or tower members.

Use pipe rollers, angle rollers etc. for this purpose
(This sometimes requires purpose built rollers to be locally manufactured)

It is strongly recommend placing observers at such places during installation (pulling or hoisting)



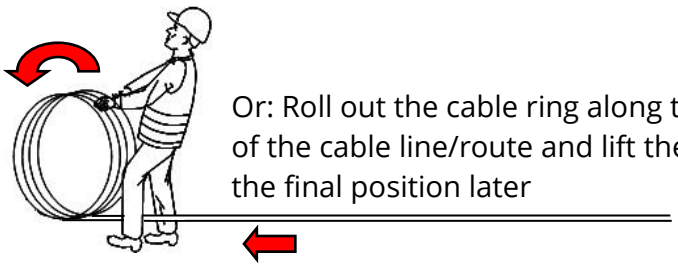
Handling of cable rings



Carefully pulling
(in communication with the other installer)

Protection by pipe rollers, wooden blanks etc.

Lift up and turned the cable ring



Or: Roll out the cable ring along the ground of the cable line/route and lift the cable in the final position later

RFS RADIAFLEX® CABLES

Pulling of Feeder cables in horizontal hollow tubes

The diameter of the hollow tube (or underground cable duct) shall be at least twice the CELLFLEX® cable diameter.

The bending radii for tubes installation shall be at least twice the minimum bending radius (for multiple bending) of the respective LCF cable (see data sheet).

Inter- connections of several tubes must not damage the cable during pulling/pushing the cable. - Avoid any risk of blocking.

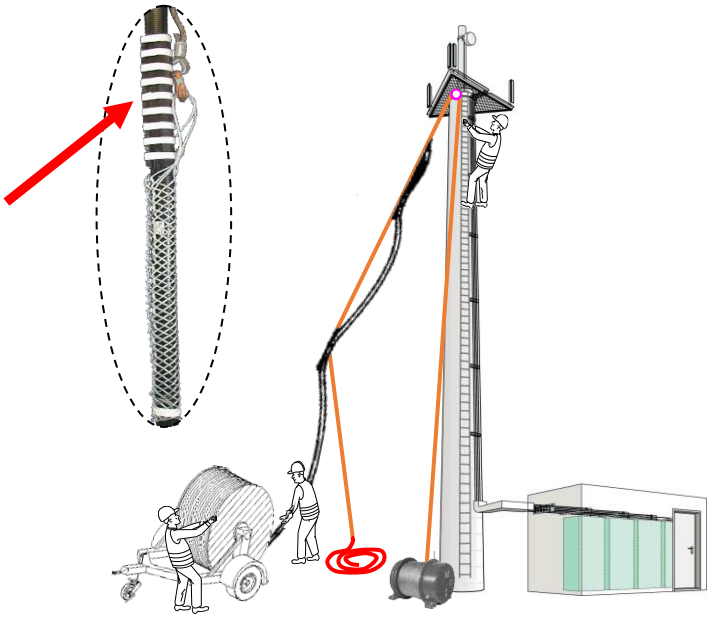
Avoid sharp edges during pulling the LCF cable.

Pulling of LCF cable can be supported by an additional layer of grease on the cable jacket.

If the cable will be pulled with a winch, we recommend to use a measuring device to make sure the max. tensile force (see data sheet) will not be exceeded.

Hoisting with hoisting grips

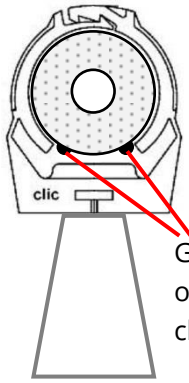
Install the hoisting grip following the included installation instruction.
Add the hoist line to the hoisting stockings or ropes sling, protect the cable against shackles and tie the upper cable connector to the hoist line.
Make certain to allow slack in the cable between the hoisting stockings in case more than one is used (one can hoist max. 70 m of cable), so each stocking can carry weight, and ascertain that the slack is maintaining during hoisting.



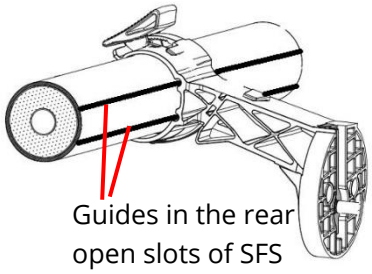
7.2 Installation of RADIAFLEX® cables with guides

To achieve the best performance of a RADIAFLEX® cable, it is recommended to install it in a defined position with the slot groups pointing away from the wall/ceiling, towards the area to be covered. This becomes more important, the higher the frequency is.

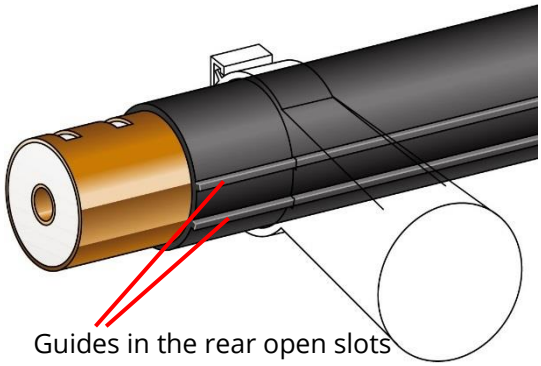
All RADIAFLEX® cable types with copper foil outer conductor in size 1 1/4" and 1 5/8" have two guides on their jacket at the opposite site of the slot groups. This simplifies the installation and finding the correct position, because the guides do fit exactly into the rear open part of RFS' standard Clic-clamps and in the rear open slots of Heavy-duty clamps and SFS clamps.



Guides in the rear open part of Clic clamp



Guides in the rear open slots of SFS clamp

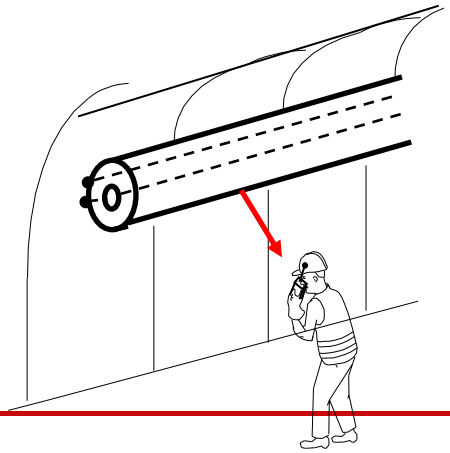


Guides in the rear open slots of Heavy-duty clamp

Installation

After installing the standard Clic-clamps or the Heavy-duty clamps in accordance of this installation Guideline, it is recommended to uncoil the RADIAFLEX® cable and lay it on the ground next to the wall. This allows the cable to stretch and minimizes loops caused being coiled on a drum. Then cable has to be fixed into the clamps with the guides pointed to the wall (ceiling). To keep the cable in this position these guides fit into the rear open part of the Clic clamp and in the open slots of Heavy-duty clamp and SFS clamp. If you need to rotate the cable into its correct position, create a loop of cable before the first clamp and use it as a large crank to align the cable. In order to do this you will need to uncoil an extra length of cable from the drum before lining it up with the clamps.

For best possible performance the Guides are pointed to the wall
(slots ae in direction of coverage).

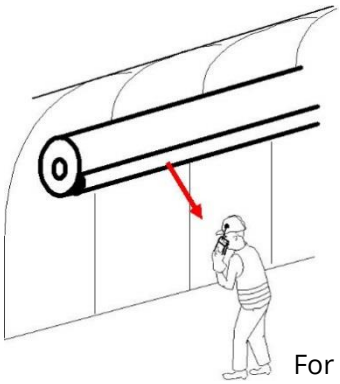


RFS RADIAFLEX® CABLES

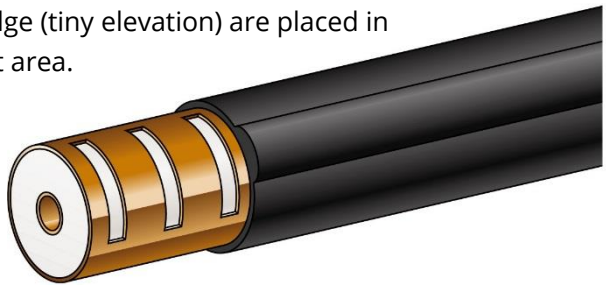
7.3 Installation of RADIAFLEX® cables with bulge

To achieve the best performance of a RADIAFLEX® cable, it is recommended to install it in a defined position with the slot groups pointing away from the wall/ceiling, towards the area to be covered. This becomes more important, the higher the frequency is.

All RADIAFLEX® cable types with copper foil outer conductor in size 1/2" and 7/8" have a thin bulge on their jacket which is atop of the slot groups and should hence face towards the area to be covered.



The bulge (tiny elevation) are placed in the slot area.

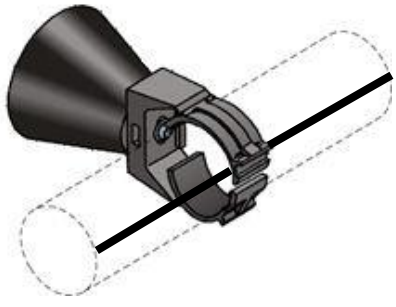


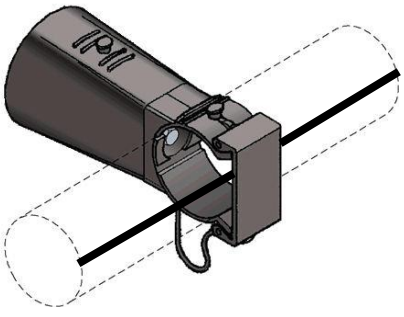
For best possible performance the bulge are pointed in direction of coverage (away from the wall).

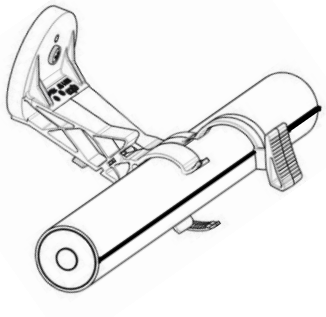
Installation:

After installing the standard Clic-clamps, Heavy-duty clamps or the SFS claps in accordance of this installation Guideline, it is recommended to uncoil the RADIAFLEX® cable and lay it on the ground next to the wall. This allows the cable to stretch and minimizes loops caused being coiled on a drum. Then cable has to be fixed into the clamps with the bulge pointed away from the wall (ceiling) in direction of coverage. The cable can be fixed in any direction into the clamp without any risk of damaging it, because the bulge is very thin. If you need to rotate the cable into its correct position, create a loop of cable before the first clamp and use it as a large crank to align the cable. In order to do this you will need to uncoil an extra length of cable from the drum before lining it up with the clamps.

Possible positions of the bulge

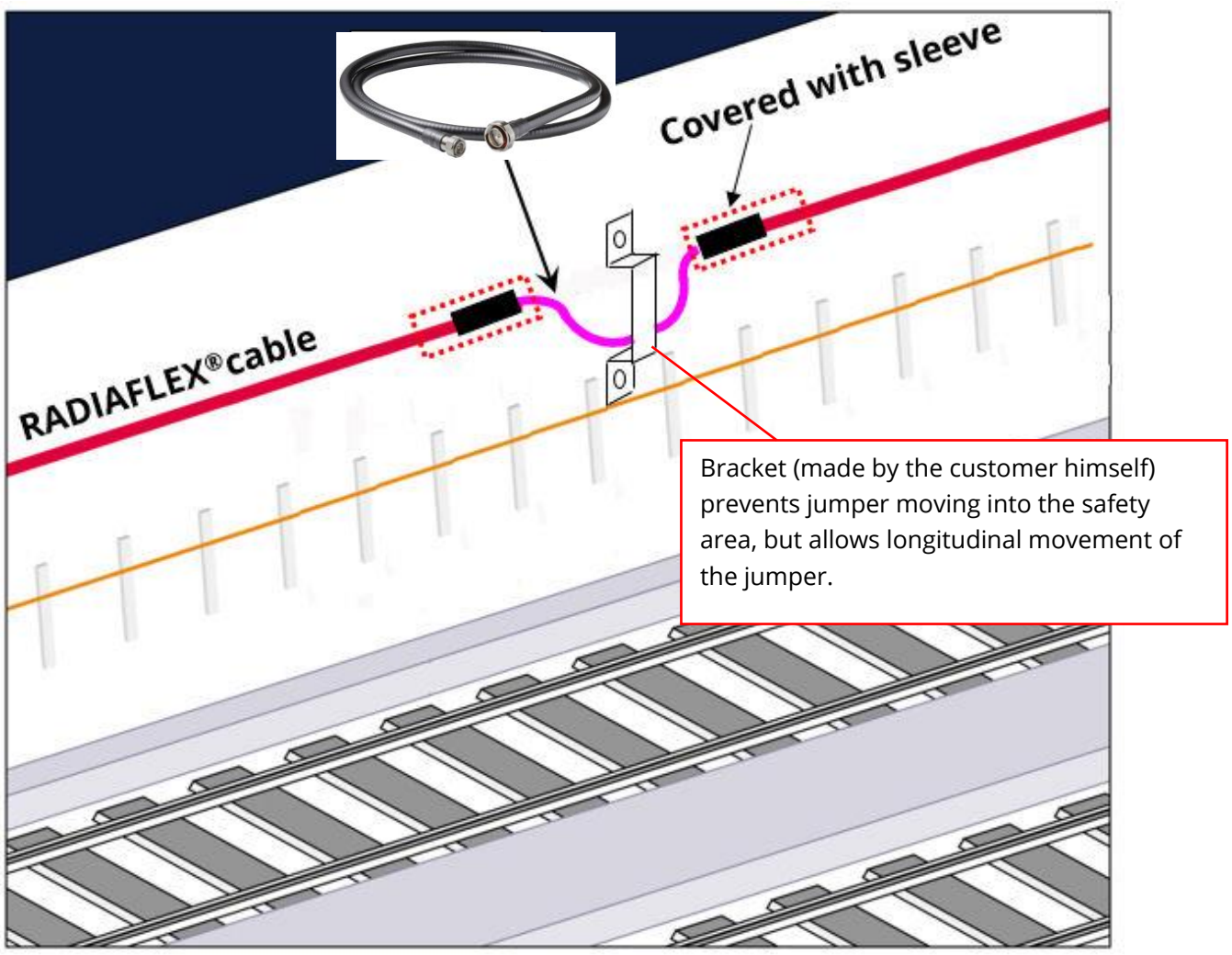






7.4 Jumper connection of two RADIAFLEX® cables

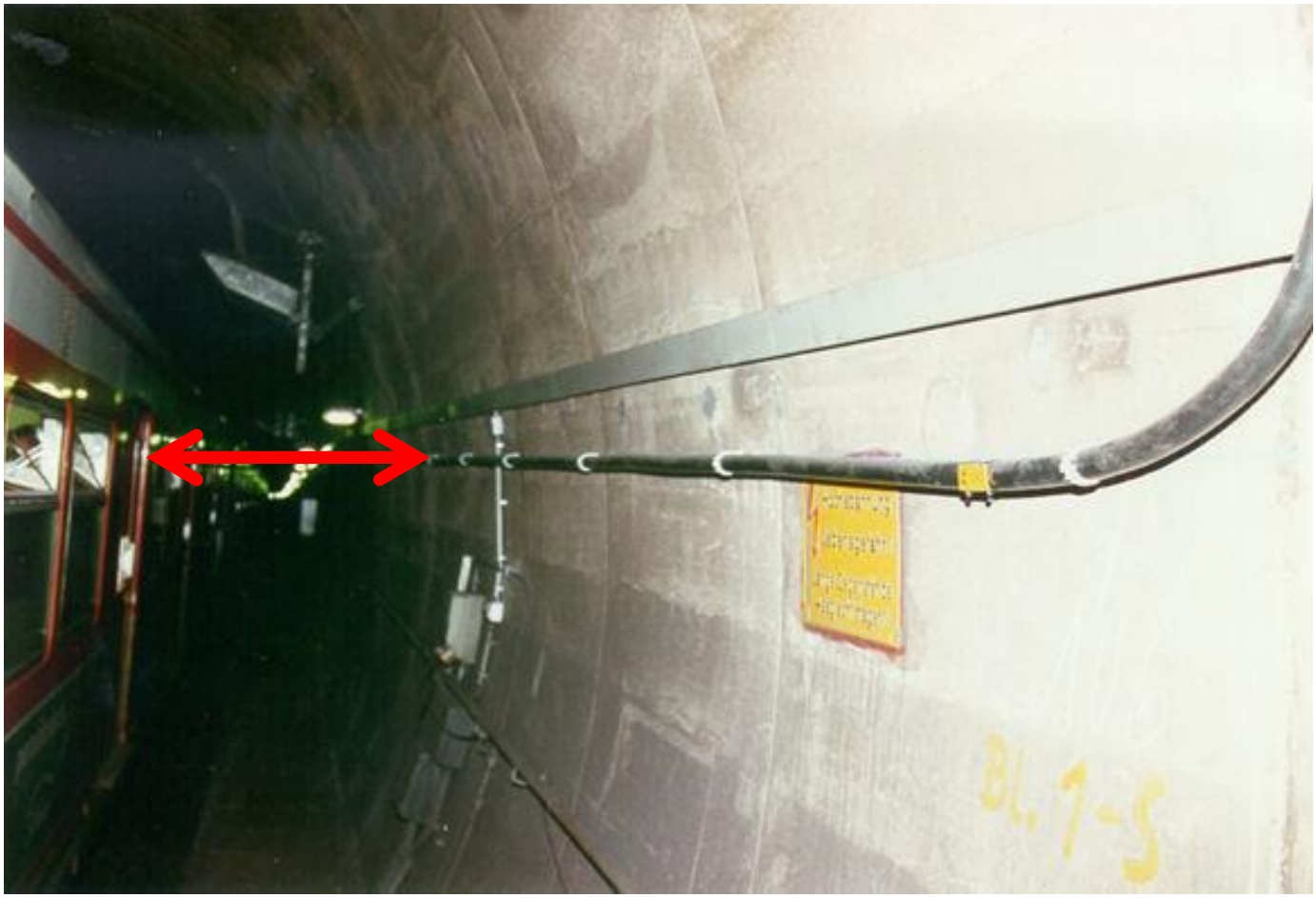
In order to prevent any mechanical stress on the connection of two longer RADIAFLEX® cable runs we recommend the use of a Jumper Cable which runs in a bow. Using this technique, the Jumper Cable absorbs extensions due to temperature cycles



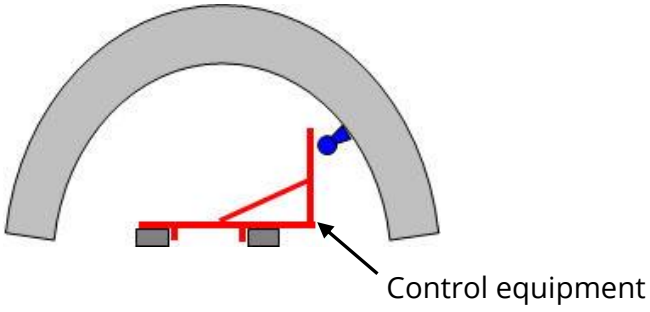
Take care of the safety distance between cable and train. In case there is a risk that the jumper can move into this safety area, we recommend the installation of a special distance stopper, e.g. going for a bracket as shown (to be provided by the customer himself) allowing move of jumper.

7.5 Safety Distance

During installation of the RADIAFLEX® cable, take care of the safety distance between cable and train. The rules from the railway operators are different, therefore ask the local operator.



If there is just a marginal distance between the cable and the supposed vehicle, this distance has to be checked regularly. Self-made control equipment can make work easier (e.g. made of wooden laths, push flexible on the rails).



8. INSTALLATION ON DIFFERENT LOCATIONS

8.1 Introduction – Installation in Tunnels or Buildings

Generally, a distinction is made between installing in tunnels or in buildings (e.g. offices, factories, etc.). When installing in tunnels, a further distinction has to be made between road, rail, and underground tunnels owing to the different installation conditions.

The following criteria are crucial for the planning and realization of installations:

In order to find an optimum position and method of fixing for the radiating cable, knowledge of the materials and design of the wall, ceiling or floor intended for the fixing are vital. The installation height of the cable is critical for the design of the installation and for determining the costs. Restricted working hours may have to be taken into account on some installation sites. This can be caused by other firms working on the site at the same time or the brief intermissions between the trains of an underground already in operation and in extreme cases can lead to working times of merely a few hours at night.

Such circumstances must be considered at the planning stage. The type of fixing has a decisive influence on both the installation work and the costs. When fixing to the wall, a basic distinction can be made between the use of plugs and fixing to existing cable ladders or anchor bars. In the latter case, time is saved by not having to drill holes but the position of cables and spacing of clamps is usually very restricted. In both cases the use of round bases is advisable.

Note: The height of the round bases depends on the cable type (see data sheet of the cable)

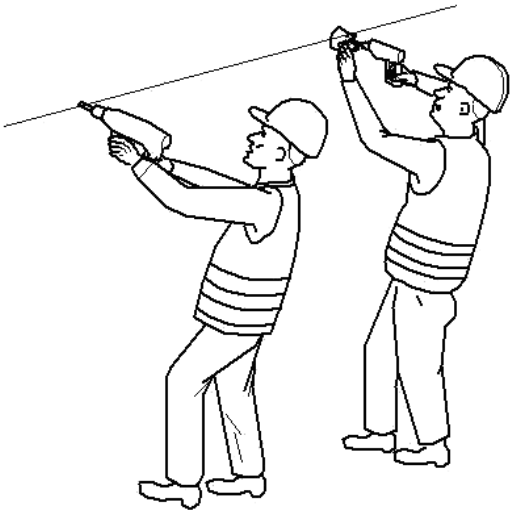
In special cases (e.g. in tunnels through rock or when spanning over larger distances in underground stations) the use of a messenger wire is advisable. Here, the correlation between the sag and the necessary wire tension has to be taken into account. Furthermore, it should be ensured that the structure could carry the necessary wire tension in the case of large spans and minimum sag.

When selecting installation vehicles for new railway and underground tunnels, it is important to know whether the track will have been laid before work starts.

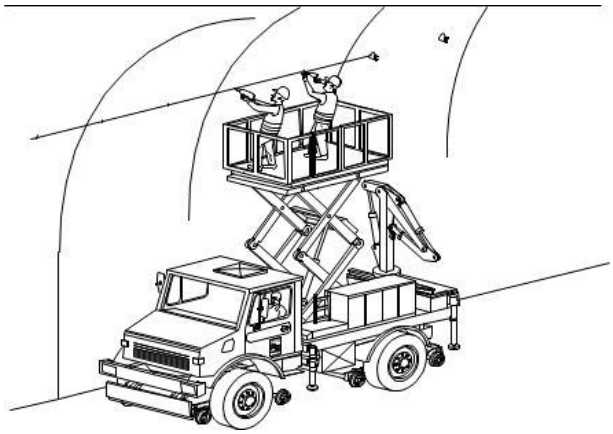
The speed of the trains and the associated pressure fluctuations in the tunnel are crucial for the selection of fixing materials, especially the clamps for the radiating cable.

8.2 Installation Methods

Installation methods are depending on the location of installation



Installation from the floor,



with special vehicles,

with ladders,

with platform,

with movable scaffold,

8.3 Installation in tunnels with only short interruptions in operation

If installation is to be carried out in a tunnel in operation, normally the cable has to be installed during short interruptions in the night. In this case the use of special vehicles is usually uneconomic.

In such cases the clips should be fixed using ladders. Installation can also be carried out with the help of a mobile scaffold, possibly moved on the rails.

Note:

If this work is performed without switching off the catenary wire, then only ladders made from non-conductive materials (e.g. wood, plastic) are permitted.

Requirements of the tunnel operator and industrial safety rules must be adhered to, in particular, safety clearances between radiating cable and live conductors.

If the installation work is carried out without or with only very short ladders, then some railway authorities also permit installation during periods of low traffic. In such cases, specially trained safety personnel are deployed to protect the installation crew.

The use of cordless electric drills is strongly recommended so that personnel can quickly evacuate the track area in the event of any danger.

Due to the short interruptions in railway operations, bringing the cable into the tunnel and installing it at the same time cannot be carried out directly from a track-bound trolley or cable drum trailer.

In such cases the cables are brought into the tunnel with a track-bound trolley or other special vehicle and initially placed adjacent to the track.

The installation crew for this work comprises of the following persons:

driver of installation vehicle

1-2 installers for pulling the cable

1 installers for turning/braking the drum

1 installer for depositing the cable adjacent the tunnel wall

safety personnel as required by local regulations

Secure the cable drum properly and drive into the tunnel. Raise the drum with the help of the drum jack. Secure the drum jack to prevent it slipping or toppling during all further operations. Cut the rope securing the cable to the drum, uncoil a few metres of cable and use rope to temporarily fix the end to the ground a few metres before the first clamp. As there should not be excessive tensile forces at this point while uncoiling more cable, a simple hand-tied loop is adequate for this fixing.

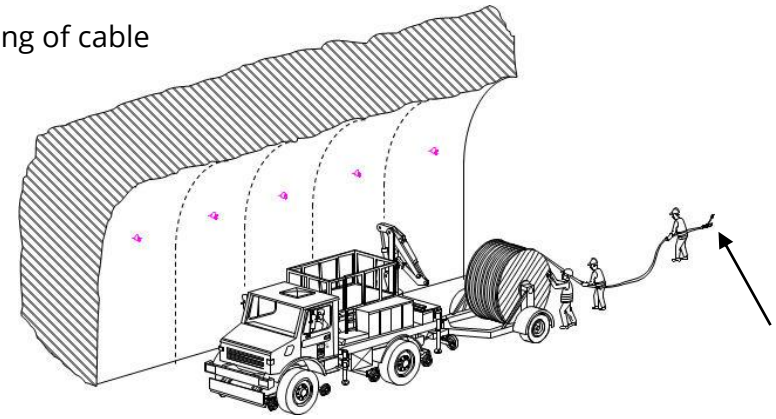
Now pull the cable from the drum by hand as the drum trailer continues to move forward slowly. Make sure that the drum is turned only by the force of the drawing and not by the forward movement of the vehicle!

Slow the rotation of the drum down by hand if necessary, in order to prevent the cable from uncoiling too quickly. Wear gloves for this in order to avoid injuries caused by wooden splinters.

At the same time, place the uncoiled cable close to the tunnel wall or install it temporarily in a cable tray. Secure the cable against sliding. Make sure that passing trains cannot catch the cable and emergency routes are not blocked. Do not underestimate the pressure wave of an approaching train nor the suction in its wake! Any cables must not block escape routes; check the requirements of the tunnel operator if necessary. Always consider the minimum bending radii during installation.

Furthermore, make sure that the cable is never pulled across sharp edges and corners. It is recommended to only uncoil as much cable as can be completely installed in a foreseeable time. This prevents the cable not fixed yet, being accidentally damaged by another installation or maintenance work. The advantage of this method is that the cable can stretch out a little while in its temporary position, which reduces the work required to straighten the cable while fixing it into the clamps. The personnel required for this depends on the mounting height of the RADIAFLEX® cable to be installed. Normally, one installer picks up the cable from the ground and lifts it up for a second installer to hold at the height of the clamps while a third installer presses the cable into the clamps and straightens it. Close the clamps depending on the type of clamp being used. If the mounting height is not too high, then two installers can carry out the installation work.

Uncoiling of cable



Fix the end,

Often necessary outside the tunnel, because may be a few meters of cable are needed for lifting up in the installation level & for turning the guide/bulge into the correct position.

8.4 Installation in tunnels - not in operation during installation work

If the installation work is carried out in a tunnel, which is not yet in operation, then this work can be performed with the help of special vehicles, or suitably prepared trailers, track-bound trolleys, platforms or scaffolds. All vehicles and generators should be fitted with the latest exhaust filters. In tunnels where the tracks are already installed, two-way vehicles are ideal. These vehicles can travel on both roads and rails (e.g. two-way Unimog).

RFS RADIAFLEX® CABLES

The following additional equipment on the installation vehicle has, in our experience, also been proved as useful:

- lifting platform or securely installed scaffold for working at great heights
- adequately sized floodlights (approx. 3 No. @ 2000 W)
- mobile generators for powering lights, drills and chargers
- trailer coupling for cable-laying truck
- lead-in rollers for reliable guiding of the cable during installation
- flashing warning beacons on the vehicle
- if necessary, a crane for loading the cable drums
- The installation crew required for the following example is:
  - driver of installation vehicle
  - installer(s) for fixing the clamps (corresponding to width of lifting platform and permissible load: 1-3 persons)
  - safety personnel as required by local regulations

Move the vehicle into position and drill the first holes. The cable route should have been marked beforehand as described in **" Marking the height of the cable clamps"**. Move the vehicle to the next position and drill the next holes. At the same time, insert plugs into the previous holes and fit the clamps. To install the cable, load the cable drum onto the track-bound trolley or the cable drum trailer taking into account the direction of rotation. Make sure that the drum is handled carefully and that it is secured properly to prevent it sliding while driving into the tunnel. Always take into account the considerable gradient of the tracks in curves. Drive into the tunnel and only remove the planking after arriving at the place of installation. For safety reasons, it is recommended to remove all nails immediately. After removing the planking, raise the drum with the help of the cable drum jack.

It is recommended to grease the shaft of the drum thoroughly, so that the drum can turn easily. Cut the rope securing the cable to the drum, uncoil a few metres of cable and temporarily fix the end to the ground a few metres before the first clamp. As there should not be excessive tensile

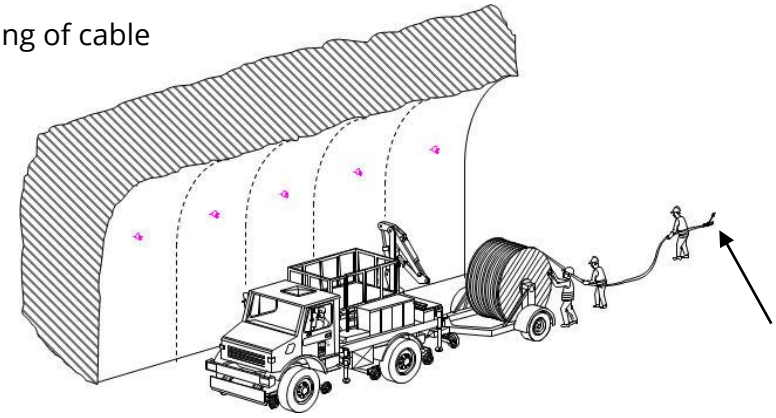
forces at this point while uncoiling more cable, a simple hand-tied loop is adequate for this fixing. Now pull the cable from the drum by hand as the drum trailer continues to move forward slowly. Make sure that the drum is turned only by the force of the pulling and not by the forward movement of the vehicle!
Slow the rotation of the drum down by hand if necessary in order to prevent the cable from uncoiling too quickly. Wear gloves for this in order to avoid injuries caused by wooden splinters.
At the same time, place the uncoiled cable close to the tunnel wall or install it temporarily in a cable tray. Secure the cable against sliding. Make sure that passing trains cannot catch the cable and emergency routes are not blocked. Do not underestimate the pressure wave of an approaching train nor the suction in its wake! Any cables must not block escape routes; check the requirements of the tunnel operator if necessary. Always consider the minimum bending radii during installation.

RFS RADIAFLEX® CABLES

This prevents the cable not fixed yet, being accidentally damaged by another installation or maintenance work. The advantage of this method is that the cable can stretch out a little while in its temporary position, which reduces the work required to straighten the cable while fixing it into the clamps.
With the appropriate equipment, the cable can be uncoiled from the drum and fixed in the already mounted clips at once. Move the vehicle into position once again in order to place the cable in the clamps. One installer now picks up the cable already uncoiled and hands it to the installers on the lifting platform. They place the cable in the clams, close the clamps and straighten the cable. Lead-in rollers mounted on the vehicle are very helpful in this work. To guarantee uninterrupted working, the installation vehicle moves forward slowly according to the speed at which the installers on the platform can work.
Install earth connections and connectors in accordance with the respective installation instructions.
If a two-way vehicle cannot be used, because several installation companies are using the same track or its use appears uneconomic, then the installation can be carried out with the help of a mobile scaffold. A track-bound version is also possible.

Method 1 - Uncoiling and fixation in two steps

Uncoiling of cable

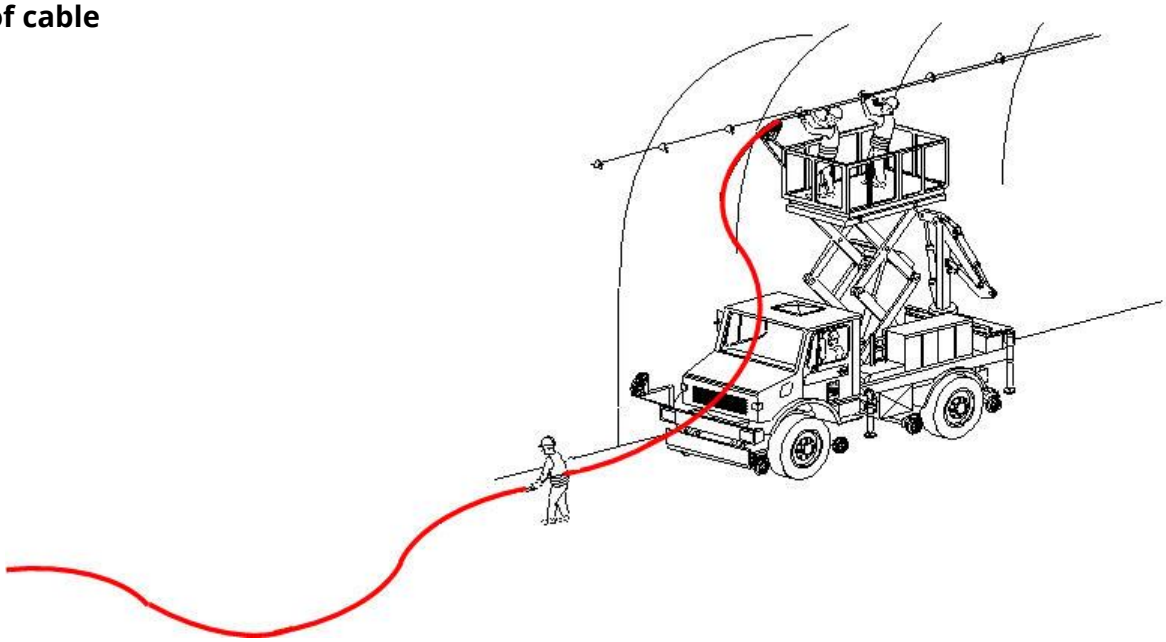


Fix the end,

Often necessary outside the tunnel, because may be a few meters of cable are needed for lifting up in the installation level & for turning the guide/bulge into the correct position.

RFS RADIAFLEX® CABLES

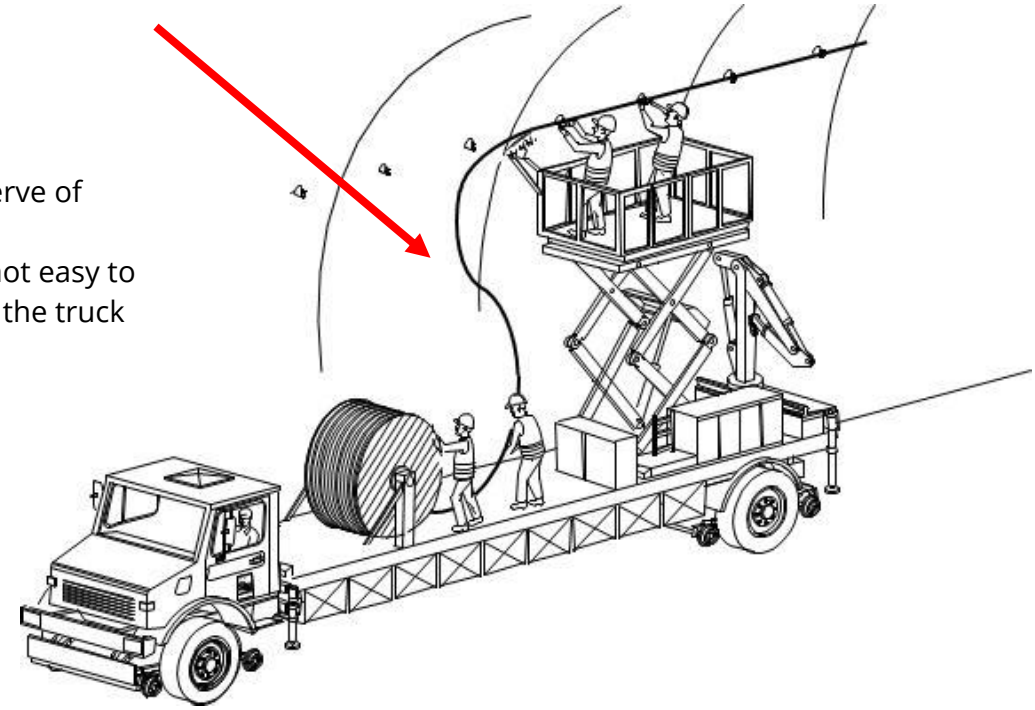
Fixation of cable



Method 2 - Uncoiling and fixation in one steps

A few meters of cable are needed for lifting up in the installation level & for turning the guide/bulge into the correct position.

Keep enough reserve of cable in order to compensate the not easy to regulate speed of the truck or train.



8.5 Installing cables in buildings

General

Because of many different building designs, it is not possible to set up a specific detailed installation instructions for all buildings.

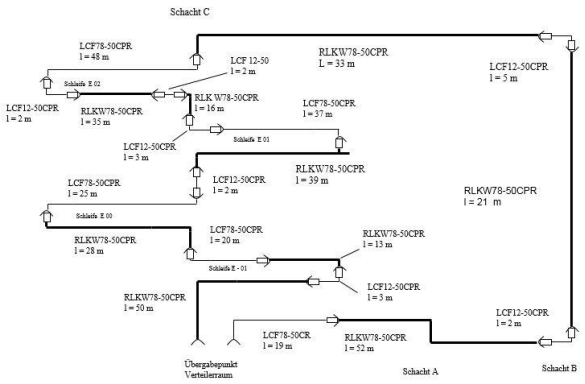
The following items have a particular influence:

- installation height
- access to the building and installation areas
- construction of walls, ceilings and floors to which clamps are to be fixed
- fixing system chosen
- etc.

The details given below are merely recommendations resulting from our many years of experience. The selection and use of the equipment used is the responsibility of the installation company.

The requirements of the house owner as well as the employees liability insurance associations (industrial safety rules) must be adhered to when working in buildings, factories, etc.

Cable routes, installation heights, earthing connections, etc. must be established exactly before starting work. Particular attention should be given to the space between cables and other building components, e.g. conductors, cables, and metallic objects. Special attention should also be paid to fire regulations, as in particular, the proper sealing of openings in walls.



RFS RADIAFLEX® CABLES

Installing cables in buildings

Clamps can be installed from ladders or stable scaffolds depending on installation height and local circumstances. If possible, transport the cable drums directly to the place of installation. Make sure that the drum is handled carefully. The planking of the cable drums should not be removed until the cables are required at the place of installation. For safety reasons, it is recommended to remove all nails immediately. Stable hydraulic cable drum jacks are suitable for lifting the drums; note the direction of rotation of the drums. It is recommended that the shaft be adequately greased in order to guarantee smooth rotation of the drum when uncoiling the cable.

After the drum has been lifted, pull the cable and lay it on the floor next to the cable run. One installer should supervise the uncoiling. Helping to rotate the drum can considerably ease the pulling for the other installers. Slow the rotation of the drum down by hand if necessary in order to prevent the cable from uncoiling too quickly. Wear gloves for this in order to avoid injuries caused by wooden splinters.

Always consider the minimum bending radii during installation. It must be ensured that the cable is never pulled across sharp edges or corners. If cables have to be pulled over the ground for long distances or over small obstacles, then the use of ground rollers is recommended. Take precautions, e.g. wooden planks or similar, to prevent damage to the jacket when drawing the cable through wall openings. Installation personnel should monitor these critical points.

All cables, which are to be fed through conduits, should be pulled into those before fitting the connectors. For short elbows, bend the front end of the cable carefully in the direction of the elbow. To pull the cable through longer conduits, it is highly recommended to attach a taut wire to a hoisting stocking to which the cable is attached for pulling through the conduit. The use of a cable hoisting grip is strongly recommended – especially for pulling cables through vertical cable ducts.

If it is not possible to transport the cable drum to the place of installation and install directly from the drum, then short lengths can be pulled from the drum and wound into a coil. To do this, raise the drum with the cable drum jack as described above. Then pull a long section from the drum on a plane and clean surface. The diameter of the coil should not be less than the core of the drum. After a few coils have been produced, it is recommended to tie those together, using for example insulation tape. This makes the winding and subsequent installation considerably easier.

Cut the cable and then seal both ends in accordance with the recommendations. It is recommended to only produce as many coils as can be installed in a foreseeable time.

This prevents the cable not fixed yet, being accidentally damaged by another installation or maintenance work. On no account may the bending radius be less than the minimum bending radius given in the data sheet. When bending the cable, apply the whole palm of the hand and avoid pressure at specific points. Install earth connections and connectors in accordance with the respective installation instructions.

RFS RADIAFLEX® CABLES

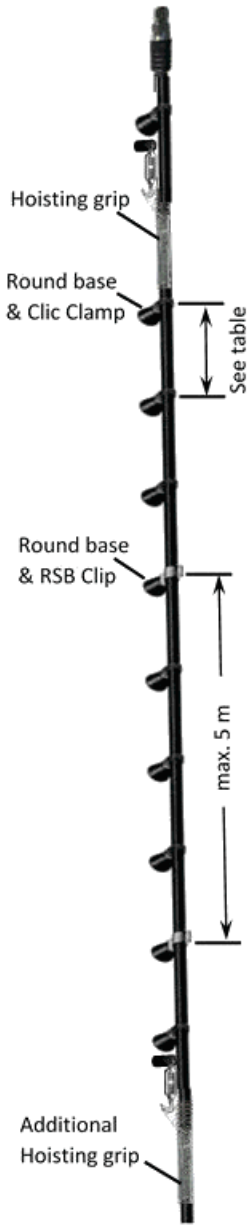
8.6 Vertical installation of RADIAFLEX® cables e.g. in Elevator shafts

A radiating cable is a key element of wireless communication system ideally suited for various applications like tunnels, mines, buildings, ships or other confined environments.
Typically, a radiating cable is dedicated to a horizontal installation position e.g. along a tunnel to provide seamless RF coverage over its whole length. For very specific applications, a vertical installation of RADIAFLEX® radiating cables is required. In such cases, the optimized installation method depends technically to a great extent on the individual project conditions. However, RFS recommends as a general guideline to apply the following installation methodology and products for a vertical installation of RADIAFLEX® cables.

Maximum length of a continuous radiating cable section 300m

Standard fixing points:
- Round base 50 or 80 mm depending on cable type (or identically construction with same functional performance)
- Clic Clamp CC-***-2 depending on cable size (or identically construction with same functional performance)
- Appropriate screw and dowel (at least M 4,5) depending on properties and conditions of the shaft.
- Max. clamp spacing see table below.

Metallized fixing point:
- Round base 50 or 80 mm depending on cable type (or identically construction with same functional performance)
- Metal clamp RSB-*** (or identically construction with same functional performance)
- Appropriate screw and metal dowel (M8) depending on the properties and conditions of the shaft.
- Max. spacing between metallized fixing points = 5 m.



A hoisting grip has to be used at the top and in intervals of 50 m to secure the cable installation as it holds the radiating cable by means of friction. Each hoisting grip has to be fixed to the radiating cable by at least one cable tie. Use protective material to protect the cable on top of the hoisting grips. Make sure that the fixing point/screw for the fixation of the hoisting grip onto the wall is able to carry the total weight of the cable (cable weight is mentioned in each data sheet of the used cable).

Cable size	1/2”	7/8”	1 1/4”	1 5/8”
Max. clamp spacing	0,5 m	0,5 m	0,7 m	0,8 m

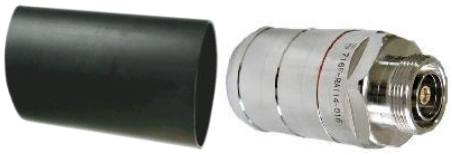
All installation work must be performed by well-trained and qualified personnel.

9. INSTALLATION OF CONNECTORS

10.1 Installation Instructions

Connectors for RADIAFLEX® cables with overlapping copper foil outer conductor

As mentioned at the beginning of this document, for the installation of the standard connectors only standard tools are needed = manual installation.



The required tools are shown in the installation instruction

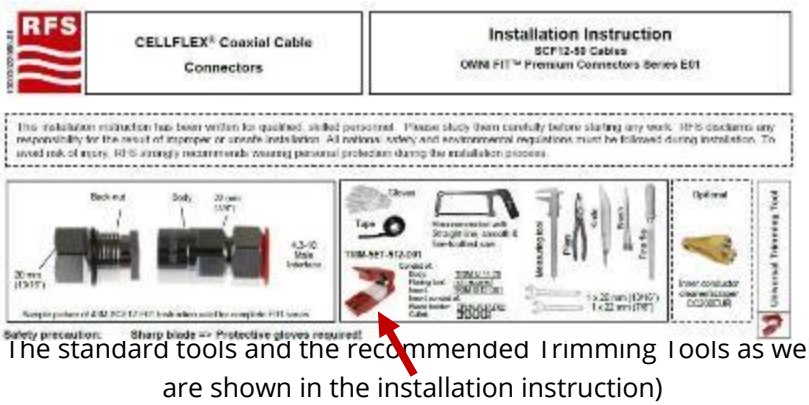
For the installation of the Premium connectors (P02 series), the use of a Trimming tool is mandatory.

The required tools are shown in the installation instruction

RFS RADIAFLEX® CABLES

Connectors for RADIAFLEX® cables with corrugated outer conductor (RSF & RCF series)

For the RSF & SCF types of RADIAFLEX® cables, the same connectors are used as for CELLFLLEX® cables.



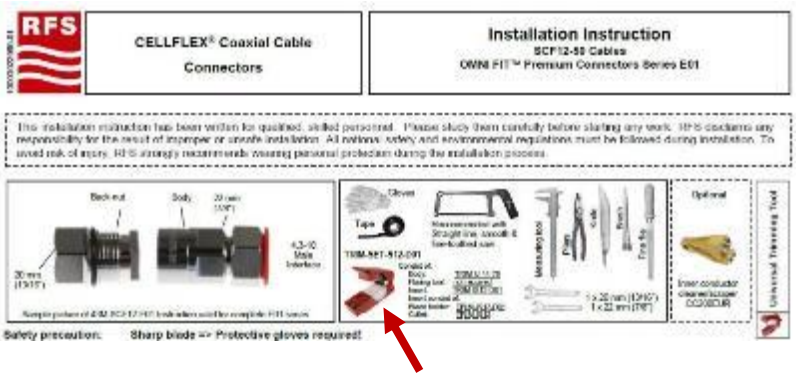
The standard tools and the recommended Trimming Tools as well are shown in the installation instruction)

Note:
A heat shrink sleeve with adhesive lining must be used in addition for RSF & RCF cable types! These sleeves are not part of the Connector delivery (except connectors of the C02 & C03 family for SCF-12 cables).
Such sleeves must be ordered in addition!

For the installation of the heat shrink sleeves a gas blow torch or an efficient hot air gun is required. A detailed application note about the proper installation of heat shrink sleeves are available @ the link of the data sheets of the connectors.

RFS RADIAFLEX® CABLES

Connectors for CELLFLEX® cables – Feeder cables

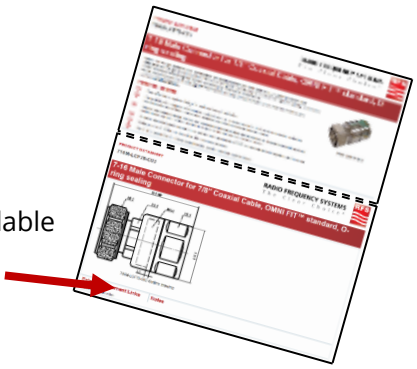


In order to achieve the best possible performance, the use of special Trimming tools are recommended. (usable Trimming Tool are shown in the installation instruction)

Installation of Connectors

Please follow the installation instructions which is included in the packing of the connector very carefully. Installation instructions are online available. Please scan the QR-Code!

Instructions for CELLFLEX® connectors, showing both: Manual way (only with standard tools) and Trimming Tool method as well (recommended)



The Link to the installation instructions is also available @ the data sheet of the connectors.
Please find the data sheet @ RFS Web page:
www.rfsworld.com/

Further helpful tools for the installation are shown at the beginning of this document.

RFS RADIAFLEX® CABLES

9.2 Connectors for CELLFLEX® cables

Cable size ∅	Cabletype (*1=Jacket option)	Standard Connector	Preparation tool for the installation	Premium Connector	Preparation tool for the installation
3/8"	SCF38-50*			43M-SCF38-E01	TRIM-SET-S38-D01
				NF-SCF38-E01	TRIM-SET-S38-D01
				NM-SCF38-E01	TRIM-SET-S38-D01
	LCF38-50*			43M-SCF38-E01	
				NF-SCF38-E01	
				NM-SCF38-E01	
				NMR-SCF38-E01	
1/2"	SCF12-50*	43M-SCF12-C03	TRIM-SET-S12-C02	43M-SCF12-E01	TRIM-SET-S12-D01
		43F-SCF12-C03	TRIM-SET-S12-C02	43F-SCF12-E01	TRIM-SET-S12-D01
		43MH-SCF12-C03	TRIM-SET-S12-C02	43MR-SCF12-E01	TRIM-SET-S12-D01
		43MP-SCF12-C03	TRIM-SET-S12-C02	NF-SCF12-E01	TRIM-SET-S12-D01
		43MR-SCF12-C03	TRIM-SET-S12-C02	NM-SCF12-E01	TRIM-SET-S12-D01
		NF-SCF12-C03	TRIM-SET-S12-C02	NMR-SCF12-E01	TRIM-SET-S12-D01
		NM-SCF12-C03	TRIM-SET-S12-C02	716F-SCF12-E01	TRIM-SET-S12-D01
		716F-SCF12-C03	TRIM-SET-S12-C02	716M-SCF12-E01	TRIM-SET-S12-D01
		716M-SCF12-C03	TRIM-SET-S12-C02	716MR-SCF12-E01	TRIM-SET-S12-D01
		716MR-SCF12-C03	TRIM-SET-S12-C02		
	LCF12-50*	43F-LCF12-C03	TRIM-SET-L12-C02	43M-LCF12-E01	TRIM-SET-L12-D01
		43M-LCF12-C03	TRIM-SET-L12-C02	43F-LCF12-E01	TRIM-SET-L12-D01
		43MH-LCF12-C03	TRIM-SET-L12-C02	43MR-LCF12-E01	TRIM-SET-L12-D01
		43MP-LCF12-C03	TRIM-SET-L12-C02	NF-LCF12-E01	TRIM-SET-L12-D01
		43MR-LCF12-C03	TRIM-SET-L12-C02	NM-LCF12-E01	TRIM-SET-L12-D01
		NF-LCF12-C03	TRIM-SET-L12-C02	NMR-LCF12-E01	TRIM-SET-L12-D01
		NM-LCF12-C03	TRIM-SET-L12-C02	716F-LCF12-E01	TRIM-SET-L12-D01
		NMR-LCF12-C03	TRIM-SET-L12-C02	716M-LCF12-E01	TRIM-SET-L12-D01
		716F-LCF12-C03	TRIM-SET-L12-C02	716MR-LCF12-E01	TRIM-SET-L12-D01
		716M-LCF12-C03	TRIM-SET-L12-C02		
		716MR-LCF12-C03	TRIM-SET-L12-C02		
		78EIA-LCF12-060 (*2)	TRIM-SET-L12-D01		

* Cable jacket option, e.g. J, JFN, CPR

*2 The Sealing Compound P2000-001 must be ordered separately, needed quantity see data sheet of the connector

RFS RADIAFLEX® CABLES

Cable size ø	Cabeltyp (*1 = Jacket option)	Standard Connector	Preparation tool for the installation of Standard connector	Premium Connector	Preparation tool for the installation of Premium connector
7/8"	LCF78-50*	43F-LCF78-C03	TRIM-SET-L78-C02	43F-LCF78-E01	TRIM-SET-L78-D01
		43M-LCF78-C03	TRIM-SET-L78-C02	43M-LCF78-E01	TRIM-SET-L78-D01
		43MH-LCF78-C03	TRIM-SET-L78-C02	NF-LCF78-E01	TRIM-SET-L78-D01
		43MP-LCF78-C03	TRIM-SET-L78-C02	NF-LCF78-E01K	TRIM-SET-L78-D01
		NF-LCF78-C03	TRIM-SET-L78-C02	NM-LCF78-E01	TRIM-SET-L78-D01
		NM-LCF78-C03	TRIM-SET-L78-C02	716F-LCF78-E01	TRIM-SET-L78-D01
		716F-LCF78-C03	TRIM-SET-L78-C02	716M-LCF78-E01	TRIM-SET-L78-D01
		716M-LCF78-C03	TRIM-SET-L78-C02	716MR-LCF78-D01	TRIM-SET-L78-D01
		78EIA-LCF78-062 (*2)	TRIM-SET-L78-D01		
		158EIA-LCF78-062 (*2)	TRIM-SET-L78-D01		
1 1/4"	LCFS114-50*	716F-LCF114-C02	TRIM-SET-L114-C02	43F-LCF114-E01	TRIM-SET-L114-D01
		716M-LCF114-C02	TRIM-SET-L114-C02	43M-LCF114-E01	TRIM-SET-L114-D01
				NF-LCF114-E01	TRIM-SET-L114-D01
				NM-LCF114-E01	TRIM-SET-L114-D01
				716F-LCF114-E01	TRIM-SET-L114-D01
				716M-LCF114-E01	TRIM-SET-L114-D01
		78EIA-LCF114-062 (*2)	TRIM-SET-L114-D01		
		158EIA-LCF114-062 (*2)	TRIM-SET-L114-D01		
1 5/8"	LCF158-50*	716F-LCF158-C02	TRIM-SET-L158-C02	43F-LCF158-E01	TRIM-SET-L158-D01
		716M-LCF158-C02	TRIM-SET-L158-C02	43M-LCF158-E01	TRIM-SET-L158-D01
				NF-LCF158-E01	TRIM-SET-L158-D01
				NM-LCF158-E01	TRIM-SET-L158-D01
				716F-LCF158-E01	TRIM-SET-L158-D01
				716M-LCF158-E01	TRIM-SET-L158-D01
		78EIA-LCF158-062 (*2)	TRIM-SET-L158-D01		
		158EIA-LCF158-062 (*2))	TRIM-SET-L158-D01		

* Cable jacket option, e.g. J, JFN, CPR

*2 The Sealing Compound P2000-001 must be ordered separately, needed quantity see data sheet of the connector

RFS RADIAFLEX® CABLES

9.3 Connectors for RADIAFLEX® cables

Cable size ø	Cabeltyp (* = Jacket option)	Standard Connector	Preparation tool for the installation of Standard connector	Premium Connector	Preparation tool for the installation of Premium connector
1/2"	RSF12-50*	43M-SCF12-C03	TRIM-SET-S12-C02	43F-SCF12-E01 (*2)	TRIM-SET-S12-D01
		43F-SCF12-C03	TRIM-SET-S12-C02	43M-SCF12-E01 (*2)	TRIM-SET-S12-D01
		NF-SCF12-C03	TRIM-SET-S12-C02	NF-SCF12-E01 (*2)	TRIM-SET-S12-D01
		NM-SCF12-C03	TRIM-SET-S12-C02	NM-SCF12-E01 (*2)	TRIM-SET-S12-D01
		716F-SCF12-C03	TRIM-SET-S12-C02	716F-SCF12-E01 (*2)	TRIM-SET-S12-D01
		716M-SCF12-C03	TRIM-SET-S12-C02	716M-SCF12-E01 (*2)	TRIM-SET-S12-D01
	RCF12-50*	43F-LCF12-C03 (*2)	TRIM-SET-L12-C02	43F-LCF12-E01 (*2)	TRIM-SET-L12-D01
		43M-LCF12-C03 (*2)	TRIM-SET-L12-C02	43M-LCF12-E01 (*2)	TRIM-SET-L12-D01
		NM-LCF12-C03 (*2)	TRIM-SET-L12-C02	NF-LCF12-E01 (*2)	TRIM-SET-L12-D01
		716M-LCF12-C03 (*2)	TRIM-SET-L12-C02	716F-LCF12-E01 (*2)	TRIM-SET-L12-D01
	RLK12-50* RLKW12-50* RLKU12-50*	NF-RA12-012	not required	43F-RA12-P02 (*3)	TRIM-SET-R12-P02
		NM-RA12-011	not required	NF-RA12-P02 (*3)	TRIM-SET-R12-P03
				NM-RA12-P02 (*3)	TRIM-SET-R12-P04
7/8"	RCF78-50*	43F-LCF78-C03 (*3)	TRIM-SET-L78-C02	43F-LCF78-E01 (*3)	TRIM-SET-L78-D01
		43M-LCF78-C03 (*3)	TRIM-SET-L78-C02	43M-LCF78-E01 (*3)	TRIM-SET-L78-D01
		NF-LCF78-C03 (*3)	TRIM-SET-L78-C02	NF-LCF78-E01 (*3)	TRIM-SET-L78-D01
		NM-LCF78-C03 (*3)	TRIM-SET-L78-C02	NM-LCF78-E01 (*3)	TRIM-SET-L78-D01
		716F-LCF78-C03 (*3)	TRIM-SET-L78-C02	716F-LCF78-E01 (*3)	TRIM-SET-L78-D01
		716M-LCF78-C03 (*3)	TRIM-SET-L78-C02	716M-LCF78-E01 (*3)	TRIM-SET-L78-D01
	RLK78-50* RLKU78-50* RLKW78-50*	NF-RA78-016	not required	43F-RA78-P02	TRIM-SET-R78-P02
		NM-RA78-015	not required	716F-RA78-P02	TRIM-SET-R78-P02
		716F-RA78-016	not required	716M-RA78-P03	TRIM-SET-R78-P02
		716M-RA78-015	not required		

RFS RADIAFLEX® CABLES

Cable size ∅	Cabletype (*1=Jacket option)	Standard Connector	Preparation tool for the installation	Premium Connector	Preparation tool for the installation
1 1/4"	RLF114-50* RLFU114-50* RLK114-50* RLKW114-50* RLKX114-50*	NF-RA114-016	not required	43F-RA114-P02	TRIM-SET-R114-P02
		716F-RA114-016	not required	716F-RA114-P02	TRIM-SET-R114-P02
1 5/8"	RLF158-50* RLFU158-50* RLK158-50* RLKW158-50* RLKU158-50* RAY158-50* RAYA158-50*	NF-RA158-016	not required	43F-RA158-P02	TRIM-SET-R158-P02
		716F-RA18-016	not required	716F-RA158-P02	TRIM-SET-R158-P02

* Cable jacket option, e.g. JFN, CPR

*2 The additional needed heat shrink sleeve must be ordered in addition:

Heat shrink sleeves	
for RSF12-50* cable connectors	HEAT-328-012
for RCF12-50* cable connectors	HEAT-328-018
for RCF78-50* cable connectors	HEAT-3812-014
for RCF114-50* cable connectors	HEAT-5016-024
for RCF158-50* cable connectors	HEAT-6319-026

*3 In order to achieve the PIM specs. the use of the mentioned trimming tool is mandatory.

10. EARTHING

10.1 Installation Instructions

Earthing of radiating cables installed in road tunnels is of minor importance than it is for those installed in train tunnels (provided that there is no outdoor overlap antenna and no high-voltage/high current system nearby).

We generally recommend to earth the jumper or feeder cable that feeds the radiating cable (,near end of cable run respective to active equipment). The far end of indoor/tunnel systems do not need to be earthed. Exceptions to this rule are systems with an overlap antenna because of the risk of lightning strike and systems with a risk of high-induced voltage by train catenaries. If there is an earthing at both ends of a long cable run we recommend an additional DC block in between to avoid closed current loops because of the risk of induction, parasitic high reverse currents in train tunnels etc. Furthermore, a DC block may help to separate earthing points that are connected to different earth systems in tunnels (tunnel earth, water earth, and building earth, depending on local conditions) because of the risk of potential differences.

We do not recommend using cable earthing kits for the radiating cables, as this might damage the thin foil outer conductor. This is rather due to the risk of mechanical damage of the outer conductor foil then by improper installation than due to deterioration of electrical performance by covering some slots.

The earthing standards required for a proper installation of the entire system are to be established prior to the installation based on the local regulations.

The following list is a rough breakdown:

Protection against over voltage caused by external influences (lightning protection).

In the case of high frequency cables, the earthing of the outer conductor and the use of overvoltage adapters (e.g. surge suppresser, DC block) is advisable. The risk of lightning damage is very high in those areas where system components are installed both internally and externally.

Over voltage protection within buildings

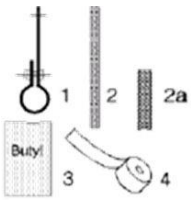
The possibility of voltage induction is the first point to watch out for in this issue. As power cables with high voltages (U > 500 V) are not normally installed in buildings, high frequency cables are earthed via standard earthing kits. In these areas, with the generally shorter section lengths of approx. 100 m of radiating cable, it is sufficient to earth the feeder or jumper cables. The danger of induced voltages can be counteracted by a single-sided earthing of the radiating cable in conjunction with a DC block in order to prevent a loop and hence a flow of current by the induced voltage.

Over voltage protection within tunnels or similar

In these situations the risk of induced voltages comes from high-voltage cables, overhead conductors, approaching trains, etc. A study of the existing risk potential must be carried out in such cases.

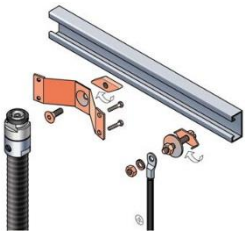
RFS RADIAFLEX® CABLES

Grounding devices:



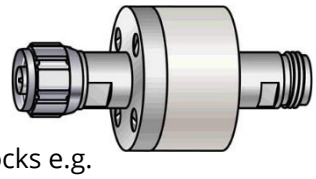
Grouding kit for jumper cables
e.g. **EAR-12-S** for SCF12 cables

Grouding kit for feeder cables
e.g. **GKSPEED20-12P** for LCF12 cables
GKSPEED20-78P for LCF78 cables
GKSPEED20-114P for LCF114 cables
GKSPEED20-158P for LCF158 cables



Connector grouding kit
e.g. **CEAR-12** for SCF12 & LCF12 connectors, **CEAR-78** for LCF78 connectors, **CEAR-114** for LCFS114 connectors & **CEAR-58** for LCF158 connectors
+ Grounding terminal **CEAR-AC**

Universal connector grouding kit (without cable)
CEAR-12-214 for LCF12up to LCF214 connectors



DC-Blocks e.g.
DC-BLOCK-3-7MF-02, DC-BLOCK-3-NMF-1, DC-BLOCK-3-7MF-1, DC-BLOCK-3-43MF-1

EMP Protector (surge arrestor or lightning arrestor), e.g.
λ/4 stub type (without DC-Path)
e.g. **716-STUB-14**

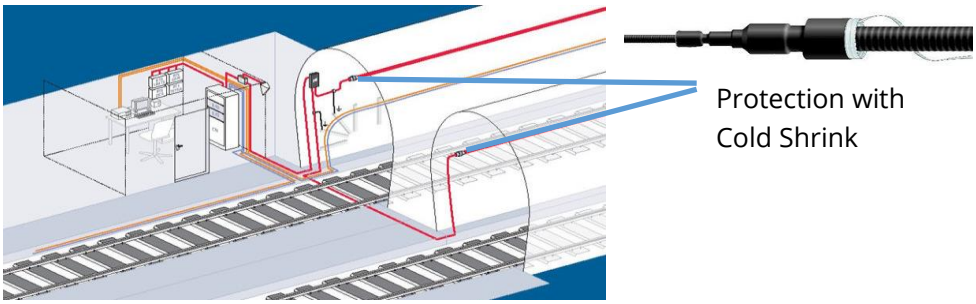
Universal Grounding Wire Kit
16mm², 0,5m **GW-16/20**

In DC systems, DC blocks can usually be omitted. However, for the majority of railway systems with traction voltages up to 25 kV AC, DC blocks will normally be included for each section of radiating cable, whatever length. All connectors in between must be sealed against touching by shrinking sleeves.

Potential equalisation

These procedures have to be carried out to protect people and equipment and are the minimum requirement that an installation has to satisfy. This protection is easily achieved with earthing kits or connector earthing for the cable as well as by earthing the equipment housings.

RFS RADIAFLEX® CABLES



Protection with
Cold Shrink

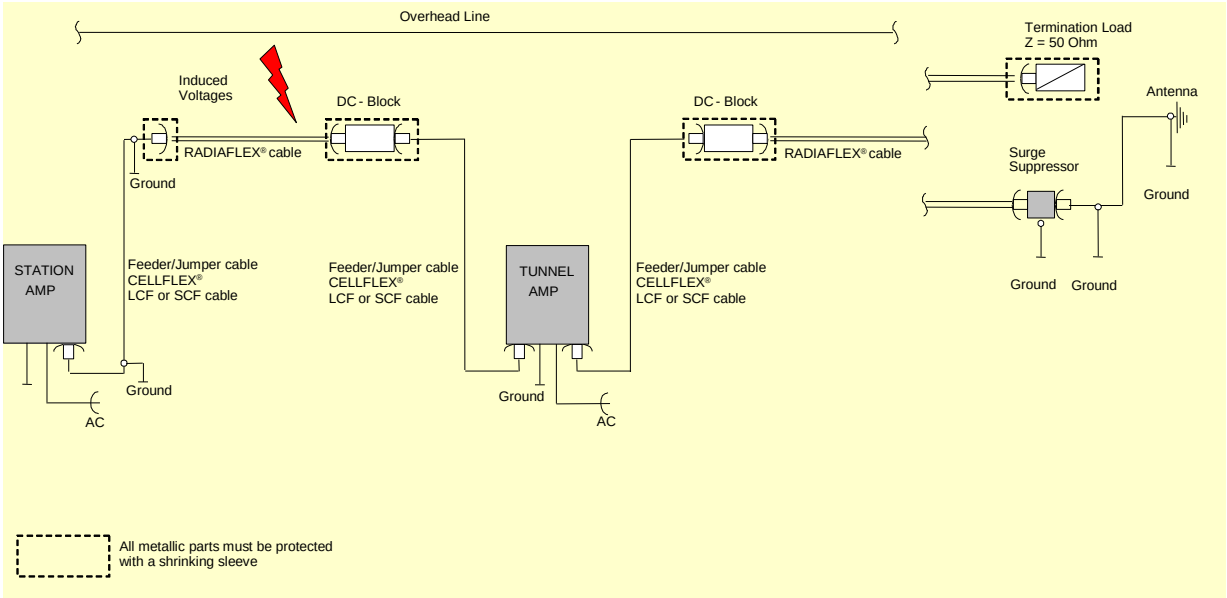
The specification and provision of earthing procedures is the No. 1 priority because people and equipment are subject to a high-risk potential. The earthing points must be planned consistently for the whole system, especially for railway systems having several earth potentials (e.g. rail-, equipment-, water-earth, etc.).

The components used for earthing must be chosen carefully so that they can fulfil their function properly. This means, for example, connecting an earthing cable of adequate size to the existing earthing system. Connections are either direct, using bi-metallic connections fixed to existing earthing cables or ring earth electrodes or made by means of spade terminals connected to existing earthing points. An anchor-bar can serve as a bus bar for several earthings.

When joining earthing cables, unsuitable combinations of metals, e.g. copper and zinc, must be acoided. In such cases, bimetal connectors must be used in order to counteract the risk of galvanic corrosion.

Earthing of RADIAFLEX® Systems

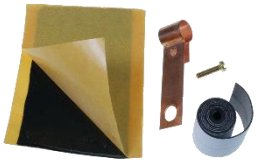
RADIAFLEX® cables itself are not earthed. The connection is carried out by earthing of the respective jumpers or feeders. In this case a cable earthing kit or a connector earthing kit has to be used.



RFS RADIAFLEX® CABLES

10.2 Installing earthing kits

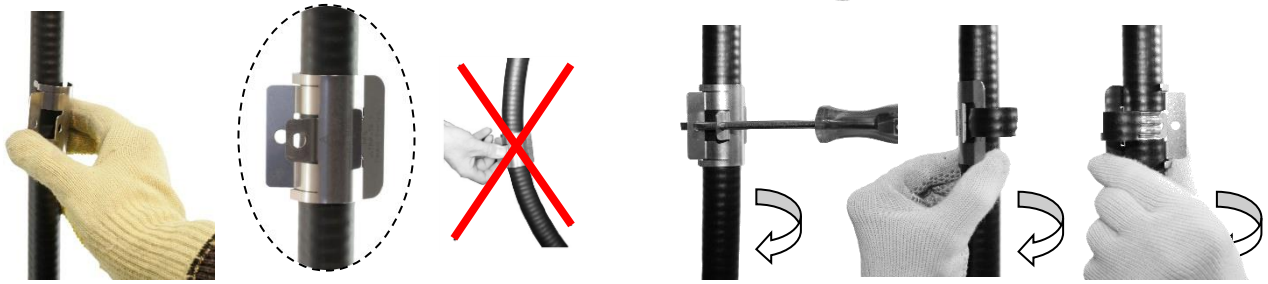
The installation instructions included with every unit must be followed when installing earthing kits. To avoid unnecessary mechanical loads on the cable, cable grounding kits should only be placed in straight sections of cable (between two clamps).

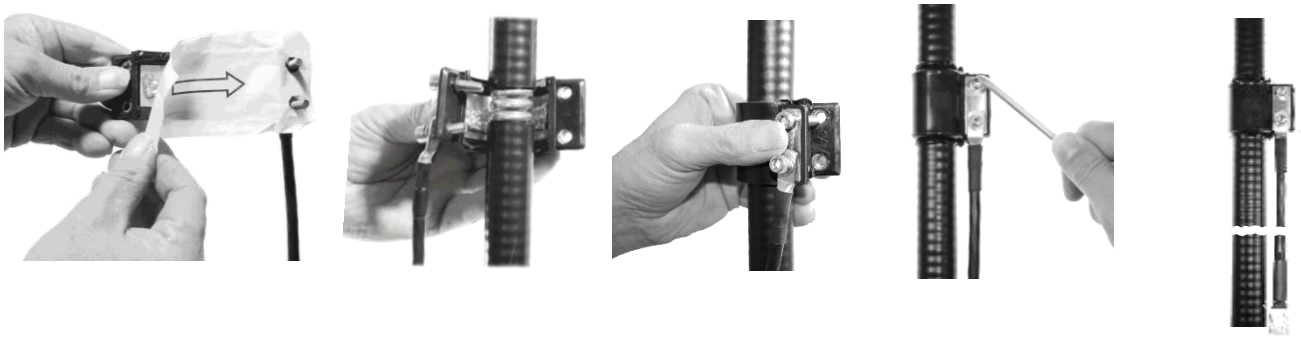


EAR-12-S for SCF12-50* cables

For the installation of GKSPEED* grounding kits the use of JSTRIP tools is recommended.

Simple and safe dismantling with:
JSTRIP-12-3 for LCF12 cables
JSTRIP-78-2 for LCF78 cables
JSTRIP-114-2 for LCFS114 cables
JSTRIP-158-2 for LCF158 cables





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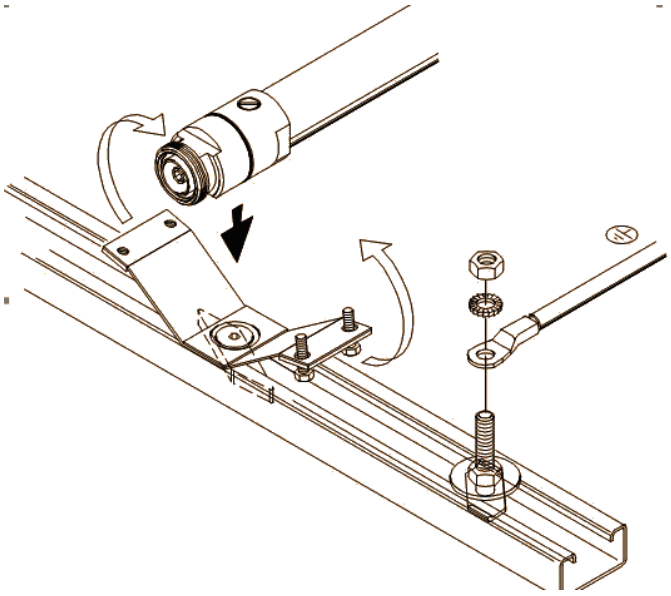
Attaching a connector earthing to a feeder cable

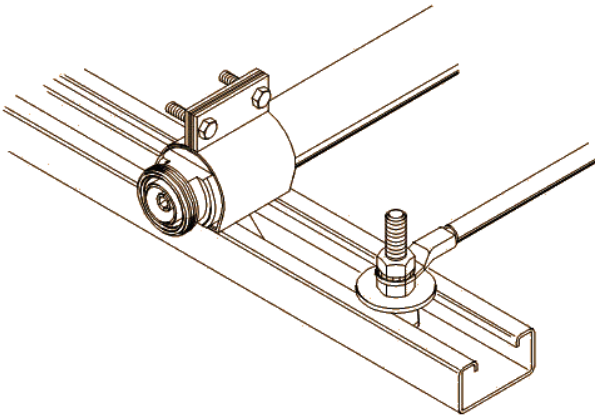
The connector earthing can be installed to earth the feeder cable, with the connector itself being earthed. It is not necessary to open the cable jacket for this. Single or multiple connector earthings can be mounted on an anchor bar. The connection between anchor bar and potential equalisation rail must be made with an adequately dimensioned earthing cable; in most cases a wire cross-section of 16 mm^2 copper is sufficient.

Installation of a connector earthing

The connector earthing kit contains a lozenge-shaped channel nut and a screw for fixing to an anchor bar. After fixing the connector earthing bracket to the anchor bar, the connector is inserted and the earthing bracket bent around and closed using the screws included. Apply a little grease to these screws beforehand.

An earthing kit for anchor rails is available for connecting an earthing cable to the anchor bar. This contains all the necessary items. The earthing block is fixed to the anchor rail by means of a lozenge-shaped channel nut. The earthing block has a threaded connection for fixing cable terminals. The earthing kits used for earthing the feeder and/or jumper cables can also be connected to this earthing point.





11. INSPECTION & TESTS AFTER INSTALLATION

11.1 Visual inspection & measurements

After installation perform the following inspection and tests:

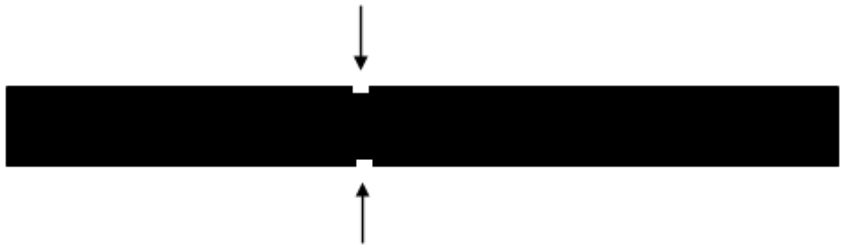
Visual inspection

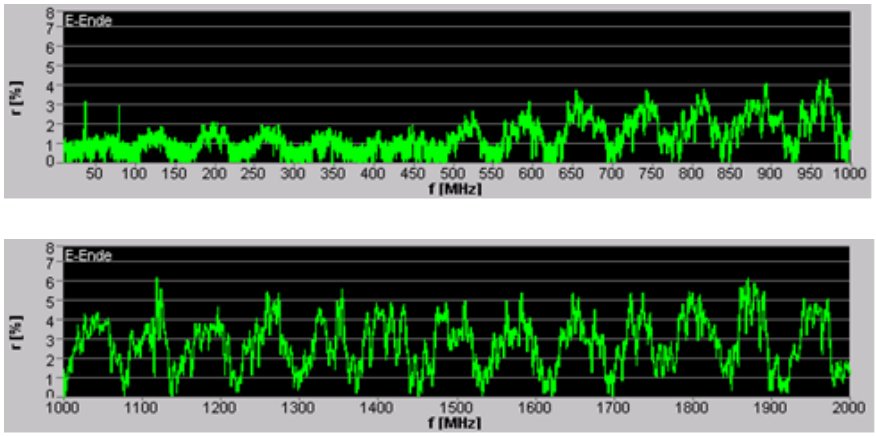
The cable should not show sharp bends, dents or other deformations. The recommended wall spacing should be kept over the entire length.

Return Loss

A return loss measurement indicates a proper installation of connectors and cables. In case of radiating cable some experience is required for the evaluation.

Single Fault





-> Creates „Sinus-like“ Return Loss

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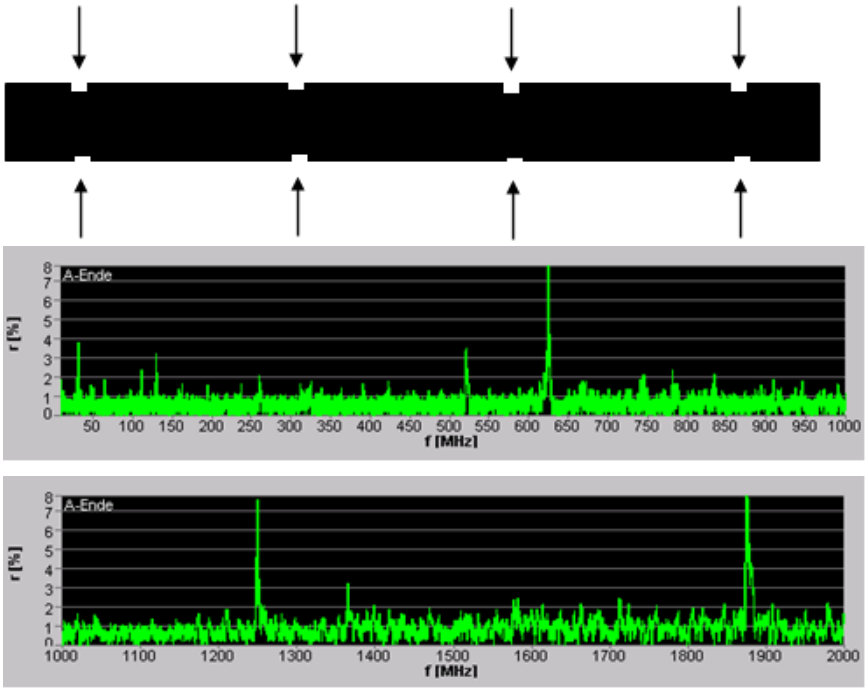
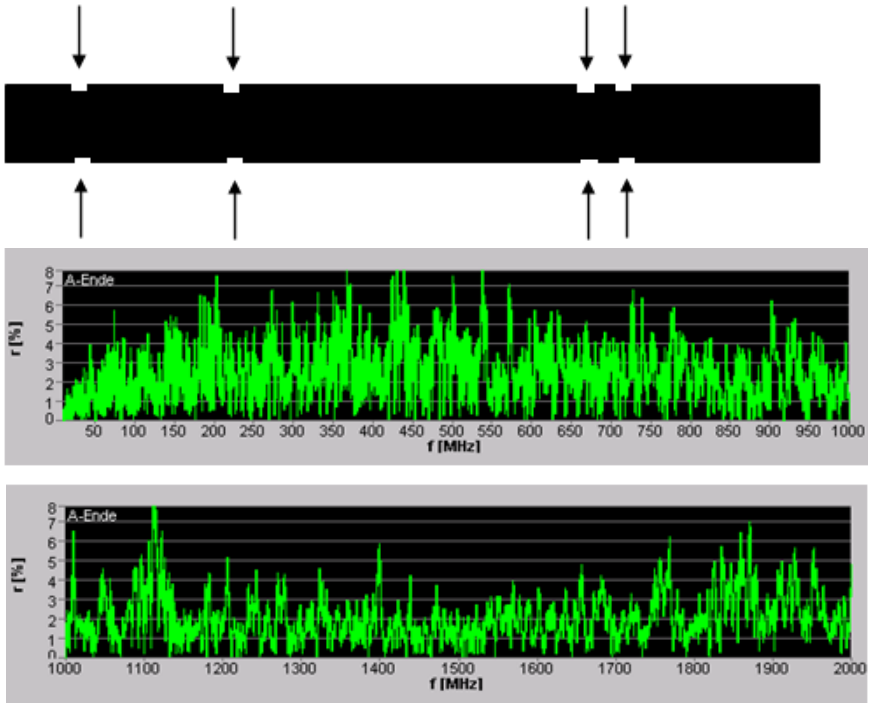
Periodic Faults



-> Create Narrow Band Peaks

Stochastic Faults



-> Create „Noise Like“ Return Loss

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Network Analyzers Measure at Discrete Frequency Points with a limited Resolution.

Periodic cable faults cause narrow return loss peaks. If level of peaks shall be measured accurately, sufficient resolution has to be chosen.

Time Domain Reflection

The measurement is commonly used for site acceptance tests of cable runs in base stations. Generally a radiating cable is a coaxial cable with periodic or non-periodic apertures in the outer conductor. Due to the impedance step at every aperture a small local reflection is created. The level of the reflected wave depends on the slot size and orientation. With a DTF measurement small cable fault can't be distinguished from slotted areas. Only significant cable damages, like cracked conductor could be detected. Instead RFS recommends to perform frequency domain return loss measurements, which gives more information about the accuracy of the slot pattern. Significant cable fault would become obvious also.

Longitudinal Loss

The longitudinal loss indicates proper connections of all components and proper installation of radiating cables. Note that environmental conditions influence the performance of radiating cables!

Measurement

Calibrate the power meter or network analyzer.

Input a signal to one port and record the power level at the other port of the cable.

Evaluation

Calculate attenuation as: in dB/100m at 20°C

$$\alpha = \frac{Ne - Ns}{L} \cdot 100$$

Ne power level at cable input [dBm]
Ns power level at cable output [dBm]
L length of cable [m]

Remark: Since resistive loss and coupling loss are both present, α cannot be corrected for the temperature.

System Loss

The system loss is the most important figure to verify the performance of the complete system. Note that environmental conditions influence the performance of radiating cables!

Measurement (see fig. 1)

- The generator frequency and output power level is adjusted.
- The signal fed into the test receiver via the antenna´s cable for calibration (output level, cable attenuation).
- The signal is fed into the radiating cable

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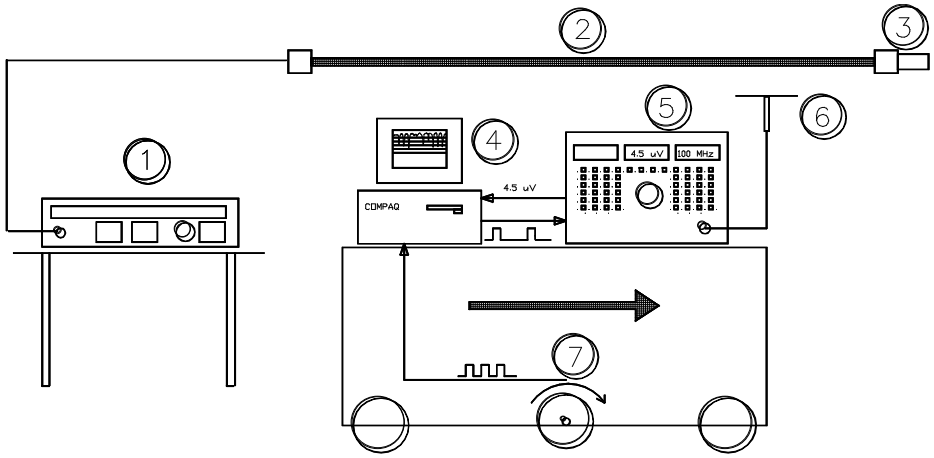
- The power level received by the antenna is recorded as a function of the distance of the antenna from the input end of the radiating cable by the test receiver. Sampling rate of measuring points ≥ 20 per half wavelength in free space.
- The system loss measurement is made with three different dipole orientations towards the cable (figure 2).



1: synthesizer
2: radiating cable
3: load
4: control unit
5: test receiver
6: λ/2 - dipole-antenna
7: distance sensor

figure 1: measurement equipment

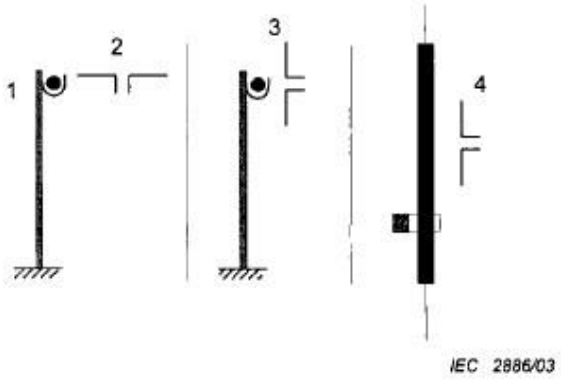


figure 2: spatial orientations of dipoles

1	Cable	3	Orthogonal
2	Radial	4	Parallel

P: Parallel (former Horizontal Parallel)
R: Radial (former Horizontal Orthogonal)
O: Orthogonal (former Vertical)

Evaluation

The local system loss is calculated as follows:

asys(z) = Lin – Lm

asys(z): system loss at the location z
Lin: input level to the radiating cable
Lm: measured level at the antenna

The system loss is characterized by two statistical figures of reception probability: 50 % and 95 %. The average system loss figures obtained with different dipole orientations are calculated with (1). Usually only sections of the system are taken into account for the calculation of the local system loss.

$$a_{sys,av} = -10 \cdot \log\left(\frac{1}{3}\left(10^{-\frac{a_{sys,r}}{10}} + 10^{-\frac{a_{sys,p}}{10}} + 10^{-\frac{a_{sys,o}}{10}}\right)\right) \quad (1)$$

Coupling Loss

The coupling loss measurement is an indirect measurement, derived from the direct system loss and longitudinal loss measurement. It has to be noted that the environment will influence the performance of radiating cables! Data sheet values are derived from free space measurements, conditions see in the chapter below.

Measurement (see fig. 1)

- The generator frequency and output power level is adjusted.
- The signal fed into the test receiver via the antenna´s cable for calibration (output level, cable attenuation).
- The signal is fed into the radiating cable.
- The power level received by the antenna is recorded as a function of the distance of the antenna from the input end of the radiating cable by the test receiver. Sampling rate of measuring points
  ≥ 20 per half wavelength in free space
- The coupling loss measurement is made with three different dipole orientations towards the cable (figure 2).

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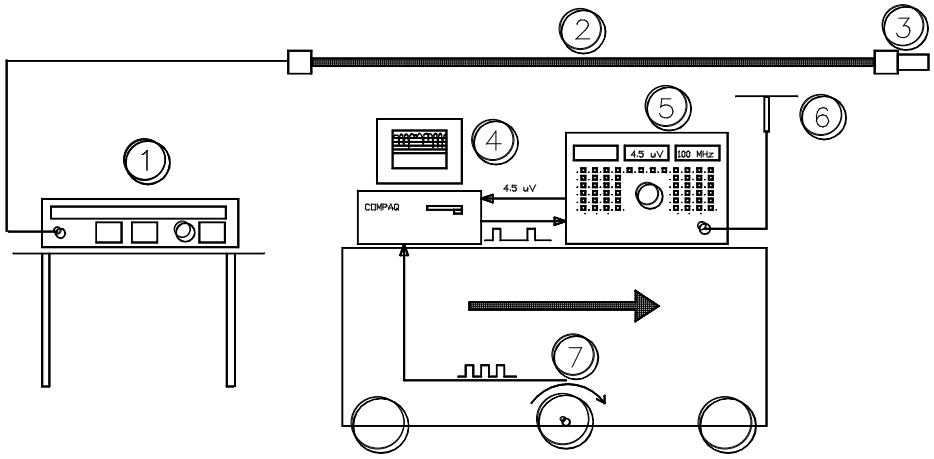


1: synthesizer
2: radiating cable
3: load
4: control unit
5: test receiver
6: λ/2 - dipole-antenna
7: distance sensor

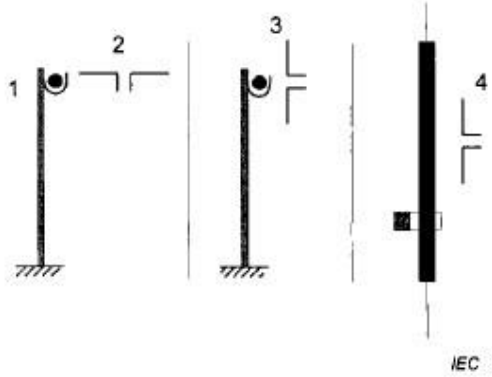
figure 1: measurement equipment

Evaluation

The local coupling loss is calculated as follows:

ac(z) = Lin – a(z) – Lm

ac(z): coupling loss at the location z
Lin: input level to the radiating cable
a(z): attenuation at the location z
Lm



Th s of reception probability: 50 % and 95 %.
Th dipole orientations are calculated with (2).

figure 2: spatial orientations of dipoles

1	Cable	3	Orthogonal
2	Radial	4	Parallel

P: Parallel (former Horizontal Parallel)
R: Radial (former Horizontal Orthogonal)
O: Orthogonal (former Vertical)

Free Space Method

The cable is laid on non metallic posts in a height of 2 m. A tuned half-wavelength dipole is put on a trolley and moved parallel to the cable. The height of the antenna centre is the same as that of the cable. The horizontal distance from the cable is also 2 m.

Standard conditions of testing:

- ambient temperature t_{amb} = +5 °C ÷ 40 °C (limitations of test equipment)
- rel. humidity < 100 % , no rain
- cable has to be clean and dry

Time Domain Reflection

The measurement is commonly used for site acceptance tests of cable runs in base stations. Generally a radiating cable is a coaxial cable with periodic or non periodic apertures in the outer conductor. Due to the impedance step at every aperture a small local reflection is created. The level of the reflected wave depends on the slot size and orientation. With a DTF measurement small cable fault can't be distinguished from slotted areas. Only significant cable damages, like cracked conductor could be detected. Instead RFS recommends to perform frequency domain return loss measurements, which gives more information about the accuracy of the slot pattern. Significant cable fault would become obvious also.

$$a_{c,av} = -10 \cdot \log\left(\frac{1}{3}\left(10^{-\frac{a_{c,o}}{10}} + 10^{-\frac{a_{c,p}}{10}} + 10^{-\frac{a_{c,r}}{10}}\right)\right) \quad (2)$$

About RFS

Radio Frequency Systems (RFS) is a global designer and manufacturer of cable, antenna and tower systems, plus active and passive RF conditioning modules, providing total-package solutions for wireless infrastructure.

RFS serves OEMs, distributors, system integrators, operators and installers in the broadcast, wireless communications, land-mobile and microwave market sectors. As an ISO compliant organization with manufacturing and customer service facilities that span the globe, RFS offers cutting-edge engineering capabilities, superior field support and innovative product design. RFS is a leader in wireless infrastructure.

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