Wireless Indoor Solutions
Application Examples

www.rfsworld.com

RADIO FREQUENCY SYSTEMS
The Clear Choice®

October 2013

RADIO FREQUENCY SYSTEMS
The Clear Choice®

RFS: A leader in Wireless Indoor Solutions

The most RF broadband passive distributed antenna system (DAS)

800/2700MHz **690/6400MHz** **2400/5875MHz** **380/6000MHz**

- **CELLFLEX and CELLFLEX LITE low loss feeder cables**
- **High performance RADIAFLEX radiating cables**
- **Broadband and ultra-broadband indoor antennas**
- **Broadband and ultra-broadband, low insertion loss, indoor passive RF components (couplers, splitters)**

RADIO FREQUENCY SYSTEMS
The Clear Choice®

In-building coverage solutions for building scenarios - DAS

- Best in class coverage systems for commercial and for mission critical multi-carrier / multi-service applications of building scenarios

In-building coverage solutions for building scenarios - DAS

ClearFill Line
Cables, antennas, components

All kind of building scenarios, e.g.

- Small, mid-size and large buildings
- Office buildings
- Hotels
- Industrial plants
- Campus areas,
- Hospitals
- Airports
- Mines
- Ships
- Vessels

Ultra – wideband solutions for all kind of services, frequencies, e.g.

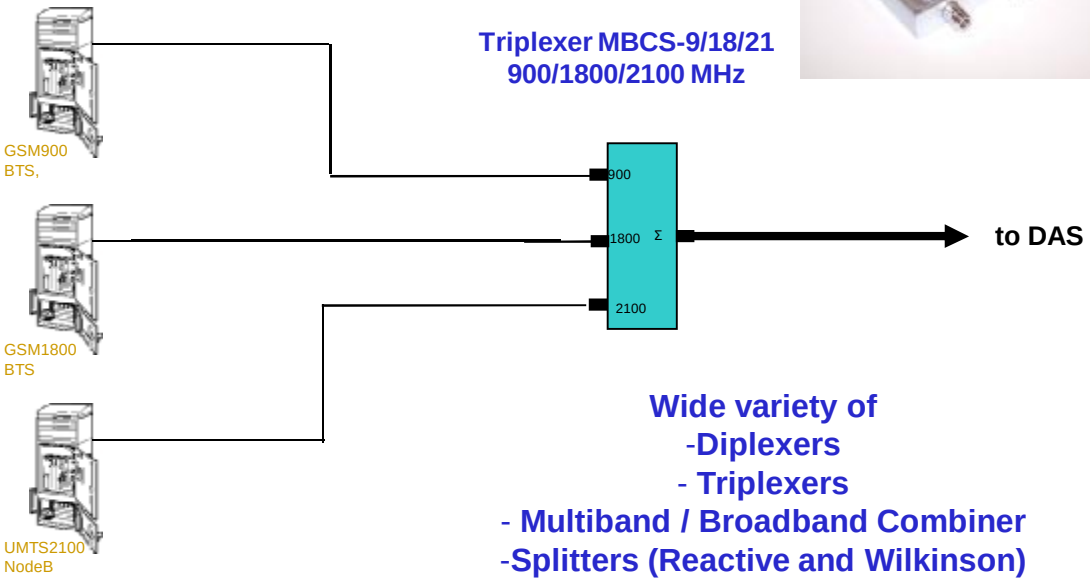
- FM
- VHF
- UHF
- TETRA
- GSM900, GSM1800, UMTS, LTE
- CDMA
- WLAN 2.4 GHz and 5 GHz
- WiMAX

FUTURE – PROOF SOLUTION!

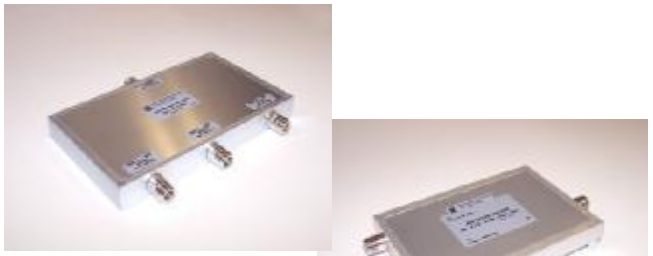
In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of dedicated Antennas

Single and/or multiple Operators possible



Triplexer MBCS-9/18/21
900/1800/2100 MHz



For multiple Operators / multiband application please note RFS Broadband Coupler series BBC44*

Wide variety of
-Diplexers
- Triplexers
- Multiband / Broadband Combiner
-Splitters (Reactive and Wilkinson)
- Directional couplers
-Tappers available

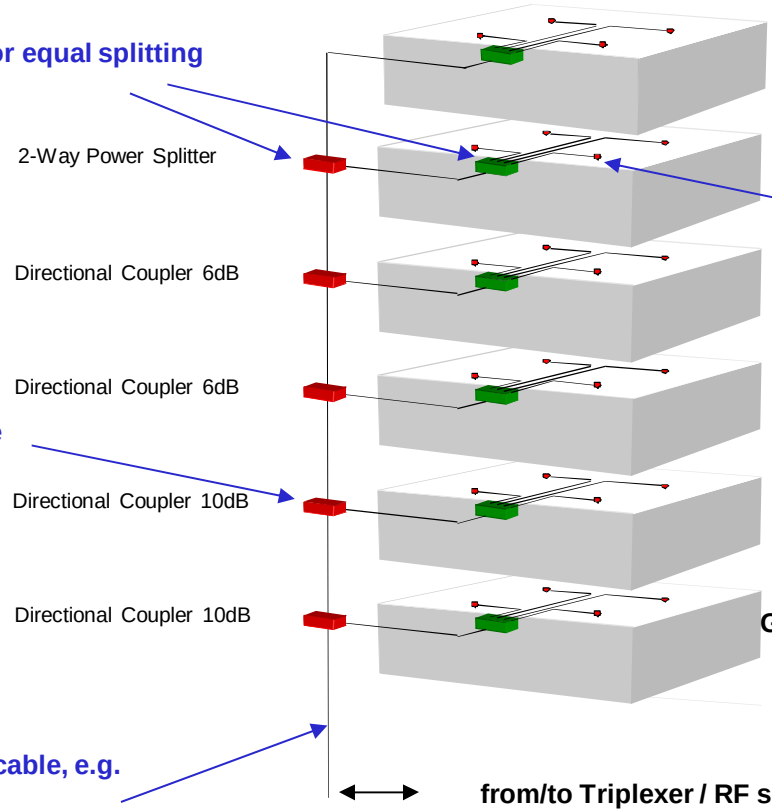
In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of dedicated Antennas

2-way, 3-way and 4-way splitters for equal splitting

Directional couplers (coupling values 5dB, 6dB, 7dB, 8dB, 10dB, 15dB, 20dB, 30dB) for unequal splitting to compensate feeder cable loss at higher floors

RF distribution via Coaxial Feeder cable, e.g. CELLFLEX cable LCF 12-50 JFN
Other types (LCF78-50JFNA, LCF114-50JFNA) can be used for loss reduction



Broadband and Ultra-broadband omnidirectional and directional antennas available
(e.g. 800 MHz-2700 MHz
698 MHz – 2700 MHz
350 MHz – 6000 MHz)

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of dedicated Antennas

Basic Indoor Link Budget

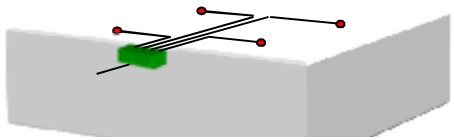
- **Coverage for 50 by 50 meters**
- **1,2 or 4 antenna set-up**
- **1 antenna for open space**
- **2 antenna for moderate dense**
- **4 antenna for heavy dense**

Link budget for Building Block (50m x 50m) - 2100MHz - Downlink			
No of antennas per building block	**1**	**2**	**4**
Power Level @ Building Block Input [dBm]	**10**	**10**	**10**
2 Way Power Splitter Loss [dB]		-3.5	
4 Way Power Splitter Loss [dB]			-7
LCF12-50JFN, 25m, Loss [dB]	-2.7		
LCF12-50JFN, 37,5m, Loss [dB]		-4.04	
LCF12-50JFN, 50m, Loss [dB]			-5.4
Antenna feeding power level [dBm]	7.3	2.5	-2.4
Common Pathloss Model			
Antenna Gain [dBi]	2	2	2
Path Loss for 35m (LOS), [dB]	-70		
Path Loss for 28m (LOS), [dB]		-68	
Path Loss for 18m (LOS), [dB]			-64
Reflection Fading Margin [dB]	-6	-6	-6
Wall loss inside building block [dB]	-20	-10	0
Predicted Reception Level @ Mobile [dBm]	**-86.7**	**-79.5**	**-70.4**

Typical attenuation values

Type of Material	Atten. [dB] @900MHz	Atten. [dB] @1850MHz	Atten. [dB] @2400MHz
Basement or foundation wall	13	14	15
Brick, concrete and concrete block	13	14	15
Cubicle wall	1	1.5	2
Drywall or sheetrock	2	2.5	3
Elevator or metallic obstacle	5	8	10
Glass door or window, no tint	2	2.5	3
Metallic rack	6	6	6
Wooden door	2	2.5	3

(source : Wireless Valley)

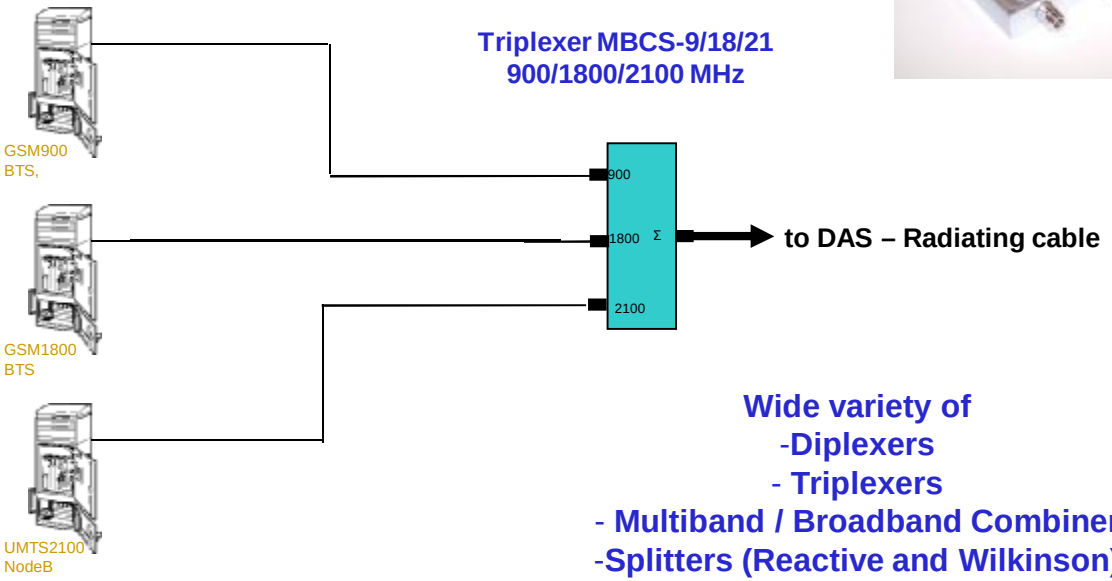


Building Block

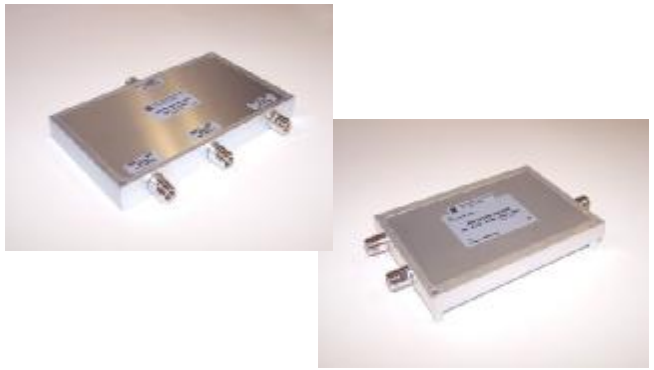
In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

Single and/or multiple Operators possible



Triplexer MBCS-9/18/21
900/1800/2100 MHz

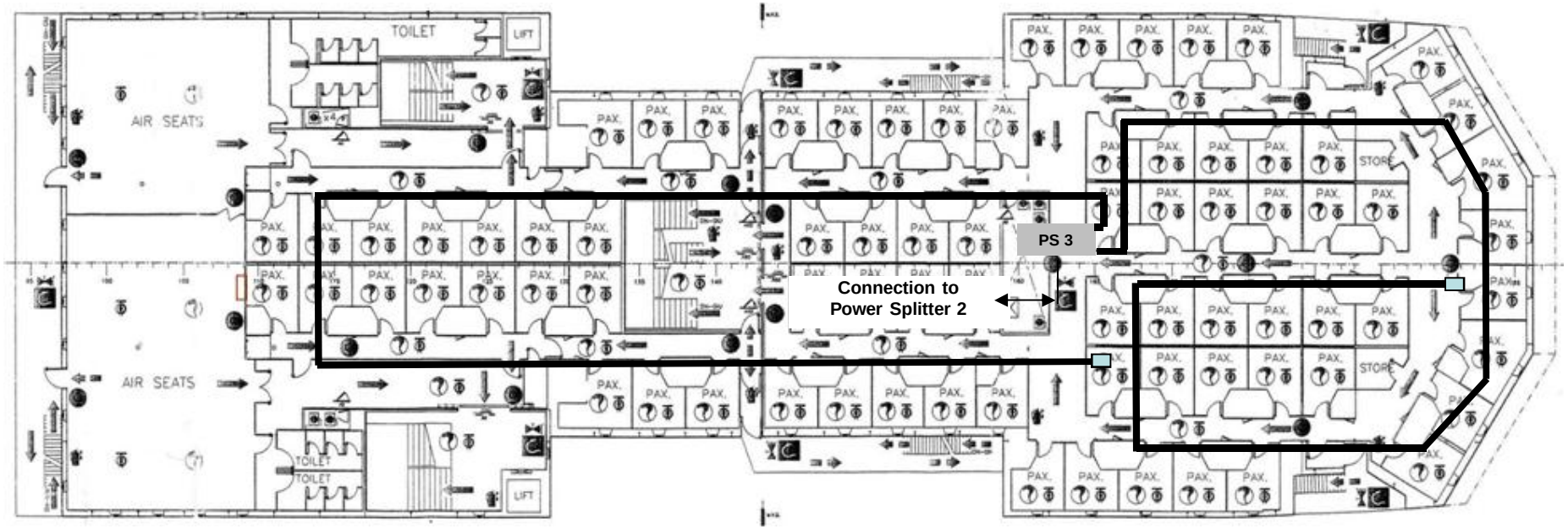


For multiple Operators / multiband application please note RFS Broadband Coupler series BBC44*

Wide variety of
-Diplexers
- Triplexers
- Multiband / Broadband Combiner
-Splitters (Reactive and Wilkinson)
- Directional couplers
-Tappers available

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables



In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

Directional couplers (coupling values 5dB, 6dB, 7dB, 8dB, 10dB, 15dB, 20dB, 30dB) for unequal splitting to compensate feeder cable loss at higher floors

Antennas (Omni- and/or Panel) can be used in combination with the RADIAFLEX cable

from/to Triplexer

RF source (BTS, OAR, etc)

RF distribution via Coaxial Feeder cable, e.g. CELLFLEX cable LCF 12-50 JFN
Other types (LCF78-50JFNA, LCFS114-50JFNA) can be used for loss reduction

Directional Coupler

P.S. 1

RADIAFLEX-cable RLKU78-50JFLA

Power Splitter 2-way

RADIAFLEX-cable RLKU78-50JFLA

RADIAFLEX cable should be always terminated at section end

RADIAFLEX-cable RLKU78-50JFLA

P.S. 3

Power Splitter 2-way

P.S. 2

2-way, 3-way and 4-way splitters for equal splitting

RADIAFLEX-cable RLKU78-50JFLA

RADIAFLEX®- Radiating cables operate as dedicated antennas, providing a homogenous, equal coverage along the cable run and are RF broadband. Therefore, they are highly applicable for coverage extension in confined areas.
For In-building applications, our RADIAFLEX cable types RLKW12-50; RLKW78-50, RLKU12-50, RLKU78-50, RCF12-50, RCF78-50 and RLKD12-50 are the best suitable selection.

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

RADIAFLEX® Radiating Cables – Basic Link Budget UMTS

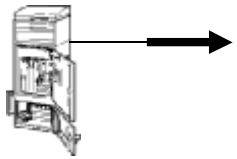
RF Output Power (CPICH) per channel:	**+ 20 dBm**
Triplexer loss:	**- 1.3 dB**
Directional coupler (6 dB):	**- 6.5 dB**
2-way Splitter:	**- 3.5 dB**
Feeder Cable Loss:	**- 1.5 dB**
Input Power at beginning of the Radiating cable:	**+ 7.2 dBm**
As per data sheet (RLKU78-50JFNA):	
Longitudinal loss per 100 m = 10 dB	
Consequently at 100 m System Length	**- 10 dB**
Coupling Loss in 2 m distance (95%):	**- 69 dB**
Received signal strength level (CPICH) @ 2m distance:	**- 71,8 dBm**

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for mission critical services TETRA 400 MHz
Solution by use of RADIAFLEX® Radiating cables

Single and/or multiple Operators

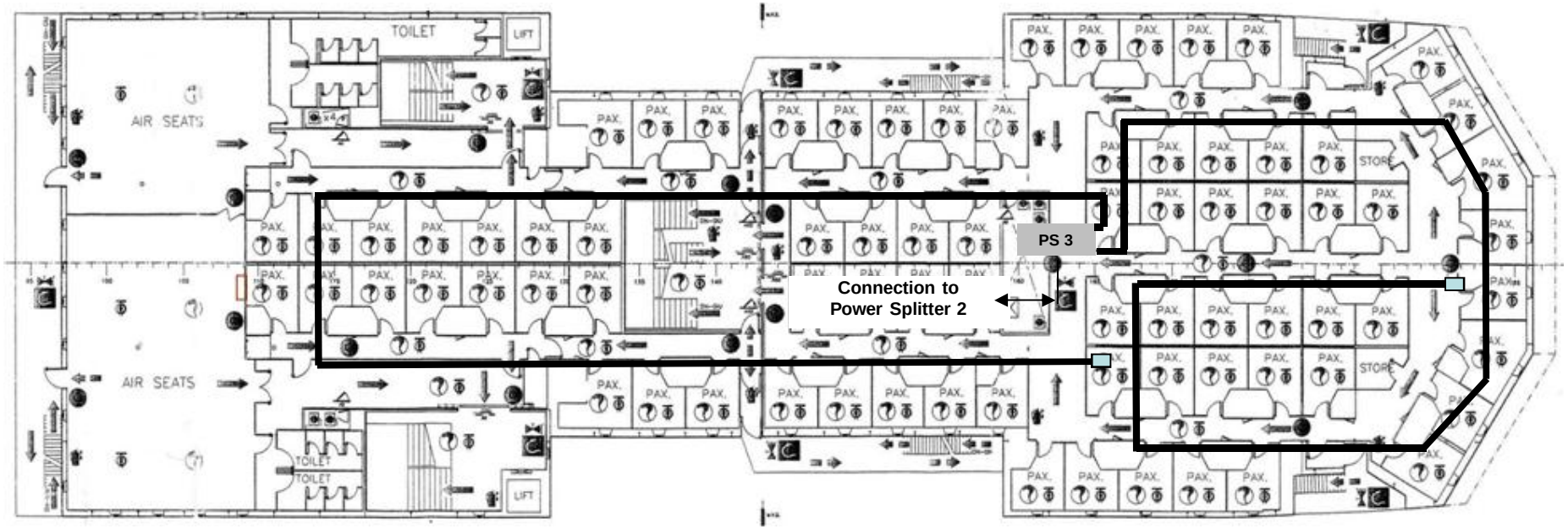
TETRA
BTS / OAR



to DAS – Radiating cable

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for mission critical services TETRA 400 MHz
Solution by use of RADIAFLEX® Radiating cables



In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for mission critical services TETRA 400 MHz
Solution by use of RADIAFLEX® Radiating cables

Directional couplers (coupling values 5dB, 6dB, 7dB, 8dB, 10dB, 15dB, 20dB, 30dB) for unequal splitting to compensate feeder cable loss at higher floors

Antennas (Omni- and/or Panel) can be used in combination with the RADIAFLEX cable

from/to RF source (BTS, OAR, etc)

RF distribution via Coaxial Feeder cable, e.g. CELLFLEX cable LCF 12-50 JFN
Other types (LCF78-50JFNA, LCFS114-50JFNA) can be used for loss reduction

Directional Coupler

P.S. 1

RADIAFLEX-cable RLK78-50JFLA

Power Splitter 2-way

RADIAFLEX-cable RLK78-50JFLA

RADIAFLEX cable should be always terminated at section end

RADIAFLEX-cable RLK78-50JFLA

P.S. 3

Power Splitter 2-way

P.S. 2

2-way, 3-way and 4-way splitters for equal splitting

RADIAFLEX-cable RLK78-50JFLA

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For In-building applications, our RADIAFLEX cable types RLK / RLKW12-50; RLK / RLKW78-50, RLKU12-50, RLKU78-50, RCF12-50, RCF78-50 and RLKD12-50 are the best suitable selection.

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for mission critical services TETRA 400 MHz
Solution by use of RADIAFLEX® Radiating cables

RADIAFLEX® Radiating Cables – Basic Link Budget 400 MHz

RF Output Power per channel:	**+ 30 dBm**
Directional coupler (6 dB):	**- 6.5 dB**
2-way Splitter:	**- 3.5 dB**
Feeder Cable Loss:	**- 0.5 dB**
Input Power at beginning of the Radiating cable:	**+ 19.5 dBm**
As per data sheet (RLK78-50JFLA):	
Longitudinal loss per 100 m = 2,7 dB	
Consequently at 100 m System Length	**- 2,7 dB**
Coupling Loss in 2 m distance (95%):	**- 59 dB**
Received signal strength level @ 2m distance:	**- 42,2 dBm**

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

RADIAFLEX® Radiating Cables, selected items for In-building scenarios

RLK series:

For applications in tunnels and buildings where low coupling loss variations are required.

RLK12-50JFNA (JFLA), up to 980 MHz
RLK78-50JFNA (JFLA), up to 980 MHz
RLKW12-50JFNA (JFLA), up to 1950 MHz
RLKW78-50JFNA (JFLA), up to 1950 MHz
RLKU12-50JFNA (JFLA), up to 2700 MHz
RLKU78-50JFNA (JFLA), up to 2700 MHz
RLKD12-50JFNA (JFLA), up to 6000 MHz

.

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

RADIAFLEX® Radiating Cables, selected items for In-building scenarios

RCF series:

For applications where particularly small bending radii are required for heavy-duty applications (e.g. mines, ships, vessels).

RCF12-50JFN (JFL), up to 6000 MHz
RCF78-50JFNA (JFLA), up to 2650 MHz
RSF12-50JFN (JFL), up to 6000 MHz

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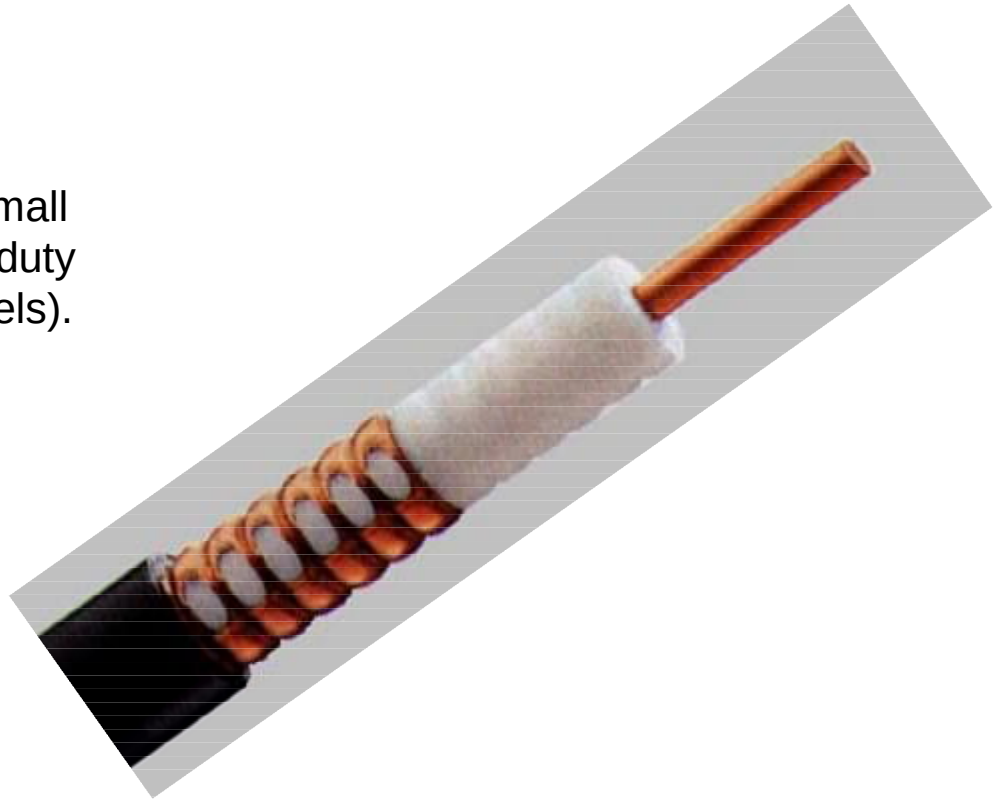


In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

RADIAFLEX® Radiating Cables, selected items for In-building scenarios

Description	RFS Model-Name
RADIAFLEX-cable 1/2" RLK* - series (foil cable) and accessories for In-building scenarios	
Radiaflex® cable 1/2", RLK / RLKW-series	RLK12-50JFLA / RLKW12-50JFLA
Radiaflex® cable 1/2", RLKU-series	RLKU12-50JFLA
Connector N-female	NF-RA12-012
Connector N-male	NM-RA12-011
Round base, 80 mm, flame retardant	RB-80-4
Clic-clamp, flame retardant, for 1/2" cables	CC-12-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 125 mm, for plastic plug	SC-45125-2
Terminating resistance, N-male, 1 W	N-TER-01
RADIAFLEX-cable 7/8" RLK* - series (foil cable) and accessories for In-building scenarios	
Radiaflex® cable 7/8", RLK / RLKW-series	RLK78-50JFLA / RLKW78-50JFLA
Radiaflex® cable 7/8", RLKU-series	RLKU78-50JFLA
Connector N-female	NF-RA78-016
Connector 716-female	716F-RA78-016
Round base, 80 mm, flame retardant	RB-80-4
Clic-clamp, flame retardant, for 7/8" cables	CC-78-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 125 mm, for plastic plug	SC-45125-2
Terminating resistance, N-male, 1 W	N-TER-01

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

RADIAFLEX® Radiating Cables, selected items for In-building scenarios

Description	RFS Model-Name
RADIAFLEX-cable 1/2" RCF* - series (corrugated cable) and accessories for In-building scenarios	
Radiaflex® cable 1/2", RCF-series	RCF12-50JFN
Connector 7/16 male for RCF12-50	716M-LCF12-D01
Connector N male for RCF12-50	NM-LCF12-D01
Round base, 50 mm, flame retardant	RB-50-4
Clic-clamp, flame retardant, for 1/2" cables	CC-12-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 95 mm, for plastic plug	SC-45195-1
Terminating resistance, N-male, 1 W	N-TER-01
RADIAFLEX-cable 7/8" RCF* - series (corrugated cable) and accessories for In-building scenarios	
Radiaflex® cable 7/8", RCF-series	RCF78-50JFNA
Connector 7/16 male for RCF78-50	716M-LCF78-D01
Connector N male for RCF78-50	NM-LCF78-D01
Round base, 50 mm, flame retardant	RB-50-4
Clic-clamp, flame retardant, for 7/8" cables	CC-78-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 95 mm, for plastic plug	SC-45195-1
Terminating resistance, N-male, 1 W	N-TER-01

In-building coverage solutions for building scenarios - DAS

Typical In-building scenario for cellular services GSM900 / GSM1800 / UMTS
Solution by use of RADIAFLEX® Radiating cables

More details for RADIAFLEX® Radiating Cables and accessories can be found in the chapter Coverage solutions for tunnels.

Coverage solutions for Tunnel scenarios

- Best in class coverage systems for commercial and for mission critical multi-carrier / multi-service applications of metro, rail and road tunnels

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX®- Radiating cables operate as dedicated antennas, providing a homogenous, equal coverage along the cable run and are RF broadband. Therefore, they are highly applicable for coverage extension in train tunnels, metros, road tunnels, station areas, etc.

Coaxial Feeder cables, e.g. CELLFLEX cable LCF 12-50 JFN.
Other types (LCF78-50JFNA, LCFS114-50JFNA; LCF158-50JFNA) can be used for loss reduction

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables – Link budget

Commercial Services		
Downlink / Tunnel		
	GSM-R	*PMR (TETRA)*
Output power level at RU per Carrier, composite	37,0 dBm	37,0 dBm
# of carriers	4	4
Pilot Power Level	0,0 dB	0,0 dB
Jumper Loss, LCF12-50, 2m	-0,2 dB	-0,1 dB
Jumper Loss, LCF78-50, 80m	-3,0 dB	-2,2 dB
DC Block RF Loss	-0,2 dB	-0,2 dB
Jumper Loss, LCF12-50, 2m	-0,2 dB	-0,1 dB
Splitter Loss, 1:4	-6,5 dB	-6,5 dB
Input Power Level at radiating cable per carrier	20,9 dBm	21,9 dBm
Radiating Cable RAY114-50JFLA		
Length of radiating cable section (maximum!)	500,0 m	
Longitudinal Loss per 100m	3,8 dB	1,9 dB
Total longitudinal loss	19,0 dB	9,5 dB
Coupling Loss (95% value)	65,0 dB	70,0 dB
Fading margin	6,0 dB	6,0 dB
Reception power level outside train	-69,1 dBm	-63,6 dBm
Target reception power level	-85,0 dBm	-85,0 dBm
Margin to design requirements	15,9 dB	21,4 dB

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables – Link budget

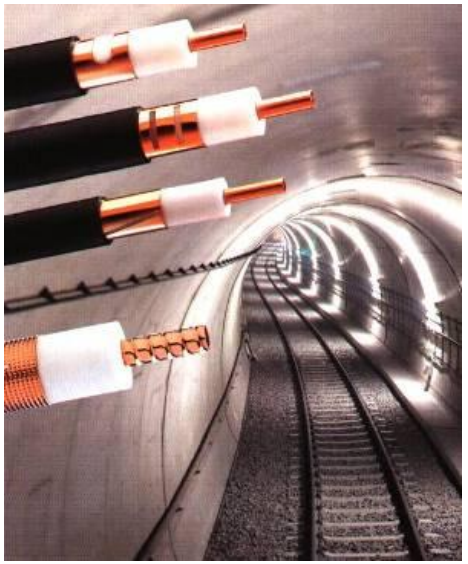
Commercial Services			
Downlink / Tunnel			
	GSM900	*GSM1800*	*UMTS2100*
Output power level at RU per Carrier, composite	37,0 dBm	37,0 dBm	40,0 dBm
# of carriers	8	8	8
Pilot Power Level	0,0 dB	0,0 dB	-10,0 dB
Jumper Loss, LCF12-50, 2m	-0,2 dB	-0,2 dB	-0,3 dB
Jumper Loss, LCF78-50, 80m	-3,0 dB	-3,0 dB	-5,6 dB
DC Block RF Loss	-0,2 dB	-0,2 dB	-0,2 dB
Jumper Loss, LCF12-50, 2m	-0,2 dB	-0,2 dB	-0,3 dB
Splitter Loss, 1:4	-6,5 dB	-6,5 dB	-6,5 dB
Input Power Level at radiating cable per carrier	17,9 dBm	17,9 dBm	8,1 dBm
Radiating Cable RAYS158-50JFLA			
Length of radiating cable section (maximum!)		250,0 m	
Longitudinal Loss per 100m	2,8 dB	3,9 dB	4,3 dB
Total longitudinal loss	7,0 dB	9,8 dB	10,8 dB
Coupling Loss (95% value)	64,0 dB	65,0 dB	68,0 dB
Fading margin	6,0 dB	6,0 dB	6,0 dB
Reception power level outside train	-59,1 dBm	-62,9 dBm	-76,7 dBm
Target reception power level	-85,0 dBm	-85,0 dBm	-90,0 dBm
Margin to design requirements	25,9 dB	22,1 dB	13,3 dB

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables

- The most appropriated system solution for all kind of tunnels, station areas, mines, ships, vessels, and specific In-building areas is the installation of RFS RADIAFLEX®- cables.
- The RADIAFLEX®- cable functions as a distributed antenna to provide communications in tunnels, mines and large building complexes and is the solution for any application in confined areas.
- Slots in the copper outer conductor allow a controlled portion of the internal RF energy to be radiated into the surrounding environment. Conversely, a signal transmitted near the cable will couple into the slots and be carried along the cable lengths.
- RADIAFLEX®- cables are used for both one-way and two-way communication systems and because of its broadband capability, a single radiating cable can handle multiple communication systems simultaneously. By combining passive devices (e.g. splitters) and radiating cables improve and extend coverage in an cost optimized way.

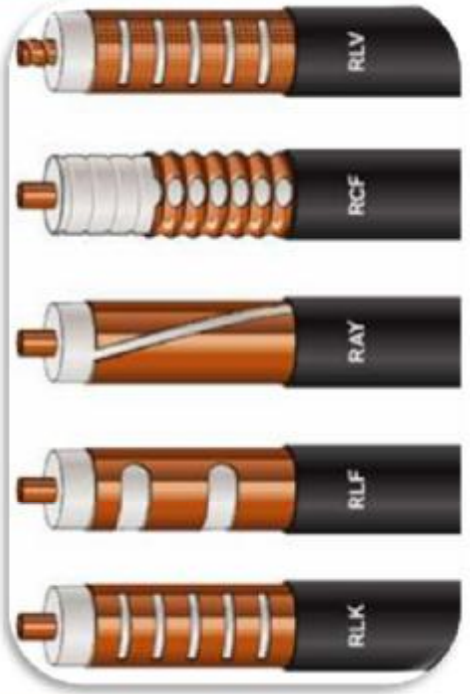


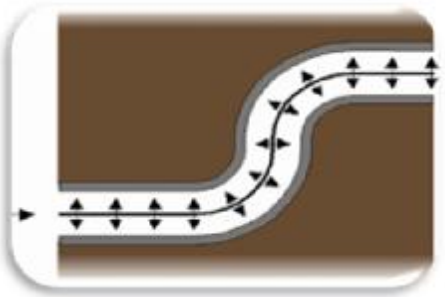
Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables

- RFS RADIAFLEX: World's largest portfolio of radiating cables; global leadership (technology, market share)
- Lower cost/best service:
  - Multi-band
  - Future-proof
- Best coverage:
  - No shading by vehicles
  - Smooth everywhere, even in trains
  - Proven safety : low smoke, flame & fire retardance
  - Better reliability vs antennas
  - Tested up to 6 GHz
  - DVB-H, DVB-SH, WiMAX, LTE ready
  - Live test environment in Hanover metro
  - Not sensitive to reflection
  - Less sensitive to wind





Typical environments

- Many curves, Small tunnel cross section

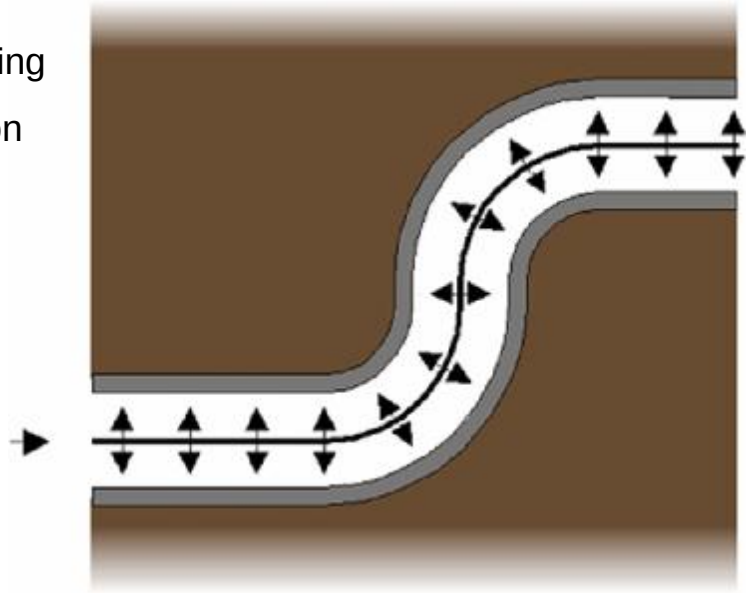
Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables

RADIAFLEX®- radiating cables operate as dedicated antennas and are RF broadband. Therefore, they are highly applicable to extend the coverage and offer many important advantages:

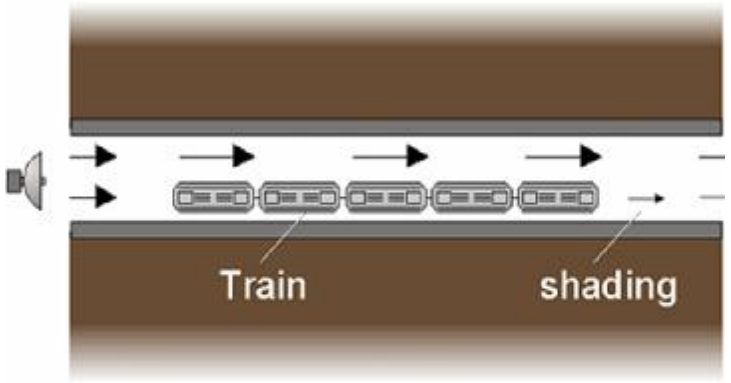
- ü Homogenous coverage along the RADIAFLEX® - cable
- ü Can be installed in accordance to the shape of the building
- ü Lower dynamic range compared with an antenna solution
- ü Multi-band solution
- ü Multi-operator solution
- ü Easy to upgrade
- ü Easy system planning
- ü Controlled coverage
- ü Better network security
- ü Minimized interference



Coverage solutions for Tunnel scenarios

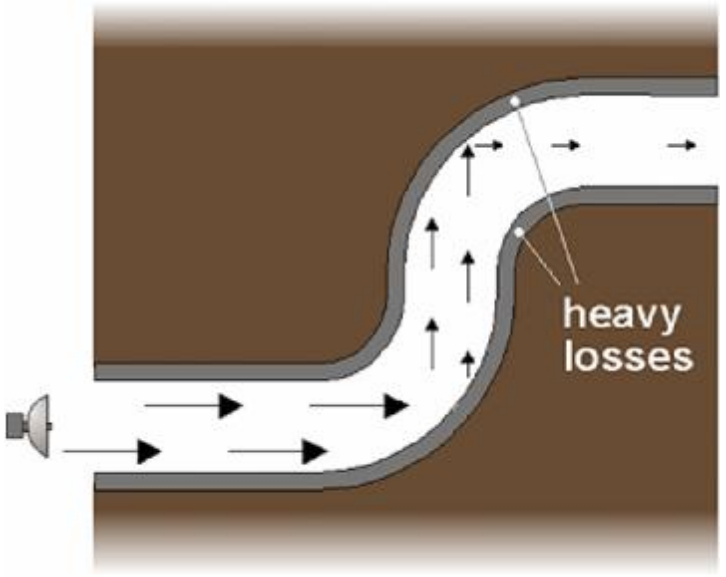
Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables vs Antennas



Cons:

- **Not broadband**
- **Not upgradeable**
- **Low frequencies**
- **Line of sight**



Pros:

- **Good for large cross-sections**
- **Installation effort**

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables: Features/Benefits

- RFS RADIAFLEX: World's largest portfolio of radiating cables; global leadership (technology, market share)
- Lower cost/best service:
  - Multi-band
  - Future-proof
- Best coverage:
  - No shading by vehicles or additional walls
  - Smooth everywhere, even in trains
  - Proven safety : low smoke, flame & fire retardance
  - Better reliability vs antennas
  - Tested up to 6 GHz
  - DVB-H, DVB-SH, WiMAX, LTE ready
  - Live test environment in Hanover metro
  - Not sensitive to reflection
  - Less sensitive to wind

Typical environments

- **Multiband applications**
- **FM / VHF / UHF applications**
- **Building structures with many lossy walls**
- **Building / tunnels with many curves**
- **Small tunnel cross sections**
- **Industrial plants with metallic high rise racks**
- **Ships/Vessels with metallized wall**

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables, selected items for In-building scenarios

RLK series:

For applications in tunnels and buildings where low coupling loss variations are required.

RLK12-50JFNA (JFLA), up to 980 MHz
RLK78-50JFNA (JFLA), up to 980 MHz
RLKW12-50JFNA (JFLA), up to 1950 MHz
RLKW78-50JFNA (JFLA), up to 1950 MHz
RLKU12-50JFNA (JFLA), up to 2700 MHz
RLKU78-50JFNA (JFLA), up to 2700 MHz
RLKD12-50JFNA (JFLA), up to 6000 MHz

.

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

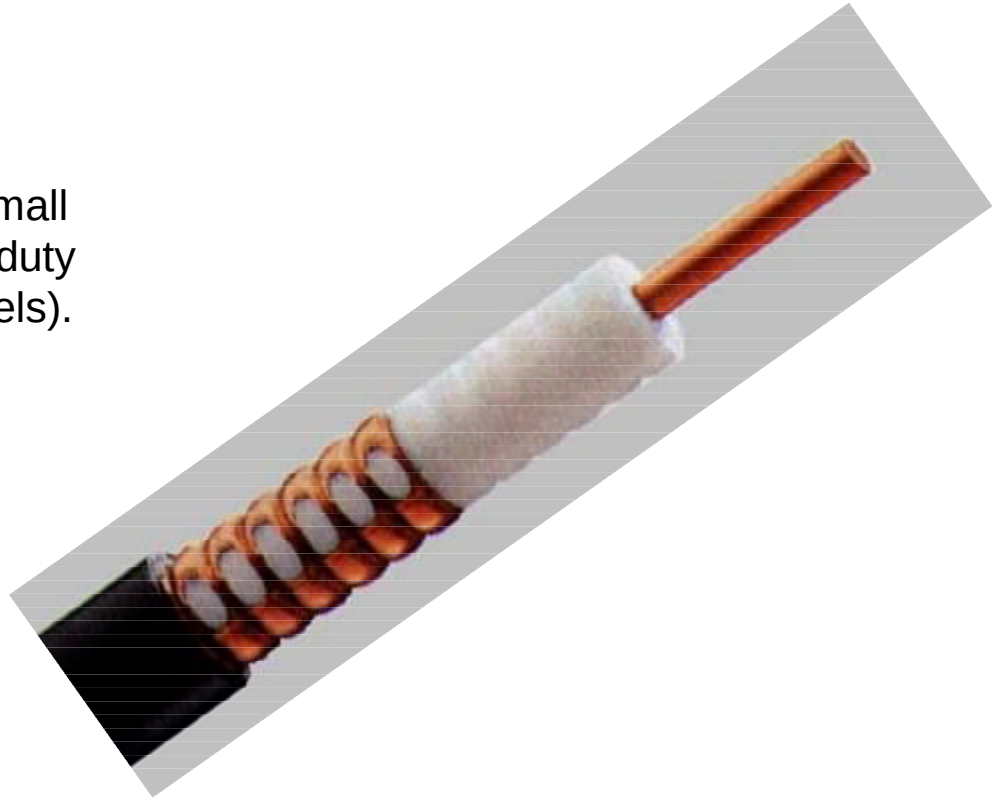
RADIAFLEX® Radiating Cables, selected items for In-building scenarios

RCF series:

For applications where particularly small bending radii are required for heavy-duty applications (e.g. mines, ships, vessels).

RCF12-50JFN (JFL), up to 6000 MHz
RCF78-50JFNA (JFLA), up to 2650 MHz
RSF12-50JFN (JFL), up to 6000 MHz

.



Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables, selected items for Tunnel scenarios

RLK series (RLK, RLKL, RLKW, RLKU):

For applications in tunnels and buildings where low coupling loss variations are required.

RLKW78-50JFNA (JFLA), up to 1950 MHz
RLKW114-50JFNA (JFLA), up to 1950 MHz
RLKU78-50JFNA (JFLA), up to 2700 MHz
RLKU114-50JFNA (JFLA), up to 2700 MHz
RLKU158-50JFNA (JFLA), up to 2700 MHz

Coverage solutions for Tunnel scenarios

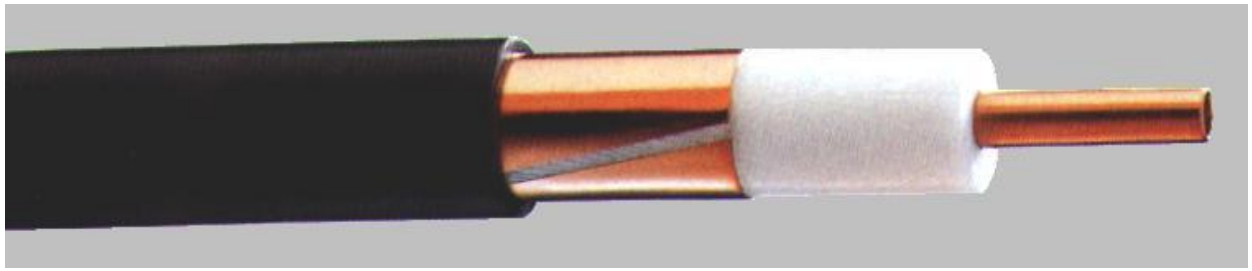
Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables, selected items for Tunnel scenarios

RAY series (RAY, RAYU, RAYS):

For applications in tunnels and buildings where low coupling loss variations are required.

RAY78-50JFNA (JFLA), up to 1000 MHz
RAY114-50JFNA (JFLA), up to 1000 MHz
RAY158-50JFNA (JFLA), up to 1000 MHz
RAYS158-50JFNA (JFLA), up to 2700 MHz



Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables, selected items for Tunnel scenarios

RLF series (RLF, RLFW, RLFU, ALFU):

For heavy-duty wideband and multi-use applications in all kind of tunnels. Due to widely separated slot-groups very insensitive against environmental influences (esp. Salt).

RLF78-50JFNA (JFLA), up to 1000 MHz
RLF114-50JFNA (JFLA), up to 1000 MHz
RLF158-50JFNA (JFLA), up to 1000 MHz
RLFU78JFNA, (JFLA), up to 2400 MHz
RLFU114-50JFNA (JFLA), up to 2400 MHz
RLFU158-50JFNA (JFLA), up to 2400 MHz

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables, selected items for Tunnel scenarios

RCF series (RCF, RSF, RHCA):

For applications where particularly small bending radii are required for heavy-duty applications (e.g. mines, ships, vessels).

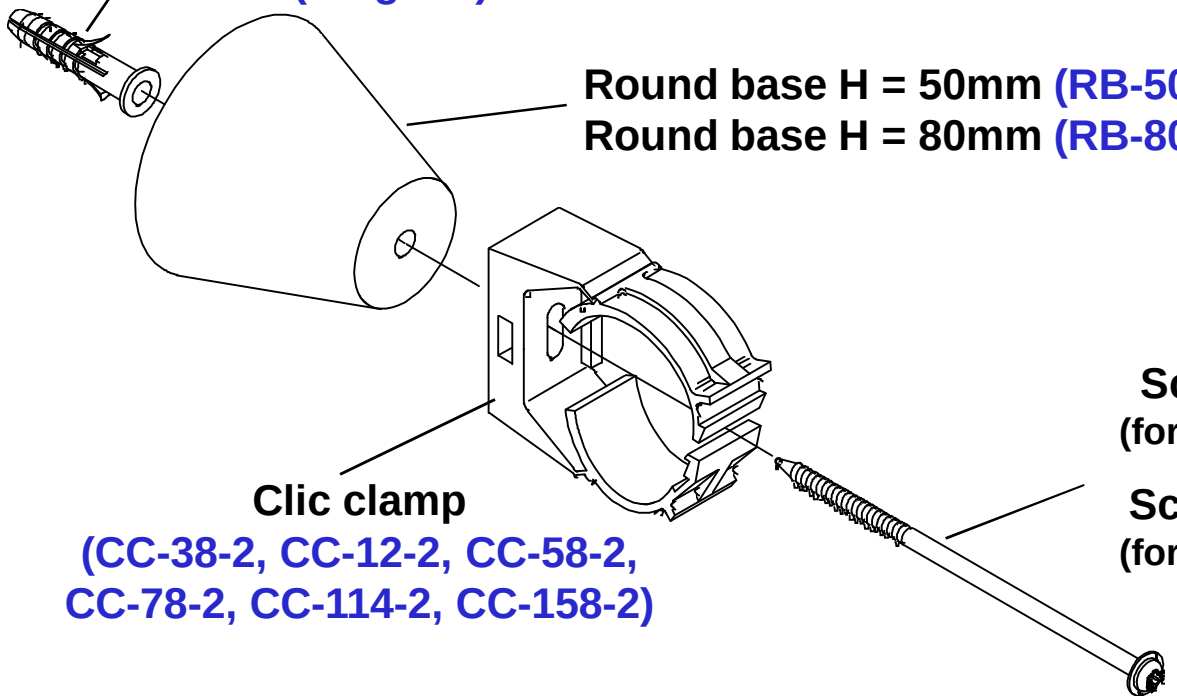
RCF12-50JFN (JFL), up to 6000 MHz
RCF78-50JFNA (JFLA), up to 2650 MHz
RSF12-50JFN (JFL), up to 6000 MHz

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Clamps

For some cable series the round base with height of 80mm has to be used!



Plastic dowel Ø 6mm
(hole Ø 6mm, 40mm deep)
(Plug-6-1)

Round base H = 50mm (RB-50-4)
Round base H = 80mm (RB-80-4)

Screw (SC-4595-1)
(for 50mm Round base)

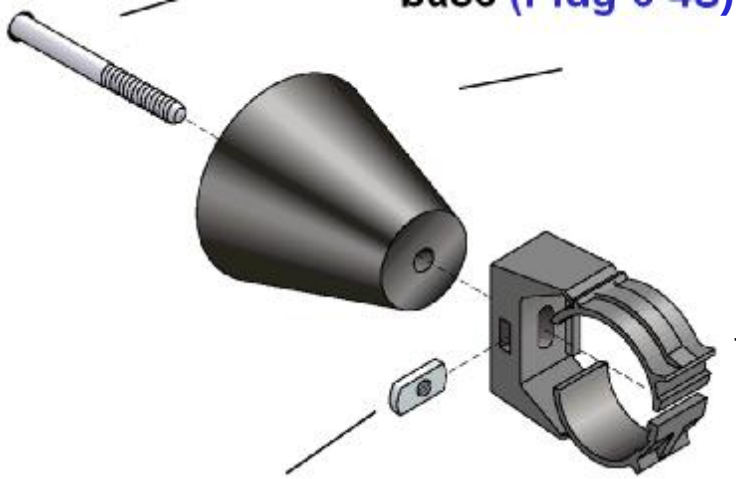
Screw (SC-45125-2)
(for 80mm Round base)

Clic clamp
(CC-38-2, CC-12-2, CC-58-2, CC-78-2, CC-114-2, CC-158-2)

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Clamps



Plug for 50mm Round base (Plug-6-3S)
Plug for 80mm Round base (Plug-6-4S)

Round base H = 50mm (RB-50-4)
Round base H = 80mm (RB-80-4)

Clic clamp (CC-38-2, CC-12-2, CC-58-2, CC-78-2, CC-114-2, CC-158-2)

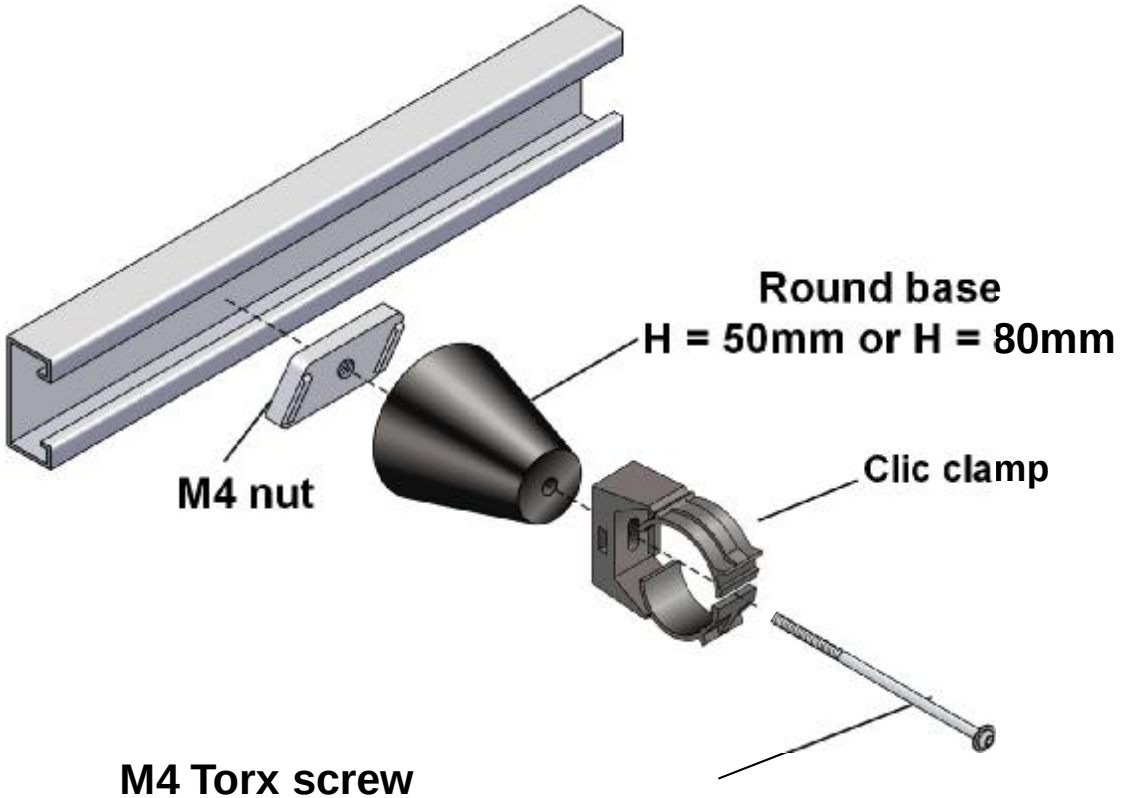
Clic flat nut M6 (CS-6-1)

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Clamps

Example for installation on anchor bar



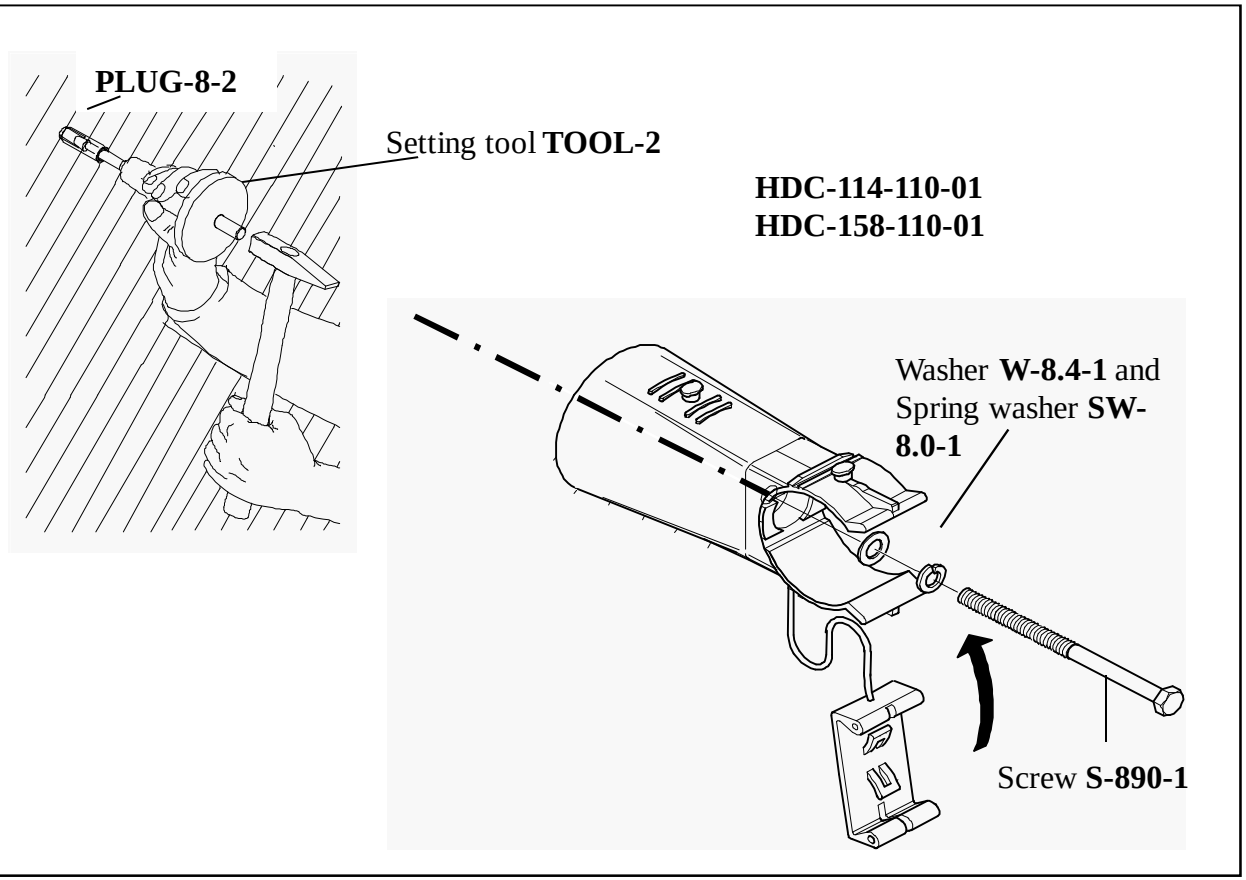
M4 Torx screw
for Round Base H = 50mm: M4 x 75
for Round Base H = 80mm: M4 x 105

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Clamps: Heavy Duty Clamp HDC for 350km/h

HDC-* are special clamps for train speed up to 350km/h**

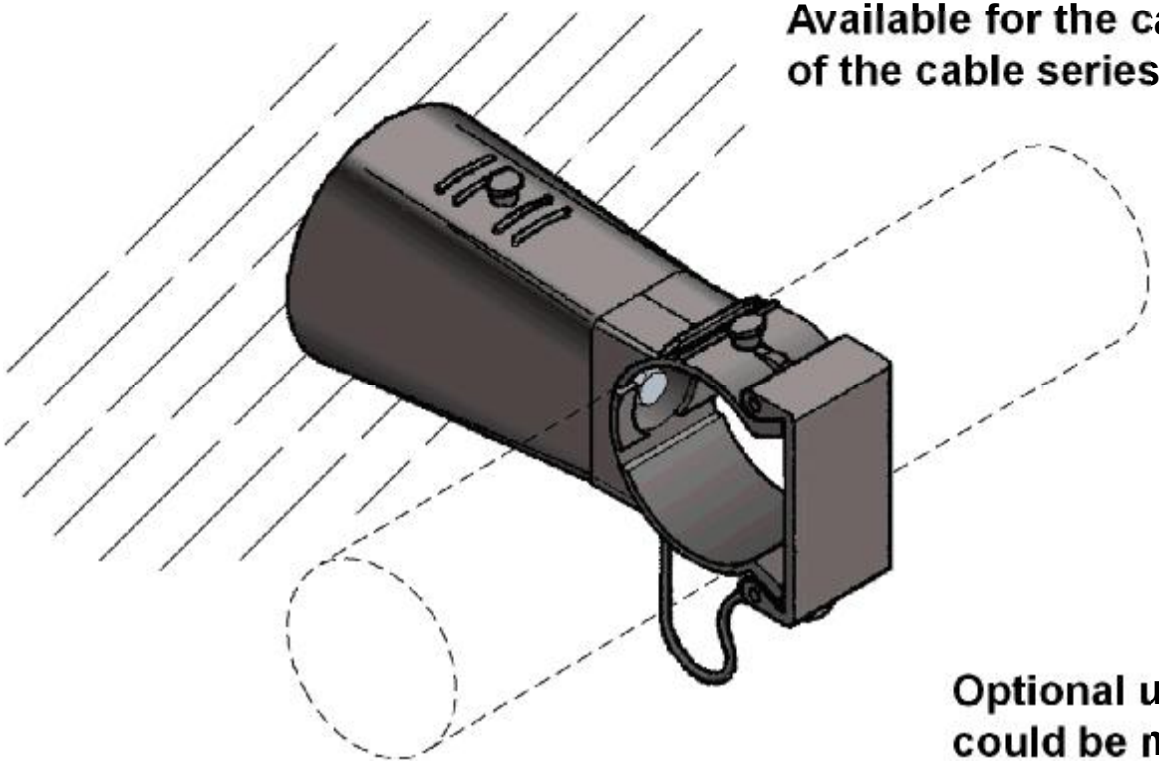


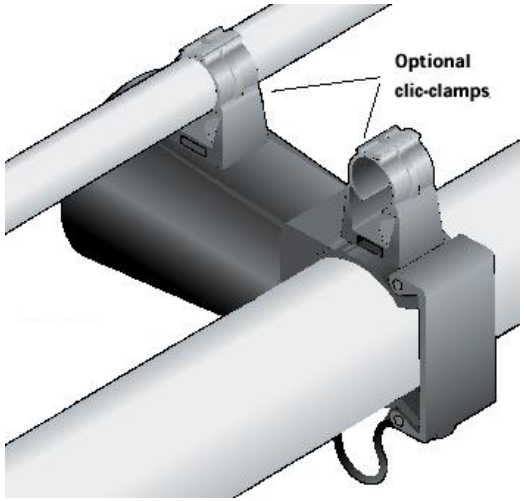
Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Clamps: Heavy Duty Clamp HDC for 350km/h

Available for the cable seizes of 11/4“ & 15/8“ of the cable series RLF, RLK, RLV and RAY.





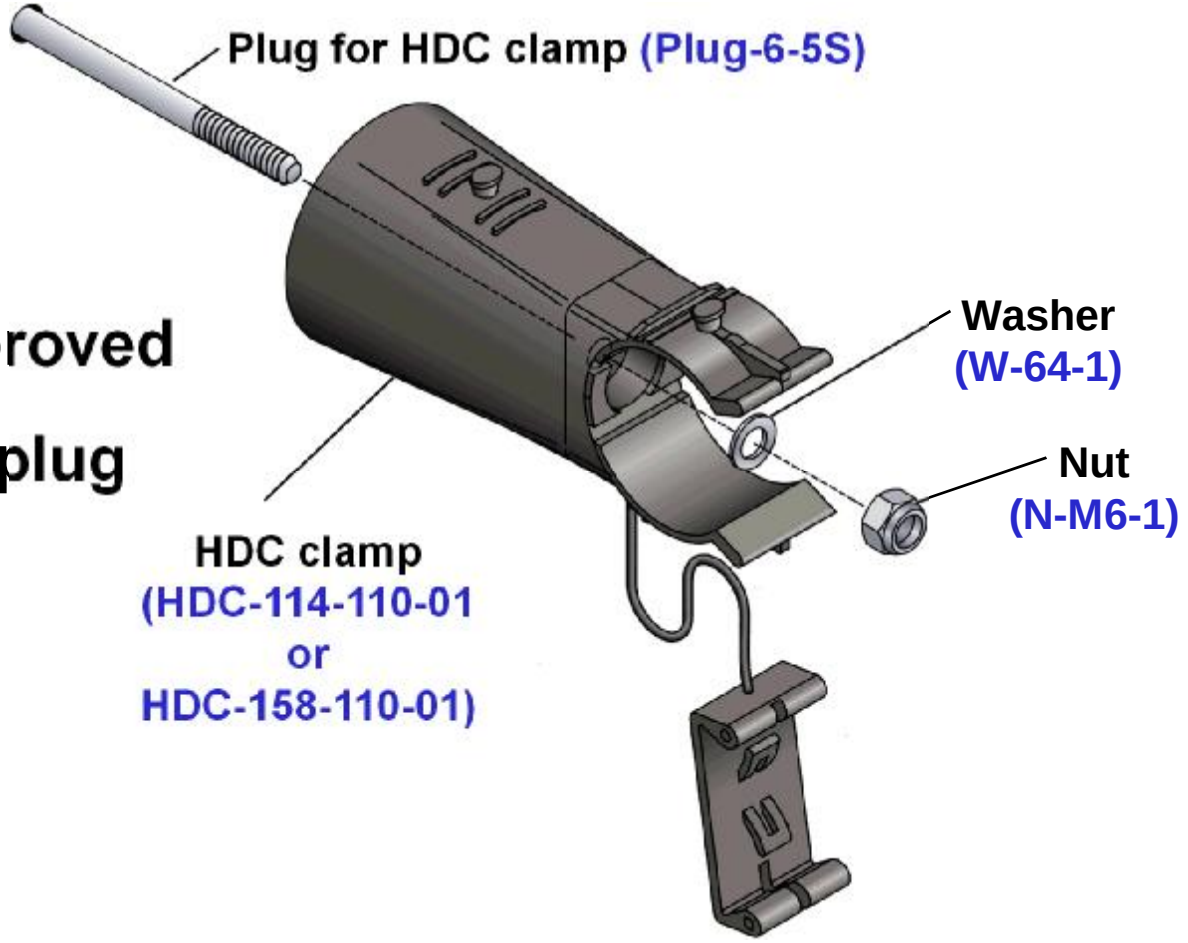
Optional up to 4 additional clic-clamps could be mounted e.g. optic backbone cables. Suitable types are CC-12-2, CC-58-2 & CC-78-2

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Clamps: Heavy Duty Clamp HDC for 350km/h

Fixing with approved stainless steel plug



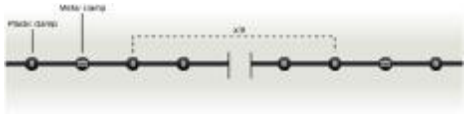
Coverage solutions for Tunnel scenarios

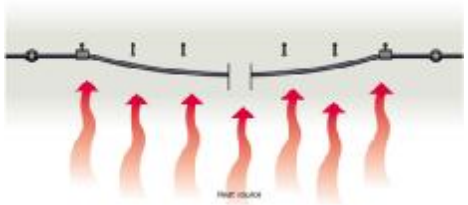
Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

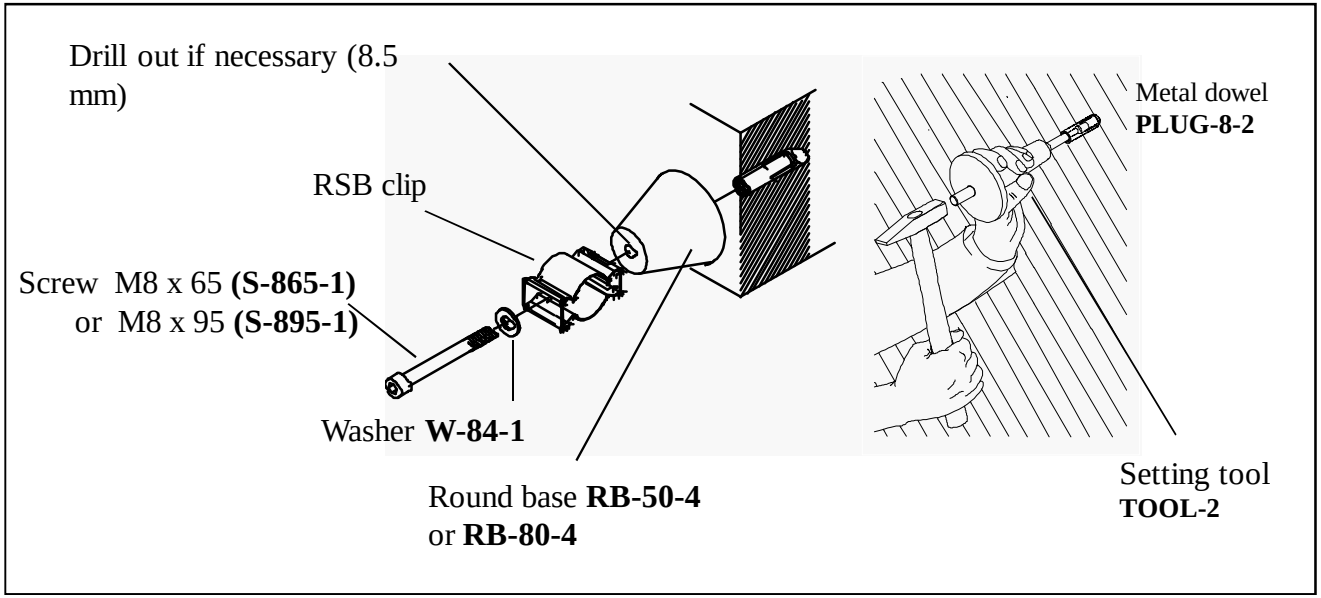
RADIAFLEX® Clamps: Fire protection clamp

Special solution for fire protecting.

Installation recommended every 8-10m







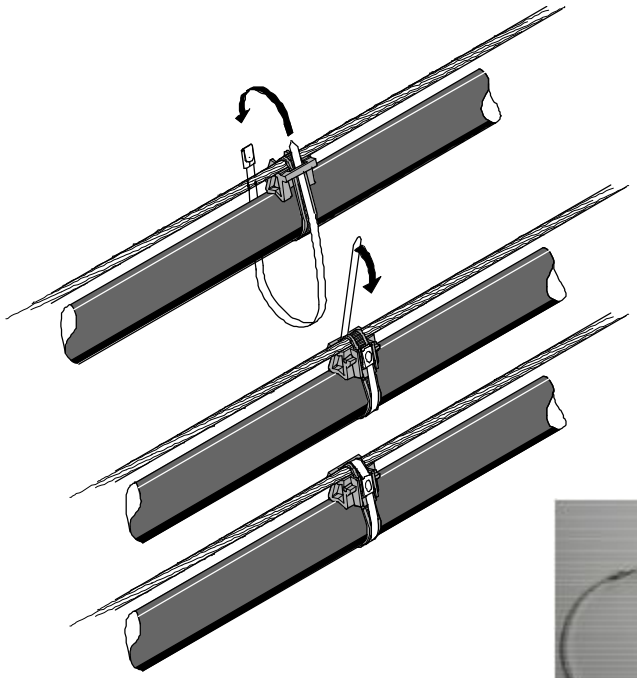
In case of fire the resistant part of the fixing will hold the cable in position and enables the cable to keep in operation as long as the cable itself allows. It also prevents the cable from detaching from the wall that might block any escape route.

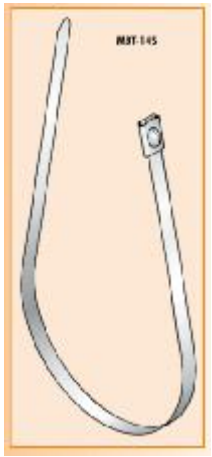
Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

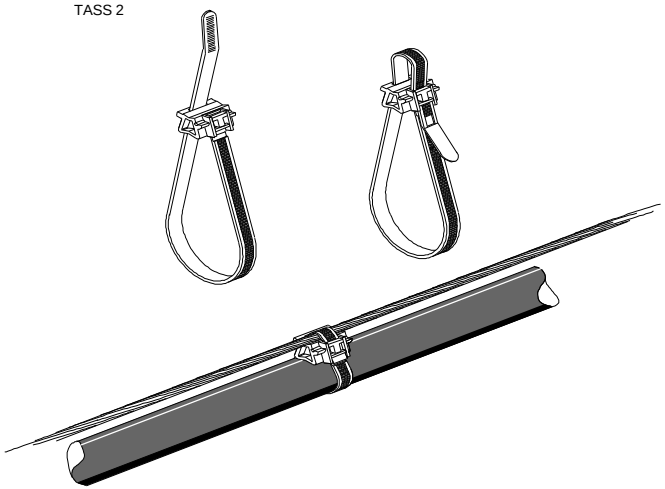
RADIAFLEX® Clamps: Messenger wire installation

Special solution for external messenger wire





TASS 2



Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

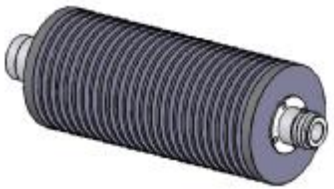
Termination Loads, selected items

Two different Groups

- **Low power 1W - 50W**
- **High power > 50W (on request)**
- **Low PIM (on request)**

N-TER-01

N-TER-10



N-TER-50

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

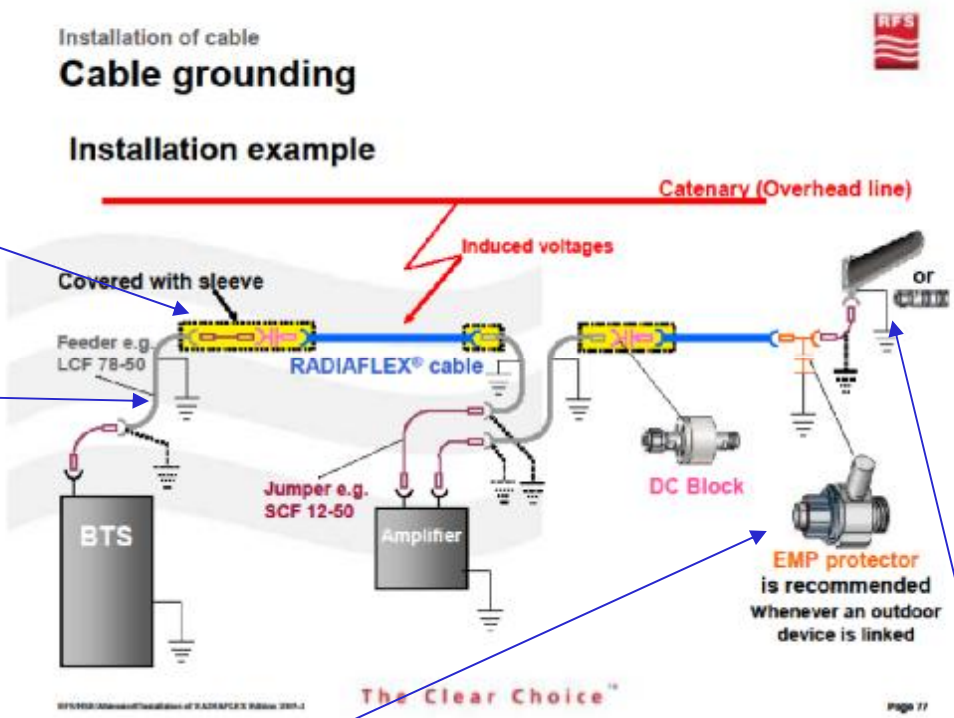
Accessories: Grounding kits, DC-Blocks, EMP-protectors, selected items

DC-Block to protect equipment and personnel due to induced voltages from the catenary/overhead line

Is needed in order to carried out potential equalization current

Coaxial Feeder cables, e.g. CELLFLEX cable LCF 12-50 JFN, or factor-fitted Jumper cables.

EMP protector
is recommended
Whenever an outdoor device is linked



EMP-Protector (Surge-Suppressor) for lightningto protect equipment and personnel

RADIAFLEX cable should be always terminated

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables, selected items for Tunnel scenarios

Description	RFS Model-Name
RADIAFLEX-cable 7/8" RLK*, RAY* - series (foil cable) and accessories for Tunnel scenarios	
Radiaflex® cable 7/8", RLKW-series	RLKW78-50JFLA
Radiaflex® cable 7/8", RLKU-series	RLKU78-50JFLA
Radiaflex® cable 7/8", RAY-series	RAY78-50JFLA
Connector N-female	NF-RA78-016
Connector 7-16-female	716F-RA78-016
Round base, 80 mm, flame retardant	RB-80-4
Clic-clamp, flame retardant, for 7/8" cables	CC-78-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 125 mm, for plastic plug	SC-45125-2
Terminating resistance, N-male, 1 W	N-TER-01
RADIAFLEX-cable 1 1/4" and accessories (foil cable) and accessories for Tunnel scenarios	
Radiaflex® cable 1 1/4", RLKW-series	RLKW114-50JFLA
Radiaflex® cable 1 1/4", RLKU-series	RLKU114-50JFLA
Radiaflex® cable 1 1/4", RAY-series	RAY114-50JFLA
Connector 7-16-female	716F-RA114-016
Round base, 80 mm, flame retardant	RB-80-4
Clic-clamp, flame retardant, for 1 1/4" cables	CC-114-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 125 mm, for plastic plug	SC-45125-2
Terminating resistance, N-male, 1 W	N-TER-01

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables, selected items for Tunnel scenarios

Description	RFS Model-Name
RADIAFLEX-cable 1 5/8" and accessories (foil cable) and accessories for Tunnel scenarios	
Radiaflex® cable 1 5/8", RLKW-series	RLKW158-50JFLA
Radiaflex® cable 1 5/8", RLKU-series	RLKU158-50JFLA
Radiaflex® cable 1 5/8", RAY-series	RAY158-50JFLA
Radiaflex® cable 1 5/8", RAYS-series	RAYS158-50JFLA
Connector 7-16-female	716F-RA158-016
Round base, 80 mm, flame retardant	RB-80-4
Clic-clamp, flame retardant, for 1 5/8" cables	CC-158-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 125 mm, for plastic plug	SC-45125-2
Terminating resistance, N-male, 1 W	N-TER-01
RADIAFLEX-cable 7/8" RCF* - series (corrugated cable) and accessories for In-building scenarios	
Radiaflex® cable 7/8", RCF-series	RCF78-50JFNA
Connector 7/16 male for RCF78-50	716M-LCF78-D01
Connector N male for RCF78-50	NM-LCF78-D01
Round base, 50 mm, flame retardant	RB-50-4
Clic-clamp, flame retardant, for 7/8" cables	CC-78-2
Nylon plug, 6 x 30 mm	PLUG-6-1
Screw,4.5 x 95 mm, for plastic plug	SC-45195-1

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables accessories, selected items for Tunnel scenarios

Description	RFS Model-Name
Accessories for RADIAFLEX - Heavy Duty Clamp	
Heavy Duty Clamp for RADIAFLEX Cable RLK158, RLKU158, RLF158, RLFW158, RLFU158, RLV158, RLVU158, RAY158, RAYS158	
Heavy duty clamp for 1 5/8"	HDC-158-110-01
Plug 6 x 110.5 mm, set for HDC 114/158 (Kit of 150 pcs.)	PLUG-6-5S
Nut DIN0985 M06 A2 6kt ssi	N-M6-1
Washer, inner dia. 6.4 mm, stainless steel	W-64-1
Heavy Duty Clamp for RADIAFLEX Cable RLK114, RLKW114, RLKU114, RLF114, RLFW114, RLFU114, RLV114, RLVU114, RAY114	
Heavy duty clamp for 1 1/4"	HDC-114-110-01
Plug 6 x 110.5 mm, set for HDC 114/158 (Kit of 150 pcs.)	PLUG-6-5S
Nut DIN0985 M06 A2 6kt ssi	N-M6-1
Washer, inner dia. 6.4 mm, stainless steel	W-64-1

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables accessories, selected items for Tunnel scenarios

Accessories for RADIAFLEX - Fire protection clamp	
Fire Protection Clamp for RADIAFLEX Cable RLK158, RLKU158, RLF158, RLFW158, RLFU158, RLV158, RLVU158, RAY158, RAYS158	
RSB-Clip for 158 (kit of 10)	RSB-158-001
Round base, 80 mm, flame retardant	RB-80-4
Metal plug, 8 x 30 mm, stainless steel	PLUG-8-2
Screw, 8.0 x 95 mm, for metal plug	S-895-1
Washer, inner dia. 8.4 mm, stainless steel	W-84-1
Fire Protection Clamp for RADIAFLEX Cable RLK114, RLKW114, RLKU114, RLF114, RLFW114, RLFU114, RLV114, RLVU114, RAY114	
RSB-Clip for 114 (kit of 10)	RSB-114
Round base, 80 mm, flame retardant	RB-80-4
Metal plug, 8 x 30 mm, stainless steel	PLUG-8-2
Screw, 8.0 x 95 mm, for metal plug	S-895-1
Washer, inner dia. 8.4 mm, stainless steel	W-84-1

Coverage solutions for Tunnel scenarios

Typical Tunnel scenario - Solution by use of RADIAFLEX® Cables

RADIAFLEX® Radiating Cables accessories, selected items for Tunnel scenarios

Accessories for RADIAFLEX - DC Block	
DC-Blocks	
DC block, 15 kV, 180-2500 MHz, 7-16 male - 7-16 female, IP65	DC-BLOCK-15-7MF
DC block, 4 kV, 160-2500 MHz, 7-16 male - 7-16 female, IP65	DC-BLOCK-4-7MF

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