

Telegärtner
**Mobile Radio Base Station
Components**

www.telegaertner.com



Mobile Radio Base Station Components

Components:

- **Connectors**
- **EMP Protectors**
- **Jumper Cables**
- **Adaptors**
- **Tools and Accessories**





SIMFix[®] Pro: Features

SIMFix[®] Pro:

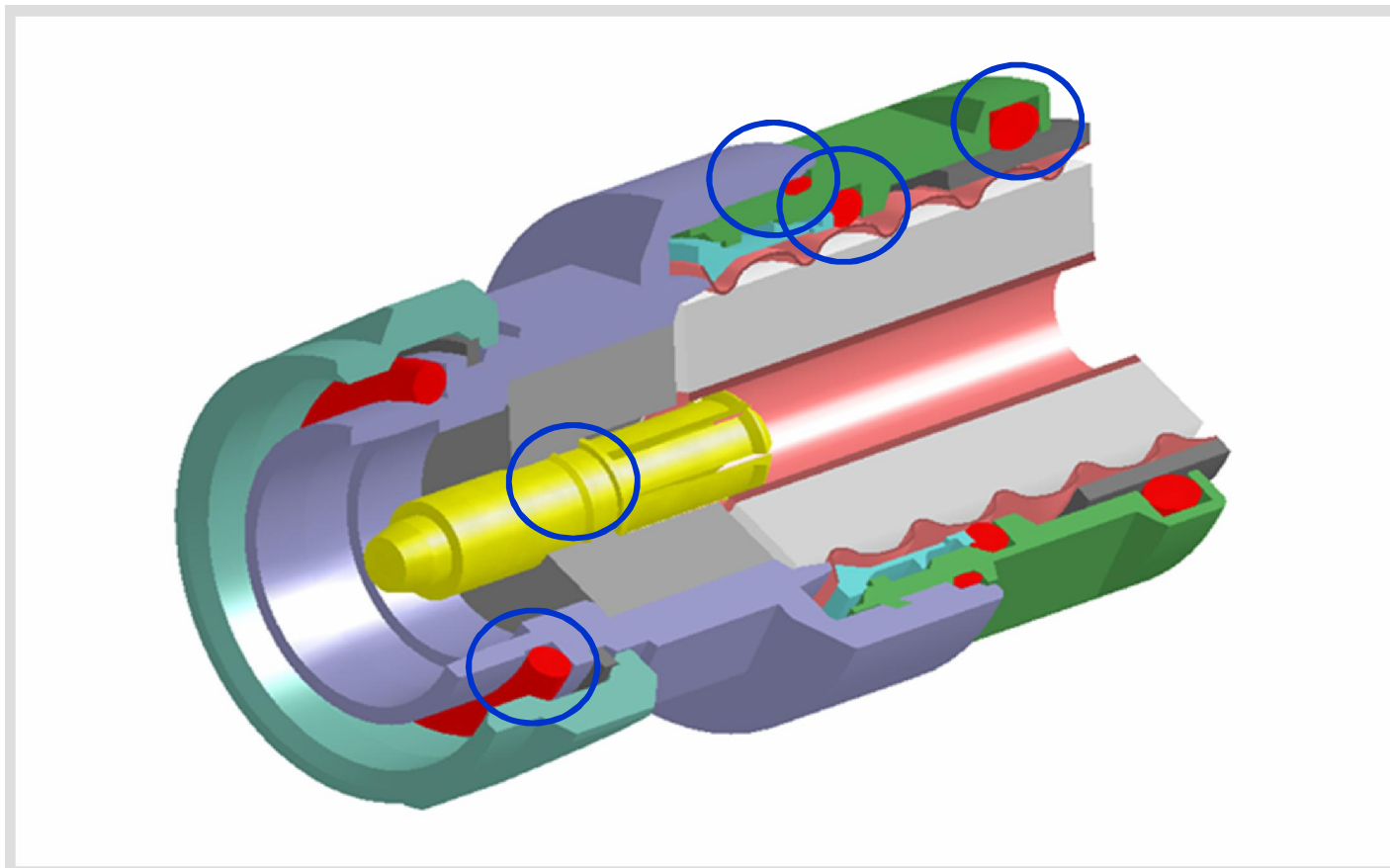
- **Weather Protection: IP68 Sealing System**
- **Electrical Parameters: Return Loss, IMP**
- **Connector Assembly**

*Waterproof up to
min. 2,5 bar (IP 68)*



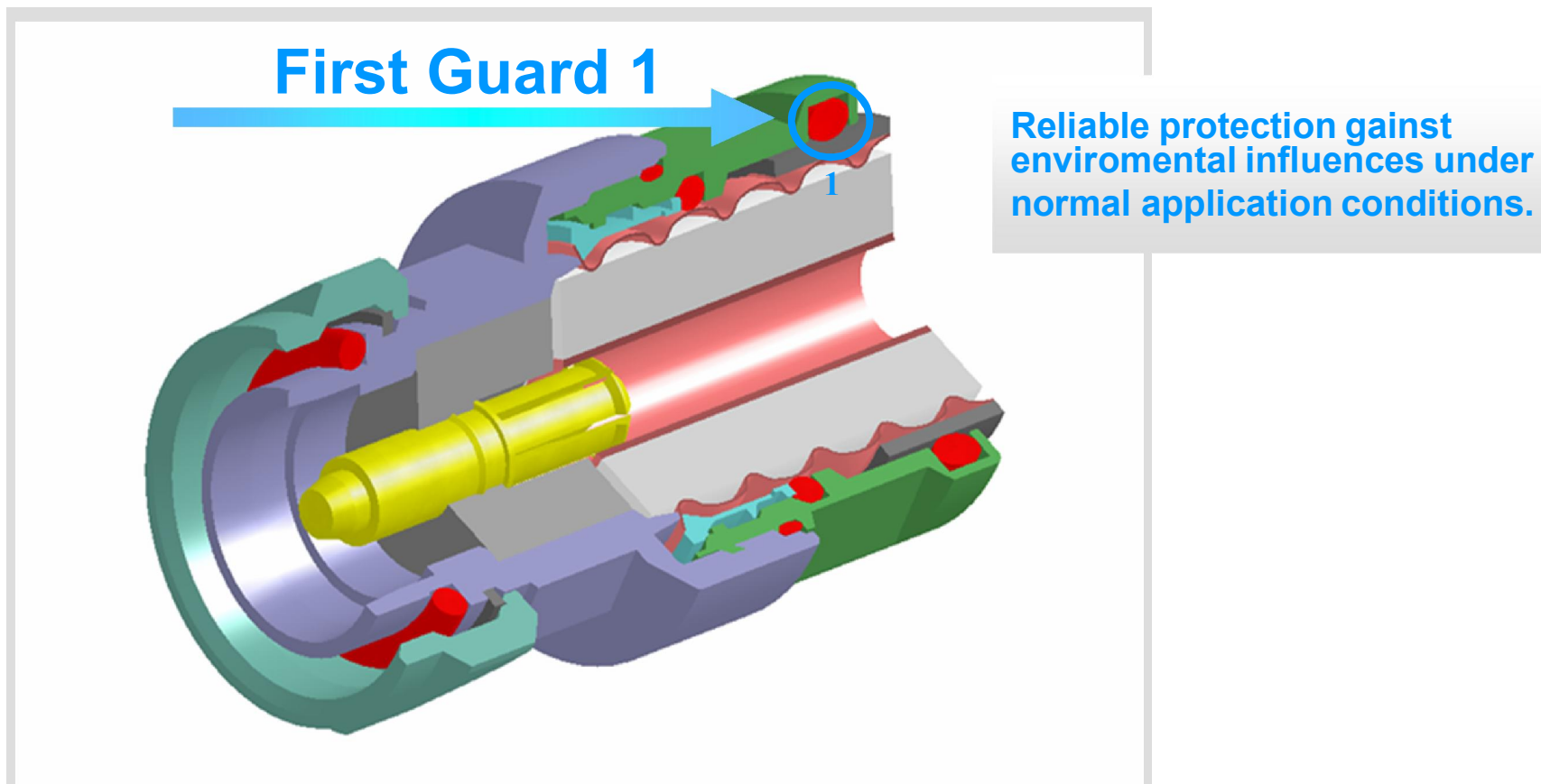


SIMFix[®] Pro: Overview Water Protection Concept IP 68

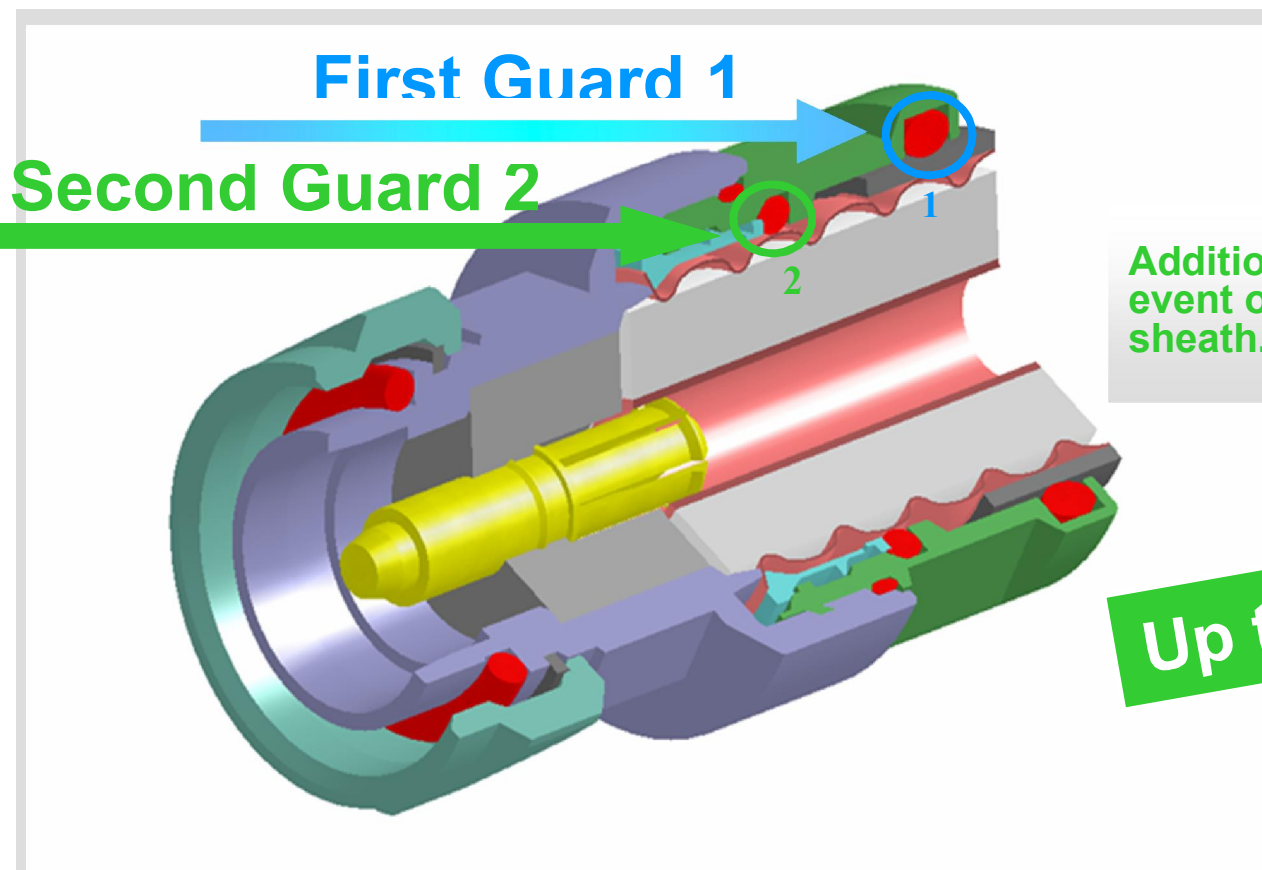




SIMFix[®] Pro: Overview Water Protection Concept IP 68



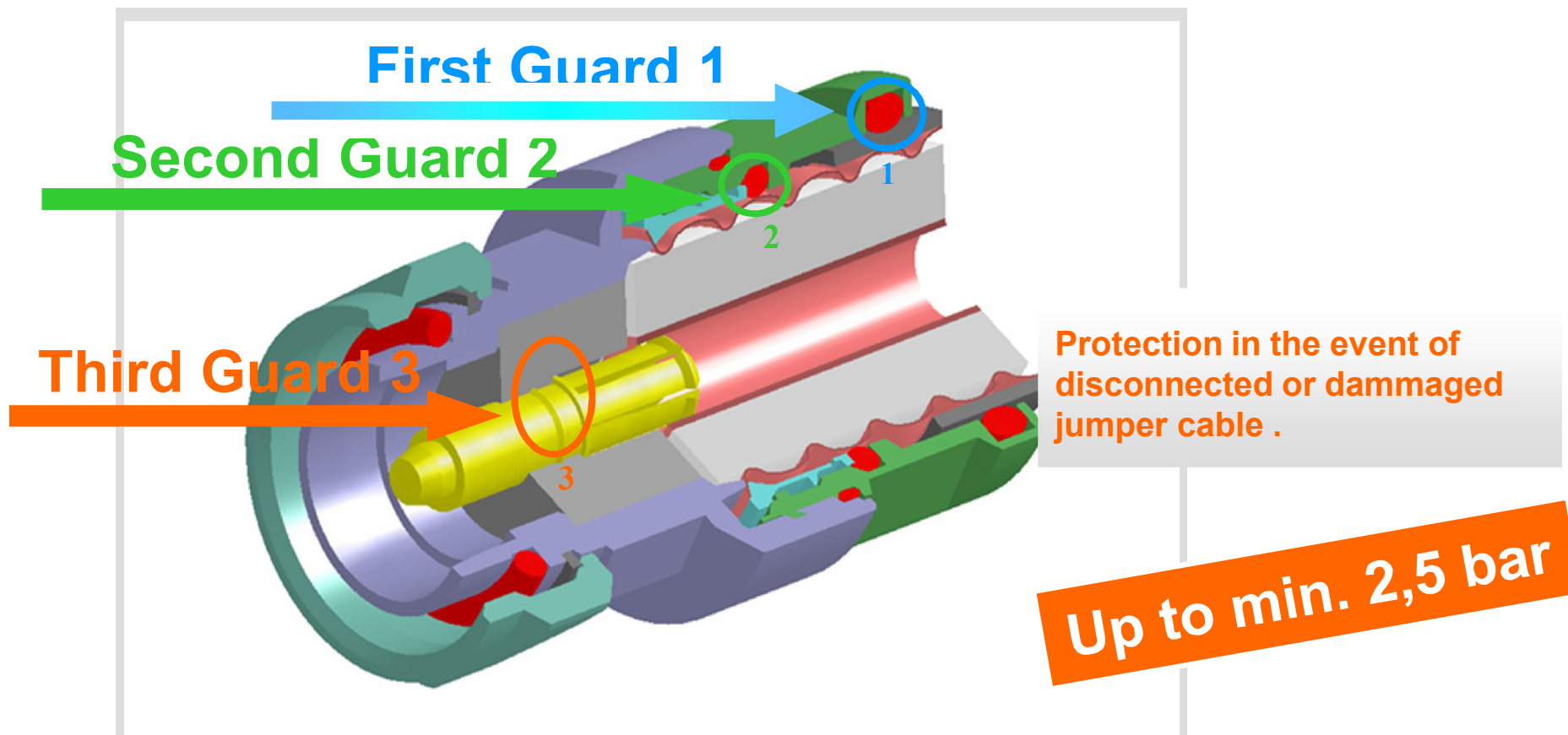
SIMFix[®] Pro: Overview Water Protection Concept IP 68



Additional protection in the event of damaged cable sheath.

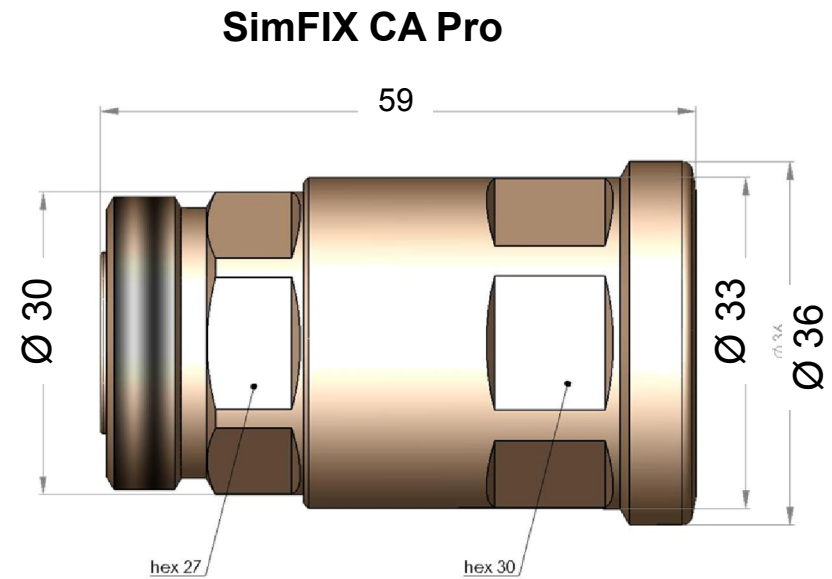
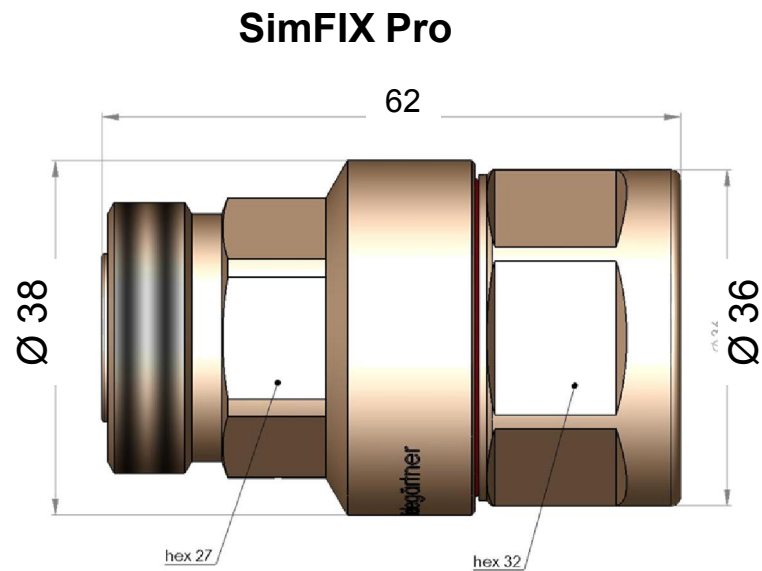
Up to min. 2,5 bar

SIMFix[®] Pro: Overview Water Protection Concept IP 68





SimFIX Pro : CA Comparison

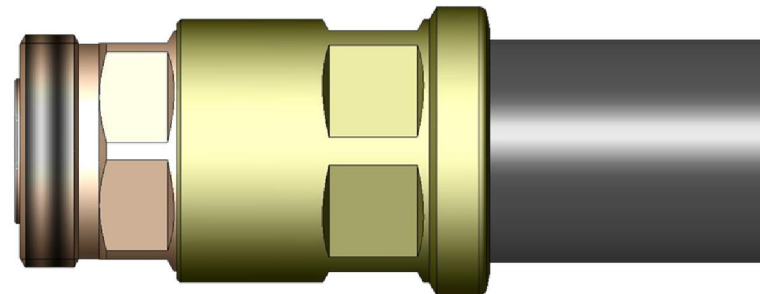




SimFIX CA : Connector for 7/8" Copper and Aluminum Cables

Design Targets

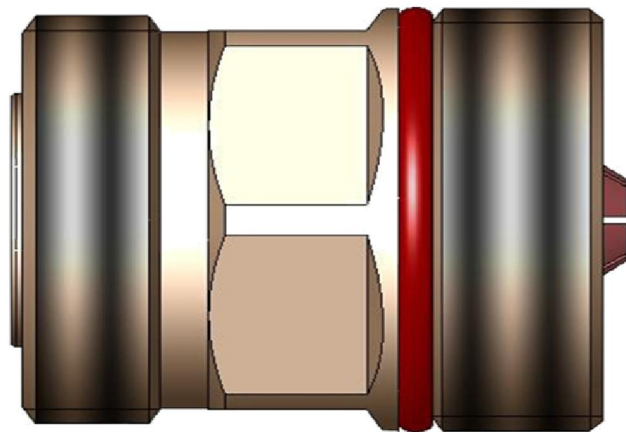
- Compatibility with Copper and Aluminum cables of major manufacturers
- Excellent electrical performance (Return Loss, IMP)
- IP68 weather proof
- Simple and reliable assembly
- Compact and cost efficient design



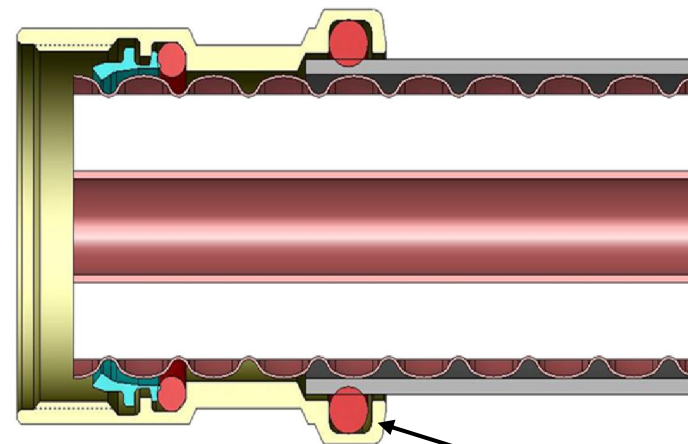


SimFIX CA : Assembly

Assembly step 1: Insertion of cable in cable clamp



Connector head

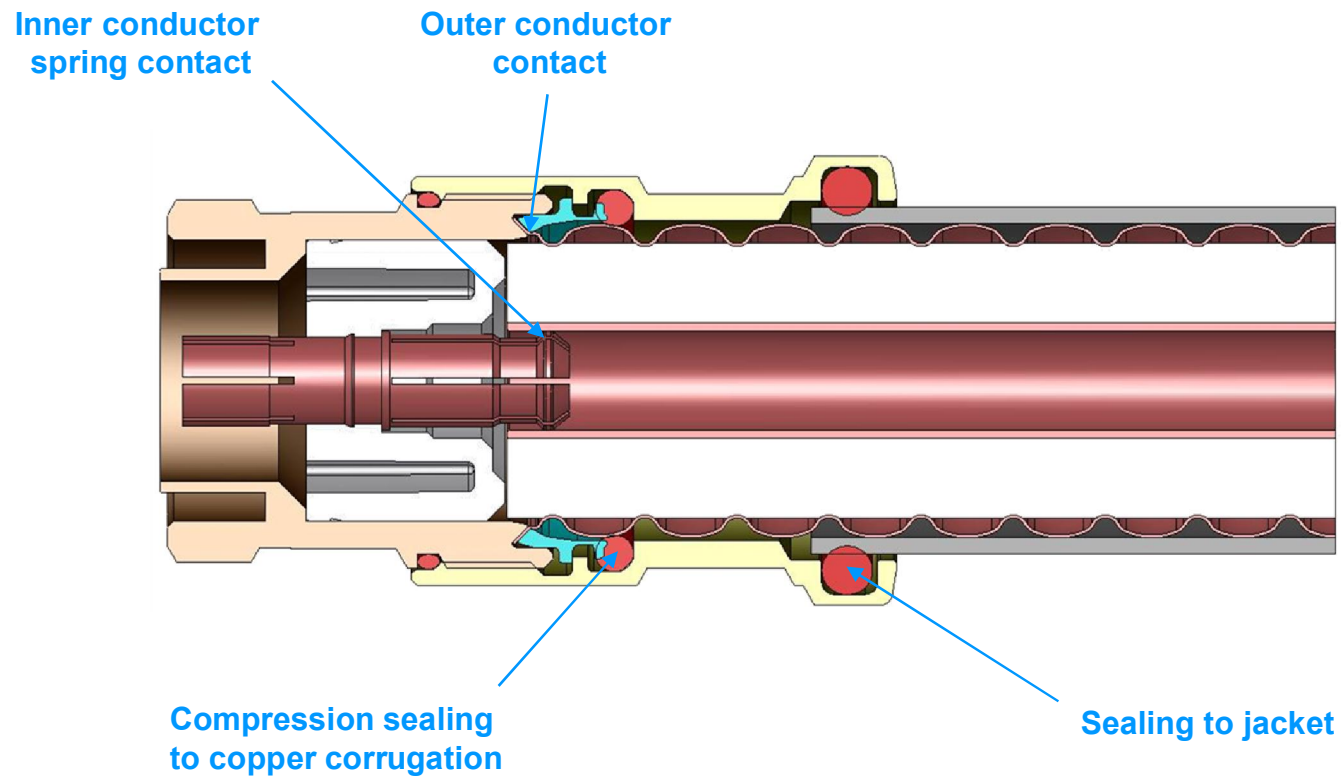


Cable clamp

7/8" Corrugated cable



SimFIX CA : Sealing and contact concept

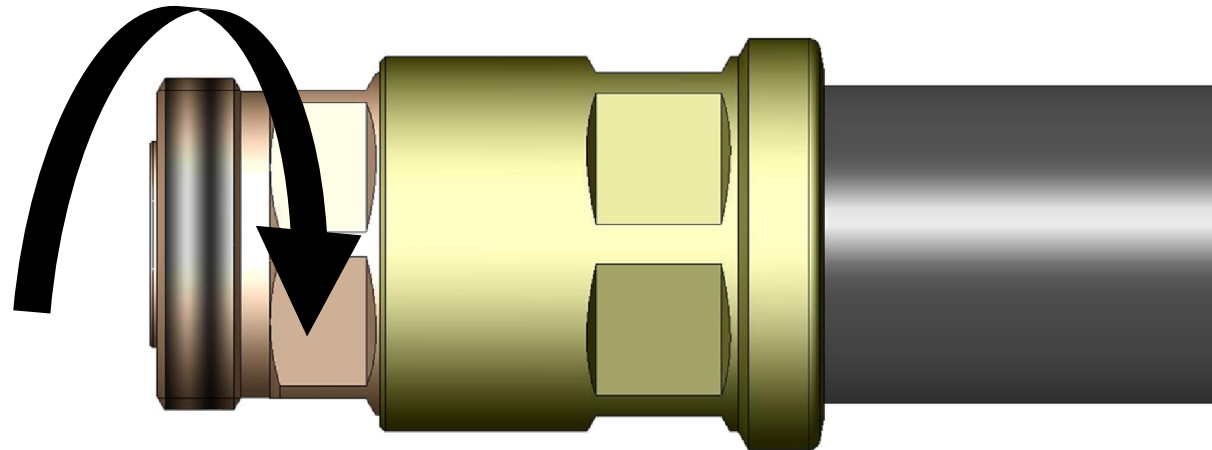




SIMFix CA 7/8"

SimFIX CA : Assembly

Assembly step 2: Screw connector head to cable clamp





SimFIX CA : 7/8" Cable Compatibility

- RFA 7/8" (Draka)
- RFA 7/8" AL (Draka)
- AVA 5-50 (Andrew)
- AL 5-50 (Andrew)
- LDF5-50A (Andrew)
- LCF 78"-50 (RFS)
- 5228 A (Eupen)
- Flexline 7/8" R (Leoni)
- HPL50 – 7/8"R (Acome)

All suitable for copper and aluminium cables!



SimFIX Pro : CA Comparison

Feature	Simfix Pro 7/8“	SimFix CA Pro 7/8“
Size	62 x 38 mm	59 x 32-36
Electrical Performance	Return Loss: >37 dB IMP: < -160 dBc	Return Loss: > 37 IMP: < -160 dBc
Cables	Copper Cables	Copper and Aluminum Cables
Weather Proofing	IP68 – with 2 integrated Silicon O- Rings	IP68 with 2 integrated Silicon O-Rings
Assembly Style	2- Piece - Design	2 – Piece Design
Tooling	Hand and Drill Tool	Hand and Drill Tool

SimFIX Pro 2 1/4"

7-16 Plug and Jack for RFA 2 1/4" Corrugated Copper Cable

- 2 – piece design
- Same assembly style as 1 5/8" types
- Tool extension kit available



Return Loss

$$\text{Return Loss (dB)} = -10 \cdot \text{Log} \frac{\text{Incident Power}}{\text{Reflected Power}}$$

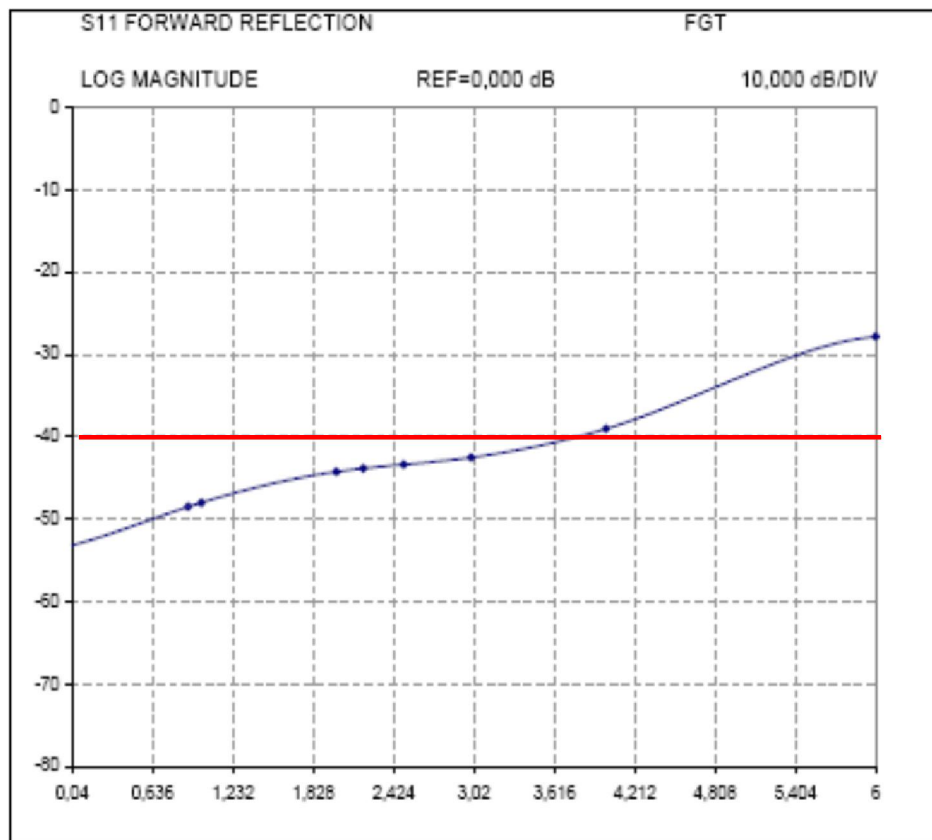
Return Loss:

If the impedance of the connector is **not** the same as that of the transmission line, then a part of the power will **not** be transferred to the connector output, **but reflected**. This power is no longer available at the connector output. Depending on the frequency being used, the return loss normally lies between **-10 dB** and **-40 dB** (**d**eci**B**el is a logarithmic function expressing the ratio of two powers).

Examples of Return Loss Values are:

Return Loss	Reflected Power
- 10 dB	10 %
- 13 dB	5 %
- 16 dB	2,5 %
- 20 dB	1 %
- 30 dB	0,1 %
- 40 dB	0,01 %

SimFIX CA : Return Loss Performance



Return Loss: > 40 dB up to 3 GHz

Marker	Frequenz	S11
1	0,900 GHz	-48,5
2	1,000 GHz	-48,0
3	2,000 GHz	-44,3
4	2,200 GHz	-43,9
5	2,500 GHz	-43,4
6	3,000 GHz	-42,5
7	4,000 GHz	-39,0
8	6,000 GHz	-27,8
9		
10		

Intermodulation

Definition:

Intermodulation describes the phenomenon that during the transmission at a base station unintentionally **additional signals** at other frequencies are produced (intermodulation products). Some of these signals can **fall into the receiving frequency** band and therefore **disturb** the receiving of external signals.

System factors leading to Intermod. problems:

- high transmission powers
- multiple channels
- common transmission path of multiple transmitting and receiving signals
- Low receive noise thresholds

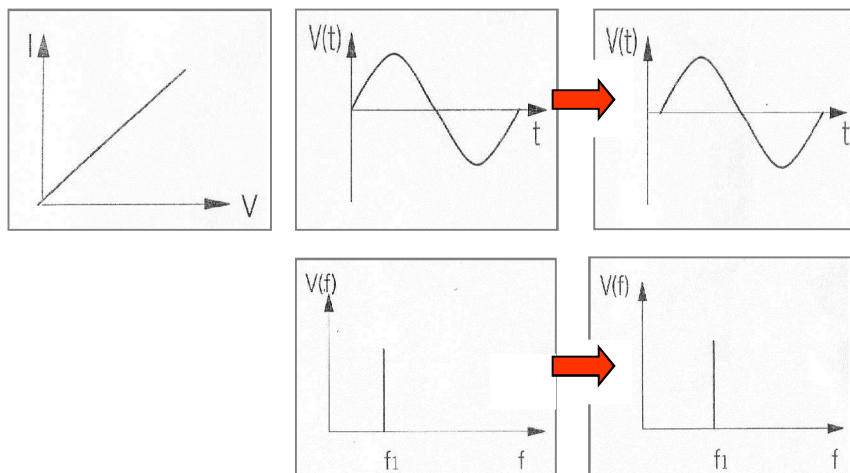
Non-linearities:

Passive Intermodulation products can **only** occur when the transmission path between the base station and the antenna shows some **non-linear characteristics**.

To keep the intermodulation products low the **non-linearities** of the connector must be **small**.

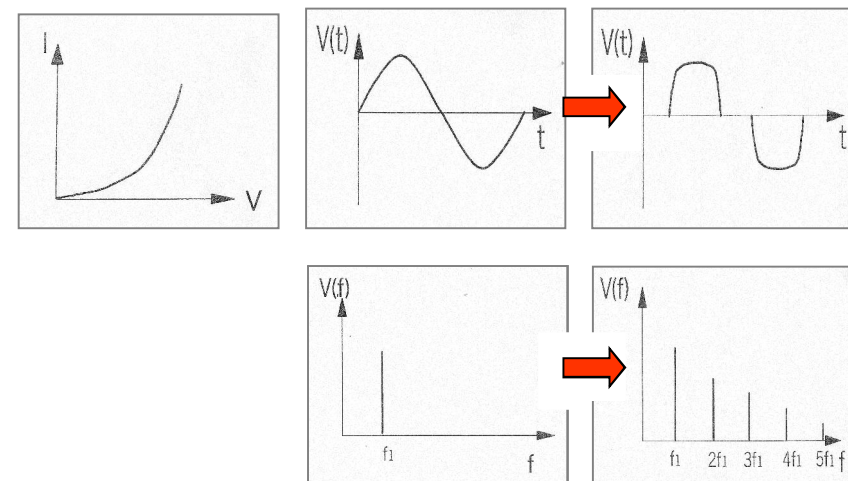
Intermodulation

Linear Response:



Discrete frequency signal input in an ideal two port device with linear V-I characteristic will result in an output signal with **identical frequency** characteristics. There will only be a change in the amplitude V and a time shift.

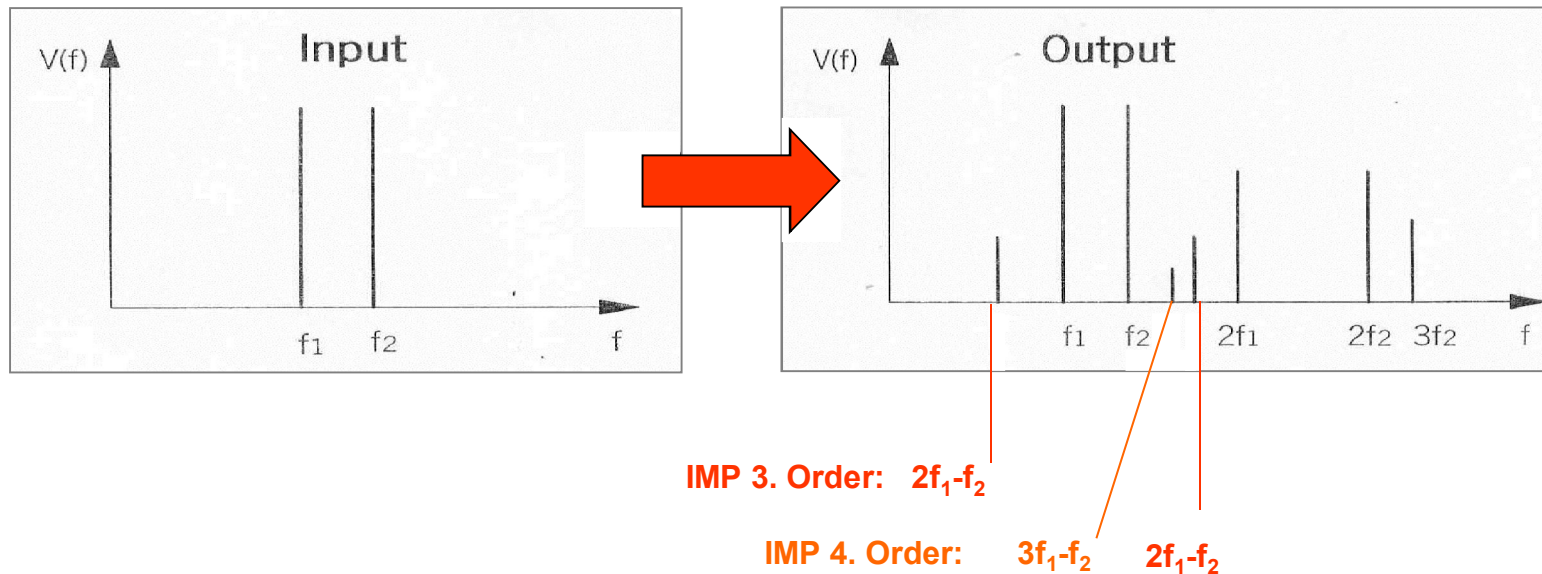
Non-Linear Response:



A two part device with non-linear V-I characteristic distorts the input signal. The output signal is changed and contains not only the fundamental **frequency** but also the **harmonics**: $2f_1, 3f_1, 4f_1, 5f_1, \dots$

Intermodulation

Intermodulation Products (IMP):



When two or more frequencies are transmitted in a non-linear two-port-device the output signal will contain beside the fundamental frequencies and it's harmonics also intermodulation products (IMP).

Intermodulation

Intermodulation Products (IMP):

The frequencies of the intermodulation products are defined by the **fundamental frequencies** and it's **harmonics** according to the formula:

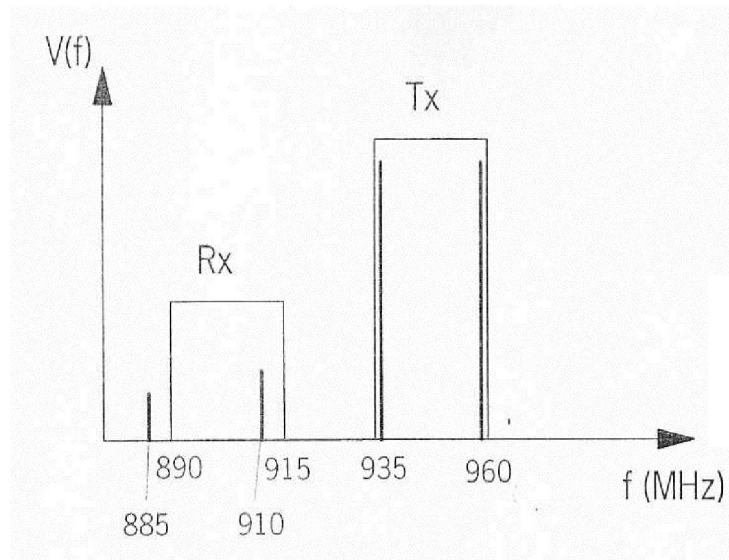
$$f_{IM} = -/+ mf_1 + -/+ nf_2$$

The IMP's can be categorized by their order which is made up by the sum of the harmonics orders (m+n).

Example: $3f_1 - 2f_2 = 5$. Order IMP

Intermodulation

Intermodulation Products at GSM Base Stations:



Tx	Tx	3. Ord IMP	5. Ord IMP	7. Ord IMP
f_1	f_2	$2f_1 - f_2$	$3f_1 - f_2$	$4f_1 - f_2$
935	960	910	885	960
937	955	919	901	883
935	945	925	915	905

As GSM uses multiple frequencies within the defined frequency band there are also multiple IMP's generated. The chart shows only some examples. The total IMP's may also differ on each base station depending on which and how many carrier frequencies are used.

Intermodulation

Causes of Non-Linearities

- **magnetic materials**
- **surfaces**
- **contact joints**
 - internal contacts
 - cable termination
 - interfaces

Intermodulation

Materials

Important: No ferromagnetic materials on conducting parts. Telegärtner materials for mobile radio base station connectors are:

Body	Spring Contact	Plating
brass	Cu alloys (CuBe etc.)	Gold/Silver/Telealloy

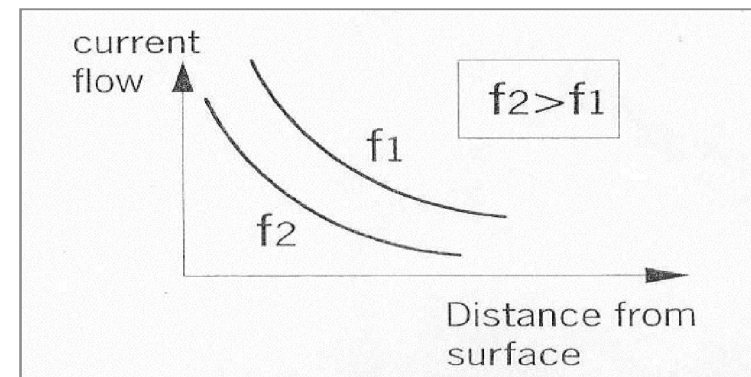
Gold is not suitable as a plating for the connectors that are used in higher power applications between the antenna and the base station, because **nickel** is commonly used as an **underlayer**.

Skin Effect

The higher the transmission frequency is the more the current flow concentrates near the surface.

Therefore the material of the **plating**, it's **thickness** and **pureness** is of **great importance** for the **electical characteristics**.

Telegärtner uses for intermodulation-sensitive products only silver and Telealloy.



Intermodulation

Materials for IM-Sensitiv Parts:

Good IMP Characteristics	Bad IMP Characteristics
Gold	Nickel
Silver	Steel
* Telealloy	Aluminum
Copper Beryllium	
Copper brass	

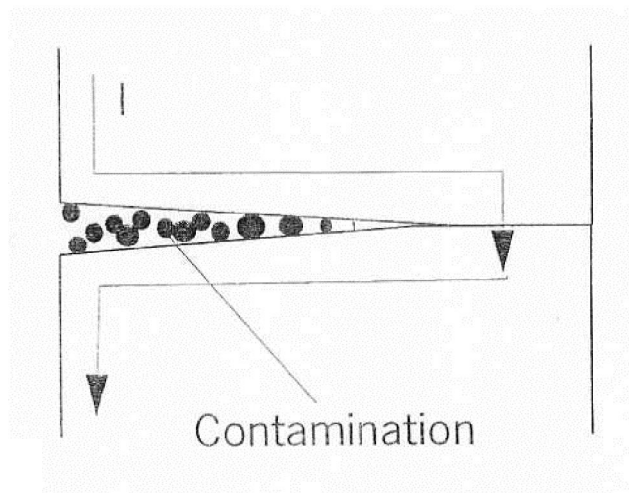
* **Telealloy** (white bronze) is a very good alternative to silver as a plating. It has approximately the **same conductance**, is **solderable, climatically resistive** and does **not** show any non-linearities.

It contains Copper, Zinc and Zinn which are **brought on the body** in one **single process**. **No underlayer** is required.

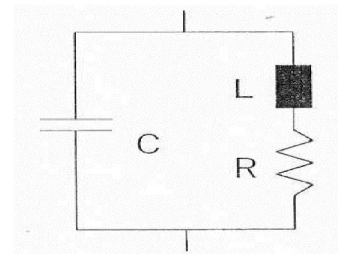
Intermodulation

Internal Contact Quality

- No irregular contact faces
- Sufficient contact pressure
- No oxidation or corrosion
- No contact impurities



Non-linear contacts can be modeled as an electrical circuit. In this example impurities cause the current to take a detour. The resulting impedance (Z) contains capacitive (C), inductive (L) and resistive (R) elements:



$$Z = \frac{R + j 2 \pi f L}{1 - (2 \pi f)^2 L C + j 2 \pi f R C}$$

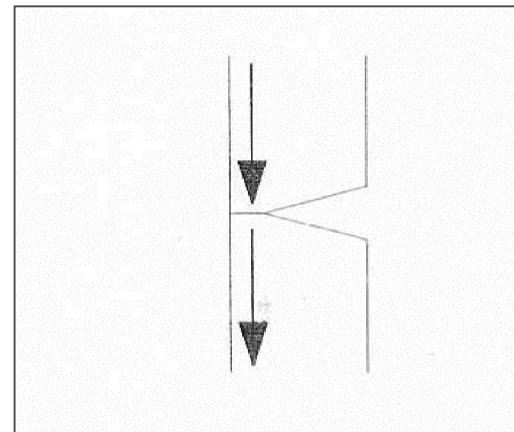
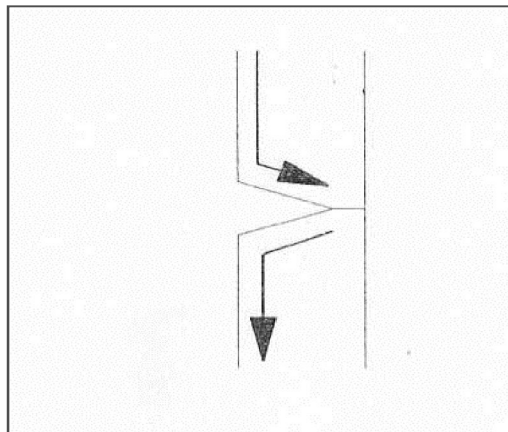
Intermodulation

Internal Design

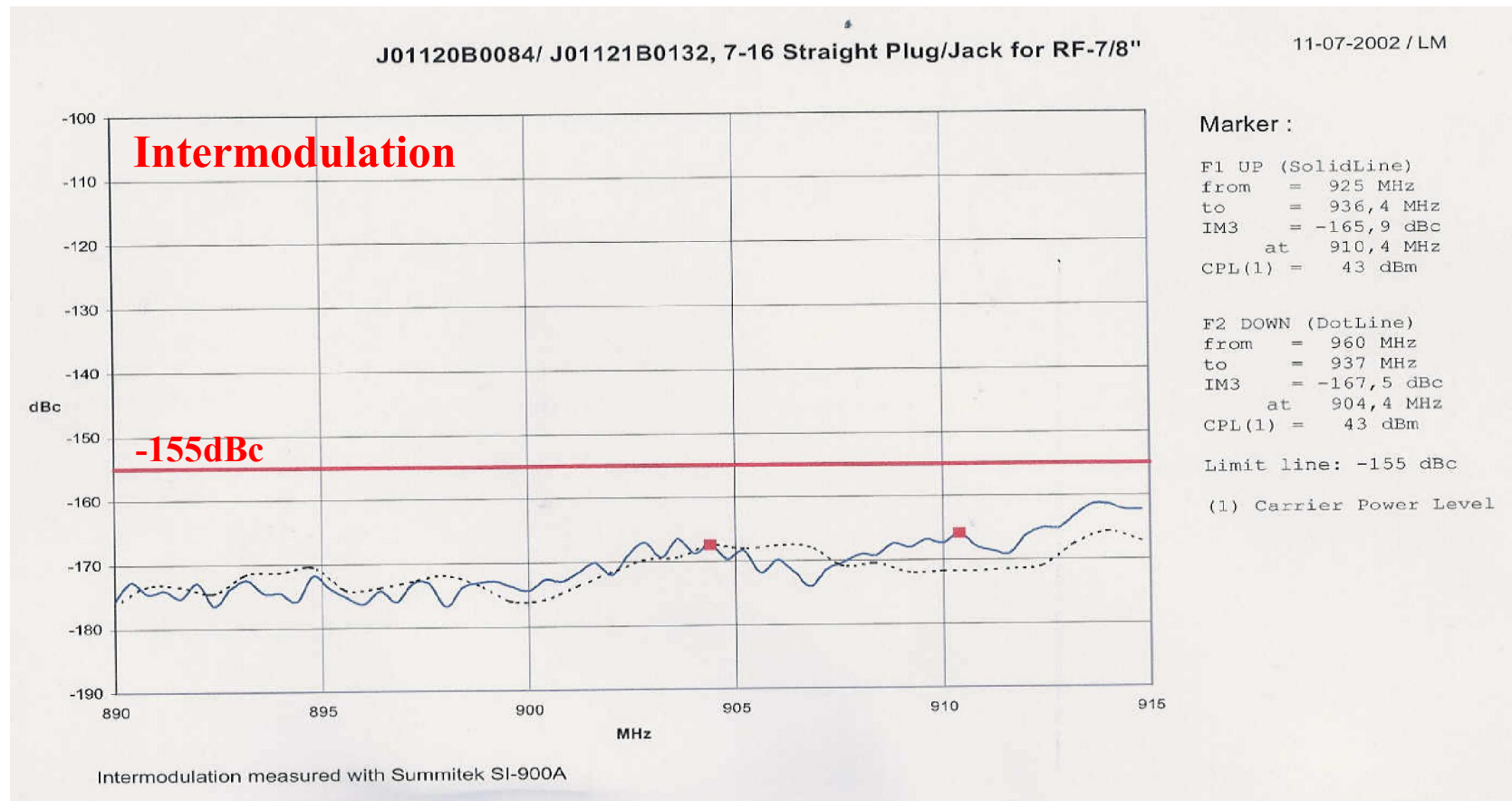
The **internal design** of a connector is also a **critical point** for its IM characteristics.

Key points are :

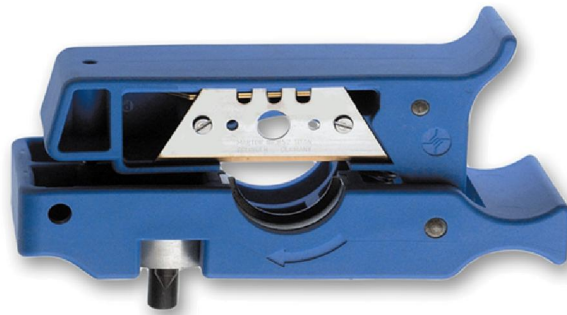
- Low current densities in contact points
- Smooth surface
- Direct current flow with clearly defined contact points



Electrical Performance: Intermodulation



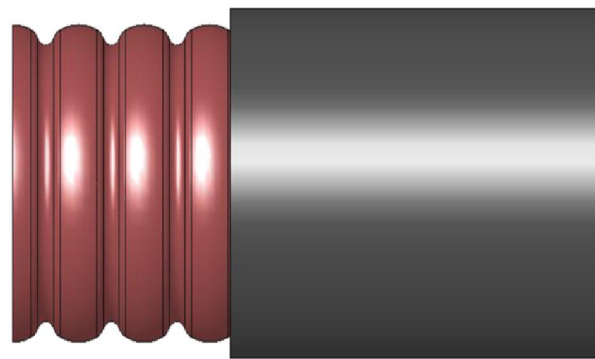
Tooling for Cable Preparation



Manual Tool



Tool for Power Drill



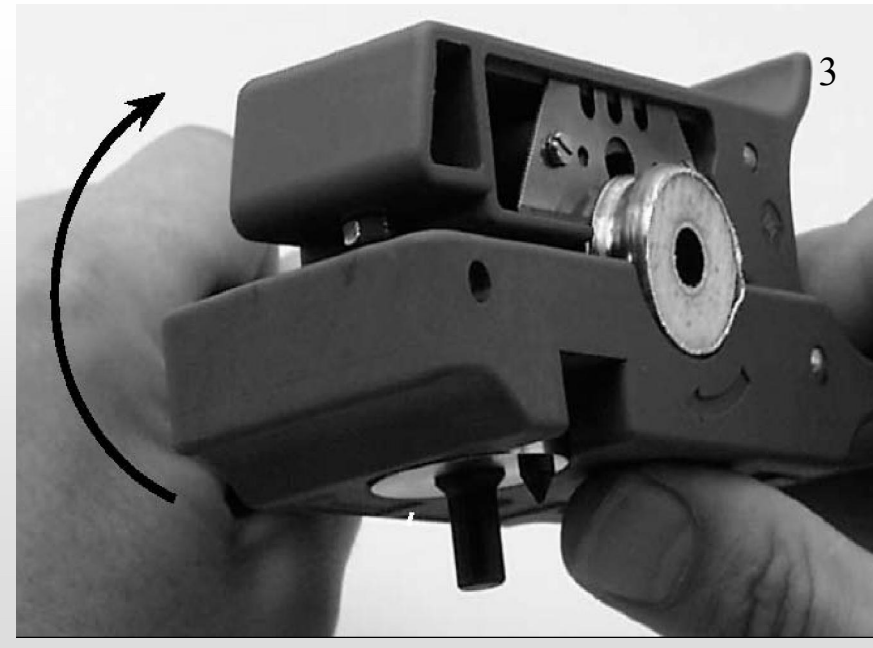


Assembling Concept: Cable 1/2" and 7/8"





Assembling Concept: Cable 1/2" and 7/8"



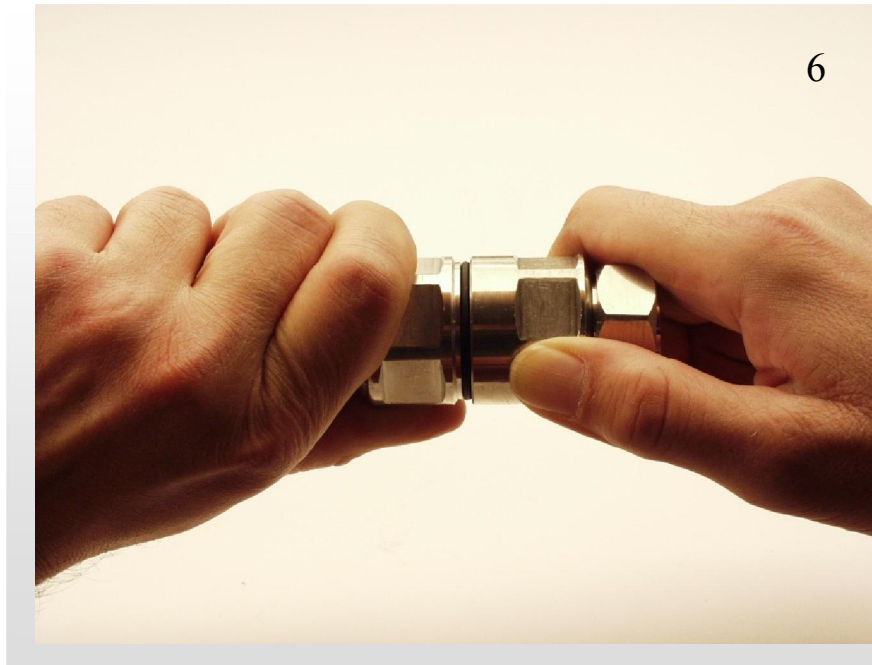


Assembling Concept: Cable 1/2" and 7/8"





Assembling Concept: Cable 1/2" and 7/8"



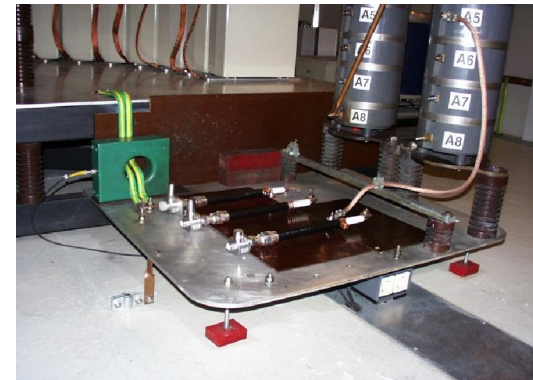
Performance Characteristics

- 1 Waterproof : IP 68
- 2 No additional sealants required
- 3 Excellent Return Loss typ. > 40 dB up to 2.5 GHz
- 4 Passive Intermodulation > 160 dBc (2x43 dB Test Signals)
- 5 Simple assembly - only two piece-parts involved
- 6 Use of high quality raw materials and plating
- 7 Special Tools for cable preparation
- 8 Compact design

EMP - and Lightning Protection Devices



7-16 and N Lightning Protection
Devices



Test Configuration for Lightning
Protection Devices

Our N and 7-16 Series Lightning Protection Devices are available in 2 different technologies:

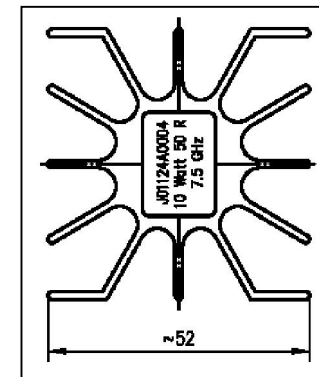
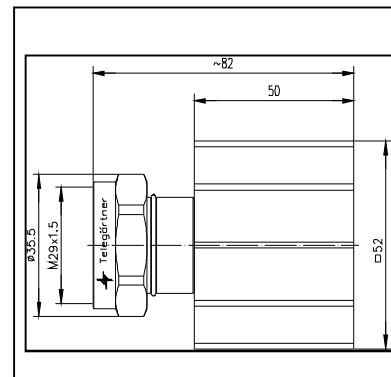
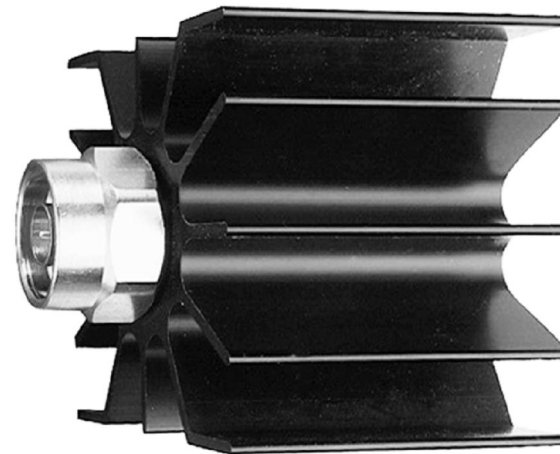
- Surge Arrestors (incorporating Gas Discharge Tube)
- $\lambda/4$ Wave Stub-Tuners



Components for Mobile Radio Base Stations

RF Power Terminators

- 10 Watt
- 7-16 and N Types
- Up to 7.5 GHz



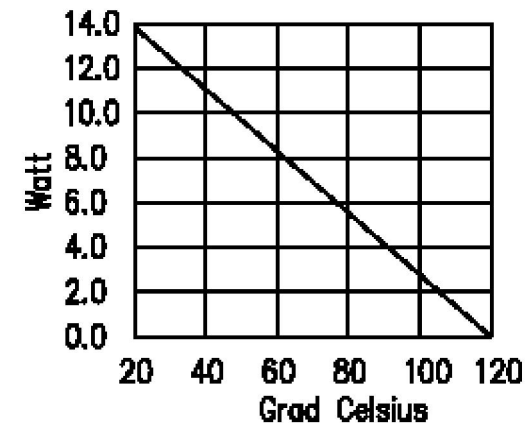
Components for Mobile Radio Base Stations

RF Power Terminators

VSWR performance up to 7.5 GHz

Frequency Frequenz	VSWR min.	VSWR typ.	RL (dB) min/typ.
1.0 GHz	1.054	1.015	30/46
2.5 GHz	1.100	1.032	26/36
7.5 GHz	1.200	1.118	21/25

Max. Power depending on
ambient temperature

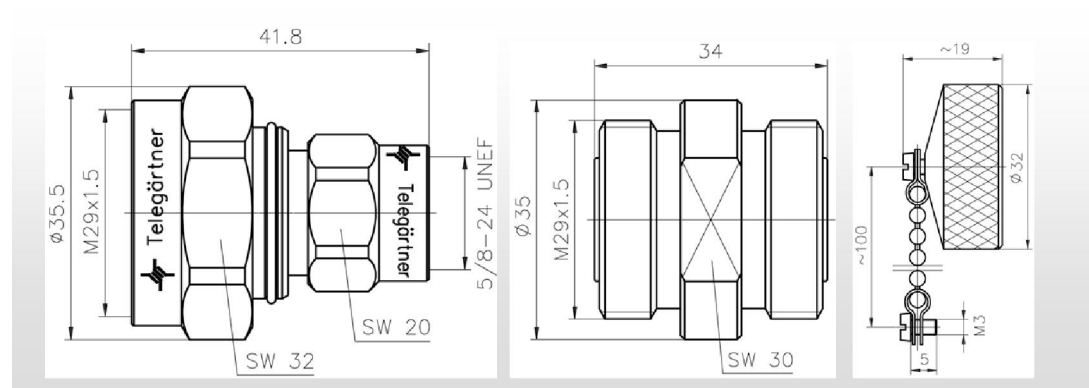




N and 7-16 Jacks, Adapters and Dust Caps



Various Jacks and Adaptors



Inter-series Adaptor

Adaptor

Dust Cap

Characteristics

- waterproof jacks and adapters
- all conducting piece-parts are silver-plated
- low Return Loss and good intermodulation
- (IMP) characteristics



Thank you for your attention