4.3-10
The New RF-interface for Mobile Communication

Reiner Berchtold / SPINNER GmbH / April 2016

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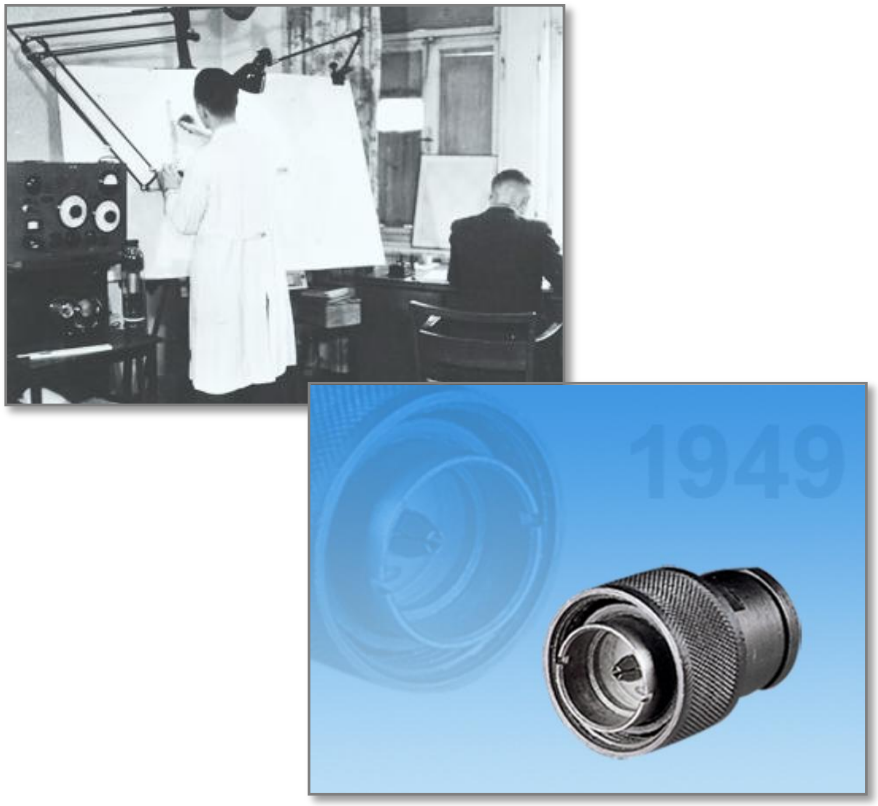


- **Findling plug** (70 Ω) was introduced during the war early in the forties.
- In the **1950‘s** Dr. Georg Spinner developed the **6-16 connector** (60 Ω), forerunner of today‘s world-famous **7-16** (50 Ω)
- In the **1960‘s** a 50 Ω version was introduced and standardized under the name **7-16**, additional a 75 Ω version named **4.6-16** was established.

The History

7-16 - A few historical facts

- 7-16 connector is the most solid and robust connector of this size available in the market.
- With a coupling torque of 30 Nm an enormous outer contact pressure is practicable. It gives the connector its excellent Intermodulation properties.
- Basically 7-16 is a more than 60 years old connector system.

1940‘s

- Findling plug

1960‘s

- 7-16 was developed and standardized

1990‘s

- 7-16 established as the ‚mobile communication connector‘

2000‘s

- 7-16 is produced in millions for the booming mobile communication market

Today

- Time for a new connector system?

The Presence

Connector Series 7-16

- 7-16 connectors show an outstanding mechanical and electrical performance when tightened with 30 Nm, but:
  - In most countries less than

    50%

    of all installers use torque wrenches.
  - Up to

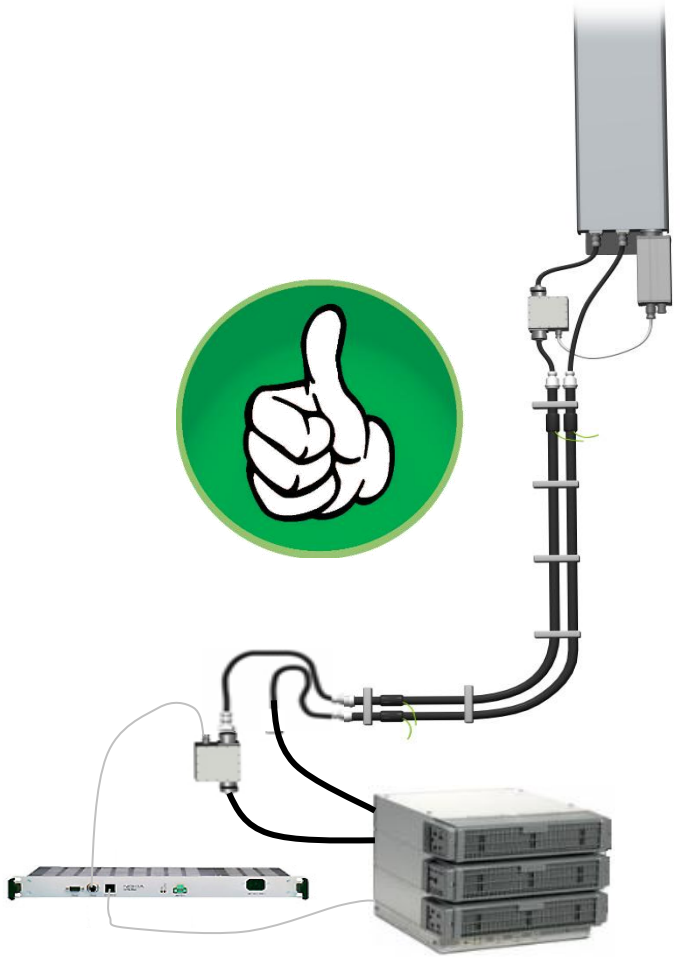
    70%

    of the reported PIM failures in the antenna feeder line are caused by insufficient torqued 7-16 connectors.

The Future

A new and innovative connector series

- The performance and reliability of mobile communication sites can be improved dramatically with a ‘torque free’ connector system.
- But how can a up-to-date mobile communication connector be realized?



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The Future

Requirements

- What are the requirements of today's and tomorrow's mobile communication systems?

Mechanical

- Low coupling torque
- Small size
- Low weight
- Tool free coupling machanism
- Protected RF contacts
- etc.

Electrical

- High return loss up to 6 GHz
- Low PIM
- High power rating
- High screening efficiency
- Low contact resistance
- 20 kA pulse current
- etc.

Environmental

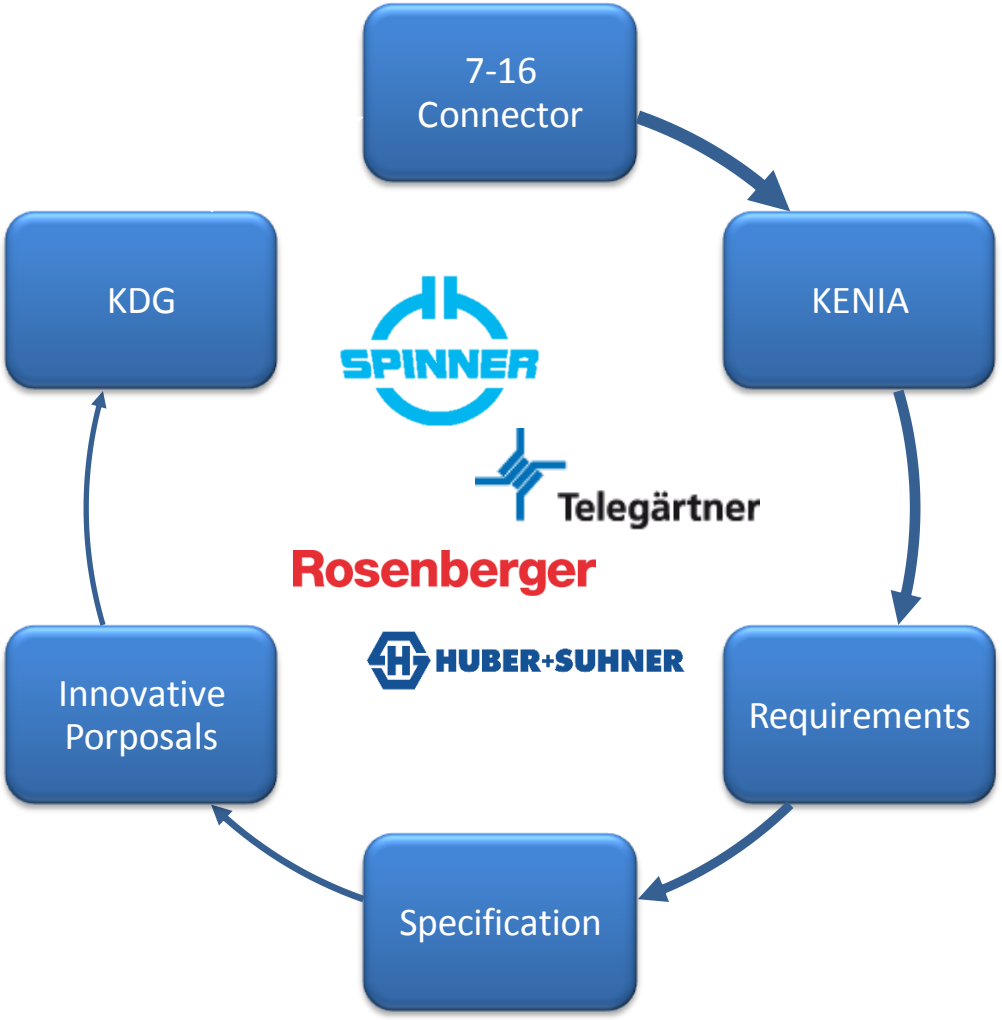
- Operating temperature -55°C to +90°C
- IP68 for outdoor environment
- Low corrosion
- Life time 20 years
- Immune against vibration
- etc.

New connector needs to be better and smaller than 7-16 with ‚foolproof' coupling

The Future

A new and innovative connector series

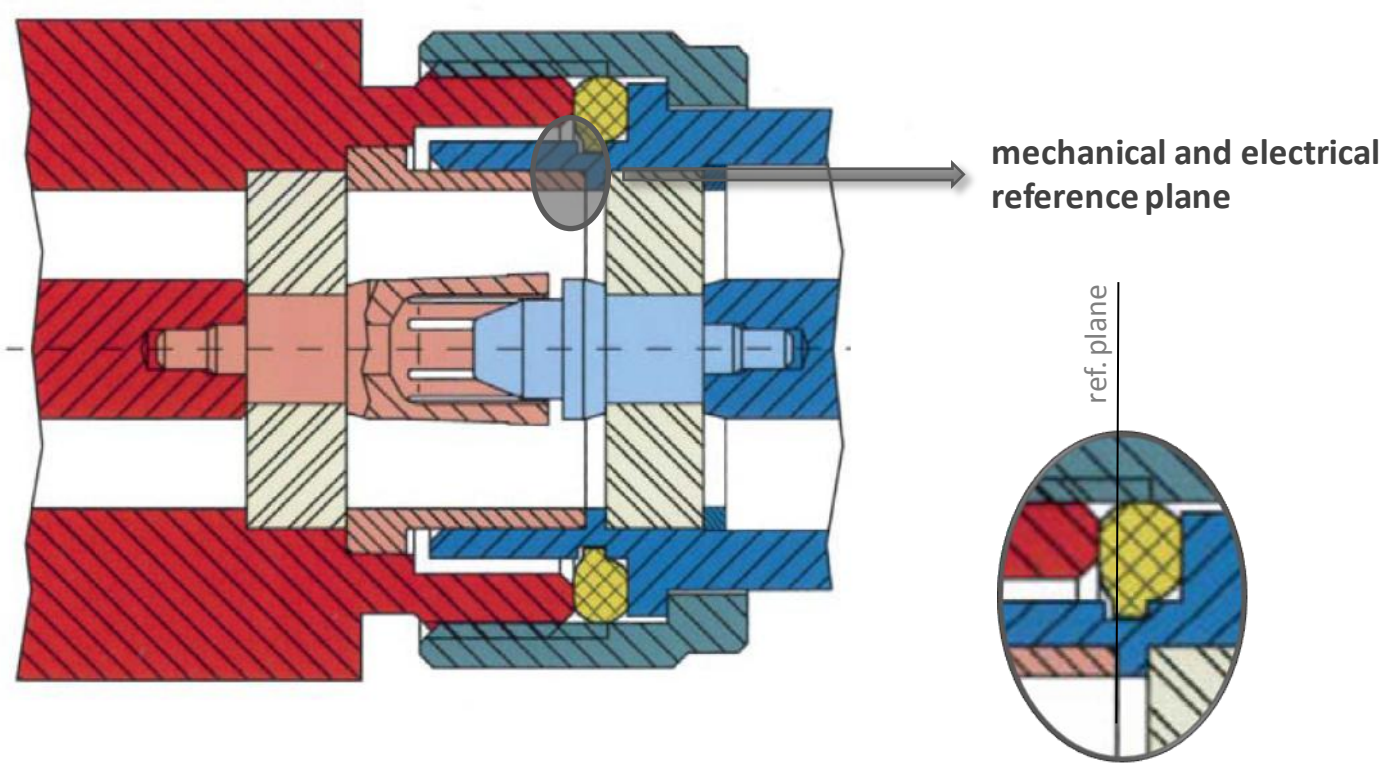
- New requirements need innovative solutions:
  - How to ensure the whole mobile communication industry can and will use the new connector?
  - ⇨ It must meet the demands of all market players
  - ⇨ Commercial availability
  - ⇨ Standardization
  - How to design the ‘ideal’ mobile communication connector?
  - ⇨ By combining the most constructive connector manufacturers



Design features

Inside the Connector

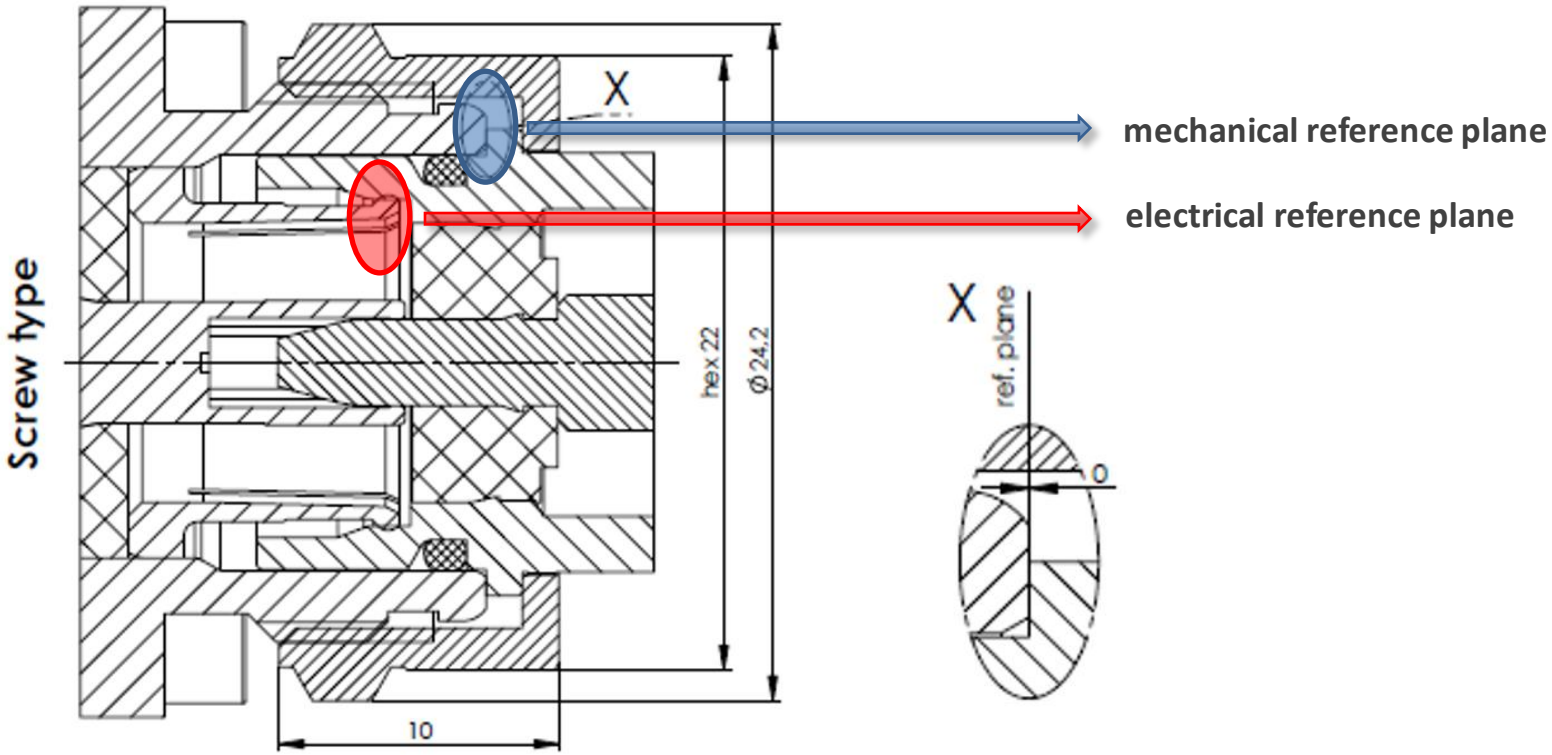
- How to overcome the high coupling torque of 7-16
  and at the same time keep the mechanical perfomance?



Design features

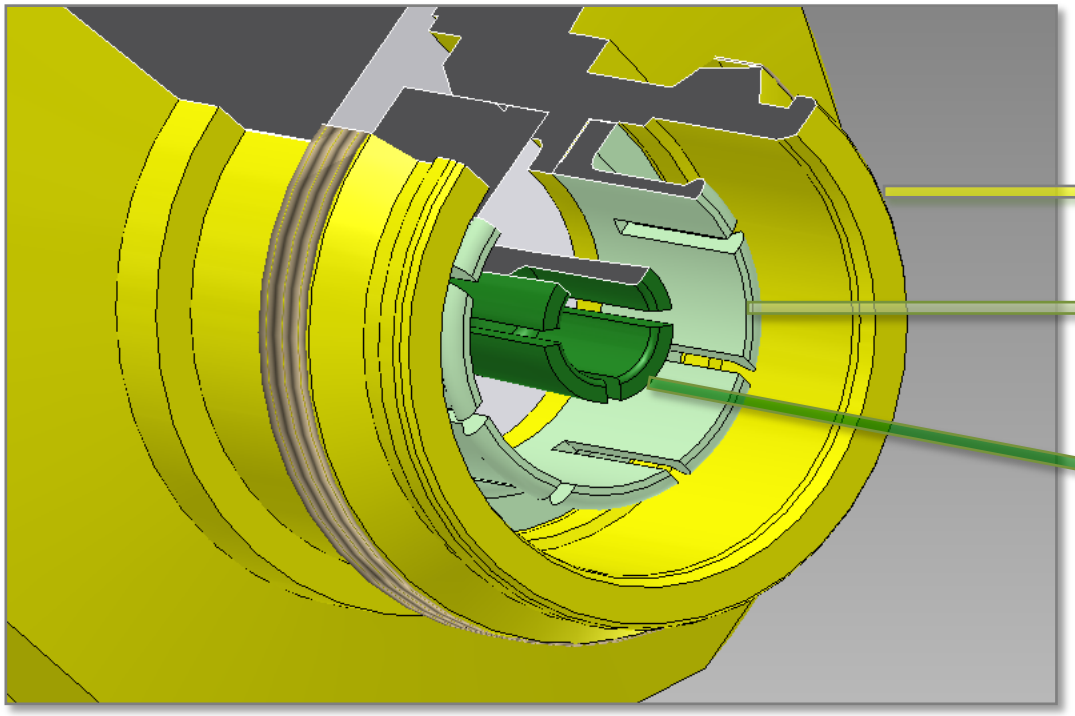
Inside the Connector

- The separation of the mechanical and the electrical reference plane allows low torque or even a tool free coupling with highest PIM performance.



Design features

Inside the Connector



solid housing ensures highest mechanical stability

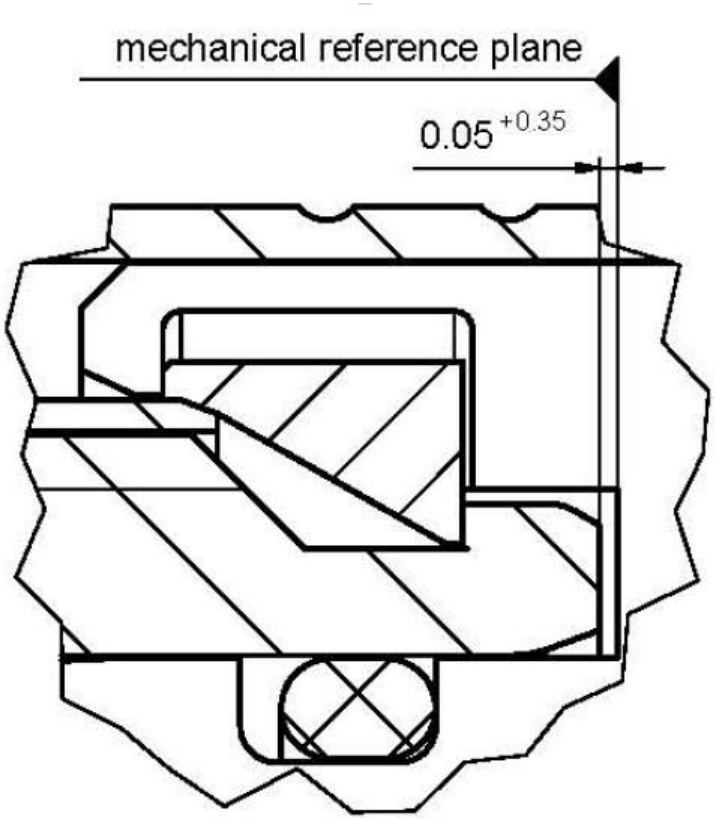
spring loaded outer conductor contact allows a torque independent contact pressure

outer and inner contact are protected by the rigid connector housing

Design features

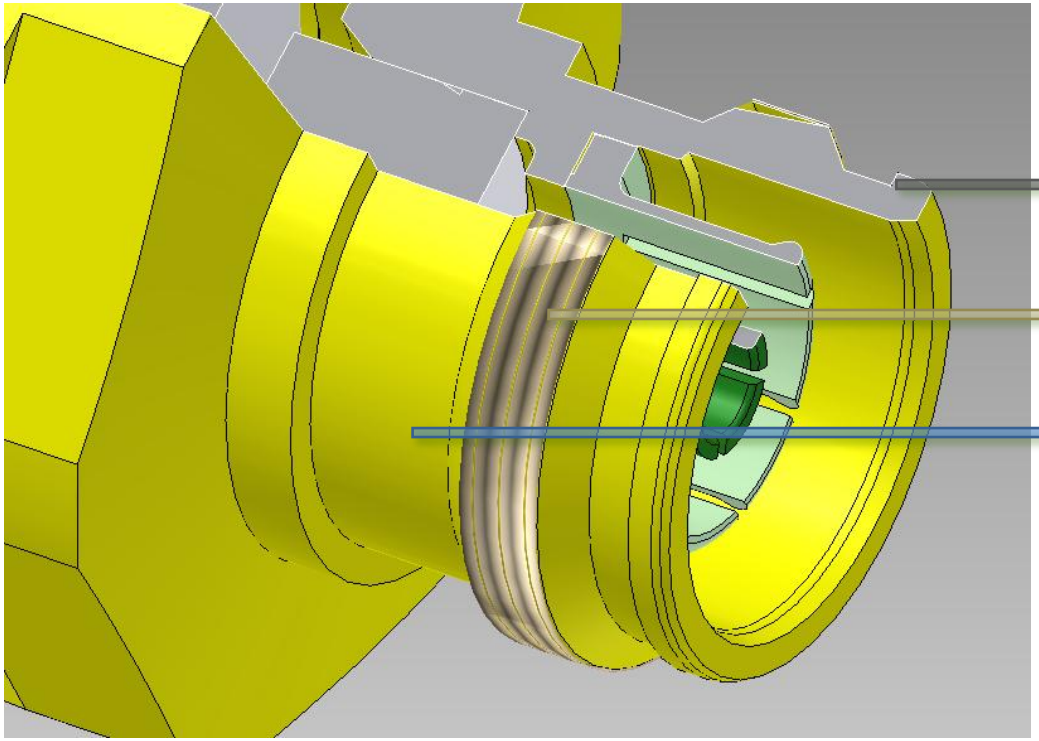
Inside the Connector

- The universal socket allows versatile coupling mechanisms.



Design features

Inside the Connector



groove for Push-Pull mechanism

M20x1 thread for screw mechanism

standardized sealing area

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Qualification

Test Program

Test	According to
Visual inspection	IEC 61169-1 9.1.2
Interface dimensions	IEC 61169-1 9.1.3
Operating current	IEC 60512-5-1 and -2
Working voltage	IEC 61169-1 9.2.6
Outer conductor retention force	IEC 61169-1 9.3.4
Centre pin captivation force	IEC 61169-1 9.3.5
Mating cycles	IEC 61169-1 9.3.4
Cable rotation	IEC 61169-1 9.3.7.2
Cable pulling	IEC 61169-1 9.3.8
Cable bending	IEC 61169-1 9.3.9
Cable torsion	IEC 61169-1 9.3.10
Transient test	IEC 62305-1
Return loss	IEC 61169-1 9.2.1
PIM	IEC 62037 App. A2

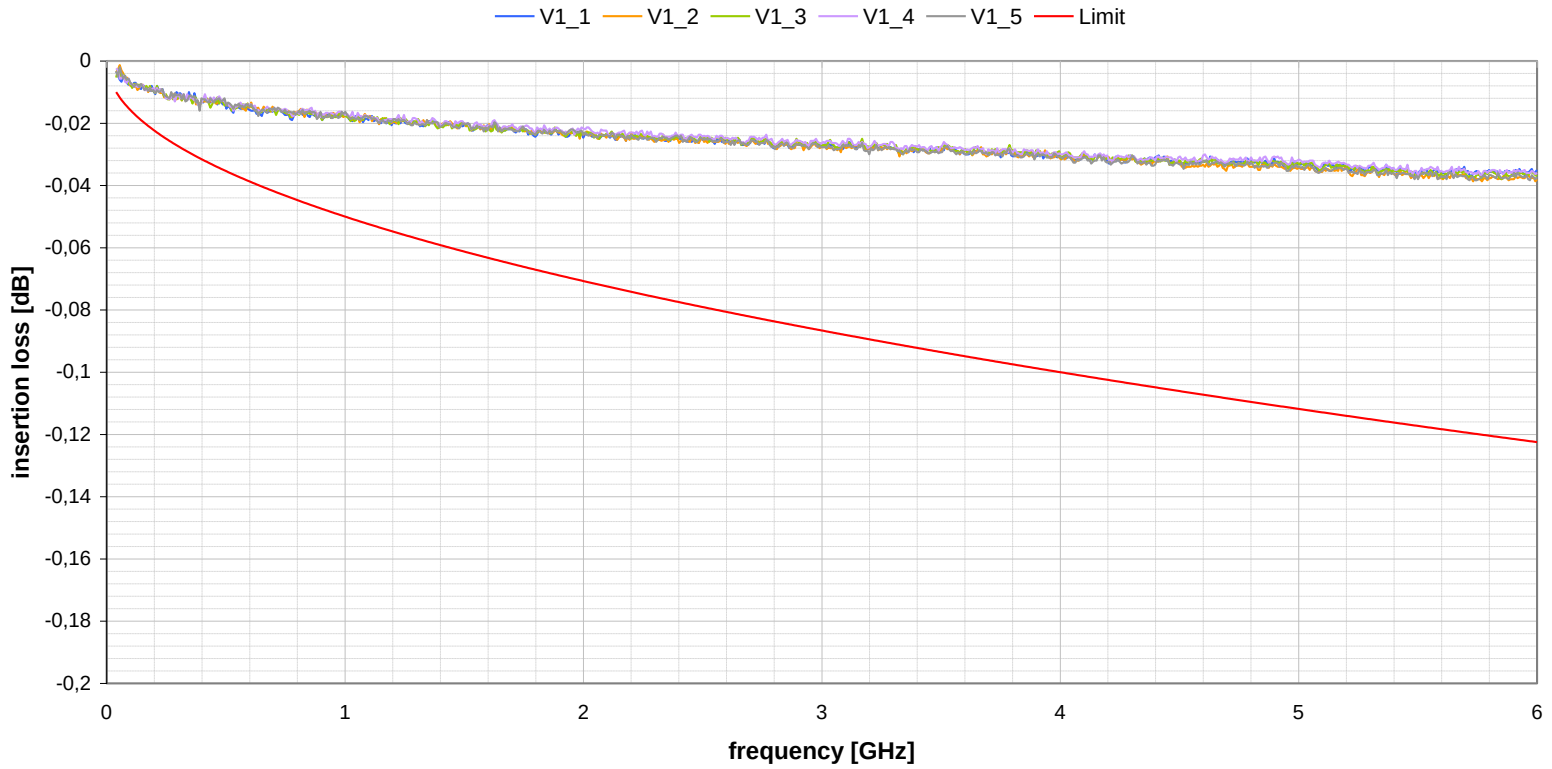
Test	According to
Screening efficiency	IEC 62153-4-7
Power handling	IEC 61169-1 9.2.2.4.2
Operating temperature	DIN EN 60068-2-1 and -2-2
Transportation temperature	IEC 61169-1 9.4.4
Storage temperature	IEC 61169-1 9.4.4
IP68	IEC 61169-1 9.2.7
Corrosion, mixed flowing gas	IEC 60068-2-60
Change of temperature	IEC 61169-1 9.4.4
Dry heat	IEC 61169-1 9.6 resp. DIN EN 60068-2-2
Cold	DIN EN 60068-2-1
Damp heat	IEC 61169-1 9.4.3 resp. DIN EN 60068-2-78
Vibration	IEC 61169-1 9.3.3
Shock	IEC 60068-2-27

The standardization of the 4.3-10 connector system (IEC 61169-54) is in progress with finalization expected in 2016.

Measurements

Insertion Loss

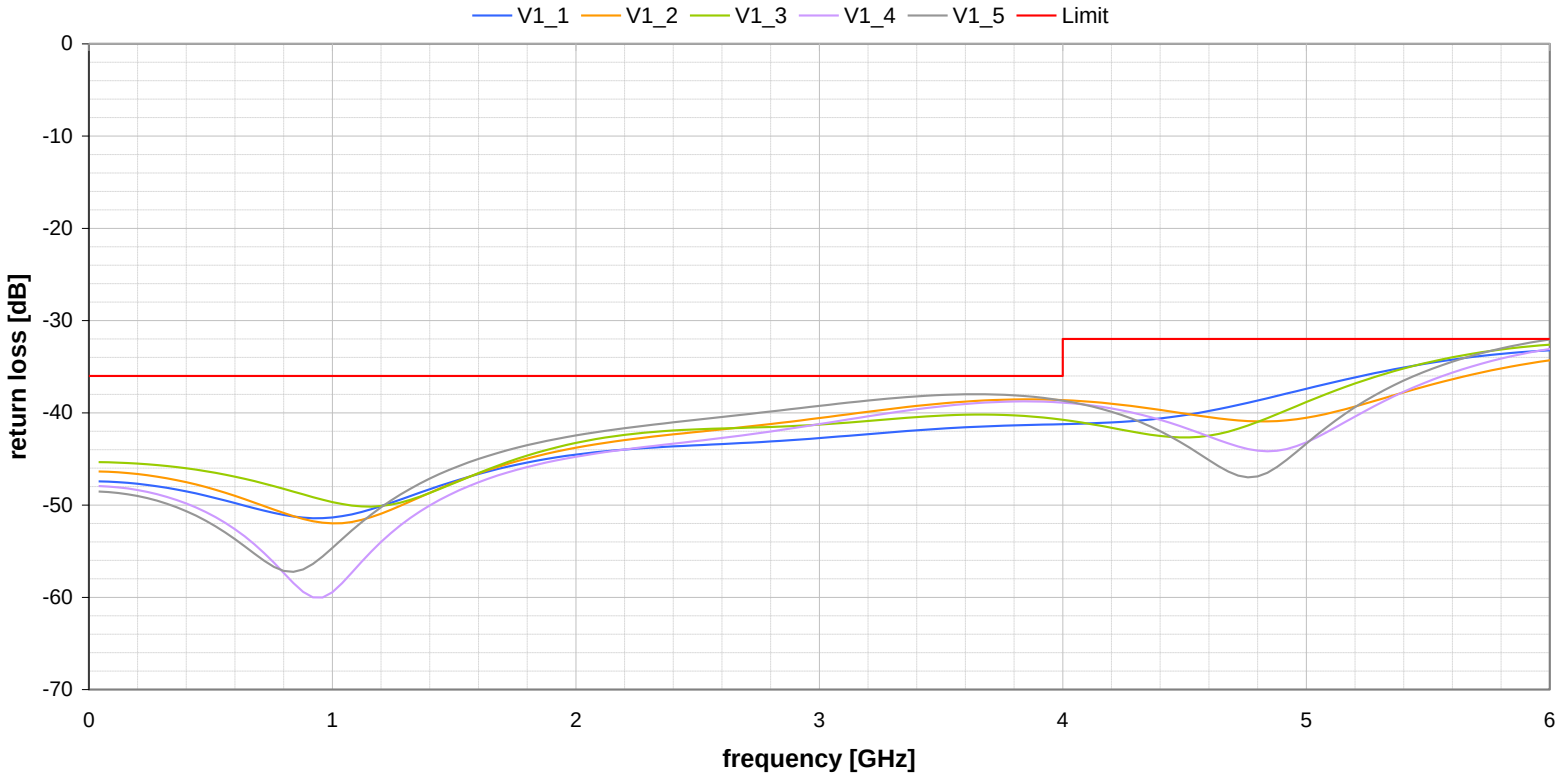
- Typical insertion loss figures below 0.04 dB at 6 Ghz measured on a mated adapter pair (N to 4.3-10)



Measurements

Return Loss

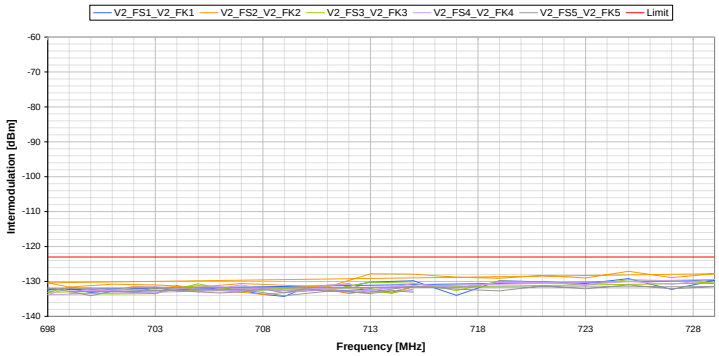
- Typical return loss figures below 36 dB up to 4 GHz
  with gated measurement on a mated adapter pair (N to 4.3-10)



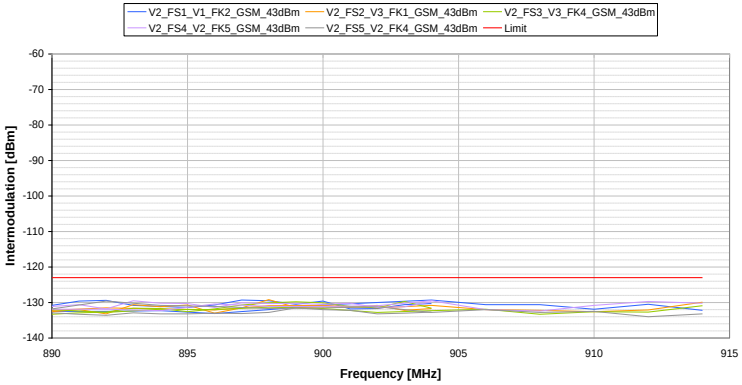
Measurements

Passive Intermodulation

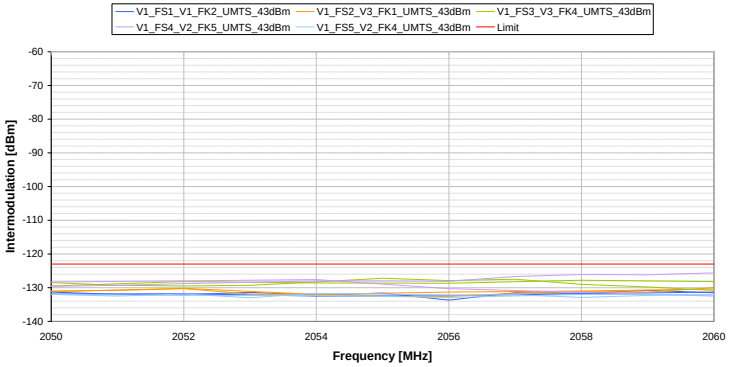
- LTE700



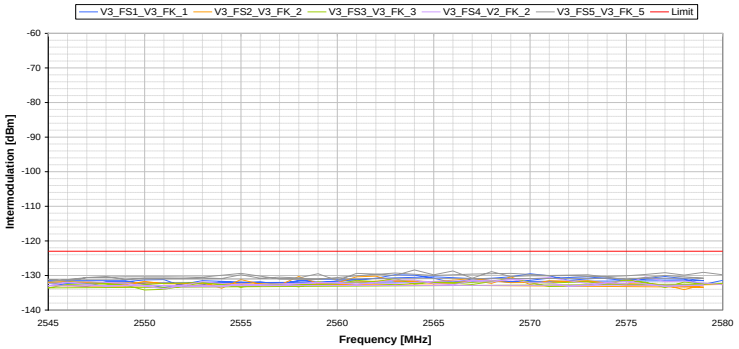
- GSM900



- UMTS



- LTE2.6



All measurements show stable PIM levels below -166dBc at a carrier power level of 2 x 43dBm (20W)

Measurements

Passive Intermodulation

Specification

Achievements

- Comparison between connectors systems 7-16 and 4.3-10

Mechanical

- Packing density 1 inch (N type, 33% below 7-16)
- Low weight (reduction by 60% for 1/2” cable)
- Necessary coupling torque 5 Nm max.
- Two tool free coupling machanisms
- Protected RF contacts
- etc.

Electrical

- 32 dB return loss up to 6 GHz
- PIM -166 dBc max.
- Power rating 500 W @ 2 Ghz
- 90 dB screening
- Low contact resistance
- 20 kA pulse current
- etc.

Environmental

- Operating temperature -55°C to +90°C
- IP68 for outdoor environment
- Low corrosion
- Life time 20 years
- Immune against vibration
- etc.

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Expectations to 4.3-10

Comparison with 7-16 connector

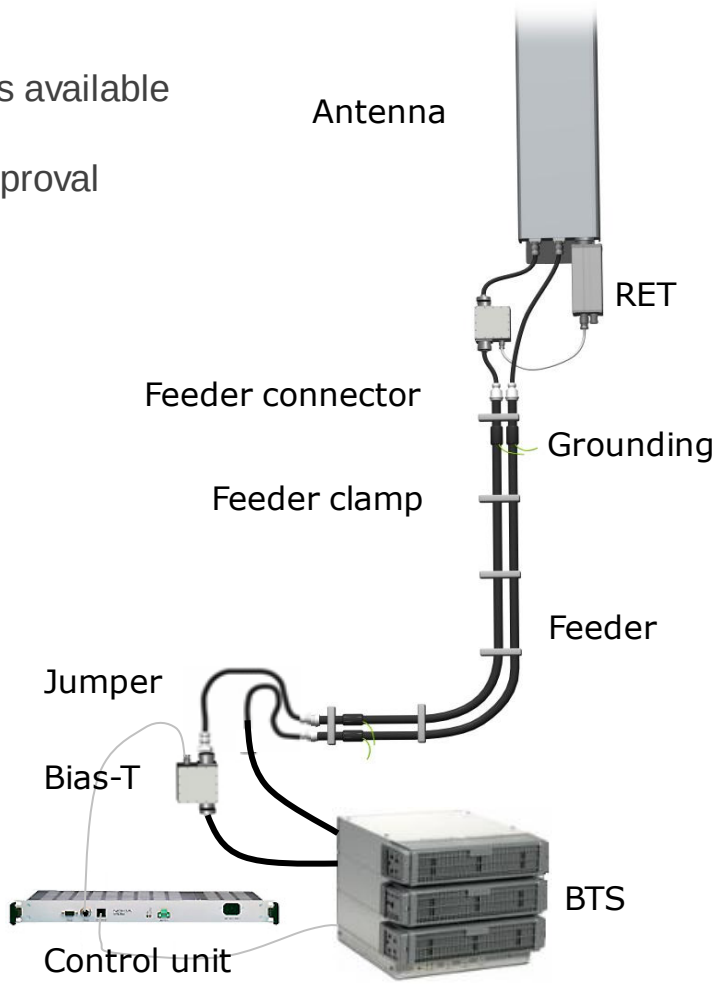
- Reduction of space requirement by more than 30%
  - ⇨ Allows high density equipment design
  - ⇨ Reduced equipment weight and cost
- Electrical performance independent from coupling torque
- Reduction of weight by up to 60%
  - ⇨ Light weight modules because of low components weight and no need of thick-walled modules
- Screw, Push-Pull and Hand-Screw variants fit onto the same socket
  - ⇨ High flexibility in connector choice
- Interface contact areas protected from damage (unmated)
- Excellent performance under mechanical/environmental stress
- Superior PIM performance independent from torque or coupling mechanism
  - ⇨ Reliable electrical performance and less installation failures

Availability

4.3-10 products

Today, the complete portfolio for mobile communication is available on the market from several vendors.
Most Operators already approved 4.3-10 or are in the approval process.

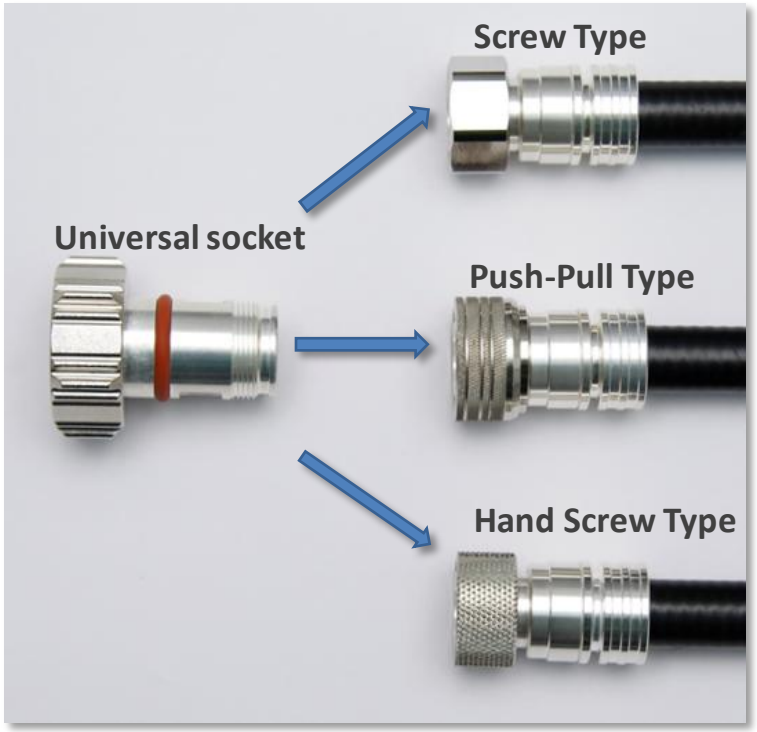
- Base stations:
  - Ericsson
  - Nokia
- Antennas:
  - Kathrein
- Feederline equipment (connectors, jumper, combiner, splitter, etc.):
  - Spinner
  - Rosenberger
  - Huber+Suhner
  - Telegärtner



Usage Recommendation

Versatile Connector Variants

One universal socket fits to all plug types



- **Screw type** connectors show highest mechanical stability and lowest PIM risk under dynamic conditions.
  They are insensitive against accidental opening by torque forces on the cable.
- ⇨ It is Spinner's first choice for outdoor base stations with hard environmental conditions like vibrations, wind load, possible icing, etc.

- **Push-Pull type** connectors allow a free rotation of the cable and are therefore immune against any undesired opening by torque forces, even in combination with bending and/or pulling forces.
- ⇨ For applications where frequent and fast mating and unmating is required.

- **Hand screw type** are also designed to allow rotation of the cable. However, a hand screw coupling mechanism can be opened by applying a pulling and/or bending force together with a torque force.
- ⇨ Favored in applications with stable conditions like indoor coverage DAS systems.

HIGH FREQUENCY PERFORMANCE WORLDWIDE

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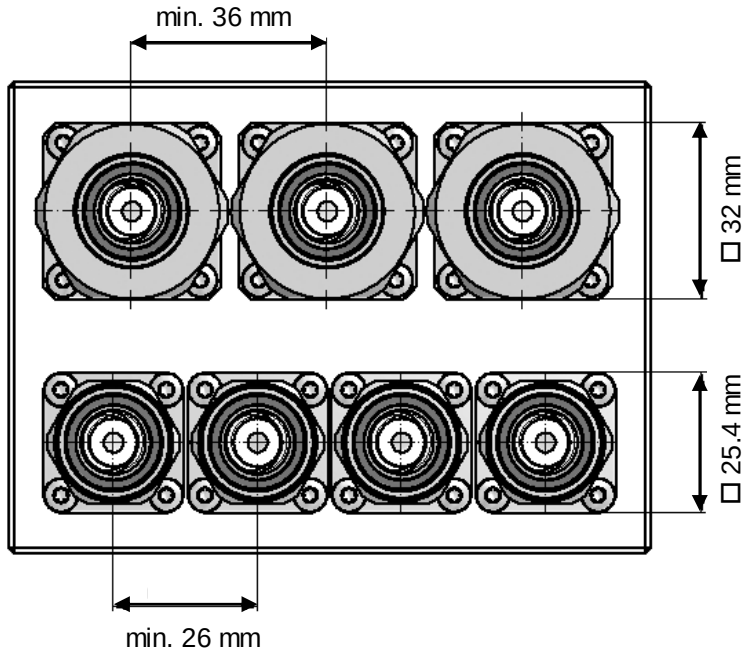
SPINNER portfolio

4.3-10 connector specification supports three coupling mechanism

Hand Screw Type | Screw Type | Push-Pull Type

Design features

Comparison with 7-16 Connector



- 33% higher port density due to compact design.
- Weight reduction by approximately 60%
  (compared to a 7-16 connector for 1/2” cable)
- The universal socket allows versatile coupling mechanisms.

Comparison with other connector types

Electrical and mechanical data of SPINNER connectors

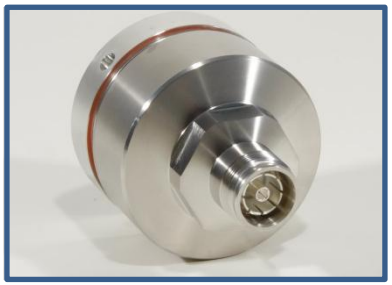
	Type N	Type 4.1-9.5	Type 4.3-10	Type 7-16
Nominal impedance	50 Ω	50 Ω	**50 Ω**	50 Ω
Cut off frequency	19 GHz	14 GHz	**13 GHz**	8.3 GHz
Intermodulation (IM3) 2 x 20 W	typ. -155 dBc	typ. -165 dBc	**typ. -166 dBc**	typ. -165 dBc
Insulation resistance*	≥ 5 GΩ	≥ 5 GΩ	**≥ 5 GΩ**	≥ 10 GΩ
Proof voltage at sea level	2.5 kV	2.5 kV	**2.5 kV**	3 kV
Working voltage at sea level	1.4 kV	1.7 kV	**1.8 kV**	2.7 kV
Power rating	450 W at 1 GHz 300 W at 2 GHz	650 W at 1 GHz 450 W at 2 GHz	**700 W at 1 GHz** **500 W at 2 GHz**	1,200 W at 1 GHz 850 W at 2 GHz
Contacting outer conductor	Face contact	Face contact	**Contact bushing**	Face contact
Coupling mechanism	screw	screw	**screw, push-pull, hand screw**	screw
Coupling torque	3.0 Nm	10 Nm	**5 Nm (screw only)**	30 Nm
Proof torque	4.0 Nm	15 Nm	**7 Nm (screw only)**	55 Nm
Tensile strength of coupling mechanism	450 N	550 N	**450 N**	1,000 N
Mechanical lifetime (operations)	500	500	**500**	500
Packaging density	1 inch 25.4 mm	1 inch 25.4 mm	**1 inch** **25.4 mm**	1.26 inch 32 mm
Temperature range	-67 to 311 °F -55 to +155 °C	-67 to 311 °F -55 to +155 °C	**-67 to 311 °F** **-55 to +155 °C**	-67 to 311 °F -55 to +155 °C
Degree of protection (mated)	IP68	IP68	**IP68**	IP68

SPINNER portfolio

SPINNER products based on the new 4.3-10 connector system








Product	Remarks
MultiFit™	Plug/socket/right angle plug screw, hand-screw, push pull
Fixed connector	Panel mount/bulkhead
Calibration Kits	Test & measurement
Adaptor N to 4.3-10	Standard and measurement
Adaptor 7-16 to 4.3-10	Standard and measurement
Jumper cable	Plug/socket/right angle plug