WHITE PAPER

4.3-10: choosing the right connector

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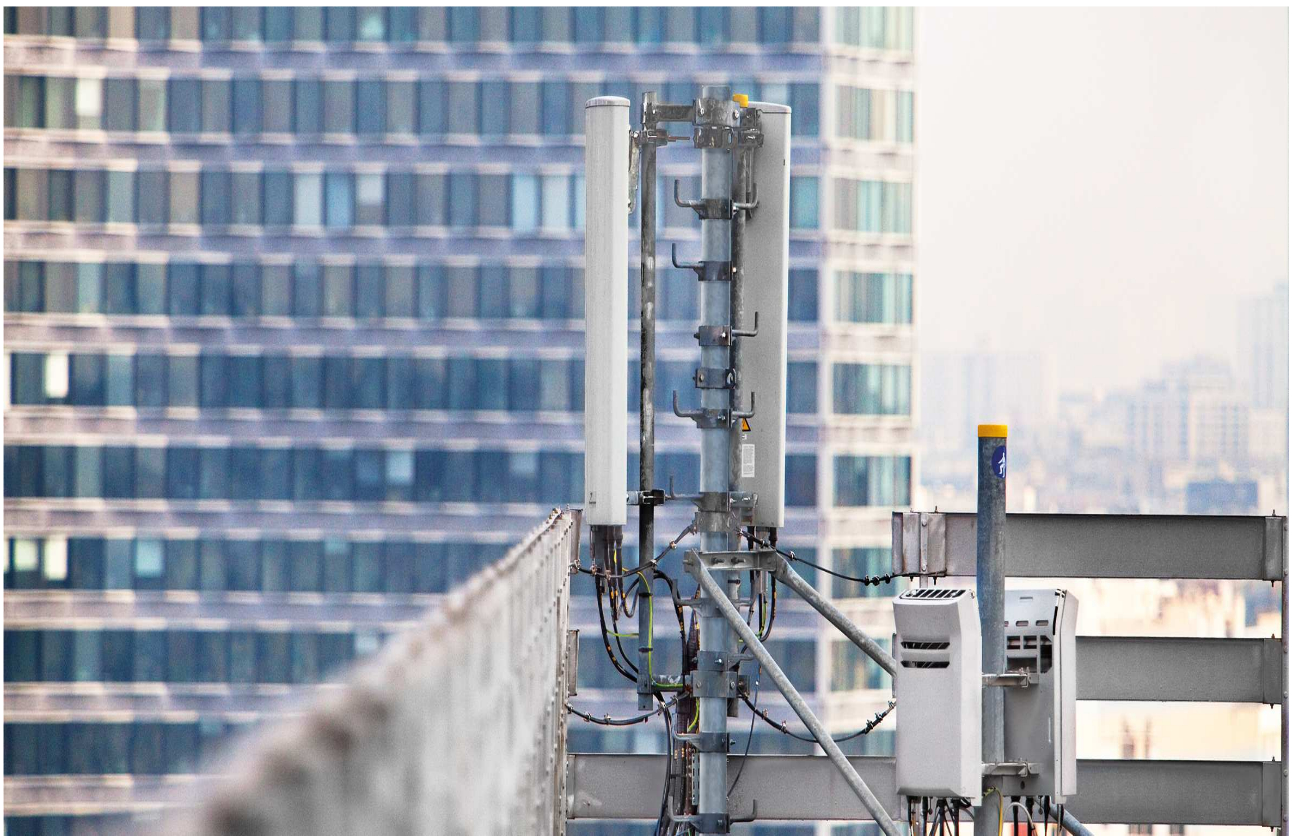

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Introduction

Choosing between classic interfaces such as 7/16, N or 4.1/9.5 connectors and the new interface 4.3-10 can have a significant impact on how a particular network will perform. There are several important considerations to make when choosing a connector, including the network design and the choice of the Mobile Telecommunications System used. This paper will compare and contrast these two categories of connectors (classical and new), highlighting their differences in terms of electrical and mechanical performance in particular applications.

Because Long Term Evolution (LTE) networks feature an increased mobile data rate of 100 Mb/s, this higher transmission rate will expose PIM (Passive Intermodulation) vulnerabilities in today's networks with frequency division duplexing. Fourth generation networks require superior network transmission fidelity, much higher than previous generations. Network operators also face the challenge of maintaining customer loyalty in an unforgiving competitive arena. As such, good network PIM performance and PIM testing are now imperative. One of the major benefits of the new 4.3-10 interface is its reliability in terms of PIM.

The size of a particular connector has a major impact in today demanding applications. Mast or roof installations require much lighter products and therefore we see a trend towards miniaturization of RRHs (Remote Radio Heads). Additionally the space available for RF ports is shrinking, and Mimo antenna systems require more antenna lines. Furthermore; reduced footprint and a higher number of ports requires connectors which can be positioned closer together without the need for tools such as torque wrenches.

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Historical Interfaces

The N connector (in full, Type N connector) is a threaded, weatherproof, medium-size RF connector. It was invented in the 1940s and was one of the first connectors capable of carrying microwave-frequency signals.

The 7/16 interface was developed in the 60's and is used in cellular networks and base stations as well as in other communications equipment. At that time large corrugated cables and high transmitted power were a challenge for the N type interface. Historically the 7/16 interface had a slotted outer contact. Then shortly after when PIM became more and more of a topic, the slotted contact was then replaced by a solid outer contact. The slotted contact was giving a not defined radial contact in addition to the front contact. PIM relies a well-defined contact whether be it a radial or front contact so therefore any uncertainty in the contact can result in a poor PIM. A solid outer contact such as that used with the 7/16 offers better performances in PIM. To guarantee the electrical performances a high torque force must be applied when mating.

The 4.1-9.5 was designed in the 70's and was used sporadically in telecom applications in the 90's for applications requiring a more robust connector than the N connector but more space efficiency than a 7/16 connector.

Figure 1

All these classical interfaces have a front contact. This means a heavy pressure is needed to maximize the number of contact points on the front surface in order to reach a stable PIM performance. The 7/16 because of the larger surface and the dimensioning of the interface needs a torque of min. 25Nm to render the electrical values stable for a reliable connection. The 4.1-9.5 needs a lower torque and the dimensioning of the interface allows more contact surface between a male and a female connector. The N connector has the size advantage and a low torque requirement if compared to the other two interfaces but consequently the PIM performances are not as good as the 4.1-9.5 or 7/16 connectors. The other problem of a low torque with these interfaces is that they may get lose under vibration or movement.

To improve these performance issues, some customers are increasing the torque of the N connector by applying additional force to the thin outer contact.

All three interfaces share the same characteristics in that the electrical parameters are strictly dependent on the torque. If the wrong torque is applied during installation then the performance in terms of PIM and Return Loss are not predictable.

The critical surfaces for good electrical performances on the 4.1-9.5 and 7/16 are exposed. With the 7/16 interface this is on the female side and with the 4.1-9.5 it is on the male side (see figure 2) thus rendering the connectors sensitive to accidental damage during their lifecycle. Abrasions and physically damaged surfaces contribute to unstable PIM performances.

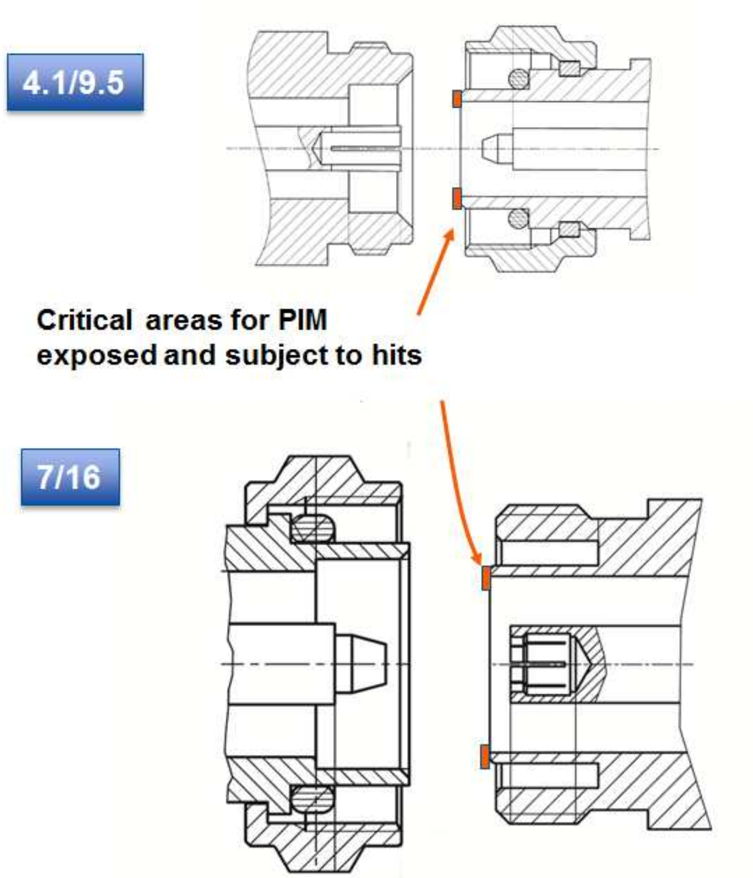


Figure 2

Evolution 4.3-10

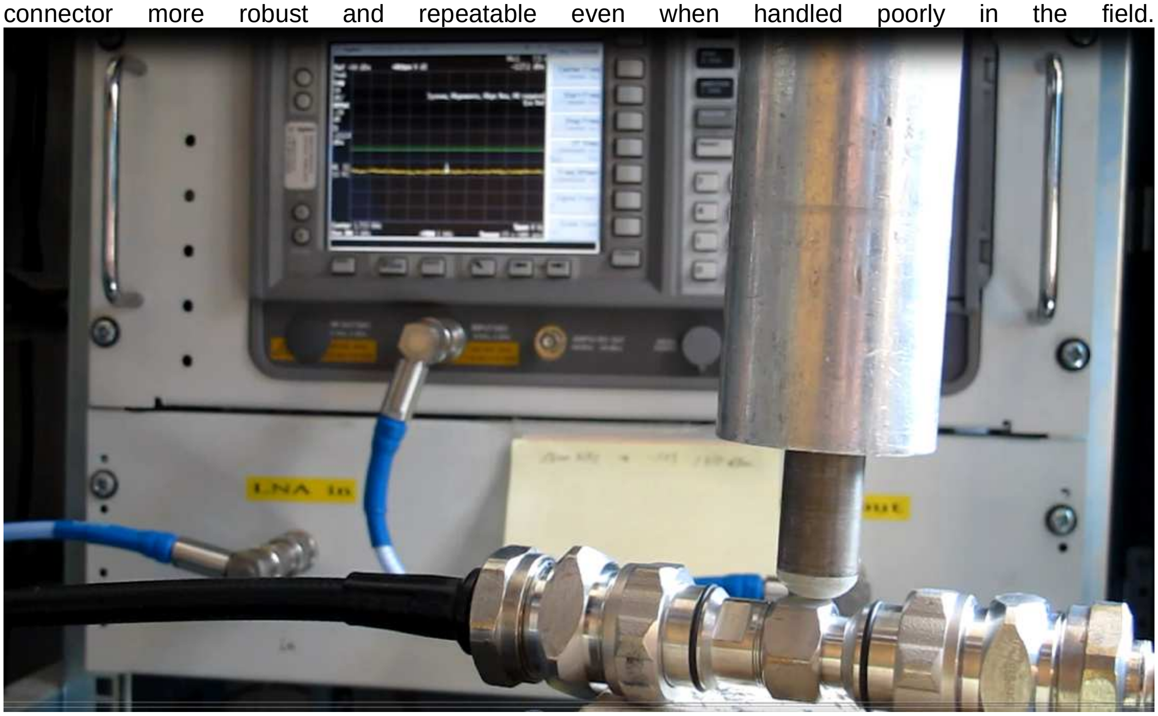
HUBER+SUHNER as a leading global supplier of RF products is an active partner of a developing group which is designated to provide innovative solutions for the telecom market. The new 4.3-10 connector system is designed to meet the rising performance needs of mobile network equipment and at the same time reducing its size to support ongoing space reduction requirements. The connector 4.3-10 satisfies the requirement for compactness with the ability to fit within a 1 inch flange (25.4 mm). It is also considerably lighter than other RF interfaces by as much as 60%. This new interface offers very low PIM performance together with weight and size advantages.

Features and Benefits of the 4.3-10

A key feature of this connector is the separation of the electrical and mechanical plane. This implies another way of contacting the outer contact. The front contact force needed for interfaces like the 7/16, N or 4.1/9.5 is no longer needed with 4.3-10. The contact is realized radially, thus allowing a lower force needed for the maximization of the contact points. This is a well-established contact method which allows for a higher degree of contact certainty. This is not comparable to the slotted contact of the 7/16 interface, where a two-fold level of uncertainty is generated. This connector interface is therefore designed to generate significantly higher PIM performances.

The decoupling of the electrical and mechanical plane gives the possibility of realizing the connection with a lower coupling torque. There is no longer the need for a high torque value to reach high electrical performances. On the contrary, this design even facilitates a hand-screw solution or a push pull design due to its innovative design. The coupling mechanism is no longer influencing PIM or return Loss performances and all of the 3 configurations (screw, hand-screw or push pull connectors) are performing in the same way. For better handling during installation the hand-screw and push pull version also allow the cable to rotate without affecting the reliable connection.

The 4.3-10 connector interface is characterized by protected contact surfaces, thus making the connector more robust and repeatable even when handled poorly in the field.



All the coupling mechanisms (screw, hand-screw and push pull) have the same PIM and return loss performances and can meet the same universal jack (female), giving absolute flexibility to the end user to install the plugs (male). For those customers which are preferring tool-less solutions, the hand-screw or push pull connectors are the perfect choice. The installation is very simple and intuitive and is especially suitable for multiple installations in very tight spaces. For applications requiring very high RF leakage performance the screw type with 5Nm torque requirement is the most appropriate answer.

The dimensions of the 4.3-10 allows the design and the coupling to fit in a 25.4mm (1 inch) flange, thus giving the possibility to design high density modules. Also the fact that the hand screw and push pull type require no torque wrench also reduces the pitch to 25.4 mm (1 inch). Since there is no longer a need for high torque settings, the panel can be made much lighter way and can have a thinner panel wall thickness. For all three types of connection typologies, the wall thickness of the modules can be reduced.

Performances characteristics comparison table

			DIN 7/16	4.3/10	DIN 4.1/9.5	N
			IEC 61169-4	**IEC 61169-54**	**IEC 60169-11**	**IEC 61169-16**
						
		Condition				
Electrical data	**Frequency range**		DC to 7.5 GHz	DC to 12 GHz	DC to 14 GHz	DC to 18 GHz
	PIM typ.	**with proper torque typical**	-162 dBc (2 x 43dBm)	-166 dBc (2 x 43 dBm)	-162 dBc (2 x 43 dBm)	-155 dBc (2 x 43 dBm)
		not properly screwed	*Unstable*	*-166 dBc (2 x 43 dBm)*	*Unstable*	*Unstable*
	RL	**with proper torque typical**		DC-3 GHz ≥ 36 dB 3-6 GHz 32dB	DC - 2GHz > 36 dB 2 - 6GHz > 26 dB	DC - 2.5GHz > 34 dB 2.5 - 5GHz > 32 dB
		not properly screwed	*not predictable*	*equal*	*not predictable*	*not predictable*
	RF leakage	**with proper torque typical**	≥ 128 dB@1 GHz	≥ 120 dB @ DC to 6 GHz (Type 1) ≥ 90 dB @ DC to 3 GHz (Type 2, 3) ≥ 70 dB @ 3 to 6 GHz (Type 2, 3)	≥ 128 dB@1 GHz	≥ 90 dB @ 2 bis 3GHz
		not properly screwed	*not predictable*	*≥ 90 dB @ DC to 3 GHz*	*not predictable*	*not predictable*
Mechanical data	**Coupling**		Screw	Type 1: Screw Type 2: Hand Screw Type 3: Push pull or Quick-lock	Screw	Screw
	Torque		25 - 30 Nm	5 Nm (type 1)	10 Nm	3 Nm
	Interface rotation		Not possible	possible with type 2, 3	Not possible	Not possible
	Flange (Pitch)	**pitch for a regular torque wrench**	32 (40) mm	25.4 (25.4) mm with type 2, 3	25.4 (32) mm	25.4 (32) mm
	Operation		≥ 500	≥ 100	≥ 500	≥ 500
	Weigth/Size		100%	60%	60%	0.4
diverses	**IP rating**		IP 68	IP 68 (25m)	IP 68	IP 68
	Disadvant.		Size. Electrical reliability dependent on torque. Electrical contact parts exposed.		Electrical reliability dependent on torque. Electrical contact parts exposed	Buckling and PIM problems

Applications

The 4.3-10 is the ideal choice for applications in new base stations as well as for solutions for distributed antenna systems (DAS), in-building architecture and in small cells applications.

In base stations the 4.3-10 can be used for interconnections both in the remote radio head as well as for the interface on the antenna and on the jumpers.

In multi-operator, multiband DAS where RF signals have to be combined, terminated, or distributed to the antenna.

In small cells applications, the 4.3-10 is particularly suited for the challenging space restrictions and electrical performances requirements.

Conclusion

With the major increase of wireless data usage, network infrastructure both in-building and outdoors must offer adequate coverage and bandwidth to handle and transport a large amount of data. Furthermore the use of data is becoming increasingly localized to areas with a high user density. Large office buildings, concentrated residential areas, public buildings like subway stations, airports, sport arenas or convention centers require infrastructure solutions that provide optimum efficiency, while at the same time resolving coverage and capacity challenges. Signals of different wireless operators with different frequencies have to be accommodated and re-distributed to provide best coverage without mutual interference. Also signal quality and reliability is becoming a differentiation feature for the operators. With today's requirements of compactness, robustness, easy installation and very reliable electrical performances, the 4.3-10 is the ultimate choice. With its reduced size, excellent electrical performance independent of the applied torque, and innovative coupling mechanisms, the 4.3-10 provides significant customer benefits and competitive advantages in communication systems.

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