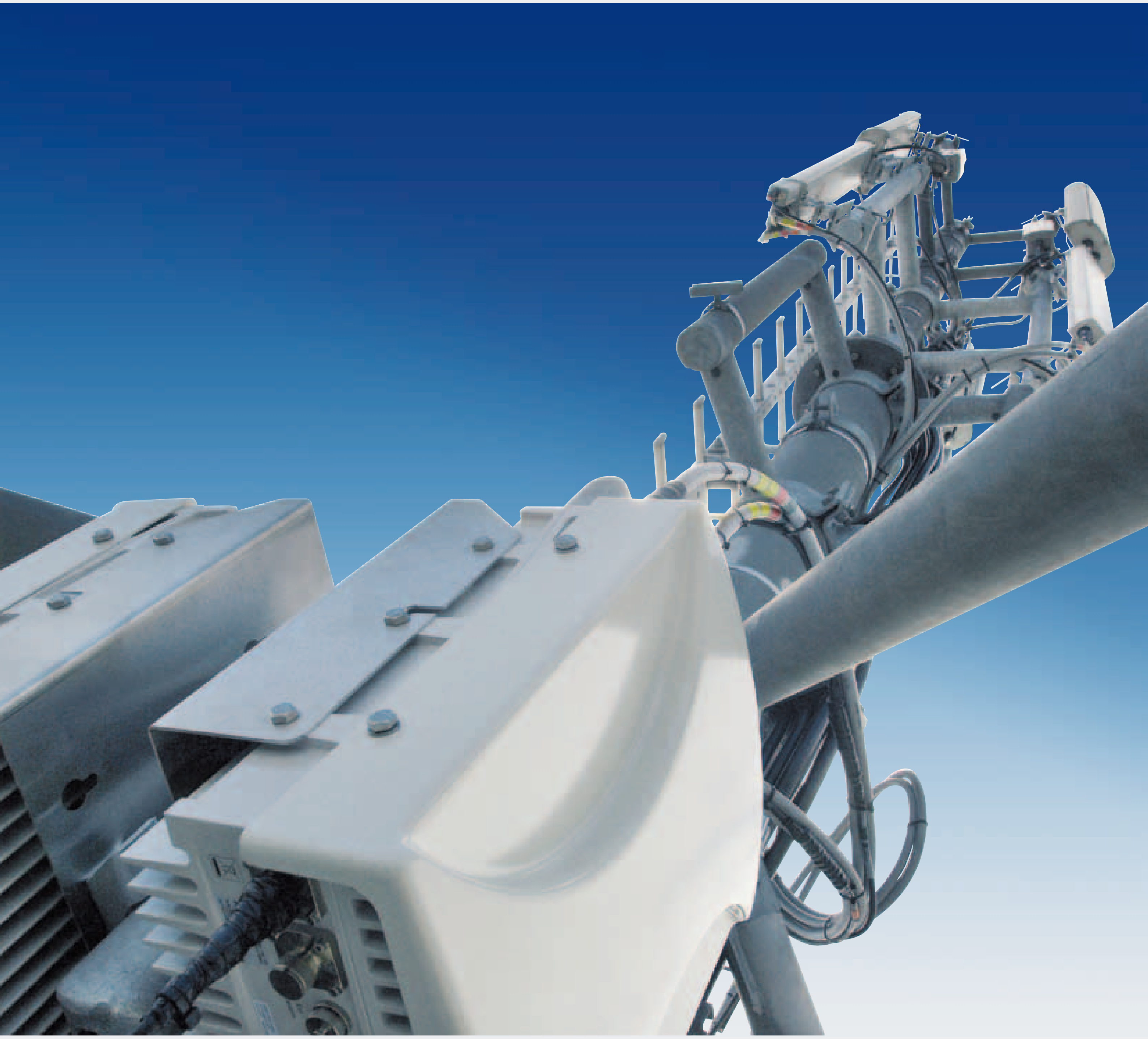
# Remote Radio Installation
## White paper

Edition 2010



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# Best Practices Guide: How to install Remote Radio Systems



The installation of remote radio systems poses new challenges for mobile operators, installers and system integrators. What installation methods are available and what are their advantages? How can a network operator install a future-proof passive infrastructure? How can installation costs and follow-up costs be saved? HUBER+SUHNER offers expert answers to these questions and offers optimum installation solutions.


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# The advantages of remote radio systems

**Mobile broadband is a reality. Data rates of up to 100 Mbps are already possible with fourth generation networks and the construction of mobile communication networks is proceeding apace. Regardless of the mobile communications standard (LTE, Wimax, UMTS, TD-SCDMA, CMDA2000, GSM), it is primarily remote radio systems which are being installed today, and the trend is upwards.**

Conventional base stations use coaxial corrugated cables to transmit the radio frequency signal from the base station to the remote mast antenna. Depending on the transmission distance and the cable cross sections, up to 50% of the transmission signal power is lost due to attenuation in the cables. Modern systems use remote radio heads (RRH) which are installed near the antenna, for example on the mast or on buildings. The radio frequency signal is generated in close proximity to the antenna and transmitted and emitted with minimal losses. The power amplifiers integrated in the RRH are passively cooled by means of convection and do not require active cooling systems such as those necessary in the case of conventional base stations. Remote radio systems reduce the network's energy consumption by 25% to 50% depending on the system configuration.

Dispensing with the high-output cooling systems and relocation of the power amplifiers to the RRH means that modern base stations have also become significantly smaller. This reduces both the system costs and the site-related leasing costs.

A further advantage of remote radio systems is the use of optical data connections, referred to as FTTA (fiber-to-the-antenna), to link the RRH to the base station. In conventional systems, the distance between the base station and antenna is limited to max. 100 m (due to the analogue signal losses). This means that expensive telecommunications rooms have to be leased near the antenna or costly containers installed on flat roofs or other outdoor areas and supplied with high-voltage current. Optical Ethernet transmits the digital data between the base station and RRH virtually loss-free and permits distances of up to 20 km. Consequently, base stations can be centrally housed in more inexpensive telecommunications rooms and network planning is rendered more flexible and modular.

The optical data link uses either existing fiber infrastructures or new installations, which are much simpler and less expensive than those using corrugated cables. Various reports also show that it takes less time to install remote radio systems with glass fibers, which is an important factor when converting cells.

# *General* aspects relating to the installation of RRHs

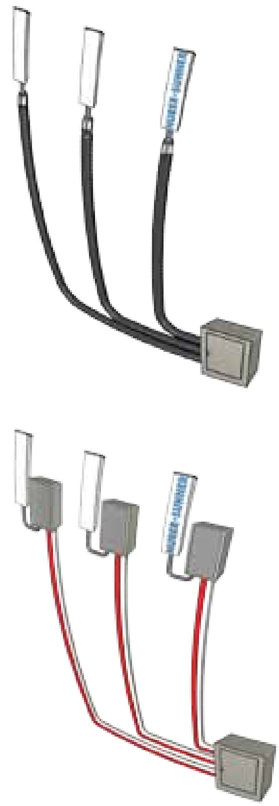


**Figure 1:** Conventional base station with corrugated cable (above) v. system with remote radio heads (below)

Conventional systems use corrugated cables to connect the antenna to the base station (see Figure 1, above). The advantage of corrugated cables lies in **field termination,** i.e. the cables can be cut to the correct length and terminated with a coaxial connector (e.g. Quickfit) during installation. This dispenses with time-consuming site surveys for measuring cable paths and simplifies cable logistics, which is a major cost factor as a result of size and weight. The connectors themselves can be assembled by trained installation personnel in the field, whereby the quality of the installation can be assured by using special assembly tools and following the instructions from the manufacturers.

Remote radio heads are typically supplied with data by means of 2-strand fiber optic cables and powered from the base station by means of shielded copper cable for reasons of lightning protection (see Figure 1, below). One major difference from the installation of corrugated cables is that the cables for RRHs **cannot be terminated in the field.** For this reason, factory-assembled cables of the correct length must be provided for every base station during installation.

## Fiber optic

System manufacturers of base stations offer factory-produced cable assemblies with lengths of increments of typically 20m in order to cover the various connection lengths. On the base station side, LC duplex connectors are used and are connected to so-called SFP modules in protected areas inside the base station. The RRHs are installed in an unprotected outdoor area and are exposed to rain, corrosion and extreme temperature fluctuations, which results in increased demands when connecting the cables to the RRHs. Two main connector types are used here: Either ODC, a robust outdoor connector from HUBER+SUHNER, or LC indoor connectors, which are protected from corrosion and mechanical influences by means of a special pre-chamber in the RRH or mechanical adapters. As a rule, fiber optic cable assemblies for RRH cannot be terminated in the field because

- the connector types (ODC) are not designed for field termination
- special dividers or seals are required on the cable assembly
- high strain relief and mechanical robustness are essential
- and theoretically possible LC field termination is not cost effective and involves a too high installation risk

Remote radio cables (left) cannot be terminated in the field.

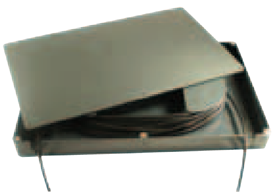
Corrugated cables (right) can be terminated in the field.

## Copper

Copper cables are generally easier to install than fiber optic cables as no minimum bending radii need to be observed, copper cables are not sensitive to lateral pressure or edges and can also be terminated in the field for certain systems. On the base station side, the copper cables are mostly stripped and fastened with screw terminals, although some system manufacturers also use factory-assembled connectors. In essence, there are three types of connection technique on the RRH side:

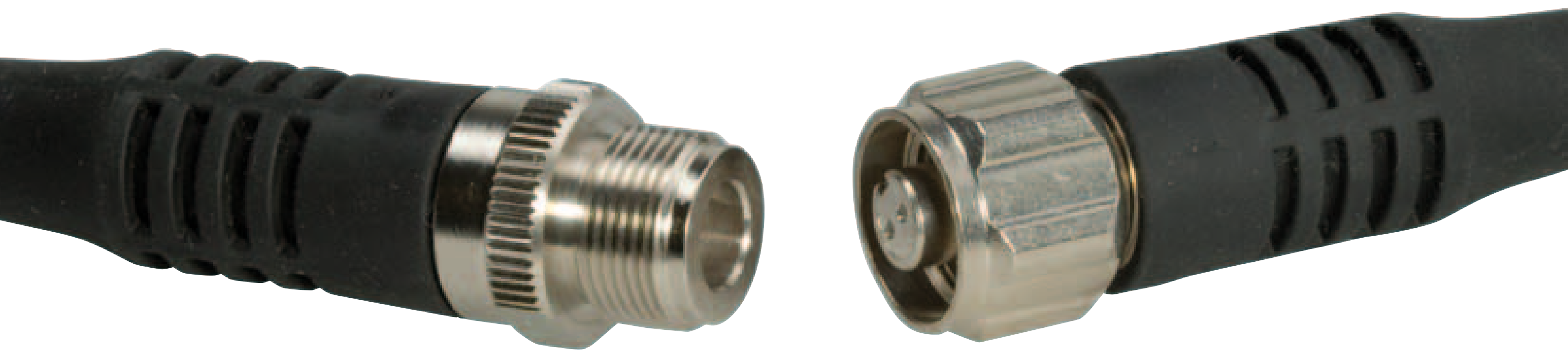
- Field-terminated connectors which connect the cable shielding directly to the grounding of the RRH.
- Connectors suitable for field termination, where grounding of the shielding usually needs to be carried out separately.
- Stripped cables that are inserted and clamped in a special pre-chamber in the RRH.

In summary, the cables required for RRH installation cannot be terminated in the field, but pre-defined, factory-produced cables are required instead. This leads to the justified question of how the unknown cable lengths can be procured and logistically handled prior to installation. The following so-called length management approaches are possible, although a combination is usually implemented:



Overlength box

- Cable assemblies with a certain overlength are generally used to avoid unsolvable situations during installation. The excess cable is stored in special boxes or in the telecommunications room. This is a widely used method.
- In advance of the network installation, the required lengths are determined by site surveys. This method is mainly used in western markets and requires time-consuming preparations, although it makes for easier logistics.
- In some countries, express logistics channels are established that enable cables of any length to be delivered in a matter of a few days. This method makes it easier for installers and system integrators to coordinate their roll-outs, but usually leads to higher costs due to the more complex logistics.
- If RRHs with ODC connectors are used, the installation teams can provide ODC extension cables that make it easy to extend cables that are found to be too short in the field.



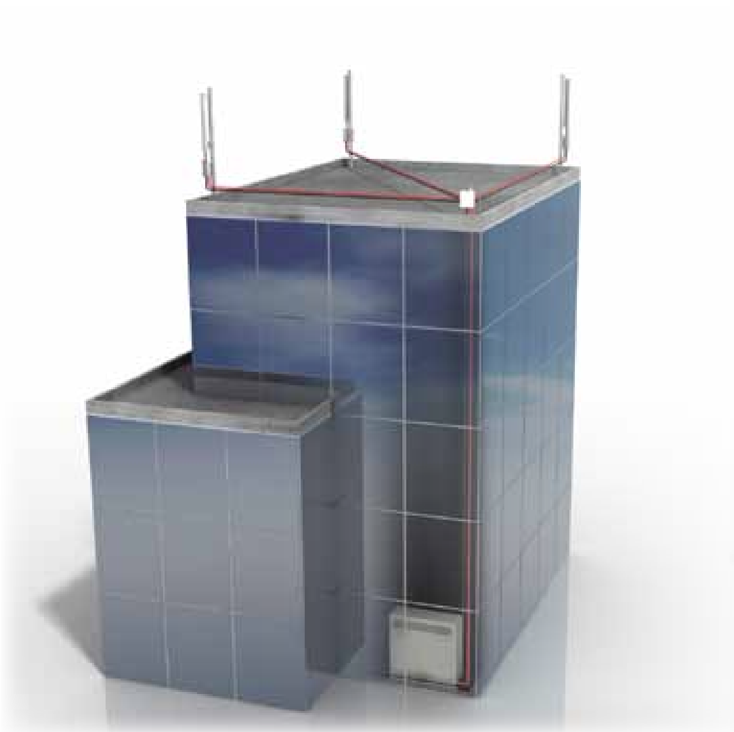
ODC extension connector

# RRH installation at different cell sites

Remote radio systems can be used for all types of cell sites. In the case of a conventional mast installation (see Figure 2, right) an RRH is installed under the antenna for each sector. The RRHs weigh between 15 and 25 kg and can be raised using a cable winch or carried up. Unlike rigid, bulky corrugated cables, the more flexible fiber optic and power cables are easier to lay, but require more mounting clamps. On average, a clamp needs to be used every 1 to 1.5 metres in the case of FO cables with an external diameter of 5.5 mm or 7 mm.

An RRH system is generally better suited to a roof-top installation with distributed antennas than a conventional system (see Figure 2, left). Owing to the length restrictions, it is usually necessary to install a conventional base station on the roof of a building in close proximity to the antennas. In addition to the special permissions and construction work often required, a crane is also needed to lift the base station into position, increasing costs and installation times. In contrast, RRHs can be carried up onto the roof by hand and installed there, while a small base station is positioned in a telecommunications room provided for the purpose inside the building. The cables that connect the RRH to the base station are space-saving, compact and in many cases, can be installed in the existing cable shafts in the building. Sometimes, an existing fiber optic infrastructure can also be used.

Some network operators are still reluctant to install active technology (RRHs) on masts due to doubts regarding the reliability and ease of maintenance of the base stations. However, these concerns have not been borne out and RRHs are mostly installed on masts. Base station failures are generally caused by faulty installation, particularly with regard to cables and connectivity components, and less by defective active technology.



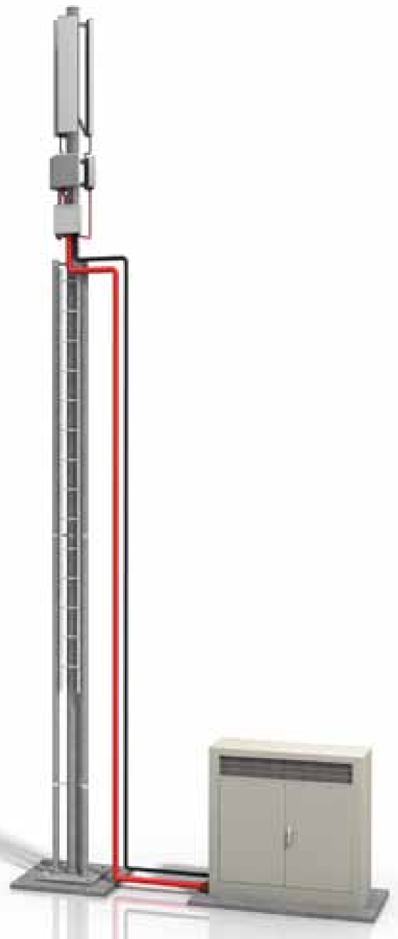
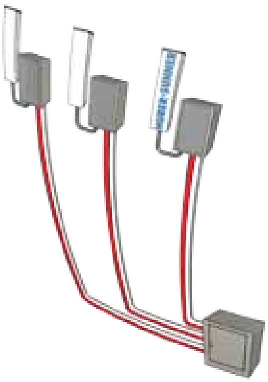


**Figure 2:** Typical mast installation with co-located antennas (right) and roof-top installation with distributed antennas (left).

# *Installation* methods for RRHs

The following sections explain the different methods for installing remote radio systems and examine the specific advantages and disadvantages in both technical and commercial terms. The installation methods outlined are all used in practice and can be combined to reflect the specific requirements of the network operator. HUBER+SUHNER is the leading provider of installation solutions for RRHs and the information is based on empirical data gathered in close cooperation with system manufacturers, network operators, installers and system integrators.

## 1. Standard solution with discrete cables



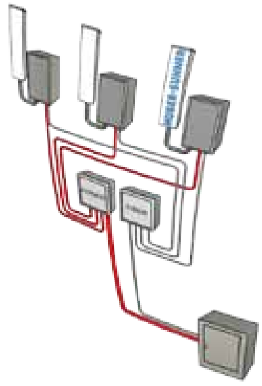
In this standard solution, every RRH is connected via a pre-assembled FO cable and a power cable. The main advantage of this solution is that every type of cell site (co-located and distributed antennas, mast, building, roof, etc) is supported and there are no restrictions in this regard. Accordingly, this installation method is preferred by OEMs in the context of turnkey projects or by network operators who are not yet familiar with the installation of RRHs.

A total of six cables are installed in a typical three-sector base station and are secured with cable clamps at intervals of between 1 and 1.5 metres. Experience during installation shows that the laying of cables is by far the most time-consuming part (more than 50% of the time). This makes this method more expensive and inefficient than those described later, particularly over long distances (>50 m). As a result of the high hourly wage rates, network operators in western countries place greater value on installation efficiency, while installation time plays a less significant role in less developed markets.

It should also be noted that each system manufacturer uses special installation cables that are only suitable for their own system. In real terms, this means that the connectivity components on the RRH are not compatible between different manufacturers and systems. When a system or vendor changes, the cable installation must be renewed or adapted using costly methods. This can even be the case when different product families from the same system vendor are used. Generally, active technology (RRH, base station) has to be upgraded or replaced every few years, while the passive cable installation has a life span of 20 years or more. In summary, it could be said that this installation method is the "simplest", but it offers no flexibility with regard to RRH replacement. From the perspective of the network operator, the future sustainability of the passive cable installation cannot be guaranteed when LTE is subsequently installed, which will typically lead to high replacement and conversion costs.

| Advantages | Disadvantages |
|---|---|
| • Suitable for all types of cell sites<br>• The simplest and preferred method for system vendors | • Six cables need to be installed for three sectors<br>• Time-consuming and complex cable installation, particularly at distances exceeding 50 m<br>• No flexibility with regard to RRH replacement, passive cable installation is not future-proof. |

## 2. Multi-riser cable with distribution box



This solution uses multi-riser cables for fiber optics and copper that are routed in separate connection boxes (or in a combined hybrid box) which are then linked to the RRHs with short jumper cables. A six-strand fiber optic riser cable with a diameter of 8.5 mm is used for a three-sector base station and is pre-assembled with six LC connectors at each end (e.g. Masterline Classic). In the box, the LC connectors are connected to the jumper cables by means of pre-mounted adapters; the other ends being terminated with RRH-specific FO connectors. The entire system can either be installed at the installation site or can be supplied as a "plug-and-play" solution with pre-assembled box.

A six-conductor shielded copper cable with a copper diameter of 6 $mm^2$ or 10 $mm^2$ is used for the power supply, depending on the distance to be covered and the power requirements of the RRH. Alternatively, a two-conductor cable (e.g. 16 $mm^2$) could be used. However, the disadvantage here is that this cable cannot be connected directly to the power supply units of most base stations and that the entire base station would fail if a short-circuit occurred in a RRH. In the box, the grounding is connected directly to the cable shielding, so that there is no need to ground the individual jumper cables. The three jumper cables are terminated at one end with the relevant RRH connectors, while the open end is clamped inside the box and connected with the multi-riser cable.

FTTA (Fiber-to-the-Antenna) box with installed Masterline cable and FO jumpers.

This is the perfect solution for mast installations. However, for sites with distributed antennas or sites with short distance (<20m) between base station and RRHs, a standard installation with individual cables can be the better solution. Irrespective of these restrictions, this installation solution is preferred by many network operators because it offers a number of key benefits.

- Flexibility: Only the short jumper cables need to be renewed when upgrading or replacing the RRH. Most of the installed passive infrastructure remains unaffected. This means that the installation is independent of the system and system vendor and offers maximum flexibility in terms of changes within the network.
- Scalability: Additional RRHs must be installed when setting up new systems or frequency bands. During initial installation, 12 or 24 fiber optic cables can be laid instead of six, so that the necessary cables are already in place if an LTE system is being set up in parallel at a later date. In order to achieve the same level of flexibility for the power supply, larger diameters can be selected for the initial installation. No expensive new cable installations are required – all that is needed is a number of additional jumpers. This means that the installation is scalable. Some mobile network operators lease their additional "cable capacity" to their competitors, thereby recouping their own investment faster.
- Future sustainability: A 12 or 24 fiber installation has a more secure future for network operators because planned network expansions are supported, possible system changes do not result in changes to the passive infrastructure and a vendor-independent infrastructure is in place. These benefits reduce general network costs and save additional investments.
- Reduced investment costs: This solution is more cost-effective over long distances (>50 m), because only two cables are laid instead of six. The savings on the cable outweigh the additional costs for the boxes and jumpers. Another cost factor that is often forgotten in advance are the clamps for mounting the cables. Multi-riser cables require fewer and simpler clamps than individual cables.

- Reduced installation costs: The length of time required for installation is a major cost factor. The system can be delivered as a pre-installed "plug-and-play" solution and can be connected directly with the active technology. In addition, the multi-riser cables are more rigid than individual cables due to their greater diameter, so that the mounting clamps can be installed at intervals of between 1.5 and 2 metres. Empirical data indicates that the cable installation times can be reduced by between a third and a half (see Figure 3).

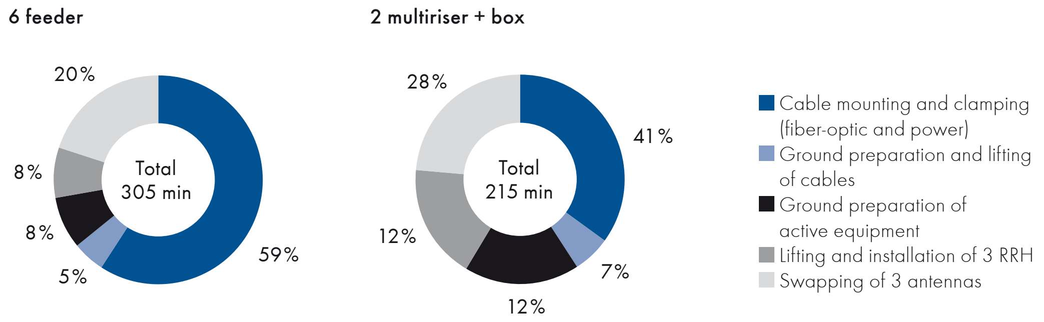


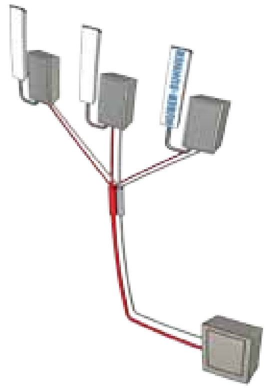

**Figure 3:** Comparison of a 50 m mast installation: Left: 6 individual cables with a total installation time of 305 min; right: System with multi-riser cable and box (215 min).

- Flexible lengths: The multi-riser copper cable is connected at both ends (base station and box) and can therefore be cut and terminated in the field. The fiber optic cable is pre-terminated on both sides, however, because of its more compact diameter, it can easily be stored in excess length boxes. This system offers better flexibility of length than an installation using individual cables.

This installation method offers many benefits for network operators and is the preferred method if the operator has the requisite technical expertise and responsibility for the setup. This method is also increasingly used in OEM turnkey projects because customer requirements can be met more effectively, despite the fact that the logistical effort on the part of the system vendor is greater.

| Advantages | Disadvantages |
|---|---|
| • Just two multi-riser cables instead of six individual cables<br>• Flexible in relation to RRH replacement or upgrades<br>• Scalable and perfect for planned LTE roll-outs and expansions<br>• Future-proof because the passive cable infrastructure supports all aspects of network evolution<br>• Lower level of investment (CAPEX)<br>• Reduced installation times, plug-and-play installation possible<br>• Good flexibility of length<br>• Preferred method of network operators | • Limited suitability for cell sites with distributed antennas |

## 3. Multi-riser cable with compact divider



This installation method is similar to the previous one, but uses robust cable dividers instead of distribution boxes. The multi-riser cable is divided into three short individual cables, which serve as supply lines for the RRHs. HUBER+SUHNER offers systems of this type for fiber optics and copper under the name Masterline Extreme.

The obvious benefit is the compactness, leading to a space-saving, lightweight solution with minimal wind load. The cable assembly is pre-assembled on both sides with system-specific connectors, can be installed directly, requires fewer securing clips and is a genuine plug-and-play system. Moreover, the costs for the box no longer apply and the 6-strand cables are less expensive than three individual cables. This is the most cost-effective method and is therefore the preferred option for cost-conscious network operators.

Nonetheless, some restrictions do exist, but most of these can be eliminated with additional measures. When RRH-specific connectors are used to terminate the cables, the entire cable assembly must be renewed in case of RRH replacement. Flexible connectivity is thus lost. If the Masterline Extreme is terminated with ODC connectors, however, full flexibility is regained. RRH with ODC connectors (e.g. Ericsson RRU22) can be connected directly, while other RRHs can also be connected with short jumper cables (ODC extension to RRH connector).

Masterline Extreme Power

The system also entails some restrictions in relation to scalability. In the case of a box solution, 24-conductor (=12 RRH) FO cables can be laid, while the Masterline Extreme is limited to nine RRHs. Unused breakout cables with ODC are pre-installed on the mast, whereby it is important that the ODC protective cap is installed correctly. If the system needs to be expanded at a later date, the dust-proof caps are unscrewed and ODC extension jumpers are installed.

| Advantages | Disadvantages |
|---|---|
| • The most cost-effective installation method (CAPEX)<br>• Minimal installation times, genuine plug-and-play system<br>• Flexible in relation to RRH replacement with ODC jumpers<br>• Scalable up to nine RRHs<br>• Future-proof because the passive cable infrastructure supports network evolution<br>• Space saving and low wind load | • Limited suitability for cell sites with distributed antennas<br>• Limited flexibility and scalability in comparison with the box solution |

Masterline Extreme assembly with four ODC connectors.

## 4. Hybrid cable

It should be noted by way of introduction that hybrid cables are the most complex and cost-intensive installation method and can in some cases even be regarded as an obstacle to installation. Nonetheless, there are certain niche applications where hybrid cables do make sense. Hybrid cables combine glass fibers and copper wires in a single cable and are used to supply RRHs directly. Figure 4 contains a flowchart with the possible application options to illustrate the use and restrictions associated with hybrid cables.

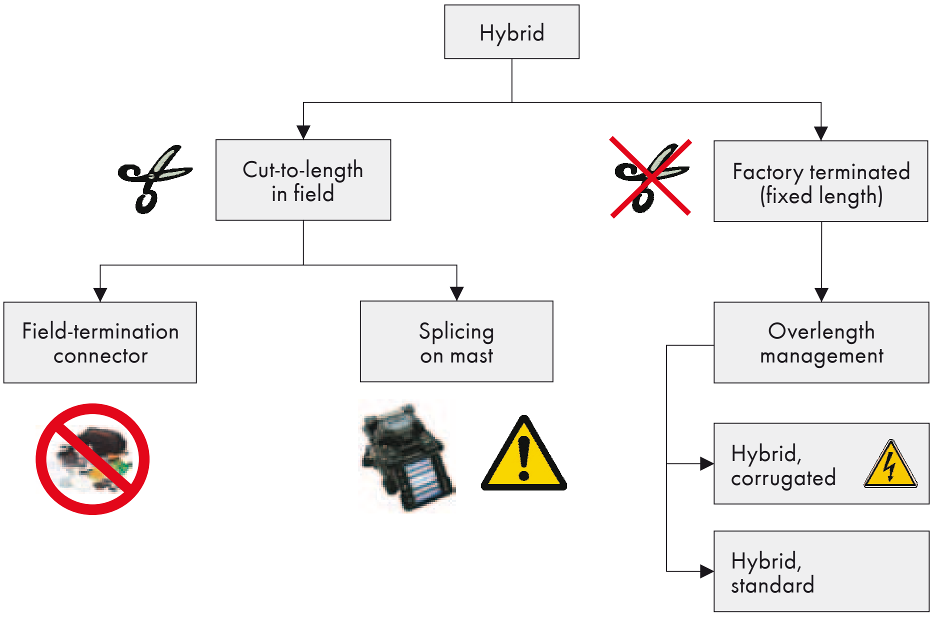
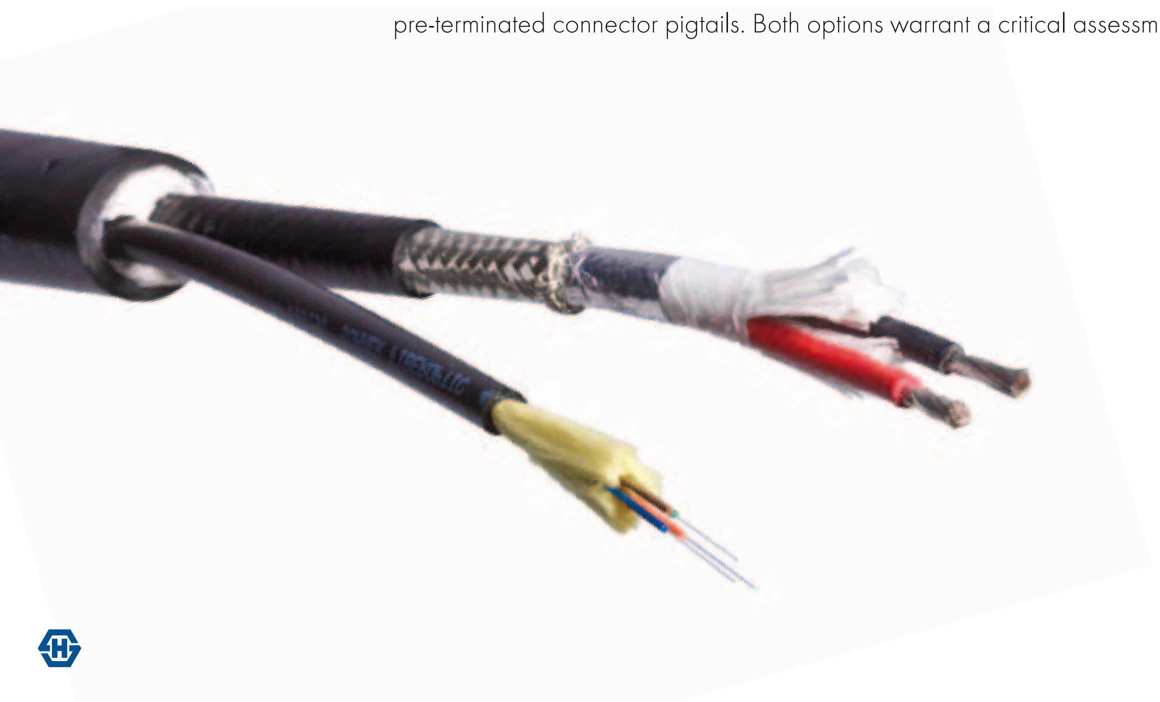



**Figure 4:** Flowchart with options for using hybrid cables.

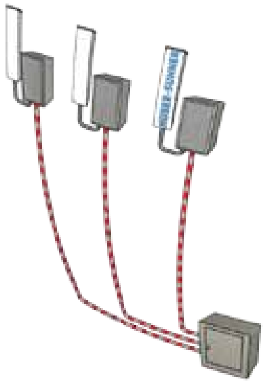
One option (left branch, Figure 4) is to cut the hybrid cables to length in the field, as is common practice when installing corrugated cables. Cutting cables to length requires either that the connectors can be terminated in the field or that the cables are spliced with pre-terminated connector pigtails. Both options warrant a critical assessment:



- Field termination: The reason why RRH cables cannot be terminated in the field has already been explained in detail above. The same applies to hybrid cables. While copper cables can be terminated in the field (terminals, special connectors), this is not possible with RRH fiber optic connectors. It is only possible to use LC connectors that can be terminated in the field in combination with a box solution and pre-assembled jumper cables. However, field termination has the following consequences: (i) The costs of field termination are many times higher than factory termination and the installation times are significantly increased. (ii) Only specialist fiber-optic installers are capable of performing a field termination because the stripping, cleaving, cleaning and handling of bare glass fiber (diameter 125 μm) is hard to master. The installation teams established in the past must be replaced or retrained. (iii) Each installation team requires an expensive field termination kit and the necessary consumables. (iv) The network quality largely depends on an individual installation process that cannot be mastered in difficult external conditions. For this reason, not one of the system manufacturers recommends field termination and quality-conscious network operators categorically reject this installation method. Field termination is not an option.
- Splicing: The splicing of glass fibers in a controlled environment is a reliable process. The splicing process is used in telecommunications rooms and in the controlled environment of the base station. On the other hand, splicing on the mast is very critical because it is practically impossible in difficult, windy conditions. In addition, a splice represents a mechanical weak-point in the fiber, which is prone to breakage when exposed to extreme variations in temperature and permanent vibration on the mast. Accordingly, splicing on the mast is associated with high risks in terms of quality. Furthermore, all the arguments that apply to termination in the field also apply to splicing. This process is considerably more expensive and time-consuming, requires special equipment, can only be carried out by experienced personnel and is not an industrialised process that offers the required reliability in high volumes. HUBER+SUHNER is not aware of any network operators who splice on the mast. On the other hand, the list of network operators who do specifically ban splicing on the mast is lengthy.

In view of these disadvantages, the field termination of hybrid cables is not an option. Nonetheless, this method is regularly proposed by companies whose expertise is mainly limited to copper technology and who take the field termination of corrugated cables as their model. These companies often lack the necessary expertise in fiber technology and do not have a clear understanding of customer-optimised, cost-effective and reliable RRH installations.

The second option (right branch, Figure 4) are factory-terminated hybrid cables supplied in pre-defined lengths. These solutions are technically reliable but not very cost-effective. The additional challenge is overlength management. Standard hybrid cables feature electric shielding made from woven metal, making the cables flexible and space-saving. Hybrid cables are also available with the same structure and dimensions as corrugated cables. The advantage of these cables is that they can be grounded with standard components. However, they are comparatively rigid and it is difficult to stow excess lengths.



## Single hybrid cables

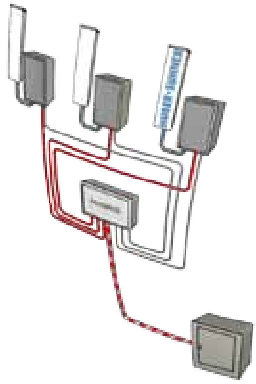
Single hybrid cables are only used to supply RRHs in special applications. One useful scenario is a flat roof installation (see Figure 2, left) in which hybrid cables are laid from the distribution box to the RRHs. The advantage of hybrid cables in this situation is that they are thicker and more robust than separate fiber optic and copper cables. Moreover, with this type of installation, the precise cable paths on the roof are known and there is no need for overlength management. The distribution box is connected to the base station by means of two separate multi-riser cables. HUBER+SUHNER offers a range of pre-assembled hybrid cables produced to customised lengths for this scenario.

In principle, there are numerous different types of hybrid cable, each of which has its advantages and disadvantages. They either have a simple cable structure with individual copper wires and glass fibers, requiring expensive shielding and complicated cable dividers, or they have two external cables bundled in an additional sheath, making the shielding, divider and the connector termination much easier. The fact is that any hybrid cable is much more expensive than the combination of individual fiber-optic and copper cables. As a rule, this cost disadvantage outweighs the advantages associated with laying a single cable instead of two.

Despite all the drawbacks, a trial was also carried out involving the termination of hybrid cables in the field. Figure 5 shows how the divider is produced in the field. After the external sheath has been removed, the dividing point is filled with epoxy resin and then taped up to prevent water ingress. This is a time-consuming process but is feasible in principle. The real problems arise when the fiber optic cable needs to be terminated with the relevant RRH connector. The termination of RRH connectors in the field is not control-lable and leads to numerous technical risks.


**Figure 5:** Field termination of hybrid cables.

## Multi-riser hybrid cables

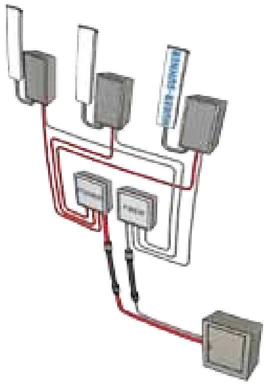


This method may seem attractive to many network operators and system integrators at first glance. However, this solution holds far more disadvantages than separate multi-riser cables. In the first place, the cost per metre for hybrid cable is much greater than for two separate cables. Depending on the type of hybrid cable, the cost can be up to three times higher, making such a solution unviable, particularly in the case of longer lengths (> 50 m). Secondly, the management of excess cable is highly critical due to the large cable diameter. It can be very difficult to stow an excess of 15 metres of cable with a diameter of 25 mm on the mast or in a base station. When separate cables are used, the bulky copper cable can be cut in the field and terminated in the box, while it is comparatively easy to roll up an excess of 15 metres of flexible fiber optic cable with a diameter of 8.5 mm. Thirdly, a combined hybrid box must always be used for a hybrid cable, which is not the optimum solution in many cases due to space constraints. Small offset boxes are easier to install.

| Advantages | Disadvantages |
| --- | --- |
| • None | • By far the most complex and expensive installation method<br>• Overlength management impossible for pre-assembled systems<br>• Field termination of the hybrid cables is very complex and entails high levels of risk in terms of installation and reliability.<br>• Requires bulky, expensive special cables |

Installations with hybrid cables are niche applications. Hybrid cables make little technical or commercial sense in large network structures. This viewpoint is also backed up by discussions with the product managers responsible for Site Solutions at a number of leading system manufacturers:

> "We have failed to find a business case for hybrid solutions."



## 5. Re-use of corrugated copper cable

One final installation method is closely associated with the already familiar multi-riser solution and is used when converting a conventional mobile communication system (using corrugated cable) to an RRH system. The installed corrugated cables are decommissioned, cut at both ends and re-used as a supply line for the RRH.

A thin, multi-strand fiber optic cable with a diameter of 3.5 mm is drawn into the inner conductor of the corrugated cable from "above" (RRH side). The cable is pre-terminated with connectors on one side and is inserted into the box, while the cable is spliced on the base station side.

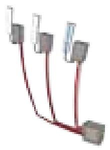
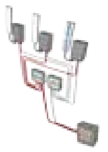
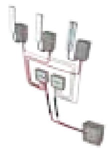
The inner and outer conductors of a second corrugated cable are used for the power supply. A special power adapter is fitted at both ends of the corrugated cable, guaranteeing secure and reliable contacts. Short jumper cables are laid on both sides, leading to the base station or to the box on the mast.

This installation method does not involve expensive work on the "cable path" because the power supply cables and the "empty ducts" for the fiber optic cables are already installed. Consequently, no structural work is required for wall and roof ducts, cable conduits do not need to be opened and no new cables need to be laid. Cable installation is usually the most time-consuming and cost-intensive factor. This method enables a complete base station to be converted within an hour. The cost savings are estimated by network operators at EUR 1,000 per base station.

**Figure 6:** Inserting and sealing the FO cable in the internal conductor of the corrugated cable (left). Power adapter for contact between the internal and external conductor (right).

## Summary and comparison of the installation solutions

The table summarizes the characteristics of the various installation methods. Method 1 is the standard solution used by system vendors and is suited for all types of cell sites. It is mainly used in turnkey projects. Methods 2 and 3 offer considerable added value and are the preferred solutions of network operators who are responsible for planning passive infrastructure. These solutions are rapidly becoming more common in the market and are increasingly being included in the product portfolio of system vendors. Hybrid solutions 4 are suitable for niche applications, but have many disadvantages. For this reason, this solution has failed to establish itself in the market and is rarely used. Method #5 is suitable for converting conventional systems to RRH systems.

| | 1. Individual cables | 2. Multi-riser cables + Box | 3. Multi-riser cables + Divider | 4. Hybrid cables | 5. Con-versions |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| Suitable cell sites | Co-located + distributed antennas | Only co-located antennas | Only co-located antennas | Only distributed antennas | Only co-located antennas |
| Flexibility during RRH replacement | No | Yes | Yes | No | Yes |
| Scalable for 6 to 12 RRHs | No | Yes | Up to 9 RRHs | No | Up to 6 RRHs |
| Future-proof | No | Yes | Yes | No | Yes |
| Overlength management | Limited | Yes | Limited | No | Yes |
| Installation time | Medium | Efficient | Plug&Play | Inefficient | Efficient |
| Cost efficiency / Overall costs | € – €€ | € | € | €€€ | € |
| Spread / Frequen-cy in practice | Leading solution | Rapid growth | Rapid growth | Rarely used | In conversions |

# Additional questions about fiber optics

Many network operators, installers and system integrators have little if any experience with the installation of fiber optic technology, while they are familiar with installing power supply systems and coaxial cables. A number of frequently asked questions are answered below.

## Singlemode or multimode?

In terms of future sustainability, singlemode is the clear choice because there are no restrictions in terms of data rate or transmission distance. The transmission rate between RRH and base station is currently 1 Gb/s and will rise to over 3 Gb/s for CPRI 4. Multimode fibers have a limited modal bandwidth, i.e. the higher the data rate, the less transmission distance is available. The OM2 multimode fibers used as standard have a modal bandwidth of 500 MHz*km, i.e. the 1 Gb/s signal can be transmitted a maximum of 0.5 km. If the data rates rise to above 3 Gb/s, coverage decreases to 150 m, which is a typical distance for modern installations. Multimode OM2 fibers are limited and no longer meet the requirements of future system generations. Singlemode is the right choice. In addition, singlemode fibers are more economical than multimode fibers, however singlemode connectors are more expensive to terminate than multimode connectors. Overall, there is no real difference in cost.

The use of singlemode and multimode is evenly balanced in the market. While Ericsson and Alcatel-Lucent mainly use singlemode, the standard at Huawei and NSN is mainly multimode. These systems can also be supplied as a singlemode version. As data rates increase it can be assumed that all system manufacturers will move to singlemode.

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## Installation problems with LC connectors?

Some RRHs use so-called pre-chambers for the installation of LC connectors. During installation, the cover of this chamber must be removed on the mast, the LC must be inserted and connected to the electronics; a strain relief must be fitted and the cover must be closed again and sealed. This installation method leads to a high rate of installation defects in all regions and for all systems, including broken fibers, damage to the LC connector, poorly sealed remote radios and damage to the SFP module. Quality-conscious network operators have developed their own method for minimizing these problems. Instead of an error-prone installation on the mast under difficult weather conditions, the RRH is pre-assembled in the warehouse with a short ODC/LC jumper cable. The remote radio is then supplied with a secure ODC pigtail and is mounted on the mast. This method is mainly used in Canada and Europe and can be applied to all RRHs with pre-chambers.

«HUBER+SUHNER is the world's leading provider of installation solutions for remote radio systems.»

# Your partner for connectivity solutions

HUBER+SUHNER is a leading global supplier of components and connectivity solutions for mobile networks. HUBER+SUHNER offers technical expertise in Radio Frequency, Fiber Optics and Low Frequency solutions under a single roof, providing a broad range of products that can be relied on in the Wireless Infrastructure Market.

## Radio Frequency

As a market leader for RF solutions HUBER+SUHNER offers a broad portfolio of components and systems for the wireless market. Our connectors, cables, assemblies, surge protectors and antennas cover all requirements that are requested for indoor and outdoor applications. You can also expect innovations created by HUBER+SUHNER in the field of test & measurement. Our test leads, low PIM adaptors, intermodulation loads, IM Standards and Quick Mate Adapters comply with the highest requirements that guarantee high quality connections.

## Fiber optics

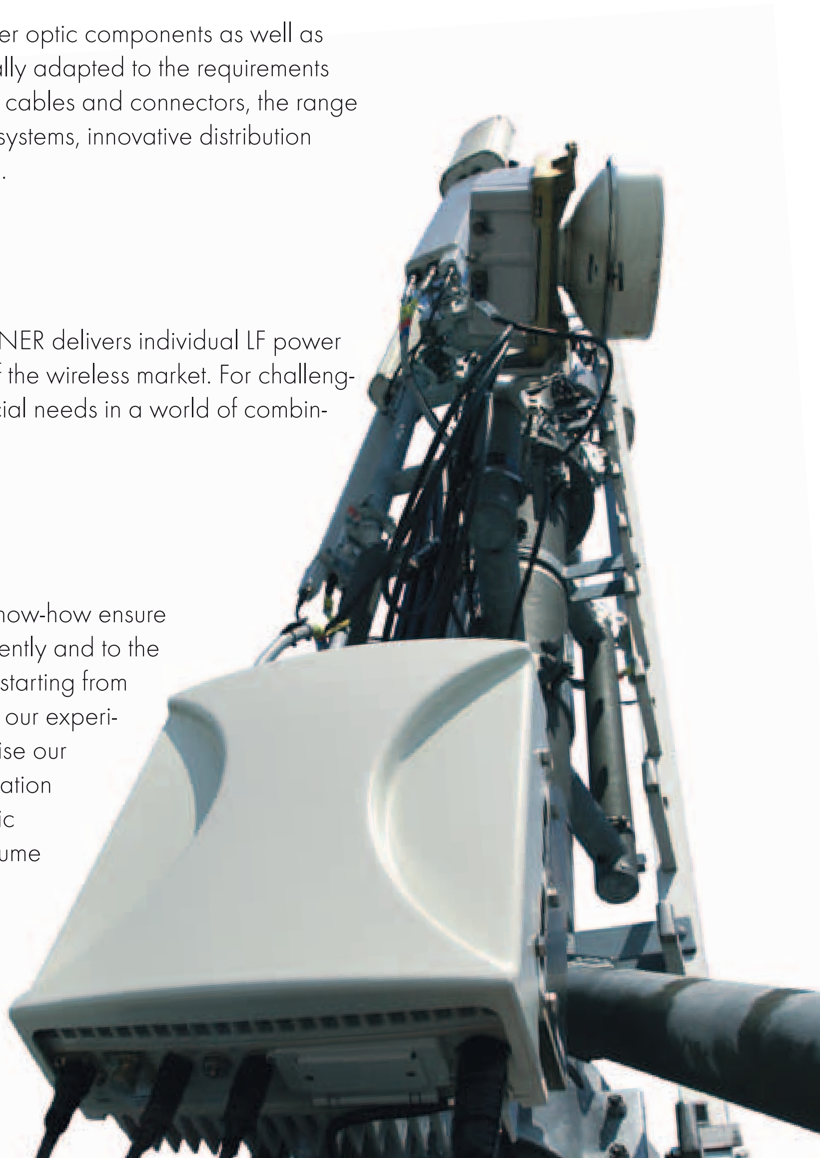
HUBER+SUHNER also offers an extensive range of fiber optic components as well as transmission and distribution technology systems specially adapted to the requirements of remote radio head systems. In addition to fiber optic cables and connectors, the range includes customer-specific assemblies, turnkey cabling systems, innovative distribution solutions and customised FO feederline cable solutions.

## Low Frequency

Based on the low frequency technology HUBER+SUHNER delivers individual LF power feederline cable solutions that meet the requirements of the wireless market. For challenging systems we offer customised solutions meeting special needs in a world of combining technologies.

## Services by HUBER+SUHNER

Our many years of experience and highly diversified know-how ensure that our customer's requirements are implemented efficiently and to the highest standard. We provide comprehensive services starting from the design stage to the completed system solution, and our experience gained in major global projects enable us to advise our customers on the right product choice, method of installation and network design. We also ensure to meet the logistic expectations of our customers, independent of high volume bulk shipments or fast and flexible on-site services with short lead-time requirements.



HUBER+SUHNER is certified according to ISO 9001, ISO 14001, ISO/TS 16949 and IRIS.

**WAIVER**
It is exclusively in written agreements that we provide our customers with warrants and representations as to the technical specifications and/or the fitness for any particular purpose. The facts and figures contained herein are carefully compiled to the best of our knowledge, but they are intended for general informational purposes only.

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