

Remote Radio Installation

White paper

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Best practice guide: How to install remote radio systems





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The installation of remote radio systems poses new challenges for mobile radio 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 provides professional answers to these questions and offers ideal installation solutions.

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The advantages of remote radio systems

Mobile broadband is now a reality. Data rates of up to 100 Mbps are already possible with fourth generation networks and the deployment of mobile communication networks is advancing rapidly due to the explosion in mobile data volumes. Remote radio systems have established themselves as a standard solution on the wireless infrastructure market and have taken the place of conventional base stations with corrugated coaxial cables.

Remote radio systems reduce the energy consumed by the network by up to 30%, depending on the system configuration, and improve network quality and network coverage respectively as signal losses have been eliminated in the corrugated cables.

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 remote radio head (RRH) to the base station. In conventional systems, the distance between the base station and antenna is limited to approx. 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 (e.g. base station hotels) and network planning is rendered more flexible and modular.

General aspects of RRH installation

Conventional systems use corrugated coaxial cables to connect the antenna to the base station. The advantage of corrugated coaxial cables lies in their capacity to be assembled for use in the field, i.e. the cables are cut to the correct length during the installation process and are terminated with a coaxial connector. This saves the need for time-consuming site visits to measure out cable routings and simplifies the task of cable logistics which, given their size and weight, constitute a significant cost factor. 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 supplied with data from the base station by means of fiber optic cables and with power by means of shielded copper cables. A major difference to the installation of corrugated coax cables lies in the fact that cables for RRHs cannot be terminated in the field. This means that factory-terminated cables cut to the correct length need to be provided for installation at each base station – efficient logistics channels and local production facilities are an essential requirement in many cases.



Fiber optic

System manufacturers of base stations offer factory-terminated cable assemblies with lengths of increments of typically 10 m in order to cover the various connection lengths. LC duplex connectors are used almost exclusively on the base station side and are connected to so-called SFP modules (electro-optical transceivers) 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 with regard to connectivity. Here, primarily three different connection techniques are employed:

- Robust, watertight and corrosion-protected external connectors that deliver a high degree of installation safety and comfort (e.g. ODC, Q-ODC, Q-XCO)
- Multi-stage sealing systems that connect fiber optic cables to remote radios in a similar manner to a connector (e.g. FullAXS, PDLC, R2CT, XCO). When connecting and disconnecting a cable, multi-stage installation sequences must be employed. From an installation point of view, these sealing systems are more prone to failure because indoor fiber optic connectors are handled in unprotected areas on the mast and incorrect installation sequence can lead to damage.
- Cable entry with a sealable «pre-chamber». With this connection technology, a pre-chamber in the RRH is opened during installation and the cable assemblies (with LC connectors) are inserted through special seals with integrated tensile load supports. This installation method is the one most prone to failure.


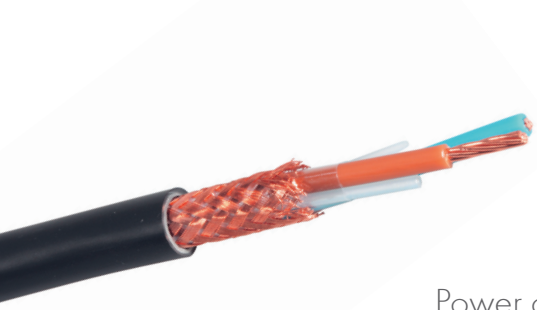
ODC	Q-XCO	FullAXS	PDLC	LC with Boot
				
Ericsson (RBS 3000) Alcatel-Lucent Samsung	Alcatel-Lucent	Ericsson (RBS 6000)	ZTE	Nokia-Siemens Networks

Table 1: Overview of the FTTH connection methods employed by system manufacturers

Generally, fiber optic connections on remote radios are not compatible and interchangeable. Every system manufacturer uses their own connection method and there can be not even compatibility between different generations of product from a single manufacturer. As well as RRH connection method, different cable diameters (from 4.8 mm to 7 mm) are used, and this can mean that different cable clamps are needed. Not least, various different types of optical fiber are used; however, over the last years, a clear trend towards standard singlemode fibers has emerged.



Power cable

Copper cables are usually easier to install than fiber optic cables because there is no need to keep to minimum bend radii. Copper cables do not react as sensitively to lateral pressures or sharp edges and can also be terminated in the field for certain RRH models. On the base station side, the copper cables are mostly stripped and clamped in screw terminals, although some system manufacturers also use factory-assembled connectors. In principle, there are three types of connection methods on the RRH side:

- Factory-terminated connectors which connect the cable shielding directly to the ground connection of the RRH.
- Connectors suitable for field termination, where grounding of the shielding needs to be carried out separately in some cases.
- Stripped cables that are inserted and clamped in special pre-chambers in the RRH.

Conclusion

Remote radios are not compatible with one another in terms of the cable connections. During modernization of a network, the replacement of RRHs frequently necessitates the re-installation of cable infrastructure. This gives rise to high installation and maintenance costs that can be minimized by means of carefully thought-out installation solutions.



Top: Six corrugated coax cables for 3 sectors

Middle: Hybrid cable for 3 RRHs

Bottom: Discrete FTTH and PTTA cables for 3 RRHs

Trends in the installation of remote radios

Remote radio systems can be used and installed for all types of radio sites. Traditionally, every RRH is connected separately using a pre-connectorized fiber optic cable and a power supply cable. The main benefit of this solution is that every type of radio site (mast, building, rooftop, etc.) is supported and this enables system manufacturers to give preference to this solution in turnkey projects. At the same time there are various installation trends that make this kind of installation (i.e. every RRH receives power from two separate cables) increasingly inefficient and less attractive to network operators.

- **More RRHs per site:**

Six to nine remote radios per radio site are now commonplace, while installations with only 3 RRHs have now become the exception rather than the rule. Today, networks are set up with up to 5 RRHs per sector, which means having 15 and more remote radios on each mast.

- **More technologies/more frequencies:**

2G, 3G and 4G networks are now being operated, modernized and extended parallel to one another. At the same time, more and more frequency bands (700, 900, 1800, 2100, 2600 MHz) are being licensed and used in the mobile radio/wireless network. This is giving rise to a growing number of remote radio heads at each site.

- **Network / site sharing:**

The exploding demand for data is compelling mobile radio operators to invest on a massive scale in LTE at a time when the costs of setting up the 3G network have yet to be amortized. Increasingly, mobile radio operators are running 'network sharing' schemes or are sharing the costs for joint set-up and use of a 4G network. In tandem with this data explosion, there is also a growing demand for more – and new – radio sites, something which is encountering increasing resistance in the broad population and the authorities. In response to this, an increasing number of legislators are calling for shared usage of radio sites among network operators to reduce the number of new sites through a policy of site sharing.

- **Doubling of sectors per site:**

In urban areas with a high density of smartphones, existing networks are coming up against their capacity limits while, at the same time, new radio sites are proving impossible to find (or are not approved). Some operators are doubling the sectors in their macrocells (60° sectors instead of 120°) to increase network capacity.

- **Frequency re-farming, multimode/multiband RRHs:**

3G/4G technology offers better spectral efficiency than GSM, whereby parts of the existing GSM spectrum are being used for UMTS/LTE and re-farmed. The system manufacturers are offering multimode RRHs for this, i.e. remote radios that simultaneously offer, for example, 2G and 3G services within one and the same identical bandwidth of the spectrum. Conversely, LTE can operate at the same time across different frequency bands with multiband RRHs. These advanced remote radios usually have several fiber optic data connections, but just one shared power supply line.

- **Aggressive roll-out plans/tight time horizon:**

The demand for mobile data has overtaken supply, i.e. the provision of mobile data. The provision of a powerful mobile data network has become a strategic requirement for mobile radio operators. Market leaders want to further extend their positions or those in the Number 2 position do not wish to lose ground to their respective leaders. Poor mobile data service now leads directly to a loss of customers. This trend leads to network roll-outs being run much more aggressively than in the last decade and the required time frame becoming ever tighter. Efficient and above all time-saving RRH installation methods are gaining an increasingly prominent position.

- **Efficient and future-oriented cable infrastructure:**
As a consequence of the data explosion, remote radios now have a service life of 3 to 5 years until an upgrade or a replacement becomes necessary. Many mobile radio operators are already running their second generation of RRHs, but they wish to continue using their cable infrastructure, which was expensive and complex to install. RRH installation systems that support several generations of active technology regardless of systems or manufacturers are gaining rising levels of acceptance on the market and have already established themselves as standard solutions on many markets.
- **Hybrid To The Antenna (HTTA):**
A fast and simple installation for 3 to 9 RRHs with a single hybrid cable has established itself as a standard solution on the US market. Hybrid solutions minimize installation costs, the number of mast cables and in turn also minimize the Total Cost of Ownership (TCO). In Europe, Australia, South East Asia and Latin America, with effect from 2013, the first full-coverage hybrid installations will also be implemented for remote radio systems.



Installation methods for RRHs

The following sections explain all of the different methods for installing remote radio systems and examine the advantages and disadvantages in both technical and commercial terms. The installation methods outlined are all used in practice and can be customized to reflect the specific requirements of the network operator when setting up networks. The sequence of installation solutions is sorted by global distribution and market acceptance. That means that the single-cable solution has been the one most frequently installed worldwide, but market acceptance for it is declining rapidly. Multi-riser cables (FTTA and PTTA or combined as a hybrid) with compact dividers are now the second most widespread method of installation. Trailing at the back are discrete hybrid cables to supply power and data to individual RRHs. To provide a quick overview, here is a graphic evaluation of each solution in turn.



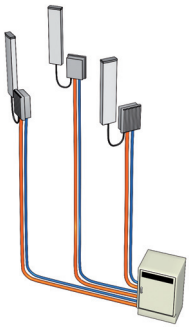
HUBER+SUHNER is the leading provider of installation solutions for RRHs and the information is based on empirical data gathered in close cooperation with system manufacturers, network operators, installers and system integrators.

1. Discrete feeders for single RRHs (FTTA/PTTA)

Discrete cables (FTTA/PTTA)



- Default solution of system vendors
- Vendor specific cables and connectors
- Not scalable
- Not future proof



In a typical 3-sector base station a total of 6 cables are installed. These are mounted at short intervals of 1 m to 1.5 m with cable clamps. Experience in installation shows that the laying of cables is by far the most time-consuming part of the entire installation. That makes this method, particularly over extended distances (> 50 m) and with more than 3 remote radios, expensive and inefficient. In particular with installations of 6 or more RRHs per site, the efficiency of installation becomes a decisive factor and other installation methods are better suited to keeping total costs low.

It must also be noted that every system manufacturer uses specific installation cables suitable only for their own systems. In concrete terms, this means that the connectivity components on the RRH are not compatible for different manufacturers and systems. When a system or manufacturer 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 manufacturer are used. As a rule, 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. To summarise, 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 typically leads to high replacement and conversion costs.

In many RRH network structures, this solution was used, and is still being used, because the system manufacturers offer it as a «standard solution». Worldwide, the vast majority of RRHs have been supplied with discrete cables. As the number of RRHs per site rises, this solution becomes increasingly inefficient and leading mobile operators are turning to installation systems better able to satisfy their existing and future requirements. Market acceptance of discrete cable solutions is on the wane.



FullAXS fiber optic assembly

2. Multi-riser cable with compact divider

This solution uses multi-riser cables for fiber optics and copper, which are «broken out» in compact dividers in single cables. These break-out cables are terminated with robust external connectors (ODC or Q-ODC) and are connected to the RRHs by means of short jumper cables (FTTA and PTTA jumpers). HUBER+SUHNER offers systems of this type for fiber optics and copper under the name MASTERLINE Extreme (MLE) for up to 12 RRHs. The obvious benefit is the compactness, meaning that it is a space-saving, lightweight solution with minimal wind load. The main advantages that make this solution the preferred installation system for many network operators are as follows:

- **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 manufacturer and offers maximum flexibility in terms of evolution 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 6, so that the necessary cables are already in place if LTE is being set up at a later date. No expensive new cable installations are required – all that is needed is a number of additional jumpers. This means that the installation is scalable. With power supply, it is not however possible to achieve the same scalability because the operators often spread their investments in expensive copper cables. In an initial expansion phase, a MASTERLINE Extreme Power (MLEP) is installed for 6 RRHs and a second MLEP is not installed until a later retrofit stage with LTE.

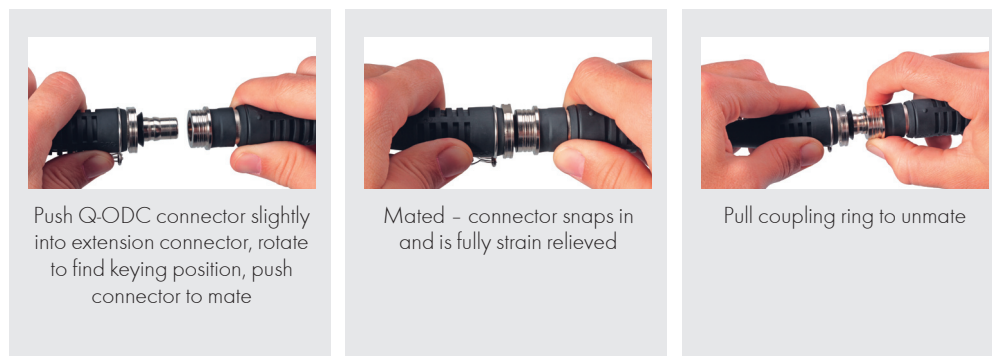


Fig. 1: Mating of fiber optic jumpers with Q-ODC quick-lock connector.

- **Future sustainability:**

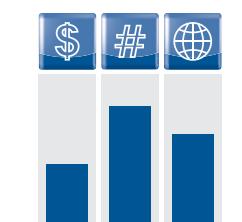
A 12- or 24-fiber installation has a more secure future for network operators because planned network expansions are supported, possible system changes do not result in changes to the passive infrastructure and a manufacturer-independent infrastructure is in place. These benefits reduce general maintenance costs and save additional investments.

- **Reduced investment costs:**

This solution is more cost-effective over long distances (>30 m), because only 2 cables are laid instead of 6 or more. As the number of RRHs rises, cost efficiency rises accordingly. Another cost saving is achieved through the use of clamps for cable mounting because multi-riser cables require fewer as well as simpler clamps instead of discrete cables.

MASTERLINE Extreme (MLE)

Multi-riser cable
with compact divider



- Installation friendly plug&play system
- Preferred non-hybrid solution
- Low wind-load and space efficient (no mast mount box)
- Supports multi-vendor installs



- **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 equipment. In addition, the multi-riser cables are more rigid than individual cables due to their greater diameter, meaning that the securing clips can be installed at intervals of between 1.5 and 2 meters. Empirical data indicates that cable installation times can be reduced by between a third and half (compared to discrete cables). In a typical installation routine, this means that one team can complete more sites per week.



MASTERLINE Extreme cable system
to supply 6 Remote Radio Heads
(RRHs).

3. Hybrid-riser cable with compact divider

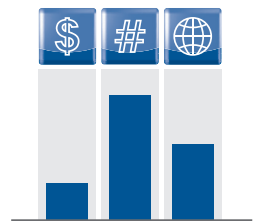
Hybrid solutions combine glass fiber cables and copper conductors within a single cable which reduces to a minimum the number of cables to be installed. On the RRH side, the hybrid cable is divided into individual fiber optic and power supply cables by means of a robust divider. The fiber optic break-out cables are terminated with external connectors (ODC or Q-ODC) and are connected to the RRH by means of FTTH jumpers. The power break-out cables either have an open end (for direct connection to the RRH or for field-terminated connectors) or also a standard interface for connection to the FTTH jumpers. HUBER+SUHNER offers hybrid systems for 3, 5, 6 and 9 RRHs and has already launched a second and improved generation of products on the market known as MASTERLINE Extreme Hybrid (MLEH).

Generally speaking, the hybrid solution (MLEH) delivers the same benefits as the separated solution for fiber optics and copper (MLE, page 11). The installation system offers flexibility in respect of further development of the network, it is independent in terms of system and manufacturer, it is scalable for up to 9 RRHs, meaning it is a secure choice for the future. The main advantage however lies in installation efficiency. The fact that just one hybrid cable is attached to the mast reduces the number of cable clamps needed and this shortens installation time to an absolute minimum. In many cases, the external diameters of the hybrid cables are identical to those of corrugated cables which means that existing clamps (e.g. 7/8") can be re-used. For the grounding of cable sheathing, standard grounding kits for corrugated cables can also be used.

Hybrid cables also have disadvantages that do not exist in the case of separated FTTH and FTTH systems. Integration of fiber optics in the hybrid cable means that hybrid assemblies need to be factory-terminated with connectors to customer-specific lengths. This makes the management of excess lengths of hybrid cable an issue of central importance. The hybrid cables at the base station must provide a simple and reliable way of insulating the external sheath over a length of several metres, to trim the copper cores to correct length and at the same time to manage the excessive length issue in respect of pre-connectorized fiber optic cables. In real network roll-outs, there is a tendency for installer to order too long hybrid cables, i.e. to avoid having too short cables on site which can not be installed. This causes a great deal of copper cable to be manufactured at additional cost that is then, at a later date, simply scrapped in the field. This problem can be minimized by having a highly capable local supply chain because customer-specific lengths can then be supplied quickly and flexibly. Full coverage in the form of a network structure with hybrid assemblies can therefore only be successful with a powerful local supply chain - even though the assemblies are large, bulky to transport and can weigh more than 100 kg.

MASTERLINE Extreme Hybrid (MLEH)

Hybrid-riser cable
with compact divider



- Most commonly installed hybrid product globally
- Preferred solution in US market
- Efficient solution for up to 9 RRHs
- Second Generation improved product launch Q1/2013
- Low wind-load and space efficient (no mast mount box)





MASTERLINE Extreme Hybrid assembly

Hybrid cables combining optical fiber and DC power for remote radios have evolved as the dominating solution in North America and shows strong acceptance in other global markets. HUBER+SUHNER's hybrid cabling system (MASTERLINE Extreme Hybrid - MLEH) is the most efficient and easiest-to-install product available on the market. No other hybrid cabling system has been installed more often globally than MLEH.

Global supply chain for hybrid assemblies

HUBER+SUHNER operates hybrid assembly shops in Poland, Mexico, China and has plans to expand the manufacturing network to other regions as well. Being close to our customers is a must for bulky hybrid assemblies with weights exceeding 100kg. Our operations network enables HUBER+SUHNER to respond immediately to our customers' needs and to provide a fast and flexible delivery performance.



4. Multi-riser cable with distribution boxes

In each case, this solution uses multi-riser cable for fiber optic and copper cables, each routed through separate boxes (or through a combined hybrid box) in order to then be connected to the RRHs by means of short jumper cables. For a 6-sector base station, a 12-strand fiber optic riser cable is used and this is pre-assembled at both ends with 12 LC connectors in each case (e.g. MASTERLINE Classic, MLC). In the box, the LC connectors are connected to the jumper cables by means of pre-mounted adapters; the other ends of these jumper cables are terminated with RRH-specific fiber connectors. The entire system can either be installed at the installation site or can be supplied with a pre-assembled box.

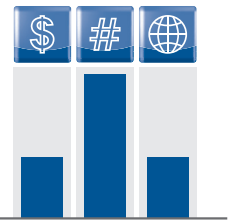
A twelve-core shielded copper cable with a copper cross section of 6 mm² or 10 mm² is used for the power supply, depending on the distance to be covered and the power consumption of the RRHs. Alternatively, a two-core cable (e.g. 16 mm²) could be used. However, the disadvantage here is that this cable cannot be connected directly to the power supply units of the base station and that the entire base station would fail if a short-circuit occurred in an RRH - the RRHs are not electrically insulated

This solution is suited for mast installations. In all cases, multi-riser cables with boxes deliver equivalent benefits to solutions with compact distributor boxes (see page 11) In addition, other overvoltage protection components (OVP) can also be used in boxes or circuit breakers can be integrated, thereby giving the entire system configuration greater flexibility. In most cases, however, additional measures of this kind are not required, or may even be excluded as a possibility on a dedicated basis.

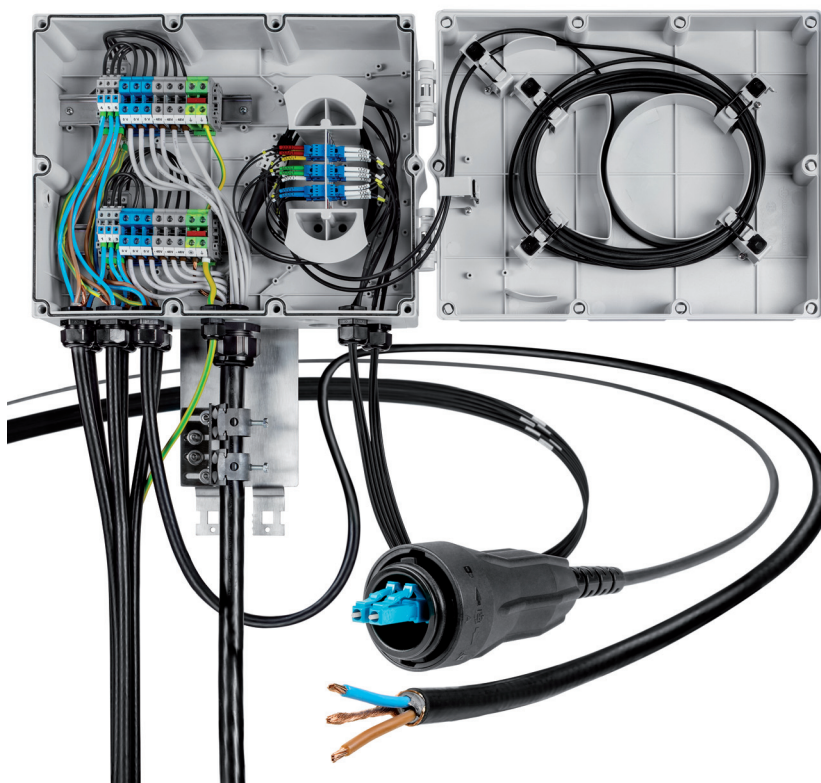
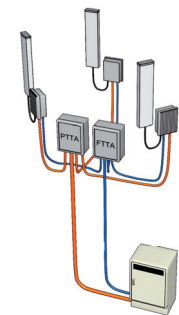
While box solutions have been traditionally the preferred solution in the past, they have been gradually replaced by box-less solutions like MASTERLINE Extreme. With increasing number of remote radios per site, space limitations at the mast and wind load became critical issues. In general, the installation method with boxes is cost effective but also requires handling and connecting of indoor LC connectors at the mast-top boxes. Many operators want to avoid the risk of opening and maintaining mast top boxes by non-trained or non-authorized persons.

MASTERLINE Classic (MLC)

Multi-riser cable with distribution boxes



- Offers greatest configuration flexibility
- Box required/ higher wind load/ higher tower leasing costs
- Requires handling of indoor fiber optic connectors



HTTA box with MASTERLINE Classic Hybrid (Page 16)

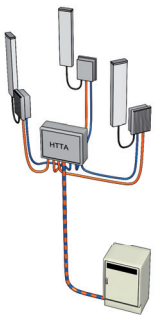
5. Hybrid-riser cable with distribution box

MASTERLINE Classic Hybrid (MLCH)

Hybrid-riser cable
with hybrid (HTTA) box



- Large hybrid boxes required
- Elaborate box installation at mast required



This hybrid solution employs a combination of fiber optic and copper cable that is directed through a hybrid box (HTTA box) and is then connected to the RRHs by means of short jumper cables. The hybrid cables (MASTERLINE Classic Hybrid, MLCH) are pre-assembled with LC connectors and are supplied for installation in predefined lengths. The advantage of this solution is that overvoltage elements, circuit breakers or surplus lengths of cable can be integrated in the hybrid box.

However, compared to a hybrid solution with compact divider (MASTERLINE Extreme Hybrid, see page 13) this solution features a range of significant disadvantages.

- **Bulky box(es):**

This solution requires comparatively large hybrid boxes with robust cable entries which, in ideal cases, involve the integration of an additional cable tensioning fixture. If the HTTA box was pre-configured on the ground in advance, tensile forces in excess of 100 kg can occur during the installation process. The box takes up a lot of space on the mast and, to an increasing extent, space is limited by the growing number of RRHs. Many hybrid systems also require an additional distribution box at the base station.

- **Mast-top installation:**

In many cases, the HTTA box needs to be pre-mounted on the mast because the bulky box cannot be pulled up inside the monopoles or cable ducts. The hybrid cable must be installed separately and cannot be inserted into the box until it is up on the mast. A bulky and inflexible hybrid cable, sensitive small LC connectors on a hybrid cable weighing a few kilograms per meter, 12 to 24 copper wires to be connected etc. all combine to present real challenges to installation personnel. Different test installations in Europe and South America have shown that the installation process (compared to MLEH, see page 13) takes virtually twice as long. In addition, the elaborate mast installation presents a high level of risk of installation faults.

- **Corrugated hybrid cable:**

In combination with hybrid boxes, hybrid cables with corrugated metal armoring are sometimes used. These cables have a similar «look & feel» to corrugated coax cables and enable identical cable clamps and accessories to be used. In many cases, these cables are very rigid as a consequence of their metal armoring which makes them inflexible, and this in turn makes the cable installation and cable routing processes costly and time-consuming. HUBER+SUHNER only uses rugged hybrid cables without metal armoring and these are characterized by good bending and routing properties, and they also exhibit efficient and most space-saving cable structure. Mobile radio operators on three continents have established that the MASTERLINE Extreme Hybrid (MLEH) solution takes about 50 % less time to install than competing hybrid solutions based on corrugated hybrid cables and hybrid boxes.

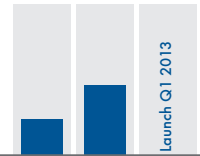
Hybrid cable solutions with boxes generally meet with less acceptance on the market, unless additional protection components are required in the hybrid box up on the mast (OVP, power fuses). Based on HUBER+SUHNER estimates, and taking a global view, about 10x more solutions are installed without hybrid boxes.

6. Hybrid-riser cable with compact connector head

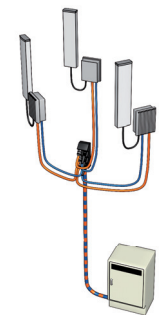
MASTERLINE Ultimate Hybrid (MLUH) is a new product that combines the benefits of the most widespread hybrid solution on the market at present (MLEH, page 13) and that makes installation on the mast more efficient and simpler. The pre-connectorized factory-sealed hybrid systems supports up to 6 RRHs and connects the remote radios with easy-to-install Q-ODC fiber optic and power jumpers. The robust connector head with an integrated pulling eye allow for easy cable lifting without the need for hoisting grips. The encapsulated connector head can be directly attached to the mast with a single «click» at a pre-mounted adapter plate. These unique features make MASTERLINE Ultimate Hybrid the best-in-class product in terms of ease of top mast installation, installation robustness and efficiency.

MASTERLINE Ultimate Hybrid (MLUH)

Hybrid riser cable with compact connector head



- Ultimate plug&play solution
- Connectorized head/ jumpers for fast and safe installation
- Most efficient hybrid solution for up to 6 RRHs
- Low wind-load and space efficient



MASTERLINE Ultimate Hybrid



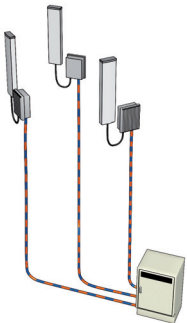
7. Single RRH hybrid feeder

Discrete feeders for single RRH (HTTA)

Single RRH hybrid feeder



- Not an economic solution
- Typically only used for low RRH count roof-top applications



Hybrid cables for supplying individual RRHs are only used in niche applications or as short jumper cables. This solution offers no flexibility in terms of replacing or upgrading remote radios because the individual hybrid cable needs to be adapted specifically to suit the RRH and the system manufacturer. Furthermore, individual cables are not scalable which means that an additional RRH requires an additional cable. This solution is the most closely comparable to individual FTTA and PTTA cables (page 10), but is several times more costly. Standard FTTA and PTTA cables are manufactured and supplied globally in high volumes and at low costs whereas individual hybrid cables represent customer-specific niche products and are correspondingly more expensive. Furthermore, «over-length management» is needed because the hybrid cables assemblies need to be produced in the factory to customer-specific lengths. This increases the incidence of inefficiency because, in some cases, many meters of cable may be wasted on a single site. With larger numbers of RRHs (>3) and high masts (>30 m), single hybrid cables are the most expensive solution.

Based on the experiences of HUBER+SUHNER there is not at present any volume roll-out that is used extensively for single hybrid cables across the board. There are however niche applications in which these cables can be used to advantage. On the one hand, hybrid cables are used as combined jumper cables on distributor boxes to individual remote radios. On the other hand, flat-roof installations with distributed RRHs (e.g. an RRH at every corner of the house) may be a worthwhile application scenario. In such cases, hybrid cables have the advantage of being thicker and more resistant to foot traffic than separate fiber optic and copper cables which, in some cases, can dispense with the need for additional cable ducts. Moreover, with this type of installation, the precise cable paths on the roof are known and there is no need for overlength management.



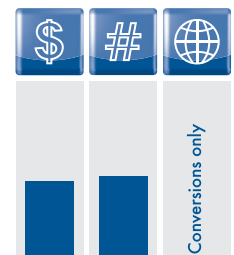
8. Re-use of corrugated copper cables

For network upgrades, conventional cell sites using corrugated coax cables are often converted into remote radio systems. The installed corrugated cables are decommissioned, cut at both ends and re-used as supply lines for the RRHs. The inner and outer conductor of a corrugated cable are used for the power supply. The special Power Smart DC 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 (or directly to the RRH). The re-use of corrugated coax cables completely avoids purchasing and installation of new power supply cables. For data transmission, a thin multi-riser fiber optic cable (Ø 3.5 mm) is drawn into the inner conductor of a second corrugated cable from «above» (RRH side). The multi-riser cable can be either terminated as MASTERLINE Classic (MLC) with HTTA box or as MASTERLINE Extreme (MLE) with Q-ODC connectors on the top to connect with jumpers to the RRHs. The cable is spliced on the base station side.

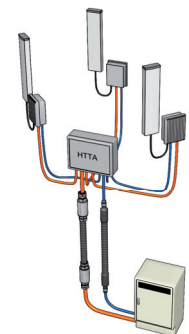
This installation method saves the cost of work on the cable path and, as a consequence, requires no constructional modifications to wall and roof apertures, cable guides do not need to be opened up and no new cables need to be laid. Normally, cable installation is the most time-consuming and costly part of any operation. This method enables a complete base station to be converted within the shortest possible time. In Europe several networks have been equipped successfully using this method. In coming years, tens of thousands of base stations are going to be converted to RRHs. For that purpose, the re-use of coax corrugated cable is an attractive and cost-efficient alternative.

Re-use of corrugated coax cables

Smart DC kit with MASTERLINE Classic



- Conversion from coax to RRHs
- Re-use of corrugated coax cables for power supply
- Significant cost savings



Smart DC kit – Power adapter for re-use of corrugated coax cables

Additional questions about fiber optics

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

Cleaning fiber optic connectors in the field?

The optical performance (optical insertion loss) of fiber optic connectors is easily and adversely affected by contamination and scratching of the ferrule surfaces. Particles of dust, smears of grease caused by touching the ferrules, or the residue from cleaning agents, can increase insertion losses and, in extreme cases, can culminate in loss of signal. During an installation it is therefore necessary to ensure that ferrule end surfaces are clean which means (i) that the dust caps should not be removed until immediately before the connection process, (ii) no fiber optic connectors should be left lying around without their protective caps in place, (iii) never touch the end surfaces or «wipe them down» and (iv) always work very carefully. LC connectors tend to be much more prone to contamination and scratching than, for example, robust ODC or Q-ODC connectors on which the ferrules are protected mechanically from physical contact.

Various market players recommend cleaning and end surface inspection of fiber optic connectors prior to initial installation due to the aforementioned arguments. All experienced fiber optic assembly manufacturers and installers advise against this practice however, and do so on a unanimous basis, since this action causes many problems that could otherwise be avoided. All quality manufacturers of fiber optic assemblies conduct a 100 % inspection of insertion losses and of the cleanliness of ferrule end face in an industrial environment governed by controlled processes. Fiber optic connectors supplied for the base station are cleaned and are ready for direct installation. A misplaced intention to clean and inspect in the field with uncontrolled processes under usual installation conditions generally gives rise to contamination and to problems in the network. Various statistical investigations and many years of experience within the landline sector confirm this. Even recent experience from the USA shows that contamination problems disappeared overnight when field cleaning work was ceased during installation work at the base station. Disregarding initial installation, field cleaning is however an important process and one that needs to be handled effectively by the installation teams. It can arise that ferrules get dirty during installation work (e.g. through physical contact) and in such cases, cleaning is urgently advised. During a network service or expansion, in many cases existing fiber optic connections are disconnected and then get reconnected - here too, cleaning is advisable.



Installation problems with LC connectors?

LC connectors are classical connectors for use in protected indoor environments (IP54) under controlled installation conditions, e.g. in closed telecom rooms. In most cases, installation on masts takes place under arduous conditions (wind, fog and rain, cold) and in exposed locations. All components must possess an IP67 protection class (watertight and dust-tight) and must satisfy corrosion resistance requirements. Handling and correct installation of an unprotected (IP54) LC connector regularly gives rise to problems in the field and these can to a large extent be avoided through the use of well trained installation teams, but cannot be avoided altogether. For this reason, the acceptance of mast boxes which require handling of LC connectors is declining at an increasing rate. Many operators also want to avoid the risk of opening and maintaining mast top boxes by non-trained or non-authorized persons. Aside of the LC handling issues, with increasing number of remote radios per site, space limitations with boxes and increased wind load becomes serious issues too. Nowadays, alternative solutions with robust external connectors (ODC, Q-ODC) and without mast boxes receive preference in most cases (see MLE, page 11).

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 low but consistent rate of installation defects, 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.

Field termination (fiber optic connectors, splicing)?

Field-terminated LC connectors are a good alternative to repairs and small installation adjustments, but they are not suitable for widespread network roll-outs and network expansions. There are various reasons for this. Factory terminated cable assemblies make it possible to achieve consistent, reliable and traceable quality right across the network. With field-terminated connectors the long-term network quality depends to a large extent on an individual installation process that takes place in an uncontrolled environment and that cannot be tracked in quality terms. For many network operators, that is reason enough to categorically exclude field termination altogether. A field-terminated LC connector also costs many times more than an industrially produced LC termination. Furthermore, installation teams require specialist skills and tools that are not available «as standard». Due to the fact that, in the FTTA sector, different types of cable (diameter, layout) and connectors are employed, there are also various technical arguments that speak against field termination.

The splicing of fiber optic cables in a protected 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 and wet conditions. In addition, it 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. Splicing on the mast is associated with high risks in terms of quality. Furthermore, many of the arguments that apply to field-termination of connectors also apply to splicing. This process is considerably more expensive and more time-consuming, it requires special equipment, can only be carried out by experienced personnel and is not an industrialized process that offers the required reliability and traceability. Splicing in mast boxes is not a commonly used or accepted connection method in the mobile communication market.

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 10 Gb/s and above. Multimode fibers have a limited modal bandwidth, i.e. the higher the data rate, the less transmission distance is available. The OM2 multimode fibers have a modal bandwidth of 500 MHz*km, i.e. the 1 Gb/s signal can be transmitted a maximum of 500 m. If the data speeds rise to above 10 Gb/s, distance reduces to 50 m. That means that multimode OM2 fibers are limited and they are no longer able to satisfy the requirements of future generations of system. Across the board, the mobile radio market is trending ever more towards singlemode fiber. Whereas Ericsson and Alcatel-Lucent have been committed to singlemode for years, Huawei and NSN have predominantly been employing multimode. Today, all system manufacturers offer single mode products and the proportion and significance of multimode products is shrinking. In the longer term, as data rates increase, it can be assumed that all system manufacturers will move to singlemode. In the discussion with network operators, multimode has already ceased to be an option for green-field installations and for long-term network expansion.

Centered around your excellence: Our global presence and experience

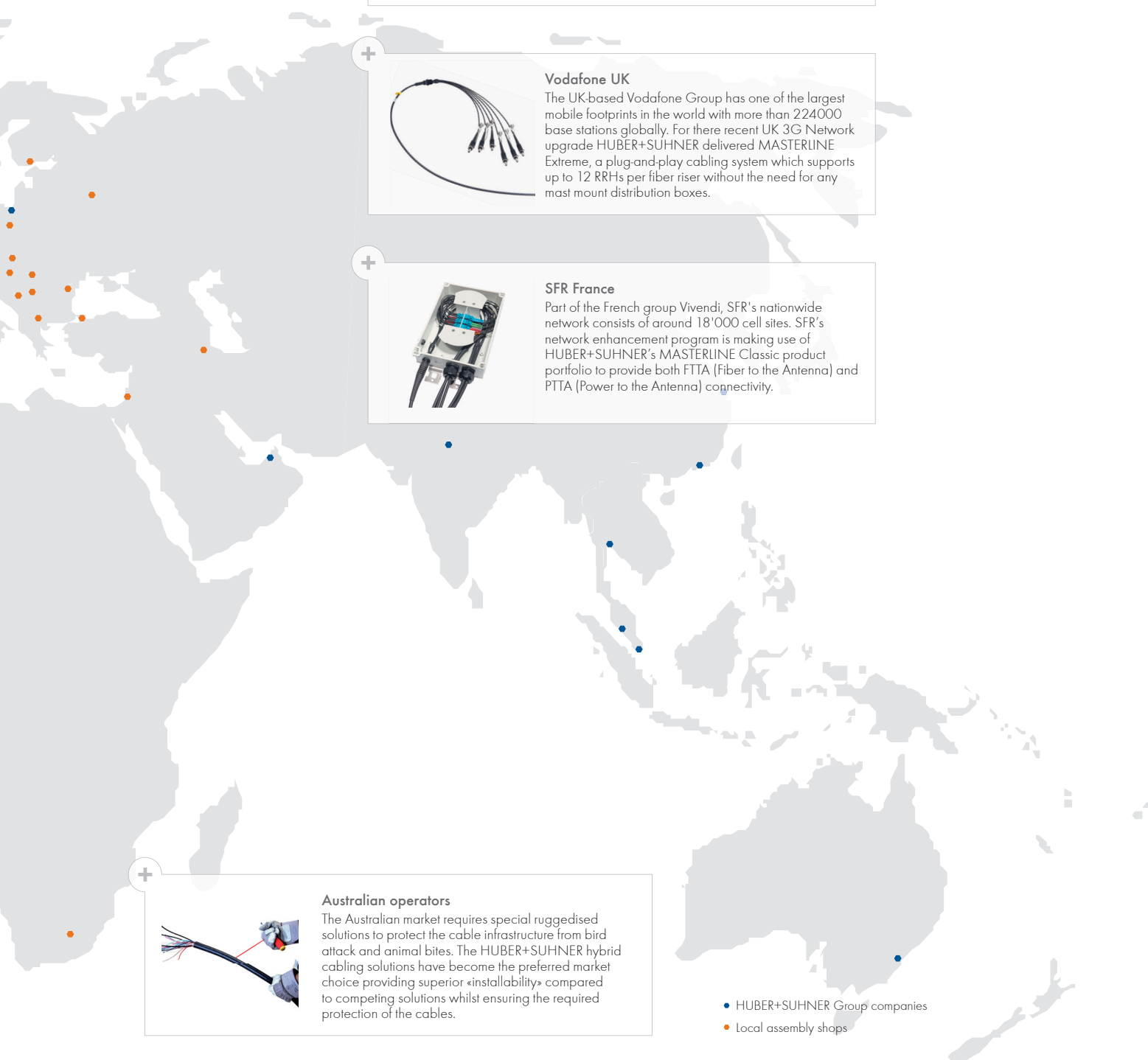
HUBER+SUHNER's continuous involvement with mobile network rollouts across the globe has helped us to become a leader in the wireless infrastructure market. Our partners and customers have been able to take advantage of our global manufacturing, assembly and distribution network covering the Americas, Asia Pacific, Europe, Middle East and Africa enabling successful completion of their infrastructure builds.

- **Worldwide manufacturing:** Being close to our customers is a must. HUBER+SUHNER operates manufacturing plants in Poland, Tunisia, China, India, Malaysia, Mexico, Brazil and Switzerland so that we can respond immediately to our customers' needs and provide best-in-class support throughout all regions of the world.
- **Worldwide assembly:** HUBER+SUHNER is globally co-operating with numerous third-party fiber optic assembly shops to extend the capacity and coverage of the HUBER+SUHNER brand. All of our assembly shops follow the same stringent processes and quality controls as our own group companies.
- **Worldwide distribution:** Customers can rely on HUBER+SUHNER's worldwide sales and support network. Market proximity is the advantage of our global presence with 15 subsidiaries and representatives in over 60 countries. Our customers benefit from our strength to deliver local solutions and services tailored to their requirements.




Ericsson Brazil

Ericsson is globally the leading equipment manufacturer and service provider for mobile communications with more than 100 000 employees world wide. HUBER+SUHNER is a core supplier to Ericsson for FTTA (Fiber to the Antenna) solutions in all geographical regions, for example in Brazil where we support with local production, logistics and engineering to specific local telecommunication standards.




Sprint/T-Mobile USA




Collectively Sprint and T-Mobile provide over 90 million subscribers mobile network services in the highly competitive US market. For their respective 4G network roll-outs HUBER+SUHNER's MASTERLINE hybrid solutions are deployed in their nationwide networks to connect the RRHs with the base station. No other hybrid cabling system can be installed faster and more efficiently.

Vodafone UK



The UK-based Vodafone Group has one of the largest mobile footprints in the world with more than 224000 base stations globally. For their recent UK 3G Network upgrade HUBER+SUHNER delivered MASTERLINE Extreme, a plug-and-play cabling system which supports up to 12 RRHs per fiber riser without the need for any mast mount distribution boxes.

SFR France



Part of the French group Vivendi, SFR's nationwide network consists of around 18'000 cell sites. SFR's network enhancement program is making use of HUBER+SUHNER's MASTERLINE Classic product portfolio to provide both FTTA (Fiber to the Antenna) and PTTA (Power to the Antenna) connectivity.

Australian operators



The Australian market requires special ruggedised solutions to protect the cable infrastructure from bird attack and animal bites. The HUBER+SUHNER hybrid cabling solutions have become the preferred market choice providing superior «installability» compared to competing solutions whilst ensuring the required protection of the cables.

● HUBER+SUHNER Group companies
 ● Local assembly shops

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HUBER+SUHNER is certified according to EN 9100, ISO 9001, ISO 14001, ISO/TS 16949 und IRIS.

Waiver

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