



4.3-10 RF Connector Migration Strategies

by NGMN Alliance

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Abstract: Brief introduction and purpose of document

The mobile communication industry has an increasing demand for smaller connectors with an improved PIM performance and a fail-proof coupling mechanism. It enables antenna and radio unit interfaces to become smaller while supporting a greater number of ports and at the same time reduces installation and PIM risks. The new 4.3-10 connector system is specified and developed to meet the requirements of mobile communication industry. This new connector could replace the common used 7-16 connector.

This new 4.3-10 connector undisputedly provides key improvements for future base station sites: smaller connector size, better PIM performance independent of coupling torque, and easier installation. However, given the large legacy in field using 7-16 connectors, an uncoordinated transition of the different industry partners to 4.3-10 based products creates related issues for operators, installers and suppliers. Therefore NGMN 4.3-10 connector taskforce was set up to harmonize the migration to this new connector.

The NGMN 4.3-10 connector taskforce team worked out a 4.3-10 connector migration proposal for radio unit, antenna and antenna line devices, including migration scenarios and corresponding cable configuration strategies, and End of Life (EoL) proposal for the 7-16 connector, which will be stated in this white paper. This NGMN white paper serves as a guideline for 4.3-10 connector migration, which is expected to lead to less installation efforts, fewer site visits, less CAPEX and OPEX, and better planning for all involved parties.

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1 INTRODUCTION TO 4.3-10 CONNECTOR

1.1 4.3-10 connector: a small and modern RF connector

As MBB networks are evolving, requirements on the RF connector have changed. The 4.3-10 connector can fulfil those requirements and is globally accepted.

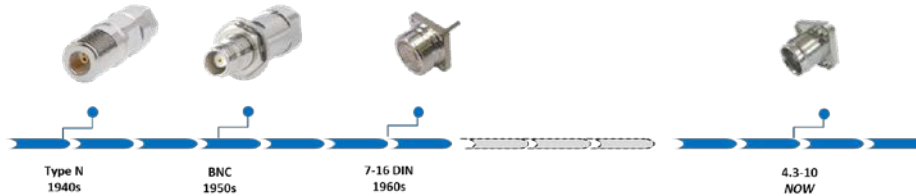


Figure 1-1: Development of Coaxial Connectors

1.1.1 4.3-10 connector: ideal for multi-port antennas, radio units and ALDs

An increasing number of frequency bands for mobile communication, technology evolution such as MIMO, carrier aggregation and beam forming, contrast with increasing issues in site acquisition. These criteria are what have been driving the demand for smaller connectors in the mobile communication industry, enabling size reductions in equipment, yet hosting an increasing number of required ports.

The 4.3-10 connector has the advantage of

- Higher accuracy of passive intermodulation (PIM) compared to 7-16 connector;
- 40% smaller dimension than 7-16 connector;
- Recommended distance between 4.3-10 connector ports is 40 mm, compared to 70 mm recommended for 7-16 connectors;
- Largely facilitating on-site installation while simultaneously increasing connector density for multiband antennas.

1.1.2 4.3-10 connector: easy and fast installation

The key technical improvement of the 4.3-10 connector is that the PIM performance of the connection is no longer dependent on the torque applied to secure the nut of the male connector. Due to the new design, the PIM performance is assured by attaching the female into the male connector. The nut only serves to mechanically secure the connection.

This enables the hand-screw and quick-lock type 4.3-10 connector to be installed without tools, and allows for the application of a traditional nut as well as hand-screw and quick-lock coupling mechanisms, see Figure1-2. Screw type applications are recommended for outdoor sites because these provide an optimal long term solution, featuring a stable and durable connection, and quick-lock type and hand screw type are recommended to be used in indoor applications.



Figure 1-2: 4.3-10 Connector Types and Layouts

Reduction of required coupling torque and a larger tolerance window contributes to easy and fast installation. The coupling torque of 7-16 connector installation is advised to be kept consistent at 30Nm, while the coupling torque of 4.3-10 connector installation, screw type taken for example, can vary from 5 Nm to maximum 15 Nm.

1.1.3 4.3-10 connector: assured PIM performance

PIM performance is assured by the design of the 4.3-10 connector. 7-16 connector still used for comparison, the outer conductor relies on a face contact, serving simultaneously as a mechanical stop (see Figure 1-3). It is well understood that the PIM performance depends on contact pressure, and the 7-16 connector is created by the torque applied to the activity of fastening the nut, influenced by friction from misalignment of the connector. This makes the PIM performance vulnerable to installation flaws like non-flush mounting and incorrect torque being applied to the nut. The design improvement of 4.3-10 connector is that the outer conductor – just like the inner conductor - uses a spring loaded lateral contact (see Figure 1-3), where the contact pressure is created and assured by simply inserting the female into the male connector, while the nut only mechanically secures the connector.

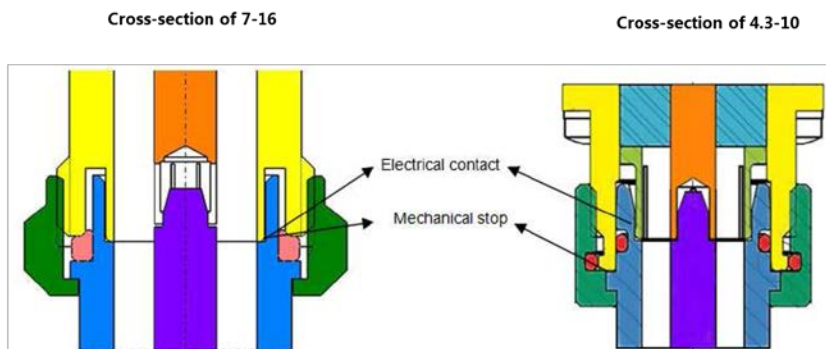


Figure 1-3 cross-section of 7-16 connector and 4.3-10 connector

1.2 4.3-10 connector is an ecosystem and an industry trend

4.3-10 is not just a connector but an ecosystem, involving radio units, antennas, ALD (TMA, combiner, bias-Tees etc.), indoor coverage devices, jumper cables, calibration kits, manufacturing equipment and so on. Many operators have shared 4.3-10 connector application plans, and a number are already starting to adopt 4.3-10 connectors. The vast majority of BTS vendors, antenna vendors, connector and cables vendors and calibration kit vendors have started 4.3-10 connector migration and provide 4.3-10 solutions.

2 4.3-10 CONNECTOR MIGRATION PROPOSAL FOR RADIO UNIT, ANTENNA AND ALD

Common migration strategies are proposed by the 4.3-10 taskforce to facilitate multilateral cooperation of operators and vendors.

2.1 Radio Unit /Active Antennas Migration Strategy Proposal

- **Radio unit/active antennas already launched (legacy) will not switch to the 4.3-10 connector.** In consideration of huge inventories in existing networks, legacy radio unit and legacy active antennas will not switch to 4.3-10 connector, as it is not convenient considering system expansion and spare parts management.
- **New radio unit platform and active antennas will introduce the use 4.3-10 connector from 2017 onwards.** Main BTS vendors are planning to use 4.3-10 connector for new radio unit and active antennas, for example, according to the information shared with 4.3-10 taskforce, Ericsson's radio unit future launch will adopt the 4.3-10 connector. Nokia's target is to start using 4.3-10 connectors in new platform radio unit



expectant deliveries during 2017, and Huawei's 4T4R radio unit will also use the 4.3-10 connector, which will be further applied in new platform radio unit and active antenna launches throughout 2017.

- **For pure TDD systems**, this might differ from region to region as the already installed base is not required to change. For new deployed TDD only systems it is recommended to use the 4.3-10 connector or some other connectors (capable of assuring PIM performance if necessary).
- **For FDD/TDD hybrid systems**, when FDD and TDD systems share a single radio unit, 4.3-10 connector or some other connectors (capable of assuring PIM performance if necessary) is recommended for upgrades and/or site extensions.

2.2 Antenna Migration Strategy Proposal

- **Legacy antennas will switch to the 4.3-10 connector according to customer requirements.** The strategy for legacy products must provide flexibility to match the requirements of various regions and different operators. Connector migration for hugely deployed antenna types can be considered, but is recommended not to be implemented for lower volume products. Legacy antennas will switch to the 4.3-10 connector to satisfy customers' growing requirements.
- **New antennas start to use the 4.3-10 connector from now onwards.** As multi-band antennas are mainstream in antenna development and the majority of newly released antennas have more than 6 RF ports, a high number of potentially 16 RF ports, utilizing the new 4.3-10 connector is key to support the deployment in 2G/3G/4G/4.5G multi-layer networks.
- **For pure TDD systems**, this might differ from region to region as the already installed base is not required to change. For new deployed TDD only systems it is recommended to use the 4.3-10 connector or some other connectors (capable of assuring PIM performance if necessary).
- **For FDD/TDD hybrid systems**, when FDD and TDD systems share an antenna, 4.3-10 connector or some other connectors (capable of assuring PIM performance if necessary) is recommended for upgrades and/or site extensions.

2.3 ALD Migration Strategy Proposal

- **Legacy Combiner, TMA, DC-stop, BT will switch to the 4.3-10 connector according to customer requirements.** Following the reasoning of legacy antennas, legacy ALD's are also recommended to switch to the 4.3-10 connector based fundamentally on customer requests.
- **All new Combiner, TMA, DC-stop and Bias Tee (BT) start to use 4.3-10 connector from now onwards.** All new combiner/filter, TMA, DC-stop, BT and other ALD's are proposed to use the 4.3-10 connector to gain the most benefits from 4.3-10 connector advantages, unifying site infrastructure and promoting antenna evolution.

2.4 Distributed antenna systems strategy proposal

Distributed antenna systems usually involves the deployment of a large number of RF connectors, representing potentially a high cost if all RF connectors of an existing installation require replacing. Depending on the topology of each particular distributed antenna system, a partial migration to the 4.3-10 connector of a legacy system is considered. This applies during an extension (or upgrade to new frequency bands) and is only applicable to relatively high power RF sections of the network to provide a reasonable balance between cost and PIM risk. For the interface of base stations or remote radio units to DAS systems, we generally recommend the use of 4.3-10 connector for new installations.

2.5 Massive MIMO

The hardware architecture of Massive MIMO systems features a challenging configuration which is difficult to define, and a commonly agreed definition in the industry where M-MIMO starts has yet to be realized. Multiple M-MIMO systems will potentially rely on a large number of transceivers that will likely result in integrated active antenna systems without dedicated jumper cables between radios and antenna. Such interfaces represent internal interfaces and are considered not included within the scope of this white paper.

2.6 End of Life (EoL) Strategy for 7-16 connector for mobile communication devices (e.g. radios, antennas, ALDs)

Due to the supply requirements of various markets (EU, LATAM, Africa etc.) it is difficult to define a dedicated EoL date for the 7-16 connector. However, an EoL date for products with 7-16 connectors, which could be replaced by products with 4.3-10 connectors, of Dec 2020 has been proposed.

3 SCENARIOS AND CORRESPONDING CONFIGURATION STRATEGIES

The gradual completion of the migration to the 4.3-10 standard for global operators will require an extended time frame. Before that, a combination of 7-16 connector and 4.3-10 connectors will be deployed on a single site, which will produce a number of different application scenarios. There are several cable configurations available for each scenario. "Hybrid connector" jumper assemblies (preferred) or adapters (only in specific cases) are offering a solution to meet additional requirements. In this chapter the scenarios in consideration of easier installation and better performance are outlined, following the general principles of corresponding configuration strategies:

➤ Series of "hybrid" jumper assemblies adapted to different application scenarios:

- When either e.g. a radio unit or antenna use 4.3-10 connectors and the other 7-16, hybrid jumpers with 4.3-10 male connector on one end and a 7-16 male connector on the other end provide an effective transition between the connecting/adjoining systems.
- When both e.g. a radio unit and antenna use 4.3-10 connectors, jumpers with a 4.3-10 male connector on both ends provides the optimal solution.

➤ Adapter:

- Adapters available to support cases where hybrid jumpers are not applicable.
- Adapters are strictly not recommended as this tends to cause increased PIM risk!
- Minimizing the amount of adapters on site is recommended!

3.1 Configuration strategies to scenarios of radio unit and antenna without ALD

The application scenarios of radio unit and antenna without combiner, TMA and BT are shown below.

3.1.1 Radio unit on the top of tower (close proximity to antenna)

As shown in the schematics below (see Figure 3-1), jumpers according to the connector type of radio unit and antenna shall be used:

- If both a radio unit and an antenna use a 4.3-10 connector, jumpers fitted with a 4.3-10 male connector on both ends are required.
- If a radio unit uses a 4.3-10 connector and an antenna uses a 7-16 connector, or a radio unit uses a 7-16 connector and an antenna uses 4.3-10 connector, jumpers fitted with a 4.3-10 male connector at one end and a 7-16 male connector at the other end are required.

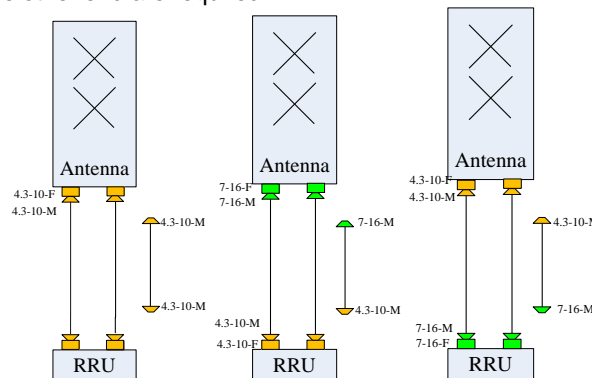


Figure 3-1 Configuration strategies to radio unit on the top of tower without ALD

3.1.2 Radio unit connecting via legacy 7-16 feeders

As shown in schematics below (see Figure 3-2), jumpers according to the connector type of radio unit and antenna shall be deployed:

- If a radio unit uses a 4.3-10 connector, jumpers fitted with a 4.3-10 male connector on one end and a 7-16 male connector at the other end will connect the radio unit with the feeder.
- If a radio unit still uses a 7-16 connector, jumpers fitted with a 7-16 male connector on both ends are required.
- If antennas use a 4.3-10 connector, jumpers fitted with a 4.3-10 male connector at one end and a 7-16 male connector at the other end are required.

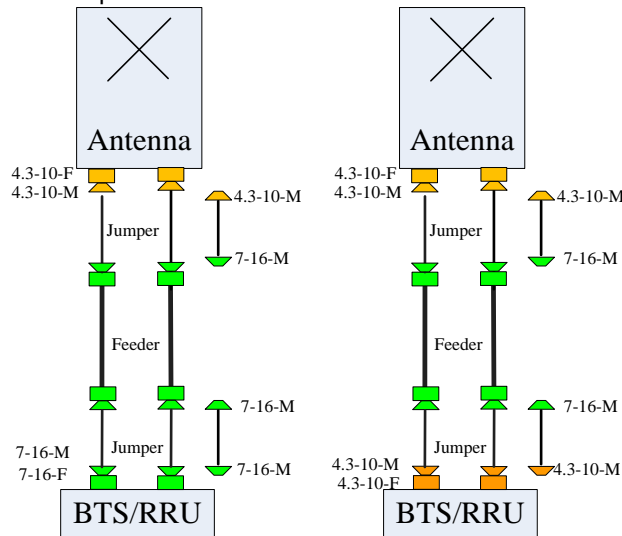


Figure 3-2 Configuration strategies to radio unit connecting via legacy 7-16 feeders without ALD

3.2 Application Scenarios of a Radio unit and an antenna with SBT

As shown in schematics below (see Figure 3-3), if a BT/SBT is connected to an antenna with a 4.3-10 connector, a SBT using a 4.3-10 connector is recommended for both newly-built sites or upgraded sites.

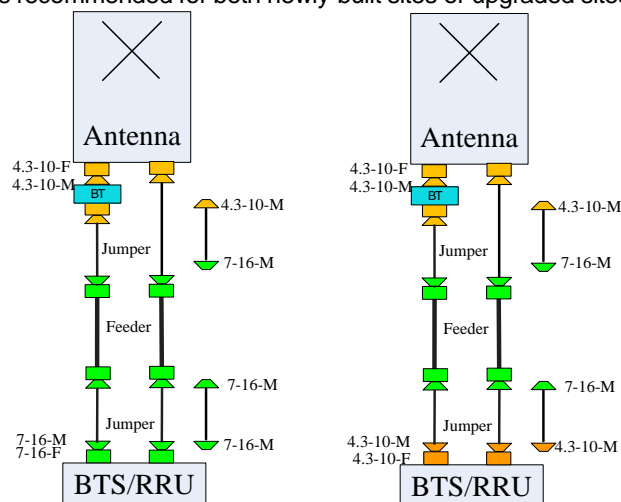


Figure 3-3 Configuration strategies to SBT with antenna with 4.3-10 connector

As shown in schematics below (see Figure 3-4), if a BT/SBT with a 7-16 connector is required to be reused during site upgrades, an adapter is recommended to connect an antenna and a BT/SBT, as oppose to jumpers fitted with a 4.3-10 male connector at one end and a 7-16 male connector at the other end.

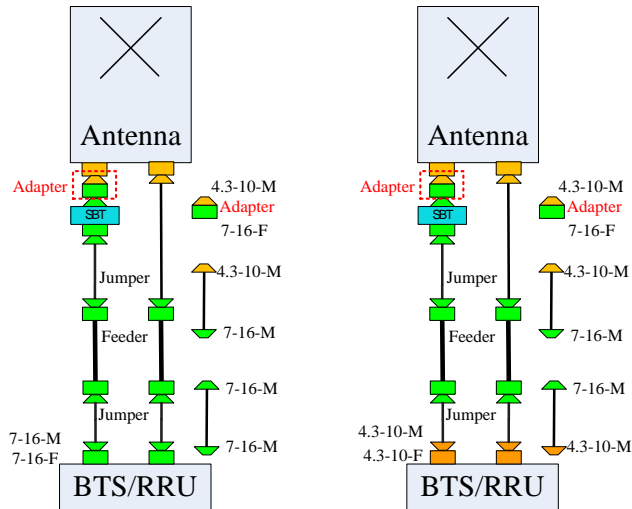


Figure 3-4 Configuration strategies to SBT with antenna with 7-16 connector

3.3 Configuration strategies for scenarios of a radio unit and an antenna with TMA

As shown in schematics below (see Figure 3-5), if a TMA uses a 4.3-10 connector, jumpers fitted with a 4.3-10 male connector at one end and a 4.3-10 male connector at the other end are required between an antenna with 4.3-10 connectors and a TMA. Jumpers fitted with a 4.3-10 male connector at one end and 7-16 connector at the other end are used to connect a TMA and Feeder.

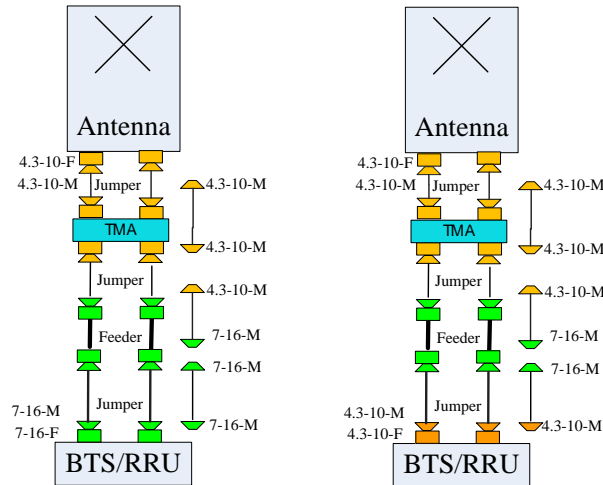


Figure 3-5 Configuration strategies to both antenna and TMA with 4.3-10 connector

As shown in schematics below (see Figure 3-6), if a TMA uses 7-16 connector, jumpers fitted with a 4.3-10 male connector at one end and a 7-16 connector at the other end are recommended between antenna and TMA. Jumpers with a 7-16 connector at both ends are required between TMA and Feeder.

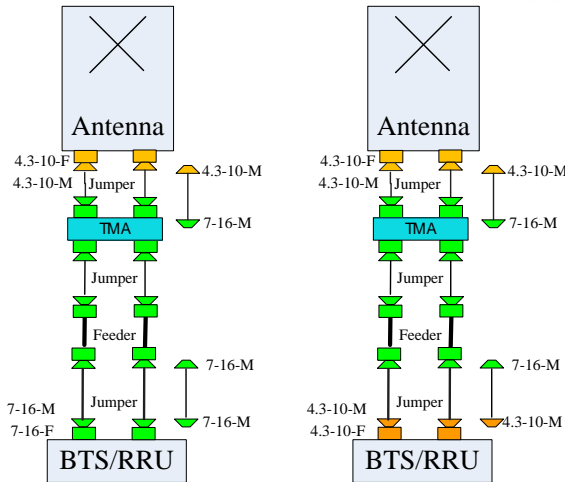


Figure 3-6 Configuration strategies to antenna with 4.3-10 connector and TMA with 7-16 connector

3.4 Configuration strategies for scenarios of a radio unit and an antenna with combiner/filter

3.4.1 Combiner/filter only used with a radio unit to conserve feeders and antennas

When a combiner/filter uses a 4.3-10 connector, the configurations are shown in schematics below (see Figure 3-7):

- Jumpers fitted with a 4.3-10 male connector at both ends are required between a combiner/filter and a radio unit using a 4.3-10 connector;
- Jumpers fitted with a 4.3-10 male connector at one end and a 7-16 connector at the other end are recommended between a combiner/filter and a radio unit using a 7-16 connector.

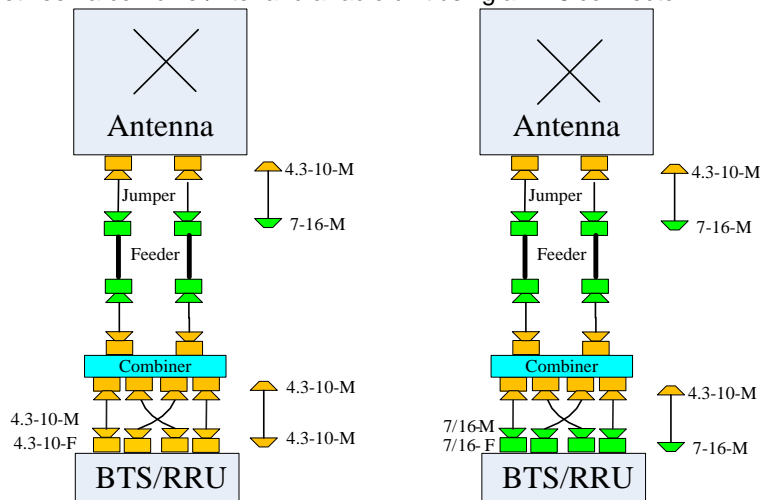


Figure 3-7 Configuration strategies to combiner with 4.3-10 connector only used with radio unit

When a combiner/filter uses a 7-16 connector, the configurations are shown in the schematics below (see Figure 3-8):

- Jumpers fitted with a 4.3-10 male connector at one end and a 7-16 connector at the other end are recommended between a combiner/filter and a radio unit using a 4.3-10 connector.
- Jumpers fitted with a 7-16 connector at both ends recommended between a combiner/filter and a radio unit using a 7-16 connector connector.

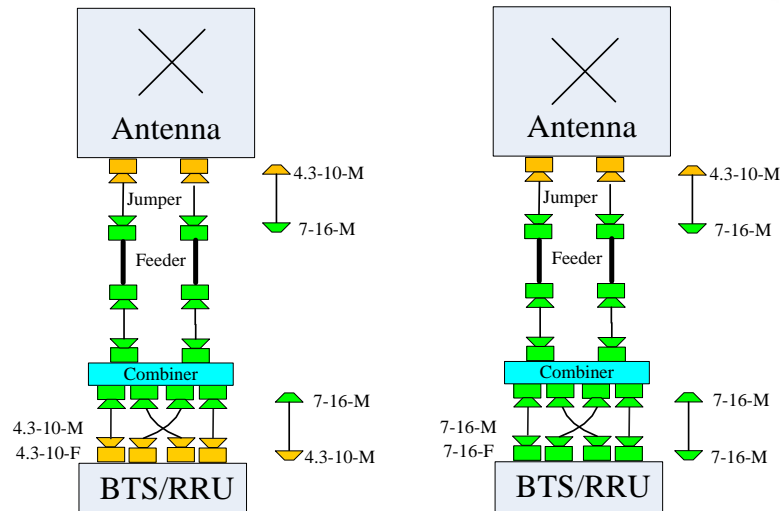


Figure 3-8 Configuration strategies to combiner with 7-16 connector only used with radio unit

3.4.2 Combiner/filter with radio unit and antenna to conserve feeders

When a combiner/filter uses a 4.3-10 connector, the configurations are shown in schematics below (see Figure 3-9):

- Jumpers fitted with a 4.3-10 male connector at both ends are required between an antenna and a combiner/filter, and are also required between a combiner/filter and a radio unit using a 4.3-10 connector.
- Jumpers fitted with 4.3-10 male connector at one end and a 7-16 connector at the other end are recommended between a combiner/filter and feeder. Also, an identical configuration is recommended between a combiner/filter and a radio unit using a 7-16 connector.

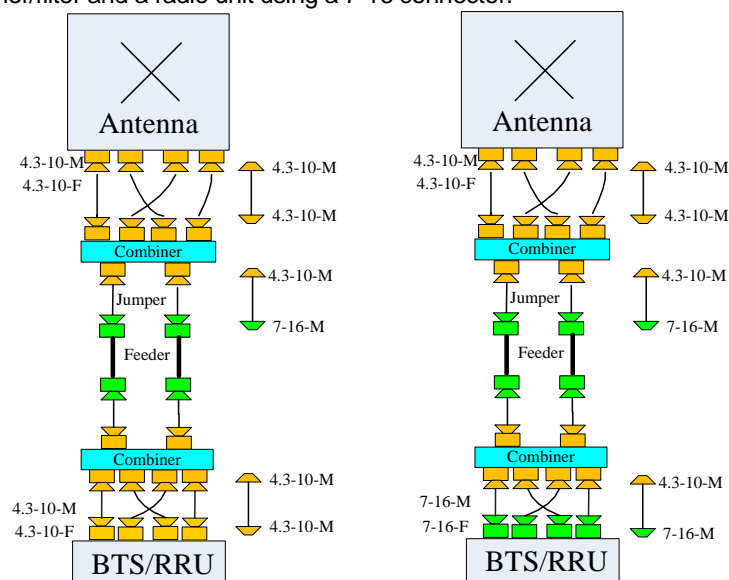


Figure 3-9 Configuration strategies to combiner with 4.3-10 connector used with both radio unit and antenna

When a combiner/filter uses a 7-16 connector, the configurations are shown in the schematics below (see Figure 3-10):

- Jumpers fitted with a 4.3-10 male connector at one end and a 7-16 connector at the other end are recommended between antenna and a combiner/filter. Also, an identical configuration is recommended between a combiner/filter and a radio unit using a 4.3-10 connector.
- Jumpers fitted with a 7-16 connector at both ends are used between a combiner/filter and feeder, and also between a combiner/filter and a radio unit using a 7-16 connector.

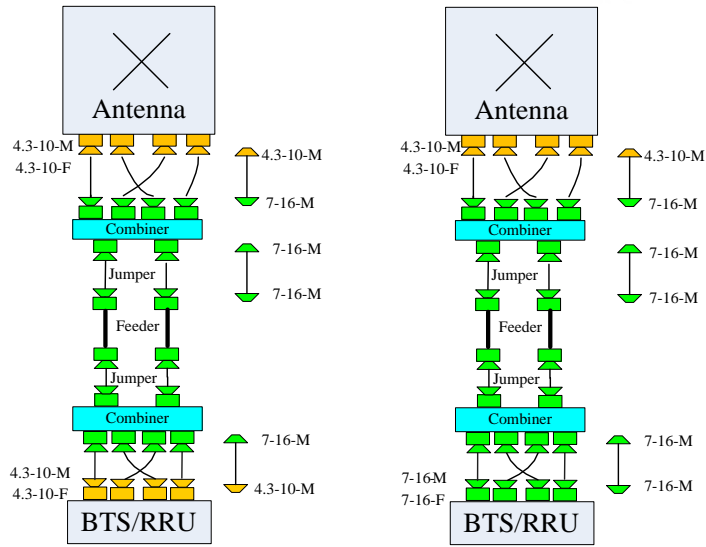


Figure 3-10 Configuration strategies to combiner with 7-16 connector used with both radio unit and antenna

3.5 Configuration strategies for scenarios of indoor coverage

A typical indoor coverage scenario using devices with a 4.3-10 connector is shown in the schematic below (see Figure 3-11), using jumpers fitted with a 4.3-10 male connector at both ends of each connection. If a number of devices still use a 7-16 connector, jumpers fitted with a 4.3-10 male connector at one end and a 7-16 connector at the other end are recommended for each connection.

In case of high power handling at main distribution network 7-16 connectors still could be used.

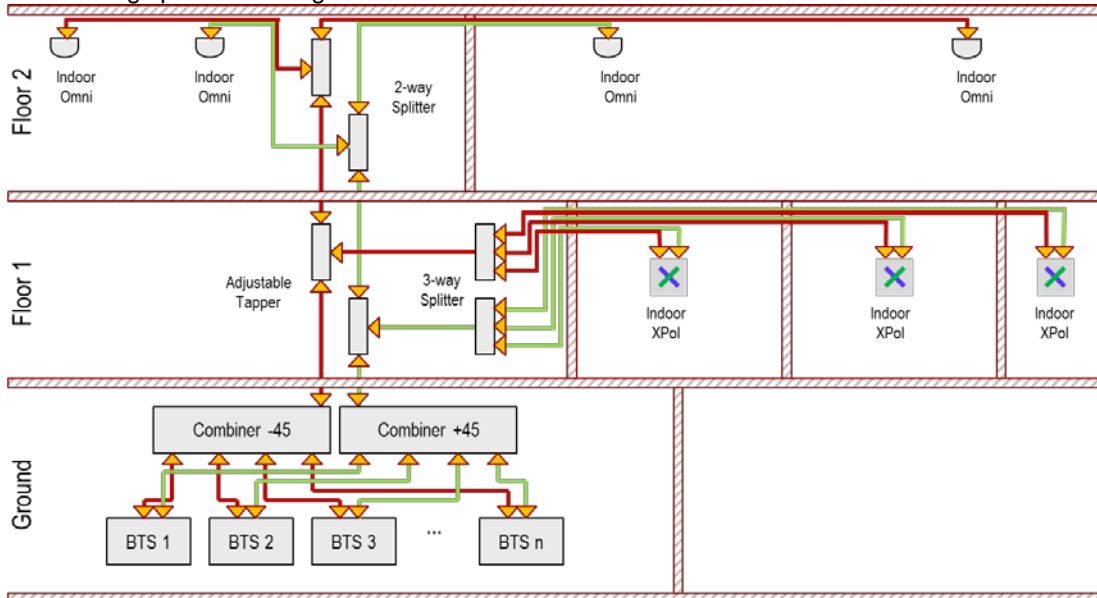


Figure 3-11 Configuration strategies to indoor coverage

4 APPENDIX

ALD	Antenna Line Device
BT	Bias Tee
CAPEX	Capital Expenditure
FDD	Frequency Division Duplex
SBT	Smart Bias Tee
MBB	Mobile Broadband
MIMO	Multiple-input Multiple-output



OPEX	Operational Expenditure
PIM	Passive Intermodulation
RRU	Remote Radio Unit
TDD	Time Division Duplex