NOKIA

Product Description

C33513.85.G0

Contents

Summary of changes

Document	Date	Comment
C33513002SE_00	10 Mar 1999	
C33513002SE_A0	11 Jun 1999	RRIC indoor unit, 15 GHz frequency band added
C33513002SE_B0	01 Nov 1999	FXC RRI indoor unit, 13, 18, and 26 GHz frequency bands, HSB with FIU 19 added
DN99600269 Issue 2-0 en	29 Dec 1999	Technical specifications updated, new document numbering scheme adopted
DN99600269 Issue 3-0 en	05 Jan 2000	Q1 routing, antenna specifications updated
DN99600269 Issue 6-0 en	16 Jun 2000	FC RRI indoor unit, space and frequency diversity, protection with RRIC, Nokia UltraSite compatibility added
DN99600269 Issue 7-0 en	31 May 2001	Changes in antenna specifications; signature data added; RJ-45; updated
DN99600269 Issue 8–0 en	30 Apr 2002	7 and 8 GHz, IFUE, FIU 19E and FIU 19RJ added, FC RRI removed

1 About this document

This document is a general description of the Nokia FlexiHopper family of microwave radios. The document covers the 7, 8, 13, 15, 18, 23, 26, and 38 GHz frequency bands of the Nokia FlexiHopper outdoor unit and the FIU 19, FIU 19E, FIU 19RJ, RRIC, and FXC RRI indoor units, and the IFUE interface unit.

This document contains the following information:

- an introduction to the Nokia FlexiHopper product family
- a description of the features of Nokia FlexiHopper and the indoor units
- examples of network applications and site configurations
- an introduction to the Nokia Network Management System and Nokia node managers
- details of the mechanical structure of the outdoor unit and the indoor units
- technical specifications.

Note

All the features described in this product description may not be supported at the time of publication. Some features may require new hardware and software versions that will be available in the future.

---

2 Introduction

A Nokia FlexiHopper network element consists of an indoor unit (IU) and an outdoor unit (OU). The units are connected together with a single coaxial cable, Flexbus. The Flexbus cable can be up to 300 m long.

One unit, all capacities; one platform, all frequencies

Nokia FlexiHopper Microwave Radios are available for the 7, 8, 13, 15, 18, 23, 26, and 38 GHz frequency bands. The radio transmission capacity of all Nokia FlexiHopper models is 2 x 2, 4 x 2, 8 x 2, or 16 x 2 Mbit/s. This can be selected using the node manager without any hardware changes.

Note

The higher the transmission capacity selected, the wider the frequency channel. Ensure the allowed frequency channels from the authorities in charge of frequency administration.

Figure 1. Nokia FlexiHopper outdoor unit

Lightweight outdoor unit

The Nokia FlexiHopper outdoor unit is small and lightweight: 21 x 23 x (12 - 22) cm^3 / 4.0 - 6.7 kg. All frequency bands use the same technical concept and a similar mechanical construction. The only mechanical difference between outdoor units is the length of the collar, which houses the antenna filter; the lower the frequency, the longer the filter and the collar.

- The transmitter uses π/4-DQPSK (differential quadrature phase shift keying) modulation, which has the advantages of a narrow spectrum and good output power efficiency.
- Typical maximum output power is 16 - 23 dBm (dependent on the frequency band).
- The output power can be adjusted electrically via the node manager.
- Hop length is from 3.0 km (38 GHz radio with 20 cm antenna at 16 x 2 Mbit/s capacity) up to over 50 km (7 and 8 GHz radios with 180 cm antenna at 16 x 2 Mbit/s capacity). These values are calculated with 0.005% unavailability in 42 mm/h rain rate conditions (European climate) with guaranteed system values. When the radios are set at lower capacity, the hop lengths are even longer.

One indoor unit supports several outdoor units

Nokia supplies four different indoor units for Nokia FlexiHopper to provide optimal features for different environments. All frequency bands use the same indoor units. One indoor unit can support two outdoor units. Up to four outdoor units can be connected to one FIU 19 indoor unit. When four outdoor units are used, one of the transmission directions must be protected.

The full radio capacity from 2 x 2 Mbit/s up to 16 x 2 Mbit/s is available with all indoor unit models. The add/drop capacity varies according to the indoor unit model. The same indoor units can also be used with Nokia MetroHopper at 4 x 2 Mbit/s radio capacity. The main features of each indoor unit are described below.

FIU 19 or FIU 19RJ – compact 19″ indoor unit

FIU 19 is an indoor unit for 19-inch applications. The main unit is only 2/3 U (29 mm) high. The interface capacity of FIU 19 can be from 4 x 2 up to 16 x 2 Mbit/s. It can be expanded easily with plug-in units in 4 x 2 Mbit/s increments. The 16 x 2 Mbit/s interface capacity requires the expansion unit, which is the same size as the main unit. The 2 Mbit/s cross-connect function is integrated into FIU 19.

FIU 19E

The FIU 19E indoor unit implements the Ethernet interface towards the IP DCN. It provides an SNMP interface to any NMS system supporting it. The Nokia Hopper Manager can be connected remotely to a FIU 19E using a LAN connection.

RRIC – transmission integrated into the base station

RRIC is an indoor unit which fits directly into Nokia Citytalk and Nokia Intratalk base stations (BTS). RRIC provides up to 4 x 2 Mbit/s add/drop capacity to the base station transmission unit (TRUx) and up to 16 x 2 Mbit/s bypass capacity to another RRIC unit. The 2 Mbit/s cross-connect function is integrated into the RRIC indoor unit. RRIC enables connection for two outdoor units and supports hot standby. Loop protection is available on the RRIC indoor unit together with the TRUx base station transmission unit.

FXC RRI – Nokia MetroSite GSM BTS, Nokia MetroHub, and Nokia UltraSite EDGE BTS indoor unit

FXC RRI is an indoor unit which can be installed in Nokia MetroSite GSM Base Station, Nokia MetroHub Transmission Node, or Nokia UltraSite EDGE Base Station. FXC RRI enables connection to two outdoor units, supports loop protection, and also provides grooming with 8 kbit/s granularity. The add/drop capacity is 16 x 2 Mbit/s.

IFUE – Nokia MetroSite WCDMA and Nokia UltraSite WCDMA interface unit

IFUE is an interface unit that can be installed in Nokia MetroSite WCDMA and Nokia UltraSite WCDMA base stations. The IFUE has three Flexbus interfaces and it provides up to 16 x 2 Mbit/s capacity.

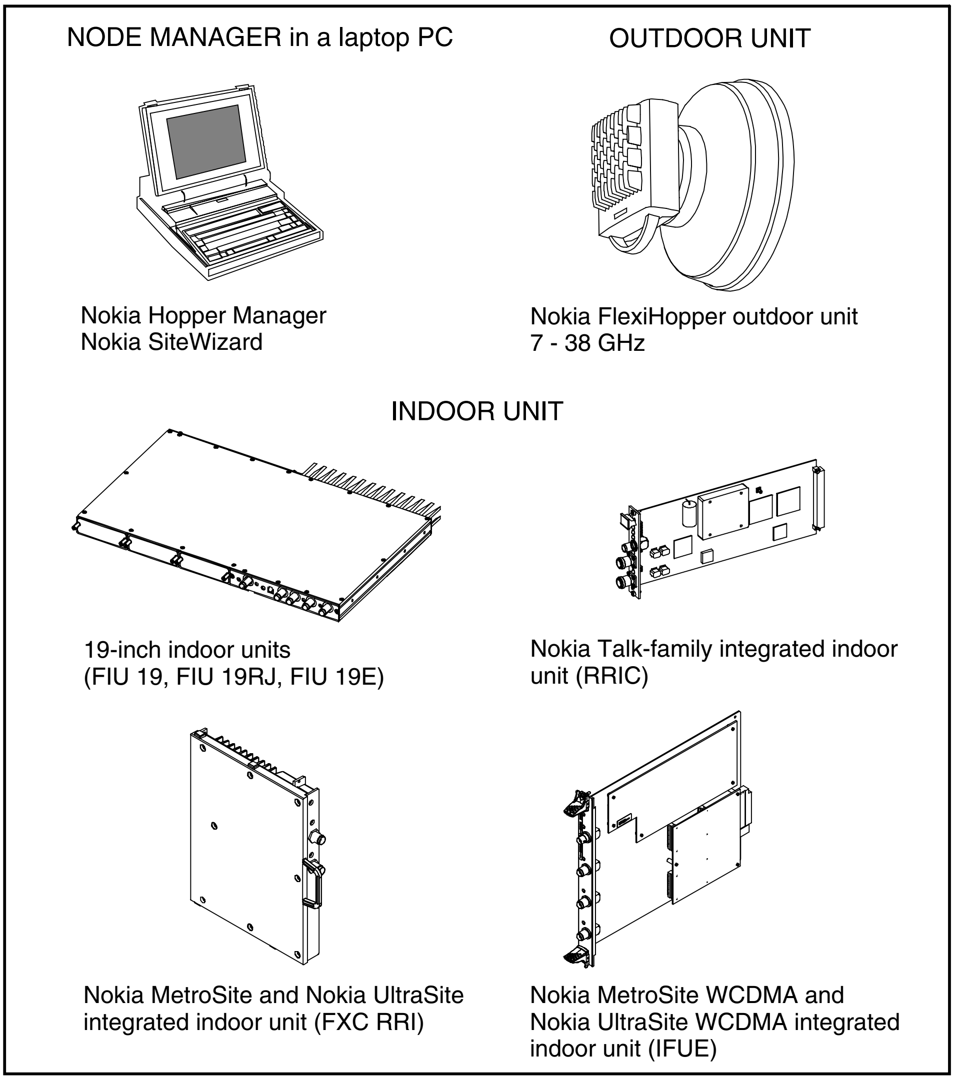


Figure 2. Components of the Nokia FlexiHopper network element

Easy to use management system

Nokia FlexiHopper can be fully controlled and managed locally by

- Nokia Hopper Manager (with FIU 19, FIU 19RJ, FIU 19E, and RRIC)
- Nokia Flexbus Unit Manager (with Martis DXX FBU interface)
- Nokia SiteWizard (with FXC RRI)
- Nokia AXC-FB Hopper Manager (IFUE)

or remotely with the Nokia NMS.

The node managers feature an easy to use graphical user interface with commissioning wizard that guides the user through commissioning tasks.

Versatile maintenance and troubleshooting facilities

- The quality of the transmission can be monitored with the built-in BER (bit error ratio) measurement (ITU-T G.826).
- Far-end and near-end loops can be used for troubleshooting.
- Software of the outdoor unit and the indoor units can be updated by using software download.

3 Features

Nokia FlexiHopper Microwave Radios have many advanced features in addition to all the essential microwave radio features. This chapter describes:

- cross-connections and Flexbus
- special features of the Nokia FlexiHopper outdoor unit
- features of the indoor units (FIU 19, FIU 19RJ, FIU 19E, RRIC, and FXC RRI) and the IFUE interface unit
- protection methods
- configuration backup.

3.1 Integrated radio and cross-connect

2 Mbit/s cross-connection is integrated into the indoor units and is freely programmable between different Flexbus and 2 Mbit/s interfaces. The indoor unit has two (FXC RRI, RRIC) or three (FIU 19, FIU 19RJ, FIU 19E, IFUE) totally independent framing/deframing sections, which can be cross-connected to external or internal Flexbus interfaces.

Flexbus – single cable interconnections

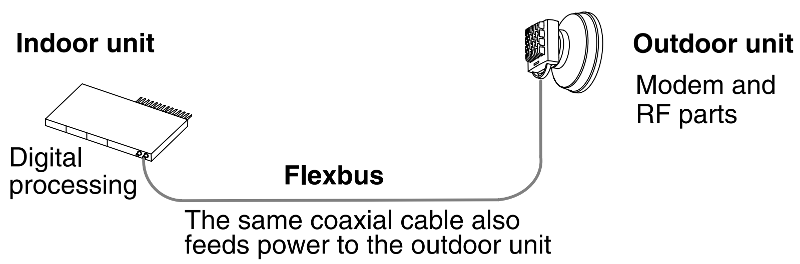


Figure 3. The basic Nokia FlexiHopper network element configuration, one indoor unit and one outdoor unit

The bidirectional Flexbus cable connects all system elements together. Flexbus carries 2 - 16 x 2 Mbit/s signals and control data between the units of the network element, from the indoor unit to the outdoor unit, as well as from one indoor unit to another indoor unit. Flexbus also feeds power to the outdoor unit.

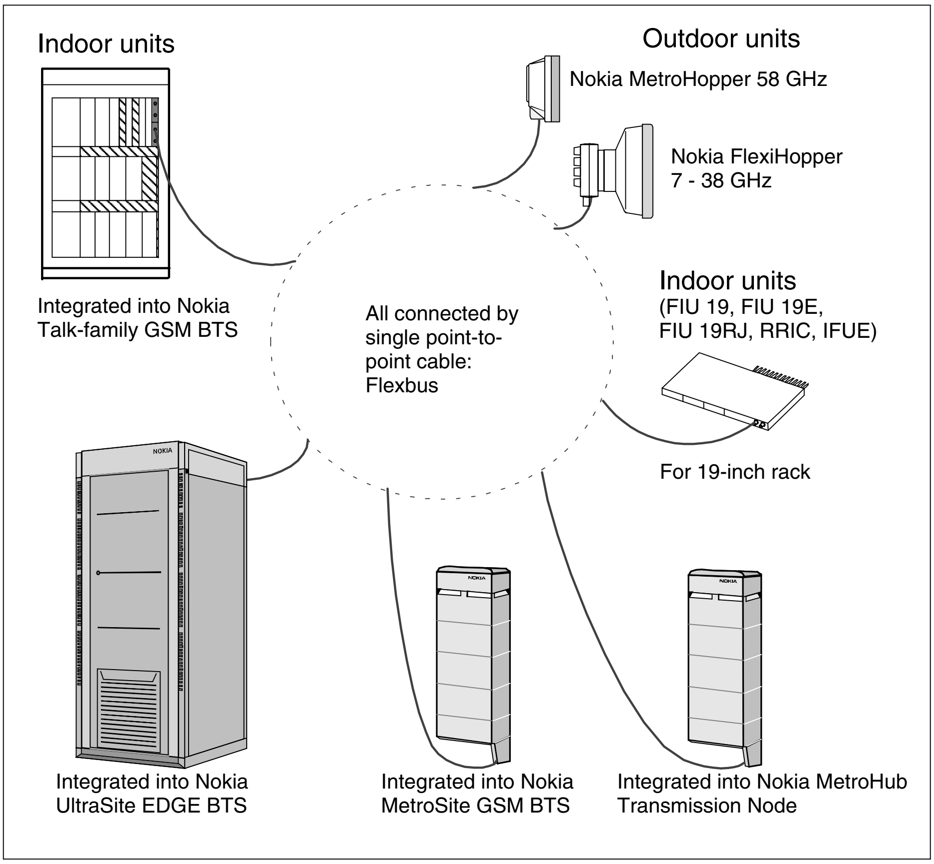


Figure 4. The Flexbus family

Flexbus gives high flexibility to PDH networks without any external multiplexers. Several different logical signals can be carried by Flexbus and all on-site cabling is made by internal electrical cross-connections. If the conventional method is needed, the separate 2M interfaces are available with the FIU 19(E) indoor unit.

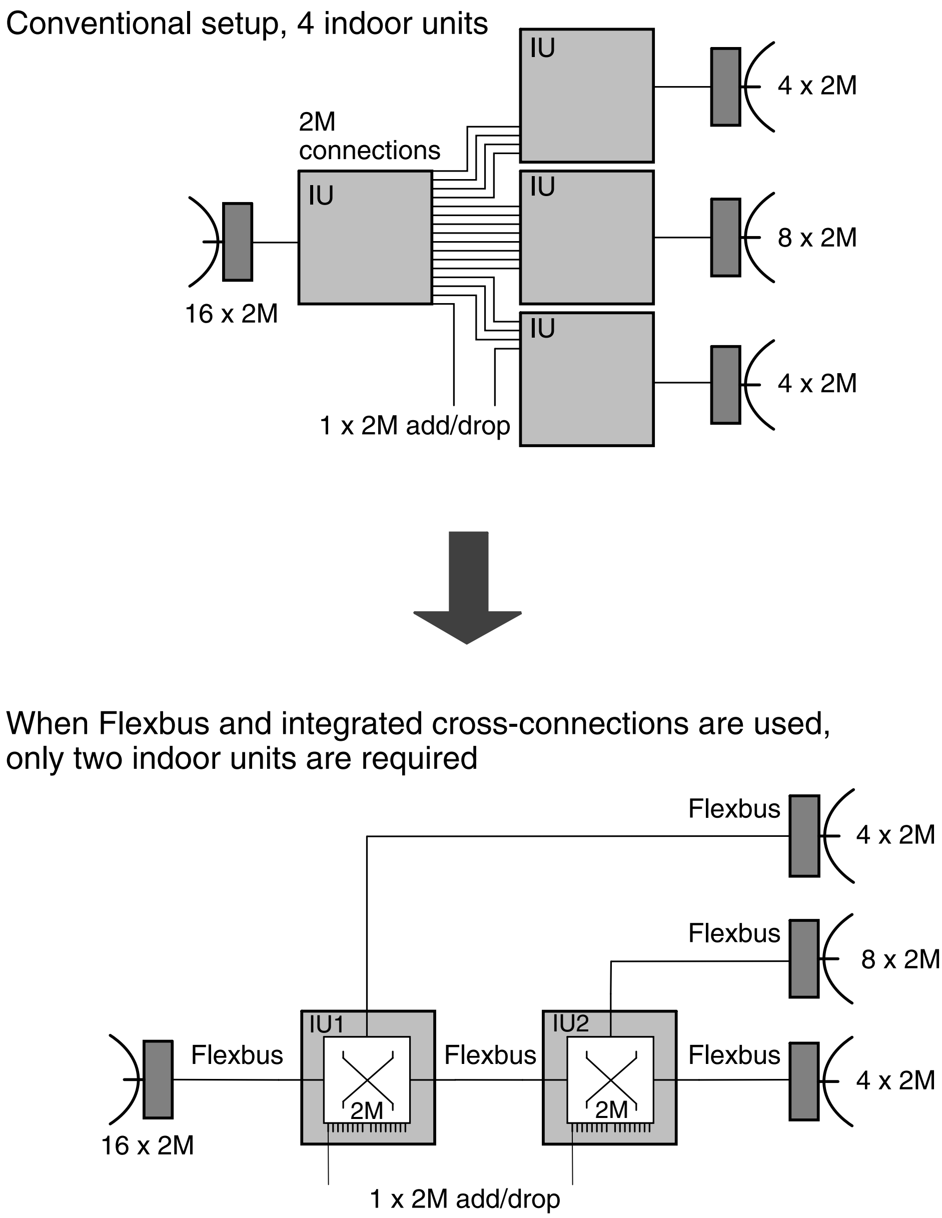


Figure 5. Removing 2M cabling from a site with FIU 19 and Flexbus

In a conventional setup (Figure 6, left) the system elements are connected together using several 2M cables. All these can be replaced with a single Flexbus cable (Figure 6, right). Note that in this example, in a conventional 16 x 2 Mbit/s 75 Ω unbalanced system, there could be up to 96 cables.

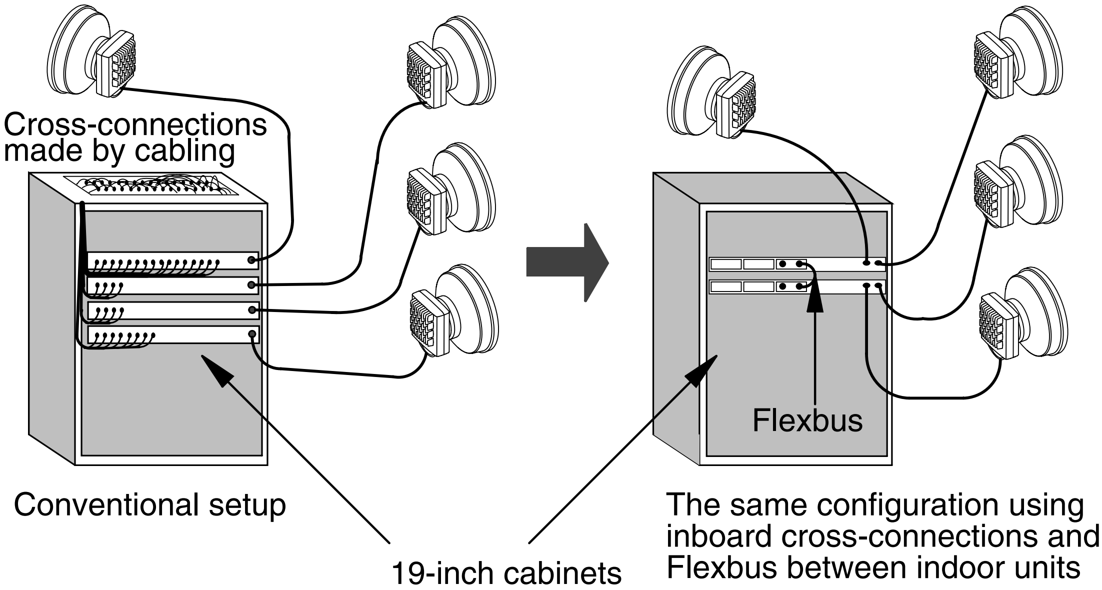


Figure 6. Site cabling effect

The cross-connections (which replace the conventional cabling) can be modified using Nokia Hopper Manager. The cross-connections in IU2 in Figure 5 are pictured in Figure 7.

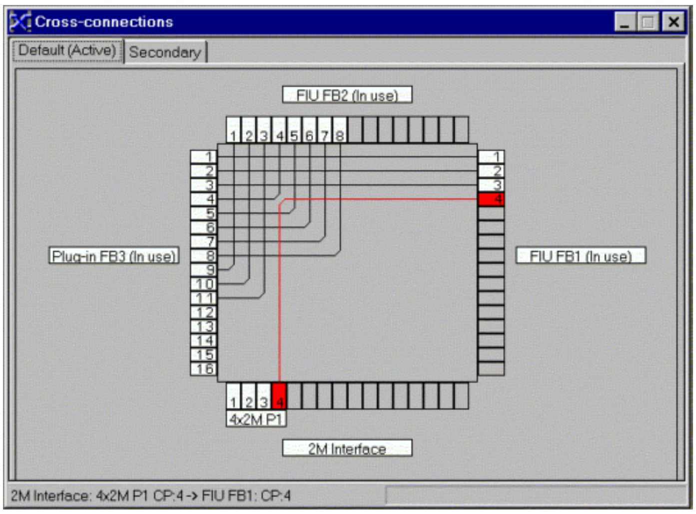


Figure 7. Cross-connections on a node manager window

3.2 Nokia FlexiHopper outdoor unit

3.2.1 Forward error correction and interleaving

Nokia FlexiHopper radios use forward error correction (FEC) and interleaving to improve signal quality. The FEC is continuously on and the interleaving is selectable between off, 2-depth, and 4-depth modes. The forward error correction uses Reed-Solomon coding [RS(63,59)]. The code uses 4 redundancy symbols for every 59 data symbols, so the redundancy of the coding is 6.4%. Together with interleaving also errors of burst type can be corrected. Maximum error correction effectiveness is achieved with 4-depth interleaving.

When the interleaving is in use, transmission delay increases slightly (see Table 6 in Section 7.1). This is normally not a problem, but in long chains of radio-links the delay accumulates, and it might be necessary to turn the interleaving off. Acceptable delay for a chain of links should be determined in transmission planning stage and the interleaving status set accordingly.

Note

Interleaving must be the same in both ends of the hop. Otherwise, transferred data is not received correctly. Keep interleaving always as 'depth-4' if no special conditions are needed.

3.2.2 ALCQ (Adaptive Level Control with Quality measure)

ALCQ is a method for automatic transmit power control. This feature enables the radio transmitter to increase or decrease the transmit power automatically, according to the response received from the other end of the hop. This approach achieves more efficient utilization of radio frequencies than the constant level approach. The controlled use of transmit power reduces interference between systems, which, in turn, allows tighter packing of radio links within the same geographical area or at network star points. For more information on ALCQ, refer to the *ALCQ and Automatic Fading Margin Measurement in FlexiHopper Microwave Radio* application note that can be obtained upon request.

The maximum transmit power is set with Nokia Hopper Manager. However, when ALCQ is in use, the radio always tries to transmit at minimum power. The common idea behind the ALCQ is to monitor the received signal level together with the bit error ratio (BER) of the receiver, and to adjust the far-end transmitter output power to adapt to the fading conditions. In addition to these conventional ALCQ operation mechanisms, FlexiHoppers also apply a novel pseudo-error monitoring for controlling ALCQ. According to this Nokia invention, the bit errors detected by forward error correction (FEC) decoder are interpreted as pseudo-errors, and further, used as an additional input for ALCQ operation. In other words, this invention can respond to degrading of signal quality before actual bit errors occur over the radio relay.

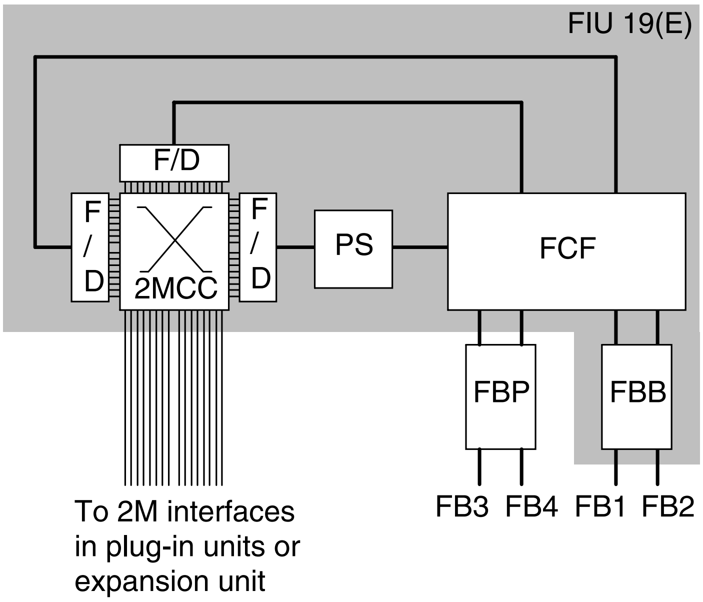
If the fading increases rapidly (multipath fading), the radio reacts immediately by increasing the power, but not higher than the set maximum value. After the fading conditions resume to normal, the power is gradually decreased. ALCQ also reacts to slow changes in fading conditions by gradually increasing the transmit power.

3.2.3 Automatic fading margin measurement

During the commissioning of a microwave radio, the operator may wish to measure the fading margin of the radio hop. Traditionally this has required much work and additional hardware, such as RF (radio frequency) attenuators. In Nokia FlexiHopper, the fading margin measurement is automatic and can be started simply by using software. For more detailed information, refer to the *ALCQ and Automatic Fading Margin Measurement in FlexiHopper Microwave Radio* application note that can be obtained upon request.

3.3 FIU 19 indoor units - FIU 19, FIU 19RJ, and FIU 19E

FIU 19 is the indoor unit for 19-inch mechanics applications. One FIU 19 can support up to four outdoor units. FIU 19 can feed power to two outdoor units via the Flexbus connections. When more than two outdoor units are used, a Flexbus plug-in unit with its own power supply is required. When four outdoor units are connected, the OUs connected through the main unit Flexbus interfaces (FB1 and FB2) must be configured to protected mode. So transmission to a maximum of three directions can be achieved with one FIU 19 indoor unit.



2MCC = 2 Mbit/s cross-connection
F/D = Framing/deframing section
FCF = Flexbus connection field
PS = Protection switch
FBB = Flexbus block
FB1, FB2 = Flexbus interfaces in the main unit (can be used for protection)
FBP = Flexbus plug-in unit
FB3 = Flexbus interfaces in the plug-in unit
FB4 = Flexbus interfaces in the plug-in unit (only available if protection between FB1 and FB2 is in use)

Figure 8. Routes of 2 Mbit/s and Flexbus signals in FIU 19(E)

FIU 19(E) has a modular construction, with optional plug-in units and an expansion unit. Settings are made easily with the node manager. Different site configurations can be implemented flexibly and with minimal costs.

Full 1+1 protection (2IU/2OU) can be implemented with FIU 19 and Nokia FlexiHopper. In this case, two FIU 19 main units are connected via an expansion unit (see Section 3.7).

Note

For FIU 19RJ and FIU 19E, the connector types for LMP, Q1, and Q2 are RJ-45.

Note

If the power cable of FIU 19E is longer than 10 m, a PSA cartridge must always be used for the power supply.

Auxiliary interfaces

The FIU 19 aux data plug-in unit offers the possibility of using various auxiliary data channels. The plug-in unit has four auxiliary data interfaces (RJ-45 connector), and the input or output of these interfaces can be set with Nokia Hopper Manager.

With one plug-in unit, it is possible to use one aux fast channel and one aux slow channel at the same time. The maximum bit rate of these channels depends on the transmission capacity of the signal. In addition, four TTL type programmable I/O channels (software controlled) and/or relay control outputs can be used. Relay controls can be used to turn on equipment rack lights, for example. See Section 7.6.1 for the specifications of the auxiliary channels.

Note

One fast and one slow auxiliary data channel can be connected to one Flexbus direction.

3.4 RRIC indoor unit

RRIC is a plug-in indoor unit which fits directly into Nokia Citytalk and Nokia Intratalk base stations. The base stations can house two RRIC units. As each RRIC supports two outdoor units and can feed power to them via the Flexbus connections, a total of four outdoor units per BTS can be supported.

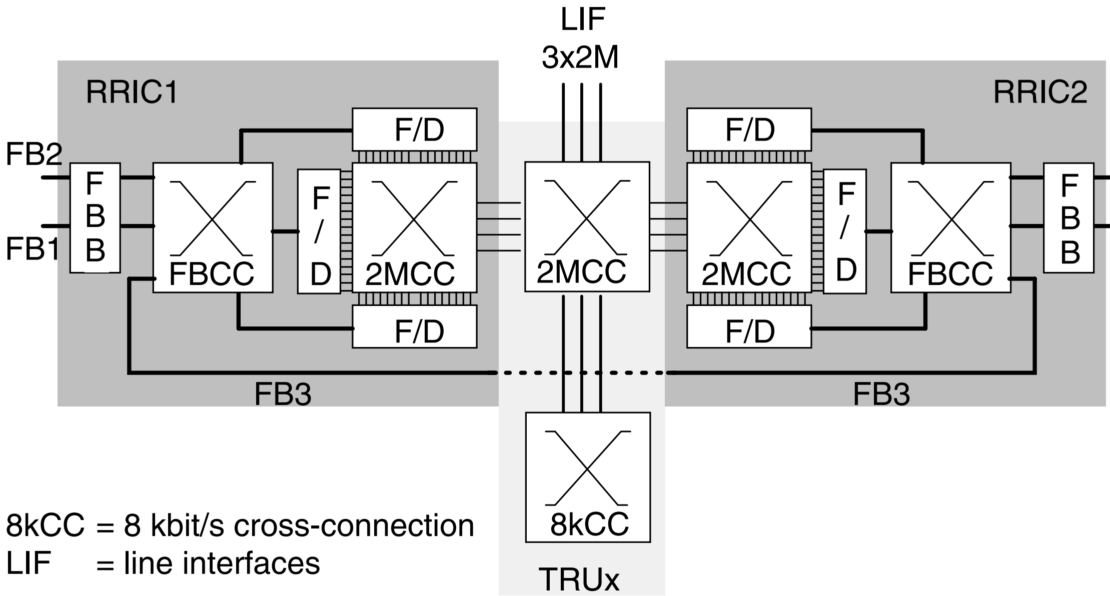


Figure 9. Routes of 2 Mbit/s and Flexbus signals in RRIC and TRUx

RRIC provides 4 x 2 Mbit/s add/drop capacity to the base station transmission unit (TRUx) and up to 16 x 2 Mbit/s bypass capacity internally via Flexbus 3 to another RRIC unit in the same BTS. The 2 Mbit/s cross-connect function is integrated into the RRIC indoor unit.

RRIC supports various protection methods (1IU/2OU) for the connected Nokia FlexiHopper radios (see Section 3.7). Loop protection is available on the RRIC indoor unit together with the TRUx base station transmission unit.

3.5 FXC RRI indoor unit

FXC RRI indoor unit is fully integrated with Nokia MetroSite GSM BTS, Nokia MetroHub, or Nokia UltraSite EDGE BTS. FXC RRI supports two outdoor units and provides up to 16 x 2 Mbit/s add/drop capacity towards Nokia MetroHub. FXC RRI has an integrated 8 kbit/s cross-connection function, enabling loop protection and grooming.

If the total Flexbus interface traffic in one FXC RRI is more than 16 x 2 Mbit/s, the extra traffic can be bypassed from one Flexbus interface to another in a separate 2 Mbit/s cross-connection field.

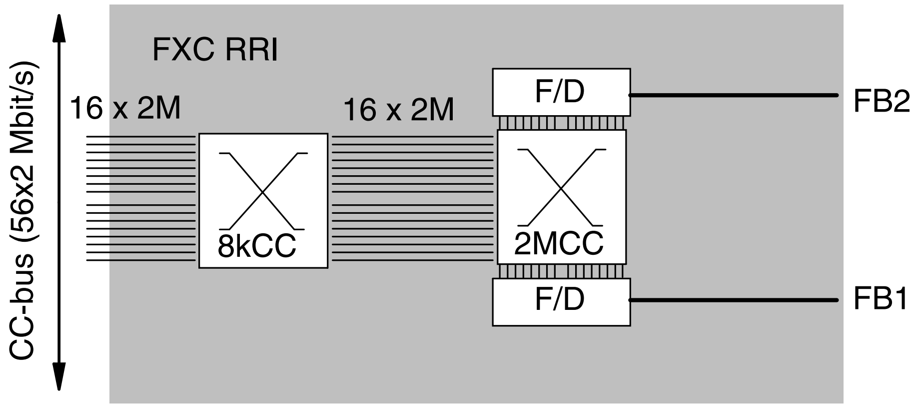


Figure 10. Routes of 2 Mbit/s and Flexbus signals in FXC RRI

3.6 IFUE interface unit

IFUE (IFU3FB) is the interface unit with three Nokia proprietary Flexbus interfaces, each with a maximum capacity of 16 x 2 Mbit/s.

Front panel interfaces

IFUE has three coaxial Flexbus TNC connectors (50 Ω) on the front panel. IFUE also features a local management port (BQ connector) for managing the connected radio equipment. A 3-colour status LED on the front panel indicates the operational status of the unit. In addition, each Flexbus interface has an own status LED.

For more information on the IFUE interface unit, refer to the *FlexiHopper and MetroHopper with IFUE User Manual*.

3.7 Protection methods

In single use, the signal is not protected against equipment or propagation faults. In the event of a fault, the connection remains broken until the equipment fault has been repaired or the cause for the propagation fault goes away.

Note

ALCQ (see Section 3.2.2) can provide some protection against propagation faults.

Three types of transmission protection are available with Nokia FlexiHopper: equipment protection, propagation protection, and loop protection.

Equipment protection

Equipment protection protects a single transmission link against faults in the equipment. In equipment protection a pair of Nokia FlexiHopper outdoor units (and possibly also a pair of indoor units) are protecting each other.

Equipment protection can be implemented by any of the following methods (with the FIU 19, and RRIC indoor units):

- hot standby (HSB) with one antenna
- HSB with two antennas

Propagation protection

Propagation protection is used to minimize the number of traffic interruptions due to interference in the transmission path. In propagation protection, a pair of Nokia FlexiHopper outdoor units (and possibly also a pair of indoor units) are protecting each other.

The changeover caused by propagation interference is error-free (hitless).

Propagation protection can be implemented by hot standby and space diversity (with the FIU 19 and RRIC indoor units).

Loop protection

Loop protection is actually a type of network topology. It differs from the former methods in that it protects an entire transmission route and not a single link. If required, single links in a loop can be protected with equipment or propagation protection methods.

Loop protection protects both against equipment faults and against interference in the transmission path. When a fault is detected, traffic is routed in the opposite direction around a ring of radio links.

With Nokia FlexiHopper the capacity of a loop can be up to 16 x 2 Mbit/s. The add/drop capacity at a loop site depends on the indoor unit used.

The FXC RRI indoor unit has an integrated 8 kbit/s cross-connection section which enables loop protection. See *Nokia MetroHub Transmission Node User Manual* for more information.

With the RRIC indoor unit, loop protection is available together with the TRUx base station transmission unit. See the relevant TRUx manual for more information.

Loop protection can also be implemented with the FIU 19 indoor unit, if external cross-connection equipment is used (Nokia DN2 Dynamic Node Equipment, for example).

3.7.1 Hot standby, hot standby + space diversity

Hot standby (HSB) equipment protection can be implemented with either one or two indoor units (FIU 19 only). When two FIU 19 units are used, they are connected through an expansion unit (EXU).

In hot standby mode, the transceivers of both radios are on, but the transmitter of the protecting radio is in mute state.

HSB can also be implemented with a single antenna. Two outdoor units are connected to one antenna via a directional coupler. The method is known as one-antenna protection and it is especially useful with larger antennas (120 and 180 cm). One-antenna protection eliminates the need to install expensive tower support structures for two antennas, and may also reduce site rent costs, if the rent paid by the operator is determined according to the number of antennas installed.

Hot standby + space diversity (HSB+SD) provides protection against both equipment and propagation faults. The setup is similar with HSB, except that the antennas of the radios are placed apart far enough, so that it is unlikely for the same propagation problem to occur simultaneously at both antennas.

1IU/2OU HSB or HSB+SD

HSB or HSB+SD setup with one indoor unit is shown in Figure 11. Active units are shown in grey and passive units in white.

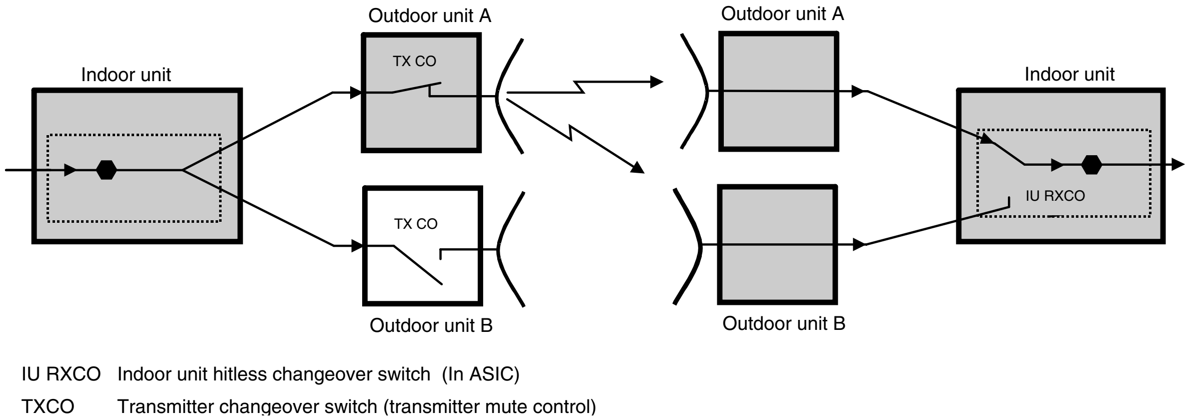


Figure 11. Nokia FlexiHopper with FIU 19 or RRIC, 1IU/2OU HSB or HSB+SD (only one direction shown)

Outdoor unit transmitter changeover switches (TXCO) are controlled by the indoor unit's processor. Active outdoor unit is changed if a hardware fault is detected in the unit or if the far-end radio cannot receive the signal. Changeover can also be performed when the reception quality at the far-end degrades.

Indoor unit hitless Rx changeover switch (IU RXCO) is located in ASIC and it is hardware controlled. Changeover is based on detected FEC (forward error correction) errors. Hitless Rx changeover is also possible by the control of the indoor unit's processor.

2IU/2OU HSB or HSB+SD

HSB or HSB+SD setup with two indoor units is shown in Figures 12 and 13. Active units are shown in grey and passive units in white.

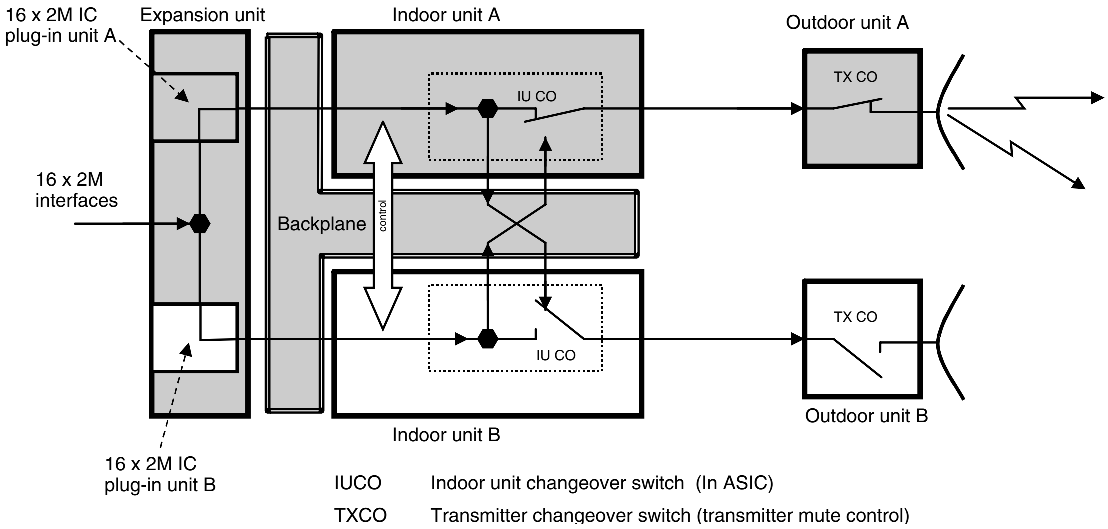


Figure 12. Nokia FlexiHopper with FIU 19, 2IU/2OU HSB or HSB+SD (Tx direction)

Indoor unit Tx changeover switches (IUCO) are located in ASICs and they are controlled by the active (master) indoor unit's processor. The IU processors are connected together with protection bus via the backplane.

The baseband branching in the expansion unit consists of passive components only (printed circuit board, wiring, and connectors). All active components of the expansion unit are located in the interface circuit (IC) plug-in units.

Active IU (master) is changed to passive (slave) if a hardware fault is detected.

Outdoor unit transmitter changeover switches (TXCO) are controlled by the active (master) indoor unit's processor. Active outdoor unit is changed if a hardware fault is detected in the unit or if the far-end radio cannot receive the signal. Changeover can also be performed when the reception quality at the far-end degrades.

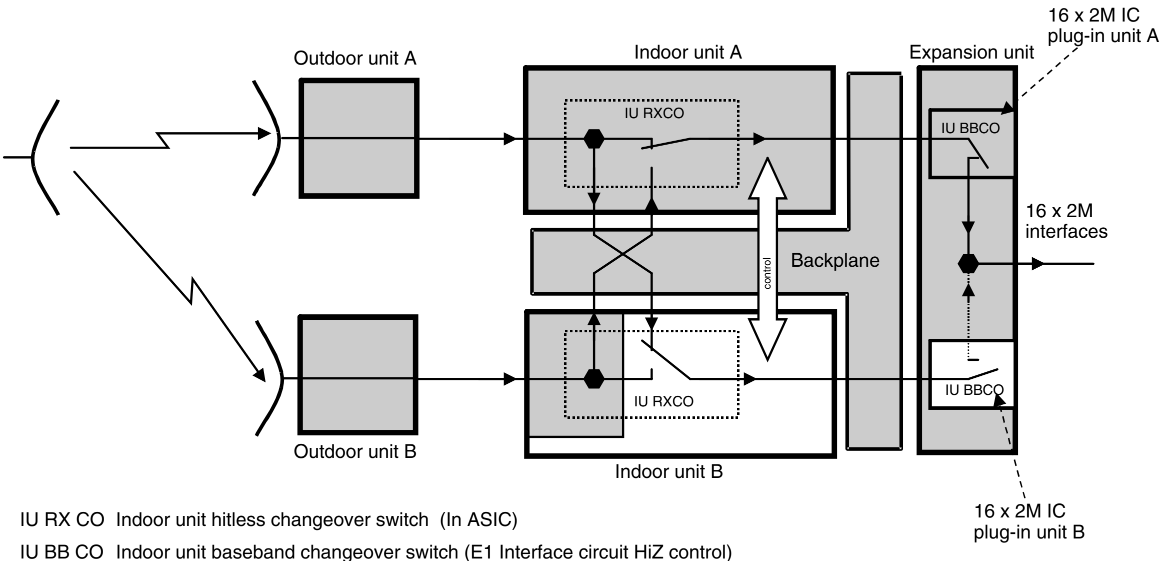


Figure 13. Nokia FlexiHopper with FIU 19, 2IU/2OU HSB or HSB+SD (Rx direction)

Indoor unit hitless Rx changeover switch (IU RXCO) is located in ASIC and it is hardware controlled. Changeover is based on detected FEC (forward error correction) errors. The hardware controlled changeover function is independent in both indoor units.

Hitless Rx changeover is also possible by the control of the indoor unit's processor. Both protection switches are controlled by the active (master) indoor unit's processor. The processors are connected together with protection bus via the backplane.

Indoor unit Rx baseband changeover switches (IU BBCO) are located in the IC plug-in units. Both outputs from plug-in unit interface circuits are connected together in the expansion unit. The interfaces of the passive (slave) indoor unit are set in high-impedance state and the signals from the active (master) indoor unit are connected to the 2M outputs.

Active IU (master) is changed to passive (slave) if a hardware fault is detected.

3.7.2 Frequency diversity, polarisation diversity

Note

Frequency and polarisation diversity are not available in the present FlexiHopper releases.

Frequency diversity provides protection against both equipment and propagation faults. In frequency diversity, two transmitters are transmitting the same signal simultaneously on different frequencies.

Polarisation diversity provides protection against both equipment and propagation faults. Polarisation diversity is otherwise identical to frequency diversity, but instead of two frequencies, the signal is transmitted on two polarisations simultaneously.

1IU/2OU FD or PD

Frequency diversity or polarisation diversity setup with one indoor unit is shown in Figure 14. Active units are shown in grey and passive units in white.

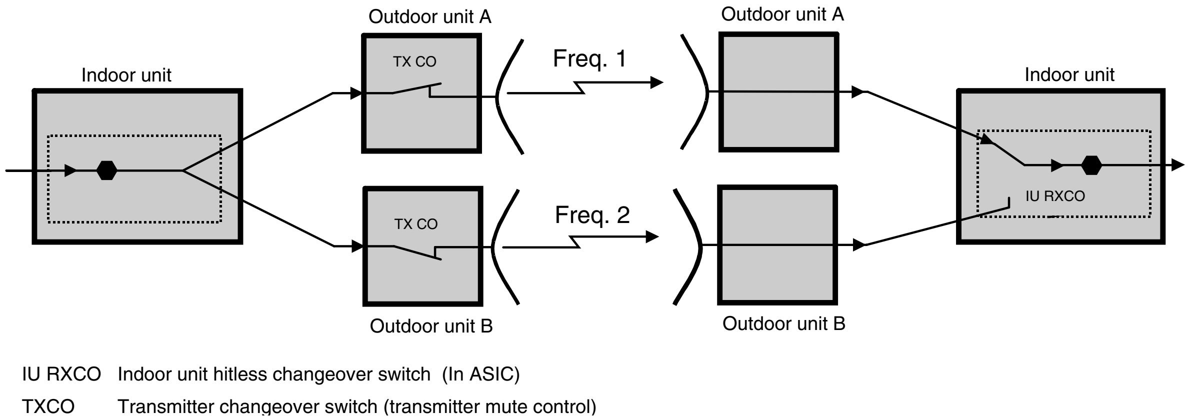


Figure 14. Nokia FlexiHopper with FIU 19 or RRIC, 1IU/2OU FD or PD (only one direction shown)

On the receiver side, both signals are received and the indoor unit selects the better signal to be switched to the 2M interfaces. Selection is done with hardware controlled hitless switch (IU RXCO), located in ASIC in the indoor unit.

2IU/2OU FD or PD

Frequency diversity or polarisation diversity setup with one indoor unit is shown in Figures 15 and 16. Active units are shown in grey and passive units in white.

Selection of the master indoor unit is done based on alarms (HW faults in unit).

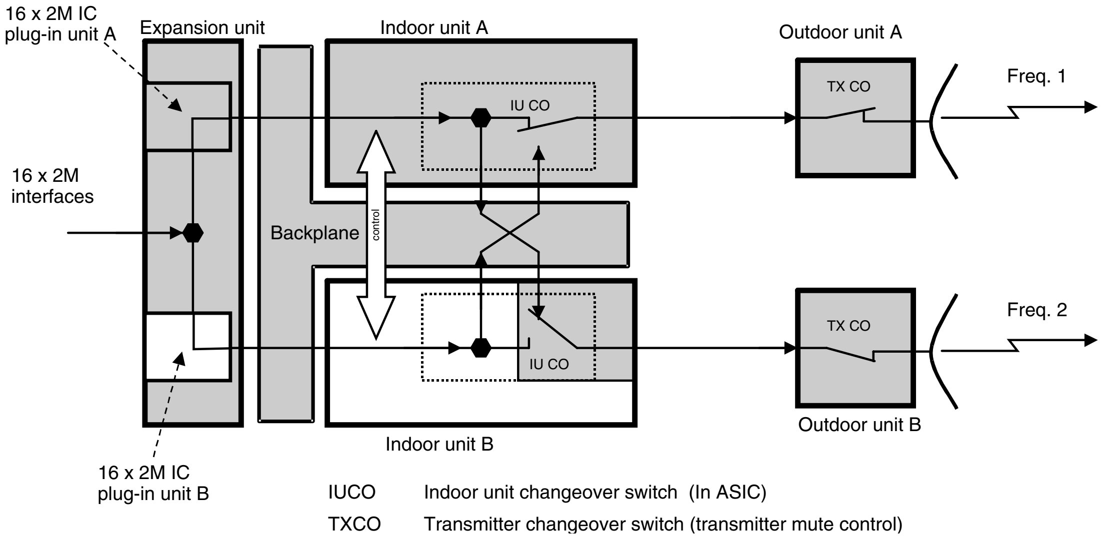


Figure 15. Nokia FlexiHopper with FIU 19, 2IU/2OU FD or PD (Tx direction)

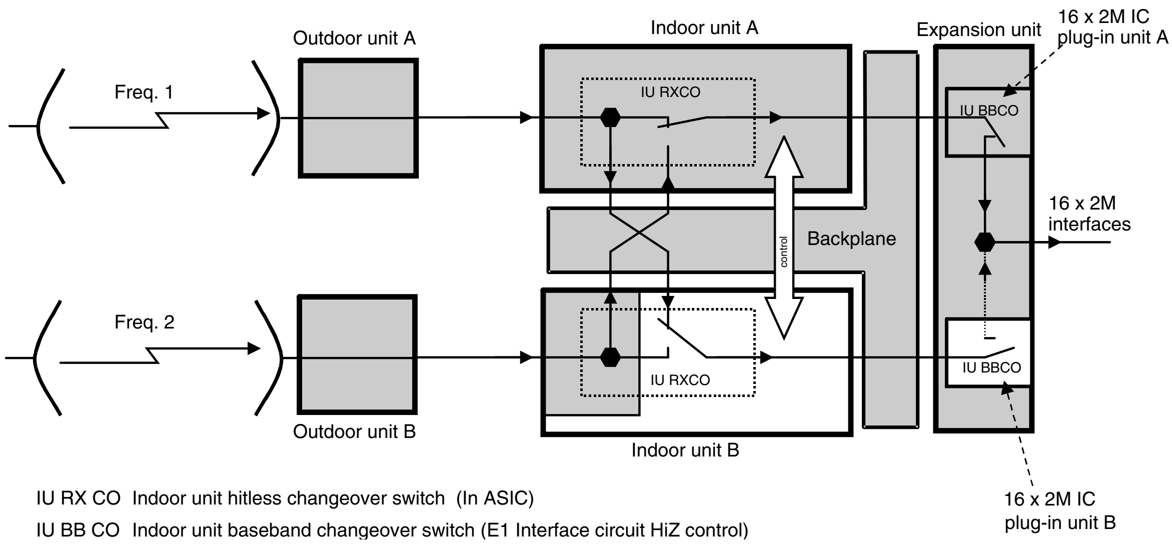


Figure 16. Nokia FlexiHopper with FIU 19, 2IU/2OU FD or PD (Rx direction)

On the receiver side, both signals are received and the indoor unit selects the better signal to be switched to the 2M interfaces. Selection is done with hardware controlled hitless switch (IU RXCO), located in ASIC in the indoor unit.

3.7.3 2IU/2OU protected chaining station

Figure 17 shows the principle of a 2IU/2OU protected chaining station implemented with the FIU 19 and Nokia FlexiHopper units. Active units are shown in grey and passive units in white.

In this figure, the 2 Mbit/s cross-connection fields (2MCC) and the framing/deframing sections and the Flexbus level cross-connections (F/D and FBCC) are also shown. The shown protection method is hot standby (or HSB+SD), but also frequency or polarisation diversity can be used.

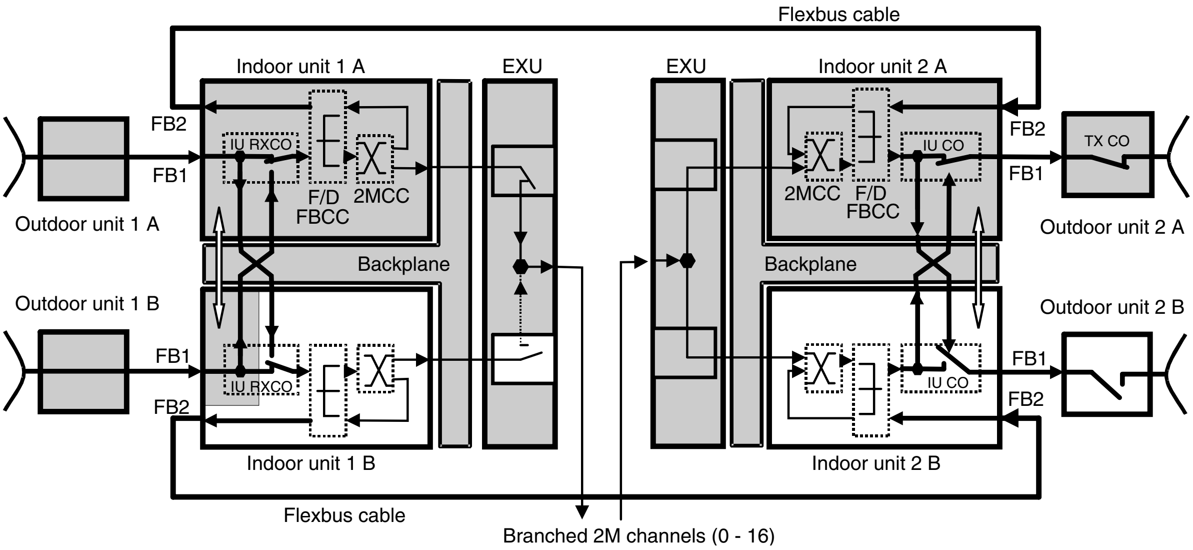


Figure 17. Nokia FlexiHopper with FIU 19, 2IU/2OU protected chaining station (only one direction shown)

In this setup:

- Repeated channels are connected by the Flexbus cables through both indoor units (A and B) from one terminal to the other.
- Repeated and branched channels are selected by the 2 Mbit/s cross-connections inside the FIU 19 units.
- Both indoor units (A and B) of each terminal have the same cross-connection settings.

3.7.4 Changeover criteria

When two indoor units (FIU 19, FIU 19E) are used, all equipment and the radio path are protected. When one indoor unit (FIU 19, FIU 19E, or RRIC) is used, the radio path is protected but the indoor unit is not. In both cases two outdoor units are used and the changeover criteria are the same. The criteria are divided in three cases: (OU) receiver changeover, (OU) transmitter changeover, and indoor unit (receive and transmit) changeover. These three are independent of each other.

Receiver changeover

In receiver changeover, the receiver switch position in the active indoor unit is changed. Depending on the received radio signal quality and available receivers, the system tries to minimise the errors in received data by selecting the outdoor unit with the lower bit error rate.

Outdoor unit is considered not available from the receiver's point of view when:

- Outdoor unit cannot lock to the incoming radio signal.
- There is no incoming radio signal.
- Outdoor unit is not connected to indoor unit, *Protection lost* alarm is generated.

If one of the outdoor units is not available (not capable for reception) or the indoor unit is not locked to the signal from the outdoor unit, the system switches and selects the available outdoor unit. *Protection lost* alarm is generated. Switching may cause bit errors.

Transmitter changeover

In transmitter changeover, the transmitting outdoor unit is changed. The indoor unit sends periodical notifications to the far-end about the radio signal quality. This makes possible to minimise errors in transmitted data.

Outdoor unit is considered not available from transmitter's point of view when:

- Outdoor unit has internal hardware errors (OU transmission incapability), *Protection lost* alarm is generated.
- Outdoor unit is not connected to indoor unit, *Protection lost* alarm is generated.

Instant transmitter changeover is performed when:

- The transmitting outdoor unit becomes unavailable, *Protection lost* alarm is generated.
- The far-end cannot receive the radio signal while near-end transmitter has no transmission faults, *Protection lost* alarm is generated.

Lazy transmitter changeover is performed when:

- The system experiences bit errors for a long period (based only on far-end BER).

Lazy transmitter changeover is possible only when both transmitters are available. It is based on analyses of the current and past events. System minimises the number of lazy transmitter changeovers, because each time when the changeover is made the synchronisation is lost.

Other factors in the lazy transmitter changeover are:

- If one of the outdoor units becomes unavailable, the system makes an instant transmitter changeover and generates *Protection lost* alarm.
- If the bit error after the changeover is 10 times more than before the changeover, the system makes another changeover back to the previous transmitter.

Indoor unit changeover

In indoor unit changeover, the active indoor unit is changed.

Basic principle in indoor unit changeover is that both receiving and transmission changes to the other indoor unit. The following criteria are used:

- Severe hardware error in the indoor unit. These are:
  - Tx-lock lost in both outdoor units
  - Rx-lock lost after rx-switch when not locked to either radio
  - 2 Mbit/s line lost in only one IU
- Hardware connection indicates that the other IU is faulty or missing (power supply missing, for example).
- Indoor unit changeover happens only once (see exception below). After that *Protection lost* alarm is activated and changeover is possible only after service operation. The terminal acts as in single use.
- 2 Mbit/s line(s) loss can cause multiple changeovers. The indoor unit which has less lost lines is always used.

3.8 Configuration backup

The Nokia FlexiHopper outdoor unit and the FIU 19 and RRIC indoor units support configuration backup. This feature makes it possible to create a backup copy of important unit configuration information to another unit(s). That information can be restored to recover from some error situations or to quickly commission a unit which is replaced.

Backups can be made automatically or manually with Nokia Hopper Manager.

The following backup cases are possible:

- Outdoor unit configuration is backed up to the indoor unit.
- Indoor unit configuration is backed up to an outdoor unit.

4 Applications

Nokia FlexiHopper is the optimal solution to a wide range of different access needs in various network environments, both in cellular and fixed applications. This chapter describes the most common of these applications.

Typical applications which can use Nokia FlexiHopper radios include:

- as an access node for Nokia UltraSite EDGE BTS or Nokia MetroSite GSM BTS
- in cellular transmission applications
  - BTS (base transceiver station) to BTS
  - BTS to BSC (base station controller)
  - BSC to MSC (mobile switching centre)
- in access applications
  - residential access
  - city access
- in dedicated networks for
  - railway companies
  - electrical utilities
  - oil and gas companies
  - defence institutions
- in PMR (professional mobile radio) systems
- in providing temporary voice or data links.

4.1 Network applications

Nokia FlexiHopper is mainly used in macrocellular sites. It can also be used in the microcell layer when there is a need for higher capacities or longer radio hops than can be achieved with Nokia MetroHopper.

After the initial roll-out phase the capacity required may increase. With its programmable capacity, Nokia FlexiHopper grows with the evolving network.

Figure 18 shows an example of transmission in a cellular network implemented using Nokia FlexiHopper with FIU 19, RRIC, and FXC RRI indoor units. Site configurations are explained in more detail in Section 4.2.

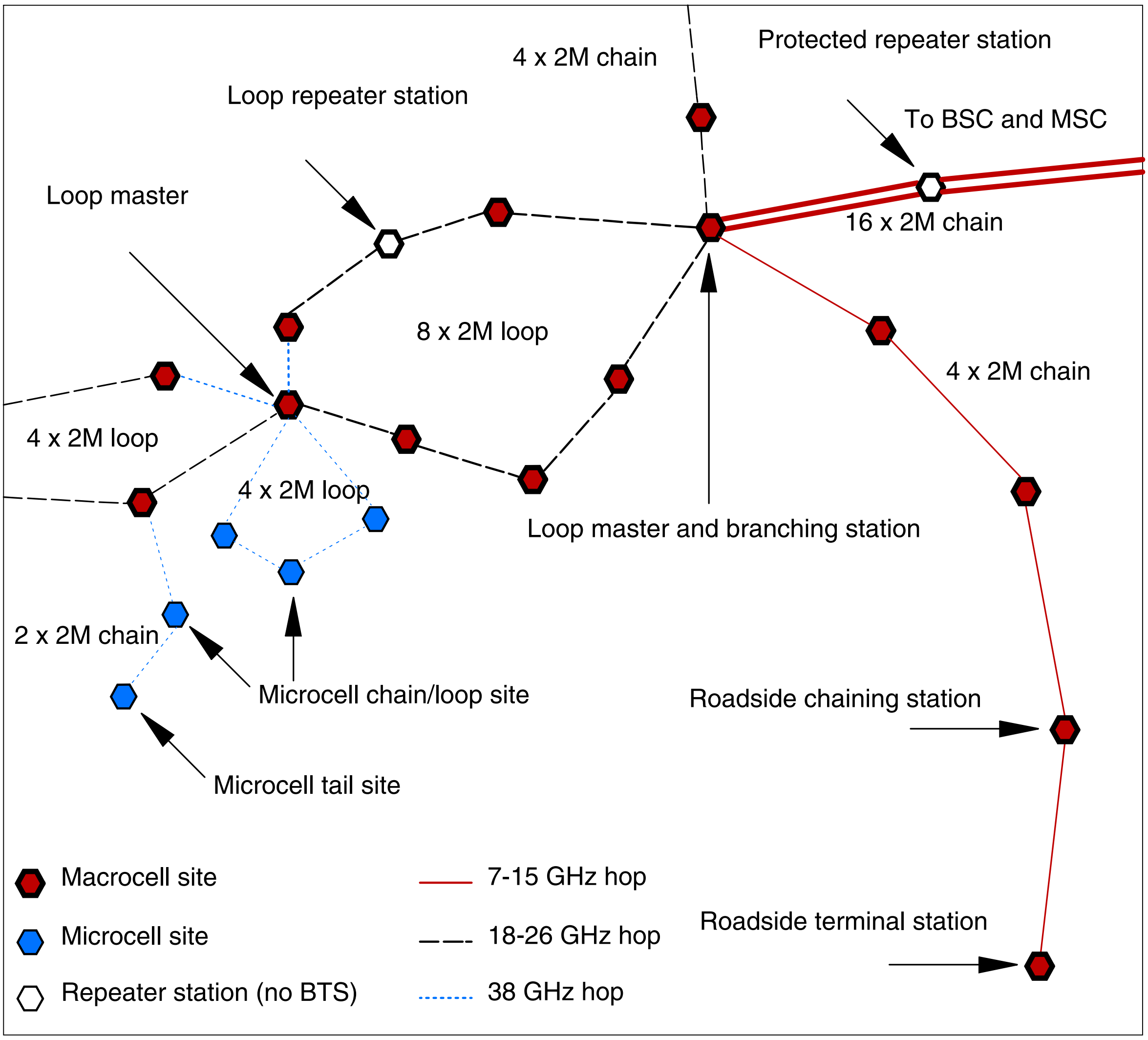


Figure 18. Example of applications with Nokia FlexiHopper in a cellular network

4.2 Site configuration examples

This section shows examples of the site configurations which can be implemented using Nokia FlexiHopper with various indoor units. The symbols used for the units are presented in Figure 19.

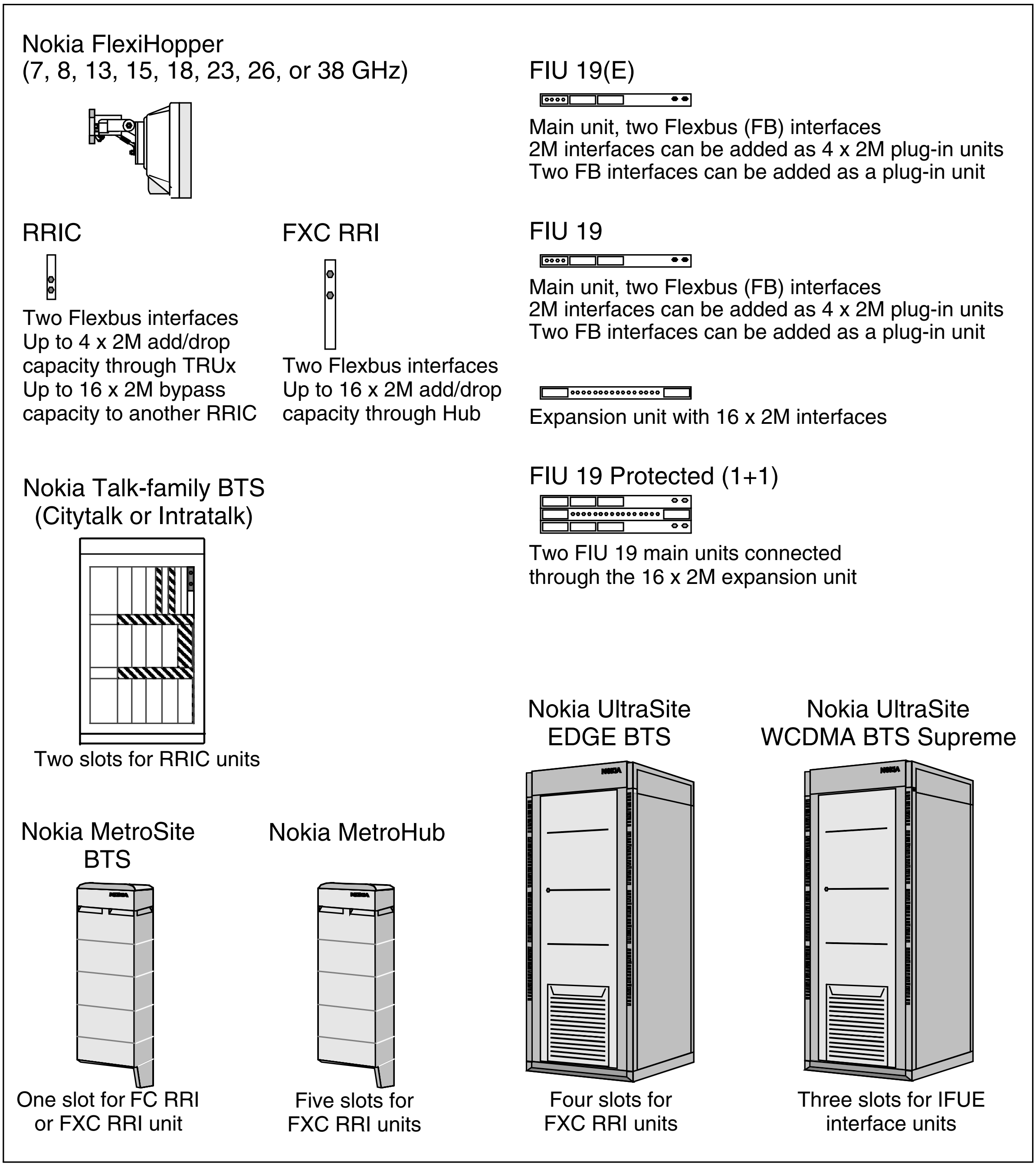


Figure 19. Key symbols used in Figures 20–31

4.2.1 Nokia FlexiHopper with FIU 19(E)

FIU 19(E) indoor unit offers many configuration possibilities. When used with a Flexbus plug-in unit, FIU 19(E) has a total of four Flexbus interfaces. Through these interfaces FIU 19(E) units can be chained without limit. When an additional power supply is connected to the plug-in unit, branching stations with one IU and up to four OUs can be implemented. When four OUs are connected, one of the transmission directions must be protected.

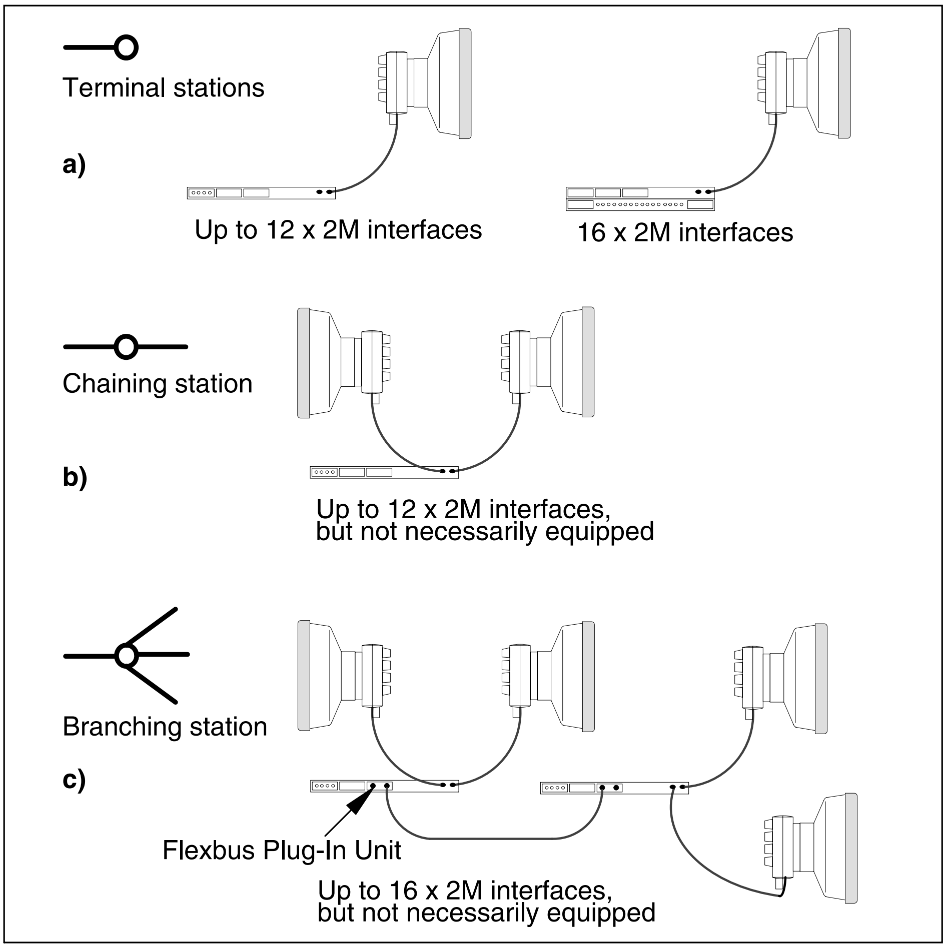


Figure 20. Unprotected stations with FIU 19

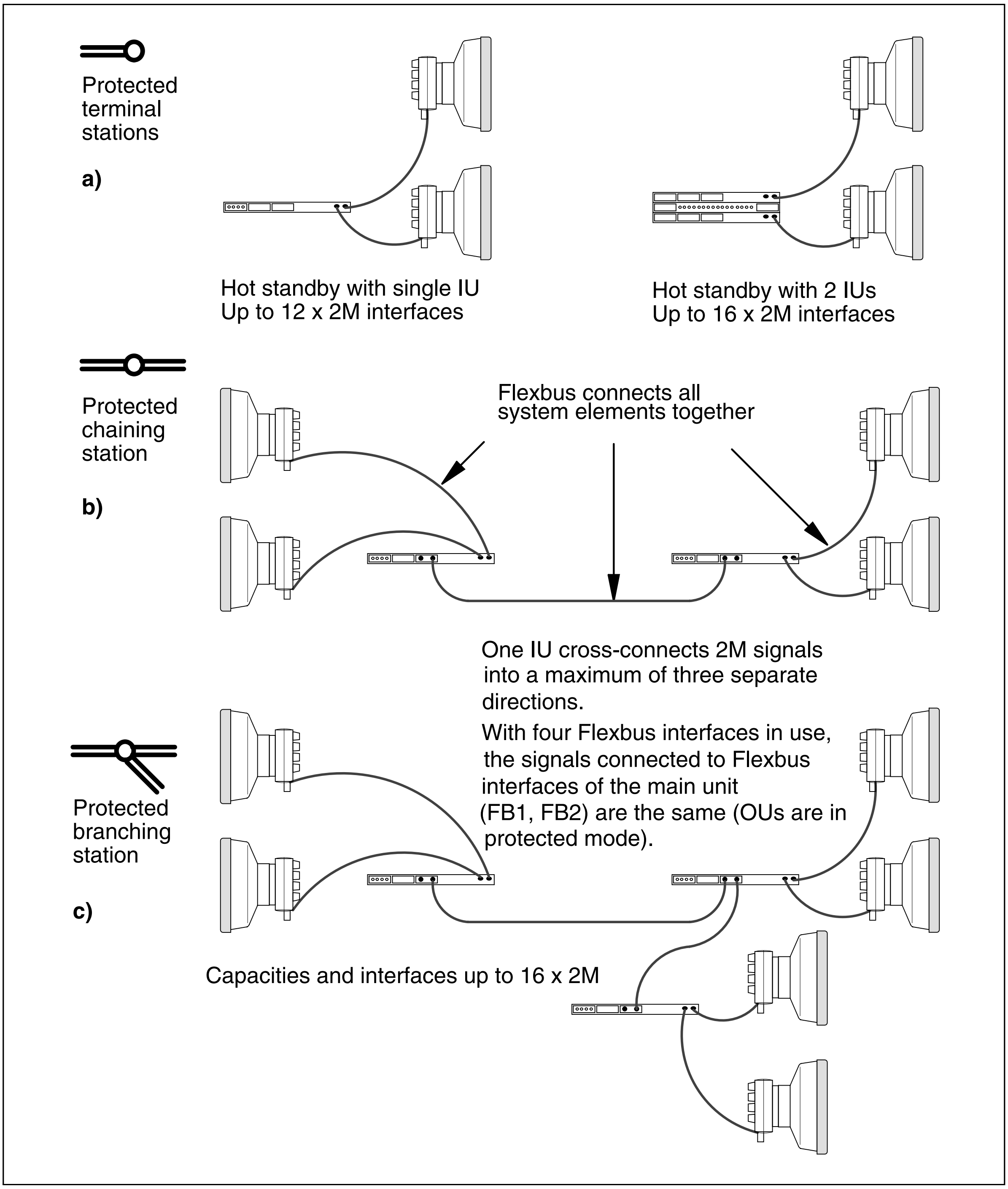


Figure 21. Protected stations with FIU 19(E)

FIU 19(E) units are only 2/3 U (29 mm) high. The actual equipping space required in a standard 19-inch rack depends on the configuration. A wide variety of site configurations can be realised with minimal use of 19-inch rack space.

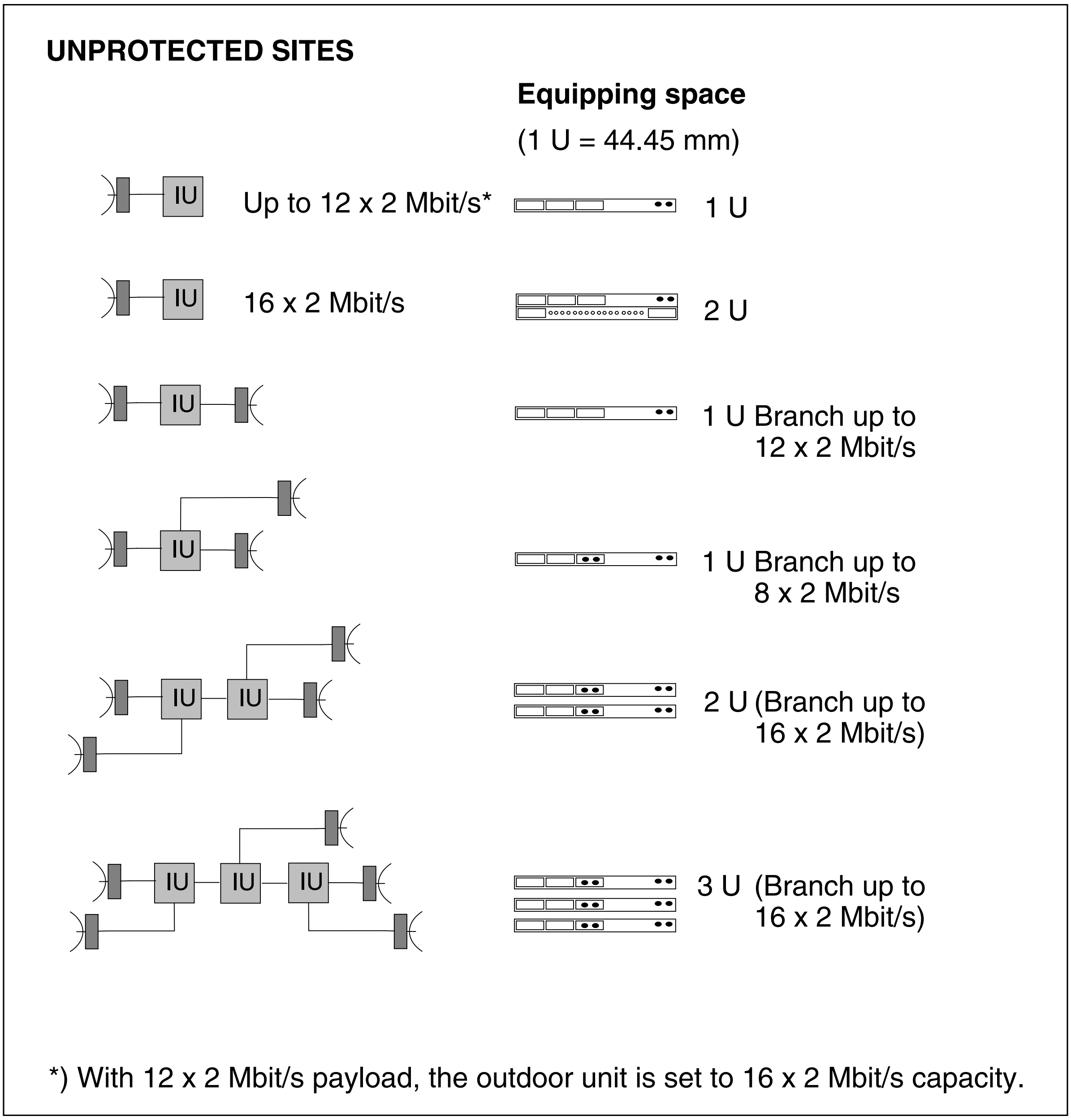


Figure 22. FIU 19 site summary – unprotected sites

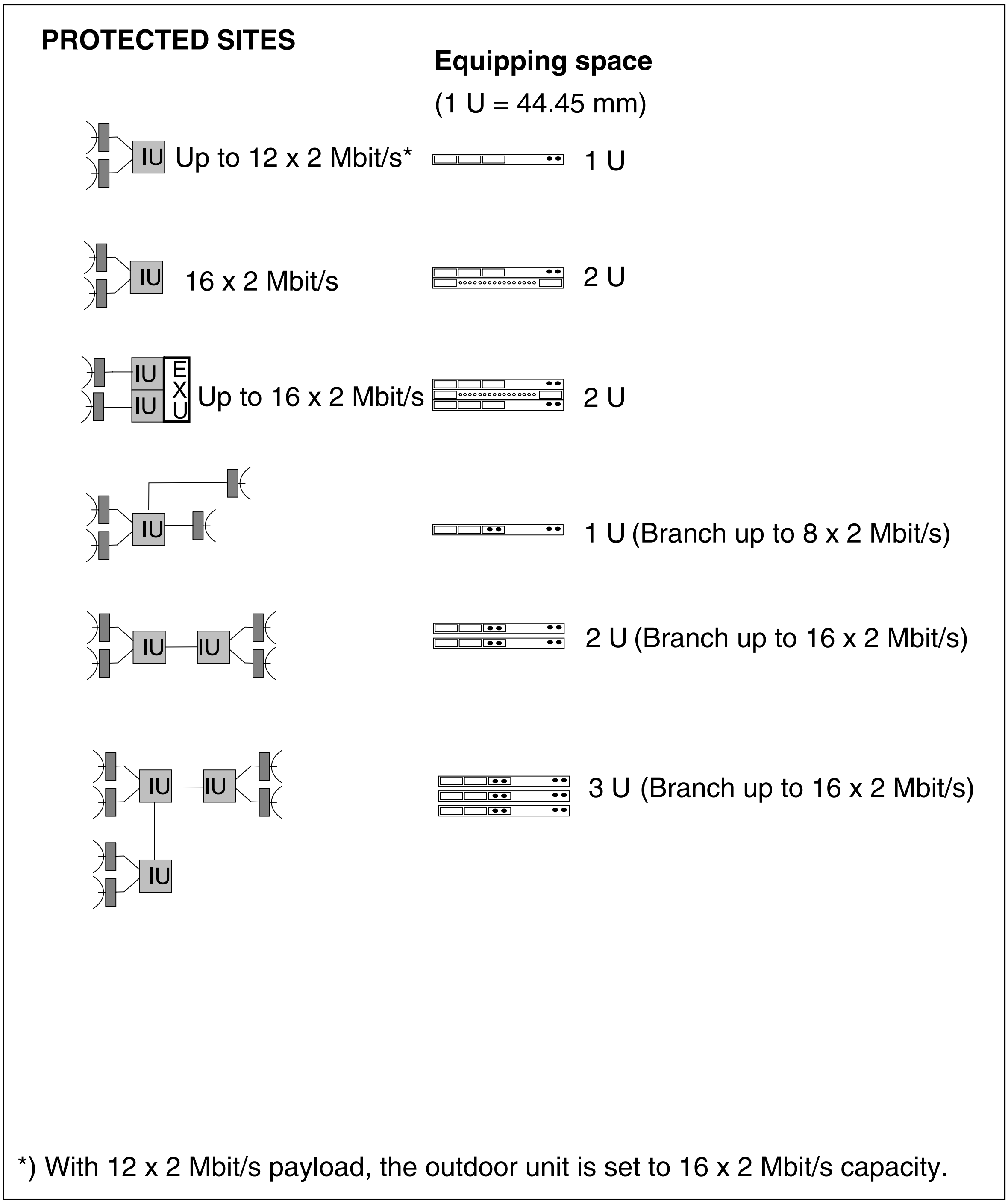


Figure 23. FIU 19 site summary – protected sites

4.2.2 Nokia FlexiHopper with RRIC

Nokia Citytalk and Nokia Intratalk base stations have slots for two RRIC indoor units. If additional transmission capacity is needed, FIU 19 indoor units can be used. For example, Nokia Extratalk Site Support System cabinet contains 6 U of 19-inch rack space where FIU 19 units can be installed.

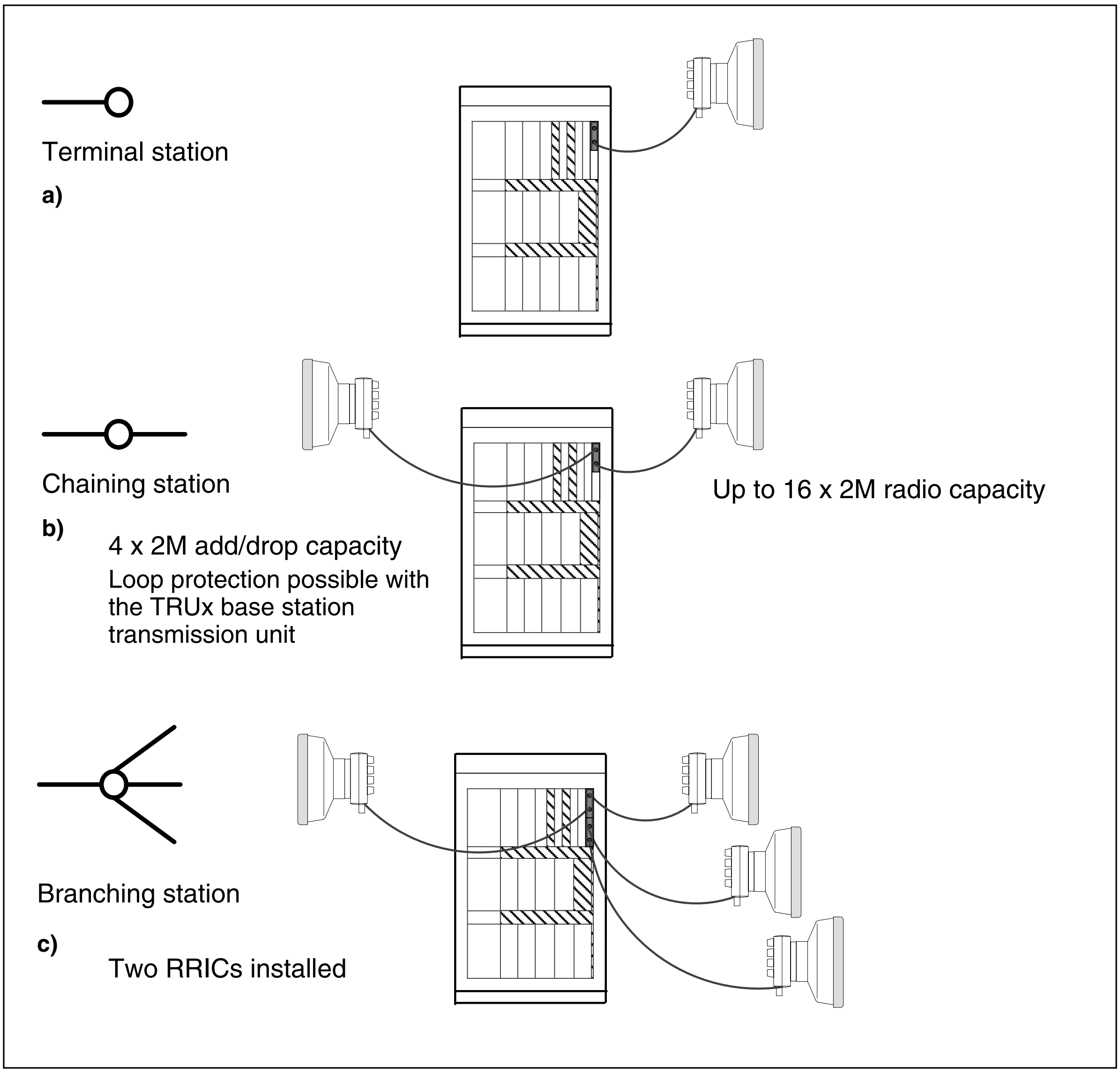


Figure 24. Unprotected sites with RRIC

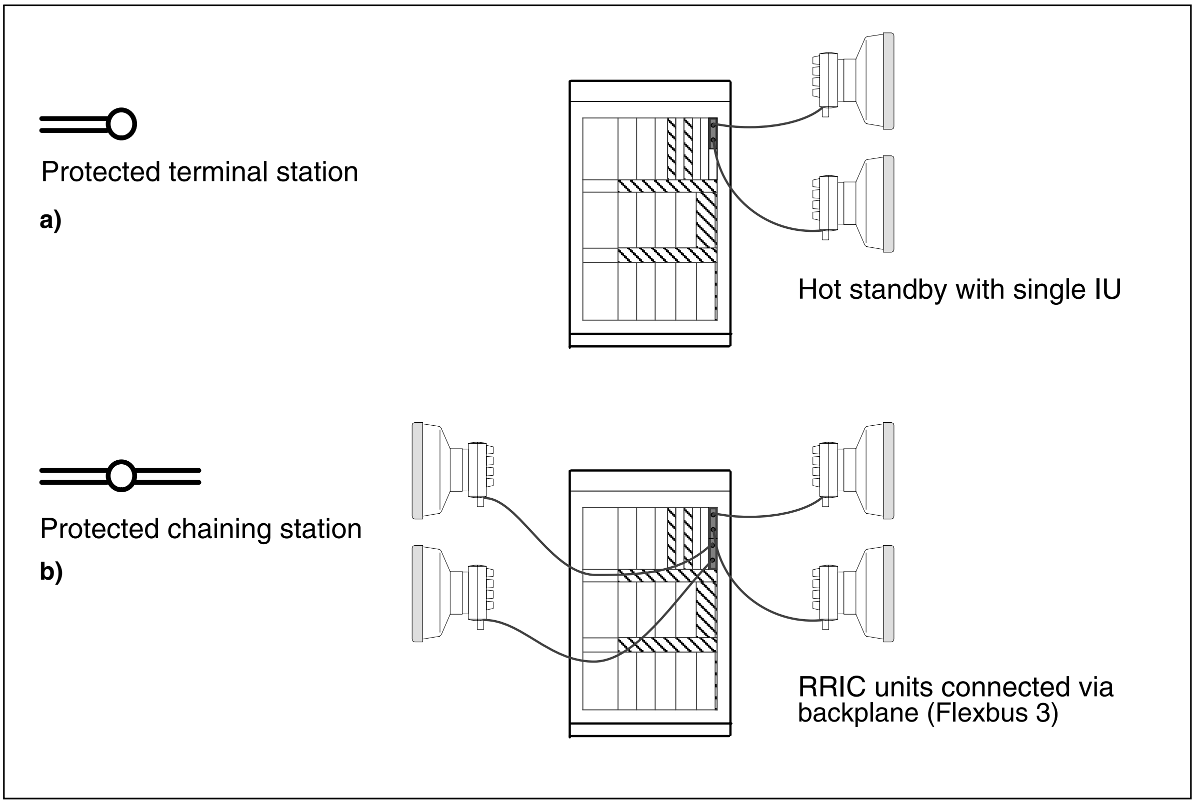


Figure 25. Protected sites with RRIC

Cross-connections between RRIC and TRUx are handled with the TruMan node manager. Example of cross-connections at a chain site is shown in Figure 26. In this example, an external cable is used. If grooming is not required, cross-connections can be made easily inside the 2 Mbit/s cross-connection field of RRIC.

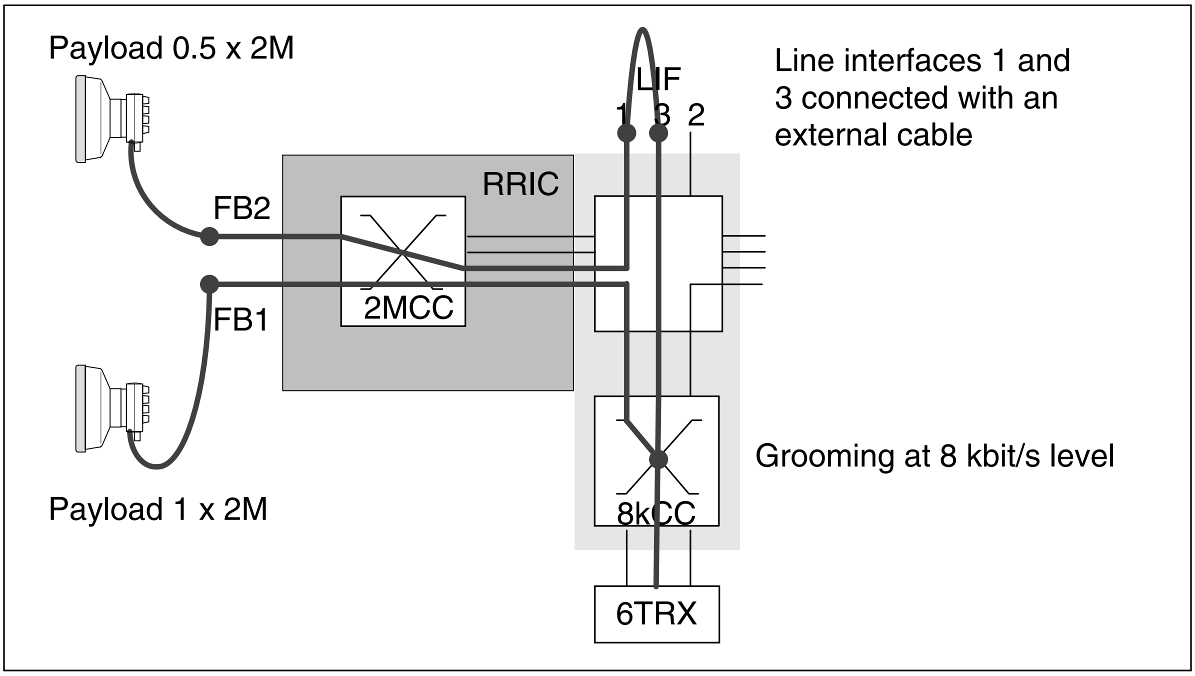


Figure 26. Chaining station with grooming capability

Figure 27 shows an example of cross-connections at a branching site.

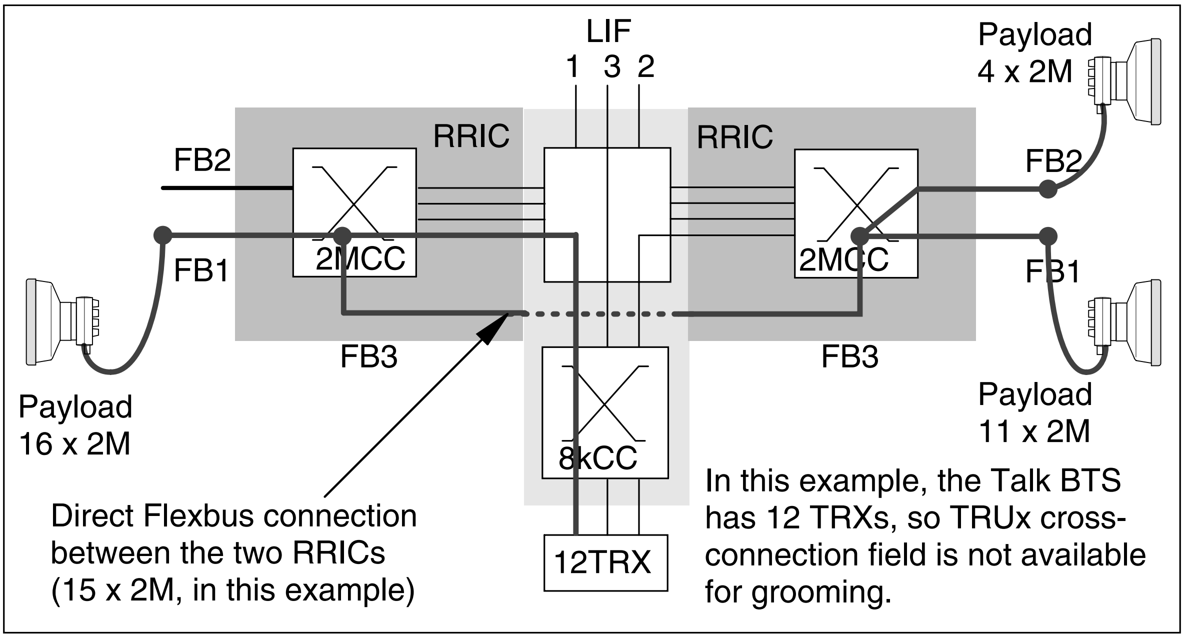


Figure 27. Branching station

Note

RRIC can be installed in the same BTS with RRIA/RRIB. In this case:

- Bypass capacity between RRIA/RRIB and RRIC is 1 x 2 Mbit/s (with an external cable).

  If the BTS is equipped with less than 12 TRX, in addition, the TRU 8 kbit/s cross-connection field can be used and the maximum capacity between RRIA/RRIB and RRIC is 2 x 2 Mbit/s.

- There is no connection between Flexbus 3 of RRIC and Repeater Bus (RBus) of RRIA/RRIB.

4.2.3 Nokia FlexiHopper at Nokia MetroSite

Nokia MetroHopper is usually the radio of choice for Nokia MetroSite transmission needs, but when more transmission capacity or longer hop distances are required, Nokia FlexiHopper can be used. Nokia FlexiHopper is fully compatible with the FXC RRI indoor unit.

Nokia MetroSite GSM Base Station has one slot for an FXC unit. Nokia MetroHub has five slots for FXC units.

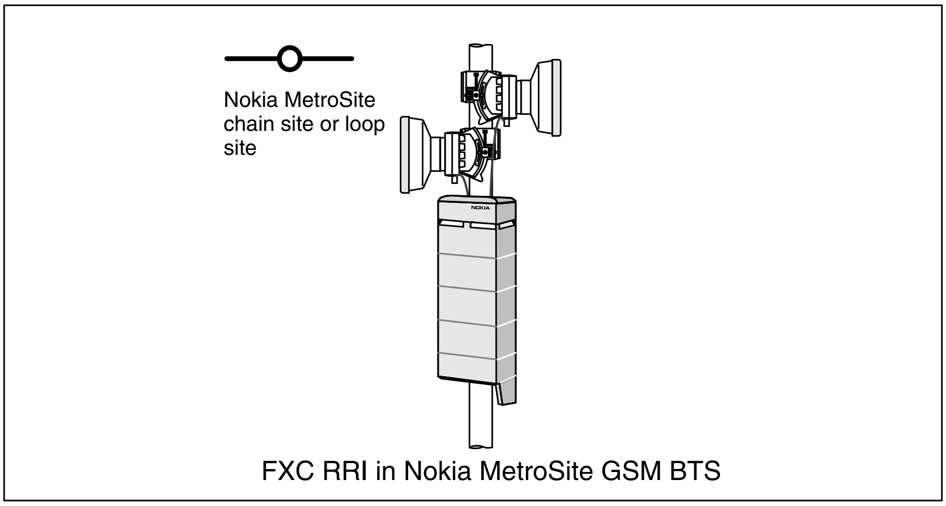


Figure 28. Nokia MetroSite GSM BTS and Nokia FlexiHopper

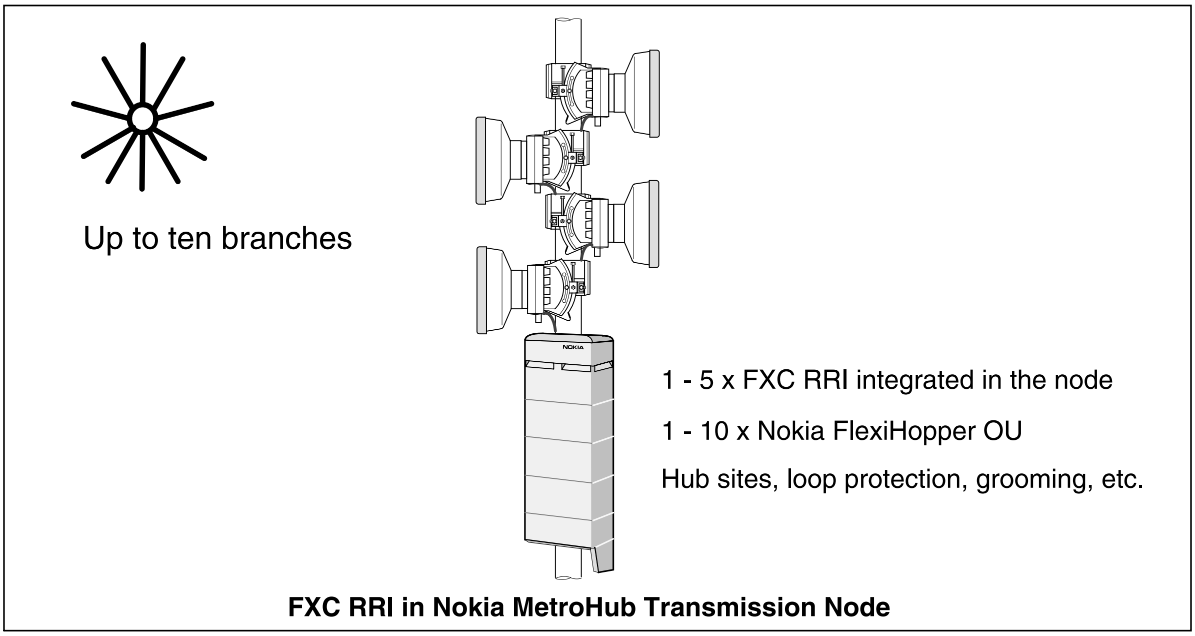
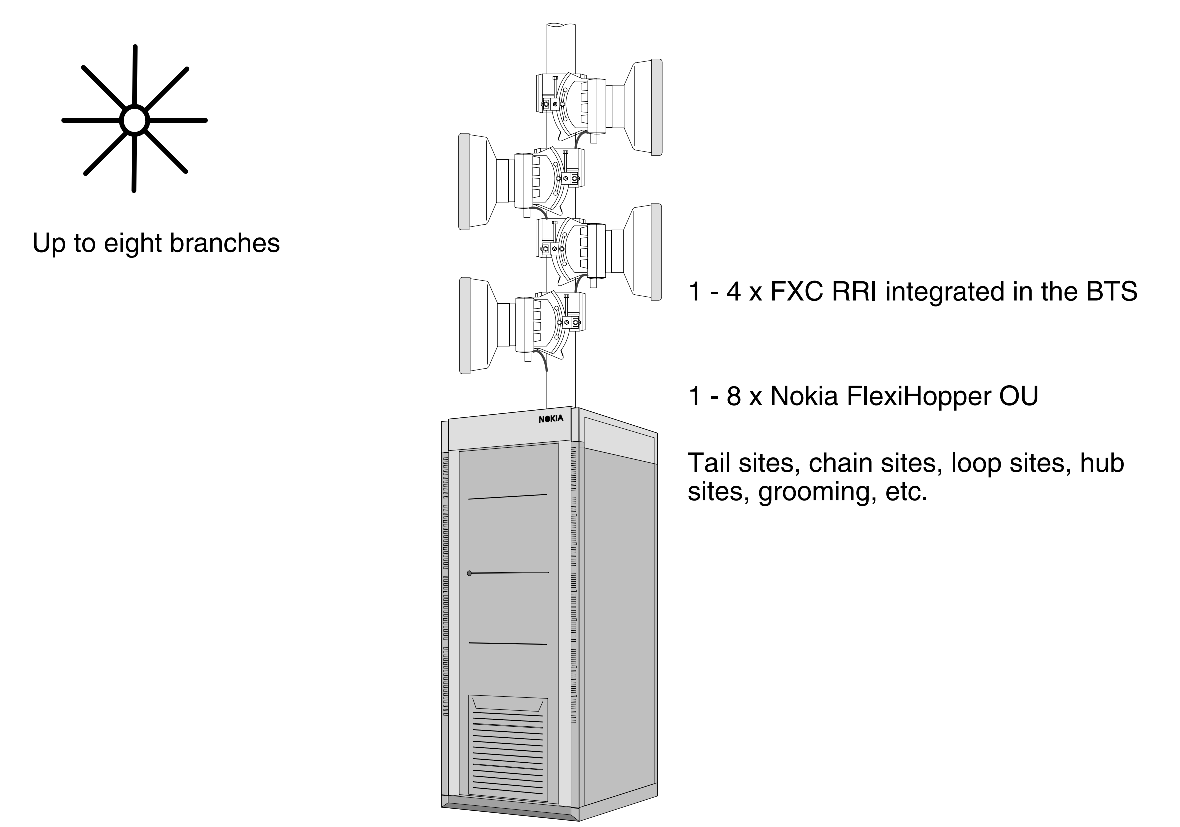


Figure 29. Nokia MetroHub and Nokia FlexiHopper

For more information on site configurations with Nokia MetroHub, see *Nokia MetroHub Transmission Node User Manual*.

4.2.4 Nokia FlexiHopper at Nokia UltraSite

Nokia FlexiHopper is connected to Nokia UltraSite EDGE BTS with the FXC RRI indoor unit.



FXC RRI in Nokia UltraSite EDGE BTS

Figure 30. Nokia UltraSite EDGE BTS and Nokia FlexiHopper

Several UltraSite cabinets can be connected together, for example, with Flexbus cables, enabling transmission to even more directions. For example, with three BTS cabinets, the maximum is 20 branches.

For more information on site transmission configurations with Nokia UltraSite EDGE BTS, see *Nokia UltraSite System Overview for GSM Evolution*.

4.2.5 Nokia UltraSite WCDMA and Nokia MetroSite WCDMA

Nokia FlexiHopper can be integrated into Nokia WCDMA base station solutions in 3rd generation networks. Nokia AXC stands for ATM Cross-connect and is the integrated transmission node for Nokia WCDMA Base Stations. AXC provides different features and interfaces to transport the ATM traffic of 3rd generation mobile networks over existing transport networks. Each AXC node consists of an ATM cross-connect unit (AXU) and a number of Interface Units (IFU). Nokia FlexiHopper is connected to the IFUE in the AXC node with a Flexbus cable.

4.2.6 Nokia GSM Office

Nokia FlexiHopper can also be used as a transmission solution for the Nokia GSM Office system. It can be connected to Nokia InSite Base Station or Nokia InHub Data Service Unit via the FIU 19 indoor unit.

5 Management

This chapter describes the management of the Nokia FlexiHopper radios with:

- the Nokia NMS
- Nokia Hopper Manager (with FIU 19 and RRIC).

Refer to *Nokia MetroSite GSM Base Station User Manual*, *Nokia MetroHub Transmission Node User Manual*, or *Nokia UltraSite EDGE Base Station User Manual* for further details on Nokia SiteWizard which is used for managing Nokia FlexiHopper with an FXC RRI indoor unit.

The Nokia FBU Manager is used for commissioning, configuring, and maintaining the MartisDXX FBU interface unit (Flexbus part), and the connected Nokia FlexiHopper Microwave Radios and Nokia MetroHopper Radios. Refer to *Nokia FBU Manager User's Guide* for further information on management with the Nokia Flexbus Unit Manager.

This chapter also introduces the use of the Q1 bus.

5.1 Nokia NMS

The Nokia Network Management System can be used centrally to collect alarm and measurement data on Nokia FlexiHopper radios in a network. The Nokia NMS can also be used to configure the radios. Communication between the Nokia NMS and the radios is via a Nokia Q1 bus.

The Nokia NMS provides a full range of functions including fault, performance, and configuration management and also transmission, trouble, and security management.

For more information, please refer to the Nokia NMS documentation.

5.2 Nokia Hopper Manager

Nokia Hopper Manager is a PC based software application for controlling and monitoring Nokia FlexiHopper and Nokia MetroHopper radios with FIU 19 and RRIC indoor units. It belongs to the Nokia product range of node managers.

Nokia Hopper Manager runs on a PC-compatible computer under Microsoft Windows 95, 98, and 2000, or Microsoft Windows NT 4.0. It has an easy to use graphical user interface with commissioning wizard that guides the user through commissioning tasks.

The manager is compatible with Nokia NMS/10. All NMS/10 compatible managers can operate at the same time on a standard PC. The manager can manage one node at a time, but several instances of Nokia Hopper Manager can be run in parallel to allow management of several nodes simultaneously.

With Nokia Hopper Manager a user can:

- commission a new node
- change the configuration of a new or previously configured node
- create 2 Mbit/s cross-connections (with FIU 19)
- troubleshoot a node
- monitor the fault status of a node
- monitor signal quality
- download new software.

Note

Cross-connections on the RRIC indoor unit are handled using the TruMan node manager.

Nokia Hopper Manager can be connected to a Nokia FlexiHopper node in one of two ways: directly via the Local Management Port (LMP), or remotely via a Nokia Q1 connection.

Nokia Hopper Manager can be used both online and offline. When used online, information is read directly from the node and interpreted by Nokia Hopper Manager. This information can then be easily changed and sent back to the node. When Nokia Hopper Manager is used offline, settings files can be created in the office and downloaded to the node at a later time.

5.3 Using Nokia Q1 bus

Q1 bus is the management connection (V.11) to the NMS. When Nokia FlexiHopper is used with an FXC RRI unit, the node is managed through the BTS or the hub.

5.3.1 FIU 19(E)

The FIU 19(E) indoor unit has two Q1 ports (Q1-1 and Q1-2) on the front panel (see Figure 54).

Inside FIU 19(E), the Q1 signal is routed through (virtual) branching gates. The positions of the gates are set with Nokia Hopper Manager.

Usually the Q1 bus is transmitted on the radio path in a separate auxiliary channel within the overhead of the radio frame. The Q1 interfaces are chained and the Q1 signal can be connected to either of them (Figure 31). In this case, a signal connected to the Q1-1 port is routed to the Flexbus interfaces (radio path), to FIU 19(E) processor, and out from the Q1-2 port. The same applies vice versa to a signal connected to the Q1-2 port.

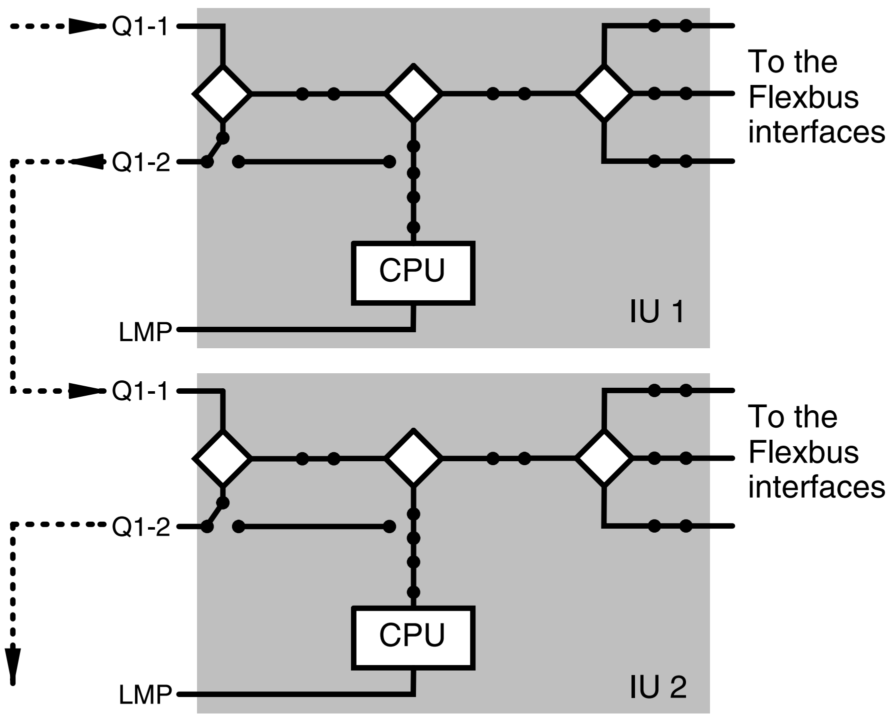


Figure 31. Chaining of the Q1 bus in FIU 19(E)

Several pieces of Q1 managed equipment can be chained at the equipment station. A cable is connected from the Q1-2 port of the first equipment to the Q1-1 port of the second equipment, another cable is connected from the Q1-2 port of the second equipment and to the Q1-1 port of the third equipment, and so on.

FIU 19(E) contains a shunt switch which ensures that when the Q1 signal is chained form Q1-1 to Q1-2, the chain does not break even if the power supply to a FIU 19(E) unit is lost or switched off.

The Q1 bus can also be carried within a 2 Mbit/s tributary. In this case, another equipment (a BTS, for example) extracts the Q1 bus and routes it further to the microwave radio. The Q1 cable from the BTS is connected to the Q1-2 port of the indoor unit and the signal from it goes straight to the processor (Figure 32). The Q1-1 port is not used.

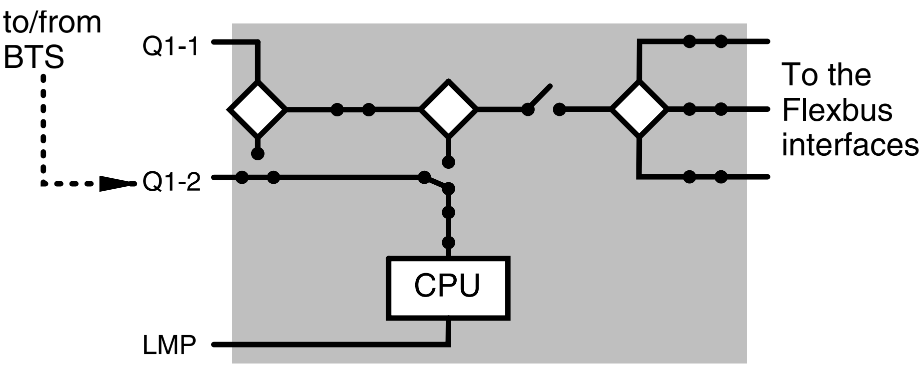


Figure 32. Example of Q1 branching in FIU 19(E)

When FIU 19 is used in 1+1 (2IU/2OU) protected mode, the Q1 interfaces are physically connected via the backplane (Figure 33). In a chaining setup, the Q1 cabling is connected to the Q1-1 port of the indoor unit A and Q1-2 port of the indoor unit B.

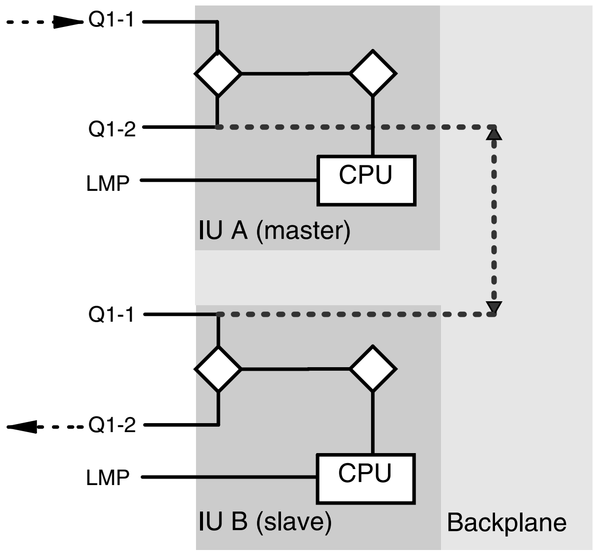


Figure 33. Q1 connection in FIU 19 in 1+1 protection setup

5.3.2 RRIC

Positions of the (virtual) branching gates inside RRIC are set with Nokia Hopper Manager (Figure 34, FB3 is the Flexbus connection to another RRIC through backplane).

Note that Q1 signal from the TRUx is always unidirectionally connected to the CPU.

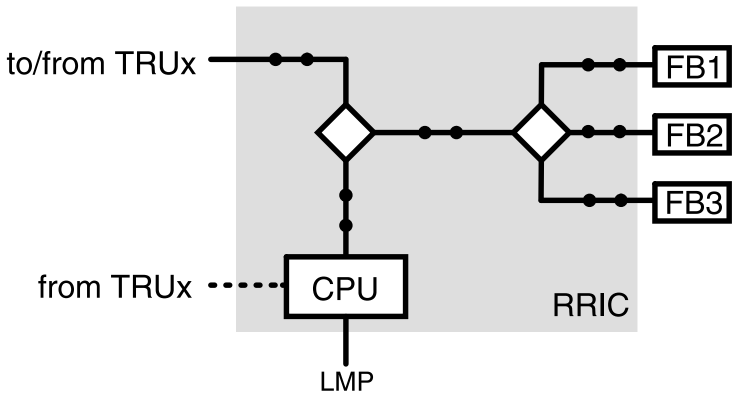


Figure 34. Branching of the Q1 bus in RRIC

When the cross-connections of an RRIC unit are managed locally with the TruMan node manager and TruMan is using the physical address of the RRIC unit (see Section 5.3.4 below), verify that you have a communication cable which grounds the PIN signal. This automatically opens the gate to the Flexbus interfaces, thus preventing management commands being sent to the far-end equipment.

5.3.3 IFUE

To provide the compatibility with other Flexbus equipment, a Q1 network element is embedded in the IFUE. The Q1 network element provides the Flexbus interface and PDH cross-connect functionality. Therefore, a complete hop can be managed by an element manager of the Nokia Hopper Manager family.

By means of the Q1 embedded operation channels (EOC) in the Flexbus links, the Q1 bus can be extended to connect also other Q1 network elements to the same Q1 bus or to connect the IFUE to a Q1 master remotely. A separate connector (LMP) at the front panel of the IFUE provides local management access for this Q1 network element.

5.3.4 Q1 addresses

Each network element is given a Q1 port network element address and an LMP network element address. Network element addresses run from 0 to 3999. Each network element is also given a Q1 port group address and an LMP group address. Group addresses run from 4050 to 4059.

The Q1 port address is used when managing the network element (NE) remotely. NEs within the same Q1 bus must have unique network element addresses. The Q1 group address is common to a group of network elements. With it, operations can be done to the whole group simultaneously.

The LMP address is used when managing the network element locally and it can be the same from site to site.

All Q1 managed network elements also recognize the Q1 broadcast address 4095. When connecting to the LMP, this address is not actually broadcast, therefore it can be used for local management.

The RRIC indoor unit recognizes also the physical address of the BTS unit slot in which it is installed (4084 or 4085).

When FIU 19 is used in connection with a Nokia Talk-family GSM BTS, FIU 19 is set as a TRE type unit in the BTS HW database file and the Q1 address for FIU 19 must be set accordingly (from 131 to 156). See the BTS documentation for more information.

5.3.5 Q1 fault handling

When FIU 19 or RRIC is used with older Nokia GSM BTS, for reasons of compatibility it might be necessary to use old style Q1 fault handling.

Q1 old style fault supervision can be used when the BTS on site does not support (new) Nokia Q1 fault handling. In this mode the alarms are handled according to the following cases:

- If the BTS does not support Nokia Q1 fault handling and FIU 19 or RRIC are using (new) Nokia Q1 fault handling, the NMS shows only the alarms generated by the FE0 (network element).
- If the BTS does not support Nokia Q1 fault handling and FIU 19 or RRIC fault handling are set to old style, the network element reports three possible alarms per functional entity, depending on alarm severity (critical, major, or minor). Only the most severe alarm is displayed.

  On FIU 19 these alarms are:

  - Critical - *Fault in unit*
  - Major - *Fault in equipment*
  - Minor - *Buffer overflow*

  On RRIC these alarms are:

  - Critical - *Fault in transmitter*
  - Major - *Fault in equipment*
  - Minor - *Buffer overflow*

In both cases, Nokia Hopper Manager can always be used to read Nokia Q1 alarms. Thus, if additional information is required of an alarm reported in the NMS, it can be got with the manager.

If the BTS supports Nokia Q1 fault handling and FIU 19 and RRIC are set to use it, the NMS shows all alarms generated by the network element.

6 Mechanical structure

This chapter describes the mechanical structure, including installation and power supply, of:

- the FlexiHopper outdoor unit, antenna and alignment unit
- the indoor units (FIU 19, FIU 19RJ, FIU 19E, RRIC, and FXC RRI) and an interface unit (IFUE).

6.1 Nokia FlexiHopper outdoor unit

The Nokia FlexiHopper OU is used together with an antenna and an alignment unit.

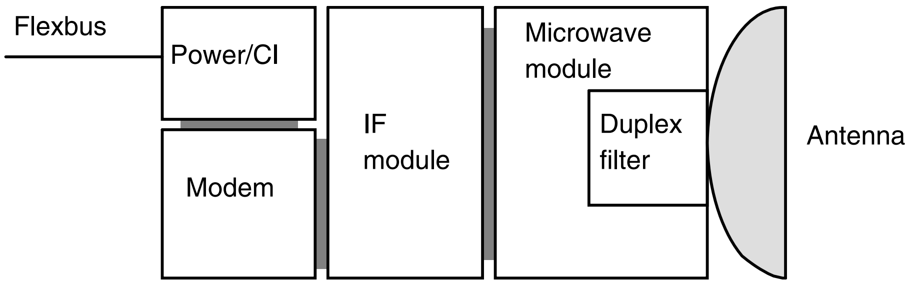


Figure 35. Nokia FlexiHopper OU, block diagram

The outdoor unit consists of:

- RF parts
  - microwave module
  - IF module
  - duplex filter

- modem
  - microprocessor environment
  - digital and analog signal processing
- power supply module and Flexbus cable interface (CI).

The antenna used with Nokia FlexiHopper may be integrated or separate. Antennas are available in five sizes: 20, 30, 60, 120, and 180 cm. The sizes available depend on the frequency band of the unit. The polarisation of the antenna can be easily changed by rotating the outdoor unit and the antenna feeder through 90°.

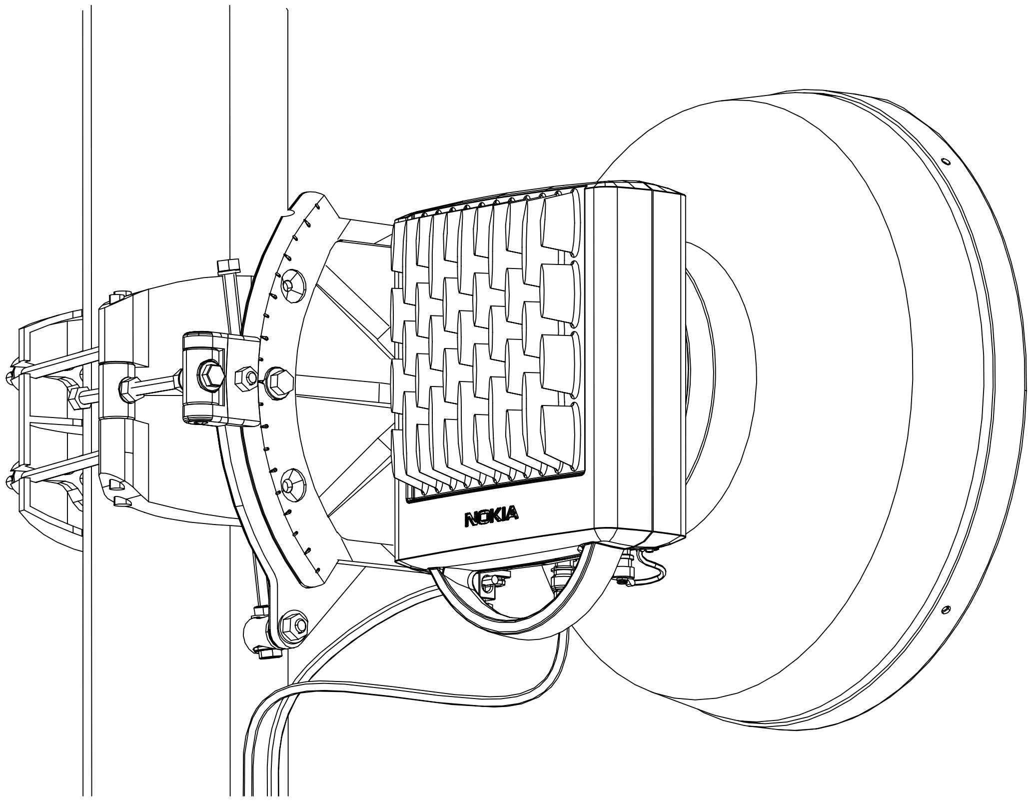


Figure 36. Nokia FlexiHopper 38 GHz outdoor unit with integrated 30 cm antenna and alignment unit

The Nokia FlexiHopper alignment unit is used with the 20, 30, and 60 cm antennas. Alignment is carried out using a ratchet or a battery-operated screwdriver.

The Nokia MetroHopper alignment bracket with an additional fastener can be used with the 20 cm (square radome) antenna.

Large antennas (120 and 180 cm) use alignment units made by the antenna manufacturers. Outdoor unit can be installed on these antennas using a snap-on mounting kit, or via a flexible waveguide or elliptical waveguide and adapter.

Installation

The outdoor unit can be installed on a roof, wall, or tower. The antenna with alignment unit can be installed on either side of a pole. Normally, no loose parts are needed in the installation of the alignment unit and the outdoor unit. The outdoor unit and the antenna are fitted with guides which prevent installation in conflicting polarisations.

Connectors and cabling

The indoor unit and the outdoor unit are connected via a single coaxial cable (Flexbus), which also feeds power to the outdoor unit. The outdoor unit has one coaxial connector for the Flexbus cable (TNC, 50 Ω) and one BNC connector for measurement of the AGC (automatic gain control) voltage. AGC voltage measurement is needed when aligning the antenna.

Power supply

The power is fed to the outdoor unit from the indoor unit via the Flexbus cable (55 V_{DC} nominal voltage). No separate power supply is needed. The power consumption of a Nokia FlexiHopper outdoor unit is less than 25 W. The actual power consumption depends on the site equipment and the power losses caused by the equipment.

6.2 FIU 19 indoor unit

The FIU 19 indoor unit is only 2/3 U (29 mm) high. The maximum interface capacity of the main unit is 12 x 2 Mbit/s. Interface capacities over 12 x 2 Mbit/s are implemented by installing the 16 x 2 Mbit/s expansion unit underneath the main unit. Protected use with two indoor units is implemented using two identical FIU 19 main units and the expansion unit, so the interface capacity will always be 16 x 2 Mbit/s. The expansion unit has the same external dimensions as the main unit.

When the expansion unit is used to provide 16 x 2 Mbit/s interfaces, an IC (interface circuit) plug-in unit is installed to EXU plug-in unit slot A. When the expansion unit is used to provide 1+1 protection, IC plug-in units are installed to both EXU plug-in unit slots. These plug-in units connect the main units and the expansion unit together through a common backplane.

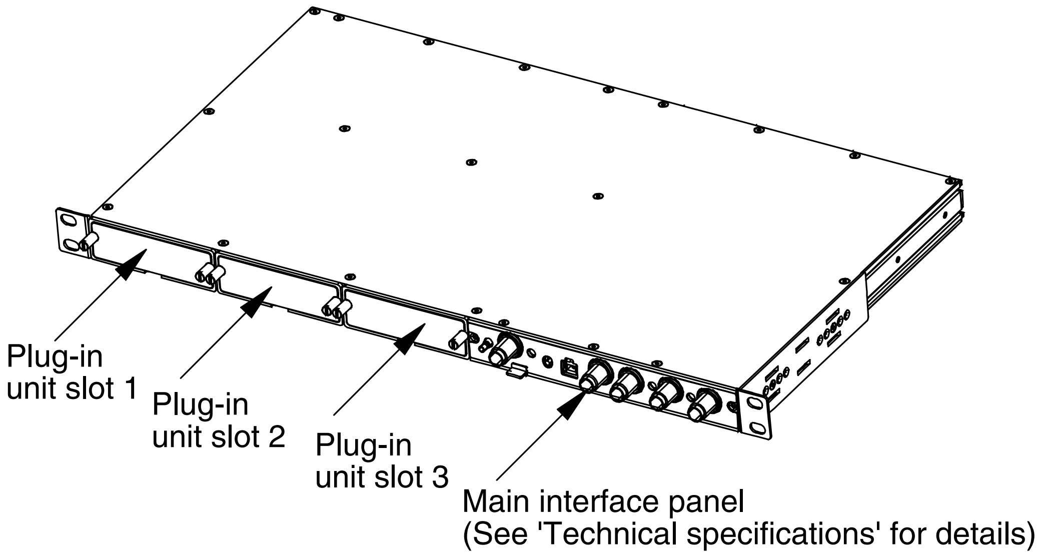


Figure 37. FIU 19 main unit

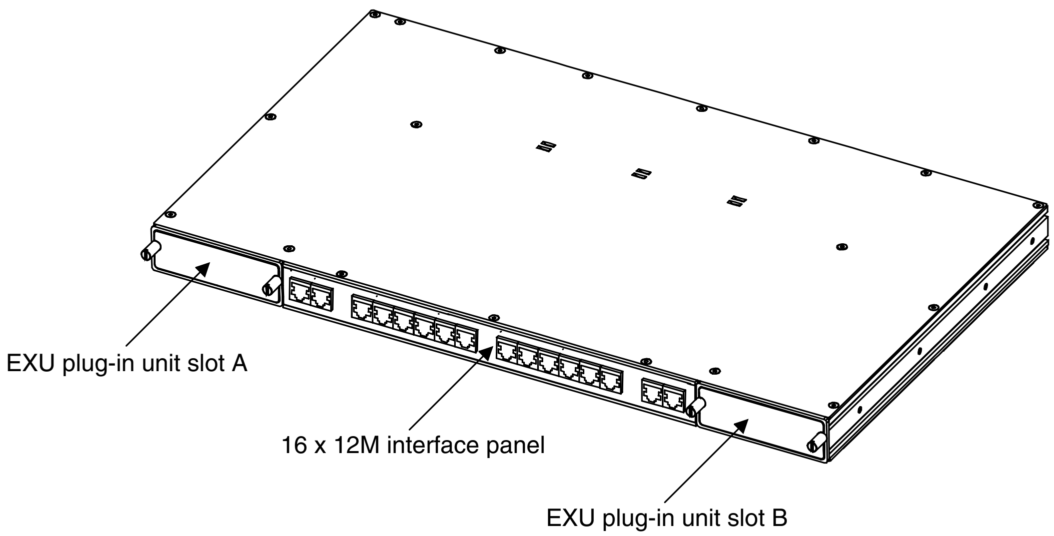


Figure 38. FIU 19 expansion unit with 120 Ω RJ-45balanced interfaces

Installation

The unit is installed horizontally into a 19-inch rack using special mounting brackets. As all the interfaces are located in the front panel, cabling can be performed easily.

FIU 19 can also be installed into an ETSI 600 x 300 mm rack or a TM4 slim rack using an adapter kit.

Connectors and cabling

The FIU 19 main unit has two Flexbus interfaces (FB1, FB2) on the front panel. These interfaces feed also power to the OUs connected through them. In addition the FIU 19 main unit has connectors for network management (Q1), power supply (PWR), local management (LMP), and measurement (MP).

2 Mbit/s interfaces can be added as plug-in units or as an expansion unit. The interfaces can be either balanced (120 Ω TQ, 120 Ω RJ-45) or unbalanced (75 Ω SMB).

Two Flexbus interfaces (FB3, FB4) can be added as an plug-in unit.

Finally, auxiliary data interfaces can be added as plug-in units.

The cabling of the interfaces depends on the installation environment. When the units have been set up in 1+1 (2IU/2OU) protection mode, the following things have to be considered:

- power supply is connected to both main units
- the Q1 cabling (in a chaining setup) is connected to the Q1-1 port of the indoor unit A and Q1-2 port of the indoor unit B (see Section 5.3.1)
- auxiliary interfaces are connected together with a branch wire
- LMP cable can be connected to either unit (unless a fault has occurred).

Power supply

FIU 19 requires a power supply input of –40.5 to –72 V_{DC}. The power consumption of a fully equipped FIU 19 is less than 17 W. The actual power consumption depends on the site equipment and the power losses caused by the equipment.

If outdoor units are connected via Flexbus to the Flexbus plug-in unit, an additional power supply input of +52 to +60 V_{DC} must be connected to the plug-in unit. If other indoor units are connected, additional power supply is not required.

Unit configurations

The following configuration options are available with FIU 19:

- Plug-in units (3 slots)
  - 4 x 2 Mbit/s balanced or unbalanced interfaces
  - Dual Flexbus interfaces
  - Auxiliary data channel interfaces, digital inputs/outputs
- Expansion units (19-inch unit underneath the main unit)
  - 16 x 2 Mbit/s expansion (balanced or unbalanced)
  - 16 x 2 Mbit/s 1+1 protection (balanced or unbalanced).

6.3 FIU 19E and FIU 19RJ indoor units

The FIU 19E product is a product variant that differs from the FIU 19 product mainly in the connertor types and thus installation. For more information on the interfaces, refer to Chapter 7.7.1. For more information about the mechanical structure, power supply, and unit configurations, refer to Chapter 6.2.

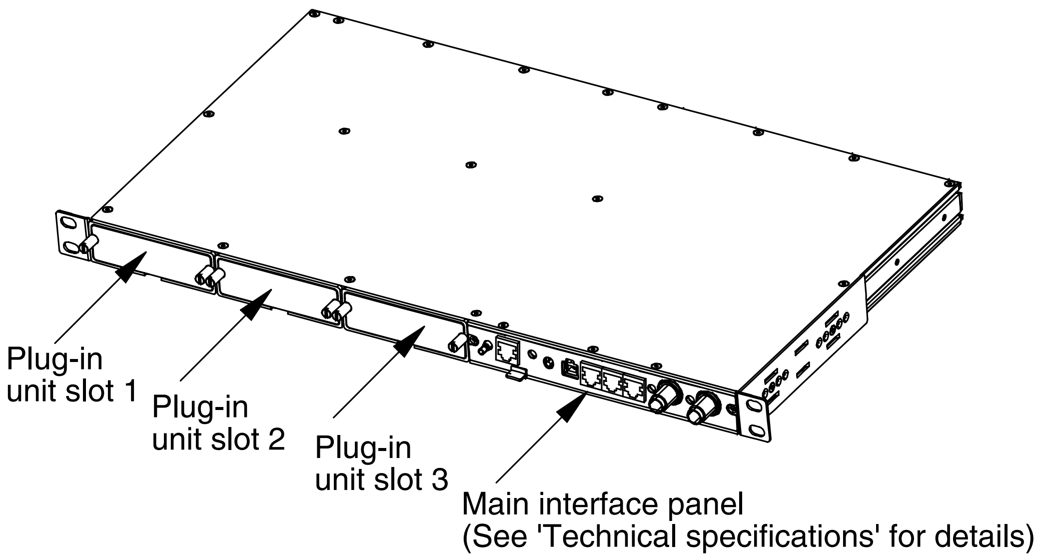


Figure 39. FIU 19E main unit

The FIU 19 Expansion unit with 16x2Mbit/s RJ-45 interfaces can also be used with the FIU 19E main unit. For more information on the FIU 19 expansion unit, refer to Chapter 6.2.

The FIU 19RJ is the same unit as FIU 19. The only difference is the connector type in the LMP and Q1 interfaces: the FIU 19 has BQ connectors while FIU 19RJ has RJ-45 connectors.

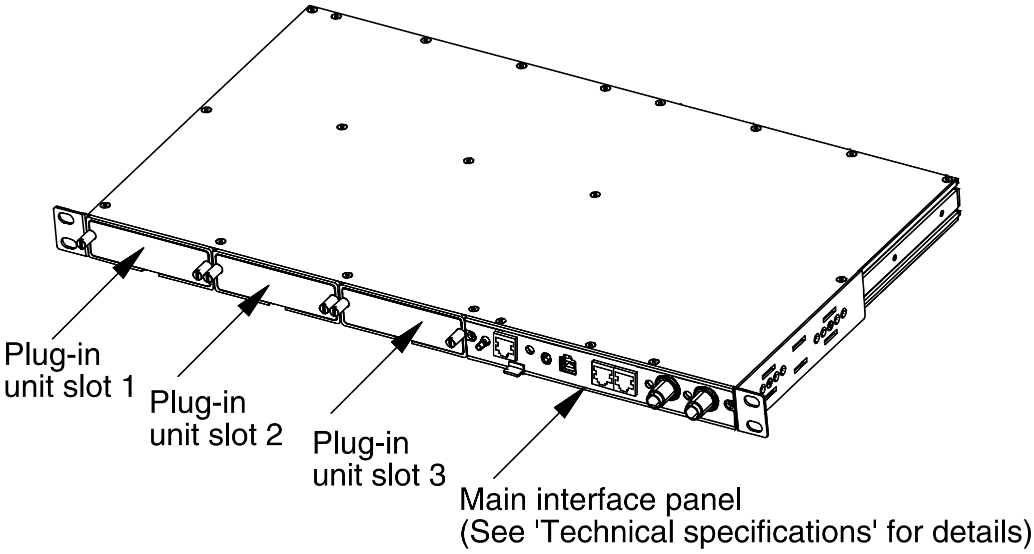


Figure 40. FIU 19RJ main unit

6.4 RRIC indoor unit

Mechanical structure and installation

RRIC is a plug-in indoor unit which can be installed in Nokia Citytalk or Nokia Intratalk base station.

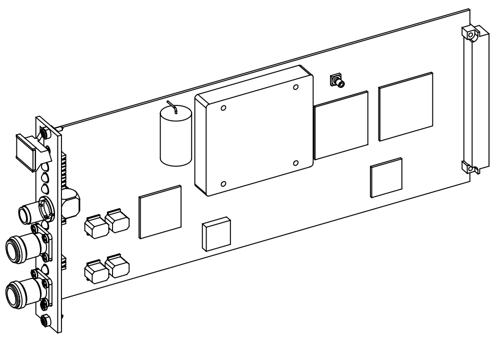


Figure 41. RRIC

Connectors and cabling

RRIC has two Flexbus interfaces (FB1, FB2) and a local management port (LMP) on the front panel. The Flexbus interfaces feed also power to the OUs connected through them.

In addition, RRIC has a third Flexbus interface (FB3) on the backplane, towards another RRIC, and a measurement point on the printed circuit board.

The Flexbus interfaces on the front panel are connected to jumper cables which lead to a connector panel on the top of the base station cabinet.

Power supply

Normally RRIC is powered by the same power supply as the BTS and there is no need for additional power. If RRIC is used with Nokia Intratalk BTS which uses AC power, an additional power supply for RRIC is required (–40.5 to –72 V_{DC}). The power consumption of RRIC is less than 7 W. The actual power consumption depends on the site equipment and the power losses caused by the equipment.

6.5 FXC RRI indoor unit

Mechanical structure and installation

FXC RRI is a plug-in indoor unit which can be installed in Nokia MetroSite GSM BTS, Nokia MetroHub, and Nokia UltraSite EDGE BTS.

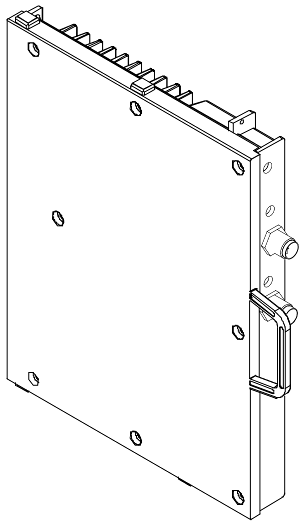


Figure 42. FXC RRI

Connectors and cabling

FXC RRI has two Flexbus interfaces on the front panel and a cross-connection bus interface on the backplane. FXC RRI is managed via the local management port in Nokia MetroSite GSM BTS, Nokia MetroHub, or Nokia UltraSite EDGE BTS.

Power supply

The base station or the hub supplies power to FXC RRI. There is no need for external power supply. The power consumption of FXC RRI is less than 8 W. The actual power consumption depends on the site equipment and the power losses caused by the equipment.

6.6 IFUE interface unit

Mechanical structure and installation

The IFUE interface unit can be installed in Nokia WCDMA base stations or in stand-alone AXCs (S-AXC) for a maximum of 16 x E1 add/drop capacity.

Connectors and cabling

The IFUE has three Nokia proprietary Flexbus interfaces (FB1–FB3: TNC-connector, 50 Ω). These interfaces also feed power to the OUs connected through them. In addition, the unit also has connectors for local management (LMP), and three light-emitting diodes (LED) for each Flexbus interface and two LEDs for indicating the status of the IFUE.

Power supply

IFUE requires a power suplly input of –37.5 to –72 V_{DC}. The power consumption if IFUE is less than 25 W. The actual power consumption depends on the amount of power feeding to the outdoor units.

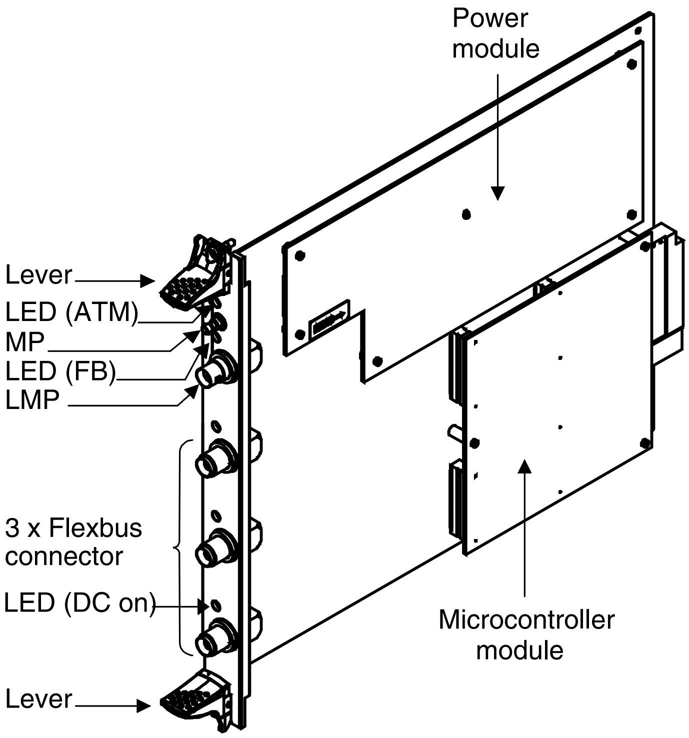


Figure 43. IFUE interface unit

7 Technical specifications

7.1 General

7.1.1 Capacities

Table 1. Capacity options (programmable)

Traffic capacity (Mbit/s)	Gross bit rate (Mbit/s, ±10 ppm)
2 x 2 4 x 2 8 x 2 16 x 2	4.715 127 5 9.430 255 18.860 510 37.721 020
Bit rate tolerances	
2 Mbit/s interface	±50 ppm

7.1.2 Operation

Table 2. Available operating modes

1 indoor unit / 1 outdoor unit (FIU 19, RRIC, FXC RRI) 1 indoor unit / 2 outdoor units (FIU 19, RRIC, FXC RRI) 1 indoor unit / 3 outdoor units (FIU 19 + additional power supply) HSB, 1 IU / 2 OU (FIU 19, RRIC) HSB, 2 IU / 2 OU (FIU 19) HSB + space diversity, 1 IU / 2 OU (FIU 19)* HSB + space diversity, 2 IU / 2 OU (FIU 19)* Loop protection (RRIC with TRUx, FXC RRI)
*) For availability of the operating modes, refer to the latest release plan.

Table 3. Cross-connections

Indoor unit	Cross-connection level
FIU 19	2 Mbit/s
RRIC	2 Mbit/s (8 kbit/s with TRUx)
FXC RRI	8 kbit/s
IFUE	2 Mbit/s

Table 4. Standards followed for statistics, jitter, and AIS

Statistics	ITU-T G.826
Jitter	ITU-T G.823
AIS	ITU-T G.921, Section 1.4

Table 5. Residual bit error ratio

RBER	$\leq 10^{-11}$

Table 6. Transmitter - receiver transmission delay (from indoor connector to indoor connector, zero length radio path, 4-depth convolutional interleaver and RS(63,59) code)

Capacity	Interleaver on	Interleaver off
2 x 2 Mbit/s	< 480 µs	< 150 µs
4 x 2 Mbit/s	< 240 µs	< 65 µs
8 x 2 Mbit/s	< 120 µs	< 33 µs
16 x 2 Mbit/s	< 60 µs	< 17 µs

7.1.3 Environment

Table 7. EMC

Emissions	
Radiated emission	EN 55022 Class B or CISPR22
Conducted emission	EN 55022 0.15 - 0.5 MHz: 66 dBμV, average 0.5 - 30 MHz: 60 dBμV, average
Immunities	
RF EM field	EN 61000-4-3 80 - 1000 MHz, 3 V/m: no errors
Electrostatic discharge	EN 61000-4-2 ±8 kV air discharge: self-recovery ±4 kV contact discharge: self-recovery
Fast common mode transients	EN 61000-4-4 1 kV: self-recovery
RF common mode	EN 61000-4-6 0.15 - 80 MHz, 3 V_{RMS}: no errors
Surges	EN 61000–4–5 1 kV, 10 Ω series resistance: no damage, self recovery
Overvoltage tolerance of the indoor-outdoor cables and outdoor unit power input	4 kV 8/20 μs short current 1.2/50 μs open voltage

Table 8. Temperature, humidity, wind

All units, Storage and transportation	
Air temperature	-40 to +70 °C
Relative humidity	10 - 100% (storage) < 95% (transport)
Nokia FlexiHopper outdoor unit, Operation	
Air temperature (in shade)	-45 to +50 °C (operational) -40 to +50 °C (start-up)

Table 8. Temperature, humidity, wind (Continued)

Sun radiation	< 1.12 kW/m^2
Relative humidity	≤ 100%
Wind	< 55 m/s
Tightness, dust/water	IP 54
FIU 19 and RRIC indoor units, Operation	
Air temperature	-10 to +50 °C
Relative humidity	< 95%
FXC RRI indoor units, Operation	
Air temperature	-40 to +50 °C (dependent on the BTS)
Relative humidity	≤ 100%
Sun radiation	< 1.12 kW/m^2

7.2 Nokia FlexiHopper outdoor unit

7.2.1 Frequencies

Table 9. Frequency bands, duplex spacing, and subbands

Outdoor unit	ITU-R Rec.	Frequency band (GHz)	Duplex spacing (MHz)	Number of subbands	Subband bandwidth (MHz)
Nokia FlexiHopper 7	F.385-6	7.125-7.425	161	4+4	56
		7.425-7.725	154	4+4	65
		7.425-7.725	161	4+4	58
Nokia FlexiHopper 8	F.386-6	7.725-8.275	311.32	3+3	125
		8.279-8.496	119	3+3	42
		8.275-8.500	126	3+3	42
Nokia FlexiHopper 13	F.497-5	12.75 - 13.25	266	3+3	84
Nokia FlexiHopper 15	F.636-3	14.5 - 15.35	420[1]	3+3	150
		14.5 - 15.35	644[1]	1+1	203
		14.5 - 15.35	728[1]	1+1	119

Table 9. Frequency bands, duplex spacing, and subbands (Continued)

Outdoor unit	ITU-R Rec.	Frequency band (GHz)	Duplex spacing (MHz)	Number of subbands	Subband bandwidth (MHz)
Nokia FlexiHopper 18	F.595-6	17.7 - 19.7	1010	4+4	270
Nokia FlexiHopper 23	F.637-2	21.2 - 23.6[2]	1232[1]	3+3	400
		22.0 - 23.6[3]	1008[1]	2+2	400
Nokia FlexiHopper 26	F.748-3	24.5 - 26.5	1008	3+3	350
Nokia FlexiHopper 38	F.749-1	37.0 - 39.5	1260	4+4	300

1) Administrations may define duplex spacing
2) Rec. 637-2 Annex 1, UK
3) Rec. 637-2 Annex 5, Germany

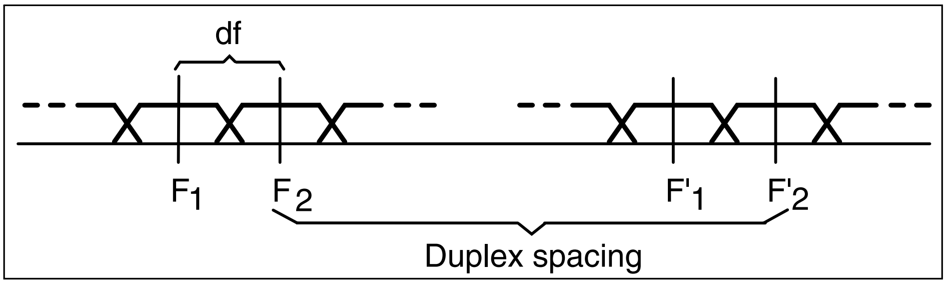


Figure 44. Channel spacing and duplex spacing

Table 10. Channel spacing between adjacent channels (ITU-R)*

Outdoor unit	Capacity (Mbit/s)	Channel spacing, df (MHz)	
		Same polarisation	Cross-polarisation
Nokia FlexiHopper 18	2 x 2 4 x 2 8 x 2 16 x 2	5.0 7.5 13.75 27.5	0 0 0 0
Nokia FlexiHopper 7 Nokia FlexiHopper 8 Nokia FlexiHopper 13 Nokia FlexiHopper 15 Nokia FlexiHopper 18 Nokia FlexiHopper 23 Nokia FlexiHopper 26 Nokia FlexiHopper 38	2 x 2 4 x 2 8 x 2 16 x 2	3.5 7.0 14.0 28.0	0 0 0 0
*) Channel spacing is not limited to these values.			

For product codes related to different subbands in Tables 11–16, refer to *Document Note* in the *Nokia FlexiHopper Microwave Radio with FIU 19/RRIC User Manual*.

Table 11. Nokia FlexiHopper 7, frequency tuning range

Subb.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**
161 MHz duplex spacing, subbands A-D and A′-D′								
A	7125.00	7168.25	7125.00	7166.50	7125.00	7163.00	7128.00	7156.00
B	7150.75	7203.25	7152.50	7201.50	7156.00	7198.00	7163.00	7191.00
C	7185.75	7238.25	7187.50	7236.50	7191.00	7233.00	7198.00	7226.00
D	7220.75	7273.25	7222.50	7271.50	7226.00	7268.00	7233.00	7261.00
A′	7286.00	7329.25	7286.00	7327.50	7286.00	7324.00	7289.00	7317.00
B′	7311.75	7364.25	7313.50	7362.50	7317.00	7359.00	7324.00	7352.00
C′	7346.75	7399.25	7348.50	7397.50	7352.00	7394.00	7359.00	7387.00
D′	7381.75	7434.25	7383.50	7432.50	7387.00	7429.00	7394.00	7422.00
154 MHz duplex spacing, subbands E-H and E′-H′								
E	7425.00	7477.25	7425.00	7475.50	7425.00	7472.00	7428.00	7465.00
F	7450.75	7512.25	7452.50	7510.50	7456.00	7507.00	7463.00	7500.00
G	7484.75	7546.25	7486.50	7544.50	7490.00	7541.00	7497.00	7534.00
H	7518.75	7571.00	7520.50	7571.00	7524.00	7571.00	7531.00	7568.00
E′	7579.00	7631.25	7579.00	7629.50	7579.00	7626.00	7582.00	7619.00
F′	7604.75	7666.25	7606.50	7664.50	7610.00	7661.00	7617.00	7654.00
G′	7638.75	7700.25	7640.50	7698.50	7644.00	7695.00	7651.00	7688.00
H′	7672.75	7725.00	7674.50	7725.00	7678.00	7725.00	7685.00	7722.00
161 MHz duplex spacing, subbands I-L and I'-L'								
I	7415.75	7470.25	7417.50	7468.50	7421.00	7465.00	7428.00	7458.00
J	7450.75	7505.25	7452.50	7503.50	7456.00	7500.00	7463.00	7493.00
K	7484.75	7539.25	7486.50	7537.50	7490.00	7534.00	7497.00	7527.00
L	7518.75	7564.00	7520.50	7564.00	7524.00	7564.00	7531.00	7561.00
I′	7576.75	7631.25	7578.50	7629.50	7582.00	7626.00	7589.00	7619.00
J′	7611.75	7666.25	7613.50	7664.50	7617.00	7661.00	7624.00	7654.00
K′	7645.75	7700.25	7647.50	7698.50	7651.00	7695.00	7658.00	7688.00
L′	7679.75	7725.00	7681.50	7725.00	7685.00	7725.00	7692.00	7722.00

Table 12. Nokia FlexiHopper 8, frequency tuning range

Sub.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**
311.32 MHz duplex spacing, subbands A-C and A′-C′								
A	7725.00	7840.93	7725.00	7839.18	7725.00	7835.68	7731.68	7828.68
B	7783.43	7904.93	7785.18	7903.18	7788.68	7899.68	7795.68	7892.68
C	7847.43	7963.68	7849.18	7963.68	7852.68	7963.68	7859.68	7956.68
A′	8036.32	8152.25	8036.32	8150.50	8036.32	8147.00	8043.00	8140.00
B′	8094.75	8216.25	8096.50	8214.50	8100.00	8211.00	8107.00	8204.00
C′	8158.75	8275.00	8160.50	8275.00	8164.00	8275.00	8171.00	8268.00
119 MHz duplex spacing, subbands D-F and D′-F′								
D	8280.75	8319.25	8282.50	8317.50	8286.00	8314.00	8293.00	8307.00
E	8308.75	8347.25	8310.50	8345.50	8314.00	8342.00	8321.00	8335.00
F	8336.75	8375.25	8338.50	8373.50	8342.00	8370.00	8349.00	8363.00
D′	8399.75	8438.25	8401.50	8436.50	8405.00	8433.00	8412.00	8426.00
E′	8427.75	8466.25	8429.50	8464.50	8433.00	8461.00	8440.00	8454.00
F′	8455.75	8494.25	8457.50	8492.50	8461.00	8489.00	8468.00	8482.00
126 MHZ duplex spacing, subbands G-I and G′-H′								
G	8276.75	8315.25	8278.50	8313.50	8282.00	8310.00	8289.00	8303.00
H	8305.25	8343.75	8307.00	8342.00	8310.50	8338.50	8317.50	8331.50
I	8333.75	8372.25	8335.50	8370.50	8339.00	8367.00	8346.00	8360.00
G′	8402.75	8441.25	8404.50	8439.50	8408.00	8436.00	8415.00	8429.00
H′	8431.25	8469.75	8433.00	8468.00	8436.50	8464.50	8443.50	8457.50
I′	8459.75	8498.25	8461.50	8496.50	8465.00	8493.00	8472.00	8486.00

Table 13. Nokia FlexiHopper 13, frequency tuning range

Subb.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)
266 MHz duplex spacing, subbands A - C and A′ - C′								
A	12752.75	12833.25	12754.50	12831.50	12758.00	12828.00	12765.00	12821.00
B	12822.75	12903.25	12824.50	12901.50	12828.00	12898.00	12835.00	12891.00
C	12892.75	12973.25	12894.50	12971.50	12898.00	12968.00	12905.00	12961.00
A′	13018.75	13099.25	13020.50	13097.50	13024.00	13094.00	13031.00	13087.00
B′	13088.75	13169.25	13090.50	13167.50	13094.00	13164.00	13101.00	13157.00
C′	13158.75	13239.25	13160.50	13237.50	13164.00	13234.00	13171.00	13227.00

Table 14. Nokia FlexiHopper 15, frequency tuning range

Subb.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)
420 MHz duplex spacing, subbands A - C and A′ - C′								
A	14502.75	14649.25	14504.50	14647.50	14508.00	14644.00	14515.00	14637.00
B	14641.25	14787.75	14643.00	14786.00	14646.50	14782.50	14653.50	14775.50
C	14779.75	14921.00	14781.50	14921.00	14785.00	14921.00	14792.00	14914.00
A′	14922.75	15069.25	14924.50	15067.50	14928.00	15064.00	14935.00	15057.00
B′	15061.25	15207.75	15063.00	15206.00	15066.50	15202.50	15073.50	15195.50
C′	15199.75	15341.00	15201.50	15341.00	15205.00	15341.00	15212.00	15334.00
644 MHz duplex spacing, subbands M and M′								
M	14504.50	14683.00	14504.50	14683.00	14508.00	14683.00	14515.00	14683.00
M′	15148.50	15327.00	15148.50	15327.00	15152.00	15327.00	15159.00	15327.00
728 MHz duplex spacing, subbands N and N′								
N	14502.75	14613.00	14504.50	14613.00	14508.00	14613.00	14515.00	14606.00
N′	15230.75	15341.00	15232.50	15341.00	15236.00	15341.00	15243.00	15334.00

Table 15. Nokia FlexiHopper 18, frequency tuning range

Sub.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**
1010 MHz duplex spacing, subbands A - D and A′ - D′								
A	17704.75	17970.75	17706.00	17969.00	17709.50	17965.50	17716.50	17958.50
B	17951.75	18218.25	17953.50	18216.50	17957.00	18213.00	17964.00	18206.00
C	18171.75	18438.25	18173.50	18436.50	18177.00	18433.00	18184.00	18426.00
D	18419.25	18668.75	18421.00	18668.75	18424.50	18668.75	18431.50	18668.75
A′	18714.75	18980.75	18716.00	18979.00	18719.50	18975.50	18726.50	18968.50
B′	18961.75	19228.25	18963.50	19226.50	18967.00	19223.00	18974.00	19216.00
C′	19181.75	19448.25	19183.50	19446.50	19187.00	19443.00	19194.00	19436.00
D′	19429.25	19678.75	19431.00	19678.75	19434.50	19678.75	19441.50	19678.75

Table 16. Nokia FlexiHopper 23, frequency tuning range

Sub.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**
1232 MHz duplex spacing, subbands A - C and A′ - C′								
A	21225.75	21622.25	21227.50	21620.50	21231.00	21617.00	21238.00	21610.00
B	21585.75	21982.25	21587.50	21980.50	21591.00	21977.00	21598.00	21970.00
C	21945.75	22342.25	21947.50	22340.50	21951.00	22337.00	21958.00	22330.00
A′	22457.75	22854.25	22459.50	22852.50	22463.00	22849.00	22470.00	22842.00
B′	22817.75	23214.25	22819.50	23212.50	22823.00	23209.00	22830.00	23202.00
C′	23177.75	23574.25	23179.50	23572.50	23183.00	23569.00	23190.00	23562.00
1008 MHz duplex spacing, subbands M - N and M′ - N′								
M	22003.75	22400.25	22005.50	22398.50	22009.00	22395.00	22016.00	22388.00
N	22193.75	22589.00	22195.50	22588.50	22199.00	22585.00	22206.00	22578.00
M′	23011.75	23408.25	23013.50	23406.50	23017.00	23403.00	23024.00	23396.00
N′	23201.75	23597.00	23203.50	23596.50	23207.00	23593.00	23214.00	23586.00

Table 17. Nokia FlexiHopper 26, frequency tuning range

Subb.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**
1008 MHz duplex spacing, subbands A - C and A′ - C′								
A	24550.75	24897.25	24552.50	24895.50	24556.00	24892.00	24563.00	24885.00
B	24823.75	25170.25	24825.50	25168.50	24829.00	25165.00	24836.00	25158.00
C	25096.75	25443.25	25098.50	25441.50	25102.00	25438.00	25109.00	25431.00
A′	25558.75	25905.25	25560.50	25903.50	25564.00	25900.00	25571.00	25893.00
B′	25831.75	26178.25	25833.50	26176.50	25837.00	26173.00	25844.00	26166.00
C′	26104.75	26451.25	26106.50	26449.50	26110.00	26446.00	26117.00	26439.00

Table 18. Nokia FlexiHopper 38, frequency tuning range

Subb.	2 x 2 Mbit/s capacity		4 x 2 Mbit/s capacity		8 x 2 Mbit/s capacity		16 x 2 Mbit/s capacity	
	Lowest channel (MHz)	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**	**Lowest channel (MHz)**	**Highest channel (MHz)**
1260 MHz duplex spacing, subbands A - D and A′ - D′								
A	37059.75	37346.25	37059.75	37344.50	37059.75	37341.00	37062.00	37334.00
B	37329.75	37626.25	37331.50	37624.50	37335.00	37621.00	37342.00	37614.00
C	37609.75	37906.25	37611.50	37904.50	37615.00	37901.00	37622.00	37894.00
D	37889.75	38176.25	37891.50	38176.25	37895.00	38176.25	37902.00	38174.00
A′	38319.75	38606.25	38319.75	38604.50	38319.75	38601.00	38322.00	38594.00
B′	38589.75	38886.25	38591.50	38884.50	38595.00	38881.00	38602.00	38874.00
C′	38869.75	39166.25	38871.50	39164.50	38875.00	39161.00	38882.00	39154.00
D′	39149.75	39436.25	39151.50	39436.25	39155.00	39436.25	39162.00	39434.00

Table 19. Transmitter frequency adjustment and stability

Frequency adjustment step*	0.001 MHz
Frequency stability in all conditions Ageing	< ±10 ppm < ±1 ppm / year < ±5 ppm / 15 years
*) The software allows a 1 kHz step and this is implemented by electrical fine tuning of the reference oscillator in addition to the coarse raster. Due to hardware limitations (such as D/A step size) the actual resolution is 10 - 25 kHz, depending on the frequency band used.	

7.2.2 Modulation and demodulation

Table 20. Modulation

Modulation method	π/4-DQPSK
Demodulation method	Partially differential

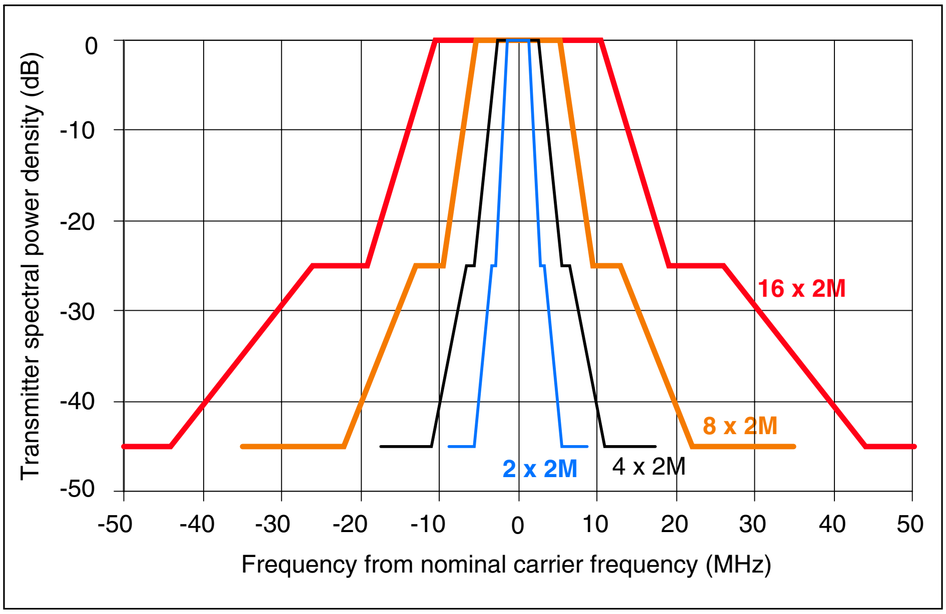


Figure 45. Spectrum mask

Table 21. Spectrum masks; Attenuation of spectrum mask (dB) at a specific distance (MHz) from centre frequency (linear interpolation between specified points)

Frequency band	Capacity and channel spacing	Attenuation (dB)	Distance from centre frequency (MHz)
All bands	2 x 2 Mbit/s (3.5 / 5.0 MHz channel spacing)	< 0 < -25 < -45	0 - 1.4 2.8 - 3.25 5.5 - 8.75
	4 x 2 Mbit/s (7.0 / 7.5 MHz channel spacing)	< 0 < -25 < -45	0 - 2.7 5.6 - 6.5 11 - 17.5
	8 x 2 Mbit/s (14.0 / 13.75 MHz channel spacing)	< 0 < -25 < -45	0 - 5.2 9.6 - 13 22 - 35
	16 x 2 Mbit/s (28.0 / 27.5 MHz channel spacing)	< 0 < -25 < -45	0 - 10.4 19.2 - 26 44 - 70
Meets the ETSI standards listed in Table 69.			

For 18g

Table 22. Emission codes (ITU-R SM.1138)

Capacity	Code
2 x 2 Mbit/s	3M50G7W, 5M00 *)
4 x 2 Mbit/s	7M00G7W, 7M50 *)
8 x 2 Mbit/s	14M0G7W, 13M8 *)
16 x 2 Mbit/s	28M0G7W, 27M5 *)

*) The latter emission codes apply only to 18G, for which there are two alternative channel spacings available. As a result both presented emission codes apply to 18G.

Table 23. Receiver bandwidths

Capacity	Receiver -3 dB bandwidth, nominal (MHz)	Receiver noise bandwidth, nominal (MHz)
2 x 2 Mbit/s	±0.9	1.8
4 x 2 Mbit/s	±1.8	3.6
8 x 2 Mbit/s	±3.6	7.2
16 x 2 Mbit/s	±7.1	14.2

7.2.3 Interference sensitivity and signature

Table 24. Co-channel interference (similar interference source)

Capacity	C/I (dB)			
	BER 10^{-3} threshold degradation		BER 10^{-6} threshold degradation	
	1 dB	3 dB	1 dB	3 dB
All capacities	18	15	23	19

Table 25. Adjacent channel interference (similar interference source)

Capacity	Channel spacing (MHz)	C/I (dB)			
		BER 10^{-3} threshold degradation		BER 10^{-6} threshold degradation	
		1 dB	3 dB	1 dB	3 dB
2 x 2 Mbit/s	3.5	-5	-8	0	-4
	5.0	-24	-27	-19	-23
4 x 2 Mbit/s	7.0	-5	-8	-1	-5
	7.5	-9	-12	-5	-9

Table 25. Adjacent channel interference (similar interference source)

Capacity	Channel spacing (MHz)	C/I (dB)			
		BER 10^{-3} threshold degradation		BER 10^{-6} threshold degradation	
		1 dB	3 dB	1 dB	3 dB
8 x 2 Mbit/s	14.0	-5	-8	-1	-5
	13.75	-4	-7	1	-3
16 x 2 Mbit/s	28.0	-5	-8	-1	-5
	27.5	-4	-7	1	-3

Table 26. Two channels away interference (similar interference source)

Capacity	C/I (dB)			
	BER 10^{-3} threshold degradation		BER 10^{-6} threshold degradation	
	1 dB	3 dB	1 dB	3 dB
All capacities	-24	-27	-19	-23

Table 27. Out-of-band CW interference tolerance*

Frequency of interference source	C/I (dB)	BER 1 x 10^{-6} threshold degradation
0.07 GHz to 2nd harmonic (excluding ± twice the channel bandwidth)	-35	1 dB
Meets the ETSI standards listed in Table 69.		

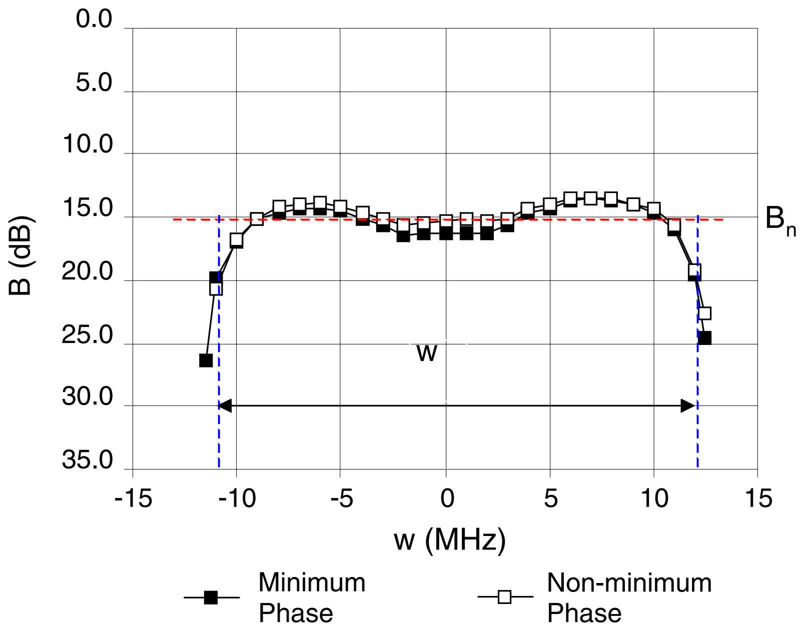


Figure 46. 10^{-3} BER signature curves for 15 GHz FlexiHopper (duplex frequency 644 MHz, capacity 16 x 2 Mbit/s

B_n = average notch depth

w = signature width

For more information, see the *Signature Measurements for 13, 15 and 18 GHz FlexiHopper Outdoor Units* application note that can be obtained upon request.

Table 28. 10^{-3} BER signature data (df is duplex frequency)

		Minimum phase		Non-minimum phase	
f (GHz)	**df (MHz)**	**w (MHz)**	**B_n (dB)**	**w (MHz)**	**B_n (dB)**
7	154/161	20 ± 2	17.0 ± 1.0	19 ± 2	16.7 ± 1.0
8	119/126	21 ± 2	17.3 ± 1.0	21 ± 2	17.1 ± 1.0
8	311.32	22 ± 2	17.8 ± 1.0	21 ± 2	17.5 ± 1.0
13	266	23 ± 2	14.3 ± 1.0	23 ± 2	14.1 ± 1.0
15	420	23 ± 2	14.5 ± 1.0	23 ± 2	14.4 ± 1.0

Table 28. 10^{-3} BER signature data (df is duplex frequency) (Continued)

		Minimum phase		Non-minimum phase	
f (GHz)	**df (MHz)**	**w (MHz)**	**B_n (dB)**	**w (MHz)**	**B_n (dB)**
15	644	23 ± 2	14.8 ± 1.0	23 ± 2	14.5 ± 1.0
15	728	23 ± 2	14.6 ± 1.0	23 ± 2	14.6 ± 1.0
18	1010	23 ± 2	14.1 ± 1.0	23 ± 2	14.0 ± 1.0

Table 29. 10^{-6} BER signature data

		Minimum phase		Non-minimum phase	
f (GHz)	**df (MHz)**	**w (MHz)**	**B_n (dB)**	**w (MHz)**	**B_n (dB)**
7	154/161	23 ± 2	15.4 ± 1.0	22 ± 2	15.4 ± 1.0
8	119/126	24 ± 2	15.8 ± 1.0	24 ± 2	15.9 ± 1.0
8	311.32	24 ± 2	15.9 ± 1.0	24 ± 2	16.0 ± 1.0
13	266	26 ± 2	13.1 ± 1.0	26 ± 2	13.1 ± 1.0
15	420	30 ± 2	10.8 ± 1.0	30 ± 2	10.7 ± 1.0
15	644	30 ± 2	10.7 ± 1.0	30 ± 2	10.5 ± 1.0
15	728	31 ± 2	10.5 ± 1.0	31 ± 2	10.5 ± 1.0
18	1010	31 ± 2	10.7 ± 1.0	31 ± 2	10.6 ± 1.0

7.2.4 Power levels

Table 30. Maximum transmit power and noise figure at antenna connector

Frequency band	Transmit power (dBm), nominal	Receive noise figure (dB), typical over temperature
7, 8 GHz	23	< 5
13, 15 GHz	20	< 6.5
18, 23 GHz	18	< 7
26 GHz	18	< 7.5
38 GHz	16	< 8

Table 31. Minimum transmit power

Frequency band	Capacity (Mbit/s)	Minimum transmit power (dBm), nominal
7, 8 GHz	All capacities	–3
13, 15 GHz	All capacities	-6
18, 23, 26, 38 GHz	2 x 2	-10
	4 x 2	-7
	8 x 2	-4
	16 x 2	-1

Table 32. Transmit power adjustment and stability

Frequency band	Transmit power stability	Transmit power adjustment step
7, 8, 13, 15, 18 GHz	< ±2 dB	1 dB
23, 26, 38 GHz	< ±3 dB	1 dB

Table 33. Spurious outputs

Spurious emissions (Tx and Rx) at antenna connector (1 MHz bandwidth)	Frequency 0.07 - 21.2 GHz 21.2 - 3rd harmonic	Level < -50 dBm < -30 dBm

Table 34. Receiver threshold at antenna connector

Frequency band	Capacity (Mbit/s)	BER 10^{-3} threshold (dBm)		BER 10^{-6} threshold (dBm)	
		Typical	Guar-anteed	Typical	Guar-anteed
7, 8 GHz	2 x 2	-95	-92	-92	-89
	4 x 2	-92	-89	-89	-86
	8 x 2	-89	-86	-86	-83
	16 x 2	-86	-83	-83	-80
13, 15, 18, 23 GHz	2 x 2	-93	-89	-90	-86
	4 x 2	-90	-86	-87	-83
	8 x 2	-87	-83	-84	-80
	16 x 2	-84	-80	-81	-77
26 GHz	2 x 2	-92	-88	-89	-85
	4 x 2	-89	-85	-86	-82
	8 x 2	-86	-82	-83	-79
	16 x 2	-83	-79	-80	-76
38 GHz	2 x 2	-90	-86	-87	-83
	4 x 2	-89	-85	-86	-82
	8 x 2	-86	-82	-83	-79
	16 x 2	-83	-79	-80	-76

Table 35. Typical receiver noise power (=FkTB) at the antenna port

Frequency band	Capacity (Mbit/s)	Receiver noise power at antenna port at room temperature (dBm), typical
7, 8 GHz	2 x 2 4 x 2 8 x 2 16 x 2	-107 -104 -101 -98
13, 15, 18, 23 GHz	2 x 2 4 x 2 8 x 2 16 x 2	-106 -103 -100 -97
26, 38 GHz	2 x 2 4 x 2 8 x 2 16 x 2	-104 -101 -98 -95

Table 36. Maximum receive power level at antenna connector

Frequency band	BER 10^{-3} level	No damage
7, 8, 13, 15, 18, 23, 38 GHz	< -20 dBm	< 0 dBm
26 GHz	< -15 dBm	< 0 dBm

Table 37. AGC tracking, received signal level measurement, automatic fading margin measurement

AGC tracking speed	> 100 dB/s
Received signal level measurement accuracy (from noise level up to -30 dBm level)	< ±3 dB (typical) < ±5 dB (guaranteed)
Accuracy of fading margin measurement (measurement range 10 - 55 dB or up to -30 dBm Rx level)	±3 dB (typical)

7.2.5 System value

Table 38. System value

Frequency band	Capacity (Mbit/s)	System value, typical (dB)	System value, guaranteed (dB)
7 GHz	2 x 2	> 118	> 115
	4 x 2	> 115	> 112
	8 x 2	> 112	> 109
	16 x 2	> 109	> 106
8 GHz	2 x 2	> 118	> 115
	4 x 2	> 115	> 112
	8 x 2	> 112	> 109
	16 x 2	> 109	> 106
13, 15 GHz	2 x 2	> 113	> 107
	4 x 2	> 110	> 104
	8 x 2	> 107	> 101
	16 x 2	> 104	> 98
18 GHz	2 x 2	> 111	> 105
	4 x 2	> 108	> 102
	8 x 2	> 105	> 99
	16 x 2	> 102	> 96
23 GHz	2 x 2	> 111	> 104
	4 x 2	> 108	> 101
	8 x 2	> 105	> 98
	16 x 2	> 102	> 95
26 GHz	2 x 2	> 110	> 103
	4 x 2	> 107	> 100
	8 x 2	> 104	> 97
	16 x 2	> 101	> 94
38 GHz	2 x 2	> 106	> 99
	4 x 2	> 105	> 98
	8 x 2	> 102	> 95
	16 x 2	> 99	> 92

The system value is defined as the attenuation value between the transmitter and receiver antenna ports which causes a bit error rate of 10^{-3}.

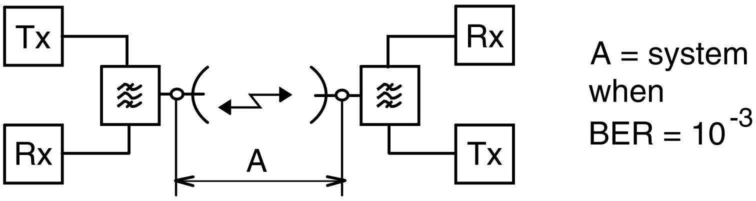


Figure 47. Defining system value

7.2.6 Synchronisation, recovery, switch-over

Table 39. Synchronisation, recovery, and switch-over

Transmitter turn on time (Tx off to on)	< 150 ms
Transmitter turn off time (Tx on to off)	< 50 ms
Receiver synchronisation (Rx off to on)	< 100 ms
Changeover time, equipment protection	< 500 ms

Receiver Hitless Changeover with Diversity Protection

When the bit error rate with both operating channels is better than 10^{-6} and the signal on one of the channels attenuates at a velocity of <50 dB/s to the ≤ 10^{-3} bit error rate level, the receiver changeover is hitless.

If the bit error rate in both operating channels is better than 10^{-4}, the improvement factor compared to the traditional AGC-based switching device is, on average, 2 decades (100 x) greater than the better one of the input signals.

7.2.7 Interfaces

Note

The antenna is normally connected directly to Nokia's proprietary quick release antenna connector. The polarisation is interchangeable (vertical / horizontal). For a separately mounted antenna, the following waveguide flanges are used.

Table 40. Antenna connector

Frequency band	**Waveguide flange**
7, 8 GHz	UBR84
13 GHz	UBR120
15 GHz	UBR140
18, 23, 26 GHz	UBR220
38 GHz	UBR320

Table 41. Electrical interfaces

Flexbus interface	TNC connector (female) 50 Ω Power supply for the OU
AGC monitor interface (antenna alignment monitor)	BNC connector Voltage range: 0.5 - 4.5 V (decreasing with increasing Rx level) Output impedance: > 10 kΩ

7.2.8 Power supply, dimensions

Table 42. FlexiHopper OU power supply and dimensions

DC supply voltage	+48 to +60 V_{DC}
Power consumption	< 25 W
Dimensions of the 7 and 8 GHz outdoor unit without antenna and alignment unit	Height 230 mm Width 210 mm Depth 230 mm Weight 6.7 kg

Table 42. FlexiHopper OU power supply and dimensions (Continued)

Dimensions of the 13 and 15 GHz outdoor unit without antenna and alignment unit	Height 230 mm Width 210 mm Depth 210 mm Weight 5.5 kg
Dimensions of the 18, 23, and 26 GHz outdoor unit without antenna and alignment unit	Height 230 mm Width 210 mm Depth 170 mm Weight 4.6 kg
Dimensions of the 38 GHz outdoor unit without antenna and alignment unit	Height 230 mm Width 210 mm Depth 120 mm Weight 4.0 kg

7.3 Antenna and alignment unit

7.3.1 Electrical characteristics

Table 43. Antenna specifications

Frequency band	Antenna size	Gain (low/mid/high -band) (dBi)	Gain tolerance (dB)	3 dB beam-width	F/B ratio (Vert./Horiz. pol.) (dB)	XPD (dB)	Return loss (dB)
7, 8 GHz	60 cm	30.3/30.8/31.6	±0.7	4.3°	56.5	30	20
	120 cm	36.3/36.9/37.6	±0.6	2.3°	62	29	20
	180 cm	40.0/40.5/41.0	±0.5	1.6°	66	30	23
13 GHz	60 cm	35.7/36.3/36.2	±1	2.5°	61	30	17.7
	120 cm	41.1/41.5/41.7	±0.5	1.3°	67	30	17.7
	180 cm	44.9/45.1/45.3	±0.5	0.9°	70	30	20
15 GHz	30 cm	31.6/32.0/32.3	±0.5	3.9°	53	30	17.7
	60 cm	36.8/37.1/37.4	±0.8	2.2°	64	30	17.7
	120 cm	42.2/42.5/43.0	±0.5	1.2°	70	30	17.7
	180 cm	45.8/46.1/46.3	±0.5	0.8°	72/71	30	20

Table 43. Antenna specifications (Continued)

Frequency band	Antenna size	Gain (low/mid/high -band) (dBi)	Gain tolerance (dB)	3 dB beam-width	F/B ratio (Vert./Horiz. pol.) (dB)	XPD (dB)	Return loss (dB)
18 GHz	30 cm	33.7/34.4/34.6	±0.8	3.1°	55	30	17.7
	60 cm	38.7/39.2/39.7	±0.8	1.8°	63	30	17.7
	120 cm	44.1/44.6/45.0	±0.5	0.9°	72	30	17.7
	180 cm	47.9/48.3/48.8	±0.5	0.6°	71/70	32	20
23 GHz	20 cm	30.5/31.0/31.5	±0.5	4.5°	56	30	15
	30 cm	35.0/35.5/36.0	±0.9	2.7°	61	30	17.7
	60 cm	40.1/40.6/41.1	±0.8	1.5°	66	30	17.7
	120 cm	45.5/46.0/46.5	±0.5	0.7°	72	30	17.7
	180 cm	48.9/49.5/50.0	±0.5	0.5°	75	30	20
26 GHz	20 cm	31.9/32.3/32.6	±0.5	4.1°	58	30	15
	30 cm	36.5/36.9/37.2	±1	2.4°	62	30	17.7
	60 cm	41.1/41.5/41.8	±0.8	1.4°	67	30	17.7
	120 cm	46.6/47.0/47.3	±0.5	0.7°	73	30	17.7
38 GHz	20 cm	34.4/35.0/35.4	±0.5	2.7°	56	30	17.7
	30 cm	39.3/39.6/39.8	±0.5	1.7°	60	30	17.7
	60 cm	44.0/44.6/44.9	±0.5	1.0°	65	30	17.7

Table 44. Antenna radiation pattern

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
7, 8 GHz	60 cm Meets also ETSI EN 300 833, R1, C3, Fig. 2c	5 10 25 100 180	20 10 6 –25 –25	5 8.5 20 70 100 180	20 17 5 –6 –25 –25	0 2 20 70 90 180	1 1 –6 –17 –29 –29

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
7, 8 GHz	120 cm Meets also ETSI EN 300 833, R1, C3, Fig. 2c	5	12	5	17	0	9
		60	–6	20	8	1	9
		95	–26	70	–8	5	–6
		180	–26	100	–25	20	–8
				180	–25	40	–10
						90	–28
						180	–28
7, 8 GHz	180 cm Meets also ETSI EN 300 833, R1, C3, Fig. 2c	5	18	5	14	0	10
		20	2	10	8	2	10
		95	–26	50	–4	5	–5
		180	–26	90	–26	10	–8
				180	–26	30	–12
						60	–23
						90	–28
						180	–28
13 GHz	60 cm Meets also ETSI EN 300 833, R1, C3, Fig. 2c	5	19.3	5	19.3	0	6
		10	14.8	10	8.3	3	6
		15	8.3	15	8.3	5	-5.5
		20	5.3	20	0.8	10	-6.5
		30	3.3	44	0.8	40	-20
		45	1.3	50	-3.7	70	-20
		70	-8.7	60	-3.7	90	-26
		100	-26.7	75	-8.7	180	-26
		180	-26.7	100	-25.7		
				180	-25.7		

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
13 GHz	120 cm Meets also ETSI EN 300 833, R1, C3, Fig. 2c	5 10 15 20 50 70 90 180	15 10 3 3 0 -6 -25 -25	5 10 12 20 35 60 90 180	15 10 4 4 0 -4 -25 -25	0 2 4.5 5 8 25 40 70 100 180	11.5 11.5 1.5 -6.5 -6.5 -10.5 -15.5 -15.5 -26.5 -26.5
13 GHz	180 cm Meets also ETSI EN 300 833, R1, C3, Fig. 2c	5 30 55 75 100 180	18 0 -2 -10 -25.2 -25.2	5 30 50 60 90 180	16 2 0 -4 -25.2 -25.2	0 2 4.5 5 8 25 40 55 100 180	15 15 5 -3 -3 -7 -12 -12 -25 -25
15 GHz	30 cm Meets also ETSI EN 300 833, R2, C2, Fig. 3b	5 15 30 45 80 160 180	18 12 2 2 -18 -20 -20	5 15 20 60 90 160 180	20 12 4 0 -18 -20 -20	0 5 10 20 55 90 180	2 2 -4 -12 -12 -22 -22

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
15 GHz	60 cm Meets also ETSI EN 300 833, R2, C2, Fig. 3b	5 11 40 52 68 90 180	15.3 7.1 -5 -5 -6.9 -24.9 -24.9	5 30 46 70 80 85 180	16 1 1 -9 -15 -24.9 -24.9	0 2 10 50 70 90 180	7 7 -9 -23 -23 -31 -31
15 GHz	120 cm Meets also ETSI EN 300 833, R2, C3, Fig.3c	5 7 10 20 30 50 60 95 180	14 13 8.5 -1 -1 -2.5 -4.5 -27.5 -27.5	5 20 30 60 75 95 180	13 -2 -2 -7 -14 -27.4 -27.4	0 1 2 5 10 20 45 70 80 90 180	14.5 14.5 4.5 -4.5 -8.5 -14.5 -15.5 -20.5 -25.5 -29.5 -29.5
15 GHz	180 cm Meets also ETSI EN 300 833, R2, C2, Fig 3b	6 15 22 42 55 70 80 180	13 9 -4 -4 -10.3 -10.3 -26 -26	5 7 10 13 15 35 45 65 90 180	15 14 9 2 1 -1 -7 -8 -25 -25	0 1.5 5 9 15 40 60 80 180	16 16 -5 -6 -8 -18 -18 -28 -28

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
18 GHz	30 cm Meets also ETSI EN 300 833, R2, C2, Fig. 3b	5	25	5	25	0	4.5
		10	13	10	13	3	4.5
		15	13	15	13	10	-7.5
		20	10	20	10	15	-7.5
		70	0	70	0	50	-15.5
		80	-8	80	-8	60	-20.5
		100	-18	100	-18	180	-20.5
		115	-20	115	-20		
		180	-20	180	-20		
18 GHz	60 cm Meets also ETSI EN 300 833, R2, C2, Fig 3b	5	25	5	22	0	9
		10	8	12	9	2	9
		20	4	18	9	4	1
		25	4	30	2	8	1
		40	-3	65	-1	10	-7
		60	-5	90	-20	15	-7
		90	-20	180	-20.8	25	-14
		180	-20.8			40	-15
						70	-22
						80	-25
						90	-31
						180	-31

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
18 GHz	120 cm Meets also ETSI EN 300 833, R2, C3, Fig 3c	5 10 25 60 95 180	18 9 2 -4 -27 -27	5 10 25 60 95 180	18 9 2 -4 -27 -27	0 1 2 4 50 80 90 90 180	14.5 14.5 8.5 8.5 -16.5 -24.5 -28.5 -31.5 -31.5
18 GHz	180 cm Meets also ETSI EN 300 833, R2, C2, Fig. 3b	5 10 15 20 30 40 60 70 80 180	20 11 6 1 -2 -2 -7.5 -11.5 -23 -23	5 10 25 45 60 70 90 180	14 6 -1 -1 -4 -9 -22 -22	0 1 3 5 7 10 13 25 55 75 85 180	18 18 8 8 0 -3 -10 -10 -12 -24 -26 -26

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
23 GHz	20 cm	5	19	5	19	0	1
	Meets also ETSI EN 300 833, R3, C3, Fig. 4c	10	12	10	12	2.5	1
		35	-3	30	0	4.5	-2
		50	-3	35	-5	5	-7
		70	-12	60	-5	10	-7
		90	-25	70	-11	60	-17
		180	-25	90	-25	100	-31
				180	-25	180	-31
23 GHz	30 cm	5	19	5	20	0	5.5
	Meets also ETSI EN 300 833, R3, C3, Fig. 4c	10	11	10	11	3	5.5
		15	8	20	6	5	-5.5
		20	4	50	0	10	-5.5
		55	-4	80	-13.5	60	-19.5
		90	-25	100	-25	85	-30.5
		180	-25	180	-25	180	-30.5
23 GHz	60 cm	5	16	5	18	0	10.5
	Meets also ETSI EN 300 833, R3, C3, Fig. 4c	10	10	10	10	2	10.5
		15	8	15	8	5	-5.5
		25	3	30	-1	10	-5.5
		30	-1	52	-1	15	-10.5
		50	-3	85	-16.5	20	-10.5
		62	-7	100	-24.5	35	-16.5
		90	-18	180	-25	60	-16.5
		100	-24.5			80	-23.5
		180	-25			90	-30.5
						180	-30.5

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	**Co-Pol. (dBi)**	**Angle (deg.)**	**Co-Pol. (dBi)**	**Angle (deg.)**	**Cross-Pol. (dBi)**
23 GHz	120 cm	5	16	5	16	0	16
	Meets also ETSI EN 300 833, R3, C3, Fig. 4c	10	7	10	8	0.5	16
		25	-1	30	-2	4	2
		50	-1	50	-2	5	-6
		60	-10	70	-10	10	-6
		75	-16	80	-15	25	-12
		90	-26	100	-26	55	-18
		180	-26	180	-26	90	-20
						180	-20
23 GHz	180 cm	5	18	5	16.5	0	19.5
	Meets also ETSI EN 300 833, R3, C3, Fig. 4c	10	9	15	4	1	17.5
		15	9	60	-6	5	-5.5
		25	0	80	-20	8	-5.5
		35	0	110	-25.5	15	-12.5
		45	-6	180	-25.5	20	-18.5
		60	-8			60	-21.5
		80	-18			75	-30.5
		90	-25.5			180	-30.5
		180	-25.5				
26 GHz	20 cm	5	19.5	5	19.5	0	2.5
	Meets also ETSI EN 300 833, R4, C2, Fig. 5b	6	18.3	6	15.3	2.5	2.5
		7	14.5	8	15.3	4.5	-0.5
		10	14.5	20	2.5	5	-5.5
		20	2.5	60	-4.5	10	-5.5
		60	-4.5	80	-15	60	-15.5
		80	-15	90	-25.7	80	-26.5
		90	-25.7	180	-25.7	180	-26.5
		180	-25.7				

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
26 GHz	30 cm Meets also ETSI EN 300 833, R4, C2, Fig. 5b	5 20 60 105 180	20 5 -3 -25 -25	5 22 60 100 140 180	20 3 -3 -23 -25 -25	0 2 3.5 5 10 15 30 60 80 180	7 7 5 -3.5 -3.5 -9 -13 -21 -24 -24
26 GHz	60 cm Meets also ETSI EN 300 833, R4, C2, Fig. 5b	5 8 15 50 66 100 180	20 17 5.5 0.5 -6 -25.5 -25.5	5 20 50 65 105 180	20 2 0.5 -5 -25.5 -25.5	0 2.5 5 15 30 50 60 80 180	11.5 11.5 -3.5 -8.5 -13.5 -13.5 -18.5 -25.5 -25.5

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
26 GHz	120 cm	5	20	5	20	0	17
	Meets also ETSI EN 300 833, R4, C2, Fig. 5b	15	10	15	10	1	17
		20	5	20	5	1.5	15
		55	0	55	0	2	7
		100	-23	100	-23	5	-3.5
		135	-24.4	135	-24.4	8	-3.5
		140	-26.4	140	-26.4	10	-8
		180	-26.4	180	-26.4	15	-13
						20	-25
						50	-25
						70	-31
						80	-35
						180	-35
38 GHz	20 cm	5	16	5	23	0	5
	Meets also ETSI EN 300 833, R5, C2, Fig. 6b at H-Pol and C3, Fig. 6c at V-Pol	7	9	7	12	2	5
		10	9	10	12	10	-3
		15	4	15	7	60	-12
		20	-1	20	-2	80	-24
		40	-7	35	-4	180	-24
		60	-10	40	-7		
		80	-17	45	-7		
		90	-21	60	-10		
		180	-21	80	-17		
				90	-21		
				180	-21		

Table 44. Antenna radiation pattern (Continued)

Frequency	Antenna size	Vert.		Horiz.		Vert. and Horiz.	
		Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Co-Pol. (dBi)	Angle (deg.)	Cross-Pol. (dBi)
38 GHz	30 cm Meets also ETSI EN 300 833, R5, C2, Fig. 6b at H-Pol and C3, Fig. 6c at V-Pol	5 10 20 50 65 80 180	15 8 0 -10 -12 -20 -20	5 10 30 40 72 90 180	18 8 -2 -2 -8 -18 -18	0 2 6 15 25 55 80 180	9.5 9.5 -4.5 -4.5 -14.5 -16.5 -22.5 -22.5
38 GHz	60 cm Meets also ETSI EN 300 833, R5, C2, Fig. 6b at H-Pol and C3, Fig. 6c at V-Pol	5 10 20 40 50 65 75 85 180	15.7 8.8 0 -7 -8.4 -10 -10 -18.5 -18.5	5 11 26 28 46 77 88 180	25 8 2 0 0 -9 -18.5 -18.5	0 2 4.5 9.5 15 30 50 70 80 180	14.5 14.5 -1.5 -1.5 -11.5 -13.5 -19.5 -19.5 -21.5 -21.5

7.3.2 Adjustment, dimensions, installation options

Table 45. Antenna adjustment ranges

Adjustment	20 cm antenna with alignment bracket	20, 30, and 60 cm antenna	120 cm antenna	180 cm antenna
Horizontal, coarse	360° (±90°, 10° steps)	360°	360°	360°

Table 45. Antenna adjustment ranges (Continued)

Adjustment	20 cm antenna with alignment bracket	20, 30, and 60 cm antenna	120 cm antenna	180 cm antenna
Horizontal, fine	±10°	±15°	±15°	±15°
Vertical, coarse	±45° (10° steps)	+25°, 0°, -25°	NA	NA
Vertical, fine	±10°	+45° to 0°, ±25°, 0° to -45°	±20°	±5°

Table 46. Antenna and alignment unit dimensions and installation options

Dimensions of the 20 cm antenna and alignment unit / alignment bracket	Height x width 246 x 256 mm (antenna) Depth 120 mm (antenna) Weight 7.7 kg (with alignment unit), 5.5 kg (with alignment bracket)
Dimensions of the 30 cm antenna and alignment unit	Diameter 390 mm (antenna) Depth 165 - 190 mm (antenna) Weight 8 kg
Dimensions of the 60 cm antenna and alignment unit	Diameter 690 mm (antenna) Depth 250 mm (antenna) Weight 12 kg
Dimensions of the 120 cm antenna and alignment unit	Diameter 1285 mm (antenna) Depth 550 - 560 mm (antenna) Weight 52 - 64 kg
Dimensions of the 180 cm antenna and alignment unit	Diameter 1940 - 1975 mm (antenna) Depth 870 - 1200 mm (antenna) Weight 108 - 127 kg
Installation pole, 20 cm antenna (23, 26 and 38 GHz) with alignment bracket	Diameter 30 - 120 mm
Installation pole, 20 cm antenna with alignment bracket and OU mounting adapter plate (23, 26 and 38 GHz)	Diameter 120 - 300 mm
Installation pole, 20, 30, and 60 cm antennas	Diameter 50 - 125 mm
Installation pole, 120 and 180 cm antennas	Diameter 115 mm

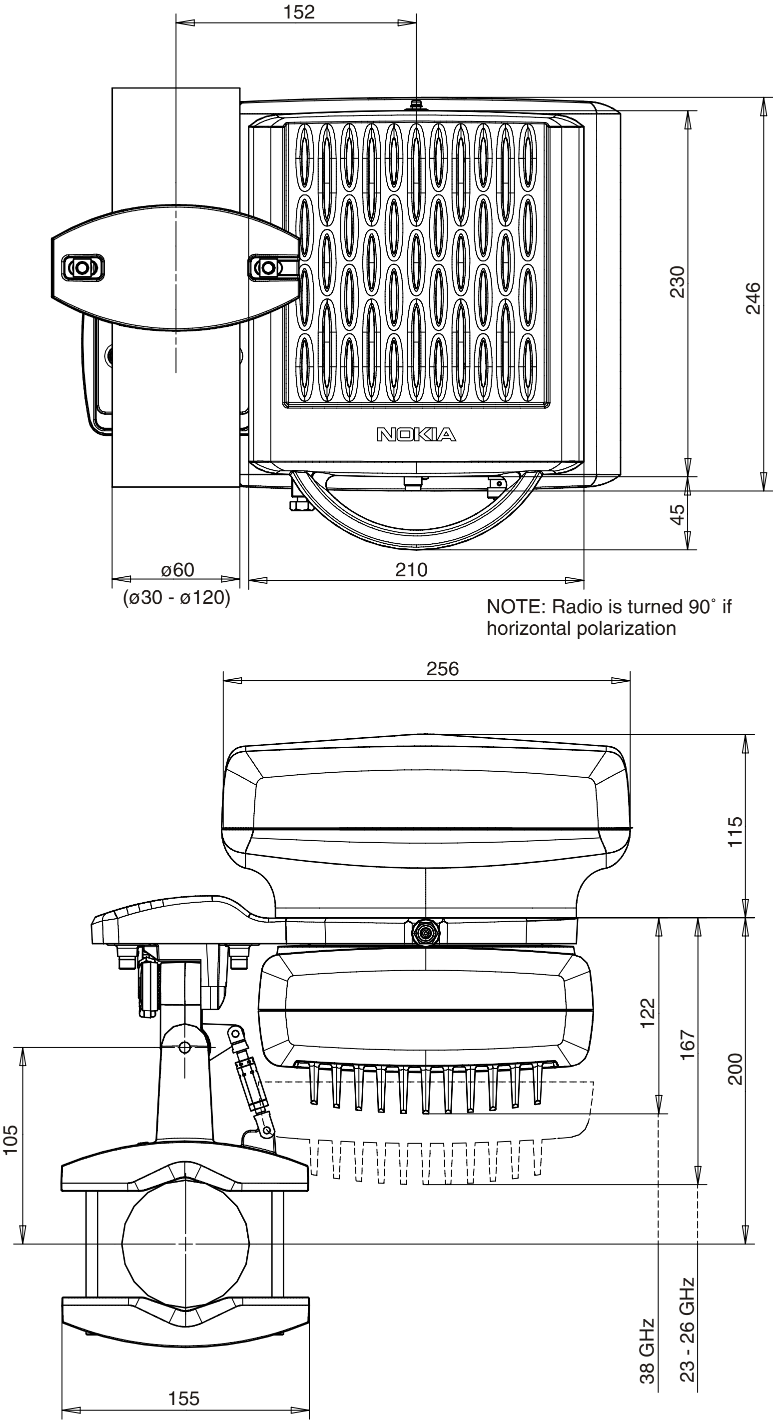


Figure 48. Outdoor unit with 20 cm square radome antenna (dimensions in mm)

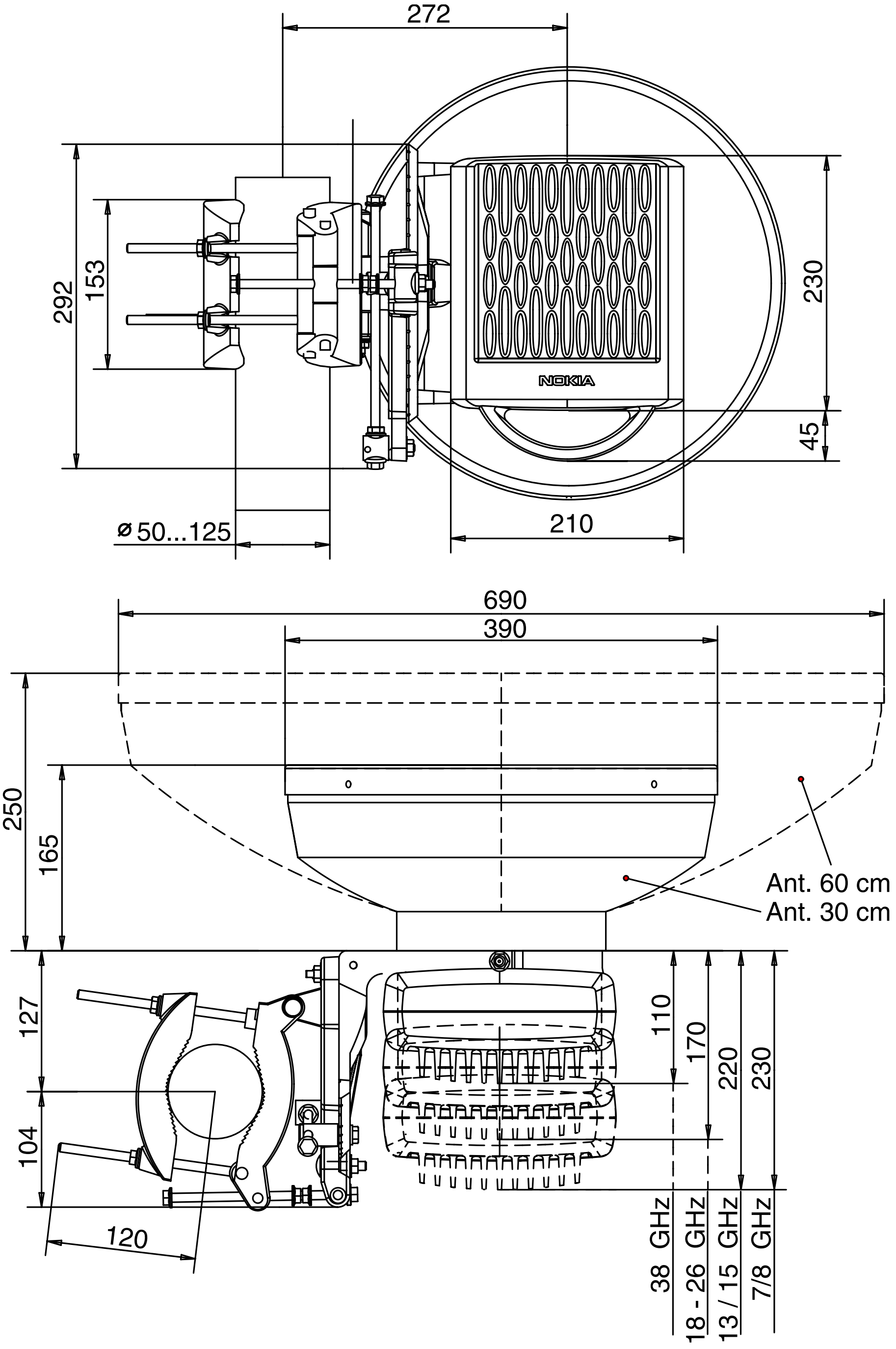


Figure 49. Outdoor unit with 30 or 60 cm antenna (dimensions in mm)

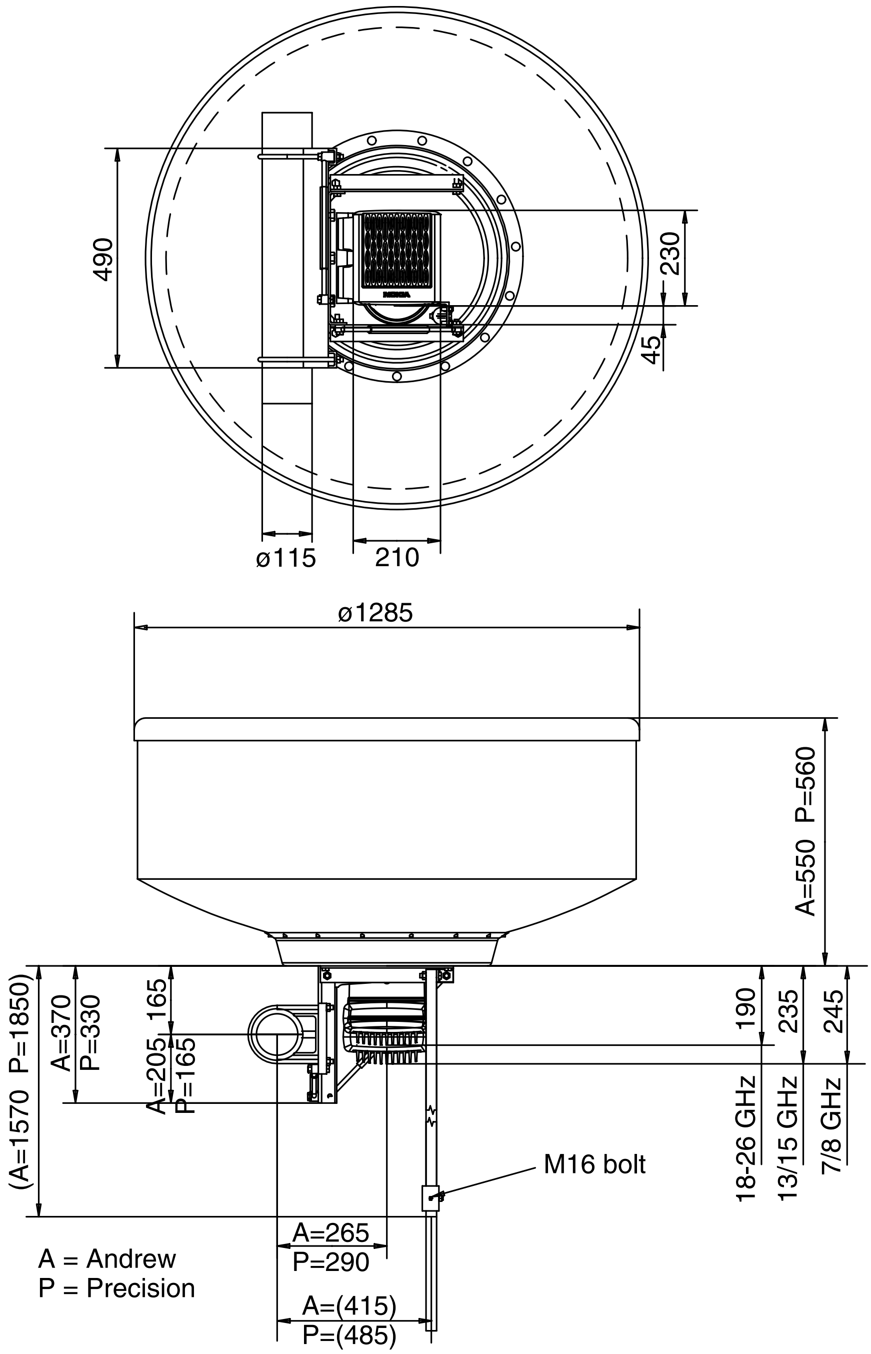
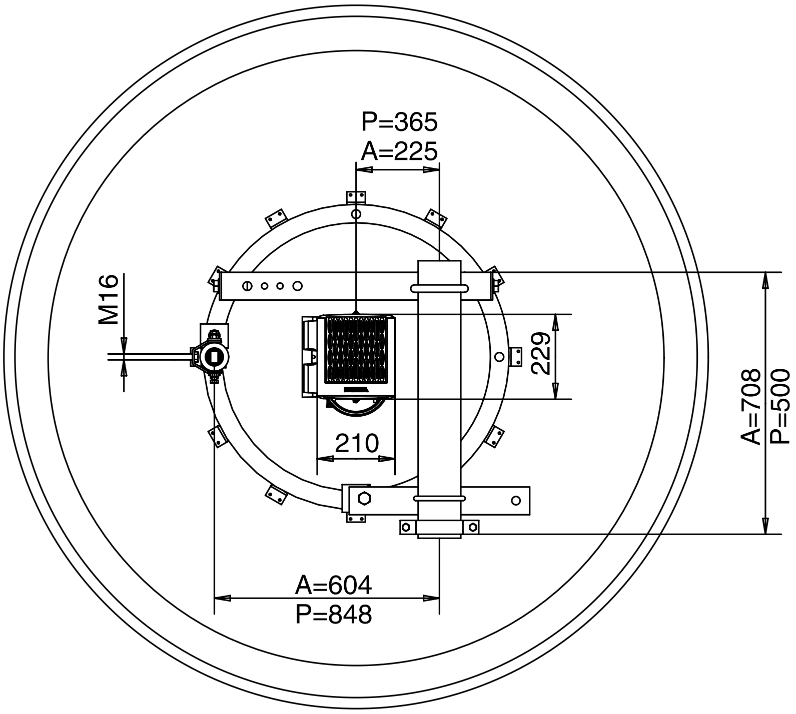


Figure 50. Outdoor unit with 120 or 180 cm antenna (dimensions in mm)


P=365
A=225
M16
229
210
A=708
P=500
A=604
P=848

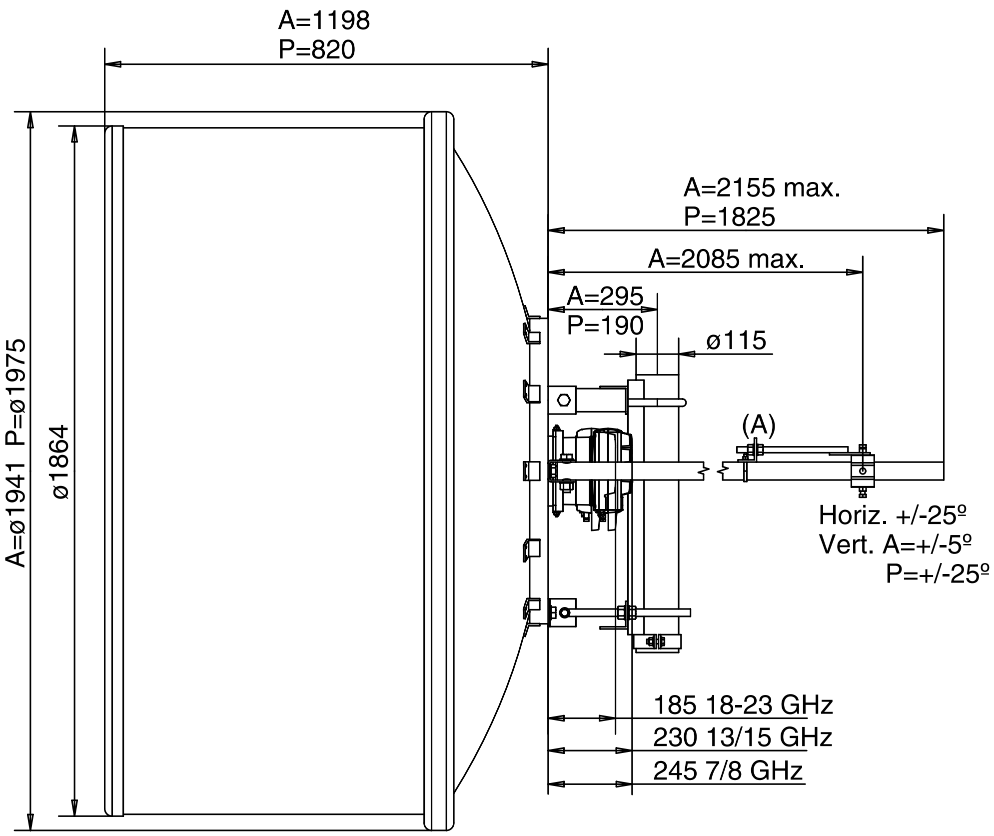

A=1198
P=820
A=ø1941 P=ø1975
ø1864
A=2155 max.
P=1825
A=2085 max.
A=295
P=190
ø115
(A)
Horiz. +/-25º
Vert. A=+/-5º
P=+/-25º
185 18-23 GHz
230 13/15 GHz
245 7/8 GHz

Figure 51. Outdoor unit with 180 cm antenna (dimensions in mm)

7.3.3 Wind load

Table 47. Wind forces and moments affecting the installation pole

Antenna diameter	Wind velocity (m/s)	F_A (N)	F_S (N)	M_T (Nm)
20 cm (with al. bracket)	55	170	90	46
	40	90	50	24
20 cm	55	170	90	25
	40	90	50	13
30 cm	55	335	150	90
	40	177	80	48
60 cm	55	935	446	252
	40	495	236	133
120 cm	55	2820	1325	865
	40	1490	700	460
180 cm	55	6350	3150	2205
	40	3360	1670	1170
F_A is the force affecting the pole from the direction of the antenna. F_S is the force affecting the pole from the side. M_T is the maximum momentum twisting the antenna around the pole.				

7.4 Coupler for 1-antenna HSB

Table 48. Insertion losses of the directional coupler (see Figures 52 and 53)

Frequency band	Insertion loss (radio to antenna)	
	Radio 1 (dB)	Radio 2 (dB)
7, 8 GHz	1.5 ± 0.3	6.1 ± 0.5
13 GHz	1.5 ± 0.3	6.2 ± 0.5
15 GHz	1.6 ± 0.3	6.2 ± 0.5

Table 48. Insertion losses of the directional coupler (see Figures 52 and 53)

Frequency band	Insertion loss (radio to antenna)	
	Radio 1 (dB)	Radio 2 (dB)
18 GHz	2.0 ± 0.2	6.2 ± 0.5
23 GHz	2.0 ± 0.2	6.5 ± 0.5
26 GHz	2.2 ± 0.2	6.5 ± 0.5
38 GHz	2.4 ± 0.2	6.5 ± 0.5

At 7, 8, 13, and 15 GHz and with 1–antenna HSB, an integrated antenna cannot be used and, thus, a separate antenna is needed.

Also, at 7, 8, 13 and 15 GHz, a flexible waveguide of 1 m is normally used. In these cases, add 0.3 dB for 7 and 8 GHz, 0.4 ± 0.2 dB for 13 GHz and 0.6 ± 0.3 dB for 15 GHz to the given values. If a longer waveguide is needed, an elliptical waveguide can be used. To get the total insertion losses in this case, add the attenuation of the elliptical waveguides (0.06 dB/m for 7 and 8 GHz, 0.12 dB/m for 13 GHz and 0.16 dB/m for 15 GHz) to the given values.

At 18, 23, 26, and 38 GHz, a short waveguide (190 mm or 127 mm) is included in the coupler. Normally an integrated antenna is used, but a separate antenna can be used with an additional waveguide. To get the insertion losses in this case, add the attenuation of the additional waveguide to the given values.

Table 49. Attenuation in a flexible waveguide (1 m)

Frequency band	Attenuation max (dB)
7, 8 GHz	0.3
13 GHz	0.6
15 GHz	0.9
18 GHz	1.2
23 GHz	1.4
26 GHz	1.6
38 GHz	2.2

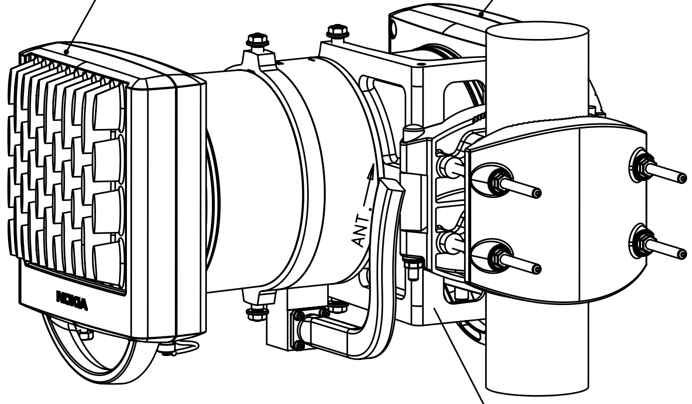


Figure 52. Nokia FlexiHopper 7, 8, 13, or 15 in 1-antenna HSB operation

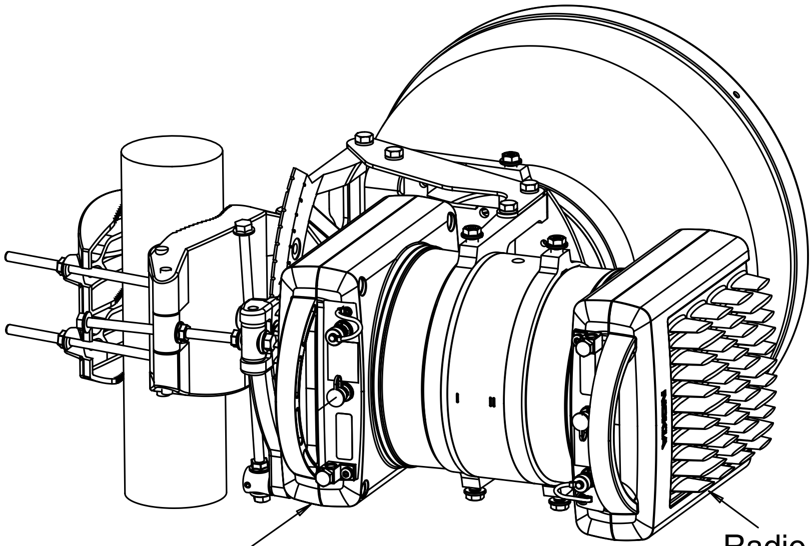


Figure 53. Nokia FlexiHopper 18, 23, or 26 in 1-antenna HSB operation

Table 50. Coupler dimensions

Dimensions of the 7, 8 GHz coupler	Height 380 mm Width 430 mm Depth 260 mm Weight 7.5 kg
Dimensions of the 13, 15 GHz coupler	Height 300 mm Width 430 mm Depth 260 mm Weight 6.8 kg
Dimensions of the 18 - 26 GHz coupler	Height 250 mm Width 280 mm Depth 300 mm Weight 5.0 kg
Dimensions of the 38 GHz coupler	Height 250 mm Width 240 mm Depth 300 mm Weight 4.8 kg

7.5 Flexbus cable

Table 51. Flexbus cable requirements

Cable type	Coaxial cable, double shielded or semi-rigid
Characteristic impedance	50 ± 2 Ω
DC resistance	< 4.6 Ω (sum of inner and outer conductor)
Data attenuation	< 9.0 dB at 19 MHz
Flexbus signals	- DC power supply - Bidirectional data (37 Mbit/s, NRZ code, 1.4 V pulse amplitude)
NOTE: Overvoltage protection and cable equalizer are integral parts of the Flexbus interface. Primary overvoltage protection is a 90 V gas-arrester.	

Table 52. Recommended cable and connector types

RG-223	max. length 140 m
RG-214	max. length 300 m
Recommended connector type	Suhner Rosenberger
Tightness, dust/water	IP 54

Note

The recommended connector type refers to connector types which should be used with the Flexbus cable. The used connector should meet these requirements either by being the equivalent of them, or bettering the performance.

7.6 FIU 19 indoor unit

7.6.1 Interfaces

Table 53. FIU 19 main unit interfaces

Main unit	
Flexbus interfaces 1 and 2 (FB1, FB2)	TNC connector 50 Ω Up to 16 x 2 Mbit/s signals, OU power supply
Network management interfaces (Q1-1, Q1-2)	TQ connector Max. 9600 bit/s, V.11
Power supply connector (PWR)	Molex Micro-Fit 3.0
Local management port (LMP)	BQ connector Max. 115 kbit/s RS-232 interface
Measurement point connector (MP)	SMB connector, 75 Ω Digital output for 2 Mbit/s signals and internal frequencies

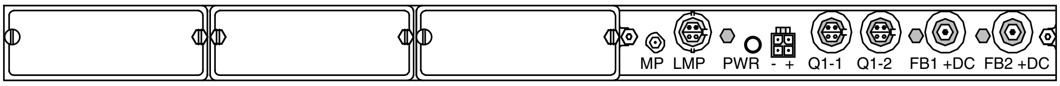


Figure 54. FIU 19 interfaces

Table 54. FIU 19 interfaces in the 4 x 2M plug-in units and the expansion unit

4 x 2M plug-in units, 16 x 2M expansion unit	
2M interfaces, n x 2 Mbit/s	SMB connector, 75 Ω or TQ connector, 120 Ω or RJ-45 connector, 120 Ω ITU-T G.703

Table 55. FIU 19 interfaces in the Flexbus plug-in unit

Flexbus plug-in unit	
Flexbus interfaces 3 and 4 (FB3, FB4)	TNC connector 50 Ω Up to 16 x 2 Mbit/s signals, OU power supply
OU power supply input (for third and fourth OU)	Molex Micro-Fit 3.0

Table 56. FIU 19 interfaces in the Aux data plug-in unit

Aux data plug-in unit	
Auxiliary interfaces (4)	Four RJ-45 modular connectors Aux slow channel Aux fast channel Four TTL-type programmable I/O channels Four relay controls

With one Aux data plug-in unit, one aux slow channel can be used. The channel can be selected from types presented in Table 57.

Note

Only one aux slow channel and one aux fast channel can be simultaneously connected to a Flexbus.

Table 57. FIU 19 Aux data plug-in unit, aux slow channels

Channel type	Capacity	Max bit rate (bit/s)	Approx. sample rate (1000 /s)	Note
EIA-232	2 x 2M	4800	32	Max cable C: 2500 pF; Max cable length: 25 m
	4 - 16 x 2M	9600	64	
ITU-T V.11 (RS-485)*	2 x 2M	4800	32	Max cable length: 1 km
	4 - 16 x 2M	9600	64	
*) Optionally also TTL type clock outputs for synchronous data				

With one Aux data plug-in unit, one aux fast channel can be used. The channel can be selected from types presented in Table 58.

Note

Only one aux slow channel and one aux fast channel can be simultaneously connected to a Flexbus.

Table 58. FIU 19 Aux data plug-in unit, aux fast channels

Channel type	Capacity	Max bit rate (bit/s)	Approx. sample rate (1000 /s)	Note
ITU-T V.11 (RS-485)*	2 - 16 x 2M	64 000 ± 100 ppm		Co/contra-directional
ITU-T G.703 120-ohm balanced**	2 - 16 x 2M	64 000 ± 100 ppm		Co-directional

Table 58. FIU 19 Aux data plug-in unit, aux fast channels (Continued)

Channel type	**Capacity**	**Max bit rate (bit/s)**	**Approx. sample rate (1000 /s)**	**Note**
ITU-T V.11 (RS-485)***	2 x 2M	9 600	64	Sampled mode
	4 x 2M	19 200	64/128	
	8 x 2M	38 400	64/128/256	
	16 x 2M	64 000	64/128/256/512	
*) Also V.11 type programmable clock channel. **) HDB3 coding used as in 2Mbit channels. Currently, no applications known to be used in. ***) Optionally also V.11 type programmable clock channel.				

Table 59. FIU 19 Aux data plug-in unit, TTL-type I/O channels

Channel type	**Input high min**	**Input low max**	**Output high min**	**Output low max**
TTL input/output	2 V	0.8 V	3.8 V	0.45 V

Table 60. FIU 19 Aux data plug-in unit, relay controls

Channel type	**Pos U_{in} max**	**Neg U_{in} max**	**I max**	**P max**
Relay control	+72 V	-72 V	50 mA	300 mW

All TTL and signal interfaces are protected with 6.2 V TVS diodes. Relay control interfaces are protected with 100 V TVS diodes.

7.6.2 Power supply, dimensions, installation options

Table 61. FIU 19 power supply, dimensions, installation options

Main unit power supply	-40.5 to -72 V_{DC}
Flexbus plug-in unit power supply	+52 to +60 V_{DC}
Power consumption (16 x 2M IU only)	< 17 W
Power consumption (16 x 2M IU + 2 OUs + maximum cable loss)	< 90 W
Dimensions of the main unit and the expansion unit	Height 29 mm (2/3 U) Width 444 mm (with 1 U brackets), 449 mm (with 1.5 U / 2 U brackets) Depth 300 mm (without connectors) Weight 2.8 kg
Dimensions of the plug-in units	Height 25 mm Width 75 mm Depth 160 mm Weight 0.075 - 0.150 kg
Installation options	IEC 19-inch rack ETSI 600 x 300 mm rack (with adapter) TM4 slim rack (with adapter)

7.7 FIU 19E indoor unit

7.7.1 Interfaces

Table 62. FIU 19E main unit interfaces

Flexbus interfaces 1 and 2 FB1, FB2	TNC connector 50 Ω Up to 16 x 2 Mbit/s signals, OU power supply
Network management interfaces Q1-1, Q1-2	RJ-45 connector Max. 9600 bit/s, V.11
Power supply connector PWR	Molex Micro-Fit 3.0

Table 62. FIU 19E main unit interfaces (Continued)

Local management port LMP	RJ-45 connector Max. 115 kbit/s RS-232 interface
Measurement point connector MP	SMB connector, 75 Ω Digital output for 2 Mbit/s signals and internal frequencies
Ethernet Interface 10baseT	RJ-45 10 Mbit/s link for management

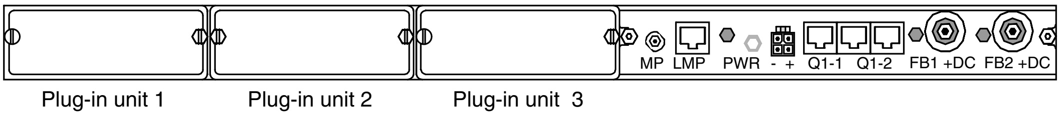


Figure 55. FIU 19E interfaces

Table 63. FIU 19E interfaces in the plug-in units and the expansion unit

4 x 2 M plug-in units, 16 x 2 expansion unit	
2M interfaces, n x 2 Mbit/s	SMB connector, 75 Ω **or** RJ 45, 120 Ω ITU-T G.703

Table 64. FIU 19E interfaces in the Flexbus plug-in unit

Flexbus plug-in unit	
Flexbus interfaces 3 and 4 (FB3, FB4)	TNC connector 50 Ω Up to 16 x 2 Mbit/s signals, OU power supply
OU power supply input (for third and fourth OU)	Molex Micro-Fit 3.0

Table 65. FIU 19E interfaces in the Aux data plug-in unit

Aux data plug-in unit	
Auxiliary interfaces	RJ-45 modular connector Aux slow interface: max. 4800 bit/s (at 2 x 2 Mbit/s capacity) or 9600 bit/s (at 4 x 2 Mbit/s or higher capacity), EIA-232 or ITU-T V.11 Aux fast interface: max. 64 kbit/s, ITU-T V.11 or ITU-T G.703 Four TTL-type programmable I/O interfaces

7.7.2 Power supply, dimensions, and installation options

Table 66. FIU 19E power supply, dimensions, and installation options

Main unit power supply	-40.5 to -72 V_{DC}
Flexbus plug-in unit power supply	+52 to +60 V_{DC}
Power consumption (IU only)	< 17 W
Power consumption (IU + 2OU_s + maximum cable loss)	< 46 W
Dimensions of the main unit (expansion unit is of same size)	Height 29 mm (2/3 U) Width 444 mm (with 1 U brackets), 449 mm (with 1.5 U brackets) Depth 300 mm (without connectors) Weight 2.8 kg
Dimensions of the plug-in units	Height 25 mm Width 75 mm Depth 160 mm Weight 0.075 - 0.150 kg
Installation options	IEC 19″ rack ETSI 500 mm rack (with adapter) TM4 slim rack (with adapter)

7.8 RRIC indoor unit

7.8.1 Interfaces

Table 67. RRIC interfaces

Front panel	
Flexbus interfaces 1 and 2 (FB1, FB2)	N-connector 50 Ω Up to 16 x 2 Mbit/s signals, OU power supply
Local management port (LMP)	BQ connector Max. 115 kbit/s, RS-232 interface
Other	
Measurement point (on the printed circuit board)	SMB connector, TTL-level Digital output for 2 Mbit/s signals and internal frequencies
Flexbus interface 3 (via backplane to another RRIC)	Up to 16 x 2 Mbit/s
2M interfaces towards TRUx	4 x 2 Mbit/s

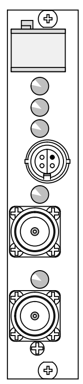


Figure 56. RRIC interfaces

7.8.2 Power supply, dimensions, installation options

Table 68. RRIC power supply, dimensions, installation options

DC supply voltage	-40.5 to -72 V_{DC} (Powered by the BTS power supply. If used in AC-powered Nokia Intratalk BTS, requires an additional power supply.)
Power consumption (IU only)	< 7 W
Power consumption (IU + 2 OUs + maximum cable loss)	< 80 W
Dimensions of indoor unit	Height 130.8 mm Width 25 mm Depth 280 mm Weight 0.44 kg
Installation options	Integrated into Nokia Citytalk or Nokia Intratalk BTS

7.9 FXC RRI indoor unit

7.9.1 Interfaces

Table 69. FXC RRI interfaces

Front panel	
Flexbus interfaces 1 and 2 (FB1, FB2)	TNC connector 50 Ω Up to 16 x 2 Mbit/s signals, OU power supply
Other	
2M interfaces towards BTS or transmission node	16 x 2 Mbit/s
Local management port (LMP)	BQ connector in Nokia MetroSite GSM BTS, Nokia MetroHub, or Nokia UltraSite EDGE BTS

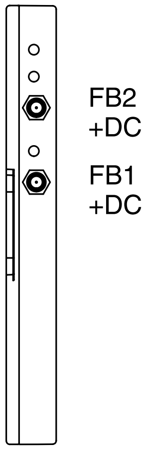


Figure 57. FXC RRI interfaces

7.9.2 Power supply, dimensions, installation options

Table 70. FXC RRI power supply, dimensions, installation options

DC supply voltage	Powered by the BTS or transmission node
Power consumption	< 8 W
Dimensions of indoor unit	Height 254 mm Width 28 mm Depth 187 mm Weight 1.35 kg
Installation options	Integrated into Nokia MetroSite GSM BTS, Nokia MetroHub, or Nokia UltraSite EDGE BTS

7.10 IFUE interface unit

7.10.1 Interfaces

Table 71. IFUE interfaces

Flexbus interfaces (FB1-FB3) Capacity ATM capacity	TNC-connector 50 Ω (female) Up to 16 x2 Mbit/s signals; radio outdoor unit power supply 16x2Mbit/s; 16x4528 cells/s (E1)
Local management port (LMP)	BQ connector
Measurement point (MP)	SMB connector

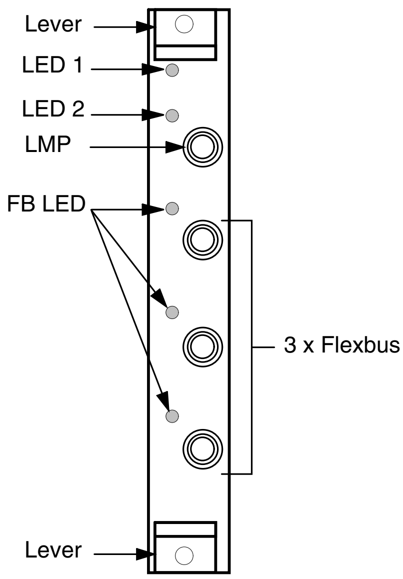


Figure 58. IFUE interfaces

7.10.2 Power supply, dimensions, Flexbus cable requirements

Table 72. Power supply and power consumption

DC power supply	-37.5 to -72 V_{DC}
Power consumption (typical)	25 W
Power consumption (max.)	25 W
Power consumption for remote power feeding per Flexbus interface (max.)	35 W

Table 73. Dimensions of IFUE

Height	264 mm
Width	25 mm
Depth	280 mm
Weight	1000 g

Table 74. Flexbus cable requirements

Cable type	Coaxial cable, double shielded or semi-rigid
Characteristic impedance	$50 \pm 2\ \Omega$
DC resistance	< 4.6 Ω (sum of inner and outer conductor)
Data attenuation	< 9.0 dB at 19 MHz
Flexbus signals	DC power supply Bidirectional data (37 Mbit/s, NRZ code, 1.4 V pulse amplitude)
NOTE: Over-voltage protection and cable equaliser are integral parts of the Flexbus interface. Primary over-voltage protection is a 90 V gas-arrester.	

Table 75. Recommended cable type

RG-223	Minimum length 140 m
RG-214	Maximum length 300 m

7.11 System requirements for Nokia Hopper Manager

Nokia Hopper Manager requires the following minimum system configuration:

Table 76. System requirements

Computer	Intel Pentium -based IBM-compatible PC
Operating system	Microsoft Windows 95/98/2000 Microsoft Windows NT 4.0 Workstation
System memory	16 MB for Windows 95 32 MB for Windows NT
Hard disk space	20 MB for the node manager software
Display	Super VGA, minimum resolution of 800 x 600
Accessories	CD-ROM drive Windows compatible mouse or pointing device Windows compatible printer (optional) LMP cable (from the PC to the node)

7.12 International recommendations

This is a list of the recommendations referred to in technical specifications.

Table 77. Signals (ITU-T)

Recommendation	Recommendation name
G.703	Physical/electrical characteristics of hierarchical digital interfaces
G.704	Synchronous frame structures used at primary and secondary hierarchical levels
G.823	The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy
G.826	Error performance parameters and objectives for international, constant bit rate digital paths at or above primary rate
G.921	Digital sections based on the 2048 kbit/s hierarchy
V.11	Data communication over the telephone network; Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s

Table 78. Frequency allocation (ITU-R)

Recommendation	Recommendation name
F.497-5	Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band
F.595-6	Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency band
F.636-3	Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band
F.637-2	Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band
F.748-3	Radio-frequency channel arrangements for radio-relay systems operating in the 25, 26 and 28 GHz bands
F.749-1	Radio-frequency channel arrangements for radio-relay systems operating in the 38 GHz band
SM.1138	Determination of necessary bandwidths including examples for their calculation and associated examples for the designation of emissions

Table 79. Radio transmission (ETSI)

Recommendation	Recommendation name
ETSI EN 301 216 (FlexiHopper 7 and 8 GHz)	Fixed Radio Systems; Point-to-point equipment; Plesiochronous DIgital Hierarchy (PDH); Low and medium capacity and STM-0 digital radio system operating in the frequency bands in the range 3 GHz to 11 GHz
ETSI EN 301 128	Fixed Radio Systems; Point-to-point equipment; Digital Radio Relay Systems (DRRS); Plesiochronous Digital Hierarchy (PDH); Low and medium capacity DRRS operating in the 13 GHz, 15 GHz and 18 GHz frequency bands
ETSI EN 300 198	Fixed Radio Systems; Point-to-point equipment; Parameters for radio systems for the transmission of digital signals operating at 23 GHz
ETSI EN 300 431 (FlexiHopper 26 GHz)	Fixed Radio Systems; Point-to-point equipment; Parameters for radio system for the transmission of digital signals operating in the frequency range 24,25 GHz to 29,50 GHz
ETSI EN 300 197 (FlexiHopper 38 GHz)	Fixed Radio Systems; Point-to-point equipment; Parameters for radio systems for the transmission of digital signals operating at 32 GHz and 38 GHz
ETSI EN 300 833	Fixed Radio Systems; Point-to-point Antennas; Antennas for point-to-point fixed radio systems operating in the frequency band 3 GHz to 60 GHz

Table 80. Environment

Recommendation	Recommendation name
ETS 300 019-1-1 Class 1.2	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Storage.
ETS 300 019-1-2 Class 2.3	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Transportation.
ETS 300 019-1-3 Class 3.2	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Stationary use at weather-protected locations.

Table 80. Environment (Continued)

Recommendation	Recommendation name
ETS 300 019-1-4 Class 4.1	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Stationary use at non-weather-protected locations.
ETS 300 019-1-4 Class 4.1E	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Stationary use at non-weather-protected locations- extended.
ETS 300 132-2	Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)
EN 55022 or CISPR22	Limits and methods of measurement of radio disturbance characteristics of information technology equipment
EN 61000–4–2	Electromagnetic compatibility (EMC) — Part 4–2: Testing and measurement techniques — Electrostatic discharge immunity test
EN 61000–4–3	Electromagnetic compatibility (EMC) - Part 4–3: Testing and measurement techniques - Radiated, radio frequency, electromagnetic field immunity test
EN 61000–4–6	Electromagnetic compatibility (EMC) - Part 4–6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000–4–5	Electromagnetic compatibility (EMC) - Part 4–4: Testing and measurement techniques - Surge immunity test
EN 61000–4–4	Electromagnetic compatibility (EMC) - Part 4–4: Testing and measurement techniques — Electrical fast transient/burst immunity test
EN 301 489–9	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.
EN 301 489–4	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific requirements for fixed radio links and ancillary equipment and services.