NOKIA

Product Description

C33513.85--H0

Contents

Contents 3

1 About this document 7

2 Introduction 9

3 Features 15
3.1 Integrated radio and cross-connect **15**
3.2 Nokia FlexiHopper outdoor unit **20**
3.2.1 Forward error correction and interleaving **22**
3.2.2 ALCQ (Adaptive Level Control with Quality measure) **22**
3.2.3 Automatic fading margin measurement **23**
3.3 FIU 19 (E) indoor units **23**
3.4 RRIC indoor unit **25**
3.5 FXC RRI indoor unit **26**
3.6 IFUE interface unit **27**
3.7 Protection methods **27**
3.7.1 Hot standby, hot standby + space diversity **29**
3.7.2 Frequency diversity, polarisation diversity **31**
3.7.3 Changeover criteria **34**
3.8 Configuration backup **36**

4 Applications 37
4.1 Network applications **37**
4.2 Site configuration examples **39**
4.2.1 Nokia FlexiHopper with FIU 19 (E) **41**
4.2.2 Nokia FlexiHopper with RRIC **45**
4.2.3 Nokia FlexiHopper at Nokia MetroSite **48**
4.2.4 Nokia FlexiHopper at Nokia UltraSite **50**
4.2.5 Nokia UltraSite WCDMA and Nokia MetroSite WCDMA **51**
4.2.6 Nokia GSM Office **51**

5 Management 53
5.1 Nokia NMS **53**
5.2 Nokia Hopper Manager **54**
5.3 Using Nokia Q1 bus **55**
5.3.1 FIU 19 (E) **55**
5.3.2 RRIC **57**
5.3.3 IFUE **58**
5.3.4 Q1 addresses **58**
5.3.5 Q1 fault handling **59**
5.4 Using TCP/IP connections **60**

6 Mechanical structure 63
6.1 Nokia FlexiHopper outdoor unit **63**
6.2 FIU 19 indoor unit **65**
6.3 FIU 19E indoor unit **68**
6.4 RRIC indoor unit **69**

6.5 FXC RRI indoor unit **70**
6.6 IFUE interface unit **71**

7 Technical specifications 73
7.1 General **73**
7.1.1 Capacities **73**
7.1.2 Operation **74**
7.1.3 Environment **75**
7.2 Nokia FlexiHopper outdoor unit **77**
7.2.1 Frequencies **77**
7.2.2 Modulation and demodulation **85**
7.2.3 Interference sensitivity and signature **87**
7.2.4 Power levels **90**
7.2.5 System value **94**
7.2.6 Synchronisation, recovery, and changeover **95**
7.2.7 Interfaces **96**
7.2.8 Power supply, dimensions **96**
7.3 Antenna and alignment unit **97**
7.3.1 Electrical specifications **98**
7.3.2 Radiation pattern envelope (RPE) values in ETSI EN 300 833 V1.4.1 standard **127**
7.3.3 Adjustment, dimensions, and installation options **130**
7.3.4 Wind load **136**
7.4 Directional coupler for 1-antenna HSB **137**
7.5 Flexbus cable **140**
7.6 FIU 19 indoor unit **141**
7.6.1 Interfaces **141**
7.6.2 Power supply, dimensions, installation options **145**
7.7 FIU 19E indoor unit **145**
7.7.1 Interfaces **145**
7.7.2 Power supply, dimensions, and installation options **147**
7.8 RRIC indoor unit **148**
7.8.1 Interfaces **148**
7.8.2 Power supply, dimensions, installation options **149**
7.9 FXC RRI indoor unit **149**
7.9.1 Interfaces **149**
7.9.2 Power supply, dimensions, installation options **150**
7.10 IFUE interface unit **151**
7.10.1 Interfaces **151**
7.10.2 Power supply and dimensions **152**
7.11 System requirements for Nokia Hopper Manager **152**
7.12 International recommendations **153**

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
DN99600269 Issue 9-0 en DRAFT	25 May 2002	**DRAFT** documentation with added FIU 19E info.
DN99600269 Issue 9-0 en	04 Feb 2003	FIU 19RJ removed. New type approval pictures and information about Nokia FlexiHopper outdoor unit added. Protection methods and electrical specifications for antennas updated.

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 (E), 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.

Note

When a feature is valid for both FIU 19 indoor unit product variants, it is either marked with a notation FIU 19 (E) or the IUs are mentioned separately.

---

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 carries power and digital baseband data and 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 2x2, 4x2, 8x2, or 16x2 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 - 6.0 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 set with 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 16x2 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 4 + 1 different indoor units for Nokia FlexiHopper to provide optimal features for different environments. All frequency bands use the same indoor units. One FIU 19 (E) can support up to four outdoor units, when one of the transmission directions is protected.

The full radio capacity from 2x2 Mbit/s up to 16x2 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 fixed 4x2 Mbit/s radio capacity.

The main features of each indoor unit are described below.

FIU 19 – compact 19″ indoor unit

FIU 19 is a modular 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 4x2 up to 16x2 Mbit/s. It can be expanded easily with plug-in units in 4x2 Mbit/s increments. The 16x2 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 indoor unit. FIU 19 enables connection for two to four outdoor units and supports hot standby and diversity protection methods.

FIU 19E

FIU 19E has all the same features as FIU 19. The FIU 19E indoor unit implements the Ethernet interface towards the IP DCN. It provides an SNMP interface and TFTP software download 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 4x2 Mbit/s add/drop capacity to the base station transmission unit (TRUx) and up to 16x2 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 protection. Loop protection is available on the RRIC indoor unit together with the TRUx base station transmission unit.

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

FXC RRI is an indoor unit which can be installed in Nokia MetroSite EDGE 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 16x2 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 16x2 Mbit/s capacity.

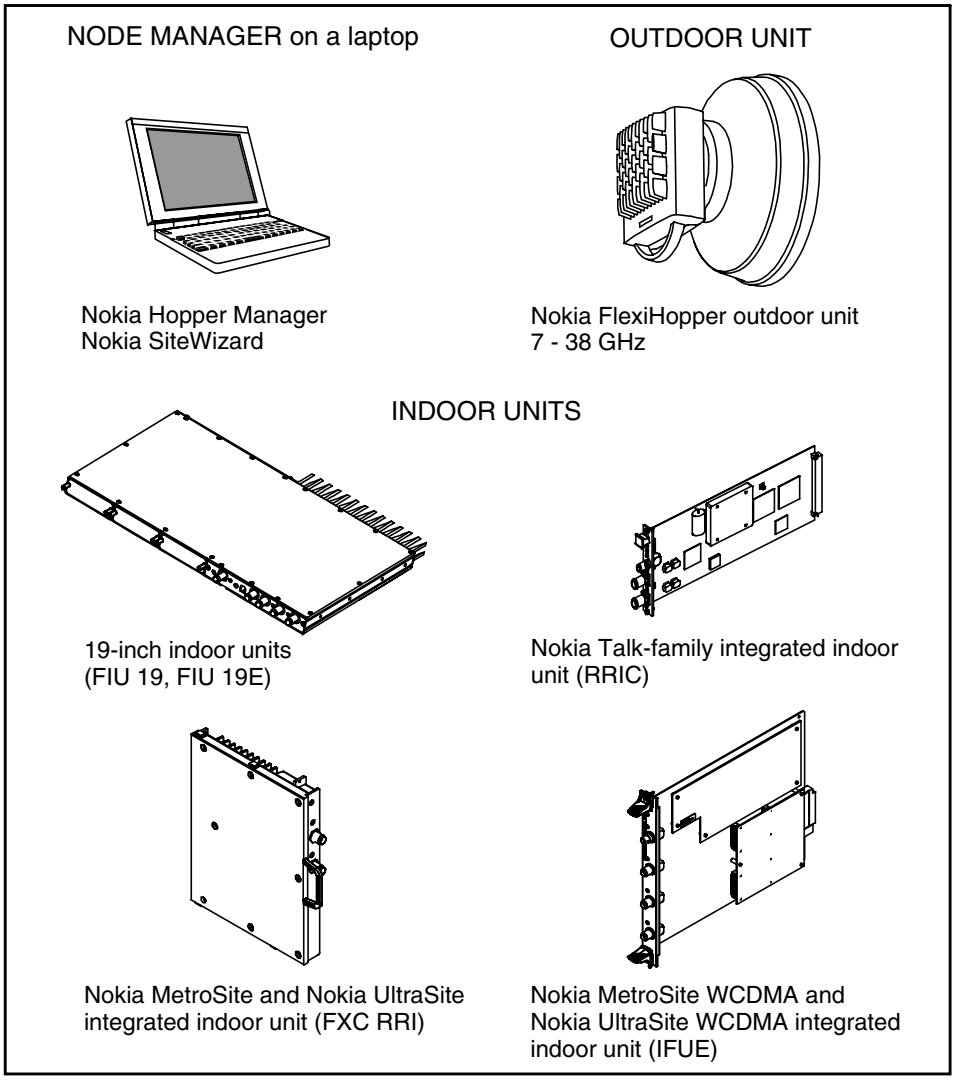


Figure 2. Components of the Nokia FlexiHopper network element

Note

MartisDXX FBU interface unit can also be used with Nokia FlexiHopper microwave radio. For more information on FBU, refer to *Nokia FBU Manager User's Guide*.

Easy to use management system

Nokia FlexiHopper can be fully controlled and managed locally by

- Nokia Hopper Manager (with FIU 19 (E), and RRIC)
- Nokia FBU Manager (with MartisDXX FBU interface)
- Nokia SiteWizard (with FXC RRI)
- Nokia AXC-FB Hopper Manager (with 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.
- Alarms with troubleshooting information.

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 (E), RRIC, and FXC RRI) and the IFUE interface unit

---

Note

MartisDXX FBU interface unit can also be used with Nokia FlexiHopper microwave radio. For more information on FBU, refer to *Nokia FBU Manager User's Guide*.

- 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 Flexbuses and 2 Mbit/s interfaces. The indoor unit has two (FXC RRI, RRIC) or four (FIU 19 (E), IFUE) totally independent framing/deframing sections, which can be cross-connected to external or internal Flexbus interfaces.

Flexbus – single cable interconnections

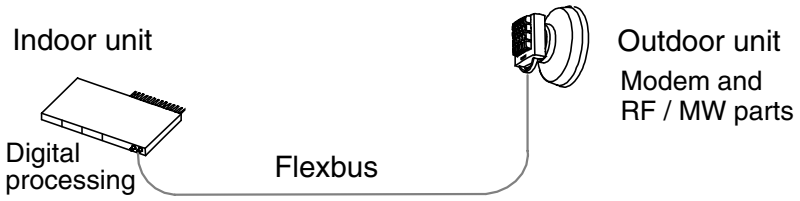


Figure 3. The basic Nokia FlexiHopper network element configuration, one indoor unit and one outdoor unit

The bidirectional Flexbus cable connects all system elements together. Flexbus carries digital 2-16x2 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 DC power to the outdoor unit.

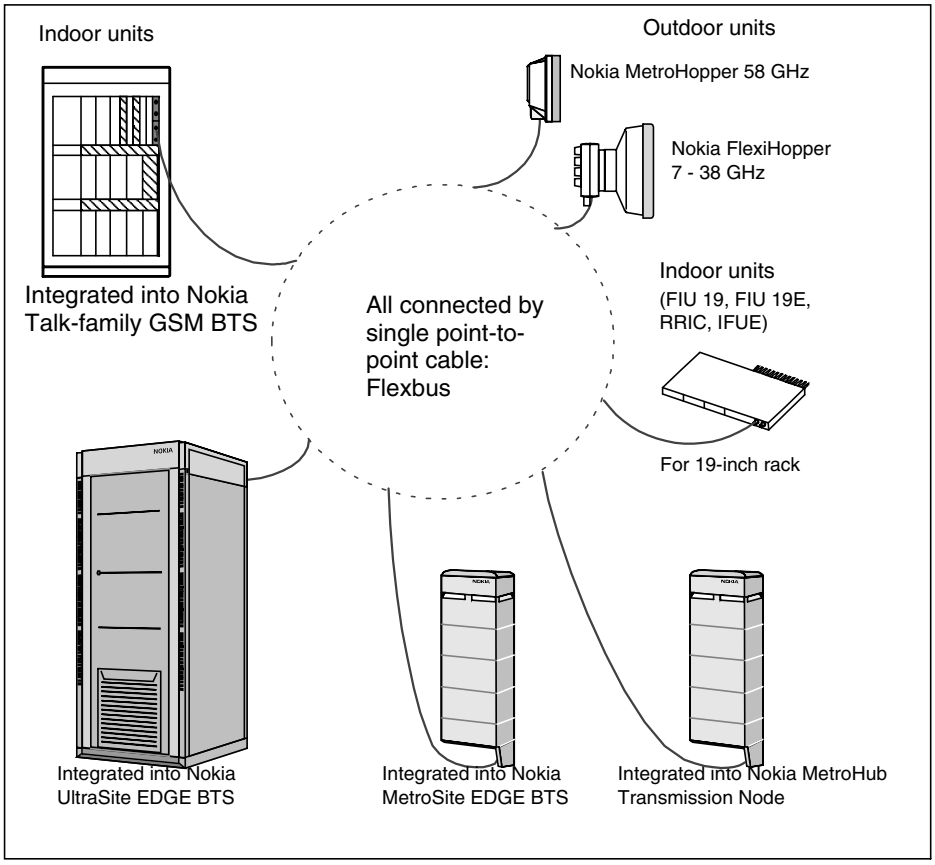


Figure 4. The Flexbus family

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.

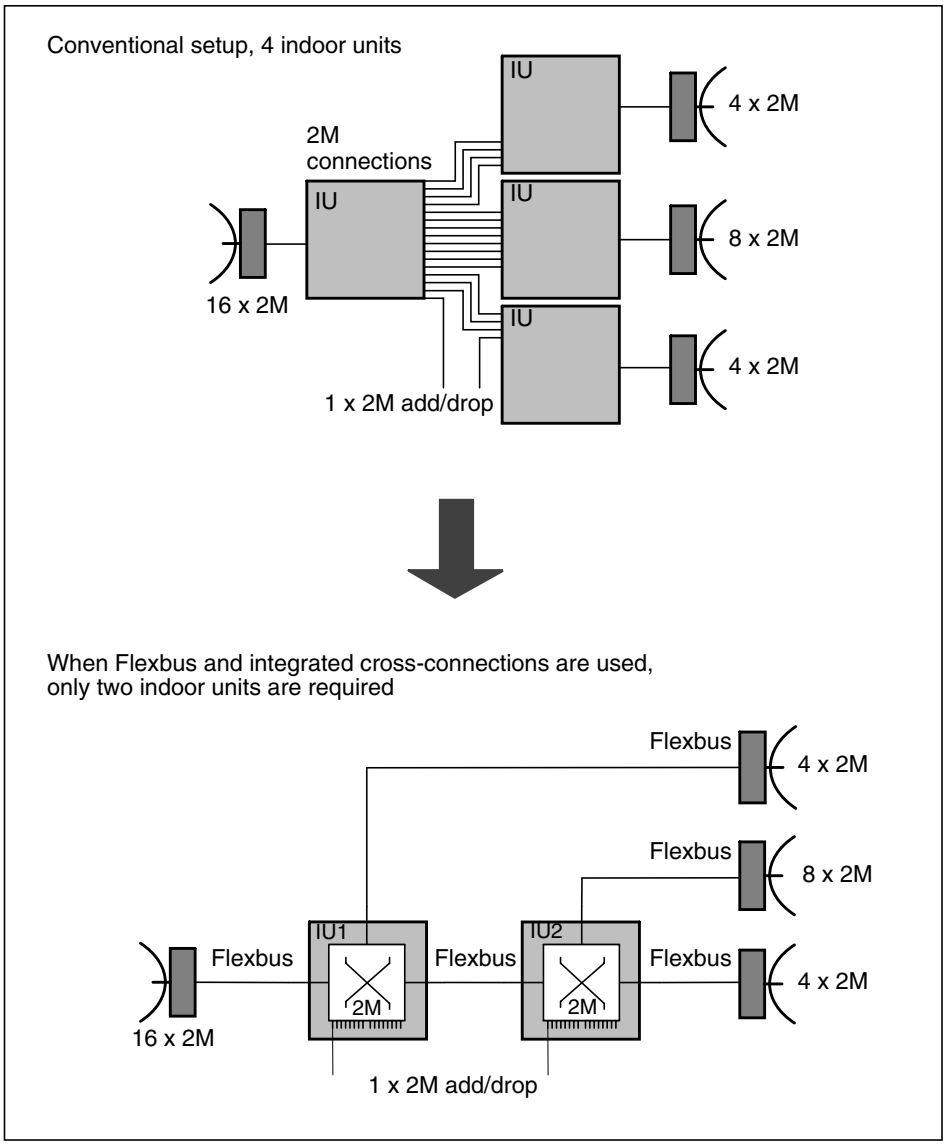


Figure 5. Removing 2M cabling from a site with FIU 19 (E) and Flexbus

In a conventional setup (Figures 5 and 6) the system elements are connected together using several 2M cables. All these can be replaced with a single Flexbus cable (Figures 5 and 6). Note that in this example, in a conventional 16x2 Mbit/s 75 Ω unbalanced system, there could be up to 96 cables.

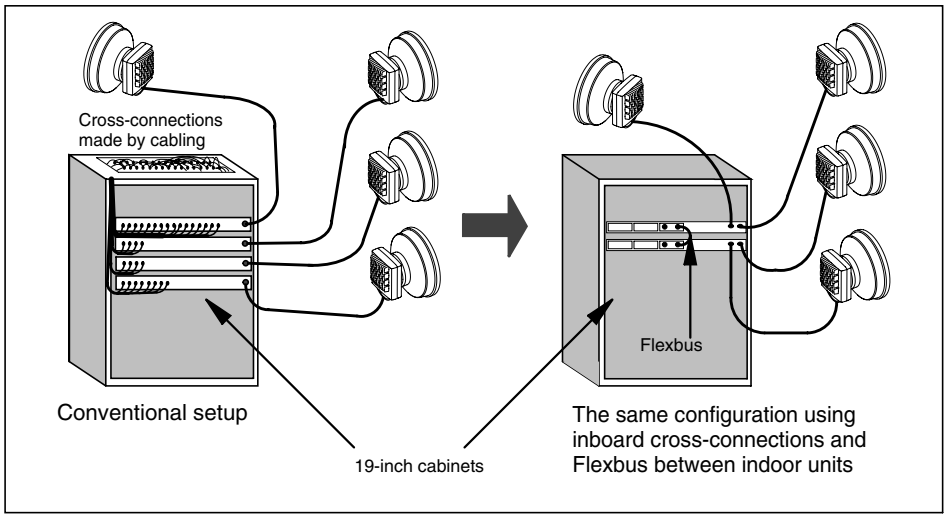


Figure 6. Site cabling effect

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

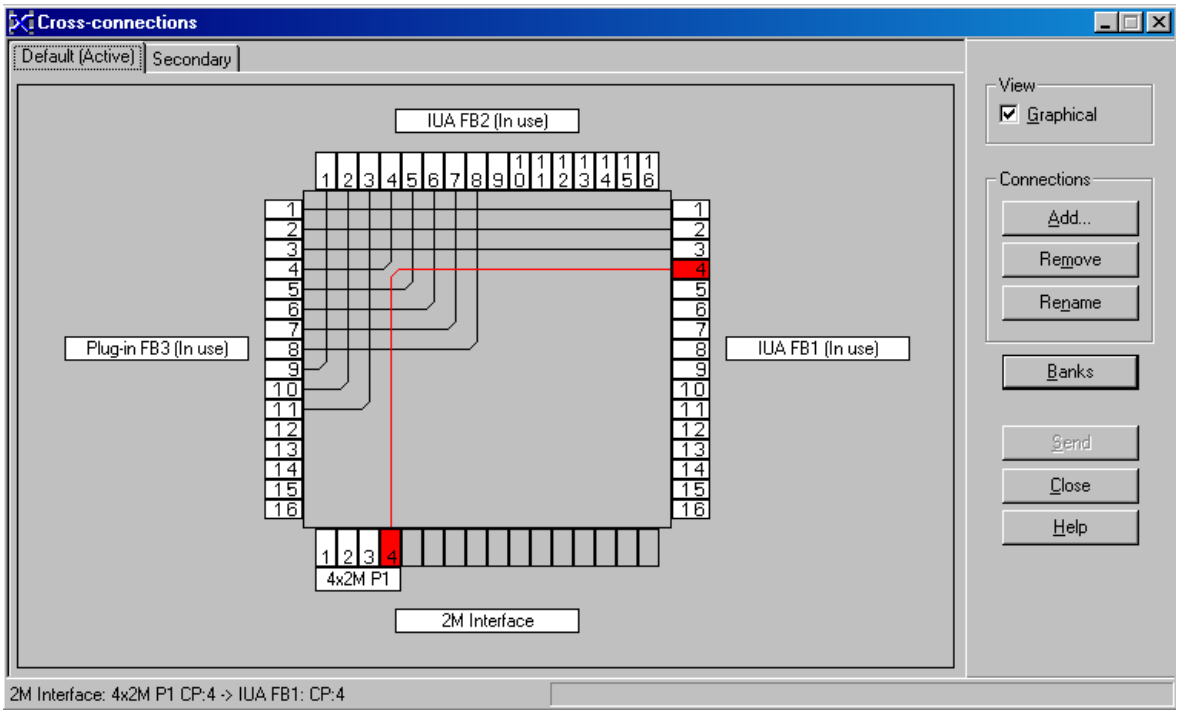


Figure 7. Cross-connections on a node manager window

3.2 Nokia FlexiHopper outdoor unit

Figure 8 shows the top-level block diagram of the radio outdoor unit. The outdoor unit includes five functional units:

- power supply unit (PSU)
- modem board
- intermediate frequency unit (IFU)
- microwave unit (MWU)
- duplex filter.

The outdoor unit is connected to the indoor unit by using a single coaxial cable, which carries the baseband data between the indoor and outdoor unit in full duplex mode. It also carries the required DC power to the outdoor unit. The cable is connected to the power supply unit in which the data traffic is filtered and transferred to the modem board. The needed DC voltages are generated in the PSU and delivered to other units through the modem board.

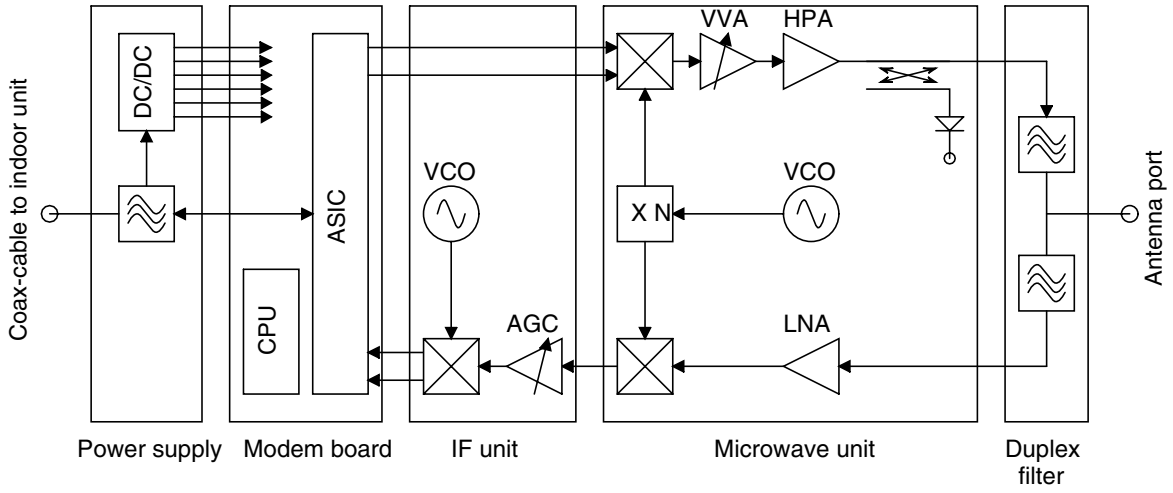


Figure 8. Block diagram of the outdoor unit

Unlike the traditional outdoor unit designs, the modem board is located in the outdoor unit, which makes it possible to use more advanced control loops between modem board and RF parts (IFU and MWU). The main component of the modem board is the custom design ASIC. The ASIC contains a digital modulator and demodulator with Reed-Solomon forward error correction (FEC). The interface between the modem board and RF part is analog I and Q signals. The modem board includes also embedded microprocessor system, which is used to control all units inside the outdoor unit as well as the far-end unit when needed.

The RF functions are divided between two units: IF unit and microwave unit. MWU includes all microwave circuits, most of which are MMICs, while IFU includes required intermediate frequency circuits.

In the transmitter side direct conversion architecture is implemented to enable use of a single microwave local oscillator. Since the I/Q up-converter operates at the end frequency, a digital feedback loop is required to correct the amplitude and phase errors of the modulator. After the up-conversion the signal is amplified enough in order to obtain the required maximum output power levels. A temperature compensated power detector is used to monitor the power level after the high power amplifier (HPA), and thus, to drive the voltage variable attenuator (VVA) in order to obtain the required output power level.

In the receiver side single IF conversion architecture is used. After the low-noise amplifier (LNA) the received signal is down-converted to IF. Automatic gain control (AGC) with a dynamic range of about 100 dB is used to obtain a constant rms-power level for the I/Q-demodulator.

The outdoor unit contains two separate phase locked oscillator circuits. In the MWU the fundamental oscillator frequency is multiplied in order to obtain the low phase noise VCO signal for the transmitter (Tx) and receiver (Rx) up- and down-converters. Due to the common VCO frequency at Tx and Rx, the IF frequency is always equal to the duplex spacing.

The waveguide duplex filter is used to separate the transmitter and receiver and to provide at the same time low loss connection to the antenna port.

3.2.1 Forward error correction and interleaving

Nokia FlexiHopper radios use forward error correction (FEC) and interleaving to improve transmission 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. For more information on FEC and interleaving, refer to the *Forward Error Correction and Data Interleaving in Flexihopper Microwave Radio* application note that can be obtained upon request.

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 (ATPC). 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 power 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, FlexiHopper also applies 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 Hopper Manager software. For more detailed information on ALCQ, 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 (E) indoor units

FIU 19 (E) is the indoor unit for 19-inch mechanics applications. One FIU 19 (E) can support up to four outdoor units. FIU 19 (E) 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 (E) indoor unit.

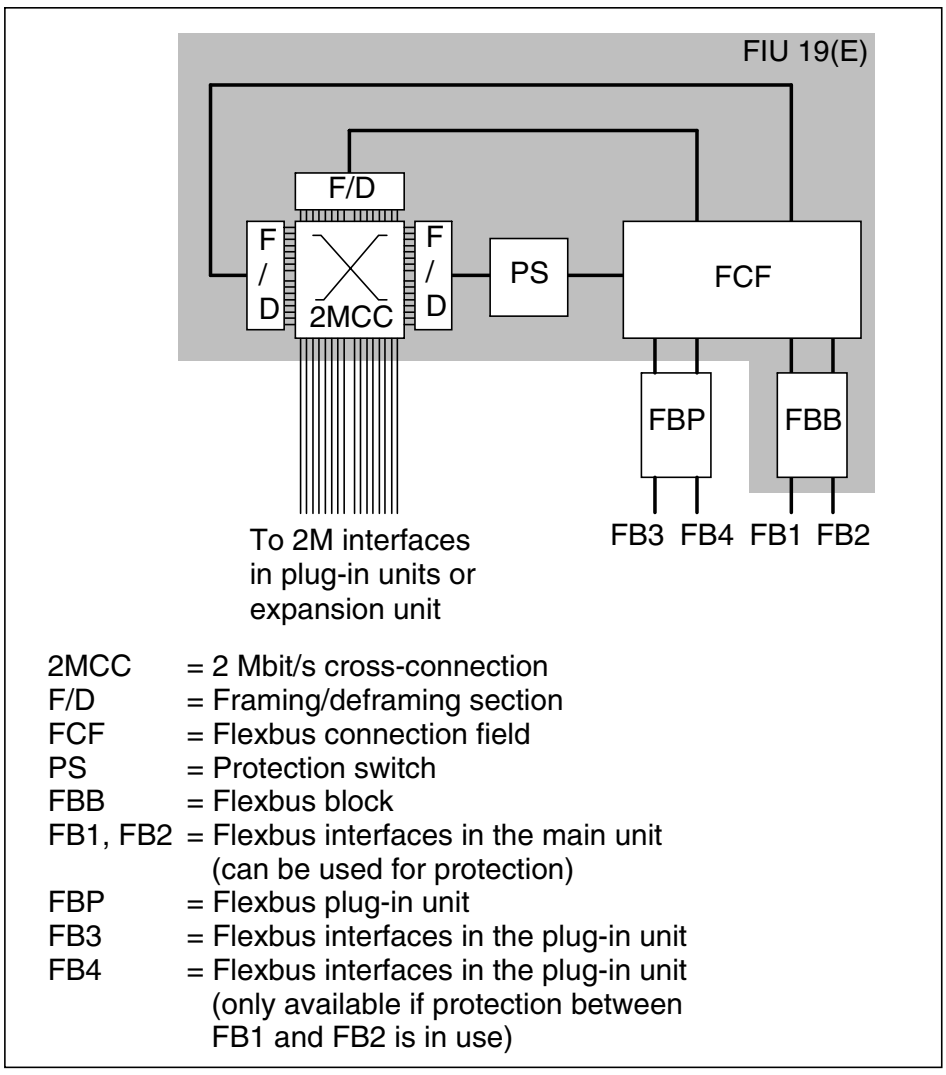


Figure 9. Routes of 2 Mbit/s and Flexbus signals in FIU 19 (E)

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 (E) and Nokia FlexiHopper. In this case, two FIU 19 (E) main units are connected via an expansion unit (see Section 3.7).

Note

For FIU 19E the connector type for LMP, Q1, and Q2 is 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 (E) 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.

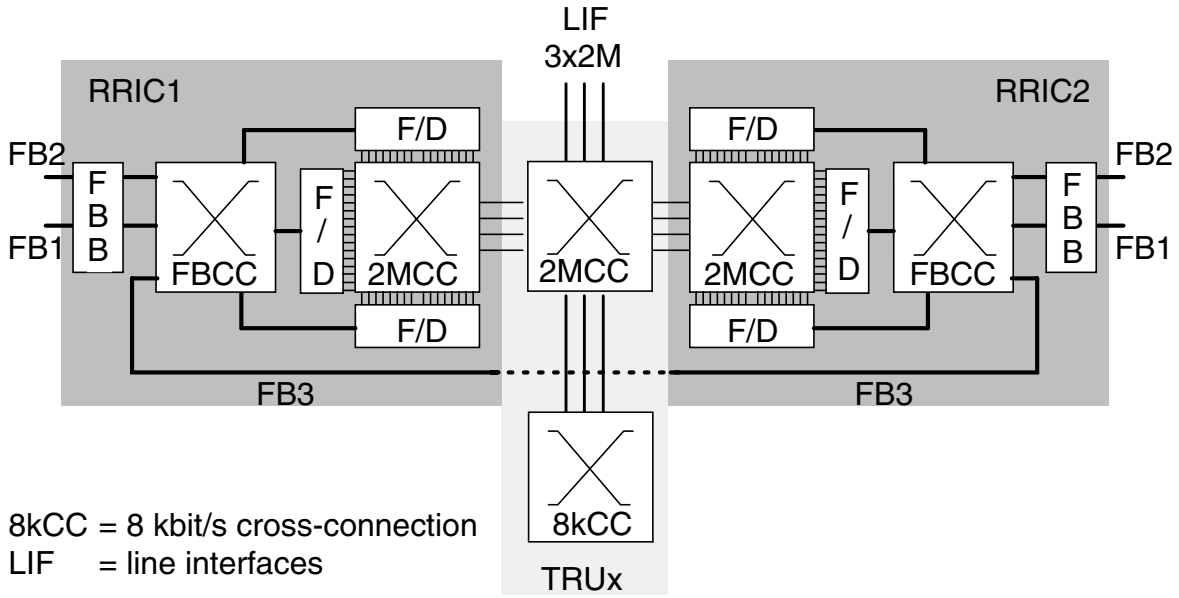


Figure 10. Routes of 2 Mbit/s and Flexbus signals in RRIC and TRUx

RRIC provides 4x2 Mbit/s add/drop capacity to the base station transmission unit (TRUx) and up to 16x2 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 EDGE BTS, Nokia MetroHub, or Nokia UltraSite EDGE BTS. FXC RRI supports two outdoor units and provides up to 16x2 Mbit/s add/drop capacity towards Nokia MetroHub. FXC RRI has an integrated 8 kbit/s cross-connection function, enabling hot standby, loop protection, and grooming.

If the total Flexbus interface traffic in one FXC RRI is more than 16x2 Mbit/s, the extra traffic can be bypassed from one Flexbus interface to another in a separate 2 Mbit/s cross-connection field.

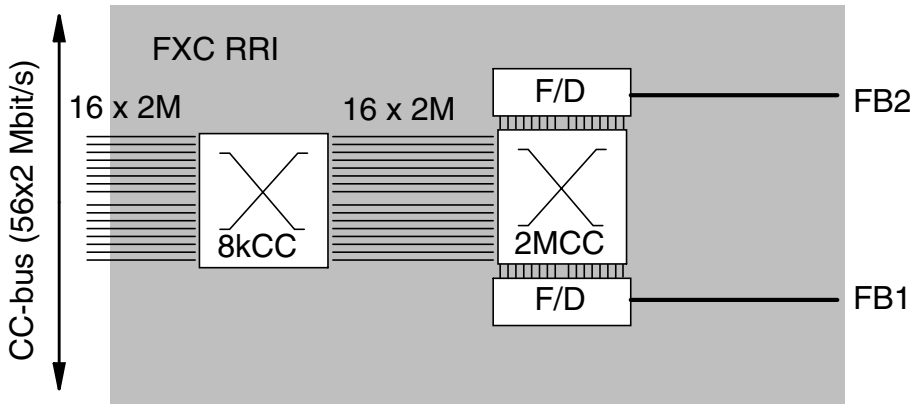


Figure 11. Routes of 2 Mbit/s and Flexbus signals in FXC RRI

3.6 IFUE interface unit

IFUE (IFU3FB) is the interface unit with three Nokia Flexbus interfaces, each with a maximum capacity of 16x2 Mbit/s.

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 Nokia FlexiHopper and MetroHopper with IFUE documentation.

3.7 Protection methods

In single use, the signal is not protected against equipment faults or propagation fading (except when loop protection is used). If a fault occures, the connection remains broken until the equipment has been repaired or the cause for the propagation fading disappears.

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. When two indoor units (FIU 19 (E) only) are used, they are connected through an expansion unit.

Equipment protection can be implemented by following methods (with FIU 19 (E), RRIC, and FXC RRI):

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

Propagation protection

Propagation protection is used to improve transmission quality and to minimise the number of traffic interruptions due to multipath fading in the transmission path. In propagation protection, a pair of Nokia FlexiHopper outdoor units are protecting each other.

The changeover caused by multipath fading is error-free (hitless).

Propagation protection can be implemented by space diversity, frequency diversity, or polarisation diversity (with FIU 19 (E) 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 changing propagation conditions in the transmission path (due to rain, for example). 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 documentation for more information.

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

Loop protection can also be implemented with the FIU 19 (E) 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 (E) only). When two FIU 19 (E) units are used, they are connected through an expansion unit (EXU).

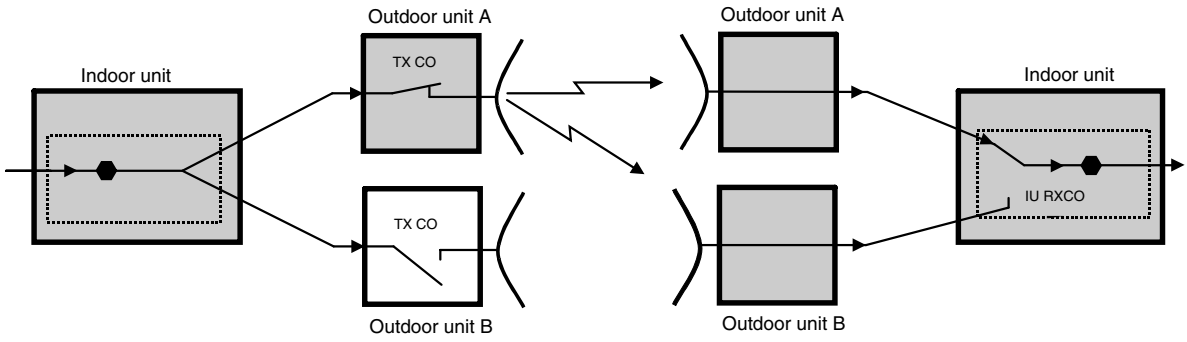
In hot standby mode, the transceivers of both radios are on, but the transmitter of the protecting radio is in mute state.

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 cm and larger ones). 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 faults and propagation fading. 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 12. Active units are shown in grey and passive units in white.



IU RXCO Indoor unit hitless changeover switch (In ASIC)
TXCO Transmitter changeover switch (transmitter mute control)

Figure 12. Nokia FlexiHopper with FIU 19 (E) or RRIC, 1IU/2OU HSB or HSB+SD (only one direction shown)

HSB changeover switches of OU transmitter (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. HSB changeover can also be performed when the reception quality at the far-end degrades (lazy changeover).

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. This switch is only used for diversity protection.

2IU/2OU HSB or HSB+SD

HSB or HSB+SD setup with two indoor units is shown in Figures 13 and 14. Active units are shown in grey and passive units in white.

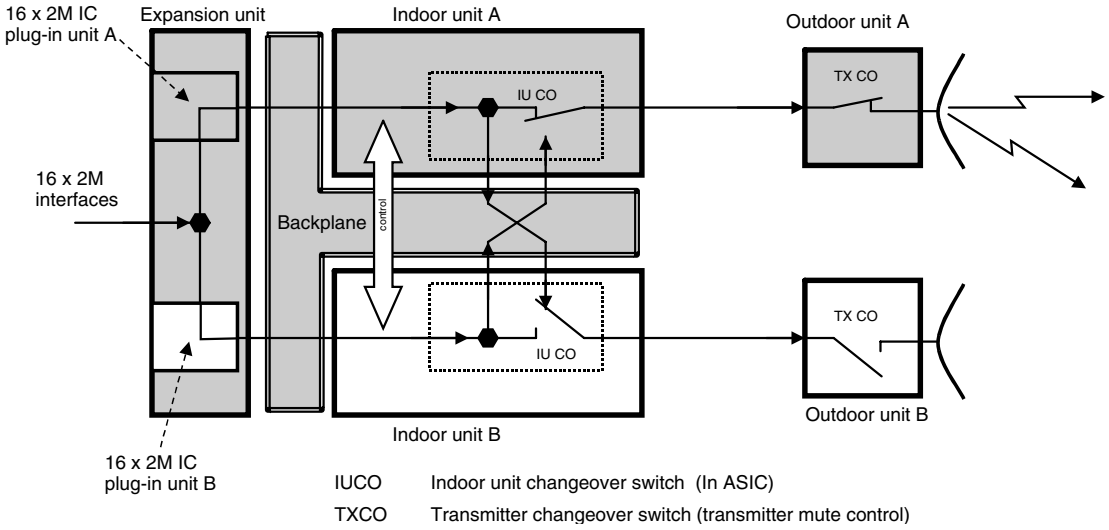


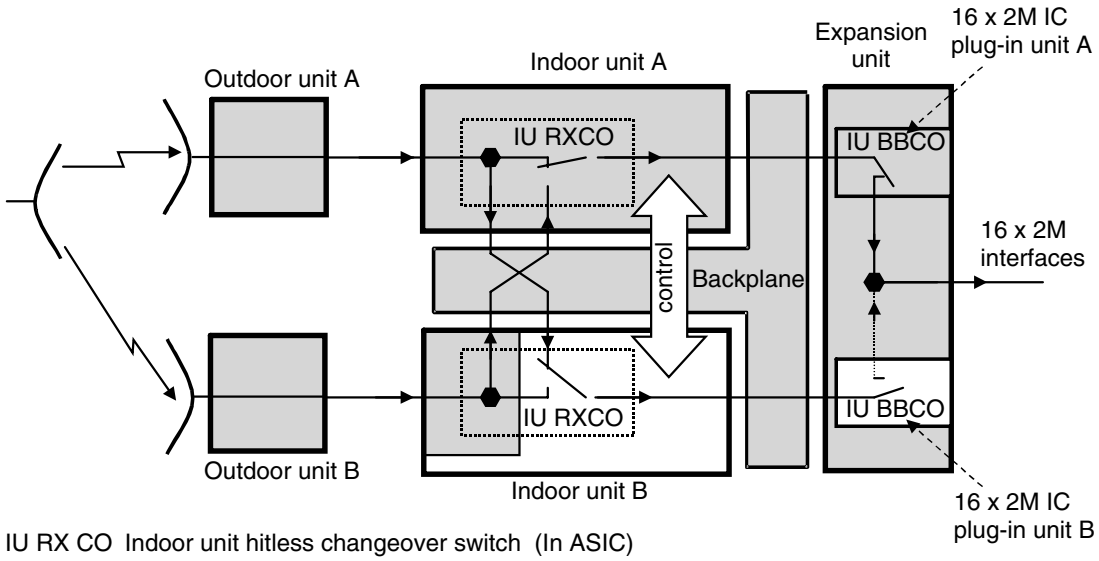
Figure 13. Nokia FlexiHopper with FIU 19 (E), 2IU/2OU HSB or HSB+SD (Tx direction)

HSB changeover switches of indoor unit transmitter (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.

HSB changeover switches of OU transmitter (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 (lazy changeover).



IU RX CO Indoor unit hitless changeover switch (In ASIC)
IU BB CO Indoor unit baseband changeover switch

Figure 14. Nokia FlexiHopper with FIU 19 (E), 2IU/2OU HSB or HSB+SD (Rx direction)

HSB changeover switches of indoor unit Rx base band (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.

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. This switch is only used for diversity protection.

Protection switches are controlled by the active (master) indoor unit's processor. The processors are connected together with protection bus via the backplane.

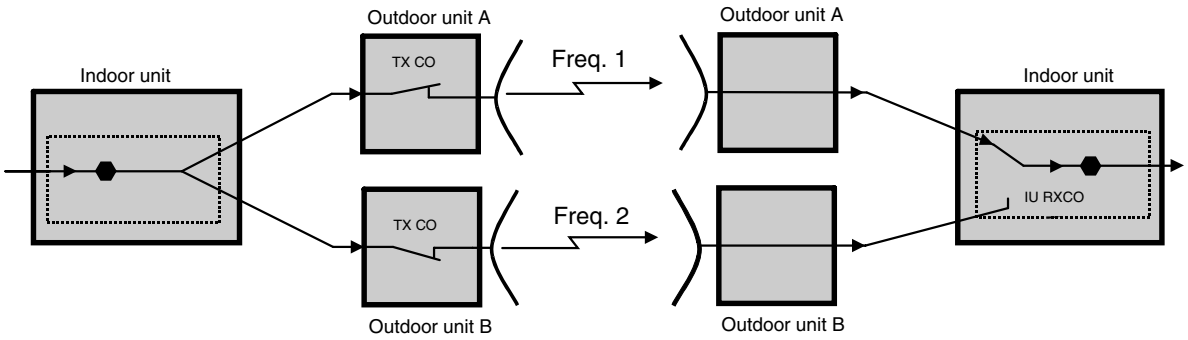
3.7.2 Frequency diversity, polarisation diversity

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

Polarisation diversity provides also protection against both equipment faults and multipath fading. 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 15. Active units are shown in grey and passive units in white.



IU RXCO Indoor unit hitless changeover switch (In ASIC)
TXCO Transmitter changeover switch (transmitter mute control)

Figure 15. Nokia FlexiHopper with FIU 19 (E) 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 two indoor units is shown in Figures 16 and 17. Active units are shown in grey and passive units in white. In these setups, IUs are always HSB protected.

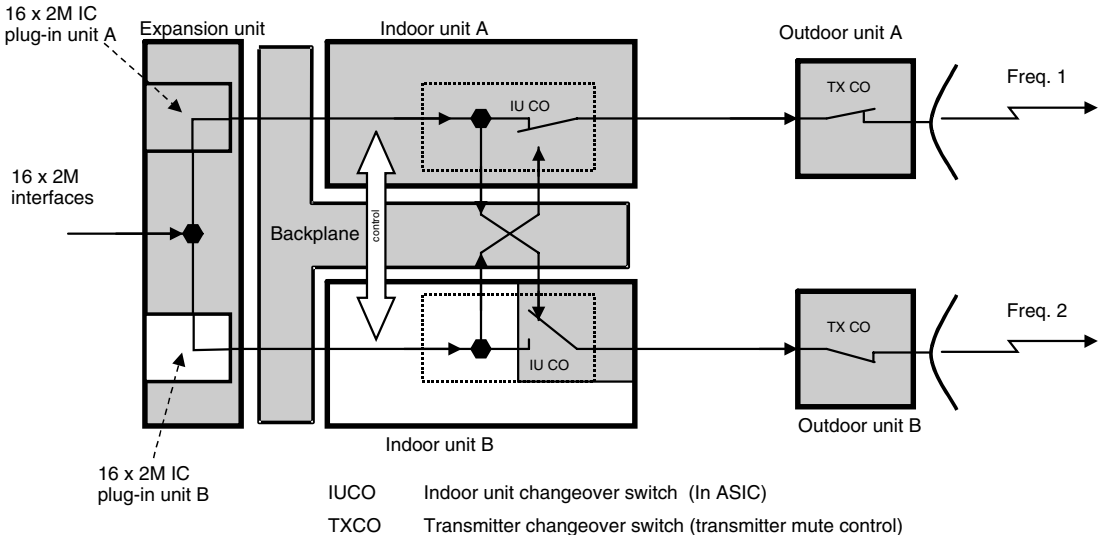


Figure 16. Nokia FlexiHopper with FIU 19 (E), 2IU/2OU FD or PD (Tx direction)

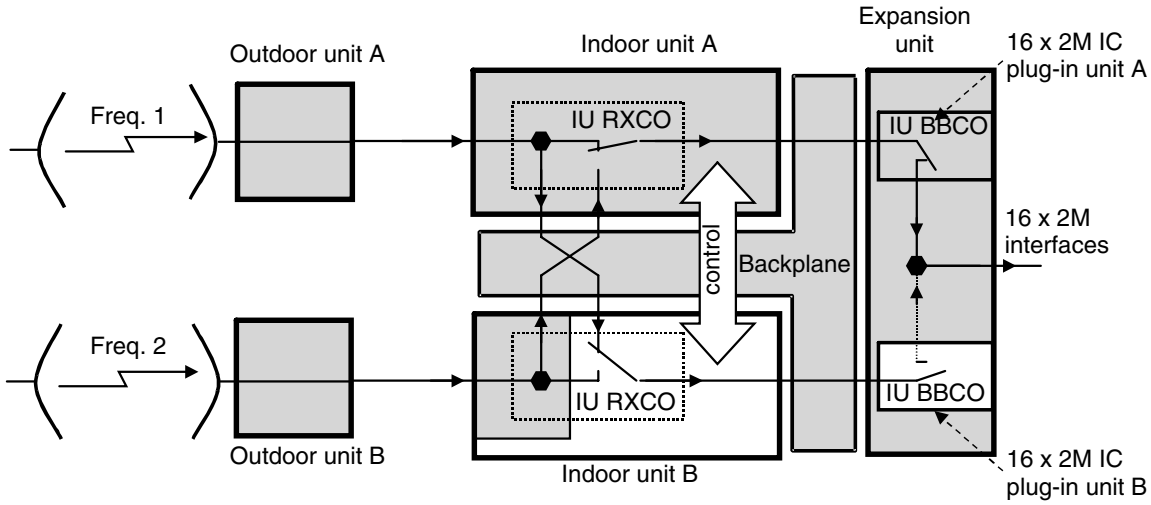


Figure 17. Nokia FlexiHopper with FIU 19 (E), 2IU/2OU FD or PD (Rx direction)

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 Changeover criteria

When two FIU 19 (E) indoor units are used, they can be equipment protected together with outdoor units. Propagation protection can also be implemented. When one FIU 19 (E) indoor unit is used, OUs can be equipment protected and propagation protected, respectively. RRIC indoor unit supports only HSB equipment protection for OUs. The changeover criteria are the same for all protection combinations. The criteria are divided into four cases: (OU) receiver changeover for HSB, (OU) receiver changeover for diversity, (OU) transmitter changeover for HSB, and indoor unit (receive and transmit) changeover for HSB. The functioning of these four is independent of each other.

Receiver changeover for HSB and diversity

In receiver changeovers, the receiver switch position in the active indoor unit is changed.

In HSB receiver changeover, OU is considered unavailable 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 unavailable (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.

In diversity receiver changeover, the system tries to minimise the errors in received data by selecting the outdoor unit with the lower bit error rate. This depends on the received radio signal quality and available receivers. Switching is hitless.

Transmitter changeover for HSB

In transmitter changeover, the transmitting outdoor unit is changed. Outdoor unit is considered unavailable from the 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.

The indoor unit sends periodical notifications to the far-end about the radio signal quality. This enables to minimise errors in transmitted data due to near-end transmitter. This is called lazy changeover. Lazy transmitter changeover is performed when the system experiences bit errors for a longer period.

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 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 rate after the changeover is 1000 times higher than before the changeover, the system makes another changeover back to the previous transmitter.

Indoor unit changeover for HSB

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 occures 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 selected.

3.8 Configuration backup

The Nokia FlexiHopper outdoor unit and the FIU 19 (E) 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 EDGE 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 (E), RRIC, and FXC RRI indoor units. Site configurations are explained in more detail in Section 4.2.

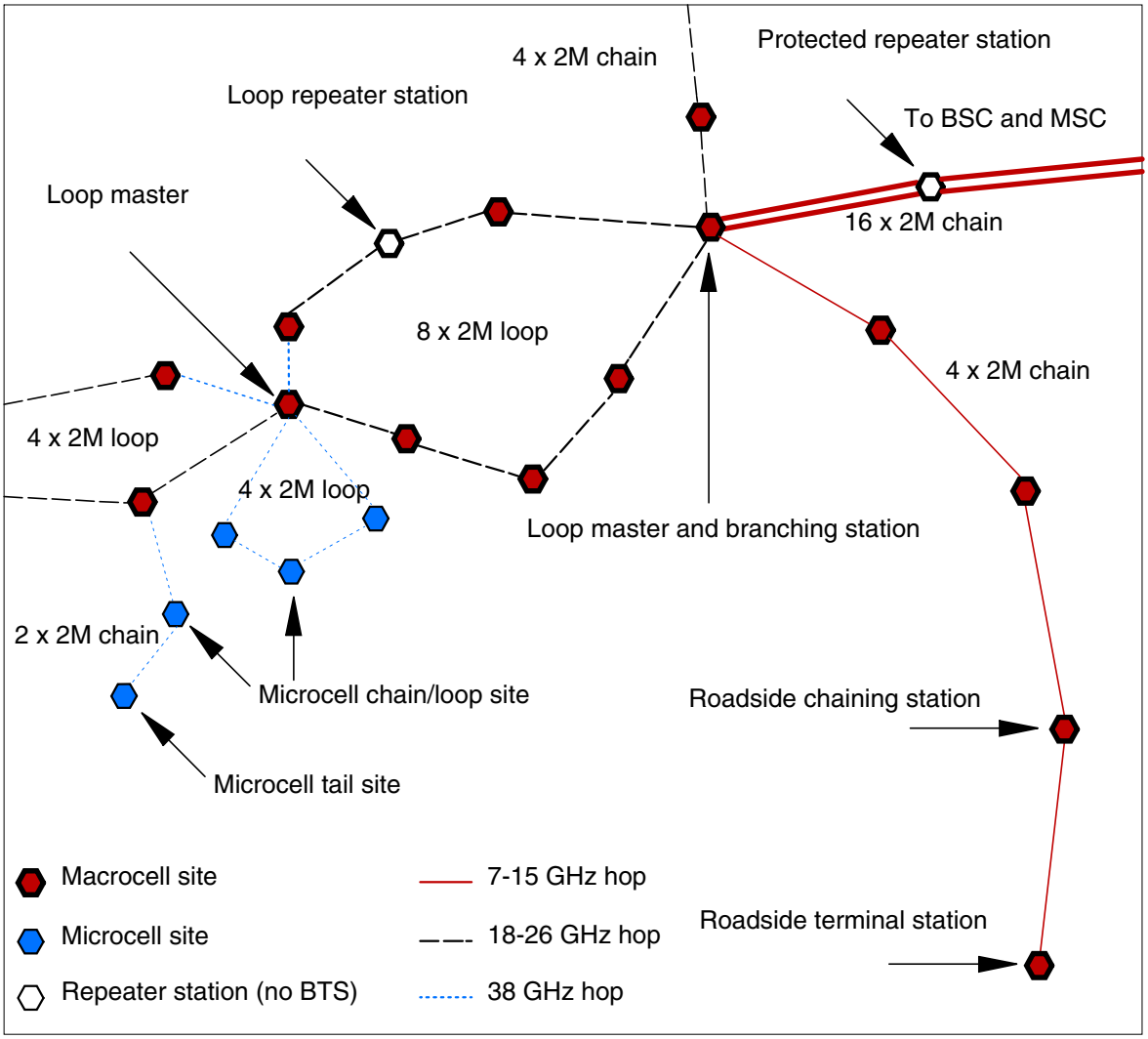


Figure 18. Example of applications with Nokia FlexiHopper in a cellular network

4.2 Site configuration examples

This section shows some 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.

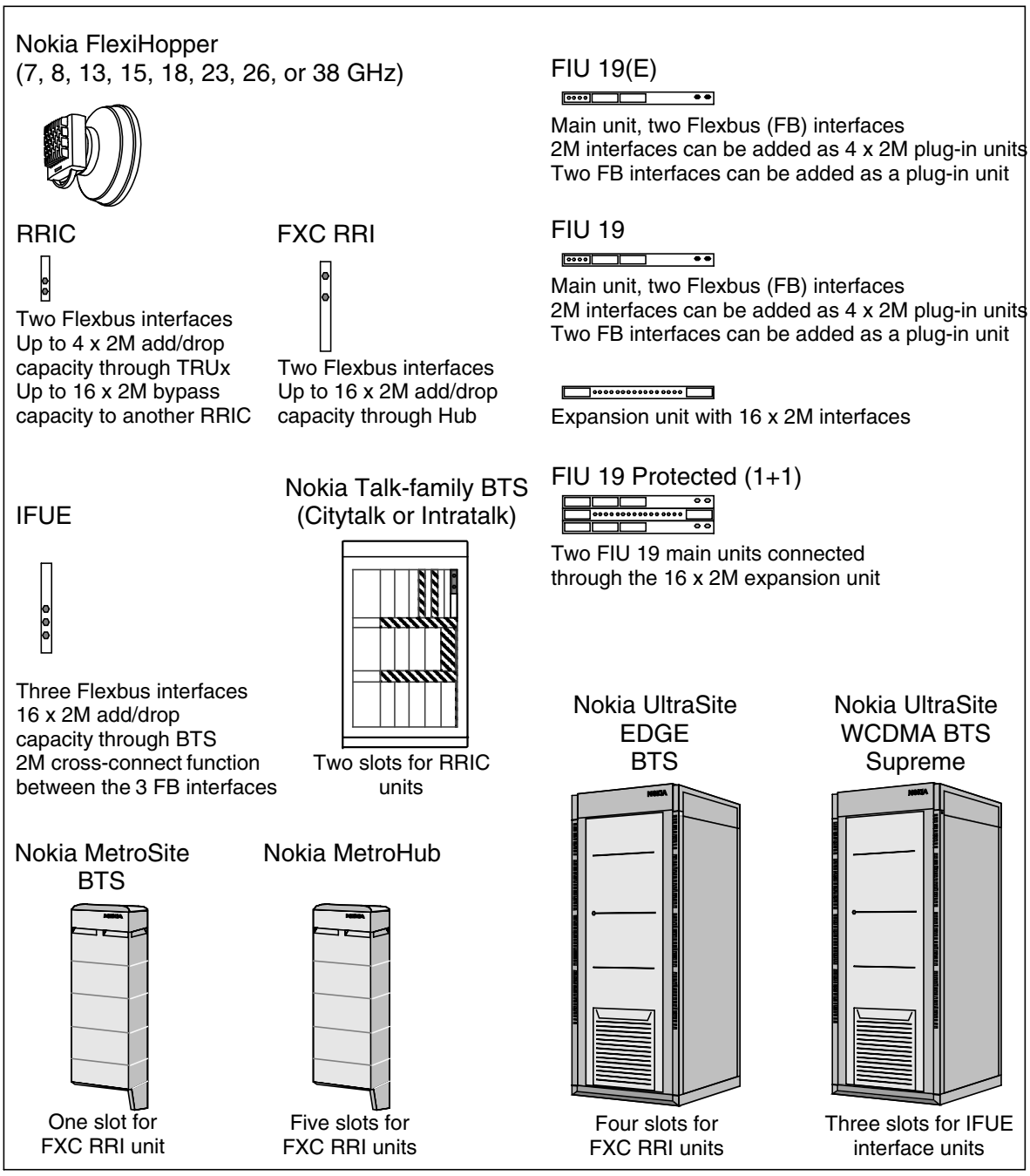


Figure 19. Key symbols used in Figures 20–30

Note

MartisDXX FBU interface unit can also be used with Nokia FlexiHopper microwave radio. For more information on FBU, refer to *Nokia FBU Manager User's Guide*.

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.

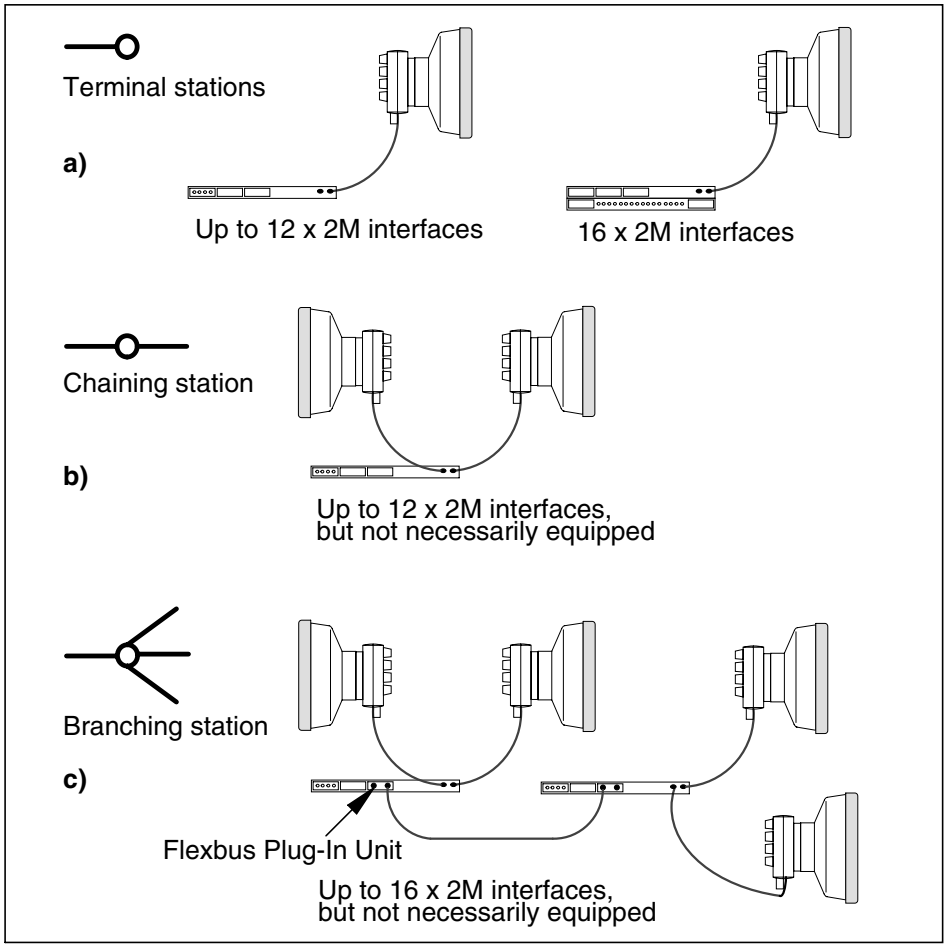


Figure 20. Unprotected stations with FIU 19 (E)

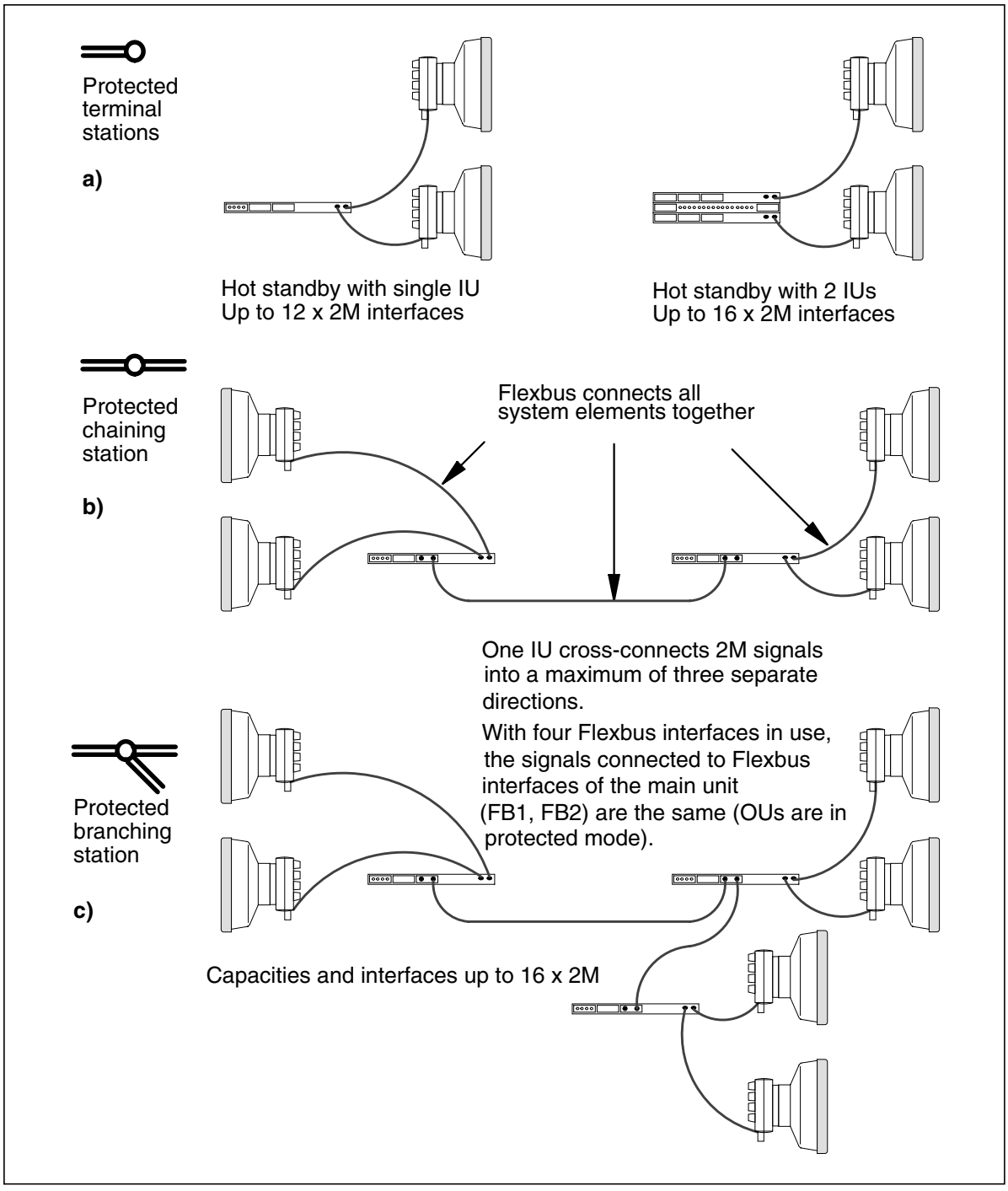


Figure 21. Protected stations with FIU 19 (E)

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.

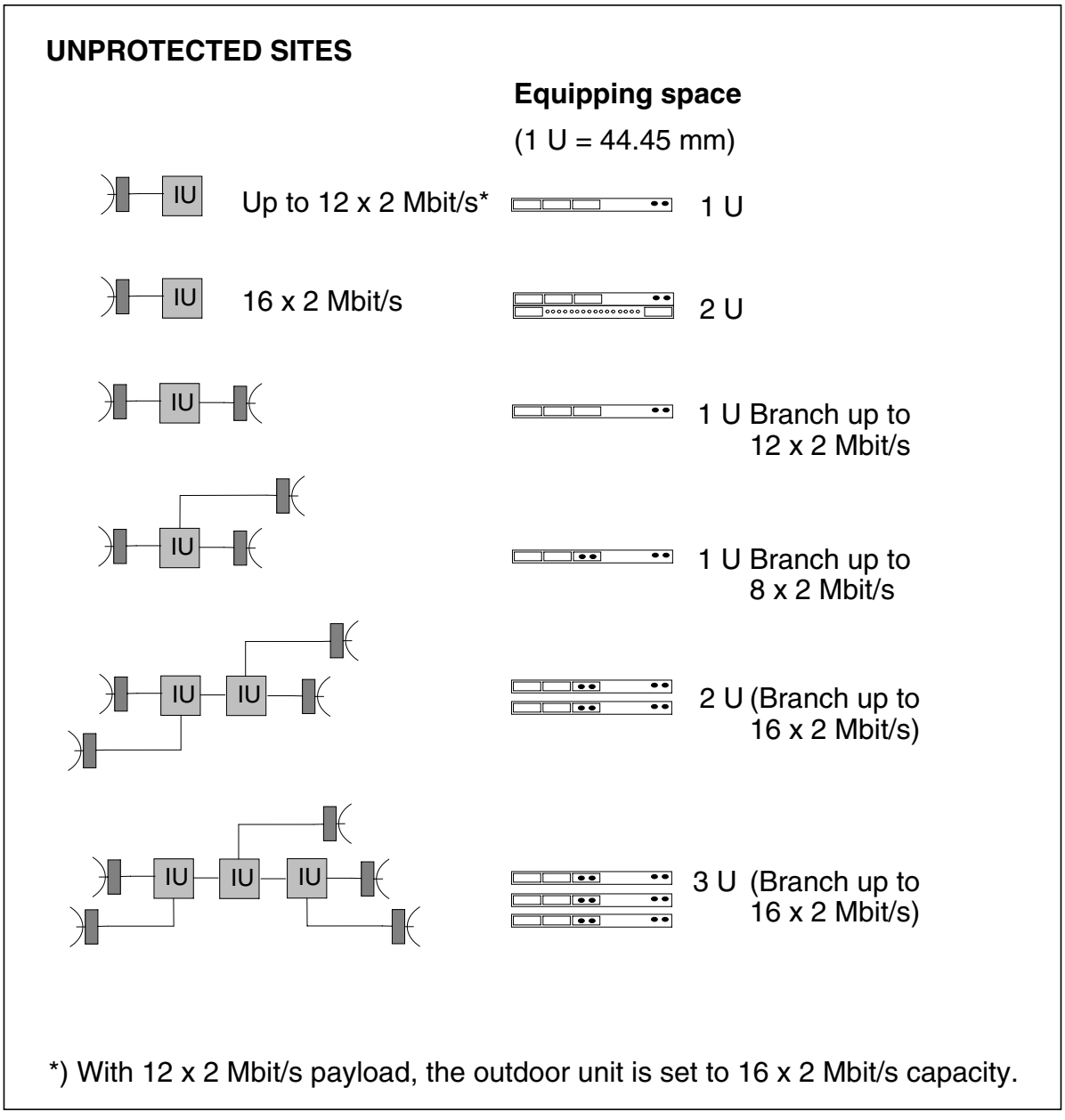


Figure 22. FIU 19 (E) site summary – unprotected sites

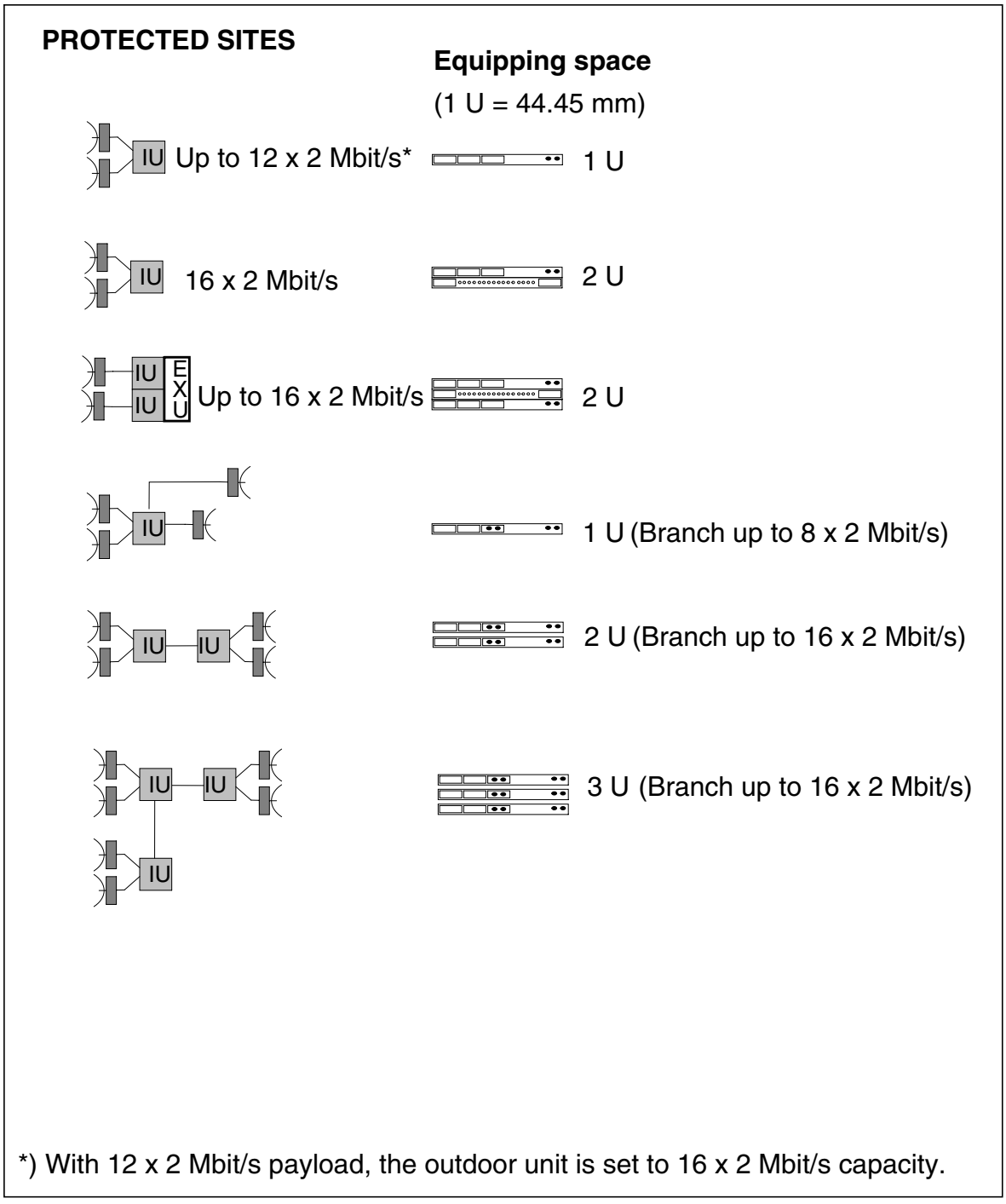


Figure 23. FIU 19 (E) site summary – protected sites

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 (E) indoor units can be used. For example, Nokia Extratalk Site Support System cabinet contains 6 U of 19-inch rack space where FIU 19 (E) units can be installed.

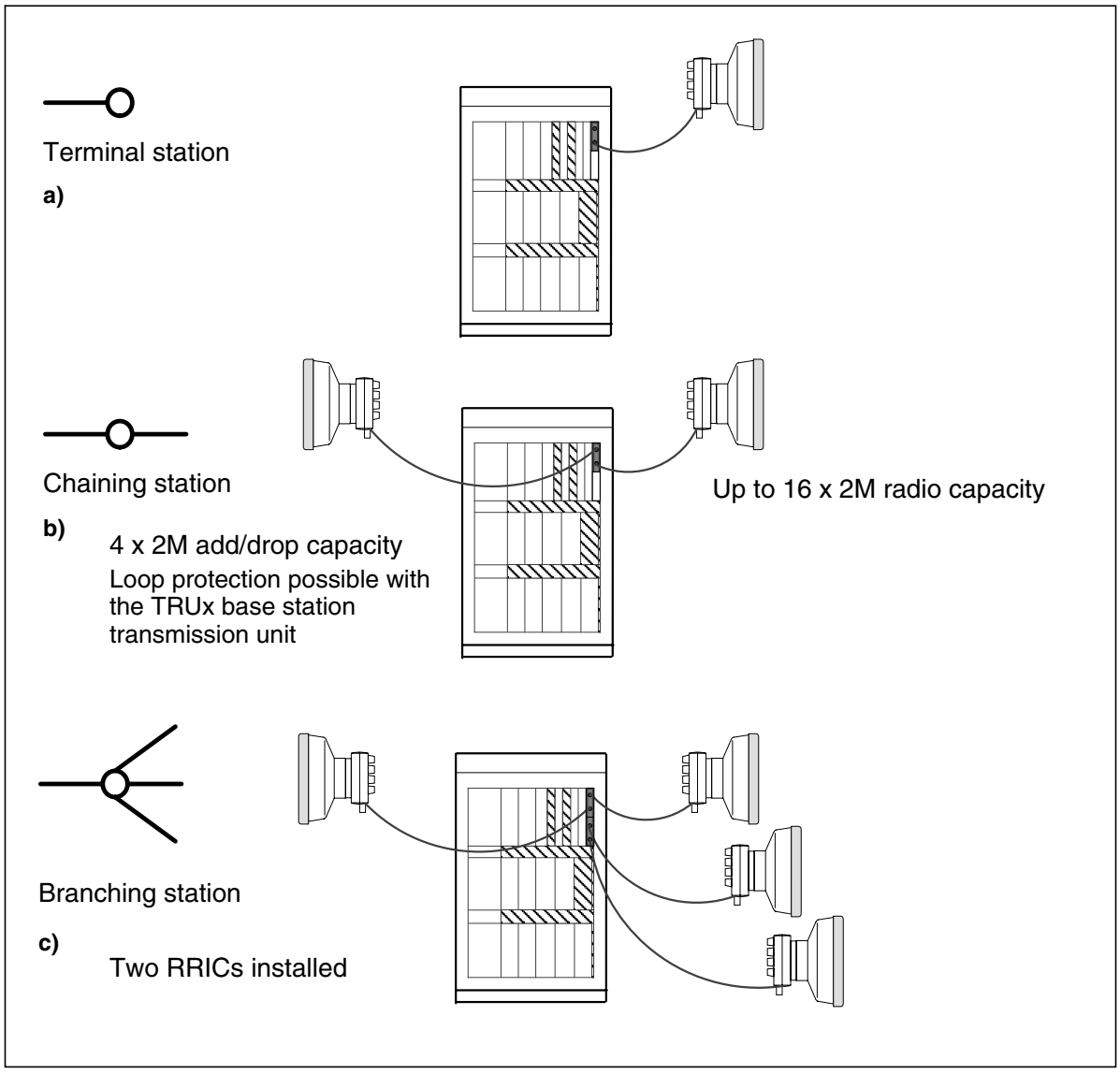


Figure 24. Unprotected sites with RRIC

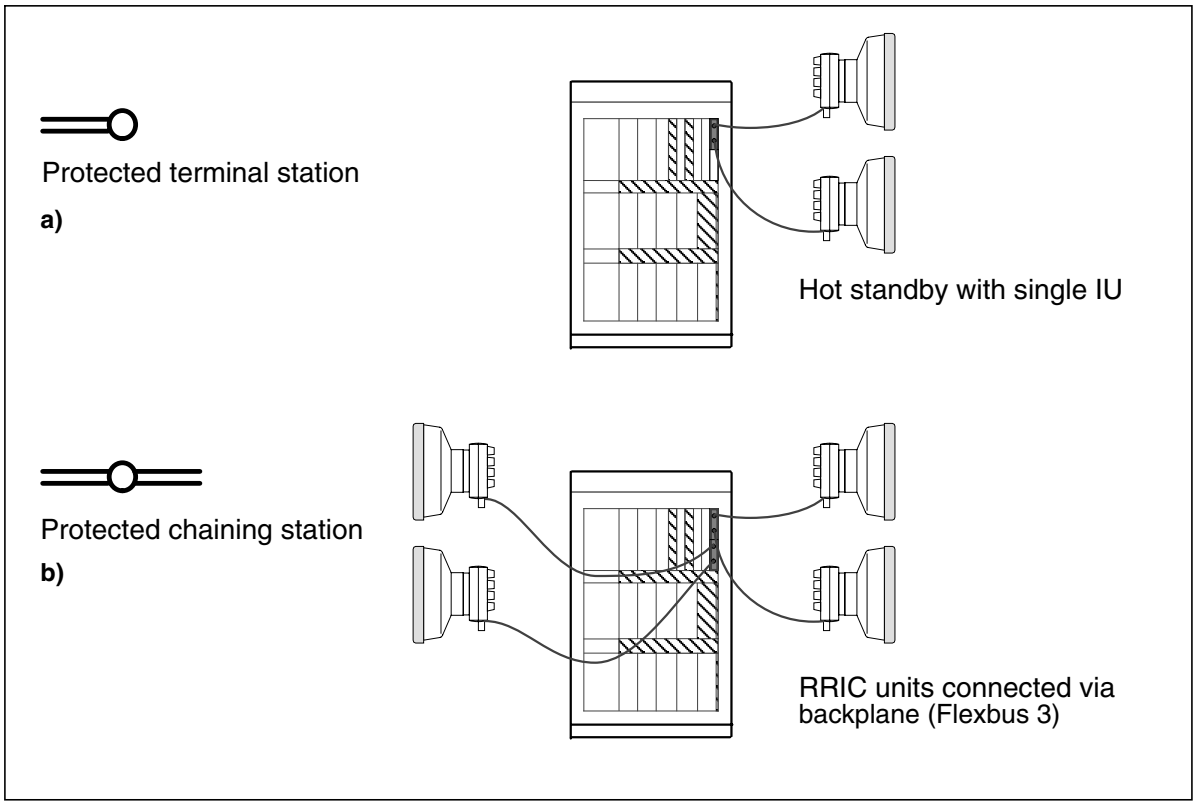


Figure 25. Protected sites with RRIC

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.

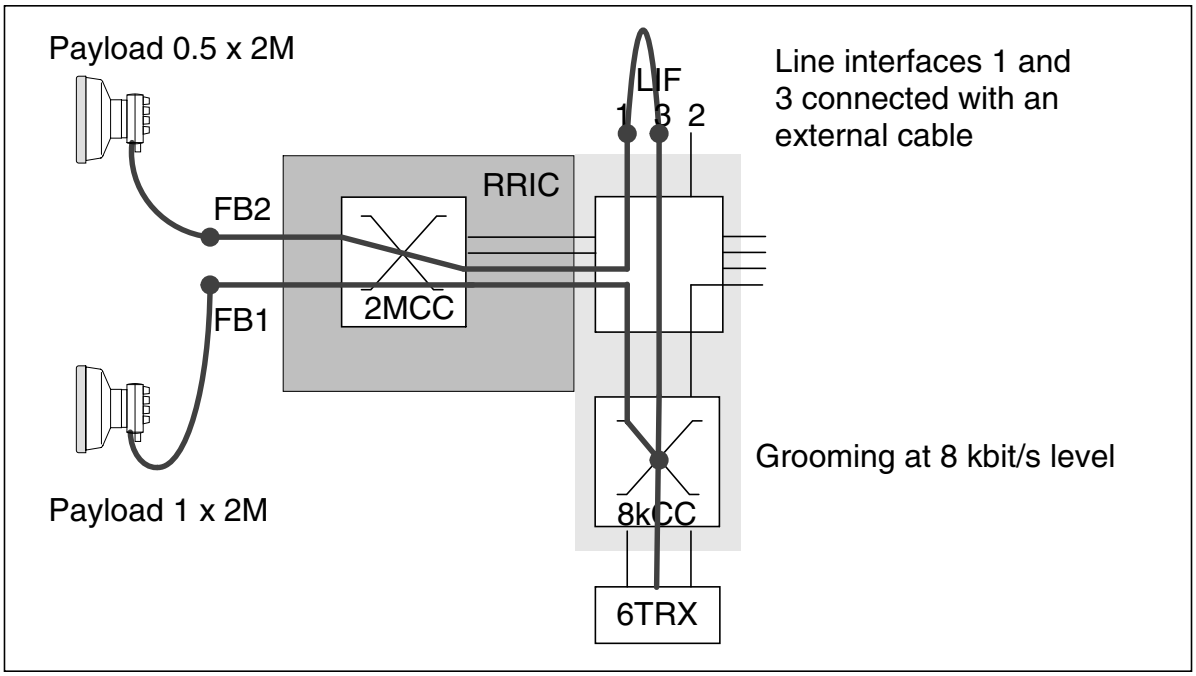


Figure 26. Chaining station with grooming capability

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

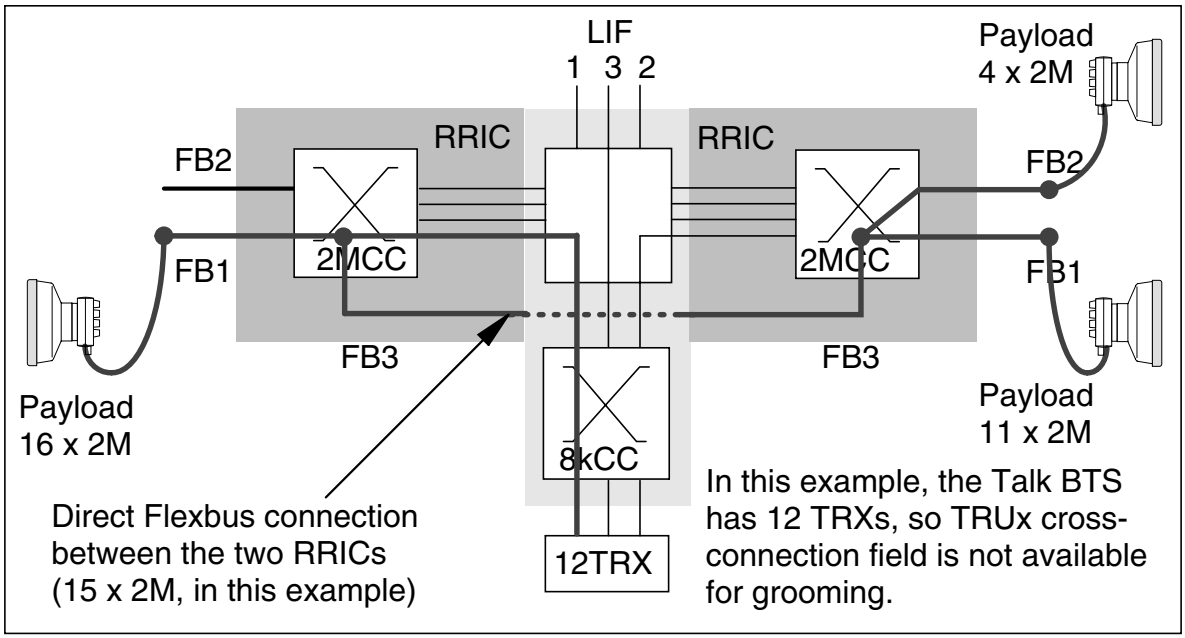


Figure 27. Branching station

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 EDGE Base Station has one slot for an FXC unit. Nokia MetroHub transmission node has five slots for FXC units.

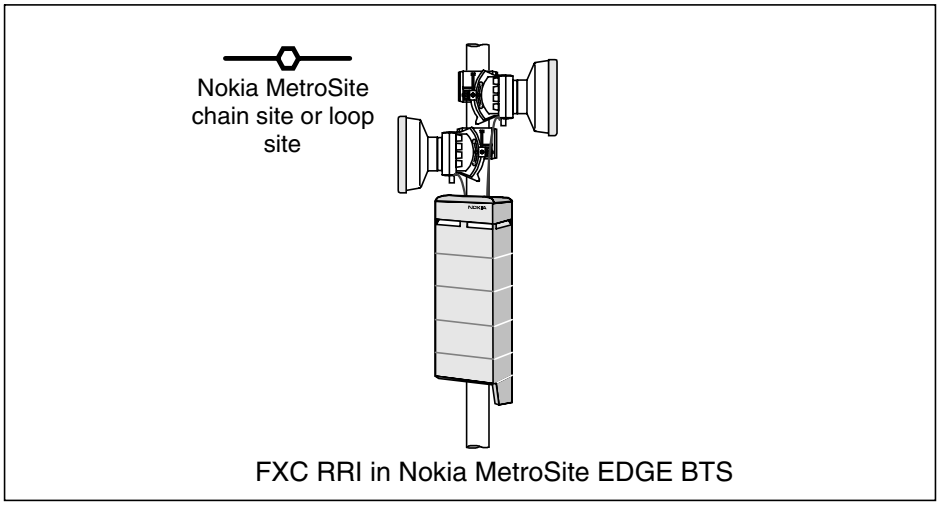


Figure 28. Nokia MetroSite EDGE BTS and Nokia FlexiHopper

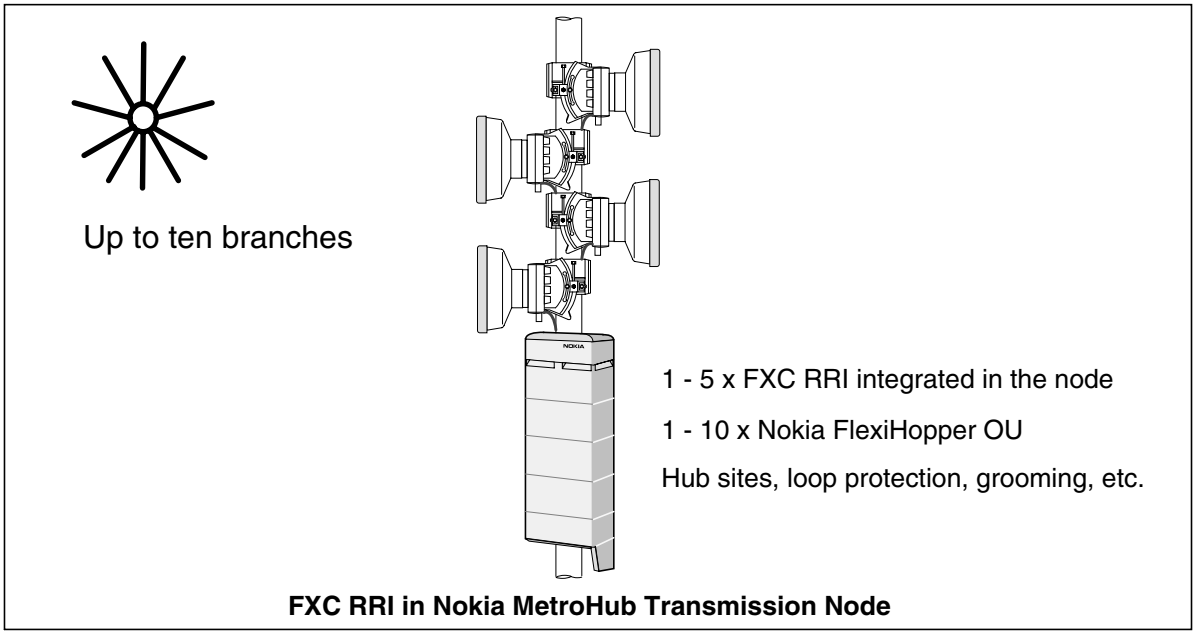


Figure 29. Nokia MetroHub and Nokia FlexiHopper

For more information on site configurations with Nokia MetroHub, see Nokia MetroHub transmission node documentation.

4.2.4 Nokia FlexiHopper at Nokia UltraSite

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

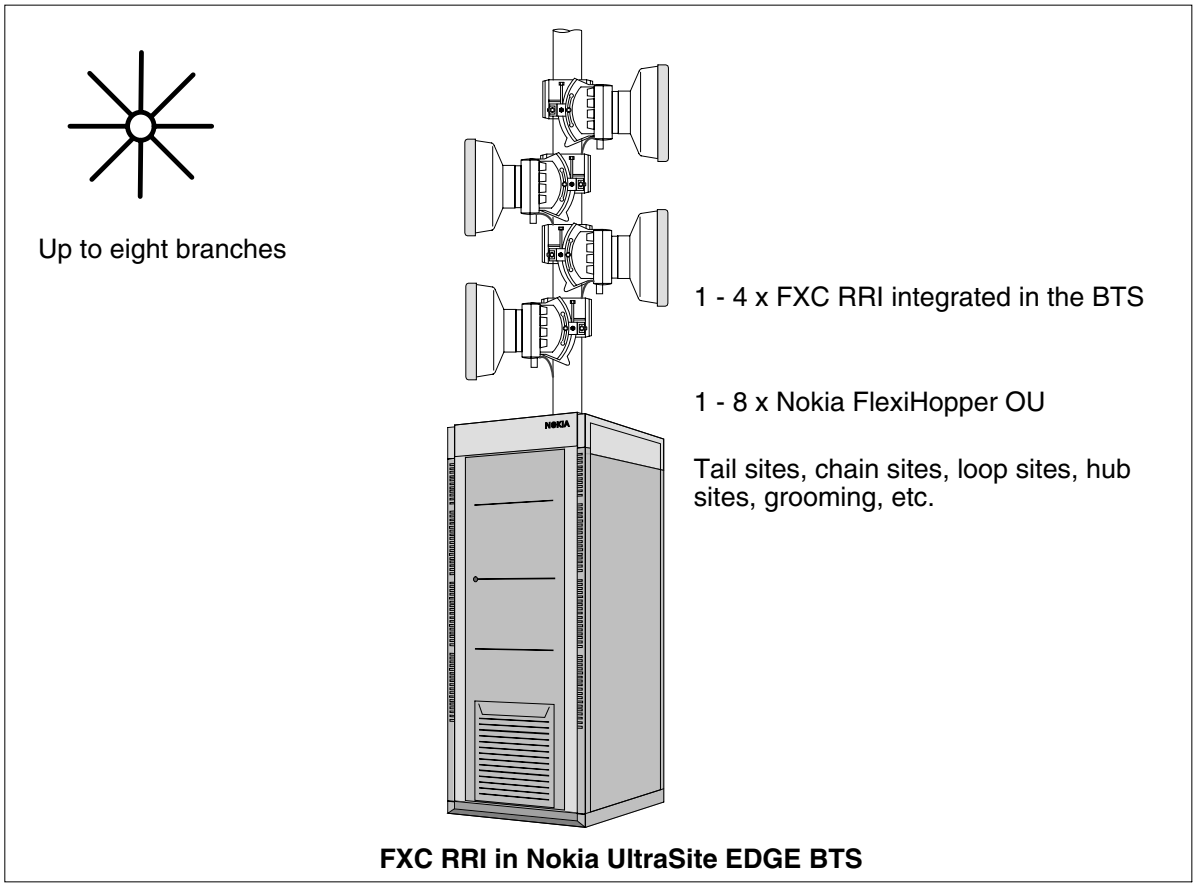


Figure 30. Nokia UltraSite EDGE BTS and Nokia FlexiHopper

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 Solution documentation.

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. Each IFUE interface unit has three Flexbus interfaces on the front panel. For example, Nokia UltraSite WCDMA BTS Supreme has six slots for the AXC (1 AXU and maximum 5 IFUE).

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 (E) indoor unit.

5 Management

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

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

Refer to Nokia MetroSite EDGE base station, Nokia MetroHub transmission node, or Nokia UltraSite EDGE base station documentation 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 Nokia FlexiHopper microwave radios and Nokia MetroHopper radios connected to it. Refer to *Nokia FBU Manager User's Guide* for further information on management with the Nokia FBU 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, 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 (E) 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, 2000, XP, 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 (E))
- troubleshoot a node
- monitor the fault status of a node
- monitor transmission quality
- download new software.

Note

RRIC cross-connections (2Mbit/s) are managed with the TruMan node manager.

FXC RRI cross-connections are managed with:

- MetroHub Manager, if FXC RRI is installed in Nokia MetroHub transmission node
- UltraSite BTS Hub Manager, if FXC RRI is installed in UltraSite BTS
- FXC RRI Manager, if FXC RRI is installed in MetroSite BTS.

IFUE cross-connections (2Mbit/s) are managed with the AXC-FB Hopper Manager.

Nokia Hopper Manager can be connected to a Nokia FlexiHopper node in three different ways: directly via the local management port (LMP), remotely via a Nokia Q1 connection, or via a LAN connection (FIU 19E). Further, the FIU 19E also supports connection via the IP interface.

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.

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.

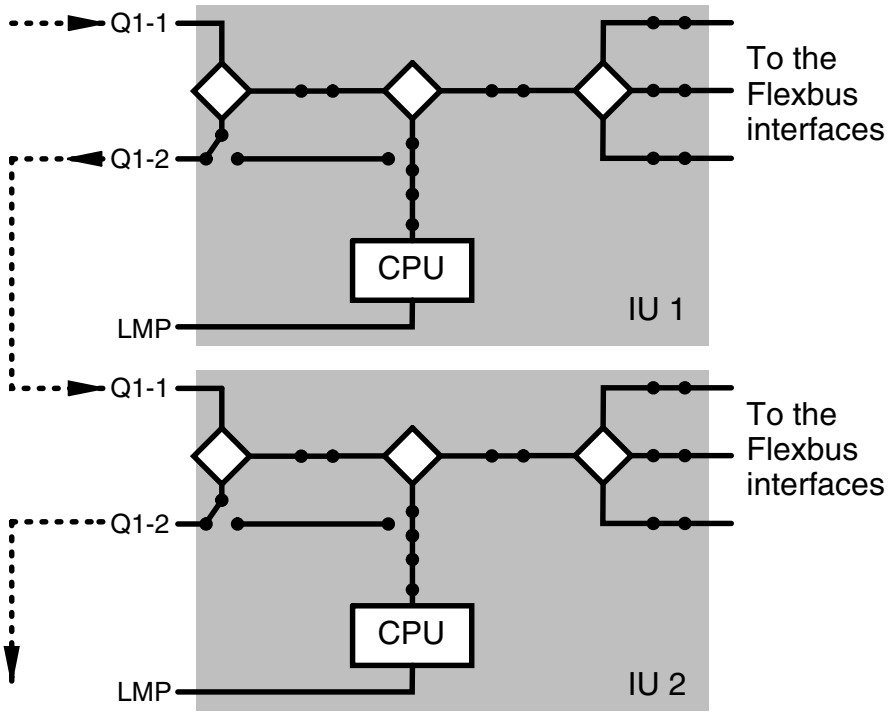


Figure 31. Chaining of the Q1 bus in FIU 19 (E)

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.

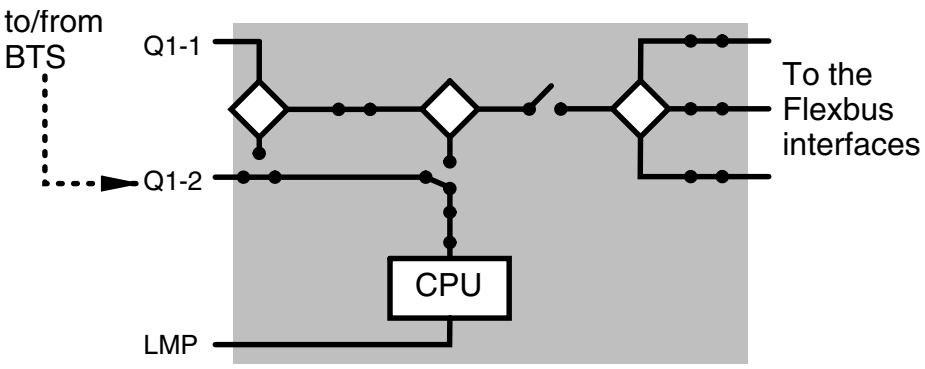


Figure 32. Example of Q1 branching in FIU 19 (E)

When FIU 19 (E) 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.

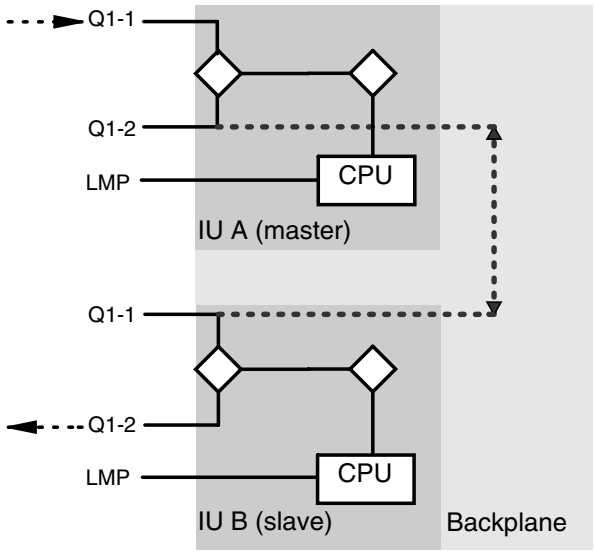


Figure 33. Q1 connection in FIU 19 (E) in 1+1 protection setup

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.

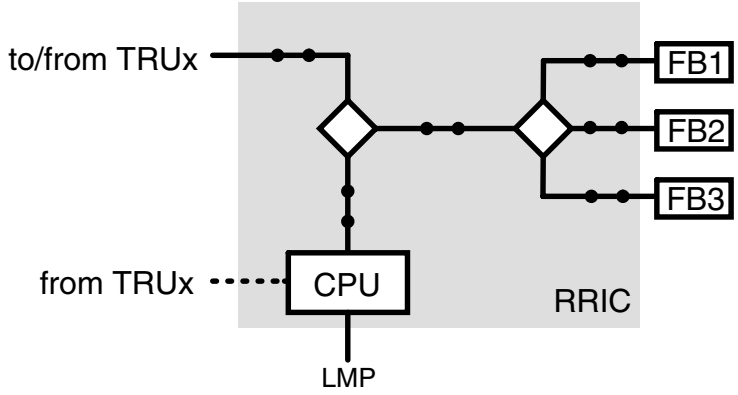


Figure 34. Branching of the Q1 bus in RRIC

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), 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 recognise 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 recognises also the physical address of the BTS unit slot in which it is installed (4084 or 4085).

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

5.3.5 Q1 fault handling

When FIU 19 (E) 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 (E) 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 (E) 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 (E) 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 (E) and RRIC are set to use it, the NMS shows all alarms generated by the network element.

5.4 Using TCP/IP connections

As alternative to the Nokia proprietary Q1 bus the FlexiHopper, using the FIU 19E as indoor unit, offers the possibility to use the Internet Protocol version 4 (IPv4) for providing management connectivity. An ethernet port is located at the front panel of the FIU 19E indoor unit, which can be used for connecting the FIU 19E to the IP data communication network. In addition it is possible to forward the IP management traffic over the radio path towards the FlexiHopper at the other end, which avoids the need for an IP connection towards the ethernet port of the FIU 19E at each site.

Proxy ARP

At tail sites, a proxy ARP (transparent subnetting according to RFC 1027) can be used for forwarding the IP traffic towards the far-end FIU 19E. The advantage of this configuration is that it is not necessary to have a routing entry for the far-end unit in the router responsible for forwarding IP traffic to the near-end site.

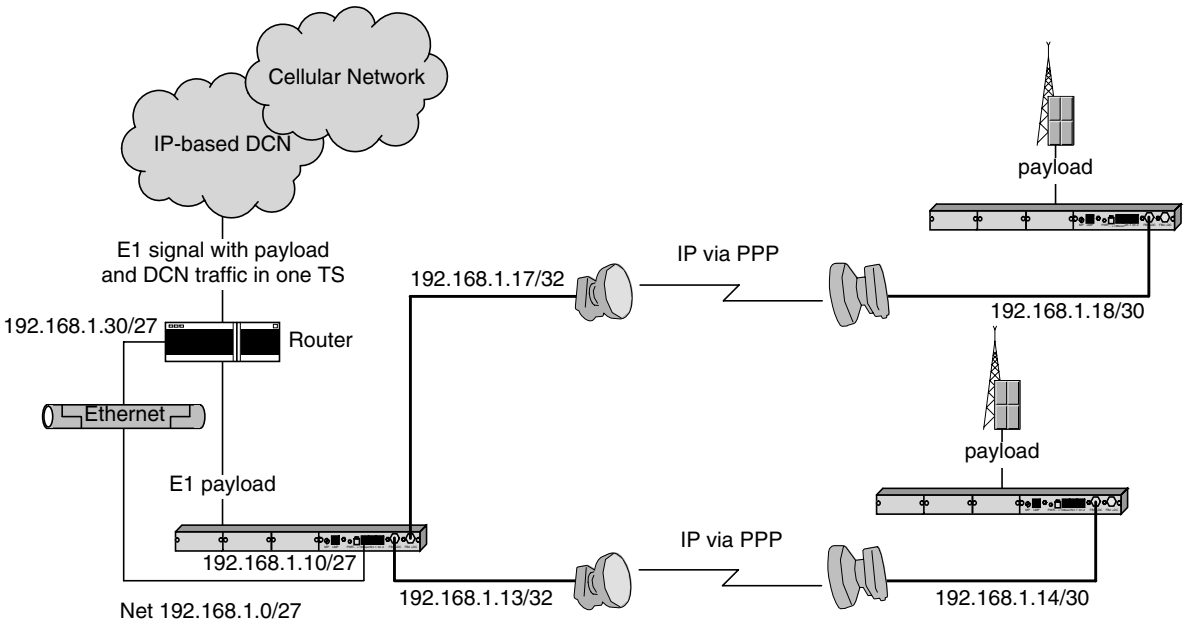


Figure 35. FlexiHopper IP DCN example

Each used port needs to be configured with one IP address. In case of point-to-point links, there is no need to establish separate subnets for the point-to-point link between two FlexiHoppers, because the host route entries are automatically added to the routing table for the next hop. Therefore the IP addresses can be distributed freely to all ports.

Note

In case of Proxy ARP, the PPP interface subnet mask at the tail site must be set to 255.255.255.252.

IP routing

Static IP routing is supported when FIU 19E is used as the indoor unit for Nokia FlexiHopper. It is possible to transmit IP traffic to other IP equipment located on site or to other sites connected via FlexiHopper radio links. See Figure 36 for an example.

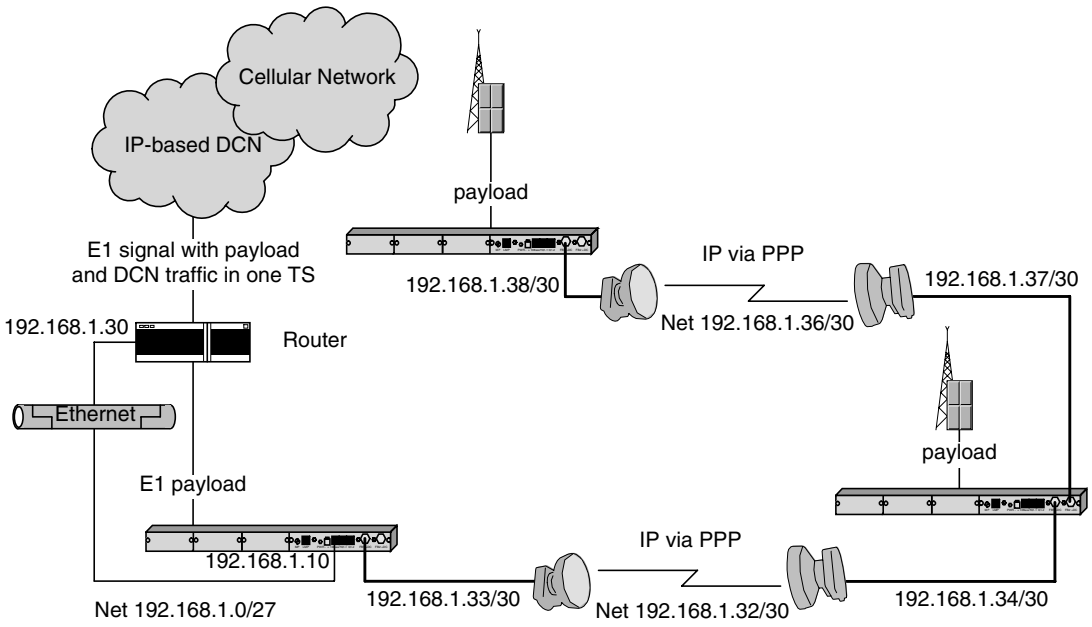


Figure 36. IP routing example

In the example the FIU 19E is located at the router side needs to have a static routing entry destination 192.168.1.36 netmask 255.255.255.252 next hop 192.168.1.34. In addition, the router located at the site has to have a static routing entry for the FIU 19E devices located at the other end of the FlexiHopper radio link. One possible entry in this example would be: destination 192.168.1.32 netmask 255.255.255.248 next hop 192.168.1.10.

NTP

With FIU 19E as the indoor unit, Nokia FlexiHopper supports Network Time Protocol (NTP). The NTP functionality is used to update the node's real time clock by connecting to an NTP server, which must be accessible via the IP-based DCN. Up to five NTP server IP addresses can be configured and prioritised in FIU 19E.

The NTP functionality in the indoor unit is enabled or disabled in the Nokia Hopper Manager or via SNMP.

TFTP

The trivial file transfer protocol (TFTP) is used to transmit software binary files via an IP-based DCN. Nokia FlexiHopper, with the FIU 19E as the indoor unit, utilises TFTP for remote software download. Alternatively, you can use the remove software download via the Nokia Q1 Tool.

The TFTP server functionality has to be enabled or disabled in the indoor unit via Nokia Hopper Manager or via SNMP.

Note

A TFTP client has to be installed/integrated into the NMS for transferring software binary files towards the FIU 19E or Nokia FlexiHopper.

---

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 (E), RRIC, and FXC RRI) and an interface unit (IFUE).

Note

MartisDXX FBU interface unit can also be used with Nokia FlexiHopper microwave radio. For more information on the FBU, refer to *Nokia FBU Manager User's Guide*.

6.1 Nokia FlexiHopper outdoor unit

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

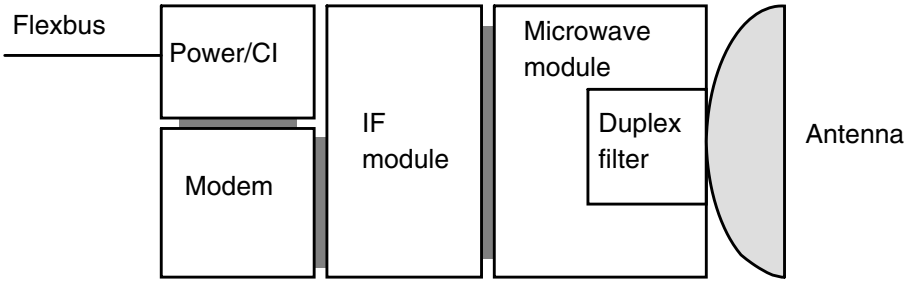


Figure 37. Nokia FlexiHopper OU, block diagram

The outdoor unit consists of:

- RF/MW parts
  - intermediate frequency (IF) module
  - microwave module
  - duplex filter
- modem
  - microprocessor system
  - 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 seven sizes: 20, 30, 60, 120, 180, 240, and 300 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°. Cross-polarisation antennas are also available.

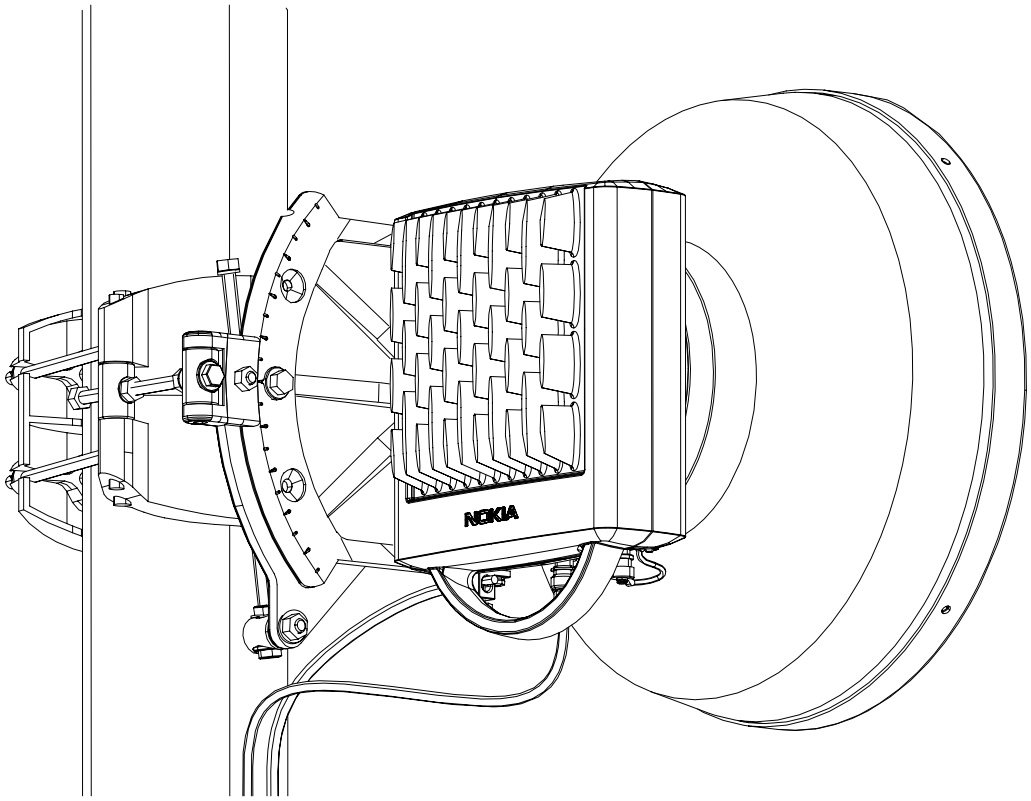


Figure 38. Nokia FlexiHopper 38 GHz outdoor unit with integrated 30 cm antenna and alignment unit

The Nokia FlexiHopper radio is connected to small (20, 30, or 60 cm) single antenna directly using Nokia alignment unit or to larger single antenna (120, 180 cm) using snap-on-adapter. No waveguides are needed. Alignment is carried out using a ratchet or a battery-operated screwdriver.

All antennas can be used also as separate connecting flexible waveguide on antenna flange. Large antennas (240, 300 cm) as well as all dual polarised antennas can be used only as separate antenna.

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 DC 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 12x2 Mbit/s. Interface capacities over 12x2 Mbit/s are implemented by installing the 16x2 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 16x2 Mbit/s. The expansion unit has the same external dimensions as the main unit.

When the expansion unit (EXU) is used to provide 16x2 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.

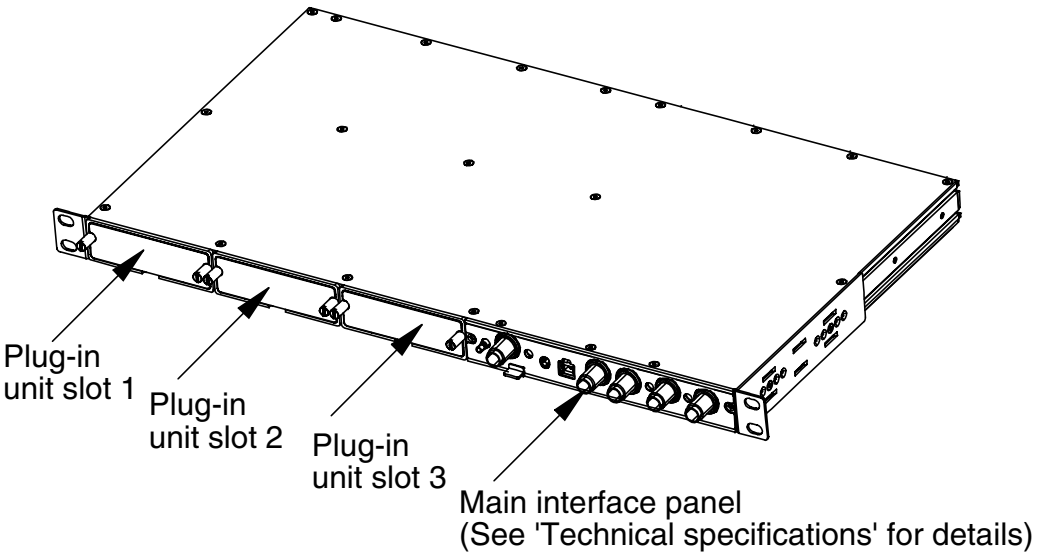


Figure 39. FIU 19 main unit

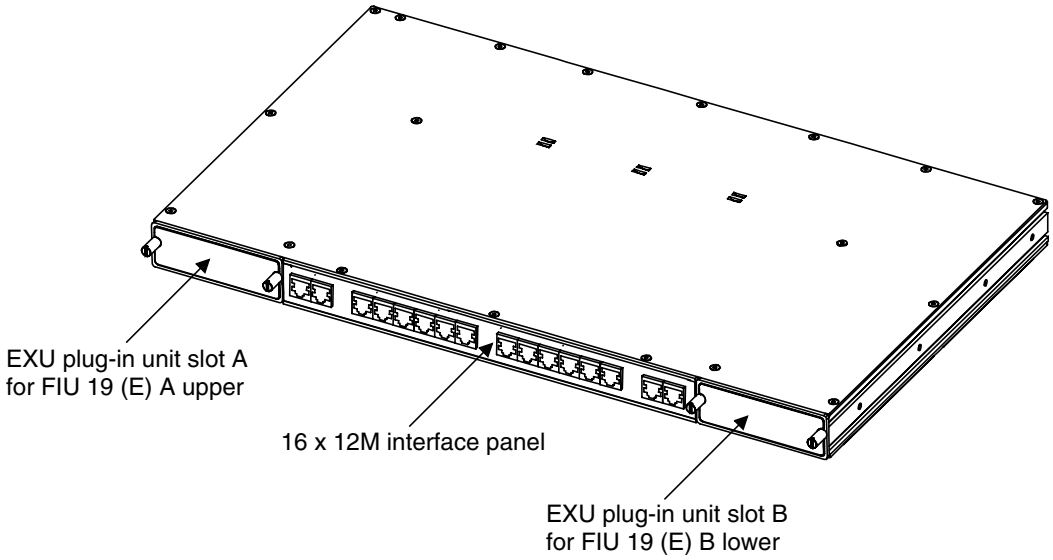


Figure 40. FIU 19 (E) EXU with 120 Ω RJ-45 balanced interfaces

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 adapter kits.

Connectors and cabling

The FIU 19 main unit has two Flexbus interfaces (FB1, FB2: 50Ω TNC connector) 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: TQ connector), power supply (PWR: Molex Micro-Fit 3.0 connector), local management (LMP: BQ connector), and measurement (MP: 75Ω SMB connector). The FIU 19E also provides a 10BaseT Ethernet interface (RJ-45 connector).

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:

- protected 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)
- when using IP DCN, the Ethernet interface of both indoor units have to be connected with the IP DCN
- auxiliary interfaces are connected together with a branching 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 to the Flexbus plug-in unit, additional power supply is not required.

Unit configurations

The following configuration options are available with FIU 19:

- Plug-in units (3 slots)
  - 4x2 Mbit/s balanced or unbalanced interfaces
  - Dual Flexbus interfaces
  - Auxiliary data channel interfaces, digital inputs/outputs
- Expansion unit (19-inch unit underneath the main unit)
  - 16x2 Mbit/s expansion (balanced or unbalanced)
  - 16x2 Mbit/s 1+1 protection (balanced or unbalanced).

6.3 FIU 19E indoor unit

The FIU 19E product is a product variant that differs from the FIU 19 product mechanically in the connector 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.

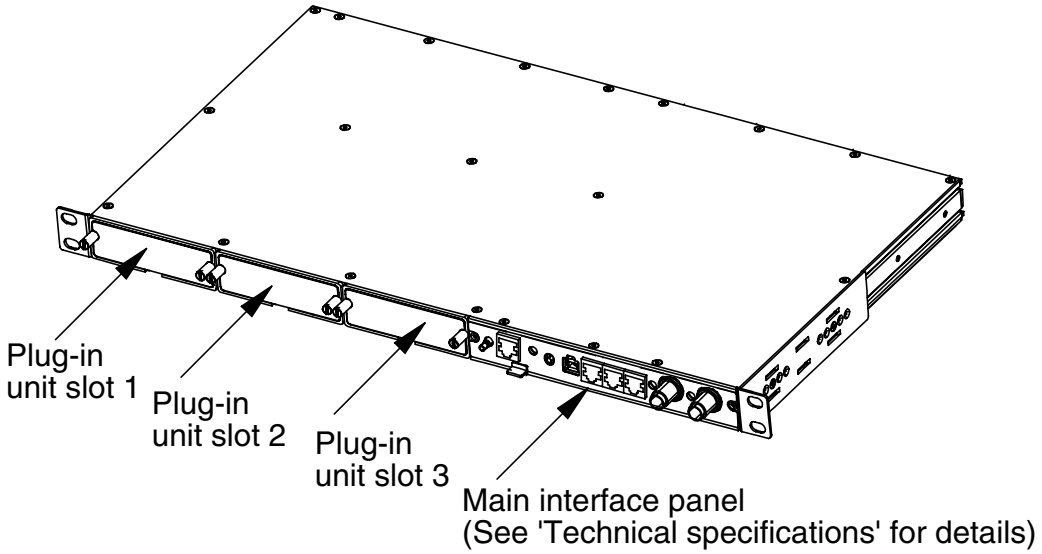


Figure 41. FIU 19E main unit

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

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.

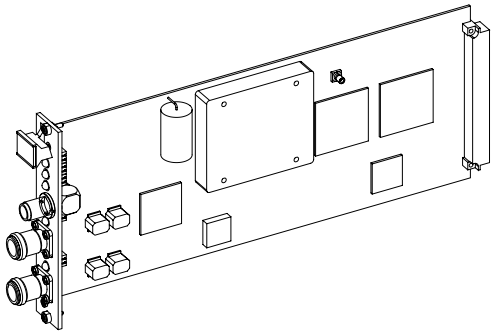


Figure 42. RRIC

Connectors and cabling

RRIC has two Flexbus interfaces (FB1, FB2: 50Ω N-connector) and a local management port (LMP: BQ connector) 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 (MP) 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 EDGE BTS, Nokia MetroHub, and Nokia UltraSite EDGE BTS.

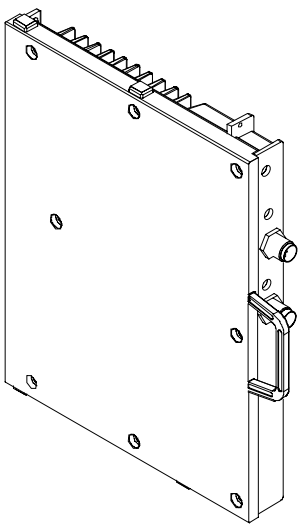


Figure 43. FXC RRI

Connectors and cabling

FXC RRI has two Flexbus interfaces (FB1, FB2: 50Ω TNC connector) 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 EDGE 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 capacity of 16x2 Mbit/s.

Connectors and cabling

The IFUE has three Nokia Flexbus interfaces (FB1–FB3: 50Ω TNC-connector). 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), one for each Flexbus interface and two LEDs for indicating the status of the IFUE.

Power supply

IFUE requires a power supply 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.

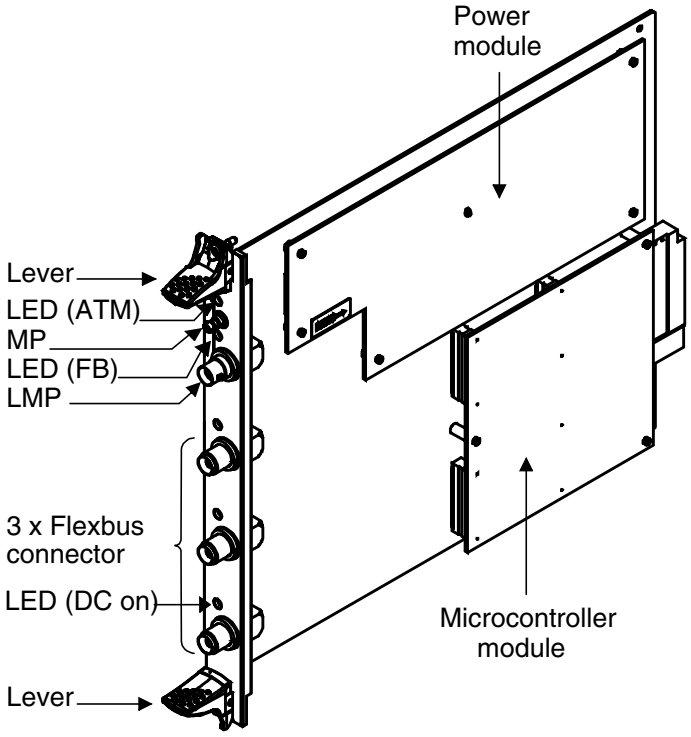


Figure 44. IFUE interface unit

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 (E), RRIC, FXC RRI)
1 indoor unit / 2 outdoor units (FIU 19 (E), RRIC, FXC RRI)
1 indoor unit / 3 outdoor units (FIU 19 (E) + additional power supply)
HSB, 1 IU / 2 OU (FIU 19 (E), RRIC, FXC RRI)*
HSB, 2 IU / 2 OU (FIU 19 (E))
HSB + space diversity, 1 IU / 2 OU (FIU 19 (E))*
HSB + space diversity, 2 IU / 2 OU (FIU 19 (E))*
Frequency diversity, 1 IU / 2 OU (FIU 19 (E))
Frequency diversity, 2 IU / 2 OU (FIU 19 (E))
Polarisation diversity, 1 IU / 2 OU (FIU 19 (E))
Polarisation diversity, 2 IU / 2 OU (FIU 19 (E))
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 (E)	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)
Sun radiation	< 1.12 kW/m^2
Relative humidity	≤ 100%
Wind	< 55 m/s
Tightness, dust/water	IP 55
FIU 19 (E) 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
		7.253-7.547	161	4+4	65
		7.425-7.725	154	4+4	65
		7.425-7.725	161	4+4	58
		7.457-7.737	168	3+3	65
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
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

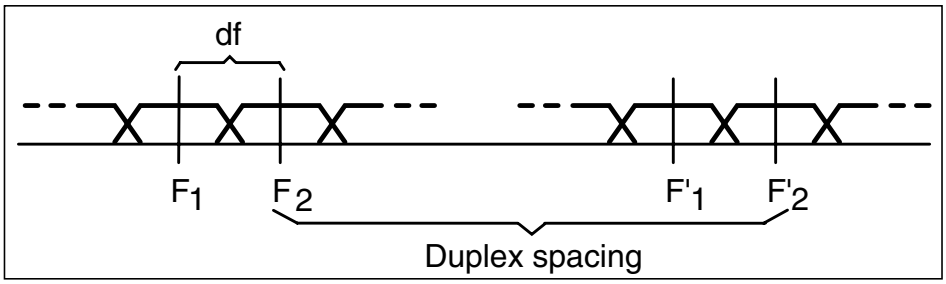


Figure 45. Channel spacing and duplex spacing

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	5.0	0
	4 x 2	7.5	0
	8 x 2	13.75	0
	16 x 2	27.5	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 – 18, refer to *Document Note* in the *Nokia FlexiHopper Microwave Radio with FIU 19/FIU 19E/RRIC User Manual*.

Note

The notation of the subbands in Tables 11 –18 has changed, for example: A → A LO, A' → A HI.

Table 11. Nokia FlexiHopper 7, frequency tuning range

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

Table 11. Nokia FlexiHopper 7, frequency tuning range (Continued)

Sub b.	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)
M LO	7240.75	7302.25	7242.50	7300.50	7246.00	7297.00	7253.00	7290.00
N LO	7272.75	7334.25	7274.50	7332.50	7278.00	7329.00	7285.00	7322.00
O LO	7304.75	7366.25	7306.50	7364.50	7310.00	7361.00	7317.00	7354.00
P LO	7336.75	7398.25	7338.50	7396.50	7342.00	7393.00	7349.00	7386.00
M HI	7401.75	7463.25	7403.50	7461.50	7407.00	7458.00	7414.00	7451.00
N HI	7433.75	7495.25	7435.50	7493.50	7439.00	7490.00	7446.00	7483.00
O HI	7465.75	7527.25	7467.50	7525.50	7471.00	7522.00	7478.00	7515.00
P HI	7497.75	7559.25	7499.50	7557.50	7503.00	7554.00	7510.00	7547.00
168 MHz duplex spacing, subbands Q LO - S LO and Q HI - S HI								
Q LO	7444.75	7506.25	7446.50	7504.50	7450.00	7501.00	7457.00	7494.00
R LO	7482.25	7543.75	7484.00	7542.00	7487.50	7538.50	7494.50	7531.50
S LO	7519.75	7569.00	7521.50	7569.00	7525.00	7569.00	7532.00	7569.00
Q HI	7612.75	7674.25	7614.50	7672.50	7618.00	7669.00	7625.00	7662.00
R HI	7650.25	7711.75	7652.00	7710.00	7655.50	7706.50	7662.50	7699.50
S HI	7687.75	7737.00	7689.50	7737.00	7693.00	7737.00	7700.00	7737.00

Table 12. Nokia FlexiHopper 8, frequency tuning range

Sub b.	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 LO - C LO and A HI - C HI								
A LO	7725.00	7840.93	7725.00	7839.18	7725.00	7835.68	7731.68	7828.68
B LO	7783.43	7904.93	7785.18	7903.18	7788.68	7899.68	7795.68	7892.68
C LO	7847.43	7963.68	7849.18	7963.68	7852.68	7963.68	7859.68	7956.68
A HI	8036.32	8152.25	8036.32	8150.50	8036.32	8147.00	8043.00	8140.00
B HI	8094.75	8216.25	8096.50	8214.50	8100.00	8211.00	8107.00	8204.00
C HI	8158.75	8275.00	8160.50	8275.00	8164.00	8275.00	8171.00	8268.00
119 MHz duplex spacing, subbands D LO - F LO and D HI - F HI								

Table 12. Nokia FlexiHopper 8, frequency tuning range (Continued)

Sub b.	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)
D LO	8280.75	8319.25	8282.50	8317.50	8286.00	8314.00	8293.00	8307.00
E LO	8308.75	8347.25	8310.50	8345.50	8314.00	8342.00	8321.00	8335.00
F LO	8336.75	8375.25	8338.50	8373.50	8342.00	8370.00	8349.00	8363.00
D HI	8399.75	8438.25	8401.50	8436.50	8405.00	8433.00	8412.00	8426.00
E HI	8427.75	8466.25	8429.50	8464.50	8433.00	8461.00	8440.00	8454.00
F HI	8455.75	8494.25	8457.50	8492.50	8461.00	8489.00	8468.00	8482.00
126 MHZ duplex spacing, subbands G LO - I LO and G HI - I HI								
G LO	8276.75	8315.25	8278.50	8313.50	8282.00	8310.00	8289.00	8303.00
H LO	8305.25	8343.75	8307.00	8342.00	8310.50	8338.50	8317.50	8331.50
I LO	8333.75	8372.25	8335.50	8370.50	8339.00	8367.00	8346.00	8360.00
G HI	8402.75	8441.25	8404.50	8439.50	8408.00	8436.00	8415.00	8429.00
H HI	8431.25	8469.75	8433.00	8468.00	8436.50	8464.50	8443.50	8457.50
I HI	8459.75	8498.25	8461.50	8496.50	8465.00	8493.00	8472.00	8486.00

Table 13. Nokia FlexiHopper 13, frequency tuning range

Sub b.	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 LO - C LO and A HI - C HI								
A LO	12752.75	12833.25	12754.50	12831.50	12758.00	12828.00	12765.00	12821.00
B LO	12822.75	12903.25	12824.50	12901.50	12828.00	12898.00	12835.00	12891.00
C LO	12892.75	12973.25	12894.50	12971.50	12898.00	12968.00	12905.00	12961.00
A HI	13018.75	13099.25	13020.50	13097.50	13024.00	13094.00	13031.00	13087.00
B HI	13088.75	13169.25	13090.50	13167.50	13094.00	13164.00	13101.00	13157.00
C HI	13158.75	13239.25	13160.50	13237.50	13164.00	13234.00	13171.00	13227.00

Table 14. Nokia FlexiHopper 15, frequency tuning range

Sub b.	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 LO - C LO and A HI - C HI								
A LO	14502.75	14649.25	14504.50	14647.50	14508.00	14644.00	14515.00	14637.00
B LO	14641.25	14787.75	14643.00	14786.00	14646.50	14782.50	14653.50	14775.50
C LO	14779.75	14921.00	14781.50	14921.00	14785.00	14921.00	14792.00	14914.00
A HI	14922.75	15069.25	14924.50	15067.50	14928.00	15064.00	14935.00	15057.00
B HI	15061.25	15207.75	15063.00	15206.00	15066.50	15202.50	15073.50	15195.50
C HI	15199.75	15341.00	15201.50	15341.00	15205.00	15341.00	15212.00	15334.00
644 MHz duplex spacing, subbands M LO and M HI								
M LO	14504.50	14683.00	14504.50	14683.00	14508.00	14683.00	14515.00	14683.00
M HI	15148.50	15327.00	15148.50	15327.00	15152.00	15327.00	15159.00	15327.00
728 MHz duplex spacing, subbands N LO and N HI								
N LO	14502.75	14613.00	14504.50	14613.00	14508.00	14613.00	14515.00	14606.00
N HI	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 b.	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 LO - D LO and A HI - D HI								
A LO	17704.75	17970.75	17706.00	17969.00	17709.50	17965.50	17716.50	17958.50
B LO	17951.75	18218.25	17953.50	18216.50	17957.00	18213.00	17964.00	18206.00
C LO	18171.75	18438.25	18173.50	18436.50	18177.00	18433.00	18184.00	18426.00
D LO	18419.25	18668.75	18421.00	18668.75	18424.50	18668.75	18431.50	18668.75
A HI	18714.75	18980.75	18716.00	18979.00	18719.50	18975.50	18726.50	18968.50
B HI	18961.75	19228.25	18963.50	19226.50	18967.00	19223.00	18974.00	19216.00
C HI	19181.75	19448.25	19183.50	19446.50	19187.00	19443.00	19194.00	19436.00
D HI	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 b.	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 LO - C LO and A HI - C HI								
A LO	21225.75	21622.25	21227.50	21620.50	21231.00	21617.00	21238.00	21610.00
B LO	21585.75	21982.25	21587.50	21980.50	21591.00	21977.00	21598.00	21970.00
C LO	21945.75	22342.25	21947.50	22340.50	21951.00	22337.00	21958.00	22330.00
A HI	22457.75	22854.25	22459.50	22852.50	22463.00	22849.00	22470.00	22842.00
B HI	22817.75	23214.25	22819.50	23212.50	22823.00	23209.00	22830.00	23202.00
C HI	23177.75	23574.25	23179.50	23572.50	23183.00	23569.00	23190.00	23562.00
1008 MHz duplex spacing, subbands M LO - N LO and M HI - N HI								
M LO	22003.75	22400.25	22005.50	22398.50	22009.00	22395.00	22016.00	22388.00
N LO	22193.75	22589.00	22195.50	22588.50	22199.00	22585.00	22206.00	22578.00
M HI	23011.75	23408.25	23013.50	23406.50	23017.00	23403.00	23024.00	23396.00
N HI	23201.75	23597.00	23203.50	23596.50	23207.00	23593.00	23214.00	23586.00

Table 17. Nokia FlexiHopper 26, frequency tuning range

Sub b.	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 LO - C LO and A HI - C HI								
A LO	24550.75	24897.25	24552.50	24895.50	24556.00	24892.00	24563.00	24885.00
B LO	24823.75	25170.25	24825.50	25168.50	24829.00	25165.00	24836.00	25158.00
C LO	25096.75	25443.25	25098.50	25441.50	25102.00	25438.00	25109.00	25431.00
A HI	25558.75	25905.25	25560.50	25903.50	25564.00	25900.00	25571.00	25893.00
B HI	25831.75	26178.25	25833.50	26176.50	25837.00	26173.00	25844.00	26166.00
C HI	26104.75	26451.25	26106.50	26449.50	26110.00	26446.00	26117.00	26439.00

Table 18. Nokia FlexiHopper 38, frequency tuning range

Sub b.	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 LO - D LO and A HI - D HI								
A LO	37059.75	37346.25	37059.75	37344.50	37059.75	37341.00	37062.00	37334.00
B LO	37329.75	37626.25	37331.50	37624.50	37335.00	37621.00	37342.00	37614.00
C LO	37609.75	37906.25	37611.50	37904.50	37615.00	37901.00	37622.00	37894.00
D LO	37889.75	38176.25	37891.50	38176.25	37895.00	38176.25	37902.00	38174.00
A HI	38319.75	38606.25	38319.75	38604.50	38319.75	38601.00	38322.00	38594.00
B HI	38589.75	38886.25	38591.50	38884.50	38595.00	38881.00	38602.00	38874.00
C HI	38869.75	39166.25	38871.50	39164.50	38875.00	39161.00	38882.00	39154.00
D HI	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

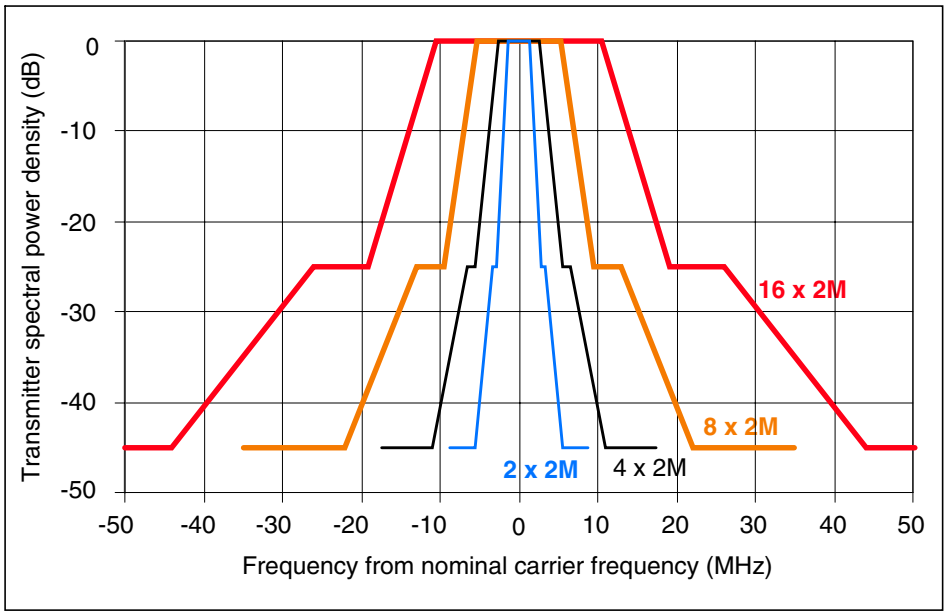


Figure 46. Spectrum mask

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 112.			

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

Capacity	Code
2x2 Mbit/s	3M50G7W, 5M00*
4x2 Mbit/s	7M00G7W, 7M50*
8x2 Mbit/s	14M0G7W, 13M8*
16x2 Mbit/s	28M0G7W, 27M5*

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

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 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 112.		

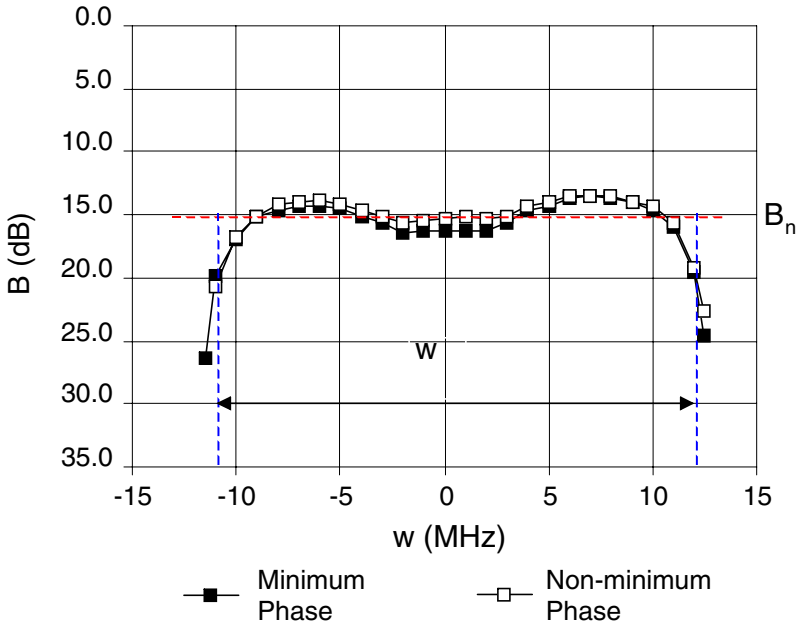


Figure 47. 10^{-3} BER signature curves for 15 GHz FlexiHopper (duplex frequency 644 MHz, capacity 16 x 2 Mbit/s) measured with 6.3 ns signal delay

Abbreviations used in Figure 47, and in Tables 28 and 29 are:

B_n	average notch depth
w	signature width
df	duplex frequency

For more information, see the *Signature Measurements for 7, 8, 13, 15 and 18 GHz FlexiHopper Outdoor Units* application note that can be obtained upon request.

Table 28. 10^{-3} BER signature data

		Minimum phase		Non-minimum phase	
f (GHz)	**df (MHz)**	**w (MHz)**	**B_n (dB)**	**w (MHz)**	**B_n (dB)**
7	154/161/168	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

Table 28. 10^{-3} BER signature data (Continued)

		Minimum phase		Non-minimum phase	
f (GHz)	**df (MHz)**	**w (MHz)**	**B_n (dB)**	**w (MHz)**	**B_n (dB)**
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
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	154/161/168	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

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

Frequency band	Transmit power (dBm), nominal	Receive noise figure (dB), typical over temperature
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 reference 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	-107
	4 x 2	-104
	8 x 2	-101
	16 x 2	-98
13, 15, 18, 23 GHz	2 x 2	-106
	4 x 2	-103
	8 x 2	-100
	16 x 2	-97
26, 38 GHz	2 x 2	-104
	4 x 2	-101
	8 x 2	-98
	16 x 2	-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, 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 BER 10^{-3}.

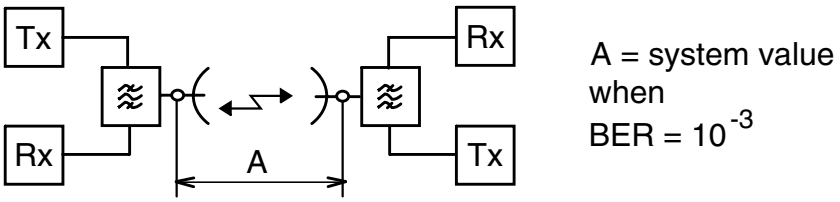


Figure 48. Defining system value

7.2.6 Synchronisation, recovery, and changeover

Table 39. Synchronisation, recovery, and changeover

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 (hot standby)	< 500 ms

Receiver hitless changeover for 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 ≤ 10^{-5}, the output BER in 2M IU interface is more than two decades (>100x) lower than the better one of the Rx signals, or when compared to the traditional AGC-voltage based switching device.

If the bit error rate in both operating channels is < 10^{-3}, the output BER in 2M IU interface is more than one decade (>10x) lower than the better one of the Rx signals.

7.2.7 Interfaces

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

DC supply voltage	+52 to +60 V_{DC}
Power consumption	< 25 W

Table 43. FlexiHopper OU dimensions

Dimensions of the 7 and 8 GHz outdoor unit without antenna and alignment unit	Height 230 mm Width 210 mm Depth 230 mm Weight 6.0 kg
Dimensions of the 13 and 15 GHz outdoor unit without antenna and alignment unit	Height 230 mm Width 210 mm Depth 210 mm Weight 5.0 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 4.5 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

Antenna flanges

Normally radio is connected to small (20, 30, or 60 cm) single antenna directly using Nokia alignment unit or to larger single antenna (120, 180 cm) using snap-on-adapter. No waveguides are needed.

All antennas can be used also as separate connecting flexible waveguide on antenna flange. Large antennas (240, 300 cm) as well as all dual polarised antennas can be used only as separate antenna.

Waveguide flanges (furnished with threads) of the antennas are:

Table 44. Waveguide flanges

Frequency band	Waveguide flange / threads
7 - 8 GHz	UBR 84 /M4
13 GHz	UBR 120 /M4
15 GHz	UBR 140 /M4
18/23/26 GHz	UBR 220 /M3
38 GHz	UBR 320 /M3

Polarisation

Polarisation of the single antennas 20 cm to 300 cm can be changed turning the feeder of the antenna by 90 degrees.

Dual-polarised antenna needs two flanges, one for V- and one for H-polarity.

7.3.1 Electrical specifications

Following abbreviations are used in Tables 45 - 78:

Gain (in dBi) dB over an isotropic radiator
Low value in the low band end
Middle value in the middle band
High value in the high band end
BW 3 dB beam width
F/B front to back ratio (180 ± 40 degrees value compared to main beam gain)
XPD cross polarisation discrimination at main beam
Isolation attenuation between ports of dual-polarised antenna
RL return loss
RPE radiation pattern envelope (0 to 180 degrees)
Co-polar V response of V-pol antenna to V-pol signal
Co-polar H response of H-pol antenna to H-pol signal
X-polar V response of V-pol antenna to H-pol signal
X-polar H response of H-pol antenna to V-pol signal

Table 45. Electrical specifications for FlexiHopper 60 cm antenna at 7-8 GHz

Frequency/ Size	**(7-8 GHz); 7100-8500 MHz/ 60 cm (2 ft)**
Type, Item	**Single T55071.02/ Dual T55071.52**
Gain	Low 30.3/ Middle 31.4/ High 32.2 dBi (min 29.8/ max 32.8 dBi)
BW (-3 dB)	4.2 deg
F/B	57 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	20 dB
RPE ETSI EN 300 833 V1.4.1	R1 C3

Co-Polar								**X-Polar**			
(dBi to dB by using 32.8 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	19	5	18	0	0	0	0	0	1	0	1
25	4	15	9	0.5	-0.2	1	-0.3	5	1	6	1
40	0	35	1	1	-0.5	1.5	-1	10	-6	10	-7
50	0	50	0	1.5	-1.3	2	-1.8	20	-6	20	-10
60	-4	65	-6	2	-2	2.5	-2.5	25	-15	30	-19
100	-25	90	-25	2.5	-3.5	3	-4.3	35	-15	70	-19
180	-25	180	-25	3	-5	3.5	-6.2	90	-27	85	-27
				3.5	-7.5	4	-7.5	180	-27	180	-27
				4	-10	4.5	-9.5				
				4.5	-12	5	-11.5				
				5	-12						

Table 46. Electrical specifications for FlexiHopper 120 cm antenna at 7-8 GHz

Frequency/ Size	**(7-8 GHz); 7100-8500 MHz/ 120 cm (4 ft)**
Type, Item	**Single T55071.15/ Dual T55071.65**
Gain	Low 36.5/ Middle 37.2/ High 37.9 dBi (min 36.2/ max 38.2 dBi)

Table 46. Electrical specifications for FlexiHopper 120 cm antenna at 7-8 GHz (Continued)

BW (-3 dB)		2.4 deg									
F/B		63 dB									
XPD/ Isolation		29 dB/ 35 dB (Dual)									
RL		20 dB									
RPE ETSI EN 300 833 V1.4.1		R1 C3									
Co-Polar								**X-Polar**			
(dBi to dB by using 38.2 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20	5	20	0	0	0	0	0	8	0	8
15	6	15	8	0.4	-0.25	0.5	-0.3	3	8	3	8
30	-1	35	2	0.7	-1.1	1	-2.1	5	-1	5	-1
55	-1.5	50	0	1	-2.4	1.3	-3.8	10	-5	10	-5
70	-6.5	70	-6	1.3	-4.5	1.7	-7	45	-22	20	-6
100	-25	85	-20	1.5	-6.4	2	-12	75	-28	45	-19
180	-25	100	-25	1.8	-9	4	-12	180	-28	55	-19
		180	-25	4	-9	5	-18			85	-26.5
				5	-18					180	-26.5

Table 47. Electrical specifications for FlexiHopper 180 cm antenna at 7-8 GHz

Frequency/ Size	**(7-8 GHz); 7100-8500 MHz/ 180 cm (6 ft)**
Type, Item	**Single T55071.16/ Dual T55071.66**
Gain	Low 39.8/ Middle 40.6/ High 41.3 dBi (min 39.6/ max 41.5 dBi)
BW (-3 dB)	1.6 deg
F/B	68 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	20 dB
RPE ETSI EN 300 833 V1.4.1	R1 C3

Table 47. Electrical specifications for FlexiHopper 180 cm antenna at 7-8 GHz (Continued)

Co-Polar								**X-Polar**			
(dBi to dB by using 41.5 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	16	5	16	0	0	0	0	0	10	0	10
10	7	10	7	0.5	-1.1	0.5	-1.1	1.5	10	2	10
20	3	20	2	0.8	-3	0.8	-3	5	-5	5	-5
60	-2.5	60	-2.5	1	-5.1	1	-5.1	40	-23	20	-18
70	-5	70	-6	1.5	-12	1.5	-13	65	-23	65	-20
95	-26	95	-26	3	-12	2	-16	70	-27	70	-27
180	-26	180	-26	5	-26	3.5	-17	180	-27	180	-27
						5	-28				

Table 48. Electrical specifications for FlexiHopper 240 cm antenna at 7-8 GHz

Frequency/ Size	**(7-8 GHz); 7100-8500 MHz/ 240 cm (8 ft)**
Type, Item	**Single T55071.24/ Dual T55071.74**
Gain	Low 42.5/ Middle 43.3/ High 44.0 dBi (min 42.1/ max 44.4 dBi)
BW (-3 dB)	1.1 deg
F/B	69 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	20 dB
RPE ETSI EN 300 833 V1.4.1	R1 C3

Table 48. Electrical specifications for FlexiHopper 240 cm antenna at 7-8 GHz (Continued)

Co-Polar								**X-Polar**			
(dBi to dB by using 44.4 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	16.5	5	14	0	0	0	0	0	14	0	14
7.5	12.5	10	13	0.3	-0.4	0.4	-0.9	2	14	2	14
11	12.5	15	6	0.6	-2.1	0.7	-3.4	5	-3	5	0
15	6	25	2	1	-7.8	1	-7.8	10	-10	15	-13
25	2	60	-4	1.2	-11.5	1.3	-14.7	30	-11	45	-15
50	-1	95	-27	1.4	-18	1.5	-22	90	-30	70	-18
60	-4	180	-27	2	-18	2.5	-22	180	-30	90	-30
100	-27			3	-24	2.5	-26			180	-30
180	-27			4	-24	4	-26				
				5	-28	5	-30				

Table 49. Electrical specifications for FlexiHopper 300 cm antenna at 7-8 GHz

Frequency/ Size	**(7-8 GHz); 7100-8500 MHz/ 300 cm (10 ft)**
Type, Item	**Single T55071.30/ Dual T55071.80**
Gain	Low 44.3/ Middle 45.1/ High 45.8 dBi (min 44.0/ max 46.1 dBi)
BW (-3 dB)	1.0 deg
F/B	72 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	20 dB
RPE ETSI EN 300 833 V1.4.1	R1 C3

Table 49. Electrical specifications for FlexiHopper 300 cm antenna at 7-8 GHz (Continued)

Co-Polar								**X-Polar**			
(dBi to dB by using 46.1 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	16	5	14	0	0	0	0	0	15.5	0	15.5
15	4	10	9	0.2	-0.2	0.3	-0.6	5	3	5	3
50	-1	35	-2	0.5	-2.1	0.5	-2	10	-8	10	-8
70	-6	70	-9	0.8	-6	0.8	-6.6	20	-8	20	-8
100	-27	95	-27	1	-10.5	1	-11	60	-18	70	-18
180	-27	180	-27	1.5	-26	1.1	-13	95	-29.5	95	-29.5
				3	-26	1.4	-24	180	-29.5	180	-29.5
				5	-30	1.5	-27				
						3	-27				
						5	-32				

Table 50. Electrical specifications for FlexiHopper 30 cm antenna at 13 GHz

Frequency/ Size	**(13 GHz); 12750-13250 MHz/ 30 cm (1 ft)**
Type, Item	**Single T55072.01**
Gain	Low 30.6/ Middle 30.8/ High 31.0 dBi (min 30.4/ max 31.2 dBi)
BW (-3 dB)	4.2 deg
F/B	53 dB
XPD	30 dB
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R1 C2

Table 50. Electrical specifications for FlexiHopper 30 cm antenna at 13 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 31.2 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	16.5	5	19.5	0	0	0	0	0	2	0	2
7.5	16.5	8	19.5	0.5	0	1	-0.5	5	2	5	2
10	10.5	10	13.5	1	-0.4	1.5	-1.5	15	-12	15	-16
15	9.5	15	13.5	1.5	-1	2	-2.5	25	-13	50	-16
20	1.5	20	3.5	2	-2	2.5	-4.5	50	-21	50	-21
45	1.5	30	3.5	2.5	-3.5	3	-6.5	85	-21	55	-21
50	-3.5	40	-0.5	3	-5	3.5	-10	95	-24.5	75	-21
67	-3.5	52	-0.5	3.5	-7.5	3.75	-12	180	-24.5	90	-23.5
90	-18.5	65	-8	4	-10	5	-12			180	-23.5
100	-18.5	70	-9.5	4.5	-13.5						
105	-21.5	75	-9.5	5	-15						
180	-21.5	95	-21.5								
		180	-21.5								

Table 51. Electrical specifications for FlexiHopper 60 cm antenna at 13 GHz

Frequency/ Size	**(13 GHz); 12750-13250 MHz/ 60 cm (2 ft)**
Type, Item	**Single T55072.02/ Dual T55072.52**
Gain	Low 35.9/ Middle 36.1/ High 36.2 dBi (min 35.4/ max 36.9 dBi)
BW (-3 dB)	2.6 deg
F/B	62 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R1 C3

Table 51. Electrical specifications for FlexiHopper 60 cm antenna at 13 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 36.9 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	17	5	17	0	0	0	0	0	6	0	6
10	13.5	10	14	0.1	0	0.5	-0.4	3	6	3	6
20	4.5	20	7	0.5	-0.2	1	-1.7	5	-5	5	-3
25	4.5	30	0	1	-1.4	1.5	-3.6	10	-6	10	-6.5
30	0	50	0	1.5	-3.4	2	-8	20	-20	15	-13
50	0	70	-8	2	-6.5	3	-16	70	-20	20	-14
80	-12	100	-25	2.5	-11.5	4.5	-16	90	-26	50	-22
100	-25	180	-25	3	-16	5	-20.5	180	-26	75	-22
180	-25			4	-16					90	-26
				5	-20					180	-26

Table 52. Electrical specifications for FlexiHopper 120 cm antenna at 13 GHz

Frequency/ Size	**(13 GHz); 12750-13250 MHz/ 120 cm (4 ft)**
Type, Item	**Single T55072.15/ Dual T55072.65**
Gain	Low 41.5/ Middle 41.6/ High 41.7 dBi (min 40.9/ max 42.3 dBi)
BW (-3 dB)	1.4 deg
F/B	68 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R1 C3

Table 52. Electrical specifications for FlexiHopper 120 cm antenna at 13 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 42.3 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	15.5	5	17	0	0	0	0	0	12.5	0	12.5
10	8.5	10	12.5	0.2	-0.05	0.25	-0.2	1.5	12.5	1.5	12.5
15	4.5	15	4.5	0.5	-1	0.5	-1	5	-5.5	5	-7.5
40	3	50	0	1	-6	1	-6	10	-7.5	15	-13.5
75	-11.5	70	-6	2	-16	1.5	-16	20	-15.5	30	-17.5
90	-24	90	-25	2.5	-16	2.5	-16	30	-15.5	60	-19.5
95	-25	180	-25	3	-18	3	-18	40	-17.5	80	-25.5
180	-25			4	-24	3.5	-21.5	60	-23.5	180	-25.5
				5	-27	4	-24	90	-25.5		
						4.5	-25	180	-25.5		
						5	-27				

Table 53. Electrical specifications for FlexiHopper 180 cm antenna at 13 GHz

Frequency/ Size	**(13 GHz); 12750-13250 MHz/ 180 cm (6 ft)**
Type, Item	**Single T55072.16/ Dual T55072.66**
Gain	Low 44.9/ Middle 45.2/ High 45.5 dBi (min 44.6/ max 45.8 dBi)
BW (-3 dB)	0.9 deg
F/B	72 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R1 C3

Table 53. Electrical specifications for FlexiHopper 180 cm antenna at 13 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 45.8 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	15	5	16	0	0	0	0	0	15.5	0	15.5
8	13	15	6	0.25	-0.5	0.25	-0.5	2	15.5	2	15.5
15	2	20	1	0.5	-3	0.5	-3	5	-0.3	7.5	-9
60	-4	50	-1	0.7	-6.5	0.8	-8	15	-14	23	-18
70	-7	63	-4	1	-13	1.8	-14	30	-21	45	-18
100	-26	72	-8	2	-15	2.8	-20	60	-22	75	-25
180	-26	95	-26	3.5	-20	4	-20	90	-26	95	-27
		180	-26	4.5	-30	5	-26.5	180	-26	180	-27
				5	-30						

Table 54. Electrical specifications for FlexiHopper 30 cm antenna at 15 GHz

Frequency/ Size	**(15 GHz); 14400-15350 MHz/ 30 cm (1 ft)**
Type, Item	**Single T55073.01**
Gain	Low 31.8/ Middle 32.1/ High 32.4 dBi (min 31.5/ max 32.8 dBi)
BW (-3 dB)	3.9 deg
F/B	54 dB
XPD	30 dB
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C2

Table 54. Electrical specifications for FlexiHopper 30 cm antenna at 15 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 32.8 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20.5	5	21	0	0	0	0	0	3	0	3
8	20.5	7	21	0.25	-0.2	0.25	0	5	3	5	3
20	7	10	16	1	-0.6	0.5	-0.5	10	-7	10	-3
25	7	30	1	1.5	-1.6	0.75	-0.4	15	-11	20	-11
35	1	40	-2.5	2	-2.9	1	-0.7	20	-17	50	-11
45	1	60	-2.5	2.5	-4.8	1.5	-1.7	30	-17	65	-17
70	-4	80	-11.5	3	-7	2	-2.9	60	-21	90	-21
100	-20	100	-20	3.5	-10	2.5	-4.8	180	-21	180	-21
180	-20	180	-20	4.5	-12	3	-7				
				5	-12	3.5	-9.8				
						4	-12				
						5	-12				

Table 55. Electrical specifications for FlexiHopper 60 cm antenna at 15 GHz

Frequency/ Size	**(15GHz); 14400-15350 MHz/ 60 cm (2 ft)**
Type, Item	**single T55073.02/ Dual T55073.52**
Gain	Low 37.1/ Middle 37.4/ High 37.6 dBi (min 36.7/ max 38.1 dBi)
BW (-3 dB)	2.2 deg
F/B	60 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C3

Table 55. Electrical specifications for FlexiHopper 60 cm antenna at 15 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 38.1 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	18	5	18	0	0	0	0	0	8	0	8
10	9	10	9	0.5	-0.3	0.5	-0.3	5	0	5	2
20	4	25	0	1	-1.8	1	-1.8	20	-16.5	30	-22
25	0	40	-0.5	1.5	-4.5	1.5	-4.5	50	-24.5	60	-22
40	-0.5	60	-6	3	-14	3	-14	80	-27.5	90	-31.5
50	-6.5	95	-27	4	-14	4	-14	95	-31.5	180	-31.5
60	-6.5	180	-27	5	-20.5	5	-20.5	180	-31.5		
80	-17										
95	-27										
180	-27										

Table 56. Electrical specifications for FlexiHopper 120 cm antenna at 15 GHz

Frequency/ Size	**(15 GHz); 14400-15350 MHz/ 120 cm (4 ft)**
Type, Item	**Single T55073.15/ Dual T55073.65**
Gain	Low 42.5/ Middle 42.7/ High 43.0 dBi (min 42.1/ max 43.3 dBi)
BW (-3 dB)	1.2 deg
F/B	71 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C3

Table 56. Electrical specifications for FlexiHopper 120 cm antenna at 15 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 43.3 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	12.5	5	15	0	0	0	0	0	13.5	0	13.5
8	11	10	9	0.25	-0.35	0.25	-0.2	1.5	13.5	1.5	13.5
10	6.5	20	0	0.75	-4.1	0.5	-1.5	5	-7	5	-6.5
20	-1.5	30	0	1	-7	0.75	-4.5	20	-18.5	20	-16.5
30	-1.5	50	-2.5	1.5	-16	1	-9	40	-18.5	45	-21.5
45	-2.5	60	-4	2.5	-16	1.5	-16	60	-21.5	70	-21.5
60	-6.5	90	-27.5	3	-17	2	-16	70	-26	90	-31.5
70	-10.5	180	-27.5	5	-30	2.5	-20	90	-31.5	180	-31.5
95	-28.5					3.5	-20	180	-31.5		
180	-28.5					5	-28				

Table 57. Electrical specifications for FlexiHopper 180 cm antenna at 15 GHz

Frequency/ Size	**(15 GHz); 14400-15350 MHz/ 180 cm (6 ft)**
Type, Item	**Single T55073.16/ Dual T55073.66**
Gain	Low 46.0/ Middle 46.3/ High 46.5 dBi (min 45.7/ max 46.8 dBi)
BW (-3 dB)	0.8 deg
F/B	73 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C3

Table 57. Electrical specifications for FlexiHopper 180 cm antenna at 15 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 46.8 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	15	5	15	0	0	0	0	0	16.5	0	16.5
15	2	8.5	10.5	0.25	-1	0.25	-1	1	16.5	1	16.5
50	-2.5	15	2	0.5	-3.2	0.5	-3.2	2.5	12.7	6	0.7
60	-4.5	30	-1.5	0.6	-5.5	0.7	-8	5.5	-0.3	18	-13
92	-27	50	-3	0.7	-8	0.9	-13	9	-9.3	28	-13
180	-27	60	-4	0.8	-12	1.5	-13	15	-9.3	50	-16
		70	-11.5	1	-16	4.5	-26	20	-14	75	-23
		90	-27	2	-16	5	-29	65	-20	90	-31
		180	-27	5	-34			95	-32	180	-31
								180	-32		

Table 58. Electrical specifications for FlexiHopper 30 cm antenna at 18 GHz

Frequency/ Size	**(18 GHz); 17700-19700 MHz/ 30 cm (1 ft)**
Type, Item	**Single T55074.01/ Dual T55074.51**
Gain	Low 33.7/ Middle 34.3/ High 34.6 dBi (min 33.3/ max 35.0 dBi)
BW (-3 dB)	3.1 deg
F/B	54 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C2

Table 58. Electrical specifications for FlexiHopper 30 cm antenna at 18 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 35.0 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	24	5	23	0	0	0	0	0	4.5	0	4.5
15	7	15	10	0.5	-0.2	0.5	-0.2	3	4.5	3	4.5
25	7	25	1	1	-1	1	-0.9	5	-5	10	-7.5
35	2	55	0	1.5	-2.1	1.5	-2.2	20	-15	15	-7.5
60	1	100	-18	2	-4.1	2	-4.5	50	-15	60	-20.5
90	-20	140	-20	2.5	-7.1	2.5	-7.9	60	-20.5	180	-20.5
180	-20	180	-20	3	-10	3	-12	180	-20.5		
				4.5	-10	5	-12				
				5	-11						

Table 59. Electrical specifications for FlexiHopper 60 cm antenna at 18 GHz

Frequency/ Size	**(18 GHz); 17700-19700 MHz/ 60 cm (2 ft)**
Type, Item	**Single T55074.02/ Dual T55074.52**
Gain	Low 38.7/ Middle 39.2/ High 40.1 dBi (min 38.0/ max 40.5 dBi)
BW (-3 dB)	1.8 deg
F/B	60 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C2 (C2: Co-pol H, C3: all others)

Table 59. Electrical specifications for FlexiHopper 60 cm antenna at 18 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 40.5 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	18.5	5	18.5	0	0	0	0	0	9.5	0	9.5
20	2.5	10	9	0.5	-0.3	0.5	-0.7	2	9.5	2	9.5
40	0	30	-1.5	1	-2.8	1	-3.2	5	-2	5	1.5
60	-1	50	-2.5	1.5	-7	1.5	-8	10	-7.5	8	1.5
90	-27	60	-4.5	2	-12	2	-15	15	-7.5	10	-6.5
170	-27	95	-27	3	-12	3.5	-15	20	-14.5	15	-6.5
170	-25	170	-27	4	-18	5	-22	40	-18.5	25	-13.5
180	-25	170	-25	5	-22			60	-24.5	40	-14.5
		180	-25					70	-24.5	70	-21.5
								90	-31.5	80	-24.5
								180	-31.5	90	-31.5
										180	-31.5

Table 60. Electrical specifications for FlexiHopper 120 cm antenna at 18 GHz

Frequency/ Size	**(18 GHz); 17700-19700 MHz/ 120 cm (4 ft)**
Type, Item	**Single T55074.15/ Dual T55074.65**
Gain	Low 44.2/ Middle 44.5/ High 45.1 dBi (min 44.0/ max 45.4 dBi)
BW (-3 dB)	0.9 deg
F/B	72 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C3

Table 60. Electrical specifications for FlexiHopper 120 cm antenna at 18 GHz

Co-Polar								X-Polar			
(dBi to dB by using 45.4 dBi)				Main Beam							
H		V		H		V		H		V	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	12	5	14	0	0	0	0	0	15	0	15
10	5	10	8	0.3	-0.3	0.2	-0.4	2	15	2	15
20	0	15	4	0.5	-2	0.5	-3	5	-4	5	-3.5
35	0	20	1.5	0.8	-6	0.8	-6	15	-16.5	10	-12
60	-5	45	-1.5	1.5	-14	1.5	-14	45	-19.5	20	-16
95	-27	55	-5	2	-14	3	-15	70	-24.5	50	-16
180	-27	70	-11	5	-32	4.5	-28	80	-31	70	-22.5
		85	-20.5			5	-28	180	-31	90	-27.5
		90	-27							95	-31
		180	-27							180	-31

Table 61. Electrical specifications for FlexiHopper 180 cm antenna at 18 GHz

Frequency/ Size	**(18 GHz); 17700-19700 MHz/ 180 cm (6 ft)**
Type, Item	**Single T55074.16/ Dual T55074.66**
Gain	Low 47.6/ Middle 48.2/ High 48.7 dBi (min 46.8/ max 49.2 dBi)
BW (-3 dB)	0.7 deg
F/B	76 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R2 C3

Table 61. Electrical specifications for FlexiHopper 180 cm antenna at 18 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 49.2 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	16	5	16	0	0	0	0	0	19	0	19
10	7	9	9	0.2	-0.5	0.2	-0.5	1.5	19	1	19
15	2	25	-1.5	0.4	-3.1	0.4	-3.4	5	0	5	0
25	-1	45	-1.5	0.5	-5.7	0.5	-7	10	-11	10	-10
45	-2	60	-4	0.6	-9	0.6	-9	25	-15	25	-11
60	-4	95	-27.5	1	-12	2	-20	45	-15	30	-13
95	-27.5	180	-27.5	1.5	-18	3.5	-26	90	-31	50	-15
180	-27.5			2.5	-22	5	-33	180	-31	95	-31
				5	-34					180	-31

Table 62. Electrical specifications for FlexiHopper 20 cm antenna at 23 GHz

Frequency/ Size	**(23 GHz); 21200-23600 MHz/ 20 cm (Squarad)**
Type, Item	**Single T55075.03**
Gain	Low 30.5/ Middle 31.0/ High 31.5 dBi (min 30.3/ max 31.7 dBi)
BW (-3 dB)	4.5 deg
F/B	56 dB
XPD	30 dB
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R3 C3

Table 62. Electrical specifications for FlexiHopper 20 cm antenna at 23 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 31.7 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	19	5	19	0	0	0	0	0	1	0	1
10	12	10	12	1	-0.5	1	-0.5	2.25	1	2.25	1
30	0	35	-3	2.25	-3	2.25	-3	4	0	4	0
35	-5	25	-0.5	4.5	-12	4	-12	5	-5	5	-5
60	-5	50	-3	5	-12	5	-12	10	-10	10	-10
90	-25	70	-12					40	-20	20	-14
180	-25	90	-25					70	-25	45	-14
		180	-25					100	-33	70	-25
								180	-33	100	-33
										180	-33

Table 63. Electrical specifications for FlexiHopper 30 cm antenna at 23 GHz

Frequency/ Size	**(23 GHz); 21200-23600 MHz/ 30 cm (1 ft)**
Type, Item	**Single T55075.01/ Dual T55075.51**
Gain	Low 35.0/ Middle 35.4/ High 35.9 dBi (min 34.2/ max 36.7 dBi)
BW (-3 dB)	2.6 deg
F/B	61 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R3 C3

Table 63. Electrical specifications for FlexiHopper 30 cm antenna at 23 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 36.7 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20	5	17.5	0	0	0	0	0	5	0	5
10	10	6	17.5	0.5	-0.3	0.5	-0.3	3	5	3	5
12	10	10	10	1	-1.2	1	-1.2	5	-5	5	-5
20	6	12	10	1.5	-4.5	1.5	-4	10	-5	10	-5
50	0	15	8	2	-8	2	-8	15	-9.5	15	-9.5
80	-13.5	20	0.5	2.5	-10	2.5	-10	30	-14.5	30	-12.5
100	-25.3	55	-4.5	4.5	-10	4.5	-10	60	-19.5	60	-18.5
180	-25.3	90	-25.3	5	-18	5	-17	85	-30.5	85	-30.5
		180	-25.3					180	-30.5	180	-30.5

Table 64. Electrical specifications for FlexiHopper 60 cm antenna at 23 GHz

Frequency/ Size	**(23 GHz); 21200-23600 MHz/ 60 cm (2 ft)**
Type, Item	**Single T55075.02/ Dual T55075.52**
Gain	Low 40.1/ Middle 40.6/ High 41.1 dBi (min 39.4/ max 41.9 dBi)
BW (-3 dB)	1.5 deg
F/B	61 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R3 C3

Table 64. Electrical specifications for FlexiHopper 60 cm antenna at 23 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 41.9 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	17.5	5	17.5	0	0	0	0	0	10.8	0	10.8
10	10	15	5	0.5	-0.9	0.5	-0.9	2	10.8	2	10.8
15	8.8	25	3	0.75	-3	0.75	-3	5	-4.5	5	-5
20	3.5	30	-1	1	-5.1	1	-5.1	10	-5	10	-5
30	-1.2	55	-4	1.5	-10	1.5	-10	15	-10	15	-9.5
60	-5	90	-24	2.5	-10	2.5	-10	25	-12.5	25	-9.5
85	-16.2	180	-24	4.5	-19	4.5	-19	35	-18	35	-16
100	-24			5	-25	5	-25	60	-18	57	-16
180	-24							80	-25	80	-23.5
								85	-30	90	-30
								180	-30	180	-30

Table 65. Electrical specifications for FlexiHopper 120 cm antenna at 23 GHz

Frequency/ Size	**(23 GHz); 21200-23600 MHz/ 120 cm (4 ft)**
Type, Item	**Single T55075.15/ Dual T55075.65**
Gain	Low 45.5/ Middle 45.9/ High 46.5 dBi (min 45.3/ max 46.7 dBi)
BW (-3 dB)	0.8 deg
F/B	72 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R3 C3

Table 65. Electrical specifications for FlexiHopper 120 cm antenna at 23 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 46.7 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	17	5	17	0	0	0	0	0	17	0	17
10	8	10	8	0.1	-0.1	0.1	-0.2	0.5	17	0.5	17
15	5	15	3	0.4	-3	0.4	-3	4	3	2	9
20	3	25	0	0.5	-6	0.5	-6	5	-5	5	-5
25	-1	40	0	0.8	-9	0.9	-9.5	8	-5	10	-5
50	-1	55	-4	1.2	-9	2	-16	10	-8	15	-15
80	-14	75	-15	1.8	-16	2.5	-16	15	-14	25	-17
100	-25	90	-25	2.5	-16	4	-28	30	-17.5	55	-17
180	-25	180	-25	3.5	-24	5	-30	50	-18	90	-30
				4	-24			70	-24	180	-30
				5	-30			90	-30		
								180	-30		

Table 66. Electrical specifications for FlexiHopper 180 cm antenna at 23 GHz

Frequency/ Size	**(23 GHz); 21200-23600 MHz/ 180 cm (6 ft)**
Type, Item	**Single T55075.16/ Dual T55075.66**
Gain	Low 48.7/ Middle 49.4/ High 49.8 dBi (min 48.4/ max 50.2 dBi)
BW (-3 dB)	0.5 deg
F/B	75 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R3 C3

Table 66. Electrical specifications for FlexiHopper 180 cm antenna at 23 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 50.2 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	16	5	15	0	0	0	0	0	20.2	0	20.2
10	4	10	7	0.2	-0.8	0.1	-0.1	1	20.2	1	20.2
15	4	30	0.6	0.3	-2.8	0.2	-0.8	5	-6	5	-6
45	0	50	0	0.5	-7	0.3	-2.8	7.5	-6	6	-6
72	-10	70	-10	1	-15	0.5	-7	10	-9	15	-12
90	-24	95	-24	2.5	-15	1	-14	40	-14	40	-12
180	-25	180	-24	5	-34	2	-20	70	-20	60	-16.5
						5	-33	90	-30	100	-30
								180	-30	180	-30

Table 67. Electrical specifications for FlexiHopper 20 cm antenna at 26 GHz

Frequency/ Size	**(26 GHz); 24250-26500 MHz/ 20 cm (Squarad)**
Type, Item	**Single T55076.03**
Gain	Low 31.9/ Middle 32.3/ High 32.6 dBi (min 31.7/ max 32.8 dBi)
BW (-3 dB)	4.1 deg
F/B	58 dB
XPD	30 dB
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R4 C2

Table 67. Electrical specifications for FlexiHopper 20 cm antenna at 26 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 32.8 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20	5	20	0	0	0	0	0	2.3	0	2.3
6	15.8	6	18.8	0.5	-0.2	0.5	-0.2	1.3	2.3	1.3	2.3
8	15.8	7	15	1	-0.8	1	-0.8	5	-5	5	-5
20	3	10	15	2	-2.9	2	-2.9	10	-5	20	-14
60	-4	20	4	4	-12.5	4	-12.5	15	-9	70	-24
80	-14.5	60	-4	5	-12.5	5	-12.5	70	-25	90	-33
90	-25.2	80	-14.5					90	-33	180	-33
180	-25.2	90	-25.2					180	-33		
		180	-25.2								

Table 68. Electrical specifications for FlexiHopper 30 cm antenna at 26 GHz

Frequency/ Size	**(26 GHz); 24250-26500 MHz/ 30 cm (1 ft)**
Type, Item	**Single T55076.01/ Dual T55076.51**
Gain	Low 36.5/ Middle 36.8/ High 37.2 dBi (min 35.5/ max 38.2 dBi)
BW (-3 dB)	2.3 deg
F/B	62 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R4 C2

Table 68. Electrical specifications for FlexiHopper 30 cm antenna at 26 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 38.2 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20	5	20	0	0	0	0	0	6.5	0	6.5
22	3	20	5	0.3	-0.1	0.3	-0.1	3.5	6.5	3.5	6.5
60	-3	30	0	0.6	-0.6	0.6	-0.6	5	-3	5	-3.5
100	-23	60	-3.5	0.9	-1.8	0.9	-1.8	10	-3	10	-3.5
180	-25	105	-25	1.5	-5.5	1.5	-5.5	15	-9	15	-10
		180	-25	1.9	-9	1.8	-9	80	-26	70	-21.5
				4	-9	4	-9	180	-26	80	-25
				5	-16	5	-16.5			180	-25

Table 69. Electrical specifications for FlexiHopper 60 cm antenna at 26 GHz

Frequency/ Size	**(26 GHz); 24250-26500 MHz/ 60 cm (2 ft)**
Type, Item	**Single T55076.02/ Dual T55076.52**
Gain	Low 41.1/ Middle 41.4/ High 41.8 dBi (min 40.6/ max 42.3 dBi)
BW (-3 dB)	1.4 deg
F/B	67 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R4 C2

Table 69. Electrical specifications for FlexiHopper 60 cm antenna at 26 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 42.3 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20	5	20	0	0	0	0	0	11.5	0	11.5
15	6	8	17	0.15	0	0.15	0	2	11.5	2	11.5
20	2	15	5.5	0.3	-0.5	0.3	-0.5	5	-3	5	-3
50	0.5	50	0.5	0.5	-1.5	0.5	-1.5	30	-15.5	25	-15.5
65	-5	80	-13.5	0.7	-3.6	0.8	-4	50	-15.5	60	-18
100	-23	100	-25	1.2	-10	1.1	-10	80	-25	80	-25
105	-25	180	-25	2.5	-10	2.5	-10	180	-25	180	-25
180	-25			3	-14	3.5	-16				
				5	-21.5	5	-21.5				

Table 70. Electrical specifications for FlexiHopper 120 cm antenna at 26 GHz

Frequency/ Size	**(26 GHz); 24250-26500 MHz/ 120 cm (4 ft)**
Type, Item	**Single T55076.15/ Dual T55076.65**
Gain	Low 46.6/ Middle 47.0/ High 47.3 dBi (min 46.3/ max 47.6 dBi)
BW (-3 dB)	0.7 deg
F/B	73 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R4 C2

Table 70. Electrical specifications for FlexiHopper 120 cm antenna at 26 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 47.6 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	17.5	5	12	0	0	0	0	0	17	0	17
10	8	8	12	0.2	-0.2	0.1	-0.25	5	-3	5	-4
15	3.5	10	6	0.35	-3	0.2	-1	8	-3	8	-4.5
40	2	15	3.5	0.7	-8	0.35	-3	15	-12.5	15	-14.5
55	0	25	3.5	1.2	-8	0.8	-8.5	50	-18.5	50	-14.5
80	-12.5	50	0.5	1.5	-14	1.2	-9	80	-25.5	80	-25.5
90	-24	60	-2.5	2	-14	1.5	-15	180	-25.5	180	-25.5
100	-25.5	70	-7.5	2.5	-20	2	-15				
180	-25.5	85	-22	4	-29.5	2.5	-16				
		100	-25.5	5	-30	4	-26				
		180	-25.5			5	-35.5				

Table 71. Electrical specifications for FlexiHopper 20 cm antenna at 38 GHz

Frequency/ Size	**(38 GHz); 37000-39500 MHz/ 20 cm (Squarad)**
Type, Item	**Single T55078.03**
Gain	Low 34.4/ Middle 35.0/ High 35.4 dBi (min 34.2/ max 35.6 dBi)
BW (-3 dB)	2.7 deg
F/B	56 dB
XPD	30 dB
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R5 C2, C3a

Table 71. Electrical specifications for FlexiHopper 20 cm antenna at 38 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 35.6 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	23	5	13	0	0	0	0	0	5	0	5
10	8	14	5	0.5	-0.5	0.5	-0.5	1.35	5	5	0
17	4	18	0	1.5	-3.6	1.5	-3.6	5	1	10	-5
30	3.5	25	-3	3.5	-12	2	-6	10	-5	30	-15
40	0	30	-8	5	-12	3	-15	50	-15	50	-15
52	-2	55	-9			4	-15	80	-20	80	-20
90	-18	65	-13			5	-22	180	-20	180	-20
180	-20	75	-20								
		180	-20								

Table 72. Electrical specifications for FlexiHopper 30 cm antenna at 38 GHz

Frequency/ Size	**(38 GHz); 37000-39500 MHz/ 30 cm (1 ft)**
Type, Item	**Single T55078.01/ Dual T55078.51**
Gain	Low 39.3/ Middle 39.5/ High 39.8 dBi (min 39.2/ max 40.2 dBi)
BW (-3 dB)	1.7 deg
F/B	62 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R4 C2, C3a (after 08/2003 R5 C3b, c)

Table 72. Electrical specifications for FlexiHopper 30 cm antenna at 38 GHz

Co-Polar								**X-Polar**			
(dBi to dB by using 40.2 dBi)				Main Beam							
H		**V**		**H**		**V**		**H**		**V**	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	16	5	15.5	0	0	0	0	0	10	0	10
10	8	10	8	0.25	-0.2	0.25	-0.2	1	10	1	10
20	0	20	-0.5	0.5	-1	0.5	-1	5	-5	5	-4
30	-2	45	-10.5	0.85	-3	0.85	-3	10	-11	15	-4
45	-2	65	-12	1.5	-10	1.3	-10	40	-17	23	-14
72	-8	80	-20	2.7	-10	2.7	-10	60	-22	50.5	-16
95	-20	180	-20	4.5	-21.5	5	-25	180	-22	80	-22
180	-20			5	-23.5					180	-22

Table 73. Electrical specifications for FlexiHopper 60 cm antenna at 38 GHz

Frequency/ Size	**(38 GHz); 37000-39500 MHz/ 60 cm (2 ft)**
Type, Item	**Single T55078.02/ Dual T55078.52**
Gain	Low 44.3/ Middle 44.6/ High 44.9 dBi (min 44.0/ max 45.3 dBi)
BW (-3 dB)	0.9 deg
F/B	63 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R5 C2, C3a (after 08/2003 R5 C3b, c)

Table 73. Electrical specifications for FlexiHopper 60 cm antenna at 38 GHz

Co-Polar								X-Polar			
dBi to dB by using 45.3 dBi				Main Beam							
H		V		H		V		H		V	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	17.5	5	15	0	0	0	0	0	15.5	0	15.5
15	3	15	0	0.25	-0.8	0.25	-0.8	2	15.5	2	15.5
20	0	40	-7	0.45	-3	0.45	-3	4	-1.5	5	-3.5
50	-1	65	-10	0.5	-4	0.5	-4	10	-1.5	15	-12.5
77	-9	70	-10	0.9	-10	0.8	-10	15	-11.5	25	-15
90	-19.7	85	-19.7	1.5	-10	1.5	-10	30	-13.5	80	-19.5
180	-19.7	180	-19.7	4	-25	4	-25	45	-19.5	180	-21.5
				5	-29	5	-30	80	-21.5		
								180	-21.5		

7.3.2 Radiation pattern envelope (RPE) values in ETSI EN 300 833 V1.4.1 standard

Table 74. RPE classes C2 and C3 at range R1 (3-14 GHz)

RPE ETSI EN 300 833 V1.4.1							
R1 C2 3-14 GHz				R1 C3 3-14 GHz			
Co-Polar		X-Polar		Co-Polar		X-Polar	
deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	26	5	10	5	20	5	5
10	20	10	5	20	8	10	0
20	12	15	5	70	-5	13	-5
50	5	30	-3	100	-25	20	-5
65	2	70	-3	180	-25	40	-6
80	2	100	-20			50	-10
105	-20	180	-20			75	-15
180	-20					95	-25
						180	-25

Table 75. RPE classes C2 and C3 at range R2 (14-20 GHz)

RPE ETSI EN 300 833 V1.4.1							
R2 C2 14-20 GHz				R2 C3 14-20 GHz			
Co-Polar		X-Polar		Co-Polar		X-Polar	
deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	25	5	10	5	18	5	5
15	13	7	7	10	9	10	1
20	10	15	2	25	2	30	-13
70	0	20	2	60	-4	50	-15
80	-8	25	-1	95	-27	85	-25
100	-18	45	-1	180	-27	95	-31
160	-20	70	-10			180	-31
180	-20	90	-20				
		180	-20				

Table 76. RPE class C3 at range R3 (20-24 GHz) and RPE class C2 at range R4 (24-30 GHz)

RPE ETSI EN 300 833 V1.4.1							
R3 C3 20-24 GHz				R4 C2 24-30 GHz			
Co-Polar		X-Polar		Co-Polar		X-Polar	
deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20	5	-5	5	20	5	-3
10	12	10	-5	20	5	20	-3
20	7	15	-8	55	0	80	-25
40	3	35	-8	100	-23	180	-25
50	0	100	-30	180	-25		
100	-23	180	-30	1.5			
180	-23			4			

Table 77. RPE classes C2, C3a, and C3b at range R5 (30-47 GHz)

RPE ETSI EN 300 833 V1.4.1												
R5 C2 30-47 GHz				R5 C3a (only V) 30-47 GHz				R5 C3b V 30-47 GHz			
Co-Polar		X-Polar		Co-Polar		X-Polar		Co-Polar		X-Polar	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	25	5	5	5	16	5	5	5	16	5	-2
10	17	15	5	10	9	15	5	10	9	8	-5
15	13	20	0	15	5	20	0	15	5	12	-10
25	8	25	-4	20	0	40	-7	20	0	20	-10
30	4	55	-6	40	-7	50	-8	40	-7	30	-12
70	-4	75	-18	50	-8	65	-10	50	-8	50	-15
90	-17	180	-18	65	-10	75	-10	65	-10	70	-17
180	-17			75	-10	90	-17	75	-10	180	-17
				90	-17	180	-17	90	-17		
				180	-17			180	-17		

Table 78. RPE classes C3b and C3c at range R5 (30-47 GHz)

RPE ETSI EN 300 833 V1.4.1

Table 78. RPE classes C3b and C3c at range R5 (30-47 GHz) (Continued)

R5 C3b H 30-47 GHz				R5 C3c V 30-47 GHz				R5 C3c H 30-47 GHz			
Co-Polar		X-Polar		Co-Polar		X-Polar		Co-Polar		X-Polar	
deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi	deg	dBi
5	20	5	-2	5	12	5	-4	5	20	5	-4
10	11	8	-5	9	9	9	-8	10	11	9	-8
15	6	12	-10	10	6	10	-10	15	6	10	-10
20	0	20	-10	15	2	40	-10	20	0	40	-10
50	-1	30	-12	20	0	45	-13	50	-1	45	-13
70	-4	50	-15	30	-4	55	-13	70	-4	55	-13
90	-17	70	-17	40	-7	70	-18	90	-17	70	-18
180	-17	180	-17	45	-9	180	-18	180	-17	180	-18
				60	-14						
				70	-18						
				180	-18						

7.3.3 Adjustment, dimensions, and installation options

Table 79. Antenna adjustment ranges, weight, and pole diameter

	Alignment bracket T55050.02	**Alignment unit** T55050.01	**Mounting unit** T55050.03	**Alignment unit as a part of antenna**		
Antenna size (cm)	**20**	**20/30/60**		**120**	**180**	**240/300**
Horizontal coarse (deg)	360	360		360		
Horizontal fine (deg)	-10...+10	-15...+15		-15...+15		-5...+5
Vertical coarse (deg)	-45...+45	-25 0 +25				

Table 79. Antenna adjustment ranges, weight, and pole diameter (Continued)

Vertical fine (deg)	-10...+10	-45...0 -25...+25 0...+45		-5...+5	-15...+15
Weight (kg)	3	5.2	4.2	Incl. in antenna weight	
Pole diameter (mm)	30-120	50-125	50-125	115	

Table 80. Antenna weights and dimensions

Antenna size (cm)	**Weight without mounting (kg)**	**Weight with mounting (kg)**	**Diameter (mm)**	**Depth (mm)**
20	2.5		256 x 246 (square)	120
30	3		390	165
60	6		690	255
120		45 - 52	1240 - 1290	440 - 600
180		90 - 102	1915 - 1950	770 - 1200
240		200	2500	1300 - 1790
300		250	3200	1415 - 1790

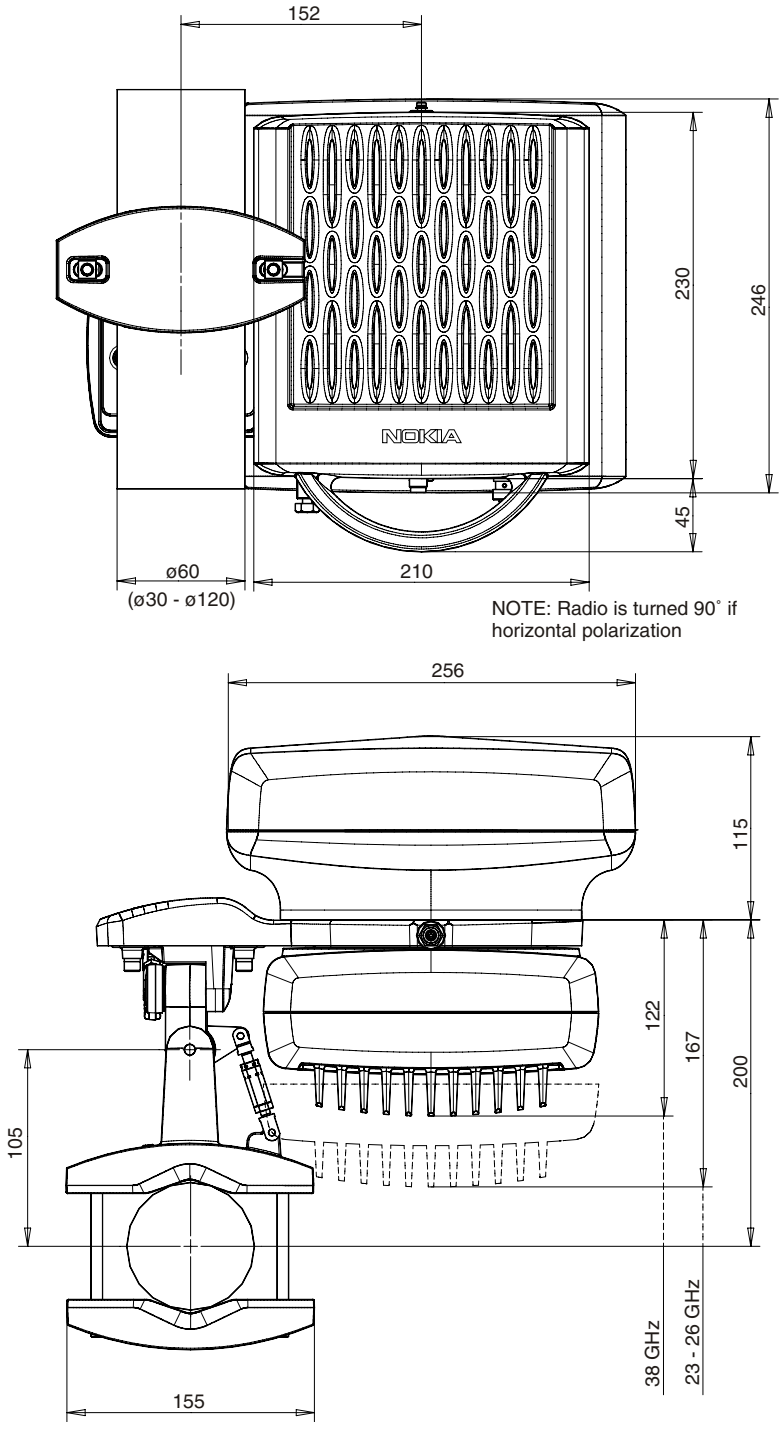


Figure 49. Outdoor unit with 20 cm square radome antenna (dimensions in mm)

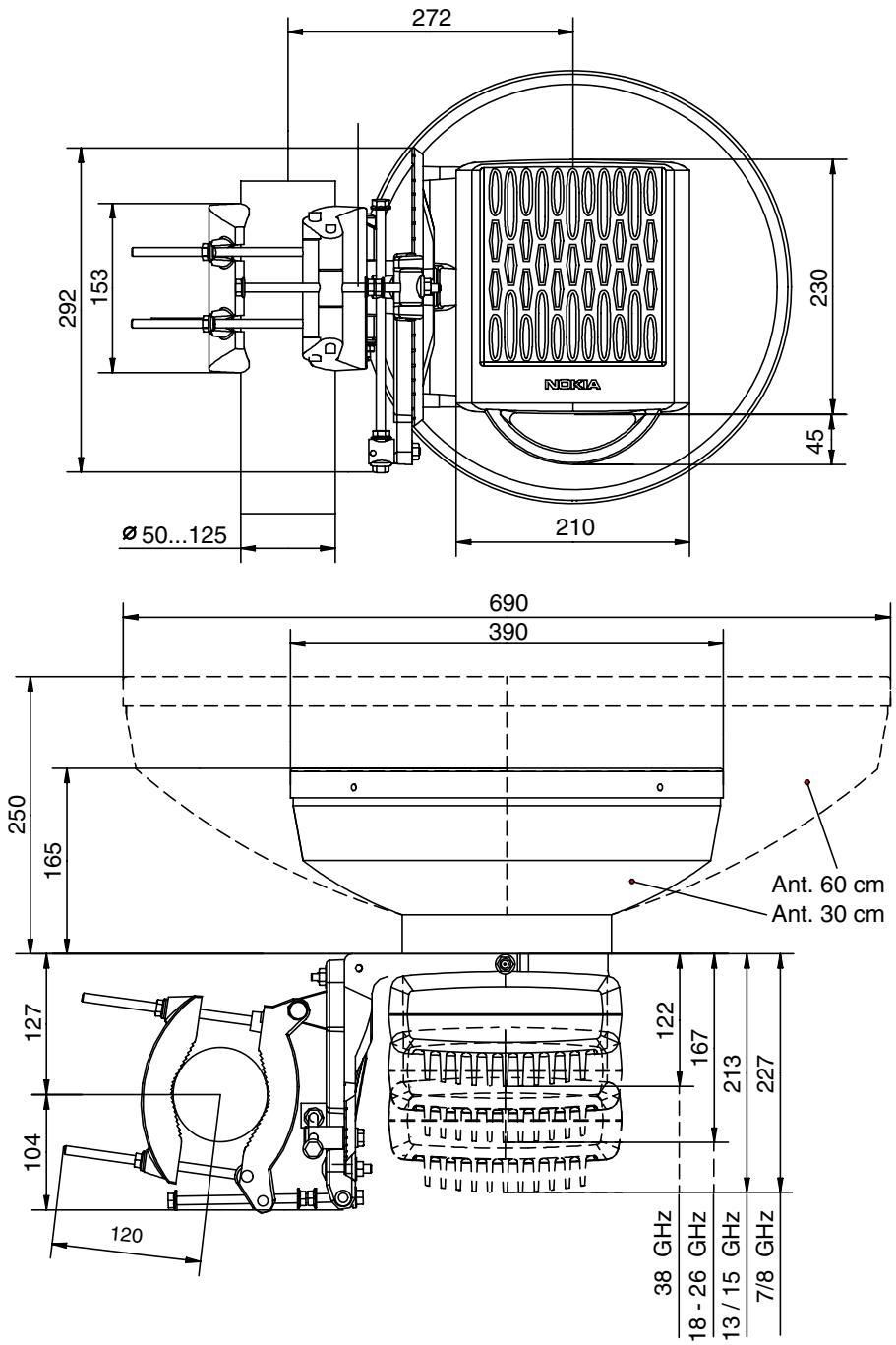


Figure 50. Outdoor unit with 30 or 60 cm antenna (dimensions in mm)

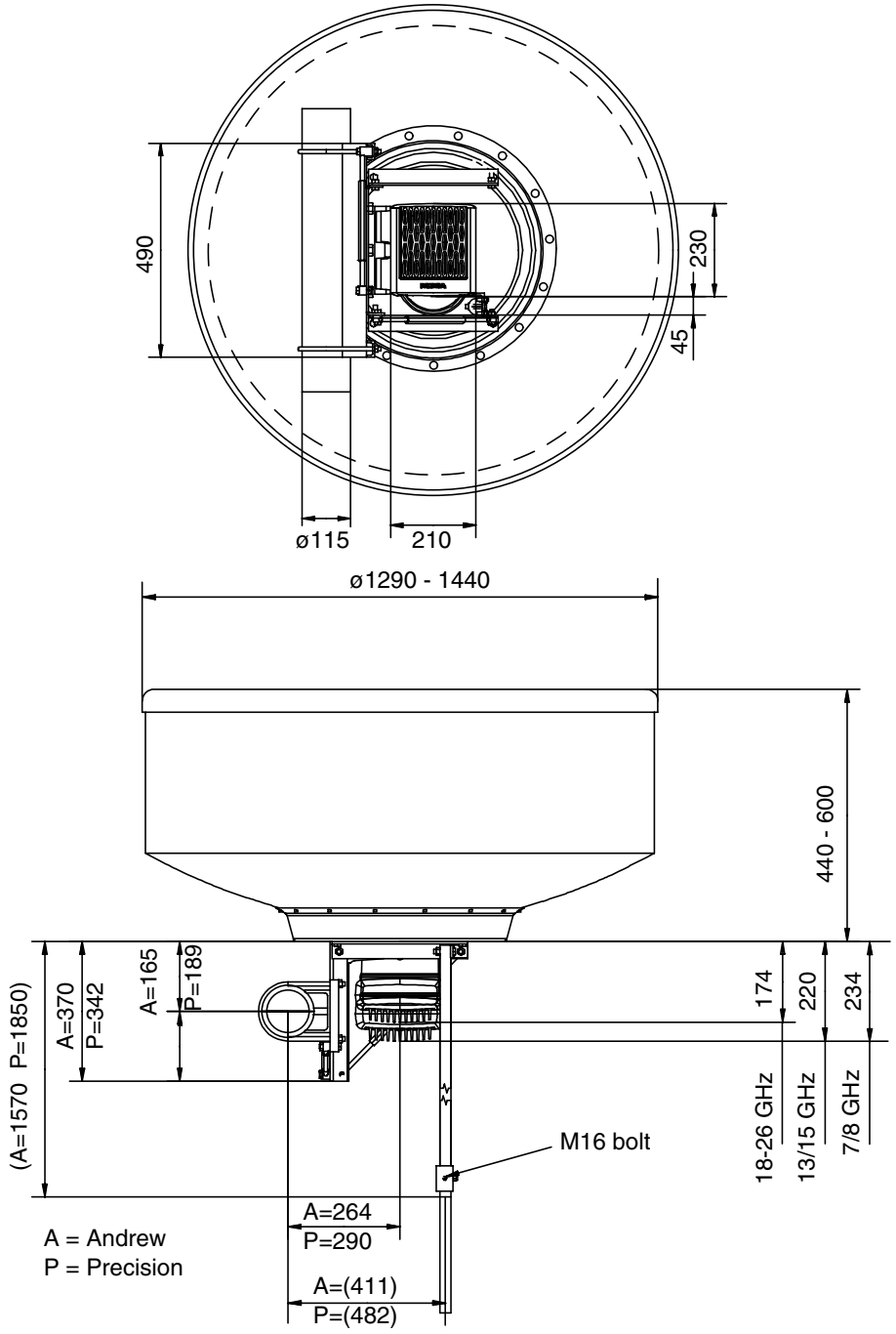
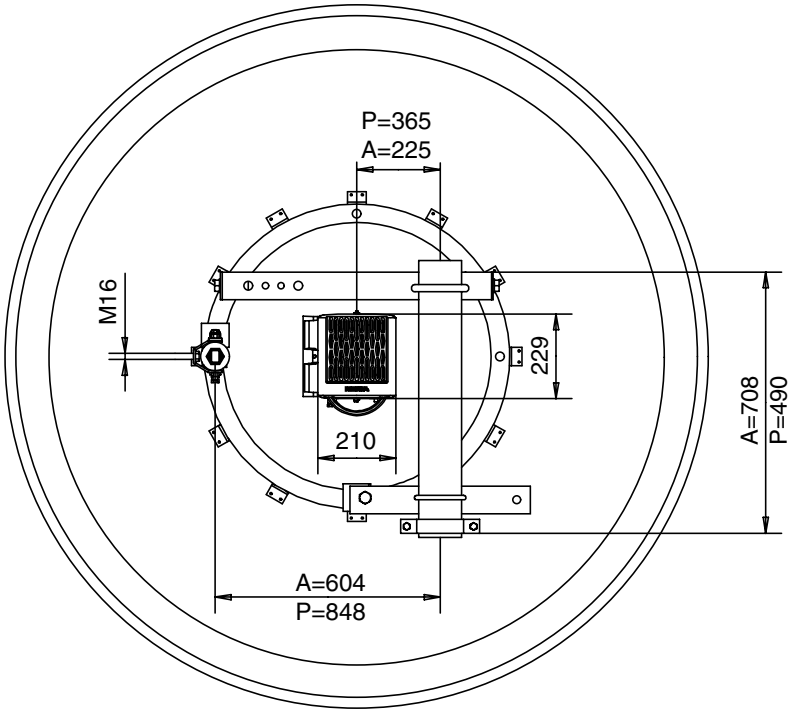


Figure 51. Outdoor unit with 120 cm antenna (dimensions in mm)



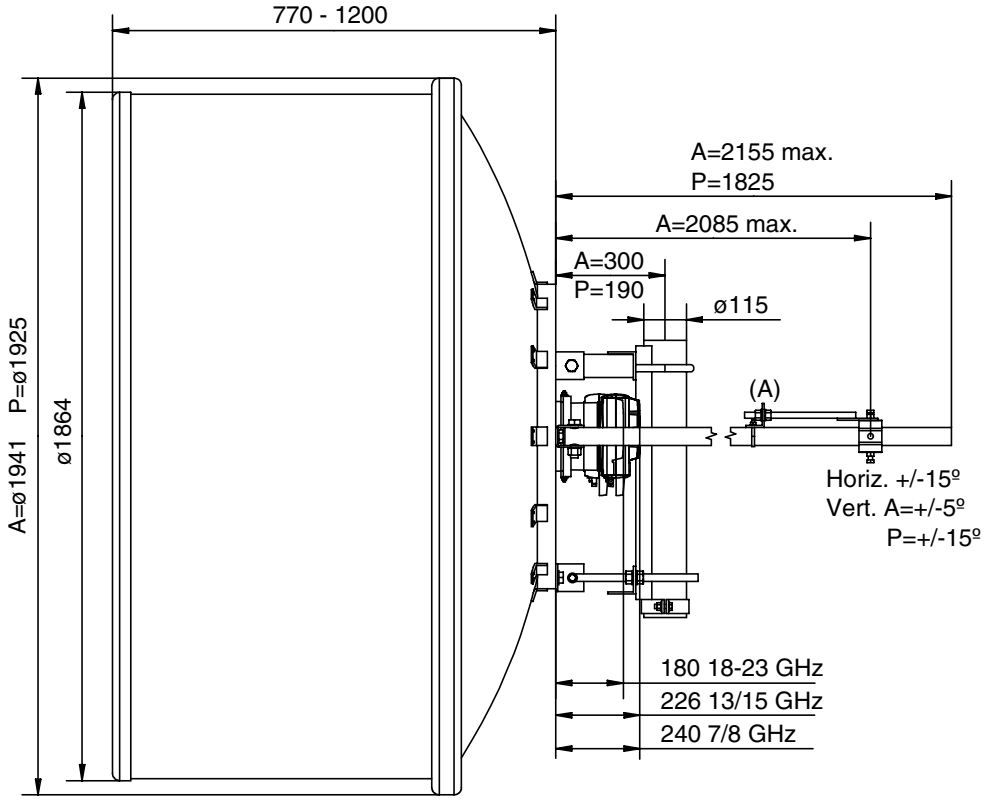


Figure 52. Outdoor unit with 180 cm antenna (dimensions in mm)

7.3.4 Wind load

Table 81. Wind forces and moments affecting the installation pole

Antenna diameter (cm)	**Wind velocity (m/s)**	**F_A (N)**	**F_S (N)**	**M_T (Nm)**
20 (with T55050.01)	55	170	90	46
	40	90	50	24
20 (with T55050.02)	55	170	90	25
	40	90	50	13
30 (with T55050.01)	55	335	150	90
	40	177	80	48
60 (with T55050.01)	55	935	446	252
	40	495	236	133
120	55	2820	1325	865
	40	1490	700	460
180	55	6350	3150	2205
	40	3360	1670	1170
240	55	11300	5590	4900
	40	5980	2960	2590
300	55	17700	8750	8630
	40	9365	4630	4565

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 Directional coupler for 1-antenna HSB

Table 82. Insertion losses of the directional coupler (see Figures 53 and 54)

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
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 83. 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

Table 83. Attenuation in a flexible waveguide (1 m) (Continued)

Frequency band	Attenuation max (dB)
23 GHz	1.4
26 GHz	1.6
38 GHz	2.2

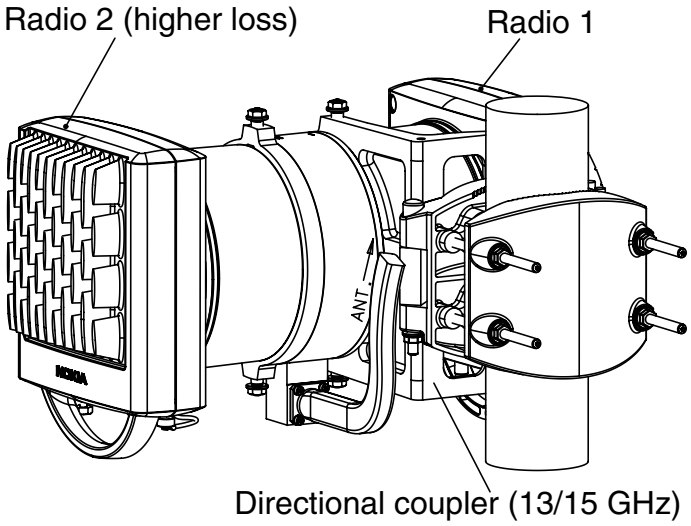


Figure 53. Nokia FlexiHopper 7, 8, 13, or 15 in 1-antenna HSB operation

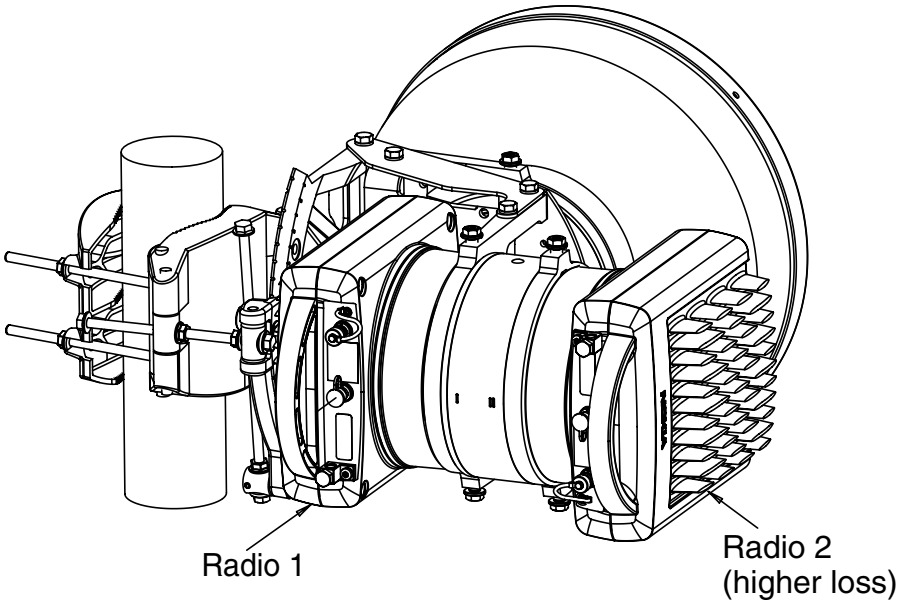


Figure 54. Nokia FlexiHopper 18, 23, or 26 in 1-antenna HSB operation

Table 84. 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 85. 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 digital 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 86. Recommended cable types for Flexbus

Cables / 50 Ω	**RG-223**	**RG-214**
Max. length (m)	140	300
Reel length (m)	500	500
Manufacturer	Amgab	Amgab
Type	90754A	90753A
Character	Halogen free	Halogen free
UL approval	UL	UL
Sales Item	T36626.01	T36629.01

Table 87. Recommended connector types for Flexbus

Connector TNC / Male	**Usability**	**Manufacturer**	**Type**	**Cable / 50 Ω**
Straight/ crimp	IU	Rosenberger	56S107-108N3	RG-223
Straight/ crimp	IU	Suhner	11TNC-50-3-115	RG-223
Angle/ crimp	IU	Rosenberger	56S207-308N4	RG-223
Angle/ crimp	IU	Suhner	16TNC-50-3-10	RG-223

Table 87. Recommended connector types for Flexbus (Continued)

Straight/ clamp	OU	Rosenberger	56S106-006N4	RG-223
Straight/ clamp	OU	Radiall	R143008	RG-223
Angle/ clamp	OU	Rosenberger	56S201-006N4	RG-223
Angle/ clamp	OU	Radiall	R143156	RG-223
Straight/ clamp	OU	Rosenberger	56S105-015N4	RG-214
Straight/ clamp	OU	Suhner	11-TNC-50-7-2	RG-214
Angle/ clamp	OU	Rosenberger	56C201-015N4	RG-214
Angle/ clamp	OU	Suhner	16-TNC-50-7-4	RG-214

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 88. 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

Table 88. FIU 19 main unit interfaces (Continued)

Main unit	
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

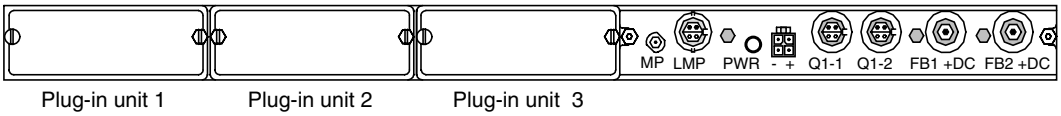


Figure 55. FIU 19 interfaces

Table 89. 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 90. 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 91. 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 92.

Note

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

Table 92. 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 93.

Note

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

Table 93. 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 Ω balanced**	2 - 16 x 2M	64 000 ± 100 ppm		Co-directional
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 94. 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 95. 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 96. 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 97. 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 97. 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

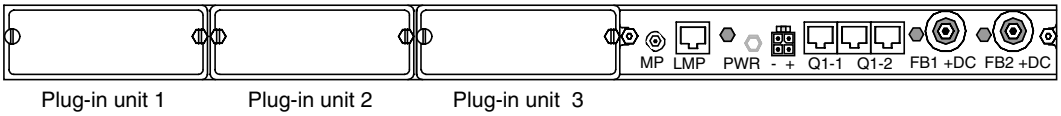


Figure 56. FIU 19E interfaces

Table 98. 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 99. 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 100. 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 101. 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 102. 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

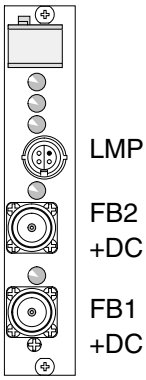


Figure 57. RRIC interfaces

7.8.2 Power supply, dimensions, installation options

Table 103. 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 104. 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 EDGE BTS, Nokia MetroHub, or Nokia UltraSite EDGE BTS

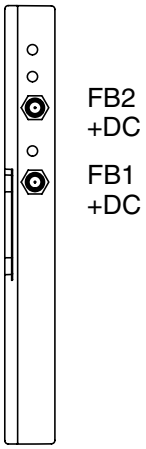


Figure 58. FXC RRI interfaces

7.9.2 Power supply, dimensions, installation options

Table 105. 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 EDGE BTS, Nokia MetroHub, or Nokia UltraSite EDGE BTS

7.10 IFUE interface unit

7.10.1 Interfaces

Table 106. IFUE interfaces

Flexbus interfaces (FB1-FB3) Capacity ATM capacity	TNC-connector 50 Ω (female) Up to 16x2 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

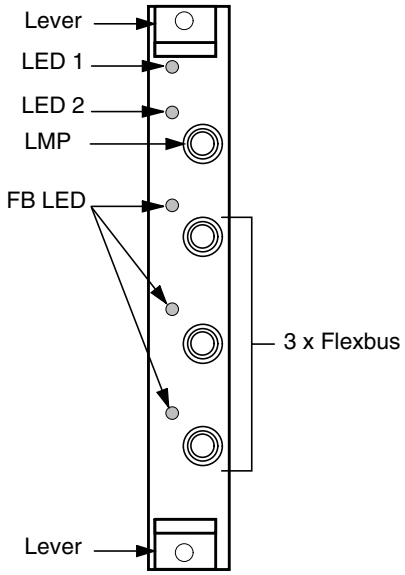


Figure 59. IFUE interfaces

7.10.2 Power supply and dimensions

Table 107. 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 108. Dimensions of IFUE

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

7.11 System requirements for Nokia Hopper Manager

Nokia Hopper Manager requires the following minimum system configuration:

Table 109. System requirements

Computer	Intel Pentium -based IBM-compatible PC
Operating system	Microsoft Windows 95/98/2000/XP Microsoft Windows NT 4.0 Workstation
System memory	16 MB for Windows 95 32 MB for Windows NT

Table 109. System requirements (Continued)

Hard disk space	32 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 110. 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 111. Frequency allocation (ITU-R)

Recommendation	Recommendation name
F.385-6	Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz frequency band
F.386-6	Radio-frequency channel arrangements for medium and high-capacity analogue or digital radio-relay systems operating in the 8 GHz frequency band
F.497-5	Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band
F.636-3	Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band
F.595-6	Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency 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 112. Radio transmission (ETSI)

Recommendation	Recommendation name
ETSI EN 301 216	Fixed Radio Systems; Point-to-point equipment; Plesiochronous Digital Hierarchy (PDH); Low and medium capacity and STM-0 digital radio systems operating in the frequency bands in the range 3 GHz to 11 GHz (7/8 GHz)
ETSI EN 301 128	Transmission and Multiplexing (TM); 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	Transmission and Multiplexing (TM); Parameters for radio systems for the transmission of digital signals operating at 23 GHz

Table 112. Radio transmission (ETSI) (Continued)

Recommendation	Recommendation name
ETSI EN 300 431	Transmission and Multiplexing (TM); Digital fixed point-to-point radio relay equipment operating in the frequency range 24,25 GHz to 29,50 GHz (26 GHz)
ETSI EN 300 197	Transmission and Multiplexing (TM); Parameters for radio systems for the transmission of digital signals operating at 32 GHz and 38 GHz (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 113. 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 weatherprotected locations.
ETS 300 019-1-4 Class 4.1	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Stationary use at non-weatherprotected locations.
ETS 300 019-1-4 Class 4.1E	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Stationary use at non-weatherprotected 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 interference characteristics of information technology equipment
EN 61000-4-2	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.

Table 113. Environment (Continued)

Recommendation	Recommendation name
EN 61000-4-3	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio frequency, electromagnetic field immunity test.
EN 61000-4-4	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.
EN 61000-4-5	Electromagnetic compatibility - Basic immunity standard - Surge immunity test
EN 61000-4-6	Electromagnetic compatibility - Basic immunity standard - Conducted disturbances induced by radio frequency fields
EN 301 489-1	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.
EN 60 950	Safety of information technology equipment

Table 114. IETF standards and RFCs

Standard number	Standard title
RFC 768	User Datagram Protocol (UDP)
RFC 791	Internetwork Protocol (IPv4)
RFC 792	Internetwork Control Message Protocol (ICMP)
RFC 793	Transmission Control Protocol (TCP)
RFC 826	Address Resolution Protocol
RFC 894	Standard for Transmission of IP Datagrams over Ethernet
RFC 950	Internet Standard Subnetting Procedure
RFC 1027	Using ARP to Implement Transparent Subnet Gateways

Table 114. IETF standards and RFCs (Continued)

RFC 1213	MIB-II; MIB for Network Management of TCP/IP-based internets
RFC 1519	Classless Interdomain Routing: An Address Assignment and Aggregation Strategy
RFC 1905	Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)
RFC 1906	Transport Mappings for Version 2 of the Simple Network Management Protocol (SNMPv2)
RFC 1907	Management Information Base for Version 2 of the Simple Network Management Protocol (SNMPv2)
RFC 2021	Remote Network Monitoring Management Information Base Version 2 (SMIv2)
RFC 2578	Structure of Management Information Version 2 (SMIv2)
RFC 2579	Textual Conventions for SMIv2
RFC 2580	Conformance Statements for SMIv2
RFC 2737	Entity-MIB
RFC 2863	The Interfaces Group of MIB-II