C33525.90--F0
Nokia MetroHub Transmission Node Rel. C2.1

Nokia MetroHub Product Description

Hereby, Nokia Corporation, declares that these Transmission Node units measured in either Nokia MetroHub, MetroSite BTS or Talk Family BTS are in compliance with the essential requirements of the Directive 1999/5/EC (R&TTE Directive) of the European Parliament and of the Council.

Complies with UL 1950, CSA 22.2 NO. 950 Information Technology Equipment. This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions. (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Contents

1 Statutory statements for ITN C2.1 transmission units

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2 Conventions used in Nokia MetroHub documentation

Warning and caution

Warning

Warnings alert the reader to dangers which may cause loss of life, physical injury, or ill health in any form.

Caution

Cautions are used to indicate possible damage to equipment, when no danger to personnel exists.

About screenshots

Note

Screenshots included in the documentation are representations only. The actual node manager program may vary slightly from the screenshots depicted.

Use of abbreviations

In this documentation set the plug-in units of Nokia MetroHub are referred to either with their full name or their abbreviation, which is also marked on the unit front. These abbreviations consist of four letters, the last one (x) indicating the version. For example: interface unit (DIUx), power interface panel (DIPx).

3 Products

3.1 Nokia MetroHub

Nokia MetroHub Transmission Node offers flexible network configuration capabilities and is an integral part of Nokia MetroSite Capacity Solution for mobile networks.

The capacity and quality requirements for telecommunications networks are increasing dramatically. Internet and commercial data applications require flawless communication connections as well as an ever-increasing amount of capacity. At the same time, the mobile phone is gradually becoming the preferred phone both at the office and at home.

To meet the expectations of their customers, network operators need modular solutions that allow them to expand the capacity of their networks flexibly and to maintain the quality of the connections at all times. Interruptions in the traffic and network downtime translate into huge revenue losses and also damage the network operators' reputation. Increased capacity and quality, on the other hand, allow operators to create more revenue-generating services and to attract more subscribers.

Nokia MetroSite Capacity Solution is a transmission solution for microcellular and macrocellular mobile networks that allows network operators to increase the capacity to match the demand. It provides a cost-effective means of fulfilling the quality and capacity expectations of network operators. Nokia MetroHub Transmission Node is an integral part of this solution.

In general, MetroHub can also be used as an all-in-one transmission node in any BSS (Base Station System) networks.

Cost-optimised and fast transmission capacity expansion

Network capacity can be expanded efficiently and smoothly with Nokia MetroHub. It provides cross-connection and media change functionality in an all-in-one package, including outdoor housing, redundant power supply and battery back-up. It also offers transmission protection with PDH loop configuration.

Importantly, Nokia MetroHub, Nokia MetroSite EDGE BTS and Nokia UltraSite EDGE BTS all use the FXC the transmission unit. Using the same transmission unit in a number of transmission solutions has a number of advantages:

- the same transmission functionality is available throughout the Abis part of the mobile network,
- the exceptionally compact size gives operators the ultimate freedom in terms of site selection (indoors and outdoors),
- significant savings in operations and maintenance costs,
- faster implementation (network roll-out).

The operator configures and manages the transmission network with a graphical user interface, Nokia MetroHub element manager. The manager makes remote operations possible, thus allowing the operator to control the network from the Nokia Network Management System (NMS) environment. With this solution, the operator can manage the network topology freely and make later configuration changes with minimum costs.

With Nokia MetroHub, network capacity can be expanded fast and smoothly and the quality improved, all with minimised implementation and operation costs. Transmission network planning thus becomes transmission capacity planning.

Typically Nokia MetroHub connects microcellular and macrocellular elements in the Abis part of mobile network.

Nokia MetroHub can be installed quickly at new locations, both indoors and outdoors. Due to its small size and unobtrusive appearance, Nokia MetroHub blends into the city environment.

Figure 1. Nokia MetroHub on a site

Unique transmission platform

Nokia MetroHub provides a unique transmission platform for various transmission equipment, such as Nokia FlexiHopper, Nokia FlexiHopper Plus, and Nokia MetroHopper radios. With Nokia MetroHub, a network can be rolled out in a fraction of the time previously needed. Thus, it is possible to start creating revenue faster. Nokia MetroHub is unique because it allows the operator 'to install' the cross-connection and media change functionality where it is needed. This maximises the trunking efficiency with less equipment. Because Nokia MetroHub is so flexible, and can be part of any number of network configurations, site maintenance is easy. As a direct consequence of this network reliability and availability are increased.

Quality through traffic protection

Nokia MetroHub provides the network with fast and automatic traffic protection with PDH loop topology. It offers cost-effective protection for radio and wireline connections. Nokia MetroHub is designed for Abis applications, and traffic protection switching takes place within a fraction of a second, which allows phone conversations to stay alive during switching. Loop topology allows you to maximise transmission network availability and also to secure the transmission capability. This can, for instance, be helpful when using radios in rainy weather. Nokia MetroHub also provides power section redundancy and battery back-up functionality as options for added security.

3.2 Nokia Network Management System

Remote control, alarm and performance data collection of Nokia MetroHub is done using Nokia NMS Network Management System.

Nokia NMS incorporates a full range of functions from fault, performance, and configuration management to transmission, trouble, and security management.

Nokia MetroHub manager is delivered with the SiteWizard CD package, which is NMS compatible. MetroHub can be remotely controlled from NMS site or also via X-terminal session.

For more detailed information, please refer to NMS documentation, for example, Nokia NetAct documentation.

3.3 Nokia MetroHub Manager

3.3.1 Nokia MetroHub Manager

Nokia MetroHub Manager is a PC-based software application used for controlling and monitoring Nokia MetroHub. It belongs to the Nokia node manager product range and is specially designed to manage the cross-connections of the whole node in an easy way. Local management access is possible without disturbing Nokia NMS, nor is any special arrangement needed. The Nokia MetroHub Manager software is available in the *Nokia SiteWizard* CD-ROM package.

The manager has an easy-to-use graphical user interface with a commissioning wizard that guides the user through commissioning tasks.

Nokia MetroHub Manager is used when:

- commissioning the node, the units inside the node or the radio outdoor units if installed,
- providing a local or, through Nokia Q1 NMS, a remote management connection to Nokia MetroHub equipment,
- creating, editing and deleting cross-connections,
- monitoring the alarm status of the node and units,
- viewing and changing the settings of the units,
- downloading and activating software in the units,
- viewing on-line help.

Nokia MetroHub Manager connects to Nokia MetroHub through the local management port of the node or accesses the node remotely through an embedded Nokia Q1 bus. Nokia MetroHub is a Nokia Q1-managed piece of equipment. Nokia MetroHub Manager is very flexible in that it can be used both online and offline. Working offline, an engineer can create the node settings while at the office, store them in a file and download to the node once on-site. When the node is managed online, the settings are read, modified and stored in real time.

3.3.2 Menu overview

All *MetroHub Manager* functions can be accessed through the application menus. The main functions under the menus are briefly described in the figure below.

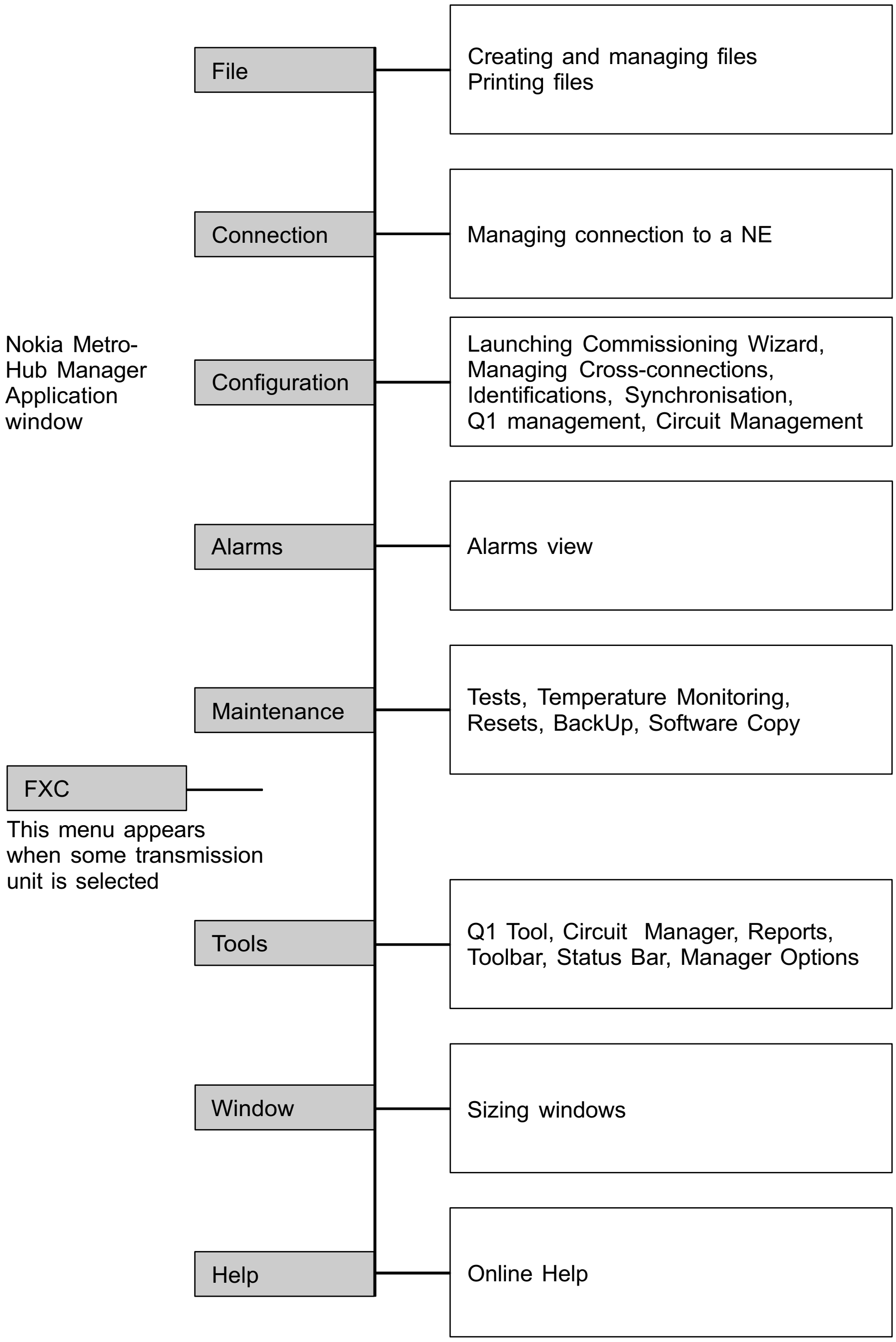


Figure 2. Overview of Nokia MetroHub Manager menus

4 Features

4.1 Capacity expansion

In addition to being a transmission node, Nokia MetroHub serves as a flexible transmission capacity reserve in the network, enabling rapid revenue growth by easy and flexible capacity increase with minimised implementation time and cost.

The growing amount of traffic in the network requires flexible transmission capacity expansion. This is accomplished by adding transmission units into the Nokia MetroHub cabinet when needed. With these units, Nokia MetroHub can be connected, for example, to ten Nokia FlexiHopper radio outdoor units, with up to 16 x 2 Mbit/s capacity each, or to ten Nokia MetroHopper radio outdoor units, with 4 x 2 Mbit/s capacity, via a single cable. The maximum interface capacity is 160 x 2 Mbit/s. It is also possible to connect Nokia MetroHub to other equipment via twenty E1 or T1 connections. Furthermore, several Nokia MetroHub Transmission Nodes can be chained using single coaxial cable.

4.2 Site deployment

Compact design

Nokia MetroHub is a stand-alone transmission node in a single housing into which Nokia transmission units and power protection can be installed.

New site locations

Unlike many other transmission nodes, Nokia MetroHub can be installed outdoors as well as indoors. The only requirement for the installation is that electricity is available. MetroHub can be installed either vertically or horizontally. Nokia MetroHub is designed to be easy to install on a wall or a pole, making new site locations possible, such as bus stops, promotional signs, lamp posts, etc. Due to the compact design and the fact that it can be painted, MetroHub blends well into the city environment. Site hunting and acquisition are thus made easier.

Straightforward site deployment

Due to the compact and integrated design of Nokia MetroHub, the overall implementation time and cost of the microcellular network is minimised.

Highly integrated system elements provide straightforward site deployment. Total site cost is minimised by reduced planning and site acquisition cost, reduced implementation and integration costs, as well as minimised operation and maintenance costs. Site rental cost are minimised and high trunking efficiency keeps transmission costs in check.

Integrated transmission units

Nokia MetroHub fully integrates a digital cross-connect with electrical interfaces. These interfaces provide connections to Nokia radios and E1/T1 lines.

Nokia MetroHub can be connected to and power up to ten Nokia MetroHopper and Nokia FlexiHopper radios via a single coaxial cable, Flexbus, between Nokia MetroHub and each radio outdoor unit. One transmission unit acting as a radio indoor unit supports two radio units.

In addition to the benefits of integration, the new innovative product concept provides a compact solution for the evolving needs of radio access: one unit supports all capacities, one platform supports all frequencies, radio and cross-connect are integrated, and interconnections are via the Flexbus.

Flexbus − single cable interconnections

Flexbus gives high flexibility to PDH networks without any external multiplexers. Flexbus carries payload, Q1 and internal radio communication signals, and all on-site cabling is made within cross-connections.

The bidirectional Flexbus cable connects all system elements together. Flexbus carries 2 - 16 x 2 Mbit/s signals and control data between elements, from a radio indoor unit to an outdoor unit, as well as to another radio indoor unit. It also takes care of the outdoor unit power feed.

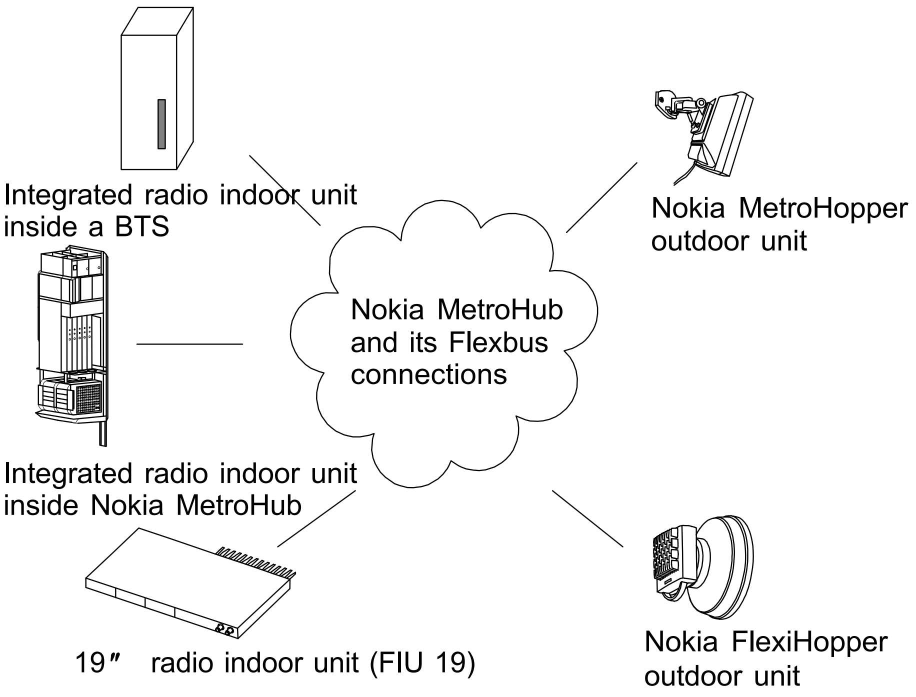


Figure 3. Nokia MetroHub and its Flexbus connections

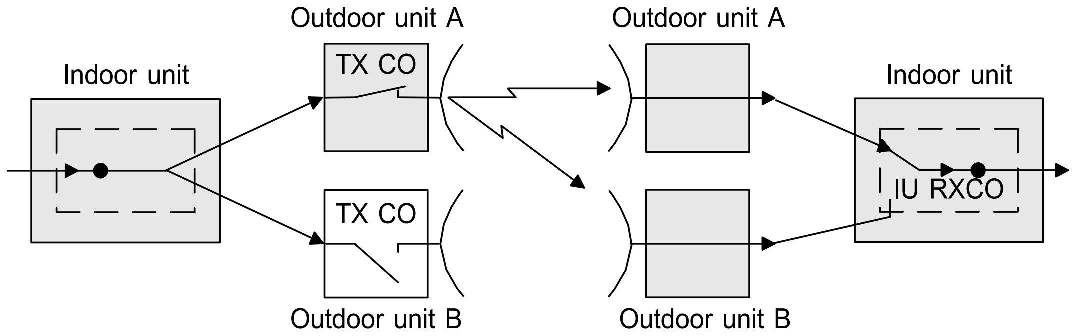
4.3 Traffic protection

4.3.1 Hot standby

Hot standby (HSB) is a method of equipment redundancy in which two radio transmitters are kept ready (switched on), so that if one fails, the other one immediately picks up where the first one left off.

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

The supported HSB setup of one FXC RRI indoor unit with two Nokia FlexiHopper outdoor units is shown in the following figure. Active units are shown in grey and passive units in white.



IU RXCO Indoor unit hitless changeover switch (In ASIC)

TX CO Transmitter changeover switch (transmitter mute control)

Figure 4. Nokia FlexiHoppers with FXC RRI, 1IU/2OU HSB (only one direction shown)

In hot standby mode, the transceivers of both radios are on but the transmitter of the protecting radio is in mute state. The changeover criteria are divided in two cases: (OU) receiver changeover and (OU) transmitter changeover. These two are independent of each other.

Outdoor unit transmitter changeover switches (TX CO) are controlled by the processor of the indoor unit. The 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.

Possible transmitter faults are:

- Flexbus cable disconnected or broken
- Flexbus power OFF
- Flexbus "in use" setting is turned to OFF
- Flexbus loop to interface or loop to equipment is set active

- Outdoor unit is not capable of transmitting for one or more of the following reasons:
  - Tx lock lost in Flexbus cable interface
  - MWU lock lost
  - Tx power setting off
  - Tx frequency not set
- Both far-end outdoor units have lost the lock to Rx-signal (R-bit is sent from far-end)

Note

Tx changeovers are disabled and the traffic is cut during protected hop fading margin measurement. For more information, see *Fading margin measurement*.

The FXC RRI unit also supports Lazy (OU) transmitter changeover, in addition to the instant (OU) transmitter changeover described above, see *Lazy transmitter changeover*.

Indoor unit Rx changeover switch (IU RXCO) is located in ASIC, and it is hardware controlled. The changeover is based on detected FEC (forward error correction) errors. The Rx changeover is also possible by the control of the indoor unit's processor. In receiver changeover, depending on the received radio signal quality and available receivers, the system tries to minimise the errors in received data by selecting the outdoor unit with the lower bit error rate. When the active receiver gets a serious fault, the receiver changeover is made. During the changeover, bit errors occur and synchronisation is momentarily lost.

Possible serious receiver faults are:

- Flexbus cable disconnected or broken
- Flexbus power OFF
- Flexbus "in use" setting is turned to OFF
- Flexbus loop to interface or loop to equipment is set active
- Flexbus Rx-signal frame lock lost
- Outdoor Unit Rx signal lock lost

After the changeover, the system activates the alarm *128 Fault in equipment* including information about which unit is faulty. Other alarms of the faulty unit show the actual reason for the fault. After the fault has been corrected (for example, the unit has been replaced and commissioned) the system activates HSB protection method and clears the alarms.

If the passive transmitter gets faulty, the system activates the *128 Fault in equipment* alarm and Tx changeover is not possible before the fault is fixed.

Note

When an outdoor unit of an HSB protected hop is replaced, the outdoor unit settings of the new outdoor unit should be checked (may be in the default state) with the node manager. The TX-frequency and interleaving settings must be the same in both outdoor units of the HSB protected hop. If the settings are different, the *143 Fault in change over function* alarm is activated. In that case the changeover is still possible, but after the TX-changeover the frequency may be illegal.

Note

Connecting a Flexbus cable to a passive outdoor unit of an operative protected HSB hop may cause a few bit errors to the transmitter and receiver of the active outdoor unit.

4.3.2 Transmission network protection using loop topology

Introduction

Nokia Loop Protection is considered the most efficient way to protect traffic in a transmission network such as a GSM base station subsystem. In a live telecommunications network it is important to secure, in addition to the actual payload traffic, the network synchronisation and the centralised network management during any period of abnormal circumstances.

For these reasons, Nokia Loop Protection protects

- payload traffic
- network synchronisation
- network management connections.

A transmission loop formed with Nokia elements consists of one loop master and several loop slaves. Usually the loop master is a transmission node whereas the loop slaves can be either transmission nodes, BTSs or a combination of both inside one loop.

The loop principle is that the transmitted signal is always sent in both directions but the received signal must be chosen from only one direction. The loop master sends pilot bits on the basis of which the switching decision is made. Each individually protected slave station needs one pilot bit.

Network synchronisation must also be ensured in a loop network and it follows the loop principle in a similar way. The synchronisation switching takes place independently from the pilot bits by having a master clock bit (MCB) and a loop control bit (LCB).

Each network element decides individually from which direction the signal and the synchronisation will be received, and so it does not require any external or additional supervision for its decision.

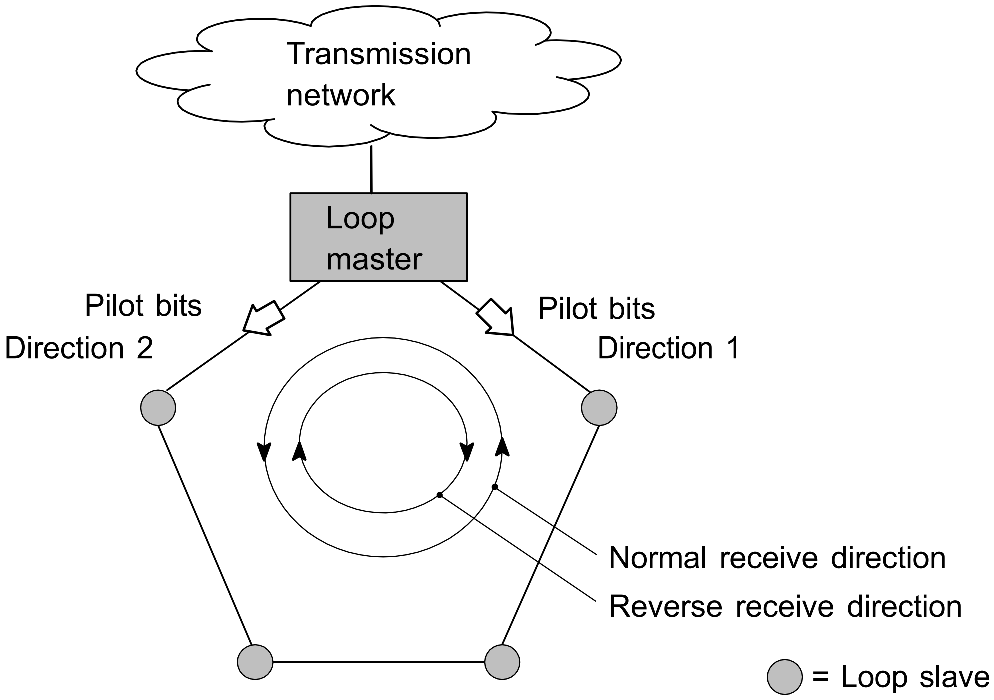


Figure 5. Loop principle

Nokia's way of implementing loop protection is ultimately secure, providing very fast route switching that recovers the transmission connections instantly. Nokia loop protection is embedded and thus very fast. Nokia loop protection protects against failures, such as cable-cut, equipment failure, heavy rain and multipath fading, and against obstacles in the line-of-sight, such as cranes and growing trees.

Compared to an unprotected wireless network, Nokia loop protection increases site availability at least tenfold and prevents end-of-chain availability degradation. Further, it enables significant hop length increases without site availability sacrifices and helps minimise radio link antenna sizes.

Nokia loop protection is an easily activated system feature where Nokia MetroHub and UltraSite BTS can act as a master node. In addition, several Nokia MetroHub nodes, UltraSite base stations, and MetroSite base stations can be looped together.

The protection functionality is compatible with the existing Nokia BSS transmission.

For more information refer to *Nokia PDH Loop Protection in GSM Networks* that can be obtained upon request.

Protecting payload traffic

A pilot bit is a special bit with a preset value (zero), sent among the protected traffic in a known position.

For example, protecting a 2 Mbit/s link requires one bit out of the 2 Mbit/s stream to be reserved for this purpose. Similarly, if the traffic is protected at a partial 2 Mbit/s level, for example, because two different base transceiver stations share one 2 Mbit/s line, one pilot bit is required for each slave station.

The location of the pilot bit is defined in the network plan, and it is often within one of the last time slots of the 2 Mbit/s frame. In principle, the location can be selected freely, but a harmonised practise in the network may be advisable for easy site commissioning and network documentation.

The state of a pilot bit is set to 0 (zero) at the sending station, which sends identical digital streams (payload and the pilot bit protecting it) in directions 1 and 2 in the loop.

Any failure in the connection between the sending station and the intended destination causes the pilot bit to change from zero to one (based on AIS). The target station, receiving a "one" instead of a "zero" then knows that the connection is faulty.

The following figure shows the loop principle between the loop master and one slave. The traffic in the other slave stations is bypassed.

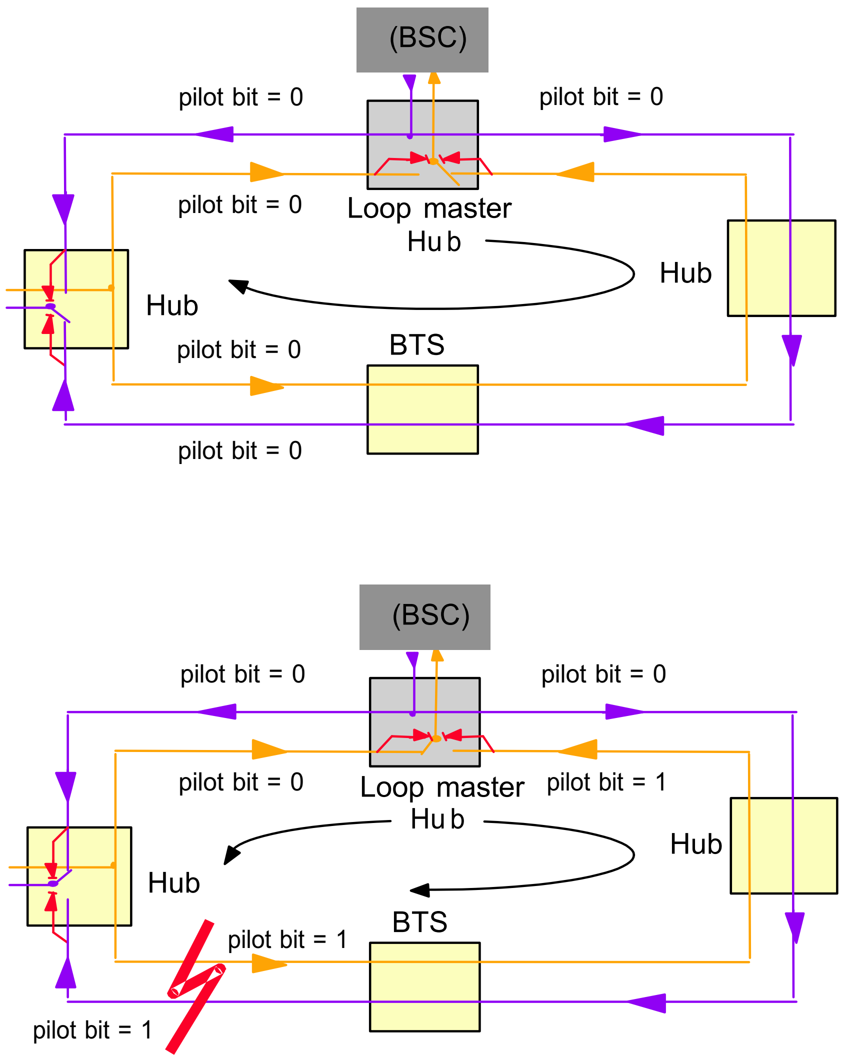


Figure 6. Traffic protection guided by pilot bit monitoring

The pilot bit is sent at the loop master MetroHub site for all the slave stations as zero with "Uni-directional fixed data" or "Bi-directional Masked" types of cross-connections. By using "Bi-directional Masked" you can reduce the amount of connections from two uni-directional to one bi-directional.

Masking pilot bits

The principle of masking in the loop network is to use the logical "AND" operation with "0", when the result is always "0", and masking with "1" when the output is the same as the input signal (either unchanged "0" or "1").

In the example in the following figure, pilot bits are sent to four slave nodes in the loop. The view is from a cross-connection termination point setting.

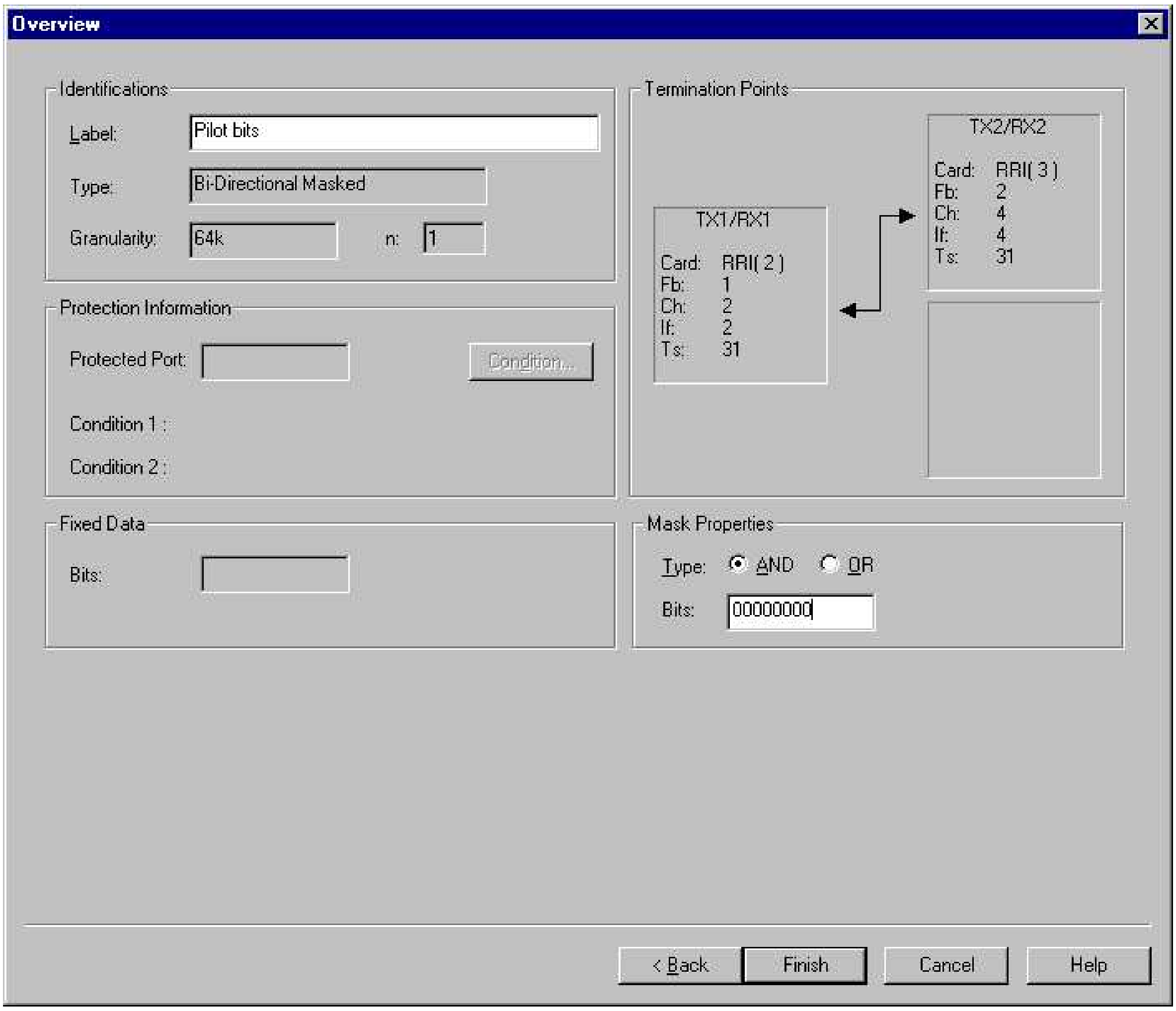


Figure 7. Pilot bit sent from a loop master

In loop slave sites, each node must forward the pilot bits from other slave stations unchanged and send its own pilot bit as zero in both loop directions. This is done with "Bi-directional Masked" type of cross-connection. The following figure presents the pilot bit masking of the second slave node (bit 2) and other pilot bits forwarding in the loop. The view is from a cross-connection termination point setting.

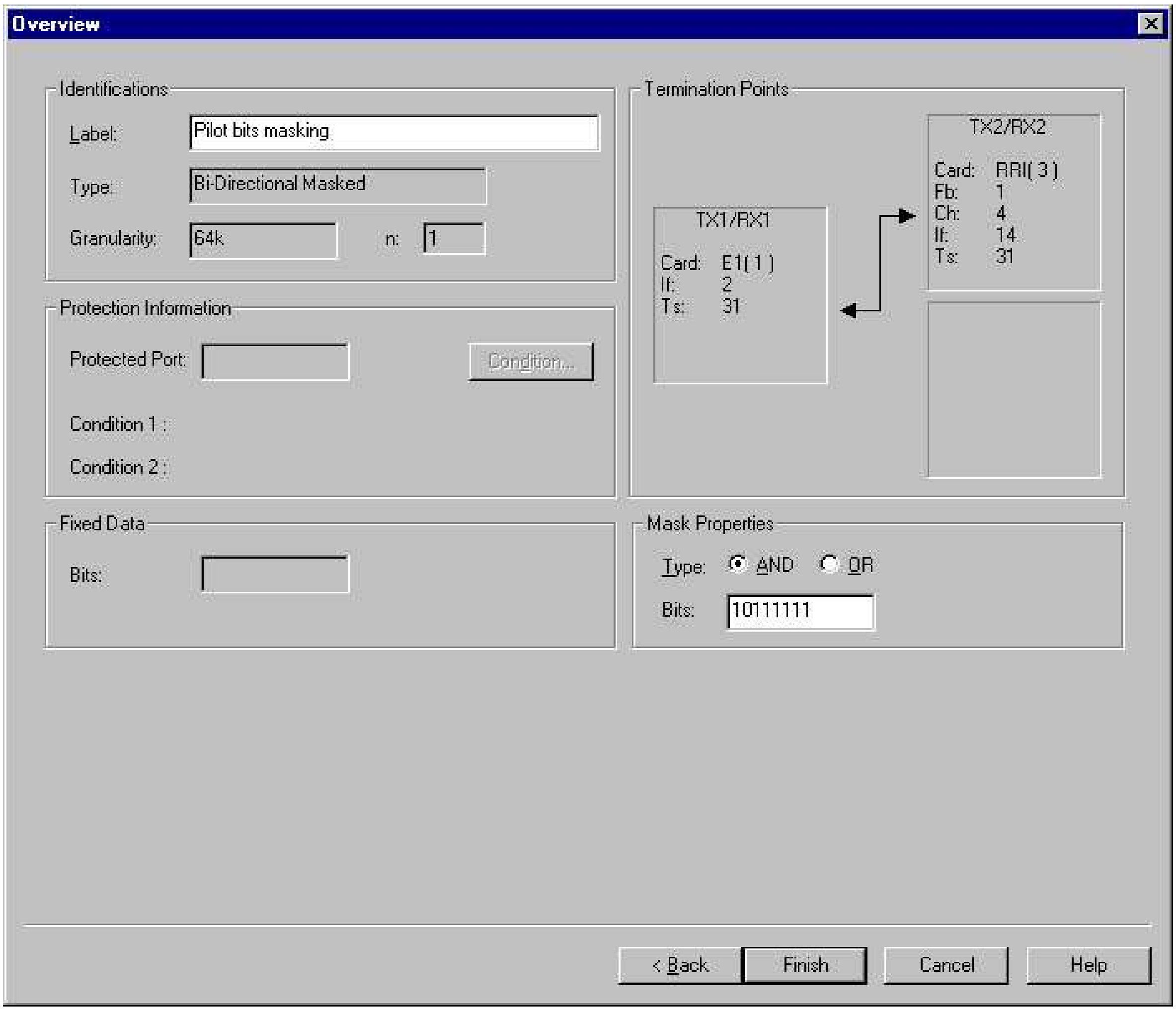


Figure 8. Pilot bit masking in the second loop slave

Nokia Loop Protection can be configured either as *equal switching* or *priority switching*. The difference between these is that in the priority switching the connection returns to the initial route as soon as the problem on that link is solved, whereas with the equal switching the system stays on the chosen link until it gets faulty. The equal switching provides better stability for the connection, and it is therefore the recommended choice for a BSS network.

Protecting network synchronisation

The implementation mechanism for an automatic detection and recovery of missing or looped network synchronisation is based on loop network clock control bits carried within the protected 2 Mbit/s stream:

- one bit for detecting if the incoming signal is synchronised by the original network synchronisation master or not (master clock bit, MCB), and
- one bit for detecting any breaks or loopbacks in the synchronisation chain (Loop Control Bit, LCB).

The loop master sets the MCB and LCB to "0" (zero) state in both directions. Any station using a certain received signal for synchronisation sends the LCB back as "1" (see the following figure), and so the counterpart knows that the synchronisation of the incoming stream is inherited in such a way that it must not be used for synchronisation to avoid a loopback or otherwise faulty synchronisation. The same applies to all slaves to make sure the synchronisation remains intact.

Similarly, faulty transmission replaces MCB and LCB with "1" and affected stations know they are not receiving a valid source signal from that direction.

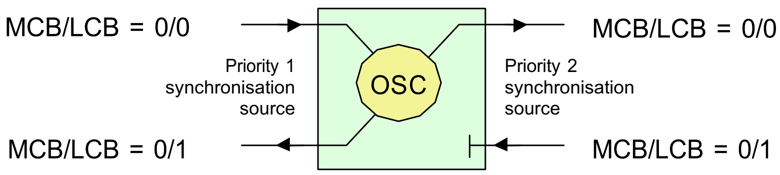


Figure 9. Manipulating synchronisation loop control bit

In the loop master MetroHub, the MCB/LCB can be sent as zero in both directions of the loop with "Uni-directional fixed data" or "Bi-directional Masked" types of cross-connections, but it is recommended to use Configuration → Synchronisation → Loop Bits setting to define the MCB/LCB bit positions. For further information on the setting, see *Adjusting synchronisation loop bit settings.*

Node master-slave detection

MetroHub will recognise that it is defined as the master of the loop based on the following information. A synchronisation priority list is always defined first, then the MCB and LCB. The system recognises if the MCB and LCB are in the Synchronisation list and that makes MetroHub a slave. If the MCB and LCB bits are not in the list, the node is a master. This detection is automatic. There are a couple of network cases which require the use of real MCB/LCB settings, so this is a better practice for common use.

These cases are, for example:

- Q1 loop termination is done based on the incoming LCB bit status. If the loop master node does not have the definition, the Q1 loop protection is not working.
- MetroHub is acting as the master of one loop and the slave of another. The equipment uses loop synchronisation MCB/LCB definition, MCB = incoming MCB bit and LCB = 0 (except towards the interface where the clock is coming, where LCB = 1).
- MCB status is forwarded as received from an upper network element (loop master using chain synchronisation with MCB definition, MCB = incoming MCB bit and LCB = 0).
- Node master running ON internal clock which is not in priority l level (MCB/LCB = 1/0)

The following figure presents the setting of MCB/LCB bits in two directions in different FXC RRI units.

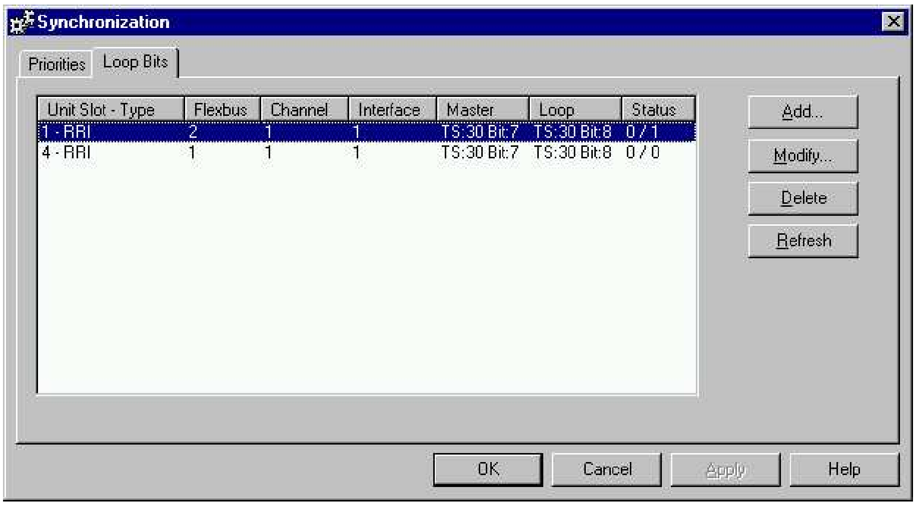


Figure 10. Setting of loop control bits

Note that node synchronisation is always based on priority and will thus return to a higher priority route whenever the problem on that link is solved, of course after certain hysteresis. This does not cause any problem to traffic because the synchronisation is coming from the same loop master.

The location of the MCB and LCB is defined in the network plan. In principle, the location can be selected freely, but a harmonised practise in the network may be advisable for easy site commissioning and network documentation.

Protecting remote network management channel

The Q1 network management channel used to manage Nokia PDH transmission elements is a bus, and therefore must not get looped.

Q1 loop protection is based on switching into a faultless direction when there is a breakage somewhere in transmission. The direction is changed according to an LCB bit (loop control bit which also controls the synchronisation in a loop network).

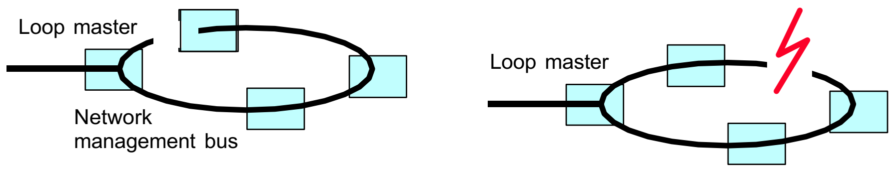


Figure 11. Network management bus circulation prevention

To avoid ringing and simultaneous polling from two directions, the Q1 loop must be terminated at the master node.

To terminate the loop at the master node:

- LCB (from the last slave node) = 0 → no faults in the network → forced termination towards the last slave node (see above figure).
- LCB (from the last slave node) = 1 → fault in the network → forced termination removed

This termination is used when the loop master is a Nokia MetroHub node, UltraSite BTS node, or Nokia DN2. The loop master is configured so that it sends network management channel in just one direction. When a fault occurs in that direction (the loop master detects that from the received LCB), it knows to allow the network management channel propagate in both directions. The Q1 EOC hybrid switch must be set to "OFF" state towards the "Secondary Port" direction in the loop master. In this case, no additional settings to normal Q1 EOC channel are needed in the slave nodes. This is the recommended way to implement Q1 network management bus protection with Nokia PDH loop protection.

In some cases, when the loop master is an older Nokia BTS integrated transmission unit (TRUx or BIUMD), Q1 protection must be done in the first loop slave on the secondary port side of the loop master. In this case, both the Q1 primary port and the secondary port must be defined for the loop slave. Nokia MetroHub, UltraSite BTS, and MetroSite BTS support Q1 slave protection.

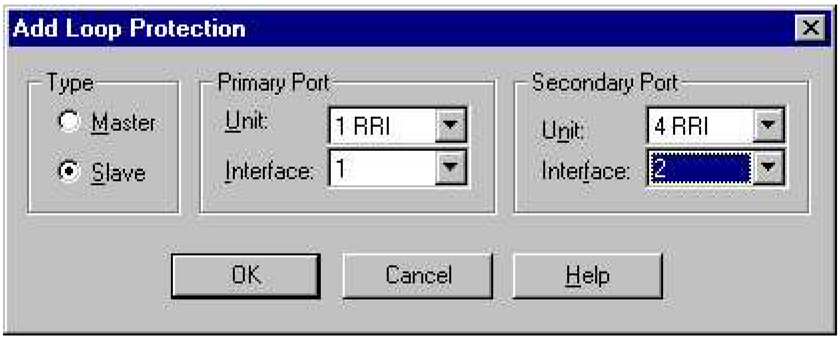


Figure 12. Setting of Q1 protection in the slave (in case of slave protection)

Note

Both the EOC and the MCB/LCB in the secondary port side must be defined in the same 2M interface in order for the Q1 loop protection to work.

Hints for using a loop network

- It is recommended that you use different FXC units for the Protected and Protecting ports of a connection to gain the maximum protection in the hardware reliability sense.
- When 16 x 2 Mbit/s capacity loops are built, each of the three loop directions requires a separate FXC RRI unit.

4.3.3 Nokia MetroHub power protection

Due to the integration of the modules, the reliability of Nokia MetroHub is increased significantly compared to non-integrated solutions.

However, node power protection is recommended for nodes with high amount of traffic through them, such as loop master nodes.

The centralised power supply of Nokia MetroHub can be protected with an optional redundant power supply. The redundant power supply has all the functions of the main power supply. Further, one can protect against AC failure with an optional battery unit where the power supply switches automatically from AC to DC input from the battery unit in case of AC failure. This switching does not cause traffic interruption or disturbance of performance.

The optional battery unit is equipped with smart battery supervision, giving protection for the node and the radios for a reasonably long time. Nokia MetroHub uses high-performance batteries to ensure reliable performance in both tropical and arctic environments.

In case the capacity of the internal battery unit is not sufficient, there is an optional high-capacity battery backup unit available. This Nokia MetroSite Battery Backup roughly doubles the MetroHub battery backup capacity and therefore offers longer backup times. For details, refer to *Nokia MetroSite Battery Backup Product Overview.*

4.3.4 Fading margin measurement

Nokia FlexiHopper can execute an automatic fading margin measurement (FMM) during radio relay commissioning. The measured fading margin can be used to verify the quality of radio link network planning. In addition, it can be used for defining a sensible ALCQ Rx-level set-point. The measurement is carried out without the aid of any additional tools or measurement equipment. The automatic fading margin measurement is based on four different measurements: The BER 10-3 threshold signal levels at each capacity and receiver's (capacity dependent) noise floor are measured in Nokia production for each radio. Moreover, the noise floor together with received interference signal level and the normal (maximum) received power level are measured with commissioned radio relay in real environment. Consequently, it is straightforward to calculate the fading margin from these measurement results. More detailed information about fading margin can be found from the *ALCQ and Automatic Fading Margin Measurement in FlexiHopper Microwave Radio Application Note* that can be obtained upon request.

Generally, the fading margin is defined here as a difference between the normal received signal level and the required signal level for 10-3 BER in the actual operation conditions over the commissioned radio hop.

4.3.5 Lazy transmitter changeover

Lazy transmitter changeover is a protection method against transmitter faults that cannot be detected by the equipment itself, for example, a faulty antenna. The FXC RRI unit sends periodical notifications to the far-end about the radio signal quality. Lazy transmitter changeover is performed, if there are errors in the transmitted data over a specified interval (see lazy changeover timing below) that are caused by the near-end transmitter.

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 the *128 Fault in equipment 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.

4.3.5.1 Lazy changeover timing

ITN C2.1 release supports Quality Class 1 Lazy changeover function, which provides the best possible protection against undetectable transmitter faults. It makes the first Tx changeover soon after constant BER is detected in the far-end. Also if far-end BER exceeds 1E-3, the Tx-changeover is done immediately.

The BER value presented in the table below is based on the far-end BER, which is the result of radio's internal process and cannot be measured. The BER value is calculated from the better receiver.

Table 1. Primary and secondary periods of Quality Class 1

Class 1	h:min:s	
BER	Primary period	Secondary period
1E-9	24 days 20:31:24	24 days 20:31:24
1E-8	10:00:00	18:00:00

Table 1. Primary and secondary periods of Quality Class 1 (cont.)

1E-7	0:30:0	3:00:00
1E-6	0:03:00	0:30:00
1E-5	0:00:30	0:10:00
1E-4	0:00:10	0:05:00
1E-3	0:00:05	0:02:00

4.3.5.2 Lazy transmitter changeover examples

Example 1

If the BER value stays over the BER level for the time period specified in the quality class for that BER level, a Tx changeover is made.

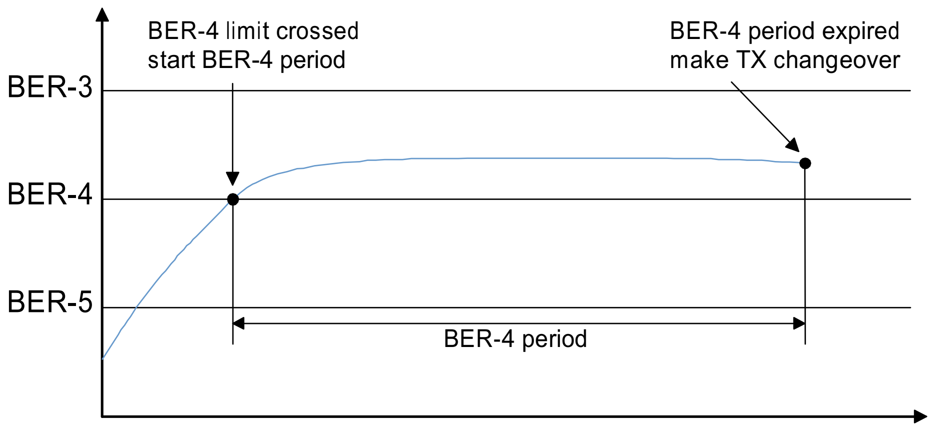


Figure 13. BER stays over the threshold for the primary period

Example 2

If the BER value drops to the previous level, the period timer is continued at the time spent since the level was crossed for the first time.

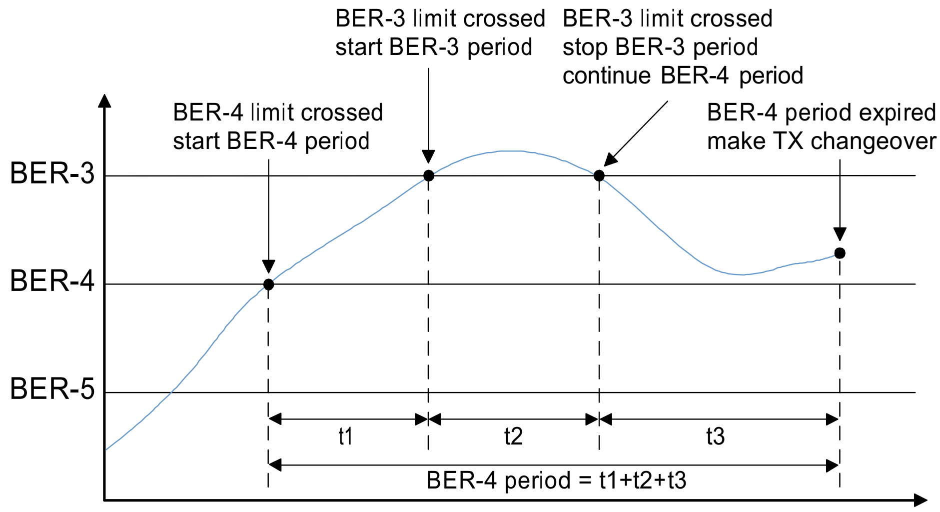


Figure 14. BER drops to the previous level and stays over threshold for the primary period

Example 3

If the BER value drops to the previous level and after that crosses over to the upper level again, the period timer is restarted from zero.

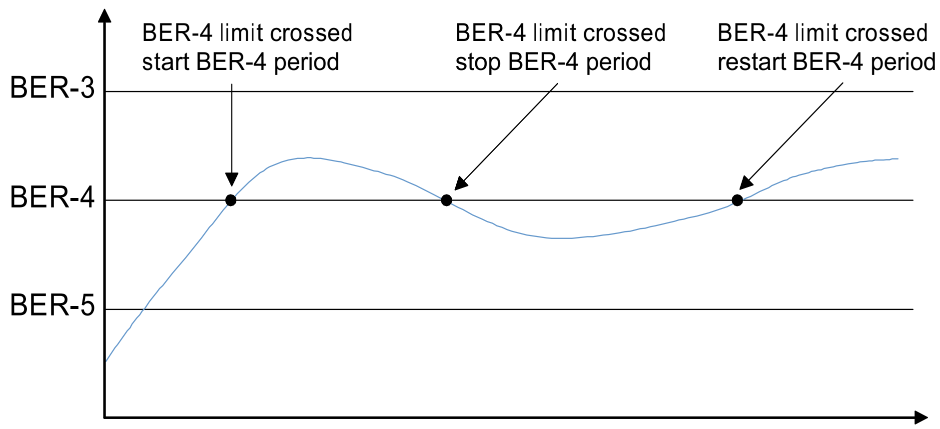


Figure 15. BER drops temporarily under the threshold and the primary period is restared

Example 4

When BER value crosses over to the upper level, but the time period left from the lower BER level is shorter than the new period, the old period is continued.

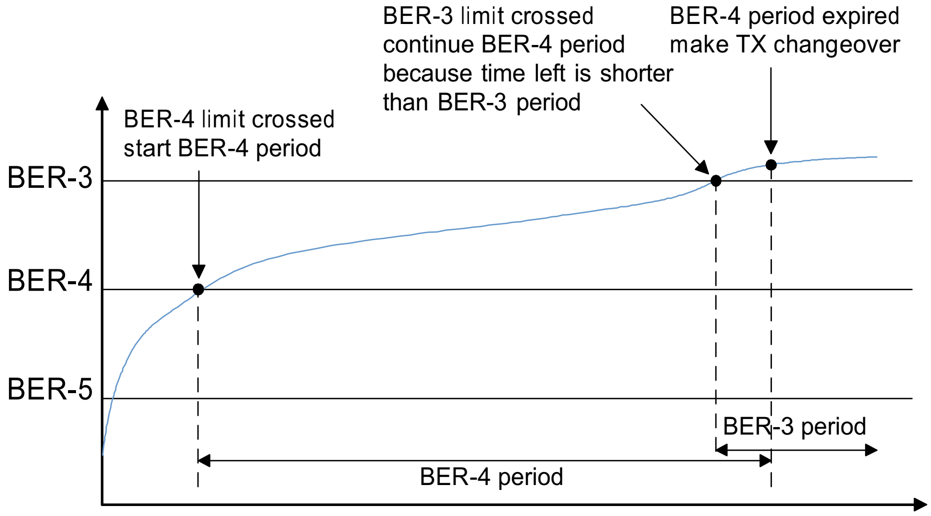


Figure 16. Lower BER primary period is continued

Example 5

If BER is over the threshold after the first changeover, then the secondary period is used for the next changeover.

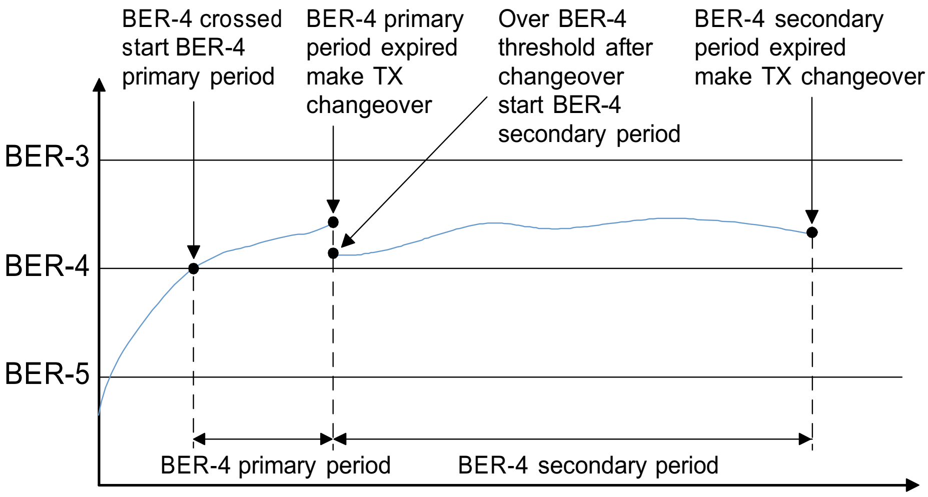


Figure 17. After the first changeover the secondary period is used

5 Applications

5.1 Integration into Nokia MetroSite EDGE Capacity Solution

Nokia MetroHub is an essential element of Nokia MetroSite EDGE Capacity Solution for mobile networks. It connects the microcellular elements to each other and to the core mobile network. In combination with Nokia FlexiHopper, Nokia FlexiHopper Plus and Nokia MetroHopper, wireline E1/T1 interfaces and Nokia MetroSite Base Station (BTS), Nokia MetroHub provides a unique solution for building mobile transmission networks.

Nokia MetroHub together with microwave radios forms a stand-alone hub site or it can be located at some microcellular Nokia MetroSite Base Station site, for example, close to the BTS on a roof top, or at a macrocell base station site. Base station connections and the last-kilometer access can be implemented with wireless or wireline connections or both.

Nokia MetroHub can be installed as an interface between macrocellular and microcellular networks when an operator starts building capacity with microcells. Using Nokia MetroHub as the interface, the microcellular network can be implemented faster, less equipment is needed, the trunking efficiency is improved and the quality of the transmissions can be enhanced.

In addition to these features, transmission operating expenditures are decreased due to smaller site costs, including rent and less expensive outdoor installation.

5.2 Typical applications

Nokia MetroHub provides an optimal integrated mobile transmission solution for base station subsystem networks. It supports various transmission network topologies and media change by providing different combinations of E1/T1 and Nokia Flexbus radio interfaces. Nokia MetroHub is optimised for but not limited to usage in mobile networks. This chapter describes the most common of these applications on both network and site level.

Typical applications where Nokia MetroHub can be used are:

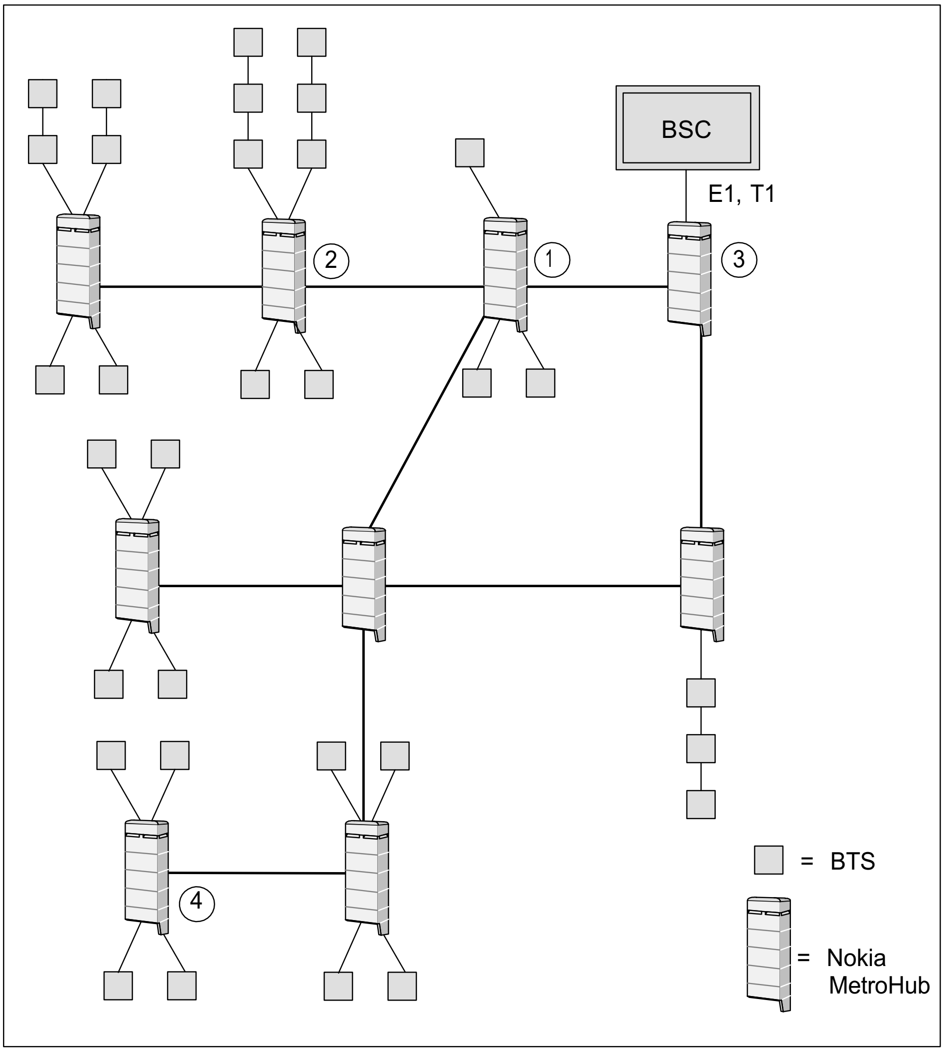
- increasing of trunking efficiency by grooming,
- chain, star, and loop topologies in a transmission network,
- transmission media change.

Nokia MetroHub has been especially designed to act as a master node in Nokia loop networks.

5.3 Network applications

Due to the increasing capacity needs of mobile networks, transmission networks have to carry more and more traffic. Nokia MetroHub is constructed to support fast roll-out, making it easy to add transmission network capacity as needed. As a result of high integration, it is possible to implement the media change from wireless to wireline in the same cabinet without additional converters.

The figure below shows some network applications of Nokia MetroHub. The figures are presented in more detail in *Site applications*



1. *Hub site 1*
2. *Traffic bypassing; Hub site 2*
3. *BSC site, capacity 16 x 2M; Hub site 3*
4. *MetroHub and FIU 19 at BSC site*

Figure 18. Network applications of Nokia MetroHub (numbers refer to the different kinds of Nokia MetroHub sites)

Nokia MetroHub grooms the traffic from several base stations. Partially filled connections are thus combined and trunk efficiency is increased. In order to ensure transmission availability, several Nokia MetroHub transmission nodes are combined into a loop. In case a transmission link in the loop breaks down, the traffic is instantly re-routed to the redundant path.

5.4 Site applications

This section gives examples of different site configurations implemented with Nokia MetroHub.

Nokia MetroHub supports up to ten radio outdoor units (Nokia FlexiHopper, Nokia FlexiHopper Plus or Nokia MetroHopper) or twenty E1/T1 lines. It is also possible to have any mixture of those by installing up to five transmission units inside Nokia MetroHub.

Note

In the following graphics, E1T1 denotes both FXC E1 and FXC E1/T1.

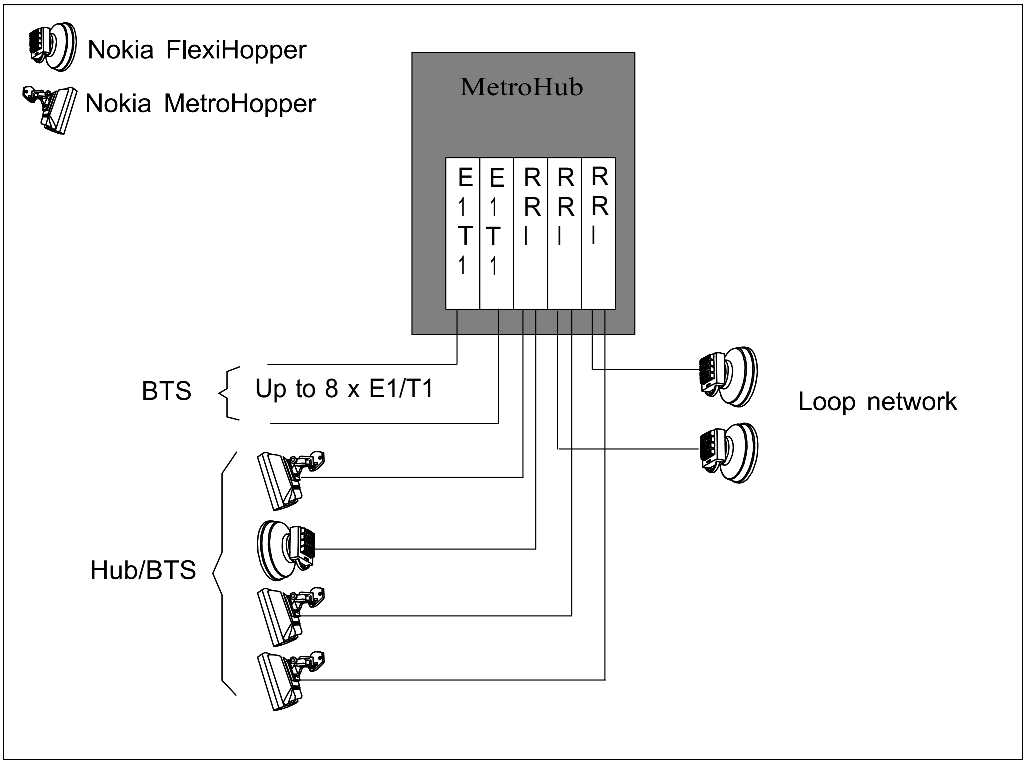


Figure 19. Hub site 1 (example)

The figure above shows a conventional hub site. The compact size of the cabinet, the integrated radio indoor units and the easy connections to the radio outdoor units via one single coaxial cable minimise site requirements.

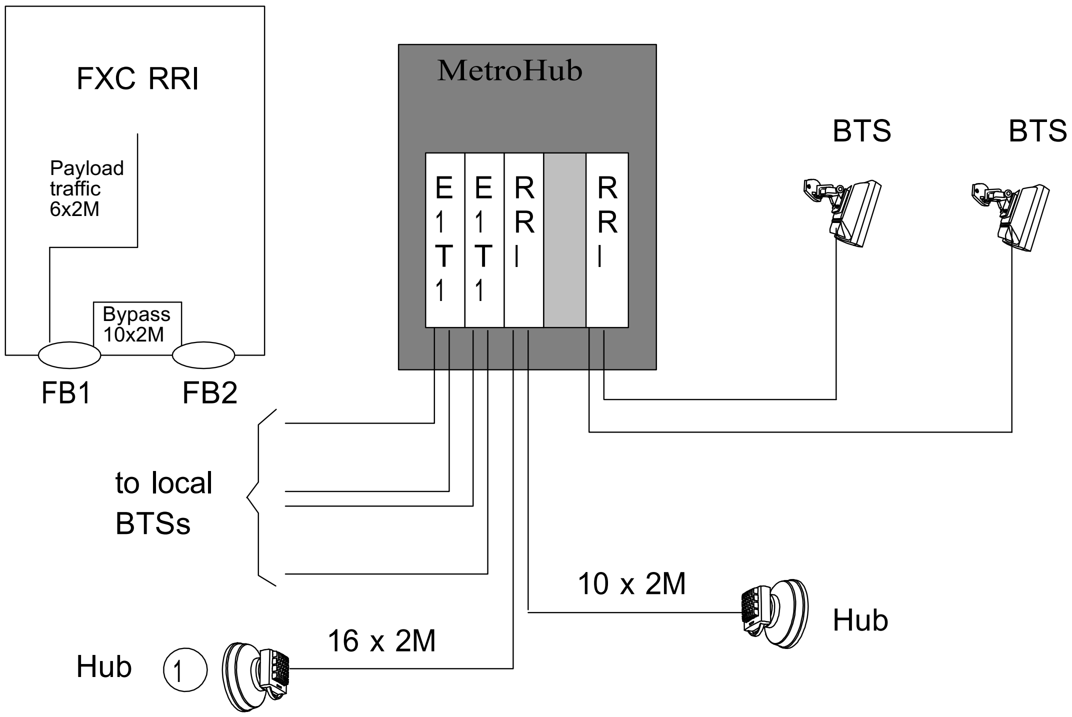


Figure 20. Traffic bypassing; Hub site 2 (example)

Traffic bypassing is the solution needed when the total cross-connection bus capacity of the unit interface is exceeded. The figure above illustrates such an application. Two Nokia FlexiHopper radios are connected to one FXC RRI. The incoming capacity of the first radio is 16x2Mbit/s. Only 6 x 2 Mbit/s is routed to the 8k cross-connection field and the remaining capacity (here 10 x 2 Mbit/s) will be bypassed via the 2M cross-connection field to the second radio. The payload traffic is split up between several wireless, for example, Nokia MetroHopper, and wireline connections.

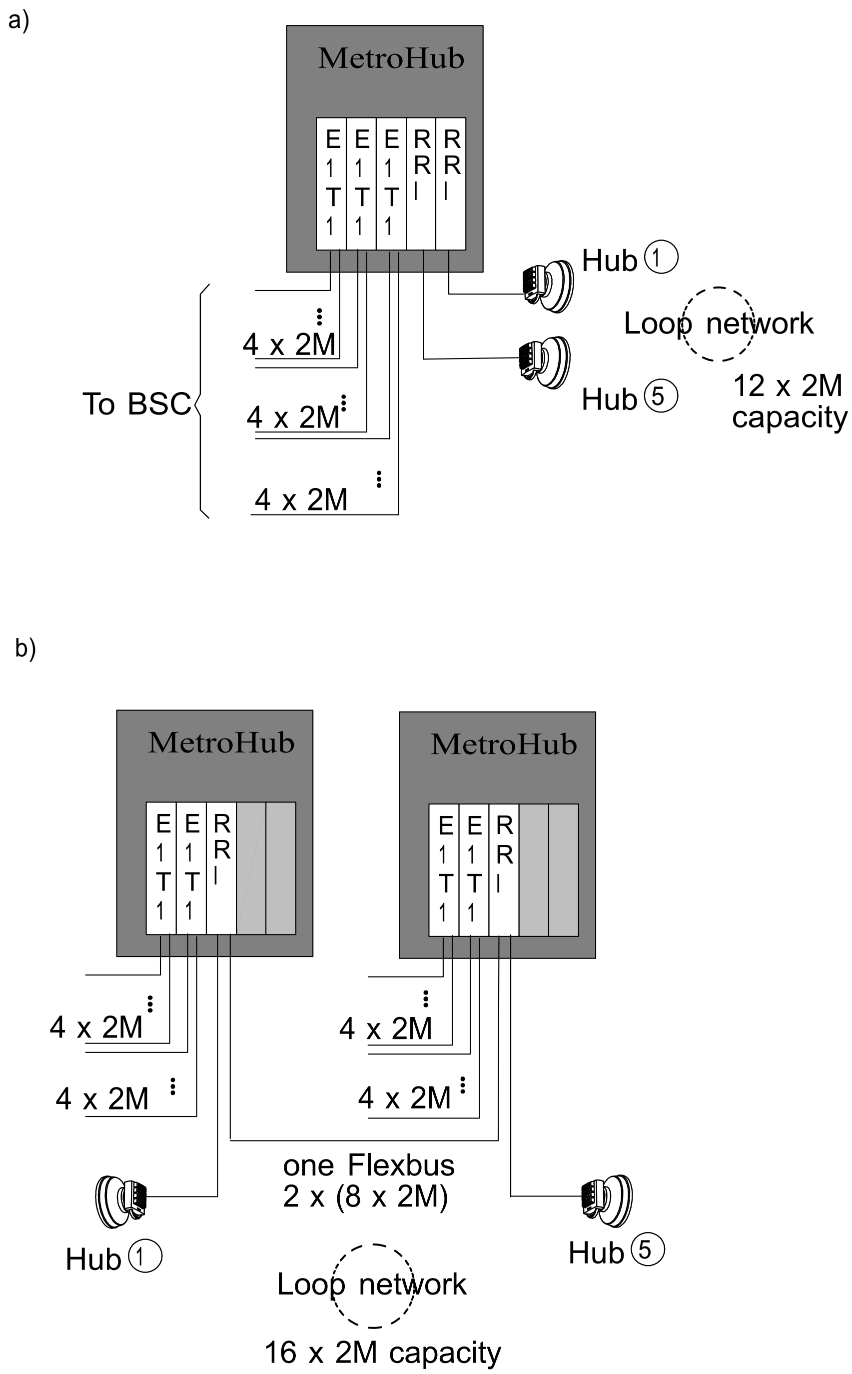


Figure 21. BSC site, Hub site 3 (example)

The figure above shows a possible Nokia MetroHub configuration at a BSC site.

In example a), the drop capacity to BSC is 12 x 2 Mbit/s. Both radios are connected to one radio indoor unit.

In example b), a second MetroHub is used in order to obtain a higher drop capacity. The total capacity of the two MetroHubs is split into two, with each MetroHub having a drop capacity of 8 x 2M to the BSC. This is achieved by using two FXC E1 or FXC E1/T1 transmission units in each of the MetroHubs. Further, each of the MetroHubs is connected to a Nokia FlexiHopper radio outdoor unit via an FXC RRI. There is one FXC RRI per MetroHub. The MetroHubs are connected to each other with a Flexbus cable.

Traffic coming from the BSC is duplicated and sent over two paths. One path goes directly to the nearest radio and causes a traffic load of 8 x 2M. Traffic on the other, redundant path is routed via Flexbus cable to the other MetroHub, causing a traffic load of 8 x 2M. Incoming traffic over the Flexbus cable is bypassed by FXC RRI to the second radio outdoor unit. The traffic load of this redundant path is, of course, the same as before: 8 x 2M.

The principle is the same regardless of which of the MetroHubs received the traffic. Thus, at any time a radio outdoor unit can receive a maximum of 8 x 2M of primary traffic (from the MetroHub to which it is connected) as well as 8 x 2M of redundant traffic (from the other MetroHub). Thus, the traffic to each radio outdoor unit can reach 2 x 8 x 2M.

In case the number of physical 2 Mbit/s interfaces is not sufficient, one easy way to extend MetroHub is to use FIU 19 radio indoor unit in addition, see the figure below. FIU19 provides a larger number of physical 2Mbit/s interfaces. The connection between FIU 19 and a FXC RRI inside MetroHub is made via Flexbus.

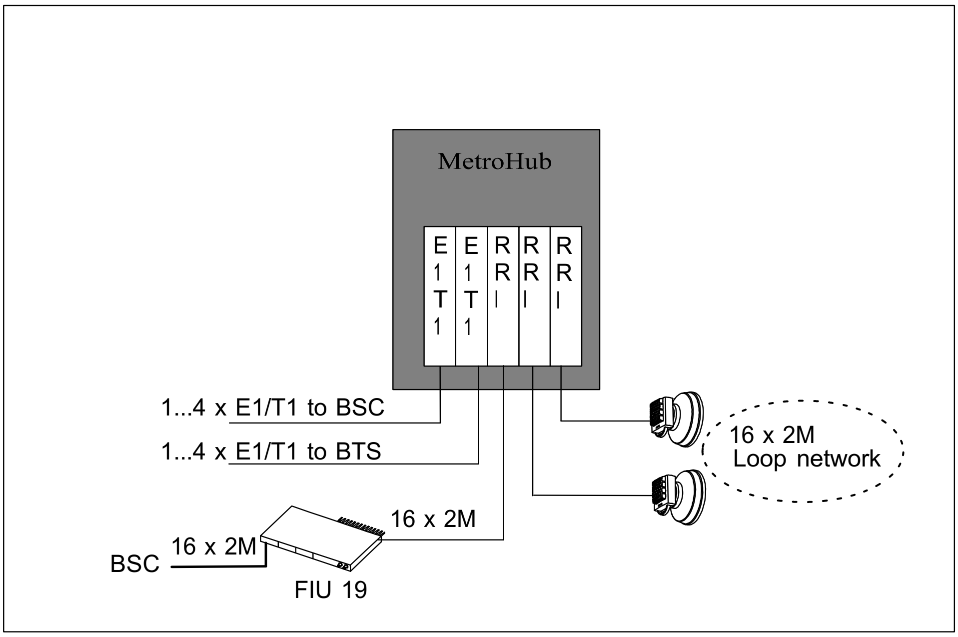


Figure 22. MetroHub and FIU 19 at BSC site

It is possible to build loop networks with 16 x 2M capacities by using the combination of FIU 19 and one MetroHub.

5.5 Node configurations

The following figure shows examples of how different FXC transmission units can be combined inside Nokia MetroHub. Unused slots require FXC shielding units. The interface unit (DIUx), which is always required, is also shown.

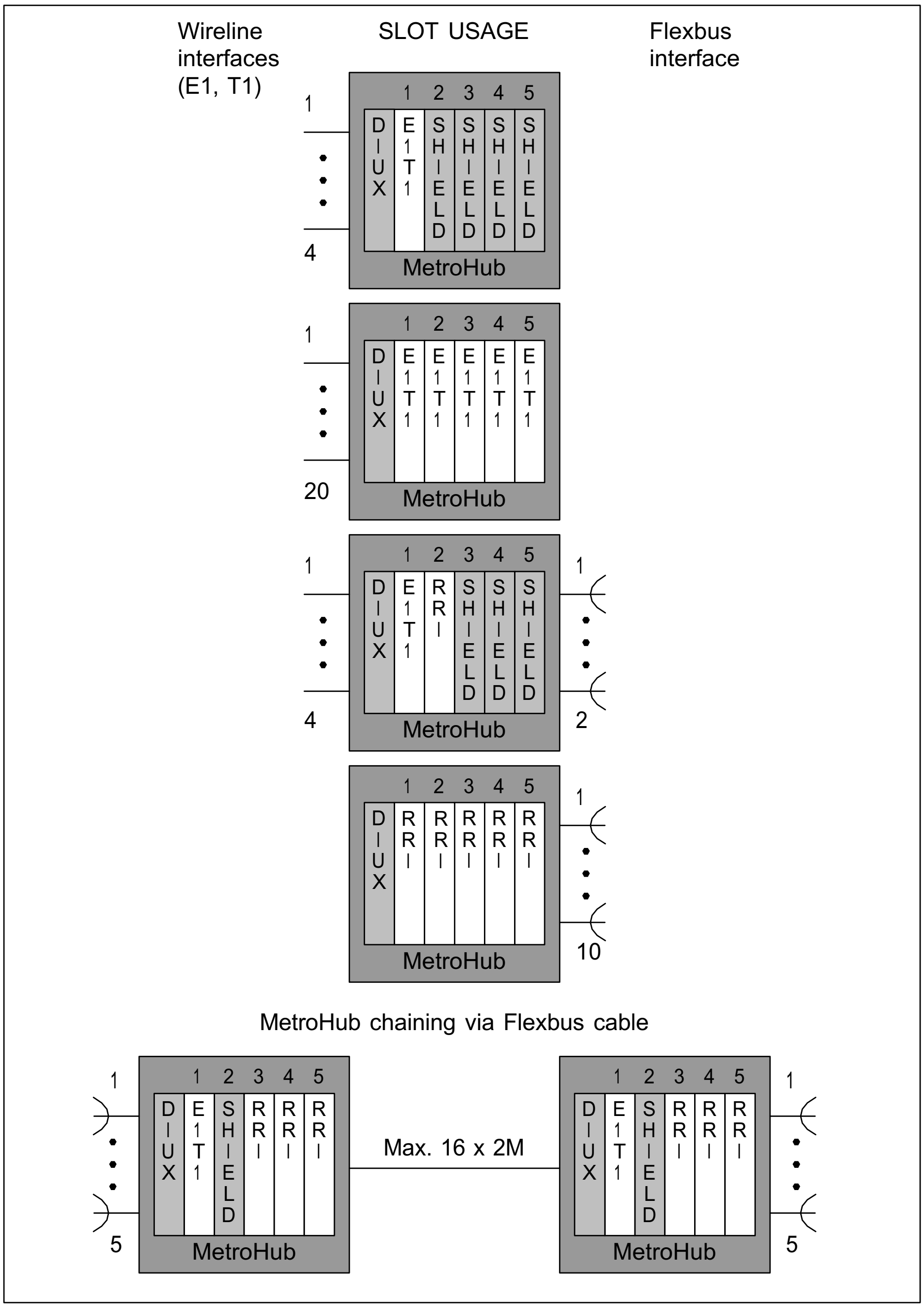


Figure 23. Node configuration examples with FXC transmission units, FXC shielding units and interface units (DIUx)

The following figure shows the available power protection options: the redundant power supply and the internal battery unit.

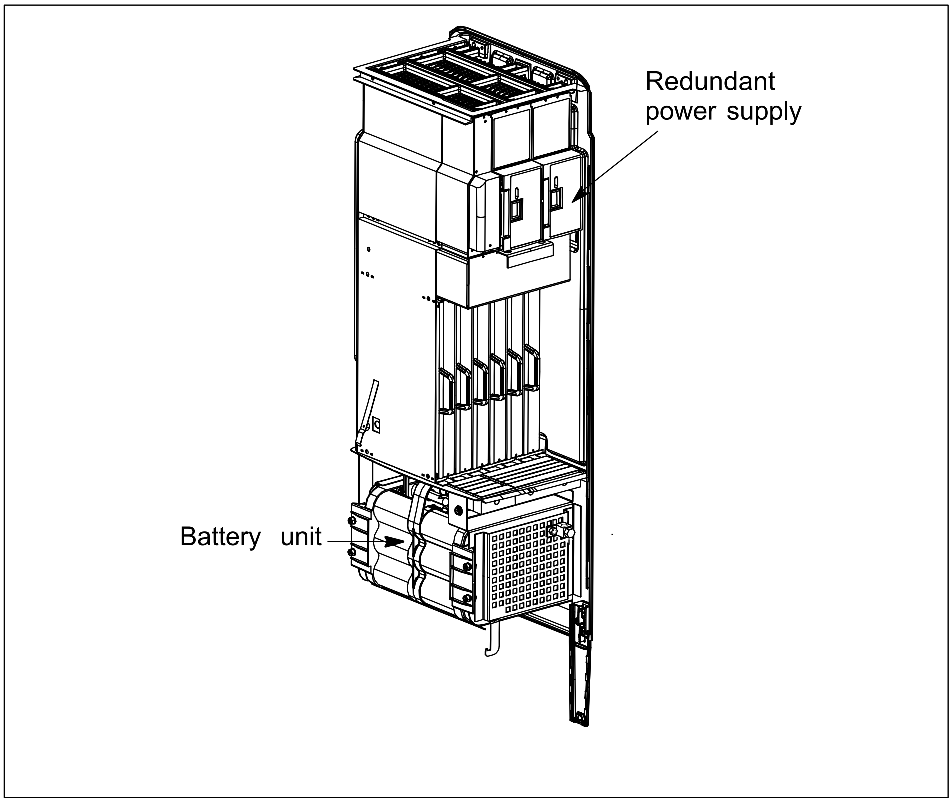


Figure 24. Power protection options

6 Functional areas

6.1 Transmission platform

6.1.1 Cross-connections

Cross-connection bus

The transmission units offer dynamic allocation and deallocation of the 56 x 2 Mbit/s cross-connection bus of the MetroHub and the UltraSite BTS according to the physical interfaces that are present in the node configuration. The user can create cross-connections between any physical interfaces connected to the cross-connection bus.

When the first cross-connection is created to the interface, the 2M cross-connection block is allocated to it. If there are no free blocks to be allocated, the node gives the alarm *20 Blocked from use*.

Backup

The active cross-connection bank is backed up in the transmission unit's non-volatile memory: so if the unit is removed, the cross-connections are restored when the unit is inserted again.

Grooming

The cross-connection feature of the transmission units makes traffic grooming possible.

The FXC units are capable of grooming traffic at 8 kbit/s granularity, which enables fully optimised and flexible use of available transmission resources. This ensures that the Abis transmission capacity can be used efficiently.

Cross-connection granularities

There are several types of cross-connection available, and each has a different granularity.

Granularity means the number of bits connected into a specific direction in a cross-connection. In the 2 Mbit/s mode, the available granularities are:

- 8k (1 bit)
- 16k (2 bits)
- 32k (4 bits)
- 64k (all the 8 bits in a time slot)
- n x 64k
- 2M

Note

All 2 Mbit/s platform interfaces are terminated which means that time slot 0 is regenerated.

Note

Only 2 Mbit/s cross-connections that are made from Flexbus to Flexbus inside a FXC RRI unit are transparent.

Basic cross-connection types

The cross-connections are created into banks. The node contains two cross-connection banks.

The transmission units support all the cross-connection types described below.

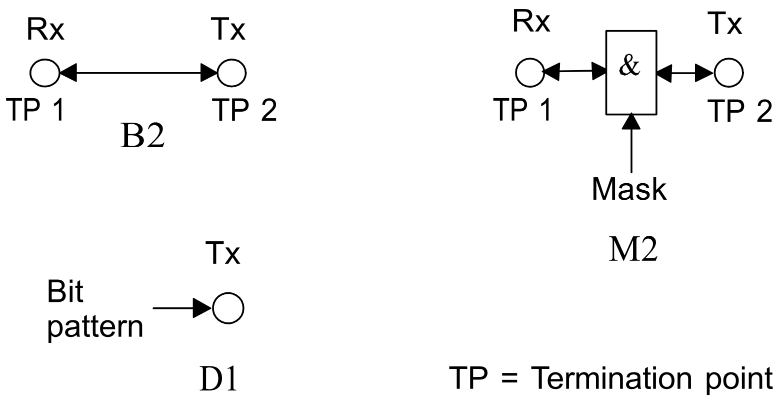


Figure 25. Basic cross-connection types supported

- B2 bi-directional cross-connection

The B2 cross-connection is a bi-directional connection between two termination points. The granularities are 2M, nx64k, 64k, 32k, 16k and 8k.

- M2 bi-directional masked cross-connection

The M2 bi-directional masked cross-connection is a bi-directional connection between two termination points. The received data stream is masked bit by bit with fixed data. Masking can be done with a logical AND or OR operation. The masking is made in both directions. The M2 cross-connection supports 64k, 32k and 16k granularity.

- D1 uni-directional fixed cross-connection

The D1 cross-connection is a uni-directional cross-connection where fixed data is sent from the Tx port as shown in the figure above. The user sets the fixed bit pattern used (for example: 01101101) and the time slot where the bit pattern is transmitted. The D1 cross-connection supports 64k, 32k, 16k and 8k granularities.

Cross-connection protection

The B2 cross-connection can be protected. Protection means that the data path through the network element has two alternative routes. The protected bi-directional cross-connection is called the PB2 cross-connection.

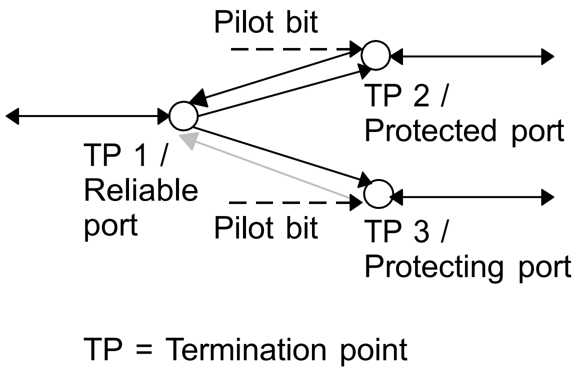


Figure 26. Protected bi-directional cross-connection

When a protected bi-directional cross-connection is made, both the switch and data duplicating cross-connections are created. Data received from the reliable port is duplicated and sent to both the protected and protecting port. The switching decision is made according to the incoming value of the chosen condition bits (pilot bits).

The granularities for protected cross-connections are n x 64k, 64k, 32k and 16k.

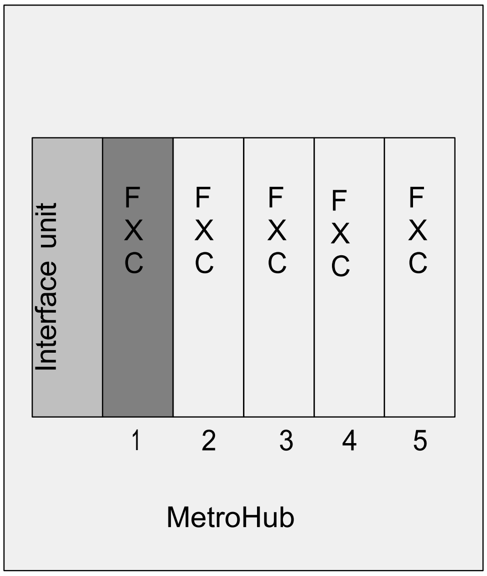
The port selection is called a *switch*. After creating the switch, the user must define the *switching condition*. The supported conditions are *Priority* and *Equal*.

For more details on loop protection, see *Transmission network protection using loop topology*.

6.1.2 Node control unit

When any of the FXC units is inserted into unit slot 1, it automatically starts to function as a node control unit. The role of the unit is thus only determined by the slot position.

The node control unit provides a common clock to synchronise all the other FXC units with. An FXC unit must always be used in unit slot 1 in order for the configuration to work.



Slot 1 Node control unit

Figure 27. Transmission unit slots

6.1.3 Synchronisation

The node control unit provides a common clock signal for synchronising all the other FXC units. Synchronisation is needed to be able to make cross-connections on a bit level and to avoid slips in transmission. It is recommended that the synchronisation input is taken from an upper network element, typically a base station controller (BSC) in BSS.

All platform interfaces can be used as a synchronisation source. The clock is selected from a four-level priority list generated by the user according to the current network configuration.

If none of the recovered line clocks in the priority list is available, all the FXC units are synchronised to the internal oscillator of the node control unit.

6.1.4 Q1 management

MetroHub is a Nokia Q1 network element. Nokia Q1 is a Nokia proprietary management protocol and it is backwards compatible with the currently used Q1. In this documentation, Nokia Q1 is referred to as Q1.

Q1 is a polling protocol used for transferring information between a master and a network element. Each network element in a Q1 network has a unique Q1 address. The polling master accesses network elements using the Q1 address. This address has to be in the range 0–3999. In BSS, the BSC is typically the polling equipment.

MetroHub is a single network element with one Q1 address. Even if there are radio outdoor units connected to an FXC RRI, they do not have their own Q1 addresses.

The *Q1 group address* is used for broadcasting the Q1 management messages to several pieces of equipment within the same group. This is for future use.

The interface unit of MetroHub provides the interfaces for local or remote management of the equipment: LMP (local management port) and Q1. Both ports have their own Q1 address and baud rate settings. LMP and Q1 interfaces are independent of each other and the node can be accessed from both of the interfaces at the same time. Two interfaces for LMP and Q1 enable chaining of both interfaces with an easy point-to-point cabling.

LMP-1 and LMP-2 interfaces are used for local access with MetroHub Manager. The LMP port has the general address 4080. This address can be used if LMP is not chained. The manager uses this address when the **Connect Locally...** option is selected. If the LMP is chained, a unique Q1 address must be selected for the LMP and the connection to the node is established with the **Connect...** option in the manager.

Q1-1 and Q1-2 interfaces are for remote management of external Q1 equipment. To enable remote management, a transmission channel for Q1 has to be created with the manager. This channel is called EOC, embedded operations channel. The channel can be transmitted either in the radio overhead or in a selected time slot inside some 2 Mbit/s signal. When the radio overhead is used, the sampling rate is always at least 64 kHz.

The following figure shows examples of Q1 network connections. The NMS forms the user interface. Between the NMS and BSC exists, for example, an X.25 connection. In this example, the BSC is the polling device. The Q1 data is transported inside a 2 Mbit/s signal between the BSC and MetroHub #1. Then the Q1 continues towards MetroHub #2. For this there are two options. The first one (A) shows that the Q1 is in the overhead of the radio connection between

MetroHub #1 and #2. The second option (B) is that the Q1 is inside a 2 Mbit/s frame between both nodes. In addition, it is possible to extract the Q1 signal from MetroHub #1 and poll another Q1 element, FIU 19, for example. For more information on how to adjust the settings, see *Adjusting Q1 management settings*.

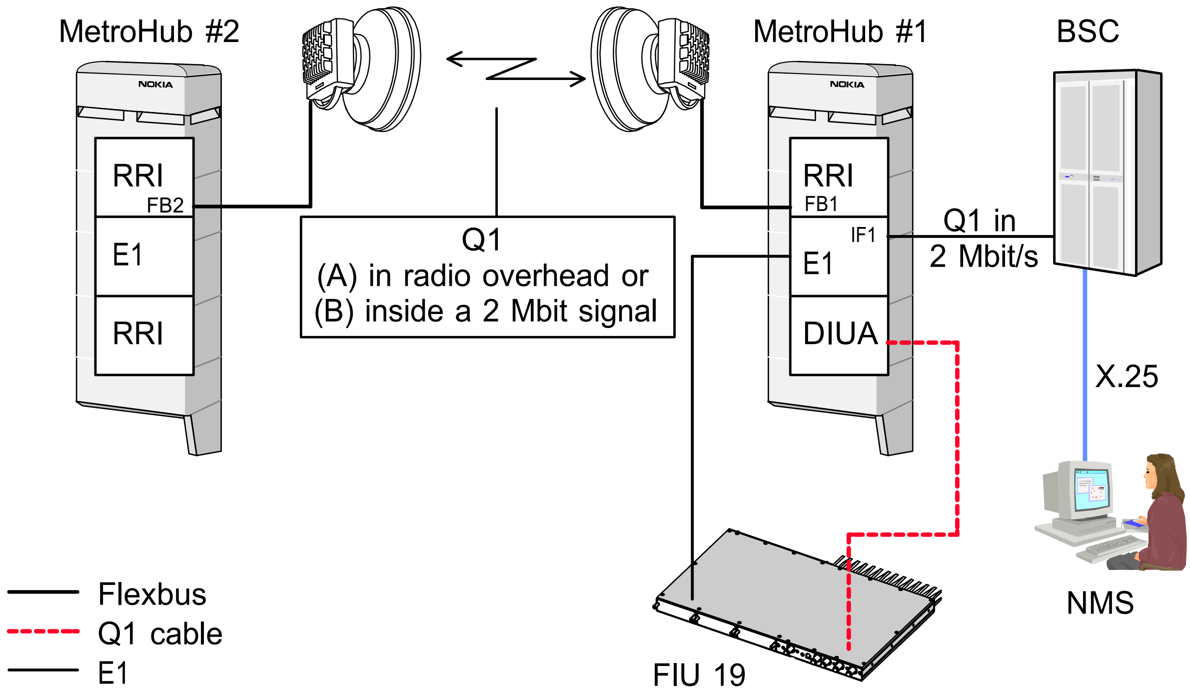


Figure 28. Examples of Q1 network connections

Local management bus

The local management bus (LMB) connects the node control unit to the local management port (LMP).

Q1 buses in a network

Large Q1 networks are sometimes divided into Q1 buses because of reliability and polling time issues. In this case, several Q1 channels will be created in the polling equipment, for example, the BSC. These channels are used to divide the network logically into different Q1 networks.

If Q1 buses are used, the Q1 channels must be considered as normal data channels up to the place where the Q1 bus usage starts. In the nodes starting from the polling equipment up to the place where Q1 bus usage starts, the Q1 channels have to be cross-connected as normal data. In the nodes that are in the Q1 bus, the EOC is used for dropping the Q1 channel to the node control unit processor, as well as for forwarding the channel to the next network element.

6.2 Performance management

FXC E1/T1 and FXC E1 line interfaces and FXC RRI platform interfaces support the following performance measurements:

Table 2. Interface performance measurements

ID text	Infinite counter	24 h counter	15 min counter	Current value	Measuring unit	Description
G.826 TT	X	X	X		seconds	Total time as specified in G.826
G.826 AT	X	X	X		seconds	Available time as specified in G.826
G.826 ES	X	X	X		seconds	Errored seconds as specified in G.826
G.826 SES	X	X	X		seconds	Severely errored seconds as specified in G.826
G.826 BBE	X	X	X		counter	Background block errors as specified in G.826
G.826 EB	X	X	X		counter	Errored block as specified in G.826

Table 2. Interface performance measurements (cont.)

ID text	Infinite counter	24 h counter	15 min counter	Current value	Measuring unit	Description
Frame sync lost	X				counter	Number of FSL errors since the counter was last cleared
Line attenuation				X	dB	Current line attenuation*)

*) Line attenuation measurement is only supported for FXC E1 and FXC E1/T1 line interfaces

Table 3. Unit performance measurement

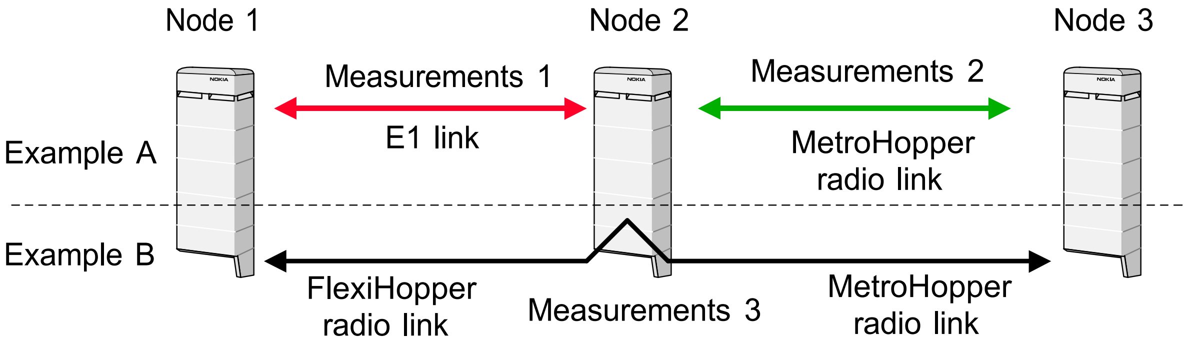
ID text	Infinite counter	24 h counter	15 min counter	Current value	Measuring unit	Description
CPU reset	X				counter	Number of unit CPU resets since the counter was last cleared
Timeslot monitoring				X	data	Data of selected timeslot

Unit reset clears all counters exept CPU reset counter, the value of which is saved to flash memory. With the node manager, the user can clear all counters.

Performance monitoring data can be read with the node manager and with BSC. With node manager all supported measurements can be reviewed exept FXC RRI 24h and 15min G.826 counters.

BSC has TRE (G.826) and TRE_SEL (G.826 and RX-input level Max_Min from radio outdoor unit) measurements. Measurement period with TRE is always 24h. For the TRE_SEL measurement, the intervals of 15, 30 or 60 minutes, or 2, 3, or 24 hours are available. Note: With 24h period RX-input level Max_Min is not available.

The measurements are only made in the receiving direction. In order to measure both directions, one must set up two different measurements. The measurements can be made as described in the following figure.



Node = Nokia UltraSite, MetroSite or MetroHub

Figure 29. Measurements

Example A

Measurements 1 are carried out between Node 1 and Node 2, where the connection is set up via an E1 line. Measurements 2 are made between Node 2 and Node 3 along a connection created with Nokia MetroHopper.

Example B

Measurements 3 are carried out between Node 1 and Node 3, where the cross-connection in Node 2 is implemented by using the traffic bypass feature. In this case the signal is not terminated in Node 2, since cross-connections made by traffic bypass are transparent on the 2 Mbit/s level. The connection between Node 1 and Node 2 is set up by using Nokia FlexiHopper and the connection between Node 2 and Node 3 is set up via Nokia MetroHopper.

6.3 Cabinet management

Cabinet management bus

The communication between the node control unit and all the other units (not FXC units) takes place via an internal cabinet management bus, see the figure *Block diagram of Nokia MetroHub*.

The cabinet management bus is used, for example, to read the alarms of units (including EAC), for climatic control, temperature measurement and unit ID information.

Node internal tests

The internal tests of MetroHub are performed in the commissioning phase and some of them can also be used as preventive maintenance tests. If a maintenance test is not passed, an alarm will be given and passed on to the NMS.

Cross-connection test

This test can only be run in the commissioning phase.

This test is for ensuring that the FXC unit combination is working. The test result is either pass or fail. The self-test function will internally test the operation of the backplane cross-connection bus between the units based on 64 kbit/s data.

In the test, all the units form a chain, the transmission quality of which will be monitored for approximately 30 seconds. The self-test function of the node will proceed to the available loop tests inside FXC units. The loopback configurations in the interfaces and cross-connections from one interface to the next are made automatically by the node manager. The internal bit pattern generator and receiver of the node control unit are used to monitor bit errors.

If there are radios connected to the FXC RRI units, the data will be looped back from the radio units during the test.

Interface unit (DIUx) tests

The tests ensure that the DIUx unit is performing the External Alarms and Control (EAC) functions properly. The user has to perform the site-specific settings separately with the configured external circuitry.

- External alarms and controls test

These tests only verify the internal hardware, independent of the usage and settings of the interfaces. External alarms tests are performed by reading the actual states of the alarm inputs, inverting the last stage of the input in hardware and verifying the results. External controls are tested by reading the stages of the control outputs and comparing the results to the settings. The testing will not affect the use of the user-defined external circuitry.

If the test is not passed, an alarm will be activated ("Unit function degraded") and it will be active until the test has been passed or the unit has been removed. The DIUx LED indicates this alarm also with yellow colour.

Fan (DMFx) test

The fan is a mechanical device, the service life of which depends on the usage (equipment temperature) and the conditions where it is used (dust, other contaminant of incoming air). To make sure that the fan provides sufficient air flow for the equipment cooling it can be tested.

The fan temperature must be warmer than -10°C (14°F). Otherwise the message "Not allowed" will be given. The fan speed is set to the maximum for 30 s. During the test there is an indication of an ongoing test ("Test mode active"). The fan alarms are monitored during the test period (broken, that is, achieved speed < 20% of the maximum, or degraded, that is, achieved speed < 85% of the maximum), and after the test either the "Pass" or "Failed" message is given to the user. A possible alarm will stay active until the test is passed or the unit removed.

Unit heating test (FXC units)

The FXC units have heating elements to provide the components a better usage environment and thus increase the lifetime of the units. The function of a heating element can be tested.

If the ambient temperature (measured from the backplane) is above +30°C, the test is not allowed and the message "Not allowed" is given to the user. If the unit heating is on at the moment, it is switched off for ca. 1 minute before the test. The unit temperatures are measured and stored. Half of the heating power is put on for 2 minutes. During the test there is an indication of an ongoing test ("Test mode active"). After the heating period, the unit temperatures are read and compared to the temperatures read before the test. A decision of a successful test is made for each unit, based on the expected temperature rises in the FXC units. If the test is not passed, the alarm is activated for the corresponding unit ("Unit function degraded").

Battery connection/capacity test

The battery life time depends on the environment, and the rate and depth of discharging. To find out the performance of the battery, you can run an automatic test.

Battery capacity testing is divided into two parts: testing the connection and testing the battery capacity (performance) after that, if applicable. The battery connection test is performed to find out if the DC connection, including fuses, is OK in the power supplies.

- Connection test

The test is started in both power supply units and the DC output alarms are polled for a period of 30 s. After the test, the user is informed about the status of the test with a PASS or FAILED message.

- Capacity test

The capacity test is based on the normal load usage of the node. There is no disturbance caused to normal operation, but the back-up time is degraded for a couple of hours after the test before the battery is recharged. The duration of the capacity test depends on the node configuration. If only a couple of units are in use and no radios are connected to the node, the test can take about 30 minutes; but if there is a higher load, the available battery capacity can be measured in a shorter time.

The node control unit polls the battery test status from the master power supply which performs the test and monitors that the battery voltage is sufficient. During the test, there is an indication of an ongoing test ("Test mode active"). After the master power supply unit has finished the test, an alarm is generated if the result is "Low capacity" ("Unit function degraded") or "Average capacity" ("Low battery voltage"). If there are no alarms from the battery, a "High capacity" message is given to the user.

Note

It is advisable to check that no AC failure has occurred within 24 hours as that could have an effect on the test result.

6.4 Cold start

Possible cold start situations are: the initial power up, starting the first time, the situation after an AC mains break down, with or without internal battery.

A cold start situation is indicated with a continuous yellow LED in the power supply unit.

The cold start logic in the power supply unit switches on the heating elements (100% heating) when the temperature is too low in MetroHub (< -10°C (14°F) in units). In a cold start case, the temperature is measured with separate sensors because there is no electricity in the node control unit and the internal buses are not working.

In a cold start situation, the batteries are charged and heated with AC (when available).

Typically the cold start time is less than 10 minutes. There is a back-up limit in the power system which will start up after 50 minutes.

6.5 Temperature management

The main purpose of the cooling and heating functions of MetroHub is to implement optimal temperature circumstances for unit electronics and the battery unit. Cooling is provided by a speed-controlled fan. The node control unit controls the fan speed and the heating power. It collects temperature information from the following units:

- FXC transmission units
- DIUx interface unit
- Backplane (ambient)
- DSUx power supply units
- DMFx fan unit

The hottest unit determines the speed of the fan and the backplane sensor determines the heating level. The heating and cooling are never on at the same time. See the figure below.

When MetroHub is operational and heating is needed, the node control unit will control the heating with reduced heating power (0...50% of maximum). The control information is transferred from the node control unit to the heating control logic in the power supply unit via the cabinet management bus.

The following units have heating elements:

- FXC transmission units
- DIUx interface unit
- DBBx battery unit

The battery AC voltage heater is switched on by the power supply unit logic. The batteries will be charged in normal conditions and heated when the battery temperature is below 5°C. The heating level and time are determined by the power system.

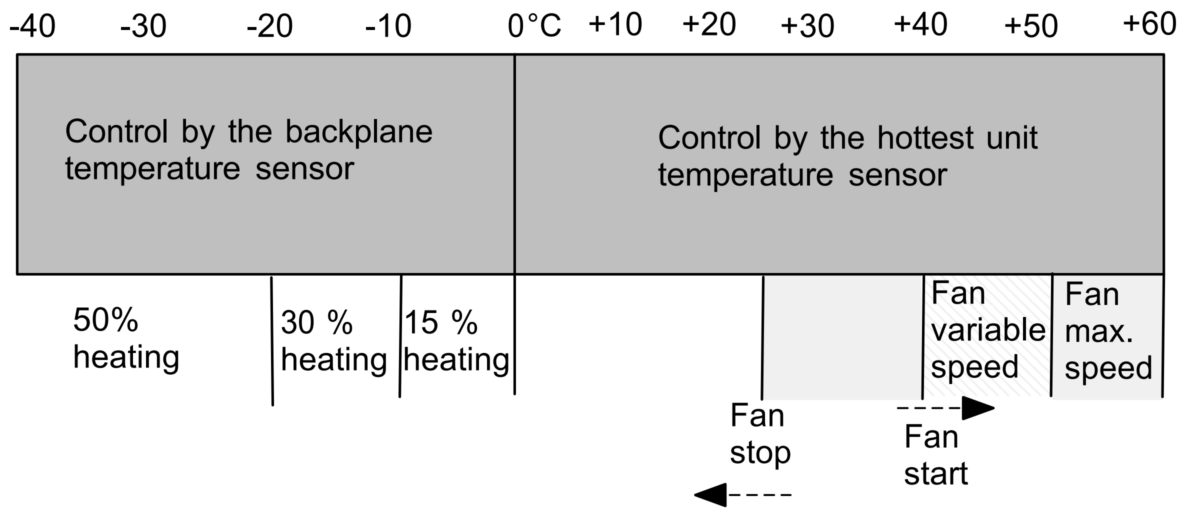


Figure 30. MetroHub cabinet temperature management for units (except for battery unit)

Overheat protection

The power supply units are the hottest units in the node in normal operation. They have their internal overheat protection including alarm before all the output voltages are shut down, except the fan voltage. The power supply voltages are reconnected when the internal temperature has decreased 15°C. During operation within the specified load and temperature ranges, overheating is an abnormal situation.

7 Units and mechanics

7.1 Overview of Nokia MetroHub hardware

This section gives an overview of the mechanical construction of Nokia MetroHub equipment.

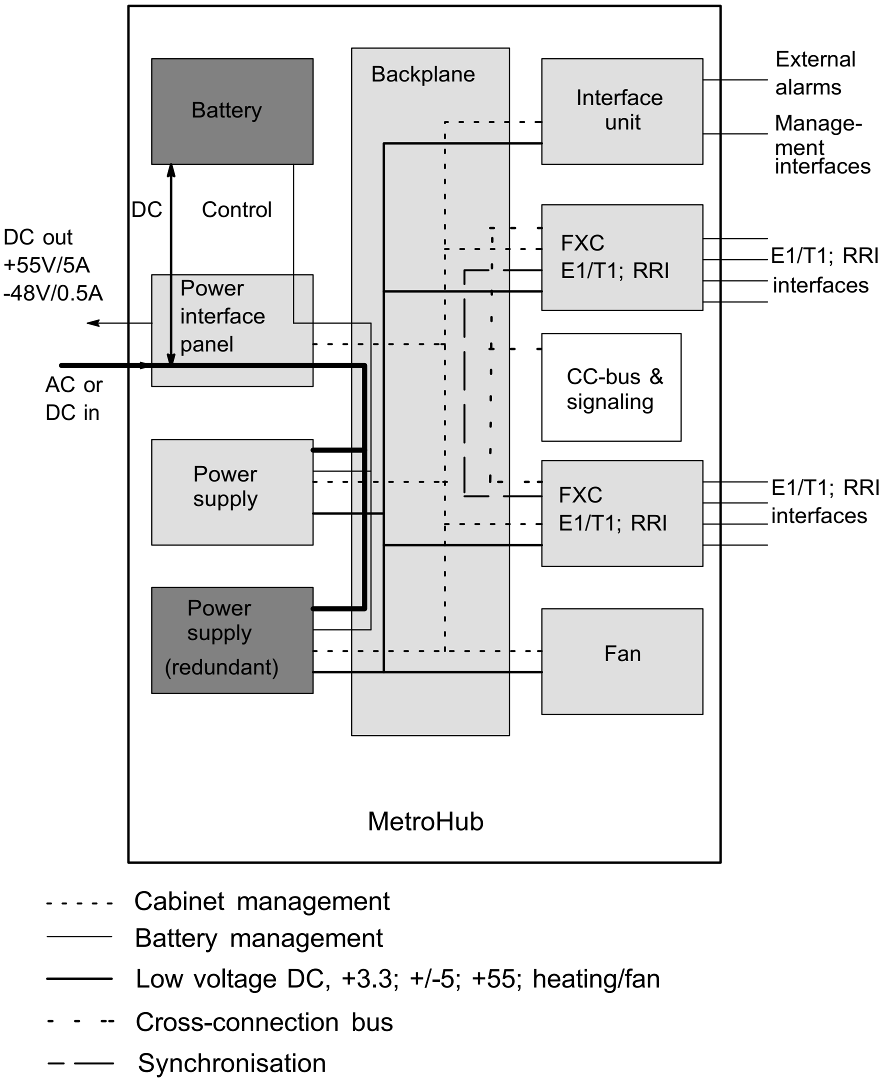


Figure 31. Block diagram of Nokia MetroHub

Nokia MetroHub has a modular structure. See the following figure.

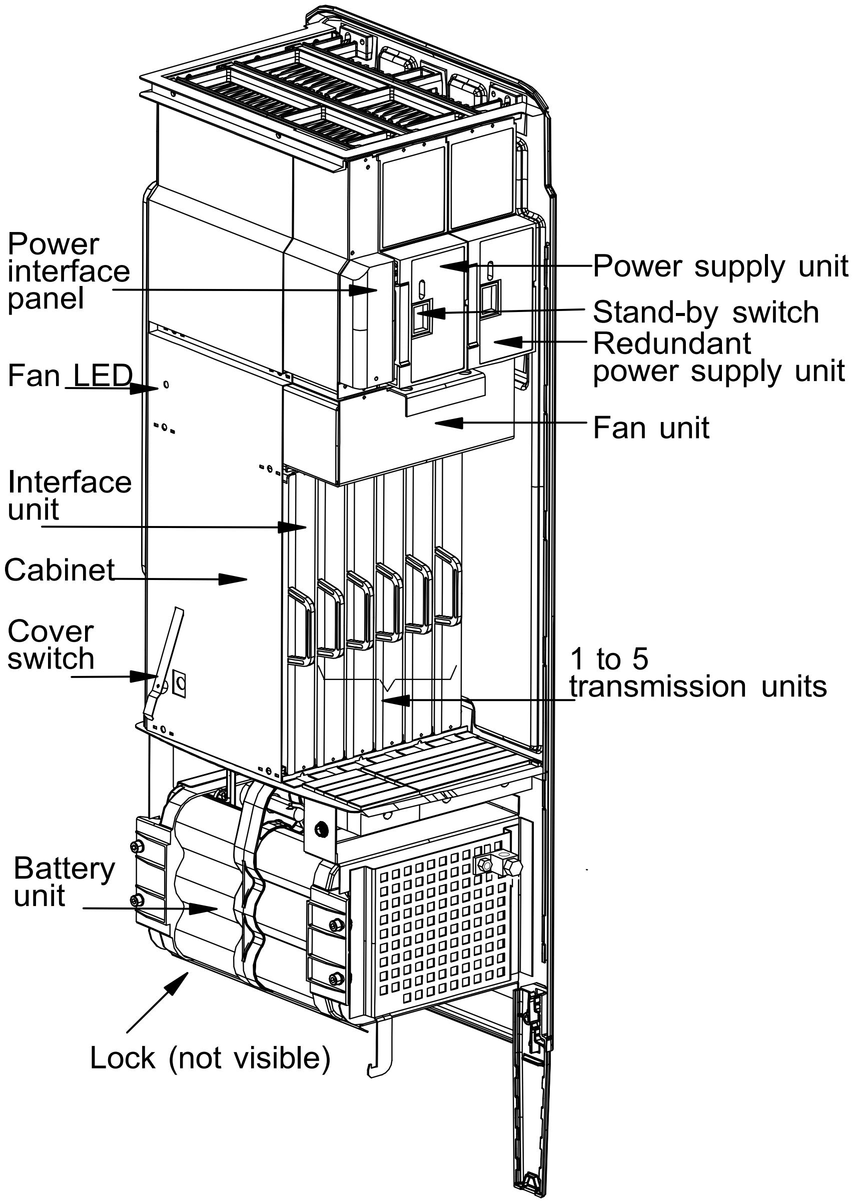


Figure 32. Nokia MetroHub

Nokia MetroHub comprises a cover and a mechanical cabinet providing a base for various plug-in units and an optional battery unit. Free unit slots have to be filled with shielding units to keep the air flow constant in any configuration and to provide sealing for the connectors.

Plug-in units

The plug-in units inside the cabinet are:

- Power interface panel
- One or two identical power supply units
- Fan unit
- Interface unit (DIUx)
- Optional battery unit

Transmission units

In addition to the above-mentioned plug-in units, Nokia MetroHub always houses one to five transmission units:

- FXC RRI transmission unit
- FXC E1 75 Ω transmission unit
- FXC E1/T1 120/100 Ω transmission unit

Connectors

There are connectors on the back of the units for connection to the backplane. The front panels contain the connectors for the user. All connectors are standardised and sealed against water. The connectors are provided with caps (not shown in pictures).

Cables

Cables are installed while the cover is off. All units can then be easily accessed, even in pole installations. Standard cables can be used. For cabling instructions, see *Overview of installing Nokia MetroHub*.

7.2 Plug-in units

7.2.1 Units of the power system

Warning

Read Warnings and cautions carefully before working with any unit of the power system.

The power system comprises the power interface panel (DIPx) and one power supply unit (DSUx). As an option, it is possible to use an additional DSUx as a redundant power supply.

To gain maximum reliability for the power system, use a redundant power supply unit with an optional internal battery unit (DBBx).

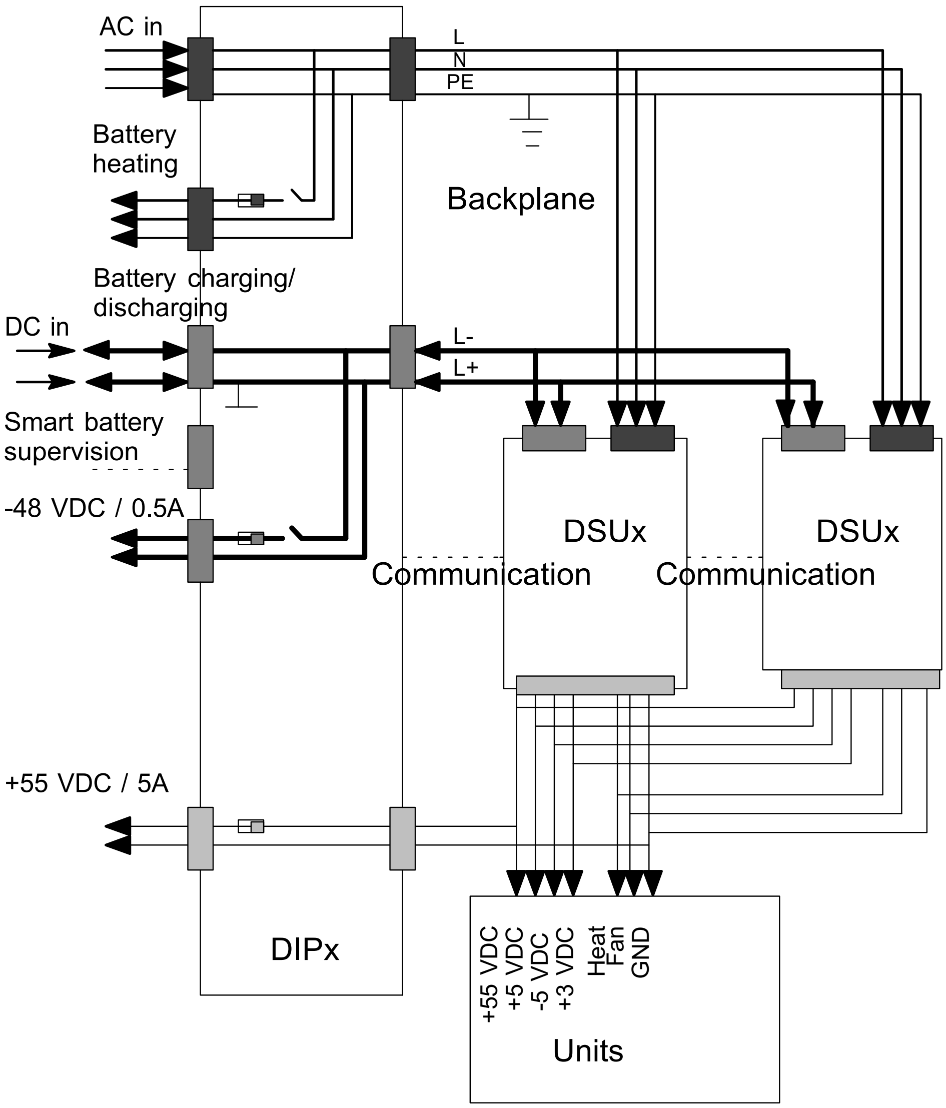


Figure 33. Block diagram of power system

Power interface panel (DIPx)

Power interface panel provides all external power connections, and distributes the incoming AC and DC voltages to the power supply units. In case AC is the regular input, the DC input can be connected to the optional battery unit. As an alternative to AC, Nokia MetroHub can also be powered from an external DC source.

The DIPx contains the following interfaces (see the following figure):

- AC supply input
- DC supply input
- Battery back-up connection
- DC supply outputs

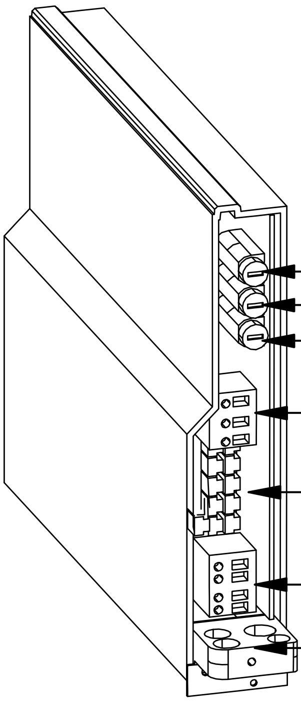


Figure 34. DIPx (without front cover)

Power supply unit (DSUx)

Power supply unit has a dual input: AC and DC. The inputs are supplied via the backplane. Both inputs can be used for normal operations. The power supply switches automatically from AC to DC input in case of AC failure, without any traffic interruption or performance disturbance.

Battery unit (DBBx)

The optional battery unit supplies Nokia MetroHub with back-up power in case of mains failure. During normal operation, the power supply unit provides a charging voltage to keep the battery unit fully charged. Temperature compensated charging, deep discharging protection, battery testing, and battery heating are controlled by the power system. The battery unit consists of one 48 V block with a handle for lifting. The unit comes with a ready-made cable with plugs.

If Nokia MetroSite Battery Back-up is used to support MetroHub, the internal battery unit of MetroHub is also needed.

See *Nokia MetroHub power requirements* for the measured battery back-up times of different configurations at different temperatures.

7.2.2 Interface unit (DIUx)

The interface unit (DIUx) includes the digital interfaces needed for local supervision, maintenance and operation: Q1 and LMP. The unit also contains an interface for connecting up to ten external alarms and four controls (EAC). There is also a cover switch sensor inside the unit and a LED on the unit.

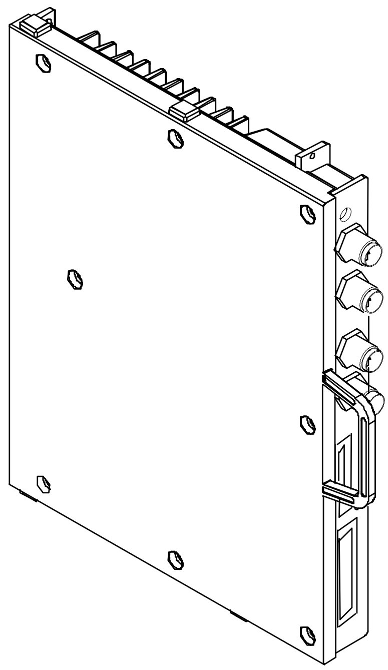


Figure 35. Interface unit (DIU)

The interface unit provides the following interfaces:

- Local Management Ports (LMP), 2 pcs
- Q1 external ports, 2 pcs
- EAC (10 external alarm inputs, and 4 external control outputs)
- Extension interface (for future use).

Local Management Port (BQ connector)

The Local Management Port (LMP) is used to access the MetroHub node locally with MetroHub Manager.

There are two Local Management Ports on the DIUx front panel to make it possible to chain several Nokia products on the site.

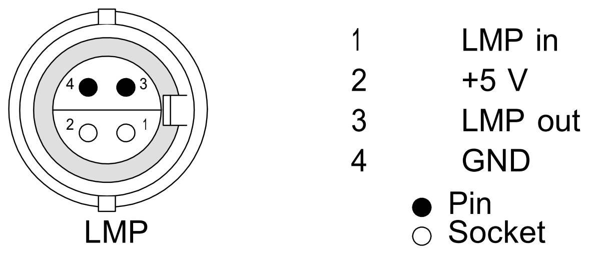


Figure 36. Local management port

Q1 port (TQ connector)

The interface unit can forward or receive management messages from MetroHub via the Q1 interfaces (Q1-1 and Q1-2). Management messages are sent on port Q1. The unit can also transfer Q1 channel data to external devices. The maximum bit rate is 115 kbit/s.

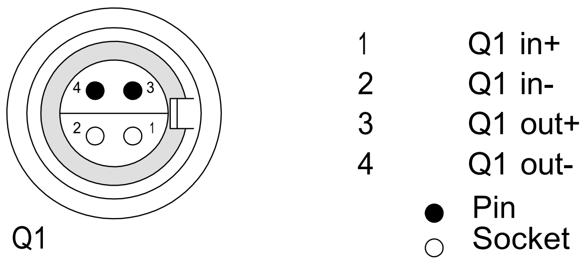


Figure 37. Q1 interface

EAC (Mini D26 connector)

The External Alarms and Controls (EAC) connector provides the interface for ten user-definable external alarm inputs (EA) and four control outputs (ECO). Alarms and controls are managed with the Node Manager.

External alarm inputs

The inputs are activated by external alarm input connecting the input signal to GND. The user defines the alarm polarity as well as whether an alarm is in use or not with the node manager.

The polarity states for the input alarms are:

- Open = The alarmless state for the active input is the open circuit.
- Closed = The alarmless state for the active input is the closed circuit.

The inputs are protected against fast transients. Supplies of +3.3V and +5V are protected with 500 mA PTC resettable fuses.

For voltage levels of external alarm inputs and a wiring scheme, see *Voltage levels*.

Control outputs

The interface unit provides four open collector control outputs. The user defines the signal polarity and switch state of each control with the node manager. The outputs are protected against fast transients. Supplies of +3.3V and +5V are protected with 500 mA PTC resettable fuses.

For voltage levels of control outputs and a wiring scheme, see *Voltage levels*.

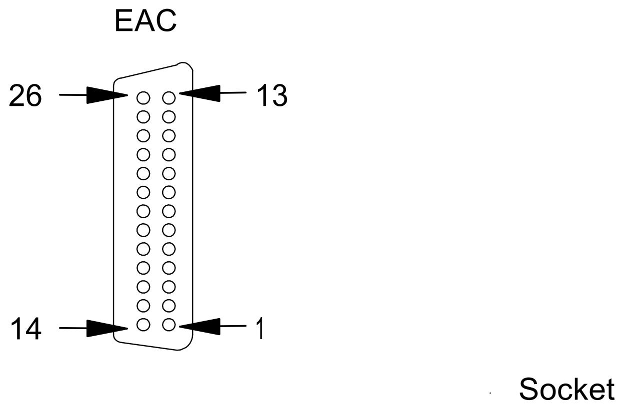


Figure 38. Pin order of EAC connector

Table 4. Pin configurations of EAC connector

Pin	Signal	Pin	Signal
1	EA1	14	GND
2	EA2	15	GND
3	EA3	16	GND
4	EA4	17	GND
5	EA5	18	GND
6	EA6	19	GND
7	EA7	20	GND
8	EA8	21	GND
9	EA9	22	GND
10	EA10	23	GND
11	ECO1	24	ECO3
12	+3 V	25	ECO4
13	ECO2	26	+5 V

Extension interface (Mini D50 connector)

The Extension interface is reserved for future use.

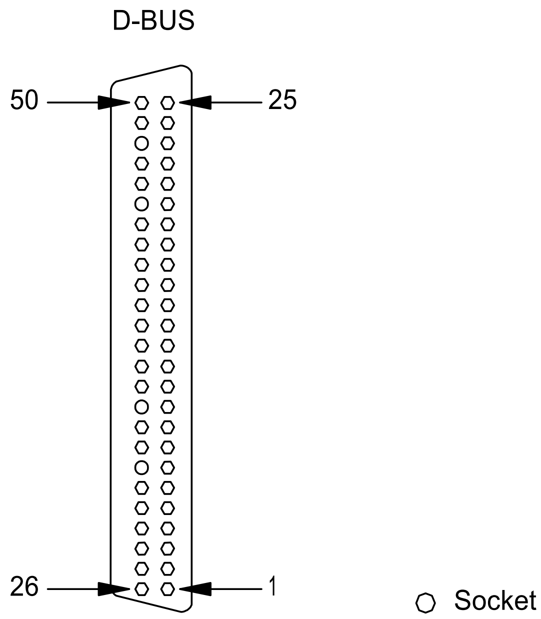


Figure 39. Pin order of extension interface (mini D50)

Table 5. Pin configuration of extension interface (mini D50)

Pin	Signal	Signal level	Pin	Signal	Signal level
1	CK2M_P	RS-485	26	CK2M_N	RS-485
2	D11DD_P	RS-485	27	D11DD_N	RS-485
3	D2DL_P*	RS-485	28	D2DL_N*	RS-485
4	FSYN_P	RS-485	29	FSYN_N	RS-485
5	D11DU_P	RS-485	30	D11DU_N	RS-485
6	D2DU_P*	RS-485	31	D2_DU_N*	RS-485
7	EXTFCK_P*	RS-485	32	EXTFCK_N*	RS-485
8	EXTFN_P*	RS-485	33	EXTFN_N*	RS-485
9	Q1DD_P	RS-485	34	Q1DD_N	RS-485
10	Q1DU_P	RS-485	35	Q1DU_N	RS-485

Table 5. Pin configuration of extension interface (mini D50) (cont.)

Pin	Signal	Signal level	Pin	Signal	Signal level
11	LMPEXT1_P	RS-485	36	LMPEXT1_N	RS-485
12	LMPEXT2_P	RS-485	37	LMPEXT2_N	RS-485
13	D12DD_P	RS-485	38	D12DD_N	RS-485
14	D12DU_P	RS-485	39	D12DU_N	RS-485
15	D13DD_P	RS-485	40	D13DD_N	RS-485
16	D13DU_P	RS-485	41	D13DU_N	RS-485
17	CAB_SHUT1*	TTL +5V	42	CUA0*	TTL +5V
18	CAB_SHUT2*	TTL+5V	43	CUA1*	TTL +5V
19	CAB_SHUT3*	TTL+5V	44	CUA2*	TTL +5V
20	CAB_SHUT4*	TTL+5V	45	CUA3*	TTL +5V
21	TERM1*	TTL+5V	46	DOGS	TTL +5V
22	TERM2*	TTL+5V	47	DGND	TTL
23	+5V	+5V (for pullups)	48	DGND	
24	+5V	+5V (for pullups)	49	DGND	
25	+5V	+5V (for pullups	50	DGND	

7.2.3 Fan unit (DMFx)

The fan maintains the air flow needed for cooling the Nokia MetroHub. The speed of the fan varies according to the temperature inside the equipment. The speed is controlled with cabinet management commands.

7.3 Transmission units

7.3.1 Transmission interfaces

The transmission interfaces of Nokia MetroHub are implemented using FXC transmission units. Nokia MetroHub can host up to 22 FXC transmission units, and it is possible to cross-connect between any of these units regardless of the physical interface type. A scalable number of transmission interfaces allow the operator to expand the capacity of the network as needed.

The transmission units are connected to each other via the backplane using the non-blocking cross-connection bus with 8 kbit/s granularity. Currently available interface variants are Flexbus, E1 and T1.

7.3.2 FXC RRI

The FXC RRI has two Flexbus interfaces, which allow the operator to connect MetroHub to any radio unit with a Flexbus interface. This requires a Flexbus cable. For example, it is possible to connect MetroHub to:

- Nokia MetroHopper radio with 4 x 2 Mbit/s capacity
- Nokia FlexiHopper radio with 2 x 2, 4 x 2, 8 x 2 or 16 x 2 Mbit/s capacity

FXC RRI transmission unit contains two Flexbus interfaces, FB1 and FB2, located on the front panel and a cross-connection bus interface on the backplane. FXC RRI does not have a separate management connector, as it is managed via the Local Management Port (LMP) of the base station or the transmission node, or via Nokia Q1 bus.

FXC RRI has separate short circuit protection for each of the Flexbus interfaces. This ensures that a short circuit in one Flexbus interface does not affect the other in MetroHub.

In case a Flexbus interface is connected to an outdoor unit, it is also possible to feed power (55 V_{DC}) to the outdoor unit through the interface.

Currently FXC RRI supports one operating mode, single use.

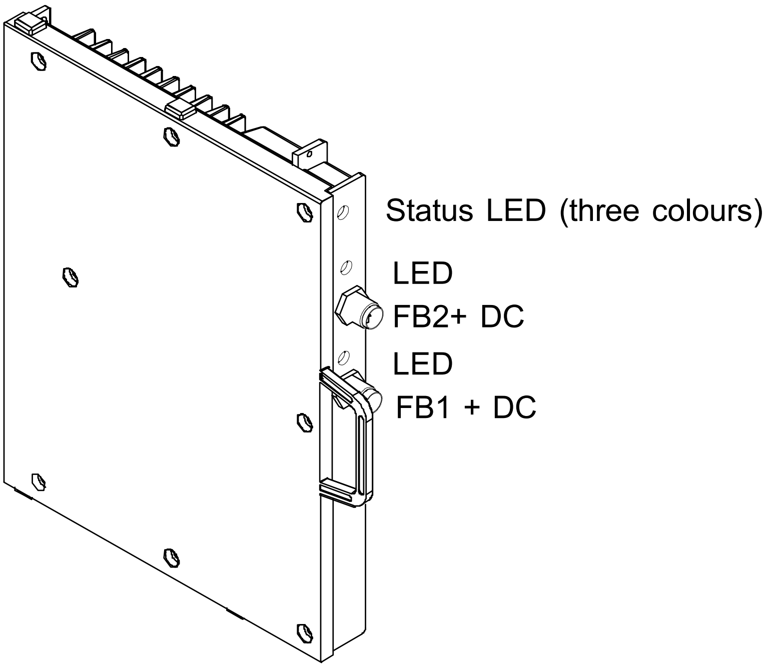


Figure 40. FXC RRI

The FXC RRI unit offers a bypass cross-connection feature, which can be used to bypass traffic through the unit transparently without terminating the signal. From the performance management point of view, a link can be extended to include several nodes, while the performance data is gathered for the whole extended link. It is possible to make bypass cross-connections even if all the platform interfaces of the FXC RRI unit are in use. In other words, the bypass cross-connection does not reserve any capacity from the cross-connection bus.

The platform interfaces of each indoor unit have a maximum capacity of 16 x 2 Mbit/s. This traffic can either be dropped to the cross-connection bus or bypassed from one interface to another in the same FXC RRI transmission unit in a separate 2 Mbit/s cross-connection field. If the total Flexbus interface traffic in one FXC RRI exceeds 16 x 2 Mbit/s, the surplus traffic has to be bypassed. In such a scenario, time slot 0 is not regenerated.

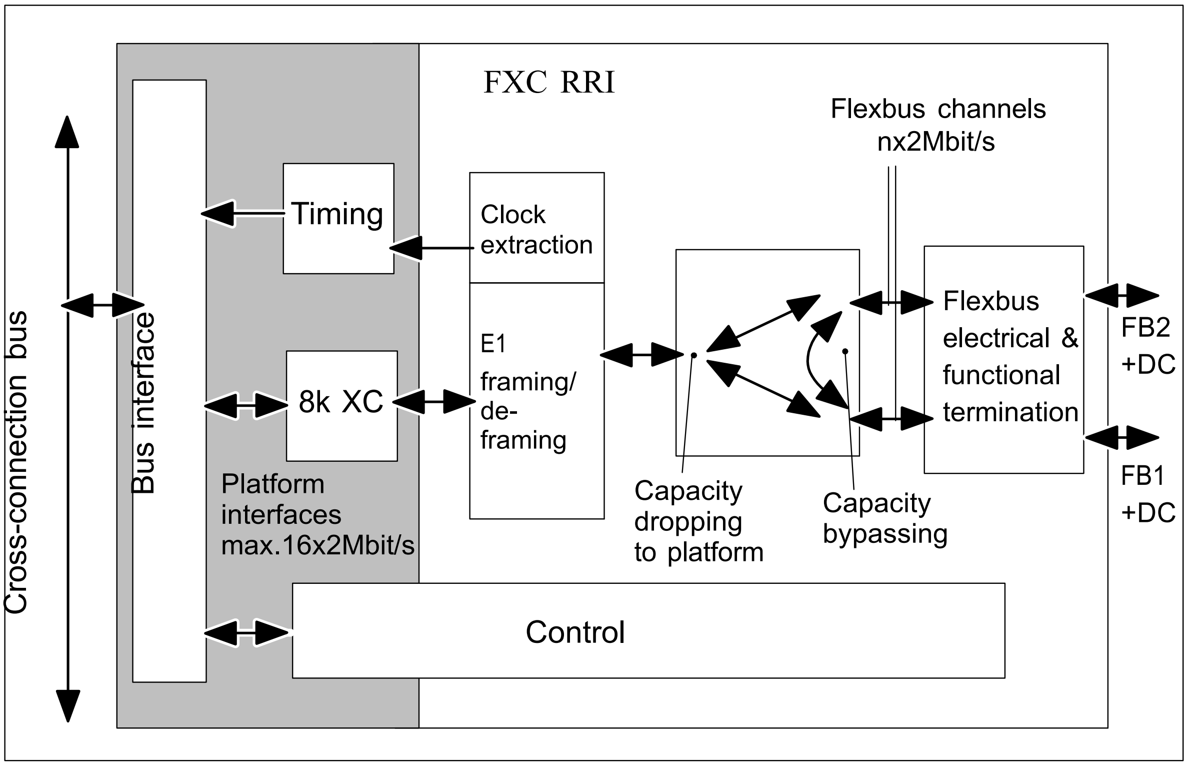


Figure 41. FXC RRI schematic diagram

A connection made between a Flexbus channel and a platform interface is a blocking connection. This means that the whole 2 Mbit/s frame is reserved for the connection even if only part of it, say, one time slot, is used.

The operator defines the traffic routes in the network elements by using the cross-connection functions available in the network elements. Thus, traffic routing means managing the cross-connections in the network elements.

The FXC RRI's cross-connection function allows the traffic to be groomed. This ensures that the transmission paths are fully utilised, thereby reducing transmission costs.

7.3.3 FXC E1 and FXC E1/T1

In mobile networks, it has to be possible to route the traffic in many different ways. FXC E1 and FXC E1/T1 offer great flexibility in this regard. FXC E1 and FXC E1/T1 transmission units provide the transmission functionality, including cross-connections, for various Nokia transmission solutions. The units can be applied as a single-unit transmission equipment or a multi-unit cross-connect node. Using these interfaces the operator defines the traffic routes using the cross-connection functions available in the network elements.

7.3.3.1 FXC E1

FXC E1 has four pairs of unbalanced 75 ohm connectors (type BT-43). Each pair forms a transmission interface. The Tx and Rx line interface connectors are separate; the upper connector is always the Tx connector and the lower the Rx connector. Each FXC E1 interface provides a 2 Mbit/s connection. With this interface, the signals can travel up to 1 km over a coaxial cable.

The 75 ohm Tx and Rx connectors are connected to each other with a grounding bridge. If the grounding bridge is removed, the grounding of the Rx connectors' outer conductor changes from direct grounding to capacitive grounding.

The unit has a tri-colour status LED which can emit green, yellow and red.

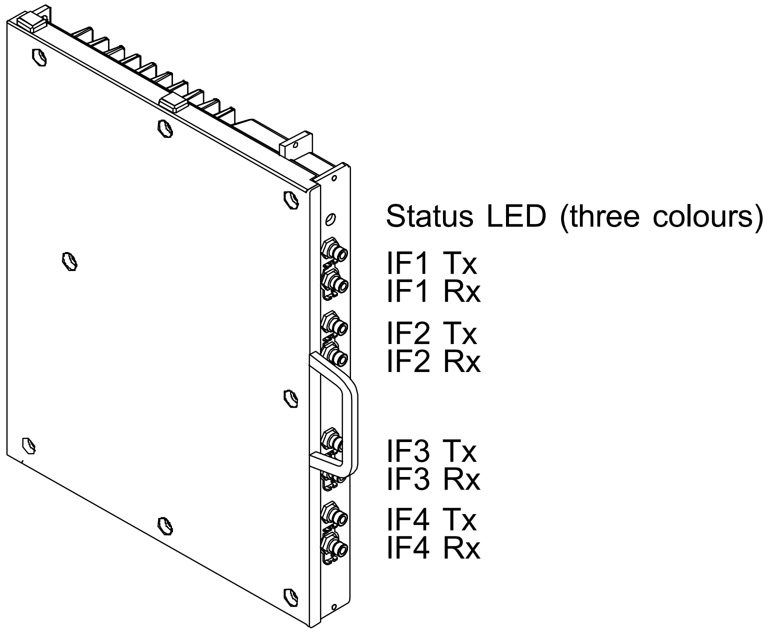


Figure 42. Unbalanced FXC E1

Additional synchronisation interface in FXC E1

The Rx-connector of line interface 4 can be used as a synchronisation interface for an externally provided 2048 kHz clock signal. Software settings determine whether this connector is used or not.

7.3.3.2 FXC E1/T1

FXC E1/T1 has four balanced TQ connectors (Tx and Rx in the same connector). Each line interface can be independently configured as a 120 ohm E1 interface or a 100 ohm T1 interface. This makes it possible to use it as an E1/T1 converter. The E1 interface offers a maximum capacity of 2 Mbits/s whereas the T1 interface offers 1.5 Mbit/s. With either one of these interfaces, the signals can travel up to 1 km over a shielded telecommunications cable.

The unit has a tri-colour status LED which can emit green, yellow and red.

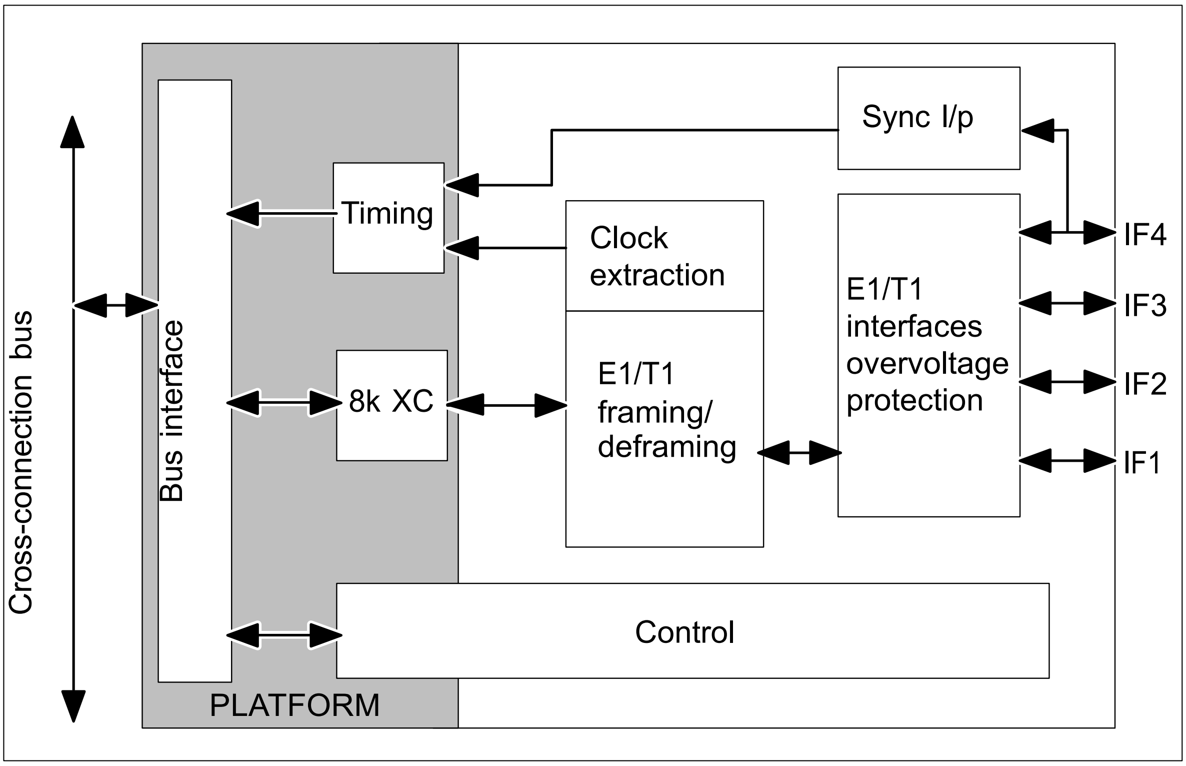


Figure 43. FXC E1 and FXC E1/T1 schematic diagram

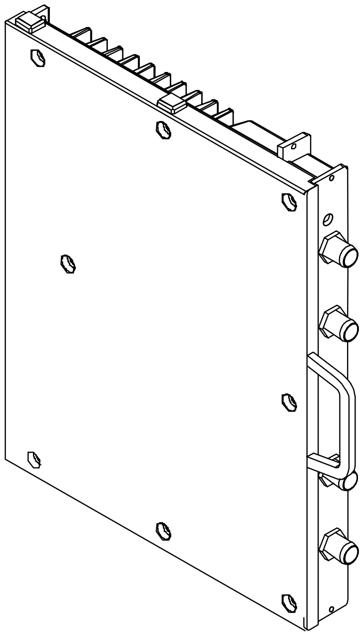
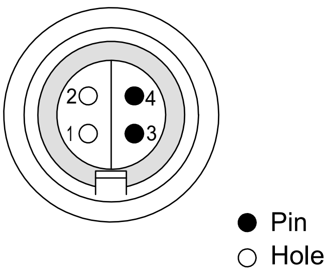


Figure 44. Balanced FXC E1/T1

There are four common TQ connectors for T1 (100 ohm) and E1 (120 ohm). The line interface connectors offer both the Tx and Rx direction.



1	Rx+
2	Rx-
3	Tx+
4	Tx-

Figure 45. TQ connector

Additional synchronisation interface in FXC E1/T1

The Rx-connector of line interface 4 can be used as a synchronisation interface for an externally provided 2048 kHz clock signal. Software settings determine whether this connector is used or not. For more information on synchronisation, see *synchronisation*.

7.4 Cover and lock

The cover of MetroHub shields the equipment against water, snow or solid foreign objects. A separate lock must be installed at the bottom of the cabinet for locking the cover.

For more information on installing the cover and lock, refer to *Overview of installing Nokia MetroHub* and *Completing the installation*.

8 Technical specifications

8.1 Dimensions

8.1.1 Nokia MetroHub dimensions and weight

Table 6. Nokia MetroHub dimensions and weight

Height	870 mm (34.25 in) 984 mm (38.7 in) with cable cover
Width	310 mm (12.2 in)
Depth	215 mm (8.5 in) (+ 34 mm mounting rack)
Weight	45 kg (99.1 lb) with battery unit 32 kg (70.5 lb) without battery unit Cabinet 11 kg (24.2 lb) Battery unit 13 kg (28.6 lb)

8.1.2 FXC RRI dimensions and weight

Table 7. FXC RRI dimensions and weight

Height	254 mm (10 in.)
Width	30 mm (1.18 in.)

Table 7. FXC RRI dimensions and weight (cont.)

Depth	220 mm (8.7 in.)
Weight	1.35 kg (3 lb.)

8.1.3 FXC E1 and FXC E1/T1 dimensions and weight

Table 8. FXC E1 and FXC E1/T1 dimensions and weight

Height	254 mm (10 in.)
Width	30 mm (1.18 in.)
Depth	220 mm (8.7 in.)
Weight	1.35 kg (3 lb.)

8.2 Interfaces

8.2.1 Nokia MetroHub interfaces

Table 9. Transmission interfaces

E1 in FXC E1 (G.703, G.704)	BT43 (female), 75 Ω
E1 in FXC E1/T1 (G.703, G.704)	TQ, 120 Ω
T1 in FXC E1/T1 (T1.403, T1.102)	TQ, 100 Ω
Flexbus in FXC RRI	TNC (female), 50 Ω

Table 10. Power system interfaces

Power supply unit stand-by switch	Flush type rocker switch
AC supply input in power interface panel	Screw type max. 2.5 mm^2/AWG 14
DC supply input in power interface panel	Plug-type Anderson Power Pole max. 6.0 mm^2/AWG 10
Battery connection in power interface panel	Plug-type
DC outputs in power interface panel	Screw-type max. 2.5 mm^2/AWG 14
Grounding in cabinet	With a grounding terminal max. 25 mm^2/ AWG 4 cable
Grounding press stud	Schaeffer code 1367

Table 11. Interfaces of DIUA unit

External alarms and controls	10 alarm inputs 4 control outputs 26-pin mini D (female)
Extension connector	50-pin mini D (female)
Q1 interfaces (2 pcs)	TQ
Local management ports LMP (2 pcs)	BQ

8.2.2 FXC RRI interfaces

Table 12. FXC RRI interfaces

Flexbus interfaces 1 (FB1) and 2 (FB2)	TNC connector 50 Ω Up to 16 x 2 Mbit/s signals Embedded power supply voltage 55 V_{DC} for radio outdoor units
Jitter and wander	ITU-T G.823

Table 12. FXC RRI interfaces (cont.)

Bidirectional data	37 Mbit/s, NRZ code, 1.4V pulse amplitude

8.2.3 FXC E1 interfaces

Table 13. E1 equipment interface

Bit rate	2048 kbit/s ± 50 ppm
Line code	HDB3
Impedance	75 Ω
Transmitter characteristics:	ITU-T G.703
– Nominal peak voltage of mark (pulse)	2.37 V
– Peak voltage of a space (no pulse)	0 ± 0.237 V
– Attenuation at 1 MHz	< 6 dB
Receiver characteristics:	ITU-T G.703
– Line attenuation at 1 MHz	< 20 dB
Jitter and wander	ITU-T G.823
E1 equipment synchronisation input (IF4 Rx):	
– Frequency	2048 kHz/s ± 50 ppm
– Sensitivity	1.5–3.0 Vpp

8.2.4 FXC E1/T1 interfaces

Table 14. E1 equipment interface

Bit rate	2048 kbit/s ± 50 ppm
Line code	HDB3

Table 14. E1 equipment interface (cont.)

Impedance	120 Ω
Transmitter characteristics:	ITU-T G.703
– Nominal peak voltage of mark (pulse)	3 V
– Peak voltage of a space (no pulse)	0 ± 0.3 V
– Attenuation at 1 MHz	< 6 dB
Receiver characteristics:	ITU-T G.703
– Line attenuation at 1 MHz	< 20 dB
Jitter and wander	ITU-T G.823
E1 equipment synchronisation input (IF4 Rx)	
– Frequency	2048 kHz/s ± 50 ppm
– Sensitivity	2–3.8 Vpp

Table 15. T1 equipment interface

Bit rate	1544 kbit/s ± 32 ppm
Line code	AMI or B8ZS
Impedance	100 Ω
Transmitter characteristics	ANSI T1.403 (DS-1) or ANSI T1.102 (DSX-1)
Jitter and wander	ITU-T G.824, AT&T TR 62411

8.2.5 Voltage levels

Table 16. External alarm input voltage levels

State	Input voltage	Input current	Loop resistance
LOW	-0.5 V...+0.75 V	> 3.9 mA	< 200 ohm
HIGH	+2.0 V...+5.5 V	< 2.8 mA	> 700 ohm
Input short circuit current to GND < 5 mA.			

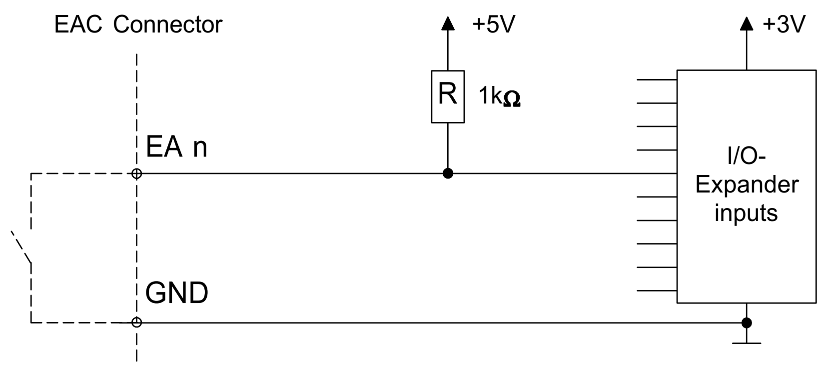


Figure 46. Wiring scheme for external alarm inputs

Table 17. Control output logic voltage levels

State	Voltage level
Allowed sink current	< 75 mA
Open circuit leakage current	< 880 µA
Allowed maximum voltage	+5 V

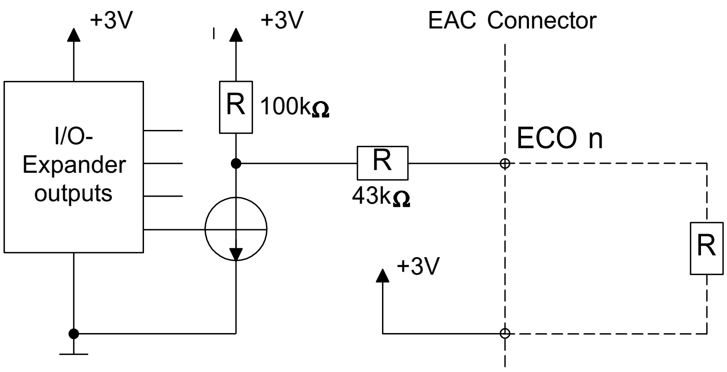


Figure 47. Wiring scheme for control outputs

8.3 Power requirements

8.3.1 Nokia MetroHub power requirements

Table 18. Power system

Voltage range	
Rated input voltages	110 to 240 VAC ; 50 to 60 Hz -48 to -60 VDC or internal battery
Permitted operating voltage fluctuation	85 VAC to 276 VAC ; 44 to 66 Hz -39 VDC to -72 VDC
Output voltages	-48 VDC/0.5 A +55 VDC/5 A
for battery back-up	-48 VDC/2.1 A for charging 110 to 240 VAC @ 1 A for heating
Power consumption	

Table 18. Power system (cont.)

Voltage range	
Max. input power	750 VA (AC) 500 W (DC)

Table 19. Battery backup time in minutes; one power supply unit in use

Configuration	**+25°C (77°F)**	**-10°C (14°F)**	**-40°C (-40°F)**
5 x FXC E1	380	300	95
6 x MetroHopper	170	130	70
10 x FlexiHopper	50	40	20
MetroHub PT with one FlexiHopper	380	270	100
MetroHub PT with two FlexiHoppers	230	160	80

Note

Using the Nokia MetroSite Battery Backup roughly doubles the above backup times.

8.3.2 FXC RRI power requirements

Table 20. Power supply and power consumption

DC supply voltage	Powered by Nokia MetroHub
Power consumption	< 8 W (For OU power consumption, see the radio documentation)

8.3.3 FXC E1 and FXC E1/T1 power requirements

Table 21. Power supply and power consumption

DC supply voltage	Powered by Nokia MetroHub
Power consumption	< 6 W

8.4 Node manager software

Nokia SiteWizard 3.1 is needed for the Nokia ITN C2.1 release.

The *transmission element managers on Nokia SiteWizard 3.1* CD-ROM are compatible with ITN C2.0 managers. Furthermore, ITN C2.1 node managers work also with ITN C1.2 hardware, but not all features or functions are supported.

Table 22. System requirements for Nokia SiteWizard

Item	**Specification**
Computer	Intel Pentium compatible PC
Operating system	Microsoft Windows 2000 (English version, Service Pack 3) Microsoft Windows NT 4.0 (English version, Service Pack 6 a) Microsoft Windows 98 (English version)
System memory	Windows 2000: 64 MB (128 MB recommended) Windows NT: 64 MB (128 MB recommended) Windows 98: 32 MB (64 MB recommended)
Monitor	SVGA, 800 x 600 resolution minimum SVGA, 1024 x 768 resolution recommended

Table 22. System requirements for Nokia SiteWizard (cont.)

Item	Specification
Disk space	50 MB minimum 200 MB recommended for full SiteWizard CD-ROM installation
Accessories	CD ROM drive Windows compatible mouse or pointing device Free 9-pin serial port and LMP cable (PC −BTS/Node) Windows compatible printer (optional)

8.4.1 Node manager sources

Nokia SiteWizard is delivered updated and on two CD-ROMs. The product code is 468783A.

8.5 Flexbus cable requirements for FXC RRI

Table 23. Flexbus cable requirements

Cable type	Coaxial cable, double shielded or semi-rigid
Recommended cable types	RG-223, max. length 140 m RG-214, max. length 300 m
Characteristic impedance	50 ± 2 Ω
DC resistance	< 4.6 Ω (sum of inner and outer conductor)
Data attenuation	< 9.0 dB at 19 MHz
Flexbus signals	- DC power supply - Bidirectional data (37 Mbit/s, NRZ code, 1.4V pulse amplitude)

Table 23. Flexbus cable requirements (cont.)

Note Over-voltage protection and cable equalizer are integral parts of the Flexbus interface. Primary over-voltage protection is a 90 V gas-arrester. External gas-arresters can be used as well.

Table 24. Recommended cable type

RG-223	Maximum length 140 m (459 ft.)
RG-214	Maximum length 300 m (984 ft.)

8.6 Transmission capabilities

Table 25. Nokia MetroHub transmission capabilities

Cross-connection bus capacity		56 x 2 Mbit/s non-blocking with 8 kbit/s granularity
Basic cross-connection types:		Granularities:
B2	Bi-directional	2M / nx64k / 64k / 32k /16k / 8k
M2	Bi-directional masked	64k / 32k / 16k
D	Uni-directional fixed	64k / 32k / 16k / 8k
Protected cross-connection type:		Granularity:
P2	Protected bi-directional	nx64k / 64k / 32k / 16k
Max. interface capacity of the node		160 x 2 Mbit/s specifications

Table 26. Nokia UltraSite transmission capabilities

Cross-connection bus capacity		56 x 2 Mbit/s non-blocking with 8 kbit/s granularity
Basic cross-connection types:		Granularities:
B2	Bi-directional	2M / nx64k / 64k / 32k /16k / 8k
M2	Bi-directional masked	64k / 32k / 16k
D	Uni-directional fixed	64k / 32k / 16k / 8k
Protected cross-connection type:		Granularity:
P2	Protected bi-directional	nx64k / 64k / 32k / 16k
Max. interface capacity of the node		128 x 2 Mbit/s specifications

Table 27. Nokia MetroSite transmission capabilities

Basic cross-connection types:		Granularities:
B2	Bi-directional	2M / nx64k / 64k / 32k /16k / 8k
M2	Bi-directional masked	64k / 32k / 16k
D	Uni-directional fixed	64k / 32k / 16k / 8k
Protected cross-connection type:		Granularity:
P2	Protected bi-directional	nx64k / 64k / 32k / 16k
Max. interface capacity of the node		32 x 2 Mbit/s specifications

9 International recommendations

9.1 Nokia MetroHub standards

Table 28. Electrical standards

Input voltage	
ETS 300 132-1:1996	Equipment Engineering Power Supply Interface at the input to Telecommunications Equipment Interface Operated by Alternated Current AC
ETS 300 132-2:1996	Power Supply Interface at the input to telecommunications Equipment Interface Operated by Direct Current DC
ETS 300 253: 1995	Earthing and bonding of telecommunication equipment in telecommunication centres
Electrical safety	
EN 60950:1992 A1:1992 A2:1993 A3:1995 A4:1996 IEC 950:1991 A1:1992 A2:1993 A3:1995 A4:1996	Safety of Information Technology equipment, Including Electrical Business Equipment + Amendments A1, A2, A3 and A4
UL 1950: 1995, 3rd edition	Standard for Safety of Information Technology equipment, including Electrical Business Equipment
FCC Part 68	Rules for Registration of Telephone Equipment PART 68: 1995

Table 28. Electrical standards (cont.)

EMC	
EN 300 386-2 V1.1.3 (1997-12)	Electromagnetic Compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements Part 2: Product family standard
FCC Part 15	FCC Rules for Radio Equipment Devices

Table 29. Environmental standards

ETS 300 019-1-1:1992	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1-1: Classification of environmental conditions: Storage
ETS 300 019-2-1:1992	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 2-1: Specification of environmental tests: Storage
ETS 300 019-1-2:1992	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1-2: Classification of environmental conditions; Transportation.
ETS 300 019-2-2:1992	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 2-2: Specification of environmental tests: Transportation.
ETS 300 019-1-4:1992	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment part 1-4: Classification of environmental conditions. Stationary use at non-weather protected locations
ETS 300 019-2-4:1992	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment part 2-2: Specification of environmental tests: Stationary use at non-weather protected locations

Table 30. Mechanical standards

ETS 300 753, 1997	Equipment Engineering (EE); Acoustic noise emitted by telecommunications equipment.
ISO 3744, 1988	Acoustics Determination of sound power levels of noise sources Engineering methods for special reverberation test rooms
IEC 68-2-57: 1989	Environmental Testing Part 2: Test Methods Ff: Vibration Time-history method
EN 60529: 1989	Degrees of Protection Provided by Enclosures (IP Code)

Acoustic noise

The maximum acoustic noise generated by Nokia MetroHub is 61 dB (A) in an outdoor environment and 55 dB (A) in an indoor environment of up to 30°C (86° F).

9.2 FXC RRI standards

Table 31. International recommendations

Flexbus interface	
ITU-T G.704 (10/94)	Synchronous frame structures used at primary and secondary hierarchical levels.
ITU-T G.706 (1991)	Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704
ITU-T G.823 (03/93)	The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy.
ITU-T G.826 (08/96)	Error performance parameters and objectives for international, constant bit rate digital paths at or above primary rate.
ITU-T G.921	Digital sections based on the 2048 kbit/s hierarchy

9.3 FXC E1 and FXC E1/T1 standards

Table 32. International recommendations

2048 kbit/s E1 interface	
ITU-T G.703 (1991)	Physical/electrical characteristics of hierarchical digital interfaces
ITU-T G.704 (10/94)	Synchronous frame structures used at primary and secondary hierarchical levels
ITU-T G.706 (1991)	Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704
ITU-T G.823 (03/93)	The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy
ITU-T G.826 (08/96)	Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate
1544 kbit/s T1 interface	
ITU-T G.824 (03/93)	The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy
ANSI T1.403 (1995) and T1.102 (1993)	Digital interface characteristics Functional Interface Characteristics PCM Coding Law Primary PCM Multiplexer Performance parameters
AT&T TR 62411 (12/90)	Jitter and Wander Multiplexing, Rate Adaptationinternational recommendations
BELCORE GR-1089	Electromagnetic compatibility and electrical safety - generic criteria for network telecommunications equipment.
FCC Part 68.308	Signal power limitations

Related topics

Conventions used in Nokia MetroHub documentation

Warnings and cautions

Nokia MetroHub Manager

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Starting the node manager

Installing software from Nokia SiteWizard

Overview of upgrading the node manager and node software

Descriptions

Menu overview

Menu overview

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Setting Nokia FlexiHopper and Nokia FlexiHopper Plus settings

Reference

128 Fault in equipment

143 Fault in change over function

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Fading margin measurement

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Transmission network protection using loop topology

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Adjusting synchronisation loop bit settings.

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Connecting the FXC E1/T1 transmission unit cables

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Node manager software

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Reference

ITN hardware and software compatibility

Descriptions

Changes in software between releases ITN C2.0 and ITN C2.1/Node manager software