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GSM/EDGE BSS, rel.
RG10(BSS), operating
documentation, issue 06**

**Flexi Multiradio BTS GSM/EDGE Product
Description**

DN0946871

Issue 01

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Non-observance of these conditions and the safety instructions can result in personal injury or in property damage.

Therefore, only trained and qualified personnel may install and maintain the system.

The system complies with the standard EN 60950 / IEC 60950. All equipment connected has to comply with the applicable safety standards.

The same text in German:

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Das System entspricht den Anforderungen der EN 60950 / IEC 60950. Angeschlossene Geräte müssen die zutreffenden Sicherheitsbestimmungen erfüllen.

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1 CE marking



Figure 1 CE marking

Hereby, Nokia Siemens Networks declares that this Base Station is in compliance with the essential requirements and other relevant provisions of Directive: 1999/5/EC.

2 FCC Part 15 compliance

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

3 Technical overview of Flexi Multiradio BTS GSM/EDGE

Introduction

Flexi Multiradio BTS is a base transceiver station that is part of the Nokia Siemens Networks Flexi BTS platform for GSM/EDGE, WCDMA, and LTE networks. It is a multi-radio or multicarrier BTS that can use all these network technologies either in dedicated or concurrent mode of operation.

Its modular design makes site acquisition and installation easy, and reduces the time needed for rolling out network coverage in a new area. It allows using existing site space efficiently, the existing Flexi BTS modules can be installed together with Flexi Multiradio BTS modules. The existing Flexi BTS cabinets and casings, power supplies, and the 3G Flexi System Module can be used with Flexi Multiradio modules.

Easy installation

Flexi Multiradio BTS is installed with weather proof modules and casings, hence a dedicated BTS cabinet is not necessary. It has a broad operational temperature range and can be used in varied climatic conditions. The modules are IP65 compliant for environmental protection. The Flexi Multiradio BTS provides high coverage and capacity for macro cellular applications.

The same modules can be used in indoor and outdoor sites for macro cellular and micro cellular solutions. The modules can be installed on floor, wall, poles, and Flexi cabinets for indoor and outdoor (FCIA and FCOA). The fixing points of the plinth in stacked installations or Flexi cabinet plinth are in the same points as in previous BTS generations. Flexi Multiradio BTS modules can also be installed into existing site support cabinets having 19-inch space and where cooling requirements are fulfilled.

Flexi Multiradio BTS GSM/EDGE modules (ESMB/C and FXxx) are equipped with an integrated air guide plate providing full thermal compliance without casings. This allows installation of the modules without casings in Flexi cabinets and enclosed 19" racks. Casings and covers are recommended in standalone 19" racks (no cabinet) for safety reasons. Casings are not part of the FXxx or ESMB/C delivery package. If the configuration requires casings, Flexi BTS Module Casing (EMHA) kits must be ordered.

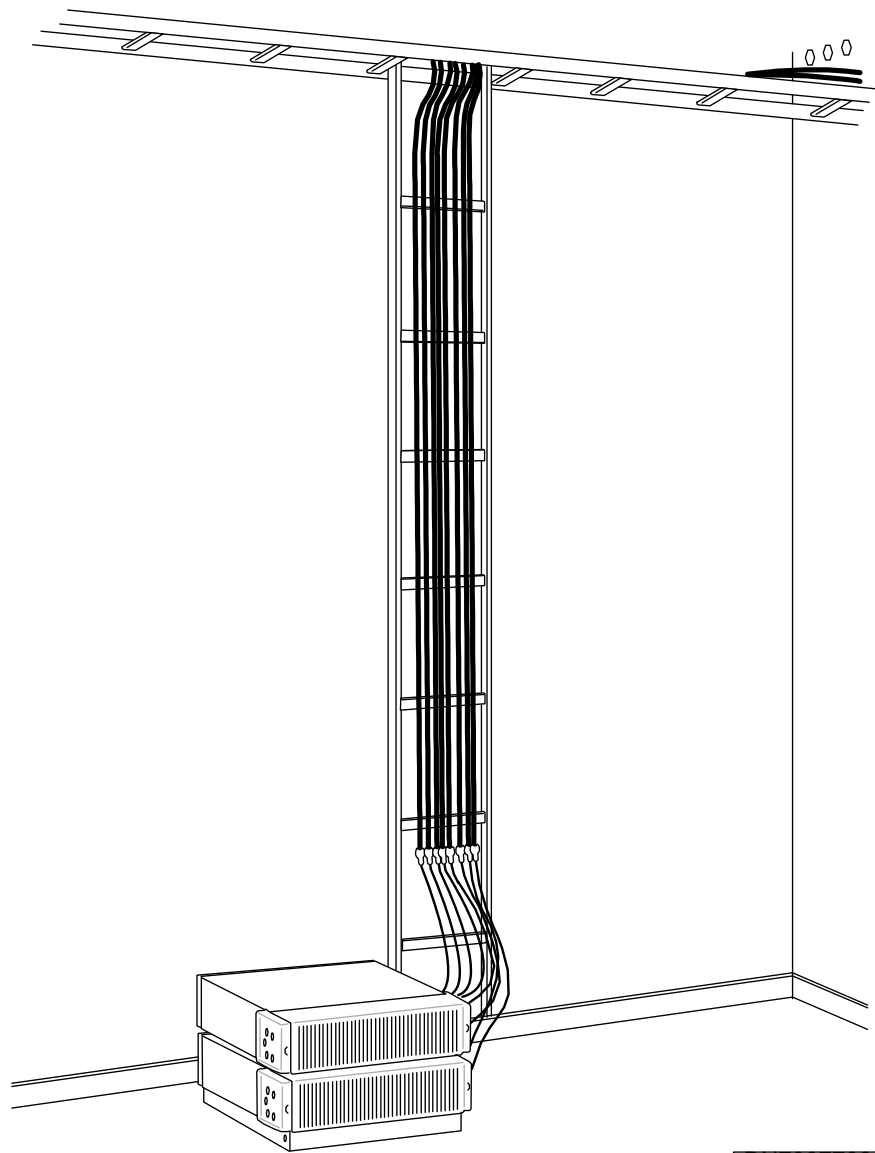


Figure 2 An example of floor installation

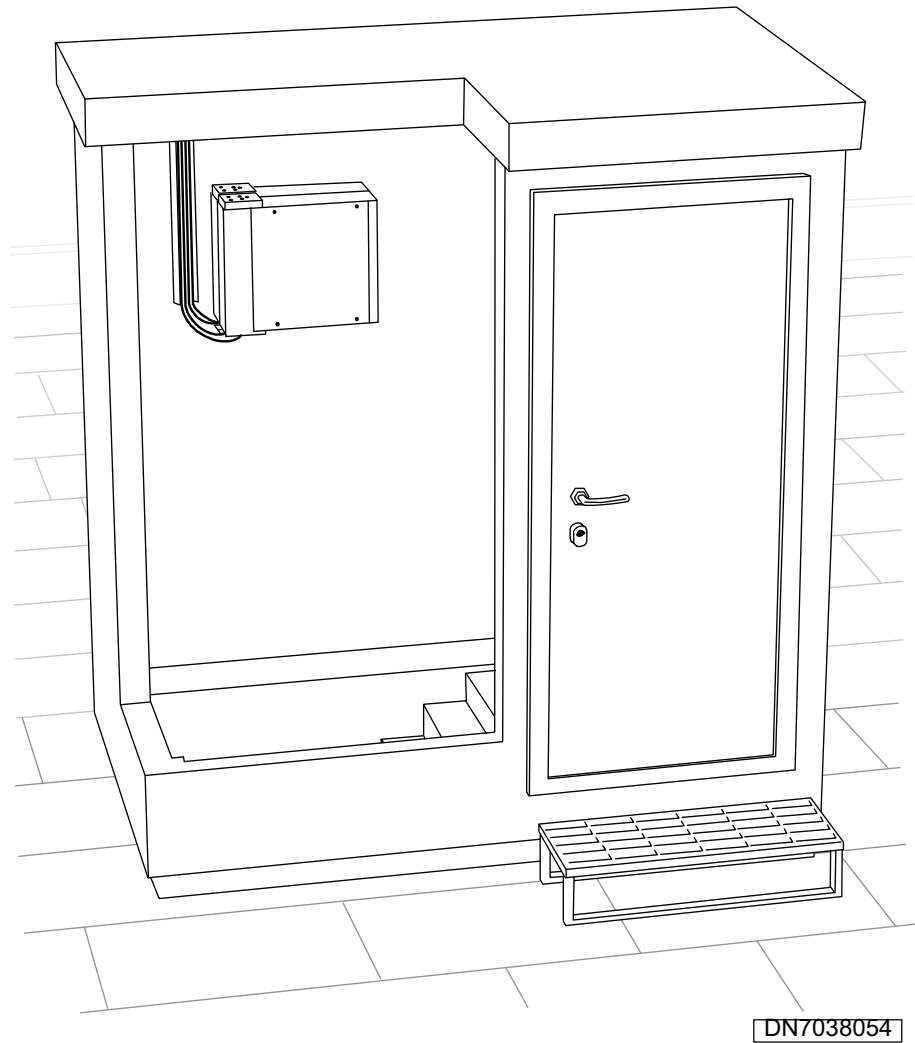
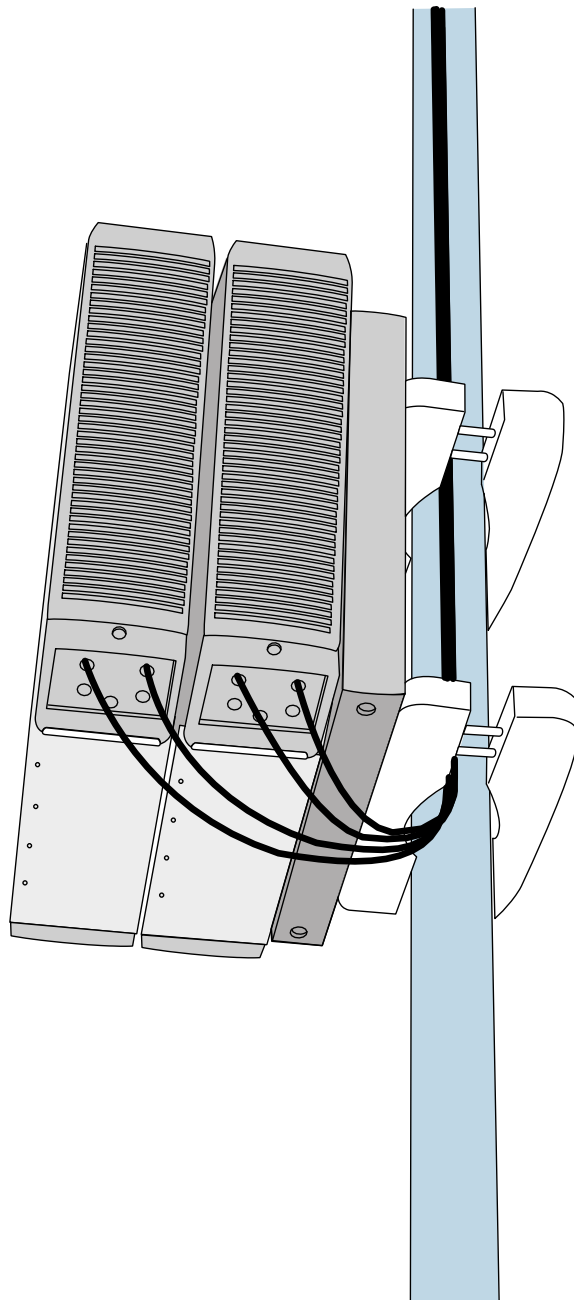


Figure 3 An example of wall installation



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Figure 4 An example of pole installation

Capacity and performance

The Flexi Multiradio GSM/EDGE System Module provides baseband capacity for 18 or 36 GSM/EDGE TRXs depending on the version (ESMB or ESMC respectively). The traffic capacity of Flexi Multiradio BTS depends on the radio capacity of the radio module, the baseband capacity and the transport capacity. The baseband capacity of GSM/EDGE and WCDMA/LTE are independent of each other as each technology uses separate System Modules and transport.

There are 3 radio branches in one Flexi Multiradio Radio Frequency module (FXxx). The TRX capacity of Flexi Multiradio BTS can be modified based on the traffic by increasing

or decreasing the number of TRXs within a Radio Module branch, or by increasing the number of radio modules. Each radio module branch supports up to 6 GSM/EDGE TRXs. The Radio module can be split into separate cells for multi-operator BTSs.

Flexi Multiradio modules can be installed on a mast or a pole reducing the antenna feeder line length and thus increases the RF performance.

Increased speed of network roll-out and reduced operating costs

Flexi Multiradio BTS minimizes BTS site rental costs as a BTS-specific cabinet is no longer needed. The floor space required for large configurations is reduced. The existing site support and auxiliary cabinets with sufficient space and cooling can be used to house the modules, further increasing the efficiency of site space. When it comes to rectifier and battery maintenance, the reduced power consumption enables the use of smaller power systems with fewer batteries. If lithium batteries are used, the maintenance interval is longer.

When it comes to site maintenance, there are advantages as compared to the current BTS solutions. Lower power consumption means longer battery back up time. Diesel generators are required less frequently, as the batteries supply the base station for a longer period of time compared to old BTSs. New installation options make it possible to install the base stations to places that are better protected against vandalism and natural catastrophes. This means that less shelter maintenance is required.

Common Nokia Siemens Networks Flexi platform for efficient multiradio sites

Common Nokia Siemens Networks Flexi multimode platform for GSM/EDGE, WCDMA, and LTE ensures that high capacity multimode sites can be built smoothly and cost-effectively. Evolution from GSM/EDGE to WCDMA and to further radio technologies such as LTE can be ensured rapidly and with minimal effort.

In Nokia Siemens Networks Flexi platform, the site design and capacity expansion principles are the same. GSM/EDGE and WCDMA, LTE modules are the same size and follow the same installation principles, which increased efficiency, as the same installation teams can do the installation for different radio technologies. The modules can be installed into the same stack or they can share the same BTS cabinet. Battery backup systems (BBU), site accessories, and transmission can also be shared.

4 Construction and modules

4.1 Main modules

Flexi Multiradio BTS supports GSM/EDGE, WCDMA and LTE for dedicated or concurrent configurations. The BTS software is different for 2G and 3G. The 2G BTS software runs in the 2G System Module (ESMB/C) and 3G software runs in the 3G System Module (FSMx) and the radio resource is shared. Therefore 2G and 3G interoperability functions are supported. The functional units of Flexi Multiradio BTS are Flexi Multiradio System Module (ESMB/C) and Radio Frequency Module (FXxx or RFM/RF Module).

4.1.1 Flexi Multiradio System Module (ESMB/C)

The Flexi Multiradio System Module provides the GSM/EDGE functionality to the BTS. It provides internal and external BTS connections, and stores and runs the GSM/EDGE BTS software.

The System Module also receives and stores the unit identification information of all other units of the BTS. ESMB and ESMC System Modules support configurations of up to 18 and 36 TRXs respectively.

The main functions of the ESMB/C are:

- GSM/EDGE BTS Operation and Maintenance
- Abis interfacing
- Open Base Station Architecture Initiative (OBSAI) connectivity
- Power distribution to other modules
- GSM/EDGE baseband
- BTS synchronization

External and internal interfaces in ESMB/C are:

- 48V DC distribution, 4 outputs and 1 Auxiliary output
- Abis interface
- External Alarm and Control Interface
- 4 optical interfaces (OBSAI RP3-1)
- Auxiliary equipment interfaces
 - Q1
 - Flexi Power Alarms (FPA)
- Local Management Port (LMP)

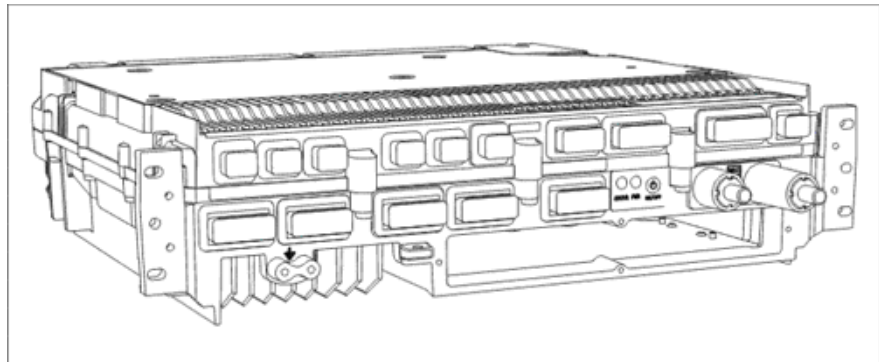


Figure 5 Isometric view of ESMB/C

The following plug-in transmission sub-module variants are available for the Flexi Multi-radio System Module (ESMB/C). In the provided transmission slot one of the following transmission sub-modules can be used. And also refer Transmission sub-modules (FlxA) section in [Optional modules](#).

- E1/T1 transmission sub-module (FIPA) - The FIPA offers eight balanced E1/T1-interfaces.
- E1 transmission sub-module (FIEA) - The FIEA offers eight unbalanced E1-interfaces.
- Flexbus transmission sub-module (FIFA) - The FIFA offers two Flexbus interfaces connecting radio links that belong to the Flexi Hopper family. FIFA can also be used for connecting other transmission devices supporting Flexbus interface.
- Abis over IP Ethernet and E1/T1 (FIQA) - The FIQA transmission sub-module offers two Fast Ethernet, one Gigabit Ethernet and, four balanced E1/T1 interfaces. SFP (Small Form-factor Plug) module is required for Gigabit Ethernet.
- Abis over IP Ethernet and E1 (FIYA) - The FIYA transmission sub-module offers two Fast Ethernet, one Gigabit Ethernet and, four unbalanced E1 interfaces. SFP module is required for Gigabit Ethernet.

See Transmission sub-modules (FlxA) for information on transmission sub-modules in the section [Optional modules](#).

For the physical interface details, see System Module (ESMB/C) interfaces in [Flexi Multiradio BTS GSM/EDGE System Module \(ESMB/C\) Description](#).

4.1.2 Flexi Multiradio RF Module (FXxx)

FXxx is a 3HU high module with a 3-branch radio transceiver. The module consists of three independent branches designed to concurrently transmit and receive multicarrier signals of multiple radio technologies. One transmitter and receiver (one branch) can create one sector. One FXxx can support up to 3 sector configuration. Each sector consists of a transmitter, receiver chains and front end filters. It contains two receive chains to provide the functionality of 2-way receive diversity functionality. It is possible to chain up to 3 radio modules with OBSAI RP3-1. The front end filters are software tunable filters. FXxx contains integrated antenna line supervision and MHA support.

The RF module also contains the necessary functionalities like the digital and control circuitry, RP3-1 interfaces and the required DC/DC power conversion. The RF modules are supplied with replaceable fan units.

External and internal interfaces in FXxx are:

- 48V DC input
- External Alarm interface compatible with FPA
- 3 optical interfaces (OBSAI RP3-1)
- 6 Antenna interfaces - 3 duplexed and 3 RX diversity
- FXDA/FXEA/FXJA has 3 RX diversity outputs and FXCx/FXFx has 6 Rx outputs

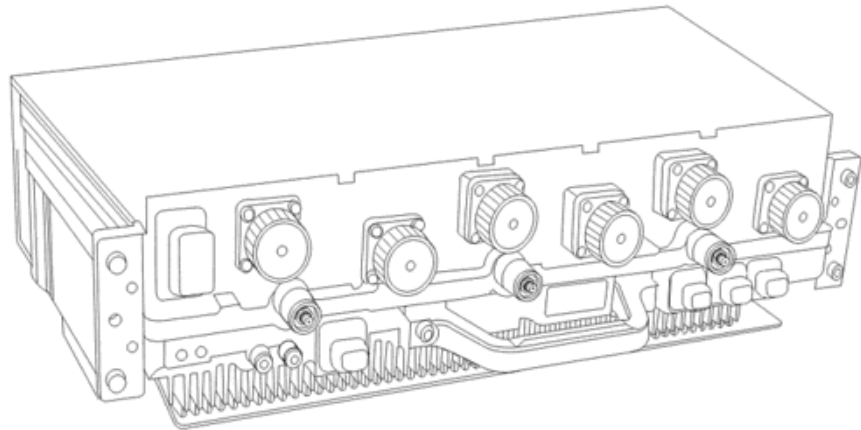


Figure 6 Isometric view of RF Module (FXDA/FXEA/FXJA)

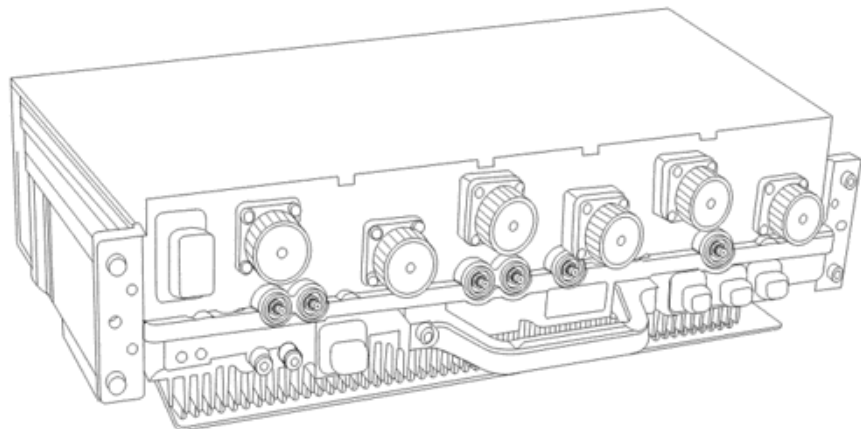


Figure 7 Isometric view of RF Module (FXCx/FXFx)

FXxx is a single band unit; there is a separate FXxx module for each frequency band supported by Flexi Multiradio BTS as follows:

- FXCA – GSM850 full band
- FXDA – GSM900 full band (E-GSM)
- FXDJ – GSM900 J-band (P-GSM for CDMA co-siting)
- FXEA – GSM1800 full band
- FXFA – GSM1900 full band

Each sector/ carrier/TRX in an FXxx can be shut down separately. The voltage of the power amplifier can be adjusted to optimize the power consumption of the module.

4.1.3 Flexi Remote Radio Head (FHxA)

Remote Radio Head is a 2-branch MCPA unit optimized for single sector usage with 2-way diversity. It consists of two individual branches to transmit and receive Multicarrier signals of multiple radio technologies concurrently. Each branch contains the transmitter and receiver chains and front end filters. Each branch contains one receiver chain in the RRH. The front end filters are fixed filters covering the whole band. FHxA contains integrated antenna line supervision. Similar to a RF module, RRH contains the necessary common functionality like digital and control circuitry, OBSAI interface and the needed DC/DC power conversion. RRH uses natural convection cooling, i.e. it does not have cooling fans. There is a common baseband part for the transceivers within the system modules.

The following is the list of interfaces in FHxA:

- 48 VDC input
- External Alarm Interface
- Optical OBSAI RP3-1 Interface
- Duplexed Antenna interfaces
- RET interface, AISG 2.0
- Antenna tilt support

The following is the list of features supported by FHxA:

- Two Transceivers to support 2 TX MIMO
- 40 + 40 W output power at antenna connectors
- Two Linear Power Amplifiers
- Two RF filters for TX/RX
- 2-way RX diversity

4.2 Optional modules

This section describes the optional modules in Flexi Multiradio BTS.

4.2.1 Flexi Power Module (FPMA)

The optional Flexi Power Module (FPMA) includes AC connection box, DC cable set, and a support frame for the actual power sub-modules (FPAA and FPBA).

4.2.1.1 Flexi Power AC-DC Sub-Module (FPAA)

The main function of the FPAA is to provide the BTS modules with 48V DC power from AC supply. The FPMA can house up to four AC/DC rectifiers, each having output power of 1 kW 48V DC.

4.2.1.2 Flexi Power Battery Sub-Module (FPBA)

The Flexi Power Battery Sub-Module (FPBA) is a separate optional sub-module used together with the FPAA. The FPMA can house up to three battery sub-modules.

4.2.2 Flexi Power DC/DC 24 V Module (FPDA)

The function of the optional Flexi Power DC/DC converter (FPDA) is to generate BTS internal 48 V DC power from the external 24 V DC supply. The FPDA is a stand-alone 2 kW DC/DC converter.

4.2.3 Flexi Power Rectifier (FPRx)

The Flexi Rectifier Module (FPRx) is a modular 6kW output power AC rectifier package made up of three individual 2kW AC/DC power modules operating in a parallel mode configuration. The FPRx outputs a positive earthed -54VDC (V48N) as a respective BTS operational supply voltage rail and for site battery charging. It supports 2G and 3G Flexi BTS configurations (indoor and outdoor cabinets, and stack, pole and wall configurations).

4.2.4 Flexi System External OVP (FSEC)

The FSEC protects Flexi Multiradio sub-modules against surge pulse(s) in power feeding lines in the feederless site solutions. The same mechanics can also be used for AC line devices, but the connectors and OVP devices need to be changed. The FSEC gives Class II (C, T2) protection for DC power feed and provides IP65 protection.

4.2.5 Flexi System External Alarm Module (FSEB)

The System Module has 6 BBU alarm inputs, 12 external alarm inputs and 6 control outputs. An optional System External Alarm Module is used when up to 24 external alarm inputs and 6 control outputs need to be supported with Flexi Multiradio BTS.

The System External Alarm Module is connected to the EAC interface in the System Module and the BBU alarm inputs to FPA interface. The System External Alarm Module provides ingress-protected screw terminals for the single alarm and control lines.

4.2.6 Transmission sub-modules (FlxA)

The transmission sub-modules (FlxA) are plug-in units housed in the Flexi Multiradio System Module (ESMB/C). The transmission sub-modules provide different network interface alternatives.

4.2.6.1 Flexbus transmission sub-module (FIFA)

The FIFA offers two Flexbus interfaces, used for connecting radio links belonging to Flexi Hopper family. FIFA can also be used for connecting other transmission devices that offer Flexbus interface.

4.2.6.2 E1 transmission sub-module (FIEA)

The FIEA offers eight E1 interfaces.

4.2.6.3 E1/T1 transmission sub-module (FIPA)

The FIPA offers eight E1/T1 interfaces.

4.2.6.4 Abis over IP Ethernet and E1/T1 (FIQA)

The FIQA is a transmission sub-module offering two Fast Ethernet, one Gigabit Ethernet, and four balanced E1/T1 interfaces. An SFP module is required for Gigabit Ethernet.

4.2.6.5 Abis over IP Ethernet and E1 (FIYA)

The FIYA is a transmission sub-module offering two Fast Ethernet, one Gigabit Ethernet, and four unbalanced E1 interfaces. An SFP module is required for Gigabit Ethernet.

4.3 Optional cabinets

Flexi Multiradio BTS modules can be installed in optional indoor and outdoor BTS cabinets. The same optional cabinets can house Flexi WCDMA and BBU modules. Therefore, it is possible to build GSM/EDGE, WCDMA/HSPA and/or multiradio (GSM/EDGE/WCDMA/HSPA) configurations in the same cabinet.

4.3.1 Flexi Cabinet for Outdoor (FCOA)

Flexi BTS outdoor cabinet is an optional sales item for new sites where a cabinet is needed. It includes a lock and a door alarm switch that is connected to the BTS System Module EAC connector. The outdoor cabinet can also be used in indoor locations where a low, locked multi-purpose equipment cabinet is needed.

FCOA can include the following optional items:

- Flexi Cabinet Site Support Module (FCSA)
- Battery back-up unit (MIBBU or FPRx)
- Air filter (FCFA)
- Fire detector
- Flexi System External Alarm (FSEB)
- Flexi System External OVP (FSEC)

4.3.2 Flexi Cabinet for Indoor (FCIA)

Flexi BTS indoor cabinet is an optional sales item for new indoor sites where a cabinet is needed.

The optional indoor cabinet can include the following optional items:

- Flexi System External Alarm (FSEB)
- Flexi System External OVP (FSEC)
- Battery back-up unit (MIBBU or FPRx)
- Lifting Handle Kit (WLHA)

4.3.3 Flexi Mounting Shield (FMSA and FMSB)

Flexi Mounting Shield (FMSA/FMSB) is an outdoor cabinet for a stacked Flexi BTS. Used instead of the plastic front and rear covers, it provides protection against solar load, large insects, and slight vandalism. Flexi Mounting Kit Floor/Wall/Pole (FMFA) is required in both cabinets.

The FMSA provides installation space for up to any two Flexi 3U modules and the plinth (6U in total). It is installed on a pole or wall.

The FMSB provides space for up to any six Flexi 3U modules and the plinth (18U in total). It is installed on the floor.

Flexi 3U Mounting Covers front/back (FMCA) as well as RF Module and System Module cable entries are not used in mounting shield installations. The cabinet door is right-handed (the handedness cannot be changed).

4.4 Optional items

This section describes the optional items in Flexi Multiradio BTS.

4.4.1 Flexi Module Casings (EMxA)

Optional Nokia Flexi Module Casings (EMxA) are used to fix the modules to floor, wall, or pole. Module casings enable module replacement without the need to completely dismantle the BTS installation and ensure environmental protection (IP55) against different environments.

4.4.2 Flexi Mounting Kits for floor, wall, and pole (FMFA and FMFA)

Flexi mounting kits for floor and wall (FMFA), and pole (FMFA) are plinths that are needed when modules are installed without a cabinet. The plinth provides grounding points for BTS and module grounding.

4.4.3 Pole Mounting Kit (VMPB)

The pole mounting kit enables BTS installation on a pole 60 - 300 mm (2.4 - 11.8 in.) in diameter.

4.4.4 Flexi Pole Mounting Kit (FPKA)

The Flexi Pole Mounting Kit (FPKA) can be used with poles between 60 mm (2.4 in.) and 120 mm (4.7 in.) in diameter. The most commonly used size is 80 mm (3.1 in.). The FPKA can replace the WMPB Pole Mounting kit in installations where the pole diameter is less than 120mm (4.7 in.).

4.4.5 Flexi Mounting Covers for Back and Front (FMCB)

Flexi mounting covers for back and front is an optional 2U (FMCB) module cover that is required in FPDA installations without a cabinet. The primary functions of the covers are to provide protection against wind-driven rain, visual protection, and mechanical protection for the cables. Furthermore, the back cover protects the installer's fingers from the rotating fans.

4.4.6 Flexi Cabinet Air Filter (FCFA)

An optional Nokia Flexi Cabinet Air Filter (FCFA) is available for the Flexi Multiradio BTS Outdoor cabinet to filter items such as salt, dust and insects out of the fresh air through the cabinet cooling input. A cabinet filter is required on oceanic and coastal areas where salt deposition is high.

4.4.7 Fire Detector

An optional fire detector is available for Flexi BTS Outdoor Cabinet. It is connected to one of the BTS EAC alarm lines.

4.4.8 Talk Conversion Kit (EMIA or EMIB)

Flexi Multiradio BTS modules can be installed into the CityTalk cabinet by using the Talk conversion kit EMIA or EMIB. The inner parts of the CityTalk cabinet is stripped out before the Flexi Multiradio BTS modules are installed and certain parts of the CityTalk cabinet are replaced with new parts belonging to the EMIA or EMIB kit.

4.4.9 Upgrade Cable Kit (EUCA)

EUCA is used for co-siting (Rx diversity sharing) Flexi Multiradio with Flexi EDGE BTS.

4.4.10 Flexi Mounting Kit Horizontal for 2G (FMUB)

Flexi Multiradio modules can be installed on existing GSM/EDGE UltraSite sites. The mounting kit can be used with the following indoor and outdoor GSM/EDGE UltraSite cabinets:

- UltraSite Indoor Cabinet (IDCA) v. 202 or newer
- UltraSite Outdoor Cabinet (ODCA) v. 202 or newer
- UltraSite EDGE Outdoor Cabinet (ODCF)

The mounting kit consists of a rack in which, for example, one System Module, up to three RF Modules, and one FPMA or FPDA are installed, and cables. The space requirement for 5 x 3U modules is 15U.

4.4.11 Mounting Kit for NB Flexi Outdoor (FMUD)

FMUD is an outdoor installation kit, which is installed in the NB 441/881 cabinet. It consists of space for a maximum of six 3U modules in two racks, to which Flexi BTS modules are installed. There are two installation options, stack installation and feederless installation.

4.4.12 Mounting Kit for NB Flexi Outdoor (FMUG)

The FMUG is an outdoor installation kit that is installed in the BS-241 Service Shelter. It consists of a rack in which two 3U Flexi BTS modules can be installed. The options to implement Flexi modules inside service shelter BS 241 with FMUG are:

- FMUG without new bottom plate: lower number of external cables.
- FMUG with new bottom plate: higher number of external cables or any restriction depending on bending radius.

5 Applications and configurations

5.1 Capacity solutions

In urban and suburban areas, operators typically provide the mobile services, including voice and data, from high capacity macrocellular sites. In urban environments, large mobile traffic hot spots must be covered, often requiring high site capacity configurations. In suburban locations, there is a simultaneous need for high capacity and cost-effective area coverage. In addition, it has the ability to expand smoothly from small to very large capacities, using the site space sparingly in order to keep site-running costs at minimum.

Flexi Multiradio BTS allows very high capacity with macrocellular sites, taking only little space even with large configurations. Up to 36 TRX configurations can be built in the volume of a traditional BTS. Flexi Multiradio BTS offers flexible combining options to increase the BTS capacity without a need to add the number of BTS antennas. The carrier capacity of the BTS can be flexibly increased by increasing the number of RF Modules.

The traffic capacity of the Flexi Multiradio BTS depends on the radio, baseband and transport capacity of the radio module. Baseband processing is done in the system module. There are separate system modules for GSM/EDGE and WCDMA/LTE in Flexi Multiradio BTS. Therefore the baseband capacity of GSM/EDGE and WCDMA/LTE is independent of each other. Also the transport for GSM/EDGE and WCDMA/LTE is separate as it is located in the system module. The transmission connection to the BTS can be shared by the system modules.

5.2 Coverage solutions

During the deployment of a GSM/EDGE network, operators prefer cost optimized network deployment, minimising the number of BTS sites required. This is achieved by optimizing the radio performance of the BTS for coverage. In a wireless network, the BTS uplink and downlink performance is balanced to increase the coverage.

Flexi radio modules can be installed in a mast or a pole. This reduces the antenna feeder line length and thus increases the RF-performance. Flexi Multiradio BTS provides several options for maximizing the coverage.

- Uplink
 - Separate Mast Head Amplifier (MHA) with radio module
 - Receiver 2-way and 4-way diversity
- Downlink
 - Intelligent Downlink Diversity
 - Multiple input multiple output (MIMO)
- Extended cell

The output power per carrier of a sector depends on the number of carriers configured in that sector. The output power decreases when the number of carries increases. The capacity of the BTS can be increased by using multiple radio frequencies. And sector configurations increase the coverage. The carriers can be split to multiple radio pipes within one sector to increase the output power to improve the BTS coverage.

The carrier capacity of a sector of a Flexi Multiradio BTS can support up to 6 GSM/EDGE TRX, 4 WCDMA carriers or 4 5Mhz LTE carriers in a dedicated or concurrent mode. The capacity of the BTS can be increased by increasing the number of radio modules.

Mast Head Amplifier (MHA)

The Mast Head Amplifier is installed next to the antenna which uses Low Noise Amplifier (LNA) to improve the receiver performance by reducing the noise figure and compensating the antenna line losses. MHA support (power feed, alarms) is integrated in the Duplex Filter and alarms are generated based on adjustable MHA current consumption window. Flexi Multiradio BTS supports Mast Head Amplifiers with 3 sector radio module but should not be used in feederless site.

Receive diversity

The fading receive sensitivity of a BTS can be improved by using multipath receive diversity. 2-way diversity requires at least two antennas for each sector and also requires receiver for each antenna, i.e. at least two receivers. The 3-branch RF module is optimized for 2RX diversity. The unit has diversity RX path in addition to main RX path in each radio pipe. So 2-way diversity can be configured in 3-branch RF module without any additional BTS HW.

4-way RX-diversity requires at least four antennas in each sector. Therefore it requires at least two radio pipes from 3-branch RF module per sector. Typically two RF modules with two parallel pipes are configured for single 4RX diversity sector. In GSM/EDGE 4-way RX-diversity can only be used in conjunction with IDD.

Intelligent Downlink Diversity in GSM (IDD)

Intelligent Downlink Diversity feature is intended to improve the performance of a GSM/EDGE system by transmitting all timeslots through two different antennas and two

separate transmitters. So IDD requires at least two TX branches per cell. One IDD cell can be served with one or two RF module. Delay and phase of the auxiliary transmitter needs to be adjusted based on the timeslot and provides excellent gain in low correlated channels. In order to decrease correlation between the main and auxiliary transmitter, phase hopping is used in the system, where phase between adjacent bursts is changed. IDD typically provides a 4 dB gain relative to single antenna transmission.

5.3 Configurations

Flexi Multiradio BTS is optimized for high capacity as well as high coverage for macro cellular applications. Modules can be used as such without a cabinet, or with an indoor or outdoor cabinet according to prevailing conditions. The carrier capacity of Flexi Multiradio BTS can be increased by increasing the number of TRX modules. It enables a flexible expansion capability, expanding sector by sector so that traffic in only one sector is impacted at the time, and the traffic in the whole BTS is not affected. Each RF module supports six GSM/EDGE carriers per RF branch.

5.3.1 RP3 Configurations

Optical OBSAI RP3-1 interface is used to connect the RF module to the System Module. It is a 3Gbps optical interface. Four RF modules can be connected to the System Module and radiate different frequencies. The radios can be used in dedicated or in concurrent mode. 3 branch RF module has three RP3-1 interfaces. GSM/EDGE and WCDMA/LTE have separate System Modules ESMB/C and FSMx and can be used simultaneously in concurrent BTS configuration. They can also be used in single radio technology configurations. FSMx can have extension System Module but not ESMB/C. ESMB/C has to be selected based on the capacity requirement. ESMB/C has four RP3-1 interfaces. The radio configuration defines the RP3-1 capacity need. RP3 configurations are kept flexible for the customer to enable cost efficient configurations as well as possibilities for ensuring the services using RP3 redundancy.

The following are the possible modes of RP3 configurations using Flexi Multiradio BTS and Flexi WCDMA BTS (FSMx) with dedicated and shared RF Modules:

- Dedicated mode
- Concurrent mode
- Dedicated and concurrent radio
- System Module synchronization

5.3.2 Radio Configurations

Flexi Multiradio BTS can be used for high capacity as well as high coverage macro or micro cellular applications. It can be used for single GSM/EDGE, WCDMA or LTE radio technology or for any combination of the mentioned radio technologies. This increases the configuration scalability; it can be configured from small to large capacity configurations. Flexi Multiradio BTS enables easy evolution path for the customer. The difference for GSM/EDGE compared to Flexi EDGE BTS is the high integration level. This reduces the amount of units, cabling and external combining needs, there are no more separated RF units and RF combining and thus no more BTS internal RF cabling.

In particular, Flexi Multiradio BTS supports:

- Up to 12 GSM/EDGE TRX/cell
- Up to 36 TRX BTS (BCF) level configurations for GSM/EDGE
- Up to 108 TRX (36+36+36) site level configurations with Multi BCF/common BCCH
- IDD with 2UD or 4UD
- Multiple TX antennas for any cell and band. This does not limit the number of the TX antennas to two, but there can be larger number of antennas in one cell
- UL diversity
 - Single UL (no diversity)

- 2UL diversity
- 4UL diversity
- Up to 12 cells
- Dual band configurations that BSC supports
 - GSM 850/1800
 - GSM 850/1900
 - GSM 900/1800
 - GSM 850/900

All possible TRX/cell configurations can be built in Flexi Multiradio BTS. In addition to symmetrical configurations like 2+2+2, asymmetrical combinations like 1+2+3 are supported.

The nominal output power at the antenna connector of a 3-branch RF Module is 60W/branch. Each branch can carry maximum of 6 carriers/TRXs. The nominal output power at each branch is the maximum cumulated sum of output powers of all the carriers/TRXs within that branch. The output power of each carrier/TRX within the branch can be adjusted individually, independent of the radio technology.

The allocated sum output power for GSM/EDGE carriers can be higher than 60W/branch (4 TRX with 20W output power). When more than 60W/branch is allocated it is only statistical output power based on the end users distributing to the coverage area and capacity dimensioning. The nominal output power at the antenna connector is still 60W, i.e. the available output power may be limited. The maximum transmit power level can be scaled from 10W to 60W. The higher output power cannot be guaranteed to all the users but only for BCCH TRX. This is used for 4TRX/pipe or bigger configurations.

Larger GSM/EDGE configurations can be built using Multi BCF/common BCCH features. Up to 36+36+36 configurations are possible. This requires that the ESMB/Cs are synchronized together. This is achieved by daisy-chaining multiple ESMB/Cs together with a chaining/synchronization cable. Maximum 9 ESMB/Cs can be synchronized together. The maximum length of the daisy-chain is 100m. The baseband processing and O&M functionality are separate for each ESMB/C. This means that each ESMB/C is seen as separate BTS (i.e. BCF-object). Chaining between Flexi Multiradio BTS, Flexi EDGE and Nokia UltraSite GSM/EDGE are possible. The same number of the BCF-objects (9) applies for the mixed chaining. Single radio branch can be shared between operators; minimum three BCCH (cells) can be allocated to a single branch and they can radiate in different power levels.

5.3.3 Cabinet configurations

Flexi Multiradio BTS is part of Flexi family and therefore it complies with all the Flexi installation options. Indoor or Outdoor Cabinets can be used according to prevailing conditions as well as modules can be installed without a cabinet. Flexi Multiradio BTS supports any multi-sector, multi-band, multi radio configuration.

Height and the heat dissipation of the modules determine the number of modules in the cabinet. Flexi cabinets provide open 19" space for the modules and the modules need to be configured in a way to enable configuration expansions. Heat dissipation may limit the configuration in Flexi cabinet. Outdoor cabinet FCOA provides 30+5+5 HU space for the modules. Indoor cabinet FCIA provides 36 HU space for modules. All Flexi WCDMA,

EDGE and Multiradio modules can be installed into common cabinet as well as other 19" equipment.

5.4 Management and software

Element manager used with Flexi Multiradio BTS is called as 2G Flexi BTS site manager. It is used for local and remote management of the Flexi Multiradio BTS. It can also be controlled remotely using NetAct.

5.4.1 2G Flexi BTS Site Manager

2G Flexi BTS site manager is used to control the BTS locally and remote management and communicate with ESMB/C. Element manager is an application that runs on the user laptop/PC on the latest Windows OSs . Site manager can be connected to the Ethernet port on the BTS or it can be connected remotely to the BTS from the NetAct. The graphical user interface of the EM makes easy for the user to workon. The main functions of BTS manager are

- BTS commissioning
- BTS supervision (Alarms, block/unblock)
- BTS maintenance
- BTS testing

Each site manager releases are backward compatible with the BTS SW release. See [Software Compatibility of Flexi Multiradio BTS GSM/EDGE](#) document for more information.

5.4.2 Software updates

Flexi Multiradio BTS uses downloadable software. The software can be loaded either locally, with the BTS Manager software, or remotely from NetAct™. Site visits are not mandatory for routine O&M tasks. All software can be downloaded and updated from NetAct™. This procedure is centralized, so that several BTSs can be upgraded with the new software either simultaneously or one by one, depending on t the operators' preference. Flexi Multiradio BTS software can be downloaded as a background operation without interrupting the operation of the BTS. The new software can be activated by the operator during a service window or preferred time.

Typically, local software downloading is done only when the NetAct™ connection is missing, for instance during commissioning. Flexi Multiradio BTS can store two software packages in its memory; the current software package and the old software package. Either of these software versions can be activated at any time.

6 Transmission

6.1 Overview of Flexi Multiradio BTS transmission

The Flexi Multiradio BTS integrated transmission function is located in Flexi Multiradio System Module (ESMB/C). There is space for one transmission sub-module in the System Module. Different transmission sub-modules are used depending on the needed interface. The Flexi Multiradio BTS has been optimized for tail and chain sites.

In case more transmission interfaces or media conversion is needed the FlexiHub (or FIU19E) can be used as a transmission hub for Flexi BTS product family.

6.2 Transmission interfaces

The Flexi Multiradio BTS transport solution is based on the Flexi platform. Since ESMB/C is a new System Module it has the following integrated transports.

ESMB/C integrated transmission

The Flexi Multiradio GSM/EDGE BTS transport requirements are the same as that of Flexi EDGE BTS. The transport interface and Abis termination is located in the System Module (ESMB/C). The transport interface comes as five different replaceable plug in units, which can be inserted into the System Module (ESMB/C). Only one plug in unit can be placed at a time.

Radiolink transmission

The FIFA is the radiolink transmission sub-module for the BTS. The FIFA has two Flexbus interfaces for connecting:

- one or two Nokia microwave radio outdoor units
- two FIFA sub-modules in different BTSs
- one Flexbus interface to another transmission device offering a Flexbus interface (such as FlexiHub, FIU19E, UltraSite EDGE, UltraSite WCDMA or Flexi WCDMA)

The proprietary Nokia Flexbus uses a coaxial cable with following functionalities:

- it carries power for the radio outdoor unit
- it carries a maximum of 16 x 2 Mbit/s in both directions
- it has a maximum cable length of 300 metres
- it is compatible with FlexiHopper Microwave Radio and MetroHopper Radio

Plug-in Unit Type	Interface	Number of interfaces per System Module	Connector
Flexbus transmission sub-module (FIFA)	Flexbus (integrated coaxial copper interfaces for Nokia microwave radios)	2	TNC

Table 1 Radio transport unit and interfaces supported by ESMB/C

Wireline transmission

Cellular access networks are based on the E1 (ETSI) and T1 (ANSI) standards. E1 capacity is 2 Mbit/s and T1 capacity is 1.5 Mbit/s. Also interfaces like Fast Ethernet and Gigabit Ethernet are in use. The below table lists the type of plug-in units/interfaces supported by ESMB/C:

Plug-in Unit Type	Interface	Number of interfaces per System Module	Connector
E1 transmission sub-module (FIEA)	E1	8	SMB, 75Ω, coaxial, unbalanced, asymmetric

Table 2 Transport unit and interfaces supported by ESMB/C

Plug-in Unit Type	Interface	Number of interfaces per System Module	Connector
E1/T1 transmission sub-module (FIPA)	E1/T1	8	RJ48, 120/100 Ω , balanced, symmetric
Abis over IP Ethernet and E1 T1 symmetric (FIQA)	Ethernet Optional optical GE E1/T1	2 x Fast Ethernet 1 x Gigabit Ethernet 4 x E1/T1	RJ45 SFP RJ48, 120/100 Ω , balanced, symmetric
Abis over IP Ethernet and E1 coax (FIYA)	Ethernet Optional optical GE E1	2 x Fast Ethernet 1 x Gigabit Ethernet 4 x E1	RJ45 SFP SMB, 75 Ω , coaxial, unbalanced, asymmetric

Table 2 Transport unit and interfaces supported by ESMB/C (Cont.)

6.3 Network configuration

Flexi Multiradio BTS uses the following transmission sub-modules:

- FIFA
- FIEA
- FIPA
- FIQA
- FIYA

FIFA sub-module

With two radiolink Flexbus connections, the FIFA sub-module operates as a repeater and interconnects the BTSs and the BSC using loop, chain, star, and point-to-point network configurations. Each Flexbus interface has a capacity of up to 16 x 2Mbit/s, dependent on the capacity of the microwave link and whether the Flexbus is used for direct interconnection to a different Flexbus interface.

FIEA and FIPA sub-modules

With eight wireline connections per sub-module (E1 has 2Mbit/s capacity and T1 has 1.5 Mbit/s capacity), the FIEA and the FIPA operate as branching points and interconnect the BTSs and the BSC using the loop, chain, star and point-to-point network configurations.

FIQA and FIYA sub-modules

With two FE and one GE interfaces the FIQA and the FIYA can provide PWE-based IP/Ethernet connectivity for the BTS. The FIQA and the FIYA can also be used for E1/T1 connectivity.

6.4 Cross-connections

The BTS integrated transmission provides a cross-connect functionality at granularities necessary to operate a transmission network that supports the specific needs of the GSM/EDGE BTS. The maximum number of individual cross-connections for the BTS integrated transmission is 128. Various cross-connection granularities are supported down to a level of 8 kbit/s (4 kbit/s for TS0). Timeslot 0 of every basic frame is reserved for basic frame alignment and the bits are generally called as Signaling Associated (Sa) bits. Hence using Sa bits of TS0 is not recommended for data transfer.

When using FIQA or FIYA plug-in unit TS0 cross-connection is not valid. This is because the CESoP standard does not permit TS0 to be transmitted via the Ethernet interface and could lead to compatibility problems.

16 kbit/s cross connects, for instance, can be used to cross-connect the BTS signalling links or BTS O&M channels with a bandwidth of 16 kbit/s. The BTS can handle the following cross-connection granularities:

- 4 kbit/s (1 bit in TS0 of every 2nd frame)
- 8 kbit/s (1 bit in a time slot)
- 16 kbit/s (2 bits in a time slot)
- 32 kbit/s (4 bits in a time slot)
- 64 kbit/s (all 8 bits in a time slot)
- $n \times 64$ kbit/s (n from 1 to 31(E1)/24(T1))
 - All E1/T1 interfaces are terminated, which means that TS0, except for the cross-connected bits, is regenerated.
- 2 Mbit/s (within FIFA transmission sub-module only)
 - Only the 2Mbit/s cross connections that are made from Flexbus to Flexbus inside one FIFA are transparent, .i.e., the E1 signal is not terminated.

6.5 Protection

Protection, as described below, is not supported in the PW connectivity. The BTS integrated transmission sub-module supports protection functions against transmission problems, such as cable cuts or equipment faults:

- Transmission network protection using loop topology
- Hot Stand By (HSB)

Transmission network protection using loop topology

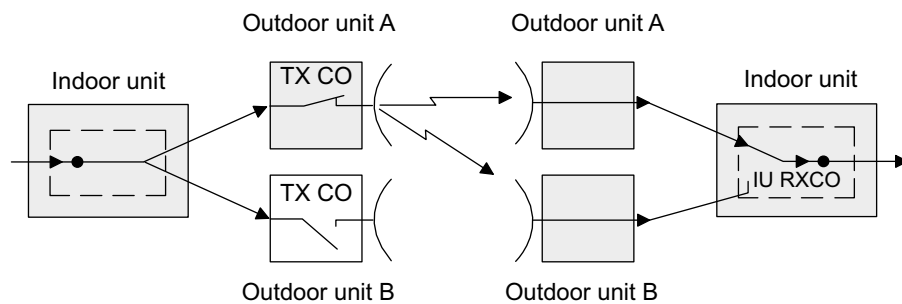
Loop protection is an efficient way to protect traffic in a transmission network, such as a GSM BSS. In a live telecommunication network, it is important to secure, in addition to actual payload traffic, the network synchronisation and the centralised network management during any period of abnormal circumstances.

For these reasons, loop protection protects:

- Payload traffic
- Network synchronisation
- Network management connections

Hot Stand By (HSB)

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 a 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 is repaired or the cause for the propagation fault vanishes. HSB provides protection against equipment faults.



IU RXCO Indoor unit hitless changeover switch (In ASIC)
 TX CO Transmitter changeover switch (Transmitter mute control)

[DN70542569]

Figure 8 FlexiHoppers with FIFA 1IU/2OU HSB (only one direction shown)

7 Co-siting

Flexi Multiradio BTS can be co-sited with the following BTSs:

- Flexi WCDMA BTS
- Flexi EDGE BTS
- UltraSite WCDMA BTS
- UltraSite EDGE BTS

In addition, Flexi Multiradio BTS can also be co-located with NSN and other vendors' GSM or WCDMA BTSs on a shared site. Flexi Multiradio BTS also supports the use of existing site support systems in co-located cases.

7.1 Multiradio sites with Flexi WCDMA BTS

Flexi EDGE, Flexi Multiradio and Flexi WCDMA BTS use the same platform, which allows cost-efficient multiradio sites. The common platform offers the following benefits in addition to efficient and flexible multiradio sites:

Common installation principles

The installation requirements are the same. GSM/EDGE and WCDMA/HSPA modules can be installed into the same stack and they can share the same BTS cabinet with common installation kits and accessories.

The 3 branch radio module has specific co-siting ports to enable RX diversity sharing between the existing legacy Nokia Siemens Networks (UltraSite, Flexi EDGE and BTSplus) BTSs when they are operating in the same band. And the existing antennas can be used. RX diversity sharing for Flexi Multiradio BTS does not affect the performance degradation in UL.

Co-siting is done with diplexers when the BTSs are operating in different bands; low band BTS is co-sited with high band BTS. The diplexer loss impacts the performance of the BTS both in UL and DL. The UL degradation can be compensated using MHA.

Common powering principles

Flexi EDGE, Flexi Multiradio BTS and Flexi WCDMA BTS utilize the same Nokia Flexi power modules and can share the same site support system.

Transport co-siting

The Flexi Multiradio BTS and Flexi WCDMA BTS can be interconnected with the E1/T1, Flexbus or Ethernet for sharing transmission capacity. In case of co-siting, the BTSs can be chained to save the backhaul connections. The BTSs share a common physical transmission connection, but separate logical E1/T1- level connection to the upper network layers BSC and RNC.

In GSM/EDGE network, E1/T1 TDM transport is usually used if the WCDMA BTS provides the physical connection. If the ATM connection is used all the way to the site, circuit emulation service (CES) can be used for GSM/EDGE traffic.

Flexi Multiradio, Flexi WCDMA and legacy BTSs have integrated E1/T1 interfaces and bit level cross connection, this enhances the transport when the BTSs are chained. Hence, the E1/T1 can be aggregated to one E1/T1.

Nokia Siemens Networks Microwave Radio uses Flexbus for radio interconnection. Flexi Multiradio, Flexi WCDMA and existing Nokia Siemens Networks legacy BTSs (except

BTSplus) have integrated Flexbus interfaces and have bit level cross connection. This enhances the transport, when BTSs are chained using Flexbus.

Flexi EDGE, Flexi Multiratio and Flexi WCDMA BTSs have integrated Ethernet interfaces with switching functionality. The system modules can be interconnected using Ethernet and the backhaul connection can be from any system module.

Antenna line co-siting

Antenna line sharing with Flexi WCDMA BTS can be arranged with a diplexer for combining and splitting of different antenna signals, if different frequency bands are used for GMS/EDGE and WCDMA/HSPA traffic.

Antenna line co-siting is used to minimize the number of antennas. Feeders are shared in case of Diplexer (combining and splitting different antenna signals) whereas RX antennas are shared in same band combiner cases.

7.2 Co-siting with UltraSite WCDMA BTS

Flexi Multiradio BTS radio modules can be used with UltraSite WCDMA BTS when UltraSite BTS is provided with Enhanced UltraSite Base Band. This brings the possibility to upgrade the existing UltraSite WCDMA BTS capacity, throughput and features.

7.3 Co-siting with UltraSite EDGE BTS

Flexi Multiradio BTS can be co-sited with UltraSite EDGE BTS. UltraSite EDGE and Flexi Multiradio BTS can be chained to form a synchronised BTS site. UltraSite EDGE BTS Site Support cabinet can be shared with Flexi Multiradio BTS. Battery backup systems can also be shared, provided that the power feeding and backup capacity of the BBU is adequate.

7.4 Co-siting with BTSplus

Flexi Multiradio BTS can be co-sited with the existing BTSplus in order to increase the capacity of the existing BTSplus.

- Transmission link can be shared between Flexi Multiradio and BTSplus. The transmission interfaces are compatible and the Abis connection can be routed through one of the BTSs to the BSC.
- The existing BTSplus antenna line can be used with Flexi Multiradio BTS and the RX diversity can be shared between the BTSs when operating in the same band without degradation in the UL performance.
- The sectors between the two BTS entities can be shared using Multi BCF and common BCCH features.
- Flexi Multiradio BTS modules can be installed inside BS241 service cabinets. This means that the module fan airflow can be reversed, which drops the MTBF of the fan unit.

7.5 Co-siting with Talk-family BTS and replacement

Flexi Multiradio BTS can be used for replacing Talk-family BTS so that the BTS modules can be installed into the CityTalk cabinet using Talk conversion kit EMIA or EMIB. Flexi Multiradio BTS can also be co-sited with the Talk-family BTS.

- The existing Talk-family antenna line can be used with Flexi Multiradio BTS and the RX diversity can be shared between the BTSs when operating in the same band. RX diversity sharing impacts the performance of the UL in Flexi Multiradio BTS.
- Transmission can be shared between Talk-family BTS and Flexi Multiradio BTS so that Talk-family BTS transmission is routed through Flexi Multiradio BTS.

8 Feederless and Distributed Site

In a feederless BTS site, BTS antenna line feeders are replaced with optical fiber connections. The RF module can be installed at a distance from the System Module, which in turn reduces the site investment and increases the RF performance as the antenna feeder lines are shorter, or not needed at all. Flexi Multiradio BTS has compatible optical OBSAI interfaces in the System Modules and separate optical converters are not required. Usage of MHA is not recommended in feederless solution.

The optical connection cable can be up to 200 meters long with multimode fiber cables. With a single mode fiber and single mode SFP interface, it is possible to reach a distance of up to 40km. The longer cables are not delivered in fixed length but are made on the field based on the required length. Characteristics of the optical OBSAI interface can be adapted to needs standard SFP modules. See Contents of delivery in [Flexi Multiradio BTS GSM/EDGE System Module \(ESMB/C\) Description](#), for more information.

Power can be fed to the remote RF module through the System Module. The 48VDC power distribution cable in the feederless site can run up to 100m for the RF module (including the whole DC-feed line prior to the PDU and the line between the remote radio module and the PDU together). In this case, the System Module and the Radio Module require separate over voltage protection devices (FSEC). Power can be fed to the remote Radio Modules with AC or DC using a remote power supply. RF module has external alarm interfaces for the power supply and other generic alarms.

9 Technical data

9.1 Operating range

The operating ranges of Nokia Flexi Multiradio BTS are shown in the table below.

Property	Temperature
Low air temperature limit	-35 °C (-31 °F)
High ambient air temperature limit (temporary)	+55 °C (131 °F)
High ambient air temperature limit with guaranteed performance	+50 °C (122 °F)

Table 3 Operating range

9.2 RF performance

The RF performance of Flexi Multiradio BTS is specified at the antenna ports of the RF module.

RX Sensitivity and TX output power values in the tables represent the nominal (or typical) performance of the BTS and can be used to plan a radio network.

BTS receiver sensitivity, without MHA	Nominal Sensitivity 800/900/1800/1900 (dBm)
4-way diversity	-118.0
2-way diversity	-115.5
Single branch	-112.7

Table 4 RX sensitivity of Flexi Multiradio BTS

The nominal output power at the antenna connector for 3-sector RFM is 60W/branch. Each branch can carry max 6TRXs. The nominal output power at each branch is the maximum cumulated sum of output powers of all the carriers/TRXs within that branch.

The output power of each carrier/TRX within the branch can be adjusted separately independent of the radio technology. The Output power can be defined with software license. WCDMA/LTE supports 8, 20, 30, 40 and 60 W modes

Configuration	Number of RF Modules	Output power per TRX	Antenna branches
2+2+2	1	30W	2/2/2
3+3+3	1	20W	2/2/2
4+4+4	1	20W*	2/2/2
6+6+6	1	15W*	2/2/2
8+8+8	2	20W*	2/2/2
12+12+12	2	15W*	2/2/2
4+4+4 4+4+4**	2	20W*	2/2/2 2/2/2
4+4+4 2+2+2**)	3	30W	2/2/2 2/2/2

Table 5 TX power of GSM configurations

* Flexible MCCA TX Power Pooling

** Dual Band Configurations

9.3 Operating voltage

The operating voltage ranges for Flexi Multiradio BTS are the following:

48 VDC Powered BTS

- Nominal input voltage, 48 VDC
- Low input voltage limit, 38 VDC
- High input voltage limit, 60 VDC

24 VDC Powered BTS

- Nominal input voltage, 24 VDC
- Low input voltage limit, 18 VDC
- High input voltage limit, 32 VDC

9.4 Compliance with EMC, RF and safety

In Europe, this means compliance with Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

In other market areas additional compliance is fulfilled according to relevant authority requirements.

EMC emission

- ETSI EN 301 489-1: Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.
- ETSI EN 301 489-8: Part 8: Specific conditions for GSM base stations.
- EN55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".
- FCC Code of Federal Regulations (CFR) 47, Part 15 "Radio Frequency Devices".
- ICES-003: Digital Apparatus.

EMC immunity

- ETSI EN 301 489-1: "Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services - Part 1: Common technical requirements".
- ETSI EN 301 489-8: Part 8: Specific conditions for GSM base stations.
- IEC 1000-4-9: Pulse magnetic field immunity test.
- IEC 1000-4-8: "Electromagnetic Compatibility (EMC) Part 4. Testing and measurement techniques Section 8: Power frequency magnetic field immunity test, Basic EMC Publication".

RF

- ETSI EN 301 502: Harmonized EN for Global System for Mobile communications (GSM) - Base Station and Repeater equipment covering essential requirements under article 3.2 of the R&TTE directive.
- FCC Code of Federal Regulations (CFR) 47, Part 22 "Public Mobile Services".
- FCC Code of Federal Regulations (CFR) 47, Part 24 "Personal Communication Services".
- FCC Code of Federal Regulations (CFR) 47, Part 2 "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations".
- RSS-132: 800 MHz Cellular Telephones Employing New Technologies.
- RSS-133: 2 GHz Personal Communication Services.

Safety

- IEC 60950-1/ EN 60950-1: "Safety of Information Technology equipment including electrical business equipment".
- EN 50383: Basic standard for the calculation and measurement of the electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunications system (110 MHz - 40 GHz).
- EN 50384: Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunications systems with the basic

restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz) - Occupational.

- EN 50385: Product standard to demonstrate the compliances of radio base stations and fixed terminal stations for wireless telecommunications systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz) - General public.
- UL 60950-1: Safety of Information Technology Equipment.
- CSA C22.2 No. 60950-00: Safety of Information Technology Equipment.