D1900
Siemens Micro Base Transceiver Station

BS-11: Universal Micro BTS

Version 2.0 **DRAFT**

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1.0 INTRODUCTION

The explosive boom in mobile communications and the resulting new application segments have driven operators to extend cellular services to areas previously not considered. These include for instance pedestrian subways, metro tunnels, shopping malls, hotel lobbies and temporary sites as exhibition halls. Realization of hierarchical cell structures is no more a difficult task and can be thus easily introduced to already deployed network layer that provides the main 'blanket' coverage.

The applications in question impose certain constraints on the implementation of so-called *microcellular* networks. Siemens carefully considered the relevant environmental (electrosmog) and safety aspects as well as aesthetics of its new product.

(figure 1.1: BS-11 in real environment)

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2.0 MICROCELLULAR NETWORKS

The GSM900/GSM1800/GSM1900 coverage and capacity bottlenecks experienced in some urban areas and in application segments previously not considered, e.g. subway tunnels, call for miniaturization in BTS technology. This is particularly the case when high capacity spots are introduced at the lower network layer with traffic capacities of more than 200 Erl/sqkm in seamless and continuous microcellular deployment.

In a typical microcellular scenario, the following are essential steps that operators proceed with in introduction of microcells:

☞ **Decrease of cell radii to ...**

- provide higher capacity (Erl/sqkm)
- increase reusability of available frequencies
- optimize network levels (overlay/ underlay)

☞ **Realize hierarchical network structure to ...**

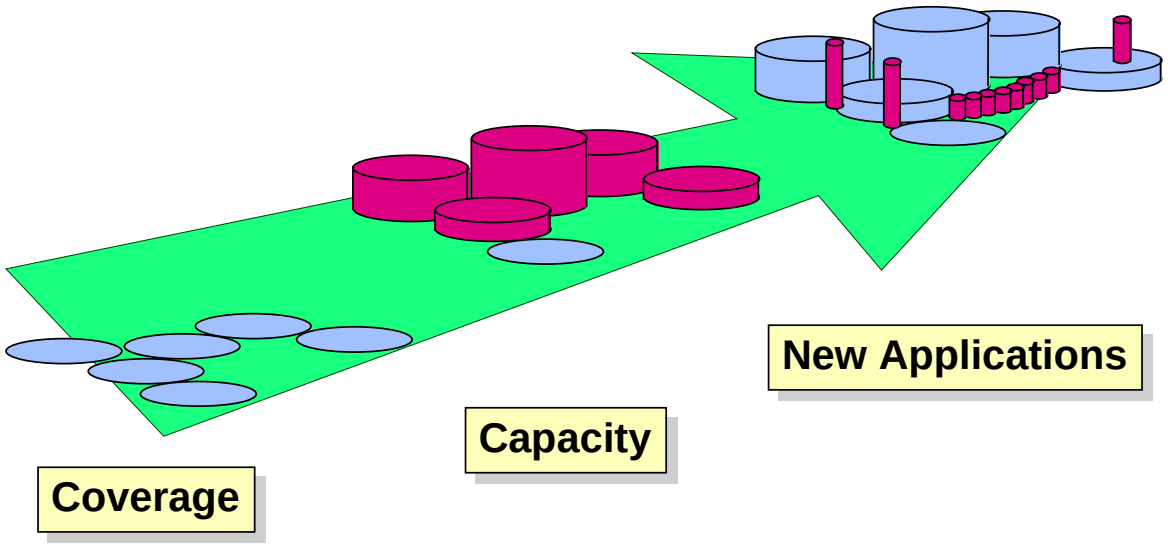
- address new application segments
- raise network redundancy
- assign frequencies for microcells
- ease microcelluar network planning

☞ **Combine coverage & capacity solutions**

☞ **Optimize investment and cost in every evolution phase**

2.1 Operator evolution

From what is mentioned above, introduction of microcells has to be rather regarded as an *evolutionary* than a *revolutionary* step, because microcellular networks rely on the fundamentals of hierarchical network architecture. This hierarchical network architecture in turn evolves from the various operator network evolution & optimization phases (figure 2.1) which represent an ongoing and continuous process during network rollout.



(figure 2.1)

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Today operators are concerned with the optimization of their embedded network base and look for mature product solutions to address their needs and to flatten the way to a broader and more flexible network as a goal in future.

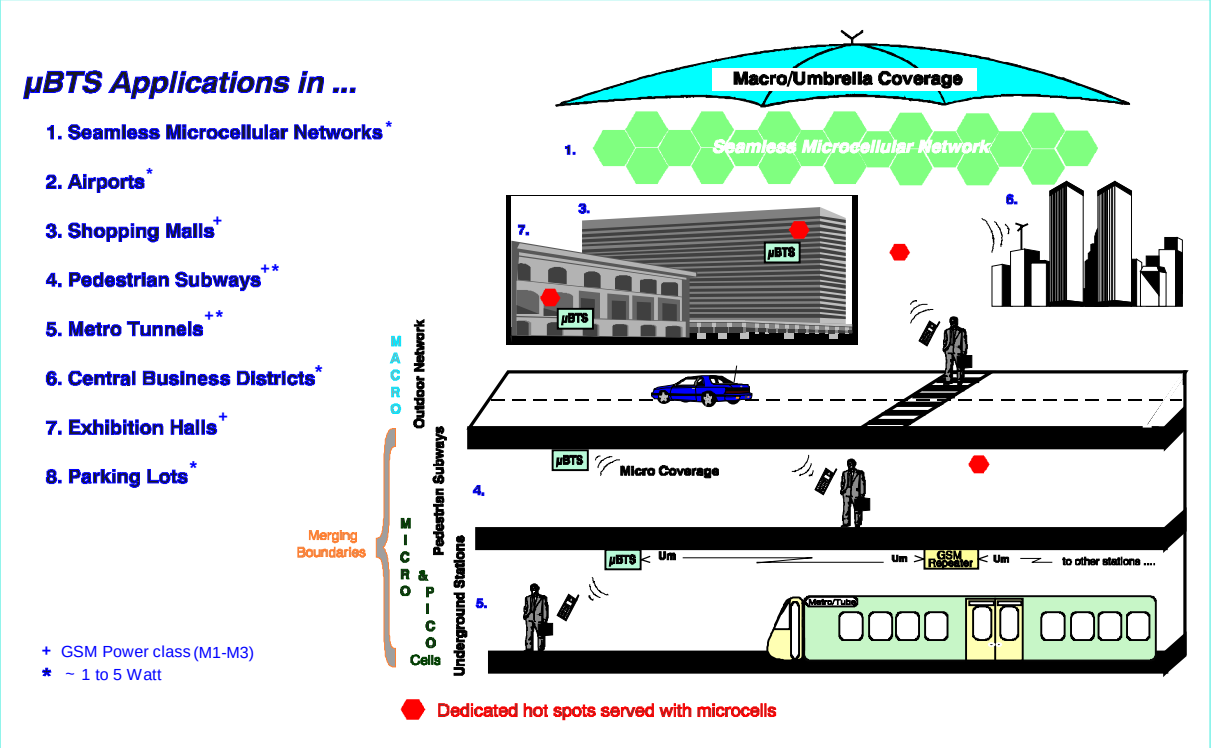
The above referred to ultimate goal which is the deployment of so-called microcells of cell radii typically < 300 m. This is a matter that requires cost efficient technology which consequently assumes an optimized hardware & software platform to the one implemented today.

2.2 Applications

The product can be universally used especially in those applications and spots not reached before. Clear advantages are sensed particularly concerning volume when compared to conventional first and second generation products of SBS baseline.

This leads to new application segments primarily in **urban and suburban** areas (figure 2.2):

- airports
- touristic sites, e.g. natural parks
- shopping malls
- train stations
- hotel lobbies
- conference halls
- exhibition halls
- hot spots. e.g. central business districts
- street tunnels



Macro, Micro & Picocellular Applications

(figure 2.2)

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Typical **rural deployment** of BS-11 is also easy thanks to specific outstanding characteristics deemed as prerequisites for deployment in rural applications e.g. low power consumption and the flexibility in terrestrial network interconnection as well as the various power classes offered by the Micro BTS product as explained hereafter.

The BS-11 concept bears in mind economy and features suitability for realization of enhanced and cost efficient microcelluar networks.

This is especially mirrored in site acquisition advantages, installation and serviceability objectives of the BS-11 as explained in § 8 and 11.

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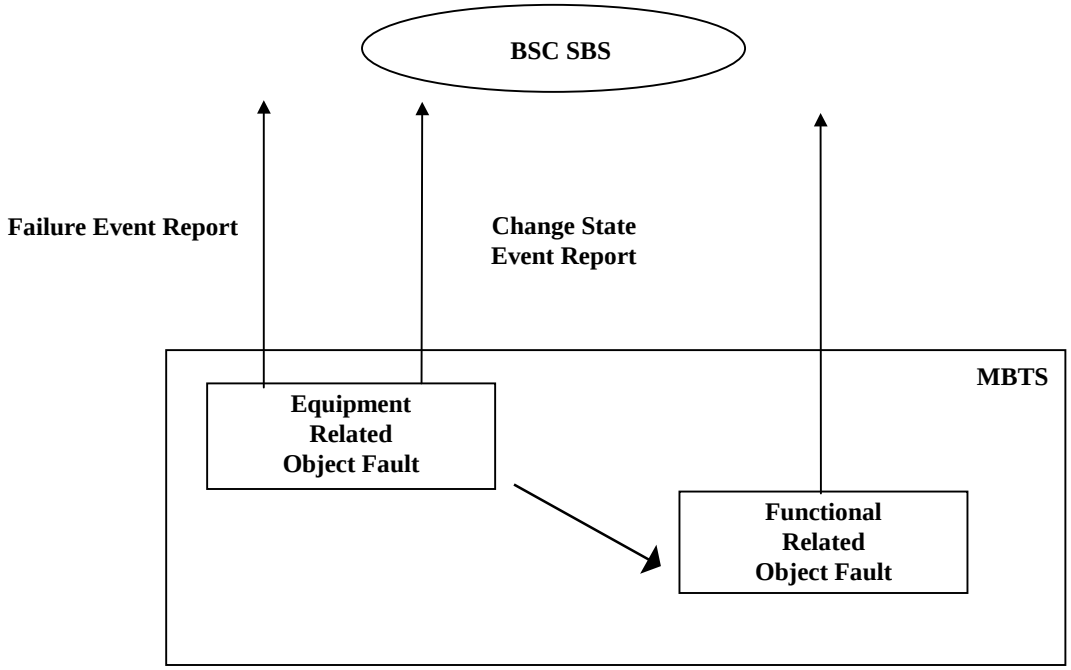
3.0 ARCHITECTURE AND PECULIARITIES

The BS-11 is a one (or two) carrier(s) universal BTS (i.e. outdoor and indoor compatible) practically based on more tailored hardware compared to SBS mainline.

jects are handled at the BSC level where the Micro BTS software is resident in case a software download is required.



Its software nevertheless is compatible with SBS BR 3.6 onward.
The deltas to the SBS mainline architecture shall be contemplated from a functional (logical) and equipment (physical) object viewpoints.

- *Logical view*,
  The representation of the Micro BTS is functionally regarded equivalent to any other Siemens BTS, e.g. BS-21E or BS-60 ...etc. This is translated into *1 (2)* TRX at the BTS site in *one* logical cell. These functional ob-

- *Physical view*

At a hardware level, the Micro BTS architecture (containment tree) is obviously different to the architectural concept used in previous BTSs. This different architecture was technologically required e.g. due to the high degree of integration in this extremely small BTS for significant volume reduction. These hardware objects are handled at the OMC level where the Micro BTS is represented at physical level (icons) for proper configuration and maintenance handling if desired (chapter 8.5 refers).

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3.1 Cabinet structure

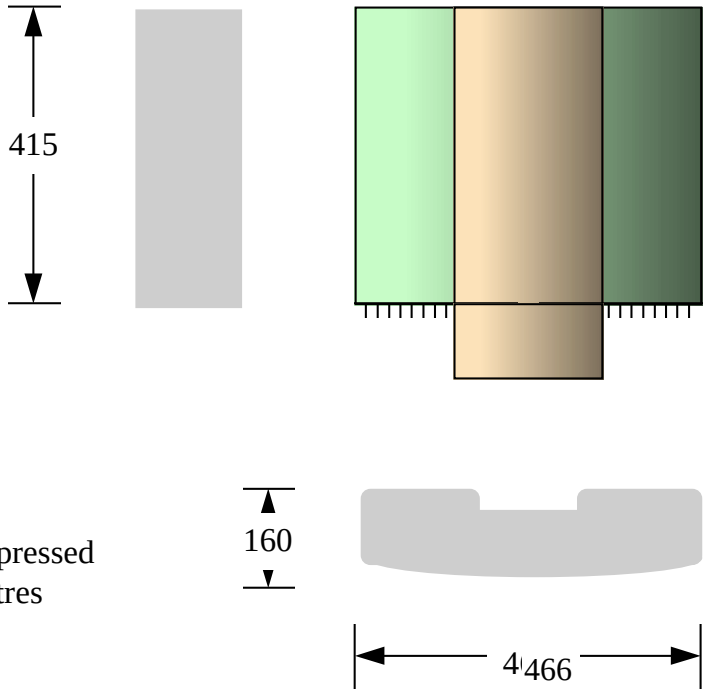
The philosophy in the Micro BTS product implementation is mainly based on the reduction of the mechanical volume to an absolute minimum to meet special application prerequisites. These prerequisites are given by the market due to lack of appropriate sites and for the increased awareness of environmental as public acceptance considerations.

Therefore the primary goal of the prerequisites has to entail enormous site acquisition advantages.

This led to the use of a new cabinet that must universally cope with practically all application environments and simultaneously **does not** require any climate specific parts as heat exchangers, air conditions and/or moving parts as fans. In other words, the heat dissipation of this product is solely foreseen by natural convection.

The BS-11 cabinet is therefore sealed in factory to avoid the penetration of moisture to the inside of the unit. Serviceability of the product is therefore only foreseen in the factory, but limited configurability can be performed onsite (see serviceability aspects later on). As the Micro BTS does not include any moving parts, no acoustic noise is emitted by the product.

The cabinet dimensions of the Siemens Micro BTS are: **466 (W) x 415 (H) x 160 (D)** which result in the extremely attractive overall volume of only 28 litres.



Dimensions expressed in millimetres

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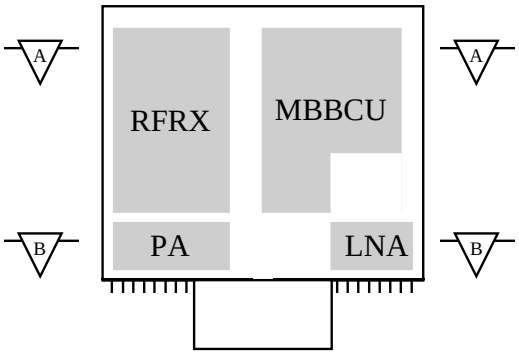
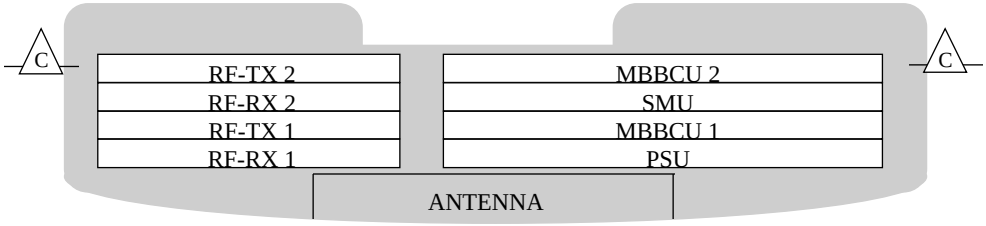
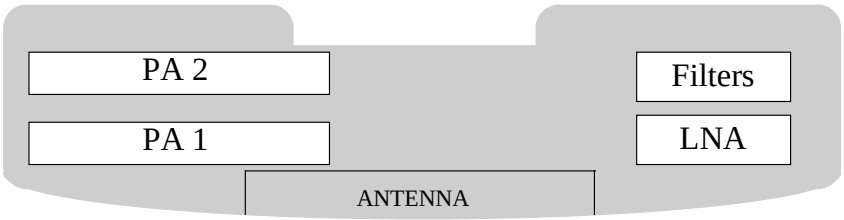
The following figures show the mechanical arrangement within the cabinet at different cross sections.



SECTION C-C



SECTION A-A



SECTION B-B

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The Micro BTS features an extremely robust housing. Its cabinet is designed for indoor as well as for outdoor applications in different environments.

The Micro BTS fulfils the standards IP 54 and IP 64 and is protected against damages performed by taper objects or tools as well as against attempts of malicious destruction of the cabinet. In addition to the construction of a hermetically closed cabinet further steps have been taken to provide a comprehensive protection against vandalism.

The Micro BTS is protected against dust, rain and external influences. Protection facilities include

- IP 54 standard and IP 64 standard
- burglar proof cabinet
- lightning arrestors

3.2 Supply concept

An internal multiple **AC/DC** unit is used for powering the BS-11. This unit directly converts the AC mains input voltage (88 - 265 V_{AC}) to the multiple internally needed DC voltages by the various boards e.g. ± 5V, +13V, +26 V etc.

As the unit reveals excellent MTBF figures (more than 50 years) additional redundancy was not needed and has been spared.

For short AC mains instability, the AC/DC unit can additionally bridge a short period (so called *hold-over time*) without having to restart a bring up procedure of the Micro BTS.

In case of AC mains instabilities longer than the above mentioned period, power feeding of the Micro BTS is maintained to ensure a safe message transfer to the OMC.

Nevertheless, for the first deployment of the product in countries with unstable power supply source and if above precaution (i.e. *hold-over time*) is still deemed too short, an external UPS solution (Uninterruptable Power Supply) can be used as an AC mains backup for e.g. several minutes (or hours) as required by the operator.

This unit can then be externally placed next to the Micro BTS in an additional cabinet or can be mounted directly to the wall in indoor sites.

3.2.1 Battery Backup

Alternatively the BS-11 is available with a -48 V_{DC} supply option with an additional optional battery backup feature. In this case, the conversion to the internal voltages of the Micro BTS is achieved by means of a DC/DC unit which replaces the AC/DC unit used in case of AC mains.

The battery backup permits normal operations at full output power on Micro BTS (1 and 2 TRX) in case of drop of mains for periods up to 30 minutes under normal operating conditions.

Furthermore supply feeding of an external network termination unit (up to 30 W) is included in the DC/DC supply budget.

The battery backup system is placed in an external, aesthetically compatible housing that can be easily mounted aside of the Micro BTS cabinet. Maintenance free batteries are used for this purpose.

3.2.2 Battery Characteristics

Cyclon batteries are foreseen for an extended operational temperature range (-45°C to +45°C). The battery package includes four battery blocks (12 V/2.5 Ah) which are connected in series. The size of each battery block is 107 mm x 73 mm x 69 mm, the weight of each battery block is 1.25 kg.

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3.3 General feature overview

3.3.1 Network & radio aspects

- GSM900/GSM1800/GSM1900 frequency bands
- 1 TRX or 2 TRX in the same cabinet
- 2 (3)W 'high' GSM900 (GSM1800) power version for universal deployment
- GSM900 power classes M3 ... M1 (from 30 mW to 250 mW)
- GSM1800 power classes M3 ... M1 (from 50 mW to 1.6 W)
- GSM1900 power classes as for GSM1800 version (compliance to T1P1 standards)
- integrated planar antennas
- duplex combining technique for 1 (2) carrier with diversity arrangement
- space (& polarization) diversity using external (integrated planar) antennas
- 6 steps static power control
- A_{50} / A_{51} and A_{52} ciphering on a per call basis
- SBS compatible A_{bis}
- full-rate; half-rate / enhanced full-rate (second release)
- star, multidrop, loop with PCM30/ PCM24; star also with Nx64 kbit/s or ISDN BA (second release)
- simplified operation & maintenance via commercial LMT (Local Maintenance Terminal)

3.3.2 Mechanical and climatic aspects

- minimum depth < 160 mm
- volume 28 litres
- weight 22 kg (1 TRX), 28 kg (2 TRX)
- power supply 88 V_{AC} - 265 V_{AC} (45 - 65 Hz), optional -48 V_{DC} (covering the range of -39 V_{DC} to -60 V_{DC}; the mean voltage is -48 V_{DC})
- low power consumption appr. 80 W for 1 TRX, appr. 160 W for 2 TRX;
  heater power consumption appr. 180 W
- outdoor temperature range: -45°C to +45°C plus additional solar radiation 1200 W/m² according to (ETSI 4.1E)
- firm to high wind force velocities (up to 100 km/h)
- no fans / no moving parts (natural convection)
- indoor / outdoor operation
- wall and pole mountable
- external cabling

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4.0 MICRO BTS FUNCTIONAL DESCRIPTION & BLOCK DIAGRAMS

4.1 General

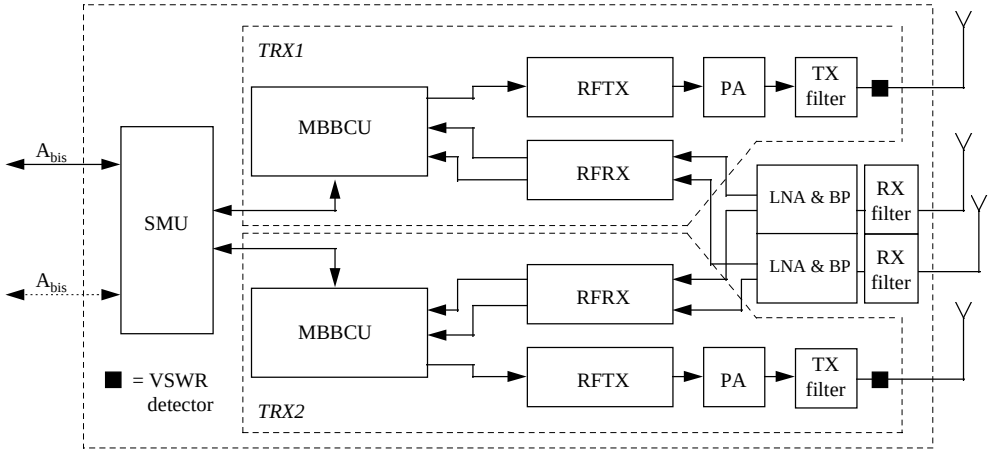
The Micro BTS is a compact module with a high level of integration. The inner cards are in limited number and are not individually replaceable in the field.

The Micro BTS is composed of the following elements (for antenna system see § 6.0):

- **Transceiver**
  - Power Amplifier (PA)
  - RF Transmitter Unit (RFTX)
  - Low Noise Amplifier & Band Pass Filter (LNA & BF)
  - RF Receiver Unit (RFRX)
  - Multichannel Base Band Unit (MBBCU)
- **Site Manager (SMU)**
- **Power Supply (PSU)**

A general block diagram for BTS using internal or external antennas is shown in figures 4.1.1 and 4.1.2 below. In the following paragraphs, the above mentioned elements are briefly described.

2-TRX Micro BTS - block diagram
(integrated antennas)



(figure 4.1.1)

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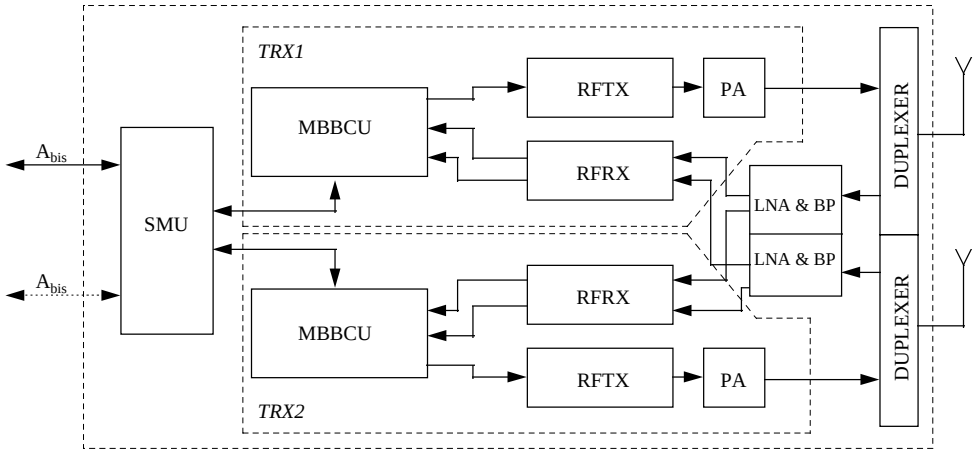
2-TRX Micro BTS - block diagram (external antennas)



(figure 4.1.2)

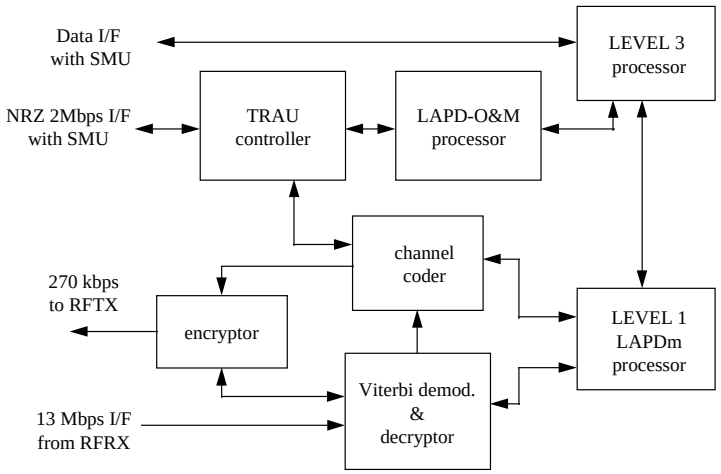
4.2 Multichannel Base Band Unit (MBBCU)

The MBBCU is the unit dedicated to the management of the 8 (full-rate) or 16 (half-rate) channels carried by the GSM TDMA frame. The unit is composed of the following main blocks:

- LAPD-O&M processor
- Level 3 processor
- LAPDm - Level1 processor
- Channel coder
- Viterbi demodulator
- Encryptor
- TRAU controller

The MBBCU block diagram in shown in figure 4.2.

MBBCU - block diagram



(figure 4.2)

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4.2.1 LAPD-O&M PROCESSOR

A National HPC46400 processor at 20 MHz clock equipped with 512 kbyte RAM and 128 kbyte flash eprom. Its functions are ...

- to manage a 64 kbit/s HDLC link to/from BSC
- to collect and process a signalling connection to/from BSC (LAPD protocol) both for radio and O&M signalling
- to manage and distribute to peripheral units configuration messages

4.2.2 LEVEL 3 PROCESSOR

A National HPC46100 processor at 40 MHz clock equipped with 512 kbyte RAM and 128 kbyte flash eprom. Its function is ...

- to process level 3 radio signalling

4.2.3 LAPDm - LEVEL 1 PROCESSOR

A National HPC46100 processor at 40 MHz clock (with 512 kbyte RAM and 128 kbyte flash eprom). Its functions are ...

- to manage level 2 radio signalling (LAPDm protocol)
- to manage low level configuration and signalling for 8 radio time slot

4.2.4 CHANNEL CODER

Four DSP are dedicated to ...

- calculate block and convolutional code to signalling and traffic data frames
- interleave/deinterleave bits
- form bursts to send to modulator via 270 kbit/s interface
- receive demodulated bursts from “Viterbi demodulator”

4.2.5 TRAU controller

It is dedicated to the transfer of TRAU frames to and from the remote Transcoder/ Rate Adaptor Unit. The TRAU controller establishes, maintains and controls the synchronisation with the remote TRAU.

4.2.6 Viterbi demodulator

Four DSPs are dedicated to demodulation. The down-converted and digitalized radio signal received via a 13 Mbit/s interface from RFRX is demodulated by means of a Viterbi algorithm.

4.2.7 ENCRYPTOR

Two DSPs are dedicated to computation of different encryption algorithms on a per call basis, the proper algorithm can be selected and used.

4.3 Radio Frequency Transmitter Unit (RFTX)

This unit is available in three versions GSM/ E-GSM900, GSM1800 and GSM1900. For the block diagram refer to figure 4.3.

The main RFTX functions are as follows:

- reception, from MBBCU Unit, of the 270 kbit/s modulating signal
- direct GMSK modulation in the defined frequency band
- RF frequency hopping.
- static power control (downlink)
- dynamic power control
- system timings generation
- RF carriers reference clock generation

Control unit functions are performed by one DSP.

Static power control allows the RF output power to be reduced from its maximum level in 6 steps of nominally 2 dB. The dif-

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ferent power classes are set via software from the LMT or OMC.

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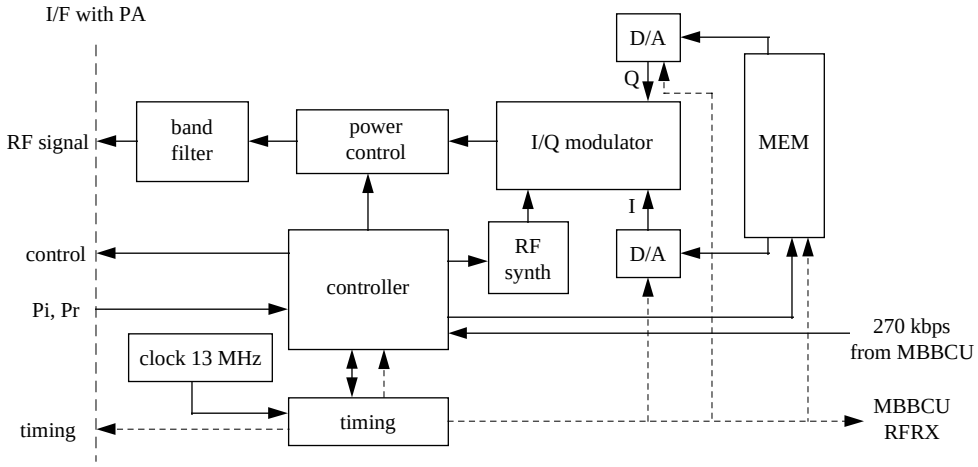
RFTX - block diagram



(figure 4.3)

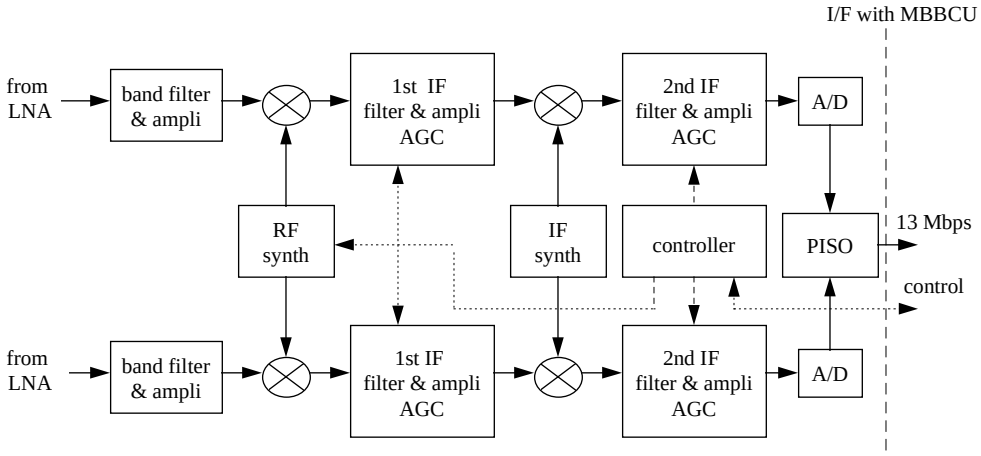
4.4 Radio Frequency Receiver Unit (RFRX)

This unit is available in three versions GSM/ E-GSM900, GSM1800 and GSM1900. For the block diagram see figure 4.4. The main RFRX functions are as follows:

- reception of radio signal from LNA/Band Filter
- conversion of radio signal to a first intermediate frequency
- AGC control
- conversion of radio signal to a second intermediate frequency
- sampling of second intermediate frequency signal for Viterbi equalization and demodulation (MBBCU functions)
- frequency hopping receive mode

The control of the unit is performed by one DSP.

RFRX - block diagram



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(figure 4.4)

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4.4.1 Power Amplifier (PA)

This unit is available in three versions GSM/ E-GSM900, GSM1800 and GSM1900. For the block diagram see figure 4.4.1.

The main PA functions are as follows:

- output band-pass filtering in the defined band
- max. output power control (according to configuration parameter)
- RF power amplifier mixer gain
- antenna VSWR alarms
- overheating sensor

4.4.2 Low Noise Amplifier & Band Filter Unit (LNA & BF):

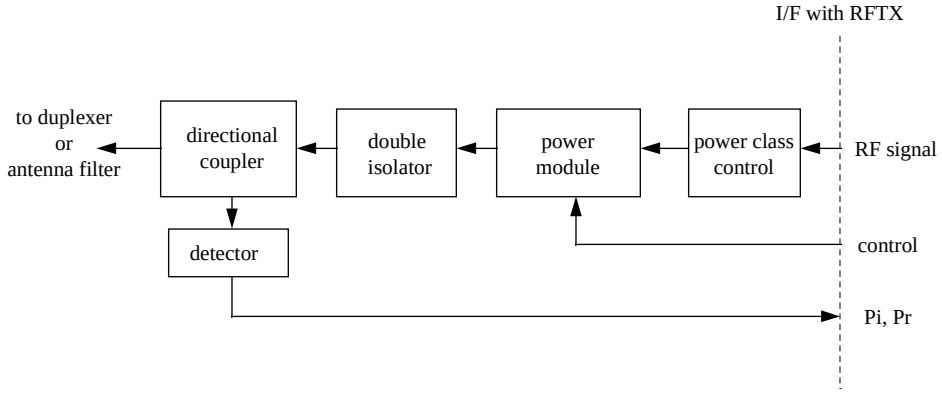
This unit is available in three versions GSM/ E-GSM900, GSM1800 and GSM1900. For the block diagram see fig. 4.4.2

The main LBF functions are as follows:

- selection of the proper RX Band.
- amplification of the input signal by means of low noise amplifier

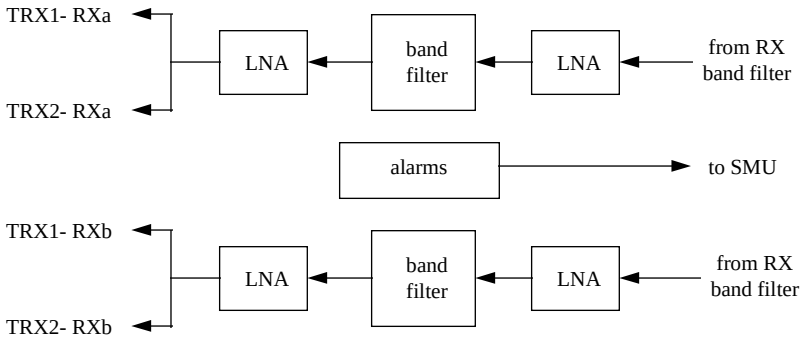
For diversity receive, two LNA & Band Filter Units are connected to the same RX unit, in which two RX chains are embedded.

PA - block diagram



(figure 4.4.1)

LNA & BP filter - block diagram



(figure 4.4.2)

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4.5 SMU functional description

This unit is the interconnection element (gateway) between the transceivers and BSC. Two versions of the SMU are planned, depending on the type of line interface required by the customer.

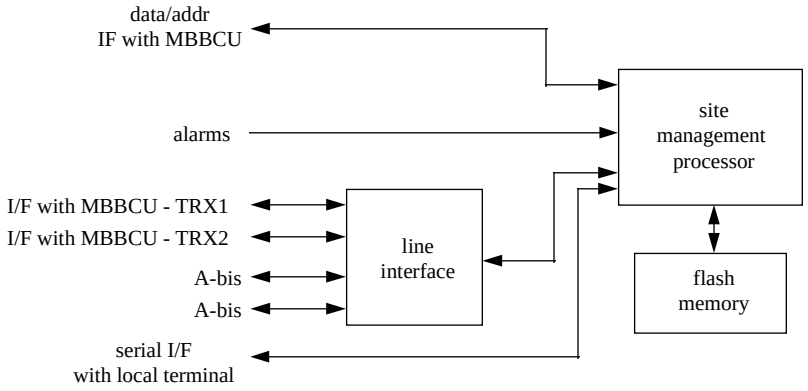
The block diagram of SMU is shown in figure 4.5. In the following the main SMU functional blocks are described.

4.5.1 Site management processor

Its functions are :

- to manage two 16 or 64 kbit/s HDLC links to/from BSC
- to process a signalling connection to/from BSC (LAPD protocol) both for radio signalling and O&M signalling
- to collect BTS alarms and notify them to BSC/OMC
- to manage a 4 Mbyte flash memory
- to handle a connection to a local terminal

SMU - block diagram



(figure 4.5)

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4.5.2 Line interface

For the Micro BTS a variety of different line interfaces are offered by the *combo card*. This feature offers utmost flexibility and allows connection with the BSC via different interconnecting network access. The *combo card* approach provides the following line interface options:

- **2048 kbit/s acc. to ITU-T G.703/G.704 (E1 level)**
- **1544 kbit/s acc. to ITU-T G.703/G.704 (T1 level)**
  Nx64kbit/s / 2048 kbit/s acc. to ITU-T G.703/G.704: A combined LI card (*combo card*) that offers the possibility of either 2 Mbit/s or Nx64 kbit/s interface by means of appropriate switching. Furthermore, Siemens is investigating the provision of customer-specific solutions as further cost-saving measures for mobile operators. These may include fractional 2 Mbit/s bitrates based on various access network standards as X.21/V.11, V.35, V.36 to name a few.
- **144 kbit/s acc. to ITU-T I.430/2048 kbit/s ITU-T G.703:** A combined LI card (*combo card*) that offers the possibility of either 2 Mbit/s or 144 kbit/s interface (2B+D) selection by means of flexible switching to either interface required by the operator. In this case only the 2B-channels are used for traffic and O&M transport whereas the D channel is transparent for the mobile network. Refer also to § 9.1.

Additionally every SMU has the drop-insert capability and manages two links, allowing to switch between the two links in case of fault.

4.5.3 Four (4) Mbytes flash memory

There are two flash eproms in this block, which are used to store software for all BTS processors.

4.5.4 Level translator I/O interface

A transistors array converts open/ground alarm criteria into digital levels. The level translator is the electronical interface for on/off alarms of additional boards integrated in the Micro BTS and for external alarms.

4.6 Power Supply Unit

Two types of power supply can be installed in the Micro BTS to allow the use of alternate or direct current power feed.

4.6.1 AC/DC Unit

The Micro BTS is equipped with an AC/DC power supply. The input voltage can be in the range of 88 V_{AC} to 265 V_{AC}. The internal voltages are the same as in the case of DC/DC (chapter 4.6.2 refers), as well as the other functions.

4.6.2 DC/DC Unit

Optionally the Micro BTS can be equipped with a DC/DC power supply instead of the AC/DC unit. The block diagram of the DC/DC unit is shown in figure 4.6.2. The main DC/DC functions are as follows:

- DC/DC conversion and output stabilization by means of “variable duty-cycle” inverters for generation of +13V, +8V, +5V, +26V and -5V
- self test and alarms to verify tolerances, overloads and possible failures (automatic switch off in case of major alarms)
- activation of the heater in case of low temperature and deactivation when conditions for normal operation are achieved
- EMI/EMC protection

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The input voltage for the DC/DC unit can be in the range of -39 V_{DC} to -60 V_{DC}.

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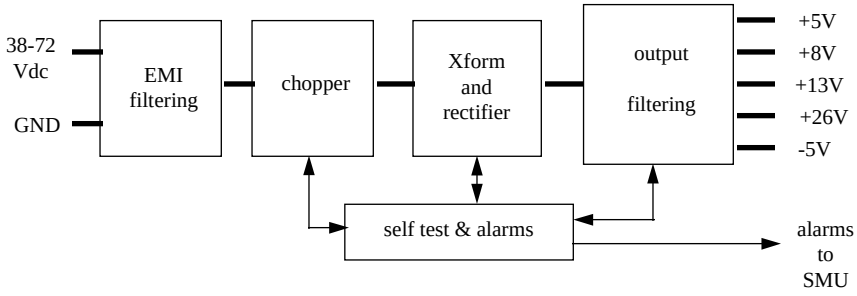
DC/DC Unit - block diagram



(figure 4.6.2)

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5.0 PRODUCT FEATURES

5.1 Summary of Micro BTS technical data

Radio characteristics	
Frequency bands	• GSM900/EGSM900 • GSM1800 • GSM1900
Capacity	• One carrier (box prepared for second TRX) • Two carriers (second carrier with frequency hopping) forming a single cell in the same box
Access Technique	TDMA / FDMA
Modulation	GMSK
Receiver Sensitivity	-104 dBm (fulfilling microcellular requirements stated in GSM 05.05)
Power Control	Static Power Control: n step static power reduction for high power class and M1, M2, M3 classes (24, 19, 14 dBm respectively acc. to GSM 05.05) ($0 \leq n \leq 6$; 2 dB each step) Dynamic Power Control (for high power class): m step dynamic power reduction (m = 15 - n; 2 dB each step) Dynamic power control can be performed on the non-BCCH TRX with remaining steps (after static power control has been adjusted) out of 15 steps available.
Combining	On-air combining
Antennas	Internal (integrated) or external
Diversity	Polarization diversity with internal antennas. Space diversity with external antennas

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RF-Branching	• Two external antennas are used in the following way (1 TRX): The first antenna for RX and TX, the second antenna for diversity RX. The combining/branching function is realized via duplexers within the box of BS-11. • In case of internal antennas the RF branching is realized by means of dedicated TX/RX filters.
Channels	
Speech channels	• Full-rate • Half-rate (only for GSM/E-GSM900 / GSM1800) • Enhanced full-rate
Data channels	• Full-rate 9.6, 4.8, 2.4, 1.2 and 0.6 kbit/s (transparent) 9.6 kbit/s (non-transparent)
Ciphering	A_{50} or A_{51} (per call basis) A_{50} or A_{52} (per call basis) A_{50} or A_{51} or A_{52} (per call basis)
Installation Data	
Applications	Indoor / outdoor
Installation	Wall and pole mounted
Size (H) x (W) x (D)	415 mm x 466 mm x 160 mm
Volume	28 l
Weight	22 kg (1 TRX) 28 kg (2 TRX)
Colours	Basic colour: White Grey (RAL 9002) Optional colours for sun shield: Red (RAL 3016), Pale Green (RAL 6021) and Grey (RAL 7032). Neutral ground colour (polyurethane) is available for customer specific painting following supplier's instructions.

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Power consumption	80 W (1 TRX), 160 W (2 TRX), 180 W for heater (when applicable)
Power supply	• 88-265 V_{AC} (45-65 Hz) or • -39 to -60 V_{DC}
Internally managed power hold-up time	Until 130 ms a message to BSC will be sent
External battery backup	Up to 30 minutes
Environmental conditions	• operational range: -45 to +45°C plus additional solar radiation (1200 W/m²) • lightning protection • heating system • cooling: natural convection
Protections	• IP 54, IP 64 • burglar proof cabinet • lightning arrestors
MTBF	45000 h (for the 1 TRX version)
Interface to LMT	
Interface with local terminal	RS-232
Simplified LMT	Basic LMT functionality (LMT software incl.). The LMT software is executable on an all purpose notebook (MS DOS). A graphical (WINDOWS) user interface is provided.
Software download	One version of operational software and one software version in flash eprom which is able to communicate for download purposes with the BSC. Software download without service interruption.
External cabling	Bottom

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5.2. Technical data for GSM900 band

Radio characteristics	
GSM frequency band EGSM frequency band	890-915 MHz / 935-960 MHz 880-915 MHz / 925-960 MHz
Output Power	GSM classes M1, M2, M3 (250 mW to 30 mW) and 2 W
Interfaces	
Interface with A_{bis}	• 2048 kbit/s according to ITU-T G.703/G.704 (PCM30) • Nx64 kbit/s according to ITU-T G.703/G.704 • 144 kbit/s ITU-T I.430 (S_0) Drop & insert for chain and loop configurations
Submultiplexing over the A_{bis} interface	8/16/64 kbit/s (traffic); 16/64 kbit/s (signalling)
Network configuration	• Multidrop with PCM30 • Star with PCM, Nx64 kbit/s or ISDN • Loop with PCM30
Compatibility with SBS releases	From BR 3.6 onward

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5.3. Technical data for GSM1800 band

Radio characteristics	
GSM1800 frequency band	1710-1785 MHz / 1805-1880 MHz
Output Power	GSM1800 classes M1, M2, M3 (1.6 W to 50 mW) and 3 W
Interfaces	
Interface with A_{bis}	• 2048 kbit/s according to ITU-T G.703/G.704 (PCM30) • Nx64 kbit/s according to ITU-T G.703/G.704 • 144 kbit/s ITU-T I.430 (S_0) Drop & insert for chain and loop configurations
Submultiplexing over the A_{bis} interface	8/16/64 kbit/s (traffic); 16/64 kbit/s (signalling)
Network configuration	• Multidrop with PCM30 • Star with PCM, Nx64 kbit/s or ISDN • Loop with PCM30
Compatibility with SBS releases	From BR 3.6 onward

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5.4. Technical data for GSM1900 band

Radio characteristics	
GSM1900 frequency band	1850-1910 MHz / 1930-1990 MHz
Output Power	GSM1800 classes M1, M2, M3 (1.6 W to 50 mW) and 3 W
Interfaces	
Interface with A_{bis}	• 1544 kbit/s according to ITU-T G.703/G.704 (T1 interface; PCM24) resp. 2048 kbit/s according to ITU-T G.703/G.704 (E1 interface; PCM30) • Nx64 kbit/s according to ITU-T G.703/G.704 • ISDN BRI: ITU-T I. 430 (external NT, power supply for external NT provided in case of DC supply; ISDN US version: line code acc. to TR-NWT-397, 393, 776 and ANSI T1.601 and 605) switchable to PCM24. Drop & insert for chain and loop configurations
Submultiplexing over the A_{bis} interface	8/16/64 kbit/s (traffic); 16/64 kbit/s (signalling)
A_{bis} physical connection	T1: 100 Ω for symmetrical lines (copper). One incoming A_{bis} connection and one outgoing (to the next element in chain or loop configuration) A_{bis} connection
Network configuration	• Multidrop with PCM24/PCM30 • Star with PCM24/PCM30, Nx64 kbit/s or ISDN • Loop with PCM24/PCM30
Compatibility with SBS releases	From BR 3.7 onward

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Compliance with US specific standards	• Mainly FCC approval for... – radiated emissions & conducted emissions => FCC Part 15: Oct. 1, 1993 – RF hazards (subpart c) – frequencies (subpart e, 24.229) – frequency stability (subpart e, 24235) – emission limits (subpart e, 24.238) • Product safety/flammability requirements acc. to UL 1950 (refers to materials, components, materials, PCBs, cables, etc.)

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6.0 METHOD OF COMBINING FOR BS-11

The BS-11 comes in its first release as a 1 TRX Micro BTS with the option to increase this capacity to 2 TRX later on (second release) when network demands call for higher capacity.

In case of 2 TRX operation, carrier combining at antenna shall be based on the '*power economical*' solution using „on air" combining as with BS-21E.

This solution employs two **external antennas** and **two duplexer** base modules. The two antennas (per cell) are simultaneously used for transmission, reception and diversity reception. Therefore a total of two transmit paths, two receive paths and two diversity receive paths are available.

Planar antennas are always provided as an integral part of the Micro BTS when initially ordered by the customer with either 1 or 2 TRX. Planar antennas use patch technology where in the TX branch up to ***two*** circularly polarized patches are employed versus ***one*** cross polarized patch of ± 45° in the RX branch. Therefore the realization of the enhanced feature '*polarization diversity*' that is of special interest for indoor applications becomes possible.

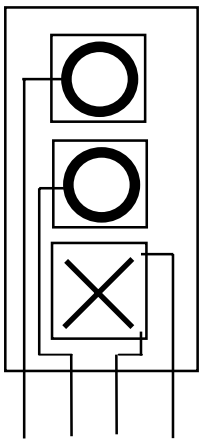
Polarization diversity counteracts propagation impairments resulting in typical indoor applications from various reflections and scattering of the signal which lead to an enormous drop in receive power level. Additionally subscribers nowadays use handheld MSs and may come too close to the Micro BTS, different to vehicle mounted equipment in the past. MS positions are thus - usually -inclined by an angle around ± 45° and are not vertically installed (polarized!) as before.

This constellation therefore justifies the use of polarisation diversity which contributes with a gain of around 1.5 - 2 dB to the receive signal. Integrated planar antennas (GSM900) have the following characteristics:

G_{TX} = 2 dBi
G_{RX} = 5 dBi

The antenna connector used is a TNC female connector. The antenna cable access is from the bottom.

Antenna radiation pattern envelopes available today reveal the characteristics depicted in the following diagrams.



TX1 n.u. RX1 RX2
TX1 TX2 RX1 RX2

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structure of planar antenna used

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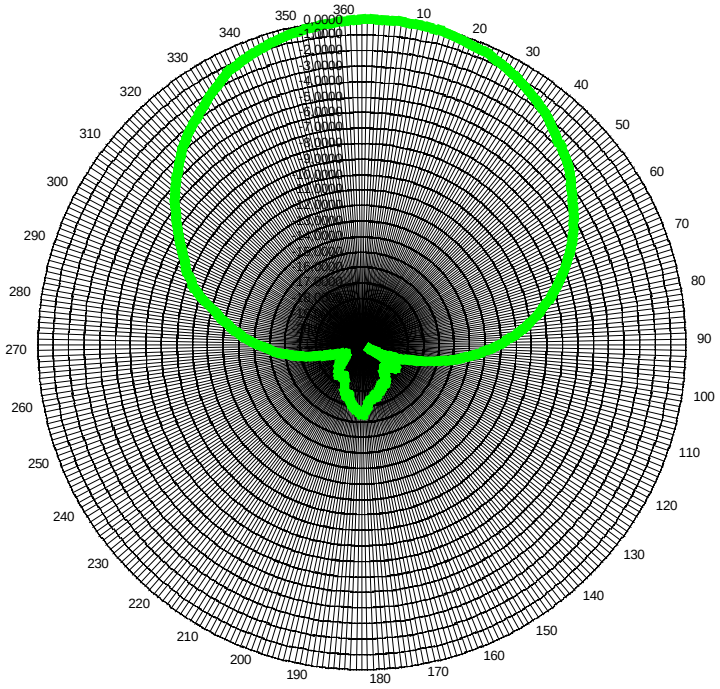
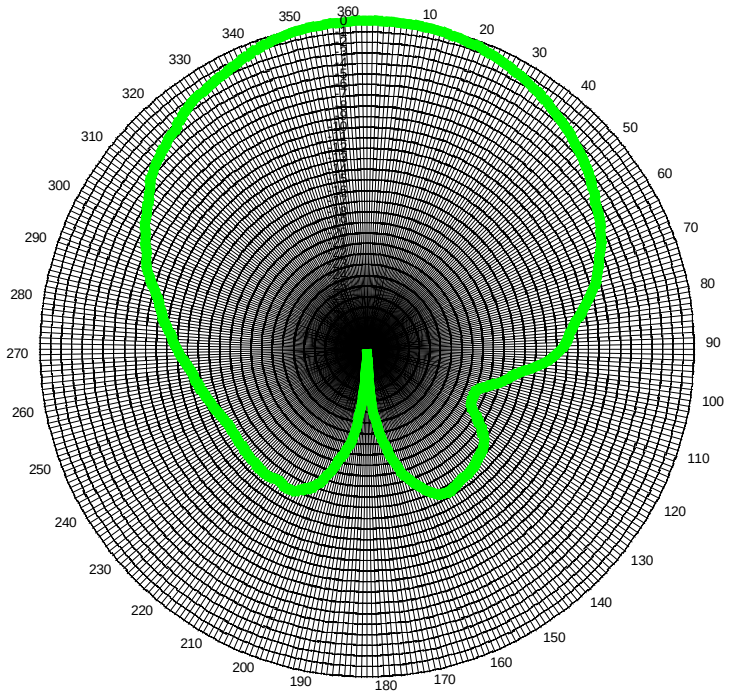


Radiation pattern envelope RX1 (f = 880 MHz)



Radiation pattern envelope TX1 H-pol. (f = 960 MHz)

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In order to ensure utmost flexibility in operation for the operator, Siemens standardly provides the Micro BTS with the relevant number of modules needed according to the antenna solution adopted by the customer. If external antennas are used, the Micro BTS is equipped with duplexers which are integrated inside the cabinet. In case of use of internal antennas, dedicated TX and RX filters are used instead of the duplexers. These are also housed inside the Micro BTS cabinet.

6.1 Transmit power options & close proximity considerations

The GSM900 (GSM1800/GSM1900) product provides 2 (3) W **'high' output transmit power** measured at the antenna connector.

GSM *Rec. 05.05* specifies in particular dedicated power classes (M1-M3) for microcellular network implementation. Importance is especially addressed to interference limitation and ensurance of coexistence with other microcellular networks of different operators. Here, antennas mounted below roof top level require minimum distances to be maintained between MS & Micro BTSs for not *blocking* Micro BTSs of different operators under *uncoordinated* operation. This is known as the ***„close proximity"*** constraint.

For interference limitation in indoor and outdoor applications as well as to cope with 'close proximity' as defined in GSM 05.05, the above 2 (3) W value can be further down scaled to the relevant M-classes (or vice versa up scaled) to support the implementation of small sized cells. This option is provided for all product versions GSM900, GSM1800, and GSM1900.

The **receiver reference sensitivity** automatically adapts itself to lower sensitivity values depending on the transmit power classes used as defined in GSM 05.05.

Power class selection in the Siemens Micro BTS is purely handled by software settings. This can be done either locally at the Micro BTS or remotely from the BSC or OMC.

After installation of the unit e.g. on the wall, the LMT can be used to further set the relevant power class desired by the operator for specific application circumstances.
For this reason, ***static power control*** is used to set the power class of the unit whereas ***dynamic power control*** is further used for automatic readjustment purposes of power levels (e.g. per TCH) to cope with interference optimization in cell network planning.

6.2 Measurement information

Measurements of uplink signal strength and quality (performed by the TRX), downlink signal strength and quality, reporting on adjacent cells (provided by MS) for a given connection, are collected by the TRX and processed for handover decision and power control.

6.3 MS/BS Power Control

For each channel, measurement of the received signal level performed by both the mobile station and the TRX are collected and pre-processed in the Micro BTS in order to command changes in output power level to MS/TRX if necessary. All the parameters involved are tuneable from OMC. These functionalities can be also enabled/disabled by OMC.

6.4 Frequency hopping

BSC determines the frequencies, all other parameters used by the hopping algorithm

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are calculated in the BTS. The use of frequency hopping is enabled/disabled through a configuration parameter which can be set by OMC for each BTS. Frequency hopping is performed at radio frequency, i.e. synthesized frequency hopping.

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7.0 CUSTOMER BENEFITS

The product reveals major benefits from customer viewpoint compared to conventional product lines available in the market at the same time window.

With a Siemens world-wide field proven mobile network infrastructure combined with the compact mechanical repackaging of BS-11, network requirements are easily met and new benefits achieved for operators. Coverage and capacity bottlenecks are addressed in an efficient and future proof way, so that operators need **no more** to deploy only repeaters or cell enhancers as their networks grow.

This and other benefits are summarized in the following:

☺ site acquisition advantages thanks to compact design of 28 litres **= less rent for little space**

☺ handling by one technician (transport, installation & commissioning) **= less personnel cost**

☺ installation time in less than one hour at prepared site **= time saving up to 70%**

☺ inconspicuous integrated planar antennas **= relaxation of public acceptance**

☺ low acoustic noise **= new urban & residential spots can be easily covered**

☺ no routine maintenance **= additional operation cost can be spared**

☺ use of planar or external antennas **= flexible choice of deployment without HW exchange**

☺ cost effective terrestrial copper interconnection **= no dependence on landline operators**

☺ attachable/detachable handle = **facilitates transportation to site**

☺ long haul link interface transmission = **distances between cascaded Micro BTS can be up to 2 km (no NTPMs)**

☺ low power consumption **= minimum cost of ownership**

☺ commercial 220/110 V_{AC} supply feeding **= no diesels or generators required**

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8.0 INSTALLATION AND SERVICEABILITY

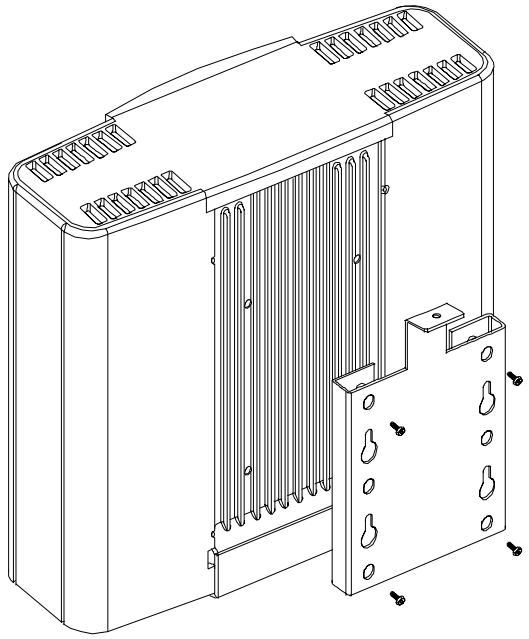
8.1 Installation procedure

The product is considered as least replaceable unit **(LRU)** and is handled by one person during installation. The installation time of BS-11 is typically less than 1 hour at prepared site conditions. The cabinet is hooked to the wall by means of a supplied wall mounting kit (pole mounting kit is also available as an extra option).

The steps for complete installation to be carried out are:

- drill work for fixing of unit slide rod on the wall
- hook unit to the wall and adjust its position
- interconnect with supply mains (88 V_{AC} - 265 V_{AC}) or alternatively -48 V_{DC} (-39 V_{DC} to -60 V_{DC})
- establish connection to the terrestrial network, e.g. via NTPM (PCM 30) or NTBA (ISDN)
- configure the unit with the aid of LMT by steps listed below

The attachment of the Micro BTS to the mounting system is depicted in figure 8.1.1.



(figure 8.1.1)

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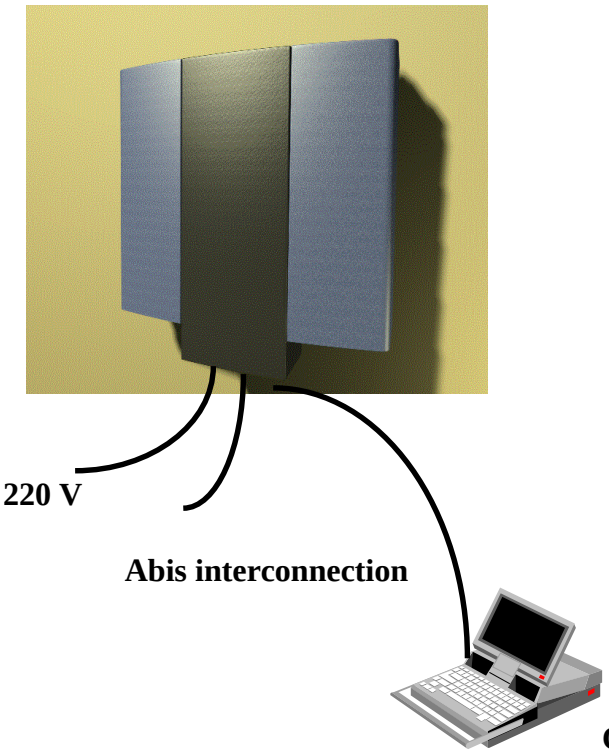

After powering of BS-11 and connection via a network termination unit (e.g. 2 Mbit/s leased line), the Micro BTS parameters e.g. LAPD signalling are set with the aid of the LMT e.g. a commercial DOS notebook. The LMT software is windows-based which provides an easy and self-explaining graphical user interface that guides the user through the Micro BTS installation steps (see figure 8.1.2.).

The external communication interface provided by the Micro BTS to the LMT is a serial interface based on RS-232. The connection of the LMT to BS-11 is achieved by means of a special cable connection that is provided in the LMT kit.

This modular Micro BTS design approach facilitates the installation process and cuts installation time to about one hour i.e. provides approximately 70% saving in installation time compared to standard Mini-BTSs. Possible installation sites can be any available site at the convenience of the operators choice, e.g. in

- non air-conditioned or air-cond. rooms
- indoor and outdoor walls
- roofs
- poles

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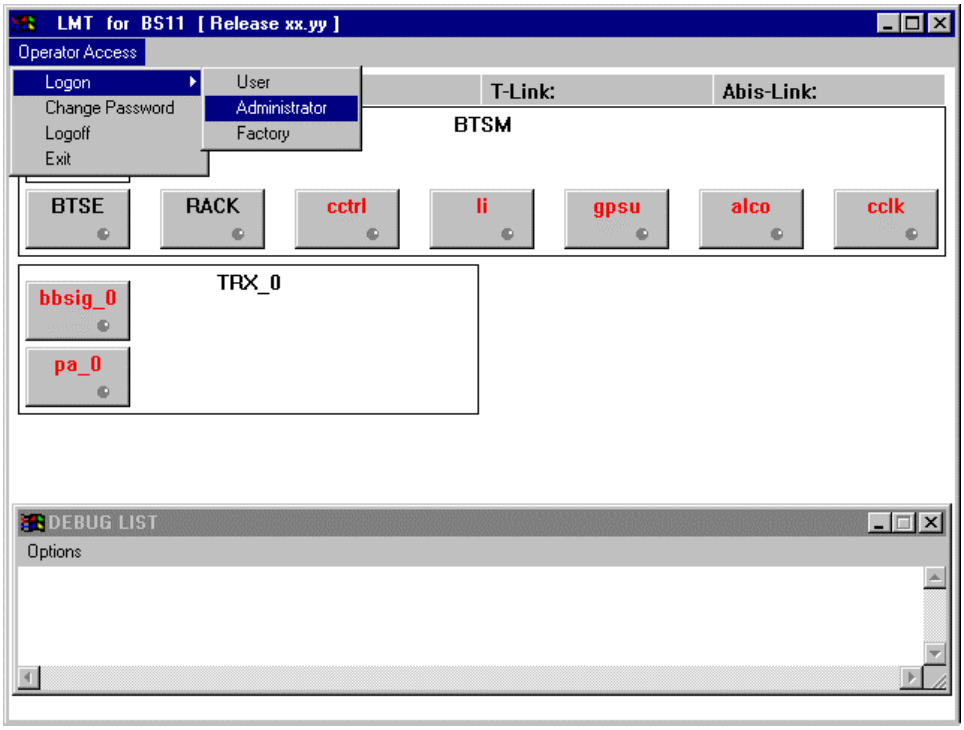

(figure 8.1.2: BS-11 configuration by LMT)

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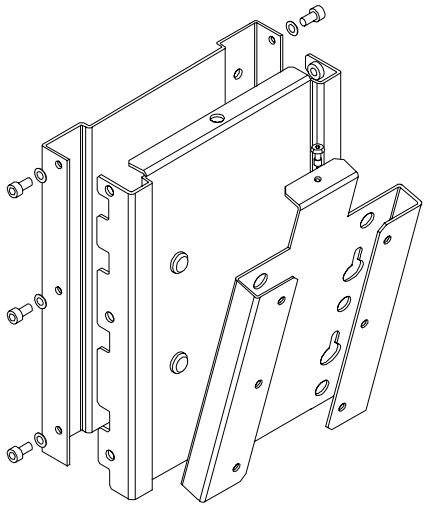
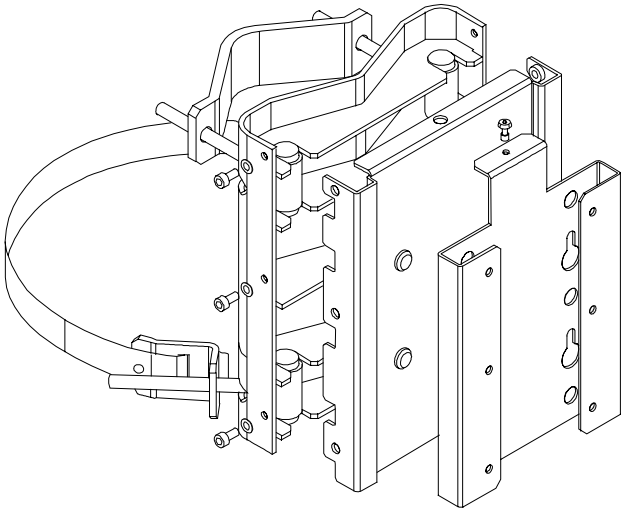
8.2 Mounting System

A kit composed of two elements is used for mounting the Micro BTS. The first one is fixed on the back side of the Micro BTS (see figure 8.1.1), while the second one is fixed on the wall (see figure 8.2.1) or on the pole (see figure 8.2.2).

During installation the two elements can be hinged on each other. This can be performed by only one person.



(figure 8.2.1)



(figure 8.2.2)

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8.3 Service aspects

The BS-11 Micro BTS is a service and environmentally friendly product thanks to the smart concept employed. The product is regarded as an LRU (least replaceable unit) ex factory and does not require routine service nor does it need very skilled personnel to deploy into field.

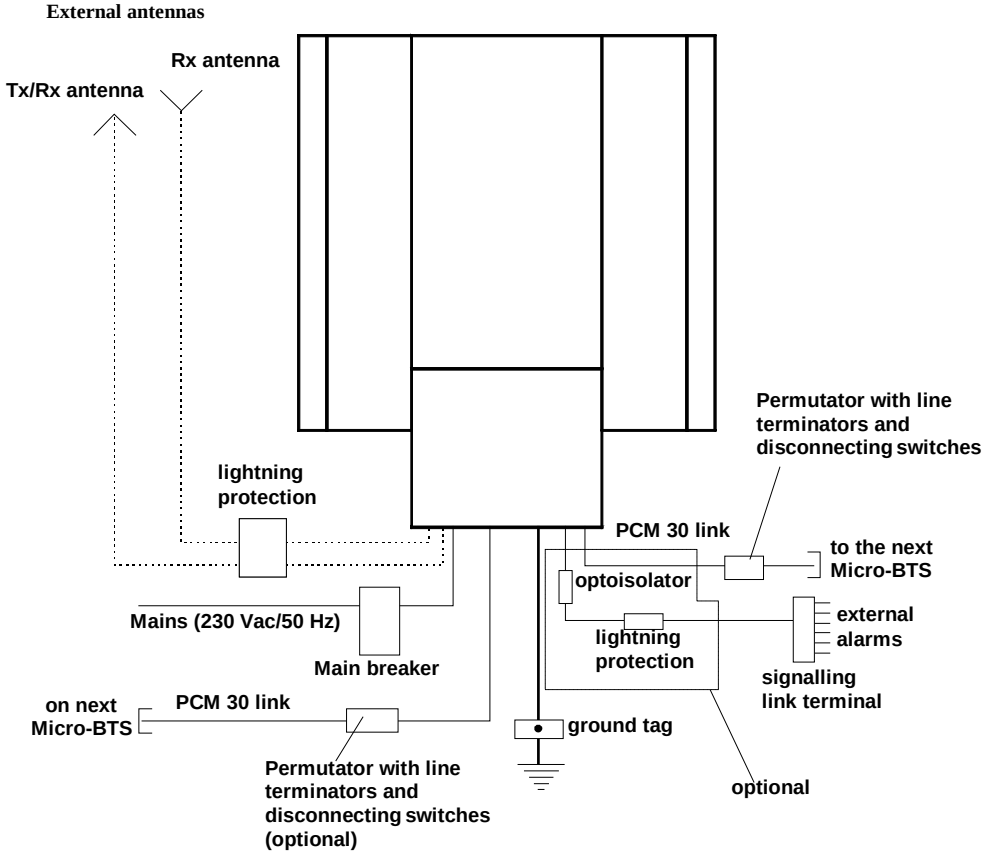
Normal technicians are capable of installing the BS-11 Micro BTS in less than 1 hour with the aid of commercially available LMT (notebook) for setting of the limited number of configuration parameters.

These include...

- test results after power on
- static setting of power class (value)
- configuration of LAPD channel
- check of antenna connector
- status of terrestrial link
- download of operational SW (optional)

As the Micro BTS is a LRU, fuses and lightning arrestors can be replaced in the field which is the minimum possible serviceability needed for the Micro BTS. No big maintenance kits are needed for this purpose.

8.4 Typical Site Configuration



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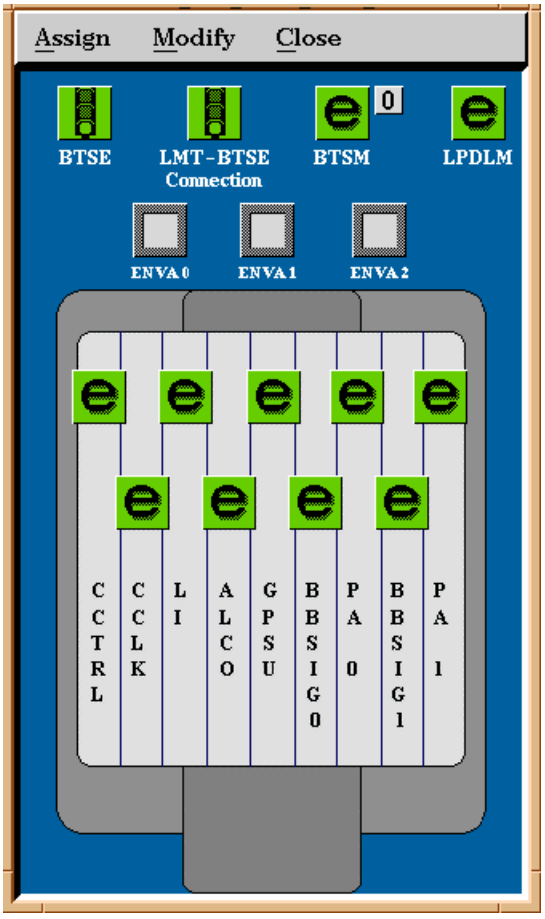
(figure 8.4)

8.5 Micro BTS representation at OMC level

At OMC level, the Micro BTS is represented as a single rack. The boards are displayed following the SBS board terminology. Board specific parameters as well as state and status information can be selected by clicking the corresponding icon.



(figure 8.5: BS-11 display at OMC)

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9.0 TERRESTRIAL NETWORK INTERCONNECTIVITY

Various options for BS-11 interconnectivity are possible and mainly depend on the operators strategy with regard to the application environment and the installation mode envisaged, e.g. indoor or outdoor.

Though the product is actually an outdoor product - and thus fulfils indoor needs as well - the unobtrusive design also allows its use in typical indoor sites as department stores for instance. In this case the relevant transmission equipment can be installed e.g. in a basement of such a building.

As for outdoor deployment, the possibility for interconnection to other network entities can be realized by externally placed link equipment with 2 Mbit/s (ITU-T G. 703) interface. This can be for instance a microwave radio terminal or a network termination (NTBA or NTPM) housed in a supplementary service shelter provided by the operator or directly mounted on the wall.

Powering means of an external link equipment is provided in case of DC/DC power supply of BS-11 via the external battery backup system.

9.1 Options of copper based solutions

9.1.1 ISDN Basic Access

The 1 or 2 TRX traffic capacity can be optionally transported by means of 1x (or respectively 2x) ISDN BA (2B+D) capacity of 144 kbit/s.

This is an extremely flexible means that Siemens provides to its customers especially when the Micro BTS is placed in a location where no classical transmission infrastructure can be used e.g. microwave in indoor applications (hotel lobbies).

Similar situations may also apply when the provision of PCM lines is either time consuming or cost inefficient for the applications in question: In some low traffic - but still attractive spots for operators - as in case of touristic spots occasionally regarded as ‘rural’, no blind fibres are available.

The accommodation principle of the 8 time slots (or 2 x 8 for 2 carriers) is depicted below. In this case the ISDN ‘D’ channel is not used for the transmission. The overall ISDN BA capacity [2B + D] = 144 kbit/s of which only the 2B channels (128 kbit/s) carry the GSM traffic and signalling per transceiver. This is explained below:

One TRX Micro BTS is easy to interconnect, as one 64 kbit/s PCM TS can accommodate up to 4 GSM TSs [4 x 16 kbit/s], i.e. for 1 TRX Micro BTS [8 GSM TSs] only 2 x 64 kbit/s are required.

Therefore it is not only possible, but mainly economical to use ISDN BA for an easy digital interconnection of the Micro BTS to the other network entities by means of conventional (in-house) copper twisted pairs. The access interface for interconnection provided by the BS-11 is at S_0-level.

The O&M signalling is transported within the 16 kbit/s capacity of the available 2B (i.e. 2 x 64 kbit/s) link capacity.

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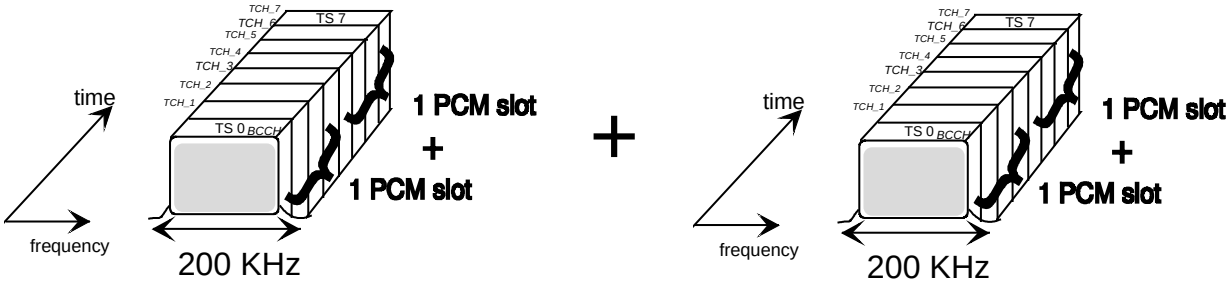

subscriber side:
S_o-bus (4 wires)
distance: up to 1000 mt (point-to-point)

network side:
landline operator's sovereignity, U_o (2 wires)
distance: up to 4000 mt

The NTBA required for this mode of transmission is placed externally and is fed by an external AC source.
In case of DC supply (-48 V), the supply of the NTBA is provided by the battery backup system of the Micro BTS.

9.1.2 Nx64 kbit/s access

The Siemens Micro BTS additionally provides the option of terrestrial interconnection by means of Nx64 kbit/s capacity, where irrespective of different market advancements and regulatory degrees, operators can always benefit from this cost efficient & flexible copper solution compared to standard PCM line cost contemplation. Operator's access to Nx64 kbit/s interface may be based on several standards as X.21/V.11, V.35 or V.36 to name a few options. These options are currently under evaluation by Siemens.

9.2 Network realization with BSC

Though the A_{bis} interface may be S_0 as by introduction of NTBA, the Micro BTS can be further interconnected to BSC link interfaces (DTLPs or QTLPs) by means of external transmission equipment. This transmission equipment has the task to convert the aggregate signal offered by the link interface of the Micro BTS (e.g. 144 kbit/s in case of S_0) to the 2 Mbit/s signal level (1.5 Mbit/s for GSM1900 in North America) for direct interfacing with the BSC.

The transmission equipment that can be used for this purpose include plesiochronous multiplexers (MUX) and/or digital cross connects (DXC). Conversion to 2 Mbit/s can be done **locally**, i.e. on the Micro BTS site

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or **remotely** from the Micro BTS site directly at the BSC.

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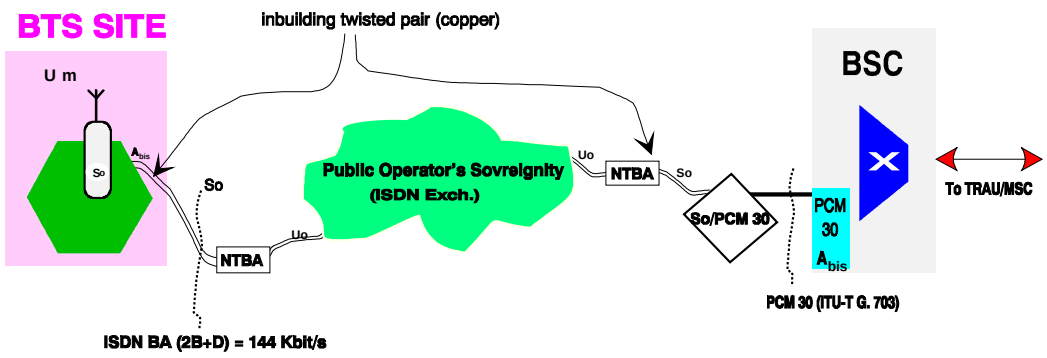
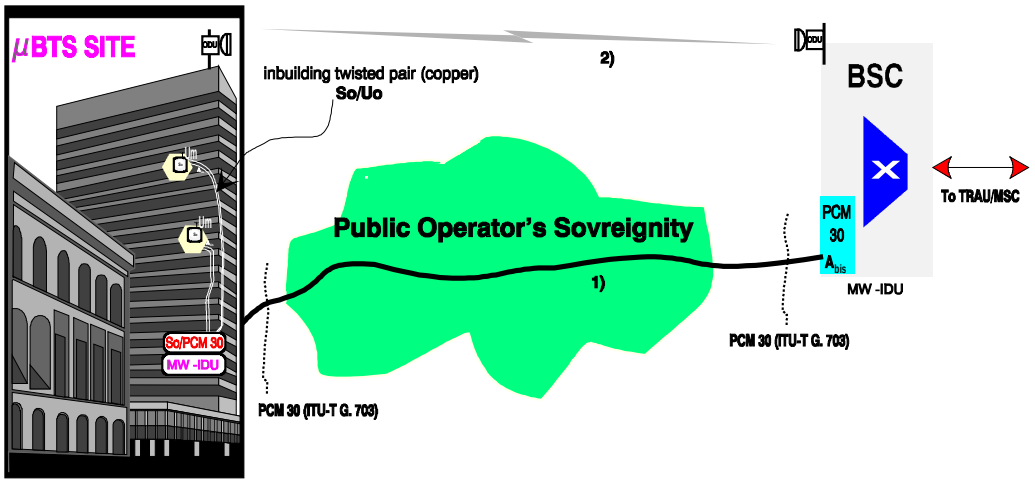
These two options are depicted below.



Option (1)



Option (2)

The Micro BTS can be optionally interconnected by 2 Mbit/s microwave systems at ITU-T G.703 level if PCM leased lines or ISDN BA are not available for the terrestrial interconnection.

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9.3 Interconnection to PABX

Thanks to the attractive ISDN feature offered by the Siemens Micro BTS, interconnection of the BS-11 via S_0-interface to PABX becomes possible.

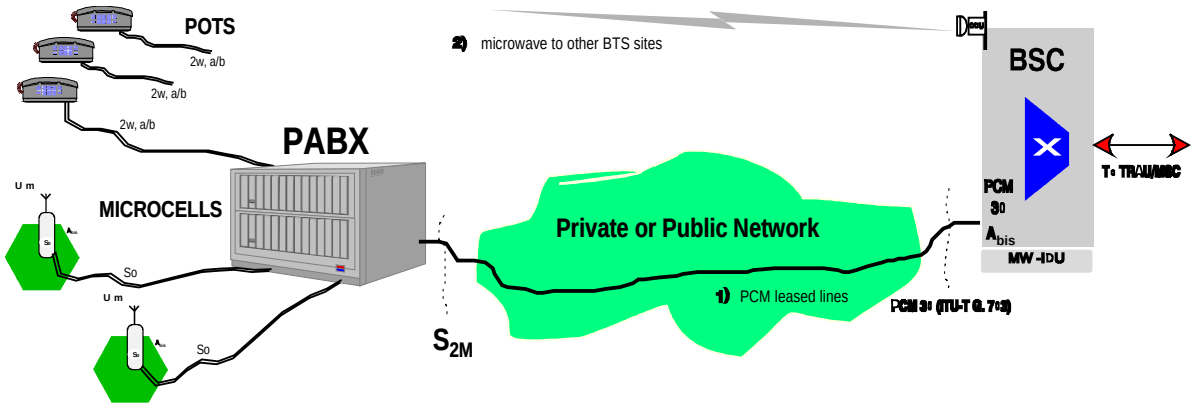
In this case, common cellular and POTS subscribers can be interconnected to an existing PABX (option 3) in a given corporate network thus resulting a great enhancement in the traffic routing within the corporate and cellular networks respectively.

Cellular and POTS subscribers can reach each other via any conventional ISDN compatible PABX (transparently) without having their calls to exit and re-enter the cellular network boundaries via the PSTN gateway. The overall generated corporate traffic may further benefit from the PABX features available as short numbering and call forwarding, for instance.

The above deployment scenario extends the classical activities of mobile operators to a new corporate, cordless and cellular market segment as a further step forward to convergence between the disappearing boundaries of fixed and mobile networks. This is certainly a new and additional source to strengthen mobile operator's competitiveness in a deregulated telecommunication market and ensures additional revenue generating means.

Other means of interconnections may be additionally investigated in future depending on market requirements and regulatory aspects. This applies especially to further copper transmission solutions as **HDSL** for instance.

Please contact Siemens in this respect should your needs call for other interconnection solutions.



(Option 3)

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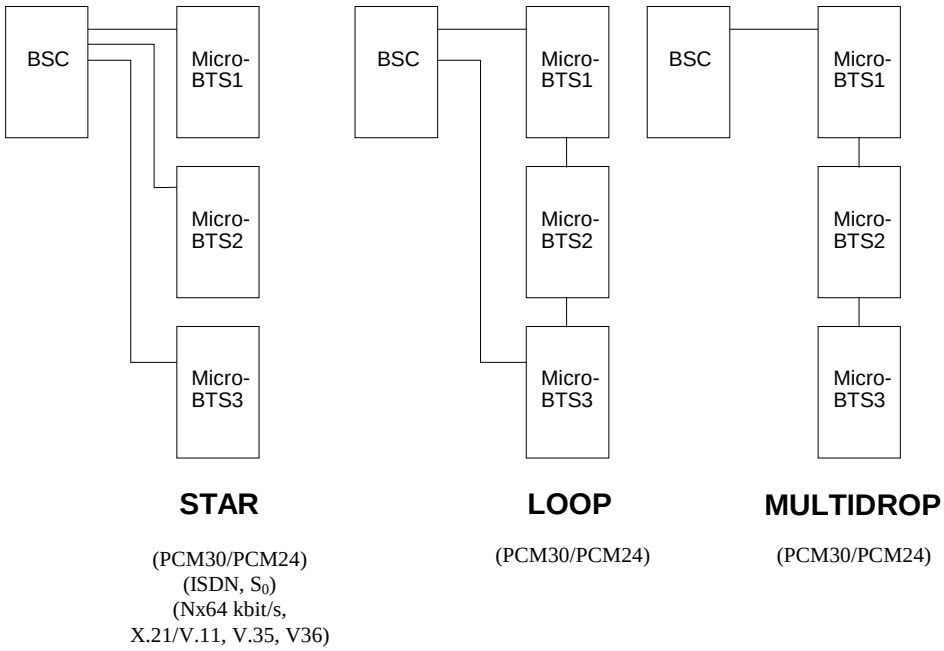
9.4 A_{bis} Interface Configurations

The supported A_{bis} configurations to connect the Micro BTS to the BSC are depicted in figure 9.4.



(figure 9.4)

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10.0 SOFTWARE HANDLING

10.1 Introduction

O&M software in the Micro BTS has been implemented according to GSM 12-series (phase 2) of technical specifications. All hardware and software resources are defined as “logical” or “physical” resources using an object oriented modelling methodology. A logical/physical resource is thus a Managed Object as defined by the Guidelines for Definition of Managed Objects (GDMO) CCITT X.722 and X.208.

The following maintenance functionalities have been identified for Micro BTS:

- supervision
- tests
- fault handling
- alarm handling
- configuration management
- software handling
- status management
- performance management

10.2 Supervision

The supervision functions are based on periodic check of the thresholds associated to each logical/physical entity. The thresholds are modified from a man machine command per device type or device group. In some cases a supervision function could be activated/deactivated with a man machine command by the operator. When the threshold (lower limit or upper limit) is exceeded a fault report is generated.

The supervision functions in BTS are integrated to cover all aspects of supervision of the logical and physical resources.

Supervision is based on measurements (e.g. voltage, current, levels (dB)), or operation counters.

By means of a local terminal it is possible to locally display information about BTS configuration, status of logical and physical objects and alarms.

BTS supervision functions are related to processors, data bases, internal/external communications, etc.

10.3 Tests

Since the Micro BTS is a compact equipment, in which units are not replaceable in the field, a self-test mechanism has been implemented, covering all main aspects of BTS functioning which provides a YES/NO answer.

10.4 Fault handling

In the BTS system a fault handling strategy minimizes the influence of the fault occurring in a device and the functionality of other devices.
A state handling strategy monitors and stores the state for all the significant resources managed by the system. Each change of state of significant resources of the BTS is notified to the SMU.

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10.5 Recovery actions

Recovery actions are those actions automatically performed when an error is detected, in order to minimize the out of service of the system and perform the "local fault tolerance".
Recovery actions can be made by SMU (when possible) or by BSC/OMC. BSC/OMC are always notified of BTS actions.

10.6 Fault reports

The fault reports give information about the priority of the fault, identity of the faulty unit and description of the faults.

The fault reports are generated by the SMU which collects all the information coming from the TRXs and through a diagnostic strategy localizes the HW/SW fault, isolates it and informs BSC/OMC.

10.7 Alarm handling

The alarm handling strategy on BTS is based on a collection of start alarms/ceased alarms on SMU. Precisely, alarm reports from several modules are correlated by SMU and filtered. SMU handles alarms, classifies them and upgrades the states of local alarm (on BTS) and remote (on BCS/OMC).

10.8 Configuration and management

The configuration process is handled by the Site Manager, that sends configuration parameters to the transceiver.

The operator can check the BTS and modify the configuration remotely from the OMC or locally from a local terminal. All local commands are immediately notified to the OMC in order to ensure data updating and to prevent data discrepancies in the OMC.

During the normal activity, changes in the BTS parameters can be performed through a BSC local terminal or through the OMC.

10.8.1 Software handling

The software package is held on F-EPROM so that it is available at system start-up. This software version can be updated with a downloading procedure through the A_{bis} interface.

Site Manager caters for file distribution to the different BTS units.

The downloading of a new software version for a system updating can be executed during the normal system activity. Activation of a new software version can be performed when required by the specific activation command.

10.8.2 Status management

A BTS Managed Object is characterised by state attributes and operations that define the operability aspects of the associated physical/logical resources.

The operator through local and/or remote commands can require the status of one or a lot of BTS Managed Objects.

10.8.3 I/O system

BTS local I/O system includes:

- a local PC interface (RS-232/V.24)
- green LED indicating that the power is ON

The local PC interface is used for displaying configuration parameters, alarms and status and also for BTS commissioning (download SW, configuration, testing).

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11.0 BACKWARD COMPATIBILITY AND FUTURE PROOF DESIGN

For the backward compatibility with future releases, the following points are ensured, where new features (SW or HW) shall not affect existing features (e.g. temperature range):

11.1 Future second TRX

From the first release onward it is foreseen that a second TRX can be inserted in the BS-11 box and can be operated in the same way as when only equipped with 1 TRX. The additional carrier will support frequency hopping.

11.2 Future Switchable Link Interfaces

In a second step switchable link interfaces for the A_{bis} interface will be optionally offered:

- ⇨ 1544 kbit/s according to ITU-T G.703/G.704 (T1 interface; PCM24)
- ⇨ Nx64 kbit/s switchable to PCM30 ITU-T G.703 or V.35/V.36 (under evaluation)
- ⇨ ISDN (S_0 interface), I.430 switchable to PCM30 G.703
- ⇨ Nx64 kbit/s switchable to PCM24 ITU-T G.703 or V.35/V.36 (under evaluation)
- ⇨ ISDN BRI US version switchable to PCM24

Basic Rate Interface (BRI) utilizes a 2B1Q coding (as opposed to 4B3T in Germany). Primary rate ISDN for the GSM1900 utilizes T1 standard facilities with either AMI or B8ZS (clear channel) coding. The physical layer (layer 1) requirements are referenced in:

- CCITT recommendation I.430
- TR-NWT-397 (ISDN Basic Access Transport System Requirements)
- TR-NWT-393 (ISDN Basic Access Digital Subscriber Lines)
- TR-NWT-776 (Network Interface Description for ISDN customer access)
- ANSI T1.601 (ISDN Basic Access Interface for use on metallic lops for application on network side of the NT- Layer 1)
- ANSI T1.605 (for S and T reference points - Layer 1)

Siemens has adapted a smart concept that combines E1/T1 interface, ISDN (including North American Version) and Nx64 kbit/s on a single card, thus reducing the number of card variants and providing logistical advantages. Above mentioned new card (including possible future enhancements) fits into the same hardware box delivered initially. New link interface cards can be only exchanged inside the factory.

11.3 Half-Rate / Enhanced Full-Rate Speech Coding

Also in a second step the Micro BTS will support half-rate speech coding as well as enhanced full-rate speech coding. The hardware delivered initially will cope with both requirements. Half-rate speech coding as well as enhanced full-rate speech coding become available by means of a software download (from OMC).

No hardware exchange is necessary.

11.4 Loop Configuration on A_{bis} Interface

The link interface card for the A_{bis} interface provided first covers the hardware prerequisites of the loop configuration. The realization of the loop configuration is only a matter of software download (from OMC) and the connection of the last BTS in the chain to the BSC (to close the loop).

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No hardware exchange is necessary.

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11.5 Power Supply -48 V_{DC}

Additionally in the second step the Siemens Micro BTS will have a -48 V_{DC} (covering the range of -39 V_{DC} to -60 V_{DC}) version of the power supply. Therefore the internal AC/DC power supply card will be exchanged by a DC/DC card instead. This new card fits into the hardware box delivered initially, i.e. it has the same physical dimensions.

Hardware cards can only be exchanged in the factory.

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12.0 LIST OF ACRONYMS

MBBCU	**BASE BAND MULTI CHANNEL UNIT**
BCCH	**BROADCAST CONTROL CHANNEL**
BSC	**BASE STATION CONTROLLER**
BTS	**BASE TRANSCEIVER STATION**
ETSI	**EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE**
GMSK	**GAUSSIAN MINIMUM SHIFT KEYING**
GSM	**GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS**
ISDN	**INTEGRATED SERVICES DIGITAL NETWORK**
LAPD	**LINK ACCESS PROCEDURE ON THE D-CHANNEL**
LAPDm	**LAPD MODIFIED**
LNA	**LOW NOISE AMPLIFIER**
MCRX	**RX MULTICOUPLER**
MS	**MOBILE STATION**
MSC	**MOBILE SERVICES SWITCHING CENTRE**
OMC	**OPERATION AND MAINTENANCE CENTRE**
PA	**POWER AMPLIFIER**
PABX	**PRIVATE AUTOMATIC BRANCH EXCHANGE**
PSU	**POWER SUPPLY UNIT**
RFRX	**RF RECEIVER UNIT**
RFTX	**RF TRANSMITTER**
SACCH	**SLOW ASSOCIATED CONTROL CHANNEL**
SDCCH	**SLOW DEDICATED CONTROL CHANNEL**
SMU	**SITE MANAGER UNIT**
S_0	**ISDN BASIC ACCESS USER INTERFACE**
TCH	**TRAFFIC CHANNEL**
TDMA	**TIME DIVISION MULTIPLE ACCESS**
VSWR	**VOLTAGE STANDING WAVE RATIO**

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