

1.2. OBJECTIVES:

Upon completion of this chapter the student will be able to:

- Describe the basic base station system structure
- Describe the functions of the Transcoder Controller
- Describe the implementation of the Transcoder Controller
- Describe the functions of the Base Station Controller
- Describe the implementation of the Base Station Controller
- Describe the functions of the Radio Base Station
- Describe the implementation of the Radio Base Station

1.3. BASE STATION CONTROLLER AND TRANSCODER CONTROLLER.

There two main options available for implementing the TRC and BSC in Ericsson's BSS:

BSC/TRC: a combined BSC and TRC on the same AXE. This is suitable for medium and high capacity applications, e.g. urban and suburban area networks. The node can handle up to 1,020 transceivers (TRXs). 15 remote BSCs can be supported from one BSC/TRC.

Stand-alone BSC and stand-alone TRC: the stand-alone BSC (without transcoders) is optimized for low and medium capacity applications and is a complement to the BSC/TRC, especially in rural and suburban areas. It caters for up to 300 TRXs. The stand-alone TRC is located at the MSC/VLR to increase transmission efficiency. A stand-alone TRC can support 16 remote BSCs.

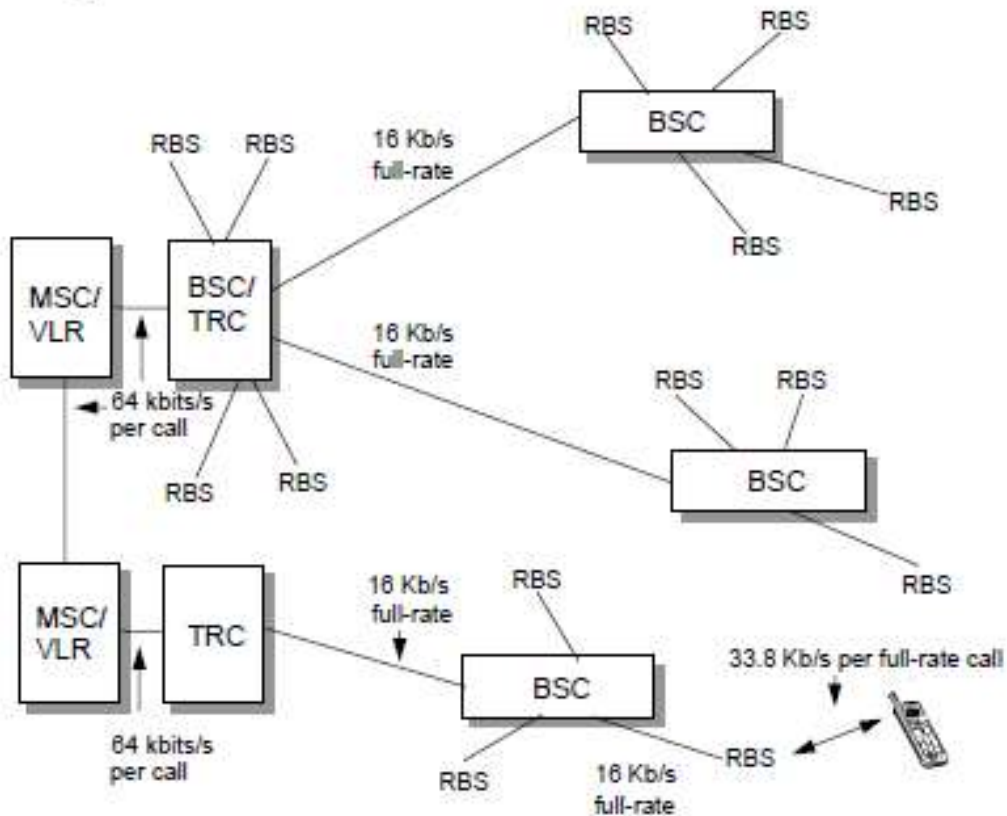


Figure 2 TRC utilization and transmission rates in BSS.

1.4. RADIO BASE STATIONS

Ericsson's Radio Base Station (RBS) 2000 series of base stations implement the GSM-defined BTS. This includes the following RBSs:

- RBS 2101
- RBS 2102
- RBS 2103
- RBS 2202
- RBS 2301
- RBS 2302
- RBS 2302 MAXITE

In Sweden, all three of the mobile network operators is working with the national rail company to ensure coverage for travelers. This involves placing an antenna on top of the train and a leaky cable running within the length of the train.

1.5. OTHER ACCESS NETWORK EQUIPMENT

Many mobile networks include additional equipment to provide improved coverage. Examples of such equipment includes:

- **Repeaters:** these are placed in locations throughout the access network to repeat the digital signal from the MS and BTS. This helps to reduce the BER and thus provide better quality calls to subscribers. A typical location for a repeater may be on top of a building.
- **Leaky cable:** this is simply a cable carrying the electromagnetic energy which has “holes” in it to leak out this radio signal at regular intervals. This may be suitable in areas which are difficult to cover using traditional base station equipment. For example, a leaky cable could be used to provide coverage within an underground train system.

1.6. TRANSCODER CONTROLLER (TRC)

1.6.1. TRC FUNCTIONS

The primary functions of a TRC are to perform transcoding and to perform rate adaptation.

Transcoding

As previously explained, the function of converting from the PCM coder information (following A/D conversion) to the GSM speech coder information is called transcoding. This function is present in both the MS and the BSS.

Rate Adaptation

Rate adaptation involves the conversion of information arriving from the MSC/VLR at a rate of 64 kbits/s to a rate of 16 kbits/s for transmission to a BSC (for a full rate call). This 16 kbits/s contains 13 kbits/s of traffic and 3 kbits/s of inband signaling information.

This is an important function. Without rate adaptation the links to BSCs would require four times the data rate capabilities. Such transmission capabilities form an expensive part of the network. By reducing the rate to 16 kbits/s, it is possible to use one quarter of the transmission links and equipment.

In Ericsson's GSM systems, the TRC contains units which perform transcoding and rate adaptation. These hardware units are called Transcoder and Rate Adaptation Units (TRAUs).

All TRAUs are pooled, meaning that any BSC connected to the TRC can request the use of one of the TRAUs for a particular call.

The TRC also supports discontinuous transmission. If pauses in speech are detected, comfort noise is generated by the TRAU in the direction of the MSC/VLR.

1.7. TRC IMPLEMENTATION.

In previous versions of Ericsson's GSM systems, the TRC did not exist. Its functions were included as part of the BSC. This has been changed to reduce the data rate between the MSC and BSC sites, thus reducing transmission network costs.

The TRC is implemented on the AXE platform consisting of standard APZ and APT subsystems and the following APT subsystems:

Table 1 BSC Subsystems

Subsystem	Functions
ROS: Radio Operation and maintenance Subsystem	Transmission network management
RTS: Radio Transmission and transport Subsystem	TRAU Handling

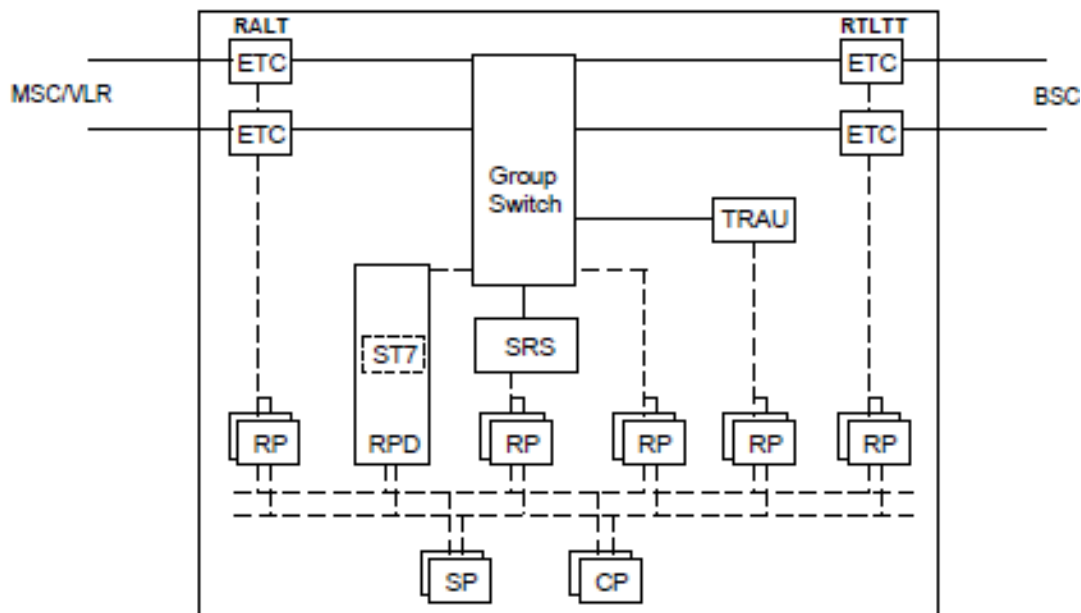


Figure 3 TRC hardware configuration.

The hardware which is specific to the TRC is:

- Transcoder and Rate Adapter Unit (TRAU)

1.8. BASE STATION CONTROLLER (BSC)

During the initial specification of GSM, the radio-related functions were intended to be included in the MSC. However, the increasing complexity of the GSM radio system led to the requirement for more dedicated radio.

1.8.1. BSC FUNCTIONS.

The BSC controls a major part of the radio network. Its most important task is to ensure the highest possible utilization of the radio resources. The main functional areas of the BSC are:

- Radio Network Management
- RBS Management
- TRC Handling
- Transmission Network Management
- Internal BSC Operation and Maintenance
- Handling of MS connections

1.8.1.1. Radio Network Management

Radio network management includes the following tasks:

- **Administration of radio network data** including:
 - Cell Description Data (e.g. cell identity, BCCH channel number, maximum and minimum output powers in the cell, RBS type, etc.)
 - System information data (e.g. information about whether or not the cell is barred from access, maximum output power allowed in the cell, BCCH channel identities in neighboring cells)
 - Locating data (e.g. cell rank used in HCS and high traffic load situations)
 - Cell load sharing data, i.e. parameters for forcing early handovers from congested cells
- **Traffic and event measurements:** (e.g. number of call attempts, congestion, traffic levels for a cell, traffic levels for an MS, number of handovers, number of dropped connections, etc.).
- **Idle channel measurement:** the RBS collects statistics from the MSs about signal strength and quality. These statistics are then used during the channel allocation process, so that a channel with low interference is allocated for a call.

1.8.1.2. RBS Management

Ericsson's RBS implementation is transceiver-orientated, ensuring good redundancy features. This means that as little as possible of the equipment is common to several transceivers.

This philosophy inevitably leads to a master slave relationship between the BSC and the transceivers in the RBS. A logical model of the RBS is built up within the BSC and RBS equipment can be logically defined, connected and disconnected.

The main tasks of RBS management are:

- **RBS configuration:** this involves the allocation of frequencies to channel combinations and power levels for each cell according to available equipment. If equipment becomes faulty causing the loss of important channels, reconfiguration of the remaining equipment is activated, sacrificing less important channels.
- **RBS software handling:** this involves the control of program loads.
- **RBS equipment maintenance:** RBS faults and disturbances are recorded and logged continuously.

1.8.1.3. TRC Handling

Although TRAU's are located in a TRC, the BSC, as controller of the radio resources of a GSM network, actually co-ordinates the sourcing of a TRAU for a call.

During call set-up, the BSC instructs the TRC to allocate a TRA device to the call. If one is available, the TRC confirms the allocation of a TRA device. The TRA device is considered to be under the control of the BSC for the duration of the call.

1.8.1.4. Transmission Network Management

The transmission network for a BSC includes the links to and from MSC/VLRs and RBSs. This involves the following tasks:

- **Transmission interface handling:** this provides functions for administration, supervision, test and fault localization of the links to RBSs. The BSC configures, allocates and supervises the 64 kbits/s circuits of the PCM links to the RBS. It also directly controls a remote switch in the RBS which enables efficient utilization of the 64 kbits/s circuits.

1.8.1.5. Internal BSC Operation and Maintenance

Operation and maintenance tasks can be performed locally in the BSC or remotely from the OSS. Internal BSC operation and maintenance involves the following features:

- **TRH maintenance:** administration, supervision and test of the TRAnscceiver Handler (TRH) is carried out in the BSC. The TRH consists of both hardware and software. A TRH is located on a Regional Processor for the Group switch (RPG). One RPG thus serves several transceivers. There can be several RPGs in the BSC.
- **Processor load control in the BSC:** this function ensures that during processor overload situations, a large number of calls can still be handled by the BSC. If too many calls are accepted,

real time requirements such as call set-up times cannot be fulfilled. To prevent this, some calls need to be rejected in situations of high load. Calls already accepted by the system are given full service and are not affected by the overload situation.

1.8.1.6. Handling of MS Connections

Call Set Up

Call set up involves the following processes:

- **Paging:** the BSC sends paging messages to the RBSs defined within the desired LA. The load situation in the BSC is checked before the paging command is sent to the RBS.
- **Signaling set-up:** during call set-up, the MS connection is transferred to an SDCCH allocated by the BSC. If the MS initiated the connection, the BSC checks its processor load before the request is further processed.
- **Assignment of traffic channel:** after SDCCH assignment, the call set-up procedure continues with the assignment of a TCH by the BSC. As this takes place, the radio channel supervision functions in the BSC are informed that the MS has been ordered to change channels. If all TCHs in the cell are occupied an attempt can be made to utilize a TCH in a neighboring cell.

During a Call

The main BSC functions during a call are:

- **Dynamic power control in MS and RBS:** the BSC calculates adequate MS and BTS output power based on the received measurements of the uplink and downlink. This is sent to the BTS and the MS every 480 ms to maintain good connection quality.
- **Locating:** the locating function continuously evaluates the radio connection to the MS, and, if necessary, suggests a handover to another cell. This suggestion includes a list of handover candidate cells. The decision is based on measurement results from the MS and BTS. The locating process is being executed in the TRC.
- **Handover:** if the locating function proposes that a handover take place, the BSC then decides which cell to handover to and begins the handover process. If the cell belongs to another BSC, the MSC/VLR must be involved in the handover. However, in a handover, the MSC/VLR is controlled by the BSC. No decision making is performed in the MSC because it has no real time information about the connection.
- **Frequency Hopping:** two types of hopping are supported by the BSC:
 - Baseband hopping: this involves hopping between frequencies on different transceivers in a cell
 - Synthesizer hopping: this involves hopping from frequency to frequency on the same transceiver in a cell

1.9. BSC IMPLEMENTATION

The BSC is implemented on a non-AM-based AXE platform consisting of standard APZ and APT subsystems and the following APT subsystems:

Table -2 BSC Subsystems.

Subsystem	Functions
RCS: Radio Control Subsystem	<ul style="list-style-type: none"> • Radio network management • Handling of MS connections
ROS: Radio Operation and maintenance Subsystem	<ul style="list-style-type: none"> • Transmission network management • Internal BSC operation and maintenance
RTS: Radio Transmission and transport Subsystem	<ul style="list-style-type: none"> • TRC Handling
TAS: Transceiver Administration Subsystem	<ul style="list-style-type: none"> • RBS Management
LHS: Link Handling Subsystem	<ul style="list-style-type: none"> • Transmission network management

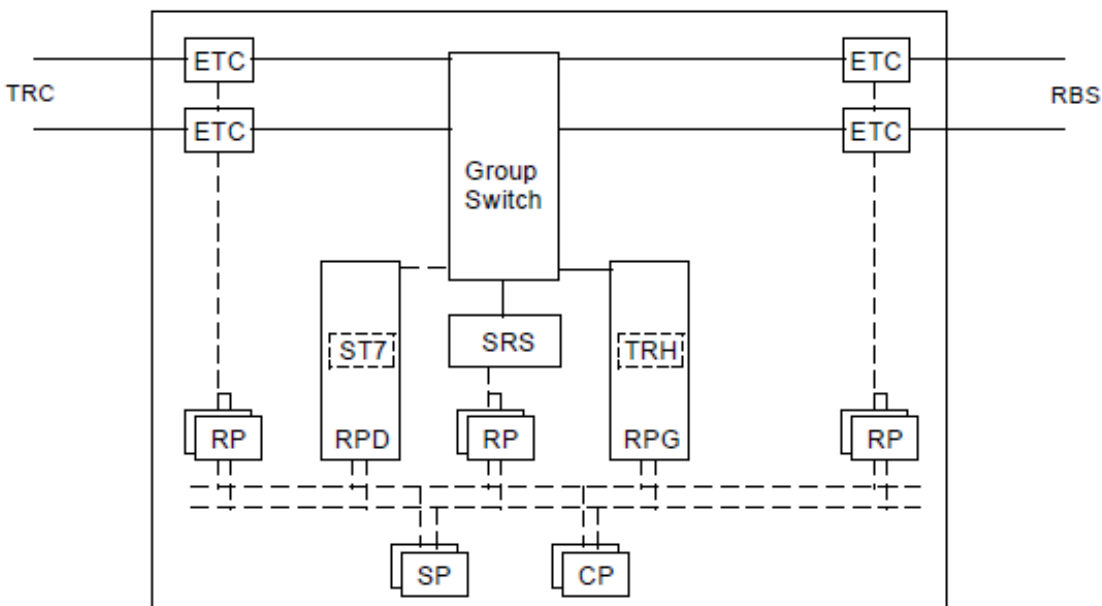


Figure 4 BSC hardware configuration.

The hardware which is specific to the BSC is:

- Regional Processor for the Group switch (RPG)/Transceiver Handler (TRH)

1.10. BSC/TRC

It is possible to combine the functions of the TRC and BSC in one AXE-based node. The subsystems in a BSC/TRC are the same as those used in a stand-alone BSC.

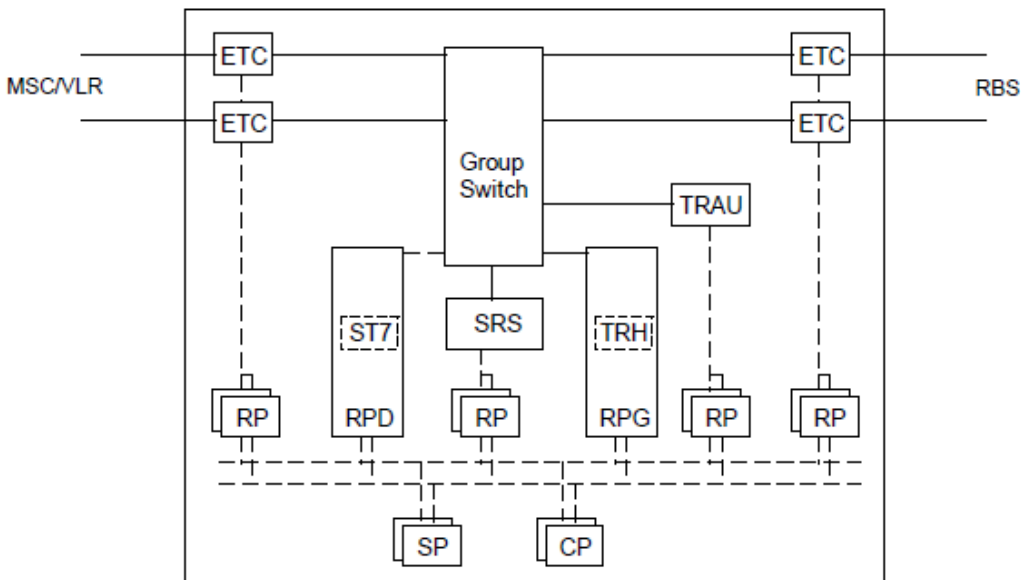


Figure 5 BSC/TRC hardware configuration.

The hardware which is specific to the BSC/TRC is:

- RPG/TRH
- TRAU

1.11. RADIO BASE STATION (RBS).

RBS INTRODUCTION

An RBS includes all radio and transmission interface equipment needed on site to provide radio transmission for one or several cells.

The RBS 2000 family is Ericsson's second generation of RBS offering products with a low total lifetime cost¹. This is achieved by functions including long Mean Time Between Failure (MTBF)

performance and short Mean Time To Repair (MTTR). In addition, this product line is quick and easy to install thus giving the possibility to achieve a rapid network roll out.

RBS 2000 provides products for both indoor and outdoor installations and is available for GSM 900, GSM 1800 and GSM 1900.

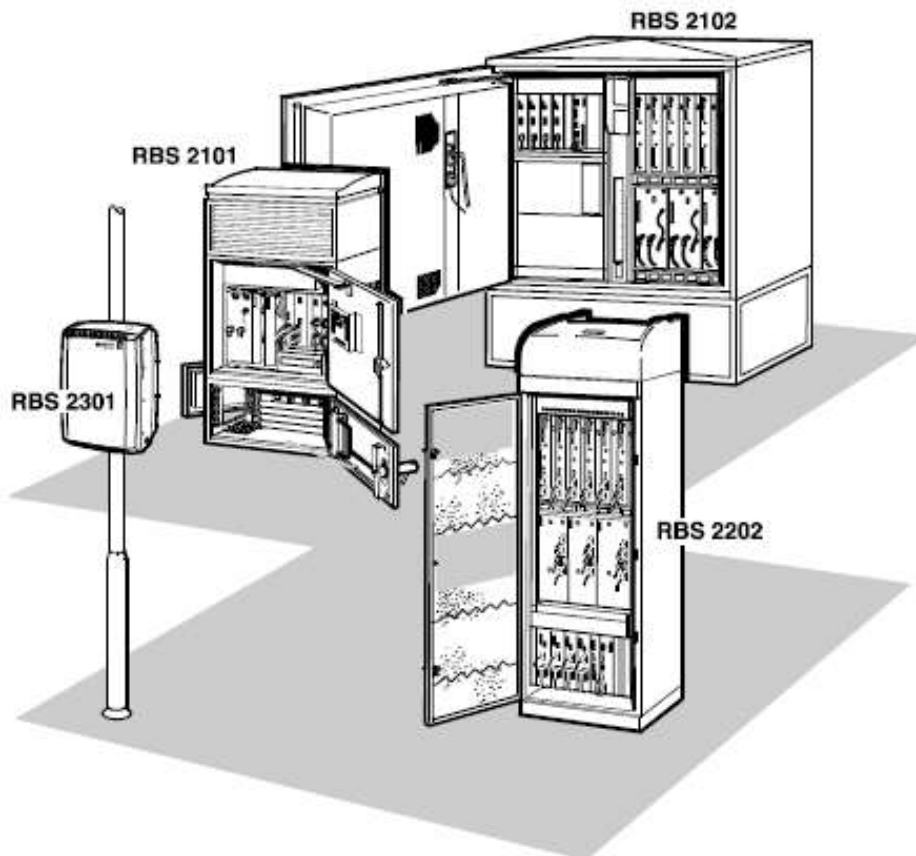


Figure 6 Examples of the RBS 2000 series.

1.11.1. RBS FUNCTIONS

RBS functionality can be divided into the following areas:

- Radio resources
- Signal processing
- Signaling link management
- Synchronization
- Local maintenance handling
- Functional supervision and testing

RADIO RESOURCES

An RBS's main function is to provide connection with the MSs over the air interface. This includes the following tasks:

- **Configuration and system start:** site configuration involves loading of software from the BSC and setting parameters prior to system startup, including:
 - Transmitter and receiver frequencies
 - Maximum output power
 - Base Station Identity Code (BSIC)
- **Radio transmission:** to transmit several frequencies using the same antenna, a combiner or a set of combiners are needed. Transmission power is controlled from the BSC.
- **Radio reception:** in addition to reception of traffic on the physical channels, a primary RBS function the detection of channel requests from MSs (e.g. when a call is being made).

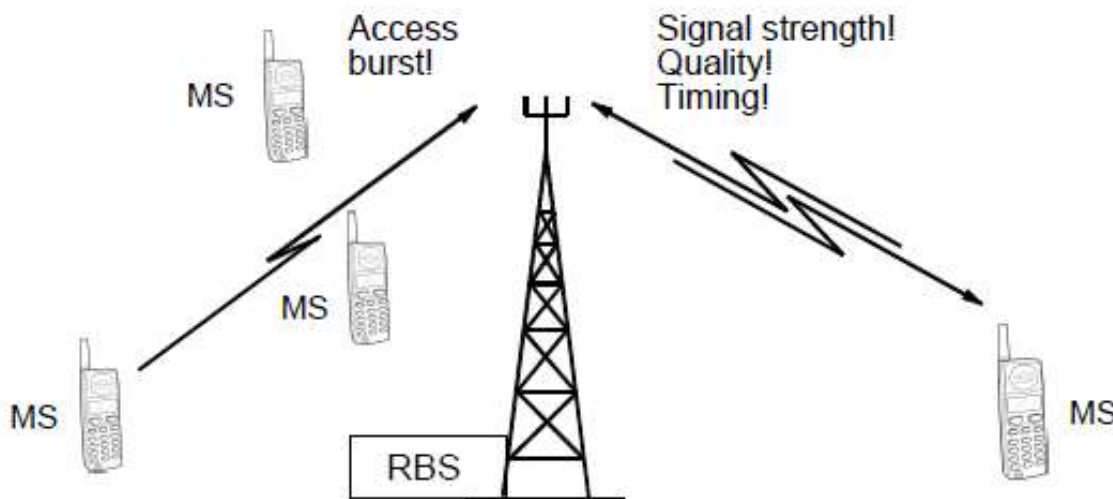


Figure 7 The RBS listening for channel requests and measuring the uplink on an established connection

SIGNAL PROCESSING

An RBS is responsible for the processing of signals before transmission and after reception. This includes:

- Ciphering using the ciphering key
- Channel coding and interleaving
- Adaptive equalization
- Realization of diversity
- Demodulation

SIGNALING LINK MANAGEMENT

An RBS manages the signaling link between the BSC and MS, applying the appropriate protocols to the information being sent.

SYNCHRONIZATION.

Timing information is extracted from the PCM-links from the BSC and is sent to a timing module within the RBS. This enables the RBS to synchronize with the correct frequency reference and TDMA frame number.

LOCAL MAINTENANCE HANDLING.

An RBS enables operation and maintenance functions to be carried out locally at the RBS site, without BSC connection. In this way, field technicians can maintain RBS equipment and software on site.

FUNCTIONAL SUPERVISION AND TESTING.

Supervision and testing of RBS functions is supported, using either built-in tests during normal operation or tests executed by command.

1.12. RBS 2000 IMPLEMENTATION

All types of RBS within the RBS 2000 series have the following characteristics:

- Support for user flexibility by providing modular hardware and software designs.
- Transceiver oriented design, which stresses using as little common equipment as possible ensuring dependable performance.
- Design and use are aimed at keeping system life cycle costs low.

The RBS 2000 series is based on standardized hardware units called Replaceable Units (RU). The major RUs are:

- Distribution switch Unit (DXU)
- TRansceiver Unit (TRU)
- Combining and Distribution Unit (CDU)
- Power Supply Unit (PSU)
- Energy Control Unit (ECU).

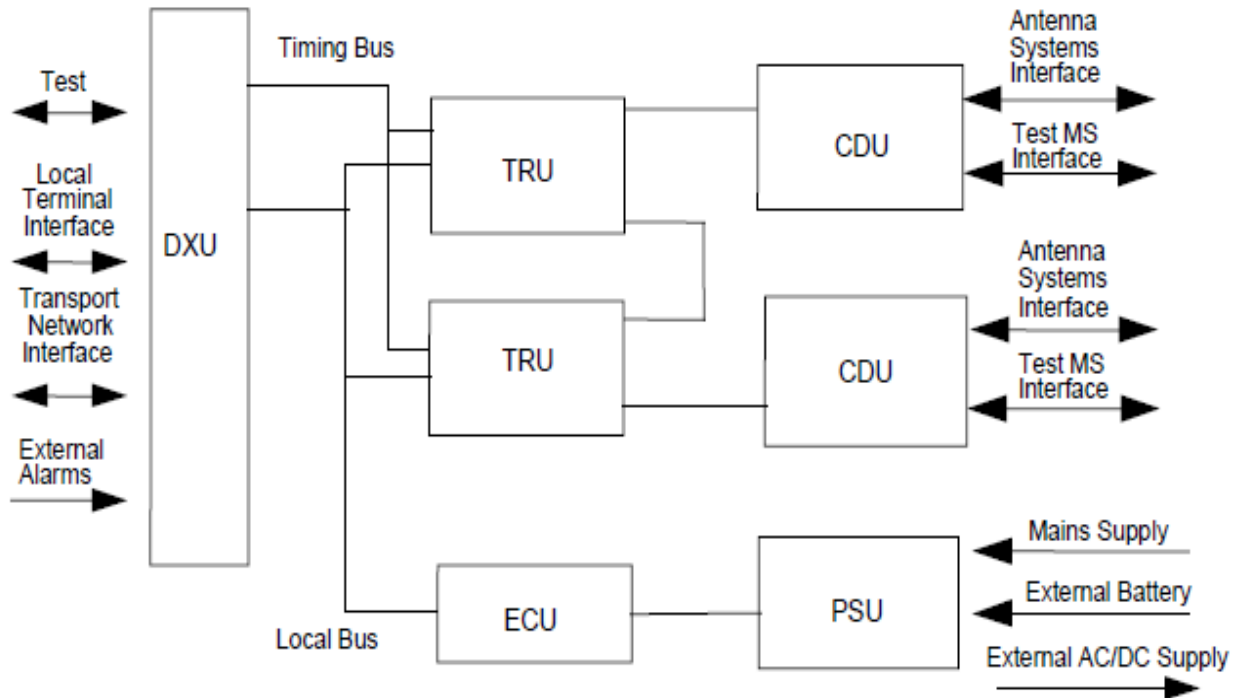


Figure 8 Replaceable units in RBS 2000.

Distribution switch Unit (DXU)

The DXU performs the following tasks:

- Provides an interface to the BSC
- Manages the link resources and connects the traffic time slots from the BSC link to the TRUs
- Controls signaling to the BSC and performs concentration
- Extracts synchronization information from the link and generates a timing reference for the RBS.

In addition, the DXU has a database which stores information about installed hardware.

1.13. Transceiver Unit (TRU)

One TRU includes all functionality needed for handling one radio carrier (i.e. the 8 time slots in one TDMA frame). It is responsible for radio transmitting, radio receiving, power amplification and signal processing.

The TRU contains a radio frequency test loop between the transmitter and the receiver. This facilitates TRU testing by generating signals and looping them back.

TRUs are connected by a bus to enable frequency hopping. Some RBS products can contain up to 6 TRUs.

1.13.1. Combining and Distribution Unit (CDU)

The CDU is the interface between the TRUs and the 2-way antenna system. The task of the CDU is to combine signals to be transmitted from various transceivers and to distribute received signals to the receivers. All signals are filtered before transmission and after reception using bandpass filters.

A range of CDU types have been developed to support different configurations within the RBS 2000 family. They consist of different types of CDUs, including:

- Without combiners
- With hybrid combiners
- With filter combiners to support large configurations CDUs with duplex filters make it possible to transmit and receive using the same antenna.

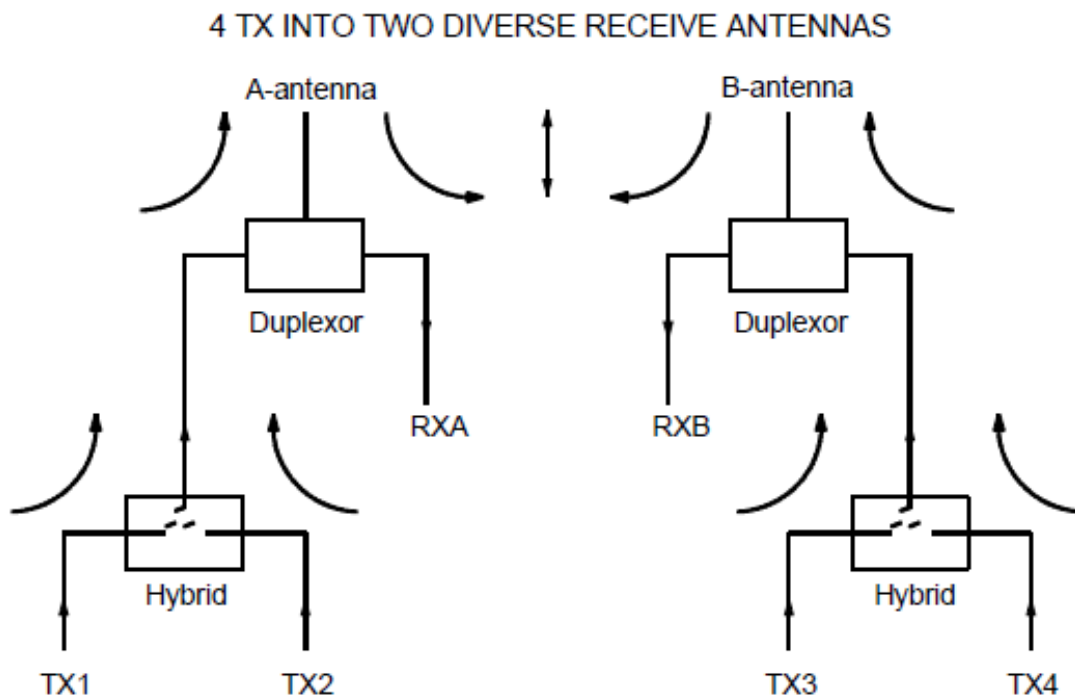


Figure 9 Example of a CDU type C

1.13.2. Power Supply Unit (PSU)

The PSU rectifies the power supply voltage to the +24 VDC necessary for RBS operation.

1.13.3. Energy Control Unit (ECU)

The ECU controls and supervises the power equipment and regulates the environmental conditions inside the cabinet.

The RBS 2000 is pre-assembled at the factory including program load and parameter settings making a quick startup possible.

Assembly can also be carried out on site. The RBS software is downloaded from the BSC and stored in a non-volatile (flash memory) program store. In a working RBS, this flash memory keeps cell down time low because traffic does not need to be interrupted. Power failure recovery can also be done quickly.

1.14. RBS 2000 IN A NETWORK

The Transmission Drop and Insert (TDI) function makes it possible to connect RBSs together. This is an important cost saving feature of Ericsson's RBSs, as an RBS need not be connected to the BSC directly via a dedicated link. Instead it may be more economic to connect that RBS to another RBS in the region, thus saving on expensive transmission costs. The following network topologies are supported:

- Star: this is the traditional architecture, where each RBS is connected directly to a BSC
- Cascade: a cascade architecture includes RBSs connected to each other without a loop, thus using transmission resources efficiently
- Loop: this architecture includes RBSs connected to each other with a loop, ensuring that even if one link fails, another path is available

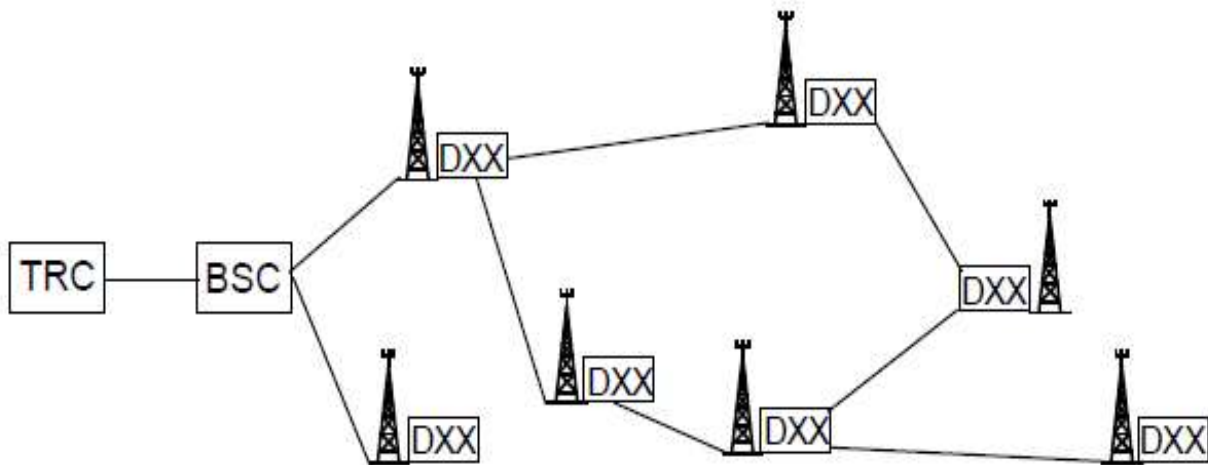


Figure 10 Ericsson's RBS 2000 Network Configurations.

1.15. RBS 2000 SERIES DESCRIPTIONS.

Table 3 RBS 2000 Series.

RBS Type	Location	Max. TRUs	Cells	Coverage Type	Dimensions (h-w-d) (mm)	Temperature Range (°C)
RBS 2101	Outdoor	2	1	Macro	1285-705-450	-33...+55
RBS 2102	Outdoor	6	1-3	Macro	1605-1300-760	-33...+45
RBS 2103	Outdoor (GSM 900 only)	6	1-3	Macro	2300-900-795	-33...+35
RBS 2202	Indoor	6	1-3	Macro	1775-600-400	+5...+40
RBS 2301	Indoor/Outdoor	2	1	Micro	535-408-160	-33...+45
RBS 2302	Indoor/Outdoor	2	1	Micro	535-408-170	-33...+45
Maxite	Indoor/Outdoor	2	1	Macro	535-408-160	-33...+45

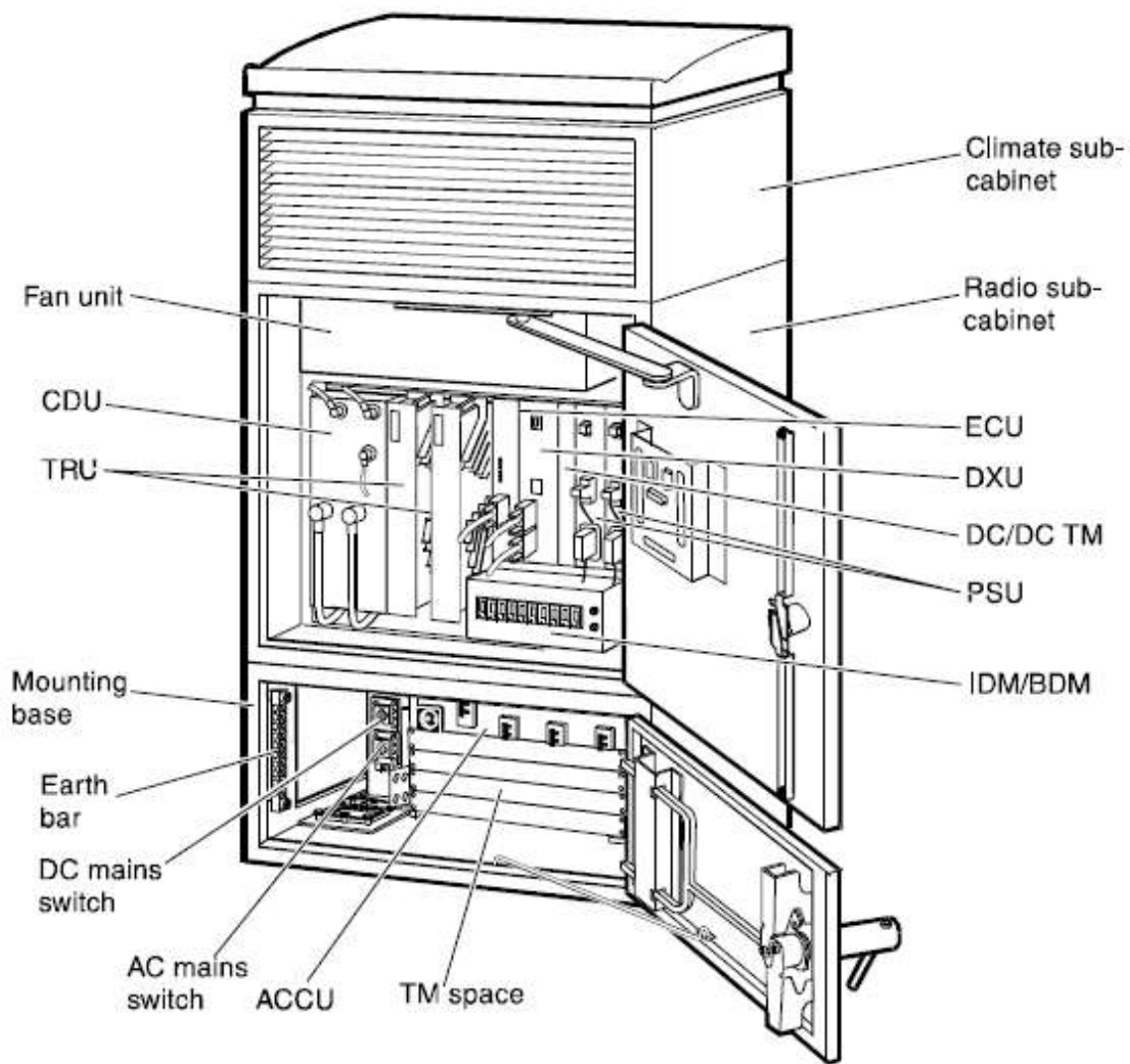


Figure 11 RBS 2101

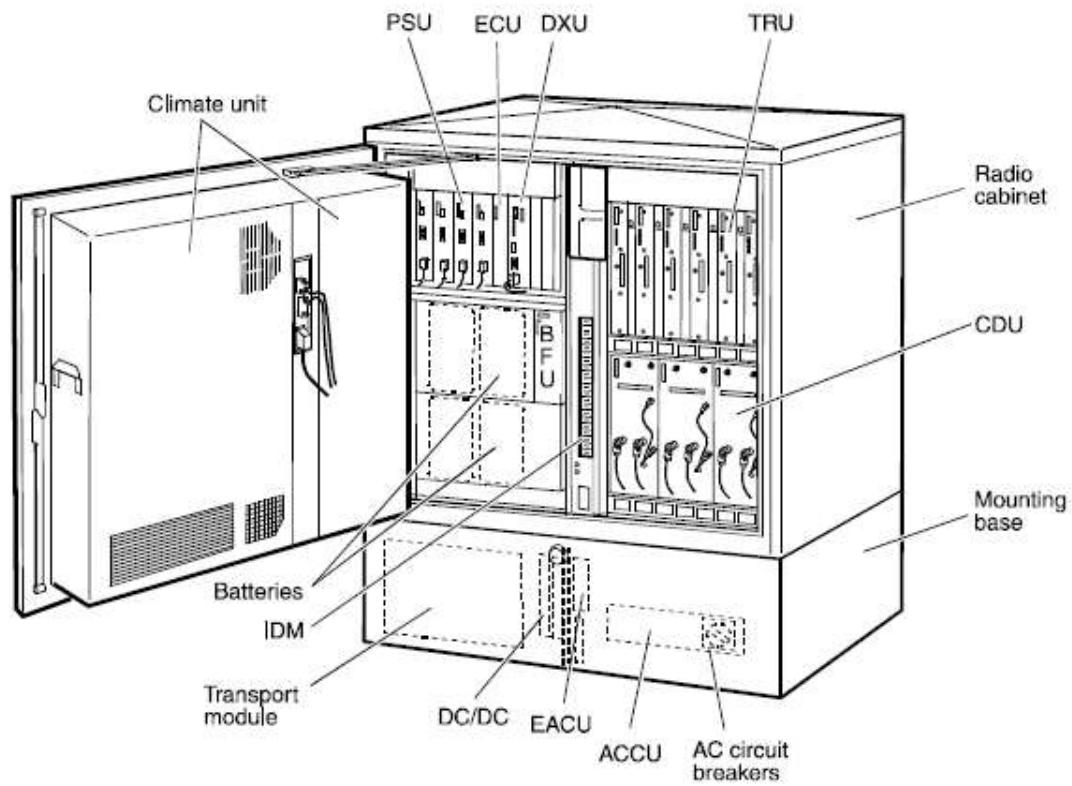


Figure 12 RBS 2102.

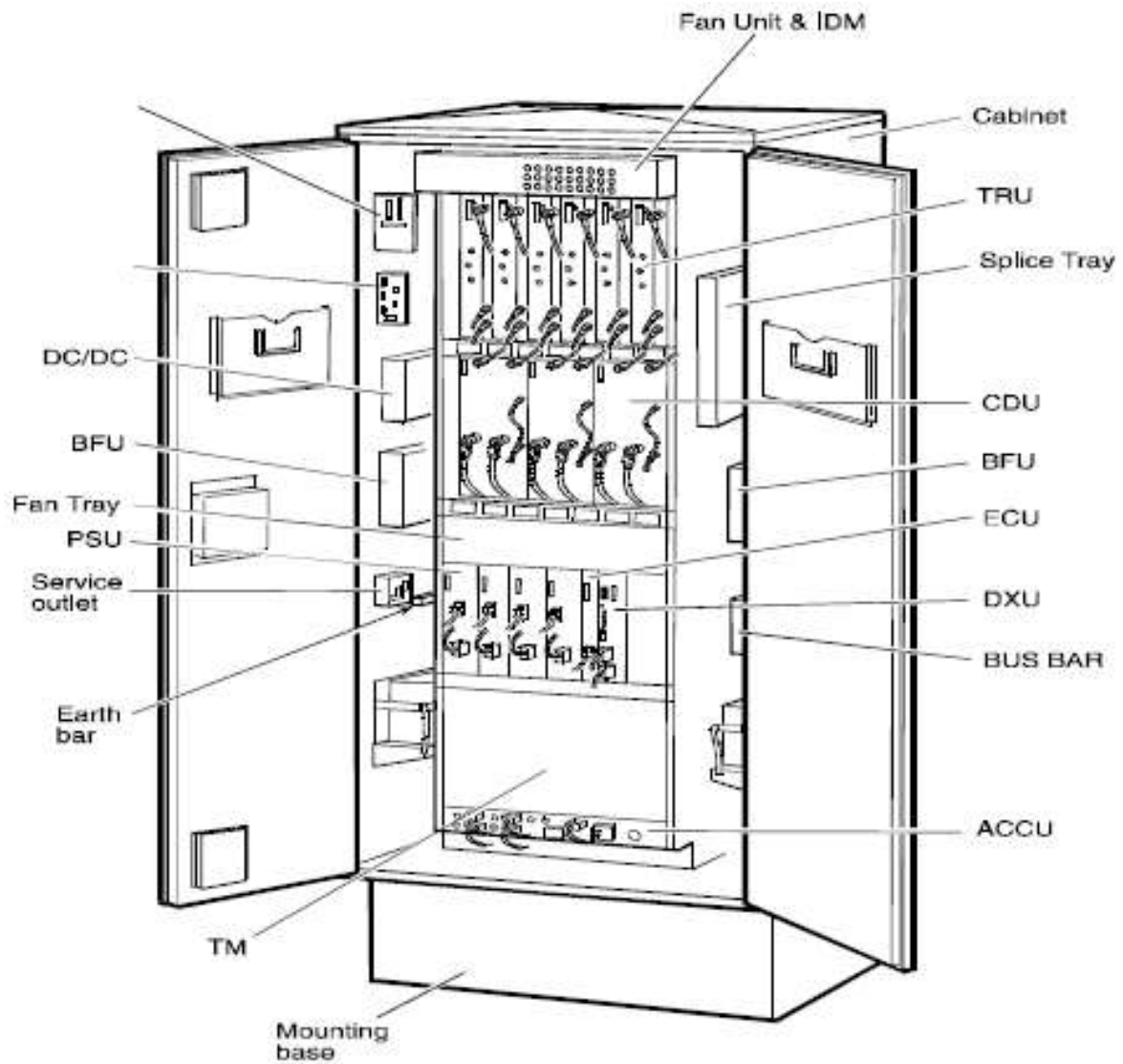


Figure 13 RBS 2103.

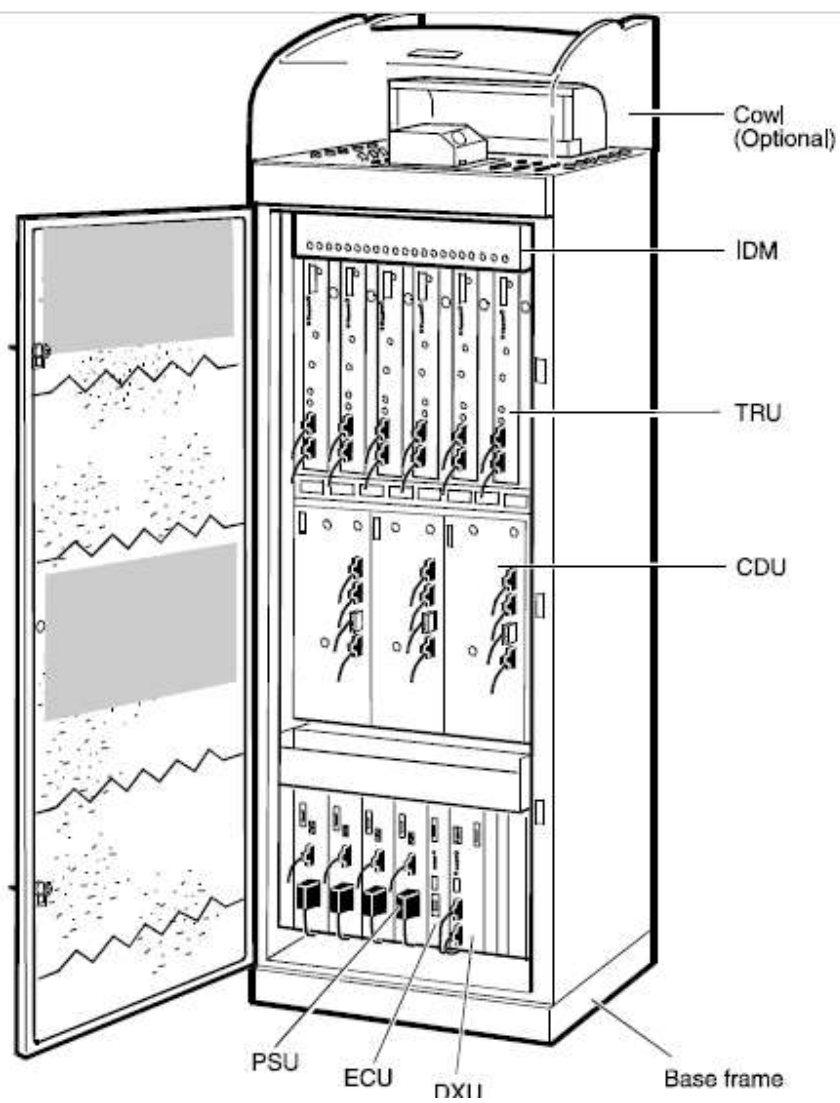


Figure 14 RBS 2202.

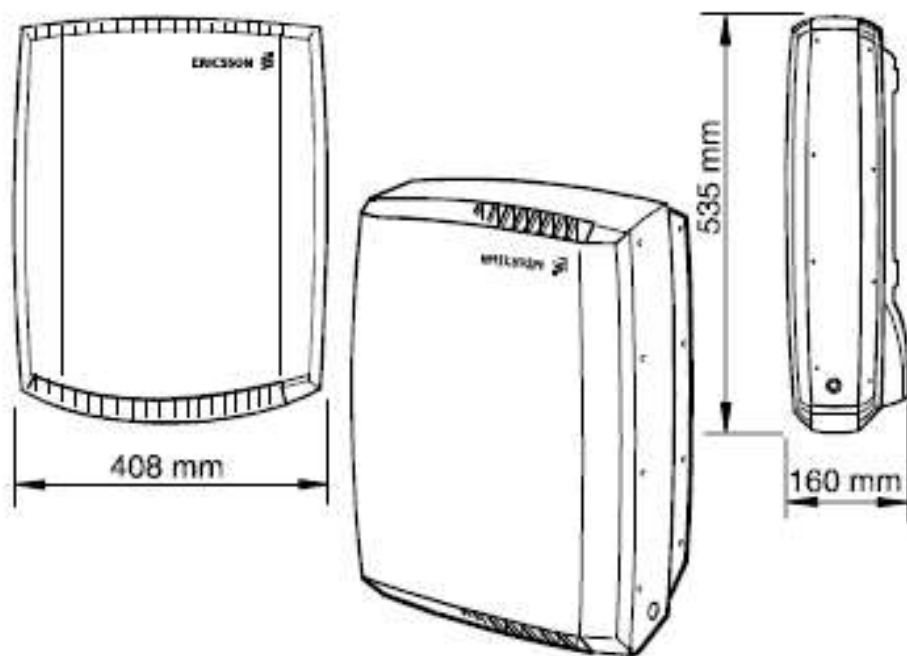


Figure 15 RBS 2301. RBS 2302 is almost identical.