EXHIBIT 11

Reference Manual

Applicant: Northern Telecom Ltd.

For Certification on:

AB6S8000

Wireless Service Provider Solutions

S8000 BTS
Reference Manual

NØRTEL
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NORTEL NETWORKS

Wireless Service Provider Solutions

S8000/S8002/S8006 BTS Reference Manual

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TD 1158: Additional external alarms on CBCF, chapter 2

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e–DRX module: all chapters

New PA, chapter 2

Tri–phase ac box (type 4), chapter 2

SR EE00198 or SR NK00810 CPCMI board: switch position, chapter 2

Power system: new type of six–rectifiers, chapter 2

Dimensioning rules and configurations updated, chapter 5

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- PR 887: S8000 Indoor 900/1800 (2D+H2D or 2H2D), chapter 6
- PR 897 : S8000 Outdoor 900/1800/1900 (2D+H2D or 2H2D), chapter 6
- PR 942 : S8000 Outdoor 900, 1800 (H2D or H4D), chapter 6
- SR 301 06261: Connector description, chapter 4
- S8002 BTS

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November 1999

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Update for the V11 release according to the SR EE90852 : Add the switch S3 on the CPCMI board

May 1999

Issue 11.03/EN

Introduction of S8002 BTS

Refer to review report of PE/DCL/0064/ V05.01/FR

September 1998

Issue 11.02/EN

Update after internal document review (PE/DCL/GES/0064 V04.01/FR).

September 1998

Issue 11.01/EN

Update for the V11 release according to the "Feature list of System Release V11" (PE/SYS/DPL/0089 V01.02/EN)

- EC 101–2447: Change in level of power consumption for S8000 Outdoor BTS (GSM 1900 only), chapter 3

- PR 549, 807: CBCF for S8000I 900/1800

- PR 776, 834: CBCF for S8000O 900/1800/1900

- PR 907 S8000 I/O 3S888 H2D 900/1800, chapter 3 and 6

- PR 967 S8000 I/O 016 H4D 900/1800, chapter 3 and 6

- Addition of the single phase AC box, type 1, chapter 3

- Addition of the tri–phase AC box, type 2, chapter 3

SYSTEM RELEASE : GSM/BSS V10

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Issue 10.06/EN

Update for the V10 release according to the SR EE90852 : Add the switch S3 on the CPCMI board

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Issue 10.05/EN

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May 1999

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April 1998

Issue 10.03/EN

After review report PE/DCL/GES/0064, V03.02/FR, chapters 2, 3, 4 and 6

March 1998

Issue 10.02/EN

- SR 30080371: DSC board dimensioning, chapter 6
- PR 740, 741, 767: Tx–Filter, chapters 2, 3, 4 and 6
- PR 742, 770, 771: DRX New Design, chapters 3 and 4
- PR 896, S8000 I/O Dual band configuration 3S444–444 (H2D), chapter 3
- Removal of J64 connector (GTW board), chapter 4
- New 75 Ω box, chapter 3

February 1998

Issue 10.01/EN

Update for V10 release according to "Feature List of system release" PE/SYS/DPL/0075, V01.03/EN.

- AR329, PF471: dual band configuration, chapter 6

After review report PE/DCL/GES/64 V03.01/FR.

SYSTEM RELEASE : GSM/BSS V09

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After review report PE/DCL/GES/64, V02.04/FR, chapters 3, 4, 5 and 6.

February 1998

Issue 09.08/EN

Update for V9 release:

- PR 485/623/486: S8000 Outdoor extension introduction, chapters 3 and 6
- PR742: DRX new design, chapter 4
- CM743: interferer cancellation on DRX, chapter 2
- PR740/767/741: new configuration with duplexer coupling, chapter 3 and 6
- New configuration with H4D coupling, chapter 6
- DRX LEDs meaning, chapter 3
- Cabling figures enhanced, chapter 1
- FCC label location corrected, chapter 3
- LEDs of climatic system introduced, chapters 3 and 4
- RF combiner board enhanced, chapter 3
- Additional equipment introduced (–48V kit, phone plug kit...), chapter 6
- SR 30080371: DSC board dimensioning, chapter 6

November 1997

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After review report PE/DCL/GES/64, V02.03/FR, chapters 3, 4 and 6

October 1997

Issue 09.06/EN

Update for V9 release according to "Feature list of system release" PE/SYS/DPL/0057, V01.07/EN:

- New Power System (7–rectifier type), chapters 3 and 4
- PR520/521: S8000 Indoor extension cabinet (GSM 900/1800), chapters 3, 4 and 6

- PR738: New RF combiner with H4D coupling, chapters 3, 4 and 6
- Cross Polarization configurations, chapters 3 and 6

Internal remarks

- Addition of BCF TEI configuration, chapter 4
- Addition of regulatory information, chapter 1

August 1997

Issue 09.05/EN

DACS introduction in S8000 Outdoor BTS, chapter 3

July 1997

Issue 09.04/EN

After review report PE/DCL/GES/64, V02.02/FR.

June 1997

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Update for V9 release according to "Feature list of system release" PE/SYS/DPL/0057, V01.06/EN

- TF 441 Power Control Enhancements, chapter 2
- BCF configurations, chapter 2
- RX–Splitter gain value, chapter 4
- DRX receive sensitivity, chapter 4

March 1997

Issue 09.02/EN

After review report PE/DCL/GES/064, V02.01/FR.

February 1997

Issue 09.01/EN

Reorganisation of the volume for V9 release.

Update for V9 release according to "Feature list of system release" PE/SYS/DPL/0057, V01.05/EN:

- PR276, PR465, PR484: S8000 Outdoor BTS 900
- FM 625: RX–Splitter alarm on S8000, chapters 2
- S8000 Indoor: New Product
- CM 330: Cell Soft Blocking improvement, chapter 2
- TF 225: Forced Hardover, chapter 2

Former versions document obsolete BSS system versions. Therefore, the publication history is not applicable.

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ABOUT THIS DOCUMENT

This document describes the S8000/S8002/S8006 Base Transceiver Station (BTS), which is a component in the Base Station Subsystem (BSS).

Applicability

This document applies to the V12 BSS system release.

Precautionary message

The following message:

> **CAUTION**
>
> **GSM–R specific**
>
> Indicates that specific equipment and specific software (such as specific software in the BSC) dedicated to Railway application is used and that therefore the feature is not available for all preliminary GSM users.

Audience

This document is for operations and maintenance personnel, and other users who want more knowledge of the BTS.

Prerequisites

It is recommended that the readers also become familiar with the following documents:

< 00 >   :   BSS Product Documentation Overview

< 01 >   :   BSS Overview

Reader should also refer to:

< 07 >   :   BSS Operating Principles

< 28 >   :   Site Preparation Guide

< 39 >   :   BSS Maintenance Principles

< 48 >   :   S8000 BTS Maintenance Manual

< 84 >   :   S8002 BTS Maintenance Manual

< 85 > : S8006 BTS Maintenance Manual

< 124 > : BSS Parameter Dictionary

< 125 > : Observation Counter Dictionary

< 128 > : OMC–R User Manual – Volume 1 of 3: Object and Fault menus

< 129 > : OMC–R User Manual – Volume 2 of 3: Configuration, Performance, and Maintenance menus

< 130 > : OMC–R User Manual – Volume 3 of 3: Security, Administration, SMS–CB, and Help menus

The glossary is in the document < 00 >, BSS Product Documentation Overview.

Related Document

< 01 > : BSS Overview

How this document is organized

Chapter 1 describes the layout and content of the BTS cabinets as well as its cabling and power distribution.

Chapter 2 describes the functions of BTS boards and modules and also describes the front panel.

Chapter 3 examines BTS architecture and describes the physical structure, focusing on the functional architecture of the subsystems.

Chapter 4 lists BTS software entities and shows how they are installed on the hardware units.

The factors governing BTS dimensioning are given in Chapter 5 with a view to selecting one of the BTS product lines given at the start of the section.

Regulatory information

Refer to the NTP < 01 > BSS Overview.

1   CABINET DESCRIPTION

1.1   Physical characteristics

1.1.1   S8000 Outdoor BTS

1.1.1.1   BTS cabinet

Physical characteristics

See document < 01 >, BSS Overview.

Operating temperature

To operate correctly, the BTS requires a temperature greater than –40°C (–40°F) and less than +50°C (+122°F).

Power supply

See document < 01 >, BSS Overview.

The maximum power the cabinet can consume is 8500 W in worst case consumption and in normal mode. This value does not take maintenance connectors and climatic units currents into account.

Autonomy of the internal battery

The internal battery is an optional equipment located in the top compartment. The battery backup time depends on the configuration and the BTS equipment and has a length of around half an hour to a few hours.

1.1.1.2   Climatic system

The climatic system controls the inside temperature of the cabinet. Low noise or normal operation is available. It is located in the top compartment of the cabinet. The climatic system can either consist:

- in two Air Cooling Units: ACUs,

- or a Direct Ambient Cooling System: DACS or DACS "LN" (Low Noise).

With ACUs

Figure 1–1 shows the S8000 Outdoor with an ACU climatic system.

The top and main compartments communicate through main compartment air inlets and main compartment outlets (see *Figure 1–2*). The top compartment has openings on the cabinet front panel that allow air to enter the cooling units and openings on the rear of the cabinet that allow the cooling units to fan air out of the cabinet.

Each ACU includes a compressor (ac–powered), an evaporator, condenser coils and refrigerant lines, external and internal air blowers, 1000W heater (resistance plate heater), digital controller, internal and ambient air temperature sensors, air filters, EMI filters, ac/dc rectifier/alarm board and circuit breakers.

The internal temperature sensors are used to regulate the temperature inside the cabinet. They are located on the climatic units, at the opening enabling air to pass from the main compartment to the top compartment. The ambient air temperature sensors enable the PCU to cut its dc power supply when the thresholds are exceeded. These sensors are located above the BCF or CBCF compartment or below the rectifiers.

The external air blower is to circulate the outside air across a condenser to extract heat from the refrigerant and expel heat to the outside air. The internal air blower circulates air through the BTS and over an evaporator to collect heat from the electronics.

There are six LEDs on the front side of each cooling unit. These LEDs indicate the alarms detected on the following type of failure (see *Figure 1–3*):

- CTRL (orange): The controller display is alarmed.

- FAN (orange): The fans for ambient air and internal equipment air are alarmed. Each airflow path contains sensors to measure the air blower speed for an air mover failure.

- HP (orange): The pressure inside the compressor is controlled to sense a high or low pressure for a compressor failure.

- CS (green) : At cold start the LED comes on if the ACUs are well ac–powered.

- dc (green) : The dc breaker is alarmed.

- ac (green) : The ac breaker is alarmed.

These LEDs are lit when healthy and off on alarm.
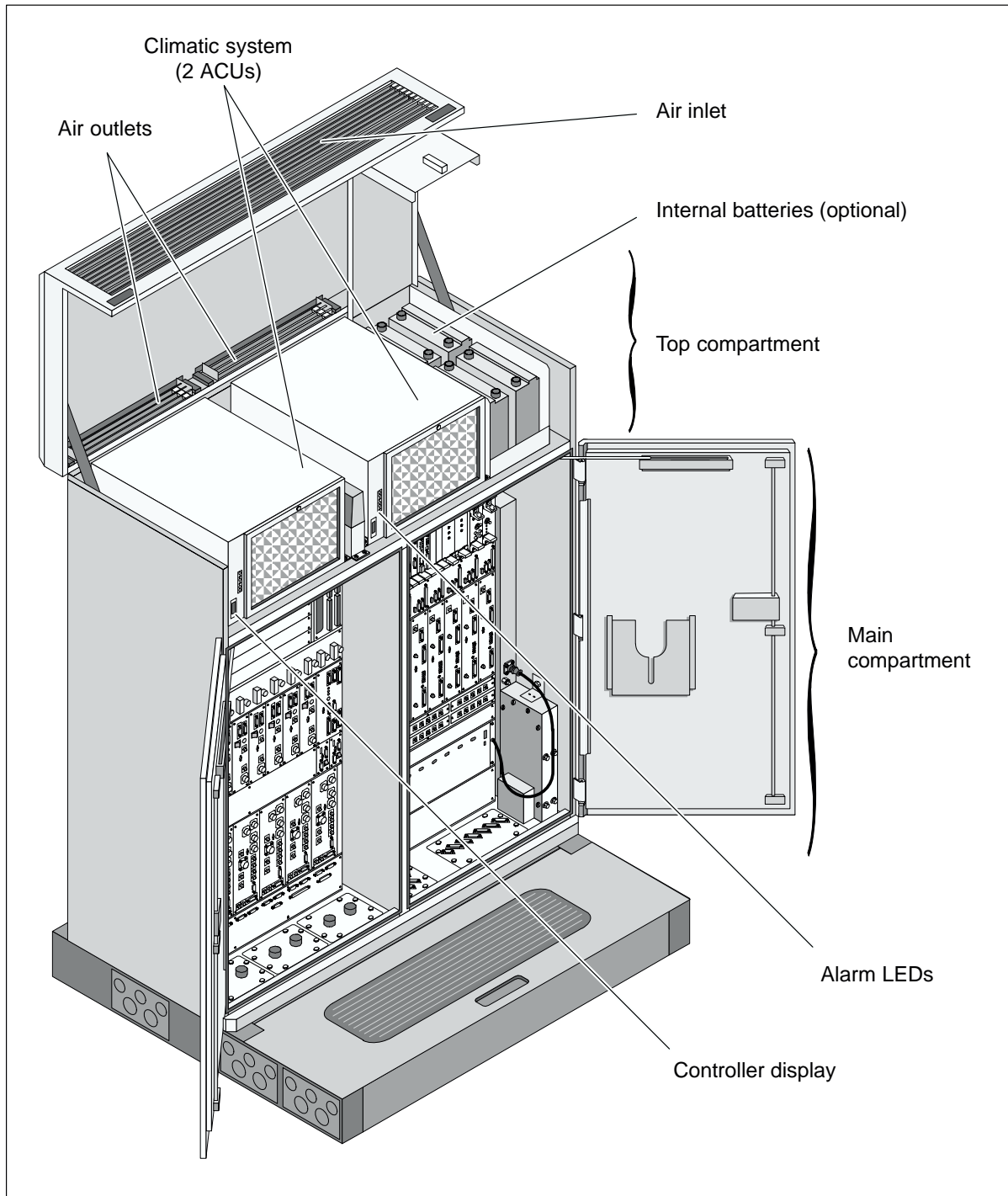
Figure 1–1   S8000 Outdoor BTS with ACU climatic system

Climatic unit air outlets

Climatic units

Top compartment air inlets

Top compartment air outlets

BTS front panel
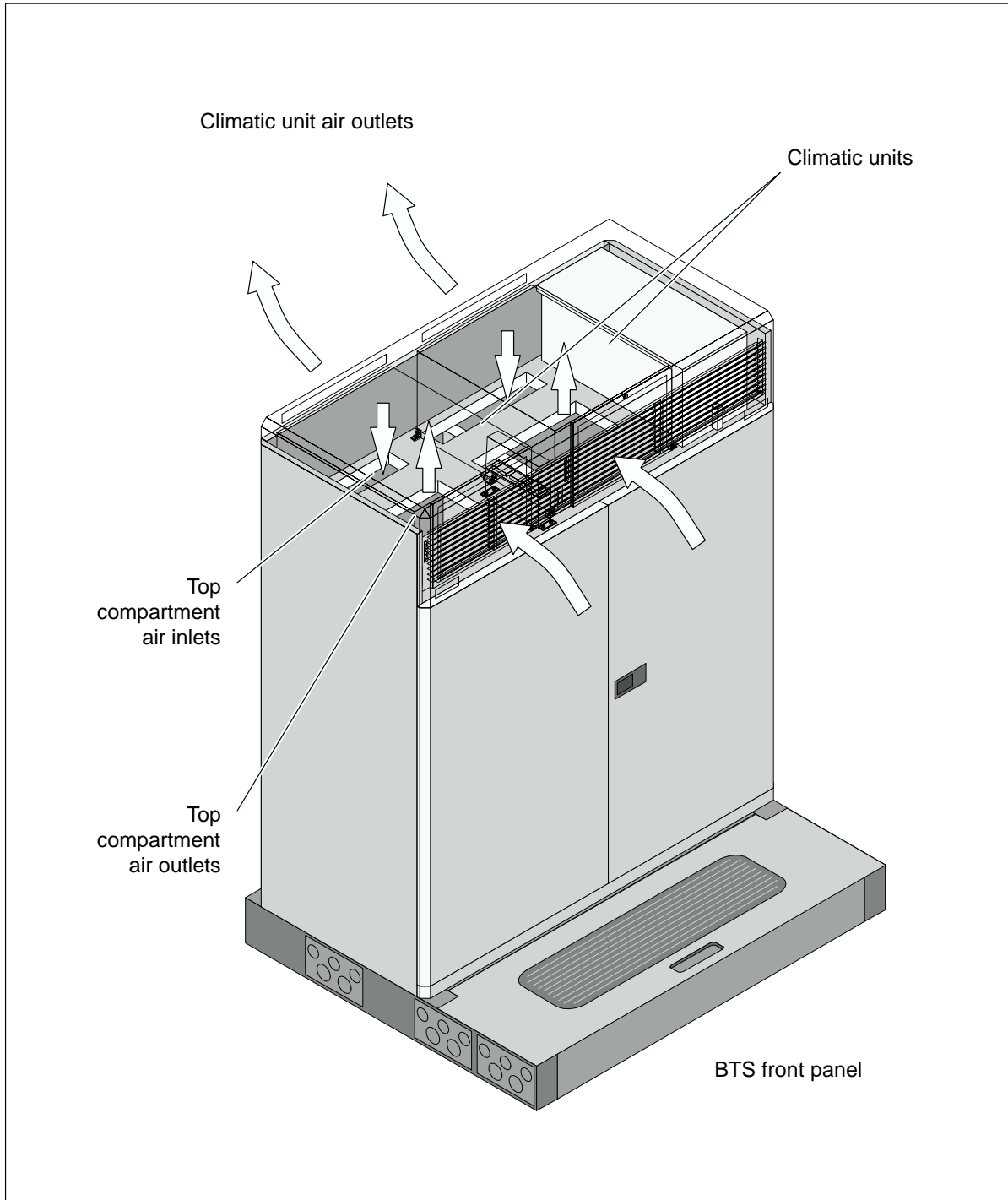
■ **Figure 1–2   S8000 Outdoor BTS: Air circulation in the BTS with ACUs**
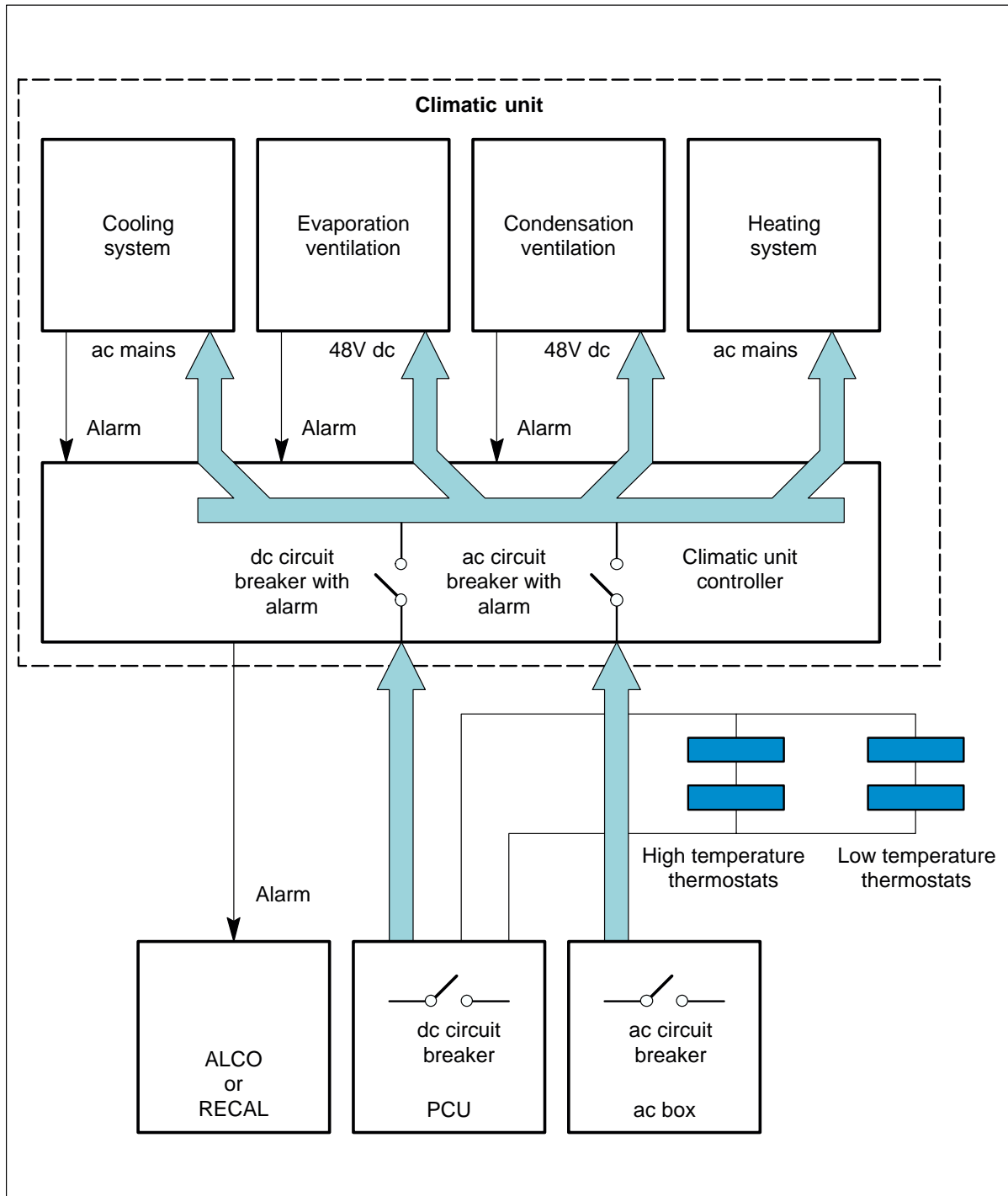
Figure 1–3   S8000 Outdoor BTS: ACU climatic system diagram

On each cooling unit there is also a controller display (red 7–segment display) that indicates the internal air temperature. This controller display has two LEDs :

■ COOL/DELAY (red): lit when the internal air temperature reaches 40°C (104°F).

■ HEAT (red): lit when the heater is on.

Technical characteristics

The ventilated air flow rate is 400 m^3/hour (14.125 cubic feet/hour).

The maximum temperature of output air is +70°C (158°F).

With DACS

Figure 1–4 shows the S8000 Outdoor with an DACS climatic system.

The operating principle is the following:

■ The air damper opens to admit external air (incoming air being filtered) and controls the inner cabinet environment by mixing appropriate amounts of outside and recirculated air.

■ The twin blowers drive air down the rear duct and into the equipment enclosure via slots at the rear. Returned air to the cooling system is routed through two sets of holes in the base, with excess air being rejected from vents either located on either side of the system (see *Figure 1–5*).

The internal temperature control is achieved by a high quality thermistor having an accuracy of ±0.2°C (32,36°F) between 0°C (32°F) and 70°C (158°F).This device is located in the left hand exit duct above a hole on the duct side ; this hole ensures that the thermistor is constantly in a moving air stream, regardless of damper position. Cooling system operational mode is solely dictated by the information provided by the thermistor.

There are four operational modes:

■ Low temperature –40°C (–40°F) <Tcab <15°C (59°F)

The heater is energised, the damper closed to the outside and air is recirculated via the holes in the base of the cooling system.

■ Medium temperature 15°C (59°C) <Tcab <40°C (104°F)

The heater is switch off, the damper remains closed and further heating of the equipment enclosure is achieved solely by the internal equipment loading.
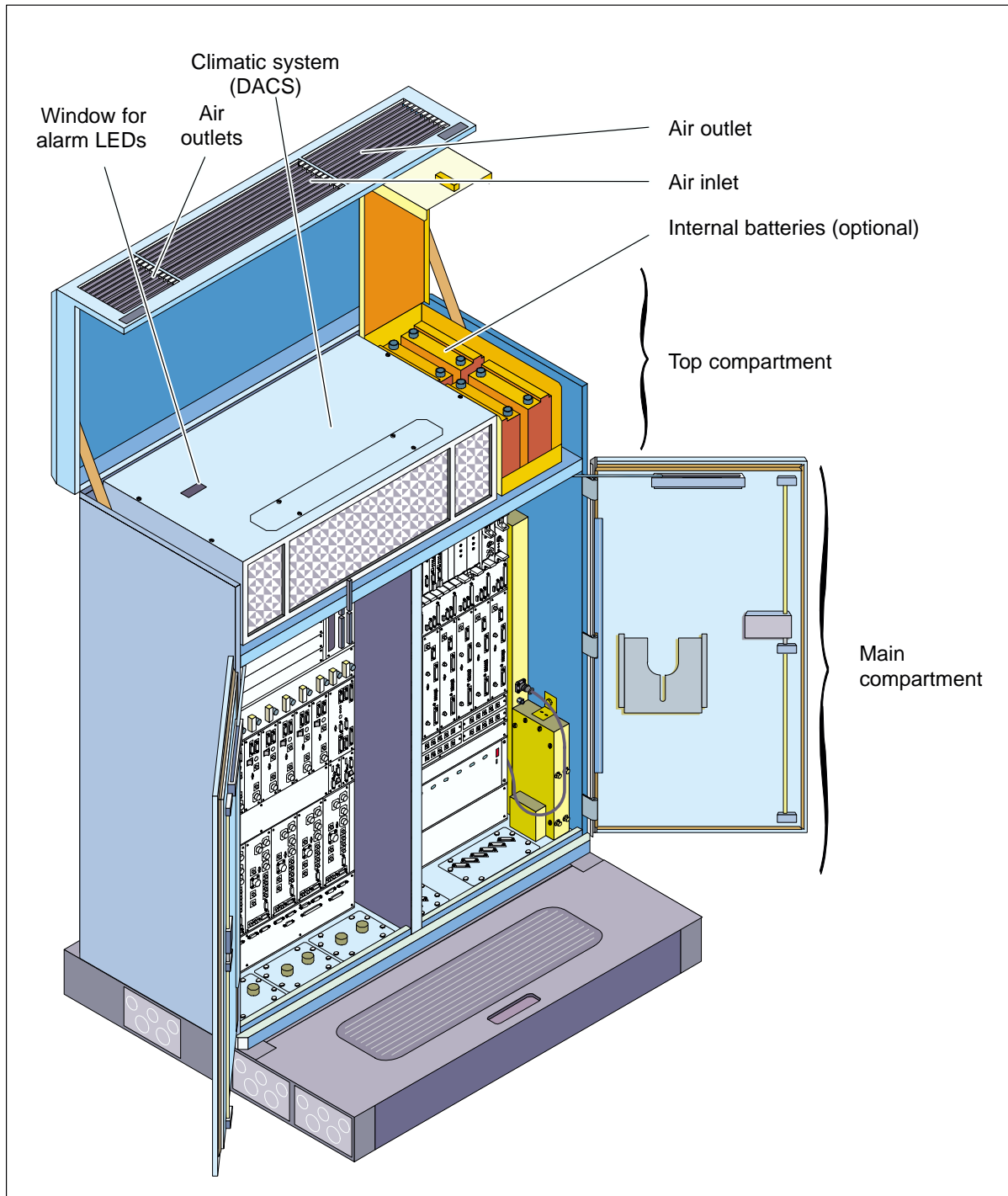
Figure 1–4   S8000 Outdoor BTS with DACS climatic system
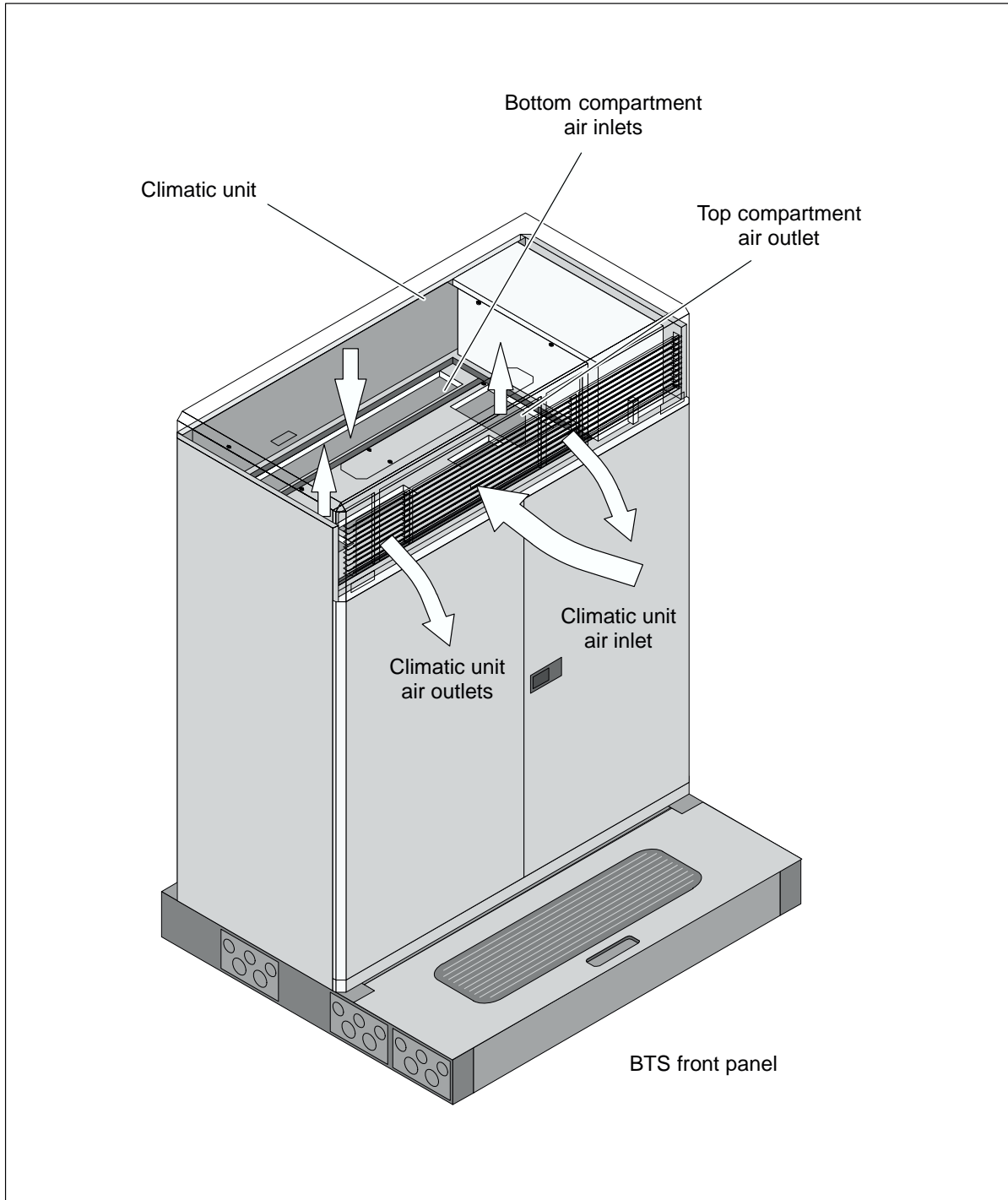
Figure 1–5   **S8000 Outdoor BTS: Air circulation in the BTS with DACS or "LN" DACS**

- Normal temperature Tcab = 40°C (104°F)

  The damper position is controlled automatically by the modulating motor, mixing appropriate amounts of recirculated and external air to maintain a constant temperature. Excess air is rejected from the cooling system from vents either side of the cooling system.

- High temperature Tcab > 40°C (104°F)

  Although the damper is fully open, the cooling system is unable to keep the cabinet temperature to 40°C (104°F) which now rises in sympathy with the external temperature. At an outside temperature of 50°C (122°F), the internal cabinet will rise to a nominal 60°C (140°F) under fully loaded conditions.

The cooling system is supplied:

- with two hard alarm outputs:

  - The first alarm output signals a fault on the cooling system,

  - The second one indicates a maintenance requirement for the filter.

- three alarm LEDs for on–site fault diagnostics:

  - The red LED indicates critical alarm for fan failure.

  - The yellow LED indicates critical alarm for heater circuit failure.

  - The green LED indicates maintenance alarm for clogged filter.

  On the top of the cooling system, there is a window in the lid which allows to view the LEDs (see *Figure 1–4*). They are normally on when healthy and off on alarm.

The cooling system is DC powered that allows internal or external battery back–up. The dc power consumption of the cooling system is 400–450W. The cold start–up performance of the unit is controlled by an inbuilt ac to dc converter (for operation of the fans) and by a 2.5 kW heating element.

With "LN" (Loise Noise) DACS

Figure 1–6 shows the S8000 Outdoor with an "LN" DACS climatic system.

The operating principle is the following:

- The air damper opens to admit external air (incoming air being filtered) and controls the inner cabinet environment by mixing appropriate amounts of outside and recirculated air.

- The twin blowers drive air down the rear duct and into the equipment enclosure via slots at the rear. Returned air to the cooling system is routed through two sets of holes in the base, with excess air being rejected from vents either located on either side of the system (see *Figure 1–5*).

Hood

DACS unit

Outlet vent

Cubicle

Plinth (optional)
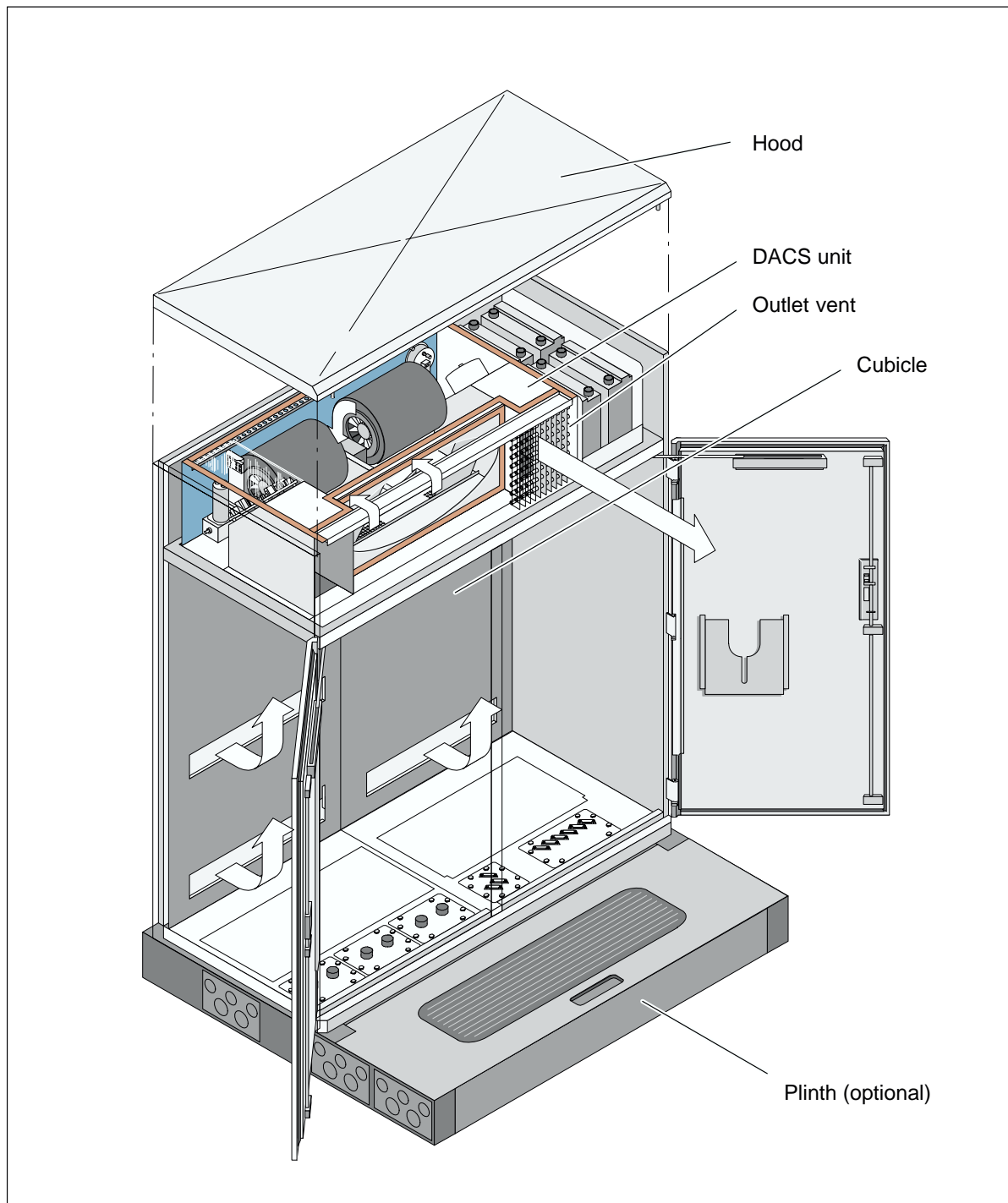
Figure 1–6   S8000 Outdoor BTS with "LN" DACS climatic system

With "LN" DACS two operating modes of the twin blowers are available:

- full speed mode
- control speed mode. In this mode:
  - if the temperature is > 45°C (113°F), the blowers run at full speed (2500 rpm).
  - if the temperature is ≤ 45°C (113°F), the blowers run at slow speed (1800 rpm).

The full speed mode or control speed mode is selected by switches located on the control board (see *Figure 1–7*).

The temperature control is achieved by two high quality thermistor having an accuracy of ±0.2°C (32,36°F) between 0°C (32°F) and 70°C (158°F):

- One is located in the left hand exit duct above a hole on the duct side. This hole ensures that the thermistor is constantly in a moving air stream, regardless of damper position.
- The other one is located behind the air inlet, and measures the ambiant air temperature.

Cooling system operational mode is solely dictated by the information provided by the thermistor.

The nominal internal operating temperature (Ts) is set by switches (see *Table 1–1*) located on the control board (see *Figure 1–7*).

The factory presetting temperature is 35°C (95°F).

Choice of nominal internal operating temperature (Ts)		Blower speed control	Nominal internal operating temperature (Ts)
Switch (SW1/1)	Switch (SW1/2)	Switch (SW1/3)	
OFF	ON	ON (for full speed)	+35°C (+ 95°F)
ON	ON	ON (for full speed)	+25°C (+ 77°F)

Table 1–1   Setting of nominal internal temperature

Cooling system operational mode is solely dictated by the information provided by the thermistor.

SW1

LED1 LED2 LED3

Alarm LEDs
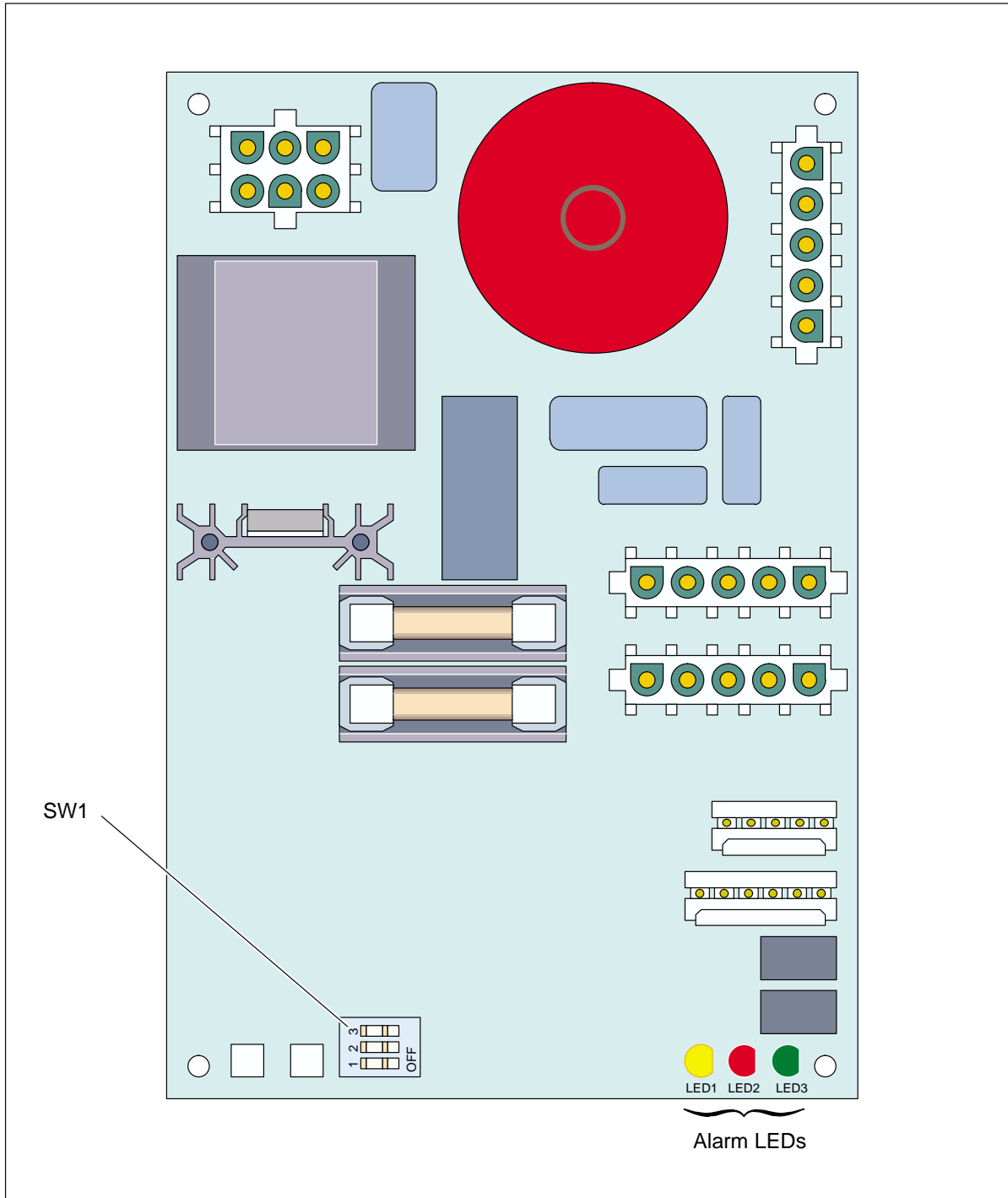
■ **Figure 1–7   Control board of climatic system with "LN" DACS**

There are four operational modes:

- Low temperature –40°C (–40°F) <Tcab <15°C (59°F)

  The heater is energised, the damper closed to the outside and air is recirculated via the holes in the base of the cooling system.

- Medium temperature 15°C (59°C) <Tcab < Ts

  The heater is switched off, the damper remains closed and further heating of the equipment enclosure is achieved solely by the internal equipment loading.

- Normal temperature Tcab = Ts

  The damper position is controlled automatically by the modulating motor, mixing appropriate amounts of recirculated and external air to maintain a constant temperature. Excess air is rejected from the cooling system from vents either side of the cooling system.

- High temperature Tcab > Ts

  Although the damper is fully open, the cooling system is unable to keep the cabinet temperature to Ts which now rises in sympathy with the external temperature. At an outside temperature of 50°C (122°F), the internal cabinet will rise to a nominal 60°C (140°F) under fully loaded conditions.

The cooling system is monitored by:

- two hard alarm outputs:

  - The first alarm output signals a fault on the cooling system,

  - the second one indicates a maintenance requirement for the filter.

- three alarm LEDs for on–site fault diagnostics.

  - The red LED indicates critical alarm for fan failure.

  - The yellow LED indicates critical alarm for heater circuit failure.

  - The green LED indicates maintenance alarm for clogged filter.

  On the top of the cooling system, there is a window in the lid which allows to view the LEDs (see *Figure 1–4*). They are normally on when healthy and off on alarm.

The cooling system is DC powered that allows internal or external battery back–up. The dc power consumption of the cooling system is 400–450W. The cold start–up performance of the unit is controlled by an inbuilt ac to dc converter (for operation of the fans) and by a 2.5 kW heating element.

1.1.1.3   Plinth

The S8000 Outdoor BTS cabinet can be installed on a plinth (see *Figure 1–8*) allowing for cable passage. The plinth characteristics are described in document < 01 >, BSS Overview.

The plinth may contain the external alarm connection box, the PCM connection box and the –48 V DC connection box.

These boxes are screwed into the inside of the plinth.

Note: One of the five–hole plates is replaced with a two–hole plate when there is an extension cabinet.
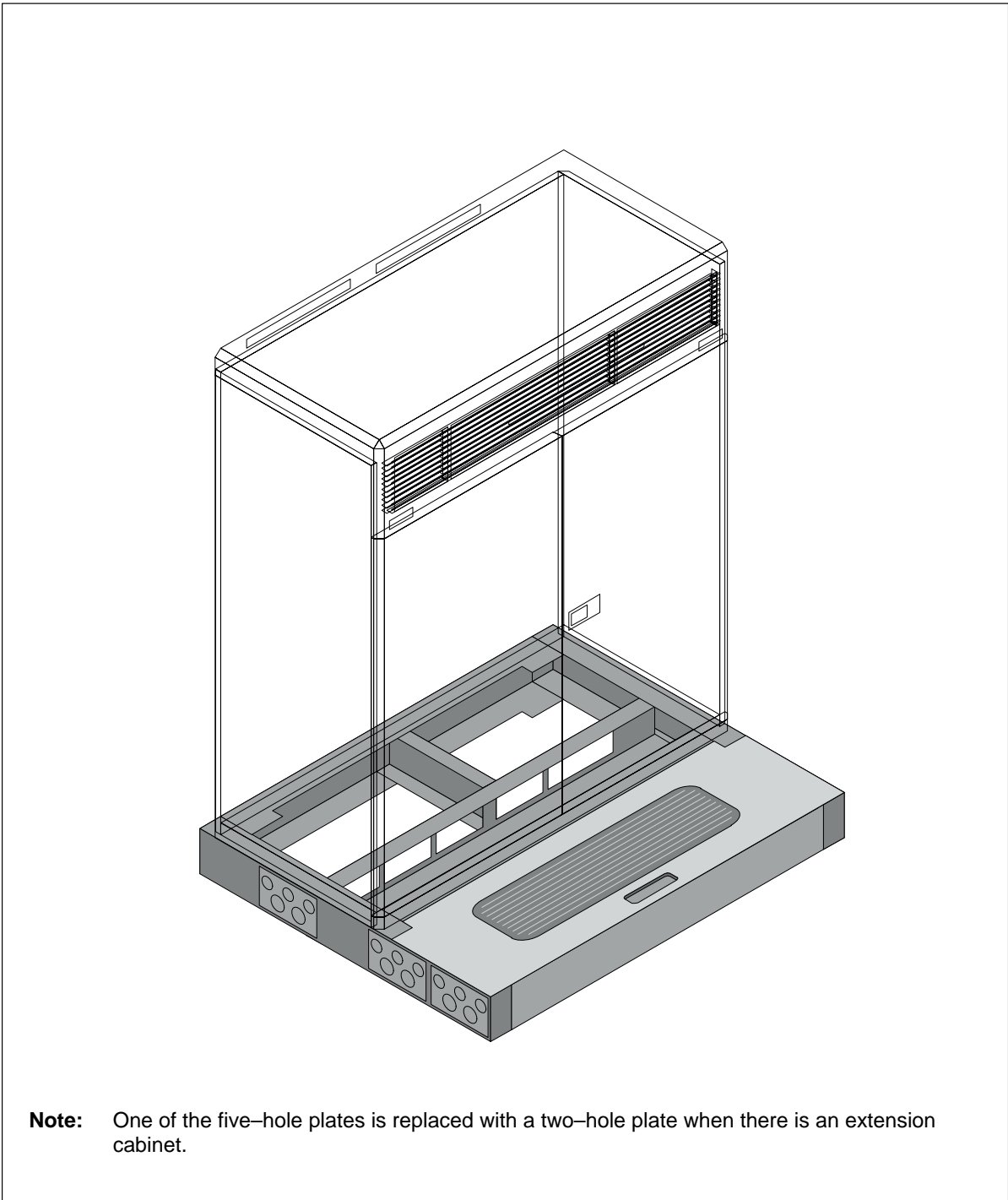
Figure 1–8   S8000 Outdoor BTS: Plinth diagram

1.1.2 S8000 Indoor BTS

1.1.2.1   Base cabinet

The S8000 Indoor BTS with BCF cabinet can be wall–mounted, or put on the floor. The base cabinet is shown in *Figure 1–9*.

Physical characteristics

See document < 01 >, BSS Overview.

Operating temperature

When the base cabinet is turned on, the external ambient air temperature must be between 0°C (32°F) and 45°C (113°F).

Once in operation, the base cabinet requires an external ambient air temperature above –5°C (23°F) and below 45°C (113°F).

Power supply

See document < 01 >, BSS Overview.

Consumption

The maximum power consumption of the base cabinet is 2080W.

1.1.2.2   BCF cabinet

The BCF cabinet can be wall–mounted or put on a support device and must not be placed further than 10 m (33'2'') away from the base cabinet. The BCF cabinet is shown in *Figure 1–10*.

DC connection

Radio output

Ventilation grid

ALPRO boards

Climatic unit

Filter
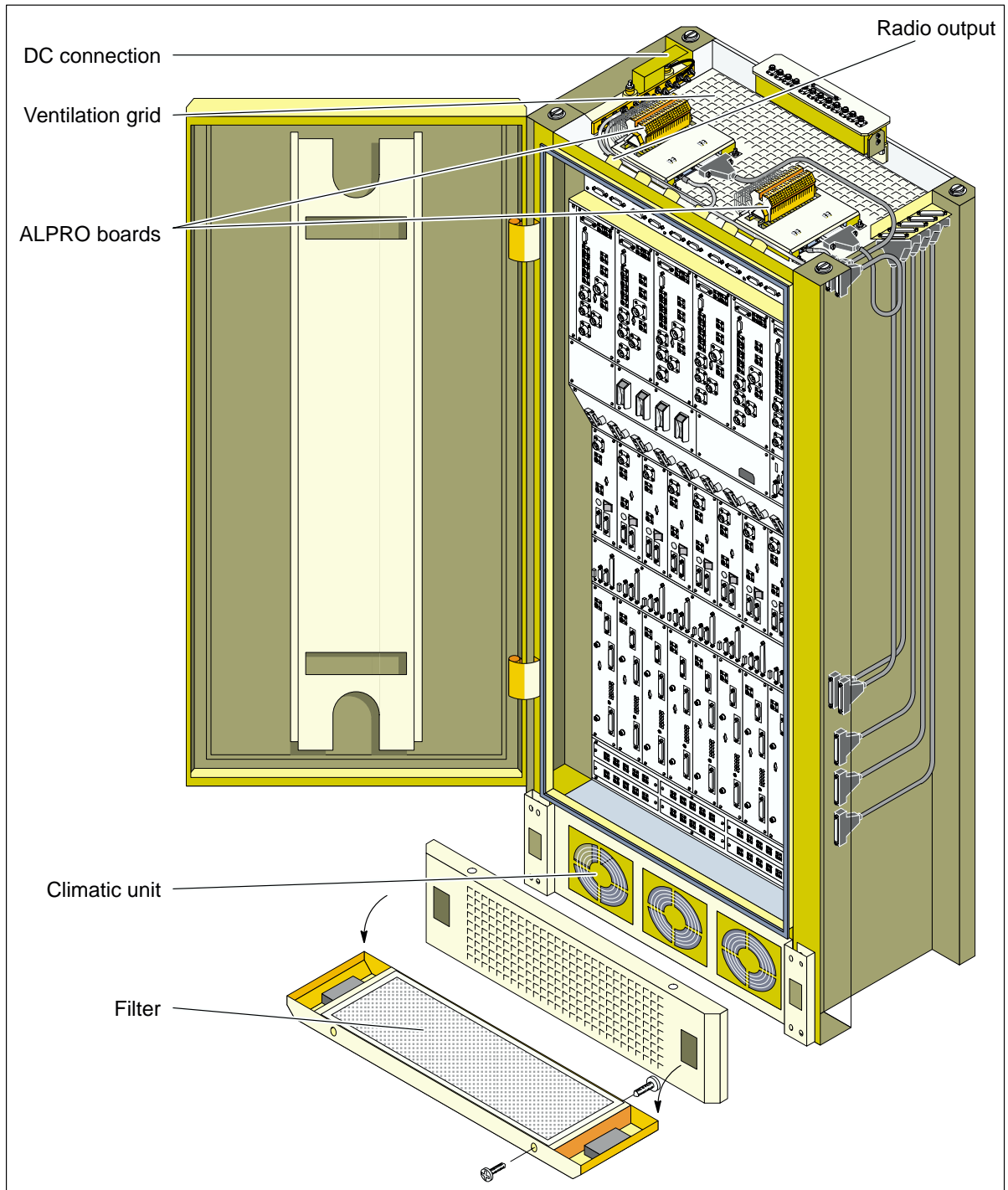
Figure 1–9   S8000 Indoor BTS: Base cabinet
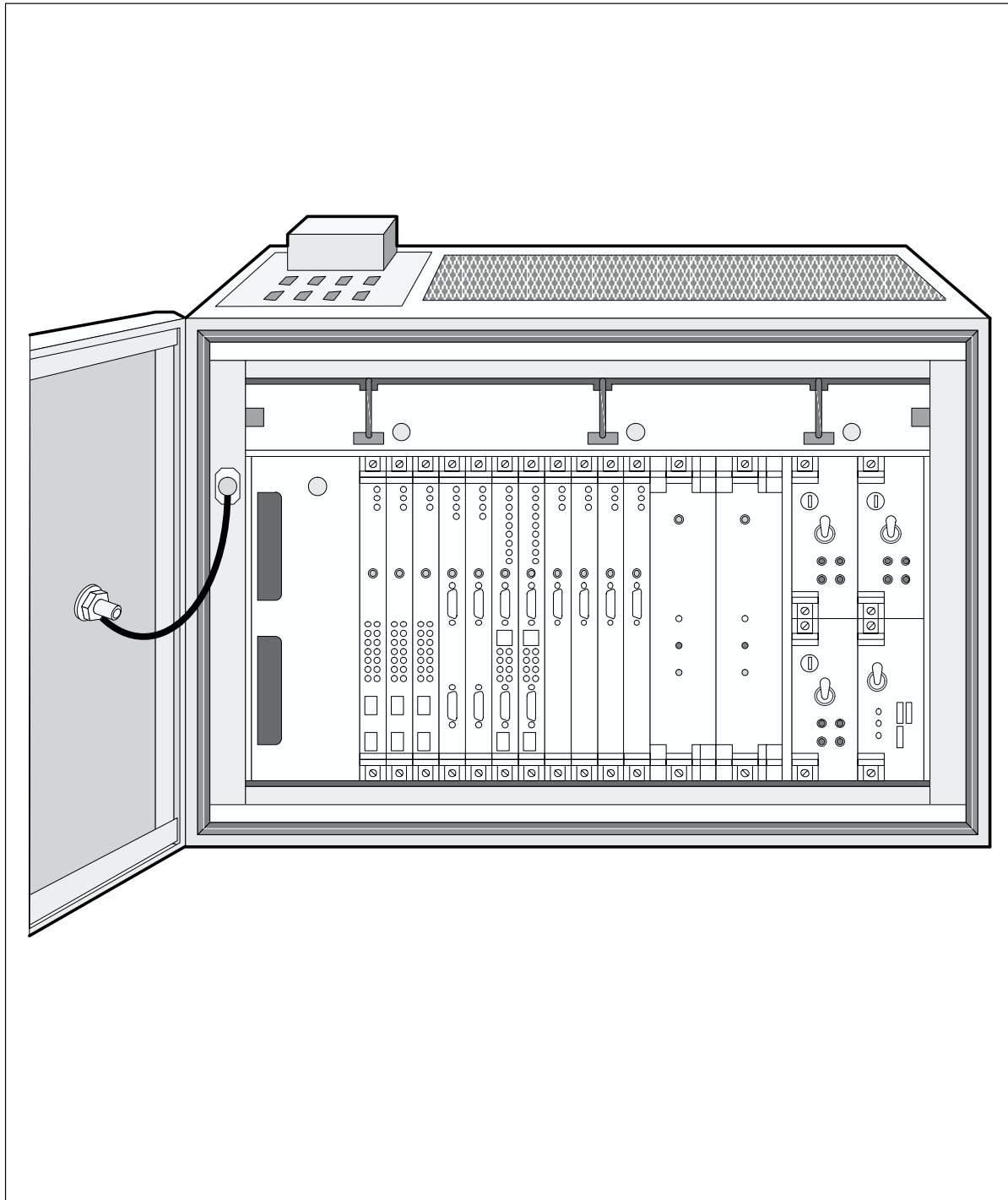
Figure 1–10   S8000 Indoor BTS: BCF cabinet

Physical characteristics

See document < 01 >, BSS Overview.

Operating temperature

When it is turned on, the BCF Cabinet requires an external ambient air temperature between 0°C (32°F) and 45°C (113°F).

Once in operation, the BCF Cabinet requires an external ambient air temperature above –5°C (23°F) and below 45°C (113°F).

Power supply

See document < 01 >, BSS Overview.

Consumption

The BCF cabinet maximum power consumption is 80 W.

1.2   Cabinet compartment layout

1.2.1   S8000 Outdoor BTS

The base cabinet and the extension cabinet are divided into three parts (*Figure 1–13* to *Figure 1–15*):

- top compartment
- left side
- right side

The layout of the equipment in the base and extension cabinets is identical in the top compartment and on the left side.

The cabinet layout on the right side of the base and extension cabinets is different. In the base cabinet, the BCF or CBCF is located in the BCF or CBCF Compartment. In the same compartment of the extension cabinet, a filling plate replaces the BCF or CBCF.

1.2.1.1   Top compartment

The top compartment opens by means of a cover on the top of the cabinet. The front of the cabinet is perforated to allow air to circulate. The top compartment has two or three elements: the optional battery box and the climatic system (the DACS, or two ACUs).

1.2.1.2   Compartment on the left side

User compartment

This compartment is available for Original Equipment Manufacturer (OEM). For more information, refer to the documentation provided by the equipment manufacturer.

For GSM 1800 frequency bands, Nortel has developed RW Series M products whose reference to the document is the following: 840–900201–002. The user interconnection compartment is optional. It is required only when a user kit or a –48 V connection box is used.

PA interconnection compartment

The PA interconnection compartment centralizes the –48 V dc power supply of the Power Amplifiers (PA).

Amplifier and alarm compartment

The amplifier and alarm compartment receives up to eight Power Amplifiers (PA) and the Alarm Collecting unit (ALCO or RECAL). The ALCO or RECAL board is connected to one or two external alarm protection boards (ALPRO), located outside the cabinet.

Figure 1–13   S8000 Outdoor BTS: Base cabinet layout (with BCF)
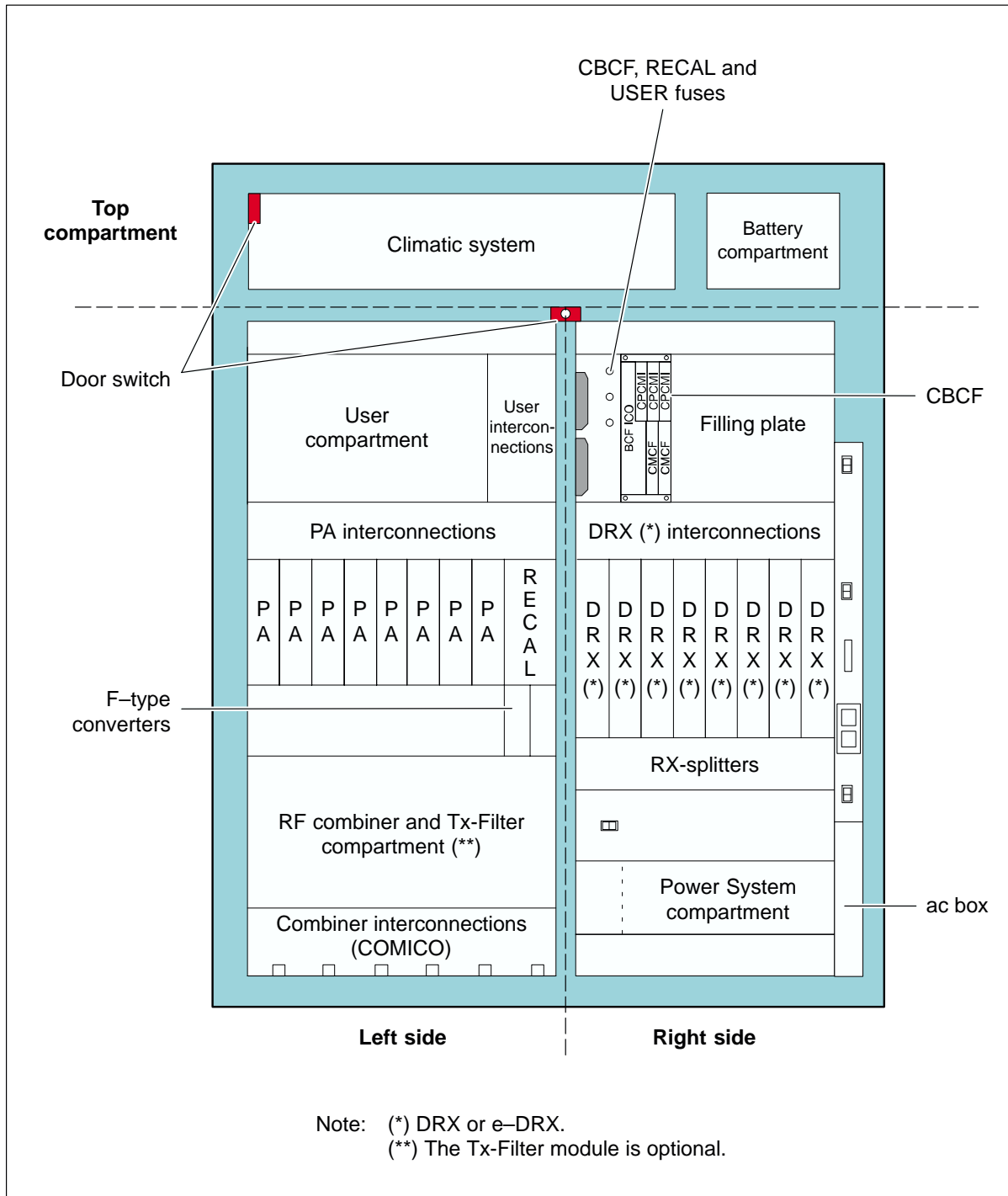
Figure 1–14   S8000 Outdoor BTS: Base cabinet layout (with CBCF)

RECAL and USER fuses

Top compartment

Battery compartment

Door switch

User compartment

User interconnections

Filling plate

PA interconnections

DRX (*) interconnections

P A	P A	P A	P A	P A	P A	P A	P A	R E C A L (***)

D R X (*)	D R X (*)	D R X (*)	D R X (*)	D R X (*)	D R X (*)	D R X (*)	D R X (*)

F–type converters

RX–splitters

RF combiner and Tx-Filter compartment (**)

Power System compartment

ac box

Combiner interconnections (COMICO)

Left side   **Right side**

Note: (*) DRX or e–DRX.   (***)   When the BCF is used:
        (**) The Tx-Filter module is optional.   • the ALCO board replaces the RECAL board
                                                        • the ALCO fuse replaces the RECAL fuse.

Figure 1–15   S8000 Outdoor BTS: Extension cabinet layout

F–type converter

A converter, called F–type converter, supplies ± 15 V dc to the LNA–splitter and the VSWR–meter.

A second F–type converter is available as an option.

RF Combiner and Tx–Filter compartment

The RF Combiner and Tx–Filter compartment can hold a maximum of either of the following combination of modules:

- six RF Combiner modules, duplexer–only (D)
- six RF Combiner modules, two–way hybrid duplexer (H2D)
- three RF Combiner modules, four–way hybrid duplexer (H4D)
- four RF Combiner modules, duplexer–only (D) and four Tx–Filter modules (TxF)

The D, H2D, and H4D RF Combiner modules perform the following functions:

- transmission coupling of two, three, or four channels
- filtering and duplexing of transmission and reception signals on the same antenna port
- amplification of reception signals
- monitoring of the antenna VSWR (option)

The Tx–Filter performs the following functions:

- filtering of transmission signals
- monitoring of the antenna VSWR (option)

Combiner interconnection compartment (COMICO)

The COMICO is the interconnection board for the modules of the RF Combiner compartment that centralizes inputs/outputs on the alarms and the power supplies.

1.2.1.3   Compartment on the right side

BCF or CBCF Compartment

The BCF or CBCF Compartment of the base cabinet contains a fuse panel and a BCF unit or CBCF Module.

The following BCF boards are visible and accessible in the front panel of the BCF Compartment:

- three PCM Interface boards (PCMI)
- two Gateway boards (GTW)
- two Control, Switching and Management boards (CSWM)

- four Data Signaling Concentration boards (DSC)
- two synchronization boards (SYNC)
- three 48 V / ±5 V / 12A converters (one converter is optional)
- one Power Sypply Command board (PSCMD)

Two CBCF boards are visible on the front panel of the CBCF module:

- Compact Main Common Function (CMCF)
- Compact PCMI (CPMI)

The fuse panel in the base cabinet contains three fuses:

- 4A–fuse to protect the BCF unit or CBCF Module
- 1A–fuse to protect the alarm collecting board (ALCO or RECAL)
- 10A–fuse to protect the user compartment

Since there is no BCF or CBCF in the extension cabinet, a filling plate occupies the place of these units.

The fuse panel in the extension cabinet contains only two fuses: a 1A fuse for the alarm collecting board and a 10A–fuse for the user compartment.

DRX (or e–DRX) interconnection compartment

The interconnection compartment centralizes DRX (or e–DRX) outputs. It connects the modules to the Power Amplifiers (PA) on the one hand, and interconnects them by means of the FH bus, on the other.

DRX (or e–DRX) compartment

The compartment receives up to eight modules.

RX–splitter compartment

The RX–splitter compartment receives up to six RX–splitters, which receive RF signals from the LNA splitter and distribute them to the DRXs (or e–DRXs) RX inputs.

Power system compartment

The power system compartment may be configured according to two types:

- The first type is a Power Controller Unit (PCU) and up to six 600W rectifiers (one of them redundant) which convert Mains Voltage to –48 V dc to be used in the cabinet. According to the number of DRXs (or e–DRXs) per cell, the number of rectifiers may be decreased.
- The other type is an integrated power system including a Controller Module, a Distribution Module and up to seven 500W rectifiers (one of them redundant).

ac box

This box is located on the right–hand side of the right–hand part of the cabinet. It receives the mains voltage and distributes it to the power system compartment and to the cooling system. The PCU only controls the dc supply. ac supply connects to the back panel that is common for all rectifiers.

In the extension cabinet, a filling plate replaces the BCF. On left of this filling plate there are two fuses.

1.2.2   S8000 Indoor BTS

1.2.2.1   Base cabinet

The compartment layout of the base cabinet is presented in *Figure 1–16*.

Cabinet top

The cabinet top (see *Figure 1–25*) can hold a maximum of two ALPRO modules. An ALPRO module consists of an ALPRO board, a protection cover, and an interconnection plate.

The fan grid in the upper panel is an air outlet. Radio outputs, the cabling with the separate BCF Cabinet (if applicable) and the cabinet power supply are achieved from the top of the cabinet.

Combiner interconnection (COMICO) compartment

This compartment consists of an interconnection board for the combiner compartment modules, which centralizes inputs/outputs on the alarms and the power supplies.

RF combiner and Tx–Filter compartment

The RF Combiner and Tx–Filter compartment can hold a maximum of either of the following combination of modules:

- six RF Combiner modules of the duplexer only type (D)

- six RF Combiner modules of the two–way hybrid duplexer type (H2D)

- three RF Combiner modules of the the four–way hybrid duplexer type (H4D)

- four RF Combiner modules of the duplexer only type (D) and four Tx–Filter modules (TxF)

- one RF Combiner Module of eight–way cavity combiner and two duplexers

To BCF cabinet (if applicable***)

Combiner interconnections
(COMICO)

RF combiner and Tx–Filter
compartment (**)

dc compartment

F–type
converters

PA interconnections

| P A | P A | P A | P A | P A | P A | P A | P A | R E C A L (***) |

DRX interconnections (*)

| D R X (*) | D R X (*) | D R X (*) | D R X (*) | D R X (*) | D R X (*) | D R X (*) | D R X (*) | C B C F (***) |

RX–splitters

Ventilation system

Note: (*) DRX or e–DRX.
(**) The Tx-Filter module is optional.

(***)   When the BCF cabinet is used:
• the ALCO board replaces the RECAL board
• a filling plate replaces the CBCF module.

Figure 1–16   S8000 Indoor BTS: Base cabinet layout

The RF Combiner modules perform the following functions:

- transmission coupling of the channels
- filtering and duplexing of transmission and reception signals on the same antenna port
- amplification of reception signals
- monitoring of the antenna VSWR (option)

The Tx–Filter performs the following functions:

- filtering of transmission signals
- monitoring of the antenna VSWR (option)

dc compartment

This compartment contains four switches to disconnect the power supply to the Power Amplifiers, the fans, the ALCO or RECAL board and the BCF or the CBCF.

The compartment also contains an F–type converter, which supplies ± 15 V dc to the LNA–splitter and the VSWR–meter. A second F–type converter is available as an option.

PA interconnection compartment

This compartment centralizes the –48 V dc power supply of the Power Amplifiers (PA).

Power Amplifier and alarm compartment

This compartment contains:

- one to eight power amplifiers (PAs)
- one ALCO or RECAL board

It is possible to connect the ALCO or RECAL board to one or two external alarm protection boards (ALPRO) located on top of the base cabinet.

DRX (or e–DRX) interconnection compartment

This compartment centralizes DRX (or e–DRX) outputs. It connects them to the Power Amplifiers (PA) on the one hand , and interconnects them by means of the FH bus, on the other.

DRX (or e–DRX) and CBCF Compartment

This compartment contains a maximum of eight modules.

The CBCF module is located in the far right of this compartment. A filling plate replaces the CBCF when the BCF is used.

RX–splitter compartment

This compartment contains up to six RX–splitters, which receive data signals from the units in the coupler compartment and distributes them to the DRXs (or e–DRXs).

Climatic compartment

This compartment contains three fans, and the FANICO board (FANICO PCB–Printed Circuit Board). One fan is optional and is used to ensure redundancy. This board enables the control of the rotation of each fan and sends an alarm (one for each fan) to the ALCO or RECAL board when the fan speed goes below a fixed threshold.

1.2.2.2   BCF cabinet

The layout of the BCF cabinet is presented in *Figure 1–17* and *Figure 1–18*.

Upper compartment

This compartment contains three fans and a FANICO board (identical to the one in the radio cabinet). Rotation management alarms are sent to the ALCO board.

There are three 800mA–fuses on the front panel of the BCF to protect the fans.

Lower compartment

This compartment contains the following BCF boards:

- three PCMI boards
- two gateway boards (GTW)
- two control and switching units (CSWM)
- four data signaling concentration units (DSC)
- two synchronization modules (SYNC)
- three 48 V / ± 5 V / 12 A converters (one converter is optional)
- one Power Supply CoMmanD unit (PSCMD).

There is a 4A–fuse on the front panel to the left of the BCF board to protect itself.
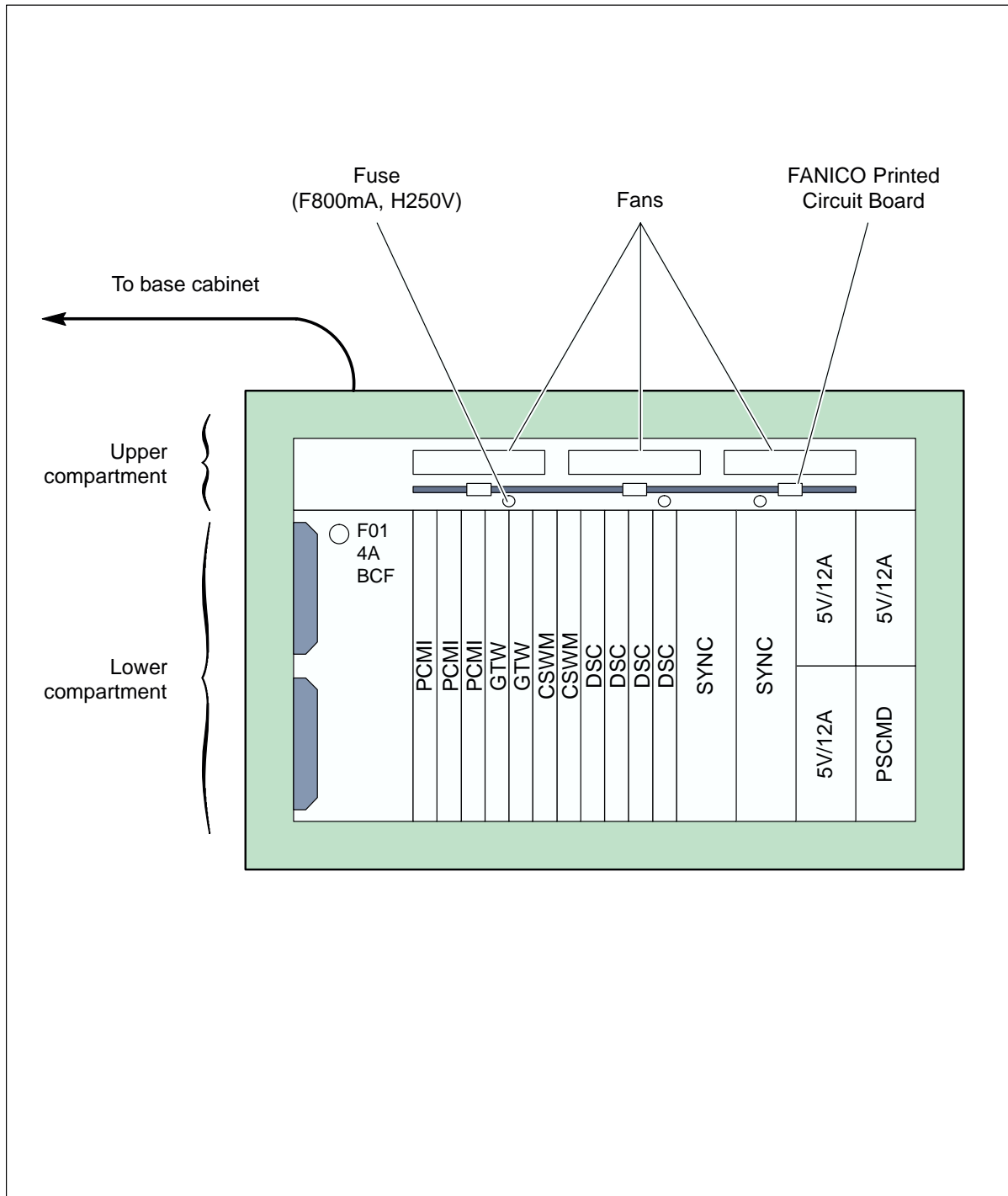
Figure 1–17   S8000 Indoor BTS: BCF cabinet layout
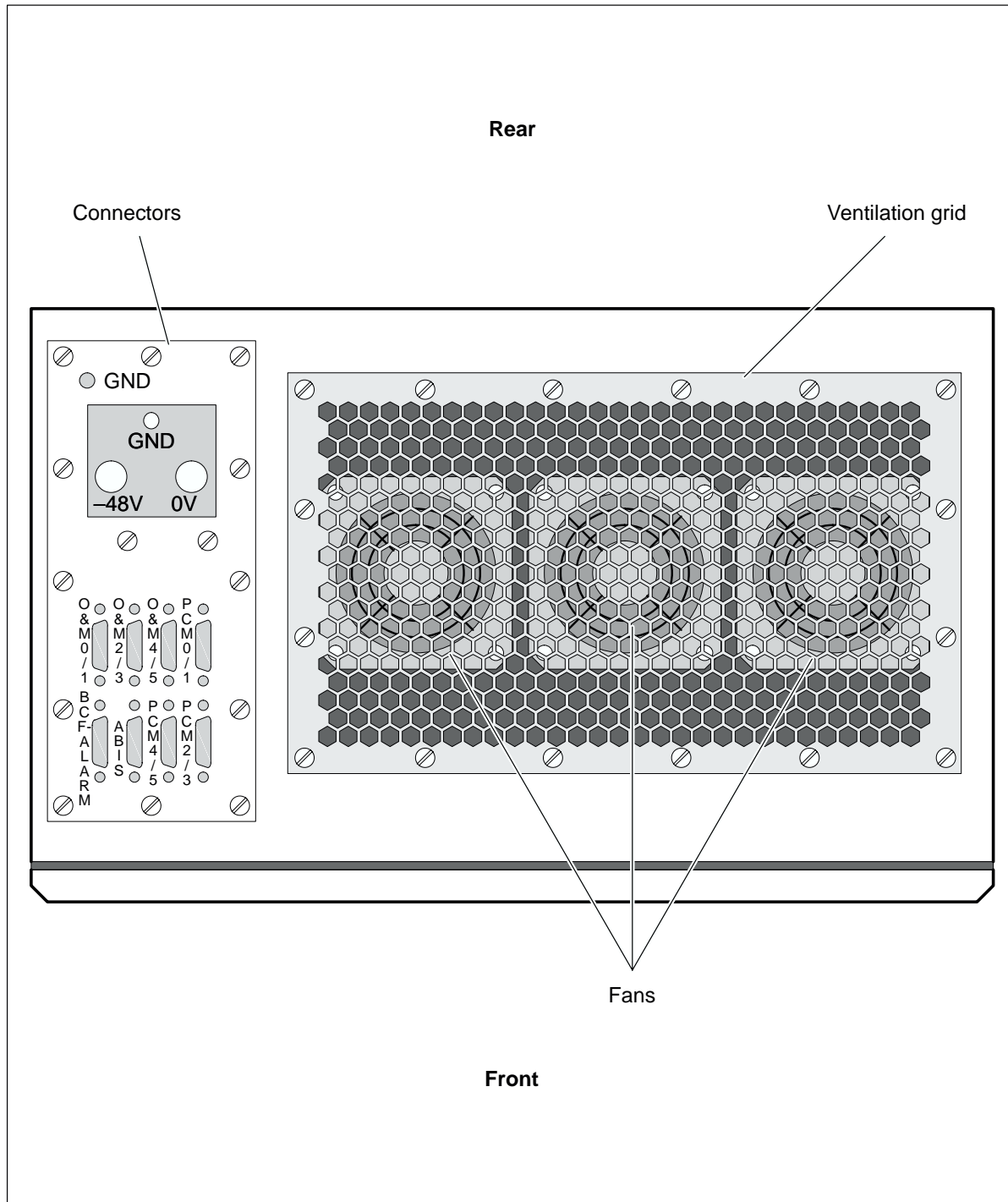
Figure 1–18   S8000 Indoor BTS: BCF cabinet top view

Back panel

The BCF back panel connects the switching part of the BTS. It provides connections for the BCF boards (see *Figure 1–19*). It receives the external PCMs from the BSC (A–bis interface) and the six private PCMs from the BTS. It also distributes the O&M bus, its own alarms and the 48 V power supply of the ALCO board.

The BCF back panel has the following connectors:

- A 37–pin female connector receives the six PCMs of the A–bis interface.
- Three 25–pin female connectors distribute the O&M bus.
- Three 25–pin female connectors each distribute two private PCMs.
- A 3–pin connector is used for power supply.
- A 4–pin connector distributes converter alarms to the ALCO unit.
- Thirty 96–pin male connectors connect the P1 and P2 connectors of the following units: PCMI, DSC, PSU, CSWM, GTW, and SYNC.
- Thirteen 8–pin male connectors supply the units connected to the back–panel.

The BCF back panel also connects PCM termination resistors in order to reduce radioelectric transmission and prevent end–of–line multiple reflection problems.

The P2 connectors are equipped with a localizing device that prevents the insertion of a board into the wrong slot. This is done by means of cells on the back–panel that are blocked and tabs that are cut out on the board connectors (see *Figure 1–20*).

The BCF back panel has only one ground. No distinction is made between logical ground and physical ground. For units that use this distinction, the mechanical ground is connected to the logical ground.

However, the reference 0 V of the –48 V power supply (M0 V) is not connected to the back–panel ground.

The –48 V dc power is protected by fuses.

Key :
          OMBout*X*   : O&M output connector No. *X*
          PCMP*X*   : Private PCM connector No. *X*
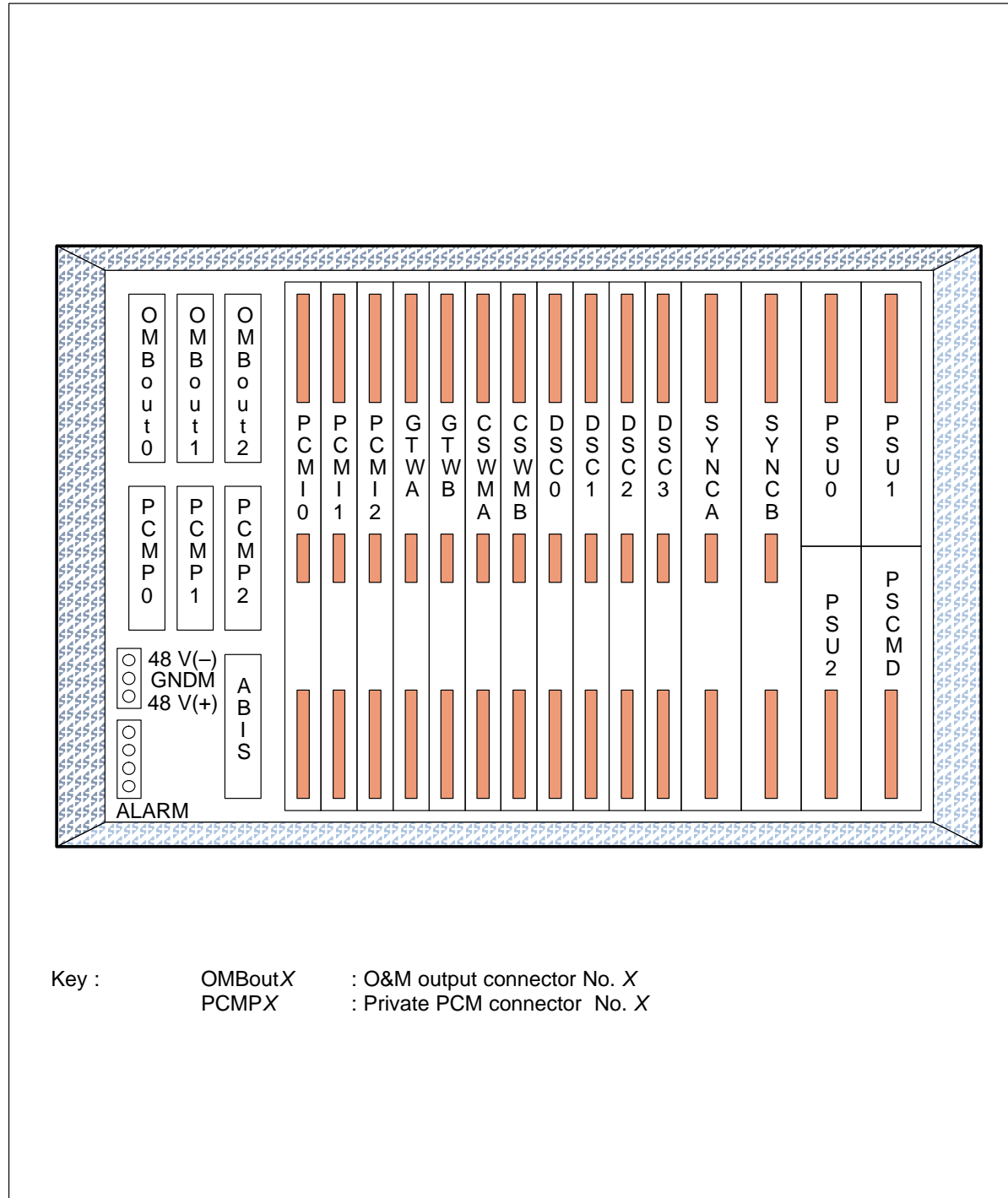
Figure 1–19   BCF back panel
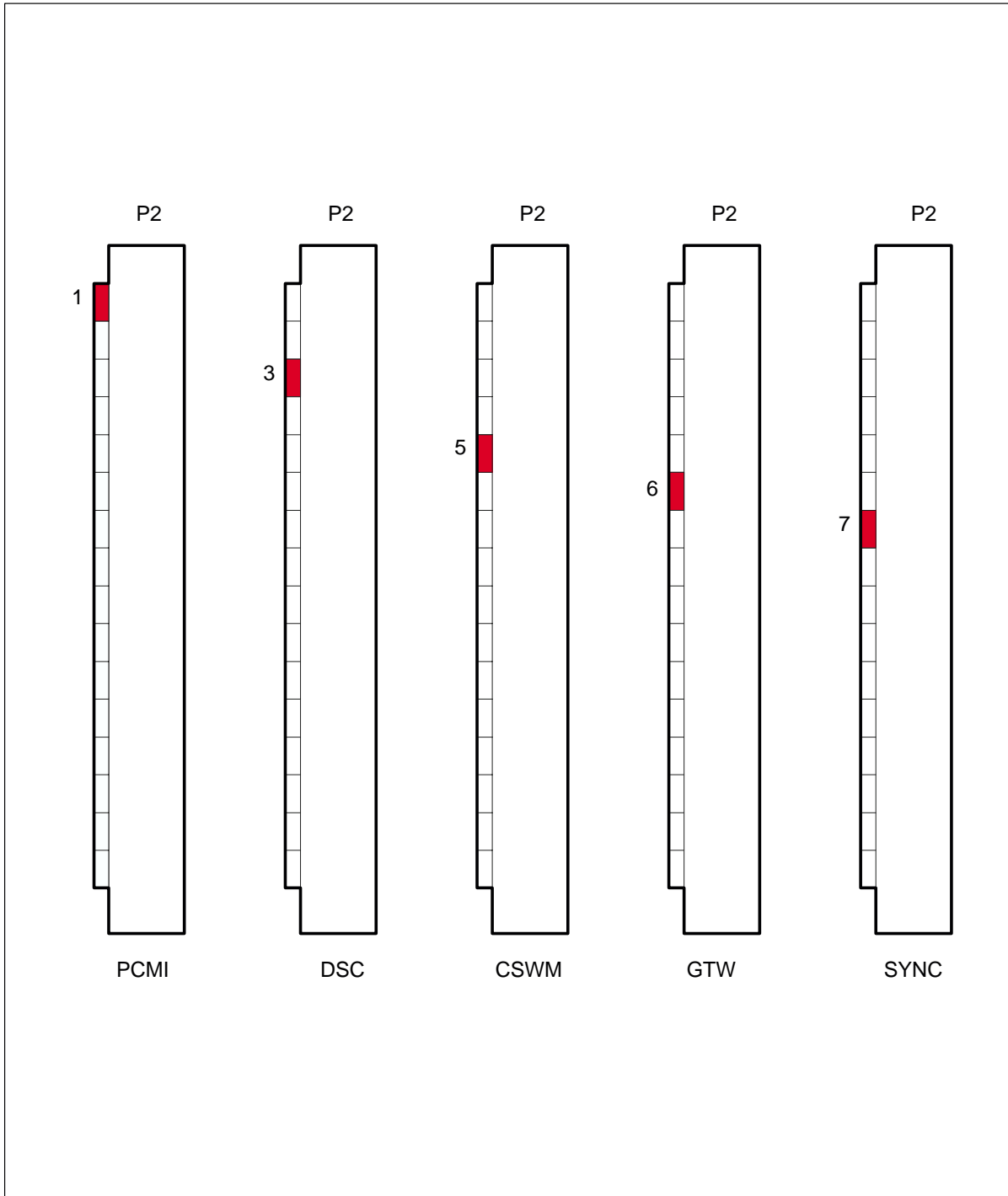
Figure 1–20   Localizing device

1.4   Power supply

1.4.1   S8000 Outdoor

The power system supplies 48 V dc power to the units in the cabinet from the mains power supply.

1.4.1.1   Description

The power system can have the following configurations:

- for the S8000 Outdoor BTS:
  - an ac box, a Power Controller Unit (PCU), a set of 600W rectifier units (SRU) and a set of batteries
  - an ac box, a Controller Module, a set of 500W Rectifiers, a Distribution Module and a set of batteries

The controller module and distribution module make up the PCU.

The PCU connects the rectifiers to the cabinet units and to the batteries (only for S8000 Outdoor BTS).

In this section, the SRU refers to both types of rectifier sets.

The PCU can be connected to a set of several rectifiers whose outputs are connected in parallel:

- for S8000 Outdoor BTS:
  - either a set of two to six 600W rectifiers (one for redundancy)
  - or a set of two to seven 500W rectifiers (one for redundancy)

Only for the S8000 Outdoor BTS, the PCU is connected to the batteries located either inside or outside the cabinet. It has four separate outputs (outputs 1 to 4) that supply the cabinet utilizations.

There are two types of battery units:

- internal batteries mounted on the top of the cabinet, which consist of four 12 V dc batteries in series (one string)

- external batteries located in the external battery cabinet, and configured in a maximum of four strings. Each string consists of four 12V dc batteries in series; the four strings being connected in parallel.

PCU functions

Two types of PCUs are available, depending on the converter type. These two PCU types have the same functions but are tied to their own rectifiers.

The PCU has the following functions:

- It connects the SRU to the batteries (only for the S8000 Outdoor BTS). When the rectifiers are no longer running, the batteries can supply the PCU outputs according to the option chosen, the choice being by front panel wiring:
  - option 1: two of the four PCU outputs are supplied
  - option 2: the four PCU outputs are powered (this is mandatory in the case of external batteries
- It generates four 54 V dc outputs (outputs 1 to 4) for supply of the cabinet boards.
- It receives the alarms from the rectifiers.
- It receives an analog signal from the temperature probe located on the batteries (internal or external) and sends a signal to the SRU to adjust rectifier output voltage inversely to battery temperature (floating voltage).
- It generates a disconnection of its four load outputs depending on the signal received from two ambient temperature probes (one is located at the top of the cabinet, the other at the bottom).

PCU connections with the SRU

The SRUs, connected in parallel, are connected to the PCU by means of the following inputs/outputs:

- 54 V (+) and 54 V(–)
- dc fault (alarm)
- ac fault (alarm)
- overtemperature (alarm)
- missing module (alarm)
- floating voltage control
- remote control
- load share

PCU connections with the batteries (only for the S8000 Outdoor BTS)

The batteries are connected to the PCU by means of the following inputs/outputs:

- 54 V (–) internal batteries
- 54 V (–) external batteries
- 54 V (+) internal and external batteries
- (+) and (–) of the temperature probe of the internal batteries
- (+) and (–) of the temperature probe of the external batteries

Interface between the PCU and the ALCO or RECAL board

The following signals are the interface between the PCU and the ALCO or RECAL board:

- Load1 threshold (PCU internal alarm, also sent to ALCO or RECAL)
- PCU protective devices (PCU internal alarm, also sent to ALCO or RECAL)
- battery on discharge (alarm) available only for the S8000 Outdoor BTS
- dc fault (alarm)
- ac fault (alarm)
- overtemperature (alarm).

The following signal carries out the control:

- CEATS 1 (Cabinet Extreme Ambient Temperature Signal).

The following cables are not connected:

- Load2 threshold (PCU internal alarm, also sent to ALCO or RECAL)
- missing module (alarm)
- remote control (used to cut the 48 V dc and switch to batteries)
- common alarms.

Battery operation of boards in the cabinet (only for the S8000 Outdoor BTS)

The PCU enables the cabinet to run on either internal or external batteries (connection of the internal or external batteries is carried out manually, and it is not possible to connect both types simultaneously). Two operating options are possible.

- option 1:
  - When the internal or external batteries are connected to the system, the SRU powers all the outputs and, if necessary, supplies power to the batteries (charging phase).
  - If the SRU is not supplying any power, the internal or external batteries energize output 4 (BCF, user equipment and ALCO or RECAL board).
- option 2:
  - When the external batteries are connected (in which case the internal batteries are disconnected manually), the SRU energizes all the outputs and, if necessary, supplies power to the batteries (charging phase).
  - If the SRU is not supplying any power, the external or internal batteries energize all the outputs.

When the SRU, for any reason, stops supplying dc voltage, the batteries are the only possible dc power supply.

However, battery output voltages decrease over time.

So, when the battery output voltage reaches the first Load1 threshold, the PCU cuts off power supply to the boards in the cabinet which are connected to outputs 1 and 3. An alarm signal is generated on the Load1 threshold output.

If the battery output voltage continues to decrease and reaches the second Load2 threshold, the PCU cuts off power supply to the boards in the cabinet which are connected to outputs 2 and 4.

The Load2 threshold is the minimum permissible voltage at battery output:

- typical value of Load1 threshold: 45 V (±2%)
- typical value of Load2 threshold: 42 V (±2%)

If the SRU recovers power supply, the batteries are charging. When voltage is equal to 50.7 V, the PCU reconnects the cabinet boards with its four outputs.

Alarms

Alarm signals from the rectifiers in the energy subrack are concentrated in 3 single signals determined by logic OR:

- ac fault alarm
- dc fault alarm
- overtemperature alarm

Extreme temperature signals from the CEATS 1

A short circuit between the two CEATS 1 pins of the HOST interface connector causes the disconnection of all outputs connected to the rectifiers and to the batteries (only for the S8000 Outdoor BTS), and the generation of the Load1 alarm signal.

From –40°C (–40°F) to 0°C (32°F), the rectifiers accept the mains voltage without deterioration, but do not function.

1.4.2   **S8000 Indoor BTS**

Figure 1–122 shows the dc power supply distribution. Two filters protect the dc distribution input against conducted emission. The dc power supply feeds the dc compartment where four outputs come out to the following equipment groups:

- the eight power amplifiers and the two F–type converters, through the power amplifier interconnection module
- the three fans, through the fan interconnection module
- the eight DRXs (or e–DRXs), through the DRX interconnection module
- the BCF or CBCF
- the ALCO or RECAL board

The dc compartment houses four breakers that allow to disconnect the powering of these equipment groups.

The dc distribution for each group uses three cables:

- +0 V dc
- –48 V dc
- ground

dc input

EMI filters

dc compartment

50A breaker

2.5A breaker

10A breaker

5A breaker

PA_ICO

FANICO

DRX_ICO

BCF or CBCF

Fuse 10A · · · Fuse 10A   Fuse 10A   Fuse 10A

Fuse 800mA   Fuse 800mA   Fuse 800mA

Fuse 2A · · · Fuse 2A

Fuse 4A

8 power amplifiers

2 F–type converters

3 fans

8 DRXs (*)

BCF or CBCF

ALCO or RECAL

Legend:

PA–ICO :   Power Amplifier interconnection

FAN–ICO :   Fan interconnection

DRX–ICO :   DRX (*) interconnection

Note:

(*) DRX or e–DRX

█ Figure 1–122   S8000 Indoor BTS: dc power supply diagram

3   ARCHITECTURE

3.1   Physical architecture

3.1.1   Introduction

This chapter provides an overview of the BTS physical architecture. BTS components are described in detail in Chapters 1 to 5.

3.1.2   Subsystems

The BTS contains three main subsystems (see *Figure 3–1* and *Figure 3–2*):

- one BCF (Cabinet or Unit) or one CBCF Module
- one TRX subsystem
- one coupling system

The content of each subsystem is listed in *Table 3–1*.

3.1.3   Internal buses

The following buses, which connect BTS components, are described in this section:

- Frequency hopping (FH) bus
- Private PCM
- GSM Time bus
- Internal PCM bus
- O&M bus

Note: The GSM Time bus, Internal PCM bus, and O&M bus are only used with the BCF Unit.

Figure 3–1 shows the internal buses used with the BCF Unit and *Figure 3–2* shows the buses used with the CBCF Module.

Subsystem	Contents*
Base Common Function (BCF) Cabinet or Unit **	• Control and Switching Module (CSWM) • Data Signalling Concentration board (DSC) • PCM Interface board (PCMI) • Synchronization board (SYNC) • Alarm Collecting board (ALCO) • Gateway (GTW)
Compact BCF (CBCF) Module **	• Compact PCM Interface board (CPCMI) • Compact Main Common Function board (CMCF) • Remote Control Alarm (RECAL) board • BCF Interconnection board (BCFICO) • CBCF Back Panel (CBP)
TRX	• Driver and Receiver unit (DRX or e–DRX) • Power Amplifier (PA)

Coupling system	• RF Combiner Module(s) of the following types:
	  – Duplexer (D)
	  – Hybrid Two–way (H2D)
	  – Hybrid Four–way (H4D)
	  – Tx Filter(s) (TxF)
	  – eight–way cavity combiner (CC8)
	• Rx Splitter(s)
	• LNA Splitter

* The number of boards or modules are not indicated and depend on the configuration of a site. ** The BTS contains a BCF or a CBCF.	

Table 3–1   BTS subsystems

3.1.3.1   FH bus

The FH bus links together all logical DRXs (or e–DRXs)

The FH bus and the transmitters connected to it ensure the function of frequency hopping and the filling of the BCCH frequency.

The FH bus is a V11 (series) bus. It is one-way and carries the signals according to the RS485 standard.
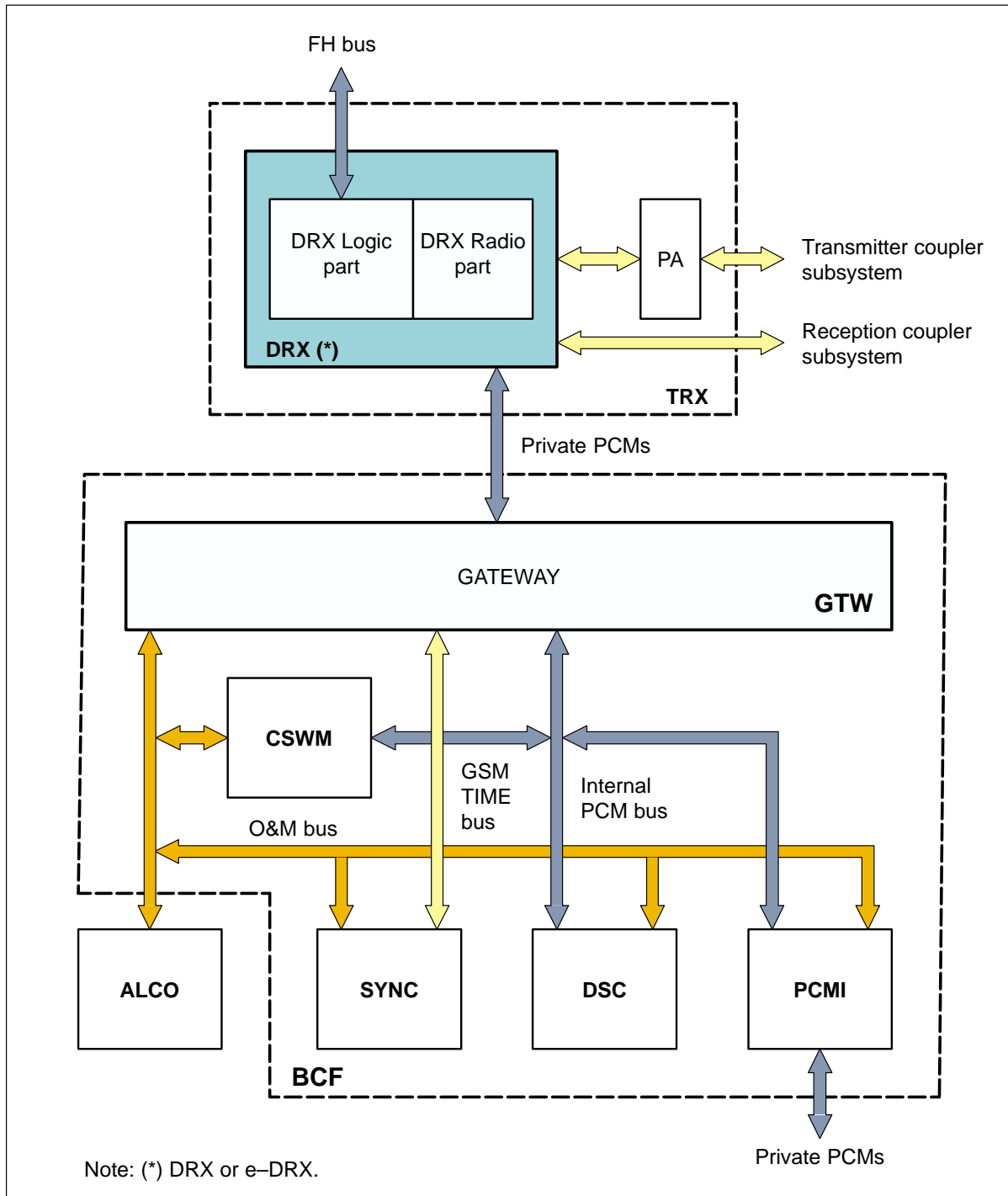
Figure 3–1   Subsystem architecture with BCF

FH bus

DRX Logic part | DRX Radio part

PA

Transmitter coupler subsystem

Reception coupler subsystem

DRX (**)

TRX

Private PCM

Private PCMs

CPCMI

CMCF

CBCF (*)

External PCMs

Private PCMs

RECAL

Note: (*) The two interconnection boards of the CBCF module (BCFICO and CBP) are not shown.
(**) DRX or e–DRX.
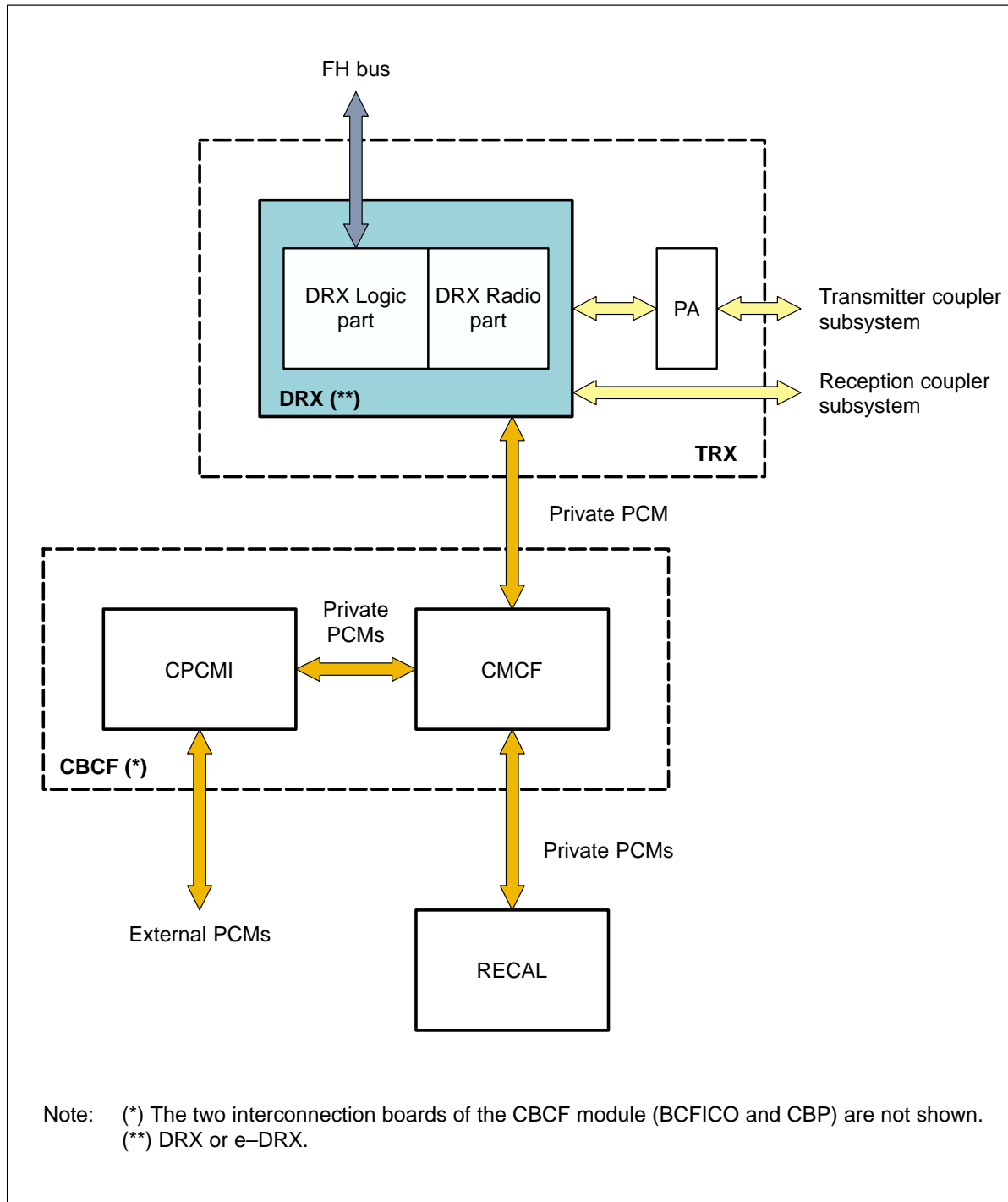
Figure 3–2   Subsystem architecture with CBCF

Each message is transmitted in synchronization with the 4Fbit clock and includes the following:

- the system time in six bytes (flag included)
- the address of the DRX (or e–DRX) that transmits the information in one byte
- the code of the send frequency on 10 bits
- the send power commands in one byte
- the NRZ message of the send data in 19 bytes

Up to 16 transmitters can be connected to this bus.

For multi–cell sites, all the cells can be connected onto a single FH bus or there may be one FH bus per cell, depending on the capacity of the site.

3.1.3.2   Private PCM

Up to six private PCMs transport data between the DRXs (or e–DRXs) and the BCF unit or CBCF Module. Each Private PCM supports up to four DRXs (or e–DRXs). Each Private PCM has a 64 kbit/s time slot (TS) distributed to all DRXs (or e–DRXs) and carries the GSM TIME signal (TS31).

Each private PCM allocates the following time slots (TS) for each DRX (or e–DRX):

- three TSs (64 kbit/s logical channels) of transparent data (traffic/signaling)
- one TS (64 kbit/s logical channel) processed by the gateway for the O&M channel, an adaptation of the O&M bus of the CSWM card

A group of six TSs, three of which are used, is allocated to each DRX (or e–DRX), as follows:

Traffic	Traffic	O&M TX OML/RSL			
1	2	3	4	5	6

TS 0 of the Private PCM is reserved for tests and supports no transmission channel.

A 4.096 MHz clock, slaved to the 4Fbit clock of the synchronization board, is used for bit synchronization of the Private PCM.

The O&M channel

The O&M channel, not availabale with the COAM version of the BTS, is carried by a TS of the private PCM and supports O&M data of the TXs. It is a duplex two–way channel. Each TX has its own O&M channel, present on the only private PCM that links the TX to the gateway.

The private PCM TS number of the O&M channel of a DRX (or e–DRX) is unvarying in a given gateway configuration. This TS number acts as the DRX (or e–DRX) address for the gateway/DRX (or e–DRX) link.

O&M data are sent only on the O&M channel of the DRX (or e–DRX) selected on the bus. Only the data received on this O&M channel are redirected to the O&M bus.

The GSM TIME channel

This one–way logical channel transports the GSM time signal to each DRX (or e–DRX). It is carried by bit 7 of TS 31 of the Private PCM. The transmission speed of the resulting transmission channel is 8 kbit/s.

A correction value is sent to each DRX (or e–DRX) over the OML link of the Private PCM. This value corresponds to the delays caused by propagation. Each DRX (or e–DRX) can therefore locally regenerate a synchronous GSM TIME bus with the BCF subsystem bus.

The refresh period must be a multiple of an occurrence between the GSM time base (577 µs) and the PCM time base (125 µs). The selected refresh period is 60 ms.

Such a 60–ms frame contains three parts:

Synchronization flag	Useful data	Filler bits

3.1.3.3   GSM TIME bus

Principle

The GSM Time bus is a V11 serial bus used in the BCF Unit to link the SYNC and GTW boards.

The data it conveys define the "local BTS time". The serial format includes a flag to detect any break in the link. Moreover it provides a "strobe" every 577 µs that accurately matches the start of each time slot.

Interface signals

The GSM TIME bus supports three types of signals. These three signals, which are generated by the synchronization unit, are transmitted in differential mode.

3.1.3.4   Internal PCM bus

Principle

The V11 bus is located between the switching matrix and the following units:

- PCM Interface units (PCMI)
- Data Signaling Concentration units (DSC)
- GaTeWays (GTW)

The 16 internal PCMs are synchronous links at 2 Mbit/s on which the data are organized in 125–μs frames divided into 32 time slots of eight bits each. A PCM is a time division multiplexed link that supports 32 channels with a throughput of 64 kbit/s.

Interface signals

The signals used are the following:

- MICR   :   Receive PCM in master–to–slave direction
- MICE   :   Transmit PCM in slave–to–master direction
- SY   :   8 kHz negative frame synchronization pulse
- H4M   :   4.096 MHz timing clock

3.1.3.5   O&M bus

Principle

The O&M bus is a V11 asynchronous master–slave type bus that is subject to physical addressing. It interconnects all units of the BCF subsystem and the TXs through the private PCM between the GTW and the DRXs. The CSWM acts as master.

The bus enables users to do the following:

- set up the initial configuration and reset it
- measure and control system status
- retrieve alarms
- force each bus subscriber to "RESET" status

Interface signals

The O&M bus is used in the BCF and originates from the CSWM card. Due to its low rate (9600 bit/s), this bus is not matched.

The O&M bus contains ten logical signals:

- from master to slave:

  – TX   : asynchronous data transmitted by the master

  – ADR[5..0]   : six address lines giving the selected slave address from 00 to 63

  – VAL   : validation pulse, during which the address must be valid (negative pulse)

  – RAZ   : initialization if this reset is pulsed during VAL pulse, inhibition if the VAL is pulsed during the RAZ (active at low level)

- from slave to master:

  – RX   : asynchronous data received by the master

Each slave receives from the back–panel six signals, NUC[5..0], that allows it to determine its address and to compare to the ADR[5..0] address.

3.2 BCF functional architecture

Depending on the BCF physical architecture, the following functions are enabled (see *Figure 3–3):*

- control and switching
- data channel concentrator
- dual trunk interface
- synchronization
- alarm regrouping

3.2.1 BCF control, switching and management (CSWM)

3.2.1.1 Functions

The CSWM unit is duplicated for safety reasons, giving CSWMA and CSWMB.

The CSWM unit is the master BCF unit. It enables communication with the BSC, organizes, stores and broadcasts all the data it receives from the BSC, supervises and uses defense action on the equipment it controls. It must do the following (see *Figure 3–4*):

- set up communication with the BSC
- manage BTS synchronization
- manage the switching matrix
- manage the FH bus
- manage slave units (DSC, PCMI, ALCO, SYNC, GTW, and the TX part of the TRX). Only the defense actions on slave processors is discussed below.
- enable duplex operations

3.2.1.2 Setting up communication with the BSC

When the CSWM is activated, it must connect to the BSC to work. A link is set up on an external PCM. Since a number of PCM links unite the BTS and BSC, individual PCM links are frequently polled. If connection attempts fail on all the available PCM, the CSWM resets.

3.2.1.3 Downloading

When the call has been set up with the BSC, the CSWM reports its status. The BSC downloads the BTS if CSW code has not already been downloaded. The set of the BCF downloadable files is formed by two catalogue files (BOOT & LOAD and DLU), containing the list of the files, a configuration file and a file containing CSW code.
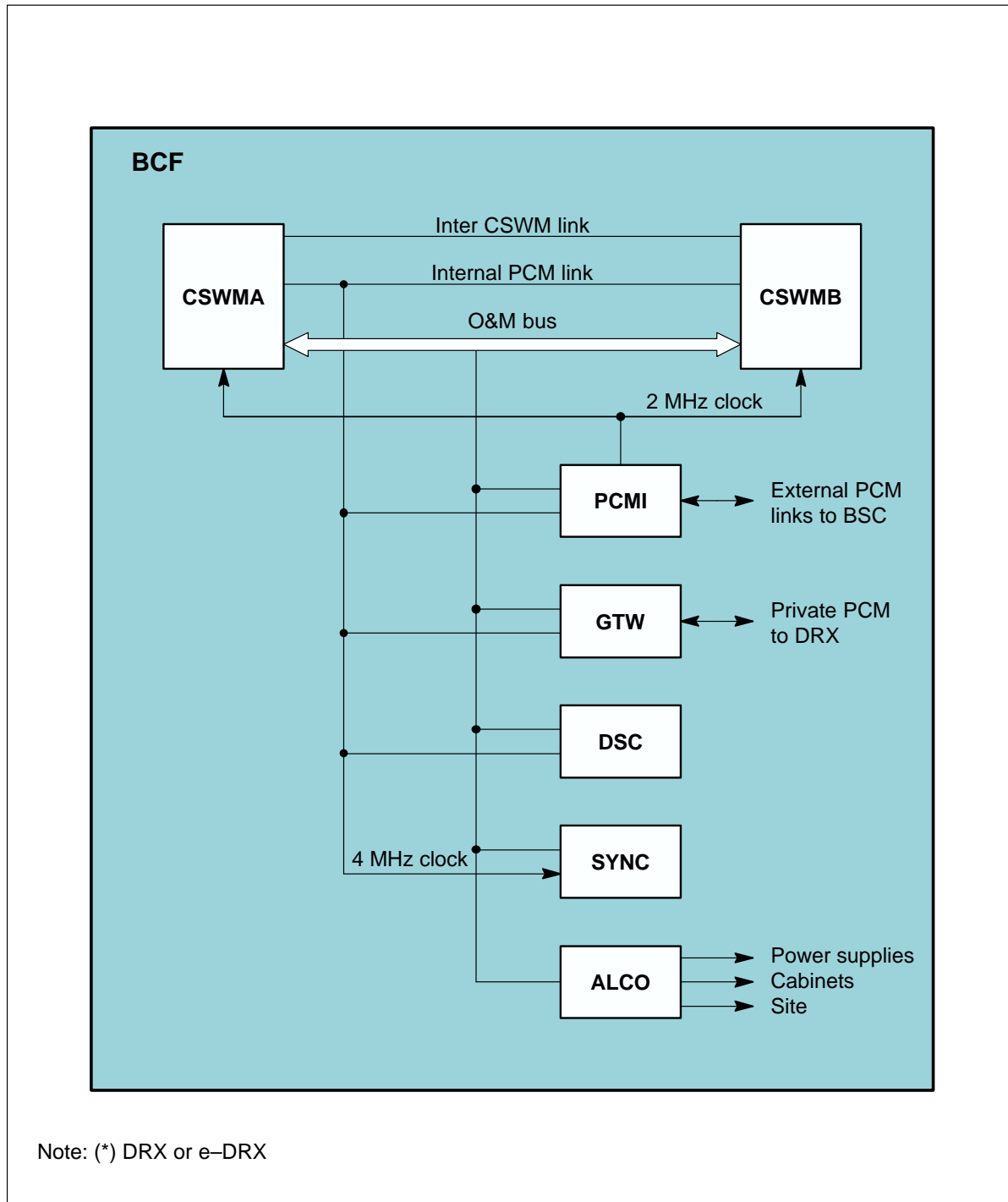
Figure 3–3   BCF architecture
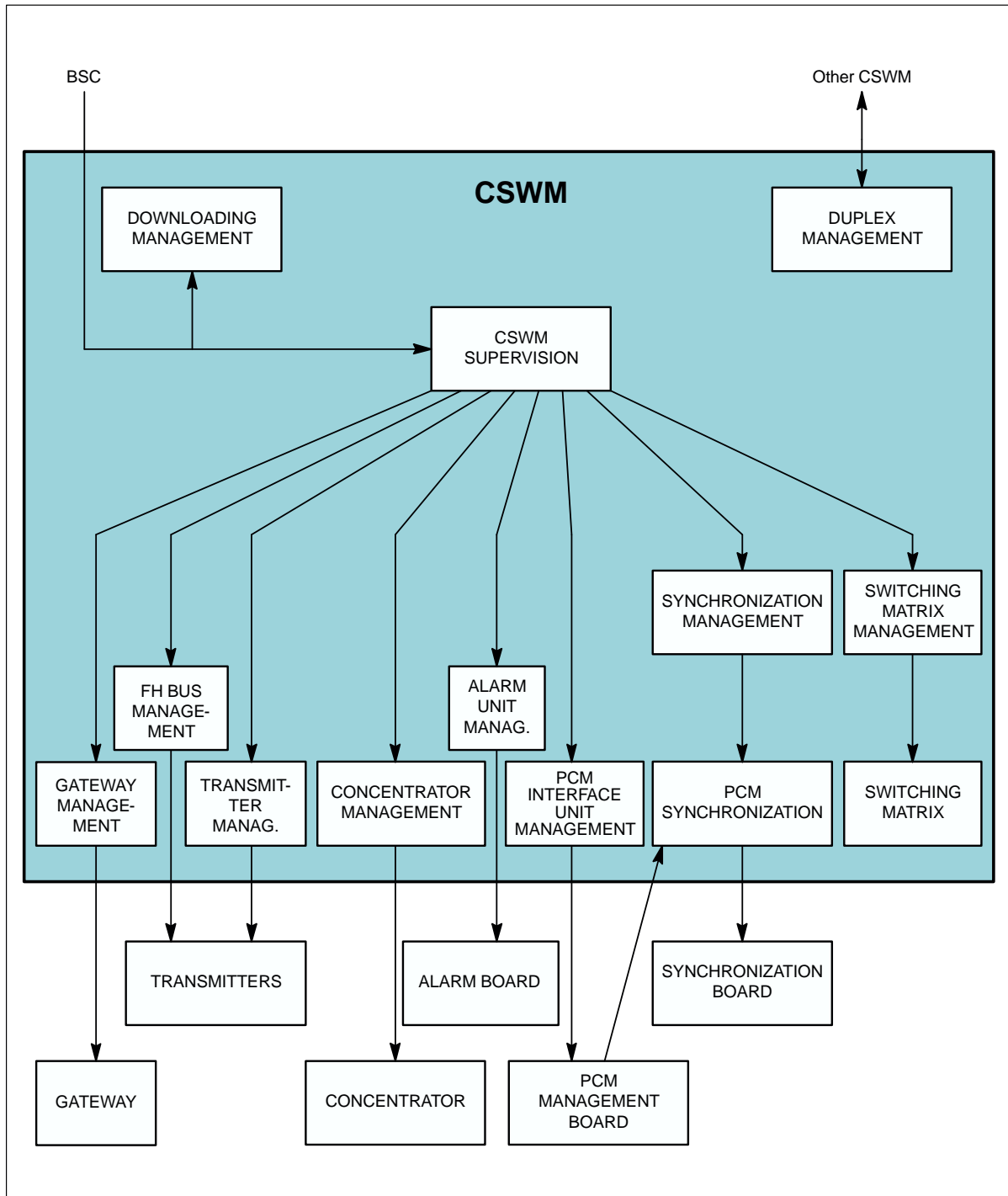
Figure 3–4   Organization of CSWM functions

3.2.1.4   Synchronization management

At start–up, the CSWM chooses the first correct clock from among six. During LAPD connection, the BTS forces the clock on the PCM carrying the LAPD.

3.2.1.5   Switching matrix management

The switching matrix management includes the following:

- initialization
- configuration
- monitoring/defense

The switching matrix has 16 PCM links. Each PCM link has the following:

- transmission test interface
- reception test interface
- idle interface

All 2n PCM time slots are connected to 2n+ 1 PCM time slots to allow PCM links to be routed when the BTS are chained together (drop and insert technique).

Initialization

The 0 time slot on each PCM link is looped back on itself by the transmission test interface, which is a hardware device that connects the PCM 0 time slot transmission and reception on the reception interface.

The frames received and transmitted in each TS 0 over each PCM link are frequently compared to allow the switching matrix to be tested at start–up time and its performance to be monitored.

Configuration

The switching matrix is configured when the BSC requests the BCF to set up or release a signaling or traffic channel.

Signaling channels are set up (or broken off) between an DRX signaling time slot and a non–concentrated link on a signaling concentrator unit. This may entail (dis)connection between a concentrated link on a signaling concentrator unit and a PCM link time slot on a PCM interface.

Traffic channels are set up (or broken off) between a DRX traffic time slot and a PCM link time slot on a PCM interface.

Monitoring/defense

The switching matrix is monitored by endless loops that are activated during the initialization phase.

If a fault occurs, the switching matrix is designated as faulty and switch over is triggered.

The cause can be pinpointed from among the following:

- switching matrix
- internal PCM bus
- idle interface
- transmission test interface
- reception test interface

3.2.1.6   FH bus management

The FH bus is connected to various DRX (or e–DRX) units.

Configuration

FH bus management becomes involved when the BSC sends cell configuration or radio transmission configuration messages.

The CSWM uses the cell configuration message to construct the internal tables needed for FH bus management.

The radio transmission configuration message is used to send monitoring masks to transmitters used to check for frequency collisions and the flags on FH input

Monitoring/defense

FH bus management receives the frequency collision and no FH bus flag messages sent by transmitters on the O&M bus.

Frequency collision messages cause an event report to be sent to the BSC (messages are correlated to avoid repetition).

No FH bus flag messages result in the following:

- a DRX (or e–DRX) fault when all the DRXs (or e–DRXs) detect the same event
- a DRX (or e–DRX) fault when one event is detected

3.2.1.7   Transmitter–oriented CSWM defense actions

The CSWM undertakes defense action when it receives alarm messages or when the scanner no longer detects transmitter activity.

If the faulty transmitter was configured (BCCH), the BTS sends an event report with impact to the BSC; otherwise, the event report is without impact.

3.2.1.8   DSC–oriented defense actions

The CSWM undertakes defense action when the DSC sends an event report on the O&M bus or when the scanner no longer detects DSC activity.

The following faults can occur:

- hardware fault

  The DSC is faulty if any of its connections fail. Then the DSC is reset, and external tests are run.

- unexpected frames or queue overflow

  The CSWM sends an event report to the BSC which takes the appropriate action.

- loss on the O&M bus

  The CSWM triggers defense action, the DSC is reset, and external tests are run.

A DSC is initialized by a reset command on the O&M bus. Start–up tests are run. If the external test results are fault–free the DSC can be returned to the list of useable units. If not, the unit must be replaced.

CSWM defense actions are determined in terms of equipment redundancy:

- If there is no redundant DSC:

  - if the DSC that is down supported O&M communication with the BSC. The CSWM must isolate the faulty DSC by breaking off connections on the switching matrix. The switching matrix restores communication with the BSC on the same PCM as before. When communication is restored, the CSWM informs the BSC that all communication previously established via that DSC is lost and cannot be recovered. The BSC then takes the appropriate action ;

  - if the lost DSC did not support O&M communication with the BSC, the CSWM must inform the BSC that all communications passing through this DSC were lost and cannot be recovered. The next actions are determined by the BSC.

- If a redundant DSC is available, the CSWM breaks off faulty DSC connections on the switching matrix and reconnects the redundant DSC to match the faulty one. All the communication previously established via that DSC is restored and an event report is sent to the BSC.

3.2.1.9   PCMI–oriented defense actions

In the event of a PCMI hardware fault, the CSWM activates self–tests by sending the appropriate commands via the O&M bus. If the results of the self tests are fault–free, the PCMI returns to operational status and the BSC is informed.

If the quality of transmission is the cause, the PCMI feeds back the information to the BSC, whether it has been able to restore communication or not.

3.2.1.10   ALCO board–oriented defense actions

If there is an ALCO card hardware failure, the CSWM restarts self–tests by means of the commands available on the O&M bus. If the self–tests are successful, the ALCO card is considered operational again and the BSC is informed.

3.2.1.11   Gateway switchover management

If there is a gateway failure, the gateways themselves determine state change (passive ⇔ active). Then the fault signal is transferred to the CSWM via the O&M bus.

Each gateway can send its status to the CSWM, either after a query from the CSWM or spontaneously after switchover.

3.2.1.12   Duplex operation between CSWMs

The duplex function manages CSWM equipment redundancy in the BCF. The BSC only perceives one CSWM at a time.

Redundancy is operated in passive/dynamic mode with hot restart:

- The standby processor does not execute the same algorithms as the active processor and does not receive the same message flow.
- The active CSWM sends stable status information to the standby side. If a problem arises on the active side, the standby CSWM takes over BCF control.
- Switchover time includes the time needed to locate the fault, return to a stable status, and restart processing.

Causes of switchover

Switchover may be triggered by hardware or software resetting. The watchdog triggers hardware resetting, and software is reset by a software init message.

Hardware resetting may be triggered by the following:

- a major hardware fault (CPU, memory units, etc.)
- a serious software fault (address error)

Software resetting may be triggered by the following:

- a minor hardware fault (switching matrix, internal PCM bus, O&M bus drivers)
- a system software fault (dynamic memory overfilling)

Switchover procedure

The switchover procedure can only be performed in a stable system status. In the event of switchover, the CSWM tries to return to the last stable condition. It checks that its database (last stable state) and slave processor states (alarm units, synchronization units, concentrator units, PCM interface units and transmitter units) are consistent and may reconfigure them.

Standby CSWM updating

The standby side is brought up to date in the following steps:

- asynchronous software downloading
- asynchronous data updating
- synchronous data updating

The active CSWM side downloads standby CSWM software asynchronously without disturbing operations on the active side.

Asynchronous data updating is performed in the following phases:

- The active CSWM instructs the standby CSWM to reinitialize its database.
- The active CSWM copies the database and sends it to standby side.
- The active CSWM stores status transitions that occur during updating and sends at the end of the sequence. It then starts synchronous updating.

Synchronous updating is performed each time the BSC sends configuration data or when the CSWM performs defense actions.

The active CSWM sends one or more update messages to the standby side before sending an acknowledgement or event report to the BSC.

3.2.2   Data Signaling Concentration unit (DSC)

The DSC is controlled by the CSWM. It communicates with the CSWM via the O&M bus. It serves channel multiplexing, demultiplexing, and Operations and Maintenance (O&M) functions.

3.2.2.1   Multiplexing and demultiplexing

The CSWM uses the DSC to set up communication between the BSC and the other entities that make up the BTS. The LAPD protocol ignores the DSC that serves concentrator and routing functions.

The DSC reads level 2 addresses (TEI) contained in LAPD frames and, using a routing table, sends the information onto another time slot. The time slot may be concentrated (a number of TEI arrive) or not (single TEI).

3.2.2.2   Operations and Maintenance (O&M) functions

Configuration

The CSWM sends the following to the DSC:

- overall configuration
- connect and disconnect configurations

Overall configuration data includes the following:

- the size of message queues
- two queue overflow thresholds
- the period defining the moment observation messages are sent

A connection configuration connects a TEI in a single time slot to a second concentrated time slot.

Disconnecting may affect a TEI in a single time slot or in a concentrated time slot.

Disconnecting a concentrated time slot automatically triggers disconnection of the concentrated TEI it contained.

Observations

The DSC returns its status to the CSWM as requested. The status report contains overload alarms and hardware failures.

The DSC sends regular observation messages to the CSWM that contain the following for the last traffic period and per time slot and TEI:

- queue size
- the maximum size reached by the queue
- number of messages handled since the last status request

Tests

The DSC constantly tests unused time slots. It performs external loop tests on CSWM request.

The results of unused time slot tests are returned to the CSWM in regular status messages.

The CSWM may request the DSC to perform external tests. The DSC checks that links are free and accepts (or refuses) start–up. The DSC returns the results of these tests as requested.

Monitoring

The DSC supervises its own equipment parts and issues one the following fault messages:

- queue overload
- receipt of unexpected frames
- PCM link hardware malfunction

Fault detection

The DSC receives two threshold values from the CSWM that give the overload situation in message transmission queues. When queue thresholds are reached, the DSC issues start and end–of–alarm messages to the CSWM on the O&M bus.

3.2.3   PCM Interface (PCMI)

The PCMI interfaces and synchronizes incoming and outgoing PCM links. It converts the external PCM coming from the BSC into internal PCM used by the BSC, and vice versa.

Each PCMI handles one external PCM link. A PCMI unit does the following:

- converts external PCM links into internal PCM for BTS use
- verifies link quality using error detection codes
- matches impedance on the type of PCM link used by the operator

3.2.3.1   Configuration

The PCMI can operate without CSWM involvement. However, the CSWM sends a configuration message on the O&M bus that contains the following:

- the number of erroneous seconds, which defines a window used to evaluate PCM alarms
- threshold M1 for frame alignment error counters
- threshold M2 for the CRC error counter
- threshold M3 for coding type error counters

3.2.3.2   Monitoring

The PCMI monitors its own equipment and PCM links, and issues fault messages concerning hardware alarms or PCM alarms.

3.2.3.3   PCM alarm management

Managing PCM alarm involves frame, multiframe, submultiframe, zero time slot, and frame alignment; CRC is not managed yet.

A frame interval is 125 μs.

The duration of a multiframe is 2 ms, representing the time of 16 frames.

The length of a submultiframe is 1 ms.

The TS0 is set aside for the frame alignment signal, multiframe alignment bits, CRC bits, and alarm sending.

Frame alignment

Frame alignment is operated by the frame alignment byte occupying the TS0 in every other frame.

Upon loss of frame alignment the alarm bit is set to 1 and the frame alignment counter is increased.

The PCM alarms

Each PCM alarm corresponds to the detection of one anomaly type on the PCM reception.

A seriously erroneous second is a second in which an NOS, SIA, RRA, or LOS alarm condition occurred or an FE or CRC counter was overrun.

These alarms are indicated by LEDs on the front of the DTI board.

- LOS: frame lock loss signal (LFA LED)

  Frame lock is considered lost when three consecutive lock signals are received with errors. This is also the case when bit 2 of TS 0 in frames that contain no locking signal is received three times in a row with errors.

- AIS: Alarm indication signal (AIS LED). Not used in the GSM 1900 frequency band.

- RRA or RAI: Remote Receive Alarm signal or Remote Alarm Indicator (RRA LED).

- NOS: no frame signal (NOS LED)

  Upon detecting the beginning of an NOS fault signal, a 64–kbit/s SIA is generated on each TS of the associated internal PCM link, an RRA is sent on the external PCM link, and the application associates an NOS error to the errored second, bringing on the NOS LED.

- FE: Frame error (FE LED).

  Used in case of 2 Mbit/s external PCM link. Error detection is effected only in operation without CRC. The application counts the incorrect frame lock words received, and compares them with the upper and lower thresholds (programmable).

- SKP: hop indication reception. Not used.

- CRC: CRC error signal (CRC LED). Not used in the GSM 1900 frequency band.

  The quest for CRC multiframe lock is associated with that for frame lock, to ensure that the frame lock word found does indeed correspond to a single lock word to which one can lock permanently.

The alarm LEDs on the front of the board are the LFA, AIS, RRA, NOS, FE, SKP, and CRC. Each alarm event turns on the associated LED for a minimum time of 200 ms.

One cause is associated with each seriously erroneous second. The alarm cause is defined in the following descending order of severity: NOS, AIS, LOS, RRA, FE, CRC, and SKP.

When the number of seriously erroneous consecutive seconds reaches the number of erroneous seconds (NBSEC) defined in the configuration message, the PCM is designated in fault condition and a message is sent to the CSW.

The end–of–fault condition is the number NBSEC of consecutive seconds without errors and the end–of–fault message is sent to the CSW.

3.2.4   Synchronization (SYNC)

The synchronization unit must synchronize the DRXs on a single reference time, GSM time. It supervises the different defense stages. There are two identical synchronization units, that have the same software (see *Figure 3–5*).

3.2.4.1   GSM time

The network supplies the reference time via three PCMI units. The CSWM selects one of the six clocks and sends it to the synchronization unit. The clock selected must have good long–term accuracy because it is used by the synchronization module to generate reference time for the radio interface with an accuracy of 5×10^{-8}.

If the external reference signal is absent, the CSWM selects a local clock derived from the SYNC module active in "free running" mode.

3.2.4.2   Monitoring

The synchronization unit is monitored by its own control and monitoring mechanisms, which check that the unit is operating correctly and GSM time is available on the GSM TIME bus.

Alarms are as follows:

- SYNO unit outage
- CSWM clock failure
- reference clock failure
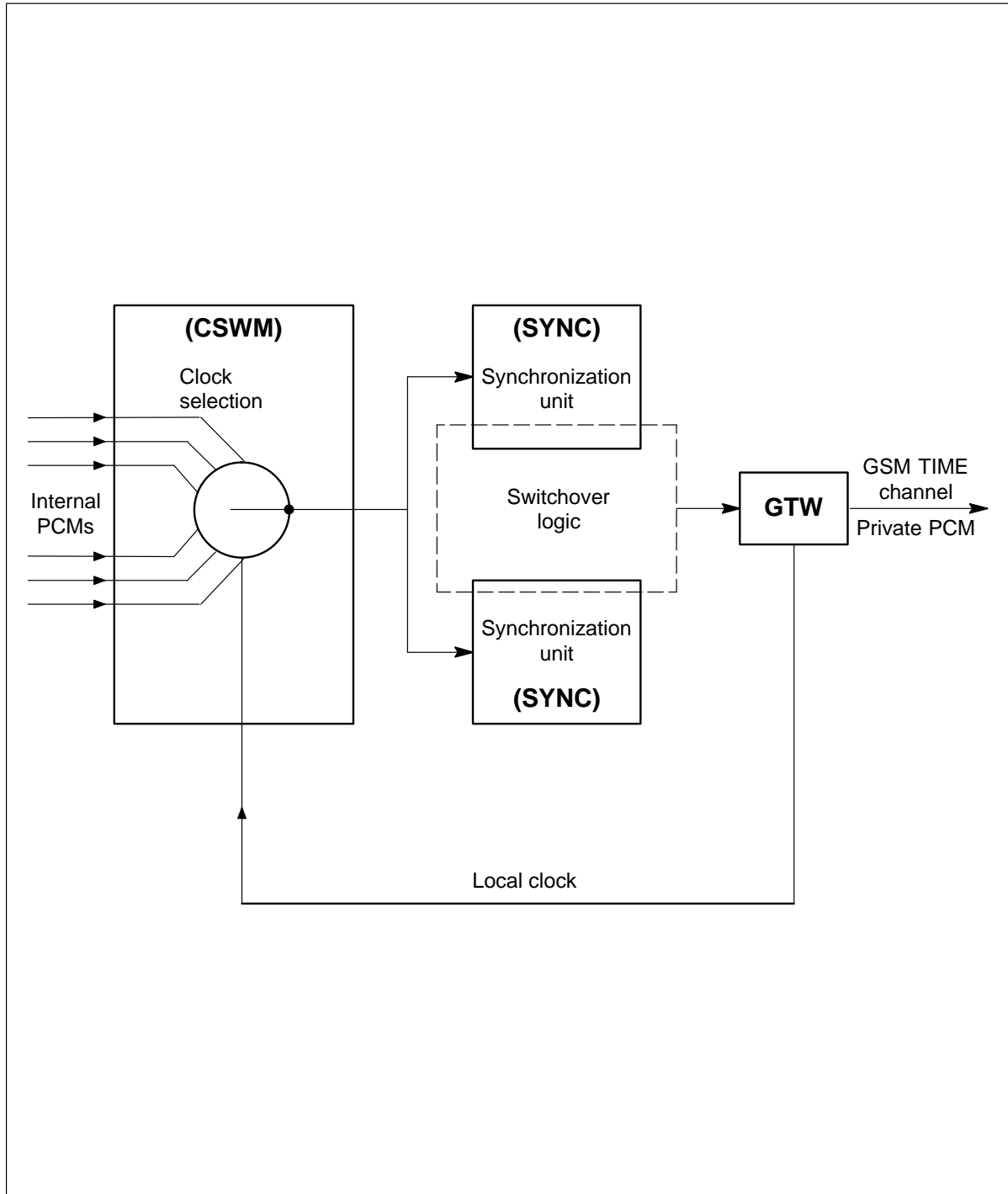
Figure 3–5 GSM time bus synchronization

The last two events are fed back to the CSWM. Defense actions are covered in section dedicated to the CSWM.

In case of a synchronization unit fault, the synchronization units make the switchover decision (active <=> standby). The fault is then fed back to the CSWM over the O&M bus.

3.2.5   Alarm collecting function (ALCO)

3.2.5.1   Functions

The alarm collecting board (ALCO), located outside the BCF, collects internal and external BTS alarms.

Internal alarms concern equipment parts on which the BCF does not use any particular detection action, while external alarms are site–dependent.

These alarms are sent via the O&M bus to the BCF control unit, which redirects them to the BSC.

The board also allows equipment located outside the BTS to be activated (future use).

3.2.6   BCF/DRX gateway (GTW)

The gateway (GTW) carries out the following functions (see *Figure 3–6*):

- adaptation of the frequency between the radio interface and the Abis interface
- adaptation of the GSM TIME bus to the GSM TIME channel
- adaptation of the O&M bus to the O&M channel for the TXs
- management of the O&M protocol for the gateway as an O&M slave
- management of part of the defense system
- management of part of the switchover logic
- initialization of the gateway board

3.2.6.1   Adaptation of the GSM TIME bus to the GSM TIME channel

This function consists in entering the GSM time on the GSM TIME bus, then making calculations and carrying out formating to send the GSM time to the DRXs by means of the GSM TIME channel.

3.2.6.2   Adaptation of the O&M bus to the O&M channel

This function consists in decoding the validation on the O&M bus of a dialogue between the CSWM and the TX, and formating the characters sent and received on the bus and the O&M channel.
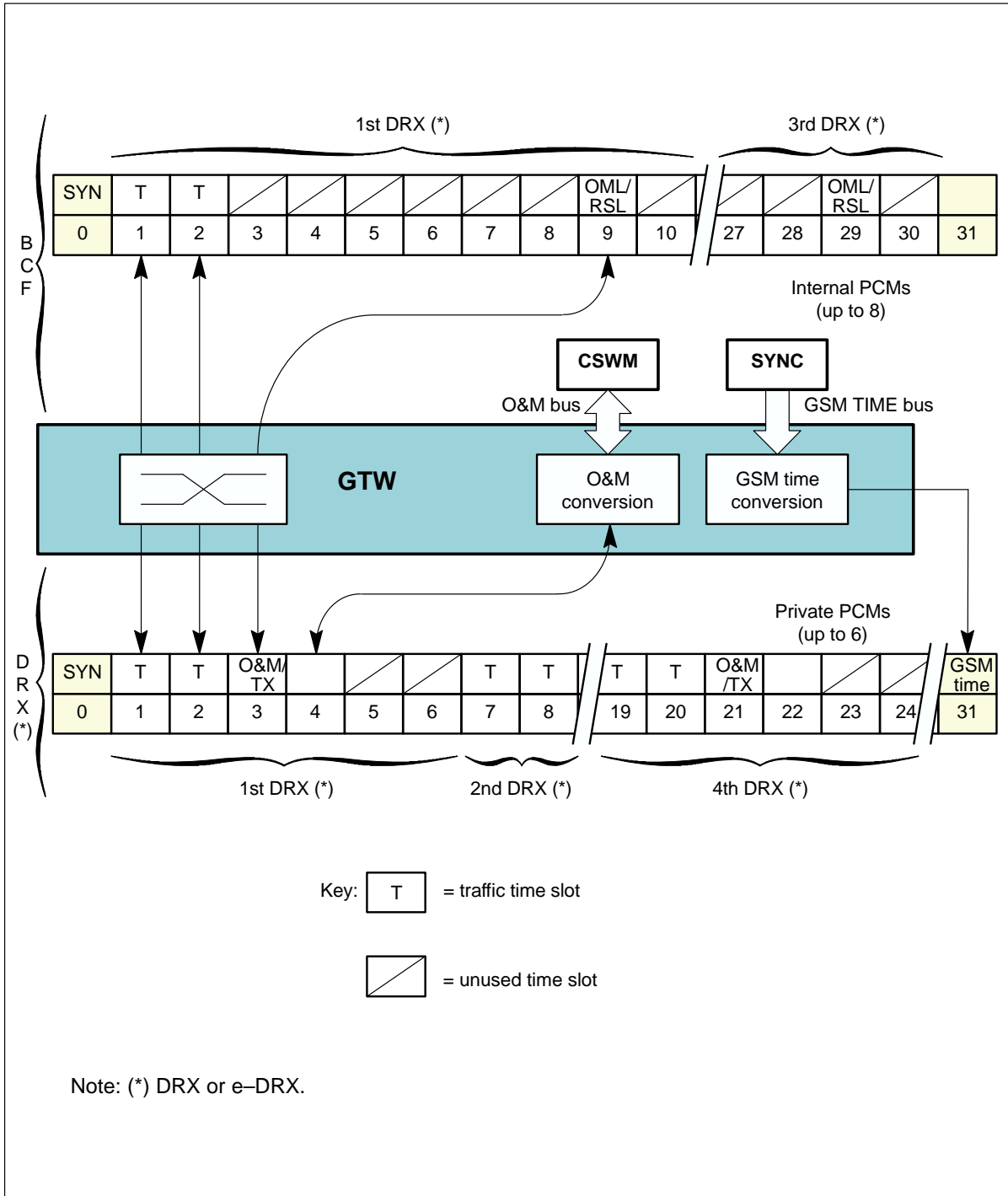
Figure 3–6   BCF/DRX Gateway (GTW)

3.2.6.3   Management of the O&M protocol

This function provides the level 2 and 3 layers of the O&M protocol concerning CSWM/gateway dialogue. The gateway is fully an O&M slave. It manages a level–3 message dictionary.

3.2.6.4   Management of the defense

The software part of the gateway defense system essentially concerns detection of minor and major faults which lead, respectively, to a "light" software reset of certain functions or passage to HALT state. A software watchdog system is also active.

3.2.6.5   Switchover management

The software's role in switchover management is to send command codes to a hardware logic circuit which controls gateway activation and de–activation.

3.2.6.6   Initialization

Initialization consists of configuring all peripherals present on the gateway board, the communication controllers, the position of the GSM TIME channel, the cross–connect matrix, and the transfer of certain initialization data from the PROM to the RAM.

3.2.6.7   Multitasking organization

Most of the functions are not related to one another and therefore operate completely asynchronously. In order for these functions to take place simultaneously for the external environment, an internal function, transparent to the outside, is needed to manage multitasking, hierarchized organization.

3.2.7   BCF configurations

The BCF exists in simplex or duplex configuration.

The following table gives the number of boards in every configuration.

Boards	Simplex BCF	Duplex BCF
CSWM	1	2 (1 active/1 passive)
PCMI	1	1 to 3
DSC	1	1 to 4
SYNC	1	2 (1 active/1 passive)
GTW	1	2 (1 active/1 passive)

Table 3–2   BCF configurations

3.3   CBCF functional architecture

The CBCF performs the following functions:

- switching, synchronization, and concentration
- control of the alarm management unit
- PCM Interface

The CMCF board performs the concentration, synchronization, and switching functions. The CMCF also controls the alarm management unit (the RECAL board), which is located outside the CBCF Module.

The CMCF board allows operation in duplex mode and in simplex mode.

The CPCMI board is the interface between the external PCM links (A–bis) and the Private PCMs in the CBCF.

CBCF modes

The CBCF can be used in simplex mode with only one CMCF board in slot 0 or 1 running in active mode. Simplex/Duplex mode is managed by a micro switch on the CMCF board. From duplex to simplex, the transaction in never automatic, it always follows a configuration. From simplex to duplex mode, there is no automatic transition when the active board detects the connection with the passive one.

3.3.1   Switching, synchronization, and concentration

The CMCF board is duplicated in the CBCF Module to provide redundancy (see *Figure 3–7*).

One CMCF central processor manages the switching matrix and the synchronization. The main processor and slave processor share the concentration and routing tasks as described below.

3.3.1.1   Switching

The two switching matrices in the CMCF receive and distribute the traffic of external PCMs as follows:

- up to six PCMs communicate with the CPCMI boards
- up to six PCMs communicate with the DRXs
- two PCMs communicate with the processing units
- one PCM to communicate GSM time
- one PCM for tests
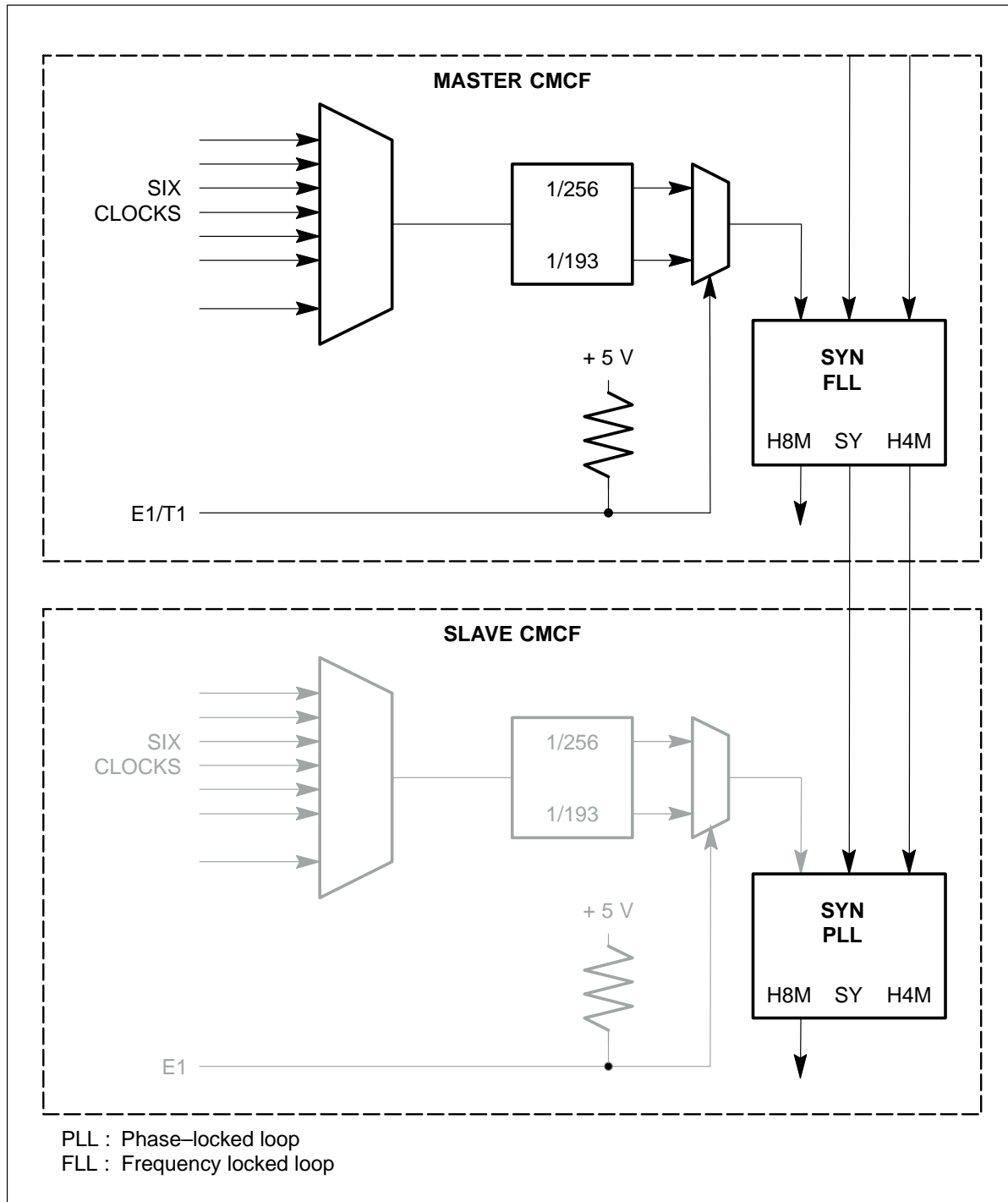
Figure 3–7   CMCF board synchronization (full configuration)

3.3.1.2   Synchronization

The CMCF provides synchronization to the radio part of the BTS.

Synchronization is obtained through a temperature–controlled oscillator that allows the selection of timing signal from seven signals (six from the external PCMs, one from an external source, and one from the CMCF master).

The selected clock signal is routed to a digital phase comparator that authorizes synchronization operations in a frequency locked loop (CMCF master) or in a phase locked loop (CMCF slave).

The CMCF slave operates in a phase locked loop so that its H4M clock is synchronized with that of the CMCF master. This ensures that phase hopping does not occur during a CMCF switchover.

GSM Time

The processing unit transmits the GSM Time every 60 ms. The GSM Time is transmitted to the switching matrices of the CMCF master. The CMCF slave reads the GSM Time in the CMCF master, which allows the synchronization of GSM Time on both CMCFs.

Figure 3–7 shows the synchronization process on the CMCF board.

Switchover

A switchover occurs in synchronization with the H4M clock. Since the master CMCF and the slave CMCF are synchronized (H4M and GSM Time), the switchover does not cause a timing disruption.

 The switchover sequence is as follows:

- active CMCF becomes inactive
- inactive CMCF detects the inactivity
- inactive CMCF becomes active

A CMCF processor becomes inactive in the following circumstances:

- H16M clock state is NOK and there is dual chain operation
- the master request is disabled
- master board is not properly connected to the back panel
- the active processor is reset while in dual chain operation

Defence and redundancy management

A switchover from one CMCF board to the other in the event of an error on the active CMCF board ensures redundancy. The hardware supports duplex and simplex modes.

A redundancy channel between both CMCF boards ensures the exchange of data between the boards in the event of a switchover.

The defense connectivity is shown in *Figure 3–8.*
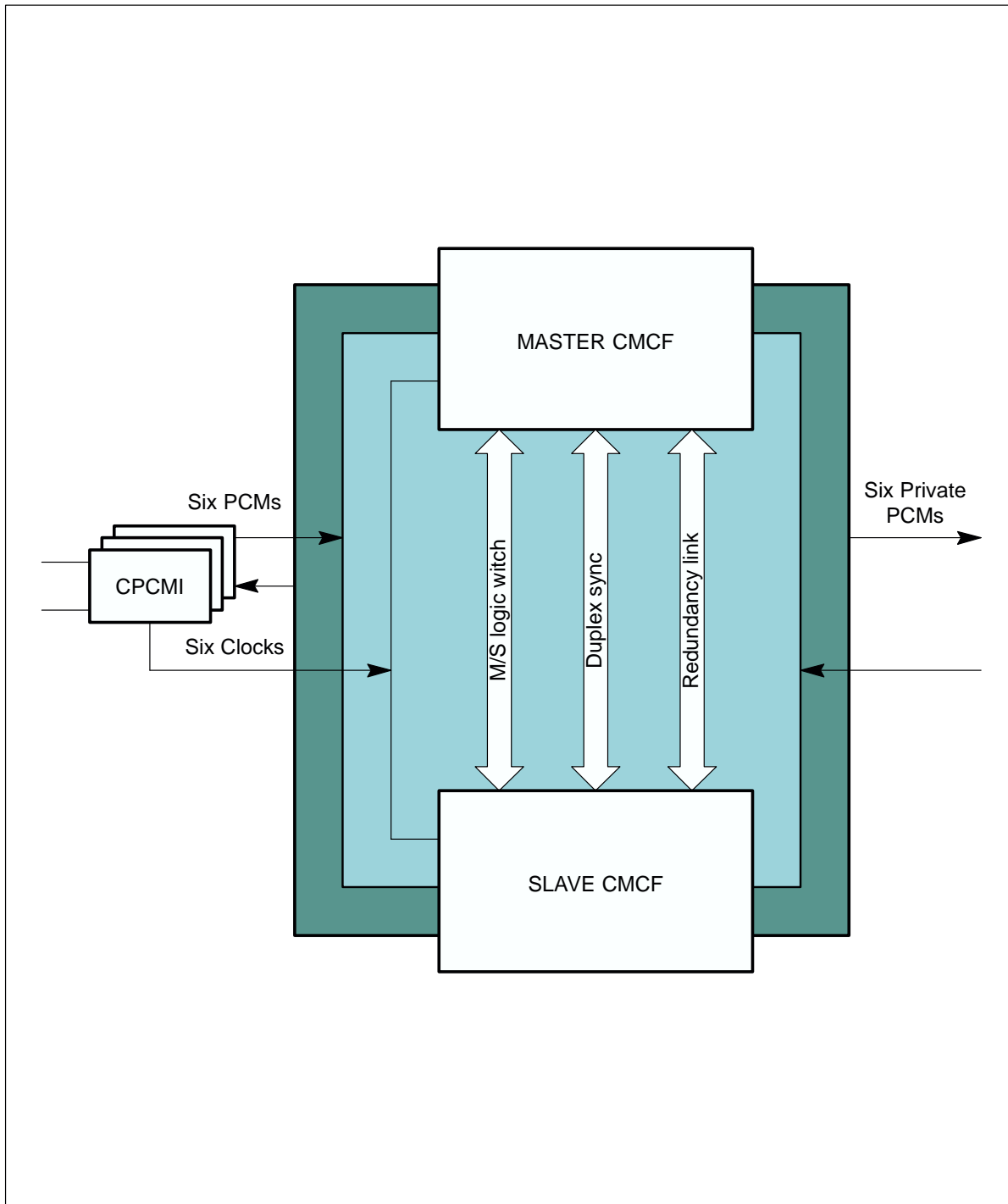
Figure 3–8   Defense connectivity between the CMCF boards (full confguration)

3.3.1.3   Concentration and routing

The concentration and routing functionality is performed by the master and slave processing units. The master processing unit manages the board ressources. The slave processing unit, which operates synchronously with the master unit, manages one PCM, one HDLC link (for master–slave communication), and one RS232 link.

The master processing unit receives a external clock signal at 4.096 MHz and generates a 33 MHz reference frequency. This frequency is supplied to the slave unit so that it can be synchronous with the master unit.

3.3.2   Control of the alarm management unit

The CMCF manages the alarm management unit, the RECAL board, located outside the CBCF Module.

The RECAL board collects internal and external alarms and routes them to the CMCF, which routes to the BSC.

The communication between the CMCF and the RECAL is done using a LAPD protocol link that uses a channel supported by time slot 25 of PCM0.

3.3.3   PCM Interface

Up to three CPCMI boards provide the interface between six external PCM links (A–bis) and six Private PCMs used inside the CBCF Module.

The interface tasks corresponds to an electrical level translation and a frame format conversion depending on the type of external PCM link (PCM E1, PCM T1, or HDSL).

The external PCM interface has functional blocs that perform the following functions:

- conversion of analog signals on the A–bis interface and the logical signals of the Framer part of the PCMI

- management of the synchronization clock

- transposition between the A–bis and the Private PCMs signals

3.3.3.1   Signalling interfaces

The CPCMI board uses the PCM and HDSL interfaces described below.

PCM A–bis interface

The E1 interface is compatible with the G703 Recommendation. Its impedance is 120 (two pairs of bidirectional symmetrical links) or 75 Ohms (coaxial cables).

The T1 interface is compatible with ANSI T1.403 and T1.102. Its impedance is 100 Ohms (two pairs of bidirectional symmetrical links).

HDSL A–bis interface

The HDSL–E1 format (2B1Q) is on one single twisted copper pair where the transmission rate is 2320 kbps for a full E1 frame. This rate is compatible with the ETSI ETR 152 RTR/TM–06002 standard.

The HDSL–T1 format (2B1Q) is on one single twisted copper pair where the transmission rate is 1552 kbps for a full T1 frame. This rate is not standardized and is considered a proprietary link.

Private PCMs

One CPCMI board is connected to two Private PCM links (PCM0 and PCM1). The O&M communication is done through an HDLC link using TS0 of PCM0.

E1/T1

Three bits supplied to the CMCF indicate whether the board is an E1 or T1.

3.4   DRX functional architecture

The DRX board has a digital part, a radio part and a power supply board (*Figure 3–9*)

3.4.1   DRX digital part

The DRX digital part consists of four units:

- the Advanced MaNagement Unit (AMNU) which manages the DRX
- the Digital Control Unit for eight chanels (DCU8) which is the signal processing unit
- the Time Base Unit (BDT) which manages the GSM_TIME for the DRX
- TX logic which is the interface with the transmission part in the DRX Radio board

3.4.1.1   AMNU unit

The AMNU unit manages the DRX. It manages the eight time slots of an TDMA frame, and the radio signaling functions.

These functions can be broken down into communication functions (RSL), on the one hand, and operating and maintenance functions (O&M), on the other (see *Figure 3–10*).

Communication functions

Communication functions include:

- routing functions
- concentration functions

Routing functions

The TDMA frame management unit routes messages from the BSC. The messages arrive on the RSL and can be broken down into two categories:

- messages concerning processing of a single time slot
- messages concerning all the time slots in the TDMA frame

Concentration functions

There are two types of messages:

- transparent messages
- non–transparent messages
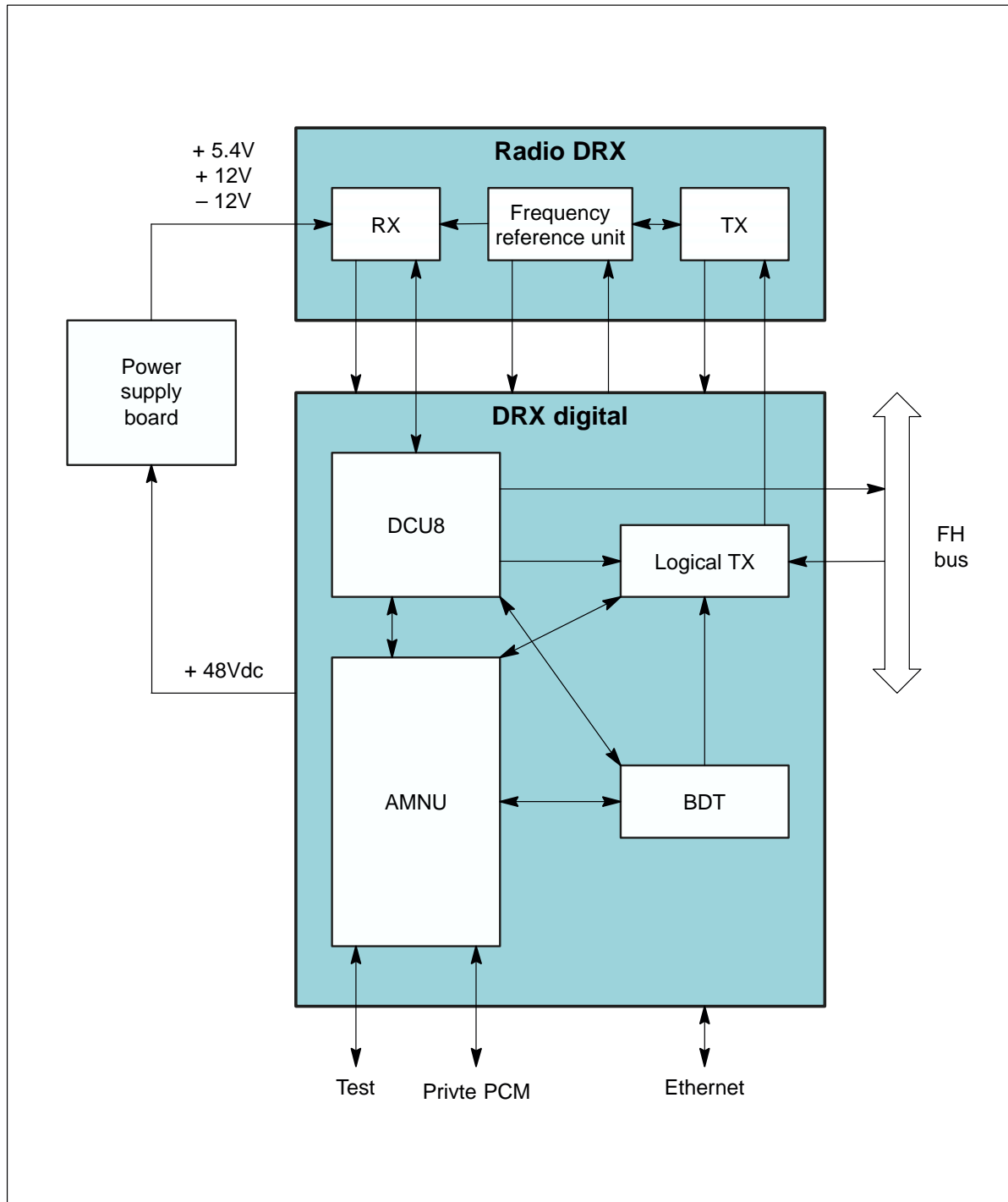
Figure 3–9   DRX board: functional block diagram
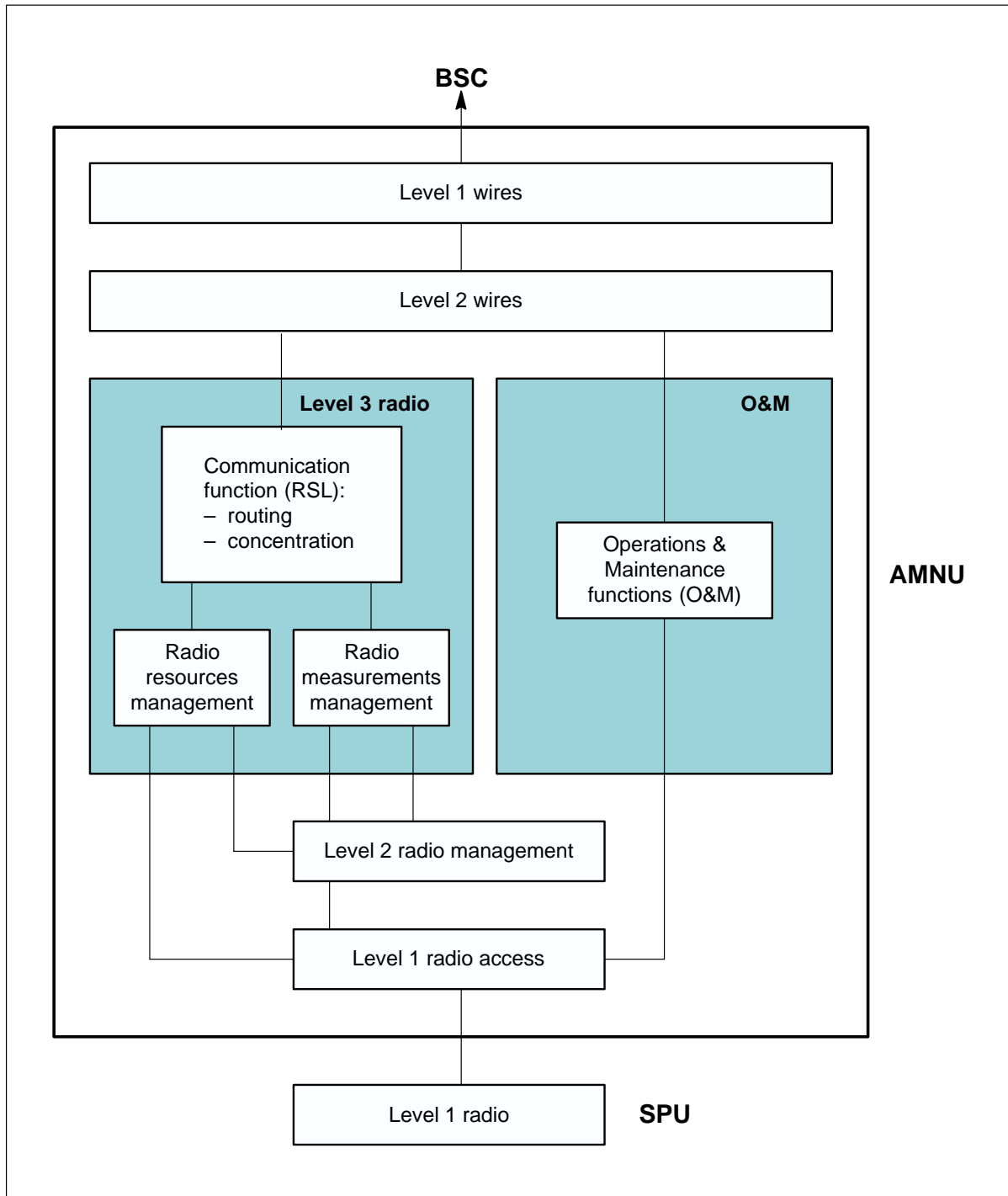
Figure 3–10   AMNU functions

Transparent messages are simply concentrated on a time slot of the internal PCM.

Non–transparent messages are:

- radio measurement messages of the mobile
- interference measurement messages on the inactive channels
- load messages on the RACH channel
- load messages on the PCH channel

Non–transparent messages are transcoded, averaged and grouped in a single message to the BSC. This message is sent to the same time slot as the transparent messages.

Operation & Maintenance functions

The following Operation & Maintenance functions are processed by the Frame management unit (AMNU):

- start–up, downloading, initialization
- configuration
- monitoring/defense

Start–up/Downloading/Initialization

The AMNU is started by a hardware reset or a reinitialization message sent by the BSC. It causes configuration of the LAPD and establishment of the OML link with the BSC.

The DRX subsystem can be downloaded only after that the BCF is downloaded and that the units of site management of cell management and of Abis signaling of the DRXs have been configured.

The BSC systematically initiates a downloading phase of the catalogue files and of the following software units:

- AMNU
- SPU
- DLU
- BOOT
- TX
- BDT
- BIST of the SPUs

Follows a re–flashing of the units for which the software versions are different.

Configuration

The DRX is configured by the BSC by means of an OML link on the Abis interface.

Configuration can be broken down into:

- a general configuration:
  - configuration of the TDMA frame
- time slot configurations:
  - configuration of radio time slots
  - configuration of the frequency hop

Configuration of the TDMA frame provides the DRX with parameters shared by the whole cell, such as:

- cell identity (BSIC)
- BCCH frequency
- indication of frequency hopping implementation
- cell type (normal or extended)

and with parameters specific to the DRX:

- the frequency of the TDMA frame if there is no frequency hopping
- indication of implentation of diversity in reception

The TDMA frame cannot be dynamically configured. A change of configuration requires re–start of the downloaded software.

The configuration of the radio time slot specifies the type of logical channel to use for a time slot.

The configuration of the frequency hopping specifies, for a time slot, the list of frequencies to use, as well as sequencing. This configuration is optional and only appears if the frequency hopping was requested in the TDMA frame configuration.

Monitoring

The BSC regularly sends status requests to the DRX to detect any problems on the OML link.

LAPD break

The LAPD, OML and RSL links are monitored by a timer. If level 2 loss is detected, the BSC and the AMNU try to reconnect. If connection has not been made by the end of the time–out, the AMNU is reinitialized.

Event reports

The AMNU collects all events detected by the DRX equipment. It performs filtration, and error reports to the BSC. Transmission error reports, and fault management on RX–splitters alarms are sent through the BCF or CBCF.

The AMNU filters to prevent repetition of non–transient events, which means it can send the BSC a single indication.

The AMNU sends errors to the BSC by sending "event report" messages. There are two types of these messages:

- transient messages which are not acknowledged by the BSC

- non–transient messages which must be acknowledged by the BSC and which are repeated by AMNU until they are acknowledged.

Radio signaling function

The radio signaling function supports two Signal Processing Units (SPU). Each SPU manages one time slot.

Two versions of the SPU software are available. One corresponds to propagation conditions in rural area and the other to propagation conditions in urban area. For the rural areas, the algorithm parameter equals zero where as it is set at the value 0.5 for urban areas. In this later case, the interferer cancellation algorithm is active.

The radio signaling functions can be broken down into four groups of functions:

- level 1 radio access

- level 2 radio management of LAPDm signaling

- level 3 radio management, which is made up of two functions:
  - radio resources management
  - radio measurements management

- operation & maintenance

Level 1 radio access

Level 1 radio access makes it possible to manage dialogue between the AMNU signaling function and the SPU processors which are connected to the AMNU. It offers:

- configuration of operating modes for each SPU

- SPU control

- transmission and reception of data on the radio channel, respecting methods for slaving to the radio frequency.

Level 2 radio management

Level 2 radio management manages the LAPDm level 2 signaling on the radio channels.

Radio resources management (radio level 3)

Radio level 3 provides the following functions:

- level 2 management on the common channels

- control of level 2 functions on dedicated channels

- activation of the common channels

- organization of the Common Control CHannel (CCCH), including chaining and repetition of paging messages and transmission of dedicated channel allocation messages

- activation or deactivation of dedicated channels, implementation of encryption and channel mode changes

- providing SPU processors with system information on the SAACH and BCCH channels

- detection of "random access" and "handover access"

- detection of radio link attenuation (monitoring of the upstream SACCH channel), verifiable by the OMC

- sending of the mobile transmission power change

Radio measurements management (level 3 radio)

This provides the following functions:

- return of interference measurements carried out by the SPU processors on the inactive dedicated channels and transmission of these measurements to the AMNU

- concatenation of measurements made by the SPUs on the active dedicated channels and those transferred by the mobile over the same period

Operation & maintenance functions (O&M)

These functions provide configuration and deconfiguration of the time slots and frequency hopping functions.

3.4.1.2   DCU8 unit

The DCU8 unit consists of two signaling processing chains, A and B, as shown in *Figure 3–11*. Each chain handles four calls in full–rate voice mode and eight calls in half–rate voice mode. Chain A and chain B are connected to a subassembly, the BB_FILT ASIC, which is the interface with the radio part and filters reception samples before sending them to the two chains. A second subassembly, the CHIF, which is associated with the BB_FILT ASIC, calculates encryption and decryption masks.

Chain A processes even radio reception time slots and odd radio transmission time slots. Conversely, chain B processes odd radio reception time slots and even radio transmission time slots.
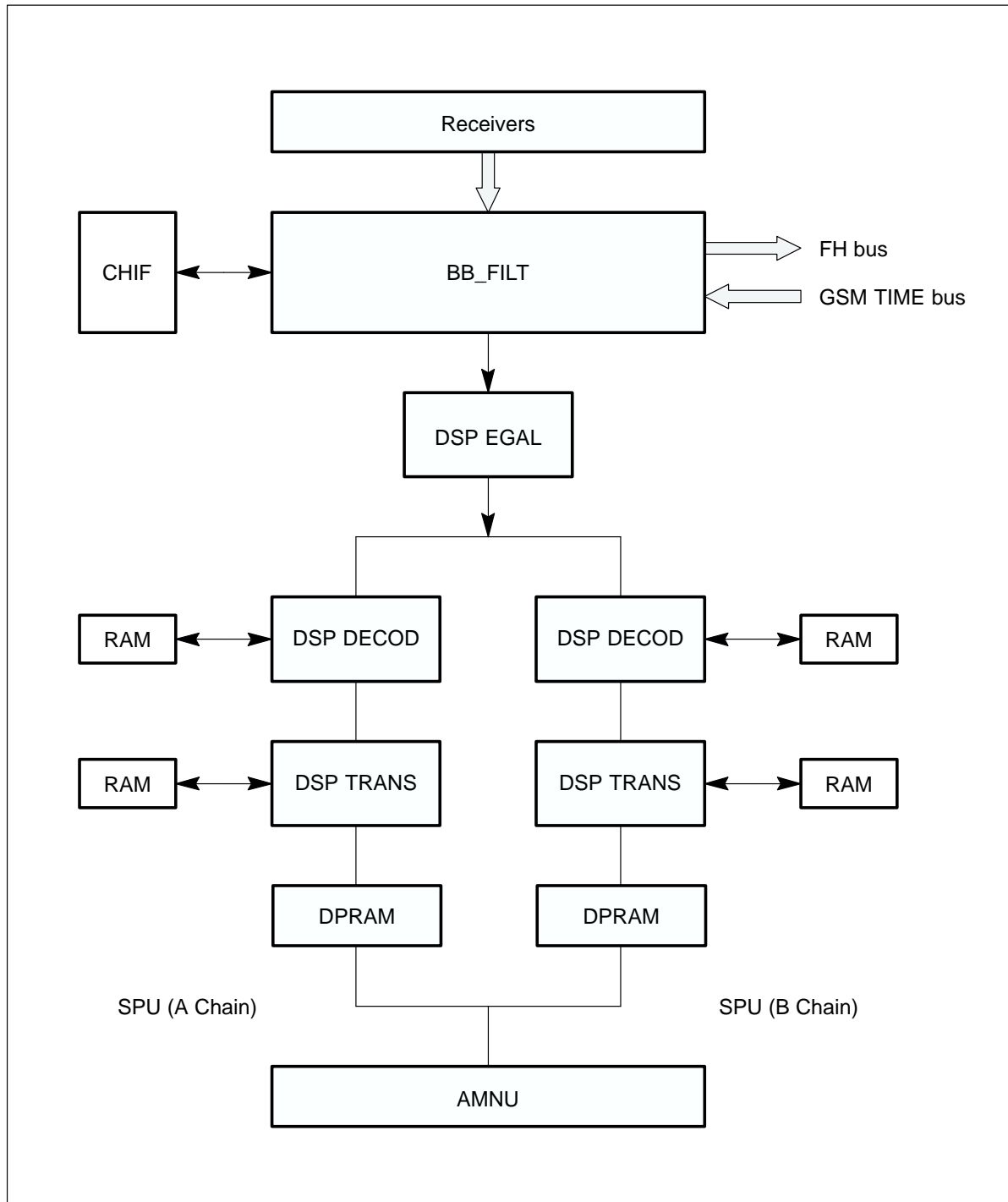
Figure 3–11   DCU8 unit diagram

The DCU8 unit has five DSPs:

■ one EGAL DSP, which equalizes the reception signal

■ two DECOD DSPs, which handle reception signal decoding, and level 1 sequencing

■ two TRANS DSPs, which handle transmission signal processing, encoding, and the interface with the remote transcoder

There is one DECOD DSP and one TRANS DSP in each chain.

SPU

The SPU carries out processing associated with the transmission layer, and to this end, it executes a certain number of functions, such as: (see *Figure 3–12* and *Figure 3–13*):

■ demodulation of GMSK signal at reception

■ ciphering/deciphering of sent and received data

■ encoding/decoding and interleaving/de–interleaving of data from the various channels

■ encoding/decoding of voice and data (from 13 kbit/s to 16 kbit/s and vice–versa)

■ transfer of discontinuous transmission (DTX) signal

■ control of transmitters and receivers

■ processing of radio measurements

Demodulation function

Demodulation consists of extracting, from the GMSK signal received, the binary data transmitted, that is 144 bits for a normal burst and 36 bits for an access burst. This is done for the eight time slots of the radio channel.

The demodulation principle selected takes into account the inter–symbol interference resulting from smoothing of the transmission phase transitions (limitation of the transmitted spectrum), multiple path phenomena, and distorsion introduced by the channel filter upon reception.

Implementation of this type of demodulator requires modification of the transmission channel as concerns pulse response, frequency deviation, and reception times. Determining these parameters is part of the job of the demodulation function.
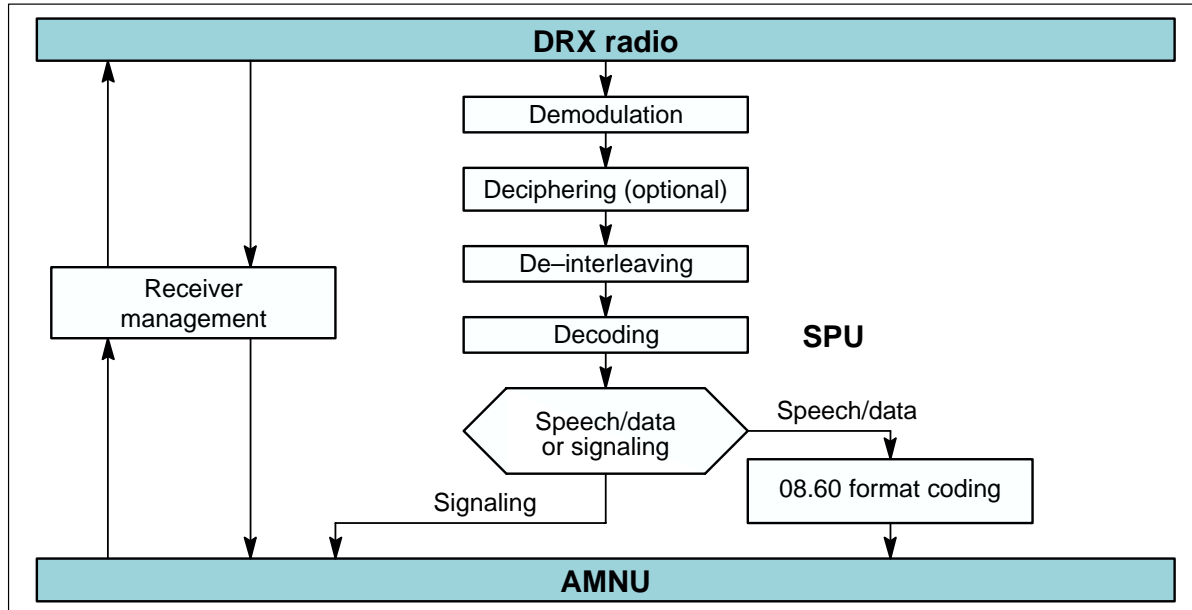
Figure 3–12   SPU reception functions
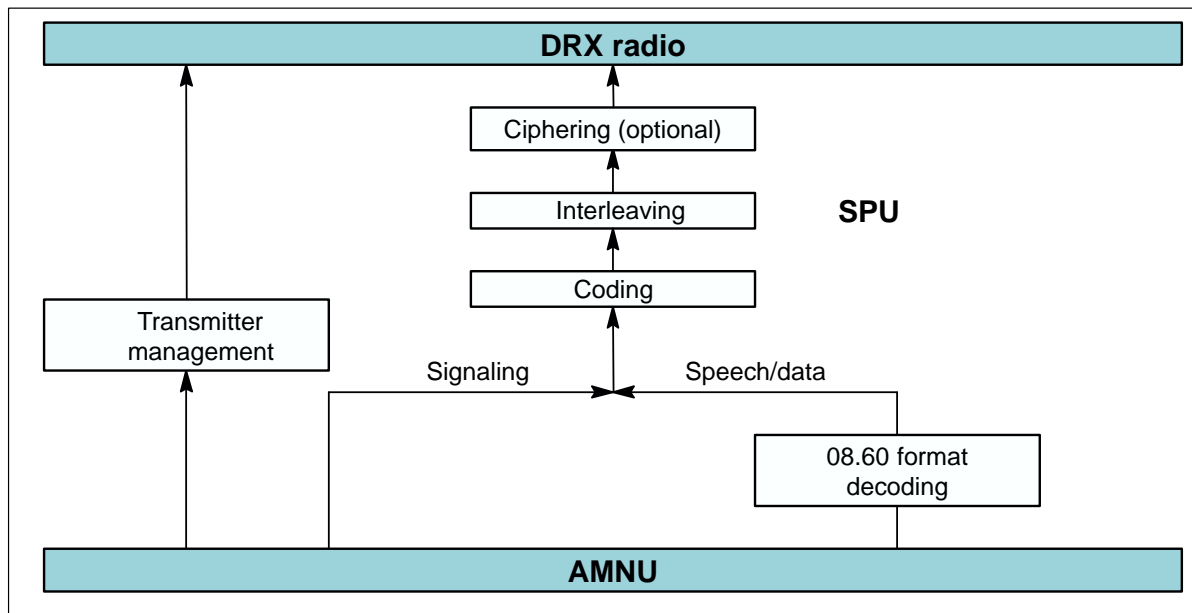
Figure 3–13   SPU transmission functions

The receiver has the space diversity function. Both received channels are combined in an equalizer which carries out joint equalization.

For each of these channels, the pulse response as well as the C/I+N ratio are estimated. These ratios are used to weight the predictions and samples of each channel.

The symbols from the equalizer are then decrypted, de–interleaved and decoded to restore the control messages and traffic sent by the mobile.

Ciphering/deciphering function

The fluxes of binary symbols sent and received on each time slot on the TCH or SDCCH are encrypted one bit at a time, in compliance with the ciphering/deciphering algorithm.

The ciphering or deciphering operation protects confidentiality of voice and signaling. It consists of adding binary bits, one by one, between sent and received data and a binary train (the ciphering sequence), generated from a ciphering key and the TDMA frame number of the time slot.

Encoding/decoding and interleaving/de–interleaving functions

All traffic and control logic channels are encoded to protect useful information against transmission errors. Each channel has its own encoding scheme, usually including the following steps for each block:

- protection of data bits with parity bits or a block code
- encoding of the "data bits + check bits" unit with a convolutional code; this operation gives encoded bits
- rearrangement and interleaving of the encoded bits
- burst formating

For data, the encoding procedure depends on the rate: the interleaving level is higher for data than for voice.

Some channels do not use the encoding schemes described above, in particular the RACH, FCCH and SCH channels, for which the notion of interleaving on several times slots does not exist.

Mobile transmission timing advance function

The BTS must measure the delay on the received signal when the mobile station makes itself known.

This measurement, known as timing advance, is forwarded in the dedicated channel assignment message (immediate assignment) to the MS, which uses this parameter to anticipate its transmission timing.

During the call establishment, the BTS computes the timing advance value and sends it within CHANNEL REQUIRED message to the BSC. If this value is above the threshold, then the BSC rejects the call establishment.

In ongoing call conditions, the timing advance is calculated at regular intervals and sent to the MS over the downlink SACCH channel.

The calculation is based on the following:

- other measurements taken during demodulation
- the timing advance used by the mobile station that is returned in the layer 1 header of the uplink SACCH

Discontinuous transmission (DTX)

Discontinuous transmission allows signals to be sent over the radio channel alone when a speech signal is present. This limits interference and MS power consumption. For each call, the MSC indicates whether the BSS "does not use" or "may use" the DTX.

The principle behind discontinuous transmission is as follows:

The base or mobile vocoder has a Voice Activity Detector (VAD) that detects if the frame constructed every 20 milliseconds contains speech. If the frame does not contain speech, the vocoder constructs a special frame called the SIlence Descriptor (SID) that contains all the background noise description elements. This frame is sent to produce a comfort noise at the far end, and radio transmission stops.

The vocoder periodically reassesses the ambient noise and reconstructs the SID frame. The frame produced in this way is sent in step with the SACCH (once every four 26-frame multiframes (480 milliseconds)).

When the vocoder detects new speech activity, a special SID frame indicating the End Of Silence (EOS) is sent, and normal speech frame sending resumes.

On the receive end, additional processing sequences interpret the incoming traffic frame types (speech, SID, FACCH, nothing) using the related flags (BFI, SID, TAF) and perform the appropriate operations.

The DTX is allowed for data in non-transparent mode.

BCCH filling

The BCCH frequency must be transmitted continuously so mobile stations can perform field strength measurements in neighbouring cells.

Continuous transmission is accomplished in the following ways:

- When frequency hopping is not used, the TRX uses the BCCH frequency as the carrier frequency for all the channels it supports. The TRX sends fillers on the BCCH frequency although it may have nothing to send in a given time slot.

- When frequency hopping is being used, one of the following occurs:
  - The hopping laws authorize permanent BCCH transmission, and all the TRXs help fill operations.
  - The hopping laws do not authorize permanent transmission and a transmitter is required to enable BCCH "filling" independently and take over when the hopping laws step down.

  Note: That the laws that enables permanent transmission on BCCH are only accepted by cavity coupling.

Transmitter and receiver control

The SPU controls a transmitter and a receiver. It calculates the frequency hopping law and determines the frequencies to synthesize.

The transmitter is controlled by the FH bus. The SPU sends the following to the transmitter:

- the power and frequency to use
- the bits to send
- the time synchronization signal

The SPU sends the following to the receiver:

- the frequency to use for the following time slot
- the synchronization clock signal
- the GSM TIME synchronization signal

The SPU receives the following from the receiver:

- digitized samples from the reception channel
- the scale factor (gain)
- the receiver alarms

Radio measurement processing

The Radio Measurement Processing performed by the BTS ensures that the network and the mobiles can communicate with each other with minimum interference at the lowest possible transmission power and with the best transmission quality.

Measurements processed by the BTS include signal strength and signal quality. The mobile takes measurements in the downlink direction (BTS –> MS), while the BTS takes them in the uplink direction (MS $\rightarrow$ BTS). Other measurements include signal strength on the BCCH frequency of the surrounding cells and the MS_BS distance.

The BTS averages these measurements for each connection. The averaged measurements are then used as the basis for a decision–making process for the following:

- power control
- call clearing
- inter–cell handover
- intra–cell handover

The BTS cyclically sends to the BSC the interferences measures done on the inactive channels.

BB–FILT ASIC

The BB_FILT ASIC constitutes the interface between the signal processing unit (SPU) of the DRX and the radio RX module on the one hand, and the enciphering ASIC on the other hand. It carries out the band–pass filtering of the digital samples output by the radio RX module, and generates the FH bus.

A single BB_FILT ASIC processes all eight TSs of the radio frame.

The functions provided by this ASIC include:

- GSM time reception interface providing the synchronization of the DSPs on the radio frame
- on transmission:
  - recording of the TX parameters and of the ciphering key, supplied by the DSP EGAL
  - transfer of the ciphering key to the CHIF ASIC
  - reading of the ciphering template from CHIF ASIC
  - ciphering of the parameters and transmission on the FH bus
- on reception:
  - recording of the RX parameters and of the ciphering key, supplied by the DSP EGAL
  - programming of RX hopping synthesizers
  - generation of channel and sampling frequency selection signals for the analog to digital converter
  - base–band filtering of the digital samples delivered by the a dc converter
  - selection of the best gain for each channel (normal and diversity)
  - transfer of these selected filtered samples to the DSP EGAL
  - transfer of the deciphering key to the CHIF ASIC
  - reading of the deciphering template from CHIF ASIC, and transfer of the template to the DSP EGAL

3.4.1.3   BDT unit

The BDT (time base) unit regenerates GSM TIME signals. The GSM time is distributed to the BDT unit of each DRX by means of the GSM TIME channel of the private PCM, every 60 ms.

The value of the propagation delay is sent to the DRX by means of the OML link of the private PCM. From these two data, each DRX makes the necessary corrections and regenerates the GSM TIME bus.

If, for any reason, the GSM time is not distributed on the BDT unit, the BDT unit locally maintains the GSM TIME bus signals and continues to provide the GSM time to the DRX units.

The BDT unit is made up of a logic block and a calculation block.

■ **Digital block**

The BDT unit receives a 26 MHz clock signal derived from the radio unit clock. This clock signal has the same stability properties as the 4Fbit clock signal provided by the BCF synchronization board and is more stable in the short term. The digital block generates the following signals:

- H4M (4.096 MHz)
- STRTM (recurrent pulse at 577 microseconds)
- TIME_DATA (containing T1, T2, T3 and TN)

Calculation block

The calculation block synchronizes the H4M and STRTM signals with the synchronization unit signals of the BCF. In addition, it updates the values T1, T2, T3 and TN.

The synchronization principle consists of forcing a divider–by–24 counter to divide by 23 (if the BDT is slow) or by 25 (if it is fast). This way, every 23 or 25 periods of 26 MHz (depending on whether the slow BDT is accelerated or the fast BDT is slowed down), the BDT corrects a period of 26 MHz.

3.4.1.4   TX logic unit

The main role of the TX logic unit is to control the radio subassembly in real time. It receives the BCF configuration commands from the AMNU. It carries out the processing and sends back reports.

Once configured, the TX logic unit reads, on each time slot, the data present on the FH bus. Then it calculates the frequency code and the power code to be used with the radio interface.

Transmission power

In general, radio power is determined by two inputs. One controls the maximum static power and the other gives the dynamic attenuation at each time slot.

The static power is given by the BCF or CBCF in the CONFIG message. The TX calculates attenuation to compensate for cable loss between the TX–driver and the power amplifier.

The dynamic power is provided by the ASIC of the TX logical unit. Its software reads the value and commands the TX–driver accordingly.

In the case of a BCCH filler, the additional attenuation introduced is always zero.

The power values that the TX and the mobile have to use are fixed by the BTS according to a control algorithm using the measurements results that it makes and the thresholds stockpiled in the OMC. The mobile and the BTS power control can be inhibited by the OMC.

The power control aim is to minimize the interferences, ensure good transmission quality and save mobile's batteries.

Power slaving

The setpoint value is slaved to compensate for gain variations of the transmission chain.

Two slaving loops are used to compensate for attenuation in the gain chain (see *Figure 3–14*).
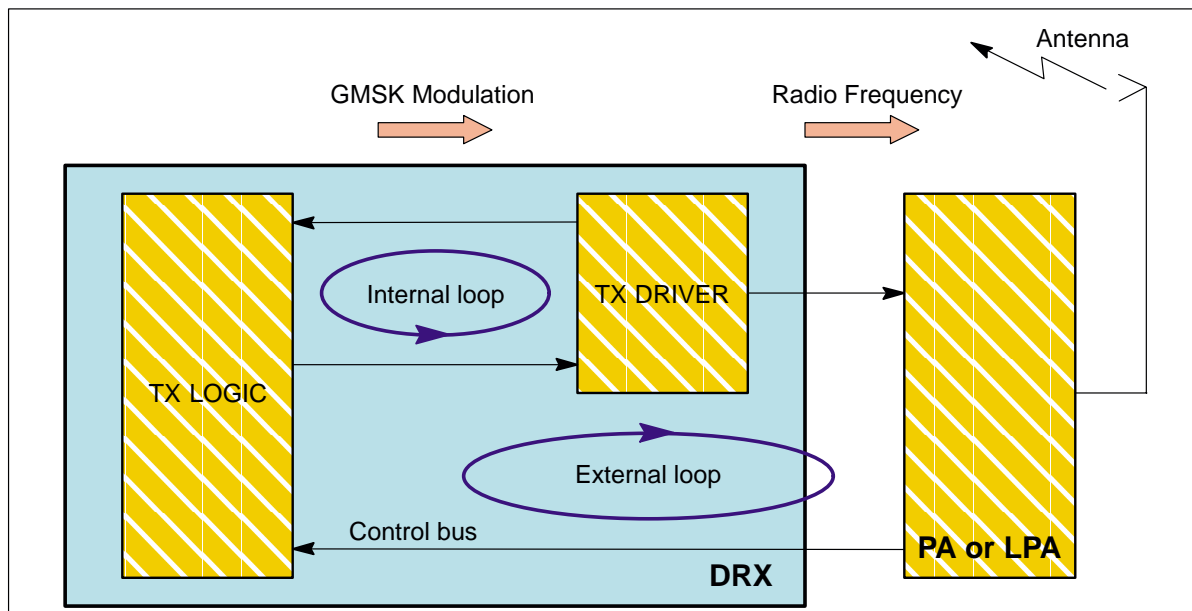
Figure 3–14   Power slaving diagram

These loops may be in the following states:

- Open: This state is used for calibration of the internal loop with the external loop.
- Initialization: This state is used for loop start–up.
- Error: A loop is in error when it is not longer in correspondence with the setpoint.
- Closed: A loop is closed when it is in slow slaved mode.

3.4.2   DRX radio part

The DRX radio part is composed of a power supply board and of the DRX radio board.

The power supply is converting common -48 V to specific +5 V/± 12 V power supply signals for the DRX radio board.

The DRX radio board is composed of three units:

- the Frequency reference (Fref) unit
- the receiver unit (RX)
- the transmitter unit (TX)

3.4.2.1   Frequency reference unit

The reference frequency for all local oscillators is derived from the Fref frequency supplied by the VCXO, itself derived from the 4.096 MHz signal provided by the DRX digital part (BCF or CBCF).

It provides a very steady and spurious–free reference clock for the RX/TX hopping and fixed synthetizers (13 MHz signal).

3.4.2.2   Receiver unit (RX)

The receiver unit (RX) has four main functions. Slot–to–slot frequency hopping is achieved with a dual synthetizer arrangement (one is active while the other one is setting to the following frequency):

- signal down conversion from radio frequency band to Intermediate Frequency (IF) then to base band frequency
- channel filtering (in IF)
- RX–level dynamic management
- digitization of the base band signal

The base band signal is then sent in binary form with its scale factor to the DRX digital part.

Receiver configuration

The receiver configuration is done by the DRX digital part, which sends:

- the reception frequency to be used for the following time slot
- the synchronization clock signal
- the GSM time synchronization signal

Receiver monitoring

The receiver monitors internal equipment: microprocessor and Phase Lock Loops (PLL).

If there is a failure or other problem, it generates an alarm:

- microprocessor fault

- frequency range not respected (if the frequency to synthesize as requested by the DRX digital part is incorrect)

- PLL loss of alignment (if one of the receiver PLLs is not aligned)

3.4.2.3   Transmitter unit (TX)

The Transmitter unit has two main parts:

- IF and RF chains

- gain control loop (or Automatic Level Control)

IF and RF Chain

An I/Q modulator with a Local Oscillator (LO) phase–locked on a reference frequency transposes the two baseband I/Q signals into the IF chain.

This 125 MHz local oscillator (LO_IF) phase–locked on a 13 MHz signal translates the baseband signals into an intermediate frequency. (The IF is 125 MHz in GSM 900, 286 MHz in GSM 1800 and 299 MHz in GSM 1900).

The second LO is used for up conversion from IF to RF.

The up–conversion is followed by bandwidth filter, amplifier stages, variable voltage attenuators, and digital attenuators.

Gain Control Loop (or Automatic Level Control)

The driver transmit chain upholds the accuracy of the transmission power compatible with the GSM recommendations against time.

The control dynamics use two components: one voltage variation attenuator (VVA) and a step–by–step digital attenuator taking target attenuation into account and compensating for it.

The Automatic Level Control also includes the PA.

3.4.3   DRX shutting down

3.4.3.1   DRX soft blocking

The DRX soft blocking consists in setting a DRX "out of service" without stopping the calls established on this DRX. If possible, an intra–cell handover is performed for those calls to release the DRX more quickly. Otherwise, the DRX will be released after the normal completion of the calls.

3.4.3.2   DRX soft blocking coupled with a forced handover

To speed up the DRX shutting down, the DRX soft blocking can be coupled with a forced handover. The calls will be handed over a neighbour cell if the signal strength is over the handover threshold for that cell.

3.4.3.3   Hint

The two actions mentionned above can be performed into a unique command to a better efficiency of the DRX shutting down.

3.4.4   Power supply board

The power supply card provides a dc voltage between 40.5 V and 57 V, to be converted into +5 V, +12 V and –12 V. The 48 V voltage is sent first to the logical DRX unit converter, then, after filtering, to the logical DRX unit and the radio DRX unit converter.

The power supply of the board varies according to the DRX types and on the frequencies.

The mechanical and electrical grounds are linked to the common reference zero volts.

3.5   e–DRX functional architecture

The e–DRX board consist of (see *Figure 3–15*):

- an e–LDRX digital board including a dc/dc converter, a frame processor TX logic (GMSK and 8–PSK modulation), and a local time base, working for all frequency bands

- an e–RDRX radio board including a dc/dc converter, a low power driver and a dual receiver

3.5.1   Modifications between the DRX and e–DRX

This chapter describes the modifications between the current DRX and the e–DRX. The main features of the e–DRX are the following:

- signal processing capacity improvement

- 8–PSK modulation compatibility

- receive dynamic extension

- TX output power dynamic reduction

- packet backhaul readiness

3.5.1.1   E–LDRX board modifications

The main modifications concerning the e–LDRX board are the following:

- the migration of BDT, AMNU, and TX into a single FPGA

- the use of one PowerQuicc

- the introduction of the 52 MHz frequency reference function

- the use of two DSP

- the extension of the memory capacity (8 Mb for SDRAM, 4 Mb for flash and 2 Mb for SRAM)

- the size reduction and integration of the dc/dc converter on the e–LDRX board

- the lower power consumption (<15W)
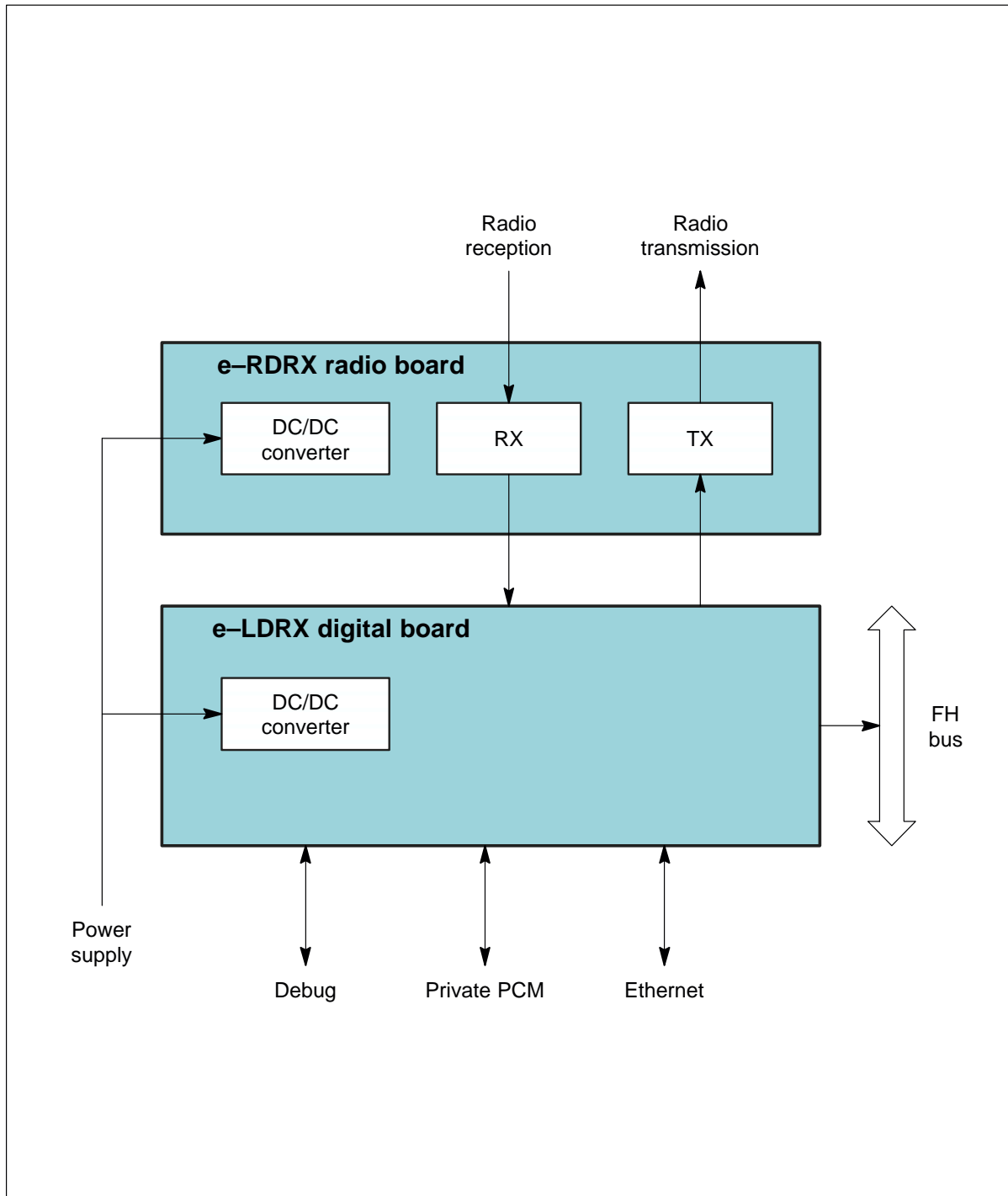
Figure 3–15   e–DRX board: functional block diagram

3.5.1.2   E–RDRX board modifications

The main modifications concerning the e–RDRX board are the following:

- the removal of the 104 MHz frequency reference
- the use of RXIC2 module (IF => BF transposition)
- the RX dynamic extension provided by an AGC (–13 to –110 dBm)
- the TX output power dynamic reduction
- the integration of the dc/dc converter on the e–RDRX board
- the lower power consumption (<15W)

3.5.2   Main external connections

3.5.2.1   Private PCM

A private internal PCM is used to link the e–DRX to the BCF. The proprietary interface has the same definition as the previous internal PCM, except that the clock is fully synchronous with the radio interface.

This bus carries the following informations:

- Radio Signaling Link (RSL) and local Operation and Maintenance (O&M) on one time slot
- Traffic links on two, three, four, six or eight time slots
- GSM_TIME channel on a separate time slot

The feature allows the e–DRX to be remotely controlled.

3.5.2.2   FH bus

The FH bus is connected to the various e–DRX units.

3.5.2.3   Power Supply

The e–DRX is powered by a –48V dc supply and the typical consumption is 25W.

3.5.2.4   Test links

The e–DRX has an Ethernet port and an asynchronous serial port. It also has serial lines for emulator connections, and real time trace facilities.

3.5.2.5   RF interfaces

The e–DRX unit provides RF reception with diversity and RF transmission at low level.

3.5.3 e–DRX functional description

This chapter describes the functional architecture of the e–DRX, but does not detail each part. The aim is to give enough information to approach easily the main features.

3.5.3.1 Logic unit (e–LDRX)

The logic unit (e–LDRX) contains (see *Figure 3–16*):

- a FPGA unit which provides:
    - a control and switching management function
    - a time base function
    - a synchronization function
- a management unit (AMNU) which processes the following functions:
    - start–up, downloading, initialization
    - configuration
    - monitoring
    - LAPD break
    - event reports
- a transmission unit which provides:
    - a radio signaling function
    - a signal processing function
    - a power regulation function
    - a RX logic function
    - a TX logic function

FPGA unit

Control and switching management function

- Setting up communication with the BSC

When the BTS is activated, it must be connected to the BSC to work. A link is set up on an external PCM link.

- Downloading

When communications have been set up with the BSC, the BTS reports its status. The BSC downloads, if necessary, the software to the BTS.
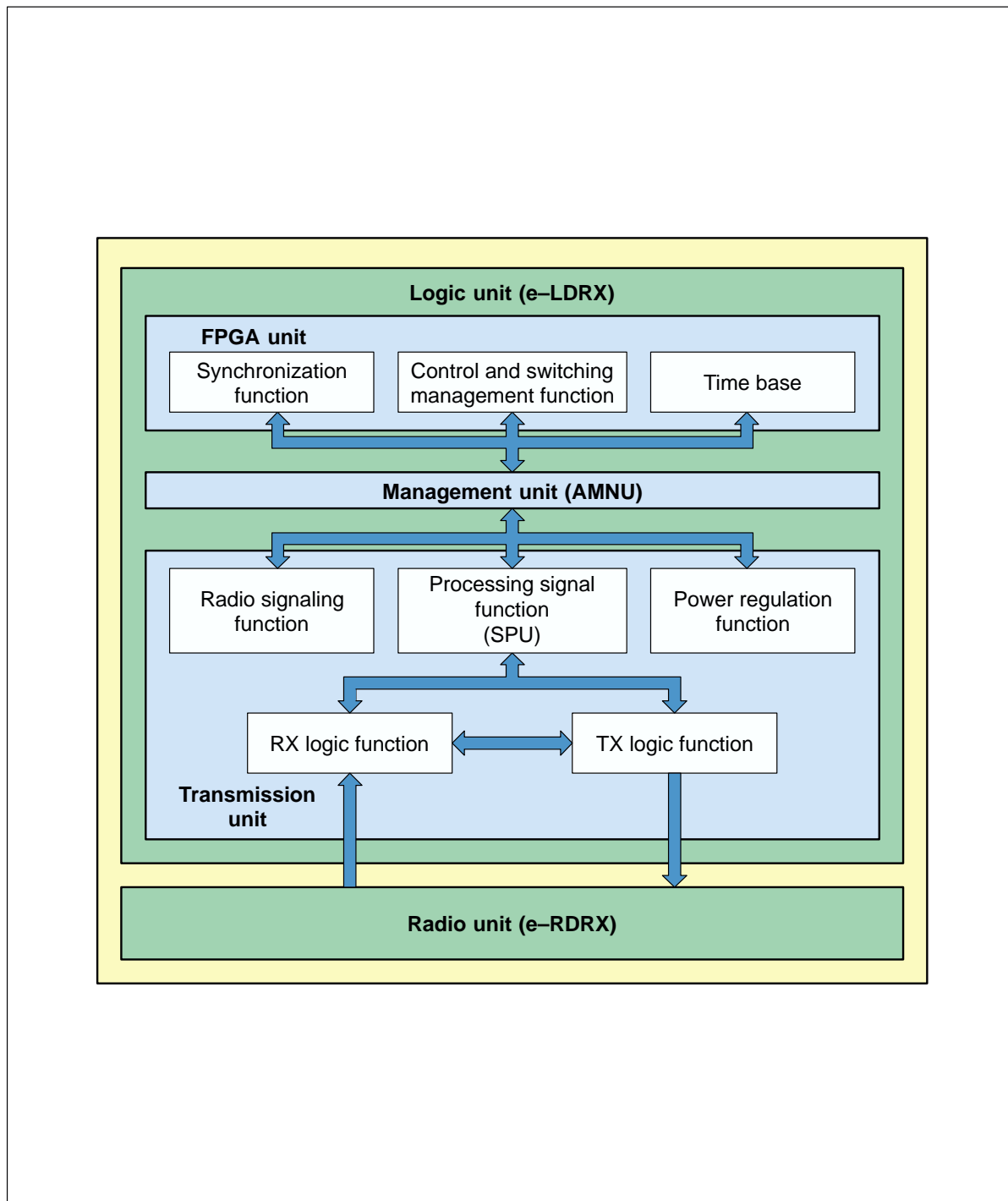
Figure 3–16   Logic unit (e–LDRX): functionnal architecture

- Synchronization management

At the start–up, the BTS selects the clock. During LAPD connection, the BTS forces the clock onto the PCM carrying the LAPD.

- Switching matrix management

Each PCM link managed by the switching matrix has a transmission test interface, reception test interface, and an idle interface

The switching matrix is configured when the BSC requests to set up or to release a signaling or traffic channel from the BTS.

Signaling channels are set up (or broken) between a transmission signaling TS and a non–concentrated link. This operation may entail (dis)connection between a a concentrated link TS coming from the BTS and a PCM link TS on the PCM interface.

Traffic channels are set up (or broken) between a transmission traffic TS and a PCM link TS on the PCM interface.

- Data signaling concentration function

The BTS uses this function to set up the communication between the BSC and the other entities that make up the BTS. This function is implemented with the LAPD protocol that serves concentrator and routing functions.

Time base

The time base regenerates the GSM_TIME bus with information issued from the GSM_TIME channel.

If, for any reason, the GSM time is not distributed to the time base, this one maintains the GSM_TIME bus signals locally and continues to provide the GSM time to the logic unit.

Synchronization function

The synchronization function must synchronize the transmissions on a single reference time: GSM _TIME.

The network provides a radio reference clock via two PCM links. This clock selected has good long–term accuracy. It's the reason that the synchronization module to generate an exact reference time for the radio interface uses this clock..

If the external reference signal is missing, the BTS selects the local clock.

The synchronization function is monitored by internal control and monitoring mechanisms. They check that the synchronization is operating correctly and that the GSM time is available on the GSM_TIME bus.

AMNU Unit

Start–up, downloading, initialization

The AMNU unit is started by a hardware reset or a re–initialization message sent by the BTS. It configures the LAPD and establishes an OML link with the BSC.

Depending the BTS request, the BTS systematically initiates a downloading phase of the catalogue files and software units.

Follow by a re–flashing of the units for which the software versions are different.

Configuration

The transmission is configured by the BSC via the BTS.

The configuration provides:

- a general configuration. It contains the configuration of the TDMA frame and provides the logic unit parameters shared by the whole cell, such as:
  - cell to identity (BSIC)
  - BCCH frequency
  - indication of frequency hop implementation
  - the frequency of the TDMA frame if there is no frequency hopping
- a configuration of the radio TS. It specifies the logic channel type to use for TS.
- a configuration of the frequency hop. It specifies, for TS, the list of frequencies to use, as well as sequencing. This configuration is optional and only appears if the frequency hop was requested in the TDMA frame configuration.

Supervision

The BTS regularly sends status requests to detect any problems.

LAPD break

A timer monitors the LAPD with the OML and RSL links. If level two loss is detected, the BSC and the AMNU try to reconnect. If connection is not re–established before the end of the time–out, the AMNU is reinitialized.

Event reports

The AMNU:

- collects all events detected (internal or external alarms)
- provides the filtration and reports errors (transmission/reception) to the BSC
- provides the filtration to prevent repetition of non–transient events, which means it can send to the BSC a single indication

The AMNU sends errors to the BSC by sending "event report" messages through the BTS. There are two types of these messages:

- transient messages which are not acknowledged by the BSC
- non–transient messages which must be acknowledged by the BSC and which are repeated by AMNU until they are acknowledged

Transmission unit

Radio Signaling function

The main characteristics of this function are described below:

- the radio access management (level 1)

  It manages a dialog between the AMNU signaling functions and the signal processing functions (SPU1 and SPU2) which are connected to the AMNU.

- the radio management (level 2)

  It manages the LAPDm level 2 signaling on the radio channels.

- the radio resources management (level 3)

  It provides mainly the level 2 management on the common channels and control of level 2 functions on dedicated and common channels.

- radio measurements management (level 3)

  It provides the return of interference measurements carried out by the two signal–processing units on the inactive dedicated channels and transmission of these measurements to the AMNU.

- Operation & Maintenance functions (O&M)

  They provide configuration and unconfiguration of the TS and frequency hopping functions.

Signal Processing function

The signal processing (SPU) function performs processing associated with the transmission layer executes a number of functions, such as:

- modulation/demodulation (8–PSK)
- ciphering/deciphering of sent and received data
- coding/decoding and interleaving/de–interleaving of data from the various channels
- mobile transmission timing advance function
- discontinuous transmission (DTX)
- BCCH filling
- transmitter and receiver control

Power regulation function

Its main function is to check instantly the associated radio subset. It receives configuration instruction via the AMNU unit. In this case, it launches processing and returns reports.

Once that the function is configured, each TS in attendance on the FH bus is reading. Next the function calculates the frequency and the power code to be applied to the radio interface. Each function act a control of the set point (emission power), to improve the non−linearity of the gain of the transmission chain.

It launches these main operations:

- frequency hopping management
- power slaving
- transmission power
- alarms management

RX logic function

The logic functions:

- maintain:
  - the interface between the SPU functions with respectively the RX radio functions on the radio unit (e−LDRX)
  - and the ciphering
- filter the digital samples, provided by the RX radio functions, to base band signals
- generate the FH bus

Each RX radio functions processes the eight TS of the radio frame.

The main characteristics of the RX1 and RX2 radio functions are:

- an interface for the reception of the GSM time to maintain the DSP synchronization on the radio frame
- for the transmission:
  - the recording transmission parameters and the cyphering key
  - the parameters cyphering and the transmission on the FH bus
- for the reception:
  - the recording of the reception parameters and the ciphering key
  - the base band filtering of the digital samples provided by the converter
  - the ciphering key moving

TX logic function

They maintain the interface between the SPU functions and respectively the TX radio functions of the radio unit (e−LDRX).

3.5.3.2   Radio unit (e–RDRX)

The radio unit (see *Figure 3–17*) processes the radio channels for transmission/reception function.

TX radio function

The transmitter module contains the transmission channels of lower power which manage the Radio Frequency (RF) signals and Intermediate Frequency (IF) signals as follows:

- I/Q modulation
- IF filtering and amplification
- IF and RF transposition
- RF band filtering
- amplification and variable attenuation
- output power control

RX radio function

The reception module includes the reception radio channels which manage the RF and the IF signals as follows:

- RF signals from LNA–splitter
- RF to IF transposition
- IF channel filtering and amplification
- RF to BF transposition
- Analog–to–digital conversion
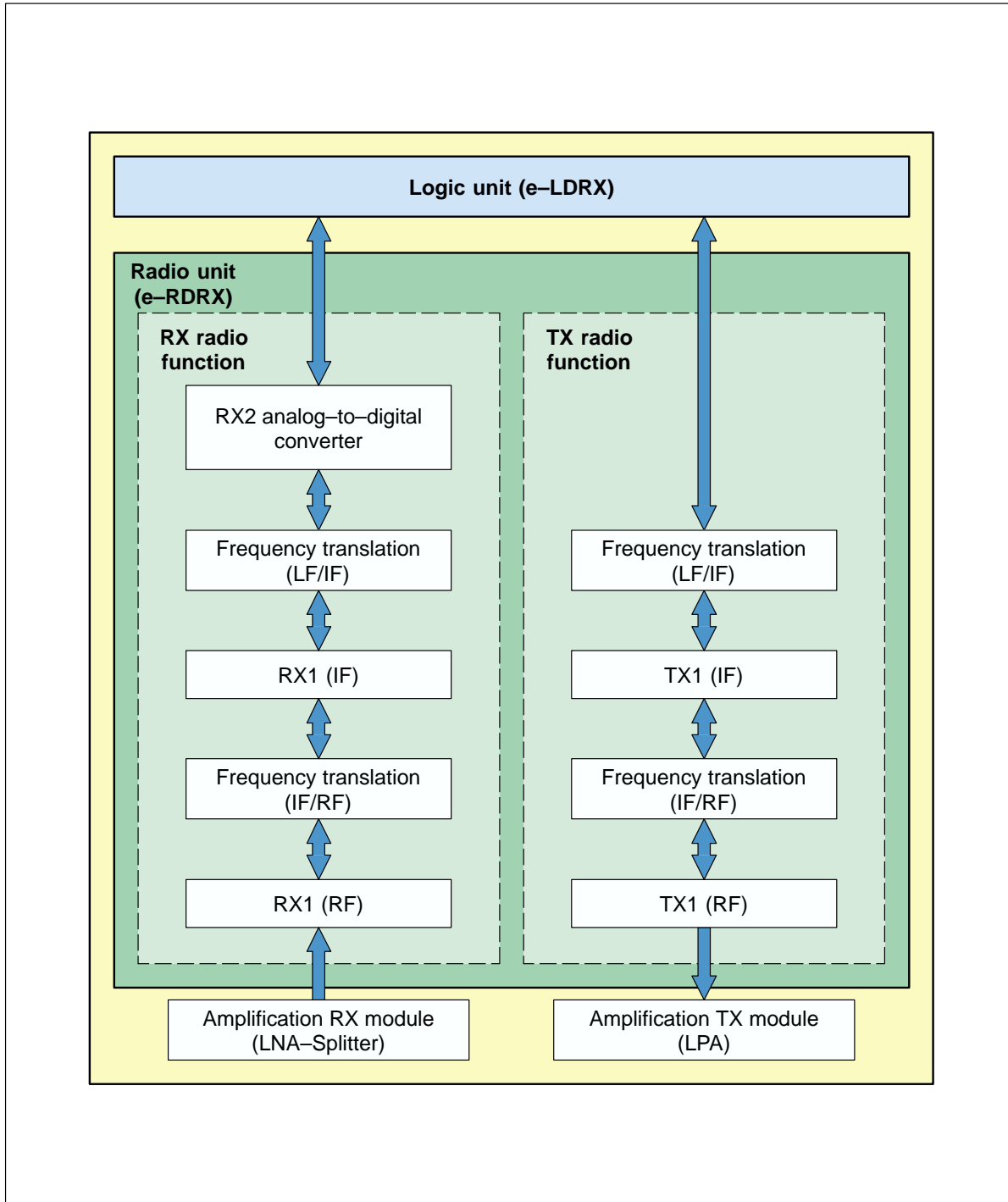
Figure 3–17   Radio unit (e–RDRX): functional unit

4   SOFTWARE DESCRIPTION

4.1   BTS software presentation

BTS software is divided into downloadable files and an onboard PROM.

4.1.1   Downloadable files

The BSC downloads these files via the A–bis interface.

There are two sets of files, BCF and DRX (or e–DRX). Each set is arranged in a file catalogue that contain the list of files and the files themselves.

4.1.2   PROM

PROM chips are read-only memory units used to store software.

They are all installed on all BTS equipment boards.

4.1.2.1   S8000 BCF software

Boards serving the BCF are described in *Table 4–1*:

Board	Software product name	Software product type
CSWM	PE_CSWM_B PE_CSWM_L	BOOT LOAD
PCMI	PE_BS_DTI_E1 or PE_BS_DTI_T1	PROM
SYNC	PE_SYN	PROM
DSC	PE_DCC	PROM
GTW	PE_GTW	PROM
ALCO	PE_BS_ALO	PROM

Table 4–1   BCF software product names

4.1.2.2   S8000 BTS CBCF Software

The software product associated with the boards and slaves of the CBCF Modules are listed in *Table 4–2*.

Board	Sofware product name	Software product type
CBCF Module	PE_CBCF_B PE_CBCF_DLU0	Boot DLU Code
CPCMI	PE_CPCMI_E1 PE_CPCMI_T1	Load Load
RECAL	PE_RECAL	Load
CC8	PE_CC8_1800	Load

Table 4–2   CBCF software product names

4.1.2.3   S8002 BTS CBCF software

The CBCF software package includes the PROMs installed in the slave units and the CMCF software which divides itself into two parts called BOOT and LOAD. All the CBCF files are downloadable as listed in *Table 4–3*.

Board	Sofware product name	Software product type
CBCF Module	PE_CBCF_L PE_CBCF_B	Load Boot
CPCMI	PE_CPCMI	Load
RECAL	PE_RECAL	Load

Table 4–3   CBCF software product names

4.1.2.4   S8000 DRX/eDRX Software

As listed in *Table 4–4,* the software products vary depending on whether the BCF
or CBCF is used in the BTS. DRX O&M software is used with the BCF. DRX
COAM is used with the CBCF or BCF from V12 onward.

Board	Sofware product name	Software product type
DRX O&M/COAM	PE_AMNU_COAM_L PE_AMNU_RSL_L PE_AMNU_B PE_SPU2G_EGAL1_L PE_SPU2G_EGAL2_L PE_SPU2G_1620_L PE_SPU2G_BIST PE_SPU2G_BIST_1620 PE_TX_L_COAM PE_BDT_L PE_TOOLS	O&M AMNU LOAD RSL AMNU LOAD AMNU BOOT SPU EGAL1 SPU EGAL2 SPU 1620 BIST SPU BIST SPU 1620 TX BDT PL TOOLS
e–DRX	Informations not available	Informations not available

Table 4–4   S8000 BTS: DRX AND e–DRX software product names

4.1.2.5   S8002/S8006 BTS DRX/e–DRX software

The software products AMNU, SPU, DLU, BOOT, TX, BDT and BISTs are listed below:

- AMNU: It is the DRX/e–DRX management unit.

- SPU: it enables level 1 radio communication with the mobile.

- BDT: It extracts the GSM TIME carried on the private PCM.

- TX: It manages and monitors radio transmission. it is installed on each DRX board. It defines the FH bus input from which the TRX reads data, and defines the transmission power to be used. it also forwards TX alarms to the CMCF and controls the Power Amplifier (PA).

- BISTs: Basis hardware self test programs of a BTS subsystem. An exemple is the AMNU BIST which tests the components of the AMNU such as memory.

AMNU, BISTS, TX BOOT, BDT BOOT, and optionnally Cyphering ASIC softwares are installed in factory.

Board	Sofware product name	Software product type
AMNU	PE_AMNU_L PE_AMNU_B	Load Boot
SPU	PE_SPU2G_EGAL_2 PE_SPU2G_DLU_DCS	Load Load
TX	PE_TX_L_GSM	Load
BDT	PE_BDT_L	Load

Table 4–5   S8002 BTS: DRX software product names

Board	Sofware product name	Software product type
AMNU	PE_AMNU_COAM_L PE_AMNU_COAM_B PE_AMNU_BOOT_BOOT PE_BOOT_INTER PE_AMNU_RSL_L PE_AMNU_OML_L	Load Boot Boot Boot Boot RSL AMNU Load O&M AMNU load
SPU	PE_SPU2G_1620_L PE_SPU2G_BIST_1620	Load Bist
TX	PE_TX_L_COAM PE_TX_OM_L	Load TX O&M Load
BDT	PE_BDT_L	Load
	PE_TOOLS	PL Tools

Table 4–6   S8006 BTS: DRX software product names

Note: The e–DRX informations are not available

4.2   BTS software functions

BTS software is distributed among three major units (see *Figure 4–1* and *Figure 4–2*):

- The DRX (or e–DRX) unit is designed to transmit and receive (modulate and demodulate) and manage TDMA frames on the radio channel.

- The CBCF and BCF manage their slave units:

  - CBCF: CPCMI, RECAL, DRX (or e–DRX), CC8

  - BCF: ALCO, DSC, DRX Interface, PCMI, Tx, and SYNC

- The TIL unit is used for in–factory testing of the BTS, and to configure, control, and supervise the BTS on site.

The following terms are used in this chapter:

- BIST: Basic hardware self–test programs of a BTS subsystem subassembly. These tests validate a subassembly intrinsically, without disturbing the other subassemblies. An example is the AMNU BIST, which tests the components (such as memory) of the AMNU unit on the DRX logical board.

- Self–tests: Global, functional test programs, which use several subassemblies in order to validate an assembly (such as the DRX or e–DRX). These tests can be broken down into tests of more or less elementary functions. This may require external equipment (so the term may be misleading).

- Downloading: A process which consists of installing, in the DRX or e–DRX (logical part), software from an external entity (terminal, Ethernet network, BSC, etc.).

- Loading: A process used to load, into the subassemblies of the DRX or e–DRX (logical part), the software it requires for its nominal operation.

4.2.1   DRX or e–DRX software functions

It is downloaded by the BSC, configured and supervised by the BSC and the CSWM (BCF) or CMCF (CBCF) through a LAPD link and a serial link. It serves as a gateway between the radio channel and the BSC. It handles both signaling and voice for all the logical channels carried by a given TDMA frame.

The module has four functions:

- The AMNU (LAPDm, L3 RSL, L3 O&M) is the DRX's management unit.

- The SPU is a gateway between the radio network and the BSC.

- TX and RX manage radio transmission and transmission.

- The BDT manages the GSM TIME.

Figure 4–1   Software functions (with BCF)
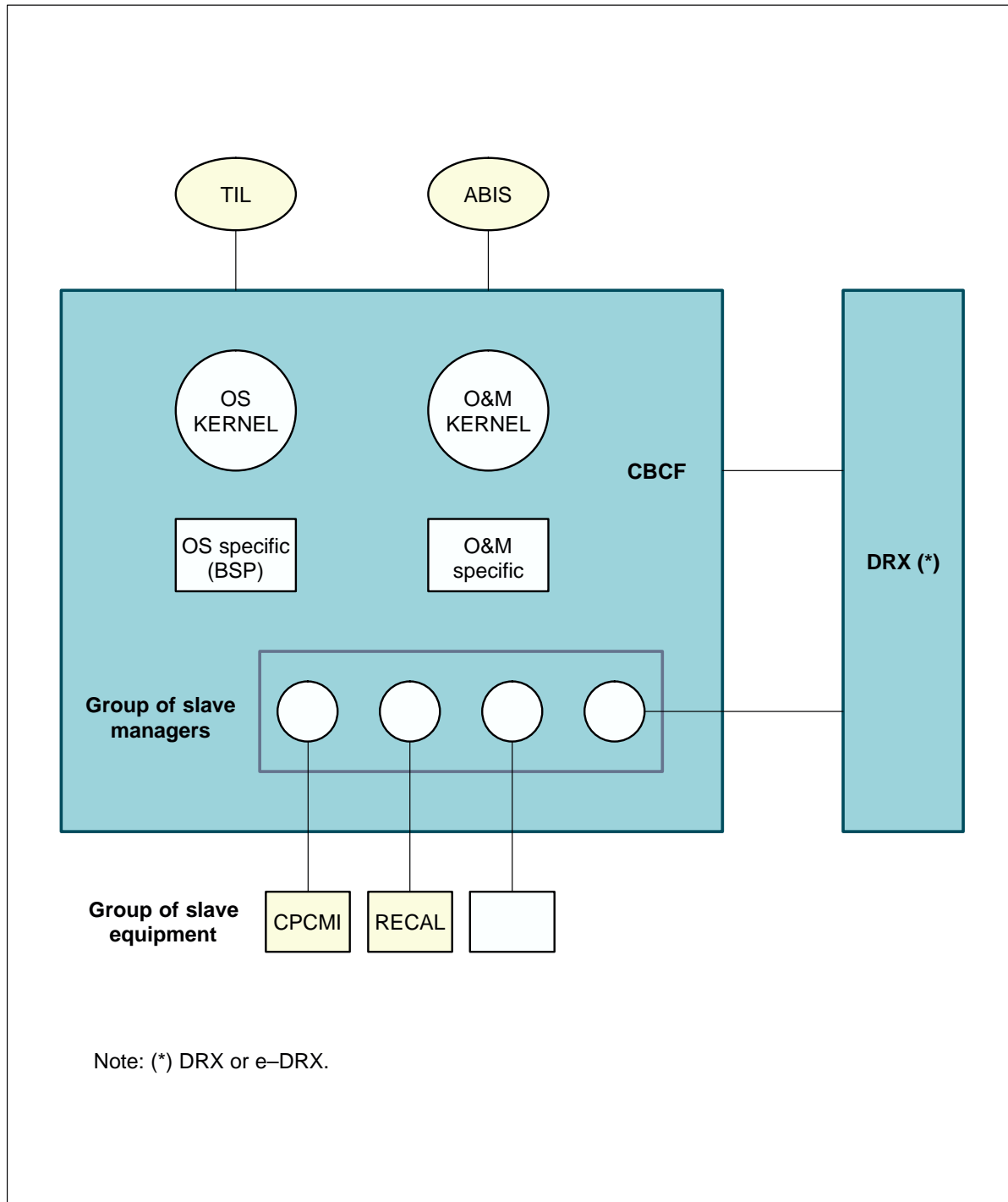
Figure 4–2   Software functions (with CBCF)

L3 O&M AMNU

This software unit centralizes the operating and maintenance functions:

- initialitization and monitoring of BISTs

- connection with Abis

- downloading and software marking

- configuration

- defense and alarms

- tool functions

- transmission of GSM TIME to BDT, and of O&M to TX

L3 RSL

This software unit represents the Radio Resource (RR) and the radio measurements function (L1M) in the BTS:

- radio link layer management

- dedicated channel management

- common channel management

- TRX management

- error handling

- measurement collecting

- measurement pre–processing (for power control by the BTS, and for call clearing and handover decision for the BSC)

LAPDm

This software unit provides the LAPDm radio level 2 protocol with the mobile.

SPU

This software unit enables the level 1 radio communication with the mobile to transmit and receive:

- gateway between radio and terrestrial network (Abis) for the traffic channel

- multiplexing and demultiplexing of the logical channels on physical channels

RX

This software unit provides the radioelectrical reception function.

L3 TX

This software unit manages and monitors radio transmission. It is installed in each DRX board. It sets the transmitter operation mode, defines the FH bus input from which the TX should read data, and defines the transmission power to be used. It also forwards TX alarms to the CSWM and controls the Power Amplifier (PA).

L1 BDT

This software unit extracts the GSM TIME carried on the PCMp (GSM TIME TS) for the BDT unit.

LAPD

This software unit manages the LAPD link level 2 protocol on PCM between DRX and BSC.

L1 O&M, L2 O&M

These software units manage the link level 1 & 2 protocol on private PCMs between DRX and CSWM.

4.2.1.1   Defense

The DRX (or e–DRX) board carries out no defense actions by itself.

4.2.2   BCF software functions

The Base Common Functions unit (BCF) is located in the cabinet. It is downloaded by the BSC, it provides the interface between the BTS and its Base Station Controller (BSC). It also handles the following functions:

- It sets the signaling channel and physical path concentration.

- It generates and distributes the GSM time to all BTS units.

- It monitors and detects all BTS alarms.

- It correlates some BTS alarms in order to provide to the BSC a logical state of the BTS, by using the event reporting procedure. The DRX is still monitored partly by the BCF (TX) and partly by the DRX (AMNU/SPU).

- It provides local protection of some BTS modules, by implementing redundant equipment units.

Synchronization unit level 3 layer (L3–SYN)

This software unit is installed in each synchronization unit. It monitors synchronization board switching, and sends a message to the CSWM whenever switching occurs.

Alarm unit level 3 layer (L3–ALCO)

This software unit is installed in the ALCO board. It makes it possible to set the board alarm loops, under CSWM control. It sends all alarm and control loop states to the CSWM.

Dual PCM link unit level 3 layer (L3–PCMI)

This software is installed in each PCMI board. It makes it possible to configure the board, and monitors the board and the two associated PCM link operations. It also carries out signaling to the CSWM when a failure occurs.

Concentrator unit level 3 layer (L3–DSC)

This software unit is installed in each DSC board and enables board configuration; It concentrates the signaling of several DRX (or e–DRX) units onto the BSC signaling channel, and conversely separates BSC signaling and routes it towards the DRX units.

L1 BDT

This level interfaces the GSM TIME bus with a dedicated TS of all private PCM links.

ROT

This level formats into frames the character flow coming from ROT, and routes these frames towards the OMC.

LAPD management (LAPD)

This software unit manages a LAPD link between the CSWM and the BSC through the DSCs.

L3 O&M CSWM

The main functions of this layer are the following:

- conversion between GSM entities and hardware entities
- configuration of the internal PCM links
- configuration of the FH bus
- supervision of the different slave equipments (PCMI, DSC, TX, ALCO, SYNC, GTW, switching matrix, O&M bus)
- management of the duplex

4.2.2.1   Defense

The BCF contains several defense mechanisms:

- paired units operating in active/standby mode:
  - two synchronization boards (SYNC)
  - two gateway boards (GTW)
  - two control and switching boards (CSWM). In order to provide switching in warm duplex mode, the standby chain is updated in real time.
- redundant units:
  - one DSC board can be reserved for redundant use
  - one PCM interface bord can be reserved for redundant use.

4.2.3   CBCF software functions

CBCF Software is based on a COAM software architecture, which is composed of three main parts:

- common software for various BTS products
  - OS Kernel
  - O&M Kernel
- BTS–specific software dedicated to a BTS product
  - OS–specific
  - O&M–specific
- slave managers

The COAM architecture is shown in *Figure 4–3*.

The CBCF software manages the following O&M functions:

- PCM management
- configuration and supervision management
- software management
- synchronization management
- test management
- duplex management
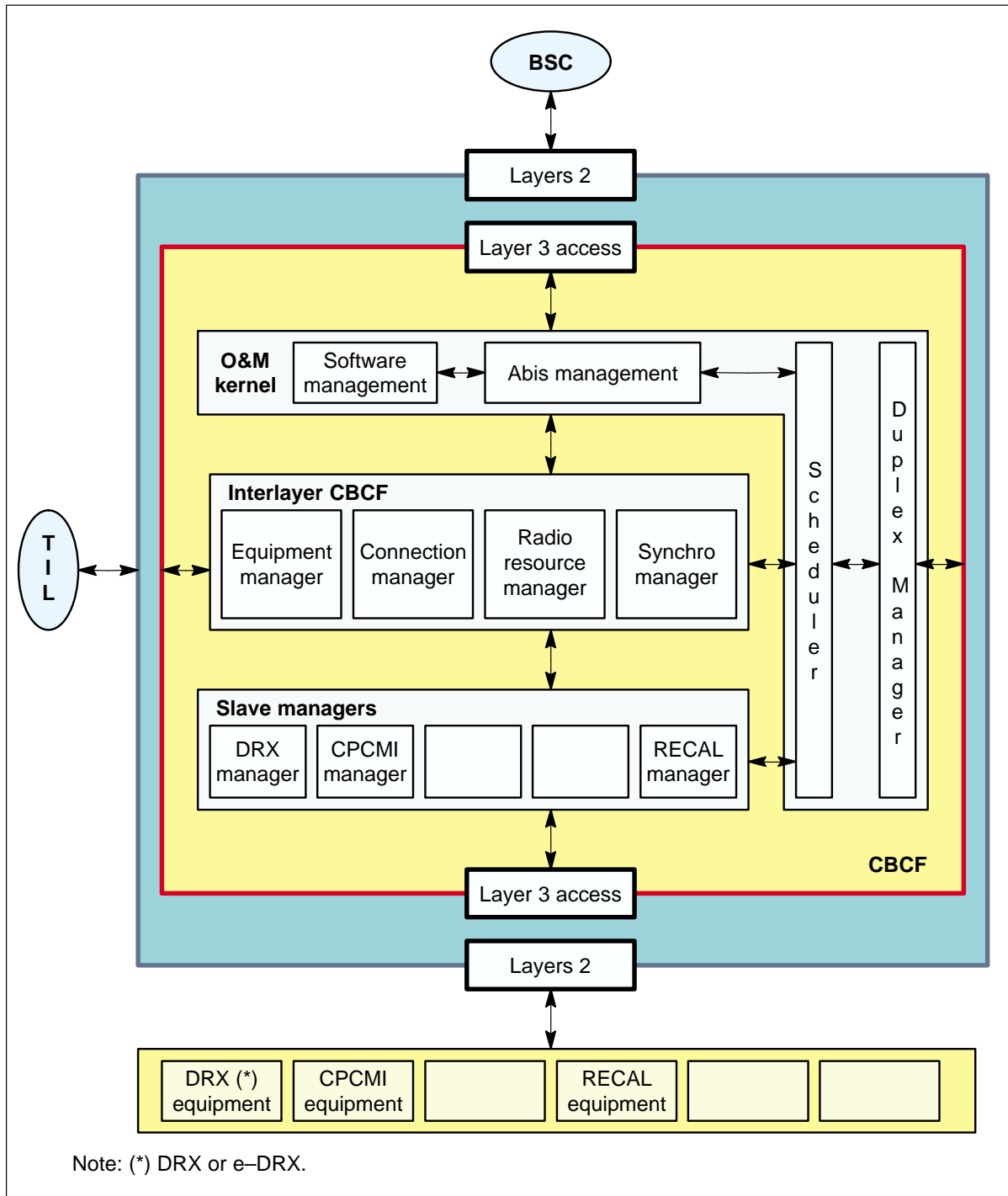
Figure 4–3   COAM architecture on the CBCF

4.2.3.1   PCM Management

This function selects one of the incoming PCMs for communication with the BSC. It then routes PCM TSs to the appropriate equipment in the BTS as the BSC requests. Other PCM TSs are routed toward another PCM to allow drop & insert functionality.

This function also ensures LAPD concentration.

4.2.3.2   Configuration and supervision management

This function translates the OML A–bis model into a physical model to offer a standardized configuration and supervision to the BSC. The CBCF acts as an A–bis front end toward the BSC for configuration and supervision purposes. It is the only link for configuration messages coming from the BSC. The CBCF uses the CBCF/DRX protocol to drive any actions concerning the DRX

4.2.3.3   Software management

The CBCF performs software management for the BTS and provides the only link for downloading messages from the BSC. When a RECAL or CPCMI board is downloaded, the CBCF/Slave protocol is used.

4.2.3.4   Synchronization management

The CBCF builds the GSM time and provides it to the DRX via a TS or a private PCM. External PCMs ensure long term stability.

4.2.3.5   Test Management

The CBCF coordinates all BTS tests. When an installation or maintenance action affects a DRX, the DRX is driven by the CBCF using the CBCF/DRX Protocol.

4.2.3.6   Duplex Management

The COAM software manages a cold and hot duplex modes.

4.2.4   TIL software functions

TIL is an application running on a PC in the WINDOWS 95 environment. The TIL application is connected to the BCF or CBCF through an ethernet connection.

The TIL is designed to do the following:

- validate the BTS in the factory

- install the BTS site

- perform diagnostics of hardware problems

- check equipment substitution

- check the equipment extension within a cabinet

Ethernet

This unit is installed in the PC. It provides the level 1 and 2 communication layer. Level 1 is a hardware driver. The level 2 protocol is an LAPD UI frame. TCP–IP Protocol is used.

L3 TIL

This software unit manages all the boards of the BTS by establishment of a network with all the GSM entities of the BTS. It integrates the factory and installation test environment.

The TIL takes the following testing into consideration:

- the conformity of the cabinet configuration

- the validity of the data links

- the external BTS PCM

- the connectors in the cabinet for cabinet extensions

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5   DIMENSIONING RULES

5.1   Generalities on dimensioning

Base Transceiver Stations (BTS) have to be dimensioned on both the radio and Abis interfaces.

The dimensions of the interface with the Base Station Controller (BSC) is calculated on the basis of traffic handled on the Abis interface PCM links.

5.1.1   RADIO interface dimensions

The dimensions of the radio interface with Mobile Stations (MS) are calculated on the basis of the number of Traffic Channels (TCH) needed to handle the traffic, the number of SDCCH/8, BCCH channels and the control channel (RACH, PCH, AGCH) dimensions.

5.1.1.1   Traffic (TCH), signaling (SDCCH/8) and broadcasting (BCCH) channels

Each transceiver (TRX) manages eight channels that can each support traffic (TCH), signaling (SDCCH), broadcasting (BCCH) and control (RACH, PCH, AGCH) channels.

The average occupation of a traffic channel is 100 seconds per call for approximately 15 seconds of occupation of a signaling channel. In all cases a broadcasting channel is reserved for use by BCCH frequency filling and control channel support.

Depending on the position of cells in relation to the location area, the number of SDCCH channels is liable to change:

- The SDCCH channel payload in cells in outer location areas is increased by location updating procedures.

- The same dimensioning rules govern multi–cell sites since each cell operates independently at radio level.

The number of TCH in a TDMA depends on the type of the TDMA:

M054E123

Standard cell				
	TS0	**TS1**	**TS2**	**TS3 à TS7**
C: combined TDMA for low traffic	BCCH + SDCCH/4	TCH	TCH	TCH
c: combined TDMA for low traffic	BCCH + SDCCH/4 + CBCH	TCH	TCH	TCH
B: TDMA for standard traffic	BCCH	SDCCH/8	TCH	TCH
b1: TDMA for standard traffic	BCCH	SDCCH/8 + CBCH	TCH	TCH
b2: TDMA for standard traffic	BCCH	TCH	TCH	TCH
S: Extension TDMA	TCH	SDCCH/8	TCH	TCH
S1: Extension TDMA (if DRX)	TCH	SDCCH/8	SDCCH/8	TCH
s: Extension TDMA	TCH	SDCCH/8 + CBCH	TCH	TCH
s1: Extension TDMA (if DRX)	TCH	SDCCH/8 + CBCH	SDCCH/8	TCH
T: Traffic TDMA	TCH	TCH	TCH	TCH

Extended cell				
	TS0	**TS1, 3, 5, 7**	**TS2**	**TS4, 6**
C_ext: combined TDMA for low traffic	BCCH + SDCCH/4		TCH	TCH
c_ext: combined TDMA for low traffic	BCCH + SDCCH/4 + CBCH		TCH	TCH
B_ext: TDMA for standard traffic	BCCH		SDCCH/8	TCH
b1_ext: TDMA for standard traffic	BCCH		SDCCH/8 + CBCH	TCH
b2_ext: TDMA for standard traffic	BCCH		TCH	TCH
S_ext: Extension TDMA	TCH		SDCCH/8	TCH
s_ext: Extension TDMA	TCH		SDCCH/8 + CBCH	TCH
T_ext: Traffic TDMA	TCH		TCH	TCH

Extended ccch					
	TS0	**TS1, 3, 5, 7**	**TS2**	**TS4**	**TS6**
b3: TDMA for standard traffic	BCCH	TCH	CCCH	TCH	TCH
b4: TDMA for standard traffic	BCCH	TCH	CCCH	CCCH	TCH
b5: TDMA for standard traffic	BCCH	TCH	CCCH	CCCH	CCCH

5.1.1.2   AGCH + PCH common channel

The channel payload is largely induced by "paging" messages used for locating the MS with a view to setting up a call. The remaining load is taken up by resource allocation messages issued by the AGCH for location updating purposes, paging responses and calls emitted by MS onto the fixed network.

The rule is to systematically reserve at least one access grant channel (AGCH).

By dimensioning paging channels a single common channel is occupied even when the needs of high capacity base station, wide location area and paging repeat message have to be covered .

5.1.2   Abis Interface dimensioning

Time slots at 64 kbit/s are needed to convey user traffic along the TCH between the BSC and BTS. Each cell must continuously transmit the BCCH frequency.

The traffic channel supports user traffic and signaling channels used for traffic management functions and operation/maintenance purposes. TCH channels are concentrated on radio sites and conveyed onto the Abis interface. Different configurations are possible on Abis interface. Each of them, is shown on *Figure 5–1.*

5.1.2.1   Drop and insert techniques

Two types of connections allow drop and insert technique: chain connection and loop connection.

Chain connection

The same external PCM link enables the connections between BSC and several Base Transceiver Station (BTS) equipments.

Each BTS uses a set of 64 kbit/s time slots.

Loop connection

For a chain connection, if one link between two BTSs fails, all the BTSs will be lost. However, to correct this disadvantage, the last BTS in the chain is looped back to the BSC using a PCM link. It is then possible to reconfigure the BTS units.

This drop and insert capability does not require any additional or specific equipment, or any specific software. When a BTS is being configured, the 64 kbit/s time slots are reserved for its usage. All other time slots stay in the "dropped" position.

The drop and insert techniques obey to the following rules:

- Wiring rule: a PCM link enters via an even DTI board (2. n) and leaves via an odd DTI board (2.n + 1).

- TEI rule: from the first BTS to the last BTS chained, the TEI number assigned to each BTS must be increased by 1.

- Number of TCHs and secondary LAPD:

$$\frac{2 \text{ x number of TRXs}}{\text{number of PCMs connected to the BTS}} + \text{secondary LAPD}$$

without taking into account redundant PCM links. In the case of a loop links configuration, the number of PCM links connected to the BTS is equal to 1.

In order to avoid LAPD crossing, the wiring and TEI rules must be applied.
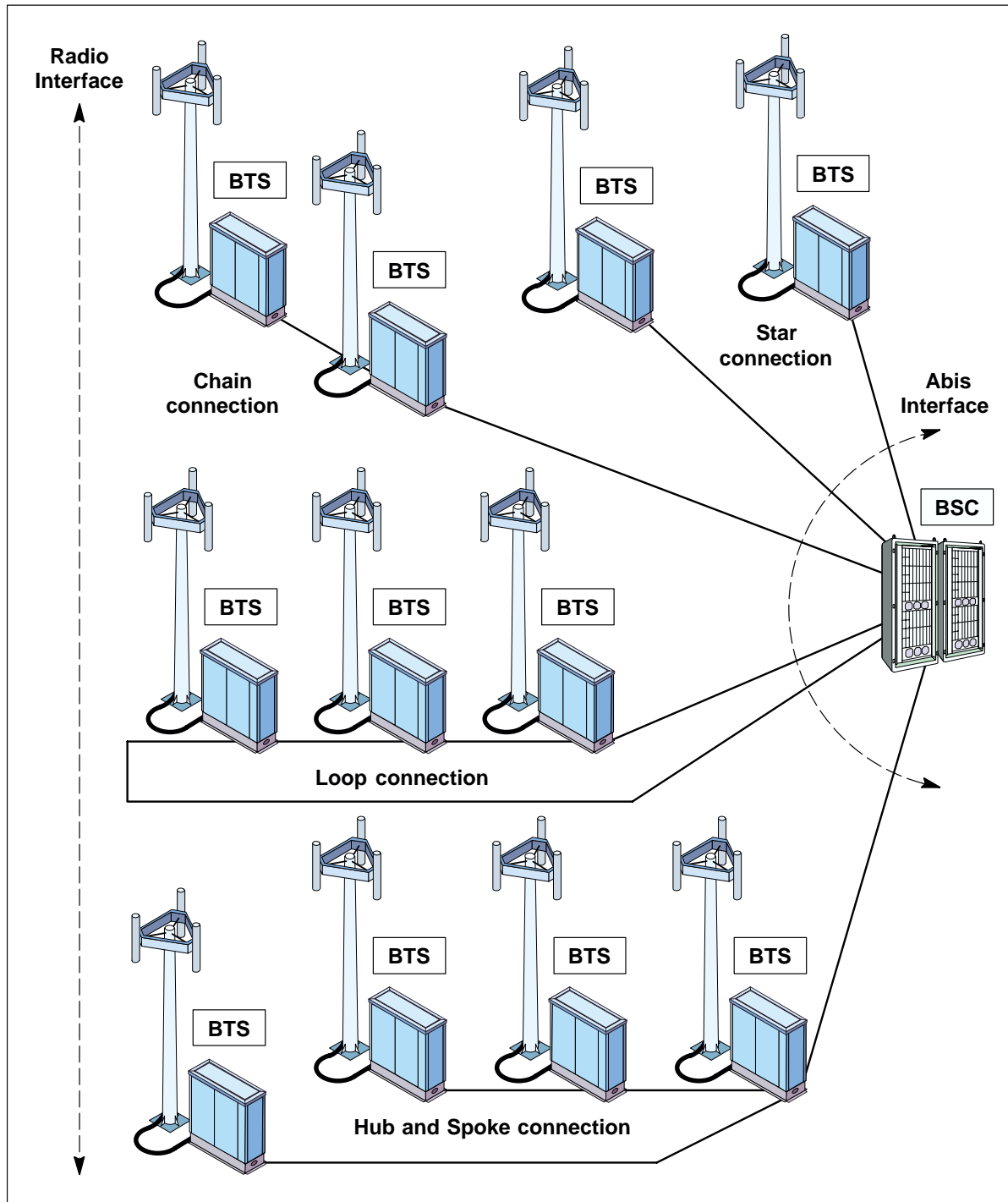
Figure 5–1   Types of BTS connections

5.2   Dimensioning of the BTS

5.2.1   Configurations

The maximum configurations are as follows:

- omnidirectional with one cabinet: 1O1 to 1O8
- omnidirectional with two cabinets: 2O16
- sectorial: up to a 3S888
- hexasectorial: up to 666_222 (dualband configuration)

5.2.2   Dimensioning of radio and Abis interfaces

Table 5–1 determines the number of traffic channels (TCH) required per cell, with an assumption of 25 mE/subscriber at peak time. The jam rate is 2% for the TCHs and 10–3 for SDCCH.

Config.	Standard cell		Extended cell		LAPD channels	Voice time slot	PCM No.
	Erlangs	TCH	Erlangs	TCH			
O1	2.27	6	0.6	3	1	2	1
O2	8.20	14	2.23	6	1	4	1
O4	21.0	29	8.20	14	1	8	1
O8	48.7	59	21	29	1	16	1
S11	4.54	12	1.2	6	1	4	1
S44	42	58	16.4	28	1	16	1
S111	6.81	18	1.8	9	1	6	1
S222	24.6	42	6.69	18	1	12	1
S233	36.2	56	17.6	26	1	16	1
S224	37.4	57	12.7	26	1	16	1
S333	42	63	23.1	30	3	18	1
S444	63	87	24.6	42	3	24	1 (E1) or 2 (T1)
S555	81.9	108	34.5	54	3	30	2
S666	104	132	42	63	3	36	2
S777	126	153	52.5	75	3	42	2
S888	146	177	63	87	3	48	2 (E1) or 3 (T1)
111_111	13.62	36	–	–	1	12	1
222_222	49.2	84	–	–	2	24	1 (E1) or 2 (T1)
444_222	87.6	129	–	–	3	36	2
444–444	126	174	–	–	3	48	2 (E1) or 3 (T1)
555_333	123.9	171	–	–	3	48	2
666_222	128.7	174	–	–	3	48	2
Blockage rate: 2%, with full–speed TCU With measurement pre–processing: 8 DRXs (or e–DRXs) / LAPD							

▌ **Table 5–1   Dimensioning of radio and Abis interfaces**

5.2.3   Dimensioning of DSC board (with BCF)

5.2.3.1   Design of DSC boards

The following table gives the number of DSC boards required according to the number of cells and the number of concentrated signaling links (without redundancy).

Cell	1 LAPD	2 LAPD	3 LAPD
1	1 DSC	–	–
2	1 DSC	2 DSC	–
3	1 DSC	2 DSC	3 DSC
4	1 DSC	2 DSC	3 DSC
5	1 DSC	2 DSC	3 DSC
6	1 DSC	2 DSC	3 DSC

Table 5–2   Board dimensioning

If at a given time, the number of DSCs available is less than the number given in this table, the entire site is lost until the number of DSCs is again correct. It is therefore strongly recommended to have a redundant DSC board.

The number of TEI that can be handled by one LAPD link is limited to 8.
Two cells cannot share the same LAPD unless the whole site is carried by the primary LAPD, except in case of an hexadecimal site.
TEI of the same cell must have the same LAPD number (if a cell has less than eight TEIs), two TEIs of different cells can also have the same concentrated channel.

There must be one DSC board per LAPD time slot: 1 DSC board can handle only one LAPD and vice versa one LAPD must be associated with a single board.

5.3   Configurations

- *Table 5–3* presents the possible configurations for the S8000 Indoor and S8000 Outdoor for each coupling system. The configurations indicated in the table below are highest configurations. They are not always available within the three frequency bands. This table is given for refrence only.

- Note that the number of converters in a cabinet can be depopulated according the number of DRXs (or e–DRXs) in the cabinet.

Coupling system	Configuration	Frequency band			
		S8000I BTS	S8000O BTS	S8002 BTS	S8006 BTS
D	1O1 to 1S222	GSM 900, GSM 1800 R–GSM,	GSM 900, GSM 1800 GSM 1900, R–GSM		
	2S111_111 to 2S222_222	Dual band 900/1800	Dual band 900/1800		
	O2			R–GSM	
D + CC8	2O16 to 3S888	GSM 1800 with CBCF module			
H2D	1O1_O1 to 1O4_O4	Dual band 900/1800	Dual band 900/1800		
	1O1 to 3S888 *	GSM 900, GSM 1800	GSM 900, GSM 1800, GSM 1900		
	3S111_111 to 3S444_444	Dual band 900/1800	Dual band 900/1800		
	S222, S42, S24, S33				GSM 1800
H4D	1O1 to 3S888	GSM 900, GSM 1800	GSM 900, GSM 1800 GSM 1900		
	6S16–16–16	**GSM 900, GSM 1800**			
D + H2D **	3S111_111 to 3S444_222	Dual band 900 /1800	Dual band 900 /1800		
2D+2TxF	1O1 to 2S44	GSM 900, GSM 1800, GSM 1900	GSM 900, GSM 1800, GSM 1900		
H2D+H4D 2H2D+H4D 2D+2H2D	1O2 to 3S888 1O2 to 3S888 1O2 to 3S666	GSM 900, GSM 1800	GSM 900, GSM 1800, GSM 1900		

* Four antennas or two cross–polar antennas are required.
** With BSS restrictions.
Note: The following values apply for all table entries:
    PA = 30 W
    Rx Splitter = Splitter 1*4 + LNA
    Receive sensitivity = –110 dBm guaranteed (If diversity and frequency hopping are considered, the receive sensitivity is –115 dBm guaranteed.)

■ **Table 5–3   Various configurations with each coupling system**

Wireless Service Provider Solutions
S8000/S8002/S8006 BTS Reference Manual

For more information, please contact:

For all countries, except USA:

Documentation Department
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