Nokia Siemens Networks

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Installation Site Requirements for Flexi BSC and TCSM

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Summary of changes

Changes between document issues are cumulative. Therefore, the latest document issue contains all changes made to previous issues.

Issue 1-0

This is the first issue of *Installation Site Requirements for Flexi BSC and TCSM*, based on *Installation Site Requirements for Base Station Controller and Transcoder*.

1 Overview

The *Installation Site Requirements for Flexi BSC and TCSM* provides the basic installation site information needed for the installation planning for the equipment. The subjects covered do not, however, include the installation planning instructions for the site power supply equipment or for the PCM and alarm distribution frames.

The following items are discussed in the *Installation Site Requirements for Flexi BSC and TCSM*:

- Technical specifications for Flexi BSC and TCSM3i
- General hardware platform requirements
- Overview of a Flexi BSC and TCSM3i installation site
- Power supply, grounding and bonding
- Electromagnetic compatibility
- Operational environment
- Cooling of DX 200 equipment
- Conversion between metric and imperial measures

This document is a companion manual for the *Engineering for Flexi BSC*. The document describes the installation (operational) environment and environmental conditions that the equipment may be exposed to. By following these instructions, you can ensure

- reliable operation
- low fault rate
- long life
- safety to personnel and property

throughout the equipment's intended service life.

The specified environments and limits correspond to engineering evaluations or tests that the equipment has been subjected to.

In general, for each condition, event or aspect, the specifications are given for normal operating conditions. In some cases there are specifications given also for exceptional conditions, such as extreme temperature or humidity, earthquake, and for non-operational conditions such as transport and storage.

The duration of and exposure to exceptional operational conditions must be short term and occasional.

Tip

For more specific warnings and cautions, refer to the document *Warnings and Cautions*.

Acronyms related to Flexi BSC

Acronyms related to Flexi BSC are presented in the following tables.

Table 1. BSC network elements

BSC = Base Station Controller, a general term for all BSC network elements		
General name	**Product name**	**Explanation**
BSCi/BSC2i	BSCi	High capacity (upgraded) version of the first generation DX 200 BSC (BSCE)
	BSC2i	High capacity version of the second generation DX 200 BSC2
Flexi BSC product family	BSC3i 660	660 TRX one cabinet configuration, upgradable to Flexi BSC
	BSC3i 1000/2000	1000 TRX one-cabinet or 2000 TRX two-cabinet configuration, upgradable to Flexi BSC
	Flexi BSC	3000 TRX one-cabinet configuration (S14)

More information on the Flexi BSC is found also in *Installing Flexi BSC and TCSM3i*.

Acronyms related to Transcoder Submultiplexer

Acronyms related to Transcoder Submultiplexer are presented in the following table.

Table 2. TCSM3i and TCSM2

TCSM3i high capacity transcoder submultiplexer, TCSM3i		
Installation option	**Product name**	**Explanation**
TCSM3i for stand-alone installation option	TCSM3i high capacity transcoder submultiplexer, American National Standards Institute (ANSI) version of TCSM3i	ET interfaces in ANSI environment
TCSM3i for stand-alone installation option	TCSM3i high capacity transcoder submultiplexer, European Telecommunications Standards Institute (ETSI) version of TCSM3i	ET interfaces in ETSI environment
TCSM3i for combined BSC/TCSM installation option	TCSM3i for combined BSC/TCSM installation option	STM-1/OC-3 interfaces in the A-interface
Second generation Transcoder Submultiplexer, TCSM2		

More information on the Flexi BSC is found also in *Installing Flexi BSC and TCSM3i*.

2 Technical specifications for Flexi BSC and TCSM3i

Cabinet dimensions

Table 3. Cabinet dimensions in M98 mechanics

BSCC and TCSA cabinet (H x W x D)	2000 x 900 x 600 mm
Cabling cabinet (H x W x D)	2000 x 300 x 600 mm
Side cable conduit (H X W x D)	2000 x 75 x 600 mm

Cabinet weight

Table 4. Cabinet weights in M98 mechanics

Cabinet maximum weight, BSCC cabinet, fully equipped	350 to 370 kg
Cabinet maximum weight, TCSA cabinet, fully equipped	320 kg
Cabling cabinet, CC	75 kg
Side Cable Conduit, SCC	10 kg

Power consumption

Rated power consumption values are nominal values that have been calculated on the basis of the *theoretical or estimated maximum power consumption.* These values do not represent the network element power consumption in normal operation, but they are useful for planning site power feed.

Operating power consumption values are based on measurements with application software installed and running in the network element, and *maximum operating power consumption* values are based on maximum traffic. These values are useful for estimating heat dissipation, site cooling planning, battery back-up planning, rectifier planning, and dimensioning. The estimated maximum operating power consumption values listed below are examples, because the type of traffic in the network element can affect the measurement result.

Power consumption in IDLE state is approximately 5% lower than the maximum operating power consumption.

Table 5. Power consumption in Flexi BSC and TCSM3i

Estimated maximum power consumption for dimensioning	Flexi BSC, one BSCC cabinet: 3.8 kW TCSM3i, stand-alone installation option with maximum configuration: • 3.0 kW (traditional E1 interfaces) • 2.7 kW (traditional T1 interfaces TCSM3i, combined BSC/TCSM installation option with maximum configuration: 2.8 kW (STM-1/OC-3 interfaces)
Estimated maximum operating power consumption	Flexi BSC, one BSCC cabinet: 2.3 to 2.7 kW TCSM3i, stand-alone installation option with maximum configuration: • 1.6 kW (traditional E1 interfaces) • 1.3 kW (traditional T1 interfaces) TCSM3i, combined BSC/TCSM installation option with maximum configuration: 1.5 kW (STM-1/OC-3 interfaces)

In the combined BSC/TCSM installation, there can be up to three TCSA cabinets (TCSA 0, TCSA 1 and TCSA 2).

Power supply

Table 6. Power supply in the cabinets

Nominal voltage		Cabinet	Minimum fuse rating	Circuit breaker rating
DC	-48V	BSCC 1)	2 x 100 A / 4 x 63 A 4)	2 x 100 A / 2 x 80 A / 4 x 63 A 4)
		TCSA 2)	2 x 100A / 4 x 63 A 4)	2 x 80 A / 4 x 63 A 4)
		TCSA 3)	2 x 100A / 4 x 63 A 4)	2 x 80 A / 4 x 63 A 4)
Notes				
1) In Flexi BSC				
2) In TCSM3i for the stand-alone installation				
3) In TCSM3i for the combined BSC/TCSM installation				
4) 2 x = one redundant supply pair; 4 x = two redundant supply pairs				

3 General hardware platform requirements

The following international specifications and recommendations are valid for M98 network elements only.

General

SR-3580, Issue 3, June 2007
NEBS Criteria Levels

Equipment safety

IEC 60950-1, April 2006
Information technology equipment - Safety - Part 1: General requirements

EN 60950-1, 2001
Safety of information technology equipment including electrical business equipment

UL 60950-1, 2003 Safety of information technology equipment

GR-1089-CORE, Issue 4, June 2006
Telcordia Technologies Generic Requirements. Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment

EMC

ETSI EN 300 386, V1.3.3 (2005-04)
Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements

Code of Federal Regulations, Title 47 (CFR 47), Telecommunication, Revised Oct. 1. 2007
Federal Communications Commission, Part 15 (FCC 15), Radio Frequency Devices ("EMC")

GR-1089-CORE, Issue 4, June 2006
Telcordia Technologies Generic Requirements. Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment

CISPR 22, ed. 5.2, 2006
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement

CISPR 24, 1997 + Am.1, 2001 + Am. 2, 2002
Information technology equipment - Immunity characteristics - Limits and methods of measurement

Power feed

ETSI EN 300 132-2, V2.1.2 (2003-09)
Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc))

ETR 283, 1996
Equipment Engineering (EE); Transient voltages at Interface A on telecommunications direct current (dc) power distributions

GR-1089-CORE, Issue 4, June 2006
Telcordia Technologies Generic Requirements. Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment

Earthing (grounding) and bonding

ETSI EN 300 253, V2.1.1 (2002-04)
Environmental Engineering (EE); Earthing and bonding configuration inside telecommunications centres

ITU-T K.27, 05/96
Protection against Interference. Bonding Configurations and Earthing inside a Telecommunication Building.

GR-1089-CORE, Issue 4, June 2006
Telcordia Technologies Generic Requirements. Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment

Environmental endurance

ETSI EN 300 019-1-1, V2.1.4 (2003-04)
: Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-1: Classification of environmental conditions; Storage

ETSI EN 300 019-1-2, V2.1.4 (2003-04)
: Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-2: Classification of environmental conditions; Transportation

ETSI EN 300 019-1-3, V2.1.2 (2003-04)
: Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weather protected locations

GR-63-CORE, Issue 3, March 2006
: Telcordia Technologies Generic Requirements. NEBS™ Requirements: Physical Protection

Earthquake

GR-63-CORE, Issue 3, March 2006 - Zone 4
: Telcordia Technologies Generic Requirements. NEBS™ Requirements: Physical Protection

ETSI EN 300 019-1-3, V2.1.2 (2003-04)
: Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weather protected locations

Acoustic noise

ETS 300 753, October 1997
: Equipment Engineering (EE); Acoustic noise emitted by telecommunications equipment

GR-63-CORE, Issue 3, March 2006
: Telcordia Technologies Generic Requirements. NEBS™ Requirements: Physical Protection

Fire resistance

GR-63-CORE, Issue 3, March 2006
Telcordia Technologies Generic Requirements. NEBS™ Requirements: Physical Protection

Altitude

GR-63-CORE, Issue 3, March 2006
Telcordia Technologies Generic Requirements. NEBS™ Requirements: Physical Protection

Telecommunication site

IEC 62305-1, First edition 2006-01
Protection against lightning - Part 1: General principles

IEC 62305-2, First edition 2006-01
Protection against lightning - Part 2: Risk management

IEC 62305-3, First edition 2006-01
Protection against lightning - Part 3: Physical damage to structures and life hazard

IEC 62305-4, First edition 2006-01
Protection against lightning - Part 4: Electrical and electronic systems within structures

RoHS

Nokia Siemens Networks DX 200 M98 mechanics hardware complies with the European Union RoHS Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment. The directive applies to the use of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE) in electrical and electronic equipment put on the market after 1 July 2006.

4 Overview of a Flexi BSC and TCSM3i installation site

This section describes briefly the equipment room layout and some basic requirements for the premises.

4.1 Floor load

The network elements can be installed on a raised or on a concrete floor. We recommend the use of a raised floor in the equipment room, with all the site cables placed under the floor. Check with local construction engineers and battery manufacturers to determine floor load requirements.

The cabinet is dimensioned according to ETSI recommendations and is suitable for, but not limited to, raised floor installations with standard 600 mm x 600 mm floor tiles.

The site floor load capacity must be sufficient to carry the installed equipment. For more information on cabinet weights, see *Technical specifications for Flexi BSC and TCSM3i*.

4.2 Equipment room layout

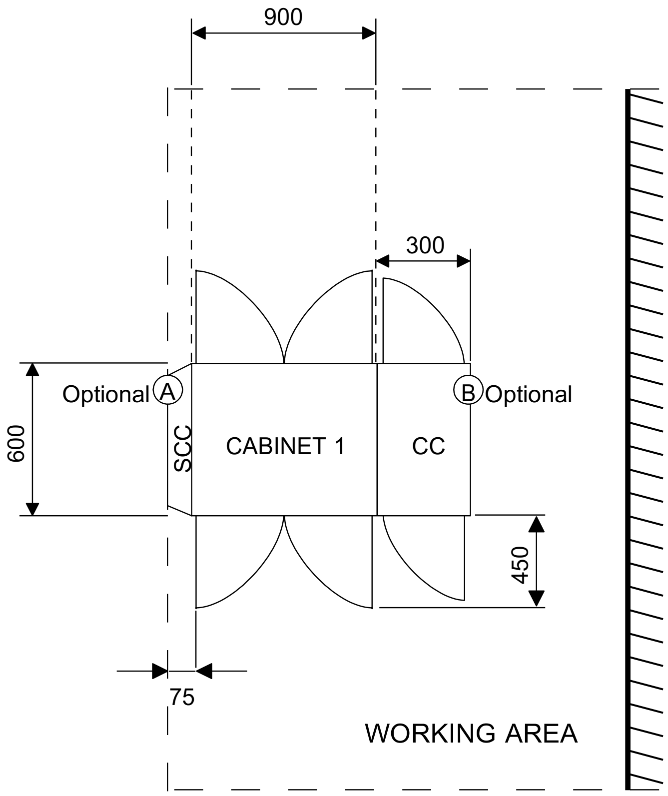
In the layout planning, the following aspects should be considered:

- Space reservation for extension cabinets: We recommend that the premises be dimensioned so that there is enough room for a fully equipped network element.
- Free space above the cabinet rows (height at least 500 mm, or 20 in.)

- Placement of the overhead cable support structures for power supply and PCM circuit cables: This is necessary for installations without a raised floor.
- AC power sockets for measuring and peripheral devices.
- Lighting for the cabinets.
- Room for maintenance between two two-cabinet units with SCCs (when the equipment room has a raised floor)
- Access to cabling underneath a raised floor: At least one row of floor tiles between cabinets must be removable for this purpose.
- If planning a NEBS-compliant site arrangement, average heat release per floor area should be calculated according to NEBS GR-63-CORE.

Each cabinet should be located in the equipment room with free space of 900 mm (35.4 in.) both at the front and the back, and 500 mm (20 in.) between the end of a cabinet row and the wall.

Figure *Space estimates of the BSCC and TCSA cabinet* shows the measurements of the Flexi BSC and the required distances from the walls.



A = Optional side cable conduit (SCC) is connected to either side of the BSCC in an equipment room with a raised floor. The SCC is not used when overhead cabling or the cabling cabinet is in use.

B = Optional cabling cabinet (CC) is connected to the BSCC cabinet when the number of external PCM circuits exceeds 48.

Figure 1. Space example for the BSCC and TCSA cabinet

Figure *Layout principles* shows the layout principles for Flexi BSC, BSC3i, stand-alone TCSM3i installation option and combined BSC/TCSM installation option.

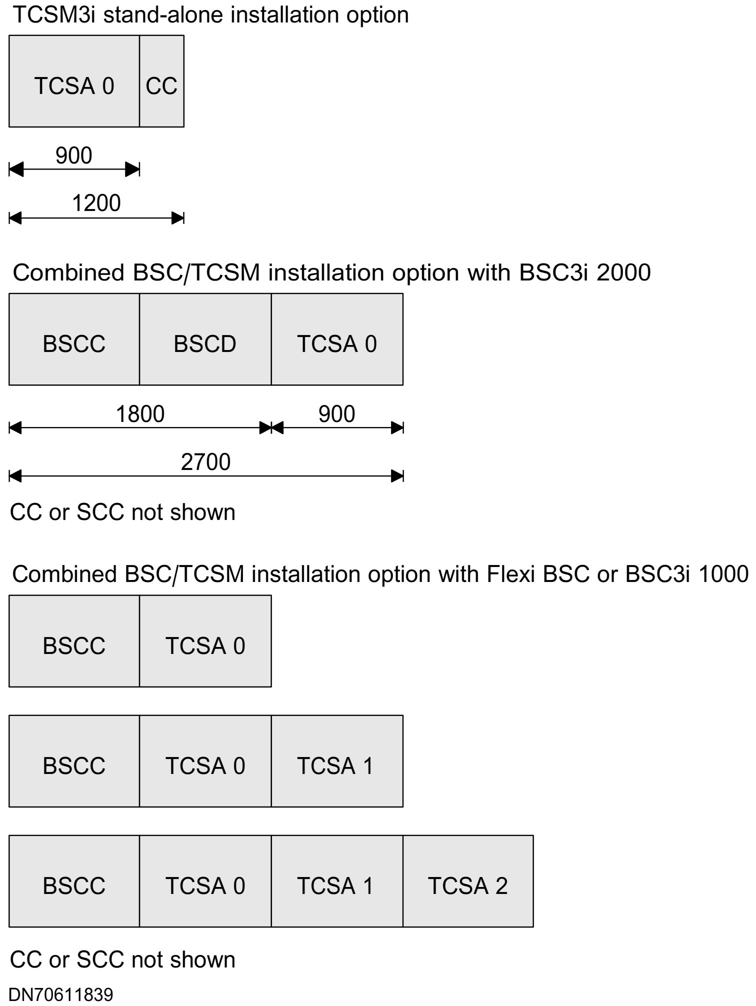


Figure 2. Layout principles

4.3 Layout examples of Flexi BSC and TCSM3i

In S14 first deliveries, one-cabinet Flexi BSC is introduced. Flexi BSC - first-delivery or upgraded - can also be used as the BSC-part in TCSM3i for combined BSC/TCSM installation option. In the combined BSC/TCSM installation option, when TCSA 1 and TCSA 2 extension cabinets are used with upgraded Flexi BSC with BSCD cabinet, the TCSA cabinets are installed from right-to-left on the left-hand side of the BSCC cabinet.

The Flexi BSCs and TCSM3is are installed in rows as shown in the following figures, including the layout examples with a side cable conduits (SCC) and cabling cabinets (CC).

Figure *Equipment room without raised floor, an example* shows layout alternatives A and B of an equipment room without raised floor. The two-row layout example A shows three TCSM3is for stand-alone installation option in one row, and one TCSM3i for combined BSC/TCSM installation option with Flexi BSC or BSC3i 1000 as BSC-part (number of ETs is 0…48), one BSC3i 2000 (number of ETs is 0…48), and one Flexi BSC or BSC3i 1000 (number of ETs is 0…48) in the other row.

The TCSA cabinet can also be installed to the left-hand side of the BSC-part as shown in alternative B, and that the network elements can be installed from left-to-right as well as from right-to-left. The cabinets, however, must be positioned within the network elements as shown in the figure.

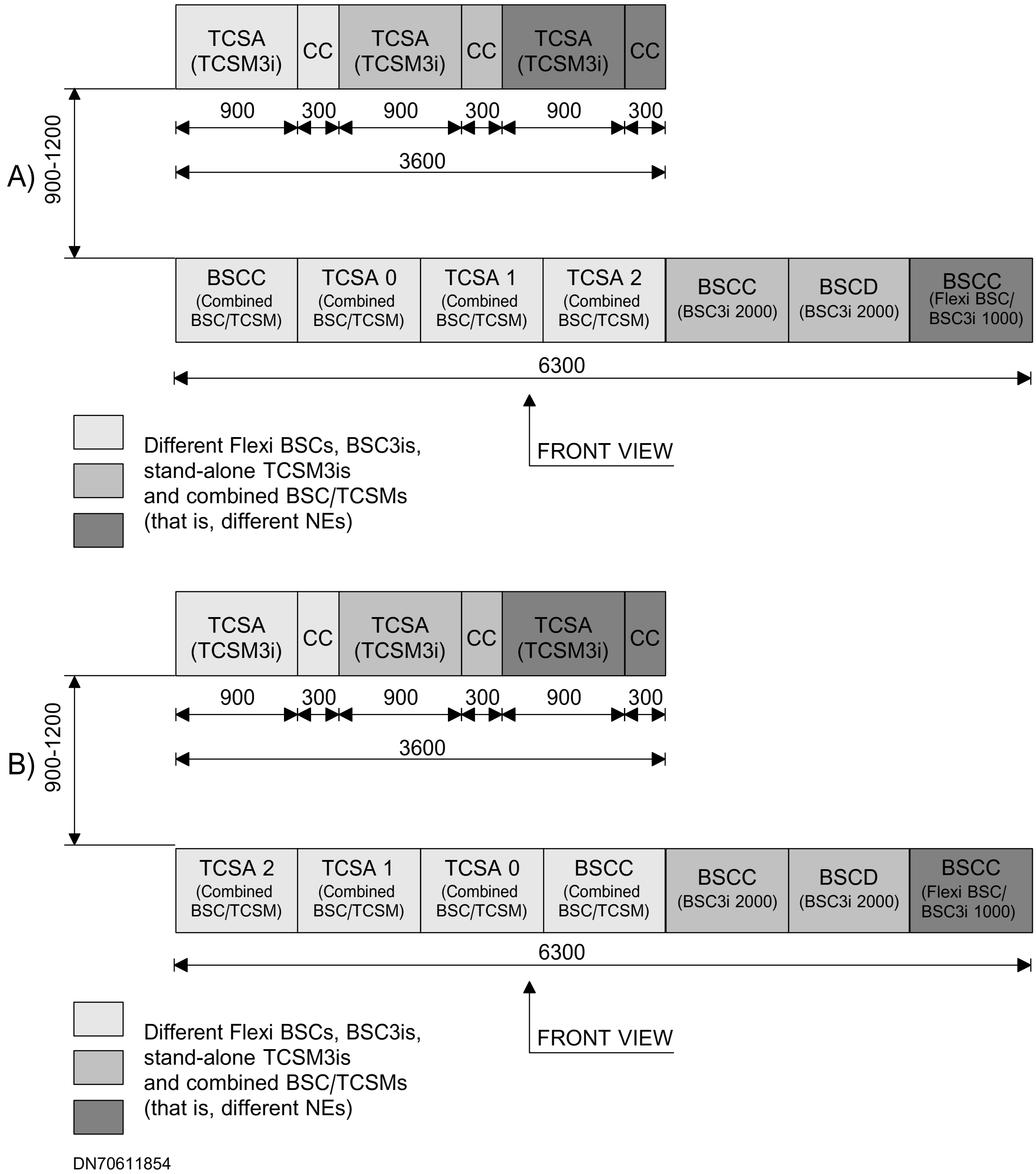


Figure 3. Equipment room without raised floor, an example

Figure *Equipment room with raised floor, example 1* shows layout alternatives A and B of an equipment room with raised floor. The two-row layout example A shows three TCSM3is for stand-alone installation option in one row, and one combined BSC/TCSM installation option with Flexi BSC or BSC3i 1000 as BSC3-part (number of ETs exceeds 48), one BSC3i 2000 (number of ETs exceeds 48), and one Flexi BSC or BSC3i 1000 (number of ETs exceeds 48) in the other row.

The TCSA cabinet can also be installed to the left-hand side of the BSC-part as shown in alternative B. The network elements can be installed from left-to-right as well as from right-to-left. The cabinets, however, must be positioned within the network elements as shown in the figure.

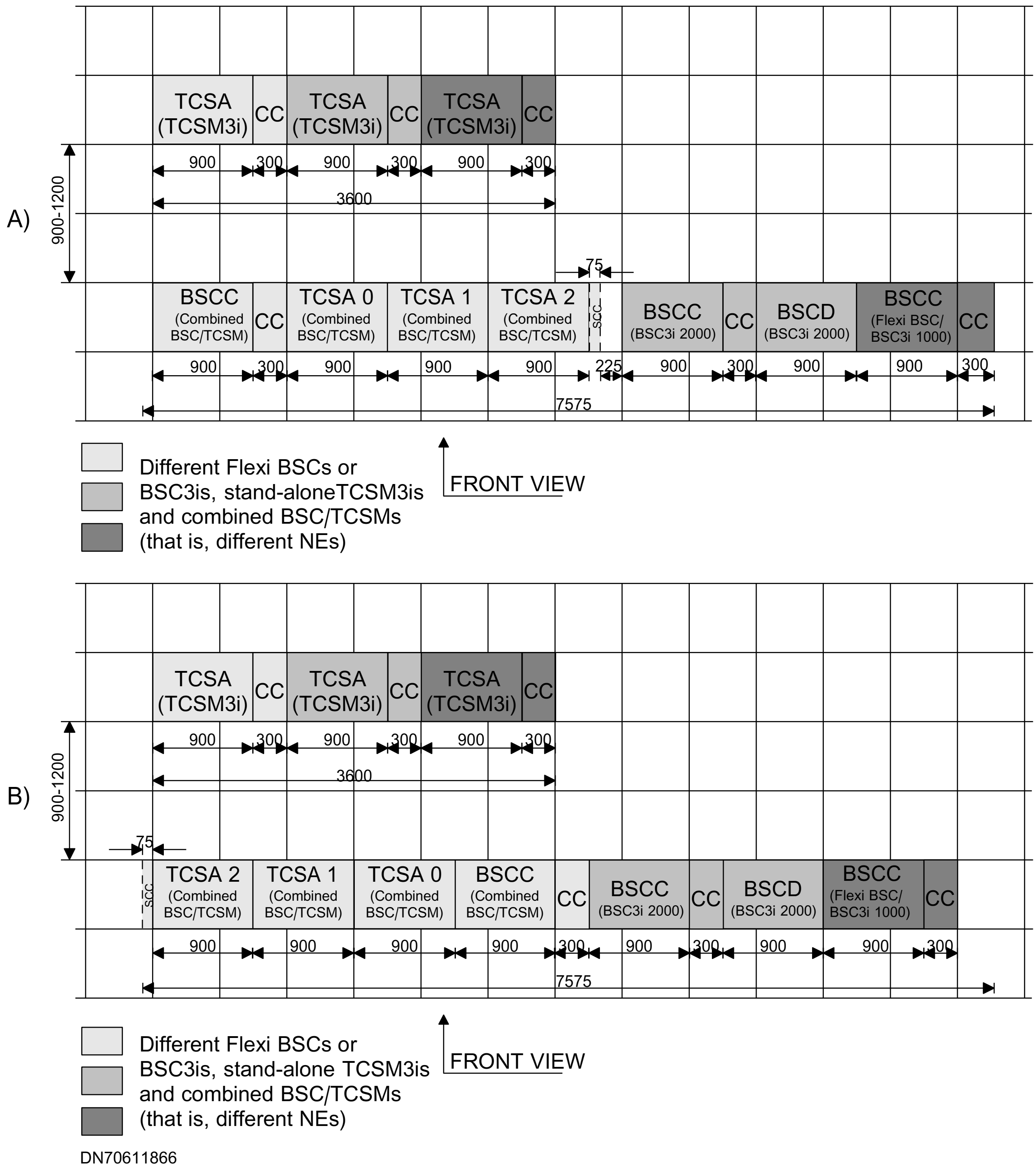


Figure 4. Equipment room with raised floor, example 1

Figure *Equipment room with raised floor, example 2* shows layout alternatives A and B of an equipment room with raised floor. The two-row layout example A shows three TCSM3is for stand-alone installation option in one row, and one combined BSC/TCSM installation option with Flexi BSC or BSC3i 1000 as BSC-part (number of ETs is 0…48), one BSC3i 2000 (number of ETs is 0…48), and one Flexi BSC or BSC3i 1000 (number of ETs is 0…48) in the other row.

The TCSA cabinet can also be installed to the right-hand side of the BSC-part as shown in alternative B. The network elements can be installed from left-to-right as well as from right-to-left. The cabinets, however, must be positioned within the network elements as shown in the figure.

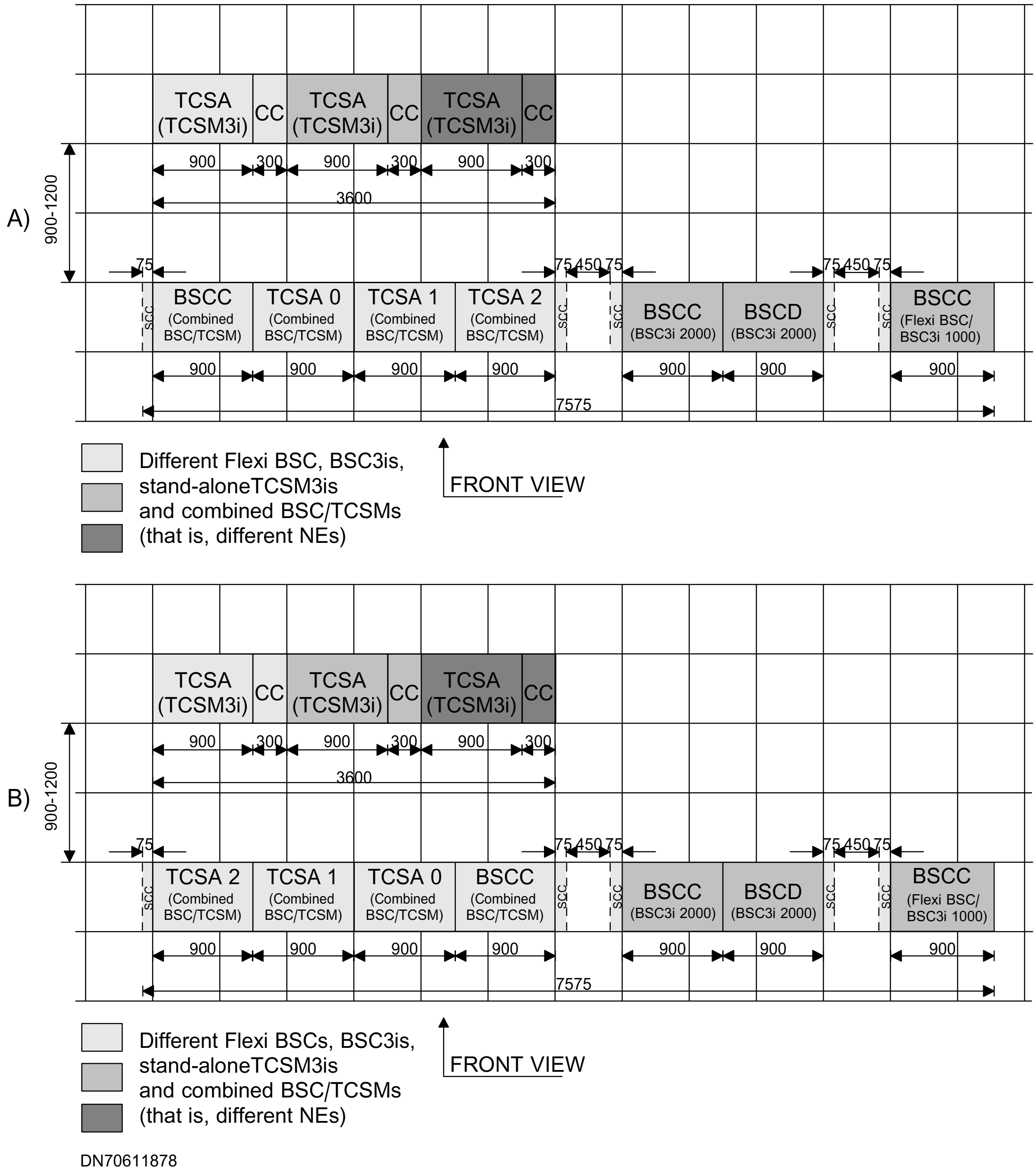


Figure 5. Equipment room with raised floor, example 2

5 Power supply, grounding and bonding

The following sections describe the general requirements for the external site power supply system and the main cables feeding the cabinets, which are not included in the DX 200 delivery. They also describe the grounding and bonding systems of the site, along with the requirements for the AC power supply in the exchange room.

Note

For simplicity, only the negative lead is drawn from the rectifiers to the cabinets in the figures describing the power supply system.

To ensure 2N redundancy of the power distribution, the cabinets of the network elements are provided with either two or four PDFU units (two PDFU-B units in new deliveries; older deliveries may have four PDFU-A units or two PDFU units). Each PDFU forms an independent feeding branch consisting of circuit breakers, diodes, filters, fuses, and other related equipment. The feed cables to the cabinets are also duplicated, with both supply lines connected to:

- both PDFU-Bs (0 and 1); or in older deliveries,
- the four PDFU-As (0-3) or
- both PDFU-A pairs (0 and 1; 2 and 3) or
- both PDFUs (0 and 1).

Note

The IC209-B and IC209-A cabinets have two PDFU-B units (or four PDFU-A units in older deliveries), while the earlier cabinet type IC209 has two PDFUs. The connection of power supply lines to the cabinets varies among different network elements and cabinet types as shown in the sections which follow. A detailed description of the internal power distribution system can be found in the network element specific *Engineering Descriptions.*

An example power distribution diagram for the network elements is shown in the figure below.

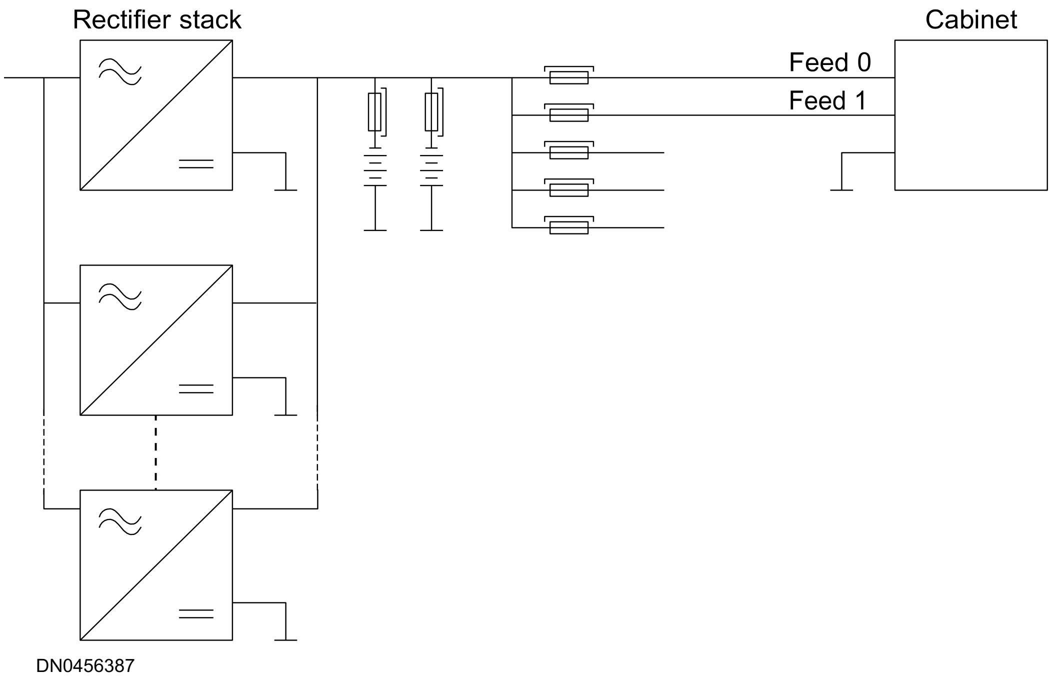


Figure 6. N+1 rectifier system with two separate backup battery strings

5.1 DC power supply

The following sections describe the general requirements for the external site power supply system and the main cables feeding the network elements.

5.1.1 General requirements for DC power supply

The DX 200 system is designed to operate on -48 VDC or -60 VDC nominal supply voltage. A floating battery system, in which rectifiers convert the voltage from AC utility power to DC and lead-acid batteries are used as backup energy storage, is the most commonly used solution to provide the DC power.

Note

The DX 200 is approved only for -48 VDC nominal supply voltage in North America (USA and Canada).

The supply voltage must meet the following requirements at the cabinet power entry interface:

Table 7. Supply voltage requirements

Requirements	for -48 V systems	for -60 V systems
Nominal voltage	-48 V	-60 V
Voltage range	-40.0 V to -57.0 V	-50.0 V to -72.0 V
Wideband noise	max. 100 mVrms	

Wideband noise is defined as the rms voltage in any 3 kHz frequency band from 10 kHz to 20 MHz.

The permitted level of narrowband noise is shown in the figure below. The values shown in the figure refer to the following maximum bandwidths:

Table 8. Maximum permitted bandwidths

Frequency range	Bandwidth (-6 dB)
25 Hz to 10 kHz	10 Hz
> 10 kHz to 20 kHz	200 Hz

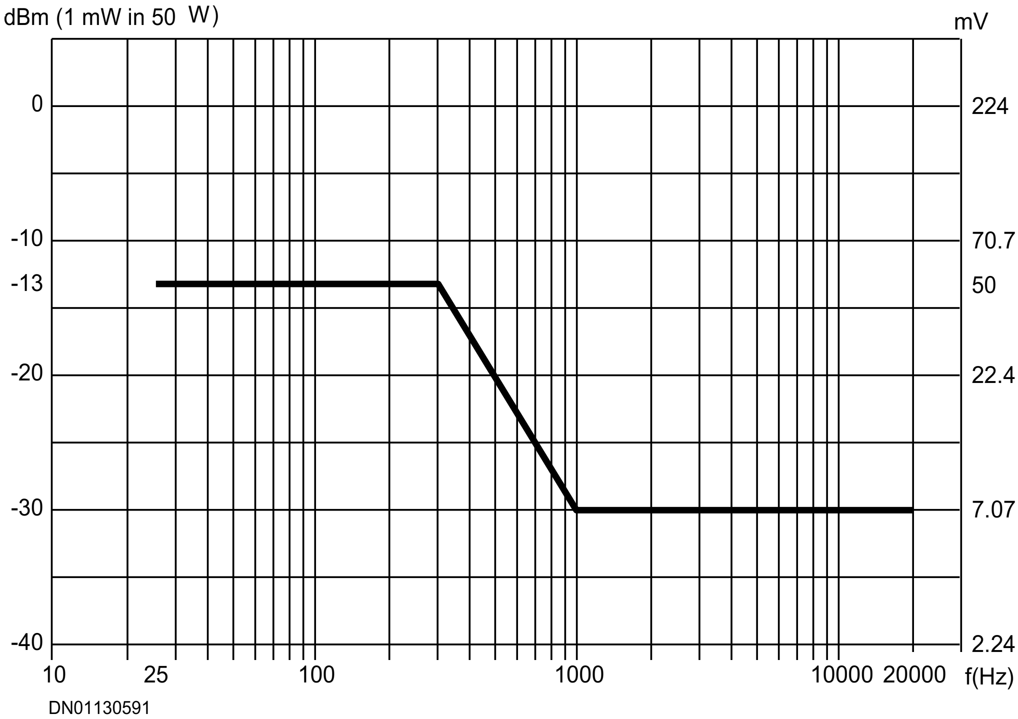


Figure 7. Maximum level of narrowband noise for the DX 200 network elements

The recommended method of measurement is with a spectrum analyser having the bandwidths shown above for the relevant frequency ranges.

The requirements for wideband and narrowband noise meet the requirements of ETSI EN 300 132-2, Section 4.8, and ANSI T1.315 standards.

Note

If the site DC power supply serves other equipment besides the DX 200, the impedance between the batteries and the main distribution bar must be sufficiently low or additional bus bar capacitors must be used to avoid interference in failure situations (between devices connected in parallel). The maximum allowable break in the power supply, caused by the other equipment, is 4 ms, so that the DX 200 equipment stays operational.

5.1.2 Overvoltage transients and surges in DC supply

Overvoltages and transients in the site at power supply interface A must be within Lightning Protection Zone 2 (LPZ2) level according to the IEC61312 and IEC62305 standard series. For the network element immunity/resistibility surge levels in practice, this typically means installation Class 0 to installation Class 1 testing parameters (according to standard IEC61000-4-5).

5.1.3 Overvoltages and outages

The DC supply line impedance may generate transients when short circuits or equipment switch-on occur. These transients can be expressed as short overvoltages or outages. The outage tolerance is dependent on the preceding input voltage value. The following figure shows the maximum tolerable input voltage outage duration (hold-up time).

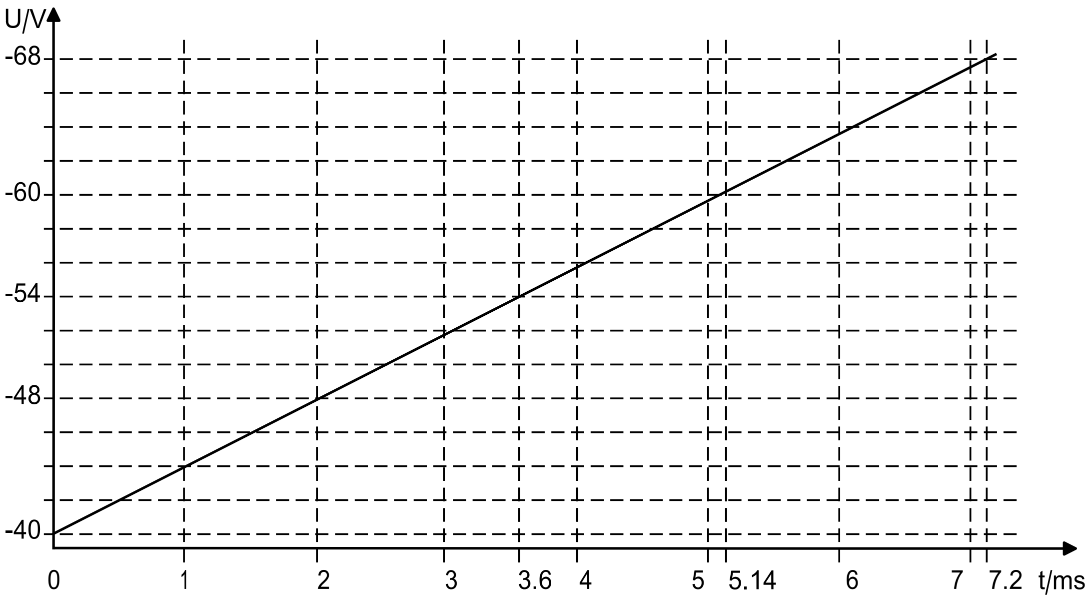


Figure 8. Hold-up time per input voltage

5.1.4 Requirements for the power supply cables (DC)

Each cabinet should be fed via two independent supply groups (cable pairs) from the site DC power. The cables must meet local requirements (such as the UL60950 standard and the National Electrical Code ANSI/NFPA No. 70 in North America). The cables are not included in the DX 200 delivery.

The cabinet power entry connectors accept cable sizes from 16 mm^2 (AWG5) to 50 mm^2 (AWG0). In order to ensure proper operation of the equipment during the entire intended period when the backup system is needed, the following factors must be considered when choosing the dimensions of the supply cables:

- The maximum allowed voltage drop in the supply cables between the main distribution bus and the terminal block is 1.5 V.
- The maximum allowed voltage drop between the batteries and the main distribution bar is 1.0 V.
- The minimum allowed discharge voltage per cell is 1.80 V (if not otherwise stated in the battery manufacturer's specifications), which equals 43.2 V for a 24-cell battery set.

The required cable dimensions (cross-section) depend on the maximum current and the cable length (resistance). The DX 200 uses switch-mode internal power supplies that draw a steady amount of power regardless of the feed voltage. Thus the load current is highest when the feed voltage is the lowest (that is, -40.5 VDC).

Calculating cable resistance

The specific resistance, ρ, for copper at +20°C is 17.2×10^{-9} Ωm.

The resistance, R, of a conductor is:

$$R = \frac{\rho \times l}{A}$$

where l = length, A = area (cross-section), ρ = specific resistance, and R = resistance.

Example:

R for a conductor of 1 m length and 16 mm^2 cross-section is:

$$R = \frac{17.2 \times 10^{-9}\,\Omega\,m \times 1\,m}{16 \times 10^{-6}\,m^2} = 1.075 \times 10^{-3}\,\Omega$$

The following table shows examples of maximum cable lengths.

Table 9. Examples for maximum cable lengths

Load power	**Current at -40.5 VDC**	**Maximum resistance (at 1.5 V drop)**	**Maximum cable length / cross-section*)**						
			6 mm^2	**10 mm^2**	**16 mm^2**	**25 mm^2**	**35 mm^2**	**50 mm^2**	**70 mm^2**
			**)	**)					
W	A	mΩ	m	m	m	m	m	m	m
500	12.3	122	42	70	113				
700	17.3	87	30	50	80				
1000	24.7	61	21	35	56	88			
1500	37.0	41		23	37	58	82		
2000	49.4	30			28	44	61	88	
2500	61.7	24				35	49	70	97
3000	74.1	20				29	41	58	81
3500	86.4	17					35	50	69
4000	98.8	15			Illegal area			44	61
4500	111.1	14						39	56
5000	123.5	12							48

*) Cabling length is valid for two pairs in parallel. One pair consists of power and return lines.

**) 6 mm^2 and 10 mm^2 conductors are suitable for FlexiServer equipment only. They are not allowed in the DX 200 system.

Simplified formula to determine the necessary conductor cross-section

To get the minimum allowed cross-section in square millimeters, insert the distance (cabling length), *b*, in meters and cabinet power, *a*, in watts, in the following equation:

$$A(mm^2) = \frac{17.2 \times 10^{-3} \Omega\, m \times b\, m \times a\, W}{60\, V^2}$$

Then choose a suitable standard cross-section.

The maximum voltage drop from the battery terminals to the element may not be more than 1.5 V + 1.0 V at maximum discharge current (ETSI EN 300 132-2).

Note

No single fault may cause the system to fall outside the specifications. There are three probable conditions (faults) that have an effect on the power feed:

1. When the power is drawn from the backup batteries (that is, when the AC mains is down), both supply groups are operational, and the ambient temperature is nominal.
2. When one supply group is down, the rectifiers are operational (that is, the supply voltage is high enough to allow for twice as high a loss in the supply cables), and the ambient temperature is nominal.
3. When the ambient temperature is exceptional (extremely high), the rectifiers are operational (that is, the supply voltage is high enough to compensate for higher loss in the supply cables), and both supply groups are operational as well.

Note

If the voltage drop from the battery terminals to the DX 200 cabinet is more than 1.5 V + 1.0 V at maximum discharge current, the minimum allowed discharge voltage per cell must be set accordingly higher.

5.1.5 Central power supply overcurrent protection

The network elements have internal overcurrent-protective devices in the power entry or distribution circuits. However, each supply branch must be equipped with an overcurrent-protective device. Typical ones are fuses or circuit breakers.

The protecting devices of the distribution lines to the cabinets are located in the power distribution centre of the equipment room. Each live conductor of a supply group must be protected using fuses or circuit breakers with the following minimum ratings:

- 63 A (70 A in North America) for each supply group feeding a load of 1600 W or less
- 32 A (35 A in North America) is sufficient for each supply group feeding a load of 800 W or less

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Note

The DC return (neutral) conductor may not be equipped with an overcurrent protector.

The maximum rating for the protective devices should not exceed 125 A. This is to ensure proper operation of the device and to avoid any fire hazard in the unlikely case of a short circuit within a DX 200 cabinet.

The overcurrent protection system must be selective to minimize the effect of a fault. The selectivity should be such that a fault triggers only the first protector upstream (towards the power source).

The easiest way to determine selectivity for the protection system is by comparing the trip time curves of the whole system of security devices. The protection of the second stage (in the network element) must be below the curve of the first stage (branch fuse). To ensure proper functioning of the overcurrent protection system, it is recommended that the branch fuse rating be at least 1.4 times the network element breaker rating.

The protecting devices of the distribution lines to the cabinets are located in the power distribution centre of the equipment room. Each live conductor of a supply group must be protected using fuses or circuit breakers.

Note

The DC return (neutral or +) conductor may not be equipped with an overcurrent protector.

The maximum fuse or circuit breaker rating is limited by the cable cross-section.

Table 10. Maximum fuse or circuit breaker rating per cross-section

6 mm^2	10 mm^2	16 mm^2	25 mm^2	35 mm^2	50 mm^2
25 A	32 A	63 A	80 A	100 A	125 A

5.1.6 Batteries

Warning

The batteries contain highly corrosive acid, and they may emit flammable hydrogen gas. The batteries should be mounted over a basin or precautions should be taken to control any spilled acid. The battery compartment (room) must be well ventilated to remove any explosive gas. Observe local regulations as well as battery manufacturers' cautions and warnings.

The batteries serve as a backup power source for the network element if the power supply from the rectifiers is interrupted. For ease and safety of battery maintenance, the use of two or more separate battery groups (strings) is recommended. To achieve a nominal voltage of 48 V, the battery group has 24 cells (30 cells for 60 V nominal voltage).

Battery capacity should be selected according to the load and desired backup time. The backup time depends on customer requirements. In designing the battery system, note that its capacity decreases somewhat as it ages.

When implementing several battery groups, the battery backup capacity (backup time) may be split between the systems.

The summed resistance of the battery, connectors and cables must be low enough to ensure that in case of a short circuit in one cabinet, the power supply to the other cabinets will not be disturbed.

If the battery feeds other equipment besides the DX 200, the resistance of the battery and its cables must be as low as possible. This is to ensure that in case of a power supply failure, the disturbance does not spread from one system to another. Therefore, it is recommended to use additional capacitors in the power distribution bus bar.

5.2 AC power supply to auxiliary equipment

If peripheral devices (terminals or printers) or routers and switches are connected to a network element, the required AC supply can be taken from the mains supply, a UPS, or a power supply equipped with inverters to ensure uninterrupted supply. The mains supply network must be designed in accordance with local regulations concerning electrical safety.

Isolating the AC power supply

The following information applies only if IBN grounding is used on the site.

When equipment powered by the AC mains supply is connected to the network element, the AC mains supply ground must be isolated from the network element ground. The isolated AC-powered equipment must be intentionally grounded to the network element ground. This is to avoid disturbance in the network element equipment, and also to prevent the operating personnel from being exposed to the danger of an electric shock in case of failures in the equipment. Two options exist for isolating the AC network:

- all AC power sockets in the vicinity of the network element cabinets are isolated using a fixed isolating transformer; or
- all equipment fed by the AC network and connected to the network element is isolated using separate isolating transformers.

Typical power consumption values for peripheral devices

The typical power consumption of peripheral devices is shown in the following table:

Table 11. Power consumption of peripheral devices

Peripheral device	Power consumption
Printer	120 W
VDU	50 W

5.3 Grounding and bonding

Grounding and bonding ensures highly reliable functioning of the site. It minimizes the electrical shock hazard for personnel, protects equipment from damage in case of electrical faults, provides EMC shielding as well as protection against electromagnetic interference, and provides an electrically robust environment where signal integrity is kept as high as possible.

Warning

When grounding the Nokia Siemens Networks DX 200 network elements, follow strictly the instructions given in the user manuals in order to protect the equipment against damaging overvoltages, and the installation and maintenance personnel against hazardous energy levels.

5.3.1 Grounding environment, cables and peripheral devices

The recommended grounding environment is Mesh-BN as specified in ITU-T Recommendation K.27. This is equivalent to the ETSI EN 300 253 CBN/MESH-BN configuration with isolated DC return conductor connected to the CBN at a single point.

The network elements are designed for a DC/I system (“3 wire system”) according to ETSI. This implies that, when the network elements are fed by DC power, the current return function and the PE grounding of the network elements are separated and each network element has a separate protective earthing cable, along with the -UB and +UB cables. This connection allows the grounding arrangement known as a star topology (ITU-T Recommendation K.27).

Requirements for the grounding cables

The grounding cables used between the network element grounding bus bar and site ground terminal must meet local requirements (such as the UL 1459 standard and the National Electrical Code NFPA 70 in North America). The cables must be coloured according to local regulations. If not prohibited, the cable jacket should be green-yellow.

NEBS-compliant installations must be connected to the grounding cables using a standard or a NEBS-compliant lug.

The cross-section of the grounding cables can vary between 25 mm^2 (AWG3) and 50 mm^2 (AWG0).

Peripheral devices

All peripheral devices and measuring and service equipment that are used in conjunction with the network elements, or in the exchange room in general, must be powered by an isolating transformer in order to prevent connecting the main supply grounding to the exchange equipment, and thus causing malfunction or damage in the equipment.

5.3.2 Sites in North America (USA and Canada)

Note

The following is to be noted at sites in North America (USA and Canada):

Power supply grounding rules in DX 200 M98-mechanics network elements (MSCi, Compact MSCi, Transit MSCi, HLRi, SRRi, Flexi BSC, BSC3i, TCSM3i and SGSN)

This equipment is designed to permit the connection of the earthed conductor of the DC supply circuit to the earthing conductor at the equipment. If this connection is made, all of the following conditions must be met:

- This equipment shall be connected directly to the DC supply system earthing electrode conductor or to a bonding jumper from an earthing terminal bar or bus to which the DC supply system earthing electrode conductor is connected.
- This equipment shall be located in the same immediate area (such as, adjacent cabinets) as any other equipment that has a connection between the earthed conductor of the same DC supply circuit and the earthing conductor, and also the point of earthing of the DC system. The DC system shall not be earthed elsewhere.
- The DC supply source shall be located within the same premises as this equipment.
- Switching or disconnecting devices shall not be in the earthed circuit conductor between the DC source and the point of connection of the earthing electrode conductor.

For more information about the grounding of the network elements, see the *Installation Instructions* for the network element in question.

Power supply grounding rules in DX 200 M92-mechanics network elements (BSC2i ANSI and TCSM2A)

- This equipment has a connection between the earthed conductor of the DC supply circuit and the earthing conductor.
- This equipment shall be connected directly to the DC supply system earthing electrode conductor or to a bonding jumper from an earthing terminal bar or bus to which the DC supply system earthing electrode conductor is connected.
- This equipment shall be located in the same immediate area (such as, adjacent cabinets) as any other equipment that has a connection between the earthed conductor of the same DC supply circuit and the earthing conductor, and also the point of earthing of the DC system. The DC system shall not be earthed elsewhere.
- The DC supply source is to be located within the same premises as this equipment.
- Switching or disconnecting devices shall not be in the earthed circuit conductor between the DC source and the point of the connection of the earthing electrode conductor.

For more information about the grounding of the network elements, see the *Installation Instructions* for the network element in question.

5.3.3 NEBS sites

The DX 200 equipment is NEBS compliant only when implemented in a Common Bonding Network (CBN) environment, that is, when grounded according to the CBN/MESH-BN principle. In particular, cables with metallic shields are to be grounded at both ends. Furthermore, the site ground is to be connected to each cabinet grounding terminal with an NRTL-listed connector fulfilling NEBS 1089-CORE requirements, with two-hole compression-type lugs.

In NEBS sites, the DC/I (isolated return) is the only accepted cabling principle. In the DC/I configuration, the DC return terminal or conductor is not connected to the equipment frame or to the grounding means of the equipment. Instead, it is connected as isolated DC return.

6 Electromagnetic compatibility

The Nokia Siemens Networks network elements are compliant with EMC directives 89/336/EEC and 2004/108/EC, and they are tested to meet the requirements of ETSI EN 300 386 (harmonised product family standard) and GR-1089-CORE (NEBS standard). They are also tested to meet the requirements set in FCC rule CFR 47, Part 15, Subpart B, Radio Frequency Devices. The network elements are designed to withstand electromagnetic interference occurring in a telecommunication center environment (both minor and major according to ITU-T K.34).

Emission performance

The emission of electromagnetic interference does not exceed the A-limit of ETSI EN 300 386, FCC rules and GR-1089-CORE. M92 network elements may be deployed in commercial, industrial or business environments, but not in commercial office, light industry or residential areas outside special purpose premises (such as Central Office or Telecommunication Center).

EMC enclosure

As a general principle, each Nokia Siemens Networks network element makes up an independent EMC-shielded unit. The cabinet doors, the cabinet frame and the sheet steel covers at the ends of the cabinet rows form the EMC enclosure. All metallic signal wire, intermediate and external cabling needs to be electromagnetically shielded.

As an exception to the general principle, several DX 200, M92 network elements (BSC2i as well as TCSM2E/A) can form one independent EMC-shielded unit when mounted together in one row (line-up).

The DC power feed-through is via a DC line filter. All signal feed-throughs are via connector panels or grounding comb panels.

Note

The EMC shield works only when the cabinet doors are closed and the feed-throughs are implemented properly.

Electrostatic discharge (ESD)

When the doors of all cabinets are closed, the equipment meets the appropriate requirements for electrostatic discharge under normal operation.

Caution

Electrostatic discharge can damage circuits or shorten their lifetime. Before touching integrated circuits, ensure that you are working in an electrostatic-free environment. Wear an ESD wrist strap or use another corresponding method to discharge static.

Use of photographic flash

The equipment as such is not prone to damage by photographic flash, such as could be the case with certain EPROM circuits. However, please pay attention to the possible requirements of this kind as set by other equipment in the same equipment room.

7 Operational environment

The following sections describe the environmental requirements and recommendations for the DX 200 network elements, and list the international standards the equipment complies with. The sections provide the key parameters for the environmental conditions during normal operation, transportation and storage, as stated in these standards.

7.1 Standards for environmental requirements

7.1.1 ETSI and IEC standards

The DX 200 network elements are tested to comply with the ETSI standards ETSI EN 300 019-1-1, ETSI EN 300 019-1-2, and ETSI EN 300 019-1-3, as specified in the tables below.

Table 12. ETSI standards defining the environmental requirements for the DX 200 network elements

Conditions		Standard	Class
Normal operation	Mechanical conditions	ETSI EN 300 019-1-3	3.2
	Other conditions[1)]	ETSI EN 300 019-1-3	3.1E
Transportation[2)]		ETSI EN 300 019-1-2	2.2
Storage	Chemically active substances, mechanically active substances and mechanical conditions	ETSI EN 300 019-1-1	1.3E
	Other conditions	ETSI EN 300 019-1-1	1.2

Table 12. ETSI standards defining the environmental requirements for the DX 200 network elements (cont.)

Conditions	Standard	Class
1) as a restriction to ETSI EN 300 019-1-3 3.1E, power-up not allowed below 0°C		
2) as a restriction to ETSI EN 300 019-1-2 2.2, no toppling around the edges allowed; rolling or pitching allowed at an angle of up to ±35° for a period of 8 seconds (angles up to 22.5° can be reached for long periods of time); temperature range extended down to -50°C		

The ETSI standards defining the environmental conditions are based on corresponding IEC standards, which are listed in the following table.

Table 13. IEC standards defining the environmental requirements for the DX 200 network elements

Conditions		Standard	Class
Normal operation	Climatic conditions 1)	IEC 60721-3-3	K3
	Special climatic conditions	IEC 60721-3-3	Z2, Z4
	Biological conditions	IEC 60721-3-3	B1
	Chemically active substances	IEC 60721-3-3	C2 (C1)
	Mechanically active substances	IEC 60721-3-3	S2
	Mechanical conditions	IEC 60721-3-3	M1
	Earthquake resistance	IEC 60721-2-6	-
Transportation	Climatic conditions 2)	IEC 60721-3-2	K3
	Biological conditions	IEC 60721-3-2	B2
	Chemically active substances	IEC 60721-3-2	C2
	Mechanically active substances	IEC 60721-3-2	S2
	Mechanical conditions 3)	IEC 60721-3-2	M1
Storage	Climatic conditions	IEC 60721-3-1	K3
	Special climatic conditions	IEC 60721-3-1	Z2
	Biological conditions	IEC 60721-3-1	B1
	Chemically active substances	IEC 60721-3-1	C2
	Mechanically active substances	IEC 60721-3-1	S3
	Mechanical conditions	IEC 60721-3-1	M3 (M4)

Table 13. IEC standards defining the environmental requirements for the DX 200 network elements (cont.)

Conditions	Standard	Class
1) as a restriction to IEC 60721-3-3 K3, power-up not allowed below 0°C		
2) as an extension to IEC 60721-3-2 K3, minimum temperature of -50°C approved (instead of the -25°C stated in the standard)		
3) as a restriction to IEC 60721-3-2 M1, no toppling around the edges allowed; rolling or pitching allowed at an angle of up to ±35° for a period of 8 seconds (angles up to 22.5° can be reached for long periods of time)		

7.1.2 NEBS standards

The Network Equipment Building System (NEBS) is a set of Telcordia (former Bellcore) standards, the purpose of which is to unify hardware requirements and help telephone companies to evaluate the suitability of products for use in their networks. Compliance to NEBS is usually required by Regional Bell Operator Companies (RBOC).

The network element hardware is NEBS Level 3 compliant as specified in SR-3580, covering GR-63-CORE and GR-1089-CORE standards in Central Office or equivalent premises, as applicable for Type 2 equipment specified in appendix B of GR-1089-CORE.

7.2 Conditions during operation

The following sections provide the key parameters for the environmental conditions during normal operation, transportation and storage, as stated in the standards above.

7.2.1 Climatic conditions

The DX 200 network elements are designed to operate in temperature-controlled, weather-protected conditions. The limits for climatic conditions during operation are shown in the following table.

Table 14. Limits for temperature and humidity during operation

Absolute maximum temperature range	-5 to +45°C

Table 14. Limits for temperature and humidity during operation (cont.)

Normal operation temperature	+10 to +35°C (nominal +23°C)
Change rate of temperature	≤ 0.5°C/min (nominal 0.1°C/min)
Relative humidity	5 to 90% (nominal 50%)

The limits for temperature and humidity should be taken as statistical fractional values which most likely will not be exceeded.

Note

Do not power up the equipment in temperatures below 0°C/32 °F.

Temperature and air flow requirements in the exchange rooms

The minimum and maximum operating temperatures for the DX 200 network elements are -5 and +45°C, respectively. For safety reasons, however, the exchange room layout and the ventilation system used should be designed so that the temperature in the premises stays between +10 and +35°C, unless peripheral and measuring devices are used which require adherence to even stricter limits.

For the personnel working in the premises, the optimal inside temperature is +23°C. In premises which are constantly occupied, the following values are recommended:

- nominal temperature +23°C; variation between +18 and +27°C allowed
- maximum temperature +27°C, may be exceeded for 10 days per year
- maximum air velocity 0.5 m/s, at +27°C

Adherence to the above air velocity limit is required in the constant occupancy zone and in the area occupied by the network element cabinets to ensure that the personnel is not exposed to draught, and that the cooling of the natural convection cabinets is not disturbed. The ventilation system used must guarantee a sufficient amount of fresh air in the premises in accordance with local regulations.

Altitude

The maximum ambient temperature of +45°C is allowed to an elevation of 3000 m above sea level. The allowed maximum ambient temperature is decreased by 0.5°C for every 100 m above 3000 m. The maximum intended operational altitude is 4500 m.

7.2.2 Dust

The DX 200 equipment has been designed for use in an urban industrial area where the maximum annual average of dust concentration is 200 µg/ m^3 (total suspended particles). The equipment is protected against the known harmful effects of dust. However, the physical and chemical properties of dust in the environment vary and may cause problems which are not always perceptible. Therefore, the exchange rooms must be kept clean and appropriate instructions must be followed to ensure operational reliability and maximum life span of the equipment.

Air filtering

If the environment contains large amounts of active dust particles, the use of air filters on the site ventilation system is recommended. Adequate filtering in the equipment rooms is generally achieved with filters that trap 40 to 70% of the dust particles or whose weight separating capacity is ≥ 90%. The use of electrical or oil filters is not allowed. The filters must be cleaned regularly.

7.2.3 Chemical impurities

The DX 200 network elements are designed to withstand impurities in quantities found in the air in a normal urban industrial area.

Acceptable levels of chemically active substances are according to ETSI EN 300 019-1-3 and levels of airborne contaminants are according to GR-63-CORE (outdoors levels). The values are shown in the following tables.

Table 15. Chemically active substances, ETSI levels

Environmental parameter	Unit[1)]	Class 3.1 to 3.3	
		Mean[2)]	**Maximum[3)]**
a) Salt mist		sea salts, road salts, excl. class 3.1[4)]	
b) Sulphur dioxide	mg/m^3	0.3	1.0
	cm^3/m^3	0.11	0.37

Table 15. Chemically active substances, ETSI levels (cont.)

Environmental parameter	Unit[1)]	Class 3.1 to 3.3	
		Mean[2)]	Maximum[3)]
c) Hydrogen sulphide	mg/m^3	0.1	0.5
	cm^3/m^3	0.071	0.36
d) Chlorine	mg/m^3	0.1	0.3
	cm^3/m^3	0.034	0.1
e) Hydrochloric acid	mg/m^3	0.1	0.5
	cm^3/m^3	0.066	0.33
f) Hydrofluoric acid	mg/m^3	0.01	0.03
	cm^3/m^3	0.012	0.036
g) Ammonia	mg/m^3	1.0	3.0
	cm^3/m^3	1.4	4.2
h) Ozone	mg/m^3	0.05	0.1
	cm^3/m^3	0.025	0.05
i) Nitrogen oxides[5)]	mg/m^3	0.5	1.0
	cm^3/m^3	0.26	0.52

[1)] The values given in cm^3/m^3 have been calculated from the values given in mg/m^3 and refer to 20°C. The table uses rounded values.

[2)] Mean values are the average values (long-term values) to be expected.

[3)] Maximum values are limit or peak values occurring over a period of not more than 30 minutes per day.

[4)] Salt mist may be present at sheltered locations of coastal areas and offshore sites.

[5)] Expressed as the equivalent values of nitrogen dioxide.

Table 16. Airborne contaminants, NEBS levels

Contaminant	Concentration[2)]	
	Unit	
Airborne Particles (TSP - Dichot 15[1)])	$\mu g/m^3$	90

Table 16. Airborne contaminants, NEBS levels (cont.)

Contaminant			Concentration 2) Unit	
	Coarse particles		μg/m³	50
	Fine particles		μg/m³	50
	Water-soluble salts		μg/m³	30
		Sulphate	μg/m³	30
		Nitrites	μg/m³	12
Volatile organic compounds (boiling point > 30°C)			ppb	400
			μg/m³	1600
Sulphur dioxide			ppb	150
Hydrogen sulphide			ppb	40
Ammonia			ppb	50
Oxides of nitrogen	NO		ppb	500
	NO_2		ppb	250
	HNO_3		ppb	50
Ozone			ppb	250
Gaseous chlorine ($HCl+Cl_2$)			ppb	6

1) TSP - Dichot 15 = total suspended particulates determined using a dichotomous sampler with a 15 μm inlet

2) $\mu g/m^3$ = micrograms per cubic meter; ppb = parts per billion (1×10^{-9})

7.2.4 Acoustic noise

The network elements are designed for Attended Telecommunication Equipment Room Class 3.1 according to ETS 300 753, and they are compliant with GR-63-CORE acoustic noise criteria.

Table 17. ETS 300 753 Limit

Equipment location	Sound Power Level *
Telecommunication equipment room (attended)	Maximum 7.2 bels
* A-weighted sound power level	

Table 18. GR-63-CORE limits

Equipment location	Sound Power Level	Temperature
Telecommunication equipment room (attended)	max 78L_{WAd} (dB)	27°C

7.2.5 Mechanical conditions

This chapter describes mechanical conditions allowed during operation of DX 200 network elements. Mechanical conditions allowed during transport and storage of DX 200 network elements are described in the *7.3.2 Mechanical conditions* section of *7.3 Conditions during transportation and storage.*

Vibration and impact

The mechanical conditions allowed during operation are shown in the following table.

Table 19. Mechanical conditions allowed during operation

Vibration	Amplitude	1.5 mm, f = 2 to 9 Hz
	Acceleration	5 m/s^2, f = 9 to 200 Hz
Impact		40 m/s^2, 22 ms

Earthquake

The network elements are earthquake durable, compliant to GR-63-CORE (NEBS - Zone 4) requirements and EN 300 019-1-3, when the floor rail installation set is used.

7.3 Conditions during transportation and storage

The following sections provide the key parameters for the environmental conditions during transportation and storage.

7.3.1 Climatic conditions

The equipment must be transported and stored in its own container. Some temperature recommendations are given in the following table.

Table 20. Limits for temperature during transportation

	Temperature	
	Minimum	**Maximum**
Transportation	-50°C	+70°C
Short-term storage	-25°C 1)	+55°C
Long-term storage	-5°C	+45°C
1) For a maximum of 60 consecutive days.		

Relative humidity during transportation and storage may vary between 5 and 95%. During long-term storage, humidity between 20 and 75% is recommended.

Altitude

Minimum air pressure during transportation is 70 kPa (corresponding to an altitude of 3000 m) to guarantee the integrity of the humidity seal. When transported to a location that is above 3000 m, the shipping container must not be exposed to rain, and the equipment must, without delay, be placed indoors in an environment that meets the operation conditions as described in *Conditions during operation*.

7.3.2 Mechanical conditions

The allowed mechanical conditions during transportation are shown in the following table.

Table 21. Mechanical strain allowed during transportation

Vibration	Amplitude	3.5 mm, f = 2 to 9 Hz
	Acceleration	10 m/s^2, f = 9 to 200 Hz
		15 m/s^2, f = 200 to 500 Hz
Impact		300 m/s^2, 6 ms

7.3.3 Moving and mounting the cabinets

The cabinets are shipped on their side in cardboard crates that are mounted on durable plywood pallets. There are two crate sizes. Dimensions including the pallets are given in the table below.

Table 22. Dimensions of shipping crates for cabinets

Cabinet	Dimensions (W × L × H)
Single IC209-B/-A	810 mm × 2220 mm × 1210 mm
IC209-B/-A + IC203/-A	810 mm × 2220 mm × 1510 mm

The plug-in units, some cables and ancillary equipment may be shipped in crates of the same size or smaller.

To facilitate moving at the site, the cabinets are equipped with wheels. They can be permanently mounted free-standing or bolted to installation rails attached to the floor. Further information on the rails and the bolts recommended is provided in the *Installation Instructions* for the network element in question.

8 Cooling of DX 200 equipment

To guarantee system availability at all times, the ventilation system must be designed to be functional without extended outage periods. The equipment rooms must have sufficient backup capacity for ventilation and air conditioning in case the primary ventilation system or power supply fails.

Cooling of equipment

In the DX 200 equipment, the intake of cool air is from the front of the cabinet. The principal air flows in the M98 mechanics cabinet and shelves are presented in the following figure.

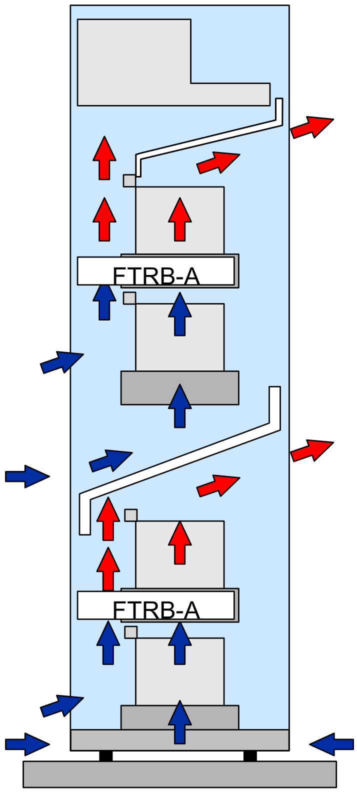

Figure 9. Ventilation in the equipment room, a TCSM3i cabinet as an example

The cooling of the equipment in the M92 mechanics racks differs from that of the M98 mechanics cabinet in following way: adequate cooling can be achieved by letting fresh, cool air through the racks from below - as long as the power density stays between 100 W/m² and 500 W/m² and the velocity of the incoming air does not exceed 0.5 m/s.

Concentrated placement of cabinets

The dense 'server farm' type of installations require especially efficient ventilation. To avoid exposure to draft and noise, the personnel are not expected to stay in those areas for extended periods. The cabinet placement, especially the empty space between the cabinet rows, must be dimensioned case by case, taking into account the ventilation capacity of the room and the building.

It is possible to exploit the front-to-back air flow of the cabinets by alternating the orientation of cabinet rows: An air inlet area supplies fresh air to two cabinet rows next to each other, and an exhaust area depletes the heated air from two cabinet rows.

Heat generation

All consumed energy is transformed into heat. The actual heat dissipation value depends on the network element, the network element configuration and the application.

9 Conversion between metric and imperial measures

Conversion factors and tables

The following tables show conversion factors.

Table 23. Conversion factors from metric to imperial measurement units

	Metric unit	Imperial equivalent
Length:		
	1 mm	0.03937 in
	1 cm = 10 mm	0.3937 in
	1 m = 100 cm	39.37 in = 3.2808 ft = 1.0936 yd
Area:		
	1 mm^2	0.0016 sq in
	1 cm^2 = 100 mm^2	0.155 sq in
	1 m^2 = 10,000 cm^2	1,550 sq in = 10.764 sq ft = 1.1956 sq yd
Acceleration:		
	1 m/s^2	3.2808 ft/s^2 = 1.0936 yd/s^2
Mass:		
	1 g	0.0353 oz
	1 kg = 1,000 g	35.2736 oz = 2.2046 lb
Energy:		
	1 kJ = 1,000 J	0.9479 Btu
Power:		
	1 W	3.413 Btu/h
Pressure:		
	1 kPa (= 1,000 Pa)	0.1450 psi

Table 23. Conversion factors from metric to imperial measurement units (cont.)

	Metric unit	Imperial equivalent
	1 bar (= 100 kPa)	14.504 psi
Wire conductor size:		
	16 mm^2	AWG 5
	25 mm^2	AWG 3
	35 mm^2	AWG 1
	50 mm^2	AWG 0

Table 24. Conversion factors from imperial to metric length measurement units

Imperial unit	Metric equivalent
1 in	25.4 mm
1 ft = 12 in	0.3048 m

Temperature conversion formula

To convert temperatures given in degrees Celsius to degrees Fahrenheit, multiply by 9, divide by 5, and add 32:

$$t_{(F)} = \frac{9}{5} t_{(C)} + 32$$