NOKIA

Installation Site Requirements for BSC and TCSM2

Contents

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Summary of changes

Summary of changes

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

Changes made between issues 8-3 and 8-2

RoHS added to *General hardware platform requirements* .

Changes made between issues 8-2 and 8-1

Minor editorial changes.

Changes made between issues 8-1 and 8-0

Editorial and structural corrections to improve the usability of the document:

- Added new chapter *General hardware platform requirements* , containing information on international specifications and recommendations.
- Renamed chapter *BSC and TCSM2 equipment room layout and space requirements* to *Floor load and free space requirements* and moved it to the beginning of the document.
- Renamed chapter *Power supply for BSC and TCSM2* to *Power supply, grounding and bonding* .
- Renamed chapter *Environmental requirements for the BSC and TCSM2* to *Operational environment* . Moved the contents of section *Electrical environment* of chapter *Environmental requirements for the BSC and TCSM2* to new chapter *Electromagnetic compatibility* .
- Removed imperial measures throughout the document, and added a new chapter *Conversion between metric and imperial measures* at the end of the document.

Changes made between issues 7-1 and 8-0

First update for S11.5.

Changes made between issues 7-0 and 7-1

Links corrected in on-line version.

1 Overview of site requirements

The *Installation Site Requirements for BSC and TCSM2* 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 BSC3i differs from the previous BSC variants.

- *General hardware platform requirements*
- *Floor load and free space requirements*
- *Power supply, grounding and bonding*
- *Electromagnetic compatibility*
- *Operational environment*
- *Ventilation in the equipment rooms*
- *Cabling of BSC3i*
- *Cabling and alarms of BSC and TCSM2*
- *Conversion between metric and imperial measures*

The following topics provide further information on the configuration and applications of the DX 200 i-series network elements:

- *Engineering for BSC*
- *Engineering for BSC3i*
- *Engineering for TCSM2*
- *Installing BSC and TCSM2*
- *Installing BSC3i*

2 General hardware platform requirements

Listed below are the international specifications and recommendations which form the basis for the requirements for Nokia network elements.

General

SR–3580 Bellcore Special Report, Network Equipment-Building System (NEBS) Criteria Levels

Equipment safety

IEC 6095 Safety of information technology equipment

EN 60950 Safety of information technology equipment

UL 60950 Safety of information technology equipment

Telcordia GR–1089–CORE
Telcordia Technologies Generic Requirements Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment

EMC

EN 300 386 Equipment Engineering (EE); Telecommunication network equipment; Electromagnetic Compatibility (EMC) requirements. The installation environment's BSC and TCSM2 products are other than telecommunication centres.

CFR 47, Part 15 Radio Frequency Devices, for unintentional radiators (ANSI C63.4,), Class B

Telcordia GR–1089–CORE
Telcordia Technologies Generic Requirements Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.

IEC 61000–4–5 Electromagnetic compatibility (EMC); Part 4–5: Testing and measurement techniques – Surge immunity test

Power feed

ETS 300 132–2 Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)

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

Earthing and bonding

ETS 300 253 Equipment Engineering (EE); Earthing and bonding of telecommunications equipment in telecommunication centres.

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

Telcordia GR–1089–CORE
Telcordia Technologies Generic Requirements Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.

Environmental endurance

ETS 300 019–1–1
Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1–1: Storage

ETS 300 019–1–2
Equipment Engineering Environmental conditions and environmental tests for telecommunications equipment Part 1–2: Transportation

ETS 300 019–1–3
Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1–3: Stationary use at weather protected locations.

GR–63–CORE Telcordia Technologies Generic Requirements NEBS Requirements: Physical Protection

Earthquake

GR–63–CORE Telcordia Technologies Generic Requirements NEBS Requirements: Physical Protection

Interfaces

LAN-requirements:

ANSI X3.263 American National Standard for Information Technology - Fibre Distributed Data Interface (FDDI) - Token Ring Twisted Pair Physical Layer Medium Dependent (TP-PMD), implemented with F-STP cable and shielded RJ45 connector.

Acoustic noise

ETS 300 753 Equipment Engineering (EE); Acoustic noise emitted by telecommunications equipment

Telecommunication site

IEC 61312–1, IEC 61312–2, IEC 61312–3, IEC 61312–4
Protection against lightning electromagnetic impulse. Parts 1 through 4

RoHS

Nokia 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.

3 Floor load and free space requirements

3.1 Floor load

The DX 200 network elements can be installed on a raised or concrete floor. We recommend the use of a raised floor in the exchange room, with all the station cables placed under the floor. Check with local construction engineers and battery manufacturers to determine floor load requirements.

The site floor load capacity must be sufficient to carry the installed equipment. Two floor load values are given for the DX 200 network elements:

Average floor load:
The average value is calculated for the area that the network elements occupy, including the maintenance passage, aisle, and free (clearance) spaces.

Point floor load: The point value is calculated for the exact cabinet foot print area.

The DX 200 M92 cabinets' maximum weight is shown in the following table.

Table 1. Maximum weight of M92 cabinets

Cabinet	Max. weight
BSC2i	205 kg
TCSM2	240 kg
Cable conduit CC19V	20 kg
Cable rack R2A1	40 kg

The average floor load caused by the DX 200 M92 network elements varies between 65 and 245 kg/m^2 depending on the network element and chosen layout.

The point load caused by one cabinet may be as high as 685 kg/m^2 .

The i-series M98 mechanics cabinets' maximum weight is:

Table 2. Maximum weight of M98 cabinets

Cabinet	Max. weight
IC209-A	352 kg
IC209-A with IC203	453 kg
Side cabling conduit SCC	10 kg

The average floor load caused by the i-series network elements varies between 65 and 210 kg/m^2 depending on the network element and chosen layout.

The point load caused by one cabinet may be as high as 652 kg/m^2 .

Floor layout

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

- Space reservation for expansion cabinets: We recommend that the premises be dimensioned so that there is enough room for a fully equipped network element.
- Placement of the overhead cable support structures for power supply and signal circuit cables: This is necessary for installations without a raised floor.
- AC power sockets for measuring and peripheral devices.
- Lighting for the cabinets.
- 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.

The i-series cabinets (IC203 and IC209–A) are dimensioned according to ETSI recommendations for easy installation on a raised floor with standard 300 mm × 300 mm modules.

The following figure shows a floor layout example for an installation site containing Nokia DX 200 equipment (MSCi, TCSM2 and BSC2) and Nokia IPA2800 MGW and RNC.

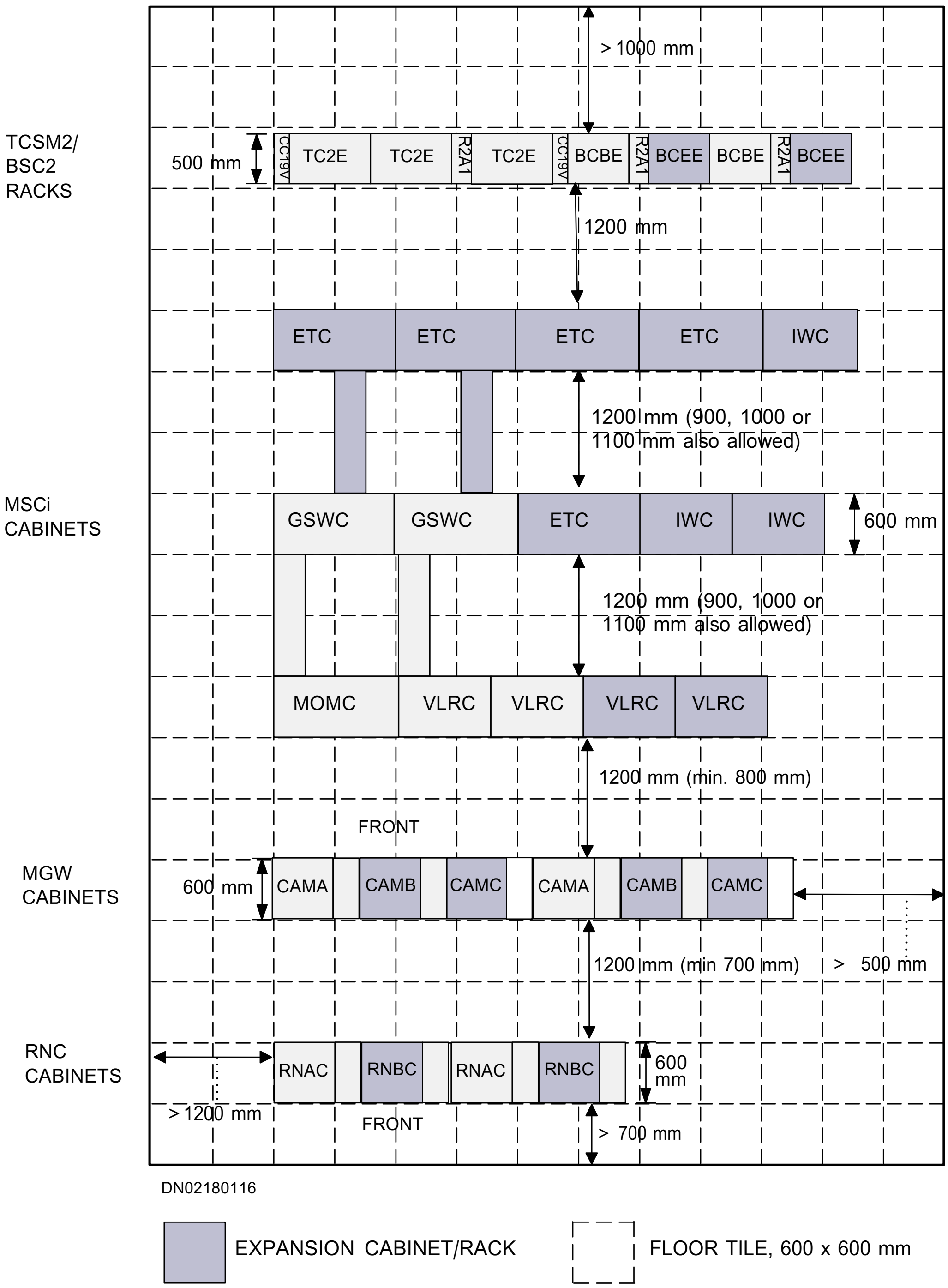

Figure 1. Example of an exchange room layout

3.2 Free space requirements

3.2.1 Minimum clearances around cabinet rows

The following minimum clearances are required around the cabinets for service and cabling access, and to ensure proper air circulation:

- 500 mm above the cabinets (required to ensure efficient ventilation)
- 900 mm both at the front and at the back of the cabinets between the cabinets and the wall
- 500 mm between the end of a cabinet row and the wall
- 900 mm between rows (minimum; 1000 mm or 1100 mm are also approved)
- 1200 mm between rows for a maintenance passage with access to all cabinet rows.

3.2.2 Cabinet dimensions

The dimensions of the racks and the vertical cable conduit are as follows:

Table 3. Dimensions of M92 racks and conduits

Rack/conduit	Dimensions (H × W × D)
BSC2 equipment rack BSC2i equipment rack	1880 mm × 600 mm × 450 mm
TCSM2 equipment rack	1880 mm × 800 mm × 450 mm
R2A1–S cable rack	1880 mm × 200 mm × 450 mm
CC19V cable conduit	1880 mm × 140 mm × 450 mm

The depth of the rack increases by 50 mm for the front and rear doors (25 mm + 25 mm). The total depth of a rack with the doors installed is, therefore, 500 mm.

The length of the rack row increases by 80 mm (40 mm + 40 mm) when the side panels are installed.

The racks stand on approximately 50 mm high adjustable legs. As there is a 90 mm upper structure (for routing cables) on top of the rack row, its maximum total height is 2020 mm.

There are two i-series cabinet types: the IC203 cabling cabinet and the IC209–A equipment cabinet. The dimensions are as follows:

Table 4. Dimensions of M98 cabinets

Cabinet	**Dimensions (H × W × D)**
IC203 cabling cabinet	1950 mm × 300 mm × 600 mm
IC209–A equipment cabinet	1950 mm × 900 mm × 600 mm

The cabinets stand on approximately 50 mm high adjustable legs; hence their maximum height is 2000 mm.

For multi-row network elements there is an inter-row cable conduit that is 190 mm high. With the cable conduit, the maximum height is 2190 mm.

Listed in the table below and illustrated in the figure that follows are the net dimensions of the cabinet types used in the i-series network elements.

3.2.3 Spare parts and documentation

Spare parts should be stored in a separate room that fulfils the requirements set for storage (see section *Transportation and storage environment*). Spare plug-in units should be stored in their original packages on shelves or in a cabinet.

The documentation needed for the operation of the network element should be located in a room near the exchange room, where it is easily accessible.

4 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.

Details on the power consumption of the individual network elements can be found in the network element specific *Engineering Descriptions* .

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 i-series 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-A has 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.

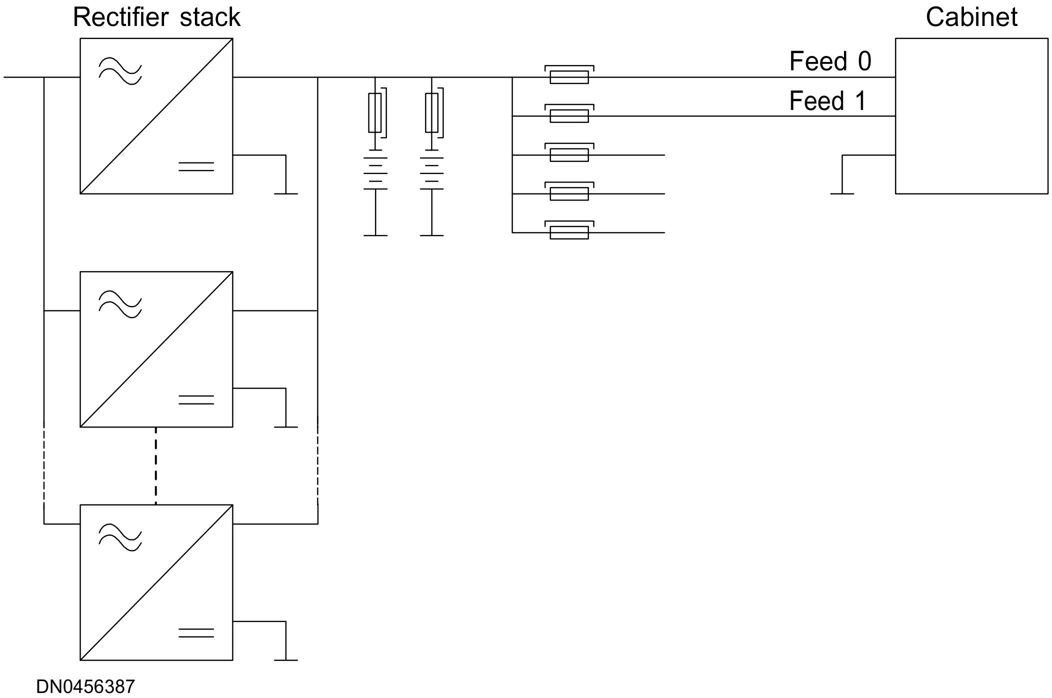

Figure 2. N+1 rectifier system with two separate back-up battery strings

A detailed description of the internal power distribution system of the network elements can be found in the network element specific *Engineering Descriptions* .

4.1 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.

4.1.1 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 back-up 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 5. 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 6. Maximum permitted bandwidths

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

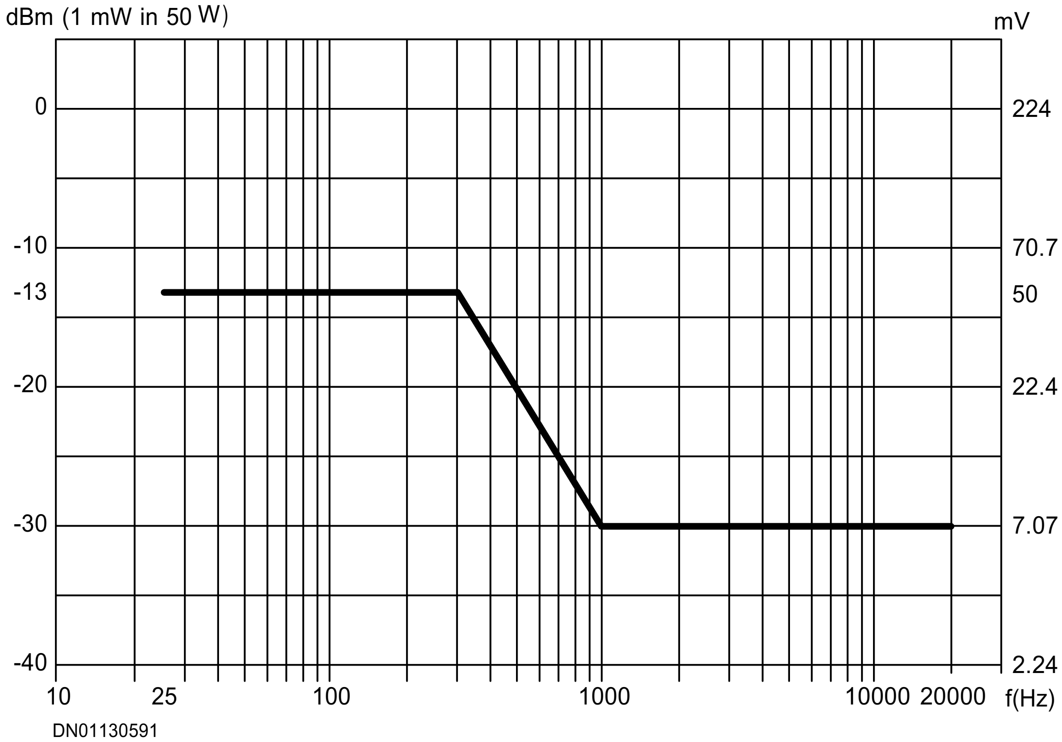

Figure 3. Maximum level of narrowband noise for the DX 200 network elements

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.

4.1.2 Over-voltage transients and surges in DC supply

Over-voltages 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 Class 0 to Class 1 testing parameters (according to standard IEC61000–4–5).

4.1.3 Over-voltages 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 over-voltages 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).

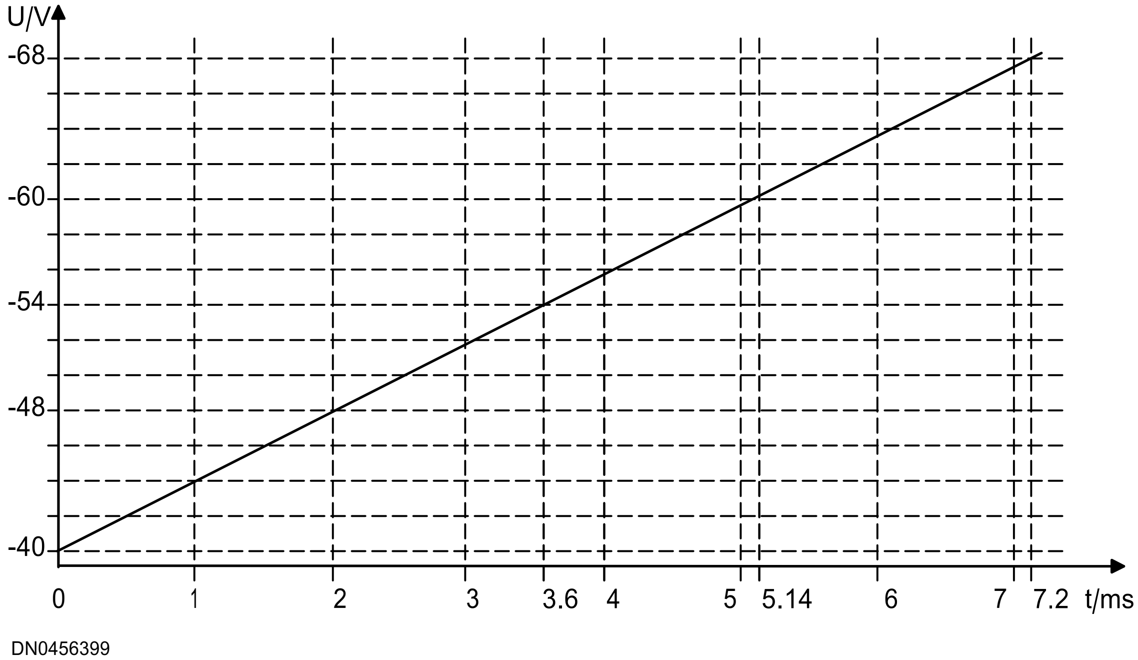

Figure 4. Hold-up time per input voltage

4.1.4 Dimensioning of the site power

To specify the site power supply systems' capacity (power in kW), please refer to the network element specific *Engineering Descriptions* for power consumption values. The back-up battery capacity is dependent on the load and the desired back-up time. The rectifiers must have enough capacity to feed the network elements and to charge the back-up batteries, as specified, simultaneously.

Note

Even for partially equipped configurations, the site power supply system should be dimensioned so that it has enough capacity to feed a fully equipped network element. Alternatively, a supply system expandable to the capacity required by a fully equipped network element must be used.

4.1.5 Redundancy of the power supply

To provide for full 2n redundancy of the power distribution, the DX 200 cabinets are provided with two independent power entry connections, each capable of handling the full cabinet load. (Some network elements or cabinets may have four actual power entry connections, but they form two functional power entry connections.)

If a single rectifier and back-up battery solution is chosen, then the cabinet must nevertheless be fed via two independent supply groups (cable pairs), each with separate overcurrent protection. This ensures operation of the DX 200 equipment in case of short circuit in one feed branch or sporadic tripping of an overcurrent protector.

The following figure shows an example of a fully redundant site power supply system.

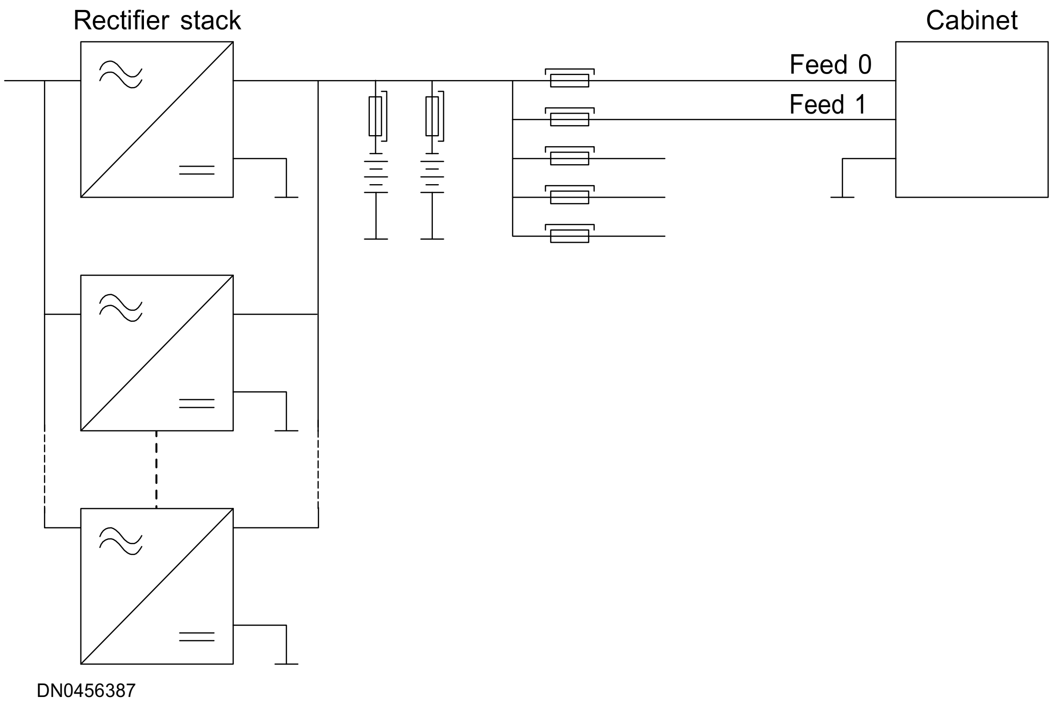

Figure 5. N+1 rectifier system with two separate back-up battery strings

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Note

More specific examples can be found in the network element specific *Engineering Descriptions* .

4.1.6 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 (AWG6) to 50 mm^2 (AWG0). In order to ensure proper operation of the equipment during the entire intended period when the back-up 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 $17.2 \times 10^{-9}\ \Omega\text{m}$.

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:

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

The following table shows examples of maximum cable lengths.

Table 7. Examples for maximum cable lengths

Load power	**Current at –40 VDC**	**Max. ohmic resistance (1.5 V drop)**	**Max. cable length / cross section*)**			
			16 mm²	**25 mm²**	**35 mm²**	**50 mm²**
W	A	mΩ	m	m	m	m
500	12.3	122	113	—	—	—
700	17.3	87	80	—	—	—
1000	24.7	61	56	88	—	—
1500	37.0	41	37	58	82	—
2000	49.4	30	28	44	61	88
2500	61.7	24	22	35	49	70
3000	74.1	20	—	29	41	58
3500	86.4	17	—	25	35	50
4000	98.8	15	—	—	30	44
4500	111.1	14	—	—	27	39
5000	123.5	12	—	—	24	35

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

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 back-up 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.

4.1.7 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 center 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.

4.1.8 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 back-up 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 back-up time. The back-up 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 back-up capacity (back-up 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.

4.1.9 Supply lines from the rectifiers to the cabinets

As a general principle, each DX 200 cabinet should have its own power feed cabling. In a cabinet with a maximum consumption of 1600 W, two groups are sufficient to provide the power.

A cabinet consuming more than 1600 W must have four separate supply groups.

As an exception to the general principle, it is also possible to feed adjacent cabinets in pairs, provided that the total power consumption of the two cabinets does not exceed 1600 W. In this case, the cabinets should be chained using two twin cables of the same type as those running between the batteries or rectifiers and the cabinets. The power cables between the cabinets are not included in the DX 200 delivery.

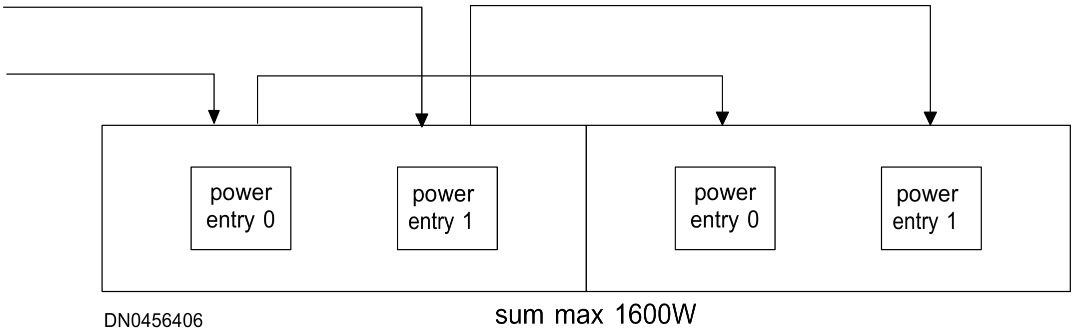

Figure 6. Chained feed for 2 cabinets, max power consumption 1600 W together

4.2 AC power supply

In the AC option, the network elements are designed to operate on 115 VAC or 230 VAC nominal supply voltages. The AC option is generally intended for applications of limited size, when a centralized DC supply system is not practical. It is up to the customer to decide whether commercial-grade AC is sufficient or an uninterrupted power supply (UPS) is preferable. A network element must be either AC- or DC-powered; mixed configurations are not allowed. However, AC and DC are allowed in the same cabinet if the cabinet contains several (one chassis) network elements.

Note

The AC feed option is available for the FlexiServer HW platform. The IP3400 HW platform accepts only AC power.

4.2.1 General requirements for AC power supply

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

Table 8. Requirements for AC supply voltage

nominal voltage:	115 VAC or 230 VAC
voltage range:	90 to 132 VAC or 180 to 264 VAC (–20% to +15%)
frequency:	47 to 63 Hz
short voltage interruptions:	≤ 20 ms (equal to one cycle missing at 50 Hz)
slow voltage fluctuations:	< 2 ms with respect to the actual value: ± 40%

4.2.2 Over-voltage transients and surges in the AC supply

Over-voltages and transients in the site at power supply interface A must be within Lightning Protection Zone 1 (LPZ1) level according to the IEC61312 and IEC62305 standard series. In addition, it is recommended that power delivery be redundant (that is, that UPS be used). For network element immunity/resistibility surge levels in practice, this typically corresponds to (Class 1 to) Class 2 testing parameters (according to standard IEC61000–4–5).

4.2.3 Power distribution requirements

When powered from an AC supply, each network element is equipped with multiple AC/DC switch-mode power supplies. The redundancy is n+1. In the case of one-branch circuit fuse trips, it is recommended for redundancy that each AC/DC power supply of one network element be supplied from a different phase and/or branch circuit, as detailed in the figure below. The power rating limits the number of AC/DC power supplies that may be connected to the same branch, depending on local conditions and regulations.

The network element grounding bus bar must be connected to the site grounding terminal even when the AC mains provides protective earth (PE) through the mains cord.

The power factor is better than 0.95. No external power factor (PF) correction is needed.

4.2.4 Requirements for the power supply cables (AC)

The cables must meet local requirements (such as the UL60950 standard and the National Electrical Code NFPA 70 in North America).

Each AC/DC power supply has a standard EN 60320 (C–14) appliance inlet to which a standard mains cord (C–13 plug) is connected.

The cross-sectional area of the power supply cables must be adequate for the current they are intended to carry when the equipment is operating under normal load, such that the maximum permitted temperature of the conductor insulation is not exceeded.

Table 9. Adequate cross-section area/conductor gauge for AC mains cords

Power rating	**Current**		**Required conductor gauge / cross-section**	
	at 120 VAC	**at 230 VAC**	**120 VAC**	**230 VAC**
W	A	A	AWG	mm^2
500	4.2	—	18	—
	—	2.2	—	0.75
600	5.0	—	18	—
	—	2.6	—	0.75
700	5.9	—	18	—
	—	3.1	—	0.75
800	6.7	—	16	—
	—	3.5	—	0.75
900	7.5	—	16	—
	—	3.9	—	0.75
1000	8.4	—	16	—
	—	4.4	—	0.75

4.2.5 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

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 a failure in the equipment. Two options exist for isolating the AC network:

a. all AC power sockets in the vicinity of the network element cabinets are isolated using a fixed isolating transformer; or

b. 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 10. Power consumption of peripheral devices

Peripheral device	Power consumption
Printer	120 W
VDU	50 W

4.3 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.

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).

The AC indoor installation must be of type TN-S at a single point as specified in ETSI EN 300 253. No PEN conductor is allowed.

When the network elements are fed by AC power, only a CBN/MESH-BN grounding system is allowed. The cabinet grounding bus bar must be connected to the site-grounding terminal even when the AC mains provides protective earth through the mains cord.

The following figures show examples for different grounding schemes.

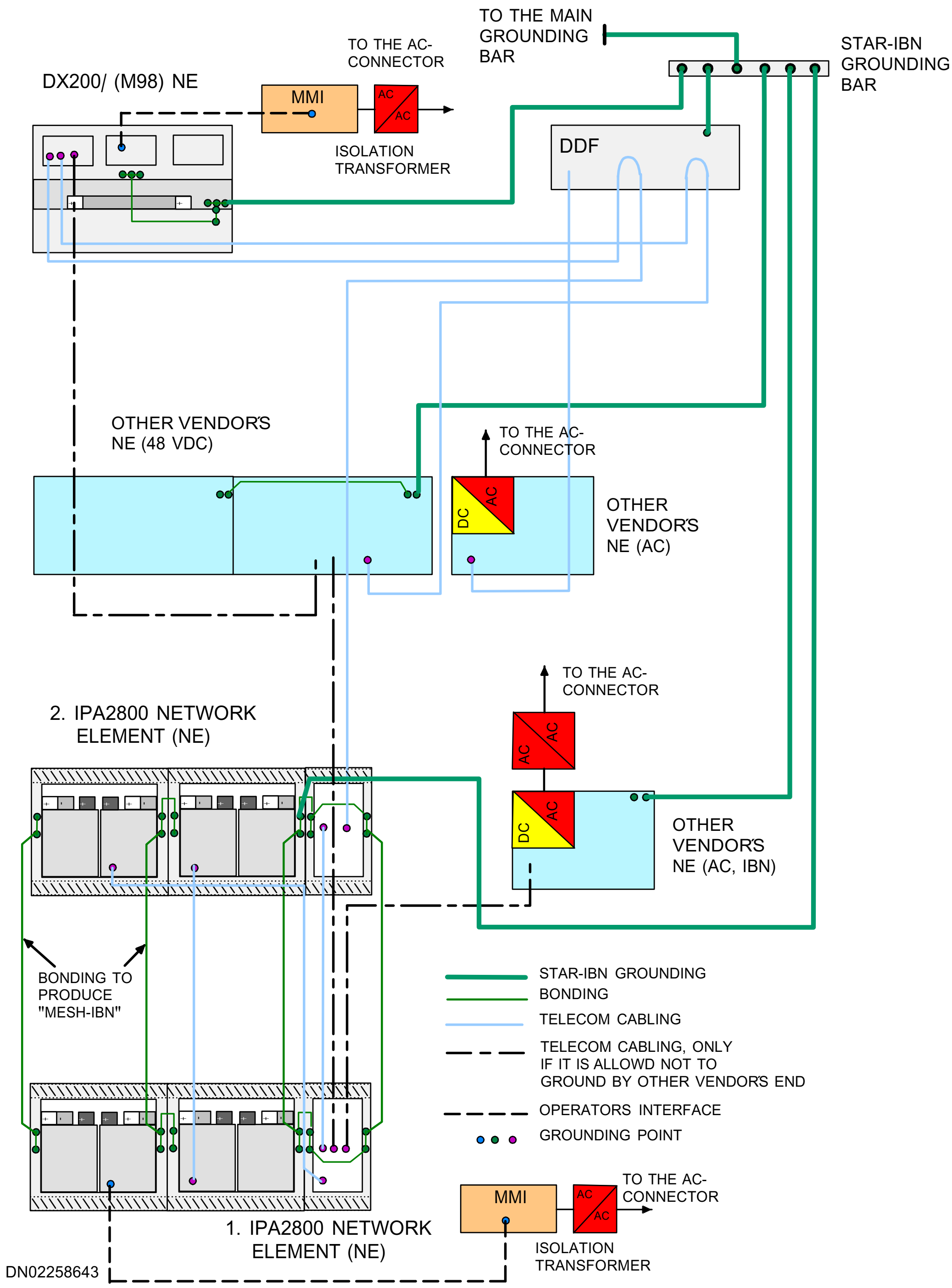

Figure 7. Grounding of network elements and external interface cables at a STAR-IBN site

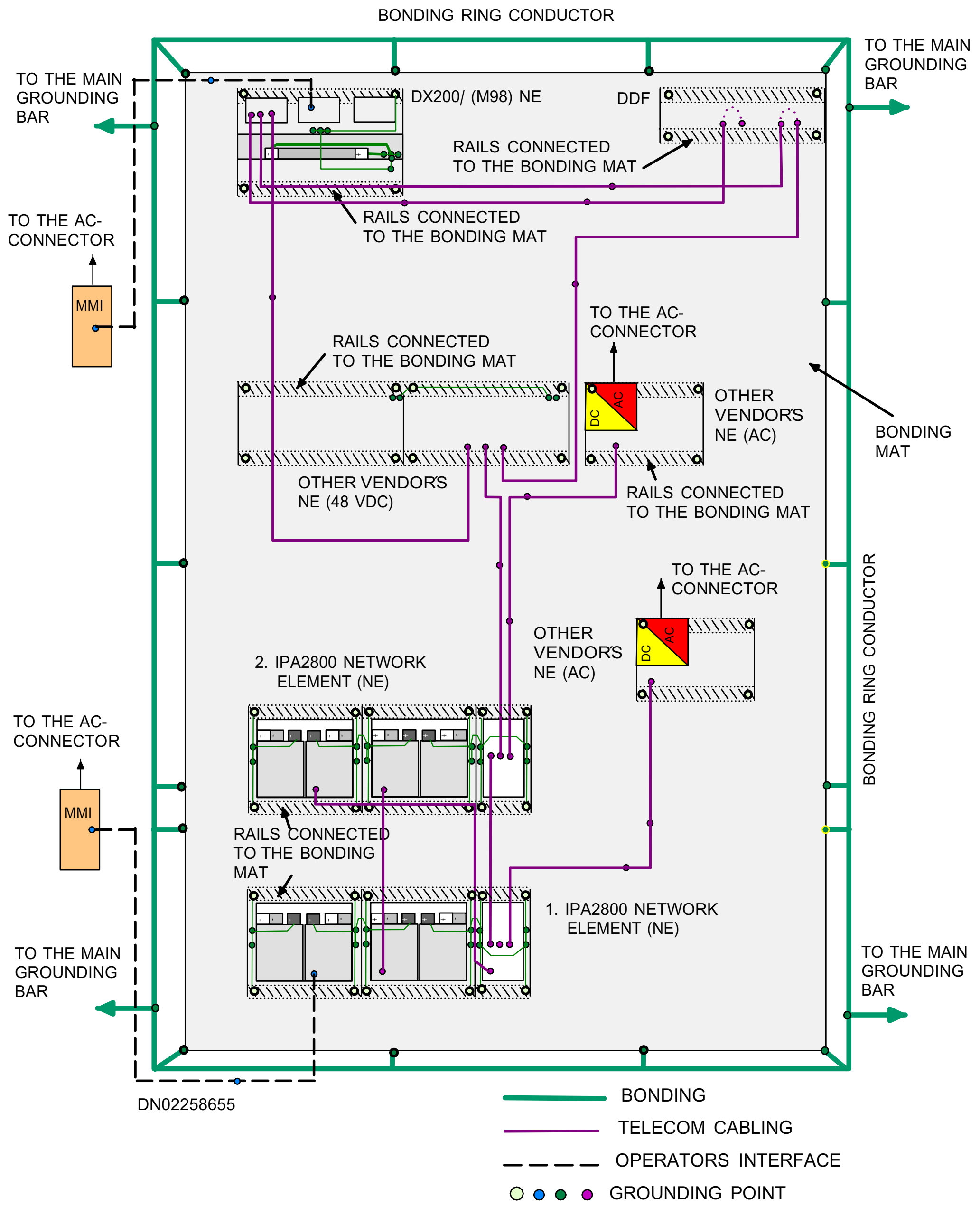

Figure 8. Grounding of network elements and external interface cables at a MESH-BN site

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).

Warning

To be noted at sites in North America (USA and Canada):

- The DX 200 equipment has a connection between the earthed conductor of the DC supply circuit and the earthing conductor.
- The DX 200 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.
- The DX 200 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 otherwise.
- The DC supply source is to be located within the same premises as the 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.

To be noted at 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, the signal cables with metallic shields must be grounded at both ends.

The power feed DC return conductor may be connected as isolated DC return (DC-I) or as Common DC return (DC-C).

In the DC-I configuration, the DC return terminal or conductor is not connected to the equipment frame or the grounding means of the equipment. In the DC-C configuration, the DC return terminal or conductor is connected to the equipment frame or to the grounding means of the equipment.

5 Electromagnetic compatibility

The Nokia network elements are compliant with EMC directive 89/336/EEC, and they are tested to meet the requirements of ETSI EN 300 386 (harmonized 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).

The emission of electromagnetic interference does not exceed the A-limit of ETSI EN 300 386, FCC rules and GR-1089-CORE. The IPA2800 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 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).

In IPA2800 network elements each subrack equipped with plug-in units and/or cover plates forms an independent EMC enclosure. To maintain this shield all metallic signal wire, intermediate and external cabling needs to be electromagnetically shielded.

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

When the network element is being installed or serviced, electrostatic discharge may cause interference or damage the equipment unless appropriate precautions are taken. Use antistatic materials on the floor and tables of the premises. During installation or service operations, use personal ground electrodes or corresponding antistatic devices (such as footwear).

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.

6 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.

6.1 Standards for environmental requirements

6.1.1 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 11. 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[2)] , mechanically active substances and mechanical conditions	ETSI EN 300 019–1–1	1.3E
	Other conditions	ETSI EN 300 019–1–1	1.2

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

Table 11. ETSI standards defining the environmental requirements for the DX 200 network elements (cont.)

Conditions	Standard	Class
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)		

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

Table 12. 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

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

Conditions		Standard	Class
	Mechanically active substances	IEC 60721–3–1	S3
	Mechanical conditions	IEC 60721–3–1	M3 (M4)

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)

6.1.2 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.

6.2 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.

6.2.1 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 13. Limits for temperature and humidity during operation (cont.)

Table 13. Limits for temperature and humidity during operation

Absolute maximum temperature range	–5 to +45°C
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

For the DX 200 network elements, power-up is not allowed below 0°C.

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.

6.2.2 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 $\mu g/m^3$ (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.

6.2.3 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 14. 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)]	

Table 14. Chemically active substances, ETSI levels (cont.)

Environmental parameter	Unit[1]	Class 3.1 to 3.3	
		Mean[2]	Maximum[3]
b) Sulphur dioxide	mg/m^3	0.3	1.0
	cm^3/m^3	0.11	0.37
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 15. Airborne contaminants, NEBS levels

Contaminant			Concentration[2)]	
			Unit	
Airborne Particles (TSP - Dichot 15[1)])			µg/m^3	90
	Coarse particles		µg/m^3	50
	Fine particles		µg/m^3	50
	Water-soluble salts		µg/m^3	
		Sulphate	µg/m^3	30
		Nitrites	µg/m^3	12
Volatile organic compounds (boiling point > 30°C)			ppb	400
			µg/m^3	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) µg/m^3 = micrograms per cubic meter; ppb = parts per billion (1×10^{-9})

6.2.4 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.

6.2.5 Earthquake

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 *Mechanical conditions* section of *Conditions during transportation and storage* .

Vibration and impact

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

Table 16. 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, when the Nokia floor rail installation set is used.

6.3 Conditions during transportation and storage

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

6.3.1 Climatic conditions

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

Table 17. Limits for temperature during transportation

	Temperature	
	min.	**max.**
Transportation	–50°C	+70°C
Short-term storage	–5°C	+45°C
Long-term storage	+15°C	+30°C

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 conditionsas described in *Conditions during operation* .

6.3.2 Mechanical conditions

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

Table 18. 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

6.3.3 Moving and mounting the cabinets

The i-series cabinets, IC209-A and IC203, 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 19. Dimensions of shipping crates for i-series cabinets

Cabinet	**Dimensions (W × L × H)**
Single IC209-A	810 mm × 2220 mm × 1210 mm
IC209-A + IC203	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 *Installing the i-series Network Elements* .

7 Ventilation in the equipment rooms

The requirements and recommendations for the ventilation system in the exchange rooms are described in the following sections:

7.1 Cooling methods available

In order to keep the temperature in the exchange rooms suitable for the equipment and personnel, heat must usually be reduced during warm seasons by means of ventilation or air-conditioning. Limits and recommendations for operating temperatures of the network elements are given in *Climatic conditions* .

Three different methods exist for achieving sufficient ventilation in the exchange rooms:

- natural ventilation
- forced ventilation
- air conditioning

Ventilation arrangements based on the above methods or combinations of those methods are described in the following sections. The numerical values given are based on the assumption that the rise of room temperature is at a constant level of t = 5°C.

7.1.1 Natural ventilation

If the thermal power to be removed per floor area (power density) is less than 50 W/m^2 and the replacement air does not require filtering, adequate cooling can be achieved through natural ventilation. The building layout, the air inlets and outlets, and the ventilation ducts must be designed so that the inside temperature does not exceed +40°C at a height of 1.5 m and at a distance of 0.5 m from the cabinets. The outlet must be located higher than the upper part of the cabinets.

7.1.2 Forced ventilation

Forced ventilation is necessary when the power density exceeds 50 W/m^2 . The most economical method is to use uncooled outside air. When uncooled air is blown directly into an area which is constantly occupied, the power density must not exceed 100 W/m^2 in order to ensure that the temperature and airflow rate are satisfactory for the personnel in the premises.

If the power density exceeds 100 W/m^2 but stays below 500 W/m^2 , adequate cooling can be achieved by letting fresh, cool air directly through the cabinets from below. The air velocity of the incoming air may not exceed 0.5 m/s.

The heat release of DX 200 equipment may exceed NEBS GR–63–CORE, 04–12 heat release limits. Take this into account when planning a NEBS-compliant site.

Fresh air fan

If incoming air is fanned into the exchange room and the cabinets are cooled by natural convection, the amount of air G (volume per hour) and the change rate of air N (times per hour) needed for the removal of thermal power P (dimension W) can be calculated by using the following formula:

$$G = \frac{C \times P}{\Delta T}$$

$$N = \frac{G}{A \times h}$$

where:

C = coefficient; C = 3 for metric units and C = 20 for imperial units

ΔT = temperature difference between incoming and outgoing air (°C/F°)

A = floor area (m^2 /sqf)

h = room height (m/ft)

The air change rates required by different power densities are presented in the following table.

T = +5°C (+41°F) and h = 4 m (13 ft)

Table 20. Change rate of air (N) with various power densities

P/m^2	P/ft^2	N = times/h
50 W	5 W	N = 7.5
100 W	10 W	N = 15
150 W	15 W	N = 22.5
200 W	20 W	N = 30
250 W	25 W	N = 37.5
300 W	30 W	N = 45

The air inlet and outlet must be designed so that the air velocity does not exceed the limit of 0.5 m/s in the constant occupancy zone and in the area occupied by the network element cabinets. The fan must contain a filter (for example, F4 AFI II NBS) and a silencer, if necessary.

Forced ventilation, incoming air through the cabinets

If air is blown separately through the cabinets and the constantly occupied areas, the power density can be raised up to 500 W/m^2 without making the temperature or airflow rate unsuitable for the personnel. The air can be blown in through a raised floor or by installing the cabinets on the air vent. The air velocity must not exceed 0.2 m/s.

Back-up for forced ventilation

The exchange rooms must have a back-up ventilation arrangement to ensure adequate cooling in case of a failure in the primary system or its power supply.

However, natural ventilation may be sufficient to ensure adequate cooling for a period during which the fault in the primary system can be eliminated. We recommend that even in a case like this, there is a temporary, forced replacement system available which can be brought to the premises in case repairing the primary system would take a prolonged period of time.

The figure *Temperature change caused by a failure of the ventilation system* shows the use of natural ventilation as a temporary back-up system during a repair period. If the ventilation system or the power supply fails, the temperature in the network element will eventually rise to a temperature (T; see the figure) which is higher than the temperature allowed for the equipment (T MAX). Note that the rate of temperature rise can be reduced - and the repair period extended - by designing the building and ventilation so that natural ventilation works as effectively as possible during a failure.

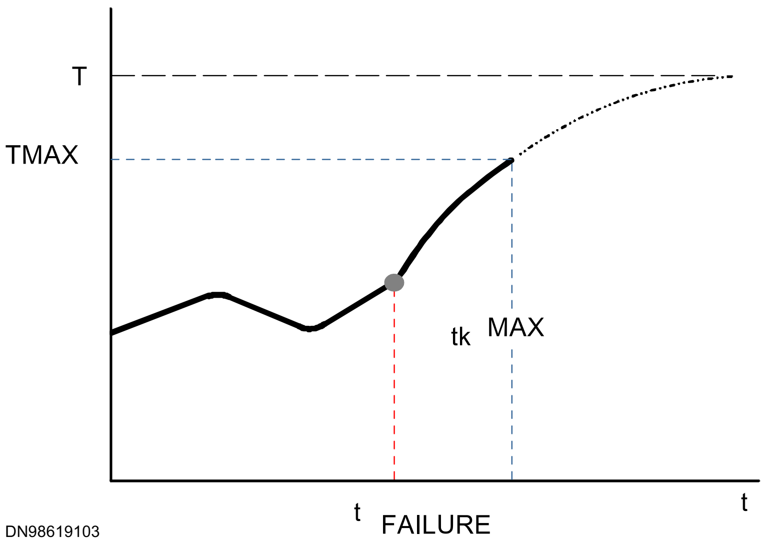

Figure 9. Temperature change caused by a failure of the ventilation system; tk = repair time

In small equipment installations, it is possible that the natural ventilation is sufficient to keep the temperature at a value lower than T MAX. If so, the natural ventilation can be used as a permanent back-up for the forced ventilation.

7.1.3 Air conditioning

At sites where some of the rooms are air-conditioned, it is practical to have air-conditioning in the exchange rooms as well. The suitable range of temperature is +18 to +27°C and that of relative humidity, 30 to 70%. In these conditions, the failure density of the network element generally decreases and the working conditions of the operating personnel improve. When air conditioning equipment is used, the maximum power density is 250 W/m^2 .

8 Cabling and alarms of BSC and TCSM2

The cabling of the BSC and TCSM2 network elements consists of interconnection cables (internal cables) and site (external) cables (outgoing cables).

The interconnection cables include all the cables inside each rack and between different racks. These cables have been cut to length and fitted with connectors at the factory. They are installed according to the cabling plan. For further information on interconnection cables, see the BSC and TCSM2 *Site Documents* , *BSC and TCSM2 installation overview* , *Overview of engineering for BSC* and *Overview of engineering for TCSM2* .

8.1 Site (external) cables

Site (external) cables are outgoing cables and include all the cables which leave the BSC and TCSM2 racks. They include:

- PCM trunk circuit cables, which are connected to the connectors on the front panels of the plug-in units
- alarm cables
- grounding cables
- power supply cables
- I/O cables
- X.25 cables (only for BSC2)
- external synchronisation cables (only for BSC2 when required)
- LAN cables.

The sheaths of the site (external) cables, except for the power supply cables, must be grounded at the grounding elements (feed-through EMC gaskets) at the top (or bottom) of the rack when they leave the rack row.

8.1.1 Cable conduits

Normally, the site (external) cables of the equipment are run above the rack rows. If the equipment room has raised flooring, it is also possible to place the cables underneath the floor. For bringing the cables from underneath the floor to the equipment racks, the following options exist:

- A vertical cable conduit (CC19V/CC19V-S/CC22V) can be used for bringing the power supply cables into the rack row. The conduit is fitted at the end of the rack row, alongside the normal side panel, which has an opening at the top. The width of the conduit is 140 mm.
- A cable rack (R2A1-S/-T) can be used for bringing all other types of external cables into the rack row, except for the power cables. It can be fitted alongside the last rack of the row (with the side panel left unistalled), or between two equipment racks. The cables are entered to the cable rack vertically from underneath the floor and then routed on horizontally from the cable rack to the equipment racks. The cable conduit CC19V/CC19V-S /CC22V, however, must always be used for routing the power cables, even in case the cabling rack is used. The width of the R2A1-S/-T rack is 200 mm.

The R2A1-S/-T rack is also used if there is need for a horizontal cable conduit (CC132) for cables running between rack rows. The horizontal conduit is installed between two R2A1-S/-T racks placed in the corresponding positions in two adjacent rows, with the ends attached to the top structures of the R2A1-S/-T racks.

The following figure and table present an example of the use of R2A1-S/-T racks and the horizontal and vertical cable conduit.

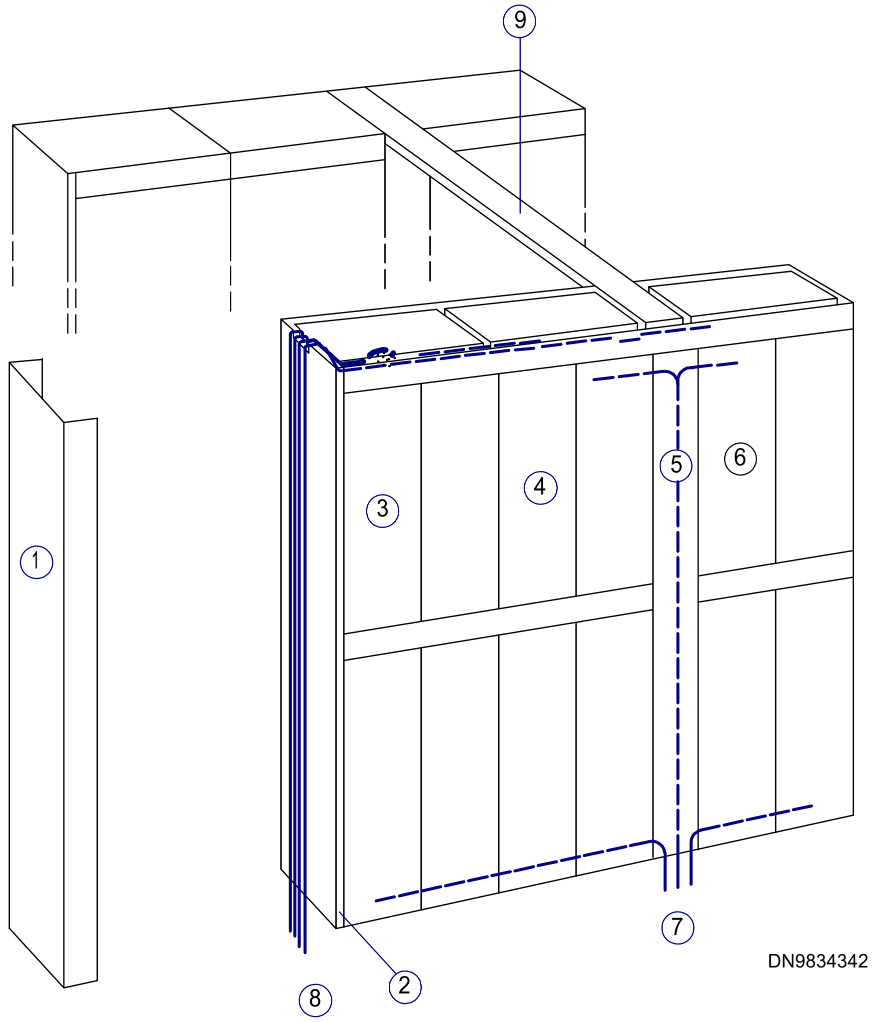

Figure 10. Use of the R2A1-S/-T rack and the cable conduits

Table 21. Items presented in the figure above

No.	Item
1	Cable Conduit CC19V/-S
2	Side plate SP19A
3	Rack 1
4	Rack 2

Table 21. Items presented in the figure above (cont.)

No.	Item
5	R2A1-S/-T rack with grounding element at the bottom (Door set DS192)
6	Rack 3
7	Trunk, alarm and grounding cables either through R2A1-S/-T or CC19V/-S beneath raised floor
8	Power supply cables
9	Cable Conduit CC132 (optional)

8.1.2 PCM trunk circuit cables in the E1 and T1 environment

The BSC2 and TCSM2 trunk circuit cables are mostly cut and connected at the installation site, but they can also be ordered from the factory with one connector installed.

The trunk circuit cables are either symmetric shielded or coaxial cables, depending on the used interface type. Cables of individual interfaces may be grouped into a bundle of cables which have a common outer shield for grounding.

In the E1 environment, two interfaces are available for trunk circuit cabling:

- When a balanced 120 Ω interface is used, the front panels of the ET2E/-S/-T plug-in units are fitted with Euroconnectors with four or eight Euroconnectors in the same trunk circuit cable for connecting PCM circuits (four or eight 2 Mbit/s trunk circuits per cable).
- When an unbalanced 75 Ω interface is used, the front panels of the ET2E-C/-SC/-TC plug-in units (BSC, TCSM2) are fitted with SMB type connectors for two coaxial cables (that is, one 2 Mbit/s trunk circuits per two cables).

In the T1 environment, that is, when a balanced 100 Ω interface is used, the front panels of the ET2A/-T plug-in units are fitted with RJ45 jacks for connecting PCM circuits.

8.1.3 Cables of peripheral devices and X.25 connections in the BSC and TCSM2

In the BSC2, the connectors for the VDUs, printers and the X.25 communications interface are in the BCBE rack, with the connectors for the peripheral devices placed in a separate connector panel and the cables for the X.25 communications interface connected to the connectors on the front panel of the plug-in units. The maximum length of the cables is 30 m (33 yd). The cable armatures are connected to metal encapsulated D connectors.

The TCSM2 has connections only for the VDU. They are located in the front panel of the TRCO plug-in units. The maximum length of the cables is 30 m. The cable armatures are connected to metal-encapsulated D connectors.

8.1.4 Integrated LAN connections

Integrated LAN connections are an optional S11 upgrade available to the BSCE, BSCi, BSC2A and BSC2E, the BSC2i upgraded from the BSC2A or BSC2E, and the first-delivery BSC2i option.

The LAN connections are used for external LAN cabling between the CPLAN-S LAN panel and an external LAN switch or router. The option is also used for LAN cabling between the LAN port of the CP6MX or CP6LX or the PCU or COCEN front panel and the CPLAN-S LAN panel.

The maximum length of a LAN bus measured from the LAN port of the CP6MX or CP6LX or the PCU or COCEN front panel is 60 m using a CNI type LAN cable.

8.1.5 Power supply cable

The power supply cables are connected to the terminal blocks of the racks.

8.1.6 Grounding of the site (external) cables

The metal sheaths (aluminium or copper) of all the cables entering the racks, except for the DC power feed cables from the rectifiers, must be grounded to the rack frame with specific grounding elements (feed-through EMC gaskets, also known as grounding combs), which are placed at the top structures of the equipment racks, or at the bottom plates of the cabling racks R2A1-S/-T.

Note

Never ground the DC power feed cables from the rectifiers.

8.2 Cable shelves and distribution frames

The cable conduits between and/or on top of the rack rows are a part of the mechanical structure, but the DX 200 system construction does not comprise actual cable shelves. Further construction arrangements are decided by the customer individually.

It is possible to use 300 or 500 mm wide aluminium profile structures mounted to the walls or to the ceiling as cable shelves. However, it is recommended that the shelves be installed above the racks, so that the power supply cables and trunk circuit cables can be installed more easily.

The hardware of the network element may not at any point be galvanically connected to the steel construction or the concrete reinforcement of the building in which the network element is situated. Therefore, the cable shelves must be isolated from the frame of the network element. Lights for the rack row can also be mounted on the shelves in order to avoid direct contact with the frame.

Since the distribution frames are not system specific, they should be designed according to local requirements. Thus, they are not covered in this manual, except for the grounding arrangements (for more information, see *Grounding and bonding*).

8.3 External alarms of the BSC

8.3.1 Receiving external alarms

The Operation and Maintenance Unit (OMU) in the BSC receives external alarms; for example, from the power units, air conditioning equipment, and pressure supervising devices. The alarms are sent through the cables in groups of 16 to the Hardware Alarm Terminal (HWAT) plug-in unit.

Each alarm is connected to the receiver as a switch-on/switch-off of ground potential. The ground potential difference between the alarm circuit and the network element must be 0.5 V.

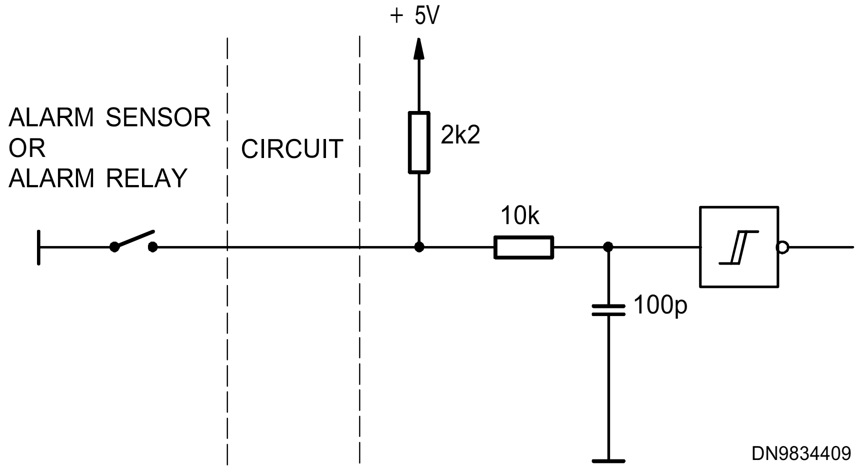

Figure 11. Transmitting and receiving circuits for external alarms

8.3.2 Sending external alarms

The computer unit in the Operation and Maintenance Unit contains 16 alarm control circuits allocated to the external alarm system, which can be used, for example, to control the alarm lamps. The maximum current from each circuit is 28 mA.

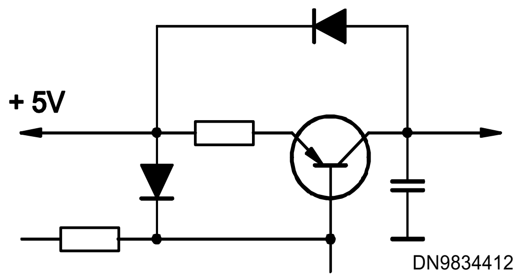

Figure 12. Transmitting circuit for external alarms in OMU

8.3.3 External Lamp Panel for BSC alarm indication

The alarm Lamp Panel (LAMPP, C4207; eight alarms) manufactured by Nokia, with lamps for five alarms, can be used as a separate alarm indicator for the BSC2. The lamp panel allows all the eight alarms to function as relay contact supplies for further handling. The load capacity of a relay contact is 1 A / 48 VDC. External alarm cables are routed to the main distribution frame and to the intermediate distribution frame to be switched onwards. An example of such a cable type is CYL.

The alarm signals to the lamp panel are transmitted through cables connecting to the distribution frame. Thus, the relay contact outlets of the lamp panel can be further connected to external alarms defined by the user. The alarm cable to the lamp panel can also be led directly from the OMU (CYL cable), but this solution does not support the relay contact outlet functions of the lamp panel.

Note

The Lamp Panel is not available for the TCSM2.

8.4 Collected power supply alarms of TCSM2 racks linked together

The equipment of one TCSM2 rack can generate a total of four power supply alarms, two by the PSA 20 units and another two by the PSFP units. The alarms of up to seven TCSM2 racks can be collected and sent together to some external equipment. In this configuration, all the internal alarms of a given rack are, as normally, routed to a single cable connector in the first PSFP of the rack. From the PSFP of each rack, an alarm cable runs to a further collecting point in one of the seven racks, the so-called mother rack. This collecting point is located in the motherboard of the mother rack's first ET1TC cartridge. From there, the alarms are transferred as an alarm input via a single cable to some external equipment, typically an MSC. The alarm condition appears as a defined voltage level on the wire.

9 Cabling of BSC3i

9.1 External cables

The external (station) cables are all cables which enter the BSC3i network elements. External cables are not included in the delivery and must be ordered separately. They include:

- PCM trunk circuit cables (E1, T1), connected to the front connectors of ET plug-in units
- X.25 cables, connected to the rear connectors of the OMU cartridge
- alarm cables from external devices, connected to the CPRJ45 panel
- LAN cables (100 Mbit/s), connected to the CPRJ45 panel
- peripheral cables (VDU, PC, printer), connected to the CPRJ45 panel
- external synchronisation cables, connected to the CPRJ45 panel
- alarm input cable from an external device connected to the rear connector of the OMU cartridge.

In addition to the above mentioned, the external cables include the following cables, which must also be ordered separately:

- power supply cables
- grounding cables.

9.1.1 PCM trunk cables

The BSC3i network elements have different types of interfaces for the PCM trunk cables for the E1 and T1 environments, as described below.

PCM trunk circuit cables in the E1 and T1 environment

The BSC3i trunk circuit cables are usually cut and connected at the installation site, but they can also be ordered from the factory with the switch end connector installed.

The trunk circuit cables are either symmetric shielded or coaxial cables, depending on the used interface type. Cables of individual interfaces may be grouped into a bundle of cables which have a common outer shield for grounding.

In the E1 environment, two interfaces are available for trunk circuit cabling:

- When a balanced 120 Ω interface is used, the front panels of the ET2E-S/-T plug-in units are fitted with Euroconnectors with four or eight Euroconnectors in the same trunk circuit cable for connecting PCM circuits (four or eight 2 Mbit/s trunk circuits per cable).
- When an unbalanced 75 Ω interface is used, the front panels of the ET2E-SC/-TC plug-in units are fitted with SMB-type connectors for two coaxial cables (that is, one 2 Mbit/s trunk circuits per two cables).

In the T1 environment, that is, when a balanced 100 Ω interface is used, the front panels of the ET2A/-T plug-in units are fitted with RJ45 jacks for connecting PCM circuits.

9.1.2 Cables for X.25 connections

The X.25 interfaces (V.24, V.24 restricted, V.35, and X.21) are connected to the special shielded extension cables (CLSC020, CLRC020 and CLTC020). These extension cables are routed through the CPGO panel to the rear connectors of the OMU cartridge.

Grounding (earthing) of the PCM trunk and X.25 cables

The metal sheaths (aluminium or copper) of the PCM trunk (E1, T1) and X.25 cables entering the cabinet must be grounded to the cabinet frame with specific grounding elements (feed-through EMC gaskets, also known as grounding combs), which are placed at the CPGO panels of the equipment cabinets.

9.1.3 Cables of peripheral devices

Connectors for the shielded VDU and printer cables are located in the CPRJ45 connector panels in the BSC3i cabinets. The connectors used are RJ45 connectors. The typical maximum length of the cables, depending on the transmission speed, is 30 m.

The CPU and ESB20 plug-in units have separate interfaces for Service Terminals used for temporary service operations. The RJ45 connectors for these are on the front panels of the plug-in units.

9.1.4 Cables for external synchronisation connections

The connectors for shielded external synchronisation cables are on the connector panel CPRJ45. The connectors used are RJ45 connectors for balanced (SYMM) interfaces and BNC for unbalanced (ASYMM) interfaces.

9.1.5 LAN/Ethernet cables

The connectors for the shielded LAN cables are on the connector panels (CPRJ45). The connectors used are RJ45 connectors.

9.1.6 External alarm cables

The BSC3i equipment can receive external alarms; for example, from the power units, air conditioning equipment, and pressure supervising devices. These alarms are transmitted through a shielded cable which connects to the connector panel CPRJ45 in the BSC3i cabinet.

If the external alarm input capacity of the CPRJ45 is not sufficient, there is an alternative cabling solution available in which the HWAT unit in the BSC3i supports an equal amount of alarms as the BSC2i application. In this solution, external alarm input signals are cabled directly to the HWAT-A unit at the back of the OMU cartridge with a dedicated cable.

In the OMU, the external alarms are processed by the HWAT-A plug-in unit, where they arrive as a switch-on/switch-off of ground potential. The ground potential difference between the alarm circuit and the exchange must be $\leq$ 0.5 V.

The external alarms are transmitted to the HWAT-A through one or two cables, which must be routed through a distribution frame.

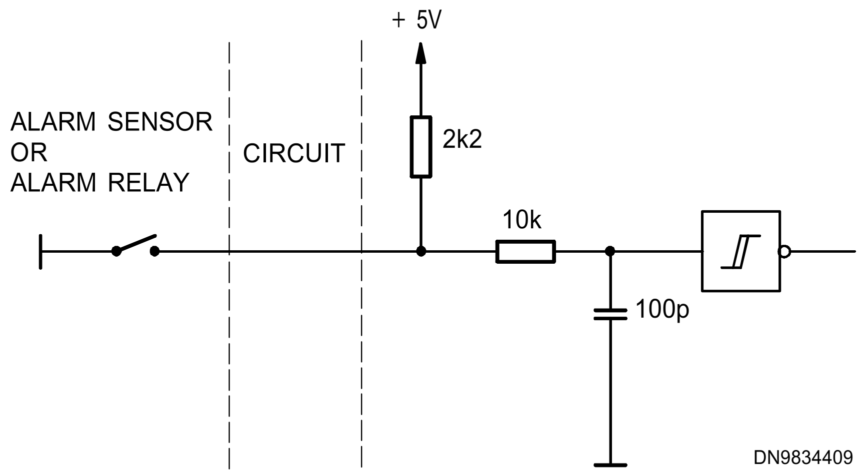

Figure 13. Transmitting and receiving circuits for external alarms

External Alarm Unit EXAU for BSC3i alarm indication

The BSC3i network elements can be equipped with an external alarm unit EXAU. The EXAU houses six replaceable alarm indicator LEDs on the front panel. The EXAU is connected to the CPRJ45 panel with a CNDC cable.

9.2 Cable shelves and distribution frames

The BSC3i network elements require some cable constructions at the site, which are not a part of the DX 200 system construction. These comprise the cable shelves (only for installations without a raised floor) and the distribution frames. The distribution frames are not system-specific and therefore not covered in this connection. The requirements for the cable shelves are described in the following section.

9.2.1 Requirements for the cable shelves

In installations without a raised floor, the station cables must be routed above the cabinet rows on separate cable shelves. The cable shelves are attached to the ceiling or a wall, with a separate branch running above each cabinet row, so that the power supply cables and trunk circuit cables can be routed easily.

To prevent galvanic connection between the cabinets and the steel construction or the concrete reinforcement of the exchange building, the cable shelves must be isolated from the exchange frame. Lamps for the cabinet row can be mounted on the shelves to avoid direct contact with the exchange frame.

Aluminium cable racks can be used as the cable shelves. The shelves can be mounted on the walls or to the ceiling.

10 Conversion between metric and imperial measures

Conversion factors and tables

Table 22. 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:		

Table 22. Conversion factors from metric to imperial measurement units (cont.)

	Metric unit	**Imperial equivalent**
	1 W	3.413 Btu/h
Pressure:		
	1 kPa = 1,000 Pa	0.1450 psi
	1bar (100kPa)	14.504 psi
Wire conductor size:		
	16 mm^2	AWG 4
	25 mm^2	AWG 2
	35 mm^2	AWG 1
	50 mm^2	AWG 0

Table 23. 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 with 9, divide by 5, and add 32:

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