GB **Gira nurse call system Plus**
Planning, installation, start-up, operation

Gira Nurse Call System Plus
System manual

GIRA

Contents

1. Introduction

The Gira nurse call system Plus is a wired call system with voice function that fulfils all of the requirements of the DIN VDE 0834 standard.

1.1 General Information

The technical data and specifications contained in this document may be changed without prior notification. The illustrations are also non-binding.

Subject to technical modifications!

Note: up-to-date information is available on the Gira website.

As the device you have purchased is constantly being further developed and updated, information in this manual may no longer be up-to-date.

Current product information is always available on the Gira website:

http://www.gira.de

Current software updates and documentation for your product are available at

http://www.download.gira.de.

1.2 System requirements

Operation of the Gira nurse call system Plus requires own cables/own low voltage power supply (24 V).

Note: emergency power supply.

According to DIN VDE 0834, emergency power supply must be ensured for specific application areas. The Gira power rectifier UPS Plus is suitable for decentral emergency power supply, Order No.: 5999 00.

1.3 Application areas (proper use).

The Gira nurse call system Plus is suitable for application areas specified in the DIN VDE 0834 standard such as hospitals, homes for the elderly and care homes etc.

The Gira nurse call system Plus is used to signal emergency situations and alert personnel. Emergency situations are displayed via a red and/or white light in the room signal lights and/or via plain text in hallway displays, and in room and duty room terminals and duty room terminals CT9 (touch screen) acoustically as well using buzzers (call forwarding). The display of the presence of care personnel is signalled via green and yellow light in the room signal lights. Communication of the care personnel with patients and communication among the care personnel is also possible via the integrated voice function.

Logging of care activities as required by the standard is via the system central control unit and ward control centre.

In general, a call system is comprised of the following elements:

Elements of a call system	Example
Call triggering elements (e.g. with voice function)	Call button, patient hand-held device and pear button in diverse versions and functions as well as pull-cord button and pneumatic call button.
Call display elements (e.g. with voice function)	Room signal light, hallway display, room/duty room terminal, duty room terminal CT9 (touch panel) in diverse versions and functions.
Call switch-off elements (e.g. with voice function)	Switch-off and presence button, room/duty room terminal, duty room terminal CT9 (touch panel) in diverse versions and functions.
Power supply elements	Power rectifier, with and without UPS.
Controlling and logging elements	System central control unit and ward control centre

Important! No guarantee assumed with improper use.

Gira assumes neither legal responsibility nor provides a guarantee for errors and damage of any kind as a result of improper use and/or unprofessional installation of the Gira nurse call system Plus.

1.4 Application areas according to DIN VDE 0834 (proper use)

An application area is an area in which a call system is installed according to proper use. The behaviour in cases of system faults is authoritative.

Note: planning for proper use.

The call system must be planned as an independent system, DIN VDE 0834 is mandatory. The area of application must be defined in cooperation with the operator. If necessary, hospital construction regulations of the states and further legislation, guidelines and standards must be considered.

– **Application area A**

  The call system enables help to be called; system disruption may cause danger to the person calling.

  The call system must detect faults and signal these. The call system must continuously monitor itself.

– **Application area B**

  With the call system, special emergency calls for example for a reanimation team are also triggered, or medical devices for patient monitoring are connected. With faults, **special** danger occurs for the person calling.

  Transmission paths, call lines and components of the system important for call triggering must be included in monitoring measures. Uninterruptible power supply of the system must also be ensured via suitable measures. The saving of calls with short interferences of the power supply (e.g. with mains failure) must be ensured.

Note: nurse call system Plus is suitable for application areas A and B.

Nurse call system Plus is suitable for application areas A and B with proper installation.

2. Planning

2.1 Standards and regulations

Call systems belong to the category of safety systems and are traditionally known according to the terms of "light call systems" or "nurse call systems".

Special regulations are in force for installing, expanding, changing, operating and maintaining such systems.

As in nearly all technology sectors, there are also unified specifications with safety systems, the compliance with which represents a minimum standard for the performance profile and capability of a product. These specifications are usually documented in standards that represent the "general state of technology".

With the planning and installation of call systems, diverse regulations and legislation as well as standards must be taken into account.

In addition, accident prevention regulations must also be observed.

Note: responsibility of the system operator.

With operation and maintenance of a call system, the specific standards and regulations must be observed.
The system operator is responsible for this.

2.2 General safety regulations

Various regulations must be complied with in addition to the VDE 0100/IEC 364-1.
DIN VDE 0834 is the basis for installation, function, operation and maintenance of the Gira nurse call system Plus. Special conditions in medical areas (DIN VDE 0100-710) and general rules for telecommunication technology also apply.

Note: observe further regulations.

During installation and according to installation and location, observance of further regulations may be required.

According to DIN VDE 0834-1, call system devices must be set up so that they cannot be damaged or destroyed with proper use or through external effects, e.g. bed transport.

2.2.1 Protection against shock currents

In rooms of application groups 1 and 2 and according to DIN VDE 0100-710, the specified protective measures must be implemented for these rooms for protection against shock currents.

The specified safety regulations must be complied with fundamentally for all call systems and not only for the Gira nurse call system Plus.

2.3 Fundamental system design

The Gira nurse call system Plus is a light call system with voice functionality. It can be operated as a large system with a system central control unit (SSZ+) and several ward control centres (SZ+) or as a small system with only one ward control centre.

	Small system (without SSZ+)	Large system (with SSZ+)
Wards	1	up to 26
Setup and configuration of organisational units	✓	✓
Software module connection to electrical loudspeaker system Order No. 5996 00	-	✓
Software module connection to DECT telephone system Order No. 5994 00	-	✓
Software module connection to fire alarm system Order No. 5993 00	-	✓

The Gira nurse call system Plus is hierarchically designed.
Here three levels are physically differentiated between:

– Room level (room bus)

– Ward level (ward bus, cable material must be 4 x 2 x 0.8 mm)

– System level (system bus, ethernet at least Cat.5)

Note: voice communication.

To implement a call system with voice communication, at room level duty-/room terminals must be planned.

The "Functions" chapter describes in detail which devices are available for the nurse call system Plus and which functions these fulfil.

The connection terminals of all system devices are colour-coded and correspond to the colouring of the recommended cable material (J-Y(St)-Y-).
In this way all devices can be connected without errors.

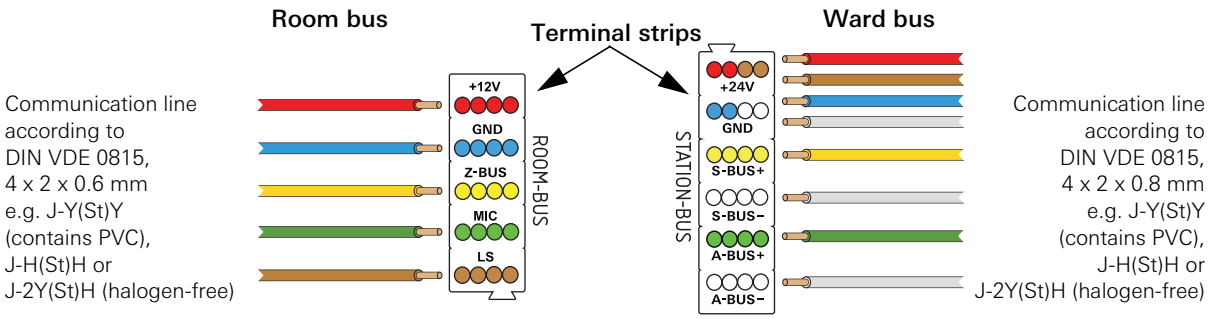


Figure 2.1: Colour coding of the connection terminals and recommended cable material

Independent of the physical (bus) levels of the call system, so-called organisational units can be set up in which wards are grouped.

Organisational units may consist of one or several rooms and also complete wards.

Ward groups can be interconnected with complete wards or with other ward groups to form new organisational units. Chapter 2.9 Planning organisational units (grouping wards) on page 25 specifies how these are planned.

Explanations for colour-coding of the devices in the drawings and tables

System bus devices (nurse call system Plus LAN - independent network)
Max. of 26 ward control centres in the large system

Ward bus devices
Max. 52 per ward

Room bus devices
Max. 16 per room

2.4 System overview of a small system

When using the nurse call system Plus as a small system, the ward control centre serves as the central control element. Self-monitoring of the system (creation of log files) is automatic (as with large systems). Only one ward control centre can be operated in a small system. The use of further ward control centres or connection to an external system (electrical loud-speaker system (ELA), fire alarm system (BMA), DECT, VoIP) is not possible.

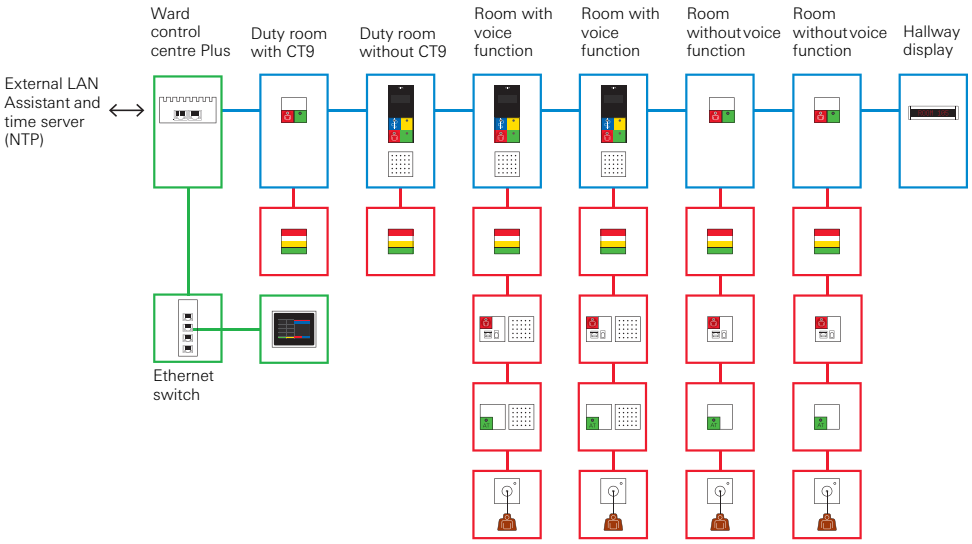


Figure 2.2: Small system with a ward control centre, switch and duty room terminal CT9

2.4.1 Properties and options with a small system

The ward control centre has two ethernet connections that are designated differently. The ethernet connection labelled "Nurse call system Plus LAN" is used for the call system network, and the "External LAN" ethernet connection for connection of the configuration PC.

The most important properties of the ward control centre:

- Control of the call system.
- Logging of call and presence activities.
- Self-logging the system (error protocol).
- Connection option for the duty room terminal CT9.

  The prerequisite for operating a CT9 in the system is an installed duty-/room terminal or room module.
  If a CT9 is only needed in a small system, the connection can be implemented directly via an ethernet cable (CAT5 or higher) on the "Nurse call system Plus LAN" connection of the ward control centre.
  If several duty room terminal CT9's are needed in a small system, the connection is implemented via a switch with ethernet cable (CAT5 or higher) (see Figure 2.2) on the "External LAN" connection of the ward control centre.
- "Nurse call system Plus LAN" connection: Network connection for the call system.
- "External LAN" connection: Enables access to the system with the configuration assistant, or establishes connection to an external network (e.g. hospital network) or to the internet via e.g. an NTP server (time server).
- The configuration of the system is implemented with the so-called configuration assistant. This software is part of the ward control centre. Access to this is via a browser on the configuration PC.
  To access the configuration assistant, see chapter 4. Start-up on page 59.

Note: power supply for a ward control centre.

Observe that DIN VDE 0834 specifies an independent, uninterruptible power supply for call systems.

2.5 System overview of a large system

When using the nurse call system Plus as a large system, a system central control unit serves as the central control element (across wards). With this configuration several wards are possible, and connection to external systems (electrical loudspeaker system (ELA), fire alarm system (BMA), DECT, VoIP) and self-monitoring of the system (creation of log files) is automatic.

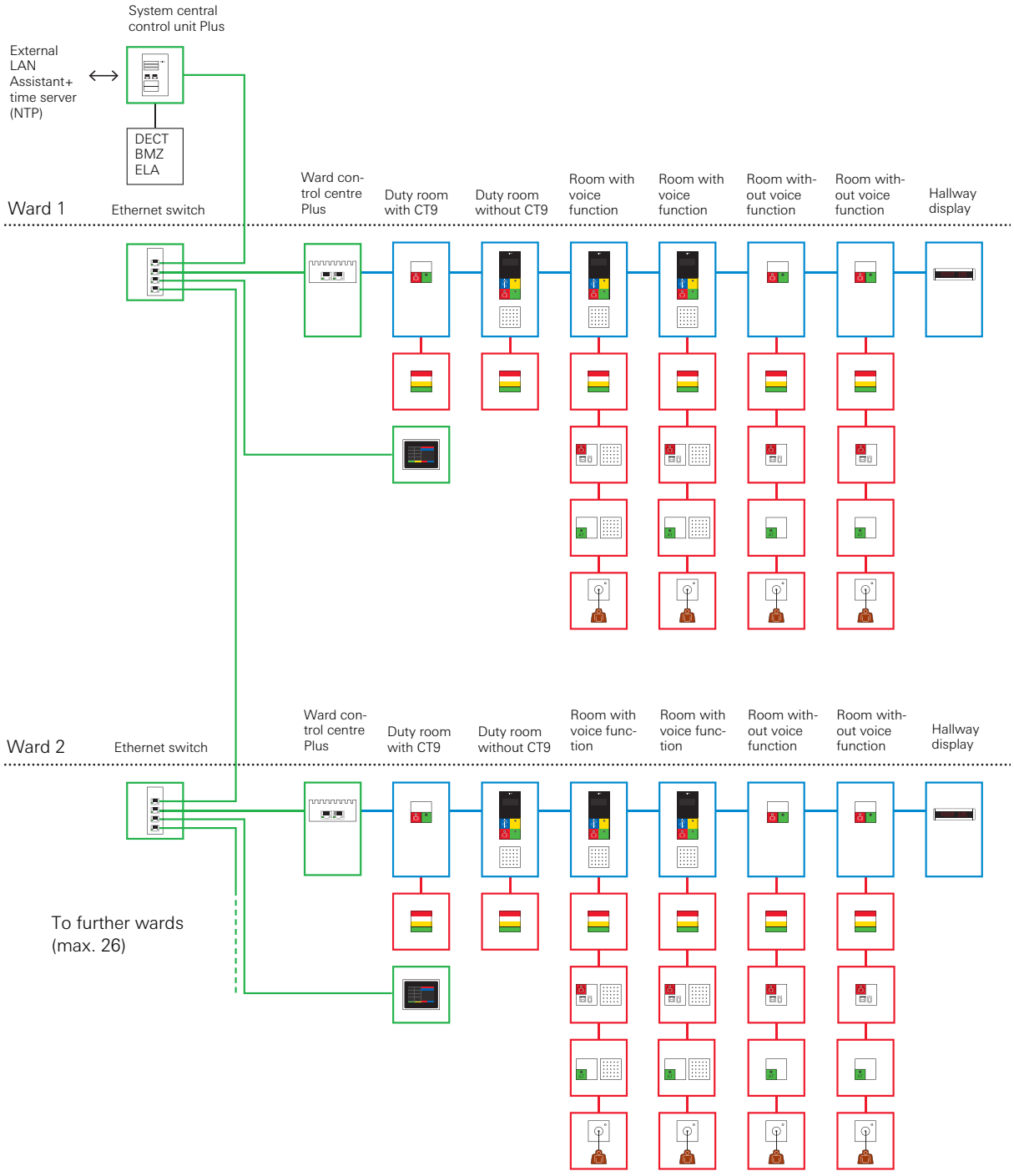


Figure 2.3: Example of system design for a large system

2.5.1 Properties and options with a large system

On the system level of the large system, the ward control centres of the call system are connected with the higher-level system central control unit via the ethernet switch(es) where applicable. The ward control centres and the system central control unit each have two ethernet connections that are designated differently. The ethernet connection designated "Nurse call system Plus LAN" is used for the call system network.

The most important properties of the system central control unit:

– Control of the call system.

– Logging of call and presence activities.

– Self-logging the call system (error protocol).

– Connection option for at least one, max. 26 ward control centres.
(We recommend: ensure own power supply for each ward).

– Connection option for duty room terminal CT9's via ethernet switch.

  The prerequisite for operating a CT9 in the system is an installed duty-/room terminal or room module.
  If one or several duty room terminal CT9's are to be integrated, the connection is implemented via a switch with ethernet cable (Cat.5 or higher) (see Figure 2.2) on the "External LAN" connection of the system central control unit.

– Connections at system level are via ethernet cable Cat.5 or higher, switches are applied where required.

– "Nurse call system Plus LAN" connection: Network connection for the call system.

– "External LAN" connection: Enables access to the system with the configuration assistant, or establishes connection to an external network (e.g. hospital network) or to the internet via e.g. an NTP server (time server).

– The configuration of the system is implemented with the so-called configuration assistant. This software is part of the system central control unit. Access to this is via a browser on the configuration PC.
  To access the configuration assistant, see chapter 4. Start-up on page 59.

Note:
power supply of the system central control unit.

Observe that DIN VDE 0834 specifies an independent, uninterruptible power supply for call systems.

– Connection option for an electrical loudspeaker system (ELA)
(Optionally available software module, Order No.: 5996 00 is required).

– Connection option for a fire alarm system (BMA)
(Optionally available software module, Order No.: 5993 00 is required).

– Connection option for a telephone system (DECT)
(Optionally available software module, Order No.: 5994 00 is required).

2.6 Planning of the wiring at room level

The central, controlling devices of a room are the room terminals, duty room terminals or room modules. These devices also represent the interfaces to the ward bus.

The devices of a room are interconnected via the room bus.

J-Y(St)Y 4 x 2 x 0.6 mm cables (or comparable) should be used.

Selection of cable material

When selecting cable material, the regulations and legislation valid at the location must be observed.
Concerns e.g. required halogen-free cable material.

With cable routing at room level, both wiring from device to device and star-shaped wiring is possible.

To prepare rooms for voice functionality, duty-/room terminals must be planned, as only these devices in combination with the voice module (included in scope of supply) offer voice functionality.

Power supply for the room devices is via the room bus line and is output from the duty-/room terminals or room modules.

The maximum cable length for the room bus is 40 m. Up to 16 room devices can be connected, not including duty-/room terminals or room modules.

2.7 Planning of the wiring at ward level

Devices at ward level such as ward control centre, duty room and room terminals or modules and surface-mounted and flush-mounted I/O modules or hallway displays are interconnected on the ward bus.

The duty-/room terminals have a display, a capacitive keypad and the option of connecting the voice module. The display can show for example the room number from which a call was triggered. Voice calls can be accepted and terminated or interconnections from wards and/or ward groups can be activated or deactivated. The duty room terminal differs from the room terminal by supplementary functions that are selected and called via the capacitive keypad below the display.

Cable material **must** be 4 x 2 x 0.8 mm (J-Y(St)Y or comparable). The ward bus is routed as a branch line, star-shaped wiring as with the room bus is not permissible.

A ward control centre serves as the central control unit for the ward and can be the interface between the ward bus and system bus.

Cable length with 24 V power supply (Gira power rectifier with or without UPS) in the ward bus can be a maximum of 300 m. For power supply, **two** wire pairs of the above-specified cable material are used (red/blue and brown/white). See also 3.6 "Connecting the devices at room bus and ward bus level" on page 39 and "Overview of power supply" in the installation chapter.

Note:
ensure power supply at the remotest point on the line.

Under the precondition of

- power rectifier Plus (Order Nos.: 5971 00 or 5998 00) or the Power rectifier Plus UPS (Order No.: 5999 00) being used and
- in compliance with all notes on specified cable lengths, and
- with observance of the energy point table, see 2.8.1 Energy point table (Calculation of maximum number of devices per power supply unit) on page 23

at least 14 V voltage can always be measured at the remotest device.

The length of the bus line at ward level can be max. 1000 metres.

The ward control centre is always the first device on the ward bus. The terminating resistances of the bus lines (data and audio bus) are activated at the last device on the bus via a jumper (yellow jumper, included in scope of supply of the ward control centre).

2.8 System power supply

The nurse call system Plus is operated with 24 V continuous current.

Important: ensure uninterruptible power supply!

The devices of the nurse call system Plus must be supplied with uninterruptible power supply. (see VDE 0834 Section 1).

If a central, uninterruptible power supply (230 V) is available in the building to be installed, then the power rectifiers (Order Nos.: 5981 00 and 5998 00) can be used without integral uninterruptible power supply (UPS).

If no central UPS is available, the power rectifier with UPS (Order No.: 5999 00) must be used.

Note: provide circuit breaker with power supply units.

Connect a circuit breaker type D, max. 16 A upstream from the power supply unit.

2.8.1 Energy point table (Calculation of maximum number of devices per power supply unit)

With the help of the energy point table, the maximum number of devices that can be supplied from one power supply unit is calculated. The basis for this calculation are the energy points. The energy points are measured so that the factor of simultaneity is taken into account with system operation. The room devices are already included in the energy points of the duty room/room terminals. Only the devices directly connected to a power supply unit are considered in the table.

If a power supply unit is not sufficient for supply of a ward, then further power supply units must be installed in the system.

Supplier	Art. No.:	Points	Calculation example: Number of devices	Points
Power rectifier 24 V/6 A	5981 00	55	1	55
Power rectifier 24 V/6 A, surface-mounted	5998 00	55		
Power rectifier 24 V/6 A, surface-mounted with UPS	5999 00	55		

Devices	Abbreviation	Points	Number of devices	Points
Duty room terminal	DZT+	2	1	2
Room terminal	ZT+	2	22	44
Room module	ZM+	1		
Hallway display, one-sided	FD+	2		
Hallway display two-sided	FDD+	3	1	3
I/O module ward bus surface-mounted Plus (8/8)	IOAP+	1	1	1
I/O module ward bus flush-mounted Plus (2/2)	IOUP+	1		
Ethernet switch	SW+	1	1	1
Ward control centre Plus	SZ+	4	1	4
System central control unit Plus	SSZ+	6		
Total energy points of connected devices				**55**

Important!
Do not connect more than 55 energy points per power supply.
If the limit of 55 points is exceeded then a further Gira power supply unit must be planned.

2.8.2 Overvoltage protection

The safe operation of call systems assumes high power supply availability that is also not influenced by external factors. As such, measures for protection against excess voltage and lightning must be planned for in the system.

The aim of these measures must be to avoid disruptions to the operational functionality of the call system or destruction of the system by atmospheric overvoltages, indirect (capacitive and inductive couplings) and conditional direct effects (galvanic coupling) from thunderstorms. Significant improvements in operational reliability are achieved with specific lightning and overvoltage protection. A corresponding lighting protection and overvoltage protection concept is to be drawn up and implemented for this, whereby overvoltage protection devices must comply for use in telecommunication and signal-processing networks according to DIN EN 61643-21: 2002-03.

Conductors of the call system that leave the building must be equipped with overvoltage protection according to DIN VDE 0845 at their point of exit. This need not be implemented when a galvanic separation securely prevents the crossing of hazardous voltages.

2.8.3 Electromagnetic compatibility

In terms of electromagnetic compatibility (EMC), general conductor routing in the immediate vicinity of possible sources of interference is to be avoided. Despite compliance to all regulations and standards concerning EMC, in individual cases influencing may occur.

2.9 Planning organisational units (grouping wards)

At least one ward control centre is required for the setup and configuration of organisational units (ward groups). Up to 6 ward groups can be managed with one ward control centre.

It is possible to connect complete wards or parts of these (one or several rooms) with other wards or parts to form new organisational units. This connection can be permanent or flexible. The configuration of rooms to ward groups is carried out in the configuration assistant of the system central control unit or ward control centre.

Each device in the system has a unique identification number. In addition, plain names must be assigned for the duty-/room terminals and room modules. Here this is usually the room number.

Creating new organisational units (ward groups) is also important for the function of call forwarding and call display.

In the state of delivery of a system (with at least one ward control centre), all rooms belong to the same organisational unit.

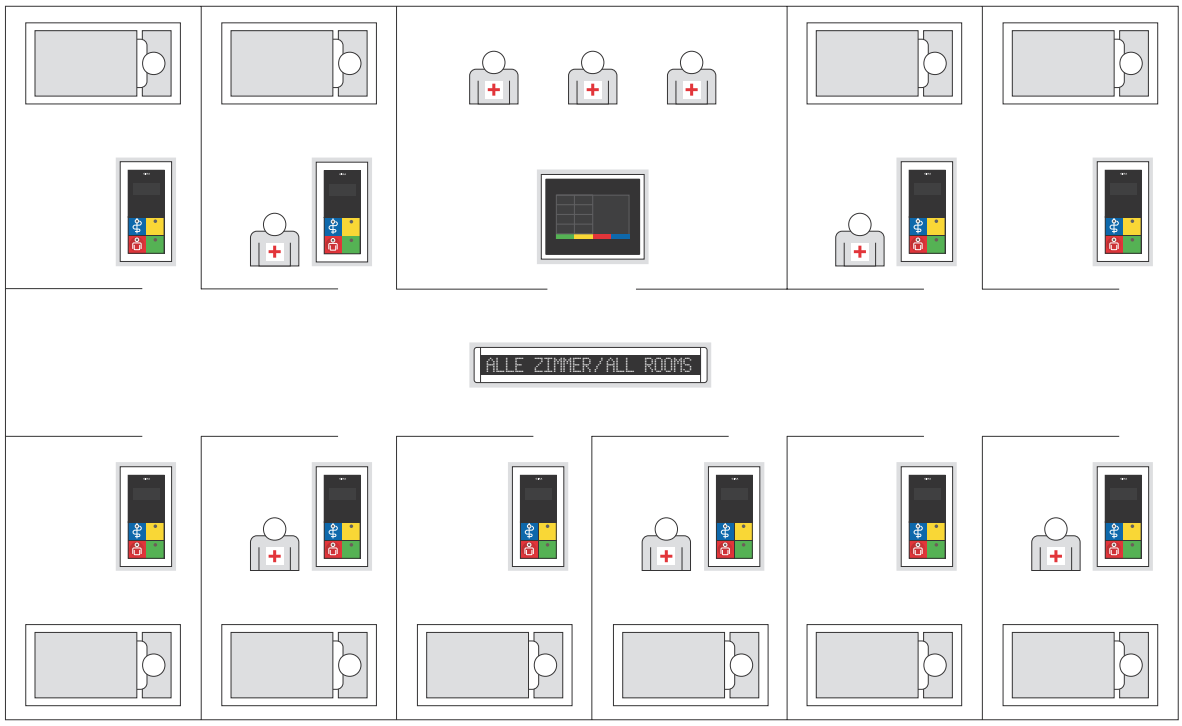


Figure 2.4: Example for an ungrouped ward as an organisational unit

The following example shows a ward split into 3 organisational units. The grouping of wards into ward groups (own organisational units) is carried out in the configuration assistant, see 4.8 "Handling the configuration software Example: Configure organisational units" on page 74.

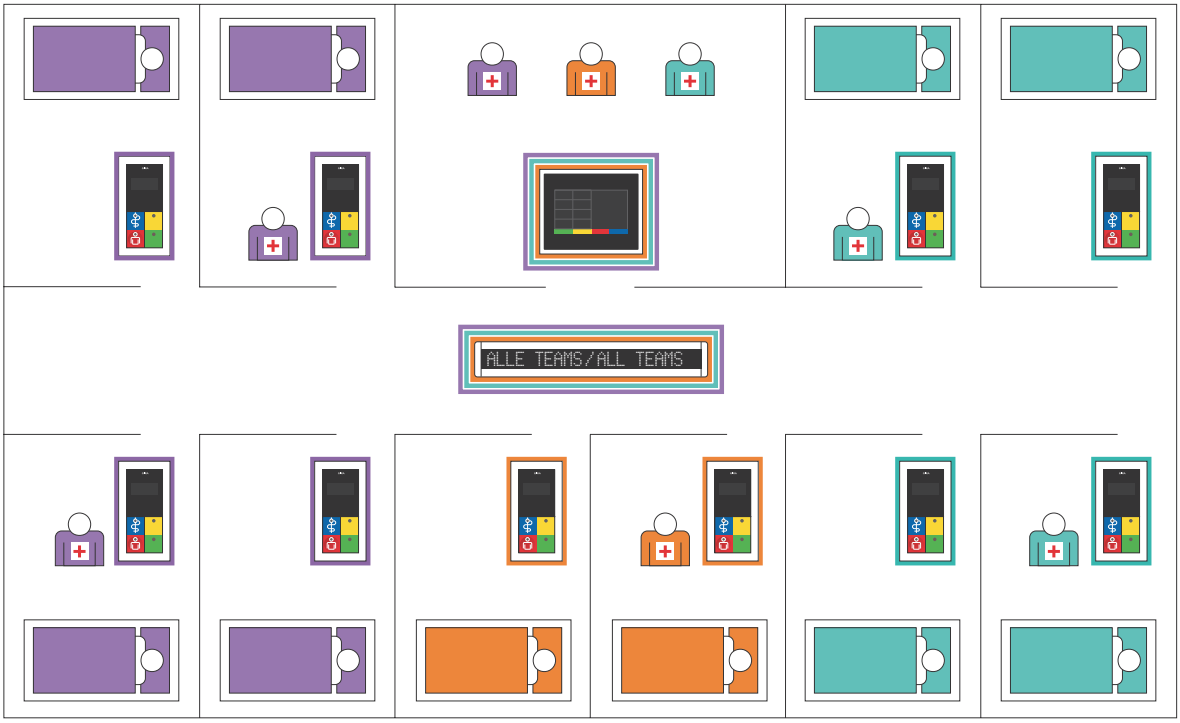


Figure 2.5: Example of a ward with three organisational units

In relation to faults that may occur in a system, DIN VDE 0834-1 specifies for the application area B:

– Larger call systems must be divided into independent sub-areas that cover a maximum of one ward.
– Faults in one of these sub-areas must not affect the other sub-areas.

From this it can be assessed that cross-ward organisational units must not be created for this application area.

Note: detailed information in the help section of the configuration assistant.

Please consult the help section of the configuration assistant for detailed measures for global configuration or interconnection of participating units and call types and for the display of presence and collective calls.

2.10 Examples of planning at room level

The maximum cable length for the room bus is 40 m. Up to 16 room devices can be connected.

2.10.1 Block diagram for a twin bed room without voice function

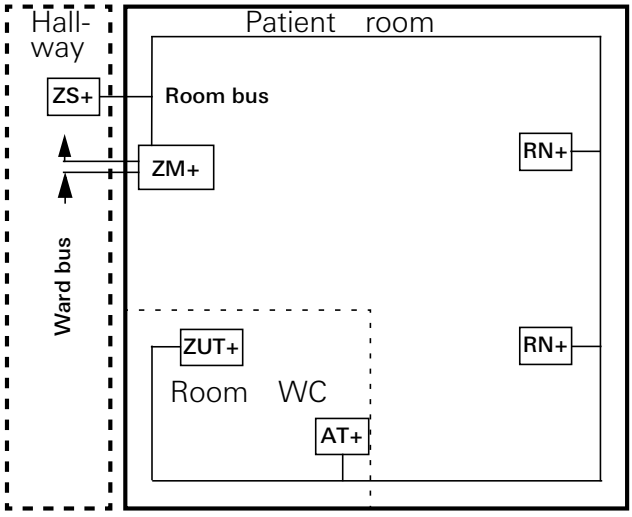


Figure 2.6: Block diagram for a twin bed room without voice function

2.10.2 Block diagram for a twin bed room with voice function

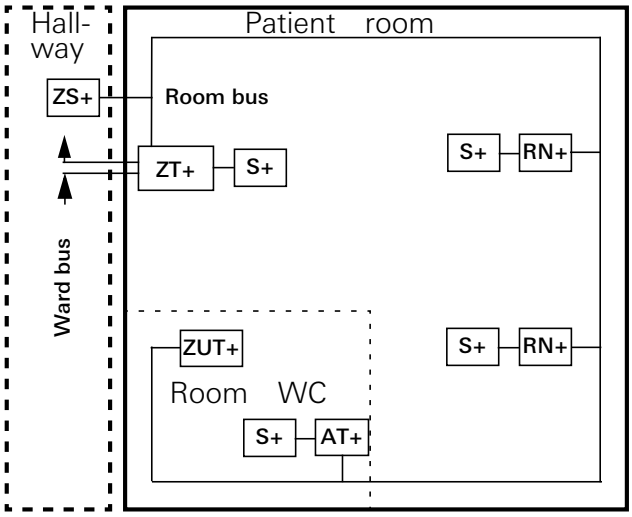


Figure 2.7: Block diagram for a twin bed room with voice function

2.11 Example: Wiring of a twin bed room with voice function and WC area

Patient rooms in care homes or hospitals are often twin-bed rooms with their own WC area (bathroom unit).

Next to the beds usually a call button with ancillary plug contact has been installed, to which a patient hand-held device can be connected. This hand-held device enables not only normal call/emergency call triggering but also switching of the reading light or the room light.

The patient has voice communication when a voice module has been connected to the call button with ancillary plug contact or when a patient hand-held device is above the ancillary plug contact. The latter makes direct voice communication possible by holding it to the mouth and ear like a telephone receiver.

Often in patient rooms there is a sitting area with table and chairs where a call button should also be installed.

A call button is normally found in the washbasin area of bathroom units.

A pull-cord button should be installed so that it can be pulled from the shower and/or toilet (not shown in the diagram). The length of the pull cord is measured to be reached by a patient lying on the ground. Next to the door in the WC area there is a switch-off button (possibly with voice module) to enable switching off a triggered call/emergency call directly on-site.

The system components of a room are connected to a room terminal or room module.

Triggered calls and presence are visually signalised via signal lights in the hallway next to or above the room door. The signal light is controlled via the room terminal or room module.

A call with continuous red light signals a WC call with continuous red and white light, an emergency call with red flashing light, a WC emergency call with red and white flashing light.

Note: switching off WC calls.

A WC call/WC emergency call can only be switched off on-site (i.e. in the WC) according to DIN VDE 0834.

The presence of care personnel in a room is displayed with green and/or yellow continuous light in the room signal light.

Routing of the cable material for the room bus is as a branch line or star-shaped.

Connection of the devices to the room bus is via the colour-coded terminal strips to avoid mistakes. The operating voltage for the room devices is output by the duty-/room terminal or room module.

Flush-mounted 2-gang boxes are included with the duty room terminals and room terminals. A voice module with suitable flat ribbon cable is included in the scope of supply, and spacers to the flush-mounted 2-gang box of the terminals are also included.

We recommend installing the room module in deep flush-mounted boxes.

The room signal light is wired to the room bus.

2.11.1 Which devices are used where?

The following tables are intended as planning aids, showing which devices are used where.

Explanation for colour coding of devices

Room bus devices
Max. 16 per room

Ward bus devices
Max. 52 per ward

System bus devices (Nurse call system Plus LAN - independent network)
Max. of 26 ward control centres in the large system

Room

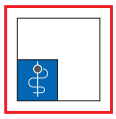
Figure	Designation	Connection to	Installation site	Voice capability	Connection of patient hand-held device
	Call button Plus (RT+) Order No. 5900 ..	Room bus	- In the room - At the bed - In the WC	-	-
	Call button with ancillary plug contact Plus (RN+) Order No. 5901 ..	Room bus	- In the room - At the bed	✓	✓
	Call and switch-off button Plus (RA+) Order No. 5902 ..	Room bus	- In the WC	-	-
	Call and switch-off button with ancillary plug contact Plus (RAN+) Order No. 5903 ..	Room bus	- In the room - At the bed	✓	✓
	Call and doctor alert button Plus (RAR+) Order No. 5904 ..	Room bus	- In the room	-	-
	Doctor alert button Plus (AR+) Order No. 5905 ..	Room bus	- In the room	-	-
	Call button with ancillary plug contact and DIA pin jack Plus (RND+) Order No. 5906 ..	Room bus	- At the bed	✓	✓

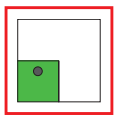
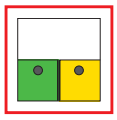
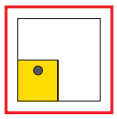
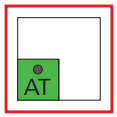
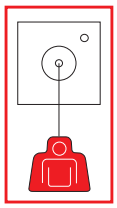
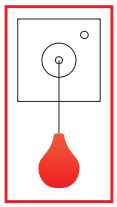
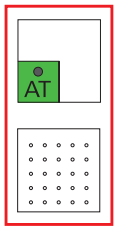
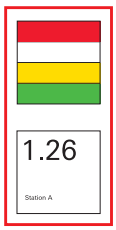
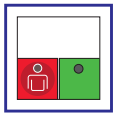
Figure	Designation	Connection to	Installation site	Voice capability	Connection of patient hand-held device
	Presence button green Plus (AW1+) Order No. 5908 ..	Room bus	- In the room	-	-
	Presence button green, yellow Plus (AW12+) Order No. 5909 ..	Room bus	- In the room	-	-
	Presence button yellow Plus (AW2+) Order No. 5910 ..	Room bus	- In the room	-	-
	Switch-off button Plus (AT+) Order No. 5911 ..	Room bus	- In the WC	-	-
	Pull-cord button Plus (ZUT+) Order No. 5912 ..	Room bus	- In the room: - At the bed - In the WC	-	-
	Pneumatic call button Plus (PRT+) Order No. 5913 ..	Room bus	- In the room: - At the bed - In the WC	-	-
	Switch-off button with voice module Plus (ATS+) Order No. 5918 .. (voice module included in scope of supply)	Room bus	- In the WC	✓	-
	Room signal light red, white, yellow, green Plus (ZS+) Order No. 5944 ..	Room bus	Hallway: - Next to/above the room door	-	-

Figure	Designation	Connection to	Installation site	Voice capability	Connection of patient hand-held device
	Room signal light red, white, yellow, green with name plate Plus (ZSN+) Order No. 5948 ..	Room bus	Hallway: - Next to the room door	-	-
	Room module with call and presence button (ZM+) Order No. 5920 ..	Room bus Ward bus	Patient room/duty room: - Next to the room door	-	-
	Room terminal doctor alert and presence 2 Plus (ZT+) Order No. 5925 .. (voice module included in scope of supply)	Room bus Ward bus	Patient's room: Next to the door	✓	-
	Duty room terminal doctor alert and presence 2 Plus (DZT+) Order No. 5929 .. (voice module included in scope of supply)	Room bus Ward bus	Duty room: Next to the door	✓	-

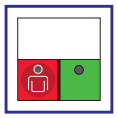
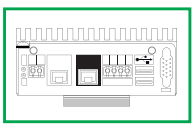
Note: devices are pre-configured.

Typical WC devices:

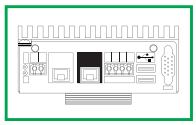
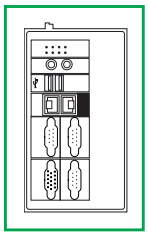
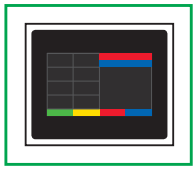
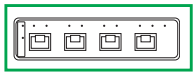
– Call and switch-off button Plus (Order No.: 5902 ..),
– Switch-off button Plus (Order No.: 5911 ..),
– Switch-off button with voice module Plus (Order No.: 5918 ..),
– Pull-cord button Plus (Order No.: 5912 ..),
– Pneumatic call button Plus (Order No.: 5913 ..)

are pre-configured for use in WC areas.

Ward

Figure	Designation	Connection to	Installation site	Voice compatibility
	Room module with call and presence button (ZM+) Order No. 5920 ..	Room bus Ward bus	Patient room/ duty room: - Next to the door	-
	Room terminal doctor alert and presence 2 Plus (ZT+) Order No. 5925 .. (voice module included in scope of supply)	Room bus Ward bus	Patient's room: - Next to the door	✓
	Duty room terminal doctor alert and presence 2 Plus (DZT+) Order No. 5929 .. (voice module included in scope of supply)	Room bus Ward bus	Duty room: - Next to the door	✓
	I/O module flush-mounted Plus (IOUP+) Order No. 5978 00	Ward bus	Any	-
	I/O module surface-mounted Plus (IOAP+) Order No. 5979 00	Ward bus	e.g. plant room of the ward	-
	Hallway display Plus (FD+) Order No. 5976 00	Ward bus	Ward hallway	-
	Hallway display two-sided Plus (FDD+) Order No. 5977 00	Ward bus	Ward hallway	-
	Ward control centre Plus (SZ+) Order No. 5971 00	Ward bus System bus	e.g. plant room of the ward	Only control of voice transmission.

System

Figure	Designation	Connection to	Application in large system	Application in small system
	Ward control centre Plus (SZ+) Order No. 5971 00	Ward bus System bus	✓	✓ Only as single device when no system central control unit is used.
	System central control unit (SSZ+) Order No. 5970 00	System bus	✓	-
	Duty room terminal CT9 Order No. 5927 00	System bus	✓	✓
	Ethernet switch (SW+) Order No. 5985 00	System bus	✓	✓

3. Installation

With installation of the Gira nurse call system Plus, attention must be paid to the applicable requirements of DIN VDE 0834, DIN VDE 0100 and further standards as well as statutory regulations.

Own wiring and own power supply is fundamentally required for the Gira nurse call system Plus.

3.1 Recommended installation steps

The following procedure for installation is recommended:

- Routing of cable material for the room bus.
- Installation and connection of the room devices.
- Routing of cable material for the ward bus.
- Installation and connection of the duty/room terminals, room and I/O modules, and hallway displays.
- Routing of cable material (Cat.5) for the system bus (ethernet).
- Installation, connection and start-up of the ward control centre(s).
- Installation, connection and start-up of the system central control unit.

3.2 Using the ward plan

All devices have a double label attached to them, one of which can be removed. With flush-mounted devices these labels are on the support ring, otherwise on the device housing. Before a device is finally installed, the loose label should be removed and stuck onto the ward plan (www.gira.de) (see next page). This plan is very helpful later for setting up the system in the configuration assistant of the ward control centre or system central control unit.

The labels have the following information:

- Unique device ID in the form of: ID 23-45678; the first two digits identify the device type, the next five digits represent the individual serial number.
- Short device description
- Item No.

The ward plan should be "filled out" with the labels during installation to prepare the system documentation that must be handed over by the installation company to the operator, see 4.10 "System documentation" on page 76,

Filling out: stick removable device labels into the table and apply notes if required.

ID 12-345678 ZT+ 5925 .. **Room 110**	ID 23-45678 RT+ 5902 .. Bed **1**	ID 34-56789 RT+ 5902 .. Bed **F**	ID 45-67890 RT+ 5902 ..	ID 56-78901 AT+ 5911 .. e.g. WC
Explanation: Room name (each number may only occur in the system once)	**Explanation:** Room device at bed 1 (Bed marking 1)	**Explanation:** Room device at bed F (own bed marking F, for bed at window)	**Explanation:** Room device without bed marking	**Explanation:** Device in WC area

ID 98-76543 SZ+ 5971 .. **Ward contr. centre**	ID 98-76543 FD+ 5977 .. **Ward bus participants (hallway display, I/O module FM, I/O module SM)**							
ID 12-345678 ZT+ 5925 .. **Room . . .**	ID 23-45678 RT+ 5902 .. e.g. bed 1	e.g. bed 2	e.g. bed 3	e.g. bed 4	. .	. .	. .	. .
DZT+ ZT+/ZM-ID	ID 56-78901 AT+ 5911 .. e.g. WC	e.g. WC	. .	. .	. .	. .	. .	. .
ID 12-345678 ZT+ 5925 .. **Room . . .**	ID 23-45678 RT+ 5902 .. e.g. bed 1	e.g. bed 2	e.g. bed 3	e.g. bed 4	. .	. .	. .	. .
DZT+ ZT+/ZM-ID	ID 56-78901 AT+ 5911 .. e.g. WC	e.g. WC	. .	. .	. .	. .	. .	. .
ID 12-345678 ZT+ 5925 .. **Room . . .**	ID 23-45678 RT+ 5902 .. e.g. bed 1	e.g. bed 2	e.g. bed 3	e.g. bed 4	. .	. .	. .	. .
DZT+ ZT+/ZM-ID	ID 56-78901 AT+ 5911 .. e.g. WC	e.g. WC	. .	. .	. .	. .	. .	. .
ID 12-345678 ZT+ 5925 .. **Room . . .**	ID 23-45678 RT+ 5902 .. e.g. bed 1	e.g. bed 2	e.g. bed 3	e.g. bed 4	. .	. .	. .	. .
DZT+ ZT+/ZM-ID	ID 56-78901 AT+ 5911 .. e.g. WC	e.g. WC	. .	. .	. .	. .	. .	. .

3.3 Notes on cable routing

In general, as well as DIN VDE 0834, other standards, legislation and guidelines must be taken into account. Because legislation and regulations sometimes differ from state to state, it is not possible here to offer a complete overview. It must however be observed that in some states the use of cabling and installation material containing halogen is not permitted.

Cables for the nurse call system Plus must not be routed with cables of other systems (with hazardous voltage) in common cables, tubes or installation channels. Circuits for safety purposes must be routed independently of other circuits. Electrical errors or modifications to the general power supply must not influence the operational safety of the call system.

The cable material of the call system must be routed with a minimum distance of 30 cm to 230 V~ cables. With shorter distances of less than 10 m, a distance of 10 cm suffices. Cable routing must be explicitly documented in the system documentation by the installation company.

Alternatively, separate cables in tubes or installation ducts with double or reinforced isolation in accordance with DIN EN 60950 can be routed. The isolation in such cases must withstand a test voltage of 4000 V effective value over a duration of one minute. The complex leakage current must not exceed 0.5 mA.

With installation of the cable network of the call system, fire protection requirements must be complied with, for example when the bus line is routed in escape and rescue routes (hallways).

Note: room and ward cable routing.

From the control unit of the room in a star configuration or from device to device (looping through).

The ward bus is routed from device to device, star-shaped wiring as with the room bus is not permissible.

3.4 Cable material

3.4.1 Type of cable material

Communication line is used according to DIN VDE 0815 with the designation:

– J-Y(St)Y ... (contains PVC)

– J-H(St)H ..., or J-2Y(St)H ... (halogen-free)

Note: variable colour coding.

Colours of the individual wires differ according to cable material used!
If other cable material than that recommended is used, ensure that the same wire colours are always routed to the same connections throughout the complete call system.

When setting up the Gira nurse call system Plus, 4 x 2 x 0.6 mm cable material should be used on the room level and 4 x 2 x 0.8 mm on the ward level. Special system cables (e.g. flat ribbon audio cable) are not required or are included with the devices.

On the system bus level, ethernet cable of at least Cat.5 must be used.

3.4.2 Cable lengths

If voltage drop is too large due to cable length and connected devices (see 2.8.1 "Energy point table (Calculation of maximum number of devices per power supply unit)" on page 23,), further power rectifiers must be installed (see 2.7 "Planning of the wiring at ward level" on page 21,).

Important: do not connect power supply units in parallel.

A new voltage line must be installed for each further power supply unit in the system. Parallel switching of power supply units is not permissible!

Equipotential bonding between the power rectifiers must be ensured.

3.5 Notes on device installation

3.5.1 Installation heights for devices

According to DIN VDE 0834, the devices of the call system must be mounted at the following heights above the floor:

– Components such as the call button or switch-off button at a height of 0.7 m to 1.5 m.

– With pull-cord buttons in bathroom units, specific requirements in DIN VDE 0100-710 must be adhered to.
  Pull-cord buttons must be fitted at least 20 cm above the highest possible position of the shower head.
  It must be possible for the pull cord to be reached by persons lying on the floor.

DIN 18024-2 (barrier-free construction) also stipulates that operating elements for wheelchair patients should be mounted to a height of 0.85 m.

Note: reef knot on the handle of pull-cord button.

The handle is to be secured with a reef knot on the pull cord.

3.5.2 Installation heights for signal lights and large displays

Components such as signal lights and large text displays should be installed at a height of 1.5 m to 2.2 m.

3.5.3 Installation conditions for control units, energy supply devices

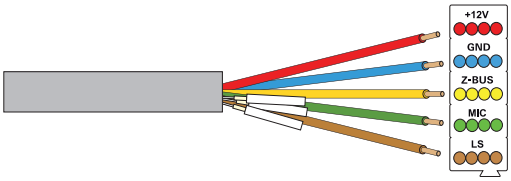
Central control devices such as system central control units, ward control centres, energy supply devices and other components without operating or signalling functions may only be installed in dry rooms (max. humidity 75 % at approx. 18 °C), and not in patient's rooms. They must be easily accessible at all times (inspection access at least 60 cm in width). Heat dissipation must not be inhibited. When installing in switch cabinets and similar facilities, heat loss must be dissipated if necessary with forced ventilation.

3.6 Connecting the devices at room bus and ward bus level

All devices have colour-coded terminal strips. The colour coding corresponds to the wire colours of the recommended cable material:
J-Y(St)Y 4 x 2x 0.8 mm at ward level and
J-Y(St)Y 4 x 2x 0.6 mm at room level
according to DIN VDE 0815.

3.6.1 Connecting devices in the room

All devices at room level have colour-coded terminals for connecting to the room bus.



Cable to be used:

Communication line according to DIN VDE 0815
4 x 2 x 0.6 mm

e.g J-Y(St)Y (contains PVC), white wires are not used here (bend away).

Or:

J-H(St)H or

J-2Y(St)H (halogen-free) > have other colour coding and are twisted 4-fold.

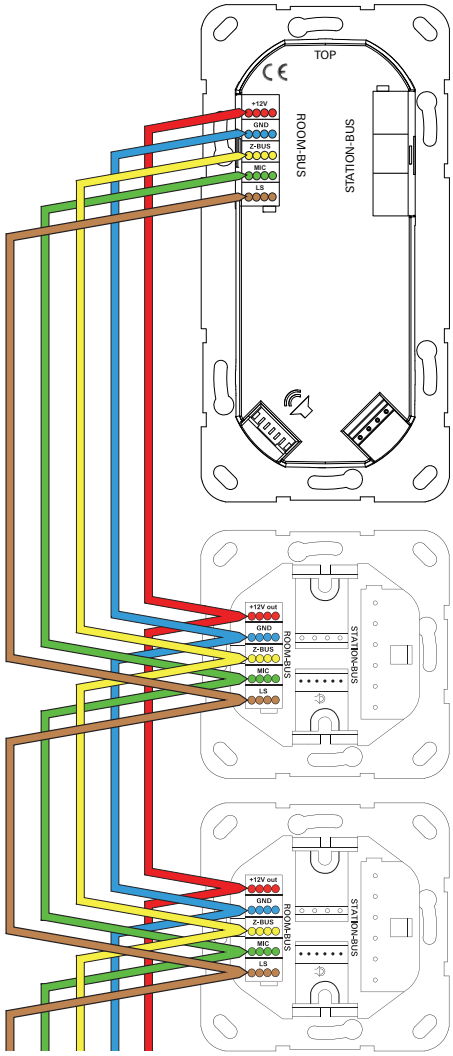
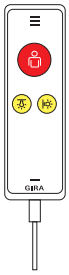


Figure 3.8: Colour coding of J-Y(St)-Y cable material on the room bus

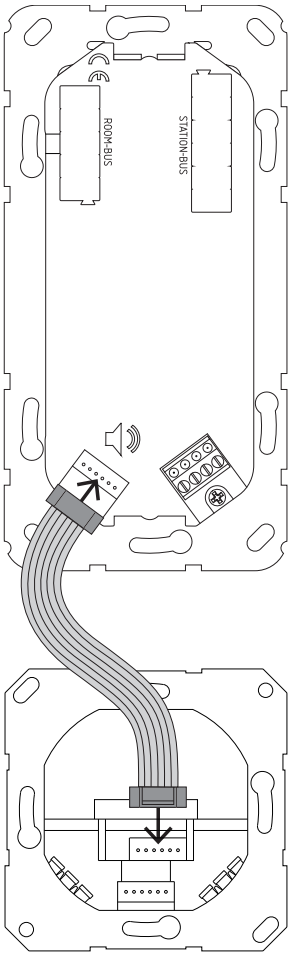
3.6.2 Connecting the voice-compatible components in the room

Figure	Designation	Connection to	Installation site
	Voice module Plus (S+) Order No. 5990 .. (with 5918 .., 5925 .., 5929 .. included in scope of supply.)	Flat plug	Patient's room and duty room: in combination with 5901 .., 5903 .., 5906 ...
	Patient hand-held device (PHG+) Order No. 5960 ..	To ancillary plug contact of: 5901 .., 5903 .. or 5906 ..	Patient's room: - At the bed

3.6.3 Connecting the voice module

All voice-compatible devices can be installed with or without the voice function. If the voice function is desired, the voice-compatible device is connected with a voice module (audio flat ribbon cable included).

Connection of voice module to the terminal:
5925 .. (ZT+)
5928 .. (DZT+)



Connection of voice module to the room device:
5901 .. (RN+)
5903 .. (RAN+)
5906 .. (RND+)

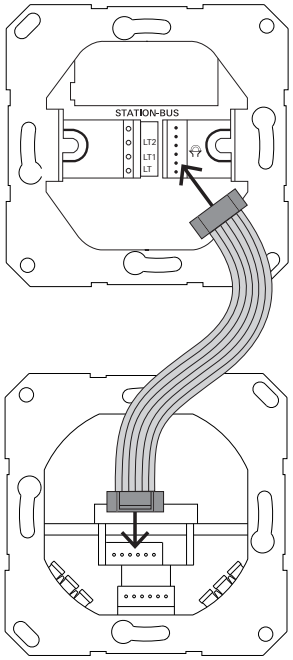


Figure 3.9: Connection of the voice module 5990 .. via flat ribbon cable to a voice-compatible room device.

3.6.4 Connecting the patient hand-held device

All voice-compatible devices can be installed with or without the voice function. If the voice function is desired, all voice-compatible room devices can be connected with the voice module via the included audio flat ribbon cable.

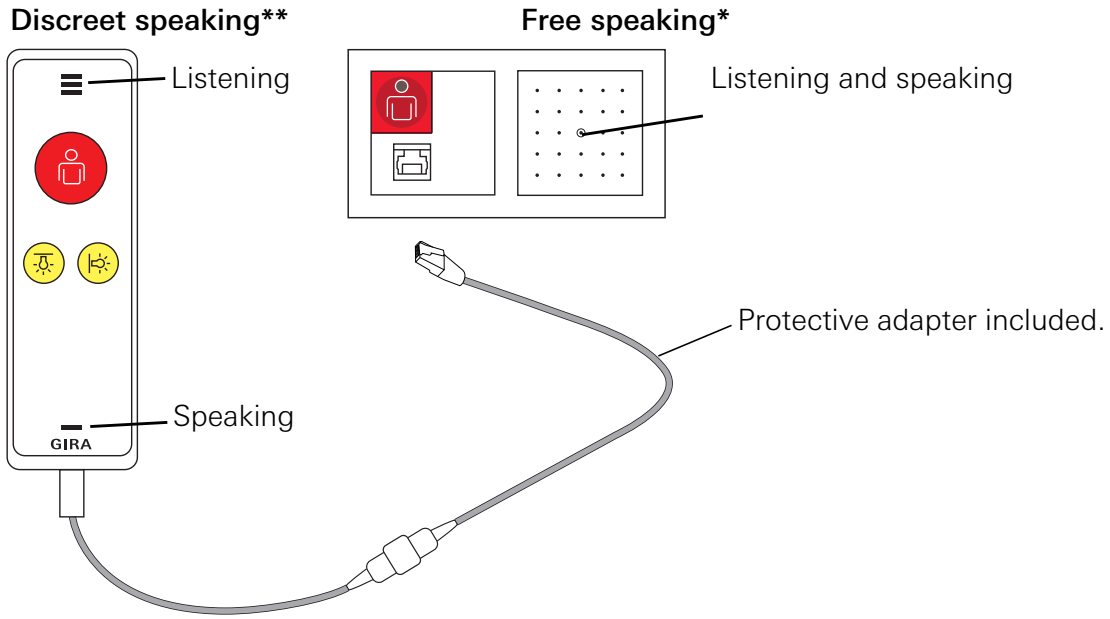


Figure 3.10: Connection between the patient hand-held device and the room device with ancillary plug contact

The voice call

Voice calls occur when a call/emergency call has been triggered.

With the Gira nurse call system Plus, two types of voice calls are differentiated:

- **Free speaking*** via voice module and patient hand-held device: following call triggering via pressing the red call button, free speaking and listening is possible.
- **Discreet speaking**** via the patient hand-held device: following call triggering via pressing the red call button on the patient hand-held device, free speaking is first possible. The "discreet speaking" function is only possible following a second pressing of the button on the patient hand-held device. The patient hand-held device is held to the mouth and ear like a telephone receiver for discreet speaking.

Connecting the patient hand-held device

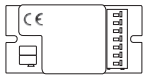
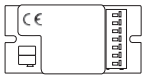
After connecting the patient hand-held device via protective adapter to a room device with ancillary plug contact, the flashing LED requests pressing the call button once on the patient hand-held device. This process checks the functionality of the hand-held device (PHD test). This test does not trigger a call (see 4.14 "PHD test" on page 78,).

Plug removal

When the cable of the patient hand-held device is pulled out of the socket, then a "plug removal call" occurs. This call must be confirmed by pressing the green button of a duty room/ room terminal or room module for at least 3 seconds.

See the "Functions" chapter for further information.

3.6.5 Switching the room light

Figure	Designation	Connection to	Installation site
	Impulse relay 1-pole Order No.: 2964 00	to 5901 .., 5903 .., 5906 ..., with 4-pole plug	between the room device with ancillary plug contact and consumer.
	Impulse relay 2-pole Order No.: 2965 00	to 5901 .., 5903 .., 5906 ..., with 4-pole plug	between the room device with ancillary plug contact and consumer.

The light at the bed and/or in the room can also be switched via the patient hand-held device as well as call triggering.

Coupling to the house electronics (e.g. light in the room and/or reading lamp at the bed) is via the 1- or 2-pole impulse relay. The terminals LT, LT1 and LT2 are zero-voltage.

Important: ensure spatial separation of cable material and devices.

Ensure distance between the 24 V DC and 230 V~ AC. Observe the regulations!

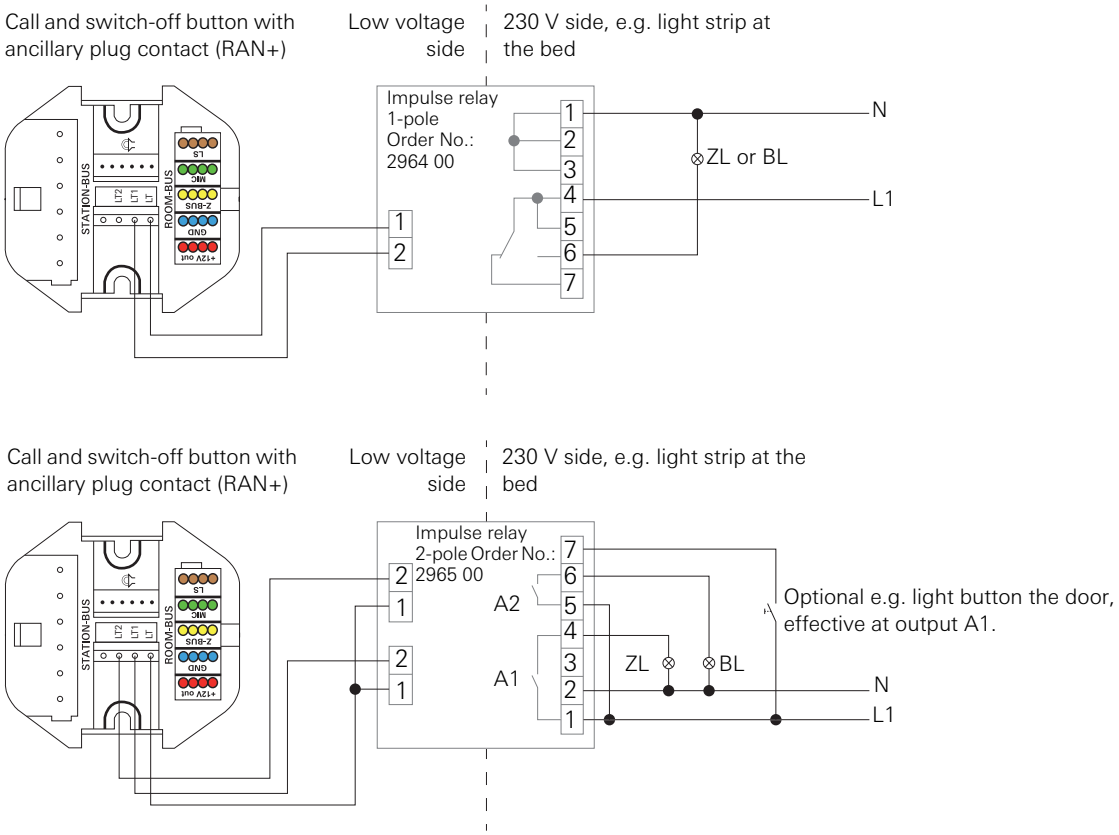


Figure 3.11: Connection of room light (ZL) and/or bed light (BL)

3.6.6 Connection of diagnostic connection cable

Cable for connection of the zero-voltage contact of a medical device with the call button with ancillary plug contact and diagnostic pin jack (nurse call system Plus), Article No.: 5906 .., or call button with 2 diagnostic pin jacks (nurse call system Plus), Article No.: 5907 ...

Important: cable must not come into contact with 230 V!

The diagnostic connection cable is only suitable for low voltage.

Note: observe operating instructions.

Observe the instructions of the medical device.

In the nurse call system Plus the zero-voltage contact of a device from other manufacturers can operate both as NC contact and NO contact. We recommend the "NC contact" wiring configuration.

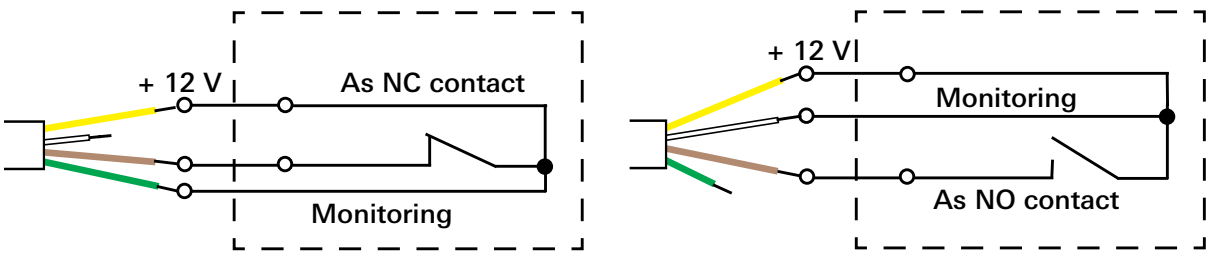


Figure 3.12: Diagnostic connection cable

First connect the open end as shown, then insert the RJ11 plug of the connection cable into the diagnostic socket of the call button (5906.. or 5907..).

The call button with ancillary plug contact and diagnostic pin jack, Article No.: 5906 .. and the call button with 2 diagnostic pin jacks, Article No.: 5907 ..feature plug monitoring that triggers a call with missing plug contact.

3.6.7 Connection of pull-cord button

Observe the special installation regulations with pull-cord buttons (especially in damp rooms) (see Page 38). Connections of the pull-cord button as with the other room devices: wire colour to colour. White wires are not required.

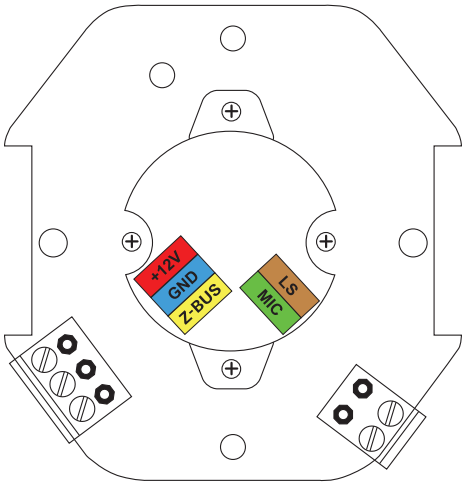


Figure 3.13: Connections of the pull-cord button

3.6.8 Connection of pneumatic buttons

Observe the special installation regulations with pneumatic buttons (especially in damp rooms).

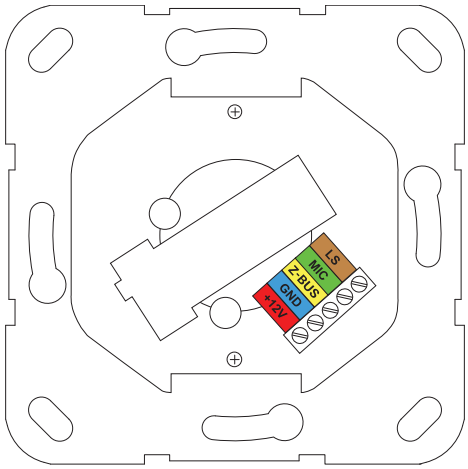


Figure 3.14: Connections of the pneumatic button

3.7 Connection to the ward devices

Duty room terminals, room terminals and room modules have **two** colour-coded terminal strips: one for the room bus (5 terminals) and one for connection to the ward bus (6 terminals). Duty-/room terminals also have a connection option for the 6-pole flat ribbon cable of the voice module.

The wires of the cable material can thus be correctly connected to the specific terminals in this way.

The terminal blocks themselves can only be attached in a specific position, thus also avoiding error.

The room module also has an audio socket, but the device only forwards the audio signal.

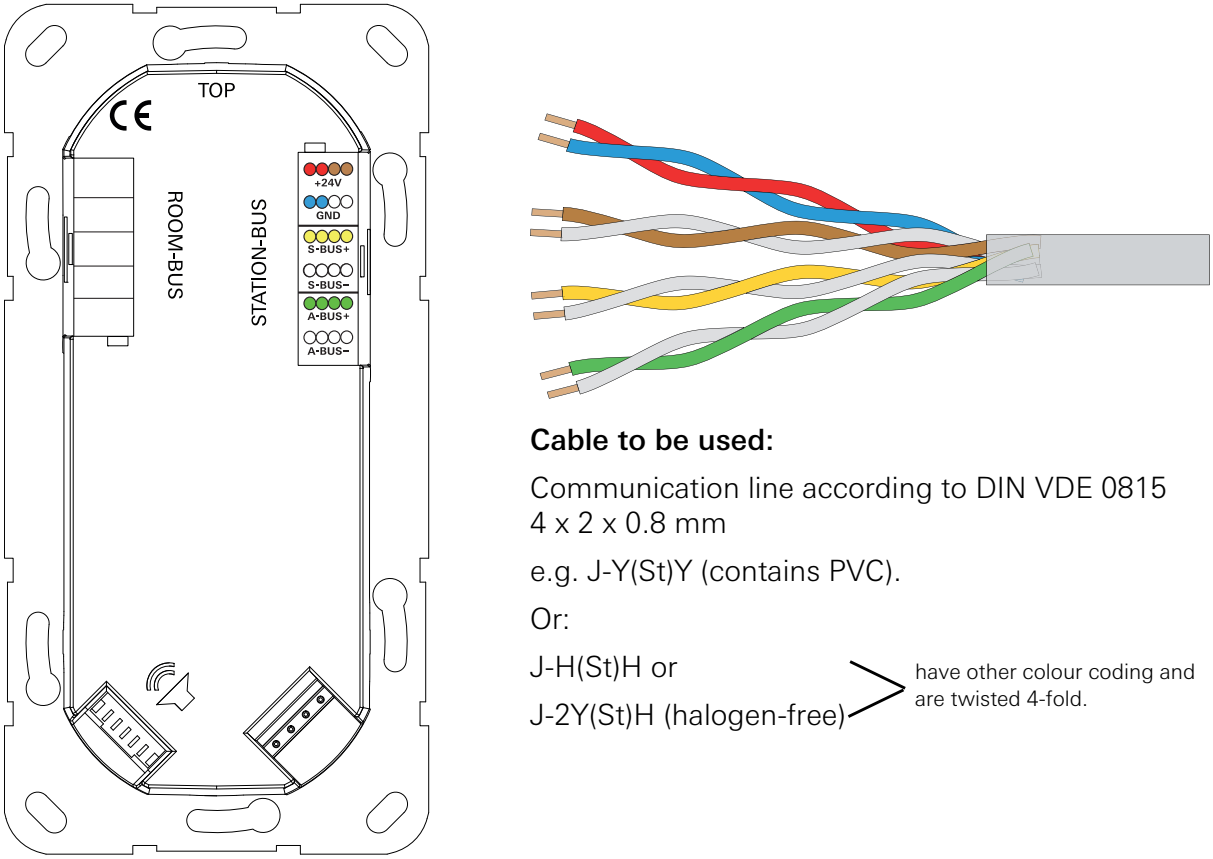
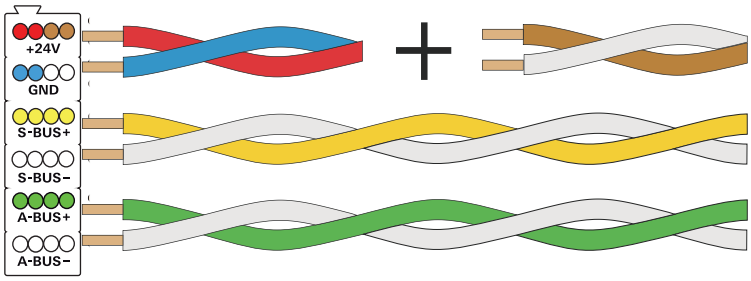


Figure 3.15: Colour coding of J-Y(St)-Y cable material on the ward bus

3.7.1 Wiring of the ward bus terminal

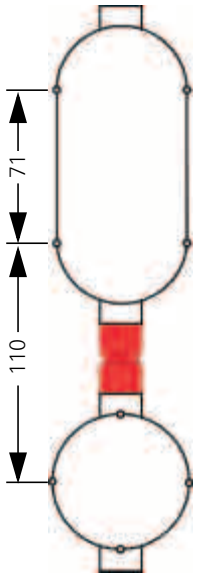
Wire pairs red/blue and brown/white are used for power supply (doubling of cross-section).



Both wire pairs yellow/white (data bus) and green/white (audio bus) must each be twisted in the complete system (twisted pair).

Figure 3.16: Use of 2 wire pairs for doubling of cross-section with power supply

3.7.2 Mounting information for the room terminal and duty room terminal:



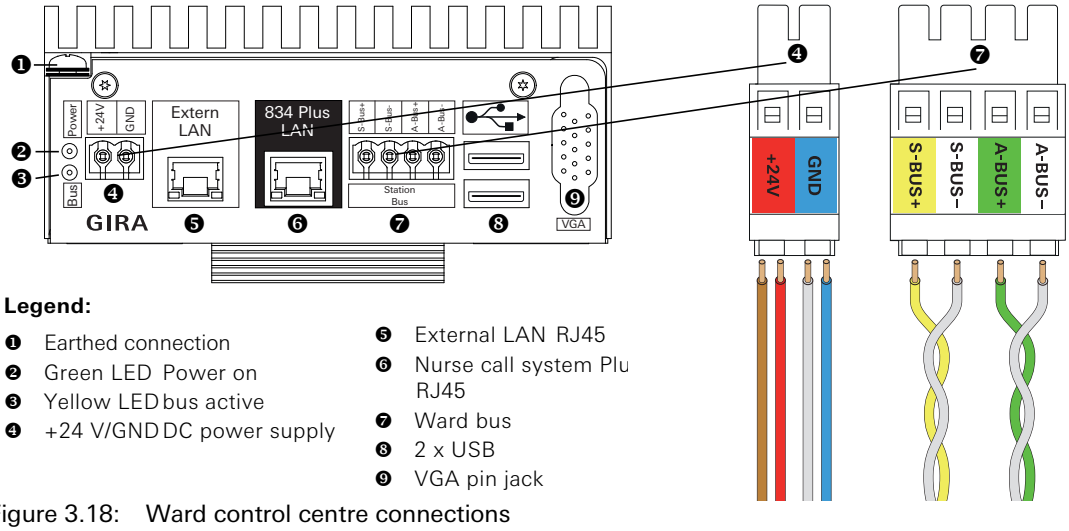
To ensure an optimal appearance, the distance between the terminal and the voice module should be implemented as shown. With the products ZT+ (Order No.: 5925 ..) and DZT+ (Order No. 5929: ..), flush-mounted boxes (1- and 2-gang) as well as a suitable spacer are included.

Figure 3.17: Arrangement of flush-mounted boxes and spacer for optimal device alignment

3.7.3 The ward control centre

The ward control centre Plus of the Gira nurse call system Plus controls and regulates the devices connected to the ward bus, such as room terminals with and without voice module. The device may be connected to the system central control unit via the system bus (nurse call system Plus LAN, and "large system" setting in the configuration assistant).

The Gira nurse call system Plus can also be controlled and regulated from only a single ward control centre Plus without a system central control unit ("small system" setting in the configuration assistant).



Legend:

❶ Earthed connection
❷ Green LED Power on
❸ Yellow LED bus active
❹ +24 V/GND DC power supply
❺ External LAN RJ45
❻ Nurse call system Plu RJ45
❼ Ward bus
❽ 2 x USB
❾ VGA pin jack

Figure 3.18: Ward control centre connections

3.8 System power supply

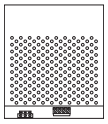
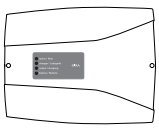
The nurse call system Plus is operated with 24 V direct current.

Important: ensure uninterruptible power supply!

The devices of the nurse call system Plus must be supplied with uninterruptible power supply! (See VDE 0834 Part 1)

If a central, uninterruptible power supply (230 V) is available in the building to be installed, then the power rectifiers (Order Nos.: 5981 00 and 5998 00) can be used without integral uninterruptible power supply (UPS).
If no central UPS is available, the power rectifier with UPS (Order No.: 5999 00) must be used.

For the nurse call system Plus the following DC voltage supplies are available:

Figure	Designation	Description	Installation site
	Power rectifier Plus (NG+) Order No. 5981 00	According to EN 60950-1 Input: 230 V AC Output: 24 V DC/6 A	Plant room - Mounting in sub-distribution unit / DIN top-hat rail
	Power rectifier Plus surface-mounted (NGA+) Order No. 5998 00	According to EN 60950-1 Input: 230 V AC Output: 24 V DC/6 A	Plant room - Surface-mounted
	Power rectifier UPS Plus (NGU+) Order No. 5999 00	According to EN 60950-1 Input: 230 V AC Output: 24 V DC/6 A Batteries: 2 x 12 V/12 Ah self-monitoring.	Plant room - Surface-mounted
	Batteries for power rectifier UPS Order No. 5991 00	According to EN 60950-1 2 x 12 V/12 Ah	Plant room - Surface-mounted

Provide circuit breaker!

Connect a circuit breaker type D, max. 16 A upstream from the power supply unit.

3.8.1 Power rectifier with UPS, Order No.: 5999 00 and batteries, Order No.: 5991 00

Power supply unit with input voltage range of 115 V -15 % to 230 V +15 % AC. Output voltage 24V DC with uninterruptible power supply (UPS). If the mains input voltage drops, connected load is supplied interruption-free via the batteries. When the mains input voltage recovers the batteries are separated from the load and recharged via the internal charging unit.

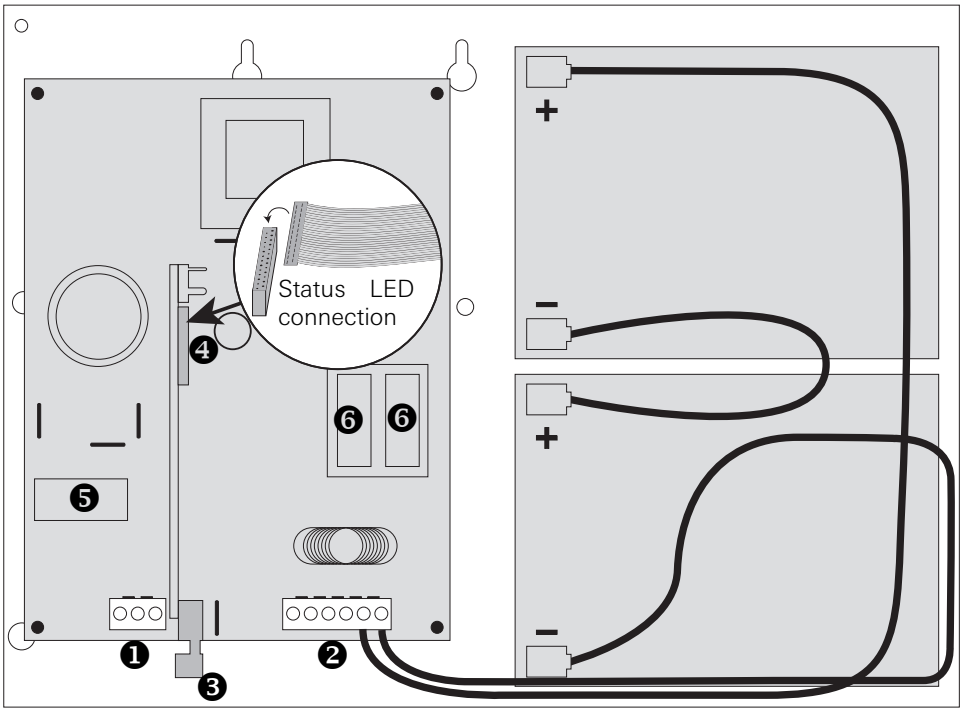
The device is designed for 24-hour operation at rated output.

Self-diagnosis for monitoring of the batteries e.g. for protection of complete draining etc.

Operating states (mains failure, battery warning and charging device) of the power rectifier can be signalled via the zero-voltage relay contacts (see Figure 3.20).

The device features the following LED status displays:

Mains	LED green when primary voltage is applied.
Charger	LED green with trouble-free charging.
Output	LED green, when voltage is applied to the consumer output.
Battery	LED green with trouble-free battery operation.
	LED red with complete drainage.



Legend:

1. Terminals for input voltage 230 V AC, see fig. 2
2. Terminals for output voltage 24 V DC, see fig. 2
3. Signal contacts, see fig. 2
4. Flat ribbon cable connection for status LED in housing cover
5. Fuse (input 230 V), T 2 A
6. Fuse (output), T 6.3 A

Figure 3.19: Power rectifier with UPS device overview

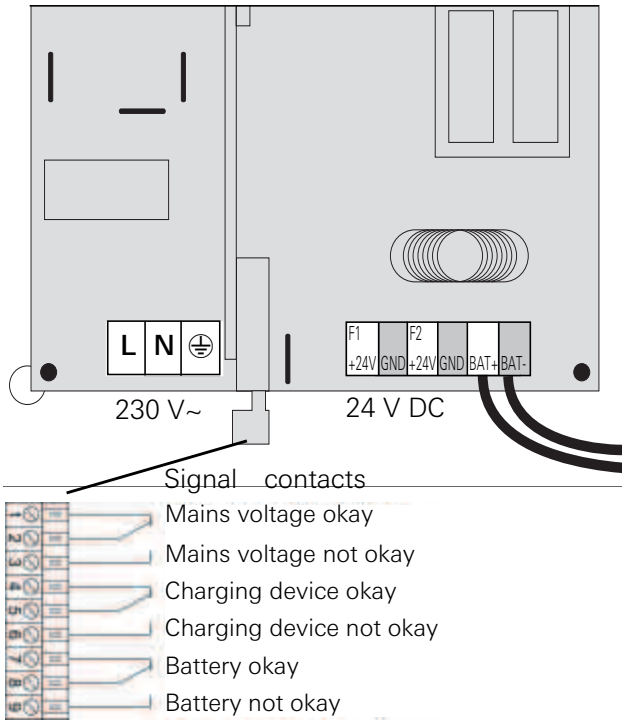
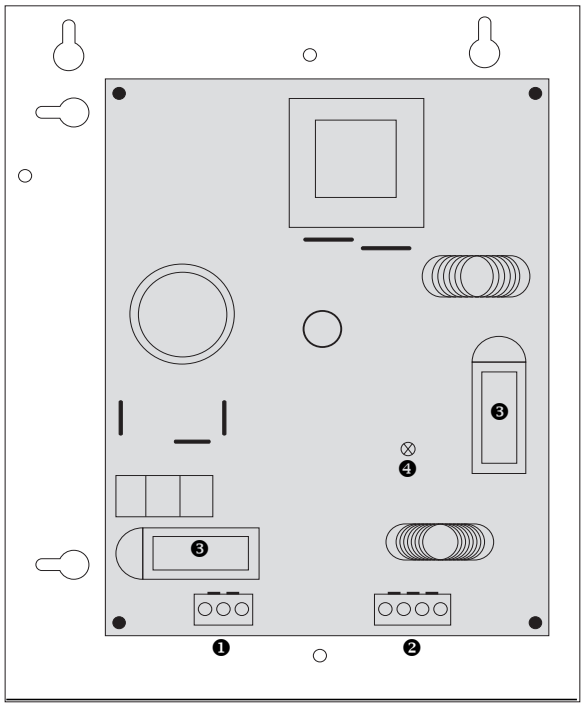


Figure 3.20: Connection of the power rectifier with UPS

3.8.2 Power rectifier, Order No.: 5981 00 and 5998 00

The power rectifier 5998 00 has an LED status display in the device cover:

The LED lights up green when mains voltage is applied.



Legend:

❶ Terminals for input voltage 230 V AC
❷ Terminals for output voltage 24 V DC
❸ Micro-fuses: input T 2 A, output T 6.3 A
❹ Status LED: green when mains voltage applied.

Figure 3.21: Device overview of power rectifier

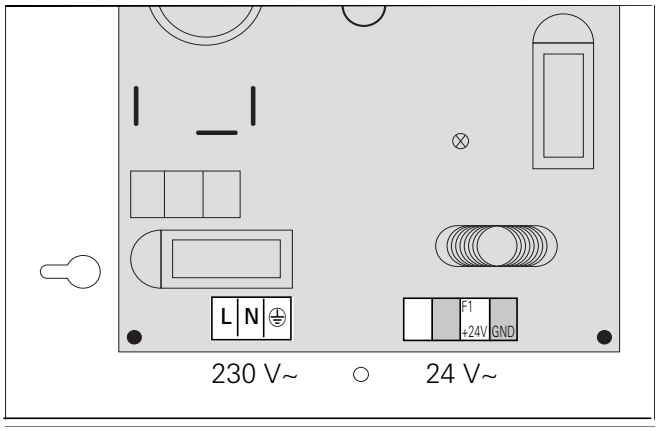
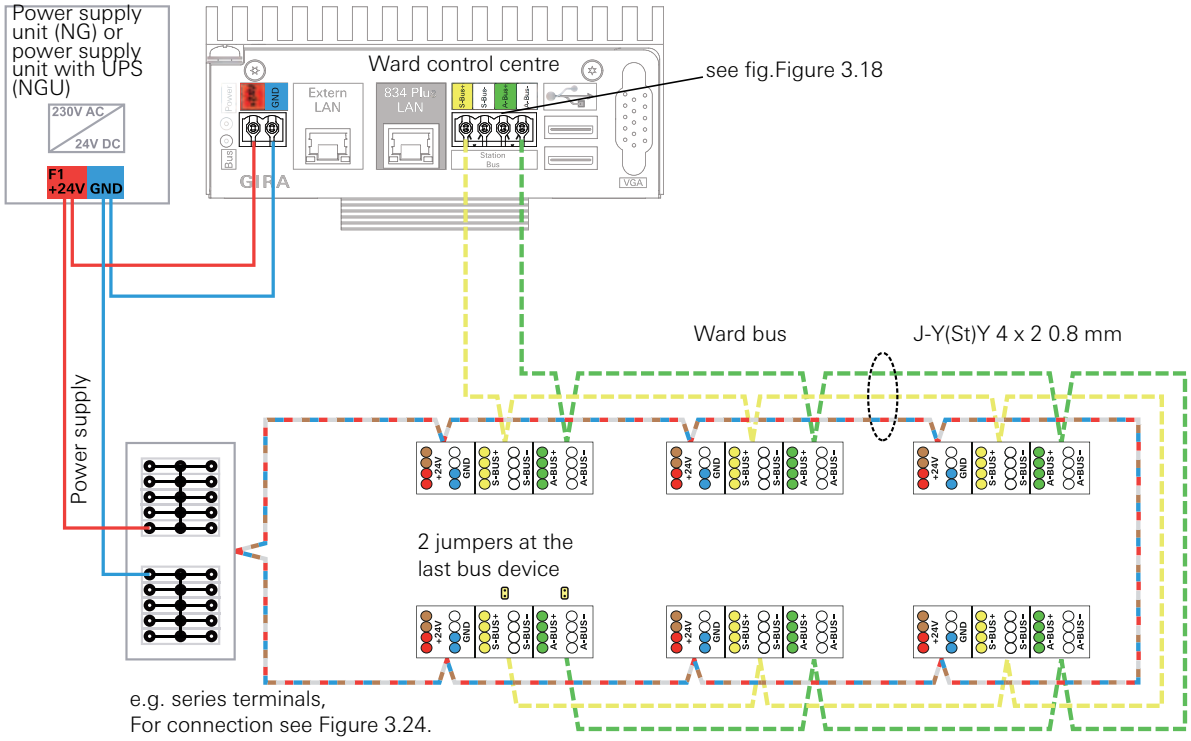


Figure 3.22: Connections of power rectifier without UPS

3.8.3 Connection of the bus participants to power supply and bus line



Legend:

Power supply: maximum 300 m per power supply unit. Close cable in a ring configuration. 24 + (red and brown), GND (blue and white).

Ward bus: wire pair yellow and white. Max 1,000 m/max. 52 ward bus participants.

Audio bus: wire pair green and white. Max 1,000 m.

Figure 3.23: Example of wiring diagram for connection of bus participants to ward bus and power supply

The bus lines (yellow/white and green/white) must be looped through from device to device. The ward control centre is always the start of the data bus. Branching is not permissible. The cable must not be connected in a ring configuration, in contrast to the power supply.

The last ward bus device must be equipped with two yellow jumpers (included with supply of the ward control centre) to activate the terminating resistances (120 Ω).

Measurement of terminating resistances in the system:

– All devices on the ward bus must be disconnected from the power supply.

– Measurement occurs between yellow and white (data bus) or green and white (audio bus).

– The result with applied jumpers:
  approx. 60 Ω with connected ward control centre
  approx. 120 Ω without connected ward control centre

3.8.4 Power supply (24 V wiring) for a ward

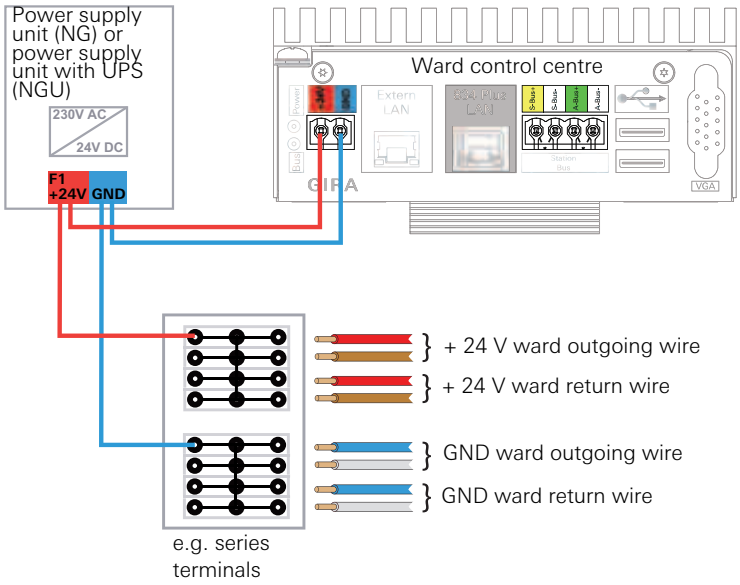


Figure 3.24: Outgoing and return wire of power supply to series terminal

3.8.5 Equipotential bonding

All protective conductors (PE) connected with the call system must be connected to the same main potential equalisation of the building or the general power supply network. If this is not possible with extended call system networks, the circuits of the call system must be split into several galvanically isolated areas.

If several power supply units are used in a system, then equipotential bonding between the earth wires and the individual power supply units should be implemented (1.5 mm^2 recommended).

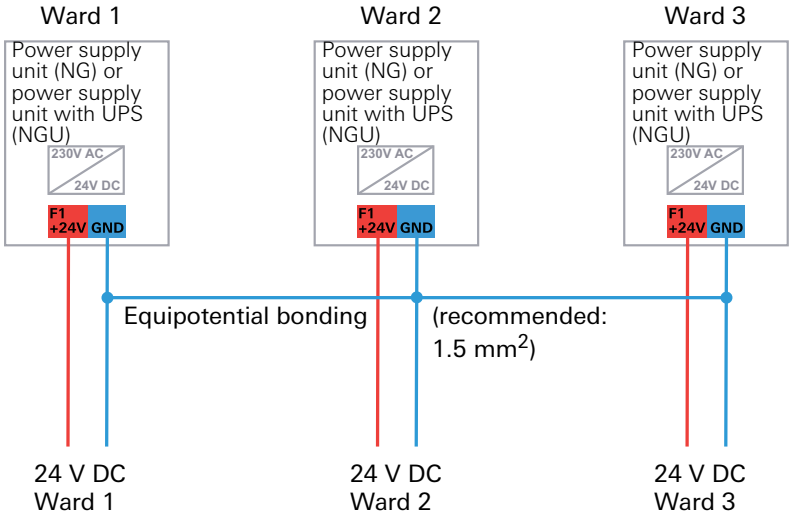


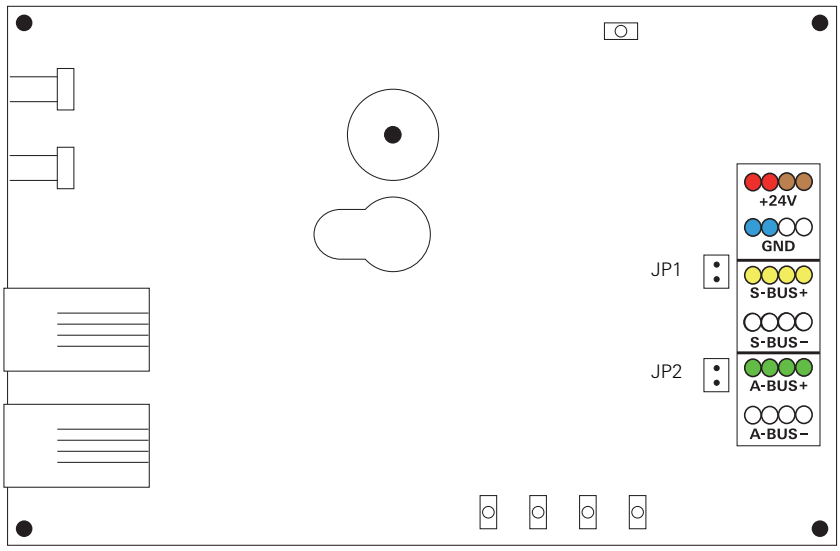
Figure 3.25: Equipotential bonding between the power supply units of a system

Equipotential bonding should also be implemented even when several power supply units are used in only one ward.

3.9 Connecting further ward devices

3.9.1 Connection of hallway displays to the power supply and ward bus

Hallway displays can show call information in plain text. A one-sided display (Order No. 5976 00) or two-sided display (Order No. 5977 00) is available for the Gira nurse call system Plus. Hallway displays are integrated onto the ward bus.



Legend:

+24 V	power supply (red/brown)	A bus -	audio cable (white)
GND	Earth (blue/white)	JP1	Terminating resistance Data line
S bus +	data line (yellow)	JP2	Terminating resistance Audio cable
S bus -	data line (white)		
A bus +	audio cable (green)		

Figure 3.26: Connection of the hallway display to the power supply and ward bus

3.9.2 Connection of I/O module flush-mounted Plus (2/2)

External voltages of 5-30 V AC/DC can be applied to both inputs as input signals, and these input voltages can differ.
Function of output: see device label.

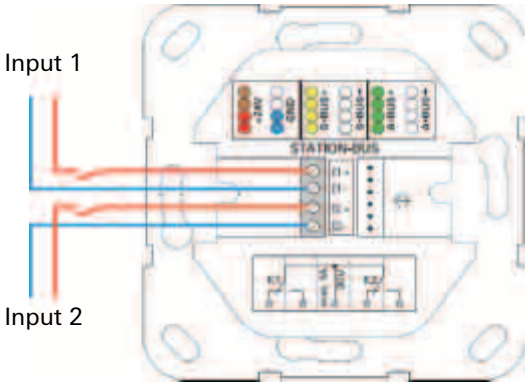


Figure 3.27: I/O module, 2-gang

3.9.3 Connection of I/O module surface-mounted Plus (8/8) to the ward bus

The 8 inputs of this module are split into 2 groups (input 1-4 and input 5-8). Each group of 4 inputs has a common reference point (COM 1-4 and COM 5-8). Voltages of 5-30 V AC/DC can be applied to the inputs.
External voltages and the integral output voltage of the module (+24 V out and GND out) can be connected.
Function of output: see device label.

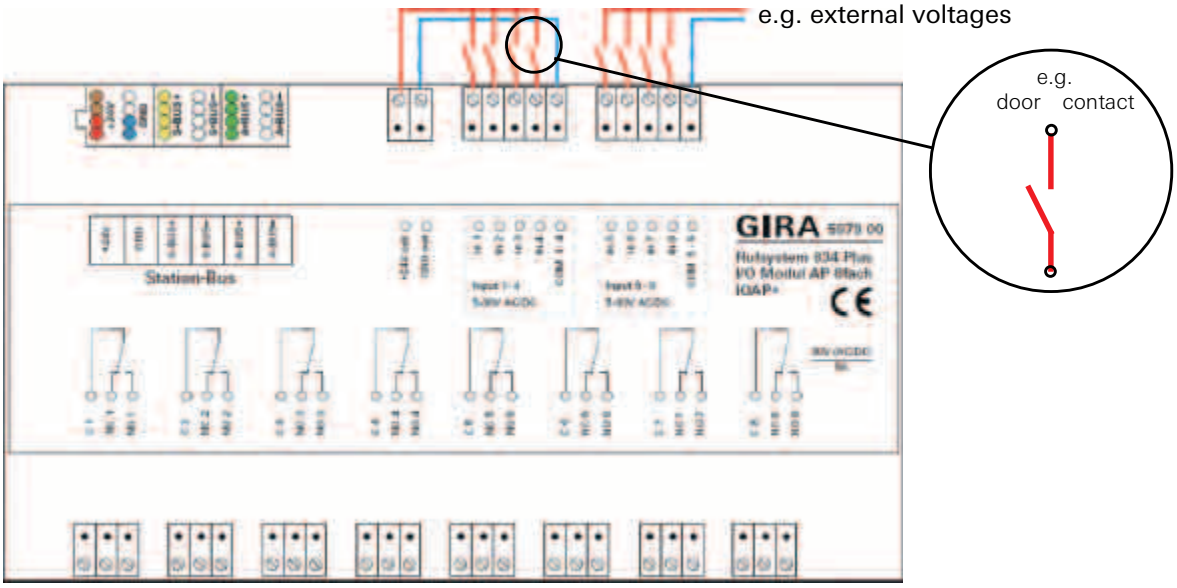
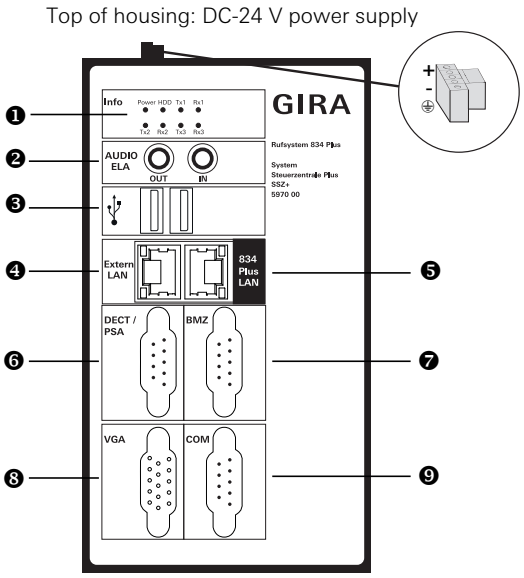


Figure 3.28: I/O module, 8-gang

3.10 The system central control unit

The central control unit for the complete system is the system central control unit (SSZ+). Ward control centres and duty room terminals CT9 are connected here via the system bus (ethernet) to the nurse call system Plus LAN connection.



Legend:

+24 V/⏚	DC power supply	❺ Nurse call system Plus LAN	RJ45
❶ LED's	Device condition	❻ DECT/PSA	RS 232
❷ Audio pin jacks	Audio In/Out	❼ BMZ	RS 232
❸ 2 x USB	f. service purposes	❽ VGA	Sub D 15-pole
❹ External LAN	RJ45	❾ COM	RS 232

Figure 3.29: Connections of the system central control unit

All devices existing in a call system are automatically recognised; also apllies for applies for the removal and addition (exchange) of devices.

The configuration assistant is used for parameterisation, see 4.5 "Starting up a large system" on page 67, and see 4.4 "Start-up of small system" on page 64,

Note: connect the nurse call system Plus to an existing network.

Consult a responsible network administrator before carrying out network settings.

To connect the ward control centre to an existing (hospital) network, the "External LAN" connection can be configured in the configuration assistant via the menu item **Administration/Set up network access** (Figure 3.29 (❶)).

Note: using a time server.

If the ward control centre Plus is not connected to an external network (e.g. company or hospital network) via the "external LAN" connection, then the system time of the nurse call system Plus cannot be automatically sourced via a time server (NTP server) on the internet.

3.11 Wiring of the system bus

The figures show connection of the network components as schematic diagrams. In reality the network cables are installed flush-mounted and the components interconnected via network connection boxes.

3.11.1 Schematic diagram of the system level for a small system

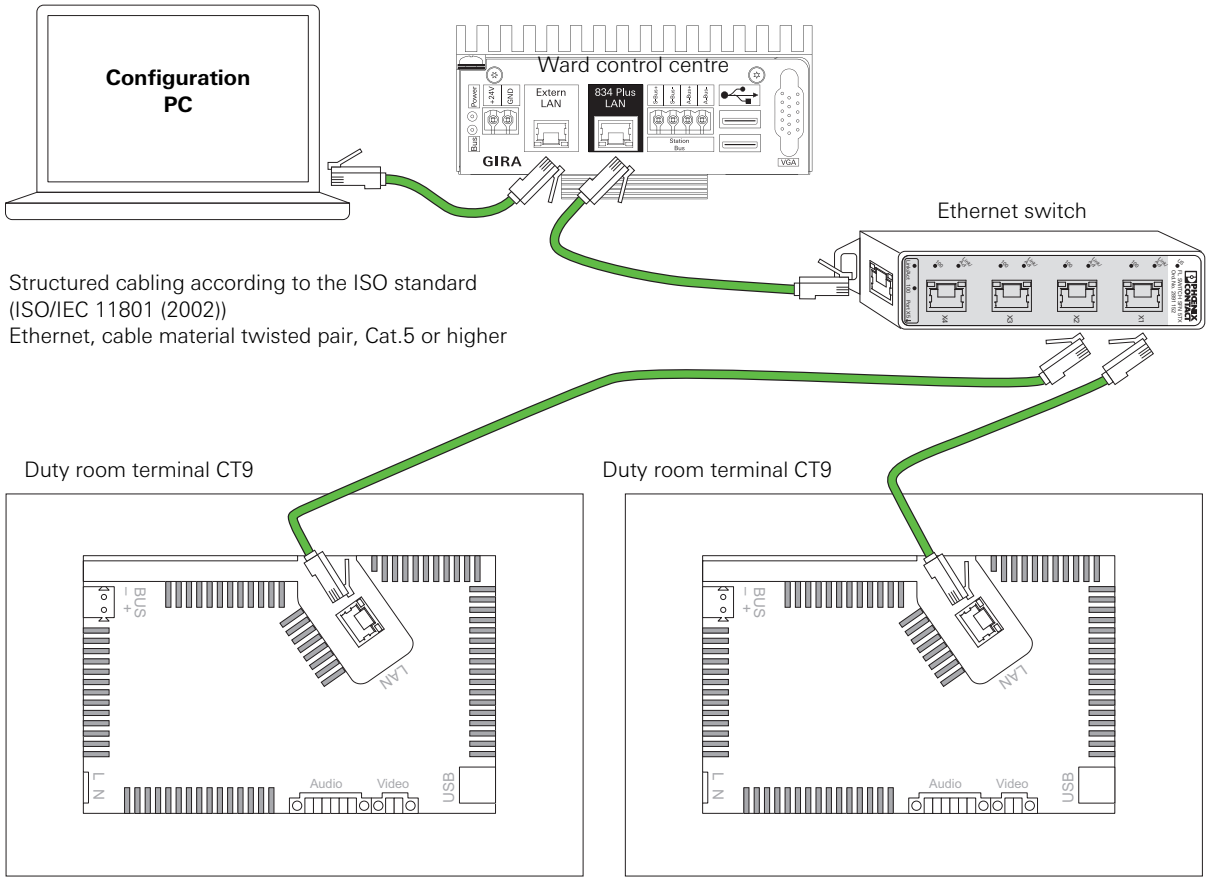


Figure 3.30: Connection of network components at system level (small system)

3.11.2 Schematic diagram of the system level for a large system

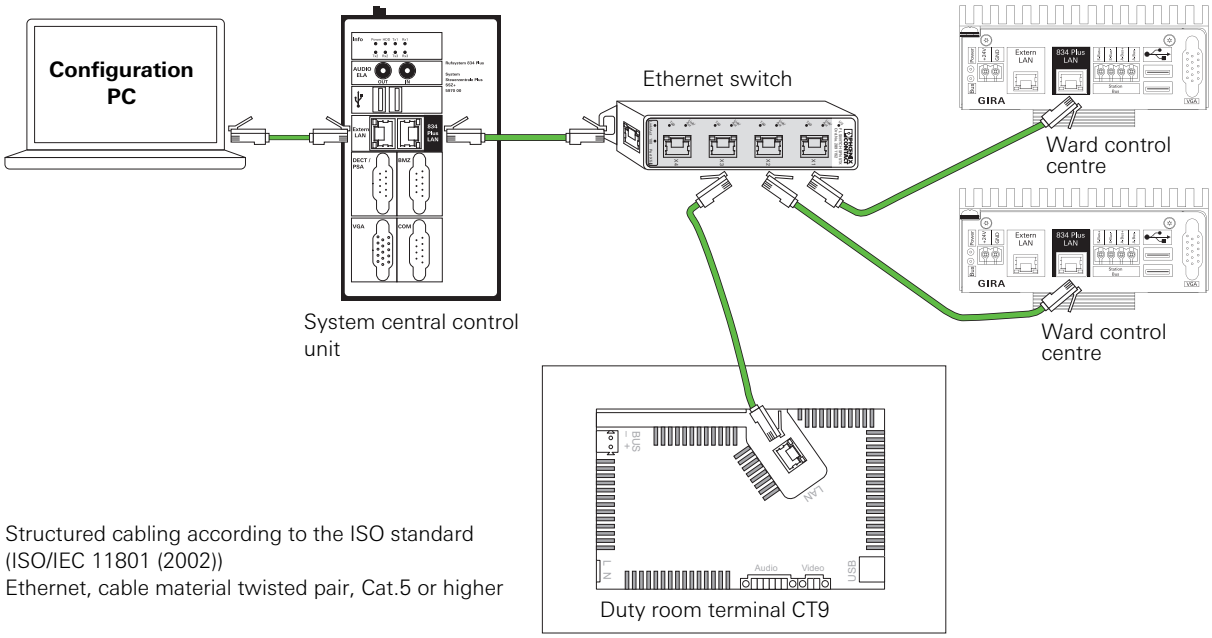


Figure 3.31: Connection of network components at system level (large system)

3.11.3 Summary of properties at system level

The system level (network level) of the Gira nurse call system Plus features the following properties:

– Network topology corresponds to a "meshed topology" (see "Meshed structures" on page 144).

– CSMA/CD is used as access process (see "CSMA/CD access process" on page 162).

– Network technology is ethernet, structured cabling according to the ISO standard (ISO/IEC 11801 (2002)), (see "What does ethernet mean?" on page 163).

– Twisted pair cable of category 5, ideally category 6 or higher must be used (see "Twisted pair cable" on page 150).

– Connection elements (plugs and connection boxes) use RJ-45 connection technology (see "Connection elements" on page 158.

– Network parameterisation is on the basis of TCP/IP (see "TCP/IP transmission protocol" on page 170).

4. Start-up

Start-up is implemented with the aid of the configuration assistant (start-up software).

- Each device identifies itself with the next instance up in the system:
  - Room devices with the duty/room terminals and/or the room modules (room bus level).
  - Duty/room terminals and/or room modules with the ward control centres (ward bus level).
    In delivered state all duty/room terminals and/or room modules of a ward control centre belong to an organisational unit, all devices can intercommunicate.
    Point 4.8 explains how other organisational units are configured.
  - Ward control centres, hallway displays, switches and duty room terminals CT9 with the system central control unit (system bus level/ethernet).

4.1 The prerequisite for starting up the Gira nurse call system Plus is that

– room bus, ward bus and system bus (if required) are installed and ready for operation.

Note: configuring a system.

First install all devices that should belong to a system before beginning with the configuration. All installed devices of a system are automatically recognised.

– The terminating resistances must be set on the ward bus.
  A ward control centre is the **first** device on the ward bus. With the **last** device on the bus, the terminating resistance of the data line and audio line must be activated with the jumpers (included in the scope of supply of the ward control centre).

– Power supply (Order No.: 5999 00, with UPS or Order No.: 5998 00/5981 00) is installed and ready for operation.

Important! System power supply

Because neither the system central control unit Plus or the ward control centre Plus has a mains switch, the systems boot immediately after connection to the power supply. This process takes up to 60 seconds.

– Start-up PC with internet browser, LAN connection and network cable are available.
  As internet browser, Firefox from version 4 or Google Crome from version 11 is recommended.

Note: IP address range of the start-up PC

Ensure that the IP address of your start-up PC is between 192.168.0.1 and 192.168.0.254 (but not 192.168.0.111) (subnet mask: 255.255.255.0).

4.2 Initial start-up

After switching on the system, all system devices register at the central control unit,

– with a small system at the ward control centre,

– with a large system at the system central control unit.

Note: the duration of the registering process may vary.

The registering process for devices in the system may require up to 5 minutes with a large system.

All devices are pre-configured so that for "standard operation" of a system, only the names for:

– ward,

– room and possibly

– beds

need to be assigned.

4.2.1 Connected devices are checked

After the system central control unit Plus and ward control centre Plus have been started in selected system mode (small system/large system), all connected devices register at the central control unit.

During the registration process the LEDs (location/reassurance lights) flash in the push buttons/housings of the devices.

After the central unit has recognised the system devices, these are then automatically monitored.

The system devices can now be parameterised with the configuration assistant.

For the duty room/room terminals, a plain text name or a room number must be assigned.

Failed devices are immediately displayed in the system.

Subsequent integration of devices is possible at any time.

Note: locating integrated devices.

Integrated devices can be located via the configuration assistant with the "identify device" function.
After carrying out this function, the LED in the button of the searched-for device flashes rapidly.
The flashing can be deactivated by pressing the "End identification" button.

4.2.2 Setting up a duty room terminal CT9

A room control unit (duty room/room terminal or room module) is required in the duty room for operating a duty room terminal CT9.

With the aid of the configuration assistant, the room control unit is linked to the duty room terminal CT9. The devices are then functionally interconnected.

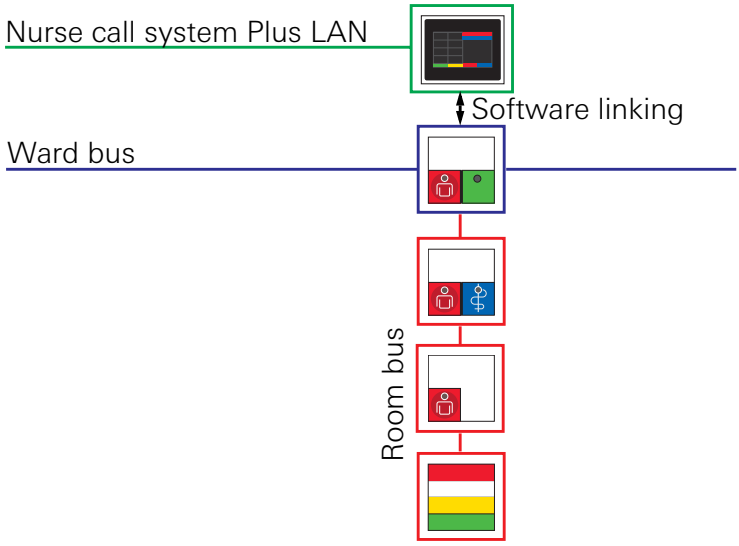


Figure 4.1: Example with a room module as room control unit and CT9

For starting up, proceed as follows:

1. Connect your start-up PC to the "External LAN" connection via the network cable.
2. Start the internet browser on your start-up PC. Enter the IP address 192.168.0.111 into the address bar of the internet browser.

The log-in screen of the configuration assistant opens.

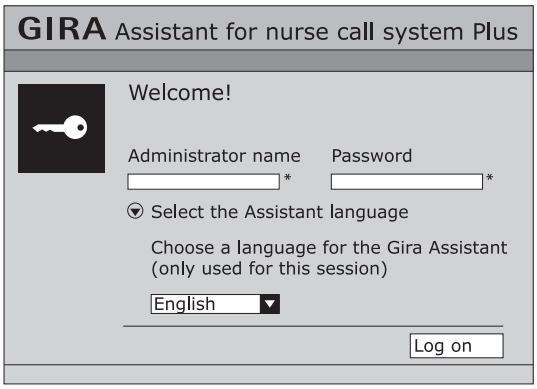


Figure 4.2: Log-in screen in the Gira configuration assistant: Entering the user name and password, language selection

1. Select the language you require for starting the configuration assistant.
   The selected language is only valid for the current session.
2. Enter "admin" in the administrator name field and "admin" in the password field.
3. Click on "Log on".

User names and passwords

User	User name	Password
Administrator	admin	admin
Care personnel management (current messages and log files)	management	management
Care personnel (current messages)	nurse	nurse
Master password	see note	see note

Note: handling of user names and passwords

We recommend changing the user name and password after the first login.

Lost/forgotten log-in data:

Contact the Gira Service Center for instructions on how to proceed.

4.3 Operating mode large system or small system

Variation large system:

A large system consists of one system central control unit, at least one ward control centre, duty/room terminals and room modules, room devices, room signal lights, possible hallway displays and I/O modules, and ethernet switches.

Note: the system central control unit and ward control centres are pre-configured.

Each ward control centre is pre-configured for operation in a large system (with a system central control unit). When a ward control centre is operated as the only controlling device in a system, then the "small system" option must be selected in the configuration assistant.

Variation small system:

A small system consists of one ward control centre, duty/room terminals and room modules, room devices, room signal lights, possible hallway display and I/O modules.

4.4 Start-up of small system

Requirements:

– Room bus and ward bus are installed and ready for operation.

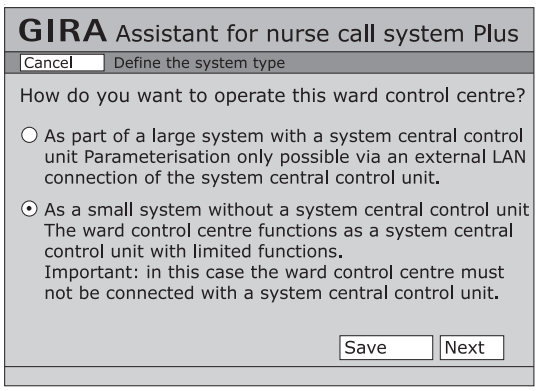


Figure 4.3: Decision about system type: small system or large system.

– All ward control centre(s) are preset as DHCP client(s). By selecting "Small system", a ward control centre is reconfigured to a DHCP server.
– The ward control centre is the **first** device on the ward bus. With the **last** device on the bus, the terminating resistance of the data line and audio line must be activated with the jumpers.
– Connect the "External LAN" connection of the ward control centre Plus with the start-up PC via the network cable.
– Start the internet browser on the start-up PC. Enter the IP address 192.168.0.111 into the address bar of the internet browser and confirm with the "Enter" key.

The start screen of the configuration assistant opens (see Figure 4.2).

– After entering the user name and password and after language selection (see Figure 4.2 and "User names and passwords" on page 62) click on "Log on".

The overview screen of the configuration assistant opens.

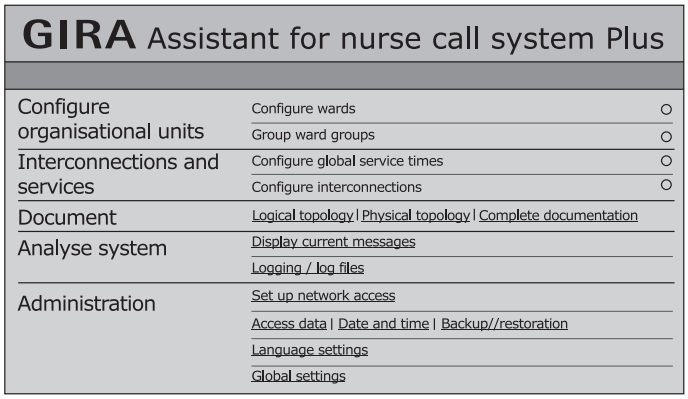


Figure 4.4: Overview screen for configuring a small system

You can now carry out settings to the system.

Menu level 1	Menu level 2	Explanation
Configure organisational units		
	Configure wards	Group wards (establish organisational units).
	Group ward groups	Connect organisational units.
Interconnections and services		
	Configure global services	Duty (shift) times can be set up for the individual week days here.
	Configure interconnections	Interconnections can be automatically or manually controlled depending on the services.
Document		
	Logical topology	Graphic displays for giving to the system operator.
	Physical topology	
	Complete documentation	
Analyse system		
	Display current messages	Active calls, presences.
	Logging/log files	Possible to filter protocol entries according to events and to export protocols.

Menu level 1	Menu level 2	Explanation
Administration		
	Set up network access	Configure external LAN. Configure nurse call system Plus LAN.
	Save/restore	Save or restore system settings.
	Access data	Change user and/or password.
	Date and time	Set up manual setting or time server.
	Language settings	Settings affecting the voice functionality of the system.
	Global settings	Settings for call types, presence and remote switch-off.
	Define system type	Definition of large system or small system.

To find out more about the meaning of specific points, please use the on-screen help of the configuration assistant for detailed information.

4.5 Starting up a large system

– Room bus, ward bus and system bus (nurse call system Plus-LAN) are installed and ready for operation.

– The controlling devices on the system bus (nurse call system Plus-LAN) such as system central control unit and ward control centre(s) are pre-configured so that the system central control unit is preset as a DHCP server and the ward control centre(s) as DHCP client(s).

– The corresponding terminating resistances must be set on the ward bus.
A ward control centre is the **first** device on the ward bus. With the **last** device on the bus, the terminating resistance of the data line and audio line must be activated with the jumpers (included in the scope of supply of the ward control centre).

– Connect the "External LAN" of the system central control unit Plus with the start-up PC via the network cable.

– Start the internet browser on the start-up PC. Enter the IP address 192.168.0.111 into the address bar of the internet browser and confirm with the "Enter" key.

The start screen of the configuration assistant opens (see Figure 4.2).

– After entering the user name and password and after language selection (see Figure 4.2 and "User names and passwords" on page 62) click on "Log on".

The overview screen of the configuration assistant opens.

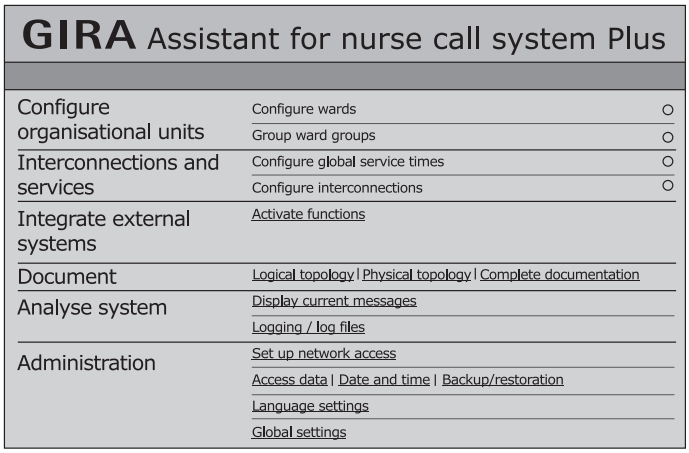


Figure 4.5: Overview screen for configuring a large system

You can now carry out settings to the system.

Menu level 1	Menu level 2	Explanation
Configure organisational units		
	Configure wards	Group wards (establish organisational units).
	Group ward groups	Connect organisational units.
Interconnections and services		
	Configure global services	Duty (shift) times can be set up for the individual week days here.
	Configure interconnections	Interconnections can be automatically or manually controlled depending on the services.
Integrate external systems*	* This menu item is only displayed with configuration of a system central control unit.	
	Activate functions	Software modules such as DECT functionality, fire alarm system connection and ELA connection.
Document		
	Logical topology	Graphic displays for giving to the system operator.
	Physical topology	
	Complete documentation	
Analyse system		
	Display current messages	Active calls, presences.
	Logging/log files	Possible to filter protocol entries according to events and to export protocols.

Menu level 1	Menu level 2	Explanation
Administration		
	Set up network access	Configure external LAN. Configure nurse call system Plus LAN.
	Save/restore	Save or restore system settings.
	Access data	Change user and/or password.
	Date and time	Set up manual setting or time server.
	Language settings	Settings affecting the voice functionality of the system.
	Global settings	Settings for call types, presence and remote switch-off.

To find out more about the meaning of specific points, please use the on-screen help of the configuration assistant for detailed information.

4.6 Network settings in the configuration assistant

After logging onto the configuration assistant of the system central control unit or ward control centre, call up a screen mask via **Modify administration/network settings** for changing network settings for the specific device.

Important:
only modify the network settings when absolutely necessary!

The network interfaces of the call system are pre-configured so that the system can normally be started up without further changes.
Make sure to discuss required changes to the settings with the IT administrator of the system.

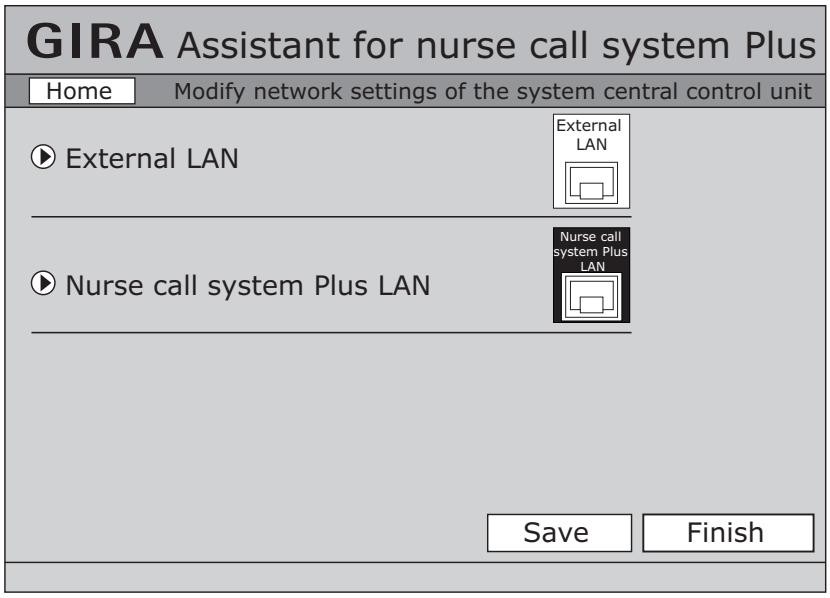


Figure 4.6: Network settings in the configuration assistant

The **Modify network settings** screen mask can be divided into two sections: External LAN and nurse call system Plus LAN.

4.6.1 "External LAN" network settings

Under External LAN the following can be set:

- Receive IP address automatically (via DHCP server): Select this option when the system central control unit or ward control centre is to be connected to an external LAN (via the External LAN connection) and should receive its IP address in the network automatically from there.
- Set IP address manually: Select this option when the system central control unit or ward control centre is to be connected to an external LAN or a start-up PC (via the External LAN connection) and should manually assign the device a specific IP address. For this you have to know the IP address, the IP address of the subnet mask and the standard gateway in the external network. To get this data, contact the network administrator responsible for the external network if necessary. As standard, the system central control unit or ward control centre is set to the IP address 192.168.0.111 and the subnet mask to 255.255.255.0.

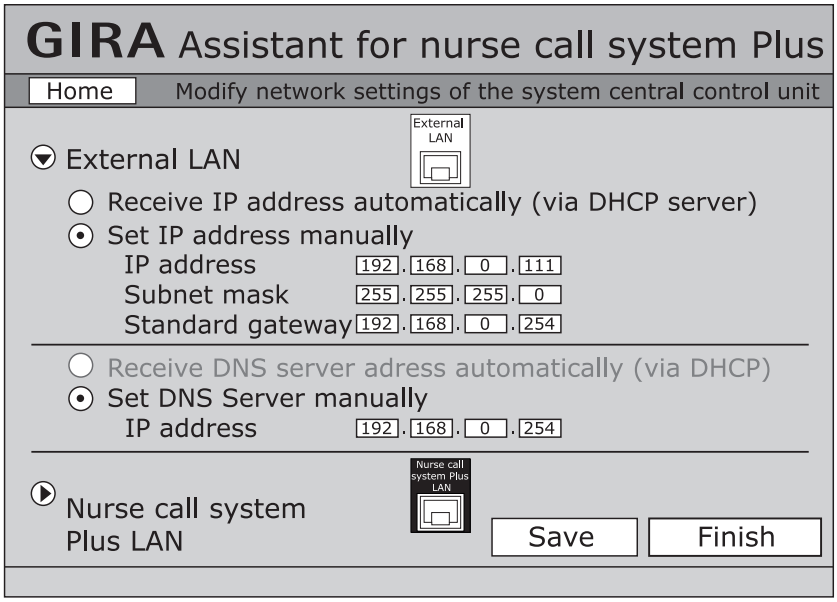


Figure 4.7: Network settings "External LAN" in the configuration assistant

4.6.2 Network settings "Nurse call system Plus LAN"

Under nurse call system Plus LAN the following can be set:

- IP address: Enter an IP address with which the system central control unit or ward control centre is logged in on the system layer of the nurse call system Plus. As standard the device is set to the IP address 192.168.0.111.
- Subnet mask: Specify a subnet mask with which the system central control unit or ward control centre is logged in on the system layer of the nurse call system Plus. As standard the device is set to the subnet mask 255.255.255.0.
- Activate DHCP server: Only select this option when the ward control centre is used as a central control unit in a small system. This then automatically distributes the individual IP addresses to the devices connected to the system layer of the nurse call system Plus.

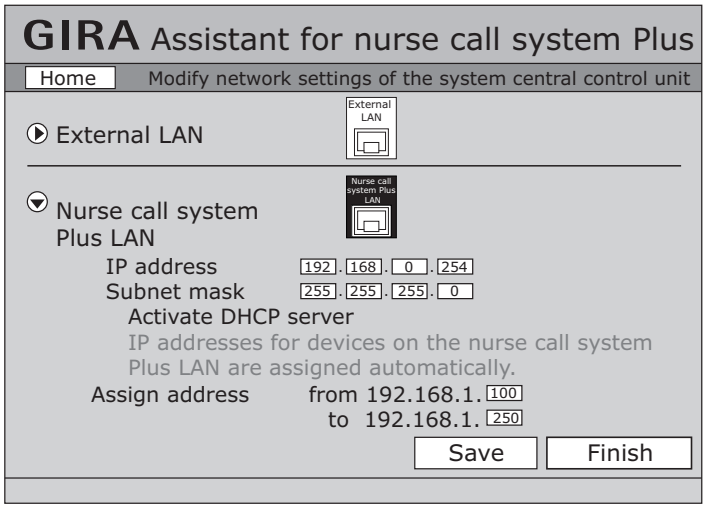


Figure 4.8: Network settings "Nurse call system Plus LAN" in the configuration assistant

See chapter "Basics of network technology" on page 135 for detailed explanations on network technology.

4.7 Connection to external systems

For the system central control unit, software packages are offered to be purchased separately for connecting to

– DECT telephone systems (DECT = Digital Enhanced Cordless Telecommunications) via ESPA 4.4.4, Order No. 5994 00

– VoIP telephone systems (VoIP = Voice over IP), Order No. 5995 00

– Fire alarm systems via ESPA 4.4.4, Order No. 5993 00

– Electrical loudspeaker systems (ELA), Order No. 5996 00

The required hardware connections are on the front of the system central control unit, correspondingly designated.

Figure 4.9: Key card for enabling (e.g. a DECT telephone system)

The individual software packages are activated and configured with the configuration assistant (software) in the system central control unit.

Activation and configuration:

- Order one or several supplementary software packages via your sales partner.
- For each software package Gira sends you a key card (see Figure 4.9).
- In the configuration assistant in the system central control unit, enter your name and the activation code specified on the key card.
- Your name is saved in the system central control unit.
- The corresponding software package is now enabled, and can be called up in the configuration assistant of the system central control unit to be configured as desired.

4.8 Handling the configuration software Example: Configure organisational units

Handling of the software is shown with the example of the menu item ***Configure organisational units -> Configure wards***.

The following example shows configuration of wards in a defined large system.

The circles at the end of a menu bar show whether a menu item has been processed. The circle is filled in if a menu item was processed.

After pressing the ***Configure wards*** button, you reach the overview for the connected ward control centres, consisting of three columns.

The ward control centres are listed in the left column.

A single click on one of the ward control centres displays information for the specific device.

A click on the tool symbol opens a further window with the option of grouping the ward into 6 organisational units. Settings are confirmed with the "Save settings" button.

The ward list now shows the set-up of ward groups with the previously processed ward.

The central column shows a list of the devices of a ward (duty/room terminals and room modules, hallway displays etc.) connected to the ward control centre.

Next to the specific icons for the devices and ward groups, a "(plain-) name" should be assigned to corresponding devices in the correct text field.

The device ID and short device description can be seen above the device as further information.

Ward devices can be assigned to a ward group via drag & drop if the ward is grouped.

One click on a ward device shows a list of connected room devices in the right-hand column.

Clicking on a room device gives you device ID, short description and the device location as information.

Three possibilities for selection of device location are set:

- In the room,
- At the bed,
- In the WC.

The location assignment of a room device is important, because a call button can be installed in the room, directly next to the bed or in the WC as well.

If you select the option "At the bed", you can assign a bed number which leads to a call being assigned to a specific bed and the bed number being displayed with a call.

If you select the option "In the WC", a call of the call button is displayed as a WC call with red and white light in the room signal light.

4.9 Interconnection of organisational units

It is possible to connect complete wards or parts of these (one or several rooms) with other wards or parts to form new organisational units. It is also possible to interconnect already established organisational units with further organisational units.

Interconnections can be implemented permanently, flexibly (time-controlled) or manually.

With interconnection of organisational units you can define the communication direction between the organisational units.
For example you can define that communication from A to B and from B to A (i.e. both directions) is permissible. Only one direction can also be defined, e.g. only from A to B.

In addition you can also define that only specific call types are forwarded, e.g. only doctor alerts.

You can find fundamental information to organisational units in chapter "Planning organisational units (grouping wards)" on page 25.

Further information to handling the configuration software can be found in the online help of the configuration assistant.

4.10 System documentation

The information from the ward plan that shows which device is installed where is compared with the configuration assistant.

Fundamentally the configuration assistant recognises which devices have been installed. In order to securely assign the room devices the information from the ward plan is used with the removed device labels.

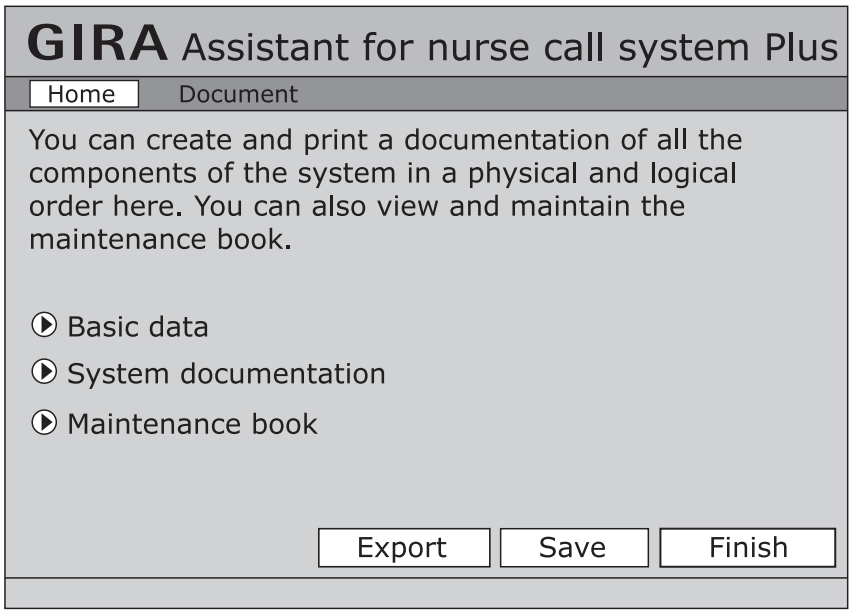


Figure 4.10: System documentation

4.11 Behaviour with faults

4.11.1 How is a fault displayed

System faults are signalled in the room signal light with a continuous red light (see Table 1 on page 84).

In the display of the (duty-) room terminal the following messages can appear:

- ***"Removal"*** if the patient hand-held device or diagnostic connection cable is removed consciously or unconsciously, a (normal) call is signalled. The message "Plug" appears in the displays of the duty room terminals and room terminals. In order to switch off such a call, the presence button on the room module or room terminal in the corresponding room must be pressed for approximately 3 seconds.
- ***"Fault"*** with wire fraction in the room or if a room device is defective or has been removed.
- ***"Bus error"*** with faults of the ward control centre or ward bus.
- ***"Fault SSZ"*** with faults of the system central control unit or in the nurse call system Plus LAN.

4.11.2 How is a fault resolved

Continuous red light in a room signal light can have 3 causes:

1. **(Normal) call**
   Press presence button once.
   If the room signal light still shows a continuous red light, then a plug removal or other fault may be the cause.
   Observe the messages in the display of the duty/room terminal!
2. **Plug removal call (text in the display of a terminal)**
   Press and hold the presence button for 3 seconds.
   If the room signal light still shows a continuous red light then another fault exists; this can be the defect of a device or a wire fraction in this room.

4.12 Removing devices

Devices no longer needed must be removed from the system in two different ways:

- Physically from the system: First remove the device from the system, observing the normal regulations and security rules.
- Removing in the software of the configuration assistant: Open the configuration assistant of the corresponding system central control unit (large system) or ward control centre (small system). Select the device previously removed physically from the system and click on the trash can symbol. Follow the instructions. Please see the help of the configuration assistant for more information.

4.13 Replacing defective devices

Defective devices in the system can be exchanged by firstly replacing them physically in the system by a new device.

If a single defective device is replaced with an identical one in the system, the system automatically transfers the configuration settings of the defective device to the new device. It only has to be then confirmed in the configuration assistant.

Note:
adoption of the settings of the defective device.

This function is only available when a single device is replaced.

When replacing several devices, the new devices have to be newly configured in the configuration assistant of the corresponding system central control unit (large system) or ward control centre (small system).

- Select the new device in the configuration assistant.
- If required, assign a new name to the device and click on the spanner symbol.
- Follow the instructions in the software.

Please see the help of the configuration assistant for more information.

4.14 PHD test

The DIN VDE 0834 standard specifies that a "mobile hand-held device" such as a newly applied patient hand-held device (pear button) must be function-tested. This occurs automatically in the system.

- The LED in the call button of the patient hand-held device (PHD/pear button) flashes rapidly.
- Press the call button once to conclude the function test.

5. Function

5.1 Functional description

The nurse call system Plus enables voice communication between the patient's room and duty room, see 5.1.1 Voice communication (voice function) page 80.

With all devices with voice function, pressing the red call button activates free speaking. If a patient hand-held device is connected to an ancillary plug contact, "discreet speaking" (and listening) with the hand-held device is also possible if the call was triggered with the hand-held device. After a "voice call", see 5.2 Call types page 82, has been accepted by the care personnel this call can be (standard-conformant) switched off via remote switch-off.

If a red call button (with patient hand-held device or pull-cord button or pneumatic call button) is actuated, this triggers a call. The call is displayed with a reassurance light in the call button (or in the housing of the pull-cord button or the pneumatic call button) and at the same time via a red continuous light of the room signal light.

If a call is triggered in a bathroom unit/WC, this so-called WC call is displayed with a red and white continuous light in the room signal light.

In all the rooms in which presence is marked by pressing the green presence button, the triggered call of another room is signalled via a buzzer tone. This function is referred to as call forwarding. The presence is displayed with green and/or yellow continuous light in the presence button and in the room signal light.

An emergency call is triggered if the red call button (or a doctor alert button) is pressed when presence is marked. The emergency call is signalled by the red flashing light of a room signal light. The emergency call is also displayed via a reassurance light in the call button/patient hand-held device (or in the housing of the pull-cord button or pneumatic call button).

Emergency calls are switched off with a switch-off button or the presence button in the room in which the call was triggered.

Switching off a voice call is implemented via a switch-off button or presence button; remote switch-off is possible.

With larger systems where it may be necessary to establish organisational units, such as grouping together rooms from various wards or ensuring call forwarding outside of wards, at least one ward control centre is required.

Logging of the call and presence activities is implemented in the ward- or system central control unit.

Following power failure, a triggered call is retained.

5.1.1 Voice communication (voice function)

The nurse call system Plus fundamentally enables voice communication (voice calls) between various rooms (e.g. patient's room and duty room).
With the call forwarding function, a voice call is forwarded to other patient's rooms or (with corresponding configuration) to other organisational units.
Voice calls can be implemented when the requisite devices have been installed. These devices are:

- Call button with ancillary plug contact Plus (Order No.: 5901 ..) with connected voice module (Order No.: 5990 ..) and/or connected patient hand-held device (Order No.: 5960 ..).
- Call and switch-off button with ancillary plug contact Plus (Order No.: 5903 ..) with connected voice module (Order No.: 5990 ..) and/or connected patient hand-held device (Order No.: 5960 ..).
- Call button with ancillary plug contact and diagnostic pin jack Plus (Order No.: 5906 ..) with connected voice module (Order No.: 5990 ..) and/or connected patient hand-held device (Order No.: 5960 ..).
- Switch-off button with voice module Plus (Order No.: 5918 ..) for bathroom unit areas.
- Room terminal Plus (Order No.: 5925 ..)
- Duty room terminal Plus (Order No.: 5929 ..)

5.1.2 The voice call

Voice calls occur when a call/emergency call has been triggered.
With the Gira nurse call system Plus, two types of voice calls are differentiated:

1. Free speaking via the voice module installed in a flush-mounted box
   If one of the two devices specified above has been installed with voice module in a patient's room (e.g. next to a bed), then free speaking and listening is possible following call/emergency call triggering by pressing the red call button.
2. Discreet speaking via the patient hand-held device
   If a device with ancillary plug contact has been installed in a patient's room (e.g. next to a bed), then initially free speaking is possible after call/emergency call triggering via the patient hand-held device, and following a further call triggering discreet speaking and listening. The patient hand-held device is held to the mouth and ear like a telephone receiver for this.

If a voice connection is not possible because for example a call with higher priority is upcoming and/or the voice channel is occupied, this is displayed.

The actual call/emergency call is visually indicated via the room signal light and via the duty room terminal or duty room terminal CT 9.

Voice connections are automatically terminated after 30 seconds.

Relaying (toggling) or changing between several upcoming voice calls is not possible.

As soon as a voice call has been triggered via a device at a bed or in a room, this call is termed a pollable call. With such pollable calls, remote switch-off is permitted after query (speaking with the person calling).

5.1.3 Consoles for voice calls

The consoles must be equipped with one of the following devices:

- Room terminal Plus (Order No.: 5925 ..) with connected voice module (included in scope of supply of room terminal).
- Duty room terminal Plus with connected voice module (included in scope of supply of duty room terminal).
- Duty room terminal CT9 (microphone and loudspeaker integrated).
  To be able to use the duty room terminal CT9, a duty room terminal or room module must be installed in the duty room.

5.1.4 Communication possibilities of the duty room terminal

The duty room terminal has various methods for voice calls.

- A collective call goes to all voice-compatible rooms, or
- A collective call goes to all voice-compatible rooms with set presence, or
- Room call (only with duty room terminal CT9), selection and talk-back with a single room

5.2 Call types

The Gira nurse call system Plus enables voice communication between the patient's room and duty room, see 5.1.1 Voice communication (voice function) page 80.
The following generally applies:

- **Voice call (free speaking/discreet speaking)**
  - After triggering a call by pressing a red call button on the device, free speaking and listening via the voice module in the patient's room is possible.
  - After triggering a call by pressing the red call button on the patient hand-held device, firstly free speaking is possible, and then with a second pressing of the red button "discreet speaking" and listening becomes possible with the patient hand-held device. The patient hand-held device is held to the ear like a telephone receiver for this purpose.

  The call is displayed with a red reassurance light in the call button and red light in the room signal light (See table Call types: page 84). The function of voice communication is possible until the call is switched off. If a voice call cannot be established because for example calls with higher priority are upcoming or nobody accepts the voice call at a console, the call is terminated after 30 seconds. The call itself is maintained and is indicated via the room signal light and the room/duty room terminal.
- **(Normal) call**
  Triggering a call by pressing a red call button.
  The (normal) call is displayed with a red reassurance light in the call button and red continuous light in the room signal light (See table Call types: page 84).
  Each bed must be assigned a unit for call triggering which the bedridden patient can reach comfortably and safely. The call button must be red and be designated with a unique symbol.
  An LED as a so-called location light is installed in the call button, pear button, patient hand-held device, cover of the pull-cord button or the pneumatic call button for easy location in the dark.
  The incoming call has validity until it is dispensed by pressing a presence or switch-off button.
- **WC call**
  Call from a bathroom unit or from separate WC rooms or rooms with bathtub or shower.
  The WC call is displayed with a white continuous light (in addition to the red continuous light) in a room signal light.
  The incoming call has validity until it is dispensed by pressing a switch-off button on-site.
- **WC emergency call**
  When the presence marking in a room with a WC area is switched on, emergency triggering is prepared because a WC emergency call is triggered if a red call button, pull-cord button or a pneumatic call button in the WC/bathroom area is actuated again. The WC emergency call is displayed with a red and white flashing light in a room signal light (See table Call types: page 84).
  The incoming call has validity until it is dispensed by pressing a switch-off button on-site.

- **Emergency call**
  Emergency call triggering is prepared by switching on presence marking in a room.
  Pressing the red call button again in the room triggers an emergency call.
  The emergency call is displayed with a red flashing light in a room signal light
  (See table Call types: page 84).
  The incoming emergency call has validity until it is dispensed by pressing a presence or switch-off button.
- **Alarm call/doctor alert**
  Doctor alert can be triggered with the doctor alert button only when Presence 1 or Presence 2 is set.
  Doctor alert is a call with its own signal for special purposes that may only switched off at the triggering location.
  The call triggering is for requesting special personnel, e.g. for calling doctors, but also for signalling special dangers e.g. fire or device failures.
  The incoming alarm/doctor alert has validity until it is dispensed by pressing a presence or switch-off button.
- **Diagnostic call/monitor call**
  Call from an electrical medical device according to the standard DIN EN 60601 (VDE 0750).
  This type of call also referred to as a monitor call must be made via separate plug-and-socket outlets (diagnostic connection cable, Order No.: 59xx 00). Diagnostic calls are alarm calls.
  The incoming diagnostic call has validity until it is dispensed by pressing a presence or switch-off button.
- **Room call (only from a duty room terminal CT9)**
  A specific room can be selected and communicated with via the CT9 menu.
  Voice communication is only possible in one direction, from the duty room terminal CT9 to the selected room.
  Room calls are eavesdropping-blocked, meaning replying is not possible. Replies from the room are only possible following a request by the care personnel via pressing a red call button (on the call button or patient hand-held device) in the room.
- **Collective call (only from a duty room terminal CT9)**
  An organisational unit (and therefore all rooms belonging to this) can be selected and communicated with via the menu of the CT9.
  Voice communication is only possible in one direction, from the duty room terminal CT9 to the selected organisational unit and its rooms.
- **Plug removal call**
  If the patient hand-held device or diagnostic connection cable is removed consciously or unconsciously, a (normal) call is signalled. The message "Plug" appears in the displays of the duty room terminals and room terminals. In order to switch off the call, the presence/switch-off button must be pressed for approximately 3 seconds.
- **Call forwarding buzzer signal**
  The call forwarding function is activated in each room in which presence is set. If a call/emergency call is triggered in another room (which belongs to the same organisational unit), a buzzer signal becomes audible in the room in which presence is set.

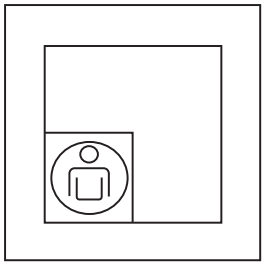
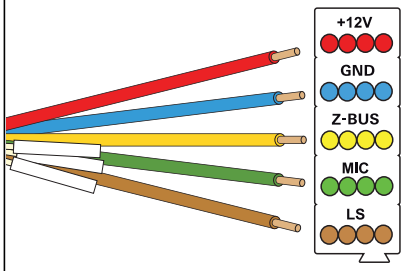
- **Signalling in case of fault**
  With device failures such as failure of the ward control centre or the system central control unit, the message "emergency mode" is shown with devices having displays. With wire fraction in a room, the message "Fault" appears.

Call type	Type and cycle sequence of the calls			
	Visual display		Colour	Acoustic signal
(Normal) call	▬▬▬▬	Continuous light	red	t_{on} =1 sec., Pause 10 ... 20 sec.
Emergency call	▬ ▬▬ ▬	Flashing light, long interval on/off approx. every 1.2 sec. ...		Tone sequence t_{on}/t_{off} = 1.2 sec.
Doctor alert/ diagnostic call	▬▬▬▬▬▬▬▬	Flashing light, short interval on/off approx. every 0.3 sec. ...		Tone sequence t_{on}/t_{off} = 0.3 sec.
(WC) bathroom unit call	▬▬▬▬	Continuous light	red and white	t_{on} =1 sec., Pause 5 ... 10 sec.
(WC) bathroom unit emergency call	▬ ▬▬ ▬	Flashing light	red and white	Tone sequence t_{on}/t_{off} = 1.2 sec.
Presence 1	▬▬▬▬	Continuous light	green	w/o
Presence 2	▬▬▬▬	Continuous light	yellow	w/o
Signalling in case of fault	▬▬▬▬	Continuous light	red	w/o
Room call		none	none	Special signal (multi-tone gong)
Collective call		none	none	Special signal (multi-tone gong)

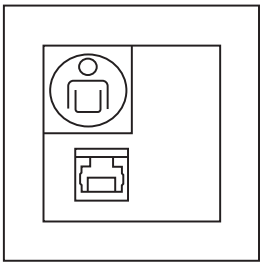
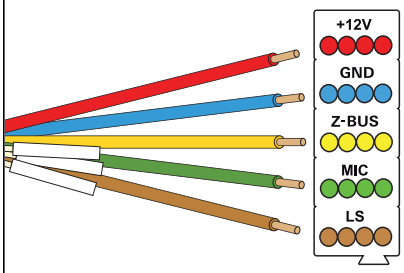
Table 1: Call types

5.3 Components of the nurse call system Plus and their functions

5.3.1 Call button Plus

Order No. 5900 .. (RT+), Call button Plus		
Connection to:	Room bus	
Note:	No connection option for voice module.	
For further information:	Description of call forwarding: Page 83.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in red button lights up weakly (location light).	
Call: Press red button once.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press 1 x switch-off button or 1 x presence button (e.g. at the terminal).
Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press 1 x switch-off button or 1 x presence button (e.g. at the terminal).

5.3.2 The call button with ancillary plug contact Plus

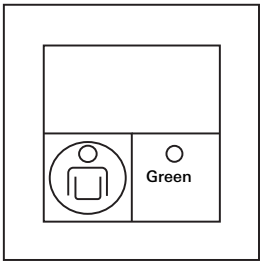
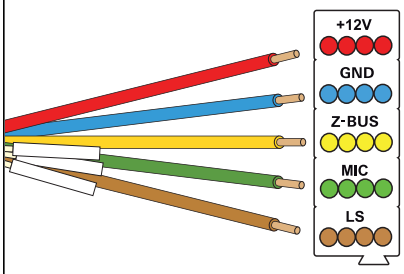
Order No. 5901 .. (RN+), call button with ancillary plug contact and connection option for voice module		
Connection to:	Room bus	
Connection of:	Patient hand-held device, radio set. Connection option for voice module. Connection for impulse relay see 3.6.5 Switching the room light page 42.	
Note:	Connection of the patient hand-held device is via a protective adapter (included in scope of supply), Order No. 2962 00.	
For further information:	Voice call, see 5.2 Call types page 82 and see 5.1.1 Voice communication (voice function) page 80. Description of plug connection: see page 83. Description of call forwarding: Page 83.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in red button lights up weakly (location light).	
Call: Press red button once. **Call via ancillary plug contact:** Press the red call button once on the patient hand-held device. Press the call button once in the radio module of the radio set.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the presence button once (on the terminal or module).

For continuation of table see next page

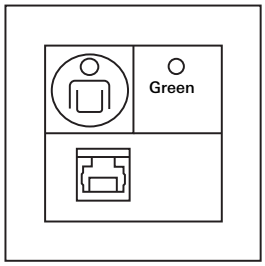
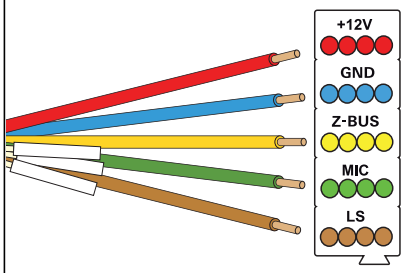
Continuation of table

"Free speaking" voice call: Press the red call button once. **"Discreet speaking" voice call via the patient hand-held device:** Press the red call button twice on the patient hand-held device.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Acoustic signal for incoming voice call at the duty room/ room terminals. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the presence/switch-off button once (on the terminal or module). Remote switch-off of the voice call: After query, press the switch-off button once.
Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** LED in the red button flashes. Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press the presence button once (on the terminal or module).
Plug removal call: Removal of the plug for the patient hand-held device or the radio receiver with the radio set. (Wire fraction is also monitored).	**Plug removal display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Plug removal switch-off:** Press and hold the presence button on the terminal or module approx. 3 seconds.

5.3.3 Call and switch-off button Plus

Order No. 5902 .. (RA+), Call and switch-off button Plus		
Connection to:	Room bus	
Note:	No connection option for voice module.	
For further information:	Description of call forwarding: Page 83.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in red button lights up weakly (location light).	
Call: Press red button once.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press green button once.
Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press green button once.

5.3.4 Call and switch-off button with ancillary plug contact Plus

Order No. 5903 .. (RAN+), call and switch-off button with ancillary plug contact and connection option for voice module	
Connection to:	Room bus
Connection of:	patient hand-held device, radio set. Connection option for voice module. Connection for impulse relay see 3.6.5 Switching the room light page 42
Note:	Connection of the patient hand-held device is via a protective adapter (included in scope of supply), Order No. 2962 00.
For further information:	Voice call, see 5.2 Call types page 82 and see 5.1.1 Voice communication (voice function) page 80. Description of plug rear radio call: page 83. Description of call forwarding: Page 83.
Device view	**Connections on rear of device**
	

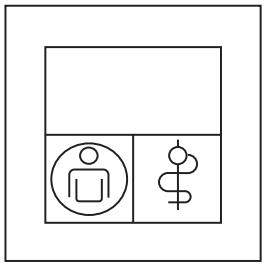
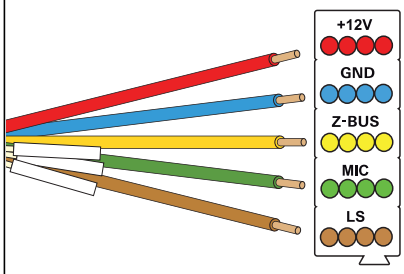
Triggering	**Display**	**Switch-off**
	Idle state: LED in red button lights up weakly (location light).	
Call: Press red button once. **Call via ancillary plug contact:** Press the red call button once on the patient hand-held device. Press the call button once in the radio module of the radio set.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the green button once or the presence button once (e.g. at the terminal).

For continuation of table see next page

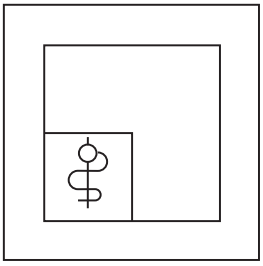
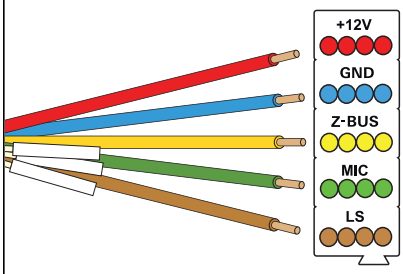
Continuation of table

"Free speaking" voice call: Press the red call button once. **"Discreet speaking" voice call via the patient hand-held device:** Press the red call button twice on the patient hand-held device.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Acoustic signal for incoming voice call at the duty room/ room terminals. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the presence/switch-off button once (on the terminal or module). Remote switch-off of the voice call: After query, press the switch-off button once.
Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** LED in the red button flashes. Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press the green button once or the presence button once (e.g. at the terminal).
Plug removal call: Removal of the plug for the patient hand-held device or the radio receiver with the radio set. (Wire fraction is also monitored).	**Plug removal display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Plug removal switch-off:** Press and hold the presence button on the terminal or module approx. 3 seconds.

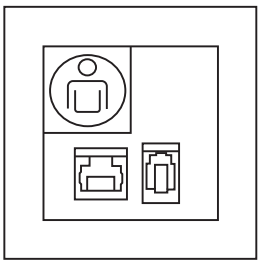
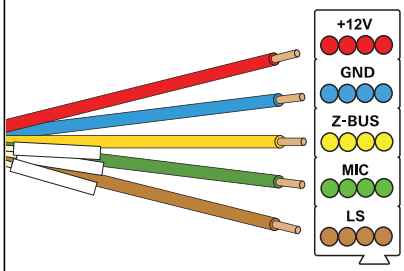
5.3.5 Call and doctor alert button Plus

Order No. 5904 .. (RAR+), call and doctor alert button Plus		
Connection to:	Room bus	
Note:	No connection option for voice module.	
For further information:	Call types: see 5.2 Call types page 82.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in red and blue button lights up weakly (location light).	
Call: Press red or blue button once (no presence marked).	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the presence button once (on the terminal).
Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** LED in the red button flashes. Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press the presence button once (on the terminal).
Doctor alert: Press the blue button once with marked presence.	**Display of doctor alert:** LED in the red and blue button flashes. Red light in the room signal light flashes. Buzzer signal for doctor alert/ diagnostic call in each room with marked presence (see table "Call types" on page 84).	**Switch off doctor alert:** Press the presence button once (on the terminal).

5.3.6 Doctor alert button Plus

Order No. 5905 .. (AR+), doctor alert button Plus		
Connection to:	Room bus	
Note:	No connection option for voice module.	
For further information:	Call types: see 5.2 Call types page 82.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in blue button lights up weakly (location light).	
Emergency call: Press the blue button once with marked presence.	**Emergency call display:** LED in the blue button flashes. Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press the presence button once (on the terminal).
Doctor alert: Press the blue button once with marked presence.	**Display of doctor alert:** LED in the blue button flashes. Red light in the room signal light flashes. Buzzer signal for doctor alert/ diagnostic call in each room with marked presence (see table "Call types" on page 84).	**Switch off doctor alert:** Press the presence button once (on the terminal).

5.3.7 Call button with ancillary plug contact and diagnostic pin jack Plus

Order No. 5906 .. (RND+), call button with ancillary plug contact and diagnostic pin jack and connection option for voice module	
Connection to:	Room bus
Connection of:	Patient hand-held device, radio set, medical device. Connection option for voice module. Connection for impulse relay see 3.6.5 Switching the room light page 42
Note:	Connection of the patient hand-held device is via a protective adapter (included in scope of supply), Order No. 2962 00. Connection of a medical device is via the diagnostic connection cable (RJ11 at one end, open end to NC contact of device from other manufacturer), Order No. 2961 00.
For further information:	Voice call, see 5.2 Call types page 82 and see 5.1.1 Voice communication (voice function) page 80. Description of plug removal call: Page 83. Connection of medical device: see 3.6.6 Connection of diagnostic connection cable page 43.
Device view	**Connections on rear of device**
	

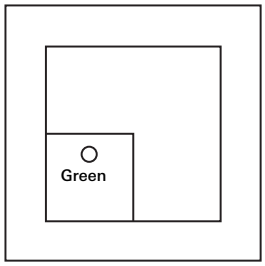
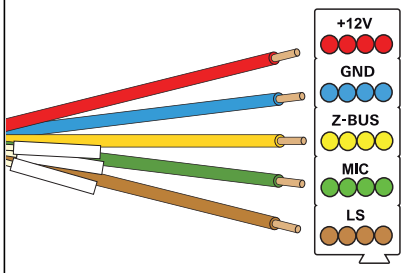
Triggering	**Display**	**Switch-off**
	Idle state: LED in red button lights up weakly (location light).	
Call: Press red button once. **Call via ancillary plug contact:** Press the red call button once on the patient hand-held device. Press the call button once in the radio module of the radio set.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the presence button once (e.g. on the terminal).

For continuation of table see next page

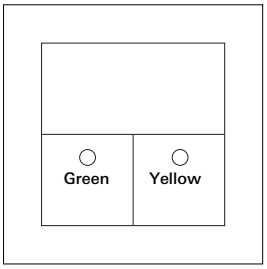
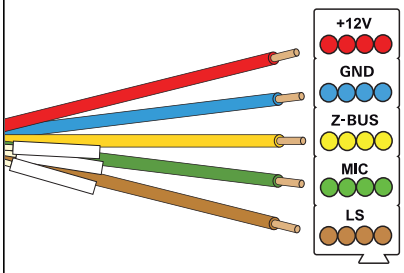
Continuation of table

"Free speaking" voice call: Press the red call button once. **"Discreet speaking" voice call via the patient hand-held device:** Press the red call button twice on the patient hand-held device.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Acoustic signal for incoming voice call at the duty room/ room terminals. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the presence/switch-off button once (on the terminal or module). Remote switch-off of the voice call: After query, press the switch-off button once.
Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** LED in the red button flashes. Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press the presence button once (e.g. on the terminal).
Diagnostic call: Triggered via the the zero-voltage contact of a medical device.	**Display of diagnostic call:** Red light in the room signal light flashes. Buzzer signal for diagnostic call in each room with marked presence (see table "Call types" on page 84).	**Switch off diagnostic call:** Press the presence button once (e.g. on the terminal).
Plug removal call: Removal of the plug for the patient hand-held device or the radio receiver with the radio set. (Wire fraction is also monitored).	**Plug removal display:** LED in red button lights up. Red light in the room signal light lights up continuously. In the display of a duty room/ room terminal the following message appears: "Plug". Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Plug removal switch-off:** Press and hold the presence button for approx. 3 seconds.

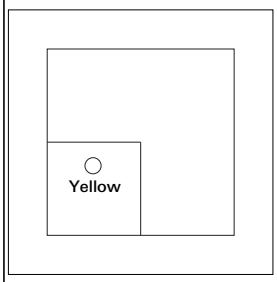
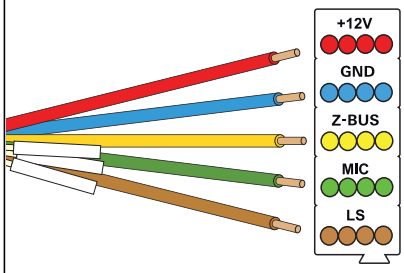
5.3.8 Presence button green Plus

Order No. 5908 .. (AW_1+), Presence button green Plus		
Connection to:	Room bus	
Note:	No connection option for voice module.	
For further information:	Description of call forwarding: see • Call forwarding buzzer signal page 83.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
Mark presence: Press green button once. Acoustic call forwarding is prepared.	**Display presence/ call forwarding:** LED in green button lights up. Green light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Switch off presence:** Press green button once.

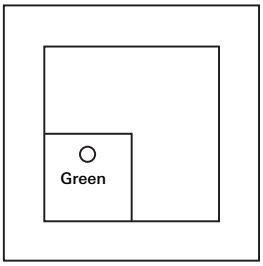
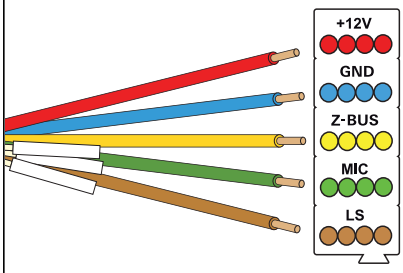
5.3.9 Presence button green, yellow Plus

Order No. 5909 .. (AW_12+), Presence button green, yellow Plus		
Connection to:	Room bus	
Note:	No connection option for voice module.	
For further information:	Description of call forwarding: see • Call forwarding buzzer signal page 83.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
Mark presence 1: Press green button once. Acoustic call forwarding is prepared.	**Display presence 1/ call forwarding:** LED in green button lights up. Green light in the room signal light lights up continuously. Buzzer signal as acoustic call forwarding for normal and emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off presence 1:** Press green button once.
Mark presence 2: Press yellow button once. Acoustic call forwarding is prepared.	**Display presence 2/ call forwarding:** LED in yellow button lights up. Yellow light in the room signal light lights up continuously. Buzzer signal as acoustic call forwarding for normal and emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off presence 2:** Press yellow button once.

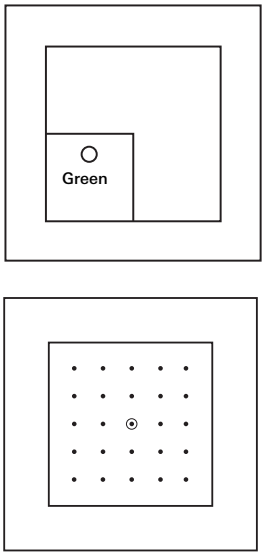
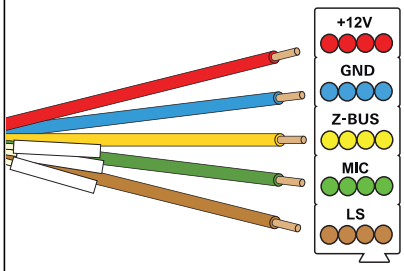
5.3.10 Presence button yellow Plus

Order No. 5910 .. (AW_2+), Presence button yellow Plus		
Connection to:	Room bus	
Note:	No connection option for voice module.	
For further information:	Description of call forwarding: see • Call forwarding buzzer signal page 83.	
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
Mark presence 2: Press yellow button once. Acoustic call forwarding is prepared.	**Display presence 2/ call forwarding:** LED in yellow button lights up. Yellow light in the room signal light lights up continuously. Buzzer signal as acoustic call forwarding for normal and emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off presence 2:** Press yellow button once.

5.3.11 Switch-off button Plus

Order No. 5911 .. (AT+), switch-off button Plus		
Connection to:	Room bus	
Note:	For use in WC areas. No connection option for voice module.	
For further information:		
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
Call triggering via e.g. call button, pull-cord button, pneumatic call button.	Reassurance light lights up in all call triggering buttons. Red light in the room signal light lights up continuously. White light in the room signal light lights up continuously.	Press green button once (switch-off button).

5.3.12 Switch-off button with voice module Plus

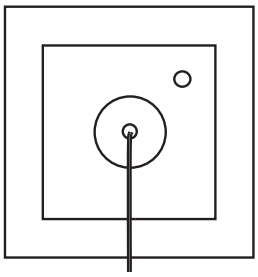
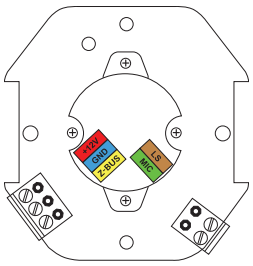
Order No. 5918 .. (ATS+), switch-off button with voice module Plus		
Connection to:	Room bus	
Connection of:	Connection option for voice module.	
Note:	For use in WC areas.	
For further information:		
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in green button lights up weakly (location light).	
Call: Press red call button, pull-cord button or pneumatic call button once. Press the call button once in the radio module of the radio set.	**Call display:** LED in green button lights up. Red light in the room signal light lights up continuously. White light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press green button on switch-off button once.

For continuation of table see next page

Continuation of table

"Free speaking" voice call: Press the red call button once.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. White light in the room signal light lights up continuously. Acoustic signal for incoming voice call at the duty room/ room terminals. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press green button on switch-off button once. Remote switch-off of the voice call: After query, press the switch-off button once.

5.3.13 Pull-cord button Plus

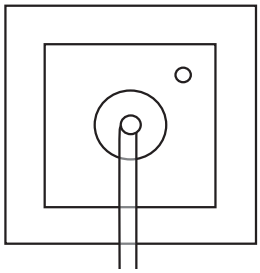
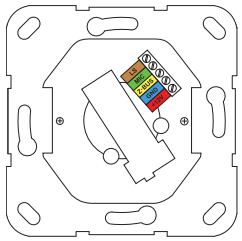
Order No. 5912 .. (ZUT+), pull-cord button Plus		
Connection to:	Room bus	
Note:	For use in bathroom/WC areas. No connection option for voice module. The handle of the pull-cord button is to be secured with a reef knot on the pull cord.	
For further information:		
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in housing of button lights up weakly (location light).	
Call/WC call: Pull on pull cord once.	**Call display:** Reassurance light lights up in the housing of the button. Red light in the room signal light lights up continuously. **WC call display:** Red and white lights in the room signal light light up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the switch-off button on-site once (e.g. in the WC area).

For continuation of table see next page

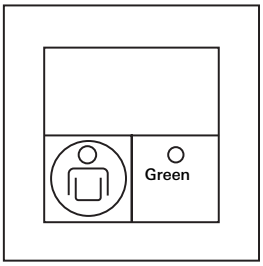
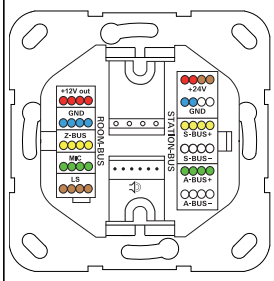
Continuation of table

Emergency call / WC emergency call: Pull the pull cord once with marked presence.	**Emergency call display:** Red light in the room signal light flashes. **WC emergency call display:** Red and white lights in the room signal light flash. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press the switch-off button on-site once (e.g. in the WC area).

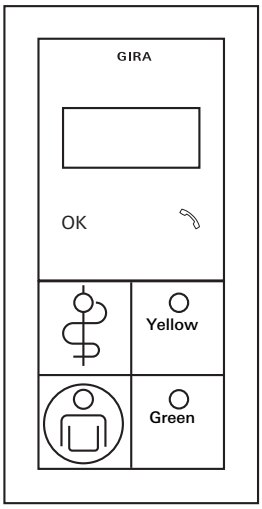
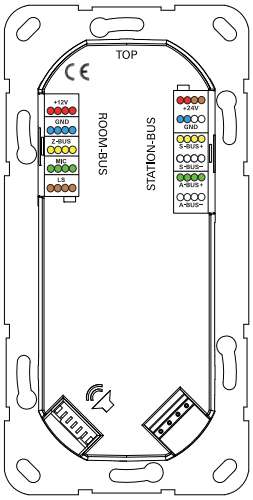
5.3.14 Pneumatic call button Plus

Order No. 5913 .. (PRT+), pneumatic call button Plus		
Connection to:	Room bus	
Note:	For use in bathroom/WC areas. No connection option for voice module.	
For further information:		
Device view	**Connections on rear of device**	
		
Triggering	**Display**	**Switch-off**
	Idle state: LED in housing of button lights up weakly (location light).	
WC call: Press the red rubber ball once.	**Call display:** Reassurance light lights up in the housing of the button. Red light in the room signal light lights up continuously. **WC call display:** White light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press the switch-off button on-site once (e.g. in the WC area).
WC emergency call: Press the red rubber ball once with marked presence.	**Emergency call display:** Red light in the room signal light flashes. **WC emergency call display:** Red and white lights in the room signal light flash. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press the switch-off button on-site once (e.g. in the WC area).

5.3.15 Room module with call and presence button Plus

Order No. 5920 .. (ZM+), room module with call and presence button Plus		
Connection to: Connection of:	Ward bus Room bus	
Note:	No connection option for voice module.	
For further information:	Description of call forwarding: Page 83.	
Device view	**Connections on rear of device**	
		
	Idle state: LED in red button lights up weakly (location light).	
Call: Press red button once.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press green button once.
Mark presence: Press green button once. Acoustic call forwarding is prepared.	**Display presence/ call forwarding:** LED in green button lights up. Green light in the room signal light lights up continuously.	**Switch off presence:** Press green button once.
Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** LED in the red button flashes. Red light in the room signal light flashes. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	**Switch off emergency call:** Press green button once.

5.3.16 Room terminal, doctor alert and presence 2 Plus

Order No. 5925 .. (ZT+), Room terminal, doctor alert, presence 2 and connection option for voice module	
Connection to:	Ward bus and room bus.
Connection of:	Voice module (included in scope of supply).
Note:	Capacitive buttons below the display for acceptance of voice calls and for selecting/deselecting further functions such as interconnection of ward groups, activation of services. Interconnection and grouping of wards and the setup of services are parameterised with the configuration assistant, see Page 74 and the online help of the software.
For further information:	Voice call, see 5.2 Call types page 82 and see 5.1.1 Voice communication (voice function) page 80. Description of call forwarding: Page 83.
Device view	**Connections on rear of device**
	
	Idle state: LED in red and blue button lights up weakly (location light).

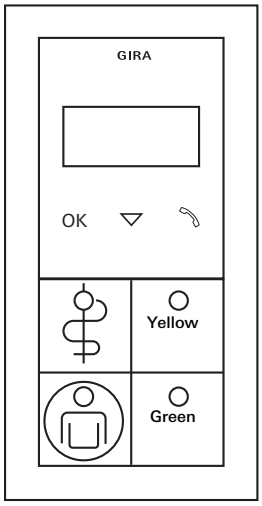
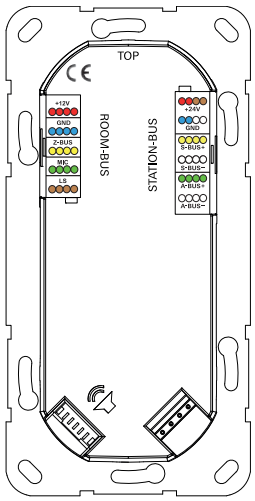
Call: Press red button once or Press blue button once (no presence marked).	**Call display:** LED in red or blue button lights up. Red light in the room signal light lights up continuously. Display shows the room number of the person calling. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press green button once.
Accept voice call: Touch the receiver symbol on the glass surface below the display.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Display shows the room number of the person calling. Acoustic signal for incoming voice call at the duty room/ room terminals. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	Remote switch-off of the voice call: After query, press the switch-off button on the terminal once. **Terminate voice call:** Touch the receiver symbol on the glass surface below the display.
1. Mark presence: Press green button once. Acoustic call forwarding is prepared.	**1. Display presence:** LED in green button lights up. Green light in the room signal light lights up continuously.	**Switch off presence:** Press green or yellow button once.
2. Mark presence: Press yellow button once.	**2. Display presence:** LED in yellow button lights up. Yellow light in the room signal light lights up.	**2. Switch off presence:** Press yellow button once.

For continuation of table see next page

Continuation of table

Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** LED in the red button flashes. Red light in the room signal light flashes. Display shows the room number of the person calling. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84). Display shows information for call forwarding with marked presence.	**Switch off emergency call:** Press green button once.
Doctor alert: Press the blue button once with marked presence.	**Display of doctor alert:** LEDs in the red and blue buttons flash. In the (duty) room terminal doctor alert or in the (duty) room terminal doctor alert and presence 2, the LEDs in the red and blue buttons flash. Display shows information for call forwarding with marked presence.	**Switch off doctor alert:** Press the green or yellow presence button once in the room in which the call was triggered.

5.3.17 Duty room terminal, doctor alert and presence 2 Plus

Order No. 5929 .. (DZT+), duty room terminal, doctor alert, presence 2 and connection option for voice module	
Connection to:	Ward bus and room bus.
Connection of:	Voice module (included in scope of supply).
Note:	Capacitive buttons below the display for acceptance of voice calls and for selecting/deselecting further functions such as interconnection of ward groups, collective calls etc. Only functions that concern the specific duty room terminal can be selected/deselected. If a service is selected or deselected at a duty room terminal in a ward control centre with several duty room terminals, for the period of selection the other duty room terminals are disabled. Interconnection and grouping of wards and the setup of services are parameterised in the system central control unit, see Page 74 and the online help of the software.
For further information:	Description of call forwarding: Page 83.
Device view	**Connections on rear of device**
	

Triggering	Display	Switch-off
	Idle state: LED in red and blue button lights up weakly (location light).	

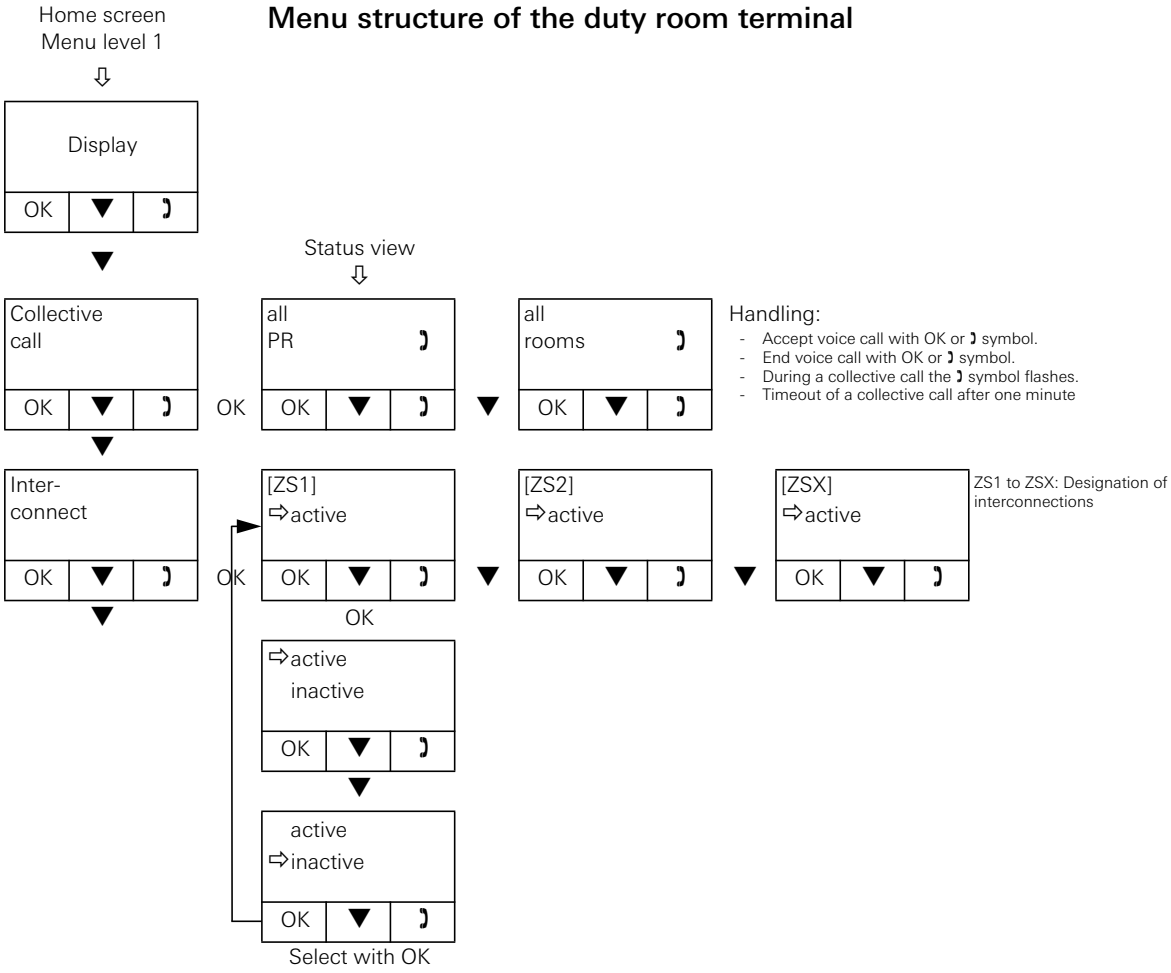
Call: Press red button once or press blue button once (no presence marked).	**Call display:** LED in red or blue button lights up. Red light in the room signal light lights up continuously. Display shows the room number of the person calling. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	**Call switch-off:** Press green button once.
Accept voice call: Touch the receiver symbol on the glass surface below the display.	**Call display:** LED in red button lights up. Red light in the room signal light lights up continuously. Display shows the room number of the person calling. Acoustic signal for incoming voice call at the duty room/ room terminals. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	Remote switch-off of the voice call: After query, press the switch-off button on the terminal once. **Terminate voice call:** Touch the receiver symbol on the glass surface below the display.
1. Mark presence: Press green button once. Acoustic call forwarding is prepared.	**1. Display presence:** LED in green button lights up. Green light in the room signal light lights up continuously.	**Switch off presence:** Press green or yellow button once.
2. Mark presence: Press yellow button once.	**2. Display presence:** LED in yellow button lights up. Yellow light in the room signal light lights up.	**2. Switch off presence:** Press yellow button once.

For continuation of table see next page

Continuation of table

Emergency call: Press 1 x red button with marked presence.	**Emergency call display:** LED in the red button flashes. Red light in the room signal light flashes. Display shows the room number of the person calling. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84). Display shows information for call forwarding with marked presence.	**Switch off emergency call:** Press green button once.
Doctor alert: Press the blue button once with marked presence.	**Display of doctor alert:** LEDs in the red and blue buttons flash. In the (duty) room terminal doctor alert or in the (duty) room terminal doctor alert and presence 2, the LEDs in the red and blue buttons flash. Display shows information for call forwarding with marked presence.	**Switch off doctor alert:** Press the green or yellow presence button once in the room in which the call was triggered.

Menu structure of the duty room terminal



5.3.18 Duty room terminal CT9 Plus

The duty room terminal CT9 (Order No. 5927 00, CT9+) is a display and operating terminal for the Gira nurse call system Plus. It can be used in the duty room parallel to a conventional duty room terminal or room module, is connected to the system bus of the call system and assigned to a duty room terminal or room module.

System conditions are visualised via the software user interface of the duty room terminal CT9. Calls can be displayed and logged and voice calls can be accepted and triggered.

Device description

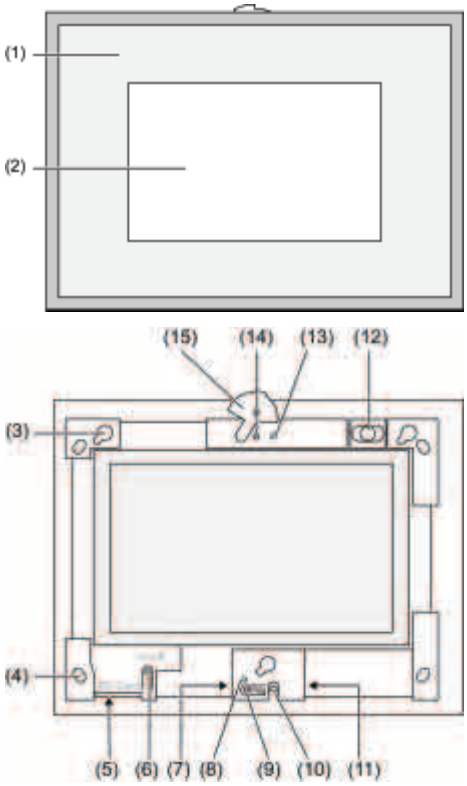


Figure 5: Design frame with touch surface (1) and front view without design frame with labels (2) to (15)

Operating and control elements on the front of the duty room terminal CT9:

(1) Design frame

(2) Touch user interface

(3) Mount for the design frame

(4) Holes for wall mounting

(5) Slot for SD memory card

(6) On/off button

(7) Programming interface (for future applications)

(8) LED Prog. (for future applications)

(9) Prog. button (for future applications)

(10) Internal microphone
(11) USB connection
(12) Internal loudspeaker
(13) Camera operation indication (not with duty room terminal CT9)
(14) Internal camera (not with duty room terminal CT9)
(15) Plate for internal camera (not with duty room terminal CT9)

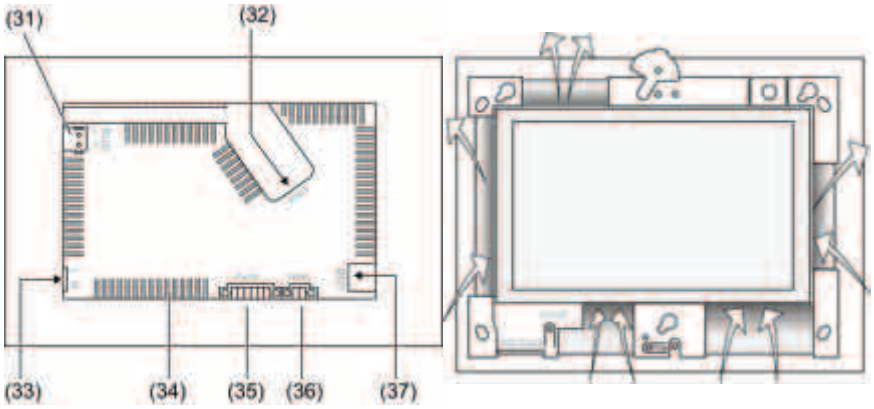


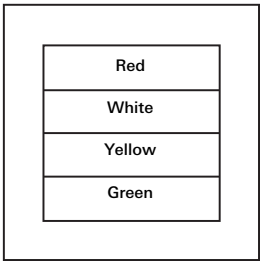
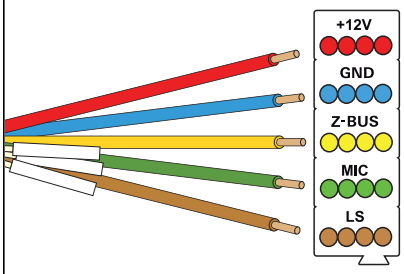
Figure 6: Connections on rear (left) and ventilation slots (right)

Rear connections of the duty room terminal CT9:
(31) Connection for future expansion (not with duty room terminal CT9)
(32) Ethernet connection
(33) Mains voltage connection
(34) Ventilation slots
(35) Connection for audio input and output (not with duty room terminal CT9)
(36) Connection for analogue video input (not with duty room terminal CT9)
(37) USB 2.0 connections

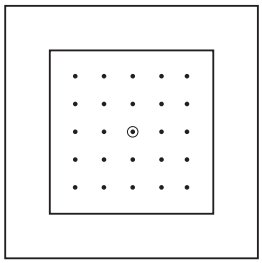
Note: observe the device operating instructions.

Please observe information on installation, start-up and functioning in the operating instructions for the duty room terminal CT9 enclosed with the device.

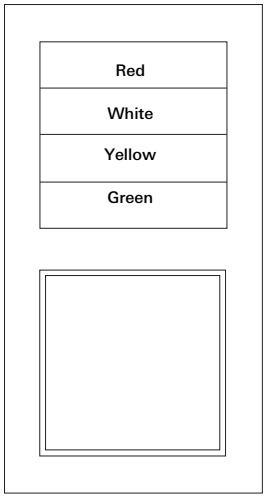
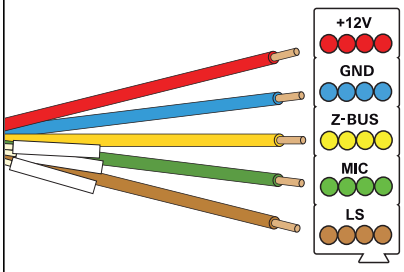
5.3.19 Red, white, yellow and green room signal light Plus

Order No. 5944 00 (ZS+), room signal light red, white, yellow, green		
Connection to:	Room bus	
Note:		
For further information:	Description of call forwarding: Page 83.	
Device view	**Connections on rear of device**	
		
	Display	
	Call display: Red light in the room signal light lights up continuously. **WC call display:** Red and white lights in the room signal light light up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	
	1. Display presence: Green light in the room signal light lights up continuously.	
	2. Display presence: Yellow light in the room signal light lights up.	
	Emergency call display: Red light in the room signal light flashes. **WC emergency call display:** Red and white lights in the room signal light flash. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	

5.3.20 Voice module Plus

Order No. 5990 .. (S+), voice module Plus	
Connection to:	Wire audio bus (via included flat ribbon cable) of call button with ancillary plug contact Plus (Order No.: 5901 ..), call and switch-off button with ancillary plug contact Plus (Order No.: 5903 ..), call button with ancillary plug contact and diagnostic pin jack Plus (Order No.: 5906 ..), switch-off button with voice module Plus (Order No.: 5918 ..), duty room terminal Plus (Order No.: 5925 ..), duty room terminal Plus (Order No.: 5929 ..).
Note:	Audio flat ribbon cable is included with the voice module.
For further information:	
Device view	**Connections on rear of device**
	

5.3.21 Red, white, yellow, green room signal light with name plate Plus.

Order No. 5948 00 (ZSN+), room signal light red, white, yellow, green with name plate		
Connection to:	Room bus	
Note:		
For further information:	Description of call forwarding: Page 83.	
Device view	**Connections on rear of device**	
		
	Display	
	Call display: Red light in the room signal light lights up continuously. **WC call display:** Red and white lights in the room signal light light up continuously. Buzzer signal for (normal) call in each room with marked presence (see table "Call types" on page 84).	
	1. Display presence: Green light in the room signal light lights up continuously.	
	2. Display presence: Yellow light in the room signal light lights up.	

For continuation of table see next page

Continuation of table

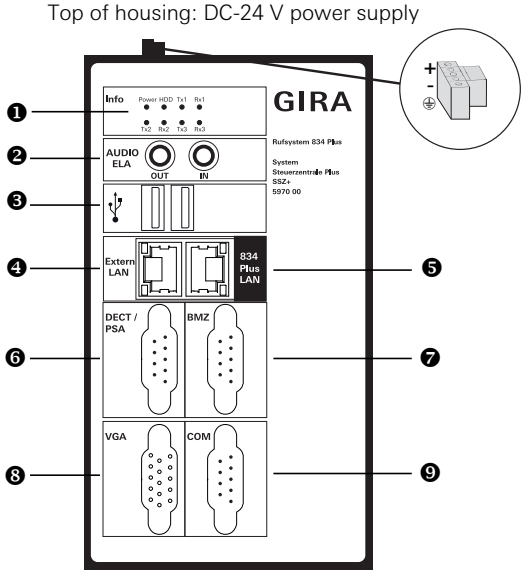
	Emergency call display: Red light in the room signal light flashes. **WC emergency call display:** Red and white lights in the room signal light flash. Buzzer signal for emergency call in each room with marked presence (see table "Call types" on page 84).	

5.3.22 System central control unit Plus

Order No. 5970 00 (SSZ+), system central control unit Plus	
Connection to:	System bus (nurse call system Plus LAN), ethernet
Connection option for:	VGA monitor, mouse and keyboard (COM/USB/PS2), audio/ELA system (jack Ø 2,5 mm), external LAN, nurse call system Plus LAN, DECT/PSA (RS 232), BMZ (RS 232).
Note:	The system central control unit is supplied pre-configured. The enabling of special software modules e.g.connection of pager/DECT/fire alarm systems can be separately purchased (software module DECT, Order No.: 5994 00; software module BMA, Order No.: 5993 00; software module ELA, Order No.: 5996 00).
For further information:	See the short instructions for the system central control unit enclosed with the device See "The system central control unit" on page 56.

Device view and connections:

Top of housing: DC-24 V power supply



Legend:

+24 V/⏚	DC power supply	❺ Nurse call system Plus LAN	RJ45
❶ LED's	Device condition	❻ DECT/PSA	RS 232
❷ Audio pin jacks	Audio In/Out	❼ BMZ	RS 232
❸ 2 x USB	f. service purposes	❽ VGA	Sub D 15-pole
❹ External LAN	RJ45	❾ COM	RS 232

For continuation of table see next page

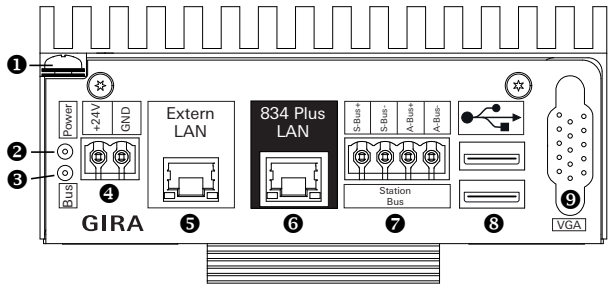
Continuation of table

Functions
The system central control unit Plus regulates and controls the complete nurse call system Plus. The device is connected to the ward control centres and CT9 duty rooms terminals (where applicable) via the system bus (nurse call system Plus LAN). All devices existing in the call system are automatically recognised. Devices can be integrated or removed from the call system at a later time. The system central control unit Plus is is ready for immediate use. Additional settings can be carried out via the configuration assistant in the device. • Central configuration during start-up of a system, e.g. assignment of plain names for rooms. • Establishment of organisational units, group ward(s), interconnect (combine) ward groups. • Cross-ward diagnosis functions. • Control of visual and acoustic call processing. • Monitoring of connected devices and cables. • Call and presence logging on various levels: ward, group, room

5.3.23 Ward control centre Plus

Order No. 5971 00 (SZ+), ward control centre Plus	
Connection to:	Ward bus and system bus (nurse call system Plus LAN).
Connection of:	VGA monitor, mouse and keyboard (COM/USB), external LAN, nurse call system Plus LAN.
Note:	The ward control centre is supplied pre-configured.
For further information:	See short instructions for the ward control centre. See "The ward control centre" on page 47.

Device view and connections:



Legend:

- ❶ Earthed connection
- ❷ Green LED — Power on
- ❸ Yellow LED — bus active
- ❹ +24 V/GND — DC power supply
- ❺ External LAN — RJ45
- ❻ Nurse call system Plus LAN — RJ45
- ❼ Ward bus
- ❽ 2 x USB
- ❾ VGA pin jack

For continuation of table see next page

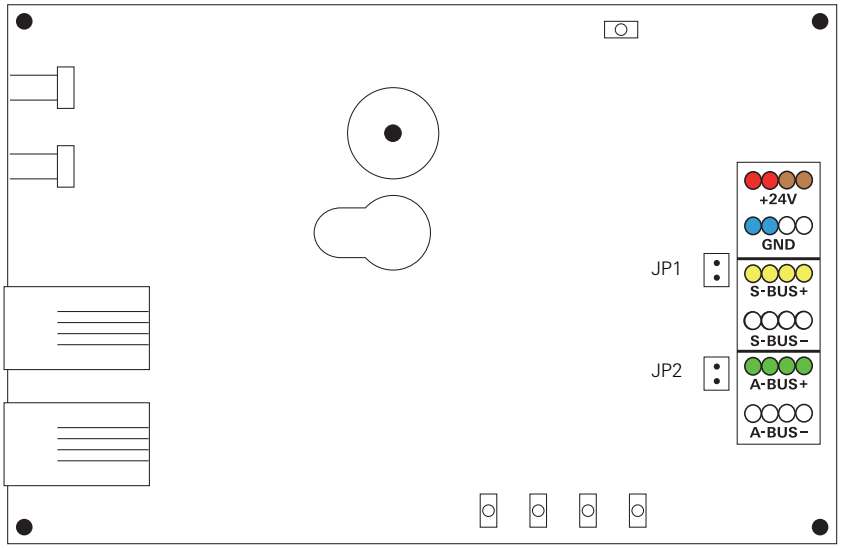
Continuation of table

Functions		
The ward control centre Plus of the Gira nurse call system Plus controls and regulates the devices connected to the ward bus, such as room terminals with and without voice module. The device may be connected to the system central control unit via the system bus (nurse call system Plus LAN, and "large system" setting in the configuration assistant). The Gira nurse call system Plus can also be controlled and regulated from only a single ward control centre Plus without a system central control unit ("small system" setting in the configuration assistant). All devices existing in the system are automatically recognised. Devices can be integrated or removed from the call system at a later time. The ward control centre Plus is immediately ready to use. Additional settings can be carried out via the configuration assistant in the device. • Central configuration during start-up of smaller systems with only one ward control centre, e.g. assignment of plain names for rooms. • Establishment of organisational units, group wards, interconnect (combine) ward groups. • Control of visual and acoustic call processing. • Monitoring of connected devices and cables. • Call and presence logging on various levels: ward, group, room		

5.3.24 Hallway displays

Order No. 5976 00 (FD+), hallway display one-sided Order No. 5977 00 (FDD+), hallway display two-sided	
Connection to:	Ward bus
Connection of:	
Note:	Control is according to configuration in the configuration assistant of the system central control unit (large system) or the ward control centre (small system).
For further information:	See "Connection of hallway displays to the power supply and ward bus" on page 54.

Device view and connections:



Legend:

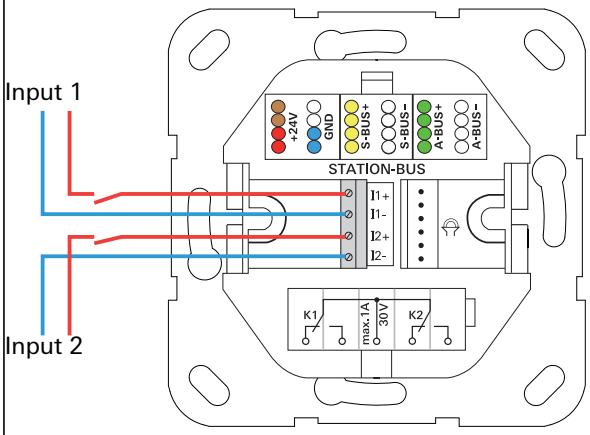
+24 V	Power supply (red/brown)	A bus -	Audio cable (white)
GND	Earth (blue/white)	JP1	Terminating resistance Data line
S bus +	Data line (yellow)	JP2	Terminating resistance Audio cable
S bus -	Data line (white)		
A bus +	Audio cable (green)		

Functions		
Hallway displays show call information in plain text. Call display and time display are according to configuration in the configuration assistant.		

5.3.25 I/O module flush-mounted Plus (2/2)

Order No. 5978 00 (IOUP+), I/O module flush-mounted ward bus Plus, 2 inputs/2 outputs	
Connection to:	Ward bus
Connection of:	Systems from other manufacturers and technical alarm messages (e.g. lift alarms etc.) and external devices (e.g. lamps, other/older light call systems etc.).
Note:	Control is according to configuration in the configuration assistant of the system central control unit (large system) or the ward control centre (small system).
For further information:	See "Connection of I/O module flush-mounted Plus (2/2)" on page 54.

Device view and connections:



Functions		

The I/O module flush-mounted ward bus has 2 inputs and 2 outputs.

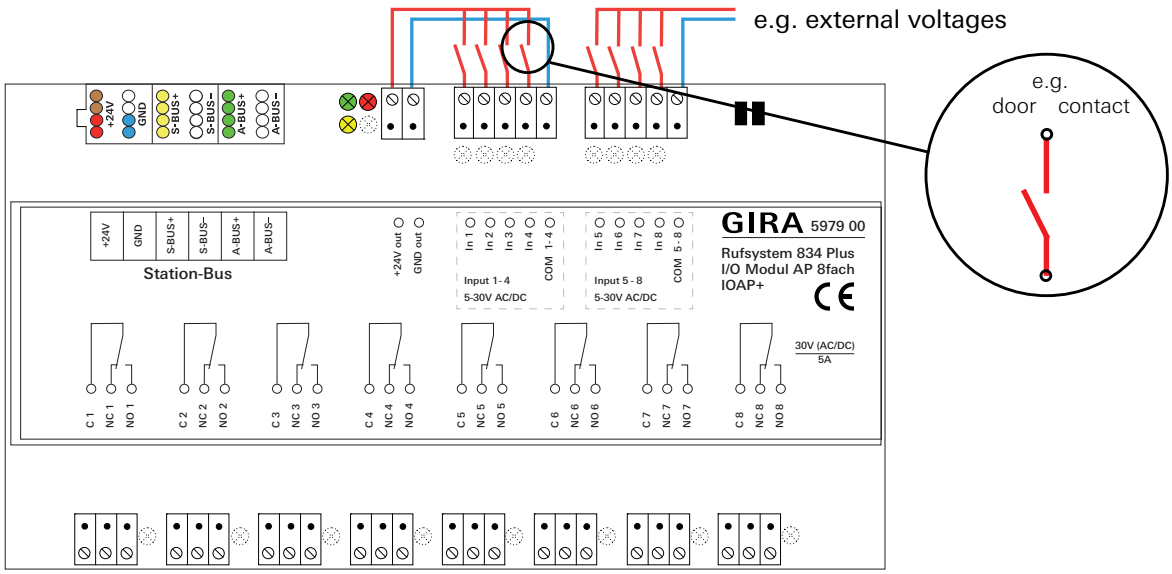
The inputs are for connection of systems from other manufacturers and technical alarm messages (e.g. fire alarm systems, lift alarms, emergency lighting, other/older light call systems, door bell etc.).

The outputs are used to switch external devices such as lamps, other/older light call systems, door magnets, horns etc.

5.3.26 I/O module surface-mounted Plus (8/8)

Order No. 5979 00 (IOAP+), I/O module surface-mounted ward bus Plus (DRA), 8 inputs/8 outputs	
Connection to:	Ward bus
Connection of:	Systems from other manufacturers and technical alarm messages (e.g. lift alarms etc.) and external devices (e.g. lamps, other/older light call systems etc.).
Note:	Series installation device (DRA), 8 HP. Control is according to configuration in the configuration assistant of the system central control unit (large system) or the ward control centre (small system).
For further information:	See "Connection of I/O module surface-mounted Plus (8/8) to the ward bus" on page 55.

Device view and connections:



Functions		

The I/O module surface-mounted ward bus has 8 inputs and 8 outputs.

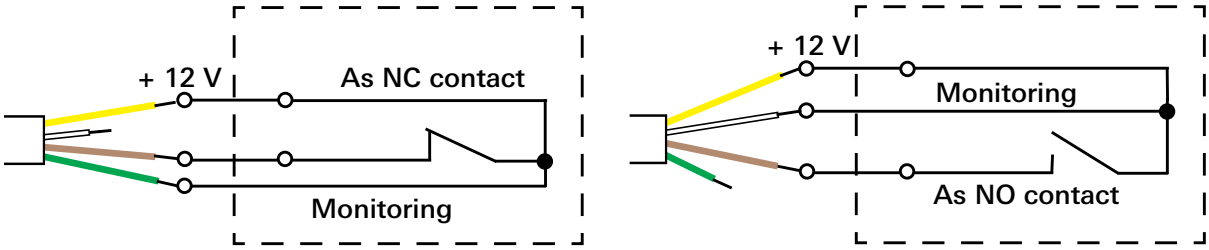
The inputs are for connection of systems from other manufacturers and technical alarm messages (e.g. fire alarm systems, lift alarms, emergency lighting, other/older light call systems, door bell etc.).

The outputs are used to switch external devices such as lamps, other/older light call systems, door magnets, horns etc.

5.3.27 Diagnostic connection cable, Order No. 2961 00 (abbreviation: DAK)

Cable for connection of the zero-voltage contact of a medical device with the call button with ancillary plug contact and diagnostic pin jack (nurse call system Plus), Article No.: 5906 .., or call button with 2 diagnostic pin jacks (nurse call system Plus), Article No.: 5907 ...

In the nurse call system Plus the zero-voltage contact of a device from other manufacturers can operate both as NC contact and NO contact. We recommend the "NC contact" wiring configuration.



First connect the open end as shown, then insert the RJ11 plug of the connection cable into the diagnostic socket of the call button (5906.. or 5907..).

The call button with ancillary plug contact and diagnostic pin jack, Article No.: 5906 .. and the call button with 2 diagnostic pin jacks, Article No.: 5907 ..feature plug monitoring that triggers a call with missing plug contact.

5.3.28 Ethernet switch, Order No.: 5985 00

Please observe the separate installation and operating instructions included with the device!

5.3.29 Power rectifier 24 V, 6 A, for top-hat rails, Order No. 5981 00 (Abbreviation: NG+)

Please observe the separate installation and operating instructions included with the device!

5.3.30 Power rectifier 24 V, 6 A, for wall installation, Order No. 5998 00 (Abbreviation: NG+)

Please observe the separate installation and operating instructions included with the device!

5.3.31 Power rectifier 24 V, 6 A with UPS, Order No. 5999 00 (abbreviation: NGU+)

Please observe the separate installation and operating instructions included with the device!

5.3.32 Batteries 12 V, 12 Ah, Order No. 5991 00

Please observe the separate installation and operating instructions included with the device with Order No.: 5999 00!

5.3.33 Radio set, Order No. 2968 00 (abbreviation: FS)

Please observe the separate installation and operating instructions included with the device!

5.3.34 Impulse relay, Order No. 2964 00 (abbreviation: ST1)

Please observe the separate installation and operating instructions included with the device!

5.3.35 Impulse relay, Order No. 2965 00 (abbreviation: ST2)

Please observe the separate installation and operating instructions included with the device!

5.3.36 Battery replacement set, Order No. 2989 00 (abbreviation: BWS)

Please observe the separate installation and operating instructions included with the device!

5.3.37 Replacement terminals for devices in the room and ward bus, 5-gang terminal, Order No.: 5955 00, 6-gang terminal, Order No.: 5956 00

5-gang terminal for room bus, 6-gang terminal for ward bus, both with colour coding.

6. Questions and answers

Questions and answers for the nurse call system Plus.

Question:	Answer:
Which cable material can be used?	At room level J-Y(St)-Y 4x2x0.6 mm should be used. At ward level J-Y(St)-Y 4x2x0.8 mm must be used. At system level network cable of at least CAT5 is used.
How many devices can be connected to the room bus?	A maximum of 16 room devices such as call and switch-off buttons, call buttons with ancillary plug contact, pull-cord buttons, room signal lights etc. Duty/room terminals and room modules are not included here.
How many devices can be connected to the ward bus?	A maximum of 52 devices can be connected to the ward bus. The energy point table shows how many devices can be supplied with voltage from one power supply unit.
How many devices can be connected to the system bus?	A system central control unit can manage up to 26 ward control centres. The use of duty room terminals CT9 and switches does not affect this quantity.
What is the maximum cable length for a room bus?	40 metres.
What is the maximum cable length for the ward bus?	1000 metres.
What is the maximum cable length for the system bus (**L**ocal **A**rea **N**etwork).?	The maximum cable length depends on the cable material used (IEEE standard 802.3x). For example, with use of Cat.5 copper network cable, maximum cable length per segment is 100 metres. The cable length can be expanded by using repeaters.

Question:	Answer:
Are specific devices needed for voice communication?	At the room level, call buttons with ancillary plug contact (Order No.:) or call buttons with ancillary plug contact (Order No.:) and diagnostic pin jack or call and switch-off buttons with ancillary plug contact (Order No.:) are required. In WC areas, a switch-off button with voice module (Order No.:) should be installed. A duty-/room terminal with voice module serves as interface from room bus to ward bus.
Does the room bus have to be closed with a terminating resistance?	No.
Does the ward bus have to be closed with a terminating resistance?	Yes, with the last device on the ward bus both the data line and audio bus have to be equipped with a terminating resistance (jumper included in scope of supply of ward control centre). The ward control centre is the first device on the ward bus.
What does the energy point table display?	The energy point table aids with the calculation of the number of ward bus participants that can be supplied with voltage from **one** power supply unit.
How many power supply units are required for a large system?	A maximum of 55 energy points per power supply unit must not be exceeded. See the energy point table.
The display shows the message: ***Bus Error.*** What does that mean?	The device has no connection to the ward control centre. The ward control centre has possibly failed. The system cannot show plain text names. or The device/system is in emergency function and a room device has failed. The room signal light shows a continuous red light.

Question:	Answer:
The display shows the message: ***Failure SSZ.*** What does that mean?	The system central control unit or the connection to this has failed. The system is in emergency function. The system cannot show plain text names.
The display shows the message: ***Service.*** What does that mean?	An error has occurred in the system but the system is still ready for operation. If a defective device is replaced, this error message is displayed until device replacement has been acknowledged in the configuration assistant.
What does emergency function mean?	Basic functioning of the devices is ensured. Calls/emergency calls can be signalled and displayed.
The LEDs in the push buttons of the room devices flash - what does that mean?	The bus line has been interrupted. A room device is possibly defective. Or: The system is in configuration phase. When all devices are logged on in the next instance up, the flashing stops.
A device is defective in the system. What must be done?	Devices of the same type (same ID) can be exchanged without problems (plug & play). After exchanging, the ***Service*** message appears in the system and remains until the replacement has been confirmed.
With the patient hand-held device (PHD), the red LED in the call button flashes rapidly after the device has been connected to the ancillary plug contact. What does that mean?	The patient hand-held device (PHD) requires a function test. For this, the red button of the device must be pressed within 30 seconds. If this does not happen, the device is ready for operation, but the error message ***PHD-Test*** is output.

Question:	Answer:
An acoustic double signal can be heard in the patient's room, the room signal light shows a continuous red light, the display of the room terminal shows the message: ***Removal***. What does that mean?	This acoustic signal signals a 'plug removal'. Either the plug of the patient hand-held device or the plug of the diagnostic connection cable has been removed from the socket. A plug removal is also signalled in the display of the room terminal with the ***Removal*** message. This plug removal call can be deactivated by pressing and holding (longer than 3 secs.) the presence button of the room module or room terminal in the room in which plug removal has occurred.
With configuration of the system central control unit or ward control centre with a configuration PC with WINDOWS® operating system the following situation occurs: After concluding the configuration of a system central control unit or ward control centre, the configuration computer is connected to another ward control centre or system central control unit (with identical IP address to the configuration PC). When calling the start screen of the configuration assistant, the browser outputs an error message that the device has not been found. The assistant can only be used after several minutes or a restart of the configuration PC. Why is that?	All system central control units and ward control centres in delivery state have the same IP address for the external LAN. If several system central control units or ward control centres are configured sequentially with the same configuration PC with the WINDOWS® operating system, following configuration of the first unit the next one is not recognised or only recognised after some time. This is because the next unit to be configured has the same IP address but each device has a different MAC address. WINDOWS® has internally saved the connection of the IP address with the MAC address, and thus at first sends erroneous packages in the network. Changes are not immediately recognised by Windows. Remedy: open the command window in WINDOWS® and use the command: **arp -d** to temporarily clean the WINDOWS® memory for network access. Then the device is located immediately and can be accessed.

7. Technical data

Installation of devices in 1/2-gang flush-mounted boxes (DIN 49073) or in flush-mounted housing.

System bus

Cable type	=	Ethernet cable of at least category 5 or higher

Ward bus

Cable type	=	Twisted communication line, cable material 4x2x0.8 mm (2 wire pairs for +24 V and GND for doubling of cross-section)
max. cable length of power supply	=	300 m
max. cable length of bus line	=	1000 m
max. number of bus participants	=	26 (see also the energy point table in the Planning chapter)
Type of cable routing	=	from device to device (**not** star-shaped)
terminating resistance required at last device on the bus	=	activate terminating resistances with jumpers (included with the ward control centre)

Room bus

Cable type	=	Twisted communication line, cable material 4x2x0.6 mm
max. cable length	=	40 m
max. number of devices in the room	=	16 (duty-/room terminals and room modules not included)
Type of cable routing	=	from device to device or star-shaped

Power supply

Direct current 24 V (± 10%)

Power rectifier with UPS (Order No.: 5999 00)

Input (primary voltage)

Rated voltage:	115 V (-15 %) to 230 V (+15 %)
Mains frequency:	45 to 65 Hz

Output (secondary voltage)

Output voltage in mains operation:	27,2 V (+/- 0.5 %)
Output voltage in battery operation:	24 V (+/- 0.5 %)
Rated output current:	6 A
Charging current limitation:	Yes
Output power:	150 W
Battery capacity:	2 x 12 Ah

Battery voltage thresholds

Switching threshold for advance warning prior to battery shut-down:	1,85 V/cell
Switching threshold for complete drainage protection:	1,8 V/cell
Protection class:	I
Protection level:	IP 30
Fuse on the primary side:	T 2.0 A

Fuse on the secondary side:	T 6,3 A
Ambient temperature at 100% load:	-5° C to +40° C
Dimensions (L x W x D):	approx. 320 x 240 x 120 mm
Weight:	approx. 10 kg, incl. batteries

Power rectifier
(Order Nos.: 5981 00 and 5998 00)

Input (primary voltage)

Rated voltage:	230 V (+/- 15 %)
Mains frequency:	45 to 65 Hz

Output (secondary voltage)

Output voltage in mains operation:	27,2 V (+/- 0.5 %)
Rated output current:	6 A
Output power:	150 W
Protection class:	I
Protection level:	IP 30
Fuse on the primary side:	T 2.0 A
Fuse on the secondary side:	T 6,3 A
Ambient temperature at 100% load:	-5° C to +40° C
Dimensions (L x W x H)	
Wall installation 5998 00:	245 x 194 x 85 mm
DIN rail 5981 00:	170 x 125 x 65 mm
Weight:	
Wall installation 5998 00:	1.85 kg
DIN rail 5981 00:	1.25 kg

Ward control centre

Operating voltage:	24 V DC
Current consumption:	300 mA
Ambient temperature:	-5 °C to +50 °C
Storage temperature:	-25 °C to +75 °C
Humidity:	max. 90%
Protection type:	IP 20
Connection terminals:	Ø to 2.5 mm^2
Mounting:	intended for DIN top-hat rail

System central control unit

Operating voltage:	24 V DC
Current consumption:	400 mA
Power consumption:	approx. 9.6 W
Ambient temperature:	-5 °C to +50 °C
Humidity:	max. 90%
Protection type:	IP 20
Connection terminals:	Ø to 2.5 mm^2
Mounting:	possible on DIN top-hat rail

7.1 Energy point table

With the help of the energy point table, the maximum number of devices that can be supplied from one power supply unit is calculated. The basis for this calculation are the energy points. The energy points are measured so that the factor of simultaneity is taken into account with system operation. The room devices are already included in the energy points of the duty room/room terminals. Only the devices directly connected to a power supply unit are considered in the table.

Supplier	Art. No.:	Points
Power rectifier 24 V/6 A	5981 00	55
Power rectifier 24 V/6 A, surface-mounted	5998 00	55
Power rectifier 24 V/6 A, surface-mounted with UPS	5999 00	55

Devices	Abbreviation	Points
Duty room terminal	DZT+	2
Room terminal	ZT+	2
Room module	ZM+	1
Hallway display, one-sided	FD+	2
Hallway display two-sided	FDD+	3
I/O module ward bus surface-mounted Plus (8/8)	IOAP+	1
I/O module ward bus flush-mounted Plus (2/2)	IOUP+	1
Ethernet switch	SW+	1
Ward control centre Plus	SZ+	4
System central control unit Plus	SSZ+	6

8. Warranty

The warranty is provided in accordance with statutory requirements via the specialist trade.

Please submit or send faulty devices postage paid together with an error description to your responsible salesperson (specialist trade/installation company/electrical specialist trade).

They will forward the devices to the Gira Service Center.

Notes:

9. Basics of network technology

What is a network, how is it designed and which components are used? This chapter answers these fundamental issues.

Specifically, you find out

– what a network is

– why so-called layer models are needed

– in which structures networks can be set up (topology)

– which cable material is used and when

– which connection elements are needed

– which network components occur in a network

– what access procedures are

– which transmission methods and transmission protocols are used and

– what are the most important command line tools for network analysis.

9.1 What is a network?

Networks are connection systems that several devices are connected to for data communication purposes. Not only computers are interconnected but also other devices such as printers, monitors, mass storage devices, control devices, controls, telecopiers etc.

According to size and extension, local area networks (LAN) or wide area networks (WAN) are differentiated between. The connection of several LAN areas is via coupling elements such as hubs, switches, bridges, routers etc. The individual networks of a LAN can be interconnected via routers or gateways and may also use public communication networks.

The internet shows that the extent of a network can range from just a few to hundreds, thousands or even millions of computers. Here, the following fundamental differences apply:

– **LAN** (Local Area Network): A local network for small, spatially limited use (e.g. in agencies, offices, doctors' practices, trade enterprises etc.), in which private data lines are used. It is used for the bit-by-bit transmission between interconnected, independent devices, is completely within the legislative spectrum of the user and is limited to the user's location.

  The LAN usually uses a fileserver concept for data, hard disk and periphery management. It may have various topologies (bus, ring, star, tree) and cabling systems at its disposal.

  Transmission speeds are between 1 and 100 Mbit/s.

  LAN components have the task of integrating departments and levels economically into a complete network. Interfaces and junctions to other networks are also made available.

– **WAN** (Wide Area Network): Also known as a "long range communication network", is not geographically limited, may connect any number of users in various cities, countries and even continents via public data lines.

– **GAN** (Global Area Network): world-wide network (internet) in which millions of computers communicate with each other.

Figure 9.1: Exemplary view of LAN, WAN and GAN

Example:

On the internet an online seminar for the Gira nurse call system Plus is offered. All those participating access as GAN clients (internet) the local company network (LAN) of GIRA as the seminar provider, as here the data required is made available.

9.2 What is a layer model?

If you read the diverse literature about network technology then you often come across information such as "data transmission is implemented according to layer 1 of the OSI model." Such information refers to the so-called "layer model". But what is meant by this and why are layer models needed?

Each process used for data transmission can be divided into three sections:

– Transmission path

– Protocol

– Application

Here the transmission path means the medium used for transmitting the data, for example cables, wires or radio. The protocol defines the use of the transmission path between several stations. The application describes the reason why data transmission takes place. It therefore makes data available and receives these as well.

As long as the transmission path, protocol and application are made available by a single supplier, this concerns a closed system in which everything is sensibly matched. This proprietary system functions, and no users are interested in the technology behind it all.

But if an open system is used, then transmission path, protocol and application must be standardised, specified and disclosed. In this way, each supplier can pick an area and develop a technology that must then be able to stand it's ground as a product and must be replaceable at all times. Products of various suppliers can in this way be combined and also replaced or expanded at any time.

In order to match up the technologies or products of various suppliers, so-called layer models have been developed in which complex processes have been split into individual sub-processes. Each sub-process is shown as a layer, and the layers are stacked one above the other. Each layer contains interfaces to adjacent layers that are intended to ensure successful communication.

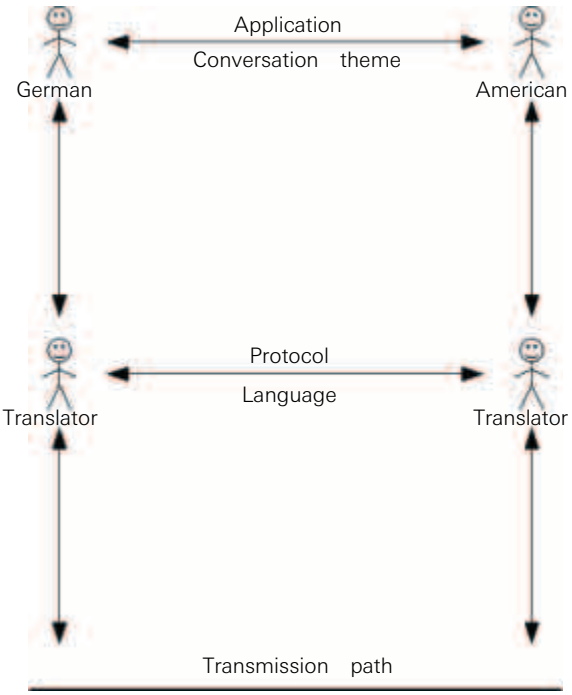


Figure 9.2: Example of a simple layer model

A simple example for a layer model is the communication between two persons that speak different languages (see Figure 9.2). In this example a German meets an American. Both do not speak the other person's language and therefore use the services of a translator. In this case then, the application corresponds to the conversation. Both translators represent the protocol by agreeing to a common language. A technical system may serve as the transmission path, e.g. telephone, fax, e-mail etc. Of course all four people can communicate with each other directly. If the translator on both sides was the same person, then this would be a proprietary system and the translator would represent the transmission path.

9.2.1 ISO/OSI-7 layer model

The ISO (International Standard Organisation) has created the OSI model, a 7-layer model, for open networks (OSI = Open Systems Interconnection). The model currently serves in general as a framework for describing protocol characteristics and protocol functions.

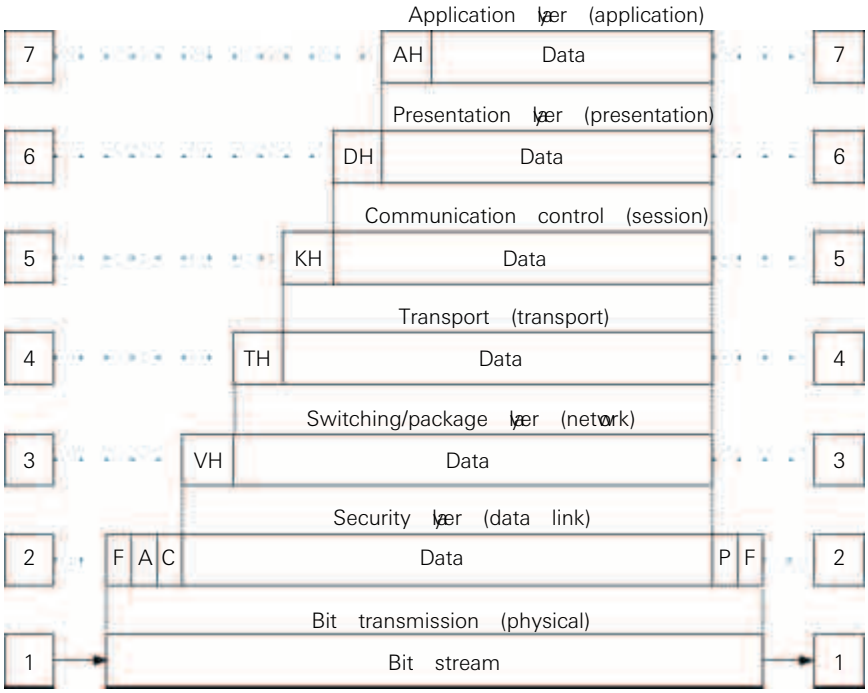


Figure 9.3: Graphic display of the OSI layer model

The design of layers with the OSI model is based on the principle that a layer offers specific services to the layer directly above it. The model is not a network architecture and merely describes which tasks the layers should adopt.

As such the OSI model supplies:

– A basis for the interpretation of existing systems and protocols in the layer perspective (important for changes).

– A reference for the development of new communication processes and for defining new protocols, i.e. a basis for compatible protocols.

Essential features of the hierarchic layer structure with computer networks are:

– The complete system is divided into an ordered quantity of subsystems.

– Subsystems of the same level represent a layer.

– The individual layers lie one above the other according to their order of rank.

– A hierarchically lower layer fulfils communication functions of the layer directly above it.

– Each layer makes available specific services. These services take on specific communication and control tasks.

In this way the individual layers make defined interfaces available to their neighbours (layer 4 for example has interfaces to layers 3 and 5). Communication only takes place via these interfaces (vertically in Figure 9.3).

The purely logical communication between the participating stations A and B however is implemented on the basis of the same layers (in the diagram horizontally, designated with "....."). Only layer 1 has a physical connection.

Tasks of the specific layers:

– Layers 1 - 4 are assigned for transport functions.

– Layers 5 - 7 are assigned for user functions.

In Figure 9.3 the corresponding data block for the layer is also shown. Each layer can (but does not have to) provide the data with an own header (or data frame) that serves for communication control on this layer. In the diagram these headers are designated e.g. with AH = header of the application layer (layer 7) or VH = header of the switching/package layer (layer 3). The data block of a layer (with frame) contains "pure application data". As such, this layer cannot change the header of the higher-level layer.

Short description of the specific layers:

– **Application layer**: Ensures connection to the user program and the dialogue with the programs.

– **Presentation layer**: Interprets the data for the application. Also takes on monitoring of information exchange, coding/decoding (e.g. EBCDIC to ASCII) of the data and definition of formats and control characters.

– **Communication control, or also session layer**: Controls the establishment, implementation and termination of connections. Here operating parameters are monitored, data streams controlled (if necessary with buffering of data), and connections re-established and synchronised in case of defects.

– **Transport layer**: Takes on the function of transport, and ensures that all data packages reach the correct recipient. Establishment of data connection between two partners, data transport, flow control, error recognition and error correction.

– **Switching/package layer** (network layer): Serves mainly for transmission of data packages and is also responsible for selection of data paths (routing), for multiplexing of several connections via single sections and for error handling and flow control between the end points of a connection (not between the user processes).

– **Security layer** (data link layer): Makes available a functional connection between two directly adjacent stations. It supplies a defined framework for data transport, error recognition and data synchronisation. Typical protocols: BSC, HDLC, TCP etc. The information is subdivided into blocks of suitable length that are designated as frames and that have testing information for error recognition and error correction.

– **Bit transmission layer** (physical layer): Implements physical transmission of the data. Sets the electrical, mechanical, functional and procedural parameters for physical connection of two units (e.g. levels, modulation, cables, wires, plugs, transmission rate etc.).

9.2.2 TCP/IP reference model

The TCP/IP reference model is named after the two primary protocols TCP (Transmission Control Protocol) and IP (Internet Protocol). The model is based on suggestions that were considered as part of the continued development of the ARPANET (Advanced Research Projects Agency Network), the precursor of the internet. The TCP/IP model was established before the OSI model.

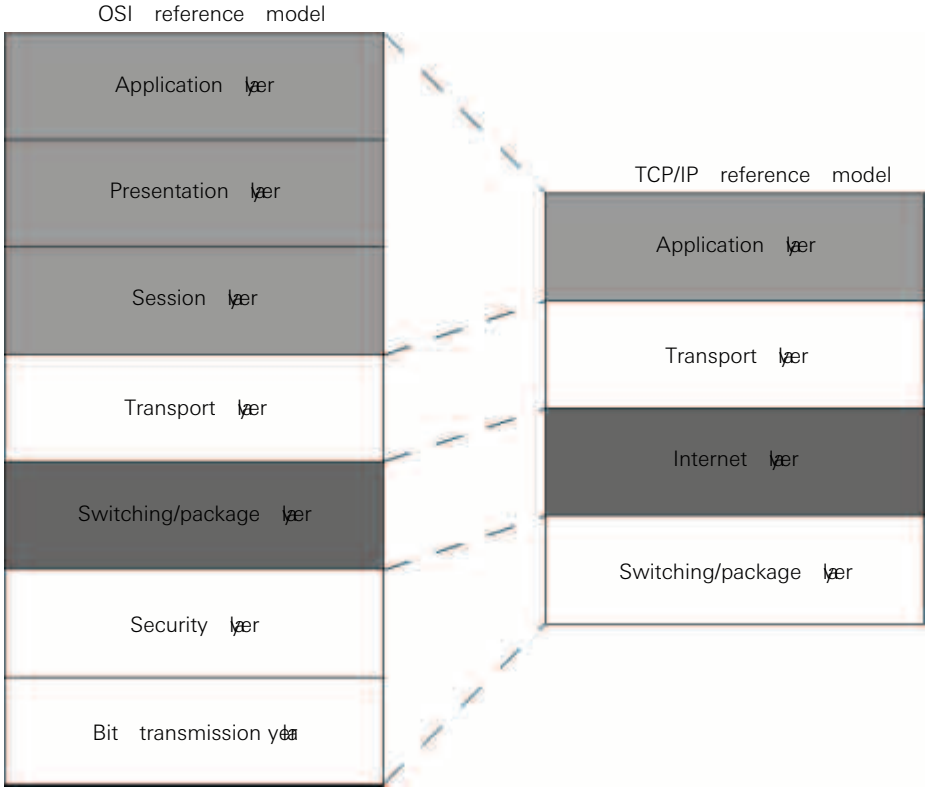


Figure 9.4: Block scheme of the TCP/IP reference model compared to the OSI model

The following aims for architecture were defined with development of the TCP/IP reference model:

– Independence from implemented network technology.

– Independence from the host computer architecture.

– Universal connection options in the complete network.

– End to end acknowledgement.

– Standardised application protocols.

As can be seen from Figure 9.4, the application layer of the TCP/IP model assumes the tasks of the application, presentation and session layers of the OSI model. The transport layer tasks stay the same, the internet layer corresponds to the switching/package layer of the OSI model. The switching/package layer of the TCP/IP model assumes the tasks of the security and bit transmission layers of the OSI model.

9.3 Network topology

The fundamental method of how individual computers and other components in a network (network stations) are interconnected and how they exchange their data is described as network topology or network architecture. The topology has a major influence on which components (e.g. wire/cable types) are needed by a network, how the cabling is routed, how the computers communicate with each other, which expansion options a network has and much more.

With the cabling of LANs, a differentiation between the logical structure and cabling structure must be made. For example a network with a logical bus structure, in terms of cabling with "twisted pair" cables, may be a star network.

All network designs can be reduced to three basic forms of network topology:

– Bus network (ethernet)

– Star network (implemented as a logical bus in the ethernet)

– Ring network (token ring)

All topologies specified here refer to package-conveying networks.

9.3.1 The bus network (ethernet)

When the stations (e.g. computers) of a network are arranged consecutively along a cable line and all stations access this line or bus, then this is called a bus network. With new installations the bus network is no longer implemented, as it only allows transmission rates of 10 Mbps.

Figure 9.5: The bus topology

An access process is responsible for the processes on the bus, and all stations comply with the rules of this. The intelligence itself is contained in the stations. All stations connected to the bus have access to the transmission medium and to the data transmitted via this.

The address of the recipient, the sender and error handling is attached to a data package. The stations not addressed as recipients ignore the data. The addressed stations read the data and send a confirmation to the sender.

If two stations send simultaneously, an electrical interference signal occurs on the bus. The transfer is then interrupted. After a certain time the stations then try to send data again. The process is repeated again and again until a station succeeds in sending data.

Because only one station can send and receive data at any one time, network performance is highly dependent on the number of connected work stations. The more computers in the network, the more frequent waiting periods occur and the slower the network.

The bus network is a passive topology, meaning the computers do not actively execute data transport but only wait for data to be sent over the network. An interruption of the data line at any position results in the complete network no longer functioning.

To prevent that sent data at the end of the data line are reflected, which would result in disrupting the sending of further data, a so-called terminator or terminating resistance is at the end of the cable, that in its size corresponds to the line impedance.

A bus network does not need much cable material, and this means a reduction of installation effort and costs. An expansion of the network with further work stations is possible at any time.

The cable lengths in a bus segment are fundamentally limited. For example, cabling with the standard Thinnet coaxial cables has a maximum segment length of 185 m, and has 500 m with the much thicker but less flexible Thicknet (yellow cable).

9.3.2 The star network

The principle of star topology is a relatively complex form of cabling. The individual work stations are arranged in a star shape around the server or around the central distributor (hub, switch etc.). As each computer here has a separate data line, large quantities of cable are needed.

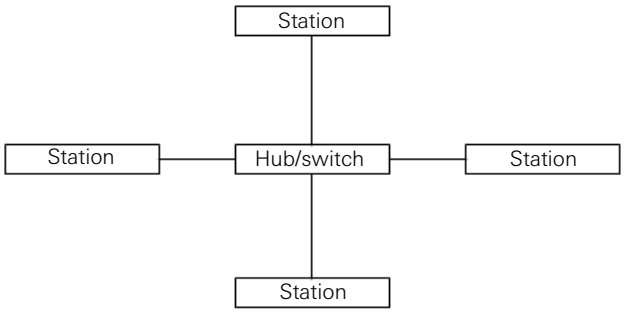


Figure 9.6: The star topology

The greater installation effort also has benefits though: when the data line is interrupted at any place in the star network, this does automatically cause failure of the complete system. The network can easily be expanded with the connection of new work stations without impairing its functionality. With longer transmission paths, active distributors (e.g. switches) or repeaters (if hubs are used) should be built in at the branchings to prevent a weakening of the signals.

9.3.3 The ring network (token ring)

With ring topology, the data line that interconnects the stations forms a closed circle. There is no cable start and cable end. Each station has a specified predecessor and successor; data traffic therefore always occurs only in one direction. A well-known example is the "Token Ring" network from IBM.

To forward data from one station to the next, these must be taken up by the individual work stations, processed and then sent again. This in turn complies to the principle of signal amplification and leads to greater transmission and data security. For this reason the expansion of such a network may be very large, as almost no signal loss occurs. Expansion of the ring network is also possible without significant effort, as only one further station has to be "coupled in" between two work stations.

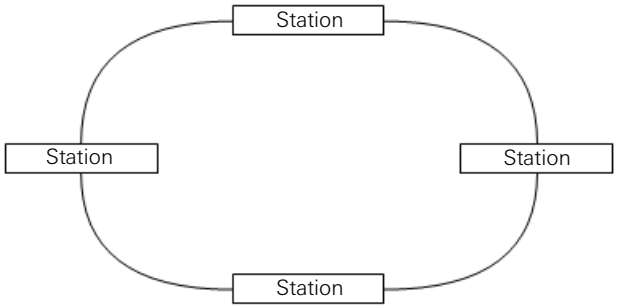


Figure 9.7: The ring topology

The ring topology also has disadvantages: as soon as any station fails or the data line is interrupted at any location, the whole system no longer functions. To face this danger of complete system failure, with some networks a type of "double ring structure" is implemented. Here a secondary ring (backup ring) serves as a reserve for failure of the primary ring.

9.3.4 Meshed structures

In addition to the basic network topology forms there are of course hybrid forms or variants. Particularly with larger company networks, often a combination of bus, star and ring topologies are used.

Usually, each device is connected with several others. There is no central unit and several independent transmission paths exist between two stations. Sometimes there is no direct connection between two stations. In this case, the path routes over one or several other stations.

According to needs, the topologies described above can be combined with each other, e.g. bus with connected stars or bus with connected buses, which leads to a tree structure. Meshed structures occur especially with wide area networks (WAN). Here redundant cable paths sometimes occur that ensure data transport even with interruption of paths. The structure of the decentral network thus corresponds to a "chaos" of various systems and transmission paths. The internet is an example of an intended "chaotic" network.

9.3.5 Advantages and disadvantages of the basic topologies

The following table gives a brief overview of the benefits and disadvantages of the basic topologies specified above.

Topology	Advantages	Disadvantages
Bus topology	– simple to install – simple to expand – short lines – low cable quantity – no network malfunctions if a station fails	– limited network expansion – network failure with line interruption – deterioration of network performance with many users – complex access methods
Star topology	– simple to network – simple to expand – high failure safety	– high cabling and installation effort – network failure if distributor fails or is overloaded
Ring topology	– simple to expand – distributed control – wide network expansion	– high cabling and installation effort – complex error search – network failure with malfunctions
Meshed topology	– decentral control – high failure safety – infinite network expansion	– expensive, high quality network – complex management

9.4 Cables

What are the most commonly used line or cable types when installing an ethernet-based network? How are they set up, and which functions and performance features do they have?

Even when the terms line and cable are differentiated between by professionals, network technology often merely refers to cable or cabling. This is why the following generally uses the term cable.

Knowledge about cables is one of the most important basics of network technology. Suitable cable routing and correct testing of cabling facilitates error searching in any network.

9.4.1 Transmission speeds

Many cable designations provide information on possible data transmission speed.

When specifying transmission speed, values are given in **bits** and not in **bytes** per second. A uniform notation of **bps** (bits per second) is used, e.g. Mbps for megabits per second. Other common abbreviations are Mbit/s or MBit/sec.

9.4.2 Transfer types

Data transfer always occurs via a so-called medium. Compared with goods traffic, this medium is akin to a road, an aviation or water path, i.e. methods of transporting goods.

With data traffic, various media are also used for transmission: cables or also air. in this case people speak of line-bound or air-bound transmission.

– **Line-bound transmission:** A line (e.g. a cable) is used for transmitting signals. Electronic signals (via metallic lines, wires) or light signals (via glass, quartz or plastic fibres) are differentiated between. Each cable consists of at least one conducting wire or fibre. With metallic lines, several wires are separated by corresponding isolation layers. All wires or fibres are surrounded by protective sheathing.
– **Air-bound transmission:** Electromagnetic waves of various frequencies (e.g. light or radio) are transmitted through the air. Other media such as steel, brickwork, wood etc. exert an influence on the information transmission and may impede or deflect this or disrupt it in another way.

To keep negative effects on data transmission with the Gira nurse call system Plus as low as possible, line-bound transmission is recommended, and air-bound transmission is thus not considered below. In addition, DIN VDE 0834 specifies wire-bound cabling for call systems, which is why networking e.g. via wireless LAN is not permissible.

9.4.3 Transmission properties

As well as expected costs, the transmission properties should be mainly taken into account before deciding upon a specific medium. This primarily includes the attenuation (ATT) and interference sensibility.

If a short conductor piece is considered, this can be represented by a so-called equivalent circuit diagram.

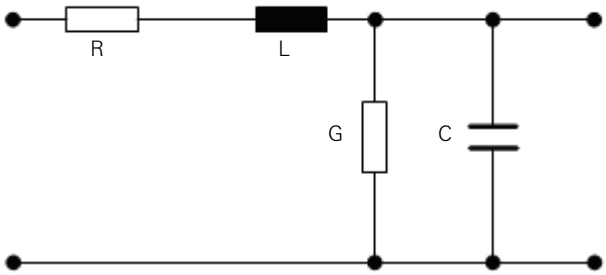


Figure 9.8: Equivalent circuit diagram for a short conductor length

Considered electrically, the properties of this short length of conductor are defined by its DC resistance R, its line inductance L and its parallel capacitance C. A cable consists of several of these equivalent circuit diagrams switched consecutively. The longer the cable and the higher the frequency with which data is transmitted via the cable, the greater the line inductance and therefore also the attenuation. The same applies for the capacity: each cable thus represents a lowpass filter, meaning the signal is consistently weakened with higher frequencies.

A further important attribute that affects the transmission properties of a cable is the surge impedance. The surge impedance is the resistance that a cable bears with the expansion of an electromagnetic wave. It is the parameter of a cable that specifies with which ohmic resistance a line must be closed to enable matching (no reflections).

With ethernet, surge impedance is set at 50 ohms. Limit frequency is reached when the output voltage has achieved 70% of the input voltage. The digital signals routed to the network cable represent a (highly harmonic) alternating current.

Originally, coaxial cables were used with ethernets. These consist of an outer conductor that completely surrounds and thus shields an inner conductor. Both conductors are electrically isolated by an isolator. Coaxial cables are available in various specifications, and for the ethernet types with a surge impedance of 50 ohms are used.

The construction of the coaxial cable is however not only advantageous because of the shielding of the inner conductor. It makes use of another phenomenon of high frequency technology: the skin effect. With very high frequencies, current flows almost only in a thin layer on the conductor surface while in the inner of the conductor almost no current flows.

With this behaviour, just the outer conductor of the coaxial cable functions exactly as a solid conductor of the same diameter. This is why the "filling" of the conductor can be done without and a "tube" should be used. In the inner of this tube there is room for the second conductor. Because the skin effect influences both the inner and outer conductor, the conducting capacity of the cable can be further improved by a thin silver coating on the inner conductor.

In the meantime, twisted two-wire lines (10BaseT) or glass fibre lines are used.

The definition of the physical channel is however only a part of the IEEE 802.3 specification. The standard specifies the physical transmission and access processes, the so-called protocols. On the physical level, designations such as 10Base5, 10Base2 and 10BaseT are important. Decisive here are three parameters:

– Transmission rate.

– Transmission method (basis or broadband; "base" or "broad").

– Statements about the spatial expansion.

For differentiating between the individual transmission media and for characterising these, the following system has been developed for cable designation:

<Data rate in MBit/s><Transmission method><Max. length/100 m>

The type of cable can also be different. Everything is available ranging from coaxial cables and glass fibre to twisted two-wire lines.

9.4.4 Structured cabling

The unified structural plan for a future-oriented and application-independent network infrastructure used for transmitting various services (voice or data) is termed structural cabling or else universal building cabling. This is intended to avoid expensive, erroneous installations and expansions and to facilitate installation of new network components.

Structured cabling is based on a generally valid cabling structure that also considers possible requirements in coming years following its installation, contains reserve capacity and can be used independently of the application. As such, it is usual to use the same cabling for the local network and the telephone connection.

The aims of structured cabling are:

– Support for all present and future communication systems

– Capacity reserves in terms of threshold frequency

– Neutral behaviour of the network in terms of transmission protocol and end devices

– Flexible expansions possible

– Failure safety via star-shaped cabling (e.g. ethernet)

– Data protection and data security can be implemented

– Compliance with existing standards

Applicable standards

In North America, structured cabling according to the telecommunication cabling standard for building cabling (TIA/EIA 568 B.1 (2001)/B.21 (2001)) is carried out. TIA/EIA is not valid worldwide though, but is an industry specification applying to the North American market. This includes the requirements of EN (European standard) and the ISO/IEC (global) with transmission properties of cabling and components.

In the European standard (EN 50173-1(2003)) and the globally valid ISO standard (ISO/IEC 11801 (2002)), structuring is in the form of hierarchy levels. These levels are formed by groups that belong together topologically or administratively.

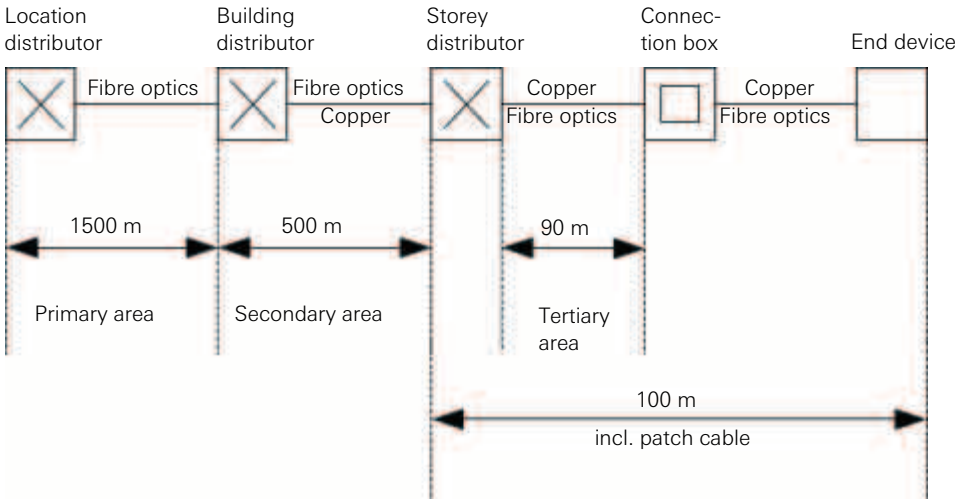


Figure 9.9: Structured cabling according to the ISO standard and European standard

Here three hierarchic levels are defined:

– Primary area: Also designated campus cabling or ground cabling. This covers cabling of individual buildings among each other and usually consists of large distances, high data transmission rates and a low quantity of stations.

  For cabling, usually glass fibre cable (50 µm) is used with a maximum length of 1500 m. Normally this concerns glass fibre cable with multimode fibres, or with larger distances, also glass fibre cable with single mode fibres. Sometimes copper cables are used for smaller distances.

  Fundamentally, the primary area should be "generously" planned: The transmission medium in terms of bandwidth and transmission speed must be open in terms of expansion. This is also the case with the implemented transmission system. A 50% reserve should in principle be planned for relative to actual requirements.

– Secondary area: Also designated as building cabling or climb range cabling. This applies to cabling for single storeys within a building. Glass fibre cables (50 µm) are preferentially used, but also copper cables with a maximum length of 500 m.
– Tertiary area: Also termed floor cabling. This applies to the cabling from distributors on the storeys to the connection boxes. A network cabinet with patch field is housed in the storey distributor and the cable terminates at the workplace of the user in a connection box in the wall or in a cable channel.

  For this relatively short distance, twisted pair cables are used with lengths limited to 90 m plus 2 x 5 m connection cable. Glass fibre cables (62.5 µm) are alternatively used, which are usually more expensive.

9.4.5 Network cable

Network cables are cables that physically connect stations or devices in a network.

There are various types of network cable. They differentiate in terms of material and structure. While copper cable is used either as twisted pair cables or coaxial cables, fibre-optic cables consist of plastic and the basic ingredient of glass.

The network of a Gira nurse call system Plus is based on ethernet. The call system is also intended for use in the secondary or tertiary area according to the ISO standard. Here twisted pair cables are favoured. This is why below, only twisted pair cables are looked at more closely.

9.4.6 Twisted pair cable

Installation at system level (ethernet) for the Gira nurse call system Plus is usually implemented in the secondary and tertiary area. Here copper cables are favoured, so-called twisted pair cables, due to reasons of cost. As the name says, these concern cables in which pairs of opposite, twisted wires are combined. The number of wire pairs varies. Twisting is intended to reduce interference from outside or from adjacent wire pairs. Sometimes these are called crossed wire pairs. It is technically correct though to refer to twisting or twisted wire pairs. The reason for this is the manufacturing method comparable with a rope.

In a star topology (e.g. when setting up an ethernet), with these cable types data transmission rates of up to 100 Mbps and more can be achieved. The maximum cable length between a computer and a central distributor (hub or switch) is around 100 metres. Impedance is 100 ohms with all twisted pair cables.

Cable structure

Twisted pair cables consist of several single wires twisted to pairs.

Term explanations for twisted pair cables:

– **Wire:** Consists of a copper conductor isolated with plastic. With installation/routing cables, the wire is rigid with a normal diameter of 0.50 mm to 0.65 mm. With flexible patch cables the wire diameter is between 0.4 mm and 0.5 mm. Often the thickness of the copper cable is specified in AWG (American Wire Gauge). The size specifications for wires in twisted pair cables are thus between AWG27 and AWG22 (the smaller the AWG number, the thicker the conductor).

– **Pair:** Two wires in each case are twisted to a pair.

– **Conductor bundle** or **core:** Designates the four pairs twisted together.

– **Cable sheath:** Surrounds the core. Usually consists of PVC or a halogen-free material.

– **Shield:** Metallic wrapping for single wire pairs and/or the core. The shield can consist of metal foil, metallised plastic foil, wire screening or a combination of single materials.

A cable can also contain additional elements as well as the wire pairs. For example:

– Supplementary wire as an electrical ground line.

– Filler wires of plastic for filling the cavities between the pairs.

– Plastic threads (e.g. of nylon) between the complete shield and cable sheath. This enables easy removal of the cable sheath. The thread has to be gripped with pliers and pulled back at a sharp angle. The thread cuts off the sheathing that can then be removed without further tools.

Shielding

Twisted pair cables are available in two or four-pair versions. With modern network installations, usually only four-pair cables are used. Because the original designations are often confusing or even contradictory, with the ISO/IEC-11801 (2002)E standard a designation scheme in the form of XX/YZZ was introduced:

ZZ stands for the type of cable. Here: TP = Twisted Pair.

Y stands for the wire shielding: U = Unshielded, F = Foiled.

XX stands for complete shielding: U = Unshielded, F = Foiled, S = Screened, SF = Screened and Foiled.

Thus the following designations are used for the various twisted pair cable versions:

UTP (Unshielded Twisted Pair): Designation according to ISO/IEC-11801 (2002)E: U/UTP. Cable with unshielded pairs and without complete shield. Is preferentially used for floor (storey) and end device cabling. Relatively sensitive to interference radiation. For example data transmission can be significantly interrupted by the cross talk or mixing of signals from adjacent wire pairs (also known as Alien Crosstalk).

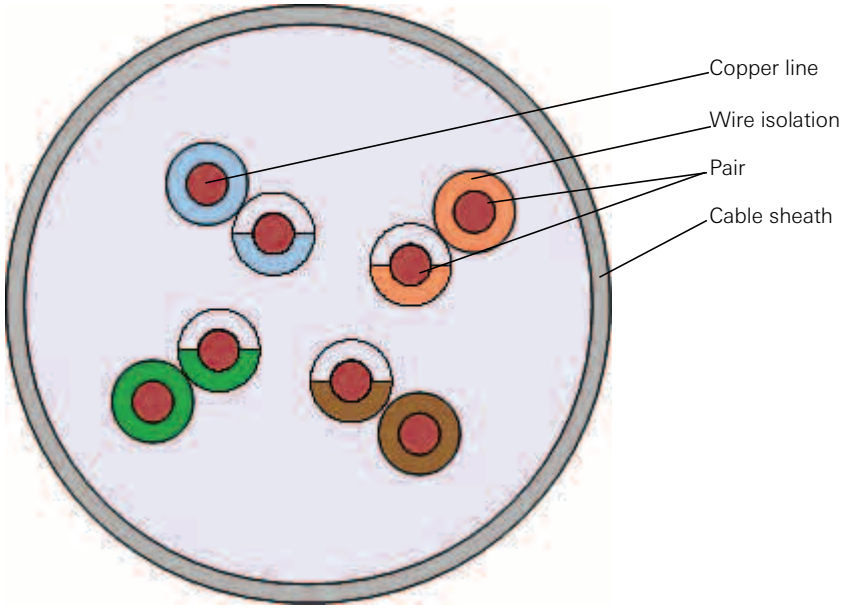


Figure 9.10: Structure of a UTP cable

FTP (Foiled Twisted Pair): Designation according to ISO/IEC-11801 (2002)E: U/FTP. The wire pairs of U/FTP and U/STP cables are surrounded by a metallic shield (usually an aluminium coated plastic foil). PiMF (Pair in Metal Foil) is the term used for the shielding of each pair. If the shield surrounds two pairs this is called four in metal foil. This cable is termed FTP in the EN50173-1 version. With the additional shielding, the FTP cable has a slightly larger outer diameter and is therefore more difficult to route (larger bending radius) than UTP cable. Cross-talk between the single wire pairs can be reduced by the shielding.

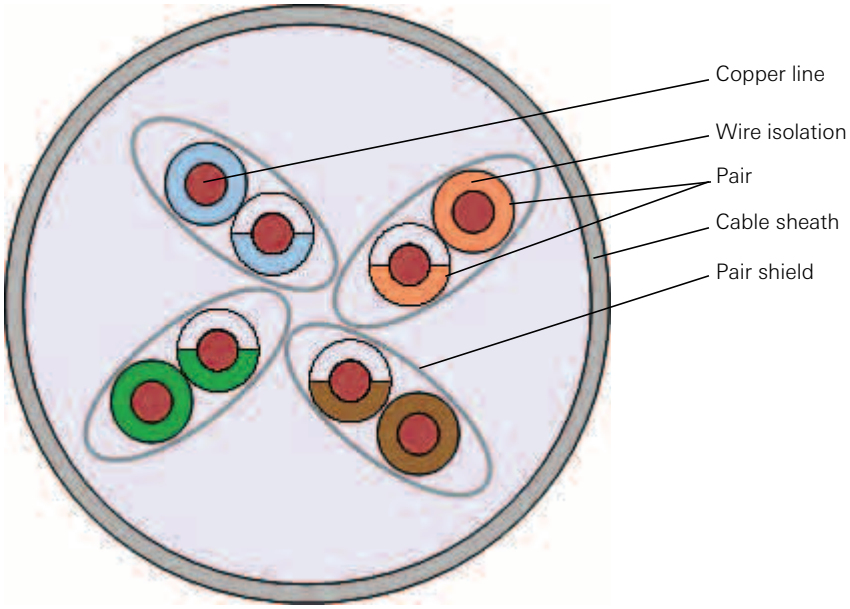


Figure 9.11: Structure of an FTP cable

S/FTP and **SF/FTP** (Screened Foiled Twisted Pair): Designation according to ISO/IEC-11801 (2002)E: S/FTP (screen), F/FTP (foil), SF/FTP (screen + foil). Structure as with FTP but with additional complete metallic shielding around the conductor bundle. The complete shield may consist of foil, wire screening or both together. In accordance with EN50173 these cables are designated with an F for foil shield, an S stands for copper screen shield. The screen covering should be more than 30% to successfully shield low frequencies.

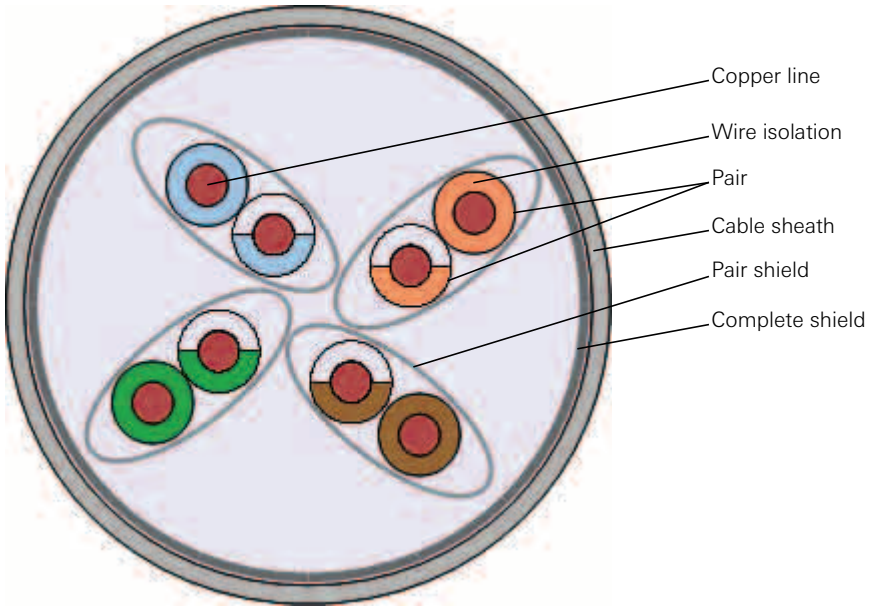


Figure 9.12: Structure of an S/FTP cable

S/UTP (Screened Unshielded Twisted Pair): Designation according to ISO/IEC-11801 (2002)E: S/UTP. Structure as with UTP but with additional metallic shield around the conductor bundle. The complete shield may consist of foil, wire screening or both together. If the complete shield consists only of one foil, the cable is also called F/UTP cable. If the complete shield consists of foil and wire screen it is termed SF/UTP cable.

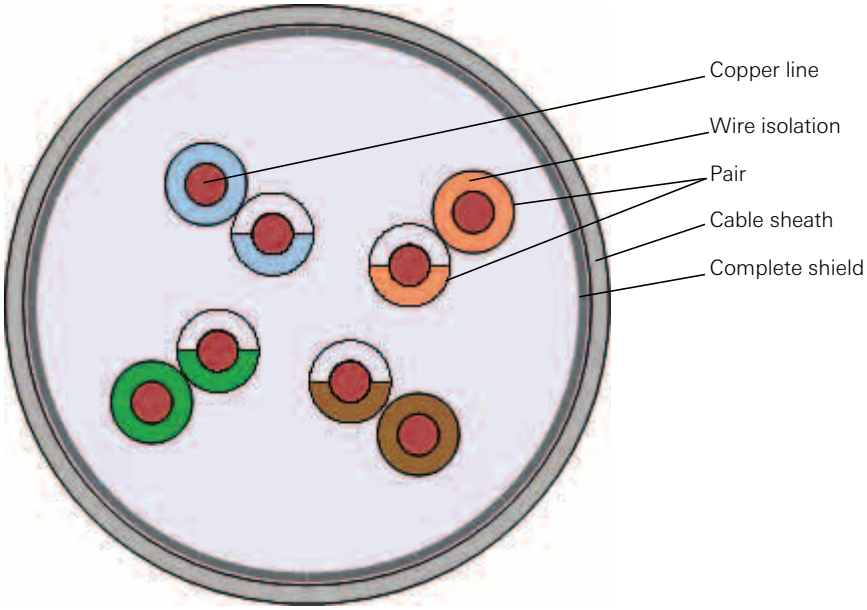


Figure 9.13: Structure of an S/UTP cable

With use of unshielded cables or plugs there is no ground connection between the network devices. This may cause potential islands.

Due to the missing ground connection, no (high) compensating current between the potential islands can flow to form any (undesired) "ground loops".

Usually the housing ground is locally connected to the device via the protective conductor and therefore dependent on the ground potential. The ground potential may be different from building to building. This is why a shielded cable is unsuitable for connection between the various buildings.

It must also be considered that the mains supply is not everywhere as qualitative as in Germany. Even in some European countries such as Portugal or England, the mains supply is significantly poorer. We recommend not to use shielded cables in such countries.

Classification of twisted pair cables

Twisted pair cables are standardised and divided into various classes and categories. Each category covers different ranges of requirements with specific quality attributes. Categories range from 1 to 7. Within these, only categories 1 and 2 are formally specified. Cables with category 1 and 2 are hardly ever found. For cables with category 3 and 4 there are no longer any applications. Their quality does not meet the requirements of today's network technologies. Cables of these categories are found only in obsolete network installations.

Still in use today are twisted pair cables of category 5. With new installations, usually cables of category 6 or 7 are used.

Cable type	EIA/TIA 568 Category	DIN EN 50173 Class	max. frequency	Impedance	Application
UTP-1	Cat.1	-	0.3 to 3.4 kHz	100 ohms	analogue voice transmission
UTP-1	-	A	100 kHz	100 ohms	analogue voice transmission
UTP-2	Cat.2	B	1 MHz	100 ohms	ISDN
UTP-3	Cat.3	C	16 MHz	100 ohms	10Base-T, 100Base-T4, ISDN, analogue telephone
UTP-4	Cat.4	-	20 MHz	100 ohms	16 MBit Token Ring
STP	IBM Type 1/9		20 MHz	150 ohms	4 and 16 MBit Token Ring
UTP, S/FTP	Cat.5	D	100 MHz	100 ohms	100Base-TX, 1000Base-T4, SONET, SOH
UTP, S/FTP	Cat.5e	D	100 MHz	100 ohms	1000Base-T
UTP, S/FTP	Cat.6	E	250 MHz	100 ohms	155-MBit-ATM, 622-MBit-ATM
S/FTP	Cat.6e	E	500 MHz	100 ohms	1000Base-T
S/FTP	Cat.6a	F	625 MHz	100 ohms	10GBase-T (to 100 metres)
S/FTP	Cat.7	F	600 MHz	100 ohms	10GBase-T (to 100 metres)
S/FTP	Cat.7a	FA	1000 MHz	100 ohms	10GBase-T, 40GBase-T and 100GBase-T (limited)

In the German-language countries usually the designation "Kategorie" is used, shortened to KAT or Kat. Often the English designation "category" or CAT or Cat is used. A KAT7 or CAT7 cable is therefore a cable of category 7 suitable for example for installing 10GBase-T or 40GBase-T ethernet.

9.4.7 Cable routing

With line-bound data transmission, not only transmission properties but also the routing of the medium must be considered. In this respect you should take a closer look at the conditions of the outer sheath of the cable:

– Tensile strength and abrasion resistance: How does the cable respond to mechanical loads?

– Flexibility: How well can the cable be routed? Which bending radius does the cable have when for example it has to be routed around corners in cable channels and ducts?

– Temperature resistance, fire resistance: How does the cable react in case of fire? Does it emit toxic gases?

Depending on the application area (e.g. office, storage or production hall), the cables must comply with highly diverse requirements. They are accordingly available in widely diverse variants. If necessary, specific standards, guidelines and regulations must be taken into account that specify which cables can be installed in which buildings.

Tips for routing cables:

– **Avoid kinks and squashing:** The bending radius specified by the manufacturer for a cable must be adhered to in all cases. If a cable is kinked, for example if it is installed in a narrow routing system, or if it is bruised by for example being driven over when lying on the floor, then the cable symmetry becomes damaged. Such loads mean that the individual copper wires of the cables are damaged, and this modifies the resistance and quality of the cable. Errors that are derived from mechanical loads usually occur later during operation and can often not be detected by measuring either at first.

– **Avoid damage to the cable sheath:** Cable with damaged sheathing must be replaced. In such cases usually the complete shield of the cable is damaged and no longer protects the cable from external electromagnetic factors. As well as the ingress of humidity that significantly impairs the electrical properties of the cable, current may be conducted away via the potential difference between both connection points.

– **Do not permit cables to come into contact with water:** Undamaged cables must not be exposed to water for more than 24 hours. Each cable must be carefully dried. If open cable ends or damaged parts of the cable come into contact with water, then the affected cable must definitely be replaced.

– **Do not route cables together with current-conducting cables:** When routing network cables, external interference factors must be avoided. If a network cable is routed parallel to a power cable for example, then the electromagnetic field of the power cable may be induced into the network cable. This also disrupts data transmission or even interrupts it.

– **Do not open twisting too much:** When laying on the wire pairs, e.g. to connect the cable to an RJ45 plug, twisting of the wire pairs should not be opened too wide. The pairs must not be "re-twisted" either, as this gives poor values with the NEXT measurement (crosstalk).

– **Equipotential bonding:** The shielded mains supply and the metallic components should be integrated into the equipotential bonding of the complete building.

9.5 Connection elements

When connecting a twisted pair cable to the network card or to a switch, so-called RJ-45 plugs and sockets are needed, as used for ISDN cables. They initially look very similar to the RJ-11 telephone plugs and sockets but are somewhat larger and have 8 wire pairs instead of 4.

RJ stands for Registered Jack (standardised socket). Often the plug is called a "western plug" as it was developed by the U.S. company "Western Electric".

The original concept with wiring intended that the two inner pins form a pair, the next outer ones a further pair, until the two outer wires that form the fourth pair. Additionally, signal transmission was optimised by the "active" pin and the pin on the ground side of each pair changing. With this pin assignment however, in the RJ-45 plug the outermost wires are so far apart that they can no longer meet the electrical requirements for high speed LAN protocols. As a result two assignment variants, TIA-568A and TIA-568B, were standardised, by which two adjacent pins in each case form the third or fourth pair. The variants A and B differentiate by the third wire pair being positioned either on the far left in the plug (A) or on pins 3 and 6 (plug B).

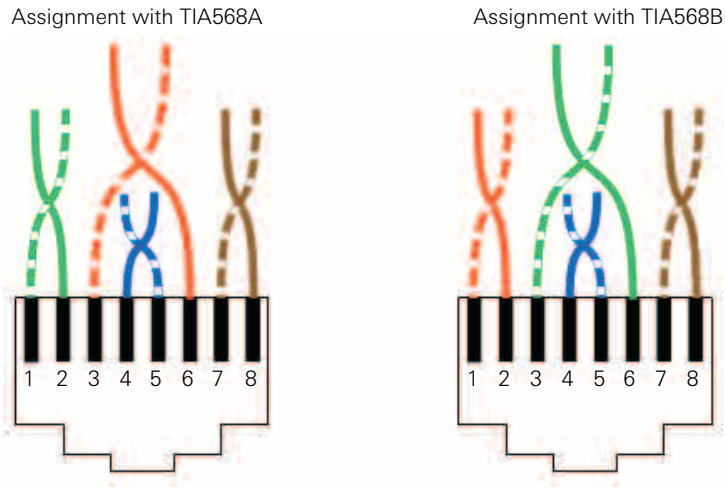


Figure 9.14: Pin assignment with variants T568A and B

Signal	Pin	Assignment with T568A	Assignment with T568B
TX+	1	green/white	orange/white
TX-	2	green	orange
RX+	3	orange/white	green/white
	4	blue	blue
	5	blue/white	blue/white
RX-	6	orange	green
	7	brown/white	brown/white
	8	brown	brown

Assignment according to 568A or 568B - what's correct?

When cabling LANs it does not matter whether TIA-568A or TIA-568B is used. Observe though that you maintain the standard once it is selected. With new installations, usually the colour coding of the connection box and patch field are complied with. **Careful** though: Make sure that the connection box and patch field are sourced from the same manufacturer! When installing additional cables in existing networks it must always first be established according to which standard connection boxes and patch fields have been assigned.

9.6 Network components

In all networks, certain components or performance attributes can be found that enable network operation to function. These include:

- **Server**: A computer that makes resources available to the users of a network for their common access. These include for example:

  Released data stored on the server and that can be used by other computers in the network.

  Released application programs installed on the server and made available to all users.

  Released hardware components (e.g. printers, modems, fax machines and other peripheral devices) which can be accessed together by all network users.
- **Client**: A computer that accesses released resources of the server. This may mean, with the example of a hospital, medical devices with network connection such as telephone systems, call system components or components of the technical building management.
- **Transmission media** for connecting the client (e.g. lines, cable).

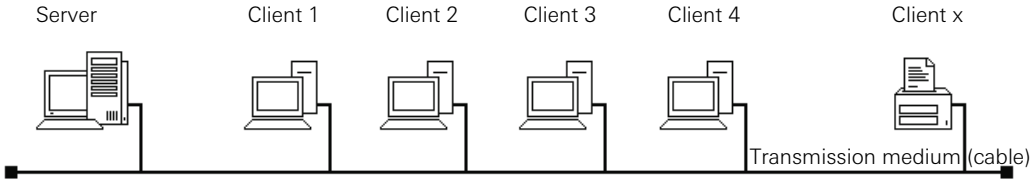


Figure 9.15: The most common components in a network

Fundamentally, all network components can be divided into active and passive network components.

9.6.1 Active network components

Active network components have their own logic and can therefore influence the actual data transmission in the network.

Examples of active network components

– **Network card:** Also termed network adapter. The network card enables for example a computer to access a network. Each network card has a hardware address (MAC address) that is globally unique. With this address a network component can be uniquely identified.

– **Repeater:** A coupling element that extends the transmission distance within a network, for example an ethernet. A repeater receives a signal and reconditions it. Then it sends it on. In this way the repeater extends the transmission distance and spatial expansion of the network.

– **Hub:** A coupling element that interconnects several stations in a network. In an ethernet network based on a star topology, the hub serves as distributor for the data packages. Hubs are restricted to pure distributing functions for data.

– **Bridge:** Subdivides a local network into two segments. Here the disadvantages of ethernet occurring especially with large networks are compensated for. Bridges as coupling elements are not typical. Limitations by the ethernet are compensated for usually by switches today.

– **Media converter:** Combines old network installations with new cabling or aids in overcoming distance limitations with network cables. A conversion between different ethernet variants (e.g. 10 MBit and 100 MBit) is not possible. Conversion only occurs between varying cable types, e.g. twisted pair to glass fibre cable.

– **Switch:** A coupling element that interconnects several stations in a network. In an ethernet network based on a star topology, the switch serves as distributor for the data packages. The function is similar to that of a hub, with the difference that a switch can switch direct connections between the connected devices, if it knows the ports of the data package recipients.

– **Router:** Connects several networks with differing protocols and architectures. Routers are often located at the outer limits of a network to connect it to the internet or another network. A router decides with a routing table which path a data package uses. This is a dynamic process that considers failures and bottlenecks without the need of an administrator becoming active. A router has at least two network connections.

– **Gateway:** Couples widely differing transmission protocols and transmission methods. There are media-converting gateways that connect between two different protocols with the same transmission method. There are also protocol-converting gateways that connect differing protocols.

– **Server:** A server is a computer providing computer power, storage and data in a network and managing access rights. In most cases this concerns a very high-performance computer that according to application is equipped with special hardware/software.

– **Proxy, also proxy server:** Server or service that operates as a buffer memory within a network to support access to the same data and files in the memory. Proxy means "representative". In its simplest form it is a type of cache for web pages.

– **Firewall:** A protective measure against foreign and unauthorised connection attempts from the public (internet, ISDN) network into the local network. With a firewall the incoming and outgoing data traffic can be controlled, logged, blocked and released.

9.6.2 Passive network components

Passive network components are part of the permanently installed infrastructure. They usually have no internal logic and influence the network more by their physical properties.

Examples of passive network components

– **Cable, line:** Interconnects the various network components, used as a transmission medium.

– **Connection box:** An interface between e.g. a line laid into the wall and an active network component.

– **Connection plug:** A coupling element for example between line and connection box.

– **Patch field:** A distribution element for lines. Is used for the setup of complex cable structures in buildings. Commonly used are patch fields for distributing network cables and telephone or glass fibre cables, especially with structured cabling.

– **Network cabinet:** A distribution cabinet into which the various network cables are routed and interconnected via active components (switches, hubs or routers for example).

9.6.3 Network components and the nurse call system Plus

Among the active network components of the Gira nurse call system Plus are the ethernet switch (SW+), the system central control unit Plus (SSZ+), the ward control centre (SZ+) and the duty room terminal CT9 (CT9+).

All of these components have a network card that makes available the corresponding network connection.

You may also come across routers that for example connect the system central control unit or ward control centre (via the "External LAN" connection). Working with a proxy may also be important.

In such cases, always consult the responsible system administrator to avoid difficulties that might result from use of foreign networks.

When installing the Gira nurse call system Plus, you will probably come across all of the passive network components such as cable, line, connection box, connection plug, patch field and network cabinet.

Here you must make sure that when using high quality cable material in particular, suitable connection boxes and plugs are used as well, otherwise disruptions or transmission loss may occur that is difficult to identify.

One of the most common causes of error in a network are erroneously switched or poor plug connections.

9.7 CSMA/CD access process

In every network there are the physical connection paths (channels) via which the individual stations intercommunicate. The method by which the individual stations use and assign these channels depends on the specific system of access, the access process. Access processes do not depend on a specific logical network structure. ALOHA, CSMA/CD, Token Ring and Token Bus are among the most well-known access processes. Because ethernet is used on the system level of the Gira nurse call system Plus as a transmission technology and this is subject to the CSMA/CD transmission process, the other processes are not considered in this section.

The abbreviation "CSMA/CD" stands for "Carrier Sense Multiple Access/Collision Detect". This access process is often used with logical bus networks (e.g. ethernet), but in principle can be used in all network topologies.

Before a station transmits, it first tests the line to determine whether data traffic is not already taking place between other stations. Transmitting first takes place when the line is free. During data transmission, detecting (listening in) takes place to determine whether a collision occurs with a station that coincidentally starts transmitting at the same time (collision detect).

With all lines, a certain run time must be taken into account so that a collision also occurs when two stations begin with the transmission process when offset by a slight time period. In such cases all transmitting stations produce a JAM signal (collision signal) on the line so that all participating transmission and reception nodes abort processing of the current data package.

In order that a transmitting station is able to reliably detect a collision, the duration of package transmission must be at least double the signal run time between two participating stations. As such, the minimal length of a data package is dependent on the signal run time and transmission rate.

The CSMA/CD framework format is defined according to IEEE 802.3. In addition to cabling problems, with CSMA/CD networks there also exist some typical error sources. Some of these are:

– **Late collisions:** Collisions occurring outside of the collision window of 512 bits. Three reasons usually exists for this: Either a station has a hardware defect (network interface, transceiver etc.). Or the software has a defect (driver), meaning the station cannot adhere to the CSMA/CD conventions (sending without detecting). The third cause may be that the configuration rules for cable length have not been complied with (signal run time too long).
– **Jabber:** If a station transmits without an interference for a longer period of time, meaning frames with more than the maximum permissible 1518 bytes, then this is called "jabber". The main cause of this is usually defect network cards or network drivers.

– **Short frames:** Frames smaller than the minimum permissible 64 bytes. The cause of this is also defect network cards or network drivers.
– **Ghost frames:** Appear similar to a data frame, but have errors in the start delimiter. Equipotential bonding currents and defects affecting the cable may lead a repeater to "believe" an approaching data package is coming. The repeater then transmits this "ghost package" into the network.

9.8 What does ethernet mean?

Ethernet describes a transmission technology for a cabled data network that was originally intended for local data networks (LAN) and is therefore also called LAN technology. Ethernet enables data exchange in the form of data packages between stations (computers, printers etc.) connected in a LAN. Until now, transmission rates of 10 Megabit/s, 100 Megabit/s (Fast Ethernet), 1 Gigabit/s (Gigabit Ethernet) to 10 Gigabit/s are specified. In its traditional form, the LAN covers only one building. In the meantime ethernet connects stations over large distances via glass fibre cable as well.

Ethernet includes definitions for cable types and plugs and transmission forms (package formats, signals on the bit transmission layer, e.g. signal voltage and frequency). In the OSI model, ethernet defines both the physical layer 1 (bit transmission layer in the OSI model) and the security layer (layer 2 in the OSI model).

9.8.1 Ethernet specification

Ethernet extensively corresponds to the IEEE 802.3 standard and can form the basis for network protocols such as AppleTalk, DECnet, IPX/SPX or TCP/IP.

The abbreviation IEEE stands for the "Institute of Electrical and Electronics Engineers". This is an international organisation of experts from the electrotechnical and engineering community, similar to the German VDE (Verband der Elektrotechnik Elektronik Informationstechnik e. V.).

At the end of the 1970's it became necessary to introduce standards for local networks. And so the project 802 was set up by the IEEE as a result. This project covers standards for Local and Metropolitan Area Networks (LAN and MAN). The standards of the 802 family apply to the bit transmission and security level of the OSI layer model. The security layer is subdivided into a Logical-Link-Control (LLC) and a Medium-Access-Control-Layer (MAC). The LLC is responsible for transmission and for access to the logical interface. The MAC layer applies to the control of access to the transmission medium and is therefore responsible for the error-free transport of the data.

Specifications for ethernet network technology are suggested and standardised over a workgroup with the designation 802. As well as ethernet (802.3) and Wireless LAN (802.11), the IEEE is also responsible for the Bluetooth (802.15.1) and WiMAX (802.16) standards. The standard is more precisely specified via the number after the dot. Individual standards within a group are designated with an appendixed letter or further digits and years.

The 802 project has now reached major importance. Its importance is so great that in the area of local networks, without ethernet and its many extensions nothing really could function. Other network standards only play a role on the outskirts.

9.8.2 Ethernet with the nurse call system Plus

The Gira nurse call system Plus is subject to the specifications of IEEE 802.3ab (gigabit ethernet via twisted pair cable). For data transmission, all four wire pairs of a twisted pair copper cable are used. The transmission rate of 1000 MBit/s is divided over the four wire pairs, each with 250 MBit/s.

The standard (IEEE 802.3ab, often also designated 1000Base-T) specifies how and in which form data are transmitted on the cable on the physical layer of the OSI layer model. All further ethernet functions, including the access process, are defined on the connection layer.

In the network sector cabling is very important. In addition to the coupling elements it is the most expensive and elaborate part of the whole installation. Network cabling is only replaced reluctantly. And definitely not when it is not absolutely necessary. A new transmission system can be more easily integrated in this sector if the complete cabling does not need to be replaced. An advantage is that with setting up Gigabit Ethernet, the existing structured cabling (twisted pair cables) can be used. Assuming though that the cables are specified for this.

1000Base-T was designed from the beginning so that it can be used with plugs and sockets of RJ-45 connection technology. In contrast to Fast Ethernet, Gigabit Ethernet needs all four wire pairs of a cable.

Fundamentally, Gigabit Ethernet is suitable here for use with CAT5 cables. But CAT5 is not always CAT5 (further information for classification of cables here: "Classification of twisted pair cables" on page 156). 1000Base-T places high demands on cable installation. In individual cases 1000Base-T fails with CAT5. If the requirements of 1000Base-T have not been taken into account with acceptance measurement of the cabling, then only with final measurements is it possible to determine whether a cabling is suitable for Gigabit Ethernet.

For short distances to 10 metres, normal CAT5 cables can definitely be used. From 10 metres the cables should be at least CAT5e to enable stable, fault-free connections. Otherwise it may happen that the gigabit connections fall back to Fast Ethernet with 100 MBit/s.

9.9 What is an IP address?

An IP address is an address in computer networks based on the Internet Protocol (IP). An example for such an IP-based network is the internet. The IP address is assigned to all devices in a network and makes these devices addressable and therefore also accessible. It can designate a single recipient or a group of recipients (Multicast, Broadcast). Likewise, several IP addresses may be assigned to a single computer.

IP addresses in a network are similar to a postal address on an envelope. They are needed to communicate data from their sender to a planned recipient. With the aid of this address the "post offices", or routers, can decide in which direction the package should be further transported. In contrast to postal addresses, IP addresses are not fixed to a specific location.

The most familiar notation for today's most common IPv4 addresses consists of four digits that can each take on values of 0 to 255, and are separated by a dot, for example 127.0.0.1. Seen technically the address is a 32-digit (IPv4) or 128-digit (IPv6) binary number (see also "TCP/IP transmission protocol" on page 170).

9.10 What is a MAC address?

MAC in network technology is an abbreviation for Media Access Control. The MAC address is the hardware address for each single network adapter that serves for unique identification of the device within a computer network. At Apple people speak of Ethernet-ID, Airport-ID or WiFi address. At Microsoft the MAC address is also termed a physical address. The representation of MAC addresses is defined by the IEEE, usually corresponding to the hexadecimal number system.

In contrast to IP addresses, MAC addresses are identification numbers not assigned by the network but saved by the software producer in the software (firmware) of a device. Thus identical devices can be identified uniquely via their own address.

Correspondingly, as well as manufacturer-independent MAC addresses there are also manufacturer-dependent MAC addresses. With manufacturer-dependent MAC addresses the actual address is preceded by a so-called manufacturer code.

Examples of manufacturer-dependent MAC addresses:

– 00-50-8B-xx-xx-xx (Compaq)

– 00-07-E9-xx-xx-xx (Intel)

9.11 What is a host?

A host means a computer in a network that sends and/or receives data. Each host has an IP address assigned to it. The last digit of the IP address designates the host. Often in network technology circles the term station or device is used for host.

Example:

In the IP address 192.168.10.5, the area 192.168.10 designates the network and ".5" the host.

9.12 What is a port?

A port in network technology is part of an address that assigns data segments to a network protocol. This concept is for example intended in TCP and UDP to address protocols on the higher layers of the OSI model. In addition, a port is also a process-specific software configuration that makes available a communication point. The port is thus comparable to a door enabling a connection between computer and network.

With TCP and UDP a port number is 16 bits in size, meaning it can accept values from 0 to 65535. Thus 65535 so-called channels are available. Some applications use port numbers that are permanently assigned by the IANA (Internet Assigned Numbers Authority) and are well-known. These usually lie between 0 and 1023 and are termed Well-Known-Ports.

The Registered Ports are between port 1024 and 49151. Application manufacturers when required can register ports for their own protocols, similar to domain names. Registration has the benefit that an application can be identified via the port number, but only if the application uses the port registered with the IANA.

The other ports from port number 49152 to 65535 are so-called dynamic and/or private ports. These can be diversely used as they are not registered and therefore do not belong to a specific application.

The Internet Assigned Numbers Authority (IANA) is an organisation that regulates the assignment of IP addresses, top level domains and IP protocol numbers, as well as assignment of the ports.

9.13 Port forwarding

A port forwarding is the forwarding of a connection that goes to another computer at a specific port via the computer network. Because the corresponding network service is not executed by the forwarding computer itself, the misleading term Virtual Server is used here.

The incoming data packages are masked via Destination NAT (see also "NAT - Network Address Translation" on page 172) and the outgoing packages via Source NAT to forward them to the other computer or to give the impression that the outgoing packages come from the computer that operates the port forwarding.

9.13.1 Port forwarding via the router

A router connected for example with a private LAN and the internet waits at a particular port for data packages. When packages come into this port they are forwarded to a specific computer and perhaps to another port in the internal network. All data packages from this computer and port, if they belong to an incoming connection, are modified via NAT (see also "NAT - Network Address Translation" on page 172) so that it has the appearance in the external network that the router is sending the packages.

With port forwarding it becomes possible for the computers within a LAN (that are not directly accessible from an external network) to function as a server, also outside of the network and especially also on the internet, so that these become uniquely addressable via a predefined port (and via NAT).

For all computers in the external network it looks like the router offers the server functionality. But that this is not so can be detected with the header lines or package run time analyses.

Example

A larger company has a local network, whereby several servers function towards outside (internet) via ADSL router and an IP address (e.g. 205.0.0.1). Now a client from the external network (internet) wants to use a service (e.g. HTTP/TCP Port 80) on a server of the company. He can however only communicate with the ADSL router of the company for the service (HTTP/TCP Port 80) via the IP address known to him (205.0.0.1). The ADSL router of the company forwards the query for the service (HTTP/TCP Port 80) to the corresponding server in the local network.

9.13.2 Port forwarding for improving security

Another application example for port forwarding is the securing of a channel for transmitting confidential data. Here, Port A is linked to Computer 1 and Port B to Computer 2 via a connection maintained in the background between two other ports of the two computers. This is called tunneling.

In this way for example, the insecure POP3 (login/password in plain text) can be secured via "packing in" into an SSH channel: port 113 on the POP server is forwarded via SSH to port 113 of the local computer by the user. The local e-mail program communicates with localhost:113 instead of pop.example.org:113 and the SSH channel transmits the data in encrypted form backwards and forwards between the two addresses via the parallel SSH connection. This makes the "grasping" of the password by an eavesdropping third party almost impossible. Although at least limited SSH access to pop.example.org must be possible, and this is usually not permitted for private users.

9.14 What is a frame?

The term frame is used with data transmission in package communicating networks, for example with ethernet. With data transmission, the data are split into several smaller packages. These packages are called frames.

The method of splitting into packages is defined in a so-called frame format. For ethernet for example, there are the frame formats Ethernet II, Ethernet 802.3 etc.

9.15 What is a gateway?

A gateway is an active network node that can interconnect two networks that are physically incompatible and/or use differing address systems. A classic example is the ISDN router that can connect between the LAN and the public telephone network (ISDN). Gateways also include fax servers and Voice-over-IP gateways.

If when configuring a local network the IP address for the standard gateway is queried, you can usually specify here the IP address of the router, e.g. the FRITZ!Box. The gateway belongs to the active network components.

9.16 VLAN - Virtual Local Area Network

A VLAN (Virtual Local Area Network) is a virtual local network within a physical network. It is defined partly via the IEEE 802.1q standard. It therefore concerns a network structure with all properties of a normal LAN but without the spatial binding. While the stations of a LAN cannot be distanced randomly far apart, a VLAN on the other hand enables further distanced nodes to be connected up to become a virtual local network.

VLANs are switched networks (networks in which switches are used) that can be logically segmented. Without a limitation through spatial position, it's possible to combine servers and workstations according to their functions to become dynamic work groups. VLANs can be set up transparently and without physical modification of the network. Regrouping is possible without repatching or moving the computers. In ideal cases this can be done with software.

A VLAN is also a broadcast and collision domain that can also stretch over several switches. The broadcast traffic (data packages are sent to all stations of a network) is only visible in the VLAN. This option of completely isolating the VLANs from each other increases security. Traffic between VLANs must be routed. Solutions exist here that achieve the speed of switches. Within the VLAN though, routing is not necessary.

Any number of network devices from differing segments can be combined to a virtual network according to various criteria (switch port, MAC address, protocol of network layer, logical network address, application), without the network having to be physically restructured.

9.16.1 Why are virtual networks needed?

Here are some basic properties describing the main advantages of VLANs:

– Broadcasts are not distributed over the complete network segment.

– Simple mapping of the organisation structure on the network structure.

– Support of dynamic work groups.

– Spatial distancing of employees has no effect on task distribution.

– If an employee of a company moves, he remains in his logical work group.

– Servers in central plant rooms are assigned to distanced work groups.

– Partly no routing needed any more.

Until now, networks were segmented with the aid of routers. Routers are expensive: many subnetworks are created, the routers require much computing time and the IP address area becomes too small very quickly.

VLANs combine the benefits of bridges and routers. A station can be easily added, removed or changed and the network can be clearly structured. In this way virtual user groups can be formed, and it is no longer necessary to assign users to various subnetworks because they are physically too far away. Servers accommodated in central rooms can be assigned to spatially distanced work groups.

Virtual networks can help in saving money because switches are cheaper than routers and easier to manage. Changing subnetwork addresses for example is very complex and therefore expensive in large networks. By using VLANs this is avoided. The broadcast traffic is not transmitted to all ports but remains in the corresponding VLAN. Broadcasts in foreign VLANs are not visible.

9.16.2 Structure of a VLAN

Routers effectively avoid broadcasts by preventing this data transmission to all stations from one subnetwork to another. Many routers in a local network however have the disadvantage that they cause much network traffic among themselves.

Protocols exchanged by the routing tables between the routers cause much network traffic and unnecessary error sources. A solution based on switches has speed benefits compared to pure IP routing. This is why layer 3 switches are used that, as with routers, create various subnetworks. The switches are configured so that their ports not only know the MAC address but are also configured according to a specific subnetwork, sometimes even a specific IP address.

This leads to the dissolving of physical structures existing with classic switches. But larger networks become confused quickly and difficult to manage.

Although the clients of the VLANs 1, 2 and 3 are connected to differing switches, they are addressed for various subnetworks. The layer 3 switches pay attention with the subnetworks to the targeted forwarding of broadcasts. If a data package has to change its subnetwork, it is automatically routed to another VLAN and assigned to the correct station.

9.17 TCP/IP transmission protocol

TCP/IP is short for Transmission Control Protocol and Internet Protocol. It concerns a protocol combination that interconnects the layers of transport and communication from the OSI layer model.

9.17.1 TCP - Transmission Control Protocol

As a connection-oriented protocol, TCP within TCP/IP has the task of data security and data flow control and also takes actions if data loss occurs. The functioning of TCP is to divide the data flow of various applications, to provide these with a header and to transfer these to the Internet Protocol (IP). At the recipient the data packages are brought into the correct sequence and transferred to the addressed application.

Each data package sent via TCP is preceded by a so-called header that includes the following data:

– Sender port

– Recipient port

– Package sequence (number)

– Checksum

– Confirmation number

Data packages that reach their target via the Internet Protocol (IP) are configured by TCP and transferred via the port number to an application. This port is constantly tapped by a process, a service or an application.

The port numbers 1 to 1023 are permanently assigned to an application or service. All other port numbers can be randomly assigned if they are not assigned to another service.

The port structure enables several applications to simultaneously implement connections via the network to communication partners.

9.17.2 IP - Internet Protocol

The Internet Protocol, or IP, is used as part of the TCP/IP protocol family for the handling of data packages. It operates on layer 3 of the OSI layer model and mainly has the task of addressing data packages and handling these in a connectionless, package-oriented network (routing). For this, all stations and end devices have an own address in the network. It serves not only for identifying a station but also the network in which the station is located.

Each data package sent via IP is preceded by a so-called header that includes the following data.

– IP version

– Package length

– Lifetime

– Checksum

– Sender address

– Recipient address

A differentiation is made between the Internet Protocol in version 4 (IPv4) and in version 6 (IPv6).

The IP address according to IP version 4 is 32 bits in size. It consists of 4 bytes and is separated by dots. Each byte can accept a value from 0 to 255 (e.g. 127.0.0.1).

IPv6 addresses consist of 128 bits and as chains of 16 bit digits in hexadecimal form are separated by a colon (":"). Sequences of zeros can be shortened one time by a double colon ("::"). Because in URLs the colon collides with the optional port specification, IPv6 addresses are set in square brackets.

The following table shows examples for specifying an IP address according to the different versions of the Internet Protocol:

Configuration of IP address according to	
IPv4	127.0.0.1
IPv6	FE80::0211:22FF:FE33:4455
IPv6-URL	http://[FE80::0211:22FF:FE33:4455]:80/

9.17.3 Advantages and disadvantages of TCP/IP

The main advantage of TCP/IP is that the protocol is not fixed to a particular manufacturer or a particular transmission system. It can be used with both simple and large, high-end computers. It can also be used equally in local networks and global networks such as the internet.

TCP/IP however is not an efficient method to transmit data. With the dividing of the data into small packages, each data package has to be preceded with a header data set, the header. Only in this way can the recipient be told what should actually happen with the data package. In this way the data package gets a management component of at least 40 bytes. Only when data packages can be formed in a size of several kbytes can the management component be kept low compared to the usage data.

9.18 NAT - Network Address Translation

Network Address Translation (NAT) concerns a process used in routers that connects local networks with the internet. While in the local network each station has a private IP address, for the internet often only a public IP address is available.

Private IP addresses can be used several times and are not valid in public networks. If though all computers with IP address are still to be given access to the internet, then the internet access router in all outward-bound data packages must replace the IP addresses of the stations with its own - public - IP address. The router saves the current connections in a table so that the incoming data packages are assigned to their correct targets. Fundamentally, two NAT processes are differentiated between:

– Source Network Address Translation (SNAT or simply NAT)

– Destination Network Address Translation (DNAT); port forwarding (see also "Port forwarding" on page 166)

9.18.1 SNAT or NAT

NAT process:

- The client sends its data package to its standard gateway (NAT router).
- The NAT router exchanges the IP address and port number and saves both with the exchanged port number in the NAT table.
- Then the NAT router routes the data package into the internet.
- The recipient (server) of the data package sends back its response.
- The NAT router now determines via the port number for which IP address the package is intended in the local network.
- Then the NAT router exchanges IP address and port number and routes it forward to the local network where it is received by the client.

Because this process changes the sender address (source) of each outward-bound data package, it is designated Source NAT (SNAT). But in reality it concerns the actual NAT process.

9.18.2 DNAT

NAT dynamically converts a public IP address to several private IP addresses. Each outgoing connection is defined with IP address and port number. With this port number, NAT can assign incoming data packages to a local station. This assignment is only valid for a short period of time though. Connections can therefore only established from the local network into the public network, but not the other way around.

If a station in the local network is to be permanently accessible from the public network, then this is only possible via a detour. The process is called Destination NAT (DNAT), and is generally also know as port forwarding (see also "Port forwarding" on page 166). Here a TCP port is permanently assigned an IP address in the router configuration. The router now routes all data packages coming into this port to this station.

Care must be taken when activating TCP ports (port forwarding). Those not making any server services available on the internet should block all of the TCP ports of the router (below 1024). With well-configured routers this is a default setting.

Those who can't do without port forwarding should set up a demilitarised zone (DMZ) for security reasons to keep the data traffic from the internet out of the local network.

9.18.3 Difficulties with NAT

Entries in a NAT table are only valid for a short time. For applications that only irregularly exchange data this means that the connection is continuously interrupted. As a result, these applications may not function in a NAT environment.

A further problem occurs when a high number of outgoing connections are active. In these cases, NAT tables sometimes run over, resulting in specific connections not existing in the table and therefore being interrupted. Also, for some applications there is a high risk of erroneous addressing due to missing address assignments.

9.18.4 NAT and IPv6

Because NAT due to its structure blocks unauthorised access from outside, so that the cyclic querying of all TCP ports of an IP address are not answered by the router, NAT is often seen as a security function for local networks. This however is wrong. NAT replaces neither a package filter nor a complete firewall.

Luckily, NAT becomes practically superfluous thanks to IPv6. The falling away of NAT improves the operation of networks significantly. Errors caused by NAT then no longer occur. In addition, errors can be located and solved more rapidly. Without NAT, some protocols also become superfluous. And because each protocol that does not have to be implemented cannot open up any security holes, this is also a benefit with IPv6.

9.19 UDP - User Datagram Protocol

The User Datagram Protocol (UDP) is a minimal, connectionless network protocol. It operates on the fourth layer (transport layer) of the OSI layer model and therefore has a comparable task to fulfil as the connection-oriented TCP. The "connectionless" property means that the protocol operates insecurely, i.e. the sender does not find out if the sent data packages arrive. TCP sends confirmations after receipt of the data; not so with UDP. Advantage: the header is much smaller than with TCP.

9.19.1 Functioning of UDP

UDP has the same task as TCP, only that it hardly has any control functions and the protocol is lighter and therefore easier to process.

As such, UDP has no methods to ensure that a data package reaches the recipient. Numbering of the data packages is also done without. UDP cannot put together the data flow in the right sequence. Instead, the UDP packages are forwarded directly to the application. Therefore the application is responsible for secure data transmission.

Usually, UDP is used for applications and services that can handle data losses or that take care of connection management themselves. These are typically DNS queries, VPN connections, audio and video streaming.

9.19.2 Port structure

The port structure is common to both UDP and TCP, and this can enable several simultaneous connections for several applications via the network.

A number is saved to every UDP data package that defines a port, behind which is an application or service that tracks this port and receives the data from the UDP.

The port numbers are counted from 0 upwards and are permanently assigned to applications until port number 1023. All other port numbers above this can be randomly used by other programs. Fore example, programs occupy a free port to make contact with a server. The server then sends the data back to the freely selected port.

The port structure enables several applications to simultaneously implement connections via the network to several communication partners. UDP ensures that the data is not transferred to the wrong application.

9.20 Subnetting (subnet mask)

The dividing of a coherent address range of IP addresses into several smaller address ranges is called subnetting.

A subnet is a physical segment of a network in which IP addresses with the same network address are used. These subnets can be interconnected via a router and then form a large coherent network.

9.20.1 Purpose of subnetting

If IP addresses in a network are assigned at random without considering the physical network structure, the routers in the network must know in which subnet the addresses are found. Of course the routers can simply forward all data packages in the hope that the packages would at some time reach their destination. In this case though, higher transmission protocols would have to again demand or send the data packages believed lost, and that would increase the network load.

If new stations are added it would take a long time until all routers could identify the new stations. Single stations at the periphery of the network would be in danger of no longer being accessible because their IP address is not known at the other end of the network.

To sensibly and orderly distribute the network load, networks are divided according to their dependence on local conditions or according to organisational factors. Here, how many network stations are within a subnet is also taken into account.

Consideration of the physical structure of the network via the specific assignment of IP addresses and therefore a logical combining of several stations to a subnet reduces the routing information to the task of the network address. The network address ensures the location of an IP address in a specific subnet. A router then only needs the routing information to this subnet and not to all of the individual stations in this subnet. The last router that routes in the target subnet is then responsible for delivery of the data package.

9.20.2 Functioning of subnetting

Each IP address is divided into a network address and a station address. The subnet mask determines at which position this separation occurs. The following table shows all possible net masks. According to the network address and subnet mask used, a specific number of network stations (hosts) is addressable in a subnet.

Number of hosts	Subnet mask	Prefix
16.777.214	255.0.0.0	/8
8.388.606	255.128.0.0	/9
4.194.302	255.192.0.0	/10
2.097.150	255.224.0.0	/11
1.048.574	255.240.0.0	/12
524.286	255.248.0.0	/13
262.142	255.252.0.0	/14
131.070	255.254.0.0	/15
65.534	255.255.0.0	/16
32.766	255.255.128.0	/17
16.382	255.255.192.0	/18
8.190	255.255.224.0	/19
4.094	255.255.240.0	/20
2.046	255.255.248.0	/21
1.022	255.255.252.0	/22
510	255.255.254.0	/23
254	255.255.255.0	/24
126	255.255.255.128	/25
62	255.255.255.192	/26
30	255.255.255.224	/27
14	255.255.255.240	/28
6	255.255.255.248	/29
2	255.255.255.252	/30

The first and last IP address of an IP address range in each case (e.g. 192.168.0.0 to 192.168.0.255) designate the network address (e. g. 192.168.0.0) and broadcast address (e.g 192.168.0.255). These addresses cannot be assigned to a station. This is why the number of IP addresses must be reduced by two to get to the correct number of useable IP addresses.

The four decimal numbers of each IP address correspond to a 32 bit value in a dual system (display of a number in zeros and ones). The subnet mask with 32 bits is as long as any IP address. Each bit of the subnet mask is assigned to a bit of an IP address. The subnet mask thus consists of a coherent sequence of 1 and 0. At the position where the subnet mask jumps from 0 to 1, the IP address splits into network address and station address.

Example:

The subnet mask 255.255.255.0 corresponds to the 32 bit value

1111 1111 1111 1111 1111 1111 0000 0000.

The following table exemplarily shows how subnet mask, IP address, network address, station address and broadcast address belong together:

	Display				32 bit value
IP address	192	.168	.0	.1	1100 0000 1010 1000 0000 0000 0000 0001
Subnet mask	255	.255	.255	.0	1111 1111 1111 1111 1111 1111 0000 0000
Network address	192	.168	.0	.0	1100 0000 1010 1000 0000 0000 0000 0000
Station address	0	.0	.0	.1	0000 0000 0000 0000 0000 0000 0000 0001
Broadcast address	192	.168	.0	.255	1100 0000 1010 1000 0000 0000 1111 1111

The subnet mask is thus placed on the IP address like a template to find out the network address and station address. The information about the network address is important with the sending of an IP data package. If the network address is identical with source and target address, then the data package is sent within the same subnet. If the network addresses are different, then the data package must be routed via the standard gateway (the default gateway) to another subnet.

9.20.3 Notation method for IP address and subnet mask

To display IP address and subnet mask in combination, two notations have established themselves.

With the first notation, IP address and subnet mask are written in succession, e.g. 192.168.0.1/255.255.255.0.

With the second notation a prefix is used for the subnet mask, as shown in the table for the possible subnet masks, e.g. 192.168.0.1 /24. The prefix specifies how many 1's in the subnet mask in the 32 bit display exist sequentially. So the prefix 24 defines the subnet mask 255.255.255.0.

9.20.4 Network classes

Depending on the specific subnet mask, networks are specified in various classes. According to network class, a specific number of stations can be addressed.

There are three network classes:

– Class A: subnet mask 255.0.0.0, IP address range from 10.0.0.0 to 10.255.255.255

– Class B: subnet mask 255.255.0.0, IP address range from 172.16.0.0 to 172.31.255.255

– Class C: subnet mask 255.255.255.0, IP address range from 192.168.0.0 to 192.168.255.255

9.21 DHCP - Dynamic Host Configuration Protocol

The Dynamic Host Configuration Protocol (DHCP) manages IP addresses in a TCP/IP network and distributes these to the corresponding stations. With DHCP, each network station is capable of configuring itself completely automatically.

9.21.1 Purpose of DHCP

To set up a network via TCP/IP, each single station has to be configured. The following settings must be made here:

- Assigning of a unique IP address
- Assigning of a subnet mask
- Assigning of the default/standard gateway
- DNS server addresses

Originally, the IP addresses in a network were assigned manually and permanently saved to the operating system of a computer (or a station). The documentation needed for this was however not always free of errors and almost never up-to-date and complete. And so the desire came about for simple and automatic address administration, especially with the operators of large networks. DHCP was developed to reduce the high effort for planning and work time.

DHCP enables all network stations to demand address configuration from a DHCP server, and to automatically configure themselves. In this way, IP addresses no longer have to be manually managed and assigned.

However, the option DHCP can be deactivated via the firmware of a station. This may be necessary for example when a station has to be integrated into an old network without a DHCP server.

9.21.2 Functioning of DHCP

DHCP works on the basis of a client server architecture. This means that a DHCP server has a pool of IP addresses that it can assign to the specific DHCP clients. With larger networks the DHCP server also has to know which subnets and standard gateways exist in the network. Normally the DHCP server is a router, e.g. a FRITZ!Box from AVM.

Each DHCP-compatible device has a so-called DHCP client. If a station or device is started with an activated DHCP client, then a mode of the TCP/IP stack, limited in its function, is run. This has no valid IP address, no subnet mask and no standard gateway.

In this case the client can only send IP broadcasts. The DHCP client sends a UDP package with the target address 255.255.255.255 and the source address 0.0.0.0. This broadcast serves as address demand to all available DHCP servers. Optimal is when only one DHCP server exists. This avoids conflicts with the assigning of addresses.

The DHCP server responds to the broadcast with a free IP address and further parameters. Following that, data transfer is confirmed.

Not only IP addresses are distributed with DHCP. Further parameters are also passed on to complete the IP configuration in the client. Each initiated DHCP server returns a UDP package with the following data:

– MAC address of the client

– Possible IP address

– Run time of the IP address

– Subnet mask

– IP address of the DHCP server/Server ID

From the selection of possibly several DHCP servers, the DHCP client locates an IP address. It then transmits a positive message to the corresponding DHCP server. All other servers also receive the message and assume the acceptance of the IP address by another server. Then the assignment of the IP address by the DHCP server has to be confirmed. As soon as the DHCP client has received the confirmation it saves the data locally. Finally the TCP/IP stack is started completely.

But DHCP can not only give the client the data for the TCP/IP network. If the DHCP client is capable of evaluating further data then the DHCP server also passes on further information such as:

– Time Server

– Name Server

– Domain Name Server (alternative)

– WINS Server

– Domain Name

– Default IP TTL

– Broadcast Address

– SMTP Server

– POP3 Server

Example for the Gira nurse call system Plus

With the Gira nurse call system Plus, a differentiation is made between small and large systems.

In large systems the system central control unit is used as a DHCP server that transmits the requisite network information to the connected ward control centres and CT9 duty room terminals. To configure the system central control unit, it is connected via a second network connection (external LAN) to a foreign network for example. The external LAN connection also has a DHCP client that is deactivated as standard. The central control unit has a permanent IP address that is active as standard so that the device can be accessed directly over the foreign network.

In small systems the ward control centre is used as a DHCP server that transmits the requisite network information to the connected CT9 duty room terminals. To configure the ward control centre, it is connected via a second network connection (external LAN) to a foreign network for example. The external LAN connection also has a DHCP client that is deactivated as standard. The ward control centre has a permanent IP address that is active as standard so that the device can be accessed directly over the foreign network.

9.22 Command line tools for network analysis

The command line tools for network technology offer the benefit under Windows that already existing network connections can be analysed and the connection setup can be tested. The tools are input via the Windows DOS entry prompt.

This chapter makes you familiar with the most important command line tools under Windows. These are:

– ipconfig

– ping, pathping

– Trace Route

– ARP

– Netstat

9.22.1 ipconfig/winipcfg (Windows)

ipconfig is a command in the Microsoft Windows operating system for example (from the network-compatible versions Windows NT und Windows 2000 onwards), that displays hardware addresses of the devices used in the local network, as far as this network operates with the TCP/IP transmission protocol. The command is input for example with a Windows operating system in the DOS entry prompt (call up via Start/run "cmd").

With the ipconfig command, the address data of the local IP network are called. The addresses can be seen as well via the system control under network settings. Display via the ipconfig command has the advantage that the data are shown clearly and concisely.

ipconfig can supply the following general information:

– IP address

– Subnet mask

– Standard gateway

Ethernet adapter, LAN connection:

With **ipconfig /all**, the following information can be output:

– Host name

– DNS server

– NetBIOS node type

– NetBIOS area ID

– IP routing activated

– WINS proxy activated

– NetBIOS resolution via DNS

Information for all network adapters including modems and ISDN cards are supplied for:

– Description

– Physical address (MAC address)

– DHCP activated

– Subnet mask

– Standard gateway

– DHCP server

– First WINS server

– Second WINS server

– Valid since

– Valid until

Example for calling with ipconfig / all

Windows IP configuration

Hostname. . . . . : TESTPC
Primary DNS suffix. . . . . :
Node type. . . . . : Hybrid
IP routing activated. . . . . : No
WINS proxy activated. . . . . .: No

Ethernet adapter, LAN connection:

Connection-specific DNS suffix. . . . . : t-online.de
Description. . . . . : Intel (R) PRO/100
Physical address. . . . . : 00-0C-B1-2E-D5-E2
DHCP activated. . . . . : Yes
Autoconfiguration activated. . . . . : Yes
IPv6 address. . . . . : 2001:db8:1:1:2570:79ba:984b:f44b(preferential)
Local connection IPv6 address. . . . . : fe80::2570:79ba:984b:f44b%1(preferential)
IP address. . . . . : 192.168.168.20
Subnet mask. . . . . : 255.255.255.0
Lease received. . . . . : Monday, 24. January 2011
Lease expires. . . . . : Monday, 24. January 2011
Standard gateway. . . . . : fe80::2d0:3ff:fe3c:7d00%1
192.168.168.1
DHCP server. . . . . : 192.168.168.1
DNS server. . . . . : 192.168.168.1

winipcfg (winipcfg.exe)

Those not wishing to work with the DOS entry prompt can also work with the Windows (Windows 9x) internal tool, **winipcfg.exe**

With a Windows standard installation this is found at **c:\windows\-path** or can be started via the run dialogue box with winipcfg.exe.

Winipcfg offers the same information and functions as ipconfig. But this variant should only be used by experienced network users or specialists.

9.22.2 Ping - Packet Internet Groper/pathping

Ping (Packet Internet Groper) is the most commonly used tool to test a network connection to another station or simply to test the local TCP/IP stack.

In the Windows operating system, Ping is available on the command line level (DOS entry prompt) as the command **ping**. The remote station can be accessed via the IP address or the domain or WINS name. If required, ping assumes the name resolution. The ping command

can be called with options that can be taken from the help system of the operating system used.

Under Windows the ping command executes the ping only 4 times in succession. With Unix or Linux the ping command executes the ping until the command is aborted. Press CTRL and C (CTRL + C) to abort.

Applications for Ping

The following information can be called with the Ping command:

– Determination of run time of a data package from sender to recipient. Here the time until the answer inputs as an echo (echo reply) is halved.

– Testing whether a station has a contact to the network, e.g. with a ping to an adjacent station or the standard gateway.

– Testing whether the TCP/IP is installed on the local station at all, e.g. with a ping to the local host or the IP address 127.0.0.1.

– Testing whether important stations (e.g. servers) are available, by querying the availability of each TCP/IP stack or the server availability with regular pings.

Pathping

Pathping is an extension of ping. It analyses the stations, similar to **tracert** or **traceroute** - over the complete path that a data package must take to a target.

Depending on the overcome stations, pathping supplies statistics after a few minutes about the accessibility of the single stations.

9.22.3 Trace Route

With Trace Route (often known as traceroute or tracert), route tracing can be carried out and visualised. Trace Route functions in a similar way to ping. This tool however gives users more information about the network connection between the local station and the remote station.

Trace Route appears on the command line/console as the command "traceroute" under Unix/ Linux and "tracert " under Windows. The remote station can be accessed via the IP address or the domain or WINS name. Trace Route also takes on name resolution if required.

Trace Route has several options to supply more information. This though will not be detailed here. The help system of the operating system has information about this.

9.22.4 ARP - Address Resolution Protocol

The Address Resolution Protocol (ARP) operates on layer 2 (security layer) of the OSI layer model and determines the hardware addresses and MAC addresses of the specific devices via IP addresses. All network types and topologies use hardware addresses to address the data packages. The hardware address of the target must be known for an IP package to reach its target.

Each network card has a unique hardware address permanently set on the card (see also "What is a MAC address?" on page 165).

Address resolution must occur via ARP before a data package can be sent. For this, ARP needs access to the IP address and hardware address. To access the hardware address of

another station, ARP sends for example an ethernet frame as broadcast message with the MAC address "FF FF FF FF FF FF". This message is received and evaluated by every network interface. The ethernet frame contains the IP address of the searched for station. If a station wants to be accessed by this IP address, it sends an ARP response back to the sender. The registered MAC address is then saved to the local cache of the sender. This cache is for quicker ARP address resolution.

Example 1: ARP request to all stations.

Station A wants to send data to station B with the internet address I(B), and does not yet know its physical address P(B). It sends an ARP request to all stations in the network that contain the specific physical address and the IP address of B.

There is also a standardised procedure for the reverse function, the RARP (Reverse ARP). Here, station A sends an RARP Request and specifies its physical address P(A). If in the network only one station is set up as RARP server (a station that "knows" all assignments of P(x) <--> I(x)), this then responds with an RARP reply to the requesting station, that contains I(A).

This function is important for example for so-called "diskless workstations" that load all of their software from a server.

Example 2: ARP command under Windows

To find out which physical address for example your PC has, you can open the command line layer on your PC under windows. Entering the command **arp** with options taken from the help system of the operating system displays the physical address.

9.22.5 Netstat

Netstat is a command line tool that displays all active TCP, UDP and IP connections, the routing table and detailed statistics for the TCP/IP data.

Netstat is entered as a command for example in the DOS prompt of Windows. The command can be called with various options that enable the display of various information.

Among others, calling can be with the following options:

– **netstat -a**: lists all active connections.

– **netstat -r**: lists the routing table.

– **netstat -s**: shows detailed statistics for the TCP/IP data.

Further options and more detailed information can be viewed in the help system of the operating system used.

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