3 *Transmission via the 230/400V power supply*

3.1 Introduction

The *EIB* can also be implemented on the 230 V supply network (power line, PL).
This extension to power line transmission opens up further fields of application. Components and tools already introduced and established on the market can, to a large extent, also be used by *EIB powerline*.
It is no longer necessary to lay separate bus lines. *EIB powerline* devices simply require the connection of active and neutral conductors.

EIB powerline

Applications of *EIB powerline* exist for updates, but also for new installations. Device dimensions and operating methods are similar to those already seen for previous, familiar *EIB* components.
Despite the often indefinite transmission properties of the low-voltage network for high-frequency signals, *EIB powerline* facilitates a fast and secure means of data transmission.
The system is bi-directional and works in half-duplex mode; i.e. every device can transmit and receive messages. It also supports the functions of the HomeAssistant.
EIB powerline is conformant with current European standards, in particular those of the DIN EN 50065 series (dealing with signalling on low-voltage electrical installations in the frequency range of 3 kHz to 148.5 kHz) and the DIN 50090 series (dealing with electrical system technology for homes and buildings, HBES).

3.1.1 Applications

In situations where, for whatever reason, the installation of a separate, additional bus line to an existent system is not desired or not possible, the use of the available 230/400 V supply network opens up new perspectives. Economy, flexibility and transmission reliability stand at the forefront of this development.
Intelligent components for almost all aspects of the conceivable applications are used to implement the desired functions.
Typical applications for the use of *EIB powerline* are:
- Switching and controlling lights, heating systems, ventilation and air conditioning.
- Blind, gate and awning control.
- Signalling functions.
- Transmission of analogue values.
- Time controls and the simulation of occupancy.

The above named applications are only the tip of the iceberg. It is true to say that the applications of *EIB powerline* cover almost all of those associated with *EIB* systems based on twisted pair lines (see Fig. 3.1-1).

3.1.2 The 230/400 V supply network as the transmission medium

The primary function of the 230/400 V network is the supply of electrical energy. *EIB powerline* uses the available lines for a dual purpose: for energy and information. As the signals for the transmission of information are applied and received between the active and neutral conductors, both these wires must exist in every connected device.

Open network Impedance

As the 230/400 V network is not available in its original form for the transmission of information, the *EIB powerline* system must be adjusted to the possibilities offered by the network. In a signalling sense, the 230/400 V network is an

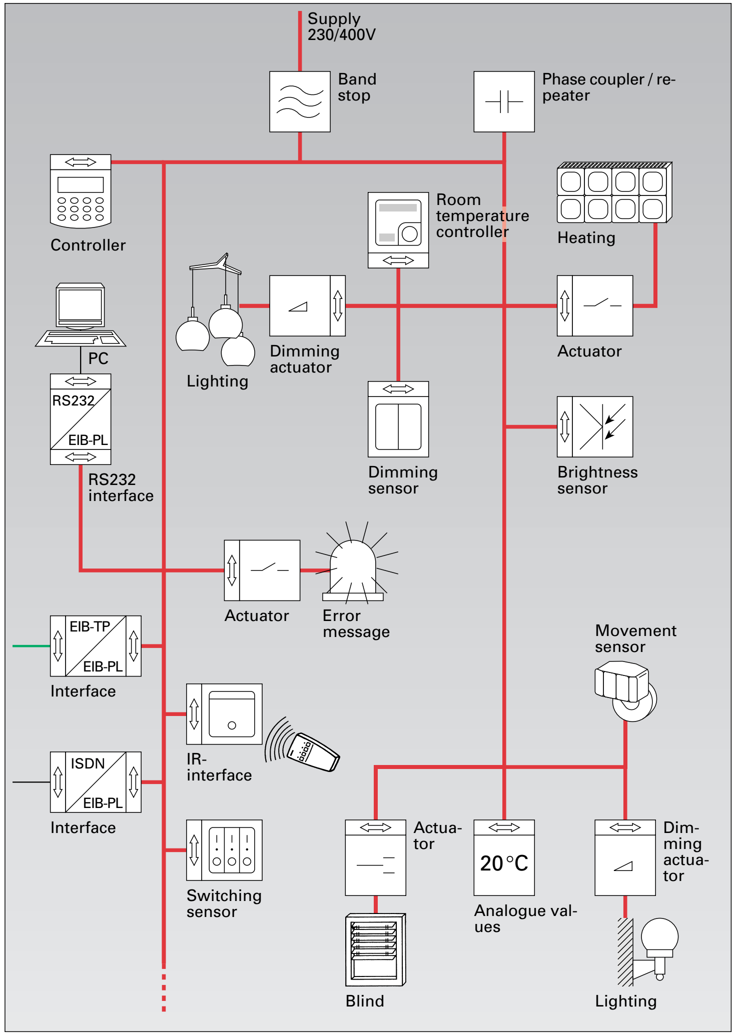

Fig. 3.1-1 *EIB powerline system overview*

open network, whose transmission behaviour, impedance and induced interference are largely unknown. When planning, the basic rules of the transmission technology must be taken into account (see chapter 3.2.3.1).

3.1.2.1 Mains power supply

Transmission across a transformer is not possible.
The network must have an undistorted, sinusoidal voltage curve with a rated voltage of 230 V. The permitted tolerance for this voltage is equal to ± 10%. Different network structures and parameters (e.g. inverter networks) are not permitted.

3.1.2.2 Mains frequency

The *EIB powerline* system is designed for a mains frequency of 50 Hz. A deviation of ± 0.5 Hz is tolerated by the system. The electric power company provides an accurate enough network. With larger deviations, as sometimes seen with emergency power units for example, transmission may be distorted. It is therefore necessary to check whether the mains frequency and network structure of the emergency power unit are sufficiently accurate.

3.1.2.3 Radio interference

Almost every electrical device that is operated on a 230 V network generates radio interference which is fed to the network. Every device manufacturer must ensure that the threshold values for radio interference as specified by the electric power company are not exceeded.
Compared with the permitted transmitting level of the *EIB powerline* devices, this radio interference is very small. Individual devices do not have any effect on the transmission. However, if several devices are connected in parallel, this may lead to overlapping and with that to increases in the radio interference. In such cases it is necessary to take into account the interference load during the pre-planning stage, by considering the load characteristics of each device (see chapter 3.2.3.3).

3.1.2.4 Mains impedance

EIB powerline is capable of detecting and analysing even the smallest of signal voltages.
A reduction of the signal voltage is usually seen in 230 V networks as a result of the capacitors that are provided in almost all electrical devices. Although this reduces the mains impedance the transmission and receiving circuits of *EIB powerline* adapt themselves to these changes.

Mains impedance

3.1.3 The transmission method

In order to be able to guarantee secure data transmission on the mains network, a new transmission method has been developed.
This new method is denoted SFSK, which stands for Spread Frequency Shift Keying. This guarantees high system reliability for all typical network conditions (see Fig. 3.1-2).
With this method, the signals are transmitted with two separate frequencies. Thanks to the so-called “correlative pattern comparison technology” and the complex correction

SFSK – Spread Frequency Shift Keying

Correlative pattern comparison technology

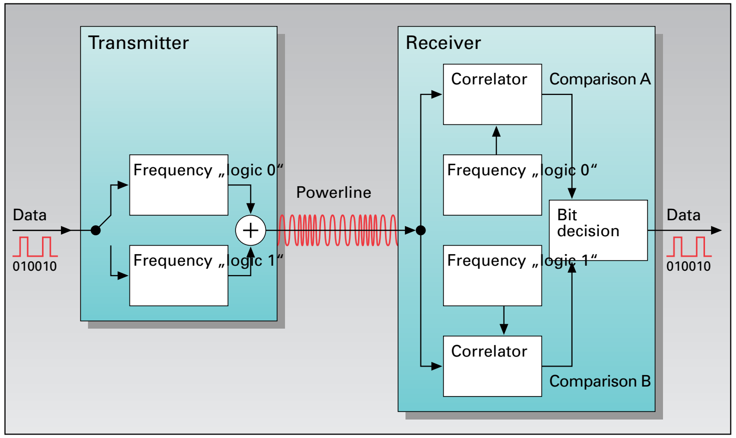

Fig. 3.1-2 EIB powerline transmission procedure

procedures, signals can be ‘repaired’ upon reception, even if there has been interference during transmission. After the successful understanding of a telegram, an acknowledgement is sent from the receiver to the transmitter. Only then is the transmission process complete. If a transmitter fails to receive a reply, it repeats the transmission process. Such a transmission process takes about 130 ms. The transmission rate of the system is 1,200 bit/s.

Frequency band

For transmission, *EIB powerline* uses a frequency band in accordance with EN50065. In the frequency band of 95kHz to 125kHz, the used frequencies are 105.6kHz and 115.2kHz.

Transmitting level

According to EN50065 such devices are designated as “class 116” devices. This means that the maximum transmitting level is equal to 116 dB (mV) on a standardised artificial mains network.

3.1.4 Topology

To guarantee reliable communication within an *EIB powerline* project, certain basic requirements must be fulfilled. The maximum number of devices within such a project should be limited to several thousand. This is necessary all the more considering that there is no possibility of a physical division into areas and lines using corresponding couplers. On the one hand, this significantly eases the installation of *EIB powerline*, but it also leads to greater telegram loads on the bus. To ensure that a clear overview is maintained in more extensive systems, a structured layout proves useful. Similar to *EIB-TP*, the system is logically divided into areas and lines. With *EIB powerline* there are a total of 8 areas each with 16 lines of 256 devices (see Fig. 3.1-3).

Overshooting
Inductive disturbance
Band stops

To avoid any overshooting into adjacent areas or inductive disturbance between neighbouring *EIB powerline* projects, band stops must be used.

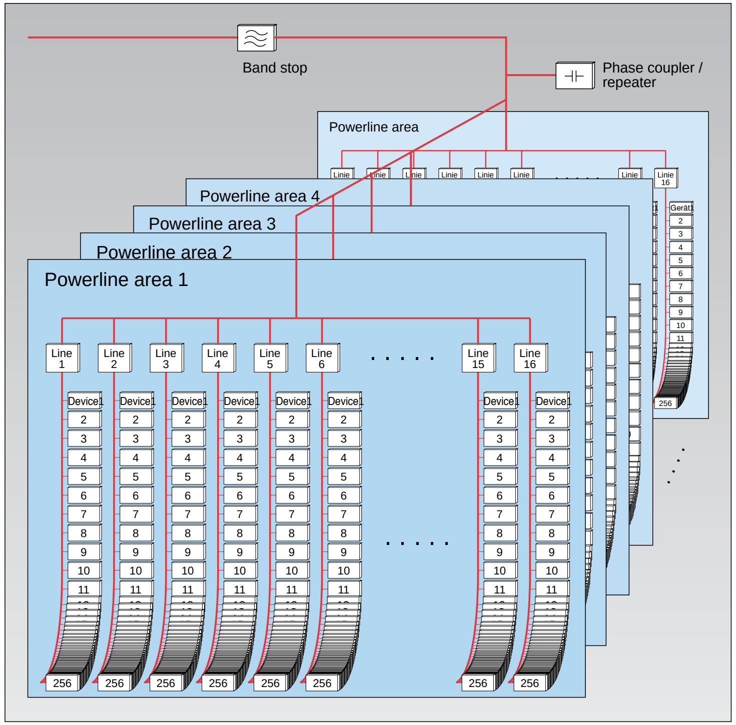

Fig. 3.1-3 EIB powerline topology

3.2 Planning

In the planning phase the exact requirements of the customer are established and then translated into the form of a specifications document or checklist.
The *EIB powerline* devices can communicate with one another from any 230/400 V network connection. All *EIB powerline* devices need a connection to the active and neutral conductors. A certain degree of reserve should be allowed in the distribution panels for subsequent extensions.

Technical connection requirements

The *EIB powerline* system must be planned in accordance with the general, established rules of the technology whilst adhering to the various regional connection requirements laid down by the respective electric power company.

3.2.1 Establishing the customer requirements

The customer requirements can be determined by asking the following questions:

- In which areas of the building should *EIB powerline* be installed immediately and where at a possible later date?
- How is the room divided up and where might this change at a later date? The answer to this question determines the division of lights, blinds and radiators etc. into individual switching groups.
- Will there be any later extensions to the system? If so, sufficient space must be left in the distribution panels.
- Within a building should a universal *EIB powerline* system be installed and/or should there be independent areas per building unit? With the help of band stops it is possible to isolate the areas from one another, thereby preventing unauthorised access. These independent areas can then be reconnected with one another via couplers so that they can exchange information.
- Which functions should the *EIB powerline* system carry out? Possible functions include controlling lights, blinds, heating systems, etc.
- Should these functions be linked together? It is possible for example, to link the window monitoring with the heating control.
- How should the consumers be controlled? With respect to time, wind strength, brightness etc.
- Are priorities needed for certain functions? With the lighting for example, manual operation can be given a higher priority than brightness-dependent control.
- Should the operating statuses of the system be displayed in a central location and should it be possible to change the statuses from there? There are suitable controllers, display and operating panels or PCs available for this.
- Are energy saving measures required?
- Are preventative measures to be included to discourage break-ins? Using time controls with random generators for the lights or blinds, it is possible to simulate occupancy. Movement detectors can be used to trigger various functions, e.g. the exterior lighting. If an *EIB powerline* system is to be used in conjunction with an *EIB-TP* installation, the media couplers described in chapter 3.3.2.7 must be installed.

3.2.2 Writing the specifications

The specifications should provide the answers to the questions posed in Appendix A.

3.2.3 Planning and installation guidelines

As with every other transmission medium in building systems engineering, there are specific guidelines for planning and installing *EIB powerline*, which must be followed to guarantee the trouble-free functioning of the system. These guidelines make it easier to assess whether the modernisation is possible in view of the local conditions and with that simplify the detailed planning.

3.2.3.1 Application areas / basic rules

Independent of the functions to be executed, *EIB powerline* systems must involve “isolated signal areas”.
This includes:

- Network areas that are disconnected from one another by band stops, e.g. in single family houses or apartment blocks.
- Island networks in object areas, e.g. lighting or blind controls in industrial and administration buildings.

The following are excluded:

- Signal transmission between houses or buildings within a street, city area etc. due to the regulations.
- Use in industrial networks involving machines and equipment without sufficient shielding from interference (such as for example, erosion machines, automatic welding machines etc.) if these cannot be separated from the network used for transmission by employing suitable interference suppressing and filter measures (e.g. band stops) or separate wiring.
- Local networks whose parameters differ from the normal network (required characteristics: 230 V ±10%, 50 Hz ±0.5%).
- Transmissions across a transformer.
- Areas in which other carrier-frequency systems are possibly used for the transmission of network data.

In general it is true to say that *EIB powerline* cannot be used for safety-relevant applications (e.g. monitoring life-support or life-saving machines in hospitals, P.A. systems, alarm systems and signalling systems, etc.), because mains-based transmission media are not permitted for these applications!

3.2.3.2 Basic requirements

The number of available *EIB powerline* addresses is equal to 32,768.
These can be divided up into 8 logical areas of 16 lines each, where each line can hold up to 256 devices, to provide a more structured layout. The actual maximum number of *EIB powerline* devices that can be used within a system is determined by the characteristic criteria described in chapter 3.2.3.3.

Characteristic criteria

The system must involve self-contained installation areas, as described in chapter 3.2.3.1.
A pre-requisite for the trouble-free operation of *EIB powerline* is perfect radio interference suppression for all electrical consumers used in the system. This can today be assumed as a consequence of the legal legal requirements and standards for these devices.
When using a great number of electric motor driven devices and frequency controlled devices, they should if necessary be checked (see chapter 3.1.2.3). If there is any doubt, a test measurement should be made in the installation area to be used for the transmission.

3.2.3.3 Pre-planning

The planning of an *EIB powerline* system follows the general, established rules of the technology whilst adhering to the various regional connection conditions laid down by the respective electric power company. As transmission occurs via the 230 V network, the current regulations according to VDE 0100 apply.

As the 230 V installation network in its original form is not intended for the transmission of information, the *EIB powerline* system must be adapted to match the available possibilities. In a signalling sense, it is an open network, whose transmission behaviour, impedance and induced interference are largely unknown. For the installation, this means that basic rules must be stipulated, in order to be able to detect and record obvious sources of radio noise during the planning stage. For this we use a characteristic number (see Appendix H) to plan the rough outlines of an *EIB powerline* system. This procedure is based on the approximation that every typical consumer in the network can be assigned a load characteristic number that identifies the degree of noise load. The sum of the load characteristic numbers for all the devices within a system in relation to the maximum transmission path between two powerline devices, yields a total load characteristic number, Z. This Z number can be used to evaluate which, if any, further planning steps are necessary.

Load characteristic

Example:
In a one-family house with approx. 200m2 of living area, the lights and blinds are to be controlled with *EIB powerline* devices. The planning has yielded a total of 130 necessary *EIB powerline* devices. From a customer survey, the number of devices in the network and with that the associated load numbers are established as follows (see Table 3.2-1).

Total load characteristic number, Z

Device	Quantity		Char. num.		Sum
PC	1	x	50	=	50
Monitor	1	x	50	=	50
Television	1	x	50	=	50
HiFi / video	5	x	10	=	50
Electronic transformers	4	x	50	=	200
Small electric devices	4	x	10	=	40
Filament lamps	50	x	1	=	50
EIB powerline devices	130	x	1	=	130
Total load characteristic number					**620**

Table 3.2-1 Establishing the total load characteristic number for EIBpowerline

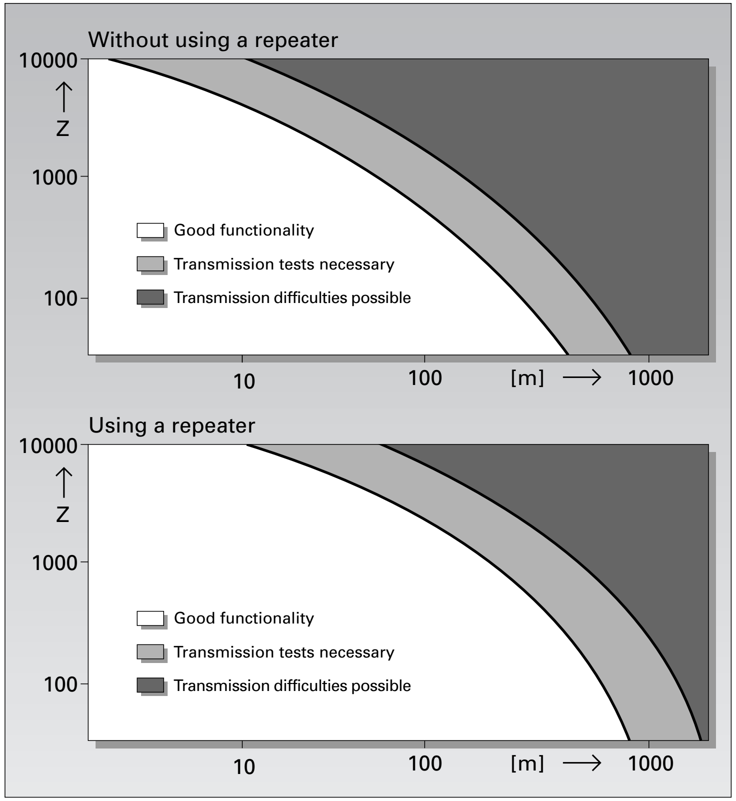

Fig. 3.2-2 The relationship between the total load characteristic number and the maximum line length between two EIB powerline devices

From the diagrams (see Fig. 3.2-2) the maximum line length between two *EIB powerline* devices can be read for various values of the total load characteristic number, Z (200 m with and 100 m without the use of a repeater).

Repeater

3.2.3.4 Planning steps for *EIB powerline* signal transmission

The following planning rules must be followed for every *EIB powerline* system, to achieve a defined basis for trouble-free signal transmission.

3.2.3.4.1 Achieving isolated signal areas

Band stop

Every *EIB powerline* system must be filtered out from the normal network with band stops (see Fig. 3.2-3). The maximum terminal capacity of the band stop is equal to 63 A per active conductor. Filtering must be provided for all three active conductors.
The band stops should be installed in front of the circuits necessary for signal transmission or directly behind the main fuses or the earth leakage circuit breaker.
The structure of the band stop is single-phase, which facilitates division when installing in the distribution panel, enabling better use of the available space.
The maximum wire cross section is equal to 25 mm^2.

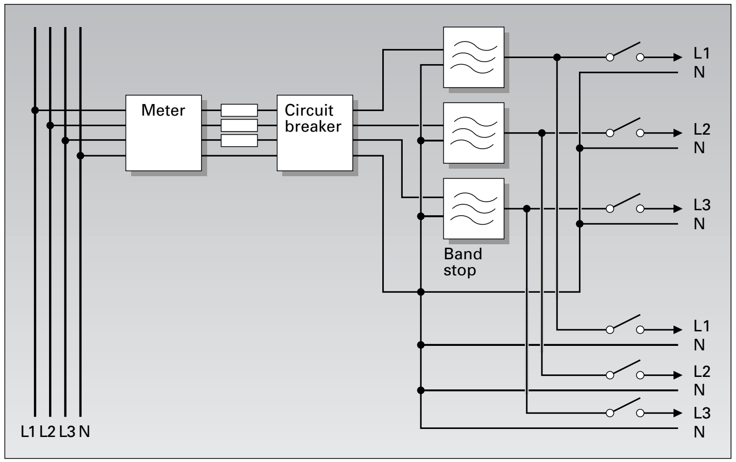

Fig. 3.2-3 Dividing circuits between band stops

3.2.3.4.2 Checking a defined phase coupling

Phase coupling

To achieve defined phase coupling, a phase coupler is installed for every system or in the case of extended networks, a repeater is used (see Fig. 3.2-4).
Phase couplers and repeaters require a three-phase connection.

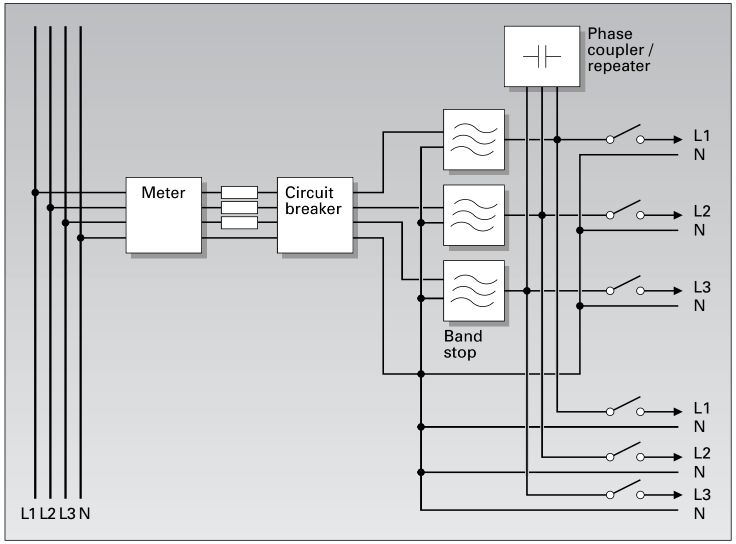

Fig. 3.2-4 Installation of an EIB powerline phase coupler/repeater

3.2.3.4.3 Planning when using a repeater

Only one repeater is permitted per *EIB powerline* system. The repeater is suitable for three-phase connection. It should be installed in a "central point" of the *EIB powerline* system, in order to be able to attain the largest possible signal range.

3.2.3.4.4 Installation wires and material

– The use of shielded wires (with earthed shielding) and cross-sections larger than 25 mm^2 are not permitted for the transmission paths.
– Automatic cutouts or earth leakage circuit breakers with nominal currents less than 10 A are not permitted within the *EIB powerline* signal circuits. In these situations, it is necessary to fall back on the use of safety fuses.

3.2.3.4.5 Telegram load

Transmission duration

The transmission duration of a telegram is approximately equal to 130 ms. This means that up to 6 telegrams/s can be transmitted via the 230 V network.

Transmission rate

Despite this high transmission rate, in practice a high simultaneity of transmission signals needs to be avoided. (Example: Cyclic transmission and polling functions in a time period less than 300 ms or the simultaneous control of more than 4 binary inputs.)

3.2.3.4.6 Device connection

All devices require the connection of active and neutral conductors.
The connection of load and signal lines must be done separately for all *EIB powerline* devices. When working with *EIB powerline* systems with known sources of radio noise (e.g. inverters, UPS supplies) separation of the load and signal circuits can be taken into account right from the planning stage.

3.2.3.4.7 Wiring arrangement

Overcoupling

Any configuration can be used – tree, star or ring.
When there are several *EIB powerline* systems within one building, the parallel wiring of different systems should be

avoided to prevent any overcoupling.

3.2.3.4.8 Overvoltage protection

As regards the planning and installation of components for protection against surge voltage, the usual standards and regulations for 230/400 V installations apply.

3.3 Project design

3.3.1 *EIB powerline* devices

The *EIB powerline* devices can be categorised as one of three structures according to the way they are installed.

Mains coupling unit

Application modules/terminals are fitted onto the flush-mounted mains coupling unit. Contact is achieved with the 10-pin user interface. The active and neutral conductors are connected via two terminal screws (conductor cross section of 1 - 2.5 mm^2).
EIB powerline devices in the form of DIN rail mounted units are snapped onto the DIN rail. Connection to an *EIB powerline* line is achieved via terminal screws (conductor cross section of 1 - 2.5 mm^2). To simplify wiring through to other devices, there are two terminals each for the connection of active and neutral conductors that are bridged internally.
EIB powerline devices in the form of surface-mounted or built-in units are attached and connected according to the manufacturer specifications. Connection to an *EIB powerline* line is also achieved here using terminal screws (conductor cross section of 1 - 2.5 mm^2).

3.3.2 Installation material for *EIB powerline*

3.3.2.1 General requirements

EIB conformity is guaranteed with the use of EIBA certified products. This is also indicated on *EIB powerline* devices with the *EIB* trademark. For the assurance of electrical safety, the manufacturer must follow the national (DIN VDE 0632 section 1 and section 501) and international regulations (EN 60669-1 as well as EN 60669-21 and IEC 669-1, 669-2-1).

3.3.2.2 Bus lines

Separate bus lines are not required as the conventional mains lines are used here. There are no known restrictions for current cable and wire types. The use of shielded 230 V lines, for which the shielding is earthed, can in practice cause strong signal attenuation for *EIB powerline* signals. This is caused by the capacity of the individual conductor, which builds up against the shielding or shielding earth. If the use of shielding is essential, a trial measurement must be made to decide upon the suitability of *EIB powerline* transmission. The same goes for mains lines with a cross section greater than 25 mm².

3.3.2.3 Automatic cutouts and earth leakage circuit breakers

In general, all types of fuses and earth leakage circuit breakers can be used. They do not represent obstacles for the transmission of signals. For the protection of circuits or devices with nominal currents less than 10 A, it is necessary to fall back on the use of safety fuse elements due to the high insertion loss.

3.3.2.4 Band stops

Band stop

The band stop is provided as a DIN rail mounted device. It is used to protect the *EIB powerline* system from any overshooting of the signals into adjacent areas, as well as to separate neighbouring *EIB powerline* systems from one another. The use of band stops is essential to guarantee the perfect functioning of the system and to fulfil the applicable regulations. The band stop is installed in front of the circuits for signal transmission or directly behind the main fuses or the main earth leakage circuit breaker (see Fig. 3.3-1). Because we are dealing with a series filter, it is necessary to ensure correct installation. It is basically necessary to use three band stops for three-phase operation. The band stops are single-phase units. These can be installed in the sub-distribution panel thereby making better use of the available space.

Series filter

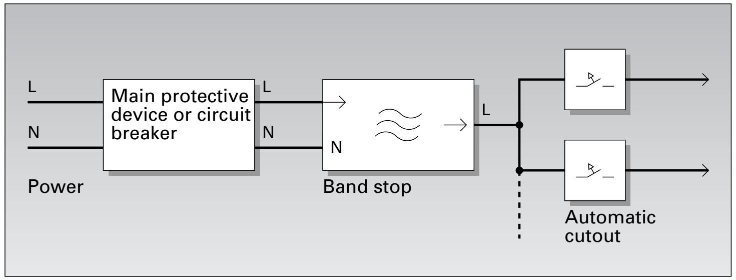

Fig. 3.3-1 Installation of an EIB powerline band stop

Load reduction must be taken into consideration for these devices due to the fact that they warm up in operation depending on the load and the ambient temperature.
The maximum load of the band stop is equal to 63 A. Connection occurs via terminal screws for a wire cross section up to a maximum of 25 mm² for the respective active conductor and a terminal screw with a wire cross section up

to a maximum of 2.5 mm^2 for the neutral conductor. If in special cases the current load of 63 A proves insufficient, the fuse circuits used for transmission must be divided among several band stops (see Fig. 3.2-3). Only when there is a separate transformer area can the use of band stops be avoided.

3.3.2.5 *EIB powerline* controller

3.3.2.5.1 Device layout

Powerline controller

The *EIB powerline* controller is a "desktop device" that can be connected to an *EIB powerline* system via a 230 V plug. The user interface is a 7-line LCD display and it is operated via 14 keys. All inputs are made using 4 cursor keys, an OK key and an ESC key (see Fig. 3.3-2).

Scroll bar
Cursor keys

There is an optional help line in the display, which gives information about the key functions available for the current menu item. A scroll bar indicates current position as soon

Fig. 3.3-2 The EIB powerline controller

as a display contains more information than can be shown on the screen. Necessary text inputs are also made using the cursor keys. More extensive text inputs can also be made directly via a standard PC keyboard, which is connected to the rear of the controller via a DIN plug. The rear of the controller also contains an RS 232 interface for data exchange with a PC. A zero modem cable is used for data transmission.
In total it is possible to program and operate up to 400 *EIBpowerline* system devices with the controller.

3.3.2.5.2 Modes of operation

As the central programming and operating unit, the *EIBpowerline* controller has the following three modes of operation:

– System settings
– Installation
– Control centre operation.

3.3.2.5.2.1 System settings

In this mode of operation, the controller is configured for use in an *EIB powerline* system. This involves setting the actual time and date, determining the display options (lighting, help line etc.) as well as establishing the user level (see Fig. 3.3-3).
The last point allows switching between a "simple" mode with basic functions and an "extended" mode with specialised functions and display possibilities for experienced users. By setting a controller number the use of up to 9 controllers within a single system is possible. The "operating system update" menu item facilitates the extension of or changes to the function range, e.g. to implement new functions from the manufacturer. In this situation, the new operating system is loaded into the controller from a PC.

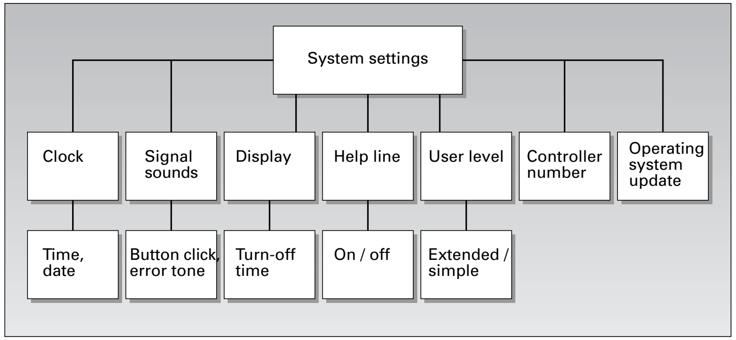

Fig. 3.3-3 System settings of the controller

3.3.2.5.2.2 Installation operation

Installation operation

In the installation mode of operation an entire *EIB powerline* project is designed and programmed into the respective devices. The sequence is based on the actual spatial and functional possibilities/requirements that exist in the project. The first step is to define the rooms (e.g. living room, bedroom, etc.) in which the functions (e.g. switching the lights on and off, adjusting/raising the blinds, etc.) are to be executed. To improve the overall clarity, these functions should then be divided into separate function groups (e.g. lights, blinds, heating, etc.).
The actions of the required/desired devices are now assigned with their input and output channels and options. The parameters of these devices can, if necessary, be adapted accordingly. During the entire planning process neither physical addresses nor group addresses appear on the screen. These are specified in the background and are "invisible" to the user. After programming is complete, installation operation can be blocked with the corresponding password. This prevents the end user making any "accidental" changes to the established functions (see Fig. 3.3-4).

New installation
This involves establishing the project data (project code, customer data, etc.). Because the controller can only be used on one project at a time, any other project already edited with the same device must first be saved. The project planner is guided through the menu accordingly.

Adding/editing actions
These two menu points allow the necessary actions to be changed or extended. It is possible to assign new devices or to adjust room or function allocations.

Edit devices/rooms
The parameters of devices already assigned to certain actions can be modified. It is also possible with this menu item to delete devices or their assigned functions or to change room codes.

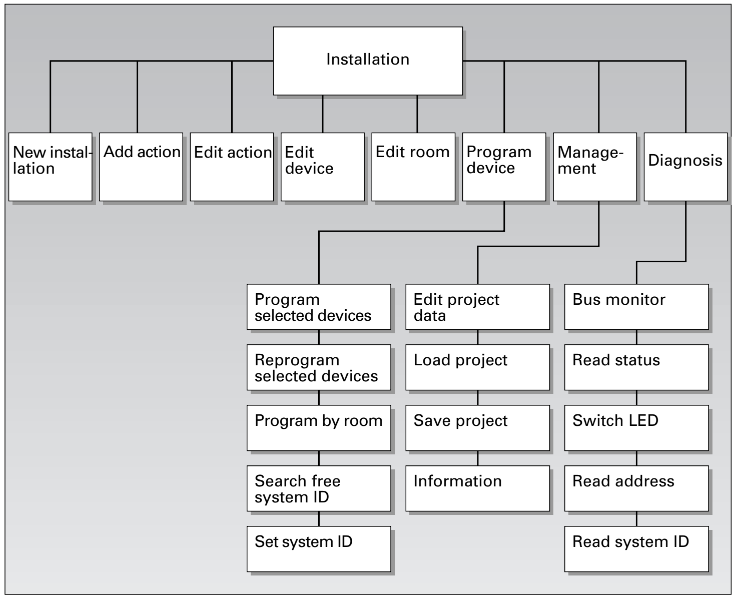

Fig. 3.3-4 Installation operation of the controller

Programming the devices
This menu item is used to program the devices. There are various useful options.

Management
This involves the management of several projects that have been set up with the *EIB powerline* controller. For security, this data can be saved on a PC and then reloaded into the controller when needed.

Diagnosis
This menu point contains various help options for servicing. Simple bus monitoring functions are also provided at this point, e.g. for reading addresses from an *EIB powerline* device.

3.3.2.5.2.3 Control centre operation

After completing the programming, this mode of operation provides the end user with a flexible, manual and time-dependent means of control for all devices and functions of an *EIB powerline* system. The user also works with the rooms, functions and actions already established in the programming. It is possible to define and call up different scenarios, in which for example a variety of single actions are combined together depending on the situation. When there are any changes to the usage of the rooms, the user can alter the terms set down in the planning stage without requiring knowledge of the programming. It is not possible for the end user to simply change the actions, this can only be done be the project planner.
In addition to manual control, all actions and scenarios can be controlled in a time-dependent manner. Aside from the "classic" time control functions such as weekly and holiday programs, it is also possible to select automatic time-shifting to account for special situations in the time-control (e.g. Christmas etc.). This mode of operation also offers the

possibility of an acoustic wake-up function (see Fig. 3.3-5).

3.3.2.6 *EIB powerline* phase couplers/repeaters

Repeater
Phase coupling

The repeater provides active phase coupling with the simultaneous repetition of all received *EIB powerline* signals. The device can be used in all situations where it is no longer possible to guarantee perfect signal transmission between *EIB powerline* terminals as a result of the paths being too long (see chapter 3.2.3.3).
The device is intended for a three-phase connection. When beginning with the design and programming of a system using ETS 2 or an *EIB powerline* controller, the necessity

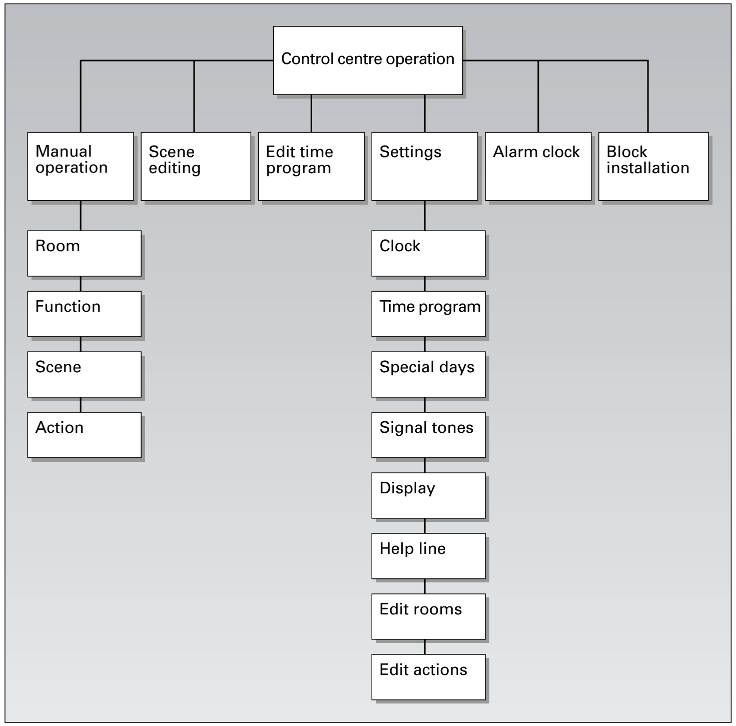

Fig. 3.3-5 Control centre operation of the controller

of using a repeater must be known right from the beginning. After the bus devices have been programmed, any subsequent incorporation of a repeater would only be possible by reprogramming all the devices! Only one repeater is generally permitted within a single *EIB powerline* system! The repeater should be installed in a central point of the system, as this achieves the greatest signal range.

3.3.2.7 Media couplers

Media coupler
Mixed installation

The media couplers are used to couple several *EIB powerline* systems together, or for the construction of mixed installations involving *EIB powerline* and *EIB-TP* areas. Coupling is achieved via an *EIB-TP* line, which connects the areas to be coupled. This line must comply with all regulations and guidelines of the *EIB-TP*.

3.3.2.8 Installation sockets and distributors

Commercial installation sockets and distribution panels can be used for the installation of *EIB powerline* components. The installation sockets for flush mounting must be suitable for screwed fixings (in accordance with DIN VDE 0606-1 or DIN 49 073-1). We recommend the use of installation boxes for light switches.

3.3.3 Project design of the *EIB powerline* devices

3.3.3.1 General advice

The project design of an *EIB powerline* system involves the same prerequisites as that of an *EIB-TP* system. Alternatively, for simple applications it is possible to use an *EIB powerline* controller.

3.3.3.2 Project design with ETS 2

In connection with the respective product data of the manufacturer, ETS 2 can be used for the planning of all *EIB* devices. The common design of *EIB powerline* and *EIB-TP* systems is also possible. It should be established right from the beginning whether a repeater is needed for the planned system, to avoid a great deal of subsequent work.
In all cases it is essential to ensure that mains coupling units, application modules as well as the application programs extracted from the database, which together form a device unit, are all from the same manufacturer.

3.3.3.3 Dividing the *EIB powerline* devices among the lines

During the project design stage, a meaningful line structure should be established to maintain the overall clarity of the planning and programming. The limits on the line lengths are given by the characteristic numbers (see Appendix H).

3.3.3.4 Wiring arrangement

Wiring arrangement

EIB powerline uses the conventional power installation. Any wiring structure can be used. When there are several *EIB powerline* systems within one building, the parallel wiring of two lines from different systems should be avoided to prevent any overcoupling.

3.4 Electrical installation with *EIB powerline*

The DIN VDE 0100 regulations should be used as a basis for *EIB powerline*. When updating *EIB powerline* it may be necessary to make changes to the power installation. These changes are examined in more detail in the following chapters. For wires and bus devices the usual requirements apply, e.g. with regard to the laying of cables in particular rooms or locations and the necessary protection levels.

Programming key

In the same way as every *EIB-TP* device, all *EIB powerline* devices have the familiar programming button to load the application program with all associated parameters. This must be pressed at the initial programming stage. The correct programming sequence is confirmed by the programming LED. In the case of subsequent function changes, it is not necessary to directly access a once programmed *EIB powerline* device. The change can be made directly via the mains line.

3.4.1 Topology

The physical topology of *EIB powerline* corresponds to the typical installation structure of a 230/400 V electrical supply network.

Star structure

Seen from the distribution panel, there is generally a star formation. With branching this can be extended into a full tree structure.
The distribution of electrical energy is achieved from one or more central supply points. From the structure of the installation it is clear that these central points are suitable for the supply of the *EIB powerline* signals via repeaters.

3.4.2 Installation of the *EIB powerline* band stop

The *EIB powerline* band stop is used to suppress the undesired transmission of signals from a system. The band stop

is installed between the output of the main protective device or the main earth leakage circuit breaker and the individual automatic cutouts (see Fig. 3.2-3).

Band stop blocking effect

The blocking effect of the band stop depends on direction. It is therefore particularly important to ensure the correct connection of the device. The wires radiating from the band stop should be laid at as great a distance as possible from the supply lines, in order to avoid any unwanted inductive disturbance.
In certain cases the current load of the band stop may not be sufficient, i.e. the sum of the output currents is greater than the nominal current of the stop. In this situation the current circuits must be split between several band stops.

3.4.3 Installation of the *EIB powerline* phase coupler/repeater

The *EIB powerline* phase coupler/repeater is built into the distribution panel (see Fig. 3.2-4).
Connection is three phase, to active and neutral conductors.

3.5 Commissioning

The commissioning of the *EIB powerline* devices requires a PC with the ETS 2 software (see chapter 5). The PC is connected to the *EIB powerline* device via an RS 232 interface. Depending on the local possibilities the *EIB powerline* devices can be commissioned after installation or not . For devices that are difficult to access, it has proven better to commission them before they are installed. This also saves time. The final site of installation for these devices must be noted exactly to avoid any malfunctioning. For commissioning purposes, the devices and the serial RS 232 interface must be connected to one another via Athenians line. The first step is to assign a physical address to every device The second step is to load the application programs into the devices including group addresses and parameters.

3.5.1 Loading the physical address

The process for loading the physical address is basically the same for all *EIB* devices and is described in chapter 6.7.

3.5.2 Loading the application programs with group addresses and parameters

The process for loading the application programs is basically the same for all *EIB* devices and is described in chapter 6.8.

3.5.3 Function tests, official acceptance and documentation

After commissioning, the system functions should be checked and compared with the functions given in the specifications document. The *EIB powerline* system should be documented in written form and on disk. This is the only way to guarantee that subsequent changes and extensions

can be made without incurring problems unnecessarily.
The power installation is carried out according to the recognised procedures in accordance with the valid technical requirements of the respective electric power company (ZVEH acceptance report according to DIN VDE 0100-610, VBG4).
The power installation should be documented in the usual way (circuit diagram, mimic diagram etc.).

3.5.4 Troubleshooting and diagnosis in an *EIB powerline* system

In general it is necessary to follow the same procedures described in chapter 8.1.2.2 during diagnosis and troubleshooting in *EIB powerline* systems. The following additional steps and procedures are specific to this medium:

- Is the mains supply available at all devices?
- Are the band stops connected properly (input and output interchanged)?
- Is a defined phase coupling guaranteed (via phase couplers or a repeater)?
- Are all devices programmed with the exact same system ID? *System ID*

If transmission is not possible between two or more points in the system, the procedure is as follows:

- All fuse circuits not directly involved in the transmission should be disconnected from the power supply.
- The transmission should be checked.
- If no connection has been achieved, the electrical consumers in the remaining circuits must be checked for their influence on the transmission and if necessary filtered out with band stops.
- Otherwise the circuits that have been switched off should be switched back on again one after the other, and each one checked as to how it affects the transmission.

To check the transmission reliability, ETS 2 can be used to lower the sensitivity of the *EIB powerline* devices within the system. If after this, the transmission remains perfect, we can assume secure transmission with normal sensitivity.

3.6 Extending an existent *EIB powerline* system

Existent *EIB powerline* systems can be extended at any time. This may be necessary after a change in usage or the extension of the building itself. The planning of the products to be extended must be carried out with the same means used to carry out the initial planning or project design (EIB *powerline* controller or ETS).
During installation it is necessary to ensure that the planning and installation guidelines specified in chapter 3.2.3 are observed for the extended system.