2 Transmission via bus lines

2.1 System description

2.1.1 Tasks of building systems engineering

Technical systems in functional and residential buildings have similar tasks to fulfil, such as for example

- Controlling lights, shutters and awnings
- Controlling the heat in individual rooms, central heating systems, air conditioning and ventilation
- Load management
- Building monitoring
- Monitoring, displaying, reporting and operating
- Communication with other systems

Until now, separate individual systems have been used to control functional processes. This results in a greater number of wires and with that increased fire risk as well as ever more complex wiring arrangements. It is scarcely possible to extend existing electrical installations in the case of renovations and changes to usage and there is no practical possibility of linking up the individual component systems.

Building systems engineering

Today however, *EIB* offers a future-safe solution to building systems engineering (see Fig. 2.1-1). The use of a separate, independent twisted pair as the transmission medium offers high reliability.
This produces an upwards-compatible, flexible and cost-effective system for a range of widely differing applications in residential buildings up to more extension applications for use in functional buildings. The entire system, from the laying of cables through assembly and installation of the bus devices right up to commissioning and maintenance,

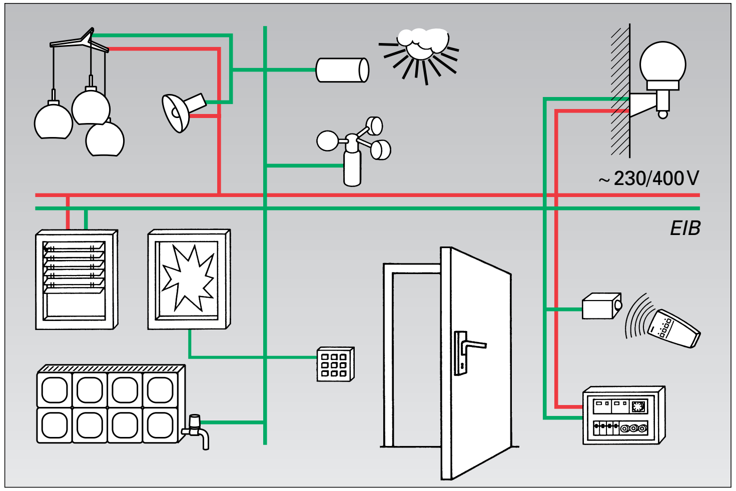

Fig. 2.1-1 EIB in electrical installations

is perfectly tailored to the electricians trade. Of particular note are the:

- laying of bus lines in parallel to the power circuit, i.e. simple arrangement of wires,
- use of conventional distributors and installation sockets,
- decentralised layout independent of the size of the system,
- ability to adapt the functions to changed usage without changing the wiring.

2.1.2 Topology

Line

Because *EIB* must be economically applicable from the very smallest system to more complex systems in functional buildings, it has a hierarchic structure. The line forms the smallest installation unit (see Fig. 2.1-2).

Line coupler

Up to 64 bus devices can be operated on every line segment. A line can consist of a maximum of 4 line segments. Using a line coupler (LC) it is possible to combine up to 15 lines in one area (see Fig. 2.1-3). If it is necessary to connect more than 64 devices to one line or it is not possible to uphold

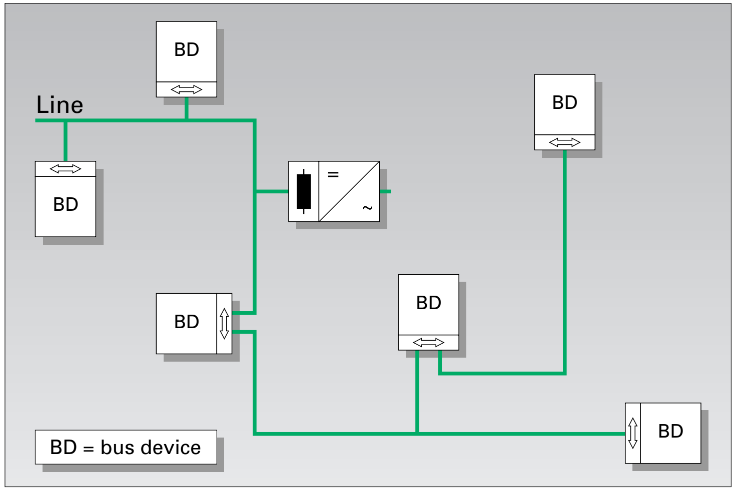

Fig. 2.1-2 EIB topology, line

the line lengths specified in chapter 2.5, repeaters can be implemented allowing further bus devices to be connected to the line or larger distances to be bridged. The repeater forms an additional line segment. Every line segment requires an *EIB* power supply with choke. In view of the number of bus devices and the line lengths, the same statements are valid for the additional line segments as for the first line segment. A maximum of three repeaters may be connected in parallel to any one line (see Fig. 2.1-4). Repeaters are not permitted in the main or area line.

Area coupler

Using an area coupler (AC) it is possible to connect up to 15 areas (see Fig. 2.1-5). And furthermore, suitable interfaces allow the *EIB* to be connected to other systems of the building systems automation.

EIB power supply

Every line has a separate *EIB* power supply (PS) and is galvanically separated from the other lines. This means that if one line fails the remaining system continues to operate unaffectedly.

Telegrams

The division of the *EIB* into areas and lines is further advantageous because it means that the local data traffic on one line or area does not affect the data throughput on any other

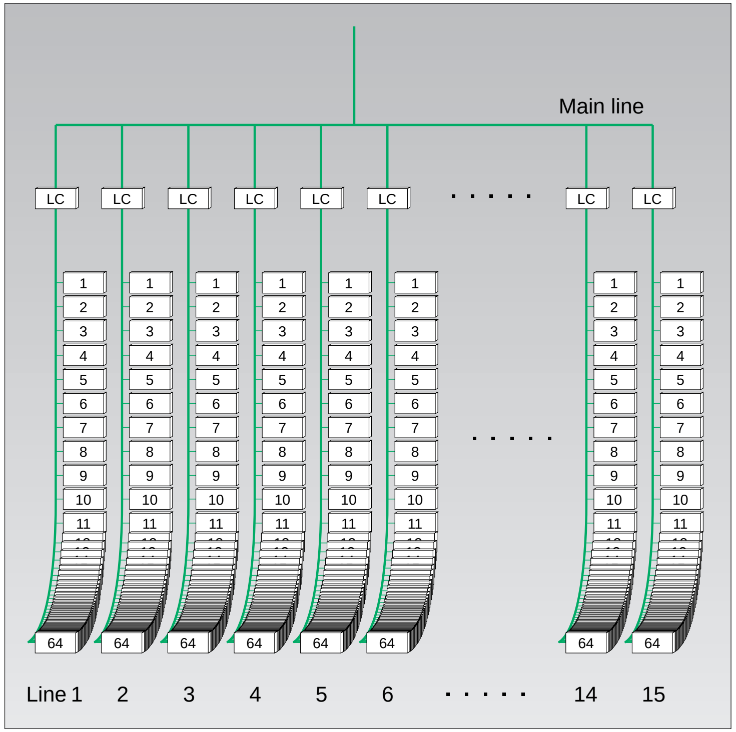

Fig. 2.1-3 EIB topology, areas

line or area. The line coupler prevents telegrams, which only concern the devices in its line, to enter into other lines. At the same time it ignores any telegrams from other lines or areas which do not concern devices within its own line. This facilitates simultaneous communication processes within several lines that are completely independent from one another. The same goes for area couplers.

Application controllers

Application controllers can be used/implemented for superordinate functions. These devices offer functions such as:

– time functions,
– event-controlled processing of control procedures,
– logging,

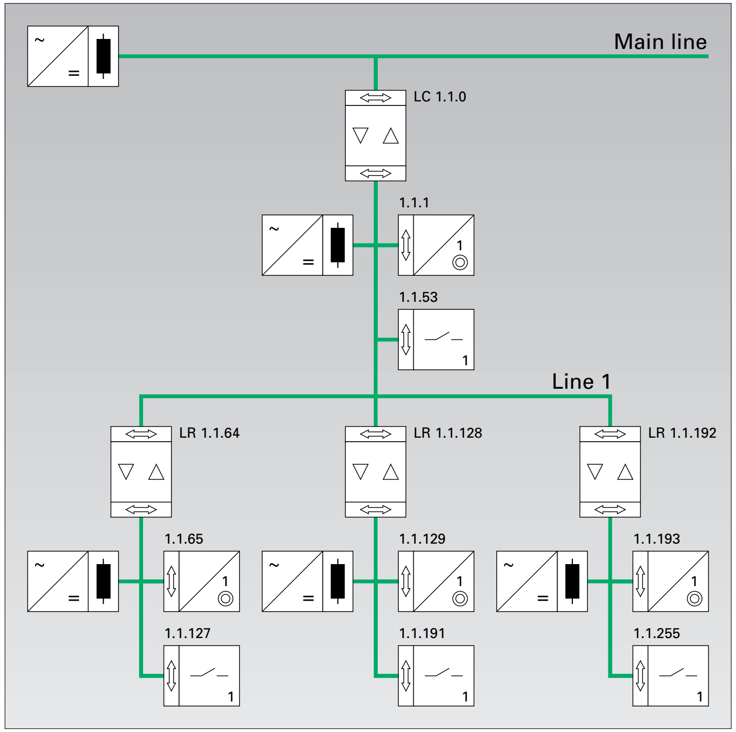

Fig. 2.1-4 Maximum extension of a line using repeaters

– connection to diagnostic and programming devices.

Thanks to the hierarchic division into areas and lines, the *EIB* installation also remains easily comprehensible for commissioning, diagnostic and maintenance purposes. Beginning with one or a small number of lines at the initial installation, it is possible to extend in a step-by-step manner as and when the requirements demand, e.g. in view of the number of devices and system line lengths.

Multimedia PC HomeAssistant

For residential buildings there is a special indication and operating unit, a standard multimedia PC with the HomeAssistant software. This enables all systems and devices in the house or apartment to be controlled and monitored.

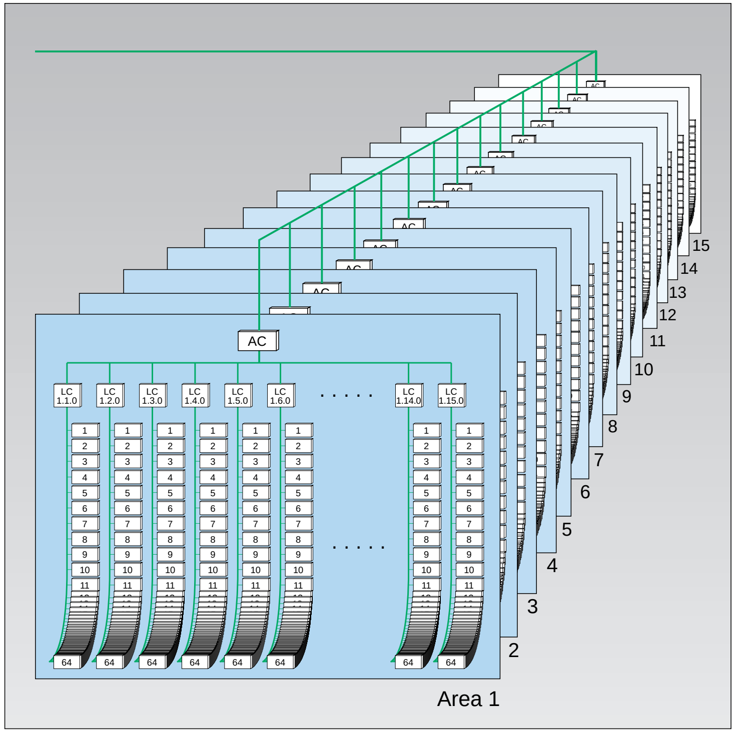

Fig. 2.1-5 EIB topology, area

These systems include heating systems, blinds, alarms and lighting as well as domestic appliances right up to the garage doors. Essentially, the tasks of the HomeAssistant are as follows:
Using suitable graphical symbols it represents all devices installed within the *EIB* system and in this way makes operation of these devices very simple. The house owner has a clear on-screen picture of the various devices within the different rooms, and is able to call up and control their respective functions via the user-interface. It is important to note here that every device works and can be controlled independently from all others.

2.1.3 Transmission technology

Transmission speed

The information, e.g. switching commands and messages, is exchanged between the individual bus devices in the form of telegrams. In terms of the transmission speed, pulse generation and reception the transmission technology is such that no terminating resistor is required for the bus line and any desired topology is possible. The information is transmitted symmetrically on the bus line, i.e. as a potential difference between the two bus wires and not as a potential difference with respect to earth (see Fig. 2.1-6). Interference that affects both wires therefore cannot influence the transmission of information.

Transmission rate

The transmission rate is equal to 9600 bit/s, the average transmission time with send and confirm is equal to approx. 25 ms.

2.1.4 Bus access

To guarantee an ordered exchange of information between the bus devices, the telegram traffic and with that the bus access must be regulated accordingly. With *EIB*, the individual packets of information are transmitted on the bus line

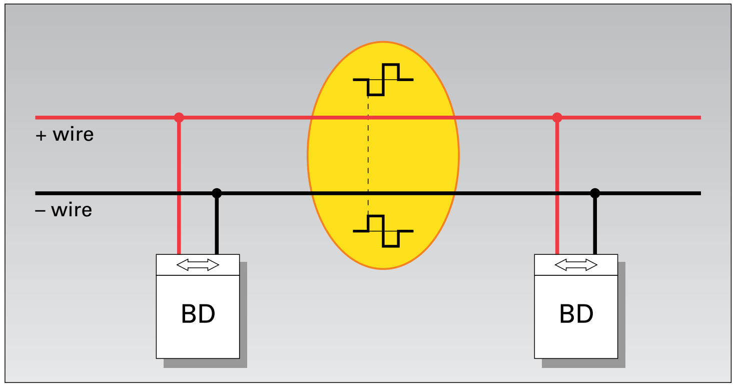

Fig. 2.1-6 Signal transmission on the bus line

in series, i.e. one after the other. This means that there is only ever information from one bus device on one line at any one time. To ensure reliability, a decentralised bus access procedure is used, where each device decides independently whether and at which of the appointed times it accesses the bus.

Decentralized bus access

In the case of devices on a particular line which access the bus independently of one another, conflicts can arise. A special bus access mechanism ensures that no information is lost and that the bus is operable at all times.

Event controlled data exchange

Thanks to an additional priority mechanism in the telegram, important telegrams (e.g. error messages) are given preference. With *EIB*, information exchange occurs in an event-controlled way; i.e. telegrams are only transmitted when an event occurs that necessitates the sending of information.

2.1.5 Telegram layout and addressing

A telegram consists of a series of characters, in which the characters with associated information are combined to form fields. The resulting telegram layout is shown in Fig. 2.1-7. The data of the control and checksum fields are necessary to ensure smooth telegram traffic and are analysed by the receiving devices.

Control and checksum fields

Source address Target address

The address field includes the source and target addresses. The source address is always the physical address. This specifies the area and line to which the sending device is assigned. The physical address is permanently assigned to the bus device during the project design stage and is only used for commissioning and service functions.

Physical address

The target address determines the communication device(s). This may involve a single device or a group of devices that are connected to the same line, a different line or distributed among several lines.

Group address

One device can belong to more than one group.
The group address determines the communication relationships within the system.

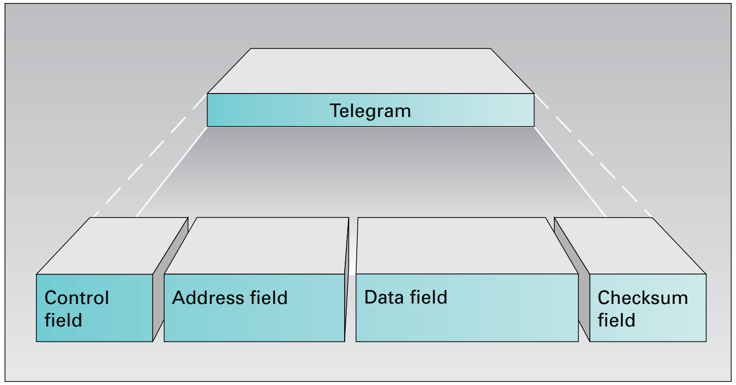

Fig. 2.1-7 Telegram layout

Data field

The data field facilitates the transmission of useful data such as for example, commands, messages, set points or measured values, etc.

2.1.6 Layout of the bus devices

Bus coupling unit Application module/ terminal

The bus devices consist of the bus coupling unit (BCU) and the application module / terminal (see Fig. 2.1-8). The information to be processed is transferred from the bus to the bus coupling unit (see Fig. 2.1-9). The latter transmits and receives data, guarantees the power supply for the electronics and stores important data such as the actual physical address, one or more group addresses as well as the application program with parameters. Co-ordination of these functions is carried out by a microprocessor, the "brain" of the bus coupling unit. The application module and application program establish the function of the bus device. This may involve sensors such as pushbuttons and binary inputs or actuators such as binary outputs, circuit breakers and dimming actuators or combinations of both, such as for example household appliances.

Application program parameters

Depending on the design of the bus device, the bus coupling units and application modules are plug-in types (e.g. flush-

Physical external interface

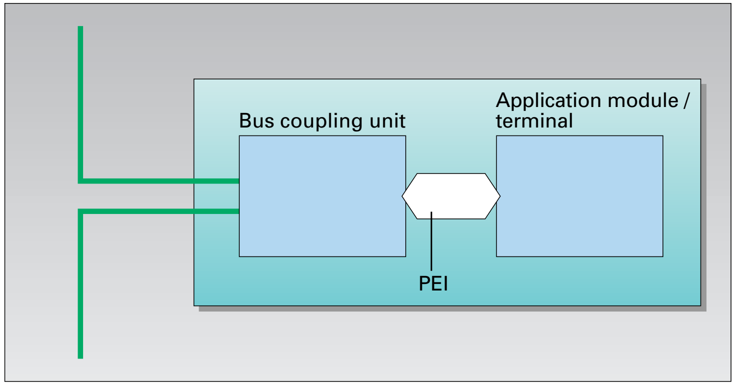

Fig. 2.1-8 *Layout of the bus device*

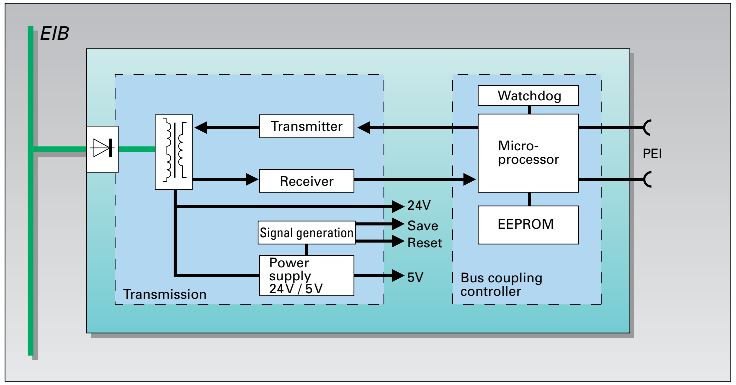

Fig. 2.1-9 *Bus coupling unit (BCU)*

mounted units and DIN rail mounted units) or they are integrated as permanently connected units within a housing (e.g. built-in and surface-mounted units) (see chapter 2.5.1.1).

2.1.7 Installation

Wiring arrangement

The wiring for the *EIB* is arranged in the same way as the mains supply, in a line, star or tree formation. In a heavily branched installation it is necessary to ensure that no rings are formed; i.e. different lines must not be connected together in ring formations (see chapter 2.5.1.2.2).

The bus devices, e.g. for controlling the various consumers and monitoring the building can either be installed in the distribution panels as DIN rail mounted units, flush-mounted units or surface-mounted units. Alternatively, they may already be contained within the electrical devices themselves (e.g. lights). Furthermore, installation channels permit the incorporation of bus devices in all forms. All these devices are connected together via the *EIB*.

Bus connection terminal
Data rail
DIN rail

The bus devices can always be placed within the installation to satisfy the requirements of the system so that optimum usage of all components is always guaranteed. It is possible to assess the main aspects of the system by the way in which the devices are placed. On the bus side, the DIN rail mounted units are connected via connection terminals or via the data rails that are incorporated into the DIN rail. Contact with the data rail is achieved by snapping the DIN rail mounted unit onto the DIN rail (see Fig. 2.1-10).

Bus line
Tracer

Data rails are connected together via data rail connectors. For all other bus devices, the bus line is carried from device to device via a bus connection terminal, whereby branch lines are also permitted. The bus line is composed of two twisted pairs with shielding and tracer (see Table 2.5-2 and Appendix G).

2.1.8 Electrical safety

SELV
Low voltage

The *EIB* is operated with SELV extra-low voltage up to 32 V DC. With that, the bus is safely separated from the mains supply. It is perfectly safe for the user to touch the bus line. *EIB* satisfies the requirements of the DIN EN 50 090 and DIN V VDE 0829 standards. All bus devices correspond to the specified DIN VDE regulations or EIBA guidelines for situations where no device regulations exist. Bus devices certified by EIBA carry the EIB® trademark. One element of EIBA certification which entitles the device to carry the EIB® trademark is proof of safe electrical separation between *EIB* and other circuits.

EIBA certification

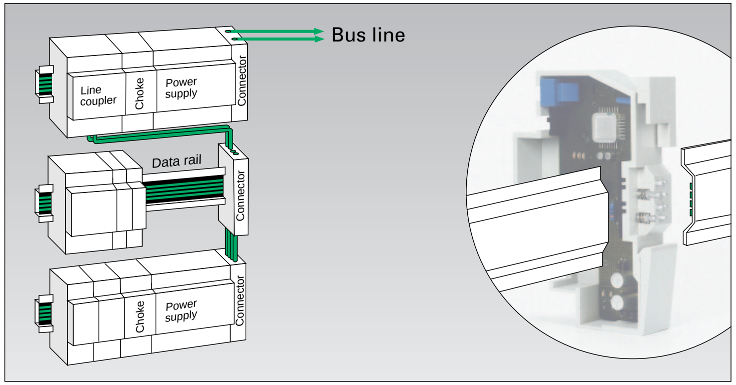

Fig. 2.1-10 Distributor with bus devices and contact system (DIN rail mounted units)

2.1.9 System and supply reliability

System and supply reliability comprises the availability of electrical energy and system functionality under all operating conditions. The structure of the heavy current (power) component of the *EIB* installation is the main influencing factor with regard to the availability of electrical energy. The selected topology in addition to the number and arrangement of devices are the primary influences affecting the availability of system functionality.
Here it is necessary to observe the requirements of the customer or operator and also any official and legal regulations or damage limitation guidelines.
The *EIB* permits a hierarchic layout for an electrical installation. The degree of freedom when designing the topology means that the entire bus system can be divided into functional units (lines, areas) (see chapter 2.1.2).
Each line segment has its own *EIB* power supply. If this fails, communication is only disrupted in that particular segment (see Fig. 2.1-11). The function of the remaining system is unaffected.
If the failed line corresponds to a main line or area line,

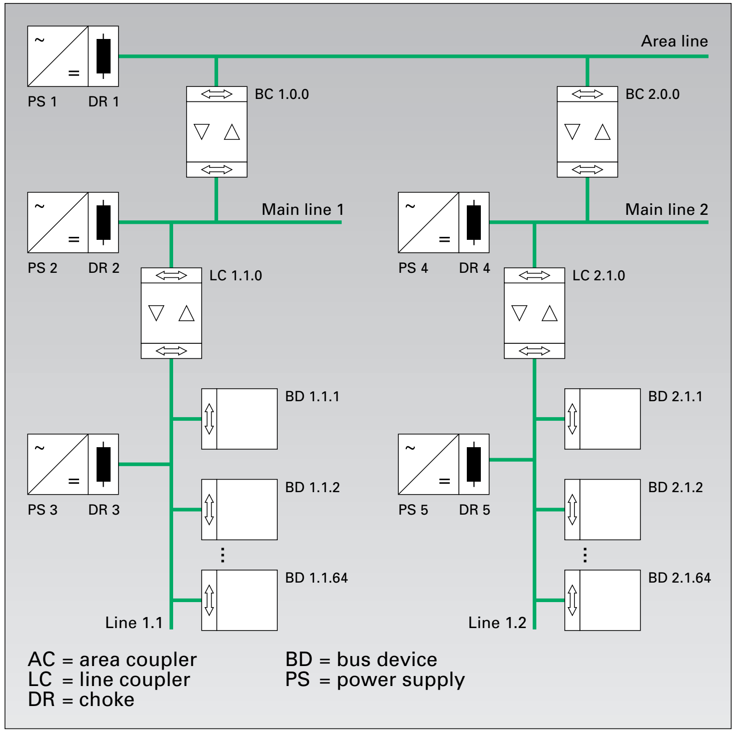

Fig. 2.1-11 Typical EIB-TP layout

telegram traffic is not possible beyond this line. The same is valid for a breakdown or short circuit within a line.
The design of *EIB* allows telegram traffic to occur simultaneously in the individual lines, if the telegrams only concern the bus devices within the respective lines and are not transmitted via the associated line couplers.
In this connection, the following questions and answers may be helpful in assessing the layout of the bus system:

- Is increased supply reliability required?
  In this case the corresponding devices should be assigned to a line segment. The *EIB* power supply of the line segment and possibly also the assigned load circuits should

be connected to an uninterruptable power supply or an emergency supply. Within a line segment it is also possible to connect two power supplies in parallel to different active conductors.

– Should it be possible to service sub-divisions of the *EIB* installation without affecting the overall system?
These sub-divisions must be without power when being serviced. For this reason we recommend that system functions be distributed among several areas of the bus system (e.g. among several lines or several areas). This means that it is then possible to deactivate specific sub-divisions. The remaining system continues to function as normal.

Visualisation

– Is it necessary to cyclically monitor specific bus devices and with that the line for functionality?
When using visualisation, application controllers or a HomeAssistant it is necessary to ensure, when selecting devices, that they permit status polling.

In the case of disturbances or power failures, the data remains stored in the bus devices and the bus devices themselves revert to the pre-defined status. After the error has been rectified or the power returned the bus devices again revert back to the status defined for this condition.

2.2 Typical applications

The following descriptions illustrate the advantages for the individual applications using *EIB*.

2.2.1 Controlling lights, shutters and blinds

Lighting control
Blind control
Shutter control

The applications for controlling lights, shutters and blinds can be used independently of one another or linked together in various functions.

The equipment itself can be switched and/or dimmed or controlled either

– locally,
– centrally,
– using infrared,
– in a time-dependent manner,
– depending on the brightness,
– depending on the temperature,
– or depending on the wind strength.

Simulation of occupancy

The resulting advantages include:

– Reduction in the energy costs thanks to switching which depends on ambient brightness, time of day and actual need.
– Increased security by the simulation of occupancy.
– Comfortable adjustment of the lighting within a room to meet the requirements using controlled switching of the lights and blinds that is based on ambient brightness, time of day and actual need.
– Increased comfort thanks to selectable states of switching levels and blind adjustment that the users are able to specify themselves.
– Simple and flexible adjustment of the lighting and blind controls when room usage changes, without the need to

modify the existent wiring.
- Existent *EIB* installations can be adapted to suit growing requirements by simply connecting additional bus devices to the available bus line.

Moreover, *EIB* offers the possibility of monitoring and controlling the lights and blinds from a central position. This is in strong contrast to conventional solutions, which would require significant modifications to both the wiring and devices.

2.2.2 Single room temperature control, heating and ventilation control

Single room temperature control

The aim of single room temperature control, heating and ventilation control is to keep the energy requirements for room heating as low as possible whilst maintaining the highest levels of comfort for the occupants.
Optimum operation of the heating system is achieved using "intelligent" control via the *EIB*:

- Set the heating times for each individual room according to the times they are used.
- Individual adjustment possibilities for the temperatures of every room depending on the usage (e.g. a higher temperature in quiet times as opposed to times when there is a body heat contribution).
- Switching off the entire heating system or centrally lowering the temperatures at times when the building is not in use.
- Rotational speed dependent control of the circulation pump.

Sensors

The different applications such as for example blind control, window monitoring and heating control can communicate with one another, which means that the sensors can be used for more than one purpose and relevant data can be

exchanged.

Remote monitoring

EIB also facilitates incorporation of remote monitoring or remote control.

2.2.3 Load management

Load management

The primary aim of load management is the economical and resource-saving use of energy that is provided by the electric power company in industry, trade and the private sector for reasons of environmental, cost and/or security considerations. The term 'load management' also covers measures for avoiding circuit overloads.
The advantages of using *EIB* to provide load management include:

- The otherwise necessary and costly wiring of ripple control receivers, load shedding relays, maximum demand controllers, timers etc. to the individual electrical appliances is reduced to the simple laying of the bus line. This means that it is easy to incorporate large numbers of small consumers into the load management. With conventional solutions this is usually avoided as a result of the effort needed to set up the necessary wiring.
- Whenever there are changes to the operational processes the load management can be adapted accordingly, without the need for rewiring.
- When optimising the load management, logging the operational behaviour of the electrical equipment takes on a great significance as this allows conclusions to be drawn about the modification of priorities. *EIB* offers the advantage here because it allows the operational behaviour to be recorded and visualised for all devices connected to the bus.

2.2.4 Monitoring, displaying, reporting and operating

In both residential and functional buildings it is often necessary to record and report the statuses of the various systems. This applies to the interior as well as to the exterior of the building.

Data includes:

– operational messages (operational status display),
– technical errors and alarms,
– monitoring data regarding the building exterior,
– people monitoring data (movement detection).

The *EIB* has multifunctional properties: All display, reporting, operating and monitoring elements can receive information and transmit commands and messages to other devices via a single bus line. This leads to clear systems and cost savings.
This means that information can be transmitted via the same bus line that is being used to control the blinds or lighting. It is possible to transmit, for example:

– measurements, e.g. inside and outside temperatures, measurements from a weather station,
– messages concerning the closed status of doors, windows and garage doors,
– movement detection inside and outside of the building,
– operational statuses and error messages of the heating system, air conditioning unit and domestic appliances,
– error messages from the lifts,
– level indication values and leakage messages,
– meter values for establishing the use of gas, oil, power, water,
– status of the exterior equipment from the lights to the sprinkler system.

The multifunctional properties of the *EIB* minimise the necessary cabling.

Visualisation program

In connection with a visualisation program, the *EIB* can be

used in functional buildings to display the status of technical equipment on a PC screen. Measured values that are transmitted via the *EIB*, e.g. the room temperature in ∞C, can also be displayed on the screen. Depending on the program, the statuses and entries can be stored on a suitable medium or printed out at a printer. This can be achieved in text or tabular format or in the form of a ground plan. n.

2.3 Communication with other systems

2.3.1 Data interface

Serial data interface

The serial data interface (RS 232 with Sub-D9 plug-in connection) allows devices such as, for example, computers (PC) to be connected to the *EIB*. This interface is used to program the EIB installation, put it into operation and to carry out maintenance or diagnostic work.
In private houses the HomeAssistant is connected via the data interface.

2.3.2 Appliance interface

Application interface

The appliance interface consists of a bus coupling unit and a communication interface, which is attached to the physical external interface. This communication interface is the connection for a six-pin western connector (RJ12). Devices, such as domestic appliances, can be connected via a six-wire signal line (see Fig. 2.3-1). The appliance interface should be installed and parameterised in the same way as every other flush-mounted bus device.

Micro-computer control

Coupling module

The device to be connected via this appliance interface must contain a suitable microprocessor and be equipped with a coupling module. The coupling module is connected via a western connector and is galvanically separated from the device control (see Fig. 2.3-2).

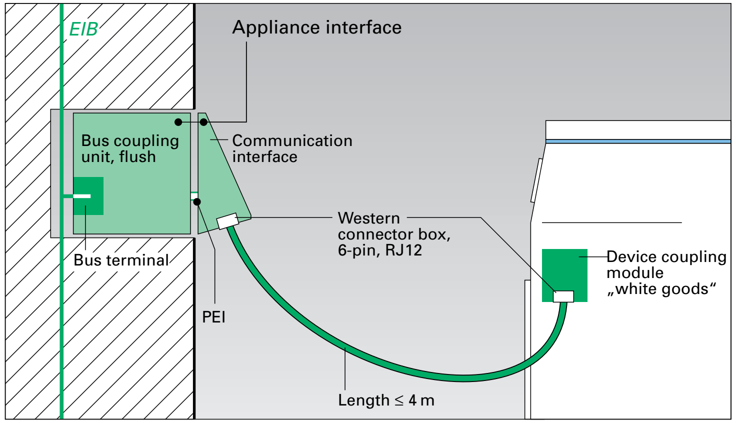

Fig. 2.3-1 Principles of an appliance interface

Fibre-optic line

It is clear to see that in the future there will be devices for which both the mains and *EIB* connections are achieved via a single line. This integrated solution demands cables that in addition to live conducting wires also have a fibre-optic line for transmitting data, as well as modified SCHUKO“ plugs and sockets. The bus coupling unit is integrated into the appliance interface (see Fig. 2.3-3).

Communication socket

Product CD-ROM

After connecting the device to the communication socket and to the 230/400 V supply, the appliance interface “signals its presence” to the HomeAssistant (see chapter 5), after which the user is prompted to insert the product-specific CD-ROM which is supplied with the device and which contains the complete application software. This includes all operating masks and user information, such as for example, the operating instructions for the device.
Integrating such a household appliance into the *EIB* installation can be achieved without additional parameterisation. This is one way of separating different building disciplines (e.g. gas and water) and different areas of responsibility.
In the future, devices that were once logged on via the communication outlet/socket can be connected to other communication outlets/sockets of the existent *EIB* system

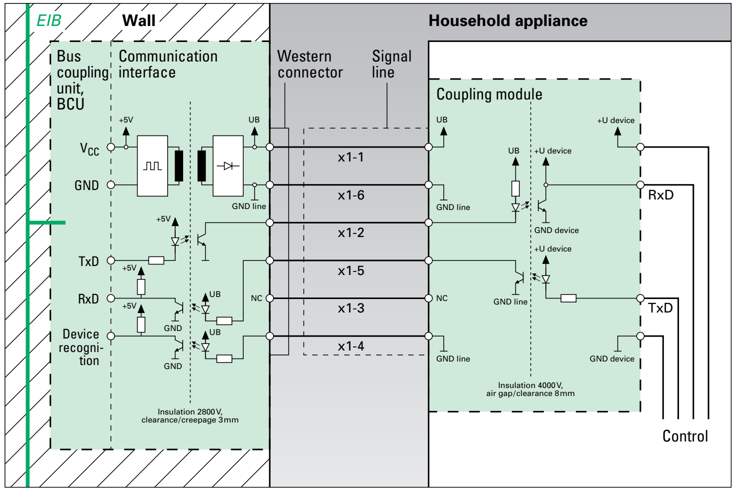

Fig. 2.3-2 Basic circuit of an appliance interface and coupling module within a housing device

and be automatically recognised (“connection of portable devices”).
The coupling module for a household device is an add-on unit, which does not affect the normal, conventional use of the device.
The software of the device to be connected must be designed so that useful communication with the HomeAssistant is possible via the communication outlet/socket and the *EIB*.

2.3.3 Interface to communications networks

The *EIB* can be connected with the telephone network via bus-compatible dialling devices. Remote control is also possible.

Communications network

In private homes, one of the many uses of the HomeAssistant is as an interface to the public communications network. From the HomeAssistant it is therefore possible to convey messages and events having arisen in the bus system and been evaluated accordingly, to any desired bus device, which

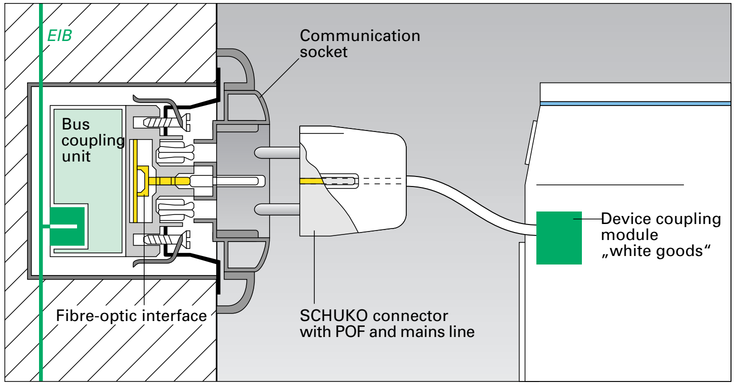

Fig. 2.3-3 *Appliance interface with fibre-optic line*

Pager

could also be a pager for example, via the communications network.

Video connection

A HomeAssistant can also be used as a TV, if a video connection and a TV card has been installed. In addition to regular TV programs, this connection also allows videotexts to be received, interpreted and used for corresponding actions in the bus system.

2.3.4 Interface between EIB transmission media

For new installations transmission via a bus line (twisted pair) is recommended.
However, transmission via existent power circuits (see chapter 3) and radio (chapter 4) is also possible with *EIB*.
Both these latter methods are especially suitable when modifying the *EIB* in existing rooms and buildings.
Gateways are used between these different transmission media.

2.3.5 Interface to the building systems automation

Building systems automation

In functional buildings the building systems automation is responsible for a variety of complex control tasks, such as

Gateway
Data interface

for example the control and monitoring of operational systems (heating, ventilation, air conditioning, switchboard systems, etc.). Among other things the building systems automation archives and analyses operational and consumption data. Information can be exchanged between the building systems automation and *EIB* systems via data interfaces/gateways.

2.3.6 Interfaces to infrared (IR) control systems

IR transmitter
IR receiver
IR decoder
IR receiver/ decoder

Corresponding interfaces are available between the *EIB* and various manufacturer-specific infrared systems.
IR transmitters, IR receivers and IR decoders or IR receivers/decoders are used.
Providing cable-free control of actuators, an IR transmitter sends infrared signals that are received by the IR receiver. These IR signals consist of frequency modulated or digitally modulated infrared light. The IR receiver amplifies the received signals and converts them into electrical signals which are then passed on to the IR decoder. The IR decoder then converts these signals into a standardised bus telegram, transmits it to the bus and with that activates the specified action.

2.4 Planning

Specifications

Checklist

In determining the functionality and scope of an *EIB* installation the first step involves detailed planning. It is vital to establish the exact needs of the customer and then to reformulate this data in the form of a specifications document or checklist.

The mains part of the *EIB* installation must be planned in accordance with the general, established rules of the technology whilst adhering to the various regional connection conditions laid down by the respective electric power companies. Installations such as backup power supplies, security lighting, and "access lighting" etc. must be looked at from the same point of view. The same standards and conditions apply.

Access lighting

As already mentioned in the introduction, it is necessary when planning to make the following fundamental decision – will the *EIB* be based on a twisted pair or will data be transmitted via the existent mains network (powerline)? Chapter 2 deals with solutions using the twisted pair variant.

Twisted pair
Powerline

Each system must be planned separately. The respective requirements determine the topology and design of the *EIB* installation. The system offers a variety of possibilities to meet the actual requirements in a number of different ways.

2.4.1 Establishing the customer requirements in functional buildings

The *EIB* offers the customer a wide range of application possibilities that for the most part cannot be implemented using conventional technology or if they can only at great cost.

These possibilities should be outlined to the customer during the planning phase to allow the most optimum *EIB* installation to be planned in accordance with current and future requirements.

The points listed below can help to clarify the exact needs of the customer.

2.4.1.1 Room and building usage

Usage change

When planning for a room or building it is necessary to consider whether there will be any changes to the usage or modifications to the room size, with the use of dividing walls for example, within a particular time period. The following questions may be helpful here:

- Which areas of the building will be fitted with *EIB* immediately and which at a later date?
  If bus devices are only to be installed in certain areas at a later date the bus lines should still be installed in these areas in preparation.
- Which rooms are subject to changes in usage? What are the smallest units of usage?
  The answer to this question determines the division of lights into switching groups and the division of blinds and heating units into control groups. There is no need to consider changes in usage in the corridors. Aspects such as access lighting and emergency lighting should also be considered when determining the number of switching groups required.
- Are the users of the building not known at the time of planning? Is this likely to cause changes to the installation?
  In these cases it is necessary to plan sufficient reserve in the distribution panels and to combine the appliances into the smallest possible groups.
- In an apartment block should there be a single common EIB system respectively independent units per apartment?
  Separate systems may be necessary when the individual apartments need to function without affecting one another. The design for each apartment should be established as described in chapter 2.4.2. This can be achieved, for example, by providing a separate bus line per apartment

or within a single-family house, per floor. The line couplers function as filters and prevent unauthorised intervention.
– Should bus devices be provided in the external areas?

Such functions can, for example, be implemented by connecting conventional devices in the external areas with bus devices for the internal areas.

2.4.1.2 Applications and functionality

The requirements of the customer determine the functionality of the *EIB* installation and have a direct influence on the scope, design and cost of such a system. The structural possibilities are a further decisive factor. To determine exactly what the customer requires from an *EIB* installation, the following questions should be answered:

– Which functions should be linked together?
  It is possible for example, to link the brightness-dependent lighting control with the blind control or the window monitoring with the heating control.
  More complex interlinking can be achieved with the use of application controllers or special linking elements.
– Are priorities to be considered for specific functions?
  With regard to the lighting, manual control can be given a higher priority than brightness-dependent control.
  The answer to this question is important for establishing the selection of devices and corresponding parameters.
– Should operational statuses or errors be displayed for the entire building?
  For this, suitable interfaces should be installed, e.g. an ISDN gateway.
– Should it be possible to display and/or change important operational statuses at specific locations, e.g. at the main gate?
  To achieve this, suitable sensors as well as indication and operating panels, displays or PCs with the corresponding visualisation software should be provided.
– What factors should the control mechanism be based on?
  Lighting in shop windows for example, can be switched on depending on the ambient daylight and switched off according to the time of day.
– Is it necessary to plan measures to save energy or operating costs?
  Lights can be controlled depending on the level of daylight and/or time of day. Large numbers of smaller consumers can be incorporated into the load management system at no extra cost.
– Are preventative measures to be included to discourage break-ins?

Using time controls or random generators it is possible to simulate occupancy. The lights are switched on and off and the blinds or shutters raised and lowered accordingly.
Movement detectors, which are usually assigned to specific circuits, can be used to control the entire exterior lighting when the property is unoccupied.
Door and window contacts, which are generally only used for display and indication purposes, can also be incorporated into the lighting control.

2.4.1.3 Division of the disciplines

Building disciplines

Different building disciplines (gas, water etc.) are usually planned, managed, installed and commissioned by different companies. The following scenarios are conceivable:
a) The functions of the various disciplines are implemented using independent *EIB* installations and there is no exchange of information between these separate systems.
Advantages:

– logical and physical independence from one another,
– no co-ordination necessary when planning and designing

the *EIB* installations (e.g. any address allocations possible)
– commissioning, diagnosis and servicing independent of the other disciplines
– clear allocation of responsibility

a) For every building discipline there is a separate line or area within the *EIB* installation that can be linked together via couplers allowing an exchange of information.

Absence of interaction

Advantages:
– information exchange between the building disciplines is possible which allows a far greater functionality than in case a)
– multiple usage of the bus devices is possible

a) Different building disciplines are incorporated into one EIB installation using common lines or areas.

Advantages:
– reduced wiring
– reduced numbers of devices (couplers)
– more easily expandable (bus line in the entire building can be used for all disciplines).

System manager

In cases b) and c) one person must be responsible for co-ordinating the various building disciplines during the planning and project design stages. Once the contract has been awarded for the individual building disciplines, a system manager should be named who also acts as the contact person once the work has been completed with regard to extensions, servicing and maintenance. These two jobs can be undertaken by one and the same individual/legal entity.

2.4.1.4 Preparatory cabling

Preparatory cabling involves the intentional laying of bus lines at significant points within the building for the case

in which the scope of the *EIB* has not yet been decided upon or finalised. Preparatory cabling is also a sound investment to allow for any changes to the usage of the building or individual rooms at a later date.

Sill cavities
Floor channels

To achieve the greatest possible degree of flexibility, it is advisable in functional buildings to lay the bus lines in sill cavities, floor channels and in the false ceilings. We also recommend connecting all distribution panels with the bus line and sufficient space should be reserved for *EIB* devices.
Other important points when planning the preparatory cabling include the provision of meter panels for recording the consumption of gas, water, electricity etc. It will be possible, in the foreseeable future, to read this information from a remote location via the telecommunications network in combination with the *EIB*.
It is also necessary to establish suitable locations for the installation of wind, rain and brightness sensors. This data is generally required when blind or brightness controls are to be implemented at a later date.
Within a system the preparatory cabling should be uniformly laid out and ‘transparent’ enough to ensure that the lines and connections can easily be found years later.
For a future-oriented electrical installation the preparatory laying of cables is an absolute must (see chapter 2.4.2.3.4).

2.4.2 Establishing customer requirements in residential buildings

It is fundamentally possible to design a residential building according to the same considerations as when dealing with functional buildings (see chapter 2.4.1.2) and therefore to plan the same functionality.
In a residential building however, the application possibilities for *EIB* are much more varied. The reasons for this are twofold, firstly there are a much greater number of different devices and appliances and secondly the needs and wishes of the occupants are very different from those of users of

functional buildings. Above all, the demands on comfort are significantly higher.
Customers in the private sector derive their wishes with regard to electrical installations from their experiences with their old and trusted installations. They are not generally aware of the many new functions available with *EIB* and the technical solutions that these entail nor do they need to be. For this reason we recommend that the questions regarding their needs and wants be formulated in such a way that the answers provide a basis for the planning and design. We recommended using a questionnaire that has been developed especially for consultation purposes.

Questionnaire

During consultation it must be made perfectly clear to the private customer that carefully planned preparatory cabling ensures all options are kept open. Thanks to its modular layout, the system can be expanded at any time in a step-by-step manner which means that customers can benefit from all future development and modernisation.
If a private customer has expressed his/her wishes and these wishes go beyond what can be achieved with conventional technology, simply explain that without the use of *EIB* these would only be possible at an extremely high cost and would not be open to flexible expansion. An example questionnaire is included in Appendix A. Chapter 7 gives a step-by-step account of designing a project.

2.4.2.1 Applications and functions in residential buildings

For the private customer the following detailed technical explanations help illustrate the higher levels of comfort, increased security etc. that can be achieved with the use of an *EIB*. The HomeAssistant that is mentioned in the following sub-chapters is described in more detail in chapter 5.

2.4.2.1.1 Lighting control applications

Lighting control

A basic description of the applications for lighting control has already been given in chapter 2.2.1. With the HomeAssistant that is integrated into the *EIB*, the following extras can be offered with the "lighting" software package, designed according to the technology available today:

– display of the lighting situation within the house, as an overview and in detail,
– switching and dimming the lights in the house; it is possible to switch individual lights or entire rooms,
– etc.

The application is operated via two mask types:

– the room selection mask
– the individual room mask; every room in the house which has lights in it is assigned a separate mask.

2.4.2.1.2 Single room temperature control applications

Single room temperature control

The basic applications have already been described in chapter 2.2.2. With the HomeAssistant that is integrated into the *EIB*, the following extras can be offered with the "single room temperature control" software package:

– display of the temperature in the individual rooms,
– changing the temperature in the individual rooms,
– entering temperature time profiles depending on actual usage of the room,
– setting up weekly and monthly programs,
– etc.

2.4.2.1.3 Blind, shutter and awning control applications

The possibilities that exist for these applications have already been described in chapter 2.2.1. With the HomeAssistant that is integrated into the *EIB*, the following extras can be offered with the “blinds and shutters” software package:

– display of the positions of blinds and shutters within the house, as an overview or in detail,
– changing the position of the blinds in the house; they can be adjusted individually as well as by room,
– incorporation into a simulation of occupancy program,
– etc.

The application is operated via two mask types:

– the room selection mask
– the individual room mask; every room in the house which has shutters or blinds is assigned a separate mask.

2.4.2.1.4 Monitoring function applications

Monitoring function

The basic applications for monitoring functions have already been described in chapter 2.2.4. With the HomeAssistant that is integrated into the *EIB*, the following extras can be offered with the “monitoring functions” software package:

– the ‘monitoring function’ provides the user with an immediate overview of all critical security areas in his house or apartment,
– it actively monitors the security sensors in the house and activates an alarm if one of these sensors is triggered,
– etc.

All door, window and shutter sensors as well as any movement detectors that are connected to the *EIB* can be incorporated into the active monitoring. With the four provided

monitoring programs the user can set the exact configuration of the monitoring system, i.e. the selection of sensors that are included in the monitoring function.

2.4.2.1.5 Telecommunication applications

Remote control
Remote polling

With the aid of bus-compatible dialling devices, the *EIB* can be connected to the telephone network (see chapter 2.3.3). Moreover, remote control (status change), remote indication (error messages) and remote polling (status messages) possibilities also exist.
It will also be possible in the future to link the HomeAssistant directly with the telephone network. Warnings and messages can then be transmitted to the outside world via the telephone network.

2.4.2.1.6 Household appliance applications

If household appliances are connected to the *EIB* via appliance interfaces and the product-specific CD has been loaded into the HomeAssistant, the following extras are possible:

– when cooking:	incorporation into security and energy management; interactive linking with a recipe library;
–when freezing:	alarm functions outside of the operating area; comfortable and energy-optimised “super” freezing;
– when washing up:	increase in the variety of programs; incorporation into energy management (low tariff);
– when washing:	incorporation into energy management (low tariff);
– when heating water:	incorporation into energy management (low energy households);

remote control via *EIB* sensors.

All devices have remote monitoring and remote control possibilities for selective functions, as well as context-sensitive help. They can all be used autonomously without the HomeAssistant software.

2.4.2.1.7 Other application areas

The closed status of doors, garages and gates can be monitored and controlled.
A further application area is represented by the integration of valves for gas, oil and water etc. to avoid any unchecked escapes.
In the future it will be possible to check the status of gas, oil, electricity and water meters and to display the equivalent cost.
Exterior systems are also an important application. In addition to garden lighting, it is possible to monitor and control sprinkler systems and fountains. Other sensors for detecting wind speed, temperature, humidity etc. can be integrated.
And a final area of importance covers communication equipment needed to integrate the following:
- Pendant PAs, info displays, ISDN gateways, radios, pagers, telecontrol units, telephones, door knobs, intercom systems, door video systems, TV, video, video cameras.

2.4.2.2 Division of the building disciplines

In functional buildings, the different building disciplines (gas, water etc.) are usually planned, designed, installed and commissioned by different companies (see chapter 2.4.1.3). This sub-division is also present in residential buildings, but not so clearly defined as in functional buildings.
If we view the wealth of possible devices and equipment corresponding to the installation recommendations, then it becomes clear that for the customer there should only be

Common system manager

one contact person for the entire arrangement, the system manager. This person, who is responsible for the entire set-up incorporating all building disciplines, e.g. an electrician, must assume responsibility for the overall functionality of the *EIB* in the building. He must have the skill to combine the individual building disciplines with regard to the bus control.
The HomeAssistant in combination with the *EIB* is a particularly suitable way for centrally monitoring and controlling devices of different building disciplines. A device, e.g. a washing machine, is connected to the system by simply fitting the communication line between the device and the appliance interface (see chapter 2.3.2) and then loading the associated CD-ROM into the HomeAssistant.

2.4.2.3 Preparatory cabling

As we have already shown in chapter 2.4.2.1, there are many possibilities for updating or extending the *EIB* system. In order to ensure that the preparatory cabling is safeguarded for the future it is vital to establish the short-term, mid-term and long-term requirements of the customer. The suggested questionnaire should be used.
The following points should be noted:

– The preparatory cabling should be sufficiently ‘transparent’ to ensure that the lines, installation sockets and end points can easily be detected years later (see chapter 2.5.2.4).
– The preparatory cabling should always be planned at the same time as the mains installation, and kept in mind when defining the installation zones and equipment levels.
– Within a system, the arrangement of wires should be uniform.

As a planning aid, the following section contains suggestions for the preparatory laying of bus lines.
In accordance with the star coding of the equipment levels

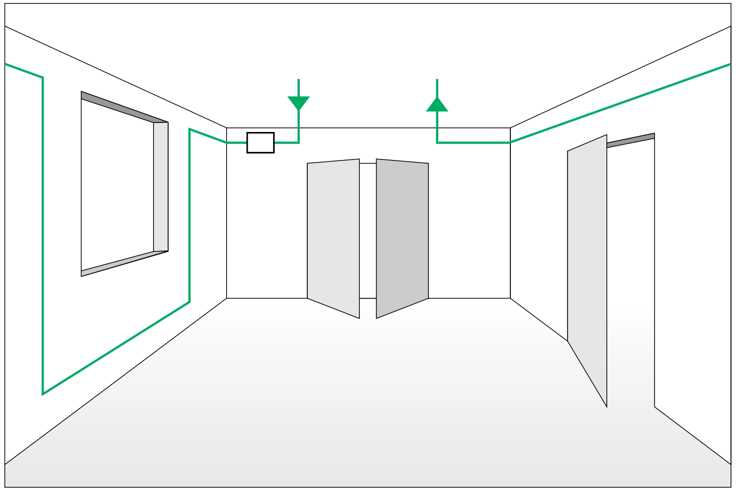

*Fig. 2.4-1 ** preparatory cabling*

Star codes

and the DIN 18015 standard, we make the following differentiation:

- * Every room has only one access point to the bus line. A subsequent bus installation only has an effect on the room, but it is extensive. No additional expenditure is required for the stairwell.
- ** The bus line is available on every wall, especially in the important zones – windows and doors. Installation sockets are already in place for branching. A subsequent bus installation restricts itself to short line sections in the room (see Fig. 2.4-1).
- *** The bus line is available at all important points within the room (see Fig. 2.4-2).

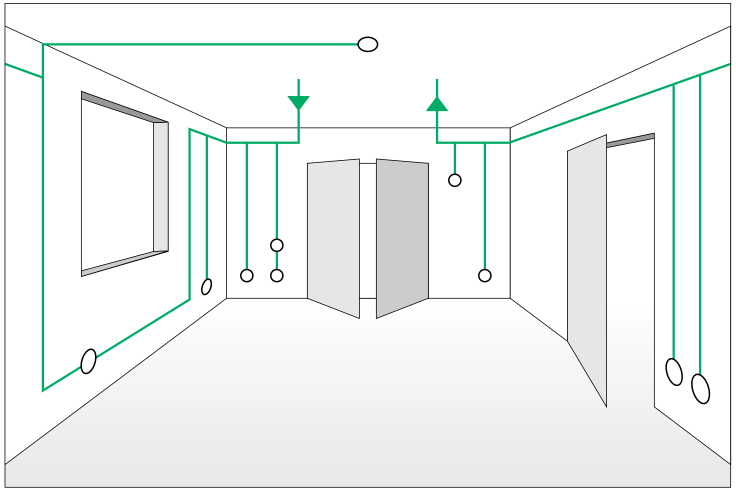

*Fig. 2.4-2 *** preparatory cabling*

Good preparatory cabling reduces necessary work to the absolute minimum. necessary when updating or modernising.
The basics of a three star installation are explored in chapter7.