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2.5
Wireless and M-Bus enabled Metering Devices

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2.5.1
Introduction

The demand for systems which allow the automatic reading of consumption data of meters installed in residential buildings is increasing steadily. At the present time, more than one million household meters including heat cost allocators in Europe and more than eight million in the USA are remotely read. One can assume that this number will double every 2 years.

In some countries, for example, in the USA automatic meter reading is progressing more rapidly than currently in Germany, the reason being that meters are read and billed monthly. A monthly part payment for the consumption of energy, as is generally practiced in Germany, is not permitted in the USA by law. Only the amount that was metered can be billed. In order to limit outstanding accounts, meters are read and billed monthly. The profitability of automatic meter reading for this monthly billing mode is a matter of fact. The deregulation of the energy sector which is also taking place in the USA underlines the trend towards automatic meter reading.

Although automatic meter reading has not yet proved that it is economical as far as the annual reading rota and tariffs involved today are concerned when compared with the manual reading of meters and heat cost allocators, the financial advantages are obvious.

For energy suppliers and/or billing service providers, automatic meter reading can be regarded as a potential for improving services to the customer. Furthermore, journeys to real estates to record all user data can be avoided and intermediate billing when tariffs and tenants change can be carried out at very little additional expense.

In view of the structural changes in the energy sector which was introduced by deregulation, automatic meter reading will gain importance in the future. Free selection and, in all probability, a frequent change of energy suppliers by the user would be virtually impossible without automatic meter reading. Also, some energy suppliers abroad are considering the fact of billing not only according to consumption units alone but also energy and peak loads. This will justify the actual production and distribution costs to a greater extent than simple billing according to energy consumption units. In this case, the large data volume which is required for billing takes automatic data transfer of the meter readings for granted. In the first place, the user will profit from all this and, therefore, it is the user who will encourage it.

A major prerequisite required by automatic remote meter reading to penetrate the market is the rapidly progressing technological development. This applies both to the availability of electronic consumption-measuring devices and the development of transmission methods in local areas via data bus and radio. The availability of new communication methods such as GSM, SMS and Internet services will also play a major role in future for transmitting data at a favorable price from residential buildings to central billing centers and providing extra services for the user.

The transmission of data via radio inside an existing building will gain more importance in the future than the transmission of data via data bus. This is due in the first place to installation costs, which are high particularly in old buildings as a line must be laid for the data bus and this is only acceptable to the parties concerned when the building undergoes a complete overhaul.

Meters which are connected directly to telephone lines via a modem or which transmit their data directly by radio via communication satellites to a monitoring or billing center are not mentioned here; transmission paths of this kind are today only of interest for large-scale meters where consumption and other data are called up at short intervals, and this applies also to the foreseeable future.

Systems with electrical point-to-point connections where pulses of mostly mechanical meters are transmitted to a building central control system and added there are not the object of further observation. These processes do not fulfill today's requirements as regards economical and service-friendly installation, simple retrofitting, and reliable data transmission.

2.5.2
Benefits of Remote Reading

Many decision-makers are of the opinion that investments in a system with remote meter reading, including the required infrastructure and operating costs, greatly exceed the costs of annual manual reading. Therefore, in their opinion, automatic remote reading of meter data is not economical – either now or in the future. This viewpoint is based in the first place on the assumption that reading and billing modalities, which have become established today due to manual reading, will remain so in the future. This is, however, more unlikely which is obvious from subsequent applications (see below and Section 2.5.3.1). Also, this viewpoint does not consider the time that the user must sacrifice to be present during reading or even other requests that the user might have. In other words, the sums are wrong which is typical for some energy suppliers whose present situation in the market is either monopolistic or oligopolistic. Many energy suppliers at home and abroad, however, are starting to take a different approach.

Remote reading already provides today such decisive advantages to both the user and energy suppliers as well as property management that extra expenses for initial equipment can be accepted. The advantages that are given qualitative consideration here can also be regarded as financial advantages.

2.5.2.1
User

- No presence required for reading the various types of meter. The presence of the user – in most cases an employed worker – required during reading of the meter which, depending on the type of energy, takes place at varying times, is becoming a virtually unbearable strain. If users were to present a bill with an appropriate hourly rate for their presence, automatic remote meter reading from this point of view would be economically worthwhile.
- Automatic remote meter reading means that apartments no longer need entering. The protection of the private sphere is rated highly today, particularly in view of criminal offenses. This applies, of course, to criminals who pretend to be meter readers and not to the legitimate meter reader.
- Tenants and tariffs fluctuate frequently in buildings which are supplied by long-distance heating. In these cases, the energy supplier or the service provider makes do with an 'auxiliary bill' (eg, number of degree days) which can be far from the correct billing of actual consumption values. Intermediate billing or cost allocation which is based on actual consumption values is only possible at low cost with the aid of automatic meter reading; the user would profit from this correct form of billing. In the course of deregulation, the necessity for frequent meter reading will increase when the user can profit from frequently changing the energy supplier. Correct billing and the possibility of benefiting from the cost advantages of diverse energy suppliers are the driving forces here behind remote reading.
- In some countries – in the first place Denmark – users receive a statistical evaluation of their consumption behavior from the energy supplier. The users can thus alter their behavior and in turn influence their energy bill – on the condition, of course, that the supplier reads the meter once or several times a day.

2.5.2.2
Energy Supplier and/or Billing Service Provider

- Lower reading and billing costs with automatic remote reading when meters are read more than once a year (changes of tenants and tariffs, increased transparency for the user when meters are read more than once a year; thus improvement of competitiveness).
- Quicker receipt of money as all values are immediately available owing to automatic reading and one does not have to wait for so-called latecomers (user not at home on reading date). This applies, in particular, to a cost allocation where all user data of a real estate are required in order to bill correctly.

- Fewer billing errors – and thus costs – as automatic reading provides all data without multiple manual data reading and realization.
- Automatic meter reading provides energy suppliers with the potential to improve services. In view of deregulation, some energy suppliers are starting to do just that.
- Introduction of a tariff structure which is better aligned to the actual costs: for energy suppliers, fixed costs amount to at least 70% of the overall costs. Energy and/or medium costs (water, long-distance heating, gas, electricity, etc.) constitute only 30% of the overall costs. Almost 90% of the fixed costs are infrastructural costs (power plant/heating plant/reprocessing and distribution network). As peak loads determine the size and configuration of the infrastructure, thought should be given to a tariff structure which corresponds to this situation (with large consumers, namely 'special customers', this is already the case). Payment according to the work price alone (m^3, kW h) does not make allowances for the actual incurred costs. A complex price setting which assists in reducing peak loads is inescapable as the extension of production and distribution capacities are difficult to realize for both political and financial reasons. Appropriate tariffs which are more than just work prices mean more data, yet only automatic transmission can cope with more data.
- Meter monitoring for water and heat meters, which, owing to the medium they measure, are more susceptible to defects than other usage meters.

2.5.2.3
Owners and/or Property Management

- The owner contributes to the satisfaction of the user by investing in the automatic reading of meters. In view of the increasing number of empty apartments, this is a point of major importance.
- Quicker billing. This is an important factor when property management must make advance payments as far as heating is concerned.
- Correct and quick billing when tenants change and thus a better chance that the users who are moving will pay their bill punctually.
- Energy management especially for commercial undertakings and functional buildings.

2.5.3
Data Transfer via Data Bus

Standardized and proprietary bus systems used today must have reached three digital numbers and are increasing continuously. The reason is that there is no bus system at the moment which optimally covers the varying requirements of different applications as far as cost is concerned. Communication requirements are frequently only covered by a hierarchy of buses.

This book does not enter into the complex topic of the 'data bus' in detail. The advantages and disadvantages of the many house buses used today with which meter data can also be transmitted are contained in various publications. Despite the fact that the applications and requirements are still relatively transparent, it is highly improbable that a single standard will prevail on the market.

Many national, European, and international standardization committees (ICE, ISO/OSI, ICI, EIA, CEN, CENELEC) have concerned themselves with the topic of 'house bus' and come to the following results. The standardization suggestions are, to a certain extent, overloaded with requests. This means that efficiency suffers and it is not possible to say whether they will prove their worth in practice. On the other hand, proprietary solutions have prevailed in practice and have been adopted by a large number of industrial companies which are working together in groups.

The transmission of meter data – battery-operated meters and allocators predominate – makes demands of a specific technical and economical nature not only on the data bus but also on the meters themselves. Before the requirements under Section 2.5.3.2 are referred to, the requirements which are in demand today and in the foreseeable future will be considered briefly in Section 2.5.3.1.

2.5.3.1 Bus Applications of the Meter Sector and the Resulting Demands on the Data Bus

In most cases, particularly in old buildings, installation costs/effort involved in laying electrical cables of the meters when data buses are used are considerable. In order to justify these costs/effort, however, it is obvious that a bus system must be designed in such a manner that not only the consumption figures of heat cost allocators but also the data of the remaining meters (gas, water, electricity) can also be read.

- *Central meter reading*: Meter data are transmitted to a central control unit building. In the meantime, a number of European manufacturers are offering usage meters for water, electricity, gas, and heating, whose meter readings (no increments) can be read at the building central control unit via a bus in the form of a protected data protocol. Depending on the make, several meter readings are made available for billing consumption, for example, several consumption values of multi-tariff meters and other measured values such as peak and reactive loads, etc., which are used for more complex billing.
- *Remote meter reading:* This can be regarded as a type of central reading. The meter data for the building which have been collected are transmitted from the building central control unit via the public telephone network or via GSM or SMS to the billing center.
- *Parameterization:* Only meter data and parameters which are irrelevant as far as calibration is concerned can be altered via the data bus, eg, new code for data coding, command for tariff zone switching, new meter number, due date when meter readings can be saved for subsequent reading.
- *Control:* This means the transmission of commands to meters. An example is switching off or disabling of the supply by a stop valve in the meter or a switch.

- *Transmission of auxiliary measured variables:* Many of the meters supplied today have auxiliary measured variables which can be used for the optimization of control processes, in particular for heating systems. Also included is the transmission of data for monitoring and controlling supply networks (load management) as well as peak loads (see Section 2.5.2).

The meters must possess the required 'intelligence' to be able to communicate with the selected data bus. For mechanical meters with pulse output, interface modules are offered which can be used to couple these meters to the data bus.

2.5.3.1.1 Demands on the Data Bus and the Connected Components

The most important requirements for a data bus suitable for meter applications and connected components such as meters and data collectors are as follows.

Topology

The building structures and layout of the apartments vary considerably. As regards the laying of bus cables and the topology, there should be no restrictions, therefore, to avoid higher installation costs. Possible bus topologies are line, tree, and star.

Energy Supply of Electronics

The European approval authorities for meters demand that the energy supply of the calculators of usage meters does not depend on the possibility of supply by the data bus so that, in the case of failure of the bus, an uninterrupted metering of consumption is ensured. To fulfill this requirement at the moment, only a measuring device which is battery operated or supplied by the mains is possible.

Apart from electrical meters, the electronic usage meters and heat cost allocators which are offered today are battery-powered for reasons of cost. The capacity of the batteries integrated in the meters is adapted exclusively to the measuring electronics of the meters; the battery cannot, therefore, provide the electrical energy supply of the bus driver module (interface electronics to the data bus). This must be provided by the bus line itself or by a second additional line. In order for the cross-sections of the supply line to remain acceptable ($<1\ mm^2$), the current consumption of the bus driver should be <5 mA.

Number of Meters Which Can be Connected to the Bus and Network Extension

The number of meters and heat cost allocators that can be connected to a bus must coincide with the requirements in practice. The following meter/allocator configurations are required per apartment: 5 heat cost allocators + 2–3 water meters (if necessary + 1 electrical meter + 1 gas meter) = 7–10 meters. More than 30 apartments in a building complex, possibly consisting of several buildings, means that up to 300 data terminals are connected to the bus network. Furthermore, maximum distances of 1000 m between the central reading/control station and the meters must be given consideration. Depending on the network topology selected in the building, the entire laid cable length may be many times this amount. This means that in view of the addressability and the electrical bus characteristics, it must be possible to connect a large number of meters and data terminals and to bridge distances a minimum of 1000 m between meters and a building central control unit – if necessary, using repeaters (amplifiers).

Addressing Meters

With most utility companies, administration and logistics (meter installation and replacement, reading and billing) are allocated the meter number (eight digits). In order to avoid additional problems for the service provider and/or the energy supplier, it should be possible to address the meters via the meter number. It is also desirable that the bus system can configure itself, ie, the system recognizes all installed devices and automatically creates and manages addressing tables when initially installed.

Supporting Data Types and Structures

The protocol should be open and extendible so that varying data types and structures (fixed and variable) can be supported for future applications.

Transmission Speed

With the above-mentioned applications, the transmission speed is not particularly critical but should nevertheless not be below 2400 bps, as otherwise the times for reading a large number of meters in a building would be too high to realize future applications. As a building can have meters with varying transmission rates, the software and hardware of the central unit must be designed for automatic speed detection.

Transmission Reliability

Taking into consideration that the laying of bus cables in the building can virtually not be affected (possible parallel laying with electrical lines), a high resistance of the data bus to inductive and capacitive field parasitic interference is required. An adequate transmission error recognition by the protocol with a Hamming distance of 4 is also required to ensure an acceptable residual error probability during transmission. This is a prerequisite for correct billing.

Equalization of the Electrical Potential Differences in Buildings

The electrical potential differences in buildings are considerable and vary as follows:

- inside an apartment, virtually no difference;
- between the apartments of a building, several volts (<10 V);
- between several buildings of an apartment block: several tens of volts.

There is also a risk of a galvanic connection of the measuring electronics with the mains voltage (220 V_{eff}) which must not, however, affect the bus. This should be ensured by constructive measures or by altering the characteristics of the interface modules.

Overvoltage Protection

Protection is required to protect the devices connected to the house bus against possible destruction by overvoltage (eg, lightening). Such overvoltages may result in the destruction of electronic components. When connecting gas meters to the data bus there is a risk of explosion. For example, if a bus cable requires laying outside a building to interconnect several buildings, lightening protection must be provided. Well-proven circuits and processes are available from the telephone and broad-band cable networks.

If necessary, protection against 220 V overvoltage should be provided in the components of the bus system.

Short-circuit Protection

The risk of a line short-circuit in living areas is particularly high. Furthermore, short-circuits can occur in devices which, if they are not intercepted by constructive measures in the components, can affect the bus in such a manner that the localization of this problem in large apartment blocks is extremely difficult. Therefore, a short-circuit in the bus cable must not result in damage to the electronics of the devices connected to the bus. A short-circuit in the electronics of a device should not result in the failure of the entire data bus so that the defective device can be automatically identified and replaced in good time.

2.5.3.2 Available Data Buses for Meter Applications

For meter applications various bus systems such as M-Bus, EIB, Echelon, Batibus, and Euridis were used. The M-Bus was designed specially for the above-mentioned meter applications and has gained acceptance throughout Europe. Euridis has established itself in France for reading E-meters, but, it is hardly suitable for other meters owing to the high current consumption for data transmission and restricted addressing possibilities. The remaining buses mentioned are less suitable for meter applications. For this reason, we will only consider here the M-bus.

2.5.3.3 M-Bus

2.5.3.3.1 Overview

The M-bus (abbreviation for metering bus) was developed initially for central or remote reading of usage meters. Development was focused on:

- support of a large number of meters;
- bridging of long transmission distances at low cost;
- reliable data transmission;
- low hardware costs;
- low costs for planning of systems, installation, maintenance, and supplementation of meter equipment for buildings.

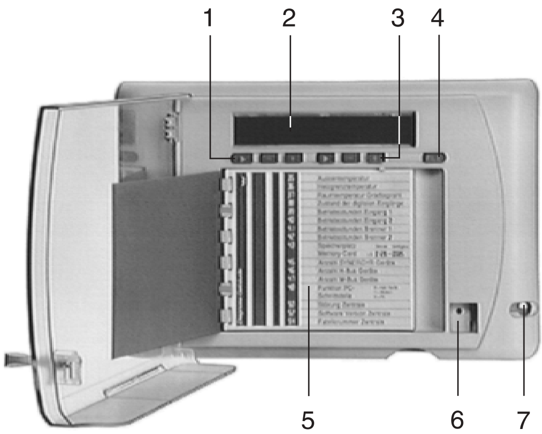

Fig. 2.5-1 Building central control unit OZW 10 (manufacturer: Siemens, Landis & Staefa)
1 Left key block
2 Display
3 Right key block
4 Memory key
5 Operating cards
6 Lock
7 Hole for sealable fastening screw

The M-bus is defined in the Standard EN1434-3. Only one communication master is permitted within the system (eg, OZW10 (Figure 2.5-1) with level converter WZC-P250 (Figure 2.5-2)).

All M-bus components comply with the EMC requirements of IEC 801 Part 2–6, severity level 3, and/or En 5008-1 and -2. The bus also complies with the German regulations for high-frequency emission (radiofrequency emission) as per DIN/VDE 0871, Part 20.

Communication is always started by the master. M-bus devices are periodically queried by a so-called master (building central control unit).

Fig. 2.5-2 M-bus level converter (manufacturer: Relay)

Tab. 2.5-1 Application examples

	Maximum distance (m)	*Overall length of all lines (m)*	*Cable diameter (mm)*	*Number of M bus devices*	*Maximum transmission rate [1] (baud)*
Smaller residential buildings	350	1000	0.8	250	9600
Larger residential buildings	350	4000	0.8	250	2400
				64	9600
Smaller accommodation	1000	4000	0.8	64	2400
Larger accommodation	3000	5000	1.5	64	2400
Town, district	5000	7000	1.5	16	300
Point-to-point connection	10 000	10 000	1.5	1	300

1) Maximum cable capacity 150 nF/km

A two-strand twisted-conductor cable is used (eg, J-Y-ST-Y-2*2*0.8). Permissible cable routings are line, tree, and star topology as well as hybrid types. Ring topology is not allowed. A bus terminal is not required.

An expansion of the network and the maximum transmission speed are limited by the number of M-bus devices, suppressor circuits, cable routing, and cable types. The expansion of the transmission network can be subdivided by a so-called 'repeater' (eg, WZC-R250) into segments and extended virtually as required. Table 2.5-1 below contains simple application examples with a level converter.

Terms and Definitions

Access Methods

Bus access is based on the master/slave concept, ie, the meters connected to the M-bus communicate only when requested to do so by the master (polling). The master (eg, building central control unit) queries the slaves (meters); the meter (slave) whose address corresponds with the M-bus device addresses responds.

Transmission Type

The type of transmission is half duplex, ie, data can be transmitted in both directions; however, communication must be made in succession as it is not possible in both directions simultaneously.

Transmission Speed

The bus interface is designed for transmission rates of 300–9600 bit/s. The M-bus standard recommends transmission rates of 300, 2400, and 9600 bit/s.

Level Converter

The level converter forms the interface to the master (building central control unit) and the first bus segment. Depending on the type, 250 meters can be connected to a level converter. When the entire bus network as regards length and meters which require operating is too large, repeaters must be used.

The input of the level converter can be either RS-232 or RS-485. The plug-in unit inserted in the level converter is important.

The output feeds an M-bus segment and thus has similar functions to the repeater.

Repeater

Repeaters are necessary to bridge greater distances and for connecting many meters to the M-bus network. The repeater transmits all data to the meters which are connected to the bus segment which it supplies. Therefore, there is a new M-bus segment at the repeater output.

The repeater amplifies and forms the signals again which could become distorted over greater distances. It also supplies the meters which are connected in the next bus segment with current. The electrical input of a repeater has the same features as a slave. The output of a repeater supplies an M-bus segment.

Expansion

The entire expansion of the bus system is limited by:

- the number of M-bus devices (slaves and/or meters) in the segment (Figure 2.5-3);
- distribution of the device in the bus segment;
- in the segment: resistance values of the used bus line (voltage drop of the bus line);
- required transmission speed; the bandwidth is limited to 9600 bit/s.

As these are the most important points, we will not enter into further details.

All M-bus devices which are connected to the same repeater or level converter belong to the same M-bus segment.

Every segment has its own repeater. Up to 250 data terminals can be connected to one repeater (segment) under worst-case conditions: all data terminals are at the end of a phase and all devices are supplied with current. This high number of terminals means that a bus installation can only consist of one segment which is connected to a master via a repeater.

Topology and Bus Installation Regulations

The M-bus operates in the network topologies star, line, and tree (Figure 2.5-4). Depending on the application, however, there is a 'preferential topology'. A ring topology should not be used in the M-bus networks.

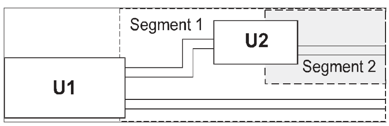

Fig. 2.5-3 Segment

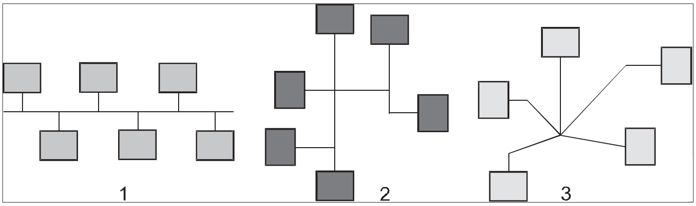

Fig. 2.5-4 Forms of topology. 1 Line; 2 Tree; 3 Star

A four-stranded telephone cable (J-Y-STY-2*2*0.8) is recommended as a transmission medium. It is cheap and easy to acquire. Two of the four strands are used for the bus; the other pair of strands are intended as a stand-by or can be used for another bus. The maximum distance between an end terminal and a repeater depends on several factors. The descriptions below provide something to go by. The entire cable length (all parallel switched lines) in one segment is 1000 m (capacitive load due to the cable: 160 nF).

When using a cable with thicker cross-section, greater distances can be bridged and/or more devices can be connected (compare both previous figures). This association can be seen in Figures 2.5-5 and 2.5-6. The following requirements and/or conditions are parameters for both figures:

- *Row 1:* Theoretical conductor length for equidistant distributed M-bus devices (eg, an M-bus device every 5 m). This is the upper configuration limit and should always have a conductor length of <4 km.
- *Row 2:* Theoretical conductor length for all M-bus devices at the end of the line (worst case).
- *Row 3:* Same as row 2. It is assumed here that the communication to the bus should still function when a short-circuit has occurred in one of the devices (easy localization of short-circuit).

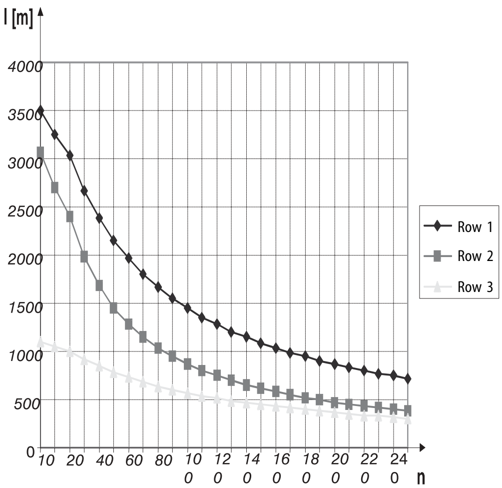

Fig. 2.5-5 Line lengths for conductor diameter 0.8 mm

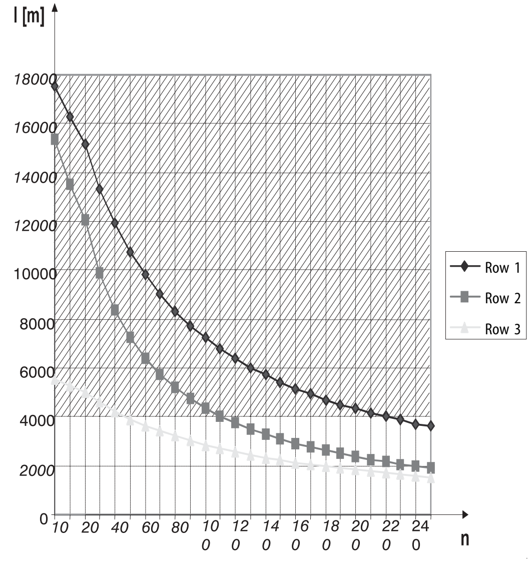

Fig. 2.5-6 Line lengths for conductor diameter 2.5 mm

The M-bus therefore does not represent a network. Controllers are not required for 'routing functions' to increase the connection possibilities of data terminals to an acceptable extent as is to be expected in larger residential buildings. Using an 'unintelligent' repeater, widely branched bus structures with an extremely large number of data terminals can be realized (several thousand terminals as long as the required reply times allow it).

Physical Specification

The physical layer is a semi-duplex, asynchronous bit-serial transmission (UART protocol) with baud rates between 300 and 9600 bit/s. Every eleventh bit must be a logic '1'.

The transmission of master to slave is performed with the aid of voltage excursions. A logic '1' (mark state) is represented by a voltage of nominal 36 V and a logic '1' (space state) by a lowering of the voltage by 12 V to a nominal 24 V.

The transmission of data from the slaves to the master is implemented electrically so that no energy is taken from the terminals for this purpose. The terminals model the electrical current which is provided by the master (mains-operated). The bit representation of a message is coded via currents. In the case of a logic '1' (mark) a current of 1.5 mA is removed from the master by the terminal; a logic '0' (space) is displayed to the master by a current consumption increased by 11–20 mA caused by the slave (see Figure 2.5-7). The transmission of a space therefore causes a slight drop in voltage at the repeater.

Explanations of the symbols in Figure 2.5-7 and other electrical parameters of the system components are as follows: $U_{MU,M} = 36$ V, voltage at the master, idle level; $U_{MU,S} = 24$ V, voltage at master, transmission level; $U_{M,M} = 12$ V, voltage at meter, idle level; $U_{M,S} = 11.3$ V, voltage at meter, transmission level; $I_M = 1.5$ mA, supply

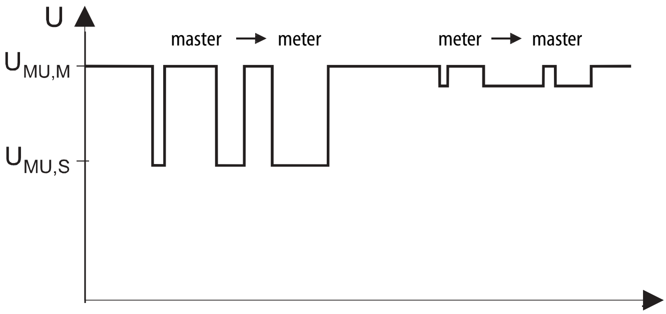

Fig. 2.5-7 Voltage change on M-Bus cable during data transmission

current, idle level; I_S = 20 mA, signal current (space level); n = 1–250, number of meters in bus system; R_S = 440 Ω, maximum safety resistor in each meter; R_C = … Ω, cable resistor; R_M = 60 Ω, maximum measuring shunt in the master; R_{CON} = 2 Ω, resistance of all connections.

Owing to the transmission in the response direction (slave to master) with current pulses due to a constant current drain in the bus transceiver (minimum 11 mA) and the voltage difference of 12 V in the opposite direction (master to slave), there is a high degree of insensitivity towards the effect of external interference (capacitive and inductive parasitic interference). Measures preventing interference suppression include, in particular, common-mode rejection, the galvanic decoupling of the repeater, and the terminals (constructive or by the optocoupler).

As a transceiver a customer-specific electric circuit was developed by Texas Instruments (TSS 721). Functions and characteristics of this integrated module are as follows:

- Communication speeds with baud rates of 300–9600 bit/s.
- Remote supply of data terminals. The interface module contains a voltage controller, which generates a controlled voltage for the processor of the data terminal of 3.2 V with maximum 500 μA. As the bus voltage when transmitting data by the master never drops to 0 V (36 V mark; 24 V space), the supply voltage for the electronics of the meters is always available at the output of the TSS 721.
- In case of bus failure and thus failure of the current supply of the terminal by the bus, the TSS 721 transmits a signal to the pin 'PF' which can be used as an interruption for the processor of the terminal to save the data in the EEPROM. Furthermore, with the signal at the output 'VS', a FET (field effect transistor) can be controlled which switches from the current supply by the bus to battery supply. This is important with usage meters which are normally battery-powered. As long as the data bus indicates no fault, they will be supplied by the bus and in case of failure of the bus, supply is continued without interruption by the battery.
- Reverse voltage protection. The connections of the bus lines at the inputs of the transceivers are random. This is achieved by the series-connected bridge rectifier in the TSS 721 at the bus inputs.

- In case of a short-circuit in the terminal, a resistor at the input of the bus (pin: BUSL1 and BUSL2) ensures that the bus is not short-circuited. A bus short-circuit would mean extensive fault locating. This series resistor (430 Ω) ensures that the bus is not short-circuited despite this device fault and still continues to function. The master can detect this short-circuit by querying all devices and demand the replacement of the defect device by giving a warning.
- Protection against overvoltage. The switching circuit is protected against overvoltage to a maximum ±50 V. Furthermore, a circuit as described in Section 2.5.3.1.1 (subsection 'Overvoltage Protection') can protect the transceiver TSS721 also against higher voltages of maximum 220 V. This circuit can ensure protection against explosion, as long as it is installed outside potentially explosive rooms, in front of each gas meter in the bus supply line. The series resistor (430 Ω) is the same as that which provides protection against short-circuits described above.

As a repeater, three marketable versions, mini, midi, and maxi repeaters, for 60, 120, and 250 terminals, respectively, are available. Their major difference is the number of connectable terminals. The repeaters supply the terminals with a maximum current of 300 mA. The repeaters are protected against short-circuit and overvoltages of maximum 220 V. They have a display against overloading (if, for example, too many terminals are connected). A master comprises a repeater and a building control unit which are interconnected via an RS 232 interface. In case meters are only read occasionally, the central control unit must not be installed permanently.

A summary of the most important data is given in Table 2.5-2.

Protocol (Link Layer and Application Layer)

As the bus is not a network and thus requires no connection, layers three to six of the OSI models are empty. In addition to the physical layer, only the link layer and the application layer are equipped with functions.

The protocol is based on the international standard IEC 870-5 which defines transmission protocols for telecontrol systems. This protocol uses asynchronic se-

Tab. 2.5-2 Summaries of the most important data

Transmission speed (bit-rate)	300–9600 bit/s
Master:	
Logic '1' (mark)	36 V nom.
Logic '0' (space)	24 V nom.
Slave:	
Logic '1' (mark)	1.1 mA nom.
Logic '0' (space)	11–20 mA nom.
Supply by the repeater	36 V/24 V; 300 mA
Supply by the bus driver (for processor of device)	500 µA

Tab. 2.5-3 Telegram formats

Individual character	*Short frame*	*Control frame*	*Long frame*
E5h	Start 10 h	Start 68 h	Start 68 h
	C Field	L Field	L Field
	A Field	L Field	L Field
	Test sum	Star 68 h	Start 68 h
	Stop 16 h	C Field	C Field
		A Field	A Field
		CI Field	CI Field
		Test sum	User data (0–252 bytes)
		Stop 16 h	Test sum
			Stop 16 h

rial bit transmission. Synchronization is carried out by start/stop bits at each character. The IEC 870-5 has three different integrity classes I1, I2, and I3. The integrity class is a dimension for the relationship between the rate of non-identified incorrect telegrams and the bit error probability of the transmission. For these integrity classes measures are defined for detecting errors in transmission. For the M-bus protocol, format class FT 1.2 is provided for the transmission of the meter reading (vertical parity bit per character with longitudinal parity total for the message). This selected format has a Hamming distance of four.

The M-bus protocol represents a subset of the IEC-870 protocol. The M-bus protocol can be extended by further functions which this IEC standard offers.

In the format class FT 1.2 there are three different telegram formats which differ from one another by a specific character at the beginning of each data block. The telegram formats are as follows (Table 2.5-3).

Individual Character

Serves to confirm messages (E5h).

Short Frame

The flag (10 h) is followed by the so-called control field and/or function field, the address field, the test sum, and the stop character. The short frame serves to initialize the slaves (normalize) and for requesting the slaves to transmit data which are not time-critical. Initialization serves the purpose of synchronizing the transmitter and receiver of data so that a loss or multiplication of messages is avoided during the subsequent data transfer without having to replace an ACK or NACK after every message (increase in efficiency).

Long Frame

This contains in addition to the fields of the short frame also the identification field CI and the data field with maximum 252 characters. The long frame is variable. A special form of the long frame is the 'control frame', which does not transmit data.

The meaning of the individual fields in the messages is as follows:

- The C field controls the data flow and monitors the correct sequence of messages and avoids the loss or the multiplication of messages. It states whether messages are to be transmitted or received and what priority the messages have.
- The address field permits the addressing of 250 terminals. The addresses 254 (FEh) and 255 (FFh) represent group addresses. The data field is used to extend the addressing space using a meter number of nine bytes (see below).
- The data field is variable and can comprise maximum 252 characters.
- The L field states the length of the data block increased by the number of control characters.
- The application layer was defined in the TC 176 (standard for heat meters). The standardization suggestion is based on the IEC 870-5 standard which defines only the data in the response direction (meter to master) and no data blocks which cause a switching of tariff in the meter.

The data structure in the opposite direction can be seen in Table 2.5-4.

The date field contains further definitions as regards the types of meter (heat meter, gas meter, water meter, electricity meter) which contain (1) the physical units of measurement in question, (2) the type of values, ie, instantaneous values, mean values, minimum values, peak values or meter readings, and (3) to which meter (which index) the data refer if multi-tariff meters are being used. These points will not be referred to in detail; the relevant standards contain all further necessary information.

The application contains the automatic configuration of an extended meter/M-bus installation. This means that the meters with their meter number of 9 bytes identify themselves to the master without a network administrator having to allocate meter numbers and physical bus addresses. This means that an additional meter can be installed in the building at all times or a meter replaced without having to extend or supplement address tables. The energy supplier and/or the service provider can keep to his meter numbers on which his entire logistics and administration are based – for communicating as previously with the meter.

The M-bus standard suggestion for the TC 176 contains at the moment only a part of the IEC 870-5 standard. From the point of view of the physical layer of the

Tab. 2.5-4 M-Bus Data telegramstructure

Identification No.	*Manufacturer*	*Version*	*Medium*	*Access No.*	*Status*	*Signature*	*Data*
4 bytes	2 bytes	1 byte	1 byte	1 byte	1 byte	max. 243 bytes	max. 243 bytes

M-bus, there are no obstacles or restrictions which prevent adopting further parts of the IEC 870-5 standard, with regard to the link and application layer. The decision for such an extension depends in the end on the product providers who select this bus for their applications.

2.5.3.3.2 **Application Examples**

With the M-bus, two types of system are applicable. These are: M-bus systems inside the house (in-house systems) and M-bus systems outside the house. Hybrid forms are also possible.

In-house Systems

The in-house systems (Figure 2.5-8) are limited to an apartment house and the bus expansion is usually only slight (eg, consumption billing of real estate).

Systems Outside the House

For systems outside the house (Figure 2.5-9), several independent real estates are usually connected which may be situated far apart (eg, long-distance heating systems).

For greater distances, repeaters are required. The site of the repeater depends on the future extension and local conditions (supply the repeater, accessibility).

Hybrid Systems

In hybrid systems (Figure 2.5-10) several real estates (with in-house bus inside the real estate) are interconnected. Several repeaters may be required.

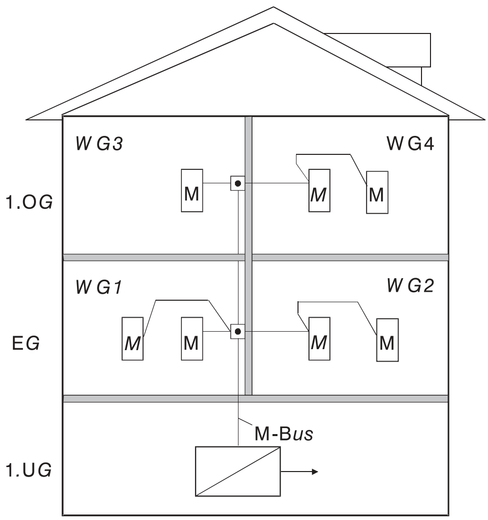

Fig. 2.5-8 In-house system. M-bus device (eg, Megatron 2 (heat meter), Memotron 2 (heat cost allocator), pulse adapter, Volutron 2 (electronic water meter)); repeater or level converter (WZC P250); level converter with connection to central unit (OZW 10) and/or PC; distribution point; apartment No.; basement/ground floor/upper floor. Source: illustrations by Siemens Landis & Staefa

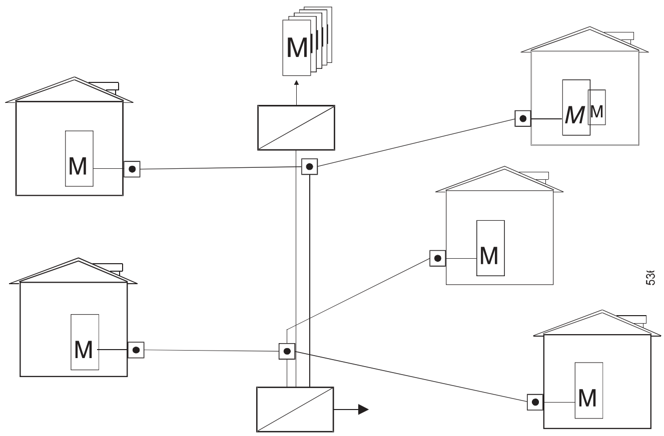

Fig. 2.5-9 Systems outside the house. Details as in Figure 2.5-8

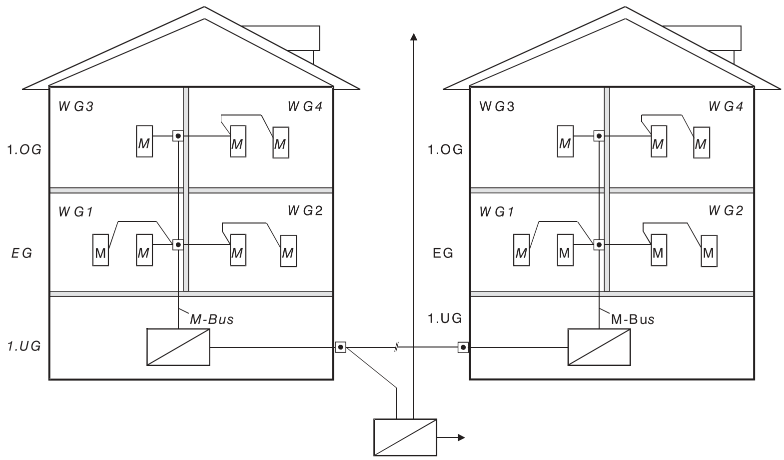

Fig. 2.5-10 Hybrid system. Details as in Figure 2.5-8

Configuration Examples

Below are some configuration examples provided by Landis & Staefa (Figure 2.5-11). The M-bus system is used for consumption cost billing and remote monitoring of district and long-distance systems and apartment houses. The M-bus central unit (OZW10) is the central device at the M-bus. It communicates via the M-bus with the connected usage meters and controllers.

The M-bus central unit can be directly connected with a PC or via a modem. The operating and alarming software and special user programs are installed on the PC.

The following M-bus devices can also be connected:

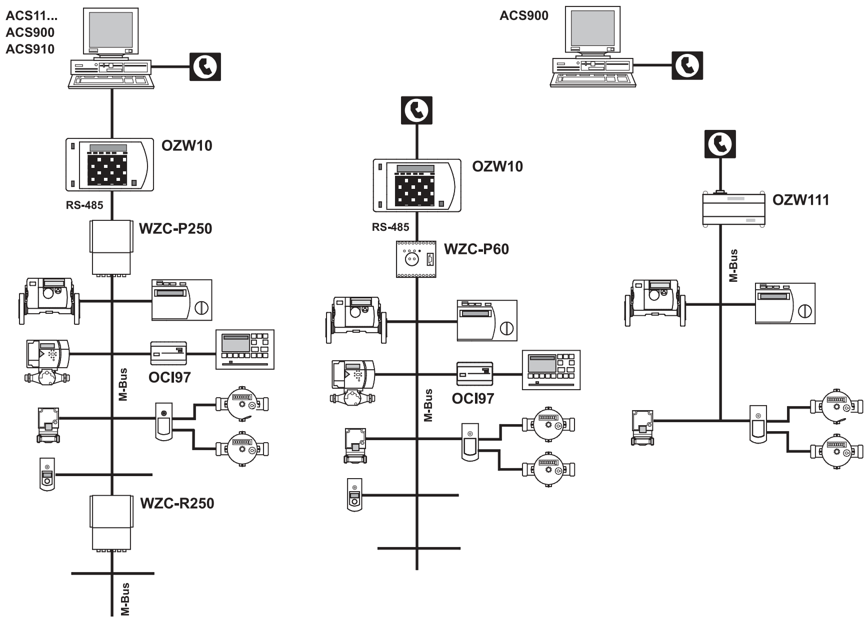

Fig. 2.5-11 M-Bus application examples

Meters:
– Heat meter SONOGYR® energy.
– Heat meter SONOGYR® WSD.
– Heat meter MEGATRON®2 WF.
– Usage meter via pulse adapter AEW21.2.
– Usage meter via pulse adapter RELAY PadpulsM1.
– Electronic heat cost allocator MEMOTRON® WHE21.

Controllers:
– Long-distance heating controller RVD2.
– Long-distance heating controller SIGMAGYR® RVP97.

2.5.3.3.3 **Overall Assessment of the M Bus**

The M-bus was designed in the first place with meter applications in mind (mains and battery-operated). It represents an extremely efficient and cost-favorable solution for this sector and gives consideration to the special operating conditions and costs of usage meters.

Both technical data and standards exist. A meter manufacturer can choose whether to aim at an integrated solution (measuring functions and protocol in one processor) to reduce manufacturing costs or whether he wishes to complete the protocol procedures in a separate communication processor available on the market.

2.5.4
Data Transmission via Radio

The first larger commercial application of data transmission of household meter readings via radio was introduced in the mid-1980s in the USA. In Germany, legal conditions were not created by the regulating authorities until the beginning of the 1990s when an ISM band of 433 MHz was also released for this application. At the same time, the restriction that at least several users must be mobile for radio applications was also withdrawn.

Since that time, development has accelerated rapidly. Several manufacturers of consumption-measuring devices offer devices and systems for measuring consumption, renowned semiconductor manufacturers offer suitable cost-favorable radio modules, and users, energy suppliers, and property management value the advantages of automatic meter reading via radio. In the meantime, a further frequency band (868 MHz) was released in Europe for the 'home automation' sector and thus also for meter reading. The use of the 868 MHz band contains, however, some worthwhile regulations which did not exist in the 433 MHz band, thus improving the reliability of data transmission.

Unfortunately, a standard does not yet exist for the 433 MHz band for meter data transmission via radio. Since the beginning of 2000, however, intensive efforts are being made to introduce such a standard at the European level in the 868 MHz band.

2.5.4.1
Data Transmission and Selection Process

Since the introduction of data transmission of meter readings via radio, four different data selection and transmission processes have become established, the advantages and disadvantages of which are described briefly below.

The various processes mainly came into being because manufacturers were searching for a compromise for their customers between the comfortable reading of data and subsequent further processing on the one hand and the device and system costs on the other. Each company prepared a solution for this compromise based on its own interests and conditions.

Data Transmission Process

Bi-directional In this mode a dialog takes place between the terminal (meter) and the data collector. The data collector may be a building central control system or a portable data collector. The data collector demands by a command a specific meter (direct addressing) to transmit its data. The receipt of the data in both directions is acknowledged and, in the case of incorrect transmission, data are re-transmitted. Data can also be transmitted to the meter (eg, for parameterization) during bi-directional transmission.

Although this solution is equivalent to the form of communication on the data buses, it has the following disadvantages for the transmission of meter readings via radio when compared with the following solutions:

1. Each device, ie, meter and data collector, must possess a receiver in addition to the transmitter. A receiver is technically more complicated and thus more expensive than a transmitter.
2. The receiver of a meter must 'check' continuously or at short intervals whether it is receiving data. This 'checking' requires a relatively high amount of current (receiving circuit and microprocessor). As most of the meters and heat cost allocators are battery-operated, this mode rapidly reduces the service life. There is also a risk that the battery will rapidly become discharged when many messages at this frequency are received by the meter, even if they are not intended for it. To ensure the measured value, the use of a second battery to supply the radio module with energy with this solution is worthwhile despite additional costs.

With regard to the high costs of a receiver in each meter as well as high current consumption, it should be considered whether this process be used for battery-operated meters.

Uni-directional with wake-up signal This process is distinguished by the fact that the meters are 'woken up' with a radio signal and subsequently transmit data. As this wake-up signal is received by all meters installed in the building, one must, of course, prevent the relevant meters from transmitting their data simultaneously, thus causing a data collision. This can be achieved if every meter transmits its data in its own fixed, allocated time slot or if transmission is stochastically distributed in succession. In the case of a data collision, the repetition algorithm must be chosen in such a manner that the probability that at least one of the repetitions was successful is extremely high. However, with this process also, there is a risk of the battery becoming prematurely discharged.

Uni-directional (stochastical transmission) This process is based on the fact that data only flows from the meter to the data collector and not vice versa and that for billing purposes it suffices when a valid meter reading per day is transmitted. With this process, the meters transmit their data stochastically and several times a day. The reason for transmitting data several times a day is in case a data telegram of a specific meter collides with the data of another meter or an external data terminal. As the telegrams are very short (millionths of a second) and the same data are transmitted several times (five to six times), it can be expected that at least one of the telegrams transmitted by a meter will be received by the data collector.

Such a process assumes that a data collector is already installed and is ready to receive data at all times. Of course, data cannot be transmitted from the collector to the meter.

However, this type of system has the following decisive advantages:

1. The meters do not require a receiver. This means considerable cost reduction.
2. The strain on the battery is reduced considerably as there is no receiver. A transmitter which is only switched on when data is transmitted requires only a

portion of the current of a receiver. This also applies when it is only switched on from time to time to determine whether it is receiving a message (eg, 'Request to transmit').

In view of the fact that most meters, especially heat cost allocators and water meters, are battery-operated and these batteries are supposed to last for 10 years, this process has a considerable advantage compared with those mentioned above.

Selection Process

As far as the form of transmission is concerned, the following possibilities are available in the 433 MHz band:

1. fully installed data collector in a building central control system for uni- or bi-directional operation;
2. fully installed data collector on every floor of a building;
3. hand-held with wake-up pulse;
4. hand-held with wake-up pulse in time window.

These four basic systems, which are described below in detail, allows, the reading of a meter without having to enter the apartment. Only the first-mentioned process provides the possibility of reading the data at all times from a control or EDPC (electronic data processing center) using a wide-area network such as the telephone network.

Despite an expected standard for the transmission of meter readings in the 868 MHz band, one can assume that the process used in the 433 MHz band will in future be applied in the 868 MHz band and that in all probability others will be added.

Fully installed data collectors in a building central control system The main features of this concept compared with the concepts described below are

1. the remote transmission of meter readings via a higher network (PPT or radio network/GSM, etc.) or a data processing central unit,
2. the use of devices with uni- or bi-directional transmission with the above-mentioned advantages.

As there is no need to travel to a real estate to read meters, the advantages are more than obvious:

- The data for all meters can be called up at all times from the billing center without additional costs worth mentioning to complete billing regardless of whether there was a change in tenant or tariff. In case of allocation billing, all user consumption data are required for correct intermediate billing. For both these cases, this can only be regarded as economical when the data are transmitted to the EDPC 'fully automatically'.
- There is a possibility of billing at shorter intervals than yearly without incurring additional costs.
- Meters can be monitored for their functional reliability.

- Meter readings can be called up for statistical purposes.
- Meter readings can be continuously evaluated for facility management.

For this process, however, an infrastructure must be installed in the building. It consists, for example, of several antennas distributed throughout the building and connected to a building central control unit via a cable (signal receiver, data collector and bridge to the public network). The antennas are distributed throughout the building in such a manner that they are within radio range of the devices. The distance between the individual meters and the nearest receiving antenna is often only 20–25 m owing to the low transmission power and the high signal damping in iron-insulated buildings.

Instead of simple antennas, it is also possible to install floor repeaters. These repeaters comprise an antenna, a receiver, a transmitter, a processor, and memory for buffering data. The repeaters should be installed within radio range of the meters as is the case with the antennas. Meter data are transmitted from repeater to repeater by radio to the building central control unit. This means that cables which are required for simple antennas can be omitted.

Collector per floor With this process, meter data which are transmitted via radio from 'intelligent data collectors' which are installed within radio range – usually on every floor – are received and stored. The data must, however, be read from the collector with a terminal, eg, a PC, so that they can then be further processed. On the other hand, mains connection is not required for remote reading and cabling of the selection process described above is not necessary.

As is the case with the above-mentioned selection process, the process described here is also suitable for meters which communicate uni-directionally.

Read-out device with wake-up signal With this portable read-out device, the 'reader' would drive to the real estate in question. The read-out device (frequently referred to as 'hand-held') requests with a command all meters installed in a real estate to transmit their data. The request usually comprises a wake-up pulse which is received by all devices which then transmit their data at different times. The advantages and disadvantages of this process were described in the section 'Data Transmission Process'.

Read-out device with wake-up signal in the time window The disadvantage of the simplified process which has just been described, namely that owing to other devices transmitting in the same frequency band which do not belong to the system the meters can be continuously requested to transmit the meter readings and thus in turn the batteries of the meters are discharged more rapidly, can be reduced by allowing the meters only to be ready for receiving the wake-up signal within a specific time, eg, on a certain day in the year when the 'reader' drives to the real estate with the portable read-out device to take the meter reading. The synchronization of the service with the time window must be ensured, otherwise the meter readings are available for the next programmed reading interval. It

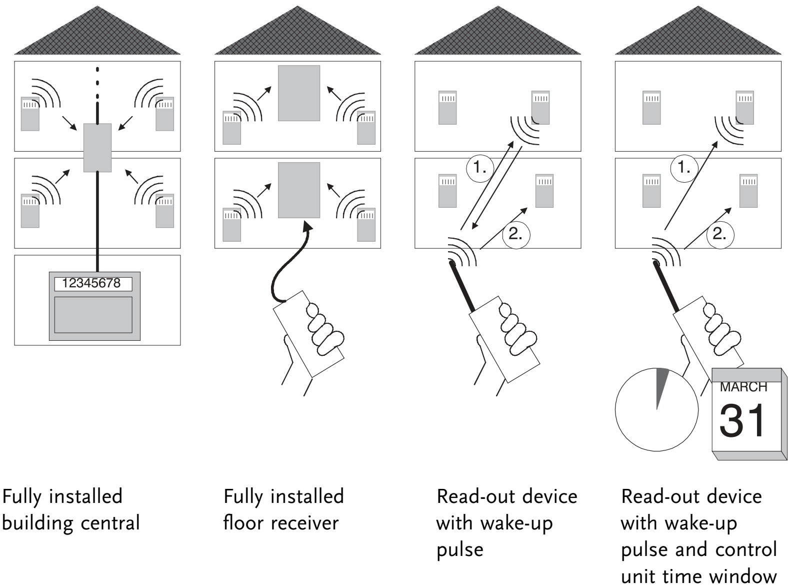

Fig. 2.5-12 Read-out methods using radio transmission

should also be taken into consideration that, over longer periods of time, not all 'clocks' of the meter still operate synchronously (accuracy and response to temperature changes of the quartz). Corresponding reserves must also be taken into account when defining the time window.

The various devices are illustrated in Figure 2.5-12.

General Requirements with Regard to the Transmission of Meter Readings via Radio

In order to ensure reliable communication via radio, functions must be provided in the hardware and software which take the special conditions in the radio environment into consideration and which go beyond the usual wire-bound transmissions. Restrictions must also be accepted as regards the application which do not apply when using a data bus. Nevertheless, radio transmission is highly suitable for the simple transmission of meter readings as long as the required technical measures given consideration in the conception of the system take the special conditions into account.

Transmission Performance

One of the most important restrictions which should be observed as regards the transmission of meter readings is the fact that most of the consumption-measuring devices are battery-operated. Not only is the energy which is available for the transmission of data within the service life of the device restricted, but also the maximum current which can be drawn over a short period of time from a longterm battery is limited (< 30 mA for normal lithium batteries, maximum 1 A h). This restricts the transmission performance to ∼0 dB m (1 mW). This performance is also limited by the antenna which can be located in a housing of a measuring device and by the approved maximum output power in a defined band.

Interferences in the Radio Channel

First one must be aware that one is not alone in a radio channel. There are also other 'legal' radio applications in the same frequency band and in the closer environment which can interfere with the transmission of one's own data. Here are some examples:

- Noise is extremely high owing to the varying applications in the same building and applications in adjoining buildings. As the free field damping between buildings is usually low compared with the damping in one's own building, external devices of other buildings may under certain circumstances be received better than the devices belonging to one's own system inside the building. Hence the superimposition and destruction of messages are more probable than when data are transmitted on a data bus. A receiver can usually only determine after receiving a complete telegram whether it has received an external message or not. Whilst receiving a weak telegram from an external system, it is blocked (capture effect) for the receipt of telegrams which originate from telegrams from its own system. Suppression of the so-called 'capture effects' should be aimed at. This means that a receiver should recognize as quickly as possible a telegram belonging to the system, even when it is receiving a telegram with a somewhat weaker level from the adjoining building. The receiver should turn its attention to the newly received telegram and not analyze the weaker one as it was probably already destroyed by the stronger telegram.
- There is a high interference potential in the ISM band of 433 MHz due to an amateur radio in the same band for which extremely high transmission outputs are allowed (maximum 10 W output power).
- In radio communication there is no controlled sequence in which messages are transmitted. Checking whether a transmission has just taken place, such as CSMA/CD processes used with buses, can be ruled out as one will nearly always hear a radio message from the neighborhood and external applications but would never be able to transmit oneself.
- The transmission conditions depend greatly on the physical state of the building and are therefore not easy to forecast. Depending on the manufacturer and application, the transmission processes (physical and link layer) can vary considerably.

Transmission Reliability

Meter readings required for billing purposes must be reliably transmitted. As the interference level with radio transmissions, as mentioned above, is extremely high, errors must be clearly recognized. A Hamming distance of > 6 should be aimed at.

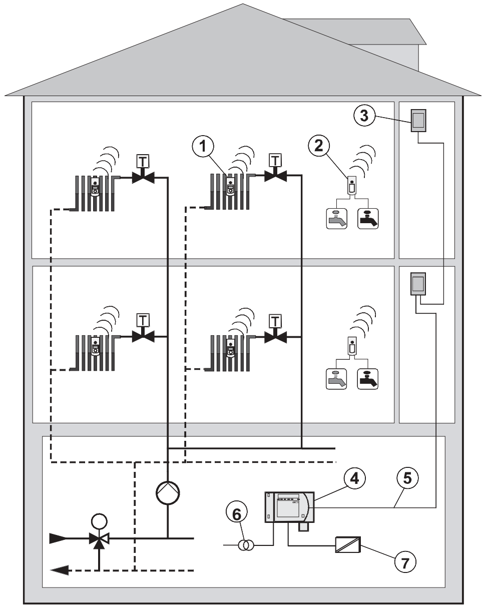

Fig. 2.5-13 Application example: apartment house (Source: Siemens Landis & Staefa)
1 Heat cost allocator MEMOTRON® WHE22
2 Pulse adapter AEW22.2
3 Multiple antenna ATW20.2
4 Radio read-out central unit OZW20
5 Coaxial cable (eg, CT100)
6 Supply transformer AC 230/24 V, 10 VA
7 Modem

Application Example with a Stationary Receiving System in the 433 MHz Range
After the 433 MHz ISM band in the amateur radio band of 430–440 MHz was released, many buildings were equipped with meters readable by radio. Almost all read-out processes which were described above exist. A great disadvantage, however, is that the various systems differ greatly from one another not only in the system architecture but also as regards the individual layers defined as per the OSI model and especially as regards the 'physical, link, and application layers'. The experience which users have gained with the various system architectures can be regarded as positive with the exception of the above-mentioned restrictions.

A system representing all the others is explained briefly as follows (Figure 2.5-13). It comprises uni-directional communicating devices which transmit data six times a day to an installed receiving system at stochastically distributed time intervals. The receiving system comprises antennas which are installed in the stairway throughout the building and are connected via a coaxial cable with a building central control unit. The consumption figures are collected in the building central control unit where they can be read out via an RS 232 interface per PC, directly by a modem or via the PTT network. An interface is also available to transmit data to a memory card (memory RAM card).

Radio Solutions in the 868 MHz Band
More and more applications are to be found in the ISM 433 MHz band, which causes a high channel load. As the legislators have not stipulated any regulations for this band, one must fear that it will become increasingly more difficult to

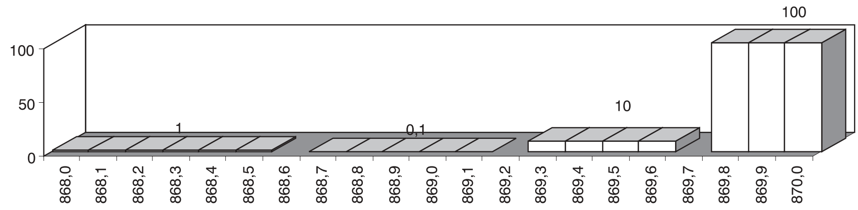

Fig. 2.5-14 Maximum duty cycle in %

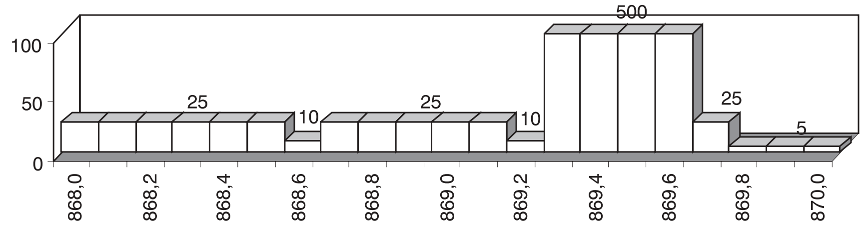

Fig. 2.5-15 Output in mW

guarantee reliable transmission when applications and installations increase. It is therefore worthwhile changing to another band, namely the SRD (short-range devices) in the 868 MHz range. In this range, not only is the output considerably limited but also the duty cycles are stipulated.

Figures 2.5-14 and 2.5-15 show both the transmission rate and the stipulated channel duty cycle.

In the 868 MHz band, the use of 600 kHz in a band is possible. Nevertheless, higher requirements are placed on the tolerances of the frequency-determining structural elements.

The output restriction, however, permits that distances in the building of ~ 25 m distance with normally built walls can be bridged. However, owing to the higher frequency compared with the ISM band of 433 MHz the damping is ~ 10 dB higher, which must be given consideration due to a higher output line of the transmitter in the device. The output is nevertheless very low in this band, so that the emitted energy has no negative effect on the health of humans. The emitted output is equivalent to approximately one thousandth of that of a mobile phone.

Standards Referring to Transmission of Meter Readings

Although the period between releasing this band to the present day is very short, an outline for a standard within the TC 294/WG5 has been agreed. It is, however, too early to go into this matter in detail. Such a step would only impede further activities of this committee. We would, however, like to make the following remarks:

- The consumption-measuring devices should be able to communicate with other components such as mobile data acquisition devices, stationary receivers, data collectors, or system network components.
- For the measuring devices, we have assumed that they can remain in operation without changing the battery for the entire service life (calibration interval) of 3–12 years. For the remaining stationary components such as mobile read-out devices one can reckon with shorter service lives.
- At the moment, five types of telegram are planned which contain on the one hand both uni- and bi-directional communication and on the other hand both portable and stationary systems for receiving data from the meters. The block length is either fixed or variable depending on the type.
- For the above-mentioned various types of telegram, various chip rates are planned. For stationary receiving systems a chip rate of 32 kHz will prevail.
- A 6-bit code (3 of 6 Code, ie, 4 data bits as a 6-bit word) is used. This provides an excellent common-mode rejection and allows suppression of the 'capture effect'.
- The IEC870-5-1/2 will be used as link layer.

Application Example with a Stationary Receiving System in the 868 MHz Band

Whereas in the application example mentioned above in the 433 MHz band it is assumed that a receiving system must be installed in the stairway-comprising antennas which are interconnected by cable, the system described here (Figures 2.5-16) comprises a network of 'intelligent' floor receivers which communicate with one another via radio. The intercommunication of the individual floor receivers is bi-directional. Data which individual measuring devices transmit are stored in the floor receiver which is most favorably located for reception and then forwarded to the next one in the floor receiver. After a certain length of time, the same data are

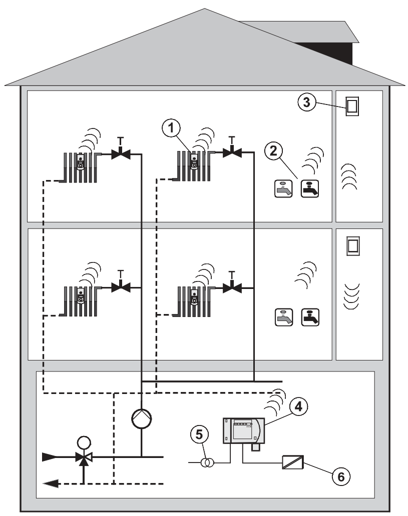

Fig. 2.5-16 Application example: apartment house (Source: Siemens Landis & Staefa)
1 Heat cost allocator MEMOTRON®
2 Electronic water meter VOLUTRON®
3 Floor receiver
4 Central unit
5 Supply transformer
6 Modem

stored in each of the individual floor receivers. All floor receivers form the receiving network. The floor receivers are battery-operated so no cabling and/or wiring is required for either data communication or the current supply.

The communication of the measuring devices is uni-directional, ie, the measuring devices transmit their data unbidden to the receiving network comprising the floor receivers. The transmission of the measuring device is synchronized with the 'temporary receiving window' of one of the floor receivers. Only in this way can the current consumption of the receiver be minimized so that battery operation is possible.

An important feature is that the network 'configures' itself and the devices also make themselves known to the network. This is the only way in which the technical expenditure for the installation of a system can be reduced to a minimum (easy configuration).

One of the installed antennas can be connected to a central control unit. The central control unit can then transmit the data via the PPT or via GSM to an EDPC. For a smaller detached house or apartment house the values stored in a 'floor receiver' can be requested via a hand-held terminal without having to enter the building.

2.5.5 Future Prospects

As already mentioned, it is highly likely that the transmission of meter readings will gain popularity owing to its extensive advantages. Certainly, many other 'home electronic functions' whose data transmission takes place inside the building via radio will without doubt be offered in conjunction with the Internet. It is to be expected that these sectors will finally merge. Attempts at standardization which are to support this merging are already in full swing.

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