

Application Note DK9322-0810-0036

TwinCAT, Building Automation

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EN 1434
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EN 1434-3
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M-Bus connection for energy and consumption meters via TwinCAT

This application example from the 'Building Automation Sub-bus Systems' series describes the basic principles of M-Bus and the functionality and integration of a PC as an M-Bus master via the TwinCAT PLC M-Bus library from Beckhoff. Through serial data transmission an M-Bus master can read up to 250 energy and consumption meters. The bus line is connected to an M-Bus line via a serial interface (Bus Terminal, EtherCAT Terminal or COM port) and a level converter as a master. The M-Bus is predominately used in buildings and properties with a large number of end users.

1. The M-Bus

The M-Bus (metering bus) is a fieldbus for logging, analyzing, optimizing and controlling energy and process data. It is as used as a standardized system for reading energy and consumption meters or other end devices or actuators. Signals are transferred serially from the connected slaves (measuring devices) to a master via a reverse polarity protected two-wire line. Depending on the application the data are stored or prepared for further processing. The field devices can be supplied with power via the bus cable. M-Bus is a typical single-master bus, in which the master requests and picks up the data from the slaves. With a primary address space of 250 addresses, up to 250 slaves can be connected to a master. Via modem interfaces, large distances can be covered in order to bring together modular extensions or complex systems. The M-Bus system is predominately used by operating companies supplying a large number of end users (e.g. industrial and technology parks, trade shows, building management systems, etc.).

Meanwhile the M-Bus has become established as a separate standard in EN 13757. This standard describes the M-Bus for application via a two-wire bus (part 2) and for radio transmission (part 4). However, standardization at the protocol level is

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incomplete. The data telegram features a freely available segment which manufacturers can use for transferring various (non-standardized) data or control characters. Before using new slaves it is therefore important to verify compatibility with the evaluation unit. All manufacturers of M-Bus meters offer downloadable specifications of the M-Bus protocols for their meters.

2. Typical field devices

The field devices used for M-Bus are typically meters for measuring tasks within a building. Examples of field devices include heat meters, water meters, hot water meters, electricity meters, pulse meters, switching devices, and heating cost distributors. A distinction is made between the reading mode. For local reading only one meter is connected, for remote reading several meters are integrated. The following data transfer options are available, depending on the reading type. The transfer protocol according to IEC 870 and EN1434-3 is used for all transfer routes.

2.1 Local reading (single meter)

- one optical interface (EN 61107 section 3.2)
- one inductive interface (CEN TC176/WG4)
- one 20 mA current loop, CL (EN 61107 section 3.1)

2.2 Remote reading (several meters)

- one two-wire fieldbus, meter bus (CEN TC176/WG4)
- one 11-bit modem
- radio system (433 or 868 MHz)

3. Master versions

The master can be an independent device or a PC with level converter. It reads the data of the connected field devices at configurable intervals and stores the meter readings permanently. All Industrial and Embedded PCs from Beckhoff can be used as a master in conjunction with TwinCAT software. The Beckhoff Bus Terminal Controllers from the BC and BX series (except for BCxx50) can also be used as a master, although in this case the limited transfer rates, the limited multi-tasking functionality and the longer cycle times must be taken into account. In addition, the program memory and, consequently the mapping is limited depending on the Bus Terminal Controller, so the number of meters that can be read is limited as a result.

Notes regarding the use of devices from the Beckhoff BC/BX series:

M-Bus devices may deliver very large values (that may exceed the DWord value range) and are therefore output in string format. Conversion to the Real format may result in inaccuracies or even invalid values. Conversion to the LReal format is therefore preferable. This approach is not available on controllers from the BC/BX series. If the values have to be provided in a number format, controllers from the BC/BX series are unsuitable if those values exceed the DWord value range.

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4. Topologies

Devices can be connected to M-Bus in a strand or star topology. For each strand a master and a level converter is required. The maximum number of meters per segment is 250. Larger systems can be formed and cascaded with the aid of repeaters.

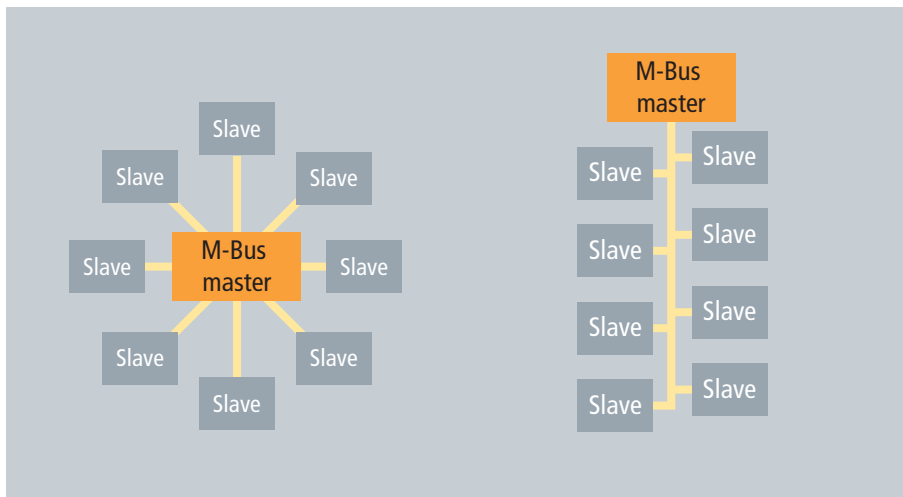


Fig. 1 Possible M-Bus topologies

One of the factors limiting the size of an M-Bus network is the wire cross-section. Wiring of an existing building is very complex and expensive, which is why in such applications radio solutions with lower infrastructure costs tend to be used.

When configuring an M-Bus topology it should be noted that the plug connectors of the bus cable are not standardized, which may result in complications if components from different manufacturers are used.

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4.1 Laying system, cross-section and cable lengths

The lower the line resistance, the longer the cable can be. However, as a basic rule the cross-section should not be less than 0.5 mm^2 (#20 AWG). Transmission errors may occur if the maximum cable length is exceeded or if the cable cross-section is too small. A normal telephone cable of type J-Y(ST)Y n x 2 x 0.8 mm (#20 AWG standard twisted-pair) can be used.

Figure 2 shows the number of M-Bus devices that can be connected in relation to the cable length of the M-Bus.

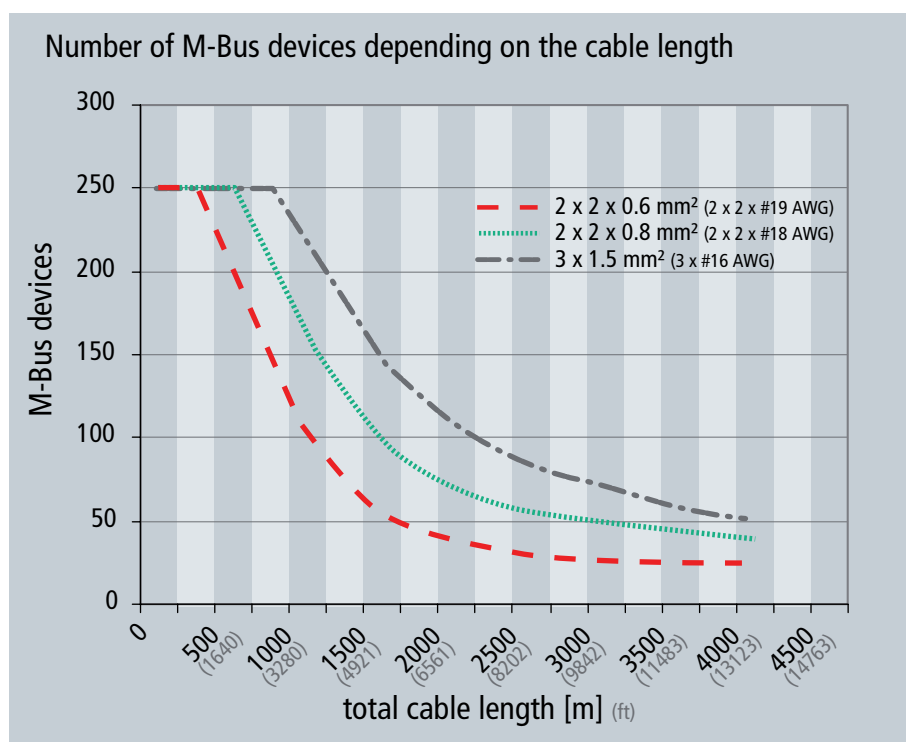


Fig. 2 Number of M-Bus devices

5. Communication

M-Bus is a single-master bus based on serial data transmission. The master queries the meters via the bus by modulating the supply voltage: A logical 1 corresponds to a signal level of 36 V DC, a logical 0 is represented by 24 V DC. This ensures that the power supply for the slaves can take place via the bus. The slave responds to the master by modulating its current consumption: 1.5 mA corresponds to logical 1, logical 0 is detected between 11 and 20 mA. Data transfer rates of 300 to 9,600 baud are possible, in some cases more than 9,600 baud. The maximum possible transfer rate of a meter depends on the manufacturer. The user must therefore check which baud rate can be used for all connected field devices within a strand. In delivery state (unparameterized) many slaves are set to 2,400 baud as standard.

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Two addressing modes are possible:

With **primary addressing** the master sends a request for data transmission to the end device 1...250. The addressed slave responds with a standard dataset, which in the simplest case consists of the meter reading, measured medium, device type, serial number and manufacturer's code.

Secondary addressing can be used to extend the address space of M-Bus. With secondary addressing the master sends a request for data transmission to all end devices via the special address 253. Individual end devices are addressed via serial number, manufacturer's code and medium. The addressed slave responds with the standard dataset.

6. Power supply

The power supply of the slaves and the master is manufacturer-dependent. A wide range of options is available, including 230 V AC external, 30 V DC external, 30 V DC integrated, etc. In addition there are battery-powered field devices which do not require a power supply connection. In this case the operator should be aware that each meter reading reduces the service life of the battery.

7. TwinCAT PLC M-Bus library: PC as an M-Bus master with connected level converter

TwinCAT supports the M-Bus with a dedicated library: TwinCAT PLC M-Bus. Via a level converter, up to 250 slaves can be connected to any PC in a suitable topology (star or strand). Devices from different manufacturers can be operated on the same bus. The M-Bus library only evaluates data with variable data structure that are identified by a leading low byte. The TwinCAT PLC M-Bus library supports the serial interfaces KL6001, KL6021 (Bus Terminals) and EL6001, EL6021 (EtherCAT Terminals), and the PC-COM port. The interfaces are connected with an M-Bus level converter (e.g. from Relay), from which the individual slaves are connected (reverse polarity protected) via a two-wire line. The TwinCAT PLC M-Bus library currently does not support secondary addressing, which is possible with M-Bus for extending the address space.

(The [link to download](#) the M-Bus library just described is at the end of the document)

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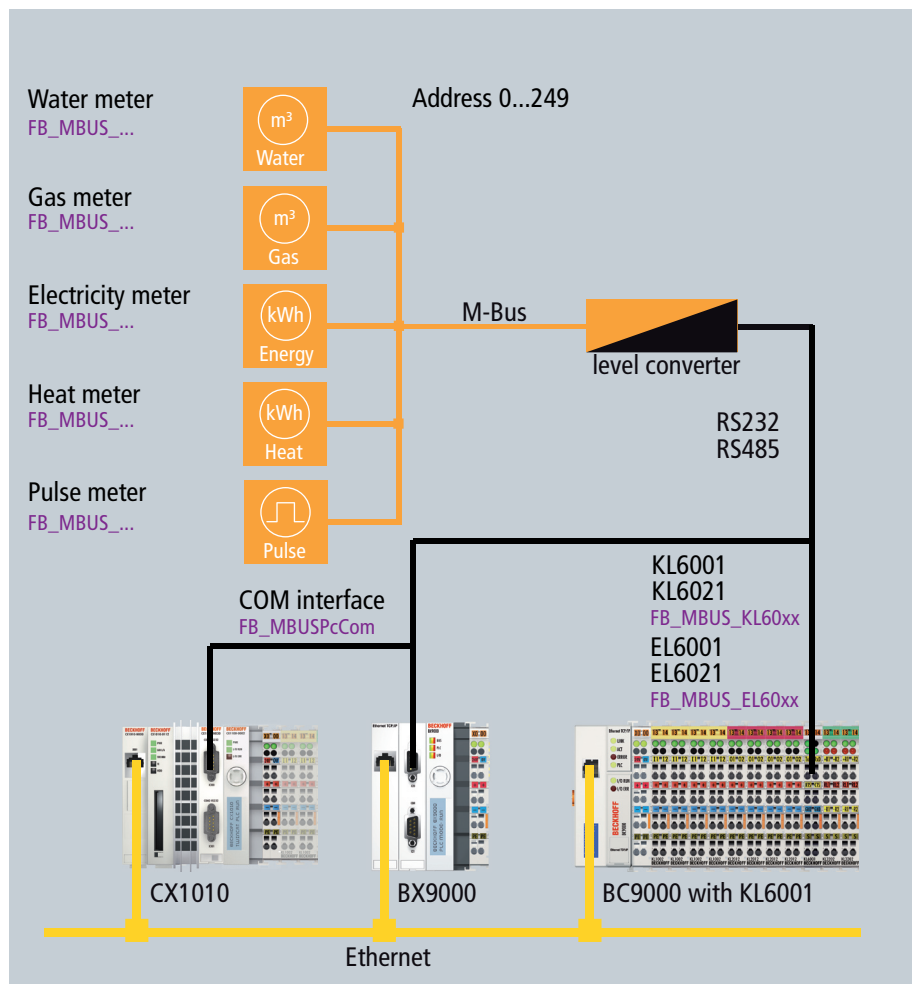


Fig. 3 Integration of M-Bus devices via level converters and serial interfaces

7.1 Benefits for the user

The function blocks are object-oriented and characterized by a self-contained, more or less complex function. The user configures the input parameters through which the function block is adapted individually to its task within the associated system.

Thanks to strongly object-oriented encapsulation of complex system functions within one function block, comprehensive system programs can be set up with a few function blocks. The blocks are linked to each other via a small number of PLC variables.

The status of all objects is indicated through a large number of different output variables at the function blocks. This simplifies the connection of HMI and visualization systems.

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For system operators this has the following advantages for system setup and operation:

- faster system program development
- faster parameterization and commissioning of the systems
- guarantee of a very large range of system functions at all times
- improved readability of programs (prerequisite for long-term maintainability and expandability of the systems)
- improved reusability of templates for systems or system components
- faster familiarization of personnel
- simple extension of existing systems
- better program documentation

Notice:

A link to an overview of all meter blocks (meters supported by the TwinCAT PLC M-Bus library) can be found at the end of this document. Beckhoff can create new meter blocks at short notice. To this end, Beckhoff requires a sample device and an M-Bus protocol description from the device manufacturer.

8. Serial interfaces (RS232/RS485) from Beckhoff

The following Beckhoff Bus Terminals and EtherCAT Terminals are available for integrating an M-Bus strand:

Baud rates of the RS232/RS485 interfaces from Beckhoff					
KL6001	KL6021	KL6031/KL6041	EL6001/EL6002	EL6021/EL6022	COM-Port PC
	300				50/75/110
	600				150/300/600
1,200	1,200				1,200
2,400	2,400		2,400	2,400	2,400
4,800	4,800	4,800	4,800	4,800	4,800
9,600	9,600	9,600	9,600	9,600	9,600
19,200	19,200	19,200	19,200	19,200	19,200
		38,400	38,400	38,400	38,400
		57,600	57,600	57,600	57,600
		115,200	115,200	115,200	115,200
					230,400
					460,800

Tab. 1 Serial interfaces from Beckhoff

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Since M-Bus can handle transfer rates between 300 and 9,600 baud, the user must ensure that the transfer rate of the terminal matches the transfer rate of the connected slaves when selecting an interface. The higher the selected baud rate, the shorter the cycle time has to be. Below 1,200 baud only the PC-COM port is recommended.

8.1 Process image

The process image of the KL6001 and KL6021 interface terminals is set to 3 bytes as standard. Since the process image of the M-Bus library has 5 bytes, the terminal mapping must be configured from 3 to 5 bytes with KS2000 Bus Terminal configuration software. To simplify the configuration Beckhoff offers special versions of the terminals (KL6001-0020 and KL6021-0020), which feature a 5-byte process image as standard.

9. Practical example

A typical area of application for M-Bus-based consumption data acquisition is in decentralized buildings. Individual production areas within a factory site are equipped with separate acquisition points. A suitable media meter is integrated for each building element. The data are collected in a control center and managed centrally. This provides the advantage that duplicate data management is avoided and the data are archived at a central location.

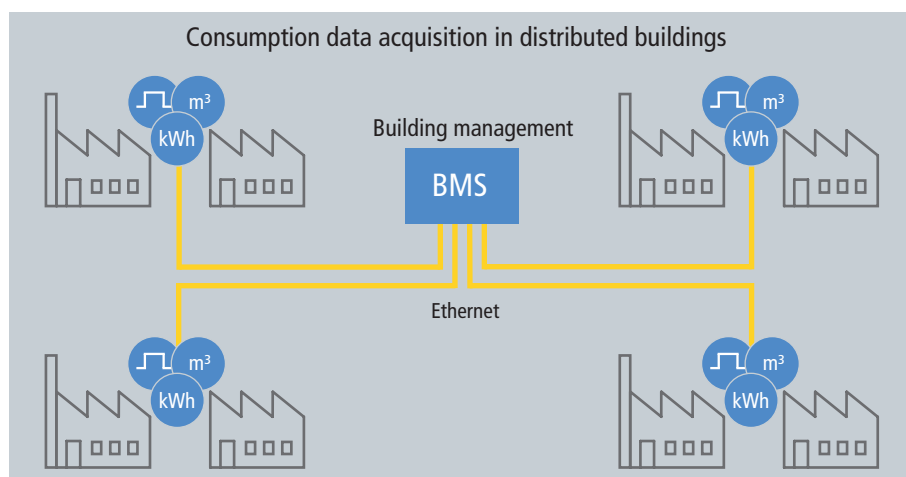


Fig. 4 The building management system is the central switching point for all buildings that are networked with Ethernet.

Each building acts as a separate data acquisition unit: Via the Beckhoff CX1010 Embedded PC with integrated Ethernet interface the data can then be made available to a central building management system. This enables the local data to be available directly in the individual systems as well as centrally. This principle significantly reduces the engineering effort and keeps the data management transparent.

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Another typical practical example is error-free meter reading at short notice when a change of tenants occurs, while safeguarding the privacy of the tenants. Remote reading enables electronic data acquisition with minimum manpower requirements (reduction of reading errors) and speedy further processing (compiling of statistics, invoicing, etc.).

– TwinCAT PLC Library M-Bus

www.beckhoff.com/english/twincat/twincat_plc_m_bus.htm

– Documentation of M-Bus library at Beckhoff Information System

http://infosys.beckhoff.com/content/1033/tcplclibmbus/html/tcplclibmbus_einleitung.htm

– Overview of supported M-Bus counter

http://infosys.beckhoff.com/content/1033/tcplclibmbus/html/tcplclibmbus_programmierung.htm

– Building Automation www.beckhoff.com/building

– Overview serial interfaces K-Bus www.beckhoff.com/english/bus_terminal/sonder.htm

– Overview serial interfaces EtherCAT www.beckhoff.com/english/ethercat/sonder.htm

– Relay GmbH www.relay.de/frame_3fach_e.htm

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