Overview M-Bus

The M-Bus ("Meter-Bus") is a new European standard for remote reading of heat meters and it is also usable for all other types of consumption meters as well as for various sensors and actuators.

With its standardization as a galvanic interface for remote readout of heat meters this bus wins a great importance for the energy industry as relevant users.

The remote reading of heat meters can take place in different ways, beginning with the classical method - manual reading by the personnel of the providers - up to the remotely controlled collection of all the meter values for a complete housing unit. The latter is a logical continuation/extension of the technical development of consumption meters and is realizable with the help of the M-Bus.

Here some substantial characteristics of this interface are mentioned regarding their new possibilities:

- The data (e.g. heat consumption) are read out electronically
- At one single cable, which connects to a building controller all consumption meters of a housing unit can be attached
- All meters are individually addressable
- Apart from the availability of the data at the controller also a remote reading is possible

A set of advantages arise, both for the supply enterprises, and for their customers:

- The reading is fast and avoids reading errors
- The data being present in machine-readable form makes the further processing easier.
- A remote readout saves personnel expenditure, avoids unnecessary penetration into the private sphere of the inhabitants and permits to mount meters in places which are difficult to access.
- Short reading intervals are possible, which reduces the problems with tenant change or tariff amendments
- Due to the short reading intervals statistical data can be obtained, which can be used as a base for network optimization

The standardisation of the m-bus results in further technical possibilities. In particular devices of different manufacturers can be operated on the same bus; the users are free therefore in the choice of the manufacturer. On the other hand, a stimulation of the market can be expected, also regarding other m-bus based counters, so that with the very variable configuration options even difficult problems can be solved.
In the development of the m-bus also economic and technical aspects of the interface have been considered, that are relevant for everyday use. These are essentially:

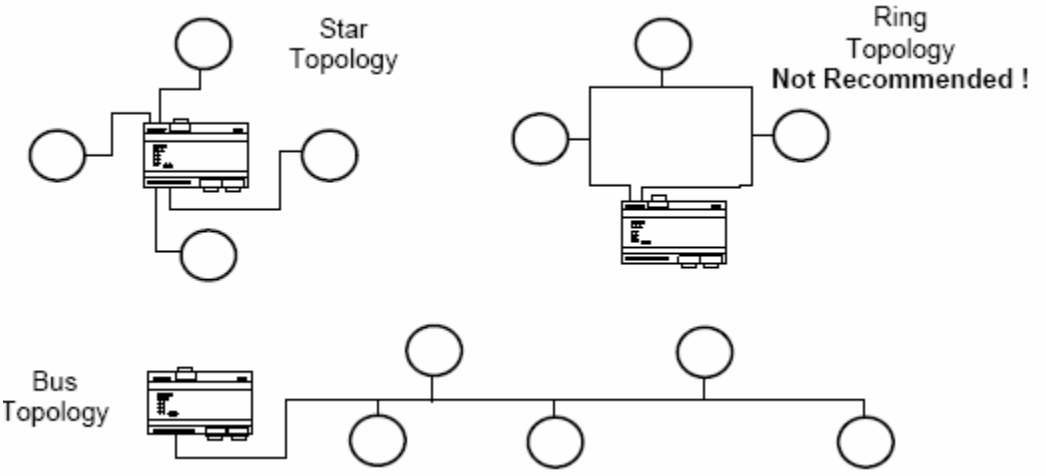
- Large number of connectable devices
- Possibility for network expansion
- Fail-safe characteristics / robustness
- Minimum cost
- Minimum power consumption in the meters
- Acceptable transmission speed

None of the many already existing bus systems was able to fulfill all these constraints. Now with the M-Bus as a new standardized interface for the reading of consumption meters, an optimal compromise between price and performance can be offered.

1 M-Bus Network Installation Notes

1.1 Topology

The topology of the M-Bus network is (almost) arbitrary. Only the ring topology as shown beneath should be avoided. In general the length of the cables should be minimized. Usually a mixture between star and bus topology should be used.



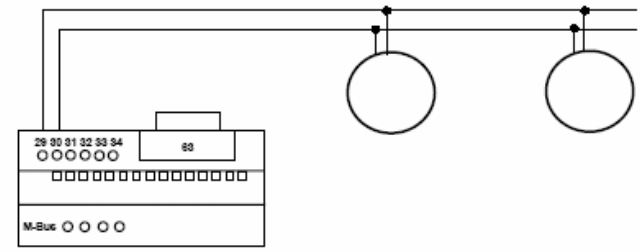
Star Topology
Each component is linked to a central processor unit with an individual transmission line. The equipment can transmit to the central unit either sequentially or simultaneously. One disadvantage of this arrangement is the increased requirement for cabling.

Ring Topology
In this case, the components are connected to one another in a ring, and the data are transferred from point to point. This topology has the disadvantage that, should a single equipment fail, the complete network will be out of action.

Bus Topology
The components are connected together with a common transmission line, with the result that at one instant only one equipment can transmit data. This topology is very cost-effective, it will not be disturbed if one of the components fails, and it allows the transmission of data to all components (Broadcasting) or to specific groups in the system (Multicasting).

1.2 M-Bus Cable

The M-Bus uses two wire cables which are going from the M-Bus Master / Repeater (HYDRO-CENTER) to each M-Bus device (bus structure). The M-Bus is polarity independent and needs no line termination resistors at the end of the cables.



Any cable type may be used as long as the cable is suitable for 42 V / 500 mA. Shielding is not necessary and not recommended since the capacity of the cable should be minimized. In most cases a standard telephone cable is used which is a twisted pair wire with a diameter of 0.75 mm^2 each (2 x 0.75 mm^2). This type of cable should be used for the main wiring. For the wiring to the meters from the main wiring (last 1 .. 5 m to the meter) a cable with smaller diameter may be used.

1.3 Maximum Cable Length in M-Bus Networks

The question for the maximum possible cable length in M-Bus networks is not easy to answer since several parameters are critical. However, an example calculation is shown here to give an estimation.

Cable Type:	2 x 0.75 mm
Cable Resistance:	75 Ohm / km
Cable Capacity:	50 nF / km
Capacity of one M-Bus Device:	1 nF
Current of one M-Bus Device:	1.5 mA

The limiting parameters in M-Bus networks are mainly the cable resistance and the cable capacity plus the capacity of the devices (= bus capacity). The cable resistance causes, depending on the bus current, a bus voltage drop. The maximum bus voltage drop may not be more than 16 V .. 18 V since the minimum bus voltage at any device must not be lower than 24 V (40 V – 24 V = 16 V).

R = U / I

R: Cable Resistance
U: Voltage Drop over Cable Length I: Bus Current
N: Number of connected M-Bus Devices

U_{max} = 16 V ; I = N * 1.5 mA : R = 16 / (1.5 * N) Ohm

The cable resistance, therefore, limits the maximum possible cable length from the M-Bus Master / Repeater (HYDRO-CENTER) to the device with the largest distance away from it (largest cable segment). The table beneath shows an estimation of the maximum cable segment length:

Number M-Bus Devices	Max. Cable Segment Resistance	Max. Cable Segment Length (75 Ohm / km)
1	10.7 kOhm	142 km
10	1.1 kOhm	14.7 km
50	213 Ohm	2.8 km
100	106 Ohm	1.4 km
150	71 Ohm	0.95 km
200	53 Ohm	0.71 km
250	43 Ohm	0.57 km

The cable segment length is the distance from the HYDRO-CENTER to the M-Bus device furthest away.

NOTE: The given maximum cable segment length takes into account only the bus resistance and not the bus capacity. Therefore, some of the cable lengths in the table may not be possible in reality. At the end of the chapter is a table with real example configurations.

The cable capacity plus the capacity of the M-Bus devices (= bus capacity) is responsible for sloppy signal edges. Therefore, the bus capacity limits the maximum data transfer rate of the M-Bus. The HYDRO-CENTER is able to drive approx. 1 µF at a baud rate of 300 baud. The table beneath gives an estimation of the bus capacity / baud rate relationship:

Baudrate	Max. Bus Capacity	Example Configuration
300 Baud	1000 nF	1 Device + 20 km Cable (1 * 1 nF + 20 * 50 nF) 50 Devices + 19 km Cable (50 * 1 nF + 19 * 50 nF) 250 Devices + 14 km Cable (250 * 1 nF + 14 * 50 nF)
2400 Baud	300 nF	1 Device + 6 km Cable (1 * 1 nF + 6 * 50 nF) 50 Devices + 5 km Cable (50 * 1 nF + 5 * 50 nF) 250 Devices + 1 km Cable (250 * 1 nF + 1 * 50 nF)
9600 Baud	100 nF	1 Device + 2 km Cable (1 * 1 nF + 2 * 50 nF) 50 Devices + 1 km Cable (50 * 1 nF + 1 * 50 nF)

The given cable length is the sum over all cables attached to one HYDRO-CENTER.

NOTE: The mentioned example configurations are taking into account only the bus capacity but not the bus resistance. Therefore, some of the cable lengths in the table may not be possible in reality. At the end of the chapter is a table with real example configurations. The tables beneath are showing some example configurations depending on bus resistance and capacity. In general the following topology is taken:

NOTE: The table values are theoretical maximum values. Usually the M-Bus devices are connected to the cable with varying distances from the HYDRO-CENTER. Therefore, larger cable length can be achieved in reality. However, for very large cable length additional parameters must be taken into account (e.g. noise) and, therefore, cable length larger than approx. 10 km should not be used without amplification.

Baud rate: **300 Baud**
Cable Resistance: 75 Ohm / km
Cable Capacity: 50 nF / km
Capacity of one M-Bus Device: 1 nF
Current of one M-Bus Device: 1.5 mA

Number of Devices	Max. Complete Cable Length (Bus Capacity)	Max. Cable Segment Length (Bus Resistance)	Max. Cable Length for Configuration shown above
1	20 km	142 km	20 km
50	19 km	14.7 km	14.7 km
250	14 km	0.57 km	0.57 km

Baud rate: **2400 Baud**
Cable Resistance: 75 Ohm / km
Cable Capacity: 50 nF / km
Capacity of one M-Bus Device: 1 nF
Current of one M-Bus Device: 1.5 mA

Number of Devices	Max. Complete Cable Length (Bus Capacity)	Max. Cable Segment Length (Bus Resistance)	Max. Cable Length for Configuration shown above
1	6 km	142 km	6 km
50	5 km	14.7 km	5 km
250	1 km	0.57 km	0.57 km

Baud rate: **9600 Baud**
Cable Resistance: 75 Ohm / km
Cable Capacity: 50 nF / km
Capacity of one M-Bus Device: 1 nF
Current of one M-Bus Device: 1.5 mA

Number of Devices	Max. Complete Cable Length (Bus Capacity)	Max. Cable Segment Length (Bus Resistance)	Max. Cable Length for Configuration shown above
1	2 km	142 km	2 km
50	1 km	14.7 km	1 km