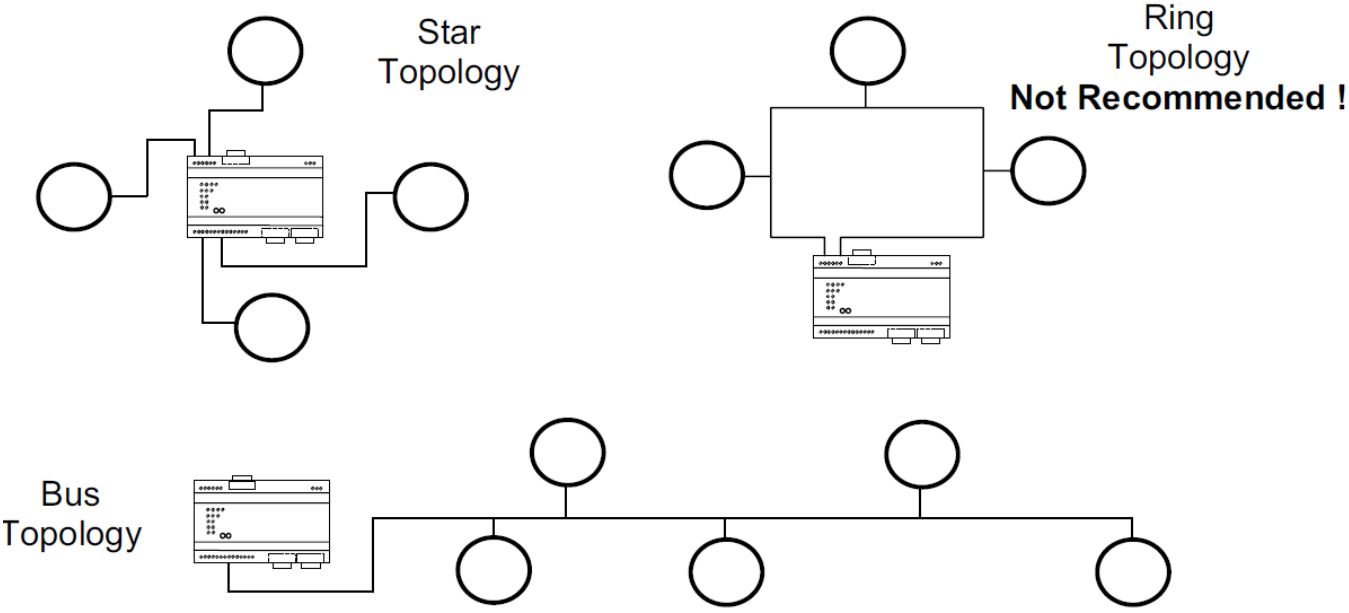
M-Bus Network Wiring Guidelines

1 M-Bus Network wiring

This manual explains how to calculate the maximum M-Bus cable length depends on technical parameters of used cable and number of M-Bus slave devices.
It can be used for calculation if one or more M-Bus master M-Bus level converter is used.
On slave side any M-Bus slave device can be used like: energy meters, PLC, ... , etc.

1.1 Topology

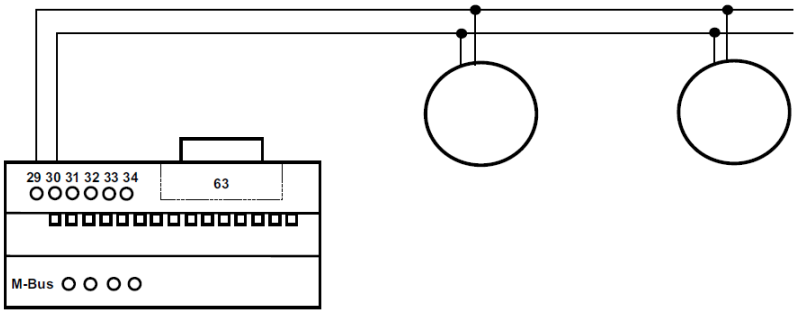
The topology of the M-Bus network is (almost) arbitrary. Only the ring topology as shown beneath should be avoided. In general the length of the cables **should be minimized.**



Usually a mixture between star and bus topology should be used.

1.2 M-Bus Cable

The M-Bus uses two wire cables which are going from the M-Bus Master / Repeater 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 36 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 0.5 mm each (2 x 0.8 mm is also suitable). 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 0.5 mm (JYStY N*2*0.5 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 11 V .. 12 V since the minimum bus voltage at any device must not be lower than 24 V (36 V – 24 V = 12 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} = 12 V
I = N * 1.5 mA

R= 12 / (1.5 * N) Ohm

The cable resistance, therefore, limits the maximum possible cable length from the M-Bus Master / Repeater 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	8 kOhm	100 km
10	800 kOhm	10 km
50	160 Ohm	2.1 km
100	80 Ohm	1.06 km
150	53 Ohm	0.71 km
200	40 Ohm	0.53 km
250	32 Ohm	0.42km

The cable segment length is the distance from the M-Bus Master 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 M-Bus Master is able to drive approx. 0,8 µF at a baudrate of 300 baud. The table beneath gives an estimation of the bus capacity / baudrate relationship:

Baudrate	Max. Bus Capacity	Example Configuration
300 Baud	500 nF	1 Device + 10km Cable (1 * 1 nF + 10 * 50 nF) 50 Devices + 9 km Cable (50 * 1 nF + 9 * 50 nF) 250 Devices + 5 km Cable (250 * 1 nF + 5 * 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 M-Bus Master / Repeater.
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:

All devices are connected to the M-Bus Master/Rep. after max. cable segment length.

NOTE: The table values are theoretical maximum values. Usually the M-Bus devices are connected to the cable with varying distances from the M-Bus Master / Repeater. 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.

Baudrate:	**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)**
1	10 km	100 km
50	9 km	2.1 km
250	5 km	0.42 km

Baudrate: **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)**
1	6 km	100 km
50	5 km	2.1 km
250	1 km	0.42 km

Baudrate: **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)**
1	2 km	100 km
50	1 km	2.1 km