Proposal for future Link Layer M-Bus

Requirements for the Link-Layer (Master and Slave)

The alphabetic percent designations (e.g. "W%") in the following clauses refer to the value specified in table 1 (see appendix).

I) Character

1.) Baudrate

a) 300 Baud shall be supported.

b) Additional recommended baudrates are 2400 baud or 9600 baud.

c) By special arrangement between a net operator and a meter manufacturer also one or several of the following baudrates could be used: 600, 1200, 4800 Baud, 19 200 or 38 400 baud.
The total segment size and the number of connected slaves limits the techni- cally safe maximum baudrate. (See installation section of physical layer).

d) The baud rate shall be kept even after the reset of the device.

e) A desired baudrate may be set by link layer management commands. (See the appropriate application layer commands). Broadcast baudrate set is not recommended.
Immmediately (<2min) after such a baudrate set command for a slave to a baudrate other than 300 Baud (transmitted at the old baudrate) a valid communication at the new baudrate shall be attempted. If (even after the appropriate number of retries) no acknowledge is received, the master shall set the slave baudrate back to the original baudrate via a baudrate set command at the attempted baudrate and then continue communcation at the original baudrate. If the communication is acknowledged, the master knows that the slave and its segment can both operate at the new baudrate. A slave without an autospeed detect must monitor after the reception of a baudrate set command to a baudrate other than 300 Baud for a valid communication at the new baudrate within 2-10 minutes after the baudrate set command. If such a communication is not properly received, the slave must switch back automatically to the previous baudrate to save it from beeing permanently lost in a baudrate which is not supported by its segment.

f) Devices may support communication with the baudrates of 300 Baud, 2400 Baud, 9600 Baud or 38 400 Baud without a prior baudrate set command (autospeed mode). In this case no baudrate switch command monitoring and autofallback is required. Thus all baudrate set commands must be acknowledged but can be ignored otherwise except for their FCB-administration (if required).

g) The transmission baudrate averaged over any RSP_UD telegram may vary under all acceptable parameters (i.e. supply voltages, temperature, current operating state and function) by not more than +-M% of the nominal baudrate.

2.) Bit position

a) For data transmission the individual bit transitions may have a non-accumulating maximum deviation from their nominal time position (calculated from the actual baudrate) of up to N% of a bit time (synchronous start-stop-distortion, see also fig. 1).

b) For data transmission the individual bit transitions may have a non-accumulating maximum deviation from their nominal time position (calculated from the nominal baudrate) of up to P% of a bit time (gross start-stop-distortion, see also fig. 1), assuming that each bit time is at least Q% of a nominal bit time (minimum signal element, see also fig. 1).

c) For data transmission the time between a start bit and both the next and the following start bit shall be not less than the nominal interval of 11 respective 22 bit times -T% of a nominal bit time (character interval requirement, see also fig. 2).

d) For data reception deviations from the nominal transition times of up to +-V% of a nominal bit time shall be tolerated (practical margin, see also fig. 3). Also the start bits of byte pairs and byte triples with a deviation of up to -Y% of a nominal bit time from their nominal value of 11 rsp. 22 bit times shall be received correctly (character interval requirement, see also fig. 4).

e) For data reception start bits with a duration of <W% of a nominal bit time shall be ignored (minimum signal element, see also fig. 5).

3.) Byte format

An asynchronous serial bit (start-stop)-transmission in half duplex mode is used. The byte format is 1 start bit, 8 data bits, 1 bit for even parity and 1 stop bit.

4.) Block format

a) In data transmission gaps between bytes are only allowed within the non accumulating bit time error budget of < +-P% of a nominal bit time (see also fig. 1)

b) In reception any gap between bytes of greater than +P% of a nominal bit time may, any gap of grater 22 bit times shall be considered as the end of a telegram.

c) At the end of each telegram the receiver shall test for a minimum quiescent time (continous mark state) of at least 11 bit times. This is required to clearly distinquish between a true isolated telegram and a section of longer telegram (see also fig. 7).

5.) Telegram abort

If a slave detects at the end of a mark level send bit a (voltage) space signal from its master it has to terminate its send telegram as soon as possible. A received continous space signal from the master for >11 bit times (break signal) shall stop the telegram send of a slave not later than 24 bit times after the start of such a break signal. For a software UART this requirement can be met by testing the received signal state either at the end of each mark state send bit or before the beginning of each start bit send. A hardware UART can utilize the break status to detect such a state.

II) Telegram

1.) General

As a link layer the format class FT1.2 of IEC-870-5-1 and a telegram structure according to IEC870-5-2 is used.

2.) Data integrity

The parity bit and the checksum byte of the FT1.2 format class of the IEC870-5-1 achieve a Hamming distance of 4 for data integrity class 2.

3.) Telegram structure

The telegram structure is described in the IEC870-5-2. All communication types of this standard may be used:

a) Normalisation (required)

Short telegram master to slave: SND_NKE. Answer: $E5
Note that this command shall only preset the internal „last received FCB-bit“ and shall not be used for any other kind of reset function

b) Request for time critical data (optional)

Short telegram master to slave: REQ_UD1. Answer: RSP_UD or $E5 if there are no time critical data pending.

c) Standard readout request (required)

Short telegram master to slave: REQ_UD2. Answer: RSP_UD

d) Status request (optional)

Short telegram master to slave: REQ_SKE. Answer: RSP_SKE

e) Data send master to slave (required)

Long telegram master to slave: SND_UD. Answer: $E5

The request for time critical may be used for an alarm poll since the link layer protocol of the IEC870-5 does not support spontanous alarms from the slaves.

4.) Telegram coding

For the coding of the individual bytes of the telegrams see IEC870-5

5.) Adressing

Adress 0 is reserved for unconfigured slaves
Each unconfigured slave shall accept and answer all communication to this adress.
Adresses 1-250 are used for primary adressing of slaves
Each slave shall accept and answer all communication to its primary adress.
Adress 251 is reserved for management communication with the primary master repeater (e.g. for physical and link layer management).
Adress 252 is reserved
Adress 253 is reserved for secondary adressing (Optional network layer)
Each selected slave shall accept and answer all communication to this adress.
For selection and deselection of individual slaves or groups of slaves see the application layer for network management.
Adress 254 is the adress for test and diagnosis. Each slave shall accept and answer all communication to this address
Adress 255 is the broadcast adress. Each slave shall accept and execute all communication to this adress without answer

6.) Link layer time schedule

The time structure of various link layer communication types is described in the IEC870-5-1.

7.) Telegram sequencing

For the administration of long multi telegram messages and for acknowledged data transmission with incremental consequences (in contrast to the transmission of sta-
tic values and parameters) the link layer protocol supports via a FCB-Bit (frame count bit) the administration of valid transfers of a telegram. For simple one telegram communication and absolute data contents (e.g. switch on) without inkremen-
tal messages (e.g. toggle switch) the slave may simply ignore the FCB-bit of the master telegrams. For slaves with multiple primary adresses and FCB-administration a “last FCB” bit shall be administered for each primary adress seperatly. The same holds true for for slaves which support both a primary address and adressing through a secondary address via adress=253 ($FD). Any valid SND_NKE shall clear this internal “last FCB”-bit. Note that the support of multi-telegram both for SND_UD messages and for RSP_UD messages requires separate
internal “last FCB”-bits for each direction. Note that for REQ_UD2-telegrams a set
FCV-bit and for a SND_NKE telegram a cleared FCV-bit and a cleared FCB-bit is required.

8.) Buffer management

The link layer protocol can administer possible slave input buffer(s). This is required if after a SND_UD data transmission from master to slave the slave requires more time than (50msec+330 bit times) for the complete processing of the
received data until the input buffer is free again. In this case the $E5 acknowledge byte signals within the maximum response time only the acceptance of the telegram
at the link layer level to the input buffer and the DFC-bit signals later that the input
buffer is free again.

III) Apendix

The values and descriptions in the following table are taken from the ISO/IEC7480 (1991).

Direction	Clause	Fig.	Description	Symbol	Unit	Device	
						Master	Slave or Mini Master
Transmit	I) 2) a)	1	Synchronous start-stop distortion	N ≤	%	5	8
	I) 2) b)	1	Gross start-stop distortion	P ≤	%	7	16
	I) 2) b)	1	Minimum signal element	Q	% UI*1)	90	84
		2	Character interval requirement				
			Average: nominal reduced by	R ≤	% UI	8	10
			Averaged over	S	Char	2	2

	I) 2) c)		Minimum: nominal reduced by	T ≤	% UI	16	20
	I) 1) e)		Modulation rate accuracy	M ≤	%	0,2	0,75
Receive	I) 2) d)	3	Practical margin	V ≥	%	40	30
	I) 2) e)	5	Minimum signal element	W	% UI	30	30
		4	Character interval requirement				
			Average: nominal reduced by	X	% UI	20	25
			Averaged over	S	Char	2	2
	I) 2) d)		Minimum: nominal reduced by	Y	% UI	40	50

Tab. 1 *Signal quality characteristics for slaves and masters*

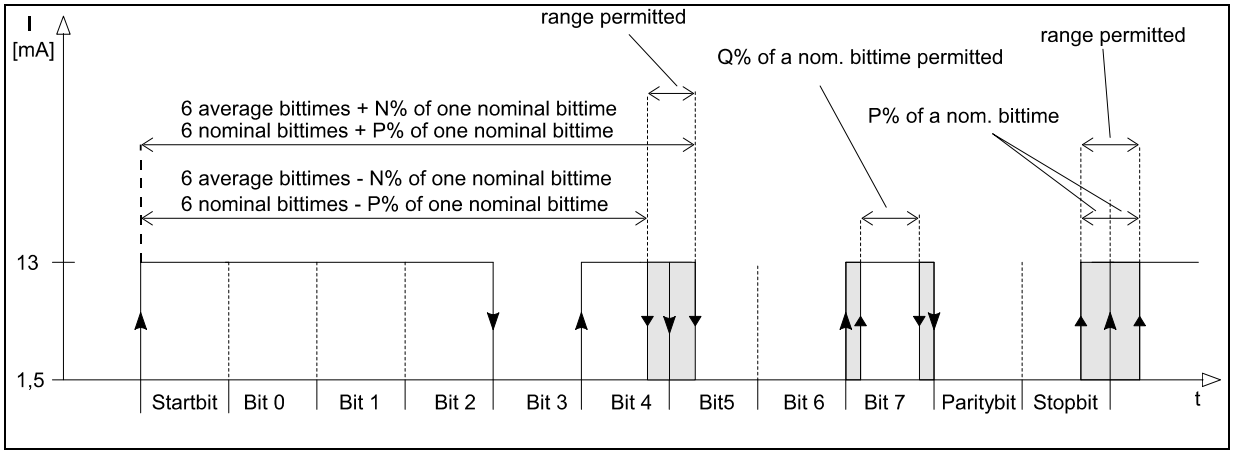

Fig. 1: *Start stop distortion (example for bit 4), minimum signal element (example for bit 7) (Transmit)*

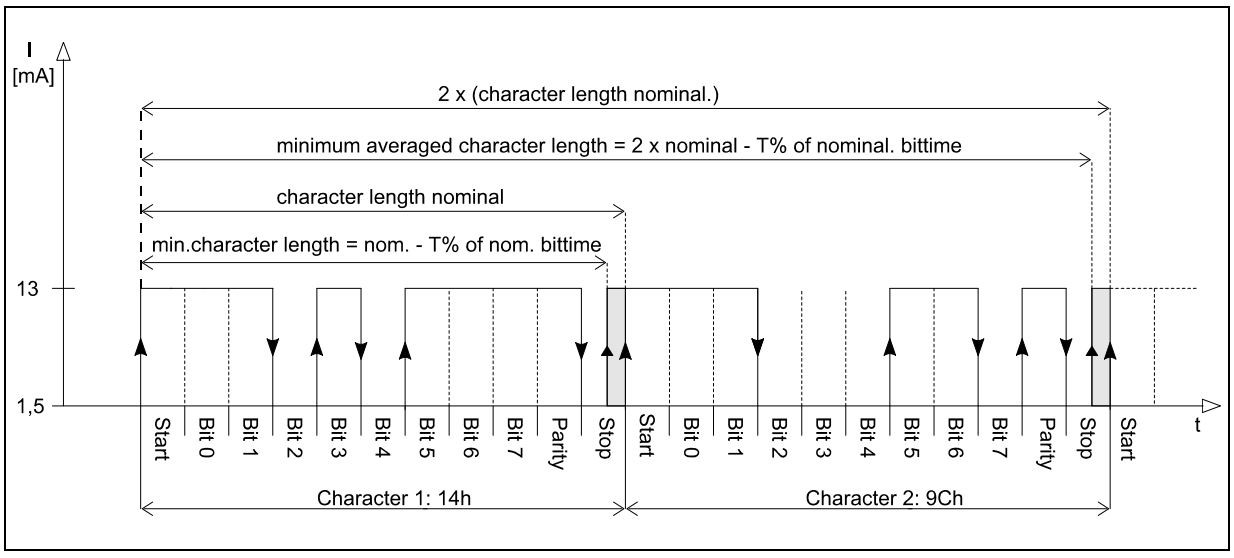

Fig. 2: *Character interval requirement (Transmit)*

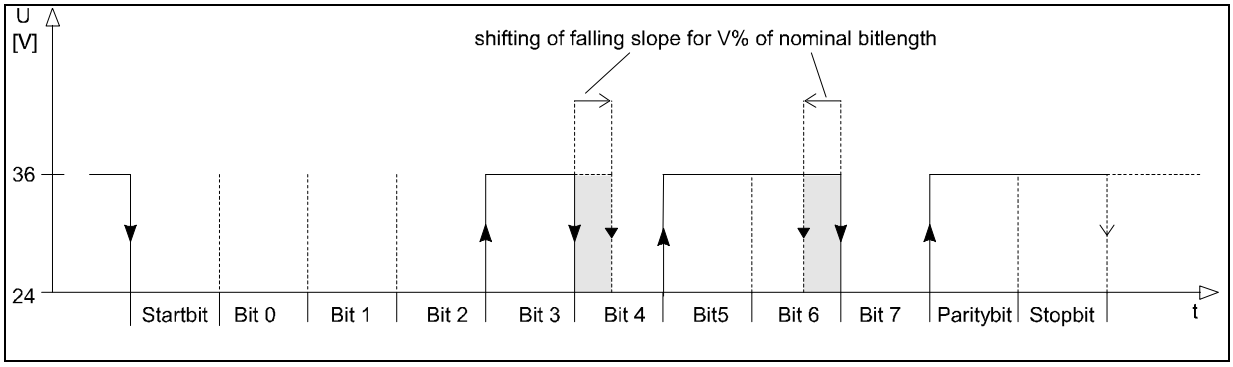

Fig. 3: *Practical receive margin (example for two falling slopes)*

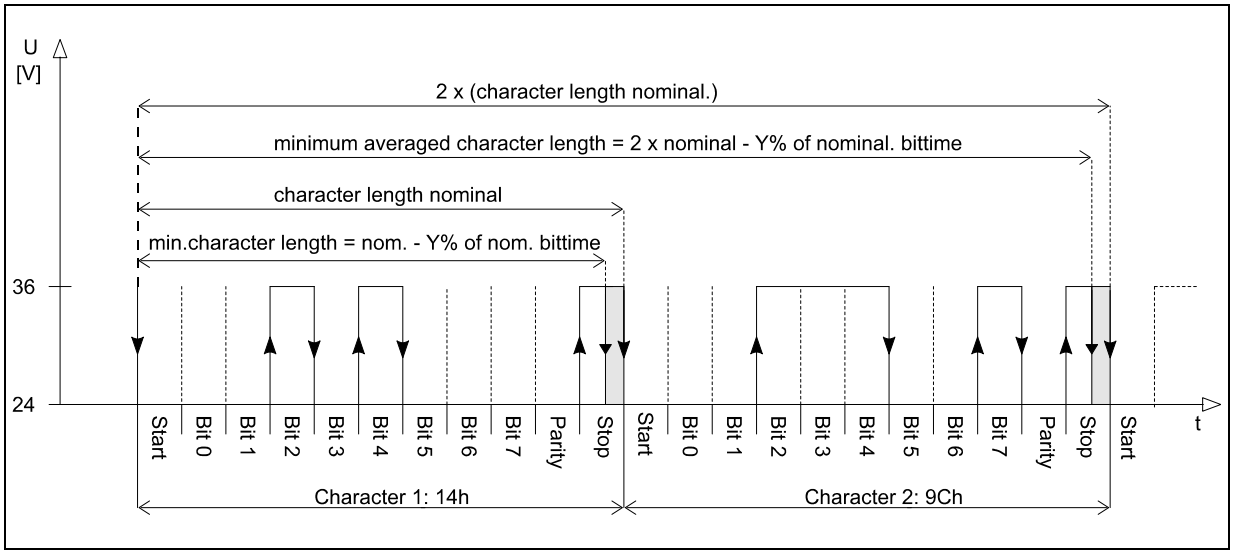

Fig. 4: *Character interval requirement (Receive)*

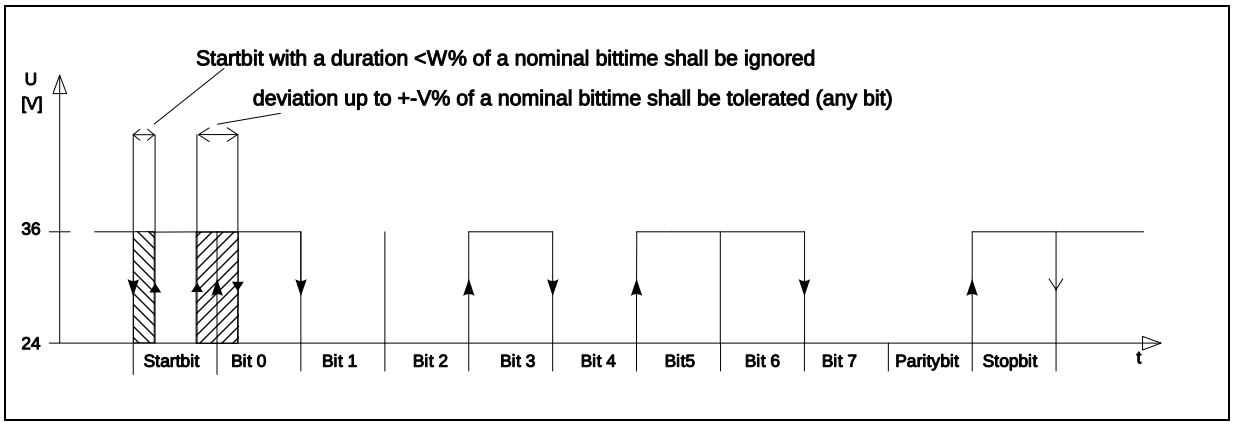

Fig. 5: *Minimum duration start element (Receive)*

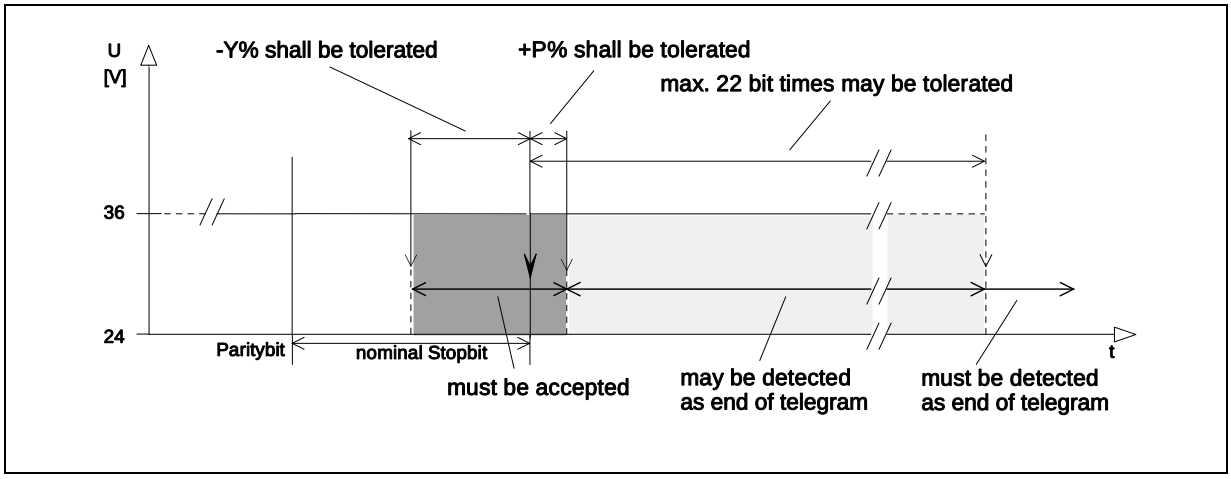

Fig. 6: *Reception of telegram packets*

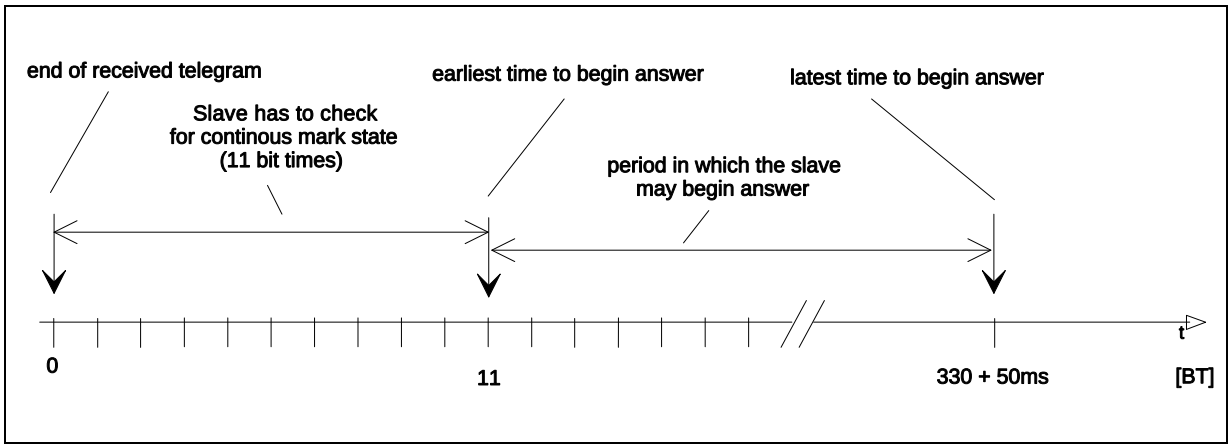

Fig. 7: *quiescent time after reception*