Open Metering System Specification Vol.2 Annex R

Meter Reading Transmission via M-Bus Compact Profile; to meet BSI TR-03109-1 TAF7

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R.1 Introduction

R.1.1 Preface

The document was primarily created to technically describe how the tariff-use-case “meter reading profile” (TAF7) according to the technical guideline BSI TR-03109-1 can be fulfilled for meters communicating via radio in the Local Metrological Network (LMN) of a Smart Meter Gateway (SMGW).

The stipulations made in this annex for the M-Bus compact profile are not limited to use for TAF7 in the SMGW. They may also be implemented for other applications in which measuring devices are to transmit current measuring values by radio with sufficient rate in order to maintain short registration periods.

This is done in compliance with the requirements from legal metrology related to the permissible deviation of the registration period [PTB-A50.7], [PTB-A50.8] and the restrictions that result from the permissible occupancy of the radio channel [EN13757-4], [REC70-03] and possible collisions with other devices in the same radio channel.

R.1.2 Glossary of Terms

This section contains additional terms and clarifications not explained in [OMS-S1], Annex A (see subclause R.1.3 References).

Table R.1 – Glossary table

Term	Description
A	**A**
acceptance window Δt_{AW}	Window, within which a measuring value is considered valid, based on compliance with the requirements for deviation from the legal time and the deviation of the actual length of the registration period from its target value according to [PTB-A50.7] subclause 3.1.7 and [PTB-A50.8] subclauses 4.2.1.2, 4.2.1.3.
actuality duration	M-Bus data value that contains the time difference between creating and sending a value. [EN13757-3]
AML	German abbreviation for “derived measuring value list”; container in the SMGW to hold a list of records. In the context of the traditional wording, here these containers are equivalent to “load profiles/meter reading profiles”. Derived lists of values can also contain original measuring values. [BSI/TR03109]
B	**B**
base time	M-Bus data value. The base time corresponds to the time of the base value, even if that does not exist. Therefore, the first entry in the compact profile is always related to the base time plus one space interval. [EN13757-3]
base value	M-Bus data value to which the compact profile refers. It shall always exist unless the increment mode “absolute value” is used. [EN13757-3]
C	**C**
compact profile	Data record with packed M-Bus data, element of the M-Bus compact profile.
D	**D**
Δt_{AW}	see acceptance window
Δt_{MP}	see measuring period
Δt_{PI}	see profile interval
Δt_{RP}	see registration period
duty cycle	Fraction of one period (e.g. one hour), in which the transmitter is active.
duty cycle limitation	Highest relevant duty cycle of the transmitter according to [EN13757-4] or [REC70-03].
E	**E**
entry time stamp	Time at which the measuring value is determined, based on the time in the SMGW.
F	**F**
G	**G**
H	**H**
I	**I**
J	**J**
K	**K**
L	**L**
M	**M**
measuring period Δt_{MP}	Interval of time a measuring device uses to determine a new measuring value (e.g. 2 s for updating the measuring value memory in the measuring device). [PTB-A50.7]

M-Bus compact profile	A possibility specified in [EN13757-3] Annex F to transmit a series of measuring values with a fixed time offset.
MsbG	Messstellenbetriebsgesetz – Metering Point Operations Act
N	**N**
O	**O**
OML	German abbreviation for “original measuring value list”; a list belonging to each meter profile in the SMGW, in which all the numerical values of a measurand measured with the meter linked to the meter profile plus their unit are stored with the time stamp of the acquisition. [BSI/TR03109] (modified)
P	**P**
profile interval Δt_{PI}	Time interval between the successive measuring values in the M-Bus compact profile. The profile interval is always an integer multiple of the measuring period of the measuring device that forms the M-Bus compact profile.
profile time	Time covered by the total number of successive measuring values in the M-Bus compact profile.
Q	**Q**
R	**R**
reception window	Window, within which the SMGW holds the measuring values received in the LMN for further processing. [BSI/TR03109]
registration period Δt_{RP}	Period for determining an energy measuring value for a load profile or meter reading profile. [PTB-A50.8]
registration time stamp	Target time of the respective registration period.
S	**S**
spacing control byte	Part of the M-Bus compact profile. It names the type of compact profile used and the spacing unit (time unit) used in the spacing value byte. [EN13757-3]
spacing value byte	Part of the M-Bus compact profile. It specifies the numerical value of the time interval between two values of the compact profile. [EN13757-3]
T	**T**
t_{ACC}	see transmission interval, individual
TAF	Tarifanwendungsfall – tariff use case [BSI/TR03109]
t_{NOM}	see transmission interval, nominal
transmission interval, individual t_{ACC}	Exact time between two subsequent synchronous or periodical transmissions which changes with each transmission. [EN13757-4]
transmission interval, nominal t_{NOM}	Average individual transmission interval between all synchronous or periodical transmissions (new, old or no data content) for wireless meters. [EN13757-4]
transmit duration	On-air time of a datagram or transmission over the radio channel.
U	**U**
V	**V**
W	**W**
X	**X**
Y	**Y**
Z	**Z**

R.1.3 References

For dated references only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[BSI/TR03109]	Technische Richtlinie BSI TR-03109-1 Anforderungen an die Interoperabilität der Kommunikationseinheit eines intelligenten Messsystems, Version 1.0.1, Datum 16.01.2019
[CEN/TR17167]	CEN/TR 17167:2018 Communication system for meters – Accompanying TR to EN 13757-2, -3 and 7, Examples and supplementary information
[EN13757-2]	EN 13757-2:2018 Communication systems for meters – Part 2: Wired M-Bus communication
[EN13757-3]	EN 13757-3:2018 Communication systems for meters – Part 3: Application protocols
[EN13757-4]	EN 13757-4:2019 Communication systems for meters – Part 4: Wireless M-Bus communication
[EN13757-7]	EN 13757-7:2018 Communication systems for meters – Part 7: Transport and security services
[OMS-CT]	OMS-Conformance-Test-Specification 4.0 Release 4, https://oms-group.org/open-metering-system/oms-spezifikation
[OMS-S1]	OMS Specification Volume 1, General Part, Issue 2.0.1, https://oms-group.org/open-metering-system/oms-spezifikation
[OMS-S2]	OMS Specification Volume 2, Primary Communication, Issue 4.3.x, https://oms-group.org/open-metering-system/oms-spezifikation
[OMS-TR07]	Open Metering System Technical Report 07, Meter Reading Transmission via M-Bus Compact Profile; to meet BSI TR-03109-1 TAF7, Version 1.0.1 – 2020-11-23 RELEASE https://oms-group.org/open-metering-system/oms-spezifikation
[PTB-A50.7]	PTB-Anforderungen PTB-A 50.7 Anforderungen an elektronische und softwaregesteuerte Messgeräte und Zusatzeinrichtungen für Elektrizität, Gas, Wasser und Wärme, April 2002, https://oar.ptb.de/files/download/56d6a9e2ab9f3f76468b4619
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[PTB_ewp]	Eichrechtliche Anforderungen an Smart-Meter-Gateways zur Daten-erfassung und Fernübertragung von Verbrauchsdaten • Dr.-Ing. Martin Kahmann, Dr.-Ing. Rainer Kramer, DVGW energie|wasser-praxis 10/2014
[REC70-03]	ERC Recommendation 70-03 Relating to the use of Short Range Devices (SRD); Tromsø 1997, Subsequent amendments, 07 June 2019 http://www.erodocdb.dk/docs/doc98/official/pdf/rec7003e.pdf

R.2 Concept

R.2.1 Problem in the Radio Channel

If a measure profile with a very short interval is required (e.g. of a few seconds), the meter usually will apply a transmission interval equal to the measuring-interval. But a radio channel will have losses in the transmissions, due to channel-occupancy by many meters and other applications. To avoid gaps in the profile, the meter can transmit more frequently, e.g. three times faster. However, this increases the channel occupancy even more and will lead to more datagram losses. The transmission interval is also limited by the duty cycle (see [REC70-03]).

The problem can be solved by transmitting many consecutive measured values in one datagram with a longer transmission interval. The [OMS-TR07], clause 7 compare both variants and shows the different collision rates for the same radio channel.

R.2.2 Solution Approach

The M-Bus standard provides the M-Bus compact profile as a data volume and transmission time-saving option for transmitting a series of measuring values with a fixed time interval between the individual values. The M-Bus compact profile may be used in wired M-Bus and in wireless M-Bus, see [EN13757-3], Annex F.2 .

In addition to the compact profile, a base time is required to declare the start time of the profile. When using a differential M-Bus compact profile, a base value is also required (see also R.3.3). Additional basic parameters such as the OBIS declaration may also be added.

Three data points are usually used. One data point (base value) defines a start value. Another data point defines a start time (base time). A third data point defines a list of further values (called compact profile) that are at a fixed and known time interval from the first data point.

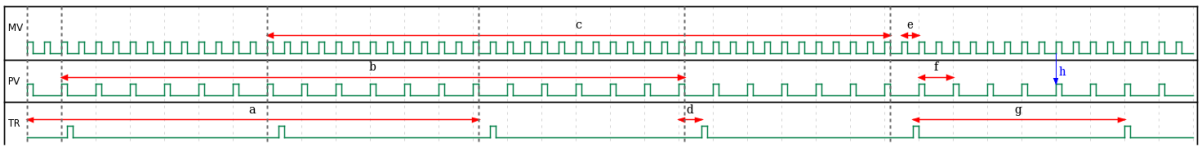
The unit seconds, minutes, hours, days, half months and months may be used as time interval. Ranges from 1 to 250 are possible in the selected unit.

This use case shall apply the “inverse compact profile” according to [EN 13757-3, Annex F]. This type is intended for the transport of an unlimited number of values as a series without assignment to a register number (e.g. a load profile). The base value is always the most recent value, followed by the older values that are older and older. The use of an M-Bus compact profile has already been described in [OMS-S2], 8.4.4.

In addition, the data point “actuality duration” according to [OMS-S2], 8.4.5.1 in connection with the updated MB data tag from [OMS-S2], Annex B shall be used. This data point describes the offset between the time of measurement and the time of transmission.

A suitable nominal transmission interval t_{NOM} is selected for the cyclical sending of the M-Bus compact profile. To ensure redundancy the number of values in the compact profile should be large enough so that if one or even multiple datagram transmissions fail there is no gap in the gateway’s measuring value reception. Therefore, the profile time should reliably cover a period of $3 \times t_{NOM}$.

Figure R.1 shows an example of the overlap of the transmitted time periods, the transmission of every n^{th} measuring value in the compact profile and the actuality duration as an offset between the last (newest) measuring value in the compact profile and the time of transmission specified by the individual transmission interval.



MV: measuring value	a: period 1st profile (shown incompletely)	d: actuality duration	g: transmission interval, individual
PV: profile value	b: period 2nd profile	e: measuring period	h: every *n*th measured value is transferred to the profile
TR: transmission	c: period 3rd profile	f: profile interval	

Figure R.1 – Exemplary timing diagram

Even if the meter does not register any progress, a new profile measuring value shall be formed at the required intervals and added to the compact profile. The actual compact profile shall also always be transmitted. Repeated transmission of the same compact profile if the meter does not progress is not permitted.

R.2.3 Measuring Period, Registration Period, Profile Interval, Transmission Interval

In order to understand this section, it is important to know the definition of the terms used (subclause R.1.2 Glossary of Terms) and to use them consistently correctly. In common usage, measuring period is often used synonymously with registration period. These are different terms here.

The measuring period Δt_{MP} of the meter shall be less than or equal to the permitted acceptance window Δt_{AW}.

$$\Delta t_{\mathrm{MP}} \leq \Delta t_{\mathrm{AW}} \quad (1)$$

The profile interval Δt_{PI} shall be less than or equal to the permitted acceptance window Δt_{AW}. It shall always be an integer multiple of the measuring period Δt_{MP}.

$$\Delta t_{\mathrm{PI}} = n \times \Delta t_{\mathrm{MP}} \leq \Delta t_{\mathrm{AW}} \quad (2)$$

For the acceptance window Δt_{AW} to always meet the conditions from [PTB-A50.8], it shall be limited to 1 % of the registration period Δt_{RP}.[1]

$$\Delta t_{\mathrm{AW}} = 0{,}01 \times \Delta t_{\mathrm{RP}} \quad (3)$$

For a successful implementation, the physically determined limit value considerations made above shall be further restricted.

The transmission of the M-Bus compact profile after completion by means of the “base value” can be delayed; hence the data point “actuality duration”. The ratio of Δt_{AW} to Δt_{PI} should be 3 to 2. Then the relative shift of a measuring value at the target time of the registration period is never more than 50 % of Δt_{PI} and two successive values of the compact profile in one datagram are always safely within the acceptance window.

$$\Delta t_{\mathrm{AW}} / \Delta t_{\mathrm{PI}} = 1{,}5 \quad (4)$$

To reliably map the profile interval selected for the application in the M-Bus compact profile, the ratio of Δt_{MP} to Δt_{PI} should be at least the integer value 2.

$$\Delta t_{\mathrm{PI}} = n \times \Delta t_{\mathrm{MP}}, \text{ with } \{n \in \mathbb{N} | n \geq 2\} \quad (5)$$

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[1] According to [PTB-A50.7] and [PTB-A50.8], the absolute error limit for the registration period’s time span Δt_{RP} is ± 1 %. If measuring values are not correlated, it shall be prevented that e.g. measuring value *n* is registered at $t_{RP}(n)$ - 1 % and measuring value *n+1* at $t_{RP}(n+1)$ + 1 %. Because then the length of Δt_{RP} would be absolutely 2 % longer than the target value. This is reliably prevented by reducing the deviation of the registration period Δt_{RP} to ± 0,5 %.

For the transmission interval t_{NOM}, the influencing factors of frame length and channel occupancy or the collision probability are decisive.

With a small number of values in the compact profile:

- frame size is small and transmit duration is short (low probability of collision, positive);
- frequency of transmission is higher due to the small number of values (reduction of t_{NOM}, negative because of higher channel occupancy).

With increasing number of values in the compact profile:

- frequency of transmission is lower (increase in t_{NOM}, positive);
- frame size and transmit duration increases (higher collision probability, negative).

A practical range can be determined from these diverging parameters. It is known from experience in the field and from simulation tests that transmit durations < 30 ms are not critical, as are nominal transmission intervals in the range from 50 s to 150 s or greater.

A practical ratio of Δt_{RP} to t_{NOM} is in the range from 4 to 1 to 8 to 1. The actual ratio should be chosen so that t_{NOM} results in an integer number in seconds.

As stated at the end of subclause R.2.2 the compact profile should surely cover a period of 3 × t_{NOM}. The number of measuring values in the time t_{NOM} results from the ratio of t_{NOM} to Δt_{PI}. After multiplying by the corresponding repetition factor (here 3), two values shall be added; one value to complete the series and one value to safely take into account the jitter prescribed in the standard [EN13757-4], see also [TR07 Annex A].

$$\text{№ of measuring values } n = 3 \times {}^{t_{NOM}}/_{\Delta t_{PI}} + 2 \qquad (6)$$

R.2.4 Specific Requirements for Meters

R.2.4.1 Electricity Meters

Table R.2 shows how it would look with a registration period of Δt_{RP} = 15 min for an electricity meter.

Table R.2 – Example calculation of Δt_{AW}, t_{NOM}, Δt_{PI} in dependency on Δt_{RP} = 15 min

Calculation of the times as a function of Δt_{RP} with the ratios of the times entered below		Registration period Δt_{RP}		Trans-mission interval t_{NOM}	Acceptance window Δt_{AW}	Profile interval Δt_{PI}
		15 min	900 s	120 s	9 s	6 s
Ratio $\Delta t_{RP}/t_{NOM}$ (default: 7,5)	7,5					
Ratio $\Delta t_{AW}/\Delta t_{PI}$ (default: 1,5)	1,5					
Necessary number of values in the compact profile when covering 3 × t_{NOM} per datagram (incl. jitter)	62			Measuring period Δt_{MP}		2 s
				Factor n between Δt_{PI} and Δt_{MP}		3
				with n = {2, 3, 4, …}		
Entry fields:						
Result fields:						

R.2.4.2 Gas Meters and Thermal Energy Meters

Table R.3 shows how it would look with a registration period of Δt_{RP} = 60 min for a gas meter or a thermal energy meter.

Table R.3 – Example calculation of Δt_{AW}, t_{NOM}, Δt_{PI} in dependency on Δt_{RP} = 60 min

Calculation of the times as a function of Δt_{RP} with the ratios of the times entered below		Registration period Δt_{RP}	Trans-mission interval t_{NOM}	Acceptance window Δt_{AW}	Profile interval Δt_{PI}
		60 min 3.600 s	480 s	36 s	24 s
Ratio $\Delta t_{RP}/t_{NOM}$ (default: 7,5)	7,5				
Ratio $\Delta t_{AW}/\Delta t_{PI}$ (default: 1,5)	1,5				
Necessary number of values in the compact profile when covering 3 × t_{NOM} per datagram (incl. jitter)	62		Measuring period Δt_{MP} 12 s Factor n between Δt_{PI} and Δt_{MP} 2 with n = {2, 3, 4, …}		
Entry fields:					
Result fields:					

For the template of Table R.2 and Table R.3 as an interactive table to be filled with your own numbers, see [OMS-TR07], Annex E.

R.2.4.3 Other Meters

Other device types should use a registration period of Δt_{RP} = 60 min like a Gas meter.

R.3 Description of the Compact Profile

R.3.1 Transmission Interval and Datagram Length

To determine the datagram length and the transmission interval, one should adhere to the duty cycle limit of ≤ 0,02 % per device recommended in [OMS-S2].

R.3.2 The Compact Profile

Values with a fixed time interval can be efficiently transmitted in a compact profile. The standard [EN13757-3] Annex F specifies the transmission of a base value and a base time in addition to the actual compact profile.

The base value is the calculation basis for differential M-Bus compact profiles that use the increment mode “increments”, “decrements” or “signed difference”. The differential measuring values in the compact profile are then added or subtracted depending on the selected increment mode.

Differential compact profiles should be used to generate moderate frame lengths.

The base time is the system time of the meter and shall be transferred with DT1!B or DT5!B according to [OMS-S2] Annex B. If the meter has no system time, the base time should be set to invalid.

NOTE 1: [EN13757-3] expects always a base time. However, in this case the data point actuality duration is used as the reference time. For this reason, an invalid base time is accepted.

The meter shall also transmit the time difference between the creation of the base value and the transmission of the frame. This time difference is transmitted in the data point “actuality duration” with MB-Data-Tag DP1!B according to [OMS-S2], Annex B.

All data points of the profile are connected to each other via the same storage number used in the Data Information Block (DIB). For the tariff-use-case TAF7 (acc. to [BSI/TR03109]) only storage number 3 shall be used.

NOTE 2: The datagram may have more than one compact profile. All compact profiles and base values have the storage number 3, but vary in tariff, subunit or VIB-Type.

The datagram shall be built immediately before it is sent so that the actuality duration covers internal latencies.

The resolution of the base value and the profile measuring values shall be suitable for billing.

NOTE 3: The [OMS-S2], Annex N shows an example of a suitable resolution.

If a differential compact profile is used and the base value is marked as “invalid” according to [EN13757-3] Annex A (see [EN13757-3] Annex F), all profile measuring values from the differential compact profile shall be ignored.

If a value in a differential compact profile is marked as “invalid” according to [EN13757-3] Annex A (see [EN13757-3] Annex F), all remaining profile measuring values from this invalid profile measuring value on shall be ignored.

R.3.3 Special Cases

R.3.3.1 Overflow

If a compact profile with differential measuring values (“increments”, “decrements” or “signed difference”) is used, the coding of the individual measuring values shall be selected so that there is no overflow of the differential measuring value due to the design. If an overflow occurs, the differential measuring value shall be marked as “invalid” according to [EN13757-3] Annex A (see [EN13757-3] Annex F).

R.3.3.2 Changes of Direction

If a compact profile uses the increment mode “increments” or “decrements”, a change of direction of the medium measured cannot be depicted. If, in this case a profile value is negative, this value shall be marked as “invalid” according to [EN13757-3] Annex A (see [EN13757-3] Annex F).

R.3.3.3 Missing Measuring Values

If a meter has no, or insufficient measuring values for the M-Bus compact profile in the memory at the time the datagram is generated (e.g. after a power failure), the datagram structure (i.e. layer structure, data records, position, etc.) shall remain the same. It is not permitted

- to suspend the sending of radio telegrams,
- to omit the M-Bus compact profile or
- to adapt the profile length to the number of available measuring values.

If no measuring value is available for a position in the M-Bus compact profile, this position shall be marked as “invalid” according to [EN13757-3] Annex A (see [EN13757-3] Annex F).