P1 Port Specification for Luxembourg's electricity meter "Smarty"

Electricity Meter- P1 Interface

Hardware Specification
And
Software Specification

V1.0

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1. Introduction & Generalities

1.1. Object

This document is the functional specification of the P1 port Interface managed by the full range of T210 electricity meters. The current documentation is mainly based on the hardware specification and software specification of the E-Meter.

1.2. Abbreviations and notations

E-Meter	Electricity meter
DLMS	Device Language Message Specification
COSEM	Companion Standard for Energy Management
IDIS	Interoperable Device Interface Specification
DSMR	Dutch Smart Metering Requirements
OMS	Open Metering Standard
MMI	Man-Machine Interface
AES	Advanced Encryption Standard
GCM	Galois Counter Mode
AAD	Additional Authenticated Data
CRC	Cyclic Redundancy Check

1.3. Main Features

The P1 port Interface is available on all the smart electricity meters in Luxembourg. Any In-home Display or Home Server solution which fulfills the specifications within this document shall be able to be interfaced with E-Meter T210-D meters. The In-Home Display shall consist in a wireless or wired solution that supports the P1 Data Output communication protocol and format as specified in the "Dutch Smart Meter Requirements v5.0.2 Final P1". The solution deployed in Luxembourg includes an additional security layer standard that is conform to the IDIS package 2.0 requirement, which enables the maintainability of the solution.

1.3.1. Hardware Interface Characteristics

As main general requirement the physical hardware Interface of the P1 transmitter shall be compliant with the ***"Dutch Smart Meter Requirements v5.0.2 Final P1".***

1.3.1.1. Physical connector

Please refer to the document:
"Dutch Smart Meter Requirements v5.0.2 Final P1" ***section 5.1 Physical Connector***

1.3.1.2. User safety

Please refer to the document:
"Dutch Smart Meter Requirements v5.0.2 Final P1" ***section 5.2 User Safety*** especially ***the sections:***

- ***5.2.1. Installation Category***
- ***5.2.2. Galvanic Isolation***

1.3.1.3. Power supply

The P1 interface is compliant with: “Dutch Smart Meter Requirements v5.0.2 Final P1” ***Section 5.3. Power Supply***

The port provides a power supply to the OSM devices, with a nominal voltage U_n = 5V.

The maximum supplied current is 250mA.

The supplied voltage is 4.9V ≤ U_n ≤ 5.3V for all currents between 0mA and 250mA.

Short circuit protection is triggered for a current I_{sc}, such as 260mA ≤ I_{sc} ≤ 350mA.

After short-circuit protection has been triggered, the current is limited to less than 50mA (fold back).

Normal operation is automatically resumed when overload condition is removed.

1.3.1.4. Variable load on power supply

Please refer to the document:
“Dutch Smart Meter Requirements v5.0.2 Final P1” section ***5.4. Variable load on power supply***

1.3.1.5. Metering system protection

Please refer to the document:
“Dutch Smart Meter Requirements v5.0.2 Final P1” section ***5.5. Metering System Protection***

1.3.1.6. P1 OSM protection

Please refer to the document:
“Dutch Smart Meter Requirements v5.0.2 Final P1” section ***5.6. P1 OSM protection***

1.3.1.7. P1 Data interface specification

Please refer to the document:
“Dutch Smart Meter Requirements v5.0.2 Final P1” section ***5.7. P1 Data interface specification***

1.3.1.8. P1 signal levels

Please refer to the document:
“Dutch Smart Meter Requirements v5.0.2 Final P1” section ***5.8. P1 Signal levels***

1.3.1.9. Data output

The data output is open collector or open drain. The typical load is a 1k pull-up to 5V.

The data output can sink a current up to 30mA with Vol ≤ 1V.

The maximum data rate is 115200 bds.

Data will be output on data output line when the data request line is "true":

- True level is ≥ 4V. (Typical level = 5V)
- False level is ≤ 1V

The data request line input current will be not more than 10mA for voltage up to 5V

The P1 port is protected against over voltage signals:

- Power supply, data out and data request lines can withstand over voltage up to +/-12V with respect to port GND, with a maximum current of +/-250mA

All port lines are protected against electrostatic discharges compliant with IEC 61000 Part 4-2 Human Body Model.

The P1 port connector is RJ12 female socket. Pin assignment follows the DSMR v5.0 requirement.

1.3.1.10. Insulation

P1 port is insulated from mains network in compliance with EN 50470-1 standard:
see § Safety constraints

The level of the rated impulse voltage is 6kV.

The level of the AC voltage test is 4kVrms.

2. P1 Port Software Interface

2.1. Introduction / Terminology

Since the meter display capability is limited, a separate physical port is dedicated to customer information. An additional device can be plugged in this port to receive customer information and display it in another way.

The In-Home Display communication protocol should comply with Dutch Smart Meter Requirements v5.0.2 Final P1.

Two signals are available on this interface:

- Request signal, which is a digital input for the meter
- Data signal, which is the output for the meter

The meter is constantly monitoring the Request line. It is said to be active when the level of the signal is LOW.

Data sent by the meter on the Data signal is transmitted as UART data with a baud rate fixed to 115200, 8 data bits, no parity bit and 1 stop bit.

2.2. Frame scheduling

As long as the Request signal is active, the meter sends frames periodically on the Data signal.

The periodicity is fixed to 10 seconds, the first frame being output at most 1 second following the activation of the Request signal.

The time required to send a frame cannot exceed 8 seconds.

The meter stops sending frames as soon as the Request signal becomes inactive.

2.3. Frame general structure

A P1 frame is a multiline block of printable text, with CR-LF line terminations.

The first line contains a slash "/" followed by the manufacturer FLAG id (three letters code), the character "5", and then a manufacturer-specific identifier of the meter type.

The second line is an empty line.

The subsequent lines are the encoded representations of the COSEM objects selected in the P1 readout list.

The last line contains an exclamation mark "!" followed by the IBM CRC16 (polynomial 0x8005, initial value 0, no final XOR value) of the whole frame including the "!", represented in hexadecimal form MSB first.

2.4. Data encoding

Each data line starts with the OBIS code of the represented object, excluding the F group.

The encoding of the value depends on its A-XDR type. It is always represented as one or several strings contained in brackets "()".

Please refer to P1 specification for the complete list of type representation.

2.5. Readout list configuration

The P1 readout list is stored in the attribute 3 of a Profile Generic object (class 7).

The other attributes and methods of this object cannot be accessed by DLMS clients.

The capture_object must contain the DSMR P1 version as first element.

If objects related to an MBUS channel are selected, the device-type of this channel must be present and be precede any other object from this channel, including the long message.

This requirement is here to be sure that the IHD knows the type of energy before processing the data.

The maximum readout list is given in the following table:

Value	OBIS reference	attribute	class	format	unit	default list
Header Information	-	-	-	Manufacturer-specific	-	x
Version for P1 output	1-3:0.2.8.255	2	1	S2	-	x
current date-time	0-0:1.0.0.255	2	8	TST		x
Logical device name	0-0:42.0.0.255	2	1	S32		x
Total imported energy register (P+)	1-0:1.8.0.255	2	3	F9(3,3)	kWh	x
Total exported energy register (P-)	1-0:2.8.0.255	2	3	F9(3,3)	kWh	x
Total imported energy register (Q+)	1-0:3.8.0.255	2	3	F9(3,3)	kvarh	x
Total exported energy register (Q-)	1-0:4.8.0.255	2	3	F9(3,3)	kvarh	x
Instantaneous imported active power (P+)	1-0:1.7.0.255	2	3	F5(3,3)	kW	x
Instantaneous exported active power (P-)	1-0:2.7.0.255	2	3	F5(3,3)	kW	x
Instantaneous imported reactive power (Q+)	1-0:3.7.0.255	2	3	F5(3,3)	kvar	x
Instantaneous exported reactive power (Q-)	1-0:4.7.0.255	2	3	F5(3,3)	kvar	x
Active threshold (SMAX)	0-0:17.0.0.255	3	71	F4(1,1)	kVA	x
Breaker control state	0-0:96.3.10.255	3	70	I1	-	x
Number of power failures	0-0:96.7.21.255	2	1	F5(0,0)	-	
Number of voltage sags L1	0-0:32.32.0.255	2	1	F5(0,0)	-	
Number of voltage sags L2	0-0:52.32.0.255	2	1	F5(0,0)	-	

Number of voltage sags L3	0-0:72.32.0.255	2	1	F5(0,0)	-	
Number of voltage swells L1	0-0:32.36.0.255	2	1	F5(0,0)	-	
Number of voltage swells L2	0-0:52.36.0.255	2	1	F5(0,0)	-	
Number of voltage swells L3	0-0:72.36.0.255	2	1	F5(0,0)	-	
Long message E-meter	0-0:96.13.0.255	2	1	Sn(n=0..2048)	-	x
Long message channel x	0-0:96.13.x.255	2	1	Sn(n=0..2048)	-	x
Instantaneous current L1	1-0:31.7.0.255	2	3	F3(0,0)	A	
Instantaneous current L2	1-0:51.7.0.255	2	3	F3(0,0)	A	
Instantaneous current L3	1-0:71.7.0.255	2	3	F3(0,0)	A	
Instantaneous active power (P+) L1	1-0:21.7.0.255	2	3	F5(3,3)	kW	
Instantaneous active power (P+) L2	1-0:41.7.0.255	2	3	F5(3,3)	kW	
Instantaneous active power (P+) L3	1-0:61.7.0.255	2	3	F5(3,3)	kW	
Instantaneous active power (P-) L1	1-0:22.7.0.255	2	3	F5(3,3)	kW	
Instantaneous active power (P-) L2	1-0:42.7.0.255	2	3	F5(3,3)	kW	
Instantaneous active power (P-) L3	1-0:62.7.0.255	2	3	F5(3,3)	kW	
Instantaneous reactive power (Q+) L1	1-0:23.7.0.255	2	3	F5(3,3)	Kvar	
Instantaneous reactive power (Q+) L2	1-0:43.7.0.255	2	3	F5(3,3)	Kvar	
Instantaneous reactive power (Q+) L3	1-0:63.7.0.255	2	3	F5(3,3)	Kvar	
Instantaneous reactive power (Q-) L1	1-0:24.7.0.255	2	3	F5(3,3)	Kvar	
Instantaneous reactive power (Q-) L2	1-0:44.7.0.255	2	3	F5(3,3)	Kvar	
Instantaneous reactive power (Q-) L3	1-0:64.7.0.255	2	3	F5(3,3)	kvar	
Device type channel x	0-x:24.1.0.255	9	72	F3(0,0)		x
Equipment Identifier channel x	0-x:96.1.0.255	2	1	S16		x
Last Index capture-time channel x	0-x:24.2.1.255	5	4	TST		x
Last Index gas channel x	0-x:24.2.1.255	2	4	F8(3,3) to F8(0,0)	m^3	x
valve position gas channel x	0-x:24.4.0.255	3	70	I1		x
Last Index water channel x	0-x:24.2.1.255	2	4	F8(3,3)	m^3	x
Last Index heat channel x	0-x:24.2.1.255	2	4	F8(3,3)	GJ	x

2.6. Channel security

P1 protocol is a plain text protocol: it is required to secure the link to ensure end user data confidentiality.

In deviation to DSMR P1, an encryption layer is added over the P1 protocol.

This encryption layer is based on DLMS security suite 0 algorithm: AES128-GCM

This channel has its own separate security context: a separated Encryption key and a dedicated frame counter.

The parameters used for the encryption algorithm are the following:

- IV is 96 bits = system-title (64 bits) || frame counter (32 bits)
- AAD is 17 bytes = 30h || 00112233445566778899AABBCCDDEEFFh
- tag length is 96 bits long

AAD is used the same way as in DLMS suite 0 with a fixed "Authentication key". This is mainly to stay as close as possible to existing DLMS implementation and achieve better interoperability with IHD devices: although the Green book makes the AK optional, most implementations use it.

Encrypted data (with its tag) is sent in binary form on the serial link, using a general-glo-ciphering frame:
DBh || 08h(system-title length) || system-title || (length of the subsequent bytes: 17 + length of data) || 30h || frame counter || ciphered data || GCM tag

A security setup (class 64) instance is defined for P1 port security.

This security setup instance cannot be referenced by an Association LN instance.

The attribute 2 is used to toggle on and off the security on P1. Only the values 0 (unencrypted) and 3 (encrypted authenticated) are permitted.

The method 2 is used to renew the encryption key. Only key_id 0 can be used with this method.

When encryption is on, the frame counter is incremented after each frame is sent.

If the frame counter reaches the maximum value 0xffffffff, the meter stops sending frames, regardless of the Request signal state.

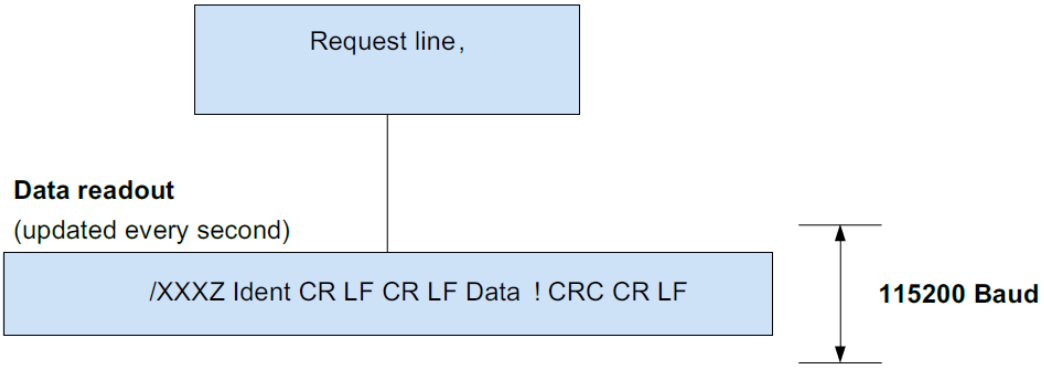
1 frame every 10 seconds is more than 1000 years, so the frame counter overflow will never happen in real use cases.

When the encryption key is changed, the frame counter is reset to 0.

3. Protocol Description

Please refer to the document:
“Dutch Smart Meter Requirements v5.0.2 Final P1” section ***6.Protocol Description***

The protocol is based on NEN-EN-IEC 62056-21 Mode D. Data transfer is requested with request line and automatically initiated every second until request line is released. The information in the P1 telegram must be updated every second.



Please refer to the document:
“Dutch Smart Meter Requirements v5.0.2 Final P1” section ***6.4 Representation of COSEM objects:***

Value Format	Format/Example	Meaning
Fn(x,y)	F7(3,3) – YYYY.YYY	Floating decimal number with a fixed number of decimals behind the decimal point (in this case 3)
Fn(x,y)	F7(0,3) – YYYY.YYY or YYYYY.YY or YYYYYY.Y or YYYYYYY	Floating decimal number with a variable number of decimals behind the decimal point (with a maximum of 3)
In	I4 - YYYY	Integer number
Sn	S6 - CCCCCC	Alphanumeric string
TST	YYMMDDhhmmssX	ASCII presentation of Time stamp with Year, Month, Day, Hour, Minute, Second, and an indication whether DST is active (X=S) or DST is not active (X=W).

4. P1 Security keys

4.1. Functionality

The secrets are owned by the Luxmetering system and entity. There are two keys to cover-up the security context of P1 Interface. In that regards one key (“Authentication key”) enables to authenticate the devices of Luxmetering as mentioned in the chapter 2.6 Channel security. This key has to be hardcoded within the product as it will be the same for all the metering devices.

In parallel Luxmetering owns the P1 unitary keys (“Encryption key”) of all the devices which enables to secure the end customer sensitive consumption data. This key shall be locally entered into the In-Home Display or Home Server solution in order to enable on unitary base the service to the end customer upon his request. The definition of the key described in the chapter 2.6 Channel security.

4.2. Key provisioning

In order to use the P1 port, the customer has to enter the encryption key in his In-Home Display or Home Server. The customer can request this key either directly from the DSO or mandate his energy supplier or energy service company to request it.

5. ANNEX 1 – DSMR P1 Specification

Dutch Smart Meter Requirements v5.0.2

6. Annex 2 Example of P1 Datagram

The following table shows an example of the P1 telegram that is in accordance to IEC 62056-21 Mode D. Be aware of the fact that the number of OBIS codes and the order of OBIS codes is not fixed. The P1 device must be able to interpret the OBIS codes and understand the representation. For example: depending on installation, the OBIS codes for a heat/cold meter might be sent before the OBIS codes of a Gas meter.

The example telegram in clear below is based on:

- DSMR version 5.0 (value 50 behind OBIS code 1-3:0.2.8.255)
- It is send at 2010, December 9th, 11h30m20s
- Gas value of 2010, December 9th, 11:25h is presented
- 4 power failures in any phase
- 2 long power failure in any phase
- Power Failure Event log:
    - Failure at 2010, December 8th, 15h20m15s, duration 240 second
    - Failure at 2010, December 8th, 15h05m03s, duration 301 seconds
- 2 voltage sags in phase L1
- 1 voltage sag in phase L2 (poly phase meters only)
- 0 voltage sags in phase L3 (poly phase meters only)
- 0 voltage swells in phase L1
- 3 voltage swells in phase L2 (poly phase meters only)
- 0 voltage swells in phase L3 (poly phase meters only)
- Only one M-Bus device is connected to the Electricity meter. The register value of the Gas meter is 12785,123 m3. This value is captured by the G meter at 2010, December 9th, at 11h25m00s wintertime.
- Instantaneous voltage per phase
- Instantaneous current per phase
- Instantaneous active power (+P) per phase
- Instantaneous active power (-P) per phase

```
/ISk5\2MT382-1000
1-3:0.2.8(50)
0-0:1.0.0(101209113020W)
0-0:96.1.1(4B384547303034303436333935353037)
1-0:1.8.1(123456.789*kWh)
1-0:1.8.2(123456.789*kWh)
1-0:2.8.1(123456.789*kWh)
1-0:2.8.2(123456.789*kWh)
0-0:96.14.0(0002)
1-0:1.7.0(01.193*kW)
1-0:2.7.0(00.000*kW)
0-0:96.7.21(00004)
0-0:96.7.9(00002)
1-0:99.97.0(2)(0-0:96.7.19)(101208152415W)(0000000240*s)(101208151004W)(0000000301*s)
1-0:32.32.0(00002)
1-0:52.32.0(00001)
1-0:72.32.0(00000)
1-0:32.36.0(00000)
1-0:52.36.0(00003)
1-0:72.36.0(00000)
0-
0:96.13.0(303132333435363738393A3B3C3D3E3F303132333435363738393A3B3C3D3E3F303132333435363738393A3B
3C
3D3E3F303132333435363738393A3B3C3D3E3F303132333435363738393A3B3C3D3E3F)
1-0:32.7.0(220.1*V)
1-0:52.7.0(220.2*V)
1-0:72.7.0(220.3*V)
1-0:31.7.0(001*A)
1-0:51.7.0(002*A)
1-0:71.7.0(003*A)
1-0:21.7.0(01.111*kW)
1-0:41.7.0(02.222*kW)
1-0:61.7.0(03.333*kW)
1-0:22.7.0(04.444*kW)
1-0:42.7.0(05.555*kW)
1-0:62.7.0(06.666*kW)
0-1:24.1.0(003)
0-1:96.1.0(32323232414243443132333435363738 39)
0-1:24.2.1(101209112500W)(12785.123*m3)
!EF2F
```