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App note 0026

FW extension module

MQTT

Document revision	Release date	For version		
		Hardware	Firmware	Software ENVIS
1.2	20.08.2024	SMY G3	$\geq$ 4.13.2	$\geq$ 2.2.36

Contents

1 About MQTT protocol

MQTT (Message Queuing Telemetry Transport) is lightweight, effective and easy-to-implement network protocol for sending messages between devices. It is designed for connecting remote locations with low band width, high latency and with devices with limited compute resources, like IoT devices and/or through large distances.

MQTT protocol is placed above TCP/IP in application layer (7. ISO/OSI layer) with default port 1883 or 8883 using SSL. Messages are exchanged between clients (publishers and subscribers) and server (broker). Send messages are marked with topic, that is relevant with data in message. Broker received data resend to subscribers, that are subscribing topic. Broker doesn't save any data permanently.

MQTT quality of service (QoS) can be set to one of three levels.

1. QoS 0 – at most once
   - Message is sent only once. Publisher after transmission doesn't wait for any confirmation.
2. QoS 1 – at least once
   - Message is received at least once. Publisher waits for confirmation after sending. If no confirmation is received, message is resend with duplicate message flag. Broker can receive one message multiple times. Duplicate messages are resend to subscribers.
3. QoS 2 – exactly once
   - Message is delivered exactly once. Each message contains unique identifier. Publisher saves message after send a waits for confirmation with same identifier. Broker after confirmation send has to wait for re-confirm message with same identifier from publisher.

1.1 Topic

Topic is basic data description, using UTF-8 coding and supports tree layout. Topics and it's arrangement depends on user. Examples:

- /building1/production-lines/line1
- production-lines/building1/line1

The first option is better for watching building one. We can just subscribe topic */building1/#*. For watching logic parts (production lines), we can use second topic layout and subscribe */production-lines/#*. We can also use first layout and subscribe */+/production-lines/#*.

Sign + is one layer placeholder. Replace one layer in topic tree.

Sign # is multi layer placeholder. Replace every next layer in topic tree.

1.2 Devices

MQTT allows asynchronous communication a it defines 3 types of devices, depending on it's role.

1. Publisher
    - Device, that generates a sends messages with topics.
    - Sensors, measurement devices, applications.
2. Subscriber
    - Device, that receives messages with subscribed topic. Messages to subscriber are sent from broker.
    - Processes messages and evaluate them.
    - Regulators, applications.
3. Broker
    - Central server, processes communication between publishers and subscribers. Receives messages from publishers and resend them to subscribers depending on subscribed topics.
    - Maintains communication between publishers and subscribers. It can add security features, like authentication or encryption.

1.3 Messages

MQTT messages have two main parts: head and data. For more secure data transfer, authentication, identificator of client or TLS/SSL connection can be used.

1.3.1 Message head

Every MQTT message contains head with fixed and eventually variable part:

- Fixed part
  - Message type (4 bits)
    - *CONNECT, SUBSCRIBE, PUBLISH...*
  - Flags (4 bits)
    - *flags depending on message type*
    - *QoS, duplicate...*
  - Length (1-4 bytes)
    - *actual message length*
- Variable part
  - Packet identifier
  - Protocol name
  - Protocol version
  - Connect flags
    - *flags for behaviour of connecting client*
  - User name
    - *used for authentification*
  - Password
    - *used for authentification*
  - Flags

1.3.2 Message data

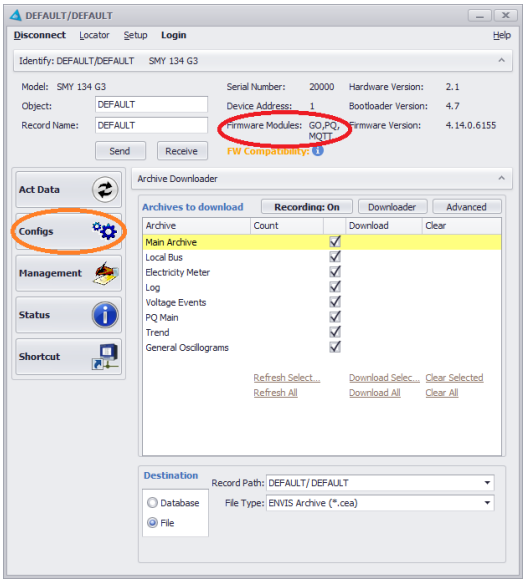
Content of message can be in any user-selected format.

2 Settings of MQTT in KMB devices

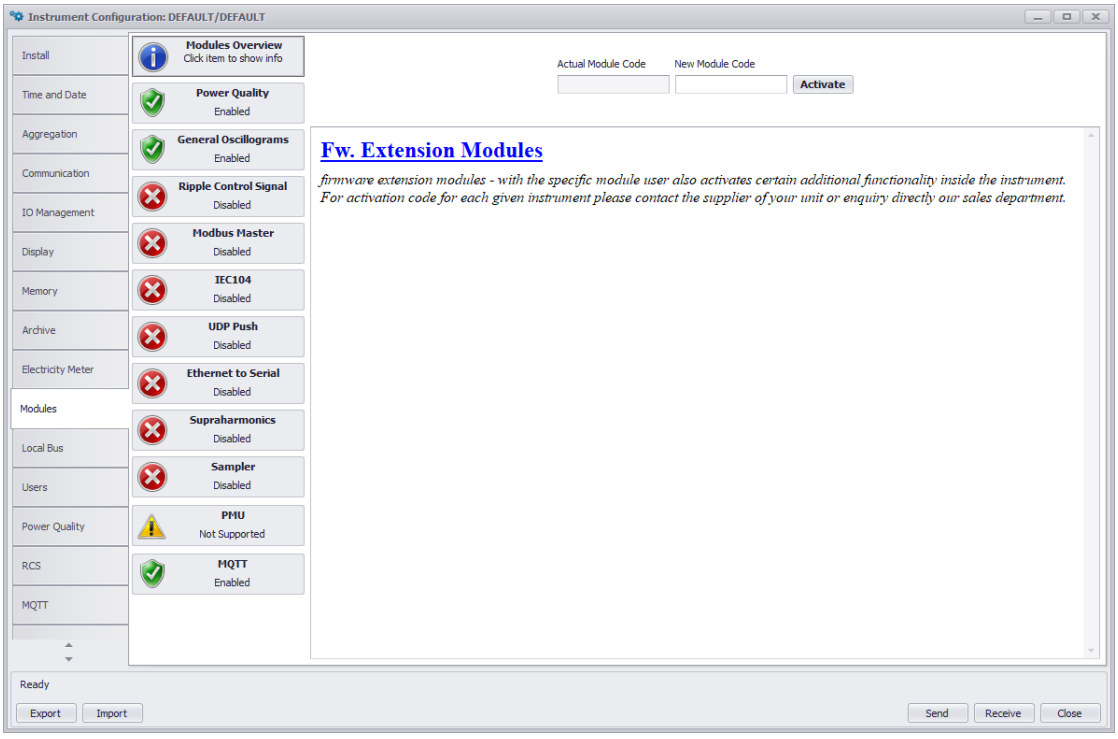
KMB devices use MQTT protocol version 3.1.1. For using MQTT, it is necessary to have compatible device (with compatible FW version and ethernet interface) and with active MQTT FW module. Device is publisher.

2.1 Device modules

Compatible and active modules in device is possible to see in *ENVIS.Daq* program. After connecting to device, active modules are on top of main screen or in *Configs* window, on *Modules* tab.



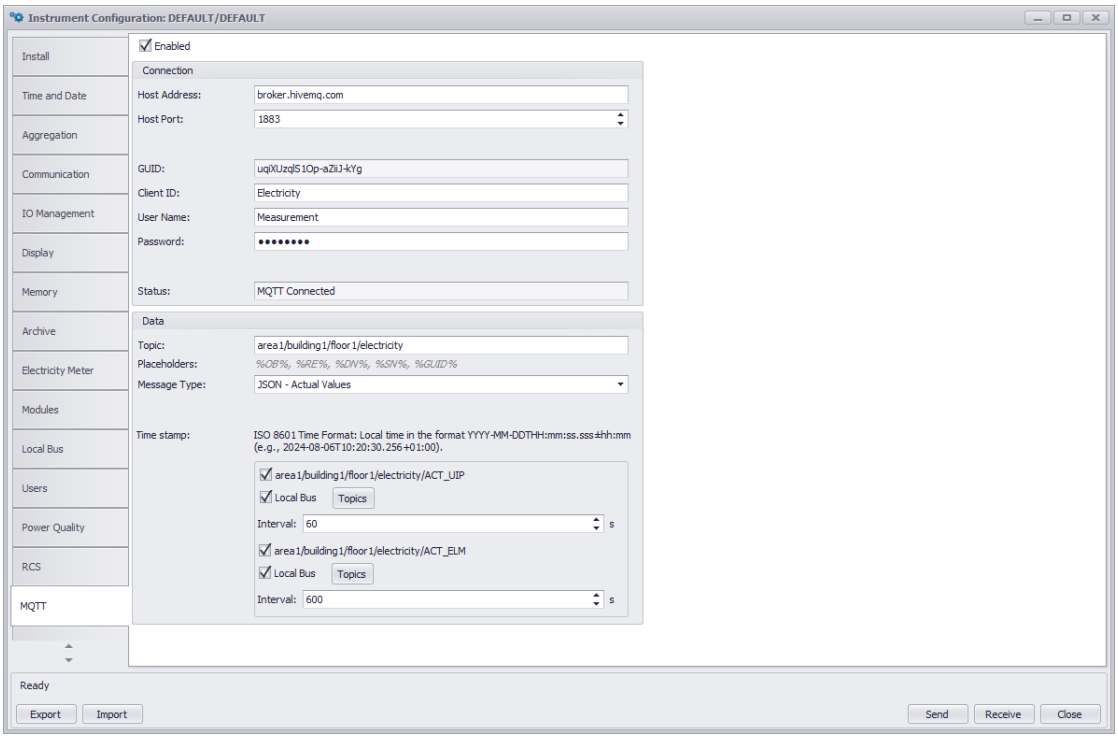
Obrázek 1: Main screen of ENVIS.Daq program, after device connect



Obrázek 2: Active modules in device

2.2 Settings

MQTT setting can be done using *ENVIS.Daq* program, in *Configs* window, *MQTT* tab. QoS is set to 0, other parameters need configuration.



Obrázek 3: Setting of MQTT communication

- Host address
  - broker address
- Host port
  - MQTT port
  - default 1883
- GUID
  - unique identifier of device, can be used for client id or topic
- Client id
  - identifier of device, resent to subscribers
- Username
  - user name for authentication
- Password
  - password for authentication

- Status
  - Status of connection between device (publisher) and broker. Values of status is usually *Disconnected*, *TCP Connecting*, *MQTT Connecting*, *MQTT Connected*. Another status values are also possible, but it shows some error of connection, communication or settings. Value is not refreshed automatically, *Receive* button at bottom right must be pressed.
- Topic
  - message topic
- Placeholders
  - variables, that can be used, for example like message topic
    - %OB% – object name
    - %RE% – record name
    - %DN% – device type name
    - %SN% – device serial number
    - %GUID% – unique identifier of device
  - Topic example: *measure/%OB%/%RE%/*
- Message type
  - data format
    - Binary
      - KMB long data protocol, human non-readable
    - JSON – Actual values
      - JSON with actual values
      - UIP (voltage, current, power) and/or electricity meter data can be chosen
      - data of slave devices on local bus can be chosen — topics of each feeder is separated and can be shown.
      - adjustable period of sending
    - JSON – Archive
      - JSON with data saved in archive
      - main archive and/or electricity meter data can be chosen
      - data of slave devices on local bus can be chosen — topics of each feeder is separated and can be shown.
      - sending average values when saving into archive – settings in *Archive* tab
    - JSON – WEB
      - JSON with data shown on webserver of device
      - device identification, UIP, harmonics and/or electricity meter can be chosen
      - adjustable period of sending
- Time stamp
  - JSON messages of actual data and archives contain time stamp of sending message from device in format *YYYY-MM-DD*T*HH*:*mm*:*ss.sss*±*hh*:*mm*, for example 2024-08-20T12:05:30.750+02:00.
    - Date: year - month - day — *YYYY-MM-DD* (2024-08-20)
    - Time: hour : minute : second . thousandths of seconds — *HH*:*mm*:*ss.sss* (12:05:30.750)
    - Time shift compared to UTC: ± hour : minute — ±*hh*:*mm* (+02:00)
      - Expression of time zone and day light saving shift.

2.3 Transceived data

2.3.1 Binary

Binary data, non-readable by human. KMB long protocol.

2.3.2 JSON – Actual values, Archive

Data in JSON containing variable name with it's value. Examples bellow have added spacing.

UIP – voltage, current, power:


```
{"Time":"2024-08-20T12:05:30.750+02:00",
"U1":"230.0","U2":"229.9","U3":"230.1",
"U12":"398.3","U23":"398.4","U31":"398.5",
"I1":"1.00","I2":"1.00","I3":"1.00","I4":"0.00",
"INC":"0.00","IPEC":"0.00",
"3P":"628.4","3Q":"-0.3","3S":"690.0","3PF":"0.9","3D":"285.0",
"P1":"230.0","Q1":"0.0","S1":"230.0","PF1":"1.0","D1":"0.2",
"P2":"198.9","Q2":"114.8","S2":"229.7","PF2":"0.9","D2":"0.0",
"P3":"199.5","Q3":"-115.2","S3":"230.3","PF3":"0.9","D3":"0.0",
"F":"50.00","F200":"50.00",
"THDu1":"0.0","THDu2":"0.0","THDu3":"0.0",
"THDi1":"0.0","THDi2":"0.0","THDi3":"0.0","THDi4":"0.0"}
```


UIP – local bus – voltage, current, power:


```
{"Time":"2024-08-20T12:05:30.750+02:00",
"U1":"230.0","U2":"229.9","U3":"230.1",
"U12":"398.3","U23":"398.4","U31":"398.5",
"I1":"1.00","I2":"1.00","I3":"1.00",
"3P":"628.4","3Q":"-0.3","3S":"690.0","3PF":"0.9","3D":"285.0",
"P1":"230.0","Q1":"0.0","S1":"230.0","PF1":"1.0","D1":"0.2",
"P2":"198.9","Q2":"114.8","S2":"229.7","PF2":"0.9","D2":"0.0",
"P3":"199.5","Q3":"-115.2","S3":"230.3","PF3":"0.9","D3":"0.0",
"F":"50.00","F200":"50.00",
"THDu1":"0.0","THDu2":"0.0","THDu3":"0.0",
"THDi1":"0.0","THDi2":"0.0","THDi3":"0.0"}
```


Data from local bus does not contain INC and IPEC values, only master devices send them.

Shortcut	Line	Quantity	Unit
Un	2	Phase voltage	V
Unn	3	Line voltage	V
In	4	Current	A
INC	5	Calculated current in neutral wire	A
IPEC	5	Calculated current in earth wire	A
3x	6	3phase value of quantity	W/var/VA/-/VA
Pn	6,7,8,9	Active power	W
Qn	6,7,8,9	Reactive power	var
Sn	6,7,8,9	Apparent power	VA
PFn	6,7,8,9	Power factor	-
Dn	6,7,8,9	Deformed power	VA
F	10	Frequency (last 10s)	Hz
F200	10	Frequency (last 200ms)	Hz
THDun	11	Total harmonic distortion of voltage	%
THDin	12	Total harmonic distortion of current	%

- n stands for phase number
- x stands for quantity
- Time is according to ISO 8601 in format $YYYY\text{-}MM\text{-}DD\mathrm{T}HH{:}mm{:}ss.sss{\pm}hh{:}mm$. Described above.

Tabulka 1: Shortcuts and their meaning in Actual / Archive UIP

ELM – electricity meter

```
{"Time":"2024−08−20T12:05:30.750+02:00",
"A1":"0.0","A2":"0.0","A3":"0.0","3A":"0.0",
"+A1":"0.0","+A2":"0.0","+A3":"0.0","+3A":"0.0",
"−A1":"0.0","−A2":"0.0","−A3":"0.0","−3A":"0.0",
"S1":"0.0","S2":"0.0","S3":"0.0","3S":"0.0",
"R1":"0.0","R2":"0.0","R3":"0.0","3R":"0.0",
"Ri1":"0.0","Ri2":"0.0","Ri3":"0.0","3Ri":"0.0",
"Rc1":"0.0","Rc2":"0.0","Rc3":"0.0","3Rc":"0.0"}
```

Master device and local bus slave devices send data of electricity meter in the same layout.

Shortcut	Line	Quantity	Unit
3x	1,2,3,4,5,6,7	3phase value of quantity	Wh/VAh/varh
An	1	Active energy	Wh
+An	2	Import of active energy	Wh
-An	3	Export of active energy	Wh
Sn	4	Apparent energy	VAh
Rn	5	Reactive energy	varh
Rin	6	Reactive inductive energy	varh
Rcn	7	Reactive capacitive energy	varh

- n stands for phase number
- x stands for quantity
- Time is according to ISO 8601 in format $YYYY$-MM-DDTHH:mm:$ss.sss$±hh:mm. Described above.

Tabulka 2: Shortcuts and their meaning in Actual / Archive ELM

2.3.3 JSON – WEB

Data in JSON containing variable name with it's value. Examples bellow have added spacing.

IDENT – device identification

```
1 {"_DEVICE":"SMY 134 G3 ",
2 "_OBJECT":"DEFAULT","_REC_NAME":"DEFAULT",
3 "_SERIAL":"20000",
4 "_FW_VER":"4.12.4.6139"}
```

Shortcut	Line	Parameter
_DEVICE	1	Device type
_OBJECT	2	Object name
_REC_NAME	2	Record name
_SERIAL	3	Device serial number
_FW_VER	4	FW version

Tabulka 3: Shortcuts and their meaning in WEB identification

UIP – voltage, current, power

Voltage, current and power values start with *_xJ* parameter, which gives unit prefix – if needed (for example k, M, G for kilo, mega, giga). *_xJ58* marks new quantity values (phase voltages, line voltages...). Values are shown with 4 digits.

Voltage *_Ln* gives value of nominal voltage of device. It is measured phase or line voltage depending on device connection.

Internal temperature *_TEMPI* is measured inside of device and is affected with own heat of device. External temperature *_TEMPE* is measured only with devices containing external temperature sensor Pt100 connection.

```
{"_UJ":"","_UJ58":"","_U1":"230.0","_U2":"229.9","_U3":"230.1",
"_ULLJ":"","_ULLJ58":"","_ULL1":"398.3","_ULL2":"398.4","_ULL3":"398.5",
"_UDCJ":"","_UDCJ58":"","_UDC1":"0.000","_UDC2":"0.000","_UDC3":"0.000",
"_IJ":"","_IJ58":"","_I1":"1.00","_I2":"1.00","_I3":"1.00","_I4":"0.00",

"_THDUJ":"","_THDUJ58":"","_THDU1":"0.000","_THDU2":"0.000","_THDU3":"0.000",
"_THDIJ":"","_THDIJ58":"","_THDI1":"0.000","_THDI2":"0.000","_THDI3":"0.000","_THDI4":"---",

"_LJ":"","_LJ58":"","_L1":"230.0","_L2":"229.9","_L3":"230.1",

"_PJ":"","_PJ58":"","_P1":"230.0","_P2":"114.8","_P3":"115.2","_P3P":"460.0",
"_QJ":"","_QJ58":"","_Q1":"0.0","_Q2":"198.9","_Q3":"-199.5","_Q3P":"-0.6",
"_SJ":"","_SJ58":"","_S1":"230.0","_S2":"229.7","_S3":"230.3","_S3P":"690.0",
"_DJ":"","_DJ58":"","_D1":"0.2","_D2":"0.0","_D3":"0.0","_D3P":"514.3",
"_PFJ":"","_PFJ58":"","_PF1":"1.000","_PF2":"0.500","_PF3":"0.500","_PF3P":"0.667",

"_PFHJ":"","_PFHJ58":"","_PFH1":"230.0","_PFH2":"114.8","_PFH3":"115.2","_PFH3P":"460.0",
"_QFHJ":"","_QFHJ58":"","_QFH1":"0.0","_QFH2":"198.9","_QFH3":"-199.5","_QFH3P":"-0.6",
"_COS1":"1.00L","_COS2":"0.50L","_COS3":"0.50C","_COS3P":"1.00C",

"_F":"50.000","_UNBU":"0.03","_UNBI":"100.00",
"_TEMPI":"42.0","_TEMPE":"---",
"_3I":"3.00","_INC":"0.00","_IPEC":"0.00"}
```


Shortcut	Line	Quantity	Unit
_Un	1	Phase voltage	V
_ULLn	2	Line voltage	V
_UDCn	3	DC component of voltage	V
_In	4	Current	A
_THDUn	6	Total harmonic distortion of voltage	%
_THDIn	7	Total harmonic distortion of current	%
_Ln	9	Nominal voltage (depending on settings)	V
_Pn	11	Active power	W
_Qn	12	Reactive power	var
_Sn	13	Apparent power	VA
_Dn	14	Deformed power	VA
_PFn	15	Power factor	-
_PFHn	17	Active power of the 1st harmonic	W
_QFHn	18	Reactive power of the 1st harmonic	var
_COSn	19	Power factor of the 1st harmonic	-
_x3P	11-19	3phase value of quantity	W/var/VA/-
_F	21	Frequency	Hz
_UNBU	21	Voltage unbalance	%
_UNBI	21	Current unbalance	%
_TEMPI	22	Internal temperature	°C
_TEMPE	22	External temperature (Pt100)	°C
_3I	23	3phase (summed) current	A
_INC	23	Calculated current in neutral wire	A
_IPEC	23	Calculated current in earth wire	A

- n stands for phase number
- x stands for quantity

Tabulka 4: Shortcuts and their meaning in WEB UIP

HAR – harmonics

Harmonics are send for voltage (_ *UHn*) and current (_ *IHn*), for 1.-3.(/4.) phase (according to n). Only odd harmonics in range 1.-15. are sent.


```
{"_UH1": [230.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00],
"_UH2": [229.90,0.00,0.00,0.00,0.00,0.00,0.00,0.00],
"_UH3": [230.10,0.00,0.00,0.00,0.00,0.00,0.00,0.00],
"_IH1": [1.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00],
"_IH2": [1.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00],
"_IH3": [1.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00],
"_IH4": [1.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00]}
```


ELM – electricity meter


```
{"_EL_3Pp":"1.5","_EL_3Pm":"0.0","_EL_3Qp":"0.2","_EL_3Qm":"0.2",
"_EL_PiTs1":"0.8","_EL_PeTs1":"0.0","_EL_QpTs1":"0.0","_EL_QmTs1":"0.0",
"_EL_PiTs2":"0.3","_EL_PeTs2":"0.0","_EL_QpTs2":"0.2","_EL_QmTs2":"0.0",
"_EL_PiTs3":"0.3","_EL_PeTs3":"0.0","_EL_QpTs3":"0.0","_EL_QmTs3":"0.2",
"_EL_COS1":"1.000L","_EL_COS2":"0.865L","_EL_COS3":"0.865C","_EL_COS3P":"1.000C"}
```


Shortcut	Line	Quantity	Unit
3P	1,5	3phase value of quantity	Wh/varh/-
_EL_PiTsn	1	Import of active energy	Wh
_EL_PeTsn	2	Export of active energy	Wh
_EL_QpTsn	3	Reactive inductive energy	varh
_EL_QmTsn	4	Reactive capacitive energy	varh
_EL_COSn	5	Power factor	-

- n stands for phase number
- x stands for quantity

Tabulka 5: Shortcuts and their meaning in WEB ELM

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