

TITAN

Application Note 51

Autonomous Reading of IEC 60870-5-102 Electricity
Meters with Transmission of Data to an MQTT
Platform

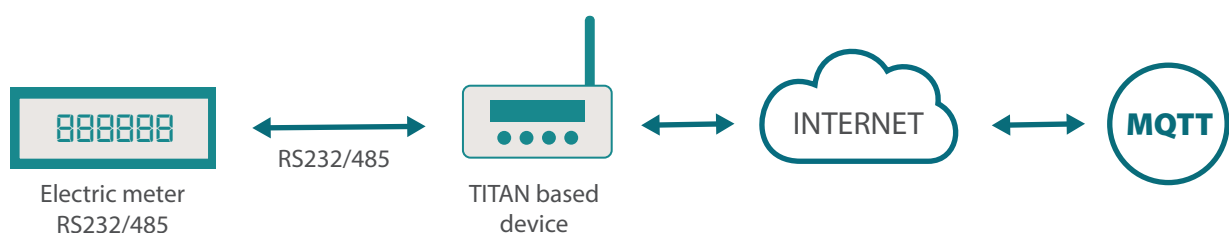
Autonomous Reading of IEC 60870-5-102 Electricity Meters with Transmission of Data to an MQTT Platform

1. Scenario Details

TITAN-based devices have all the typical functionalities of 4G/3G/2G routers, as well as a series of added features that make them one of the most feature-packed routers on the market. Some of the added features include the ability to read IEC 60870-5-102 meters autonomously, to periodically read the instantaneous values, to read the closing values each day and to store the data in the internal datalogger to send it to a platform (HTTP / HTTPS, MQTT / MQTTS, FTP), as long as there is 4G/3G/2G coverage.



2. Description of the Scenario in the Example

- We have an Electricity Meter (IEC 60870-5-102) with an RS232 serial port (9600,8,N,1)
- We want to configure the TITAN-based device to autonomously read an IEC 60870-5-102 meter every 15 minutes, and to extract the instantaneous values (active absolute energy, inductive active absolute energy, reactive active absolute energy, active total power, reactive total power, etc.) and to send the data read from the Electricity Meter to an MQTT broker.
- The TITAN-based device also needs to be able to read the closing values of the meter each day and to configure the number of days (31 days by default). Similarly, the values read must be sent to an MQTT broker each day.



3. Configuring the Associated Serial Port

In this example, the TITAN-based device's RS232 port will be used, this is the serial port through which the Electricity Meter is connected. To configure this, go to the "Serial Settings > Serial Port1-232" menu and enter the appropriate values. The appropriate values are those that coincide with the configuration of the Electricity Meter's serial port, which in the case of this example is 9600,8,N,1.

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★ **Mobile**

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★ **Firewall**

◆ Authorized IPs

★ **Serial Settings**

◆ **Serial Port1-RS232**

◆ Serial Port2-RS485

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★ **External Devices**

◆ Logger configuration

◆ ModBus Devices

◆ Generic Serial Device

◆ Temperature Sensor

◆ IEC102 Meter

◆ W-MBus

▶ **Serial Gateway** ▶ **Com1 Settings**

Baudrate:

9600

▼

Baudrate of serial port

Data bits:

8

▼

Number of data bit

Parity:

none

▼

Parity

Stop bits:

1

▼

Number of stop bits

Flow Control:

none

▼

Flow control of serial port

Timeout ms:

0

msec without serial data before sending (default: 50)

☐ **Allow local embedded AT commands**

Ex.: <MTXTUNNEL>AT</MTXTUNNEL>

☐ **Allow remote embedded AT commands**

Ex.: <MTXTUNNELR>AT</MTXTUNNELR>

☐ **Allow incoming GSM call (CSD Data Call)**

Only **TCP Server** and **TCP Client** functions or **Nothing**

☒ **Function: Nothing or used by External Device or Script**

4. WAN Configuration

The TITAN-based device needs to be configured to have IP communication via 4G/3G/2G, as MQTT communication will require the corresponding interface in this scenario. To do this, go to the “Mobile > Basic Settings” menu and enable the WAN interface at the least, also specify the SIM card’s APN / username / password. Given that CSD calls are not required in this scenario, we recommend you select “Auto (4G/3G/2G)” in the “Network Selection” field.

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 - ◊ Snmp
 - ◊ Tacacs+
 - ◊ Mqtt
 - ◊ Http / Https
 - ◊ User Permissions

Mobile > Basic Settings

Mobile WAN

Enabled (IP active)

Enable Wireless WAN interface

Sim Mode

SIM1

Sim selection

SIM1 APN:

movistar.es

APN of SIM card 1

SIM1 Username:

MOVISTAR

Username of SIM card 1

SIM1 Password:

Password of SIM card 1

SIM1 Pin:

PIN of SIM card 1

SIM2 APN:

APN of SIM card 2

SIM2 Username:

Username of SIM card 2

SIM2 Password:

Password of SIM card 2

SIM2 Pin:

PIN of SIM card 2

Authentication:

Auto

Authentication method

Network selection:

Auto (4G/3G/2G)

Network selection

DNS selection:

Get DNS from Operator

DNS1:

8.8.8.8

Preferred DNS1

DNS2:

8.8.4.4

Preferred DNS2

Remote webserver management:

☒

Enable remote webserver management

5. MQTT Configuration

The TITAN-based device is going to send the data from the Electricity Meter to an MQTT broker, so the MQTT section of the device must also be configured. To do this, go to the “Other > Mqtt” menu and configure it appropriately. In this example, the HIVEMQ testing platform will be used. Enter “tcp://broker.mqttdashboard.com:1883” in the “MQTT Broker” field, and the device's IMEI in the “MQTT ID” field as an identifier, enter “[IMEI]”. We also need to be able to send AT commands to the TITAN-based device from the MQTT platform to perform maintenance tasks, configuration, device status readings, etc., in order to be able to send AT commands to the TITAN-based device remotely, the “MQTT AT Topic” and “MQTT AT Resp Topic” fields must be filled in. The AT commands should be sent to the first topic so that they are received and executed by the TITAN-based device. The TITAN-based device will send the responses to the executed AT commands to the second topic, this is the topic on the MQTT platform where we can get the responses to the executed AT commands. The following screenshot shows the settings required for this scenario.

Other > MQTT Client

Enabled: ☒ Enable MQTT client

MQTT Broker: Destination MQTT Broker. Examples:
tcp://test.mosquitto.org:1883
ssl://test.mosquitto.org:8883 (certificate needed)
ssl://test.mosquitto.org:8884 (certificates needed)

MQTT Username: MQTT Username (blank if not used)

MQTT Password: MQTT Password (blank if not used)

MQTT ID: Device identification

MQTT Qos: MQTT Quality Of Service (0 ... 2)

MQTT Keepalive: Seconds for keepalive (30 ... 3600)

MQTT Persistence: ☐ Data persistence

MQTT AT Topic: This topic will be subscribed for receiving AT Commands (usefull for individual device)

MQTT AT Resp Topic: This topic will be used for publishing the AT Command Responses of AT Topic

MQTT AT Topic 2: This topic will be subscribed for receiving AT Commands (usefull for groups)

MQTT AT Resp Topic 2: This topic will be used for publishing the AT Command Responses of AT Topic 2

MQTT AT Topic 3: This topic will be subscribed for receiving AT Commands (usefull for all devices)

MQTT AT Resp Topic 3: This topic will be used for publishing the AT Command Responses of AT Topic 3

MQTT Script Topic 1: When data is received in this topic the 'Topic Script' will be executed.

MQTT Script Topic 2: When data is received in this topic the 'Topic Script' will be executed.

6. LOGGER Configuration

The next step is to configure the TITAN-based device's LOGGER. We must configure the device's internal memory (where it saves the data read from the Electricity Meter) and the method used to send the saved data to remote platforms (in this example, MQTT). The LOGGER is configured in the "External Devices > Logger configuration" menu.

The optional ID field can be configured (with an arbitrary device identifier if you do not want to use the IMEI as such). The method for sending data to the platform can be configured as LIFO or FIFO, as applicable. The "Time format" field must be set to the standard UNIX format.

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 - SSL Certificates
- External Devices**
 - Logger configuration**
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 - Generic Serial Device
 - Temperature Sensor
 - IEC102 Meter
 - W-MBus

External Devices > Logger

ID: ID-869101054287764

Optional. Device identification

Send mode: LIFO

Send mode (normally FIFO)

Time format: unix (yyyy-mm-ddTHH:mm:ss)

Time format used in timestamp logger data

Use script: ☐

Check for customized json using 'Json Transformer Script' in [Script](#) section.

Use array: ☐

Check if you want to send more than one JSON per transimition.

Communication mode: WEB PLATFORM (HTTP REST)

Enabled: ☐

Communication mode HTTP enabled

Mode: HTTP GET (JSON)

Method of sending data

Custom parameters:

Optional. Ex: &a=1&b=2 only for "HTTP GET/PUT (PARAMETERS)" modes

Custom header1:

Optional. Custom header1. For example: Content-type;application/json

Custom header2:

Optional. Custom header2. For example: IDENTITY_KEY;YOUR_KEY

Custom header3:

Optional. Custom header3.

Also in the LOGGER configuration section, at the bottom of the page, the "Enabled" box must be checked to activate the MQTT delivery mode. The delivery topic (the MQTT topic to which the TITAN-based device will send the data) must be set to "/LOGGER" in this example.

- Reboot
- Logout

Communication mode: MQTT

Enabled: ☒

Communication mode MQTT enabled

MQTT Topic: /LOGGER

MQTT Topic. Example: [IMEI]/logger

Note: Other>MQTT menu must be configured

7. IEC-60870-5-102 Configuration

The last step is to configure the IEC-60870-5-102 protocol of the electricity meter. Go to the “External Devices > IEC102 Meter” menu. In this section we must enable the service and specify the serial port to use for the TITAN-based device (“Serial Port 1”), and the interval at which the instantaneous values are to be read, in this case 15 minutes.

In the following fields we enter a customizable value with the meter identifier (in this example ID00000), as well as the link address, the metering point address and the password. As the meter's pricing Information is also needed, the "Fiscal close" box must be checked and the number of days set to 31.

Lastly, in order for the data from the reading to be stored in the TITAN-based device's LOGGER to be sent to the MQTT platform, the “Logger” box must be activated.

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Mobile

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- Keep Online

Ethernet

- Basic Settings

Firewall

- Authorized IPs

Serial Settings

- Serial Port1-RS232
- Serial Port2-RS485
- SSL Certificates

External Devices

- Logger configuration
- ModBus Devices
- Generic Serial Device
- Temperature Sensor
- IEC102 Meter**
- W-MBus

External Devices > IEC102 Meter

Enabled: ☒ Enable Temperature sensor

Communication Port: Serial Port 1 Select the serial port for reading

Period: 15 minutes Reading period for instant values

ID Meter: ID00000 Customizable label for identification

Link address: 1 Link address of meter (1...65535)

Meas. address: 1 Measurement address (1...65535)

Password: 1 Password of meter (1...65535)

Fiscal close: ☒ Read and send Fiscal close data once per day (Contract I)


Fiscal close days: 31 Number of days (1 ... 31) Default 31

Logger: ☒ Logger must be used. Please, [configure logger](#) before using this option. Recommended 'Register Size': 7000, 'Number of registers': 100

After pressing the “SAVE CONFIG” button to save the changes, we must REBOOT the TITAN-based device for the new configuration to take effect. It can be rebooted from the “Other > Reboot” menu.

8. Testing the Scenario

Lastly we need to check that the system is operating correctly. Once the TITAN-based device has been restarted, wait a few seconds and check that the device has obtained an IP address in the “Mobile>Status” menu.


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Mobile > Status

Firmware version:	5.2.6.08 (Webdyn EasyModem)	
WAN Mobile IP:	176.82.161.192	WAN IP (2G/3G/4G) Network
GSM Module:	EC21 Revision: EC21EFAR06A05M4G	
IMEI:	869101054287764	Device identification
SIM:	SIM-1 (SIM READY)	Used SIM and status
Network (2G/3G/4G):	4G (MOVISTAR)	Used network at this moment
Signal Strength:	22 (-69dbm)	Signal Strength (0 ... 31)
Extra signal info:	Rsrp: -101dBm Rsrq: -14dB	For 3G & 4G Network



Next, check that the connection with the MQTT broker is correct in the “Other>MQTT” menu.

Other > MQTT Client > Status


Internet status:	Online
MQTT connection status:	Connected

Checked every MQTT
Keepalive period

REFRESH

It can also check that the connection exists in the MQTT broker and is well established, by sending an AT command to the TITAN-based device via MQTT. As such, we must configure the /ATR (to receive responses from the executed AT commands) and /LOGGER topics to which the TITAN-based device will send the data read from the Electricity Meter.

No es seguro | hivemq.com/demos/websocket-client/

 **HIVEMQ**

Websockets Client Showcase

Connection

connected

Publish

Topic

/AT

QoS

0

Retain

☐

Publish

Message

AT+CSQ

Messages

2022-07-13 11:38:39 Topic: /ATR Qos: 0

AT+CSQ +CSQ: 22,99 OK

Subscriptions

Add New Topic Subscription

Qos: 2 /LOGGER

Qos: 2 /ATR

Next we must check communications with the Electricity Meter. Go to the “External Devices>IEC102 Meter” menu. Towards the bottom of the screen, click on the “FORCE READ” button to force the device to read the instantaneous values from the Electricity Meter. The values read from the meter should then be displayed on the screen as shown in the following screenshot, indicating that the meter and the TITAN-based device’s serial port are configured correctly.

- Time Servers
- Remote Console
- Snmp
- Tacacs+
- Mqtt
- Http / Https
- User Permissions
- Passwords Web UI
- CA Certificates
- Email Config
- ModBus Slave
- Titan Scripts**
- Connectivity tools
- Digital I/O
- Custom Skin
- Led Config
- Syslog
- Backup / Factory
- Firmware Upgrade
- Reboot
- Logout

External Devices > IEC102 Meter > Read Instant Values

TS:	2022-07-13T09:40:38Z	TimeStamp (Titan time)
VabA:	0	Active absolute energy
VabRi:	0	Inductive Reactive Absolute Energy
VabRc:	0	Absolute Reactive Capacitive Energy
pat:	0	Total Active Power
prt:	0	Total Reactive Power
fpt:	1000	Total power factor
paf1:	0	Active Power Phase I
prf1:	0	Reactive Power Phase I
fpf1:	1000	Power Factor Phase I
paf2:	0	Active Power Phase II
prf2:	0	Reactive Power Phase II
fpf2:	1000	Power Factor Phase II
paf3:	0	Active Power Phase III
prf3:	0	Reactive Power Phase III
fpf3:	1000	Power Factor Phase III
if1:	0	Current Phase I
tf1:	1114	Voltage Phase I
if2:	0	Current Phase II
tf2:	1125	Voltage Phase II
if3:	0	Current Phase III
tf3:	3	Voltage Phase III

REFRESH DATA

FORCE READ

(Force read will take 10 seconds)

The data obtained by clicking on "FORCE READ" are NOT stored in the logger, as the "FORCE READ" button only forces a reading of the Electricity Meter's instantaneous values to check that the configuration is correct. Before the MQTT platform receives the instantaneous values, we will need to wait for the time interval configured in the TITAN-based device's "External Devices > IEC102 Meter" menu, which in this example is 15 minutes. Once this time has elapsed, the data sent by the TITAN-based device should be received on the MQTT platform, as shown in the following image.

The screenshot shows the HiveMQ Websockets Client Showcase interface. At the top, there's a status bar indicating 'No es seguro' and the URL 'hivemq.com/demos/websocket-client/'. The main header features the Hivemq logo and the title 'Websockets Client Showcase'. Below the header, the interface is divided into several sections:

- Connection:** Shows a green dot and the text 'connected'.
- Publish:** Includes fields for 'Topic' (set to '/AT'), 'QoS' (set to 0), and a 'Retain' checkbox. A 'Publish' button is present. Below these is a 'Message' input field containing 'AT+CSQ'.
- Subscriptions:** Features an 'Add New Topic Subscription' button. Below it, two subscriptions are listed: '/LOGGER' and '/ATR', both with 'Qos: 2'.
- Messages:** Displays a list of received messages. A message from topic '/LOGGER' with 'Qos: 1' is highlighted, showing a JSON object with various device parameters.

Example of a JSON object containing the instantaneous values

```
{
  "IMEI": "869101054287764",
  "TYPE": "IEC102",
  "TS": "2022-07-13T09:42:06Z",
  "P": "ID-869101054287764",
  "ID": "ID00000",
  "VABA": 0,
  "VABRI": 0,
  "VABRC": 0,
  "PAT": 0,
  "PRT": 0,
  "FPT": 1000,
  "PAF1": 0,
  "PRF1": 0,
  "FPF1": 1000,
  "PAF2": 0,
  "PRF2": 0,
  "FPF2": 1000,
  "PAF3": 0,
  "PRF3": 0,
  "FPF3": 1000,
  "IF1": 0,
  "TF1": 1115,
  "IF2": 0,
  "TF2": 1127,
  "IF3": 0,
  "TF3": 3
}
```

Where:

IMEI: ID number of the TITAN-based device.

TYPE: type of JSON. In this case the type is IEC102.

TS: timestamp of the time the data was collected.

P: Logger ID field.

ID: ID field of the IEC102 configuration in the TITAN-based device.

VABA: absolute active energy

VABRI: inductive absolute reactive energy

VABRC: inductive absolute reactive energy

PAT: total active power

PRT: total reactive power

FPT: total power factor

PAF1: phase I active power

PRF1: phase I reactive power

FPF1: phase I power factor

PAF2: phase II active power

PRF2: phase II reactive power

FPF2: phase II power factor

PAF3: phase III active power

PRF3: phase III reactive power

FPF3: phase III power factor

IF1: phase I intensity

TF1: phase I voltage

IF2: phase II intensity

TF2: phase II voltage

IF3: phase III intensity

TF3: phase III voltage

Obtaining Real-Time Values from the Platform Without Waiting

The Electricity Meter's instantaneous values can be read from the MQTT platform at any time. To do this, simply execute the following AT command: `AT^MTXTUNNEL=SETIEC102,ID00000` where ID00000 is the identifier of the meter specified in the TITAN-based device's "External devices >IEC102 Meter" menu.

A few seconds after the previous AT command was executed (the time required for the TITAN-based device to interrogate the Electricity Meter) we can obtain the instantaneous values via MQTT by executing the command: `AT^MTXTUNNEL=GETIEC102,ID00000`.

The following image shows a screenshot with both commands executed and their respective responses.

The screenshot displays a MQTT client interface with the following sections:

- Connection:** Shows a green dot and the text "connected".
- Publish:** Includes a "Topic" field with "/AT", a "QoS" dropdown set to "0", an unchecked "Retain" checkbox, and a "Publish" button. The "Message" field contains the command: `AT^MTXTUNNEL=GETIEC102,ID00000`.
- Subscriptions:** Features an "Add New Topic Subscription" button and a list of two subscriptions:
 - Qos: 2, Topic: /LOGGER
 - Qos: 2, Topic: /ATR
- Messages:** A list of received messages with the following details:
 - Message 1: Received at 2022-07-13 11:45:40, Topic: /ATR, Qos: 0. The payload is `AT^MTXTUNNEL=GETIEC102,ID00000` followed by a large JSON object. The command part is highlighted with a red box.
 - Message 2: Received at 2022-07-13 11:45:26, Topic: /ATR, Qos: 0. The payload is `AT^MTXTUNNEL=SETIEC102,ID00000 OK`. The command part is highlighted with a red box.

Reading the Electricity Meter's Closing Values

We can also read the Electricity Meter's closing values without having to wait for the day to change by executing a special AT command on the TITAN-based device:

`AT^MTXTUNNEL=SETIEC102_CTAVM2,<IDMETER>,<horaIni>,<minutoIni>,<diaIni>,<mesIni>,<anoIni>,<horaFin>,<minutoFin>,<diaFin>,<mesFin>,<añoFin>`

An example of an AT command would be:

`AT^MTXTUNNEL=SETIEC102_CTAVM2,ID00000,0,0,1,07,22,0,0,13,07,22`

Similarly to the AT command for reading the instantaneous values, a few seconds after receiving the OK for this AT command, we can obtain the closing values from the Electricity Meter using the following AT command:

AT^MTXTUNNEL=GETIEC102_CTAVM2,ID00000

```
2022-07-13 11:55:38 Topic: /ATR Qos: 0
AT^MTXTUNNEL=GETIEC102_CTAVM2,ID00000
{"IMEI":"869101054287764","TYPE":"IEC102_CTAVM2","TS":"2022-07-13T09:55:35Z","P":"ID-869101054287764","ID":"ID00000","CTAVM2":[{"DO":20,"EaA":0,"EiA":0,"CA":2,"EaRi":0,"EiRi":0,"CRi":2,"EaRc":0,"EiRc":0,"CRc":2,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":0,"EPA":0,"CE":128,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-11T13:49-1"},{"DO":21,"EaA":0,"EiA":0,"CA":0,"EaRi":0,"EiRi":0,"CRi":0,"EaRc":0,"EiRc":0,"CRc":0,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":0,"EPA":0,"CE":0,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-11T13:49-1"},{"DO":22,"EaA":0,"EiA":0,"CA":0,"EaRi":0,"EiRi":0,"CRi":0,"EaRc":0,"EiRc":0,"CRc":0,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":0,"EPA":0,"CE":0,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-11T13:49-1"},{"DO":23,"EaA":0,"EiA":0,"CA":0,"EaRi":0,"EiRi":0,"CRi":0,"EaRc":0,"EiRc":0,"CRc":0,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":0,"EPA":0,"CE":0,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-11T13:49-1"},{"DO":24,"EaA":0,"EiA":0,"CA":2,"EaRi":0,"EiRi":0,"CRi":2,"EaRc":0,"EiRc":0,"CRc":2,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":2,"EPA":0,"CE":0,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-11T13:49-1"},{"DO":25,"EaA":0,"EiA":0,"CA":0,"EaRi":0,"EiRi":0,"CRi":0,"EaRc":0,"EiRc":0,"CRc":0,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":0,"EPA":0,"CE":0,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-11T13:49-1"},{"DO":26,"EaA":0,"EiA":0,"CA":0,"EaRi":0,"EiRi":0,"CRi":0,"EaRc":0,"EiRc":0,"CRc":0,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":0,"EPA":0,"CE":0,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-11T13:49-1"}]} OK

2022-07-13 11:55:24 Topic: /ATR Qos: 0
AT^MTXTUNNEL=SETIEC102_CTAVM2,ID00000,0,0,1,07,22,0,0,13,07,22
OK
```

The JSON object containing the integrated totals returned by the TITAN-based device has the following structure:

```
{"IMEI":"869101054287764","TYPE":"IEC102_CTAVM2","TS":"2022-07-13T09:55:35Z","P":"ID-869101054287764","ID":"ID00000","CTAVM2":[{"DO":20,"EaA":0,"EiA":0,"CA":2,"EaRi":0,"EiRi":0,"CRi":2,"EaRc":0,"EiRc":0,"CRc":2,"R7":0,"C7":128,"R8":0,"C8":128,"MPA":0,"FMPA":"2022-07-11T13:49-1","CMA":0,"EPA":0,"CE":128,"DINI":"2022-06-22T15:14-1","DEND":"2022-07-
```

11T13:49-1"}, ...

Where:

IMEI: ID number of the TITAN-based device.

TYPE: type of JSON. In this case the type is IEC102_CTAVM2.

TS: timestamp of the time the data was collected.

P: Logger ID field.

ID: ID field of the IEC102 configuration in the TITAN-based device.

CTAVM2: array containing the read data

The data array (CTAVM2 field) is made up of the following JSON objects:

DO: object address

EaA: absolute active energy

EiA: incremental active energy

AC: active energy qualifier

EaRi: inductive absolute reactive energy

EiRi: inductive incremental reactive energy

CRi: inductive reactive energy qualifier

EaRc: capacitive absolute reactive energy

EiRc: capacitive incremental reactive energy

CRc: capacitive reactive energy qualifier

R7: register 7 reserve

C7: register 7 reserve qualifier

R8: register 8 reserve

C8: register 8 reserve qualifier

MPA: maximum power

FMPA: date of the maximum

CMA: maximum qualifier

EPA: excesses of the powers

CE: excess qualifier

DINI: start of the period

DEND: end of the period