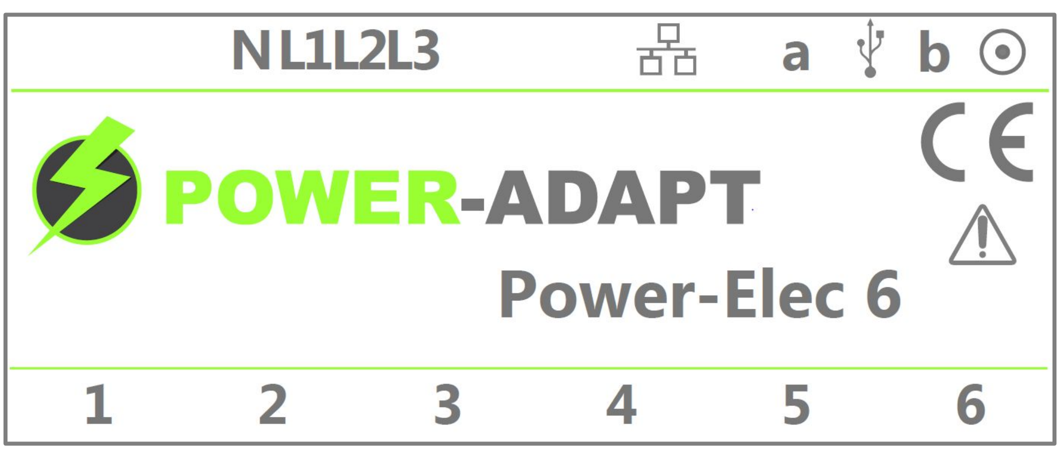
Power-Elec 6

Multiple circuits, connected, energy meter



Integration Manual

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Summary

1. Danger and warning

- This notice is not an installation manual. Please refer to the installation manual for the product implementation instructions.
- For the safety of personnel and equipment, it is imperative to read the entire user manual before installing and commissioning the equipment.
- Failure to comply with the instructions in the user manual does not engage the responsibility of the manufacturer. Local standards, guidelines, provisions and regulations must be respected.

2. General presentation

The Power-Elec 6 is a communicating electrical sub-metering solution that can measure up to 6 three-phase or 18 single-phase outputs (or a combination of both) in the same control cabinet, making it an ideal tool for sub-metering. It performs the functions of electric energy meter (active, reactive energy, power factor) and integrates communication interfaces to a supervision solution.

It generates its own Wi-Fi network to allow quick and easy configuration from a computer or a smartphone.

Depending on the configuration, the metering data is transmitted in Modbus TCP via the Ethernet interface or wirelessly according to the LoraWAN specification.

The main advantages of the solution are real-estate optimization in the cabinets, reduced installation time and cost reduction.

3. Modbus TCP integration

3.1 Power-Elec 6 Modbus configuration

The Power-Elec 6 meter supports the Modbus TCP protocol. It includes a Modbus TCP server that transmits measurement data via its Ethernet interface. It can thus present the measurement data of all configured outlets.

For configuration of the Power-Elec 6 Ethernet interface and activation of the modbus service, please refer to the user manual.

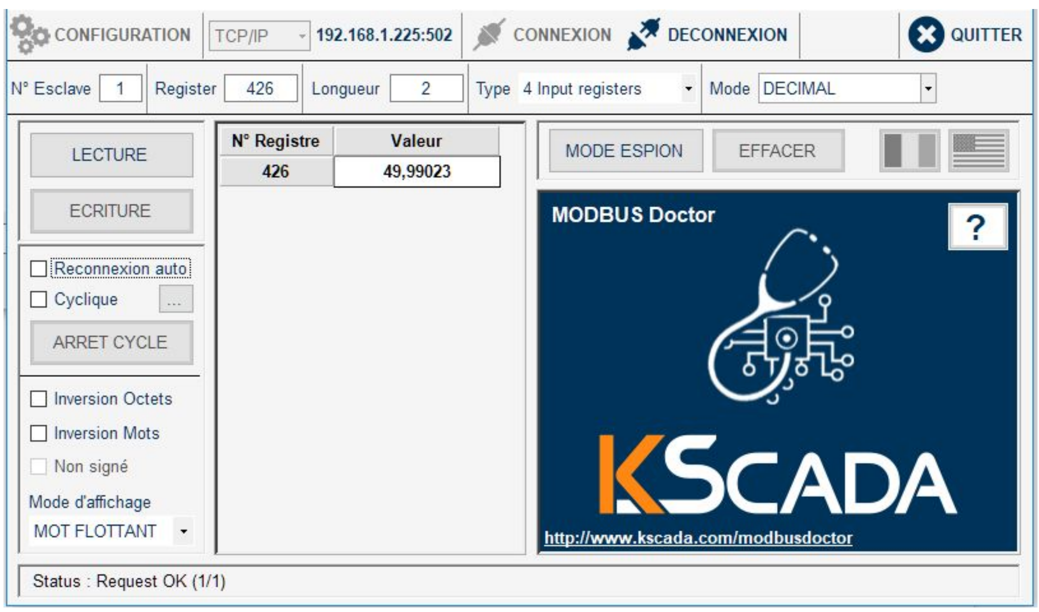
3.2 Modbus client configuration

The configuration to apply to a Modbus client to query a Power-Elec 6 meter is as follows:

- the TCP port number to use is **502**, the standard Modbus TCP port number
- the slave ID is ignored by the Modbus server, you can use 1 as default value
- the data type to use is « **Input register** »
- the Modbus registers have a length of **16 bits** (16 bits words), in big endian format, compliant with the Modbus standard
- number of words and data encoding depends on the type of information
    - electrical information is in **float32** on 2 registers, **least significant register 1st**
    - format of other information is detailed in the following sections

3.3 Modbus client configuration example

Example for reading the frequency on channel 1 connector 2 with Modbus Doctor software:



3.4 Modbus registers

A. General Information

The Power-Elec 6 provides 2 types of information via Modbus.

- general information of the meter
- information specific to a circuit

The following table presents general information made available and the encoding of the associated registers.

	Encoding	No of words (16 bits)	Range of registers		Remarks
			start	end	
Software version	2 x uint8	1	0	0	most significant byte = major version number least significant byte = minor version number ex for version 1.6: 0x0106
Modbus table version	uint16	1	1	1	value = 0x0002
MAC address	6 x uint8	3	2	4	most significant word first

The table presented in this manual is **version 2**.

For general information the format of this table is identical to **version 1** of the Modbus table.

This version is not backward compatible with **version 1** for circuit specific information.

B. Information per circuit

The following table presents the different measurements provided for each PE6 circuit.

	Unit	Encoding	words/ channel	Range of registers		Remarks
				start	end	
Circuit configuration		enum	1	8	25	0x0000: disabled 0x0001: single phase 0x0002: three-phase with neutral 0x0003: balanced three-phase with neutral 0x0004: three-phase without neutral 0x0005: balanced three-phase no neutral 0x0006: three-phase with voltage transformer
Active energy import index	kWh	float32	2	28	63	least significant word first
Reactive energy import index	kVArh	float32	2	64	99	
Active energy export index	kWh	float32	2	100	135	
Reactive energy export index	kVArh	float32	2	136	171	
Active power	W	float32	2	172	207	
Reactive power	Var	float32	2	208	243	
Power factor	-	float32	2	244	279	
RMS current	A	float32	2	280	315	
RMS current 1 min average	A	float32	2	316	351	
RMS voltage	V	float32	2	352	387	
RMS voltage 1 min average	V	float32	2	388	423	
Frequency	Hz	float32	2	424	459	

Within the same range of registers, registers for each channel are always ordered in the same way, starting from registers for connector 1 channel 1 up to registers for connector 6 channel 3.

The formula for obtaining the register number for connector n channel m is:

$$start + ((n-1)*3 + m - 1) * wpc$$

with

- *start = start of the range*
- *wpc = number of words per channel*
- *n = connector number (between 1 et 6)*
- *m = channel number (between 1 et 3)*

An example of resulting table is given in appendix 5.1.

The exact mapping, taking in account the meter configuration, is also displayed in the PE6 configuration web page in the modbus tab.

Depending on the setup mode of a circuit, meaning of data provided for each channel may vary. The following table summarizes the possible cases.

<table>
<tr><td></td><td colspan="3">single phase or balanced three-phase</td><td colspan="3">three-phase</td></tr>
<tr><td>Channel</td><td>1</td><td>2</td><td>3</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>Active energy import index</td><td rowspan="12">circuit 1</td><td rowspan="12">circuit 2</td><td rowspan="12">circuit 3</td><td>circuit</td><td colspan="2" rowspan="7">NA</td></tr>
<tr><td>Reactive energy import index</td><td>circuit</td></tr>
<tr><td>Active energy export index</td><td>circuit</td></tr>
<tr><td>Reactive energy export index</td><td>circuit</td></tr>
<tr><td>Active power</td><td>circuit</td></tr>
<tr><td>Reactive power</td><td>circuit</td></tr>
<tr><td>Power factor</td><td>circuit</td></tr>
<tr><td>RMS current</td><td rowspan="4">phase 1</td><td rowspan="4">phase 2</td><td rowspan="4">phase 3</td></tr>
<tr><td>RMS current 1 min average</td></tr>
<tr><td>RMS voltage</td></tr>
<tr><td>RMS voltage 1 min average</td></tr>
<tr><td>Frequency</td><td colspan="3">phase 1</td></tr>
</table>

4. LoRaWAN integration

4.1 Provisioning Power-Elec 6 on a LoRaWAN infrastructure

The Power-ELec 6 is compliant to LoraWan v1.0.1 for Class A devices in the 868MHz ISM frequency band.

The Power-Elec 6 only supports the OTAA provisioning mode. The parameters used to provision a PE6 on a LoraWan Network Server are:

- DevEUI
  - the DevEUI is identical to the serial number
  - it can be found on the product label and in the configuration web page
- AppEUI
  - factory-set value to **4543415f5045366e**
- AppKey
  - AppKey for each PE6 is communicated to you by Eco-Adapt or your distributor on delivery of the products

The Power-Elec 6 complies with the recommended default values for the EU868 band:

- Delay between TX and RX : 1 sec
- RX2 receive frequency : 869.525 MHz
- RX2 data rate : SF12 125kHz (DR0)

The profile on the LoraWan network server must be chosen accordingly.

4.2 Enabling Lora communication on the PE6

Once LoraWan provisioning has been done on the network server, the Power-ELec 6 meter must be manually joined to the network.

Connect to the web configuration page of the PE6, navigate to Radio service setup in the "**Radio**" tab, then activate the service by clicking on the On/Off button and save the configuration.

A message will appear to indicate the result of the network join attempt. The network pairing time can vary from several seconds to a few minutes depending on the radio coverage of the network. If the join process fails, this operation must be repeated manually after checking antenna installation and provisioning on the network server.

For more details, please refer to the user manual.

4.3 LoRa frame format

The general payload format for LoRaWan frames is shown in the following table:

byte offset	Description	Encoding
0	**Frame type**	uint8
1	**Channel identifier #1**	ID_BYTE
2 3 4 5	**Active Energy Index (kWh)**	Float 32 bits LSB
6	**...**	
5(n-1)+1	**Channel identifier #n (max 9)**	ID_BYTE
5(n-1)+2 5(n-1)+3 5(n-1)+4 5(n-1)+5	**Active Energy Index (kWh)**	Float 32 bits LSB

Byte at offset #0 is the frame header, it can currently take 2 possible values:

- 0x01 : frame containing import active energy indexes
- 0x02: frame containing positive reactive energy indexes

From byte #1 we find a sequence of blocks of 5 bytes, one block for each activated circuit. Each block consists of:

- 1 byte: circuit identifier (ID_BYTE)
- 4 bytes: index value in Float32 least significant byte first

The circuit identifier byte is a bit field with format:

ID_BYTE							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
CONNECTOR (3 bits)			CHANNEL (2 bits)		MODE(3 bits)		

- bits #5-7: connector number (1 to 6)
- bits #3-4: channel number (0 to 3)
- bits #0-2: configuration mode for this connector (see following table)

Encoding for the connector mode:

MODE			
	bit 2	bit 1	bit 0
Reserved	0	0	0
Single phase	0	0	1
Three-phase with neutral	0	1	0
Three-phase balanced with neutral	0	1	1
Three-phase without neutral	1	0	0
Three-phase balanced without neutral	1	0	1
Three-phase with voltage transformer	1	1	0
Reserved	1	1	1

For connectors configured in three-phase, indexes are transmitted with channel number 0 in the circuit identifier byte of the LoRaWAN frame.

For connectors configured in single-phase or balanced three-phase, indexes are transmitted with the corresponding channel number (1 to 3).

A sample code of javascript parser is provided in appendix as well as examples of raw and decoded frames.

5. Annex

5.1 Modbus registers

Example of a lookup table between register number and channel for the active energy import index.

	Connector	Channel	Register no	Remarks
Active energy import index	1	1	28	List of registers concerning the active energy import indexes. Two registers per circuit for a 32-bit float value
			29	
		2	30	
			31	
		3	32	
			33	
	2	1	34	
			35	
		2	36	
			37	
		3	38	
			39	
	3	1	40	
			41	
		2	42	
			43	
		3	44	
			45	
	4	1	46	
			47	
		2	48	
			49	
		3	50	
			51	
	5	1	52	
			53	
		2	54	
			55	
		3	56	
			57	
	6	1	58	
			59	
		2	60	
			61	
		3	62	
			63	

5.2 Javascript parser for LoRa PE6 frames

```
const CHANNEL_MODES = {
   1: 'Mono-phase',
   2: 'Three-phase with neutral',
   3: 'Balanced three-phase with neutral',
   4: 'Three-phase without neutral',
   5: 'Balanced three-phase without neutral',
}

function parse_pe6(payload) {

 const buffer = new ArrayBuffer(payload.length/2)
 const data_view = new DataView(buffer)

 var parsed_payload = { 'header': {}, 'channel_data': [] }

 for (let i=0; i < payload.length/2; i++) {
     data_view.setUint8(i, parseInt(payload.substr(i*2,2), 16));
 }

 parsed_payload.header.raw = data_view.getInt8(0)

 if (parsed_payload.header.raw == 1) {
     parsed_payload.header.desc = 'Active energy index'
     parsed_payload.header.unit = 'kWh';
 } else if (parsed_payload.header.raw == 2) {
     parsed_payload.header.desc = 'Reactive energy index'
     parsed_payload.header.unit = 'kvarh';
 }

 let channel_id = 0
 for (let i=0; i < (buffer.byteLength-1)/5; i++) {
     channel_id = data_view.getUint8(1+i*5)
     parsed_payload.channel_data.push({
         'channel_id': channel_id,
         'channel_mode': CHANNEL_MODES[channel_id & 0x07],
         'channel': (channel_id >> 3) & 0x03,
         'connector': channel_id >> 5,
         'value': data_view.getFloat32(2+i*5, true)
     })
 }

 return parsed_payload
}

function format_parsed_pe6(parsed_payload) {
 let lines = []
 parsed_payload.channel_data.forEach(function(channel_data) {
     lines.push(['connector/channel : ',
                 channel_data.connector, '/',
                 channel_data.channel, ' (',
                 channel_data.channel_mode, ') ',
                 parsed_payload.header.desc, ' = ',
                 channel_data.value.toFixed(3), ' ',
                 parsed_payload.header.unit].join(''))
 })
 return lines
}
```

Using the parser and decoded frame samples

```
var parsed_payload =
parse_pe6('012250ede84342d8b6ce42621a66a44382c3ec6643a25439ac42c26152c842');
console.log(parsed_payload);
console.log(format_parsed_pe6(parsed_payload).join('\n'));
```

```
connector/channel : 1/0 (Three-phase with neutral) Active energy index = 465.854 kWh
connector/channel : 2/0 (Three-phase with neutral) Active energy index = 103.357 kWh
connector/channel : 3/0 (Three-phase with neutral) Active energy index = 328.798 kWh
connector/channel : 4/0 (Three-phase with neutral) Active energy index = 230.925 kWh
connector/channel : 5/0 (Three-phase with neutral) Active energy index = 86.112 kWh
connector/channel : 6/0 (Three-phase with neutral) Active energy index = 100.161 kWh
```

```
parsed_payload = parse_pe6('01246a75b345448a707943');
console.log(parsed_payload);
console.log(format_parsed_pe6(parsed_payload).join('\n'));
```

```
connector/channel : 1/0 (Three-phase without neutral) Active energy index = 5742.677 kWh
connector/channel : 2/0 (Three-phase without neutral) Active energy index = 249.440 kWh
```

```
parsed_payload = parse_pe6('0229f0a7c63d3139d6c53d39a60ac63d');
console.log(parsed_payload);
console.log(format_parsed_pe6(parsed_payload).join('\n'));
```

```
connector/channel : 1/1 (Mono-phase) Reactive energy index = 0.097 kVArh
connector/channel : 1/2 (Mono-phase) Reactive energy index = 0.097 kVArh
connector/channel : 1/3 (Mono-phase) Reactive energy index = 0.097 kVArh
```

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