

641M 4G-LTE SparkplugB Gateway Configuration Guide

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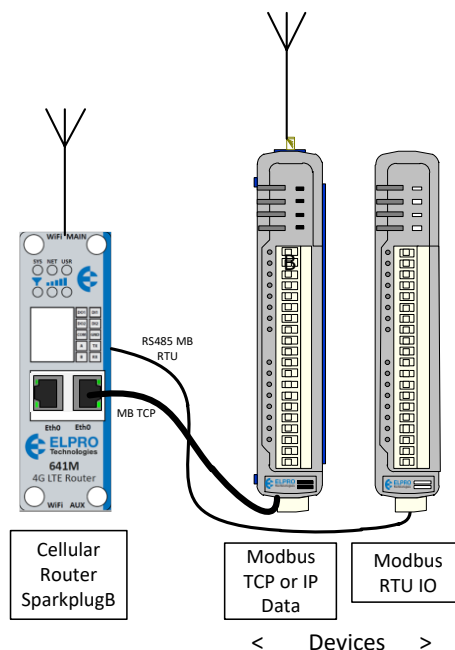
Network Overview

The network example below is typical of an application where SparkplugB can be used in communication applications using IIOT or Industry 4.0 SCADA such as Ignition from Inductive Automation.

SparkplugB is a protocol extension of MQTT which is very commonly used in automation and industrial applications. A typical site consists of a Node (Router or Wireless unit), connected via Ethernet/Serial to a Device (Modbus TCP, Modbus RTU device or controller) to provide connectivity to the plant or equipment. Each of these devices are polled by the Node to collect the process data and send commands.

The SparkplugB remote unit will logically consist of two parts:

1. Edge of Network (EoN)
2. Device



In this example above, the 4G cellular router will provide the connection to the WAN for MQTT client to connect though to the broker/server. The data is collected using Modbus TCP and Modbus RTU with built in Modbus Master gateway.

Configuration of SparkplugB Gateway

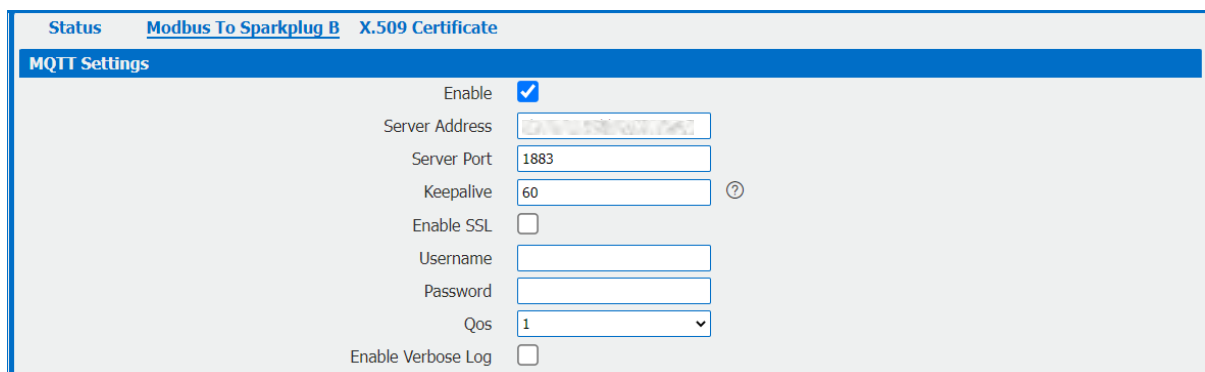
The gateway provides an interface between the 641M local inputs and/or Modbus RTU/TCP master-slave external devices using SparkplugB (SpB) protocol commonly used in industrial IoT applications.

The Modbus-Sparkplug gateway software application needs to be loaded into the 641M. To do this you will need obtain the software application from ELPRO support and then use the Software option in menu to upload this application and restart the 641M to add this software application.

The Modbus-Gateway will then be accessible in the Applications menu on the configuration web page.

Broker/Server Settings

To configure the sparkplug gateway select the Modbus Sparkplug Application, then click on the Modbus to Sparkplug B tab to complete the initial configuration. See below:



Enable: Select the enable box to enable the Sparkplug gateway.

Server Address: IP address or domain name for the MQTT-Sparkplug server/broker.

Server Port: Port number for the MQTT-Sparkplug Server or broker, usually 1883 for TCP or 8883 for SSL connection.

Keepalive: TCP keep alive ping time to server in seconds

Enable SSL: Select when using SSL (TLS) connection to server. Certificates need to be uploaded in the x.509 tab. This requires CA Certificate, Client (Local) Certificate and Client (Local) Key.

Username: Username for server login. Can be blank if not used.

Password: Password for server login. Can be blank if username login not used.

QoS: MQTT Quality of Service setting. For SparkplugB recommend using 1.

Enable Verbose Log: Provides extended details for system log on connection state or errors.

SparkplugB Topic

Sparkplug allows for an overall system name which is called a Group ID. Within a group there will be a number of Nodes (or Edge of Network) and each node requires a Node ID.

Nodes will have one or more devices connected which can be local inputs, local outputs, external PLC, controller or smart sensors connected through Modbus gateway.

Configuration of the Sparkplug B settings is described below:

The screenshot shows two panels. The top panel, 'Sparkplug B Settings', contains four input fields: 'Group ID' with the value 'ELPRO-WaterCo', 'Node ID' with '641-Router', 'Node Update' with '60', and a 'Trigger' dropdown menu set to 'Data Change'. The bottom panel, 'Devices Settings', is a table with the following data:

Index	Device Type	Device ID	Connection Index	Slave ID
1	Local-IO	LocalDI	1	1

Group ID: System wide name for the functional group of Nodes

Node ID: Name for this 641M node within the group.

Node Update: Each node has a number of automatically published information and diagnostic data that is available. These values will be automatically published as an update after each number of seconds configured (1-86400 seconds).

Trigger: This configures how the device data is sent. It can be configured for Data Change; will cause a publish when there is any change in data value or Cyclic; which will use the Node update time configured for the node above to publish data periodically.

Each internal or external device published input or output subscription is configured in the Device Settings. To make a new device configuration click on the + symbol.

Example of configuration of local inputs and outputs is seen below.

Device Settings

In Sparkplug, devices are connected to the Node which provides the network connectivity to the unit. A device can be the 641M local inputs or outputs, or connected external controller, HMI, PLC, or other Modbus unit.

The device configuration is configured and this configuration adds to the device to the topic tree with the devices data payload.

The screenshot shows two panels. The top panel, 'Device Settings', contains three input fields: 'Index' with the value '1', 'Device Type' with a dropdown menu set to 'Local-IO', and 'Device ID' with 'LocalDI'. The bottom panel, 'Metrics Settings', is a table with the following data:

Index	Name	Register Address	Data Type	Mode
1	DI1 Counter	0	BOOLEAN	Read-Only
2	DI2	0	BOOLEAN	Read-Only
3	DO1	0	BOOLEAN	Read-Write
4	DO2	0	BOOLEAN	Read-Write

At the bottom of the Metrics Settings panel are 'Save' and 'Close' buttons.

Index: Reference for this Device configuration.

Device Type: Local-IO or Modbus Slave. The Modbus Slave option will allow MQTT data to be linked to either Modbus Master Poll (of the slave), configuration in the Modbus gateway.

Device ID: Sparkplug Device name used in publish topic


Metrics Settings: Configure each input or output separately as required for application (see below).


Device type Local-IO

To enable the local inputs and outputs to be used for Sparkplug applications you first need to navigate to the Industrial Interface/Digital IO menu and select the Digital IO tab.

Digital Input Settings		
Index	Enable	Alarm ON Mode
1	true	Low
2	true	Low

Digital Output Settings				
Index	Enable	Alarm Source	Alarm ON Action	Alarm OFF Action
1	true	Modbus Sparkplug	High	Low
2	true	Modbus Sparkplug	High	Low

For inputs click the icon  and enable the digital input to allow its use.

For outputs click the icon , select enable and configure the Alarm Source to use Modbus Sparkplug as indicated in example below.

Digital Output

Digital Output Settings

Index: 1

Enable:

Alarm Source: Modbus Sparkplug

Alarm ON Action: Digital Input 1

Alarm OFF Action: Digital Input 2

SMS

Modbus Alarm

Modbus Sparkplug

Save Close

Local Input/Output Metrics

Metrics Settings

Metrics Settings

Index: 1

Name: DI1 Counter

Data Type: BOOLEAN

Mode: Read-Only

Save Close

Index: Reference for this metric. Automatically populated by the 641M and cannot be user configured.

Name: Value used for payload name of Sparkplug message. Local inputs must use fixed name to allow direct access to input values. These are:

- Digital Input 1: DI1
- Digital Input 2: DI2
- Digital Input 1 Counter value: DI1 Counter
- Digital Input 2 Counter value: DI2 Counter
- Digital Output 1: DO1
- Digital Output 2: DO2

Data Type: Payload value data type format. Choose from pick list typical data types are BOOLEAN for digital input and output on/off and for digital input counter values Uint16 or Uint32.

Mode: To publish an input value select Read-Only and for output value select Read-Write here to include auto publish on output change of value event.

Local IO available for 2 digital/pulse count and 2 digital outputs. Digital inputs provide a counter value together with normal on/off. Digital outputs support automatic publish when using Sparkplug allow control systems to receive output state change.

Device Type Modbus-Slave

Sparkplug gateway can interface with external Modbus RTU or TCP devices using the Modbus Master gateway and integrate their register values into MQTT Sparkplug metrics (payload data). Firstly configure the Modbus master application to setup the polling of the register values and second in the Sparkplug gateway application to either publish (inputs) or subscribe (outputs). The Modbus poll is linked to the Sparkplug configuration using the Connection Index.

For example, see below configuration for a local ELPRO 115S-12 Modbus IO module. This is reading digital inputs 1 through to 4 in first line and digital outputs 5-8 in second line from slave address 2.

Channel Status								
Index	Description	Connection Index	Type	Slave ID	Register Address	Function Code	Status	Value
1	DI1-4	1	RS485	2	0	2	Read successfully	0, 0, 0, 0
2	DO5-8	1	RS485	2	5	1	Read successfully	0, 0, 0, 0

Note that the Index number in modbus master status tab is used as the Connection Index when configuring Modbus devices for Sparkplug application.

The Sparkplug application configuration for the Modbus input and output data example can be seen below in summary for index 2.

Devices Settings				
Index	Device Type	Device ID	Connection Index	Slave ID
1	Local-IO	LocalDI	1	1
2	Modbus-Slave	MB-Slave	1	2

Device settings need to be configured to connect the Modbus master with Sparkplug device and also registers for the individual Sparkplug metrics to send in the payload. Clicking on the + will add a device and open the configuration and allow for metrics to be added to device payload.

Devices Settings

Index

Device Type

Device ID

Connection Index ?

Slave ID ?

Metrics Settings

Index	Name	Register Address	Data Type	Mode	+
1	DI-1	0	BOOLEAN	Read-Only	✍️ ⊗
2	DI-2	1	BOOLEAN	Read-Only	✍️ ⊗
3	DI-3	2	BOOLEAN	Read-Only	✍️ ⊗
4	DI-4	3	BOOLEAN	Read-Only	✍️ ⊗
5	Pump1-Start	4	BOOLEAN	Read-Write	✍️ ⊗
6	Pump2-Start	5	BOOLEAN	Read-Write	✍️ ⊗

Save
Close

Index: Auto-populated field by 641M.

Device Type: Modbus-Slave for this configuration of Modbus data from the Modbus Master gateway.

Device ID: Device ID of source of data to use in the Topic. In example above would result in topic of: spBv1.0/ELPRO-WaterCo/DBIRTH/641-Router/**MB-Slave**

Connection Index: This is the connection index number of the Modbus Master poll. You can find this in the Status tab of the Modbus Master application.

Slave ID: Slave address from Modbus poll setup in Modbus Master application.

Next step is to setup the Sparkplug metrics payload for each register mapping. To add a new metric click on + at right hand corner of configuration screen.

Metrics Settings

Index

Name ?

Register Address

Data Type

Mode ?

Save
Close

Index: Auto-populated field by 641M.

Name: Metric name to be used in payload.

Register Address: Register address of the value that is connected with this Metric.

Data Type: Select the data type of this metric.

Mode: Configure as Read-Only for inputs and Read-Write for outputs.

The configuration of outputs is very similar to inputs. Configuration mapping will create a subscription to the broker for the output payload value. There is an automatic publish of the value setup to reflect the change in state. See example below.

Metrics Settings

Index	<input type="text" value="5"/>	
Name	<input type="text" value="Pump1-Start"/>	?
Register Address	<input type="text" value="4"/>	
Data Type	<input type="text" value="BOOLEAN"/>	▼
Mode	<input type="text" value="Read-Write"/>	? ▼

Output register is configured to align with registers in a Master Poll and Name is metric name to be used. Mode set to Read-Write to allow writing of values.

TLS x.509 Certificate Store

The 641M can support TLS connections with the broker/server for MQTT and Sparkplug.

For Sparkplug gateway TLS connections, certificates need to be loaded into the certificate store first before a TLS connection can be made.

To do this navigate to the Modbus Sparkplug application and select the x.509 Certificate tab. CA Certificate, Client Certificate and Client Private Key files are required before it is possible to upload. These files can be created by the network administrator.

Status
Modbus To Sparkplug B
X.509 Certificate

X.509 Certificate Import

CA Certificate	<input type="text" value="Choose File ca.crt"/>	📁
Local Certificate File	<input type="text" value="Choose File client.crt"/>	📁
Local Private Key	<input type="text" value="Choose File client.key"/>	📁

X.509 Certificate Files

Index	File Name	File Size	Date Modified	
1	ca.crt	1387	Thu Dec 9 13:44:10 2021	⊗
2	client.crt	1257	Thu Dec 9 13:44:19 2021	⊗
3	client.key	1675	Thu Dec 9 13:44:30 2021	⊗

Once the certificates and key are available upload each file one at a time. For each file click Choose File, navigate to the folder that contains the files and then click the 📁 button to store in the 641M. If the file is suitable the unit will respond with Operation successful.

Diagnostics

The 641M Modbus-Sparkplug offers several diagnostics to support site commissioning and diagnostics.

Sparkplug Reported Diagnostics

The Node does report a number of diagnostics and system information elements through the sparkplug messages.

System Info/	Device Model
	Firmware Version
	Kernel Version
	Serial Number
Diagnostics/	System Uptime

Cellular CSQ
Cell Tx Bytes
Cell Rx Bytes
Eth0
Eth1
WiFi Status
OpenVPN Connection 1
OpenVPN Connection 2
OpenVPN Connection 3
OpenVPN Connection 4
OpenVPN Connection 5
IPSec Connection 1
IPSec Connection 2
IPSec Connection 3
IPSec Connection 4
IPSec Connection 5

The Node also supports two control commands supported by the 641M:

- Rebirth
- Reboot

Status Information

Sparkplug Status page indicates if Sparkplug gateway is enabled and the connection status.

Status	Modbus To Sparkplug B	X.509 Certificate
Modbus To Sparkplug B Status		
Enable	Enabled	
MQTT Connection Status	Connected	

The Modbus master status page will give details on polling and values received.

Status	Modbus Poll	Modbus Alarm	Modbus Write					
Channel Status								
Index	Description	Connection Index	Type	Slave ID	Register Address	Function Code	Status	Value
1	DI1-4	1	RS485	2	0	2	Read successfully	1, 0, 0, 0
2	DO5-8	1	RS485	2	5	1	Reading	0, 0, 0, 0
3	Pump2	2	RS485	3	0	1	Read successfully	0, 0

More detailed information is available through the system log file. The syslog can be found in the Overview menu. See example below:

Syslog	Events
Syslog Information	
Dec 9 14:48:27	elpro user.debug modem[976]: +CSQ: 31,99
Dec 9 14:48:27	elpro user.debug modem[976]: OK
Dec 9 14:48:36	elpro user.debug modbus_to_sparkplug[8452]: Client mosq/iPRgNTJ[3>a8EEQJr6 sending PUBLISH (d0, q1, r0, m1703, 'spBv1.0/ELPRO-WaterCo/NDATA/641-Router', ... (984 bytes))
Dec 9 14:48:37	elpro user.debug modbus_to_sparkplug[8452]: Client mosq/iPRgNTJ[3>a8EEQJr6 received PUBACK (Mid: 1703)
Dec 9 14:48:42	elpro user.debug modem[976]: AT+CSQ
Dec 9 14:48:42	elpro user.debug modem[976]: +CSQ: 31,99
Dec 9 14:48:42	elpro user.debug modem[976]: OK
Dec 9 14:48:58	elpro user.debug modem[976]: AT+CSQ

Reference

Reported Node Control, System Info and Diagnostics (JSON data)

spBv1.0/ELPRO-WaterCo/NBIRTH/641-Router

```
{
  "timestamp":1638428224845,"metrics":[
    {
      "name":"Node Control/Rebirth","timestamp":1638428224845,"dataType":"Boolean","value":false},
    {
      "name":"Node Control/Reboot","timestamp":1638428224845,"dataType":"Boolean","value":false},
    {
      "name":"System Info/Device Model","timestamp":1638428224888,"dataType":"String","value":"EL-641M-2"},
    {
      "name":"System Info/Firmware
      Version","timestamp":1638428224892,"dataType":"String","value":"1.1.7 (e3e9ae8)"},
    {
      "name":"System Info/Kernel
      Version","timestamp":1638428224896,"dataType":"String","value":"4.4.92"},
    {
      "name":"System Info/Serial
      Number","timestamp":1638428224950,"dataType":"String","value":"21095024330003"},
    {
      "name":"Diagnostics/System
      Uptime","timestamp":1638428224950,"dataType":"String","value":"00:00:52"},
    {
      "name":"Diagnostics/Cellular
      CSQ","timestamp":1638428224954,"dataType":"String","value":"High(31,-51dBm)"},
    {
      "name":"Diagnostics/Cell Tx Bytes","timestamp":1638428224958,"dataType":"String","value":"19.31
      MB"},
    {
      "name":"Diagnostics/Cell Rx Bytes","timestamp":1638428225002,"dataType":"String","value":"3.70
      MB"},
    {
      "name":"Diagnostics/Eth0","timestamp":1638428225875,"dataType":"String","value":"Up"},
    {
      "name":"Diagnostics/Eth1","timestamp":1638428225903,"dataType":"String","value":"Down"},
    {
      "name":"Diagnostics/WiFi Status","timestamp":1638428225906,"dataType":"String","value":""},
    {
      "name":"Diagnostics/OpenVPN Connection 1
      Status","timestamp":1638428226066,"dataType":"String","value":"Disconnected"},
    {
      "name":"Diagnostics/OpenVPN Connection 2
      Status","timestamp":1638428226069,"dataType":"String","value":"Disconnected"},
    {
      "name":"Diagnostics/OpenVPN Connection 3
      Status","timestamp":1638428226082,"dataType":"String","value":"Disconnected"},
    {
      "name":"Diagnostics/OpenVPN Connection 4
      Status","timestamp":1638428226085,"dataType":"String","value":"Disconnected"},
    {
      "name":"Diagnostics/OpenVPN Connection 5
      Status","timestamp":1638428226120,"dataType":"String","value":"Disconnected"},
  ]
}
```

```
{"name":"Diagnostics/IPSec Connection 1
Status","timestamp":1638428226216,"dataType":"String","value":"Disconnected"},
{"name":"Diagnostics/IPSec Connection 2
Status","timestamp":1638428226249,"dataType":"String","value":"Disconnected"},
{"name":"Diagnostics/IPSec Connection 3
Status","timestamp":1638428226252,"dataType":"String","value":"Disconnected"},
{"name":"Diagnostics/IPSec Connection 4
Status","timestamp":1638428226256,"dataType":"String","value":"Disconnected"},
{"name":"Diagnostics/IPSec Connection 5
Status","timestamp":1638428226289,"dataType":"String","value":"Disconnected"}], "seq":0, "uuid":"641-
Router"}
```

For more information, please contact your local ELPRO reseller or ELPRO sales, sales@elpro.com.au. Technical support can be obtained by contacting support@elpro.com.au or visit the ELPRO web site www.elpro.com.au

References:

- ELPRO 215U-2/415U/915U-2 User Manual: <https://elpro.com.au/resources/user-manuals/>
- MQTT Standard Specification: <https://mqtt.org/mqtt-specification/>
- Sparkplug B Specification: <https://projects.eclipse.org/projects/iot.tahu>
- MQTT and Sparkplug B videos and information on Automation and SCADA: <https://inductiveautomation.com/resources/video>