

# XMPS2000

## MQTT Configuration Task SRS

XMPS2000 MQTT SRS	<u>Author</u>	Sayali Gadre	<u>Date</u>	20 September 2023
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## Task 1: MQTT Client

### Requirement:

In the system configuration folder under the ethernet folder, additional 'MQTT' folder to be added along with the previous MODBUS TCP Server and Client folders. Under the 'MQTT' folder, additional two folders to be added for 'MQTT Publish' and 'MQTT Subscribe' as shown.

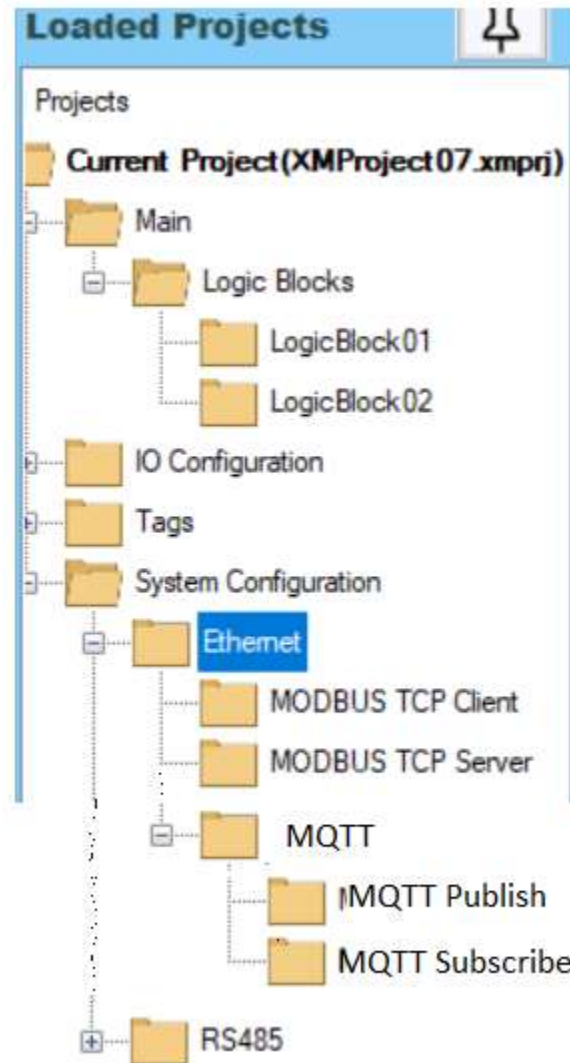


Fig. 1

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On clicking on the MQTT folder, a row should appear as follows:

Hostname	Port	Username	Password	CA3 certificate	Client certificate	Client key	Clean Session	Keep Alive

Fig. 2

The utility view is as shown:



Hostname	Port	Username	Password	CA3 certificate	Client certificate	Client key	Clean Session	Keep Alive

Fig. 3

It should contain the following fields:

1. Hostname
2. Port
3. Username
4. Password
5. CA3 certificate
6. Client certificate
7. Client key
8. Clean Session
9. Keep Alive

Initially, all 0 values are contained in it. On double clicking on this row, a pop-up should appear as given below:

Name	Value	Data Type
<input type="text" value="Hostname"/>	<input type="text"/>	String (100)
<input type="text" value="Port"/>	<input type="text"/>	(1883 or 8883)
<input type="text" value="Username"/>	<input type="text"/>	(optional) String (50)
<input type="text" value="Password"/>	<input type="text"/>	(optional) String (50)
<input type="text" value="CA3 certificate"/>	<input type="text"/> P	(select path)
<input type="text" value="Client certificate"/>	<input type="text"/> P	(select path)
<input type="text" value="Private Key"/>	<input type="text"/> P	(select path)
<input type="text" value="Clean Session"/>	<input type="text"/>	(optional) (Bool)
<input type="text" value="Keep Alive"/>	<input type="text"/>	(optional) RANGE: 0 to 3600

Fig. 4

The data types for the respective fields are as shown in the pop-up.

1. For the fields CA3 certificate, Client certificate, and private key, in the value section, an icon P should be available from which user can select a desktop path to upload the respective files. The extension of these files will be .pem and .key.
2. After clicking on OK, if all the fields are correctly filled, then, it should not give any error, but, if any of the field is missing, it should display an error as that particular information is not filled. The fields labelled as optional can remain empty and no error should appear for those- username, password, clean session and keep alive.
3. On clicking on 'OK', the data given should be filled in the appropriate fields.

## Task 2: MQTT Publish Pop-up and Table

On right clicking on the 'MQTT Publish' folder, option should be given for 'Add Publish Block' as shown:

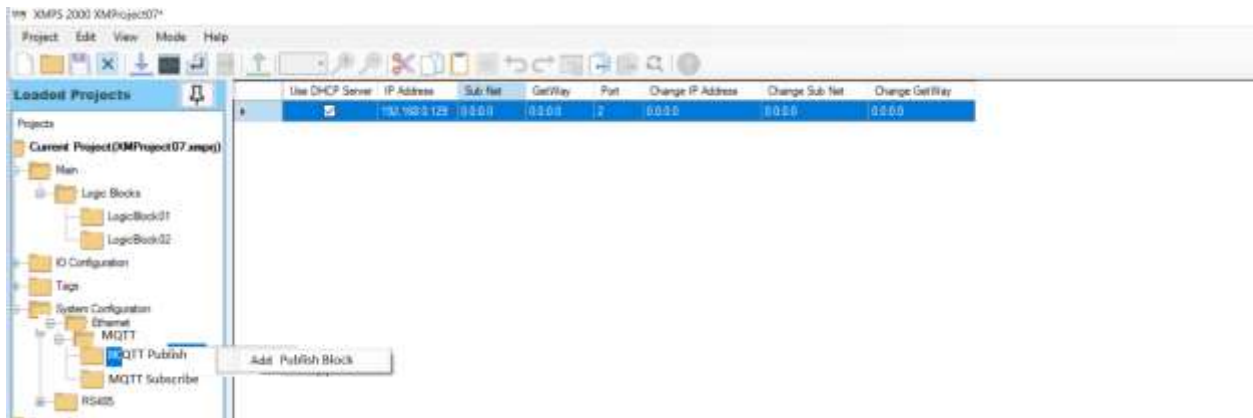


Fig. 5

On clicking on the 'Add Publish Block' option, a pop-up should appear as shown:

**Publish Parameters**

Topic		String (50)
Payload	Add PUB REQ	
Payload Size		
QoS		(0 or 1)
Retain Flag		(Bool)

OK

Fig. 6

1. Topic should be a string of maximum 50 characters
2. Payload should contain a button of Add PUB REQ and it should work as given below

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3. Payload size will display the value in int format for number of requests
4. The datatype for QoS is also int, and it should have a dropdown with the values 0, 1. No other value is permitted.
5. Retain flag will contain a user-entered Boolean value.

On clicking on the Add PUB REQ, another pop-up should be seen (for adding tags):

**ADD PUBLISH REQUEST**

Topic

Key\_name

String (50)

Variable

☒

Length

RANGE: 1 to 255

Fig. 7

- Topic should appear the same as given in Publish Parameters pop-up and should not be editable (It should be fixed).
- Key name will be entered in string format whose maximum length will be 50 characters.
- For variable block, a dropdown should appear which will display all the available variables, so that one of them can be selected (tag name). Also, one additional block to be given to the right so that new address can be entered. If a new address is entered, the following pop-up should appear for adding the tag.
- Even if this pop-up is kept empty, no error should appear as, Publish Requests can be added later as shown for the **table** below.

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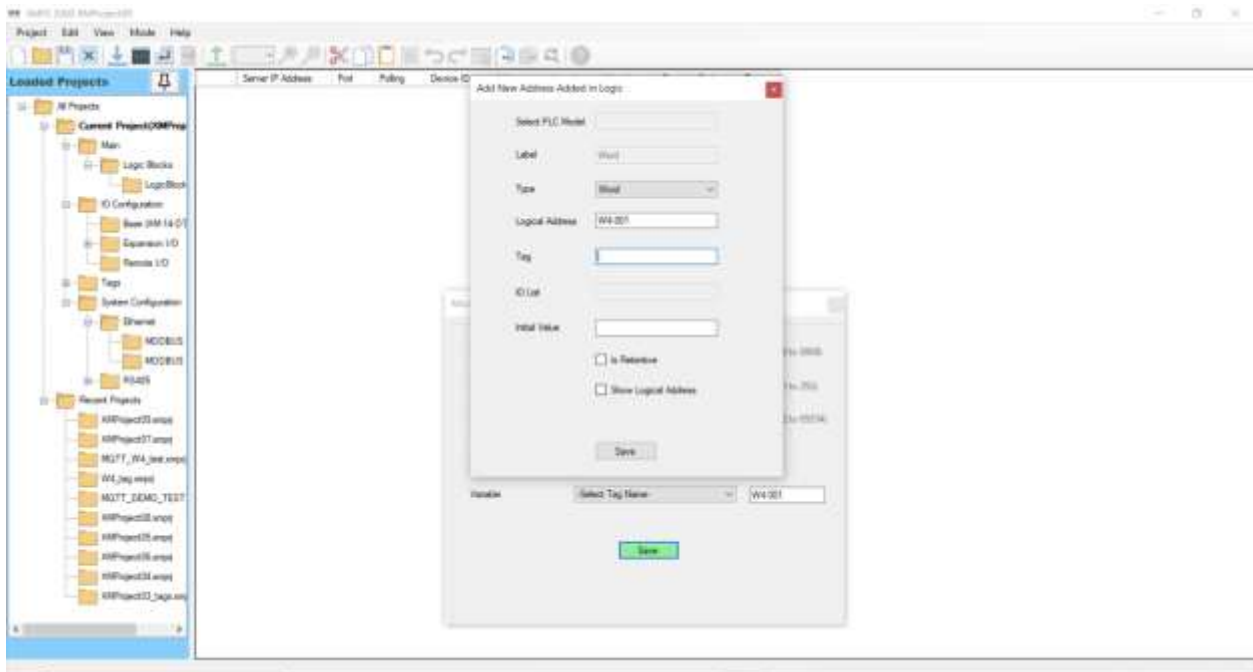


Fig. 8

Length will be an integer for entering the size.

On clicking save, a **table** should appear as shown containing all the information given in the pop-up:

PUB [1]	Topic	QoS	Retain Flag
	<input type="text"/>	<input type="text"/>	<input type="text"/>
ADD PUBLISH REQUEST			
	Key_name	Variable	Length

Fig. 9

For adding multiple 'publish requests' for a given topic, right click on PUB [1] and select 'ADD PUBLISH REQUEST', so that, for each request and additional row will be generated to display the tag information:



PUB [1]	Topic	QoS	Retain Flag
	<input type="text"/>	<input type="text"/>	<input type="text"/>
ADD PUBLISH REQUEST			
	Key_name	Variable	Length
	<input type="text"/>	<input type="text"/>	<input type="text"/>
	<input type="text"/>	<input type="text"/>	<input type="text"/>
	<input type="text"/>	<input type="text"/>	<input type="text"/>

Fig. 10

For editing the main 'Publish Parameters' pop-up, double click on the first row (containing topic, QoS, etc) so that the same pop-up appears again and is editable.

PUB [1]	Topic	QoS	Retain Flag
	<input type="text"/>	<input type="text"/>	<input type="text"/>
ADD PUBLISH REQUEST			
	Key_name	Variable	Length
	<input type="text"/>	<input type="text"/>	<input type="text"/>
	<input type="text"/>	<input type="text"/>	<input type="text"/>

**Publish Parameters**

Topic	<input type="text"/>	String (50)
Payload	<input type="text"/>	
Payload Size	<input type="text"/>	
QoS	<input type="text"/>	{0 or 1}
Retain Flag	<input type="text"/>	{Bool}
OK		

Fig. 11

Similarly, for editing a row (of key-value) double click on the row so that the 'ADD PUBLISH REQUEST' pop-up appears again. Doing this should not create a new row, but, edit the selected row itself.

For multiple publish blocks, repeat the same procedure from 'Add Publish Block'. The next table will have the name- PUB [2]. Finally, the utility should look like:

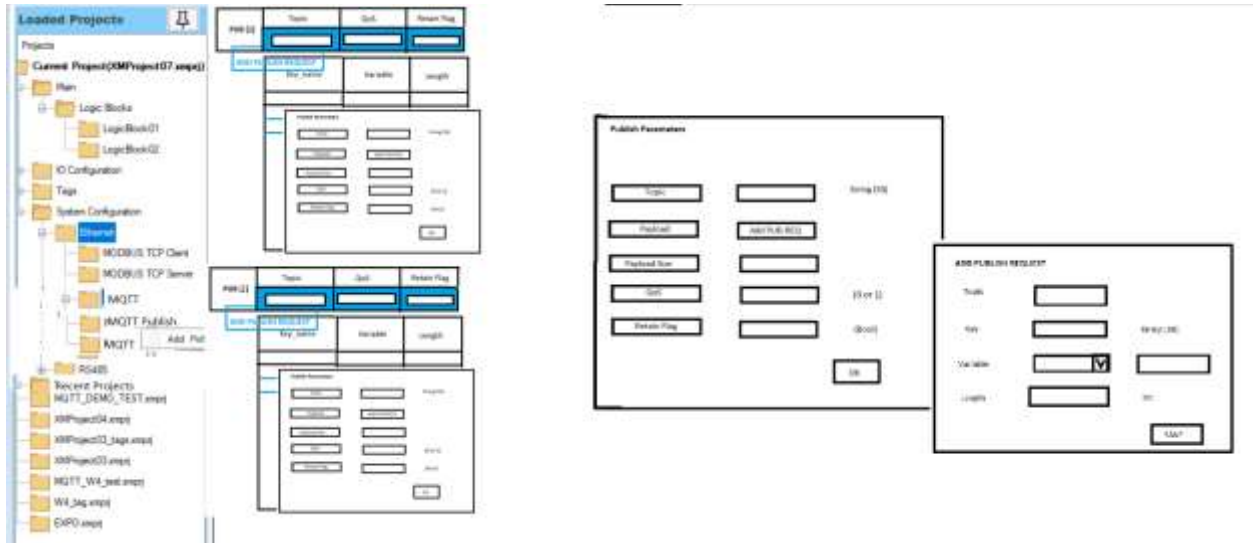


Fig. 12

The tables for PUB [1], PUB [2], and so on should be visible when clicked on 'MQTT Publish' folder. Also, each row should be editable and on right-clicking on each row, should have the following options for Delete Record, Copy, Cut, and Paste.

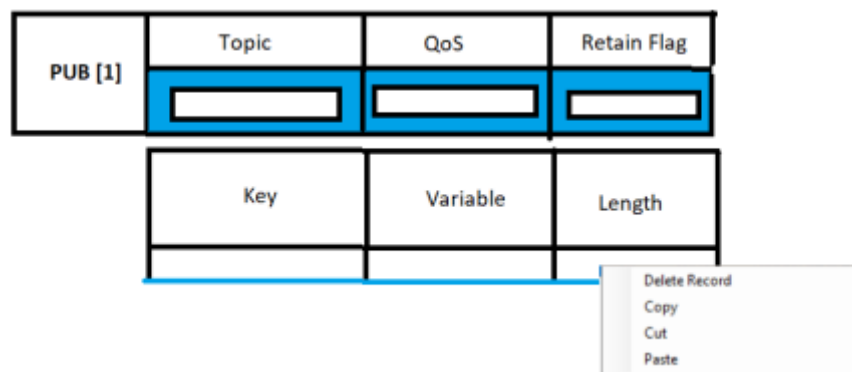


Fig. 13

The same options should also appear after right-clicking on the first row containing topic, QoS, etc. If the rows are copy-pasted, then, the pop-up should contain the previous values.

### Task 3: MQTT Subscribe Pop-up and Table

On right clicking on the 'MQTT Subscribe' folder, option should be given for 'Add Subscribe Block' as shown:

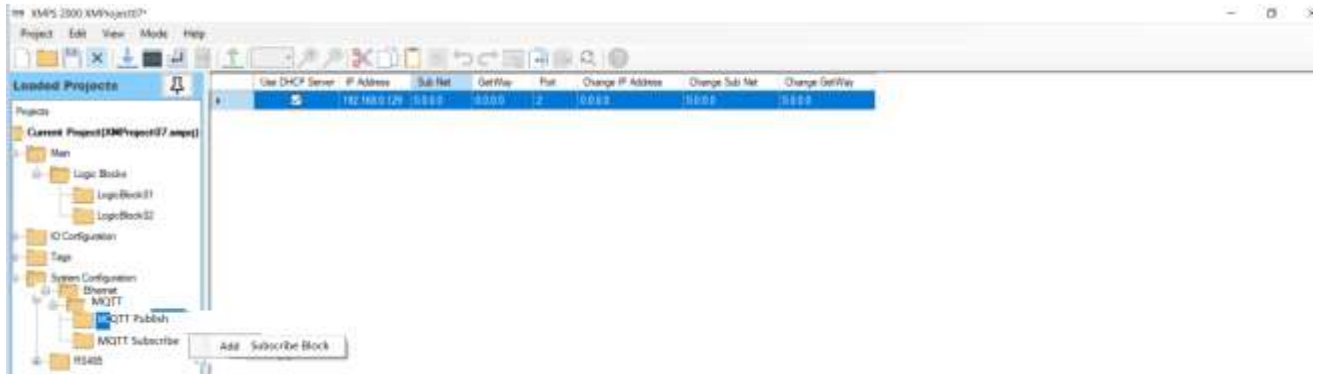


Fig. 14

On clicking on the 'Add Subscribe Block' option, a pop-up should appear as shown:

**Subscribe Parameters**

Topic		String (50)
QoS		(0 or 1)
MAXPayloadSize		INT
Received Messages	<div style="border: 1px solid black; padding: 5px; display: inline-block;">RECEIVED Messages</div>	
<div style="border: 1px solid black; padding: 5px 10px;">OK</div>		

Fig. 15

1. Topic should be a string of maximum 50 characters
2. The datatype for QoS is also int, and it should have a dropdown with the values 0, 1. No other value is permitted.
3. MAXPayloadSize contains the maximum payload size set for subscribed messages payload in integer.
4. Received messages will contain 'RECEIVED Messages' button. On clicking it, another pop-up should appear as given below:

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Received Messages

Topic

Key\_name

String (50)

Variable

☐

LENGTH

RANGE: 0 to 255

SAVE

Fig. 16

- Topic should appear the same as given in Subscribe Parameters pop-up and should not be editable (It should be fixed).
- Key name will be entered in string format whose maximum length will be 50 characters. (Key-matching will occur, so that, data can be separated per key).
- For variable block, a dropdown should appear which will display all the available variables, so that one of them can be selected (tag name). Also, one additional block to be given to the right so that new address can be entered. If a new address is entered, the following pop-up should appear for adding the tag.
- Length should be an integer in the range 1 to 255.
- Even if this pop-up is kept empty, no error should appear as, Publish Requests can be added later as shown for the **table** below.

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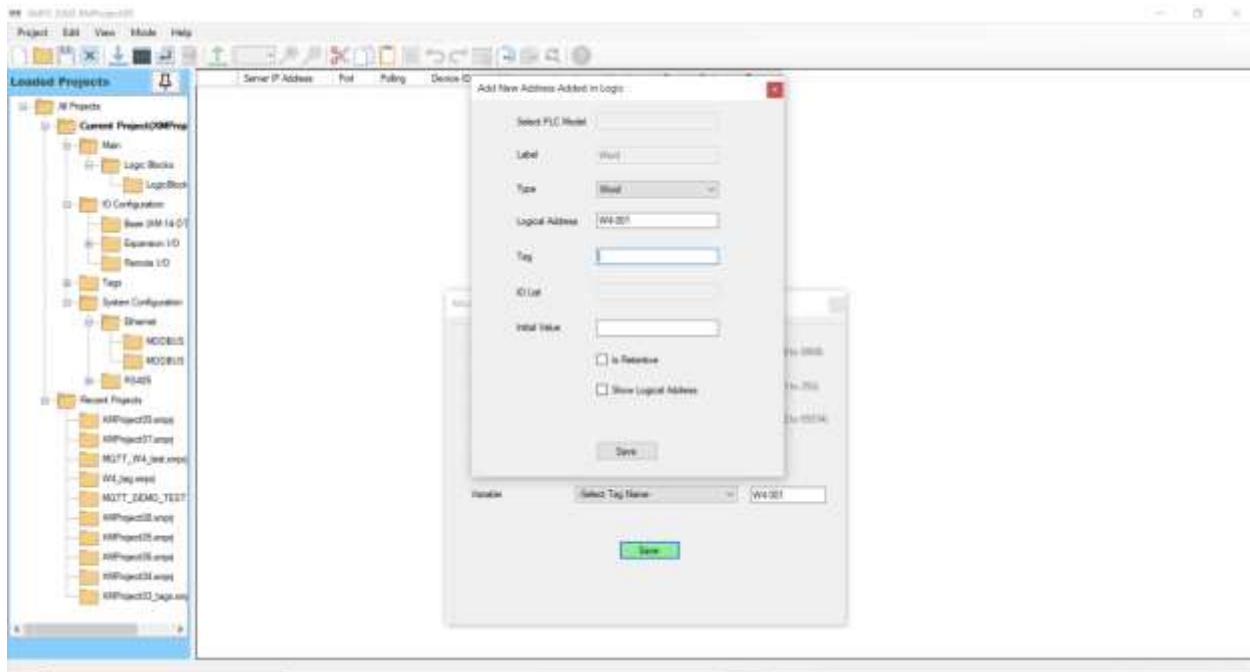


Fig. 17

On clicking save, a **table** should appear as shown containing all the information given in the pop-up:

	Topic	QoS	MAX Payload Size
SUB [1]			
ADD RECEIVED MESSAGES			
	Key_name	Variable	LEN

Fig. 18

**Length** will be dependent on the **data-type**.

For adding multiple 'publish requests' for a given topic, right click on SUB [1] and select 'ADD RECEIVED MESSAGES', so that, for each request and additional row will be generated to display the tag information:

	Topic	QoS	MAX Payload Size
SUB [1] ADD RECEIVE MESSAGES			

Key_name	Variable	LEN

Fig. 19

For editing the main 'Subscribe Parameters' pop-up, double click on the first row (containing EN, topic, etc) so that the same pop-up appears again and is editable.

	Topic	QoS	MAX Payload Size
SUB [1] ADD RECEIVE MESSAGES			

Key_name	Variable	LEN

**Subscribe Parameters**

String (50)  
(0 or 1)  
RANGE: 0 to 255

Fig. 20

Similarly, for editing a row (of key-value) double click on the row so that the 'ADD PUBLISH REQUEST' pop-up appears again. Doing this should not create a new row, but, edit the selected row itself.

For multiple subscribe blocks, repeat the same procedure from 'Add Subscribe Block'. The next table will have the name- SUB [2]. Finally, the utility should look like:

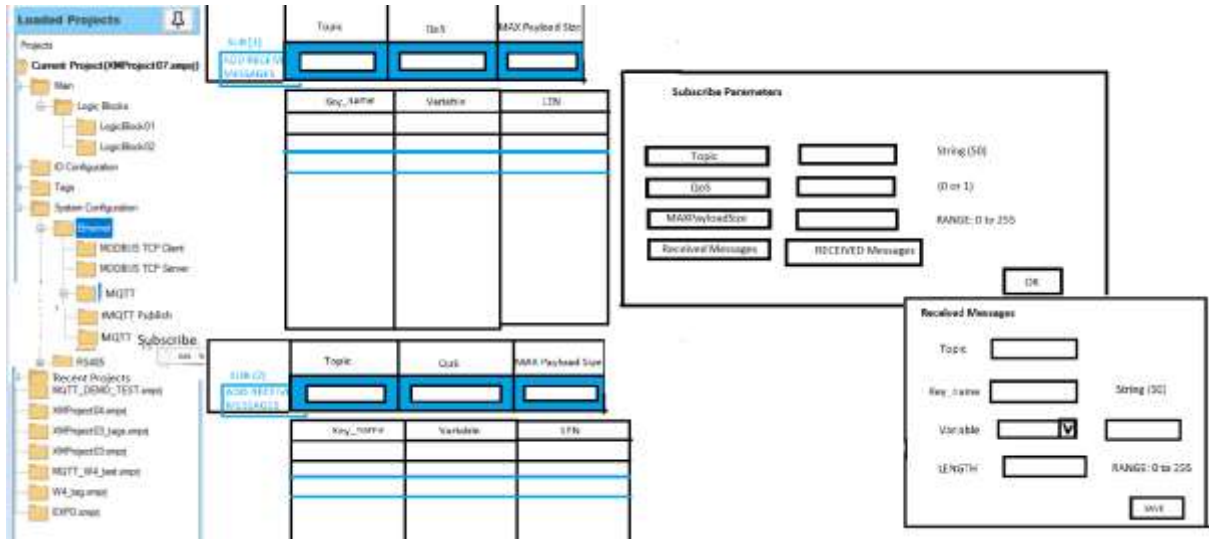


Fig. 21

The tables for SUB [1], SUB [2], and so on should be visible when clicked on 'MQTT Subscribe' folder.

Also, each row should be editable and on right-clicking on each row, should have the following options for Delete Record, Copy, Cut, and Paste.

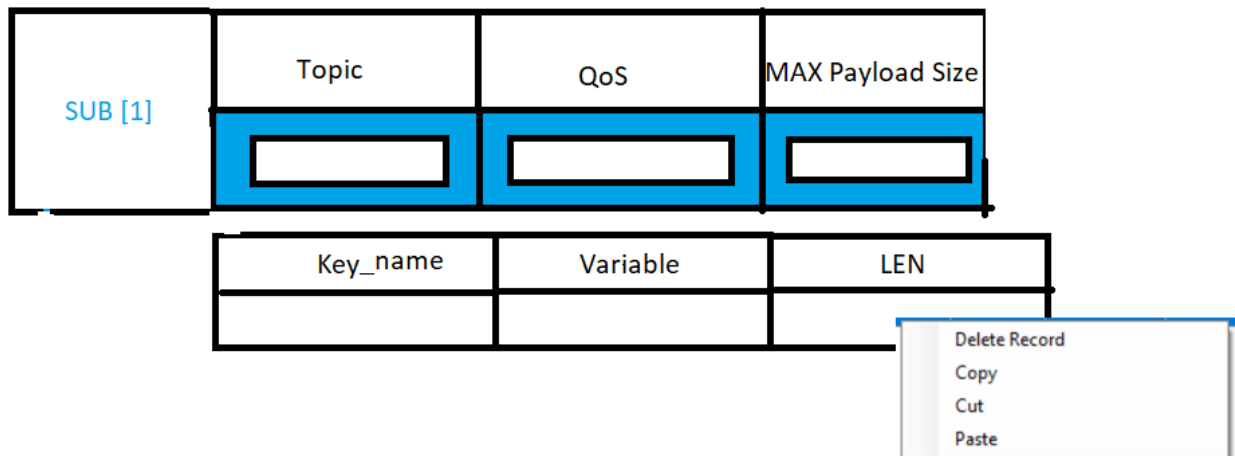


Fig. 22

The same options should also appear after right-clicking on the first row containing topic, QoS, etc.

If the rows are copy-pasted, then, the pop-up should contain the previous values.

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## Task 4: MQTT Function Block

### Publish Function Block:

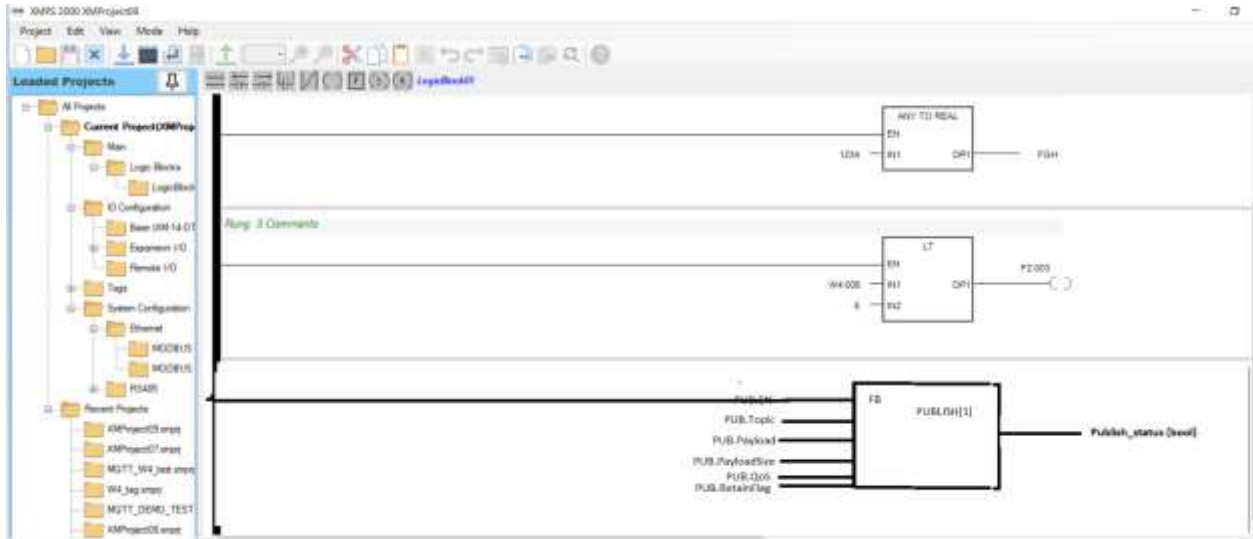


Fig. 23

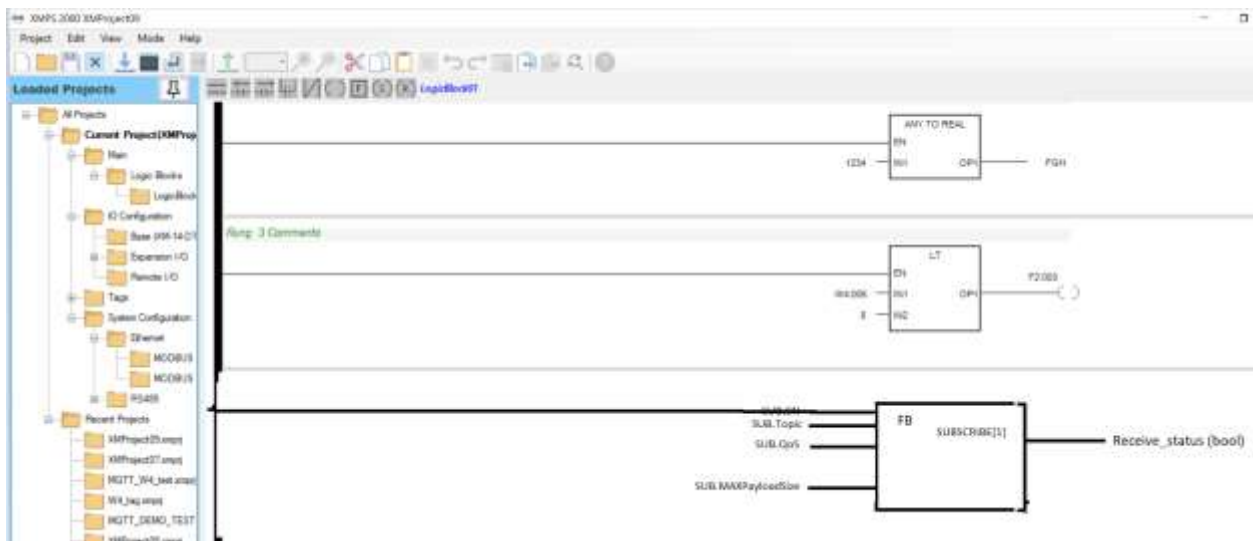


Fig. 24

If any of the fields in the Function Block pop-up is not filled, then, display an error showing that a particular field is not filled.

The function block will be active only on using it and not just by configuration of parameters under MQTT.

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- a) The pop-up will contain the instruction type as 'MQTT' and Instructions as- 1. MQTT Publish, and 2. MQTT Subscribe. (Enable configured here, will be for per topic.)
- b) Enable should be configurable by giving Boolean address also.

Pop-up for Publish (datatype BOOL only):

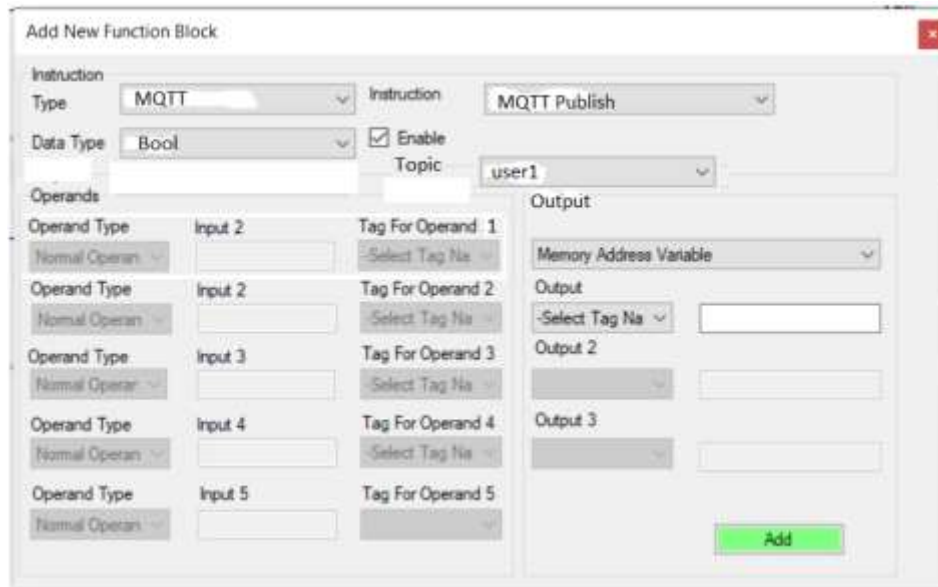


Fig. 25

Pop-up for Subscribe (datatype BOOL only):

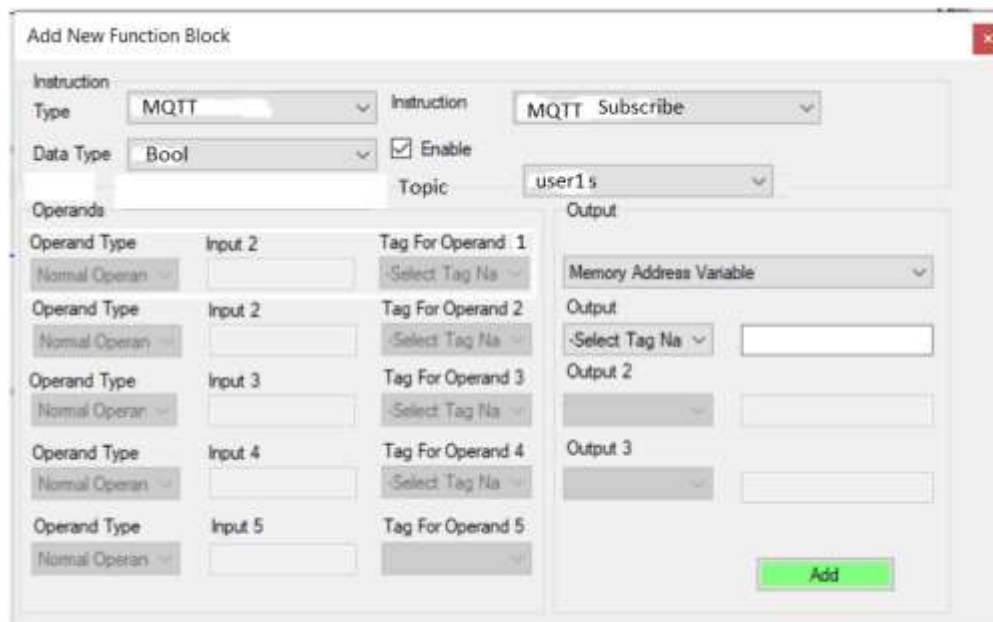


Fig. 26

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- c) Additional 'Topic' block needs to be added. If configuration is done for more than one publish and subscribe blocks in MQTT folder under ethernet, then, all the topics that are configured must be visible and any one of them can be selected for using the Function Block. There are no other inputs to be configured.
- d) This 'topic' block should be visible only for 'MQTT Publish' and 'MQTT Subscribe' Function Blocks and not for any other Function Blocks.
- e) Using tooltip, the parameters for all the function blocks should be visible along with their values, when user moves cursor on the function block.
- f) For deleting, first delete the function block, and then the entries in MQTT Publish and Subscribe. If reverse is done, then, an error 'first delete function block' should be displayed.

### Task 5: Mcode file generation for MQTT Function Block

Mcode should be generated for the respective function blocks:

Frame	Valid input
Rung No.	
Data type	0 to 5
Enable Type	0 and 1
Enable	F2:001
OPCODE	0
Type of operand 1	3
OP1	1
Type of operand 2	3
OP2	1
Type of operand 3	-
OP3	-
Type of operand 4	-
OP4	-
No. of Operand	2
T_C Name	-
Output 1	0x2c00075
Output 2	-

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(Only the changes are highlighted in bold).

- i. Rung No. should contain the appropriate rung number on which the MQTT FB is.
- ii. Data type will be 0 (bool) for MQTT Publish as well as Subscribe (no other data type can be selected)
- iii. Enable type will be 0/ 1 indicating enable and disable respectively.
- iv. **Enable** can be given a **Boolean address** which will be displayed
- v. **OPCODE** will be based on whether MQTT Publish is selected, or MQTT Subscribe. **0x03b0** is the Function Block is for **MQTT Publish** and **0x03c0** is the Function Block is for **MQTT Subscribe**. (Decimal – 59 and 60 respectively with data-type 0 i.e. Bool).

Instruction Type		Instruction		
MQTT	MQTT	Function	OPCODE	Data Type
		MQTT Publish	0x03b0	BOOL
		MQTT Subscribe	0x03c0	BOOL

- vi. Type of operand 1 will be 3 for numeric (among 0, 1, 2, and, 3, for normal, negation, not used and numeric).
- vii. **OP1** will contain the **topic number** (based on which topic is selected).
- viii. Operands 2 to 4 will remain empty.
- ix. Hence, No. of operand will be 1
- x. Output 1 will contain the Boolean address (in decimal) for publish or subscribe status.

Example of Mcode for MQTT with two publish blocks on the first two rungs and subscribe block on the third rung:

36

3

1

0

1

574128128

59

0

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1

2

0

2

0

2

0

1

0

574128132

0

2

0

1

574128136

59

0

2

2

0

2

0

2

0

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20

1

0

574128140

0

3

0

0

0

60

0

1

2

0

2

0

2

0

1

0

574128144

0

35

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## Task 6: Addition of System Tags

Additional four system tags to be added to the previous tags for displaying the output of the MQTT Connection. These tags will be-

1. MQTT\_CONNECTED
2. MQTT\_ERROR
3. MQTT\_ERROR\_CODE
4. MQTT\_STATE

S3:036	STATUS_MQTT_CONNECTED	Data Type-Bool
S3:037	STATUS_MQTT_ERROR	Data Type-Bool
S3:038	STATUS_MQTT_ERROR_CODE	Data Type-Byte
S3:039	STATUS_MQTT_STATE	Data Type-Byte

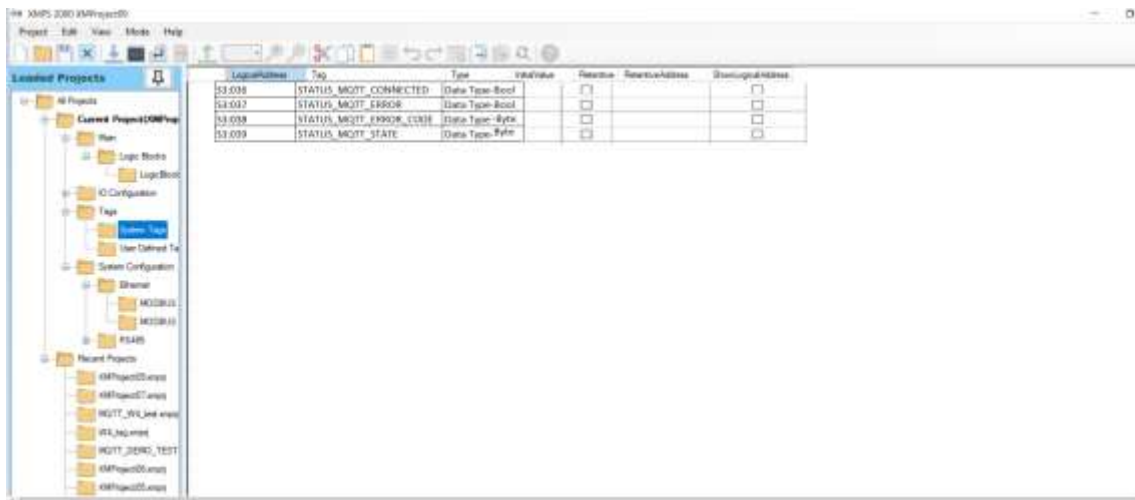


Fig. 27

Error code and state are enumerations and should display the code for corresponding message during run-time in Actual Value Column.

## Task 7: Saving contents to MQTT\_CNF text file and downloading it separately

- All the contents of the MQTT Client must be stored in a file named 'MQTT\_CNF'.
- Format for the file should be –  
8611: pqr@amazonaws.com  
8612: 8883 ... and so on (value after the colon and next value on new line).
- If any of the fields - username, password, clean session and keep alive are kept empty, 0 should appear as the value in MQTT\_CNF file.
- For certificates, their contents should directly be available instead of the given path.
- The PUB REQUESTS and RECEIVED MESSAGES parameters should also be added in the same file.
- This file should be downloaded separately at the time of downloading the project.
- The MQTT\_CNF file can be given as:

Configuration:

Data	Comment	Data Size
8611	Hostname	2 byte
	address	100 byte
8612	Port	2 byte
	address	2 byte
8613	username	2 byte
	address	50 byte
8614	password	2 byte
	address	50 byte
8615	CA3 certificate	2 byte
	address	1700 byte
8616	Client certificate	2 byte
	address	1700 byte
8617	Private key	2 byte
	address	1700 byte
8618	Clean Session	2 byte
	address	1 byte
8619	Keep Alive	2 byte
	address	4 byte

## Publish Requests:

8620	Number of publish topics	2 byte
	address	4 byte
PUB [1]		8 byte
	Topic	10 byte
	QoS	1 byte
	Retain Flag	1 byte
	Number of publish requests	4 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	.	
	.	
PUB [2]		8 byte
	Topic	10 byte
	QoS	1 byte
	Retain Flag	1 byte
	Number of publish requests	4 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	.	
	.	
	.	
.		
.		



## Subscribe Requests:

Data	Comment	Data Size
8621	Number of subscribe topics	2 byte
	address	4 byte
SUB [1]		8 byte
	Topic	10 byte
	QoS	1 byte
	Maximum Payload size	2 byte
	Number of requests	2 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	.	
	.	
SUB [2]		8 byte
	Topic	10 byte
	QoS	1 byte
	Maximum Payload size	2 byte
	Number of requests	2 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	key_name	50 byte
	variable - address	4 byte
	length	2 byte
	.	
	.	
	.	
.		
.		
.		

Example of MQTT CNF file:

8611: a2vhueyrc7ywi4-ats.iot.eu-west-1.amazonaws.com

8612: 8883

8613: abcd

8614: pqrst@123

8615: -----BEGIN CERTIFICATE-----

MIIBtjCCAVugAwIBAgITBmyf1XSXNmY/Owua2eiedgPySjAKBggqhkJOPQQDAjA5

MQswCQYDVQQGEwJVUzEPMA0GA1UEChMGQW1hem9uMRkwFwYDVQQDExBbWF6b24g

Um9vdCBDQSAzMB4XDTE1MDUyNjAwMDAwMFoXDTQwMDUyNjAwMDAwMFowOTELMAkG

A1UEBhMCVVMxDzANBgNVBAoTBkFtYXpvcjEzMBCGA1UEAxMQQW1hem9uIFJvb3Qg

Q0EgMzBZMBMGBYqGSM49AgEGCCqGSM49AwEHA0IABCMxp8ZBf8ANm+gBG1bG8IKI

ui2yEujSLtf6ycXYqm0fc4E7O5hrOXwzpcVOho6AF2hiRVd9RFgdszflZwjZt6j

QjBAMA8GA1UdEwEB/wQFMAMBAf8wDgYDVR0PAQH/BAQDAgGGMB0GA1UdDgQWBBSr

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-----END CERTIFICATE-----

8616: -----BEGIN CERTIFICATE-----

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NlOXTQ5MTIzMTIzNTk1OVowHjEcMBoGA1UEAwwTQVdTIElVVCBDZXJ0aWZpY2F0

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8617: -----BEGIN RSA PRIVATE KEY-----

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-----END RSA PRIVATE KEY-----

8618: 1

8619: 360

8620: 2

PUB [1]

user1

1

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1

3

Current

536987680

5

Voltage

536987684

4

Resistance

536987688

3

PUB [2]

user2

1

0

4

Total\_Power

536987692

3

Reactive\_Power

536987696

13

Apparent\_Power

536987700

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Author

Sayali Gadre

Date

20 September 2023

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