MGate 5109 with DNP3 SCADA Application

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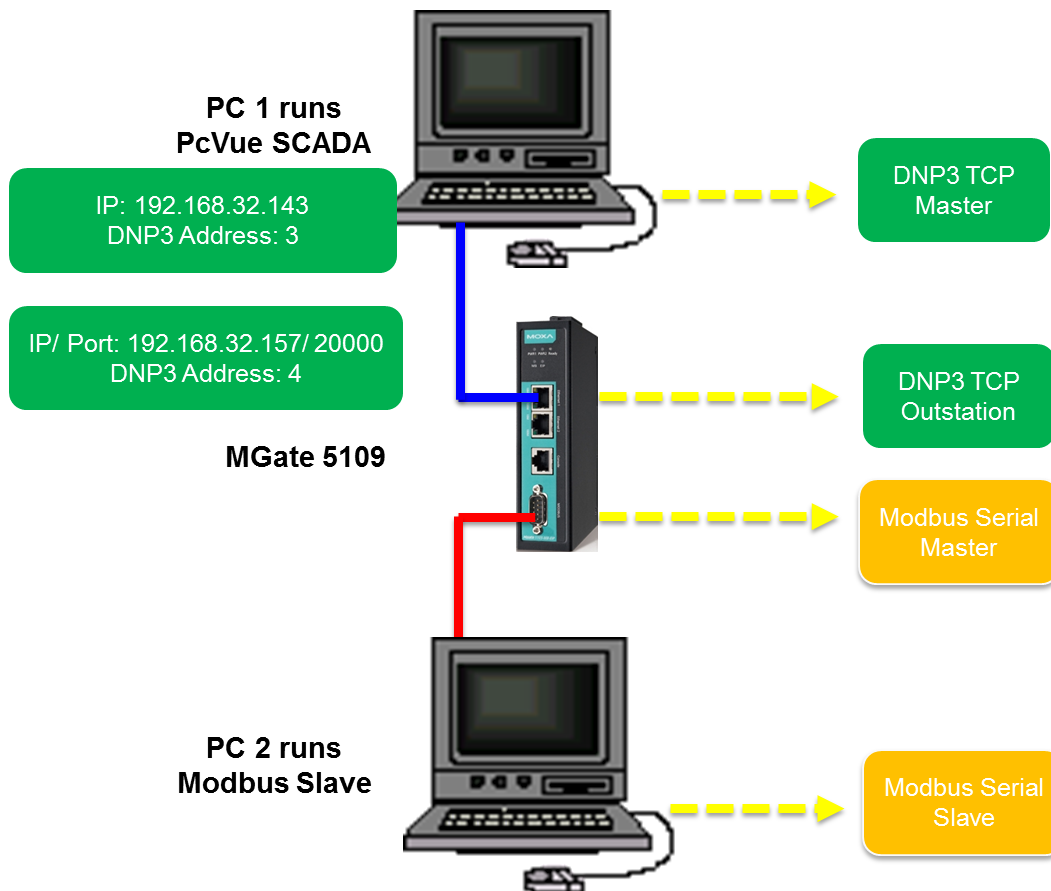Fax: +886-2-8919-1231

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1. System Topology

This application note demonstrates how to use the **MGate 5109** to communicate with a **DNP3-based SCADA**. **PcVue SCADA** is used as a DNP3 TCP Master to remotely control and monitor Modbus RTU via the MGate 5109.

The MGate 5109's protocol conversion is **DNP3 TCP/UDP Outstation <-> Modbus RTU/ASCII Slave**.

**PC 1 runs
PcVue SCADA**

IP: 192.168.32.143
DNP3 Address: 3

DNP3 TCP
Master

IP/ Port: 192.168.32.157/ 20000
DNP3 Address: 4

DNP3 TCP
Outstation

MGate 5109

Modbus Serial
Master

**PC 2 runs
Modbus Slave**

Modbus Serial
Slave

MGate 5109 is the agent to convert Modbus to DNP3, and vice versa. In agent mode, the MGate 5109 uses an internal memory to exchange data between Modbus and DNP3 protocols. The MGate's internal memory is divided into two parts: one for input and the other for output, as shown in the figure below:
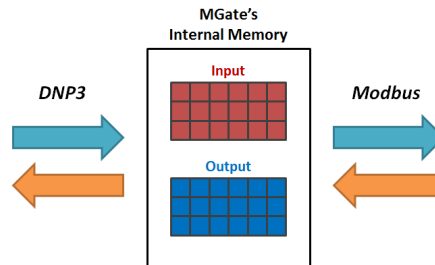
In order to simplify the configuration for internal memory mapping, the MGate 5109 shows the corresponding protocol addresses for both Modbus and DNP3, which you will find in the I/O Data Mapping. Let's take DNP3 Binary Output as an example. Because DNP3 Binary Output can be read and written, you will find the following information in the I/O Data Mapping page. The details of the configuration will be explained in this technical note.

Here is a brief checklist to help you review the steps needed for a successful conversion.

	Equipment	Check items
1	Modbus TCP Server	Hardware connections. Modbus registers to be read or written.
2	MGate 5109	Hardware connections. MGate basic settings. Modbus master commands. DNP3 outstation settings
1	DNP3 TCP Master	Hardware connections DNP3 outstation configurations DNP3 master address setting DNP3 oustation objects configuration: BI/BO/AI/AO/Counter

2. Required Equipment and Components

2.1. PcVue SCADA

PcVue SCADA system is published by **ARC Informatique**. Version **11.1** is used in this demonstration. It has a DNP3 built-in driver for DNP3 communication.

2.2. Modbus Slave

Modbus Slave is the very popular Modbus slave simulator to test and debug your Modbus devices. It supports Modbus RTU/ASCII and Modbus TCP/IP.

Download Website: http://www.modbustools.com/download.html

3. MGate 5109 Setting

Log in to the MGate 5109's web console, and then complete the following settings:

3.1. Serial Settings
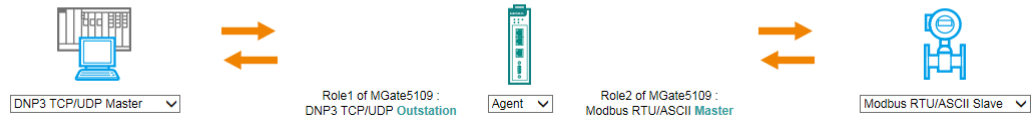
Set as below:

Serial Settings

Port	Baud rate	Parity	Data bit	Stop bit	Flow control	FIFO	Interface
1	115200	None	8	1	None	Enable	RS-485 2-wire

3.2. Protocol Conversion
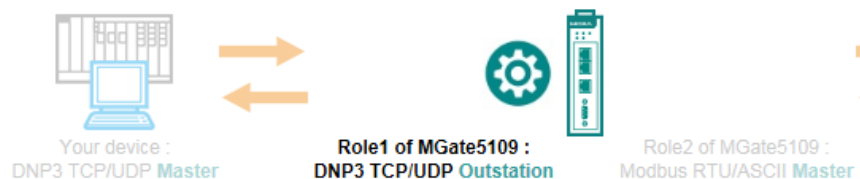
Set as below:

3.3. DNP3 Settings

In **DNP3 TCP/UDP Outstation Settings**, complete the following settings below:

- Set the **DNP3 address** as **4**
- Set **Enable unsolicited response** to **Enable**.
- Set the **Unsolicited response master DNP3 address** as **3**
- Set the **Unsolicited response master IP/Port** as PC1's **20000** port.

Set the **Object Point Numbers** as below:

DNP Object Settings

Object Type	Number of Points
Binary Input	16
Binary Output	16
Counter	2
Analog Input	2
Analog Output	2

Click **Binary Input** to set **Default static variation** as **2: With Flags**, set **Default event variation** as **2: With Absolute Time**.

Binary Input

Number of points	16
Default static variation	2: With Flags
Default event variation	2: With Absolute Time

Click the **Event Settings** button to set all of **BI Event Class** as **1**.

Binary Input Settings

Binary Input

Number of points
Default static variation
Default event variation

Event Settings

Point Index
0
1
2
3

Quick Events Setting

Points Index   0-15
Class of Event   ○ 0   ● 1   ○ 2   ○ 3

Set   Cancel

Click **Counter** to set **Counter Length** as **1: 32 Bit**.

Set all **Class of Event** as **2**.

Click **Analog Input** to set **Analog Input Length** as **1: 32 Bit**.

Set **AI Class of Event** as **3**.

Set AI 0 **Event Trigger Method** as **Change of state**. When this value gets changed, it sends an unsolicited message with a notification about the event.

Set AI 1 **Event Trigger Method** as **Deadband** and the value as **10**. If the AI's value is updated to under 10, it does not generate an event. If the AI 1's value is updated to over 10, it sends an unsolicited message with a notification about this event.

Event Settings

Point Index	Class of Event	Event Trigger Method	
0	○0 ○1 ○2 ◉3	Change of state ∨	
1	○0 ○1 ○2 ◉3	Deadband ∨	10 (0 - 65535)

3.4. Modbus Settings

In Modbus RTU/ASCII Settings, keep the settings as the default value:

Modbus RTU/ASCII Settings

| | Your device :
DNP3 TCP Master | Role 1 of MGate5109 :
DNP3 TCP Outstation | Role 2 of MGate5109 :
Modbus RTU/ASCII Master | Your device :
Modbus RTU/ASCII Slave |
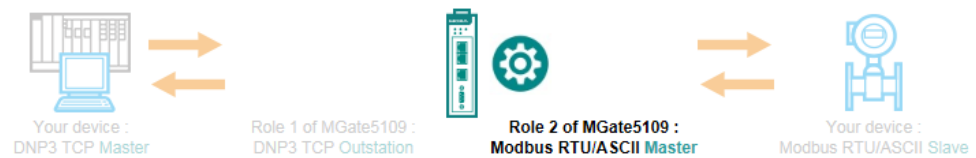
Role	Master
Mode	RTU ∨

Master Settings

Initial delay	0	(0 - 30000 ms)
Max. retry	3	(0 - 5)
Response timeout	1000	(10 - 120000 ms)
Inter-frame delay	0	(10 - 500 ms, 0: default)
Inter-character timeout	0	(10 - 500 ms, 0: default)

Set out the mapping of Modbus RTU to a DNP3 data object as below:

Modbus Slave ID	Mapping DNP3 Data Object	Modbus Data Type	Points Mapping	Swap
1	BI	Coil	BI 0 → Coil 1, BI 1 → Coil 2…, BI 15 → Coil 16	None
2	BO	Coil	BO 0 → Coil 1, BO 1 → Coil 2…, BO 15 → Coil 16	None
3	Counter	Register	Counter 0 → Register 1 and 2, Counter 1 → Register 3 and 4	**Word**
4	AI	Register	AI 0 → Register 1 and 2, AI 1 → Register 3 and 4	**Word**
5	AO	Register	AO 0 → Register 1, AO 1 → Register 2	None

Add Modbus Command to read/write Modbus RTU Slave as below:

Modbus Commands

➕ Add   ✏ Edit   🖺 Clone   🗑 Delete   ↕ Move

Index	Name	Slave ID	Function	Address / Quantity	Trigger	Poll Interval	Endian Swap
1	ReadBI	1	1	Read address 0, Quantity 16	Cyclic	1000	None
2	ReadBO	2	1	Read address 0, Quantity 16	Cyclic	1000	None
3	WriteBO	2	15	Write address 0, Quantity 16	Data Change	N/A	None
4	ReadCounter	3	3	Read address 0, Quantity 4	Cyclic	1000	Word
5	ReadAI	4	3	Read address 0, Quantity 4	Cyclic	1000	Word
6	ReadAO	5	3	Read address 0, Quantity 2	Cyclic	1000	None
7	WriteAO	5	16	Write address 0, Quantity 2	Data Change	N/A	None

3.5. I/O Data Mapping Settings

In the I/O Data Mapping web page, choose the scenario **DNP3 TCP/UDP Master → Modbus RTU/ASCII Slave**. Map **BO 0-15** and **AO 0-1** to **WriteBO** and **WriteAO** commands as below and then submit:

Choose another scenario: **Modbus RTU/ASCII Slave → DNP3 TCP/UDP Master**. Map **BI 0-15**, **BO 0-15**, **Counter 0-1**, **AI 0-1** and **AO 0-1** to **ReadBI**, **ReadBO**, **ReadCounter**, **ReadAI** and **ReadAO** as below and then submit:

:• I/O Data Mapping

Select your scenario   `DNP3 TCP/UDP Master <-- Modbus RTU/ASCII Slave ▾`

Modbus Mapping address arrangement   `Automatic ▾`

Your device :
DNP3 TCP/UDP **Master**

read

Role 1 of MGate5109 :
DNP3 TCP/UDP **Outstation**

Role 2 of MGate5109 :
Modbus RTU/ASCII **Master**

read

Your device :
Modbus RTU/ASCII **Slave**

☐ : Full mapping   ☐ : Un-full mapping   ☐ : None mapping
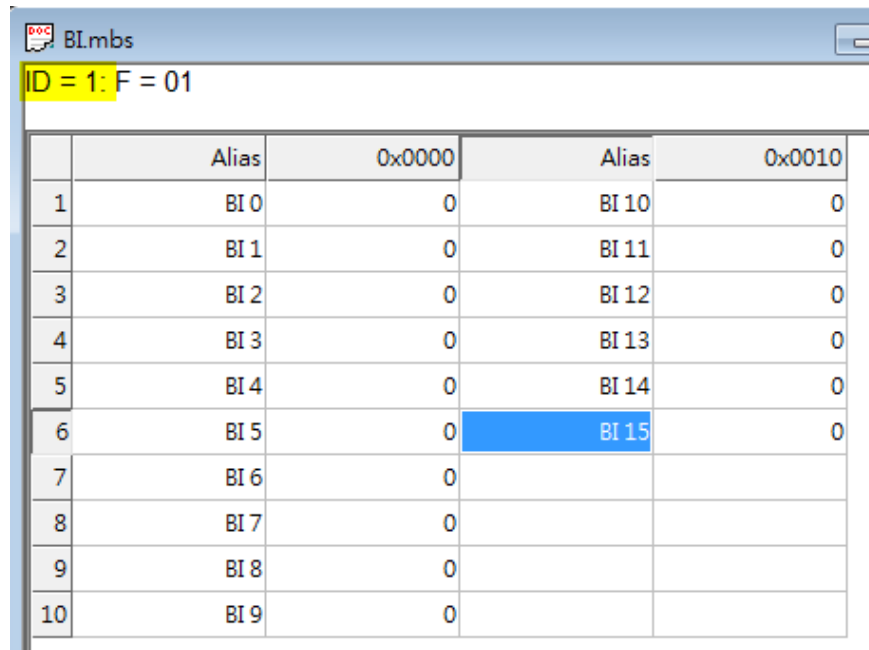
Type		Index			Name	Function	Internal Address			Quantity
Binary Input ▾		0	...	15	ReadBI	1	0	...	1	2 bytes
Binary Output ▾		0	...	15	ReadBO	1	2	...	3	2 bytes
Counter ▾		0	...	1	ReadCounter	3	4	...	11	8 bytes
Analog Input ▾		0	...	1	ReadAI	3	12	...	19	8 bytes
Analog Output ▾		0	...	1	ReadAO	3	20	...	23	4 bytes

Make sure all of the DNP3 object points are mapping to Modbus-command quantities equally.

4. Modbus Slave Setting

PC2 runs **Modbus Slave** and connects to the MGate 5109's serial port. Add the Modbus definition as below:

BI Definition, Slave ID 1:

BO Definition, Slave ID 2:

Counter Definition , Slave ID 3:

AI Definition , Slave ID 4:
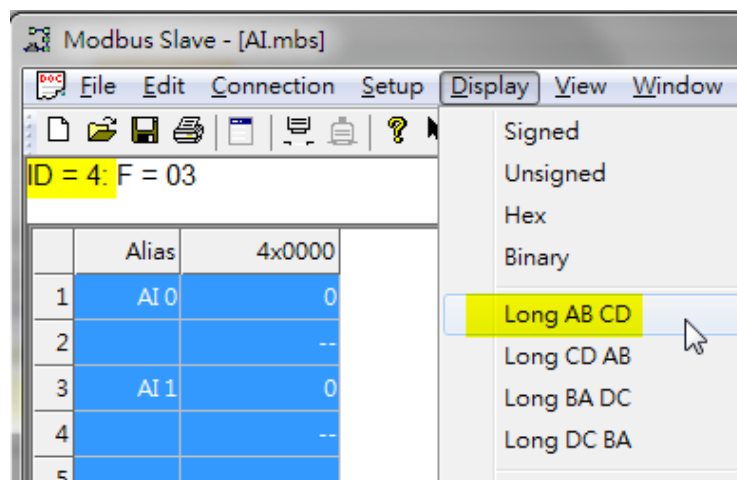
AO Definition , Slave ID 5:
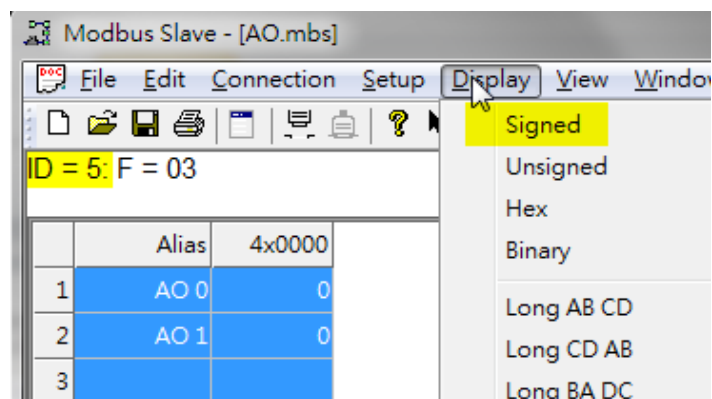
5. PcVue Setting

PC1 runs PcVue. Click **Configure->Communication->DNP3** to set DNP3 communications.
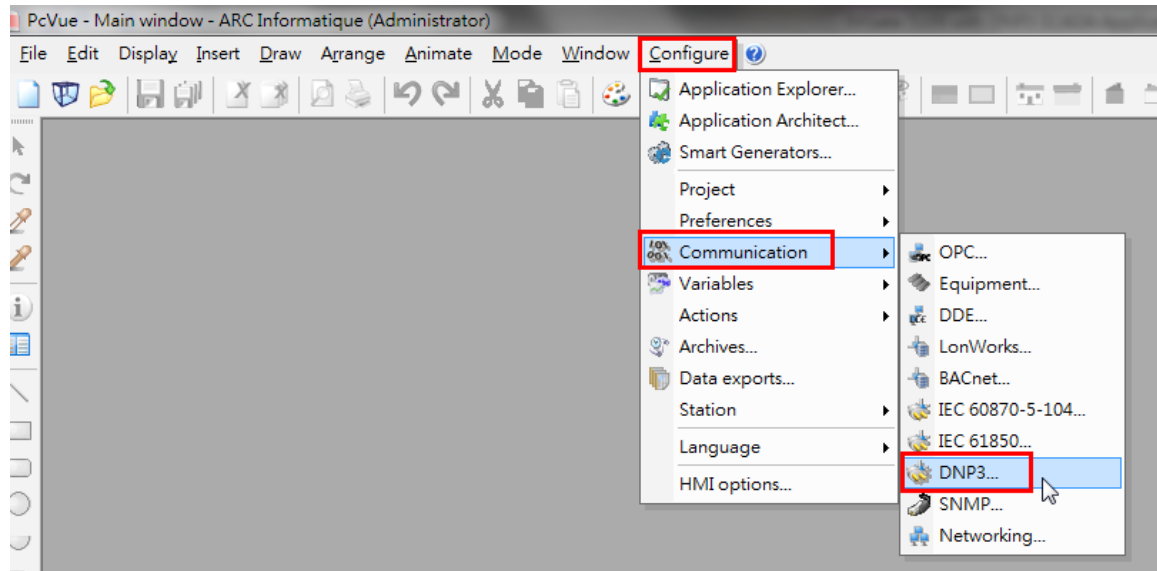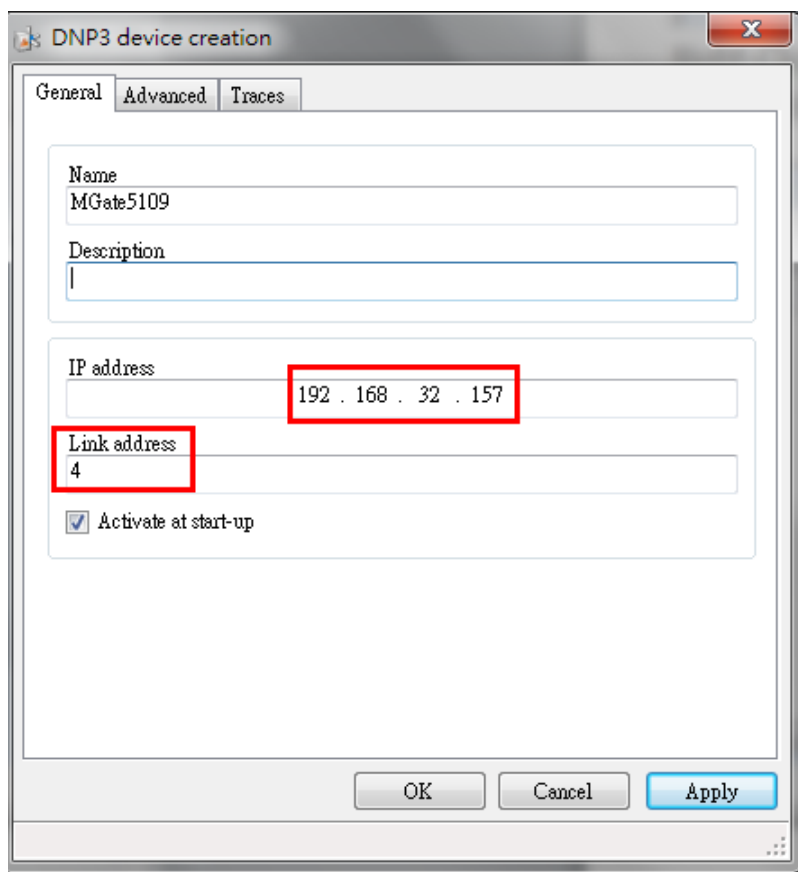

Click **New network** to add a DNP3 TCP network.
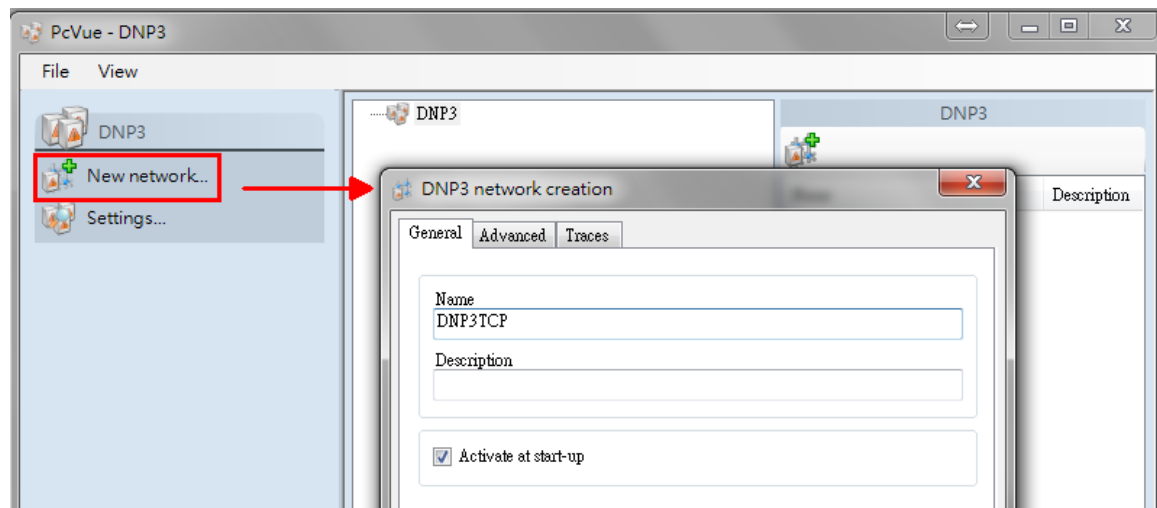
Right-click this network to add **New device**.
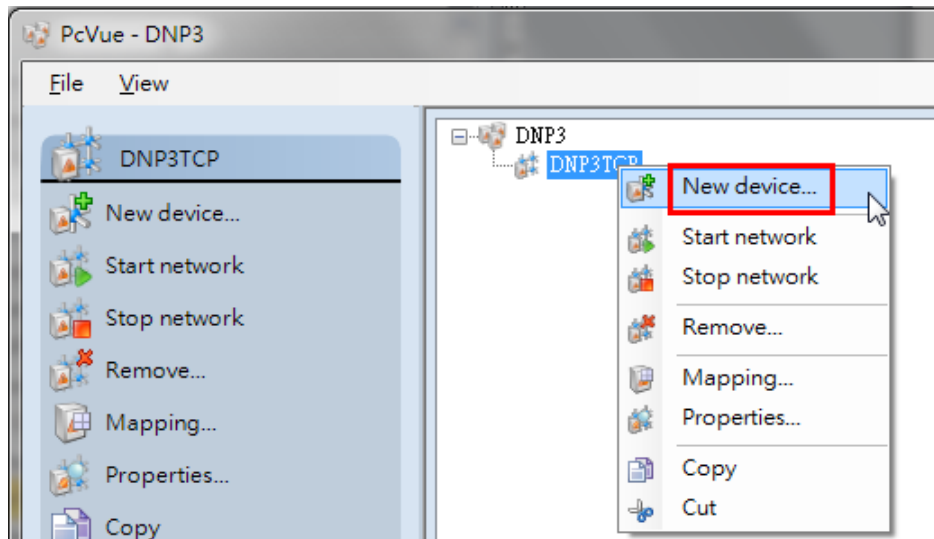
Input MGate 5109's IP in **IP address** field. Set **Link address** as **4**.

Change **Local link address** to **3** in the **Advanced** tab.
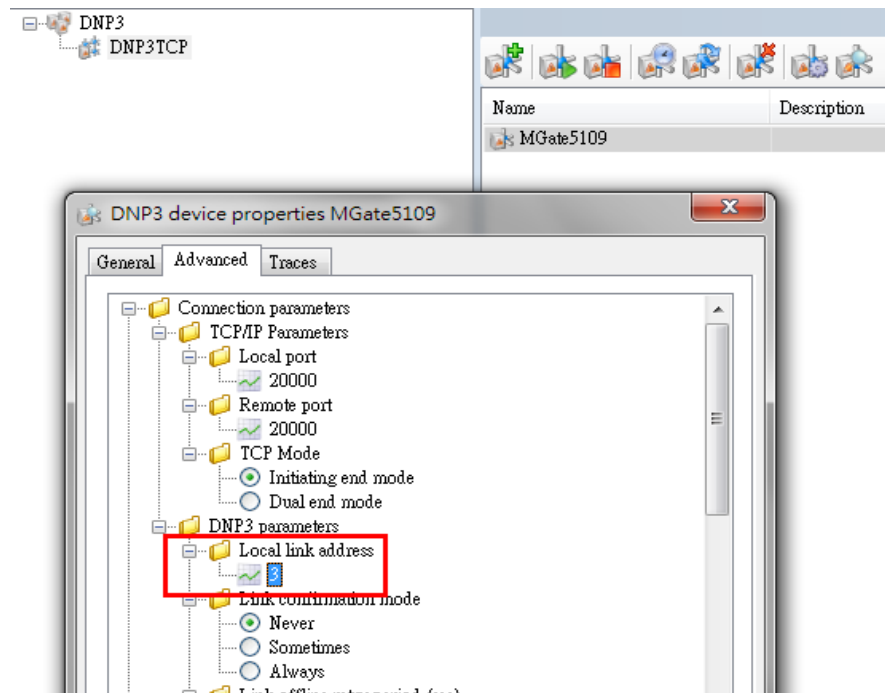
Click **Enable Unsolicited Message** and set the **Polling period** under **Integrity Poll** at **60000ms**.
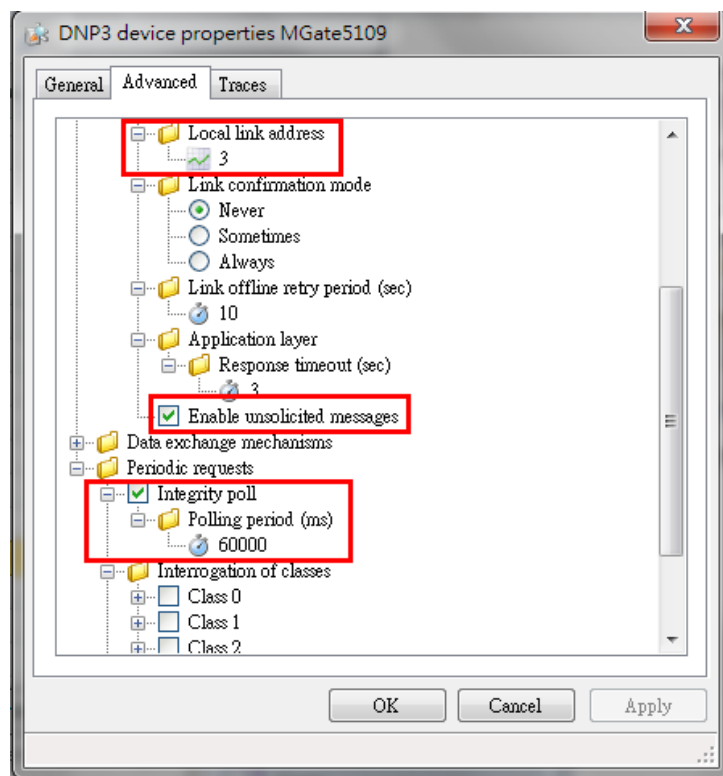
Click **Start device.** SCADA will then try to connect to the MGate 5109. If the MGate 5109 is connected, the **State** would show **Connected**.
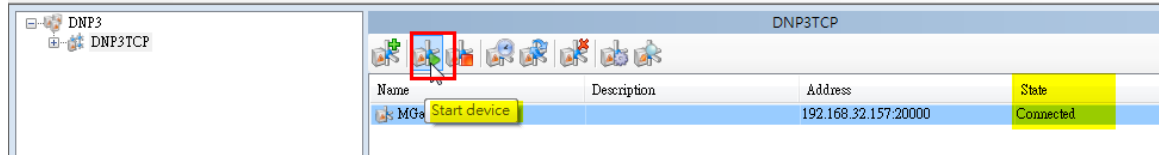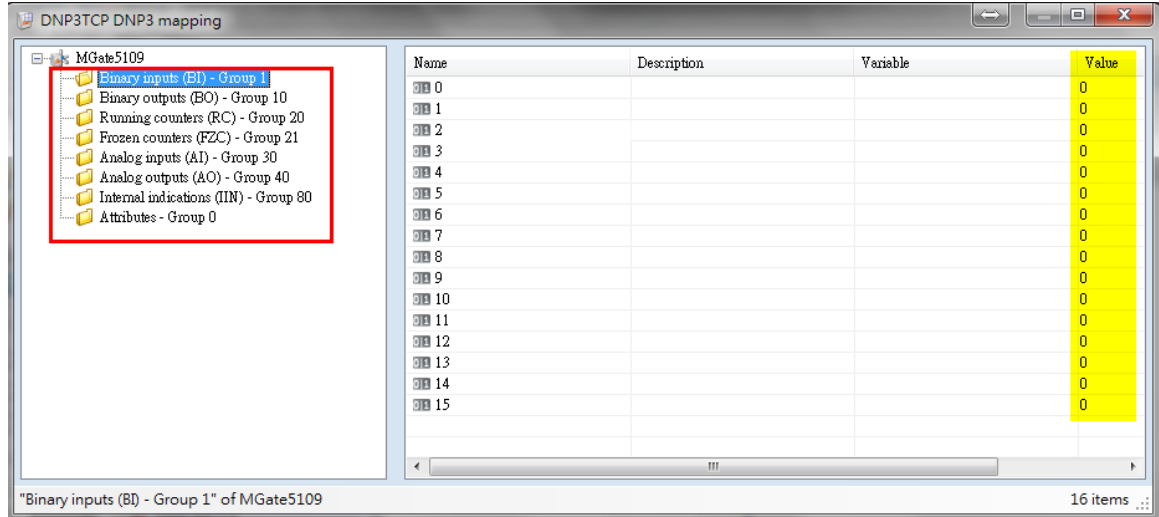
Click **Mapping** for a DNP3 Object Status window to pop up.
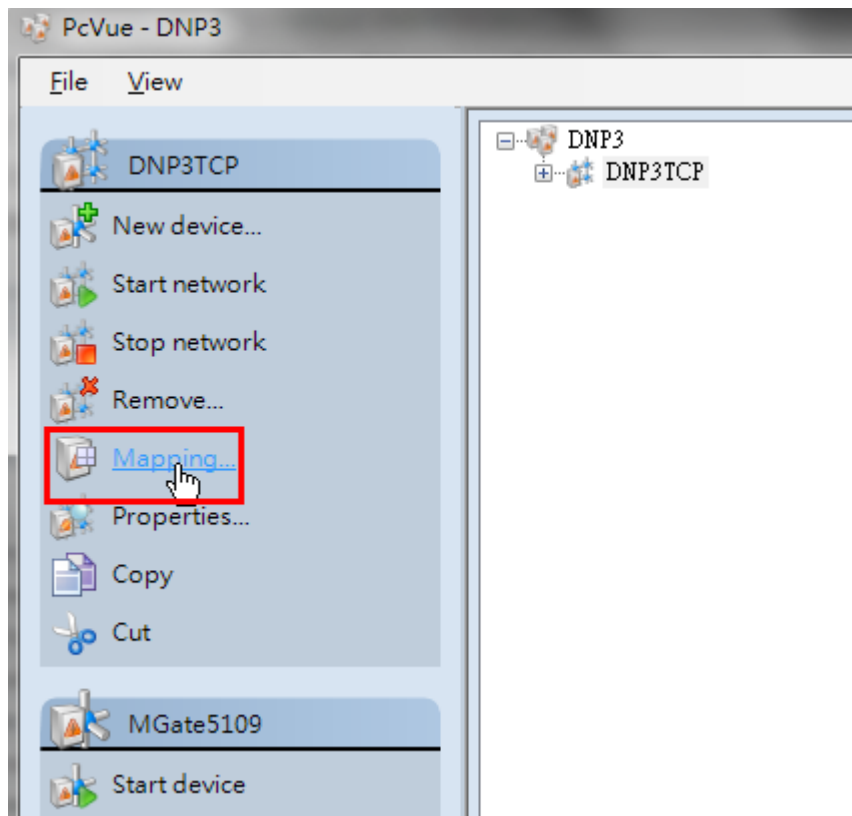
See SCADA poll back the MGate 5109's objects, including BI, BO, AI, and AO.

Also see these object points' value.

6. Communication Test

6.1. MGate Protocol Diagnose Introduction

In the MGate 5109 web console, **Protocol Status** diagnoses the protocol status. It includes **I/O Data View** and **DNP3 TCP/UDP Diagnose** as below:

In the **I/O Data View** web page, select **Data flow direction** to see the IO raw data in **DNP3 TCP/UDP Master-> Modbus RTU/ASCII Slave** or **Modbus RTU/ASCII Slave -> DNP3 TCP/UDP Master**.

In the **DNP3 TCP/UDP Outstation Diagnose** web page, users can monitor the DNP3 Outstation status, including its Data Object Points status.

DNP3 TCP/UDP Outstation Diagnose

☐ Auto refresh   Refresh

Outstation Statictics

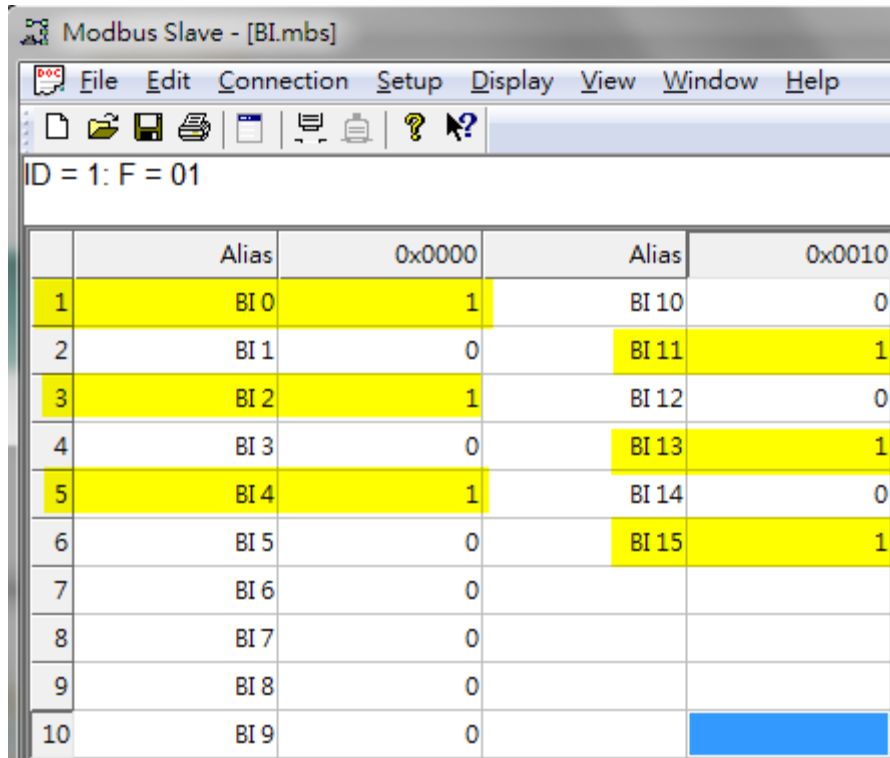|	
Received Requests	27
Sent Responses	27
Sent Unsolicited Message	0
Binary Input Event buffer	0
Counter Event buffer	0
Analog Input Event buffer	0
Connected Master IP	192.168.32.143

Point Information

Binary Input ∨

Point Index	Value	Flags	Time Updated
0	OFF	OFFLINE	N/A
1	OFF	OFFLINE	N/A
2	OFF	OFFLINE	N/A
3	OFF	OFFLINE	N/A
4	OFF	OFFLINE	N/A
5	OFF	OFFLINE	N/A
6	OFF	OFFLINE	N/A

6.2. DNP3 Connection Status

Check **System Monitoring → Protocol Status → DNP3 TCP/UDP Diagnose**, and make sure **Connected Master IP** is PC1**.**

DNP3 TCP/UDP Outstation Diagnose

☐ Auto refresh   Refresh

Outstation Statictics

Received Requests	27
Sent Responses	27
Sent Unsolicited Message	0
Binary Input Event buffer	0
Counter Event buffer	0
Analog Input Event buffer	0
Connected Master IP	192.168.32.143

Point Information

Binary Input ∨

Point Index	Value	Flags	Time Updated
0	OFF	OFFLINE	N/A
1	OFF	OFFLINE	N/A
2	OFF	OFFLINE	N/A
3	OFF	OFFLINE	N/A
4	OFF	OFFLINE	N/A
5	OFF	OFFLINE	N/A
6	OFF	OFFLINE	N/A

6.3. Read BI Test

Change Modbus Slave ID 1's Alias BI 0, 2, 4, 11, 13, 15 status to **On** as below:

Check the following's status in MGate DNP3 TCP/UDP Diagnose page:

MGate IO Dataview:

I/O Data View

BI 7 6 5 4 3 2 1 0   BI 15 14 13 12 11 10 9 8
☑ Auto refresh   0 0 0 1 0 1 0 1   1 0 1 0 1 0 0 0

Data flow direction [DNP3 TCP/UDP Master <-- Modbus RTU/ASCII Slave ▾]   Start address(Hex) [0]

Internal Address	00	01	02	03	04	05	06	07	0
0000h	15	A8	00	00	00	00	00	00	0
0010h	00	00	00	00	00	00	00	00	0
0020h	00	00	00	00	00	00	00	00	0

PcVue SCADA BI Status

DNP3TCP DNP3 mapping

MGate5109
- Binary inputs (BI) - Group 1
- Binary outputs (BO) - Group 10
- Running counters (RC) - Group 20
- Frozen counters (FZC) - Group 21
- Analog inputs (AI) - Group 30
- Analog outputs (AO) - Group 40
- Internal indications (IIN) - Group 80
- Attributes - Group 0

Name	Description	Value
0		1
1		0
2		1
3		0
4		1
5		0
6		0
7		0
8		0
9		0
10		0
11		1
12		0
13		1
14		0
15		1

6.4. Read Counter Test

Change Modbus Slave ID 3's Alias Counter 0's status to 1 and Counter 1's status to 2 as below:

Check the following's status:

MGate IO Dataview:

PcVue SCADA Counter Status:

6.5. Read AI Test

Modify Modbus Slave ID 3's Alias AI 0 status to **-12345678** and AI 1 status to **12345678** as below:

Check the following's status:

MGate IO Dataview:

PcVue SCADA AI Status:

If we change the status of Modbus Slave ID 3's Register 3 and 4 (AI 1) to 1, it wouldn't generate an event because its deadband is 10. SCADA's AI 1 must wait for the next Integrated Poll (interval is 60000ms) to update its value.

6.6. Write BO and AO Test

In **DNP3TCP DNP3 mapping**, right-click on BO 0 to set **Create variable**.
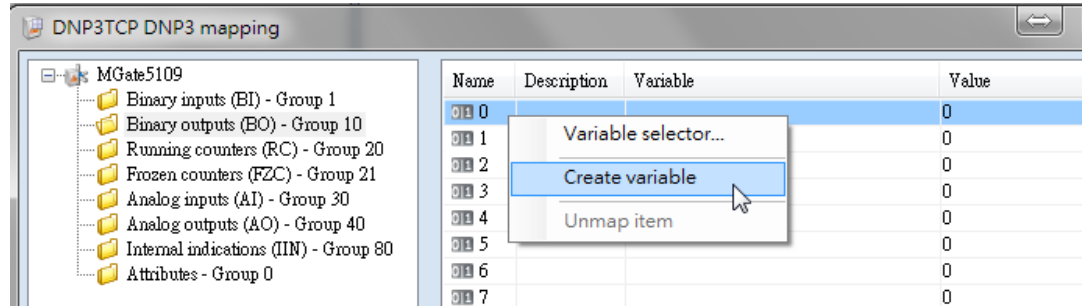
Use the default setting and click **OK**.
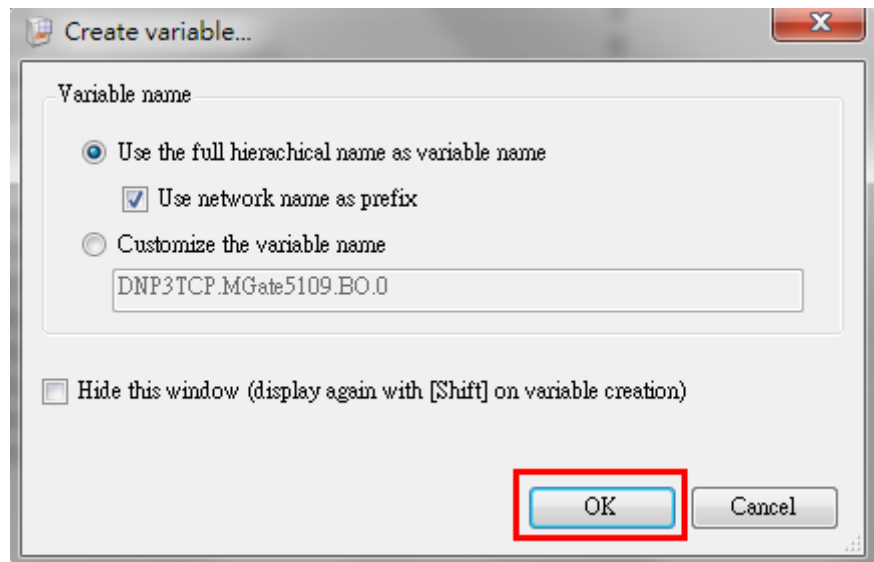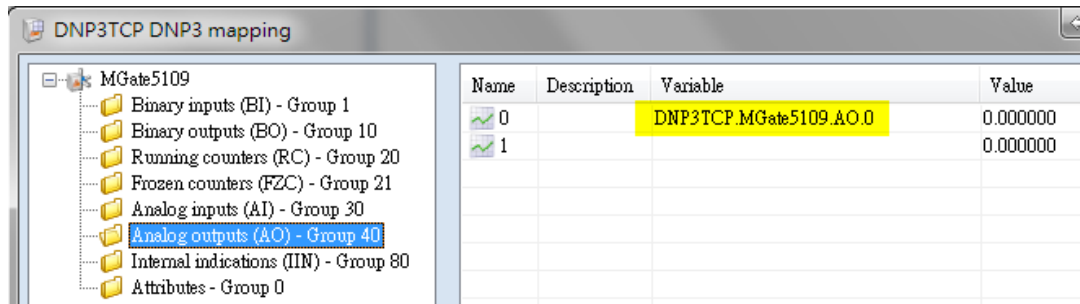
BO 0 will map to this variable.
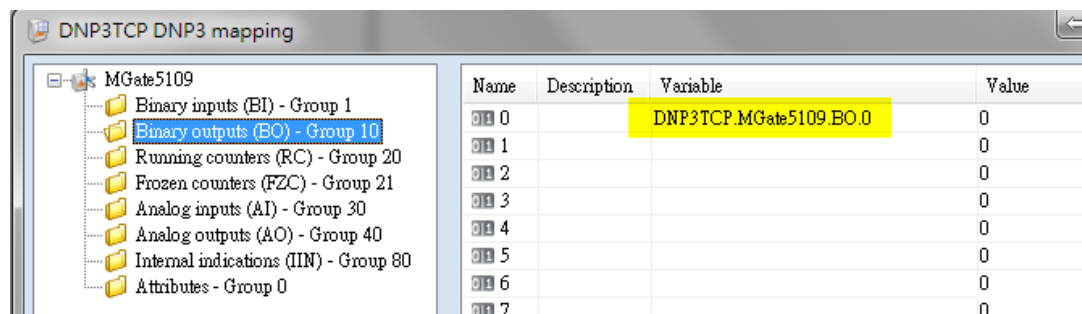
Use the same method to create the AO 0 variable as below:

In PcVue **Main window**, click **Configure → Variables → Selector**.
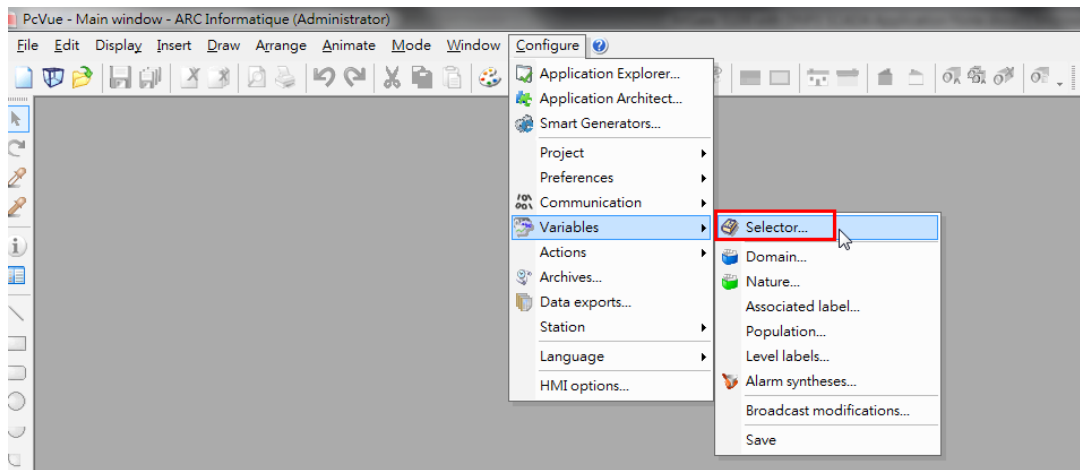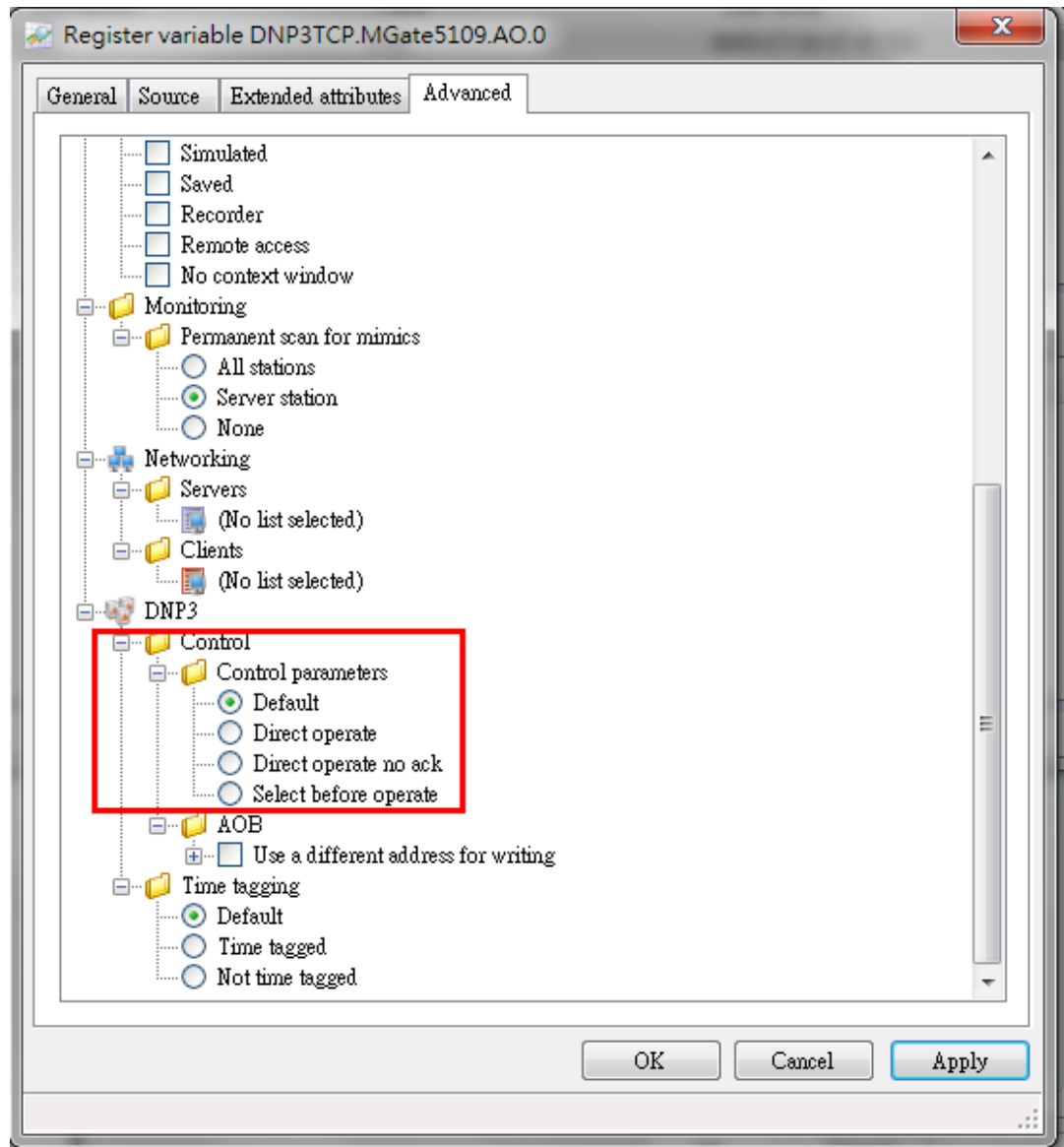

Click the AO 0 variable **Properties** to edit:
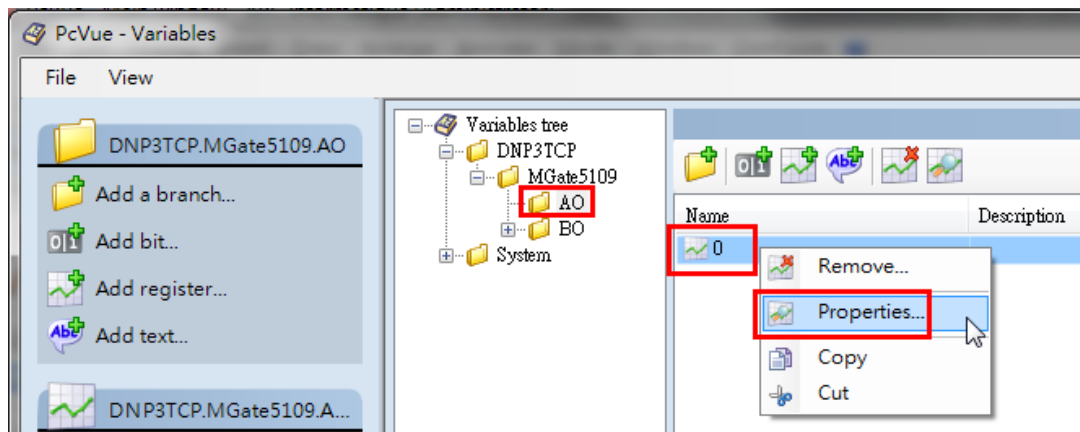
Because the MGate 5109 only supports **DNP3 Level2**, the AO **variation type** should select **16 Bit** under the **Source** tab.
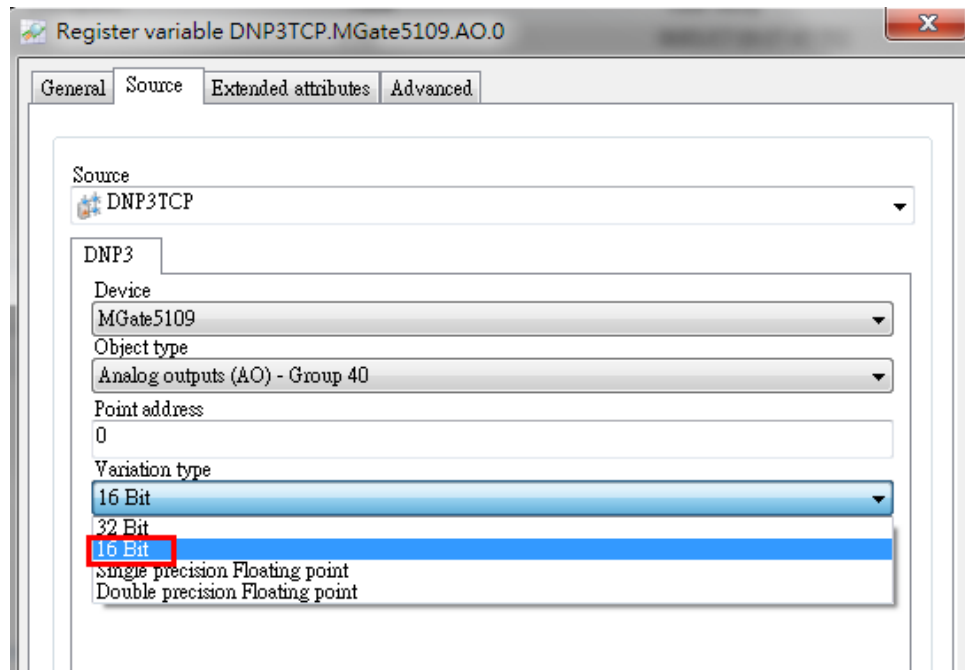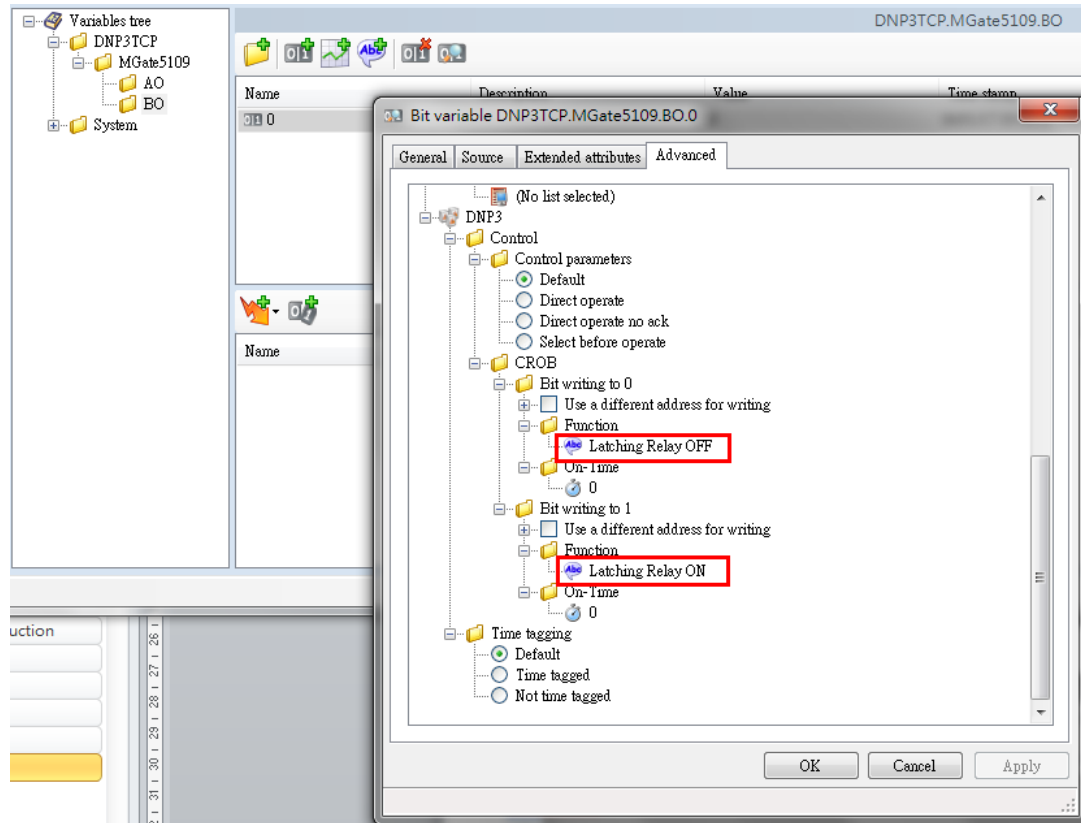
Under the **Advanced** tab, configure the **Control** parameters as below:

Under BO 0 variable's advanced setting, select the **CROB** parameter. Use **Latching Relay ON** and **Latching Relay OFF**.

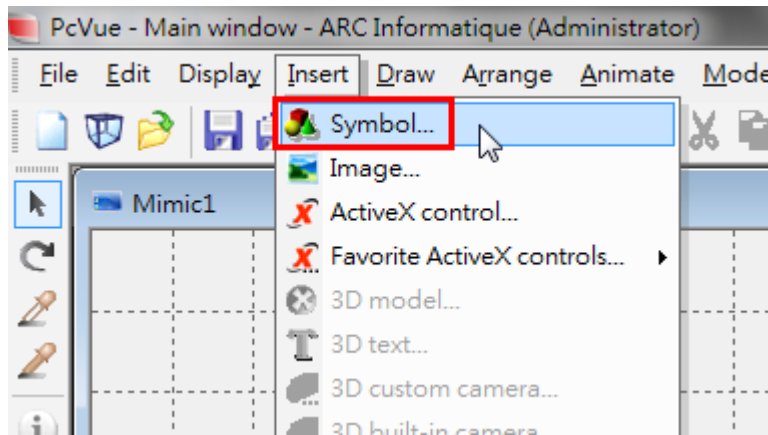Under the **PcVue Main window**, click **New** to create a new **Mimic**. Mimic is PcVue's HMI graphic object.
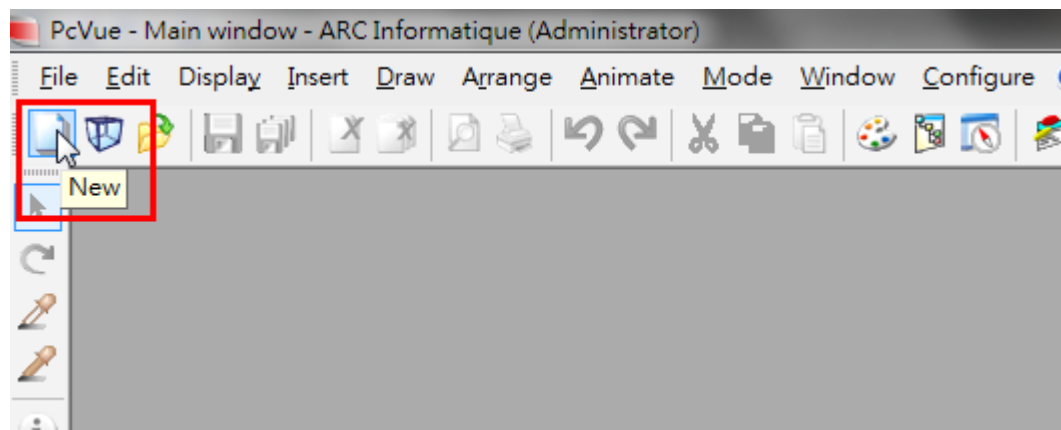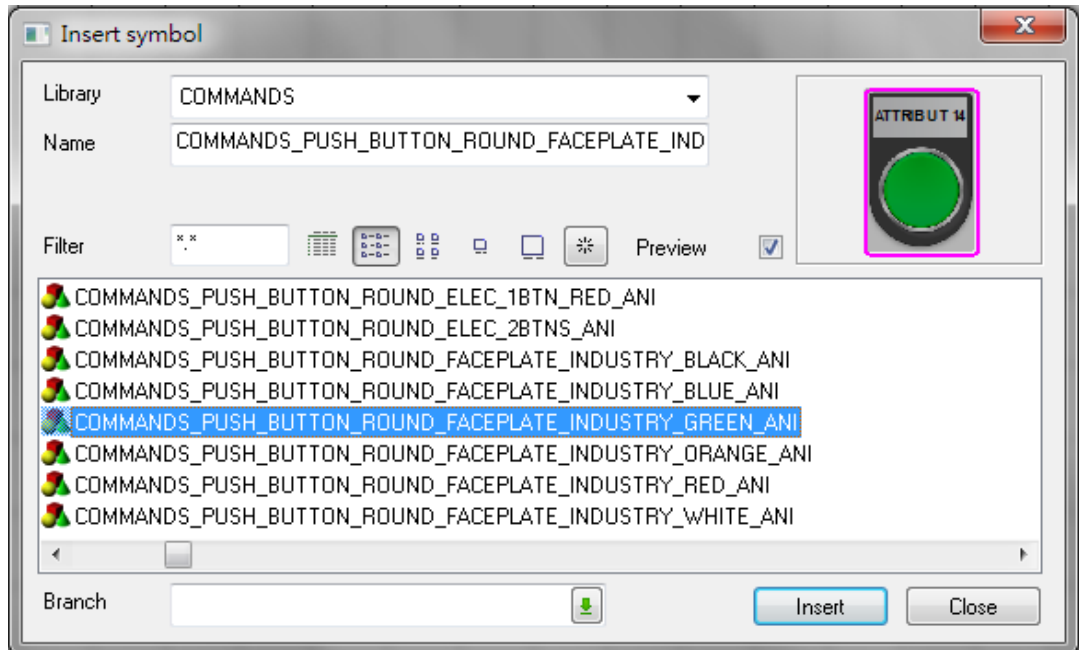
Click **Insert → Symbol**.

Choose a button symbol.

Right-click this symbol, then click **Animate → Send → Bit**
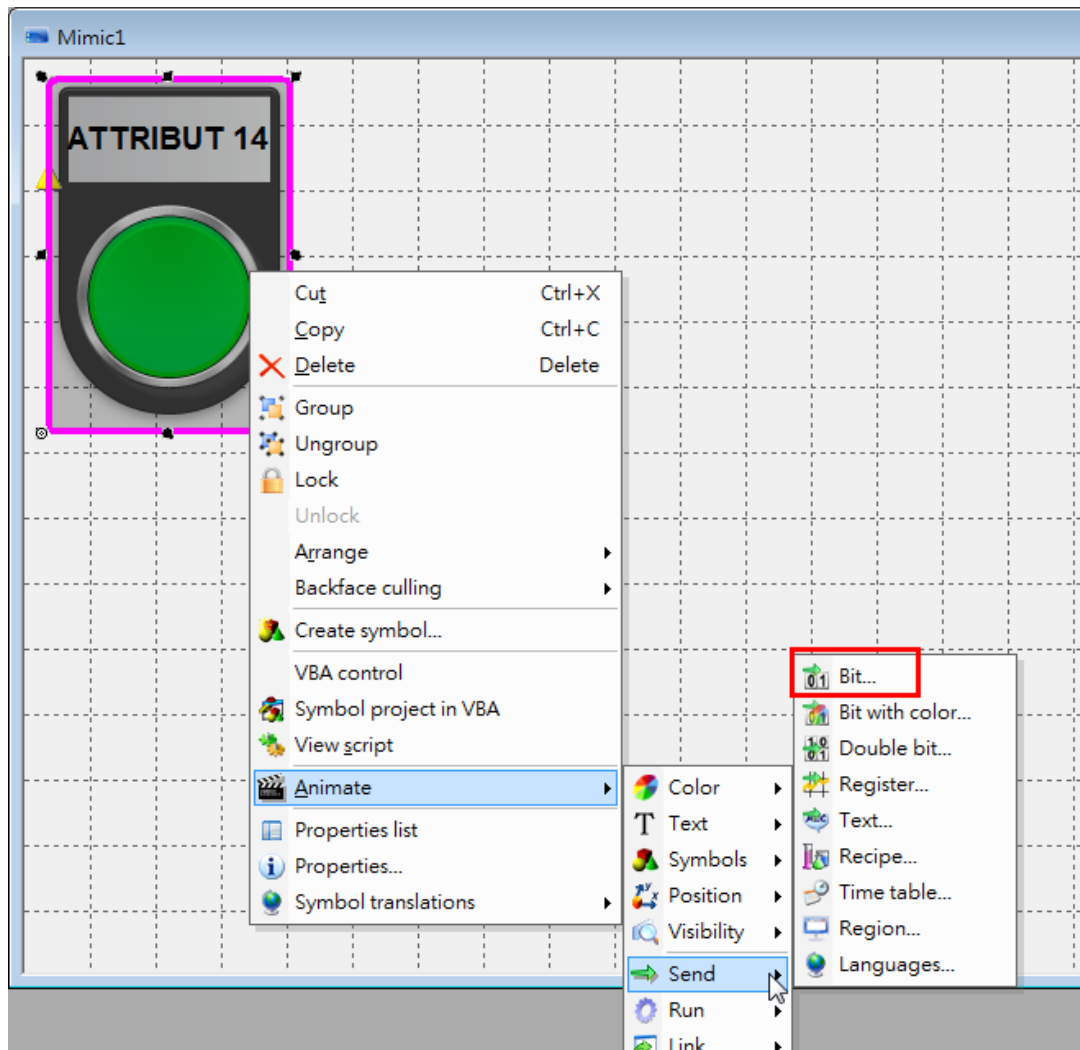
Set BO 0's variable in the **Bit** field. Under **Command type**, select **Reversed**.
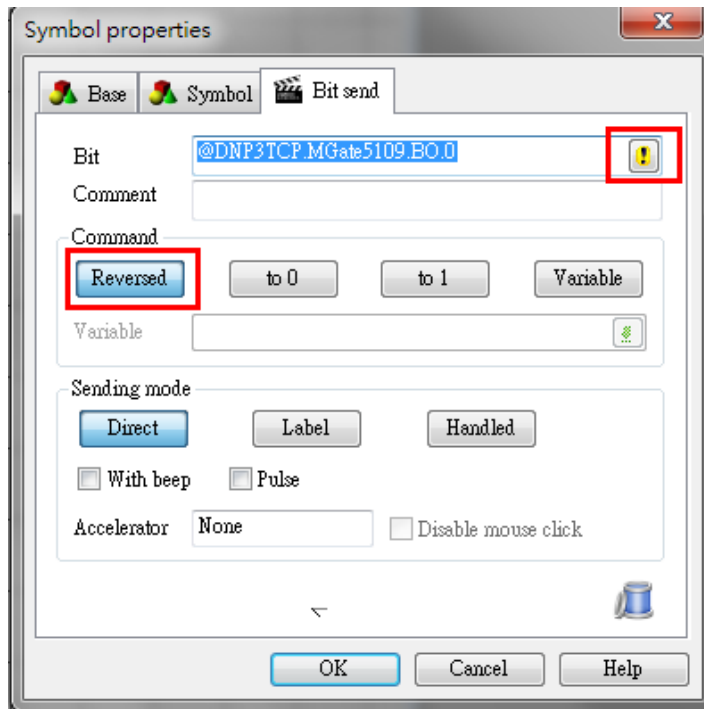
Right-click on **Mimic** to execute **Run** mode.
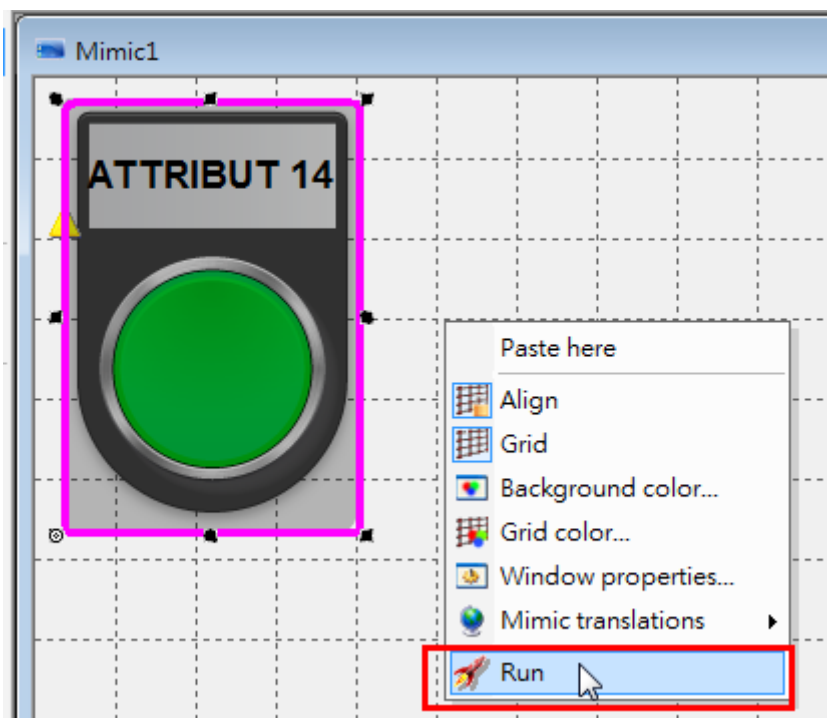
If you click this BO 0 button; it would write BO 0 **On**. Because this object command type is **Reversed**, click it again so that it would write BO 0 **Off**.
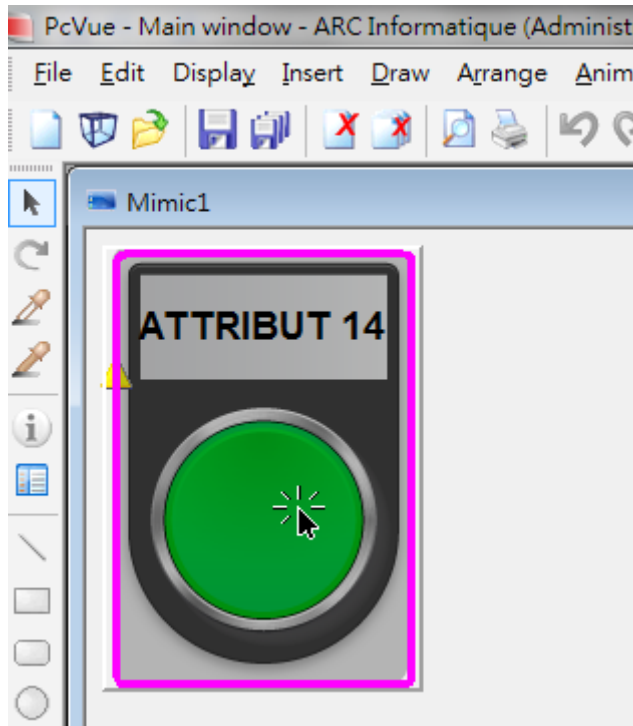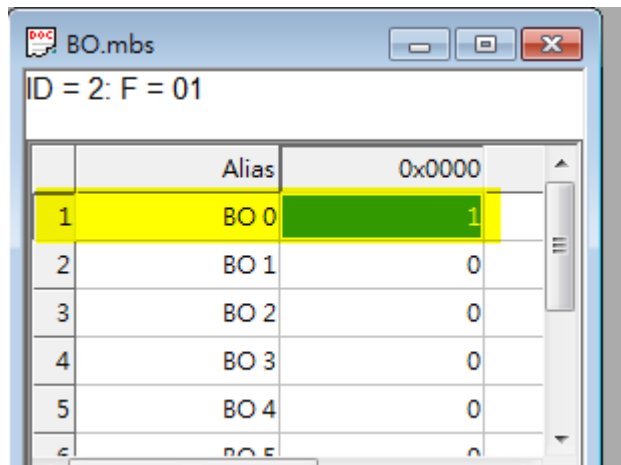

MGate DNP3 Diagnose:

Point Information

Binary Output ⌄

Point Index	Value	Flags	Time Updated
0	ON	ONLINE	2017-01-06 13:32:43
1	OFF	ONLINE	2017-01-06 13:32:43
2	OFF	ONLINE	2017-01-06 13:32:43
3	OFF	ONLINE	2017-01-06 13:32:43

Modbus Slave-BO:

Return to **Edit** mode. Click **Draw → Text**.
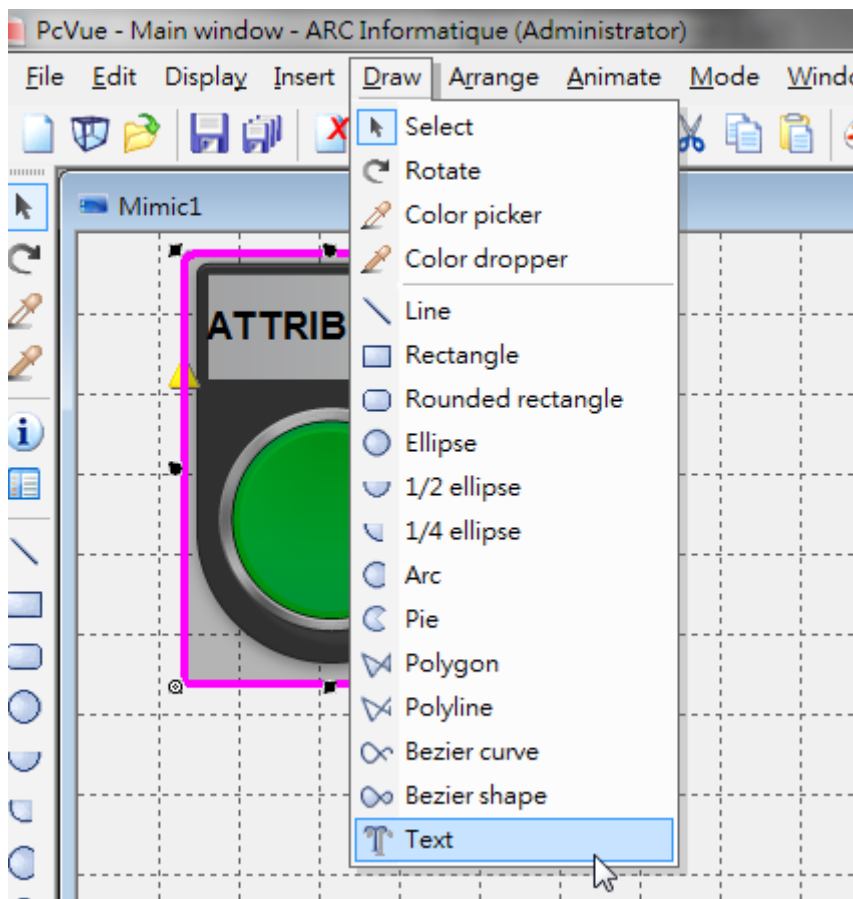
Input text as "**######**".

Right-click this text object, click **Animate → Text → Register Value**.
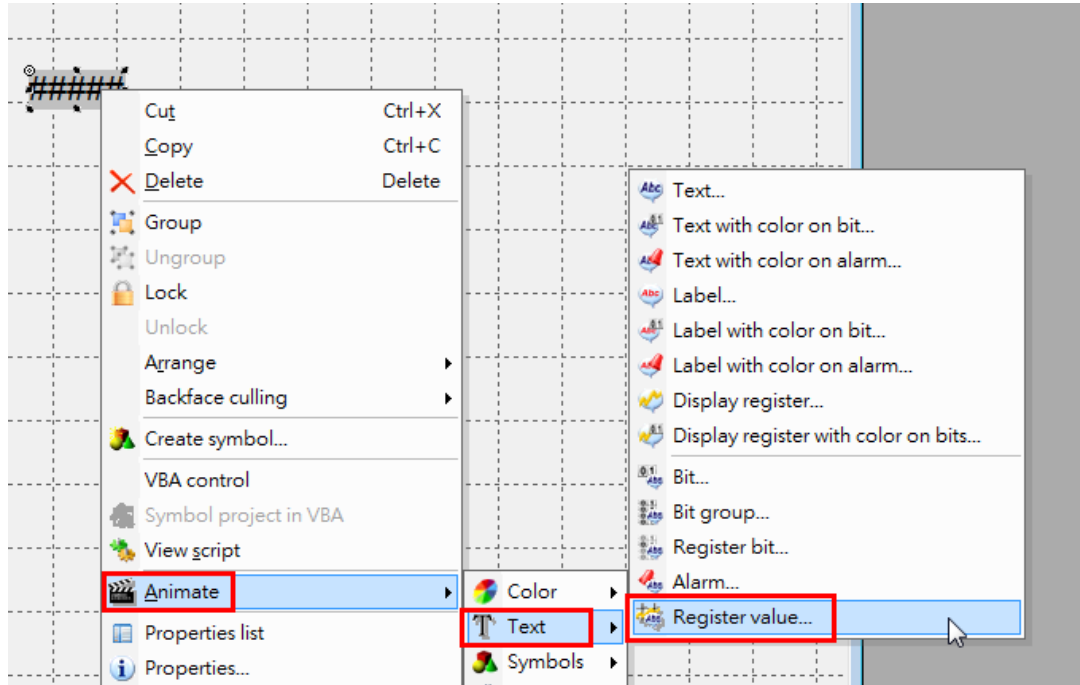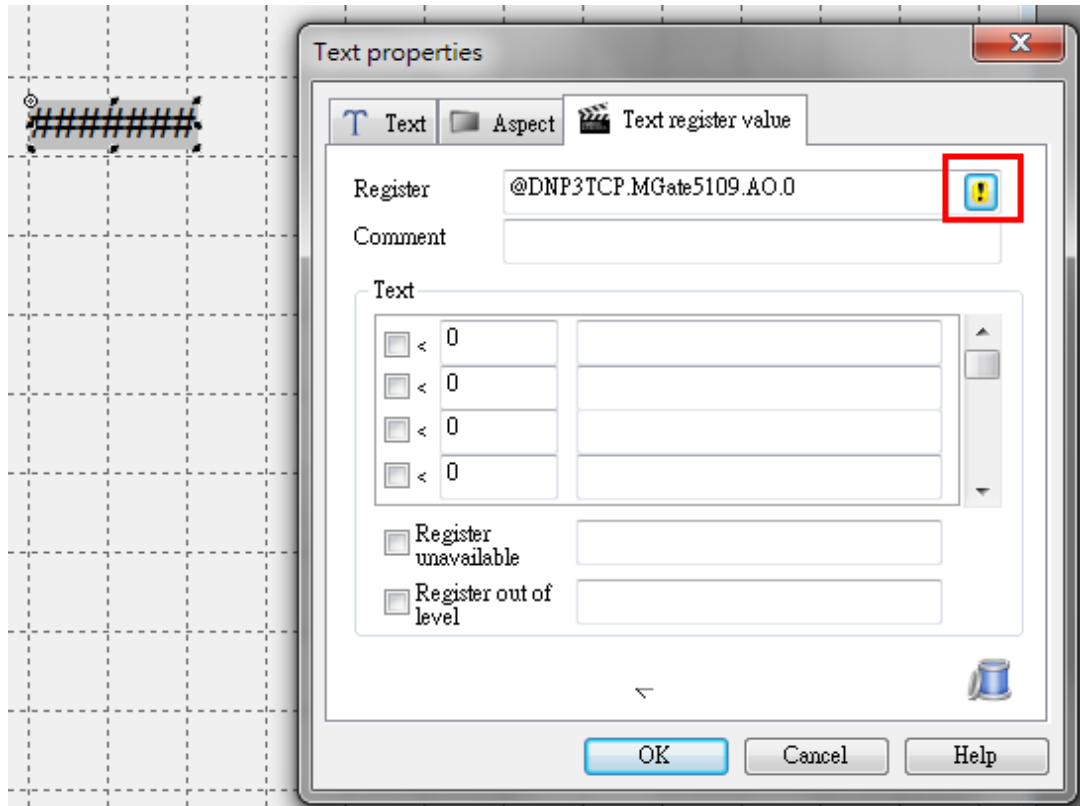
Select the AO 0 variable in the **Register** field.

Right-click this text object and click **Animate → Send → Register**.
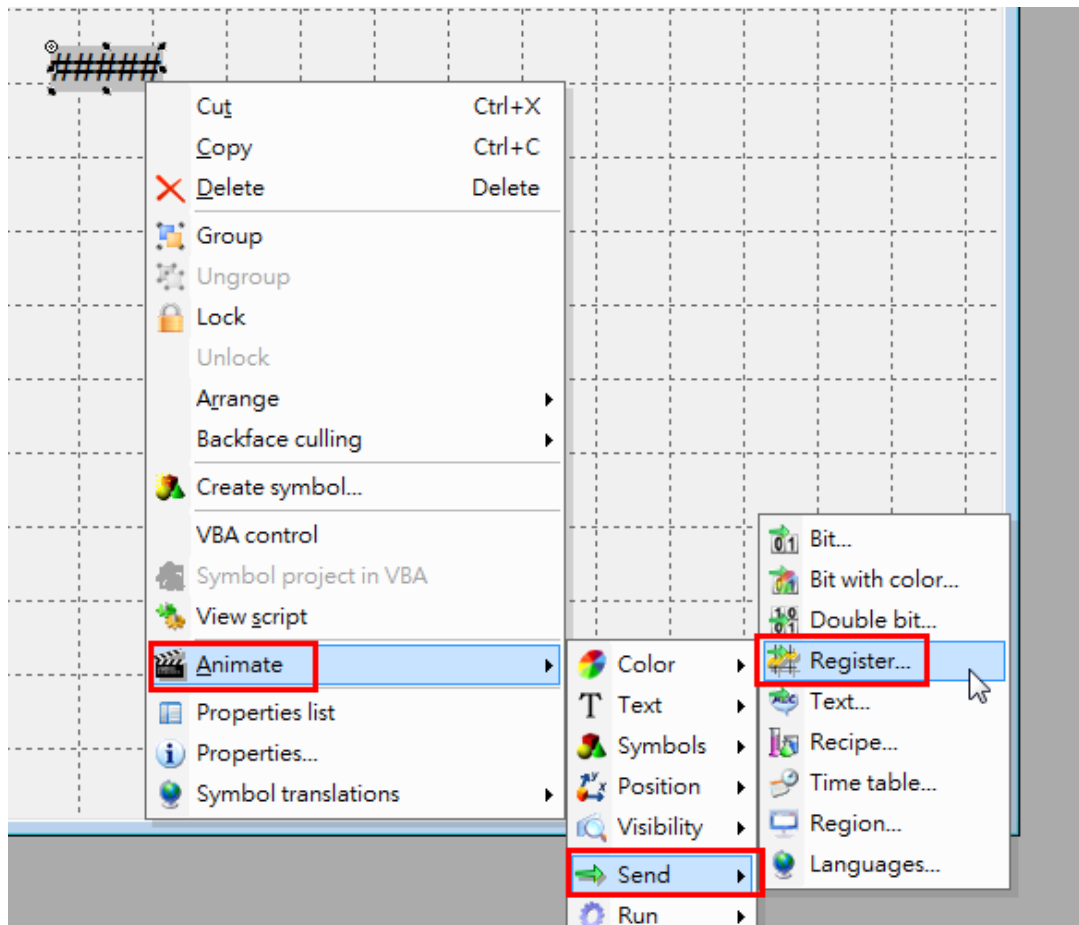
Select the AO 0 variable in the **Register** field. Select **Keyboard** as the **Sending mode**.
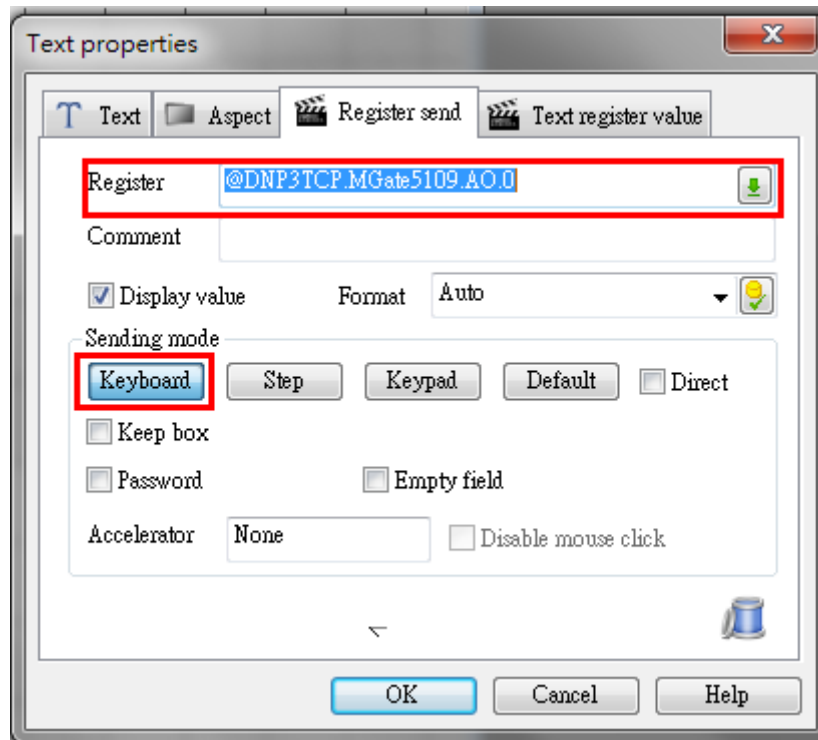
Right-click on **Mimic** to execute **Run mode**.

This text object will show the current status as **0**. When you right-click on it, a keyboard to input **Control value** will pop up. Input **123** and click **OK**.
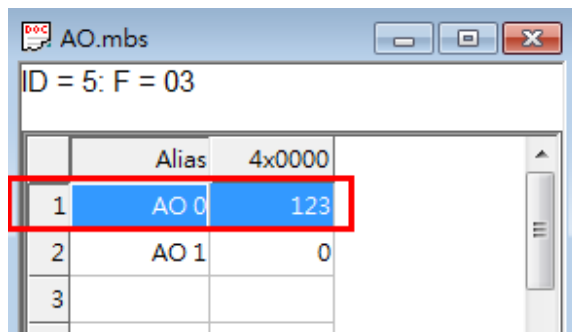
MGate DNP3 Diagnose:

Point Index	Value	Flags	Time Updated
0	123	ONLINE	2017-01-06 11:39:11
1	0	ONLINE	2017-01-06 11:39:11

Point Information

Analog Output

Modbus Slave-AO:

AO.mbs

ID = 5: F = 03

	Alias	4x0000
1	AO 0	123
2	AO 1	0
3		

After **Integrated Poll** (interval as 60000 ms), this text object's value will be updated as **123**.

ATTRIBUT 14

123