

Modbus Slave Simulator User Manual

Version 1.01 09.04.2025

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Introduction

This simulator has been developed as a bachelor thesis project through HVL Haugesund by Albert Haugland Kristiansen and Sebastian Waszkiewicz. The simulator has the purpose of testing signals within a given IO-list to verify program functionality and signals reading appropriate values. Within this user manual you will find instructions on how to operate the GUI of the program, and the functions within the program.

1 System Requirements

- System with Windows 10 or above
- .Net 8 Runtime, program will prompt you to install it on first launch. If not visit this website: <https://dotnet.microsoft.com/en-us/download/dotnet/8.0>

2 Packages used in the project

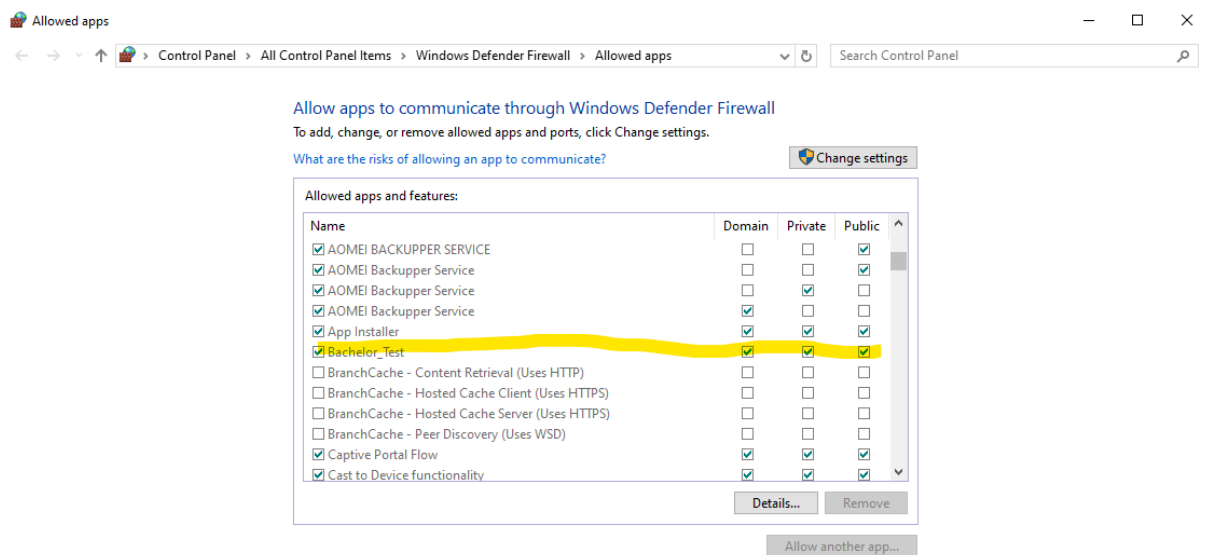
The following libraries/packages are being used:

- NModbus4: For the modbus communication part.
- System.Data.OleDb: For accessing the IO-lists in MS Access.
- System.IO.Ports: For opening the COM port of the computer for the RTU slave.
- System.Net.Sockets: For opening the IP address socket for listening.
- System.Management: For finding the description of the COM port mainly.

3 Firewall enabling

When installing the simulator there may be a need for letting the program through the firewall. To do this do the following:

1. Open Windows Control Panel
2. Press System and Security
3. Locate “Windows Defender Firewall”
4. Press the “Allow and app through Windows Firewall”
5. Allow the “Wartsila simulator.exe” file through. *The file may be named “Bachelor_Test”.*



4 GUI Explanation

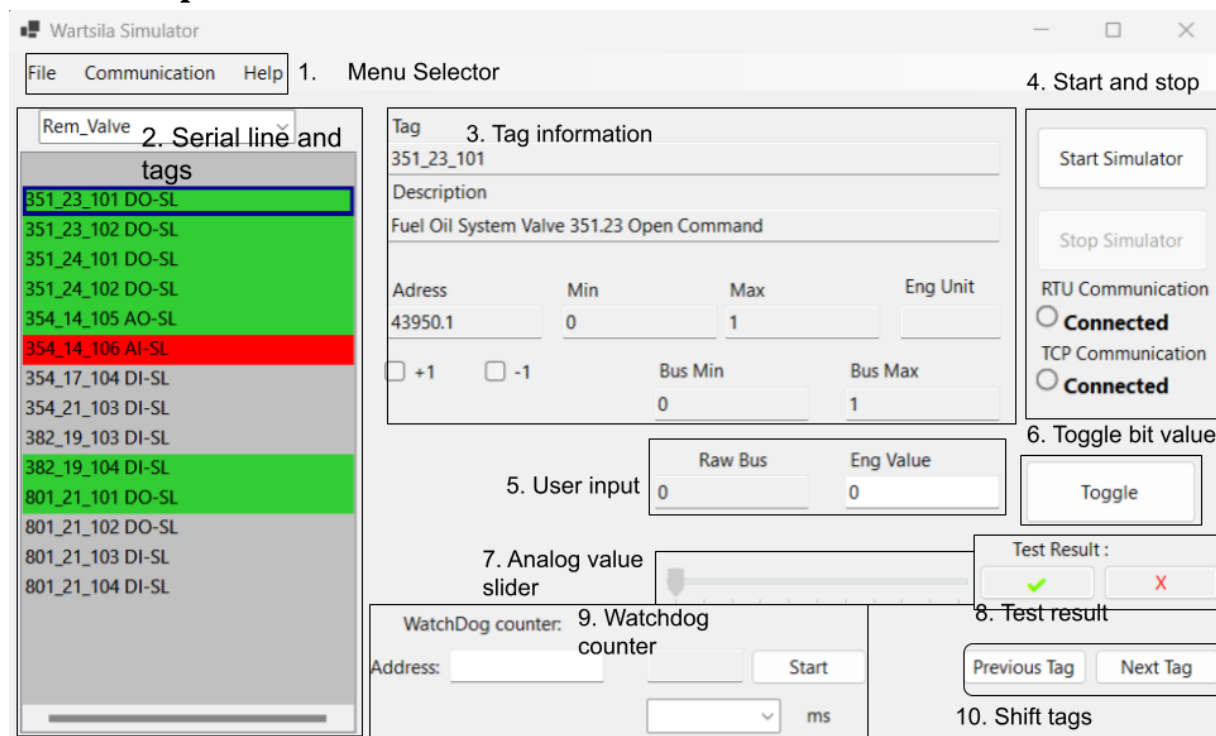


Figure 1 – Sections of the GUI

1. Menu selector is for the purpose of importing an IO list and setting the communications parameters

Menu option	Description
File	Undermenu: <ol style="list-style-type: none"> 1. Import IO list: Lets you import an IO list of your choosing from MS Access 2. Exit: Exits the program
Communication	Allows you to adjust the parameters for the COM port on the RTU side and set an IP address for the TCP side.
Help	Undermenu: <ol style="list-style-type: none"> 1. User manual: Opens this document

2. Serial line dropdown box: When an IO list has been imported, all serial lines within the list will show up in the dropdown box for selection.
Tag list: When a serial line has been selected all tags belonging to the serial line will show up in the listbox.

3. Tag information: When a tag has been selected from the list, all information about the tag will automatically fill out to each textbox. There is also an option for adding 1 or subtracting 1 from the address that is filled in from the tag. This is primarily if the value is not responding to the corresponding tag and modbus protocols having the register 1 higher than its actual value. Most of the time this will not be an issue.
4. Start and stop button: This will start or stop the simulator. You will need to have gone through the communication settings before the simulator can be started. When the simulator is receiving communication request via RTU or TCP the corresponding light will lit green.
5. User input: In the textbox "Eng Value" you can type in the value you want to send to the PLC. The "Raw Bus" textbox will automatically scale the value you have inputted.
6. Toggle bit values: This button will allow you to change the state of the tag. *This only applies to tags that have a dotted address for example "40001.2"*. The button will change the state from HIGH to LOW if it was HIGH and LOW to HIGH if it was LOW.
7. Analog value slider: Allows you to easily adjust values for a analog signal by sliding it along the bar.
8. Test result: The two buttons will allow you to input either "OK" or "Not OK" to the IO list you selected in the column: "W_Citech_Test".
9. Watchdog counter: This will allow you to assign a watchdog counter to any given tag of choosing and any given interval. Simply type in the address you want the watchdog counter to be assigned and choose an interval in the dropdown box.
10. Shift tags: Used to select next or previous tag in the list

5 Starting the simulator

1. Press the communications button in the file menu

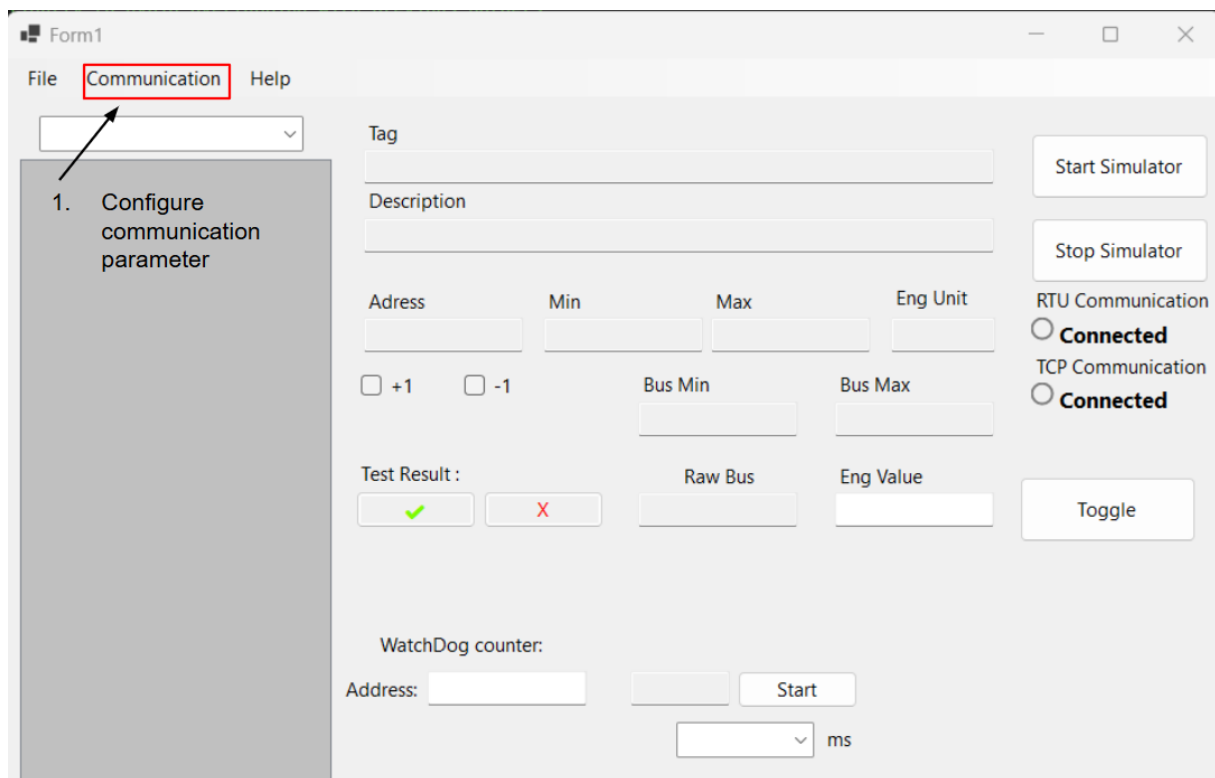


Figure 2 – Opening commincation menu

2. Configure the different parameters shown in figure 3

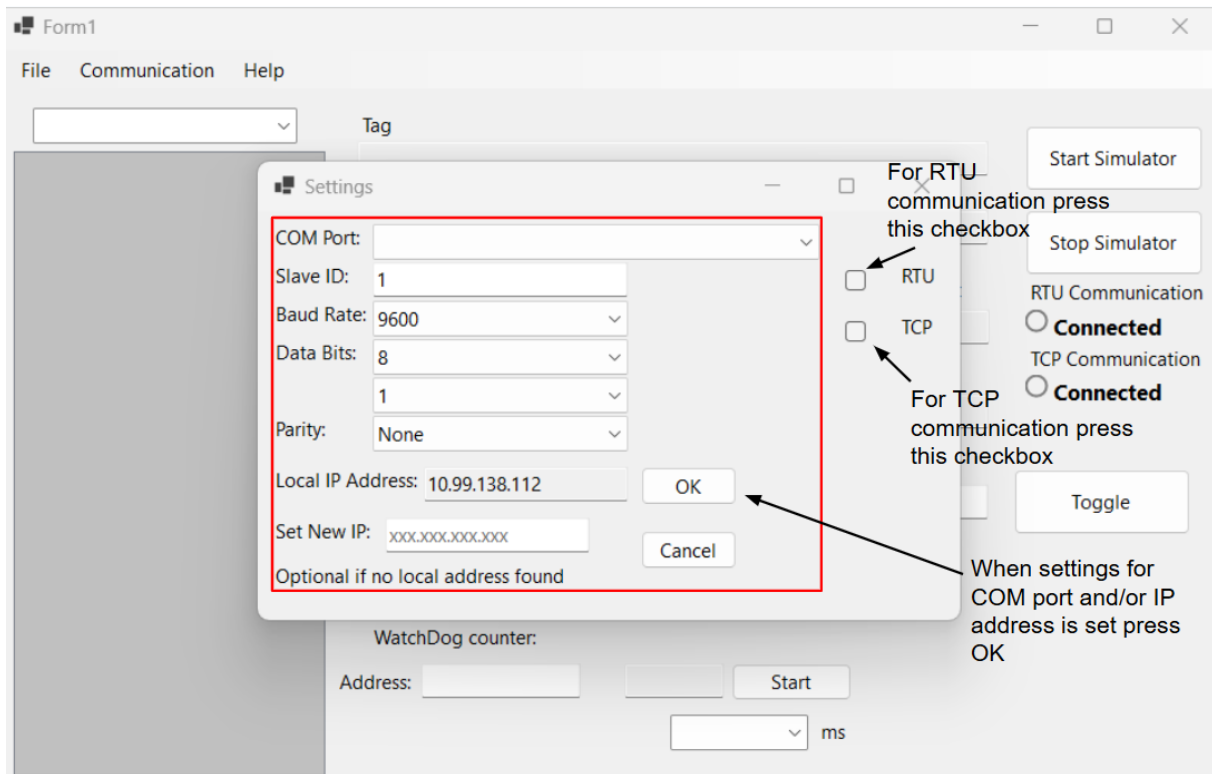


Figure 3 – Configuring the COM port and IP address

3. Set up the COM port with correct parameters for your PLC
4. The IP address fetches your “Ethernet” IP address by default, if this is the wrong IP address you can manually override it with typing an IP in the “Set New IP” textbox.
5. Choose which communications channels you want to open (RTU/TCP) by checking the boxes
6. Press the OK button
7. Press “Start Simulator”, when simulator is receiving requests from RTU or TCP side the “Connected” checkbox will be lit green as shown in figure 4

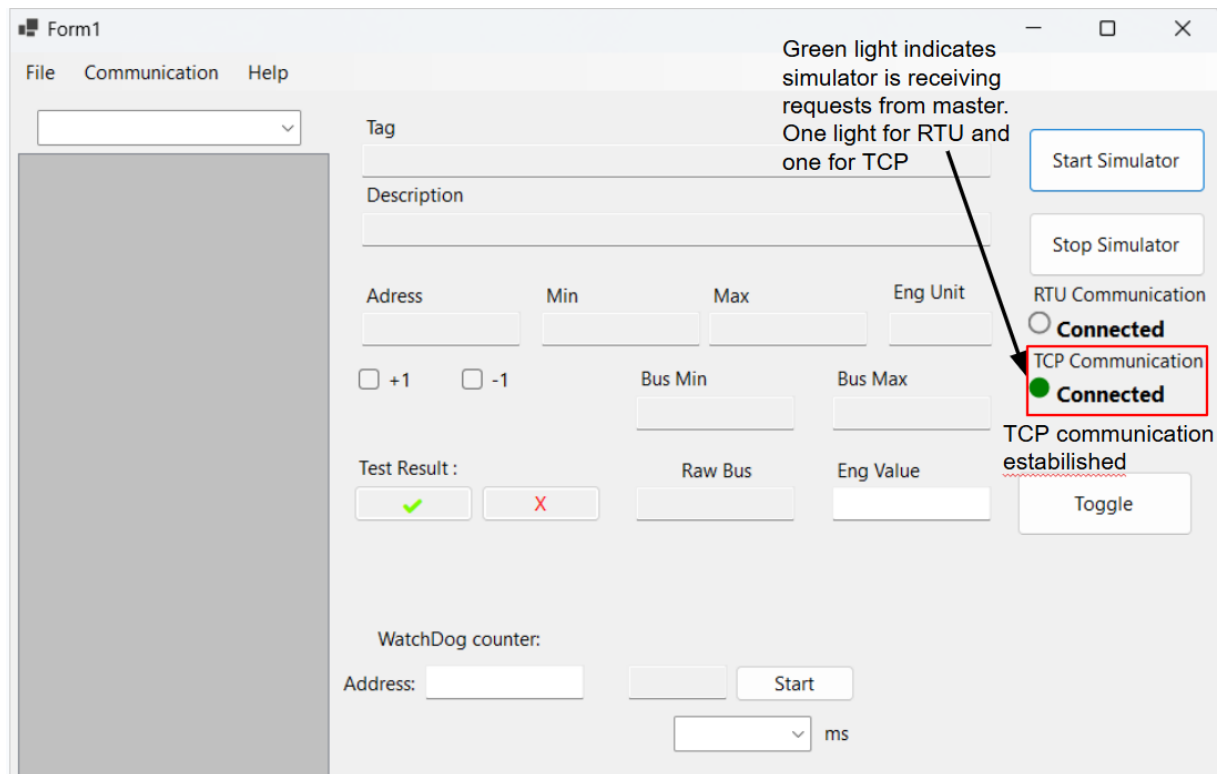


Figure 4 – Slave is connected and receiving requests from master on TCP side

This is the first step to start communication between the PLC and simulator. For the simulator to connect to the PLC all parameters must match the configuration set in the program of the PLC. Once the parameters have been configured and the start button has been pressed the simulator will eventually receive communication requests. This may take some time for the RTU communication side for various reasons, PLC model, program setup for PLC etc. You may have to wait for some time before the simulator receives requests from the RTU channel.

6 Loading IO list

The simulator will accept .mdb files for databases in Access. The default path has been loaded as: "C:\\Marine\\Projects" when the button is pressed.

1. Press the file menu, then press the "Import IO-list" undermenu

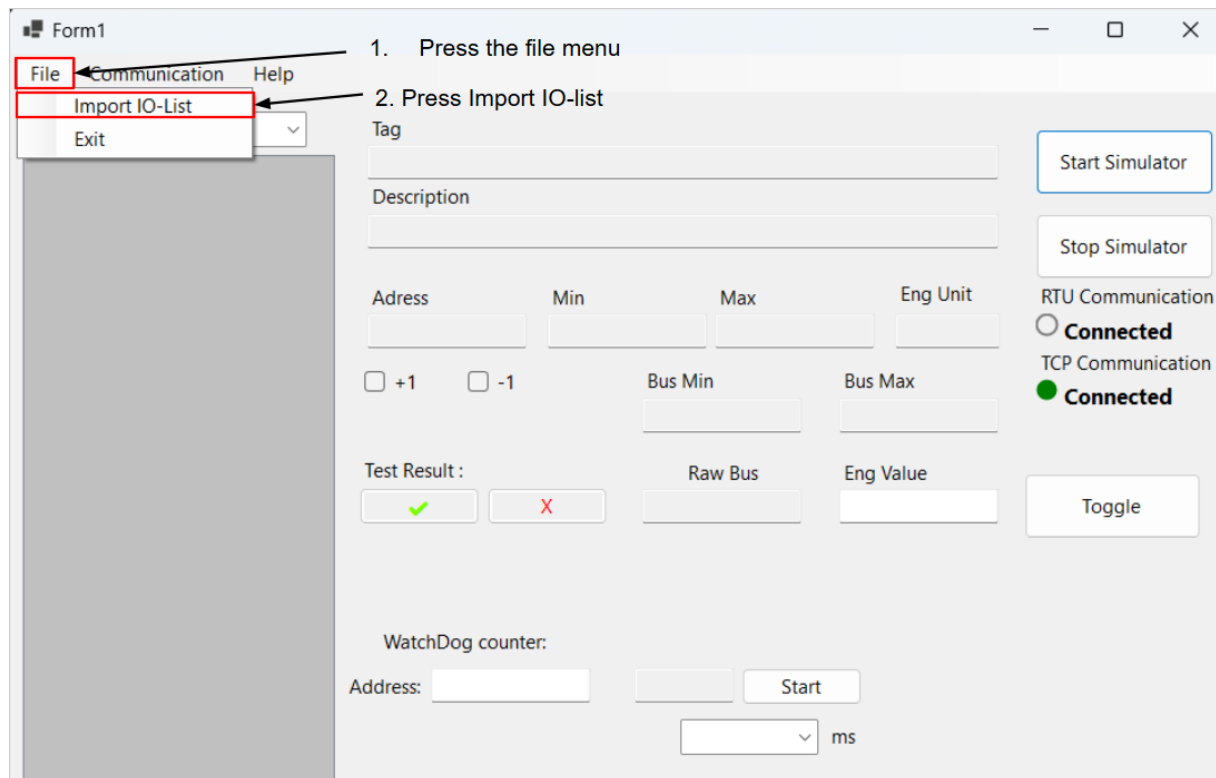


Figure 5 – Importing IO-list from database

2. Select the IO-list you want by accessing the folders for the selected project project.

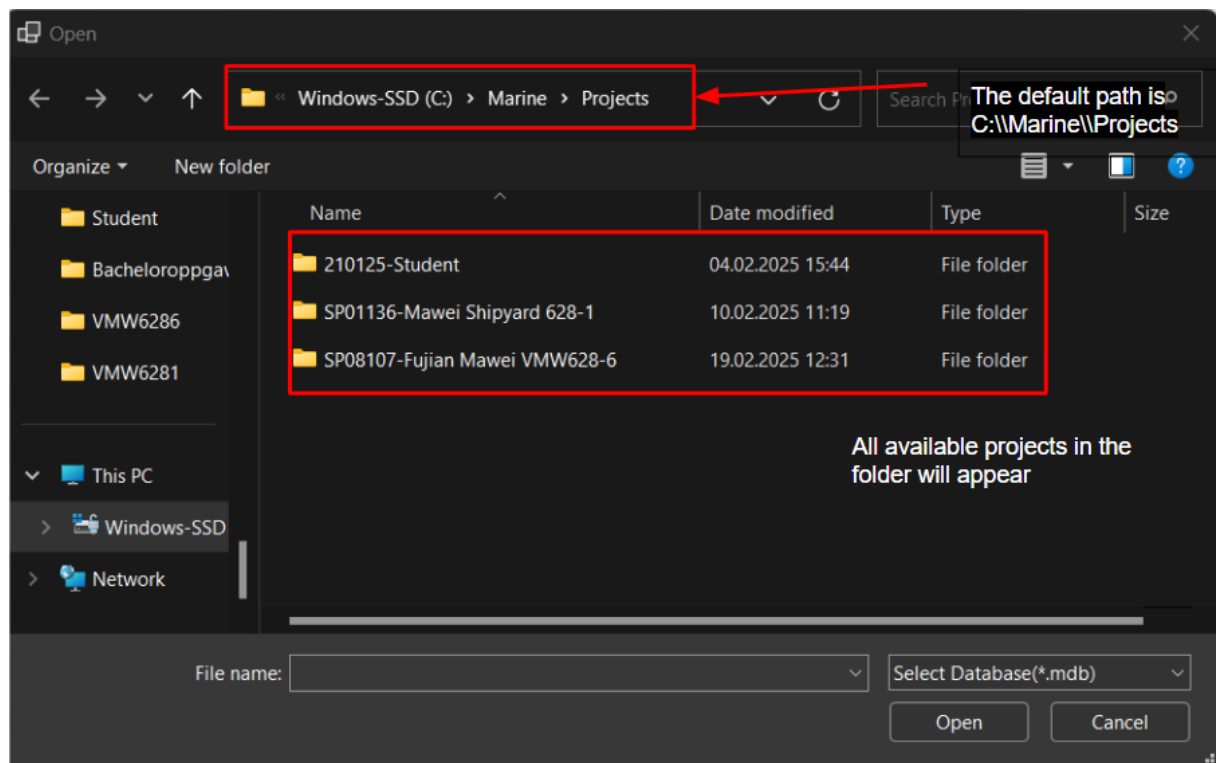


Figure 6 – Folder window for importing IO-lists

Simply select the .mdb file of the IO-list you wish to import and the program will save all the signals contained within the list.

7 Using the simulator

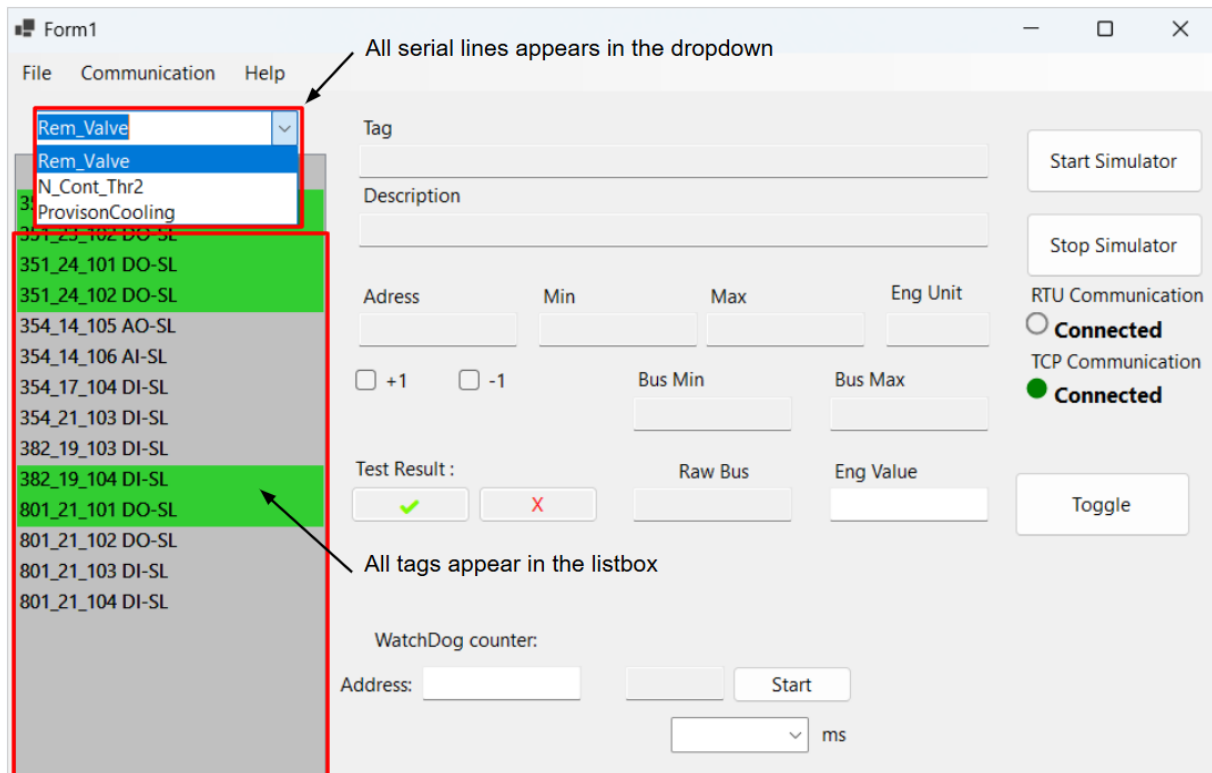


Figure 7 – Serial lines and tags

1. Once IO-list has been imported, press the dropdown box shown in figure 7 and select the serial line you want to test. Tags will fill in the box under when you have selected a serial line
2. Select the tag you want to test, information about the tag will show up in the boxes to the right of the tag list. This can be done by either clicking, double clicking or using arrow up and down keys when one tag has been clicked already

Form1

File Communication Help

N_Cont_Thr2

404_001_020_2_359 DI-SL
404_001_020_20_351 DI-SL
404_001_020_23_351 DI-SL
404_001_020_26_351 DI-SL
404_001_020_28_351 DI-SL
404_001_020_29_351 DI-SL
404_001_020_31_351 DI-SL
404_001_020_32_351 DI-SL
404_001_020_35_351 DI-SL
404_001_020_4_359 DI-SL
404_001_020_5_209 DI-SL
404_001_020_6_207 DI-SL
404_001_020_70_358 AI-SL
404_001_020_70_375 AO-SL
404_001_020_71_358 AI-SL
404_001_020_80_359 DI-SL
404_001_020_9_359 DI-SL
404_001_020_90_359 DI-SL

Tag
404_001_020_70_375

Description
Bow Thr.2 Contr. Motor RPM Demand

Address 40003 Min -100 Max 100 Eng Unit %

☐ +1 ☐ -1 Bus Min -10000 Bus Max 10000

Test Result : ☒ ☐

Buttons used for the result of the test

Raw Bus 1000

Raw bus value automatically scales when value is entered

Eng Value 10

User can type in values to send to PLC

Toggle

Toggle button can be used for dot addresses for ON/OFF

WatchDog counter:
Address: Start

ms

Tag selected

All information about the tag autofills when selected

Start Simulator

Stop Simulator

RTU Communication ☐ Connected

TCP Communication ☒ Connected

Figure 8 – Testing a signal

3. Type in the value you want to send to PLC in the “Eng Value” box and press “ENTER” to send it. “Raw Bus” box will automatically scale the value based on the min/max values.
4. Test it to the extend you need, if the signal is OK and corresponding to how it should function press the green checkbox under the “Test Result” section to verify the signal is OK. If the signal is not correct press the red X checkbox to log “Not OK”. This information will be saved in the column “W_Citech_Test” in the IO list you selected.
5. Go through all the tags you want and test them

If you wish to change communication channels at any point when the simulator is running, the simulator must be stopped and communication parameters need to be set again. This means for example if you were using the simulator with TCP channel, and you now wish to change to using both RTU and TCP the simulator must be stopped and parameters set in the communication menu.

The simulator is fairly simple to operate once communication has been established as in chapter 3 and IO-list imported as in chapter 4. Simply just choose the tag you want to test, write in the value and press ENTER to save the value and it will be sent when the PLC requests it. This way you can effectively test each one of the signals within the IO-list you choose and save the result directly back into the IO-list when you are satisfied with the testing.

8 Watchdog Counter

The screenshot shows the 'Form1' window of the Modbus Slave Simulator. The 'File', 'Communication', and 'Help' menus are at the top. A list of tags is on the left, with '404_001_020_70_375 AO-SL' selected. The main configuration area includes fields for 'Tag' (404_001_020_70_375), 'Description' (Bow Thr.2 Contr. Motor RPM Demand), 'Address' (40003), 'Min' (-100), 'Max' (100), 'Eng Unit' (%), 'Bus Min' (-10000), 'Bus Max' (10000), 'Raw Bus' (1000), and 'Eng Value' (10). There are checkboxes for '+1' and '-1', and a 'Test Result' section with green and red status indicators. A 'WatchDog counter:' section has an 'Address' field set to '8001' and a 'Start' button. A '200 ms' interval is also shown. A 'Toggle' button is on the right. A green 'Connected' status indicator is present.

Figure 9 – Configuring the watchdog

1. Type in the address you want the watchdog counter assigned to (Without the leading 4 digit)
2. Select the interval of how often the watchdog should check if there is connection
3. Press the start button to start the counter
4. If communication breaks the watchdog will attempt to restart the simulator 3 times to reestablish connection, if this fails a warning will display.

The watchdog has been constructed with the intent to support whatever register address of choosing. This way for whatever project you have loaded you can choose the address for the watchdog to count. The simulator will warn you if it has attempted restart and is not able to establish connection again, this way if the simulator itself had a problem with the connection it will attempt to fix itself by restarting.

9 Troubleshooting

This chapter will give information on how to fix simple issues that might occur while you are using the application

9.1 Connection problem

If you are struggling to get a connection between the PLC and the simulator, make sure the following things are correct:

- Is the IP fetched in the communication settings the correct IP you want to use? If not use the textbox "Set New IP" to manually override which IP to use
- Is the settings for the COM port correctly set up with the settings in the PLC program?

9.2 Communication timeouts

If you are experiencing that the TCP side of the simulator is not sending any values to the PLC, try to stop the simulator and start it again. There might happen something that suddenly makes the communication timeout, simply try to restart it. If that does not fix it then the issue might lay elsewhere like the PLC or the Ethernet itself.

9.3 Watchdog counter not counting?

If you are experiencing that the watchdog is ticking in the application, but you are not seeing this in the PLC make sure of the following things:

- Have you written in the address correctly? Make sure you are writing only the numbers after the leading 4 number. This means if the address is 40478 for the watchdog you only write 0478 or 478 in the textbox for the address of the watchdog