

APPENDIX

APPENDIX A
Process Equipment

The equipment in this process can be divided into six groups as follow

1. Computer
2. Controller
3. Basic equipment
4. Utility Hardware
5. Signal conditioning
6. Final control element
7. Sensor and/or transmitter

1. Computer

The computer specification is described as follow.

Computer Name: COMPUTER-372D5B

Operating System: Microsoft Windows XP Professional (5.1, Build 2600)

Language: English

System Manufacturer: stem manufacturer

System Model: System Product Name

BIOS: BIOS Date: 09/22/06 08:55:55 Ver: 08.00.12

Processor: Intel® Pentium® D CPU 3.40GHz (2 CPUs)

Memory: 1024MB RAM

Page file: 584MB used, 4876MB available

DirectX Version: DirectX 9.0c (4.09.0000.0904)

2. Controller

There are two controller was used in this work. Yokogawa YS150 controller control the level in the first tank and Sigma SFN48-M-RRA-N controller control the temperature in the second tank. These controllers have the feature in the Appendix Figure A1 and Appendix Figure A2 respectively.



Appendix Figure A1 Yokogawa YS150



Appendix Figure A2 Sigma SFN48-M-RRA-N

2. Basic equipment

Basic equipment will support process to be able to operate. All of equipment in this group is not involve with current signal the example of this group such as PVC pipe, electric wire, stainless steel tank, globe valve, and air tube.

3. Utility hardware

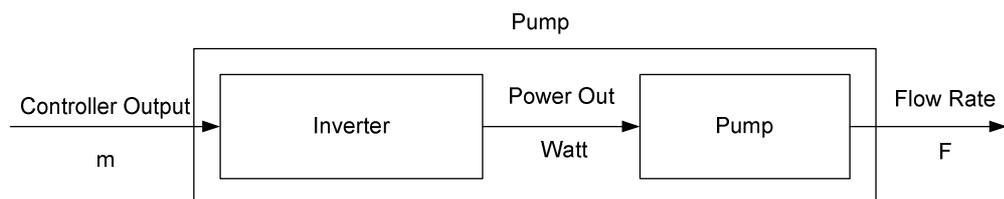
This process consists of two hardware, pump and air compressor. The function of them is the supporting the process for example, air compressor provide the air supply to control valve.

3.1 Pump

In this work is used a centrifugal pump which is one of the simplest pieces of equipment to support the process. Appendix Figure A2 shows the centrifugal and Appendix Figure A3 shows the wiring of pump with inverter.



Appendix Figure A3 Centrifugal pump



Appendix Figure A4 Pump connecting schematic

3.2 Air compressor

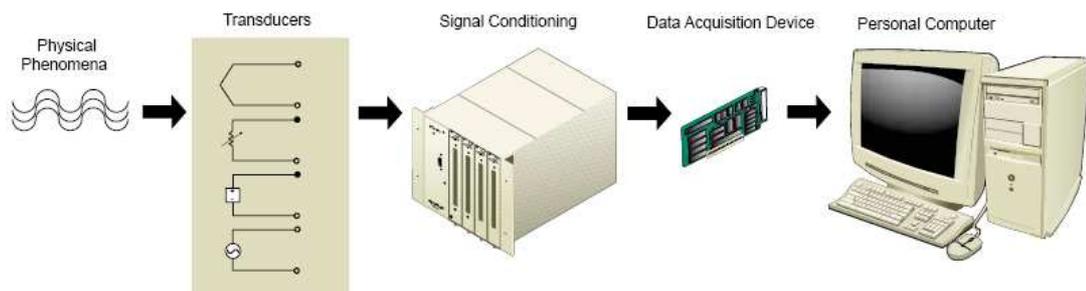
Centrifugal compressors produce high-pressure discharge by converting angular momentum imparted by the rotating impeller (dynamic displacement), as illustrated in the figure below.



Appendix Figure A5 Air compressor

4. Signal conditioning

The SCXI is a part of data acquisition system shown in Appendix Figure A5. It is used to communicate between process signal and computer. The detail will focus on the function of SCXI.



Appendix Figure A6 Signal conditioning component of a PC-based DAQ system.

Source: National Instrument (2000)



Appendix Figure A7 The signal conditioning using in this work

Sometimes transducers generate signals too difficult or too dangerous to measure directly with a DAQ device. For instance, when dealing with high voltages, noisy environments, and extreme high and low signals, or simultaneous signal measurement, signal conditioning is essential for an effective DAQ system. Signal conditioning maximizes the accuracy of a system, allows sensors to operate properly, and guarantees safety. It is important to select the right hardware for signal conditioning. Signal conditioning is offered in both modular and integrated forms. Signal conditioning accessories can be used in a variety of applications including:

- Amplification
- Attenuation
- Isolation
- Multiplexing
- Simultaneous sampling

Regardless of the types of sensors or transducers, the proper signal conditioning equipment can improve the quality and performance of system. Signal conditioning functions are useful for all types of signals, including amplification, filtering, and isolation.

4.1 Amplification

Because real-world signals are often very small in magnitude, signal conditioning can improve the accuracy of data. Amplifiers boost the level of the input signal to better match the range of the analog-to-digital converter (ADC), thus increasing the resolution and sensitivity of the measurement. While many DAQ devices include onboard amplifiers for this reason, many transducers, such as thermocouples, require Additional amplification.

In addition, using external signal conditioners located closer to the signal source, or transducer, improves the signal-to-noise ratio of the measurement by boosting the signal level before it is affected by environmental noise.

4.2 Attenuation

Attenuation is the opposite of amplification. It is necessary when the voltages to be digitized are beyond the input range of the digitizer. Attenuation is necessary for measuring high voltages.

4.3 Filtering

Additionally, signal conditioners can include filters to reject unwanted noise within a certain frequency range. Almost all DAQ applications are subject to some level of 50 or 60 Hz noise picked up from power lines or machinery. Therefore, most conditioners include low-pass filters designed specifically to provide maximum rejection of 50 to 60Hz noise.

4.4 Isolation

Improper grounding of the system is one of the most common causes for measurement problems, including noise and damaged measurement devices. Signal conditioners with isolation can prevent most of these problems. Such devices pass the

signal from its source to the measurement device without a physical connection by using transformer, optical, or capacitive coupling techniques. Besides breaking ground loops, isolation blocks high-voltage surges and rejects high common-mode voltage and thus protects both the operators and expensive measurement equipment.

4.5 Multiplexing

Typically, the digitizer is the most expensive part of a data acquisition system. By multiplexing, you can sequentially route a number of signals into a single digitizer, thus achieving a cost-effective way to greatly expand the signal count of your system. Multiplexing is necessary for any high-channel-count application.

4.6 Simultaneous Sampling

When it is critical to measure two or more signals at the same instant in time, simultaneous sampling is required. Front-end signal conditioning can provide a much more cost-effective simultaneous sampling solution than purchasing a digitizer for each channel. Typical applications that might require simultaneous sampling include vibration measurements and phase difference measurements.

5. Final control elements

The final control element comes in a variety of forms depending on the specific control application. The most common type of the final control element in chemical processing is the pneumatic control valve, which regulates the flow of fluids. Some other types include the variable speed pump and the heater.

5.1 Control valve

Most control valves consist of a plug on the end of stem. The plug opens or closes an orifice opening as the stem is raised or lowered. Valves are designed to fail either in the completely open or the completely shut position. Which action is

appropriate depends on the effect of the manipulated variable on the safety of the process.

The increasing air pressure closes the valve, this is an air to close (AC) valve and vice versa called air to open (AO) valve. Thus, there are AO and AC valves are shown in Appendix Figure A7.

In this work, air to close control valve (CV1) is connected with SCXI-1325 at channel 1 and air to open control valve (CV2) is connected with SCXI-1325 at channel 2.



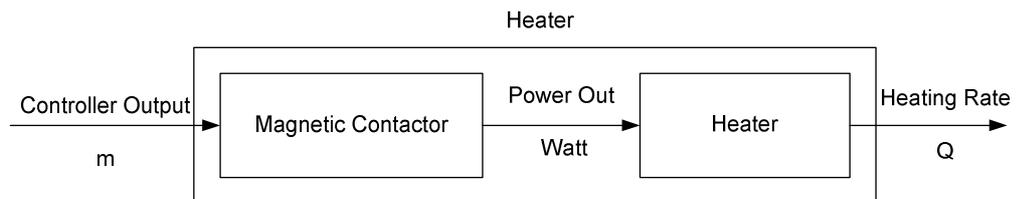
Appendix Figure A8 AO valve (left) and AC valve (right)

5.2 Heater

Flange immersion heater is used in applications that require the heater to be immersed in the substance to be heated. It is equipped with pipe threads, flanges or other mounting hardware. Flange immersion heater can use AC or DC voltage and single-phase or three-phase power. Most heaters used alternating current (AC) instead of direct current (DC). Appendix Figure A8 shows the flange immersion heater and its wiring of heater with magnetic contactor.



Appendix Figure A9 Flange heater

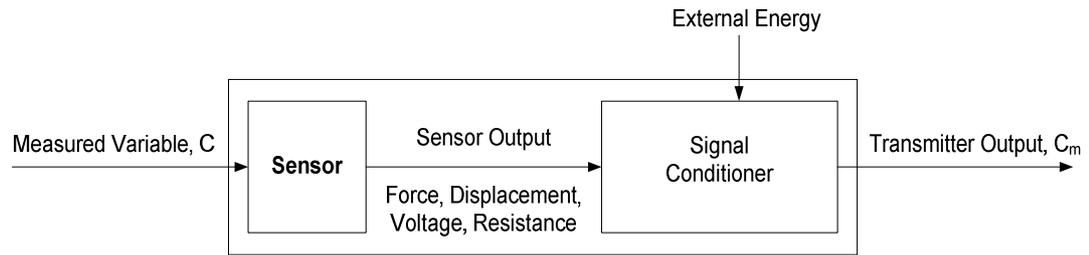


Appendix Figure A10 Heater connecting schematic

In this work, heater is connected with magnetic relay which is the contact on-off switch. The magnetic relay is connected with SCXI-1325 at channel 3.

6. Sensor and Transmitter

The sensor is a device that converts a signal to be measured into a signal in a different form. The input of the sensor is measured and the output is the signal produced by the sensor. The output of sensor can be force, displacement, voltage, electrical, or other physical quantity. Usually, a signal conditioner is required to convert the sensor output into an electrical or mechanical (pneumatic) signal suitable for use by a controller or display device. Sensors are also called transducers or primary elements. Figure 9 is shown block diagram of sensor/transmitter.



Appendix Figure A11 Block diagram of sensor/transmitter combination

In this work, there are two sensor used for measurement of level and temperature as follow.

6.1 Differential pressure transmitter

The suitable method in this process is pressure gauge method. Since, the pressure measured at the bottom of tank containing a liquid density and specific gravity is directly proportional to the level of liquid in the tank. This is the simplest method used for liquid level measurement in an open tank. Hydrostatic pressure of any liquid in an open tank is given by the equation:

$$P = \rho gh \quad (A1)$$

Where,

P = Pressure (N/m^2)

ρ = Liquid density (kg/m^3)

g = Specific gravity (m/s^2)

h = height of liquid (m)

This principle is utilized in pressure gauge instrument for level measurement. In this work, YOKOGAWA EJA110 differential pressure transmitter is connected with SCXI-1322 at channel 1 and ADZ-SMX-10.0 pressure transmitter connected with channel 2 at the first and second tank respectively. The level transmitters in this work are shown in Appendix Figures A10 and A11.



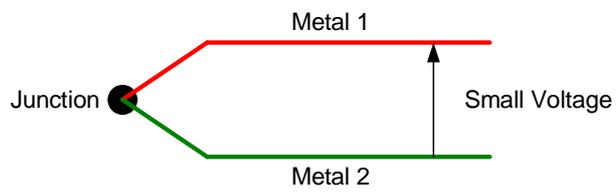
Appendix Figure A12 YOKOGAWA EJA110 differential pressure transmitter



Appendix Figure A13 NAGANO ADZ-SMX-10.0 pressure transmitter

6.2 Thermocouple type K

The working principle of a thermocouple depends on the thermo-electric effect. If two dissimilar metals are joined together so as to form a closed circuit, there will be two junctions where they meet each other. The amount of the current produced depends on the difference in temperature between two junctions and on the characteristics of the two metals. The typical thermocouple type K is shown in Appendix Figure A12.



Appendix Figure A14 Thermocouple type K

In this work, the thermocouple type K is used to measurement the temperature of liquid. The thermocouple type K is connected with SCXI-1322 at channel 3 and 4.

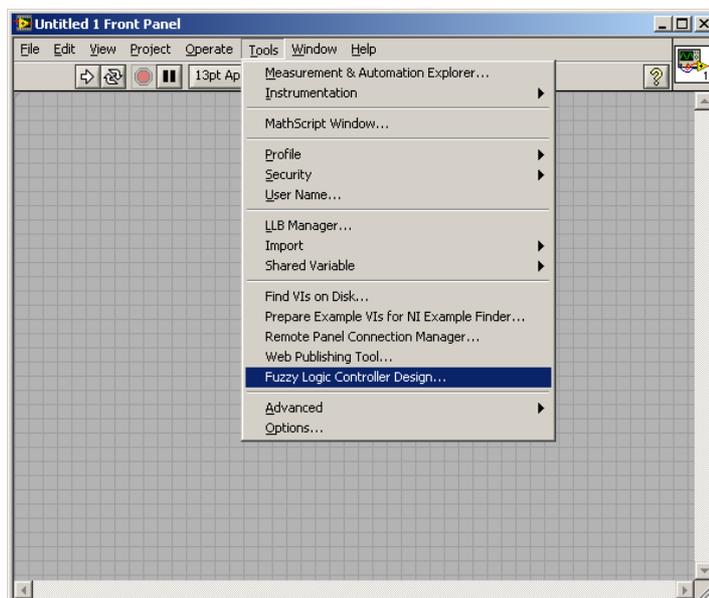
APPENDIX B

The Fuzzy-Set-Editor and Rulebase-Editor

The Fuzzy-Set-Editor can be set up to control process. The Fuzzy-Set-Editor consists of ANTECEDENCE, which is represented the error input and CONSEQUENCE, which is represented the control signal output page. The Rulebase-Editor is set the rule based for control.

Fuzzy Logic Control can control the process by setting the set and the rule. The procedure is shown as follows.

1. It has a way to use the fuzzy logic controller tool for control on web-based is shown in Figure B1: Click Tool → Fuzzy Logic Controller Design

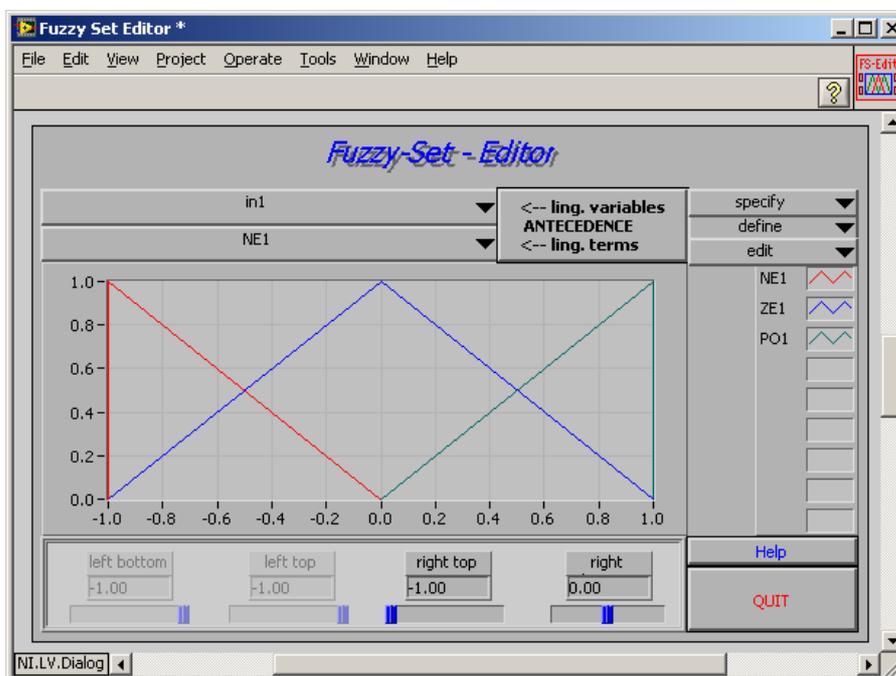


Appendix Figure B1 The opening Fuzzy Logic Controller Design

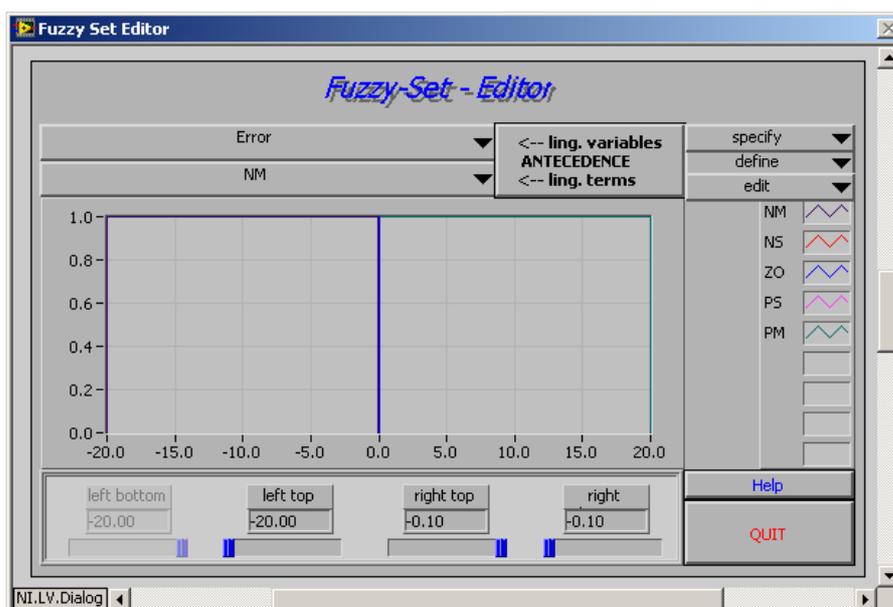
2. Then, Click File → new. Appendix Figure B2 shows the new project of Fuzzy-Set-Editor

3. Define the suitable quantitative variable for the process such as negative big, NB, negative medium, NM, negative small, NS, zero, ZO, positive small, PS, positive medium, PM, and positive big. Appendix Figure B3 shows the

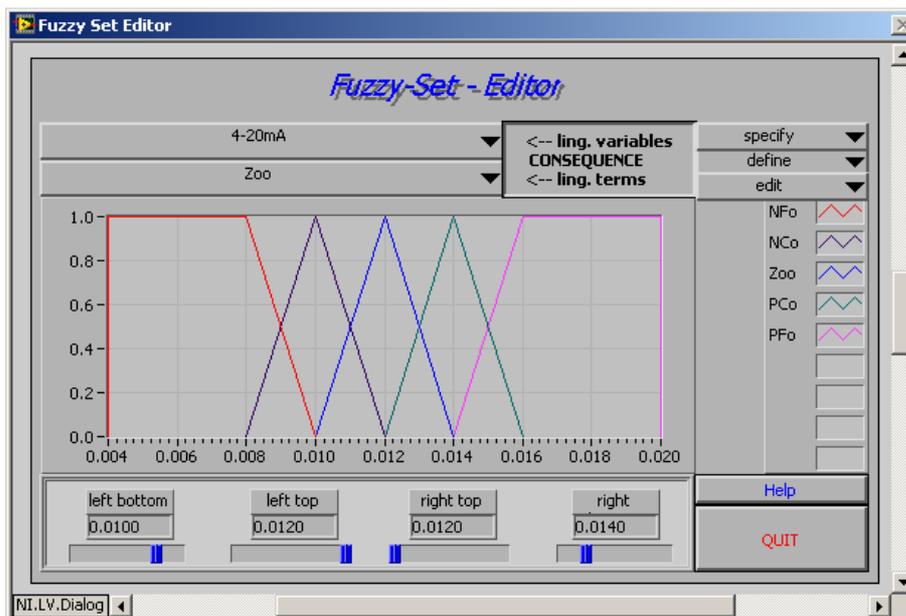
ANTECEDENCE setting, which is error and Appendix Figure B4 shows the CONSEQUENCE setting, which is 4-20 mA analog output signal.



Appendix Figure B2 The new project of Fuzzy-Set-Editor

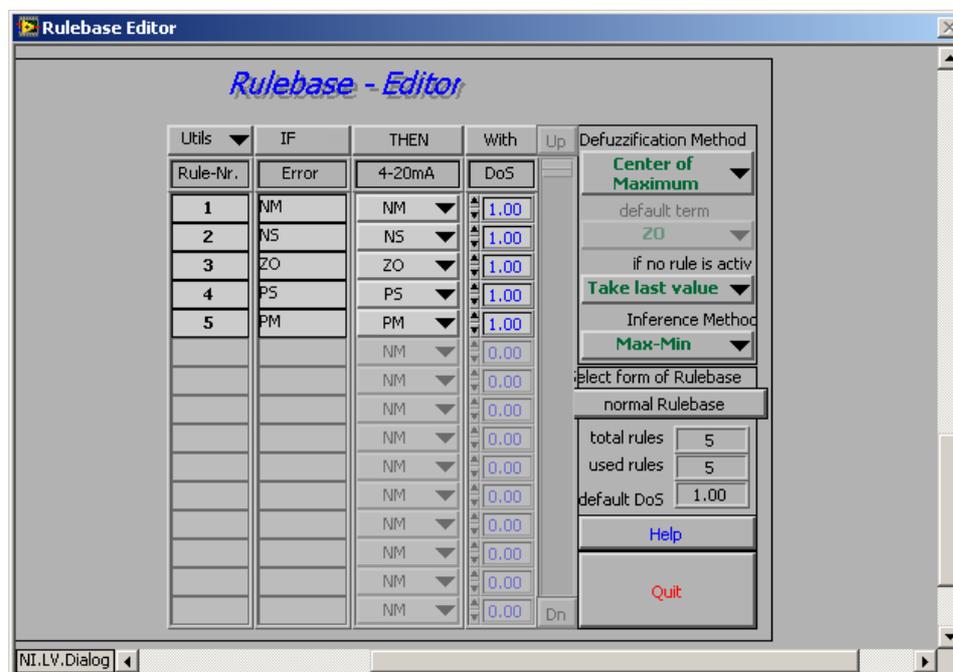


Appendix Figure B3 The setting error input of level control with Fuzzy-Set-Editor



Appendix Figure B4 The setting Analog signal output of level control with FSE

4. Set the Rule Base for the control case. For example, Rule number 1, If negative medium then 4-20 mA adjusted negative medium too.

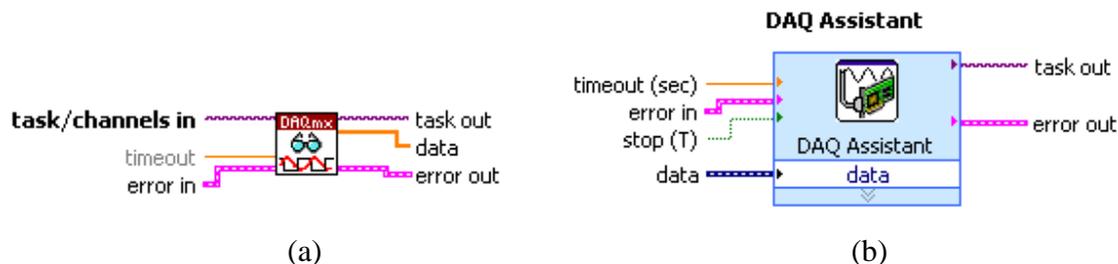


Appendix Figure B5 Setting the rule base of level control with Rulebase-Editor

APPENDIX C

National Instrument Data Acquisition (NI-DAQ) Assistant Setting

NI-DAQ assistant and DAQmx read is used in this work. Since DAQ assistant and DAQmx read are VIs in LabVIEW to communicate between signal conditioning and computer. DAQmx read and NI-DAQ assistant are shown in Appendix Figure C1.



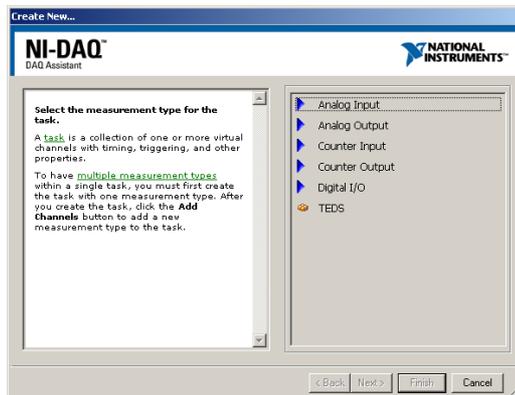
Appendix Figure C1 DAQmx read VI (a) and DAQ assistant VI (b)

For DAQmx read, “task in or DAQmx Task” that is established by user is used to receive analog signal from any tasks on the signal conditioning which connect with sensor/transducer and “data” is sent data array to each calibration block such as tank1, and temp1.

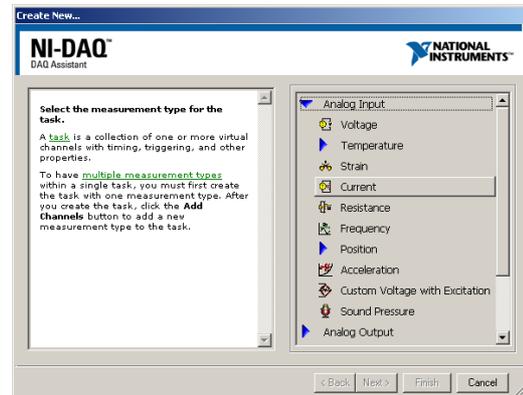
For DAQ Assistant, “data” is used for drive the final control element in order to manipulate system to stable condition. Most of ‘data’ is come from controller.

The procedure of “task in” set up

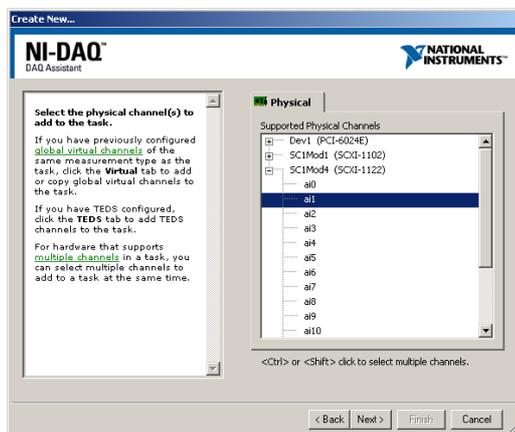
1. At block diagram part, right click-Measurement I/O → NI-DAQmx DAQmx Read.VI.
2. And again, right click-Measurement I/O → NI-DAQmx → DAQmx Task Name.
3. Create Task by choose Brown → Create New → MAX Task → Analog Input → Current → SCXI-1122 → ai1 → Enter Name and Finish.



(a)



(b)



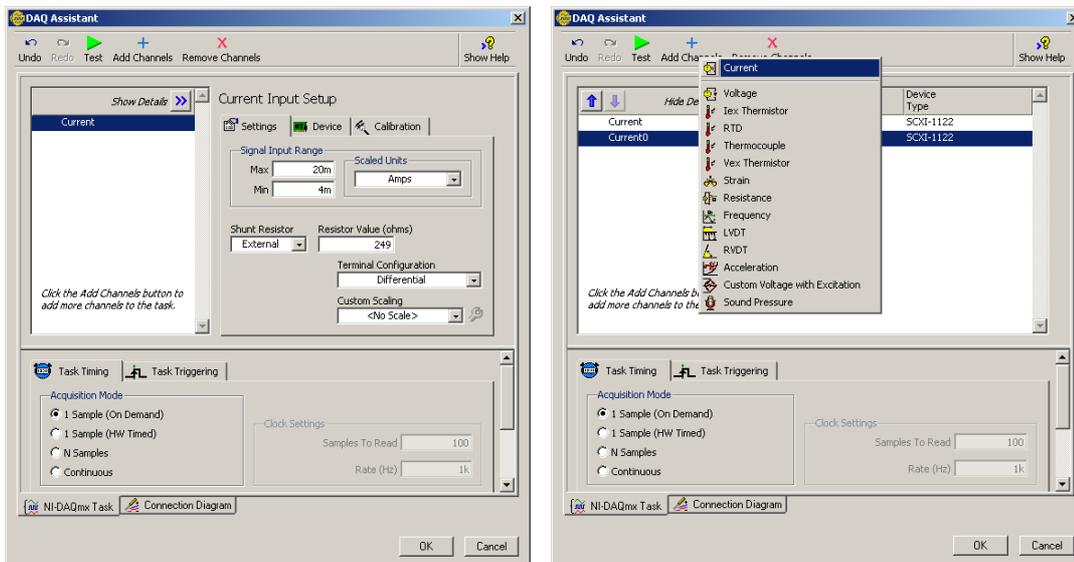
(c)



(d)

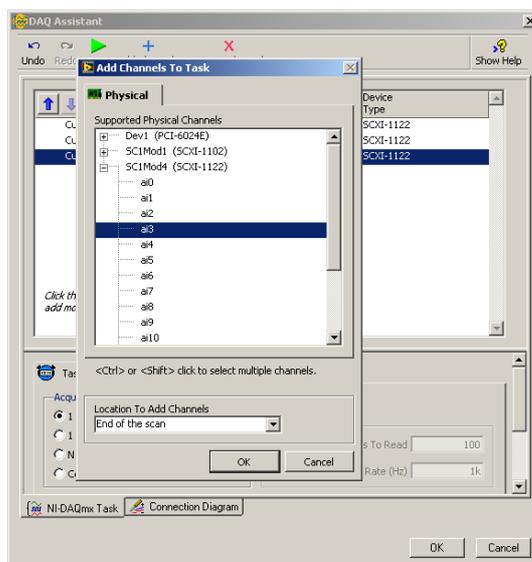
Appendix Figure C2 Task creation

4. The DAQ Assistant will appear. Set the input range as 4-20mA and choose one sample on demand
5. Click on Show Detail → Add Channel → Current → SCXI-1122 Channel 2.
6. And again in Channel 3 and 4 → OK.



(a)

(b)

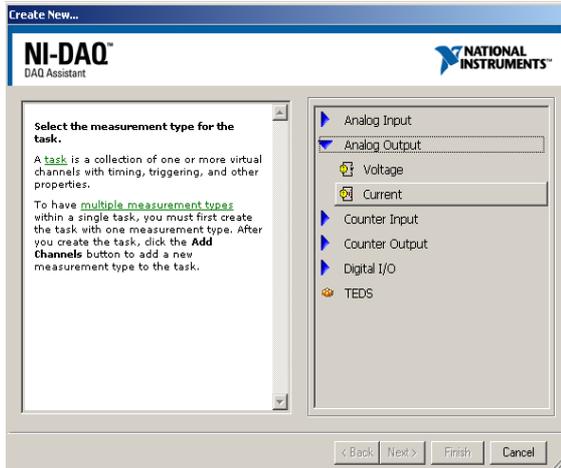


(c)

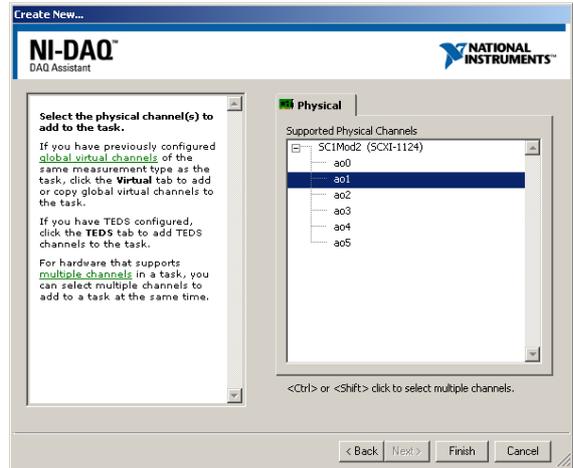
Appendix Figure C3 Adding Channel in the Task

The procedure of ‘DAQ Assistant’ set up

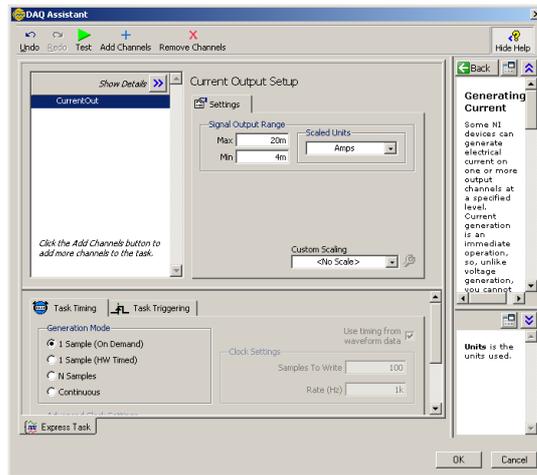
1. At block diagram part, right click → Express → Output → DAQ Assistant
2. The Figure 60a will appear. It has a different setting from previous.



(a)



(b)



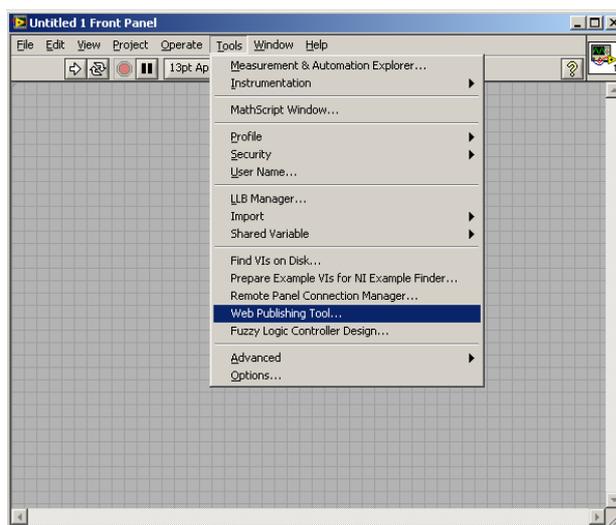
(c)

Appendix Figure C4 Creating DAQ Assistant for final control element

APPENDIX D
LabVIEW on web-based

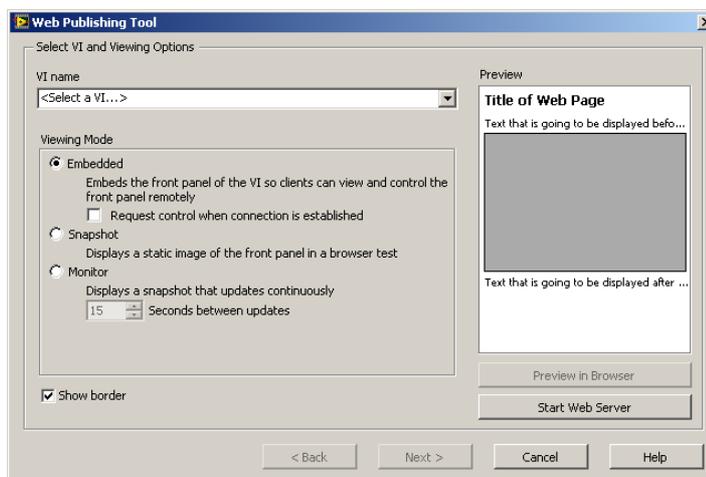
LabVIEW can control the process on web-based by the procedure as follows.

1. It has a way to use the web publishing tool for control on web-based is shown in Figure D1: Click Tool → Web Publishing Tool.



Appendix Figure D1 Web Publishing Tool

2. When web publishing tool was appeared, waiting for just a second until “Select VI” appear at VI name block. Figure D2 shows Web Publishing Tool feature.



Appendix Figure D2 Web Publishing Tool feature

3. The 10 files needed to control is Chosen.

1-1 Tank Manual Complete

2-1 Tank PID Complete

3-1 Tank IMC Complete

4-1 Tank GMC Complete

5-1 Tank Fuzzy Complete

6-2 Tank Manual Complete

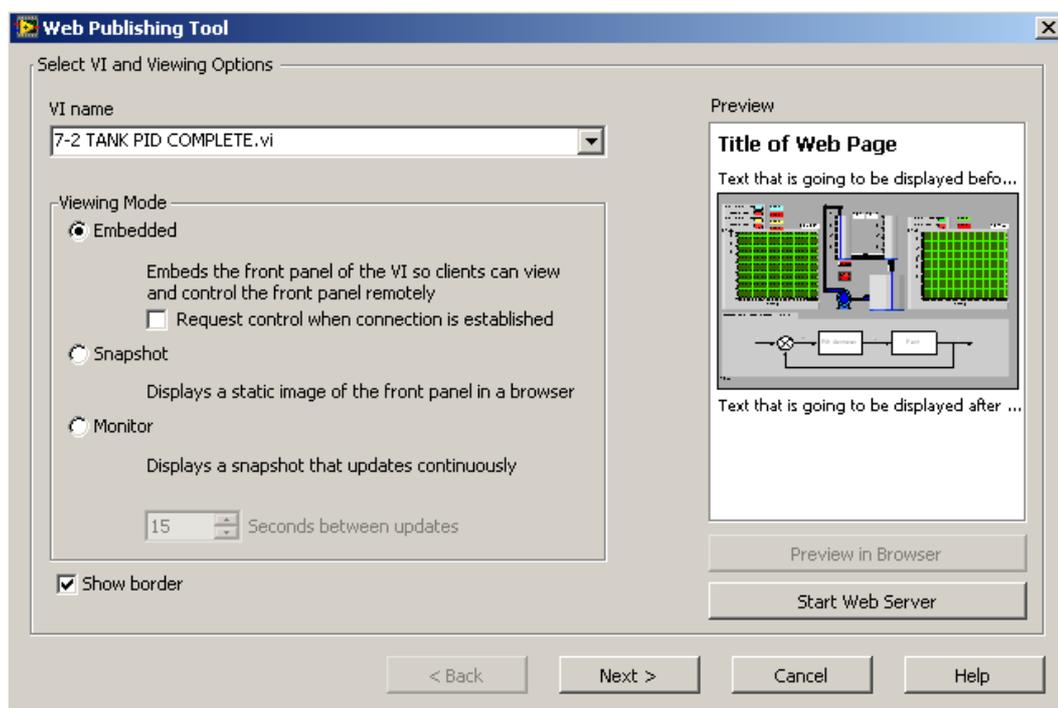
7-2 Tank PID Complete

8-2 Tank IMC Complete

9-2 Tank GMC Complete

10-2 Tank Fuzzy Complete

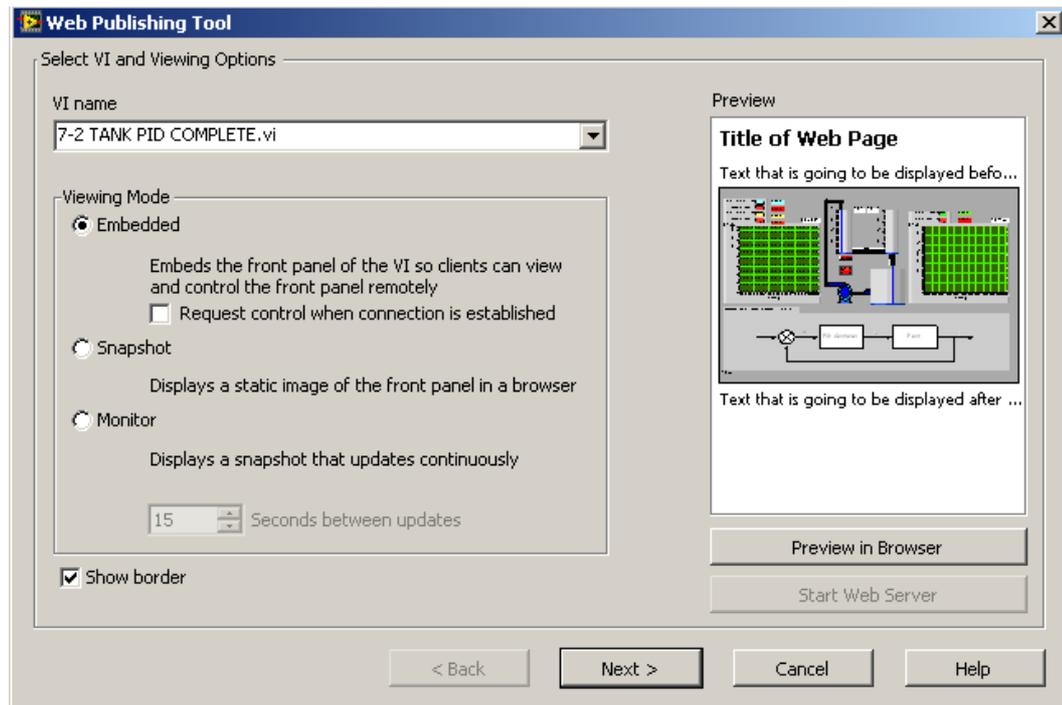
For example, the file 7-2 Tank PIC Complete was need to control. It is shown in Figure D3.



Appendix Figure D3 Web Publishing Tool setting

4. Viewing Mode consists of Embedded, Snapshot, and Monitor. Only Embedded can control process but Snapshot and Monitor just show the data on web-based. The procedure is shown in Figure D4: Click start web server and save to disk.

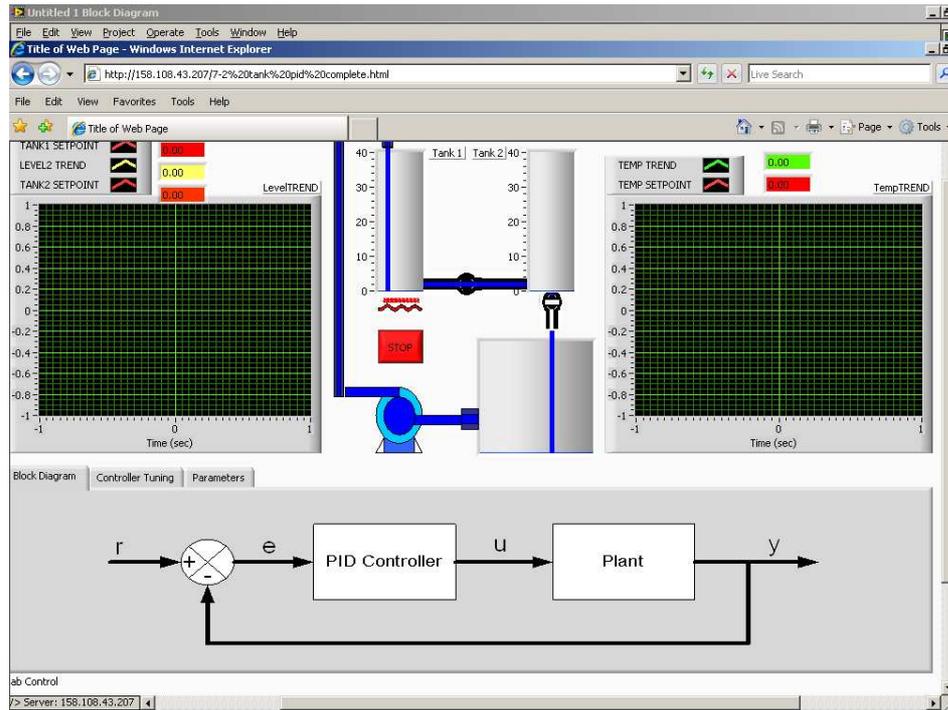
→ OK.



Appendix Figure D4 Web Publishing Tool start web server

5. From another computer, put the IP address of the server computer must be known and / file name needed to control at the address bar. For example, “158.108.43.207/7-2 PID complete”. Appendix Figure 5D shows the URL for control two-interacting tank via IE 7.0.

6. Then, left click one time and then right click for “request control of VI” if not click for “release control of VI” for another computer to be able control this process.



Appendix Figure D5 LabVIEW control via IE 7.0