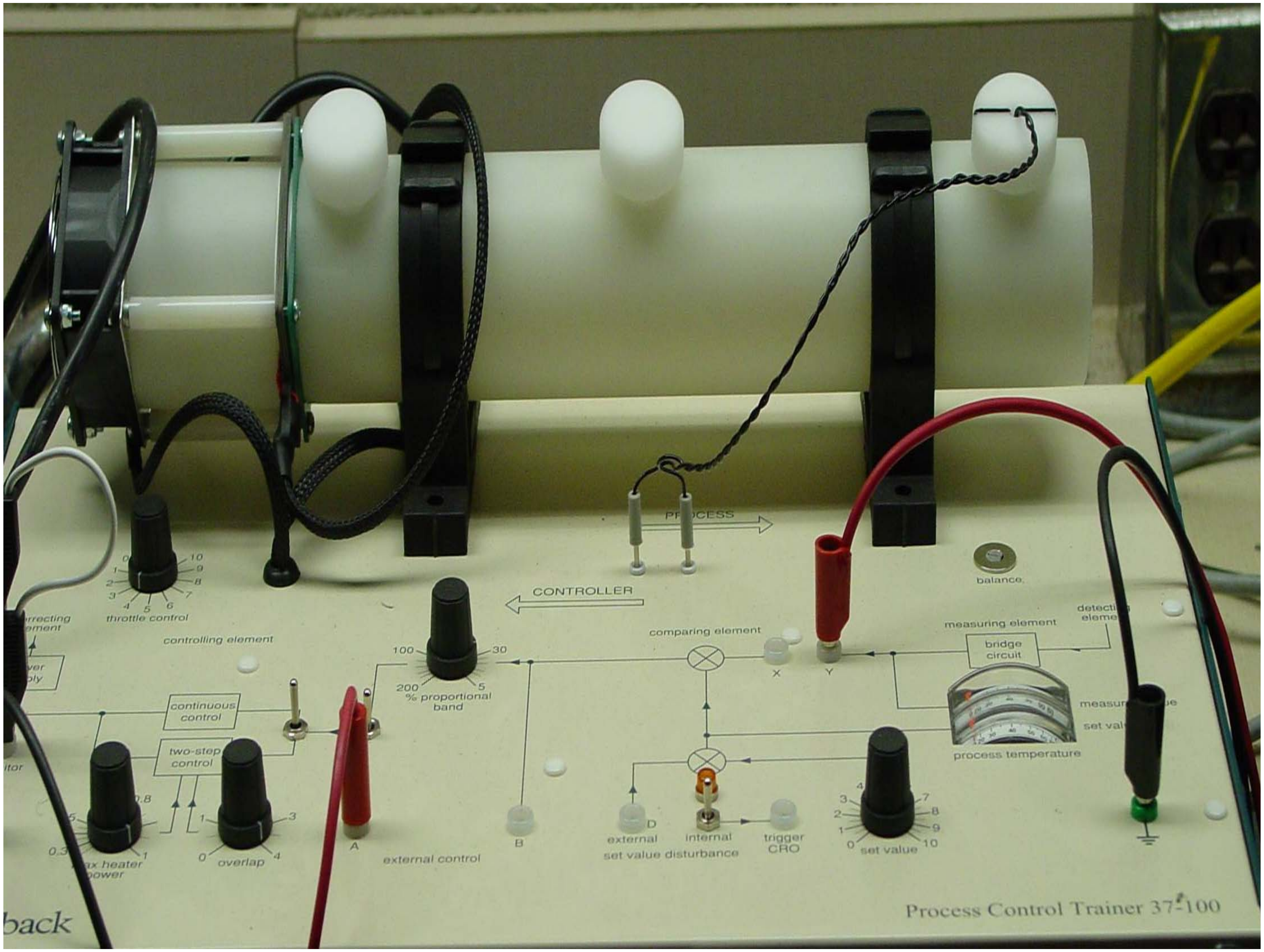
EXPERIMENTAL METHODS

NI DAQ LAB

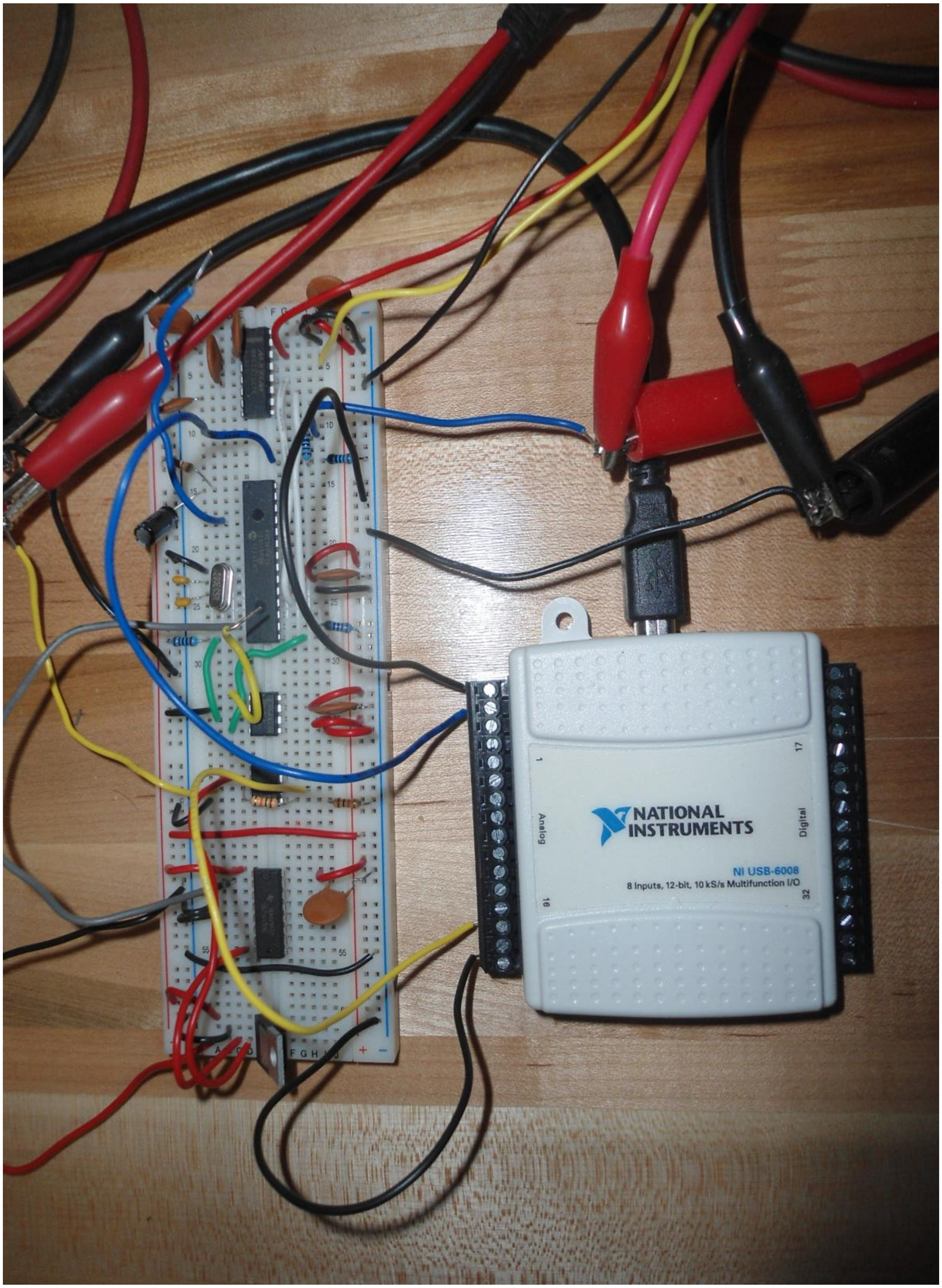
PURPOSE: The purpose of this lab is to give you some experience with control of the pipe flow setup using the National Instruments NI USB 6009 DAQ.

PROCEDURE: The DAQ has been wired into the pipe flow setup. Plug the DAQ into the computer and follow the prompts. Activate the LABVIEW Virtual Instrument DAQ. Examine the performance of the setup controlled by DAQ. Repeat the experiment using the MATLAB m code ONE and the SIMULINK block diagram TWO.

OBSERVATIONS: Compare the NI DAQ setup with that of the Z World Engineering RUGGED GIANT setup.



PROCESS
CONTROLLER
balance
throttle control
controlling element
comparing element
measuring element
bridge circuit
process temperature
% proportional band
continuous control
two-step control
overlap
external control
external
internal
set value disturbance
trigger CRO
set value
Process Control Trainer 37-100



NATIONAL INSTRUMENTS
NI USB-6008
8 Inputs, 12-bit, 10 kS/s Multifunction I/O
Analog
Digital
1
16
17
32

NI USB-6009

Low-Cost, Bus-Powered Multifunction DAQ for USB

12- or 14-Bit, Up to 48 kS/s, 8 Analog Inputs

- 8 analog inputs at 12 or 14 bits, up to 48 kS/s
- 2 analog outputs at 12 bits, software-timed
- 12 TTL/CMOS digital I/O lines
- One 32-bit, 5 MHz counter
- Digital triggering
- Bus-powered
- 1-year warranty

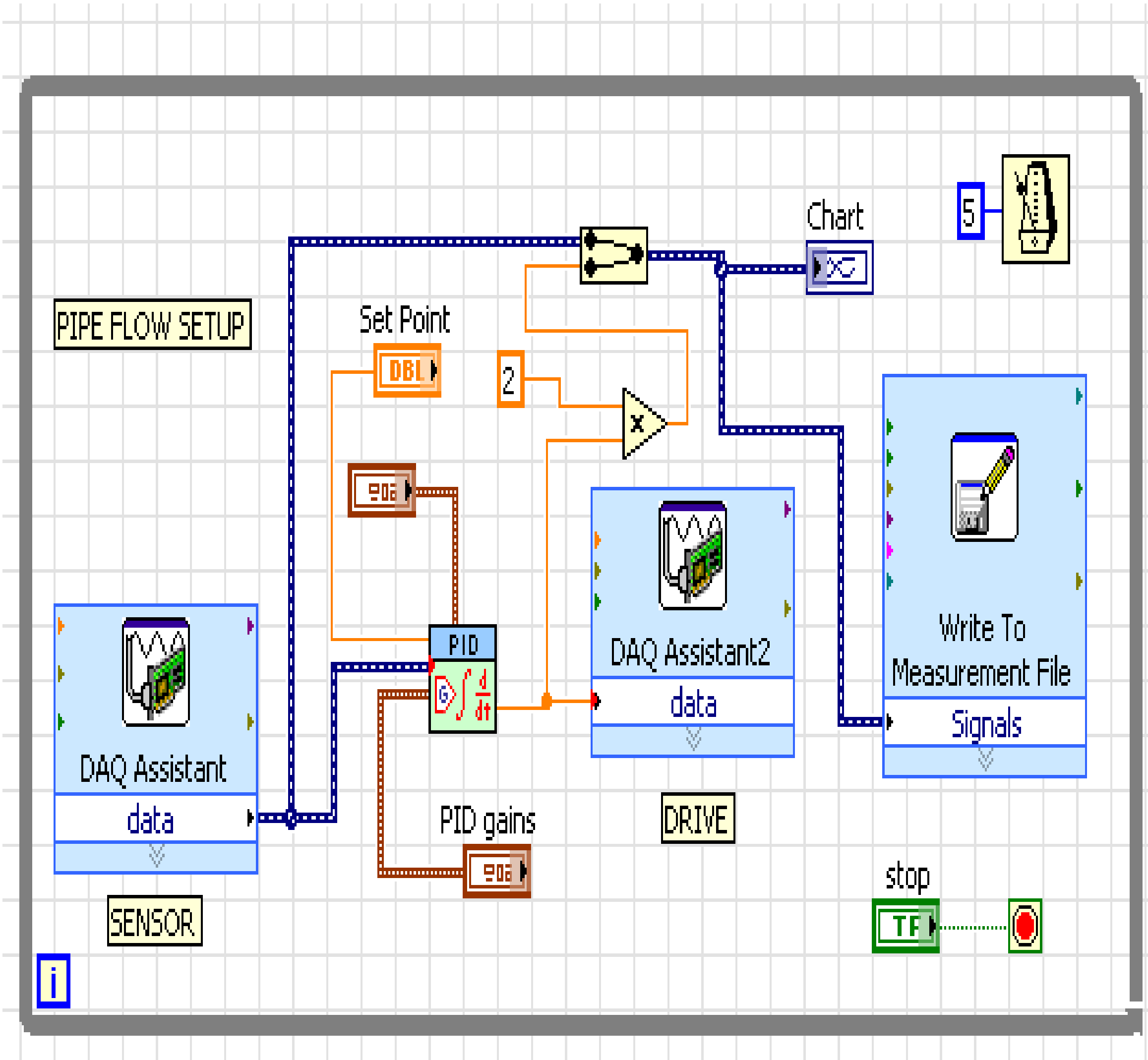
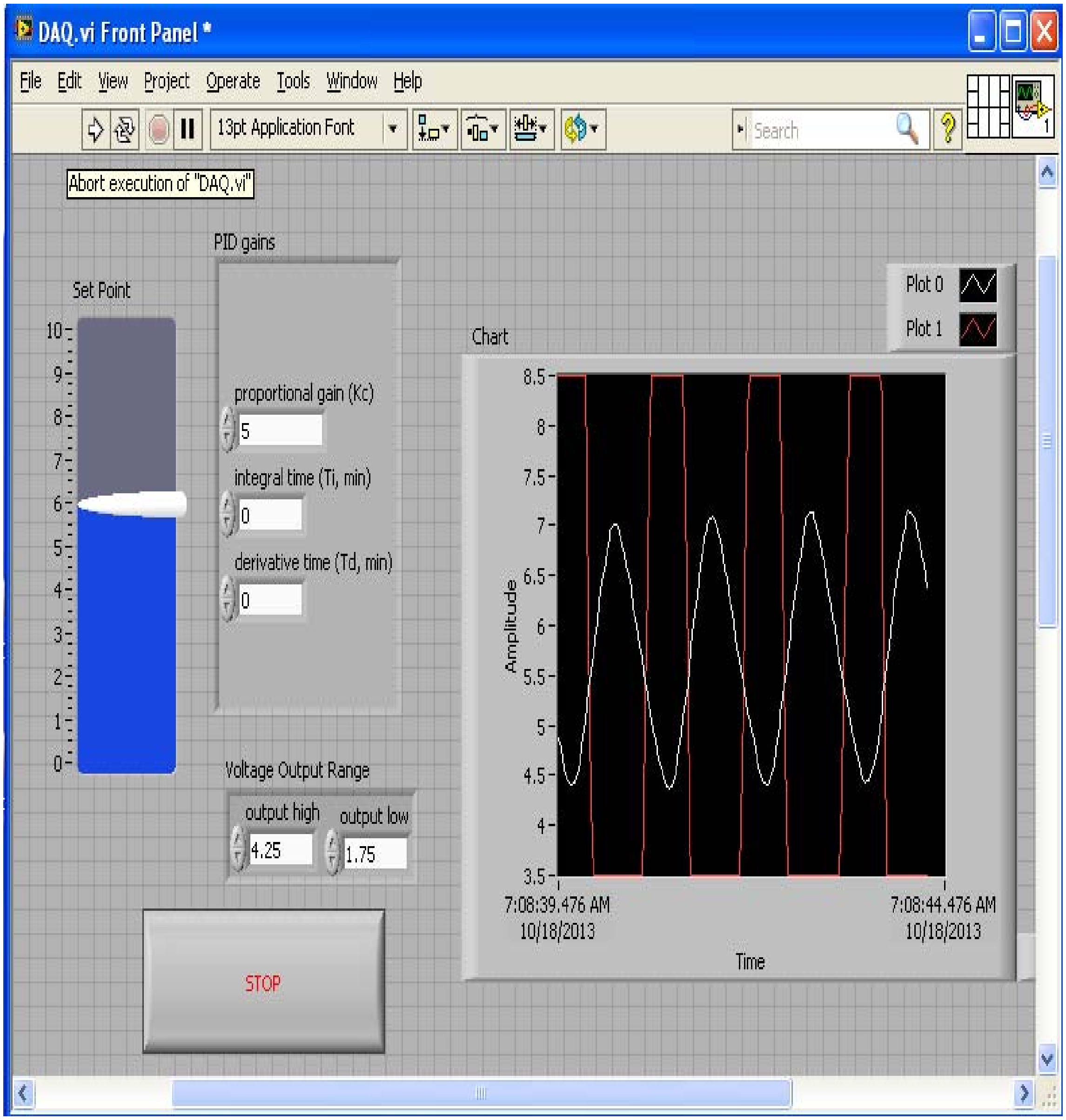
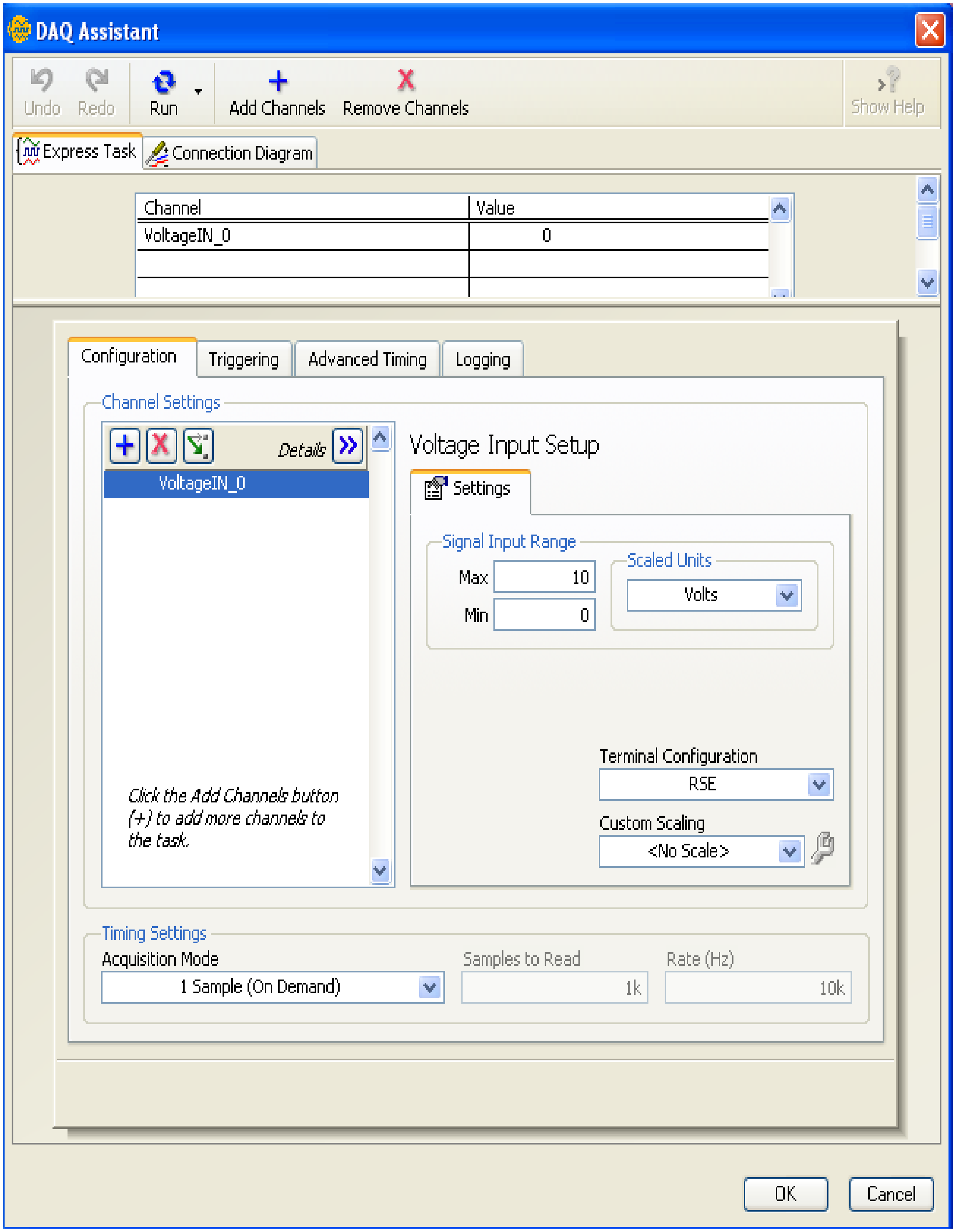
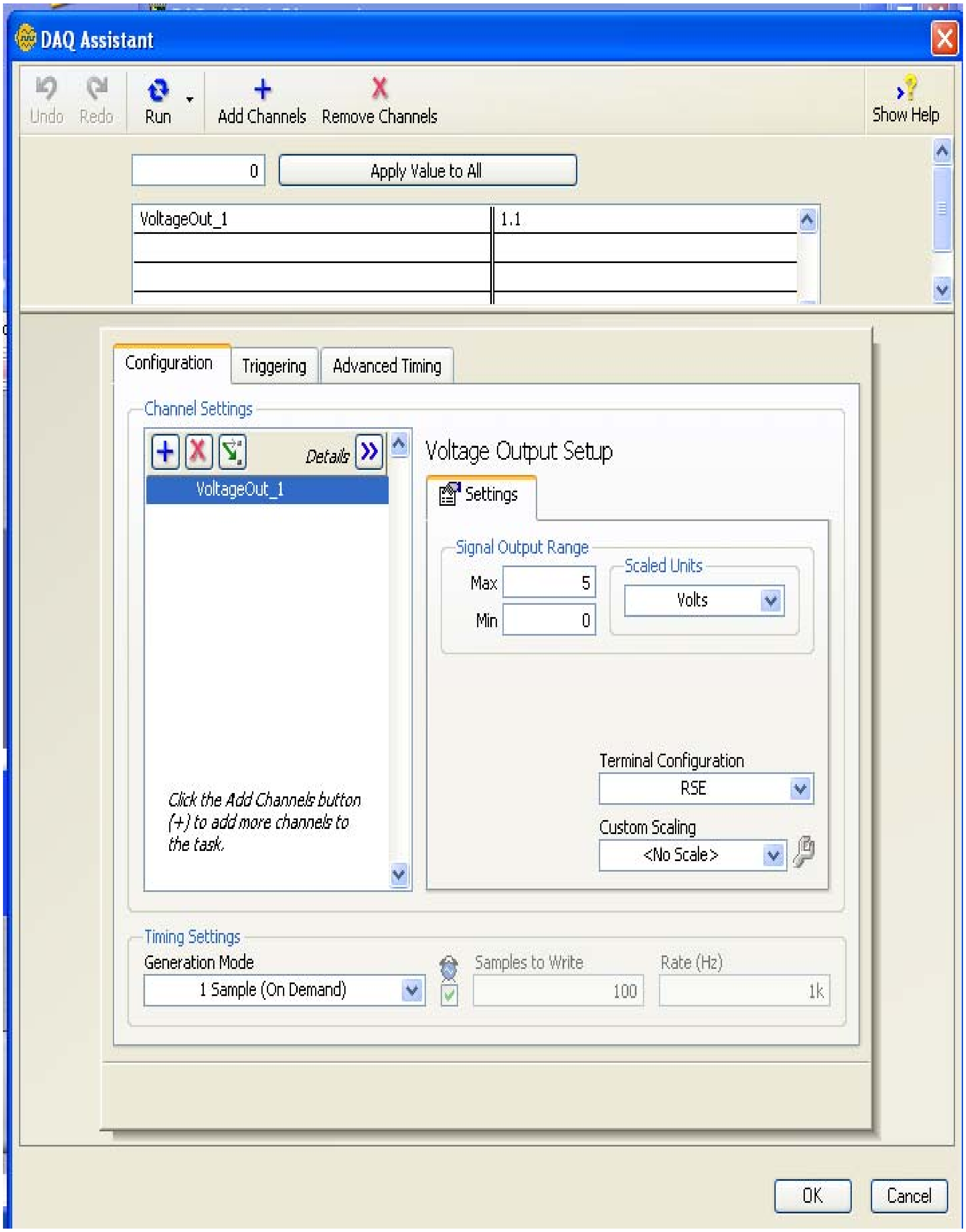


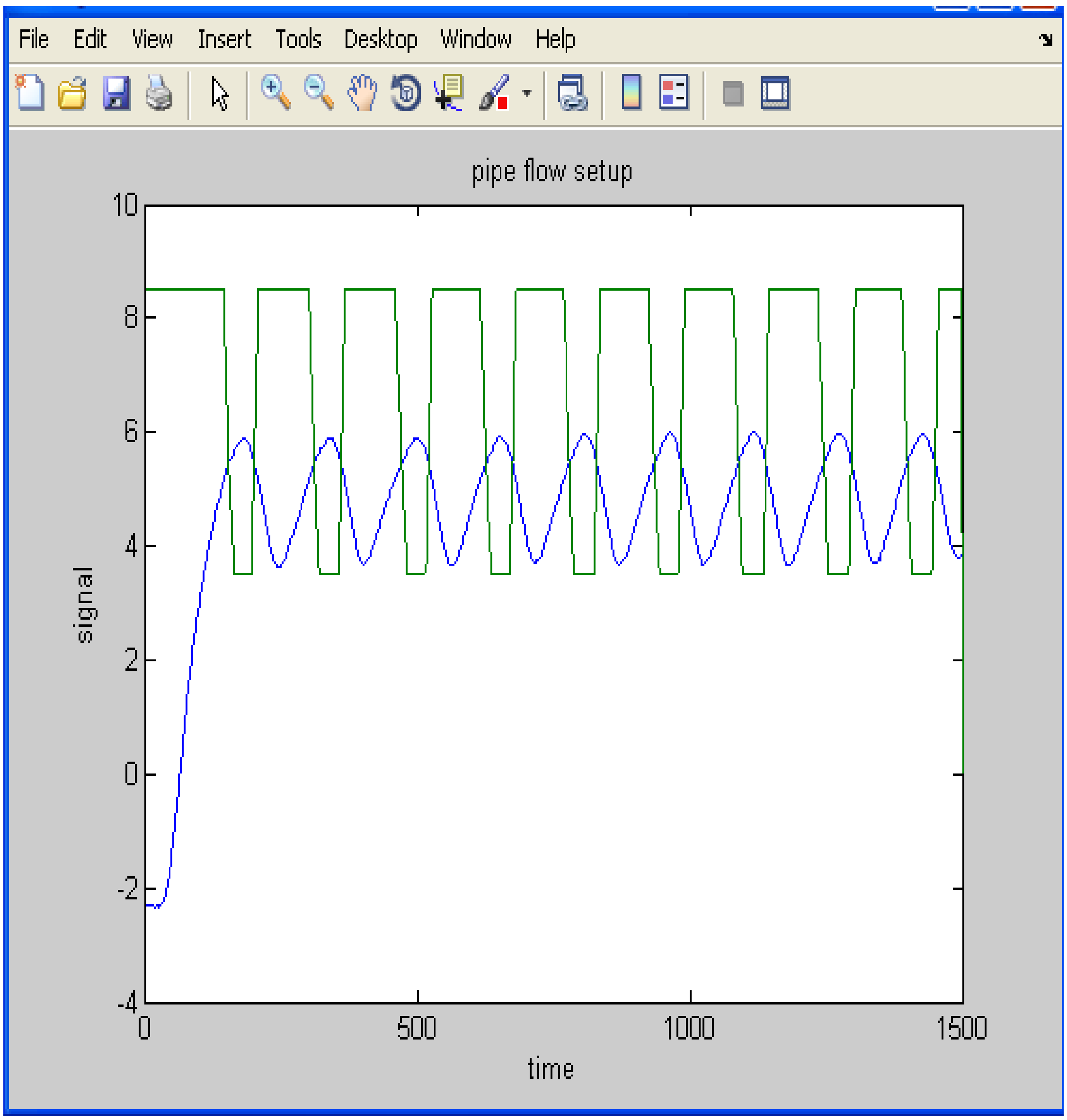
Chart
5
PIPE FLOW SETUP
Set Point
DBL
2
PID
DAQ Assistant2
data
Write To
Measurement File
Signals
DAQ Assistant
data
PID gains
DRIVE
stop
TF
SENSOR
i

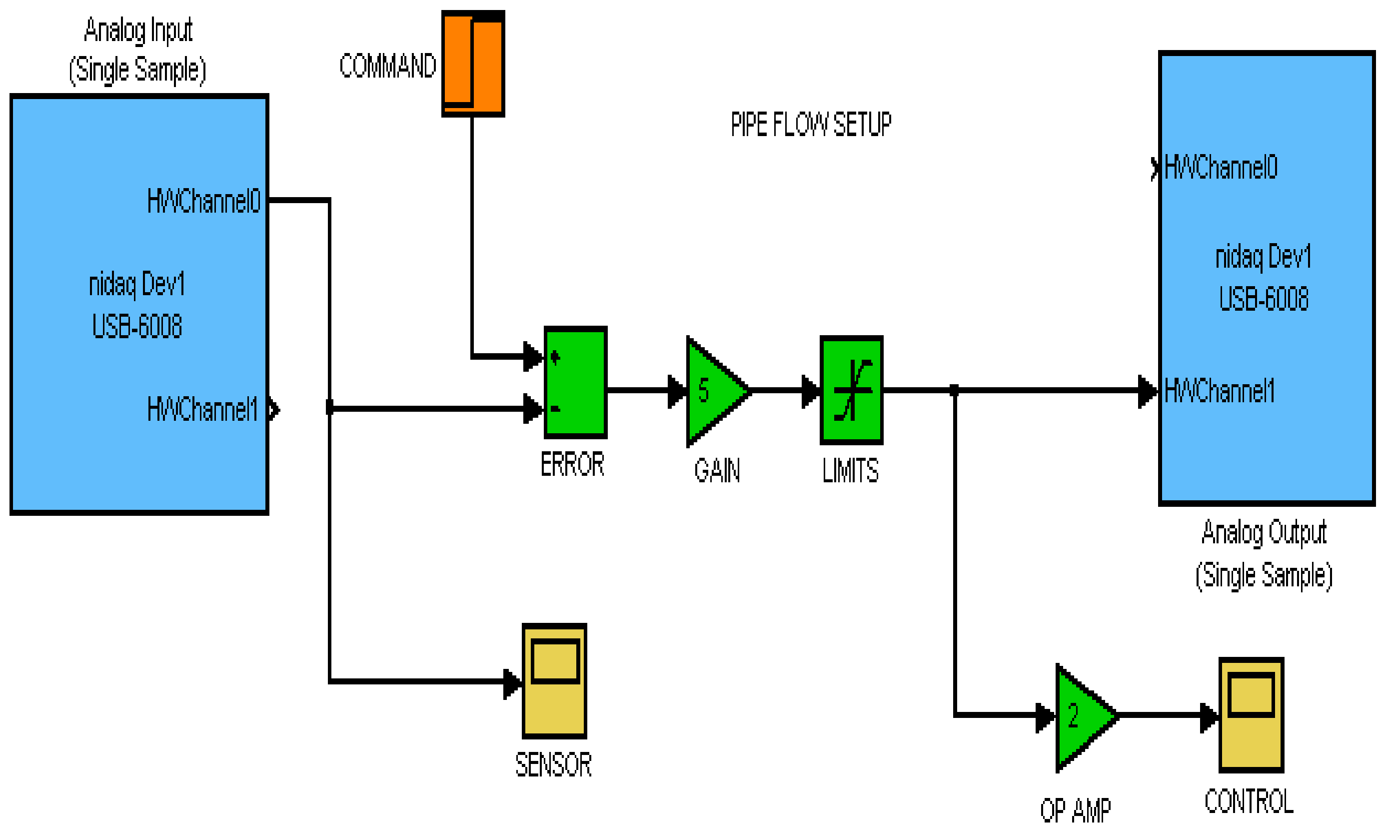

DAQ.vi Front Panel *
File Edit View Project Operate Tools Window Help
13pt Application Font
Search
Abort execution of "DAQ.vi"
PID gains
Set Point
10
9
8
7
6
5
4
3
2
1
0
proportional gain (Kc)
5
integral time (Ti, min)
0
derivative time (Td, min)
0
Voltage Output Range
output high
4.25
output low
1.75
STOP
Chart
Plot 0
Plot 1
Amplitude
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
7:08:39.476 AM
10/18/2013
7:08:44.476 AM
10/18/2013
Time

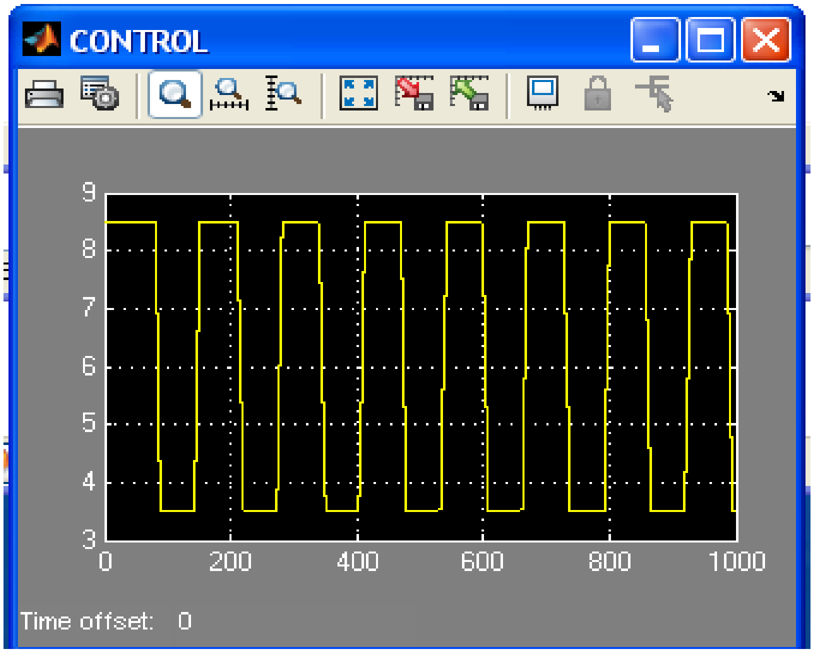

DAQ Assistant
Undo
Redo
Run
Add Channels
Remove Channels
Show Help
Express Task
Connection Diagram
Channel
Value
VoltageIN_0
0
Configuration
Triggering
Advanced Timing
Logging
Channel Settings
Details
VoltageIN_0
Click the Add Channels button (+) to add more channels to the task.
Voltage Input Setup
Settings
Signal Input Range
Max
10
Min
0
Scaled Units
Volts
Terminal Configuration
RSE
Custom Scaling
<No Scale>
Timing Settings
Acquisition Mode
1 Sample (On Demand)
Samples to Read
1k
Rate (Hz)
10k
OK
Cancel

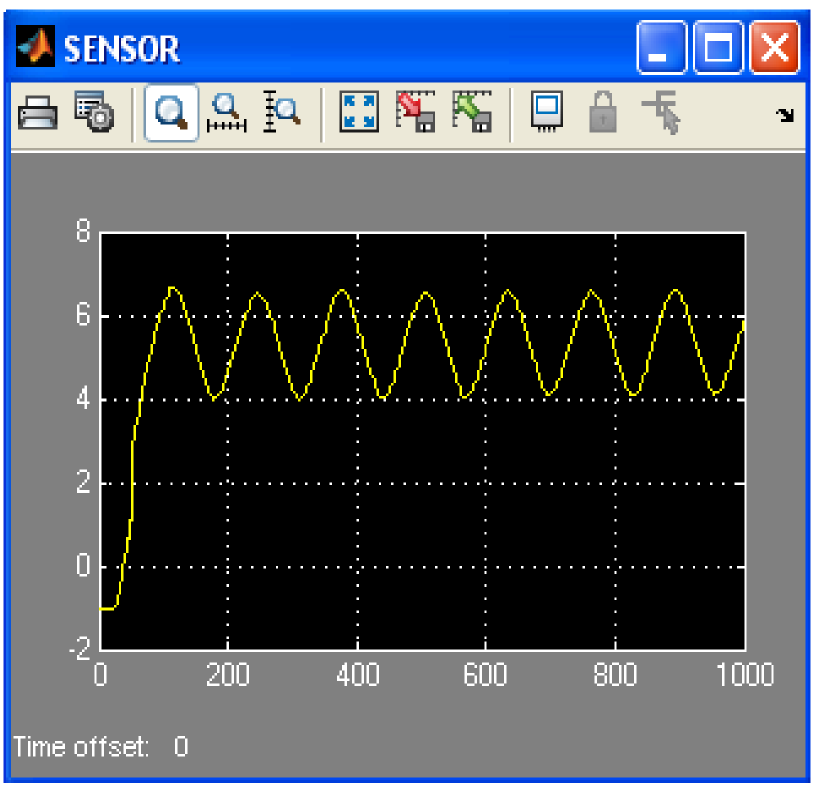

DAQ Assistant
Undo
Redo
Run
Add Channels
Remove Channels
Show Help
0
Apply Value to All
VoltageOut_1
1.1
Configuration
Triggering
Advanced Timing
Channel Settings
Details
VoltageOut_1
Click the Add Channels button (+) to add more channels to the task.
Voltage Output Setup
Settings
Signal Output Range
Max
5
Min
0
Scaled Units
Volts
Terminal Configuration
RSE
Custom Scaling
<No Scale>
Timing Settings
Generation Mode
1 Sample (On Demand)
Samples to Write
100
Rate (Hz)
1k
OK
Cancel

```
%
% PIPE FLOW SETUP
%

NIT=1000;
target=6.0;
gain=5.0;
device='dev1';

AI0=analoginput('nidaq',device);
addchannel(AI0,0);
AO1=analogoutput('nidaq',device);
addchannel(AO1,1);

for IT=1:NIT

TIME(IT)=IT;

sensor=getsample(AI0);

IN(IT)=sensor;

error=target-sensor;
control=gain*error;
signal=control;
if(control>5.0)
 signal=5.0; end;
if(control<0.0)
 signal=0.0; end;

if(IT==NIT)
 signal=0.0; end;

OUT(IT)=2*signal;

putsample(AO1,signal);

end

plot(TIME,IN,TIME,OUT)
```

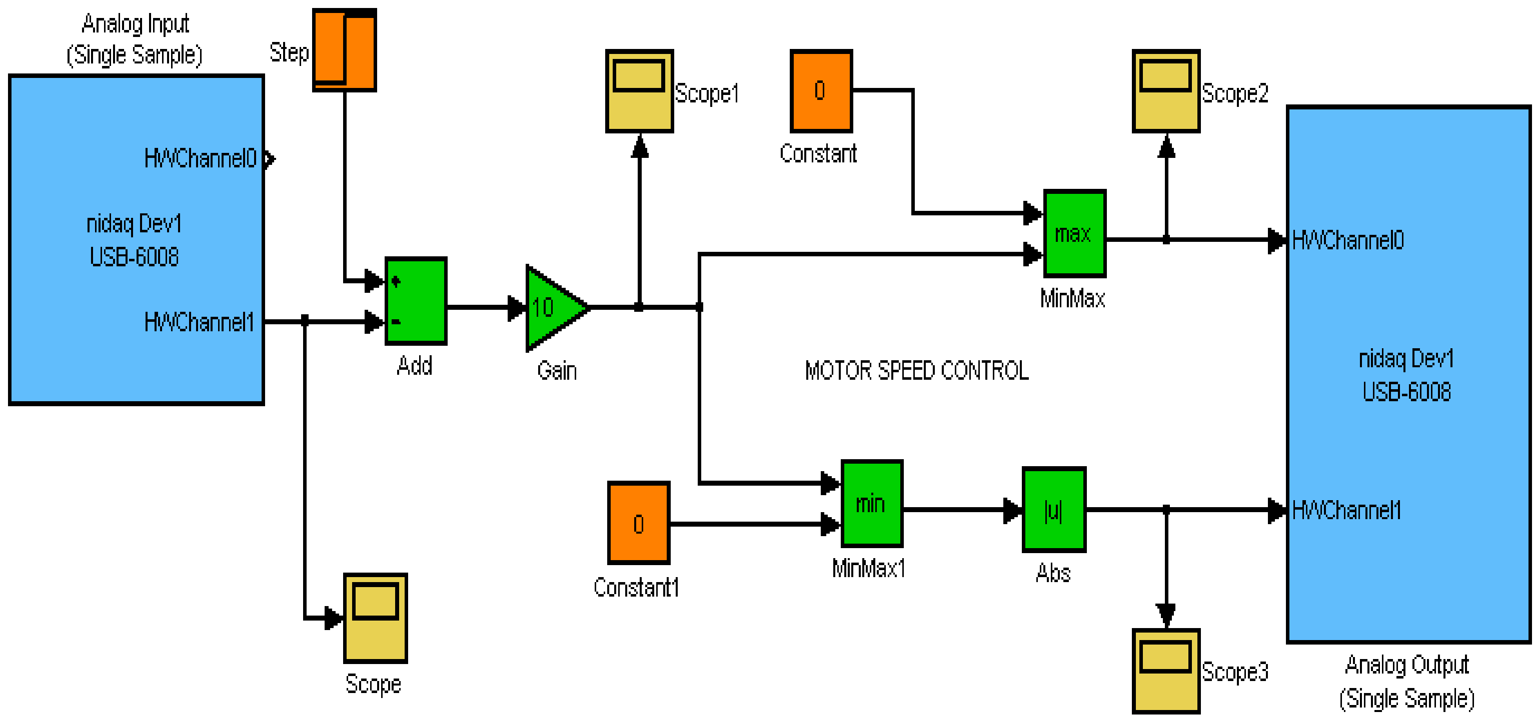

File Edit View Insert Tools Desktop Window Help
pipe flow setup
signal
time
10
8
6
4
2
0
-2
-4
0
500
1000
1500


Analog Input
(Single Sample)
HWChannel0
nidaq Dev1
USB-6008
HWChannel1
COMMAND
PIPE FLOW SETUP
ERROR
5
GAIN
LIMITS
SENSOR
2
OP AMP
CONTROL
HWChannel0
nidaq Dev1
USB-6008
HWChannel1
Analog Output
(Single Sample)


CONTROL
9
8
7
6
5
4
3
0
200
400
600
800
1000
Time offset: 0


SENSOR
8
6
4
2
0
-2
0
200
400
600
800
1000
Time offset: 0

```
%
% MOTOR SPEED CONTROL
%
NIT=1000;
target=1.25;
gain=10.0;
device='dev1';

AI1=analoginput('nidaq',device);
addchannel(AI1,1);
AO0=analogoutput('nidaq',device);
addchannel(AO0,0);
AO1=analogoutput('nidaq',device);
addchannel(AO1,1);

for IT=1:NIT

TIME(IT)=IT;

sensor=getsample(AI1);

IN(IT)=sensor;

error=target-sensor;
control=gain*error;
signal=abs(control);
if(signal>5.0)
 signal=5.0; end;

if(IT==NIT)
 signal=0.0; end;

OUT(IT)=control;

if(error>0.0)
putsample(AO0,signal);
putsample(AO1,0.0);
end

if(error<0.0)
putsample(AO0,0.0);
putsample(AO1,signal);
end

end

plot(TIME,IN,TIME,OUT)
```


Analog Input
(Single Sample)
HWChannel0
nidaq Dev1
USB-6008
HWChannel1
Step
Add
10
Gain
Scope
Scope1
0
Constant
0
Constant1
max
MinMax
min
MinMax1
|u|
Abs
Scope2
Scope3
MOTOR SPEED CONTROL
HWChannel0
nidaq Dev1
USB-6008
HWChannel1
Analog Output
(Single Sample)