FeSCADA & ADAM 6017

Introduction

An application was done to show the possibilities of FeSCADA. By the end of this paper the reader will learn how FeSCADA can be used with Advantech ADAM 6017 Ethernet IO module.

1. Description
2. Hardware
3. ADAM 6017 setup
4. ADAM 6017 Modbus registers
5. FeMODBUS communication setup
6. FeSCADA project
7. Special application
8. Conclusions

1) Description

A heating and cooling application was developed with the aid of Advantech ADAM 6017 Ethernet IO module and a FeSCADA PID controller. Two RTD sensors and one thermocouple sensor are used to read temperatures. A 25W, 10Ω resistor is used as the heating element. Two Solid State Relays (SSR) are used to control the heating power (from a 24 VDC power supply) and a fan (cooling power).

The example is common for other types of Ethernet IOs, because it is an industrial practice for many producers to use Modbus TCP communication.

2) Hardware

The hardware is composed of one Advantech ADAM 6017 Ethernet IO module, with the following characteristics:

- input voltage: 10-30 VDC

- 8 analog inputs, 16-bit resolution, 100 samples/second

    rages - voltage: from ±0.15 V up to ±10 V

        - current: ±20 mA, 0~20 mA, 4~20 mA

- 2 digital outputs, sink, 0...30 VDC

- communication protocols: Modbus/TCP, TCP/IP, UDP, HTTP, DHCP, MQTT, SNMP, ASCII command

Two RTD sensors Pt100, together with two temperature transmitters: 0...250^{O}C to 4-20mA and 0...500^{O}C to 4-20mA.

One K type thermocouple wire.

Two Solid State Relays (SSR) 100VDC, 20A.

One NTE 25W, 10Ω resistor, the heating element.

Cooling fan, 24VDC, 0.16A.

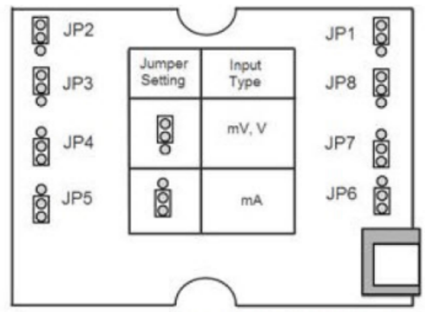
Hardware prices.

Name	**Unit price**	**Qty**	**Price**	**Description**
ADAM 6017	$380.00	1	$380.00	8 channels analog IO module
uxcell Temperature Transmitter	$12.00	2	$24.00	Pt100 signal converter 0...250 ^{O}C to 4-20 mA 0...500 ^{O}C to 4-20 mA
TWTADE PT100	$13.00	2	$26.00	Pt100, 3 wire sensors -50...200 ^{O}C
Thermocouple	$10.00	1	$10.00	K thermocouple wire
D1D20	$72.00	2	$144.00	Solid State Relay 100VDC, 20A

Power spupply 24VDC	$40.00	1	$40.00	120W, 24VDC, 5A
Nidec fan, 24DVC	$13.00	1	$13.00	0.16A inverter cooling fan
	TOTAL =		**$637.00**	

3) ADAM 6017 setup

ADAM 6017 has to be setup for the type and range of our temperature transmitters and for the thermocouple. By default, the module is setup to read ±10V. To change a channel to measure current a jumper has to be moved, for that particular channel.



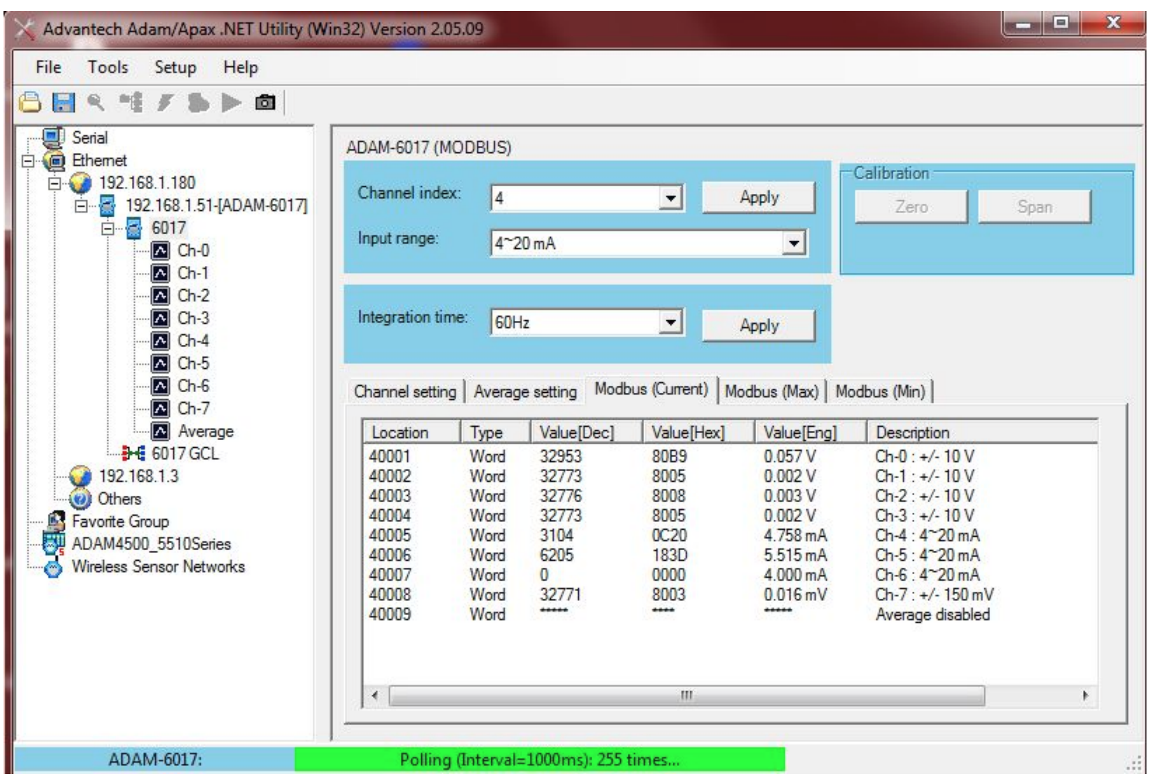
ADAM-6017-BE & AE

Because it has 16 bits resolution, the whole measuring range is converted to:

a) 0...65535, for positive ranges: 0~0.5V, 0~1V, 0~5V, 0~10V, 0~20mA, 4~20mA

b) -32768 ... 32767 for ± ranges: ±0.15V, ±0.5V , ±1V, ±5V, ±10V, ±20 mA

To setup ADAM 6017 for the IP address and the measuring ranges, the software ADAM.NET is used. We set the IP address to 192.168.1.51. See below



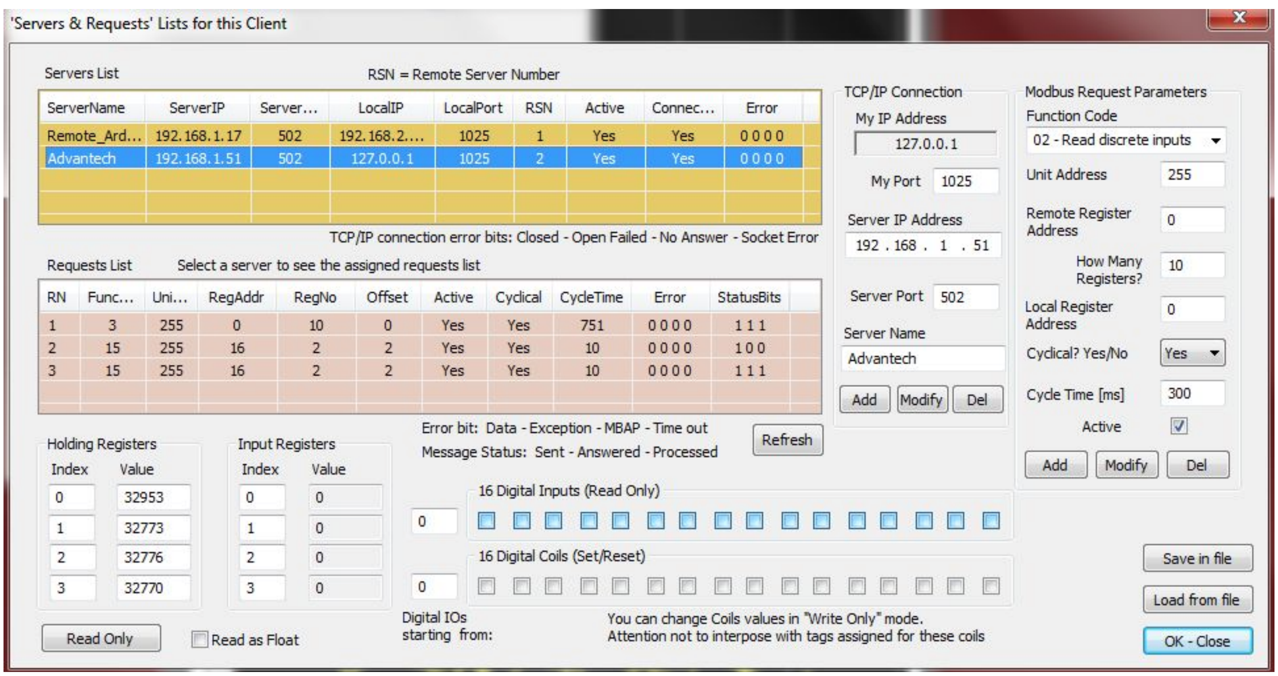
4) ADAM 6017 Modbus registers

The following table is showing the Modbus register numbers for the IO module: channels data and digital outputs.

Parameter	**Modbus register number**	**Description**
Data channels 0…7 (read only)	0…7	**Holding registers**, 16 bits, with the values from the 8 channels
Digital outputs 0,1 (read/write)	16, 17	**Coils** addresses for the two digital outputs

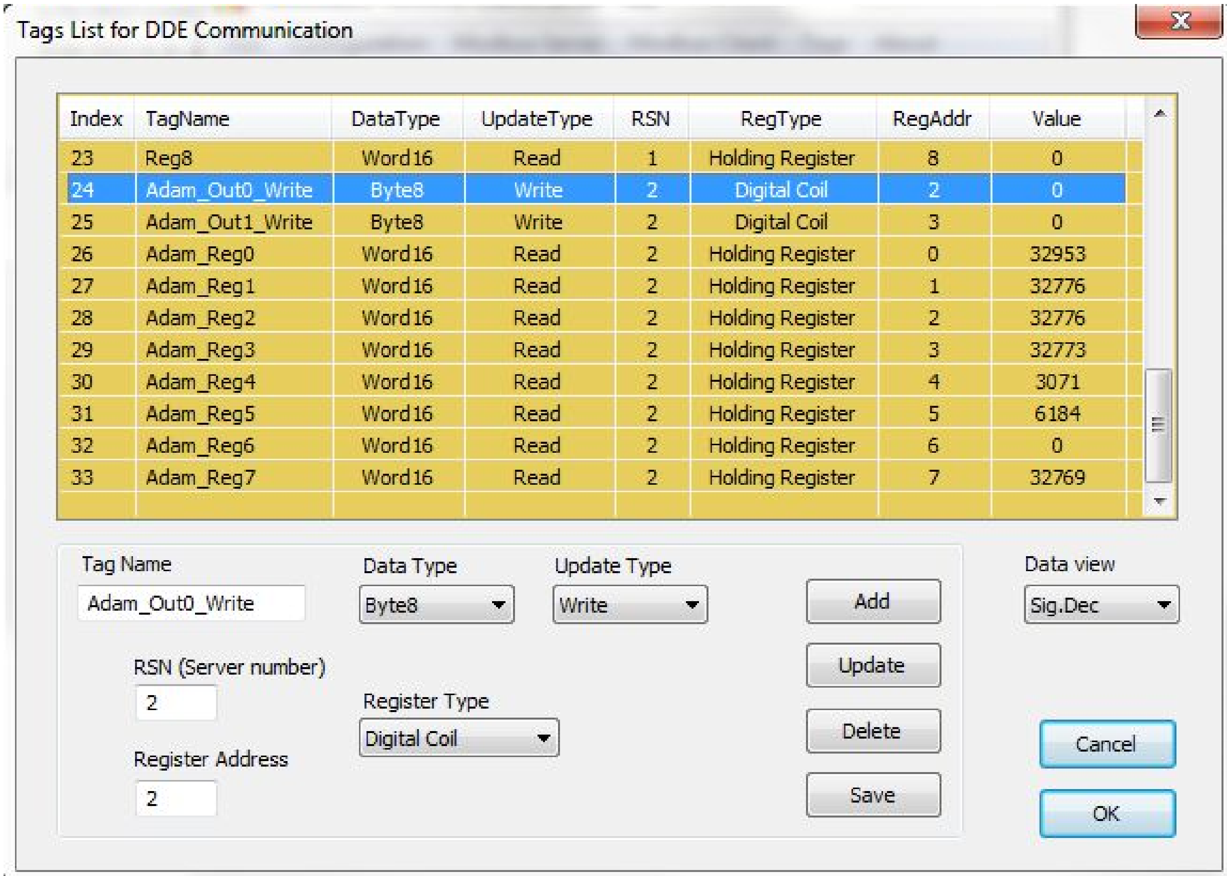
5) FeMODBUS communication setup

FeMODBUS software is used to connect to ADAM 6017, which is a Modbus server on port 502. We send 2 requests: one is to read the first 10 holding registers every 751 ms, the second is to write 2 coils, every 10 ms. We put two times the coils writing, to make sure the ADAM will get the command. The fast coil writing is essential for a good PID control.



After setting up all the requests we defined tags which we linked with different registers on the local computer. The tags are used for DDE communication between

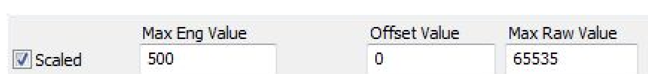
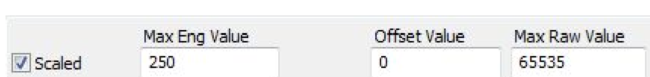
FeMODBUS and FeSCADA. All the tags are assigned to the Remote Server Number 2 (RSN 2).

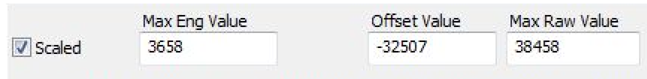


6) FeSCADA project

The first step in a FeSCADA project is to define the DDE communication channels and the tags. In the picture below one can see that we defined one DDE channel as channel number 1: DDE_Application = “MB” and DDE_Topic = “TAGS”.

Every tag has an internal name used in FeSCADA and a DDE Name for communication with the MB DDE server. All the tags defined in FeMODBUS will have a correspondent tag in FeSCADA. We kept the name the same with 3 exceptions:

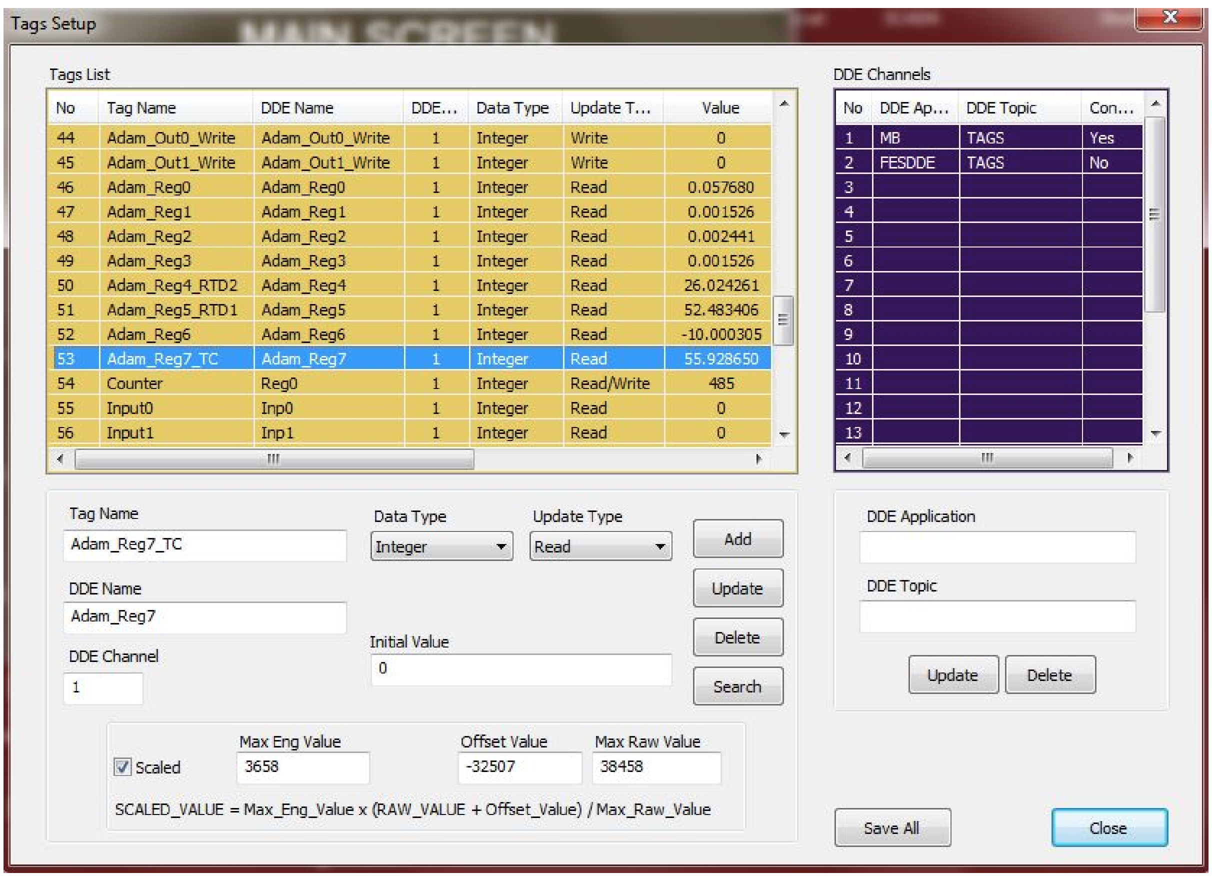
FeMODBUS	FeSCADA	Scaled
Adam_Reg4	Adam_Reg4_RTD2	
Adam_Reg5	Adam_Reg5_RTD1	

Adam_Reg7	Adam_Reg7_TC	

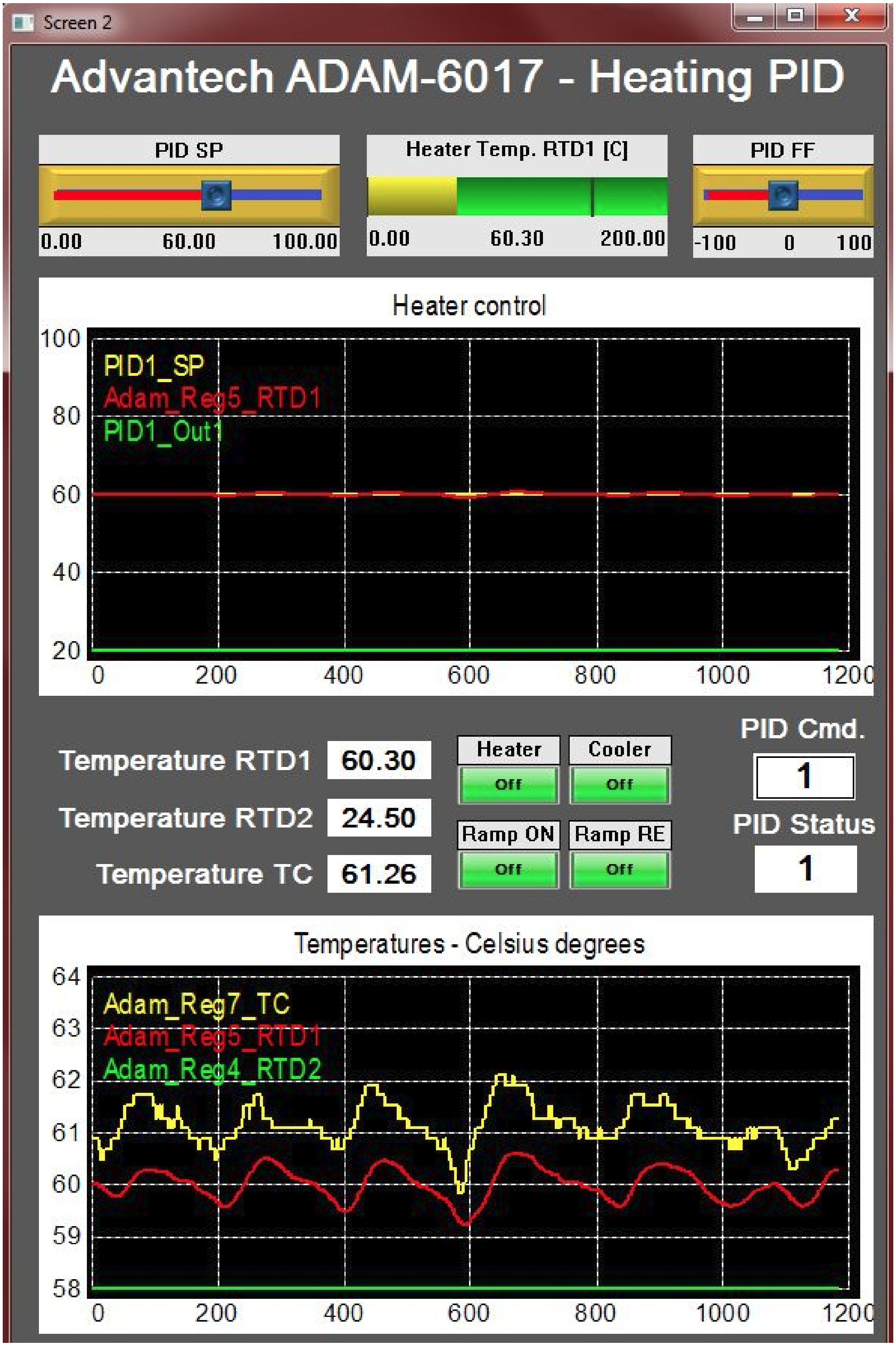
The scaling for type K thermocouple is based on its sensitivity of approximately 41 µV/°C and 150mV maximum range, for 32767.

The thermocouple has to be calibrated at 0 °C (water with ice) and it will be acceptable in the range 0 … 100 °C. For calibration we changed the *Offset Value* and *Max Raw Value*.

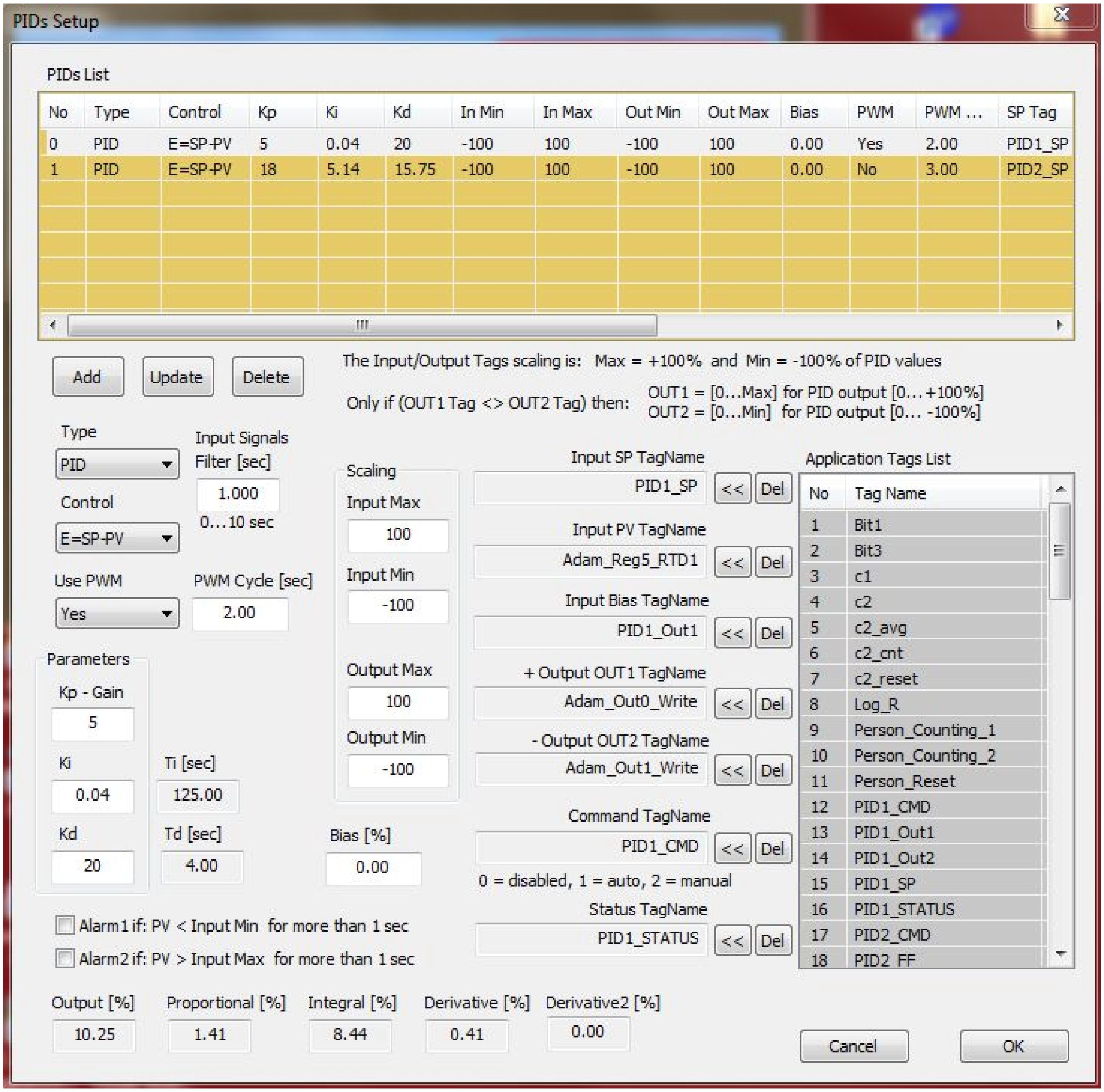
Observation: The thermocouple value is not as precise as the RTD's.



Now we can build a screen (window) to show the data, and to put some indicators and buttons. In the picture below one can see a snapshot of this screen.


Screen 2
Advantech ADAM-6017 - Heating PID
PID SP
0.00
60.00
100.00
Heater Temp. RTD1 [C]
0.00
60.30
200.00
PID FF
-100
0
100
Heater control
PID1_SP
Adam_Reg5_RTD1
PID1_Out1
Temperature RTD1
60.30
Temperature RTD2
24.50
Temperature TC
61.26
Heater
Off
Cooler
Off
Ramp ON
Off
Ramp RE
Off
PID Cmd.
1
PID Status
1
Temperatures - Celsius degrees
Adam_Reg7_TC
Adam_Reg5_RTD1
Adam_Reg4_RTD2

In FeSCADA we defined some more memory tags and a PID: *PID1_SP*, *PID1_CMD*, *PID1_STATUS*, etc. (see below).



When *PID1_CMD* has the value 1(one) the PID is active and it will compute the outputs to maintain the process value as close as possible to the set point value, *PID1_SP*. The set point value can be changed by the user. We read the process temperature from *Adam_Reg5_RTD1*.

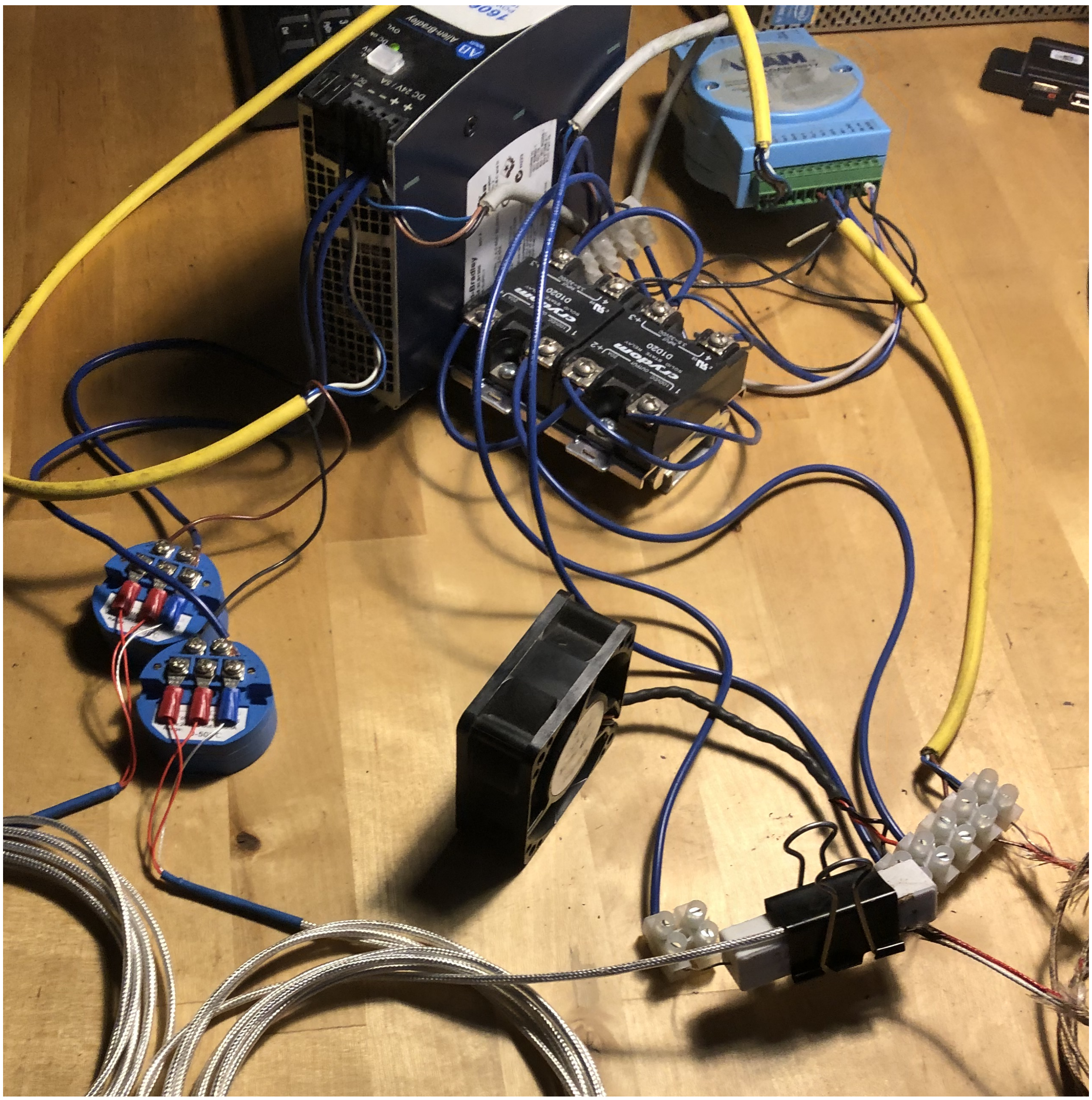
The PID outputs are using pulse width modulation (PWM). The cycle time is 2 seconds.

If the PID output is positive then the heating output (OUT1) is used in the proportion: 0...100% → 0… 2 seconds.

If the PID output is negative then the cooling output (OUT2) is used in the proportion: 0… -100% → 0...2 seconds.

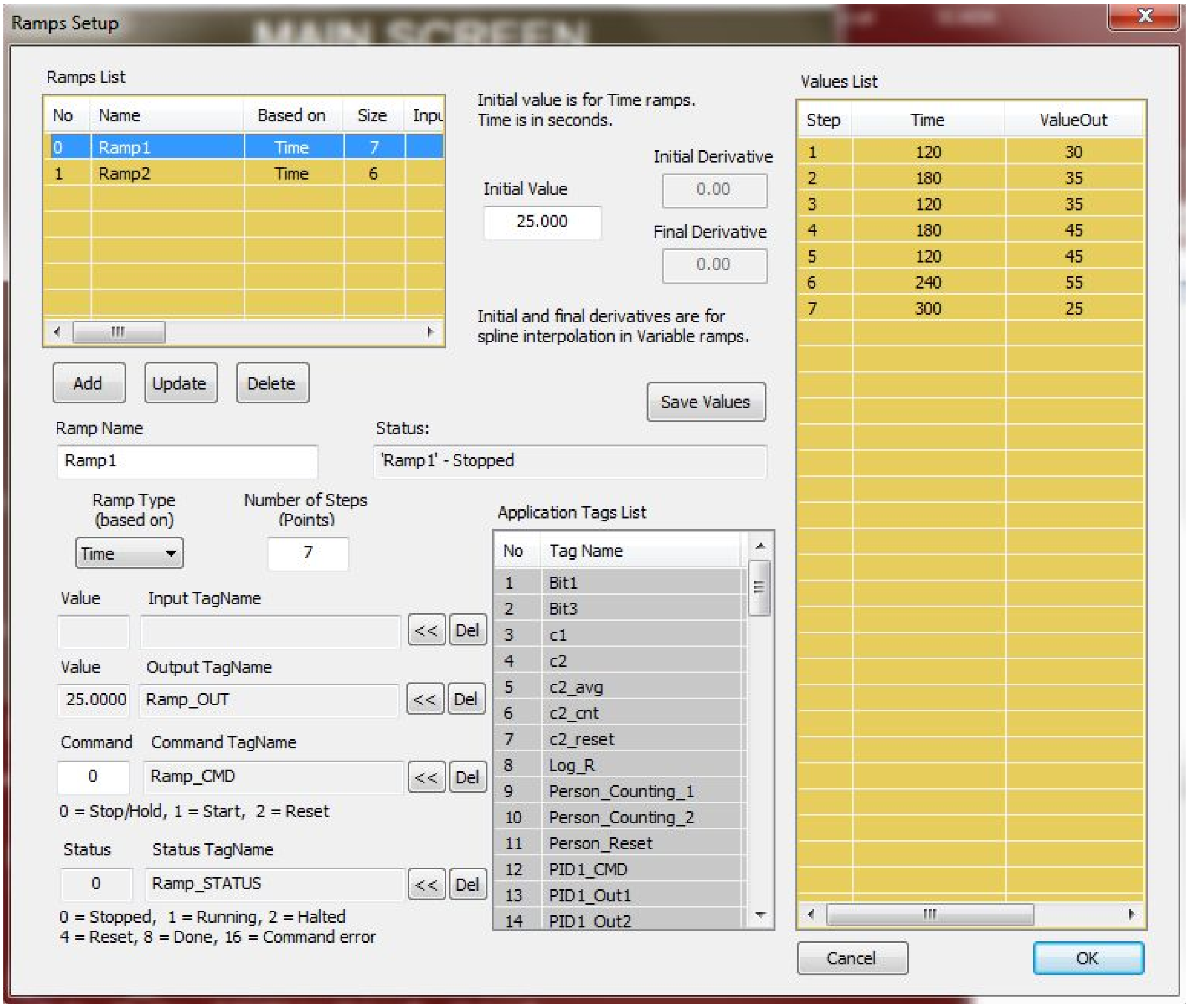
OUT1 → *Adam_Out0_Write*, which is used for SSR1, current (heating),

OUT2 → *Adam_Out1_Write*, which is used for SSR2, fan (cooling).

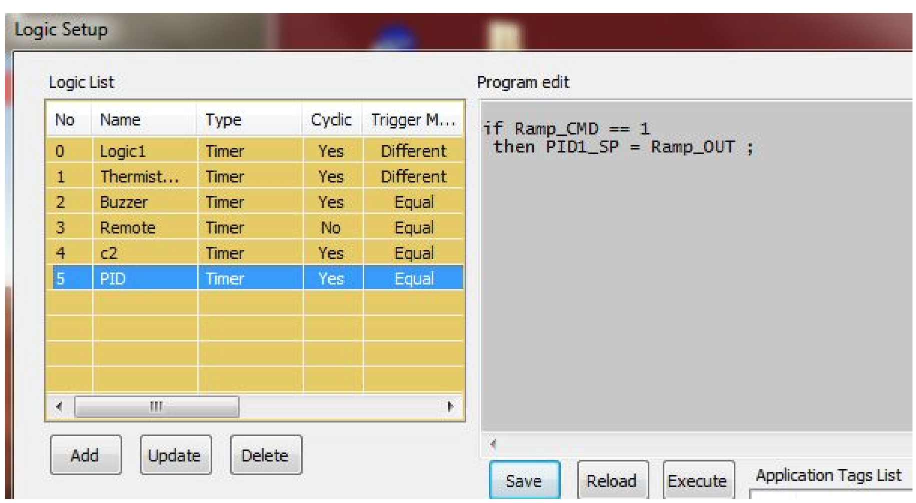


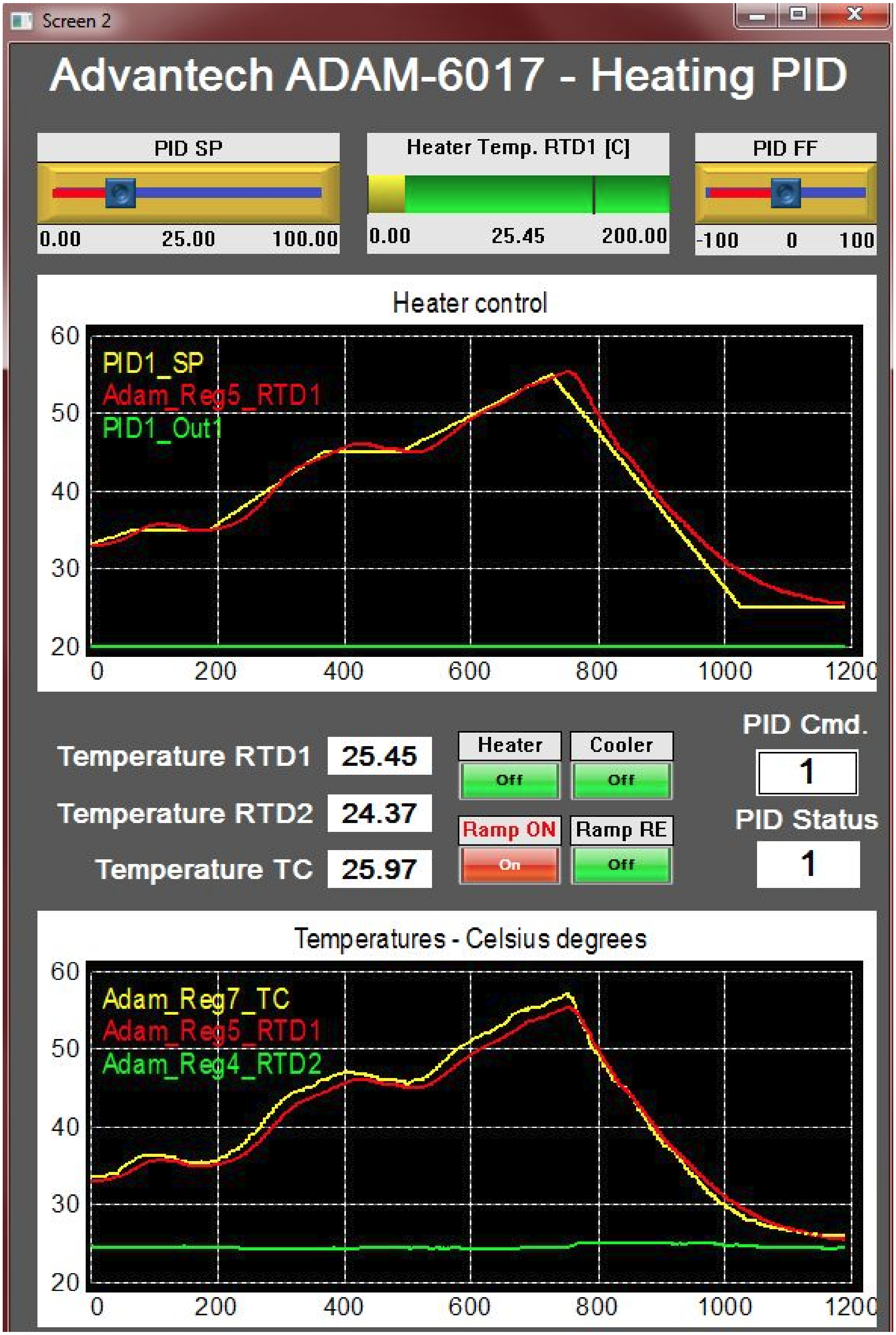
7) Special application

We defined a ramp with the memory tags: *Ramp_CMD*, *Ramp_STATUS*, *Ramp_OUT*.



In the same time we defined a logic program that will copy the value of the tag *Ramp_Out* in the PID set point tag, *PID1_SP*, if the ramp is running (if *Ramp_CMD* is 1).




Screen 2
Advantech ADAM-6017 - Heating PID
PID SP
0.00
25.00
100.00
Heater Temp. RTD1 [C]
0.00
25.45
200.00
PID FF
-100
0
100
Heater control
PID1_SP
Adam_Reg5_RTD1
PID1_Out1
60
50
40
30
20
0
200
400
600
800
1000
1200
Temperature RTD1
25.45
Temperature RTD2
24.37
Temperature TC
25.97
Heater
Off
Cooler
Off
Ramp ON
On
Ramp RE
Off
PID Cmd.
1
PID Status
1
Temperatures - Celsius degrees
Adam_Reg7_TC
Adam_Reg5_RTD1
Adam_Reg4_RTD2
60
50
40
30
20
0
200
400
600
800
1000
1200

8) Conclusions

The application has shown an example of using FeSCADA and FeMODBUS to monitor 3 temperature sensors and to control a heating and cooling system with the aid of ADAM 6017 Ethernet IO module from Advantech. The communication protocol is Modbus TCP.