United Electronic Industries

The High-Performance Alternative

UEIModbus User Manual 2.1

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1. Introduction

MODBUS is a messaging protocol developed by Modicon in 1979, used to establish master-slave/client-server communication between intelligent devices. It is a de facto standard, truly open, and the most widely used network protocol in the industrial manufacturing environment. (Specifications available at http://www.modbus-ida.org).

MODBUS devices communicate using a master-slave technique in which only one device (the master) can initiate transactions (called queries). The other devices (slaves) respond by supplying the requested data to the master, or by taking the action requested in the query.
A slave is any peripheral device (I/O transducer, valve, network drive, or other measuring device), which processes information and sends its output to the master using MODBUS. Masters can address individual slaves, or can initiate a broadcast message to all slaves. Slaves return a response to all queries addressed to them individually, but do not respond to broadcast queries.

UEIModbus extends the capability of the PowerDNA distributed data acquisition system by turning it into a MODBUS/TCP slave that can be accessed by any software client that can act as a MODBUS/TCP master. Most popular HMI software packages support the MODBUS/TCP protocol.

1.1. Register tables

The MODBUS specification defines four register tables (or register maps) in which I/Os can be read or written.

Register table	Classic Name	Description	Data representation
0xxxx	Coils (Read/Write)	A 0x reference address is used to drive output data to a digital output channel.	1 bit
1xxxx	Discrete Inputs (Read-only)	Read Discrete Inputs. The ON/OFF status of a 1x reference address is controlled by the corresponding digital input channel.	1 bit
3xxxx	Input Registers (Read-only)	A 3x reference register contains a 16-bit number received from an external source like an analog input signal.	16 bits
4xxxx	Holding Registers (Read/Write)	A 4x register is used to store 16-bits of numerical data (binary or decimal), or to send the data from the CPU to an output channel.	16 bits

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For each of those tables, the protocol allows a maximum of 65536 data items to be accessed. It is slave dependent, in which data items are accessible by a master. Typically, a slave implements only a small memory area.

UEIModbus only implements memory areas big enough to hold the number of channels used on each layer.

1.2. Mapping of PowerDNA I/O layers to MODBUS register tables.

Each PowerDNA I/O layer is addressed using a device number starting with 0 for the top layer, 1 for the layer below, and so on. This device number is used to calculate the address of the MODBUS registers associated with each layer by multiplying it by 1000.

Device 0 MODBUS registers will start at address 0
Device 1 MODBUS registers will start at address 1000
…
Device x MODBUS registers will start at address 1000*x

Coils and Discrete Inputs registers can only represent one bit. They are used to hold the digital output and input line state of digital devices.

Input and Holding registers can represent 16-bit. Each register can represent a digital port or an analog channel raw value for devices of resolution lesser or equal to 16 bits.

To represent values greater than 16 bits, two Input or Holding registers are needed.
Two registers are also needed to represent the scaled value of analog channels using the 32-bit IEEE floating point representation.
Four registers are needed to represent the scaled values of analog channels using the 64-bit IEEE double precision floating point representation.

1.2.1. Digital input/output device representation

Digital I/O devices are always mapped twice:

- Each individual line is mapped in the Coil (for output) or Discrete Input(for input) tables
- Each port is mapped in the Holding register (for output) or Input register (for input) tables.

Here is an example for a 12-bit DI layer at dev. 2.

Discrete Input table	Physical channel
2001	Input port 0 line 0
2002	Input port 0 line 1
2003	Input port 0 line 2
…	…
2011	Input port 0 line 10
2012	Input port 0 line 11

Input Register table	Physical port
2001	Input port 0

1.2.2. Analog device representation

Analog input devices are mapped in the input register table and the holding register table. Analog output devices are mapped in the holding register table.

Here is an example for a 16 channels AI layer at dev3 configured to acquire data as simple precision floating point values (32-bits: two registers per channel):

Input Register table	Holding Register table	Physical channel
3001	3001	channel 0
3003	3003	channel 1
…	…	…
3031	3031	channel 15

Here is an example for an 8 channels AO layer at dev5 configured to use double precision floating point values (64-bits: 4 registers per channel):

Holding Register table	Physical channel
5001	channel 0
5005	channel 1
…	…
5027	channel 6
5031	channel 7

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2. Configuring the UEIModbus from the command line

You will need to configure the IP address and the I/O channels you wish to make available to MODBUS/TCP masters.

The IP address must be configured using the serial port.

The I/O channels are configured in the file "/etc/modbusslave.conf", located on the root file system.

2.1. Connecting through the serial port

Connect the serial cable to the serial port on the UEIModbus cube and the serial port on your PC.

You will need a serial communication program:

- Windows: ucon, MTTTY or HyperTerminal.
- Linux: minicom or cu (part of the uucp package).

The PowerDNA I/O module uses the serial port settings: 57600 bits/s, 8 data bits, 1 stop bit and no parity. Run your serial terminal program and configure the serial communication settings accordingly.

Connect the DC output of the power supply (24VDC) to the "Power In" connector on the PowerDNA cube and connect the AC input on the power supply to an AC power source.

You should see the following message on your screen:

```
U-Boot 1.1.4 (Jan 10 2006 - 19:20:03)

CPU:    MPC5200 v1.2 at 396 MHz
        Bus 132 MHz, IPB 66 MHz, PCI 33 MHz

Board: UEI PowerDNA MPC5200 Layer
I2C:    85 kHz, ready
DRAM:   128 MB
Reserving 349k for U-Boot at: 07fa8000
FLASH:   4 MB
In:     serial
Out:    serial
Err:    serial
Net:    FEC ETHERNET

Type "run flash_nfs" to mount root filesystem over NFS
```

```
Hit any key to stop autoboot:  5

## Booting image at ffc10000 ...
   Image Name:   Linux-2.6.16.1
   Created:      2006-11-10  16:07:06 UTC
   Image Type:   PowerPC Linux Kernel Image (gzip compressed)
   Data Size:    917636 Bytes = 896.1 kB
   Load Address: 00000000
   Entry Point:  00000000
   Verifying Checksum ... OK
   Uncompressing Kernel Image ... OK
id mach(): done
...
< lots of kernel messages >
...
BusyBox v1.2.2 (2006.11.03-19:16+0000) Built-in shell (ash)
Enter 'help' for a list of built-in commands.

~ #
```

You can now navigate the file system and enter standard Linux commands such as ls, ps, cd…

2.2. Configuring the IP address

Your UEIModbus cube is configured at the factory with the IP address 192.168.100.2 to be part of a private network.

You can change the IP address for the current session using the command:

```
setip <new IP address>
```

2.3. Starting/Stopping MODBUS slave service

MODBUS/TCP request from MODBUS masters are handled by the MODBUS slave service.

The UEIModbus is pre-configured to automatically start the MODBUS slave service at boot time.

Use the following command to stop the MODBUS slave service:

```
/etc/init.d/modbusslave stop
```

Use the following command to start the MODBUS slave service:

```
/etc/init.d/modbusslave start
```

Use the following command to restart the MODBUS slave service:

```
/etc/init.d/modbusslave restart
```

Use the following command to disable automatic start of MODBUS slave service:

```
mv /etc/rc.d/S40modbusslave /etc/rc.d/K40modbusslave
```

Use the following command to enable automatic start of MODBUS slave service:

```
mv /etc/rc.d/K40modbusslave /etc/rc.d/S40modbusslave
```

2.4. Configuring I/O channels

The file /etc/modbusslave.conf describes the devices and channels that will be available through the MODBUS protocol.

Each line starting with '#' is a comment.
Each line starting with "AI" configures an analog input device.
Each line starting with "AO" configures an analog output device.
Each line starting with "DI" configures a digital input device.
Each line starting with "DO" configures a digital output device.
Each line starting with "CI" configures a counter input device.
Each line starting with "CO" configures a frequency/PWM output device

You must re-start the MODBUS slave service to activate changes made to the configuration file:

```
/etc/init.d/modbusslave restart
```

2.4.1. Configuring an analog input device

The configuration line for an analog input device can contain any of the following "name=value" pairs. If a parameter is omitted, a default value will be used instead.
It is not case sensitive.

- Device={X}: the id of the device to configure.
- NumChannels={X}: the number of channels to use (first channel is always 0).
- InputMode={DIFF|RSE}: the input mode
- Gain={X}: the gain, "0" for gain of 1, "1" for next higher gain and so on.
  For example AI-207 comes with the following gains:
  1,2,4,8,10,20,40,80,100,200,400,800.
  Set Gain=6 to configure gain of 40, Gain =7 to configure gain of 80 and so on.
- MeasurementType={V|TC}: the measurement type, voltage or thermocouple.

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- TCType={E|J|K|S|R|T|B|N|C}: the thermocouple type.
- TempScale={C|F|K}: the temperature scale, Celsius, Fahrenheit or Kelvin.
- CJCType={BUILTIN|CONSTANT}: the cold-junction compensation type. "BUILTIN" uses the sensor on the terminal panel, "CONSTANT" uses a constant value.
- CJCConst={X}: the cold-junction compensation temperature to use when CJCType is set to "CONSTANT".
- DataType={i16|i32|swi32|f32|swf32|f64|swf64}: The data type used to transmit values between the slave and the master.
  f32: single-precision floating point
  swf32: single-precision floating point. Upper 16-bits and lower 16-bits are swapped
  f64: double precision floating point.
  swf64: double precision floating point. Upper 32-bits and lower 32-bits are swapped

The following example configures device 2 to acquire temperatures on its first 4 channels (don't wrap the line when typing it):

```
AI device=2 numChannels=4 inputMode=DIFF gain=8 measurementType=TC
TCType=K tempScale=C CJCType=BUILTIN dataType=f32
```

2.4.2. Configuring an analog output device

The configuration line for an analog output device can contain any of the following "name=value" pairs. If a parameter is omitted, a default value will be used instead. It is not case sensitive.

- Device={X}: the id of the device to configure.
- NumChannels={X}: the number of channels to use (first channel is always 0).
- DataType={i16|i32|swi32|f32|swf32|f64|swf64}: The data type used to transmit values between the master and the slave.
  f32: single-precision floating point
  swf32: single-precision floating point. Upper 16-bits and lower 16-bits are swapped
  f64: double precision floating point.
  swf64: double precision floating point. Upper 32-bits and lower 32-bits are swapped

The following example configures device 0 to generate on its first 4 channels:

```
AO device=0 numChannels=4 dataType=f32
```

2.4.3. Configuring a digital input device

The configuration line for a digital input device can contain any of the following "name=value" pairs. If a parameter is omitted, a default value will be used instead. It is not case sensitive.

- Device={X}: the id of the device to configure.
- NumChannels={X}: the number of ports to use (first port is always 0).
- DataType={i16|i32|swi32|f32|swf32|f64|swf64}: The data type used to transmit values between the slave and the master.
  i16: 16-bits integer
  i32: 32-bits integer
  swi32: swapped 32-bits integer. Upper 16-bits and lower 16-bits are swapped

The following example configures device 5 to acquire digital signals on its first port:

```
DI device=5 numChannels=1 dataType=i32
```

2.4.4. Configuring a digital output device

The configuration line for a digital output device can contain any of the following "name=value" pairs. If a parameter is omitted, a default value will be used instead. It is not case sensitive.

- Device={X}: the id of the device to configure.
- NumChannels={X}: the number of ports to use (first port is always 0).
- DataType={i16|i32|swi32|f32|swf32|f64|swf64}: The data type used to transmit values between the master and the slave.
  i16: 16-bits integer
  i32: 32-bits integer
  swi32: swapped 32-bits integer. Upper 16-bits and lower 16-bits are swapped

The following example configures device 1 to generate digital patterns on its first port:

```
DO device=1 numChannels=1 dataType=i32
```

2.4.5. Configuring a counter input device

The configuration line for a counter input device can contain any of the following "name=value" pairs. If a parameter is omitted, a default value will be used instead. It is not case sensitive.

- Device={X}: the id of the device to configure.
- NumChannels={X}: the number of counters/ports to use (first port is always 0).

- DataType={i16|i32|swi32|f32|swf32|f64|swf64}: The data type used to transmit values between the slave and the master.
  i16: 16-bits integer
  i32: 32-bits integer
  swi32: swapped 32-bits integer. Upper 16-bits and lower 16-bits are swapped
- Mode={count|quad|period|pulsewidth}: The mode used to configure the counter to measure events, quadrature encoder position, period or pulse width
- Source={internal|external}: The source signal to count or measure, internal uses the on-board 66MHz clock, external uses the signal connected to the counter's input pin.
- Gate={internal|external}: The gate signal to enable/disable the counter, internal sets the gate automatically when counter starts, external uses a signal connected to the counter's gate pin.
- InputInverted={0|1}: Set to 1 to invert the input signal.

The following example configures device 2 to measure quadrature encoders position connected to ports 0,1,2,3:

```
CI device=2 numChannels=4 dataType=i32 mode=quad source=external
gate=internal inputinverted=0
```

2.4.6. Configuring a frequency/PWM output device

The configuration line for a frequency output device can contain any of the following "name=value" pairs. If a parameter is omitted, a default value will be used instead.
It is not case sensitive.

- Device={X}: the id of the device to configure.
- NumChannels={X}: the number of counters/ports to use (first port is always 0).
- DataType={i16|i32|swi32|f32|swf32|f64|swf64}: The data type used to transmit values between the master and the slave.
  i16: 16-bits integer
  i32: 32-bits integer
  swi32: swapped 32-bits integer. Upper 16-bits and lower 16-bits are swapped
- Mode={pulse|train}: The mode used to configure the counter to output pulse(s), "pulse" will output a single pulse each time a new value is written to the Modbus register. "train" will continuously output pulses.
- lowticks={X}: The initial number of clock ticks used to specify the low state duration.
- highticks={X}: The initial number of clock ticks used to specify the high state duration.

The following example configures device 2 to output pulses out of ports 0,1,2,3:

```
CO device=2 numChannels=4 dataType=i32 mode=train lowticks=1000
highticks=1000
```

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3. UEIModbus configuration GUI

The UEIModbusConf provides a GUI to ease configuration and test of the UEIModbus.

- Connect the serial cable to the serial port on the UEIModbus cube and the serial port on your PC.
- Connect the DC output of the power supply (24VDC) to the “Power In” connector on the PowerDNA cube and connect the AC input on the power supply to an AC power source.
- Run the UEIModbusConf.exe program

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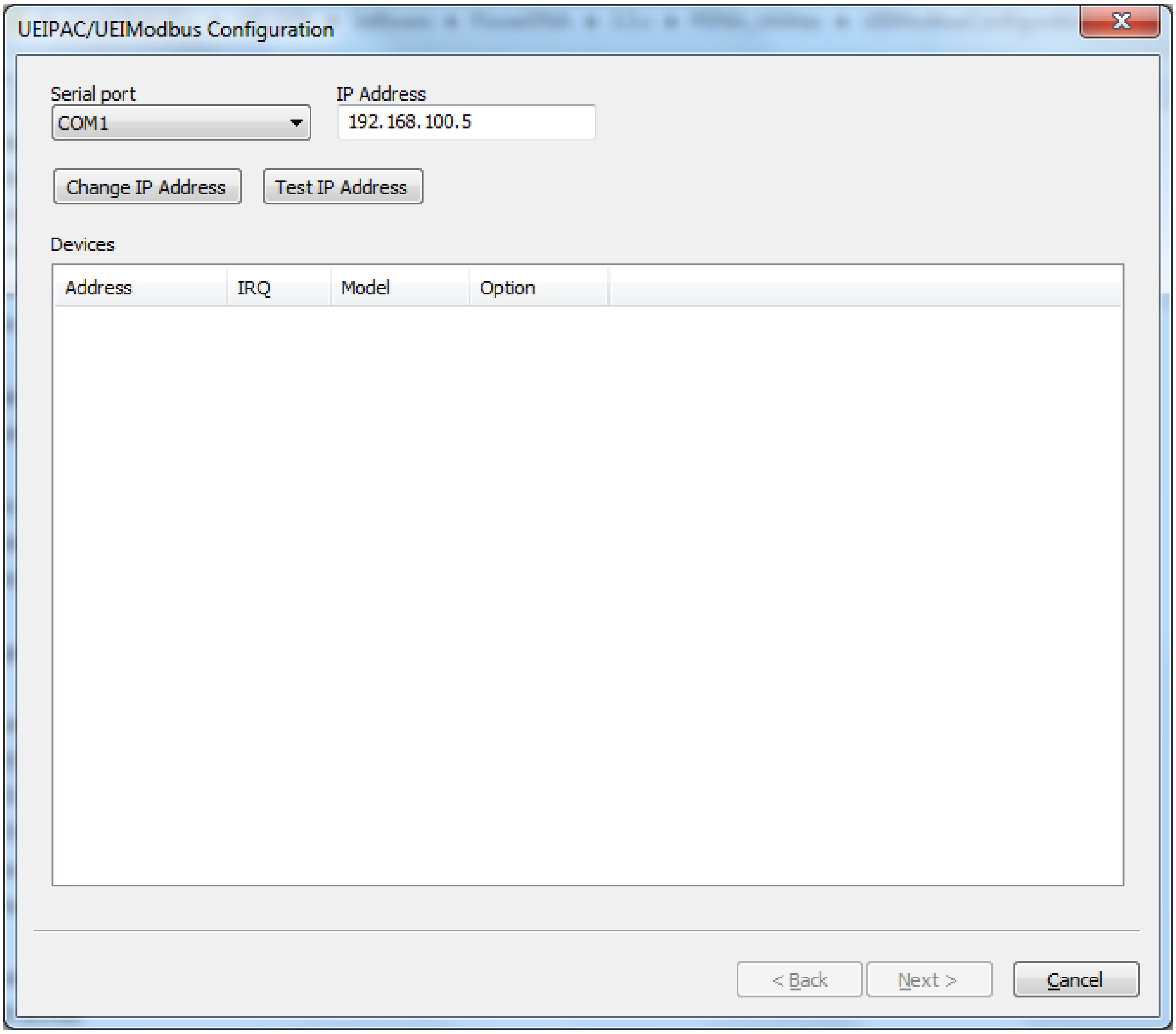
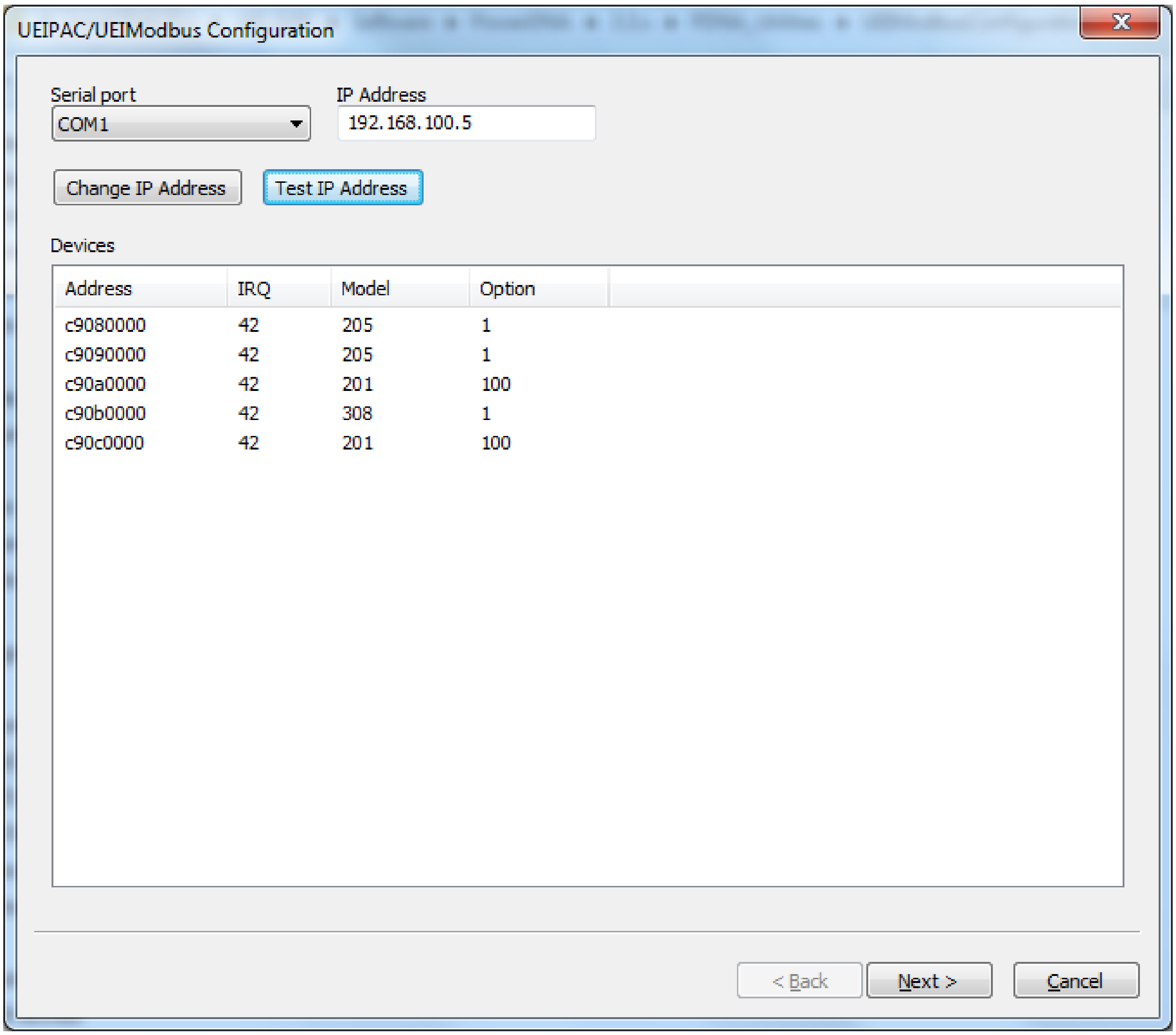
3.1. Configure IP address



- Select the host PC serial port connected to the UEIModbus
- Type the IP address of the UEIModbus
- Click on **Change IP Address** to program the new IP address
- Click on **Test IP Address** to test the IP address

Once the IP address test is successful, the list of I/O layers installed in the UEIModbus will appear in the **Devices** list box. The button **Next>** will also become enabled.


UEIPAC/UEIModbus Configuration
Serial port
COM1
IP Address
192.168.100.5
Change IP Address
Test IP Address
Devices
Address
IRQ
Model
Option
c9080000 42 205 1
c9090000 42 205 1
c90a0000 42 201 100
c90b0000 42 308 1
c90c0000 42 201 100
< Back
Next >
Cancel

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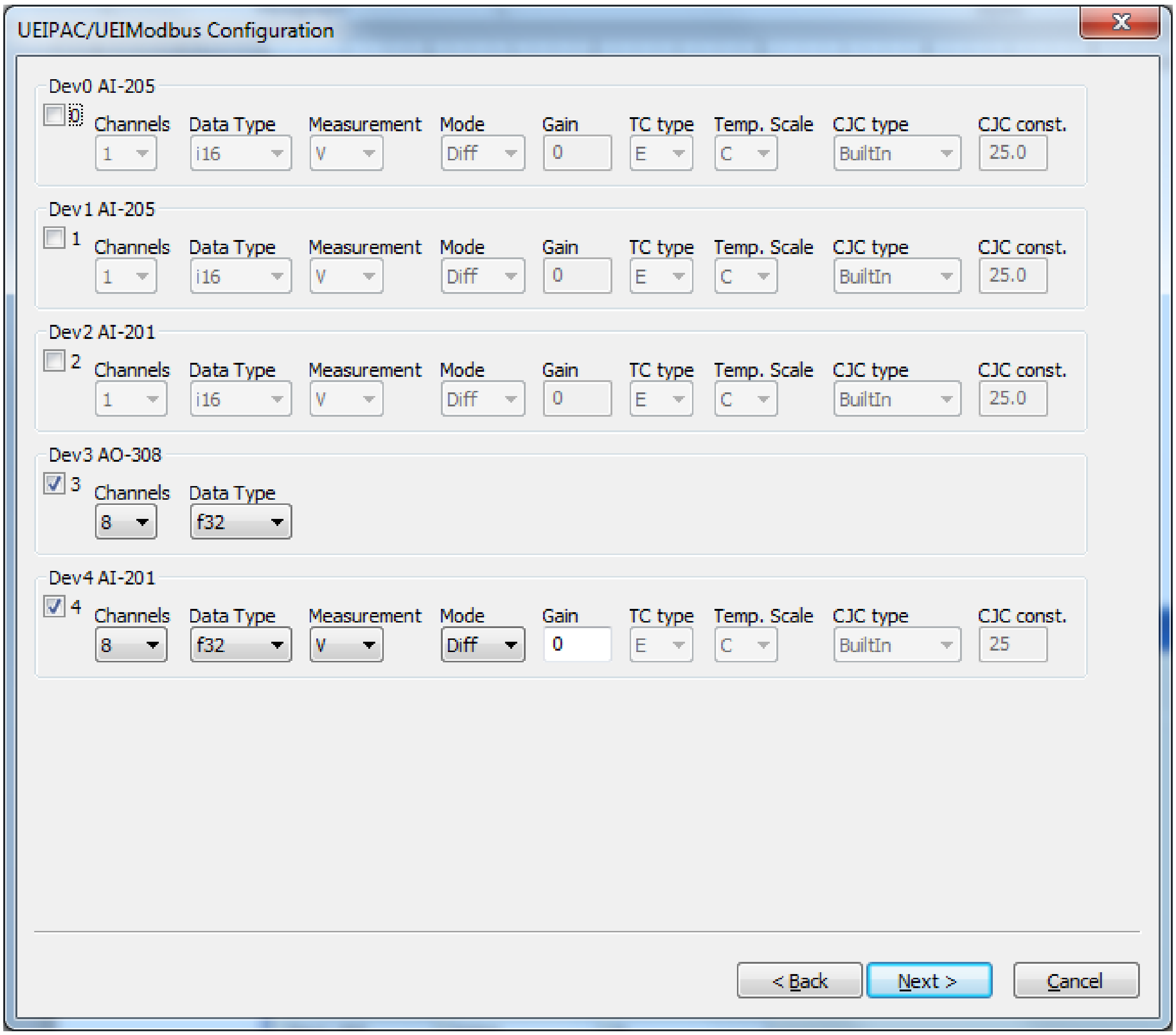
3.2. Configuring I/O channels



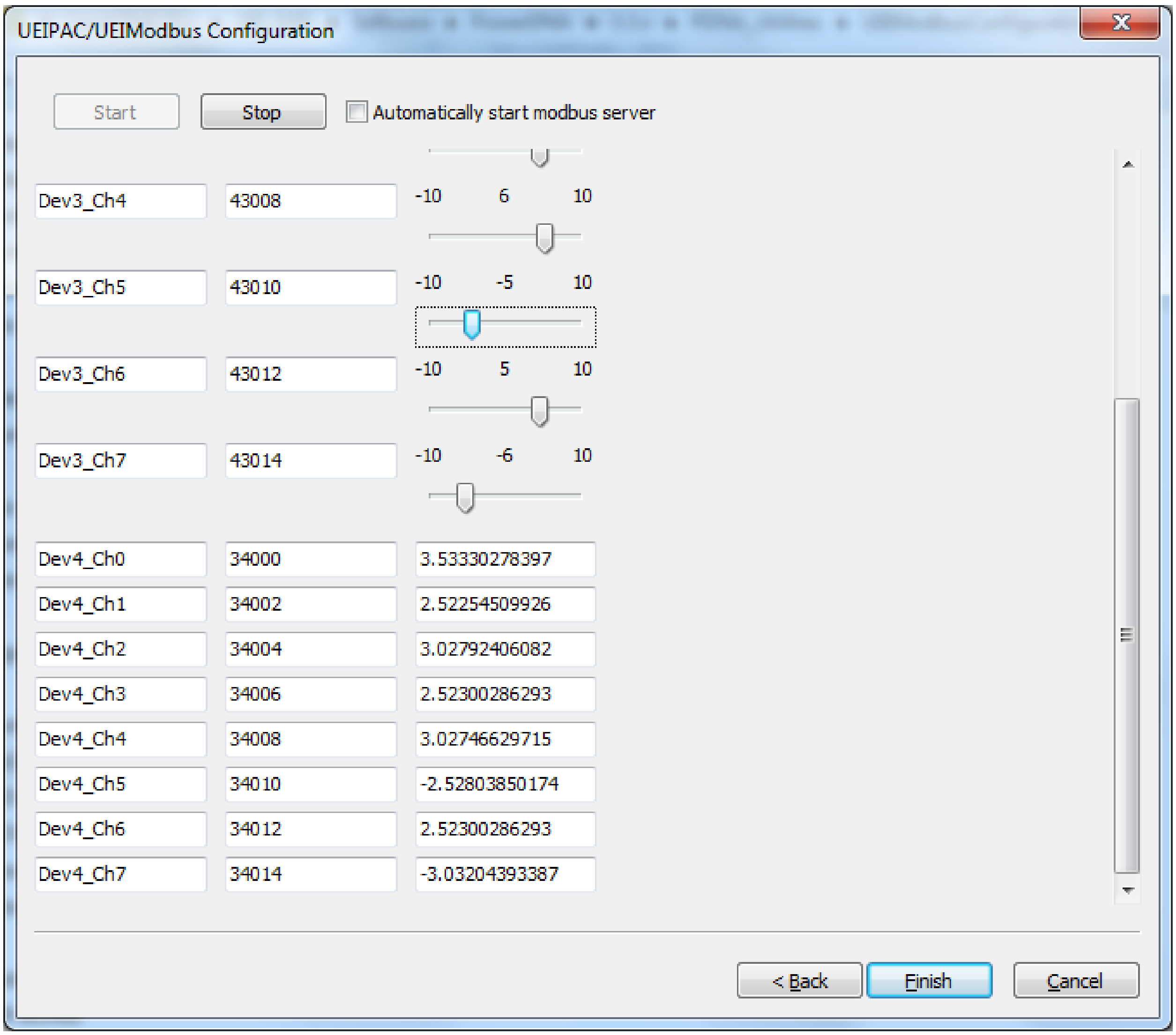
Enable the devices you wish to access.

Configure the parameters for each selected device. Refer to section 2.4 for more informations about device parameters

Click on **Next>** to test the configured I/O channels

3.3. Test I/O channels

Click on **Start** to start reading from the I/O channels using MODBUS/TCP protocol.



Check **Automatically start modbus server** to start MODBUS slave service at boot time.

Click on **Finish** to save the changes to the UEIModbus and terminate the configuration program.