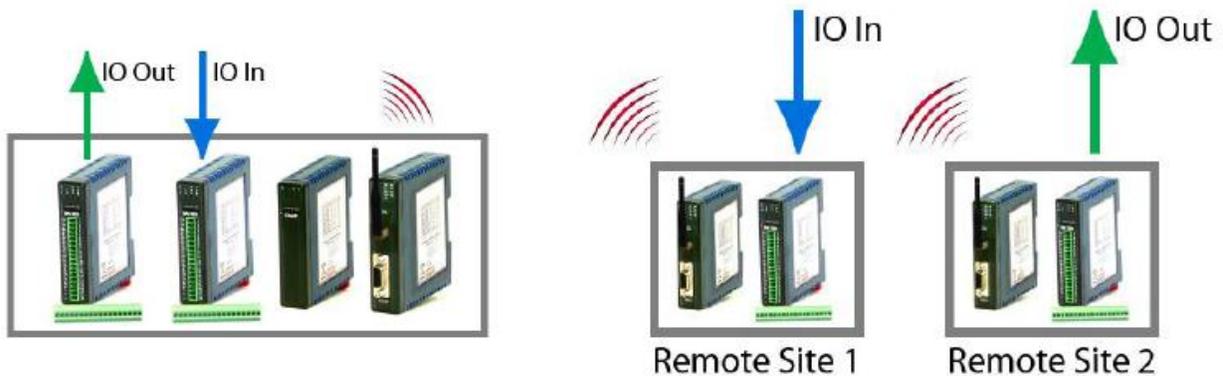


# ioPro Mirrored IO System

## Quick Start Guide (Ver. 6)



***[www.ioselect.com](http://www.ioselect.com)***

## Introduction

This document will cover how to use the ioPro family of products to create a Mirrored IO system (AI ➔ AO and DI ➔ DO). It will cover doing this wired and wirelessly.

A typical Mirrored IO system will consist of at least the following units:

- One ioPro IOMAP or IOMAP2 module
- One or more Input ioPro module (ex: 16DI or 8AI-I-ISO)
- One or more Output ioPro module (ex: 16DO, 4RO, or 8AO-I)
- Optionally, at least two ioPro WDL 900MHz radio modules

Although there are a fair number of parts that have to be assembled, it is really quite straight forward. This guide is designed to gather all the necessary information in one place to make a Mirrored IO system setup a smooth process.

## Suggested Tools

Before beginning, the following tools should be available to make the setup fast and easy:

1. Wire – 20 gauge works well
2. Flat head screw driver (very small)
3. A 24 VDC power supply – (requires 2 power supplies if this is a wireless system)
4. A 4 – 20 mA current source (process calibrator that inputs a current signal to the AI unit)
5. A current meter (multi-meter with current measurement option to read the resulting output signal from an AO unit. If a volt meter is only available, it can be used (with a resistor) to read the current loop. A 250  $\Omega$  resistor will result in a 0 – 5 V signal, a 500  $\Omega$  resistor will result in a 0 – 10 V signal.
6. Whip antennas for each ioPro WDL unit (if this is a wireless system)
7. OPTIONAL – A RS-485 connection to a PC. This is usually achieved via some converter (RS-232 to RS-485, USB to RS-485, etc.)
8. OPTIONAL (Wireless) – A standard 9 pin RS-232 cable (DCE to DTE) – This may not be needed, but having it around is useful to connect to a PC if the WDL configuration needs to be changed.

## Which IO Mapper to Use?

The specific IO Mapper needed depends on the ioPro modules being used in the application.

## IOMAP

- Digital Input: 16DI, 16DI-110, 16DI-220
- Digital Output: 16DO, 4RO (first 4 channels of corresponding 16DI module)
- Analog Input: 8AI-I-ISO, 8AI-V-ISO
- Analog Output: 8AO-I, 8VO-I
- Mixed IO modules: NONE

**Primary Advantage**                      Easy setup (DIP Switch only in most cases)

**Primary Disadvantage**                  No mixed IO module support

## IOMAP2

- Digital Input: All the above
- Digital Output: All the above
- Analog Input: All the above
- Analog Output: All the above
- Mixed IO Modules: 8DIO, DAIO, DAIO2

**Primary Advantage**                      Mixed IO module support

**Primary Disadvantage**                  More complicated configuration (requires ioStudio and an RS485 connection to a PC configure)

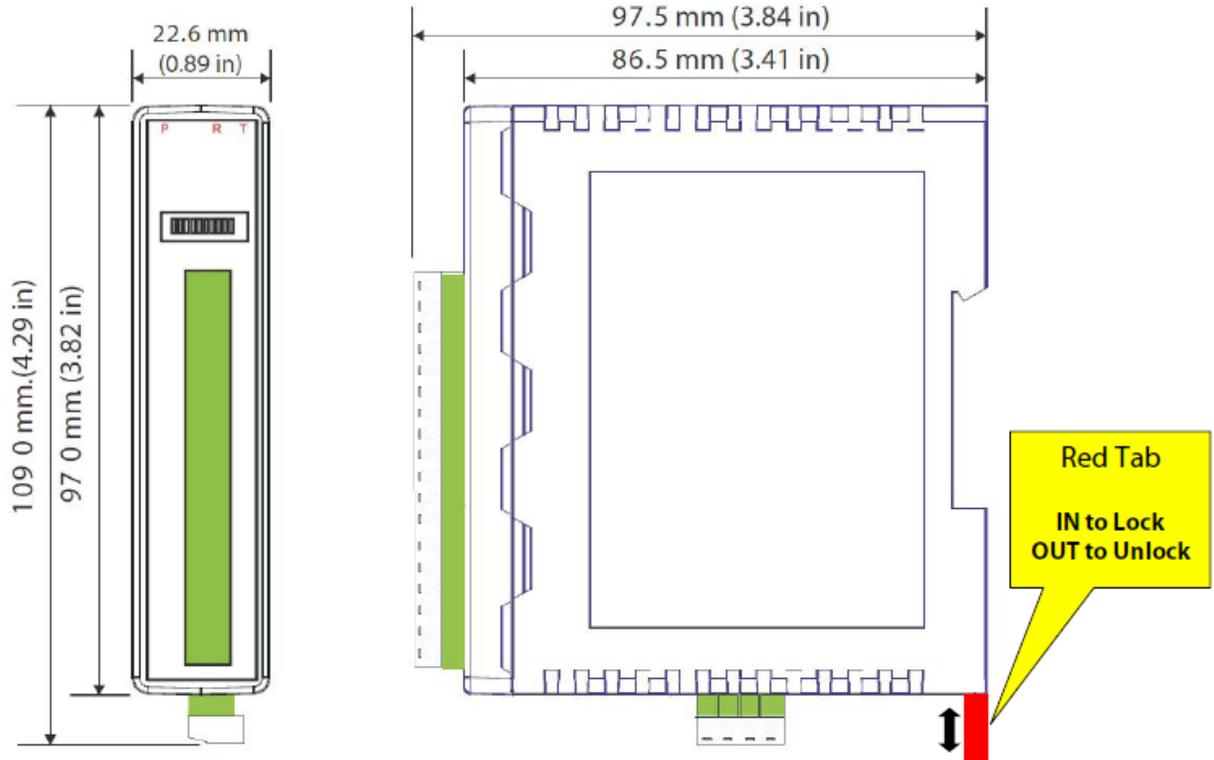
## Step 1 – Where to put the IO Mapper

All ioPro Mirrored IO systems have an IO mapper as the master coordinator. This is typically an ioPro IOMAP, but in some cases can be a PM101 Programmable Gateway. Here we will cover the IOMAP case, the PM101 case will be covered later.

Although the IO mapper can be placed essentially anywhere, experience has shown the best place is at the “Main” or “Central” site. For example, if IO from a remote site is destined to come back to a Control Room the IOMAP should be located in the Control Room enclosure.

## Step 2 – Basic Mechanicals and Wiring

The ioPro modules are designed for DIN rail mounting, simply place the unit on the DIN rail and push in the red tab on the bottom to lock the unit onto the rail.



There are only two connections that need to be made to each module at this point (power and RS-485 communications):

Pin	Connection
1	- 12Vdc @ 32mA
2	+ 24Vdc @ 18mA
3	+ Comms
4	- RS485

DC power (10 – 26 VDC) must be supplied to each module. RS-485 communications is how the module communicates to each other, therefore all +485 and -485 terminals must be connected together in a fully wired system. In a wireless setup (ioPro WDL's at each site), the RS-485 is "Stopped" on a WDL at each site, so at each site all the +485 and -485 terminals are connected on all ioPro modules.

**NOTE: Initial Testing for First-timers**

We suggest that any initial system be first setup in a fully wired configuration, and then add the radios on each end. This can be done on a desktop so that all units are in close physical proximity and all LED's can be seen easily.

By getting the system initially working in a fully wired configuration various radio variables can be eliminated and focus can be set on getting the ioPro units configured and wired correctly.

**NOTE: RS-485 Termination (120 Ω)**

If the system being installed results in long RS-485 line lengths (Greater than 100 feet) then the RS-485 line should be terminated at each end. In a radio based system, the terminations does not have to be used (RS-485 line lengths are typically very short).

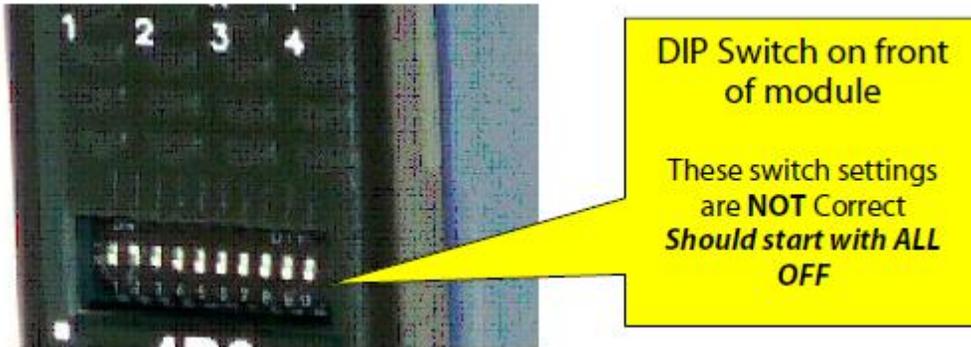
### Step 3 – Configuring the ioPro Modules

Once the modules have been mounted and power has been wired, the ioPro modules can be configured and field wired.

#### Setting the DIP Switches

Each ioPro module has a DIP switch on the front of the module. These switches need to be set correctly based on the configuration of the system being assembled.

**NOTE:** When facing the module, Switch 1 (LSB) is far left and Switch 10 (MSB) is far right.



#### WDL Module

The only configuration option here is selecting RS-232 or RS-485 communication via the front mounted DIP switch.

RS-232	Switch 2 ON, All other OFF
RS-485	Switch 1 ON, All other OFF

**NOTE:** Set the WDL to RS-485 for communication to ioPro modules. In general, RS-232 mode will only be used for configuring the WDL module with the XCU configuration software. This is not typically needed, since the WDLs are typically shipped pre-configured.

## Digital Modules

First make sure all the switches (1 through 10) are set to the OFF position. (Please note the EXCEPTION for the 16DI module below). We work with digital modules in pairs (Digital input module 1 is mirrored to digital output module 1, etc.). Each of these “Pairs” will be set to the same address using the DIP switch positions 1 through 5 (binary addresses 0 to 31). For example with “Pairs” of digital modules):

Digital Module Pair	Address Setting	DIP Switches (1,2,3,4,5)
1	0	OFF, OFF, OFF, OFF, OFF
2	1	<b>ON</b> , OFF, OFF, OFF, OFF
3	2	OFF, <b>ON</b> , OFF, OFF, OFF
4	3	<b>ON</b> , <b>ON</b> , OFF, OFF, OFF
...	...	...
32	31	<b>ON</b> , <b>ON</b> , <b>ON</b> , <b>ON</b> , <b>ON</b>

**NOTE:** When facing the module Switch 1 (LSB) is far left and Switch 10 (MSB) is far right.

**NOTE:** Always start with the lowest available address.

**NOTE:** A pair consists of an Input (AI or DI) module and its corresponding Output (AO or DO) module. Here we are setting the Input and the corresponding Output module to the same address. This seems odd to people familiar with other RS-485 based systems that need a unique address for each module (Modbus-RTU for example). Mirroring with an IOMAP is a “Special Case” and the system has been specifically designed to work this way.

**NOTE:** With the 16DIxxxx module Switch 10 needs to be turned ON. The reason for this is that Switch 10 = OFF forces any module into a Safe Mode setting (9600 Baud, Replay Delay = 0). This setting will not work reliably in typical mirrored IO configurations

with the 16DIxxxx. Setting Switch 10 = ON will tell the unit to use its standard settings as defined by its internal Modbus registers (these settings as shipped will work fine). The main parameters effected are Baud Rate = 9600 and Replay Delay = 3 (which is 30 msec).

## Analog Modules

First make sure all the switches (1 through 10) are set to the OFF position. We work with analog modules in pairs (Analog input module 1 is mirrored to analog output module 1, etc.). Each of these “Pairs” will be set to the same address using the DIP switch positions 1 through 6 (binary addresses 32 to 47). For example with “Pairs” of digital modules:

Analog Module Pair	Address Setting	DIP Switches (1,2,3,4,5,6)
1	32	OFF, OFF, OFF, OFF, OFF, <b>ON</b>
2	33	<b>ON</b> , OFF, OFF, OFF, OFF, <b>ON</b>
3	34	OFF, <b>ON</b> , OFF, OFF, OFF, <b>ON</b>
...	...	...
16	47	<b>ON</b> , <b>ON</b> , <b>ON</b> , <b>ON</b> , OFF, <b>ON</b>

**NOTE:** When facing the module Switch 1 (LSB) is far left and Switch 10 (MSB) is far right.

**NOTE:** Always start with the lowest available address.

## The IOMAP Module (IO Mapper)

Configuring the IOMAP is a little confusing because of how the DIP switches are segmented. Basically, we are telling the IOMAP how many digital and analog “Pairs” there are (it knows the addresses to scan based on that information).

DIP switches 1 to 5 controls how many digital pairs there are and DIP switches 6 to 9 controls how many analog pairs there are. For example:

Digital Pairs	Analog Pairs	Digital Pair CFG DIP Switches (1, 2, 3, 4, 5)	Analog Pair CFG DIP Switches (6, 7, 8, 9)
1	0	<b>ON</b> , OFF, OFF, OFF, OFF	OFF, OFF, OFF, OFF
0	1	OFF, OFF, OFF, OFF, OFF	<b>ON</b> , OFF, OFF, OFF
1	1	<b>ON</b> , OFF, OFF, OFF, OFF	<b>ON</b> , OFF, OFF, OFF
2	2	OFF, <b>ON</b> , OFF, OFF, OFF	OFF, <b>ON</b> , OFF, OFF
7	3	<b>ON</b> , <b>ON</b> , <b>ON</b> , OFF, OFF	<b>ON</b> , <b>ON</b> , OFF, OFF

## IOMAP2 as the IO Mapper

This section covers how to configure a system using the IOMAP2 as the IO Mapper.

### Module Settings

The IOMAP2 works differently than the IOMAP. The IOMAP2 can have up to 50 module pairs of any supported type in any order, but these “Pairs” must be consecutive addresses. Make sure the Input Module has a smaller numerical address than its Output Module counterpart. For example:

Module Pair	Module Type	Module Address
1	16DI	1
	16DO	2
2	8DIO	3
	8DIO	4
3	8AI-I-ISO	5
	8AO	6
...	...	...
50	DAIO2	99
	DAIO2	100

Setting of the module addresses is like this (standard binary addresses).

Address Setting	DIP Switches (1, 2, 3, 4, 5, 6, 7)
0	OFF, OFF, OFF, OFF, OFF, OFF, OFF
1	<b>ON</b> , OFF, OFF, OFF, OFF, OFF, OFF
2	OFF, <b>ON</b> , OFF, OFF, OFF, OFF, OFF
3	<b>ON</b> , <b>ON</b> , OFF, OFF, OFF, OFF, OFF
...	...
99	<b>ON</b> , <b>ON</b> , OFF, OFF, OFF, <b>ON</b> , <b>ON</b>
100	OFF, OFF, <b>ON</b> , OFF, OFF, <b>ON</b> , <b>ON</b>

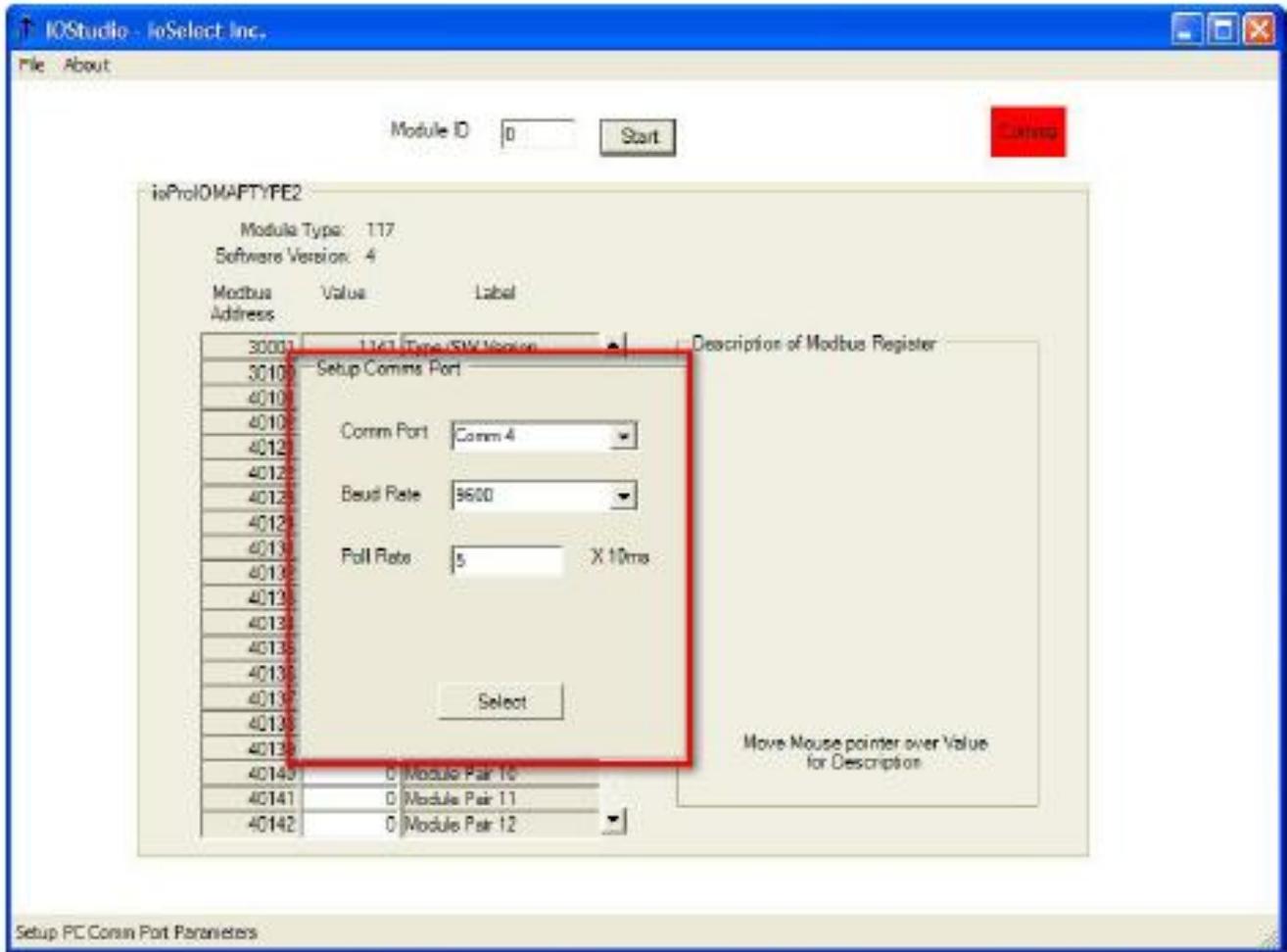
Once the module DIP switch settings are complete these “Pairs” need to be configured in the IOMAP2 via ioStudio.

### The IOMAP2 Module (IO Mapper)

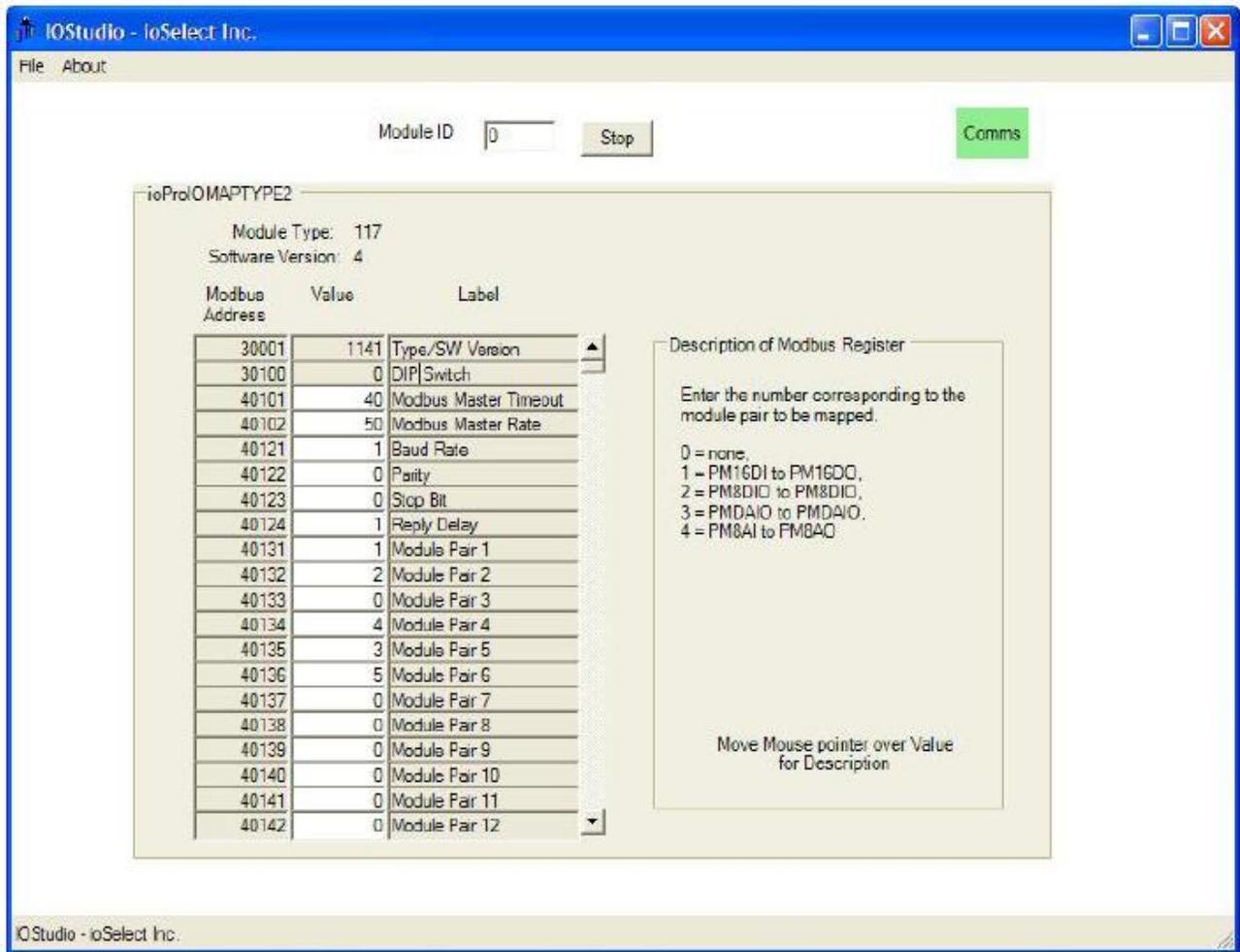
There is only one DIP switch position used on the IOMAP2.

Switch 1 Off	IOMAP2 in Modbus Slave Mode at Address 0 – Use this position to configure the IOMAP2 with ioStudio
Switch 1 On	IOMAP2 in Modbus Master Mode and it starts polling it configured “Pairs” of IO modules

Unlike the IOMAP, most of the IOMAP2's configuration takes place using ioStudio with a PC connection to the IOMAP2 via RS-485. The ioStudio configuration software is available for free on our website ([www.ioselect.com](http://www.ioselect.com)). Once you start ioStudio, set the File → PC Comms setting appropriately for you PC serial connection to the unit.



With Switch 1 OFF on the IOMAP2 its Modbus ID (Address) is 0, so set the Module ID in ioStudio to 0. Then ioStudio should discover the unit.



**NOTE:** The pictured version of ioStudio does not have the DAIO2 in the description of the filed, but it works fine. Newer versions of ioStudio, this is fixed.

**NOTE:** To change a value, double-click in the corresponding “Value” box. A data entry box will appear with a cursor in it like this:

40124	1	Reply Delay
40131	1	1
40132	2	Module Pair 2

Type in the new value and press enter.

40124	1	Reply Delay
40131	1	1
40132	2	Module Pair 2

The value entered will be displayed and immediately saved to flash memory.

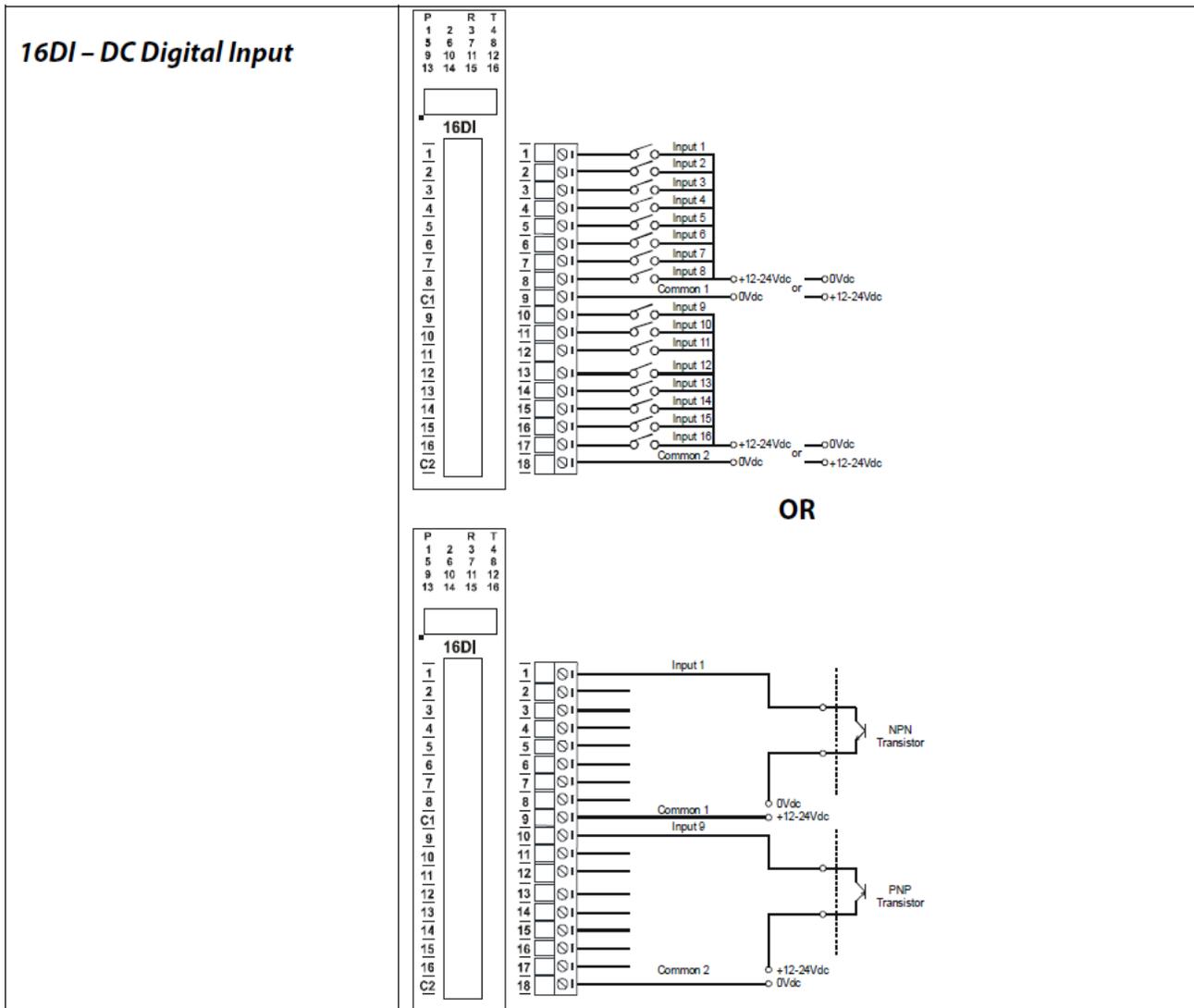
40124	1	Reply Delay
40131	1	Module Pair 1
40132	2	Module Pair 2

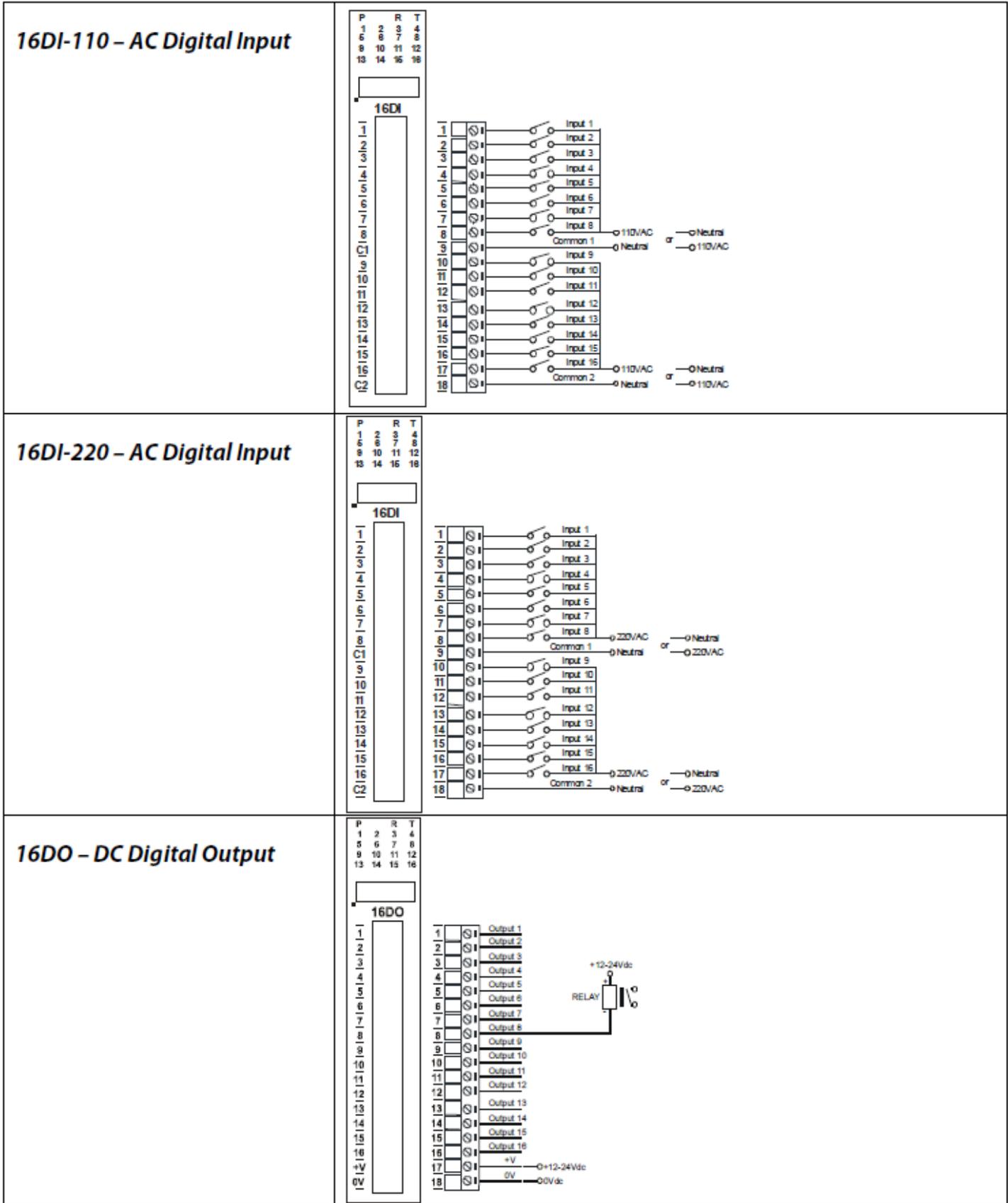
Once the pair settings are complete, quit ioStudio and set the IOMAP2's Switch 1 to ON and it will start scanning the configured modules.

## Wiring the Field Configurations

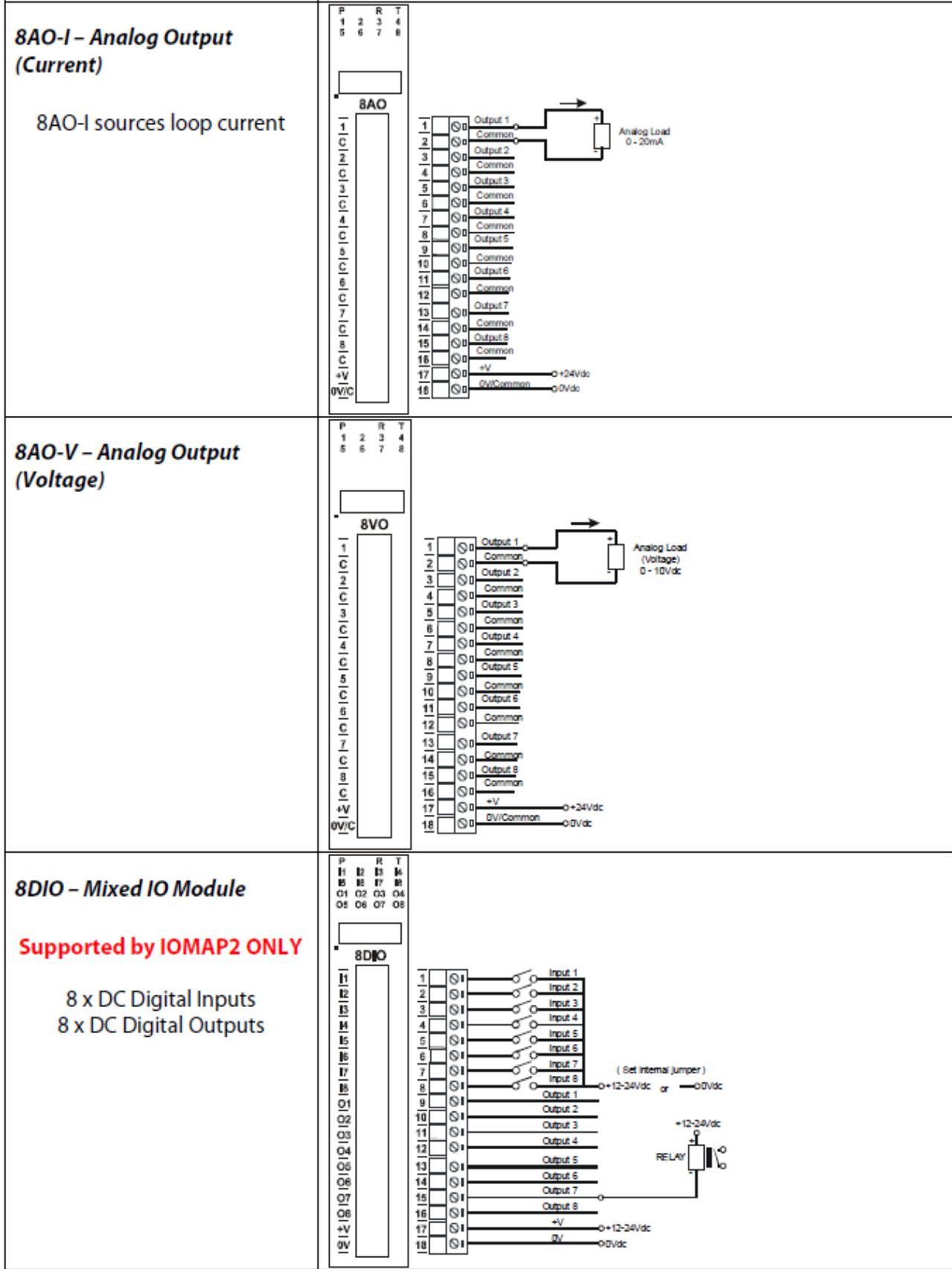
This section shows typical field wiring for the various ioPro units used in mirrored systems. In the following diagram base connections are shown on the left for reference, and field connections are shown on the right.

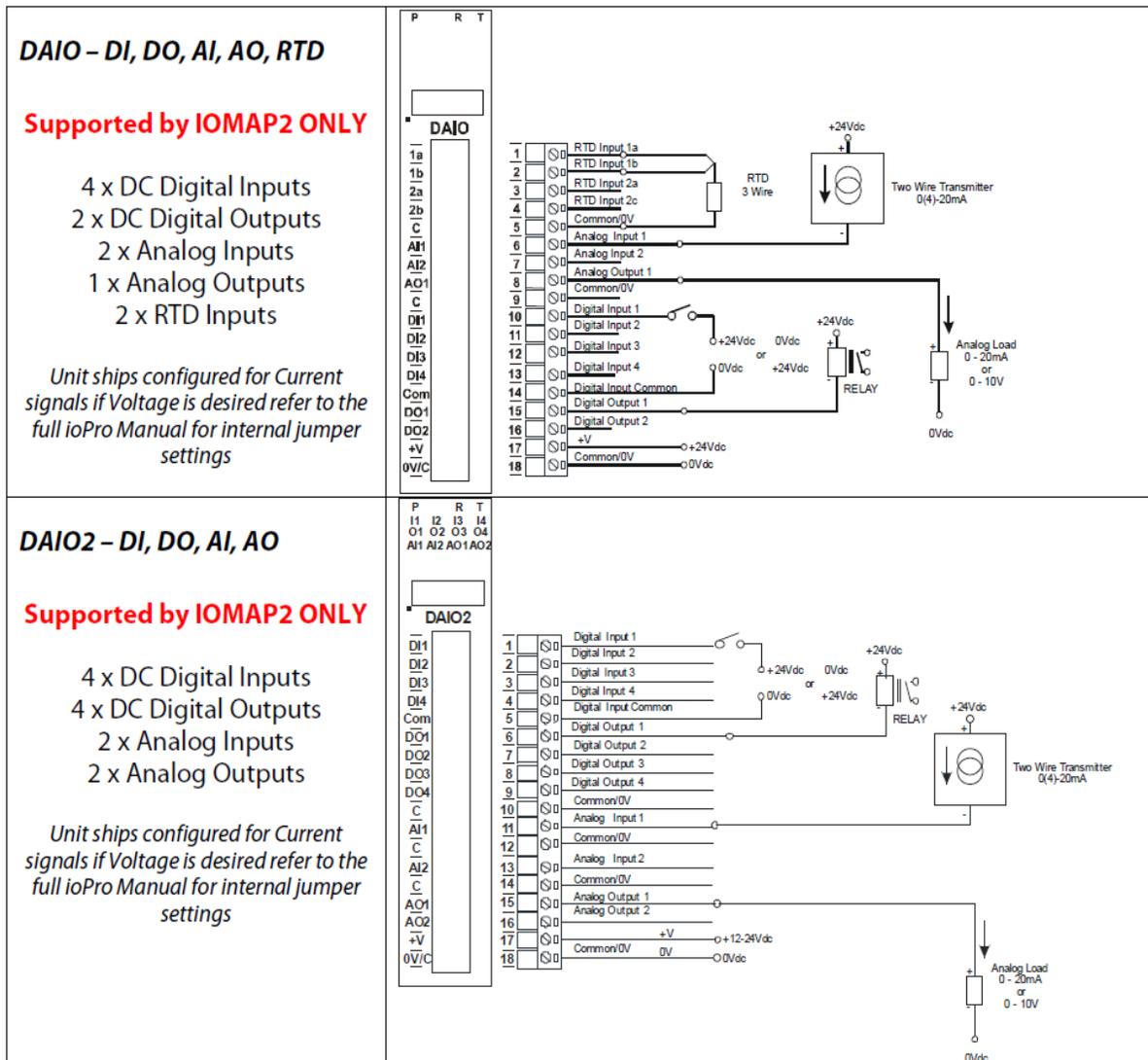
**NOTE:** Although it is not required it is strongly suggested to separate the ioPro Logic voltage (Side Terminal 1 and 2) from the field device voltages. Use of separate DC power supplies provides the maximum Field Device to Logic isolation of 1500 V. For bench testing or special application a single power supply can be used, but in this case the ioPro's internal galvanic isolation is being defeated.











Once the field wiring is complete, the units can be powered up and the system should be running and mirroring signals. For any given module, use the Tx / Rx (Transmit / Receive) LEDs to determine if the signal is being detected by the input module or outputted by the output module.

### Special WDL Considerations

The ioPro WDL has two Received Signal Strength Indicator (RSSI) LEDs on the front. They have the following meaning:

Greater Than -80 db	2 LED	Excellent Signal (> 20 db Fade Margin)
Greater Than -90 db	1 LED	Good Signal (> 10 db Fade Margin)
Less Than -90 db	0 LED	Poor Signal (< 10 db Fade Margin)

By default the ioPro WDLs are configured for immediate use. This default configuration will work in most applications. In some instances these default settings will need to be changed. The most common times are:

1. Multiple ioSelect based Mirrored IO systems in the same physical location where they can hear each other (typically within a couple miles).
2. Many remote sites communicating to one central site.

In these cases the user should refer to the **ioPro WDL Radio Setup Guide** available on the ioSelect website ([www.ioselect.com](http://www.ioselect.com)). This guide covers the configuration of the ioPro WDL in detail (beyond the scope of this document).

### ioStudio

It was previously discussed how to use the ioStudio program to configure the ioPro module “Pairs” in the IOMAP2 unit. Generally, the ioPro modules are preconfigured from ioSelect with the appropriate settings, but sometimes things need to be changed in the field.

### Communication Settings

Modbus Address	Register Name	Low Limit	High Limit	Access	Description
40121	Baud Rate	1	7	R/W	2400, 4800, 9600, 19200, 38400, 57600, 115200
40122	Parity	0	2	R/W	0 = none, 1 = even, 2 = odd
40123	Stop Bits	0	2	R/W	0 = Default (1), 1 = 1 stop bit, 2 = 2 stop bits
40124	Replay Delay	0	65535	R/W	0 = Disable, > 0 = Enable. (x10 ms)

If the Baud Rate, Parity, or Stop Bits are changed Switch 9 (front DIP switch) on the module MUST be set to ON for these settings to take effect (Switch 10 = OFF forces the module to 9600 Baud). Also if a WDL is used, its communication settings will need to be changed using the XCTU software (see the ioPro WDL Radio Setup Guide for more information).

Replay Delay in general should be set to 3 on all modules, but it really only matters for 16Dlxxxx modules in mirrored wireless applications. Again, Switch 9 (front DIP switch) must be turned ON for this setting to take effect.

### IO Mapper Specific Settings

Modbus Address	Register Name	Low Limit	High Limit	Access	Description
40101	Master Timeout	0	65535	R/W	Modbus Master Timeout (x10 ms)
40102	Master Poll Rate	0	65535	R/W	Modbus Master Poll Rate (x10 ms)

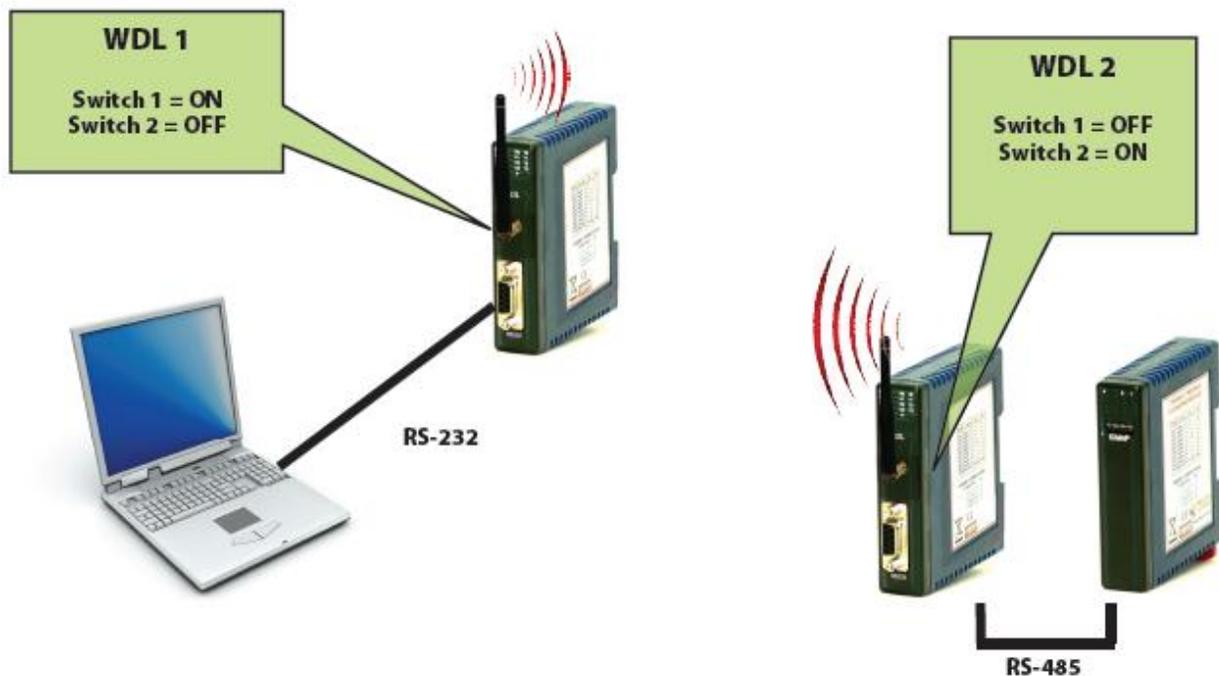
These two values control the specifics of how an IO Mapper polls the other IO modules.

<b>Modbus Master Timeout</b>	Controls how long the IO Mapper will wait for a message response from the CURRENT IO module before polling the NEXT module. This parameter should be LONGER than the Poll Rate value below.
<b>Modbus Master Poll Rate</b>	Controls how long the IO Mapper will wait after getting a valid response from the CURRENT module until polling the NEXT module.

There are many other parameters in the various modules. Most are fairly self-explanatory, are documented in the ioPro Manual, and have useful descriptions in ioStudio. In any case, the ones above are the ones used with Mirrored IO systems which are the focus of this document.

### Using Two WDLs as a RS-232 to RS-485 Converter

Sometimes it is difficult to obtain a RS-485 converter, but if your PC has an RS-232 port then two WDLs can be used as a RS-232 to RS-485 converter in a pinch to use ioStudio to change some ioPro settings.



Basically, WDL 1 above is a “RS-232 to Radio” Modem and WDL 2 above is a “RS-485 to Radio” Modem. Now any ioPro module connected to WDL 2 can be accessed by its DIP Switch set address by ioStudio running on the PC connected to WDL 1.

Many customers use this configuration of WDLs to permanently connect ioPro units or other RS-485 Modbus devices back to a PC or PLC with a RS-232 port. This is useful when you have a Modbus master unit that can poll the ioPro modules or other Modbus devices directly (instead of converting back to IO as with Mirrored IO systems).

## Troubleshooting

At this point the system should be working. If not here are some things to look for:

1. Check module wiring. Use an Ohm meter to check for proper connections.
2. With the IOMAP, make sure Pair 1 of the digital module is set to address 0. It is common to set it accidentally to address 1 thinking Digital Pair 1 = Address 1. However this is wrong.
3. All Output modules (DO, RO, and AO) should be set to “Slave” mode (DIP Switch 9 = OFF).
4. All NON 16DIxxxx modules should be set to internal settings if using 16DI module is part of the network (DIP Switch 10 = ON).
5. All 16DIxxxx modules (16DI, 16DI-110, 16DI-220, etc.) should be set to internal baud and replay delay (DIP Switch 10 = ON)
6. LEDs – When things are working properly data flows in the following pattern (of course this happens quite fast, but the pattern is discernable):

IOMAP	IOMAP2
1. IOMAP – Tx 2. Current AI / DI – Rx then Tx 3. IOMAP and Corresponding AO / DO – Rx 4. Start Over with Next Pair  <b>NOTE:</b> The AO / DO will not Transmit (No Tx)	1. IOMAP2 – Tx 2. Current AI / DI – Rx then Tx 3. IOMAP2 – Rx 4. IOMAP2 – Tx 5. Corresponding AO / DO – Rx then Tx 6. IOMAP2 – Rx 7. Start Over with Next Pair

In all cases with WDLs involved, the WDL will transmit (Tx) whenever a local attached serial device transmits (Tx). This will cause the other radio to receive a radio packet (RSSI LEDs go on) and then this WDL will send this received (Rx) data out the serial port.

7. What do the Rx and Tx LEDs mean.

<b>IO Module</b>		<b>WDL</b>	
Rx	The IO module is receiving a serial packet from the RS-485 bus.	Rx	The WDL has received a valid RF packet from another radio and will now send it out the configured serial port.
Tx	The IO module is transmitting a serial packet to the RS-485 bus. Typically, in response to a valid received command.	Tx	The WDL has received a valid serial packet from the serial port and will now send it out the radio.

8. The ioPro WDL does not have a power LED, but when power is applied the Tx and Rx LEDs will briefly flash.
9. To verify I/O channels on modules, ensure that the module receives 12 to 24 VDC on the front terminal strip.
10. Make sure that the I/O terminal block (longer of the 2 green terminal blocks) is receiving the proper voltage.

## More Information or Support

Please contact ioSelect directly.

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# Thank You