

# Ethernet Industrial I/O Module Hardware Manual

Model 2410 | Rev.1.0.1 | September 2010

SENSORAY | embedded electronics |



Designed and manufactured in the U.S.A.

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# Chapter 1: Quick Setup Guide

## 1.1 Overview

Each 2410 module is assigned a static IP address. By assigning a unique IP address to each module, it is possible to connect a virtually limitless number of modules to a network.

As shipped from the factory, the IP address is set to 192.168.24.10 with netmask 255.255.0.0. These settings may be changed by following the directions given below.

## 1.2 Select Network Addresses

1. **Choose a temporary IP address** for the 2410 module. This address must be compatible with the network that will be used to configure the module, and it will only be used during the configuration process.

Make sure the temporary address you choose is not used by another host on the configuration network.

*Example:*

Your configuration network is 192.168.0.0 with netmask 255.255.0.0. The only other hosts on this network are your PC at 192.168.1.2 and a router at 192.168.1.1. In this case an arbitrary, unused address such as 192.168.1.25 may be used for the module.

2. **Choose a permanent IP address** for the module. This is a static address that will be permanently assigned to the module unless you manually change it again later. The permanent address must be compatible with the network to which the module will be attached in your application.

Make sure the permanent address you choose is not used by any other hosts on the target network. The permanent address may be the same as the temporary address (in step 1, above) if the module is being configured on the target LAN.

*Example:*

Your target network is 10.0.0.0 with netmask 255.0.0.0. In this case you could assign an arbitrary, unused address such as 10.1.2.3 to the module.

## 1.3 Configure the Network Interface

1. **Connect the module to your configuration LAN** with an Ethernet patch cable, Category-5 or higher. Use a crossover cable if you are connecting the module directly to a computer, otherwise use a standard patch cable.
2. **Apply 24VDC power** to the module.
3. **Switch to Configuration mode.** Hold down the module's CONFIG pushbutton while you press and then release the RST pushbutton. The blue LED under the CONFIG pushbutton will light when the module is in Configuration mode. If multiple modules are connected to your network, ensure that only one module is in Configuration mode.

4. **Program the temporary IP address.**

Run ARP with this command line:

```
arp -s <temp_addr> 08-00-56-FF-FF-FF
```

*Example:*

```
arp -s 192.168.1.25 08-00-56-FF-FF-FF
```

### Windows

You can do this in either of the following ways:

- Navigate to Start | Run, then type the command into the dialog box and click OK.
- Open a console window, then type the command at the shell prompt followed by Enter.

### Linux

Open a shell, then type the command at the shell prompt followed by Enter.

5. **Open this URL** from a web browser:

```
http://<temp_addr>/config.htm
```

*Example:*

```
http://192.168.1.25/config.htm
```

The module's Configuration web page should appear in your browser window.

6. **Program the permanent network settings.** In the designated field on the Configuration web page, enter the permanent IP address you chose earlier. If necessary, also enter a new netmask and gateway address. Click the Submit button and wait for the page to reload.
7. **Reset the module.** Press and release the RST pushbutton. Your permanent network settings are now in effect.

# Chapter 2: Introduction

## 2.1 Overview

Sensoray's Model 2410 is a compact electronics module that interfaces 48 general purpose TTL/CMOS compatible digital I/O (DIO) channels to a 10/100 Mbps Ethernet. Each channel may be independently configured to operate as an input, an output, or in wired-or mode.

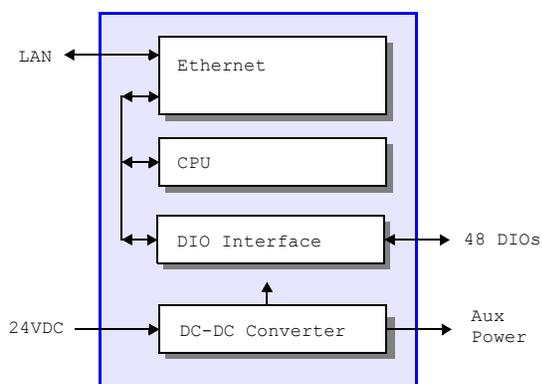
A standard 50 pin header is provided for connecting the module to external solid-state relay racks. An optional termination board, Model 2410TA, may be top mounted to the module to add convenient field wiring terminal blocks without enlarging the module's footprint.

Each DIO channel has several functional features:

- LED state indicator. The 48 indicators may be collectively dimmed for viewing comfort or power reduction.
- 24mA output drive, active low with pull-up.
- Programmable PWM output mode.
- Programmable input edge detection and capture.
- Programmable input debounce.

The module includes a number of hardware features that simplify its integration into host systems: it is compact, requires only a single 24VDC power source, and can be quickly installed by simply snapping it onto a standard DIN mounting rail. The module communicates by means of standard network protocols: Telnet for manual control and automation applications, and HTTP for diagnostics.

**Figure 1: Module Block Diagram**



A typical system consists of one or more 2410 modules, a 24VDC power supply, a client computer and a local area network (LAN).

In the simplest case, the LAN may consist of a crossover cable that connects a client directly to a single 2410 module. In more complex systems, each 2410 module will typically connect to a network switch or router, which in turn provides access to the module from one or more clients.

Numerous LEDs reside on the module to give a comprehensive visual indication of the state of the module. Each LED is labeled on the module silkscreen to indicate its function.

## 2.2 Heartbeat

A “heartbeat” LED flashes several times per second as an indication that the module’s internal CPU is functional and various other resources are operating within error limits.

 **HBT** lights periodically to indicate the module’s internal control systems are operating normally.

## 2.3 Module Reset

### 2.3.1 RST Pushbutton

The module will immediately execute a hardware reset when the RST pushbutton is pressed.

 **RST** lights briefly while the module is being reset.

### 2.3.2 CONFIG Pushbutton

The module will enter its Configuration mode if the CONFIG pushbutton is pressed while RST is pressed and then released. In the Configuration mode, the module’s network interface assumes a known MAC address and it listens at all IP addresses. See Chapter 1 for details.

 **CONFIG** lights when the module is in Configuration mode.

### 2.3.3 Module State Upon Reset

Upon power-up, or in response to a hardware or software reset, any open communication sessions are closed and all DIO channels are forced to known initial states:

- Output drivers are set to the inactive state (pulled high).
- Outputs are configured to operate in Standard (vs. PWM) mode.
- Input edge detection is disabled.
- Input debounce is set to 10 ms.

## 2.4 Safety Features

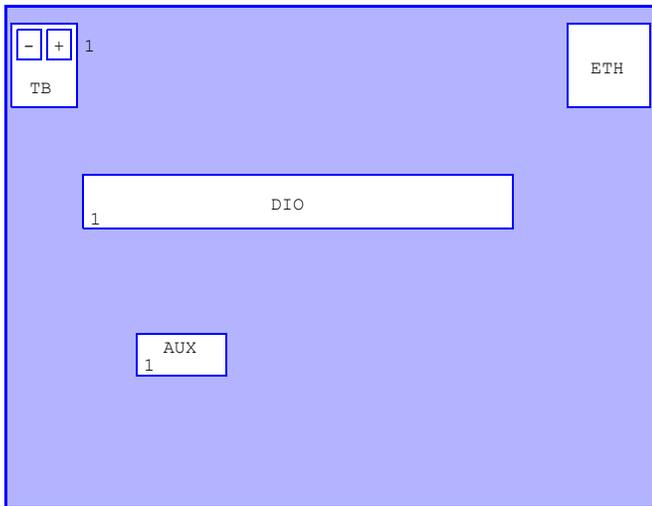
Model 2410 features special mechanisms that can be used to enhance the safety of application systems:

- A hardware watchdog timer forces a hardware reset in the event of a malfunction by the module’s internal CPU, thus forcing all digital outputs to their inactive (high) states.
- A communication watchdog timer generates a software reset if a network client ceases to communicate. This can optionally reset all outputs to their inactive states.

## 2.5 Connectors

All connectors have mechanical detentes or provision for hold-downs to help maintain connections in high-vibration environments.

Figure 2: Module Layout



The connectors shown in Figure 2 have these functions:

- AUX — Auxiliary 5VDC output power for relay racks.
- DIO — General purpose digital I/O channels.
- ETH — Ethernet interface.
- TB — 24VDC input power terminal block.

Several connectors are reserved for manufacturing and test. Applications should not make electrical connections to these connectors: P1, JP2. A shunt must be installed at JP1 for normal operation.

## 2.6 Power Connections

Module input power must be connected to the terminal block labeled “TB” in Figure 2.

Table 1: Terminal Block Pinout

Pin	Name	Function
1	+24V	+24VDC module power.
2	GND	Return for the +24VDC signal on pin 1.

Auxiliary 5VDC output power is available from the AUX connector (see Figure 2). This can be used to supply limited auxiliary power to external relay racks or other low current loads that require 5VDC power. See Chapter 5 for the electrical specifications for this circuit.

Table 2: Auxiliary Power Output Connector Pinout

Pin	Name	Function
1	+5V	+5V output power.
2, 3	GND	Return for the +5V signal on pin 1.
4	NC	No connect. This pin makes no electrical connection to the module’s circuitry.

 **PWR** lights continuously when 24VDC power is applied and the module’s internal power supply is operating.

## 2.7 Ethernet Connection

An RJ-45 jack (ETH connector in Figure 2) interfaces the module to a 10BaseT/100BaseTX Ethernet network. A Category-5 (or better) shielded or unshielded twisted pair (STP or UTP) patch cable—which is not supplied with the module—must be plugged into this jack.

Use a standard patch cable if you are connecting the module to a switch, hub or router. Use a crossover cable if the module will be directly connected to a dedicated Ethernet client.

Two LEDs are located near the ETH connector:

-  **LNK** lights continuously when incoming link pulses are detected.
-  **ACT** lights briefly when incoming Ethernet packets are detected.

# Chapter 3: Network Interface

The 2410 module connects to a network through its Ethernet interface. This interface supports 10/100 Mbps networks with automatic speed detection. Ethernet provides several important advantages over other popular communication interfaces, including:

- Platform independence.
- Protection from hardware obsolescence.
- Elimination of disruptive ground loops in the client-server communication path.

## 3.1 HTTP Server

The module implements an embedded HTTP server and web site. The web site makes it possible to configure the module and control digital I/O states from a web browser.

The module's web site is intended for module configuration and diagnostic uses. It is not recommended for automated client applications.

## 3.2 Telnet Server

A built-in telnet server provides the principal means for controlling the module's I/O resources from automated client applications. Because it is based on plaintext messages, telnet also serves as a practical alternative to HTTP for manually controlling the module.

The module's telnet server supports multiple concurrent telnet sessions, each with a private, dedicated shell. The shells, in turn, provide access to a variety of plaintext shell commands. Network clients interact with I/O devices by sending shell commands, and receiving the output of shell commands, over telnet.

Upon receiving a shell command from a network client, the module executes the command—often causing manipulation of an I/O interface—and then returns any requested data to the client. In most cases, a client will open a telnet session and leave it open until it has completely finished communicating with the module (e.g., when the client application closes).

Every telnet client can access all of the I/O resources on the module, except that only one telnet client may receive asynchronous event notifications (i.e., notification of captured digital input edges) at a time.

Applications may have any number of open telnet sessions on a module, up to the maximum number supported by the module. This is a flexible arrangement that makes possible a wide range of configurations. For example:

- A host computer could employ a telnet session for automated module control while, at the same time, a portable laptop computer employs another session for diagnostic monitoring.

- Multiple host computers—each responsible for managing specific I/O resources on a 2410 module (e.g., a subset of the 48 DIO channels)—can concurrently communicate with a specific module over independent telnet sessions.
- A module's telnet clients need not reside on different host computers; a single host may run multiple threads or processes, each of which has a private telnet session.

### 3.2.1 Telnet Time-outs

Each telnet session has a programmable time-out interval that specifies the maximum time allowed between consecutive shell commands. If no shell commands are received within the time-out interval, the telnet server will automatically close the session and optionally reset DIO interfaces to their default states.

The module's telnet time-out function serves two purposes:

- **Crash recovery.** If a client terminates a telnet session in an “ungraceful” way (e.g., application crash), the server will time-out the session, thus freeing it for re-use. This is a critical feature in systems with deeply embedded 2410 modules.
- **Safety.** Malfunctioning hardware or software may cause a telnet client to cease communicating with the 2410. In such cases, the telnet server will time-out and force the outputs of various module interfaces to their “safe” states.

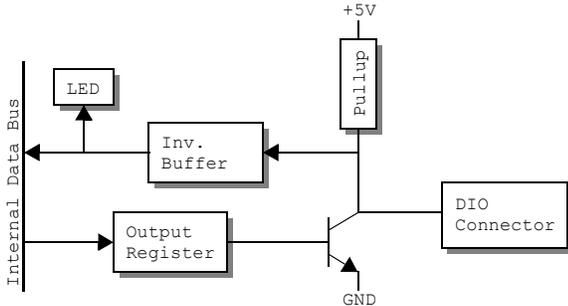
All telnet sessions begin with a default time-out interval and disabled time-out reset (time-out will not reset the module). Once a telnet session has been opened, the client can issue a “WTO” shell command to change the interval and specify whether to reset the module upon time-out.

# Chapter 4: Digital I/O Interface

## 4.1 Overview

Model 2410 has 48 general-purpose digital I/O (DIO) channels, numbered 0 to 47.

**Figure 3: DIO Block Diagram (1 of 48 channels shown)**



As shown in Figure 3, the DIO output section consists of an output register, open-collector transistor, and pullup resistor. The transistor drives the DIO signal to GND when the output is turned on (i.e., logic one stored in output register), and the pullup resistor pulls the DIO signal high when the output is turned off (logic zero stored in output register).

The input section consists of an inverting buffer and a status LED. The logic level at the DIO connector is inverted so that the LED will light and the channel will be sampled as a logic one when the DIO signal is low (0V at the connector). Conversely, 5V at the connector will turn off the LED and be sampled as logic zero.

 **0-47** - Each of these LEDs will light when the associated DIO signal is driven low by the onboard driver or by an external active-low driver.

### 4.1.1 Basic Modes

Each DIO channel may be independently operated in one of these modes:

- **Output** - The channel is driven by its onboard driver and is typically connected to an external load.
- **Input** - The onboard driver remains in the off state so that an external driver (open collector or open drain) can drive the channel low. When the external driver is turned off, the channel is pulled high by the onboard pullup resistor.
- **Wired-OR** - The channel is connected to an external driver (open collector or open drain) so that it can be driven low by either the onboard driver or the external driver. If both drivers are turned off, the channel is pulled high by the onboard pullup resistor.

### 4.1.2 PWM Output Mode

When operating as an output (or wired-OR), a DIO channel may be configured to operate in either Standard or PWM mode. In the Standard mode (default upon reset), a channel's driver is programmed to explicit, static states by the network client. When operating in PWM mode, a channel will output a square wave with period and duty cycle specified by the client.

### 4.1.3 Input Debounce and Capture

The module's internal CPU samples each DIO channel 1000 times per second and passes the samples through a debounce filter. A channel is regarded to be in a particular physical state only after it has been in that state for a specific "debounce" time interval. The debounce interval, which defaults to 10 ms upon reset, is independently configurable for each channel.

After passing through debounce filters, the channels are monitored for state changes. When enabled to do so, the module will register a detected state change and optionally send a notification message to a client. See the *Model 24xx Family API and Programming Guide* for details.

Note: The module's synchronous sampling mechanism introduces latency between the time a physical input changes and the moment that change will be visible to a client. Debounced inputs are delayed by the debounce interval plus up to one additional sample period (1 ms).

## 4.2 DIO Connections

All DIO channels are available through the 50-pin header labeled DIO in Figure 2.

**Table 3: DIO Connector Pinout**

Pin	Signal	Pin	Signal
1	DIO31	26	DIO6
2	DIO30	27	DIO5
3	DIO29	28	DIO4
4	DIO28	29	DIO3
5	DIO27	30	DIO2
6	DIO26	31	DIO1
7	DIO25	32	DIO0
8	DIO24	33	DIO15
9	DIO39	34	DIO14
10	DIO38	35	DIO13
11	DIO37	36	DIO12
12	DIO36	37	DIO11
13	DIO35	38	DIO10
14	DIO34	39	DIO9
15	DIO33	40	DIO8
16	DIO32	41	DIO23

**Table 3: DIO Connector Pinout**

Pin	Signal	Pin	Signal
17	DIO47	42	DIO22
18	DIO46	43	DIO21
19	DIO45	44	DIO20
20	DIO44	45	DIO19
21	DIO43	46	DIO18
22	DIO42	47	DIO17
23	DIO41	48	DIO16
24	DIO40	49	NC
25	DIO7	50	GND

### 4.2.1 External Relay Racks

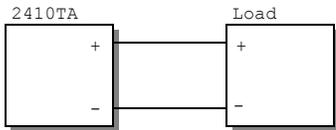
The DIO connector pinout is compatible with a variety of solid state relay racks (e.g., SSR-RACK08, SSR-RACK24 and SSR-RACK48). However, there is no universal standard pinout for relay racks, so before purchasing a rack you should verify that it has a compatible pinout.

Most SSR racks include a terminal block, a Molex connector, or both to connect 5VDC power to the rack. The 2410 module provides 5VDC for this purpose on its AUX power connector (see Figure 2).

### 4.2.2 Sensoray 2410TA Termination Board

On the 2410TA board, each DIO has two terminal block connections: the active-low DIO signal (marked “-”) and +5V (marked “+”). When a channel is functioning as an output, these two terminals may be connected to a load as shown in Figure 4.

**Figure 4: Recommended Output Wiring**

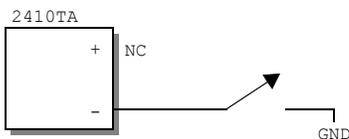


The load impedance must be high enough to limit DIO current to its maximum allowed value. See page 7 for details.

If the load is inductive (e.g., a mechanical relay), a protection diode should be added across the load to suppress induced EMF that might otherwise damage the DIO circuitry.

When a channel is operating as an input (e.g., hard contact), the active-low input signal is connected as shown in Figure 5.

**Figure 5: Recommended Input Wiring**



# Chapter 5: Specifications

**Table 4: Communications Interface**

Network	Physical layer	10BaseT, 100BaseTx Ethernet
	Bit rate	10/100 Mbps, auto-detecting
	Isolation	1500Vrms
	Protocols	ARP, HTTP, ICMP, IPv4, TCP, Telnet
	Configuration	Programmable via HTTP (static ARP): IP address, netmask, gateway
HTTP Server	Concurrent sessions	1
	Functions	Status, configuration, I/O monitor/control
TELNET Server	Concurrent sessions	3
	Time-out interval	5 minutes (default, programmable via HTTP), programmable per session via shell

**Table 5: General Purpose Digital I/O**

Digital Inputs	Input type	5V TTL/CMOS compatible
	Off state input voltage	+2.0 to +5.25 VDC
	On state input voltage	0.0V to +0.8 VDC
	Input impedance	10 Kohm
	Sample rate	1 KHz
	Debounce period	0 to 255 milliseconds, 1ms resolution
Digital Outputs	Output type	Active low, open collector with 10 Kohm pullup resistor
	Output current, on state	24mA maximum
	PWM resolution	1 ms on-time, 1 ms off-time (max frequency = 500 Hz)

**Table 6: Power and Environmental**

Module Power	Input power	24VDC $\pm$ 5% @90mA (digital outputs off, no external loads)
Auxiliary Power Output	Voltage	+5VDC $\pm$ 5%, referenced to module input power supply return
	Current	400mA maximum
Temperature	Operating range	-25 to 85°C

**Table 7: Mechanical**

Module Dimensions	Outer dimensions	5.0H x 4.1W x 2.2D inches. W = overall DIN rail length. D = module height from DIN rail back panel; additional clearance required for field wiring.
Mating Connectors (not included)	ETH	RJ-45 plug, AMP 554169 or equivalent
	DIO	50 pin socket, Tyco 1-1658621-0 or equivalent
	AUXPWR	Molex 22-01-3047 with 08-50-0114 pin contact (4), or equivalent