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PiC900™

Hardware Manual

Version 13.0

Giddings & Lewis
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CHAPTER 1

PiC900 Hardware Setup

Generally throughout this manual, the PiC900 refers to the PiC900 family of programmable industrial computers and includes the PiC90.

General Precautions

READ AND UNDERSTAND THIS SECTION IN ITS ENTIRETY BEFORE UNDERTAKING INSTALLATION OR ADJUSTMENT OF PiC CONTROL EQUIPMENT

The advice contained in this section will help users to operate and maintain the equipment in a safe manner at all times.

PLEASE REMEMBER THAT SAFETY IS EVERYONE'S RESPONSIBILITY

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The basic rules of safety set forth in this section are intended as a guide for the safe operation of equipment. This general safety information, along with explicit service, maintenance and operational materials, make up the complete instruction set. All personnel who operate, service or are involved with this equipment in any way should become totally familiar with this information prior to operating.

User Responsibility

It is the responsibility of the buyer to ensure that the procedures set forth here are followed and, should any major deviation or change in use from the original specifications be required, appropriate procedures should be established for the continued safe operation of the system. It is strongly recommended that you contact your OEM to ensure that the system can be safely converted for its new use and continue to operate in a safe manner.

Safety Instructions

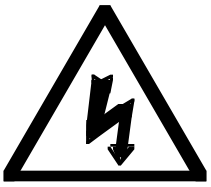
1. Do not operate your equipment with safety devices bypassed or doors removed.
2. Only qualified personnel should operate the equipment.
3. Never perform service or maintenance while automatic control sequences are in operation.
4. To avoid shock or serious injury, only qualified personnel should perform maintenance on the system.
5. ATTENTION - DANGER TO LIFE
   Do not touch the main power supply fuses or any components internal to the power modules while the main power supply switch is ON. Note that when the main power switch is OFF, the incoming supply cable may be live.
6. GROUNDING (Protective Earth)
   The equipment must be grounded (connected to the protective earth connection) according to OEM recommendations and to the latest local regulations for electrical safety. The grounding (protective earth) conductor must not be interrupted inside or outside the equipment enclosures. The wire used for equipment grounding (connection to protective earth) should be green with a yellow stripe.
7. If there is any doubt at all as to the safety of the equipment, you should set the main power switch to OFF and contact your OEM for advice.

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Safety Signs

The purpose of a system of safety signs is to draw attention to objects and situations which could affect personal or plant safety. It should be noted that the use of safety signs does not replace the need for appropriate accident prevention measures. Always read and follow the instructions based upon the level of hazard or potential danger.

Warning Labels



Danger Electric
Shock Risk

Hazard warning. When you see this safety sign on a system, it gives a warning of a hazard or possibility of a hazard existing. The type of warning is given by the pictorial representation on the sign plus text if used.

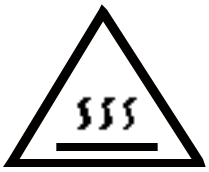
The safety color is black on a yellow background with a black symbol. To ignore such a caution could lead to severe injury or death arising from an unsafe practice. If voltage levels are included in the text they must indicate the maximum level of the hazard in normal or fault condition.

Danger, Warning, or Caution warning.



Symbol plus DANGER, WARNING or CAUTION: These notices provide information intended to prevent potential personal injury and equipment damage.

Hot Surface warning



Hot Surface

Safety First

Giddings & Lewis equipment is designed and manufactured with consideration and care to generally accepted safety standards. However, the proper and safe performance of the equipment depends upon the use of sound and prudent operating, maintenance and servicing procedures by trained personnel under adequate supervision.

For your protection, and the protection of others, learn and always follow these safety rules. Observe warnings on machines and act accordingly. Form safe work-

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ing habits by reading the rules and abiding by them. Keep these safety rules handy and review them from time to time to refresh your understanding of them.

Safety Inspection

Before Starting Operations

1. Ensure that all guards and safety devices are installed and operative and all doors which carry warning labels are closed and locked.
2. Ensure that all personnel are clear of those areas indicated as potentially hazardous.
3. Remove (from the operating zone) any materials, tools or other objects that could cause injury to personnel or damage the system.
4. Make sure that the control system is in an operational condition.
5. Make certain that all indicating lights, horns, pressure gauges or other safety devices or indicators are in working order.

After Shutdown

Make certain all controlled equipment in the plant is safe and the associated electrical, pneumatic or hydraulic power is turned off. It is permissible for the control equipment contained in enclosures to remain energized provided this does not conflict with the safety instructions found in this section.

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Operating Safely

1. Do not operate the control system until you read and understand the operating instructions and become thoroughly familiar with the system and the controls.
2. Never operate the control system while a safety device or guard is removed or disconnected
3. Where access to the control system is permitted for manual operation, only those doors which provide that access should be unlocked. They should be locked immediately after the particular operation is completed.
4. Never remove warnings that are displayed on the equipment. Torn or worn labels should be replaced.
5. Do not start the control system until all personnel in the area have been warned.
6. Never sit or stand on anything that might cause you to fall onto the control equipment or its peripheral equipment.
7. Horseplay around the control system and its associated equipment is dangerous and should be prohibited.
8. Know the emergency stop procedure for the system.
9. For maximum protection when carrying out major servicing requiring the system to be powered down, the power source should be locked using a lock for which only you have the key. This prevents anyone from accidentally turning on the power while you are servicing the equipment.
10. Never operate the equipment outside specification limits.
11. Keep alert and observe indicator lights, system messages and warnings that are displayed on the system.
12. Do not operate faulty or damaged equipment. Make certain proper service and maintenance procedures have been performed.

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Electrical Service & Maintenance Safety

1. **ALL ELECTRICAL OR ELECTRONIC MAINTENANCE AND SERVICE SHOULD BE PERFORMED BY TRAINED AND AUTHORIZED PERSONNEL ONLY.**
2. It should be assumed at all times that the POWER is ON and all conditions treated as live. This practice assures a cautious approach which may prevent accident or injury.
3. To remove power:
   LOCK THE MAIN SWITCH IN THE OPEN POSITION.
   USE A LOCK TO WHICH ONLY YOU HAVE THE KEY.
4. Make sure the circuit is safe by using the proper test equipment. Check test equipment regularly
5. Capacitors take time to discharge. Care should be taken in manual discharging of capacitors
6. There may be circumstances where troubleshooting on live equipment is required. Under such conditions, special precautions must be taken:
   a. Make sure your tools and body are clear of the areas of equipment which may be live.
   b. Extra safety measures should be taken in damp areas.
   c. Be alert and avoid any outside distractions.
   d. Make certain another qualified person is in attendance.
7. Before applying power to any equipment, make certain that all personnel are clear of associated equipment.
8. Control panel doors should be unlocked only when checking out electrical equipment or wiring. On completion, close and lock panel doors.
9. All covers on junction panels should be fastened closed before leaving any job.
10. Never operate any controls while others are performing maintenance on the system.
11. Do not bypass a safety device.
12. Always use the proper tool for the job.
13. Replace the main supply fuses only when electrical power is OFF (locked out).

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Cleaning Safely

Manual cleaning Procedure

1. Do not use toxic or flammable solvents to clean control system hardware.
2. Turn off electrical power (lock out) before cleaning control system assemblies.
3. Keep electrical panel covers closed and power off when cleaning an enclosure.
4. Always clean up spills around the equipment immediately after they occur.
5. Never attempt to clean a control system while it is operating.
6. Never use water to clean control equipment unless you are certain that the equipment has been certified as sealed against water ingress. Water is a very good conductor of electricity and the single largest cause of death by electrocution.

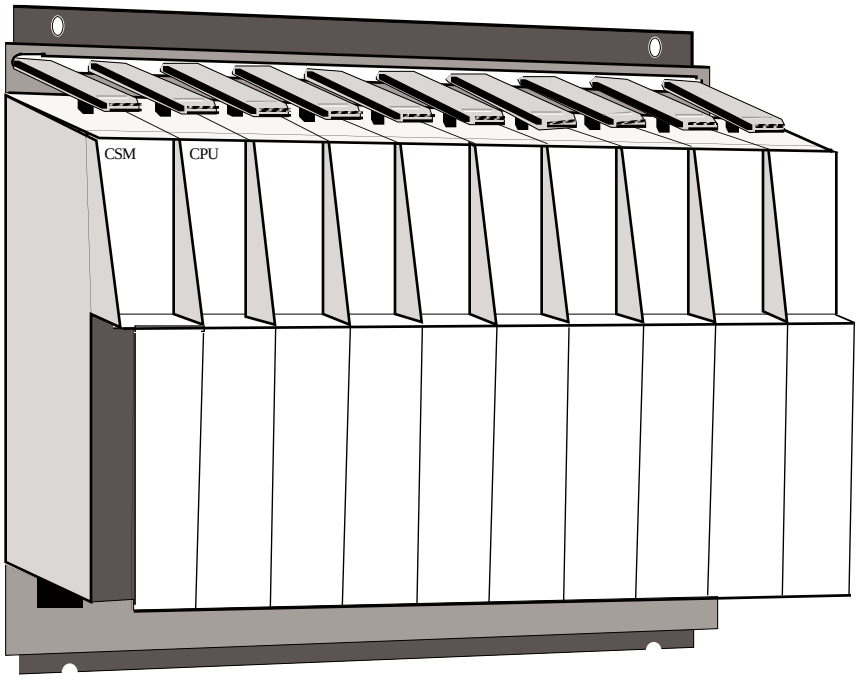
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The PiC(*Programmable industrial Computer*) 900 system is a combination of hardware and software that allows you to control an application to your specifications. A *Central Processing Unit* (CPU) integrates the hardware and software elements.

1. *Hardware* consists of a system rack, hardware modules, and the I/O connections to the application. All hardware is modular. This makes the PiC900 hardware easy to configure.

   The PiC900 is designed to interact with a computer workstation and/or an operator interface device. However, the application may be programmed to execute without either device.

Figure 1. The PiC900 system hardware

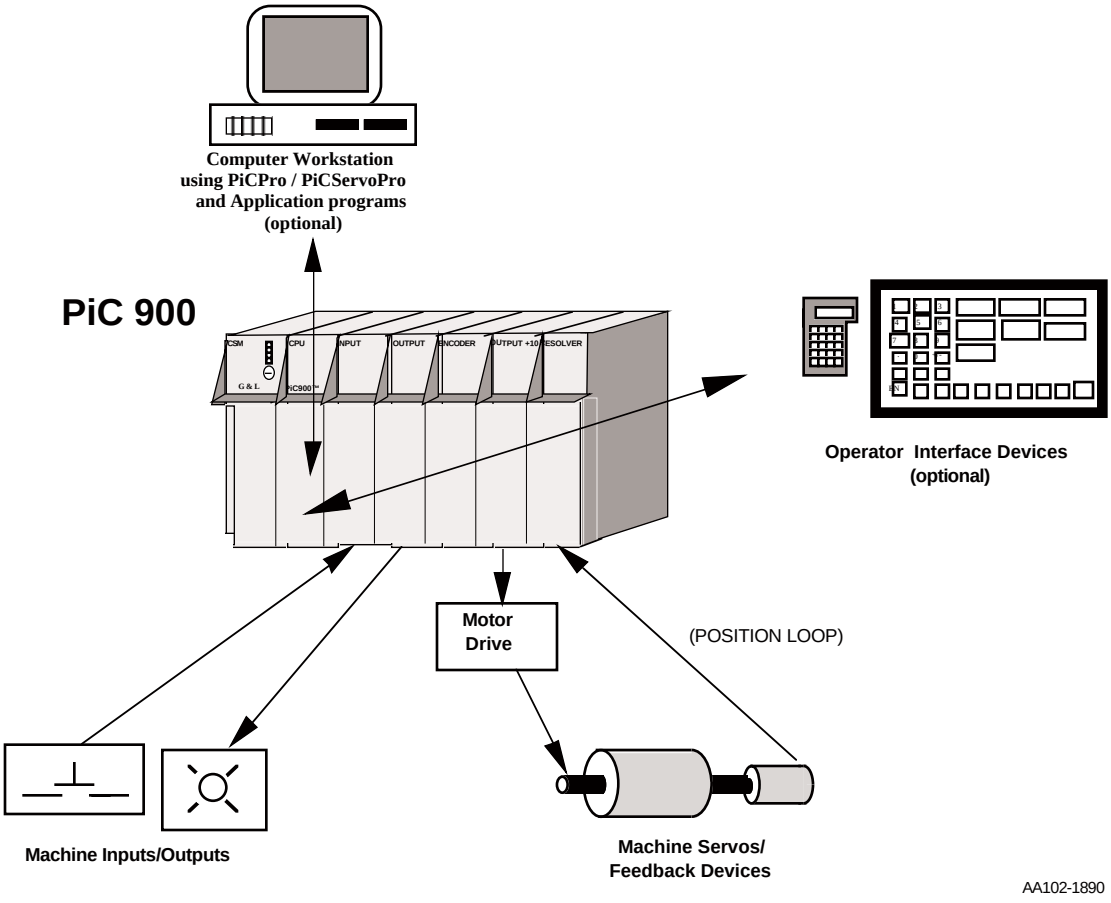


NOTE: The CSM and CPU modules are combined into one physical module in the PiC90 system. This combination module is referred to as the CSM/CPU module in this manual.

2. *Software* is covered in the Software manual. It consists of:
   - A software module (application program) created using PiCPro. It is designed to control a specific application.
   - The PiCServoPro development tools installed on your computer workstation. The tools include PiCPro, ServoSetup, and SERCOS setup.

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Figure 2. Diagram of the PiC900 system in operation



3. A combination of hardware and software run an application.

   Hardware input modules accept data from the application.

   Data is processed as specified in the software application program.

   Commands generated by the program instructions are sent to the application by hardware output modules.

   Data sent to the workstation by the PiC allows an operator to monitor and modify the application using PiCPro commands.

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The *system rack* has four functions:

1. It provides physical support for the top and bottom of each hardware module.
2. It passes power from the CSM (or CSM/CPU)to each of the other modules.
3. It contains a data bus, address bus and control lines. These lines allow data to pass between the CPU (or CSM/CPU) module and each of the other modules.
4. It has a 64-pin female connector at each slot position which allows communication between modules.

Dimensions of the Racks

PiC900 system racks differ only in length and the number of hardware modules they can contain. A dimensional diagram of each rack is shown on the following pages.

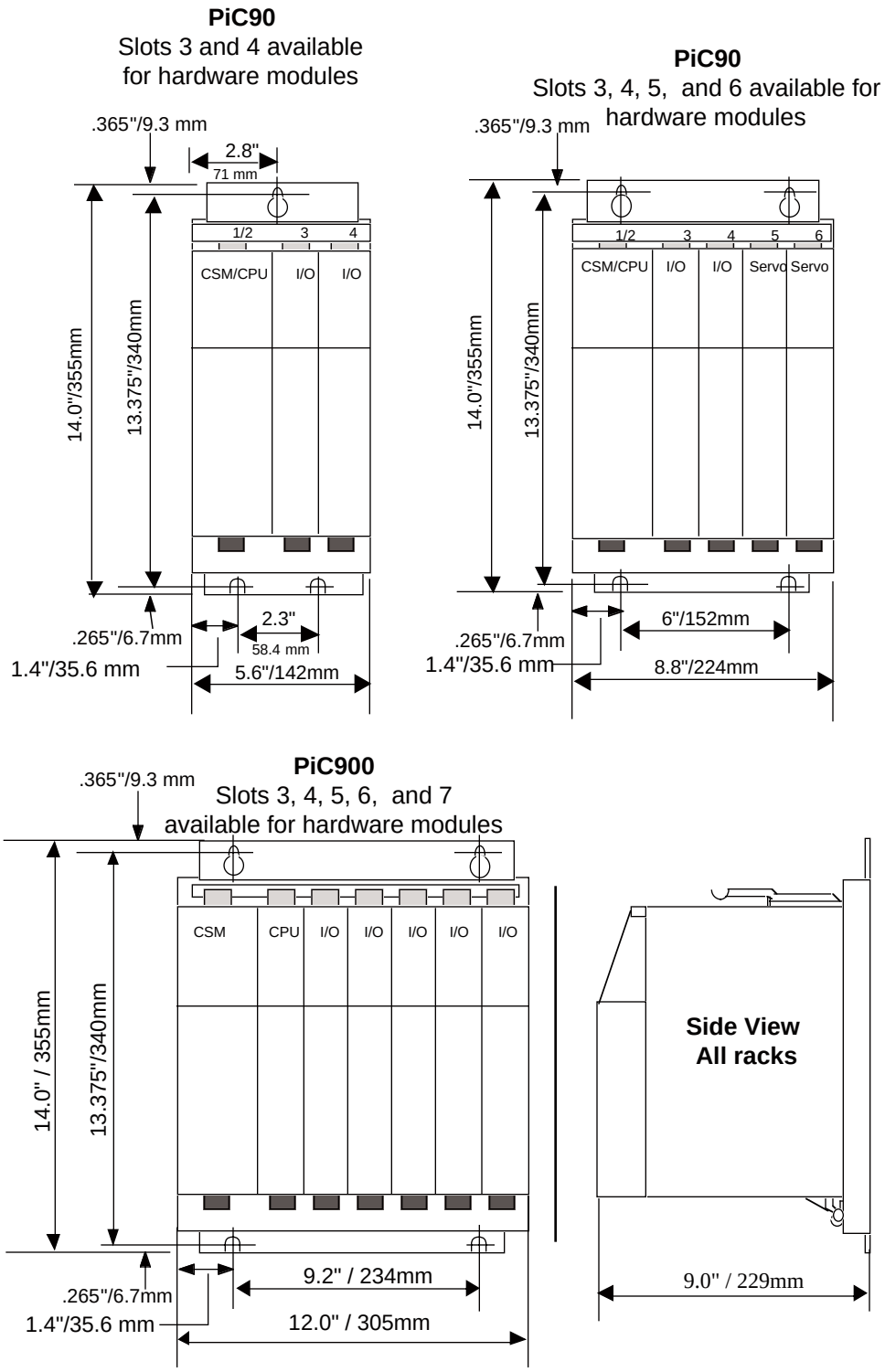
	Number of actual slots	Number of modules	Length	Height	Depth (with modules)	Part Number
PiC900	13	CSM, CPU, 11 I/O	21.6"	14.0"	9.0"	503-18011-03
	10	CSM, CPU, 8 I/O	16.8"	14.0"	9.0"	503-18010-03
	7	CSM, CPU, 5 I/O	12.0"	14.0"	9.0"	503-18009-03
PiC90	5*	CSM/CPU, 4 I/O	8.8"	14.0"	9.0"	503-19184-02
	3*	CSM/CPU, 2 I/O	5.6"	14.0"	9.0"	503-19185-02

*The PiC90 retaining bar labels the CSM/CPU module slot as 1/2, leaving 2 or 4 slots available for I/O modules.

In Figure 1-3, racks with 3, 5, and 7 slots are shown with modules inserted. All racks are the same height and have the same profile. The other two rack sizes are shown empty (Figures 1-4 and 1-5).

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Figure 3. System racks with modules installed



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Figure 4. The 10-slot system rack

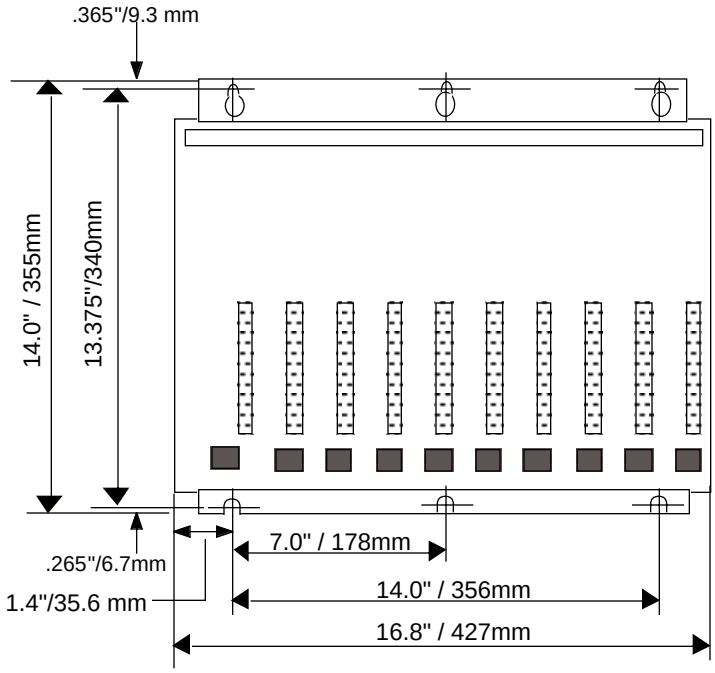
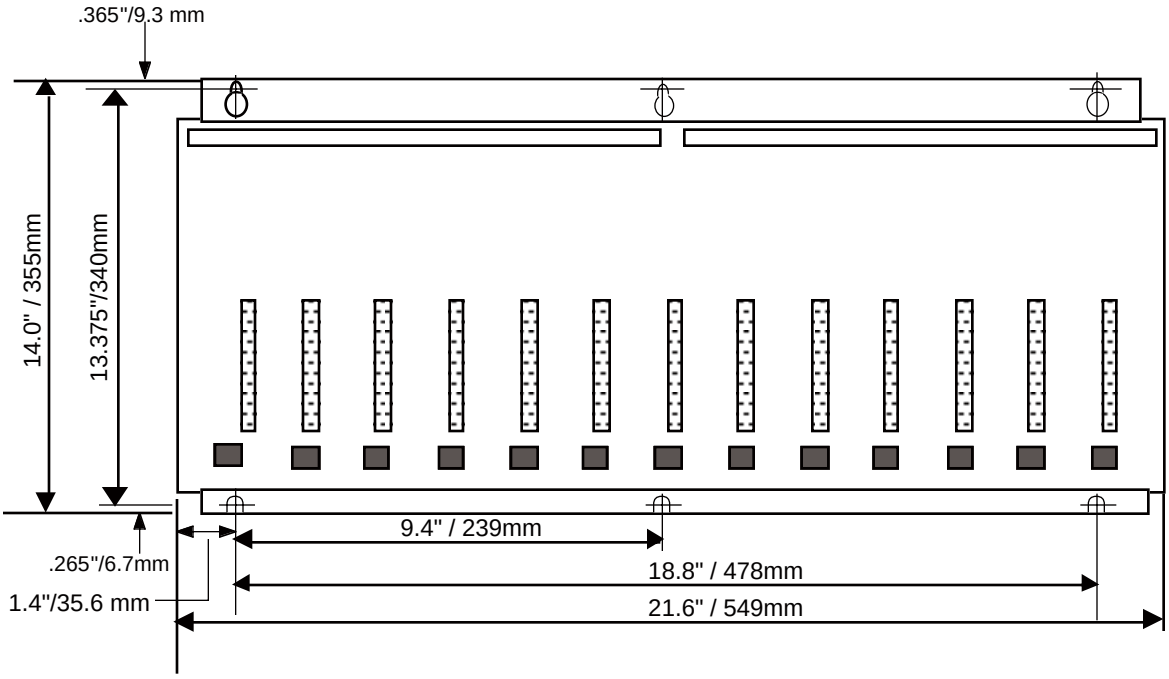


Figure 5. The 13-slot system rack



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General Requirements

You are not required to install the system rack in a control cabinet. However a cabinet protects the system from dust and mechanical damage and is recommended.

Two methods of power distribution are shown. The one in Figure 1-6 works in most situations. For installations where electrical noise is severe, Figure 1-7 illustrates a setup with filtered AC power. In both cases,

- Install the system rack away from all sources of strong electromagnetic noise. Such noise can interfere with PiC900 operation.
- Protect the PiC900 system away from all the following:

  conductive fluids and particles
  corrosive atmosphere
  explosive atmosphere

The diagrams and recommendations may be modified if necessary so the wiring conforms to current NEC standards or government regulations.

NOTE: All PiC modules are presently rated for operation between 7˚C and 55˚C. The PiC900/90 is suitable for operation in a pollution degree 2 environment (i.e., normally, only non-conductive pollution occurs).

Control Cabinet Specifications

1. A control cabinet for the PiC900 should have a NEMA-12 rating or better. A cabinet with this rating protects its contents from dust and mechanical damage.
2. It must be large enough to provide adequate air circulation for the system rack, drives, and other components. You must have at least 2" free space within the cabinet on all sides of the system rack.
3. It must have a rigid vertical surface to mount the rack on.
4. The door should open fully for easy access.

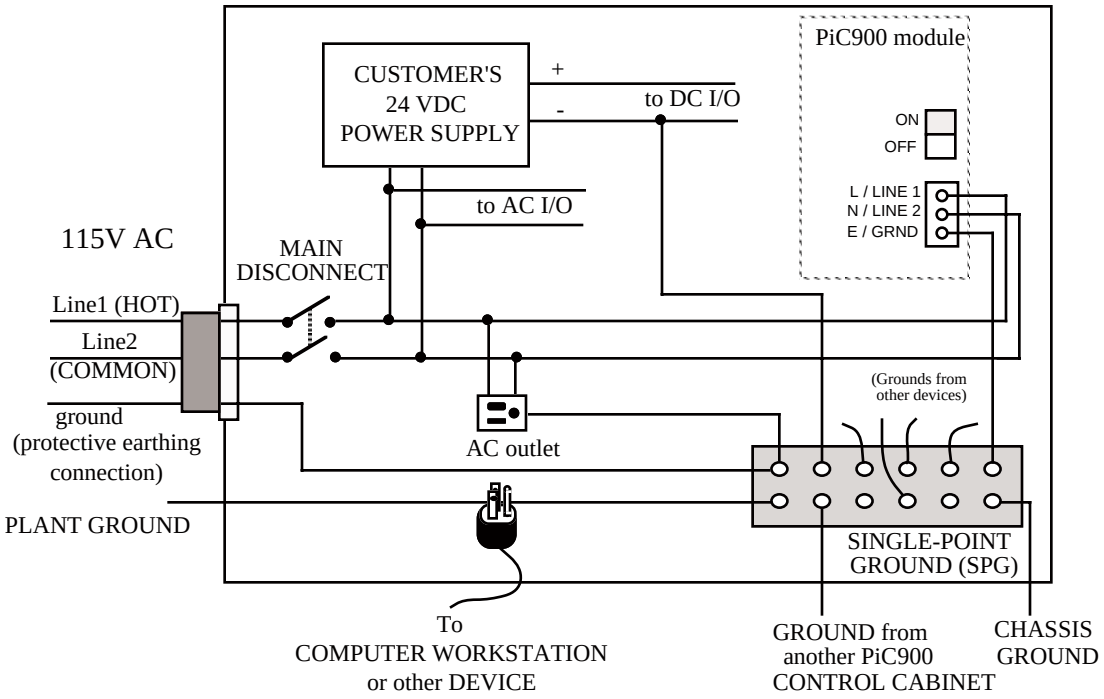
IMPORTANT
Post warnings according to National, State, or local codes for the voltage present in the control cabinet.

Power Distribution Diagrams

The PiC900 system requires one AC power source for the system rack and its modules and one or more AC and/or DC sources for the connections to the I/O devices. Figures 1-6 and 1-7 show two ways to provide all necessary power in one setup.

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Figure 6. Example of 115V AC basic power distribution to a PiC900 system



The AC power source is connected to the PiC900 system through a 3-pin female connector. It plugs into the power connector of the CSM (or CSM/CPU). The ground from the power source and "GRND" (protective earthing ground) from the CSM (or CSM/CPU) module must be connected to the Single-Point Ground (SPG).

Devices connected to the hardware modules must have their own power sources for input data or output control signals. Both versions of the power distribution setup provide properly grounded AC and DC sources that can be used for such devices. You can use other wiring setups, provided that each one is:

- at the correct voltage and current levels for the module and the device.
- connected to the same Single-Point Ground that the system rack uses.

It is recommended that the same main disconnect switch be used for the PiC900 system and for all devices in the application.

NOTE: This main (primary) disconnect switch must have a minimum contact separation of 3 mm in all poles to meet requirements of the Low Voltage directive (73/23/EEC).

IMPORTANT

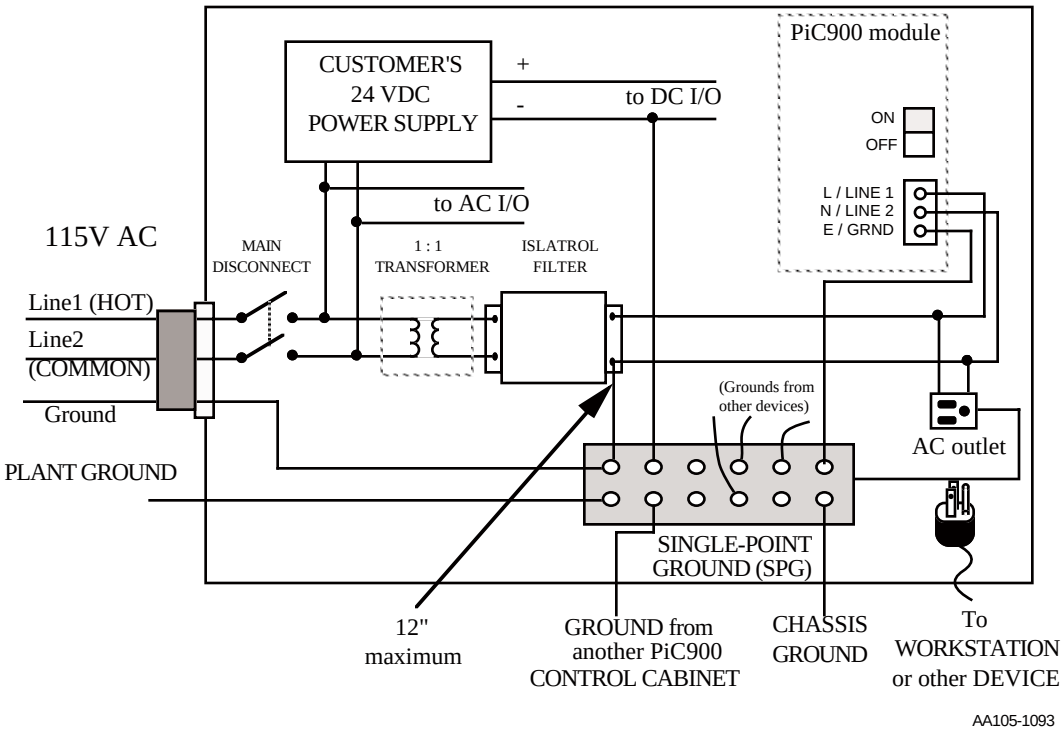
No matter how the system is installed, before you replace a module or connect it to the application, make sure that power is off to the system rack and to the devices the modules are wired to.

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The basic power distribution may be modified if the AC power source is subject to severe voltage spikes and surges. In many installations, a control transformer rated at a minimum of 0.5 KVA and a noise filter such as Islatrol model I-115/U may have been installed in series with the AC power source. Even though this model has worked successfully in the past, it is not CE approved. To meet the requirement of the Low Voltage Directive (73/23/EEC), a CE approved filter must be used. Control Concepts has an "Elite" series of Islatrol filters that have this CE approval.

Filtered power distribution is recommended for most applications. It will prolong the life of the control. *It should always be used when using communication and/or analog hardware.*

Figure 7. Example of 115V AC filtered power distribution to a PiC900 system



Grounding the System

The ground of the PiC900 system power source must be connected directly to a *Single Point Ground* (SPG) tie block. The tie block should be made of brass or copper, bolted or brazed to the control cabinet. If the tie block is bolted rather than brazed, scrape away paint or grease at the point of contact. Put star washers between the tie block and the cabinet to ensure good electrical contact.

Metal enclosures of power supplies, drives, etc., should also have good electrical contact with the SPG.

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CAUTION

The Single Point Ground should be the only common point for all the ground lines. If not, ground loops may cause current flow between components of the system which can interfere with proper operation of the PiC900.

Devices to be connected directly to the Single Point Ground include:

1. Plant safety ground.
2. Ground (GRND - protective earthing connection) from CSM: the green/yellow wire.
3. "Common" or "0 V" lines from power supplies that provide external power to the I/O modules and the devices to which they are connected.
4. Chassis grounds from the devices themselves, such as device drivers, machinery, and operator interface devices.
5. AC common line from the noise filter, if any.
6. The ground of the power source of the computer workstation, if any, from which you monitor the system operation. An AC outlet in the control cabinet is recommended. See Figure 1-6 or 1-7.
7. Single point grounds from other control cabinets, if any, in the PiC900 system.
8. Shielded I/O wires. Shielded I/O wiring is recommended for use with analog output, encoder interface, and resolver interface modules.

Controlling Heat Within the System

The hardware module cases and the system rack are designed to promote air circulation and dissipate heat. The rack must be mounted vertically to take advantage of this design. Normally no fans or air conditioners are needed. However, if the environment outside the control cabinet is hot or humid, you may need to use a fan, heat exchanger, dehumidifier or air conditioner to provide the correct operating environment.

Table 1-1. Operating Limits for the System Rack

Temperature	7 to 55˚ C (45 to 131˚ F)
Relative humidity	0 to 95%, non-condensing

Make sure that components installed in the cabinet with the rack do not raise the temperature above system limits and that any hot spots do not exceed specifications. For instance, when heat-generating components such as transformers, drives or motor controls are installed, separate them from the system by one of the following:

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- Place them near the top of the control cabinet so their heat output rises away from the PiC900 system.
- Put them in another control cabinet above or to one side of the cabinet with the system rack. This protects the PiC900 system from both heat and electrical noise.

The PiC900 system itself is a source of heat, though in most installations its heat dissipates without harmful effects. System heat is generated from power dissipated by:

1. the power supply
2. logic side components on each hardware module installed in the system
3. field side input/output components on each module

If you need to calculate total heat generated by a particular setup, refer to Appendixes for the specifications of each hardware module you have installed.

CAUTION

If the PiC900 system is operated outside the recommended limits, the rack or the modules installed in it may be damaged. This will void the warranty.

1.4 Hardware Modules

All modules except the CSM and CSM/CPU have identical dimensions so they can be physically placed in any slot in the system rack. The CSM and CSM/CPU are 2.4" wide instead of 1.6", but its length and depth, and the rack connector in the back, are the same as the other modules.

IMPORTANT

- The CSM or CSM/CPU must be placed in the first slot on the left of the system rack.
- In the PiC900, the CPU module must be in the second slot.
- All I/O modules may be assigned by the application program to any other slot.

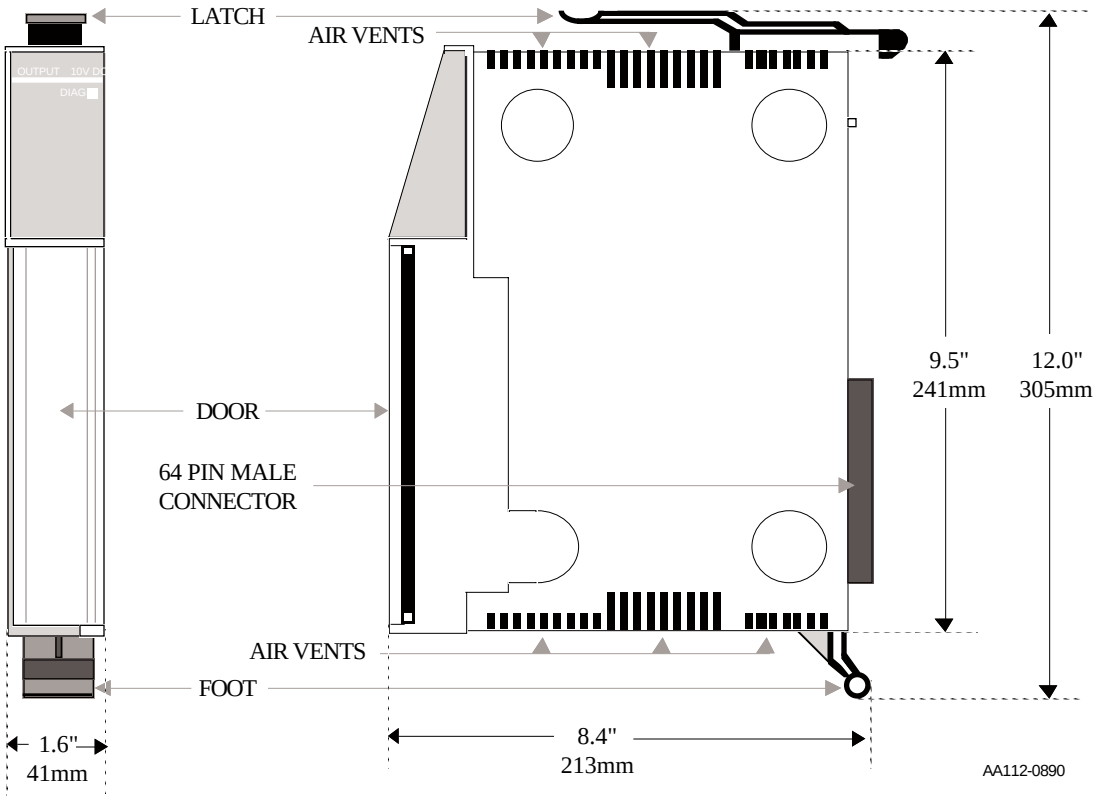
The face of each *hardware module* is in two segments. The upper segment identifies the type of module and gives LED status information. Every module has a DIAG LED which is discussed at the end of this section. LEDs that give status for specific modules are explained in Appendixes.

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The lower segment contains a screw terminal connector that allows you to wire inputs or outputs of the PiC900 to specific parts of the application. A door swings shut to protect these connections.

The bosses and vents on the side allow free circulation of air within the system (Figure 1-8).

Figure 8. Front and Right Side of a Module



Handling a Module

The module's case protects its internal circuitry against mechanical damage in shipping and handling. However, like any electronics device, the circuitry can be destroyed by:

- temperatures over 55˚ C (131˚ F)
- moisture condensing inside the module
- static discharge
- exposure to a magnetic field strong enough to induce a current in the circuitry
- freezing temperatures, vibration, and other hazards

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Normally there is no need to open a module case. Occasionally you must replace a battery or a fuse. Modules with replaceable components have a diagram and detailed anti-static precautions in the appendixes.

IMPORTANT
It is good practice to keep the module in the system rack or in an anti-static bag at all times.

Types of Modules

Each module has its name printed at the top of the front face, separated by color-coded bands from the rest of the upper segment. The colors identify which of the four main categories the module belongs to.

silver - CSM, CPU, CSM/CPU, I/O driver, relay output modules
blue - DC I/O
red - AC I/O
green - servo/analog I/O

Power comes through the AC input plug. It is then converted to DC power. There is an internal battery back-up. See diagrams and specifications in the appendixes. All the other modules are powered from the CSM (or CSM/CPU) which sends specific DC voltages through the system rack.

In the PiC900, the CPU module contains a Central Processing Unit and several kinds of memory. It uses power from the CSM to control the application, integrating the hardware and software components of the PiC900 system. See the diagrams and specifications in Appendixes. The CPU module is always in the second slot, next to the CSM. In the PiC90, these two modules are combined into the CSM/CPU.

Several models of the PiC9X have the capability to communicate between PiC900s and/or perform I/O expansion.

With the PiC90, there is an optional peer-to-peer communications port on the CSM/CPU.

The I/O Driver Module for connecting expansion racks to a master rack is covered in Appendix B2.

Several types of *I/O modules* are available. Refer to the Table of Contents for a complete listing of all I/O modules available.

An input module accepts signals that convey status information. An output module sends commands to the application.

An I/O module has either 25 or 40 screw terminal connections. Each screw terminal is assigned to a specific function. This is illustrated in a wiring diagram in each module write-up in the appendixes. Some connections are used for the external power supply, and others for data signals. Modules that use differential signals have paired terminals for data and other terminals assigned as shield commons.

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Installing a Module in the Rack

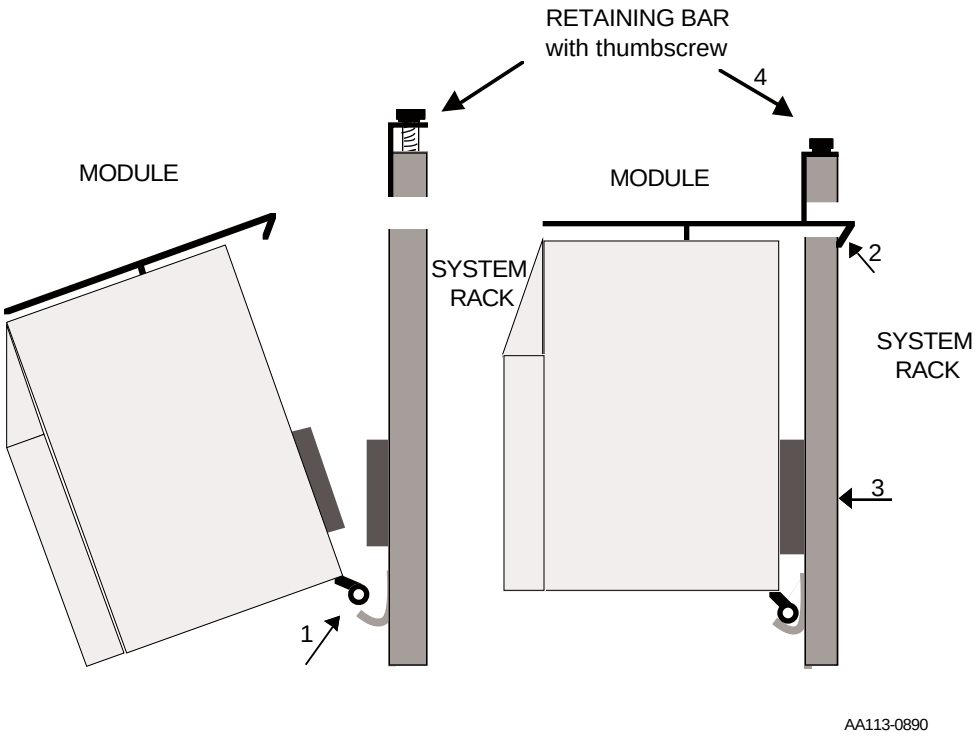
CAUTION
ALWAYS turn off power at the main disconnect switch before installing, removing or wiring a module.

To install a module in the system rack (Figure 1-9), follow these steps:

1. Loosen the thumbscrews on the metal retaining bar at the top of the rack.
2. Set the foot of the module in the J-Clip near the bottom of the rack (1) and rotate the module until the latch snaps into the slot near the top of the system rack (2). The connection between the male 64-pin connector on the module and the female one on the system rack is complete.
3. Tighten the thumbscrews on the retaining bar to hold modules securely in place (4).

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Figure 9. Steps in the procedure



IMPORTANT
Always loosen the thumbscrews on the retaining bar *before* attempting to install or remove modules from the system rack. Tighten the thumbscrews firmly after all modules are installed.

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The screw terminal connectors on each I/O module allow you to connect the PiC900 system with the application. You need two kinds of information about the terminal assignments in order to wire a module correctly:

1. the screw assignment diagram for that module, found in the appendixes
2. the inputs and outputs assigned to run this specific application supplied by the software application program

Each signal to or from a module takes the form of a voltage which is powered by external AC or DC sources (that is, not from the system rack). Figures 1-6 and 1-7 illustrated AC and DC power distribution.

Making a Wiring Worksheet

You can make a set of wiring worksheets for each application program.

- Appendix H has a wiring worksheet for each I/O module. Make a copy of the appropriate worksheet for each I/O slot in the system rack.
- Copy the input or output connection wire numbers or signal names that came with the software program onto the worksheets. Check each one carefully. Note: power supply signals may be daisy-chained.
- A label is supplied for the inside of the module door on which to enter the wire name of each screw terminal. Copy the wire name onto the worksheet for future reference.

Making the I/O Connections

- The acceptable range of wire sizes is 20 (.5 mm^2) to 14 (2 mm^2) gauge. Use copper wire.
- The shield wire is not insulated. Do not leave bare wire exposed. Protect bare wiring with one of the following:

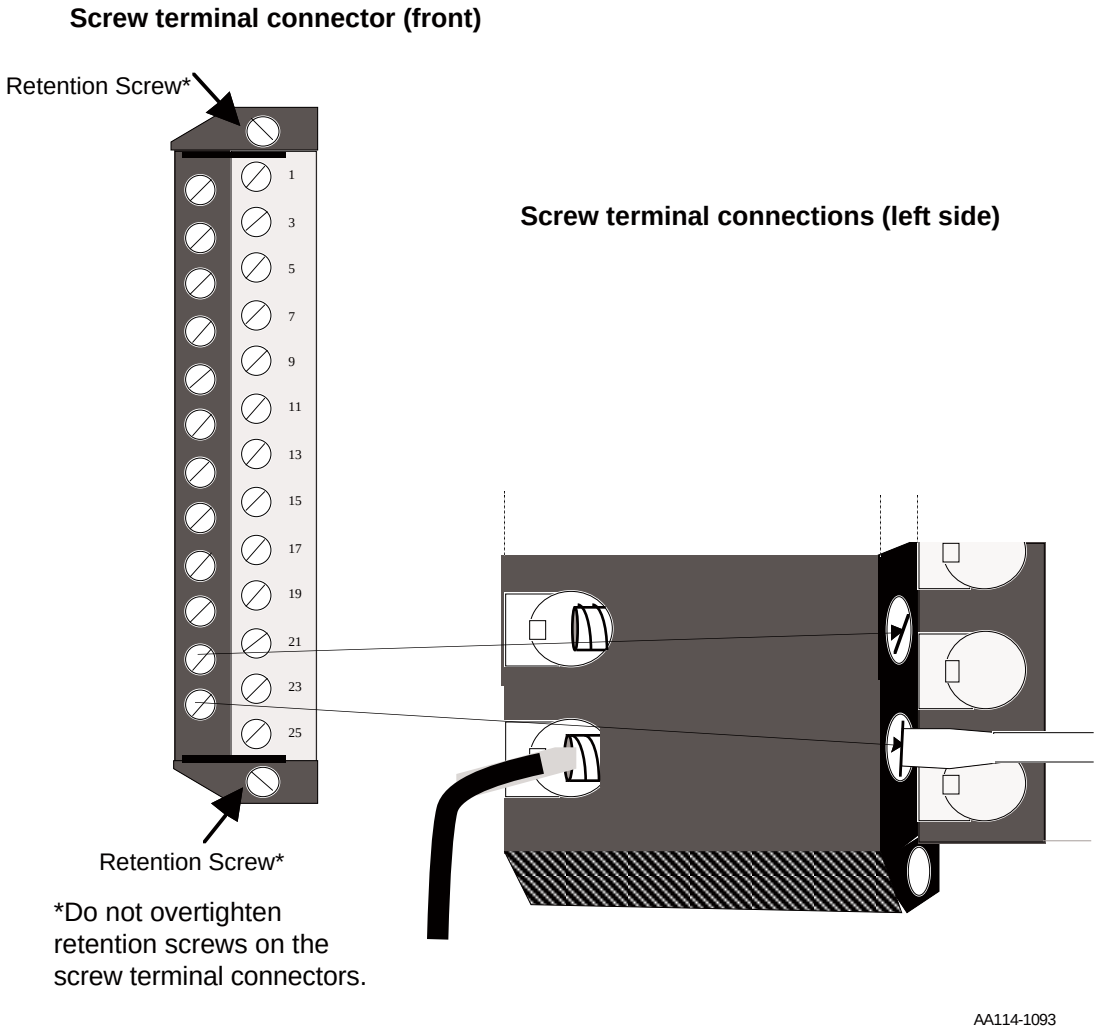
  spaghetti tubing
  tape
  shrink tubing

  NOTE: All wires/cables connected to the PiC must be mechanically secured against undue stress and must be suitably rated and approved for the voltage and conditions of use.
- Install the modules in the system rack before you start the I/O wiring. Make sure the wires are the correct length. When the wiring is complete the connectors should not be stressed. You may find that a wiring jig makes the job easier; instructions for making one are given in Appendix I.
- Strip 0.2" (5.1 mm) of insulation from the end of the wire.

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- Start wiring at the bottom left screw terminal. Work up the left (inner) column. Then continue with the lowest terminal in the column on the right, and work up. (See Figure 1-10.)

Figure 10. How to Wire a Screw Terminal



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IMPORTANT

Make sure all screws are tight when adding wires or when probing unwired terminals. If the screw head is not fully tightened, there is no electrical connection between the screw head and the circuitry on the module.

1.6 Preventing Electrical Noise in Data Lines

The PiC900 system relies on electrical signals to report what is going on in the application and to send commands to it. In addition, signals are constantly being exchanged within the system. The PiC900 is designed for use in industrial environments, but there are limits to how much noise it can tolerate. Some suggestions are given below to reduce electrical noise.

1. Keep electrically noisy devices away from the PiC900.
2. Reduce noise generated by the application itself.
3. Protect data signals from noise.
4. Use differential devices for analog and encoder signals.

CAUTION

Errors in data transmission in a PiC900 system may cause malfunctions in the application.

Any device or wire that generates or uses electricity can create electrical noise in nearby circuits or devices. 'Nearby' is a relative term: an arc welder can create noise problems for many feet in all directions - including the room above.

When one device's currents affect another device, they are said to be coupled. Coupling between a pair of wires running parallel to each other is directly proportional to the length of the parallel portion and inversely proportional to the distance between them.

Keep Noisy Devices Away from the PiC900.

Make sure that arc welding equipment, heavy duty motors, and other devices that use large amounts of current and their power lines are at least 10 feet away from the PiC900 and the devices connected to it.

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Shield all cables that carry heavy current near the system, using continuous foil wrap or conduit grounded at both ends. Such cables include power leads for high-frequency welders and for pulse-width-modulation motor drives.

Reduce Noise Generated by the Application Itself.

Equip inductive devices that are not directly connected to PiC900 modules with arc suppression circuits. These devices include contactors, solenoids and motors.

Wires in the system which carry high current should be routed away from data lines that are sensitive to noise.

AC, DC, communications, and analog cables must not be bundled together inside or outside the control cabinet. See Figure 1-11.

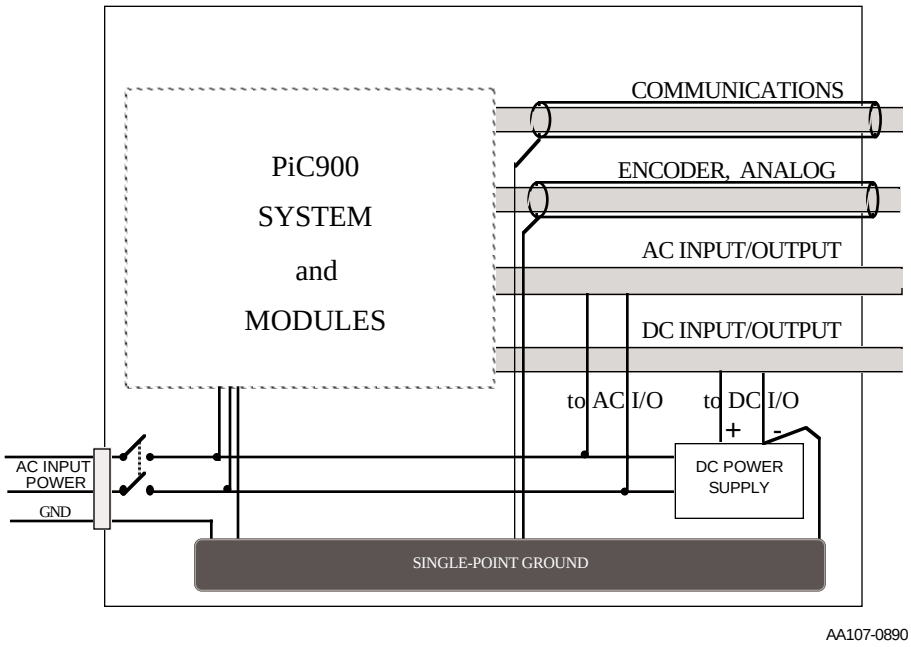
Protect Data Wires from Noise

Install the system rack as close to the application as you can. Short communications lines are less affected by noise than long ones.

Make all connections to the Single-Point Ground as short as possible, and use 14 gauge or larger wire for these connections.

Route data lines 6" or more away from power lines or run them through separate conduit. Communications lines, for example those that use RS232, RS422 or bi-phase transformer mode signals, should also be shielded. In Figure 1-11 the communications data lines and the encoder/resolver/analog data lines are each in a separate conduit, grounded at the SPG.

Figure 11. Power and signal cables from the system



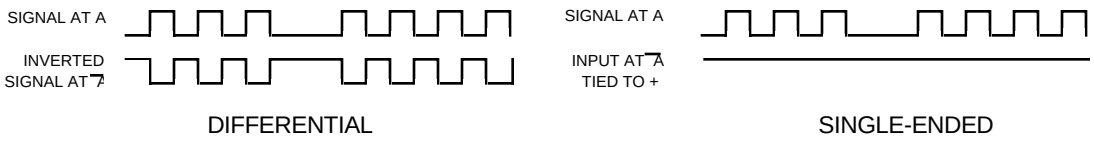
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Use Differential Devices for Analog and Encoder Signals

A *differential* device receives or sends one signal over two wires (typically a shielded twisted pair). The input/output voltage at the second terminal is the inverse of the first. Information is received/sent as the difference between the two voltages.

A *single-ended* device effectively receives or sends data over only one line. Information is received/sent as the difference between the signal voltage and the device's ground potential.

Figure 12. Differential vs. Single-Ended Digital Pulse Train



The advantages of using differential signals are:

1. A differential signal is less susceptible to electromagnetic noise. Static or other interference affects both of the twisted-pair wires equally, so the difference between the normal and inverted voltage remains unchanged. A differential signal can be transmitted over a much longer distance or in a much noisier environment than a single-ended one. A single-ended device's signal can be affected by noise while the ground to which it is compared is not. The receiver cannot tell the difference between a pulse from the sending device that carries information and a pulse created by noise on the line.
2. PiC900 hardware circuitry can detect signal loss from an encoder if the signal is differential, but not if it is single-ended. The application program can be set to shut down the application if such an error is detected.

IMPORTANT
Use differential drivers or differential inputs if possible. If single-ended devices must be used, keep the distance between the device and the PiC900 less than 10 feet.

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1.7 Starting an Operation

Good procedure suggests that the system should be tested each time a new application is powered up. Each module in the PiC900 rack is tested automatically every time power is applied. The DIAG LED on each module should be off indicating that the module passed the diagnostic tests.

Installing and Testing the Hardware Modules

1. Insert the CSM (or CSM/CPU) into the first slot at the left end of the system rack.
2. With the PiC900, insert the CPU module into the second slot next to the CSM.
3. Turn off the main disconnect switch and plug the AC connector into the power connector. Turn on input power and the power switch (see the power distribution diagrams). The DIAG LED turns on and then turns off when the module passes its diagnostic tests. With the PiC900, the DIAG LED on the CPU module repeats these steps. Turn off the power switch and the main disconnect switch.
4. Slide the I/O modules into the appropriate slots designated in the software program.

Connecting the PiC900 System to the Application

1. Turn off the main disconnect switch in the control cabinet. If some devices are not powered from the control cabinet, turn them off also.
2. Connect the screw terminal connectors according to your diagrams.
3. Turn on power to the system and the power switch. The PWR light goes on and stays on. The DIAG light on each module goes on, then goes off in turn.
   Turn the key clockwise.
   The SCAN light goes on.
   The application starts to work under control of the system.
4. If an application program is not in system memory, the Software manual describes a number of procedures that may be used to put it there.

1.8 Troubleshooting

Table 1-2 summarizes how to proceed when performing certain maintenance and/or setup functions.

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Table 1-2. Summary

In order to:	
Turn off the entire application.	Turn off main disconnect in the AC input line (which should also turn off all external power supplies to the application), and the power switch; unplug the AC power.
Wire the I/O modules to the application.	Turn off main disconnect in the AC input line and the power switch; unplug the AC power.
Replace a module in the rack.	Turn off main disconnect in the AC input line.
Change a fuse in an output module. Change the battery.	Turn off main disconnect in the AC input line.
Connect/disconnect the PiC900 with the computer workstation through the PiCPro port.	Turn off the power switch.
Connect/disconnect the PiC900 with an operator interface through the User port.	Turn off the power switch.
Download an application program into the CPU module memory.	Make sure power is on (check the PWR LED). The Run key may be off or on.
Stop the scan.	From the workstation - use PiCPro commands. From the PiC900 - turn off the RUN/STOP switch.

This section covers two types of diagnostics; power-on and run-time.

Power-On Diagnostics

When the system is powered up, it tests itself and reports the results of the tests in the form of LED signals.

Power LED

If the PWR light does not go on, or goes off during operation of the system, check that power is still connected to the CSM (or CSM/CPU). If it is, turn off the main disconnect switch and replace the CSM (or CSM/CPU)

Scan LED

If the SCAN LED does not go on:

- Check that the PWR light is ON.
- Check that the DIAG lights on all modules are OFF.
- Check that the key switch is in the Run position.

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- If the application program is in RAM, turn off the Run key, download the program again from the workstation, and turn on the key.
- If the program is in an EPROM, make sure the it is correctly installed. See Appendix A2 for the PiC900 and A4 for the PiC90.

Diagnostic LEDs

Each module has an LED marked DIAG which lights up briefly while its diagnostic tests are running and then goes off. If the DIAG LED on any module remains on, the module has failed one of its tests. Follow these steps:

1. Turn off power to the system and to the application.
2. If the I/O wiring is connected, remove the screw terminal connector from the module, but leave its wiring attached.
3. Pull the defective module from the rack.
4. Insert a replacement module of the same type in the rack. Replace the screw terminal connector on the new module.
5. Turn on power to check diagnostics again.

NOTE

Diagnostics are run only when the system is powered up. It is possible that a module might fail during operation. If so, its DIAG light remains off. If you suspect that a module might be defective, cycle power to run diagnostics again.

If the diagnostic LEDs remain lit on one or more of the modules, there may be something wrong with the CSM or CPU module (or the CSM/CPU). Follow these steps in tracing the problem:

1. Turn off the main disconnect switch in the control cabinet and any other power to the application.
2. Remove all modules except the CPU and CSM (or the CSM/CPU).
3. Turn on the power to run diagnostics again.
4. With the PiC900, if both LEDs stay lit, turn off power, replace either the CSM or the CPU module and turn on power. If LEDs remain lit, put original module back in and replace the other module. With the PiC90, replace the CSM/CPU module.
5. If the problem is not the CSM or CPU (or the CSM/CPU) module, turn off power, replace one of the I/O modules, and turn on power to run its diagnostics. Repeat until you find the defective module.

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6. If the problem can not be traced to a module, check the I/O wiring and the devices the system is connected to. There may be a short or other problem outside the system rack.

Run-Time Diagnostics

While the PiC900 is running, other tests are performed on a regular basis with their results also reported to you through LEDs.

•If the BATT LED on the CSM or CSM/CPU starts flashing, the battery must be replaced. See Appendix A1 for the PiC900 and A4 for the PiC90.

•If the FB LED on one of the output modules goes on, a fuse must be replaced. See the section on the specific module in Appendixes for details.

•While the PiC900 is running, the DIAG LED on the CPU or the CSM/CPU will flash a three digit code signal if there is an error. For example, if there is a long pause-flash-pause-flash-flash-pause-flash-flash-flash-long pause, the code is 123. The errors are described in Appendix M.

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Appendix A - PiC Control Modules

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A.1-PiC900 CSM/RSM Central Service Module/Remote Service Module

Introduction

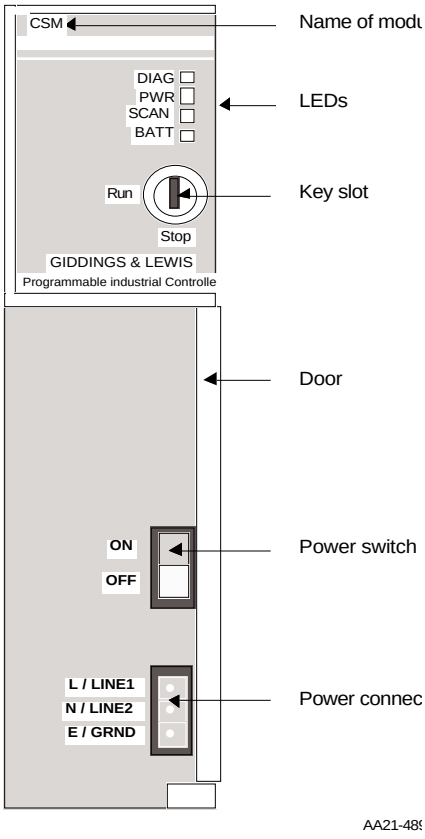
The Central Service Module (CSM) and the Remote Service Module (RSM) convert incoming power to regulated DC power. Through the bus, the CSM supplies this power to the modules in the master rack and the RSM supplies this power to the modules in an expansion rack. The CSM has the following additional features:

- Scan control which includes a key switch to run/stop the scan when power is on.
- A lithium battery to back up such items as non-volatile RAM in the CPU module and the time-of-day clock on the CSM module when power is turned off.
- An internal clock to provide time of day and date when needed by the software.

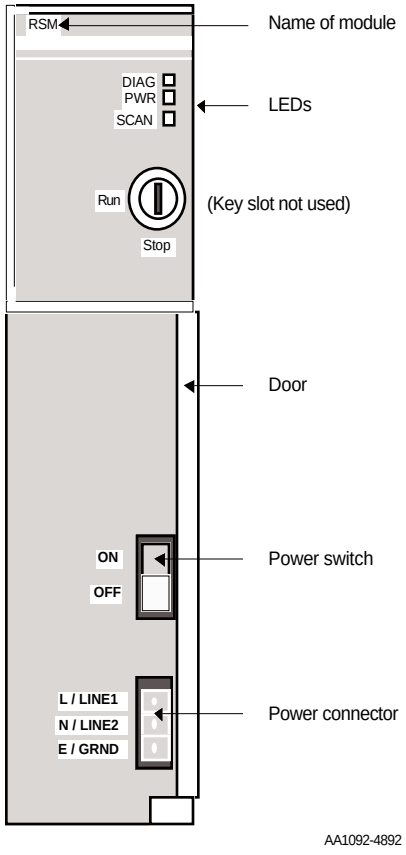
The CSM and the RSM must always be located in the first slot on the left in the master rack and expansion rack respectively.

Figure A1-1. CSM/RSM

CSM - the Central Service Module
(for master rack)



RSM - the Remote Service Module
(for expansion rack)



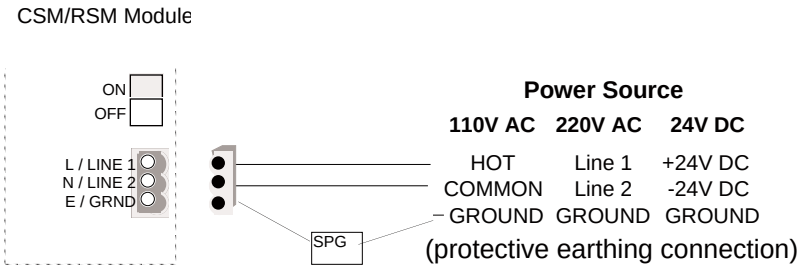
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Connections

The CSM and RSM modules receive power through a 3-pin power connector. Figure A1-2 illustrates the connections as listed below.

Module	AC Power Source 110VAC	AC Power Source 220VAC	DC Power Source 24VDC
L / LINE 1 to	Hot	Line1	+24V
N / LINE 2 to	Common	Line2	-24V
E / GRND to	Single Point Ground	Single Point Ground	Single Point Ground

Figure A1-2. Power to the System



Theory of Operation

The CSM (RSM) module converts incoming input power into DC power at voltages of + 5V, + 15 V, and - 15 V and supplies them to the logic side of the modules in the rack. External power supplies are used for the field side of the I/O modules. Such supplies are not routed through the CSM (RSM), but they should all have the same power cut-off switch as the PiC900. See the power distribution diagrams in Chapter 1.

CAUTION

The on/off rocker switch on the face of the CSM (RSM) does not control the I/O power supplies.

Always shut off power at the main disconnect switch before you replace a module in the system rack.

With the CSM, a key is supplied to protect the system from unauthorized start-ups. You can set up the PiC900 hardware, power up and run the diagnostic tests, and even load a software application program without the system key. However, the application program will not be scanned until you turn the Run/Stop key on the CSM to the Run position.

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CSM Time-of-Day Clock

An internal clock IC maintains the current date and time. If power is off to the system, the battery maintains the clock. The application program and PiCPro can access this clock. Details are given in the Software Manual.

LEDs

DIAG, diagnostic LED

The DIAG LED should turn on briefly whenever power is turned on to the system. The processor in the CPU module automatically runs diagnostic tests on all modules at power up. This LED goes on during testing, and then turns off when the module passes all the tests.

Status LEDs

The CSM has four LEDs to indicate status. During normal operation the DIAG and BATT LEDs should be off, and the PWR and SCAN LEDs should be on.

The RSM has three LEDs to indicate status. During normal operation the DIAG LED should be off, and PWR and SCAN LEDs should be on.

PWR, power LED

The PWR light should be on all the time that power is on to the system. It indicates that the + 5V supply is within tolerance. See the specification sheet at the end of the section.

SCAN, scan LED

The SCAN light indicates that the processor is executing the application program. If scan loss occurs the light will go off and there is an orderly shutdown procedure.

CSM BATT, battery LED

The BATT light should turn on briefly while the battery is checked at power-on. After the battery passes its test, the LED goes off.

If the BATT LED starts flashing either at start-up or during system operation, the lithium battery must be replaced. Each module that uses the battery to back up its data has circuitry that can maintain its data for approximately two hours if the CSM is not in the system rack.

Power must be on for at least five minutes to ensure that modules that require backup power will retain their data while the CSM is out of the system rack.

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Replacing the Battery on the CSM

Follow the procedure below to replace a battery.

1. After AC power has been applied to the CSM for at least five minutes, turn off power at the control cabinet main disconnect switch and at the CSM power switch. Unplug the AC input power connector from the CSM.
2. Remove the CSM module from the rack by pressing down the latch at the top and pulling it out.
3. Use a static-free work surface if possible. Ground yourself using a properly grounded wrist strap before you open the case. These are standard precautions before handling any electronics component.
4. Lay the CSM on the work surface with its label side up. Press the plastic tabs at the top and bottom of the module case toward each other and lift the side off.

WARNING

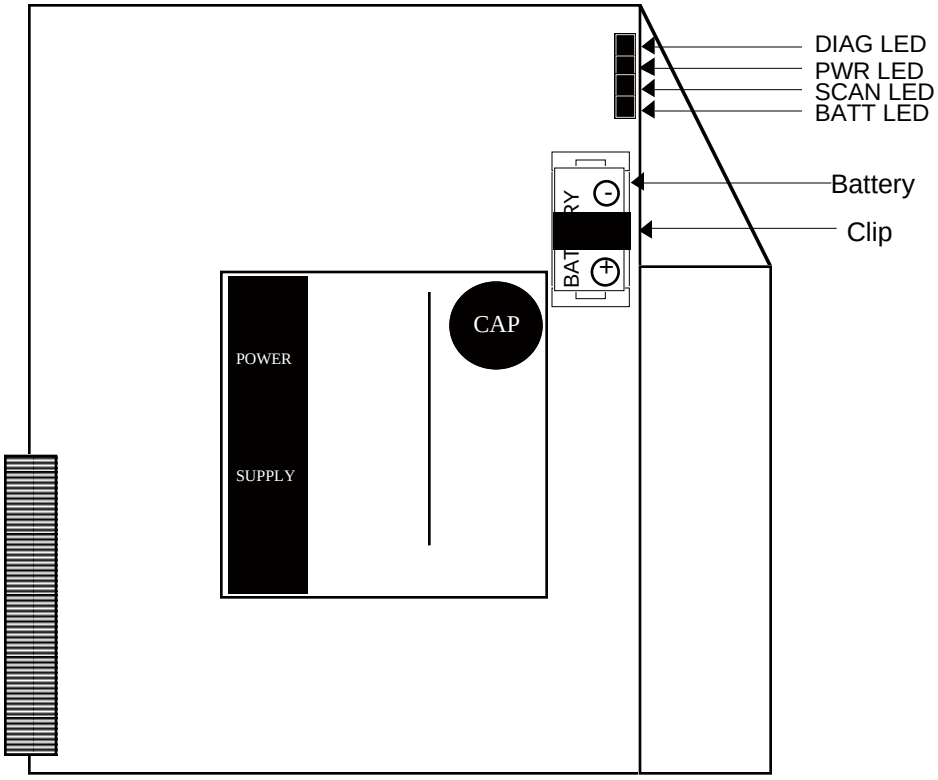
DO NOT touch any of the capacitors.

Do not touch the pins on any of the ICs; even with precautions against static you may destroy the circuitry.

5. Use Figure A1-3 to locate the battery. Note how it is oriented.

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Figure A1-3. Battery Location in CSM Module



6. Use an insulated screwdriver to pry out one end of the battery clip. Remove the clip. Lift the battery out. Replace it with a 3V, 2/3A lithium battery. (See the specification sheet at the end of this section.) Replace the clip ensuring that it is latched.

7. Close the case and insert the CSM in the rack. Connect the power cable. Turn on power and check the LEDs.

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Specification Table

Characteristic	CSM/RSM specifications
Functions	Supplies regulated DC power to the hardware modules installed in the rack
AC power source Part numbers	110-230 VAC, 47-63 Hz, 2A 502-03512-03 CSM-50 502-03813-03 CSM-60 502-03732-03 RSM-50 502-03817-03 RSM-60
DC power source Part number	20 - 60 VDC, 5A 502-03973-00 CSM-50 (24VDC)
Input connector	3-terminal plug connector, meets all specifications for touch safety in accordance with IEC 529 and DIN VDE 0470 part 1
Power output, total	CSM/RSM-50 50 W CSM/RSM-60 60 W CSM 24VDC 50W
Individual outputs	+ 5 V @4.0 A + 15 V @2.0 A -15 V @0.5 A + 5 V @8.5 A +15V @1.5 A -15V @1.5 A 5V @ 4.0 A +15V @ 1.0 A -15V @ 0.5 A
Battery (CSM only)	1.2 Ah 3V, 2/3A lithium battery 401-52446-00
CAUTION for Lithium Batteries Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of used batterries according to the manufacturers instructions.	
+ 5 V supply monitor	Trip points ± 5% ± .5%: 4.725 to 4.775V and 5.225 to 5.275 V PWR LED goes off and PiC900 shuts down
± 15 V supply monitor	Trip points ± 8% ± 2%: 13.5 to 14.1 V and 15.9 to 16.5 V
Time-of-day clock (CSM only)	Access via PiCPro or application program.
Clock tolerance (CSM only)	At 25° C, ±1 second per day Over temperature, voltage and aging variation, +2/-12 seconds per day
Logic side power requirements (typical)	25 mA @ +5V 2 mA @+15V 2 mA @ -15V 2 µA @ +3V (from battery during power down on CSM)
Operating temperature range	7° C to 55° C (45° F to 131° F)

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Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed (CSM/RSM-50)	File No. E126417 NRAQ Programmable Controllers
Physical size	2.4" wide x 12" high x 8.4" deep (including latch) 61 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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NOTES

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A.2-PiC900 CPU - (Document 108-31043-00)

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A.3 - CPU - 91X (Document 108-31044-00)

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A.4 - PiC90 - CSM/CPU (Document 108-31045-00)

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NOTE

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A.5 - RSM I/O - Remote Service Module I/O Driver

Introduction

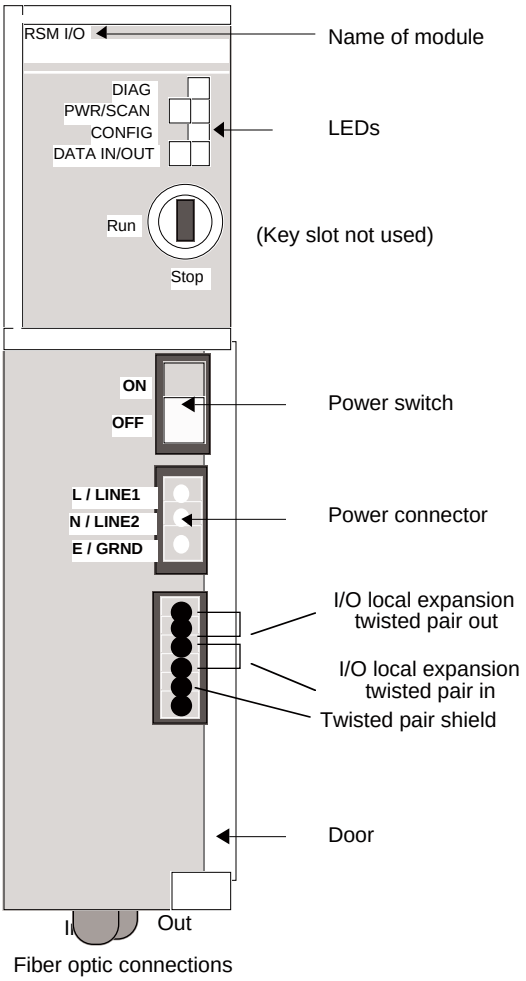
When a PiC90 3- or 5- slot rack is used as a remote or local expansion rack for a PiC900 master rack, an RSM I/O driver module is required in slot 1/2 of the PiC90 rack. (Each PiC90 used as an expansion rack must have an RSM I/O module.)

The RSM I/O driver module converts AC power to regulated DC power. Through the bus, the RSM supplies this power to the modules in an expansion rack.

Refer to Appendix N2 for information on I/O expansion connections.

The DIAG LED turns on briefly while the diagnostic tests are running.

Figure A5-1. RSM I/O - the Remote Service Module I/O Driver (for 3- or 5- Slot PiC90 Expansion Rack)



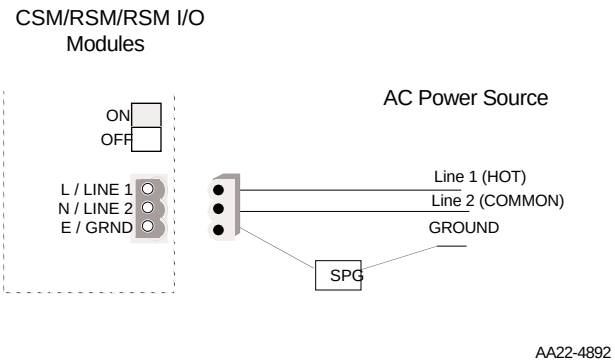
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Connections

The RSM I/O driver module receives power through a 3-pin power connector. Figure A5-2 illustrates the connections as listed below.

Module		AC Power Source
L / LINE 1	to	Hot
N / LINE 2	to	Common
E / GRND	to	Single Point Ground

Figure A5-2. AC power to the system



The pinout for the 6-pin I/O driver connector is shown in Figure A5-3. This connector is used for local I/O expansion using twisted pair wire.

The top two connections are for the I/O expansion twisted pair out. The next two are for the I/O expansion twisted pair in. The fifth connection is a shield used with twisted pair wire. The sixth connection is not used.

Remote I/O expansion uses fiber optic cable connected to the fiber optic connectors shown in Figure A5-1.

NOTE: It is possible to combine local and remote expansion racks in the same system. Use twisted pair wiring to connect racks that are up to 40 feet apart and use fiber optic cable to connect racks that are up to 2000 feet apart.

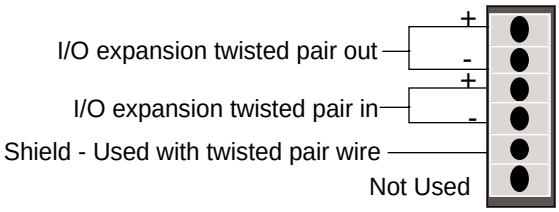
EMC NOTE

To ensure EMC compliance, use fiber optic cables only.

In some applications using only local expansion racks, it may be possible to comply to EMC standards when using shielded twisted pair wires. Verification would have to be done on a system by system basis.

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Figure A5-3. Pinout for the I/O driver twisted pair connector



CAUTION

The system is polarity dependent.

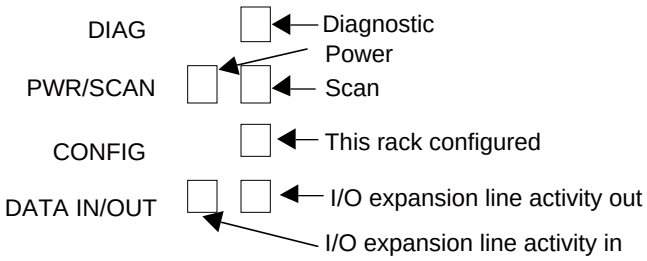
Always connect the positive (+) **output** of one module to the positive (+) **input** of the next and the negative (-) to the negative (-), etc.

Always connect the positive (+) **input** of one module to the positive (+) **output** of the next and the negative (-) to the negative (-), etc.

LEDs

The RSM I/O driver module has six LEDs to indicate status. They are shown in Figure A5-4.

Figure A5-3. RSM I/O driver LEDs



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DIAG	Diagnostic	On	The DIAG LED goes on when power is on and testing is performed by the CPU in the master rack. NOTE: The processor in the CPU module automatically runs diagnostic tests on all modules in an I/O expansion loop at power up.
		Off	It turns off when the module passes all the tests. During normal operation the DIAG LED should be off.
PWR	Power	On	The PWR light should be on whenever power is on. It indicates that the + 5V supply is within tolerance. See the specification sheet at the end of the section. During normal operation the PWR LED should be on.
		Off	No power on
SCAN	Scan	On	The SCAN light indicates that the application program is being executed. During normal operation the SCAN LED should be on.
		Off	If scan loss occurs the light will go off and there is an orderly shutdown procedure.
CONFIG	This rack configured	On	Communication established with this expansion rack connected in an I/O expansion loop.
		Off	Communication not established
DATA IN	I/O expansion line activity in	Dull glow	Indicates the line receiving in is active.
		Off	No activity in
DATA OUT	I/O expansion line activity out	Dull glow	Indicates the line transmitting out is active.
		Off	No activity out

NOTE: The diagnostic LED on the CPU module flashes certain error codes connected with I/O expansion. These codes are listed in Appendix M.

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Theory of Operation

The RSM I/O driver module converts AC input power into DC power at voltages of + 5V, + 15 V, and - 15 V and supplies them to the logic side of the modules in the rack. External power supplies are used for the field side of the I/O modules. Such supplies are not routed through the RSM I/O driver module, but they should all have the same power cut-off switch as the PiC900. See the power distribution diagrams in the Hardware chapter..

CAUTION

The on/off rocker switch on the face of the RSM I/O driver module does not control the I/O power supplies.

Always shut off power at the main disconnect switch before you replace a module in the system rack.

Specification Table

Characteristic	RSM I/O driver specifications
Functions	Supplies regulated DC power to the hardware modules installed in the rack Allows additional racks of I/O modules to be connected to a PiC900 master rack
Part number	502-03876-02
AC power source	110-230 VAC, 47-63 Hz
Input connector	3-terminal plug connector, meets all specifications for touch safety in accordance with IEC 529 and DIN VDE 0470 part 1
Power output, total	40 W
Individual outputs	+ 5 V @ 5.0 A + 15 V @ 2.0 A -15 V @ .5 A
+ 5 V supply monitor	Trip points ± 5% ± .5%: 4.725 to 4.775V and 5.225 to 5.275 V PWR LED goes off and PiC900 shuts down
PiC9XX CPU module	Communication capabilities in the master rack
Logic side power requirements (typical)	510 mA @ +5V

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Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	2.4" wide x 12" high x 8.4" deep (including latch) 61 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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A.6 - CPU - Central Processing Unit Module 94X Turbo

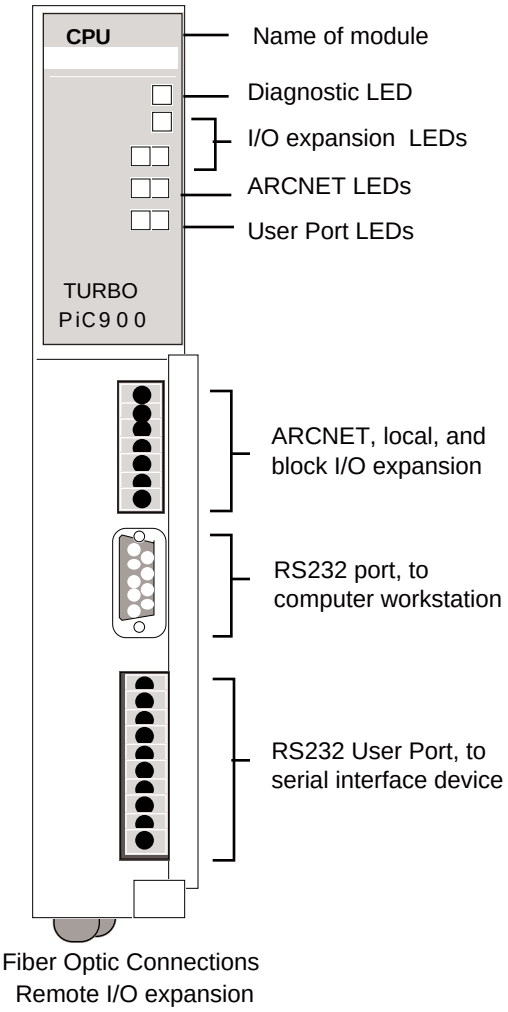
Introduction

The PiC94X Turbo CPU module controls the PiC900 system and executes the application program. It contains:

- A processor IC providing overall control
- A math coprocessor
- Eight LEDs as shown in Figure A6-1
- RAM (EPROM optional) memory for the application program and for RAMDISK
- RAM memory for data storage as the system runs
- FLASH memory for the system software
- RS232 ports to communicate with the computer workstation and with a serial interface device
- Optional communication (ARCNET and I/O expansion) capability
- Optional flash memory system (FMS) for storing things like application source modules

The CPU module must always be in the second slot from the left in the system rack.

Figure A6-1. PiC94X Turbo CPU Module



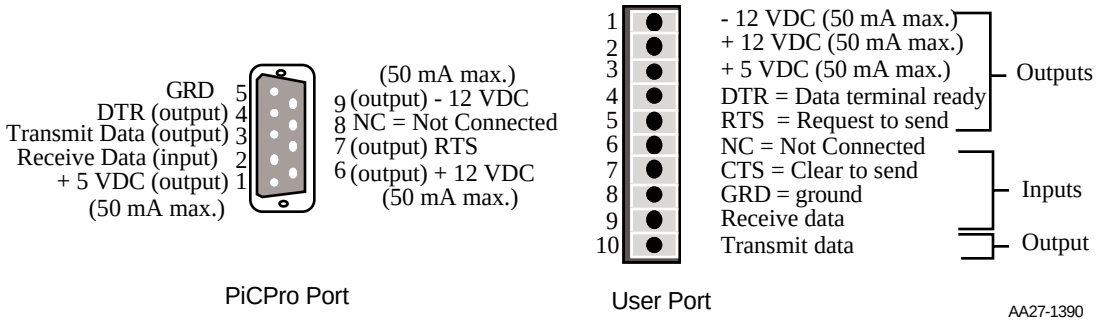
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Connections

Serial Ports

The PiCPro Port (9-pin D connector) communicates with the workstation serial port and the User Port (10-pin screw terminal connector) communicates with an optional serial interface device.

Figure A6-2. Pinouts for the Two RS232 Communications Ports



The PiCPro Port allows the PiC900 to communicate with the workstation. This port is used when downloading an application program from the workstation into RAM memory. It may also be used to exchange data between the workstation and the PiC900 system while the PiC900 system is running.

The pinout for the PiCPro Port cable is shown below.

PiCPro Cable Pinout

9-pin female (to PC)		9-pin female (to PiCPro Port)
3	to RD	2
2	to TD	3
5	to GND	5

NOTE: Other pins may be connected in the cable recieved from Giddings & Lewis, but only pins 2, 3, and 5 are used.

The User Port is used to communicate with a touch-screen, a hand-held controller, or other serial interface device.

ARCNET and I/O Expansion

ARCNET and I/O Expansion are available on some PiC94X Turbo CPUs. The specification table at the end of this appendix lists the CPU modules that have this communication capability on board.

The 7-pin screw terminal connector is used for ARCNET communications and local or block I/O expansion. The fiber optic connectors are used for remote I/O

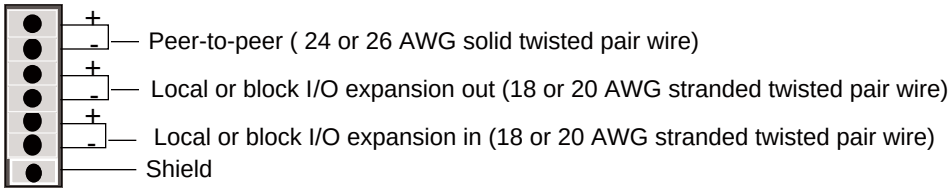
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expansion. NOTE: You can choose to do only one type of expansion at a time: local *or* block I/O *or* remote.

The top two pins are used for peer-to-peer (ARCNET) communication connections using twisted pair wire*. The next four pins are used for local [up to a 40 feet (12 m) segment] I/O expansion (up to seven expansion racks) or block I/O expansion using twisted pair wire*. The bottom pin is a shield connection. When using shielded wire, connect the shields to it.

*Use shielded cables when it is necessary to meet EMC standards. The recommended wire has 100Ω characteristic impedance.

Figure A6-3. Pinout for ARCNET, I/O Local Expansion and Block I/O Expansion Port



CAUTION

The network is polarity dependent.

In peer-to-peer communications, always connect the positive (+) of the twisted pair interface of the first PiC to the positive (+) of the twisted pair interface of the second PiC and the negative (-) to the negative (-), etc.

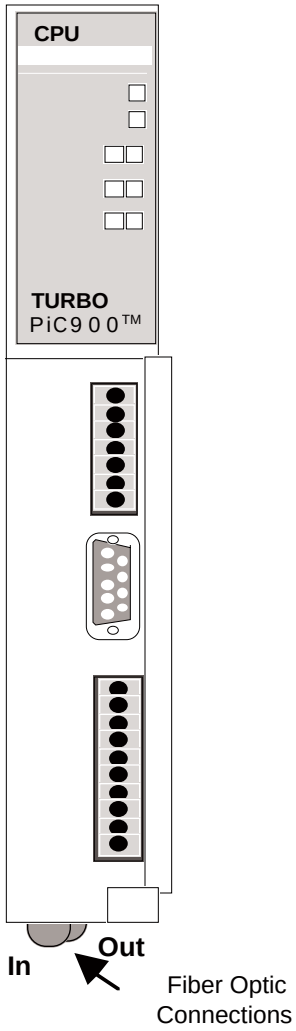
In I/O expansion systems, connect the positive (+) of the twisted pair out of the CPU module to the positive (+) of the twisted pair in on the next module and the negative (-) to the negative (-), etc. Connect the positive (+) of the twisted pair in of the CPU module to the positive (+) of the twisted pair out on the next module and the negative (-) to the negative (-), etc.

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Remote I/O Expansion

For remote I/O expansion [from 4 feet (1.2 m) to 2,000 feet (610 m)/segment], fiber optic cable is connected to the two bottom connectors on the CPU module as shown in Figure A6-4.

Figure A6-4. Location of Fiber Optic Connections for Remote I/O Expansion



See Appendix N1 Peer-to-Peer Communication Connections for information on connecting PiCs on a network.

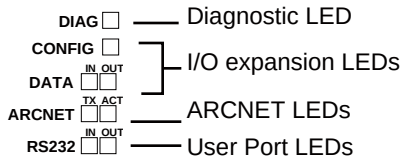
See Appendix N2 I/O Expansion Connections for more information on local and remote I/O expansion and block I/O expansion.

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LEDs

There are seven communication LEDs on this CPU module in addition to the DIAG LED. They are located directly under the DIAG LED as shown in Figure A6-5.

Figure A6-5. Communication LEDs



Below is a list of the LEDs and what they mean.

DIAG	On Flashing Off	On briefly during startup. Flashes error codes under certain conditions. These codes are listed in Appendix M. Normal operation
CONFIG I/O expansion rack configured	On	Communication established with this expansion rack connected in an I/O expansion loop.
	Off	Communication not established
DATA IN I/O expansion line activity in	Dull glow Off	Indicates the line receiving in is active. No activity in
DATA OUT I/O expansion line activity out	Dull glow Off	Indicates the line transmitting out is active. No activity out
ARCNET TX ARCNET transmit status	On Blinking Off	Normal network activity Network reconfiguration Not active part of network
ARCNET ACT ARCNET active status	Flash/On Off	Data being transferred to/from ARCNET interface No data transfer
RS232 IN User Port data IN	On Off	Data being received at user port No data being received at user port
RS232 OUT User Port data OUT	On Off	Data being transmitted from user port No data being transmitted at user port

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Theory of Operation

The CPU module performs the following tasks:

1. It runs diagnostic tests, checks the battery in the CSM, and performs other routine maintenance tasks.
2. It executes the application program, communicating with the I/O modules.
3. It maintains communication with the workstation through the PiCPro port. This port is dedicated to the communication functions of PiCPro/PiCServoPro.
4. It maintains communication with the user interface device through the User port. Details of this communication depend partly on the type of interface device. Refer to the manual that comes with the device.
5. If ARCNET and I/O expansion communications are on board, it supports peer-to-peer, ARCNET and I/O expansion communication capability.

Diagnostics

The CPU runs diagnostic tests on each module in the system rack whenever power is turned on to the PiC94X. The CSM is tested first, then the CPU module, then all the I/O modules in turn.

A module's DIAG LED is on while it is being tested, and goes off when its internal circuitry checks out. If a DIAG LED does not go out after the diagnostic tests, a fault has been detected. See the Troubleshooting section of the Hardware chapter.

EPROM for the PiC94X

The PiC94X has a socket for a 1 Mbyte EPROM. The recommended EPROM is:

Atmel AT27C080-20DC

This EPROM has three memory areas:

1. Application
2. RAMDISK
3. System

The software manual gives directions for creating a file in a format suitable for an EPROM programmer. This file may be loaded from a workstation into the EPROM using any of a number of commercially available EPROM Programmers.

The application file originates at address zero and, therefore, requires no offset. The file uses the 16-bit word format.

With the PiC94X processor, when programming an EPROM with RAMDISK information, it is necessary to locate the RAMDISK information in the EPROM memory as follows:

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For the default 256/512 memory configuration, the RAMDISK is located at 80000. For the optional 384/384 memory configuration, the RAMDISK is located at 60000.

When a new version of the system software is issued by Giddings & Lewis, it also can be loaded via the EPROM programmer. The CPU will check the time/date stamp of the system in EPROM and compare it with the system in FLASH. If the system in EPROM is newer than the system in FLASH, it will reprogram the FLASH with the new system.

PiC900 Memory Organization

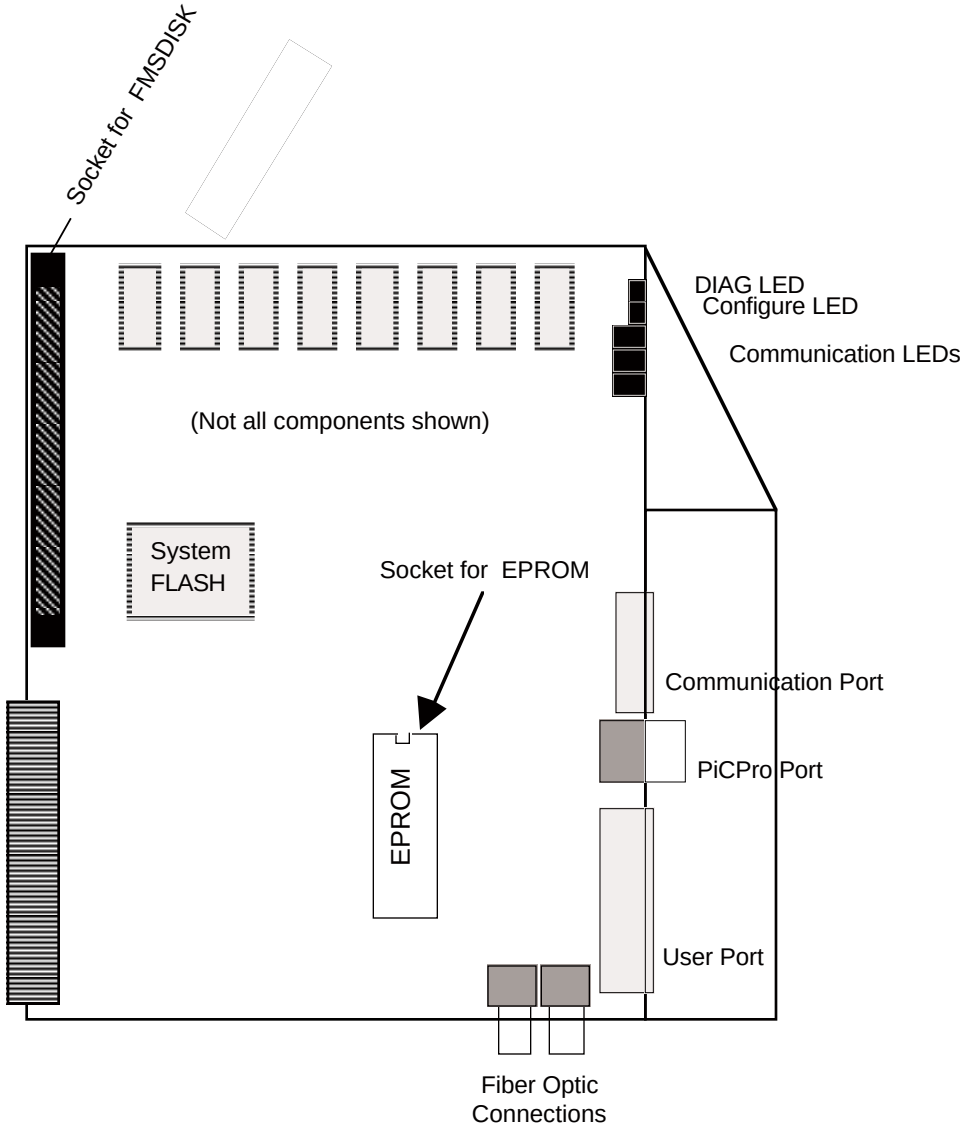
The CPU module contains 1 Megabyte of memory. This memory is divided into four groups. The groups are:

1. System Memory which is used for executive data, bit memory, and user variables. Specific areas of memory are reserved for each of these functions.
2. RAMDISK which is used to provide extra memory for program data storage. To access the data on the RAMDISK, you use special I/O commands covered in the software manual. May be loaded from an EPROM in which the data has been programmed.
3. Application Memory which is where the application program is stored. May be loaded from an EPROM in which an application has been programmed.
4. System FLASH which contains executive code for the system, diagnostics, etc. May be updated from the PC or loaded from an EPROM in which the system has been programmed.

Figure A6-6 shows the location of the EPROM for the PiC94X.

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Figure A6-6. Position of the EPROM on the PiC94X



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Procedure for Installing an EPROM into the Socket

1. Turn off power at the main disconnect switch. If the CPU is installed in the PiC rack, remove it.
2. Lay the CPU module on a static-free surface, cover side up. Ground yourself using a properly grounded wrist strap before you open the module. These are standard precautions before handling any electronic components
3. Press the plastic tabs at the top and bottom of the module toward each other and lift off the module cover.

CAUTION

Do not touch the pins on the EPROM. EPROM circuitry can be easily damaged. Broken or bent pins prevent the EPROM from functioning properly.

4. Use Figure A6-6 to see where the EPROM should be placed. If an EPROM occupies the socket already, use a removal tool to remove it.
5. Use an insertion tool to position the new EPROM over the socket being sure to match the notches.

CAUTION

Make sure the EPROM is oriented correctly. If it is installed backwards, it may be destroyed when power is turned on to the system.

Line up the pins and push it in place.

6. Replace the module cover. Insert the CPU module in the rack next to the CSM. Turn on power at the main disconnect switch and check the LEDs.

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Specification Table

Characteristics	CPU 94X module specifications
Function	Executes the application program. Executes Diagnostics on the system and its modules. Communicates through RS232 port to external devices. Can provide ARCNET and I/O expansion from module

CPUs							Number of servo axes available at six update rates**					
Model	**CPU**	**Part Number**	**Speed**	**App Mem**	**RAM Mem**	**User Mem**	**8 ms**	**4 ms**	**2 ms**	**1 ms**	**.5 ms**	**.25 ms**
941	80486DX2	502-04111-01	16 MHz	512K	256K	64K	24/12	12/6	6/3	3/2	1	0
Turbo2	80486DX2	502-04111-11*	16 MHz	512K	256K	64K	24/12	12/6	6/3	3/2	1	0
943	80486DX2	502-04011-01	32 MHz	512K	256K	64K	32	24/12	12/6	6/3	3/2	1
Turbo2	80486DX2	502-04011-11*	32 MHz	512K	256K	64K	32	24/12	12/6	6/3	3/2	1
945	80486DX2	502-03994-01	50 MHz	512K	256K	64K	32	32	24/12	12/6	6/3	3/2
Turbo3	80486DX2	502-03994-11*	50 MHz	512K	256K	64K	32	32	24/12	12/6	6/3	3/2
947	80486DX4	502-04112-01	100MHz	512K	256K	64K	32	32	32	24/12	12/6	6/3
Turbo3	80486DX4	502-04112-11*	100MHz	512K	256K	64K	32	32	32	24/12	12/6	6/3

*ARCNET and I/O expansion communications are standard on these modules.

** When two numbers are listed (H/L), the High number is typical when running things like RATIO_GR, RATIOCAM, VEL_STRT, POSITION, DISTANCE move types, etc. The Low number is typical when running time axes, servo tasks, RATIO_RL, M_LINCIR, M_SCRVLC move types, etc. The latter place a heavier burden on CPU time than the former. Consult Giddings & Lewis for assistance if you want to exceed the number of axes in this chart.

Flash memory system board (optional)	4 Megabyte FMS Board 502-03882-00 8 Megabyte FMS Board 502-03882-20
Memory	1 Megabyte max.
PiCPro Port (to workstation)	RS232 serial port, secured protocol Software selectable baud rate to 115.2K
User Port (to serial interface device)	RS232 serial port Supports RTS/CTS hardware handshaking Software selectable baud rate to 19.2K

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<table>
<tr><td>Logic side power requirements (typical)</td><td>
<table>
<tr><th>Part Number</th><th>+5 V</th><th>+15 V</th><th>-15 V</th></tr>
<tr><td>502-04111-01</td><td>700 mA</td><td>4 mA</td><td>10 mA</td></tr>
<tr><td>502-04011-01</td><td>800 mA</td><td>4 mA</td><td>10 mA</td></tr>
<tr><td>502-03994-01</td><td>900 mA</td><td>4 mA</td><td>10 mA</td></tr>
<tr><td>502-04112-01</td><td>1200 mA</td><td>4 mA</td><td>10 mA</td></tr>
<tr><td>502-04111-11*</td><td>900 mA</td><td>4 mA</td><td>39 mA</td></tr>
<tr><td>502-04011-11*</td><td>1000 mA</td><td>4 mA</td><td>39 mA</td></tr>
<tr><td>502-03994-11*</td><td>1100 mA</td><td>4 mA</td><td>39 mA</td></tr>
<tr><td>502-04112-11*</td><td>1400 mA</td><td>4 mA</td><td>39 mA</td></tr>
</table>
All CPUs draw 15 µA from the battery during power down.
</td></tr>
<tr><td>Operating temperature range</td><td>7°C to 55°C (45°F to 131°F)</td></tr>
<tr><td>Storage temperature range</td><td>-40°C to 85°C (-40°F to 185°F)</td></tr>
<tr><td>Humidity</td><td>5 to 95%, non-condensing</td></tr>
<tr><td>CE Marked</td><td>Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards:

EN 50081-2:1993 EMC Generic Industrial Emissions
EN 50082-2:1995 EMC Generic Industrial Immunity
EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers

Operates with emissions below EN55011/ CISPR 11 Class A limits
Immune to:
• Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2
• RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204
• Electrical fast transients per EN61000-4-4
• Magnetic fields per EN61000-4-8

Refer to the EMC Guidelines for more information.</td></tr>
<tr><td>UL and C/UL Listed</td><td>File No. E126417 NRAQ Programmable Controllers</td></tr>
<tr><td>Physical size</td><td>1.6" wide x 12" high x 8.4" deep (including latch)
41 mm x 305 mm x 213 mm</td></tr>
<tr><td>Vibration (per IEC 68-2-6)</td><td>10-57 Hz (constant amplitude .15 mm)
57 - 2000 Hz (acceleration 2 g)</td></tr>
<tr><td>Shock (per IEC 68-2-27)</td><td>Four shocks per axis (15g/11 msec)</td></tr>
</table>

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NOTES

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A.7 - PiC9011/9012 - CSM/CPU (Document 108-31046-00)

(This document is archived and available from Giddings & Lewis by requesting part number 108-31046-00.)

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NOTE

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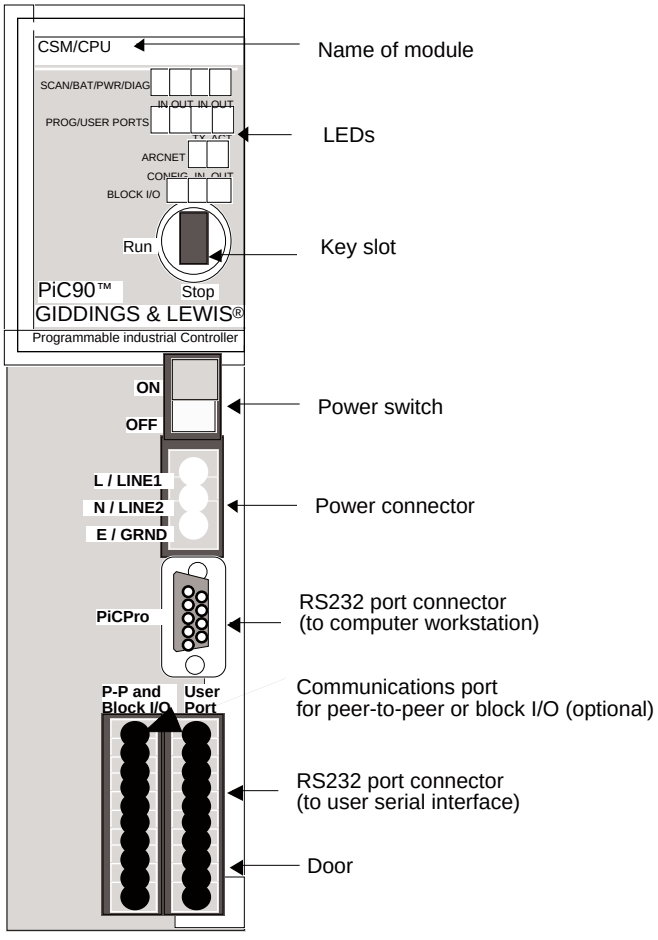
A.8 - PiC904X- CSM/CPU Central Service Module/Central Processing Unit

Introduction

The PiC904X CSM/CPU module occupies the 1/2 slot in the rack.

The CSM/CPU converts AC or DC power to regulated DC power. It supplies this power to the modules in the rack through the bus. The PiC904X CSM/CPU controls the system and executes the application program.

Figure A8-1. PiC904X CSM/CPU Module



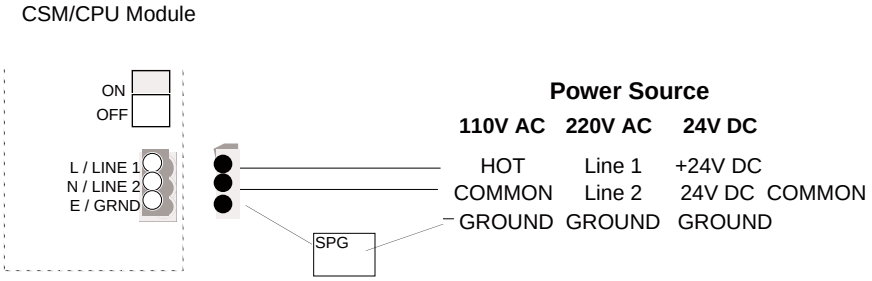
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Connections

The CSM/CPU module receives power through a 3-pin power connector. Figure A8-2 illustrates the connections as listed below.

Module	AC Power Source 110VAC	AC Power Source 220VAC	DC Power Source 24VDC
L / LINE 1 to	Hot	Line1	+24V
N / LINE 2 to	Common	Line2	24V Common
E / GRND to	Single Point Ground	Single Point Ground	Single Point Ground

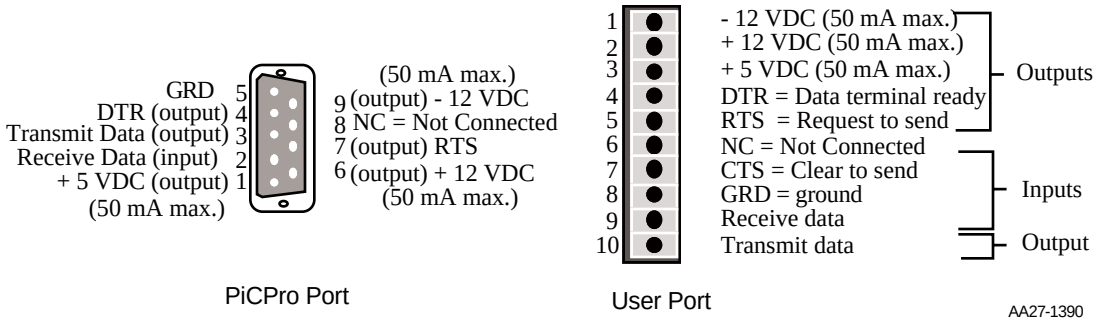
Figure A8-2. Power to the System



Serial Ports

The PiCPro Port (9-pin D connector) communicates with the workstation serial port and the User Port (10-pin screw terminal connector) communicates with an optional serial interface device.

Figure A8-3. Pinouts for the Two RS232 Communications Ports



The PiCPro Port allows the PiC904X to communicate with the workstation. This port is used when downloading an application program from the workstation into RAM memory. It may also be used to exchange data between the workstation and the PiC904X system while the PiC904X system is running.

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The pinout for the PiCPro Port cable is shown below.

PiCPro Cable Pinout

9-pin female (to PC)		9-pin female (to PiCPro Port)
3	to RD	2
2	to TD	3
5	to GND	5

NOTE: Other pins may be connected in the cable received from Giddings & Lewis, but only pins 2, 3, and 5 are used.

The User Port is used to communicate with a touch-screen, a hand-held controller, or other serial interface device.

Peer-to-Peer (ARCNET) and Block I/O Expansion (Optional)

Peer-to-peer and block I/O expansion are optional on the PiC904X. The PiC90s with this communication capability have a communications port with a 10-pin screw terminal connector to the left of the user port. (See Figure 7-1.)

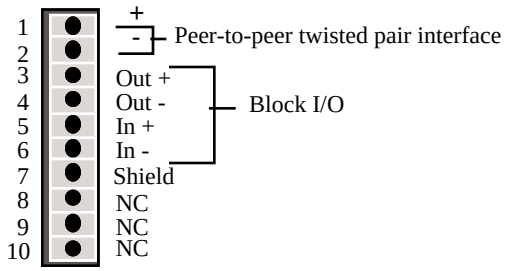
The top two pins are used for peer-to-peer communication connections using twisted pair wire*.

The next four pins are used for block I/O expansion (up to 77 block modules) where the maximum distance between block modules is 200 feet using shielded twisted pair wire*.

The 7th pin is a shield connection. When using shielded wire, connect the shields to it.

*Use shielded cables when it is necessary to meet EMC standards. The recommended wire has 100Ω characteristic impedance.

Figure A8-4. Pinout for ARCNET and Block I/O Expansion Port



Peer-to-Peer(ARCNET)/
Block I/O communications port

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CAUTION

The network is polarity dependent.

In peer-to-peer communications, always connect the positive (+) of the twisted pair interface of the first PiC to the positive (+) of the twisted pair interface of the second PiC and the negative (-) to the negative (-), etc.

In block I/O expansion systems, connect the positive (+) of the twisted pair out of the CPU module to the positive (+) of the twisted pair in on the next block I/O module and the negative (-) to the negative (-), etc. Connect the positive (+) of the twisted pair in of the CPU module to the positive (+) of the twisted pair out on the next block I/O module and the negative (-) to the negative (-), etc.

See Appendix N1 Peer-to-Peer Communication Connections for information on connecting PiCs on a network.

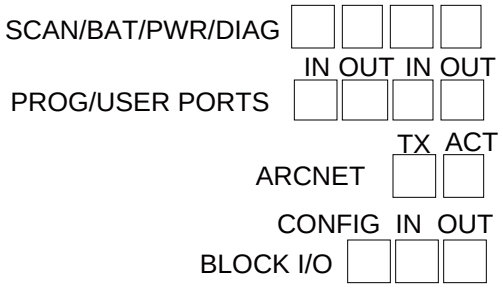
See Appendix N2 I/O Expansion Connections for more information on block I/O expansion.

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LEDs

There are 11 LEDs on the PiC904X CSM/CPU as shown in Figure A8-5 below. This section describes these LEDs.

Figure A8-5. LEDs



Status LEDs

The CSM/CPU module has four LEDs to indicate status as shown in the top row in Figure A8-5 above. They are described below.

NOTE: During normal operation the DIAG and BATT LEDs should be off, and the PWR and SCAN LEDs should be on.

Scan (SCAN)	
ON	The processor is executing the application program.
OFF	Scan is lost and there is an orderly shut down procedure followed.
Battery (BAT)	
ON	Goes on briefly while the battery is checked at power-on.
OFF	Battery passed power up test.
Flashing	Replace lithium battery. See replacement procedure that follows.
Power (PWR)	
ON	Power is on to the system. It indicates that the +5V supply is within tolerance. See the specification sheet.
OFF	No power to the system
Diagnostic (DIAG)	
ON	On briefly during startup diagnostics. If it remains ON, module has failed startup diagnostics.
OFF	Normal operation
Flashing	Flashes error codes under certain conditions. These codes are listed in Appendix M.

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Communication LEDs

There are seven communication LEDs shown in Figure A8-5: two for RS232 communication, two for ARCNET communication, and three for Block I/O communication. They are described below.

PiCPro Programming Port Data In (IN)	
ON	Data being received at programming port
OFF	No data being received at programming port
PiCPro Programming Port Data Out (OUT)	
ON	Data being transmitted from programming port
OFF	No data being transmitted from programming port
RS232 User Port Data In (IN)	
ON	Data being received at user port
OFF	No data being received at user port
RS232 User Port Data Out (OUT)	
ON	Data being transmitted from user port
OFF	No data being transmitted from user port
ARCNET Transmit Status (TX)	
ON	Normal network activity
OFF	Not active part of network
Blinking	Network reconfiguration
ARCNET Active Status (ACT)	
Flash/ON	Data being transferred to/from ARCNET interface
OFF	No data transfer
BLOCK I/O Module Configuration (CONFIG)	
ON	Communication established with block I/O modules
OFF	Communication not established with block I/O modules
BLOCK I/O Data In (IN)	
ON	Indicates the CPU is receiving data from block I/O modules
OFF	Indicates the CPU is not receiving data from block I/O modules
BLOCK I/O Data Out (OUT)	
ON	Indicates the CPU is transmitting data to block I/O modules
OFF	Indicates the CPU is not transmitting data to block I/O modules

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CSM/CPU Time-of-Day Clock

An internal clock IC maintains the current date and time. If power is off to the system, the battery maintains the clock. The application program and PiCPro can access this clock. Details are given in the Software manual.

Theory of Operation

The CSM/CPU module converts input power into DC power at voltages of +5V, +15 V, and -15 V and supplies them to the logic side of the modules in the rack. External power supplies are used for the field side of the I/O modules. Such supplies are not routed through the CSM/CPU, but they should all have the same power cut-off switch as the PiC9041.

CAUTION

The on/off rocker switch on the face of the CSM/CPU does not control the I/O power supplies.

Always shut off power at the main disconnect switch before you replace a module in the system rack.

With the CSM/CPU module, a key is supplied to protect the system from unauthorized start-ups. You can set up the PiC9041 hardware, power up and run the diagnostic tests, and even load a software application program without the system key. However, the application program will not be scanned until you turn the Run/Stop key on the CSM/CPU to the Run position.

The CSM/CPU module does the following:

- Performs diagnostic tests.
- Checks the battery.
- Performs routine maintenance tasks.
- Executes the application program.
- Communicates with the I/O modules.
- Maintains communication with the workstation through the PiCPro port.
- Maintains communication with the user interface device through the user port. (Details for this communication depend partly on the type of interface device. Refer to the manual that comes with the device.)
- Provides peer-to-peer (ARCNET) communication and block I/O expansion capability (optional).

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Application in Flash

The 904X has a flash chip on board that allows you to load an application program into it. This is standard on the 904X and not the same as the optional Flash Memory System (FMS) that you can add. Having the application in the standard flash chip ensures that you will not lose the application if the battery fails. On power up, the application is transferred from the flash chip to RAM as it is when directly downloaded from PiCPro.

To place the application in flash:

1. Compile the application into a hex file in PiCPro.
2. Use the SENDHEX utility (refer to the PiCPro Utilities Manual) to download the application into flash.

Even though you have placed an application in flash, you can still download and run a differenct application from PiCPro. However, when you cycle power on the PiC, the application in flash will always be placed into RAM.

If you want to remove the application from FLASH so that it is not placed into RAM when you cycle power, use the SENDHEX utility to send the CLRFLASH.HEX file to the PiC.

Replacing the Battery on the CSM/CPU

Follow the procedure below to replace a battery.

1. After power has been applied to the CSM/CPU for at least five minutes, turn off power at the control cabinet main disconnect switch and at the CSM/CPU power switch. Unplug all connectors from the CSM/CPU.
2. Remove the CSM/CPU module from the rack by pressing down the latch at the top and pulling it out.
3. Use a static-free work surface if possible. Ground yourself using a properly grounded wrist strap before you open the case. These are standard precautions before handling any electronics component.
4. Lay the CSM/CPU on the work surface with its label side up. Press the plastic tabs at the top and bottom of the module case toward each other and lift the side cover off

WARNING

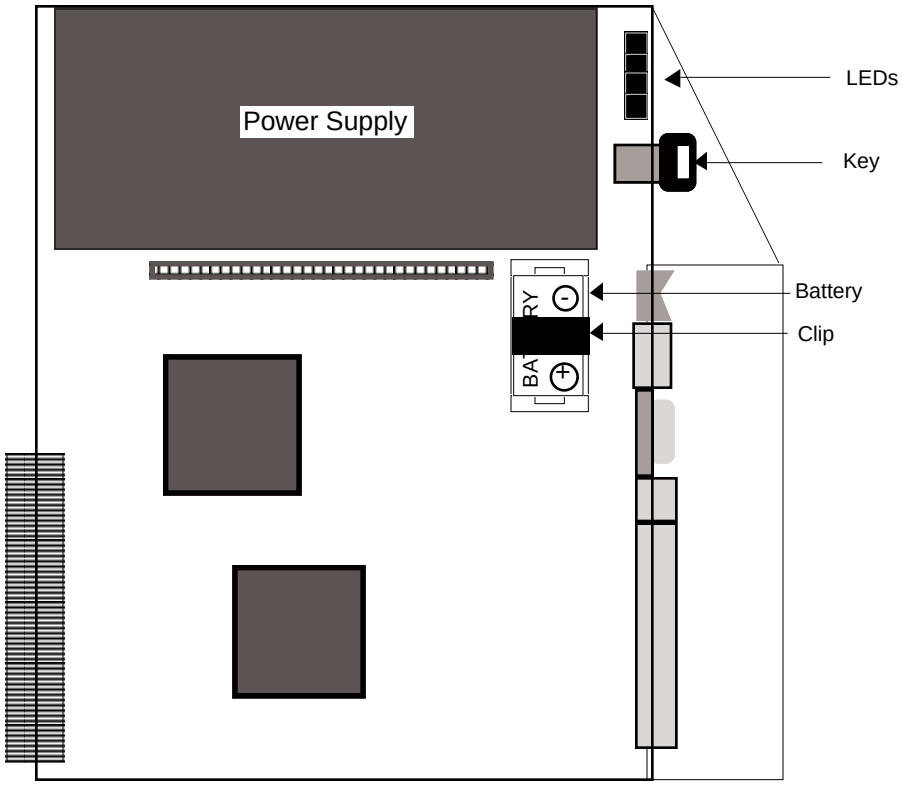
Do not touch any of the capacitors.

Do not touch the pins on any of the ICs; even with precautions against static you may destroy the circuitry.

5. Use Figure A8-6 to locate the battery. Note how it is oriented.

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Figure A8-6. Inside the CSM/CPU Module: Position of Battery



6. Use an insulated screwdriver to pry out one end of the battery clip. Remove the clip. Lift the battery out. Replace it with a 3V, 2/3A lithium battery. (See the specification sheet at the end of this section.) Replace the clip ensuring that it is latched.
7. Close the case and insert the CSM/CPU in the rack. Reconnect all the cables. Turn on power and check the LEDs.

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Specification Table

Characteristic	CSM/CPU specifications
Functions	Supplies regulated DC power to the hardware modules installed in the rack. Executes the application program. Executes Diagnostics on the system and its modules. Communicates through the RS232 ports to external devices. Peer-to-peer communication with PiC900 family of controls (optional)

Models available						Number of servo axes available at six update rates*					
PiC90 Model (for use with AC Power Source)	**Part Number**	**Speed**	**App Mem**	**RAM Mem**	**User Mem**	**8 ms**	**4 ms**	**2 ms**	**1 ms**	**.5 ms**	**.25 ms**
9041 Standard w/o comm	502-04104-01	16 MHz	256K	128K	64K	12	6	4	2	1	0
9041 Standard w comm	502-04104-11	16 MHz	256K	128K	64K	12	6	4	2	1	0
9043 Turbo w/o comm	502-04125-01	32 MHz	256K	128K	64K	12	12	8	4	2	1
9043 Turbo w comm	502-04125-11	32 MHz	256K	128K	64K	12	12	8	4	2	1
PiC90 Model (for use with DC Power Source)											
9041 Standard w/o comm	502-04110-00	16 MHz	256K	128K	64K	12	6	4	2	1	0
9041 Standard w comm	502-04110-10	16 MHz	256K	128K	64K	12	6	4	2	1	0
9043 Turbo w/o comm	502-04126-00	32 MHz	256K	128K	64K	12	12	8	4	2	1
9043 Turbo w comm	502-04126-10	32 MHz	256K	128K	64K	12	12	8	4	2	1

*The number of axes listed is typical for RATIO_GR, RATIOCAM, VEL_STRT, POSITION and DISTANCE move types. Applications which use time axes, servo tasks, RATIO_RL, M_LINCIR , or M_SCRVLC moves require more CPU time. Consult Giddings & Lewis for assistance if you want to exceed the number of axes in this chart.

AC power source	110-230 VAC, 47-63 Hz, 1A
DC power source	20 -30V DC, 3 A
Input connector	3-terminal plug connector, meets all specifications for touch safety in accordance with IEC 529 and DIN VDE 0470 part 1
Power output, total	CSM/CPU 40 W (for AC power source) 30 W (for DC power source)

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Individual outputs	**AC Power Source** **DC Power Source** + 5 V @ 5.0 A 3A + 15 V @ 2.0 A 1A -15 V @ .5 A .5A
Battery	1.2 Ah 3V, 2/3A lithium battery
CAUTION for Lithium Batteries Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of used batterries according to the manufacturers instructions.	
+ 5 V supply monitor	Low trip point 4.50V min 4.75V max High trip point 5.50V min 5.94V max PWR LED goes off and PiC9041 shuts down
Flash memory system board (optional)	4 Megabyte FMS Board 502-03882-00 8 Megabyte FMS Board 502-03882-20
PiCPro port	Used to connect to the work station RS232 serial port, secured protocol Software selectable baud rate (300 to 57600 baud)
User port	Used to connect to a serial interface device RS232 serial port Supports RTS/CTS hardware handshaking Baud rates to 19.2 K
Peer-to-peer communications (optional)	Allows for communication between PiC90s and/or PiC900s (up to 255) A dedicated network controller supports peer-to-peer communications. Provides a twisted pair wire interface that is transformer isolated. Data is transferred serially at a rate of 2.5 megabits per second.
Block I/O expansion (optional)	Allows for communication between the PiC90 and block I/O modules (up to 77) The maximum distance between modules is 200 feet using shielded twisted pair wire
Time-of-day clock	Access via PiCPro or application program.
Clock tolerance	At 25° C, ±1 second per day Over temperature, voltage and aging variation, +2/-12 seconds per day

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Logic side power requirements (typical)	450 mA @ +5 V 502-04104-00, 502-04110-00 650 mA @ +5 V 502-04104-10, 502-04110-10 600 mA @ +5 V 502-04125-00, 502-04126-00 800 mA @ +5 V 502-04125-10, 502-04126-10 5 mA @+15 V all 10 mA @ -15V 502-04104-00, 502-04110-00, 502-04125-00, 502-04126-00 40 mA @ -15V 502-04104-10, 502-04110-10 502-04125-10, 502-04126-10 5 µA @ +3V (all) From the battery during power down
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	2.4" wide x 12" high x 8.4" deep (including latch) 61 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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Appendix B - Communication Modules

B.1 - I/O Driver Module

Introduction

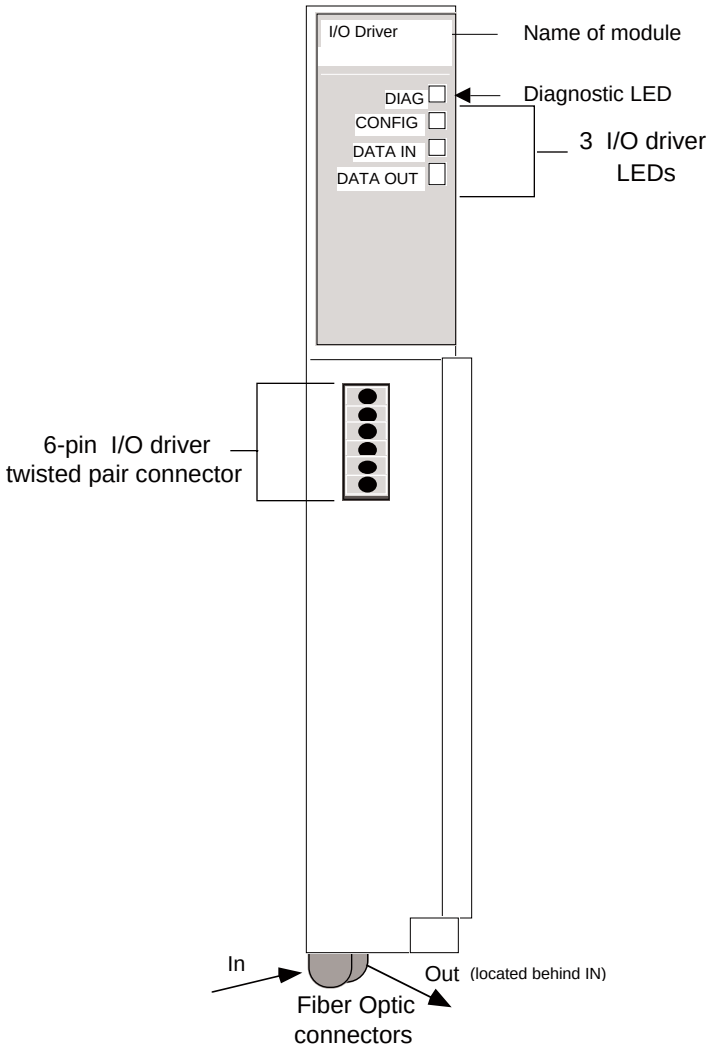
A PiC900 system may include expansion racks containing I/O modules. The I/O driver module must be installed in each expansion rack. A PiC900 CPU module with a daughter board or a PiC9XX CPU module with communication capability must be installed in the master rack.

The I/O driver module must always be in the second slot from the left in each expansion rack.

Refer to Appendix N2 for information on I/O expansion connections.

The DIAG LED turns on briefly while the diagnostic tests are running.

Figure B1-1. The I/O DRIVER Module



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Connections

The pinout for the 6-pin I/O driver connector is shown in Figure B1-2. This connector is used for local I/O expansion using twisted pair wire.

The top two connections are for the I/O expansion twisted pair out. The next two are for the I/O expansion twisted pair in. The fifth connection is a shield used with twisted pair wire. The sixth connection is not used.

Remote I/O expansion uses fiber optic cable connected to the fiber optic connectors shown in Figure B1-1.

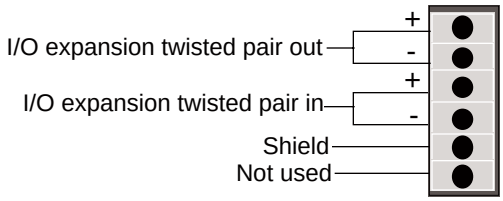
NOTE: It is possible to combine local and remote expansion racks in the same system. Use twisted pair wiring to connect racks that are up to 40 feet apart and use fiber optic cable to connect racks that are up to 2000 feet apart.

EMC NOTE

To ensure EMC compliance, use fiber optic cables only.

In some applications using only local expansion racks, it may be possible to comply to EMC standards when using shielded twisted pair wires. Verification would have to be done on a system by system basis.

Figure B1-2. Pinout for the I/O driver twisted pair connector



CAUTION

The system is polarity dependent.

Always connect the positive (+) **output** of one module to the positive (+) **input** of the next and the negative (-) to the negative (-), etc.

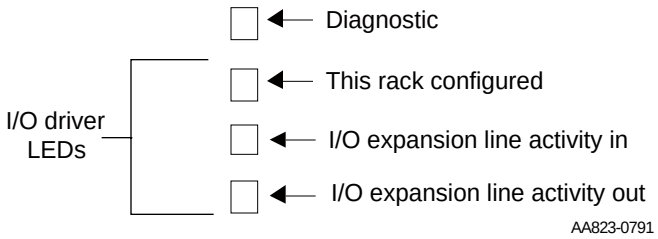
Always connect the positive (+) **input** of one module to the positive (+) **output** of the next and the negative (-) to the negative (-), etc.

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LEDs

There are three LEDs on the I/O driver module in addition to the DIAG LED. They are located directly under the DIAG LED as shown in Figure B1-3.

Figure B1-3. I/O Driver LEDs



NOTE: The diagnostic LED on the CPU module flashes certain error codes connected with I/O expansion. These codes are listed in Appendix M.

This rack configured	On	Communication established with this expansion rack connected in an I/O expansion loop.
	Off	Communication not established
I/O expansion line activity out	Dull glow	Indicates the line transmitting out is active.
	Off	No activity out
I/O expansion line activity in	Dull glow	Indicates the line receiving in is active.
	Off	No activity in

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Specification Table

Characteristics	I/O driver module specifications
Function	Allows additional racks of I/O modules to be connected to a PiC900 master rack
Part number	502-03657-03
PiC9XX CPU module with communication capabilities in the master rack	
Logic side power requirements (typical)	510 mA @ +5V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
EMC Compliant Emissions Noise immunity	 Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per IEC1000-4-2 • RF electromagnetic fields per IEC 1000-4-3 • Electrical fast transients per IEC 1000-4-4 on incoming power lines Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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B.2 - Serial Communications Module (2, 4 channel)

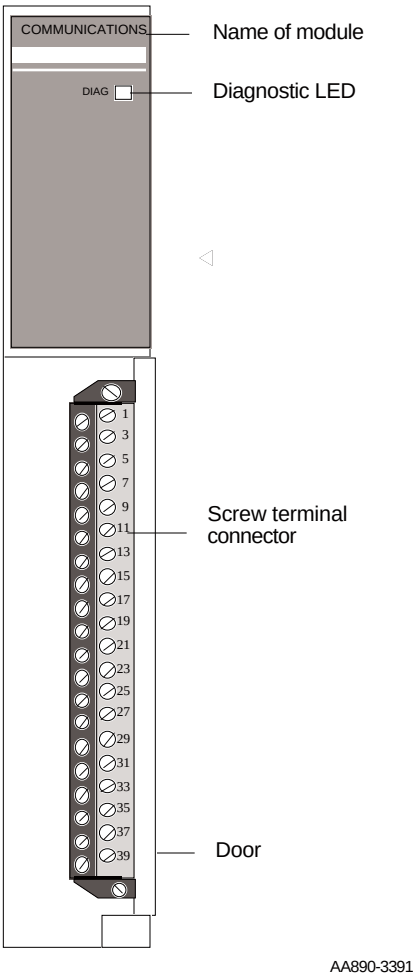
Introduction

The serial communications module provides two or four channels to be used for asynchronous serial communication with external devices such as computers, operator interface devices, etc.

For each channel, RS232 electrical interface is provided for data and control lines; RS422/485 electrical interface is provided for data lines.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure B2-1. Serial Communications Module (2, 4 ch)



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Connections

A screw terminal connection is provided for each input and output as shown in Figure B2-2. RS232 or RS422/485 interface is available on all four channels.

This table defines the inputs and outputs available for each channel on the module using an RS232 interface.

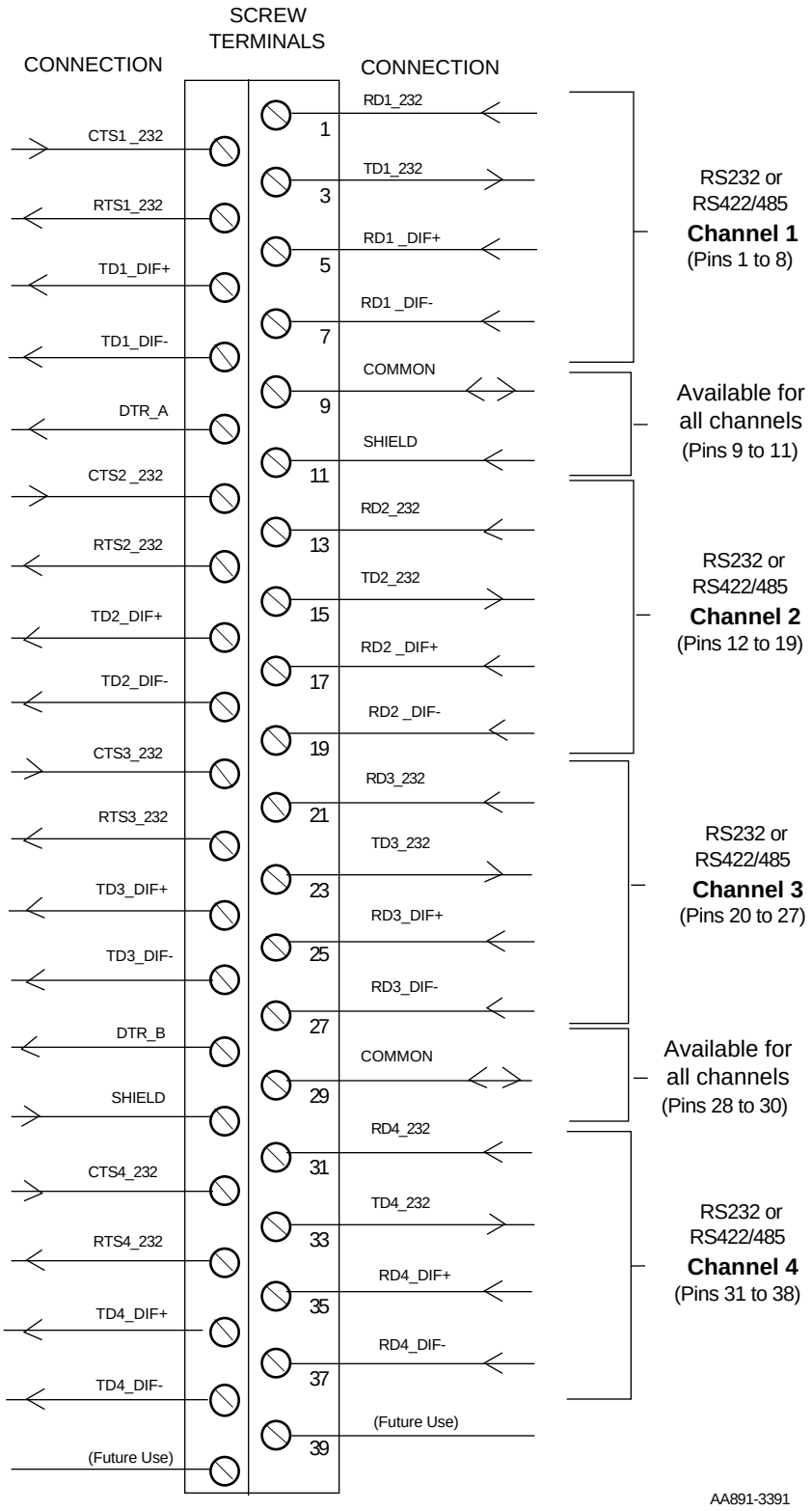
Label	Definition	Input/Output
RDx_232	Receive data	Input
TDx_232	Transmit data	Output
CTSx_232	Clear to send (handshaking)	Input
RTSx_232	Request to send (handshaking)	Output
DTRx	Data terminal ready (pullup to 12V)	Output

This table defines the inputs and outputs available for each channel on the module using an RS422/485 interface.

Label	Definition	Input/Output
RDx_DIF+	Receive data	Input
RDx_DIF-		Input
TDx_DIF+	Transmit data	Output
TDx_DIF-		Output

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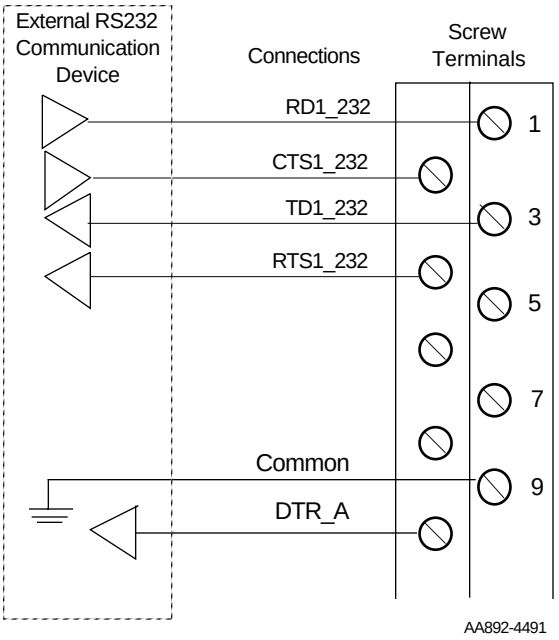
Figure B2-2. Screw Terminal Connection Assignments



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Figure B2-3 illustrates how to connect an RS232 device to channel 1. Maximum cable length for RS232 devices is 50 feet.

Figure B2-3. Connections for an RS232 Device (Ch 1)

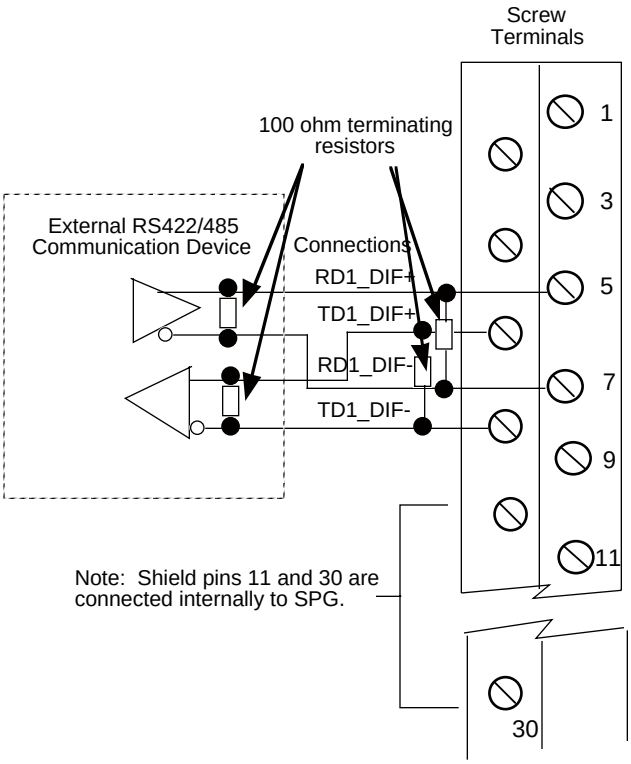


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Figure B2-4 illustrates how to connect an RS422/485 device to channel 1.

NOTE: RS422 refers to an earlier standard that applied only to single drop connections. RS485 refers to multidrop connections. See Figure B2-5.
Since the interface is used for both RS422 *and* RS485, terminating resistors are required for proper operation.

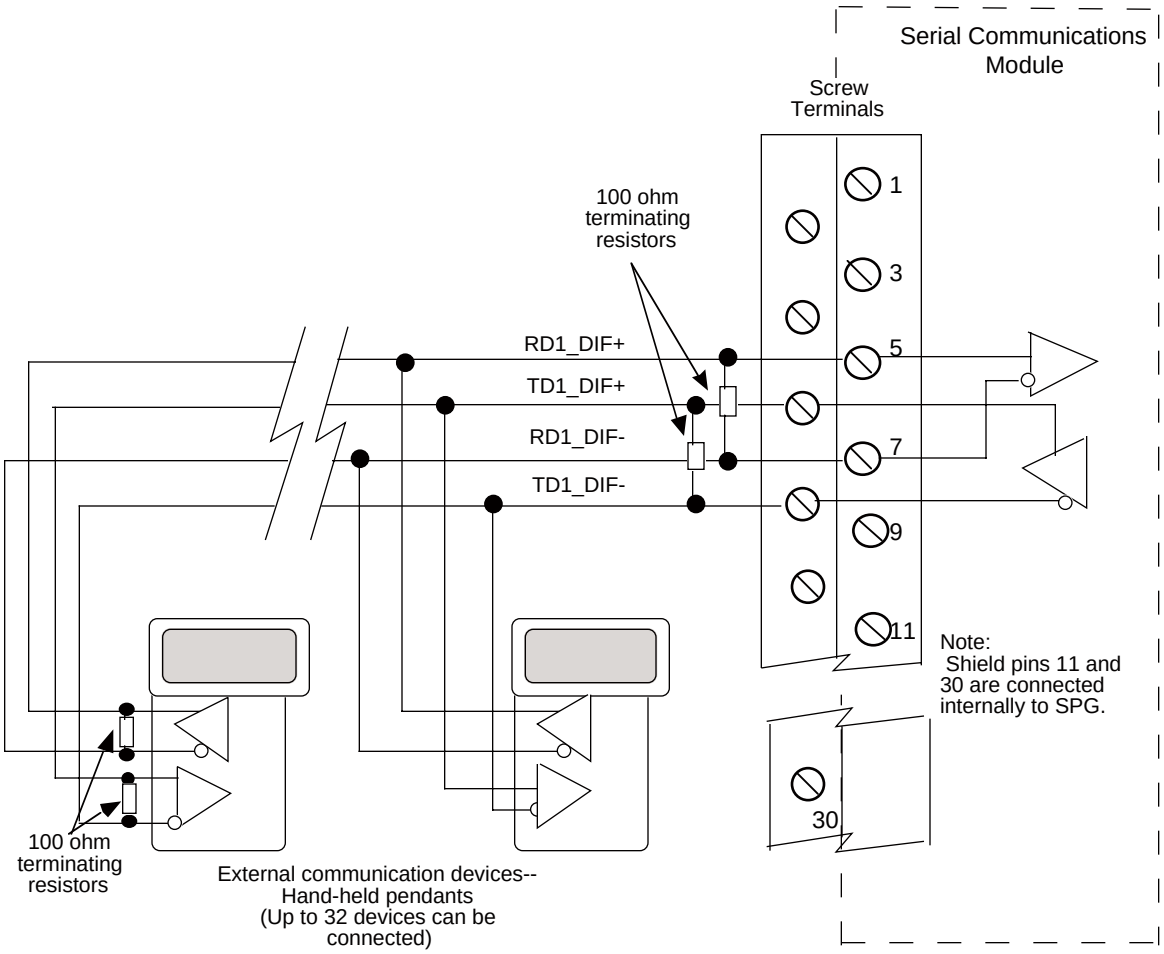
Figure B2-4. Connections for an RS422/485 Device (Ch 1)



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With RS485, multidrop connections are possible as shown in Figure B2-5. The serial communications module acts as the master, sending control sequences to activate/deactivate external devices such as hand-held terminals, touch control screens, etc. Up to 32 devices can be connected per channel. Maximum cable length is 4000 feet. A terminating resistor (100 Ω) is installed on each end of the system as shown.

Figure B2-5. Multidrop Connections



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Theory of operation

Serial communication is accomplished through the use of one or two DUARTs (Dual Universal Asynchronous Receiver/Transmitter). External serial devices are connected to a given channel of a DUART through either an RS232 interface *or* an RS422/485 interface.

There is a dedicated processor with FIFO buffers on the module which services the DUARTs. This saves the main CPU from the time-consuming task of directly polling each DUART. The processor supports data transfers with rates up to 19.2 Kbaud for each channel. At rates above 9600 baud, hardware handshaking should be used.

The FIFO buffers provide the main means of data transfer between the main CPU and the DUARTs. Up to 1 K of input data and 1 K of output data may be buffered at a given time for each channel.

Communication is handled through PiCPro software.

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Specification Table

Characteristics	Communications Module Specifications
Function	Provides 2 or 4 asynchronous serial communication channels to be used with serial interface devices
Part number	2 channel- 502-03676-23 4 channel- 502-03676-03
Dedicated processor	80C186, 8 MHz, 32K x 16 EPROM, 8K x 16 RAM
Ports 1, 2, 3, and 4	RS232 or RS422/485 electrical interface Supports RTS/CTS hardware handshaking Baud rates to 19.2 Kbps
Logic side power requirements (typical)	420 mA @ +5V (2 ch) 450 mA @ +5V (4 ch) 5 mA @ +15V 5 mA @ -15V 50 mA per terminated RS422/485 channel @ +5V 5 mA per active RS232 channel @ +15V 6 mA per active RS232 channel @ -15V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.

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UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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B.3 - DeviceNet™ Module

Introduction

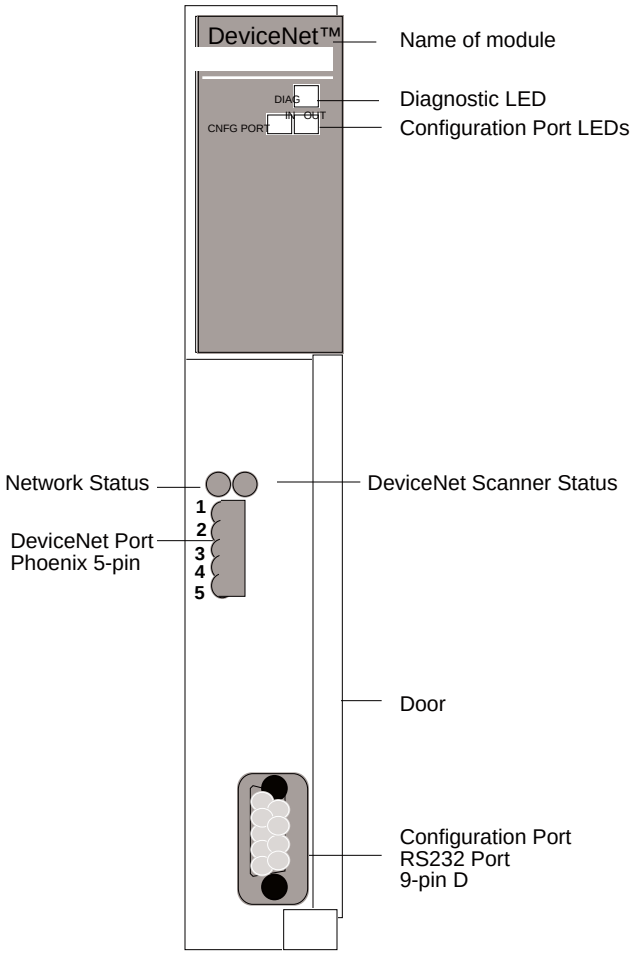
The DeviceNet™ scanner module is an interface between the PiC and a DeviceNet network. The module contains an on-board processor, a DeviceNet compliant interface, and firmware that makes it act as the master to all other nodes on the network.

Prior to initial operation, a file is generated with specific configuration software in an external PC. This file must be downloaded via the RS232 configuration port to the DeviceNet module prior to initial operation. Two indicator LEDs (IN/OUT) are connected to this configuration port.

Directly above the DeviceNet port are two LEDs that provide operation information; Network Status and DeviceNet Scanner Status.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure B3-1. DeviceNet Module

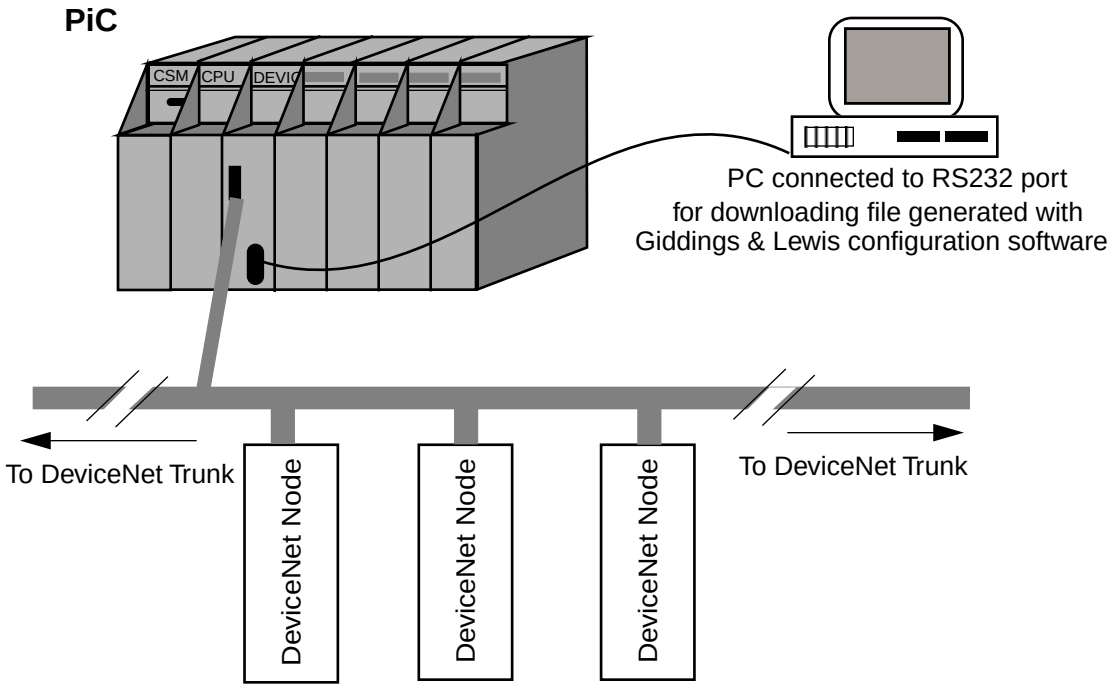


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Connections

DeviceNet connections are illustrated in Figure B3-2. Up to 63 DeviceNet Nodes may be attached to the DeviceNet scanner module.

Figure B3-2. DeviceNet Connections



The DeviceNet Port

The DeviceNet port is on the front of the module near the center as shown in Figure B3-1. The pinout for the DeviceNet port is shown below:

Pin #	Signal Name	Standard Wire Colors
1	V-	black
2	CAN_L	blue
3	Shield (drain)	bare
4	CAN_H	white
5	V+	red

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The Configuration (RS232) Port

There is an RS232 port on the lower front of the module as shown in Figure B3-1. This is used to connect to a PC in order to download a file representing your DeviceNet network.

Pin #	Signal Name	In/Out
2	Receive Data	In
3	Transmit Data	Out
5	Ground	In/Out

LEDs

The two configuration port LEDs and DeviceNet port LEDs are described below.

Port	LED	Color	State	Definition
DeviceNet	**Network status**	Green	OFF	Off-line
			ON	On-line and connected to at least one node
			Flashing	On-line and connected to at least one node
		RED	ON	Unrecoverable Fault (dupicate MAC ID check failed, critical bus fault, etc.)
			Flashing	I/O connections in timed-out state or other Recoverable Fault
	Scanner status	Green	OFF	No power or else reset asserted
			ON	Scanner OK and active
			Flashing	Scanner OK but not active
		Red	ON	Hardware or software error
			Flashing	Recoverable configuration error (invalid data downloaded)
		Orange	ON	Configuration (download) mode
Configuration	**IN**	Red	Flickering	Data is being passed to the module
			OFF	No data to the module
	OUT	Red	Flickering	Data is being passed from the module
			OFF	No data from the module

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Theory of operation

The DeviceNet scanner module provides a memory image of the nodes (slaves) connected to a DeviceNet network. It is this memory image that is controlled by your LDO created in PiCPro. The module's on-board processor continually transfers data between this memory image and the actual DeviceNet nodes.

Communication between the DeviceNet module and the nodes can be set at 125 Kbaud, 250 Kbaud, or 500 Kbaud. The baud rate, the relationship between the memory image and specific data in each node, and other parameters are established with configuration software run in an external PC.

This configuration software generates two files. One file is downloaded to the DeviceNet module through its RS232 serial port. The other file is used by PiCPro to establish the relationship between the memory image and the declared variables in the LDO. To ensure that a given location in the memory image is connected to a variable in the LDO and to the corresponding data in the DeviceNet node, the same tag name or label must be used.

For example, when running the configuration software, PROX_SW1 could be used as the name for the boolean bit representing a DeviceNet proximity switch's logic state. The name PROX_SW1 must also be used for the corresponding variable in your LDO.

NOTE

The G&L DeviceNet configuration software (G&L Part No. M.1017.4267) is required to configure the DeviceNet scanner (within the DeviceNet module) for the devices on the associated network.

IMPORTANT

Additional information about DeviceNet can be obtained from www.odva.org.

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Specification Table

Characteristics	DeviceNet Module Specifications
Function	Interfaces to a DeviceNet network with up to 63 other nodes
Part number	M. 1016.9720 (old # 502-04157-98)
DeviceNet Port	Phoenix style 5-pin male connector
Configuration Port	RS232 interface
Logic side power requirements (typical)	275 mA @ 5 V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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B.4 - ETHERNET™ - TCP/IP Module

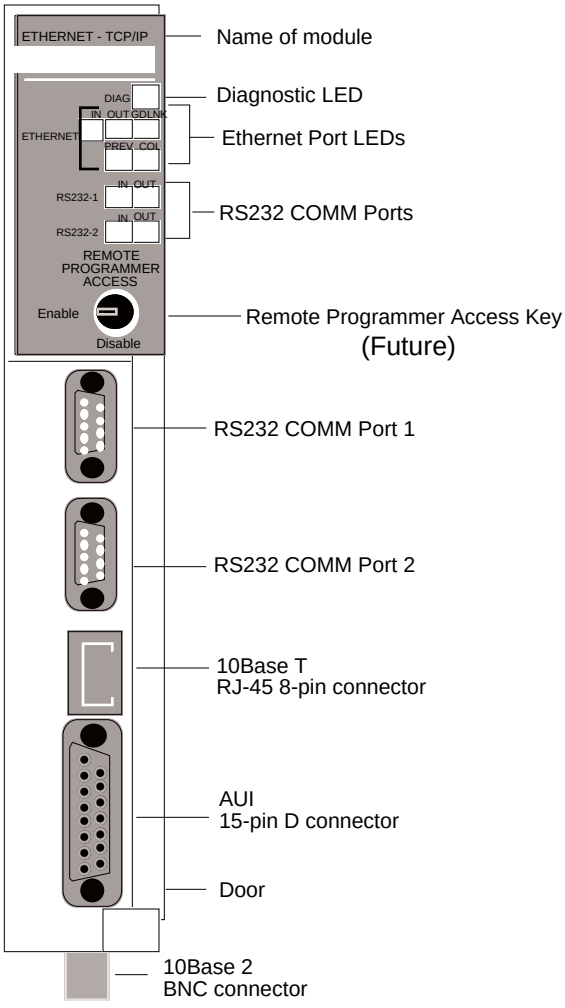
Introduction

The ETHERNET - TCP/IP module provides the PiC with Ethernet access and Internet connectivity. Connections for 10Base T, 10Base 2, and AUI (Attachment Unit Interface) are provided following the IEEE 802.3 specification. The data transfer rate is 10 Mbps. Applications can range from connecting several PiCs, connecting groups of PiCs and PCs, or connecting to a system that includes Internet access.

At the end of this document is a partial list of Internet links to useful information about Ethernet and TCP/IP networking.

The Remote Programmer Access key (future feature) will allow you to enable/disable PiCPro for Windows running over Ethernet. The DIAG LED goes on briefly while the diagnostic tests are running shortly after power is applied.

Figure B4-1. Ethernet - TCP/IP Module



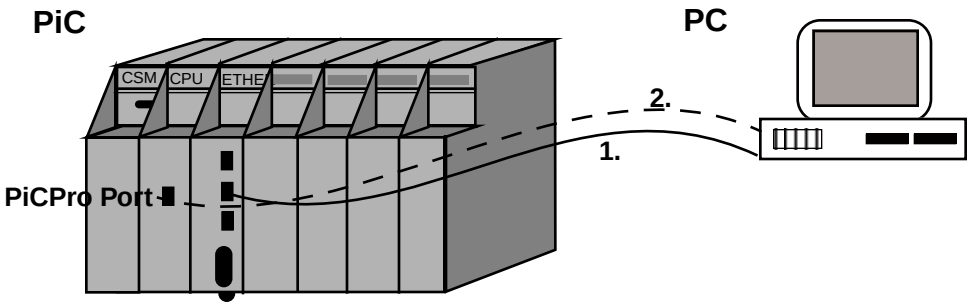
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Connections

The PiCPro cable is used to make a connection between the PC and the PiC.

1. Connect the PC to the RS232 Com 2 Port on the Ethernet - TCP/IP module to download the TCP/IP configuration file.
2. Connect the PC to the PiCPro Port on the CPU to download the application LDO.

Figure B4-2. PiC/PC Connections



You may choose one of three connection choices to set up your Ethernet - TCP/IP system.

1. 10Base T (10 Mbps, baseband, over twisted pair cable)
2. AUI (Attachment Unit Interface, over shielded twisted pairs of wires with an overall shield covering these individual shielded wire pairs)
   NOTE: The 15-pin AUI connector does not have the traditional slide lock clip. Instead, #4-40 screw lock bushings are provided. If you want to use a standard transceiver cable, remove the slide lock posts from the male end of the cable. Plug the cable into the AUI connector and secure with #4-40 screws. A screw retainer kit with captivation clips is available from AMP (part number 205980-1). A 20 inch ribbon cable is available from Giddings & Lewis for connecting to microtransceivers. It has the advantage of allowing the access door on the Ethernet - TCP/IP module to close.
3. 10Base 2 (10 Mbps, baseband, over thin coaxial cable)

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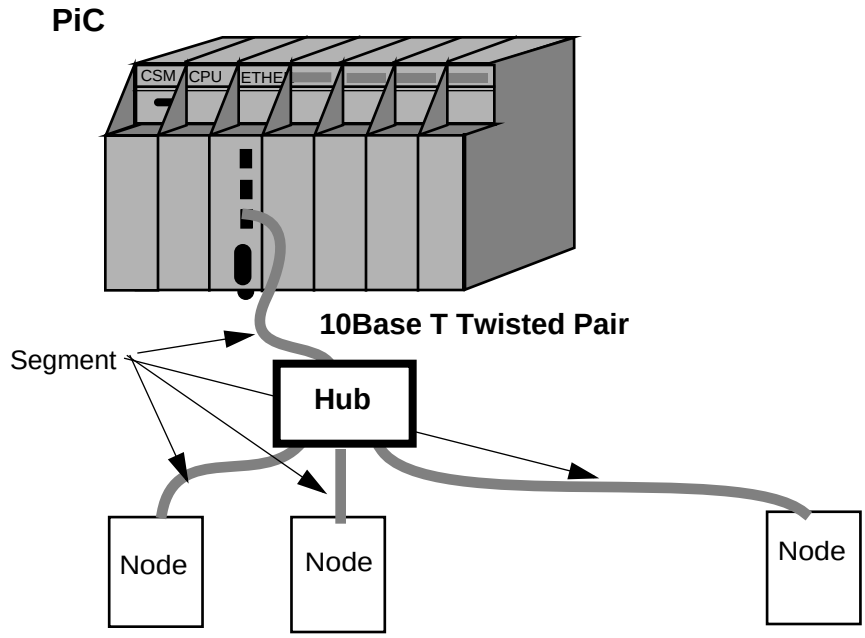
The table below summarizes the specifications (IEEE 802.3) for the Ethernet connections available on the Ethernet - TCP/IP module.

	Connections		
	10Base T	**AUI**	**10Base 2**
Type of Cable	Category 3 or 5 (5 recommended) UTP (unshielded twisted-pair) Shielded category 5 cable is optional.	78 Ω shielded twisted-pair transceiver	RG-58 thinnet coaxial
Connection	RJ-45	DB-15	BNC T connector
Terminator resistance Ω	NA	NA	50
Topology	Star bus	Point to Point	Bus
Distance	100 m (328’) between transceiver (TCP/IP module) and hub	50 m	Minimum of 0.5 m (23") between computers, maximum of 185 m (607’)
Maximum cable segment length	100 m (328’)	50 m (164’)	185 m (607’)
Computers per segment	NA	NA	30

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A typical 10Base T connection is shown below.

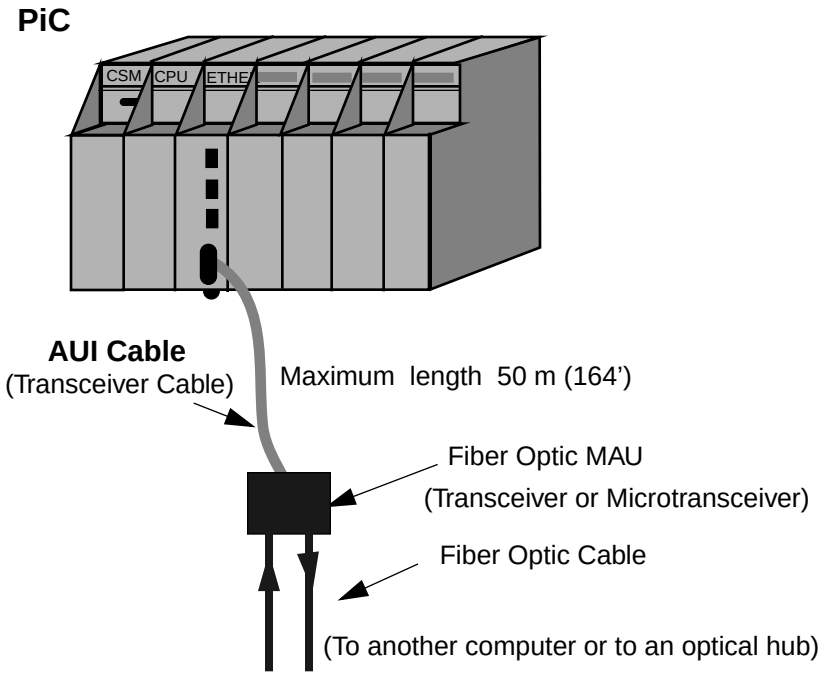
Figure B4-3. Ethernet - TCP/IP 10Base T Connections



Maximum segment length is 100 m (328').

A typical AUI connection is shown below.

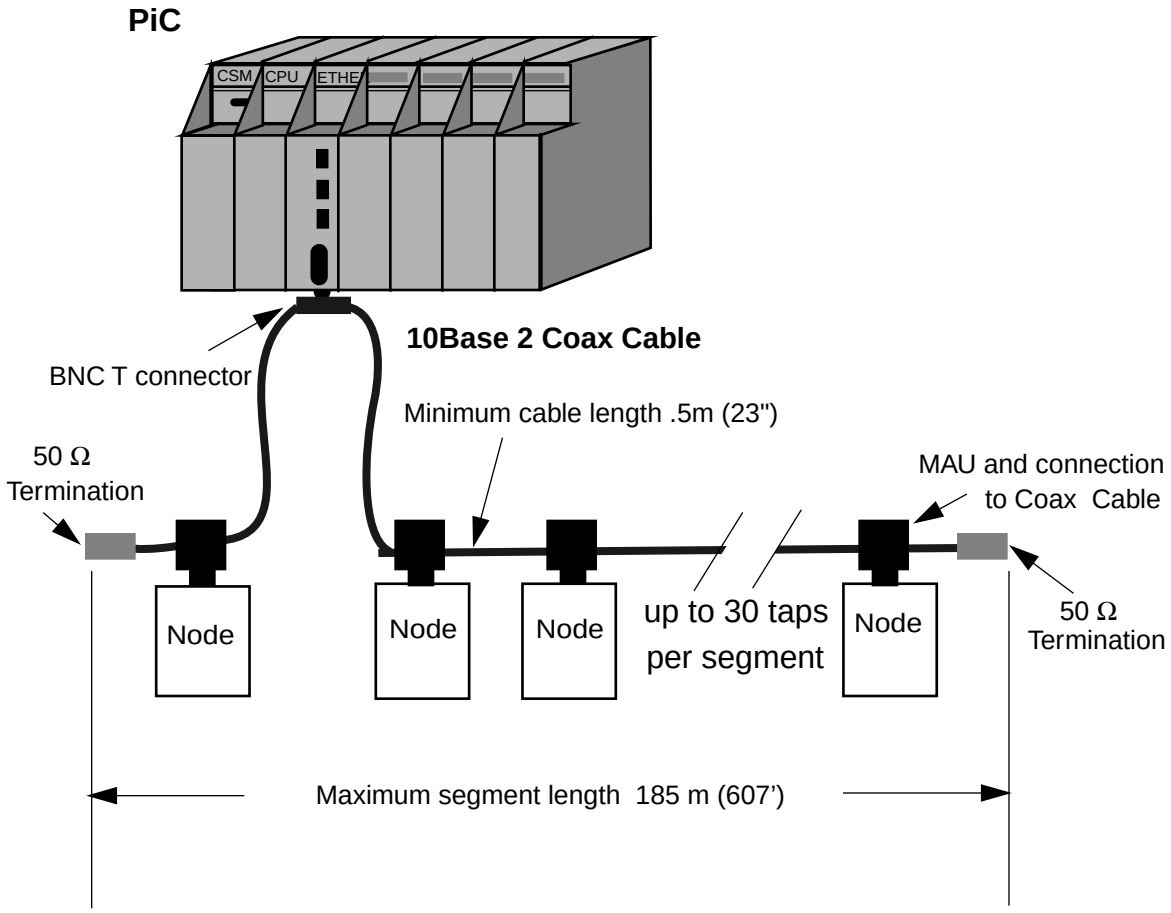
Figure B4-4. Ethernet - TCP/IP AUI Connections



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A typical 10Base 2 connection is shown below.

Figure B4-5. Ethernet - TCP/IP 10Base 2 Connections



The Ethernet Ports

There are three ethernet ports on the module as shown in Figure 4-3. One of these ports may be used to make your ethernet connections depending on the type of medium you are using.

The 10Base-T port uses a RJ-45 style 8-pin connector using 100 Ω unshielded twisted pair category 3 or 5 (IEEE 802.3 section 14.4). The maximum length of the twisted pair cable segment is 100 m (328 ft.). NOTE: The connector is also suitable for shielded cable and will ground the shield to the chassis.

The AUI connection uses a shielded D style 15-pin connector using 78 Ω shielded twisted pair cable (IEEE 802.3 section 7.4.3). The maximum length of the twisted pair cable is 50 m (164 ft.).

The 10Base-2 (found on the bottom of the module) uses a BNC style coax connector and 50 Ω coax (IEEE 802.3 section 10.5). The maximum length of the coax cable is 185 m (607 ft.).

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The RS232 COMM Ports

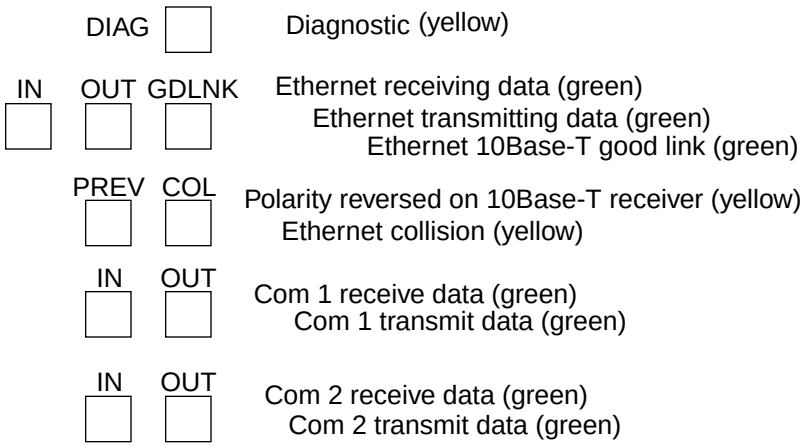
There are two RS232 ports at the top of the module as shown in Figure 4-3. COMM 1 will be used for modem connections (future). COMM 2 is used to download your configuration file to the PiC.

Pin #	Signal Name	
2	Receive Data	RX
3	Transmit Data	TX
5	Ground	Gnd
7	Ready to send	RTS
8	Clear to send	CTS

LEDs

There are nine LEDs on the Ethernet - TCP/IP module in addition to the DIAG LED. They are located directly under the DIAG LED as shown below.

Figure B4-6. Ethernet - TCP/IP LEDs

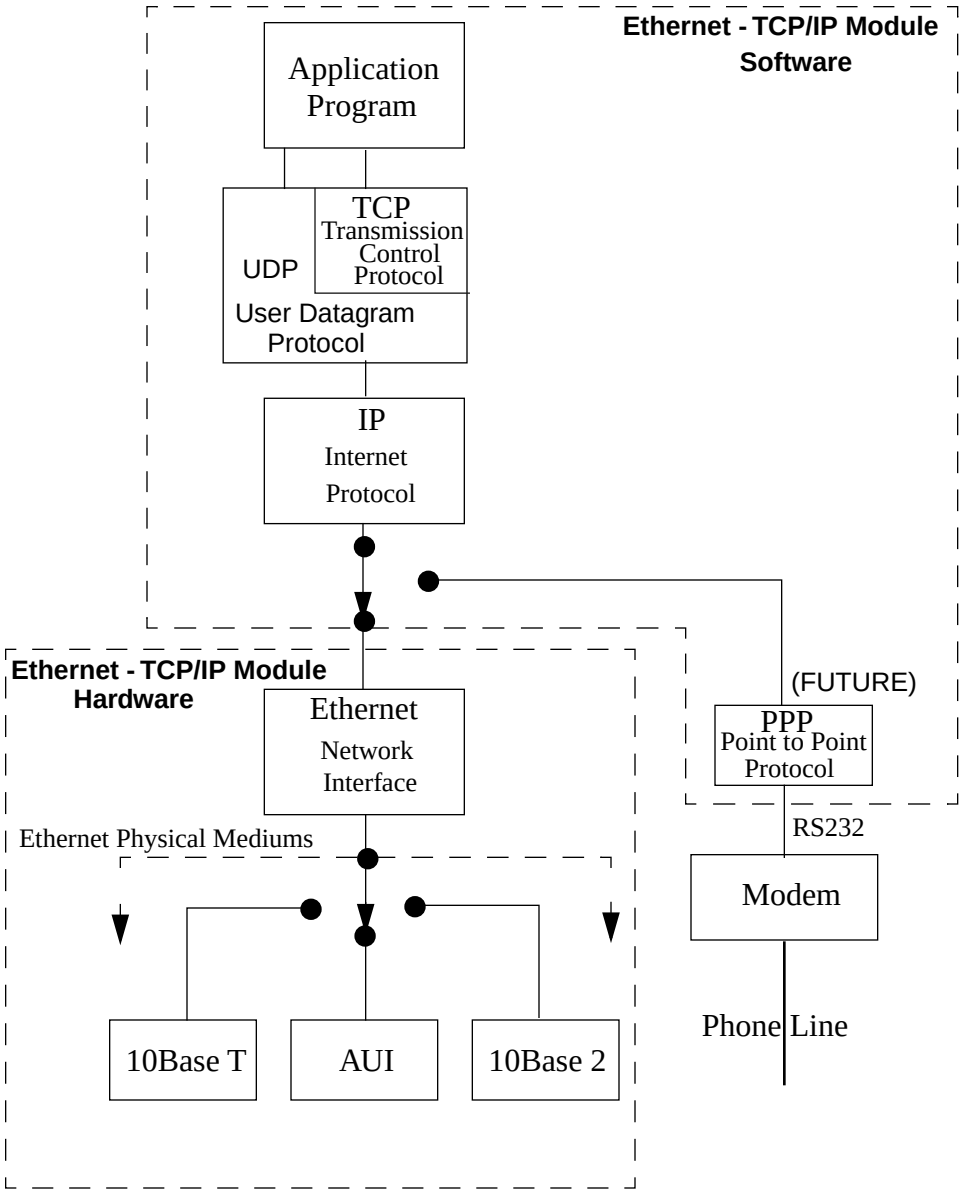


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Theory of operation

The Ethernet - TCP/IP module contains a 32-bit processor to handle TCP/IP, PPP (future), and Ethernet protocols. It allows you to use the Ethernet network architecture and the TCP/IP standard set of protocols to communicate and access other modules, computers, or the Internet and its resources. The topology alternatives include linear bus and star bus. The CSMA/CD (Carrier Sense Multiple Access with Collision Detection) access method is used to regulate traffic on the main cable segment. The design is based on the IEEE 802.3 specifications. The data rate is 10 Mbps. The diagram below provides an overview.

Figure B4-7. Ethernet - TCP/IP Overview



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Specification Table

Characteristics	Ethernet - TCP/IP Module Specifications
Function	Provides the PiC with Ethernet access and Internet connectivity
Part number	502-04137-00
RS232 Port 1	Com Port 1 modem (future)
RS232 Port 2	Com Port 2 (for firmware and configuration loading)
10Base T	RJ-45 8-pin connector Maximum twisted pair length is 100 m (328 ft.).
AUI	15-pin D connector Maximum twisted pair length is 50 m (164 ft.).
10Base 2	BNC connector Maximum coax cable length is 185 m (607 ft.).
Logic side power requirements (typical)	+5V @ 1250 mA +15V @ 30 mA maximum -15V @ 30 mA maximum
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
EMC Compliant Emissions Noise immunity	 Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8KV air discharge) per IEC 1000-4-2 • RF electromagnetic fields per IEC 1000-4-3 • Electrical fast transients per IEC 1000-4-4 on incoming power lines Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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Useful Internet Links

http://www.3com.com/technology/tech_net/white_papers/500698.html#6
http://www.library.ucg.ie/Connected/Course/index.htm
http://www.combsnet.com/cable/Basics/types.html
http://www.jdltech.com/solutions/Standards_Terms.cfm
http://www.jdltech.com/solutions/LAN_terms.cfm
http://www.datatech.com/hot/w96_2.htm
http://www.standards.ieee.org/catalog/IEEE802.3.html
http://www.3com.com/nsc/glossary/main.htm
http://www.alliedtelesyn.com/prd_tran.htm#microtrans
http://www.lothlorien.net/collections/computer/ethernet_frames.html
http://www.lantronix.com/htmfiles/mrktg/catalog/etntba.htm
http://www.warehouse.com/datacomm/

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B.5 - Profibus Module

Introduction

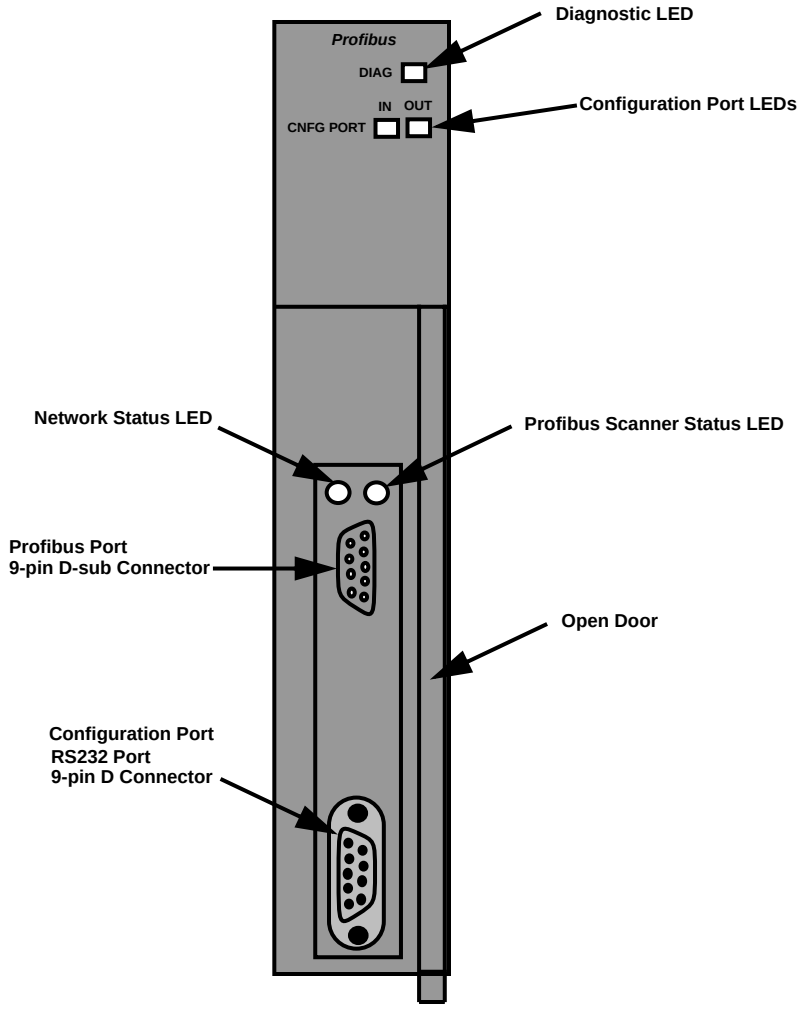
The PiC900 Profibus scanner module is an interface between the PiC and a Profibus network. The module contains an on-board processor, a Profibus compliant interface, and firmware that makes it act as the master to all nodes assigned to it on the network.

Prior to initial operation, a file is generated with specific configuration information in an external PC. This file must be downloaded via the RS232 configuration port to the Profibus scannerProfibus module prior to initial operation. Two indicator LEDs (IN/OUT) are connected to this configuration port.

Directly above the Profibus port are two LEDs that provide operation information; Network Status and Profibus Scanner Status.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure B5-1. Profibus Module

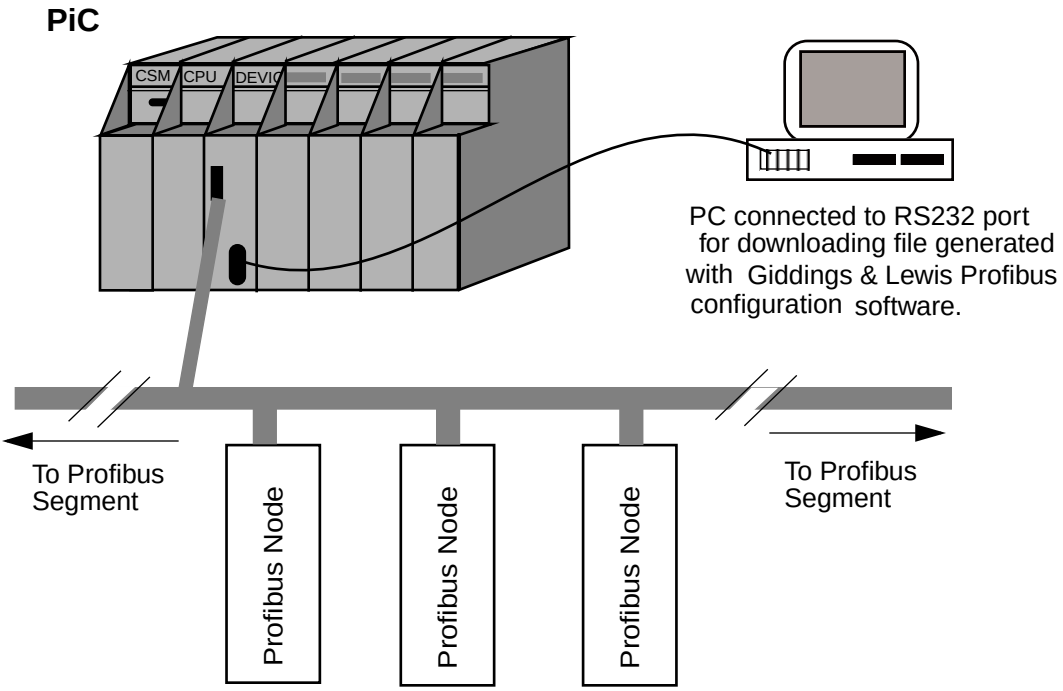


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Connections

Profibus connections are illustrated in Figure B5-2. Up to 31 Profibus nodes, without repeaters, may be attached to the Profibus scanner. Up to 125 other Profibus nodes, using repeaters, may be attached to the Profibus scanner module.

Figure B5-2. Profibus Connections



The Profibus Port

The Profibus port is on the front of the module near the center as shown in Figure B5-1. The pinout for the Profibus port is shown below:

Pin #	Signal Name
1	Chassis ground
2	reserved
3	data +
4	Tx enable
5	Isolated ground
6	voltage plus
7	reserved
8	data -
9	reserved

Note:
It is strongly recommended that you use Profibus Sub-D connectors wiht switchable (ON/OFF) termination, such as Siemans
6ES7 972-0BA11-0XA0 or
6ES7 972-0BB11-0XA0.

Only use Profibus type A cable, such as Belden 3079A or Siemens 6XV1 830-0AH10.

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The Configuration (RS232) Port

There is an RS232 port on the lower front of the module as shown in Figure B5-1. This is used to connect to a PC in order to download a file representing your Profibus network.

Pin #	Signal Name	In/Out
2	Receive Data	In
3	Transmit Data	Out
5	Ground	In/Out

LEDs

The two configuration port LEDs and the two Profibus port LEDs are described below.

Port	LED	Color	State	Definition
Profibus	**Network status**	Green	OFF	Off-line
			ON	On-line and connected to at least one node
		Red	ON	On-line but bus error present (baud rate or wiring problem)
	Scanner status	Green	OFF	No power or else reset asserted, interface closed
			ON	Scanner OK and active (interface open)
		Red	ON	Interface open, at least one slave faulted
		Orange	ON	Configuration (download) mode
Configuration	**IN**	Red	Flickering	Data is being passed to the module
			OFF	No data to the module
	OUT	Red	Flickering	Data is being passed from the module
			OFF	No data from the module

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Theory of operation

The Profibus scanner module provides a memory image of the nodes (slaves) connected to a Profibus network. It is this memory image that is controlled by your LDO created in PiCPro. The module's on-board processor continually transfers data between this memory image and the actual Profibus nodes.

Communication between the Profibus module and the nodes can be set between 9600 baud (1200m max.) and 12M baud (100m max.) The baud rate, the relationship between the memory image and specific data in each node, and other parameters are established with configuration software run in an external PC.

This configuration software generates two files. One file is downloaded to the Profibus module through its RS232 serial port. The other file is used by PiCPro to establish the relationship between the memory image and the declared variables in the LDO. To ensure that a given location in the memory image is connected to a variable in the LDO and to the corresponding data in the Profibus node, the same tag name or label must be used.

For example, when running the configuration software, PROX_SW1 could be used as the name for the boolean bit representing a Profibus proximity switch's logic state. The name PROX_SW1 must also be used for the corresponding variable in your LDO.

IMPORTANT

Additional information about Profibus can be obtained from www.profibus.com.

NOTE

The G&L Prorfibus configuration software (G&L Part No. M.1300.7794) is required to configure the Profibus scanner (within the Profibus module) for the devices on the associated network.

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Specification Table

Characteristics	Profibus Module Specifications
Function	Interfaces(acts as DP Master - Class 1), to a Profibus network with up to 125 other nodes, using repeaters
Part number	M.1300.7050
Profibus Port	Phoenix style 5-pin male connector
Configuration Port	RS232 interface
Logic side power requirements (typical)	275 mA @ 5 V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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Appendix C - Discrete I/O Modules

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C.1 - Output 24V DC Source Module (32 or 16 points)

Introduction

The output 24V DC module sources voltage for individual loads from one or more DC power supplies. Each external supply is nominally 24 volts, but can be between 5 and 32 volts. It is available in the following configurations.

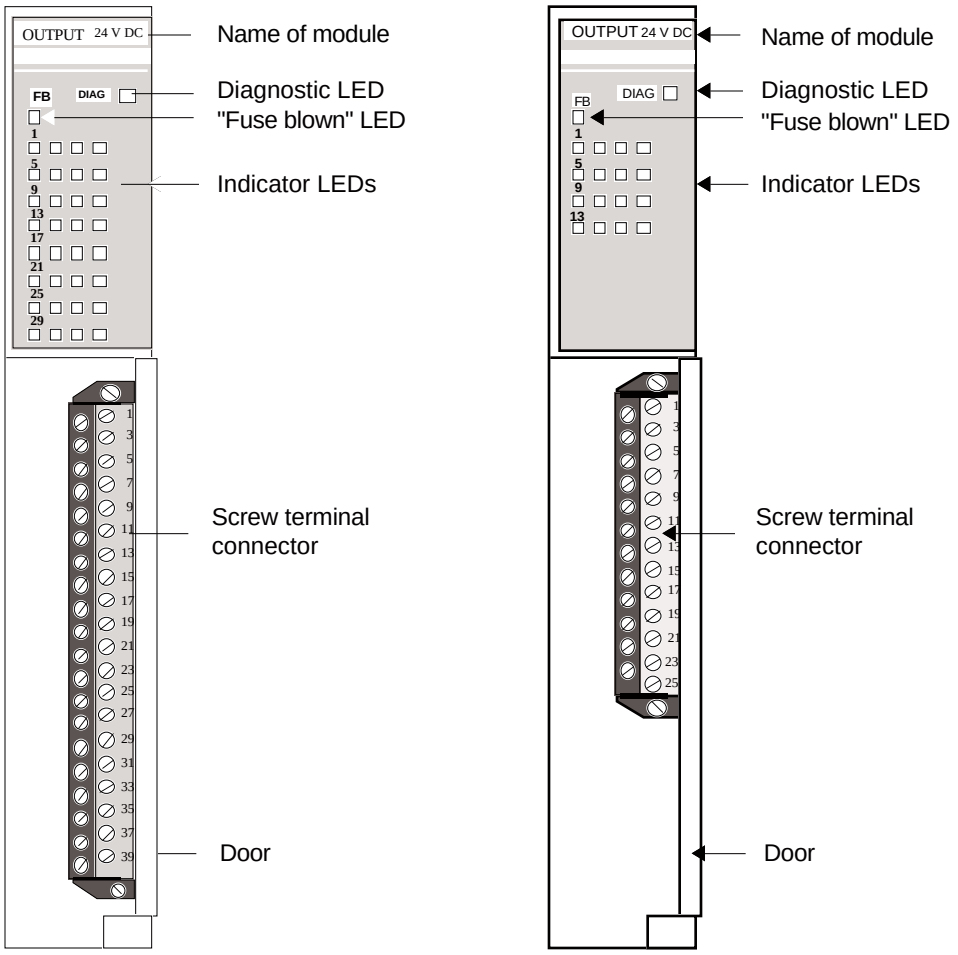
1. 32 point 24V DC output module
2. 16 point 24V DC output module

32 or 16 LEDs in the upper section of the module indicate the logic state that drives each output. Another LED labeled FB turns on if the fuse in any active circuit is open or missing.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure C1-1. OUTPUT 24V DC source module

32 point **16 point**



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Connections

A screw terminal connection is provided for each output and for each external power supply connection. The outputs are isolated in four groups of eight or four with two additional terminals per group for the DC HOT and COMMON. (See Figure C1-2.)

The external DC supply that powers the output signals should have a wire connected from its 0V (COMMON) terminal directly to the single point ground used for the system rack. Its power disconnect switch should be the same one used for the system rack. In the power distribution diagrams in Chapter 1, a 24V DC supply was set up according to these guidelines.

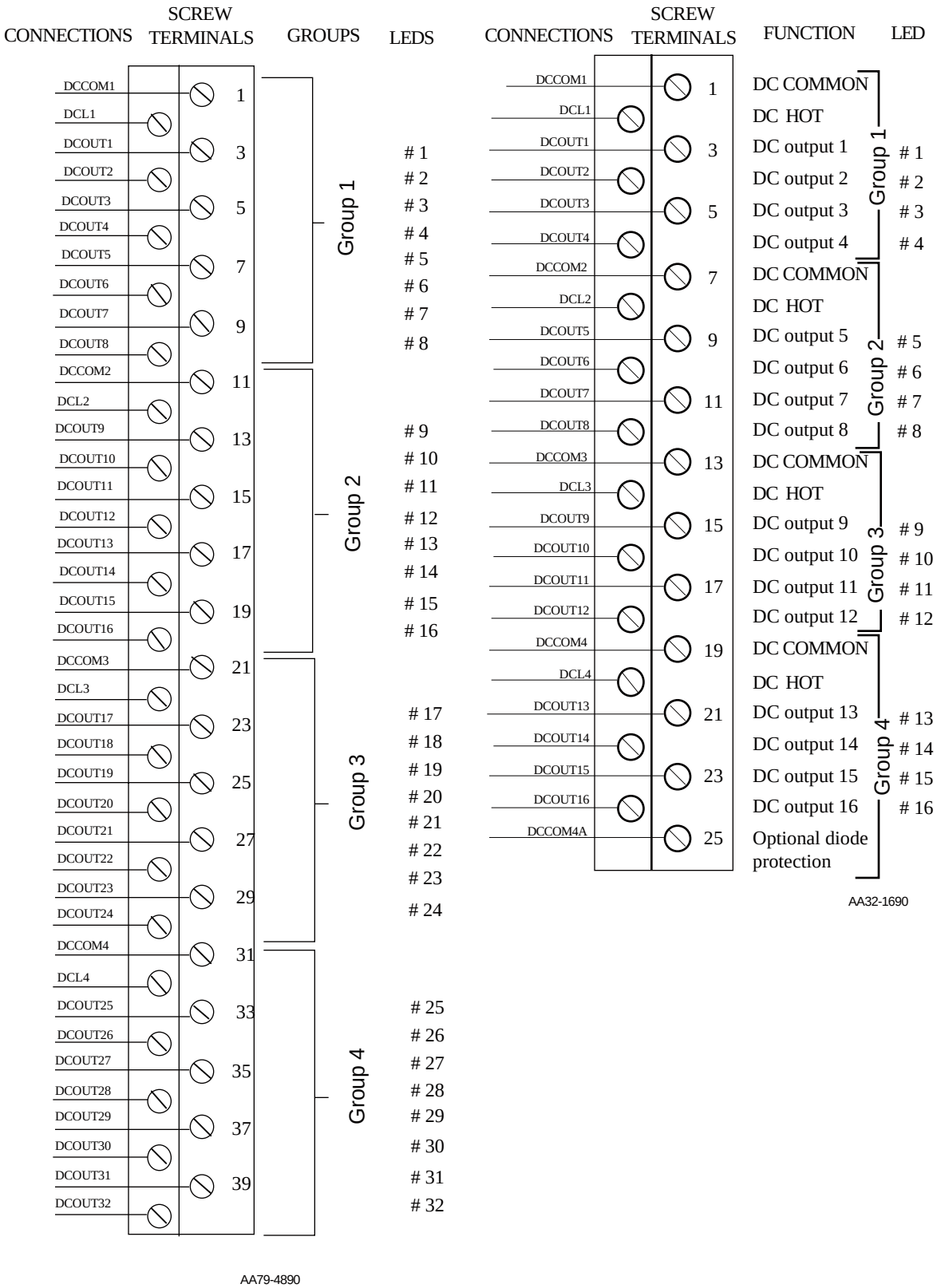
The DC power supply for each group of eight or four devices may be different if required. In most cases one power supply is daisy-chained to all groups.

IMPORTANT

Do not connect the DC HOT and COMMON to a group unless you plan to use one or more of its outputs.

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Figure C1-2. Screw Terminal Connection Assignments



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Each group has its own fuse. The "fuse blown" LED circuit is active for all groups that have a power supply connected.

Connections for one group of outputs are illustrated in Figure C1-3 and C1-4.

The common side of each load must be connected to the 0V terminal of the supply. This 0V terminal is connected to the SPG used by the system rack.

Figure C1-3. Connections for One Group of Outputs (32 pt module)

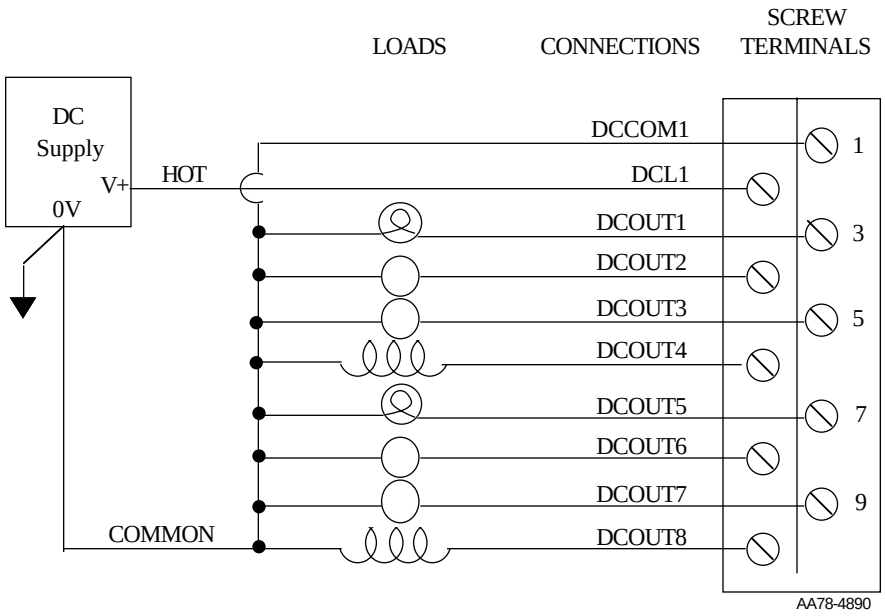
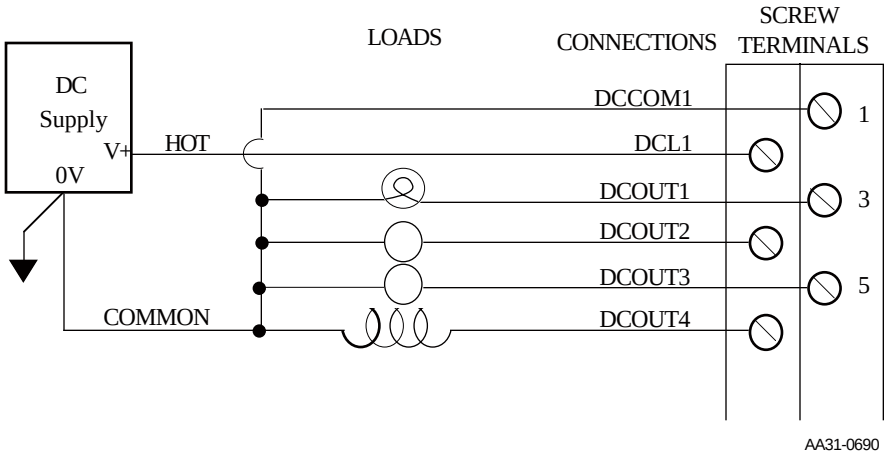


Figure C1-4. Connections for one group of outputs (16 pt module)



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Theory of Operation

Each output point is a solid state switch rated at .4 A for the 32 point module and .75A for the 16 point module. It turns on or off according to the logic state sent to it by the CPU. If the CPU sends it a logic 1, the switch closes and the device is powered. If the CPU sends a logic 0, the switch opens and power to the device is cut off. The CPU updates the logic state for each switch every time it scans the program.

The logic side of the switch is optically isolated from the field side. An LED gives the logic state of each switch. If you need to know whether voltage is actually present at the field side, use a voltmeter on the terminal screws.

Each group has its own protective fuse in series with the source to protect against current overload in case the outputs are shorted to ground. In addition, each output is protected with internal clamping diodes. Without clamping, high voltage transients (kickback) from inductive loads might damage the module.

Protecting from an Inductive Load

Resistive loads can be connected to the module and controlled by the system with no precautions other than making sure they have a connection to the common of the DC power supply. When an output is energized, represented in Figure C1-4a by a closed switch, current passes through the load into the common line. When the output is de-energized, represented in C1-4b by an open switch, current stops. The state of the outputs is controlled by the CPU module.

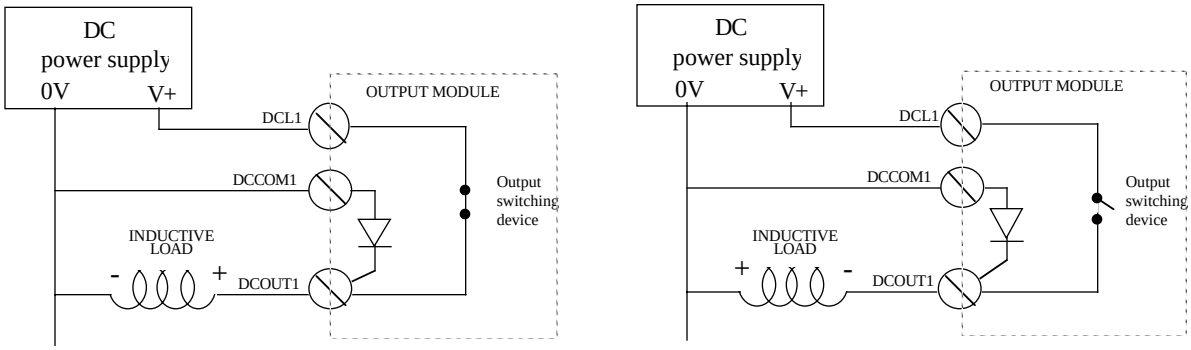
Inductive loads have an electrical "kickback" when current is stopped. This can damage or destroy the output switching device. Each output in the Output 24V DC module has a diode through which reverse current can be safely routed.

Figure C1-5 shows how the internal diode works with an inductive load. When the output is turned off the inductive field collapses. This creates a reverse voltage across the load called "kickback" which tries to continue the current. The voltage is in series with the DC power supply. The combined voltage appears across the output switching device in the module.

If this were the only path available, voltage across the device would peak at several hundred volts. The internal diode provides another path for current. This limits the peak reverse voltage across the load to less than 1 V. Every switch in the Output 24V DC module has this protection so you can connect an inductive load to any terminal.

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Figure C1-5. Diagram of Internal Protection for Inductive Loads



a) Output energized

b) Output de-energized

AA33-0690

External Zener Diode on 16 Point Module

In some cases such as a fast-switching device, the energy from an inductive load may need to be discharged more quickly than the built-in diode allows. The fourth group of outputs on the 16 point module allows you to provide an optional path through an external zener diode. A zener diode gives a higher voltage return path than an ordinary diode does.

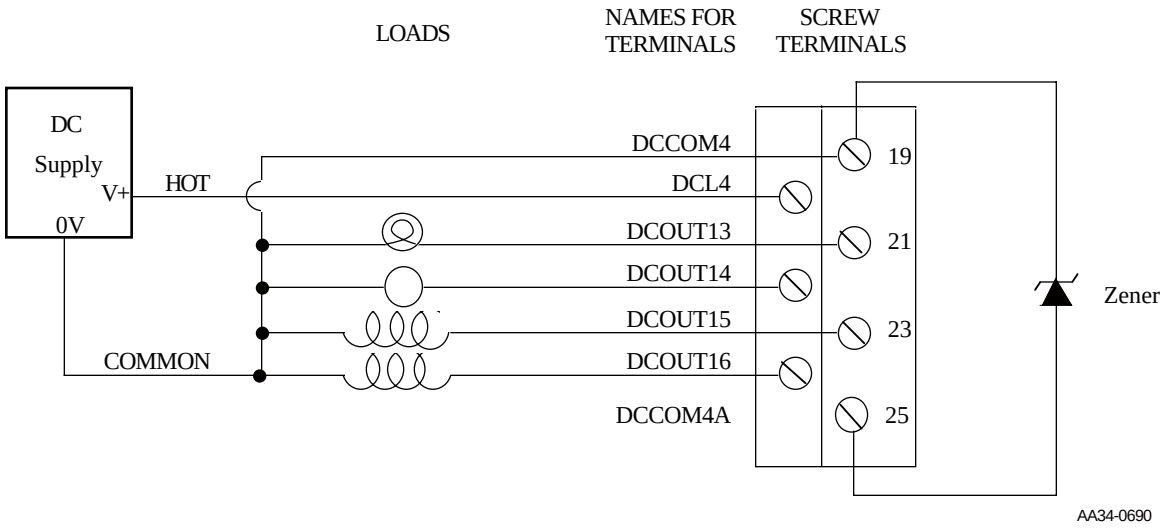
This fourth group has the anode side of the clamping diodes brought out to allow for this quicker discharge. As shown in Figure C1-6 you can connect a zener diode (rated up to 30 V) externally, between the common of the fourth group of outputs and this extra terminal. That is, connect the cathode side of the zener to terminal 19, the common of the fourth group of outputs, and connect the anode to terminal 25.

IMPORTANT

You must use either a jumper or a zener diode between terminals #19 and #25 any time the fourth group of outputs is in use with inductive load(s).

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Figure C1-6. External Zener Diode for Fast-Switching Inductive Loads (Outputs 13 to 16 on the 16 point Module)



Replacing a fuse

This module has four fuses, one for each group of outputs. Fuses are checked only for groups which have external power applied. If power is applied to a group in which the fuse is blown or missing, the FB LED on the module's upper segment lights up. The fuse is in series with the HOT line to the group, to protect the output switching device and the load.

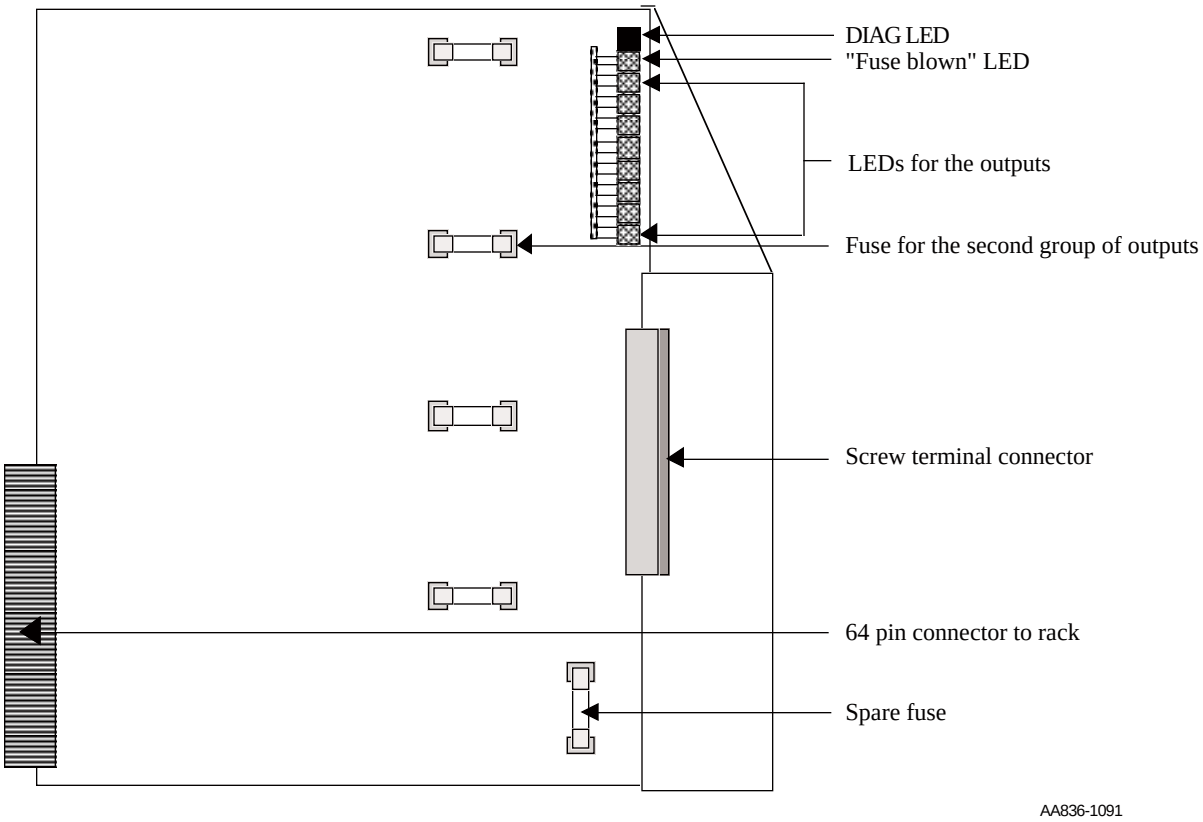
The fuse protects against a short circuit in an output device, but not against a sustained marginal overload current. See the specification table at the end of this section.

Follow the procedure below to change a blown fuse.

1. Turn off the main disconnect switch for the system rack and the external DC power supply to this module. Remove the screw terminal connector.
2. Press down the latch at the top of the OUTPUT 24V DC module and pull it out of the rack. Lay it on a static-free surface, label side up. Ground yourself using an antistatic wrist strap before you open the module.
3. Press the plastic tabs at the top and bottom of the module toward each other and lift off the module cover.

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Figure C1-7. Positions of Fuses



4. Identify the fuse that has blown, and use an insulated screwdriver or fuse puller to remove it. Put a new fuse in its slot. The replacement must be a fast-acting 3A 250 VAC fuse. The following are recommended:

   Littlefuse 235-003

   Bussman GMA-3

   or an equivalent.

   For your convenience, there is an extra fuse in the lower front corner of the module.

5. Replace the module cover, making sure that the top and bottom tabs are fully engaged.

6. Check the wiring to the devices to find why the fuse blew, and correct the situation before you continue running the program.

7. Slide the module back in its slot, connect the screw terminal connector, and turn power back on. After the diagnostic tests run, the DIAG and the FB LEDs should both be off.

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Specification Table

Characteristic	Output 24V DC module specifications
Function	Sources an external DC supply to 16/32 loads
Part number	32 point 502-03640-02 16 point 502-03549-02
DC source requirements	Nominal 24V DC; range 5 to 32 VDC
Field side connector	32 point 40-pin card edge connector, screw terminals 16 point 25-pin card edge connector, screw terminals
Protection of logic circuits	Optical isolation between the logic and field side
Grouping of outputs	Four groups of 8 or 4 solid-state switches. Each group may use its own DC supply, or one supply may be daisy-chained. UL 508 spacing
Fuse per group of 8 switches	Fast-acting, UL rated 3A 250 VAC metric fuse, 5 x 20 mm
Maximum current per group	2 A of continuous current for the group; 32-point - each switch is rated at .4 A continuous 16 point - each switch is rated at .75 A continuous
Indicator lights, output circuits	An LED for each output
Indicator light, module	A DIAG LED turns OFF when the module passes its diagnostic tests at power-on
Indicator light, fuses	A logic side LED lights to indicate a "blown fuse" condition when power is on to a group with missing or open fuse
Switch characteristics	Solid-state switches
Time delay on for resistive loads	30 µsec max
Time delay off for resistive loads	300 µsec max
Leakage current in off state	0.5 mA max
Switch voltage, maximum ON	32 point 1.8 VDC @ .4 A 16 point 1.6 VDC @ .75A
Surge current, maximum	32 point 2.5 A for 40 msec., every 2 seconds 16 point 5 A for 40 msec, every 2 seconds; fuse blows if this is exceeded
Response to scan loss	All outputs are reset to the OFF state

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Logic side power requirements (typical)	1 mA @ +5V 32 point 25 mA per energized output @ +5V 16 point 23 mA per energized output @ +5V
Field side power dissipation, worst case (at 32 VDC)	15.8 W
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch). 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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C.2 - Input 24V DC Module (32 or 16 points)

Introduction

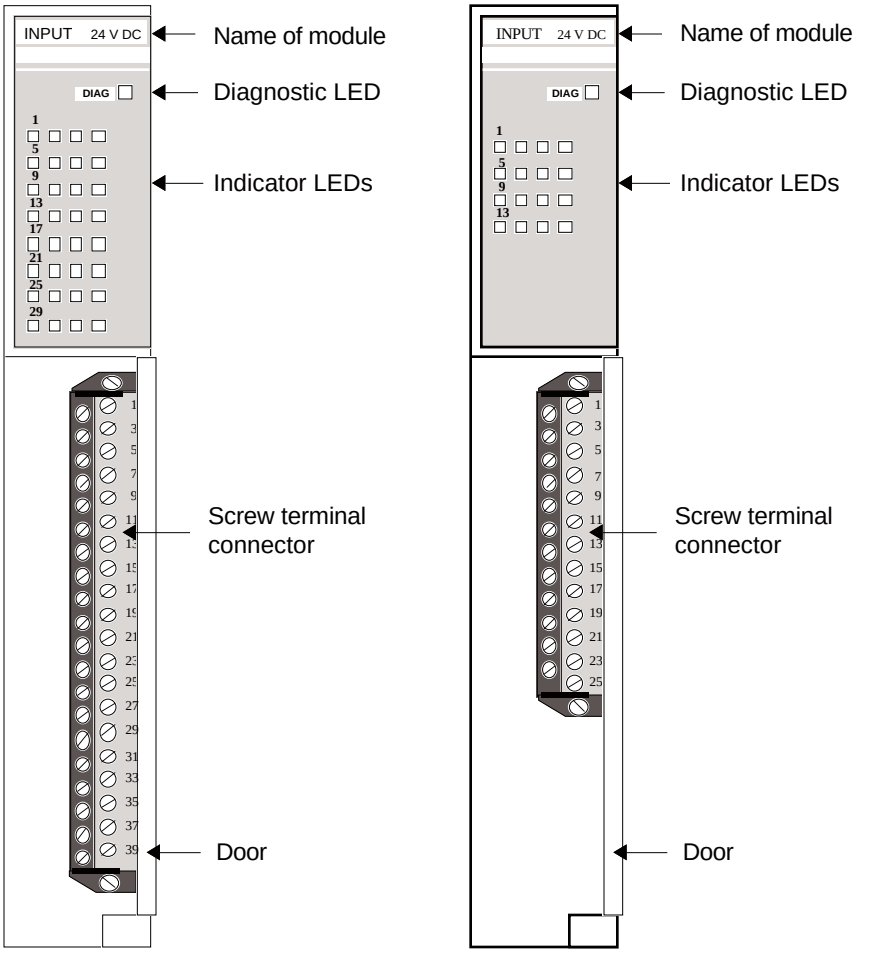
The input 24V DC module converts DC signals from devices into logic levels that the CPU can use. Each signal is converted into a corresponding logic 1 or 0 which is transmitted through the system bus to the CPU module. An "on" signal is nominally 24 VDC, but can be any level between 14 and 30 volts. An "off" signal is any level below 5V. The wiring configurations may be sink or source.
The module is available in the following configurations.

1. 32 point 24V DC input module
2. 6 point 24V DC input module

32 or 16 LEDs in the upper section of the module indicate the logic state of each input. The DIAG LED goes on briefly while the diagnostics tests are running.

Figure C2-1. INPUT 24V DC Module

32 point **16 point**



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Connections

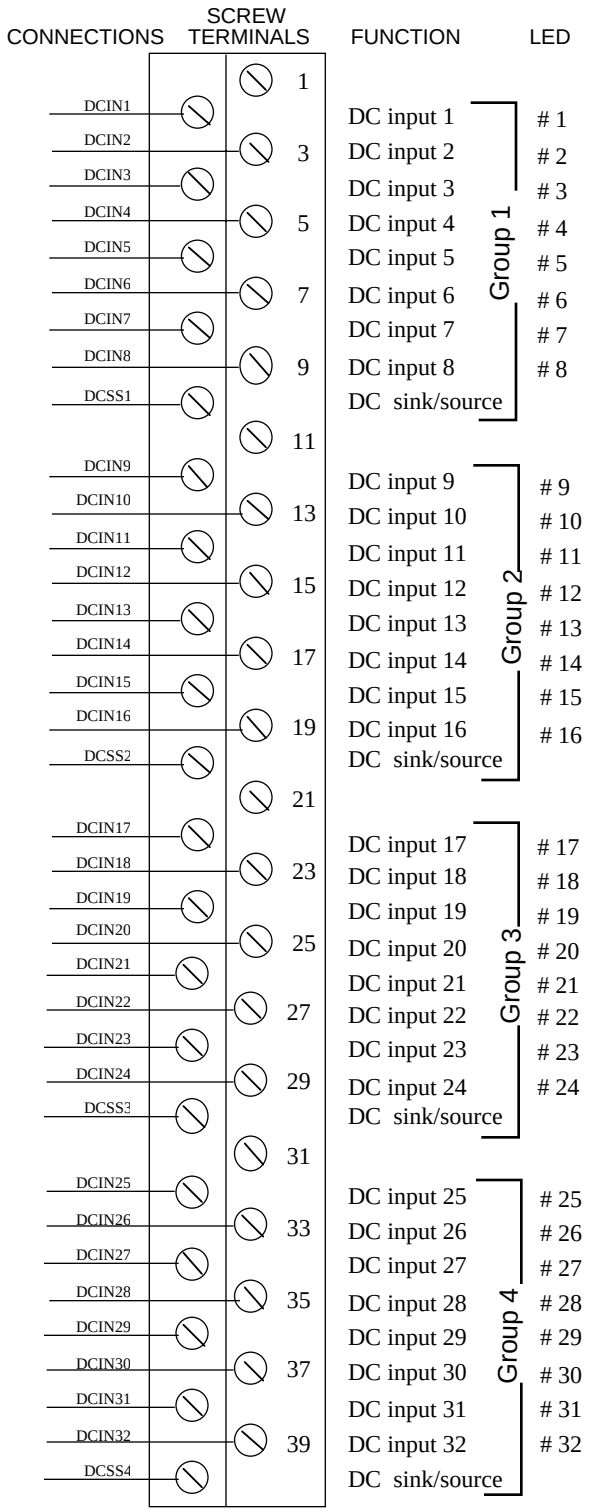
A screw terminal connector is provided for each input and for each external power supply connection. The inputs are isolated in four groups of eight or four, with one additional terminal per group for the DC source/sink connection. The devices connected to terminals in the same group have a common DC supply and are wired in the same configuration, sink or source.

The external DC supply that powers the input signals should have a wire connected from its 0V (COMMON) terminal directly to the single-point ground used for the system rack. Its power disconnect switch should be the same one used for the system rack. In the power distribution diagrams in Chapter 1, a 24 VDC supply is set up according to these guidelines.

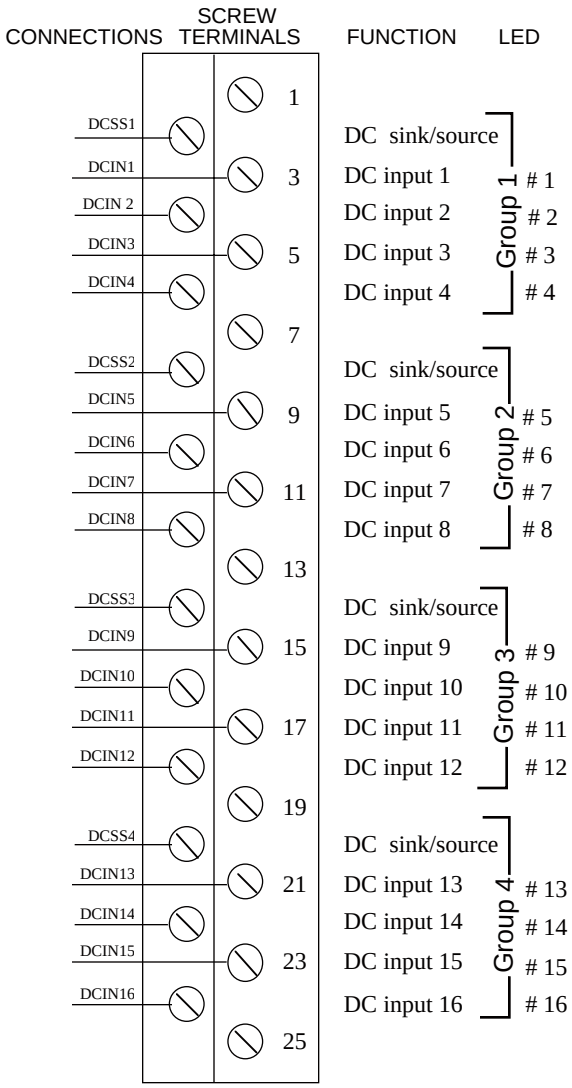
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Figure C2-2. Screw Terminal Connector Assignments

32 point



16 point



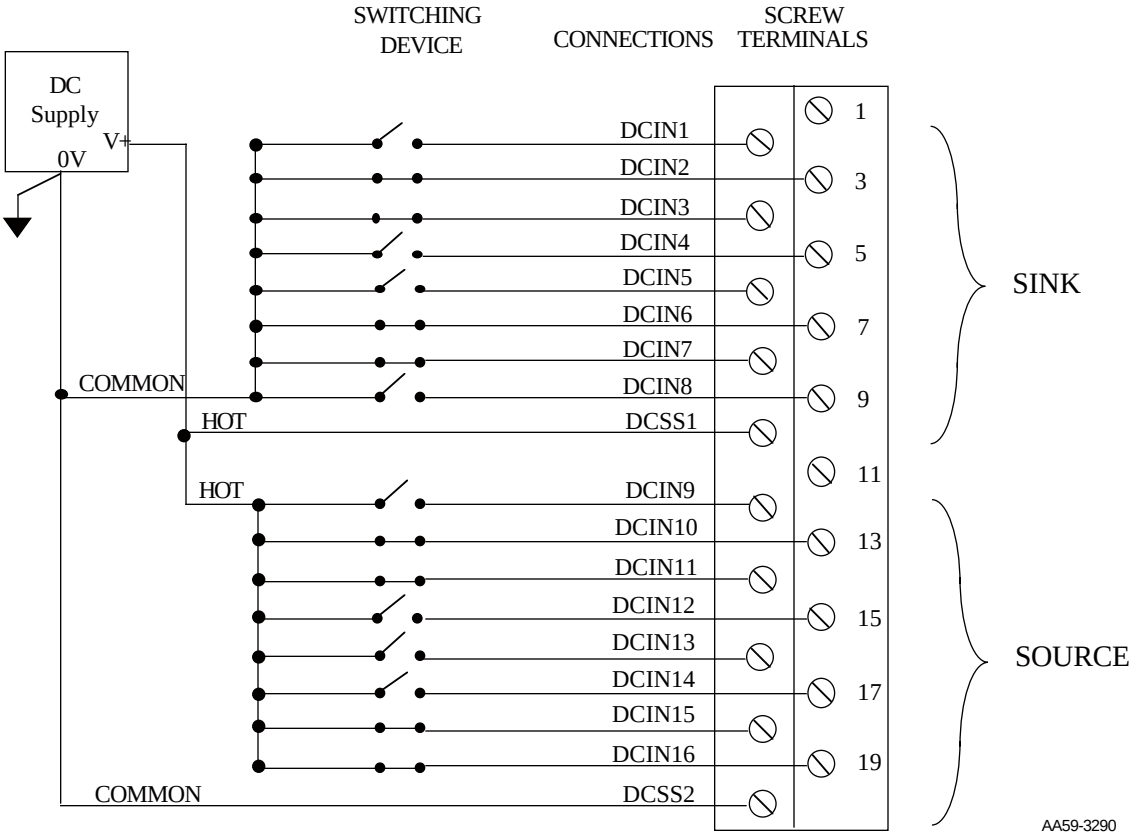
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Figure C2-3 and C2-4 illustrates two groups of inputs using the same power supply.

Each group can work independently of the others; some groups may be sink and others source. The DC power supply for each group may be different if required. Typically just one DC power supply is used, daisy-chained from one group to the next.

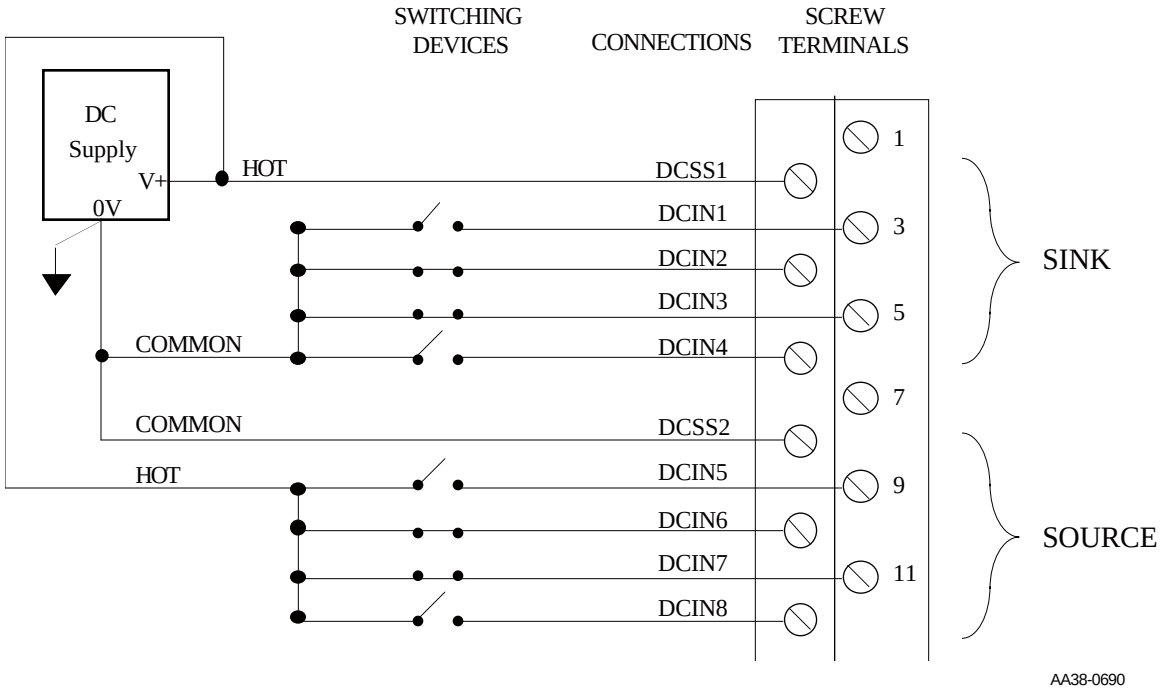
The first group of eight inputs is shown with devices "sinking" current through the DC Input module. The HOT terminal of the power supply must be connected to the module at DCSS1. The second group of eight inputs are shown with devices "sourcing" current through the input module. The COMMON terminal of the power supply must be connected to the module at DCSS2. In this example the DC power supply is the same for both groups.

Figure C2-3. Connectors for Two Groups of Inputs (32 point module)



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Figure C2-4. Connectors for Two Groups of Inputs (16 point module)



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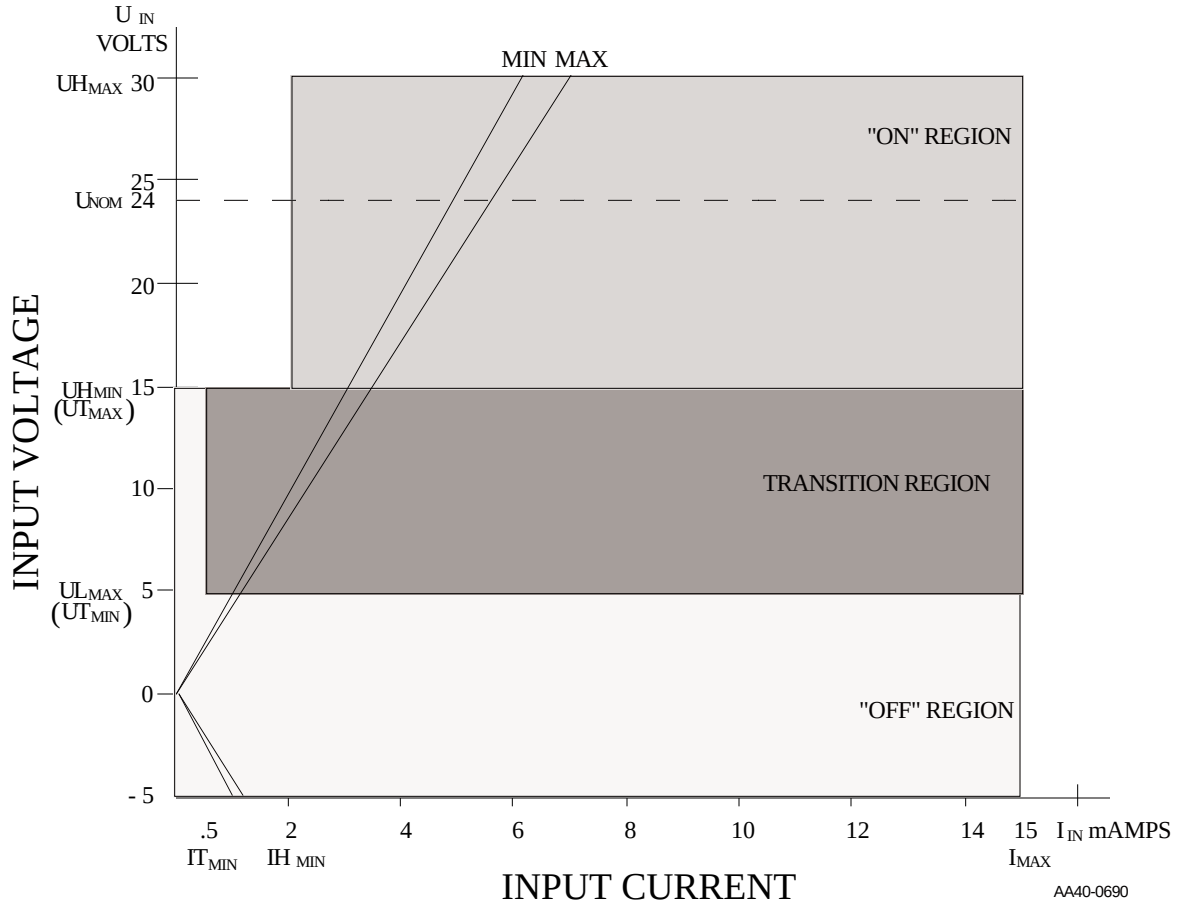
Theory of Operation

Each input is guaranteed "on" at 14 to 30 VDC and guaranteed "off" at 0 to 5 VDC; polarity doesn't matter. Its on/off state is converted to a corresponding logic 1 or 0. This logic state is transmitted through the system bus to the CPU module, where the processor uses it as data in the ladder program. The logic side of the input is optically isolated from the field side.

An LED in the upper section of the module indicates the logic state of each input. Each group is represented by a horizontal row of 4 LEDs. If you need to know whether voltage is present at the field side, use a voltmeter on the terminal screws.

The shaded blocks in Figure C2-5 show the limits specified by the IEC. The lines show the maximum and minimum V/I of the inputs in this module. The voltage/ current curve in this graph shows that the input module is well within the IEC Type 1 limits.

Figure C2-5. Input Characteristics Compared to IEC Standards



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IMPORTANT

Switching devices can sometimes have a leakage current that exceeds the IT_{min} (current allowed when off) of an input module. In order to use such a device, an impedance (typically, a resistor) needs to be used in parallel with the input.

For example, some of the newer proximity switches use two wires instead of three. The third wire was used for a power or ground line. Without the third wire, the switch is easier to install. However, it requires more leakage current in the off state to power its internal circuitry.

As a conservative estimate, use the following formula to calculate an external resistance value. It keeps the input voltage at or below 2.4V when the switching device is in the "off" state.

$$\frac{2.4V}{\text{Switch Leakage} - 0.75mA} \geq R$$

If the switch leakage specification is ≤ 1.7 mA, then:

$$\frac{2.4V}{1.7 - 0.75mA} \geq 2.5K\Omega$$

Use a resistor less than or equal to 2.5 K Ω. Be sure that the wattage is adequate for the resistor when the switching device is in the "on" state remembering that:

$$P = \frac{V^2}{R}$$

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Specification Table

Characteristic	Input 24V DC module specifications
Function	Monitors on/off states from DC voltage inputs
Part number	32 point 502-03605-00 16 point 502-03548-00
Field side connector	32 point 40-pin card edge connector, screw terminals 16 point 25-pin card edge connector, screw terminals
Input signals (exceed IEC standards)	Nominal 24 VDC on, 0 VDC off, conforming to IEC Type 1 inputs per IEC 1131-2 (four groups of eight or four inputs)
UH Max (max. allowed voltage)	30 VDC
IH Max (max. current @ 30 VDC)	7.5 mA
UL Min	Polarity independent
Guaranteed on	14 VDC
IH Min (min. current @ UH Min)	2.8 mA
Guaranteed off	5 VDC
IT Min (current allowed when off)	.75 mA
Time delay on	1 ms max.
Time delay off	1 ms max.
Protection of logic circuits	Optical isolation between the logic and field sides, 4000V peak
Indicator lights, input circuits	An LED indicates the logic state of each input
Indicator light, module	The DIAG LED goes OFF when the module passes power-on diagnostic tests
Logic side power requirements (typical)	32 point 29 mA @+5V 7 mA per energized input @+5V 16 point 2mA @+5V 7mA per energized input @+5V
Field side power dissipation, worst case	32 point 7.2W 16 point 3.6W
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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NOTES

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C.3 - Output 120/240V AC Module (32 or 16 point)

Introduction

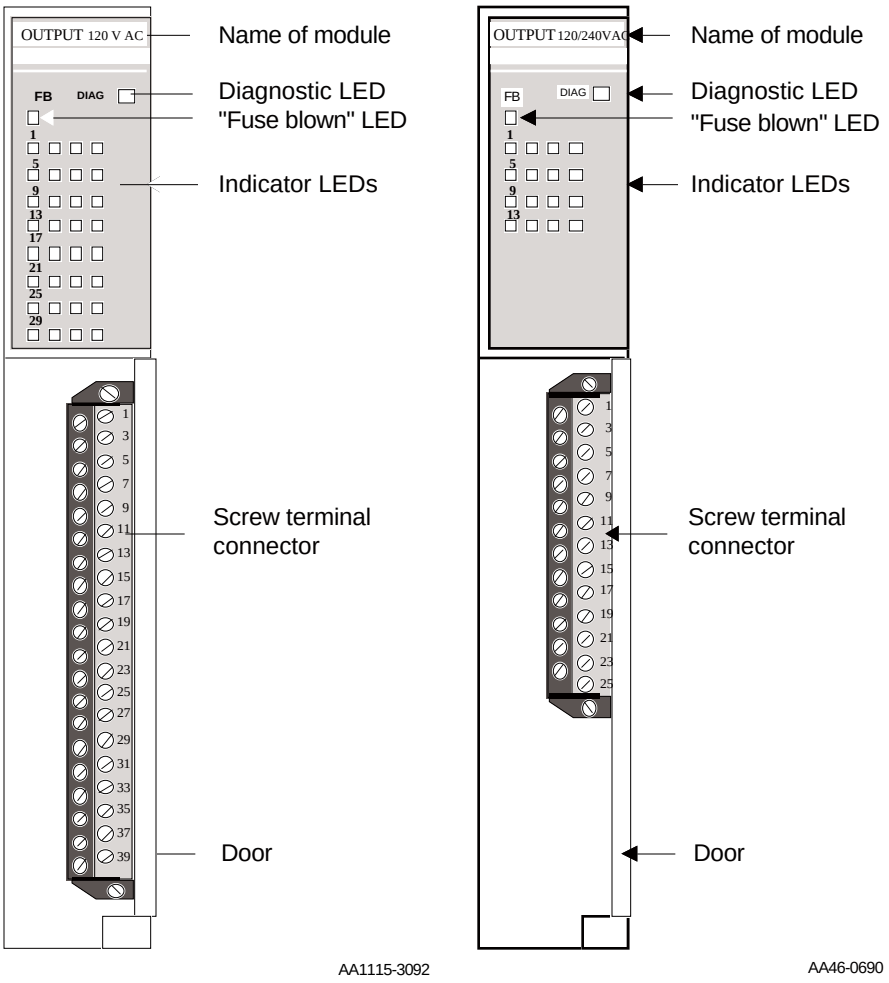
The 120/240V output module switches voltage for individual loads from one or more AC power sources. Each external AC source is nominally 115 VAC, but can be between 48 and 240 volts. It is available in the following configurations;

1. 32 point 120/240V AC output module
2. 16 point 120/240V AC output module

32 or 16 LEDs in the upper section of the module indicate the logic state that drives each output. Another LED labeled FB turns on if the fuse in any active circuit is open or missing.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure C3-1. OUTPUT 120/240 VAC Module



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Connections

A screw terminal connection is provided for each output, and for each external power source connection. The outputs are isolated in four groups of eight or four, with two additional terminals per group for the AC HOT and COMMON. (See Figure C3-2.)

The external AC source for each group of 8 devices may be different if required. In most cases one power source is daisy-chained to each group.

The AC source should be connected to the single-point ground used for the system rack. Its power disconnect switch should be the same one used for the system rack. See the power distribution diagrams in Chapter 1 for two possible AC external source set-ups.

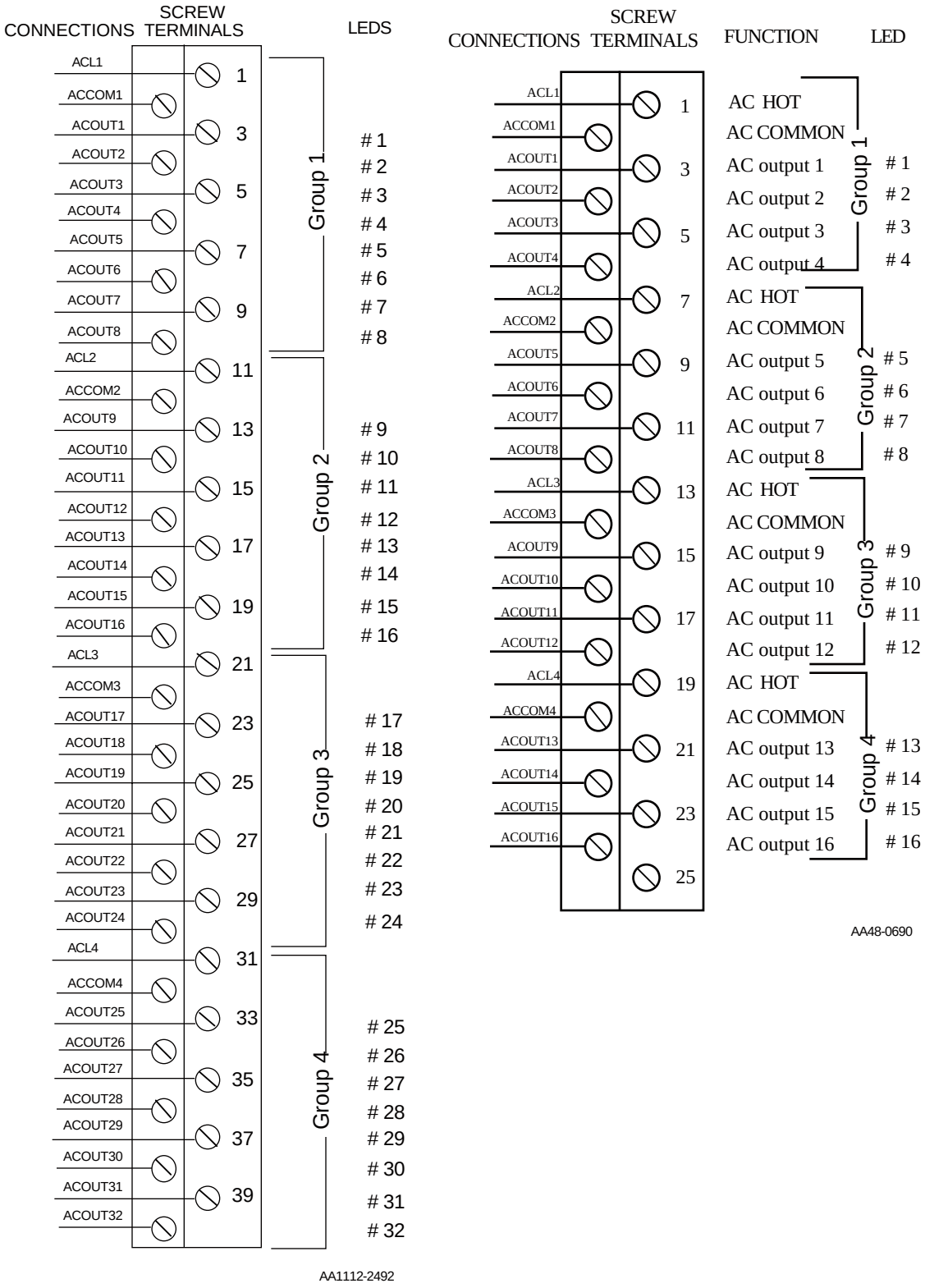
NOTE

Do not connect an AC HOT and COMMON to a group unless you plan to use one or more of its outputs.

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Figure C3-2. Screw Terminal Connector Assignments

32 point **16 point**



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Each group has its own protective fuse. The "fuse blown" LED circuit is active for all groups that have a power source connected.

Figure C3-3 and C3-4 illustrates the connections for one group of outputs.

The common side of each load must be connected to the COMMON of the AC source.

Figure C3-3. Connectors for One Group of Outputs (32 point module)

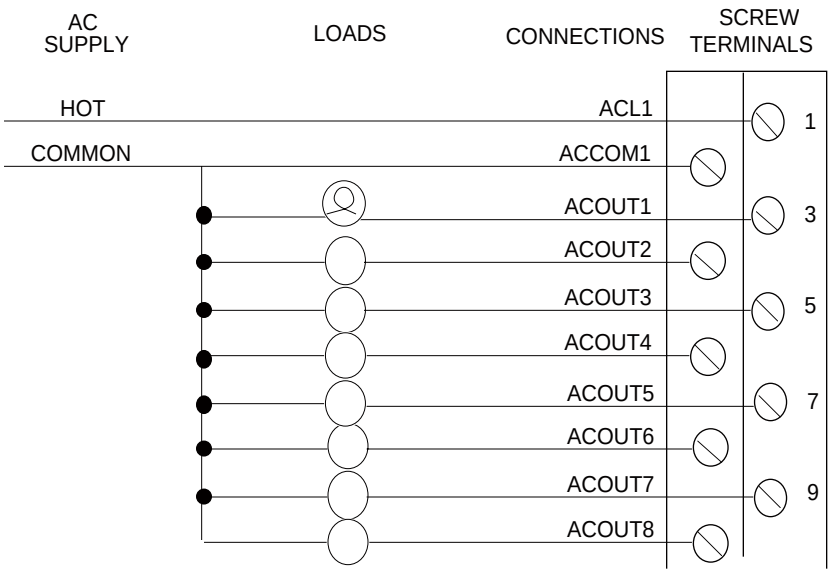
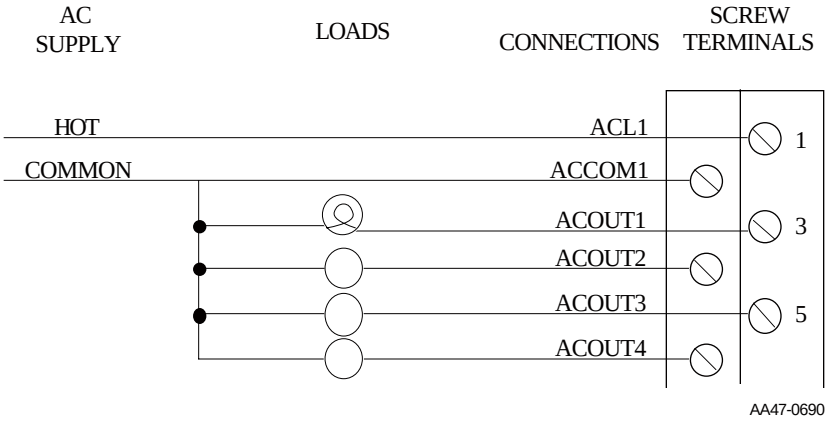


Figure C3-4. Connectors for One Group of Outputs (16 point module)



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Theory of Operation

Each output point is a solid state switch rated at .75A continuous for the 32 point module and 2A continuous for the 16 point module. It turns on or off according to the logic state sent to it by the CPU. If the CPU sends it a logic 1, the switch closes and the load is powered. If the CPU sends a logic 0, the switch opens and power to the load is removed. The CPU updates the logic state for each switch every time it scans the program.

The logic side of the switch is optically isolated from the field side. An LED gives the logic state of each output. If you need to know whether voltage is actually on at the field side, use a voltmeter on the terminal screws.

The output switch is turned on near the zero voltage crossing of the AC power source and is turned off at zero current.

Each group has its own protective fuse in series with the source to protect against current overload in case the outputs are shorted to ground.

Protecting from an Inductive Load

Arc suppression is not required for a non-inductive load or for an inductive load switched only by the Output 120/240V AC (32 pt) module.

If an inductive load is in series with an external switch or contact, an external arc suppresser is required as shown in Figure C3-5 and C3-6. When an inductive load is turned off it can generate a voltage spike which may peak at several thousand volts. Such a spike can cause erratic operation and may damage the module. You must place an arc suppresser across the inductive device to absorb the excess energy.

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Figure C3-5. Arc Suppression for a Switched Inductive Load (32 pt module)

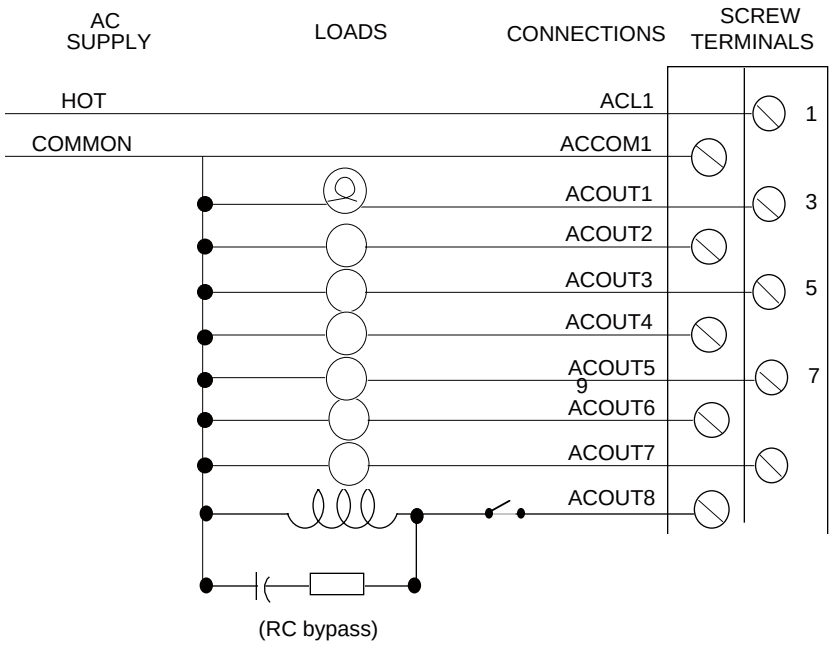
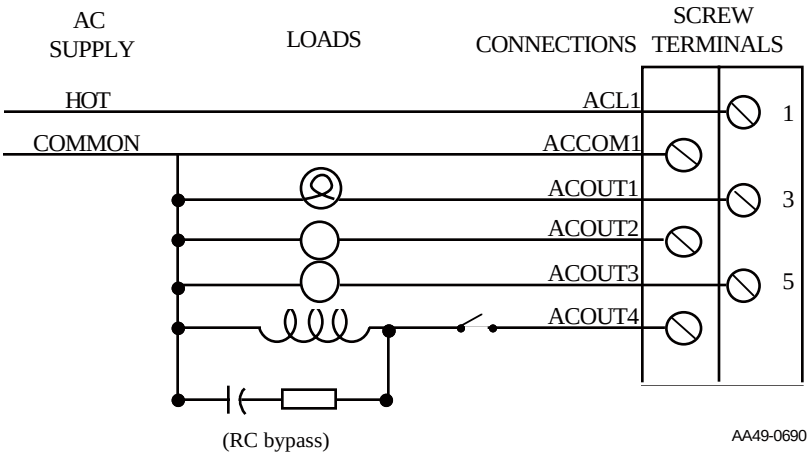


Figure C3-6. Arc Suppression for a Switched Inductive Load (16 pt module)



Specifications for the RC bypass:

resistor: 220 Ω 1 Watt
capacitor: 1.0 µF, 600 V

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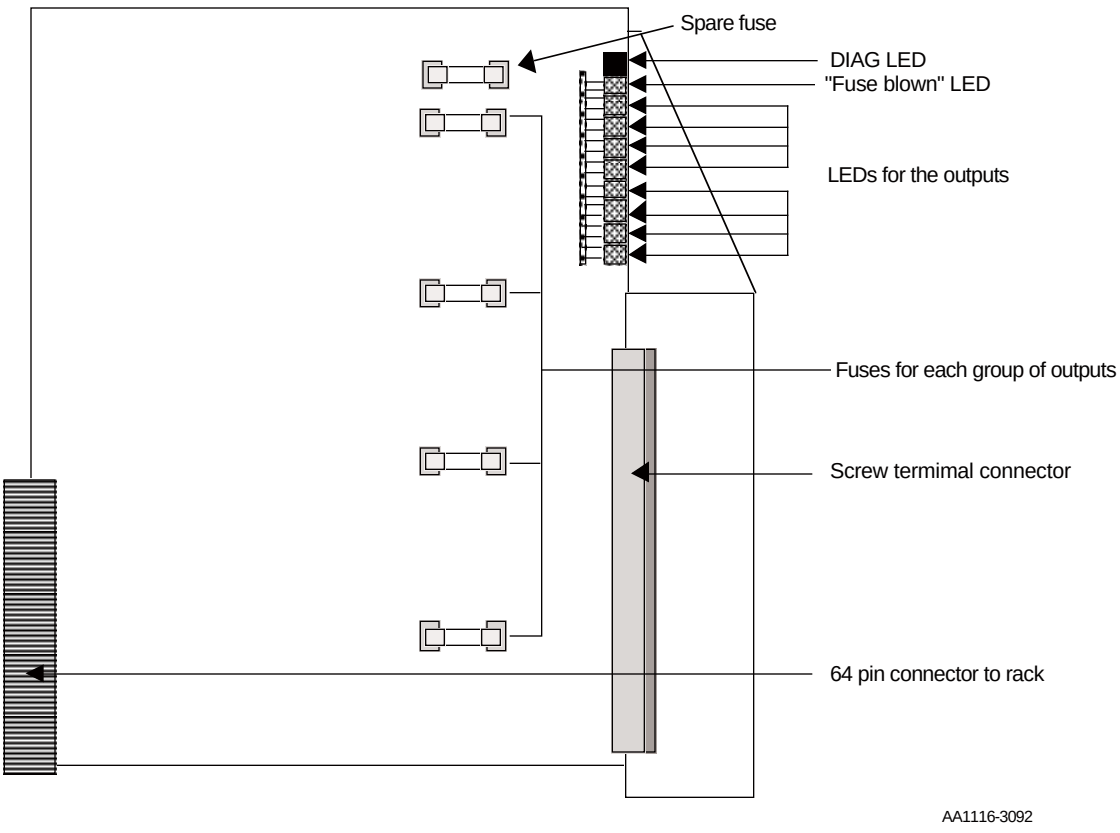
Replacing a Fuse

This module has four fuses, one for each group of outputs. Fuses are checked only for groups which have external power applied. If power is applied to a group in which the fuse is blown or missing, the FB LED on the module's upper segment lights up. The fuse is in series with the HOT line to the group, to protect the output switching device and the load.

The fuse protects against a short circuit in an output device, but not against a sustained marginal overload current. See the specification table at the end of this section.

1. Turn off the main disconnect switch for the system rack and the external AC power source to this module. Remove the screw terminal connector bar.
2. Press down the latch at the top of the OUTPUT 120/240V AC (32 pt) module and pull it out of the rack. Lay it on a static-free surface, label side up. Ground yourself using an antistatic wrist strap before you open the module.
3. Press the plastic tabs at the top and bottom of the module toward each other and lift off the module cover.

Figure C3-7. Position of Fuses



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4. Identify the fuse that has blown, and use an insulted screwdriver or fuse puller to remove it. Put a new fuse in its slot. The replacement fuse must be a fast-acting 3A 250 VAC fuse. The following fuses are recommended:

   Littlefuse 235-003
   Bussman GMA-3
   or an equivalent.

   For your convenience, there is an extra fuse in the lower front corner of the module.

5. Replace the module cover, making sure that the top and bottom tabs are fully engaged.

6. Slide the module back in its slot, and turn power back on. After the diagnostic tests runs, the DIAG and the FB lights should both be off.

7. Check the wiring to the devices to find why the fuse blew, and correct the situation before you continue running the program.

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Specification Table

Characteristic	Output 120/240V AC module specifications
Function	Switches an external AC source to 32 or 16 loads
Part number	32 point 502-03641-02 16 point 502-03551-02
AC source requirements	Nominal 115 VAC, range 48 to 240 VAC
Field side connector	32 point 40-pin card edge connector, screw terminals 16 point 25-pin card edge connector, screw terminals
Protection of logic circuits	Optical isolation between the logic and field side, 2830 VAC
Arrangement of outputs	Four groups of 8 or 4 solid-state switches. Each group can use its own AC source, or one source can be daisy-chained. UL 508 spacing
Fuse per group of 8	Fast-acting, UL rated 3A 250 VAC metric fuse, 5 x 20 mm
Maximum current per group	2 A of continuous current for the group; 32 point each switch is rated at .75 A continuous 16 point each switch is rated at 2 A continuous
Indicator lights, output circuits	An LED for each output
Indicator light, module	A DIAG LED turns OFF when the module passes its diagnostic tests at power-on.
Indicator light, fuses	A logic side LED lights to indicate a "blown fuse" condition when power is on to a group with a missing or open fuse.
Switch characteristics	Solid-state switches.
Switch voltage, maximum ON	32 point 1VAC @ .75A RMS 16 point 1.2VAC @ 2A RMS
Surge current, maximum	20 A for 2 cycles, every 2 seconds; fuse blows if this is exceeded.
Frequency	50 / 60 Hz. ± 5%
Time delay on, maximum	1/2 cycle (turns on at zero voltage)
Time delay off, maximum	1/2 cycle (turns off at zero voltage)
Minimum load current	50 mA
Leakage current in OFF state, maximum	4 mA @ 120 VAC 6 mA @ 240 VAC

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Response to scan loss	All outputs are reset to the OFF state
Logic side power requirements (typical)	32 point 1 mA @ +5V 7 mA per energized output @ +5V 16 point 1 mA @ +5V 23 mA per energized output @ +5V
Field side power dissipation, worst case	32 point 11.0W 16 point 12.0W
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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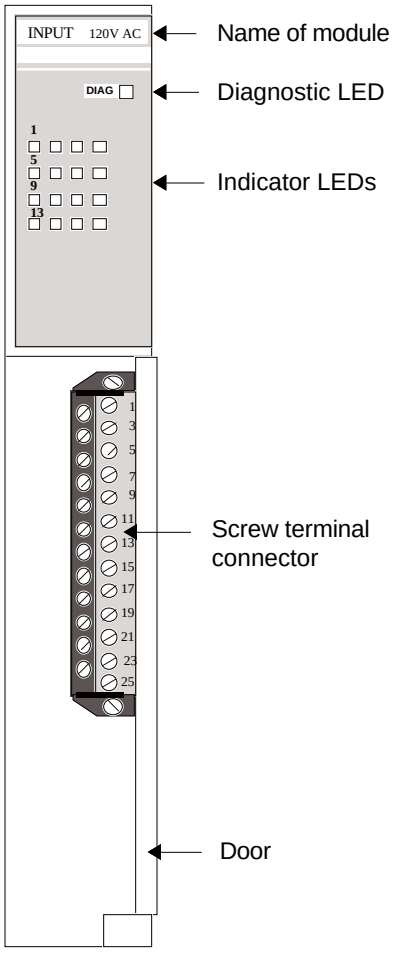
C.4 - Input 120V AC Module (16 points)

Introduction

The input 120V AC module converts AC signals from 16 devices into logic levels that the CPU can use. Each signal is converted into a corresponding logic 1 or 0 which is transmitted through the system bus to the CPU module. An "on" signal is nominally 120 VAC, but can be any level between 79 and 132 volts. An "off" signal is any level below 20 VAC. The wiring configurations may be sink or source.

16 LEDs in the upper section of the module indicate the logic state of each input. The DIAG LED goes on briefly while the diagnostic tests are running.

Figure C4-1. INPUT 120V AC Module (16 PT)



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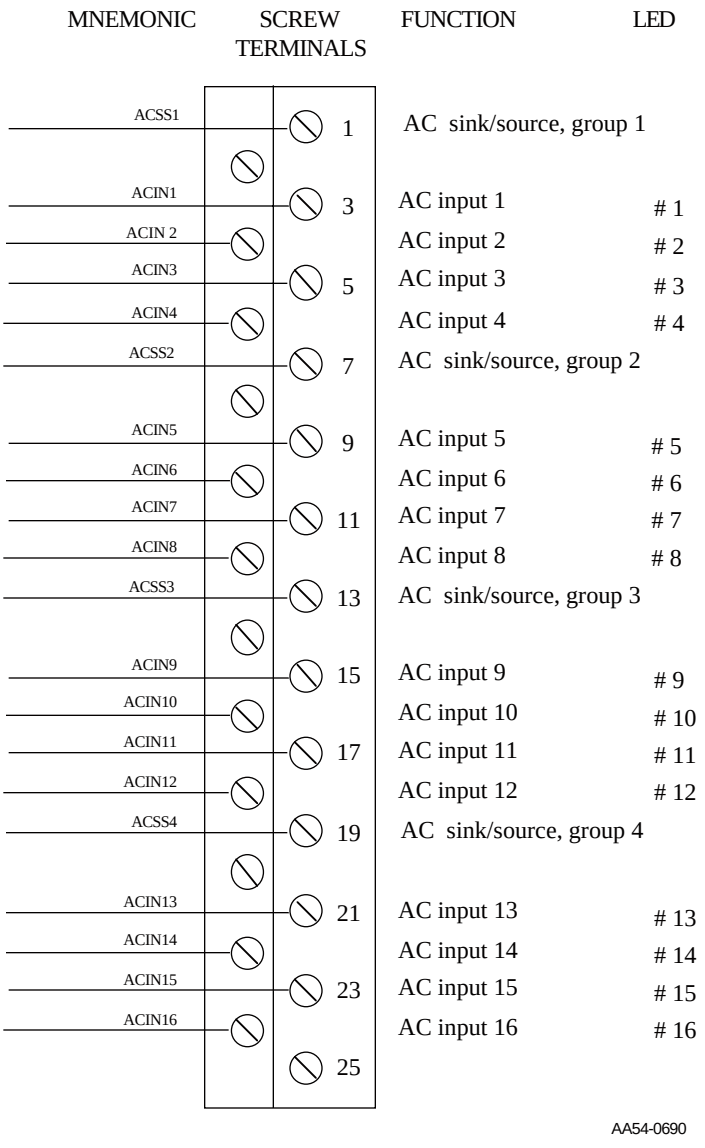
Connections

A screw terminal connector is provided for each input, and for each external power source. The inputs are isolated in four groups of 4, with one additional terminal per group to determine sink or source operation. The devices for each group must be powered from the same AC source. (See Figure C4-2.)

Each group can work independently from the others; some groups may be sink and others source. The AC power source for each group may be different if required. Typically just one source is used, daisy-chained from one group to the next.

The AC input should be connected to the single point ground used for the system rack. Its power disconnect switch should be the same one used for the system rack. See the power distribution diagrams in Chapter 1 for AC power connections.

Figure C4-2. Screw Terminal Connector Assignments

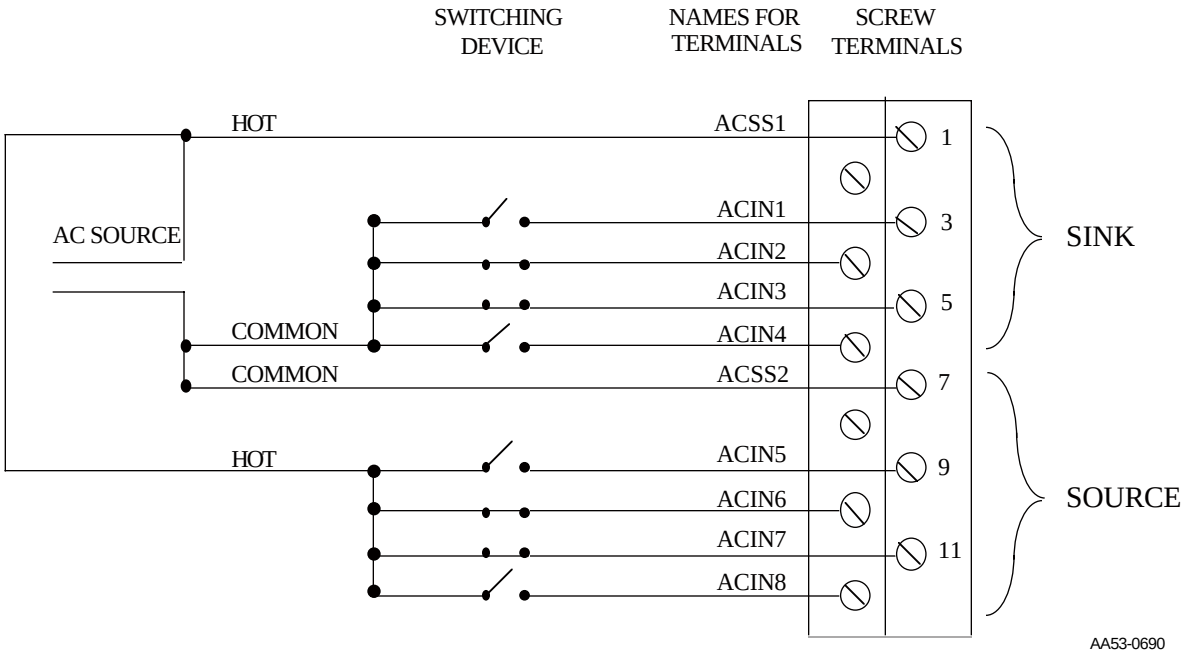


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Figure C4-3 illustrates two groups of inputs using the same AC source. The first group of four inputs are shown with devices "sinking" current through the AC Input module. The HOT terminal of the power source must be connected to the module at ACSS1.

The second group of four inputs are shown with devices "sourcing" current through the AC Input module. The COMMON terminal of the power source must be connected to the module at ACSS2.

Figure C4-3. Connectors for Two Groups of Inputs



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Theory of Operation

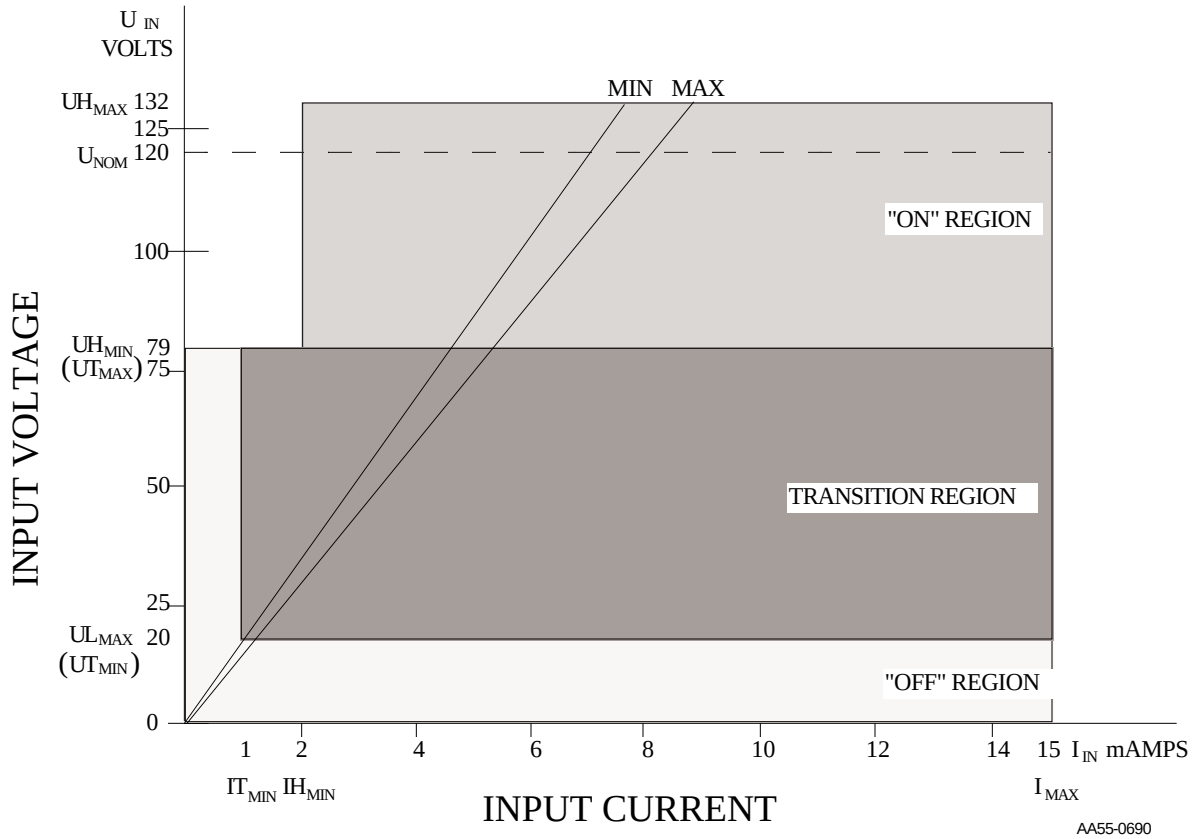
Each input is guaranteed "on" between 79 and 132 VAC and guaranteed "off" between 0 and 20 VAC. Its on/off state is converted to a corresponding logic 1 or 0. This logic state is transmitted through the system bus to the CPU module, where the processor uses it as data in the ladder program. The logic side of the input is optically isolated from the field side.

An LED in the upper section of the module indicates the logic state of each input. The four LEDs representing each group are in a horizontal row. If you need to know the voltage at the field side, use a voltmeter on the terminal screws.

Figure C4-4 shows the input characteristics of the module compared to IEC standards.

The shaded blocks show the limits specified by the IEC, and the lines show the maximum and minimum V/I of the inputs in this module. This voltage/current curve in this graph shows that the AC input module is well within the IEC Type 1 limits.

Figure C4-4. Input Characteristics Compared to IEC Standards



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IMPORTANT

Switching devices can sometimes have a leakage current that exceeds the IT_{min} (current allowed when off) of an input module. In order to use such a device, an impedance (typically, a resistor) needs to be used in parallel with the input.

For example, some of the newer proximity switches use two wires instead of three. The third wire was used for a power or ground line. Without the third wire, the switch is easier to install. However, it requires more leakage current in the off state to power its internal circuitry.

As a conservative estimate, use the following formula to calculate an external resistance value. It keeps the input voltage at or below 12V when the switching device is in the "off" state.

$$\frac{12V}{\text{Switch Leakage} - 1mA} \geq R$$

If the switch leakage specification ≤ 1.7 mA, then:

$$\frac{12V}{1.7 - 1mA} \geq 17.1K\Omega$$

Use a 16 K Ω, 2W or any lower resistance and higher wattage resistor. Be sure that the wattage is adequate for the resistor remembering that:

$$P = \frac{V_{rms}^2}{R}$$

It would be acceptable to use a .15 µF (or greater) capacitor rated for 120V AC. The advantage of the capacitor is minimal power dissipation.

$$Xc = \frac{1}{2\pi fC}$$

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Specification Table

Characteristic	Input 120V AC (16 pt) Module Specifications
Function	Monitors on/off states from up to 16 AC voltage inputs
Part number	502-03550-02
Field side connector	25-pin card edge connector, screw terminals
Input signals	Nominal 120 VAC on, 0 VAC off, conforming to IEC Type 1 inputs per IEC 1131-2 (four groups of four inputs)
UH Max (max. allowed voltage)	132 VAC
IH Max (max. current @ 132 VAC)	8.7 mA
UL Min	0 V
Guaranteed on	79 VAC
IH Min (min. current @ UH Min)	4.6 mA
Guaranteed off	20 VAC
IT Min (current allowed when off)	1 mA
Frequency	50/60 Hz ± 5%
Time delay on, max.	14 ms
Time delay off, max.	20 ms
Protection of logic circuits	Optical isolation between the logic and field sides, 1780 VAC
Indicator lights, circuits	An LED indicates its logic state of each input
Indicator light, module	The DIAG LED goes off after the module passes its diagnostic tests at power-on.
Logic side power requirements (typical)	1 mA @ +5V 11 mA per energized input @ +5V
Field side power dissipation, worst case	18.4 W
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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NOTES

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C.5 - Output 24V DC Sink Module (32 point)

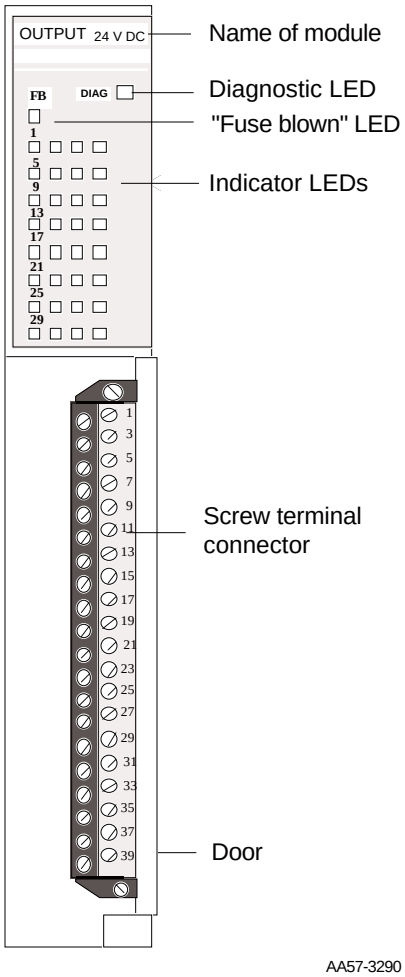
Introduction

The output 24V DC module sinks voltage for 32 individual loads from one or more DC power supplies. Each external supply is nominally 24 volts, but can be between 5 and 32 volts. It is available in three configurations.

1. 32 point, all diode protected
2. 32 point, 16 diode protected/16 unprotected
3. 32 point, all unprotected

32 LEDs in the upper section of the module indicate the logic state that drives each output. Another LED labeled FB turns on if the fuse in any active circuit is open or missing.
The DIAG LED goes on briefly while the diagnostic tests are running.

Figure C5-1. OUTPUT 24V DC Sink Module



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Connections

A screw terminal connection is provided for each output. The outputs are isolated in four groups of eight with one additional terminal per group (DCOUT) for the DC fused supply (DCIN HOT). (See Figure C5-3.)

Two terminals are provided for DC common. There is one common for two groups of eight outputs. Two terminals are provided for the DC supply input. Each DC supply input is split into two separate fused circuits and returned to a terminal for field use (See Figure C5-2.) The "fuse blown" LED circuit is active for all groups that have a power supply connected.

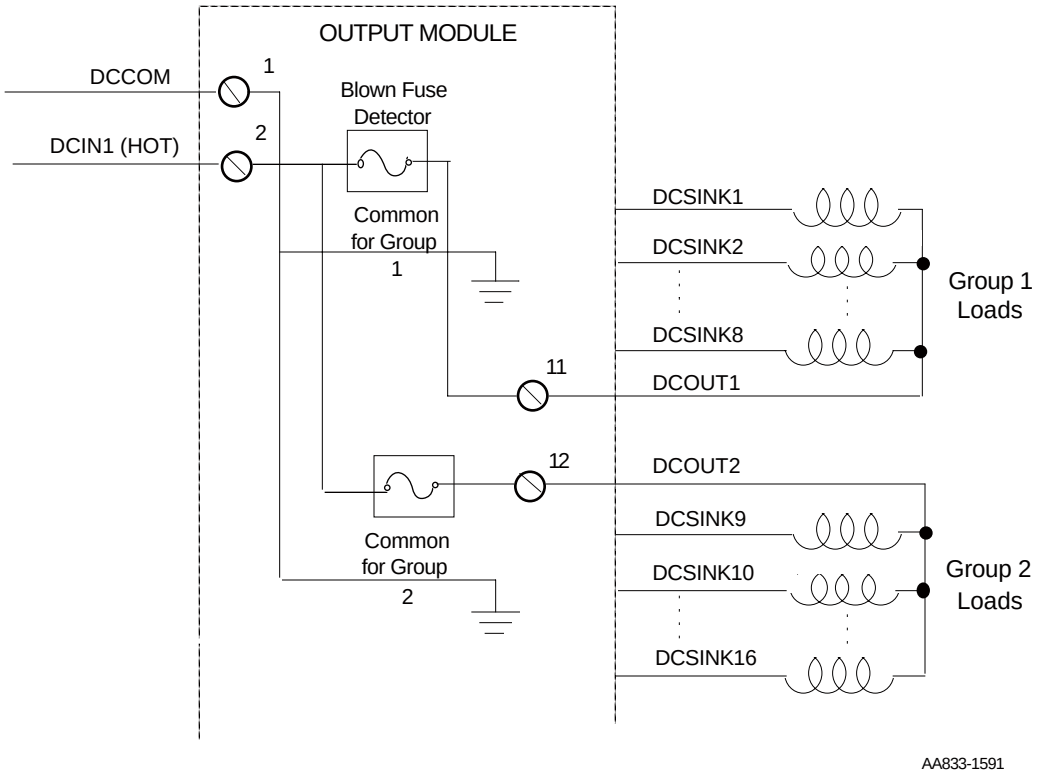
The DC power supply for each set of 16 devices may be different if required. In most cases one power supply is daisy-chained to all groups.

The external DC supply that powers the output signals should have a wire connected from its 0V (COMMON) terminal directly to the single point ground used for the system rack. Its power disconnect switch should be the same one used for the system rack. In the power distribution diagrams in the Hardware chapter, a 24V DC supply was set up according to these guidelines.

IMPORTANT
Do not connect the DC HOT (DCIN) and COMMON (DCCOM) to a group unless you plan to use one or more of its outputs.

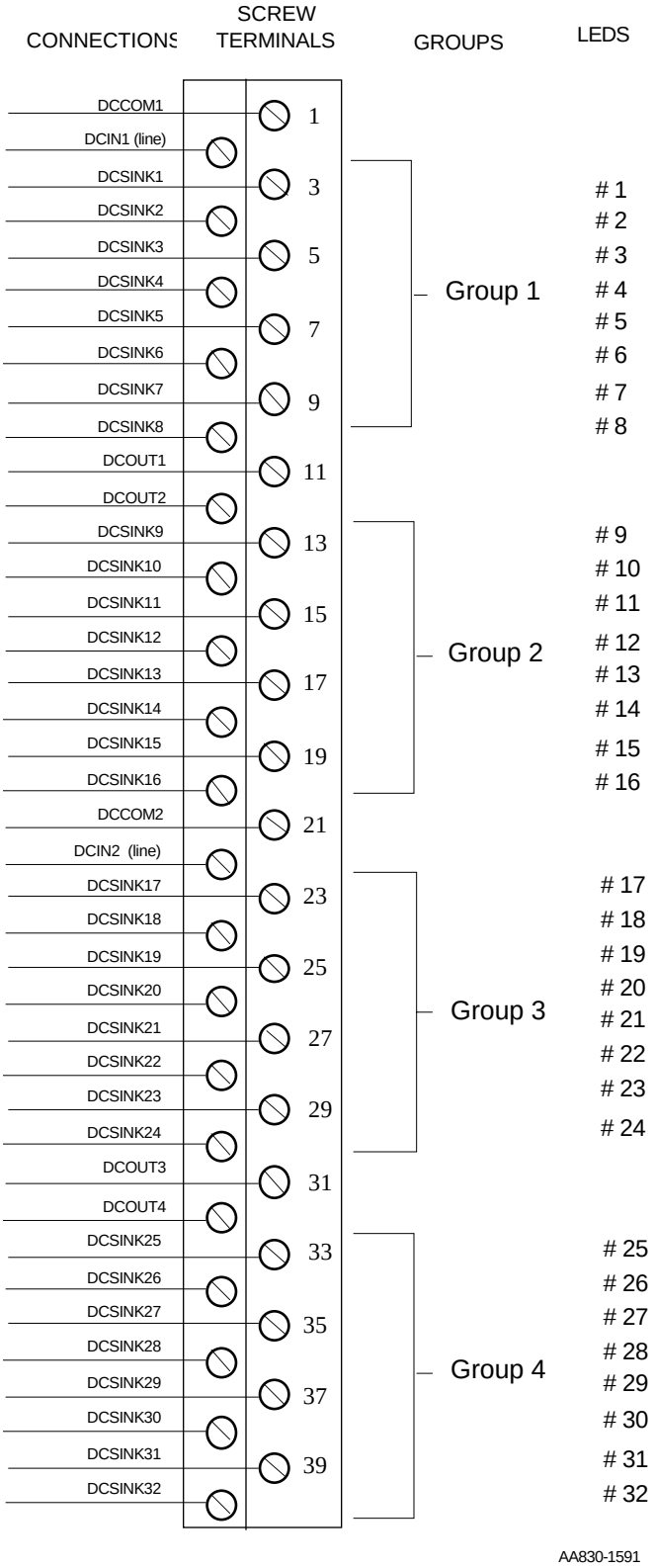
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Figure C5-2. Internal Module Connections for Group 1 and 2 Outputs



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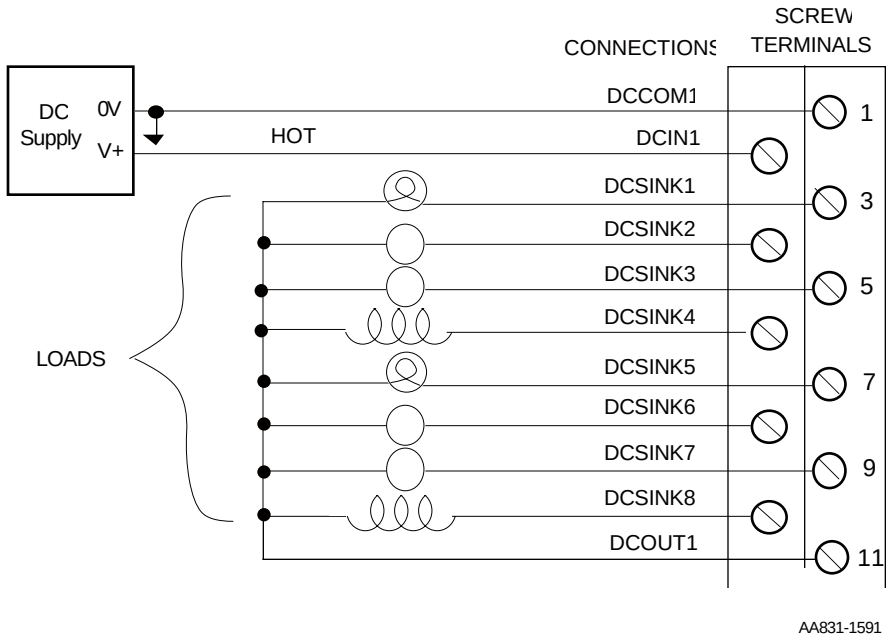
Figure C5-3. Screw Terminal Connection Assignments



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Connections for one group of outputs are illustrated in Figure C5-4.

Figure C5-4. Connections for One Group of Outputs



Theory of Operation

Each output point is a solid state switch rated at .4 A. It turns on or off according to the logic state sent to it by the CPU. If the CPU sends it a logic 1, the switch closes and the load is provided a path to common. If the CPU sends a logic 0, the switch opens and power to the load is cut off. The CPU updates the logic state for each switch every time it scans the program.

The logic side of the switch is optically isolated from the field side. An LED gives the logic state of each switch. If you need to know whether voltage is actually present at the field side, use a voltmeter on the terminal screws.

Each group has its own protective fuse in series with the source to protect against current overload in case the outputs are shorted to ground.

In addition on the 32 point, all protected module, the outputs are protected with internal clamping diodes. Without clamping, high voltage transients (kickback) from inductive loads might damage the module.

On the 32 point, 16 protected/16 unprotected module, 16 of the outputs are protected with internal clamping diodes. Without clamping, high voltage transients (kickback) from inductive loads might damage the module. The remaining 16 outputs do not have the internal clamping diode protection. These outputs should be used for non-inductive loads such as resistive or electronic loads.

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On the 32 point, all unprotected module, the outputs do not have internal clamping diode protection. These outputs should be used for non-inductive loads such as resistive or electronic loads.

Protecting from an Inductive Load

Resistive loads can be connected to the module and controlled by the system with no precautions other than making sure they have a connection to the DCOUT fused supply. When an output is energized, represented in Figure C5-5a by a closed switch, current passes through the load into the common line. When the output is de-energized, represented in C5-5b by an open switch, current stops. The state of the outputs is controlled by the CPU module.

Inductive loads have an electrical "kickback" when current is stopped. This can damage or destroy the output switching device. Any diode protected output in the Output 24V DC module has a diode through which reverse current can be safely routed.

Figure C5-5 shows how the internal diode works with an inductive load. When the output is turned off the inductive field collapses. This creates a reverse voltage across the load called "kickback" which tries to continue the current. The voltage is in series with the DC power supply. The combined voltage appears across the output switching device in the module.

If this were the only path available, voltage across the device would peak at several hundred volts. The internal diode provides another path for current. This limits the peak reverse voltage across the load to less than 1 V.

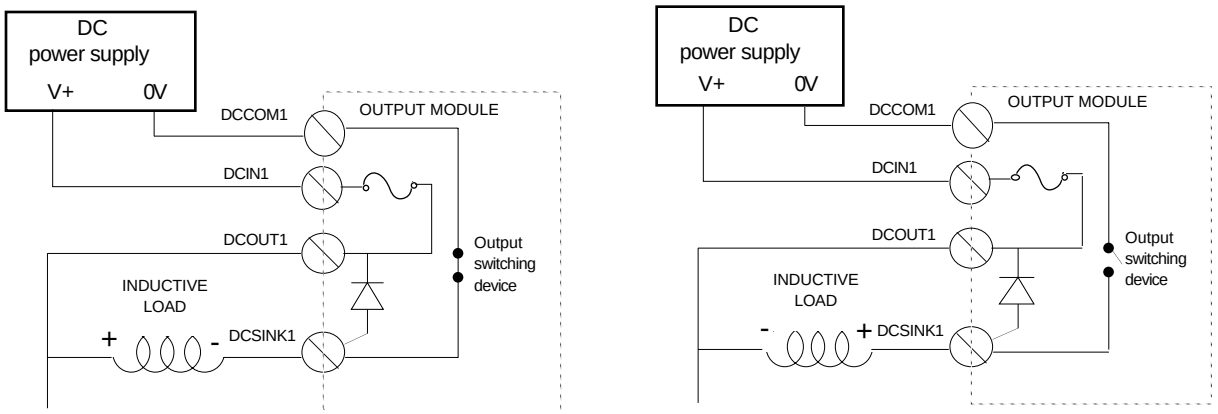
On the 32 point, all protected module, every point has this protection. You can connect an inductive load to any screw terminal.

On the 32 point, 16 protected/16 unprotected module, the first 16 switches (DCSINK 1 through DCSINK 16) has this protection so you can connect an inductive load to any of these terminals. The last 16 switches (DCSINK 17 through DCSINK 32) do not have the internal clamping diode protection. These outputs should be used for non-inductive loads such as resistive or electronic loads.

On the 32 point, all unprotected module, none of the points has the internal diode protection. These outputs should be used for non-inductive loads such as resistive or electronic loads.

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Figure C5-4. Diagram of Internal Protection for Inductive Loads



a) Output energized

b) Output de-energized

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NOTE

If inductive loads need to be connected to any unprotected point, an external diode must be connected between the load and DCOUT.

Replacing a Fuse

This module has four fuses, one for each group of outputs. Fuses are checked only for groups which have external power applied. If power is applied to a group in which the fuse is blown or missing, the FB LED on the module's upper segment lights up. The fuse is in series with the HOT line to the group, to protect the output switching device and the load.

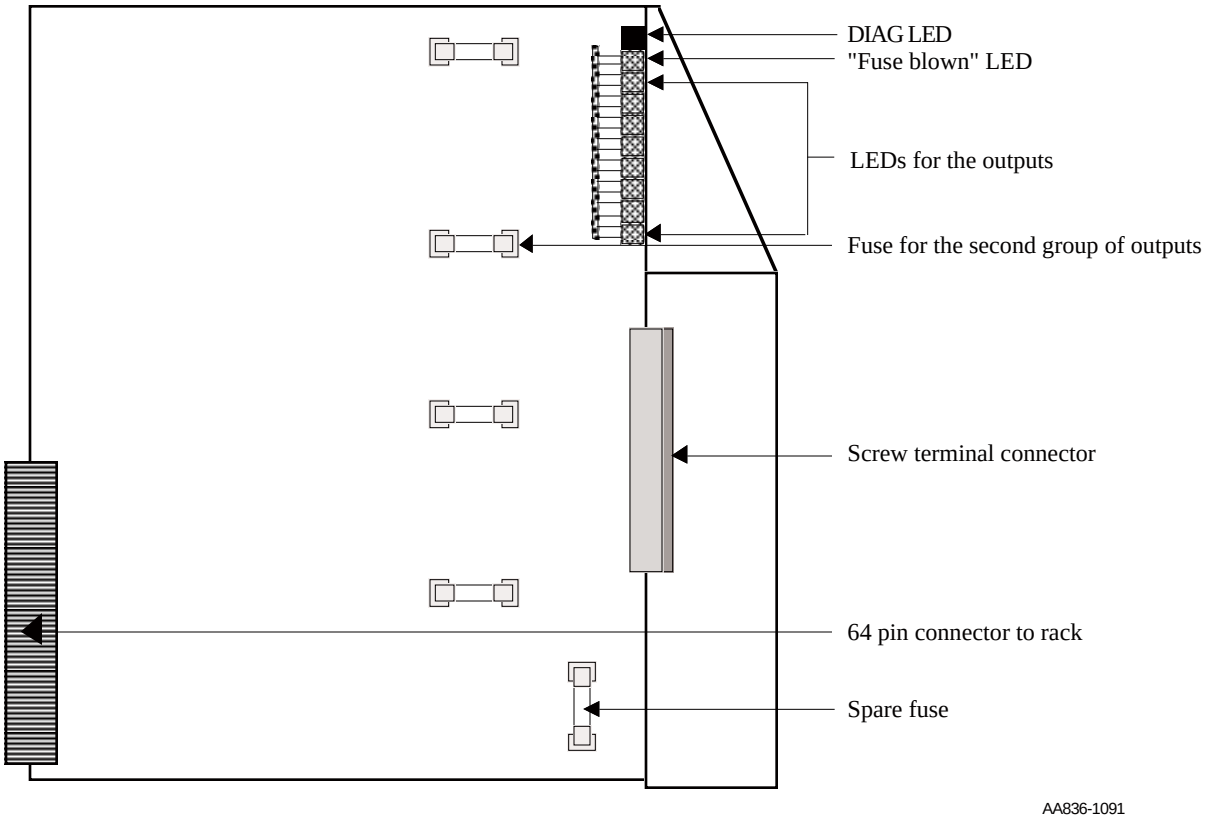
The fuse protects against a short circuit in an output device, but not against a sustained marginal overload current. See the specification table at the end of this section.

Follow the procedure below to change a blown fuse.

1. Turn off the main disconnect switch for the system rack and the external DC power supply to this module. Remove the screw terminal connector.
2. Press down the latch at the top of the OUTPUT 24V DC module and pull it out of the rack. Lay it on a static-free surface, label side up. Ground yourself using an antistatic wrist strap before you open the module.
3. Press the plastic tabs at the top and bottom of the module toward each other and lift off the module cover.

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Figure C5-5. Positions of Fuses



4. Identify the fuse that has blown, and use an insulated screwdriver or fuse puller to remove it. Put a new fuse in its slot. The replacement must be a fast-acting 3A 250 VAC fuse. The following are recommended:

   Littlefuse 235-003
   Bussman GMA-3
   or an equivalent.

   For your convenience, there is an extra fuse in the lower front corner of the module.

5. Replace the module cover, making sure that the top and bottom tabs are fully engaged.

6. Check the wiring to the devices to find why the fuse blew, and correct the situation before you continue running the program.

7. Slide the module back in its slot, connect the screw terminal connector, and turn power back on. After the diagnostic tests run, the DIAG and the FB LEDs should both be off.

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Specification Table

Characteristic	Output 24V DC module (32 pt sink) specifications
Function	Sinks an external DC source to 32 loads
Part number	16 protected/16 unprotected 502-03674-02 All diode protected 502-03674-22 All unprotected 502-03674-42
DC source requirements	Nominal 24V DC; range 5 to 32 VDC
Field side connector	40-pin card edge connector, screw terminals
Protection of logic circuits	Optical isolation between the logic and field side
Grouping of outputs	Four groups of 8 solid-state switches. Two groups share a DC supply. Two DC supplies are allowed per module. (One supply may be daisy chained.) UL 508 spacing
Fuse per group of 8 switches	Fast-acting, UL rated 3A 250 VAC metric fuse, 5 x 20 mm
Maximum current per group	2 A of continuous current for the group; each switch is rated at .4 A continuous
Indicator lights, output circuits	An LED for each output
Indicator light, module	A DIAG LED turns OFF when the module passes its diagnostic tests at power-on
Indicator light, fuses	A logic side LED lights to indicate a "blown fuse" condition when power is on to a group with missing or open fuse
Switch characteristics	Solid-state switches
Time delay on for resistive loads	30 µsec max
Time delay off for resistive loads	300 µsec max
Leakage current in off state	0.5 mA max
Switch voltage, maximum ON	1.8 VDC @ .4 A
Surge current, maximum	2.5 A for 40 msec., every 2 seconds
Response to scan loss	All outputs are reset to the OFF state.
Logic side power requirements (typical)	1 mA @+5V 25 mA per energized output @ +5V
Field side power dissipation, worst case (at 32 VDC)	15.8 W

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Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch). 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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C.6 - Output Relay Module (8 points)

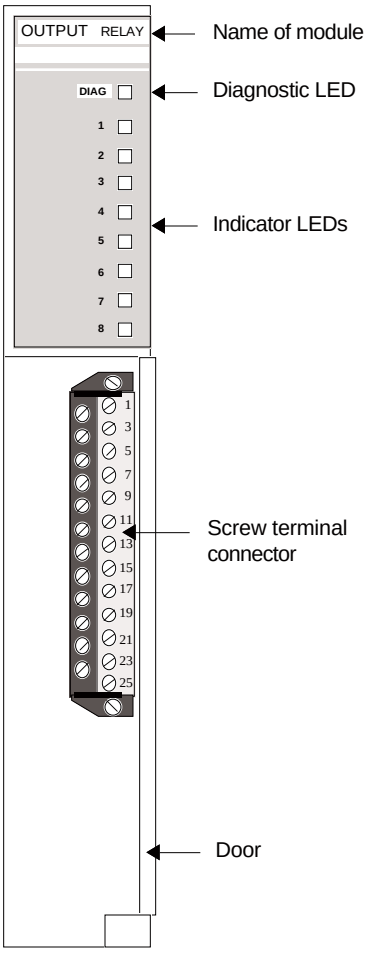
Introduction

The relay output module can switch eight relay contacts. Four relays are normally open(NO)/normally closed(NC) form C type and four are normally open (NO) form A type.

Eight LEDs in the upper section of the module indicate the logic state that drives each relay.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure C6-1. OUTPUT Relay Module (8 PT)



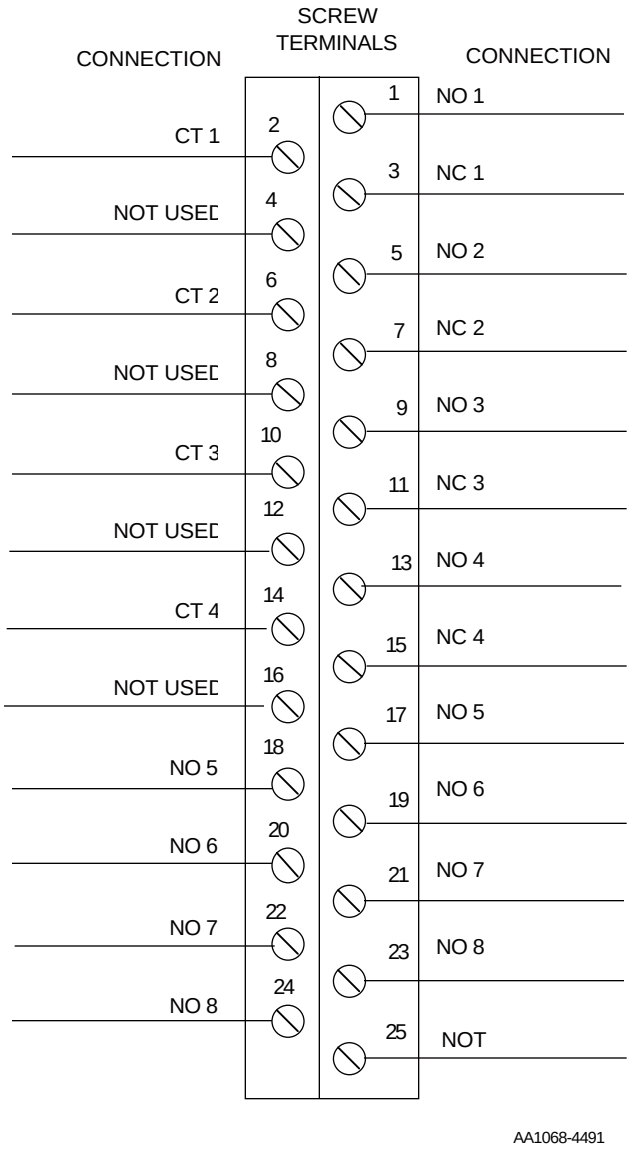
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Connections

A screw terminal connection is provided for each side of the contact. The form C type has three connections; normally open (NO), normally closed (NC), and the common terminal (CT). Only two of the connections can be wired at any time. The common terminal connection must be wired with either the normally open or the normally closed connection depending on the application.

The form A type has two connections; one for each side of the contact.

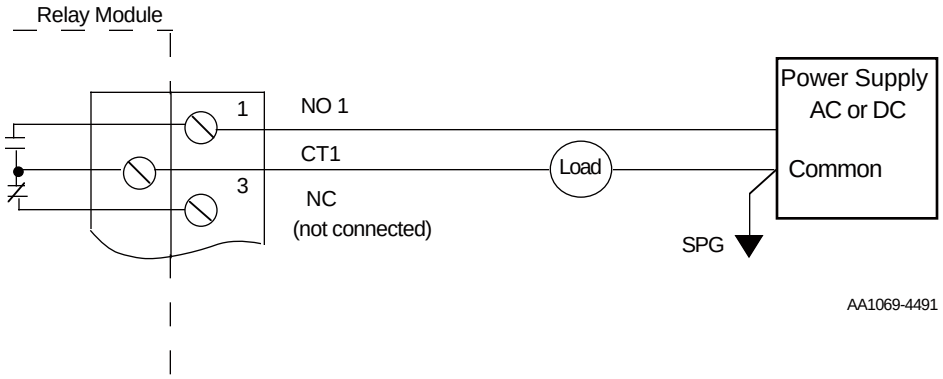
Figure C6-2. Screw Terminal Connector Assignments



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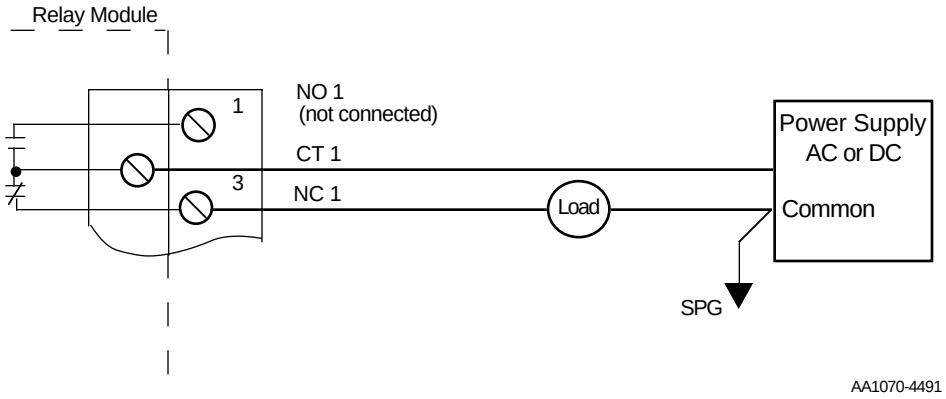
If the normally open contact of the form C type is required for the application, wire as shown in Figure C6.3.

Figure C6-3. Connections for Form C Normally Open



If the normally closed contact of the form C type is required for the application, wire as shown in Figure C6-4.

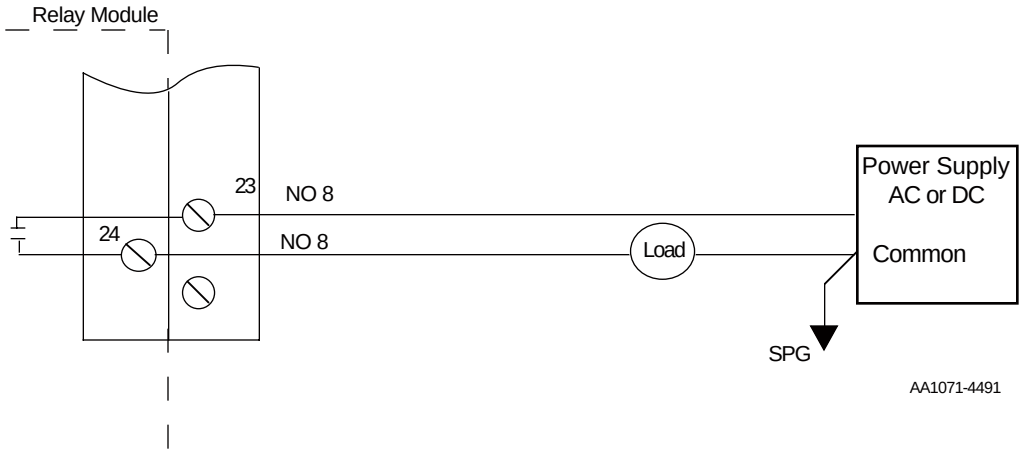
Figure C6-4. Connections for Form C Normally Closed



To wire the normally open contact of form A, refer to Figure C6-5.

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Figure C6-5. Connections for Form A Normally Open

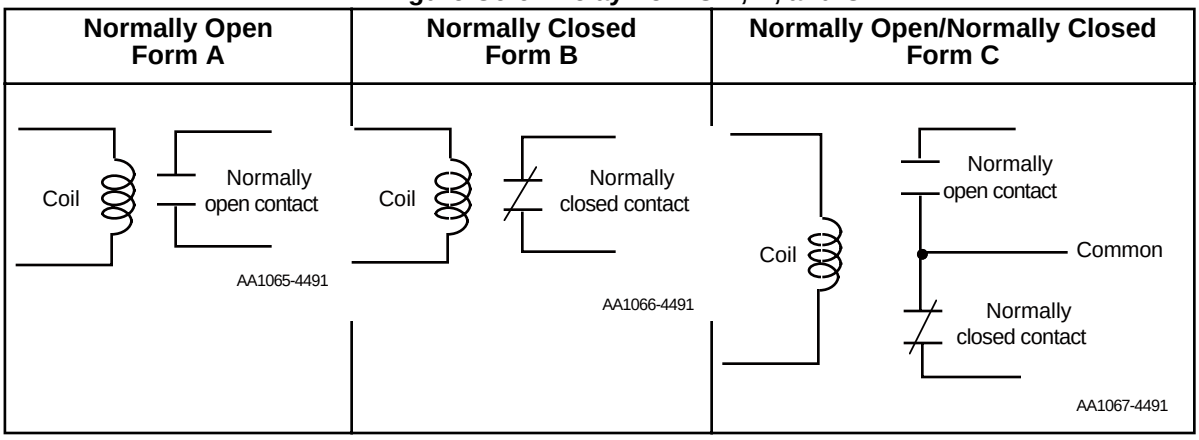


Theory of Operation

A relay is composed of a coil and a set of contacts. When current is passed through the coil, the relay is energized. When no current flows through the coil, the relay is de-energized. The contacts close or open depending on the state of the coil. When the contacts are closed, current can pass through them. When the contacts are open, no current passes.

There are three configurations for contacts referred to as form A, B and C as illustrated in Figure C6-6. The relay output module has form A and form C available.

Figure C6-6. Relay Forms A, B, and C



A relay is energized or de-energized according to the logic state sent to it by the CPU. If the CPU sends a logic 1, the relay is energized. If the CPU sends a logic 0, the relay is de-energized. The logic state for each relay is updated every time the CPU scans the program.

The names of the two types of contacts - normally open and normally closed - reflect the state of the contacts when the coil is de-energized.

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For example, a normally open contact will not pass current when the coil is de-energized. If the coil is energized, the contacts close and current will pass.

The normally closed contact will pass current when the coil is de-energized. If the coil is energized the contacts open and no current will pass.

These states are summarized in Table C6-1.

Table C6-1. Summary of NO and NC Relays

	Normally Open	Normally Closed
Energized (LED on)	contacts closed/current flow	contacts open/no current flow
De-energized (LED off)	contacts open/no current flow	contacts closed/current flow

The LED for each output reflects the state of the coil. The LED is on when the coil is energized and off when the coil is de-energized.

Specification Table

Characteristic	Output relay (8) module specification
Function	Switches eight relay contacts
Part number	502-03644-02
Field side connector	25 pin card edge connector, screw terminals
Output channels	8
Relay characteristics Contact types	Four form C (NO/NC) Four form A (NO)
Maximum switching voltage	280 VAC resistive load; 50 VDC resistive load
Minimum switching current	100 mA
Maximum switching current (DC)	0-24VDC @ 3 A 30 VDC @ 2.5A 40VDC @ 1.5 A 50 VDC @ 1.0A
Maximum switching current (AC)	0-120 VAC @ 3 A280 VAC @ 2.5A
Initial contact resistance	100 mΩ
Turn on time (resistive load)	10 msec maximum
Turn off time (resistive load)	10 msec maximum
Expected life, electrical	10^5 operations minimum
Expected life, mechanical	10^7 operations minimum
Breakdown voltage between contacts	750 V_{rms} for 1 minute

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Breakdown voltage between contacts and coil	1500 V_{rms} for 1 minute
Maximum switching frequency	20 energize/deenergize cycles/min. (to satisfy expected life ratings)
Indicator light, module	DIAG LED turns off after the module passes its diagnostic tests. A logic side LED for each relay turns on when the logic side energizes the relay.
Isolation	Electromechanical relay provides protection between logic and field side
Logic side power requirements (typical)	1 mA @ 5V 5 mA @ +15V 39 mA per energized output @ +15V (Pt 1-4) 24 mA per energized output @ +15V (Pt 5-8)
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
EMC Compliant Emissions Noise immunity	 Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8KV air discharge) per NEC 1000-4-2 • RF electromagnetic fields per IEC 1000-4-3 • Electrical fast transients per IEC 1000-4-4 on incoming power lines Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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C.7 - Input/Output TTL (24/8 pts)

Introduction

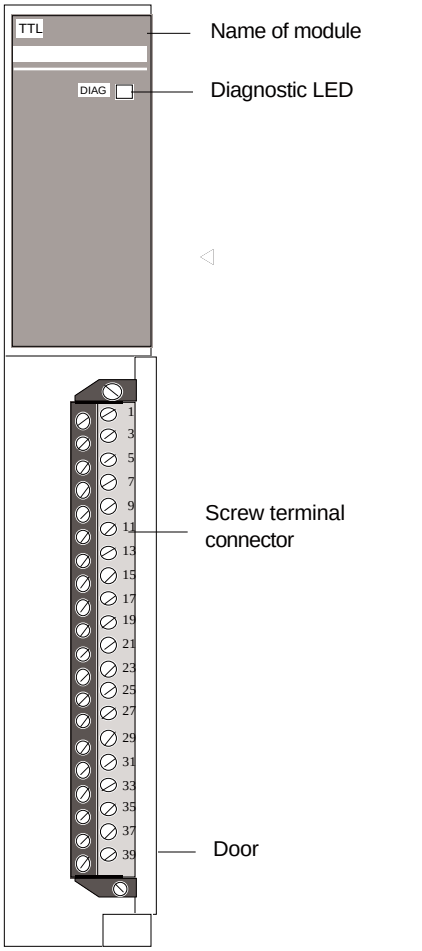
The TTL (Transistor-Transistor Logic) module provides 24 optically isolated input points and 8 optically isolated output points to interface with TTL devices (or other 5 VDC devices such as photoelectric sensors).

The module can also be used as a feedback module to read devices like linear displacement transducers (TEMPOSONICS™, BALLUFF) or absolute encoders. These devices provide high speed, low voltage, low noise parallel digital signals.

An external +5V DC is required for operation.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure C7-1. TTL (24 inputs/8 outputs)



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Connections

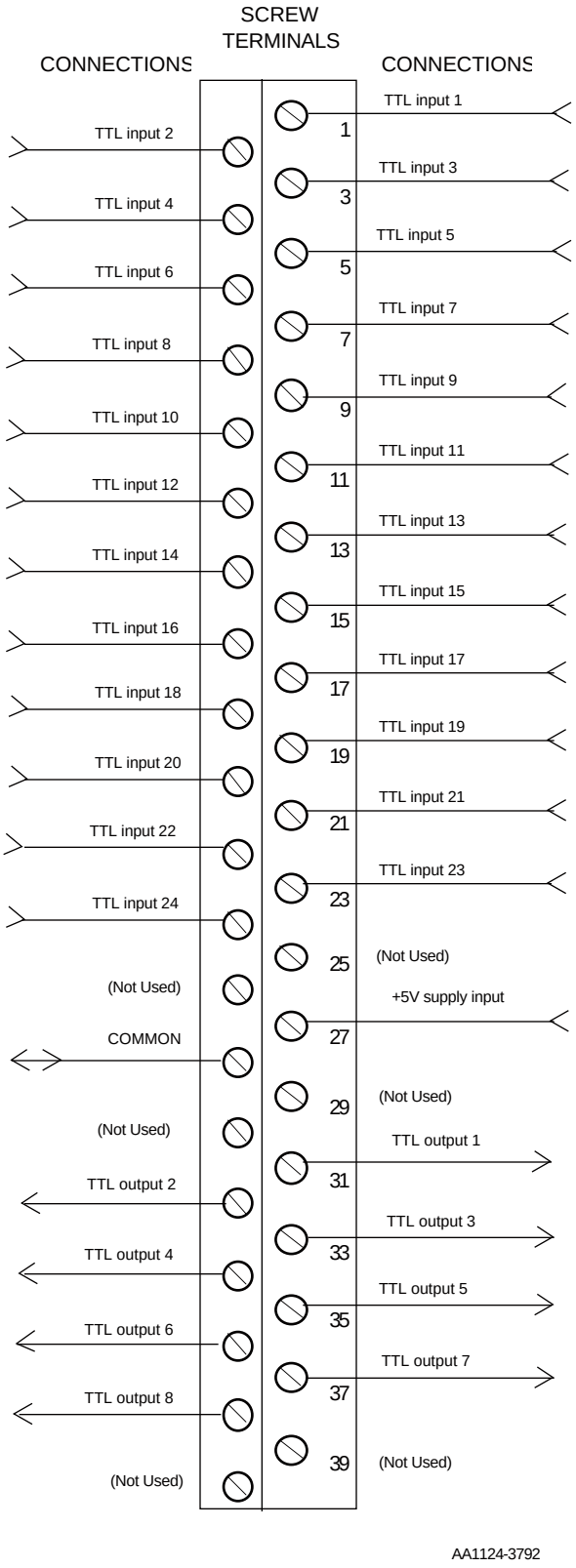
A screw terminal connection is provided for each input and output point and for the external power supply connection as shown in Figure C7-2.

The external power supply that powers the I/O circuitry should have a wire connected from its 0V (common) terminal to the rack's single point ground.

The power disconnect switch should be the same one used for the CSM (Central Service Module). In the power distribution diagrams in Chapter 1, a DC supply is shown set up according to these guidelines.

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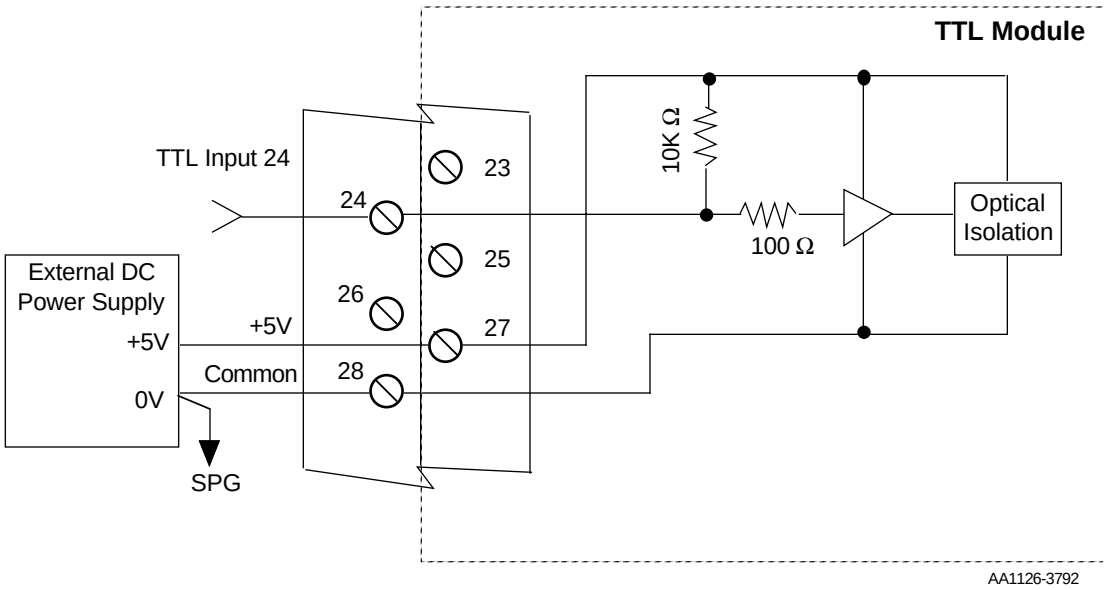
Figure C7-2. Screw Terminal Connection Assignments



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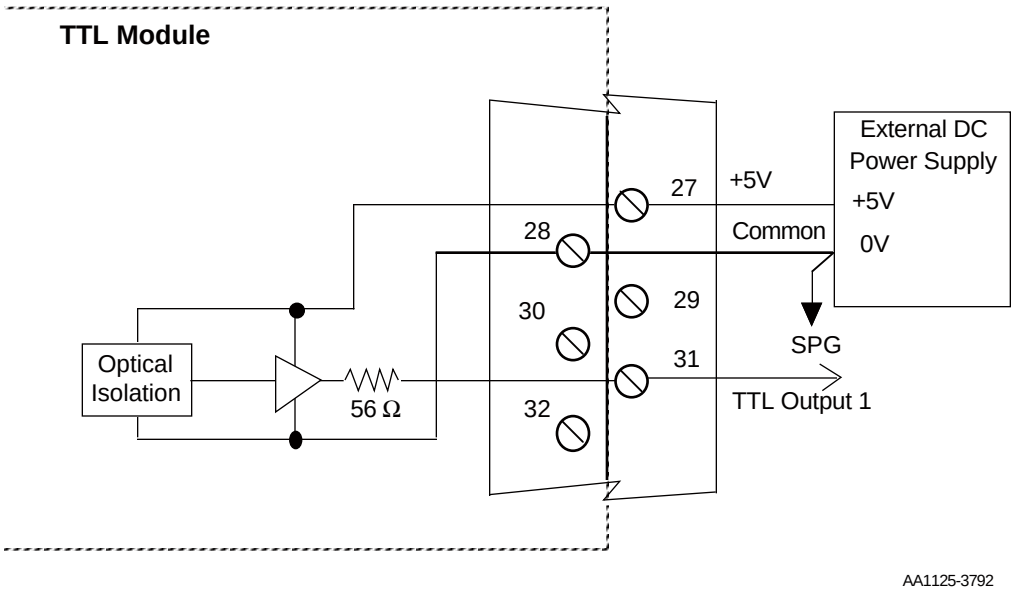
A typical input is shown in Figure C7-3. A 10K Ω pull-up resistor allows the inputs to be compatible with both totem pole and open collector output devices.

Figure C7-3. Connections for TTL Input 24



An output connection is shown in Figure C7-4.

Figure C7-4. Connections for TTL Output 1

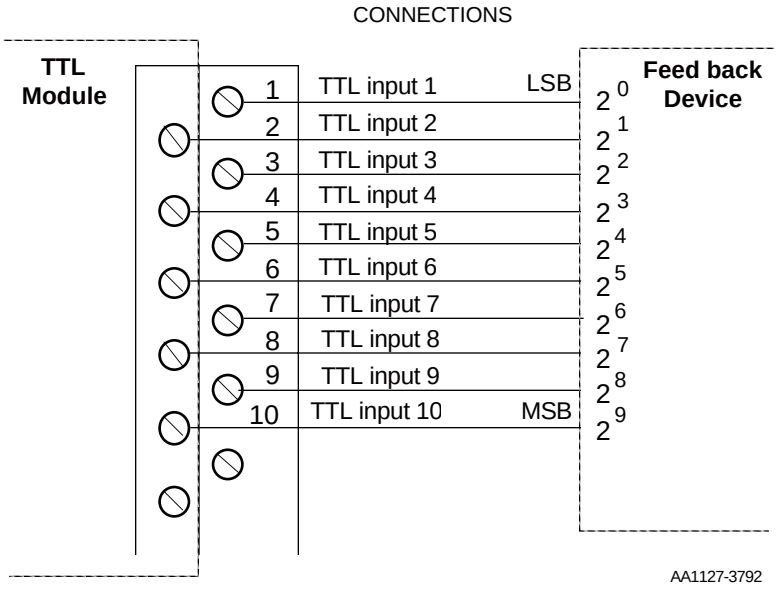


The TTL inputs can also be connected to the digital outputs of a feedback device. These digital outputs must be of the totem pole or open collector variety and must meet the requirements listed in the specification table.

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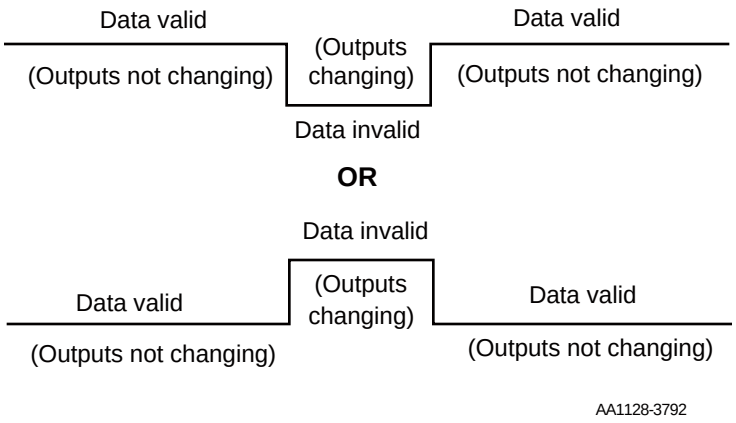
The digital outputs of the feedback device are usually weighted from the least significant bit (LSB) to the most significant bit (MSB). *Always connect the LSB to the TTL input 1.* Continue to connect the remaining bits in order of significance until all available bits from the feedback device are connected. Figure C7-5 illustrates how a feedback device with 10 bits (2^9) of parallel data is connected to the TTL module.

Figure C7-5. Connections for Digital Inputs from Feedback Device



Some manufacturers of feedback devices provide a data valid signal in addition to the parallel output data. This signal is used to indicate when the parallel data is available for reading. The signal may be defined in one of two ways as shown in Figure C7-6.

Figure C7-6. Valid Data



This valid data signal is always connected to TTL input 24. The method of indicating valid data is defined in the servo setup software.

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Theory of Operation

The input circuitry of the TTL I/O module converts TTL level signals into logic levels that the CPU can use.

A TTL device is at one of two defined voltage levels at any given moment. The voltage level corresponds to one of two defined logic levels: 1 or 0.

A logic 1 (also “true” or “on”) signal is a voltage level between 2 volts and the power supply voltage (nominally 5 volts).

A logic 0 (also “false” or “off”) signal is any level below 0.8 volts.

These levels are compatible with TTL, LSTTL, ASTTL, and ALSTTL families.

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Specification Table

Characteristics	TTL module specifications
Function	Monitors on/off states of 24 TTL inputs and controls on/off state of 8 TTL outputs.
Part number	502-03810-03
Field side connector	40 pin card edge connector, screw terminals
External power supply	+5 V ±5% 450 mA
Isolation	2500 VRMS between field side and logic side
Input characteristics	V_{in} high- 2.0 V minimum V_{in} low - 0.8 V maximum I_{in} high - 1µA maximum I_{in} low - -0.65 mA maximum Minimum input pulse width1 µsec
Output characteristics	V_{ol} -0.8 V maximum @ I_o = 10 mA (sinking) V_{oh} -4.0 V minimum @ I_o = -10 mA (sourcing) Output turn on/off time - 300 nano sec Maximum cable length - 3 meters (approximately 10 feet)
Logic side power requirements (typical)	+5V @ 450 mA
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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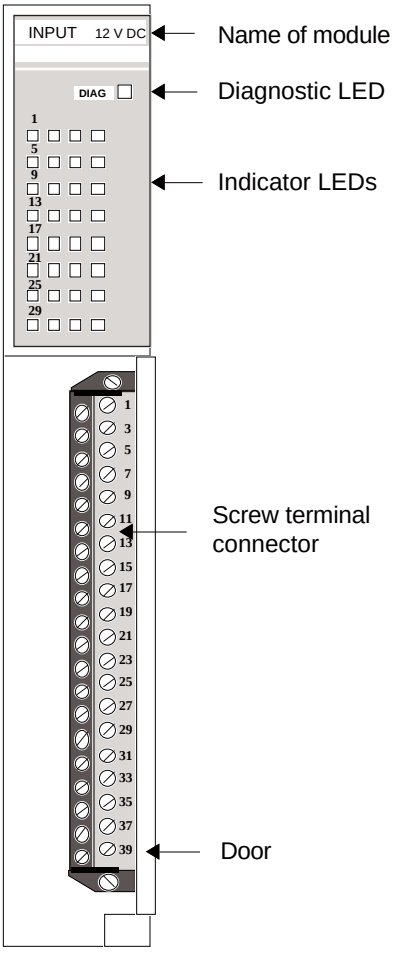
C.8 - Input 12V DC Module (32 points)

Introduction

The input 12V DC module converts DC signals from 32 devices into logic levels that the CPU can use. Each signal is converted into a corresponding logic 1 or 0 which is transmitted through the system bus to the CPU module. An "on" signal is nominally 12 VDC, but can be any level between 10 and 14 volts. An "off" signal is any level below 5V. The wiring configurations may be sink or source.

32 LEDs in the upper section of the module indicate the logic state of each input. The DIAG LED goes on briefly while the diagnostics tests are running.

Figure C8-1. INPUT 12V DC Module (32 PT)



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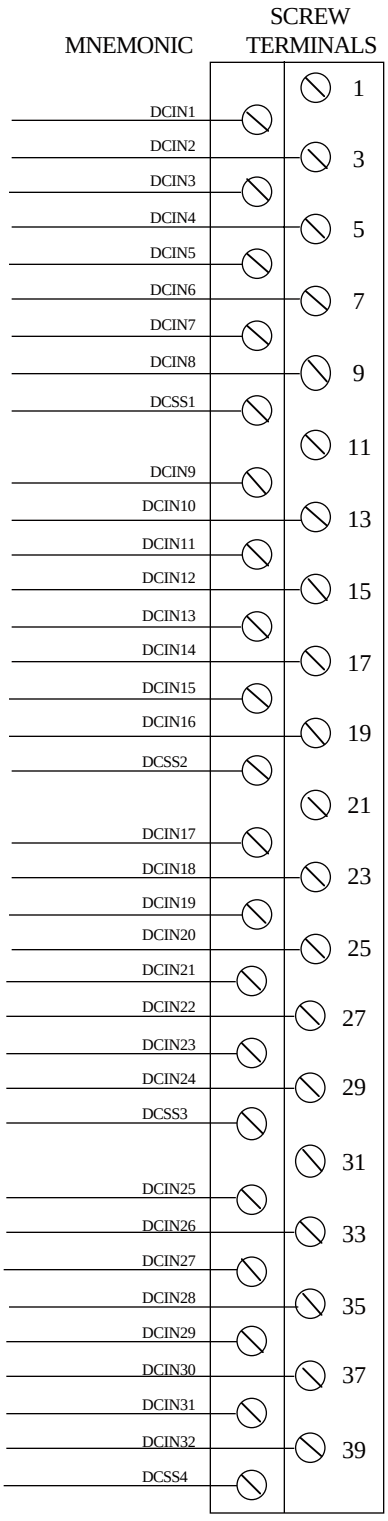
Connections

A screw terminal connector is provided for each output and for each external power supply connection. The inputs are isolated in four groups of eight, with one additional terminal per group for the DC source/sink connection. The devices connected to terminals in the same group have a common DC supply and are wired in the same configuration, sink or source.

The external 12 VDC supply that powers the input signals should have a wire connected from its 0V (COMMON) terminal directly to the single-point ground used for the system rack. Its power disconnect switch should be the same one used for the system rack. In the power distribution diagrams in the Hardware chapter, a 24 VDC supply is set up according to these guidelines. Set up the 12 VDC supply in the same manner.

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Figure C8-2. Screw Terminal Connector Assignments



FUNCTION	LED
DC input 1	# 1
DC input 2	# 2
DC input 3	# 3
DC input 4	# 4
DC input 5	# 5
DC input 6	# 6
DC input 7	# 7
DC input 8	# 8
DC sink/source, group 1	
DC input 9	# 9
DC input 10	# 10
DC input 11	# 11
DC input 12	# 12
DC input 13	# 13
DC input 14	# 14
DC input 15	# 15
DC input 16	# 16
DC sink/source, group 2	
DC input 17	# 17
DC input 18	# 18
DC input 19	# 19
DC input 20	# 20
DC input 21	# 21
DC input 22	# 22
DC input 23	# 23
DC input 24	# 24
DC sink/source, group 3	
DC input 25	# 25
DC input 26	# 26
DC input 27	# 27
DC input 28	# 28
DC input 29	# 29
DC input 30	# 30
DC input 31	# 31
DC input 32	# 32
DC sink/source, group 4	

AA44-3290

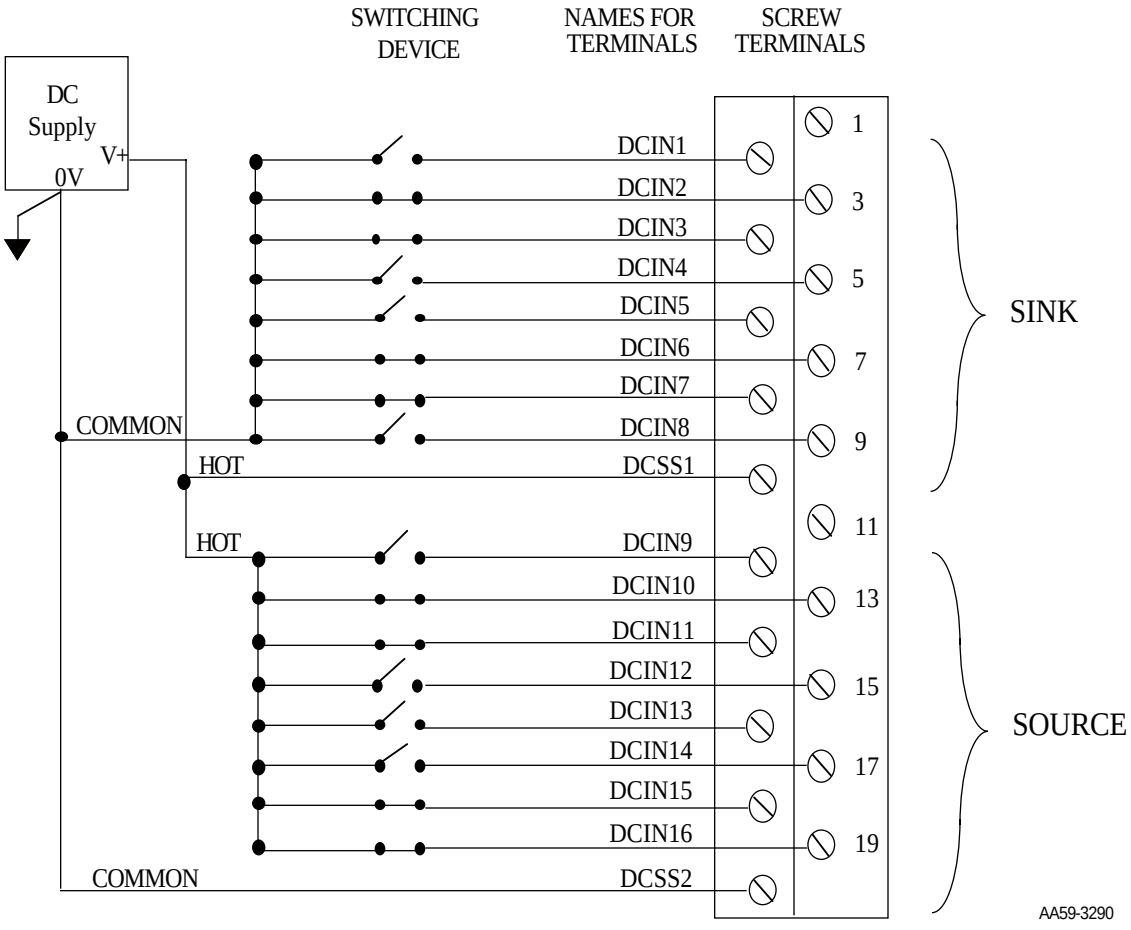
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Figure C8-3 illustrates two groups of inputs using the same power supply.

Each group can work independently of the others; some groups may be sink and others source. The DC power supply for each group may be different if required. Typically just one DC power supply is used, daisy-chained from one group to the next.

The first group of eight inputs is shown with devices "sinking" current through the DC Input module. The HOT terminal of the power supply must be connected to the module at DCSS1. The second group of eight inputs are shown with devices "sourcing" current through the input module. The COMMON terminal of the power supply must be connected to the module at DCSS2. In this example the DC power supply is the same for both groups.

Figure C8-3. Connectors for Two Groups of Inputs



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Theory of Operation

Each input is guaranteed "on" at 10 to 14 VDC and guaranteed "off" at 0 to 5 VDC; polarity doesn't matter. Its on/off state is converted to a corresponding logic 1 or 0. This logic state is transmitted through the system bus to the CPU module, where the processor uses it as data in the ladder program. The logic side of the input is optically isolated from the field side.

An LED in the upper section of the module indicates the logic state of each input. Each group is represented by a horizontal row of 4 LEDs. If you need to know whether voltage is present at the field side, use a voltmeter on the terminal screws.

Specification Table

Characteristic	Input 12V DC (32 pt) module specifications
Function	Monitors on/off states from up to 32 DC voltage inputs
Part number	502-03643-00
Field side connector	40-pin card edge connector, screw terminals
Input signals	Nominal 12 VDC on, 0 VDC off conforming to IEC 1131-2 (four groups of eight inputs)
Maximum allowed voltage	14 VDC
Maximum current @ 14 VDC	8.5 mA
Guaranteed on	10 VDC
Minimum current @ 10 VDC	5 mA
Guaranteed off	5 VDC
Current allowed when off	2 mA
Time delay on	1 ms max.
Time delay off	1 ms max.
Protection of logic circuits	Optical isolation between the logic and field sides, 4000 V peak
Indicator lights, input circuits	An LED indicates the logic state of each input
Indicator light, module	The DIAG LED goes OFF when the module passes power-on diagnostic tests
Logic side power requirements (typical)	29 mA @ +5V 7 mA per energized input @ +5V
Field side power dissipation, worst case	3.8 W

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Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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C.9 - 24V DC Input/Output Sink Module (16/8 points)

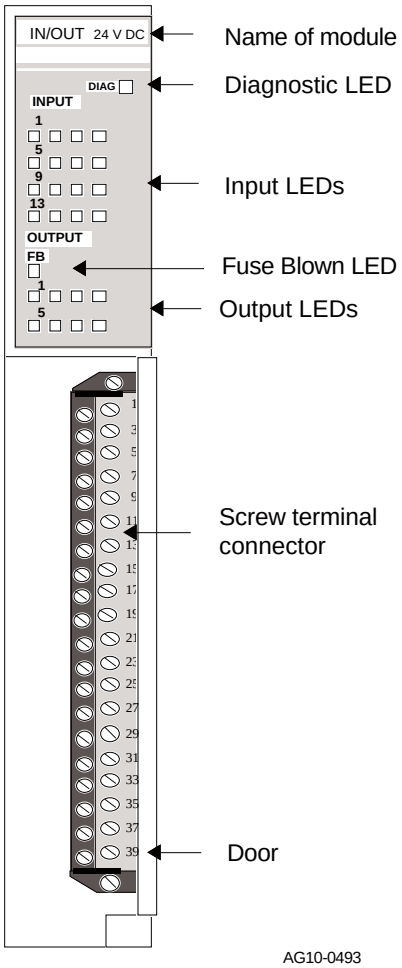
Introduction

The input section of the 24V DC I/O module converts DC signals from 16 devices into logic levels that the CPU can use. Each signal is converted into a corresponding logic 1 or 0 which is transmitted through the system bus to the CPU. An "on" signal is nominally 24 VDC, but can be any level between 14 and 30 volts. An "off" signal is any level below 5V. The wiring configurations may be sink or source. 16 LEDs indicate the logic state of each input.

The output section of the module sinks voltage for eight individual loads from one DC power supply. The external supply is nominally 24 volts, but can be between 5 and 32 volts. Eight LEDs on the module indicate the logic state that drives each output. Another LED labeled FB turns on if the fuse in the active circuit is open or missing.

The DIAG LED goes on briefly while the diagnostics tests are running.

Figure C9-1. 24V DC Input/Output Module (16/8 sink pt)



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Connections

Inputs

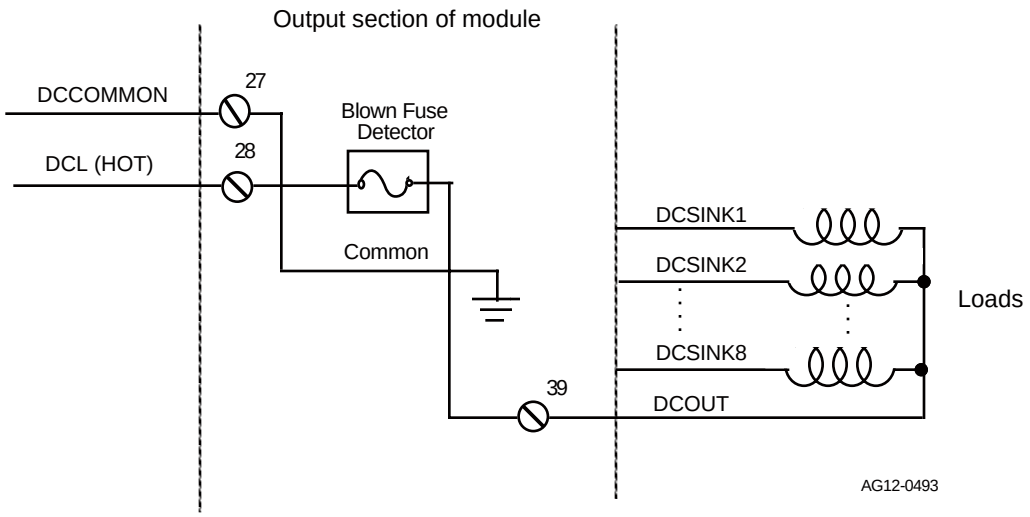
A screw terminal connector is provided for each input and for each external power supply connection. The inputs are isolated in two groups of eight, with one additional terminal per group for the DC source/sink connection. The devices connected to terminals in the same group have a common DC supply and are wired in the same configuration, sink or source.

Outputs

A screw terminal connection is provided for each output. The outputs are isolated in one group of eight with one additional terminal (DCOUT) for the DC fused supply (DCL HOT). See Figure C9-3.

One terminal is provided for DC common and one terminal is provided for the DC supply input. The DC supply input is a fused circuit and returns to a terminal for field use. The "fuse blown" LED circuit is active when a power supply is connected. Figure C9-2 shows the internal fuse circuitry.

Figure C9-2. Internal Module Connections for Outputs



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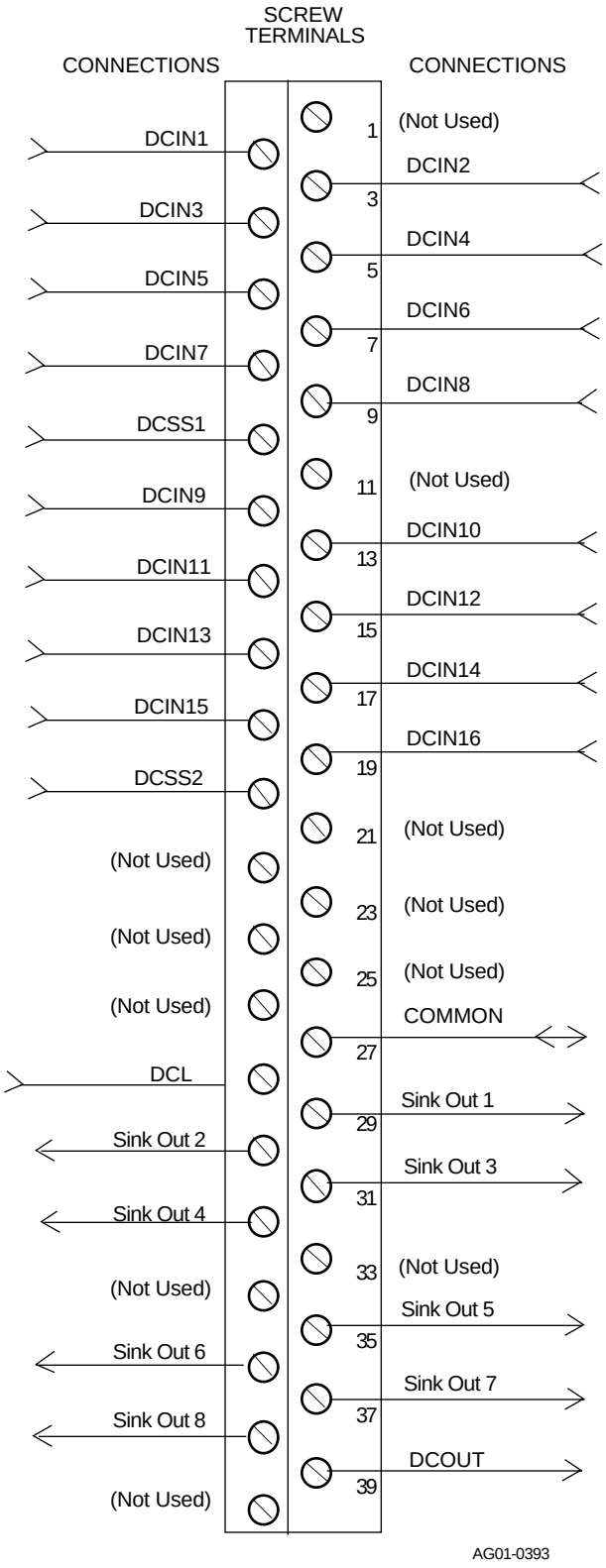
IMPORTANT
Do not connect the DC HOT (DCL) and COMMON (DCCOMMON) to the group unless you plan to use one or more of its outputs.

The external DC supplies that power the input and output signals should have a wire connected from their 0V (COMMON) terminal directly to the single-point ground used for the system rack. Their power disconnect switch should be the same one used for the system rack. In the power distribution diagrams in the Hardware chapter, a 24 VDC supply is set up according to these guidelines.

Figure C9.3 shows all the screw terminal connections.

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Figure C9-3. Screw Terminal Connector Assignments



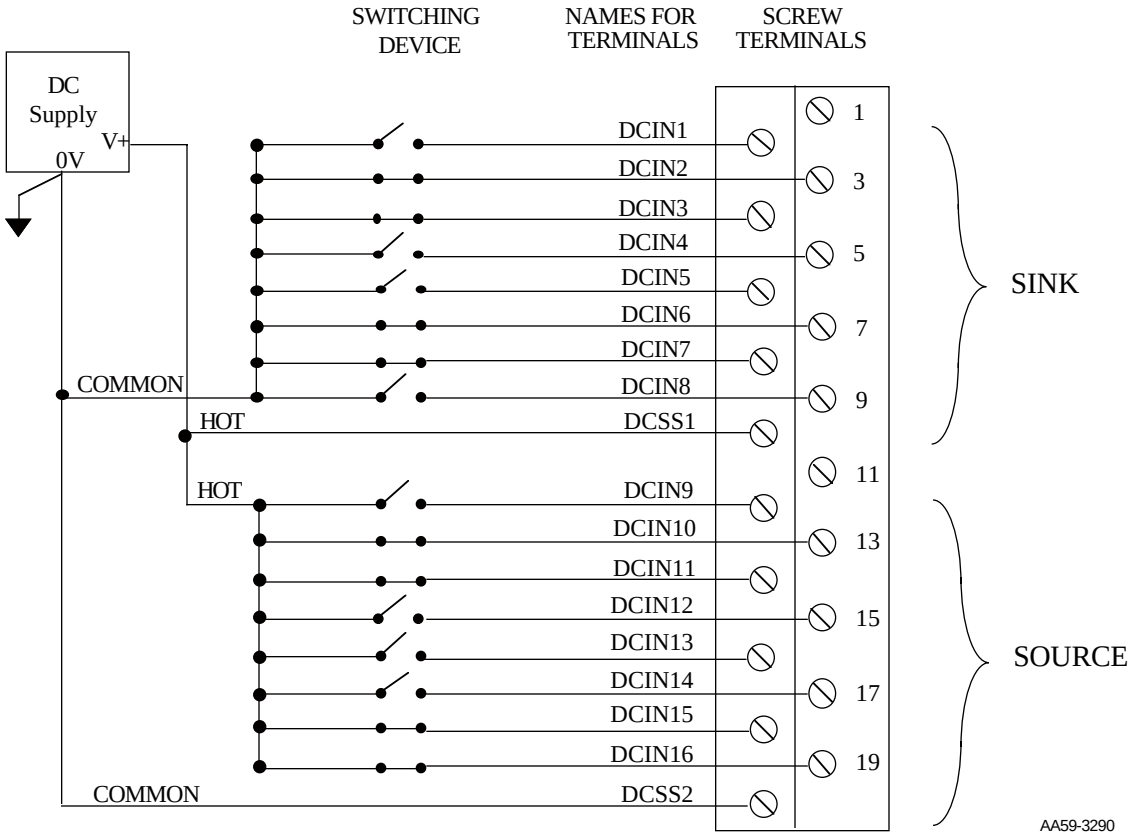
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Figure C9-4 illustrates two groups of inputs using the same power supply.

Each group can work independently of the other; one group may be sink and the other source. The DC power supply for each group may be different if required. Typically just one DC power supply is used, daisy-chained from one group to the next.

The first group of eight inputs is shown with devices "sinking" current through the module. The HOT (V+) terminal of the power supply must be connected to the module at DCSS1. The second group of eight inputs are shown with devices "sourcing" current through the module. The COMMON (0V) terminal of the power supply must be connected to the module at DCSS2. In this example the DC power supply is the same for both groups.

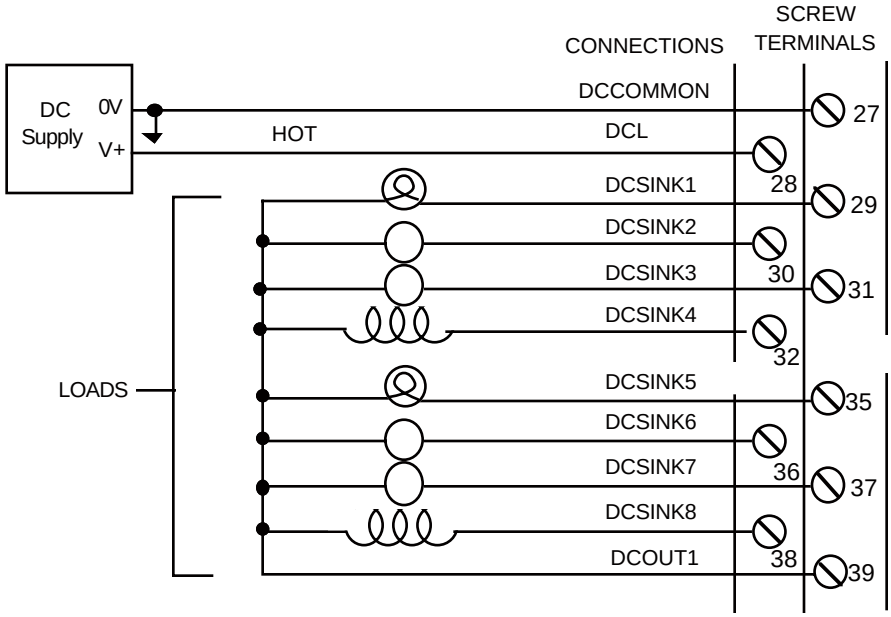
Figure C9-4. Connectors for Two Groups of Inputs



Connections for one group of outputs are illustrated in Figure C9-5.

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Figure C9-5. Connections for One Group of Outputs



Theory of Operation

Inputs

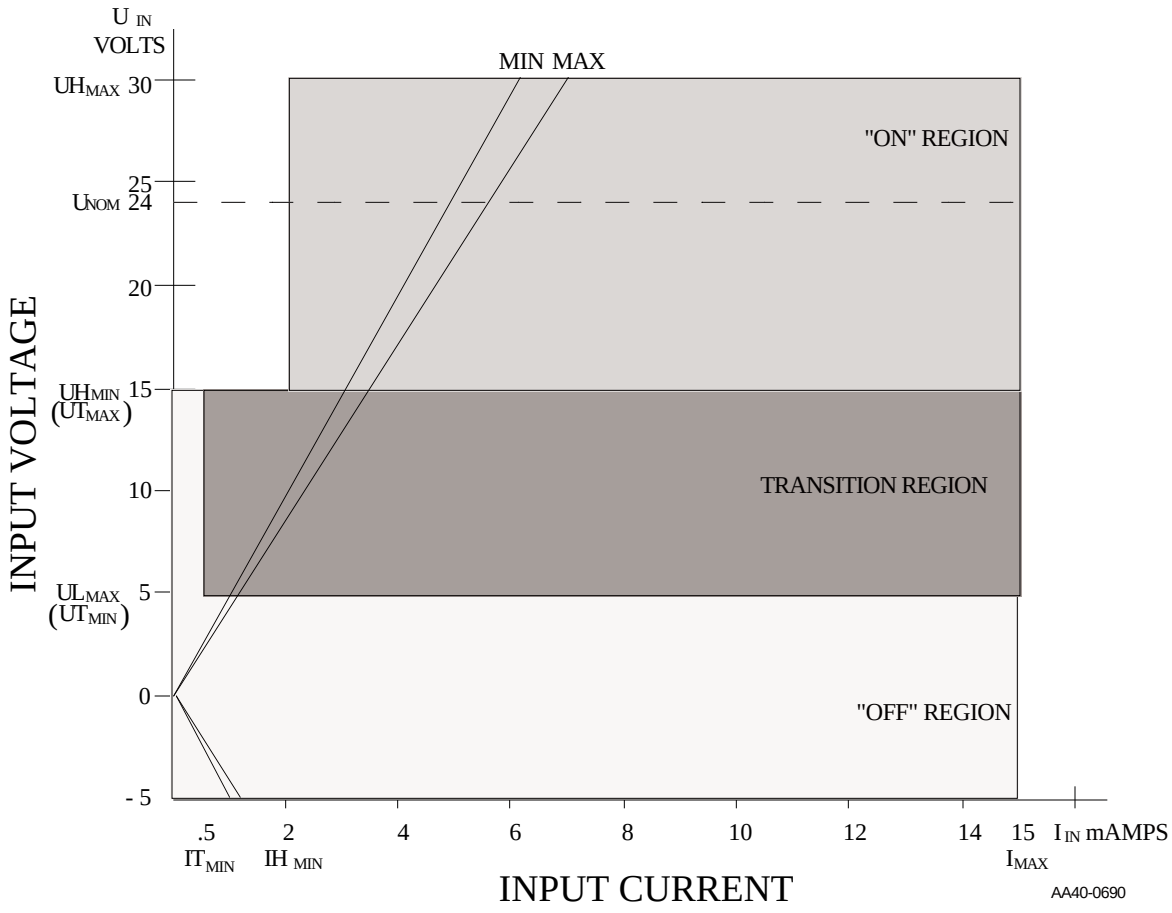
Each input is guaranteed "on" at 14 to 30 VDC and guaranteed "off" at 0 to 5 VDC. This is polarity independent. Its on/off state is converted to a corresponding logic 1 or 0. This logic state is transmitted through the system bus to the CPU module where the processor uses it as data in the ladder program. The logic side of the input is optically isolated from the field side.

An LED on the module indicates the logic state of each input. Each group is represented by a horizontal row of four LEDs. If you need to know whether voltage is present at the field side, use a voltmeter on the terminal screws.

The shaded blocks in Figure C9-6 show the limits specified by the IEC. The lines show the maximum and minimum V/I of the inputs in this module. The voltage/current curve in this graph shows that the input module is well within the IEC Type 1 limits.

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Figure C9-6. Input Characteristics Compared to IEC Standards



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IMPORTANT

Switching devices can sometimes have a leakage current that exceeds the IT_{min} (current allowed when off) of an input module. In order to use such a device, an impedance (typically, a resistor) needs to be used in parallel with the input.

For example, some of the newer proximity switches use two wires instead of three. The third wire was used for a power or ground line. Without the third wire, the switch is easier to install. However, it requires more leakage current in the off state to power its internal circuitry.

As a conservative estimate, use the following formula to calculate an external resistance value. It keeps the input voltage at or below 2.4V when the switching device is in the "off" state.

$$\frac{2.4V}{\text{Switch Leakage} - 0.75mA} \geq R$$

If the switch leakage specification is ≤ 1.7 mA, then:

$$\frac{2.4V}{1.7 - 0.75mA} \geq 2.5K\Omega$$

Use a resistor less than or equal to 2.5 K Ω. Be sure that the wattage is adequate for the resistor when the switching device is in the "on" state remembering that:

$$P = \frac{V^2}{R}$$

Outputs

Each output point is a solid state switch rated at .4 A. It turns on or off according to the logic state sent to it by the CPU. If the CPU sends it a logic 1, the switch closes and the load is provided a path to common. If the CPU sends a logic 0, the switch opens and power to the load is cut off. The CPU updates the logic state for each switch every time it scans the program.

The logic side of the switch is optically isolated from the field side. An LED gives the logic state of each switch. If you need to know whether voltage is actually present at the field side, use a voltmeter on the terminal screws.

A fuse in series with the source protects against current overload in case the outputs are shorted to ground.

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Protecting from an Inductive Load

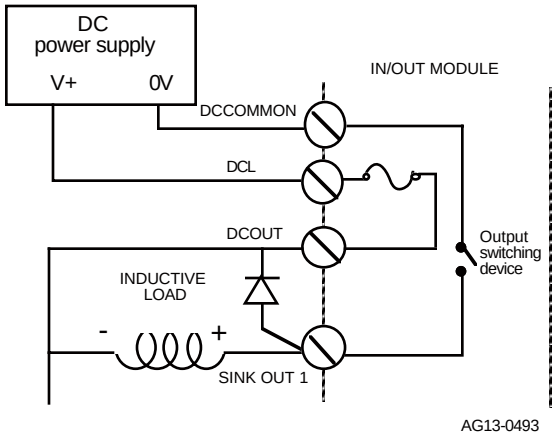
The outputs should be used for non-inductive loads such as resistive or electronic loads. Resistive loads can be connected to the module and controlled by the system with no precautions other than making sure they have a connection to the DCOUT fused supply. When an output is energized, current passes through the load into the common line. When the output is de-energized, current stops. The state of the outputs is controlled by the CPU module.

Inductive loads have an electrical "kickback" when current is stopped. This can damage or destroy the output switching device. When the output is turned off, the inductive field collapses. This creates a reverse voltage across the load called "kickback" which tries to continue the current. The voltage is in series with the DC power supply. The combined voltage appears across the output switching device in the module. If this were the only path available, voltage across the device would peak at several hundred volts.

IMPORTANT

If inductive loads need to be connected to the outputs, an external diode must be connected between the load and DCOUT as shown in Figure C9-7 below.

Figure C9-7. Connecting an External Diode



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Replacing a Fuse

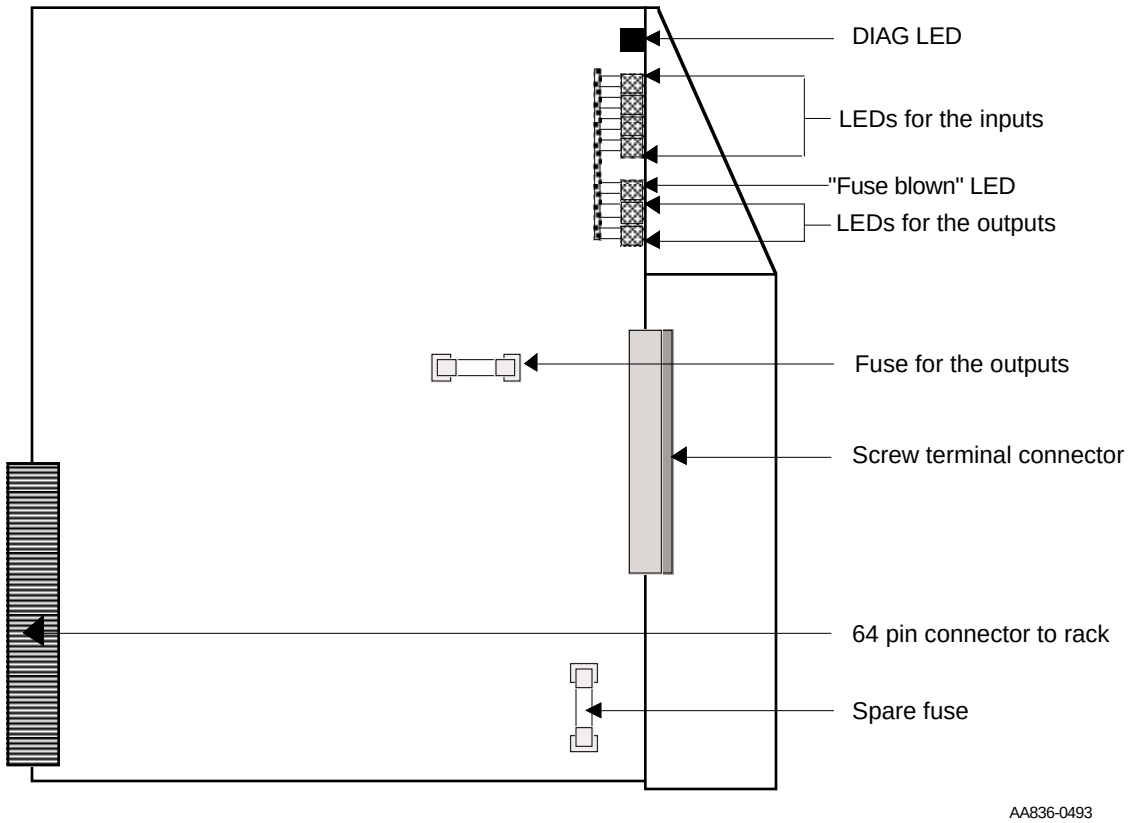
This module has one fuse for the outputs. The fuse is checked only when external power is applied. If power is applied and the fuse is blown or missing, the FB LED on the module lights up. The fuse is in series with the HOT line to the group to protect the output switching device and the load.

The fuse protects against a short circuit in an output device, but not against a sustained marginal overload current. See the specification table.

Follow the procedure below to change a blown fuse.

1. Turn off the main disconnect switch for the system rack and the external DC power supply to this module. Remove the screw terminal connector.
2. Press down the latch at the top of the module and pull it out of the rack. Lay it on a static-free surface, label side up. Ground yourself using an antistatic wrist strap before you open the module.
3. Press the plastic tabs at the top and bottom of the module toward each other and lift off the module cover.

Figure C9-8. Positions of Fuses



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4. Use an insulated screwdriver or fuse puller to remove the fuse. Put a new fuse in the slot. The replacement must be a fast-acting 3A 250 VAC fuse. The following are recommended:

   Littlefuse 235-003
   Bussman GMA-3
   or an equivalent.

   For your convenience, there is an extra fuse in the lower front corner of the module.

5. Replace the module cover, making sure that the top and bottom tabs are fully engaged.

6. Check the wiring to the devices to find why the fuse blew, and correct the situation before you continue running the program.

7. Slide the module back in its slot, connect the screw terminal connector, and turn power back on. After the diagnostic tests run, the DIAG and FB LEDs should both be off.

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Specification Table

Characteristic	Module specifications
Function	Monitors on/off states from up to 16 DC voltage inputs Sinks an external DC source to eight loads
Part number	502-03843-02
Field side connector	40-pin card edge connector, screw terminals
Logic side power requirements (typical)	30 mA @ 5V 7 mA per energized input @ +5V 25 mA per energized output @ +5V
Field side power dissipation (worst case at 32V DC)	3.6 W for inputs 4.0 W for outputs
Indicator lights, input/output circuits	An LED for each input/output
Indicator light, module	A DIAG LED turns OFF when the module passes its diagnostic tests at power-on
Indicator light, fuses	A logic side LED lights to indicate a "blown fuse" condition when power is on to the eight outputs when a fuse is missing or open
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers

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Physical size	1.6" wide x 12" high x 8.4" deep (including latch). 41 mm x 305 mm x 213 mm
Input section(16 pt)	
Input signals	Nominal 24 VDC on, 0 VDC off, conforming to IEC Type 1 inputs per IEC 1131-2 (two groups of eight inputs)
UH Max (max. allowed voltage)	30 VDC
IH Max (max. current @ 30 VDC)	7.5 mA
UL Min	Polarity independent
Guaranteed on	14 VDC
IH Min (min. current @ UH Min)	2.8 mA
Guaranteed off	5 VDC
IT Min (current allowed when off)	.75 mA
Time delay on	1 ms max.
Time delay off	1 ms max.
Protection of logic circuits	Optical isolation between the logic and field sides 4000 V peak
Output section (8 pt sink)	
DC source requirements	Nominal 24V DC; range 5 to 32 VDC
Protection of logic circuits	Optical isolation between the logic and field side
Grouping of outputs	One group of 8 solid-state switches. UL 508 spacing
Fuse per group of 8 switches	Fast-acting, UL rated 3A 250 VAC metric fuse, 5 x 20 mm
Maximum current per group	2 A of continuous current for the group; each switch is rated at .4 A continuous
Switch characteristics	Solid-state switches
Time delay on for resistive loads	30 µsec max
Time delay off for resistive loads	300 µsec max
Leakage current in off state	0.5 mA max
Switch voltage, maximum ON	1.8 VDC @ .4 A
Surge current, maximum	2.5 A for 40 msec., every 2 seconds
Response to scan loss (present)	All outputs are reset to the OFF state

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Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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C.10 - 24V DC Input/Output Source Module (16/8 points)

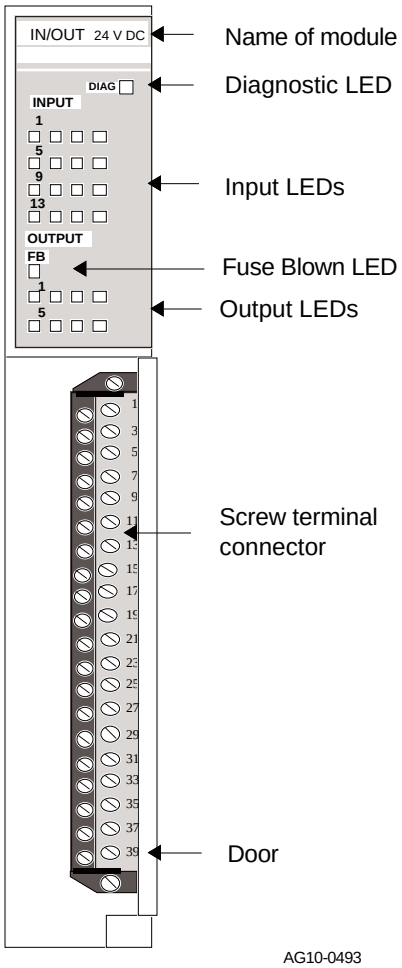
Introduction

The input section of the 24V DC I/O module converts DC signals from 16 devices into logic levels that the CPU can use. Each signal is converted into a corresponding logic 1 or 0 which is transmitted through the system bus to the CPU. An "on" signal is nominally 24 VDC, but can be any level between 14 and 30 volts. An "off" signal is any level below 5V. The wiring configurations may be sink or source. 16 LEDs on the module indicate the logic state of each input.

The output section of the module sources voltage for eight individual loads from one or two DC power supplies. Each external supply is nominally 24 volts, but can be between 5 and 32 volts. Eight LEDs indicate the logic state that drives each output. Another LED labeled FB turns on if the fuse in any active circuit is open or missing.

The DIAG LED goes on briefly while the diagnostics tests are running.

Figure C10-1. 24V DC input/output module (16/8 source PT)



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Connections

Inputs

A screw terminal connector is provided for each output and for each external power supply connection. The inputs are isolated in two groups of eight, with one additional terminal per group for the DC source/sink connection. The devices connected to terminals in the same group have a common DC supply and are wired in the same configuration, sink or source.

Outputs

A screw terminal connection is provided for each output and for each external power supply connection. The outputs are isolated in two groups of four with two additional terminals per group for the DC HOT (DCL) and COMMON (DC COMMON). See Figure C10-4.

Two terminals are provided for DC common. There is one common for each group of four outputs. Two terminals are provided for the DC supply input. The "fuse blown" LED circuit is active for any group that has a power supply connected.

The DC power supply for each group of four devices may be different if required. In most cases one power supply is daisy-chained to both groups.

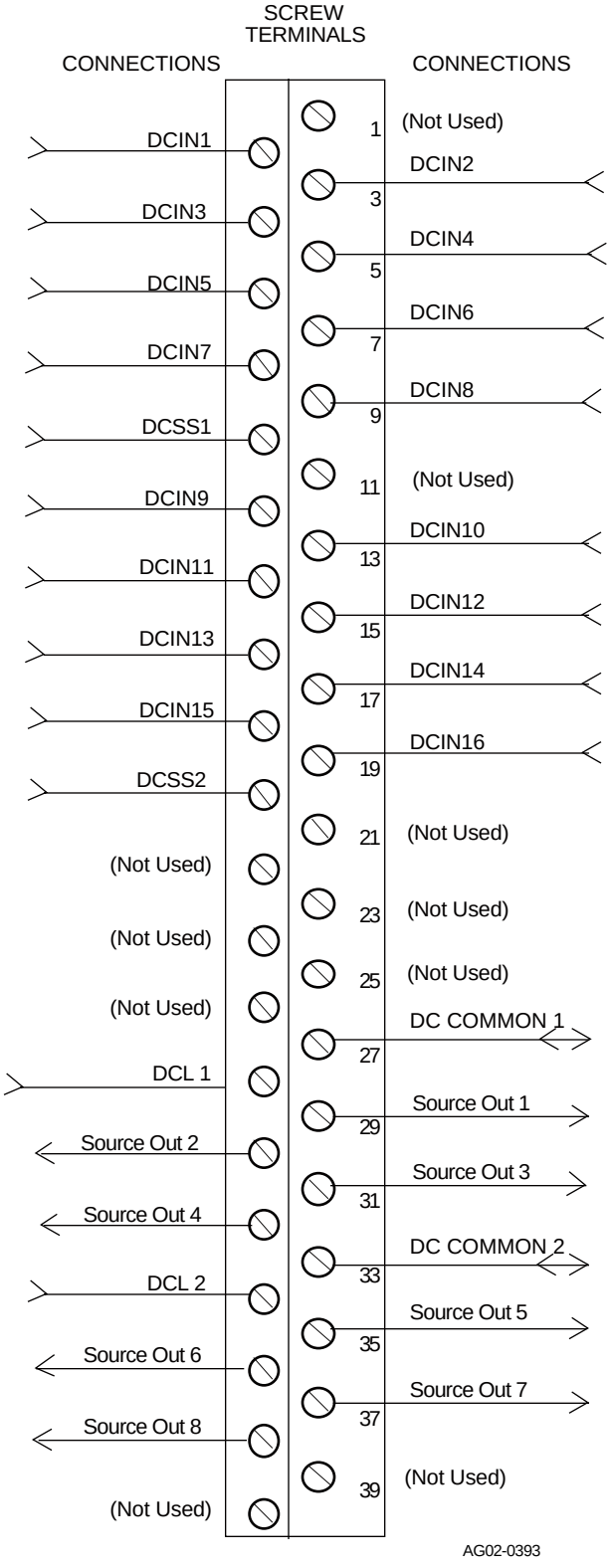
IMPORTANT
Do not connect the DC HOT (DCL) and COMMON (DCCOMMON) to a group unless you plan to use one or more of its outputs.

The external DC supplies that power the input and output signals should have a wire connected from their 0V (COMMON) terminal directly to the single-point ground used for the system rack. Their power disconnect switch should be the same one used for the system rack. In the power distribution diagrams in the Hardware chapter, a 24 VDC supply is set up according to these guidelines.

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Figure C10-2 shows the screw terminal connections for the module.

Figure C10-2. Screw Terminal Connector Assignments



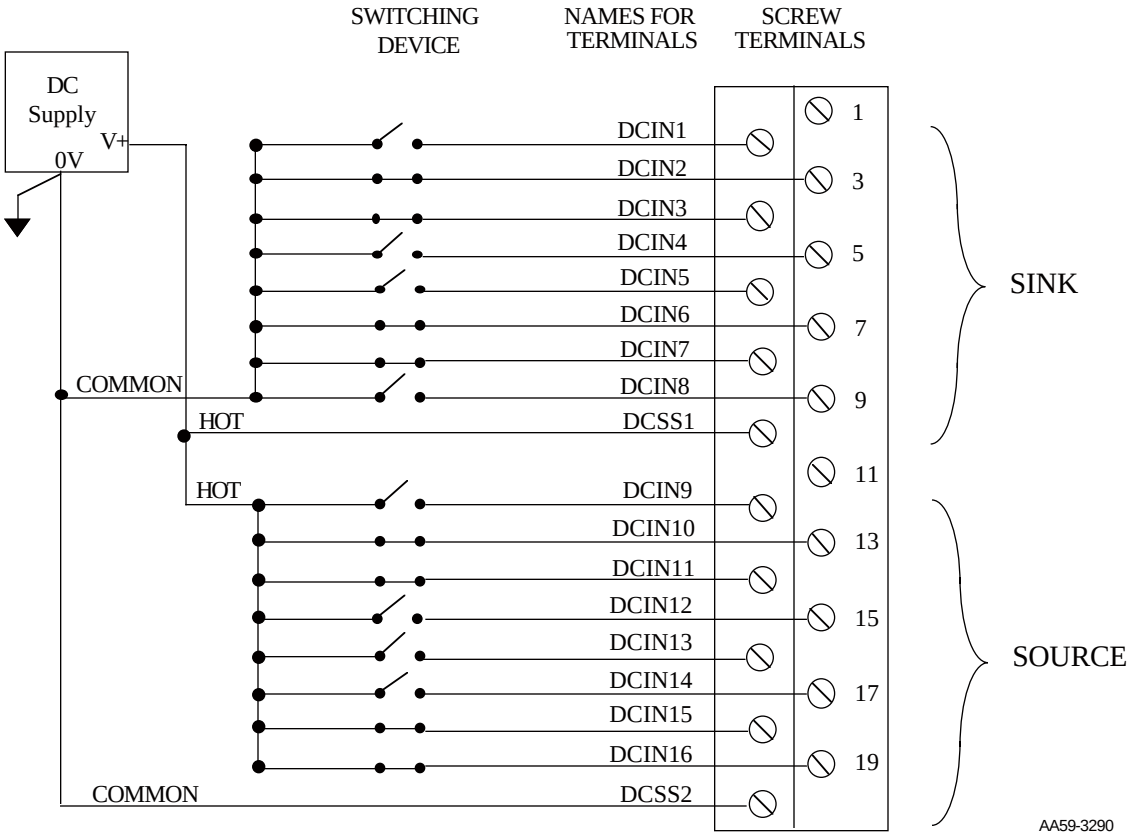
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Figure C10-3 illustrates two groups of inputs using the same power supply.

Each group can work independently of the other; one group may be sink and the other source. The DC power supply for each group may be different if required. Typically just one DC power supply is used, daisy-chained from one group to the next.

The first group of eight inputs is shown with devices "sinking" current through the module. The HOT (V+) terminal of the power supply must be connected to the module at DCSS1. The second group of eight inputs are shown with devices "sourcing" current through the input module. The COMMON (0V) terminal of the power supply must be connected to the module at DCSS2. In this example the DC power supply is the same for both group.

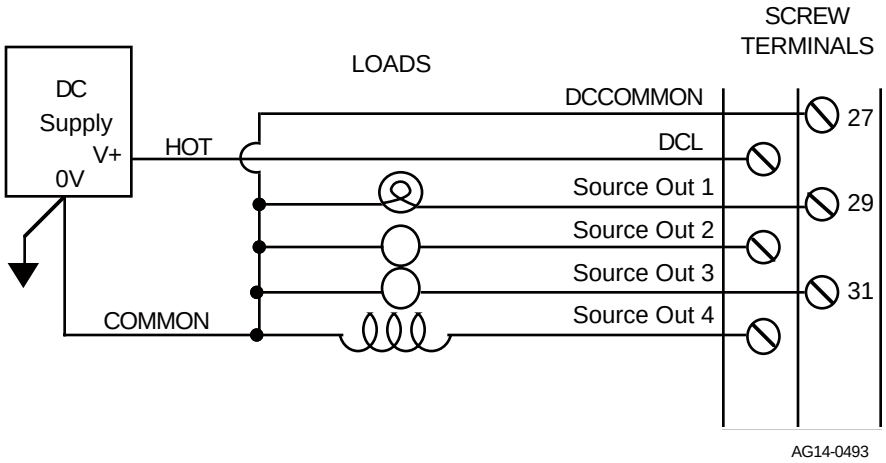
Figure C10-3. Connectors for Two Groups of Inputs



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Connections for one group of outputs are illustrated in Figure C10-4.

Figure C10-4. Connections for One Group of Outputs



Theory of Operation

Inputs

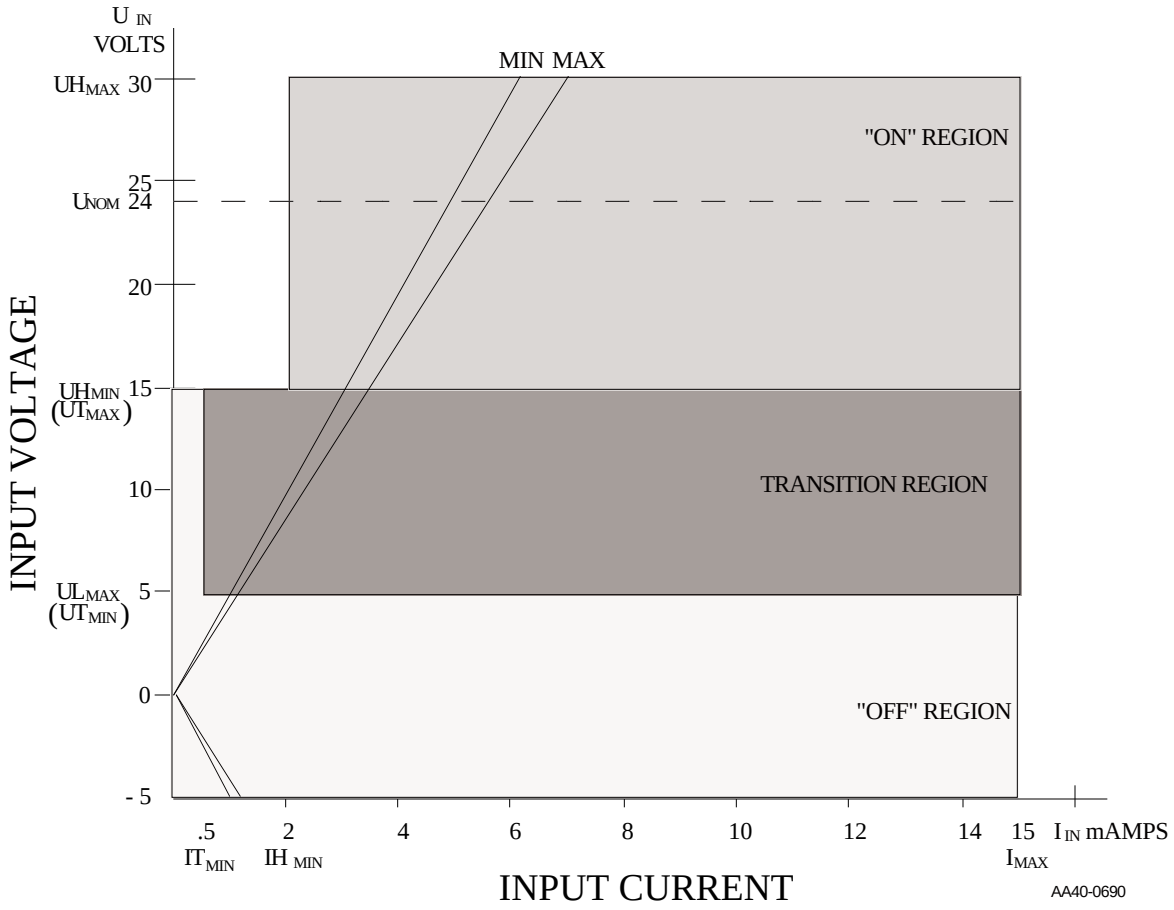
Each input is guaranteed "on" at 14 to 30 VDC and guaranteed "off" at 0 to 5 VDC. This is polarity independent. Its on/off state is converted to a corresponding logic 1 or 0. This logic state is transmitted through the system bus to the CPU module where the processor uses it as data in the ladder program. The logic side of the input is optically isolated from the field side.

An LED indicates the logic state of each input. Each group is represented by a horizontal row of 4 LEDs. If you need to know whether voltage is present at the field side, use a voltmeter on the terminal screws.

The shaded blocks in Figure C10-5 show the limits specified by the IEC. The lines show the maximum and minimum V/I of the inputs in this module. The voltage/current curve in this graph shows that the input module is well within the IEC Type 1 limits.

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Figure C10-5. Input Characteristics Compared to IEC Standards



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IMPORTANT

Switching devices can sometimes have a leakage current that exceeds the IT_{min} (current allowed when off) of an input module. In order to use such a device, an impedance (typically, a resistor) needs to be used in parallel with the input.

For example, some of the newer proximity switches use two wires instead of three. The third wire was used for a power or ground line. Without the third wire, the switch is easier to install. However, it requires more leakage current in the off state to power its internal circuitry.

As a conservative estimate, use the following formula to calculate an external resistance value. It keeps the input voltage at or below 2.4V when the switching device is in the "off" state.

$$\frac{2.4V}{\text{Switch Leakage} - 0.75mA} \geq R$$

If the switch leakage specification is ≤ 1.7 mA, then:

$$\frac{2.4V}{1.7 - 0.75mA} \geq 2.5K\Omega$$

Use a resistor less than or equal to 2.5 K Ω. Be sure that the wattage is adequate for the resistor when the switching device is in the "on" state remembering that:

$$P = \frac{V^2}{R}$$

Outputs

Each output point is a solid state switch rated at .75 A. It is turned on or off according to the logic state sent to it by the CPU. If the CPU sends it a logic 1, the switch closes and the device is powered. If the CPU sends a logic 0, the switch opens and power to the device is cut off. The CPU updates the logic state for each switch every time it scans the program.

The logic side of the switch is optically isolated from the field side. An LED gives the logic state of each switch. The four LEDs representing a group are in a horizontal row on the module. There are two rows for the two groups. If you need to know whether voltage is actually present at the field side, use a voltmeter on the terminal screws.

Each group has its own protective fuse in series with the source to protect against current overload in case the outputs are shorted to ground. In addition, each output is protected with internal clamping diodes. Without clamping, high voltage transients (kickback) from inductive loads might damage the module.

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Protecting from an Inductive Load

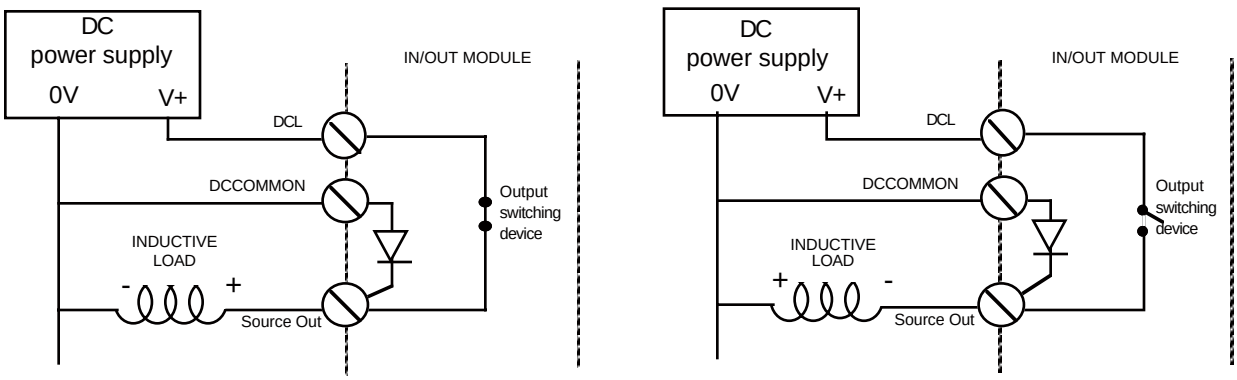
Resistive loads can be connected to the module and controlled by the system with no precautions other than making sure they have a connection to the DCOUT fused supply. When an output is energized, represented on the left in Figure C10-6 by a closed switch, current passes through the load into the common line. When the output is de-energized, represented on the right in C10-6 by an open switch, current stops. The state of the outputs is controlled by the CPU module.

Inductive loads have an electrical "kickback" when current is stopped. This can damage or destroy the output switching device. Each output in the Output 24V DC module has a diode through which reverse current can be safely routed.

Figure C10-6 shows how the internal diode works with an inductive load. When the output is turned off the inductive field collapses. This creates a reverse voltage across the load called "kickback" which tries to continue the current. The voltage is in series with the DC power supply. The combined voltage appears across the output switching device in the module.

If this were the only path available, voltage across the device would peak at several hundred volts. The internal diode provides another path for current. This limits the peak reverse voltage across the load to less than 1 V. You can connect an inductive load to any of the output source terminals.

Figure C10-6. Diagram of Internal Protection for Inductive Loads (Outputs 1 to 8)



Replacing a fuse

This module has two fuses, one for each group of outputs. Fuses are checked only for groups which have external power applied. If power is applied to a group in which the fuse is blown or missing, the FB LED on the module lights up. The fuse is in series with the HOT line to the group to protect the output switching device and the load.

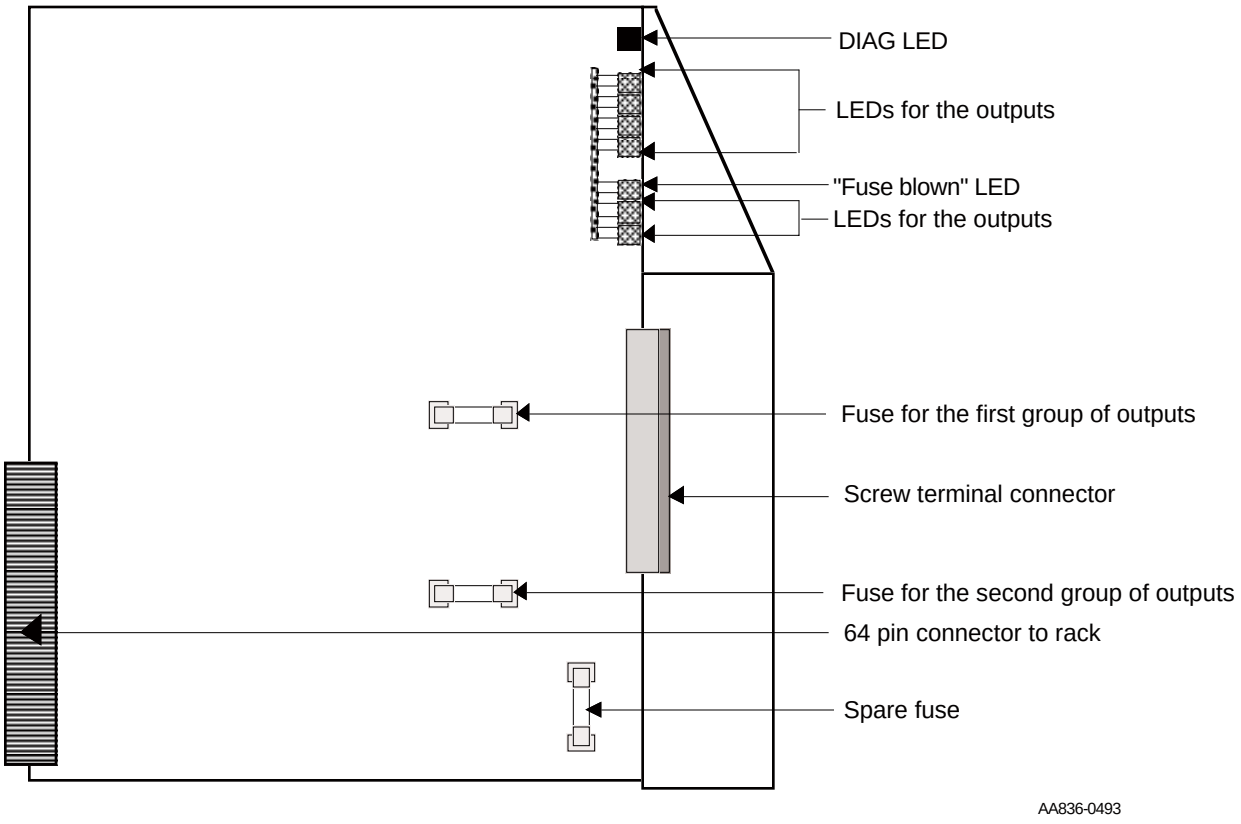
The fuse protects against a short circuit in an output device, but not against a sustained marginal overload current. See the specification table.

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Follow the procedure below to change a blown fuse.

1. Turn off the main disconnect switch for the system rack and the external DC power supply to this module. Remove the screw terminal connector.
2. Press down the latch at the top of the module and pull it out of the rack. Lay it on a static-free surface, label side up. Ground yourself using an antistatic wrist strap before you open the module.
3. Press the plastic tabs at the top and bottom of the module toward each other and lift off the module cover.

Figure C10-7. Positions of Fuses



4. Identify the fuse that has blown, and use an insulated screwdriver or fuse puller to remove it. Put a new fuse in its slot. The replacement must be a fast-acting 3A 250 VAC fuse. The following are recommended:

   Littlefuse 235-003
   Bussman GMA-3
   or an equivalent.

   For your convenience, there is an extra fuse in the lower front corner of the module.

5. Replace the module cover, making sure that the top and bottom tabs are fully engaged.

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6. Check the wiring to the devices to find why the fuse blew, and correct the situation before you continue running the program.
7. Slide the module back in its slot, connect the screw terminal connector, and turn power back on. After the diagnostic tests run, the DIAG and the FB LEDs should both be off.

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Specification Table

Characteristic	Input/Output module specifications
Function	Monitors on/off states from up to 16 DC voltage inputs Sources an external DC source to 8 loads
Part number	502-03842-02
Field side connector	40-pin card edge connector, screw terminals
Logic side power requirements (typical)	30mA@ +5V 7 mA per energized input @ +5V 23 mA per energized output @ +5V for outputs
Field side power dissipation worst case (at 32 VDC)	3.6 W for inputs 6.4 W for outputs
Indicator lights, input/output circuits	An LED indicates the logic state of each input/output
Indicator light, module	The DIAG LED goes OFF when the module passes power-on diagnostic tests
Indicator light, fuses	A logic side LED lights to indicate a "blown fuse" condition when power is on to a group with missing or open fuse
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch). 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)
Input section(16 pt)	
Input signals	Nominal 24 VDC on, 0 VDC off, conforming to IEC Type 1 inputs per IEC 1131-2 (two groups of eight inputs)
UH Max (max. allowed voltage)	30 VDC
IH Max (max. current @ 30 VDC)	7.5 mA
UL Min	Polarity independent
Guaranteed on	14 VDC
IH Min (min. current @ UH Min)	2.8 mA
Guaranteed off	5 VDC
IT Min (current allowed when off)	.75 mA

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Time delay on	1 ms max.
Time delay off	1 ms max.
Protection of logic circuits	Optical isolation between the logic and field sides, 4000 V peak
Output section (8 pt source)	
DC source requirements	Nominal 24V DC; range 5 to 32 VDC
Protection of logic circuits	Optical isolation between the logic and field side
Grouping of outputs	Two groups of four solid-state switches. UL 508 spacing
Fuse per group of 8 switches	Fast-acting, UL rated 3A 250 VAC metric fuse, 5 x 20 mm
Maximum current per group	2 A of continuous current for the group; each switch is rated at .75 A continuous
Switch characteristics	Solid-state switches
Time delay on for resistive loads	30 µsec max
Time delay off for resistive loads	300 µsec max
Leakage current in off state	0.5 mA max
Switch voltage, maximum ON	1.8 VDC @ .4 A
Surge current, maximum	2.5 A for 40 msec., every 2 seconds
Response to scan loss (present)	All outputs are reset to the OFF state

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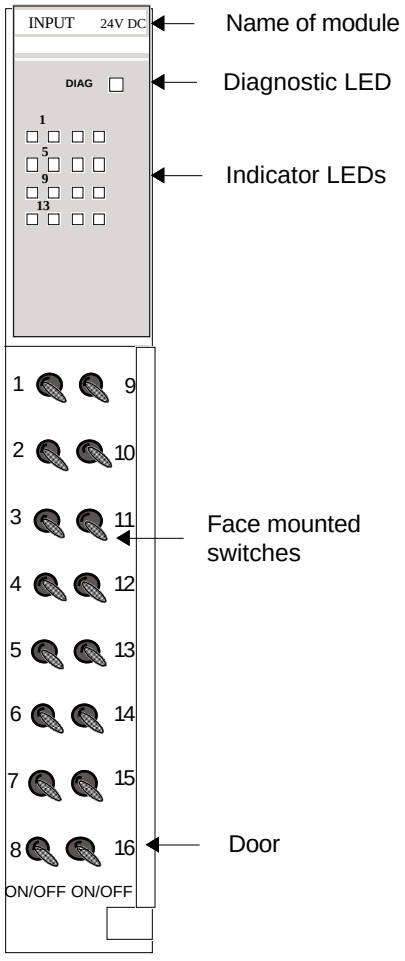
C.11 - Input Switch Module (16 switches)

Introduction

The input switch module converts the position status of 16 on/off switches mounted on the face plate into logic levels that the CPU can use. The on/off position status of each switch is converted into a corresponding logic 1 or 0 which is transmitted through the system bus to the CPU module.

16 LEDs in the upper section of the module indicate the logic state of each switch input. The DIAG LED goes on briefly while the diagnostic tests are running.

Figure C11-1. INPUT switch module (16)



Theory of Operation

The switch module contains the same circuitry as the input 24VDC module. In addition, it has an internal 5V to 15VDC converter. This 15VDC source is electrically isolated from the logic and is routed to each face mounted switch. Each

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switch can then supply either 15VDC (on) or 0V (off) to an optically isolated input.

The switch's on/off state is converted to a corresponding logic 1 or 0. This logic state is transmittted through the system bus to the CPU module where the processor uses it as data in the ladder program. An LED in the upper section of the module indicates the logic state of each input.

Specification Table

Characteristic	Input switch (16) module specifications
Function	Monitors on/off states from up to 16 face mounted switches
Part number	502-03651-00
Field side connector	25-pin card edge connector, face plate, switches
Protection of logic circuits	Optical isolation between the logic and field sides
Indicator lights, input circuits	An LED indicates the logic state of each switch
Indicator light, module	The DIAG LED goes OFF when the module passes power-on diagnostic tests
Logic side power requirements (typical)	2 mA @ +5V 11mA per energized input @ +5V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm.
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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Appendix D - Servo/Feedback Modules

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D.1 - Input Encoder Module (2, 4, or High-Speed 4 channel)

Introduction

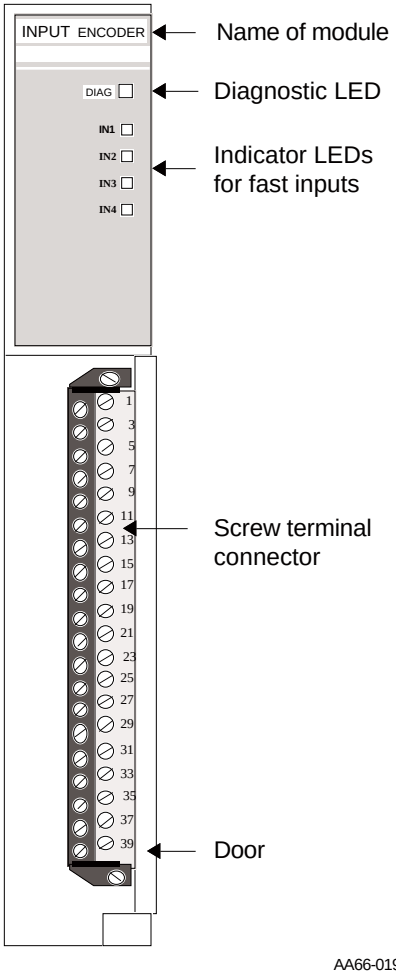
The encoder module can interface to two or four independent incremental encoders or equivalent devices. Information from the encoders is used to update four separate position counters and latches within the module.

For each channel, a 24-bit counter is incremented or decremented based on signals it receives from the A and B outputs of an encoder. The counter value can be latched (stored) if the module receives either an "index" signal from the encoder or a 24 VDC "fast" input signal.

An LED in the upper section of the module goes on when the fast input for each channel is energized.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure D1-1. INPUT ENCODER module



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Connections

All signals to the encoder module must come to its screw terminal connector through shielded twisted pair wires. These wires must be protected against electrical noise because of the speed and/or voltage levels of the signals transmitted through them. See the discussion on "Preventing electrical noise in data lines" in the Hardware chapter.

Each encoder module channel has four signal pairs, each of which has two screw terminal connections. The signal pairs are:

encoder input A
encoder input B
index input
24 VDC fast input

In addition the module has eight screw connections for terminating the shields. All eight are connected together inside the module. They are the same point electrically and are connected internally to SPG.

IMPORTANT

The power supply to the encoder (or signal source device) must have its common connected to the SPG.

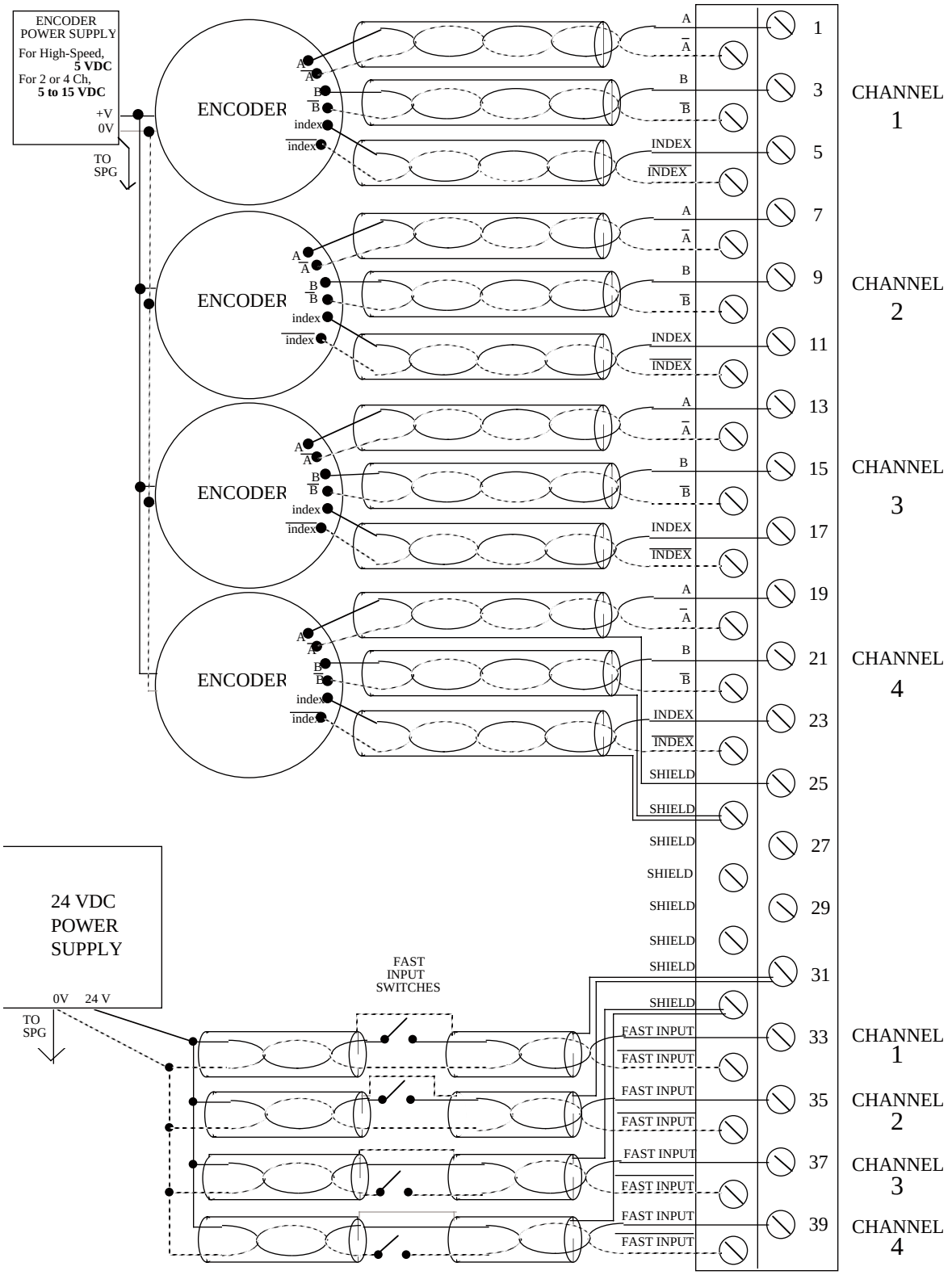
If the 24 VDC "fast" input is used, its power supply common must also be connected to the SPG.

Figure D1-2 shows the assignments for all the screw terminal connections on the module. To make the diagram more readable,

- The shielded twisted pair wires are shown with transparent shields.
- The shielded twisted pair wires are shown grounded only for channel 4. In an actual application, every cable shield must be grounded.
- For the 4 channel module, the fast inputs for channels 1 and 2 are shown in source configuration; those for channels 3 and 4 are shown in sink configuration.

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Figure D1-2. Connections for the Input encoder module (4 ch) terminals



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Encoder Drivers

For 2, 4 , and high-speed encoder modules

Acceptable drivers provided by encoder manufacturers include:

Differential voltage drivers	75183 8830 75114 9614 26LS31

For 2 or 4 channel encoder modules

Single-ended open collector drivers	7406

339 type output devices will not work with the Input encoder module (2, 4 ch) because their output current level is too low.

NOTE

Encoders with differential drivers are strongly recommended. They provide better noise immunity and capability for the module to detect "loss of feedback."

See the section in the Hardware chapter on "Preventing electrical noise in data lines" for a comparison of signals from differential and single-ended drivers.

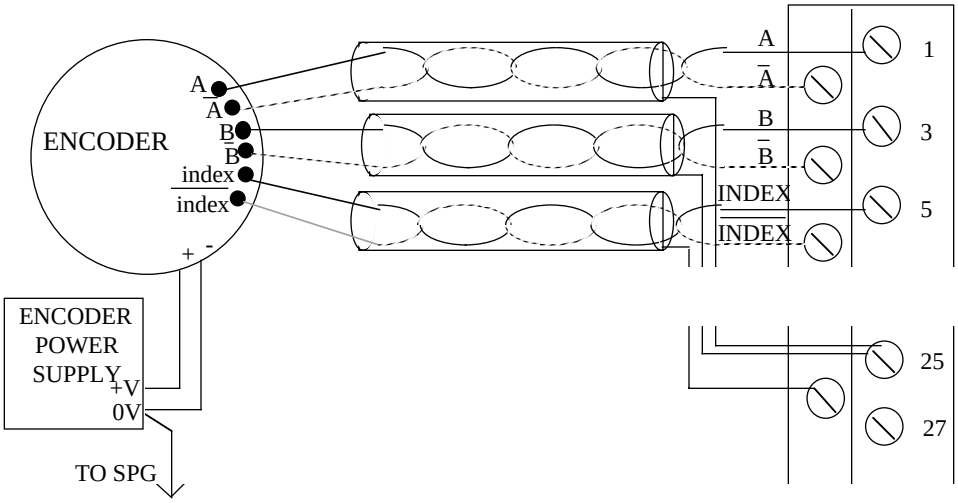
If the encoder has differential output drivers as shown in Figure D1-3, the three encoder outputs are paired:

A and $\overline{A}$
B and $\overline{B}$
index and $\overline{index}$

The high speed encoder module accepts differential inputs only.

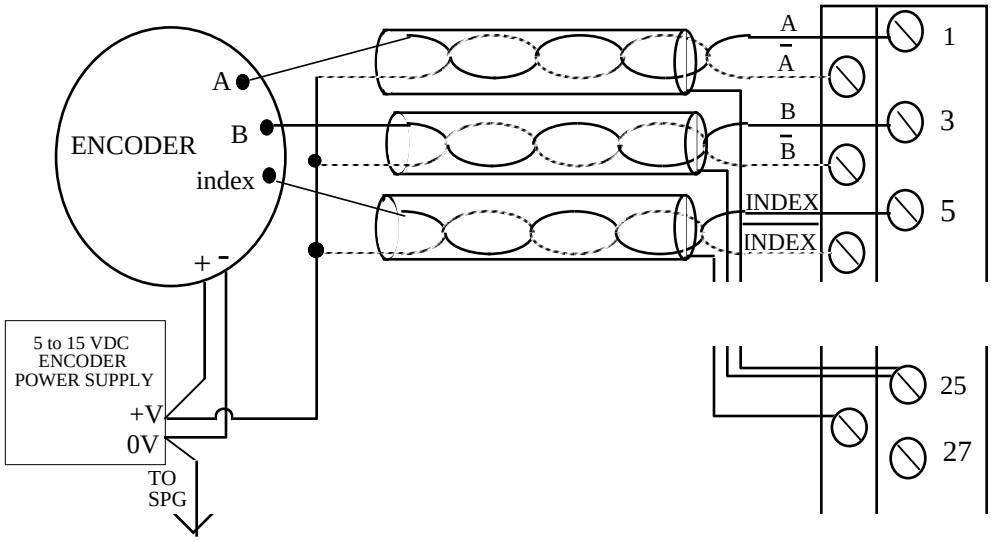
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Figure D1-3. Wiring from an Encoder with Differential Drivers



If the 2 or 4 channel encoder has single-ended drivers, there are three single outputs: A, B, and index. Each output is referenced to the +V terminal of the encoder power supply. (See Figure D1-4.)

Figure D1-4. Wiring from an Encoder with Single-Ended Drivers



The signal at output A or B from the encoder has a frequency that is the product of:

the resolution of the encoder in pulses (lines) per revolution, and
the speed of the encoder in revolutions per second.

Thus an encoder that generates 2,000 pulses (lines) per revolution and rotates at 10 revolutions per second generates 20,000 pulses (lines) per second. In a quadrature

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type encoder, the interface module would supply 80,000 Feedback Units per second.

Incremental Encoders

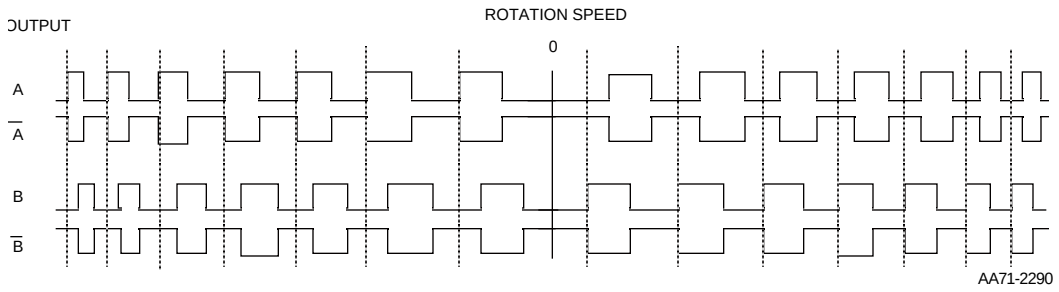
An *incremental encoder* is a position transducer. It transmits quadrature or pulse type signals through its "A" and "B" outputs with a frequency proportional to the rotational velocity of its shaft. It transmits a pulse through its index output once per revolution of the device.

There are two types of incremental encoders, quadrature and pulse. Giddings & Lewis recommends quadrature type encoders, which are the most commonly used.

A *quadrature encoder* sends square wave type signals. When the shaft rotates at a constant velocity, the A and B outputs are square waves and are at the same frequency. However they are out of phase with each other by 90°. When the encoder shaft rotates in one direction, each A pulse leads the corresponding B pulse by 90°. When it rotates the other direction each A pulse lags its B pulse by 90°.

The signals illustrated in Figure D1-5 indicate that the encoder shaft rotates in one direction at first. Its speed of rotation decreases to 0 and then it starts rotating the other direction. The signals are shown as differential. $\overline{A}$ is the inverse of the signal A and $\overline{B}$ is the inverse of signal B.

Figure D1-5. Signals Transmitted by a Quadrature Encoder with Differential Outputs

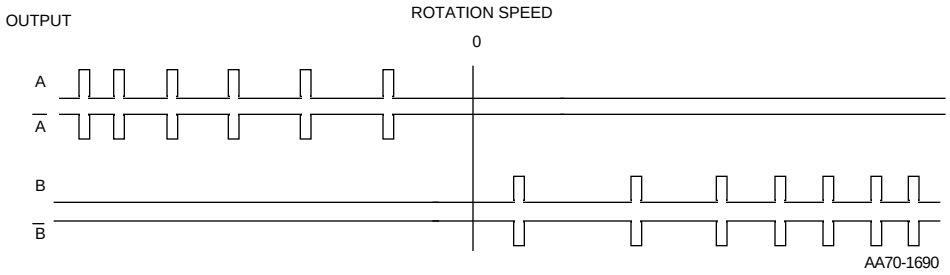


A *pulse encoder* sends pulses through output A for one direction of its shaft rotation, and output B for the other direction. When the shaft is not rotating, no pulse is generated.

The signals illustrated in Figure D1-6 indicate that the encoder shaft rotates in one direction at first. Its speed of rotation decreases to 0 and then it starts rotating the other way. The signals are shown as differential, with the inverse of signal A and the inverse of signal B. A pulse encoder may alternate signals at its two outputs, but it cannot send signals from both outputs at the same time.

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Figure D1-6. Signals Transmitted by a Pulse Encoder with Differential Outputs



Theory of Operation

The encoder module uses differential type inputs to interface with up to four independent incremental encoders.

Quadrature Type

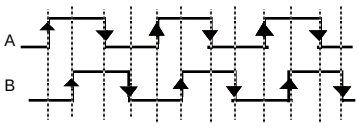
For the 2, 4 channel module

- The maximum input frequency is 250,000 lines per second, which results in 1,000,000 Feedback Units (FUs) per second in the encoder module.

For the high-speed module

- The maximum input frequency is 2,500,000 lines per second, which results in 10,000,000 Feedback Units (FUs) per second in the encoder module.

Figure D1-7. Counting quadrature pulses



The module counts positive and negative transitions at both channel A and channel B. One quadrature cycle in this case gives 4 Feedback Units.

Pulse Type

For the 2, 4 channel module

- The module can accept up to 500,000 pulses per second at either input.

For the high-speed module

- The module can accept up to 5,000,000 pulses per second at either input.

For each encoder channel, there is a 24-bit up/down counter. It is incremented or decremented in accordance with the counting mode selected. There is also a 24-bit latch associated with each Input encoder module channel.

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The module can be programmed so that the counter value is "latched" or stored under one of these conditions:

- an index pulse from the encoder
- a positive or negative transition of the fast input
- the next index pulse after the required transition of the fast input

Each of the four 24-bit latches has a *fast 24 VDC input* associated with it. Each input is optically isolated. This input is intended to receive a signal from a device other than an encoder. It is typically used for referencing or synchronization purposes.

Fast input characteristics include:

- The detection of a signal occurs faster than it does for the DC inputs in other modules, due to less filtering. Because of this there is also less noise immunity.
- The response to a fast input signal is independent of ladder scan time. The module can be programmed to latch a position count as soon as this input is detected.

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Specification table

Characteristic	Input Encoder module (2, 4, HS) specifications
Function	Counts pulses from up to 4 encoders Latches the counter value at an index or 24 VDC input event
Part number	4 ch 502-03782-02 (2.5 VDC - 7 VDC) 502-03786-02 (3.5 VDC - 16.5 VDC) 2ch 502-03782-22 (2.5 VDC - 7 VDC) 502-03786-22 (3.5 VDC - 16.5 VDC) high-speed 502-03947-00
2,4 Ch Encoder (A, B, and index) High-speed Encoder	Differential or single ended; differential recommended 2632 differential receiver
Guaranteed on, min.	502-03782-XX 502-03786-XX 2.5 VDC @ 2.5 mA 3.5 VDC @ 7.3 mA
Input voltage, max.	502-03782-XX 502-03786-XX 502-03947-00 7 VDC 16.5 VDC 5 VDC
Input current, max.	502-03782-XX 502-03786-XX) 22 mA @ 7 VDC 30 mA @ 16.5VDC
Input voltage, threshold (high-speed) Input termination (high-speed)	±200mV 120 Ω
Signal pulse width, min. (2, 4 ch) (high-speed)	.6 µs(600 ns) 75 ns
Quad signal freq, max. (2, 4 ch) (high-speed)	250 KHz for A or B input (1 M FU count rate) 2.5 MHz (10M FU count rate)
Pulse signal freq, max. (2, 4 ch) (high-speed)	500 KHz for A or B input (500 KFU count rate) 5 MHz (5M FU count rate)
Field side connection	40 pin card edge connector, screw terminals
Encoder device	1. Quadrature type incremental encoder (recommended) 2. Pulse type incremental encoder
Stored position value range	24-bit up/down counter 24-bit latch
Fast input	Nominal 24 VDC, switched externally to the module Active high or low Reverse polarity protected
Voltage max.	30 VDC

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Guaranteed on	15 VDC
Guaranteed off	5 VDC
Input impedance	2.7 K
On/off time, max.	50 µs
Indicator light	LED is lit when current flows into the input
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
Cable length, max. (2, 4 ch)	200 ft. @ 250 KHz and 45° quad error (with differential driver)
Cable length, max. (high speed)	50 ft. @ 2.5 MHz with 100 ns minimum separation between A and B
Logic side power requirements (typical for 2, 4 ch)	572 mA @ +5V 1 mA @ +15V 1 mA @ -15V 21 mA per energized input @ +5V 12 mA per fast input @ +5V
Logic side power requirements (typical for high-speed)	370 mA @ +5V 12 mA per fast input @ +5V
Field side power dissipation, worst case (2, 4 ch)	7.4 W
Field side power dissipation, worst case (high speed)	1.5 W from encoder +5V supply 1.6 W from fast input supply
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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NOTES

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D.2 - Input Resolver Module (2, 4 channel)

Introduction

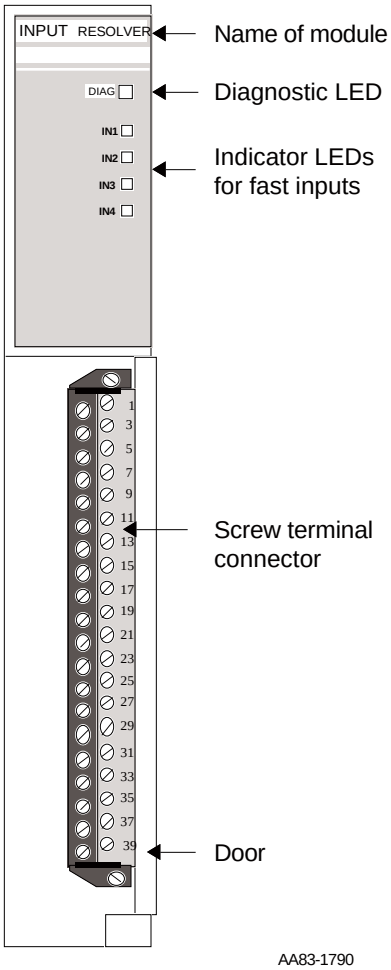
The input resolver module can interface to two or four independent resolvers (or equivalent transducers). Information from the resolvers is used to update two or four separate position counters and latches within the module.

For each channel, the module sends out two sine waves 90° out of phase with each other and receives a signal whose phase represents the angular position of the resolver. This input signal is used to update a 24-bit counter. This module can be programmed to "latch" (store) the counter value when a signal is received by the fast input for that channel.

An LED in the upper section of the module goes on when the fast input for each channel is energized.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure D2-1. INPUT RESOLVER module (4 CH)



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Connections

All signals to the resolver module must come to its screw terminal connector through shielded twisted pair wires. These wires must be protected against electrical noise because of the speed and/or voltage levels of the signals transmitted through them. See the discussion in the Hardware chapter on "Preventing electrical noise in data lines".

Each input resolver channel has four signal pairs, each of which has two screw terminal connections. The signals are:

RPO output
QPO output
FDBK input
24 VDC fast input

In addition the module has eight screw connections for terminating the shields. All eight are connected inside the module so they are the same point electrically.

IMPORTANT

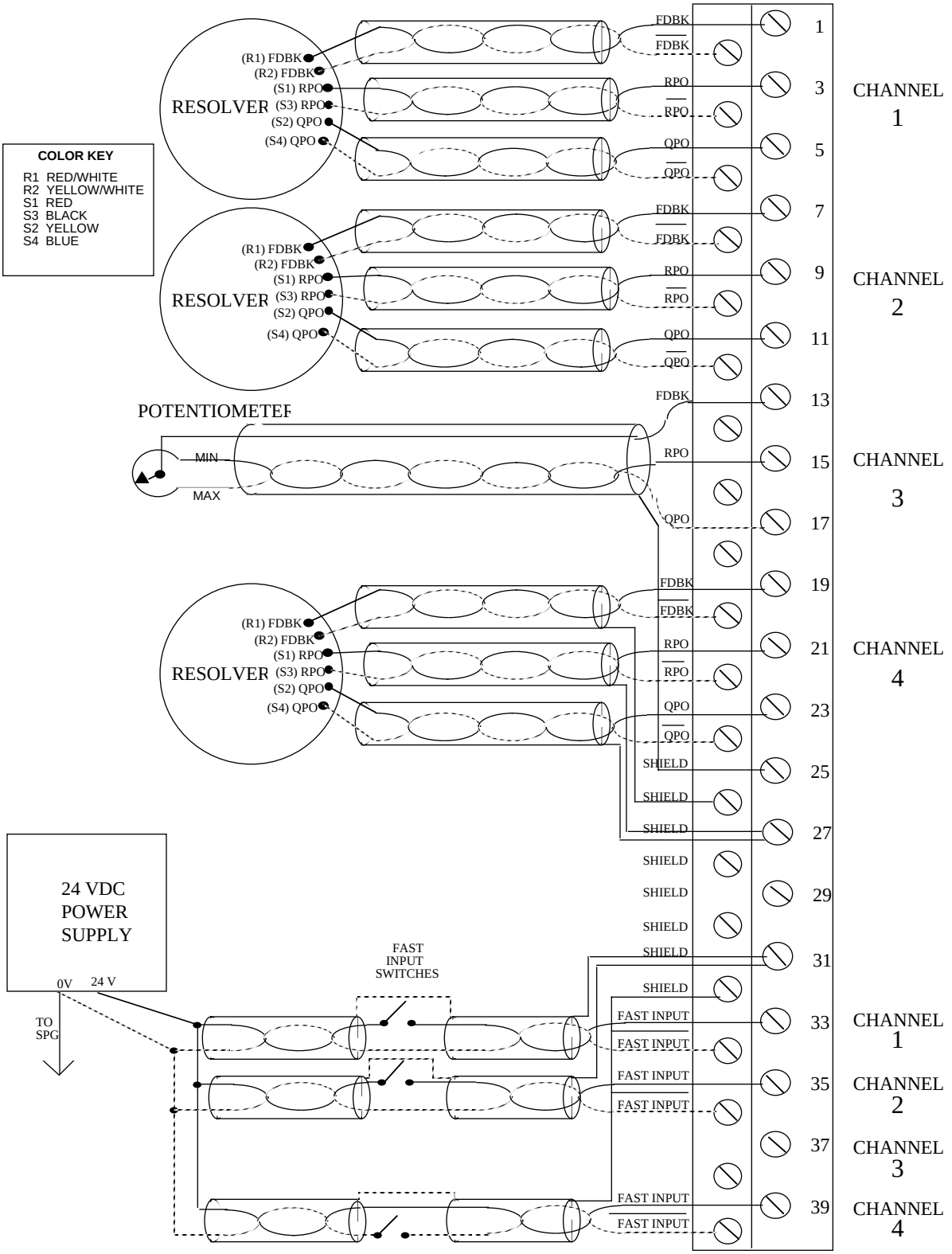
If the 24 VDC fast input is used, its power supply common must be connected to the SPG.

Figure D2-2 shows the assignments for all the screw terminal connections on the module. To make the diagram more readable,

- The shielded twisted pair wires are shown with transparent shields.
- Channel 3 shows how a potentiometer can be wired to the module.
- The shielded twisted pair wires are shown grounded only for channel 4. In an actual application, every cable shield must be grounded.
- The fast inputs for channels 1 and 2 are shown in source configuration; that for channel 4 is shown in sink configuration.

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Figure D2-2. Connections for the Input Resolver Terminals

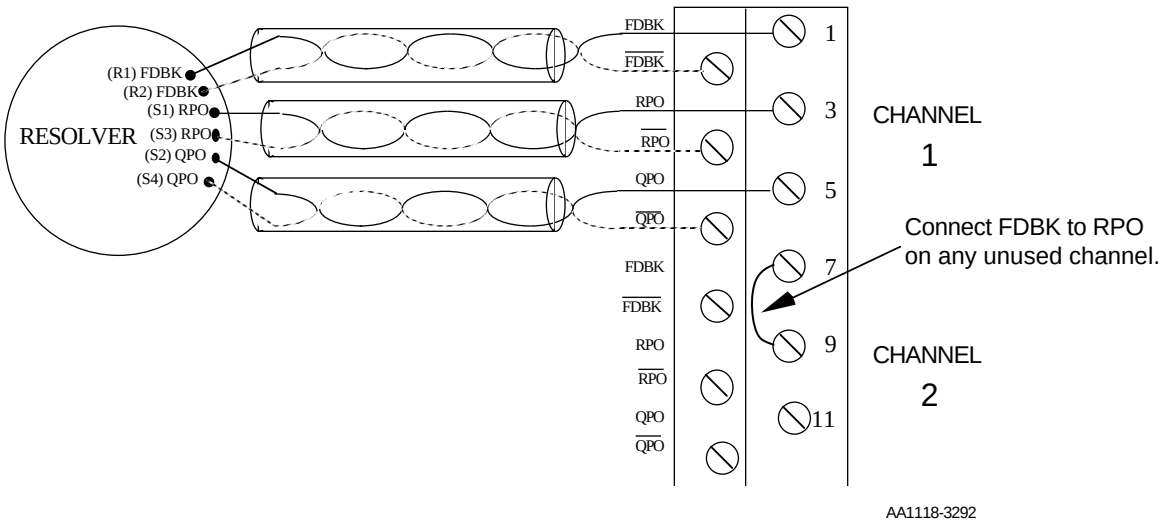


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IMPORTANT

If a channel is not being used, tie its FDBK input to its RPO output to ensure proper operation. See Figure D2-3.

Figure D2-3. Unused Channel Connection

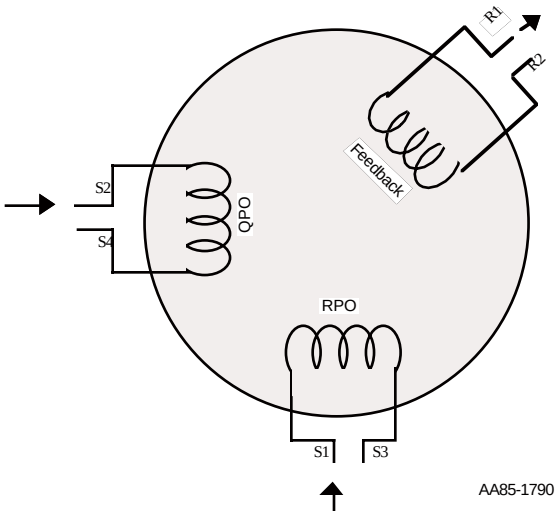


Resolvers

A resolver (Figure D2-4) is a servo feedback device which provides absolute position over one electrical revolution. It receives RPO (reference phase output) and QPO (quadrature phase output) signals from the interface module. RPO and QPO signals are sine waves 90° out of phase with each other. They energize two stator coils positioned at 90° to each other. The stator coils induce a sine wave signal called FDBK (feedback) in the rotor coil. The phase of this signal, with respect to RPO, depends on the rotor coil's position.

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Figure D2-4. Diagram of a Resolver



The recommended resolver has a part number in the specification sheet at the end of this section. Other resolvers may be used, if they conform to the interface module specifications.

Theory of Operation

The module sends out two sine wave signals, RPO and QPO. These signals have the same voltage amplitude and frequency but are 90° out of phase. The module then receives a FDBK sine wave signal whose phase is a measure of the angular rotation of the resolver.

The phase information is used to increment or decrement an internal 24-bit up/down counter. A phase shift of 360° corresponds to 4,000 counts of resolution, so one count represents 5.4 arc-minutes of rotation of the resolver. The value in the counter thus represents the current position of the resolver.

In addition to the counter, there is a 24-bit latch associated with each resolver interface. This module can be programmed so that the counter value is *latched* or stored when a fast 24 VDC input pulse is received for that channel.

Each of the four 24-bit latches has a *fast 24 VDC input* associated with it. Each input is optically isolated. This input is typically used for referencing or synchronization purposes.

Fast input characteristics include:

- The detection of a signal occurs faster than it does for the DC inputs in other modules, due to less filtering. Because of this there is also less noise immunity.
- The response to a fast input signal is independent of ladder scan time. The module can be programmed to latch a position count as soon as this input is detected.

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Specification Table

Characteristic	Input Resolver module specifications
Function	Measures the position of a transducer that accepts a 2-phase quadrature excitation, such as a resolver or potentiometer
Part number	4 ch 502-03552-02 2 ch 502-03552-22
Field side connector	40 pin card edge connector, screw terminals
Excitation method	2-phase quadrature for control transformer type of resolver
Excitation frequency	2 KHz
RPO and QPO outputs	
Output voltage	16 V_{P-P} (5.7 V_{RMS})
Current per output channel, max.	4ch 5 mA $_{RMS}$ (14 mA $_{p-p}$) 2ch 10mA$_{RMS}$ (20 mA $_{p-p}$)
Resolver transformer ratio	.5 to 1.0
Resolution, resolver	4000 Feedback Units (FUs) per electrical revolution
Resolution, potentiometer	1000 Feedback Units (FUs) per electrical revolution
Accuracy at constant temperature	± 20 arc minutes
Accuracy over temperature range	± 45 arc minutes
Electrical velocity, max.	15000 RPM (1M FU/Sec.)
Cable length, max.	200 ft.
Stored position value range	24-bit up/down counter 24-bit latch
Fast input	Nominal 24 VDC
Reverse polarity protection	YES
Voltage max.	30 VDC
Guaranteed on	15 VDC
Guaranteed off	5 VDC
Input impedance	2.7 K
On/off time, max.	50 µs
Indicator lights, fast inputs	LED is lit when current flows into the input.
Indicator light, module	DIAG LED goes off when the module passes its diag-nostic tests

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Logic side power requirements (typical for 4 ch)	473 mA @ 5V 133 mA @+15V 20 mA @-15V 14 mA per energized input @ +15V 14 mA per energized input @ -15V 12 mA per fast input
Logic side power requirements (typical for 2 ch)	296 mA @ 5V 105 mA @ +15V 16 mA @ -15V 14 mA per energized input @ +15V 14 mA per energized input @ -15V 13 mA per fast input
Field side power dissipation, worst case	4 ch 1.4 W 2 ch .7W
Recommended resolver	Giddings & Lewis part number 501-98409-00 Harowe 11BRW 300-F-1/10
Other suggested resolvers	Clifton 11BHW-0IE/A004 Kearfott CR41095050
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.

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UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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D.3 - Input Multi-Channel Resolver Module (12 channel)

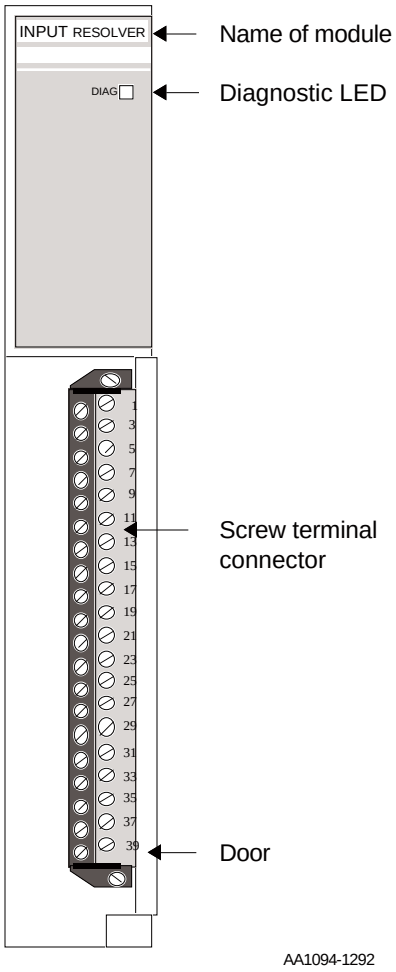
Introduction

The input multi-channel resolver module can interface to 12 independent resolvers (or equivalent transducers). Feedback information from the resolvers is used to update the on-board memory. The position of each resolver can be read at any time by the PiC900.

For each channel, the module sends out two sine waves 90° out of phase with each other and receives a signal whose phase represents the angular position of the resolver. The resolution of the angular position is 4000 counts per revolution or 0.09 degrees.

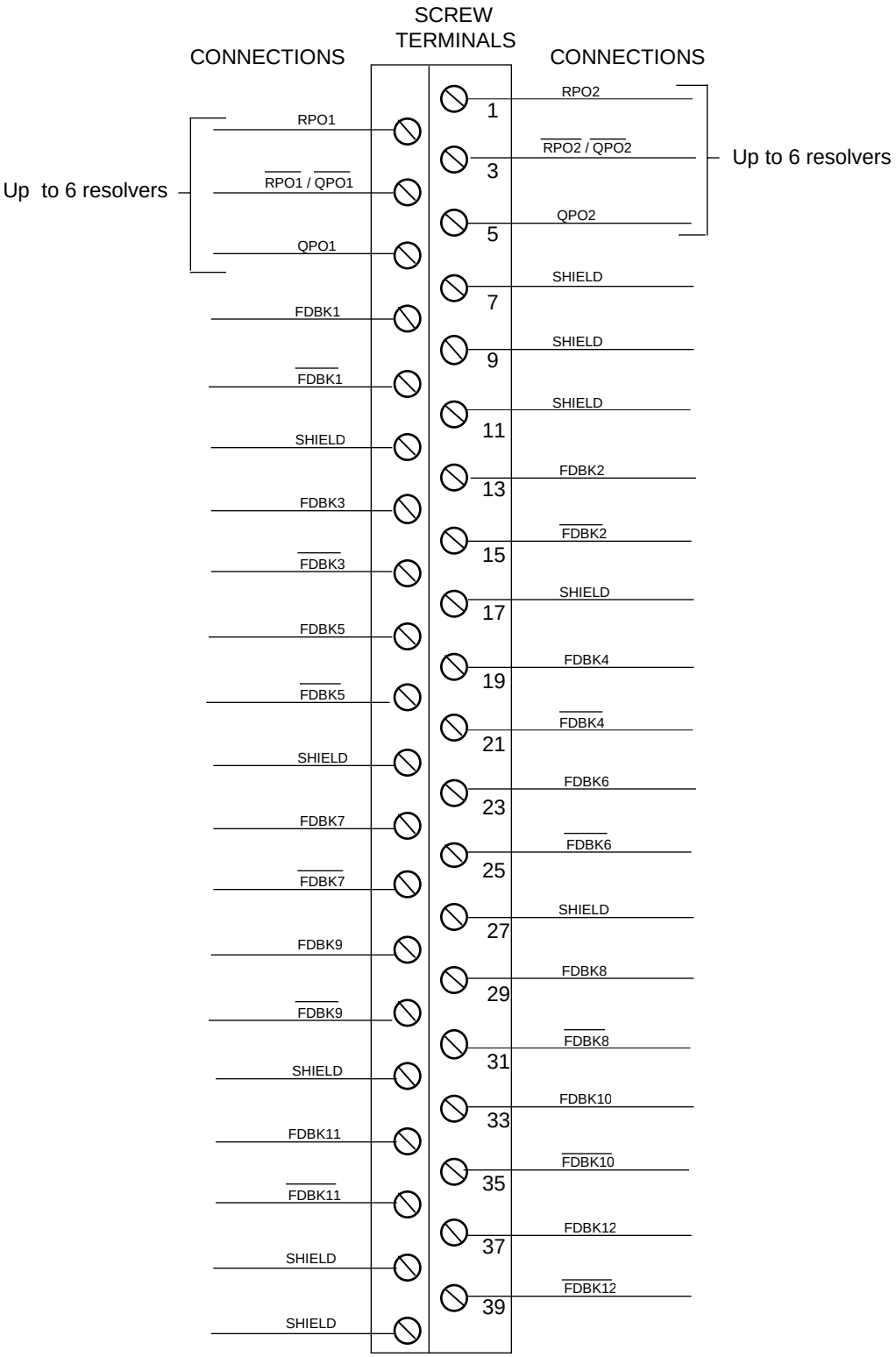
The DIAG LED goes on briefly while the diagnostic tests are running.

Figure D3-1. INPUT RESOLVER (Multi-Channel) Module (12 CH)



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Figure D3-2. Connections for the Input Resolver Terminals



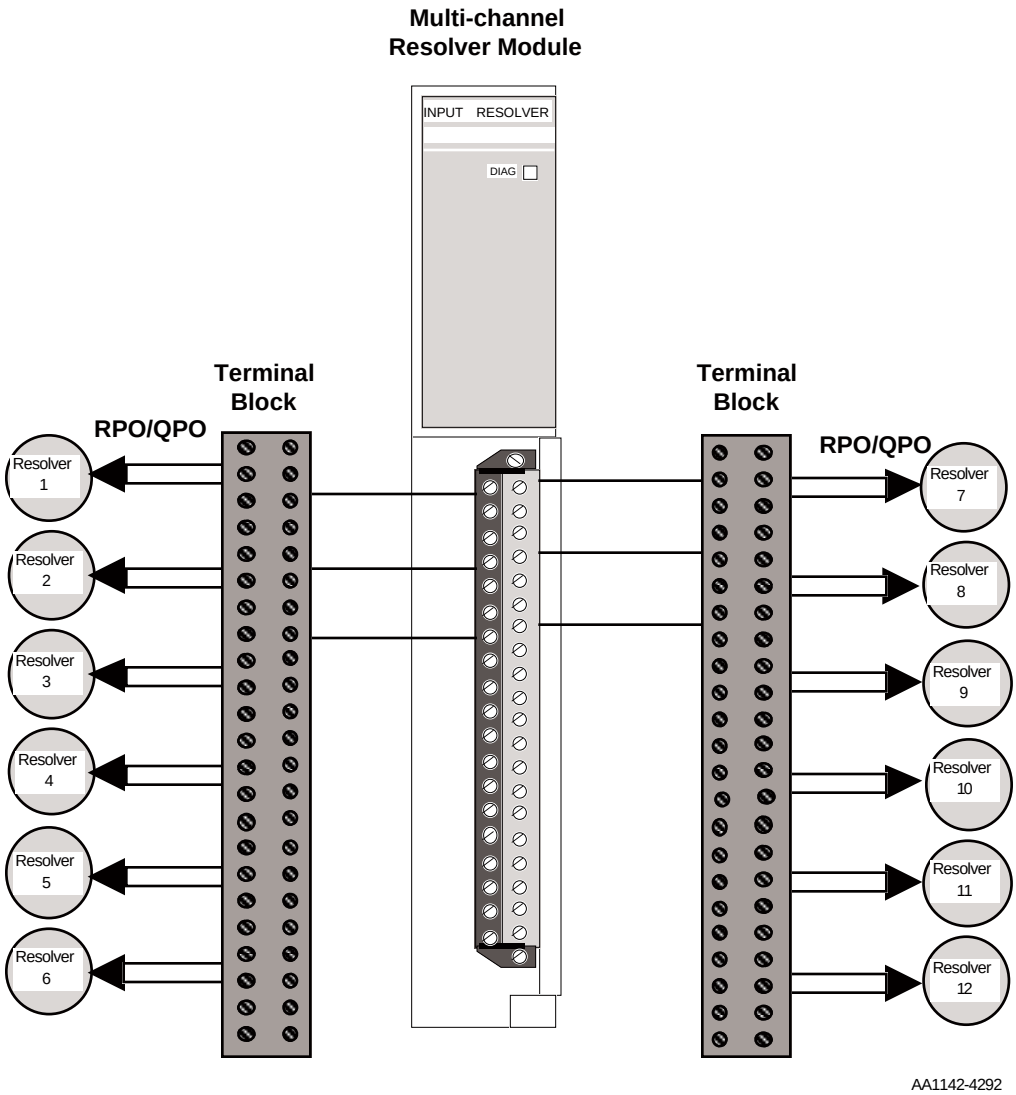
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Connections

Figure D3-2 shows the screw terminal connections for the multi-channel resolver module.

To connect 12 resolvers to the multi-channel resolver module, two user-supplied external terminal blocks must be used - one for each group of six resolvers as shown in Figure D3-3. (See Figure D3-4 for detail wiring of one resolver.)

Figure D3-3. Using Terminal Blocks to Connect 12 Resolvers



Each resolver has three signal pairs. The signals and where they are connected are listed below. All signals from the resolvers must come to the screw terminal connectors (either on the multi-channel resolver or on the terminal block) through shielded twisted pair wires. These wires must be protected against electrical noise because of the speed and/or voltage levels of the signals transmitted through them.

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The maximum length of the twisted pair wire from the resolver to the terminal block is 100 feet.

Signal pair from resolver	Connection
RPO and /shield	To terminal block
QPO and /shield	To terminal block
FDBK and /shield	To multi-channel resolver

The feedback from each resolver is brought back to the appropriate feedback channel connections on the multi-channel resolver module. The module has nine screw connections for terminating the feedback shields. All are connected inside the module so they are the same point electrically. If you are using more than nine resolvers, some of the feedback shields will have to be doubled up on the shield connections.

The shields from the RPO and QPO signals are terminated on shield screw connections on the terminal block.

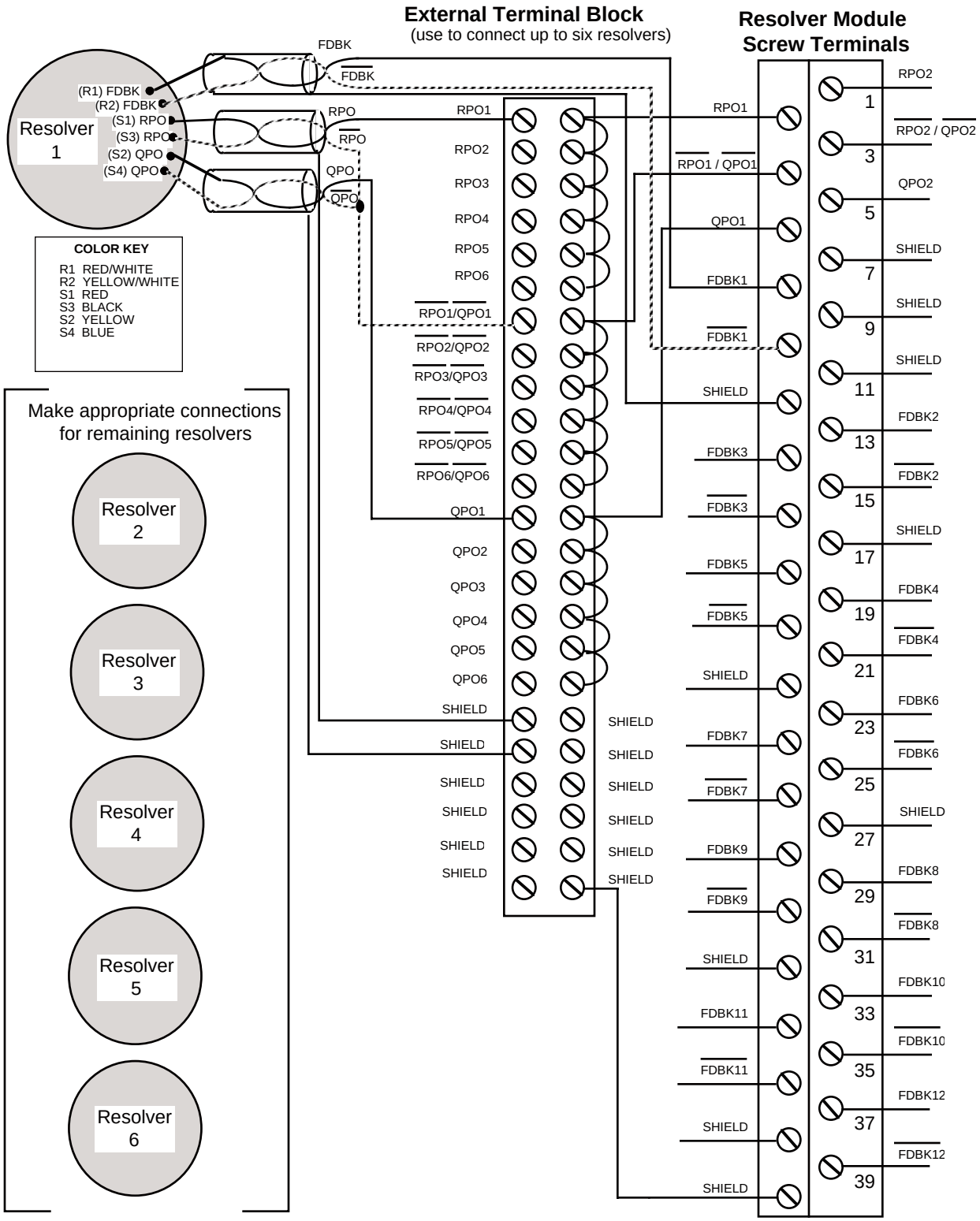
The shield at the device end of the cable is not connected.

Figure D3-4 shows how to wire a terminal block and the first resolver. The RPO, QPO, and outputs from the module are each connected to the terminal block. Each is then jumpered so that there are six signals of each type available for the six resolvers (RPO1, RPO2,... QPO1, QPO2,... , ,... etc.). 18 AWG wire is recommended for these connections. The maximum wire length between the multi-channel resolver module and the terminal block is 6 feet.

The feedback signal from the resolver and its shield are wired directly to the module, not the terminal block.

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Figure D3-3. Connecting Resolver to Terminal Block to Module

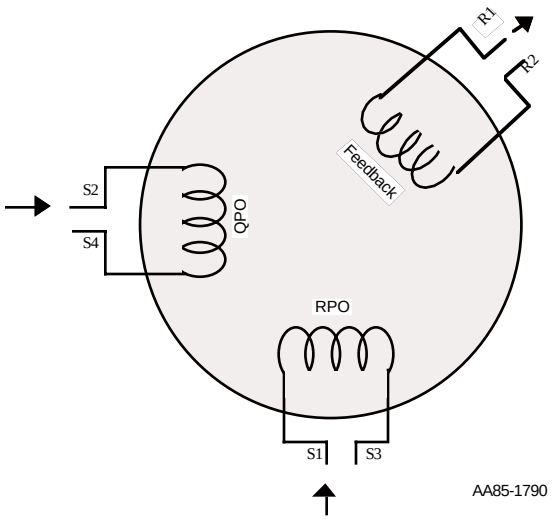


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Resolvers

A resolver (Figure D3-5) is a servo feedback device which provides absolute position over one electrical revolution. It receives RPO (reference phase output) and QPO (quadrature phase output) signals from the interface module. RPO and QPO signals are sine waves 90° out of phase with each other. They energize two stator coils positioned at 90° to each other. The stator coils induce a sine wave signal called FDBK (feedback) in the rotor coil. The phase of this signal, with respect to RPO, depends on the rotor coil's position.

Figure D3-4. Diagram of a Resolver



The recommended resolver has a part number in the specification sheet at the end of this section. Other resolvers may be used if they conform to the interface module specifications.

Theory of Operation

The module sends out two sine wave signals, RPO and QPO. These signals have the same voltage amplitude and frequency but are 90° out of phase. The module then receives a FDBK sine wave signal whose phase is a measure of the angular rotation of the resolver.

A phase shift of 360° corresponds to 4,000 counts of resolution, so one count represents 5.4 arc-minutes of rotation of the resolver. The value in the on-board memory represents the current position of the resolver.

The on-board memory position is updated every 3.0 msec for each of the 12 resolvers. There is a loss of feedback indicator for each resolver.

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Specification Table

Characteristic	Input Resolver (12 ch) ModuleSpecifications
Function	Measures the position of a transducer that accepts a 2-phase quadrature excitation, such as a resolver or potentiometer
Part number	502-03722-02
Field side connector	40 pin card edge connector, screw terminals
Excitation method	2-phase quadrature for control transformer type of resolver
Excitation frequency	4KHz
RPO and QPO outputs	
Output voltage	15 V_{P-P} (5.3V_{RMS})
Current per output channel, max.	100 mA
Resolver transformer ratio	.5 to 1.0
Resolution, resolver	4000 Feedback Units (FUs) per electrical revolution
Resolution, potentiometer	1000 Feedback Units (FUs) per electrical revolution
Accuracy at constant temperature	± 12 arc minutes
Accuracy over temperature range	± 5.4 arc minutes /10˚F
Velocity, max.	15000 electrical RPM (1M FU/Sec.)
Cable length, max.	6 ft. from module to terminal block (18 AWG) 100 ft. from terminal block to resolvers (twisted pair)
Stored position value range	0-3999
Indicator light, module	DIAG LED goes off when the module passes its power-on diagnostic tests
Logic side power requirements (typical)	200 mA @ +5V 60 mA @ +15V 60 mA @ -15V
Recommended resolver	Giddings & Lewis part number 501-98409-00 Harowe 11BRW 300-F-1/10
Other suggested resolvers	Clifton 11BHW-0IE/A004 Kearfott CR410959
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)

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Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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D.4 - Servo Module Encoder with Analog Input

Introduction

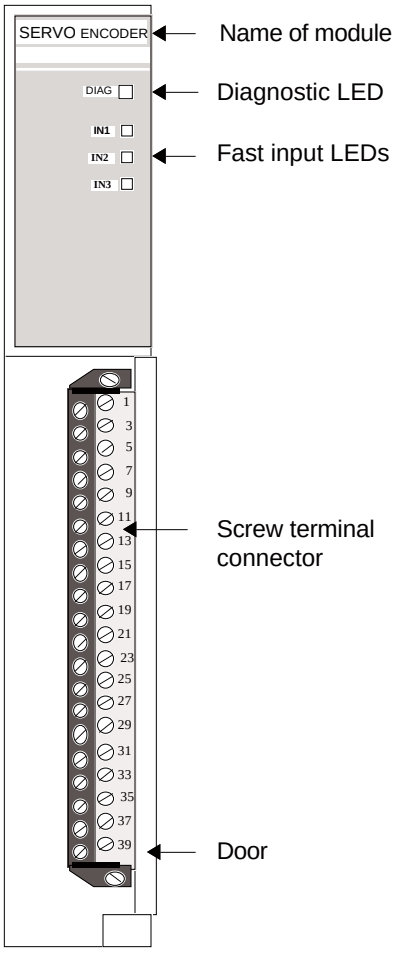
The servo encoder module provides:

- 2 analog output channels
- 4 analog input channels
- 3 encoder input channels
- 3 fast inputs

An LED goes on when the fast input for each encoder channel is energized.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure D4-1. Servo Encoder Module



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Connections

All signals to the module must come to the screw terminal connectors through shielded twisted pair wires. Shielded twisted pair wires are used to connect:

- Each analog output channel to a receiving device.
- All analog input signals to the module.
- All encoder signals to the module.
- All fast input signals to the module.

These wires must be protected against electrical noise because of the speed and/or voltage levels of the signals transmitted through them. See the discussion on "Preventing electrical noise in data lines" in the Hardware chapter.

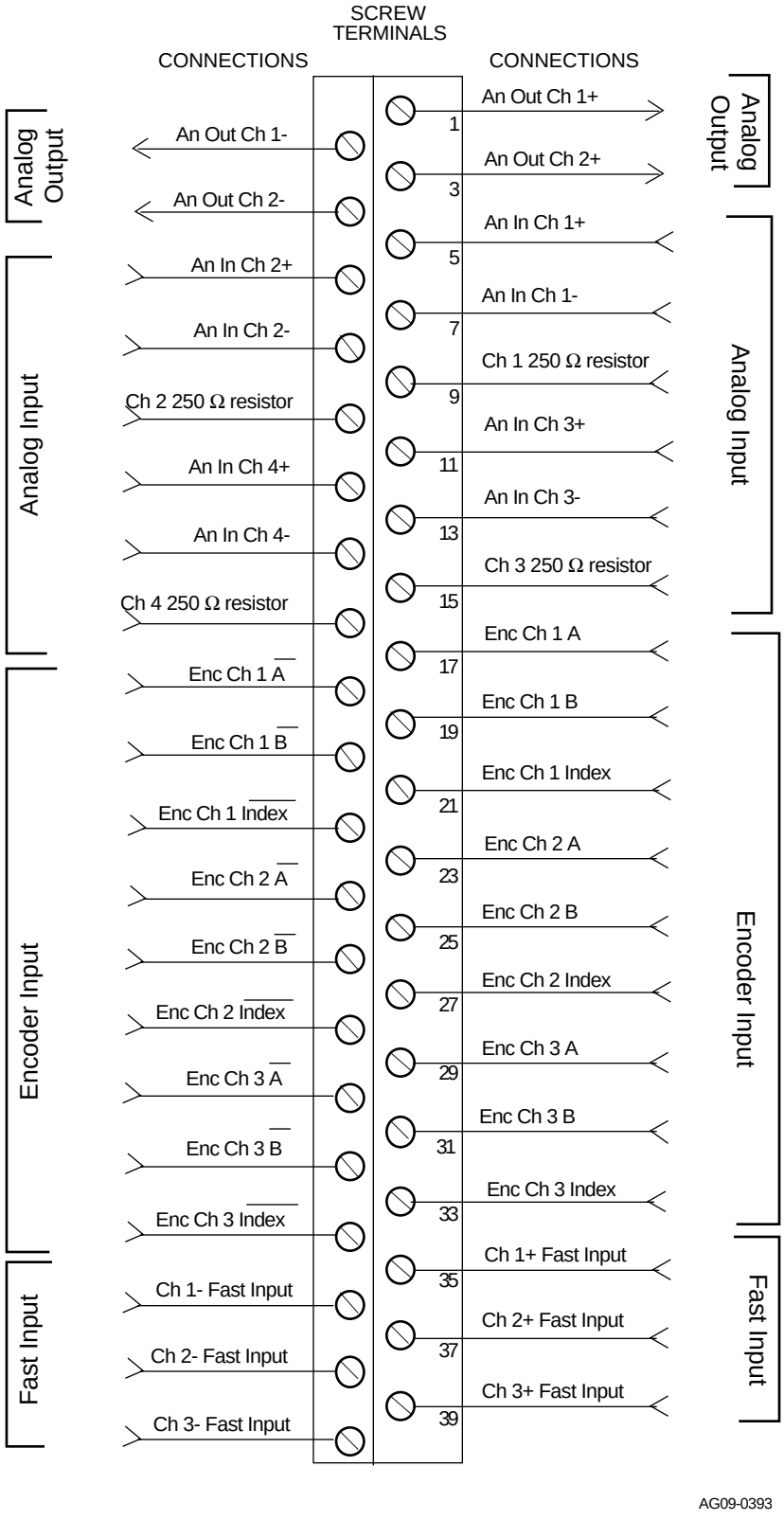
IMPORTANT

One end of the shield from the twisted pair wire must be connected to chassis ground.
Any power supplies used must be connected to the Single Point Ground.

Figure D4-2 shows the assignments for all the screw terminal connections on the module.

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Figure D4-2. Connections for the Servo I Encoder Module Terminals

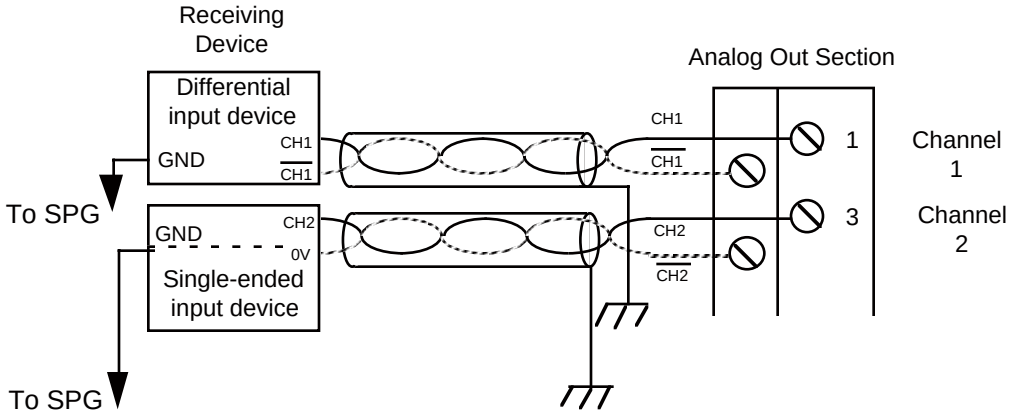


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Analog Output Connections

You may connect the differential type output from this module to a single-ended or differential input device. Figure D4-3 shows the difference between the two types of connections. Note that one wire in the twisted pair is connected to the 0 V terminal on the single-ended receiving device. This 0V terminal must be referenced to the SPG through the device's ground connection.

Figure D4-3. Differential and Single-Ended Receiving Devices



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Analog Input Connections

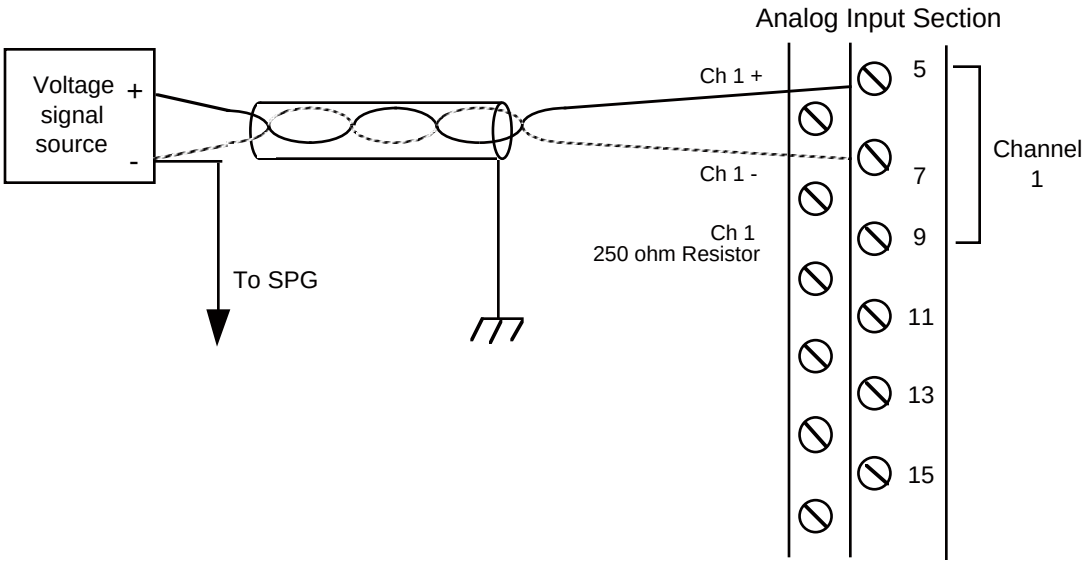
Each input channel has three connection pins. The signals are:

+ voltage input
- voltage input
250 ohm current sense resistor for 0/20 mA and 4/20 mA applications

When connecting an analog voltage output device to the module, the positive wire of the twisted pair goes to the + screw terminal and the negative wire goes to the - screw terminal. Figure D4-4 illustrates these connections for channel one.

Notice that no connection is made to the screw terminal with the internal 250 Ω resistor when connecting a voltage source device.

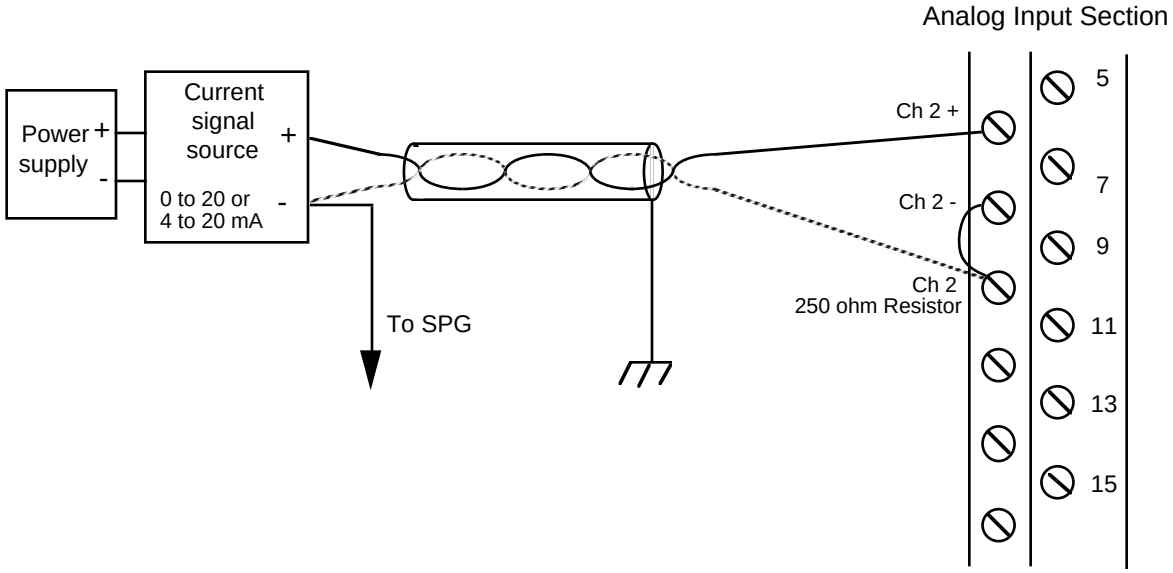
Figure D4-4. Voltage Input Connections



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When using a 0 to 20 mA or 4 to 20 mA current output device, the positive wire of the twisted pair is connected to the + input and the negative wire is connected to the 250 Ω resistor input. A jumper is placed between the - input and the 250 Ω resistor input as shown in Figure D4-5 (from pin 8 to pin 10 for channel 2). This connects a 250 Ω internal resistor across the input.

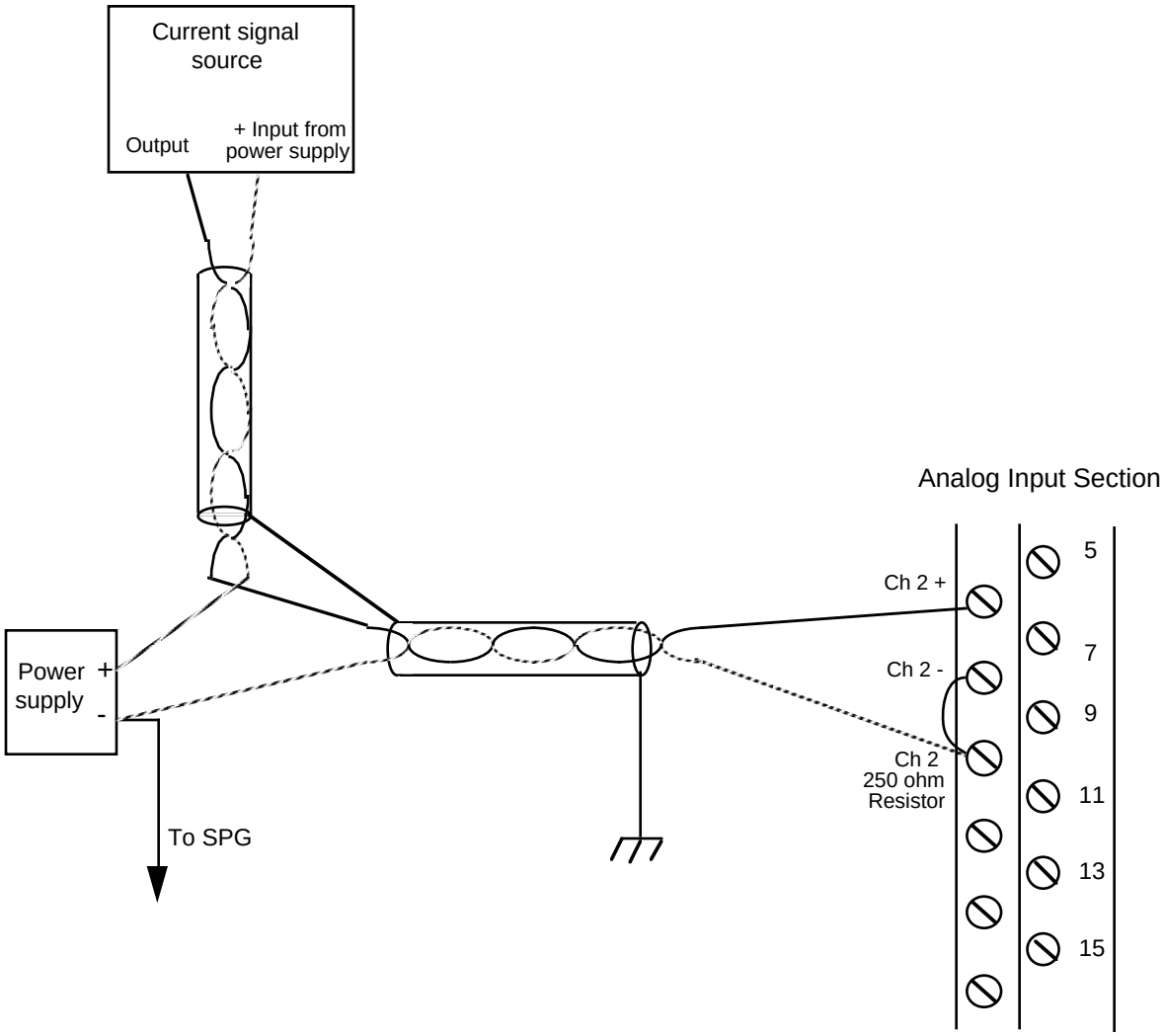
Figure D4-5. Current Input Connections (0 to 20 or 4 to 20 mA)



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An alternative method of connecting a two wire 4 to 20 mA current device is shown in Figure D4-6. Place a jumper between the - input and the 250 Ω resistor input.

Figure D4-6. Current Input Connections (4 to 20 mA)



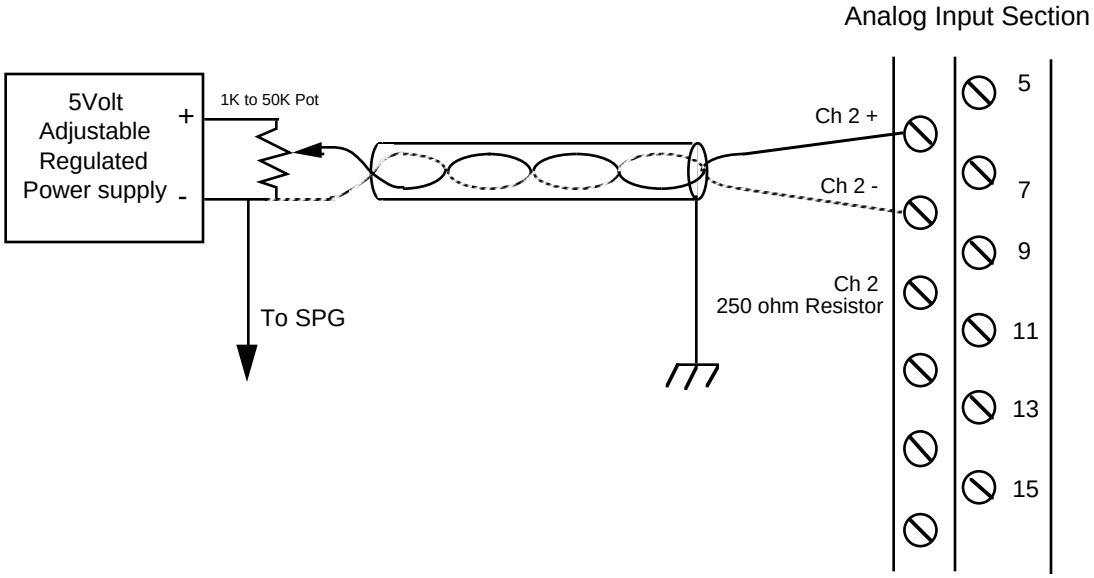
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Figure D4-7 illustrates an example of wiring an external potentiometer to the module using twisted pair wire.

For this example, set up the channel initialization function (A_INCHIT) in software for 5 V unipolar with a filter of 100 ms.

The 5 V power supply output voltage adjustment can be set for the maximum potentiometer output value. For example, the supply could be adjusted until the VALU output of the analog input channel read function (A_INCHRD) reads 4095 with the pot at its maximum position.

Figure D4-7. Adding an External Potentiometer



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Encoder Connections

Each encoder channel has four signal pairs, each of which has two screw terminal connections. The signal pairs are:

encoder input A
encoder input B
index input
24 VDC fast input

Encoder Drivers

Information from the encoders is used to update three separate position counters and latches within the module.

For each channel, a 24-bit counter is incremented or decremented based on signals it receives from the A and B outputs of an encoder. The counter value can be latched (stored) if the module receives either an "index" signal from the encoder or a 24 VDC "fast" input signal.

Acceptable drivers provided by encoder manufacturers include:

Differential voltage drivers	75183 8830 75114 9614 7513 26LS31
Single-ended open collector drivers	7406

339 type output devices will not work with the module because their output current level is too low.

NOTE

Encoders with differential drivers are strongly recommended. They provide better noise immunity and capability for the module to detect "loss of feedback."

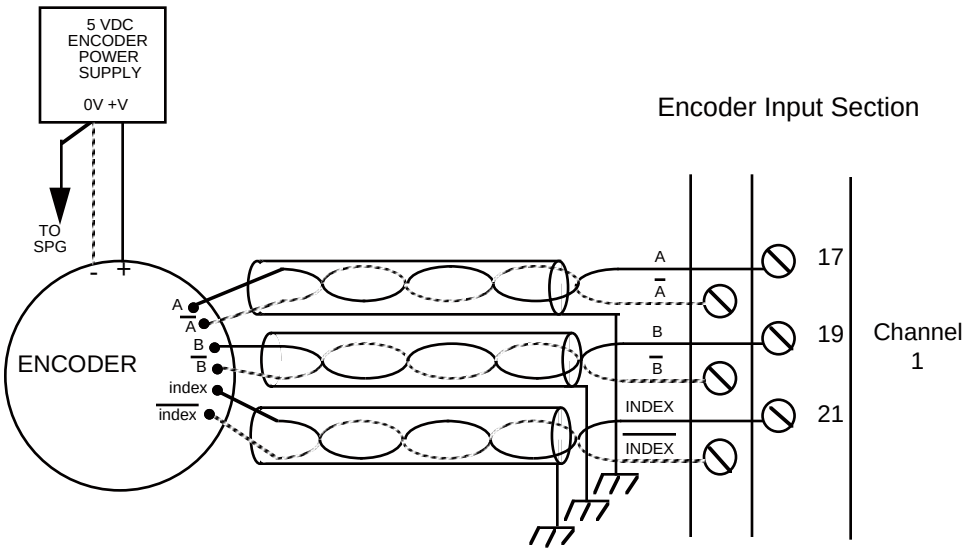
See the section in the Hardware chapter on "Preventing electrical noise in data lines" for a comparison of signals from differential and single-ended drivers.

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If the encoder has differential output drivers as shown in Figure D4-8, the three encoder outputs are paired:

A and $\overline{A}$
B and $\overline{B}$
index and $\overline{index}$

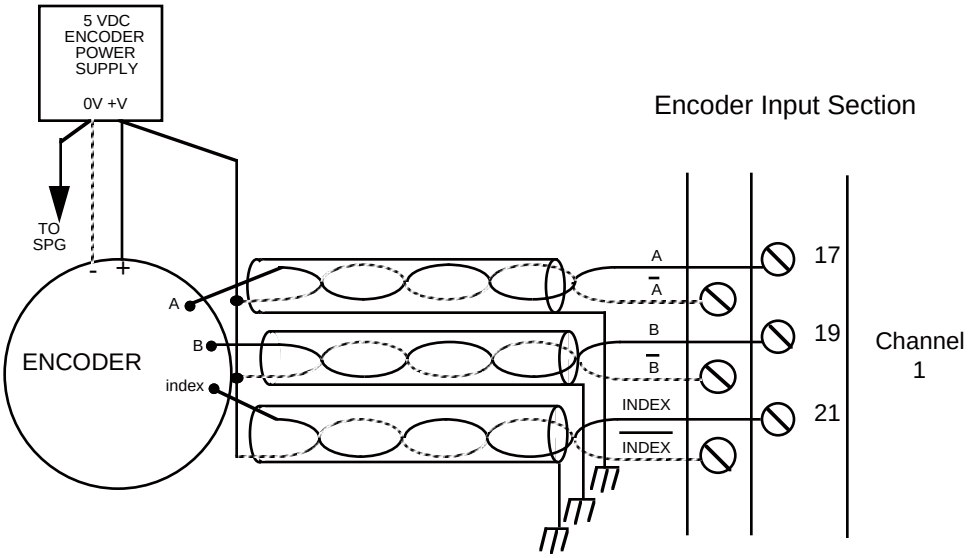
Figure D4-8. Wiring from an Encoder with Differential Drivers



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If an encoder has single-ended drivers, there are three single outputs: A, B, and index. Each output is referenced to the + V terminal of the encoder power supply. See Figure D4-9.

Figure D4-9. Wiring from an Encoder with Single-Ended Drivers



IMPORTANT
The minimum width signal that can be accepted by the encoder section is 0.6 µseconds.

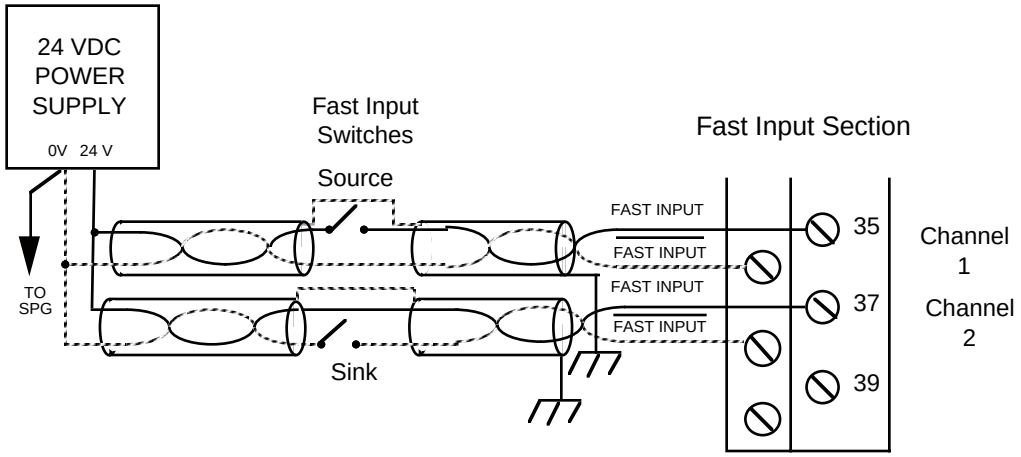
The signal at output A or B from the encoder has a frequency that is the product of the resolution of the encoder in pulses (lines) per revolution and the speed of the encoder in revolutions per second.

Thus an encoder that generates 2,000 pulses (lines) per revolution and rotates at 10 revolutions per second generates 20,000 pulses (lines) per second. In a quadrature type encoder, the interface module would supply 80,000 Feedback Units per second.

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Fast inputs should be connected as shown in Figure D4-10.

Figure D4-10. Fast Input Connections



Incremental encoders

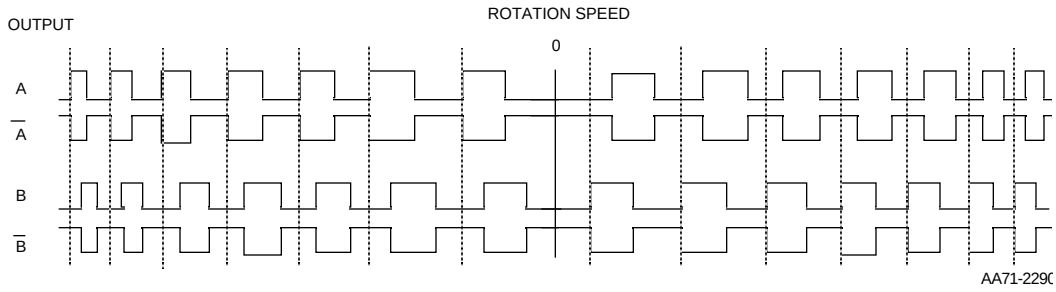
An *incremental encoder* is a position transducer. It transmits quadrature or pulse type signals through its "A" and "B" outputs with a frequency proportional to the rotational velocity of its shaft. It transmits a pulse through its index output once per revolution of the device.

There are two types of incremental encoders, quadrature and pulse. Giddings & Lewis recommends quadrature type encoders, which are the most commonly used.

A *quadrature encoder* sends square wave type signals. When the shaft rotates at a constant velocity, the A and B outputs are square waves and are at the same frequency. However they are out of phase with each other by 90°. When the encoder shaft rotates in one direction, each A pulse leads the corresponding B pulse by 90°. When it rotates the other direction each A pulse lags its B pulse by 90°.

The signals illustrated in Figure D4-11 indicate that the encoder shaft rotates in one direction at first. Its speed of rotation decreases to 0 and then it starts rotating the other direction. The signals are shown as differential. $\overline{A}$ is the inverse of the signal A and $\overline{B}$ is the inverse of signal B.

Figure D4-11. Signals Transmitted by a Quadrature Encoder with Differential Outputs

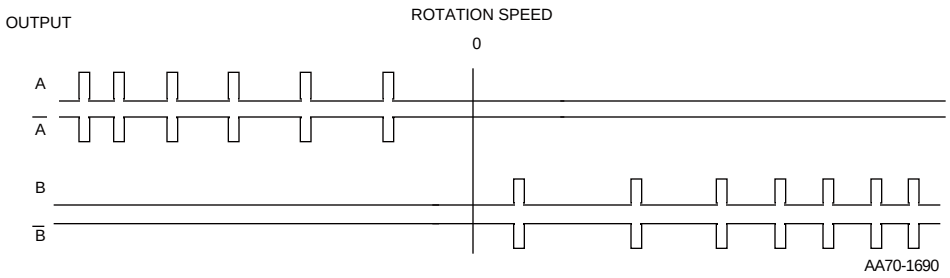


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A *pulse encoder* sends pulses through output A for one direction of its shaft rotation, and output B for the other direction. When the shaft is not rotating, no pulse is generated.

The signals illustrated in Figure D4-12 indicate that the encoder shaft rotates in one direction at first. Its speed of rotation decreases to 0 and then it starts rotating the other way. The signals are shown as differential, with the inverse of signal A and the inverse of signal B. A pulse encoder may alternate signals at its two outputs, but it cannot send signals from both outputs at the same time.

Figure D4-12. Signals Transmitted by a Pulse Encoder with Differential Outputs



Analog Output Theory of Operation

The CPU sends the analog output section a 16-bit digital word for each analog output channel used. Each digital word is converted to a corresponding voltage within the range of ±11 V. The voltage is buffered and brought out to a pair of screw terminal connections as a differential type voltage output. This output is less subject to interference from electrical noise than a single-ended output would be.

You can adjust each analog output channel in software for offset adjustments, gain scaling, and unipolar outputs.

For safety reasons, all outputs are automatically reset to 0 V when a scan loss condition occurs.

Analog Input Theory of Operation

A 12 bit A/D converter samples each analog input channel in sequence at the input scan rate. These values are stored in memory on the module so that any channel value can be read while the A/D converter is processing another channel sample.

Each channel can be set up for a maximum input sensitivity of .125 V to 10 V, bipolar or unipolar, or for 4 to 20 mA or 0 to 20 mA current input. To sense current the internal 250 Ω resistor must be connected as shown in Figures D4-5 or D4-6.

All inputs are differential with the input signals electrically isolated from the logic side and filtered for a high degree of noise immunity.

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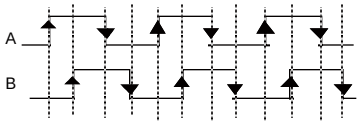
The default noise filter time constant is 1 ms. If more noise filtering is required, two longer time constants, 10 ms and 100 ms, are software selectable. The longer time constants will improve noise immunity but lengthen signal response time. Using the longer time constants may reduce closed position loop performance if the input is used for position feedback.

Encoder Theory of Operation

The encoder section uses differential type inputs to interface with up to three independent incremental encoders. These inputs are optically isolated and current limited.

- From a quadrature type, the maximum input frequency is 250,000 lines per second, which results in 1,000,000 Feedback Units (FUs) per second in the module.

Figure D4-13. Counting Quadrature Pulses



The module counts positive and negative transitions at both channel A and channel B. One quadrature cycle in this case gives 4 Feedback Units.

- From a pulse type, the module can accept up to 500,000 pulses per second at either input.

There is a 24-bit up/down counter on the module. It is incremented or decremented in accordance with the counting mode selected. There is also a 24-bit latch associated with each encoder channel.

The module can be programmed so that the counter value is "latched" or stored under one of these conditions:

- An index pulse from the encoder
- A positive or negative transition of the fast input
- The next index pulse after the required transition of the fast input

Each of the four 24-bit latches has a *fast 24 VDC input* associated with it. Each input is optically isolated. This input is intended to receive a signal from a device other than an encoder. It is typically used for referencing or synchronization purposes.

Fast input characteristics include:

- The detection of a signal occurs faster than it does for the DC inputs in other modules, due to less filtering. Because of this there is also less noise immunity.
- The response to a fast input signal is independent of ladder scan time. The module can be programmed to latch a position count as soon as this input is detected.

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Specification Table

Characteristic	Servo Encoder module specifications
Function	Converts a 16-bit digital word into a ±11V analog output signal for each of two channels Converts an analog input signal into a 12-bit digital word for each of four channels. Counts pulses from up to three encoders Latches the counter value at an index or 24 VDC fast input event
Part number	502-03839-04
Logic side power requirements (typical)	482 mA @ +5V 42 mA @ +15V 62 mA @ -15V Analog Output 1 mA per energized output @ +5V 11 mA per energized output @ +15V 11 mA per energized output @ -15V Analog Input 120 mA @ +5V 112 mA @ +15V Encoder 21 mA per energized input @ +5V 12 mA per fast input @ +5V
Field side connection	40 pin card edge connector, screw terminals
Field side power dissipation, worst case	7.4 W
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
Indicator light	LED is lit when current flows into the fast input
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Analog Output section (2 ch)	
Output channels	2
Resolution	16 bits, or 65536 steps over the full output range
Output voltage characteristics	
Nominal voltage range	± 11 VDC
Voltage accuracy @ 11 V	± 5%
Output current, max. @ ±10V	± 10 mA
Output update time increment	32 µsec
Output voltage after power up	0 V ± 20 mV
Response to "scan loss"	All outputs reset to 0 V ± 20 mV
Output ripple	< 10 mV_{RMS} at 30 KHz
Short circuit protection	Current limited outputs

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Response to scan loss (present) Response to scan loss (future)	All outputs are reset to the OFF state Software selectable: All outputs reset to the OFF state All outputs retain their current state
Analog Input section (4 ch)	
Input channels	4
Resolution	12 bits, or 4096 steps over the full input range
Input sensitivity (software selectable)	
Voltage ranges	Unipolar Bipolar 0 to 10 V ±10 V 0 to 5V ±5 V 0 to 2.5V ±2.5 V 0 to 1.25V ±1.25V 0 to 1V ±1 V 0 to .5 V ±.5 V 0 to .25V ±.25 V 0 to .125V ±.125 V
Current range	0 to 20 mA, 4 to 20 mA
Common mode maximum voltage (The maximum voltage that can safely be applied between either input terminal and circuit common.)	±40V
Common mode operating voltage (The maximum voltage that can be applied between either input terminal and circuit common with inputs still operating properly.)	±11V
Internal current sense resistor	250 ohms
Maximum current sense resistor power	.12 W
Differential input resistance (each input to ground)	1 M Ohms
Filter time constant - software selection	1 ms, 10 ms, 100 ms
Accuracy	.5% of FSR at 25^{o}C ± 100 PPM /^{o}C
0 Offset	From ±2 counts @ 10V to ±8 counts @ .125V

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Encoder Input section (3 ch)	
Input Encoder (3 ch) (A, B, and index)	Differential or single ended; differential recommended
Guaranteed on, min.	2.5 VDC @ 2.5 mA
Input voltage, max.	7 VDC
Input current, max.	22 mA @ 7 VDC
Signal pulse width, min.	.6 µs(600 ns)
Quadrature signal frequency, max.	250 KHz for A or B input (1 M FU count rate)
Pulse encoder signal frequency, max.	500 KHz for A or B input (500 KFU count rate)
Encoder device	1. Quadrature type incremental encoder (recommended) 2. Pulse type incremental encoder
Stored position value range	24-bit up/down counter 24-bit latch
Fast input	Nominal 24 VDC, switched externally to the module Active high or low Reverse polarity protected
Voltage max.	30 VDC
Guaranteed on	15 VDC
Guaranteed off	5 VDC
Input impedance	2.7 K
On/off time, max.	50 µs
Cable length, max.	200 ft. @ 250 KHz and 45° quad error (with differential driver)
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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D.5 - Servo Module Encoder

Introduction

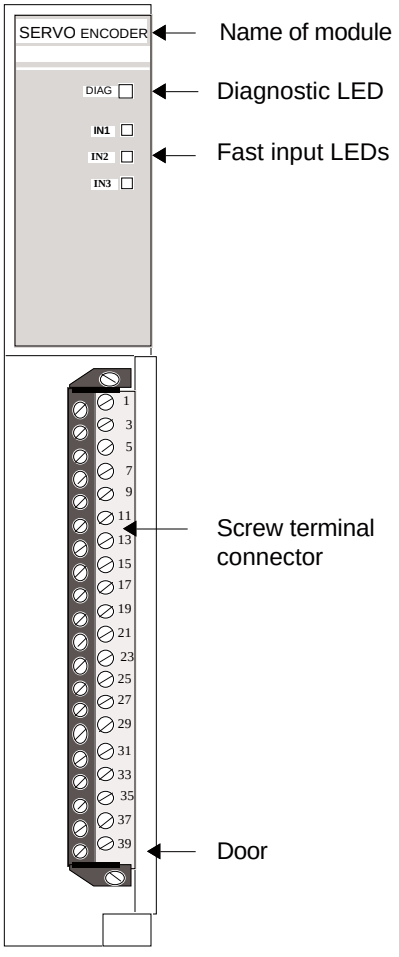
Depending on the model you have, the Servo encoder module provides:

- 4, 3, or 2 analog output channels
- 3, 2, or 1 encoder input channels
- 3, 2, or 1 fast input

An LED goes on when the fast input for each encoder channel is energized.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure D5-1. Servo Encoder Module



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Connections

All signals to the module must come to the screw terminal connectors through shielded twisted pair wires. Shielded twisted pair wire is used to connect:

- Each analog output channel to a receiving device
- All encoder signals to the module
- All fast input signals to the module

These wires must be protected against electrical noise because of the speed and/or voltage levels of the signals transmitted through them. See the discussion on "Preventing electrical noise in data lines" in the Hardware chapter.

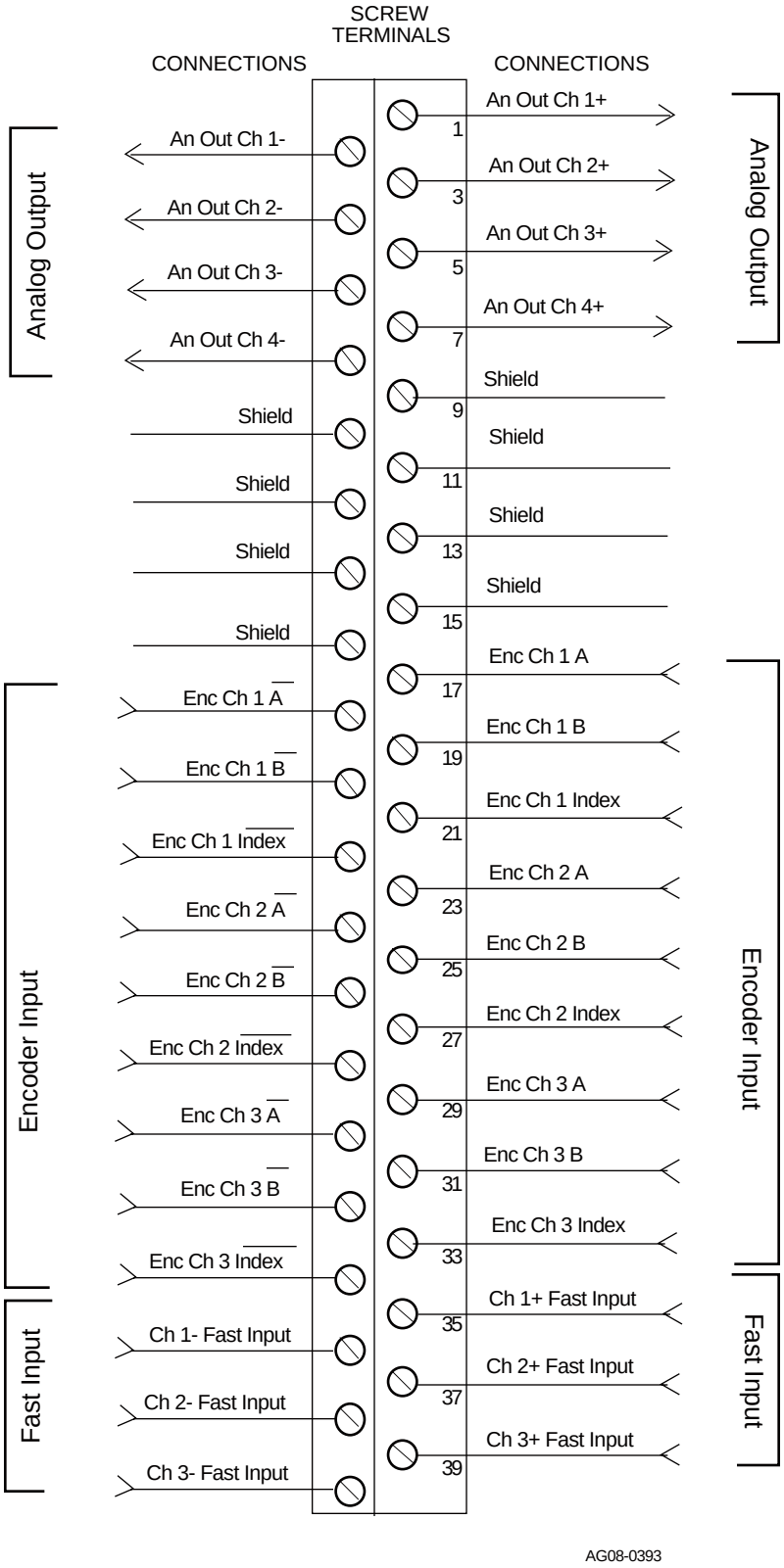
The module has eight screw terminal connections for terminating the shields. All eight are connected internally to SPG.

The shield at the device end of the cable is not connected.

Figure D5-2 shows the assignments for all the screw terminal connections on the module.

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Figure D5-2. Connections for the Servo Encoder Module Terminals

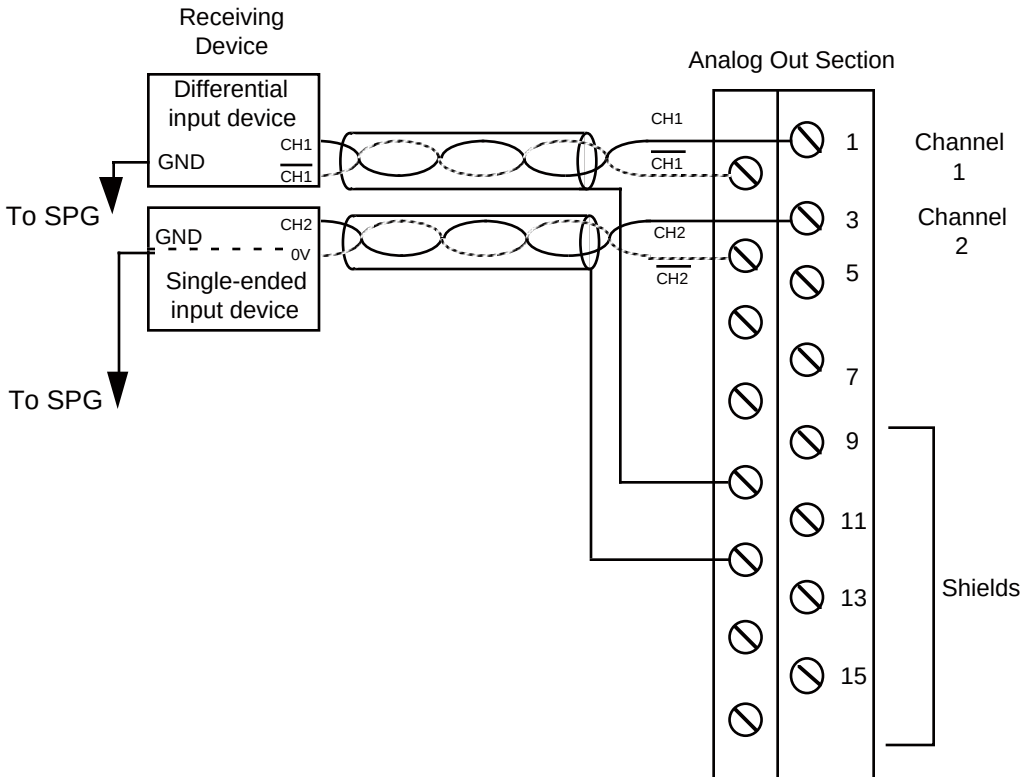


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Analog Output Connections

You may connect the differential type output from the analog output section to a single-ended or differential input device. Figure D5-3 shows the two types of connections. Note that one wire in the twisted pair is connected to the 0 V terminal on the single-ended receiving device. This 0 V terminal must be referenced to the SPG through the device's ground connection.

Figure D5-3. Differential and Single-Ended Receiving Devices



Encoder Connections

Each encoder channel has four signal pairs, each of which has two screw terminal connections. The signal pairs are:

encoder input A
encoder input B
index input
24 VDC fast input

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IMPORTANT

The power supply to the encoder (or signal source device) must have its common connected to the Single Point Ground.

If the 24 VDC "fast" input is used, its power supply common must also be connected to the Single Point Ground.

Encoder Drivers

Information from the encoders is used to update four separate position counters and latches within the module. For each channel, a 24-bit counter is incremented or decremented based on signals it receives from the A and B outputs of an encoder. The counter value can be latched (stored) if the module receives either an "index" signal from the encoder or a 24 VDC "fast" input signal.

Acceptable drivers provided by encoder manufacturers include:

Differential voltage drivers	75183 8830 75114 9614 7513 26LS31
Single-ended open collector drivers	7406

339 type output devices will not work with the Input encoder module (4 ch) because their output current level is too low.

NOTE

Encoders with differential drivers are strongly recommended. They provide better noise immunity and capability for the module to detect "loss of feedback."

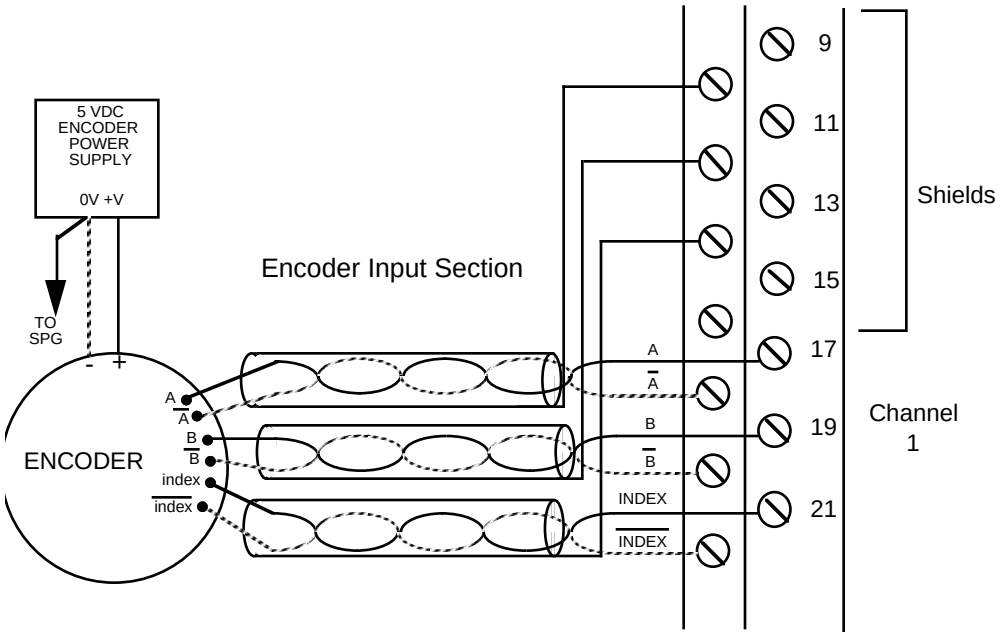
See the section in the Hardware chapter on "Preventing electrical noise in data lines" for a comparison of signals from differential and single-ended drivers.

If the encoder has differential output drivers as shown in Figure D5-4, the three encoder outputs are paired:

A and $\overline{A}$
B and $\overline{B}$
index and $\overline{index}$

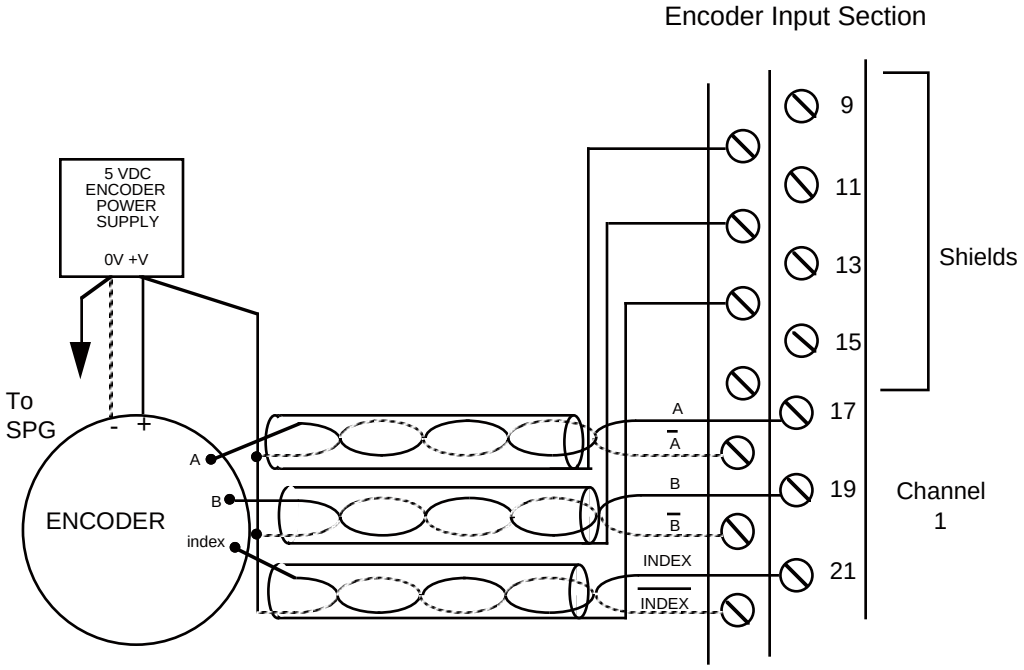
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Figure D5-4. Wiring from an Encoder with Differential Drivers



If an encoder has single-ended drivers, there are three single outputs: A, B, and index. Each output is referenced to the + V terminal of the encoder power supply. See Figure D5-5.

Figure D5-5. Wiring from an Encoder with Single-Ended Drivers



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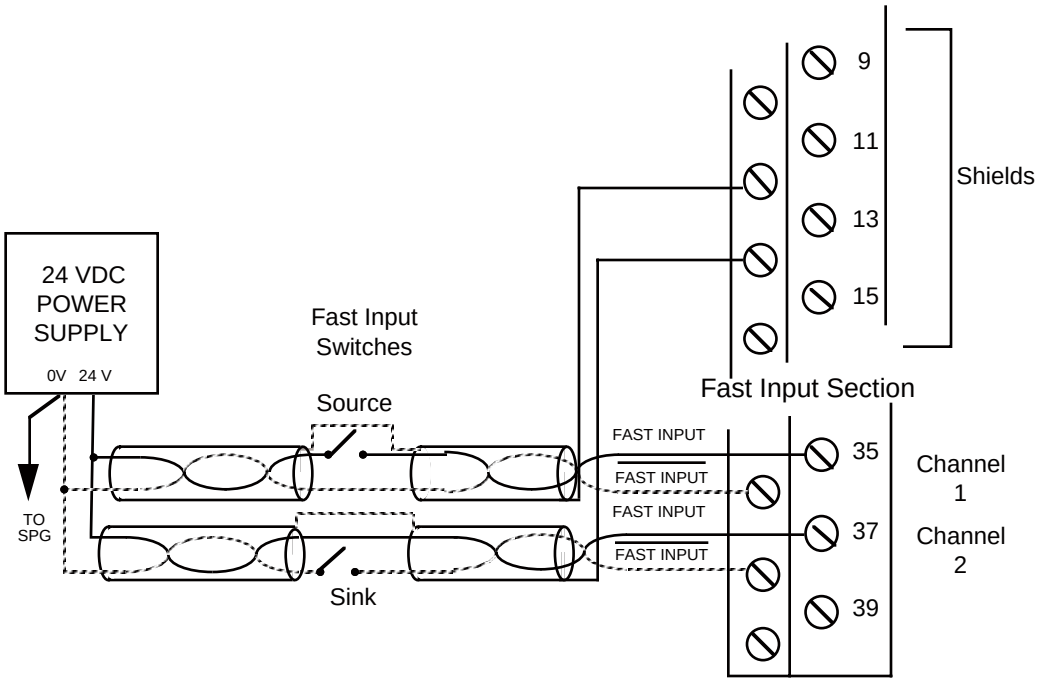
IMPORTANT
The minimum width signal that can be accepted by the encoder section is 0.6 µ seconds.

The signal at output A or B from the encoder has a frequency that is the product of the resolution of the encoder in pulses (lines) per revolution and the speed of the encoder in revolutions per second.

Thus an encoder that generates 2,000 pulses (lines) per revolution and rotates at 10 revolutions per second generates 20,000 pulses (lines) per second. In a quadrature type encoder, the interface module would supply 80,000 Feedback Units per second.

The fast input is connected as shown in Figure D5-6.

Figure D5-6. Fast Input Connections



Incremental encoders

An *incremental encoder* is a position transducer. It transmits quadrature or pulse type signals through its "A" and "B" outputs with a frequency proportional to the rotational velocity of its shaft. It transmits a pulse through its index output once per revolution of the device.

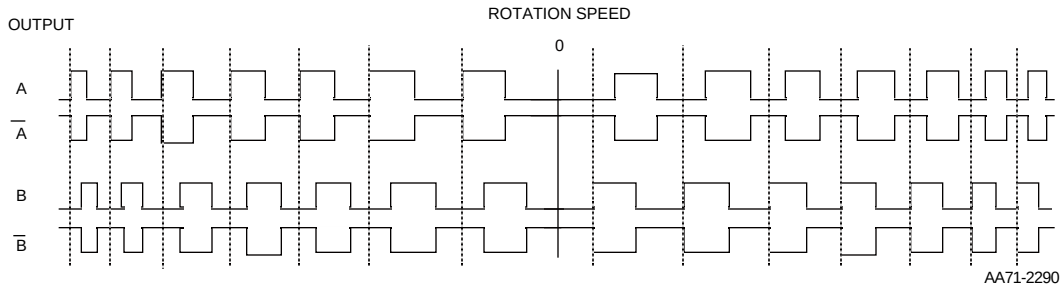
There are two types of incremental encoders, quadrature and pulse. Giddings & Lewis recommends quadrature type encoders, which are the most commonly used.

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A *quadrature encoder* sends square wave type signals. When the shaft rotates at a constant velocity, the A and B outputs are square waves and are at the same frequency. However they are out of phase with each other by 90°. When the encoder shaft rotates in one direction, each A pulse leads the corresponding B pulse by 90°. When it rotates the other direction each A pulse lags its B pulse by 90°.

The signals illustrated in Figure D5-7 indicate that the encoder shaft rotates in one direction at first. Its speed of rotation decreases to 0 and then it starts rotating the other direction. The signals are shown as differential. $\overline{A}$ is the inverse of the signal A and $\overline{B}$ is the inverse of signal B.

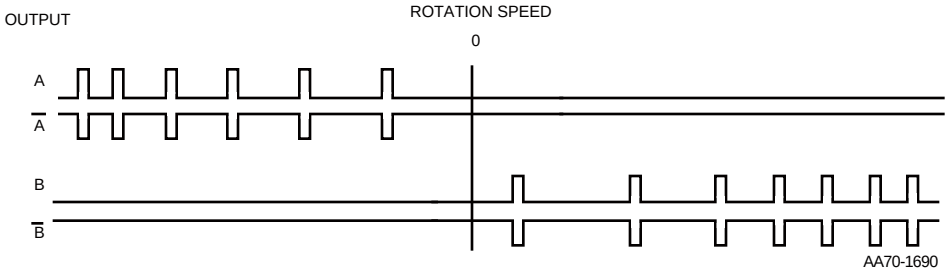
Figure D5-7. Signals Transmitted by a Quadrature Encoder with Differential Outputs



A *pulse encoder* sends pulses through output A for one direction of its shaft rotation, and output B for the other direction. When the shaft is not rotating, no pulse is generated.

The signals illustrated in Figure D5-8 indicate that the encoder shaft rotates in one direction at first. Its speed of rotation decreases to 0 and then it starts rotating the other way. The signals are shown as differential, with the inverse of signal A and the inverse of signal B. A pulse encoder may alternate signals at its two outputs, but it cannot send signals from both outputs at the same time.

Figure D5-8. Signals transmitted by a pulse encoder with differential outputs



Analog Output Theory of Operation

The CPU sends the analog output section a 16-bit digital word for each analog output channel used. Each digital word is converted to a corresponding voltage within the range of ±11 V. The voltage is buffered and brought out to a pair of screw terminal connections as a differential type voltage output. This output is less subject to interference from electrical noise than a single-ended output would be.

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You can adjust each analog output channel in software for offset adjustments, gain scaling, and unipolar outputs.

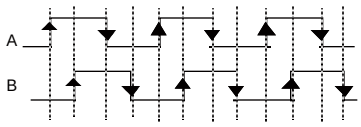
For safety reasons, all outputs are automatically reset to 0 V when a scan loss condition occurs.

Encoder Theory of Operation

The encoder section uses differential type inputs to interface with up to three independent incremental encoders. These inputs are optically isolated and current limited.

- From a quadrature type, the maximum input frequency is 250,000 lines per second, which results in 1,000,000 Feedback Units (FUs) per second in the encoder module.

Figure D5-9. Counting Quadrature Pulses



The module counts positive and negative transitions at both channel A and channel B. One quadrature cycle in this case gives 4 Feedback Units.

- From a pulse type, the module can accept up to 500,000 pulses per second at either input.

There is a 24-bit up/down counter on the module. It is incremented or decremented in accordance with the counting mode selected. There is also a 24-bit latch associated with each encoder channel.

The module can be programmed so that the counter value is "latched" or stored under one of these conditions:

- an index pulse from the encoder
- a positive or negative transition of the fast input
- the next index pulse after the required transition of the fast input

Each of the four 24-bit latches has a *fast 24 VDC input* associated with it. Each input is optically isolated. This input is intended to receive a signal from a device other than an encoder. It is typically used for referencing or synchronization purposes.

Fast input characteristics include:

- the detection of a signal occurs faster than it does for the DC inputs in other modules, due to less filtering. Because of this there is also less noise immunity.
- the response to a fast input signal is independent of ladder scan time. The module can be programmed to latch a position count as soon as this input is detected.

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Specification Table

Characteristic	Servo module encoder specifications
Function	Converts a 16-bit digital word into a ±11V analog output signal for each of two channels Counts pulses from up to three encoders Latches the counter value at an index or 24 VDC input event
Part number	502-03840-04 4 Analog Outputs/3 Encoder Inputs 502-03840-24 3 Analog Outputs/2 Encoder Inputs 502-03840-44 2 Analog Outputs/1 Encoder Input
Logic side power requirements (typical)	413 mA @ +5V 55 mA @ +15V 51 mA @ -15V Analog Output 1 mA per energized output @ +5V 11 mA per energized output @ +15V 11 mA per energized output @ -15V Encoder 21 mA per energized input @ +5V 12 mA per fast input @ +5V
Field side connection	40 pin card edge connector, screw terminals
Field side power dissipation, worst case	7.4 W
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
Indicator light, fast inputs	LED is lit when current flows into the fast input
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Analog Output section (4, 3, or 2 ch)	
Resolution	16 bits, or 65536 steps over the full output range
Output voltage characteristics	
Nominal voltage range	± 11 VDC
Voltage accuracy @ 11 V	± 5%
Output current, max. @ ±10V	± 10 mA
Output update time increment	32 µsec
Output voltage after power up	0 V ± 20 mV
Response to "scan loss"	All outputs reset to 0 V ± 20 mV
Output ripple	< 10 mV_{RMS} at 30 KHz
Short circuit protection	Current limited outputs
Response to scan loss	All outputs are reset to the OFF state

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Encoder Input section (3, 2, or 1 ch)	
Input Encoder (A, B, and index)	Differential or single ended; differential recommended
Guaranteed on, min	2.5 VDC @ 2.5 mA
Input voltage, max	7 VDC
Input current, max	22 mA @ 7 VDC
Signal pulse width, min	.6 µs(600 ns)
Quadrature signal frequency, max	250 KHz for A or B input (1 M FU count rate)
Pulse encoder signal frequency, max	500 KHz for A or B input (500 KFU count rate)
Encoder device	1. Quadrature type incremental encoder (recommended) 2. Pulse type incremental encoder
Stored position value range	24-bit up/down counter 24-bit latch
Fast input	Nominal 24 VDC, switched externally to the module Active high or low Reverse polarity protected
Voltage max	30 VDC
Guaranteed on	15 VDC
Guaranteed off	5 VDC
Input impedance	2.7 K
On/off time, max	50 µs
Cable length, max	200 ft. @ 250 KHz and 45° quad error (with differential driver)
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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D.6 - Output Stepper Module (2, 4, or 8 channel)

Introduction

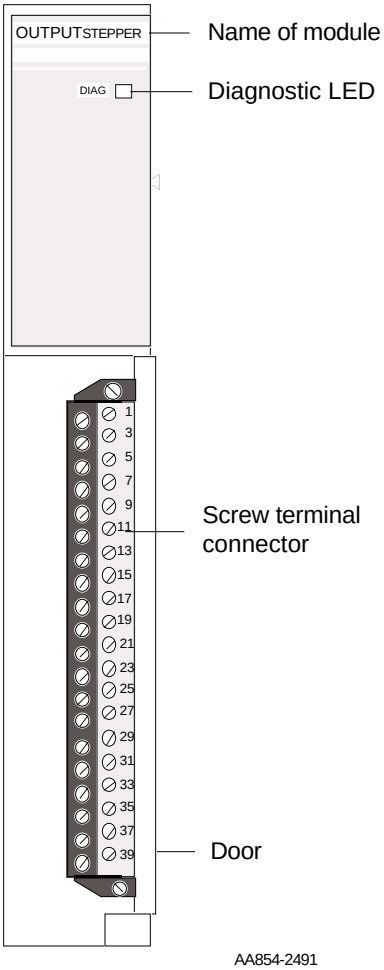
The output stepper motor control module (SMCM) can control up to eight stepper drives. The maximum step rate is one million steps per second.

An external power supply (4.5 VDC to 20 VDC) is required for operation.

Commands and control data are sent to the module, and status and position information are received from the module, via software.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure D6-1. OUTPUT STEPPER Module (2, 4, 8 ch)



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Connections

A screw terminal connection is provided for each output and for the external power supply connection. (See Figure D6-2.) The outputs are optically isolated. (See Figure D6-3.)

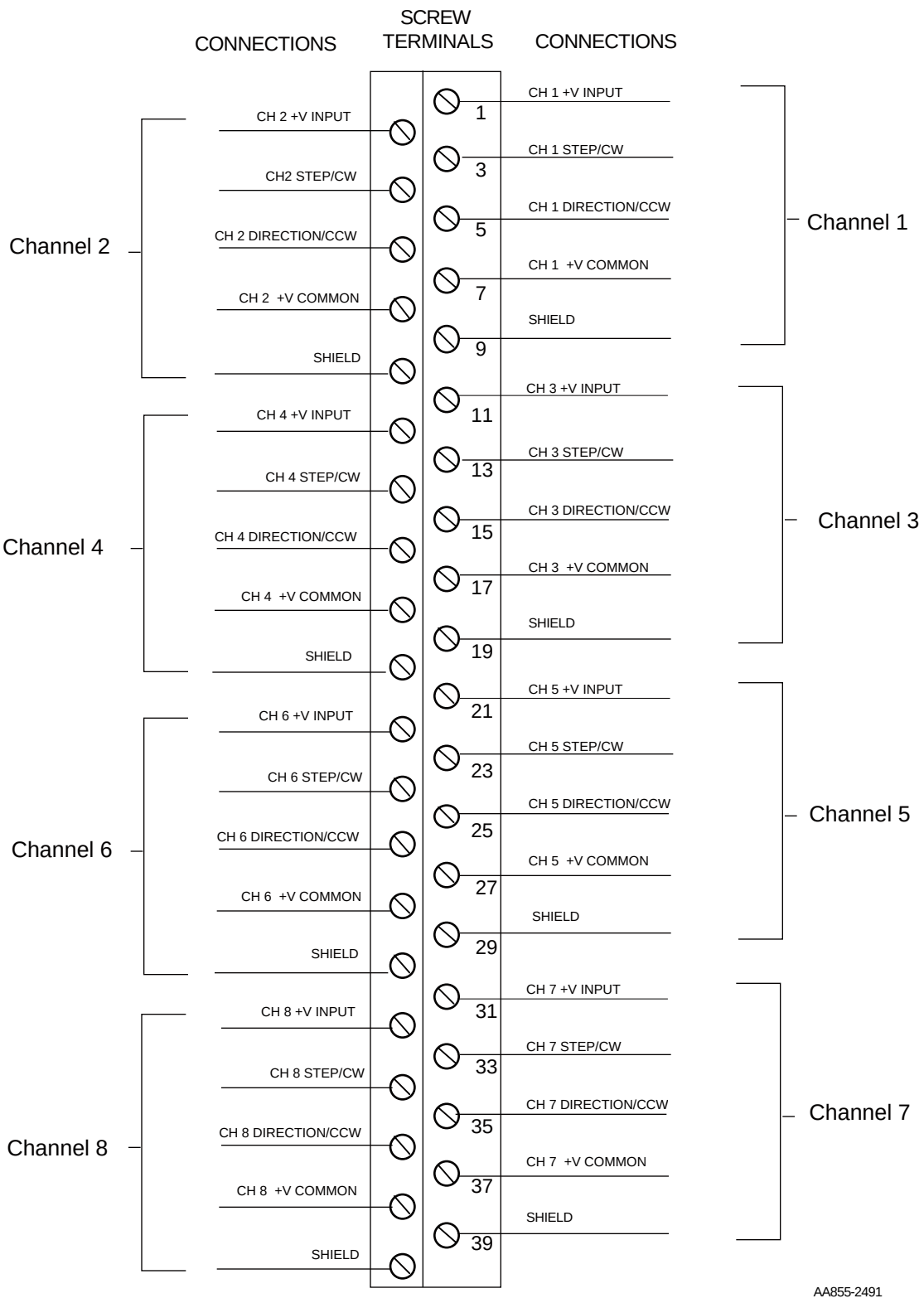
The external DC supply that powers the output signals should have a wire connected from its 0V (COMMON) terminal directly to the rack's single point ground. The power disconnect switch should be the same one used for the Central Service Module. In the power distribution diagrams in the Hardware chapter, a DC supply was set up according to these guidelines.

The external DC supply can be provided by any combination of the following:

- The stepper drive
- An external DC supply daisy-chained to several channels
- Separate external DC supplies for individual channels

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Figure D6-2. Screw terminal connection assignments

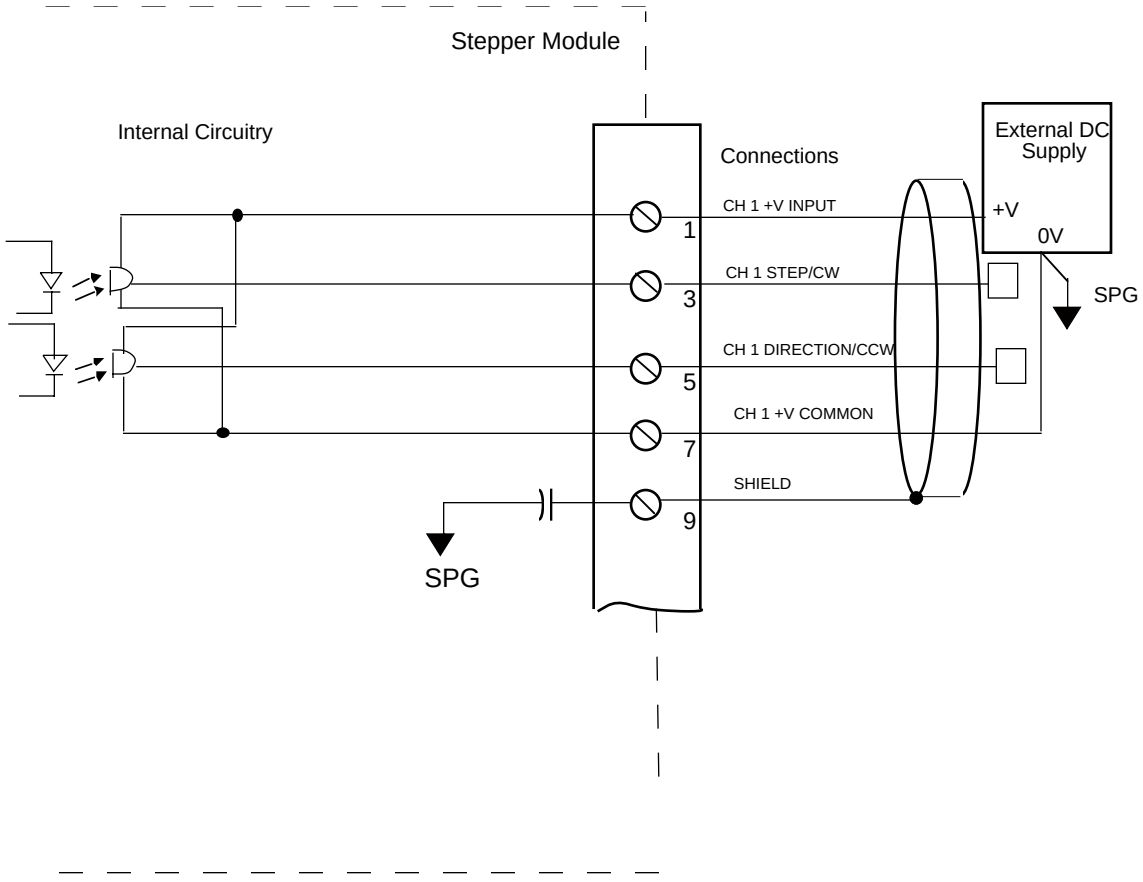


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Connections for one channel are illustrated on the right in Figure D6-3.

+V input	to	the +V terminal of the external power supply
Step/cw output	to	the step or clockwise input of the drive
Direction/ccw output	to	direction or counterclockwise input of the drive
Common	to	the 0V terminal of the external power supply NOTE: When the drive inputs are optically isolated, tie the 0V of the external power supply to SPG.
Shield		All shield pins on the module are connected to each other internally and AC coupled to SPG.

Figure D6-3. Connections for One Channel



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Connecting the SMCM to Stepper Drives

Consult your drive manual regarding the proper connection of an indexer such as the SMCM. Four types of drive inputs and the proper connection techniques are shown in Figures D6-4 to D6-7.

When working with opto-coupler drive inputs, be sure the input diode is protected by a current-limiting resistor as stated in the following important note.

IMPORTANT

There is a limit to the amount of current the input diode of the drive opto-coupler can withstand. If this current is exceeded, the device will be destroyed.

The SMCM is capable of sinking considerably more current than the 15 mA specified. Most drives having opto-coupler inputs have a series current-limit resistor sized properly for a +5V external supply.

If the drive being used has an opto-coupler input but does not have a current-limit resistor or if the current-limit resistor is too small, then one will have to be added externally. Consult your drive manual for information regarding this topic.

Following the wiring guidelines listed below will increase the reliability of the SMCM/drive system.

1. Route the wiring from the SMCM separately from any high current or electrically noisy wiring.
2. Keep the wires connecting the SMCM to the drive less than 10 feet in length.
3. Shield the wiring from the SMCM. Tie shields to the SMCM shield terminal screw and leave the other end of the shield unconnected.

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Opto-Coupler Drive Inputs

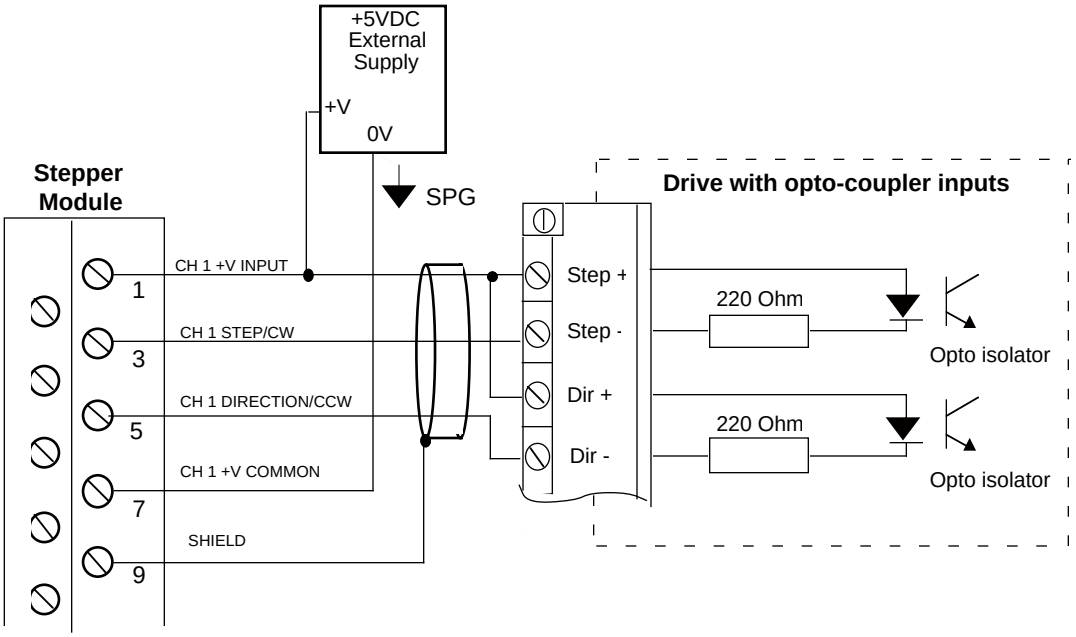
The inputs for this type of drive will be:

1. Step +
2. Step -
3. Direction +
4. Direction -

Make the following connections as illustrated in Figure D6-4:

SMCM		External Power Supply		Drive
Step/CW	to	N/C	to	Step -
Direction/CCW	to	N/C	to	Direction -
+V Input	to	+V	to	Step + and Direction +
+V Common	to	0V	to	N/C

Figure D6-4. SMCM Connections to Opto-Coupler Drive Inputs



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Opto-Coupler with Common Source Drive Inputs

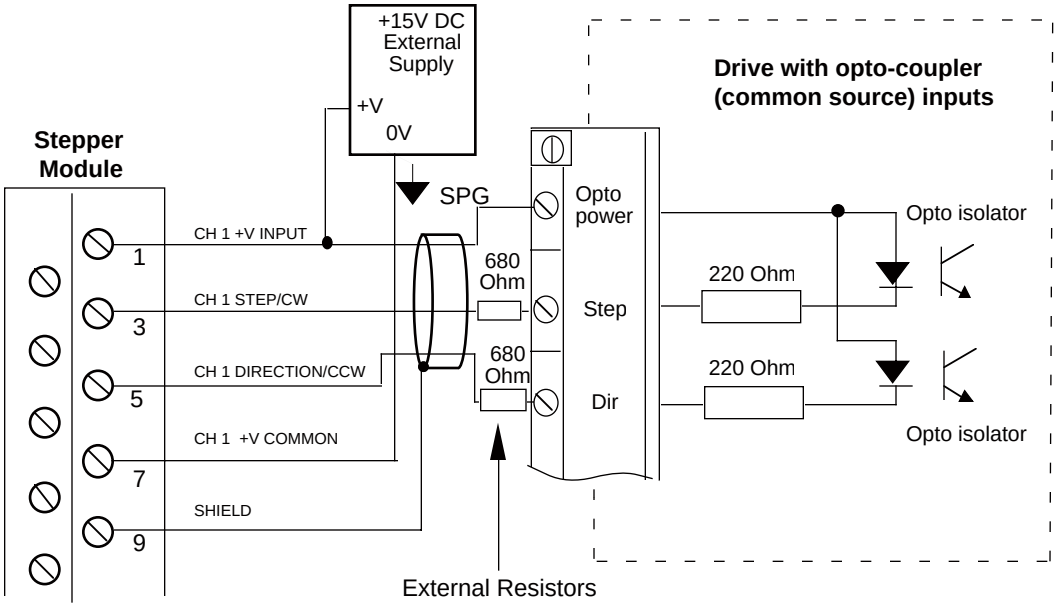
The inputs for this type of drive will be:

1. Opto power input
2. Step
3. Direction

Make the following connections as illustrated in Figure D6-5:

SMCM		External Power Supply		Drive
Step/CW	to	N/C	to	Step
Direction/CCW	to	N/C	to	Direction
+V Input	to	+V	to	Opto power input
+V Common	to	0V	to	N/C

Figure D6-5. SMCM Connections to Opto-Coupler Drive Inputs with Common Source



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Single-Ended Drive Inputs

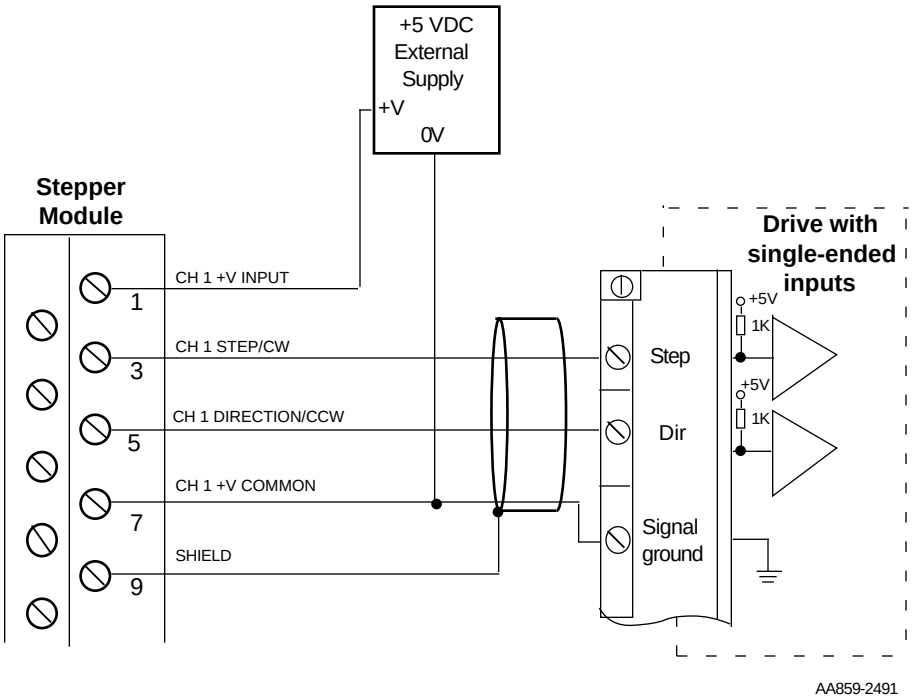
The inputs for this type of drive will be:

1. Step
2. Direction
3. Signal ground

Make the following connections as illustrated in Figure D6-6:

SMCM		Power Supply		Drive
Step/CW	to	N/C	to	Step
Direction/CCW	to	N/C	to	Direction
+V Input	to	+V	to	N/C
+V Common	to	0V	to	Signal ground

Figure D6-6. SMCM Connections to Single-Ended Drive Inputs



If the pull-up resistors internal to the drive are inadequate, you may need to add external pull-up resistors. Install them as close as possible to the drive.

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Differential Drive Inputs

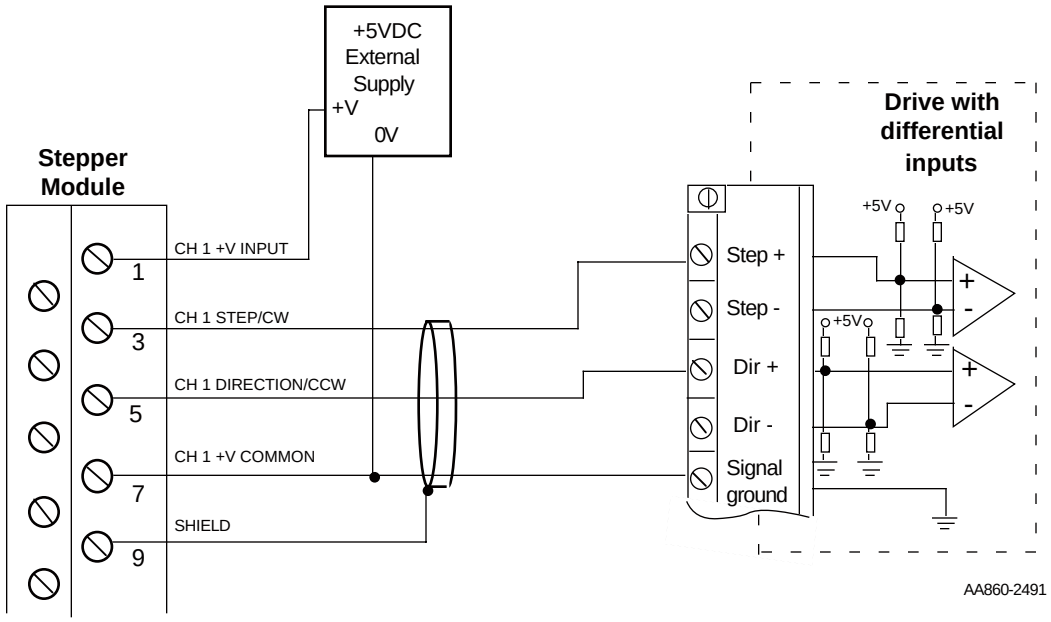
The inputs for this type of drive will be:

1. Step +
2. Step -
3. Direction +
4. Direction -
5. Signal ground

Make the following connections as illustrated in Figure D6-7:

SMCM		Power Supply		Drive
Step/CW	to	N/C	to	Step +
Direction/ CCW	to	N/C	to	Direction +
+V Input	to	+V	to	N/C
+V Common	to	0V	to	Signal ground

Figure D6-7. SMCM Connections to Differential Drive Inputs



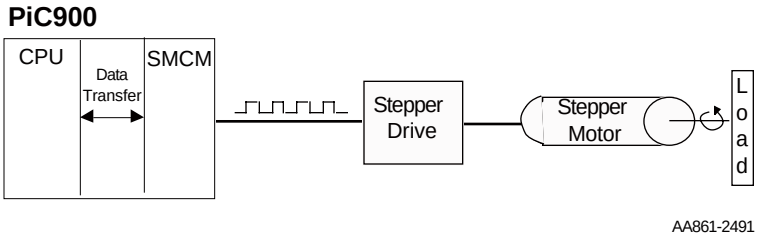
If the Step- and Direction- inputs are not biased to one half the external supply by the drive, external voltage dividers will be required. Install them as close to the drive as possible.

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Theory of Operation

The stepper module is part of an open loop control system used to position from one to eight axes. The diagram in Figure D6-8 illustrates one axis being controlled by the SMCM. Digital signals from the SMCM are converted into fixed increments of motion via the stepper drive. This allows the stepper motor to move the load accurately and reliably by following the number of input steps.

Figure D6-8. Open Loop Stepper System



The SMCM controls the position, velocity, and acceleration of the stepper motor. The number of pulses generated by the SMCM provides distance information (steps) and the rate of these pulses provides velocity information (steps/sec). The rate of change of the pulse rate provides acceleration/deceleration information (steps/sec/sec).

Commands (acc/dec rates, maximum velocity, reference position, distance, position, and velocity moves) and control data (E-stop, C-stop, start, pause, continue, modes) are sent to the module and status and position information are received from the module via software. Each channel can have up to 500 commands queued up on the module.

The step rate programmed by you for a velocity command (or calculated by the SMCM during acceleration or deceleration) versus the actual rate output from the SMCM is defined by the following equation:

$$ActualRate = \frac{10 \times 10^6}{X}$$

where X is the integer quotient of $\frac{10 \times 10^6}{ProgrammedRate}$

Refer to the Software Manual for information on controlling the SMCM via software.

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Specification Table

Characteristic	Output stepper module (2, 4, 8 ch) specifications
Function	Controls up to eight stepper drives
Part number	502-03677-02 8 channel 502-03677-22 2 channel 502-03677-42 4 channel
+V input (from external supply)	4.5 VDC to 20 VDC, 45 mA per connected channel
Step/CW output rating Direction/CCW output rating	Totem pole, 15 mA sink, 5 mA source
Field side connector	40-pin card edge connector, screw terminals
Protection of logic circuits	Optical isolation between the logic and field side
Indicator light, module	A DIAG LED turns OFF when the module passes its diagnostic tests at power-on
Position range	±2,147,352,575 steps
Step rate	0 to 1,000,000 steps/sec
Step rate accuracy	$ActualRate = \frac{10 \times 10^6}{X}$ where X is the integer quotient of $\frac{10 \times 10^6}{ProgrammedRate}$
Acceleration/deceleration rate	1 to 16,777,215 steps/sec/sec
Reference range	±2,147,352,575 steps
Response to scan loss	Pulse output halted
Logic side power requirements (typical)	404 mA @ +5V 8 channel 239 mA @ +5V 4 channel 156 mA @ +5V 2 channel 6 mA per active channel @ +5V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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D.7 - Slider Driver Module

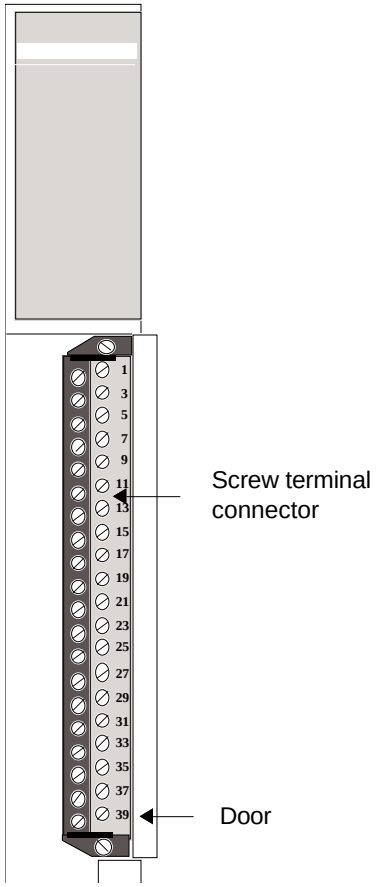
Introduction

The Slider Driver module is an interface between the PiC Resolver module and up to two independent Inductosyn systems.

For each Inductosyn system, the Slider Driver module accepts two sinusoidal signals from the Resolver module and applies them to the slider of the Inductosyn system. The Slider Driver module then accepts feedback from the scale amplifier of the Inductosyn system, conditions the signal and passes this information to the Resolver module. The Resolver module uses the feedback signal to determine position information.

Refer to the Input Resolver Module for additional information.

Figure D7-1. Slider Driver Module



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Connections

All signals to this module must come to the screw terminal connector through shielded twisted pair wires. These wires must be protected against electrical noise. See the discussion in the Hardware chapter on “Preventing electrical noise in data lines”.

Three signal pairs connect the module to the PiC Resolver module. Each signal pair has two screw terminal connections. The signals are:

RPO from resolver module
QPO from resolver module
FDBK to resolver module

Three signal pairs connect the module to each Inductosyn system. Two signal pairs are connected to the slider and one signal pair is connected to the output of the scale amplifier. Each signal pair has two screw terminal connections. The signals are:

RPO to slider
QPO to slider
SFDBK from scale amplifier

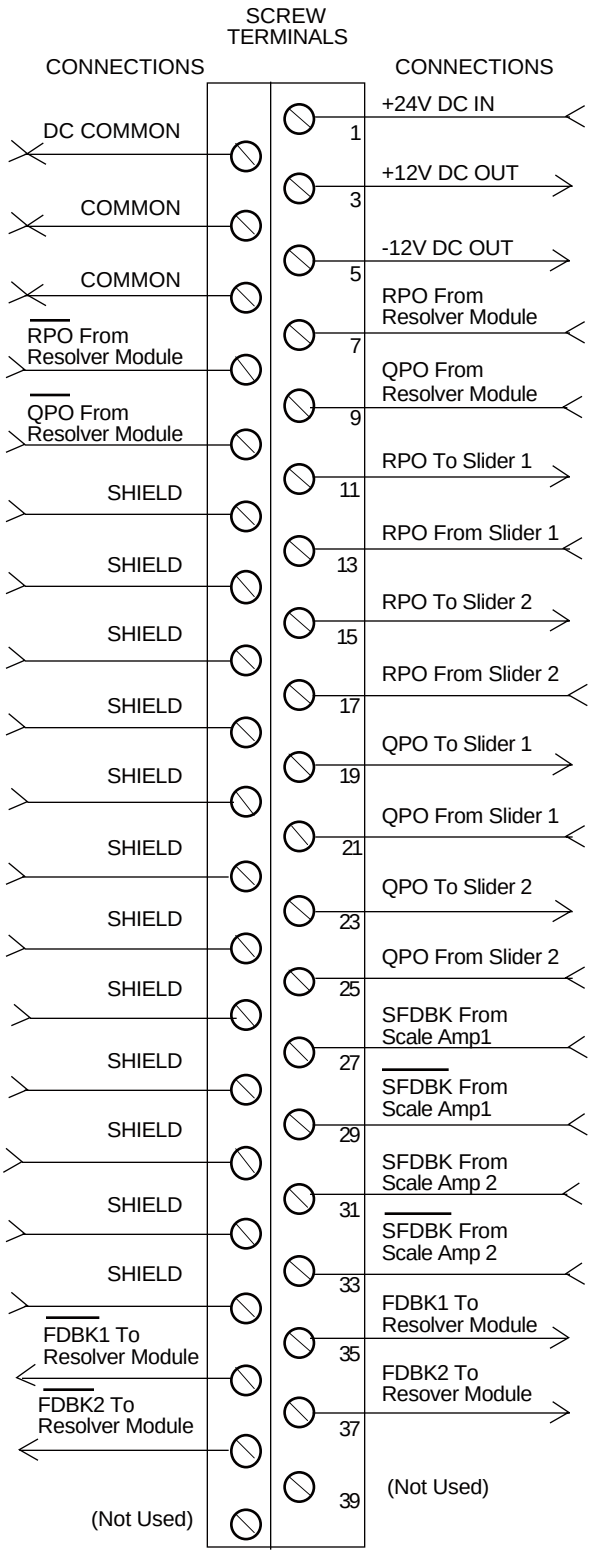
Two connections are required for an external +24VDC power supply.

In addition the module has 12 screw connections for terminating the shields. All twelve are connected inside the module so they are the same point electrically. They are also internally connected to the common pins 4 and 6. Connect pin 4 or 6 to the Single Point Ground (SPG) to which the system rack is connected.

The slider and scale amplifier have ground connection points also. Connect these points to the Single Point Ground (SPG) to which the system rack is connected.

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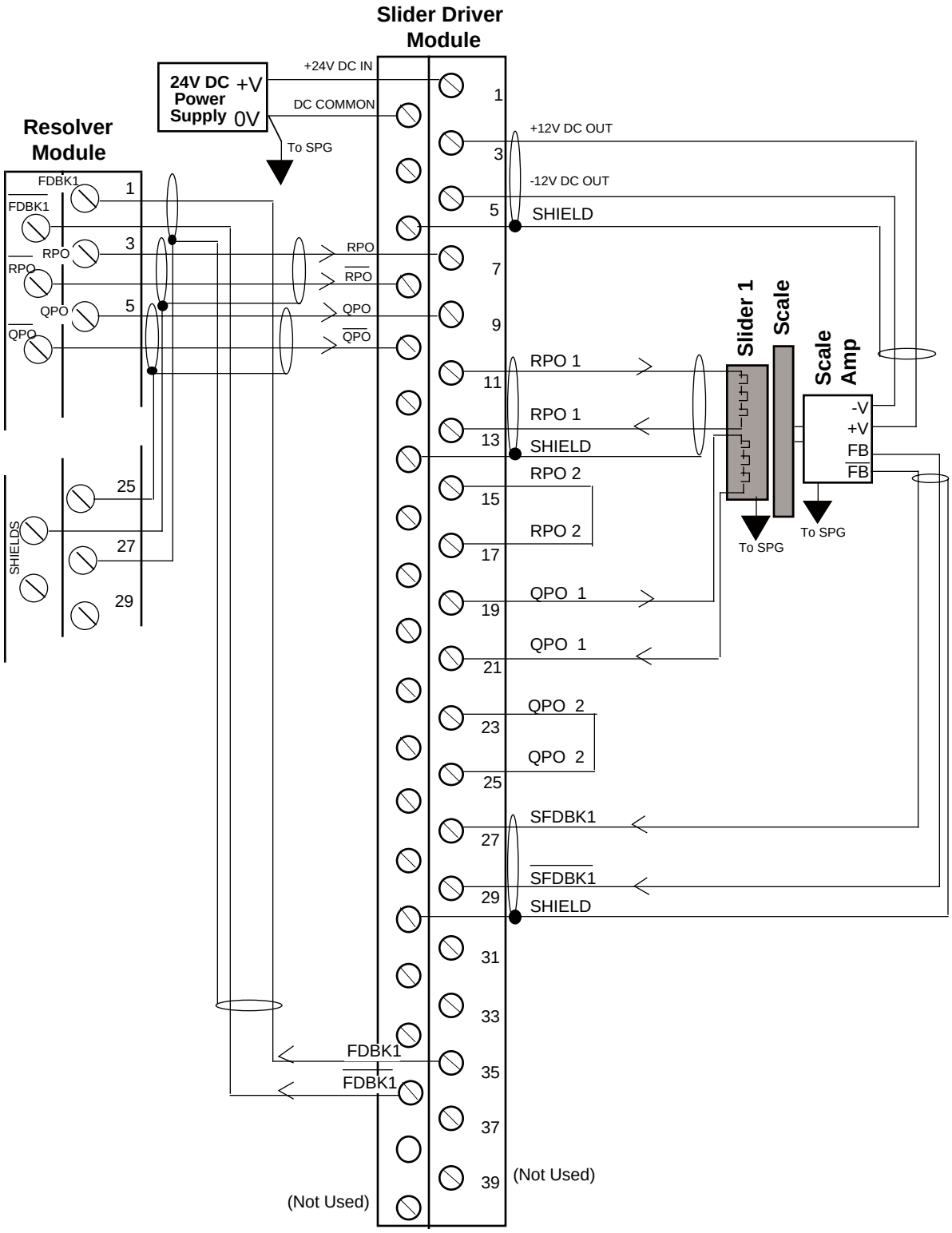
Figure D7-2. Screw Terminal Connector Assignments



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Figure D7-3 illustrates the connections between the PiC Resolver Module, the Slider Driver Module, and a single Inductosyn system. Note that RPO2 pins 15 and 17 are jumpered and QPO2 pins 23 and 25 are jumpered when only one Inductosyn system is connected.

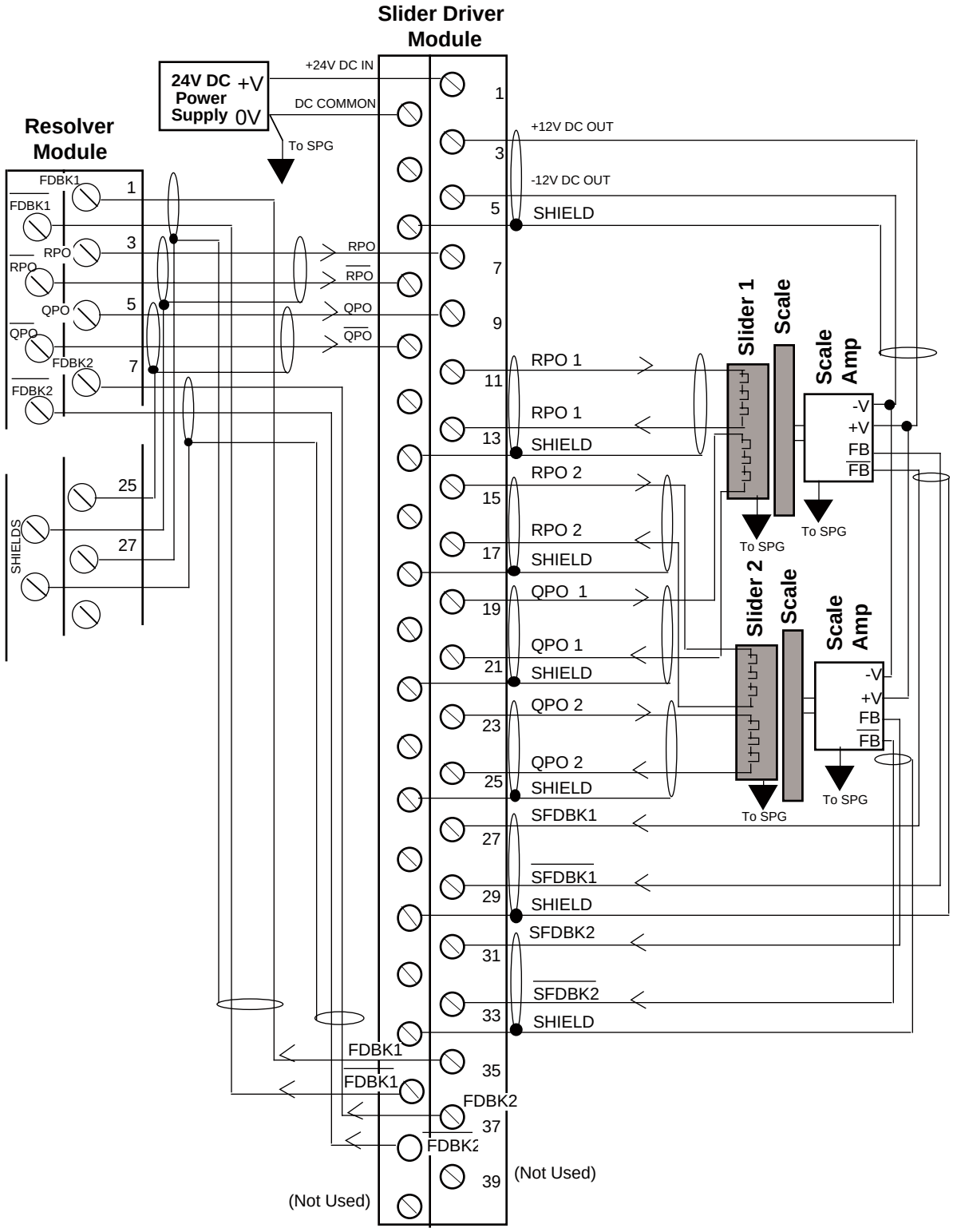
Figure D7-3. Connections to a Single Inductosyn System



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Figure D7-4 illustrates the connections between the PiC Resolver Module, the Slider Driver Module, and two Inductosyn systems.

Figure D7-4. Connections to Two Inductosyn Systems



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Theory of Operation

An Inductosyn system is a linear transducer consisting of printed circuit patterns along two flat bars. One of these bars is called the scale, the other is the slider. The scale is permanently attached along an axis of interest. The slider is attached to part of a machine that moves along the axis of interest.

When the machine moves, the slider passes over the scale. The slider and the scale are separated by an air gap. Alternating current passing through the slider creates a field which induces a signal in the scale. Position information is determined by the phase relationship between these signals.

The PiC Resolver module does not have the capability to drive a slider directly. The Slider Driver module provides the necessary current drive requirements. This module takes RPO and QPO from the Resolver module and applies them to the slider. The output of the scale is quite small and requires amplification. The Slider Driver module accepts the output of the scale amplifier and passes this signal back to the Resolver module, where the position information is determined.

The Slider Driver module obtains all of its power from an external +24VDC supply. Output voltages of ±12VDC are available to power the scale amplifier.

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Specification Table

Characteristic	Slider Driver Module Specifications
Function	Drives up to two Inductosyn sliders
Part number	502-03956-02
Field side connector	40 pin card edge connector, screw terminals
External Supply	
Input Voltage range	+18 to 30 VDC
Nominal input	+24VDC
Input current (max)	1Amp
Output Voltages	±12VDC current limited
Scale Amplifier	503-13704-00 NOTE: If the Inductosyn scales and sliders are purchased from Giddings & Lewis, this is the required scale amplifier.
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.

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Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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NOTES

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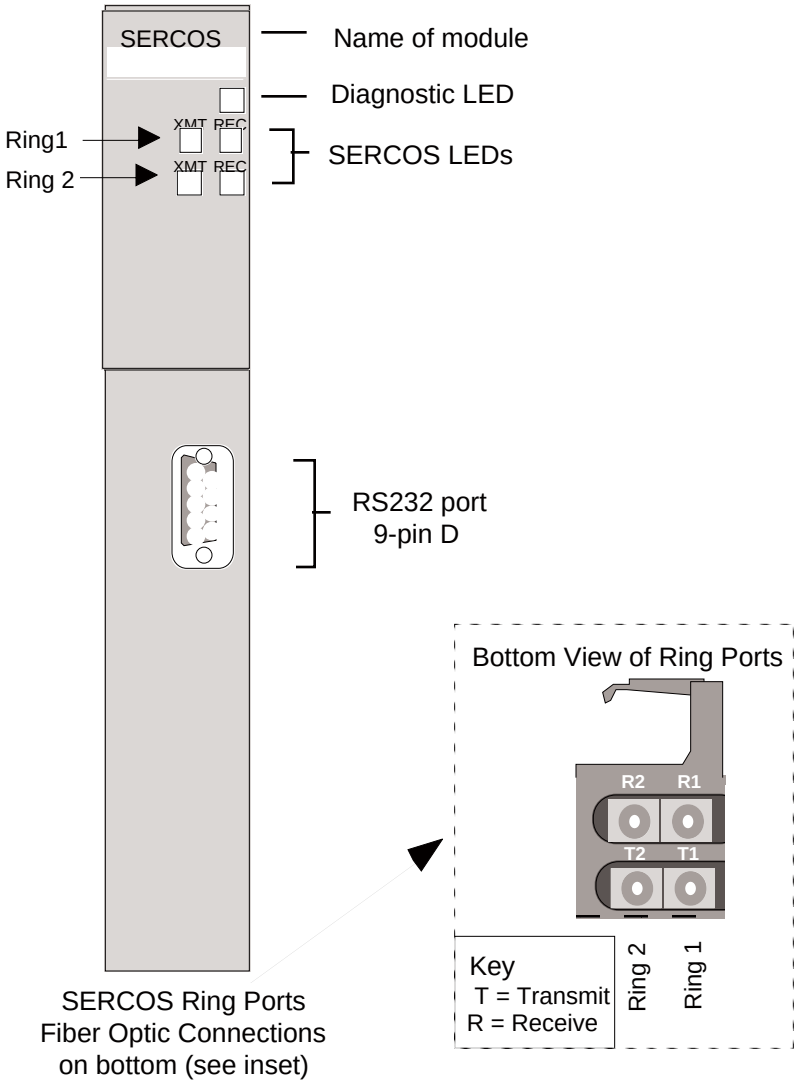
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D.8 - SERCOS Module

Introduction

The SERCOS module is an interface between the PiC and one or two fiber optic rings. A ring can have from one to eight SERCOS slaves. The module contains an on board processor. Five LEDs provide diagnostic information and transmit and receive status for the SERCOS rings. There are one or two SERCOS ring ports located at the bottom of the module. Each ring port has a receive and a transmit fiber optic connector. There is also an RS232 port used for loading FLASH memory updates.

Figure D8-1. SERCOS Module with Two Ring Ports

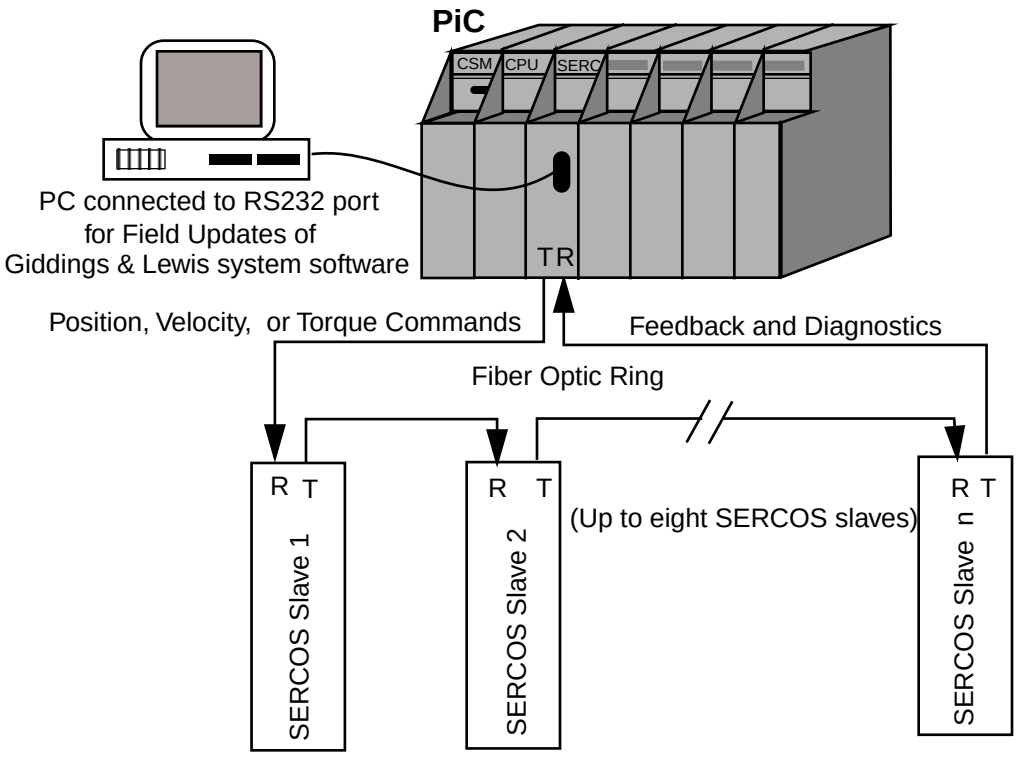


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SERCOS Ports

The SERCOS ports located on the bottom of the module can connect to one or two SERCOS rings. The connection to each ring is made through a pair of female fiber optic SMA connectors. The module's transmitter is connected to the first receiver in the loop and the module's receiver is connected to the last transmitter in the loop.

Figure D8-2. SERCOS Connections - One Ring



Serial Port

There is an RS232 serial port on the front of the module. This is used to connect to a PC in order to do a field update of the FLASH memory on the processor. The pinout is shown below.

Figure D8-3. Pinout for the 9-Pin D Connector

Pin #	Signal Name	In/Out
2	Receive Data	In
3	Transmit Data	Out
5	Ground	In/Out

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Theory of Operation

The SERCOS module is controlled by your LDO created in PiCPro. An on-board processor interprets the functions and performs appropriate operations according to the SERCOS communications protocol.

The data transfer rate is 2M Baud with user-defined update rate.

If a scan loss occurs, SERCOS communications are reset. There is no communication with the SERCOS slaves until you reinitialize.

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Specification Table

Characteristic	SERCOS Module Specifications
Function	Interfaces with up to two rings with from one to eight digital drives
Part number	Two-Ring Module 502-03944-04 One-Ring Module 502-03944-14
SERCOS port	SMA female connectors for interfacing to 1000 µ meter plastic fiber optic cable with SMA male connectors
Update port	RS232 interface Fiber optic receiver specifications: Peak input power (optical level low) -31.2 dBm max Peak input power (optical level high -20.0 dBm min, -5 .0 dBm max Fiber optic transmitter specifications: Peak output power (optical level high) -10.5 dBm min, -5.5 dBm max
Logic side power requirements	575 mA @ 5V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm

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Specification Table for the Fiber Optic Cable

Characteristics	Fiber optic cable specifications
Function	For use with SERCOS rings with segments from 0 to 30 meters (98 feet)
Type	Plastic with step index profile
Core diameter Fiber diameter	980 µm ±60 µm 1000 µm ±60 µm
Operating temperature	0˚ C to 55˚ C (32˚ F to 131˚ F)
Minimum bend radius	One time: 30 mm Continuous: 80 mm
Tensile strength	One time: 250 N Continuous: 100 N
Connectors	SMA style which accommodates 1000 µm size cable
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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D.9 - Output Stepper Axis Module (2, 4, or 8 channel)

Introduction

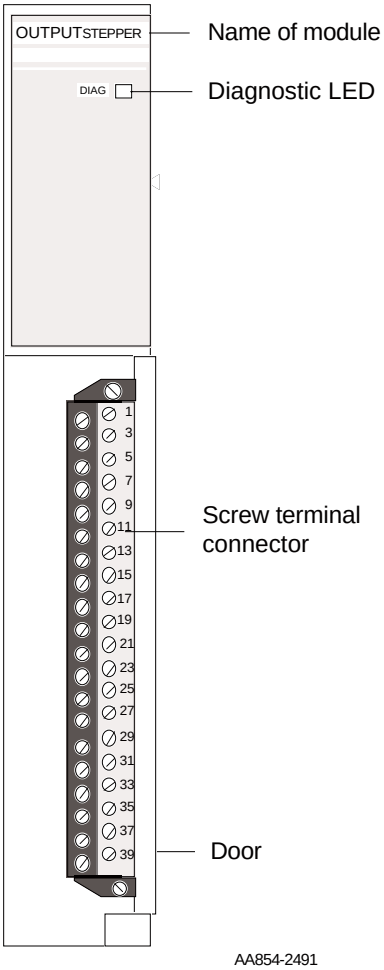
The output stepper axis module (SAM) can control up to eight stepper drives. The maximum step rate is ten million steps per second.

An external power supply (4.75 VDC to 5.25 VDC) is required for operation.

Commands and control data are sent to the module, and status information is received from the module, via the motion.lib software in PiCServoPro.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure D9-1. OUTPUT STEPPER Axis Module (2, 4, 8 ch)



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Connections

A screw terminal connection is provided for each output and for the external power supply connection. (See Figure D9-2.) The outputs are optically isolated. (See Figure D9-3.)

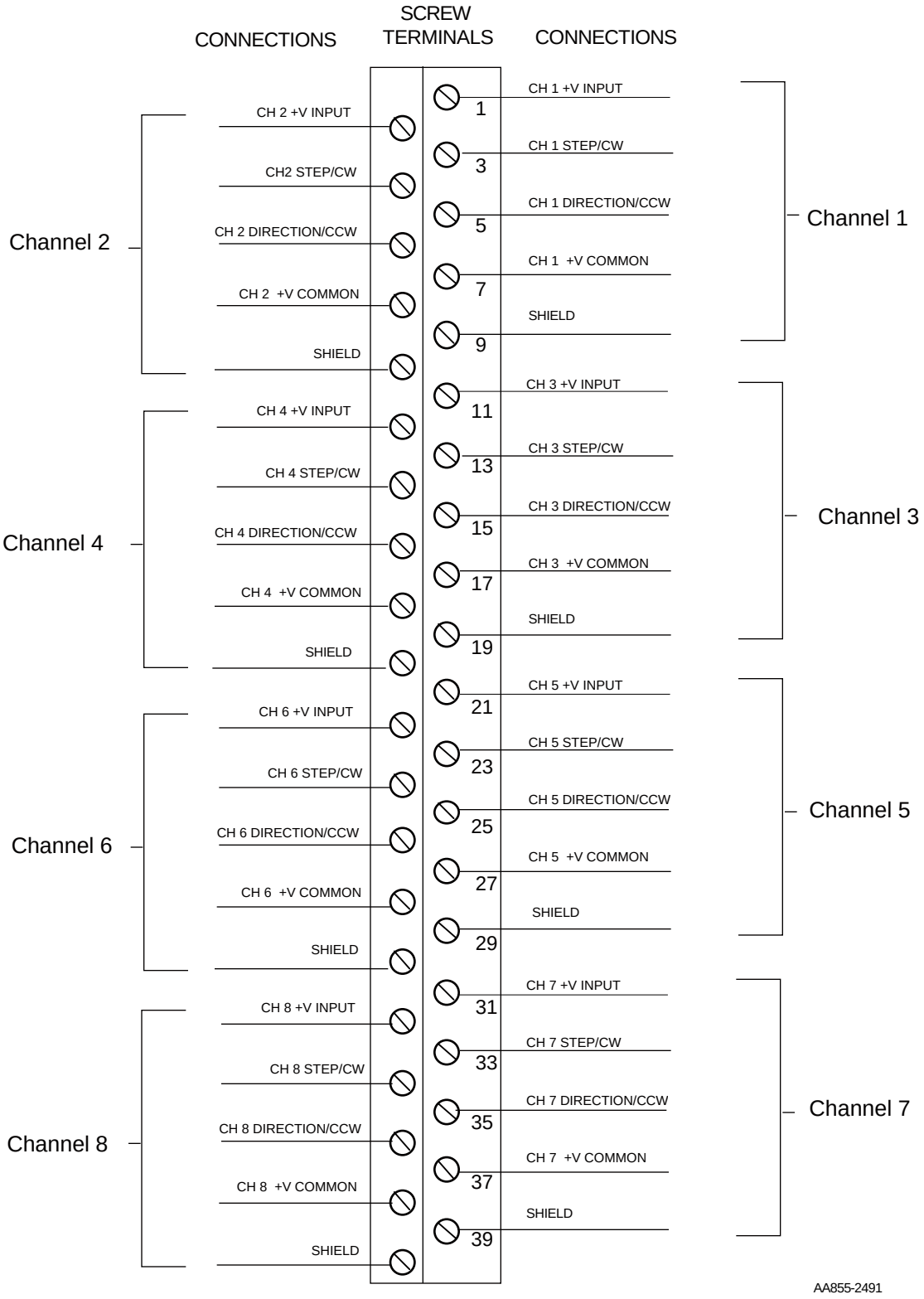
The external DC supply that powers the output signals should have a wire connected from its 0V (COMMON) terminal directly to the rack's single point ground. The power disconnect switch should be the same one used for the Central Service Module. In the power distribution diagrams in the Hardware chapter, a DC supply was set up according to these guidelines.

The external DC supply can be provided by any combination of the following:

- The stepper drive
- An external DC supply daisy-chained to several channels
- Separate external DC supplies for individual channels

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Figure D9-2. Screw terminal connection assignments

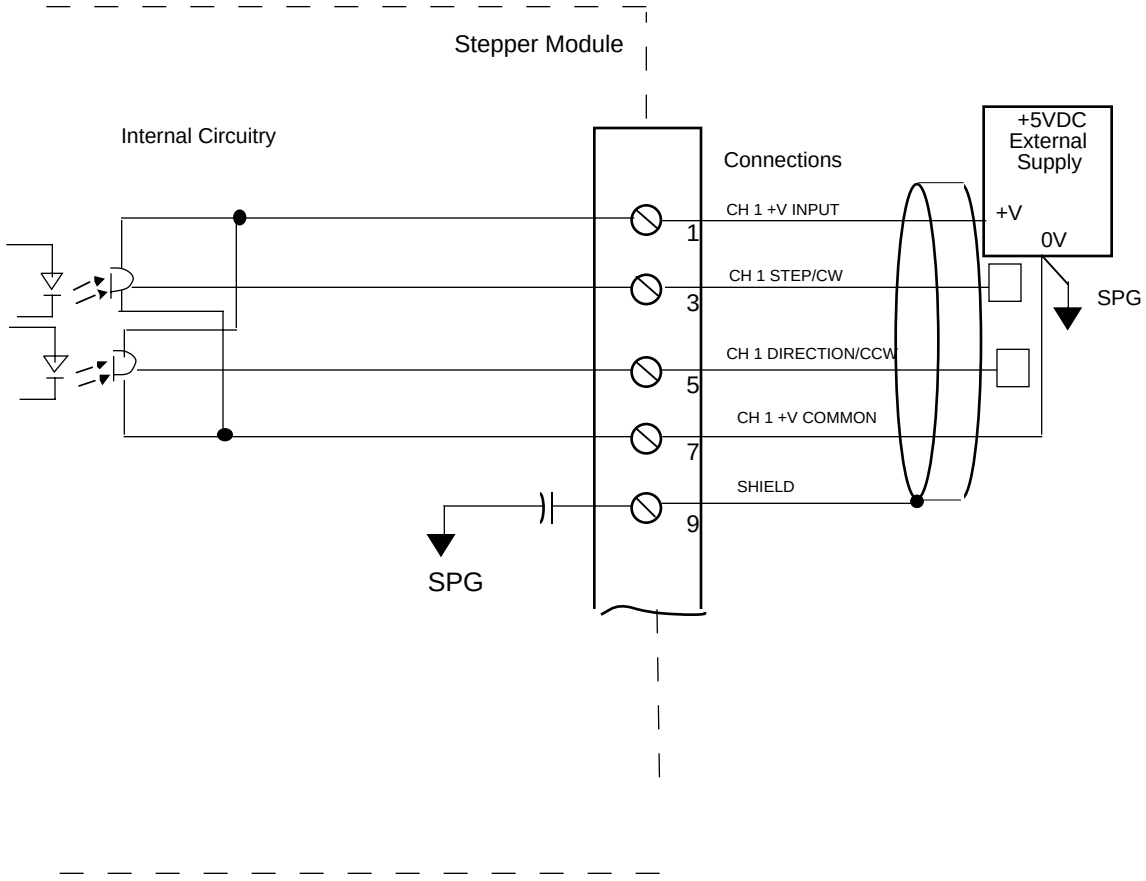


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Connections for one channel are illustrated on the right in Figure D9-3.

+V input	to	the +V terminal of the external power supply
Step/cw output	to	the step or clockwise input of the drive
Direction/ccw output	to	direction or counterclockwise input of the drive
Common	to	the 0V terminal of the external power supply NOTE: When the drive inputs are optically isolated, tie the 0V of the external power supply to SPG.
Shield		All shield pins on the module are connected to each other internally and AC coupled to SPG.

Figure D9-3. Connections for One Channel



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Connecting the SAM to Stepper Drives

Consult your drive manual regarding the proper connection of an indexer such as the SAM. Four types of drive inputs and the proper connection techniques are shown in Figures D9-4 to D9-7.

When working with opto-coupler drive inputs, be sure the input diode is protected by a current-limiting resistor as stated in the following important note.

IMPORTANT

There is a limit to the amount of current the input diode of the drive opto-coupler can withstand. If this current is exceeded, the device will be destroyed.

The SAM is capable of sinking considerably more current than the 15 mA specified. Most drives having opto-coupler inputs have a series current-limit resistor sized properly for a +5V external supply.

If the drive being used has an opto-coupler input but does not have a current-limit resistor or if the current-limit resistor is too small, then one will have to be added externally. Consult your drive manual for information regarding this topic.

Following the wiring guidelines listed below will increase the reliability of the SAM/drive system.

1. Route the wiring from the SAM separately from any high current or electrically noisy wiring.
2. Keep the wires connecting the SAM to the drive less than 10 feet in length.
3. Shield the wiring from the SAM. Tie shields to the SAM shield terminal screw and leave the other end of the shield unconnected.

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Opto-Coupler Drive Inputs

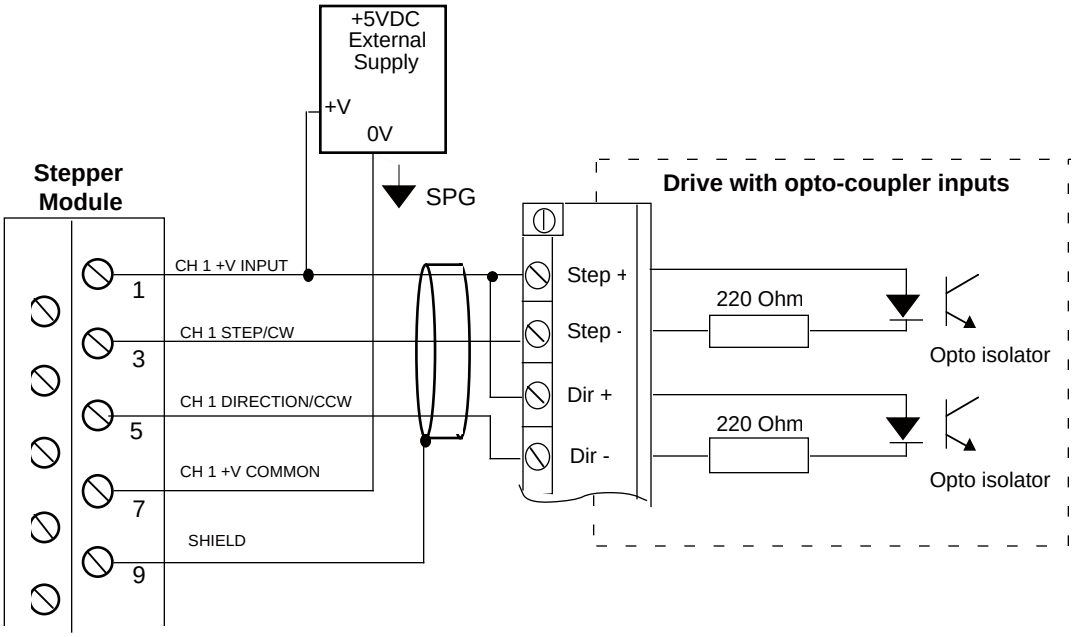
The inputs for this type of drive will be:

1. Step +
2. Step -
3. Direction +
4. Direction -

Make the following connections as illustrated in Figure D9-4:

SAM		External Power Supply		Drive
Step/CW	to	N/C	to	Step -
Direction/CCW	to	N/C	to	Direction -
+V Input	to	+V	to	Step + and Direction +
+V Common	to	0V	to	N/C

Figure D9-4. SAM Connections to Opto-Coupler Drive Inputs



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Opto-Coupler with Common Source Drive Inputs

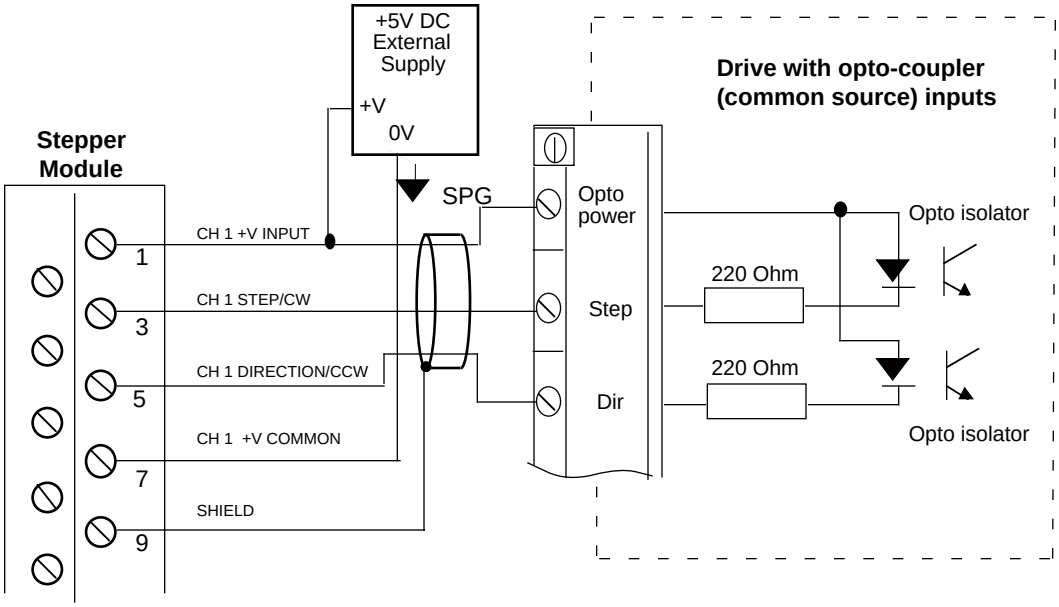
The inputs for this type of drive will be:

1. Opto power input
2. Step
3. Direction

Make the following connections as illustrated in Figure D9-5:

SAM		External Power Supply		Drive
Step/CW	to	N/C	to	Step
Direction/CCW	to	N/C	to	Direction
+V Input	to	+V	to	Opto power input
+V Common	to	0V	to	N/C

Figure D9-5. SAM Connections to Opto-Coupler Drive Inputs with Common Source



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Single-Ended Drive Inputs

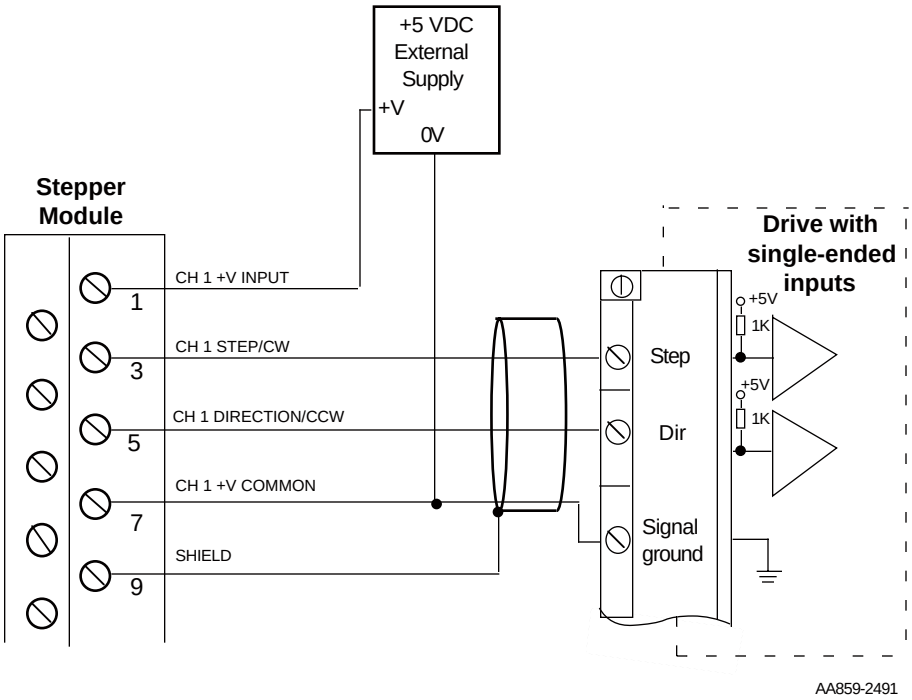
The inputs for this type of drive will be:

1. Step
2. Direction
3. Signal ground

Make the following connections as illustrated in Figure D9-6:

SAM		Power Supply		Drive
Step/CW	to	N/C	to	Step
Direction/CCW	to	N/C	to	Direction
+V Input	to	+V	to	N/C
+V Common	to	0V	to	Signal ground

Figure D9-6. SAM Connections to Single-Ended Drive Inputs



If the pull-up resistors internal to the drive are inadequate, you may need to add external pull-up resistors. Install them as close as possible to the drive.

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Differential Drive Inputs

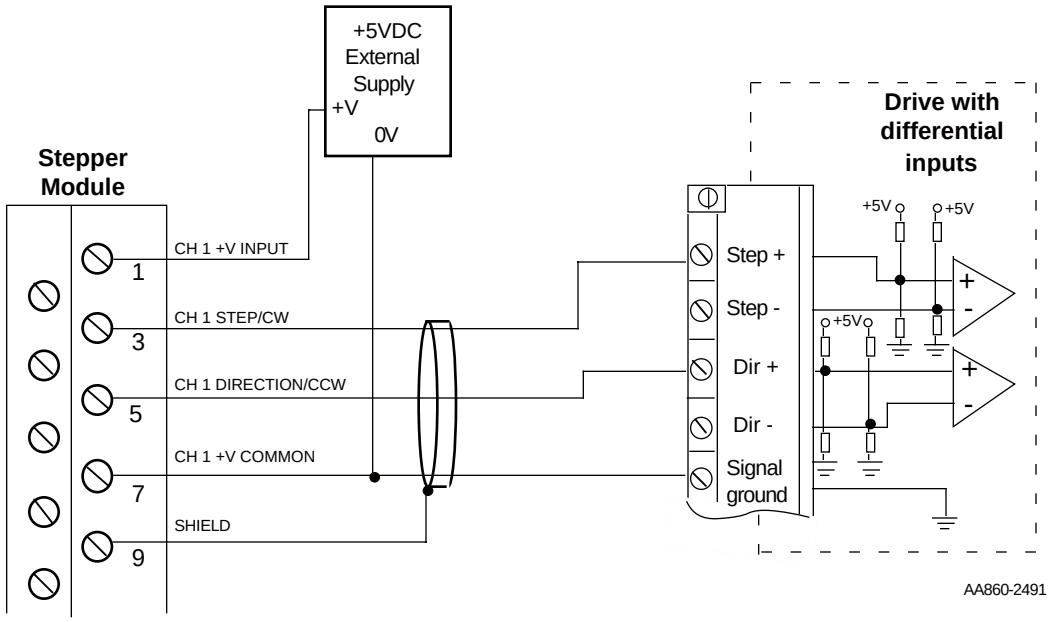
The inputs for this type of drive will be:

1. Step +
2. Step -
3. Direction +
4. Direction -
5. Signal ground

Make the following connections as illustrated in Figure D9-7:

SAM		Power Supply		Drive
Step/CW	to	N/C	to	Step +
Direction/ CCW	to	N/C	to	Direction +
+V Input	to	+V	to	N/C
+V Common	to	0V	to	Signal ground

Figure D9-7. SAM Connections to Differential Drive Inputs



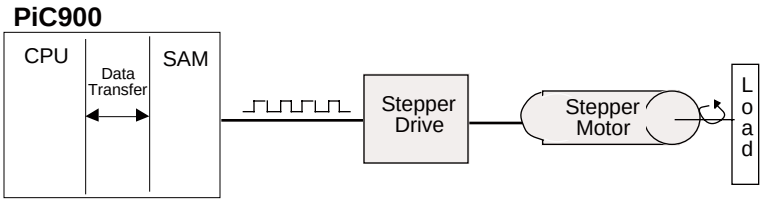
If the Step- and Direction- inputs are not biased to one half the external supply by the drive, external voltage dividers will be required. Install them as close to the drive as possible.

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Theory of Operation

The stepper module is part of an open loop control system used to position from one to eight axes. The diagram in Figure D9-8 illustrates one axis being controlled by the SAM. Digital signals from the SAM are converted into fixed increments of motion via the stepper drive. This allows the stepper motor to move the load accurately and reliably by following the number of input steps.

Figure D9-8. Open Loop Stepper System



The CPU, through the SAM controls the position, velocity, and acceleration of the stepper motor. The number of pulses generated by the SAM provides distance information (steps) and the rate of these pulses provides velocity information (steps/sec). The rate of change of the pulse rate provides acceleration/deceleration information (steps/sec/sec).

For safety reasons, the SAM stops outputting pulses to the stepper drive when a scan loss occurs.

Valid step rates sent by the CPU for a velocity command (or calculated by the CPU during acceleration or deceleration) are defined by the following equation:

$$ValidRate = \frac{10 \times 10^6}{X}$$

where X is any integer from 1 to 8,388,609.

Refer to the Software Manual for information on controlling the SAM via software.

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Specification Table

Characteristic	Output stepper module (2, 4, 8 ch) specifications
Function	Controls up to eight stepper drives
Part number	502-04077-00 8 channel 502-04077-20 2 channel 502-04077-40 4 channel
+V input (from external supply)	4.75 VDC to 5.25 VDC, 45 mA per connected channel
Step/CW output rating Direction/CCW output rating	Totem pole, 15 mA sink, 5 mA source
Field side connector	40-pin card edge connector, screw terminals
Protection of logic circuits	Optical isolation between the logic and field side
Indicator light, module	A DIAG LED turns OFF when the module passes its diagnostic tests at power-on
Step rate	0 to 10,000,000 steps/sec
Step rate accuracy	$ValidRate = \frac{10 \times 10^6}{X}$ where X is any integer from 1 to 8,388,609
Response to scan loss	Pulse output halted
Logic side power requirements (typical)	140 mA 8 channel 80 mA 4 channel 50 mA 2 channel
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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Appendix E - Analog Modules

E.1 - Input Analog Module (8 channel)

Introduction

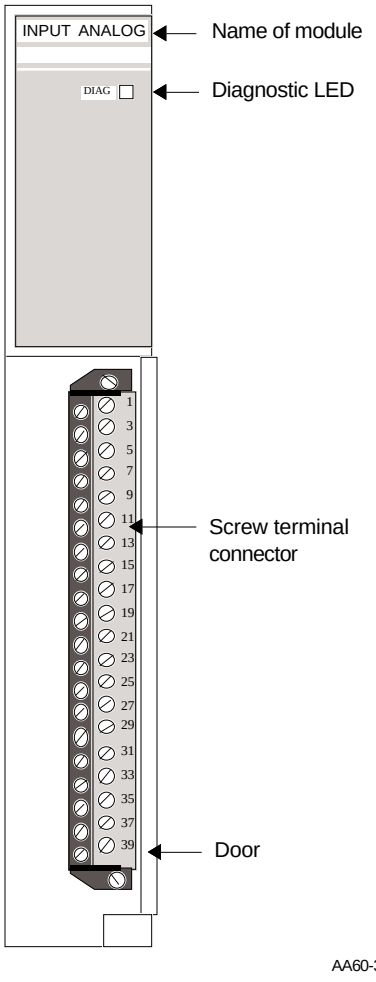
The analog input module is designed to interface the PiC with voltage or current output devices to monitor such things as pressure, flow, speed, position, or temperature. There are two versions of the analog input module available. One has 12-bit resolution and the other has 14-bit resolution.

The module has eight independent analog conversion channels. Each channel converts a unipolar or bipolar analog input voltage or current into a 12- or 14- bit digital value. This data is transmitted to the PiCs CPU for processing.

There is an internal current sense resistor for each channel for use with 0 to 20 mA or 4 to 20 mA devices. This module contains no user adjustable potentiometers or hardware switches. All necessary gain adjustments are done in software. The analog module can be configured as a feedback module using the Servosetup software.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure E1-9. INPUT ANALOG Module (8 CH)



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Connections

All signals to the input module must come to the screw terminal connectors through shielded twisted pair wires. See the discussion in the Hardware chapter on "Preventing electrical noise in data lines".

Each input channel has three connection pins. (See Figure E1-2.) The signals are:

+voltage input
-voltage input
250 ohm current sense resistor for 0/20 mA and 4/20 mA applications

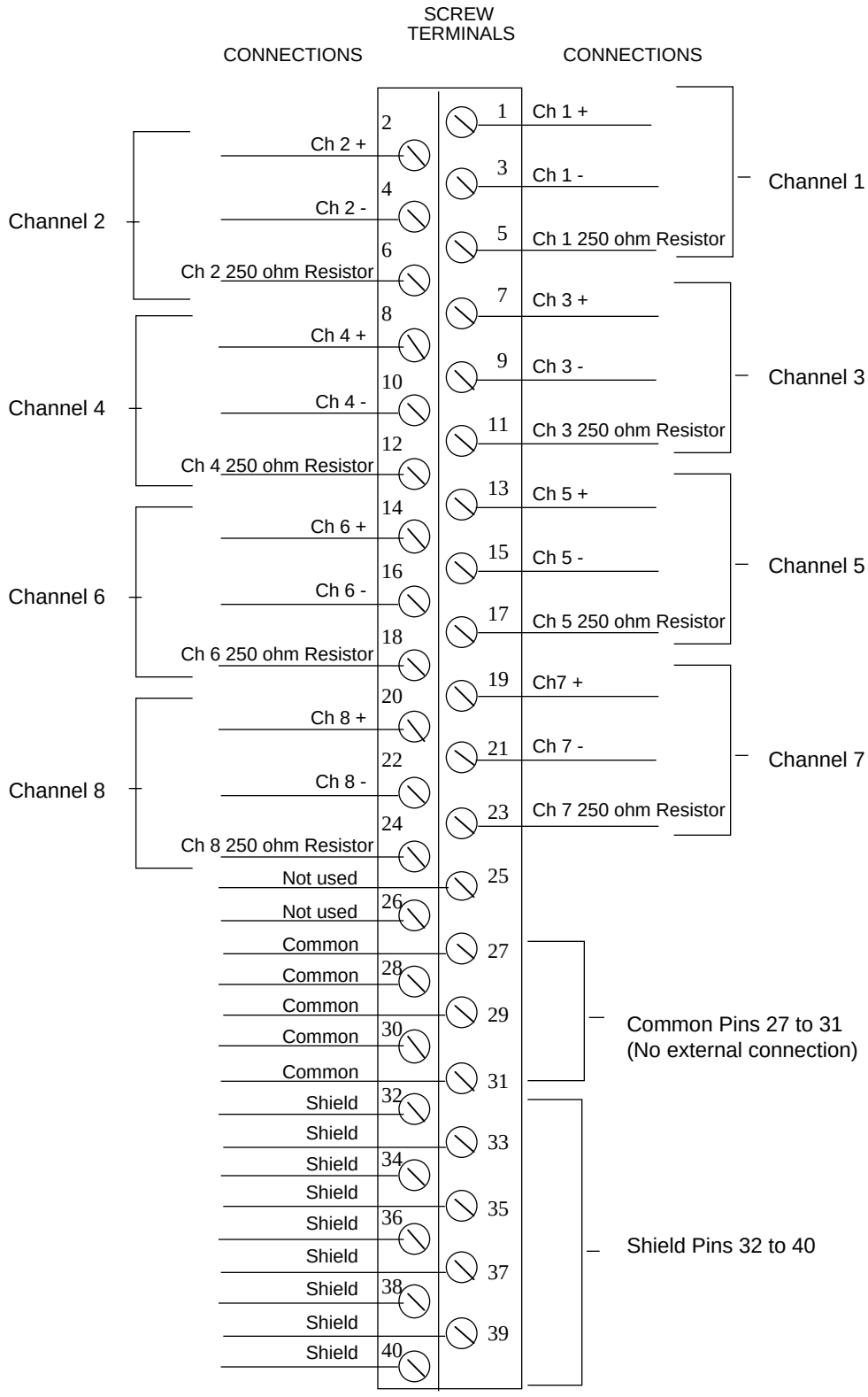
There are five common connection pins. All five pins are interconnected within the module so that they are the same point electrically. These pins are internally connected to the Single Point Ground (SPG).

In addition the module has nine screw connections for terminating the shields. All nine are interconnected within the module so they are the same point electrically. These pins are internally connected to SPG. The shield at the device end of the cable is not connected.

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Figure E1-2 shows the assignments for all the screw terminal connections on the module.

Figure E1-10. Connections for the Input Terminals

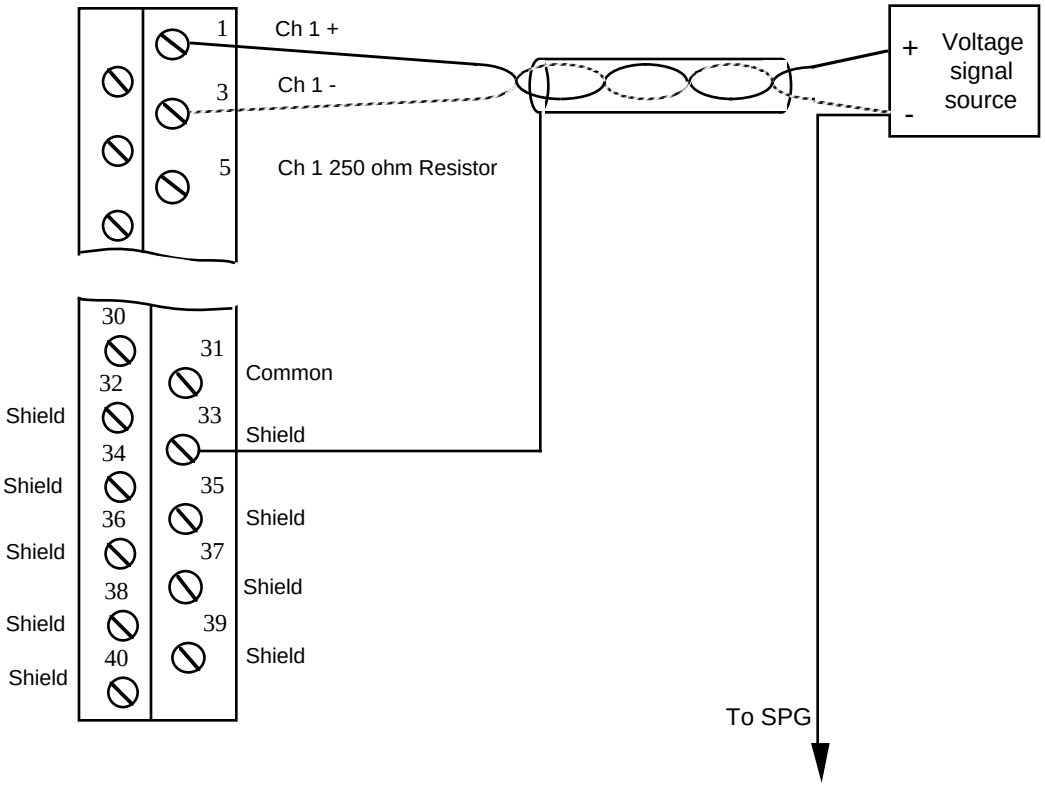


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When connecting an analog voltage output device to the module, the positive wire of the twisted pair goes to the + screw terminal and the negative wire goes to the - screw terminal. Figure E1-3 illustrates these connections for channel one.

Notice that no connection is made to the screw terminal with the internal 250 Ω resistor when connecting a voltage source device.

Figure E1-11. Voltage Input Connections

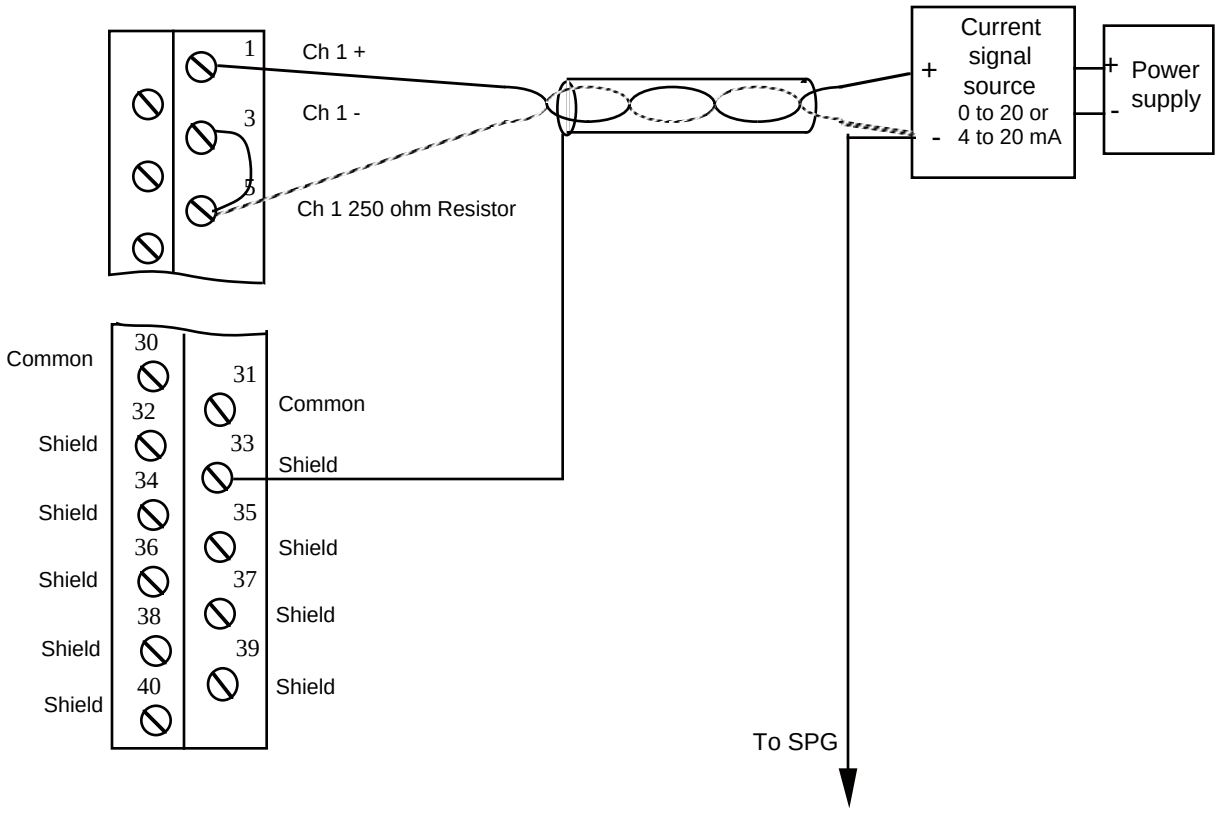


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When using a 0 to 20 mA or 4 to 20 mA current output device, the positive wire of the twisted pair is connected to the + input and the negative wire is connected to the 250 Ω resistor input.

A jumper is placed between the - input and the 250 Ω resistor input as shown in Figure E1-4 (from pin 3 to pin 5 for channel 1). This connects a 250 Ω internal resistor across the input.

Figure E1-12. Current Input Connections (0 to 20 or 4 to 20 mA)



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An alternative method of connecting a two wire 4 to 20 mA current device is shown in Figure E1-5. Place a jumper between the - input and the 250 Ω resistor input.

Figure E1-13. Current Input Connections (4 to 20 mA)

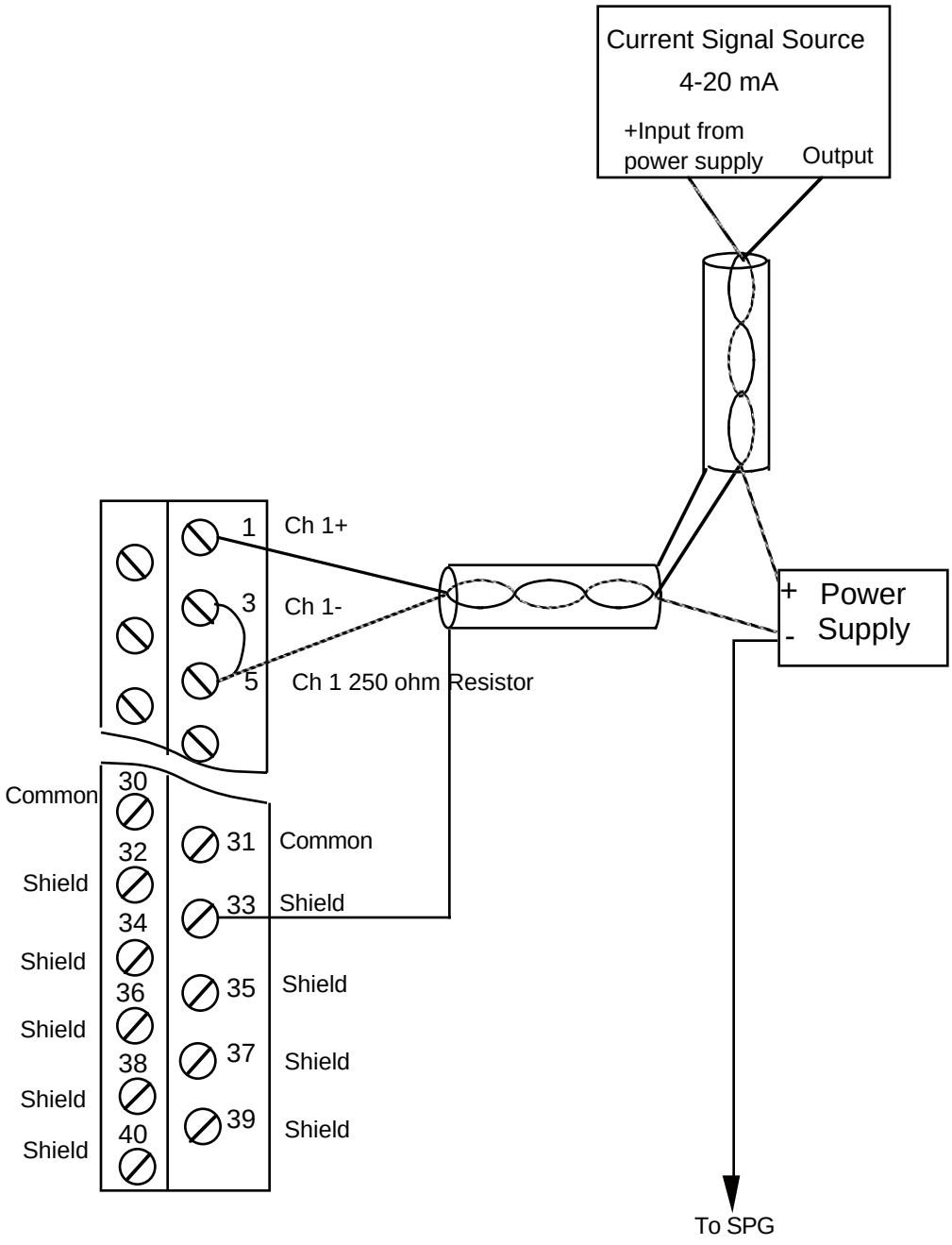


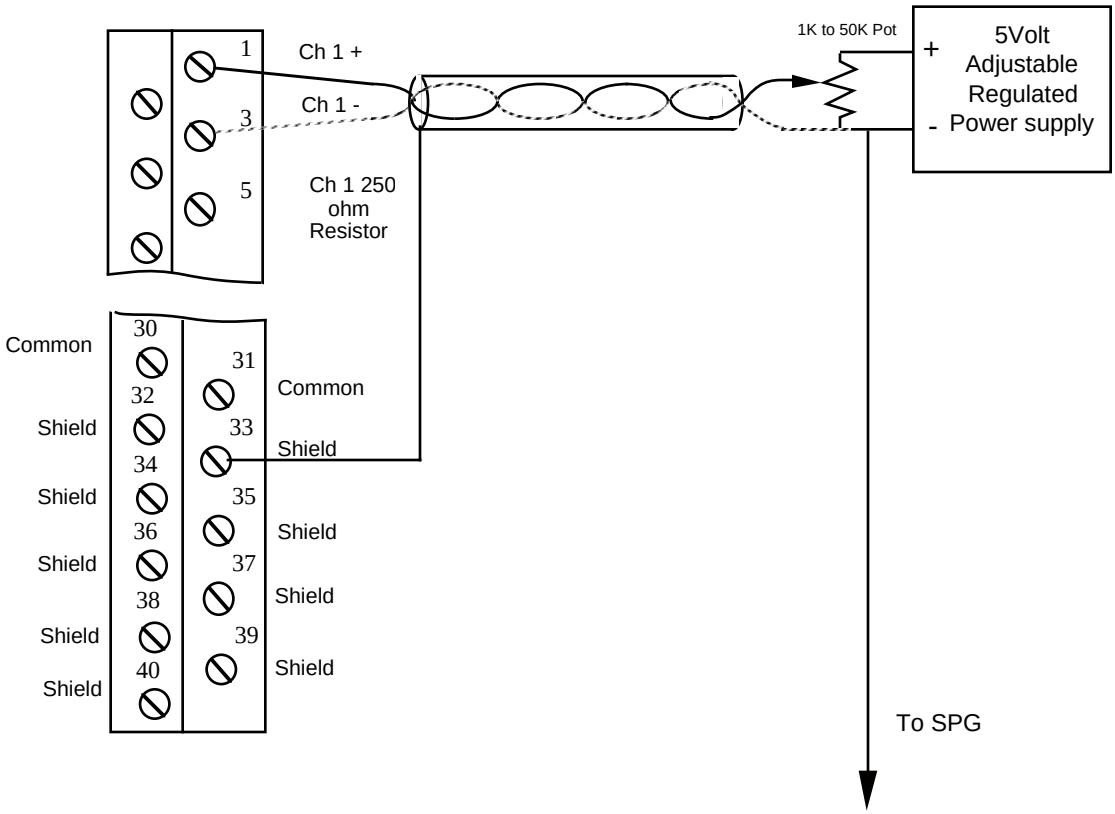
Figure E1-6 illustrates an example of wiring an external potentiometer to the module using twisted pair wire.

For this example, set up the channel initialization function (A_INCHIT) in software for 5 V unipolar with a filter of 100 ms.

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The 5 V power supply output voltage adjustment can be set for the maximum potentiometer output value. For example, the supply could be adjusted until the VALU output of the analog input channel read function (A_INCHRD) reads 4095 (12-bit) or 16383 (14-bit) with the pot at its maximum position.

Figure E1-14. Adding an External Potentiometer



Theory of Operation

A 12- or 14- bit A/D converter samples each channel in sequence at the input scan rate. These values are stored in memory on the module so that any channel value can be read while the A/D converter is processing another channel sample.

Each channel can be set up for a maximum input sensitivity of .125 V to 10 V, bipolar or unipolar, or for 4 to 20 mA or 0 to 20 mA current input. To sense current the internal 250 Ω resistor must be connected as shown in Figures E1-4 or E1-5.

All inputs are differential with the input signals electrically isolated from the logic side and filtered for a high degree of noise immunity.

The default noise filter time constant is 1 ms. If more noise filtering is required, two longer time constants, 10 ms and 100 ms, are software selectable. The longer time constants will improve noise immunity but lengthen signal response time. Using the longer time constants may reduce closed position loop performance if the input is used for position feedback.

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Specification Table

Characteristic	Input Analog (8 ch) module specification
Function	Converts an analog input signal into a 12- or 14-bit digital word for each of eight channels.
Part number	**12-bit** 502-03642-03 **14-bit** 502-04050-00
Field side connector	40 pin card edge connector, screw terminals
Input channels	8
Resolution	12 bits, or 4096 steps over the full input range 14 bits, or 16384 steps over the full input range
Input sensitivity (software selectable)	
Voltage ranges	Unipolar / Bipolar 0 to 10 V / ±10 V 0 to 5 V / ±5 V 0 to 2.5 V / ±2.5 V 0 to 1.25 V / ±1.25V 0 to 1 V / ±1 V 0 to .5 V / ±.5 V 0 to .25 V / ±.25 V 0 to .125 V / ±.125 V
Current range	0 to 20 mA, 4 to 20 mA
Common mode maximum voltage (The maximum voltage that can safely be applied between either input terminal and circuit common.)	±40V
Common mode operating voltage (The maximum voltage that can be applied between either input terminal and circuit common with inputs still operating properly.)	±11V
Internal current sense resistor	250 ohms
Maximum current sense resistor power	.12 W
Differential input resistance (each input to ground)	1 M Ohms
Filter time constant - software selection	1 ms, 10 ms, 100 ms

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Accuracy of 4-20 mA range	12-bit - .2% of FSR at 25°C 14-bit - .15% of FSR at 25°C ± 100 PPM /°C
Accuracy of all other ranges	12-bit - .5% of FSR at 25°C 14-bit - .2% of FSR at 25°C ± 100 PPM /°C
0 Offset	12-bit-from ±2 counts @ 10V to ±8 counts @ .125V 14-bit-from ±5 counts @ 10V to ±40 counts @ .125V
Logic side power requirements (typical)	120 mA @ +5V 112 mA @ +15V
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm

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Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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E.2 - Input J-K Thermocouple Module (12 channel)

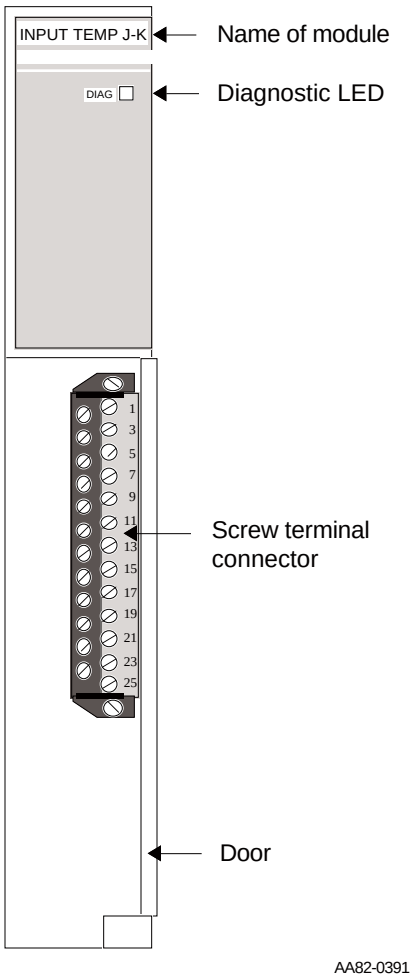
Introduction

The input temp J-K thermocouple modules (one for use with grounded thermocouples and one for use with ungrounded thermocouples) has 12 independent thermocouple or analog conversion channels which receive signals from J or K type thermocouples or from a voltage source. Each channel converts an analog signal into a 12-bit digital word which is processed by the PiC900.

This module requires no hardware adjustments. All adjustments such as Fahrenheit or Celsius scaling and thermocouple ranges are software selectable.

The DIAG LED turns on briefly while the diagnostic tests are running.

Figure E2-1. INPUT TEMP J-K Module (12 CH)



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Connections

Thermocouple signal levels are very small (1˚C is approximately 50 µV) and, consequently, sensitive to electrical noise. The module inputs are processed to reduce noise sensitivity. Always follow procedures to eliminate electrical noise from the system. Some guidelines for reducing noise are listed below.

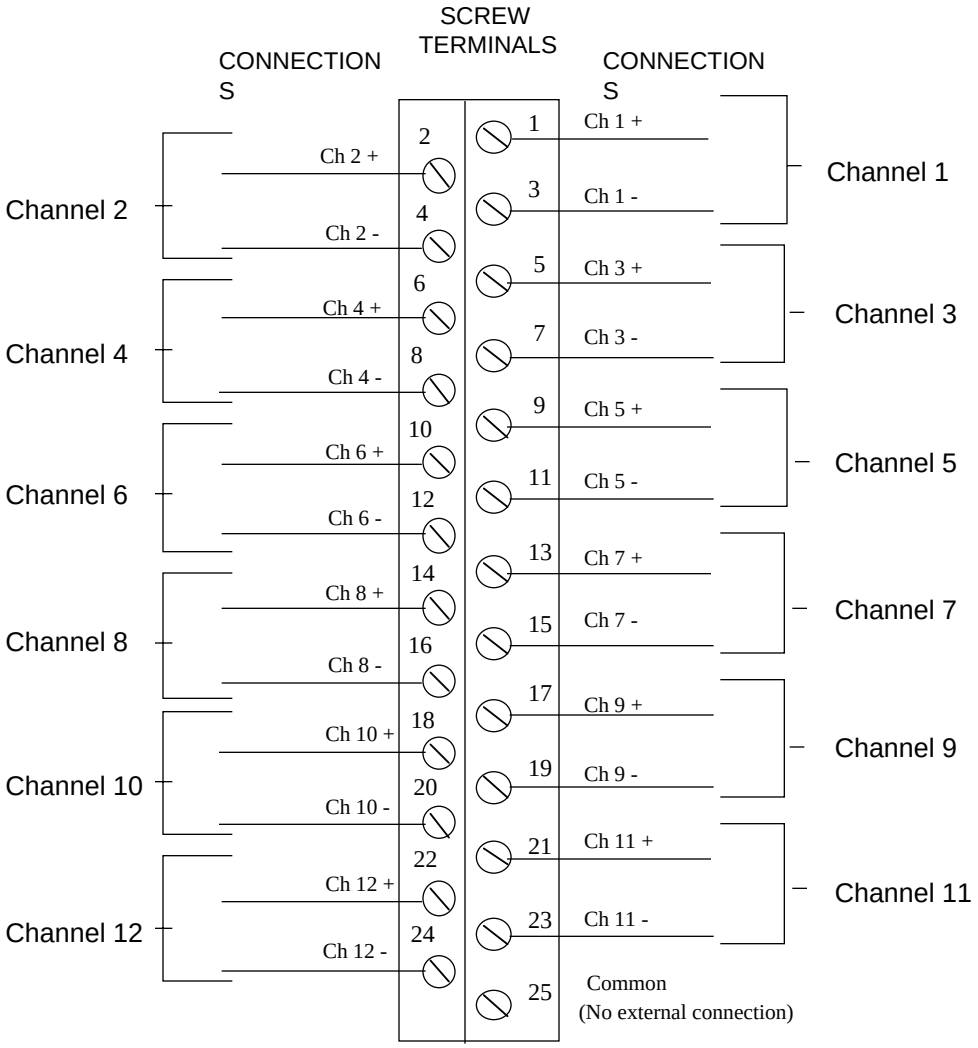
- Route thermocouple wires separately from sources of noise such as motors, AC wiring, etc.
- Keep both wires of the thermocouple physically close.
- If the point being measured is a noisy source, use shielded wire and electrically isolate the thermocouple junction from the point of measurement.
- Use shielded thermocouple wire in severe noise environments.

For ±100 mV input signals, do the following to protect from noise:

- Use shielded twisted pair wire.
- Connect the shield to the cabinet or to the metal enclosure at the cable entrance. Figure E2-2 shows the assignments for all the screw terminal connections on the module.

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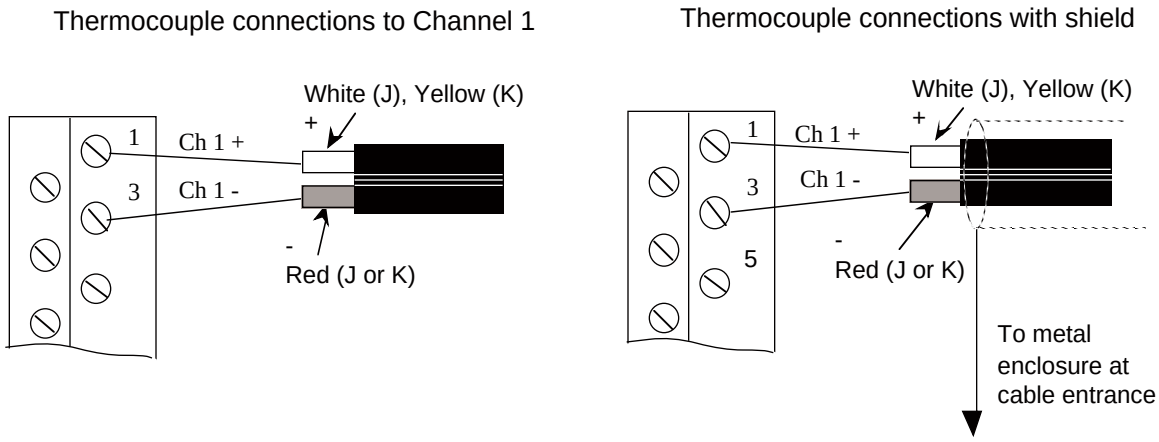
Figure E2-2. Connection for Input Terminals



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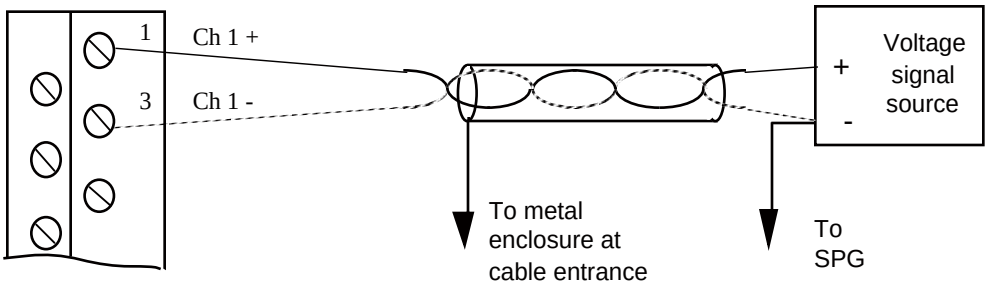
When connecting thermocouples to the module, the white wire of J type (the yellow wire of K type) is connected to the + input and the red wire of J or K type is connected to the - input as shown on the left in Figure E2-3. On the right is a shielded thermocouple connection.

Figure E2-3. Thermocouple Connections



When making an analog input connection to a ±100 mV type signal, shielded twisted pair wire should be used with the shield connected to SPG close to the module as shown in Figure E2-4.

Figure E2-4. Analog Input Connections



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If the ±100 mV range will be exceeded, external resistors must be added. The resistors should be positioned as close to the PiC900 as possible.

NOTE: Units are V_{in} in volts and R_1 and R_2 in K Ωs.

Select a R_1 value from .5K Ω to 2K Ω. Use the following formula to calculate the value of R_2:

$$R_2 = (V_{in} \times 10)\left(\frac{R_1 \times 260}{R_1 + 260}\right)$$

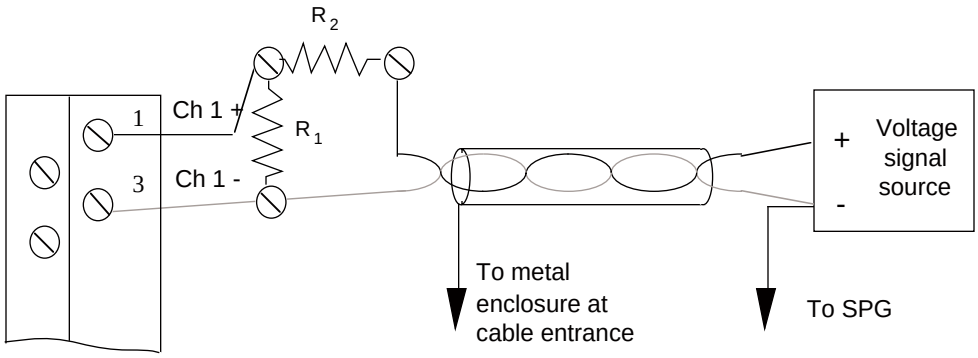
For example, if the input range will be ±10 V and R_1 = 1K Ω , then the value of R_2 would be:

$$R_2 = (10V \times 10)\left(\frac{1 \times 260}{1 + 260}\right)$$

$$R_2 = 99.6K$$

A 100K Ω resistor could be used for R_2 in this example. It is the closest standard 1% value.

Figure E2-5. Analog Input Connections with External Resistors



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Theory of Operation

The input thermocouple module receives analog signals from thermocouples or analog inputs and converts them to a 12 bit digital word for each channel in use. Each channel can be set up individually for three different thermocouple input ranges (see specification table) or for ±100 mV.

The module provides cold junction compensation. Cold junction compensation corrects for error voltages which occur at the point where the thermocouple wire terminates into the PiC900 module connector. *Always make the connection into the module with the thermocouple wire to ensure that cold junction compensation is effective.*

All inputs are differential with input signals electrically isolated from the logic side. The inputs are filtered with a 120 ms time constant for a higher degree of noise immunity.

The ±100 mV input can be used only in applications which do not require a response time faster than 120 ms.

Thermocouple Precautions

Certain precautions should be taken when working with thermocouples to ensure the integrity of your system.

- Avoid any vibration, bending or other mechanical stress which may strain the thermocouple wire and change its characteristics.
- Use 24 AWG solid or larger for runs less than 30 feet. Use 20 AWG or larger for runs greater than 30 feet. (The maximum thermocouple wire length is 1,000 feet.)
- Use shielded wire to protect from severe electrical noise.
- Use the thermocouple wire well within its temperature rating.

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Specification Table

Characteristic	Thermocouple module specification
Function	Measure J or K type thermocouple wire inputs or ± 100 mV analog inputs
Part numbers	**Ungrounded** 502-03658-02 **Grounded** 502-03809-02
Field side connector	25-pin card edge connector, screw terminals
Input channels	12
Resolution	12 bits
Input voltage sensitivity (software selectable)	±100 mV
J type thermocouple temperature ranges (at 25˚C)	-150˚C to 1200˚C (-238˚F to 2192˚ F) -35˚C to 620˚C (-31˚F to 1148˚ F) -10˚C to 280˚C (+14˚F to 536˚ F)
K type thermocouple temperature ranges (at 25˚C)	-200˚C to 1300˚C (-328˚F to 2372˚ F) -80˚C to 820˚C (-112˚F to 1508˚ F) -35˚C to 415˚C (-31˚F to 779˚ F)
J or K type accuracy	J type .37% of the 1350˚C span K type .36% of the 1500˚C span
±100 mV accuracy	± (50 µV + 1 count + input x 1%)
Time between samples (software selectable)	5000 to 65,535 µsec
Filter time constant	120 ms
Cold junction compensation	0 to 80°C ± 1°C at the sensor
Open thermocouple detection	Indicated by software (No detection for grounded thermocouples)
Logic side power requirements (typical)	80 mA @ +5V 112 mA @ +15V
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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E.3 - Input RTD Module (6 channel)

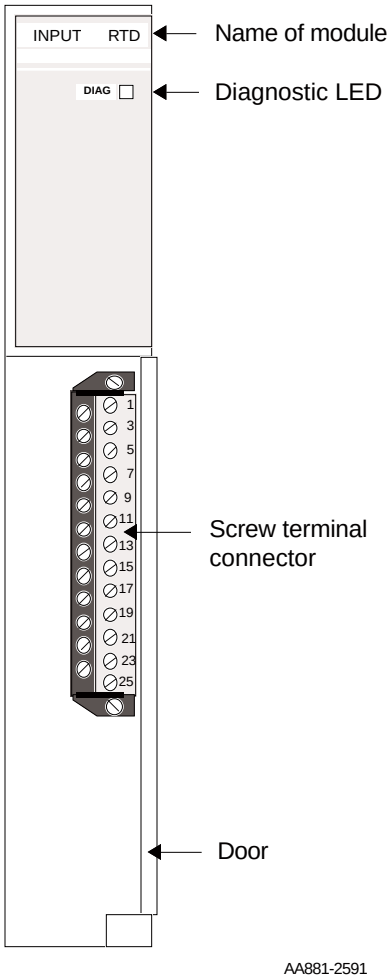
Introduction

The input **resistance temperature detector** (RTD) module has 6 independent RTD conversion channels which receive signals from 50 Ω or 100 Ω RTDs. Each channel converts a resistance into a 12-bit digital word which is processed by the PiC900.

This module requires no hardware adjustments. All adjustments such as Fahrenheit or Celsius scaling and temperature ranges are software selectable.

The DIAG LED turns on briefly while the diagnostic tests are running.

Figure E3-1. INPUT RTD Module (6 CH)



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Connections

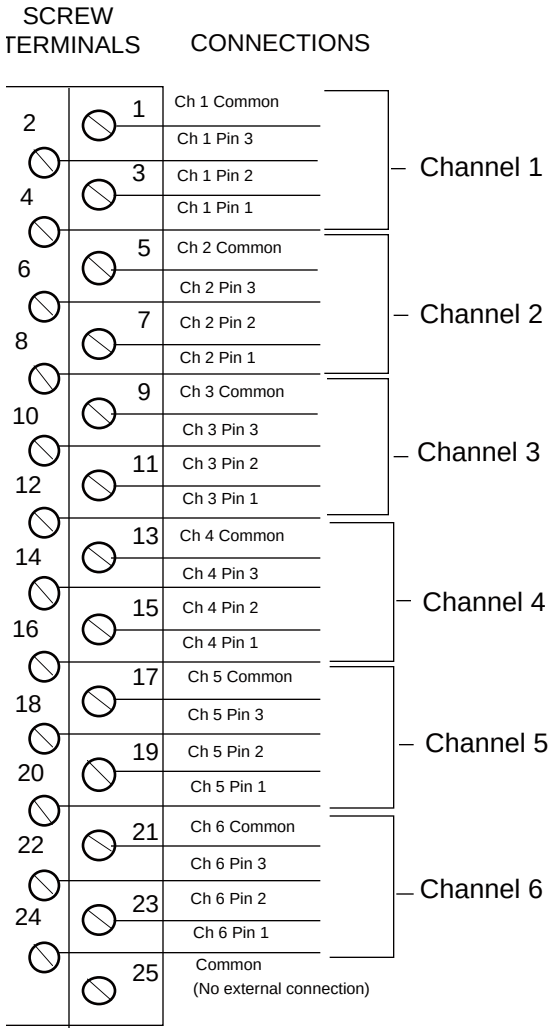
RTD signal levels are very small (approximately 1.0 mA constant current source) and, consequently, sensitive to electrical noise. The module inputs are processed to reduce noise sensitivity. Always follow procedures to eliminate electrical noise from the system. Refer to the EMC Guidelines. Some additional guidelines for reducing noise are listed below.

- Route RTD wires separately from sources of noise such as motors, AC wiring, etc.
- Keep RTD wires physically close to each other.
- In severe noise environment, use twisted pair wire for two pin RTDs and use shielded wire (3 conductor w/ground recommended) for three pin RTDs.

Figure E3-2 shows the assignments for all the screw terminal connections on the module.

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Figure E3-2. Connection for Input Terminals



RTDs may be 2- or 3-wire types. Inaccuracies in temperature will occur as the RTD wire (lead) length increases. Compensation for temperature inaccuracies must be taken into account when using RTDs. The RTD module provides internal lead compensation for 3-wire RTDs with lead lengths up to 1000 feet. No internal lead compensation is available for 2-wire RTDs. They are accurate without any lead compensation up to 20 feet.

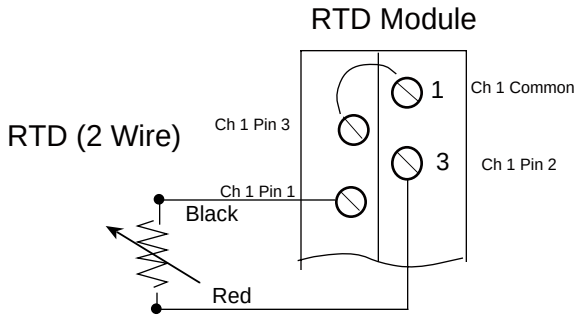
Adjustments for lead compensation can be made by you via the software for both 2- and 3-wire RTDs for up to 5000 feet of lead length.

When connecting the 2-wire RTD to the module, the black wire and red wires may be connected to pins 1 and 2 for the channel. Pin 3 is connected to the channel common with a jumper. See Figure E3-3 below.

NOTE: All the channel commons are connected internally to Pin 25 and to single point ground. No external connection to Pin 25 should be made.

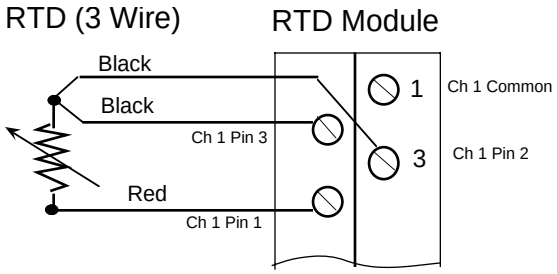
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Figure E3-3. RTD (2-wire) Connections



When connecting a 3-wire RTD to the module, the red wire and the black wires are connected to pins 1, 2, and 3 for the channel.

Figure E3-4. RTD (3-wire) Connections



Theory of Operation

The input RTD module receives analog signals from 50 Ω or 100 Ω RTDs and converts them to a 12 bit digital word for each channel in use. Each channel can be set up individually for up to three different RTD input ranges.

The three temperature ranges for RTDs are.

	50 Ω RTD	**100 Ω RTD**
1		-200˚C to 350˚C (-328˚F to 1562˚F)
2	-200˚C to 850˚C (-328˚F to 1562˚F)	-200˚C to 266˚C (-328˚F to 510.8˚F)
3	-200˚C to 266˚C (-328˚F to 510.8˚F)	-200˚C to 0˚C (-328˚F to 32˚F)

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RTD Precautions

Certain precautions should be taken when working with RTDs to ensure the integrity of your system.

- Avoid any vibration, bending or other mechanical stress which may strain the RTD wire and change its characteristics.
- Use 24 AWG solid or larger for runs less than 30 feet. Use 20 AWG or larger for runs greater than 30 feet.
- Use shielded wire to protect from severe electrical noise.
- Use the RTD wire well within its temperature rating.

Specification Table

Characteristic	RTD module specification
Function	Measures 50 Ω and 100 Ω RTD inputs
Part number	502-03679-02
Field side connector	25-pin card edge connector, screw terminals
Input channels	6
Resolution	12 bits
RTD types	European curve (Alpha = .00385) for 50 Ω and 100 Ω two and three wire RTDs
50 Ω temperature ranges	-200˚C to 850˚C (-328˚F to 1562˚ F) -200˚C to 266˚C (-328˚F to 510.8˚ F)
100 Ω temperature ranges	-200˚C to 850˚C (-328˚F to 1562˚ F) -200˚C to 266˚C (-328˚F to 510.8˚ F) -200˚C to 0˚C (-328˚F to 32˚ F)
Maximum RTD lead wire length	
24 AWG or smaller	< 20 feet
20 AWG or larger	2-wire RTD - under 20 feet without lead compensation NOTE: Lead length can affect accuracy of 2-wire RTDs with lengths over 20 feet. 2-wire RTD - up to 5000 feet with lead compensation 3-wire RTD - up to 1000 feet without lead compensation 3-wire RTD - up to 5000 feet with lead compensation
Accuracy	.6% FSR @ 25°C Temperature coefficient of 75 PPM/°C

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Time between samples (software selectable)	2000 to 65,535 µsec
Filter time constant	120 ms
Open RTD detection	Indicated by software
Logic side power requirements (typical)	80 mA @ +5V 112 mA @ +15V
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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E.4 - Output ±10V DC Module (8 or 4 channel)

Introduction

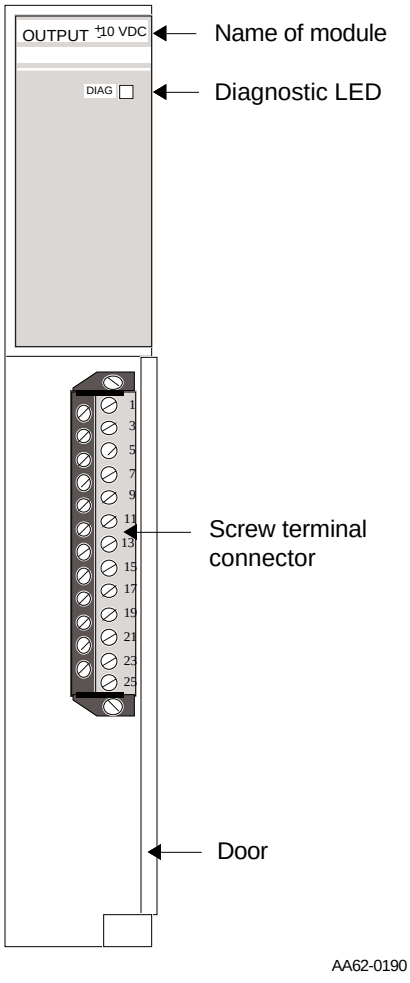
The output ±10V DC module has independent D/A conversion channels. Each channel converts a 16-bit digital word into a differential type analog output signal. The full range of the output signal is - 11 V to + 11 V, with a resolution of 1 part in 65,536. It is available in the following configurations:

1. 8 channel ±10V DC module
2. 4 channel ±10V DC module

A typical use for this module is to supply the velocity command to a servo drive. This module contains no potentiometers or hardware switches. All necessary adjustments are done in software.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure E4-1. OUTPUT ±10V DC Module



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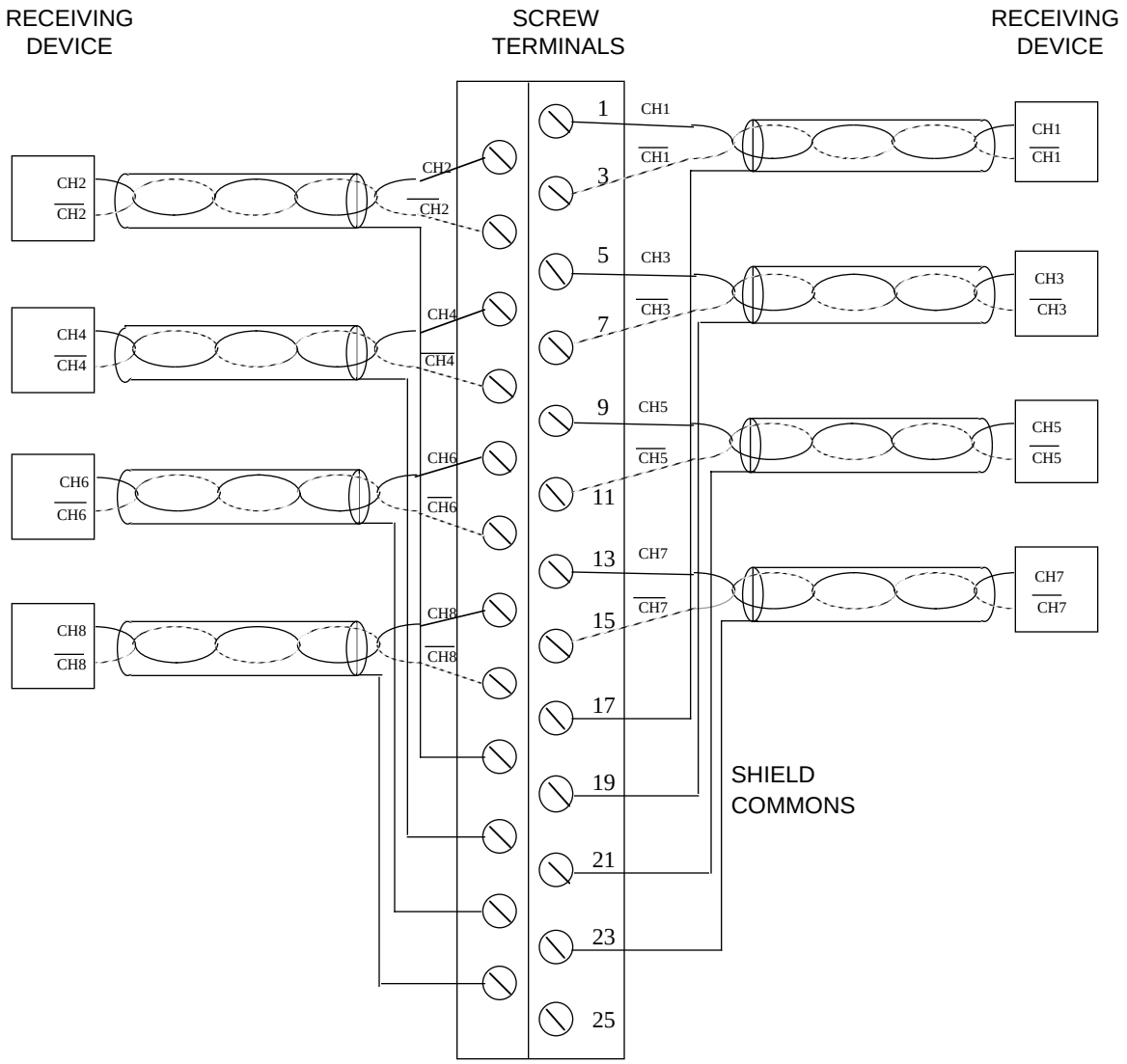
Connections

Each analog output channel must be connected to a receiving device with shielded twisted pair wires. Figure E4-2 illustrates the 8 channel module. Only channels 1 through 4 are available on the 4 channel module.

Because of the signal levels involved, these wires must be protected from electrical noise. Refer to the EMC Guidelines for information on how to protect these wires.

Two screw terminal connections are assigned to each channel to carry the signals. In addition, the module has nine screw terminal connections for terminating the shields. All nine are connected together inside the module, so they are the same point electrically. They are internally connected to SPG and no external connection should be made.

Figure E4-2. Screw Terminal Connector Assignments



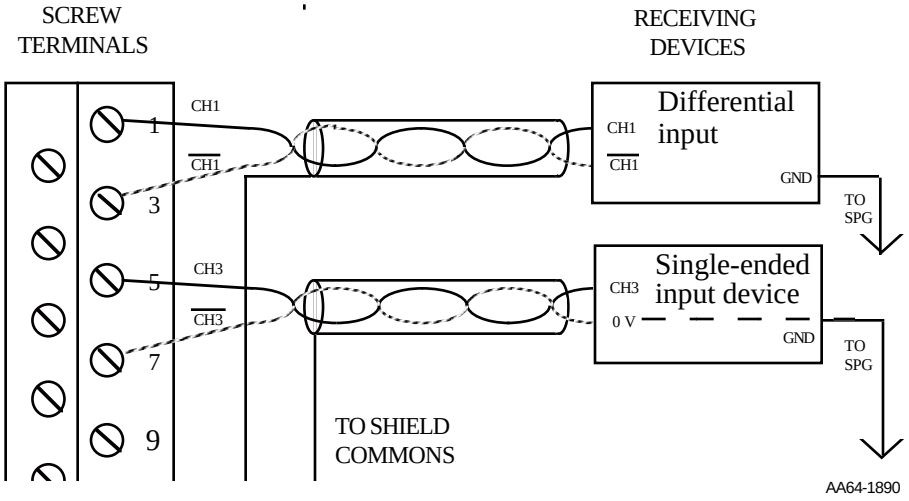
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Analog Output Receiving Devices

In Figure E4-2 it was assumed that all the receiving device inputs were differential. However, you may connect the differential type output from this module to a single-ended input device. Figure E4-3 shows the difference between the two types of connections. Note that one wire in the twisted pair is connected to the 0 V terminal on the receiving device. This 0V terminal must be referenced to the SPG through the device's ground connection.

It is recommended that the receiving device have a differential input for best noise immunity. See the discussion on "Preventing electrical noise in data lines" in the Chapter 1 and the EMC Guidelines.

Figure E4-3. Differential and Single-Ended Receiving Devices



Theory of Operation

The CPU module sends the output module a 16-bit digital word for each channel used. Each digital word is converted to a corresponding voltage within the range of ±11 V. The voltage is buffered and brought out to a pair of screw terminal connections as a differential type voltage output. This output is less subject to interference from electrical noise than a single-ended output would be.

You can adjust each channel in software for offset adjustments, gain scaling, and unipolar outputs.

For safety reasons, all outputs are automatically reset to 0 V when a scan loss condition occurs.

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Specification Table

Characteristic	Output ±10V DC module specification
Function	Converts a 16-bit digital word into a +/- 11 V analog signal for each of eight or four channels.
Part number	8 ch 502-03518-03 4 ch 502-03518-23
Field side connector	25 pin card edge connector, screw terminals
Output channels	8 4
Resolution	16 bits, or 65536 steps over the full output range
Output voltage characteristics	
Nominal voltage range	± 11 VDC
Voltage accuracy @ 11 V	± 5%
Output current, max. @ ±10V	± 10 mA
Output update time increment	32 µs
Output voltage after power up	0 V ± 20 mV
Response to "scan loss"	All outputs reset to 0 V ± 20 mV
Output ripple	< 10 mV_{RMS} at 30 KHz
Short circuit protection	Current limited outputs
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
Logic side power requirements (typical)	For 8 channel module; 43 mA @ +5V 11 mA @ +15V 6 mA @ -15V 2 mA per energized output @ +5V 12 mA per energized output @ +15V 12 mA per energized output @ -15V For 4 channel module; 37 mA @ +5V 5 mA @ +15V 3 mA @ -15V 1 mA per energized output @ +5V 11 mA per energized output @+15V

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Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing
CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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NOTES

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E.5 - Output 4-20mA Module (6 channel)

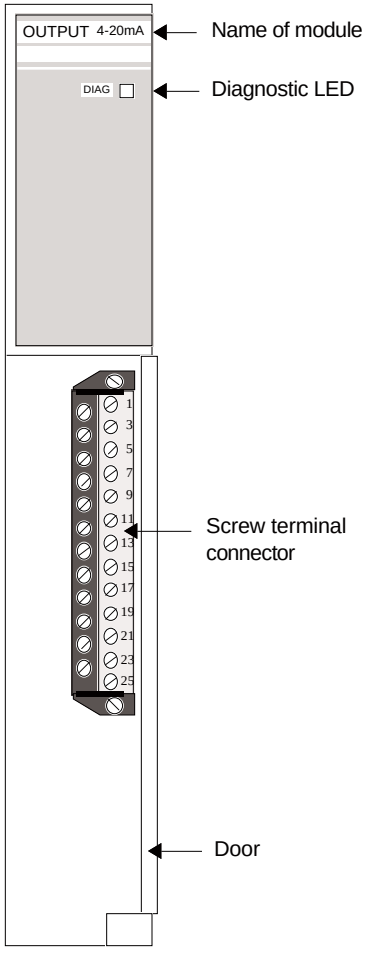
Introduction

The 4-20mA output module has six independent 4-20mA conversion channels. Each channel converts a 15-bit digital value into a single ended type 4-20mA analog current output signal. The full range of the output signal is 4mA to 20mA, with a 15-bit resolution of one part in 32,768.

A typical use for this module is to supply a control signal to valves. This module contains no user adjusted potentiometers or hardware switches. All necessary adjustments are done in software.

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure E5-1. OUTPUT 4-20mA Module (6 CH)



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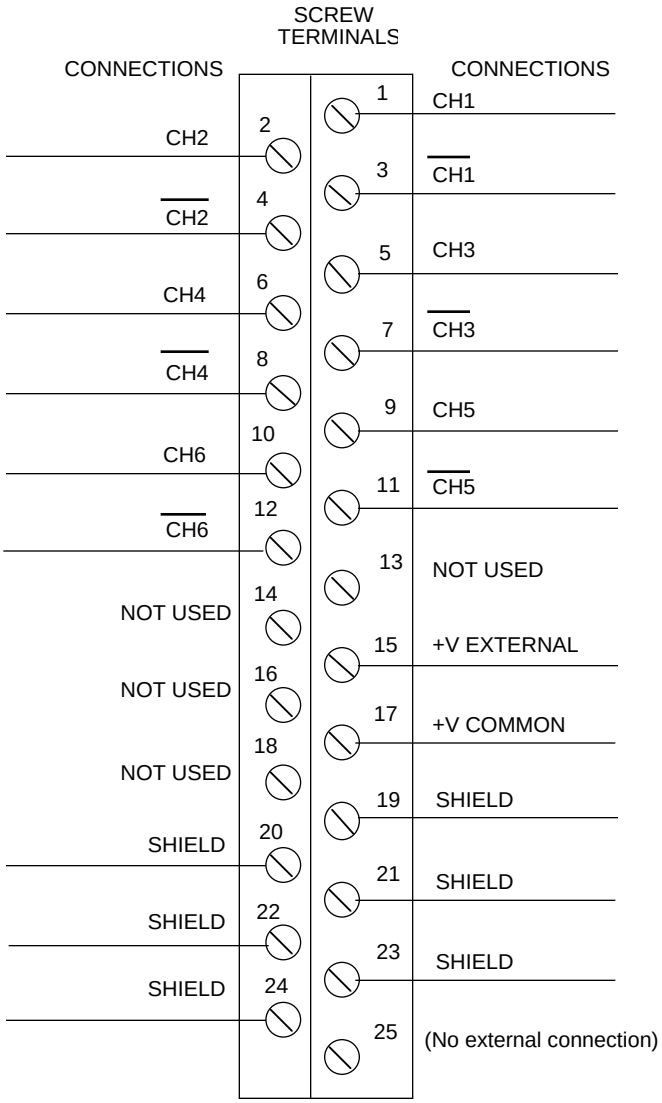
Connections

Two screw terminal connections are assigned to each channel to carry the signals. (See Figure E5-2.) The negative outputs of each channel ($\overline{CHn}$) are connected internally to the +V Common.

In addition, the module has six screw terminal connections for terminating the shields. All six are connected internally, so they are the same point electrically.

Two connections are used to connect an external power supply.

Figure E5-2. Screw Terminal Connector Assignments

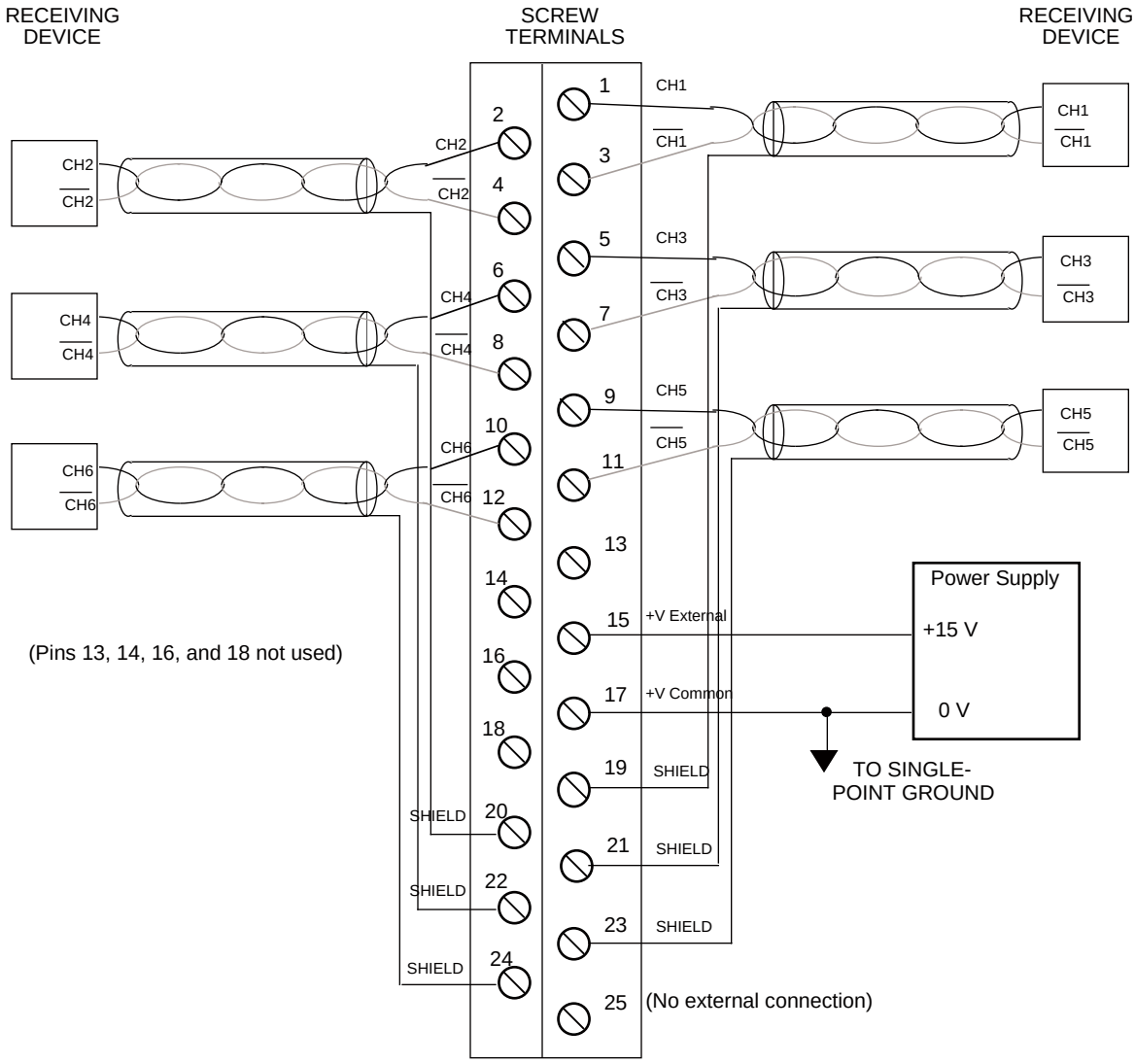


Each 4-20mA output channel is connected to a receiving device with twisted pair wires. (See Figure E5-3.) For extremely noisy environments, use shielded twisted pair wire. See the discussion on "Preventing electrical noise in data lines" in the Chapter 1 and the EMC Guidelines.

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The shield connections are internally connected to the Single Point Ground (SPG) to which the system rack is connected. No external connection should be made.

Figure E5-3. Receiving Devices and Power Supply Connections



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Theory of Operation

The CPU module sends the output module a 16-bit digital word for each channel used. Each digital word is converted to a corresponding current within the range 4-20mA. The current is brought out to a pair of screw terminal connections as a single-ended type current output.

You can adjust each channel in software for offset adjustments and gain scaling.

For safety reasons, all outputs are automatically reset to 4mA when a scan loss condition occurs.

All outputs have clamping diodes and a capacitor to permit the driving of non-resistive (i.e. inductive) loads.

All outputs can drive loads whose impedance is less than or equal to:

$$\frac{V_{EXT}^{-3.6V}}{20mA} = R_{LOAD}$$

Example: If VEXT = 24V, then the maximum impedance equals:

$$\frac{24V_{EXT}^{-3.6V}}{20mA} = 1020\Omega$$

The load range in this example is from 0 to 1020 Ω.

Anytime the load impedance is exceeded, the OPEN flag is set in software. Normally, it is an open circuit that causes this flag to be set.

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Specification Table

Characteristic	Output 4-20mA (6 ch) specification
Function	Converts a 15-bit digital value into a 4-20mA analog current signal for each of six channels
Part number	502-03681-02
Field side connector	25-pin card edge connector, screw terminals
Output channels	6
Resolution	15 bits, or 32,768 steps over the full output range
Zero Offset	.1% FSR (Full Scale Range)over full temperature range
Accuracy	.1% FSR (Full Scale Range)over full temperature range
Output current, max.	20 mA
Output update time increment	100 µsec
Output voltage after power up	$V_{OUT} = I_{OUT} * R_{LOAD}$
Response to "scan loss"	All outputs reset to 4mA
Short circuit protection	Current is limited to: I_{OUT} = where I_{OUT} = 4 to 20mA
Indicator light, module	DIAG LED goes off after module passes its diagnostic tests
External power supply +V and current Line and load regulation Maximum noise	 +15 V to +24 V: ≥ 250mA .5% 100mV pk-pk
Isolation	Field side has differential isolation via Op Amp buffer between logic and field side The open alarm flag is optically isolated between field and logic side
Logic side power requirements (typical)	125 mA @ +5V 30 mA @+15V 18 mA @ -15V
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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CE Marked	Conforms to Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC by conforming to the following standards: EN 50081-2:1993 EMC Generic Industrial Emissions EN 50082-2:1995 EMC Generic Industrial Immunity EN 61131-2:1994/A11:1996 Low voltage directive requirements for programmable controllers Operates with emissions below EN55011/ CISPR 11 Class A limits Immune to: • Electrostatic discharge (4K V contact mode, 8K V air discharge) per EN61000-4-2 • RF electromagnetic fields per EN61000-4-3, ENV 50141, and ENV50204 • Electrical fast transients per EN61000-4-4 • Magnetic fields per EN61000-4-8 Refer to the EMC Guidelines for more information.
UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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E.6 - Analog Input\±10V Output (4 Channel)

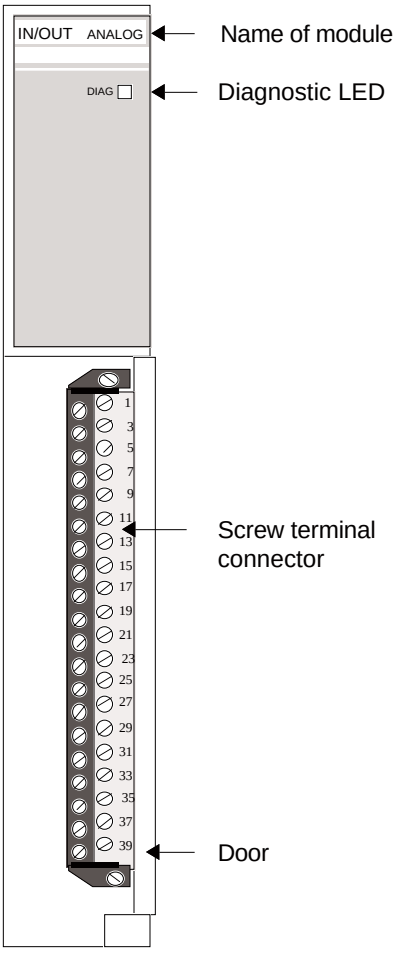
Introduction

The analog in/out module provides:

- 4 analog input channels
- 4 analog output channels

The DIAG LED goes on briefly while the diagnostic tests are running.

Figure E6-1. Analog In/± 10V Out Module



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Connections

All signals to the module must come to the screw terminal connectors through shielded twisted pair wires. Shielded twisted pair wires are used to connect:

- Each analog output channel to a receiving device.
- All analog input signals to the module.

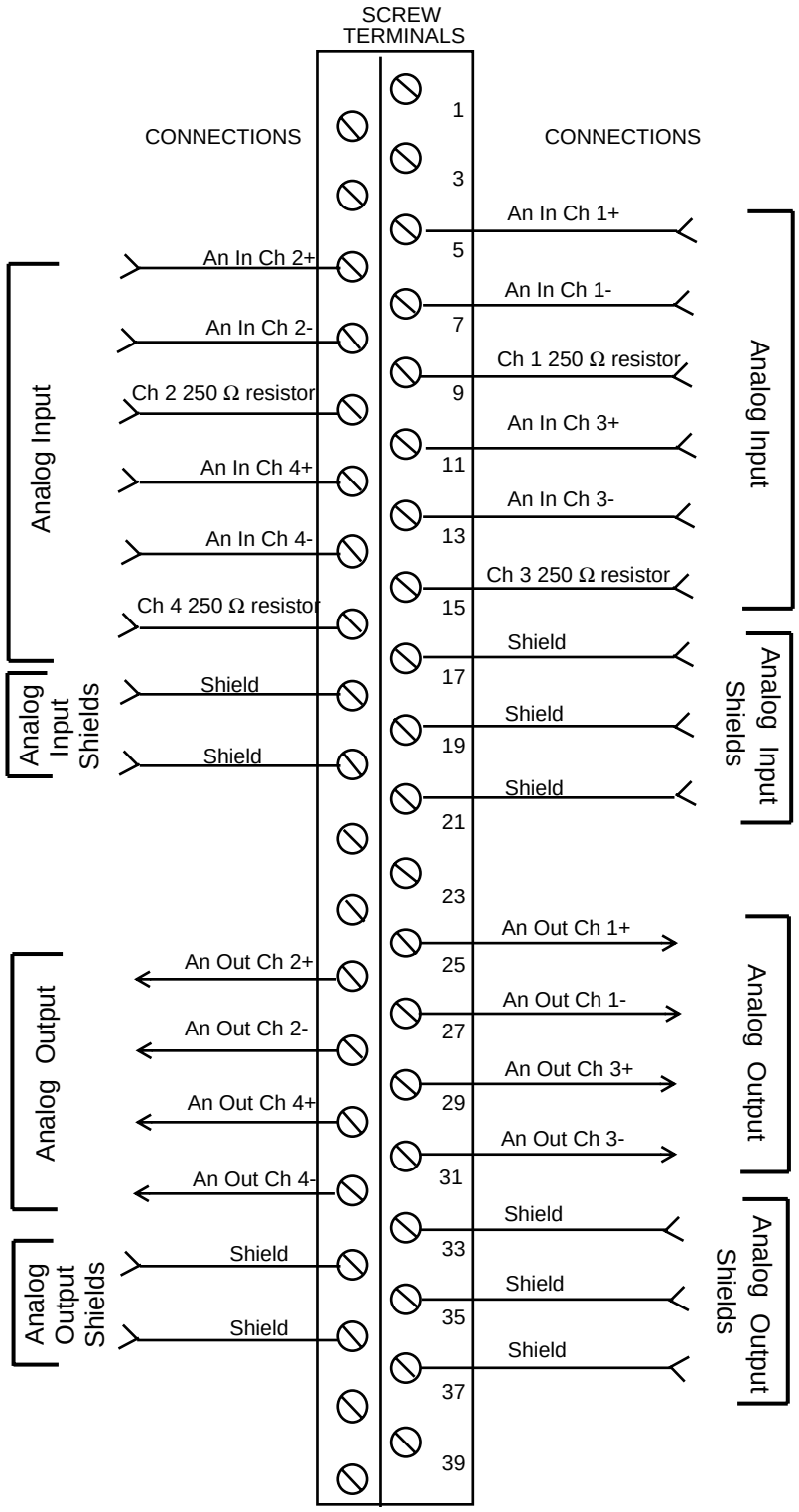
These wires must be protected against electrical noise because of the speed and/or voltage levels of the signals transmitted through them. See the discussion on "Preventing electrical noise in data lines" in the Hardware chapter and the EMC guidelines.

Shields are provided for the analog input section and for the analog output section. Any power supplies used must be connected to SPG.

Figure E6-2 shows the assignments for all the screw terminal connections on the module.

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Figure E6-2. Connections for the Analog In/± 10V Out Module Terminals

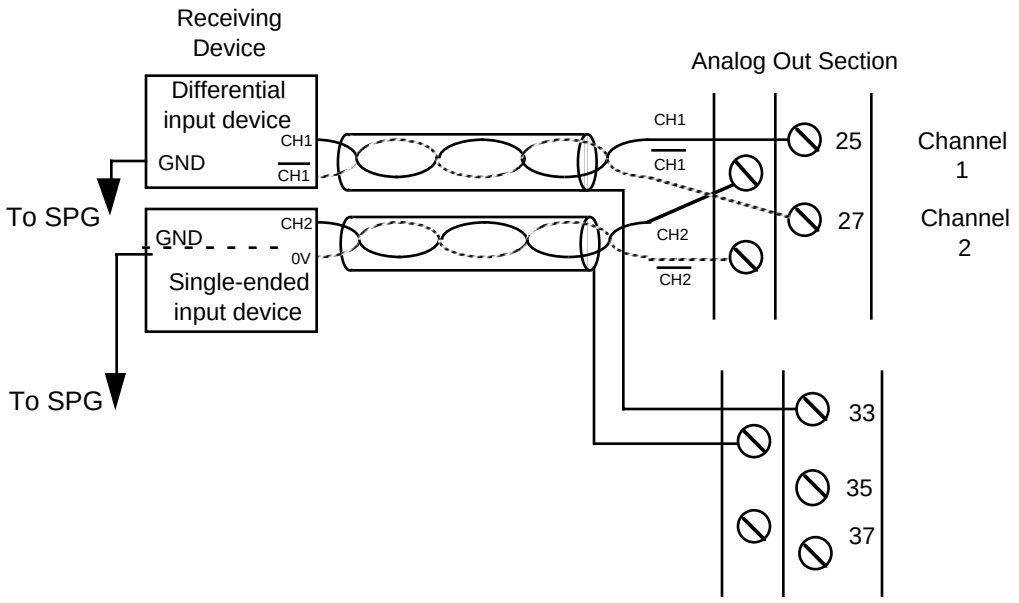


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Analog Output Connections

You may connect the differential type output from this module to a single-ended or differential input device. Figure E6-3 shows the difference between the two types of connections. Note that one wire in the twisted pair is connected to the 0 V terminal on the single-ended receiving device. This 0V terminal must be referenced to the SPG through the device's ground connection.

Figure E6-3. Differential and single-ended receiving devices



Analog Input Connections

Each input channel has three connection pins. The signals are:

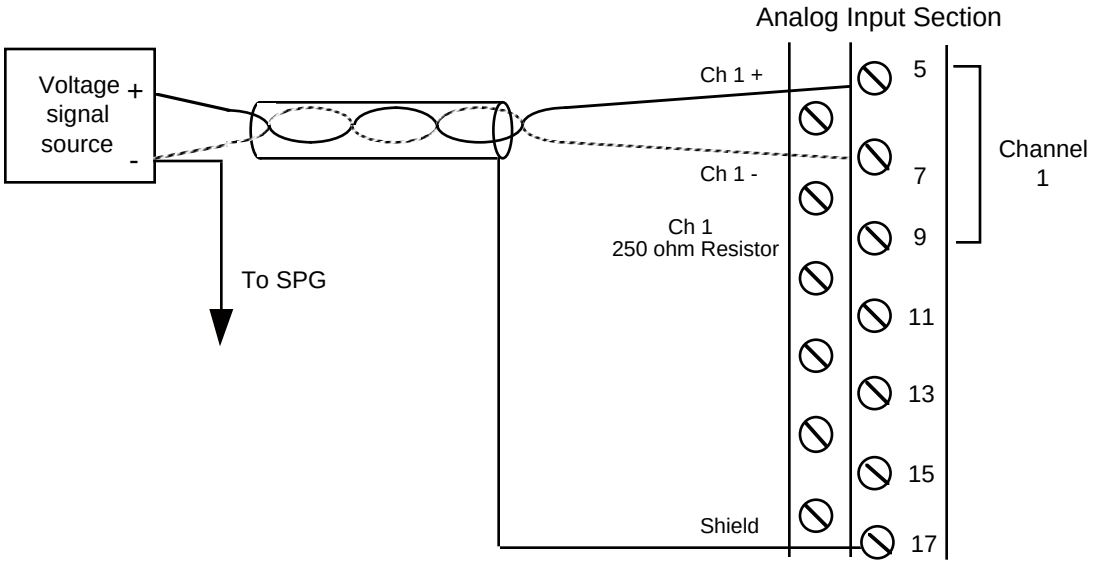
+ voltage input
- voltage input
250 ohm current sense resistor for 0/20 mA and 4/20 mA applications

When connecting an analog voltage output device to the module, the positive wire of the twisted pair goes to the + screw terminal and the negative wire goes to the - screw terminal. Figure E6-4 illustrates these connections for channel one.

Notice that no connection is made to the screw terminal with the internal 250 Ω resistor when connecting a voltage source device.

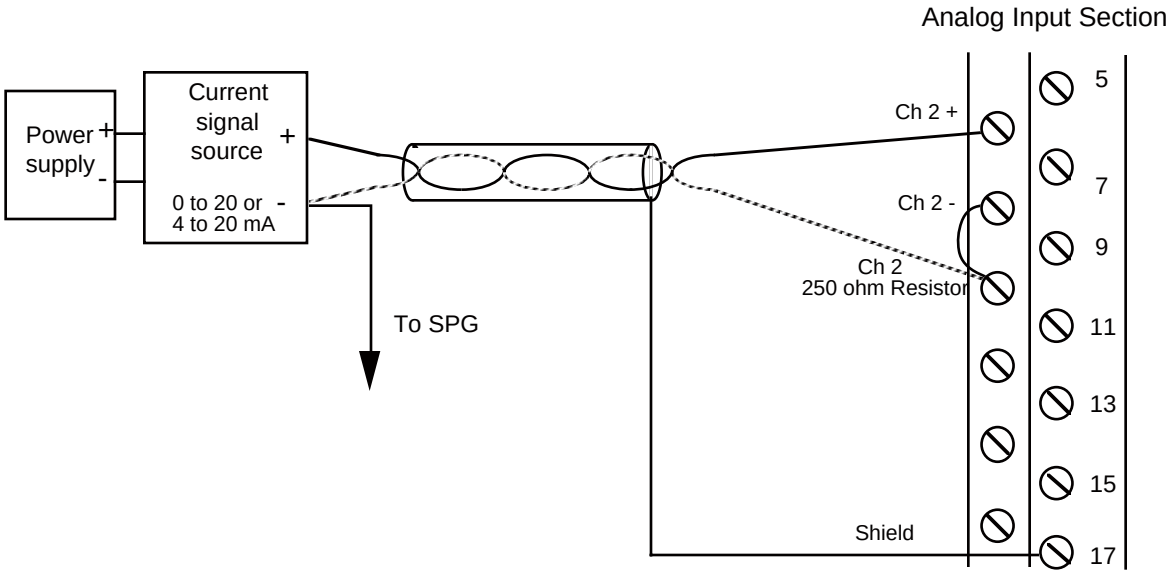
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Figure E6-4. Voltage Input Connections



When using a 0 to 20 mA or 4 to 20 mA current output device, the positive wire of the twisted pair is connected to the + input and the negative wire is connected to the 250 Ω resistor input. A jumper is placed between the - input and the 250 Ω resistor input as shown in Figure E6-5 (from pin 8 to pin 10 for channel 2). This connects a 250 Ω internal resistor across the input.

Figure E6-5. Current Input Connections (0 to 20 or 4 to 20 mA)



An alternative method of connecting a two wire 4 to 20 mA current device is shown in Figure E6-6. Place a jumper between the - input and the 250 Ω resistor input.

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Figure E6-6. Current Input Connections (4 to 20 mA)

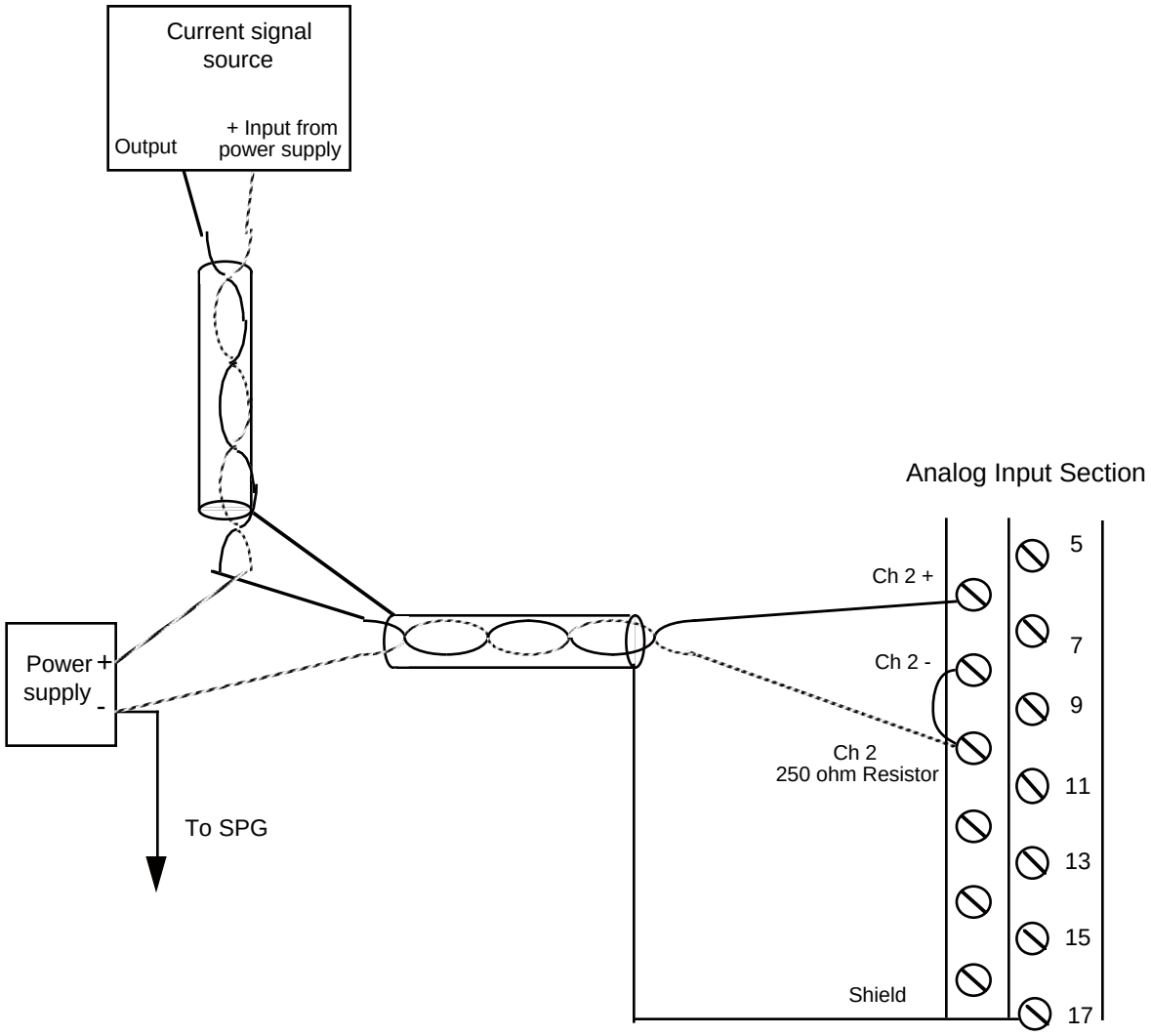


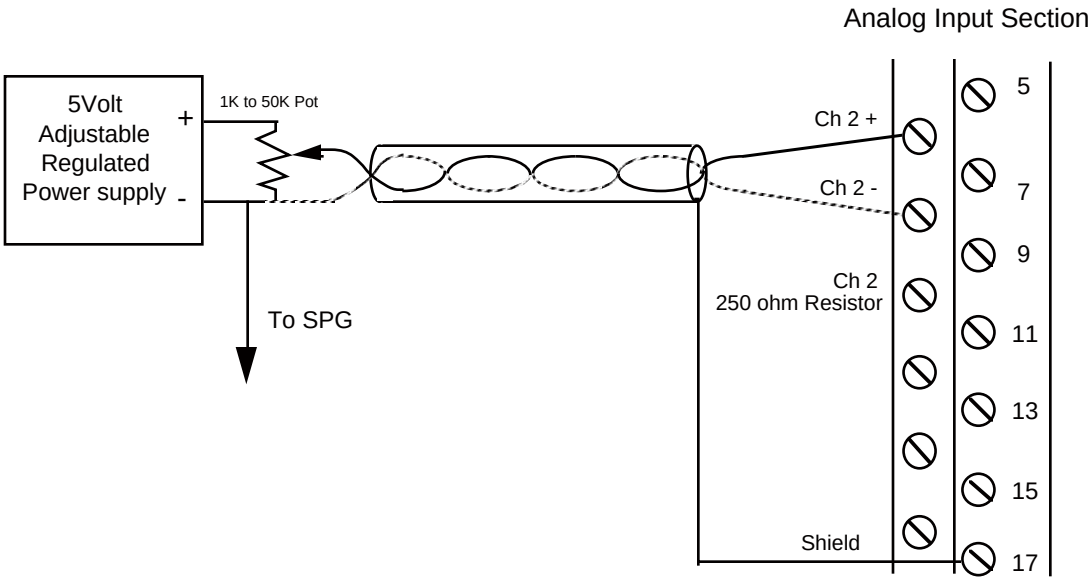
Figure E6-7 illustrates an example of wiring an external potentiometer to the module using twisted pair wire.

For this example, set up the channel initialization function (A_INCHIT) in software for 5 V unipolar with a filter of 100 ms.

The 5 V power supply output voltage adjustment can be set for the maximum potentiometer output value. For example, the supply could be adjusted until the VALU output of the analog input channel read function (A_INCHRD) reads 4095 with the pot at its maximum position.

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Figure E6-7. Adding an External Potentiometer



Analog Output Theory of Operation

The CPU sends the analog output section a 16-bit digital word for each analog output channel used. Each digital word is converted to a corresponding voltage within the range of ±11 V. The voltage is buffered and brought out to a pair of screw terminal connections as a differential type voltage output. This output is less subject to interference from electrical noise than a single-ended output would be.

You can adjust each analog output channel in software for offset adjustments, gain scaling, and unipolar outputs.

For safety reasons, all outputs are automatically reset to 0 V when a scan loss condition occurs.

Analog Input Theory of Operation

A 12 bit A/D converter samples each analog input channel in sequence at the input scan rate. These values are stored in memory on the module so that any channel value can be read while the A/D converter is processing another channel sample.

Each channel can be set up for a maximum input sensitivity of .125 V to 10 V, bipolar or unipolar, or for 4 to 20 mA or 0 to 20 mA current input. To sense current the internal 250 Ω resistor must be connected as shown in Figures E6-5 or E6-6.

All inputs are differential and filtered for a high degree of noise immunity.

The default noise filter time constant is 1 ms. If more noise filtering is required, two longer time constants, 10 ms and 100 ms, are software selectable. The longer time constants will improve noise immunity but lengthen signal response time.

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Using the longer time constants may reduce closed position loop performance if the input is used for position feedback.

Specification Table

Characteristic	Analog In/±10V Out module specifications
Function	Converts a 16-bit digital word into a ±11V analog output signal for each of four channels Converts an analog input signal into a 12-bit digital word for each of four channels.
Part number	502-03907-03
Logic side power requirements (typical)	192 mA @ +5V 70 mA @ +15V 53 mA @ -15V Analog Output 1 mA per energized output @ +5V 11 mA per energized output @ +15V 11 mA per energized output @ -15V
Field side connection	40 pin card edge connector, screw terminals
Indicator light, module	DIAG LED goes off after the module passes its diagnostic tests
Operating temperature range	7° C to 55° C (45° F to 131° F)
Storage temperature range	-40° C to 85° C (-40° F to 185° F)
Humidity	5 to 95%, non-condensing

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UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
Physical size	1.6" wide x 12" high x 8.4" deep (including latch) 41 mm x 305 mm x 213 mm

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Analog Output section (4 ch)	
Output channels	4
Resolution	16 bits, or 65536 steps over the full output range
Output voltage characteristics	
Nominal voltage range	± 11 VDC
Voltage accuracy @ 11 V	± 5%
Output current, max. @ ±10V	± 10 mA
Output update time increment	32 µsec
Output voltage after power up	0 V ± 20 mV
Response to "scan loss"	All outputs reset to 0 V ± 20 mV
Output ripple	< 10 mV_{RMS} at 30 KHz
Short circuit protection	Current limited outputs
Response to scan loss	All outputs are reset to the OFF state
Analog Input section (4 ch)	
Input channels	4
Resolution	12 bits, or 4096 steps over the full input range
Input sensitivity (software selectable)	
Voltage ranges	Unipolar / Bipolar 0 to 10 V / ±10 V 0 to 5V / ±5 V 0 to 2.5V / ±2.5 V 0 to 1.25V / ±1.25V 0 to 1V / ±1 V 0 to .5 V / ±.5 V 0 to .25V / ±.25 V 0 to .125V / ±.125 V
Current range	0 to 20 mA, 4 to 20 mA
Common mode maximum voltage (The maximum voltage that can safely be applied between either input terminal and circuit common.)	±40V
Common mode operating voltage (The maximum voltage that can be applied between either input terminal and circuit common with inputs still operating properly.)	±11V

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Internal current sense resistor	250 ohms
Maximum current sense resistor power	.12 W
Differential input resistance (each input to ground)	1 M Ohms
Filter time constant - software selection	1 ms, 10 ms, 100 ms
Accuracy	.5% of FSR at 25^{o}C ± 100 PPM /^{o}C
0 Offset	From ±2 counts @ 10V to ±8 counts @ .125V
Vibration (per IEC 68-2-6)	10-57 Hz (constant amplitude .15 mm) 57 - 2000 Hz (acceleration 2 g)
Shock (per IEC 68-2-27)	Four shocks per axis (15g/11 msec)

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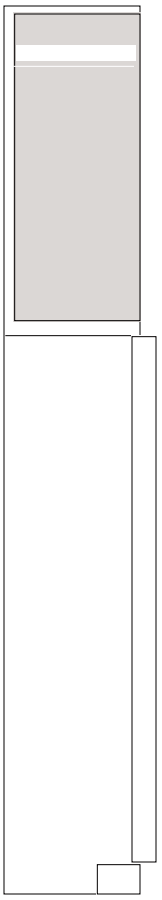
Appendix G - Barrier Module

G1 - Barrier Module

Barrier Module for Empty Slot

A Barrier module is available for any empty slot in the system rack. The part number for the barrier module is M.1016.9125 (old # 502-03673-00).

Figure G1-1. The Barrier Module



AA840-1191

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UL and C/UL Listed	File No. E126417 NRAQ Programmable Controllers
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Appendix H - Wiring Worksheets

H.1 - Wiring Worksheets

Output 24 V DC (16 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	group 1 DC common		
2		group 1 DC line		
	3	group 1 output 1		
4		group 1 output 2		
	5	group 1 output 3		
6		group 1 output 4		
	7	group 2 DC common		
8		group 2 DC line		
	9	group 2 output 5		
10		group 2 output 6		
	11	group 2 output 7		
12		group 2 output 8		
	13	group 3 DC common		
14		group 3 DC line		
	15	group 3 output 9		
16		group 3 output 10		
	17	group 3 output 11		
18		group 3 output 12		
	19	group 4 DC common		
20		group 4 DC line		
	21	group 4 output 13		
22		group 4 output 14		
	23	group 4 output 15		
24		group 4 output 16		
	25	group 4 zener common		

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Output 24 V DC (32 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	group 1 DC common		
2		group 1 DC line		
	3	group 1 output 1		
4		group 1 output 2		
	5	group 1 output 3		
6		group 1 output 4		
	7	group 1 output 5		
8		group 1 output 6		
	9	group 1 output 7		
10		group 1 output 8		
	11	group 2 DC common		
12		group 2 DC line		
	13	group 2 output 9		
14		group 2 output 10		
	15	group 2 output 11		
16		group 2 output 12		
	17	group 2 output 13		
18		group 2 output 14		
	19	group 2 output 15		
20		group 2 output 16		
	21	group 3 DC common		
22		group 3 DC line		
	23	group 3 output 17		
24		group 3 output 18		
	25	group 3 output 19		
26		group 3 output 20		
	27	group 3 output 21		
28		group 3 output 22		
	29	group 3 output 23		
30		group 3 output 24		
	31	group 4 DC common		
32		group 4 DC line		
	33	group 4 output 25		
34		group 4 output 26		
	35	group 4 output 27		
36		group 4 output 28		
	37	group 4 output 29		
38		group 4 output 30		
	39	group 4 output 31		
40		group 4 output 32		

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Input 24V DC (16 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	(not used)		
2		group 1 DC sink / source		
	3	group 1 input 1		
4		group 1 input 2		
	5	group 1 input 3		
6		group 1 input 4		
	7	(not used)		
8		group 2 DC sink / source		
	9	group 2 input 5		
10		group 2 input 6		
	11	group 2 input 7		
12		group 2 input 8		
	13	(not used)		
14		group 3 DC sink / source		
	15	group 3 input 9		
16		group 3 input 10		
	17	group 3 input 11		
18		group 3 input 12		
	19	(not used)		
20		group 4 DC sink / source		
	21	group 4 input 13		
22		group 4 input 14		
	23	group 4 input 15		
24		group 4 input 16		
	25	(not used)		

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Input 24V DC (32 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	(not used)		
2		group 1 input 1		
	3	group 1 input 2		
4		group 1 input 3		
	5	group 1 input 4		
6		group 1 input 5		
	7	group 1 input 6		
8		group 1 input 7		
	9	group 1 input 8		
10		group 1 DC sink / source		
	11	(not used)		
12		group 2 input 9		
	13	group 2 input 10		
14		group 2 input 11		
	15	group 2 input 12		
16		group 2 input 13		
	17	group 2 input 14		
18		group 2 input 15		
	19	group 2 input 16		
20		group 2 DC sink / source		
	21	(not used)		
22		group 3 input 17		
	23	group 3 input 18		
24		group 3 input 19		
	25	group 3 input 20		
26		group 3 input 21		
	27	group 3 input 22		
28		group 3 input 23		
	29	group 3 input 24		
30		group 3 DC sink / source		
	31	(not used)		
32		group 4 input 25		
	33	group 4 input 26		
34		group 4 input 27		
	35	group 4 input 28		
36		group 4 input 29		
	37	group 4 input 30		
38		group 4 input 31		
	39	group 4 input 32		
40		group 4 DC sink / source		

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Output 120/240V AC (16 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	group 1 AC line		
2		group 1 AC common		
	3	group 1 output 1		
4		group 1 output 2		
	5	group 1 output 3		
6		group 1 output 4		
	7	group 2 AC line		
8		group 2 AC common		
	9	group 2 output 5		
10		group 2 output 6		
	11	group 2 output 7		
12		group 2 output 8		
	13	group 3 AC line		
14		group 3 AC common		
	15	group 3 output 9		
16		group 3 output 10		
	17	group 3 output 11		
18		group 3 output 12		
	19	group 4 AC line		
20		group 4 AC common		
	21	group 4 output 13		
22		group 4 output 14		
	23	group 4 output 15		
24		group 4 output 16		
	25	(not used)		

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Output 120/240V AC (32 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	group 1 AC line		
2		group 1 AC common		
	3	group 1 output 1		
4		group 1 output 2		
	5	group 1 output 3		
6		group 1 output 4		
	7	group 1 output 5		
8		group 1 output 6		
	9	group 1 output 7		
10		group 1 output 8		
	11	group 2 AC line		
12		group 2 AC common		
	13	group 2 output 9		
14		group 2 output 10		
	15	group 2 output 11		
16		group 2 output 12		
	17	group 2 output 13		
18		group 2 output 14		
	19	group 2 output 15		
20		group 2 output 16		
	21	group 3 AC line		
22		group 3 AC common		
	23	group 3 output 17		
24		group 3 output 18		
	25	group 3 output 19		
26		group 3 output 20		
	27	group 3 output 21		
28		group 3 output 22		
	29	group 3 output 23		
30		group 3 output 24		
	31	group 4 AC line		
32		group 4 AC common		
	33	group 4 output 25		
34		group 4 output 26		
	35	group 4 output 27		
36		group 4 output 28		
	37	group 4 output 29		
38		group 4 output 30		
	39	group 4 output 31		
40		group 4 output 32		

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Input 120V AC (16 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	group 1 AC sink / source		
2		(not used)		
	3	group 1 input 1		
4		group 1 input 2		
	5	group 1 input 3		
6		group 1 input 4		
	7	group 2 AC sink / source		
8		(not used)		
	9	group 2 input 5		
10		group 2 input 6		
	11	group 2 input 7		
12		group 2 input 8		
	13	group 3 AC sink / source		
14		(not used)		
	15	group 3 input 9		
16		group 3 input 10		
	17	group 3 input 11		
18		group 3 input 12		
	19	group 4 AC sink / source		
20		(not used)		
	21	group 4 input 13		
22		group 4 input 14		
	23	group 4 input 15		
24		group 4 input 16		
	25	(not used)		

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Output ±10V DC (8 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1		
2		channel 2		
	3			
4				
	5	channel 3		
6		channel 4		
	7			
8				
	9	channel 5		
10		channel 6		
	11			
12				
	13	channel 7		
14		channel 8		
	15			
16				
	17	shield		
18		shield		
	19	shield		
20		shield		
	21	shield		
22		shield		
	23	shield		
24		shield		
	25	shield		

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Output ±10V DC (4 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1		
2		channel 2		
	3			
4				
	5	channel 3		
6		channel 4		
	7			
8				
	9	(not used)		
10		(not used)		
	11	(not used)		
12		(not used)		
	13	(not used)		
14		(not used)		
	15	(not used)		
16		(not used)		
	17	shield		
18		shield		
	19	shield		
20		shield		
	21	shield		
22		shield		
	23	shield		
24		shield		
	25	shield		

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Input Encoder (4 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1 input A		
2		channel 1 input		
	3	channel 1 input B		
4		channel 1 input		
	5	channel 1 index		
6		channel 1		
	7	channel 2 input A		
8		channel 2 input		
	9	channel 2 input B		
10		channel 2 input		
	11	channel 2 index		
12		channel 2		
	13	channel 3 input A		
14		channel 3 input		
	15	channel 3 input B		
16		channel 3 input		
	17	channel 3 index		
18		channel 3		
	19	channel 4 input A		
20		channel 4 input		
	21	channel 4 input B		
22		channel 4 input		
	23	channel 4 index		
24		channel 4		
	25	shield		
26		shield		
	27	shield		
28		shield		
	29	shield		
30		shield		
	31	shield		
32		shield		
	33	channel 1 fast input		
34		channel 1		
	35	channel 2 fast input		
36		channel 2		
	37	channel 3 fast input		
38		channel 3		
	39	channel 4 fast input		
40		channel 4		

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Input Encoder (2 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1 input A		
2		channel 1 input		
	3	channel 1 input B		
4		channel 1 input		
	5	channel 1 index		
6		channel 1		
	7	channel 2 input A		
8		channel 2 input		
	9	channel 2 input B		
10		channel 2 input		
	11	channel 2 index		
12		channel 2		
	13	(not used)		
14		(not used)		
	15	(not used)		
16		(not used)		
	17	(not used)		
18		(not used)		
	19	(not used)		
20		(not used)		
	21	(not used)		
22		(not used)		
	23	(not used)		
24		(not used)		
	25	shield		
26		shield		
	27	shield		
28		shield		
	29	shield		
30		shield		
	31	shield		
32		shield		
	33	channel 1 fast input		
34		channel 1		
	35	channel 2 fast input		
36		channel 2		
	37	(not used)		
38		(not used)		
	39	(not used)		
40		(not used)		

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Input Resolver (4 ch) Wiring Worksheet

Name of application program				Rack #	Slot #
	1	channel 1 feedback	(red/white)		
2		channel 1	(yellow/white)		
	3	channel 1 RPO	(red)		
4		channel 1	(black)		
	5	channel 1 QPO	(yellow)		
6		channel 1	(blue)		
	7	channel 2 feedback	(red/white)		
8		channel 2	(yellow/white)		
	9	channel 2 RPO	(red)		
10		channel 2	(black)		
	11	channel 2 QPO	(yellow)		
12		channel 2	(blue)		
	13	channel 3 feedback	(red/white)		
14		channel 3	(yellow/white)		
	15	channel 3 RPO	(red)		
16		channel 3	(black)		
	17	channel 3 QPO	(yellow)		
18		channel 3	(blue)		
	19	channel 4 feedback	(red/white)		
20		channel 4	(yellow/white)		
	21	channel 4 RPO	(red)		
22		channel 4	(black)		
	23	channel 4 QPO	(yellow)		
24		channel 4	(blue)		
	25	shield			
26		shield			
	27	shield			
28		shield			
	29	shield			
30		shield			
	31	shield			
32		shield			
	33	channel 1 fast input			
34		channel 1			
	35	channel 2 fast input			
36		channel 2			
	37	channel 3 fast input			
38		channel 3			
	39	channel 4 fast input			
40		channel 4			

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Input Resolver (2 ch) Wiring Worksheet

Name of application program				Rack #	Slot #
	1	channel 1 feedback	(red/white)		
2		channel 1	(yellow/white)		
	3	channel 1 RPO	(red)		
4		channel 1	(black)		
	5	channel 1 QPO	(yellow)		
6		channel 1	(blue)		
	7	channel 2 feedback	(red/white)		
8		channel 2	(yellow/white)		
	9	channel 2 RPO	(red)		
10		channel 2	(black)		
	11	channel 2 QPO	(yellow)		
12		channel 2	(blue)		
	13	(not used)			
14		(not used)			
	15	(not used)			
16		(not used)			
	17	(not used)			
18		(not used)			
	19	(not used)			
20		(not used)			
	21	(not used)			
22		(not used)			
	23	(not used)			
24		(not used)			
	25	shield			
26		shield			
	27	shield			
28		shield			
	29	shield			
30		shield			
	31	shield			
32		shield			
	33	channel 1 fast input			
34		channel 1			
	35	channel 2 fast input			
36		channel 2			
	37	(not used)			
38		(not used)			
	39	(not used)			
40		(not used)			

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Input Analog (8 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1 input +		
2		channel 2 input +		
	3	channel 1 input -		
4		channel 2 input -		
	5	channel 1 250 Ω resistor		
6		channel 2 250 Ω resistor		
	7	channel 3 input +		
8		channel 4 input +		
	9	channel 3 input -		
10		channel 4 input -		
	11	channel 3 250 Ω resistor		
12		channel 4 250 Ω resistor		
	13	channel 5 input +		
14		channel 6 input +		
	15	channel 5 input -		
16		channel 6 input -		
	17	channel 5 250 Ω resistor		
18		channel 6 250 Ω resistor		
	19	channel 7 input +		
20		channel 8 input +		
	21	channel 7 input -		
22		channel 8 input -		
	23	channel 7 250 Ω resistor		
24		channel 8 250 Ω resistor		
	25	(not used)		
26		(not used)		
	27	common		
28		common		
	29	common		
30		common		
	31	common		
32		shield		
	33	shield		
34		shield		
	35	shield		
36		shield		
	37	shield		
38		shield		
	39	shield		
40		shield		

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Thermocouple TEMP J-K (12 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1 +		
2		channel 2+		
	3	channel 1 -		
4		channel 2 -		
	5	channel 3 +		
6		channel 4+		
	7	channel 3 -		
8		channel 4 -		
	9	channel 5 +		
10		channel 6+		
	11	channel 5 -		
12		channel 6 -		
	13	channel 7 +		
14		channel 8+		
	15	channel 7 -		
16		channel 8 -		
	17	channel 9 +		
18		channel 10+		
	19	channel 9 -		
20		channel 10 -		
	21	channel 11 +		
22		channel 12+		
	23	channel 11 -		
24		channel 12 -		
	25	common		

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Output 24 V DC Sink (32 pt, 1 to 16 diode protected) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	group 1 DC common		
2		group 1 DC line		
	3	group 1 sink 1		
4		group 1 sink 2		
	5	group 1 sink 3		
6		group 1 sink 4		
	7	group 1 sink 5		
8		group 1 sink 6		
	9	group 1 sink 7		
10		group 1 sink 8		
	11	group 1 DCOUT		
12		group 2 DCOUT		
	13	group 2 sink 9		
14		group 2 sink 10		
	15	group 2 sink 11		
16		group 2 sink 12		
	17	group 2 sink 13		
18		group 2 sink 14		
	19	group 2 sink 15		
20		group 2 sink 16		
	21	group 3 DC common		
22		group 3 DC line		
	23	group 3 sink 17		
24		group 3 sink 18		
	25	group 3 sink 19		
26		group 3 sink 20		
	27	group 3 sink 21		
28		group 3 sink 22		
	29	group 3 sink 23		
30		group 3 sink 24		
	31	group 3 DCOUT		
32		group 4 DCOUT		
	33	group 4 sink 25		
34		group 4 sink 26		
	35	group 4 sink 27		
36		group 4 sink 28		
	37	group 4 sink 29		
38		group 4 sink 30		
	39	group 4 sink 31		
40		group 4 sink 32		

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Output 24 V DC Sink (32 pt all diode protected) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	group 1 DC common		
2		group 1 DC line		
	3	group 1 sink 1		
4		group 1 sink 2		
	5	group 1 sink 3		
6		group 1 sink 4		
	7	group 1 sink 5		
8		group 1 sink 6		
	9	group 1 sink 7		
10		group 1 sink 8		
	11	group 1 DCOUT		
12		group 2 DCOUT		
	13	group 2 sink 9		
14		group 2 sink 10		
	15	group 2 sink 11		
16		group 2 sink 12		
	17	group 2 sink 13		
18		group 2 sink 14		
	19	group 2 sink 15		
20		group 2 sink 16		
	21	group 3 DC common		
22		group 3 DC line		
	23	group 3 sink 17		
24		group 3 sink 18		
	25	group 3 sink 19		
26		group 3 sink 20		
	27	group 3 sink 21		
28		group 3 sink 22		
	29	group 3 sink 23		
30		group 3 sink 24		
	31	group 3 DCOUT		
32		group 4 DCOUT		
	33	group 4 sink 25		
34		group 4 sink 26		
	35	group 4 sink 27		
36		group 4 sink 28		
	37	group 4 sink 29		
38		group 4 sink 30		
	39	group 4 sink 31		
40		group 4 sink 32		

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Input RTD (6 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1 common		
2		channel 1 pin 3		
	3	channel 1 pin 2		
4		channel 1 pin 1		
	5	channel 2 common		
6		channel 2 pin 3		
	7	channel 2 pin 2		
8		channel 2 pin 1		
	9	channel 3 common		
10		channel 3 pin 3		
	11	channel 3 pin 2		
12		channel 3 pin 1		
	13	channel 4 common		
14		channel 4 pin 3		
	15	channel 4 pin 2		
16		channel 4 pin 1		
	17	channel 5 common		
18		channel 5 pin 3		
	19	channel 5 pin 2		
20		channel 5 pin 1		
	21	channel 6 common		
22		channel 6 pin 3		
	23	channel 6 pin 2		
24		channel 6 pin 1		
	25	common (to SPG)		

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Serial Communications (2,4 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	RD1_232		
2		CTS1_232		
	3	TD1_232		
4		RTS1_232		
	5	RD1_DIF+		
6		TD1_DIF+		
	7	RD1_DIF-		
8		TD1_DIF-		
	9	common		
10		DTR_A		
	11	shield		
12		CTS2_232		
	13	RD2_232		
14		RTS2_232		
	15	TD2_232		
16		TD2_DIF+		
	17	RD2__DIF+		
18		TD2_DIF-		
	19	RD2_DIF-		
20		CTS3_232		
	21	RD3_232		
22		RTS3_232		
	23	TD3_232		
24		TD3_DIF+		
	25	RD3_DIF+		
26		TD3-DIF-		
	27	RD3_DIF-		
28		DTR_B		
	29	common		
30		shield		
	31	RD4_232		
32		CTS4_232		
	33	TD4_232		
34		RTS4_232		
	35	RD4_DIF+		
36		TD4_DIF+		
	37	RD4_DIF-		
38		TD4_DIF-		
	39	(not used)		
40		(not used)		

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Output 4-20mA (6 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1		
2		channel 2		
	3	channel 1		
4		channel 2		
	5	channel 3		
6		channel 4		
	7	channel 3		
8		channel 4		
	9	channel 5		
10		channel 6		
	11	channel 5		
12		channel 6		
	13	(not used)		
14		(not used)		
	15	+ V external		
16		(not used)		
	17	+ V common		
18		(not used)		
	19	shield		
20		shield		
	21	shield		
22		shield		
	23	shield		
24		shield		
	25	shield		

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Output Stepper (8 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1 +5 V input		
2		channel 2 +5 V input		
	3	channel 1 step/cw		
4		channel 2 step/cw		
	5	channel 1 direction/ccw		
6		channel 2 direction/ccw		
	7	channel 1 common		
8		channel 2 common		
	9	shield		
10		shield		
	11	channel 3 +5 V input		
12		channel 4 +5 V input		
	13	channel 3 step/cw		
14		channel 4 step/cw		
	15	channel 3 direction/ccw		
16		channel 4 direction/ccw		
	17	channel 3 common		
18		channel 4 common		
	19	shield		
20		shield		
	21	channel 5 +5 V input		
22		channel 6 +5 V input		
	23	channel 5 step/cw		
24		channel 6 step/cw		
	25	channel 5 direction/ccw		
26		channel 6 direction/ccw		
	27	channel 5 common		
28		channel 6 common		
	29	shield		
30		shield		
	31	channel 7 +5 V input		
32		channel 8 +5 V input		
	33	channel 7 step/cw		
34		channel 8 step/cw		
	35	channel 7 direction/ccw		
36		channel 8 direction/ccw		
	37	channel 7 common		
38		channel 8 common		
	39	shield		
40		shield		

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Output Relay (8 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	NO 1		
2		CT 1		
	3	NC 1		
4		(not used)		
	5	NO 2		
6		CT 2		
	7	NC 2		
8		(not used)		
	9	NO 3		
10		CT 3		
	11	NC 3		
12		(not used)		
	13	NO 4		
14		CT 4		
	15	NC 4		
16		(not used)		
	17	NO 5		
18		NO 5		
	19	NO 6		
20		NO 6		
	21	NO 7		
22		NO 7		
	23	NO 8		
24		NO 8		
	25	(not used)		

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Input Resolver (12 ch) Wiring Worksheet

Name of application program				Rack #	Slot #
	1	RPO2	(red)		
2		RPO1	(red)		
	3	/	(black) (blue)		
4		/	(black) (blue)		
	5	QPO2	(yellow)		
6		QPO1	(yellow)		
	7	shield			
8		channel 2 feedback	(red/white)		
	9	shield			
10		channel 2	(yellow/white)		
	11	shield			
12		shield			
	13	channel 2 feedback	(red/white)		
14		channel 3 feedback	(red/white)		
	15	channel 2	(yellow/white)		
16		channel 3	(yellow/white)		
	17	shield			
18		channel 5 feedback	(red/white)		
	19	channel 4 feedback	(red/white)		
20		channel 5	(yellow/white)		
	21	channel 4	(yellow/white)		
22		shield			
	23	channel 6 feedback	(red/white)		
24		channel 7 feedback	(red/white)		
	25	channel 6	(yellow/white)		
26		channel 7	(yellow/white)		
	27	shield			
28		channel 9 feedback	(red/white)		
	29	channel 8 feedback	(red/white)		
30		channel 9	(yellow/white)		
	31	channel 8	(yellow/white)		
32		shield			
	33	channel 10 feedback	(red/white)		
34		channel 11 feedback	(red/white)		
	35	channel 10	(yellow/white)		
36		channel 11	(yellow/white)		
	37	channel 12 feedback	(red/white)		
38		shield			
	39	channel 12	(yellow/white)		
40		shield			

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Input/Output TTL (24/8 pts) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	Input 1		
2		Input 2		
	3	Input 3		
4		Input 4		
	5	Input 5		
6		Input 6		
	7	Input 7		
8		Input 8		
	9	Input 9		
10		Input 10		
	11	Input 11		
12		Input 12		
	13	Input 13		
14		Input 14		
	15	Input 15		
16		Input 16		
	17	Input 17		
18		Input 18		
	19	Input 19		
20		Input 20		
	21	Input 21		
22		Input 22		
	23	Input 23		
24		Input 24		
	25	(not used)		
26		(not used)		
	27	+ 5V external supply		
28		common		
	29	(not used)		
30		(not used)		
	31	Output 1		
32		Output 2		
	33	Output 3		
34		Output 4		
	35	Output 5		
36		Output 6		
	37	Output 7		
38		Output 8		
	39	(not used)		
40		(not used)		

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Input 12V DC (32 pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	(not used)		
2		group 1 input 1		
	3	group 1 input 2		
4		group 1 input 3		
	5	group 1 input 4		
6		group 1 input 5		
	7	group 1 input 6		
8		group 1 input 7		
	9	group 1 input 8		
10		group 1 DC sink / source		
	11	(not used)		
12		group 2 input 9		
	13	group 2 input 10		
14		group 2 input 11		
	15	group 2 input 12		
16		group 2 input 13		
	17	group 2 input 14		
18		group 2 input 15		
	19	group 2 input 16		
20		group 2 DC sink / source		
	21	(not used)		
22		group 3 input 17		
	23	group 3 input 18		
24		group 3 input 19		
	25	group 3 input 20		
26		group 3 input 21		
	27	group 3 input 22		
28		group 3 input 23		
	29	group 3 input 24		
30		group 3 DC sink / source		
	31	(not used)		
32		group 4 input 25		
	33	group 4 input 26		
34		group 4 input 27		
	35	group 4 input 28		
36		group 4 input 29		
	37	group 4 input 30		
38		group 4 input 31		
	39	group 4 input 32		
40		group 4 DC sink / source		

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Input/Output 24V DC (16/8 sink pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	(not used)		
2		group 1 input 1		
	3	group 1 input 2		
4		group 1 input 3		
	5	group 1 input 4		
6		group 1 input 5		
	7	group 1 input 6		
8		group 1 input 7		
	9	group 1 input 8		
10		group 1 DC sink / source		
	11	(not used)		
12		group 2 input 9		
	13	group 2 input 10		
14		group 2 input 11		
	15	group 2 input 12		
16		group 2 input 13		
	17	group 2 input 14		
18		group 2 input 15		
	19	group 2 input 16		
20		group 2 DC sink / source		
	21	(not used)		
22		(not used)		
	23	(not used)		
24		(not used)		
	25	(not used)		
26		(not used)		
	27	group 1 DC common		
28		group 1 DC line		
	29	group 1 sink output 1		
30		group 1 sink output 2		
	31	group 1 sink output 3		
32		group 1 sink output 4		
	33	(not used)		
34		(not used)		
	35	group 1 sink output 5		
36		group 1 sink output 6		
	37	group 1 sink output 7		
38		group 1 sink output 8		
	39	group 1 DCOUT		
40		(not used)		

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Input/Output 24V DC (16/8 source pt) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	(not used)		
2		group 1 input 1		
	3	group 1 input 2		
4		group 1 input 3		
	5	group 1 input 4		
6		group 1 input 5		
	7	group 1 input 6		
8		group 1 input 7		
	9	group 1 input 8		
10		group 1 DC sink / source		
	11	(not used)		
12		group 2 input 9		
	13	group 2 input 10		
14		group 2 input 11		
	15	group 2 input 12		
16		group 2 input 13		
	17	group 2 input 14		
18		group 2 input 15		
	19	group 2 input 16		
20		group 2 DC sink / source		
	21	(not used)		
22		(not used)		
	23	(not used)		
24		(not used)		
	25	(not used)		
26		(not used)		
	27	group 1 DC common		
28		group 1 DC line		
	29	group 1 source output 1		
30		group 1 source output 2		
	31	group 1 source output 3		
32		group 1 source output 4		
	33	group 2 DC common		
34		group 2 DC line		
	35	group 2 source output 5		
36		group 2 source output 6		
	37	group 2 source output 7		
38		group 2 source output 8		
	39	(not used)		
40		(not used)		

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Servo Encoder (3 ch) Analog input (4 ch) Analog output (2 ch)

Name of application program			Rack #	Slot #
	1	channel 1 analog output +		
2		channel 1 analog output -		
	3	channel 2 analog output +		
4		channel 2 analog output -		
	5	channel 1 analog input +		
6		channel 2 analog input +		
	7	channel 1 analog input -		
8		channel 2 analog input -		
	9	channel 1 250 Ω resistor		
10		channel 2 250 Ω resistor		
	11	channel 3 analog input +		
12		channel 4 analog input +		
	13	channel 3 analog input -		
14		channel 4 analog input -		
	15	channel 3 250 Ω resistor		
16		channel 4 250 Ω resistor		
	17	channel 1 encoder input A		
18		channel 1 encoder input		
	19	channel 1 encoder input B		
20		channel 1 encoder input		
	21	channel 1 encoder index		
22		channel 1 encoder		
	23	channel 2 encoder input A		
24		channel 2 encoder input		
	25	channel 2 encoder input B		
26		channel 2 encoder input		
	27	channel 2 encoder index		
28		channel 2 encoder		
	29	channel 3 encoder input A		
30		channel 3 encoder input		
	31	channel 3 encoder input B		
32		channel 3 encoder input		
	33	channel 3 encoder index		
34		channel 3 encoder		
	35	channel 1 fast input		
36		channel 1		
	37	channel 2 fast input		
38		channel 2		
	39	channel 3 fast input		
40		channel 3		

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Servo Encoder (3 ch) Analog output (4 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	channel 1 analog output +		
2		channel 1 analog output -		
	3	channel 2 analog output +		
4		channel 2 analog output -		
	5	channel 3 analog output +		
6		channel 3 analog output -		
	7	channel 4 analog output +		
8		channel 4 analog output -		
	9	shield		
10		shield		
	11	shield		
12		shield		
	13	shield		
14		shield		
	15	shield		
16		shield		
	17	channel 1 encoder input A		
18		channel 1 encoder input		
	19	channel 1 encoder input B		
20		channel 1 encoder input		
	21	channel 1 encoder index		
22		channel 1 encoder		
	23	channel 2 encoder input A		
24		channel 2 encoder input		
	25	channel 2 encoder input B		
26		channel 2 encoder input		
	27	channel 2 encoder index		
28		channel 2 encoder		
	29	channel 3 encoder input A		
30		channel 3 encoder input		
	31	channel 3 encoder input B		
32		channel 3 encoder input		
	33	channel 3 encoder index		
34		channel 3 encoder		
	35	channel 1 fast input		
36		channel 1		
	37	channel 2 fast input		
38		channel 2		
	39	channel 3 fast input		
40		channel 3		

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Analog input (4 ch)/Analog output (4 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	(not used)		
2		(not used)		
	3	(not used)		
4		(not used)		
	5	channel 1analog input +		
6		channel 2 analog input +		
	7	channel 1 analog input -		
8		channel 2 analog input -		
	9	channel 1 250 Ω resistor		
10		channel 2 250 Ω resistor		
	11	channel 3 analog input +		
12		channel 4 analog input +		
	13	channel 3 analog input -		
14		channel 4 analog input -		
	15	channel 3 250 Ω resistor		
16		channel 4 250 Ω resistor		
	17	shield		
18		shield		
	19	shield		
20		shield		
	21	shield		
22		(not used)		
	23	(not used)		
24		(not used)		
	25	channel 1 analog output +		
26		channel 2 analog output +		
	27	channel 1 analog output -		
28		channel 2 analog output -		
	29	channel 3 analog output +		
30		channel 4 analog output +,		
	31	channel 3 analog output -		
32		channel 4 analog output -		
	33	shield		
34		shield		
	35	shield		
36		shield		
	37	shield		
38		(not used)		
	39	(not used)		
40		(not used)		

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Slider/Driver Wiring Worksheet

Name of application program			Rack #	Slot #
	1	+24V DC input		
2		DC common		
	3	+12V DC output		
4		common		
	5	-12V DC output		
6		common		
	7	RPO from resolver module		
8		$\overline{\text{RPO}}$ from resolver module		
	9	QPO from resolver module		
10		$\overline{\text{QPO}}$ from resolver module		
	11	RPO to slider 1		
12		shield		
	13	RPO from slider 1		
14		shield		
	15	RPO to slider 2		
16		shield		
	17	RPO from slider 2		
18		shield		
	19	QPO to slider 1		
20		shield		
	21	QPO from slider 1		
22		shield		
	23	QPO to slider 2		
24		shield		
	25	QPO from slider 2		
26		shield		
	27	SFDBK from scale amp 1		
28		shield		
	29	$\overline{\text{SFDBK}}$ from scale amp 1		
30		shield		
	31	SFDBK from scale amp 2		
32		shield		
	33	$\overline{\text{SFDBK}}$ from scale amp 2		
34		shield		
	35	FDBK1 to resolver module		
36		$\overline{\text{FDBK1}}$ to resolver module		
	37	FDBK2 to resolver module		
38		$\overline{\text{FDBK2}}$ to resolver module		
	39	(not used)		
40		(not used)		

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Block Output 24V DC Source (16 pt) Wiring Worksheet

Name of application program			Module #
	1	line 1	
2		output 1	
	3	output 3	
4		output 5	
	5	output 7	
6		line 2	
	7	output 9	
8		output 11	
	9	output 13	
10		output 15	
	11	(not used)	
12		24V	
	13	com 1	
14		output 2	
	15	output 4	
16		output 6	
	17	output 8	
18		com 2	
	19	output 10	
20		output 12	
	21	output 14	
22		output 16	
	23	0V	
24		chassis ground	

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Block Input 24V DC Module (16 pt) Wiring Worksheet

Name of application program			Module #
	1	24V	
2		input 1	
	3	input 3	
4		24V	
	5	input 5	
6		input 7	
	7	24V	
8		group 1 ss	
	9	24V	
10		input 9	
	11	input 11	
12		24V	
	13	input 13	
14		input 15	
	15	24V	
16		group 2 ss	
	17	24V	
18		shield	
	19	0V	
20		input 2	
	21	input 4	
22		0V	
	23	input 6	
24		input 8	
	25	0V	
26		group 1 ss	
	27	0V	
28		input 10	
	29	input 12	
30		0V	
	31	input 14	
32		input 16	
	33	0V	
34		group 2 ss	
	35	0V	
36		chassis ground	

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Block Input Analog (4 ch) Wiring Worksheet

Name of application program		Module #
	1	24V
2		DC com
	3	(not used)
4		channel 1 +
	5	channel 1 -
6		channel 1 250 ohm resistor
	7	shield
8		(not used)
	9	channel 2 +
10		channel 2 -
	11	channel 2 250 ohm resistor
12		shield
	13	chassis ground
14		(not used)
	15	(not used)
16		channel 3 +
	17	channel 3 -
18		channel 3 250 ohm resistor
	19	shield
20		(not used)
	21	channel 4 +
22		channel 4 -
	23	channel 4 250 ohm resistor
24		shield

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Block Output 4-20 mA (4 ch) Wiring Worksheet

Name of application program			Module #
	1	(not used)	
2		(not used)	
	3	(not used)	
4		channel 1 +	
	5	channel 1 -	
6		shield	
	7	(not used)	
8		(not used)	
	9	channel 2 +	
10		channel 2 -	
	11	shield	
12		+24V DC	
	13	(not used)	
14		(not used)	
	15	(not used)	
16		channel 3 +	
	17	channel 3 -	
18		shield	
	19	(not used)	
20		channel 4 +	
	21	channel 4 -	
22		shield	
	23	DC common	
24		chassis ground	

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Block 24V DC 8 in/8 out Wiring Worksheet

Name of application program			Module #
	1	DC Line 1	
2		output 1	
	3	output 3	
4		output 5	
	5	output 7	
6		(not used)	
	7	(not used)	
8		(not used)	
	9	24V	
10		input 1	
	11	input 3	
12		24V	
	13	input 5	
14		input 7	
	15	24V	
16		input sink/source (ss)	
	17	24V	
18		24V	
	19	DC Com1	
20		output 2	
	21	output 4	
22		output 6	
	23	output 8	
24		(not used)	
	25	(not used)	
26		(not used)	
	27	0V	
28		input 2	
	29	input 4	
30		0V	
	31	input 6	
32		input 8	
	33	0V	
34		input sink/source (ss)	
	35	0V	
36		Chassis ground	

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Input Resolver (6 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	RPO		
2		RPO GND		
	3	shield		
4		feedback 1+		
	5	feedback 1-		
6		shield		
	7	feedback 2+		
8		feedback 2-		
	9	shield		
10		feedback 3+		
	11	feedback 3-		
12		24V		
	13	QPO		
14		QPO GND		
	15	feedback 4+		
16		feedback 4-		
	17	shield		
18		feedback 5+		
	19	feedback 5-		
20		shield		
	21	feedback 6+		
22		feedback 6-		
	23	0V		
24		Chassis ground		

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Output Stepper/Input Encoder/Input 24V DC Wiring Worksheet

Name of application program			Rack #	Slot #
	1	ST1 STEP/CW		
2		ST1 DIR/CW		
	3	ST1 +VIN		
4		+5V OUT		
	5	ST1 +VINCOM		
6		+5V OUTCOM		
	7	shield		
8		+5V output		
	9	ENC1A		
10		ENC1$\overline{A}$		
	11	ENC1B		
12		ENC1$\overline{B}$		
	13	ENC1INDEX		
14		ENC1$\overline{INDEX}$		
	15	input 1		
16		0V		
	17	24V		
18		24V		
	19	ST2 STEP/CW		
20		ST2 DIR/CW		
	21	ST2 +VIN		
22		+5V OUT		
	23	ST2 +VINCOM		
24		+5V OUTCOM		
	25	shield		
26		+5V OUT		
	27	ENC2A		
28		ENC2$\overline{A}$		
	29	ENC2B		
30		ENC2$\overline{B}$		
	31	ENC2 INDEX		
32		ENC2 $\overline{INDEX}$		
	33	input 2		
34		input sink /source (ss)		
	35	0V		
36		Chassis ground		

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Output Analog ±10V DC (4 ch) Wiring Worksheet

Name of application program			Rack #	Slot #
	1	(not used)		
2		(not used)		
	3	(not used)		
4		Ch1+		
	5	Ch1-		
6		shield		
	7	(not used)		
8		(not used)		
	9	Ch2+		
10		Ch2-		
	11	shield		
12		+24VDC		
	13	(not used)		
14		(not used)		
	15	(not used)		
16		Ch3+		
	17	Ch3-		
18		shield		
	19	(not used)		
20		Ch4+		
	21	Ch4-		
22		shield		
	23	DC Com		
24		Chassis GND		

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Appendix I - Wiring Jig

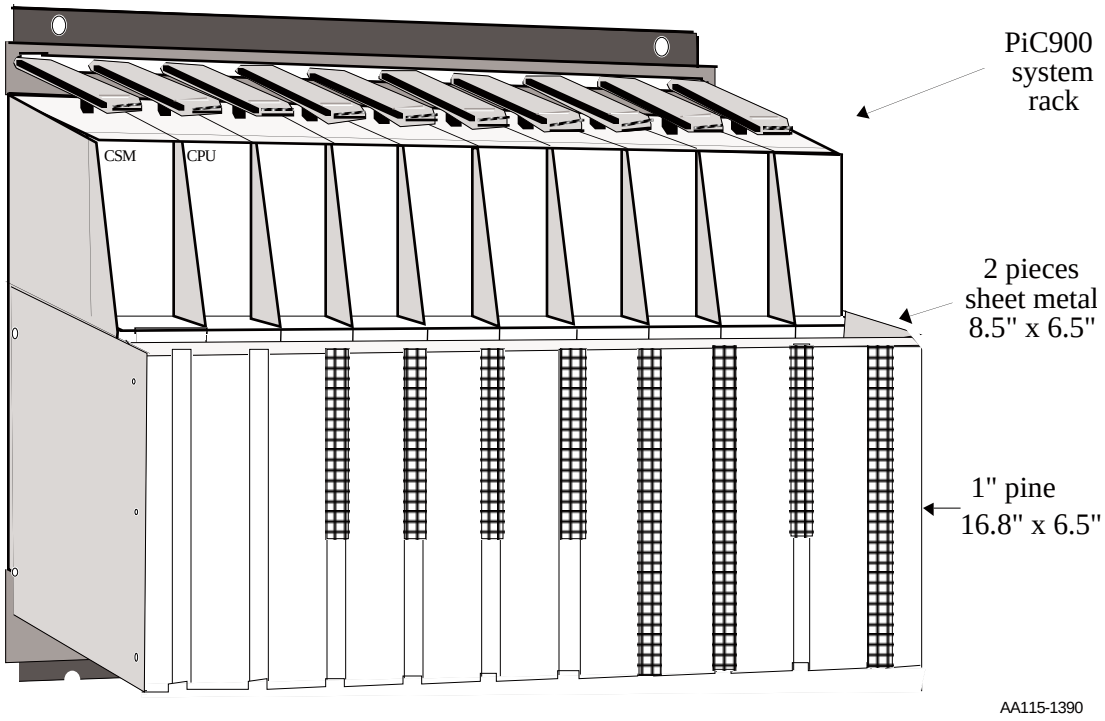
I.1 - A Wiring Jig

Making a jig

The PiC was designed to get maximum controlling power in as small a footprint as possible. This can cause a problem because the screw terminal connectors are difficult to get at when the modules are installed in the rack. If you lay the module on the bench to make connections, the wires may be too short or too long when the system is set up. This puts stress on the connections, which may become disconnected and cause problems.

An installation jig brings the connectors out where you can see what you are doing and still cut the wires to the correct length. Directions for making one are given here.

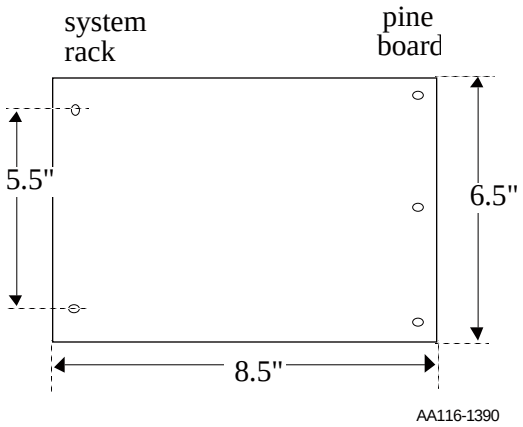
Figure I-1. Jig for Wiring I/O Modules



1. This jig was designed for use with the 10-slot system rack. Cut 10 grooves in the pine board, 3/8" across and 1/2" deep. They will be about 1 1/2" apart. Adjust the length of the board and the number of grooves to fit different sized system racks.
2. The PiC900 system rack already has holes drilled in its sides, 5 1/2" apart. Drill two holes to match along one of the short sides of each metal plate, and three screw holes along the other side.

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Figure G1-2. Side plate of the jig



3. Use 3 wood screws to fasten a metal side to one end of the grooved pine board, and repeat with the second metal piece at the other end of the board. The jig is now ready for use.

Using a jig

1. Remove the hardware modules in the PiC900 system rack.
2. Unscrew the screw terminal connector from each I/O module and pull it off.
3. Push it into the corresponding groove in the jig, with the top of the screw terminal connector at the top of the jig. Keep the screw terminal connectors in the same order as their modules in the system rack, so you can replace each connector on the correct module.
4. Fit the jig over the rack. Insert 2 fasteners through the drill holes on each side of the jig, into the top and middle holes on the sides of the rack, to keep it in place during wiring.
5. Connect the wires to their assigned screw terminals starting from the bottom left terminal, as shown in the Hardware chapter.
6. When all the wiring is finished, pull each screw terminal connector from its slot in turn.
7. Unfasten the jig and store it.
8. Install hardware modules as specified and push the screw terminal connector on its respective module.

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Appendix J - Power-on Circuitry

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J.1 - Power-on Circuitry

Wiring One Axis to Power-On Circuitry

This appendix presents an explanation of wiring one axis to power-on circuitry. In any application, it is important to provide for the safe starting and stopping of a machine. Variations to this recommended method are acceptable as long as they follow this intent.

Figure J-1 on the next page illustrates the power-on circuitry for one axis. Additional axes needed for an application should be wired in a similar manner.

1. There are three switches in series with the POWER-ON relay:

    1. MACHINE ON switch
    2. EMERGENCY STOP (E-stop) pushbutton
    3. MACHINE START pushbutton

    The MACHINE ON switch and the EMERGENCY STOP pushbutton are normally closed. The MACHINE START pushbutton must be pressed to energize the POWER-ON relay.

    It is assumed that power is supplied to this circuit through an output module. This module must have its source power available at all times.

    A ladder diagram module (LDO) in the PiC900 is used to control the turning on and turning off of power through this module. When the LDO is not being scanned, there is no power supplied through the output module.

2. When the POWER-ON relay is energized, the POWER-ON contact 2 is used to latch it on. POWER-ON contact 1 and contacts from the series switches are brought back through an input module to be monitored by the LDO.

3. Since the POWER-ON relay does not typically have enough contacts or does not have contacts of high enough current rating, POWER-ON contact 3 is used to energize an AUXILIARY POWER-ON contactor.

4. Power is supplied through AUXILIARY POWER ON contact 1 to the AXIS 1 POWER-ON contactor (M1).

    The plus and minus end-of-travel (EOT) limit switches are wired in series with this path.

    The END LIMIT OVERRIDE pushbutton is used to allow backing the machine off the limit switch if it is sitting on it.

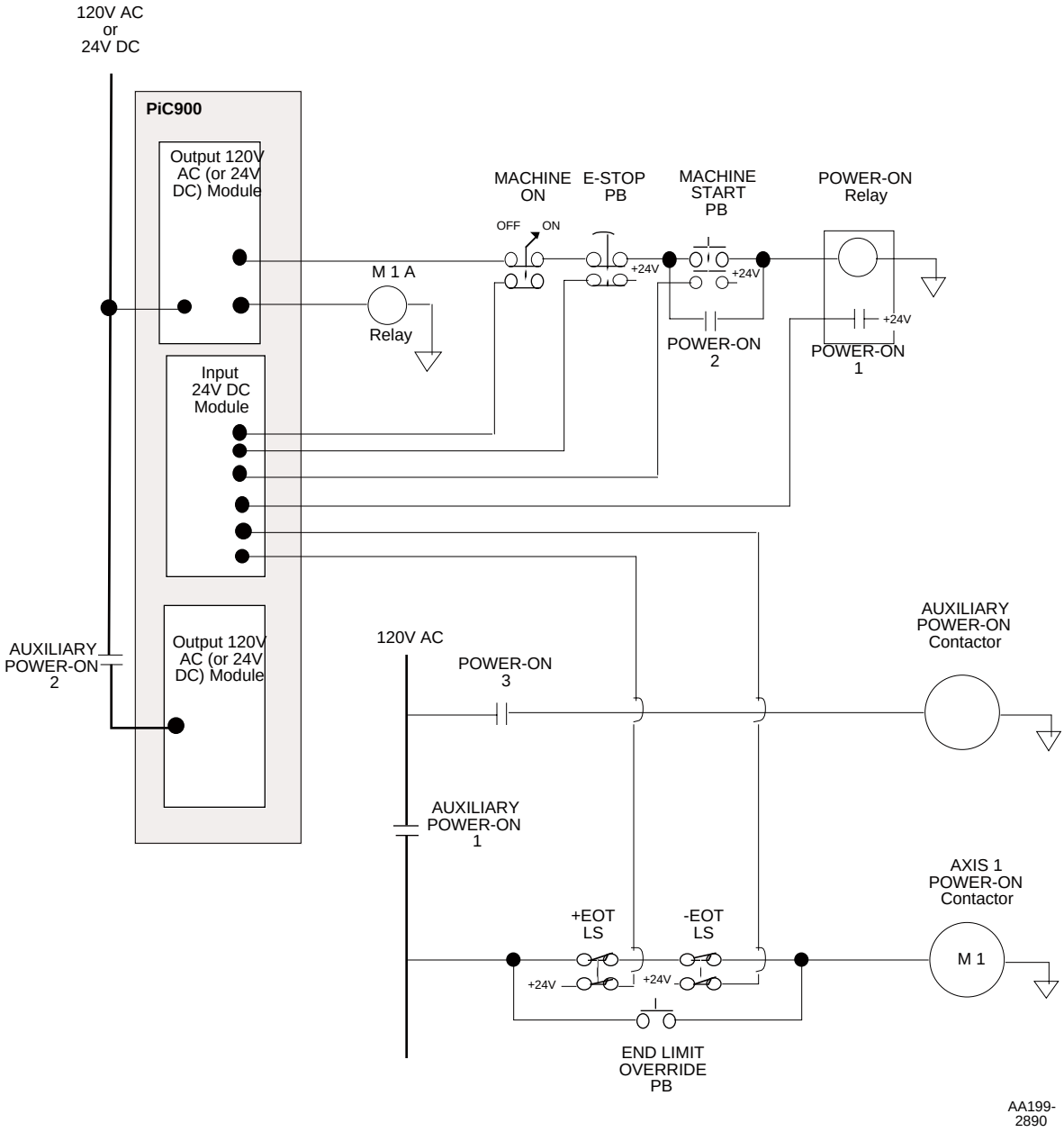
    The status of the end limit switches is also brought back through an input module. This allows LDO control over the direction used for moving off an end limit.

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5. Power is supplied to other output modules through AUXILIARY POWER-ON contact 2.
6. When applicable, a contact from relay M1A is used to enable the servo drive for axis 1. This relay is controlled by the LDO. Typically, it is turned on two seconds after the POWER-ON contact 1 is detected as closed.
7. Losing LDO scan, pressing of the E-STOP PB, or opening the MACHINE ON switch will remove power from machine operations.

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Figure J1-1. Recommended Power-On Circuitry



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Appendix K - Math Coprocessor Installation

K.1 - Math Coprocessor Installation (Document 108-31047-00)

Description of Archived Document

(This document is archived and available from Giddings & Lewis by requesting part number 108-31047-00.)

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Appendix L - Flash Memory Installation

L.1 - Flash Memory Installation

Installation of Flash Memory Board

The Flash Memory System (FMS) board provides flash disk storage for things like ladder source files on PiC CPUs with an FMS socket. Files are sent to the FMS board via PiCPro software.

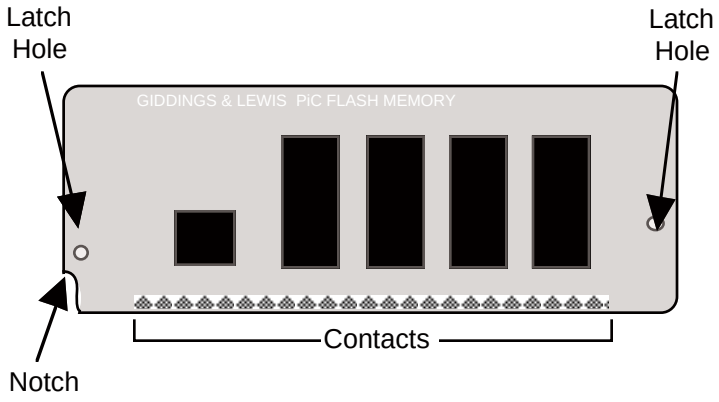
The FMS board is available in either a 4 Megabytes (4M) or 8 Megabytes (8M) size.

Part numbers	4M FMS Board- 502-03882-00
	8M FMS Board- 502-03882-20

Procedure for Installing the FMS Board

1. Lay the CPU module on a static-free surface, label side up. Ground yourself using a properly grounded wrist strap before you open the CPU module. These are standard precautions before handling any electronic components.
2. Press the plastic tabs at the top and bottom of the CPU module toward each other and lift off the CPU module cover. Figure L-2 shows the location of the FMS socket on a PiC900 and a PiC90.
3. To insert the FMS board in the socket, grasp it by the sides. The component side of the board should face the inside of the CPU module ensuring that the notched end will go into the correct channel of the FMS socket. Avoid touching the contacts at the bottom of the FMS board. See Figure L-1.

Figure L1-1. FMS Board



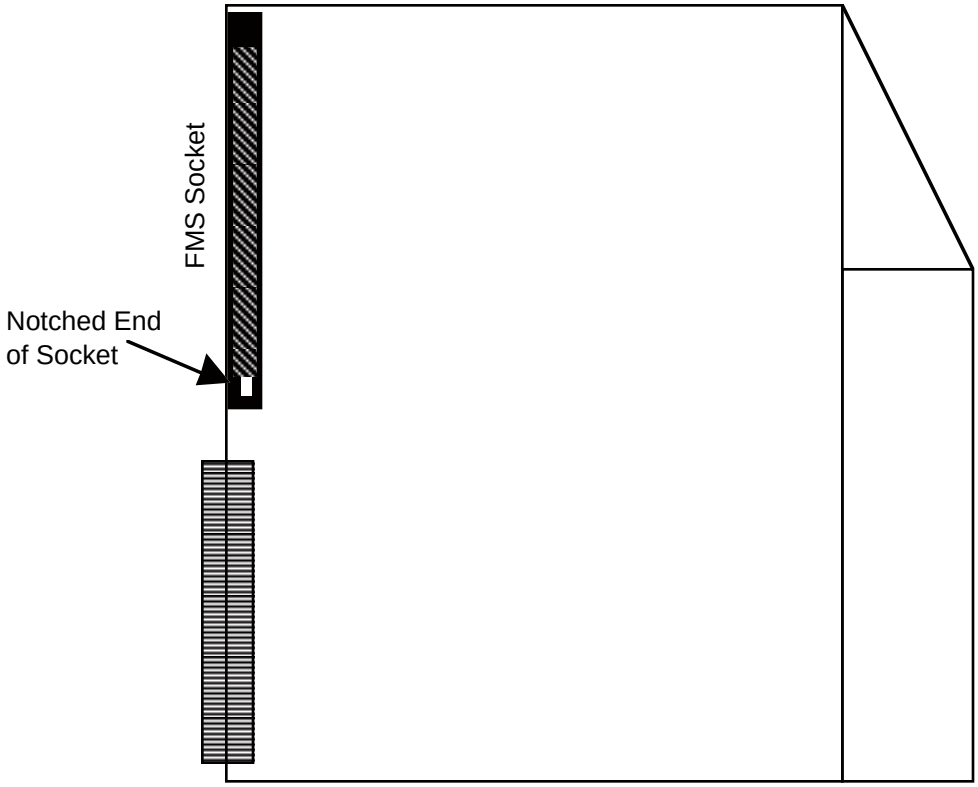
4. Line up the sides of the FMS board with the channels on the ends of the FMS socket being sure the notched end of the FMS board is going into the notched end channel of the FMS socket.
5. Press the FMS board firmly in place. Be sure the latches on the FMS socket go into the latch holes on the FMS board.

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6. Replace the CPU module cover. Insert the CPU module in the rack. Turn on power at the main disconnect switch.

Figure L1-2. The PiC900/90 CPU Modules: FMS Socket Location

PiC900/90



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Appendix M - Diagnostic LED Error Codes

M.1 - Diagnostic LED Error Codes

Error Codes

While the PiC900 is running, the DIAG LED on the CPU module will flash a three digit code signal if there is an error. For example, if there is a long pause-flash-pause-flash-flash-pause-flash-flash-flash-long pause, the code is 123. The errors are described below.

Code	Error	Description
122	No math coprocessor	Attempted to perform floating point operation with no math coprocessor installed on the CPU.
123	Scan too long	A ladder scan loss has occurred because the CPU takes more than 200 ms to scan the application program. Whenever the scan light is out, the discrete outputs go to the OFF state and the analog outputs are zeroed.
124	Excessive overhead	The system overhead update time is excessive.
125	Insufficient memory	There is insufficient memory on the CPU to run the current program.
126	No hardware bit memory	There is no bit memory installed on the CPU and the program requires it.
127	No software bit memory	There is no bit memory capability via software and the program requires it.
222	Driver error	No driver support on the CPU for the I/O module. Update your system EPROMs.
22_	Master rack error	The I/O modules in the master rack do not match what was declared in the hardware master declaration table. The number of flashes in the third digit (_) identifies the slot number that is in error.
232*	Communications error	A failure has occurred in remote I/O communications.
233*	Number of racks error	The number of expansion racks in the system does not match the number of expansion racks declared in the expansion hardware declaration table.

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3_ _*	Expansion rack error	The I/O modules in the expansion rack(s) or the block I/O modules do not match what was declared in the expansion hardware declaration table. **For rack expansion:** The number of flashes in the second digit indicates the remote rack (1 through 8). The number of flashes in the third digit indicates the slot number. **For block I/O modules:** The number of flashes in the second and third digits indicates the block I/O module (01 through 77). The second digit will flash a 1 - 7, 10 for 0. The third digit will flash a 1 - 9, 10 for 0. For example, if the second digit flashes **3** times and the third digit flashes **10** times, the module is **30**.

*Errors connected with I/O expansion. Refer to the I/O Driver Module write-up in the Hardware Manual for more information.

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Appendix N - Communication Connections

N.1 - Peer-to-Peer Communication Connections

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Establishing Communications

It is possible to establish communication between PiCs equipped with peer-to-peer communication capability using various connection configurations. These configurations will depend on how many PiCs you are communicating with and how great a distance the total network will cover.

Two to seven (eight with some systems) PiCs can be connected using twisted pair wire. The twisted pair wiring can consist of one or more lengths connecting the PiCs. A **minimum** length of 6 feet (2 m) between devices on a network is required. The total network length end-to-end may be a **maximum** of 400 feet (122 m). This is referred to as a *wire segment.*

With the use of active hubs, it is possible to link up to 255 PiCs in a network extending up to four miles (6400 m) using twisted pair, coax and/or fiber optics cabling. With coax cable, a minimum length of 6 feet (2 m) between devices on a network is required. The total network length end-to-end may be a maximum of 2000 feet (610 m). With glass fiber optics, there is no minimum length. The total network length end-to-end may be a maximum of 3000 feet (915 m), 6000 feet (1800m), or 9000 feet (2740m) based on 50, 62.5, or 100 micron glass fiber optics cable respectively.

CAUTION

Although considerable noise immunity is obtained with the isolated twisted pair interface, care should be taken to route twisted pair wires and coax cables separate from wires used for high voltage, motors, solenoids, etc.

Throughout Appendix N1 and N2, refer to the individual module write-ups for the communication connection pinouts for your module.

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Communication Topologies

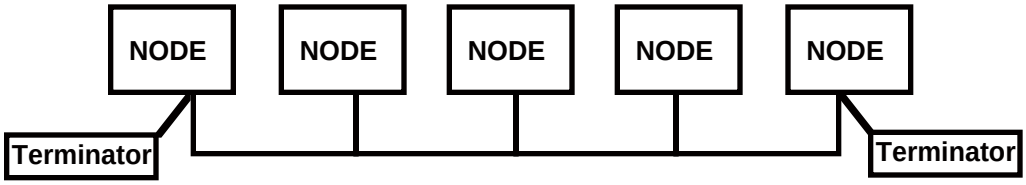
There are several possible layouts or topologies for peer-to-peer communications. They are summarized here.

The PiC or any device that contains an ARCNET controller chip and cable transceiver and is connected to a network is referred to as a *node*. The PiC has no internal termination and, therefore, whenever a PiC appears at the end of a segment it must be terminated with a 100 Ω resistor.

A device that facilitates interconnecting multiple nodes by matching line impedance is called a *hub.* The active hubs used here have internal termination.

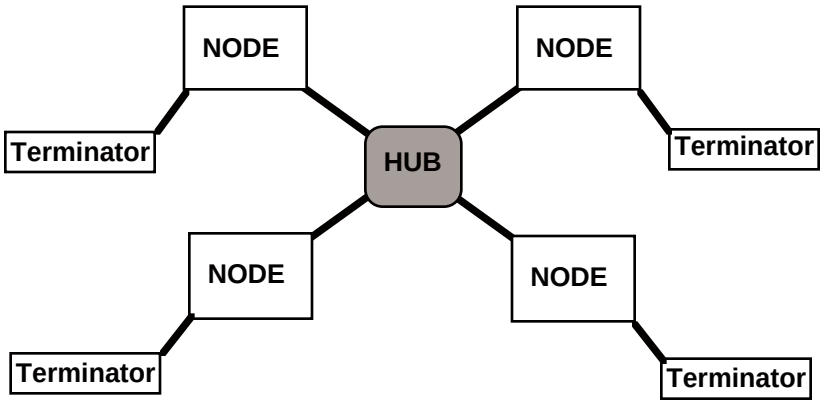
Bus Topology

In bus topology, the nodes can be connected without the use of a hub. Cabling distances and node numbers are less than when a hub is used. Whenever a bus topology is used, each end of the bus must be terminated with a resistive terminator.



Star Topology

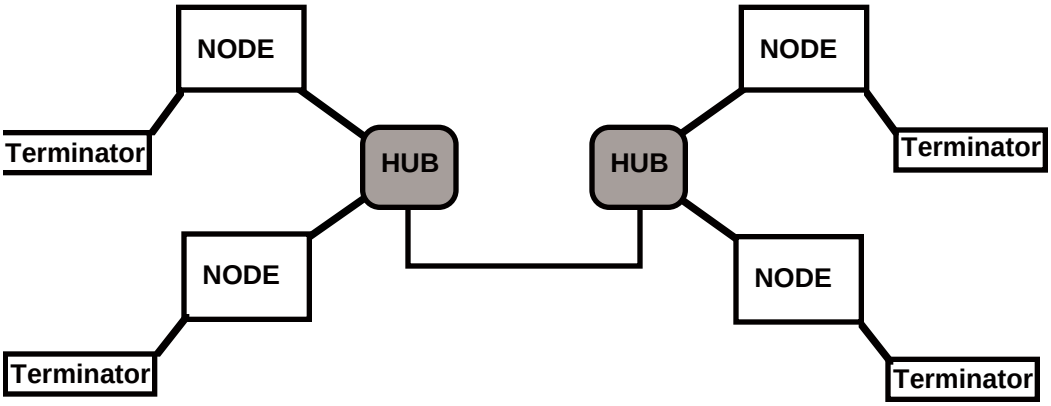
The star topology requires the use of a hub. This topology makes troubleshooting easiser since only one node is connected to one port on the hub.



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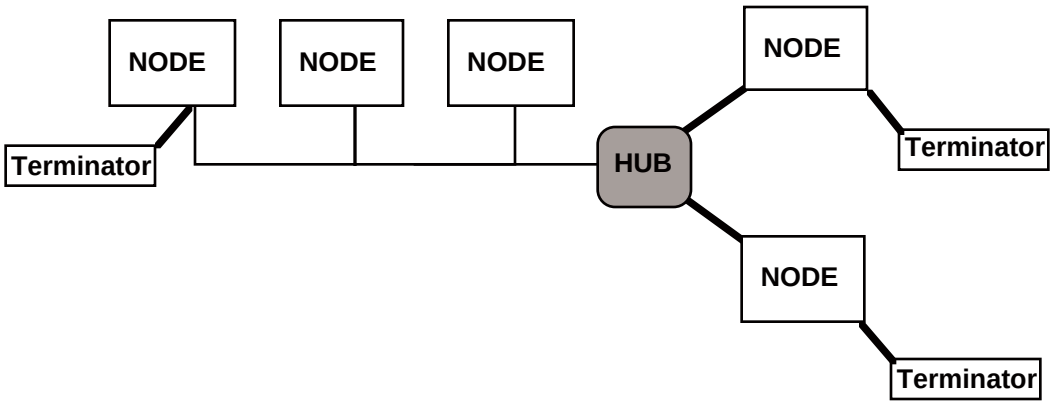
Distributed Star Topology

Whenever hubs are cascaded together, the topology is called a distributed star. Each hub can have various nodes connected to it.



Distributed Star/Bus Topology

A star topology can be combined with a bus topology.

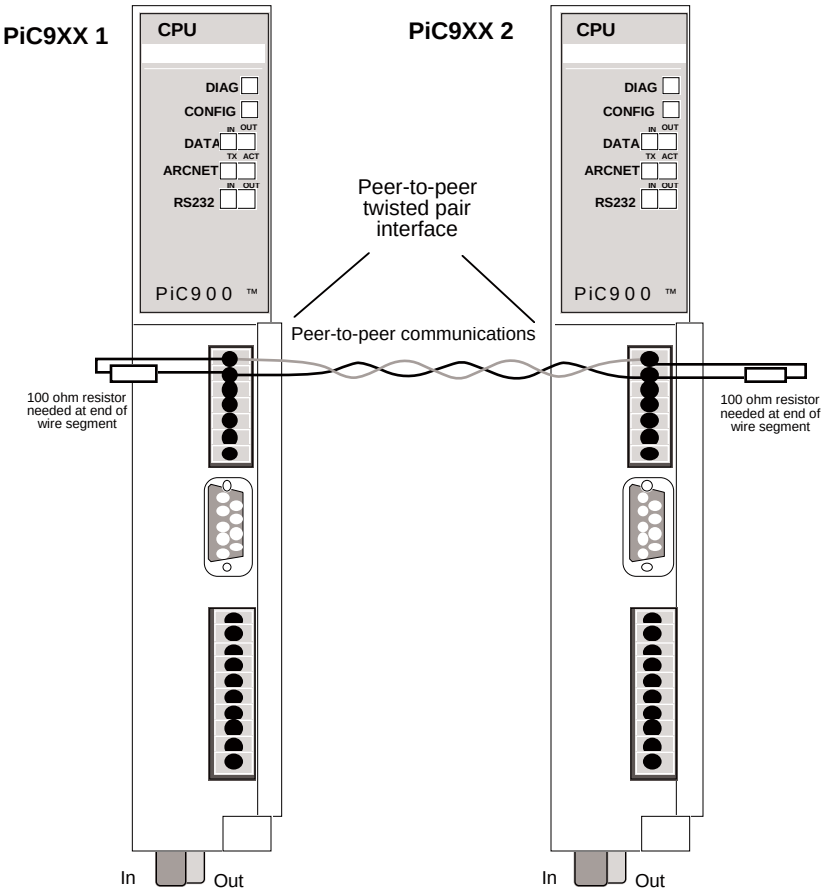


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Connecting PiCs up to 400 feet - Bus Topology

Connections for peer-to-peer expansion using two different types of PiCs are illustrated in Figure N1-1. Twisted pair wire is used. 100 Ω resistors must be installed at each end of the wire segment.

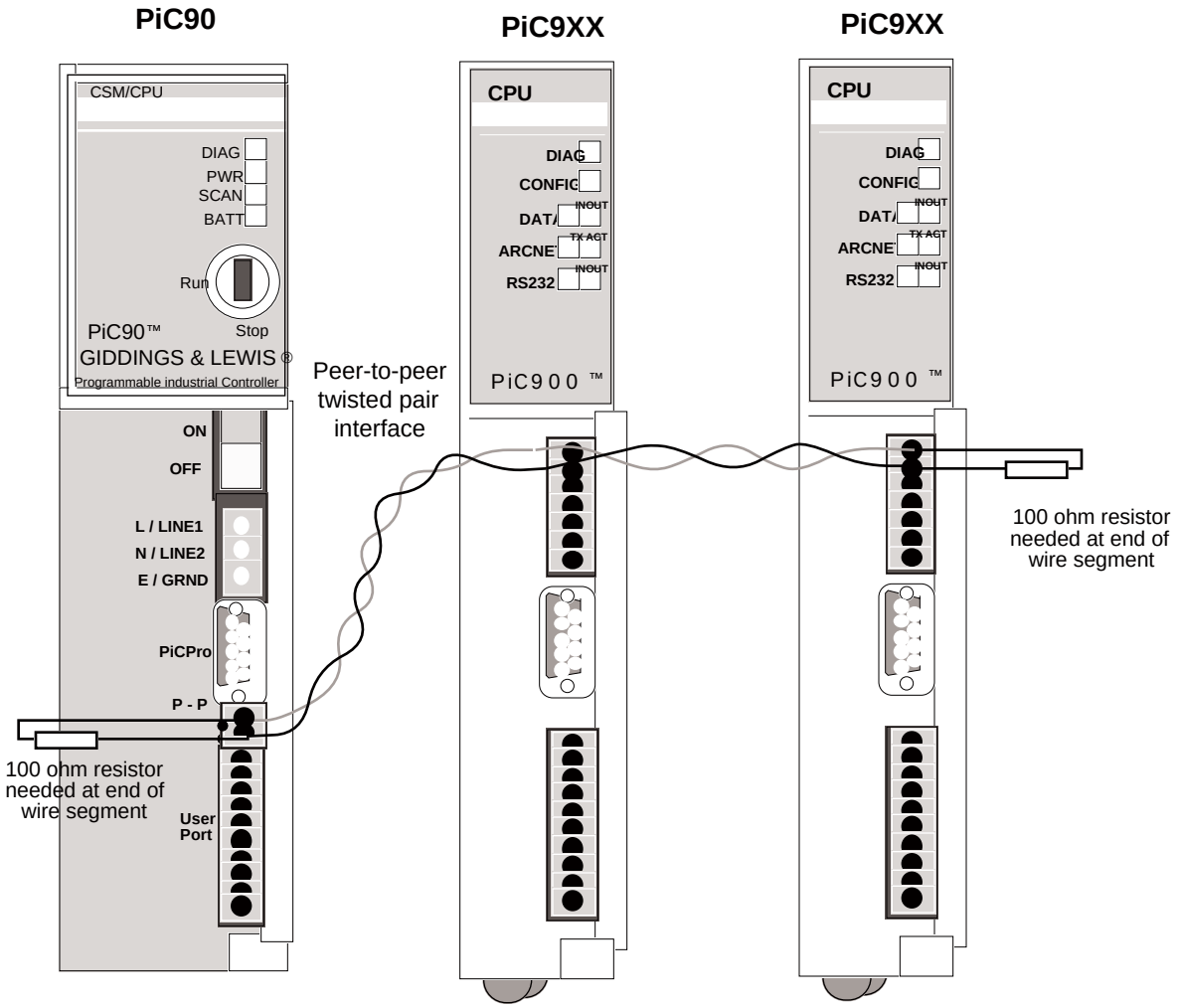
Figure N1-1. Connections between PiC9XXs - Bus Topology



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Connections for peer-to-peer expansion using two PiC9XXs and a PiC90 are illustrated in Figure N1-2. Twisted pair wire is used. 100 Ω resistors must be installed at each end of the wire segment.

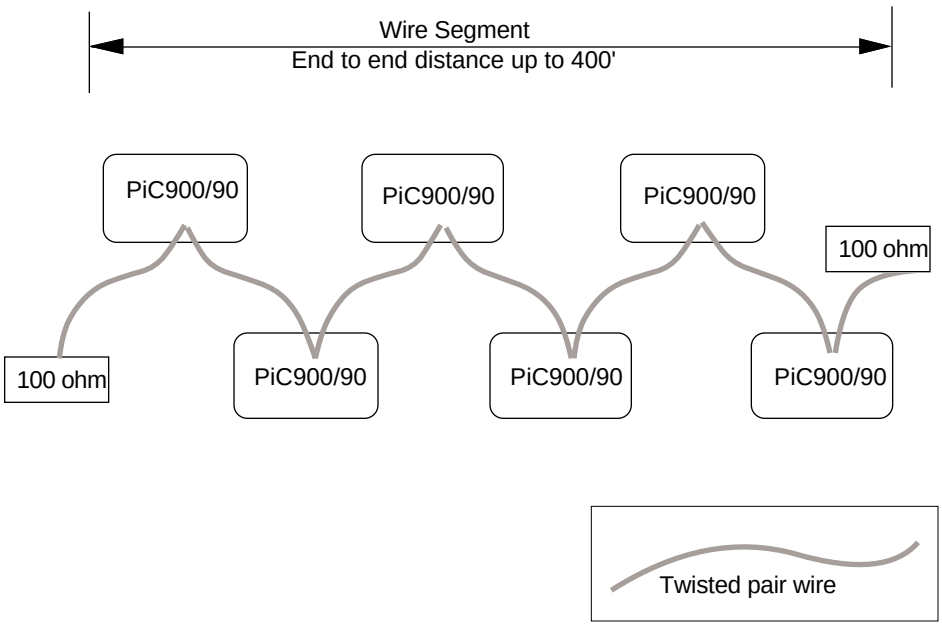
Figure N1-2. Connections between PiC90/9XXs - Bus Topology



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Figure N1-3 illustrates how multiple PiCs can be connected using twisted pair wire. The total twisted pair wire segment is under 400 feet (122 m). Notice that the ends of the wire segment must be terminated with a 100 Ω resistor.

Figure N1-3. Connecting PiCs within 400 feet (122 m) - Bus Topology



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Expanding with Active Hubs

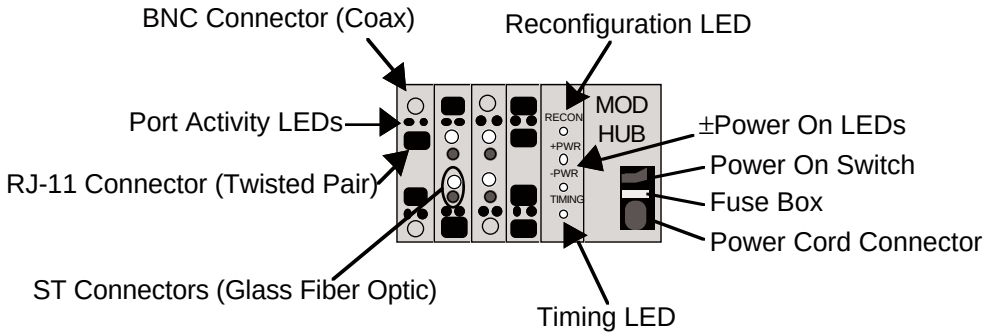
An active hub may be added to the system if greater than 400 feet distances need to be covered and/or if more than eight PiCs need to be included in the network. An active hub also allows you to communicate using a variety of cabling types.

The MOD HUB from Contemporary Control Systems, Inc. (CCSI) is an electronic device used to expand networks. Its main function is to match line impedance. It regenerates the network signal for distances from 6 to 400 feet (100 m) using twisted pair cable, from 6 to 2,000 feet (610 m) using RG 62/U coax cable in a bus topology (0 to 2000 in a star topology), or 0 to 9,000 feet (2740 m) using glass fiber optics cable. With the use of a MOD HUB, these cabling types can be intermixed depending upon the requirements of your network.

The MOD HUB uses plug-in expansion modules each containing four ports. The ports may be all one type of connection (twisted pair, coax, or fiber optics) or a mix of two types of connections (twisted pair/coax, twisted pair/fiber optics, coax/fiber optics). You decide on the type of cabling or mix of cabling you need and choose the appropriate expansion modules. The MOD HUB is available in two sizes: a 16 port enclosure holding up to four modules or a 48 port enclosure holding up to 12 modules. The MOD HUB requires AC power and is available in 120V or 240V versions.

Diagnostic LEDs help with troubleshooting. Each expansion module has LEDs indicating activity for each port. There are four other LEDs on the timing module of the hub. Refer to the MOD HUB documentation from CCSI for more information.

Figure N1-4. MOD HUB 16 with Four Expansion Modules



There is also a network interface module (NIM) available from CCSI if you need to interface your network to a PC. The PCX series of NIMs supports coax, twisted pair, or fiber optics connectors on it. See Figure N1-9.

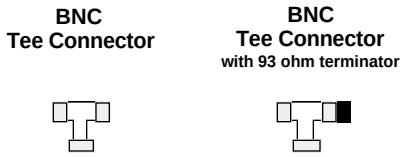
Connectors

Coax

Coax cable is connected to the MOD HUB using BNC tee connectors.

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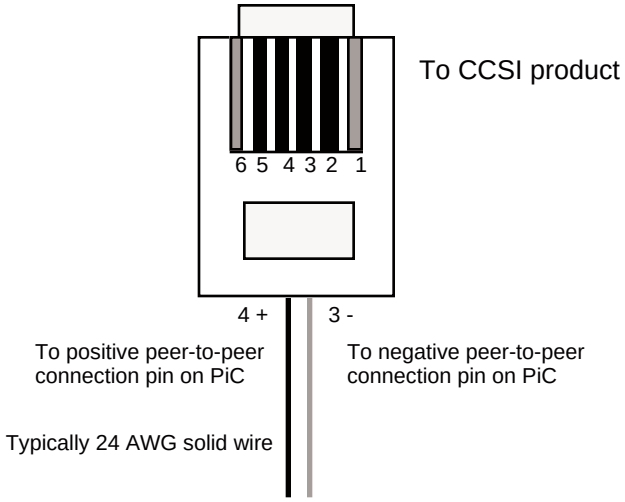
Figure N1-5. BNC Connector for Coax Cable



Twisted Pair

The twisted pair wire from the PiCs must be connected to an RJ11 modular plug. The pinout for the RJ11 modular plug for any of the recommended CCSI products is shown in Figure N1-6. Be sure that you match polarity when making the connection from the connector on the PiC to the RJ11 modular plug.

Figure N1-6. RJ11 Modular Plug (6 position - 4 contact) for Twisted Pair Wire



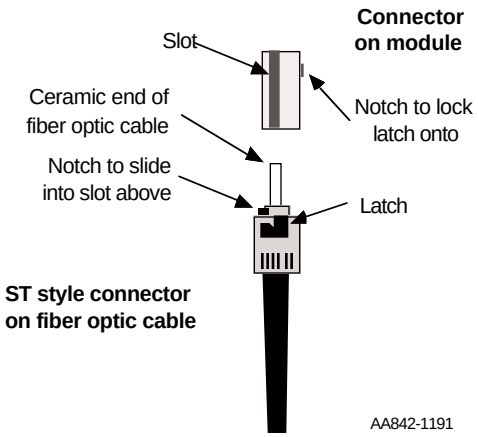
Refer to the specification table at the end of for alternate wire sizes.

Fiber Optics

Fiber optic cables are duplex, multimode in either 50/125, 62.5/125, or 100/140 micron cable. Use the bayonet style ST connectors.

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Figure N1-7. ST Connector for Fiber Optic Cable



CAUTION

Never create a loop with the network cabling. For example, do not connect the PiCs (or hubs) in such a manner that the cabling attached to the last device is also connected to the first device.

Figures N1-8 and N1-9 illustrate some of the connection configurations for peer-to-peer communication using active hubs.

In Figure N1-8, two active hubs are connected using coax cable. The twisted pair wire is used to connect a bus of PiCs to the hubs. Note that the end of the bus is terminated with a 100 Ω resistor.

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Figure N1-7. MOD HUBs using Coax and Twisted Pair - Distributed Star/Bus Topology

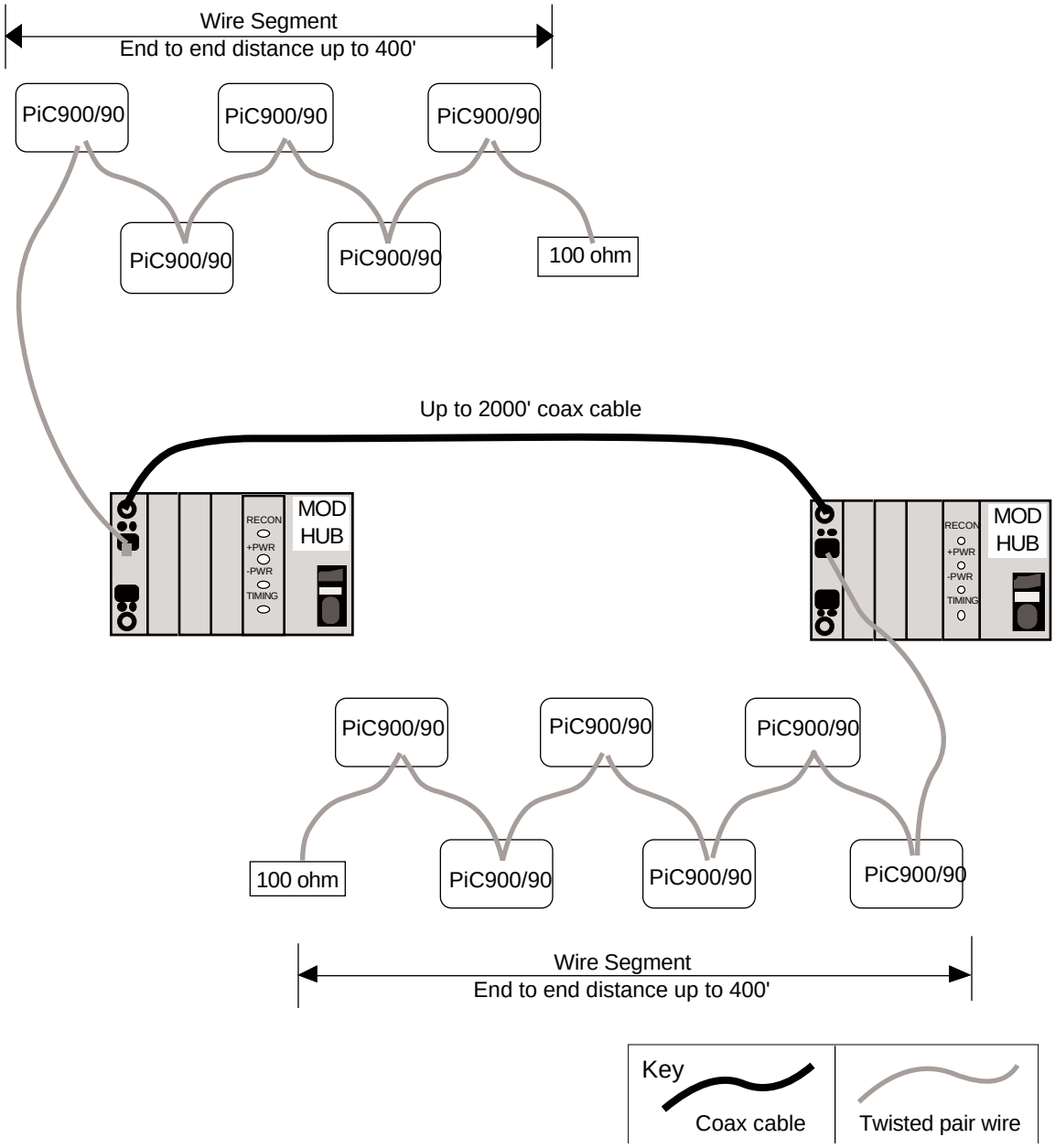
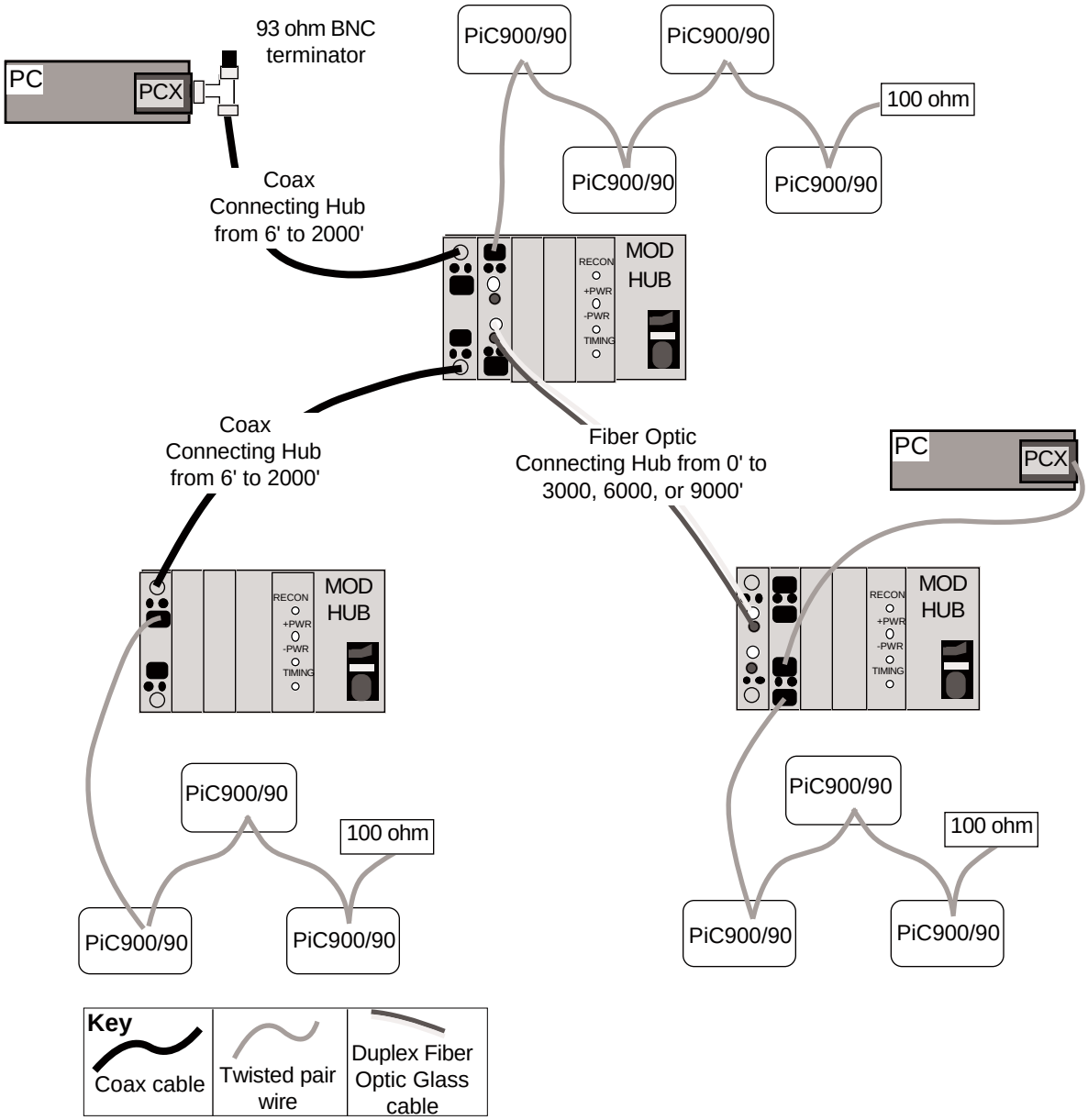


Figure N1-9 shows some other network possibilities. The maximum cable distance between any two PiC900s located at opposite ends of the network is 20,000 feet/4 miles (6400 m). More modules could be added to each MOD HUB as your system requires.

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Figure N1-8. Cascading Hubs to further Extend the Network - Distributed Star/Bus Topology



Some of the items listed below are available from:

Contemporary Control Systems, Inc. (CCSI)
2512 Wisconsin Avenue
Downers Grove, IL 60515

Phone: 630 963-7070

It is recommended that they be used for peer-to-peer communications.
NOTE: Part numbers may be changed by manufacturers.

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CCSI also has network configuration guides available and other information you may find helpful.

Recommended connectivity products	Description
Active MOD HUB	MOD HUB-16 (16 port, 120V) MOD HUB-16E (16 port, 240V) MOD HUB-16F (16 port, 120 V, flange mount) MOD HUB 16 EF (16 port, 240 V, flange mount) MOD HUB-48 (48 port, 120 V) MOD HUB-48E (48 port, 240 V) NOTE: There is also a HUB rack mounting kit available.
EXP modules	The following expansion plug-in modules are available, each with four ports: EXP-TPS (Twisted Pair) EXP-CXS (Coax) EXP-TPS/CXS (Twisted Pair/Coax) EXP-FOG-ST (Glass Fiber Optics with ST connector) EXP-TPS/FOG-ST (Twisted Pair/Glass Fiber Optics with ST connector) EXP-CXS/FOG-ST (Coax/Glass Fiber Optics with ST connector)
PCA (16 bit) module	An ARCNET Network Interface Module for the IBM compatible PC PCA-CXS (Coax) PCA-66-TPB (Twisted Pair) PCX-20-TPB (Twisted Pair) PCA-FOG-ST (Glass Fiber Optics with ST connector) TPB-Terminal Resistor (RJ-11 100 Ω terminator)
ARC DETECT™	Handheld network analyzer recommended for maintaining and troubleshooting your network.
BNC Tee connector	BNC/T
93 Ω BNC terminator	BNC/TER
RG62/U coax cable	Belden #86262
Glass fiber optics 50/125 62.5/125 100/140	 Belden 227822 Belden 225872 Belden 226822

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Twisted pair wire	24 or 26 AWG solid or 26 AWG stranded One recommended type is Belden 1227A - 24 AWG solid copper unshielded twisted pair. This comes with two pairs. Use only one pair. For EMC compliance, it is necessary to use shielded twisted pair wire. One recommended type is Belden 9729-24 AWG (7 x 32) stranded conductors. This also comes with two pairs. Use only one pair and terminate the shield wire only if there is a pin provided for this at the ARCNET node. **IMPORTANT** Use of other wire sizes may result in an impedance mismatch that could disable communications with some or all nodes on a network when doing peer-to-peer communications.

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N.2 - I/O Expansion Connections

Expansion Racks

I/O expansion racks can be added to a PiC900 system. There are three methods of connecting an I/O expansion system.

1. **Local** - up to seven expansion racks linked to the master rack, with a maximum segment length *between* racks of 40 feet (12 m), using twisted pair wire.

IMPORTANT
The twisted pair interface should only be used for racks within the same enclosure and supplied by the same AC power source. Otherwise electrical noise problems may occur. Noise related problems can be eliminated by using the fiber optic interface in remote expansion.

2. **Remote** - up to seven expansion racks linked to a master rack, with a maximum segment length *between* racks of 2000 feet (610 m), using fiber optic cable.

The expansion rack must have either a CSM or a RSM module in slot 1 and an I/O driver module in slot 2. If a PiC90 is used as an expansion rack, it must have the RSM/IO driver module in slot 1/2.

The following can be used in the master rack of an I/O expansion system.

CPU Module in Master Rack	Number of Expansion Racks Supported
PiC9XX CPU with communication capabilities	1 to 7 racks

The following expansion racks can be used in an I/O expansion system.

Expansion Rack	Number of Slots Available
PiC90 with RSM I/O driver	3 or 5 slots
PiC900 with RSM or CSM and I/O driver	7, 10, or 13 slots

It is possible to combine local and remote expansion racks in the same system. Use twisted pair wiring to connect racks that are up to 40 feet apart and use fiber optic cable to connect racks that are up to 2000 feet apart.

Ring, or loop, topology is used for the layout of an expansion system. The ‘out’ of the last expansion rack is connected to the ‘in’ of the master rack. Rack numbers are assigned in the order each expansion rack is wired in the loop.

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IMPORTANT
Because of the ring configuration, all expansion racks must be present and have power applied in order for I/O expansion to function properly.

3. **Block I/O** - up to 77 block I/O modules in an expansion system. Maximum distance between block modules is 200 feet using shielded twisted pair wire.

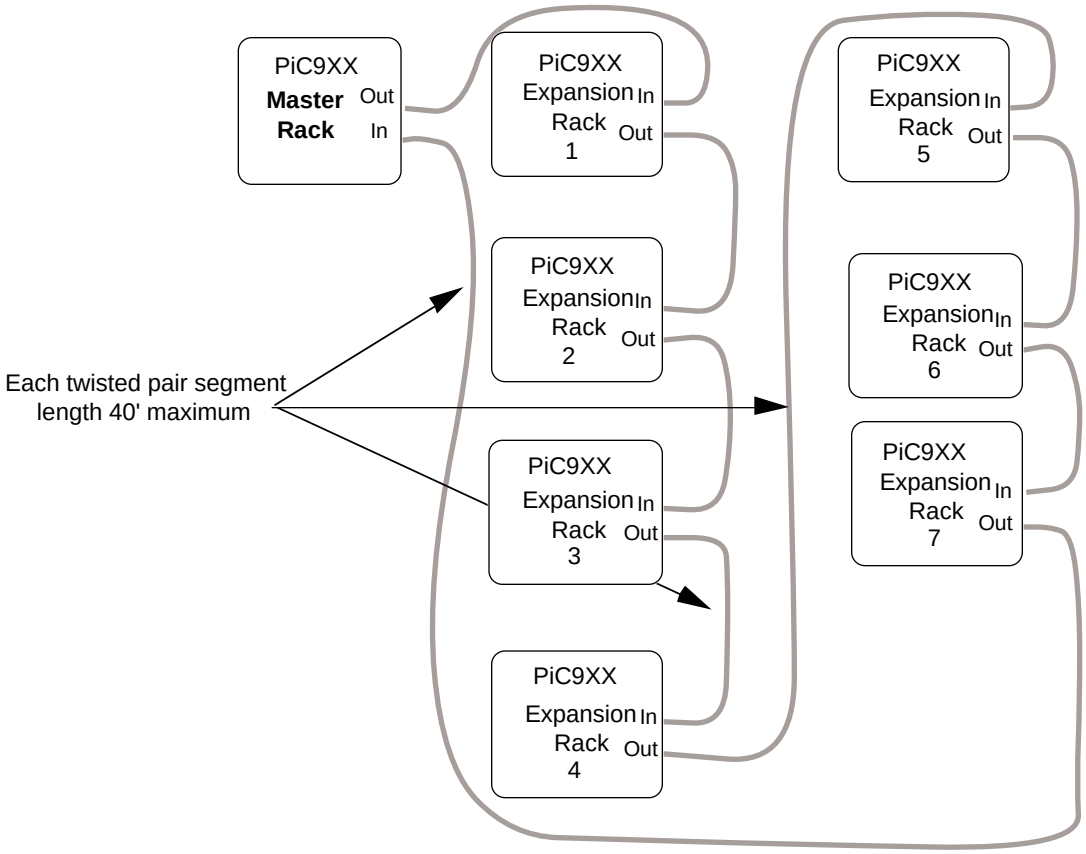
Local I/O Expansion

Whenever the wire segments from rack to rack are less than 40 feet (12 m), twisted pair wiring can be used. 18 to 20 AWG stranded twisted pair wire is typically used. Local I/O expansion is intended for connecting expansion racks mounted in the same control cabinet as the master rack.

One PiC9XX layout possibility is illustrated in Figure N2-1.

Notice that the expansion system forms a loop with expansion rack eight connected to the master rack. A loop configuration is required for all expansion systems.

Figure N2-1. Local Expansion Layout for a PiC9XX Master Rack



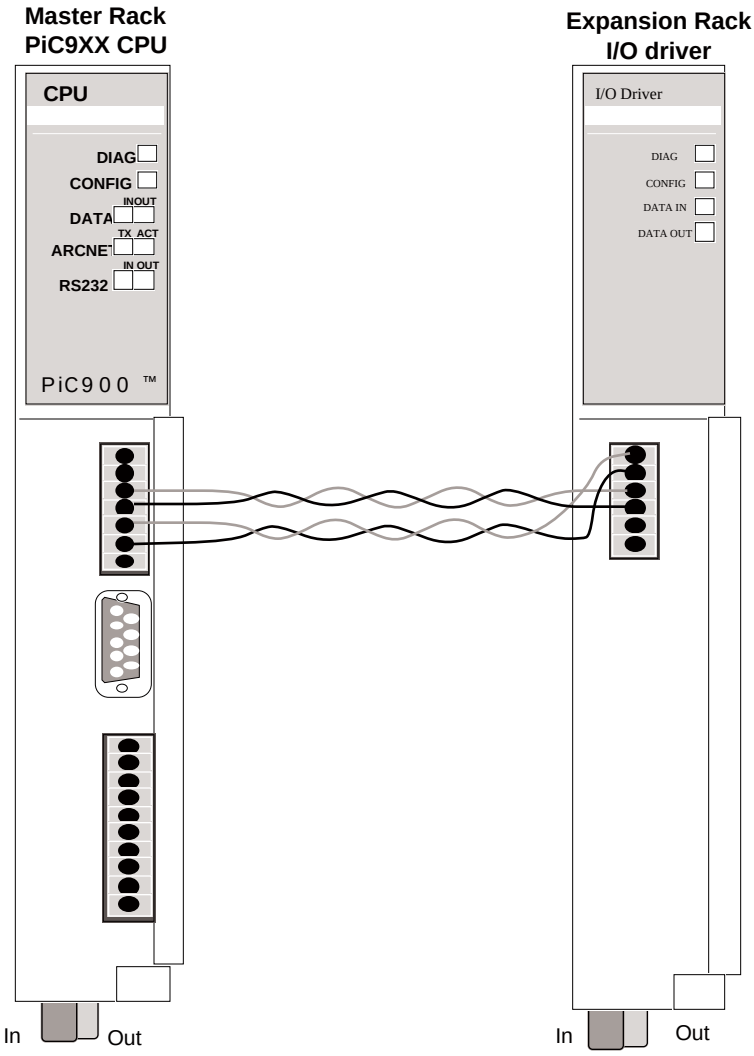
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Local Expansion with a PiC9XX

The connections made from the PiC9XX communications connector on the CPU module in the master rack to the twisted pair connector on the I/O driver in an expansion rack is shown in Figure N2-2. This represents a system with only one expansion rack in the loop.

If more racks were included in the system, they would be wired similarly running the twisted pair *out* of expansion rack 1 to the twisted pair *in* of expansion rack 2, and so on until the final expansion rack is wired. The twisted pair out of the final rack is run to the twisted pair in of the master rack so that a loop is created.

Figure N2-2. Twisted Pair Connections for Local I/O Expansion (PiC9XX to PiC9XX)



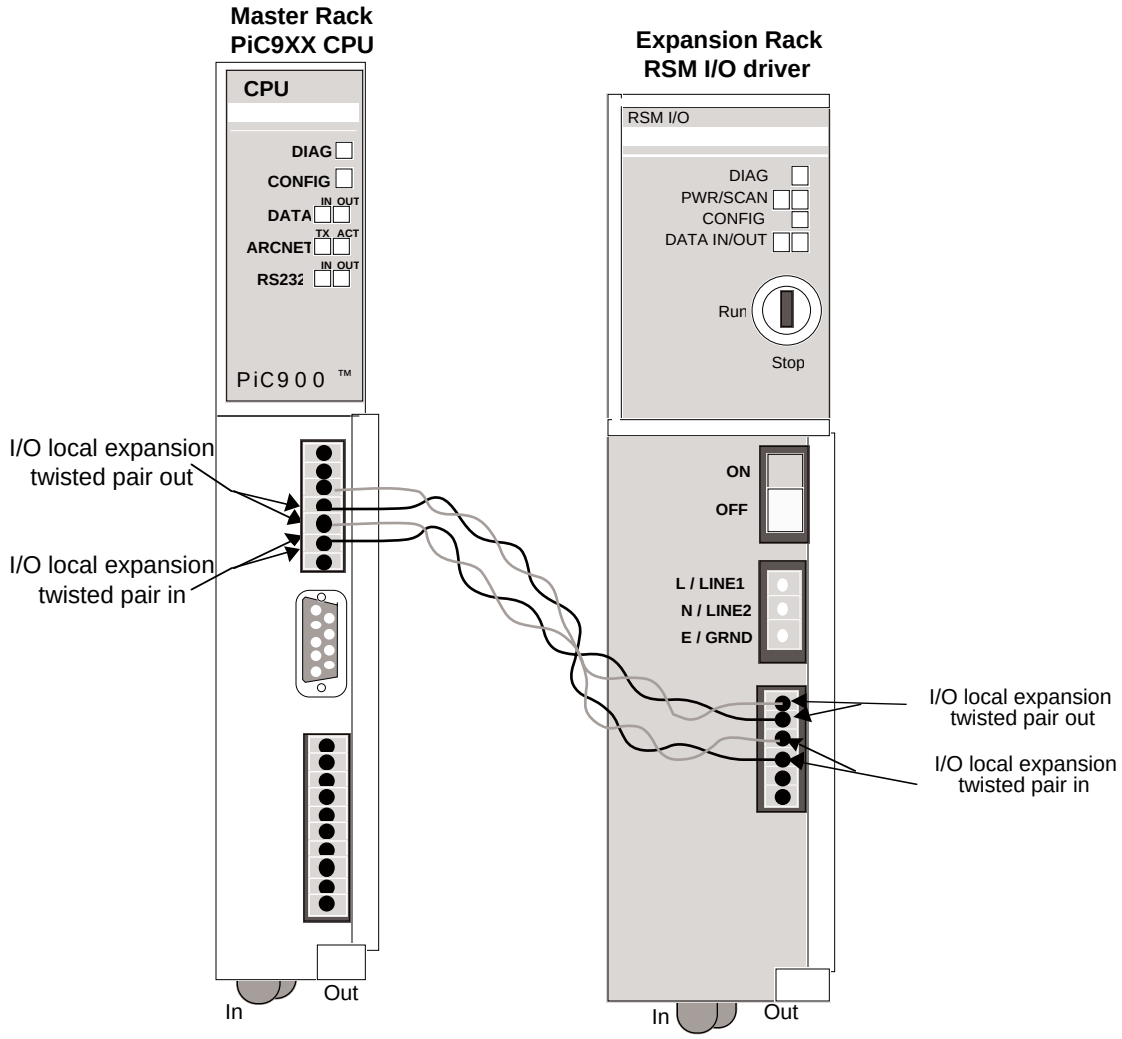
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Local Expansion with a PiC9XX and a PiC90

The connections made from the PiC9XX communications connector on the CPU module in the master rack to the twisted pair connector on the PiC90 RSM I/O driver in an expansion rack is shown in Figure N2-3. This represents a system with only one expansion rack in the loop.

If more racks were included in the system, they would be wired similarly running the twisted pair *out* of expansion rack 1 to the twisted pair *in* of expansion rack 2, and so on until the final expansion rack is wired. The twisted pair out of the final rack is run to the twisted pair in of the master rack so that a loop is created.

Figure N2-3. Twisted Pair Connections for Local I/O Expansion (PiC9XX to PiC90)



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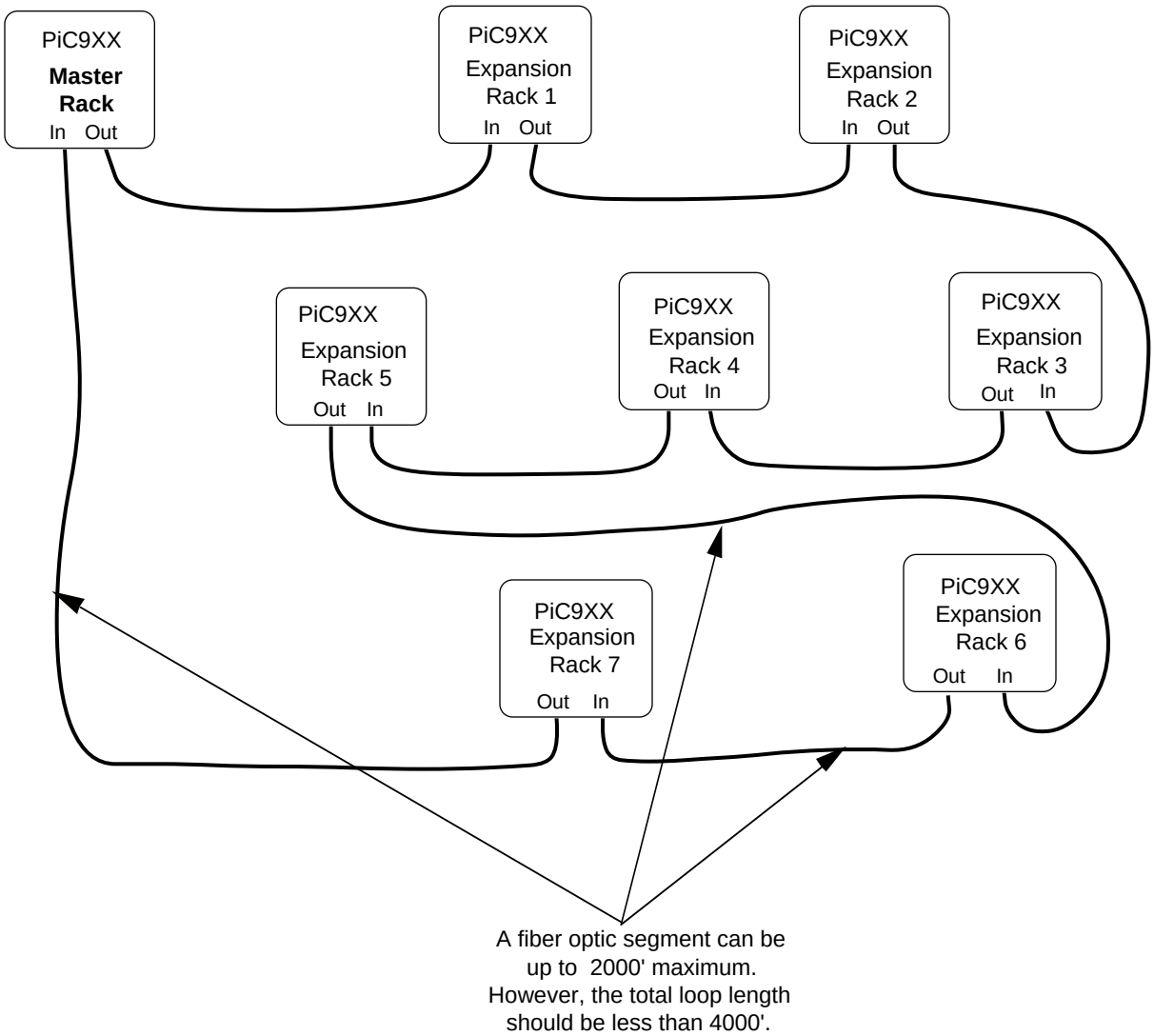
Remote I/O Expansion

When isolation is required or the segments from rack to rack are more than 40 feet (12 m), fiber optic cable is used. The fiber optic connectors are found on the bottom of the PiC900 modules. Fiber optic segments can be up to 2,000 feet (610 m) in length. The total loop length should be less than 4,000 feet (1,210 m).

One layout possibility is illustrated in Figure N2-4.

Notice that the expansion system forms a loop with the expansion rack seven connected to the master rack. A loop configuration is required for all expansion systems.

Figure N2-4. Remote I/O layout for a PiC900 master rack



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Fiber Optic Cables

Fiber optic cables for remote I/O expansion are available in various lengths with connectors attached. It is also possible to order the cable and connectors separately.

Item	Part number
Cable with connectors	502-037XY-YY*
Cable	401-54631-00
Connector	401-54652-00

*The XY-YY part of the part number allows you to enter the length of the cable you are ordering. Cable can be ordered any length from 4 feet to 2,000 feet.

The X may be a 0, 1, or 2.
The Ys may be any digit from 0 to 9.

For example, to order a 4 foot cable, the part number would be:

502-03700-04

To order a 1,234 foot cable, the part number would be:

502-03712-34

If fabricating your own cable, it must have the characteristics shown in the fiber optic cable specification table.

Handling Precautions

When working with fiber optic cable, the following precautions should be followed.

1. Keep the slip covers on the ends of the connectors until ready to hook up.
2. When routing cable through difficult runs, use a simplex pulling grip.
3. Do not exceed the recommended tensile strength. (Tensile strength is the ability of a fiber to be stretched or pulled without breaking.)
4. Do not exceed the recommended bend radius. (Bend radius is a limit on how much the fiber should be bent. Bends increase attenuation slightly and decrease tensile strength.) Bends tighter than a 2 inch radius may cause permanent damage to the cable

See the fiber optic cable specification table at the end of this appendix.

Connecting ST Style Fiber Optic Connector to the Module Connector

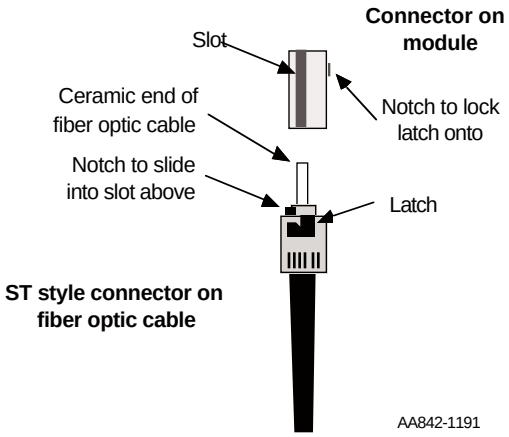
The procedure for connecting the ST style connector to the module connector is as follows:

1. Remove the protective cap from the ceramic tip of the ST style connector.
2. Find the slot on the module connector and line up the notch on the ST style connector with it.

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3. Push the spring-loaded latch section of the ST connector up to the notch on the module connector and twist to lock in place.

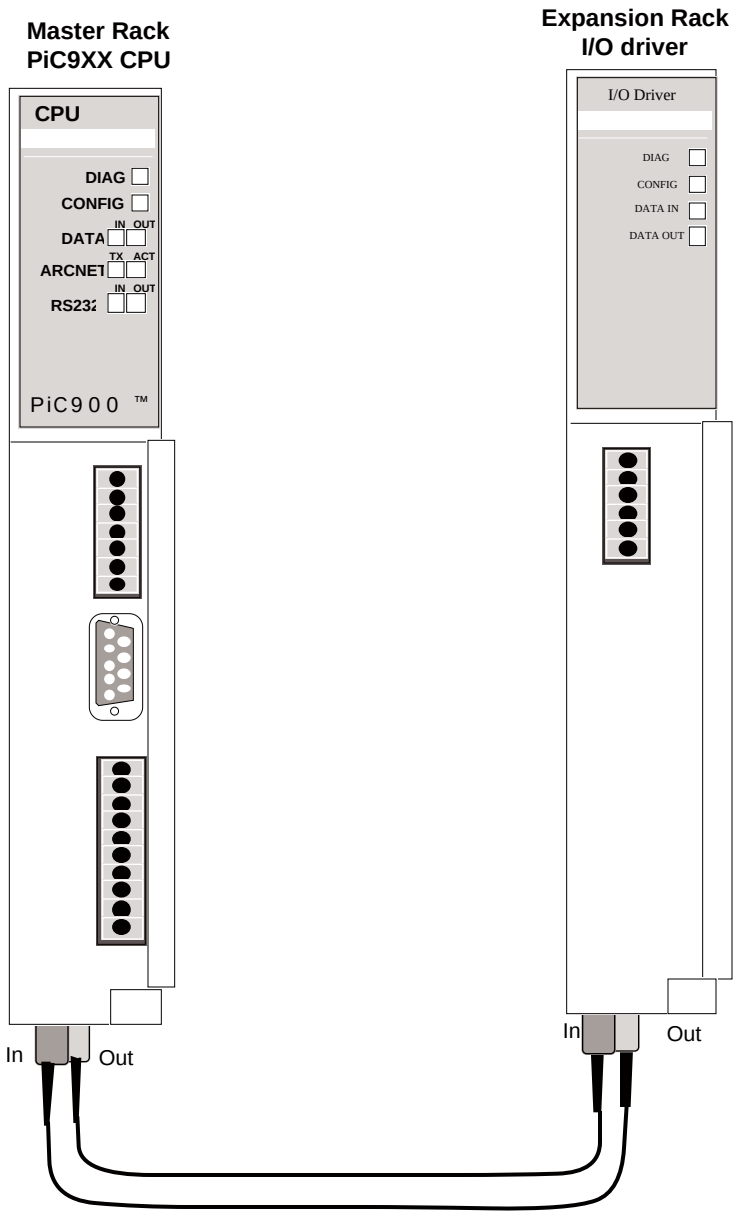
Figure N2-5. Connecting Fiber Optic Cable to Module



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For remote I/O expansion, the I/O expansion fiber optic in and out cables are connected to the connectors located on the bottom of the module as shown in Figure N2-6.

Figure N2-6. Fiber Optic Connections for PiC9XX Remote I/O Expansion

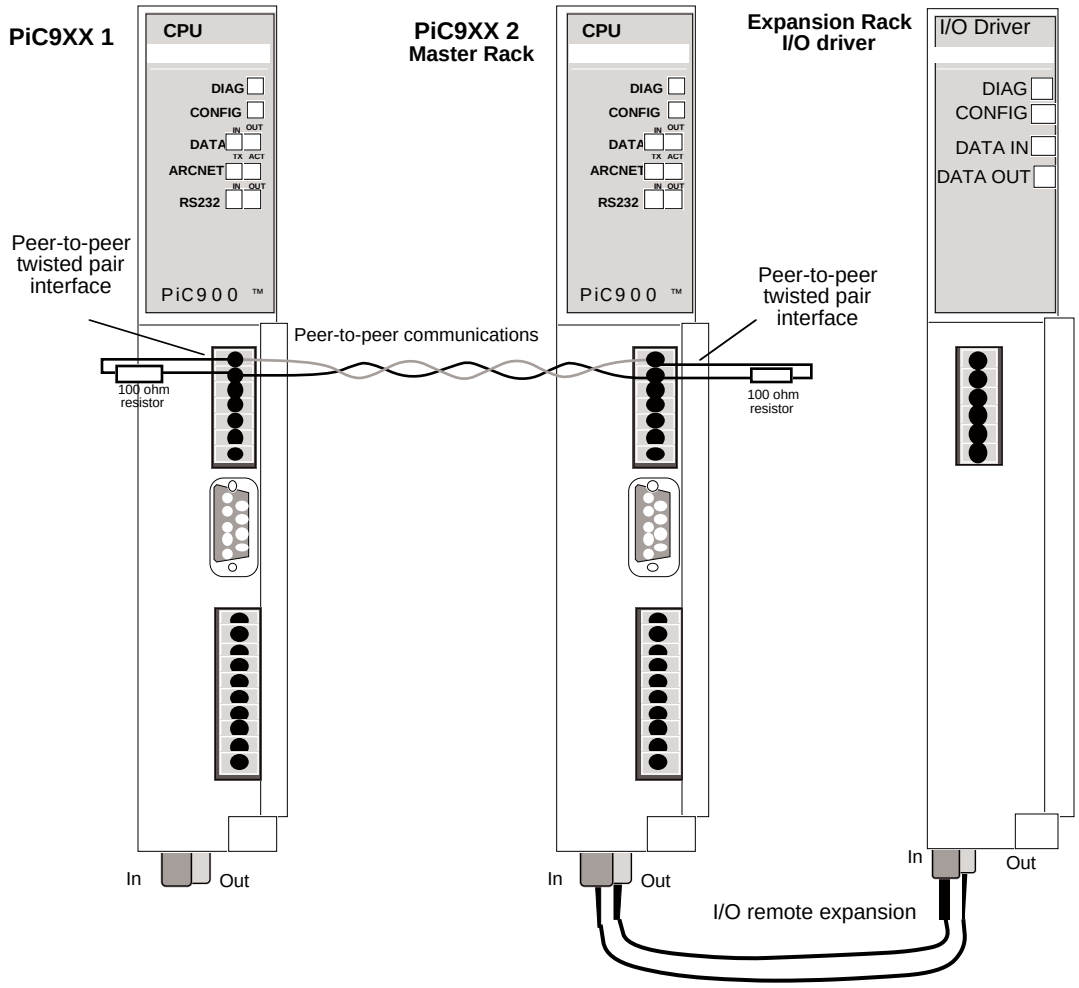


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Peer-to-Peer and Remote I/O Expansion

Figure N2-7 illustrates both peer-to-peer and I/O expansion with the PiC9XX with communication capabilities.

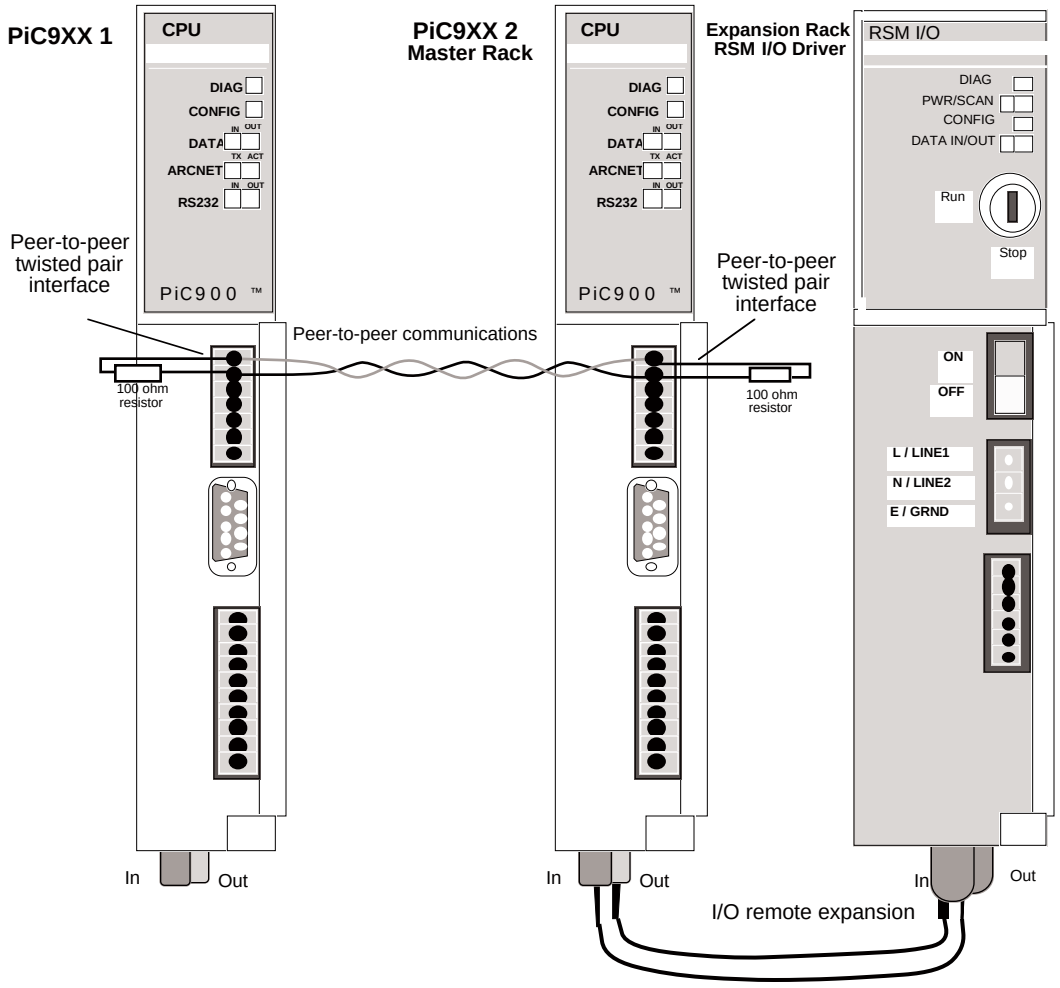
Figure N2-7. Peer-to-Peer (between two PiC9XXs) and I/O Expansion Connections



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Figure N2-8 illustrates both peer-to-peer and I/O expansion when the I/O expansion rack is a PiC90.

Figure N2-8. Peer-to-Peer (between two PiC900s) and I/O Expansion Connections



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Specification Table for Fiber Optic Cable

Characteristics	Fiber optic cable specifications
Function	For use with I/O expansion from 4 to 2,000 feet.
Part number	Cable with connectors 502-037XY-YY Cable only 401-54631-00 Connector only 401-54652-00
Type	Glass plenum or non-plenum
Size	62.5/125 µm
Operating temperature	0˚ C to 55˚ C (32˚ F to 131˚ F)
Bend radius	Greater than 2 inches during installation and operation
Tensile strength	110 # during installation and operation
Connectors	ST style which accommodates 62.5/125 µm size cable

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Block I/O Expansion

Block I/O is a self-contained I/O interface with its own logic power supply derived from an external 24V DC source. Each block has a communication interface that includes two transmitters (RS485) and two receivers (optically isolated). Blocks differ as to the type of I/O interface (analog or digital) provided.

Block I/O is an alternative to PiC900 rack I/O expansion. It is used to distribute small groups of interface logic close to the actual location of I/O devices. It allows you to replace long runs of I/O cables with twisted pairs of communication wires. The Block I/O footprint has been minimized for easy installation into small enclosures or junction boxes.

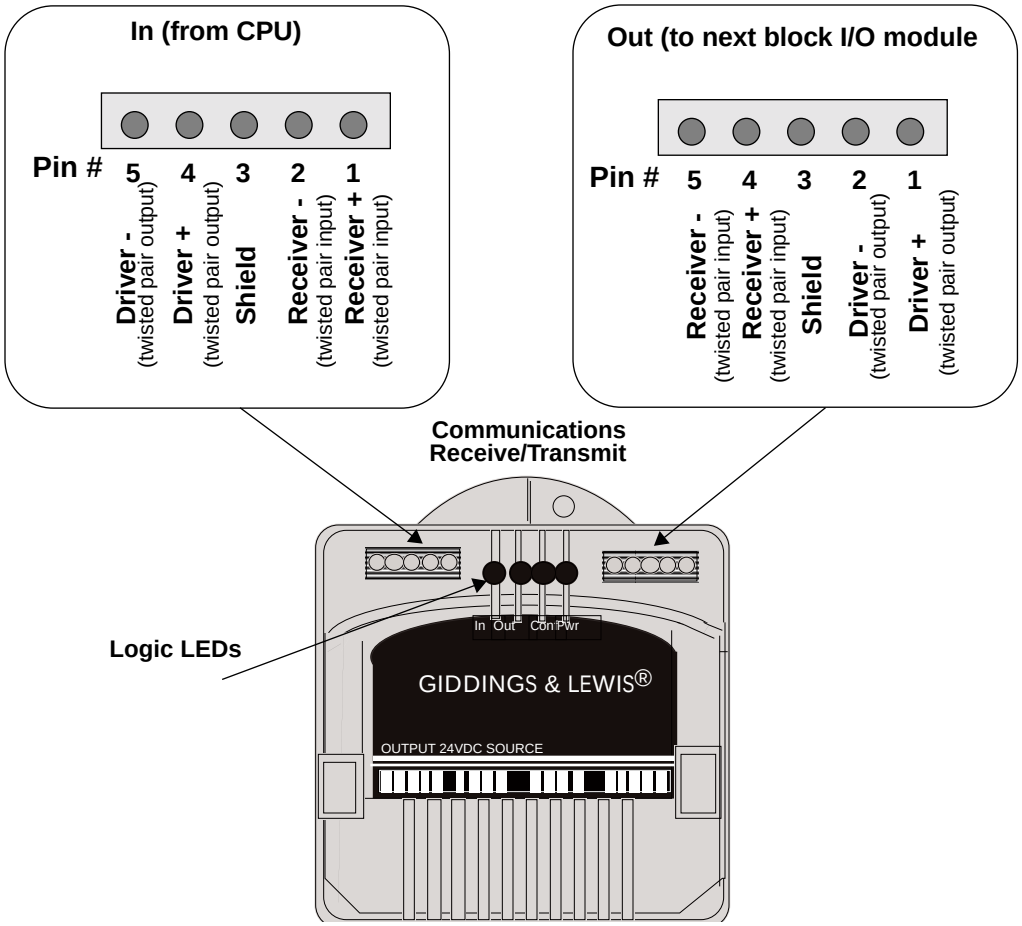
Block I/O cannot be intermixed within a rack I/O expansion loop. Block I/O uses a slower data rate and optical isolation to accommodate longer distances between modules. It requires the latest version of the PiC9XX CPU with the block I/O interface option.

Block I/O modules can be mounted directly to a panel or to a DIN rail. The package contains a metal piece that is used to make contact with the module when used with a Din rail. For an alternate connection to chassis or for panel mounting, a terminal pin is provided. Chassis connection is required for conformance to EMC standards.

There are two 5-pin communications connectors and four logic LEDs on the top of the block I/O module as shown in Figure N2-9 below.

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Figure N2-9. Pinouts for Communication Connectors



LEDs

The four LEDs are described below.

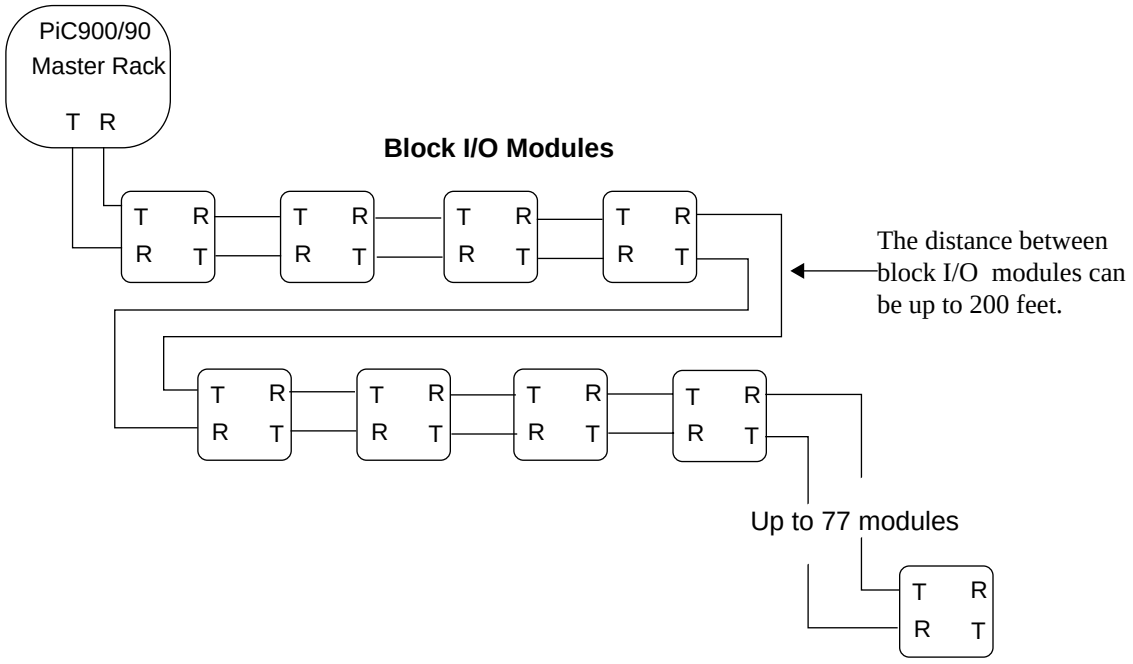
LED	Color	State	Definition
DATA IN	Yellow	ON	Indicates the line is active
		OFF	No activity
DATA OUT	Yellow	ON	Indicates the line is active
		OFF	No activity
CONFG	Green	ON	Communication established with this block I/O module
		OFF	Communication not established
PWR	Green	ON	Internal +5V logic power supply OK
		OFF	No external 24V applied or internal 5V logic supply not OK

More information about using the LEDs for troubleshooting is available in Appendix P.

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One possible layout for PiC900 expansion using block I/O modules is shown in Figure N2-10. There can be up to 200 feet between block I/O modules. The recommended wire is Belden 9729, 24 AWG stranded conductors, twisted pair (100Ω characteristic impedance) with shield.

Figure N2-10. Block I/O Layout for PiC900 Expansion

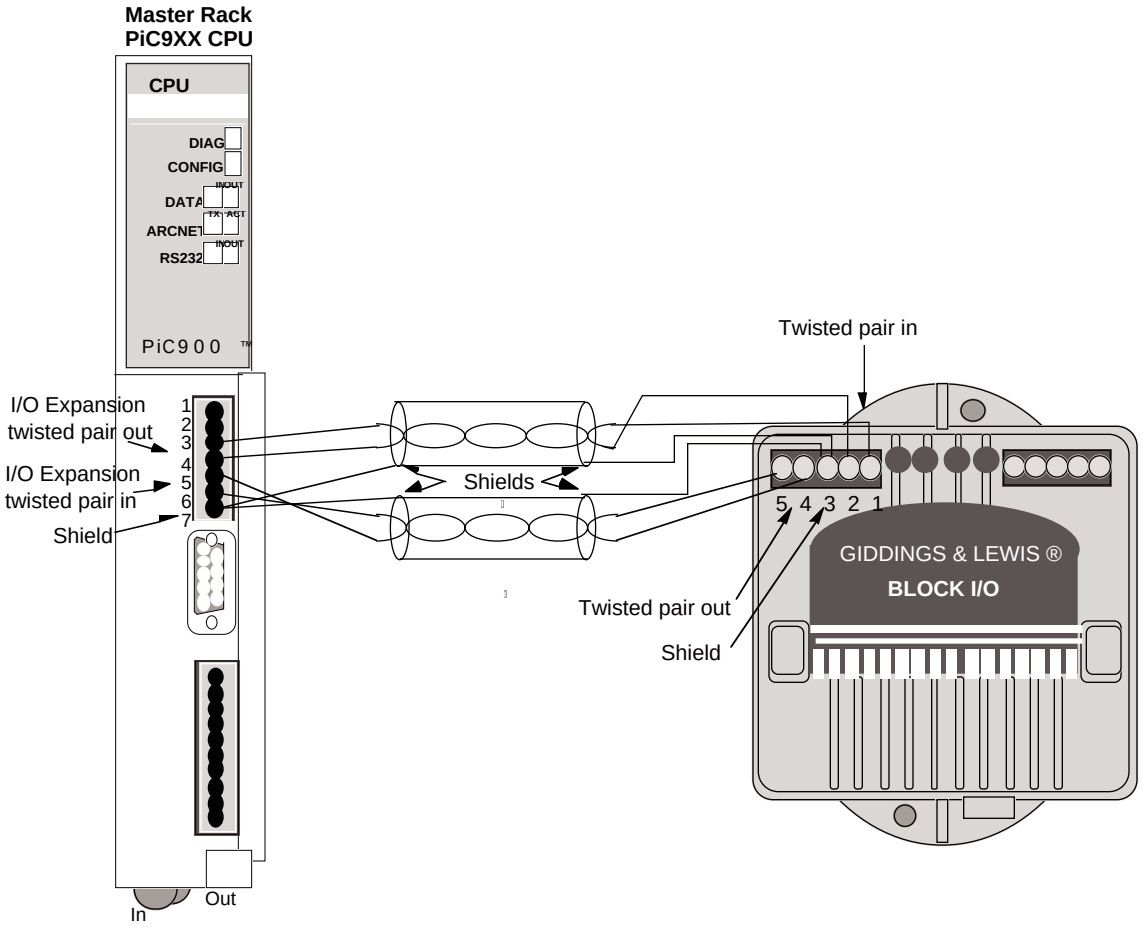


NOTE: Unlike wiring for I/O expansion racks, it is not necessary to return the last block I/O module back to the PiC900. The interconnecting cable between block I/O modules contains both a forward and a return communication path.

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Figure N2-11 shows the connections between a PiC9XX master rack and a block I/O module. To add the next block I/O module, twisted pair wire would be connected to the 5-pin connector on the upper right side of the block I/O module.

Figure N2-11. PiC9XX CPU to Block I/O Module Connections



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NOTES

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Appendix O - EMC Guidelines

O.1 - CE and EMC Guidelines

NOTE: The CE mark on PiC products assures compliance with both the EMC and low voltage European directives. Prior to this CE mark, EMC on the product label only assured compliance with the EMC directives.

Background on EMC (Electromagnetic Compatibility) Compliance

In order to market products in the European Union after January 1, 1996, an electromagnetic compatibility directive (EU Directive 89/336/ECC) must be met. All products must be designed and manufactured in such a way that:

1. Electromagnectic disturbances generated by the products do not cause interference to other systems.
2. The performance of the product is not affected by electromagnetic disturbances within the environment in which the product is intended to operate.

The directive refers to relevant harmonized European EMC standards against which product conformity can be assessed, although other methods of assessment, notably the preparation of a Technical File, are permissible. The equipment manufacturer or the manufacturer's agent in the Community must make a Declaration of Conformity and can place the CE mark on the product. Failure to conform with the requirements of the directive can result in a total ban on sales throughout the Single Market and legal action could be taken against the signatory of a false declaration of conformity.

Background on Low Voltage Compliance

In order to market products in the European Union after January 1, 1997, the low voltage directive (EU Directive 73/23/EEC) must be met.

The intention of the directive is to assure user safety under normal operating and fault conditions. The directive includes the use of certain warning labels and user instructions. It establishes limits to prevent electrical shock hazard, overheating and fire.

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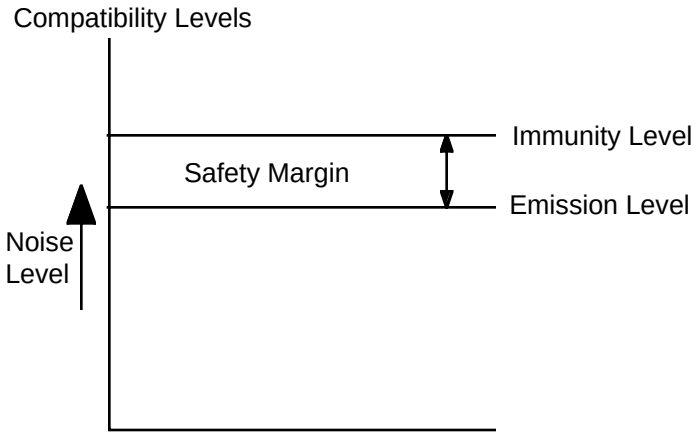
RFI Emission and Immunity

The EMC product characteristics are classified by the emission and immunity performance.

Emissions not only include radiated noise from the product enclosure and cabling, but also that which is conducted away from the product along the cables connected to it. This may be subsequently radiated from the cable or conducted directly into another product which shares this cable e.g. the main AC supply.

Immunity is how susceptible a product is (e.g. to the radiated and conducted emissions from the product mounted next to it). To ensure compatibility, the immunity of a product must always exceed the expected emissions in the environment in which it operates as is shown in the diagram below. This is to ensure a margin of safety.

Figure O1-1. Safety Margin



In addition to conducted and radiated immunity, products must also be capable of withstanding:

1. Electro-static discharges (ESD)
2. Conducted fast transient voltages

The discharge spark generated from ESD can easily damage electronic components.The conducted fast transient voltages are induced in cables laid in close proximity to other cables in which large inductive loads are switched (such as relays, contactors, and AC motor starters). This is a good example of what can happen to sensitive control and signal cabling connected to drives when poorly installed in enclosures on industrial sites.

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Classes of EMC Operating Environments

Before the correct level of EMC can be designed into equipment, the EMC operating environment must be defined. For example in industrial locations where high power equipment is in use, high levels of background electrical noise would be expected when compared to a household or office environment. Since it is more expensive to reduce the emissions from higher power equipment than to increase the immunity, the emission limits allowed in industrial environments are higher than for household or office environments. Vice versa for immunity because of the higher emission limits in industrial environments, the immunity requirements are more strict than for the household or office environment. Hence in order to achieve EMC between different equipment, it is essential to know what EMC operating environment it is to be installed in, and to compare the installation environment to the environment for which it was designed.

Today using generic EMC standards, two environments are defined:

1. Industrial
2. Residential, commercial, and light industrial

The environments are locations defined on the basis of whether the AC supply is shared with other locations or is buffered from them with a distribution transformer. If your location is buffered via a distribution transformer, then you are in an industrial environment. If you share your AC supply with a neighboring location, then you are in a residential, commercial, or light industrial environment. For example, an industrial unit which shares its AC supply with a neighboring unit is defined as a residential, commercial, and light industrial location. If it is supplied from its own distribution transformer, then it is an industrial location.

Conformance with the EMC Directive

Giddings & Lewis will comply with the Directive by self-certification to the following generic EMC standards:

1. EN50081-2 for industrial emissions using EN55011 (based upon CISPR 11A)
2. EN50082-2 for industrial immunity using

   IEC 61000-4-2 (ESD-4KV contact mode, 8 KV air discharge)
   IEC 61000-4-3 (Radiated susceptibility)
   IEC 61000-4-4 (Electrical fast transient)
   IEC 61000-4-8 (Magnetic Fields)

A statement of compliance will be made with the letters “EMC” or "CE" on the product, but will be valid only if the product is installed properly.

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Conformance with the Low Voltage Directive

Giddings & Lewis will comply with the Directive by self-certification to the following standard:

EN 61131-2:1994/A11:1996 Low Voltage Requirement for Programmable Controllers

A statement of compliance will be made with the letters "CE" on the product but will be valid only if the equipment is properly installed.

Changes to the PiC Products

Giddings & Lewis PiC products had originally been designed with a high level of noise immunity and tested according to standards such as NEMA showering arc and the original version of IEC 801-2. However, the EU directive for immunity requires testing to standards that have more variables and are more repeatable. The directive also requires control of emissions, something that is not regulated in U. S. industrial environments.

As a result, changes have been made to the hardware modules within the PiC product line. The changes have included the addition of filtering, re-routing of foils and/or the addition of ground planes to printed circuit boards, use of some conductive enclosures, provision for shielded wires* for peer-to-peer communication, and internal connection of SPG to field side connectors.

*A recommended shielded wire is:

Belden	**24 AWG (7 X 32)**	**9729**

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Changes Affecting the User

Many of the changes Giddings & Lewis has implemented are transparent to the user. However, there are some changes affecting user installation.

Giddings & Lewis continues to recommend separation of low level signals (encoder, analog, communications, fast DC inputs) from high voltage or high current lines from any of the above. More specifically, maintain *at least* one inch of separation around encoder signals and around communication signals.

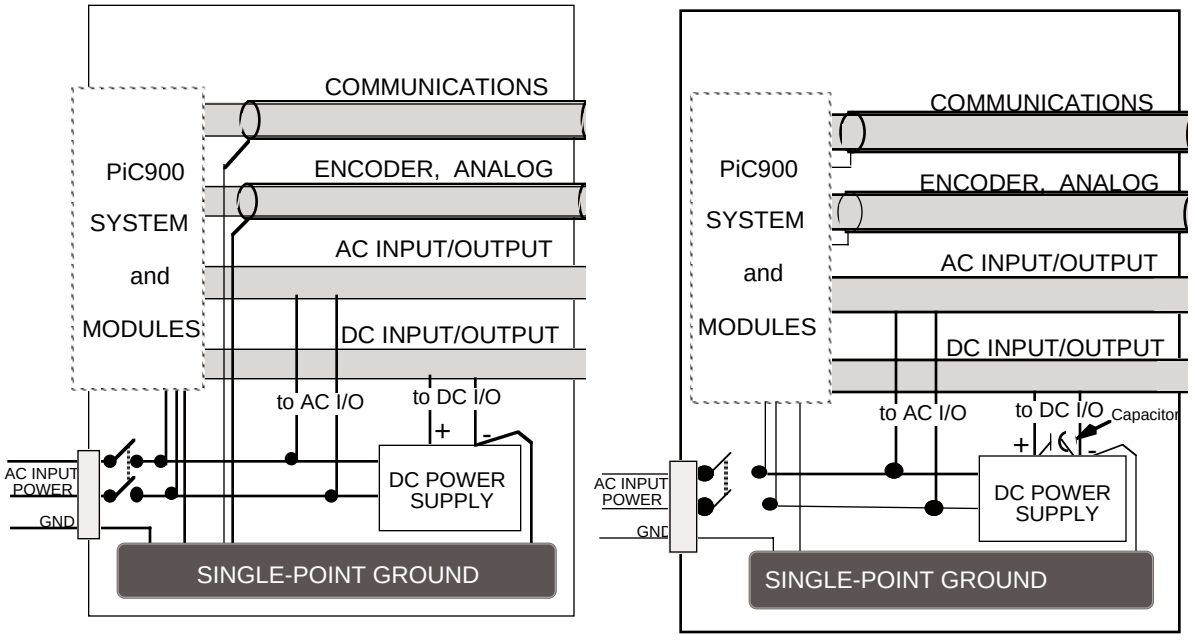
It is no longer necessary to connect a wire from a module to SPG. This user-installed wire had been a source of emissions and thus the connection should not be made. Analog modules typically had this requirement in the past.

To prevent excessive conducted emissions from a DC power source (typically 24V) used for digital I/O, a 1000 picofarad capacitor should be used. Connect the capacitor from the +24V DC to COMMON at the distribution terminals. The same applies to any other external DC power source used with the PiC product.

The figure on the left below illustrates the connection method *before* EMC compliant products were available. The figure on the right illustrates the recommended connections when using EMC compliant products. On the right, note that the SPG connection has been eliminated and that a capacitor is connected to the 24V DC supply.

Figure O1-2.

Connections before EMC Compliant Products Recommended EMC Compliant Connections

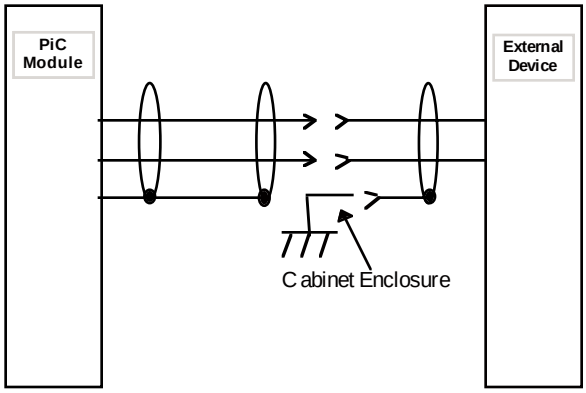


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There is now a provision for shield termination to the CPU modules for peer-to-peer communication. Shielded cable must be used to reduce emissions.

Inside a control cabinet, the practice of connecting the shields of shielded cables at the modules should be continued. For shielded cable entering/leaving the cabinet, see the diagram below.

Figure O1-3. Connecting Shielded Cable



The two different methods of terminating shields are used to accommodate two different immunity requirements. Immunity required inside an enclosure is considered lower because cables are typically less than 3 meters in length and/or can be separated from each other and from noise sources.

Immunity required external to an enclosure is considered higher because the user may have less control over the noise environment. Low level signal cables that can be external to an enclosure and AC/DC digital I/O cables have been tested at a 2 KV level for electrical fast transients (EFTs). Low level signals that can be less than 3 meters in length or can be separated from noise sources are tested at a 1 KV level.

Under the stated conditions, there will be no disturbance of digital I/O, encoder, or stepper operation. For analog signals, there may be momentary disturbances but there will be self-recovery when the noise subsides.

In order to meet the EU directive requirement for emissions and immunity, fiber optics must be used for I/O expansion.

Although the PiCs will pass the electrical fast transient test on incoming power lines, users may still want to use a power line conditioner as detailed in Chapter 1 of the PiC900 Hardware Manual.

As a general precaution, do not operate transmitters, arc welding equipment, or other high noise radiators within one meter of a PiC enclosure that has the door open. Continue to equip inductive devices, if they are in series with a mechanical contact or switch, with arc suppression circuits. These devices include contactors, solenoids and motors. Shield all cables that carry heavy current near the system, using continuous foil wrap or conduit grounded at both ends. Such cables include power leads for high-frequency welders and for pulse-width-modulated motor drives.

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NOTE: Shields for signal wires are grounded at only one end, to provide immunity to outside noise sources. However, the shields for "noise sources" are grounded at both ends, to reduce emissions and "contain" the noise.

Worst case tests with analog I/O modules have caused momentary disturbances no greater than .5V in a +10V to -10V range and .5 mA in a 4 to 20 mA range. Worst case tests with an RTD module have caused momentary disturbances no greater that + or -4°C in a range of -200° to 266°C. Worst case tests with a JK thermocouple module have caused momentary disturbances no greater than + or - 1 mV over a 100 to 1.

NOTE: To assure compliance with the low voltage directive, it is necessary to follow installation instructions in the controller Hardware Manual. Also refer to any instructions specific to individual control modules.

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Using CE/EMC and Non-CE/EMC Modules

IMPORTANT: *Failure to follow these guidelines may result in undesired system performance!*

NOTE: CE indicates compliance to both the EMC and low voltage directives. EMC indicates compliance to the EMC directive.

There are several issues that must be considered when using CE/EMC compliant and Non-CE/EMC compliant Modules. This document addresses these issues.

Module Identification - To determine whether a module is CE/EMC or Non-CE/EMC, look at the gray Unit Tag located on the side of the plastic module case. CE/EMC modules will have "CE" or “EMC” printed near the “MAX. AMBIENT TEMP.” specification. Non-CE/EMC will not have “EMC” or "CE" printed in this location.

Grounding - Due to differences in shielding requirements, it is extremely important to follow proper shielding guidelines for a given module. Failure to do so may result in intermittent operation in noisy environments.

For modules that have an SPG terminal and/or one or more SHIELD terminal, perform the following:

- For CE/EMC modules, do not connect the SPG terminal or SHIELD terminals to the system’s Single Point Ground.
- For Non-CE/EMC modules, connect the SPG terminal, or a SHIELD terminal, to the system’s Single Point Ground

CE/EMC CSM and RSM Modules - Using an CE/EMC CSM, RSM, or CSM/CPU (PiC90) with certain Non-CE/EMC analog modules may cause intermittent operation. Follow these guidelines for determining the type of CSM, RSM, or CSM/CPU that should be used in a particular rack:

- If your rack contains one or more Non-CE/EMC modules that perform D/A conversion or provide an Encoder interface, you must use a non-CE/EMC CSM, RSM, or CSM/CPU (PiC90).
- If your rack does not contain one or more Non-CE/EMC modules that perform D/A conversion or provide an Encoder interface, you may use either a CE/EMC or Non-CE/EMC CSM, RSM, or CSM/CPU (PiC90).

NOTE: All modules and backplanes must be CE/EMC compliant for a system to be CE/EMC compliant.

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EMC Directive and Low Voltage Directive
DECLARATION OF CONFORMITY

Application of Council Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC

Manufacturer's Name: Giddings & Lewis Controls, Measurement, and Sensing
Manufacturer's Address: 660 South Military Road
Fond du Lac, Wisconsin 54936-1658

European Representative Name: Cross Hüller
European Representative Address: Randles Road, Knowsley Industrial Park
Prescot, Merseyside L34 9EZ England

Herewith declares that all **PiC900™/PiC90™/ PiC9™ and Block I/O modules** listed below,

502-03512-03,07	502-03674-02,22	502-03839-04	502-04030-00	503-25164-02
502-03518-03,23	502-03674-42	502-03840-04,24	502-04050-00	503-25187-01,11
502-03548-00	502-03676-03,23	502-03840-44	502-04073-20	503-25188-01,11
502-03549-02	502-03677-02,22	502-03842-02	502-04077-00,20	503-25189-01,11
502-03550-02,06	502-03677-42	502-03843-02	502-04077-40	503-25768-01,11
502-03551-03,08	502-03679-02	502-03846-X3	502-04104-01,11	503-25906-01
502-03552-02,22	502-03681-02,07	502-03853-X3	502-04110-00,10	503-25907-01
502-03605-00,05	502-03692-03	502-03876-02	502-04111-01,11	503-25908-01
502-03640-02,07	502-03698-22	502-03882-XX	502-04112-01,11	503-25909-01
502-03641-03,08	502-03722-02	502-03907-03	502-04125-01,11	503-25910-01
502-03642-03,08	502-03732-03,07	502-03944-XX	502-04126-00,10	503-25986-01
502-03643-00	502-03782-02,22	502-03947-00	503-13704-00	503-25987-01
502-03644-03	502-03786-02,22	502-03956-02	503-18009-03,08	503-25988-01
502-03651-00	502-03809-02	502-03963-X1	503-18010-03,08	X = 0 → 9
502-03657-03,07	502-03810-03	502-03973-00	503-18011-03,08	
502-03658-02	502-03813-03,07	502-03994-X1	503-19184-02	
502-03673-00	502-03817-03,07	502-04011-X1	503-19185-02	

when installed in accordance with the instructions contained in the "PiC900 Hardware Manual" (P/N 401-54514-00), conform to the following generic and basic standards.

EN 50081-2:1993	EMC Generic Industrial Emissions
EN 50082-2:1995	EMC Generic Industrial Immunity
EN 61131-2:1994/A11:1996	Low voltage requirements for programmable controllers

Future modules (with higher P/N's) labeled with the CE mark will also conform to these standards.

We, the undersigned, hereby declare that the equipment specified above conforms to the above directive(s).

Legal Representative in Europe

Signature	
Full Name	Roger M. Collins
Position	Managing Director
Place	Cross Hüller
Date	OCT 18 99

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EMC Directive and Low Voltage Directive
DECLARATION OF CONFORMITY

Application of Council Directives 73/23/EEC, 89/336/EEC, 92/31/EEC, 93/68/EEC

Manufacturer's Name: Giddings & Lewis Controls, Measurement, and Sensing
Manufacturer's Address: 660 South Military Road
Fond du Lac, Wisconsin 54936-1658

European Representative Name: Cross Hüller
European Representative Address: Randles Road, Knowsley Industrial Park
Prescot, Merseyside L34 9EZ England

Herewith declares that all **MMC (Machine and Motion Control)** units listed below,

503-26606-XX, 503-26683-XX, 503-26684-XX, 503-26842-XX → 503-26856-XX
(X = 0 → 9)

and approved cables and accessories, when installed in accordance with the instructions contained in the "MMC Hardware Manual" (P/N 108-31050-00), conform to the following generic and basic standards.

EN 50081-2:1993	EMC Generic Industrial Emissions
EN 50082-2:1995	EMC Generic Industrial Immunity
EN 61131-2:1994/A11:1996	Low voltage requirements for programmable controllers

MMC units bear the CE mark to indicate conformance to these standards.

We, the undersigned, hereby declare that the equipment specified above conforms to the above directive(s).

Legal Representative in Europe

Signature	
Full Name	Roger M. Collins
Position	Managing Director
Place	Cross Hüller
Date	OCT 18 99

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EMC Directive and Low Voltage Directive
DECLARATION OF CONFORMITY

Application of Council Directive(s) 73/23/EEC,89/336/EEC, 92/31/EEC, 93/68/EEC

Manufacturer's Name: Giddings & Lewis Controls, Measurement, and Sensing
Manufacturer's Address: 660 South Military Road
Fond du Lac, Wisconsin 54936-1658

European Representative Name: Cross Hüller
European Representative Address: Randles Road, Knowsley Industrial Park
Prescot, Merseyside L34 9EZ England

Herewith declares that all **servo drives** listed below,

Model Name	Part Number	Model Name	Part Number	Model Name	Part Number
DSM110	401-34400-00	DSM030	401-56453-00	DSM015P	401-56452-50
DSM120	401-34401-00	DSM110P	401-34400-50	DSM030P	401-56453-50
DSM130	401-34402-00	DSM120P	401-34401-50	DSM110 SERCOS	401-30277-00
DSM175	401-34403-00	DSM130P	401-34402-50	DSM120 SERCOS	401-30278-00
DSM1150	401-34404-00	DSM175P	401-34403-50	DSM130 SERCOS	401-30279-00
DSM007	401-56451-00	DSM1150P	401-34404-50	DSM175 SERCOS	401-30280-00
DSM015	401-56452-00	DSM007P	401-56451-50	DSM1150 SERCOS	401-30281-00

when operating any of the following **motor families**,

SSM, HSM, NSM, YSM and FSM

when operating with or without the **optional Touch Pad**,

P/N 401-34405-00

and when installed in accordance with the installation instructions contained in the "Centurion DSM100 Drive Hardware and Installation Manual" (P/N 108-30083-00), or "MicroDSM Installation Manual" (P/N 108-31017-00), conform to the following generic and basic standards.

EN 55011:1993	(CISPR 1) Group 1 class A
EN 50082-2:1995	EN 61000-4-2, ENV 50140, ENV 50204, EN 61000-4-4, ENV 50141, EN 61000-4-8
EN 60204:1993	

We, the undersigned, hereby declare that the equipment specified above conforms to the above directive(s).

Legal Representative in Europe

Signature	
Full Name	Roger M. Collins
Position	Managing Director
Place	Cross Hüller
Date	OCT 18 99

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Cutler-Hammer

EATON

Declaration of Conformity

Cutler-Hammer Automation
173 Heatherdown Drive
P. O. Box 6166
Westerville, Ohio 43086-6166
Phone (614) 882-3282

We as the manufacturer, declare under our sole responsibility that the products listed below bearing the "CE" Mark to which this Declaration relates are in conformity with the provisions of the directives and standards referenced:

Giddings & Lewis Operator Interface Products

Models:

Trueview 2180 Series
Trueview 3100 Series
Trueview 3300 Series
Trueview 3400 Series

Directives and Standards			
73/23/EEC Low-Voltage Directive	89/336/EEC EMC (Electromagnetic Compatibility) Directive		
	EN 50081-2 Generic Emissions		EN 50082-2 Generic Immunity
EN 61131-2, 1995	EN 61000-4-2, 1995 EN 61000-4-3, 1996 EN 61000-4-4, 1995	EN 61000-4-5, 1995 EN 61000-4-6, 1996 EN 61000-4-8, 1993	EN 61000-4-11, 1994 EN 61131-2, 1995 EN 55022 "A", 1994

This Declaration is issued from the location shown above and is authorized by:

Mira R. Gearhart

Mira R. Gearhart – Manager, Product Development and Project Management

7-14-99

Date

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