

Horner Electric's Distributed I/O for GE Fanuc's Series 90™-30 PLC

Seriplex™ I/O System User's Manual



Horner Electric Advanced Products Group

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TABLE OF CONTENTS

| | |
|---------------------------------------|----|
| PREFACE | vi |
| ABOUT THE PROGRAMMING EXAMPLES | vi |
| COPYRIGHT NOTICE | vi |
| TRADEMARK ACKNOWLEDGMENTS | vi |

CHAPTER 1: INTRODUCTION

| | | |
|-----|-----------------------------------------|----------|
| 1.1 | Introduction to Distributed I/O Systems | Page 1-1 |
| 1.2 | Introduction to [IQ] ² | Page 1-2 |
| 1.3 | Module Features | Page 1-4 |
| 1.4 | I/O Block Features | Page 1-4 |
| 1.5 | Standard I/O Blocks Available | Page 1-5 |

CHAPTER 2: INSTALLATION

| | | |
|-----|----------------------------------------------------|-----------|
| 2.1 | Module Placement | Page 2-1 |
| 2.2 | Module Wiring | Page 2-1 |
| 2.3 | LED Indicators | Page 2-2 |
| 2.4 | Power Supply | Page 2-2 |
| 2.5 | Network Wiring | Page 2-4 |
| 2.6 | I/O Block Field Wiring | Page 2-5 |
| 2.7 | Transient Protection | Page 2-5 |
| | 2.7.1 AC Applications | Page 2-5 |
| | 2.7.2 DC Applications | Page 2-6 |
| 2.8 | Mounting I/O Blocks | Page 2-6 |
| 2.9 | Configuring the Series 90-30 | Page 2-7 |
| | 2.9.1 Configuration Using the Hand-Held Programmer | Page 2-7 |
| | 2.9.2 Configuration with Logicmaster 90 | Page 2-10 |

CHAPTER 3: PROGRAMMING I/O BLOCKS

| | | |
|-----|-----------------------------------------------------------|----------|
| 3.1 | Programmable Attributes | Page 3-1 |
| | 3.1.1 Address Numbers | Page 3-1 |
| | 3.1.2 Input Status | Page 3-1 |
| | 3.1.3 Output Status | Page 3-1 |
| | 3.1.4 Channel C Output Status | Page 3-2 |
| | 3.1.5 Block Mode | Page 3-2 |
| | 3.1.6 The Control Byte | Page 3-2 |
| 3.2 | Programming I/O Blocks Using the APC Hand-Held Programmer | Page 3-3 |
| 3.3 | Expanded Edit | Page 3-4 |
| 3.4 | Reading an I/O Block | Page 3-5 |
| 3.5 | Verifying a Block | Page 3-5 |
| 3.6 | Programming Special I/O Blocks | Page 3-6 |
| 3.7 | Programming Errors | Page 3-7 |

PREFACE

This manual explains the use of the Horner Electric [IQ]² Seriplex Modules and how they interface with GE Fanuc Series 90-30 PLCs. This manual describes the programming of the I/O which are available when used with the 90-30 interface module.

ABOUT THE PROGRAMMING EXAMPLES

The example programs and program segments in this manual are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, Horner Electric cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the [IQ]² Modules to appropriately design the end system, to appropriately integrate the [IQ]² Modules and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

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Seriplex is a trademark of APC
[IQ]² is a trademark of Horner Electric

| |
|------------------------------|
| MODULE SPECIFICATIONS |
|------------------------------|

I/O Connector Specifications

| PARAMETER | MIN | MAX | UNITS |
|----------------------------|------------|------------|--------------|
| +12V Power Input | - | 15 | mA |
| | 11.5 | 12.5 | VDC |
| Clock Frequency Output | 16 | 100 | KHz |
| Data Frame Size | 16 | 128 | bits |
| Total Remote I/O Scan Time | 0.4 | 8.5 | mS |

Power Load Specifications

| PARAMETER | MIN | MAX | UNITS |
|-------------------|------------|------------|--------------|
| +5VDC (Logic) | - | 200 | mA |
| +24VDC (Relay) | - | 0 | mA |
| +24VDC (Isolated) | - | 0 | mA |

Environmental Specifications

| PARAMETER | MIN | MAX | UNITS |
|---------------------------|------------|------------|--------------|
| Operating Temperature | 0 | +60 | °C |
| Storage Temperature | -40 | +85 | °C |
| Humidity (non-condensing) | 5 | 95 | %RH |

CHAPTER 1: INTRODUCTION

1.1 Introduction to Distributed I/O Systems

In the traditional approach to Programmable Logic Controller (PLC) installation, the PLC and its associated I/O cards are centrally located in a control panel. Wiring to external devices such as pushbuttons, limit switches, solenoids, etc. is run through conduit from the central control panel to the point of control. In many applications this is a very satisfactory approach, because all of the input and output devices are located in fairly close proximity to the central control panel.

In other applications, however, the field devices are scattered over a fairly large distance, not at all in close proximity to the central control cabinet. In these cases, the costs of running a great many wires through conduit over the necessary distance causes the costs of installation to be excessive. These applications are much more logically and economically installed utilizing what is known as "Distributed I/O".

Distributed I/O is a term which refers to a hardware setup in which PLC I/O modules are not centrally located in a control panel, but instead are individually installed at or near the point of control. The modules are typically interconnected to the PLC via a communications link, with a single multi-conductor shielded cable. Because I/O wiring is run only a few feet from field devices to individual I/O modules, and the modules are interconnected with a single cable, wiring costs are low.

The GE Fanuc Series 90-30 to date has not had the capability to be utilized as the only PLC in a truly "Distributed I/O" application. Horner Electric's goal was to introduce a simple and dependable Distributed I/O system which would allow the Series 90-30 to be used in these applications.

After evaluating Distributed I/O systems which could be adapted for use with the GE Fanuc Series 90-30, Horner Electric selected the Seriplex™ I/O System developed by APC. The Seriplex I/O system has won a number of awards for design excellence, and met all the criteria for a simple, dependable, fast Distributed I/O network. The integration of the Seriplex I/O architecture with the GE Fanuc Series 90-30 PLC has resulted in Horner Electric's $[\text{IQ}]^2$ Distributed I/O System (pronounced *eye-cue squared*).

1.2 Introduction to $[\text{IQ}]^2$

The Horner Electric $[\text{IQ}]^2$ Distributed I/O System consists of two main components. First, is an $[\text{IQ}]^2$ Interface Module which resides in a single Series 90-30 I/O slot, and interfaces to a network of $[\text{IQ}]^2$ I/O blocks. These $[\text{IQ}]^2$ I/O blocks utilize the Seriplex Distributed I/O System, and are manufactured by APC and brand labelled $[\text{IQ}]^2$ by Horner Electric. The I/O blocks consist typically of 2 digital inputs ("I") and 2 digital outputs ("Q"), hence the $[\text{IQ}]^2$. There are two standard $[\text{IQ}]^2$ Interface Modules available. The HE693APG128 allows up to 63 inputs and 63 outputs from a number of I/O blocks to be addressed to a single PLC slot. The HE693APG256 allows 127 inputs and 127 outputs to be addressed to a single PLC slot.

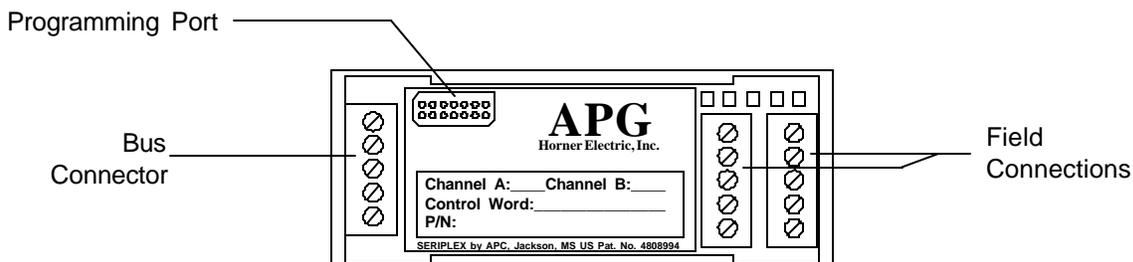


Figure 1-1 Standard $[\text{IQ}]^2$ I/O block.

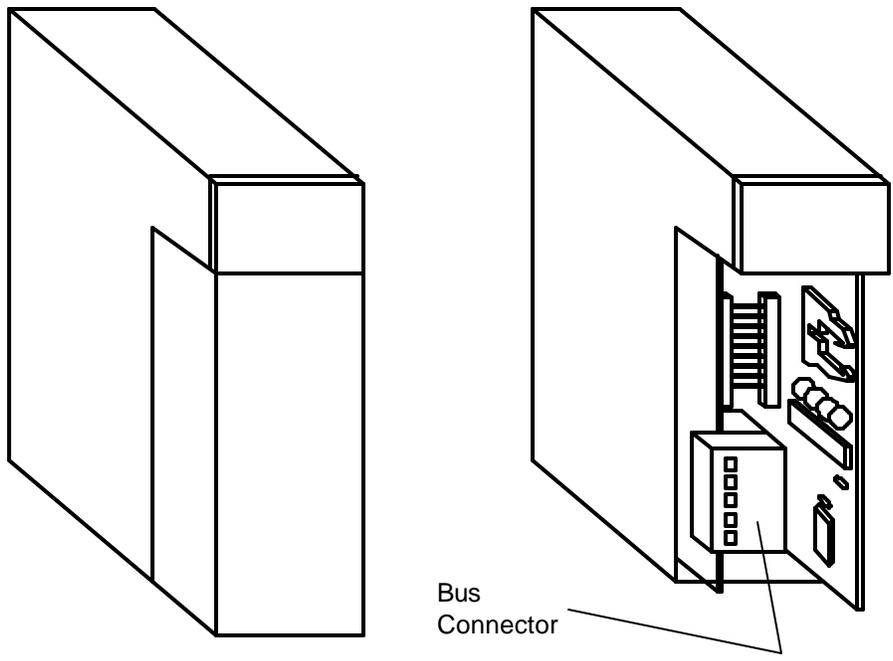


Figure 1-2 [IQ]² Interface Module with Front-cover with Front-Cover removed.

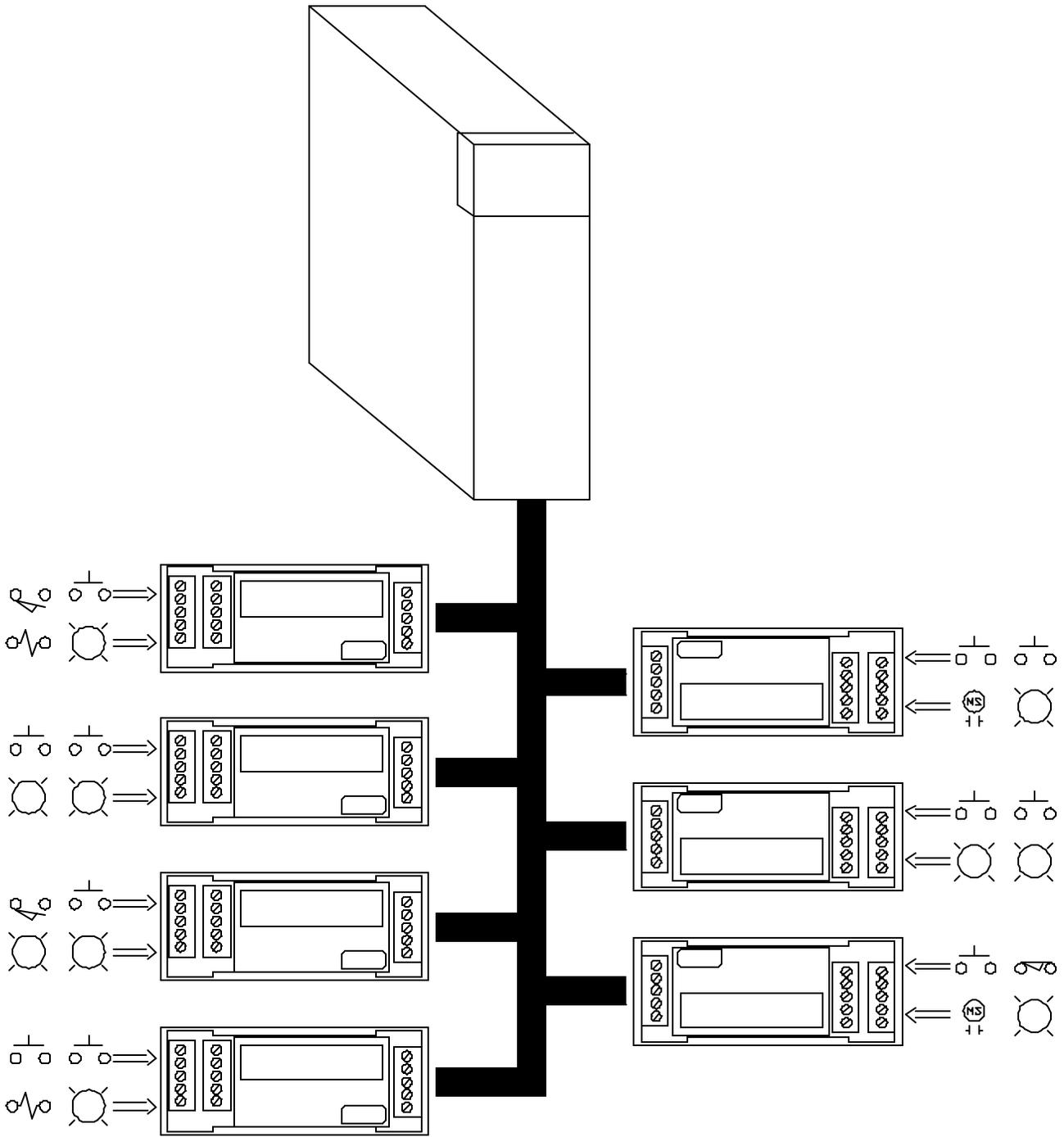


Figure 1-2 Typical [IQ]² Installation.

1.3 Module Features

The Distributed I/O System Network Module offers a variety of features, including:

- o Maps I/O Blocks directly into Series 90-30 I/O
- o Configurable Network Clock Rate up to 100KHz
- o Configurable Network Frame Size up to 128 I/O
- o Detects I/O Network Faults

The Interface Module is an intelligent, distributed I/O module for the GE Fanuc Series 90-30 Programmable Logic Controller (PLC). The ladder logic program can treat the Interface Module like it was a very high density (64 inputs/64 outputs or 128 inputs/128 outputs) digital I/O module.

Distributed I/O blocks connect to the Interface Module via a four-wire bus connection. Total network distance may be up to 3300 feet.

1.4 I/O Block Features

The I/O System offers the following features:

- o Rugged Controls rated from -20°C to 85°C
- o Reliable surface-mount technology
- o Optical Isolation of greater than 2500V RMS
- o System runs on 12VDC and is highly noise immune
- o Epoxy potted modules withstand harsh environments
- o Universal DC inputs for both NPN and PNP type sensors
- o High speed bus replaces hundreds of conductors with only four wires

1.5 Standard I/O Blocks Available

A variety of [IQ]² blocks are available from Horner Electric. A listing follows below:

| Part Number | Input# | Vo | Curren | Output | Volt | RMS Amps | Max Amps | Leakage |
|-------------|------------------|----|--------|-------------------|--------------|-------------|-------------|---------|
| APG-2A2A4A | 2 | A | 7mA | 2 | 90-140 AC | 4 A | 20 A | <3mA |
| APG-02A4A | <i>No inputs</i> | | | 2 | 90-140 AC | 4 A | 20 A | <3mA |
| APG-2A0 | 2 | A | 7mA | <i>No outputs</i> | | | | |
| APG-2D2D15A | 2 | DC | 23mA | 2 | 12-28Vd | 15A | 30 A | <1mA |
| APG-2DS2D2 | 2 | DC | 2mAs | 2 | 2-36Vdc | 2 A | 5 A | <1uA |
| APG-2D3D20 | 2 | DC | 23mA | 3 | 2-36Vdc | 20mA | 60mA | <1uA |
| APG-2D0 | 2 | DC | 23mA | <i>No outputs</i> | | | | |
| APG-2DS0** | 2 | DC | 2mAs | <i>No outputs</i> | | | | |
| APG-02D2A | <i>No inputs</i> | | | 2 | 2-36Vdc | 2 A | 5 A | <1uA |
| APG-8D0 | 2 | DC | 23mA | <i>No outputs</i> | | | | |
| APG-08D20m | <i>No inputs</i> | | | 8 | 2-36Vdc | 20mA | 160mA | <1mA |

CHAPTER 2: INSTALLATION

2.1 Module Placement

The Interface Module may be placed in any I/O module slot of the GE Fanuc Series 90-30 model 311, 321, or 331. The user should **never** insert or remove the Interface Module while power is applied to the host PLC. Follow the guidelines defined in the Series 90-30 literature for proper module insertion and removal.

2.2 Module Wiring

The Interface Module is equipped with a 5-pin removable screw terminal block assembly. This screw terminal is accessible by removing the plastic front cover on the module case. This plastic front cover is easily removed by releasing two tabs on either side of the module case. These tabs can be released with a small flat-bladed screwdriver, or by squeezing the front cover gently on both of its sides.

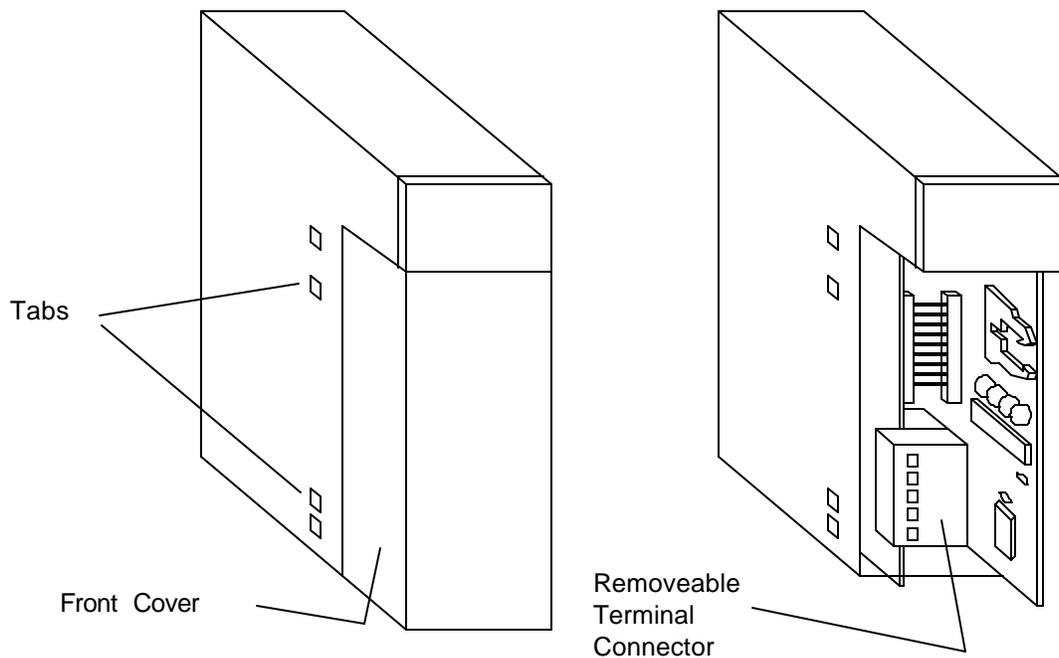


Figure 2-1 [IQ]² Interface Module with and without Front-Cover.

The terminal block provides the connection between the I/O bus and the Interface Module. The pinout is shown in **Figure 2-2**.

| PIN | SIGNAL | DESCRIPTION |
|-----|--------|-----------------------|
| 1 | NC | Not connected |
| 2 | COM | Network Signal Common |
| 3 | +12VDC | Network Power |
| 4 | CLOCK | Network Clock |
| 5 | DATA | Network Data |

Figure 2-2. Network Interface Module Pinout.

The connection diagram for an entire system is shown in **Figure 2-4**. Note that pin 1 of I/O block terminal strips is for SHIELD connection (both in and out). The Network Interface Module terminal strip does not facilitate SHIELD connection. The SHIELD connection at that end must be connected directly to the ground terminal of the Series 90-30 power supply.

2.3 LED Indicators

The Network Module has a single LED which, when illuminated, indicates that the module is scanning I/O successfully. If the PLC is in RUN mode, and the network module LED is not illuminated, a network fault is present.

| INDICATOR | COLOR | DESCRIPTION |
|-----------|-------|-----------------------------|
| RUN | Green | I/O Scanning and Network OK |

Figure 2-3. Network Module LED Indicators

2.4 Power Supply

An isolated 12 Vdc power source is required for the network. The current capacity must be equal to 1.2 times the total load current on the [IQ]² Network. Careful attention should be also be paid to excessive voltage drop especially on systems with long wire runs (e.g. over 2000 feet). Power can be fed at multiple points within the installation to remedy this problem. The line regulation should be +/- .05% for a 10% AC line change. For a 50% load change, the voltage output should change no more than +/- .05%. The output ripple should be 5.0mV PK-PK maximum.

Standard I/O Block Network Wiring (Using Standard Network Cable)

| TERMINAL NUMBER | SIGNAL NAME | WIRE TYPE | WIRE COLOR |
|-----------------|-------------|-----------|------------|
| 1 | SHIELD* | - | - |
| 2 | COM | 16 AWG | BLACK |
| 3 | +12VDC | 16 AWG | RED |
| 4 | CLOCK | 22 AWG | GREEN |
| 5 | DATA | 22 AWG | WHITE |

*Note: Network Module has NC on Terminal 1

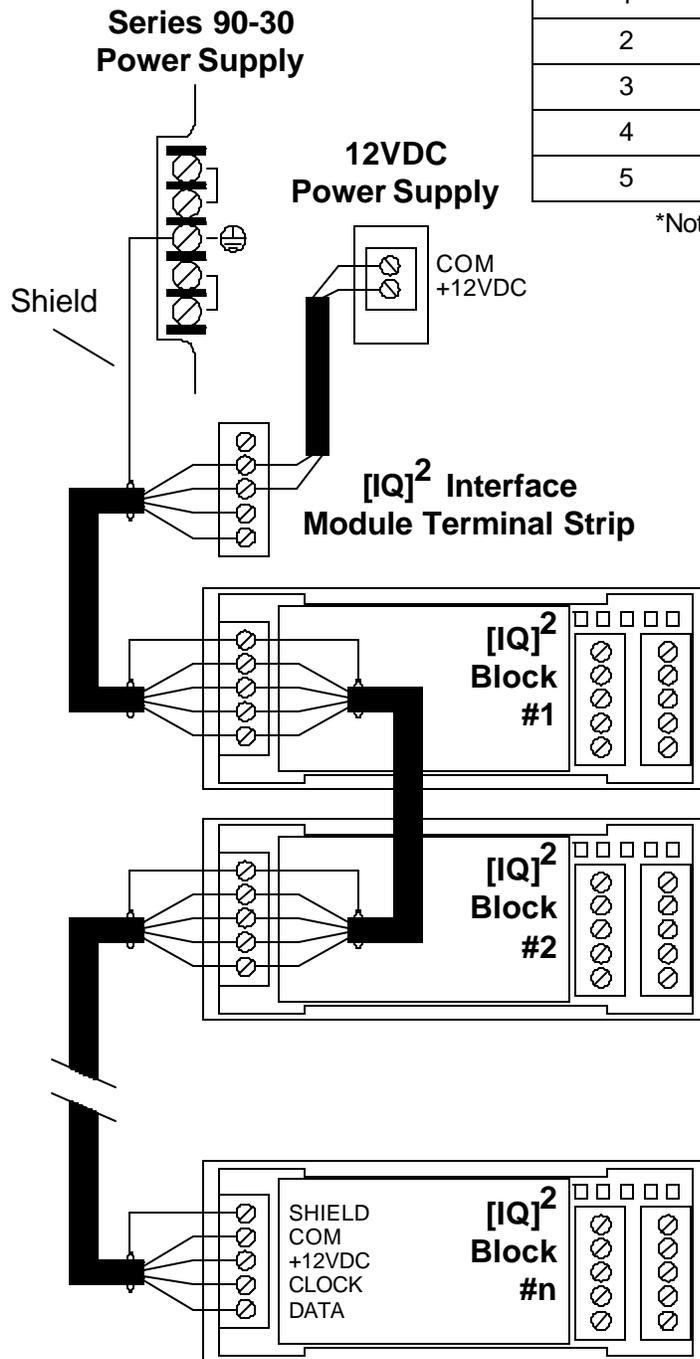


Figure 2-3. Typical [IQ]² Network Wiring Diagram.

2.5 Network Wiring

As with any circuit, the operation of a [IQ]² installation will be affected by the size of the installation (module count, distance between modules), the gauge and capacitance of the wire used, and the ambient operating temperature.

[IQ]² modules are tolerant to changes in DC supply voltage (± 3 V), and the power consumption per module is small (typically less than 12 milliamps); therefore, large systems can be supported with relatively small amounts of current.

Horner Electric recommends the use of one pair of 16 AWG wire (for power conductors) and one pair of 22 AWG low capacitance wire (for data and clock signals) with a passive overall shield. As in all communications wiring, it is recommended that [IQ]² cable not be run with other power cables. Also, Horner Electric recommends not using twisted pair for the clock and data lines.

| | Capacitance in Picofarads/Foot | | | | | |
|------------------------|--------------------------------|------|-------------|------|------|------|
| | 5 | 10 | 15 | 20 | 25 | 30 |
| Clock Frequency in KHz | Distance in Feet | | | | | |
| 100 | 2499 | 1249 | 833 | 624 | 499 | 416 |
| 75 | 3333 | 1666 | 1111 | 833 | 666 | 555 |
| 64 | 3906 | 1953 | 1302 | 976 | 781 | 651 |
| 50 | 4999 | 2499 | 1666 | 1249 | 999 | 833 |
| 32 | 7812 | 3906 | 2604 | 1953 | 1562 | 1302 |
| 25 | 9999 | 4999 | 3333 | 2499 | 1999 | 1666 |
| 16 | 15624 | 7812 | 5208 | 3906 | 3124 | 2604 |

Note: Shaded area indicates specifications on standard cable sold by Horner Electric

Figure 2-5. [IQ]² Network Distance, Clock Speed vs. Cable Capacitance.

The [IQ]² Network can be configured in any shape required: ring, loop-back, bus, or star. The ring or loop-back configurations provide redundancy and an added measure of protection for system operation. With this configuration, the bus wire may be broken at any single point with no loss of system operation (as long as there is no sustained shorting of the signals). Terminating resistors are not needed in the [IQ]² Network.

The distance of a [IQ]² Network is determined by the capacitance of the bus signal (clock and data) wires and the system clock speed.

2.6 I/O Block Field Wiring

Most inputs and outputs on [IQ]² I/O modules are electrically and optically isolated (exception: APG-2DS2D2A, APG-2DS0). Consequently, the modules can switch either side of the power to the input or load. That is, DC modules can switch positive or ground to the input or load; AC modules can switch the hot or the neutral to the input or load. If DC inputs and/or outputs are utilized, Horner Electric recommends using an isolated power supply other than the power supply used for the network since optical isolation is lost when power supplies are combined.

2.7 Transient Protection

All inductive loads in AC or DC circuits generate a reverse voltage proportional to the forward current and the inductance of the inductive load. This reverse voltage can often exceed the tolerance level of [IQ]² I/O modules. As with any solid state device, certain steps must be taken to reduce this reverse voltage to a manageable level.

2.7.1 AC Applications

Horner Electric suggests using MOV (metal-oxide varistors) to protect Seriplex I/O modules from AC transients at both input and output terminals. When the protected device encounters high voltage spikes, the varistor (MOV) impedance changes from a high standby value to a low conducting value, thus clamping the transient voltage to a protective level. The failure mode of the MOV is short circuit (they will sacrifice themselves to protect the circuit). NOTE: Once installed, the MOV's should be checked periodically in case they have short circuited and need replacing.

The MOV must always be placed as close as possible to the inductive load. If at all possible, it should be placed across the terminals of the load. If long runs are made between the load and the Seriplex module or if multiple circuits are run through a wire way, MOV's should be placed across the terminals of the Seriplex modules for added protection per figure 3-2.

Circuits involving control transformers should include MOV's across the secondary control voltage line below the fuse per figure 3-1. These fuses are usually located right on the control transformer or very close to it. If one is not present is should be added.

Proper sizing of MOV's is important. Horner Electric recommends the following MOV's for 4 amp, 120 Vac circuits: GE V180LAZ0, Panasonic ERZ-C20DK201, Siemens S20K130, Stetron 0183NR20-4, Marcon TNR15G181K. However, the designer of the circuit should be aware of the potential for transients and should calculate this potential to be certain the correct MOV is selected.

2.7.2 DC Applications

Place a high speed diode across the inductive load to clamp the reverse voltage to the source and maintain the reverse voltage to a saturated diode drop (.7 to 1.2 volts). It is important to place the diode clamp as close as possible to the inductive load to reduce the noise radiation and insure the cleanest possible circuit.

It is a good rule of thumb to size the diode greater than one fifth and less than or equal to the current of the inductive load. It is important that a high speed diode be used. Many of the general purpose diodes do not have the necessary turn-on speed to protect inductive loads. The voltage of the diode should be 2 times that of the power source. (Example: a solenoid with 3 amps of current at 24 Vdc could have a diode with a current rating of 1 amp continuous and a voltage break down of 50 V). The circuit designer must assure that the polarity of the diode is correct when installed and that the diode is properly sized for the system. Special consideration should be given to the potential for ground fault conditions and oscillating inductive loads.

2.8 Mounting I/O Blocks

[IQ]² I/O blocks are ruggedly built for mounting at the point of use. Each block has two mounting options: DIN rail and panel. The panel option uses side brackets which allow the blocks to be "flush" mounted and screwed into a panel. To designate panel mounting, add a "-P" suffix to the part number when ordering a block. The default mounting option is DIN rail.

It is recommended that [IQ]² I/O blocks be mounted inside industrial enclosures to prevent potential oxidation of the terminals. The wiring of the blocks within a metal enclosure will usually not require shielded wires.

2.9 Configuring the Series 90-30

Before any I/O module can be accessed by the Series 90-30, the "makeup" of I/O modules must be defined inside the Series 90-30 CPU. This process is called "configuration". [IQ]² Positioning Module configuration is supported by Logicmaster 90, version 2.01 or later . Alternatively, the user may configure the Series 90-30 using the Hand-Held Programmer.

2.9.1 Configuration Using the Hand-Held Programmer

1. Install the [IQ]² Network Module. Apply power to the Series 90-30 rack. The Series 90-30 will perform it's power-up diagnostics and a menu will appear on the Hand-Held Programmer's display.
2. Enter the key sequence detailed on the following pages with the GE Fanuc 90-30 Hand-Held Programmer:

| Display | Key | Comments |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div style="border: 1px solid black; padding: 2px;">1. PROGRAM <S</div> play will | MODE | Press the "MODE" button, the display will not change. |
| <div style="border: 1px solid black; padding: 2px;">2. DATA</div> | | |
| <div style="border: 1px solid black; padding: 2px;">1. PROGRAM <S</div> <div style="border: 1px solid black; padding: 2px;">2. DATA</div> | 4 | Press the "4" button, a "4" will appear as the first character in the display. |
| <div style="border: 1px solid black; padding: 2px;">4 1. PROGRAM <S</div> <div style="border: 1px solid black; padding: 2px;">2. DATA</div> | ENT | Press the "ENT" button, the display will now show the Series 90-30 CPU status. |
| <div style="border: 1px solid black; padding: 2px;">R0:00 PLC <S</div> <div style="border: 1px solid black; padding: 2px;">KEY CLK: OFF</div> This | DOWN | Press the "down arrow" button until the slot number containing the Network Module appears following the "R0:". example assumes that the module resides in slot 1, therefore the down arrow button is only pressed once. |
| <div style="border: 1px solid black; padding: 2px;">R0:01 EMPTY <S</div> | READ/VERFY | Press the "READ/VERFY" button. |
| <div style="border: 1px solid black; padding: 2px;">R0:01 READ <S</div> | ENT | Press the "ENT" button, this will cause the Series 90-30 to "read" the Network Module. The model number of the module will be displayed (APG128 or APG256). |
| <div style="border: 1px solid black; padding: 2px;">R0:01 APG128 <S</div> | 1 | At this point, the Network Module has informed the Series 90-30 that it possesses 64 (APG128) or 128* (APG256) digital inputs (%I) that must be "mapped" into the Series 90-30 register space. Pressing the "1" button will cause the Series 90-30 to place the %I registers starting at %I001. |
| <div style="border: 1px solid black; padding: 2px;">R0:01 APG128 <S</div> <div style="border: 1px solid black; padding: 2px;">I64:I 001-064</div> | ENT | Press the "ENT" button. The %I registers are now configured. |

***Note:** When configuring an APG256, the Hand-Held Programmer appears to be indicating "28" for the number of %I and %Q points, instead of 128. This is simply a limitation of the display capabilities of the Hand-Held Programmer. The actual number of %I and %Q points is 128.

| Display | Key | Comments |
|---------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R0:01 APG128 <S Q64: Q | 1 | At this point, the Network Module has informed the Series 90-30 that it possesses 64 (APG128) or 128* (APG256) digital outputs (%Q) that must be "mapped" into the Series 90-30 register space. Pressing the "1" button will cause the Series 90-30 to place the %Q registers starting at %Q001. |
| R0:01 APG128 <S Q64:Q1 | ENT | Press the "ENT" button. The %Q registers are now configured. |
| SCAN R0:01 APG128 <S Q64:Q001-Q064 | RIGHT | Press the "right arrow" button. The RATE message will appear on the display. |
| R0:01 APG128 <S SCAN RATE:100MHZ | -/+ ENT RIGHT | Pressing the "-/+" key will cause the SCAN RATE value to cycle between the legal scan rate values (16, 25, 32, 50, 64, 75, 100). The "ENT" key must be pressed when the desired value is displayed to the |
| R0:01 APG128 <S SCAN SIZE: 64 IO | -/+ ENT | Pressing the "-/+" key will cause the SCAN SIZE value to cycle between the legal scan size values (16, 32, 48, 64, 80, 96, 112, 128). The "ENT" key must be pressed when the desired value is displayed to set the scan size. |

Note: When configuring an APG256, the Hand-Held Programmer appears to display "28" for the scan size and %Q points, instead of 128. This is simply a limitation of the display capabilities of the Hand-Held Programmer. The actual number of %I and %Q points is 128.

2.9.2 Configuration with Logicmaster 90

The Following are step-by-step instructions for the configuration of the Network Module using GE Fanuc Logicmaster 90-30:

1. Enter the Logicmaster 90 Configuration Package from the Main Menu (<F2>).
2. Select the proper folder.
3. Choose I/O Configuration from the Configuration Menu (<F1>).
4. Cursor over to the slot containing the Network Module.
5. Select Other (<F8>), and Foreign (<F3>).
6. A list of parameters will be displayed. Cursor down to %I Reference Address and enter the starting %I register for the Network Module.
7. Cursor down to the %I Size, and enter 64 (APG128) or 128 (APG256).
8. Cursor down to %Q Reference Address and enter the starting %Q register for the Network Module.
9. Cursor down to the %Q Size, and enter 64 (APG128) or 128 (APG256).
10. Cursor over to Byte 1, and enter a binary 1 (00000001). This parameter is set to one for all "smart modules" (like the Network Module) which have configurable parameters.
11. Cursor down to Byte 2, and enter the value for the Scan Rate (see chart).

| BYTE 2 VALUE | SCAN RATE |
|--------------|-----------|
| 00000000 | 16 MHz |
| 00000001 | 25 MHz |
| 00000010 | 32 MHz |
| 00000011 | 50 MHz |
| 00000100 | 64 MHz |
| 00000101 | 75 MHz |
| 00000110 | 100 MHz |

| BYTE 3 VALUE | SCAN SIZE |
|---------------------|-------------------|
| 00 | 16 |
| 01 | 32 |
| 02 | 48 |
| 03 | 64 |
| 04 | 80 (APG256 only) |
| 05 | 96 (APG256 only) |
| 06 | 112 (APG256 only) |
| 07 | 128 (APG256 only) |

CHAPTER 3: PROGRAMMING I/O BLOCKS

This section of the manual covers programming of the I/O blocks. Each block must be programmed with address and control information. This information is entered into an EEPROM in the individual blocks via a programming device. This information enables blocks to communicate and execute relay logic functions as directed by the [IQ]² Network Module. Using this approach, the logic necessary to control the process or machine is written in software on the 90-30 CPU . First, the blocks must be programmed for the system to operate.

3.1 Programmable Attributes

Each block has several attributes which must be programmed by the user. The attributes include addresses and logic information. The addresses are decimal values, and the logic information is programmed as a single 8 bit control byte (see The Control Byte on page 2-3). This programming is usually done at initial system set-up. The information is stored in the block's EEPROM . This EEPROM maintains the programmed information despite power failures, and needs to be re-programmed only if the user desires to change the address of the block.

The programmable attributes are listed in the following sub-sections.

3.1.1 Address Numbers

Each channel on a block (a typical discrete block has two channels) must be assigned an address. The addresses do not have to be used in any particular order, but must be decimal values in the range of 016 to 143 (for HE693APG128) or 016 to 271 (for HE693APG256). The address assigned to each channel will be used to identify both its inputs and its outputs.

3.1.2 Input Status

Bits 7 and 6 of the block's control byte are used to tell the block which voltage level to use as the input "ON" condition. A "0" indicates that the input will be "ON" when voltage is applied, and a "1" indicates that the input will be "OFF" when voltage is applied.

3.1.3 Output Status

Bits 5 and 4 of the block's control byte are used to configure the outputs as normally open or normally closed. A "0" bit indicates a normally open output (the output supplies voltage when logic conditions are satisfied), and a "1" indicates a normally closed output (the output supplies voltage unless logic conditions are satisfied).

3.1.4 Channel C Output Status

Most discrete I/O blocks have a special output which is a logical function of the states of the channel A and channel B outputs. This is the channel C output. Bit 3 in the block's control byte identifies this output as normally open (bit 3="0") or normally closed (bit 3="1").

NOTE :On discrete blocks with two outputs, channel C output must be selected by a jumper on the block

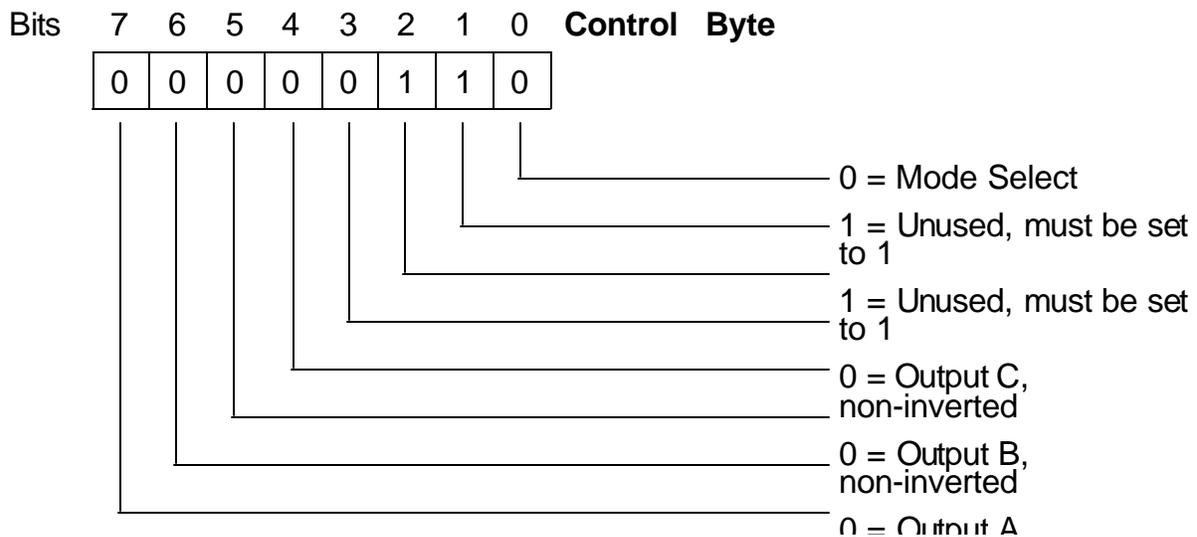
3.1.5 Block Mode

Bit 0 in the control byte is used to select the block's mode of operation. This bit should always be set with a "1" when using a [IQ]² Network Block. Bits 1 and 2 are test bits which are not used in normal operation and must be set to "1".

3.1.6 The Control Byte

An 8 bit control byte is used to control each I/O block. This control byte (sometimes called the control word) is entered into an EEPROM in the I/O block with a programming device.

As with most solid-state control systems, the inputs are field driven ("ON") when power is flowing in the circuit. All inputs at the same address simultaneously place their input signal on the data line (i.e. an OR is performed on the signals). These signals may be inverted before going on the line depending on the setting of the control byte. All outputs at the same address then sample the data line and logically combine its state with the control byte (i.e. an XOR is performed) to determine if the output should be turned ON. If the logic conditions are satisfied, power is caused to flow in the output field circuit.



Mounting Options

Seriplex I/O blocks are ruggedly built for mounting at the point of use. Each block has two mounting options: DIN rail and panel. The panel option uses side brackets which allow the blocks to be "flush" mounted and screwed into a panel. To designate panel mounting, add a "-P" suffix to the part number when ordering a block. The default mounting option is DIN rail.

It is recommended that Seriplex I/O blocks be mounted inside industrial enclosures to prevent potential oxidation of the terminals. The wiring of the blocks within a metal enclosure will usually not require shielded wires.

Maintenance

At present, the Seriplex custom integrated circuit has a rating of 80,000 hours mean time between failure (MTBF). It is estimated that the block itself should experience at least a 10 year operating life without failure in actual field installations. As long as the operating environment is maintained within the specifications of the individual blocks, there should be no preventive maintenance necessary other than to ensure that accumulated dust does not short across terminals.

3.2 Programming I/O Blocks Using the APC Hand-Held Programmer

To program or re-program an I/O Block with the APC Hand-Held Programmer, follow these steps: (Note: This manual refers to the distributed I/O blocks as "blocks"; the APC Hand-Held Programmer refers to the I/O blocks as "modules"; they are one and the same.)

Step 1:

Press the ON/OFF button. The Disconnect Block screen will appear reminding you to completely disconnect the block before programming, reading, or testing it. The block will not save its programmed information if it is connected to the network bus.

Press any key to bring up the Edit screen. The blinking cursor will be in the Channel A address entry position.

Step 2:

Enter the desired address for Channel A. If you make a mistake, use the left arrow to reposition the cursor and re-enter the correct data. When the entry is correct, press the down arrow to move to the Channel B address entry position.

Step 3:

Enter the desired address for Channel B. If you make a mistake, use the left arrow to reposition the cursor and re-enter the correct data. When the entry is correct, press the down arrow to move to the control byte data entry position.

Pressing the CLR key will erase an entire field.

Step 4:

Enter the desired control byte value. The default control byte is 00000110. You may edit this control byte data directly by using the 1 and 0 keys to set or clear each bit. If you should make a mistake, use the left arrow to position the cursor and re-enter the correct data. You are now ready to connect and program the block.

Step 5:

Ensure that the block to be programmed is completely disconnected. Then push and hold the programming cable firmly in the programming port on the block and press the PROG key.

The Programming screen will appear while programming is in process.

Disconnect Module

**UNPLUG ALL
CONNECTORS
BEFORE PROGRAMMING
*Press any Key***

Edit

**APC SP Prog. V3.02
CHANNEL A:
CHANNEL B:
CONTROL: 00000110**

The Programming screen will appear while programming is in progress, then the Programming Complete screen when the programming is finished.

Automatic verification takes place when the programming is complete, and the Verifying Block screen appears while this takes place. When verification is complete, the Verifying Complete screen will appear to signal that the block was successfully programmed and is ready for use.

If the block does not pass the automatic verification, make sure that the cable is firmly plugged into the programming port and re-try. If it continues to fail, the block should be replaced.

3.3 Expanded Edit

The *Expanded Edit* screen provides a more readable interface for entering control byte information.

To use expanded edit, position the cursor on the control byte field in the *Edit* screen and press the **SP2** key. This key will act as a toggle between the *Edit* screen and the *Expanded Edit* screen. Use the arrow keys to move between the data fields. Press any key (except **ON/OFF**, the arrow keys, or **SP2**) to toggle the state of the selected field.

The field values can be set to either **INV** (i.e. inverted) or **NON** (i.e. non-inverted). The mode field can be set to either 1 or 2. Press the **SP2** key to return to the *Edit* screen where the control byte will now reflect the new settings in binary form.

NOTE: *You cannot program or test a block while using expanded edit. The PROG and TEST keys will only function from the Edit screen.*

Programming

Programming the
Module

Programming Complete

Programming
Complete

Verifying Module

Verifying Module

Verifying Module

Please Wait

Verify Complete

Verify Complete
Module Passes

Press Any Key

Expanded Edit

APC SP Prog. V3.02
IN A: NON OUTA: NON
IN B: NON OUTB: NON
MODE: 2 OUTC: INV

3.4 Reading an I/O Block

To read the information programmed into an existing block follow these steps:

Step 1:

Press the **ON/OFF** button. The *Disconnect Block* screen will appear on the LCD display. Pressing any key will bring up the *Edit* screen. The blinking cursor will be in the Channel A address entry position.

Step 2:

Firmly connect the programming cable to the I/O block.

Step 3:

Press the **SP1** key. The *Checking Block* screen will appear momentarily while the block is being read. Once the block has been read, the *Edit* screen will display the block's programmed data.

3.5 Verifying a Block

The programming on each block is automatically verified once the **PROG** key has been pressed during the programming operation. However, the block can be verified "manually" through the use of the **TEST** key. To do this, enter the correct address and control byte for the block. Then, firmly connect the Hand-Held Programmer to the block and press the **TEST** key. If the block's stored program matches the address and control byte in the Hand-Held Programmer, then the Verify Complete screen will display. If not, the Module Fails screen will display.

Disconnect Module

UNPLUG ALL
CONNECTORS
BEFORE PROGRAMMING
Press any Key

Edit

APC SP Prog. V3.02
CHANNEL A:
CHANNEL B:
CONTROL: 00000110

Checking Module

Checking Module

Please Wait

3.6 Programming Special I/O Blocks

There are some blocks which require slightly different programming. They are listed below.

| Block | Number of Addresses | Control Word | Channel A Address | Channel B Address |
|--------------|----------------------------|---------------------|--------------------------|--------------------------|
| APG-8DO | 8 | 0000011_ | Starting | Same as A |
| APG-8D20mA | 8 | 0000011_ | Starting | Same as A |

Each of these blocks occupies multiple, consecutive addresses on the Seriplex bus beginning with the starting address. Furthermore, the first 7 digits of the control byte are restricted (the 8th bit is used to set the operating mode).

To program these blocks, follow the same procedure indicated in the Programming Steps section.

3.7 Programming Errors

There are several errors that could occur while programming. When an error occurs, always double check the connection between the programming cable and the block's programming port. Most errors are caused by a poor connection between these contacts.

Undefined fields

This will appear when the PROG or TEST key is pressed before the fields have been completely entered.

No Module present

This will appear when the PROG, SP1 or TEST key is pressed with no block present (usually caused because of poor connection between programmer and block).

Module fails

This will appear if the block fails verification. This indicates that the block did not retain the address and control byte information. Check the connection and re-try. If it happens repeatedly, the block should be replaced.

Data failure

This will appear if the block failed verification and it was caused by a bad data line connection. Check the connection and re-try. If it happens repeatedly, the block should be replaced.

Module bad

This will appear if the block could not be read. Check the connection and re-try. If it happens repeatedly, the block should be replaced.

Undefined Fields

One or more fields are
undefined

Press any Key

No Module

No Module
Present

Press any Key

Module Fails

Verify Complete

Module Fails

Data Failure

Unable to Control DATA
bus

Module Verify Fails

Press Any Key

Module Bad

Module Bad

Press Any Key

Block Troubleshooting

Due to the simplicity of the Seriplex I/O system, troubleshooting is limited to a few basic steps. In normal operation, the LEDs on the blocks should reflect the state of the field circuit. If the input field circuit is active and the input LED is not on, or if the output LED is on and the output device is not being activated, inspect the wiring between the field device and the block. If the block itself appears to be functioning improperly, check for improper or faulty Seriplex bus connections. If these appear to be correct, disconnect the block and check that it has been programmed correctly (see *Reading a Block* on page 2-7). If the block does not respond, it should be replaced.

Safe States

When the clock signal is lost (i.e. the network is down), each output block defaults to its programmed shelf state (either normally open or normally closed).

NOTE: A safe state output table can be used in Mode 2 to set the output conditions (see *Safe States Output Table* on page 4-13).

Disconnecting a Block From the Bus

While not recommended for safety reasons, Seriplex I/O blocks can be disconnected from a live system without disrupting bus communications. Simply unplug the bus connector. The rest of the system will continue to function normally. **NOTE:** Do NOT disconnect any load side connections while power is available to load terminals!

Through Map on page 4-12). The following diagrams illustrate Mode 2 operation. (* Page Changed) Control Word

RS-485 2-wire Multi-Drop Cabling Diagram Installing the Serial Interface Card

(1) Set the proper communications mode (RS-232 or RS-422/RS-485) with switch SW1-8 (see page 5-3) (2) Make sure that the baud rate, parity and stop bits settings exactly match the settings of the [IQ]2 Network Block (see UART Settings). The system will not operate if these settings do not match. (3) Set the card to the proper operating mode (mode 1 or mode 2) with switch SW2-8 (see page 5-3). (4) Set the line termination jumpers (J1 + J2) to the proper settings (see End-of-Line Termination on page 5-6). (5) Mount the card to the panel using the standoffs provided. (6) Connect the wires from the Seriplex bus to the 5 position bus connector P1. Refer to Seriplex Bus (P1) Pin Out on page 5-4. (7) Connect the communications cable to the appropriate port. The RS-232 port will accept a DB-9S connector. Refer to RS-422/RS-485 (P3) Pin Out on page 5-4. (8) Connect the +5V power supply to terminals 1 and 2 on P2. (9) The serial interface card is now ready for operation. Operating the Serial Interface Card

Modes of Operation

The serial interface card has four modes of operation. The operating mode is set by issuing the appropriate command from the host computer to the slave unit.

(1) Force Long Reset - This is the default mode following power-up. When in this mode, the interface card stops the Seriplex clock and all blocks on the Seriplex bus default to their programmed off-state. Read and write commands will not update the blocks. (2) Normal - This is the standard operating mode. The host computer can issue read and write commands to blocks connected to the interface card. (3) Monitor - This mode is used when the host computer will only monitor the status of the blocks. Write commands will not update the blocks. (4) Safe - This mode is used to immediately set the output blocks connected to the interface card to the conditions stored in its safe state buffer. This can be used to quickly set the output blocks to a known state in case of an emergency.

Start Up Procedure

Follow these steps to start operating the serial interface card.

- (1) Issue an S_PARAM command (see s_param() on page 5-16) from the host to the serial interface, if either of the following conditions exist: the Seriplex clock rate is to operate at a speed other than the default of 32 KHz, or the Seriplex frame size is to be less than the default of 256 channels. If neither condition applies, go to step 2.
- (2) Issue an S_MAP command (see s_map() on page 5-16) from the host to the slave unit if the system has any multiplexed blocks (APG-AIN1216, APG-COUNT16 or APG-AOUT128). The S_MAP commands will instruct the interface where the multiplexed blocks will reside on the Seriplex bus.
- (3) Issue either the NORMAL or MONITOR commands (see normal() and monitor() on page 5-12) to instruct