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Allen-Bradley

Analog Input Module

(Cat. No. 1771-IFE Series C)

User Manual

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Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI–1.1, “Safety Guidelines For The Application, Installation and Maintenance of Solid State Control” (available from your local Allen-Bradley office) describes some important differences between solid-state equipment and electromechanical devices which should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we make notes to alert you to possible injury to people or damage to equipment under specific circumstances.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Attention helps you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.

Important: We recommend you frequently backup your application programs on appropriate storage medium to avoid possible data loss.

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Summary of Changes

This edition of this publication contains new and revised information not included in the previous edition.

New Information

This edition of this document includes information formally included in a release note (publication 1771-6.5.115–RN1, September 1996). This information covered:

- addition of an A/B simulation switch that allowed the Series C module to be used in place of Series A or B modules.
- an appendix listing the major differences between Series of the Analog module.

Updated Information

In addition, minor corrections have been made in response to requests for change from users.

Change Bars

The areas in this manual which are different from previous editions are marked with change bars (as shown to the right of this paragraph) to indicate the addition of new or revised information.

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Using This Manual

Purpose of Manual

This manual shows you how to use your Analog Input module with an Allen-Bradley programmable controller. It helps you install, program, calibrate, and troubleshoot your module.

Audience

You must be able to program and operate an Allen-Bradley programmable controller to make efficient use of your input module. In particular, you must know how to program block transfers.

We assume that you know how to do this in this manual. If you do not, refer to the appropriate programming and operations manual before you attempt to program this module.

Vocabulary

In this manual, we refer to:

- The analog input module as the “input module” or the “module”
- The programmable controller as the “controller”

Manual Organization

This manual is divided into seven chapters. The following chart shows each chapter with its corresponding title and a brief overview of the topics covered in that chapter.

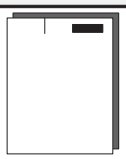
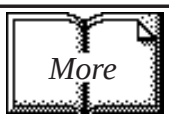
Chapter	Title	Topics Covered
1	Overview of the Analog Input Modules	Description of the module including general and hardware features
2	Installing the Input Module	Module power requirements, keying, chassis location Wiring of the field wiring arm
3	Module Programming	Sample programs
4	Configuring Your Module	Hardware and software configuration Input range selection Data format
5	Module Status and Input Data	Reading data from the module Read block format
6	Calibrating Your Module	Information on calibrating your module
7	Troubleshooting Your Module	Troubleshooting guide for problem diagnosis
Appendix	**Title**	**Topics Covered**
A	Specifications	
B	Differences Between Series A and B Modules and Series C Modules	Lists major differences between module series.

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Appendix	Title	Topics Covered
C	Programming Examples	
D	Data Table Formats	Information on BCD, 2s complement binary, signed magnitude (12-bit) binary
E	Block Transfer (Mini-PLC-2 and PLC-2/20 Processors)	How to use GET-GET instructions
F	Forms	Useful forms for identifying your data table

Conventions

We use these conventions in this manual:

In this manual, we show:	Like this:
that there is more information about a topic in another chapter in this manual	
that there is more information about the topic in another manual	

Related Products

You can install your input module in any system that uses Allen-Bradley programmable controllers with block transfer capability and the 1771 I/O structure.

Contact your nearest Allen-Bradley office for more information about your programmable controllers.

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Product Compatibility

The 1771-IFE series C module can be used with any 1771 I/O chassis. Communication between the discrete analog module and the processor is bidirectional; the processor block-transfers output data through the output image table to the module and block-transfers input data from the module through the input image table. The module also requires an area in the data table to store the read block transfer data and write block transfer data. I/O image table use is an important factor in module placement and addressing selection. Compatibility and data table use is listed below.

Compatibility and Use of Data Table

Catalog Number	Use of Data Table				Compatibility			
	Input Image Bits	Output Image Bits	Read Block Words	Write Block Words	Addressing			Chassis Series
					1/2-Slot	1-Slot	2-Slot	
1771-IFE/C	8	8	22	39	Y	Y	Y	A, B

A = Compatible with 1771-A1, -A2, -A4
B = Compatible with 1771-A1B, -A2B, -A3B, -A3B1, -A4B
Y = Compatible without restriction.

You can place your input module in any I/O module slot of the I/O chassis. You can put two input modules in the same module group. You can put an input and an output module in the same module group.

Do not put the module in the same module group as a discrete high density module. Avoid placing analog input modules close to ac modules or high voltage dc modules.

Do not use this module with a cat. no. 1771-AL PLC-2/20, 2/30 Local Adapter.

Related Publications

For a list of publications with information on Allen-Bradley programmable controller products, consult our publication index (SD499).

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Overview of the Analog Input Module

Chapter Objectives

This chapter, we describe:

- features of the module
- how the module communicates with programmable controllers

Module Description

The Analog input module is an intelligent block transfer module that interfaces analog input signals with any Allen-Bradley programmable controllers that have block transfer capability. Block transfer programming moves input data words from the module's memory to a designated area in the processor data table in a single scan. It also moves configuration words from the processor data table to module memory.

The input module is a single-slot module and requires no external power supply. (If using passive transducers for input, the user must supply loop power.) After scanning the analog inputs, the input data is converted to a specified data type in a digital format to be transferred to the processor's data table on request. The block transfer mode is disabled until this input scan is complete. Consequently, the minimum interval between block transfer reads is the same as the total input update time for each analog input module.

Features

The Analog input module senses up to 16 single-ended or 8 differential analog inputs and converts them to a proportional four-digit BCD or twelve-bit binary value. You can select from five voltage or three current input ranges. Each input can be configured as a current or voltage input with internal jumpers.

This module's program selectable features include:

- 16 single-ended or 8 differential inputs
- User program selectable input ranges on a per channel basis (see table)
- Selectable real-time sampling
- Selectable scaling to engineering units
- Selectable digital filtering
- Selectable data format

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Program Selectable Input Ranges

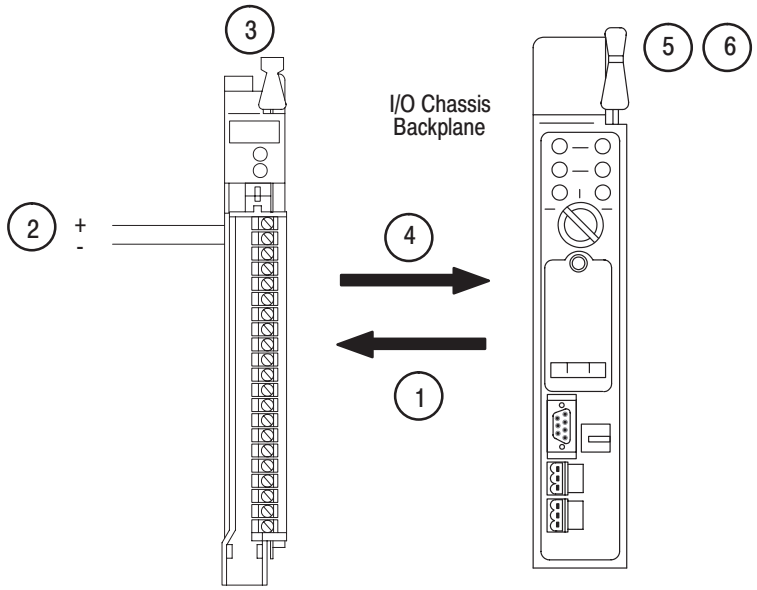
Voltage	Current
1 to 5V dc	4 to 20mA
0 to 5V dc	0 to 20mA
-5 to +5V dc	-20 to +20mA
-10 to +10V dc	
0 to 10V dc	

How Analog Modules Communicate with Programmable Controllers

The processor transfers data to the module (block transfer write) and from the module (block transfer read) using BTW and BTR instructions in your ladder diagram program. These instructions let the processor obtain input values and status from the module, and let you establish the module's mode of operation.

1. The processor transfers your configuration data to the module via a block transfer write instruction.
2. External devices generate analog signals that are transmitted to the module.

Communication Between Processor and Module



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3. The module converts analog signals into binary or BCD format, and stores theses values until the processor requests their transfer.
4. When instructed by your ladder program, the processor performs a read block transfer of the values and stores them in a data table.
5. The processor and module determine that the transfer was made without error, and that input values are within specified range.
6. Your ladder program can use and/or move the data (if valid) before it is written over by the transfer of new data in a subsequent transfer.
7. Your ladder program should allow write block transfers to the module only when enabled by operator intervention or at power-up.

Accuracy

The accuracy of your input module is described in Appendix A.

Chapter Summary

In this chapter you read about the functional aspects of the input module and how the module communicates with the programmable controller.

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Installing the Input Module

Chapter Objectives

In this chapter, we tell you about:

- calculating the chassis power requirement
- choosing the module's location in the I/O chassis
- configuring your module configuration plugs
- keying a chassis slot for your module
- installing the input module
- wiring the input module's field wiring arm

Compliance to European Union Directives

If this product has the CE mark it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131–2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

For specific information required by EN 61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- Industrial Automation Wiring and Grounding Guidelines For Noise Immunity, publication 1770-4.1
- Guidelines for Handling Lithium Batteries, publication AG-5.4
- Automation Systems Catalog, publication B111

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Before You Install Your Input Module

Before installing your input module in the I/O chassis:

You need to:	As described under:
Calculate the power requirements of all modules in each chassis.	Power Requirements, page 2–2.
Determine where to place the module in the I/O chassis.	Module Location in the I/O Chassis, page 2–3.
Set the Series A/B simulation jumper.	Setting the A/B Simulation Jumper, page 2–5
Key the backplane connector in the I/O chassis.	Module Keying, page 2–6.
Make connections to the wiring arm.	Wiring Your Input Module, page 2–8 and Grounding, page 2–13.

Important: **The 1771-IFE module is shipped from the factory set for voltage mode and Series C applications.** Refer to "Setting the Configuration Plugs on the Module"on page 2–3 for other combinations of current and voltage inputs and "Setting the Series A/B Simulation Jumper" on page 2–5.

Electrostatic Damage

Electrostatic discharge can damage semiconductor devices inside this module if you touch backplane connector pins. Guard against electrostatic damage by observing the following precautions:



ATTENTION: Electrostatic discharge can degrade performance or cause permanent damage. Handle the module as stated below.

- Wear an approved wrist strap grounding device, or touch a grounded object to rid yourself of electrostatic charge before handling the module.
- Handle the module from the front, away from the backplane connector. Do not touch backplane connector pins.
- Keep the module in its static-shield bag when not in use.

Power Requirements

Your module receives its power through the 1771 I/O power supply. The module requires 500mA from the backplane.

Add this current to the requirements of all other modules in the I/O chassis to prevent overloading the chassis backplane and/or backplane power supply.

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Locating the Module in the I/O Chassis

Place your module in any I/O module slot of the I/O chassis except for the extreme left slot. This slot is reserved for PC processors or adapter modules.

Group your modules to minimize adverse affects from radiated electrical noise and heat. We recommend the following.

- Group analog input and low voltage dc modules away from ac modules or high voltage dc modules to minimize electrical noise interference.
- Do not place this module in the same I/O group with a discrete high-density I/O module when using 2-slot addressing. This module uses a byte in both the input and output image tables for block transfer.

Setting the Configuration Plugs on the Module

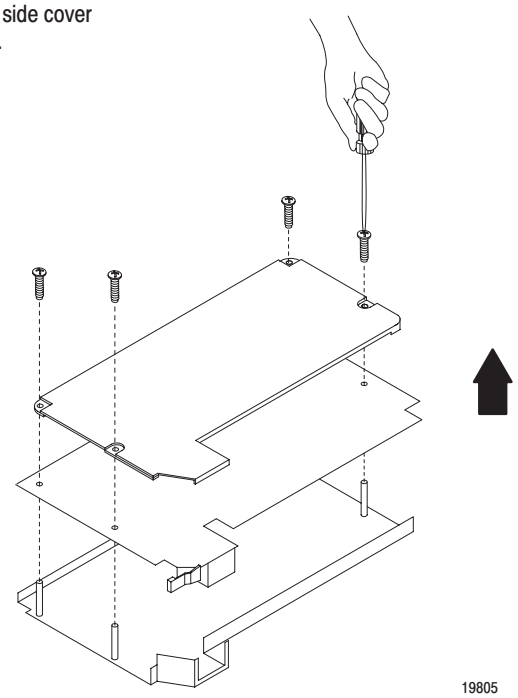
The analog input module (1771-IFE/C) has configuration plugs for determining the input type (voltage or current) desired for each input. **The module comes from the factory with the configuration plugs positioned for voltage mode.**

Note that you can select either voltage or current for each input, but they must all be either single-ended or all differential.

Important: Do not mix single-ended and differential inputs on the module.

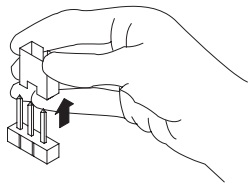
To set the configuration plugs for your desired inputs:

1 Remove the four screws securing the side cover to the module and remove the covers.



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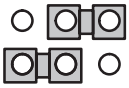
2 Reposition the configuration plugs associated with each input channel according to your requirements.



You can mix voltage mode and current mode settings on the module. Make sure that the entire module is set for either single-ended or differential. Do not mix them.

Voltage Mode

Differential or Single-ended (factory set)



Current Mode

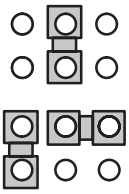
Differential Current **Single-ended Current**

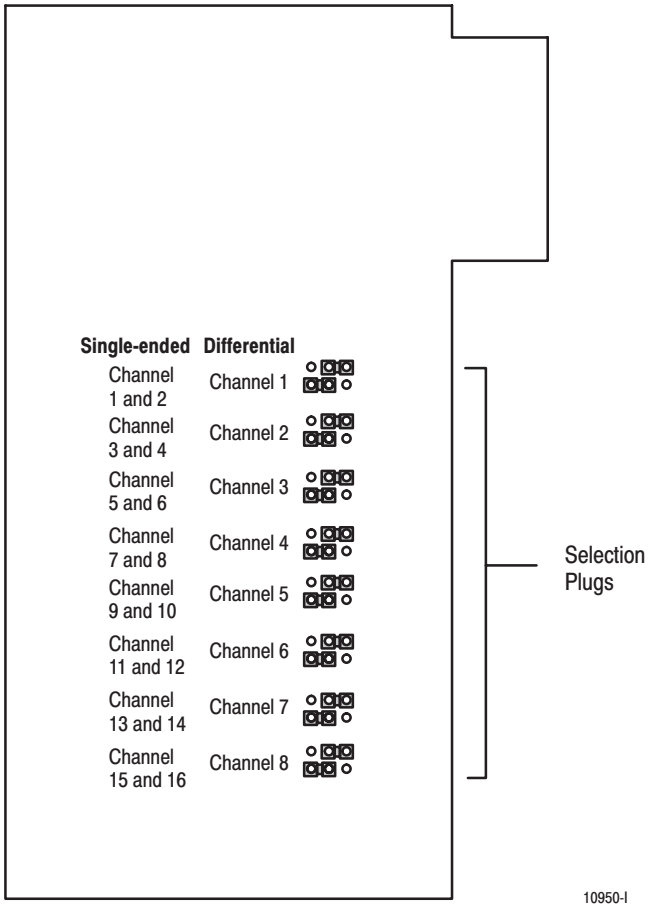


Single-ended

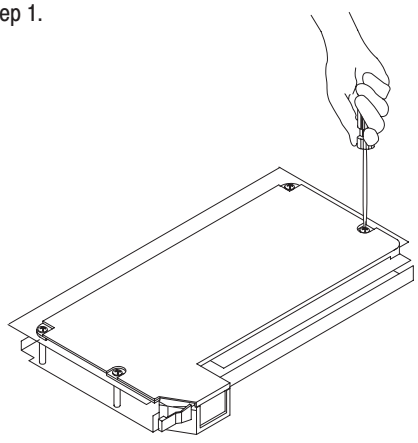
Odd channel current
Even channel voltage

Even channel current
Odd channel voltage





3 Reposition the cover and secure with the fours screws removed in step 1.



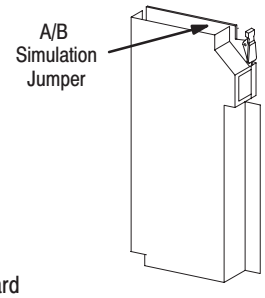
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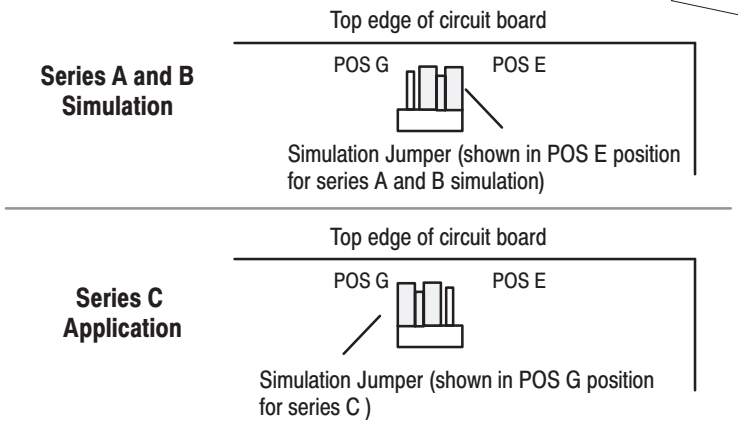
Setting the Series A/B Simulation Jumper

The module is shipped with the series A/B simulation jumper set in position **POS G** for Series C applications. This setting returns input data above and below the range end points. If you are replacing a Series A or B 1771-IFE module with this module, and your application cannot tolerate underrange/overrange data, reset the simulation jumper to the **POS E** position as shown below, to internally limit input data to range end points.

Set the Series A/B Simulation Jumper

1. Locate the simulation jumper at the top edge of the module circuit board.
2. Using your fingers, slide the jumper off the 2 posts.
3. Carefully position the jumper on 2 of the 3 posts that correspond to your requirement.





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Key the Backplane Connector

Place your module in any slot in the chassis except the leftmost slot which is reserved for processors or adapters.

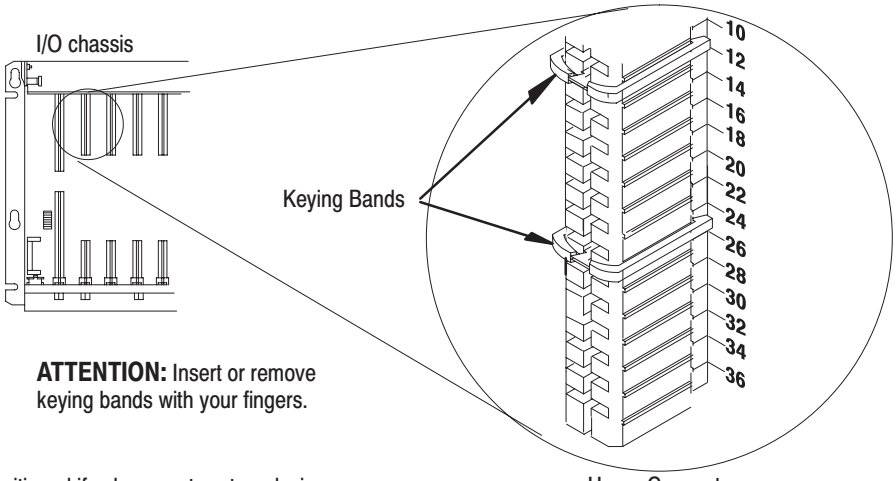
ATTENTION: Observe the following precautions when inserting or removing keys:

- insert or remove keys with your fingers
- make sure that key placement is correct

Incorrect keying or the use of a tool can result in damage to the backplane connector and possible system faults.

The 1771-IFE/C module is slotted at two places on the rear edge of the circuit board. These slots mate with plastic keying bands which mount on the backplane connector.

Position the keying bands in the backplane connector to correspond to the key slots.



Keying Band Location
Between10 and 12
Between 24 and 26

ATTENTION: Insert or remove keying bands with your fingers.

The keying bands can be repositioned if subsequent system design and rewiring make insertion of a different type of module necessary.

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Installing the Analog Module

To install your module in an I/O chassis:

1. First, turn off power to the I/O chassis:

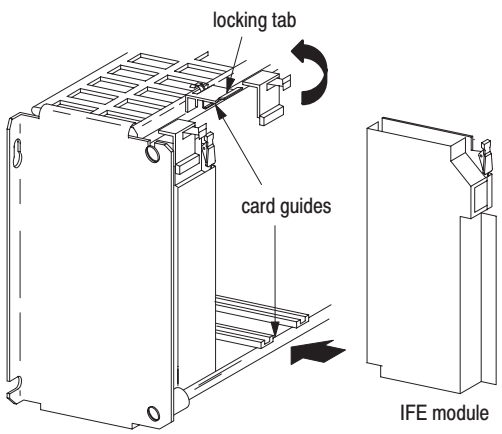
ATTENTION: Remove power from the 1771 I/O chassis backplane and field wiring arm before removing or installing an I/O module.

- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

2 Place the module in the card guides on the top and bottom of the slot that guide the 1771-IFE/C module into position.

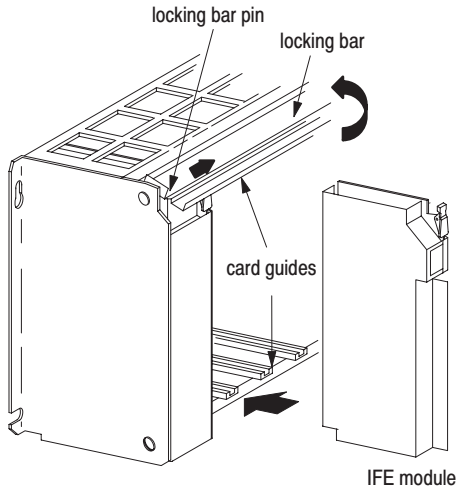
Important: Apply firm even pressure on the module to seat it into its backplane connector.

1771-A1B, -A2B, -A3B, -A3B1, -A4B I/O chassis



Snap the chassis latch over the top of the module to secure it.

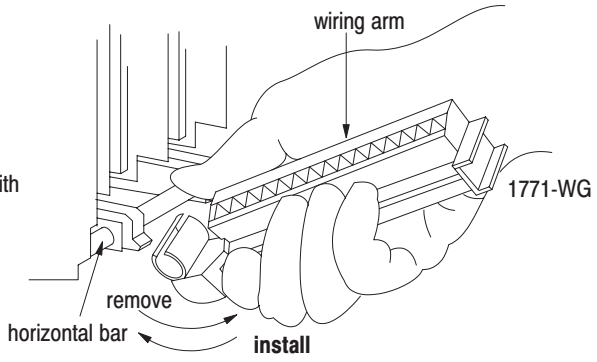
1771-A1B, -A2B, -A3B1, -A4B Series B I/O chassis



Swing the chassis locking bar down into place to secure the modules. Make sure the locking pins engage. 19809

3 Attach the wiring arm (1771-WG) to the horizontal bar at the bottom of the I/O chassis.

The wiring arm pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.



17643

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Wiring Your Analog Input Module

Connect your I/O devices to the cat. no. 1771-WG wiring arm shipped with the module. The wiring arm is attached to the pivot bar at the bottom of the I/O chassis. It pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.



ATTENTION: Remove power from the 1771 I/O chassis backplane and field wiring arm before removing or installing an I/O module.

- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

Input connections for the 1771-IFE module with single-ended inputs are shown in Figure 2.1 and Figure 2.2. Input connections for the 1771-IFE with differential inputs are shown in Figure 2.3 and Figure 2.4.

Minimizing Ground Loops

To minimize ground-loop currents on input circuits:

- use single-ended mode whenever possible
- use 2-wire transmitters with a common power supply
- separate 2-wire and 4-wire transmitters between different modules
- tie 4-wire transmitter and/or separate power supply grounds together

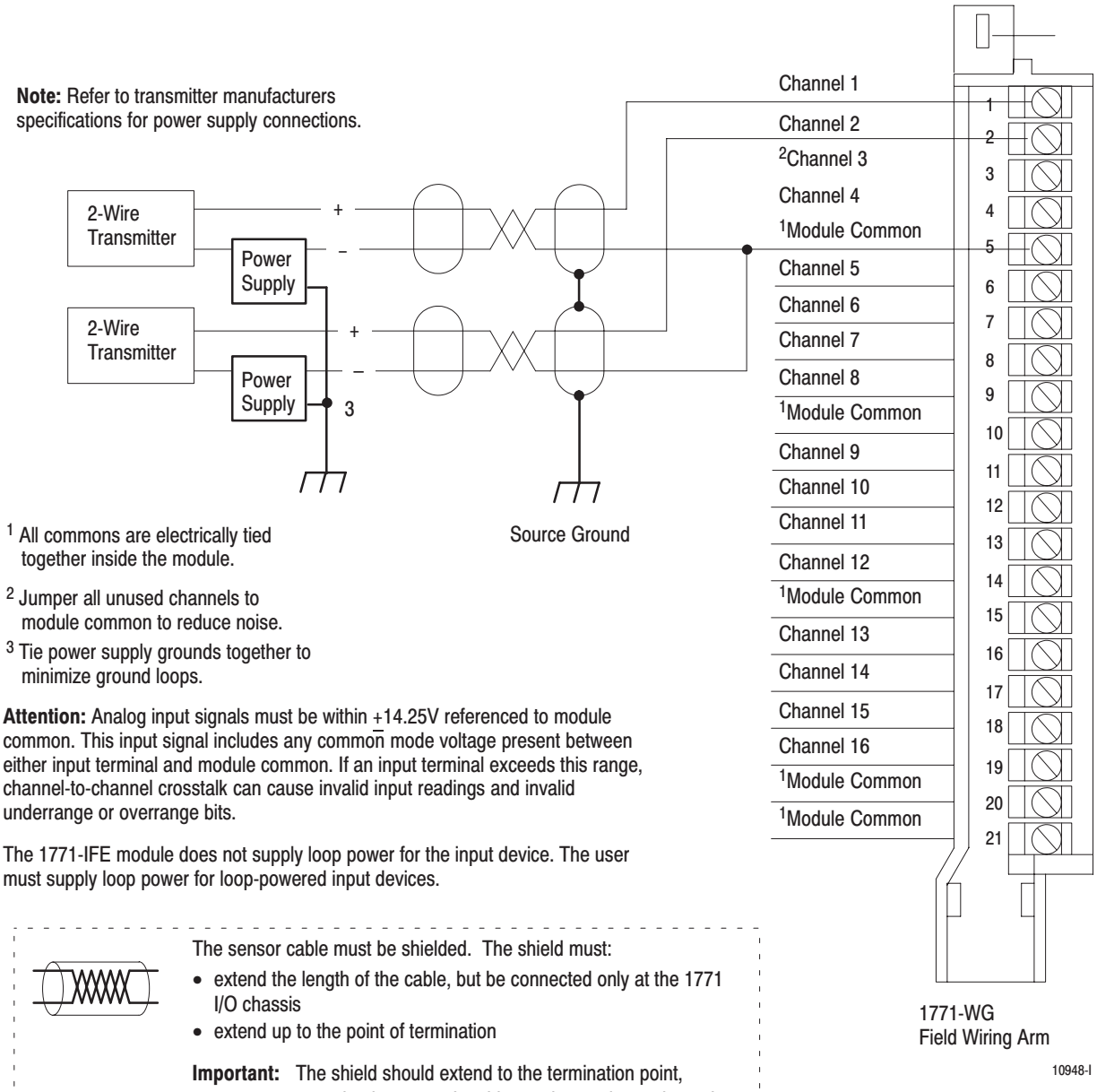
Important: We do not recommend mixing 2-wire and 4-wire transmitter inputs on the same module. Power supply placement can make it impossible to eliminate ground loops.

Cable Lengths

Recommended maximum cable length for voltage-mode input devices is 50 feet. This recommendation is based on considerations of signal degradation and electrical noise immunity in typical industrial environments. Cable length for current-mode input devices need not be as restrictive because analog signals from these devices are less sensitive to electrical noise interference.

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Figure 2.1
Connection Diagram for 16 Single-ended Inputs and Two-Wire Transmitters



[1] All commons are electrically tied together inside the module.

[2] Jumper all unused channels to module common to reduce noise.

[3] Tie power supply grounds together to minimize ground loops.

Attention: Analog input signals must be within ±14.25V referenced to module common. This input signal includes any common mode voltage present between either input terminal and module common. If an input terminal exceeds this range, channel-to-channel crosstalk can cause invalid input readings and invalid underrange or overrange bits.

The 1771-IFE module does not supply loop power for the input device. The user must supply loop power for loop-powered input devices.

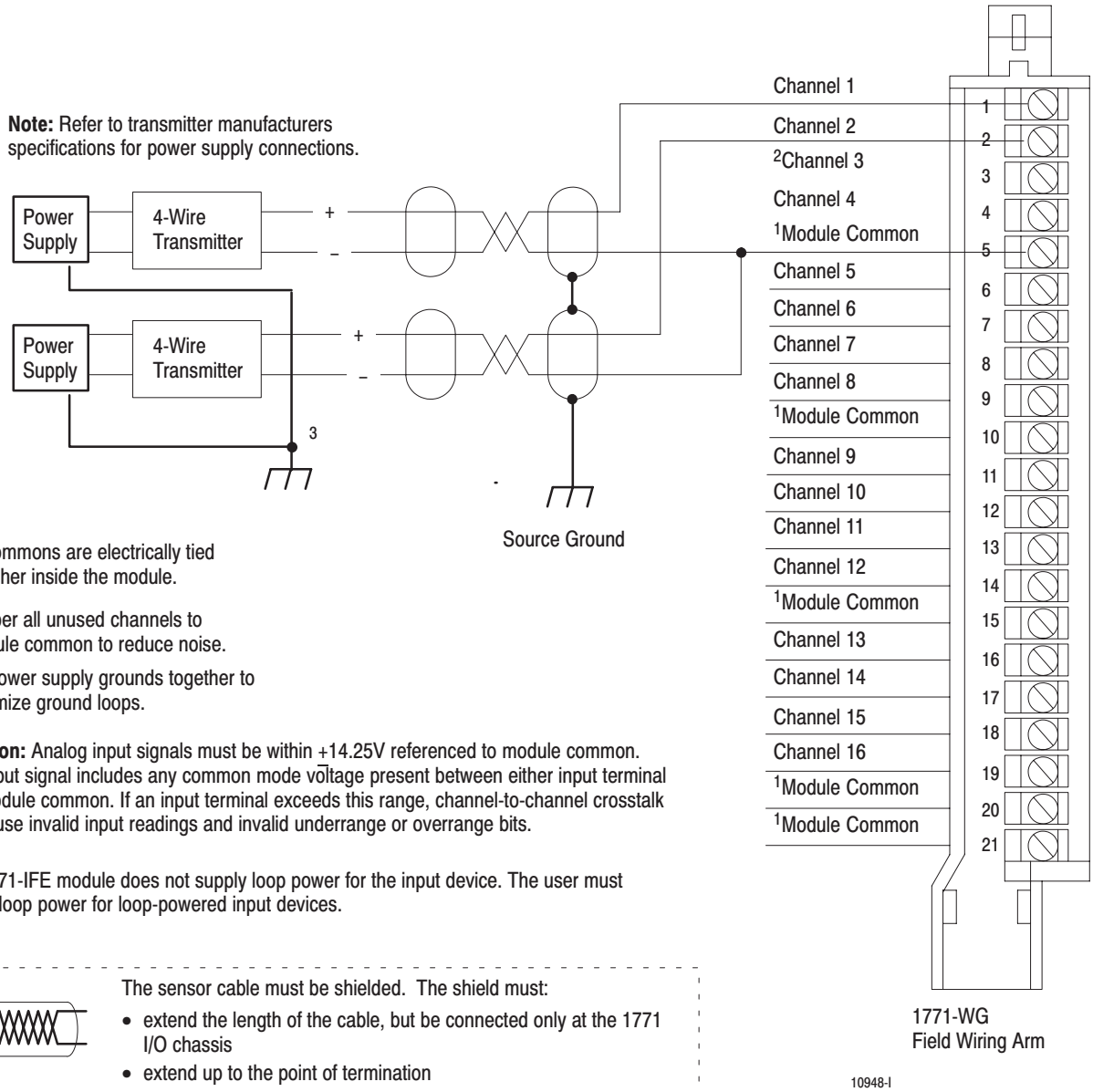
The sensor cable must be shielded. The shield must:

- extend the length of the cable, but be connected only at the 1771 I/O chassis
- extend up to the point of termination

Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

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Figure 2.2
Connection Diagram for 16 Single-ended Inputs and Four-Wire Transmitters



[1] All commons are electrically tied together inside the module.

[2] Jumper all unused channels to module common to reduce noise.

[3] Tie power supply grounds together to minimize ground loops.

Attention: Analog input signals must be within +14.25V referenced to module common. This input signal includes any common mode voltage present between either input terminal and module common. If an input terminal exceeds this range, channel-to-channel crosstalk can cause invalid input readings and invalid underrange or overrange bits.

The 1771-IFE module does not supply loop power for the input device. The user must supply loop power for loop-powered input devices.

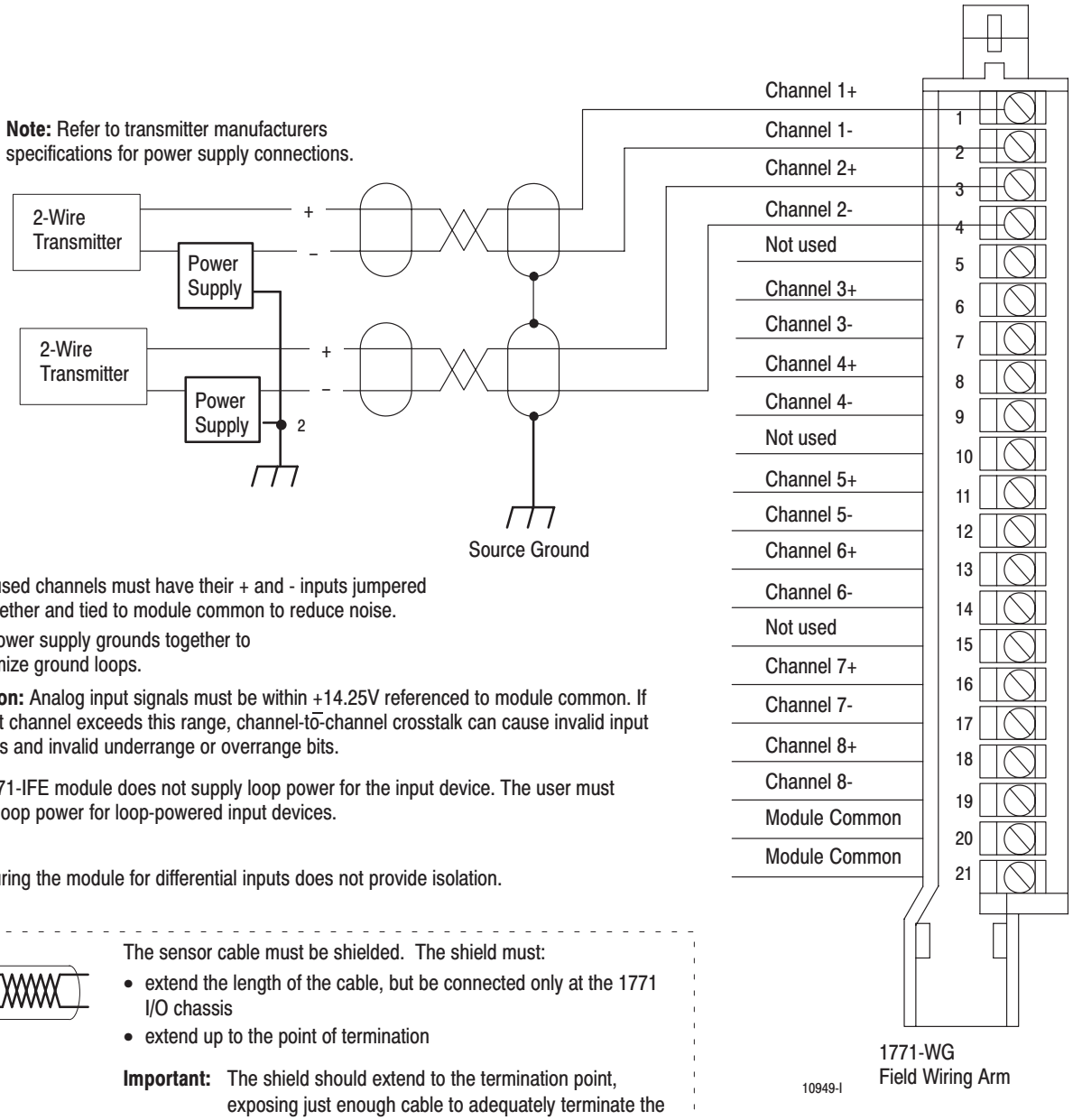
The sensor cable must be shielded. The shield must:

- extend the length of the cable, but be connected only at the 1771 I/O chassis
- extend up to the point of termination

Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

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Figure 2.3
Connection Diagram for 8 Differential Inputs and Two-Wire Transmitters



NOTE:

1. Unused channels must have their + and - inputs jumpered together and tied to module common to reduce noise.
2. Tie power supply grounds together to minimize ground loops.

Attention: Analog input signals must be within +14.25V referenced to module common. If an input channel exceeds this range, channel-to-channel crosstalk can cause invalid input readings and invalid underrange or overrange bits.

The 1771-IFE module does not supply loop power for the input device. The user must supply loop power for loop-powered input devices.

Configuring the module for differential inputs does not provide isolation.

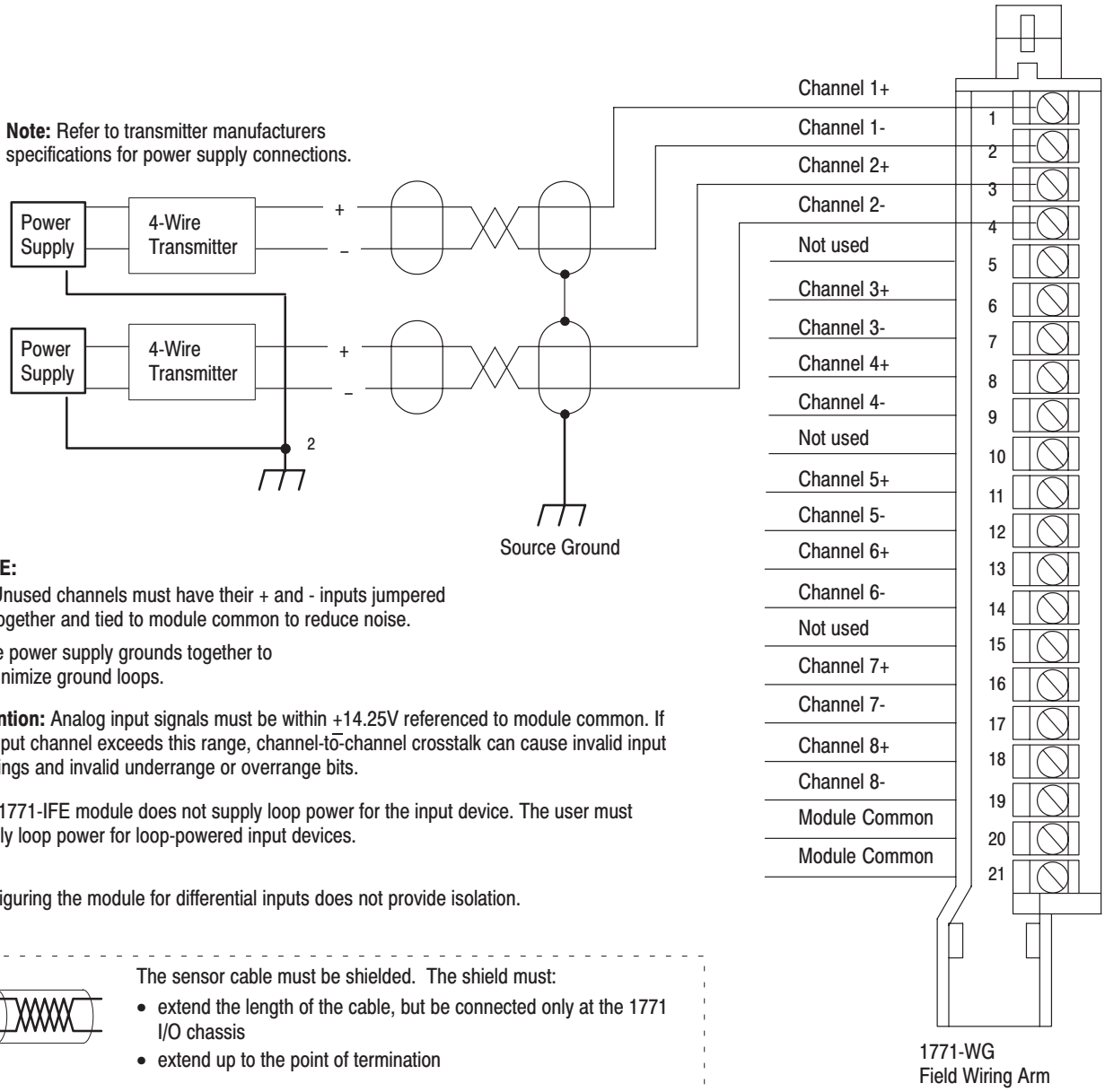
The sensor cable must be shielded. The shield must:

- extend the length of the cable, but be connected only at the 1771 I/O chassis
- extend up to the point of termination

Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

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Figure 2.4
Connection Diagram for 8 Differential Inputs and Four-Wire Transmitters



NOTE:

1. Unused channels must have their + and - inputs jumpered together and tied to module common to reduce noise.

2 Tie power supply grounds together to minimize ground loops.

Attention: Analog input signals must be within +14.25V referenced to module common. If an input channel exceeds this range, channel-to-channel crosstalk can cause invalid input readings and invalid underrange or overrange bits.

The 1771-IFE module does not supply loop power for the input device. The user must supply loop power for loop-powered input devices.

Configuring the module for differential inputs does not provide isolation.

The sensor cable must be shielded. The shield must:

- extend the length of the cable, but be connected only at the 1771 I/O chassis
- extend up to the point of termination

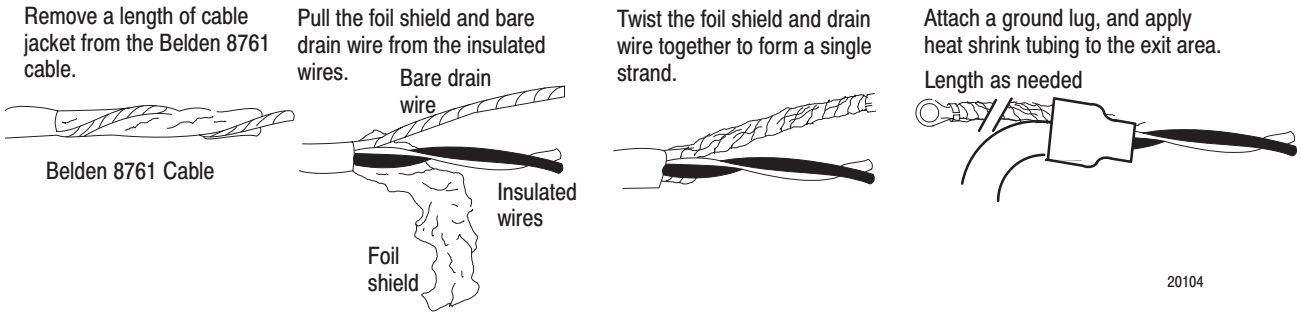
Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

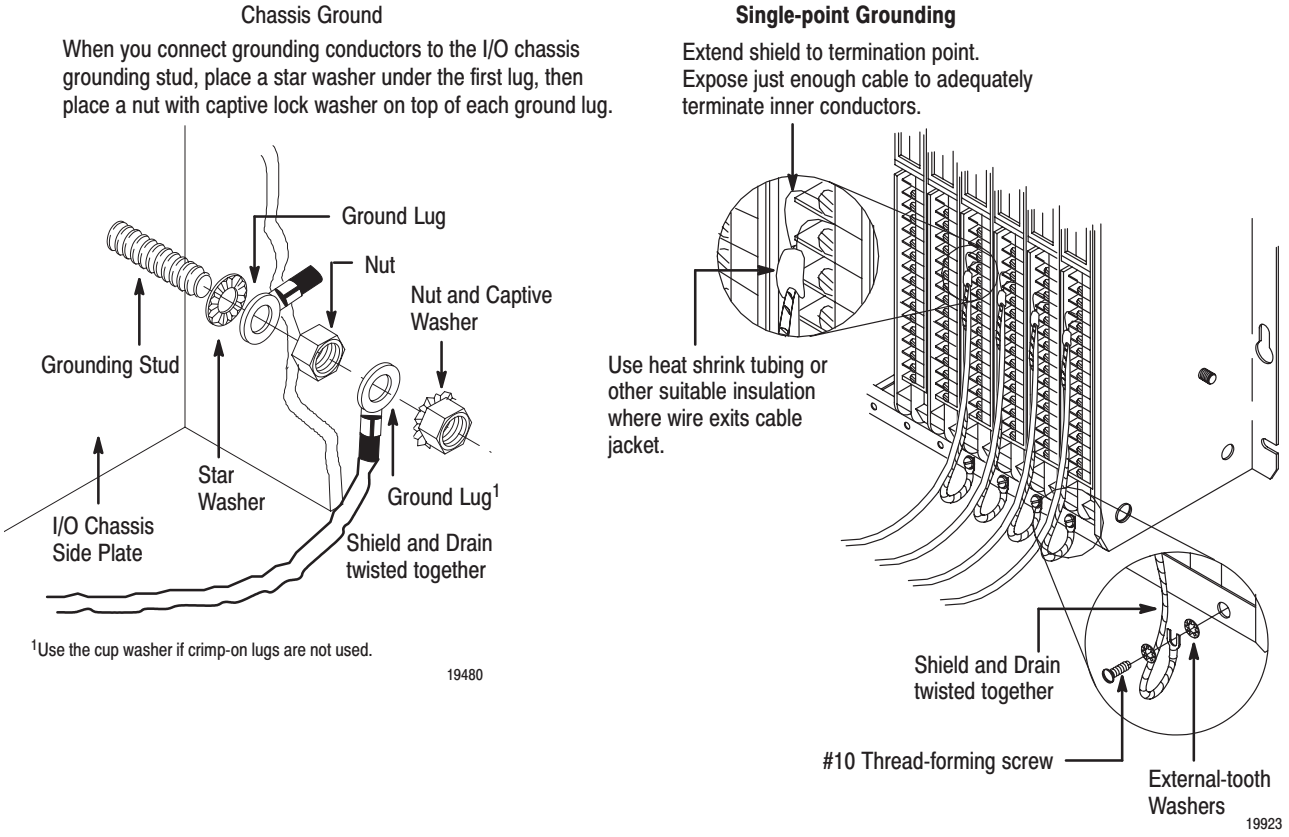
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Grounding

When using shielded cable wire, ground the foil shield and drain wire only at one end of the cable. We recommend that you wrap the foil shield and drain wire together, and connect them to a chassis mounting bolt, grounding stud or chassis single-point grounding point (Figure 2.5). Use heat shrink tubing to seal the exit point of the wires. At the opposite end of the cable, tape exposed shield and drain wire with electrical tape to insulate it from electrical contact.

Figure 2.5
Cable Grounding



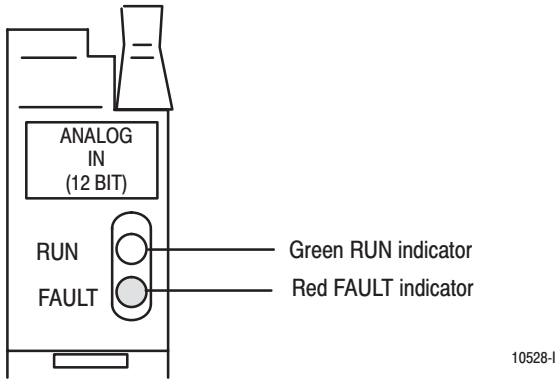


Refer to Wiring and Grounding Guidelines, publication 1770-4.1 for additional information.

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Indicator Lights

The front panel of the analog input module contains a green RUN indicator and a red FAULT indicator. At power-up an initial module self-check occurs. If there is no fault, the red indicator turns off.



The green indicator comes on when the module is powered. It will flash until the module is programmed. If a fault is found initially or occurs later, the red fault indicator lights. Possible module fault causes and corrective action is discussed in Chapter 7, Troubleshooting.

Chapter Summary

In this chapter you learned how to install your input module in an existing programmable controller system and how to wire to the field wiring arm.

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Module Programming

Chapter Objectives

In this chapter we describe:

- block transfer programming
- sample programs in the PLC-2, PLC-3 and PLC-5 processors
- module scan time issues

Block Transfer Programming

Your module communicates with your processor through bidirectional block transfers. This is the sequential operation of both read and write block transfer instructions.

The block transfer write (BTW) instruction is initiated when the analog module is first powered up, and subsequently only when the programmer wants to write a new configuration to the module. At all other times the module is basically in a repetitive block transfer read (BTR) mode.

The application programs for the three processor families were written to accomplish this handshaking in the described manner. They are minimum programs; all the rungs and conditioning must be included in your application program. If you wish to disable BTRs for any reason, or add interlocks to the BTW rung to prevent writes from happening at certain times, you are allowed to do it. You may **not** eliminate any storage bits or interlocks that are included in our examples. If interlocks are removed, the program may not work properly.

The analog input module will work with a default configuration of zeroes entered in all five words of a five word BTW configuration block. See the configuration default section to understand what this configuration will look like. Also, refer to Appendix C for example configuration blocks and instruction addresses to get started.



ATTENTION: In PLC-2 family processors you must not enable both the read and write instructions at the same time. Undesirable data could transfer, resulting in unpredictable machine operation. Using the prescribed programs will prevent this situation.

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PLC-2 Programming

The PLC-2 program example regulates when each block transfer will be initiated to eliminate problems caused by limited regulation of bidirectional block transfers. Both storage bits are needed, as shown in the example, to accomplish this task in all PLC-2 systems, local or remote, with long or short program scans. Therefore, the program as shown is the minimum required. Note that PLC-2 processors that do not have the block transfer instruction must use the GET-GET block transfer format which is outlined in Appendix E.

Figure 3.1
PLC-2 Family Sample Program Structure

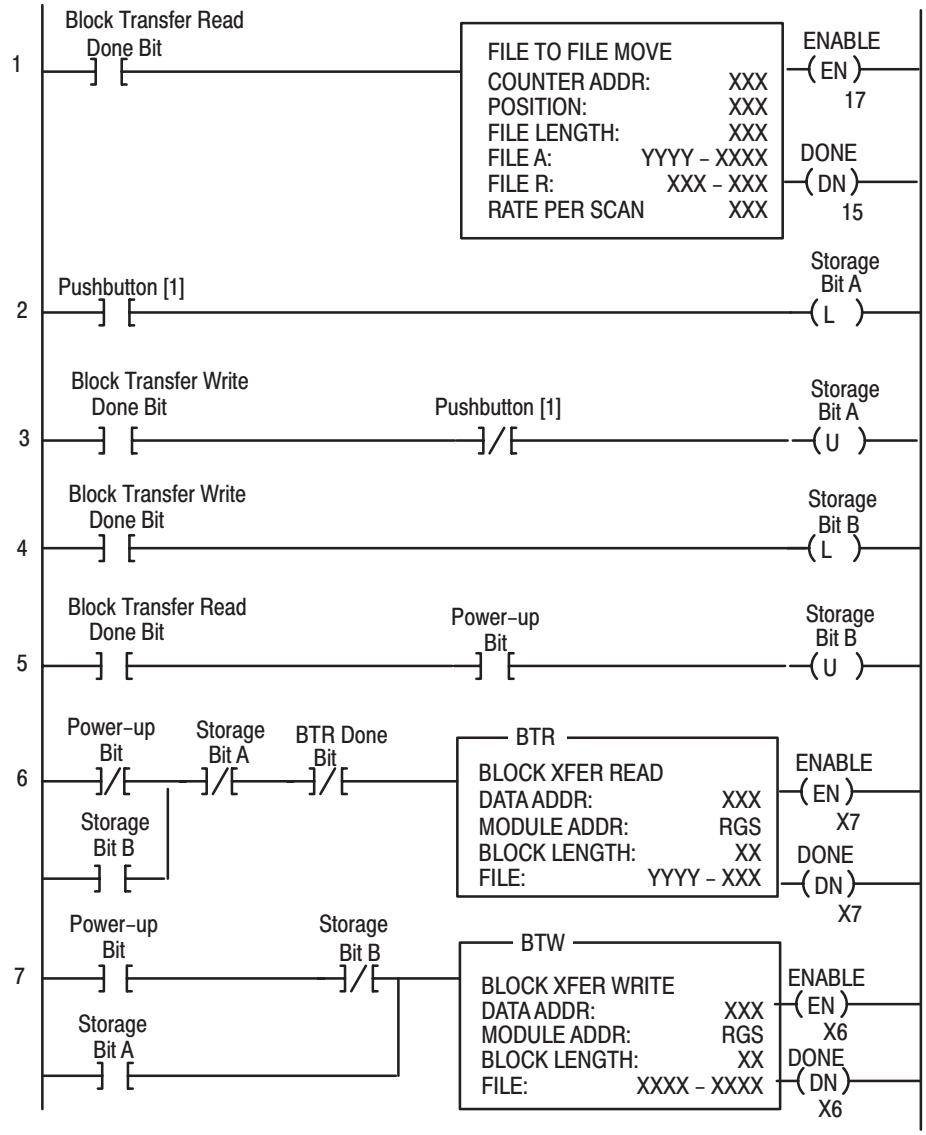
Rung 1
Block transfer read buffer: the file-to-file move instruction holds the block transfer read (BTR) data (file A) until the processor checks the data integrity. If the data was successfully transferred, the processor energizes the BTR done bit, initiating a data transfer to the buffer (file R) for use in the program.

If the data is corrupted during the BTR operation, the BTR done bit is not energized and data is not transferred to the buffer file. In this case, the data in the BTR file will be overwritten by data from the next BTR.

Rungs 2 and 3
These rungs provide for a user-initiated block transfer write (BTW) after the module is initialized at power-up. Pressing the pushbutton locks out BTR operation and initiates a BTW that reconfigures the module. Block transfer writes will continue for as long as the pushbutton remains closed.

Rungs 4 and 5
These rungs provide a "read-write-read" sequence to the module at power-up. They also make sure that only one block transfer (read or write) is enabled during a particular program scan.

Rungs 6 and 7
These rungs are the conditioning block transfer rungs. Include all the input conditioning shown in the example program.



[1] You can replace the pushbutton with a timer "done" bit to initiate the block transfer write on a timed basis. You can also use any storage bit in memory.

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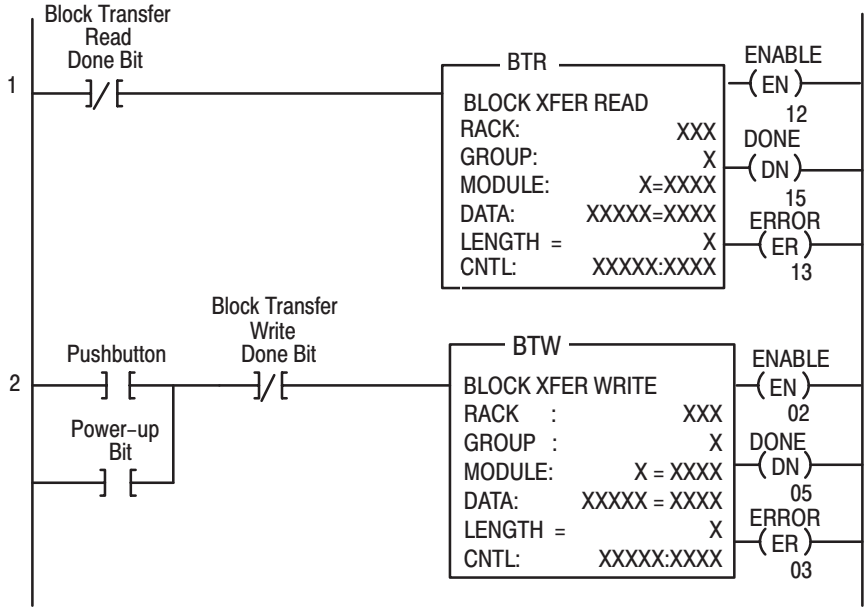
PLC-3 Programming

Block transfer instructions with the PLC-3 processor use one binary file in a data table section for module location and other related data. This is the block transfer control file. The block transfer data file stores data that you want transferred to your module (when programming a block transfer write) or from your module (when programming a block transfer read). The address of the block transfer data files are stored in the block transfer control file.

The industrial terminal prompts you to create a control file when a block transfer instruction is being programmed. **The same block transfer control file is used for both the read and write instructions for your module.** A different block transfer control file is required for every module.

A sample program segment with block transfer instructions is shown below.

Figure 3.2
PLC-3 Family Sample Program Structure



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Program Action

At power-up, the user program examines, the BTR done bit in the block transfer read file, initiates a block transfer write to configure the module, and then does consecutive block transfer reads continuously. The power-up bit can be examined and used anywhere in the program.

Rungs 1 and 2

Rungs 1 and 2 are the block transfer read and write instructions. The BTR done bit in rung 1, being false, initiates the first read block transfer. After the first read block transfer, the module performs a block transfer write and then does continuous block transfer reads until the pushbutton is used to request another block transfer write. After this single block transfer write is performed, the module returns to continuous block transfer reads automatically.

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PLC-5 Programming

The PLC-5 program is very similar to the PLC-3 program with the following exceptions:

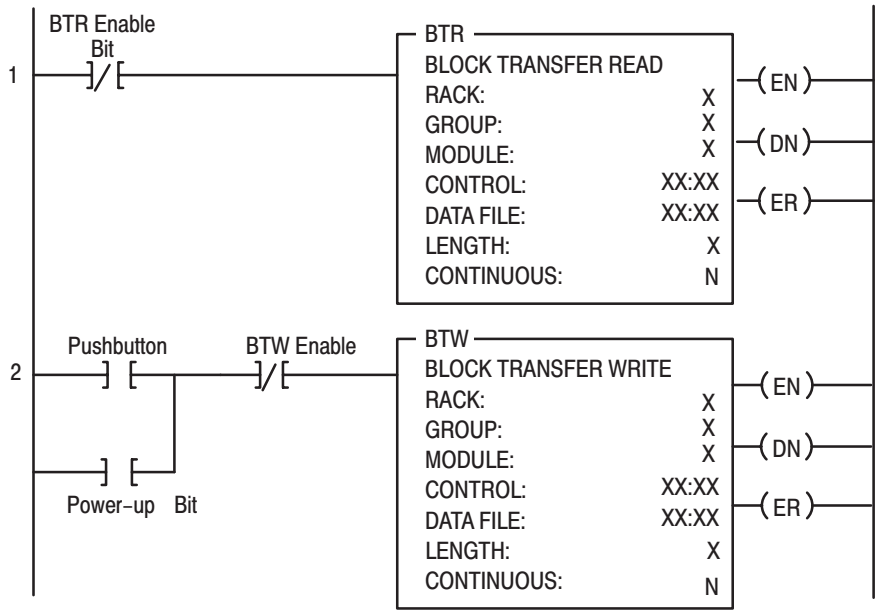
1. You must use enable bits instead of done bits as the conditions on each rung.
2. A separate control file must be selected for each of the block transfer instructions. Refer to Appendix B.

Figure 3.3
PLC-5 Family Sample Program Structure

Program Action

Rungs 1 and 2
At power-up, the program enables a block transfer read and examines the power-up bit in the BTR file (rung 1). Then, it initiates one block transfer write to configure the module (rung 2). Thereafter, the program continuously reads data from the module (rung 1).

A subsequent BTW operation is enabled by a pushbutton switch (rung 2). Changing processor mode will not initiate a block transfer write.



10956-I

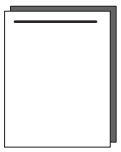
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Module Scan Time

Scan time is defined as the amount of time it takes for the input module to read the input channels and place new data into the data buffer. Scan time for your module is shown in Appendix A.

The following description references the sequence numbers in Figure 3.4.

Following a block transfer write “1” the module inhibits communication until after it has configured the data “2,” performed calibration check “3” (if requested), scanned the inputs “4,” and filled the data buffer “5.” Write block transfers, therefore, should only be performed when the module is being configured or calibrated.

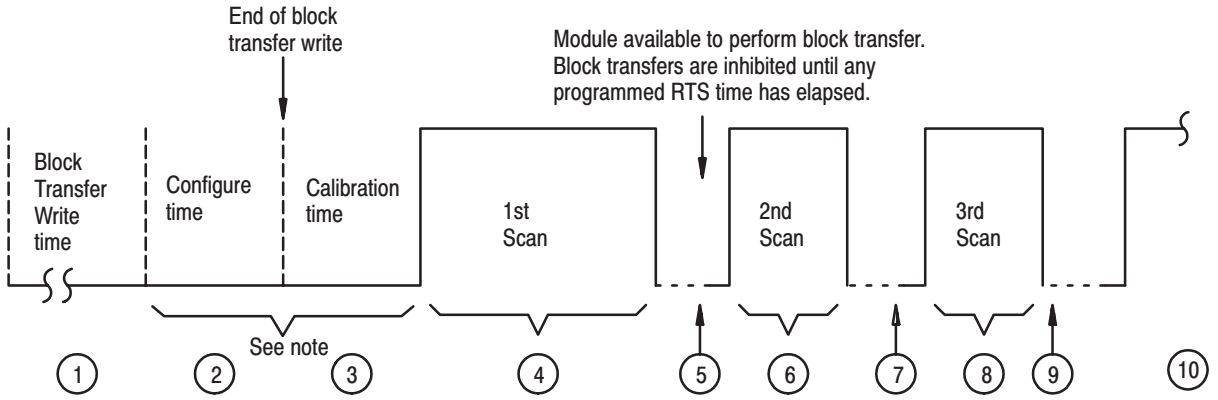


Any time after the second scan begins “6,” a BTR request “7” can be acknowledged. This interrupts the scan and the BTR empties the buffer. (If RTS is enabled, a BTR will only occur after the specified time period. Refer to chapter 4.)

Following the BTR, the input module inhibits block transfer communications with the programmable controller until it has scanned its inputs “8” and new data is ready ”9.” The input module repeats the scan sequence “10,” updating the input values until another block transfer request is received. Therefore, BTRs will only be completed as frequently as the total scan time of the input module.

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Figure 3.4
Block Transfer Time



Note: Configure/Calibration time:
Single-ended mode = 2s configure; 4.5s calibration
Differential mode = 1s configure; 2.5s calibration
Scan time:
= 13.7ms for 8 differential inputs (no scaling or digital filter);
= 27.4ms for 16 single-ended inputs (no scaling or digital filter)

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Chapter Summary

In this chapter, you learned how to program your programmable controller. You were given sample programs for your PLC-2, PLC-3 and PLC-5 family processors.

You also read about module scan time.

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Configuring Your Module

Chapter Objectives

In this chapter, we describe;

- configuring your module's features
- conditioning your inputs
- entering your data.

Configuring Your Input Module

Because of the many analog devices available and the wide variety of possible configurations, you must configure your module to conform to the analog device and specific application that you have chosen. Data is conditioned through a group of data table words that are transferred to the module using a block transfer write instruction. Before continuing, make sure you read "Setting the Configuration Plugs on the Module" in chapter 2.

The software configurable features available with the Analog Input Module (cat. no. 1771-IFE/C) are:

- input range selection
- input type
- data format
- digital filtering
- real time sampling
- scaling to engineering units
- calibration

Note that digital filtering and scaling values must be entered in BCD format only. Change your display format to BCD in the PLC-5 and PLC-3 to accomplish this.

Note: Programmable controllers that use 6200 software programming tools can take advantage of the IOCONFIG utility to configure this module. IOCONFIG uses menu-based screens for configuration without having to set individual bits in particular locations. Refer to your 6200 software literature for details.

Note: Programmable controllers that use process configuration and operation software (cat. no. 6190–PCO) can take advantage of those development and runtime tools used for the application of programmable controllers in process control. The PCO worksheets and the menu-driven configuration screens and faceplates let you configure, test/debug and operate the I/O module. Refer to your 6190-PCO software literature for details.

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During normal operation the processor transfers 1 to 39 words to the module when you program a block transfer write instruction to the module's address. This BTW file contains configuration words, and calibration words (words 38 and 39) for each channel.

When a block transfer transfer length of 0 is programmed, the 1771-IFE/C will respond with the series A default length of 37.

Input Range Selection

You can configure the module to operate with any of five voltage or three current ranges. You select individual channel ranges using the designated words of the block transfer write instruction (Table 4.A). Use BTW word 1 for range selection of channels 1 through 8, and BTW word 2 for channels 9 through 16. Two bits are allocated for each channel.

Table 4.A Input Range Selection Bits

Bit 01	Bit 00	Voltage or current input
0	0	1 to 5V dc, 4 to 20mA[1]
0	1	0 to 5V dc, 0 to 20mA[1]
1	0	-5 to +5V dc, -20 to +20mA[1,2]
1	1	-10 to +10V dc[2], 0 to 10V dc

[1] Current input mode selected by configuration plug.
[2] Configurable using bi-polar scaling.

Dec. Bits	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Description
Octal Bits	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	
Write Word 1	8		7		6		5		4		3		2		1		Range Selection - Channels 1 thru 8
Write Word 2	16		15		14		13		12		11		10		9		Range Selection - Channels 9 thru 16

Table 4.B shows the incremented voltage or current assigned to each bit for the seven different input ranges. For example, if the channel 1 input range is 0 to +5V and the actual incoming signal is at mid-range (+2.5V) the value in the module's data word would be 0000 1000 0000 0000 (binary) or 2048 (decimal). The input is 2048/4096, or 1/2 of full scale.

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Table 4.B Input Voltage and Current Ranges for the Analog Input Module

Nominal Voltage or Current Range	Corresponding 4-Digit BCD Output Range	Corresponding 12-Bit Binary Output Range	Voltage or Current Per Bit
+1 to +5V	0000 to +4095	0000 to + 4095	0.98mV
0 to 5V	0000 to +4095	0000 to +4095	1.22mV
-5 to +5V	-4095 to +4095	-4095 to +4095	1.22mV
-10 to +10V	-4095 to +4095	-4095 to +4095	2.44mV
0 to +20mA	0000 to +4095	0000 to +4095	.0049mA
+4 to +20mA	0000 to +4095	0000 to +4095	.0039mA
-20 to +20mA	-4095 to +4095	-4095 to +4095	.0049mA

Note: Voltage and current input ranges are selectable on a per channel basis.

Input Type

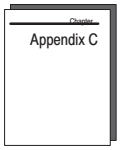
Select single-ended or differential inputs using the designated bit in the configuration file. Inputs to a particular module must be all single-ended or all differential. Set BTW word 3, bit 08 (bit 10 octal) as shown below.

Table 4.C Selecting Single-ended or Differential Inputs

Decimal Bit 8 (Octal Bit 10)	Input type
1	differential inputs
0	single-ended inputs

Dec. Bits	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Description
Octal Bits	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	
Write Word 3	Real Time Sampling					Data Format		Input Type	Digital Filter								Real time sampling, data format, input type and digital filter

Data Format



You must indicate what format will be used to read data from your module. Typically, you select BCD with PLC-2 processors, and 2's complement binary with PLC-3 and PLC-5 processors. See Appendix D for details on data format. You use BTW word 3, bits 09-10 (11-12 octal) to set the data format.

Table 4.D Selecting the Data Format

Decimal Bit 10 (Octal Bit 12)	Decimal Bit 09 (Octal Bit 11)	Data Format
0	0	BCD
0	1	Reserved
1	0	two's complement binary
1	1	signed magnitude binary

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Digital Filtering

The module has hardware-based high frequency filters on all channels to reduce the effect of electrical noise on the input signal. Software digital filtering is meant to reduce the effect of process noise on the input signal. Digital filtering is selected using BTW word 3, bits 00-07.

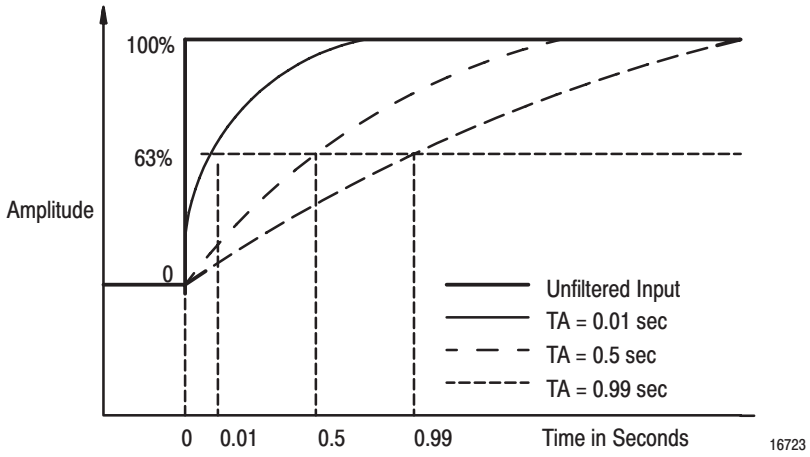
The digital filter equation is a classic first order lag equation (Figure 4.1). Using a step input change to illustrate the filter response (Figure 4.2), you can see that when the digital filter constant time elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.

Figure 4.1
Digital Filter Equation

$$Y_n = Y_{n-1} + \left[\frac{\triangle t}{\triangle t + TA} \right] (X_n - Y_{n-1})$$

Where:
Y_n = present output, filtered peak voltage (PV)
Y_{n-1} = previous output, filtered PV
$\triangle t$ = module channel update time (seconds)
TA = digital filter time constant (seconds)
X_n = present input, unfiltered PV

Figure 4.2
Digital Filter Lag Equation Illustration



Digital filter time constant values of 0.00 BCD to 0.99 BCD (0.00 BCD = no filter; 0.99 BCD = maximum filter) are set in bits 00 through 07 of word 3 of the block transfer write instruction. If an invalid digital filter value is entered (i.e., 0.1F), bit 02, word 1 of the block transfer read instruction will be set. If an invalid digital filter value is entered, the module will not perform digital filtering. If you use the digital filtering feature, the filter time constant value chosen will apply to all input signals.

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Real Time Sampling

The real time sampling (RTS) mode of operation provides data gathered at precisely timed intervals for use by the processor. BTW word 3 bits 11–15 (13–17 octal) are used to set the real time sampling interval.

RTS is invaluable for time based functions (such as PID and totalization) in the PLC. It allows accurate time based calculations in local or remote I/O racks. In the RTS mode the module scans and updates its inputs at a user defined time interval (T) instead of the default interval. The module ignores block transfer read (BTR) requests for data until the sample time period elapses. **The BTR of a particular data set occurs only once at the end of the sample period and subsequent requests for transferred data are ignored by the module until a new data set is available.** If a BTR does not occur before the the end of the next RTS period, a time-out bit is set in the BTR status area. When set, this bit indicates that at least one data set was not transferred to the processor. (The actual number of data sets missed is unknown.) The time-out bit is reset at the completion of the BTR.

Set appropriate bits in the BTW data file to enable the RTS mode. You can select RTS periods ranging from 100 milliseconds (ms) to 3.1 seconds. Refer to the table below for actual bit settings. Note that the default mode of operation is implemented by placing all zeroes in bits 11–15 (13–17 octal).

Table 4.E
Bit Settings for the Real Time Sample Mode

Decimal Bits	15	14	13	12	11	Sample Time Period	15	14	13	12	11	Sample Time Period
Octal Bits	17	16	15	14	13		17	16	15	14	13	
	0	0	0	0	0	No RTS, Default settings	1	0	0	0	0	1.6s
	0	0	0	0	1	100ms	1	0	0	0	1	1.7s
	0	0	0	1	0	200ms	1	0	0	1	0	1.8s
	0	0	0	1	1	300ms	1	0	0	1	1	1.9s
	0	0	1	0	0	400ms	1	0	1	0	0	2.0s
	0	0	1	0	1	500ms	1	0	1	0	1	2.1s
	0	0	1	1	0	600ms	1	0	1	1	0	2.2s
	0	0	1	1	1	700ms	1	0	1	1	1	2.3s
	0	1	0	0	0	800ms	1	1	0	0	0	2.4s
	0	1	0	0	1	900ms	1	1	0	0	1	2.5s
	0	1	0	1	0	1.0s	1	1	0	1	0	2.6s
	0	1	0	1	1	1.1s	1	1	0	1	1	2.7s
	0	1	1	0	0	1.2s	1	1	1	0	0	2.8s
	0	1	1	0	1	1.3s	1	1	1	0	1	2.9s
	0	1	1	1	0	1.4s	1	1	1	1	0	3.0s
	0	1	1	1	1	1.5s	1	1	1	1	1	3.1s
Default Settings =	Single-ended inputs - 25 ms Differential inputs - 12.5 ms											

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Scaling

Your module can perform linear conversion of unscaled data to engineering units, (for example; gallons/minute, degrees C, degrees F and pounds/square inch). Unscaled data in the module has a range of 0 through 4095 for the unipolar ranges (0 to 5V dc/0 to 20mA and 1 to 5V dc/4 to 20mA); and -4095 to +4095 (8190) for the bipolar ranges (±5V/±20mA and ±10V). BTW words 6 through 37 are the scaling words for channels 1 through 16. Channel 1 minimum scaling values are set in word 6, and maximum scaling values are set in word 7. Channel 2 minimum scaling values are set in word 8, and maximum scaling values are set in word 9, and so on for the other channels.

The format of this data is 4-digit BCD. The resolution at the module of scaled values is the same as for unscaled data: one part in 4095 for 0 to 5V dc/0 to 20mA and 1 to 5V dc/4 to 20mA ranges; and one part in 8190 for the ±5V/±20mA and ±10V ranges. Resolution at the processor, however, is determined by the scaled ranges (i.e., if 0 = minimum and 500 = maximum, resolution is now 1 part in 500). Each input channel can be scaled independently of the other channels.

Note: To achieve the 0 to +10V range you must use bipolar scaling. Select the ±10V range and scale for ± the actual intended range. If you need 0 to 100 gpm, set scaling values at -100 and +100. You will effectively be creating a 0 to 10V range that is scaled from 0 to 100.

Implementing the Scaling Feature

You implement the scaling feature by:inserting minimum and maximum scaled values in the appropriate configuration words using BCD format.

A. If any of the minimum or maximum values are negative, set the appropriate sign bits in the minimum or maximum sign bit word

B. If a single channel is scaled, all channels must be scaled, and all 37 configuration words must be written to the module.

Scaling Ranges

The maximum range of the scaling values is ±9999 BCD. **These values must be entered in BCD.**

Typically, invalid values are “minimum greater than maximum,” or “minimum equal to maximum.” **If invalid values are entered into the scaling words, the corresponding input in the BTR data will be zero and the invalid scaling bit will be set.**

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Important: **Scaling values must always be entered in BCD format,** even if the data format chosen is binary. If scaling is selected for any channel, all channels must be scaled. If scaling is not required on certain channels, set those to the default input range: 0 to 4095 for 0 to + voltage or current ranges, and -4095 to +4095 for - to + voltage or current ranges.

If scaling is not selected, the module requires specific minimum BTR file lengths for the number of channels used. The BTW file length can be set to 3 words. Table 4.F shows the required BTW and BTR file lengths.

Table 4.F
Block Transfer Read and Write File Lengths

Channels Used	BTR File Length	BTW File Length
1	5	7
2	6	9
3	7	11
4	8	13
5	9	15
6	10	17
7	11	19
8	12	21
9	13	23
10	14	25
11	15	27
12	16	29
13	17	31
14	18	33
15	19	35
16	20	37
Calibration Words	21	38
	22	39

Important: Use decimally addressed bit locations for PLC-5 processors.

The module will return values outside the scaling range. For example, if a module is in the 0–5V dc mode, scaled for 0 to 5000, and has –2V dc applied, it will return –2000.

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Default Configuration

If a write block of five words, with all zeroes, is sent to the Analog Input Module (cat. no. 1771-IFE series C), default selections will be:

- 1 to 5V dc or 4 to 20mA (dependent on configuration jumper setting)
- BCD data format
- no real time sampling (RTS)
- no filtering
- no scaling
- single-ended inputs

Table 4.G
Analog Input Module (1771-IFE/C) Block Transfer Write Configuration Block

Dec. Bits	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Description
Octal Bits	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	
Word 1	8		7		6		5		4		3		2		1		Range Selection - Channels 1 thru 8
2	16		15		14		13		12		11		10		9		Range Selection - Channels 9 thru 16
3	Real Time Sampling					Data Format		Input Type	Digital Filter								Real time sampling, data format, input type and digital filter
4	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Sign Bits, minimum scaling values
5	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Sign Bits, maximum scaling values
6																	Channel 1 - minimum scaling
7																	Channel 1 - maximum scaling
8																	Channel 2 - minimum scaling
9																	Channel 2 - maximum scaling
10																	Channel 3 - minimum scaling
	⇓								⇓				⇓				⇓
37																	Channel 16 - maximum scaling
38	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Offset Calibration
39	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Gain Calibration

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Bit/Word Descriptions for the Analog Input Module Block Transfer Write Configuration Block

Note that decimal bits are shown, with octal bits in parentheses.

<table>
<tr><th>Word</th><th>Decimal Bit (Octal Bit)</th><th colspan="3">Description</th></tr>
<tr><td rowspan="6">Words 1 and 2</td><td rowspan="6">Bits 00-15 (00-17)</td><td colspan="3">Input range selections allow the user to configure the inputs for any of 7 input voltage or current ranges. Two bits are required for each channel. Bits 00 and 01 for channel 1, bits 02 and 03 for channel 2, etc.</td></tr>
<tr><td>Bit 01</td><td>Bit 00</td><td>Voltage or Current Input</td></tr>
<tr><td>0</td><td>0</td><td>1 to 5V dc, 4 to 20mA (default)</td></tr>
<tr><td>0</td><td>1</td><td>0 to 5V dc, 0 to 20mA</td></tr>
<tr><td>1</td><td>0</td><td>-5 to +5V dc, -20 to +20mA</td></tr>
<tr><td>1</td><td>1</td><td>-10 to +10V dc, 0 to 10V dc</td></tr>
<tr><td rowspan="7">Word 3</td><td>Bits 00-07 (00-07)</td><td colspan="3">Digital filter reduces effect of noise on input. See ”Digital Filtering” on page 4–4. (Default is no filter.)</td></tr>
<tr><td>Bit 08 (10)</td><td colspan="3">Input type, set bit for differential mode on all channels.
Reset (0) = single-ended inputs (default)
Set (1) = differential inputs</td></tr>
<tr><td rowspan="5">Bits 09-10 (11-12)</td><td colspan="3">Data format – set to match your processor.</td></tr>
<tr><td>Bit 10 (12)</td><td>Bit 09 (11)</td><td>Data Format</td></tr>
<tr><td>0</td><td>0</td><td>BCD (default)</td></tr>
<tr><td>0</td><td>1</td><td>Reserved</td></tr>
<tr><td>1</td><td>0</td><td>Two’s complement binary</td></tr>
<tr><td>1</td><td>1</td><td>Signed magnitude binary</td></tr>
<tr><td>Bits 11-15 (13-17)</td><td colspan="3">Real time sampling – Default is no RTS. See appendix A for timing details. See Table 4.E for real time intervals.</td></tr>
<tr><td>Word 4</td><td>Bits 00-15 (00-17)</td><td colspan="3">Minimum sign bits, when set, designate negative minimum scaling values for the corresponding input channels. Bit 00 corresponds to channel 1, bit 01 corresponds to channel 2, etc.</td></tr>
<tr><td>Word 5</td><td>Bits 00-15 (00-17)</td><td colspan="3">Maximum sign bits, when set, designate maximum scaling values that are negative. Maximum scaling value must be greater than minimum on any particular channel. Bit 00 corresponds to channel 1, bit 01 corresponds to channel 2, etc.</td></tr>
<tr><td>Words 6 thru 37</td><td>Bits 00-15 (00-17)</td><td colspan="3">Minimum and maximum scaling values for each channel. Enter in BCD format.</td></tr>
<tr><td>Word 38</td><td>Bits 00-15 (00-17)</td><td colspan="3">Offset calibration – Each bit represents a channel (bit 00 to channel 1, bit 01 to channel 2, etc.). When the bit is set, and a BTW has been sent, the module will read the channels and adjust the offset to analog ground potential. In differential mode, bits 08 thru 15 (10 thru 17 in octal) are ignored. In current mode, apply 0mA.</td></tr>
<tr><td>Word 39</td><td>Bits 00-15 (00-17)</td><td colspan="3">Gain calibration – Each bit represents a channel (bit 00 to channel 1, bit 01 to channel 2, etc). When the bit is set, and a BTW has been sent, the module will read the channels and adjust the gain correction values. If used on +, 0 to 5, or 1 to 5V ranges, a value of 5V is expected. If used on +10V range, 10V is expected. In differential mode, bits 08 thru 15 (10 thru 17 in octal) are ignored. In current mode, apply 20mA.</td></tr>
</table>

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Chapter Summary

In this chapter you learned how to configure your module's features, condition your inputs and enter your data.

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Module Status and Input Data

Chapter Objectives

In this chapter, we describe:

- reading data from your module
- block transfer read block format

Reading Data From Your Module

Block transfer read programming moves status and data from the input module to the processor's data table in one I/O scan (Figure 5.1). The processor's user program initiates the request to transfer data from the input module to the processor.

Figure 5.1
Word Assignments for Analog Input Module (1771-IFE/C) Block Transfer Read

Dec. Bits	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Description
Octal Bits	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	
Word 1										HF	EE	CS	RTS	IS	OR	PU	Diagnostics
2	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Data underrange for channels 1–16[1]
3	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Data overrange for channels 1–16[1]
4	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Data polarity for channels 1–16
5	Channel 1 Input																Channel 1 Input
6	Channel 2 Input																Channel 2 Input
7	Channel 3 Input																Channel 3 Input
8	Channel 4 Input																Channel 4 Input
	⇓									⇓	⇓				⇓		
20	Channel 16 Input																Channel 16 Input
21	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Offset Calibration Results
22	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Gain Calibration Results

Where: PU = Power up bit
OR = Out of range bit
IS = Invalid scaling bit
RTS = Real time sampling bit
HF = Hardware Fault
EE = EEPROM status bits
CS = Calibration status bits

[1] These bits are set (1) at approximately the input range limits selected (Table 5.B).

During normal operation, the processor transfers up to 20 words (22 during calibration) to the module when you program a BTR instruction to the module's address.

When a BTR length of 0 is programmed, the 1771-IFE/C will respond with the series A module default length of 20.

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Block Transfer Read Format

The bit/word description for the block transfer read of the Analog Input Module is described below.

Table 5.A
BTR Word Format for the Analog Input Module

Word	Decimal Bit (Octal Bit)	Description
Word 1	Bit 00	**Power up bit (PU)** – Used by the module to tell the processor that it is alive but not yet configured. It is a key element in the application program.
	Bit 01	**Out of range bit (OR)** – This bit is sent to tell the processor that one or more channels are either over or under range.[1]
	Bit 02	**Invalid scaling bit (IS)** – This bit reports that the scaling is somehow invalid. Usually, both values are equal or minimum is greater than maximum when this bit comes on. Can also be an **invalid filter** value.
	Bit 03	**Real time sample fault bit (RTS)** – This bit is set if the module is configured for RTS and a block transfer read has not occurred within the user–programmed period.
	Bit 04	**Calibration status bit (CS)** – When calibrating the module, this bit will be cleared if the calibration was successful. If the bit is set, an incorrect voltage/current was applied, or offset and gain calibrations were attempted simultaneously.
	Bit 05	**EEPROM status bit (EE)** – This bit is set if an error occurs saving calibration data to nonvolatile memory. If this bit is set at powerup, the data from the EEPROM did not pass the checksum and no calibration values are used.
	Bit 06	**Hardware fault (HF)** – When this bit is set, the dc/dc converter fuse has blown. Digital logic will continue to operate.
	Bits 07–15 (07–17)	Not used.
Word 2	Bits 00–15 (00–17)	**Underrange bits** for each channel. Bit 00 for channel 1, bit 01 for channel 2, etc.[1] These bits are set (1) at approximately the input range limits selected from Table 5.B.
Word 3	Bits 00–15 (00–17)	**Overrange bits** for each channel. Bit 00 for channel 1, bit 01 for channel 2, etc.[1] These bits are set (1) at approximately the input range limits selected from Table 5.B.
Word 4	Bits 00–15 (00–17)	**Polarity bits** – Set when input is less than zero. Bit 00 for channel 1, bit 01 for channel 2, etc.
Word 5 thru 20		**Input values** – Word 5 for channel 1, word 6 for channel 2, etc.
Word 21	Bits 00–15 (00–17)	**Offset calibration results bits** – Each bit represents a channel. After a calibration BTW has been sent, the module confirms calibration by echoing back the channels that were calibrated during the offset calibration BTW. In differential mode, channels 09 thru 16 are zero.
Word 22	Bits 00–15 (00–17)	**Gain calibration results bits** – Each bit represents a channel. After a calibration BTW has been sent, the module confirms calibration by echoing back the channels that were calibrated during the gain calibration BTW. In differential mode, channels 09 thru 16 are zero.

[1] **Attention:** If an input terminal's voltage exceeds ±14.25V as referenced to module common, channel-to-channel crosstalk can cause invalid input readings and invalid underrange/overrange bits.

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Table 5.B
Input Range Selection

Voltage input	Current input[1]
1 to 5V dc	4 to 20mA
0 to 5V dc	0 to 20mA[1]
–5 to +5V dc	–20 to +20mA[2]
–10 to +10V dc[2]	
0 to 10V dc	

[1] Current input mode selected by configuration plug.
[2] Configurable using bi–polar scaling.

Chapter Summary

In this chapter you learned the meaning of the status information that the input module sends to the processor.

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Calibrating Your Module

Chapter Objective

In this chapter, we describe:

- checking your calibration
- calibrating your module.

When and How to Calibrate Your Analog Input Module

Your module is shipped to you already calibrated. If you are checking calibration, or if it becomes necessary to recalibrate the module, you must do so with the module in an I/O chassis. The module must communicate with the processor and industrial terminal.

Before calibrating the module, you must enter ladder logic into the processor memory, so that you can initiate BTWs to the module, and the processor can read inputs from the module.

Periodically (frequency based on your application), check your module calibration. Calibration may be required to remove module error due to aging of components in your system.

Calibration can be accomplished using either of two methods:

- manual calibration, as described below.
- 6200 I/O CONFIGURATION software – refer to your 6200 software publications for procedures for calibrating.

When calibrating your module, you must perform:

- offset calibration first
- gain calibration second

Tools and Equipment

In order to calibrate your input module you will need the following tools and equipment:

Tool or Equipment	Description	Model/Type	Available from:
Precision Voltage Source	0–100mV, 1μV resolution	Analogic 3100, Data Precision 8200 or equivalent	
Industrial Terminal and Interconnect Cable	Programming terminal for A–B family processors	Cat. No. 1770–T3 or Cat. No. 1784–T45, –T47, –T50, etc.	Allen–Bradley Company Highland Heights, OH

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Checking Module Calibration

If a calibration check of your module becomes necessary:

1. Verify that the module is in voltage mode. In single-ended mode, apply voltages to channels 1 through 16.
2. Send a configuration block transfer write to the module that replicates the specific application. (This forces the module to do an internal calibration.)
3. Apply –10V, –5V, –2.5V 0V, 1V, 2.5V, 5V, and 10V to the module. In differential, apply voltages to channels 1 through 8

   Verify that the values returned are within 0.1% of bipolar full scale. .

Range	Scaling	Accuracy (V/mA)
0 to 5V	0, 5000	±0.010V
1 to 5V	1000, 5000	
–5 to +5V	–5000, 5000	
–10 to +10V	–9999, 9999	±0.020V
4 to 20mA	400, 2000	±0.04mA
0 to 20mA	0, 2000	
–20 to +20mA	–2000, 2000	

Range	Error (counts) (no scaling)
0 to 5V	±4
1 to 5V	±4
–5 to +5V	±8
–10 to +10V	±8
4 to 20mA	±4
0 to 20mA	±4
–20 to +20mA	±4

4. If values are within tolerance, no calibration is necessary. If not, perform calibration below.

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Calibrating your Input Module

The analog input module is shipped **already calibrated.** Calibration of the module consists of applying a voltage or current across each input channel for offset and gain calibration. Offset and gain values are shown in the following table.

Table 6.A
Offset and Gain Values for Calibrating the 1771-IFE series C Analog Input Module

	Single-ended		Differential	
Range	**Offset Value**	**Gain Value**	**Offset Value**	**Gain Value**
1 to 5V – 4mV	0V	5.000V	0V	5.000V
0 to 5V – 5mV	0V	5.000V	0V	5.000V
–5 to +5V	0V	5.000V	0V	5.000V
–10 to +10V	0V	10.000V	0V	10.000V
0 to 10V	0.V	10.000V	0V	10.000V
4 to 20mA	0.000mA	20.000mA	0.000mA	20.000mA
0 to 20mA	0.000mA	20.000mA	0.000mA	20.000mA
–20 to +20mA	0.000mA	20.000mA	0.000mA	20.000mA

Offset Calibration

Normally all inputs are calibrated together. To calibrate the offset of an input, proceed as follows:

1. Apply power to the module.
2. Apply the offset voltage of 0V or current of 0.000mA (Table 6.A) as required to all 16 channels.
3. After the connections stabilize, set all bits in write word 38 to 1 and all bits in word 39 to 0. Send a 39 word block transfer write (BTW) to the module to calibrate the offset. Refer to chapter 4. (In Differential mode, the upper byte of word 38 is not set (bits 8–15 decimal or 10–17 octal are 0).)

   When the BTW is sent, all channels are calibrated to 0.000V.

Write Block Transfer Word 38 for Offset Calibration

Decimal Bits	**15**	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Octal Bits	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Channel	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Word 38	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

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The BTR echoes back the status of each of the channels to verify calibration. If selected channels were calibrated satisfactorily, the BTR will reflect this by having their bits set to 1. (In Differential mode, the upper byte of word 21 in the BTR is not set (bits 8–15 decimal or 10–17 octal are 0).)

Read Block Transfer Word 21

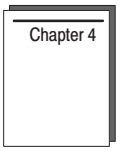
Decimal Bits	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Octal Bits	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Channel	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Word 21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

4. Proceed to Gain Calibration below.

Gain Calibration

Calibrating gain requires that you apply 5.000V, 10.000V or 20mA (as determined by your range and mode) (Table 6.A) across each input channel.

1. Apply power to the module.
2. Apply the gain voltage as shown in Table 6.A to all 16 channels (single-ended) or 8 channels (differential).
3. After the connections stabilize, request the gain calibration by sending a 39 word block transfer write (BTW) to the module. Refer to chapter 4.



When the BTW is sent, all selected channels are calibrated (set to 1) shown in Table 6.A. If a channel is not selected for calibration, its bit is 0. (In Differential mode, the upper byte of word 39 is not set (bits 8–15 decimal or 10–17 octal are 0).) All bits in word 38 will be set to 0.

Write Block Transfer Word 39 for Gain Calibration

Decimal Bits	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Octal Bits	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Word 39	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

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The BTR echoes back the status of each of the channels to verify the calibration. If all channels were calibrated satisfactorily, the BTW will reflect this by having all bits set to 1.

Read Block Transfer Word 22

Decimal Bits	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Octal Bits	**17**	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Word 22	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Chapter Summary

In this chapter, you learned how to calibrate your input module.

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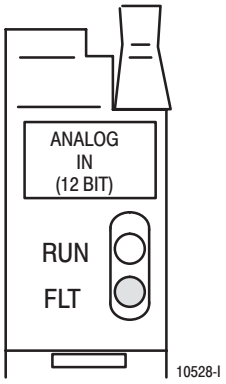
Troubleshooting Your Input Module

Chapter Objective

In this chapter, we describe how to troubleshoot your module by:

- observing the indicators
- monitoring status bits reported to the processor.
- checking module operation
- checking for common mode voltages
- isolating a bad input

Diagnostics Reported by the Module



At power-up, the module momentarily turns on the red indicator as a lamp test, then checks for:

- correct RAM operation
- firmware errors

Thereafter, the module lights the green RUN indicator when operating without fault, or lights the red FAULT indicator when it detects fault conditions. The module also reports status and specific faults (if they occur) in every transfer of data (BTR) to the PC processor. Monitor the green and red indicators and status bits in word 1 of the BTR file when troubleshooting your module.

Diagnostic Bits Reported By the Analog Input Module

Diagnostic bits in the read block transfer status words provide diagnostic capabilities.

Word 1 provides power-up and valid data status. **Words 2, 3 and 4** provide channel data status.

If a module on-board self test fault occurs, block transfers will be inhibited, the red fault (FLT) will light, and the green run (RUN) light will go out.

Word 1
Diagnostics word 1 is the first data word in the read block transfer file for transfer to the central processor. It contains a **power-up bit** (bit 00) that is set (1) when the module is first powered up. It is reset (0) after a write block transfer. It also contains an **under-range or over-range bit** (bit 01) that is set when any input is under or over-range.

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An **invalid scaling data bit** (bit 02) is set if invalid scaling data is entered into any of the minimum/maximum scaling value words. **Note that minimum equal to maximum is an invalid value.** If invalid values are entered into the minimum or maximum scaling words the corresponding read block transfer input channel word will be set to 0000.

Bit 02 is set if an invalid digital filter value is entered (e.g., 1F). If an invalid digital filter value is entered, the module will not perform digital filtering.

The **real time sample (RTS) fault bit** (bit 03) is set if the module is configured for RTS and a block transfer read has not occurred within the user-programmed period.

Bit 04 is the **calibration status bit**. This bit is reset (0) when a successful calibration is completed. If the bit is set (1), an incorrect voltage/current was applied, or offset and gain calibrations were attempted together.

The **EEPROM status bit** (05) is set when an error occurs when saving calibration data to nonvolatile memory. If this bit is set at powerup, the EEPROM data did not pass checksum and calibration values are being used.

The **hardware failure bit** (06) is set when a blown fuse is detected, or when the EEPROM can’t recover from a fault.

Word 2
Word 2 provides for under-range conditions. When a particular channel input is under-range, the associated bit will be set. As long as inputs are under range the associated bit remains set. Bit 00 corresponds to channel 1, bit 01 to channel 2, etc.

Word 3
Word 3 provides for over-range conditions. When a particular channel input is over-range, the associated bit will be set. As long as inputs are in range the associated bit remains reset. Bit 00 corresponds to channel 1, bit 01 to channel 2, etc.

Word 4
Word 4 provides an indication of a particular channel’s input polarity (set, or 1 = negative; reset, or 0 = positive). Bit 00 corresponds to channel 1, bit 01 to channel 2, etc.

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The following table lists the probable cause and recommended actions for some common trouble indications.

Troubleshooting Chart for Analog Input Module (1771-IFE/C)

Legend

- ○ Off
- ● On
- ✕ Blinking

Indicators	Probable Cause	Recommended Action
● RUN (green) ○ FLT (red)	Normal operation	None
✕ RUN (blinking) ○ FLT (off)	Awaiting configuration Block Transfer Write	Send configuration BTW
○ RUN (green) ● FLT (red)	Hardware failure in module	Return module for repair
○ RUN Neither LED ○ FLT comes on	No power	Turn off power. Remove and reinsert module into chassis. Return power. If problem still exists, and chassis power supply is functioning properly, return the module for repair.

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CheckingModule Operation

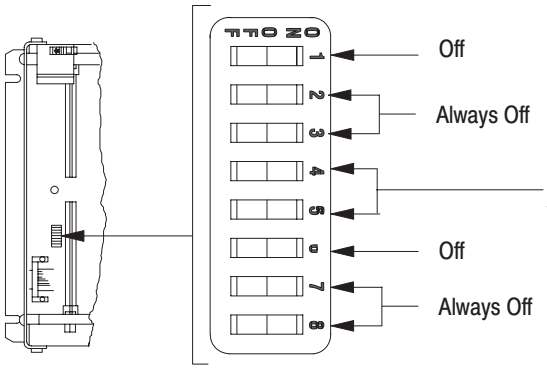
The following allows you to run a check on module operation, and isolate a fault either to the module or external to the module.

Connect the Module in a Simple Test System

Set up a 1771 I/O chassis with a PLC-5 processor in the leftmost slot.

1 Set the chassis backplane switch 5 to ON. All other backplane switches to Off.
This sets the chassis to 1-slot addressing.

Note: Check the processor screen to verify that the processor is set for 1-slot addressing.



Switches		Addressing
4	5	
OFF	OFF	2-slot
OFF	ON	1-slot
ON	OFF	1/2 slot
OFF	OFF	

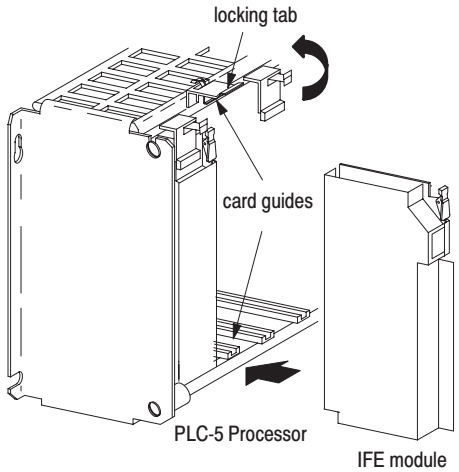
Pressed in on right ON (closed)

Pressed in on left OFF (open)

2 Place the module in the card guides on the top and bottom of the first slot next to the processor. These slots guide the 1771-IFE/C module into position.

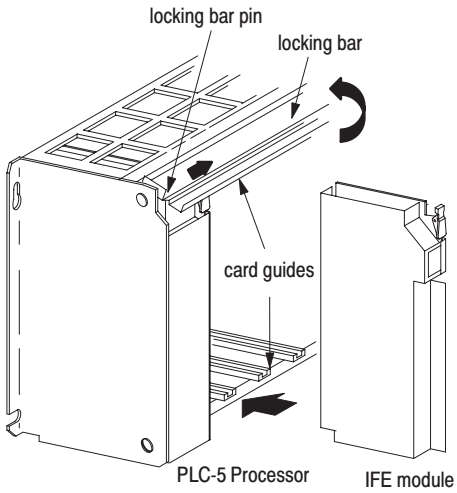
Important: Apply firm even pressure on the module to seat it into its backplane connector.

1771-A1B, -A2B, -A3B, -A3B1, -A4B I/O chassis



Snap the chassis latch over the top of the module to secure it.

1771-A1B, -A2B, -A3B1, -A4B Series B I/O chassis



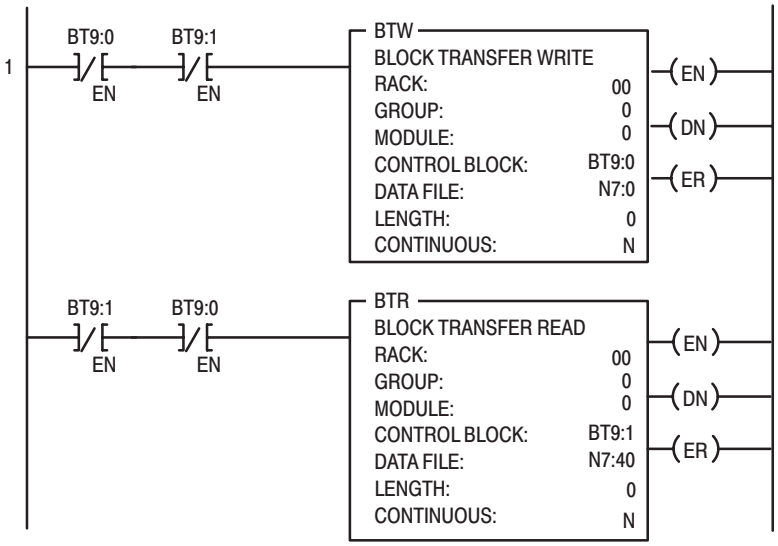
Swing the chassis locking bar down into place to secure the modules. Make sure the locking pins engage. 19809

After inserting the module into the slot, apply power to the chassis.

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3 Enter the following ladder logic into the processor.

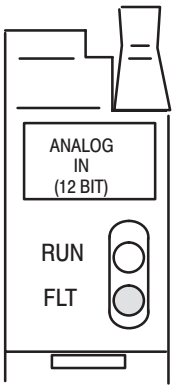
Note: This programming is only to test the block transfer write and read functions. It is not intended for regular use.



4 The module lights the green RUN indicator when operating without fault, or lights the red FAULT indicator when it detects fault conditions.

If the module is operating correctly, the module will be receiving BTRs and sending BTWs. The indicator light will indicate green/flashing green.

If the indicator is blinking green, the module has not received a configuration block transfer write.



5 This configuration sets the IFE module for:

1-5V range
Single-ended inputs
BCD data format
No digital filter
No real time sampling
0–4095 scaling

Monitor the status bits in word 1 of the BTR file when troubleshooting your module.

Write block transfer configuration data

Read block transfer data

Note: $16533_{10} = 4095_{16}$ (BCD)

Block Transfer Write

Data Table Report		PLC-5/11		Addr 4 IFE				Data Table File N7:0		
ADDRESS	0	1	2	3	4	5	6	7	8	9
N7:0	0	0	0	0	0	0	16533	0	16533	0
N7:10	16533	0	16533	0	16533	0	16533	0	16533	0
N7:20	16533	0	16533	0	16533	0	16533	0	16533	0
N7:30	16533	0	16533	0	16533	0	16533	0	0	0
N7:40	2	–1	0	0	0	0	0	0	0	0
N7:50	0	0	0	0	0	0	0	0	0	0
N7:60	0	0	0	0	0	0	0	0	0	0
N7:70	0	0	0	0	0	0	0	0	0	0
N7:80	0	0	0	0	0	0	0	0	0	0
N7:90	0	0	0	0	0	0	0	0	0	0
N7:100	0	0	0	0	0	0	0	0	0	0

Note: If all input terminals are shorted together and tied to module common, the input data for all channels will read zero.

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6 The module also reports status and specific faults (if they occur) in every transfer of data (BTR) to the PC processor. Monitor the green and red indicators and the status bits in word 1 of the BTR file when troubleshooting your module.

Block transfer control files

Data Table Report PLC-5/11 Addr 4 IFE Data Table File N7:0

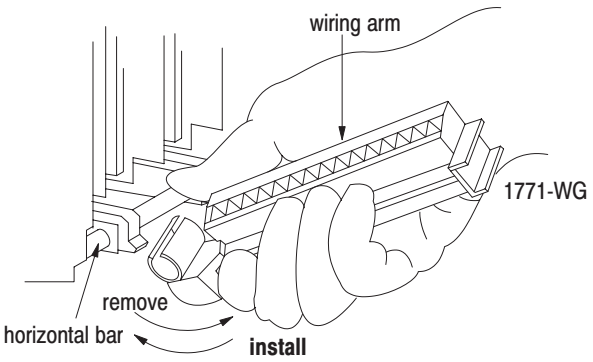
ADDRESS	EN	ST	DN	ER	CO	EW	NR	TO	RW	RLEN	DLEN	FILE	ELEM	R	G	M
BT9:0	0	1	1	0	0	1	1	0	0	0	37	7	0	0	0	0
BT9:1	1	1	0	0	0	1	1	0	1	0	20	7	40	0	0	0
BT9:2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Memory Map Report PLC-5/11 Addr 4 IFE Data Table File N7:0

FILE	TYPE		LAST ADDRESS	SIZE (elements)	SIZE (words)
0	O	output	O:037	32	38
1	I	input	I:037	32	38
2	S	status	S:127	128	134
3	B	binary or bit	B3/15	1	7
4	T	timer	T4:0	1	9
5	C	counter	C5:0	1	9
6	R	control	R6:0	1	9
7	N	integer	N7:103	104	110
8	F	floating point	F8:0	1	8
9	BT	block transfer	BT9:2	3	24

7 Attach the wiring arm (1771-WG) to the horizontal bar at the bottom of the I/O chassis.

The wiring arm pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.



After connecting the field wiring arm to the module, proceed to check the module operation when receiving inputs.

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Checking for Common Mode Voltages

Common mode voltage on any input must not exceed ±14.25V as referenced to module common (terminals 20 and 21). Common mode voltages occur when the ground potentials of current transmitter and/or voltage device power sources are at differential potentials (as referenced to module common). The resulting ground currents can cause voltage potentials at the input terminals.

Observe the following guidelines whenever possible to prevent common mode voltages:

- use single-ended mode
- use 2-wire transmitters with a common power supply
- separate 2-wire and 4-wire transmitters between different modules
- tie 4-wire transmitter and/or separate power supply grounds together

Affect of Common Mode Voltage on Inputs

If common mode voltage exceeds ±14.25V on any input, channel to channel crosstalk can occur. All channel input data in the programmable controller data table could be invalid. Incorrect overrange and underrange bits could also occur

Data Table Report PLC-5/11 Addr 4 IFE Data Table File N7:0

ADDRESS	0	1	2	3	4	5	6	7	8	9
N7:0	0	0	0	0	0	0	16533	0	16533	0
N7:10	16533	0	16533	0	16533	0	16533	0	16533	0
N7:20	16533	0	16533	0	16533	0	16533	0	16533	0
N7:30	16533	0	16533	0	16533	0	16533	0	0	0
N7:40	2	–1	0	0	0	0	0	0	0	0
N7:50	0	0	0	0	0	0	0	0	0	0
N7:60	0	0	0	0	0	0	0	0	0	0
N7:70	0	0	0	0	0	0	0	0	0	0
N7:80	0	0	0	0	0	0	0	0	0	0
N7:90	0	0	0	0	0	0	0	0	0	0
N7:100	0	0	0	0	0	0	0	0	0	0

Normal block transfer read with all channels connected to module common

Data Table Report PLC-5/11 Addr 4 IFE Data Table File N7:0

ADDRESS	0	1	2	3	4	5	6	7	8	9
N7:0	0	0	0	0	0	0	16533	0	16533	0
N7:10	16533	0	16533	0	16533	0	16533	0	16533	0
N7:20	16533	0	16533	0	16533	0	16533	0	16533	0
N7:30	16533	0	16533	0	16533	0	16533	0	0	0
N7:40	2	–2	1	0	16533	0	0	0	0	0
N7:50	0	0	0	0	0	0	0	0	0	0
N7:60	0	0	0	0	0	0	0	0	0	0
N7:70	0	0	0	0	0	0	0	0	0	0
N7:80	0	0	0	0	0	0	0	0	0	0
N7:90	0	0	0	0	0	0	0	0	0	0
N7:100	0	0	0	0	0	0	0	0	0	0

Block transfer read with channel 1 input <14.25V and all channels connected to module common

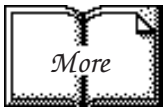
Block transfer read with channel 1 input approximately 20V and all channels connected to common

Data Table Report PLC-5/11 Addr 4 IFE Data Table File N7:0

ADDRESS	0	1	2	3	4	5	6	7	8	9
N7:0	0	0	0	0	0	0	16533	0	16533	0
N7:10	16533	0	16533	0	16533	0	16533	0	16533	0
N7:20	16533	0	16533	0	16533	0	16533	0	16533	0
N7:30	16533	0	16533	0	16533	0	16533	0	0	0
N7:40	2	–21846	1	0	16533	0	5950	0	5950	0
N7:50	5950	0	5950	0	5950	0	5950	0	5950	0
N7:60	0	0	0	0	0	0	0	0	0	0
N7:70	0	0	0	0	0	0	0	0	0	0
N7:80	0	0	0	0	0	0	0	0	0	0
N7:90	0	0	0	0	0	0	0	0	0	0
N7:100	0	0	0	0	0	0	0	0	0	0

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A noise spike which exceeds ±14.25V on an input will also cause crosstalk to occur. This transient condition will affect all inputs. Refer to publication 1770-4.1, “Wiring and Grounding Guidelines for Noise Immunity.”



Troubleshooting a Bad Input

After determining that the module is operating correctly, troubleshoot any faulty inputs by:

- measuring each input with respect to module common
- disconnecting inputs from the field wiring arm one at a time while observing module action
- testing for input channel functionality

Measuring Each Input with Respect to Module Common

During this procedure, monitor the input data table of the programmable controller and observe any changes which occur.

1. Make sure the field wiring arm is in position on the module.
2. Apply power to the 1771 I/O chassis.
3. Check each input (either single-ended or differential) for common mode voltages exceeding ±14.25V with respect to module common.
   - **A.** Hold the positive probe of the voltmeter on the first input terminal.
   - **B.** Hold the negative probe of the voltmeter on a module common terminal (terminals 20 or 21).
4. If any voltage is seen that exceeds ±14.25V, remove that channel’s input wiring and observe the affect on the input data table of the programmable controller.



ATTENTION: Remove power from the 1771 I/O chassis backplane and field wiring arm before removing or installing input wiring.

- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

If no other common mode voltages are present, the input data for all other channels should stabilize to some predictable value.

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5. Attempt to equalize all grounds at the offending channel before reconnecting the input wiring.



ATTENTION: Remove power from the 1771 I/O chassis backplane and field wiring arm before removing or installing input wiring.

- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

6. If the common mode voltage cannot be removed on the input, an isolation device may be required on that channel.

Disconnecting Inputs from the Field Wiring Arm One at a Time While Observing Module Action

During this procedure, monitor the input data table of the programmable controller and observe any changes which occur.

1. Make sure the field wiring arm is in position on the module.
2. Apply power to the 1771 I/O chassis.
3. While observing the input data table, remove one input at a time.



ATTENTION: Remove power from the 1771 I/O chassis backplane and field wiring arm before removing or installing input wiring.

- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

4. When the offending input channel is disconnected, the input data table will stabilize to some predictable values.

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Testing for Input Channel Functionality

To test the functionality of an input channel:

1. Remove the input wiring from the field wiring arm.

ATTENTION: Remove power from the 1771 I/O chassis backplane and field wiring arm before removing or installing input wiring.

- Failure to remove power from the backplane or wiring arm could cause module damage, degradation of performance, or injury.
- Failure to remove power from the backplane could cause injury or equipment damage due to possible unexpected operation.

2. Connect a battery (or other voltage source) across the input terminals. When the 4-20mA range is selected, the voltage source must not exceed 1-5V.

ATTENTION: The voltage source must be within the selected voltage range. If the source voltage is greater than the selected voltage range of the input, module damage will result.

3. Monitor the input data table for predictable values.(values relative to the input source voltage).

Chapter Summary

In this chapter you learned how to interpret the indicator lights, and troubleshoot your input module.

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Specifications

Description	Value
Inputs per module	16 single–ended; 8 differential low level
Module Location	1771 I/O rack – 1 slot
Input voltage ranges (nominal)	+1 to +5V dc 0 to +5V dc –5 to +5V dc –10 to +10V dc 0 to +10V dc
Input current ranges (nominal)	+4 to +20mA 0 to +20mA –20 to +20mA
Resolution	12–bit binary 12 bits plus sign on bipolar ranges
Accuracy	0.1% of full scale range @ 25°C
Linearity	±1 LSB
Repeatability	±1 LSB
Isolation Voltage	Isolation meets or exceeds the requirements of UL Standard 508, and CSA Standard C22.2 No. 142.
Input overvoltage protection	200V (voltage mode)[1] 8V (current mode)[2]
Input overcurrent protection (current ranges)	30mA
Common mode voltage	±14.25 Volts
Input impedance	>10 Megohms for voltage ranges; 250 ohms for current ranges
Common mode rejection	80 db, dc–120Hz
Current Requirements	500mA @ +5V from I/O chassis backplane
Temperature Coefficient	±50ppm/°C of full scale
Power Dissipation	2.5 Watts (maximum)
Thermal Dissipation	8.52 BTU/hr (maximum)
Unscaled BCD and binary output to processor	0000 to $+4095_{10}$ for polar ranges (0 to 5V, +1 to +5V, 0 to +20mA, and +4 to +20mA) -4095_{10} to 4095_{10} for bipolar ranges (±5V, ±10V, ±20mA)
Engineering units sent to processor	$\pm 9999_{10}$ with selectable scaling
Internal scan rate	13.7ms for 8 differential inputs (no digital filtering) –add 0.3ms for filtering 27.4ms for 16 single–ended input (no digital filtering) –add 0.3ms for filtering
Specifications continued on next page	

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Description	Value
Environmental conditions operational temperature: storage temperature: relative humidity: Operating Storage	 0 to 60^{0}C (32 to 140^{0}F) –40 to 85^{0}C (–40 to 185^{0}F) 5 to 95% (without condensation) 5 to 85% (without condensation)
Conductors Wiring Category	14 gauge (2mm^2) stranded (max.) 3/64 inch (1.2mm) insulation (max.) Category 2[3]
Keying	between 10 and 12 between 24 and 26
Wiring Arm	Catalog Number 1771–WG
Field Wiring Arm Screw Torque	7-9 inch-pounds
Agency Certification (when product is marked)	• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed • CE marked for all applicable directives
Installation Instructions	1771-5.45

[1] The inputs are protected to 200V. However, if an input terminal's voltage exceeds ±14.25V as referenced to module common, channel-to-channel crosstalk can cause invalid input readings and invalid underrange/overrange bits.
[2] Only 8 volts can be placed directly across the input when configured in the current mode.
[3] Refer to publication 1770–4.1, "Programmable Controller Wiring and Grounding Guidelines."

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Differences Between Series A and B Modules and Series C Modules

The following is a list of the major differences between the Series A and B 1771-IFE modules and the series C 1771-IFE module

Figure B.1
Differences Between 1771-IFE Series A and B and 1771-IFE Series C Modules

Feature	Series A, and B	Series C
Indicator lights	1. At power–up, the green run indicator comes on and stays on. 2. Limited to 3 bits of diagnostic information	1. At powerup, the green run indicator blinks until a configuration BTW is received. After a configuration BTW is received, the green indicator stay on. 2. Has 6 bits of diagnostic information representing 6 possible faults.
Input Data	Input clamped at range ends. Will not go above or below range limits.	Returns input data above and below the range end points. For example, a 1–5V input with default scaling will return all values between +5.2V. Jumper settable for Series A and B simulation to internally limit input to range end points.
Default Scaling		Allows default scaling with both maximum and minimum scaling values as zero. No scaling error will be reported.
Block Transfer Lengths	Maximum block transfers lengths of 20 words for BTR and 37 words for BTW. Default length of 0 words.	Maximum block transfers lengths of 22 words for BTR and 39 words for BTW (due to autocalibration). Default length of 0 words (same as series A).
Configuration Plugs	24 configuration plugs to set on 3 row headers.	16 configuration plugs to set on eight 2 row headers.
Compatibility	The series A and B modules are compatible with the 1771-AL PLC local adapter.	The series C module is **not compatible** with the 1771-AL PLC local adapter.
Calibration Procedures	Used jumpers and potentiometers to adjust 10V reference and null input offset.	Uses precision voltage source to supply voltage and a block transfer to set offset and gain.
Agency Approvals	Series A module not CE certified. Series B module CE certified.	Series C module CE certified.

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Programming Examples

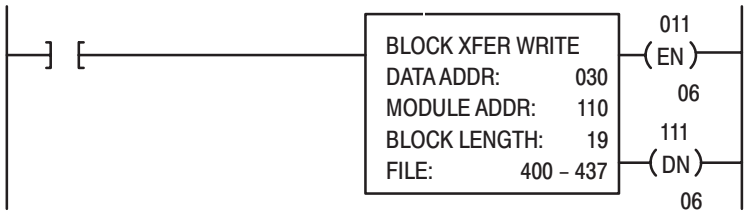
Sample Programs for the Analog Input Module

The following are sample programs for entering data in the configuration words of the write block transfer instruction when using the PLC-2, PLC-3 or PLC-5 family processors.

PLC-2 Family Processors

To enter data in the configuration words, follow these steps:

Example:
Enter the following rung for a write block transfer:



400 is the address of the write block transfer data file. You want to examine configuration word 1.

Step	Action	Description
1.	Press [SEARCH]8<data address>	Finds the block transfer instruction
2.	Press CANCEL COMMAND	Removes preceding command
3.	Press [DISPLAY]0 or 1	Displays the file in binary or BCD
4.	Move cursor to data to be modified	
5.	Enter new data	
6.	Press [INSERT]	Writes data to file element

Use the above procedure to enter the required words of the write block transfer instruction. Be aware that the block length will depend on the number of channels selected and whether scaling is or is not performed; for example, the block may contain only 3 words if no scaling is performed but may contain 37 words if using 16 inputs with scaling.

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The PLC-2 family write block transfer data file should look like Figure C.1.

Figure C.1 Write Block Transfer Data Transfer for a PLC-2 Family Processor

DATA ADDR: 030

BINARY DATA MONITOR
BLOCK TRANSFER WRITE
MODULE ADDR: 110
FILE: 400-444

BLOCK LENGTH: 37

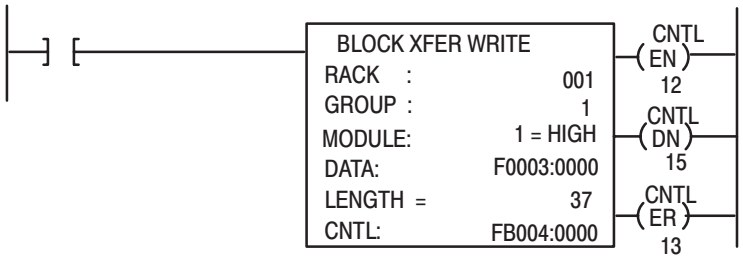
POSITION	FILE DATA	
001	00000000	00000000
002	00000000	00000000
003	00000000	00000000
004	00000000	00000000
005	00000000	00000000
006	00000000	00000000
007	00000000	00000000
008	00000000	00000000
009	00000000	00000000
010	00000000	00000000
011	00000000	00000000
012	00000000	00000000
013	00000000	00000000
014	00000000	00000000
015	00000000	00000000
DATA	00000000	00000000

PLC-3 Family Processor

Following is a sample procedure for entering data in the configuration words of the write block transfer instruction when using a PLC-3 processor.

To enter data in the configuration words, follow these steps:

Example:
Enter the following rung for a write block transfer:



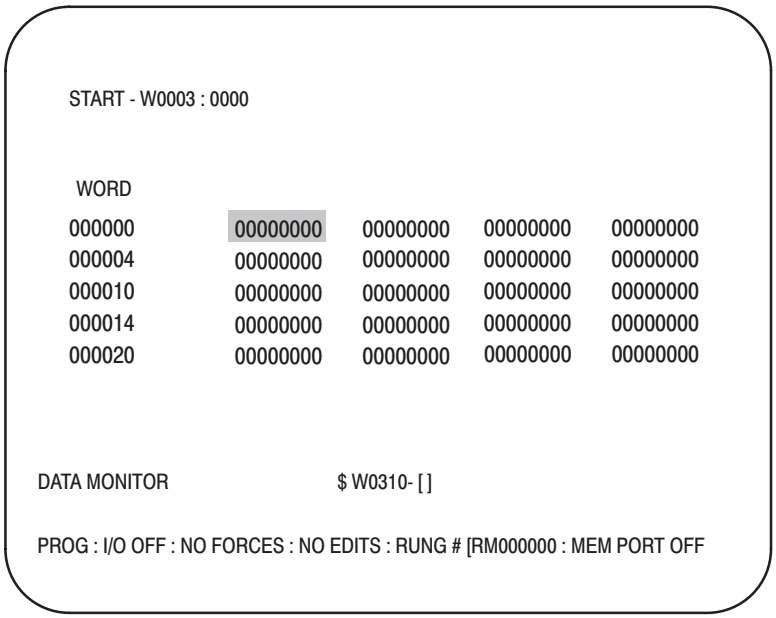
F0003:0000 is the address of the write block transfer data file. You want to enter/examine word 1.

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1. Press [SHIFT][MODE] to display your ladder diagram on the industrial terminal.
2. Press DD, 03:0[ENTER] to display the block transfer write file.

The industrial terminal screen should look like Figure C.2. Notice the highlighted block of zeroes. This highlighted block is the cursor. It should be in the same place as it appears in Figure C.2. If it is not, you can move it to the desired position with the cursor control keys. Once you have the highlighted cursor in the right place as shown above, you can go on
to step 3.

Figure C.2 Write Block Transfer for a PLC-3 Processor



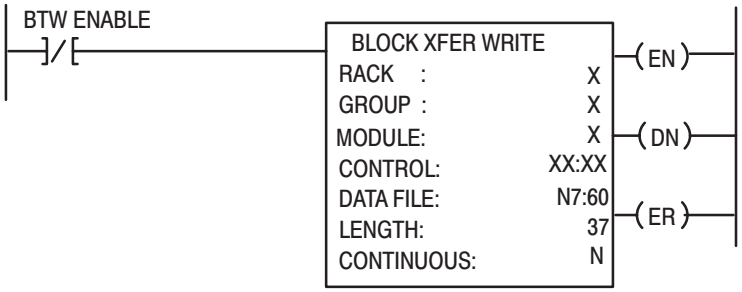
3. Enter the data corresponding to your bit selection in word 0 through 4.
4. When you have entered your data, press [ENTER]. If you make a mistake, make sure the cursor is over the word you desire to change. Enter the correct data and press [ENTER].
5. Press [CANCEL COMMAND]. This returns you to the ladder diagram.

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PLC-5 Family Processors

The following is a sample procedure for entering data in the configuration words of the block transfer write instruction when using a PLC-5 processor and 6200 programming software.

1. Enter the following rung:



N7:60 is the address of the BTW transfer file

2. Press [F8] (data monitor),[F5] (change address) and enter N7:60 to display the configuration block.

The industrial terminal screen should look like Figure C.3.

Figure C.3 Sample PLC-5 Data File (Hexadecimal Data)

ADDRESS	0	1	2	3	4	5	6	7	8	9
N7:60	5003	00FF	00FF	0040	0085	0040	0085	0040	0085	0040
N7:70	0085	0040	0085	0040	0085	0040	0085	0040	0085	0000
N7:80	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
N7:90	0000	0000	0000	0000	0000	0000	0000			

3. Enter the data corresponding to your bit selections and add scaling values, if scaling is desired.

4. [ESC] returns you to the ladder program.

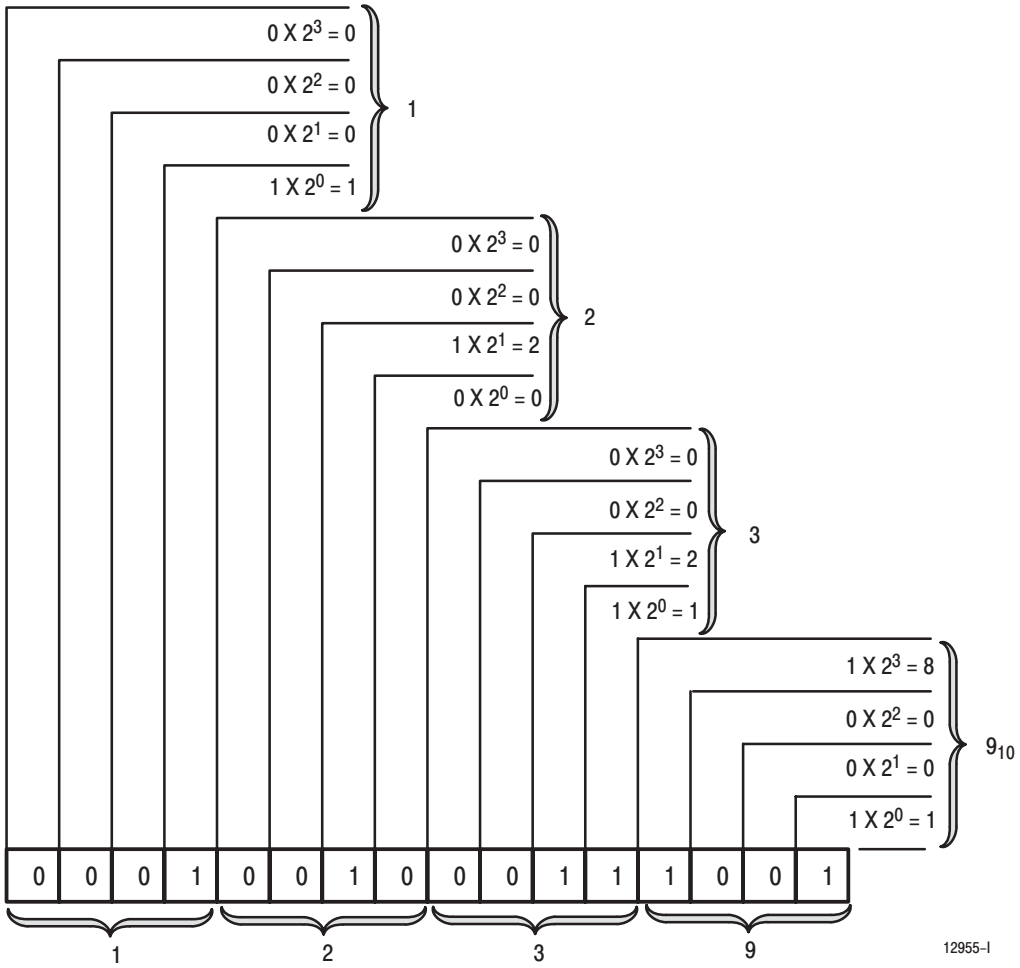
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Data Table Formats

4-Digit Binary Coded Decimal (BCD)

The 4-digit BCD format uses an arrangement of 16 binary digits to represent a 4-digit decimal number from 0000 to 9999 (Figure D.1). The BCD format is used when the input values are to be displayed for operator viewing. Each group of four binary digits is used to represent a number from 0 to 9. The place values for each group of digits are 2^0, 2^1, 2^2 and 2^3 (Table D.A). The decimal equivalent for a group of four binary digits is determined by multiplying the binary digit by its corresponding place value and adding these numbers.

Figure D.1 4-Digit Binary Coded Decimal



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Table D.A BCD Representation

Place Value				Decimal Equivalent
2^3 (8)	2^2 (4)	2^1 (2)	2^0 (1)	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Signed-magnitude Binary

Signed–magnitude binary is a means of communicating numbers to your processsor. It should be used with the PLC-2 family when performing computations in the processor. It cannot be used to manipulate binary 12-bit values or negative values.

Example: The following binary number is equal to decimal 22.

$$\mathbf{10110_2 = 22_{10}}$$

The signed–magnitude method places an extra bit (sign bit) in the left–most position and lets this bit determine whether the number is positive or negative. The number is positive if the sign bit is 0 and negative if the sign bit is 1. Using the signed magnitude method:

0 10110 = +22
1 10110 = –22

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Two's Complement Binary

Two's complement binary is used with PLC-3 processors when performing mathematical calculations internal to the processor. To complement a number means to change it to a negative number. For example, the following binary number is equal to decimal 22.

$$\mathbf{10110_2 = 22_{10}}$$

First, the two's complement method places an extra bit (sign bit) in the left-most position, and lets this bit determine whether the number is positive or negative. The number is positive if the sign bit is 0 and negative if the sign bit is 1. Using the complement method:

0 10110 = 22

To get the negative using the two's complement method, you must invert each bit from right to left after the first "1" is detected.

In the above example:

0 10110 = +22

Its two's complement would be:

1 01010 = –22

Note that in the above representation for +22, starting from the right, the first digit is a 0 so it is not inverted; the second digit is a 1 so it is not inverted. All digits after this one are inverted.

If a negative number is given in two's complement, its complement (a positive number) is found in the same way:

1 10010 = –14
0 01110 = +14

All bits from right to left are inverted after the first "1" is detected.

The two's complement of 0 is not found, since no first "1" is ever encountered in the number. The two's complement of 0 then is still 0.

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Block Transfer (Mini-PLC-2 and PLC-2/20 Processors)

Multiple GET Instructions - Mini-PLC-2 and PLC-2/20 Processors

Programming multiple GET instructions is similar to block format instructions programmed for other PLC-2 family processors. The data table maps are identical, and the way information is addressed and stored in processor memory is the same. The only difference is in how you set up block transfer read instructions in your program.

For multiple GET instructions, individual rungs of ladder logic are used instead of a single rung with a block transfer instruction. A sample rung using multiple GET instructions is shown in Figure E.1 and described in the following paragraphs.

Rung 1: This rung is used to set four conditions.

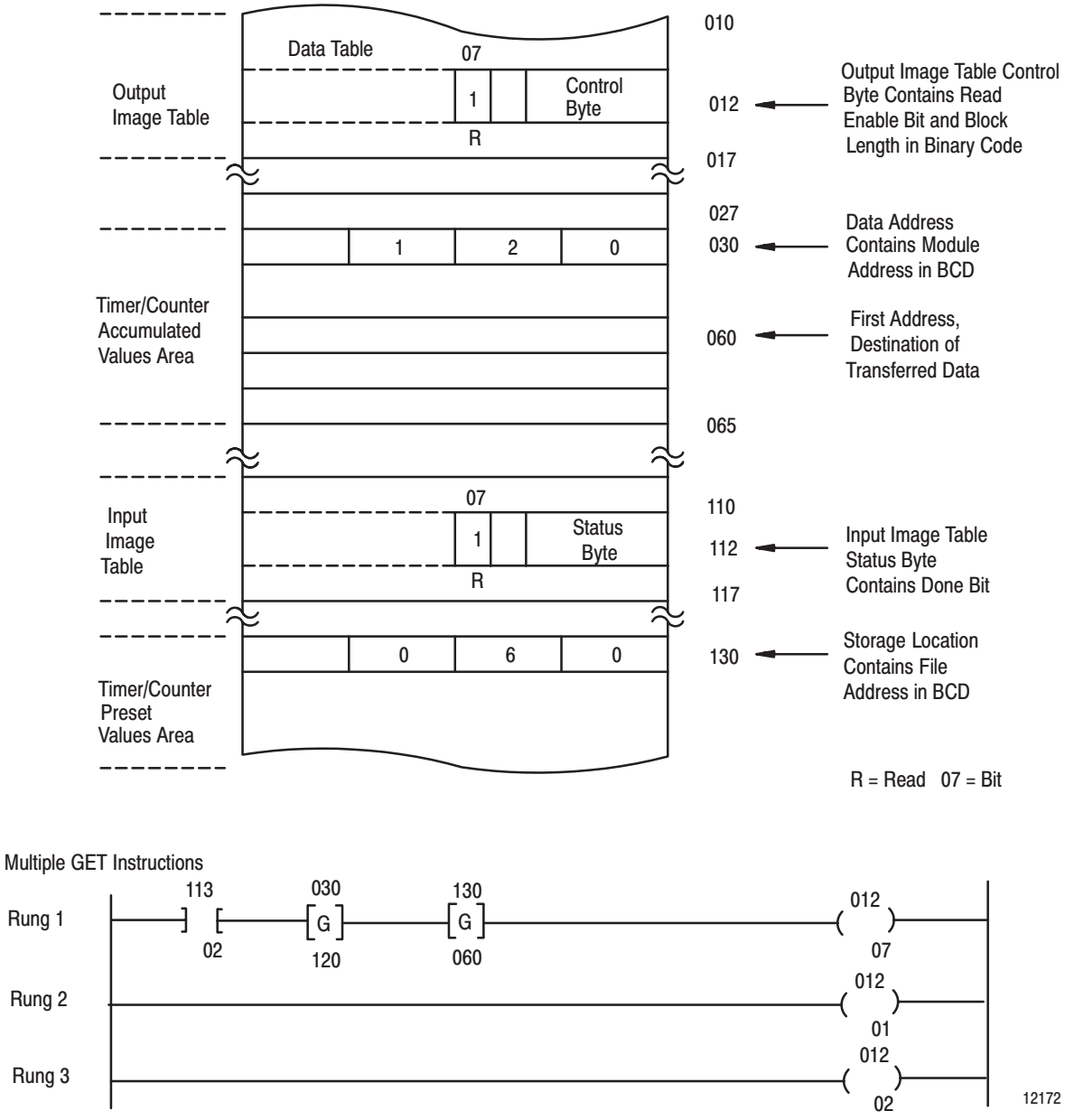
- **Examine On Instruction (113/02) -** This is an optional instruction. When used, block transfers will only be initiated when a certain action takes place. If you do not use this instruction, block transfers will be initiated every I/O scan.
- **First GET Instruction (030/120) -** identifies the module's physical address (120) by rack, group and slot; and where in the accumulated area of the data table this data is to be stored (030).
- **Second GET Instruction (130/060) -** indicates the address of the first word of the file (060) that designates where the data will be transferred. The file address is stored in word 130, 100_8 above the data address.
- **Output Energize Instruction (012/07) -** enables the block transfer read operation. If all conditions of the rung are true, the block transfer read enable bit (07) is set in the output image data table control byte. The output image table control byte contains the read enable bit and the number of words to be transferred. The output energize instruction is defined as follows:
- "0" indicates that it is an output instruction
- "1" indicates the I/O rack address
- "2" indicates the module group location within the rack
- "07" indicates this is a block transfer read operation (if this were a block transfer write operation, "07" would be replaced by "06".)

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Rungs 2 and 3: These output energize instructions (012/01 and 012/02) define the number of words to be transferred. This is accomplished by setting a binary bit pattern in the module's output image table control byte. The binary bit pattern used (bits 01 and 02 energized) is equivalent to 6 words or channels, and is expressed as 110 in binary notation.

Rung Summary: Once the block transfer read operation is complete, the processor automatically sets bit 07 in the input image table status byte and stores the block length of the data transferred.

Figure E.1 Multiple GET Instructions (Mini-PLC-2 and PLC-2/20 Processors Only)



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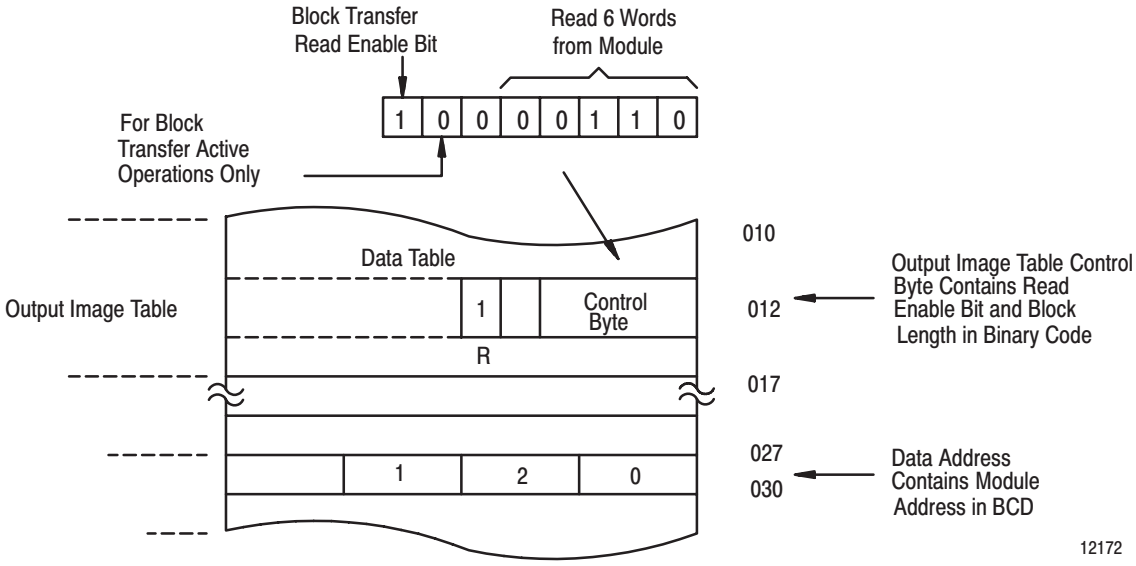
Setting the Block Length (Multiple GET Instructions only)

The input module transfers a specific number of words in one block length. The number of words transferred is determined by the block length entered in the output image table control byte corresponding to the module's address.

The bits in the output image table control byte (bits 00 - 05) must be programmed to specify a binary value equal to the number of words to be transferred.

For example, Figure E.2 shows if your input module is set up to transfer 6 words, you would set bits 01 and 02 of the lower image table control byte. The binary equivalent of 6 words is 000110. You would also set bit 07 when programming the module for block transfer read operations. Bit 06 is used when block transfer write operations are required.

Figure E.2 Setting Block Length (Multiple GET Instructions only)



Number of Words to Transfer	Binary Bit Pattern Lower Output Image Table Byte					
	05	04	03	02	01	00
Default	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
		:		:		
18	0	1	0	0	1	0
19	0	1	0	0	1	1

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Forms

This appendix contains forms useful in setting up your data table.

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Analog Block Transfer Read

Position	Decimal File Word Octal	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
		17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	
1		Not used									Diagnostic bits							
2																		Data Underrange
3																		Data Overrange
4																		Data Polarity “0” = (+)
																		“1” = (–)

Position	File Word	Channel Number	Value
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

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Analog Block Transfer Write

Position	Decimal File Word Octal	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
		17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	
		Channels 1 through 8 Range Selection																
		8		7		6		5		4		3		2		1		Channel Number
1																		
		Channels 9 through 16 Range Selection																
		16		15		14		13		12		11		10		9		Channel Number
2																		
Position	Decimal File Word Octal	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
		17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00	
3																		Module Configuration
4																		Minimum scaling value sign bits
5																		Maximum scaling value sign bits

Position	File Word	Channel Number	Min./Max Value	Position	File Word	Channel Number	Min./Max Value
6				22			
7				23			
8				24			
9				25			
10				26			
11				27			
12				28			
13				29			
14				30			
15				31			
16				32			
17				33			
18				34			
19				35			
20				36			
21				37			

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