ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Rockwell / Allen-Bradley 1771-IXE/B* at our website: *Click HERE*

Allen-Bradley

Thermocouple/ Millivolt Input Module

(Cat. No. 1771-IXE Series D)

User Manual

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 purposes of 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 that should be taken into consideration when applying products such as those described in this publication.

Reproduction of the contents of this copyrighted publication, in whole or in part, without written permission of Allen-Bradley Company, Inc., is prohibited.

Throughout this manual we use notes to make you aware of safety considerations:



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

Attention statements help you to:

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

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

ControlNet is a trademark; PLC is a registered trademark of Allen-Bradley Company, Inc.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Using This Manual

Purpose of Manual

This manual shows you how to use your Thermocouple/Millivolt 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 (PLC) to make efficient use of your input module. In particular, you must know how to program block transfer instructions.

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

Vocabulary

In this manual, we refer to:

- The individual input module as the “input module”
- The Programmable Controller, as the “controller.”

Manual Organization

This manual is divided into eight 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 Input Module	Description of the module, including general and hardware features
2	Installing the Input Module	Module power requirements, keying, chassis location Wiring of field wiring arm
3	Module Programming	How to program your programmable controller for this module Sample programs
4	Module Configuration	Hardware and software configuration Module write block format
5	Module Status and Input Data	Reading data from your module Module read block format
6	Module Calibration	How to calibrate your module
7	Troubleshooting	Diagnostics reported by the module
Appendix A	Specifications	Your module’s specifications
Appendix B	Programming Examples	
Appendix C	Data Formats	Information on BCD, signed magnitude binary, and 2’s complement binary

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Chapter	Title	Topics Covered
Appendix D	Block Transfer with Mini–PLC–2 and Mini–PLC–2/20	How to use GET–GET instructions for block transfer with Mini–PLC–2 and Mini–PLC–2/20 processors
Appendix E	Differences between Series A, B, C and D versions	Lists differences from Series A 1771–IXE module
Appendix F	Thermocouple Characteristics	Extractions from NBS Monograph 125 (IPTS–68)

Warnings and Cautions

This manual contains warnings and cautions.



ATTENTION: A warning indicates where you may be injured if you use your equipment improperly.



ATTENTION: Cautions indicate where equipment may be damaged from misuse.

You should read and understand cautions and warnings before performing the procedures they precede.

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.

Product Compatibility

These input modules can be used with any 1771 I/O chassis. Communication between the 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 and write block data. I/O image table use is an important factor in module placement and addressing selection. The module's data table use is listed in the following table.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table P.A 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 1/2 –slot	Addressing 1–slot	Addressing 2–slot	Chassis Series
1771–IXE/D	8	8	12/13	27/28	Yes	Yes	Yes	A and B

A = Compatible with 1771–A1, A2, A4 chassis.
B = Compatible with 1771–A1B, A2B, A3B, A4B chassis.
Yes = Compatible without restriction
No = Restricted to complementary module placement

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
- 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 unless you are using 1 or 1/2 slot addressing. Avoid placing this module close to AC modules or high voltage DC modules.

Related Publications

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table of Contents

Overview of the Thermocouple/Millivolt Input Module

Chapter 1

Chapter Objectives 1–1
Module Description 1–1
Features of the Input Module 1–1
How Analog Modules Communicate with Programmable Controllers 1–2
Accuracy 1–3
Getting Started 1–3
Chapter Summary 1–3

Installing the Thermocouple/Millivolt Input Module

Chapter 2

Chapter Objectives 2–1
Before You Install Your Input Module 2–1
Prevent Electrostatic Discharge 2–1
Understand Compliance to European Union Directives 2–2
  EMC Directive 2–2
  Low Voltage Directive 2–2
Understand Product Compatibility 2–2
Calculate Power Requirements 2–3
Determine Module Placement in the I/O Chassis 2–3
Key the Backplane Connector 2–3
Install the Module and Field Wiring Arm 2–4
Connect Wiring to the Field Wiring Arm 2–5
  Cable Lengths 2–6
Grounding 2–6
Interpret Status Indicators 2–7
Chapter Summary 2–7

Module Programming

Chapter 3

Chapter Objectives 3–1
Block Transfer Programming 3–1
PLC-2 Programming Example 3–2
  Program Action 3–3
PLC-3 Programming Example 3–4
    Program Action 3–4
PLC-5 Programming Example 3–5
Module Scan Time 3–6
Chapter Summary 3–6

Publication 1771-6.5.130 - May 1999

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Module Configuration — **Chapter 4**

Chapter Objectives 4–1
Configuring the Thermocouple/Millivolt Input Module (1771–IXE/D) . 4–1
Input Type 4–2
Temperature Scale 4–2
Data Format 4–3
Real Time Sampling 4–3
Channel Alarms 4–4
Calibration 4–4
Configuration Block for a Block Transfer Write 4–5
Bit/Word Descriptions 4–6
Chapter Summary 4–8

Module Status and Input Data — **Chapter 5**

Chapter Objectives 5–1
Reading Data from the Module 5–1
Bit/Word Descriptions 5–2
Chapter Summary 5–3

Module Calibration — **Chapter 6**

Chapter Objective 6–1
Tools and Equipment 6–1
Calibrating Your Input Module 6–1
About Auto-Calibration 6–1
Performing Auto-Calibration 6–2
  Offset Calibration 6–2
  Gain Calibration 6–3
  Save Calibration Values 6–4
Performing Manual Calibration 6–5
  Setting Channel Offset Calibration 6–5
  Setting Channel Gain Calibration 6–7
Chapter Summary 6–9

Troubleshooting — **Chapter 7**

Chapter Objective 7–1
Diagnostics Reported by the Module 7–1
Troubleshooting with the Indicators 7–2
Status Reported by the Module 7–2
Chapter Summary 7–4

Specifications — **Appendix A**

Thermocouple/Millivolt Input Module Accuracy A–2
Lead Resistance Compensation A–3
  Source Impedance Compensation for Millivolt Inputs A–3
Filtering A–3

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Programming Examples — **Appendix B**

Sample Programs for the Input Module B–1
PLC–2 Family Processors B–1
PLC–3 Family Processors B–2
PLC–5 Family Processors B–3

Data Table Formats — **Appendix C**

4–Digit Binary Coded Decimal (BCD) C–1
Signed–magnitude Binary C–2
Two's Complement Binary C–2

Block Transfer (Mini–PLC–2 and PLC–2/20 Processors) — **Appendix D**

Multiple GET Instructions – Mini–PLC–2 and PLC–2/20 Processors . D–1
Setting the Block Length (Multiple GET Instructions only) D–2

Differences Between Series A, Series B, Series C and Series D Thermocouple/Millivolt Input Modules — **Appendix E**

Major Differences between Series E–1

Thermocouple Restrictions (Extracted from NBS Monograph 125 (IPTS–68)) — **Appendix F**

General F–1
J (Iron vs Copper–Nickel <Constantan*>) Type Thermocouple . . . F–1
K (Nickel–Chromium vs Nickel–Aluminum) Type Thermocouple . . F–2
T (Copper vs Copper–Nickel <Constantan*>) Type Thermocouple F–3
E (Nickel–Chromium vs Copper–Nickel <Constantan*>) Type Thermocouple F–4
S (Platinum–10% Rhodium vs Platinum) & R (Platinum–13% Rhodium vs Platinum) Type Thermocouples F–5

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Overview of the Thermocouple/Millivolt Input Module

Chapter Objectives

This chapter gives you information on:

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

Module Description

The Thermocouple/Millivolt 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 which does not require an external power supply. 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 (50ms).

Features of the Input Module

The 1771–IXE/D module senses up to 8 differential analog inputs and converts them to values compatible with Allen–Bradley programmable controllers.

This module's features include:

- 8 input channels configurable for thermocouple input ranges or millivolt input ranges: Types E, J, K, T, R and S thermocouples and $\pm$100 millivolts
- two types of inputs allowed: 4 of one input type and 4 of another
- cold junction compensation
- scaling to selected temperature range in ^{o}C or ^{o}F
- temperature resolution of 1^{o}C or 1^{o}F, millivolt resolution to 10 microvolts
- user selectable high and low temperature alarms

Publication 1771-6.5.130 - May 1999

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

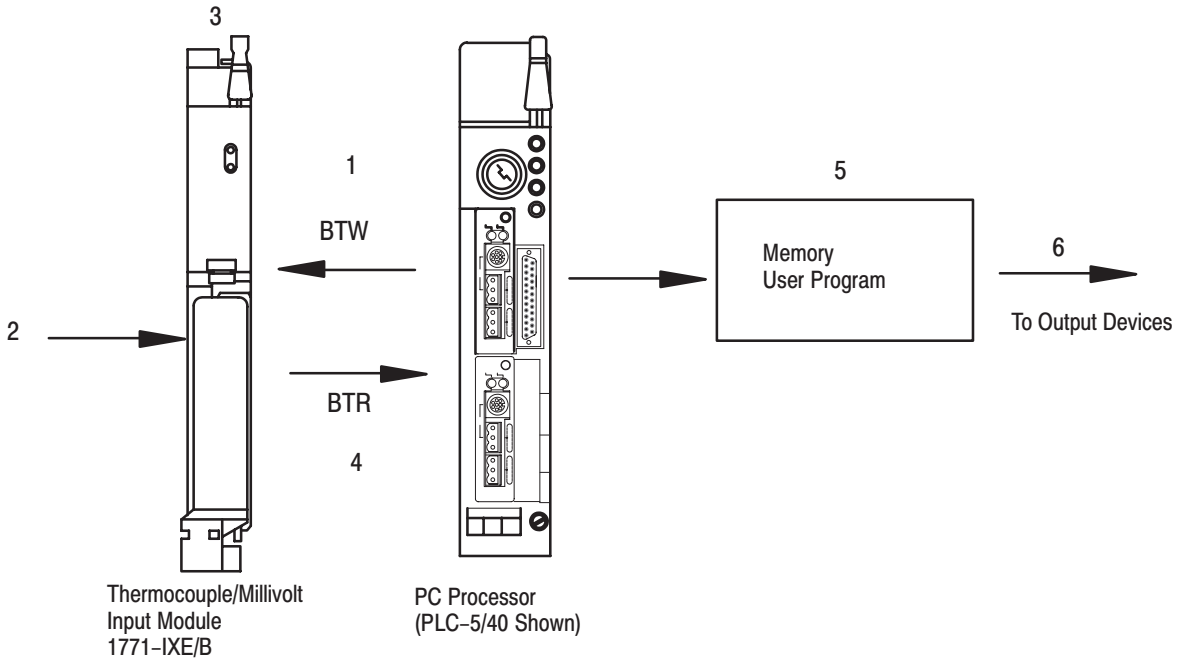
- all features selectable through programming
- self–diagnostics and status reporting at power–up
- detection of open circuit if thermocouple fails
- automatic offset and gain calibration for each channel
- software calibration of all channels, eliminating potentiometers

How Analog Modules Communicate with Programmable Controllers

The processor transfers data to and from the module using BTW (block transfer write) and BTR (block transfer read) 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 (Figure 1.1).

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

Figure 1.1
Communication Between Processor and Module



Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

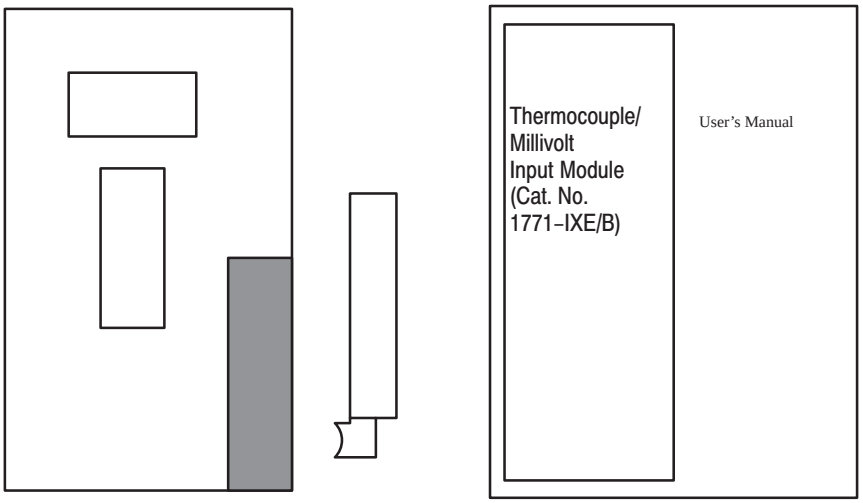
3. The module converts analog signals into binary or BCD format, and stores theses values until the processor requests their transfer.
4. When instructed by your ladder program, the processor performs a read block transfer of the values and stores them in a data table.
5. The processor and module determine 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 the operator at power–up.

Accuracy

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

Getting Started

Your input module package contains the following items. Please check that each part is included and correct before proceeding.



Input Module 1771–IXE/D

Field Wiring Arm Cat. No. 1771–WI

User's Manual 1771–6.5.130

10526–I

Chapter Summary

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Installing the Thermocouple/Millivolt Input Module

Chapter Objectives

This chapter gives you information on:

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

Before You Install Your Input Module

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

Action required:	Refer to:
Calculate the power requirements of all modules in each chassis.	Calculate Power Requirements
Determine where to place the module in the I/O chassis.	Module Location in the I/O Chassis
Key the backplane connector in the I/O chassis.	Module Keying
Make connections to the wiring arm.	Connecting Wiring and Grounding

Prevent Electrostatic Discharge

The thermocouple/mV input module is sensitive to electrostatic discharge.



ATTENTION: Electrostatic discharge can damage integrated circuits or semiconductors if you touch backplane connector pins. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential
- Wear an approved wrist-strap grounding device
- Do not touch the backplane connector or connector pins
- Do not touch circuit components inside the module
- If available, use a static-safe work station
- When not in use, keep the module in its static-shield bag

Publication 1771-6.5.130 - May 1999

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Understand 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 Allen-Bradley publication 1770-4.1, Industrial Automation Wiring and Grounding Guidelines.

Open style devices must be provided with environmental and safety protection by proper mounting in enclosures designed for specific application conditions. See NEMA Standards publication 250 and IEC publication 529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

Understand Product Compatibility

The 1771-IXE module can be used with any 1771 I/O chassis. Compatibility and data table use is listed below.

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-IXE/D	8	8	12/13	27/28	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.

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Calculate Power Requirements

The module receives its power through the 1771 I/O power supply and requires 850mA 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.

ATTENTION: Do not insert or remove modules from the I/O chassis while system power is ON. Failure to observe this rule could result in damage to module circuitry.

Determine Module Placement 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.

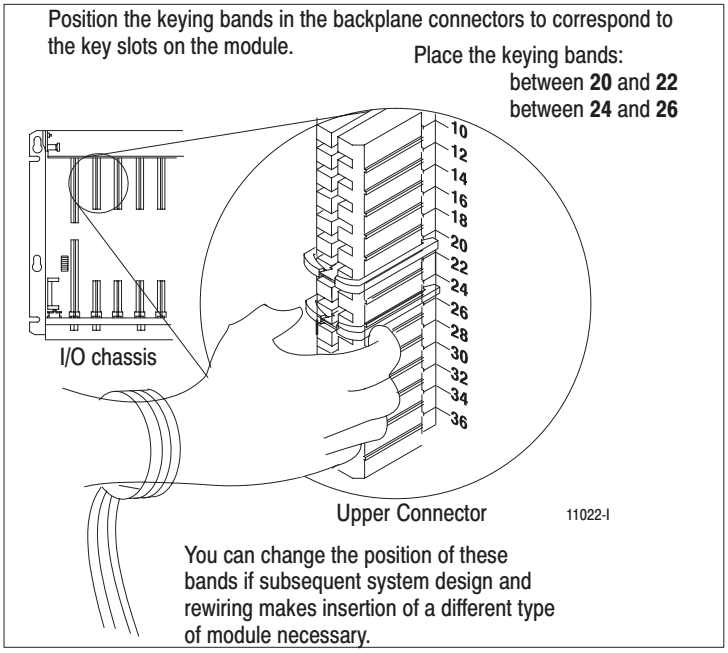
Key the Backplane Connector

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.



Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

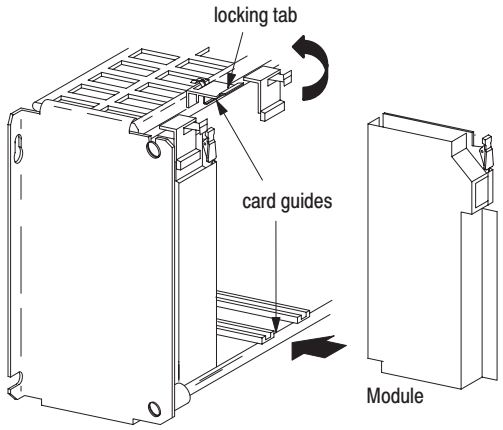
Install the Module and Field Wiring Arm

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.

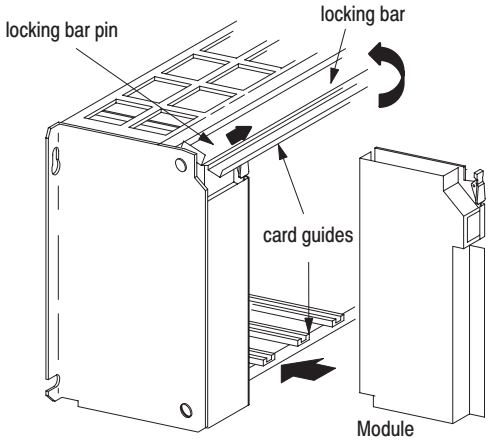
1

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



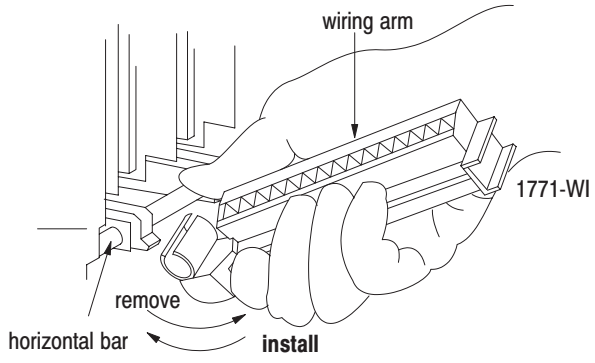
Swing the chassis locking bar down into place to secure the modules. Make sure the locking pins engage.

19809

2

Attach the wiring arm (1771-WI) 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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Connect Wiring to the Field Wiring Arm

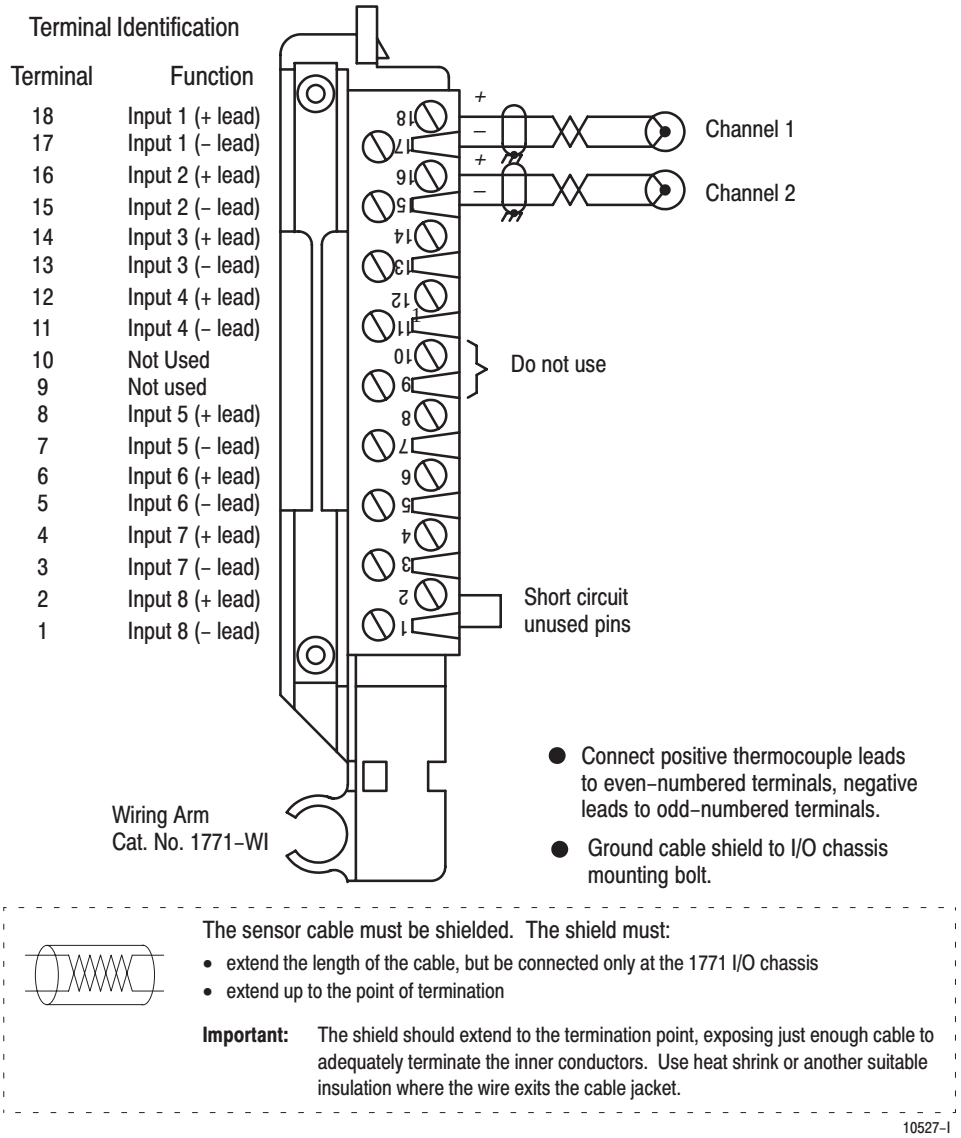
Connect your I/O devices to the cat. no. 1771-WI wiring arm shipped with the module.

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-IXE/D are shown below.

Figure 2.1
Wiring Connections for the 1771–IXE Series D



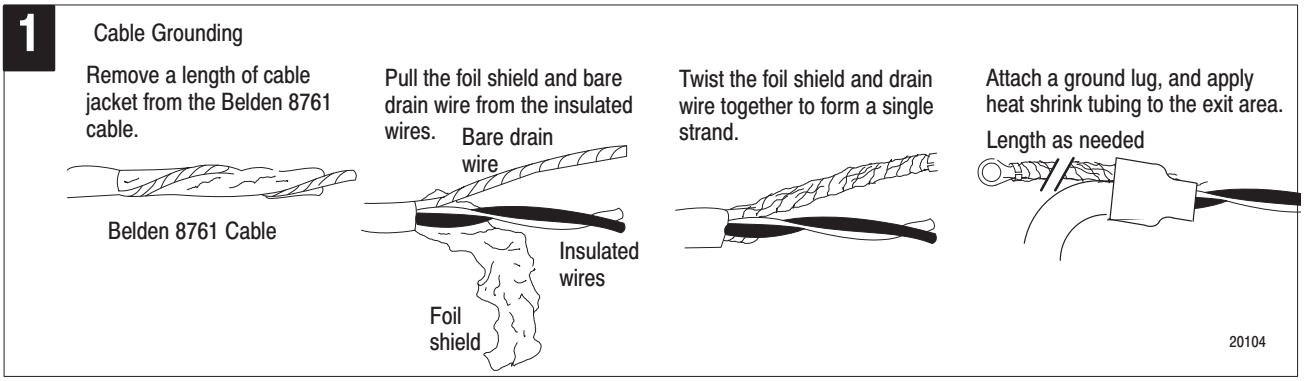
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

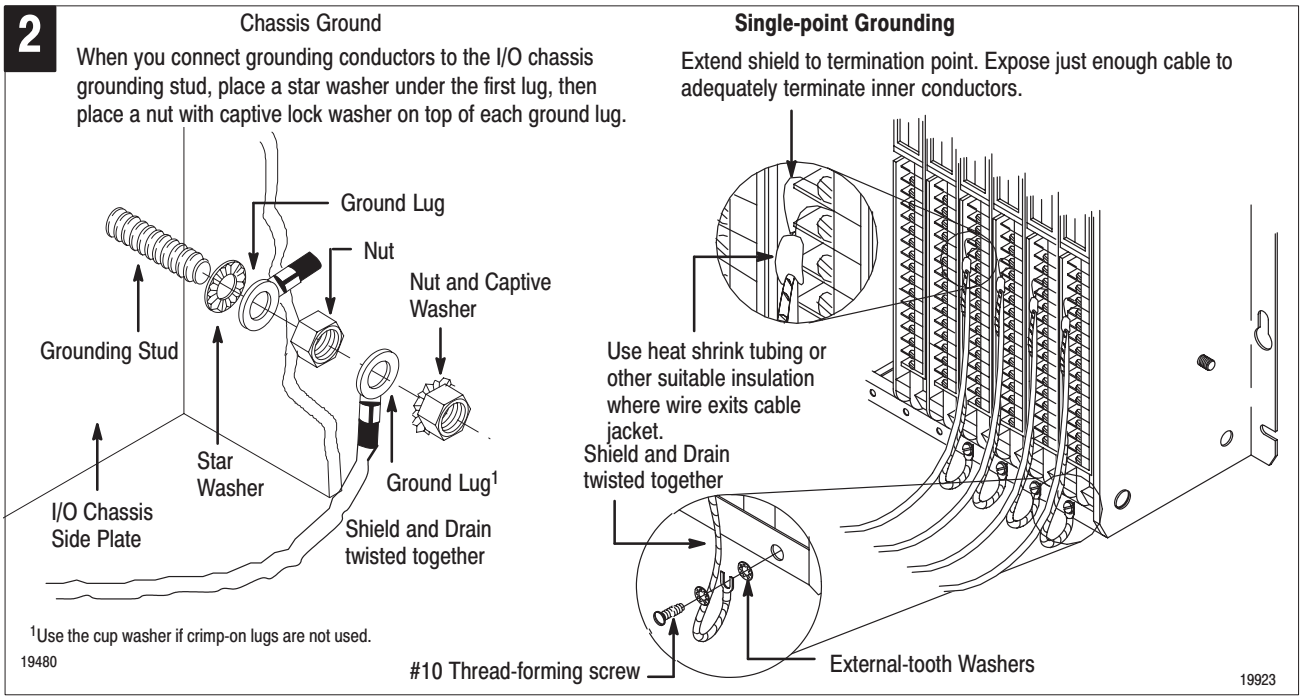
Cable Lengths

Recommended maximum cable length for voltage-mode input devices is 50 feet, due to possible signal degradation and electrical noise immunity in typical industrial environments.

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. 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.

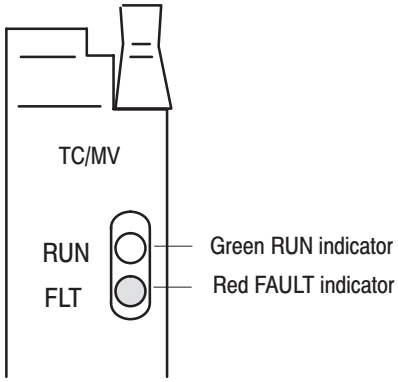




Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1 for additional information.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Interpret Status Indicators



The front panel of the thermocouple/mV input module contains a green RUN indicator and a red FAULT indicator. At power-up, the module momentarily turns on the red indicator as a lamp test, then checks for:

- correct RAM operation
- EPROM operation
- EEPROM operation
- a valid write block transfer with configuration data

If there is no fault, the red indicator turns off.

Thereafter, the module lights the green RUN indicator when operating without fault, or lights the red FAULT indicator when it detects fault conditions. If the red FAULT indicator is on, block transfers will be inhibited. Possible module fault causes and corrective action are discussed in Chapter 8, 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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 the 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 following example programs accomplish this handshaking routine. These are minimum programs; all rungs and conditioning must be included in your application program. You can disable BTRs, or add interlocks to prevent writes if desired. Do not eliminate any storage bits or interlocks included in the sample programs. If interlocks are removed, the program may not work properly.

Your analog input module will work with a default configuration of all zeroes entered in the configuration block. See the configuration default section to understand what this configuration looks like. Also, refer to Appendix B for example configuration blocks and instruction addresses to get started.

Your program should monitor status bits (such as overrange, underrange, alarms, etc.) and block transfer read activity.

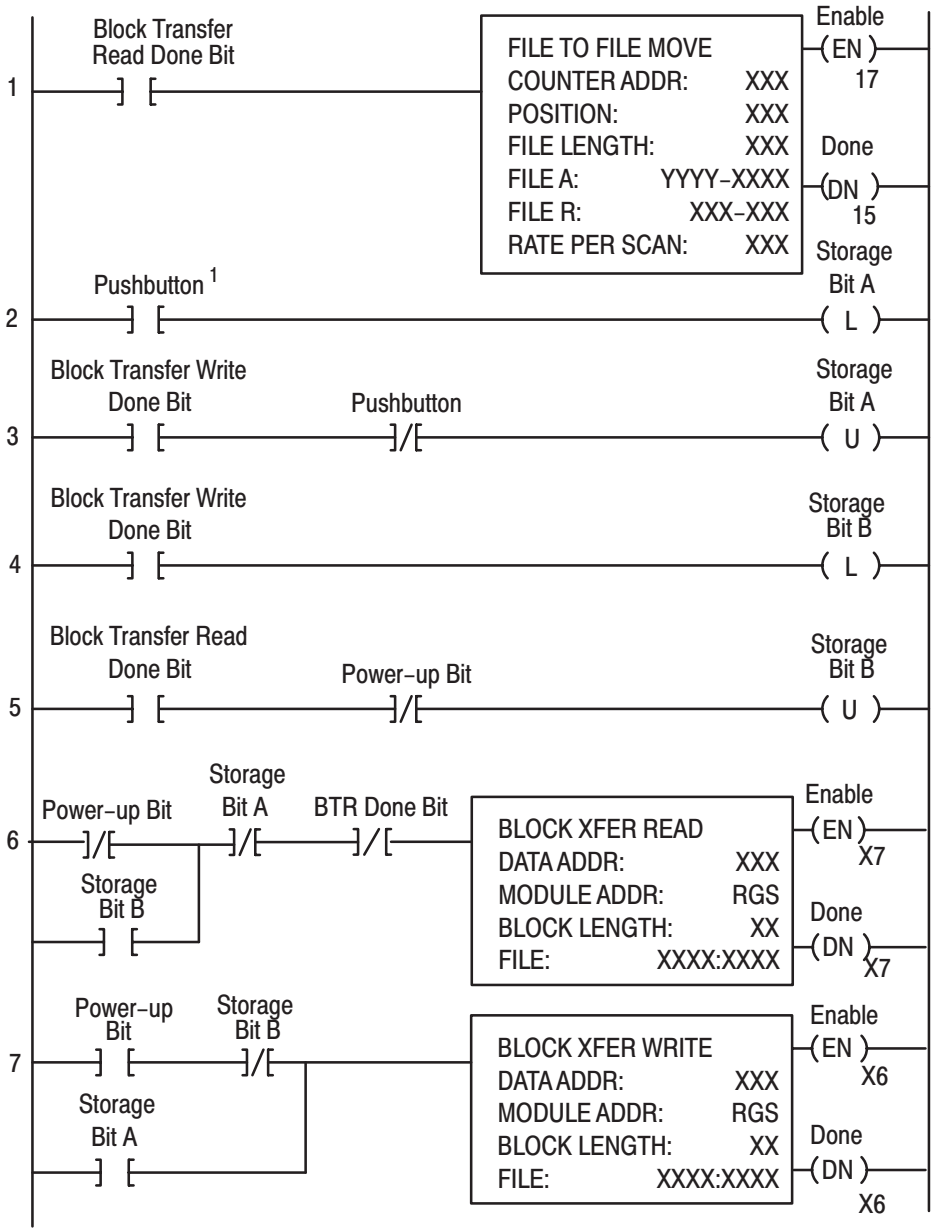
The following example programs illustrate the minimum programming required for communication to take place.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

PLC-2 Programming Example

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 D.

Figure 3.1
PLC–2 Family Sample Program Structure



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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Program Action

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.

1. 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.
2. 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 configures 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 ensure 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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

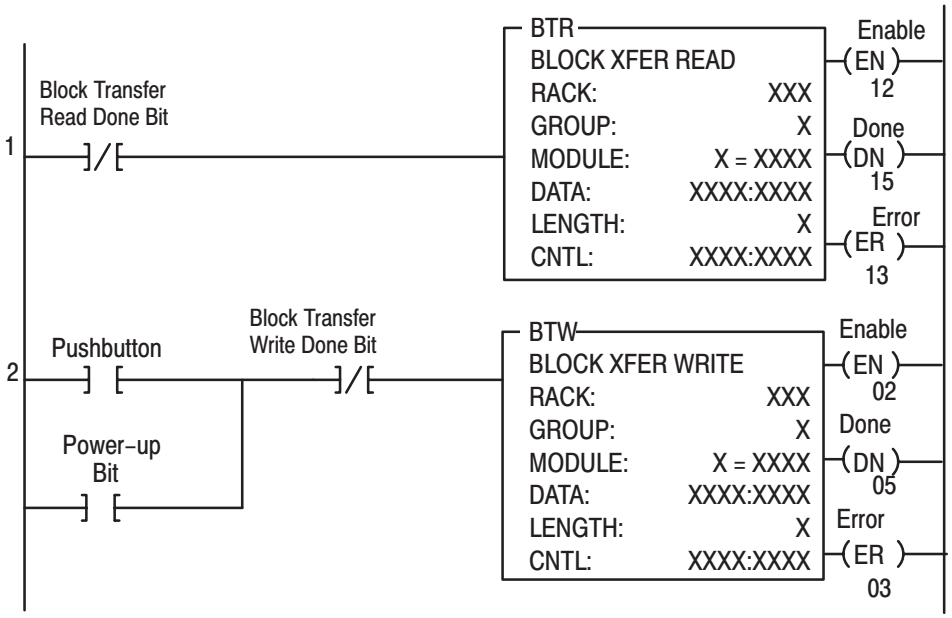
PLC-3 Programming Example

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 the module (when programming a block transfer write) or from the 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 in Figure 3.2, and described below.

Figure 3.2
PLC–3 Family Sample Program Structure



Program Action

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

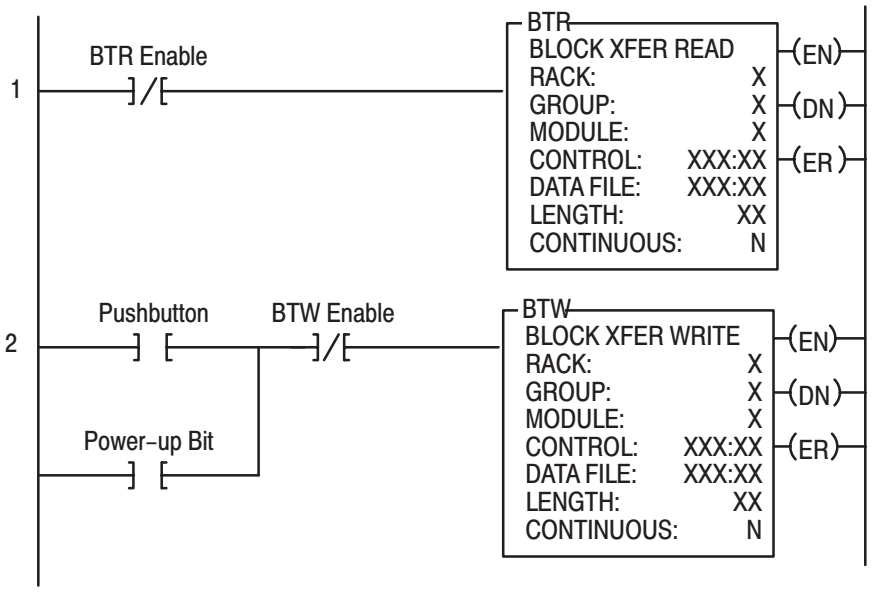
Rungs 1 and 2 – Rungs 1 and 2 are the block transfer read and write instructions. The BTR enable bit in rung 1, being false, initiates the first read block transfer. After the first read block transfer, the module performs a block transfer write and then does continuous block transfer reads until the 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.

PLC-5 Programming Example

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

- You must use enable bits instead of done bits as the conditions on each rung.
- A separate control file must be selected for each of the BT 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 unless the first pass bit is added to the BTW input conditions.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 Figure 3.4.

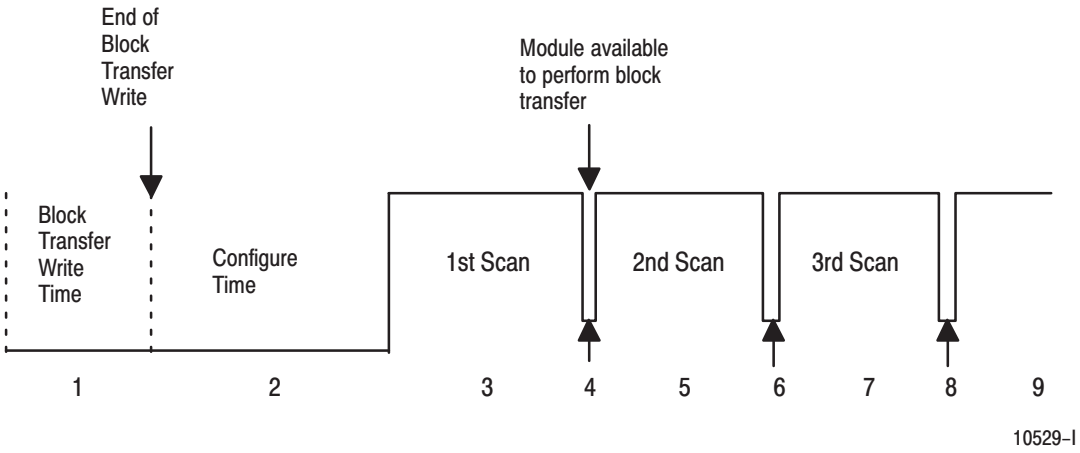
The following description references the sequence numbers in Figure Figure 3.4.

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

Any time after the second scan begins “5”, a block transfer read (BTR) request “6” can be acknowledged.

When operated in the default mode (RTS) = 00, a BTR will be released every 50 milliseconds. When operated in RTS = T, BTR will be waived until ”T”millseconds, at which time 1 BTR will be released.

Figure 3.4
Block Transfer Time



Internal Scan time = 50msec
T = 100ms, 200ms, 300ms ... 3.1sec.

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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Module Configuration

Chapter Objectives

In this chapter you will read how to configure your module's hardware, condition your inputs and enter your data.

Configuring the Thermocouple/Millivolt Input Module (1771–IXE/D)

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.

You can configure the following features for the 1771–IXE/D module:

- type of input
- one or two input types
- ^{o}C or ^{o}F
- data format
- real time sampling
- alarming
- calibration

Configure your module for its intended operation by means of your programming terminal and write block transfers.

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.

During normal operation, the processor transfers from 1 to 27 words to the module when you program a BTW instruction to the module's address. The BTW file contains configuration words, high and low channel alarm settings, and calibration values that you enter for each channel. **When a block transfer length of 0 is programmed, the 1771–IXE/D will respond with the Series A default value of 27.**

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Input Type

The thermocouple/millivolt input module accepts the following types of inputs:

Table 4.A
Types of Inputs

Input Type	Input Type	Temperature Range °C	Bits 00	01	02	03	04	05
Millivolt	Millivolt	–100 to +100	0	0	0	0	0	0
Thermocouple	E	–270 to 1000	1	0	0	1	0	0
	J	–210 to 1200	0	1	0	0	1	0
	K	–270 to 1380	1	1	0	1	1	0
	T	–270 to 400	0	0	1	0	0	1
	R	–50 to 1770	1	0	1	1	0	1
	S	–50 to 1770	0	1	1	0	1	1
			1	1	1	1	1	1

The input type is selected by setting bits in the block transfer write (BTW) file. Two different inputs can be selected. You can have 4 inputs set for one type, and 4 inputs set for another type; or you can have all inputs the same. If you select different types of inputs, set bit 06 to 1. If you do not select 2 different input types, the module defaults to all inputs set to those selected by bits 00 –02.

Set this bit for 2 different input types (see table 5.D)

Set these bits for input type.

Word	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
1	Sample Time					Format		T	0	E	Input Type			Input Type		

Temperature Scale

The temperature scale reported by the module is selected by setting bit 10 in the configuration word. When bit 10 is set (1), the temperature is reported in degrees Fahrenheit. When reset (0), the temperature is reported in degrees Celsius.

The temperature bit 10 is ignored when the millivolt input type is selected.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Data Format

You must indicate what format will be used to read data from your module. Typically, BCD is selected with PLC–2 processors, and binary (also referred to as integer or decimal) is selected with PLC–3 and PLC–5 processors. See Table 4.B and Appendix C for details on Data Format.

Table 4.B Selecting Format for Reading Data

Decimal Bit 10 Octal Bit 12	Decimal Bit 9 Octal Bit 11	Data Format
0	0	BCD – binary coded decimal
0	1	2's complement binary
1	0	Signed magnitude binary
1	1	Same as signed magnitude binary

Real Time Sampling

The real time sampling (RTS) mode of operation provides data from a fixed time period for use by the processor. 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 (ΔT) 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 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 (msec) to 3.1 seconds in increments of 100msec. Refer to Table 4.C below for actual bit settings. Note that the default mode of operation is implemented by placing all zeroes in bits 13 through 17. Note that binary representation of the RTS bit string is the RTS period X 100msec. For example, 900msec = 01001 = (9 X 100msec).

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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

Decimal Bits Octal Bits	15 17	14 16	13 15	12 14	11 13	Sample Time Period
	0	0	0	0	0	RTS default (50ms)
	0	0	0	0	1	100 ms
	0	0	0	1	0	200 ms
	0	0	0	1	1	300 ms
	0	0	1	0	0	400 ms
	0	0	1	0	1	500 ms
	0	0	1	1	0	600 ms
	0	0	1	1	1	700 ms
	0	1	0	0	0	800 ms
	0	1	0	0	1	900 ms
	0	1	0	1	0	1.0 sec
	0	1	1	1	1	1.5 sec
	1	0	1	0	0	2.0 sec
	1	1	0	0	1	2.5 sec
	1	1	1	1	0	3.0 sec
	1	1	1	1	1	3.1 sec

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

Channel Alarms

Each channel has an alarm enable bit, an alarm polarity bit, and high and low alarm values associated with it. These bits and words are explained in the bit/word definitions in Table 4.E.

Calibration

You have the ability to calibrate this module using auto–calibration or by manually setting the individual channel words. Words 20 through 27 in the configuration word (Table 4.E) are the calibration words for channels 1 through 8 respectively. Calibration is explained in chapter 6.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Configuration Block for a Block Transfer Write

The complete configuration block for the block transfer write to the module is defined in Table 4.D below.

Table 4.D
Configuration Block for Thermocouple/Millivolt Input Module Block Transfer Write

Word	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
1	Sample Time					Format		T	0	E	Type			Type		
2	Not Used								Enable Channel Alarms (one bit per input channel)							
3	High Alarms Polarity (one bit per input channel)								Low Alarms Polarity (one bit per input channel)							
4	Channel 1 Low Alarm Value															
5	Channel 1 High Alarm Value															
6	Channel 2 Low Alarm Value															
7	Channel 2 High Alarm Value															
8	Channel 3 Low Alarm Value															
9	Channel 3 High Alarm Value															
10	Channel 4 Low Alarm Value															
11	Channel 4 High Alarm Value															
12	Channel 5 Low Alarm Value															
13	Channel 5 High Alarm Value															
14	Channel 6 Low Alarm Value															
15	Channel 6 High Alarm Value															
16	Channel 7 Low Alarm Value															
17	Channel 7 High Alarm Value															
18	Channel 8 Low Alarm Value															
19	Channel 8 High Alarm Value															
20	Calibration Values for Channel 1															
21	Calibration Values for Channel 2															
22	Calibration Values for Channel 3															
23	Calibration Values for Channel 4															
24	Calibration Values for Channel 5															
25	Calibration Values for Channel 6															
26	Calibration Values for Channel 7															
27	Calibration Values for Channel 8															
28	Auto–calibration Request Word															

E = enable bit for input types (refer to bit/word description)
T = temperature scale bit (refer to bit/word description)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Bit/Word Descriptions

Bit/word descriptions of BTW file words 1 thru 3 (configuration), 4 thru 19 (channel alarm values), and 20 thru 27 (calibration values) are presented in Table 4.E. Enter data into the BTW instruction after entering the instruction into your ladder diagram program.

Table 4.E
Bit/Word Definitions for Thermocouple/Millivolt Input Module

<table>
<tr><th>Word</th><th>Bits</th><th>Description</th></tr>
<tr><td>Word 1</td><td>bits 00–02</td><td>Input type codes for inputs 1 thru 8 (or 1 thru 4 if bit 06 is set to 1). Tells the module what type of input device you connected to the module.
<table>
<tr><th>Type</th><th>02</th><th>01</th><th>00</th></tr>
<tr><td>Millivolt input</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>”E” thermocouple</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>”J” thermocouple</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>”K” thermocouple</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>”T” thermocouple</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>”R” thermocouple</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>”S” thermocouple</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td></td><td>1</td><td>1</td><td>1</td></tr>
</table></td></tr>
<tr><td></td><td>bits 03–05</td><td>Input type codes for inputs 5 thru 8 (bit 06 must be set to 1). Tells the module what type of input device you connected to inputs 5 thru 8.
<table>
<tr><th>Type</th><th>05</th><th>04</th><th>03</th></tr>
<tr><td>Millivolt input</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>”E” thermocouple</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>”J” thermocouple</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>”K” thermocouple</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>”T” thermocouple</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>”R” thermocouple</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>”S” thermocouple</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td></td><td>1</td><td>1</td><td>1</td></tr>
</table></td></tr>
<tr><td></td><td>bit 06</td><td>When set to 0 bits 00–02 define input type for all channels.
When set to 1 bits 00–02 defines input type for channels 1–4, and bit 03–05 defines input type for channels 5–8.</td></tr>
<tr><td></td><td>bit 07</td><td>Not used (set to 0)</td></tr>
<tr><td></td><td>bit 10</td><td>Temperature scale bit, when set, reports temperature in ^{o}F; when reset, in ^{o}C. The module ignores this bit for millivolt inputs.</td></tr>
</table>

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

<table>
<tr><th>Word</th><th>Bits</th><th>Description</th></tr>
<tr><td>Word 1 (cont.)</td><td>bits 11–12</td><td>Format bits tell the module which format to use for reporting input values to the processor.
<table>
<tr><td>Format</td><td>12</td><td>11</td></tr>
<tr><td>4–digit BCD</td><td>0</td><td>0</td></tr>
<tr><td>2’s complement binary</td><td>0</td><td>1</td></tr>
<tr><td>Signed magnitude binary</td><td>1</td><td>0</td></tr>
<tr><td></td><td>1</td><td>1</td></tr>
</table>
Select the format used by your processor.</td></tr>
<tr><td></td><td>bits 13–17</td><td>Real time sample interval bits determine the sample time for updating module inputs. You select sample time in 0.1 second intervals using binary code. (All values between 0.1 and 3.1 seconds in 0.1 second intervals are available.) We tabulated some values for you.
<table>
<tr><td>Sample Time</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td></tr>
<tr><td>0.1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0.5</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0.6</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>0.7</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>0.8</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0.9</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>1.0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1.5</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>2.0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>2.5</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>3.0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
</table></td></tr>
<tr><td>Word 2</td><td>bits 00–07</td><td>Channel alarm enable bits tell the module which channel alarm values are activated. Set bit 00 for alarm(s) in channel 1, and set alarm(s) in words 4 (low alarm) and 5 (high alarm). Repeat the procedure for setting alarms in channels 2 thru 8 (bits 01–07 and words 6–19 respectively).</td></tr>
<tr><td></td><td>bits 10–17</td><td>Not used (set to 0)</td></tr>
<tr><td>Word 3</td><td>bits 00–07</td><td>Low alarm polarity bits tell the module the sign of the values that you enter in low alarm words: set for negative, reset for positive. Bits 00–07 represent words 4, 6, 8, 10, 12, 14, 16, and 18 for channels 1 thru 8, respectively.</td></tr>
<tr><td></td><td>bits 10–17</td><td>High alarm polarity bits tell the module the sign of the values that you enter in high alarm words: set for negative, reset for positive. Bits 10–17 represent words 5, 7, 9, 11, 13, 15, 17 and 19 for channels 1 thru 8, respectively.</td></tr>
<tr><td>Words 4 thru 19</td><td></td><td>Low and High channel alarm values that you enter via the terminal in BCD are converted automatically by the module to its own format. Store low and high channel alarms in pairs, low alarm values in even–numbered words, high alarm values in odd–numbered words. For example, store channel 1 low and high alarm values in words 4 and 5, respectively.</td></tr>
</table>

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Word	Bits	Description
Words 20 thru 27		Calibration words are a composite of two independent bytes for each channel. Enter calibration data in signed magnitude binary only. The most significant bit in each byte is the sign bit; set for negative, reset for positive. Use the high byte (bits 10–17) for offset correction, the low byte (bits 00–07) for gain correction for each channel. Use word 20 for channel 1 thru word 27 for channel 8. Refer to Chapter 7 for calibration procedures.
Word 28		Auto–calibration request word – used to automatically calibrate selected channels and save the calibration constants in EEPROM. (Refer to Chapter 7.)

Chapter Summary

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Module Status and Input Data

Chapter Objectives

In this chapter you will read about:

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

Reading Data from the Module

Block transfer read programming moves status and data from the input module to the processor's data table in one I/O scan (Table 5.A). The processor user program initiates the request to transfer data from the input module to the processor.

During normal operation the module transfers up to 12 words to the processor's data table file. The words contain module status and input data from each channel. When a block transfer length of zero (0) is programmed, the 1771–IXE/D will respond with the Series A default value of 12.

Table 5.A
BTR Word Assignments for Thermocouple/Millivolt Input Module (1771–IXE/D)

Decimal Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Octal Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
1	Input polarity[1]								Status bits							
2	Inputs over range[1]								Inputs under range[1]							
3	Inputs > high alarm[1]								Inputs < low alarms[1]							
4	Channel 1 input															
5	Channel 2 input															
6	Channel 3 input															
:	:															
11	Channel 8 input															
12	Cold Junction Temperature in °C															
13	Auto–calibration Status Word															

[1] = one bit per input channel

NOTE: Channel input and calibration words 4–12 are expressed as follows:

°F or °C	XXXX	BCD
millivolt	XX.XX	BCD or binary
Cold Junction Temperature	XXXX	BCD or binary (°C only)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Bit/Word Descriptions

The complete bit/word description for the block transfer read from the module is defined in Table 5.B.

Table 5.B
Bit/Word Description for Thermocouple/Millivolt Input Module (1771–IXE/D)

Word	Bit	Definition
Word 1	Bit 00	Power–up bit is set to indicate that the module is waiting for its first write block transfer
	Bit 01	Out of range bit is set if one or more channel inputs are above or below the range for which you configured the module
	Bit 02	Real time sample time–out bit is set when the module updates an input buffer with new data before the processor has read the previous data. Monitor this bit only if you select real time sampling.
	Bit 03	Not used
	Bit 04	Low cold junction temperature bit is set when the cold junction temperature is less than 0°C.
	Bit 05	High cold junction temperature bit is set when the cold junction temperature exceeds 60°C.
	Bit 06	Not used
	Bit 07	EEPROM calibration values could not be read.
	Bits 10–17	Polarity bit for each channel is set to indicate negative polarity: bit 10 for channel 1 thru bit 17 for channel 8. These bits are used in BCD and signed magnitude data formats.
Word 2	Bits 00–07	Underrange bit for each channel is set to indicate an input is out of range: bit 00 for channel 1 thru bit 07 for channel 8.
	Bits 10–17	Overrange bit for each channel is set to indicate an input is out of range: bit 10 for channel 1 thru bit 17 for channel 8. Also set for open channel detection.
Word 3	Bits 00–07	Low alarm bit for each channel is set to indicate the input is less than the low limit value you entered in the corresponding low alarm word (word 4, 6, 8, 10, 12, 14, 16, or 18): bit 00 for channel 1 thru bit 07 for channel 8.
	Bits 10–17	High alarm bit for each channel is set to indicate the input has exceeded the high limit value you entered in the corresponding high alarm word (word 5, 7, 9, 11, 13, 15, 17, or 19): bit 10 for channel 1 thru bit 17 for channel 8.
Words 4–11		Input for channel 1 through 8 respectively.
Word 12		Cold junction temperature in °C.
Word 13		Auto–calibration word.
	Bit 00	Offset calibration complete bit
	Bit 01	Gain calibration complete bit

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Word	Bit	Definition
Word 13 (continued)	Bit 02	Save to EEPROM bit
	Bits 03–05	Not used
	Bit 06	EEPROM fault bit
	Bit 07	Calibration fault bit
	Bits 10–17	Uncalibrated channel bits

Chapter Summary

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Module Calibration

Chapter Objective

In this chapter we tell you how to calibrate your module.

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

Calibrating Your Input Module

The thermocouple/millivolt input module is shipped already calibrated. If it becomes necessary to recalibrate the module, you must calibrate 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.

Calibration can be accomplished using either of two methods:

- auto–calibration
- manual calibration

About Auto-Calibration

Auto–calibration calibrates the input by generating offset and gain correction values and storing them in EEPROM. These values are read out of EEPROM and placed in RAM memory at initialization of the module.

The auto–calibration routine operates as follows:

- Whenever a block transfer write (BTW) of length 28 is performed to the module (any time after the module has been powered up), it interrogates word 28 for a request for auto–calibration.
- The request can be for the following: offset calibration, gain calibration, save operation (save to EEPROM).

When using auto–calibration, write transfer calibration words 20 through 27 must contain zeroes.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Performing Auto-Calibration

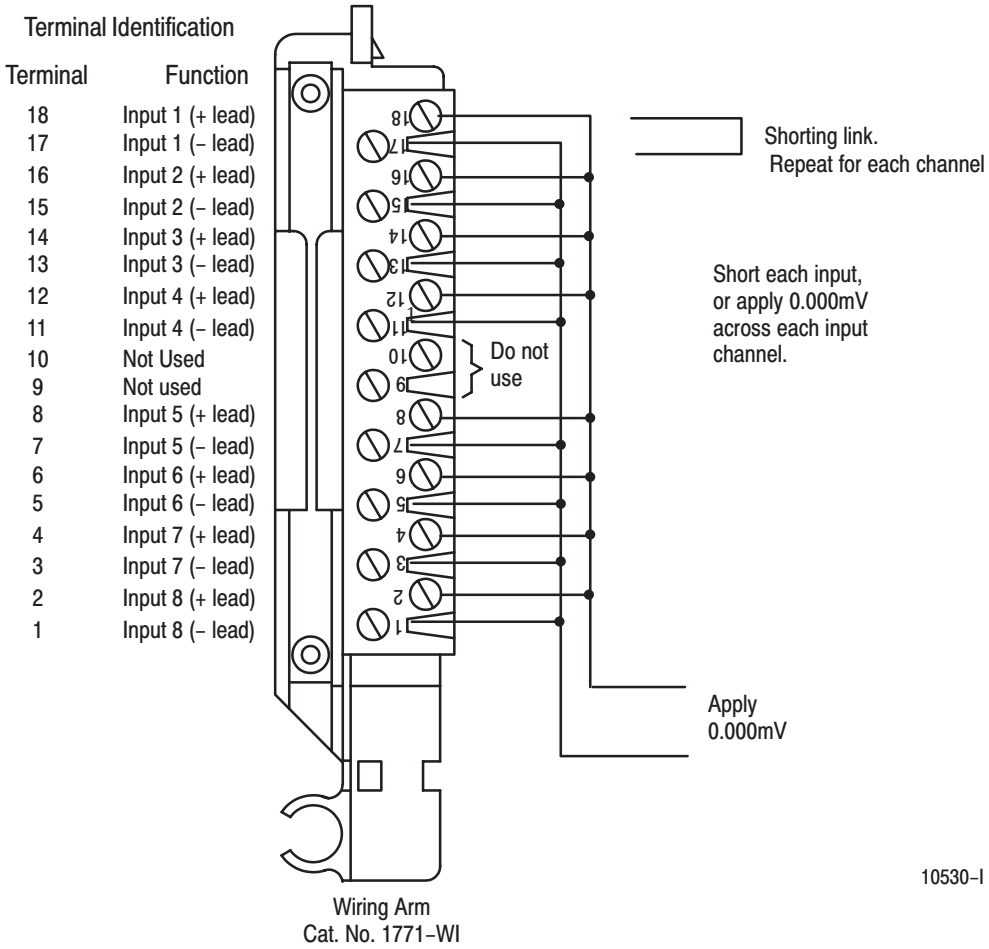
Calibration of the module consists of applying 0.000mV across each input channel for offset calibration, and +100.000mV across each input channel for gain correction.

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. Connect shorting links, or apply 0.000mV across each input channel on the 1771–WI field wiring arm as shown in Figure 6.1.

Figure 6.1
Shorting Inputs for Offset Calibration



3. After the connections stabilize, request the offset calibration by setting bit 00 in block transfer write word 28 and sending a block transfer write (BTW) to the module. Refer to Table 6.A.

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 6.A
Write Block Transfer Word 28

Word Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
Word 28	Inhibit Calibration								Requested Auto–Calibration							
	8	7	6	5	4	3	2	1	Set these bits to 0					Requested Save Values	Requested Gain Cal.	Requested Offset Cal.

NOTE: Normally, all channels are calibrated simultaneously (bits 10–17 of word 28 are octal 0). To disable calibration on any channel, set the corresponding bit 10 through 17 of word 28.

4. Queue block transfer reads (BTRs) to monitor for offset calibration complete and any channels which may have not calibrated successfully. Refer to Table 6.B.

Table 6.B
Read Block Transfer Word 13

Word Bit	17	16	15	14	13	12	11	10	07	06	05	04	03	02	01	00
Word 13	Uncalibrated Channels								Auto–Calibration Status							
	8	7	6	5	4	3	2	1	Cal. Fault	EEPROM Fault	Not used			Save to EEPROM Complete	Gain Cal. Complete	Offset Cal. Complete

5. Proceed to Gain Calibration below.

Gain Calibration

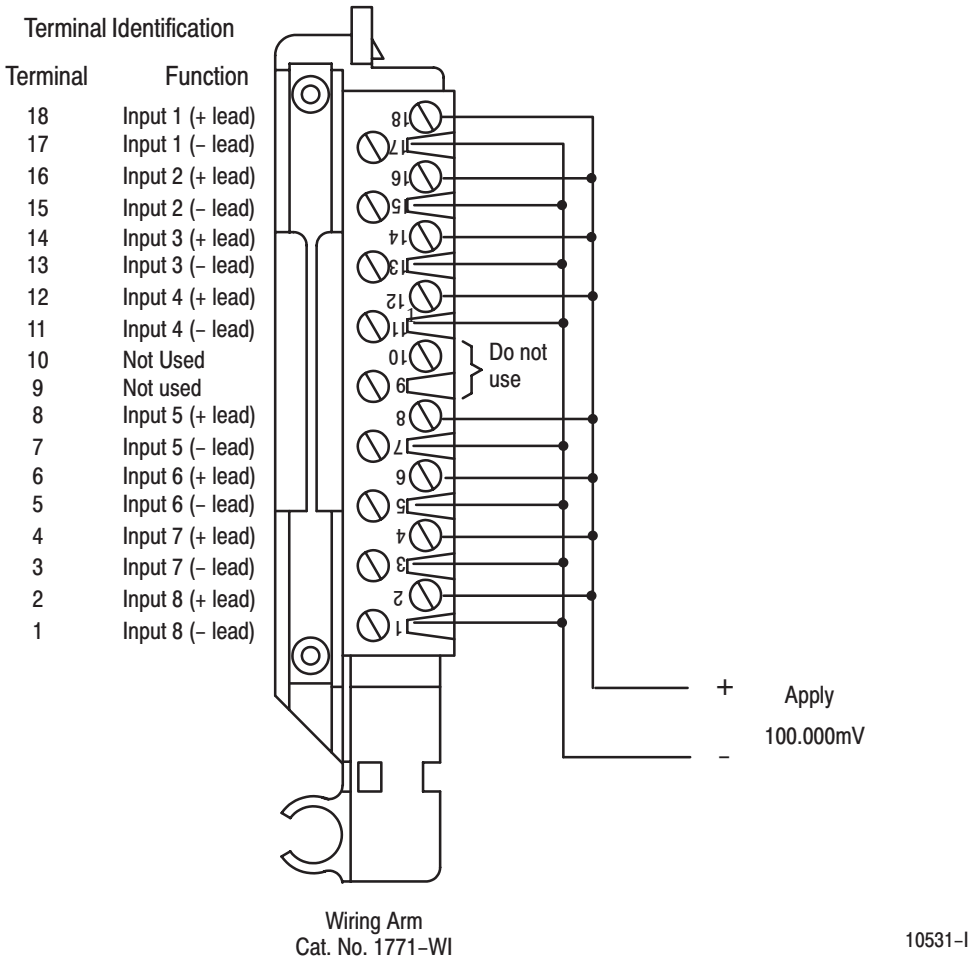
Calibrating gain requires that you apply +100.000mV across each input channel.

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

1. Apply +100.000mV across each input channel as shown in Figure 6.2.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Figure 6.2
Applying 100.00mV for Gain Calibration



2. After the connections stabilize, request the gain calibration by setting bit 01 in BTW word 28 and sending a block transfer write (BTW) to the module. Refer to Table 6.A.

   When the BTW is sent, all channels are calibrated to +100.00mV.

   NOTE: Normally, all channels are calibrated simultaneously (bits 10–17 of word 28 are octal 0). To disable calibration on any channel, set the corresponding bit 10 through 17 of word 28.

3. Queue BTRs to monitor for gain calibration complete and any channels which may not have calibrated successfully.

Save Calibration Values

If any ”uncalibrated channel” bits (bits 10–17 of word 13) are set, a save cannot occur. Auto–calibration should be performed again, starting with offset calibration. If the module has a faulty channel, the remaining functioning channels can be calibrated by inhibiting calibration on the faulty channel.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

The module can be run with the new calibration values, but will lose them on power down. To save these values, proceed as follows:

1. Request a ”save to EEPROM” by setting bit 02 in BTW word 28 and sending the BTW to the module. Refer to Table 6.A.
2. Queue BTRs to monitor for ”save complete”, ”EEPROM fault” and ”calibration fault.” An EEPROM fault indicates a nonoperative EEPROM; a calibration fault indicates at least one channel was not properly offset or gain calibrated and a save did not occur.

Performing Manual Calibration

You calibrate each channel by applying a precision voltage to the input terminals, comparing correct with actual results, and entering correction into the corresponding calibration word for that channel. The correction takes affect after it is transferred to the module by the corresponding BTW instruction in your ladder diagram program. Always start with offset adjustment followed by gain adjustment.

Before calibrating the module, you must enter ladder logic into processor memory, so that you can initiate write block transfers to the module, and the processor can read inputs from the module. Write transfers will contain calibration values in words 20 through 27 for the channel you are calibrating.

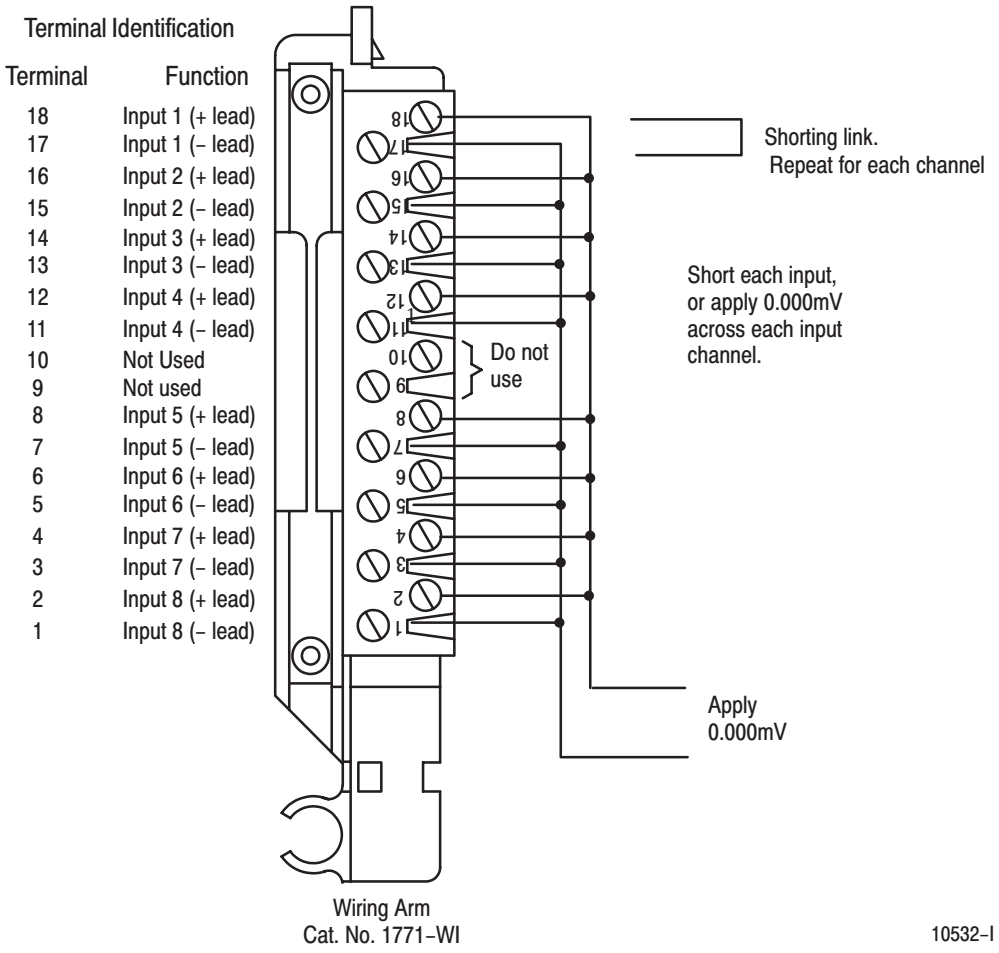
Use a precision voltage source, such as Data Precision 8200 or equivalent, for your calibration input voltage.

Setting Channel Offset Calibration

1. Select the millivolt range and binary data format. (BCD could be used, but it cannot display values larger than 100mV required during gain calibration.)
2. Apply 0.000 millivolts to the channel input as shown in Figure 6.3.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Figure 6.4
Shorting Inputs for Offset Calibration



3. Observe the input value read by the processor (word 4 of the BTR file for channel 1). It should be 0000.

4. Multiply the difference between your observed value and 0.000 by 3.0933. Determine the magnitude and sign of the required correction.

   You can adjust the correction up to ±127 binary counts (±410.56µV).

   A negative correction means that the reading was too high and you want to **subtract** a corrective amount from that reading.

   A positive correction means that the reading was too low and you want to **add** a corrective amount to that reading.

5. Enter the magnitude and sign of the correction in binary code into the upper (offset correction) byte of the calibration word for that channel. (BTW file, word 20, bits 17–10 for channel 1.)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

For example, if the observed value was 17, enter –53 [(0 – 17) x 3.0933 = –53] in signed magnitude binary into the upper byte of the calibration word for that channel. Enter 10110101 in bits 17–10 of word 20. The lower byte will remain zero at this time.

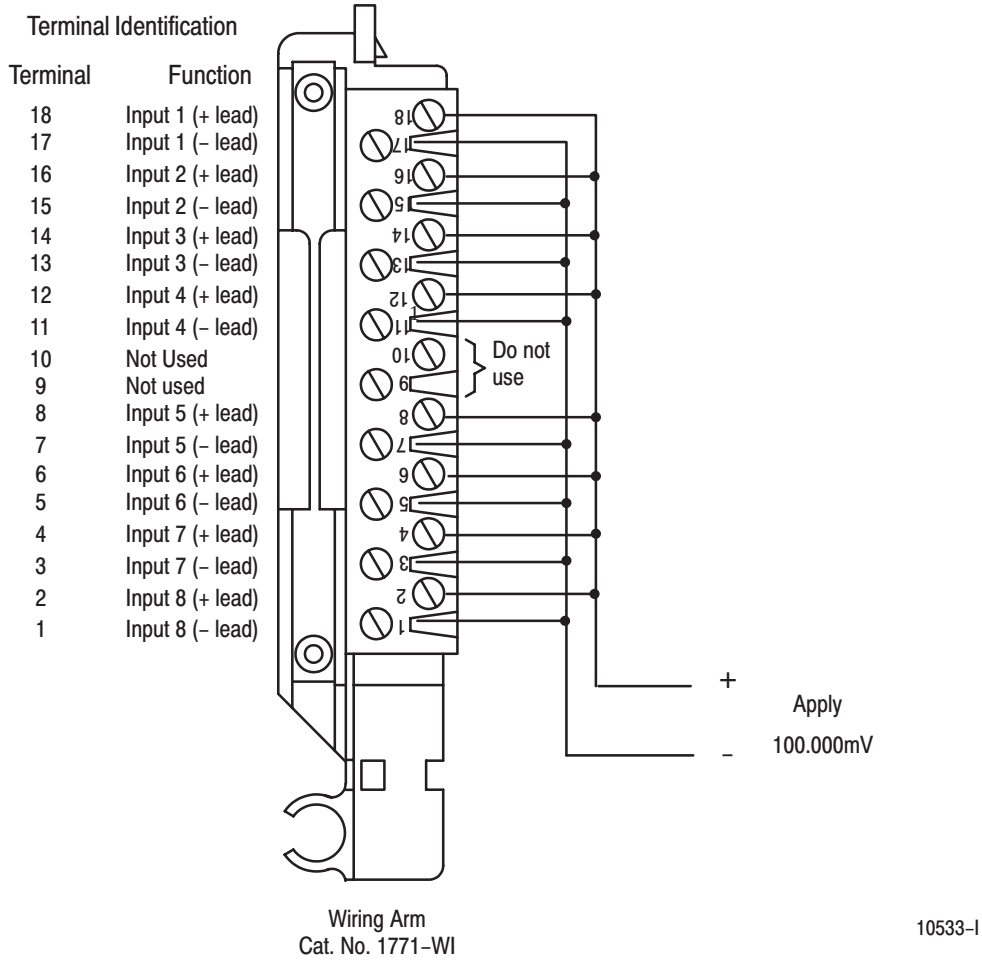
6. Repeat steps 3 through 5 for each of the remaining input channels.

7. Initiate a write block transfer to send the corrections to the module. The input value read by the processor should now be 0000 for all channels.

Setting Channel Gain Calibration

1. Now set the precision voltage source for +100.000 millivolts. Allow sufficient time (at least 10 seconds) for the input filter and voltage source to settle.

Figure 6.5
Applying 100.000mV for Gain Calibration



Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

2. Record the input value read by the processor in the BTR file (word 4 for channel 1). Determine the **percentage** difference from 10000 and the sign of the correction.

   You can adjust the correction up to ±0.19379%.

   A negative correction means that the reading was too high and you want to **subtract** a corrective amount from that reading.

   A positive correction means that the reading was too low and you want to **add** a corrective amount to that reading.

   If programming in BCD, the upper limit for the display is A000. If the overrange bit is set, turn back the voltage reference until the overrange turns off. Use the difference for the calculation.

   For example, if the observed value was 10014, then 10000–10014 = –14, and –14 divided by 10000 = –0.14%.

3. Using the following table, select gain correction values that most nearly add up to the percentage that you determined in step 1. Select a value only once.

Bit	Value
Bit 07	Sign bit
Bit 06	= 0.0976562%
Bit 05	= 0.0488281%
Bit 04	= 0.024414%
Bit 03	= 0.012207%
Bit 02	= 0.00610351%
Bit 01	= 0.00305175%
Bit 00	= 0.00152587%

   Enter the bit code representing the sum of the corrections into the lower byte (gain correction) of the calibration word for that channel.

   For example, to attain the value of 0.140%, you would add:

Percentage	Bit Number
0.0976562	Bit 06
0.024414	Bit 04
0.012207	Bit 03
0.00610351	Bit 02
Total = 0.1403807%	

   Enter 11011100 in the lower byte of the calibration word for that channel. This entry would set bits 07 (sign) and 06, 04, 03 and 02 which is –0.1403807, very close to the required –0.14. Remember to keep the upper byte the same as it was from step 5.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

4. Repeat the above steps 2 and 3 for channels 2 through 8.
5. Initiate a write block transfer to send the corrections to the module. The input value read by the processor should now be 10000 (A000 for BCD) for all channels.
6. If the correction changes the result in the wrong direction, change the sign and reenter it.

Important: If the % correction required is larger than +0.19379, check your reference voltage. If the reference voltage is correct, perform auto–calibration.

Chapter Summary

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Troubleshooting

Chapter Objective

We describe how to troubleshoot your module by observing LED indicators and by monitoring status bits reported to the processor.

Diagnostics Reported by the Module

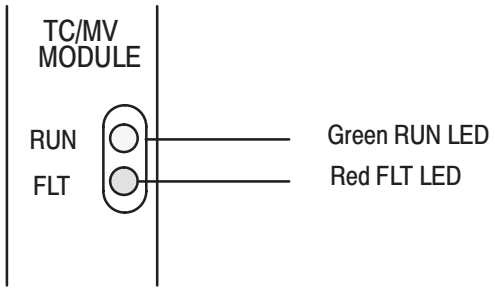
At power–up, the module momentarily turns on both indicators as a lamp test, then checks for

- correct RAM operation
- EPROM operation
- EEPROM operation
- a valid write block transfer with configuration data

Thereafter, the module lights the green RUN indicator when operating without fault, or lights the red FAULT indicator when it detects fault conditions. If the red FAULT indicator is on, block transfers will be inhibited.

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

Figure 7.1
Status Indicators



Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Troubleshooting with the Indicators

Table 7.A shows LED indications and probable causes and recommended actions to correct common faults.

Table 7.A
Troubleshooting Chart for Thermocouple/Millivolt Input Module (1771–IXE/D)

Indication	Probable Cause	Recommended Action
Both LEDs are OFF	No power to module Possible short on the module LED driver failure	Check power to I/O chassis. Recycle as necessary. Replace module.
Red FLT LED ON and Green RUN LED is ON	Microprocessor, oscillator or EPROM failure	Replace module.
Red FLT LED ON	If immediately after power–up, indicates RAM or EPROM failure.[1]	Replace module.
	If during operation, indicates possible microprocessor or backplane interface failure.[1]	Replace module.
Green RUN LED is flashing	Power–up diagnostics successfully completed.	Normal operation.
	If LED continues to flash, and write block transfers (BTW) cannot be accomplished, you have a possible interface failure.	Replace module.

[1] When red LED is on, the watchdog timer has timed out and backplane communications are terminated. Your user program should monitor communication.

Status Reported by the Module

Status Reported in Word 1

Design your program to monitor status bits in the lower byte of word 1, and to take appropriate action depending on your application requirements. You may also want to monitor these bits while troubleshooting with your industrial terminal. The module sets a bit (1) to indicate it has detected one or more of the following conditions as shown in Table 7.B.

Table 7.B
Status Reported in Word 1

Word	Bit	Explanation
1	00	Module is powered but has not received its first (configuration) block transfer. The green LED is flashing.
	01	One or more inputs are out of the range for which you configured the module.
	02	Module updated its inputs before the processor read them. The RTS interval timed out before the processor read the data.
	03	Not used
Word 1 (cont)	04	The module's ambient temperature is below 0ºC. Temperature readings will be inaccurate.
	05	The module's ambient temperature is above 60ºC. Temperature readings will be inaccurate.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Word	Bit	Explanation
	06	Not used
	07	EEPROM calibration constants could not be read. The module will continue to operate but readings may be inaccurate.
	10–17	Sign bits for each channel

Status Reported in Words 2 and 3

Design your program to monitor over/under range bits, and to take appropriate action depending on your application requirements. You may also want to monitor these bits while troubleshooting with your industrial terminal.

Bits 00–07 and 10–17 each represent an input for channels 1–8, respectively. For example, bit 04 represents input channel 5. The module sets a bit (1) to indicate it has detected an out of range condition. Refer to Table 7.C.

Table 7.C
Status Reported in Words 2 and 3

Word	Bit	Condition
2	00–07	Inputs underrange. Bit 00 is channel 1, bit 07 is channel 8. If input connections and voltages are correct, this status may indicate failed channel communications with the microprocessor. If all channels are underrange, this indicates a possible dc/dc converter failure or a blown fuse.
	10–17	Inputs overrange. Bit 10 is channel 1, bit 17 is channel 8. If input connections and voltages are correct, this status may indicate a failed thermocouple functional analog block (TC FAB).
3	00–07	Corresponding channel input value is below the alarm value that you entered for that channel.
	10–17	Corresponding channel input value has exceeded the alarm value that you entered for that channel.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Status Reported in Word 13

Design your program to monitor status bits in word 13 during auto–calibration, and to take appropriate action depending on your requirements. You may also want to monitor these bits while troubleshooting with your industrial terminal. The module sets a bit (1) to indicate it has detected one or more of the following conditions as shown in Table 7.D.

Table 7.D
Status Reported in Word 13

Word	Bit	Condition
13	6	The EEPROM could not be written.
	7	Channel(s) could not be calibrated as indicated by bits 10 through 17 respectively.
	10–17	Bit 10 (channel 1) through bit 17 (channel 8) could not be calibrated. Check field wiring arm connections and source for proper voltage.

Chapter Summary

In this chapter, you learned how to interpret the LED status indicators, status words and troubleshoot your input module.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Specifications

Number of Inputs	8, all of the same type or 4 each of 2 different types
I/O Chassis Location	Any single I/O module slot
Type of Input (Selectable)	Type E, chromel/constantan (–270 to 1000°C) Type J, iron/constantan (–210 to 1200°C) Type K, chromel/alumel (–270 to 1380°C) Type R, Pt/Pt–13% Rh (–50 to 1770°C) Type T, copper/constantan (–270 to 400°C) Type S, Pt/Pt–10% Rh (–50 to 1770°C) Millivolt (–100 to +100mV dc)
Thermocouple Linearization	IPTS–68 standard, NBS MN–125
Cold Junction Compensation	Range: 0 to 60°C Accuracy: ±0.5°C
Temperature Scale (Selectable)	°C or °F
Input Resolution	1°C, 1°F, or 10uV
Input Isolation	1000V peak between inputs, between input and common, and between input and backplane connections
Common Mode Rejection	120dB at 60Hz, up to 1000V peak
Common Mode Impedance	Greater than 10 megohms
Normal Mode Rejection	60dB at 60Hz
Input Overvoltage Protection	120V rms, continuous
Open Input Detection	Open input produces a maximum value reading in less than 10 seconds
Input Connections	18–terminal wiring arm (Cat. No. 1771–WI)
Data Format (Selectable)	4–digit BCD 2's complement binary signed magnitude binary
Calibration	Auto–calibration (offset and gain) Zero offset and gain adjustment for each channel via programming terminal Verify every six months for maintaining absolute accuracy
Processor Compatibility	Any A–B processor using the 1771 I/O structure and block transfer
Environmental Conditions Operating Temperature: Rate of Change: Storage Temperature: Relative Humidity:	 0 to 60°C (32 to 140°F) Ambient changes greater than 0.5°C per minute may temporarily degrade performance during periods of change –40 to 85°C (–40 to 185°F) 5 to 95% (without condensation)
Backplane Power Consumption	750mA @ 5V; 3.75 Watts maximum
Field Wiring Arm	Cat. No. 1771–WI
Keying	Between 20 and 22 Between 24 and 26
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 • C–Tick marked for all applicable acts

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Thermocouple/Millivolt Input Module Accuracy

The accuracy of your thermocouple readings depends on:

- module accuracy
- lead resistance effect
- accuracy of the thermocouple

The accuracy of the module is shown in NO TAG and NO TAG at ambient temperature (25ºC) and over the temperature range (0–60ºC).

Use the calibration procedure in Chapter 6 to adjust your module to compensate for your specific environment.

Table A.A
Thermocouple Range Accuracy Based on Temperatures Above 0ºC

Thermocouple Type	Temperature Range ºC	Max Error @ Calibration Temperature (25ºC)[1]	Temperature Drift ºC/ºC (0–60ºC) or ºF/ºF (32–140ºF)
E	–270 to 1000	±0.74ºC/±1.08ºF	±0.0400
J	–210 to 1200	±0.78ºC/±1.10ºF	±0.0423
K	–270 to 1380	±0.77ºC/±1.15ºF	±0.0640
T	–270 to 400	±0.77ºC/±1.17ºF	±0.0183
R	–50 to 1770	±1.50ºC/±2.11ºF	±0.0914
S	–50 to 1770	±1.50ºC/±2.31ºF	±0.0926

[1] Error is specified from 0ºC (32ºF) to the maximum range of the thermocouple. Error does not include thermocouple error (see appendix F).

Table A.B
Millivolt Range Accuracy

Millivolt Range	Max Error @ Calibration Temperature (25ºC)	Millivolt Drift
–100 to 100	±8.85uV	±3.856uV/ºC

Table A.C
Radiated Noise Susceptibility

Radiated Noise	Susceptibility Error
300–1000MHz Circular Wave, Field Strength = 10V/M	< ±1%

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Lead Resistance Compensation

Allowable Distances

The open thermocouple detection circuit injects a current of approximately 7.3 nanoamps into the thermocouple cable. A total lead resistance of 1370 ohms (685 ohms one–way) cable resistance will produce +1 count (10uV) of error.

Source Impedance Compensation for Millivolt Inputs

Source resistance causes similar errors to occur with millivolt inputs. If source resistance is less than 100 ohms, no compensation is necessary to maintain stated accuracy. If source resistance is greater than 100 ohms, the error can be calculated as follows:

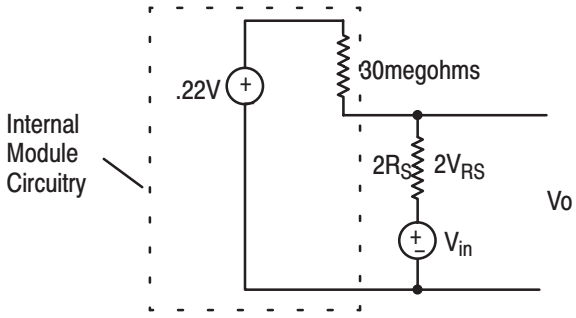
$$\text{Error (in calibration counts)} = - \frac{309329\ R_s\ (0.22 - Vin)}{R_s + 15M\ \text{ohms}}$$

Where R_s = source resistance (one–way cable resistance)
V_{in} = applied input voltage

When using thermocouples, Vin is the approximate thermocouple voltage of the temperature of interest.

$V_O = V_{IN} + 2V_{RS}$

$\text{Error} = 2V_{RS}$



To maintain a display error of < 5uV at V_{in} = OV, R_S should be < 341 ohms. Refer to NBS NM–125 Thermocouple Reference Tables for determining actual thermocouple voltage versus temperature readings.

Filtering

The analog input module has hardware–based high frequency filters on all channels to reduce the effect of electrical noise on the input signal. In addition, a 6–pole digital filter, which begins rolling off at 8.0Hz, is also incorporated.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Programming Examples

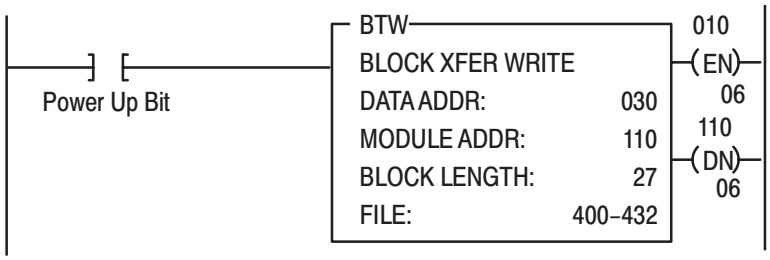
Sample Programs for the Input Module

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. NOTE: For complete programming sample, refer to Figure 4.1.

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.

In RUN/PROG Mode

Action	Result
1. Press [SEARCH]8<data address>	Finds the block address transfer instruction
2. Press CANCEL COMMAND	Removes preceeding command
3. Press [DISPLAY]0 or 1	Displays the file in binary or BCD
4. Press [SEARCH]51	On line data change
Cursor defaults to first entry in file when SEARCH 51 is pressed.	
5. Press [INSERT]	Writes data to file element

In PROG Mode

Action	Result
1. Press [SEARCH]8<data address>	Finds the block transfer instruction
2. Press CANCEL COMMAND	Removes preceeding command
3. Press [DISPLAY]0 or 1	Displays the file in binary or BCD
4. Press [DISPLAY]001 and enter data	Puts cursor on word 1
5. Press [INSERT]	

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 alarming or user calibration are implemented. For example, the block may contain only 1 word if no alarming or user calibration are implemented, but may contain 27 words if using 8 inputs with alarming and user calibration. The PLC–2 family write block transfer data file should look like Figure B.1.

Figure B.1
Write Block Transfer Data Transfer for a PLC–2 Family Processor

DATA ADDR: 030 BINARY DATA MONITOR BLOCK LENGTH: 27
BLOCK XFER WRITE
MODULE ADDR: 110
FILE: 400–432

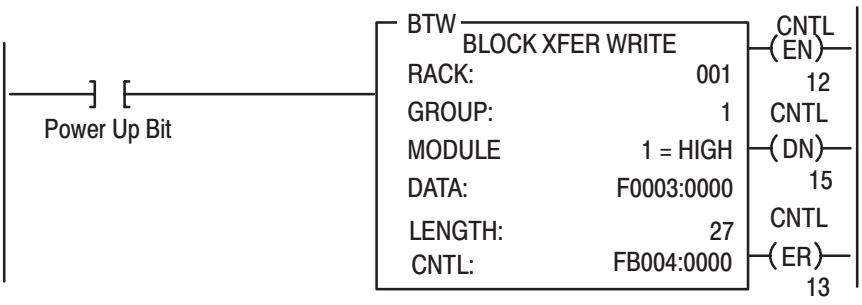
POSITION	FILE DATA			
001	00000000	00000000	00000000	00000000
002	00000000	00000000	00000000	00000000
003	00000000	00000000	00000000	00000000
004	00000000	00000000	00000000	00000000
005	00000000	00000000	00000000	00000000
006	00000000	00000000	00000000	00000000
007	00000000	00000000	00000000	00000000
008	00000000	00000000	00000000	00000000

PLC–3 Family Processors

Following is a sample procedure for entering data in the configuration words of the write block transfer instruction when using a PLC–3 processor. For a complete sample program, refer to Figure Figure 3.2.

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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 B.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 B.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, you can go on to step 3.

3. Enter the data corresponding to your bit selection in words 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].

Figure B.2
Write Block Transfer for a PLC–3 Processor

```
                START – W0003 : 0000

WORD #      0                1                2                3
00000  00000000 00000000  00000000 00000000  00000000 00000000  00000000 00000000
00004  00000000 00000000  00000000 00000000  00000000 00000000  00000000 00000000
00010  00000000 00000000  00000000 00000000  00000000 00000000  00000000 00000000
00014  00000000 00000000  00000000 00000000  00000000 00000000  00000000 00000000
00020  00000000 00000000  00000000 00000000  00000000 00000000  00000000 00000000

  DATA MONITOR                  $ W03:0 – [ ]
  PROG : I/O OFF   NO FORCES :   NO EDITS :   RUNG # [RM000000]   : MEM PROT OFF
```

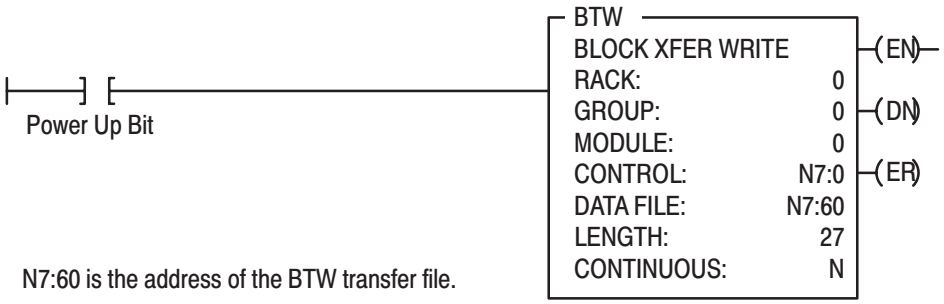
5. Press [CANCEL COMMAND]. This returns you to the ladder diagram.

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. For a complete sample program, refer to Figure Figure 3.3.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

1. Enter the following rung:



2. Press [F8],[F5] and enter N7:60 to display the configuration block. The industrial terminal screen should like Figure B.3.

Figure B.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				

The above data file would configure the module as follow:

- ”K” thermocouples on all inputs
- temperature scale of Celsius
- output data in BCD format
- real time sampling set to a 1 second scan rate
- all channel alarms ON
- all channel minimum alarm values set to –40
- all channel maximum alarm values set to +85
- all calibration values set to 0

3. Enter the data corresponding to your bit selections and add alarm and calibration values, if so desired.

4. [ESC] returns you to the main menu.

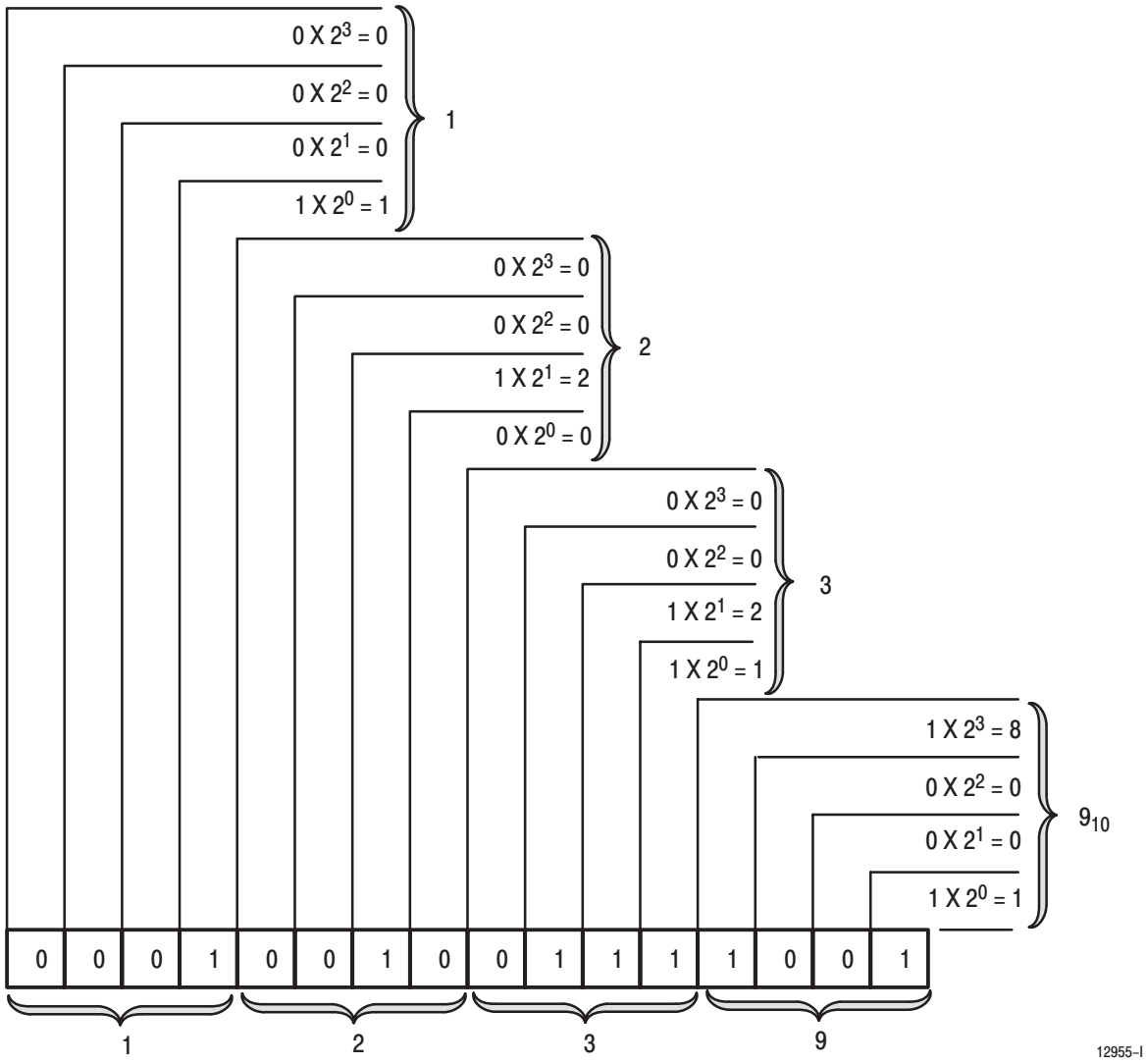
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 (NO TAG). 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 (NO TAG). 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 C.1
4–Digit Binary Coded Decimal



Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table C.A BCD Representation

Place Value 2^3 (8)	2^2 (4)	2^1 (2)	2^0 (1)	Decimal Equivalent
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

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.

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 NO TAG and described in the following paragraphs.

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

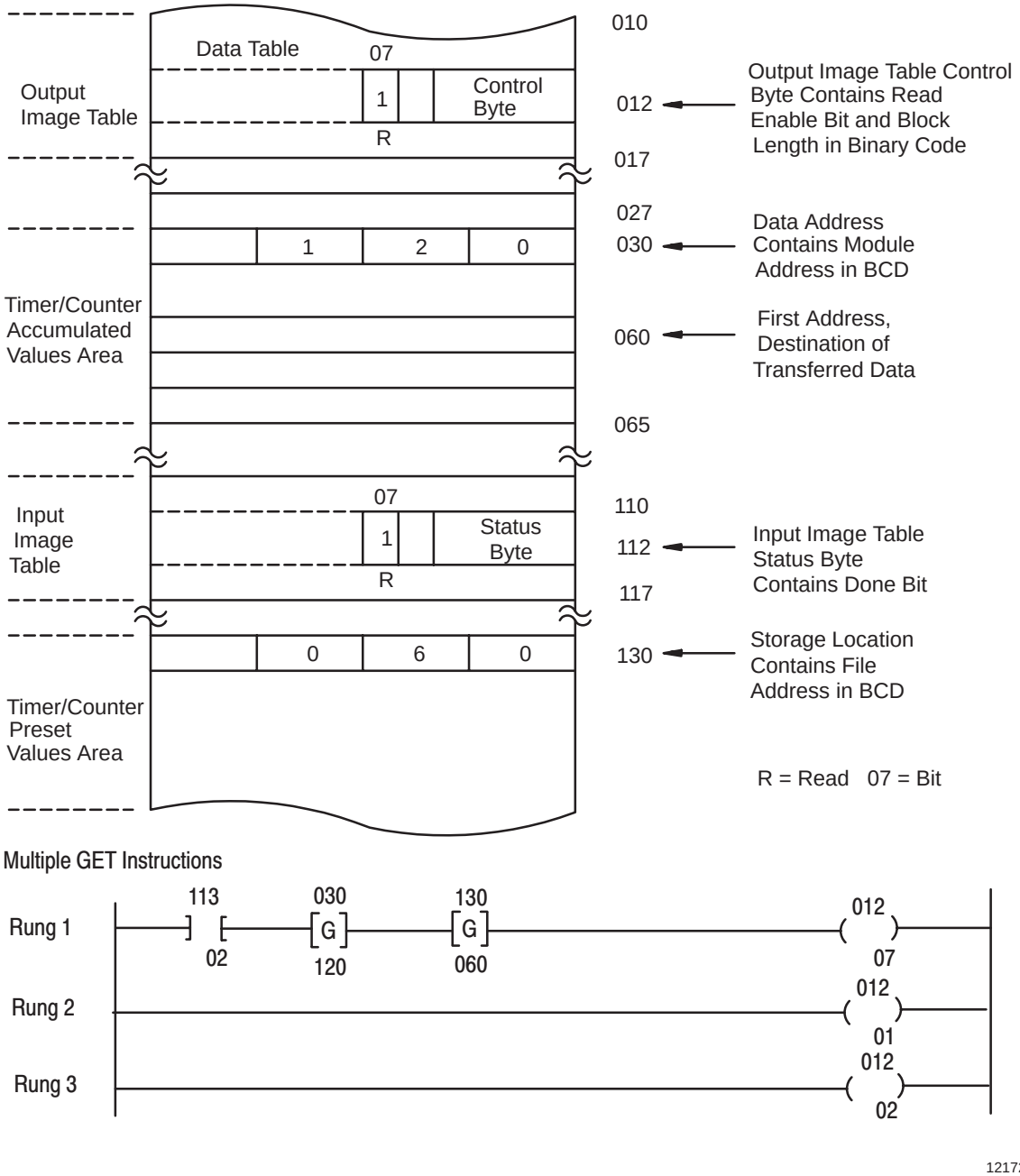
- **Examine On Instruction (113/02) –** This is an optional instruction. When used, block transfers will only be initiated when a certain action takes place. If you do not use this instruction, block transfers will be initiated every I/O scan.
- **First GET Instruction (030/120) –** identifies the module's 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”.)

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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 D.1
Multiple GET Instructions (Mini–PLC–2 and PLC–2/20 Processors Only)



12172

Setting the Block Length (Multiple GET Instructions only)

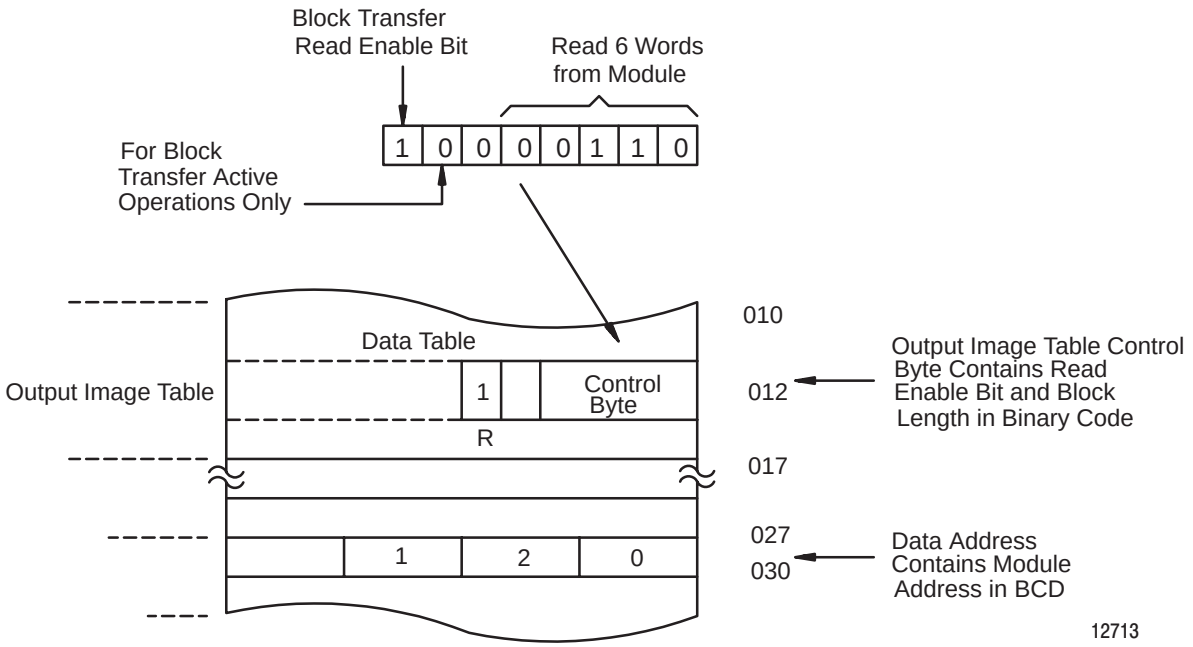
The input module transfers a specific number of words in one block length. The number of words transferred is determined by the block length entered in the output image table control byte corresponding to the module's address.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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, NO TAG 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 D.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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Differences Between Series A, Series B, Series C and Series D Thermocouple/Millivolt Input Modules

Major Differences between Series

The following is a list of major differences between Series A, Series B, Series C and Series D Thermocouple/Millivolt Input module (cat. no. 1771–IXE).

Definition	Series A	Series B	Series C and Series D
Calibration	Uses potentiometers for calibration settings with calibration done at –99 and +99mV.	Calibration is done automatically using auto–calibration feature, or manually through programming.	
Offset, Gain Calibrations	User offset calibration range of +1270uV. Offset correction of 3.2328 uV/bit. User gain correction of .012207%/LSB with a maximum of 1.5503%.	User offset calibration range is +410.5uV maximum. An offset correction is 3.2328 uV/bit User gain correction is now .00152588%/LSB for a maximum of ±0.193787%.	
Real Time Sampling	Series A default value was 500ms.	The default RTS setting (RTS = 0) makes data available every 50ms.	
Cold Junction Calibration	In Series A, BTR word 12 was the cold junction calibration word.	BTR WORD 12 is the rounded Cold Junction Temperature resolute to 1 degree C displayable in the programmed format (BCD, 2s complement or signed magnitude).	
	Cold Junction calibration done by user.	Cold Junction calibration automatically calibrated at power up.	
	Cold junction temperature is updated once per 15 second interval.	Cold junction temperature is digitally filtered with a filter time constant of 12.8 seconds.	
		Cold junction value is updated continously	
High and Low Alarms Limits	When a low alarm is programmed greater than a high alarm, the Series A displayed only low alarm.	When a low alarm is programmed greater than a high alarm both low and high alarms will be activated when the input is between the two values.	
Backplane Current	1200mA at 5V.	750mA at 5V.	850mA at 5V.
Agency Certification (when product or packaging is marked)	• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed		• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed • CE marked for all applicable directives

Publication 1771–6.5.130 - May 1999

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Explanation of Differences

- Calibration is now done automatically using auto–calibration feature, or manually through programming.
- calibration is now done at 0.000mV and +100.000mV .
- If EEPROM read of the auto cal values fails, BTR WORD 1 bit 7 is asserted.
- Series A used potentiometers for calibration settings with calibration done at –99 and +99mV.
- RTS can now be reduced to 100ms for all thermocouples by programming RTS = 1.
- The default RTS setting (RTS = 0) makes data available every 50ms. Series A default value was 500ms.
- BTR WORD 12 is the rounded Cold Junction Temperature resolute to 1 degree C displayable in the programmed format (BCD, 2s complement or signed magnitude). In Series A, BTR word 12 was the cold junction calibration word.
- BTW WORD 1 bit 7 is no longer used (cold junction update).
- Cold Junction calibration by the user is no longer required; it is calibrated at power up.
- Cold junction temperature is digitally filtered having a filter time constant of 12.8 seconds. It is no longer updated once per 15 second interval.
- Cold junction value is updated continously in Series B. Update was once every 15 seconds in Series A.
- Backplane power is approximately 750mA at 5V. Series A had a backplane power requirement of 1200mA.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

- Accuracy specifications over typical RANGES and TEMPERATURES are:

Input Type	Range IS	Range WAS	Accuracy IS
E	–270 to 1000°C	–200 to 1000°C	E = ± 2.14°C
J	–210 to 1200°C	–200 to 1200°C	J = ±2.26°C
K	–270 to 1380°C	–200 to 1372 °C	K = ±3.01°C
R	–50 to 1780°C	– 50 to 1768°C	R = ±4.70°C
S	–50 to 1780°C	– 50 to 1768°C	S = ±4.74°C
T	–270 to 400°C	–200 to 400°C	T = ±1.41°C
mV	±100.00	±100.00	mV = ±144uV

NOTE: Measurements of the most negative temperature extremes are less accurate, as the Seebeck coefficient of the thermocouple drops below the input resolution of the module, 3.2328uV/bit. Above specifications are valid to ?degrees on thermocouple types ? and ?.

- User offset calibration range is ±410.5uV maximum. Series A was ±1270uV. An offset correction is 3.2328 uV/bit not 10uV/bit. User gain correction is now .00152588%/LSB for a maximum of +0.193787%. Series A was .012207%/LSB with a maximum of 1.5503%.
- Multiple BTRs may occur before configuration of the module.
- A block transfer read request with a word length of 00 will return with the old Series A block transfer default length (27 for a write; 12 for a read). To access the auto calibration word, the block transfer length must be set to 28 for a write and 13 for a read.
- Auto calibration can be performed on all channels simultaneously or on only certain channels of interest. In either case, channels being calibrated must be connected to the precision voltage source. Input impedance > 10 Megohms/channel.
- When a low alarm is programmed greater than a high alarm both low and high alarms will be activated when the input is between the two values. The Series A displayed only low alarm.
- An invalid alarm entry (only 0–9 BCD accepted) will cause the alarm value to be set equal to zero.
- In mV mode when displaying in 2's complement or signed magnitude format, the module will continue to display readings past the over or under range limit until the input saturates.
- The module employs a digital filter capable of 120dB/decade rolloff from a corner frequency of 8 Hz.
- This Series B module is NOT compatible with the 1771–EX extender board. Use the 1771–EZ extender board with Series B.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

- The Series B module requires approximately 2 seconds to execute initialization after power is applied.
- The red LED will be turned on and the green LED extinguished when the watchdog timer times out.
- A type code of 111_2 will yield S type thermocouple.
- Data format of 11_2 yields signed magnitude instead of 2's complement.
- When the module is programmed for RTS = 0, and the PLC is switched from run to program and back to run, an RTS timeout is inhibited on the switch from program to run.
- Allowable ambient temperature change to maintain accuracy is 0.5ºC/min.
- Series B, C and D have CE certification.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Thermocouple Restrictions (Extracted from NBS Monograph 125 (IPTS-68))

General

Following are some restrictions extracted from NBS Monograph 125 (IPTS–68) issued March 1974 on thermocouples J, K, T, E, R and S:

J (Iron vs Copper–Nickel <Constantan*>) Type Thermocouple

The J thermocouple “is the least suitable for accurate thermometry because there are significant nonlinear deviations in the thermoelectric output from different manufacturers. ... The total and specific types of impurities that occur in commercial iron change with time, location of primary ores, and methods of smelting.”

“Type J thermocouples are recommended by the ASTM [1970] for use in the temperature range from 0 to 760C in vacuum, oxidizing, reducing or inert atmospheres. If used for extended times above 500C, heavy gage wires are recommended because the oxidation rate is rapid at elevated temperatures.”

“They should not be used in sulfurous atmospheres above 500C. Because of potential rusting and embrittlement, they are not recommended for subzero temperatures. They should not be cycled above 760C even for a short time if accurate readings below 760C are desired at a later time.”

“The negative thermoelement, a copper–nickel alloy, is subject to substantial composition changes under thermal neutron irradiation, since copper is converted to nickel and zinc.”

“Commercial iron undergoes a magnetic transformation near 769C and <an alpha – gamma> crystal transformation near 910C. Both of these transformations, especially the latter, seriously affect the thermoelectric properties of iron, and therefore, the Type J thermocouples. ... If Type J thermocouples are taken to high temperatures, especially above 900C, they will lose accuracy of their calibration when they are recycled to lower temperatures.”

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

"ASTM Standard E230–72 in the Annual Book of ASTM Standards [1972] specifies that the standard limits of error for Type J commercial thermocouples be +/–2.2C between 0 and 277C and +/–3/4 percent between 277 and 760C. Limits of error are not specified for Type J thermocouples below 0C or above 760C. Type J thermocouples can also be supplied to meet special limits of error, which are equal to one half the limits given above. The recommended upper temperature limit for protected thermocouples, 760C, applies to AWG 8 (3.3mm) wire. For smaller wires the recommended upper temperature decrease to 593C for AWG 14 (1.6mm), and 371C for AWG 24 or 28 (0.5 or 0.3mm).

K (Nickel–Chromium vs Nickel–Aluminum) Type Thermocouple

"This type is more resistant to oxidation at elevated temperatures than the Types E, J or T thermocouples and consequently it finds wide application at temperatures above 500C."

"Type K thermocouples may be used at" liquid hydrogen "temperatures. However, their Seebeck coefficient (about 4uV/K at 20K) is only about one–half of that of Type E thermocouples. Furthermore, the thermoelectric homogeneity of KN thermoelements is generally not quite as good as that of EN thermoelements. Both the KP and the KN thermoelements do have a relatively low thermal conductivity and good resistance to corrosion in moist atmospheres at low temperatures."

"Type K thermocouples are recommended by the ASTM [1970] for continuous use at temperatures within the range –250 to 1260C in oxidizing or inert atmospheres. Both the KP and the KN thermoelements are subject to oxidation when used in air above about 850C, but even so, Type K thermocouples may be used at temperatures up to about 1350C for short periods with only small changes in calibration."

"They should not be used in sulfurous, reducing, or alternately reducing and oxidizing atmospheres unless suitably protected with protecting tubes. They should not be used in vacuum (at high temperatures) for extended times because the Chromium in the positive thermoelement vaporizes out of solution and alters the calibration. They should also not be used in atmospheres that promote "green–rot" corrosion (those with low, but not negligible, oxygen content)."

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

“ASTM Standard E230–72 in the Annual Book of ASTM Standards [1972] specifies that the standard limits of error for Type K commercial thermocouples be +/–2.2C between 0 and 277C and +/–3/4 percent between 277 and 1260C. Limits of error are not specified for the Type K thermocouples below 0C. Type K thermocouples can also be supplied to meet special limits of error, which are equal to one half the standard limits of error given above. The recommended upper temperature limit for protected Type K thermocouples, 1260C, applies for AWG 8 (3.3mm) wire. For smaller wires it decreases to 1093C for AWG 14 (1.6mm), 982C for AWG 20 (0.8mm), and 871C for AWG 24 or 28 (0.5 or 0.3mm).”

T (Copper vs Copper–Nickel <Constantan*>) Type Thermocouple

“The homogeneity of most Type TP and TN (or EN) thermoelements is reasonably good. However, the Seebeck coefficient of Type T thermocouples is moderately small at subzero temperatures (about 5.6uV/K at 20K), being roughly two–thirds that of Type E thermocouples. This, together with the high thermal conductivity of Type TP thermoelements, is the major reason why Type T thermocouples are less suitable for use in the subzero range than Type E thermocouples.”

“Type T thermocouples are recommended by the ASTM [1970] for use in the temperature range from –184 to 371C in vacuum or in oxidizing, reducing or inert atmospheres. The recommended upper temperature limit for continuous service of protected Type T thermocouples is set at 371C for AWG 14 (1.6mm) thermoelements, since Type TP thermoelements oxidize rapidly above this temperature. However, the thermoelectric properties of Type TP thermoelements are apparently not grossly affected by oxidation since Roeser and Dahl [1938] observed negligible changes in the thermoelectric voltage of Nos. 12, 18, and 22 AWG Type TP thermoelements after heating for 30 hours in air at 500C. At this temperature the Type TN thermoelements have good resistance to oxidation and exhibit only small changes in thermal emf with long exposure in air, as shown by the studies of Dahl [1941].” ... “Operation of Type T thermocouples in hydrogen atmospheres at temperatures above about 370C is not recommended since severe embrittlement of the Type TP thermoelements may occur.”

“Type T thermoelements are not well suited for use in nuclear environments, since both thermoelements are subject to significant changes in composition under thermal neutron irradiation. The copper in the thermoelement is converted to nickel and zinc.”

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

"Because of the high thermal conductivity of Type TP thermoelements, special care should be exercised in the use of the thermocouples to insure that both the measuring and reference junctions assume the desired temperatures."

ASTM Standard E230–72 in the Annual Book of ASTM Standards [1972] specifies that the standard limits of error for Type T commercial thermocouples be +/–2 percent between –101 and –59C, +/–.8C between –59 and 93C and +/–3/4 percent between 93 and 371C. Type T thermocouples can also be supplied to meet special limits of error, which are equal to one half the standard limits of error given above (plus a limit of error of +/–1 percent is specified between –184 and –59C). The recommended upper temperature limit for protected Type T thermocouples, 371C, applies to AWG 14 (1.6mm) wire. For smaller wires it decreases to 260C for AWG 20 (0.8mm) and 240C for AWG 24 or 28 (0.5 or 0.3mm).

E (Nickel–Chromium vs Copper–Nickel <Constantan*>) Type Thermocouple

"Type E thermocouples are recommended by the ASTM Manual [1970] for use in the temperature range from –250 to 871C in oxidizing or inert atmospheres. The negative thermoelement is subject to deterioration above about 871C, but the thermocouple may be used up to 1000C for short periods."

"The ASTM Manual [1970] indicates the following restrictions .. at high temperatures. They should not be used in sulfurous, reducing or alternately reducing and oxidizing atmospheres unless suitably protected with protecting tubes. They should not be used in vacuum (at high temperatures) for extended times, because the Chromium in the positive thermoelement vaporizes out of solution and alters the calibration. They should also not be used in atmospheres that promote "green–rot" corrosion (those with low, but not negligible, oxygen content)."

"The negative thermoelement, a copper–nickel alloy, is subject to composition changes under thermal neutron irradiation since the copper is converted to nickel and zinc."

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

“ASTM Standard E230–72 in the Annual Book of ASTM Standards [1972] specifies that the standard limits of error for the Type E commercial thermocouples be +/–1.7C between 0 and 316C and +/–1/2 percent between 316 and 871C. Limits of error are not specified for Type E thermocouples below 0C. Type E thermocouples can also be supplied to meet special limits of error, which are less than the standard limits of error given above: +/–1.25C between 0 and 316C and +/–3/8 percent between 316 and 871C. The recommended upper temperature limit for protected thermocouples, 871C, applies to AWG 8 (3.3mm) wire. For smaller wires the recommended upper temperature decreases to 649C for AWG 14 (1.6mm), 538C for AWG 20 (.8mm) and 427C for AWG 24 or 28 (0.5 or 0.3mm).

S (Platinum–10% Rhodium vs Platinum) & R (Platinum–13% Rhodium vs Platinum) Type Thermocouples

“The ASTM manual STP 470 [1970] indicates the following restrictions on the use of S {and R} type thermocouples at high temperatures: They should not be used in reducing atmospheres, nor in those containing metallic vapor (such as lead or zinc), nonmetallic vapors (such as arsenic, phosphorous or sulfur) or easily reduced oxides, unless suitably protected with nonmetallic protecting tubes. They should never be inserted directly into a metallic primary tube.”

“The positive thermoelement, platinum–10% rhodium {13% rhodium for R}, is unstable in a thermal neutron flux because the rhodium converts to palladium. The negative thermoelement, pure platinum, is relatively stable to neutron transmutation. However, fast neutron bombardment will cause physical damage, which will change the thermoelectric voltage unless it is annealed out.”

“The thermoelectric voltages of platinum based thermocouples are sensitive to their heat treatments. In particular, quenching from high temperatures should be avoided.”

“ASTM Standard E230–72 in the Annual Book of ASTM Standards [1972] specifies that the standard limits of error for Type S {and R} commercial thermocouples be +/–1.4C between 0 and 538C and +/–1/4% between 538 and 1482C. Limits of error are not specified for Type S {or R} thermocouples below 0C. The recommended upper temperature limit for continuous use of protected thermocouples, 1482C, applies to AWG 24 (0.5mm) wire.

* It should be noted that the Constantan element of Type J thermoelements is NOT interchangeable with the Constantan element of Types T or N due to the different ratio of copper and nickel in each.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

A

Accuracy, 1−3

B

backplane connector keying, 2−3

Bit/Word descriptions, 1771−IXE, 4−6

block transfer, 2−3

Block transfer programming, 3−1

Block transfer read, 5−1
- bit/word descriptions, 1771−IXE, 5−2
- BTR word assignments, 1771−IXE, 5−1

C

cable lengths, 2−6

calculating power requirements, 2−3

Calibration
- channel offset, 1771−IXE, 6−5
- procedure for 1771−IXE, 6−5
- tools, 6−1

Communication, how data is transferred, 1−2

Configuring your module
- 1771−IXE features, 4−1
- configuration block, 1771−IXE, 4−5

connecting wiring, 2−5

D

determining module placement, 2−3

Diagnostics
- indicators, 2−7, 7−1
- reported by module, 7−1

F

Filtering, A−3

G

grounding the module, 2−6

I

installing the module, 2−4

interpreting the status indicators, 2−7

K

keying the backplane, 2−3

M

Manual calibration, 6−5

module grounding, 2−6

module installation, 2−4

module location, in I/O chassis, 2−3

module placement, 2−3

N

noise interference, 2−3

P

power requirements, 2−3
- from backplane, 2−3

Pre−installation considerations, 2−1

Programming example
- PLC−2, 3−2
- PLC−3, 3−4
- PLC−5, 3−5

R

Real time sampling, 4−3
- bit settings, 4−4

recommended cable lengths, 2−6

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

S

Scan time, 3–6

Specifications,
Thermocouple/Millivolt input module, 1771–IXE, A–1

status indicators, 2–7

T

Thermocouple/Millivolt input module, features, 1–1

Troubleshooting, table, 1771–IXE, 7–2

V

voltage–mode input devices, recommended cable length, 2–6

W

wiring connections, 2–5

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Allen-Bradley
Publication Problem Report

If you find a problem with our documentation, please complete and return this form.

Pub. Name **Thermocouple/RTD Input Module User Manual**

Cat. No. **1771-IXE Series D** Pub. No. **1771-6.5.130** Pub. Date **May 1999** Part No. **955132-11**

Check Problem(s) Type:	Describe Problem(s):	Internal Use Only
☐ Technical Accuracy	☐ text ☐ illustration	
☐ Completeness What information is missing?	☐ procedure/step ☐ illustration ☐ definition ☐ example ☐ guideline ☐ feature ☐ explanation ☐ other	☐ info in manual (accessibility) ☐ info not in manual
☐ Clarity What is unclear?		
☐ Sequence What is not in the right order?		
☐ Other Comments Use back for more comments.		

Your Name _____ Location/Phone _____

Return to: Marketing Communications, Allen-Bradley Co., 1 Allen-Bradley Drive, Mayfield Hts., OH 44124-6118
Phone: (216)646-3176
FAX: (216)646-4320

Publication ICCG-5.21-August 1995 PN 955107-82

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

PLEASE FASTEN HERE (DO NOT STAPLE)

Other Comments

PLEASE REMOVE

PLEASE FOLD HERE

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST-CLASS MAIL PERMIT NO. 18235 CLEVELAND OH

POSTAGE WILL BE PAID BY THE ADDRESSEE

Rockwell Automation
Allen-Bradley

1 ALLEN BRADLEY DR
MAYFIELD HEIGHTS OH 44124-9705

Publication 1771-6.5.130 - May 1999

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Rockwell Automation

Allen-Bradley

Allen-Bradley, a Rockwell Automation Business, has been helping its customers improve productivity and quality for more than 90 years. We design, manufacture and support a broad range of automation products worldwide. They include logic processors, power and motion control devices, operator interfaces, sensors and a variety of software. Rockwell is one of the world's leading technology companies.



Worldwide representation.

Argentina • Australia • Austria • Bahrain • Belgium • Brazil • Bulgaria • Canada • Chile • China, PRC • Colombia • Costa Rica • Croatia • Cyprus • Czech Republic • Denmark • Ecuador • Egypt • El Salvador • Finland • France • Germany • Greece • Guatemala • Honduras • Hong Kong • Hungary • Iceland • India • Indonesia • Ireland • Israel • Italy • Jamaica • Japan • Jordan • Korea • Kuwait • Lebanon • Malaysia • Mexico • Netherlands • New Zealand • Norway • Pakistan • Peru • Philippines • Poland • Portugal • Puerto Rico • Qatar • Romania • Russia–CIS • Saudi Arabia • Singapore • Slovakia • Slovenia • South Africa, Republic • Spain • Sweden • Switzerland • Taiwan • Thailand • Turkey • United Arab Emirates • United Kingdom • United States • Uruguay • Venezuela • Yugoslavia

Allen-Bradley Headquarters, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414 382-2000 Fax: (1) 414 382-4444

Publication 1771–6.5.130 - May 1999
Supersedes Publication 1771–6.5.77 - January 1991

PN955132–11
Copyright 1999 Allen-Bradley Company, Inc. Printed in USA

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP