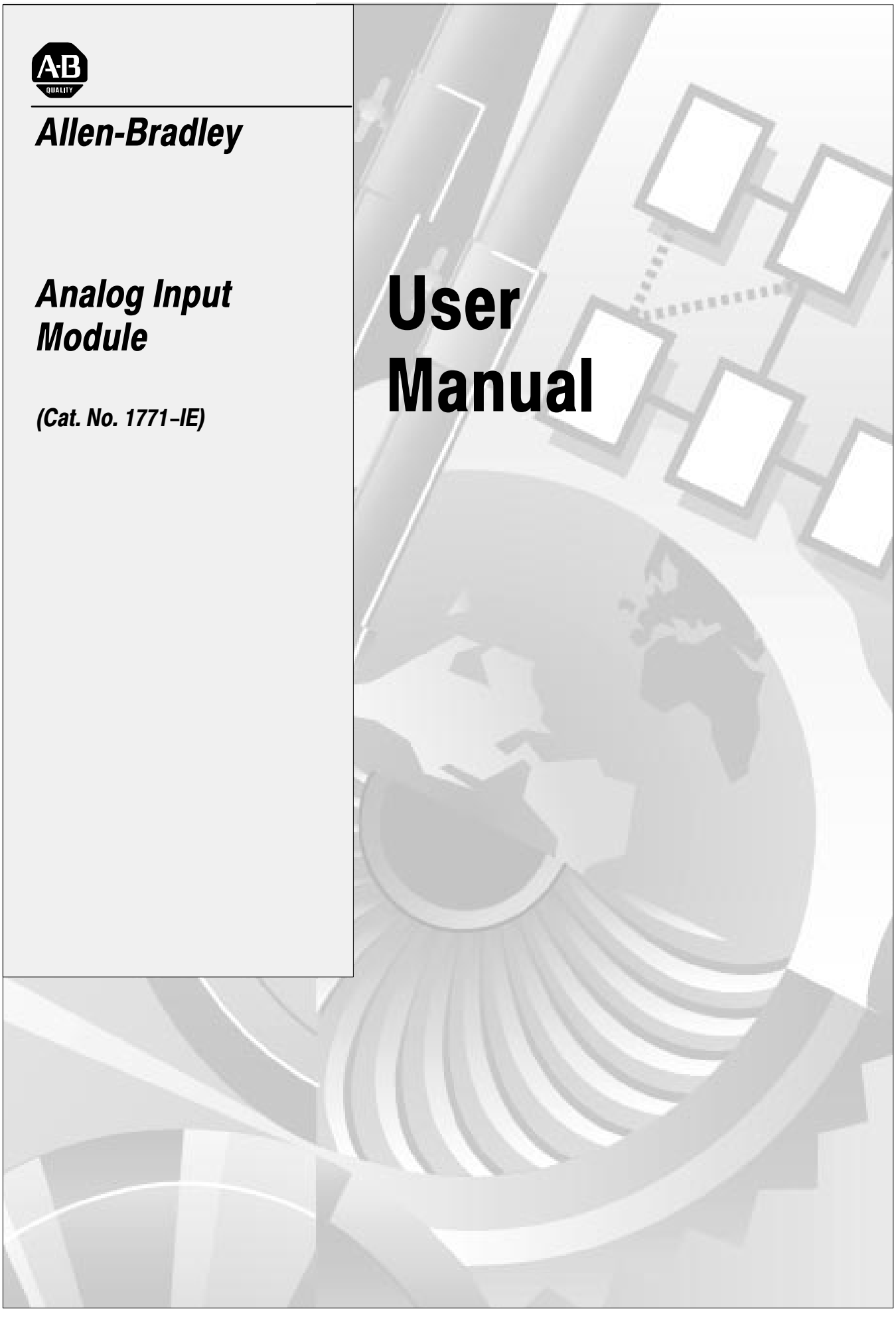

Allen-Bradley

Analog Input Module

(Cat. No. 1771–IE)

User Manual

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Chapter 1

Using This Manual

Chapter Objective

This chapter tells you how to use this manual efficiently.

Purpose of This Manual

This manual shows you how to use your 8-bit Analog Input Module with an Allen-Bradley programmable controller. It helps you install, program, calibrate, and troubleshoot your module.

Audience

We assume that you know how to program and operate an Allen-Bradley programmable controller. In particular, you should know how to program block transfer. If you do not, refer to the appropriate programming and operations manual before you use the 8-bit Analog Input Module.

Warnings and Cautions

This manual contains warnings and cautions. A warning tells where you may be injured if you use your equipment improperly. Cautions tell where equipment may be damaged from misuse.

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

Related Publications

For a list of publications with information on the Allen-Bradley line of modules and programmable controllers, consult our publication index (SD499).

Quick Locator

You will find the following terms or concepts described as follows:

Block Transfer Programs	Page 4-1
Calibration	Page 5-1
Configuration Switches	Page 3-9, 5-3
External Power Supply	Page 3-2
Input Channel Ranges	Page 2-2
Input Data Format	Page 2-4
Specifications	Page 2-6
Status Bits	Page 2-5
Wiring/Grounding	Page 3-4, 3-8

Chapter 2

Overview of the Analog Input Module

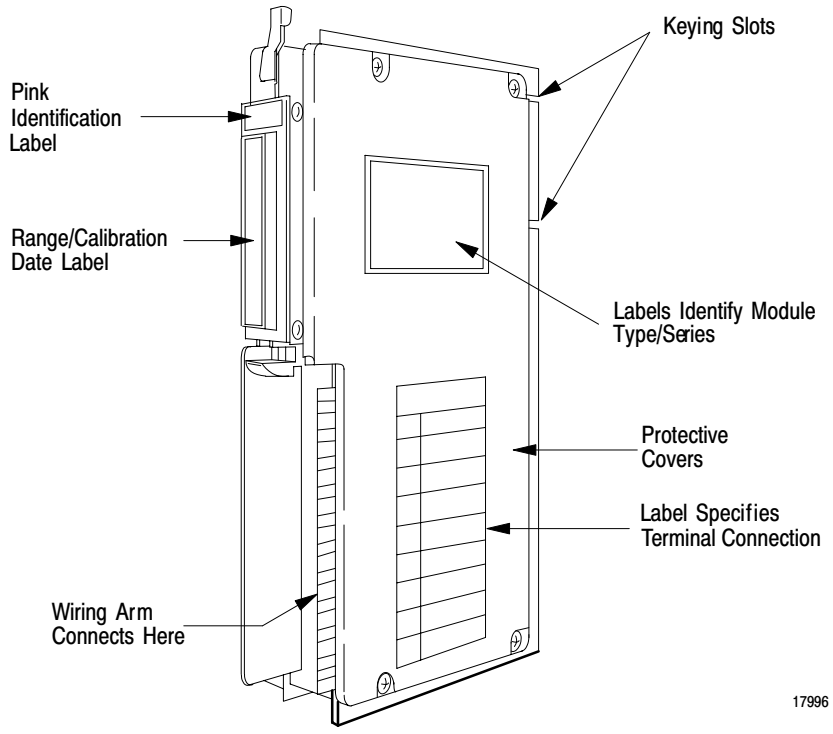
Chapter Objectives

This chapter gives you a functional and hardware overview of the analog input module.

Description

The module (Figure 2.1) senses analog signals at its inputs and converts these signals to 3-digit Binary Coded Decimal (BCD) values (0 to 255 BCD) for use by your programmable controller.

Figure 2.1
Analog Input Module



The module accepts up to eight analog signals having a single voltage or current range that you select based on the type of input devices required by your application. It allows your programmable controller to

manipulate values representing temperature, pressure, rotational speed, light intensity, and position.

A wiring arm (cat. no. 1771-WB) accompanies the module. It acts as a terminal strip for input connections. The wiring arm pivots on the I/O chassis to connect with terminals on the front of the input module. Thus, the wiring arm lets you quickly connect or disconnect your input wiring when inserting or removing the input module from the I/O chassis.

The input module meets the requirements of the Instrument Society of America, Standard S50.1 (1975), "Compatibility of Analog Signals for Electronic Industrial Process Instruments."

Input Channels

The input module supports eight single-ended input channels. All eight channels have the same voltage or current range that you select when ordering the module. The range is factory set and calibrated.

Nominal Range:	Precise Range:	Units/Bit:	Order Code
1 to 5 V 4 to 20mA	1 to 4.9844 V 4 to 19.937 mA	15.60 mV/bit 0.063 mA/bit	01 05
0 to 5 V 0 to 20 mA	0 to 4.980 V 0 to 19.922 mA	19.53 mV/bit 0.078 mA/bit	02 06
-10 to 10V	-10 to 9.922V	78.13 mV/bit	03
-20 to 20 mA	-20 to 19.844 mA	0.156 mA/bit	07
0 to 10 V	0 to 9.96 V	39.06 mV/bit	04

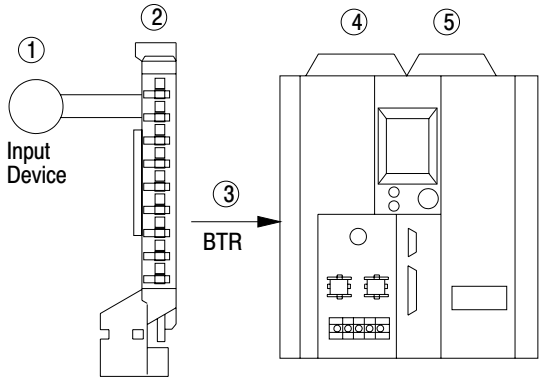
When ordering 1771-IE modules, place the order code as a suffix to the catalog number. For example, 1771-IE-04.

You can change from a voltage range to the equivalent current range and vice versa within limited catagories. For example, from the above table you can switch from a range of (1 to 5 VDC) to (4 to 20 mA) or (0 to 5 VDC) to (0 to 20 mA) without recalibrating.

How Analog Modules Communicate With Programmable Controllers

Analog input modules communicate with a programmable controller by block transfer in the following manner (Figure 2.2).

Figure 2.2
Communication Between Input Module and Processor



1. Input devices generate analog signals which are transmitted to the input module.

2. The input module converts analog signals into BCD values and stores them until the processor requests a transfer of data.

3. When instructed by your ladder diagram program, the processor performs a read block transfer of the values and stores them in its data table.

4. Your program can determine that the transfer was made without error, and that the values are within a specified range.

5. Your program can use and/or move the data before it is written over by the transfer of new data in a subsequent block transfer.

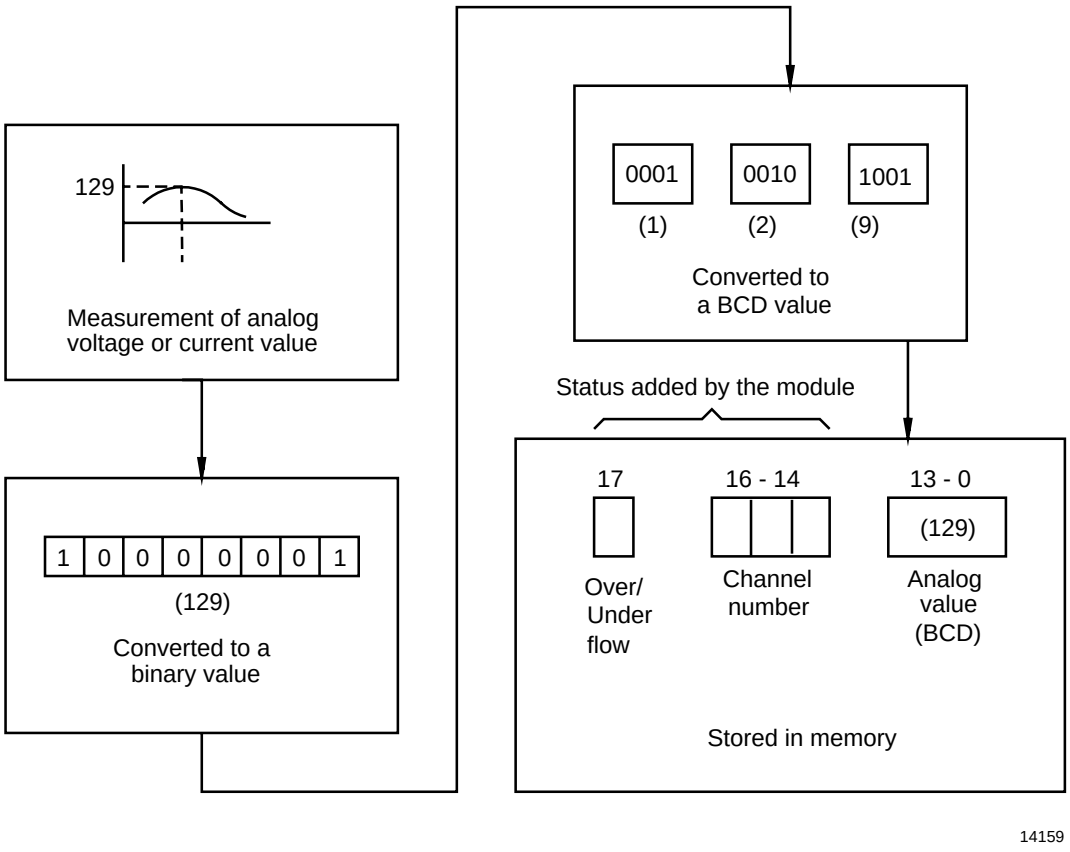
How the Input Module Converts Analog Signals

The input module converts analog signals to digital values readable by your processor (Figure 2.3).

The input module scans its inputs every 2.5ms and converts analog data to a digital format. It stores this data momentarily until transferred to the processor's data table. The module reserves the last 200 microseconds of

each input scan for formatting data, and cannot accept block transfers during this time.

Figure 2.3
Input Conversion and Formatting

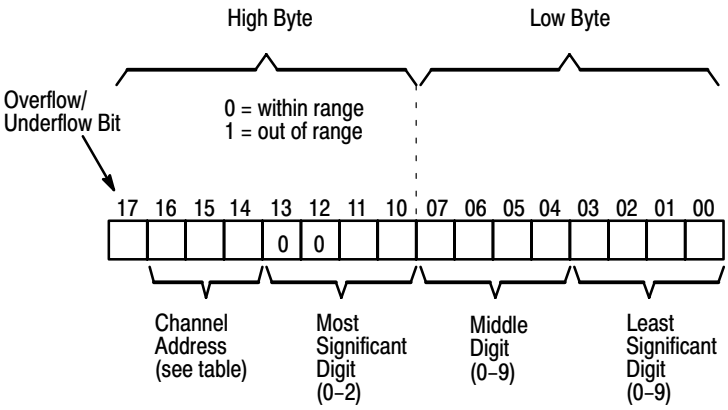


Input Data Format

Input data is transferred to the processor in 12-bit 3-digit BCD format with a range of 0-255.

The processor stores the data in 16-bit input words (Figure 2.4). The 16 bits are used as follows:

Figure 2.4
Analog Input Word



Channel Address Codes

Bits 16 15 14	Channel Number
0 0 0	1
0 0 1	2
0 1 0	3
0 1 1	4
1 0 0	5
1 0 1	6
1 1 0	7
1 1 1	8

14165

Bits 00-11 These bits contain input values which range from 0 to 255 BCD (8 bit resolution).

Bits 12-13 These bits must remain reset (to 0) for proper operation.

Bits 14-16 These bits indicate by binary code which channel is being read.

Bit 17 This bit indicates an overflow/underflow condition, and is set (to 1) under the following conditions:

- input value is zero or negative
- input value is greater than or equal to 255

Specifications

Inputs Per Module
8 single-ended

Input Voltage Ranges (nominal)
1 to 5 V
0 to 5 V
0 to 10 V
-10 to 10 V

Input Current Ranges (nominal)
0 to 20 mA
4 to 20 mA
-20 to 20 mA

Input Overvoltage Protection
±35 VDC
25 VRMS (sinusoidal)

Input Overcurrent Protection
±30 mA

Input Impedance
10^{10} Ohms for voltage ranges
250 Ohms (±0.1%) for current ranges

Electrical-Optical Isolation
between input circuit and control logic: 1500 V

Backplane Current Requirement
400 mA at 5 VDC

Ambient Temperature Rating
operating: 0 to 60°C
(32 to 140°F)

storage -40 to 85°C
(-40 to 185°F)

Humidity Rating
5 to 95% (non-condensing)

Keying (between)
4 and 6
26 and 28

A/D Converter Type
successive approximation, monotonic

Resolution
1 part in 256 (2^8)

Linearity
± 0.1% of full scale at 25° C

Offset
±0.15% of full scale at 25° C

Gain
±0.15% of full scale at 25° C

Quantizing Error
±1/2 LSB (0.19% of full scale)

Absolute Accuracy (including linearity, offset, and gain at 25° C)
0.3% of full scale ±1/2 LSB

Stability (drift over the full temperature range)
temperature coefficient = ±85 ppm/°C of full scale

Inaccuracy (due to internal electrical noise)
3 sigma noise 0.2% RMS of full scale

Chapter 3

Installing the Analog Input Module

Chapter Objectives

This chapter gives you information on:

- choosing an external power supply
- wiring the input module's field wiring arm
- keying a chassis slot for your module
- setting internal configuration switches
- installing the input module

Before You Install the Input Module

The input module is shipped to you configured for block transfer operation. If you want to use single transfer, see Appendix C for proper switch settings.

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

1. Calculate the power requirements of all modules in each chassis. See "Power Requirements."
2. Determine where to place the module in the I/O chassis. See "Module Location in the I/O Chassis."
3. Key the backplane connector in the I/O chassis. See "Keying."
4. Make connections to the wiring arm. See "Wiring" and "Grounding."
5. Set configuration switches (only if you want single transfer, or to change to the alternate input range).

Electrostatic Damage

Electrostatic discharge can damage semiconductor devices inside this module if you touch backplane connector pins, or when you set configuration plugs or switches inside the module. Guard against electrostatic damage by observing the following precautions:

- Touch a grounded object to rid yourself of elctrostatic charge before handling the module.
- Handle the module from the front, away from the backplane connector. Do not touch backplane connector pins.
- When setting internal switches or configuration plugs, do not touch semiconductor devices inside the module. Use a static-safe work station if available.
- Keep the module in its static-shield bag when not in use.

CAUTION: Electrostatic discharge can degrade performance or cause permanent damage. Handle this module as stated above.

Power Requirements

Your module requires 400 mA from the I/O chassis backplane. Calculate the power usage of all modules in the I/O chassis so you do not exceed the power rating of the chassis backplane or the backplane power supply.

The input module also requires an external power supply exclusively for analog modules. Using a separate supply protects the analog signal from transients caused by the switching of digital circuits. The specifications for the external DC power supply are:

Specifications	5V	15V	-15V
current per input module	150mA	70mA	70mA
voltage tolerance	1%	1%	1%
regulation (type)	linear (series or shunt)	linear (series or shunt)	linear (series or shunt)
line regulation (for 10 VAC RMS input change)	.02%	.02%	.02%
load regulation	.04%	.02%	.02%
ripple	1 mV	1 mV	1 mV
overvoltage protection	7 V	18 V	-18 V
current limit (% of full load)	125%	125%	125%

We recommend either of two Allen-Bradley power supplies:

Power Supply (cat. no. 1770-P1) provides sufficient current for two 1771-IE input modules. This supply operates on either 120 or 220/240 VAC.

The Remote Power Supply (cat. no. 1778-P2) provides external power for up to ten 1771-IE input modules. Do not use this supply for I/O chassis power when powering analog modules. We recommend that you order one or two power cables (cat. no. 1771-CF), and connect no more than five 1771-IE input modules with a single power cable.

Power and common connections can be jumpered from one 1771-IE input module to the next. Be careful to minimize the voltage drop in your power connections.

WARNING: Maintain at least 5.0 VDC between the 5 VDC terminal and common terminal measured at the wiring arm. A lower voltage could cause intermittent operation resulting in possible damage to equipment and personal injury.

Module Location

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

- Do not put this input module in the same module group with a discrete high density I/O module when using 2-slot addressing because this input module uses both the input and output image tables for block transfer. Two analog input modules, however, may be put in the same module group.
- Group analog input modules away from AC or high voltage DC I/O modules to minimize electrical noise interference.

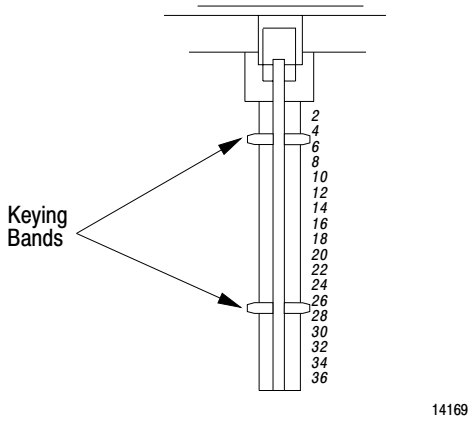
Keying

Once you designate a slot for your input module, you should not place other types of modules in this slot. We recommend that you use the keying bands, shipped with your I/O chassis, to accept only one type of module in a designated I/O slot.

To key a module slot to accept only the 1771-IE module, position the keying bands on the upper backplane connector at the following positions (Figure 3.1):

- between 4 and 6
- between 26 and 28

Figure 3.1
Keying Positions



Wiring

Connect analog devices and external power to your input module through the Field Wiring Arm (cat. no. 1771-WB). The wiring arm pivots on the front of the I/O chassis to connect with the module. Wiring connections are made at the wiring arm, so you can remove the module from the chassis without disconnecting the wiring.

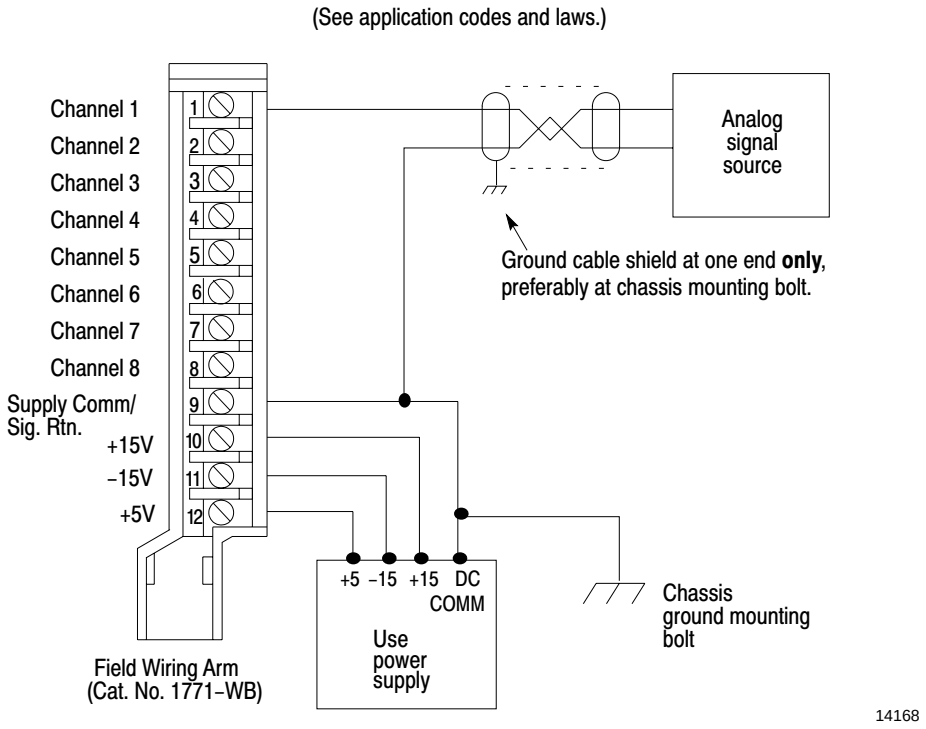
Connection diagram (Figure 3.2) shows connections of analog devices and power supply to the wiring arm of the input module.

The COMMON terminal on the wiring arm connects to the power supply COMMON and SIGNAL RETURN wires from each of your input devices (Figure 3.2). Do not confuse the SIGNAL RETURN wire with the cable shield. The SIGNAL RETURN is one of the insulated wires of the cable-twisted pair. The cable shield is discussed in the next section.

When wiring analog devices to the wiring arm, use Belden No. 8761 or an equivalent cable. We recommend that the cable from voltage mode input devices does not exceed 50 feet in length. We base this recommendation on considerations of noise immunity in typical industrial environments.

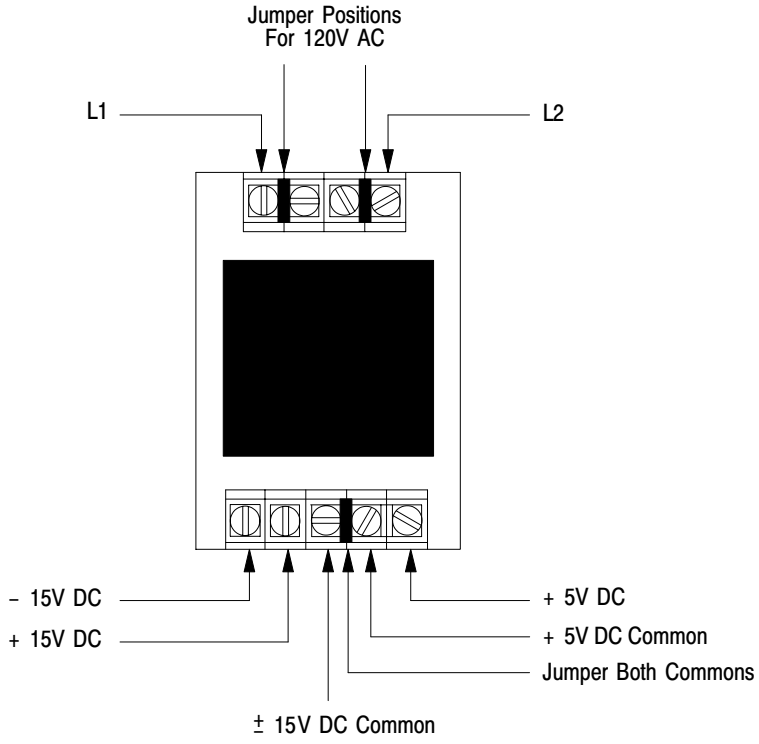
There is no restriction on cable length for current mode input devices. Cable length resistance, however, when added to module input resistance, must not be enough to cause an overload on the analog driving device.

Figure 3.2
Connection Diagram



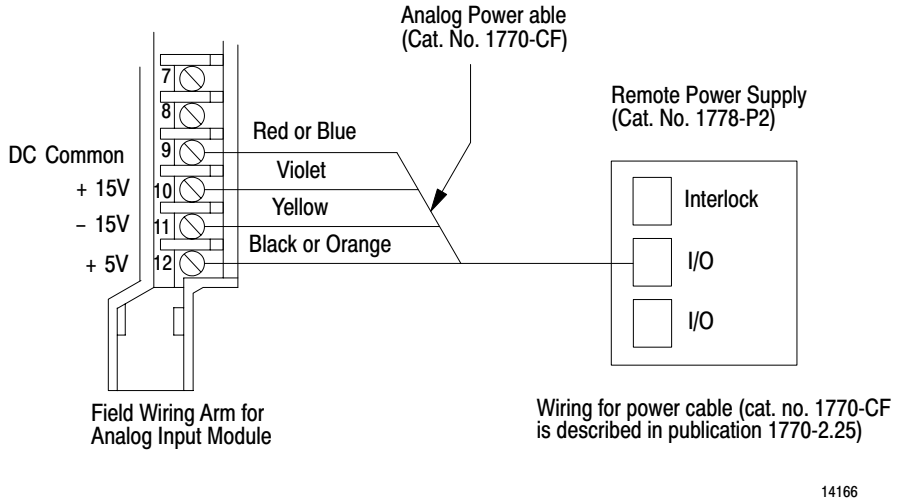
If you use a 1770-P1 power supply for your external power source, you must jumper the 5 VDC COMMON and the 15 VDC COMMON terminals together either at the power supply or at the module. Figure 3.3 shows the wiring connections for the Power Supply (1770-P1).

Figure 3.3
Power Supply Connections (cat. no. 1770-P1)



If you use the 1778-P2 remote power supply, connect it to the wiring arm using one or two power cables (Figure 3.4).

Figure 3.4
Power Supply Connections (cat. no. 1778-P2)



Grounding

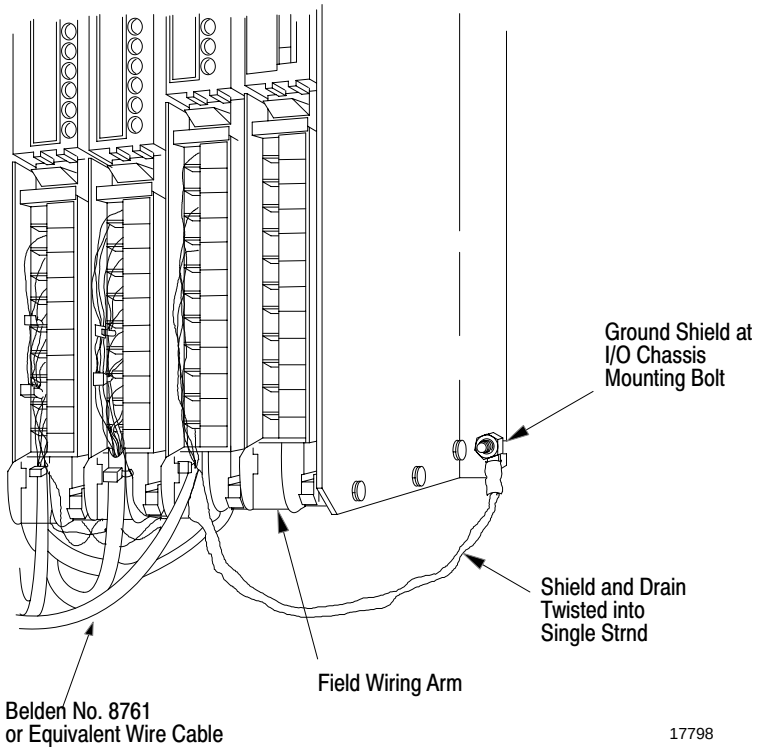
Ground the drain wire and shield of the Belden No. 8761 or equivalent cable (Figure 3.5) at one end of the cable only. Twist the drain wire and shield into a single strand. The best ground for this connection is an I/O chassis mounting bolt or stud.

Insulate the shield and drain wire at the other end of the cable using electrical tape.

You may mount a separate terminal near the input module for DC COMMON and SIGNAL RETURN wires. This terminal should be mounted as close to the module as possible to minimize the length of unshielded wire.

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

Figure 3.5
Grounding the Cable Shield



Refer to the connection diagram for eact twisted-pair terminal connections.

Setting Configuration Switches

The module is set for block transfer operation andcalibrated at the factory for the voltage or current range that you ordered.

CAUTION: Electrostatic discharge can degrade performance or cause permanent damage to the module. Follow the guidelines on electrostatic discharge located at the beginning of this chapter before handling the module.

Transfer Mode

You should change the mode of operation to single transfer if your processor is one of the following:

- PLC (now obsolete)
- Mini-PLC-2 (cat. no. 1772-LN1, -LN2)

Refer to Chapter 5, “Setting These Switches,” for setting the Transfer Mode switch to single transfer.

Signal Mode

Without recalibrating, you can change the 1 to 5 VDC or the 0 to 5 VDC input voltage range to its corresponding 4 to 20 mA or 0 to 20 mA current range. Refer to Calibration, chapter 5, for the location of the signal mode switch assembly (Figure 5.1). Set all switches to the same setting as follows:

If your module is calibrated for one of these two voltage ranges and you want to change to the corresponding current range: set all switches ON.

If your module is calibrated for one of these two current ranges and you want to change to the corresponding voltage range: set all switches OFF.

Changing to any other input range requires that you recalibrate your module to obtain accurate operation.

Installing the Input Module

Now that you have determined the power requirements, location, keying, wiring, and grounding for the input module, you are ready to install it in the chassis. Use the following procedure:

1. Turn off power to the I/O chassis.

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

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

---

2. Insert your module into the chassis. Plastic tracks on the top and bottom of the slots guide the module into position. Do not force the module into the backplane connector, but apply firm even pressure.

3. Snap the I/O chassis latch over the module. This secures the module in place.

4. Connect the wiring arm to the module.

5. Turn on power to the I/O chassis.

Chapter 4

Programming the Analog Input Module

Chapter Objectives

In this chapter we describe a general block transfer program, and present a programming example for each family of programmable controllers.

Block Transfer Programming

Program your processor to transfer data from the module to the processor's data table using a block transfer read (BTR) instruction. We give you programming examples. Because every application is different, we urge you not to copy examples but to use the appropriate example as a guide.

Block transfer programming using the BTR instruction is covered in this chapter for most PLC-2 family processors, all PLC-3 family processors, and the PLC-5/15 processor. Other programs for transferring data are found as follows:

Processor	Method	Appendix
Mini-PLC-2 (cat. no. 1772-LN3) PLC-2/20 (cat. no. 1772-LP1, LP2)	Block Transfer, Multiple GET	A
PLC (cat. no. 1774-LB2, LC2)	Single Transfer	B

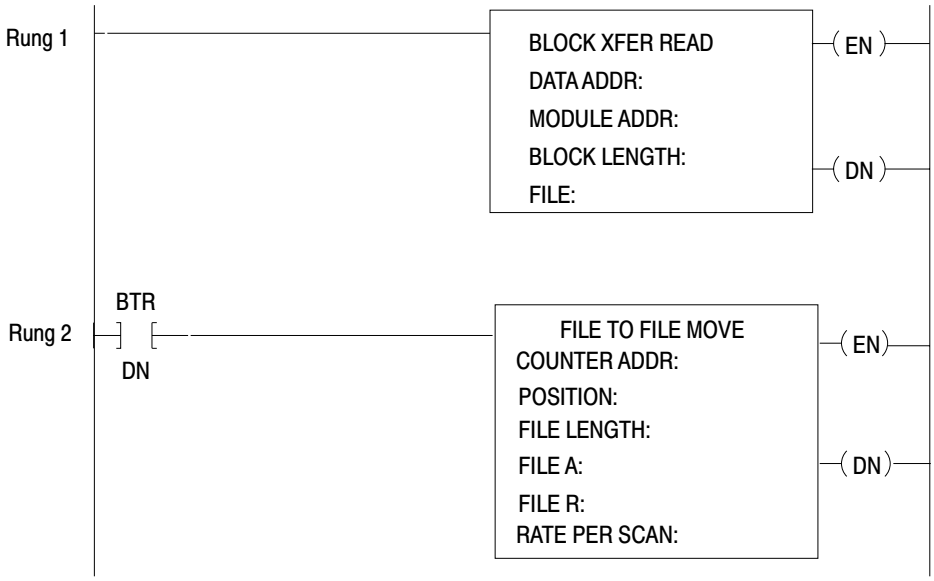
We assume that you know how to enter ladder diagram programming via your programming terminal, how to enter instruction parameters, and how to map your data table or data files for proper data storage. If not, refer to the manuals that came with your processor. If necessary, refer to Publications Index, SD499, which lists all publications of the Industrial Computer Group.

General Example

We describe programming rungs in one general example applicable to most PLC-2 family processors (Figure 4.1). Although instruction formats are different, the program is also applicable to all PLC-3 family processors, and the PLC-5/15 processor. We also present an example for each processor family with specific addresses to show relationships

between instructions. Do not copy these examples. They are for instructional purposes only.

Figure 4.1
Example Read-Only Block Transfer Program



Rung 1 This rung uses the BTR instruction to transfer data to the processor. It transfers data on alternate scans unless you condition it with instructions that enable it less often.

Rung 2 This rung moves transferred data to a storage location unless old data was not updated by a new transfer (BTR done bit not set).

Important: Each input word contains an overflow- underflow bit (bit 17) that your program should monitor to be sure the value is within range. The module sets this bit when it detects data at or beyond the limits of 0 and 255. We leave this programming logic to you because it is application dependent.

PLC-2 Family Example

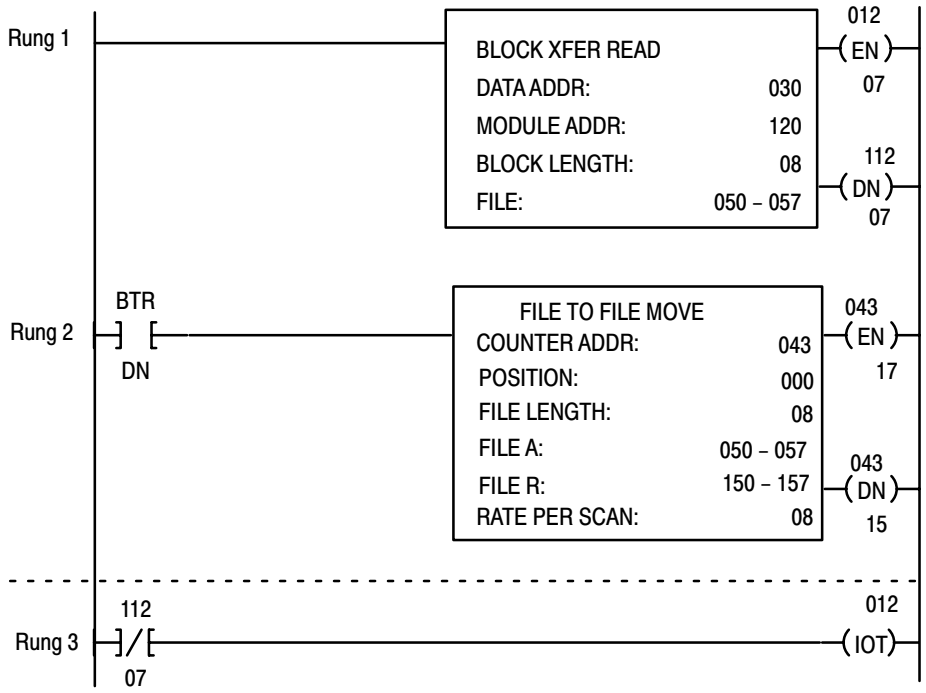
This example is written for the following conditions (Figure 4.2).

The module resides in rack 1, module group 2, slot 0 8-word block transfer

BTR data (control) address is 030
BTR file address is 050

FFM counter address is 043
FFM number of words moved is 8
FFM source file A is 050
FFM destination file R is 150
FFM rate per scan is 8

Figure 4.2
Example Program for PLC-2 Family Processors (Local Chassis)



Use only when 1771–IE is in a local chassis and block transfers to this module are inhibited.

Important: When your input module is in a local I/O chassis, random chance could allow block transfer requests to occur during module housekeeping and prevent block transfers. This condition is apparent when the done bit remains reset and no new data is transferred. If this condition should occur, we recommend that you add rung 3 to your program. It guards against the possibility of the processor repeatedly asking for a block transfer each time the module inhibits block transfers while updating its inputs.

This rung adds up to 0.13ms to the processor scan time so use it sparingly. Locate it at the beginning of your ladder program. This logic is not required for PLC-2 family remote systems or for any other processor family.

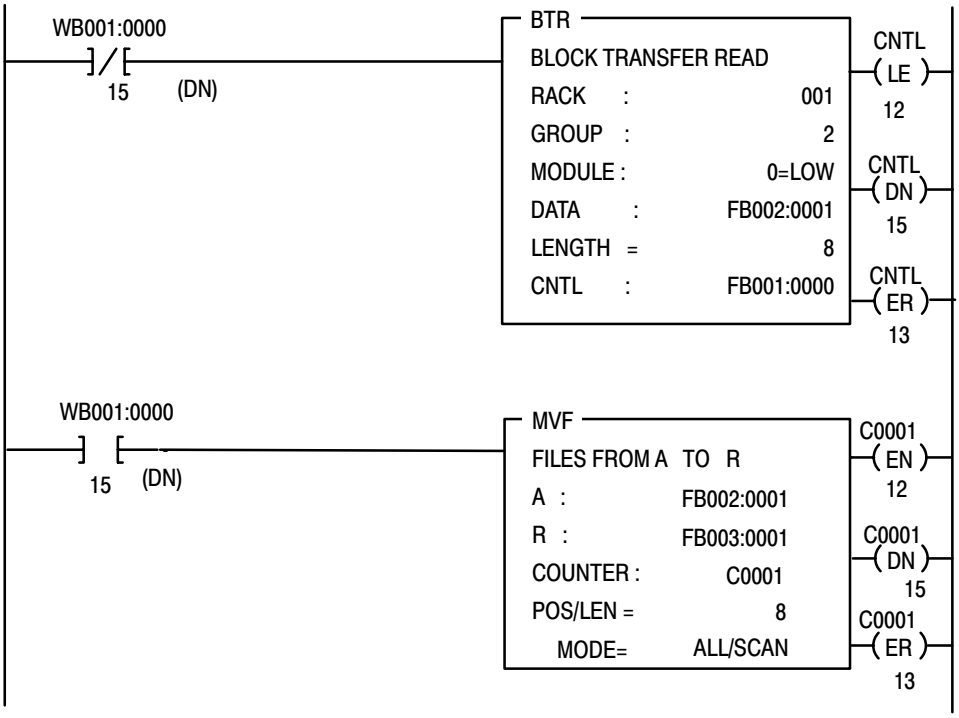
PLC-3 Family Example

This example is written for the following conditions (Figure 4.3).

The module resides in rack 1, module group 2, slot 0
8-word block transfer
BTR control address is FB001:0000
BTR file address is FB002:0001

MVF source file A is FB002:0001
MVF destination file R is FB003:001
MVF counter address is C000l
MVF number of words moved is 8
MVF rate per scan is all/scan

Figure 4.3
Example Program for PLC-3 Family Processors

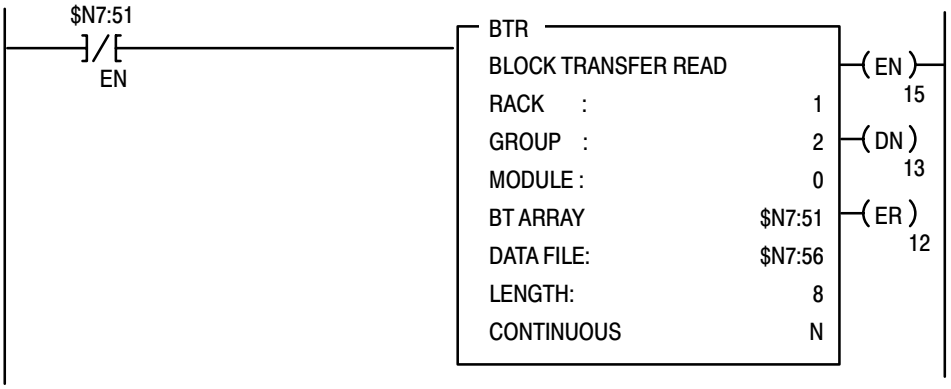


PLC-5/15 Example

This example is written for the following conditions (Figure 4.4).

The module resides in rack 1, module group 2, slot 0 8-word block transfer
BT Array (integer control address) is $N7:51
Data file (integer file address) is $N7:56

Figure 4.4
Example Program for the PLC-5/15 Processor



Important: The PLC-5/15 processor buffers read block transfer data automatically, so program buffering is not required.

Programming Considerations

We suggest that you follow programming considerations applicable to your programmable controller. They are listed below and described in the manual that accompanied your controller.

PLC-2 Family

- Determine the first available block transfer address in the timer and counter area of the data table. For PLC-2/20 and PLC-2/30 processors, it depends on the number of assigned remote I/O rack numbers.
- Leave unused addresses following your last block transfer address for future block transfer instructions.
- Load zeros into the address following the last (reserved) block transfer address to establish a boundary that prevents the processor from looking further for additional block transfer addresses.
- Buffer incoming (BTR) data. Be sure it is valid before using it. Examine the BTR done bit and any other status bit that monitors its validity.

PLC-3 Family

- If your application requires many block transfer modules, distribute the modules over as many I/O chassis as possible to optimize transfer time for the system as a whole.
- Where allowed by your application, program block transfers to occur less often than once per program scan.
- Buffer incoming (BTR) data. Be sure it is valid before using it. Examine the BTR done bit and any other status bit that monitors its validity.

PLC-5/15

- Incoming (BTR) data is buffered automatically by the processor.

Chapter 5

Calibrating the Analog Input Module

Chapter Objective

This chapter describes how you calibrate the module.

Service Information

Your input module is calibrated at the factory. We recommend that you recalibrate it every year to maintain accuracy. If for some reason you can not calibrate the module, return it to Allen-Bradley Company for recalibration. The mailing address is:

Allen-Bradley Company
Industrial Computer Group
747 Alpha Drive
Highland Heights, Ohio 44143

Calibration Equipment

We recommend the following equipment for calibrating the module:

Equipment:	Description/Source:
precision voltage source	±10V, 0.1mV resolution minimum Analog 3100, Data Precision 8200, or equivalent
digital voltmeter	5 1/2 digit, 0.01% accuracy minimum Keithley 191, Fluke 8300A, or equivalent
sealant	"Torque Seal" by Organic Products or equivalent
alignment tool	P/N 35F616, for potentiometer adjustment, Newark Electronics or equivalent
industrial terminal	cat. no. 1770-T3 with cable (cat. no. 1772-TC) for PLC-2 family processors cat. no. 1770-T4 with cable (cat. no. 1775-CAT) for PLC-3 family processors cat. no. 1784-T50 for PLC-5/15 processors

Before You Calibrate

Before you calibrate, follow these steps:

1. Turn OFF power to the I/O chassis backplane and to your wiring arm.

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

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

---

2. Disconnect all analog signal inputs from the module's wiring arm (leave 5V, ±15V DC, and COMMON connections attached). Label the inputs to aid you in reconnection.

3. Remove the module from the chassis by pivoting the wiring arm down and releasing the plastic lever at the top of the module. Pull the module straight out from the slot.

CAUTION: Electrostatic discharge can degrade performance or cause permanent damage. Refer to the guidelines at the beginning of chapter 3.

---

4. Remove screws from the four corners of each cover plate and remove the covers. This gives you access to internal switch assemblies.

Calibrating the Input Module

Connect your industrial terminal to your processor so you can display channel input values in BCD during calibration. Be sure your processor is programmed to block transfer data from the module. For safety purposes, disable all outputs or disable your ladder program except for transferring data from the module you are calibrating.

To calibrate the module, you

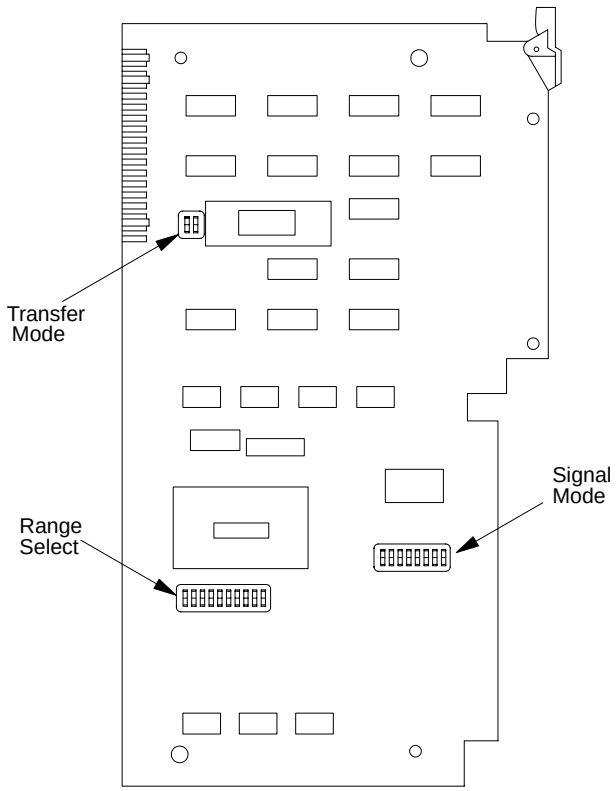
- set internal switches
- adjust the offset (Part A)
- adjust the offset (Part B)
- calibrate the gain

Setting the Switches

There are three sets of switch assemblies (Figure 5.1) in the module:

- Range Select
- Signal Mode
- Transfer Mode

Figure 5.1
Location of Switch Assemblies



Set these switches as follows:

1. Range Select switch assembly lets you select a current or voltage input range by setting switches 1-10. These switch settings remain the same during and after calibration.

Change these switch settings only if you want to change to another voltage or current input range group.

Range:	Switch Number									
	1	2	3	4	5	6	7	8	9	10
1 to 5V 4 to 20 mA	OFF OFF	OFF OFF	ON ON	ON ON	OFF OFF	ON ON	OFF OFF	ON ON	OFF OFF	OFF OFF
0 to 5V 0 to 20 mA	ON ON	ON ON	OFF OFF	OFF OFF	ON ON	ON ON	OFF OFF	ON ON	OFF OFF	ON ON
0 to 10V	ON	ON	OFF	OFF	ON	ON	OFF	ON	OFF	OFF
±10V	ON	ON	OFF	OFF	ON	OFF	ON	OFF	ON	OFF
±20mA	ON	ON	OFF	OFF	ON	OFF	ON	ON	OFF	OFF

2. Signal Mode switch assembly lets you select current mode (all switches are ON) or voltage mode (all switches are OFF).

CAUTION: Be sure external power (15, 5 VDC) is OFF before changing the signal mode switch.

Set all eight switches to OFF (voltage mode) during calibration.

3. Transfer Mode switch assembly lets you select single transfer (switch 1 ON) or block transfer (switch 1 OFF).

Change the setting of switch 2 to ON only for the Offset (Part A) procedure.

Offset (Part A)

This procedure applies only if your input range is (1 to 5 VDC) or (4 to 20 mA).

Important: If the input range of your module is other than a range of (1 to 5 VDC) or (4 to 20 mA), skip this procedure and go directly to Offset (Part B).

Make this adjustment for channel 1, only.

1. Set switch number 2 ON of the transfer mode switch assembly.

2. Place the module back in its I/O slot, and connect the wiring arm.

3. Change the processor mode select switch to test or program mode. Turn on power to the processor, I/O chassis, and external power supply to the module.

4. Connect the precision voltage source:

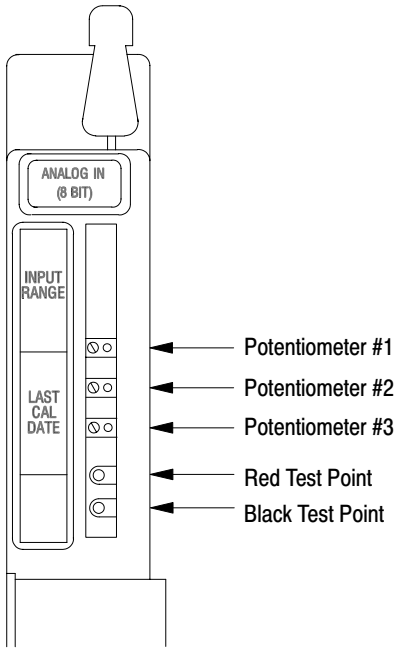
- positive lead to input channel 1
- negative lead to DC COMMON of the wiring arm

5. Turn on the precision voltage source and set it to 1.0000 Vdc.

6. Connect the DVM leads to the test points on the front of the module, positive lead to the red test point, negative lead to the black test point.

7. Read the voltage at the test points. It must be 0.0000 0.2 mV. If not, adjust potentiometer #1 on the front of the module (Figure 5.2).

Figure 5.2
Location of Potentiometers and Test Points



8. Seal the setting with a drop of sealant.

9. Turn off power to the external power supply, I/O chassis, and processor.

10. Remove the module from the I/O chassis.

11. Reset switch number 2 OFF of the transfer mode switch assembly.

12. After replacing the covers, place the module back in its slot in the I/O chassis.

Offset (Part B)

Start your calibration procedure here if your input range is NOT (1 to 5 VDC) or (4 to 20 mA).

You make one adjustment for all channels at the same time for offset, then one adjustment for gain calibration.

1. Jumper all 8 input terminals together at the wiring arm.

2. Connect the precision voltage source to the jumpered input terminals and to ground.

3. Set the precision voltage source to the input value required for minimum output for your particular input range. Remember that you set the module to operate in voltage mode for calibration.

Range	Input for Minimum Output
1 to 5 V	1.0078 V
0 to 5 V	0.0098 V
-10 to 10 V	-9.9609 V
0 to 10 V	0.0195 V

4. Observe the BCD value. It should toggle between 000 and 001 for equal lengths of time. If not, adjust potentiometer #2.

Do not seal the potentiometer until you have finished adjusting the gain.

Gain

5. Set the precision voltage source to the input value required for maximum output for your particular input range. Remember that you set the module to

Range	Input for Maximum Output
1 to 5 V	4.9766 V
0 to 5 V	4.9707 V
-10 to 10 V	9.8828 V
0 to 10 V	9.9414 V

6. Observe the BCD value. It should toggle between 254 and 255 for equal lengths of time. If not, adjust potentiometer #3.

7. Recheck offset and gain to be sure that they are properly set. Adjust if necessary.

8. Seal the potentiometers.

9. If your input range was a current range, reset the signal mode switch assembly to current mode (all switches on).

10. Re-install and test the module with known values before operating with I/O devices.

Appendix **A**

Block Transfer (Multiple GET) for PLC-2/20

Example Program

This read-only program (Figure A.1) transfers a block of input data from the analog input module to a momentary storage (buffer) in the processor's data table. If valid, input data is moved elsewhere in the data table for use by your ladder program. If invalid, it is written over by the next block transfer. This program performs the same function as the 2-rung program described in chapter 4.

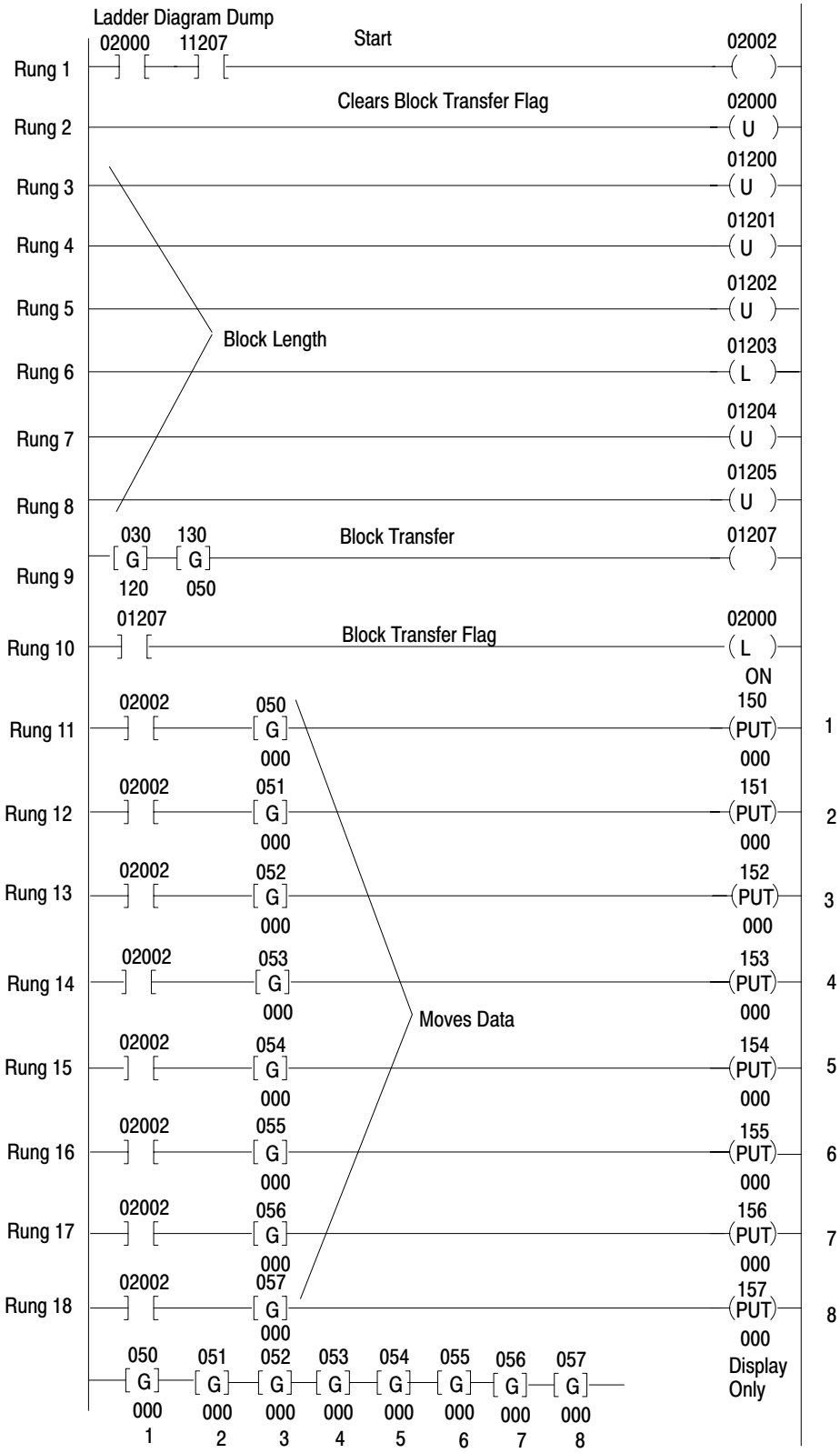
Important: If you place your input module in a local chassis, we recommend that you add the same rung as described in the PLC-2 family example (Figure 4.2, Rung 3). This rung guards against the possibility of the processor repeatedly asking for a block transfer when the module momentarily inhibits block transfers while updating its inputs.

Assumptions

The example program is based on the following assumptions:

- module in rack 1, module group 2, slot 0
- 8-word block transfer
- block transfer (control) address 030
- read block transfer (buffer) file 050-057
- storage file 150-157

Figure A.1
Example Program for PLC-2/20



Description

Scan 1

Rung 9

This rung controls block transfer. Preconditions are optional. The first available word 030 in the timer/counter accumulated area stores module location 120. Word 130 in the timer/counter preset area stores the address of the first word in the BTR (buffer) file.

Output bit 01207 initiates block transfer. The first digit of this output address is zero, because it is in the output image table. The next three digits are the module's location: rack, module group, and slot numbers. The last digit, 7, is the BTR enable bit (bit 17 if the module was in slot 1).

Rung 10

Bit 01207 is examined to determine if a block transfer was initiated. If initiated, Bit 02000 is latched until the next program scan.

Scan 2

Rung 1

This rung detects the request (02000) and completion (11207) of a block transfer to this module. Upon completion, it lets transferred data move to storage location words 150-157 in rungs 11-17.

Rung 2

This rung resets the block transfer operation. Bit 02000 is unlatched. It will be latched again if a block transfer request is made this program scan.

Rungs 3 - 7

These rungs determine the block length by setting a binary code equal to the number of words transferred.

Rungs 11 - 18

These rungs move data from the BTR read file to storage. When the block transfer one-shot (02002) is set, data in each (buffer) word address 050-057 is moved to storage location 150-157 where it can be used by your ladder program. If data is not moved, it is written over by the next block transfer.

Important: Each input word contains an overflow- underflow bit (bit 17) that your program should monitor to be sure the value stored in that word is within range. The module sets this bit when it detects data at or beyond the limits of 0 and 255. We leave this programming logic to you because it is application dependent.

Last Rung

These GET instructions display the BCD value of each transferred word, and are for display only.

Appendix B

Single Channel Transfer for PLC Processors

Example Program

Programming techniques used in this example program (Figure B.1) for the PLC processor include:

- I/O scan counter
- conditional ignore zone

I/O Scan Counter

The I/O scan counter (rungs 1-3) controls the transfer sequence and gives the module sufficient time to respond to channel byte and update select commands.

The scan counter increments only when a program scan and I/O scan have occurred. It does this by manipulating a specially chosen bit. The bit must be in the input image table, and must have an input module associated with it. The terminal corresponding to this bit must NOT have an input device wired to it so it can be turned OFF each I/O scan. Choose a bit which satisfies these conditions:

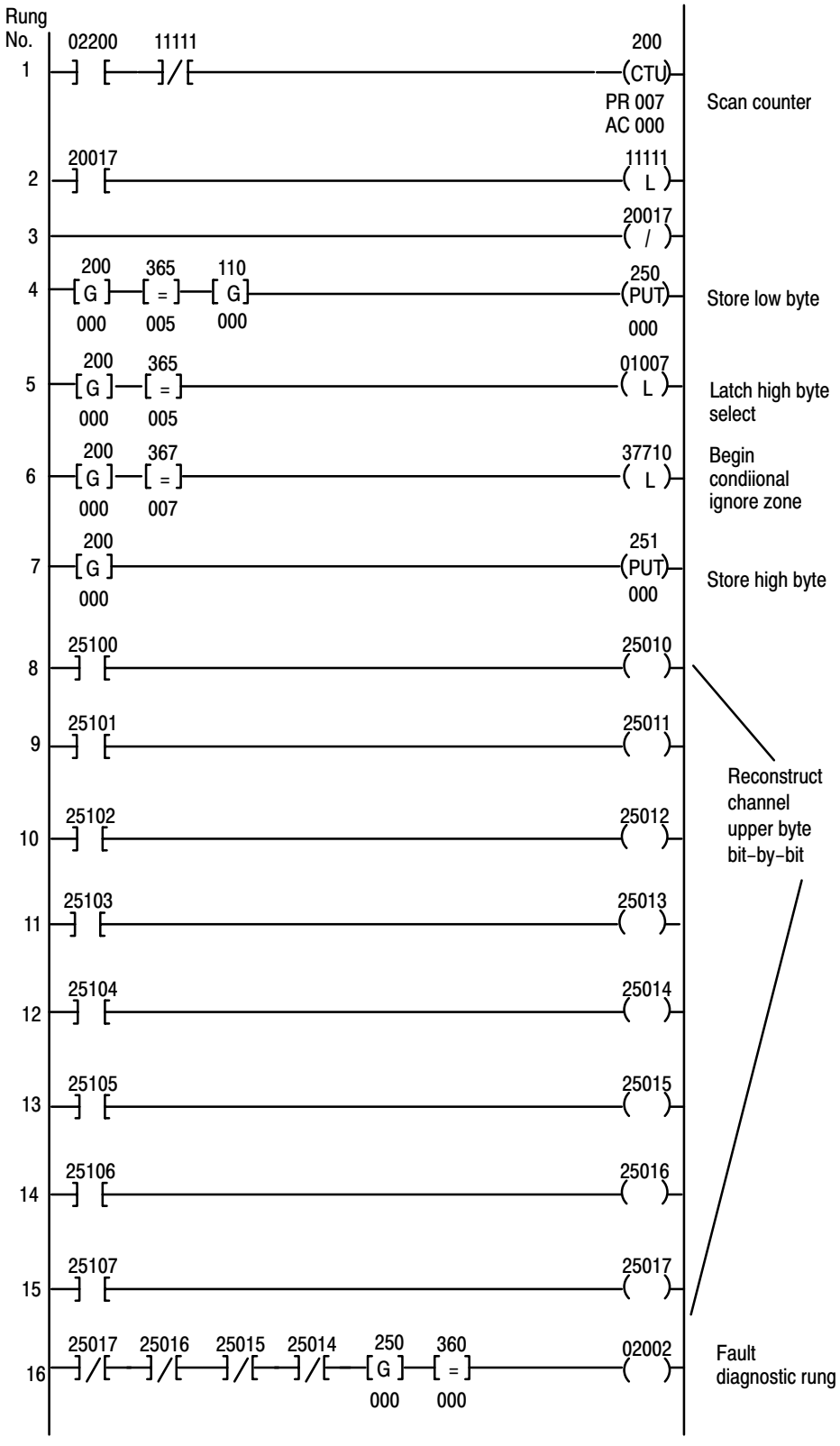
- It has an input address with the same assigned rack number as the input module.
- The input terminal associated with that bit address should be in a module group with a higher module group number than the one the input module is in.
- The input terminal associated with that bit address must be unused. Wire it to DC COMMON or L2 (AC Low) to guard against wiring it to an input device.

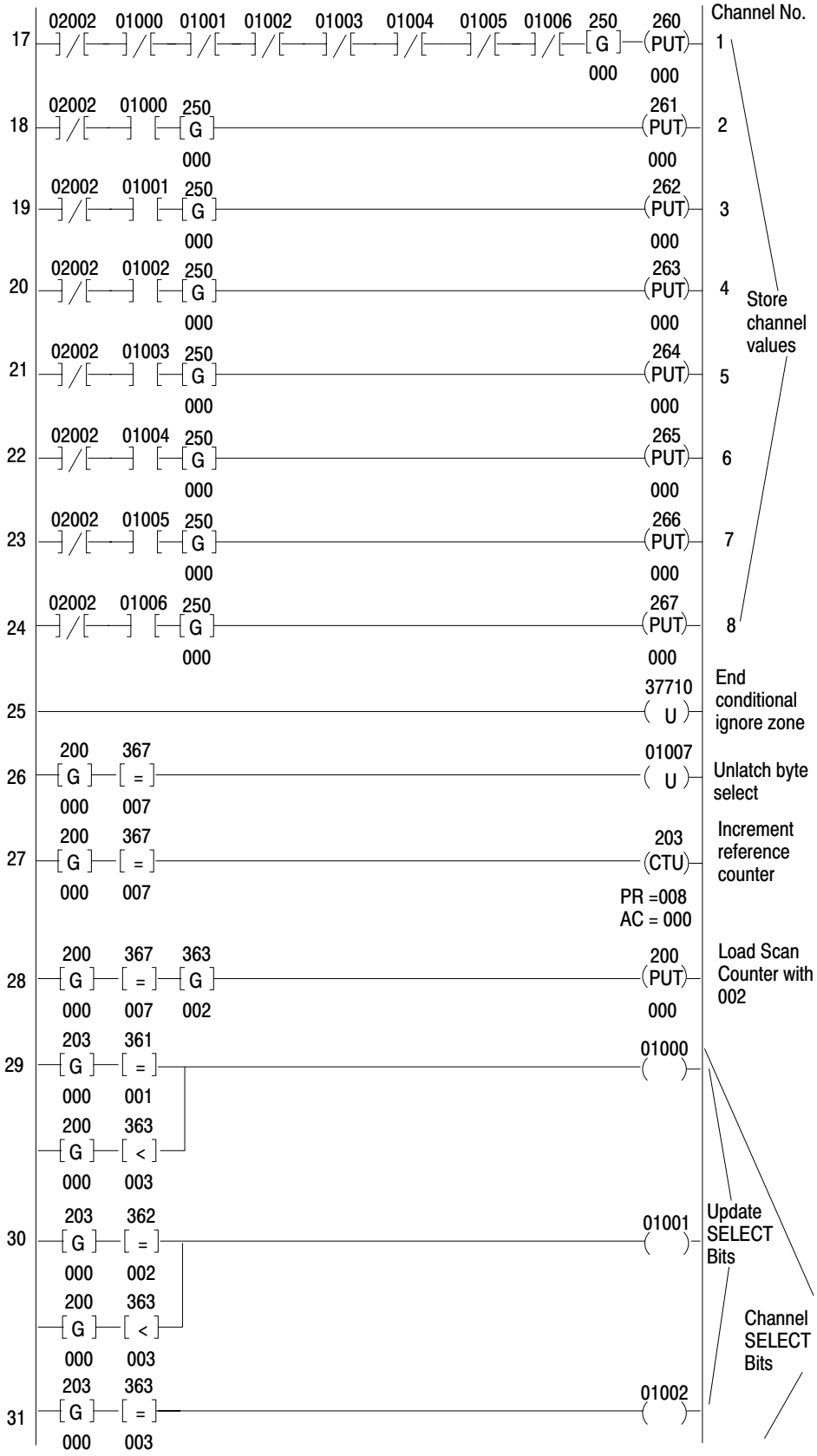
Conditional Ignore Zone

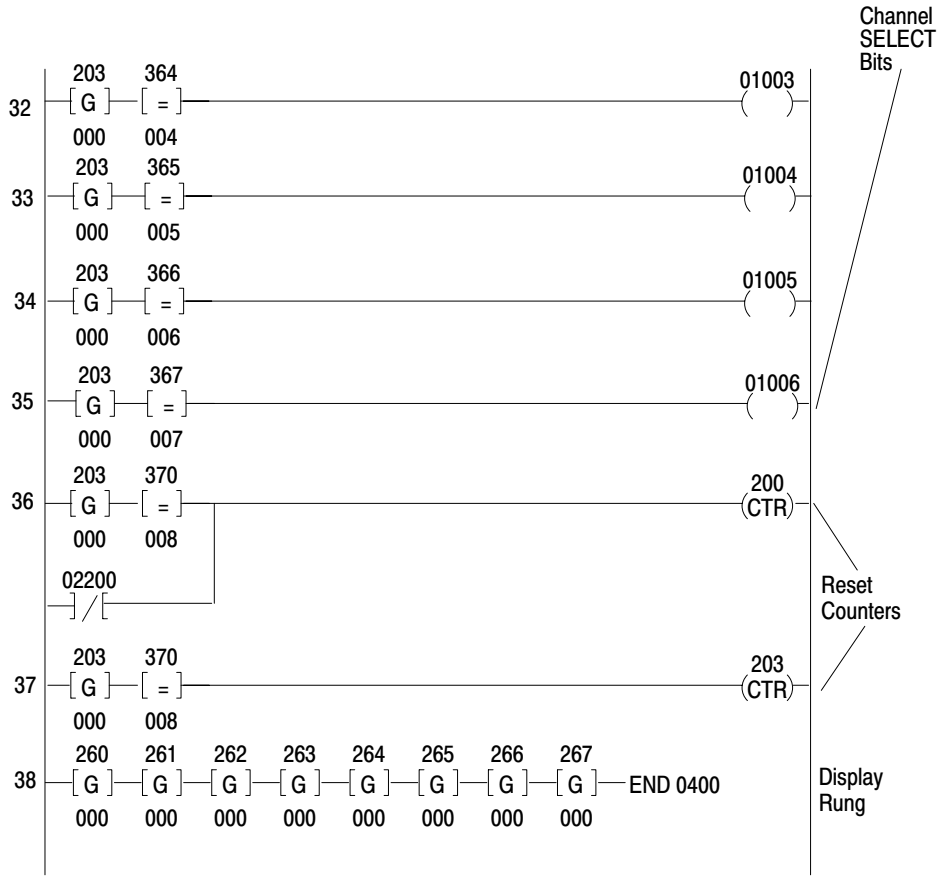
The conditional ignore zone controls multiple output instructions based on a set of overriding conditions. When these conditions are true, the outputs within the zone are controlled by the conditions in their individual rungs. When false, the zone outputs are held in their last state, whether ON or OFF.

The rungs within the conditional ignore zone (rungs 6-25) reconstruct and store the 16-bit input word from each channel. The override condition of the zone must be true (I/O scan counter accumulated value = 007) for the state of any output within the zone to be changed.

Figure B.1
Example Program for the PLC Processor



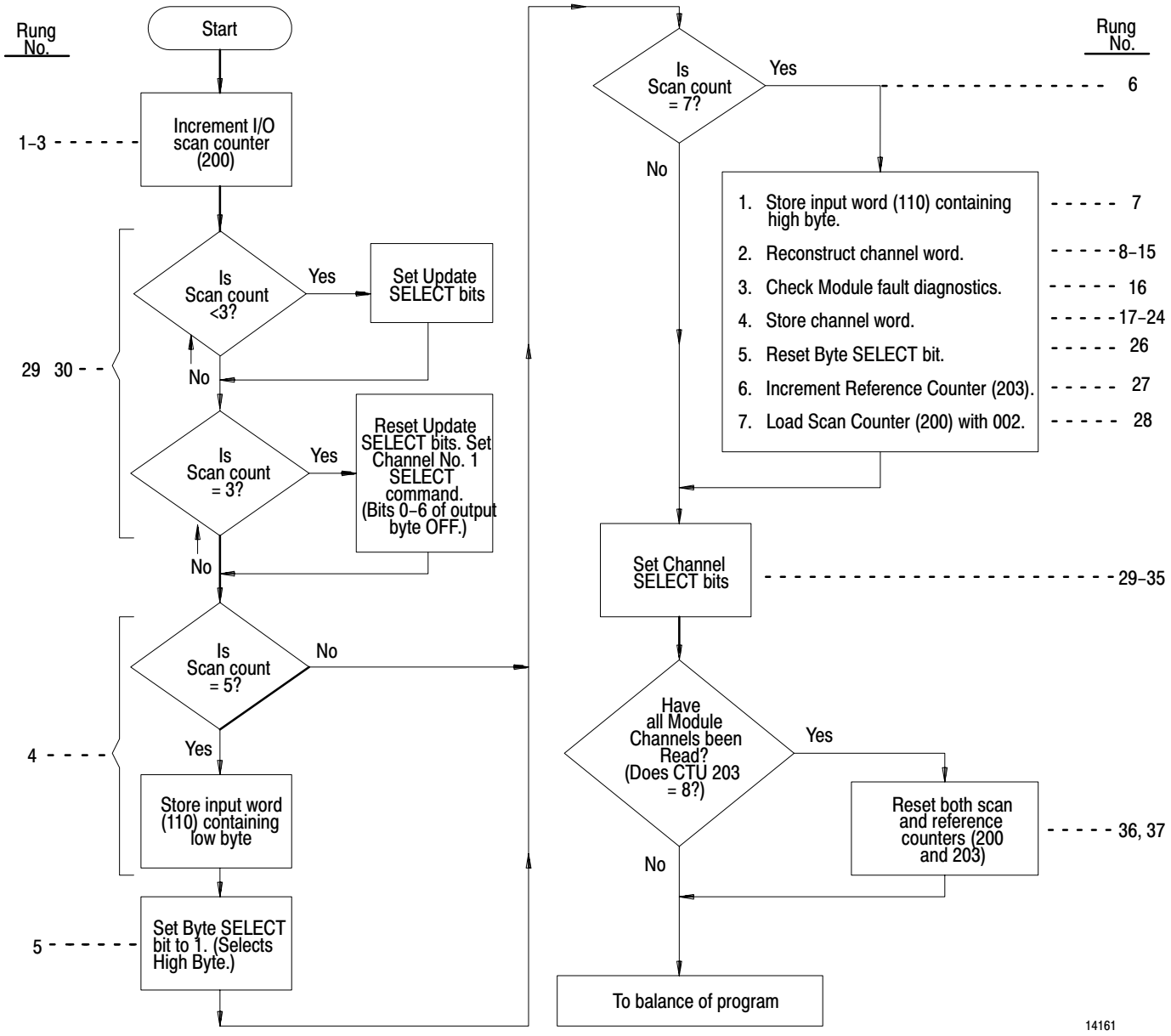

Channel No.
17 02002 01000 01001 01002 01003 01004 01005 01006 250 G 000 260 PUT 000 1
18 02002 01000 250 G 000 261 PUT 000 2
19 02002 01001 250 G 000 262 PUT 000 3
20 02002 01002 250 G 000 263 PUT 000 4
21 02002 01003 250 G 000 264 PUT 000 5
22 02002 01004 250 G 000 265 PUT 000 6
23 02002 01005 250 G 000 266 PUT 000 7
24 02002 01006 250 G 000 267 PUT 000 8
Store channel values
25 37710 U
End conditional ignore zone
26 200 G 000 367 = 007 01007 U
Unlatch byte select
27 200 G 000 367 = 007 203 CTU PR =008 AC = 000
Increment reference counter
28 200 G 000 367 = 007 363 G 002 200 PUT 000
Load Scan Counter with 002
29 203 G 000 361 = 001 200 G 000 363 < 003 01000
30 203 G 000 362 = 002 200 G 000 363 < 003 01001
Update SELECT Bits
31 203 G 000 363 = 003 01002
Channel SELECT Bits


Channel SELECT Bits
32
203 G 000
364 = 004
01003
33
203 G 000
365 = 005
01004
34
203 G 000
366 = 006
01005
35
203 G 000
367 = 007
01006
36
203 G 000
370 = 008
200 CTR
02200
Reset Counters
37
203 G 000
370 = 008
203 CTR
38
260 G 000
261 G 000
262 G 000
263 G 000
264 G 000
265 G 000
266 G 000
267 G 000
END 0400
Display Rung

Program Logic

In single channel transfer, the processor transfers data one byte at a time. Your program must reconstruct the data into 16-bit words in the correct sequence. We developed a flow chart (Figure B.2) that describes single transfer programming to help you understand the logic.

Figure B.2
Flow Chart for PLC Example Program



Assumptions

The example program is based on the following assumptions:

- The input module is in slot 0 of module group 0 in rack 1.
- All eight channels are used. If fewer channels are used, rungs may be eliminated.
- The following data table addresses are used to store values:

  - words 250-251 serve as momentary storage

  - words 260-267 store input channel values

  - words 360-370 store constants 000-008

Using Less Than Eight Input Channels

Often fewer than eight input channels are connected to the module. If using fewer than eight inputs, omit channels in reverse order. Omit channel 8 first, channel 7 second, etc, when connecting analog devices and when programming.

You can shorten the program to conserve memory and decrease program scan time. To reduce program size, study the sequence of events used to update module data and to read the data from each channel. Reduce the program as follows:

- Omit channel select bit instructions starting with 10116, 01005, etc. (rung 17).
- Omit rungs that store channel values starting with rung 24, rung 23, etc.
- Reduce the byte select comparison value in word 367 (rung 26).
- Reduce the preset of the increment reference counter (rung 27).
- Program channel select bits only for those channels you are using. Omit rung 35 for channel 8, rung 34 for channel 7, etc.
- Reset counters to the number of channels used by reducing the comparison value stored in word 370 (rungs 36 and 37) accordingly.
- Reduce the number of GET instructions in the display rung (rung 38).

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